

BMW i3 Cost Analysis

Zone 5: System Electronics



Legal Disclaimer: All company names, product names, and service names mentioned are used for identification purposes only and may be registered trademarks, trademarks, or service marks of their respective owners. All analyses are done without participation, authorization, or endorsement of the manufacturer. Any cost analyses presented in this material are estimates prepared by Munro & Associates, Inc. from generally available data. Munro & Associates, Inc. believe these estimates reflect the probable costs. The actual producer did not supply the data, and therefore the actual costs may differ from these estimates. Furthermore, Munro & Associates, Inc. extends no warranties with respect to any information in this document, and shall bear no liability whatsoever for the use of the information. Copyright © 2015 Munro & Associates, Inc. All rights reserved. Do not reproduce, distribute, disseminate, photocopy, fax, transmit, download to a shared database, or otherwise copy, transfer, sell, publish, or send this material, or any portion thereof, by any means without the express written permission of Munro & Associates Inc. under penalty of law.

Technical Disclaimer: The goal of this analysis is to establish a should cost value for manufacturing the vehicle and its sub-systems. These cost totals do not include tooling, Engineering Research and Development (ER&D), testing and calibration, logistics, or profit. Manufacturing process assumptions, such as manual assembly vs. automation or mold cavity numbers, were selected based on an annual volume of 20,000.

<u>Subject</u>	<u>Page</u>
<u>Disclaimers</u>	<u>2</u>
<u>Description of Report Content</u>	<u>20</u>
<u>Data Overview</u>	<u>21</u>
<u>Interpreting Data</u>	<u>29</u>
<u>Cost Analysis</u>	<u>35</u>
<u>Zone 5: Electronics Overview</u>	<u>36</u>
<u>Zone 5: Electronics</u>	<u>37</u>
<u>System Electronics Overview</u>	<u>38</u>
<u>System Electronics</u>	<u>39</u>

Note: Munro logo in upper right of each page is a link to the front page of the report.

<u>Subject</u>	<u>Page</u>
<u>Infotainment Unit and Bracket Asm</u>	<u>40</u>
<u>Infotainment Unit Installation</u>	<u>69</u>
<u>IP Screw Cover</u>	<u>71</u>
<u>Central Information Display Installation</u>	<u>73</u>
<u>Passenger A-Pillar Foam Asm</u>	<u>75</u>
<u>Passenger A-Pillar Foam Installation</u>	<u>82</u>
<u>Passenger A-Pillar Speaker Mount Asm</u>	<u>84</u>
<u>Passenger A-Pillar Speaker Mount Installation</u>	<u>91</u>
<u>Passenger A-Pillar Speaker Asm</u>	<u>93</u>

Note: Munro logo in upper right of each page is a link to the front page of the report.

<u>Subject</u>	<u>Page</u>
<u>Passenger A-Pillar Speaker Installation</u>	100
<u>Driver A-Pillar Foam Asm</u>	102
<u>Driver A-Pillar Foam Installation</u>	109
<u>Driver A-Pillar Speaker Mount Asm</u>	111
<u>Driver A-Pillar Speaker Mount Installation</u>	118
<u>Driver A-Pillar Speaker Asm</u>	120
<u>Driver A-Pillar Speaker Installation</u>	127
<u>Back-up Antenna Installation</u>	129
<u>Horn and EDME Mounting Bracket Asm</u>	131

Note: Munro logo in upper right of each page is a link to the front page of the report.

<u>Subject</u>	<u>Page</u>
<u>EDME and Horn Installation</u>	<u>136</u>
<u>KAFAS and Controller Mounting Bracket Asm</u>	<u>138</u>
<u>KAFAS and Controller Installation</u>	<u>140</u>
<u>Remote Control Receiver and Bracket Installation</u>	<u>142</u>
<u>Side Wave Traps and Filter Installation</u>	<u>144</u>
<u>Telematic Communication Box and Bracket Asm</u>	<u>146</u>
<u>Bracket Installation</u>	<u>186</u>
<u>Touch Box Control Unit Installation</u>	<u>188</u>
<u>Proximity Sensor Installation</u>	<u>190</u>

Note: Munro logo in upper right of each page is a link to the front page of the report.

<u>Subject</u>	<u>Page</u>
<u>Parking Maneuvering Assistant Installation</u>	<u>192</u>
<u>Antenna Amplifier Asm</u>	<u>194</u>
<u>Assemble Antenna Amplifier</u>	<u>207</u>
<u>Body Wire Harnesses Overview</u>	<u>209</u>
<u>Body Wire Harnesses</u>	<u>210</u>
<u>Body Domain Controller and Bracket Asm</u>	<u>211</u>
<u>Fuse Box Installation</u>	<u>256</u>
<u>PDC Mounting Tray Asm</u>	<u>258</u>
<u>PDC Mounting Tray Installation</u>	<u>265</u>

Note: Munro logo in upper right of each page is a link to the front page of the report.

<u>Subject</u>	<u>Page</u>
<u>Fuse Box Bracket Asm</u>	<u>267</u>
<u>Fuse Box Bracket Installation</u>	<u>274</u>
<u>Power Distribution Center Asm</u>	<u>276</u>
<u>Cover, Power Distribution Center</u>	<u>292</u>
<u>Main Wire Harness Installation</u>	<u>294</u>
<u>Driver Underbody Wire Harness Installation</u>	<u>296</u>
<u>12V Battery and Bracket Asm</u>	<u>298</u>
<u>12V Battery and Bracket Installation</u>	<u>322</u>
<u>Positive Battery Cable Wire Harness Installation</u>	<u>324</u>

Note: Munro logo in upper right of each page is a link to the front page of the report.

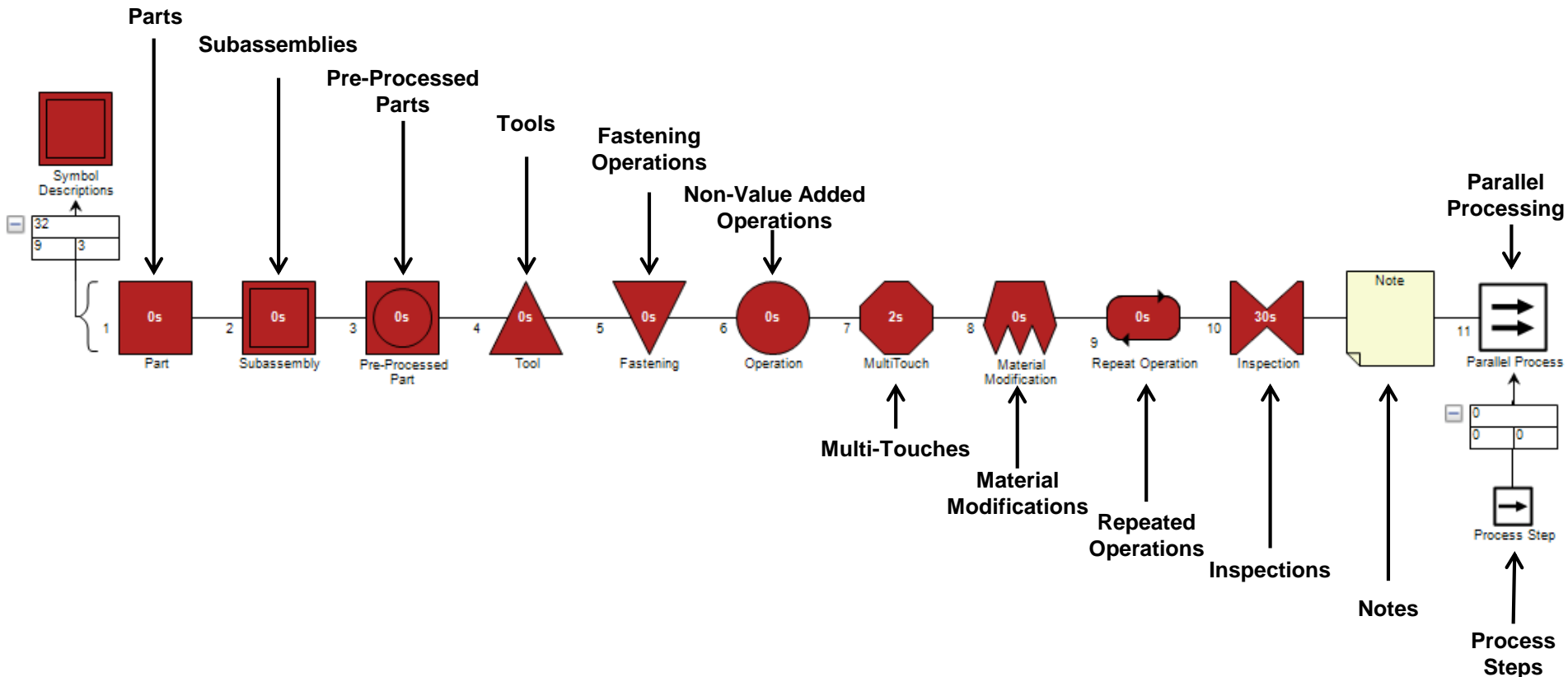
<u>Subject</u>	<u>Page</u>
<u>Negative Battery Cable Installation</u>	<u>326</u>
<u>Ground, Chassis to Power Module Installation</u>	<u>328</u>
<u>Ground, Motor Asm to Power Module Installation</u>	<u>330</u>
<u>Ground, Power Module to Chassis Installation</u>	<u>332</u>
<u>Ground, Rear X Brace To Heat Shield Installation</u>	<u>334</u>
<u>Ground, Chassis to Exhaust Heat Shield Installatio</u>	<u>336</u>
<u>Ground, Chassis to Engine Installation</u>	<u>338</u>
<u>Ground, AC Compressor To Motor Installation</u>	<u>340</u>
<u>Ground, Chassis to Motor Installation</u>	<u>342</u>

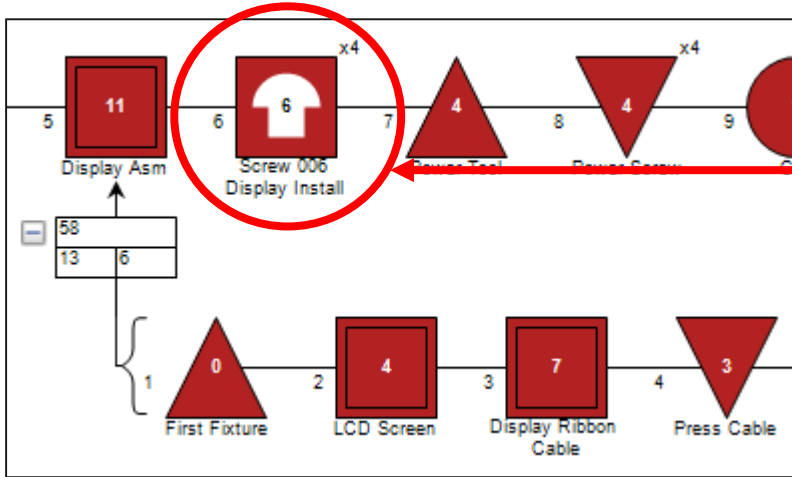
Note: Munro logo in upper right of each page is a link to the front page of the report.

<u>Subject</u>	<u>Page</u>
<u>Steering Column Ground Strap Installation</u>	<u>344</u>
<u>Appendix Reports</u>	<u>346</u>
<u>TechInsights Electronics Reports</u>	<u>347</u>
<u>Munro & Associates Wire Harness Reports</u>	<u>872</u>
<u>Technical References</u>	<u>1290</u>

Note: Munro logo in upper right of each page is a link to the front page of the report.

- The Design Profit® Software is used to provide a detailed cost map analyzing every subassembly, part, operation, & tool in the manufacturing process.
- The various symbols shown below are used in a hierarchical diagram to quantify & compare design and manufacturing efficiencies & costs.





Part Properties

This Symbol is Contained in: **Default Assembly**

Number: *Library* Screw 006 Display Install Quantity: 4 Repeat

Name: *Symbol* Screw 006 Display Install Repeat Rate: 100%

Description: *Library* Screw 006 Display Install Amount: 1 Unit of Measure: Each Fluid

Actual Time: 6.0000 sec Dwell: 0.0000 sec Engineered Service

Eye Catching

Material: (None) Weight: 0.0000 lb Supplier: [Dropdown]

Investment Cost: \$0.00 Piece Cost: \$0.06

Does It Have To Move? Fastener

Does It Have To Be A Different Material? Key/Critical Component

Scoring Fastener Quality Multimedia Categories Notes Instructions Attachments Custom Fields

Munro Score: 6 Part / Operator Part / Part

Eng Hours Score: 5 Unstable Part Fight Gravity

No Gets Score: 3 Pull Apart Complex Motions

Handle Carefully Vision Restricted

Small Part Access Limited

Filthy Part Operator Dependent

Wear Gloves Hold Down

Unwrap Parts Ergo Danger

Hazardous Material Poka Yoke Issue

Pick Up Part

One Hand

Two Hands

Crane

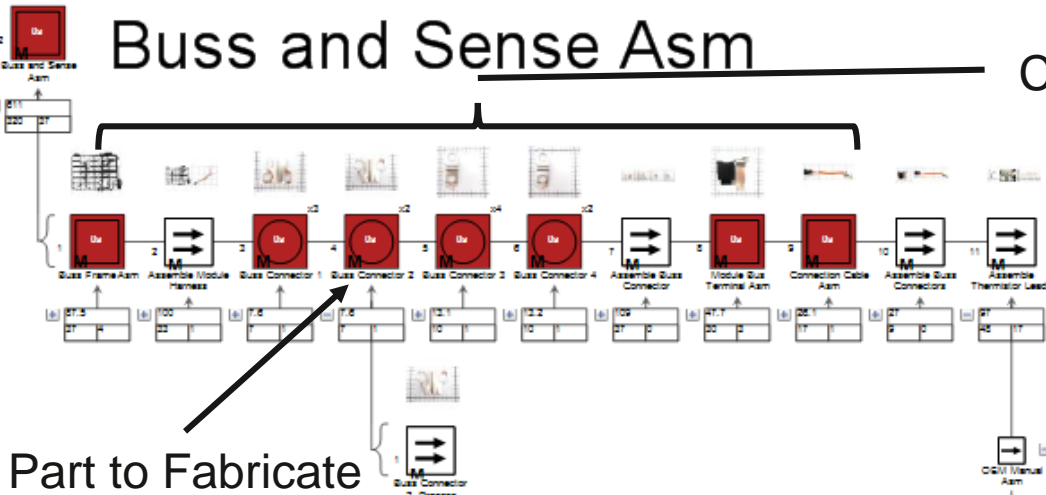
No Handling

Label... Library Item... [Navigation] OK Cancel

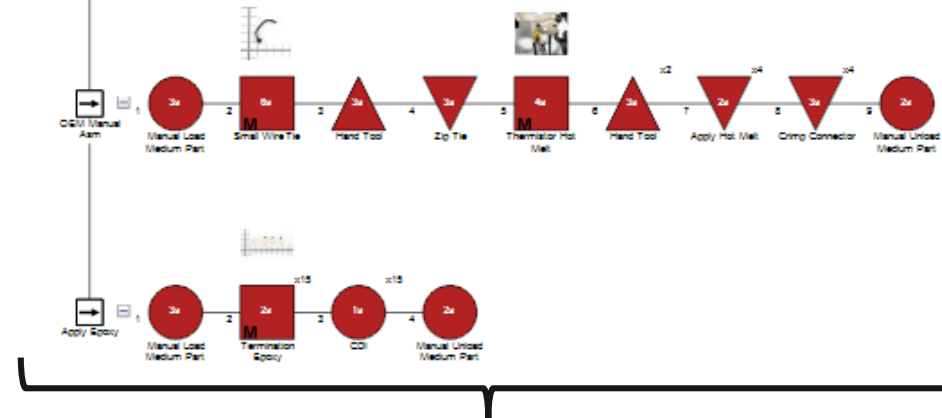
Each symbol is created by filling out a properties window. Penalty conditions and other information related to the symbol are assigned, in order to calculate the effect of handling difficulties on assembly time.

Buss and Sense Asm

Components to be Assembled



Part to Fabricate



Assembly Operations

Fabrication Operations



Above is a Design Profit cost map. The top horizontal line of symbols indicates the assemblies, parts, and assembly processes used to create the above parent assembly. Each of the symbols below a parent are analyzed in detail. Total costs are then rolled-up to the parent symbol. The vertical string of symbols on the left shows the details of each step and work cell in the fabrication process. The vertical string of symbols on the right shows the details of each step and work cell in the assembly process.

The following assumptions were made for the cost analysis:

- All processing was documented in the Design Profit software.
- All raw material prices are based on quotes and published information.
- All manufacturing processes include the man and machine to establish an hourly cost for the manufacturing work cell for each process and country utilized in creating the vehicle. These work cell rates are used along with calculation of cycle time to generate the process costs of components. Machine rates are developed through an internal model, accounting for all aspects of the primary and secondary equipment for the process. Operator rates are based on the specific country, and related industry labor rates. Adjustments are made for the number of operators in the workcell.
- Common/basic components were costed as commodity items. These included: bearings, seals, fasteners, and electronic components.
- Bearings/Seals/Fasteners are compared to numerous costed bills of materials to establish a purchased price.
- Electronic component costs are based on the costed bill of materials on hand, quote requests, and published information. Component pricing is run through trend lines to establish a cost for the appropriate targeted volumes.
- Machining cycle times are calculated using operations based on speeds and feeds from the standard machinist handbook.

Sales, General, and Administration:

- The SG&A mark-up used for commodity parts is a flat 3.0% typically used as a standard industry value. This mark-up accounts for the purchasing and handling of commodity parts.
- The SG&A mark-up used for fabricated parts raw material and processing costs is a variable rate based on the technology level associated with the system. A table of the standard percentage mark-ups is shown to the right. Low technology is typical of a system mostly consisting of simple parts, such as basic stampings and injection molded parts. High technology is typically a system with complex automated assembly, high tolerance machined parts, and complex electronic systems, or more standard processes applied to new applications. Cutting edge is typically a system that uses first to market application of an advanced technology.

	Technology Level	SG&A Mark-Ups
Low	1	6.0%
	2	7.0%
	3	8.0%
	4	9.0%
	5	10.0%
Medium	6	11.0%
	7	12.0%
	8	13.0%
	9	14.0%
	10	15.0%
High	11	16.0%
	12	17.0%
	13	18.0%
	14	19.0%
	15	20.0%
Cutting Edge	16	21.0%
	17	22.0%
	18	23.0%
	19	24.0%
	20	25.0%

Quality Burden (Q Burden) is the additional cost carried by each good product unit, to account for the actions and materials used to correct defects in parts (as received or produced) or in production processes. Q Burden is a key component of the Cost of Quality and may be considered equivalent to failure costs. Q Burden reflects the variable cost of poor quality. The probability of a defect can be estimated from industry averages or can be based on company statistics. Q Burden is calculated by adding the incident and disposition costs for each defect and multiplying the sum by the probability of a defect occurrence. The incident is the set of actions that are taken immediately upon the discovery of a real or suspected defect. The disposition is the actions to deal with the defective production after the incident.

Q Burden does not include:

- Base overhead associated with the quality organization (the amount required to assure compliance with industry and customer standards)
- Process documentation generally needed in order to communicate requirements and standards for production, inspection, and testing
- Inspection and test equipment depreciation and consumables (unless needed for troubleshooting defective product)
- Defect prevention activity (investment in new equipment, process improvement, mistake-proofing activities, redesign, lean/six sigma activities, etc.)



The die casting material costs and cycle times are calculated in an internal parametric based cost estimating sheet, and outputs are fed into Design Profit to develop final fabrication costs. Since die casting is a more material driven primary fabrication process, the cells to the right include general dimensional values and material selections.

Die Casting Material Costs & Cycle Times

Part Name: Top Plate, Top Plate w/Silicone Bead

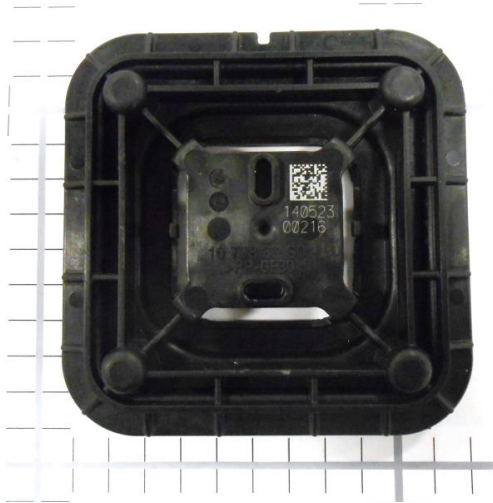
Inputs:

Die Casting Inputs:			
1	Height - Tool Draw	82	mm
2	Length - Longest	314	mm
3	Width - Shortest	250	mm
4	Max. Wall Thickness	5.5	mm
5	Weight of Part - Finished	0.738	kg
6	Percent Loss from Machining	7.00	%
7	Number of Cavities in Tool	2	
8	Number of Die Lock Features	0	
9	Material Number	7	

Material Name	Abbreviation	Cost (\$/kg)
Al-9Si-3Cu(Fe)	A380	\$2.27

Outputs to DP:

Die Casting Outputs:			
1	Min. Die Casting Machine	1927	tons
2	Die Casting Time	28.13	sec
3	Raw Material Weight	0.790	kg
4	Material Cost	\$1.79	



The injection molding material costs and cycle times are calculated in an internal parametric based cost estimating sheet, and outputs are fed into Design Profit to develop final fabrication costs. Since injection molding is a more complex material driven primary fabrication process, the cells to the right include detailed dimensional values and material selections.

Injection Molding Material Costs & Cycle Times

Part Name: Vent Body

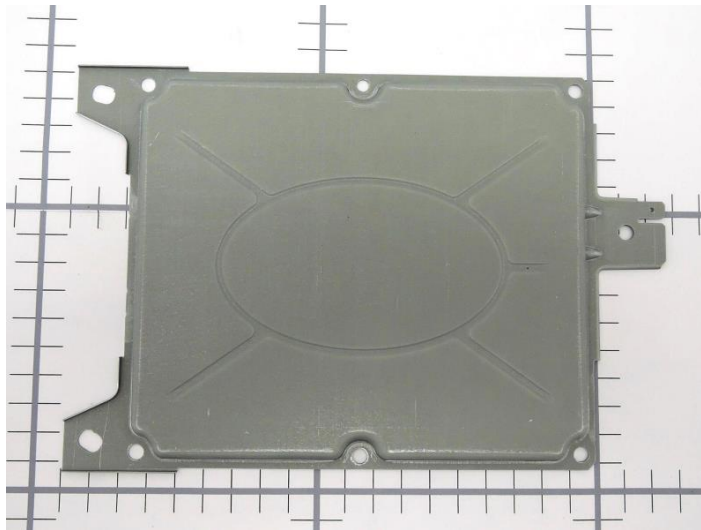
Inputs:

Injection Molding Inputs:			
1	Number of Injection Shots: (1, 2, & 3)	1	
2	Weight of Part	0.050	kg
3	Number of Cavities in Tool	2	
4	Number of Die Lock Features	0	
5	Recycle Offal (1=Yes, 0=No)	0	
6	Height - Tool Draw	19.52	mm
Inputs for Each Injection Shot:			
7	Injection Process: (Standard=1, MuCell=2, & Foaming Agent=3)	1	
8	Length - Longest (mm)	105.4	
9	Width - Shortest (mm)	105.3	
10	Percentage of Part Area Used Based on Square Area of Length x Width	90.00	
11	Nominal Wall Thickness (mm)	2	
12	Material Number	59	

	Material Name	Abbreviation	Cost (\$/kg)	Offal Value (\$/kg)
-	Polypropylene (30% glass)	PP + GF30	\$2.71	\$0.00
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Outputs to DP:

Injection Molding Outputs:			
1	Min. Injection Molding Press	103	tons
Outputs for Each Injection Shot:		PP + GF30	-
2	Injection Molding Time (sec)	7.29	-
3	Net Weight (kg)	0.050	-
4	Raw Material Weight (kg)	0.053	-
5	Raw Material Cost	\$0.14	-



The stamping material costs and cycle times are calculated in an internal parametric based cost estimating sheet, and outputs are fed into Design Profit to develop final fabrication costs. Since stamping is a more machine driven primary fabrication process, the cells to the right include dimensional values related to stations operating in the press, along with material selections.

Stamping Material Costs & Cycle Times

Part Name: Bottom Cover, Cell Control

Inputs:

Stamping Inputs:			
General Inputs:			
1	Stamping Quality: (Standard=1, Fine Blanking=2)	1	
2	Parts per Hit (Side by Side Across Press Width)	1	
3	Material Number	6	
Blanking Inputs:			
4	Shape Type: (Formed Sheet=1, Drawn Box=2, Drawn Cylinder=3)	1	
5	Part Height - Tool Draw	6.73	mm
6	Wrap Length - Longest	225	mm
7	Wrap Width - Shortest	150	mm
8	Sheet Thickness	0.65	mm
9	Number of Blanking Hits (If Unknown = 0)	0	
Piercing Inputs:			
10	Number of Circular Holes	8	
11	Average Diameter of Circular Holes	5	mm
12	Number of Non-Circular Holes	2	
13	Total Perimeter of Non-Circular Holes	64	mm
14	Number of Piercing Hits (If Unknown = 0)	0	
Bending Inputs:			
15	Number of Bends	0	
16	Total Length of Bend Lines	0	mm
17	Number of Bending Hits (If Unknown = 0)	0	
Flanging Holes Inputs:			
18	Number of Flanged Holes	0	
19	Total Perimeter of Flanged Holes	0	mm
20	Number of Flanging Holes Hits (If Unknown = 0)	0	
Forming Depression Inputs:			
21	Number of Depressions	1	
22	Total Perimeter of Depressions	560	mm
23	Number of Forming Depression Hits (If Unknown = 0)	0	
Deep Drawing Inputs:			
24	Drawn Area Depth	0	mm
25	Drawn Area Length - Longest	0	mm
26	Drawn Area Width - Shortest	0	mm
27	Number of Deep Drawing Hits (If Unknown = 0)	0	

Material Name	Abbreviation	Cost (\$/kg)
Medium Carbon Steel 1040 - Galvanized	AISI 1040 - Galvs	\$1.50

Outputs to DP:

Stamping Outputs: (Progressive Die)			
1	Stamping Press	60	tons
2	Stamping Cycle Time	0.67	sec
3	Blank Weight	0.197	kg
4	Material Cost	\$0.30	

Zone Report Outline:

- Zone Information
 - Zone Overview
 - Zone Executive Summary
- Chapter Information
 - Chapter Overview
 - Eye Catching Features
 - Executive Summary
 - Repeating Series of Sets of Costing Detail Pages
 - Assembly Details (Set of 3 Pages)
 - Part Details (Set of 2 Pages)
 - Assembly Process (Set of 2 Pages)
- Appendix Information
 - TechInsights Reports
 - Electronic Component Costing Details
 - Munro & Associates Wire Harness Reports
 - Wire Harness Costing Details
- Zones and Chapters are meant to be similar in structure to a system and sub-system breakdown, however, they may or may not represent specific Original Equipment Manufacturer (OEM) organizations. For example, the Zone 7: Driveline contains the chapters for Motor, Gear Box and Half Shafts.



Battery Pack	
Summary	
Parts	11,254
Fasteners	246
Part Numbers	196
Steps	5,009
Fastenings	5,009
Right First Time	0.29
OEM Process Time (Hr.)	0.88
Supplier Process Time (Hr.)	29.30
Total Weight (kg)	233.71
Material Cost**	Values Available in Report
OEM Process Cost	
Supplier Process Cost	
Q Burden	
SG&A	
Manufacturing Cost*	

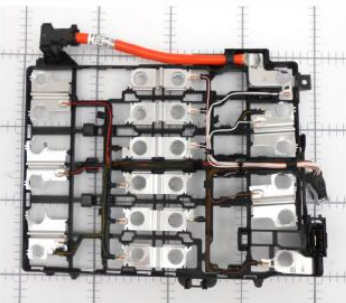

* Excluding tooling, ER&D, logistics, and profit margin
 ** Includes material cost and purchased parts cost

24 March 2015 Copyright Munro and Associates Inc.© 2015 www.LeanDesign.Com 7

At the beginning of each Zone report and beginning of each Chapter, there will be a Executive Summary page. This page provides the high level totals of the Zone or Chapter, based on the following detailed data. The upper part of the summary table shows typical metrics totaled from the assembly and fabrication processes, including part counts, operation counts, timing, and weights. The lower part of the table shows the total costs incurred from these processes.

Executive Summary: Page 1 of 1

Buss and Sense Asm

Battery Pack Asm
 HV Battery Module, Asm
 Buss and Sense Asm

Assembly Summary

Parts	38
Fasteners	0
Part Numbers	17
Steps	319
Fastenings	54
Light Time	96.82 %
OEM Process Time (Min)	4.71
Supplier Process Time (Min)	5.47
Total Weight (kg)	0.46

Material Cost**	Values Available in Report
OEM Process Cost	
Supplier Process Cost	
Q Burden	
SG&A	
Manufacturing Cost*	

* Excluding tooling, ER&D, logistics, and profit margin
 ** Includes material cost and purchased parts

23 March 2015
Copyright Munro and Associates Inc.© 2015 www.LeanDesign.Com
11

Assembly Details: Page 1 of 3

As the report progresses through the breakdown hierarchy of the Chapter, when an assembly is analyzed, three detail pages will be provided. The first page, shown to the left, is a high level overview. The top left photo is the independent assembly, placed on a grid for a reference perspective. The bottom left photo is the assembly in location, once it is assembled to its parent assembly. The top right is a list of the parent assemblies of this assembly. The bottom right is a table summarizing total metrics and costs related to the completed assembly.

Buss and Sense Asm											
Name	Qty	Fasteners	Parts	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Buss Frame Asm	1	19	4	37	19	99.61%	0.80	0.00	22.00	17.74	0.15
Assemble Module Harness	1	10	1	33	10	99.47%	1.67	0.00	0.00	0.00	0.00
Buss Connector 1	3	0	1	7	0	99.94%	0.00	0.00	0.00	7.60	0.01
Buss Connector 2	2	0	1	7	0	99.94%	0.00	0.00	0.00	7.60	0.01
Buss Connector 3	4	0	1	10	0	99.90%	0.00	0.00	5.60	7.60	0.01
Buss Connector 4	2	0	1	10	0	99.90%	0.00	0.00	5.60	7.67	0.01
Assemble Buss Connector	1	11	0	37	11	99.62%	1.18	0.00	38.00	0.00	0.00
Module Bus Terminal Asm	1	2	3	30	2	99.70%	0.00	0.00	27.00	20.70	0.06
Connection Cable Asm	1	1	1	17	1	99.83%	0.00	0.00	14.00	12.10	0.10
Assemble Buss Connectors	1	2	0	9	2	99.85%	0.28	0.00	10.00	0.00	0.00
Assemble Thermistor Leads	1	9	17	48	9	99.85%	0.78	0.00	50.00	0.00	0.00

Buss and Sense Asm											
Name	Part	Series	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost		
Buss Frame Asm											
Assemble Module Harness											
Buss Connector 1											
Buss Connector 2											
Buss Connector 3											
Buss Connector 4											
Assemble Buss Connector											
Module Bus Terminal Asm											
Connection Cable Asm											
Assemble Buss Connectors											
Assemble Thermistor Leads											

Values Available in Report

The second assembly detail page, shown to the left, is the detailed breakdown of the totals for each line item within the current assembly. The line items within the breakdown will include assemblies, parts, and assembly processes. This makes these tables effectively a combined Bill of Materials (BOM) and Bill of Process (BOP) for that assembly. The top table provides the typical metrics totaled from the assembly and fabrication process of each line item. The bottom table provides the total costs incurred from these processes.

Assembly Details: Page 2 of 3

- Note for large assemblies with many line items this page could become multiple pages.

Buss and Sense Asm

Detailed Summary

Parts	38
Fasteners	0
Part Numbers	17
Steps	319
Fastenings	54
Right First Time	96.82
OEM Asm. Time (Min)	4.71
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	0.00
Supplier Fab. Time (Min)	2.24
Total Weight (kg)	0.46
Purchased Part	Values Available in Report
Material Cost	
OEM Asm. Cost	
OEM Fab. Cost	
Supplier Asm. Cost	
Supplier Fab. Cost	
Q Burden	
SG&A	
Manufacturing Cost*	


* Excluding tooling, ER&D, logistics, and profit margin
 ** Includes material cost and purchased parts cost

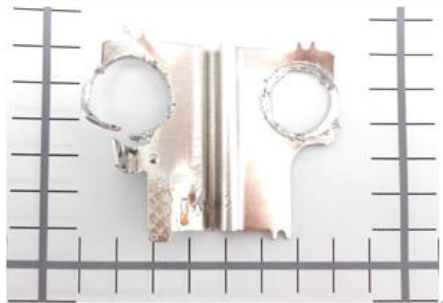

24 March 2015 Copyright Munro and Associates Inc.© 2015 www.LeanDesign.Com 13

The third assembly detail page, shown to the left, is a detailed summary of the totals shown on the previous page. The upper part of the summary table shows typical metrics totaled from the assembly and fabrication process, including part counts, operation counts, timing, and weights. The lower part of the table shows the total costs incurred from these processes.

Assembly Details: Page 3 of 3

Buss Connector 2



- ...Buss and Sense Asm
- Buss Connector 2
- Buss Connector 2, Process

Process Summary

Right First Time	99.94 %
Process Time (Sec)	7.60
Total Weight (kg)	0.01

Material Cost**	Values Available in Report
OEM Process Cost	
Supplier Process Cost	
Q Burden	
SG&A	
Manufacturing Cost*	


* Excluding tooling, ER&D, logistics, and profit margin
** Includes material cost and purchased parts cost

24 March 2015
Copyright Munro and Associates Inc.© 2015 www.LeanDesign.com
14

Part Details: Page 1 of 2

As the report progresses through the breakdown hierarchy of the Chapter, when a part is analyzed, two detail pages will be provided. The first page, shown to the left, is a high level overview. The top left photo is the independent part, placed on a grid for a reference perspective. The bottom left photo is the part in location, once it is assembled to its parent assembly. The top right is a list of the parent assemblies of this part. The bottom right is a table summarizing total metrics and costs related to the completed part.

Buss Connector 2



Buss Connector 2, Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Wash	3.50	1						
Debur	3.50	1						
Stamp, 25 Ton Press	0.60	1						

Buss Connector 2, Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Buss Connector 2, Material	1	Aluminum 1350 - Coil Stock					

SAMPLE


24 March 2015
Copyright Munro and Associates Inc.© 2015 www.LeanDesign.Com
15


The second part detail page, shown to the left, is the detailed breakdown of the totals for the raw materials and each process step to fabricate the part. The top table provides the typical fabrication process metrics and costs totaled for each step. The bottom table provides the total costs for raw material or purchased parts used in the fabrication process.

Part Details: Page 2 of 2

- Note for complex parts with many steps this page could become multiple pages.

Assemble Thermistor Leads






\HV Battery Module, Asm
 \Buss and Sense Asm
 \Assemble Thermistor Leads

Process Summary

Right First Time	99.67 %
Process Time (sec)	97.00
Total Weight (kg)	0.01

Material Cost**	Values Available in Report
OEM Process Cost	
Supplier Process Cost	
Q Burden	
SG&A	
Manufacturing Cost*	

* Excluding tooling, ER&D, logistics, and profit margin
 ** Includes material cost and purchased parts cost



24 March 2015
Copyright Munro and Associates Inc.© 2015 www.LeanDesign.com
16

As the report progresses through the breakdown hierarchy of the Chapter, when an assembly process is analyzed, two detail pages will be provided. The first page, shown to the left, is a high level overview. The top left are photos of the purchased parts utilized in the process, placed on a grid for a reference perspective. The bottom left photo is a view of the location, once the process is complete. The top right is a list of the parent assemblies of this process. The bottom right is a table summarizing total metrics and costs related to the process.

Assembly Process Details: Page 1 of 2

Assemble Thermistor Leads

Overall Cycle Time (Sec) Parts / Cycle Number of Operators Workcell Rate (\$/hr) Country Process Cost Right First Time Q Burden

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	47.00	1	1.00					
Apply Epoxy	50.00	1	0.25					

Values Available in Report

Assemble Thermistor Leads

Qty Material Material Cost / kg (\$/kg) Net Weight (kg) Gross Material Weight (kg) Purchased Part Cost Material Cost

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Small Wire Tie	1	Commodity Item					
Thermistor Hot Met	1	Commodity Item					
Termination Epoxy	15	Commodity Item					

Values Available in Report

24 March 2015 Copyright Munro and Associates Inc.© 2015 www.LeanDesign.Com 17

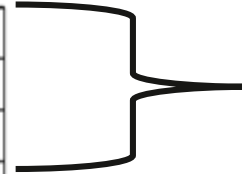
The second assembly process detail page, shown to the left, is the detailed breakdown of the totals for the purchased parts and each assembly process step. The top table provides the typical assembly process metrics and costs totaled for each step. The bottom table provides the total costs for purchased parts used in the assembly process. If a electronic component or wire harness are in the list of purchased parts, then this page will also have a link to the accompanying report in the Appendix.

Assembly Process Details: Page 2 of 2

- Note for complex processes with many steps this page could become multiple pages.

Detailed Summary

Parts	38
Fasteners	0
Part Numbers	17
Steps	319
Fastenings	54
Right First Time	96.82%
OEM Asm. Time (Min)	4.71
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	3.23
Supplier Fab. Time (Min)	2.24
Total Weight (kg)	0.46
Purchased Part Cost	Values Available in Report
Material Cost	
OEM Asm. Cost	
OEM Fab. Cost	
Supplier Asm. Cost	
Supplier Fab. Cost	
Q Burden	
SG&A	
Manufacturing Cost*	

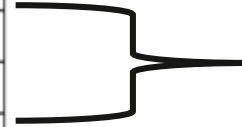


Summary tables, include three metrics related to part count. The first metric, “Parts” is the total quantity of parts. The second metric, “Fasteners” is the total quantity of fasteners, within that total part count, meaning that the fasteners count is a sub-total of the parts count. The third metric, “Part Numbers” is the total unique part instances in the total part count (this includes numbers for both main parts and fasteners).

Detailed Summary

Parts	38
Fasteners	0
Part Numbers	17
Steps	319
Fastenings	54
Right First Time	96.82%
OEM Asm. Time (Min)	4.71
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	3.23
Supplier Fab. Time (Min)	2.24
Total Weight (kg)	0.46

Purchased Part Cost	Values Available in Report
Material Cost	
OEM Asm. Cost	
OEM Fab. Cost	
Supplier Asm. Cost	
Supplier Fab. Cost	
Q Burden	
SG&A	
Manufacturing Cost*	

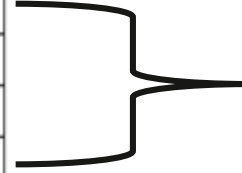


Summary tables, also include two metrics related to operation counts. The first “Steps”, is the total count of the operations required to complete an assembly, part, or assembly process. Operations counted in this total include handling of parts, movement of equipment or operators, handling of tools, fastenings of parts and assemblies, operations to add and remove material during the fabrication process, etc. The second “Fastenings” is the total count of the operations specifically related to fastenings components together, meaning that the fastening count is a sub-total of the steps count.

Detailed Summary

Parts	38
Fasteners	0
Part Numbers	17
Steps	319
Fastenings	54
Right First Time	96.82%
OEM Asm. Time (Min)	4.71
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	3.23
Supplier Fab. Time (Min)	2.24
Total Weight (kg)	0.46

Purchased Part Cost	Values Available in Report
Material Cost	
OEM Asm. Cost	
OEM Fab. Cost	
Supplier Asm. Cost	
Supplier Fab. Cost	
Q Burden	
SG&A	
Manufacturing Cost*	



Often it would be expected that the analysis would have the same number of fasteners to fastenings, however, that is not always the case. One scenario is shown to the right, where there are less fasteners, than fastenings. This is typical of welding operations or the application of sealant or adhesive, as there is not a standard bolt, nut, or clip to be counted as a fastener. A second scenario is where there are more fasteners, than fastenings. This is typical of a process that engages multiple fasteners at the same time, like a multi-head nut runner.

Detailed Summary


Parts	38
Fasteners	0
Part Numbers	17
Steps	319
Fastenings	54
Right First Time	96.82%
OEM Asm. Time (Min)	4.71
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	3.23
Supplier Fab. Time (Min)	2.24
Total Weight (kg)	0.46

Purchased Part Cost	Values Available in Report
Material Cost	
OEM Asm. Cost	
OEM Fab. Cost	
Supplier Asm. Cost	
Supplier Fab. Cost	
Q Burden	
SG&A	
Manufacturing Cost*	



Summary tables include “Right First Time” (RFT). This value states the probability that all the steps that total to this point in the process will be completed without an error. Naturally, as the number and complexity of steps required to complete the assembly, part, or assembly process increase, the RFT percentage will decrease. RFT is calculated using typical best-in-class PPM values for incident rates. However, even with high Sigma level processes, as the steps count increases greatly, the RFT percentage will decrease greatly.

Driver Side Half Shaft Installation




No Commodity Items Required for This Process

- Zone 7 Driveline
- Half Shafts
- Driver Side Half Shaft Installation

Process Summary

Right First Time	99.96 %
Process Time (Sec)	12.00
Total Weight (kg)	0.00
Material Cost**	\$0.00
OEM Process Cost	Values Available in Report
Supplier Process Cost	
Q Burden	
SG&A	
Manufacturing Cost*	

* Excluding tooling, ER&D, logistics, and profit margin
** Includes material cost and purchased parts



25 March 2015
Copyright Munro and Associates Inc.© 2015 www.LeanDesign.Com
340

Some assembly processes will not require the use of commodity items in the process to fasten parts and assemblies. For example, the installation of the half shafts to the vehicle utilizes a press fit, and therefore does not require commodities, like bolts, nuts, or clips to fasten in place. When no commodities are required, the top left photos will be replaced with the standard statement shown on the left. Additionally there will be no weight or material cost / purchased parts cost present in the process summary.

Interpreting Data – Low Q Burden

Buss Connector 2, Process								
Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Wash	3.60	1						\$0.00
Debur	3.60	1						\$0.00
Stamp, 25 Ton Press	0.60	1						\$0.00

Values Available in Report

Some assembly and fabrication process steps that have few operations or operations with low PPMs of defects, will often display \$0.00 in Q Burden. This is simply because the Q Burden value for that step in the process is less than one cent. However, this fraction of a cent of cost will be rolled-up to any parent part or assembly for these processes and added to its totals.

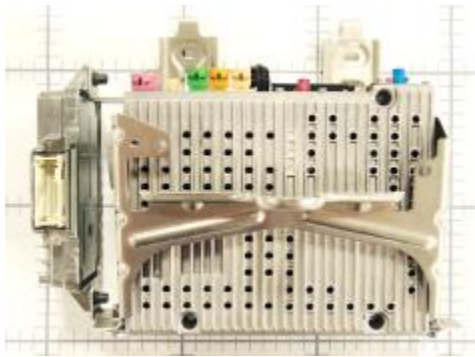


Cost Analysis

Zone 5: Electronics Overview



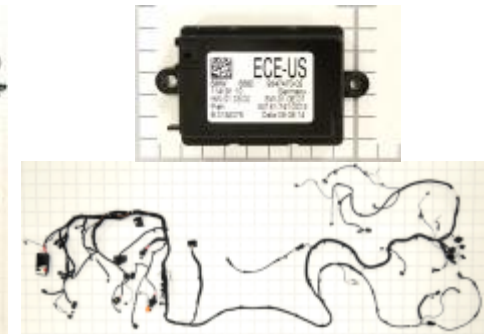
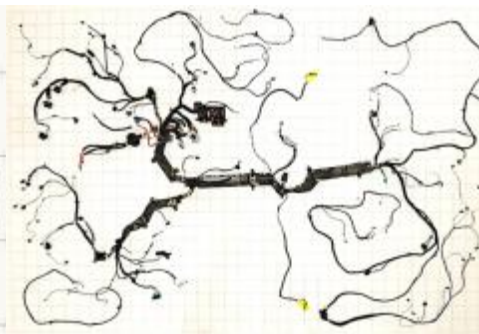
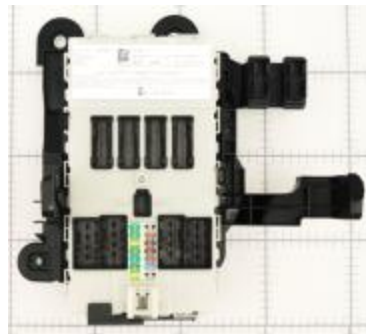
Zone 5 contains system electronics and the body wiring harnesses. The system electronics is comprised of infotainment, center display, rear view camera, telematics communication, audio system, park/maneuver assist modules. The wiring system contains all of the harnesses associated with the typical 12 volt systems used through out the vehicle. The harness group also contains the 12 volt battery and power distribution box.



All major components were costed in detail, while prices were applied to commodity items (i.e. seals, fasteners, latches, and seat belts).

Estimates are based on actual parts.

Photos: Background on 100mm grid paper.



Summary

Parts	291
Fasteners	156
Part Numbers	157
Steps	1,470
Fastenings	586
Right First Time	64.12%
OEM Process Time (Hrs)	0.98
Supplier Process Time (Hrs)	0.50
Total Weight (kg)	38.73
Material Cost**	\$1,827.33
OEM Process Cost	\$89.70
Supplier Process Cost	\$17.58
Q Burden	\$6.66
SG&A	\$280.93
Manufacturing Cost*	\$2,222.20

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

System Electronics Overview



The electronics system primarily contains the 12 volt systems within the vehicle. The main components in the group include: infotainment, central display and telematics communication modules. Additional modules within the group include RF transceivers, touch box control unit, wave trap, suppression module, fuel tank depressurization module, rear view camera module park maneuver (assist) module and audio components. A majority of the modules were housed in injection molded housings except the infotainment unit and rear view camera module which were in metal housings.

All major components were costed in detail, while prices were applied to commodity items (i.e. seals, fasteners, latches, and seat belts).

Estimates are based on actual parts.

Photos: Background on 100mm grid paper.



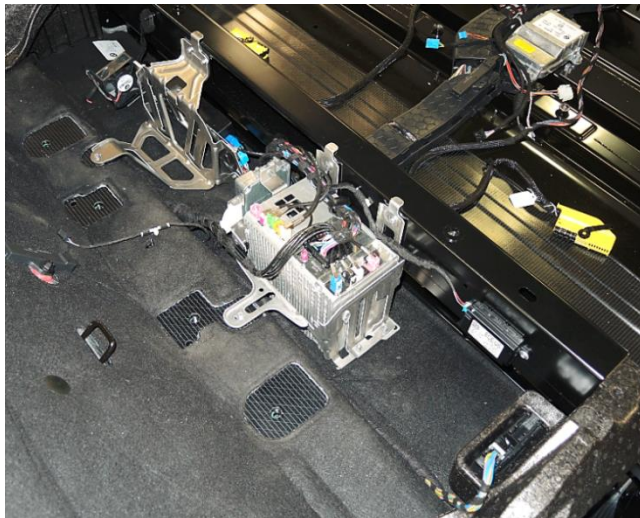
Summary

Parts	123
Fasteners	64
Part Numbers	71
Steps	462
Fastenings	142
Right First Time	84.63%
OEM Process Time (Hrs)	0.22
Supplier Process Time (Hrs)	0.20
Total Weight (kg)	6.55
Material Cost**	\$1,021.34
OEM Process Cost	\$20.08
Supplier Process Cost	\$6.54
Q Burden	\$2.50
SG&A	\$164.04
Manufacturing Cost*	\$1,214.50

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Infotainment Unit and Bracket Asm



\...
 \Zone 5 Electronics
 \System Electronics
 \Infotainment Unit and Bracket Asm
Assembly Summary

Parts	23
Fasteners	16
Part Numbers	10
Steps	101
Fastenings	23
Right First Time	96.81 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	3.66
Total Weight (kg)	2.30

Material Cost**	\$592.39
OEM Process Cost	\$0.00
Supplier Process Cost	\$2.61
Q Burden	\$0.49
SG&A	\$95.15
Manufacturing Cost*	\$690.64

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Infotainment Unit and Bracket Asm



Infotainment Unit and Bracket Asm

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Bracket Asm, Infotainment Unit and Bracket Asm	1	7	6	28	6	99.44 %	0.00	0.00	0.47	0.38	0.2580
Retention Slider, Infotainment Unit Asm	1	1	0	1	0	99.99 %	0.00	0.00	0.00	0.01	0.0008
Assemble Bracket to Infotainment Unit	1	5	6	14	6	98.99 %	0.00	0.00	1.05	0.00	1.7720
Optional Equipment System, Infotainment Unit & Bra	1	8	9	49	9	98.78 %	0.00	0.00	0.52	0.78	0.2648
Assemble Infotainment Auxiliary Printed Circuit	1	2	2	6	2	99.57 %	0.00	0.00	0.47	0.00	0.0070

Infotainment Unit and Bracket Asm

Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
Bracket Asm, Infotainment Unit and Bracket Asm	\$0.18	\$0.76	\$0.00	\$0.00	\$0.20	\$0.25	\$0.08	\$0.20	\$1.68
Retention Slider, Infotainment Unit Asm	\$0.00	\$0.01	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.02
Assemble Bracket to Infotainment Unit	\$0.04	\$558.65	\$0.00	\$0.00	\$0.95	\$0.00	\$0.15	\$89.54	\$649.33
Optional Equipment System, Infotainment Unit & Bra	\$0.18	\$32.55	\$0.00	\$0.00	\$0.22	\$0.56	\$0.18	\$5.34	\$39.04
Assemble Infotainment Auxiliary Printed Circuit	\$0.02	\$0.00	\$0.00	\$0.00	\$0.42	\$0.00	\$0.06	\$0.07	\$0.58

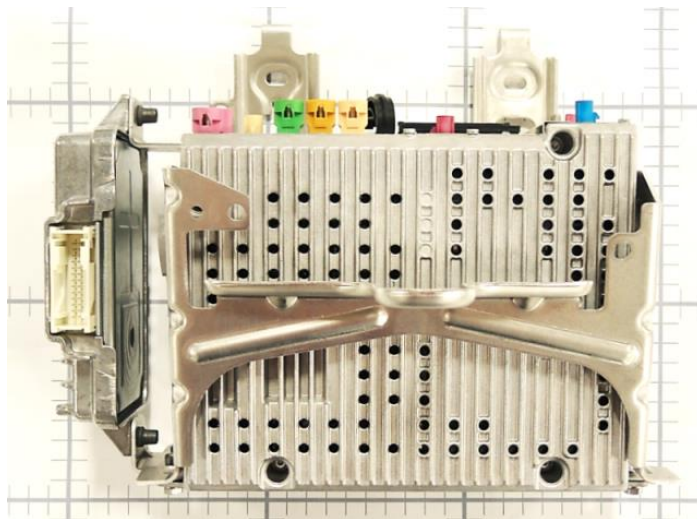
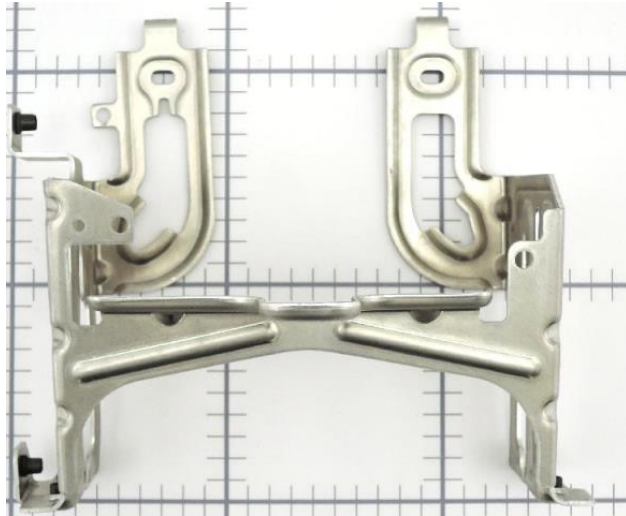
Detailed Summary

Parts	23
Fasteners	16
Part Numbers	10
Steps	101
Fastenings	23
Right First Time	96.81%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	2.50
Supplier Fab. Time (Min)	1.16
Total Weight (kg)	2.30
Purchased Part Cost	\$0.42
Material Cost	\$591.97
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$1.79
Supplier Fab. Cost	\$0.82
Q Burden	\$0.49
SG&A	\$95.15
Manufacturing Cost*	\$690.64

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Bracket Asm, Infotainment Unit and Bracket Asm



\...

\System Electronics

\Infotainment Unit and Bracket Asm

\Bracket Asm, Infotainment Unit and Bracket Asm

Assembly Summary

Parts	7
Fasteners	6
Part Numbers	2
Steps	28
Fastenings	6
Right First Time	99.44 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	0.84
Total Weight (kg)	0.26

Material Cost**	\$0.94
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.45
Q Burden	\$0.08
SG&A	\$0.20
Manufacturing Cost*	\$1.68

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Bracket Asm, Infotainment Unit and Bracket Asm



Bracket Asm, Infotainment Unit and Bracket Asm

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Bracket, Bracket Asm	1	1	0	7	0	99.97 %	0.00	0.00	0.00	0.38	0.2553
Assemble Bracket	1	6	6	20	6	99.47 %	0.00	0.00	0.47	0.00	0.0027

Bracket Asm, Infotainment Unit and Bracket Asm

Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
Bracket, Bracket Asm	\$0.00	\$0.76	\$0.00	\$0.00	\$0.00	\$0.25	\$0.01	\$0.16	\$1.18
Assemble Bracket	\$0.18	\$0.00	\$0.00	\$0.00	\$0.20	\$0.00	\$0.08	\$0.04	\$0.50

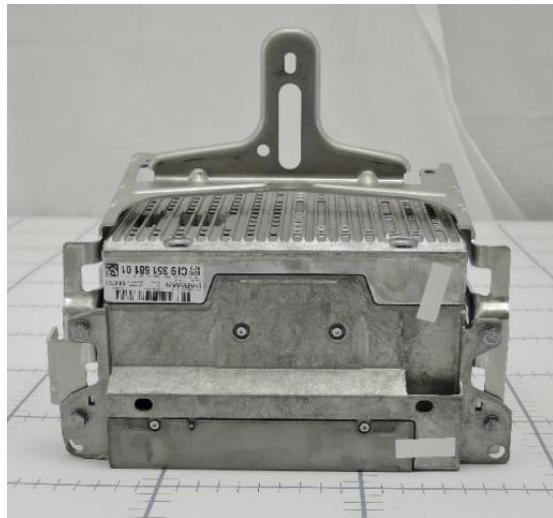
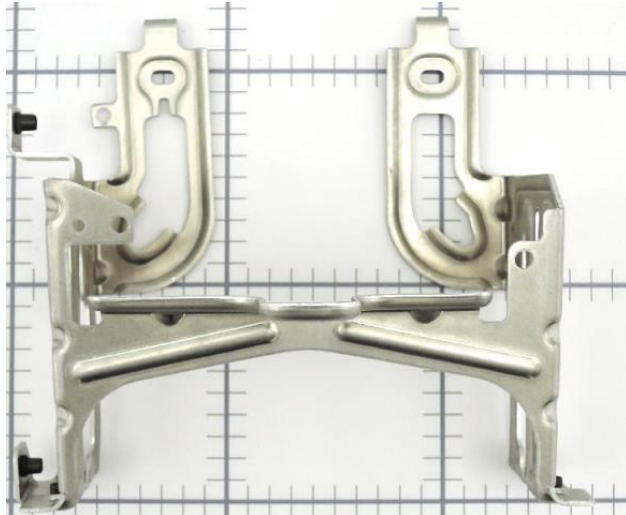
Detailed Summary

Parts	7
Fasteners	6
Part Numbers	2
Steps	28
Fastenings	6
Right First Time	99.44%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	0.47
Supplier Fab. Time (Min)	0.38
Total Weight (kg)	0.26
Purchased Part Cost	
	\$0.18
Material Cost	
	\$0.76
OEM Asm. Cost	
	\$0.00
OEM Fab. Cost	
	\$0.00
Supplier Asm. Cost	
	\$0.20
Supplier Fab. Cost	
	\$0.25
Q Burden	
	\$0.08
SG&A	
	\$0.20
Manufacturing Cost*	
	\$1.68

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Bracket, Bracket Asm



\...

- \Bracket Asm, Infotainment Unit and Bracket Asm
- \Bracket, Bracket Asm
- \Bracket Process

Process Summary

Right First Time	99.97 %
Process Time (Sec)	22.60
Total Weight (kg)	0.26

Material Cost**	\$0.76
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.25
Q Burden	\$0.01
SG&A	\$0.16
Manufacturing Cost*	\$1.18

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Bracket, Bracket Asm

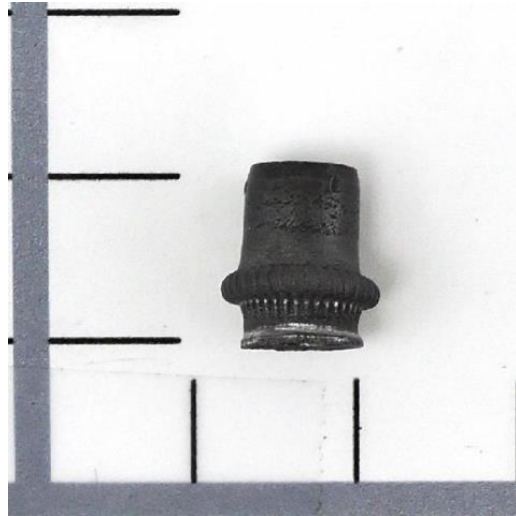
Bracket Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Wash	9.00	1	0.25	20.00	GER	\$0.05	99.99%	\$0.00
Deburr	9.00	1	0.25	37.40	GER	\$0.09	99.99%	\$0.00
600 Ton Stamping Press	4.60	1	0.25	86.53	GER	\$0.11	99.99%	\$0.00

Bracket Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Stainless Steel-304, Bracket	1	Stainless Steel 304L - Coil Stock	\$2.62	0.2553	0.2960	\$0.00	\$0.76

Assemble Bracket



\...

- \Infotainment Unit and Bracket Asm
- \Bracket Asm, Infotainment Unit and Bracket Asm
- \Assemble Bracket

Process Summary

Right First Time	99.47 %
Process Time (Sec)	28.00
Total Weight (kg)	0.00

Material Cost**	\$0.18
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.20
Q Burden	\$0.08
SG&A	\$0.04
Manufacturing Cost*	\$0.50

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

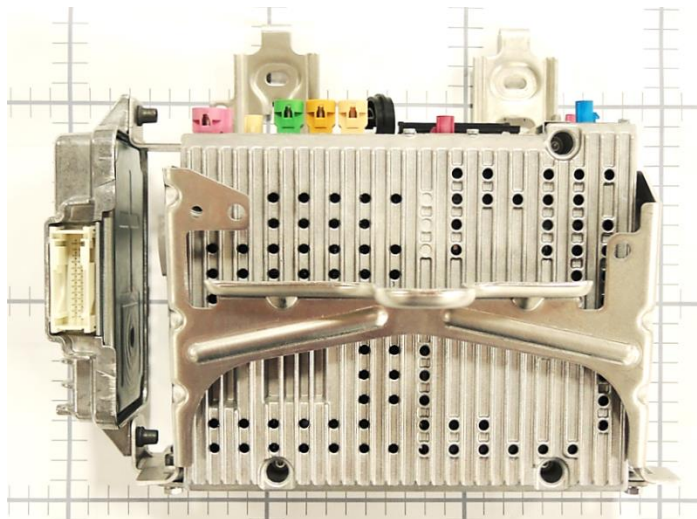
Assemble Bracket

Assemble Bracket

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Automated Asm	28.00	1	0.25	25.62	GER	\$0.20	99.47%	\$0.08

Assemble Bracket

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Rivet, Bracket.Asm	6	Commodity Item	Purchased	0.0005	-	\$0.03	\$0.00



- \...
- \Infotainment Unit and Bracket Asm
- \Retention Slider, Infotainment Unit Asm
- \Retention Feature Process

Process Summary

Right First Time	99.99 %
Process Time (Sec)	0.30
Total Weight (kg)	0.00

Material Cost**	\$0.01
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.00
Q Burden	\$0.00
SG&A	\$0.00
Manufacturing Cost*	\$0.02

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Retention Slider, Infotainment Unit Asm



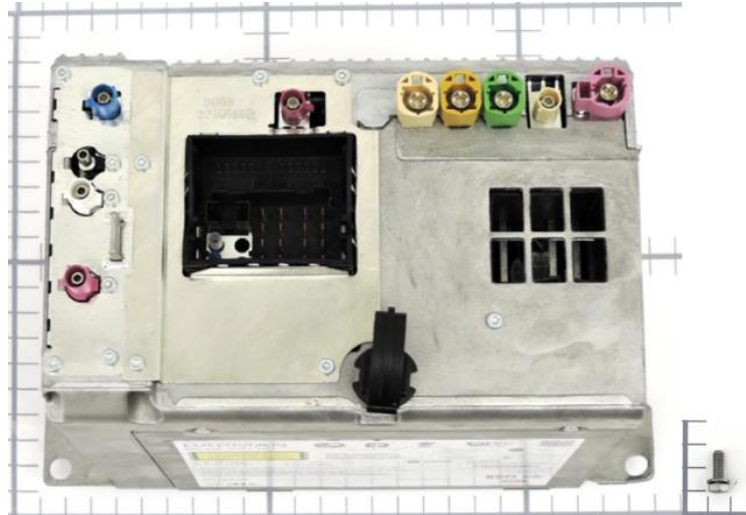
Retention Feature Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
55Ton Injection Molding Press	14.40	48	0.25	23.71	GER	\$0.00	99.99%	\$0.00

Retention Feature Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
PA66, Retention Feature	1	PA66	\$4.15	0.0008	0.0009	\$0.00	\$0.01

Assemble Bracket to Infotainment Unit



- \...
- \System Electronics
- \Infotainment Unit and Bracket Asm
- \Assemble Bracket to Infotainment Unit

Process Summary

Right First Time	98.99 %
Process Time (Sec)	63.00
Total Weight (kg)	1.77

Material Cost**	\$558.69
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.95
Q Burden	\$0.15
SG&A	\$89.54
Manufacturing Cost*	\$649.33

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Bracket to Infotainment Unit



Assemble Bracket to Infotainment Unit

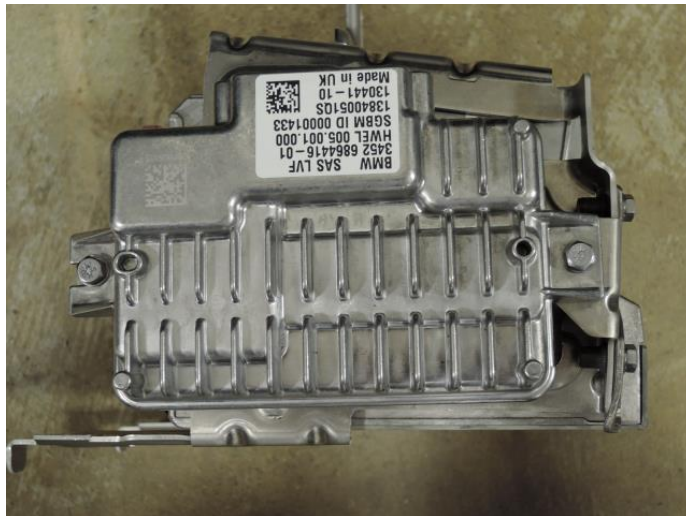
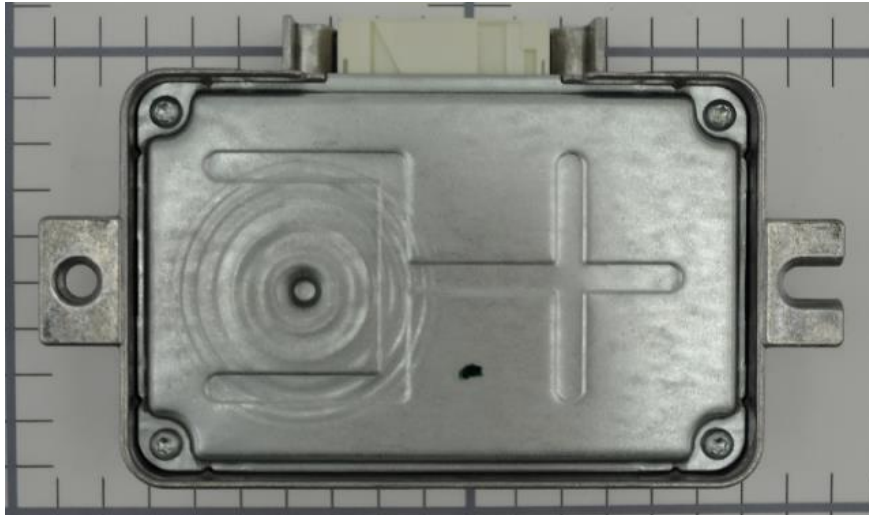
Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	63.00	1	1.00	54.32	GER	\$0.95	98.99%	\$0.15

Assemble Bracket to Infotainment Unit

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Digital Radio Module	1	See Appendix	-	1.7580	-	\$0.00	\$558.65
M5x13mm-Hex SEMS Torx	4	Commodity Item	Purchased	0.0035	-	\$0.01	\$0.00

[Click Here for TechInsights Electronics Report on Digital Radio Module](#)

Optional Equipment System, Infotainment Unit & Bra



\...
 \System Electronics
 \Infotainment Unit and Bracket Asm
 \Optional Equipment System, Infotainment Unit & Bra
Assembly Summary

Parts	8
Fasteners	4
Part Numbers	5
Steps	49
Fastenings	9
Right First Time	98.78 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	1.30
Total Weight (kg)	0.26

Material Cost**	\$32.73
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.79
Q Burden	\$0.18
SG&A	\$5.34
Manufacturing Cost*	\$39.04

* Excluding tooling, ER&D, logistics, and profit margin
 ** Includes material cost and purchased parts cost

Optional Equipment System, Infotainment Unit & Bra



MUNRO
& ASSOCIATES, INC.

Optional Equipment System, Infotainment Unit & Bra

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Platform, Optional Equipment System Asm	1	1	0	16	0	99.92 %	0.00	0.00	0.00	0.53	0.1599
Assemble Platform	1	1	5	8	5	99.73 %	0.00	0.00	0.10	0.00	0.0632
Cover, Optional Equipment System Asm	1	1	0	7	0	99.97 %	0.00	0.00	0.00	0.25	0.0379
Assemble Cover	1	4	4	13	4	99.17 %	0.00	0.00	0.37	0.00	0.0036
Assemble Labels	1	1	0	3	0	99.99 %	0.00	0.00	0.05	0.00	0.0002

Optional Equipment System, Infotainment Unit & Bra

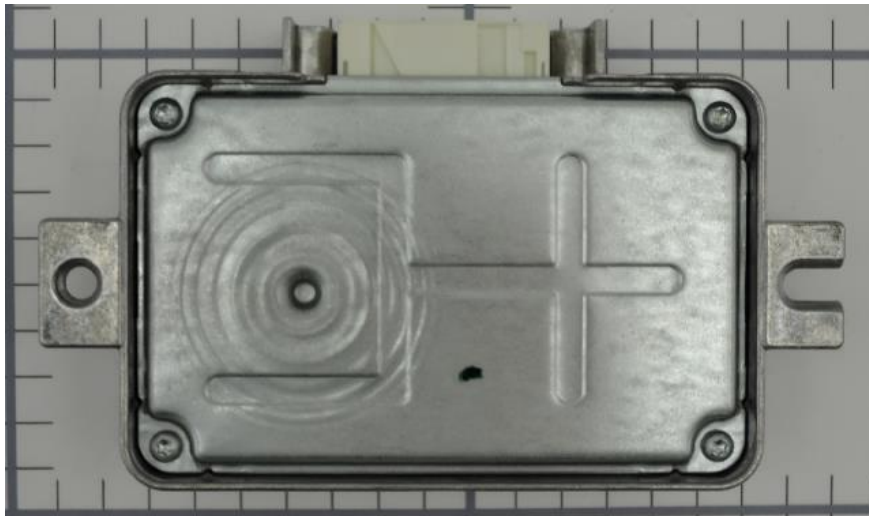
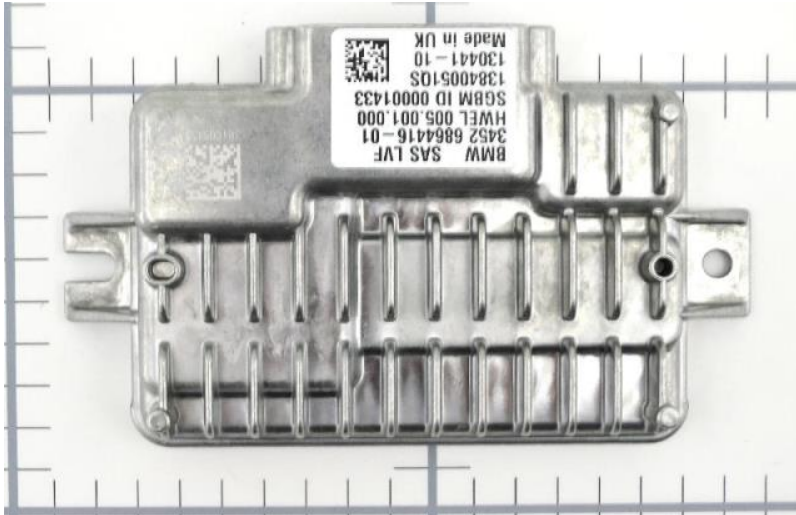
Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
Platform, Optional Equipment System Asm	\$0.00	\$0.37	\$0.00	\$0.00	\$0.00	\$0.47	\$0.01	\$0.13	\$0.99
Assemble Platform	\$0.00	\$31.89	\$0.00	\$0.00	\$0.04	\$0.00	\$0.04	\$5.11	\$37.08
Cover, Optional Equipment System Asm	\$0.00	\$0.29	\$0.00	\$0.00	\$0.00	\$0.09	\$0.00	\$0.06	\$0.45
Assemble Cover	\$0.08	\$0.00	\$0.00	\$0.00	\$0.16	\$0.00	\$0.12	\$0.03	\$0.39
Assemble Labels	\$0.10	\$0.00	\$0.00	\$0.00	\$0.02	\$0.00	\$0.00	\$0.01	\$0.13

Detailed Summary

Parts	8
Fasteners	4
Part Numbers	5
Steps	49
Fastenings	9
Right First Time	98.78%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	0.52
Supplier Fab. Time (Min)	0.78
Total Weight (kg)	0.26
Purchased Part Cost	\$0.18
Material Cost	\$32.55
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$0.22
Supplier Fab. Cost	\$0.56
Q Burden	\$0.18
SG&A	\$5.34
Manufacturing Cost*	\$39.04

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost



- \...
- \Optional Equipment System, Infotainment Unit & Bra
- \Platform, Optional Equipment System Asm
- \Bracket Process

Process Summary

Right First Time	99.92 %
Process Time (Sec)	32.00
Total Weight (kg)	0.16

Material Cost**	\$0.37
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.47
Q Burden	\$0.01
SG&A	\$0.13
Manufacturing Cost*	\$0.99

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Platform, Optional Equipment System Asm



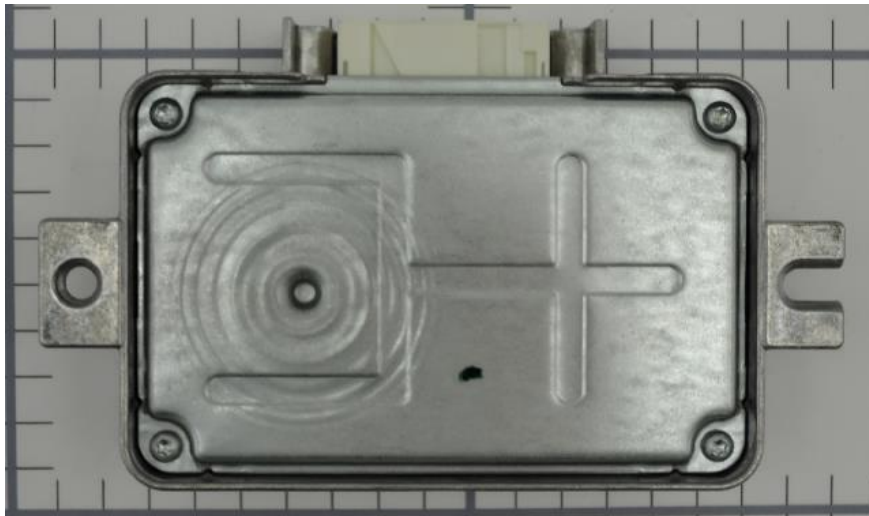
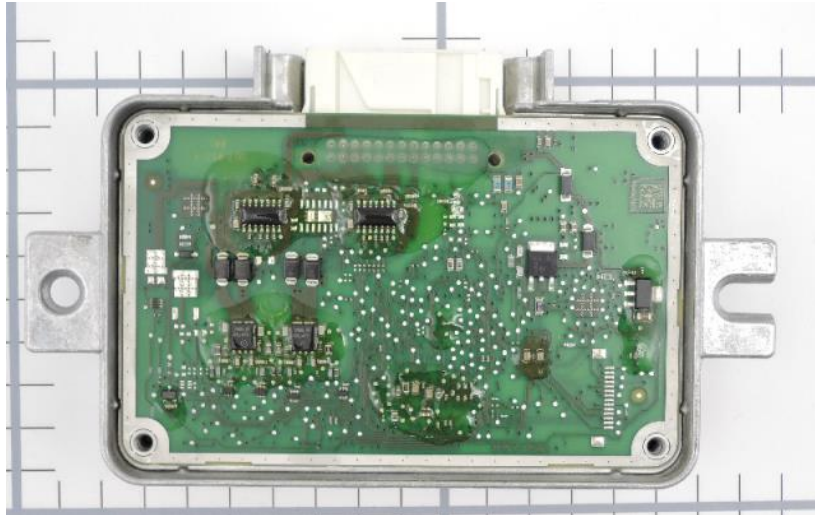
MUNRO
& ASSOCIATES, INC.

Bracket Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Laser Etch	6.00	1	0.25	18.05	GER	\$0.03	99.98 %	\$0.00
Wash	7.00	1	0.25	20.00	GER	\$0.04	99.99 %	\$0.00
Deburr	8.00	1	0.25	21.70	GER	\$0.05	99.99 %	\$0.00
CNC Machining	4.40	1	0.25	49.86	GER	\$0.06	99.98 %	\$0.00
840 Ton DieCast Machine	26.40	4	1.00	160.91	GER	\$0.30	99.99 %	\$0.00

Bracket Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
A380, Platform	1	A380	\$2.27	0.1599	0.1610	\$0.00	\$0.37



\...

- \Infotainment Unit and Bracket Asm
- \Optional Equipment System, Infotainment Unit & Bra
- \Assemble Platform

Process Summary

Right First Time	99.73 %
Process Time (Sec)	6.14
Total Weight (kg)	0.06
Material Cost**	\$31.89
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.04
Q Burden	\$0.04
SG&A	\$5.11
Manufacturing Cost*	\$37.08

* Excluding tooling, ER&D, logistics, and profit margin

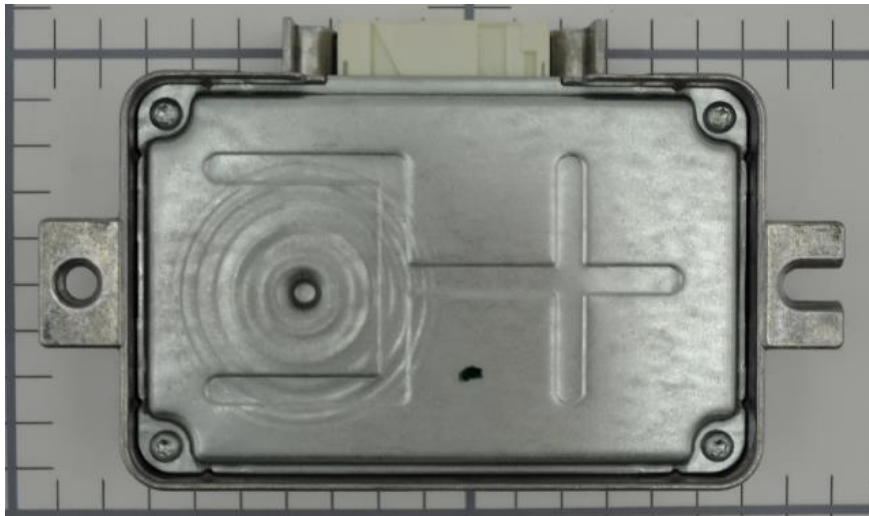
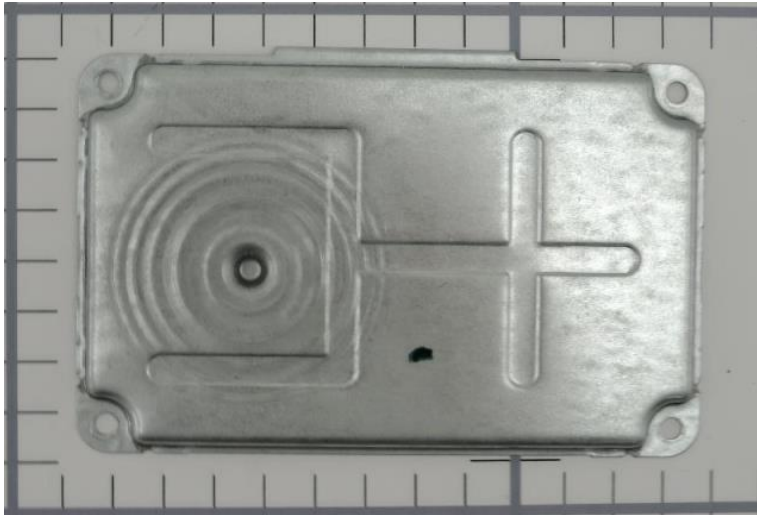
** Includes material cost and purchased parts cost

Assemble Platform									
Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden	
Supplier Automated Asm	6.14	1	0.25	25.62	GER	\$0.04	99.73 %	\$0.04	

Assemble Platform								
Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost	
Auxiliary Printed CircuitBoard, Optional Equipmen	1	See Appendix	-	0.0632	-	\$0.00	\$31.89	

[Click Here for TechInsights Electronics Report on Optional Equipment Board](#)

Cover, Optional Equipment System Asm



\...

- \Optional Equipment System, Infotainment Unit & Bra
- \Cover, Optional Equipment System Asm
- \Cover Process

Process Summary

Right First Time	99.97 %
Process Time (Sec)	14.70
Total Weight (kg)	0.04

Material Cost**	\$0.29
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.09
Q Burden	\$0.00
SG&A	\$0.06
Manufacturing Cost*	\$0.45

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Cover, Optional Equipment System Asm



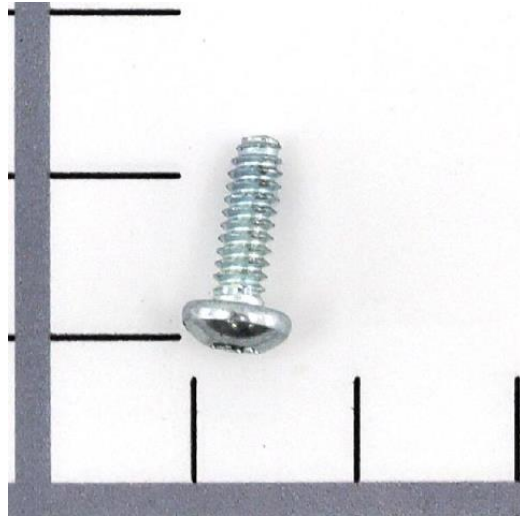
Cover Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Wash	7.00	1	0.25	20.00	GER	\$0.04	99.99%	\$0.00
Deburr	7.00	1	0.25	21.70	GER	\$0.04	99.99%	\$0.00
350 Ton Stamping Press	2.80	4	0.25	54.69	GER	\$0.01	99.99%	\$0.00

Cover Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, Cover	1	Stainless Steel 304- Coil Stock	\$2.58	0.0379	0.1130	\$0.00	\$0.29

Assemble Cover



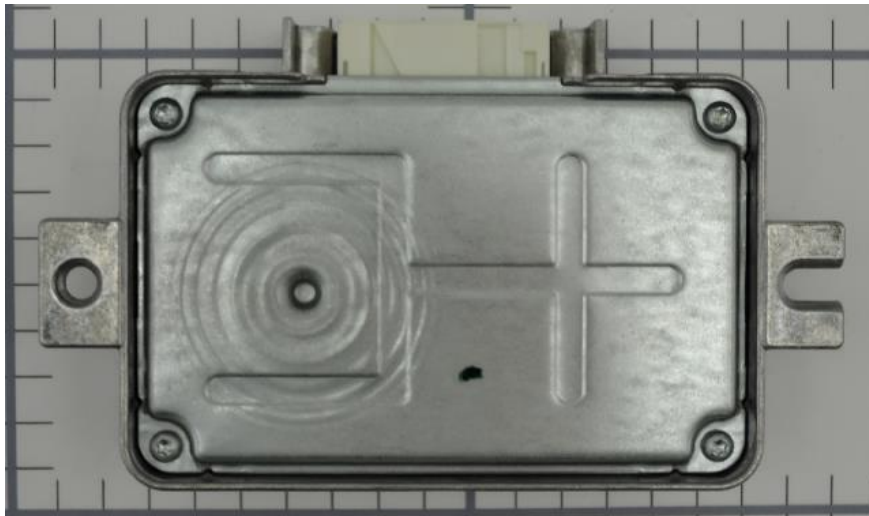
\...

- \Infotainment Unit and Bracket Asm
- \Optional Equipment System, Infotainment Unit & Bra
- \Assemble Cover

Process Summary

Right First Time	99.17 %
Process Time (Sec)	22.00
Total Weight (kg)	0.00

Material Cost**	\$0.08
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.16
Q Burden	\$0.12
SG&A	\$0.03
Manufacturing Cost*	\$0.39



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

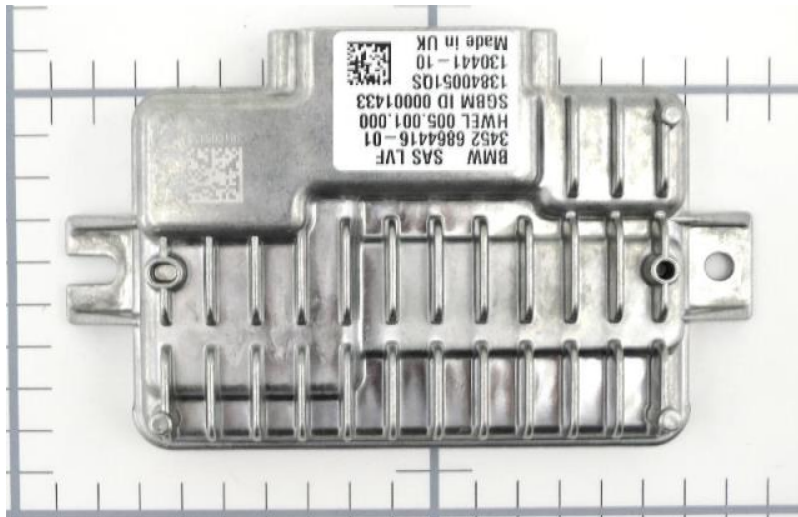
Assemble Cover

Assemble Cover

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Automated Asm	22.00	1	0.25	25.62	GER	\$0.16	99.17%	\$0.12

Assemble Cover

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
M3x11mm-Pan Head Torx	4	Commodity Item	Purchased	0.0009	-	\$0.02	\$0.00



\...

- \Infotainment Unit and Bracket Asm
- \Optional Equipment System, Infotainment Unit & Bra
- \Assemble Labels

Process Summary

Right First Time	99.99 %
Process Time (Sec)	3.00
Total Weight (kg)	0.00
Material Cost**	\$0.10
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.02
Q Burden	\$0.00
SG&A	\$0.01
Manufacturing Cost*	\$0.13

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Labels



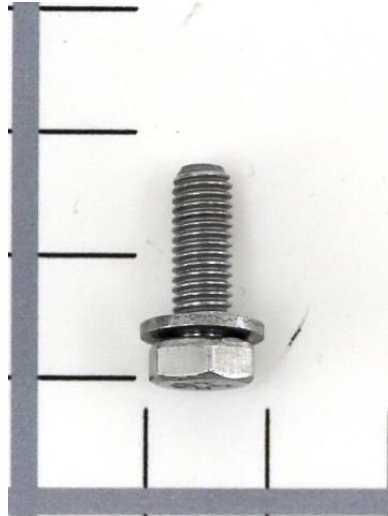
Assemble Labels

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Automated Asm	3.00	1	0.25	25.62	GER	\$0.02	99.99%	\$0.00

Assemble Labels

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Label, Auxiliary Printed Circuit Board	1	Commodity Item	Purchased	0.0002	-	\$0.10	\$0.00

Assemble Infotainment Auxiliary Printed Circuit

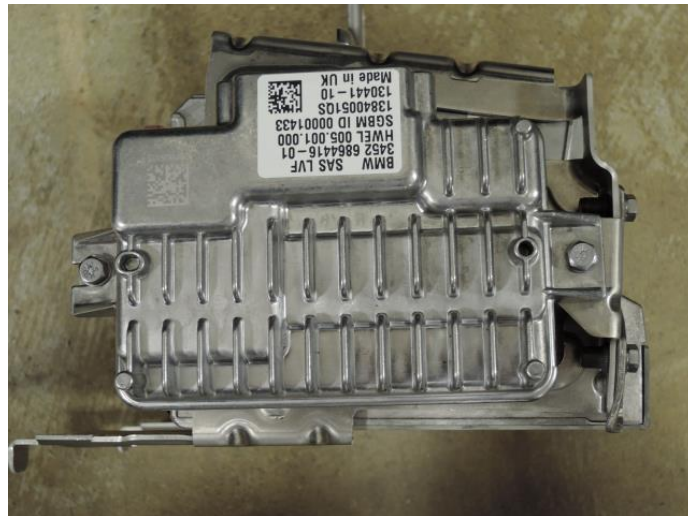


\...
 \System Electronics
 \Infotainment Unit and Bracket Asm
 \Assemble Infotainment Auxiliary Printed Circuit

Process Summary

Right First Time	99.57 %
Process Time (Sec)	28.00
Total Weight (kg)	0.01

Material Cost**	\$0.02
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.42
Q Burden	\$0.06
SG&A	\$0.07
Manufacturing Cost*	\$0.58



* Excluding tooling, ER&D, logistics, and profit margin
 ** Includes material cost and purchased parts cost

Assemble Infotainment Auxiliary Printed Circuit

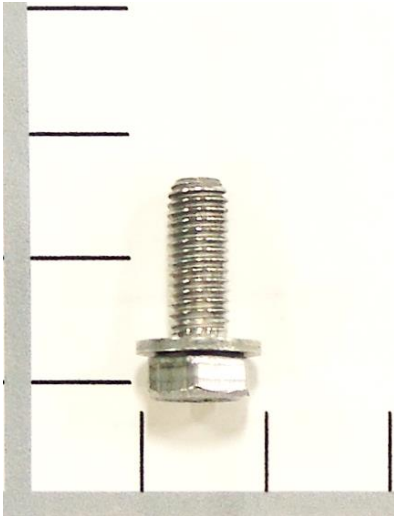


Assemble Infotainment Auxiliary Printed Circuit

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	28.00	1	1.00	54.32	GER	\$0.42	99.57%	\$0.06

Assemble Infotainment Auxiliary Printed Circuit

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
M5x13mm-Hex SEMSTorx	2	Commodity Item	Purchased	0.0035	-	\$0.01	\$0.00

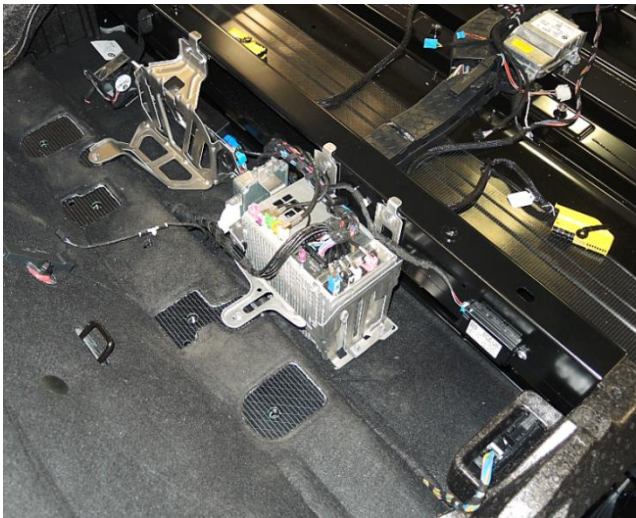


\...
 \Zone 5 Electronics
 \System Electronics
 \Infotainment Unit Installation

Process Summary

Right First Time	98.99 %
Process Time (Sec)	109.50
Total Weight (kg)	0.01

Material Cost**	\$0.03
OEM Process Cost	\$2.78
Supplier Process Cost	\$0.00
Q Burden	\$0.15
SG&A	\$0.45
Manufacturing Cost*	\$3.41



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Infotainment Unit Installation



Infotainment Unit Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	109.50	1	1.00	91.41	GER	\$2.78	98.99%	\$0.15

Infotainment Unit Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
M5x13mm-Hex SEMSTorx	3	Commodity Item	Purchased	0.0035	-	\$0.01	\$0.00



\...
 \System Electronics
 \IP Screw Cover
 \Screw Cover Process

Process Summary

Right First Time	99.99 %
Process Time (Sec)	0.44
Total Weight (kg)	0.00

Material Cost**	\$0.01
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.00
Q Burden	\$0.00
SG&A	\$0.00
Manufacturing Cost*	\$0.02



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

IP Screw Cover

Screw Cover Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
55Ton Injection Molding Press	7.04	16	0.25	23.71	GER	\$0.00	99.99%	\$0.00

Screw Cover Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, IP Screw Cover	1	HDPE	\$2.23	0.0009	0.0010	\$0.00	\$0.01



\...

- \Zone 5 Electronics
- \System Electronics
- \Central Information Display Installation

Process Summary

Right First Time	99.44 %
Process Time (Sec)	62.50
Total Weight (kg)	0.91

Material Cost**	\$129.36
OEM Process Cost	\$1.59
Supplier Process Cost	\$0.00
Q Burden	\$0.08
SG&A	\$20.95
Manufacturing Cost*	\$151.98

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Central Information Display Installation



Central Information Display Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	62.50	1	1.00	91.41	GER	\$1.59	99.44 %	\$0.08

Central Information Display Installation

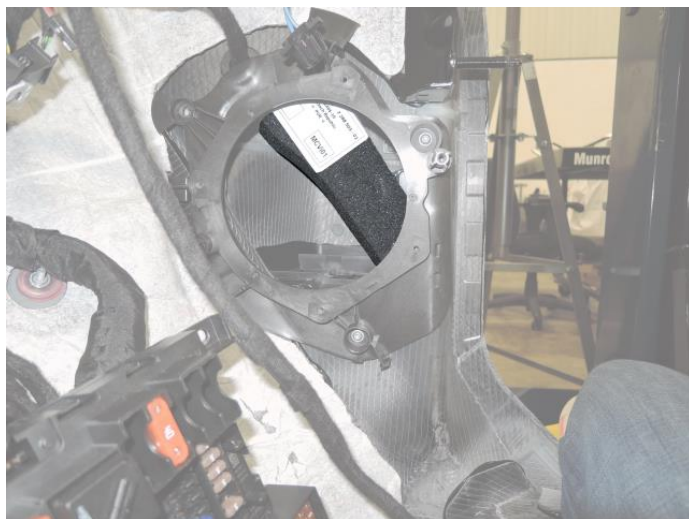
Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Central Information Display Asm	1	See Appendix	-	0.9100	-	\$0.00	\$129.34
M4x20mm-Torx Screw	2	Commodity Item	Purchased	0.0021	-	\$0.01	\$0.00

[Click Here for TechInsights Electronics Report on 10.2" Infotainment Display](#)

Passenger A-Pillar Foam Asm



MUNRO
& ASSOCIATES, INC.



\...

- \Zone 5 Electronics
- \System Electronics
- \Passenger A-Pillar Foam Asm

Assembly Summary

Parts	2
Fasteners	0
Part Numbers	2
Steps	7
Fastenings	0
Right First Time	99.93 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	0.24
Total Weight (kg)	0.02

Material Cost**	\$0.05
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.09
Q Burden	\$0.01
SG&A	\$0.02
Manufacturing Cost*	\$0.17

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Passenger A-Pillar Foam Asm



Passenger A-Pillar Foam Asm

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Passenger A-Pillar Foam	1	1	0	3	0	99.96 %	0.00	0.00	0.00	0.05	0.0151
Assemble Passenger A-Pillar Foam	1	1	0	3	0	99.97 %	0.00	0.00	0.18	0.00	0.0003

Passenger A-Pillar Foam Asm

Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
Passenger A-Pillar Foam	\$0.00	\$0.04	\$0.00	\$0.00	\$0.00	\$0.01	\$0.01	\$0.01	\$0.06
Assemble Passenger A-Pillar Foam	\$0.01	\$0.00	\$0.00	\$0.00	\$0.08	\$0.00	\$0.01	\$0.01	\$0.10

Detailed Summary

Parts	2
Fasteners	0
Part Numbers	2
Steps	7
Fastenings	0
Right First Time	99.93%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	0.18
Supplier Fab. Time (Min)	0.05
Total Weight (kg)	0.02
<hr/>	
Purchased Part Cost	\$0.01
Material Cost	\$0.04
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$0.08
Supplier Fab. Cost	\$0.01
Q Burden	\$0.01
SG&A	\$0.02
Manufacturing Cost*	\$0.17

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Passenger A-Pillar Foam

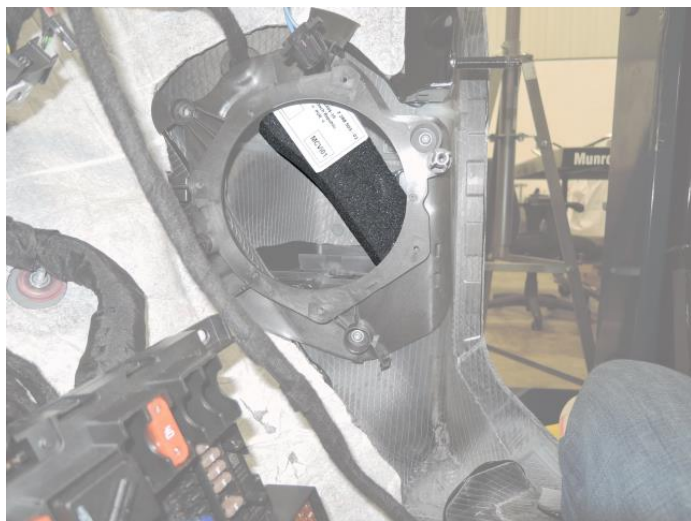


- \...
- \Passenger A-Pillar Foam Asm
- \Passenger A-Pillar Foam
- \A-Pillar Foam Asm Process

Process Summary

Right First Time	99.96 %
Process Time (Sec)	3.20
Total Weight (kg)	0.02

Material Cost**	\$0.04
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.01
Q Burden	\$0.01
SG&A	\$0.01
Manufacturing Cost*	\$0.06



* Excluding tooling, ER&D, logistics, and profit margin
 ** Includes material cost and purchased parts cost

Passenger A-Pillar Foam

A-Pillar Foam Asm Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
25Ton Trim Press	3.20	1	0.25	11.50	CZE	\$0.01	99.96%	\$0.01

A-Pillar Foam Asm Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, Passenger A-Pillar Foam	1	Medium Density Foam	By Area	0.0151	-	\$0.00	\$0.04

Assemble Passenger A-Pillar Foam



- \...
- \System Electronics
- \Passenger A-Pillar Foam Asm
- \Assemble Passenger A-Pillar Foam

Process Summary

Right First Time	99.97 %
Process Time (Sec)	11.00
Total Weight (kg)	0.00

Material Cost**	\$0.01
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.08
Q Burden	\$0.01
SG&A	\$0.01
Manufacturing Cost*	\$0.10



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Passenger A-Pillar Foam



Assemble Passenger A-Pillar Foam

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	11.00	1	1.00	24.59	CZE	\$0.08	99.97%	\$0.01

Assemble Passenger A-Pillar Foam

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Label, Driver A-Pillar Foam Asm	1	Commodity Item	Purchased	0.0003	-	\$0.01	\$0.00

Passenger A-Pillar Foam Installation



\...
 \Zone 5 Electronics
 \System Electronics
 \Passenger A-Pillar Foam Installation

Process Summary

Right First Time	99.96 %
Process Time (Sec)	12.00
Total Weight (kg)	0.00

Material Cost**	\$0.00
OEM Process Cost	\$0.30
Supplier Process Cost	\$0.00
Q Burden	\$0.01
SG&A	\$0.05
Manufacturing Cost*	\$0.36



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Passenger A-Pillar Foam Installation



Passenger A-Pillar Foam Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	12.00	1	1.00	91.41	GER	\$0.30	99.96%	\$0.01

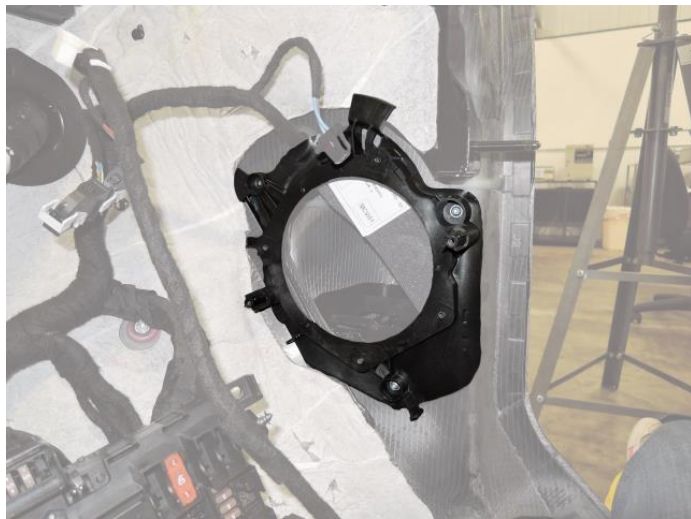
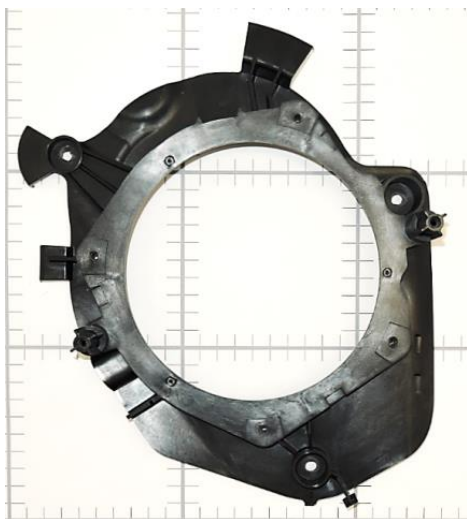
Passenger A-Pillar Foam Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
-------------	-----	----------	----------------------------	-----------------	----------------------------	---------------------	---------------

Passenger A-Pillar Speaker Mount Asm



MUNRO
& ASSOCIATES, INC.



\...

- \Zone 5 Electronics
- \System Electronics
- \Passenger A-Pillar Speaker Mount Asm

Assembly Summary

Parts	2
Fasteners	0
Part Numbers	2
Steps	6
Fastenings	1
Right First Time	99.96 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	0.49
Total Weight (kg)	0.15

Material Cost**	\$0.41
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.24
Q Burden	\$0.01
SG&A	\$0.10
Manufacturing Cost*	\$0.76

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Passenger A-Pillar Speaker Mount Asm



MUNRO
& ASSOCIATES, INC.

Passenger A-Pillar Speaker Mount Asm

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Passenger A-Pillar Speaker Mount	1	1	0	1	0	99.99 %	0.00	0.00	0.00	0.06	0.1525
Assemble A-Pillar Speaker Mount	1	1	1	4	1	99.97 %	0.00	0.00	0.43	0.00	0.0005

Passenger A-Pillar Speaker Mount Asm

Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
Passenger A-Pillar Speaker Mount	\$0.00	\$0.40	\$0.00	\$0.00	\$0.00	\$0.12	\$0.00	\$0.08	\$0.60
Assemble A-Pillar Speaker Mount	\$0.01	\$0.00	\$0.00	\$0.00	\$0.12	\$0.00	\$0.00	\$0.02	\$0.16

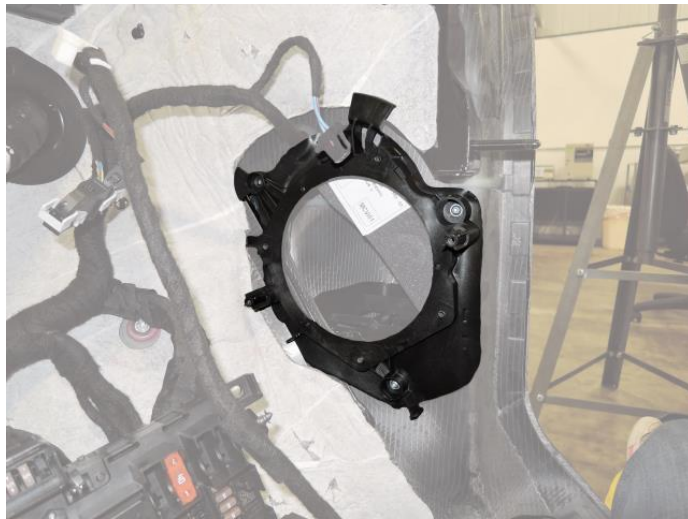
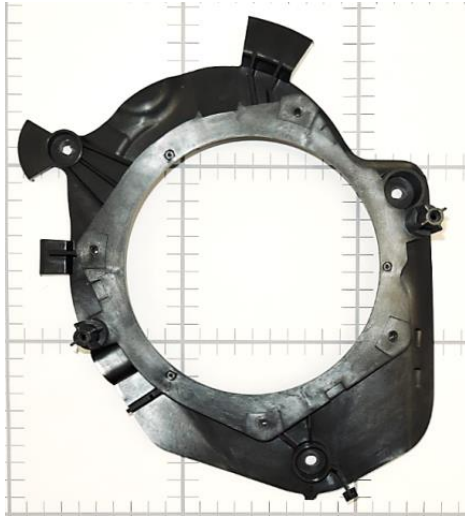
Detailed Summary

Parts	2
Fasteners	0
Part Numbers	2
Steps	6
Fastenings	1
Right First Time	99.96%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	0.43
Supplier Fab. Time (Min)	0.06
Total Weight (kg)	0.15
Purchased Part Cost	\$0.01
Material Cost	\$0.40
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$0.12
Supplier Fab. Cost	\$0.12
Q Burden	\$0.01
SG&A	\$0.10
Manufacturing Cost*	\$0.76

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Passenger A-Pillar Speaker Mount



\...

- \Passenger A-Pillar Speaker Mount Asm
- \Passenger A-Pillar Speaker Mount
- \Passenger A-Pillar Speaker Mount Process

Process Summary

Right First Time	99.99 %
Process Time (Sec)	3.36
Total Weight (kg)	0.15

Material Cost**	\$0.40
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.12
Q Burden	\$0.00
SG&A	\$0.08
Manufacturing Cost*	\$0.60

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Passenger A-Pillar Speaker Mount



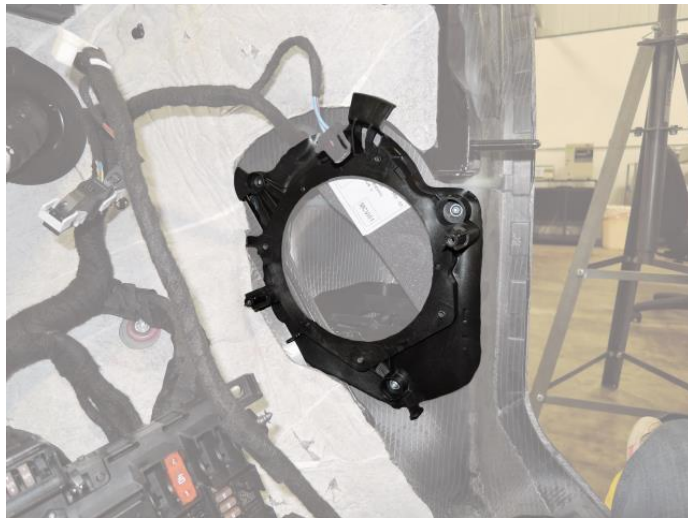
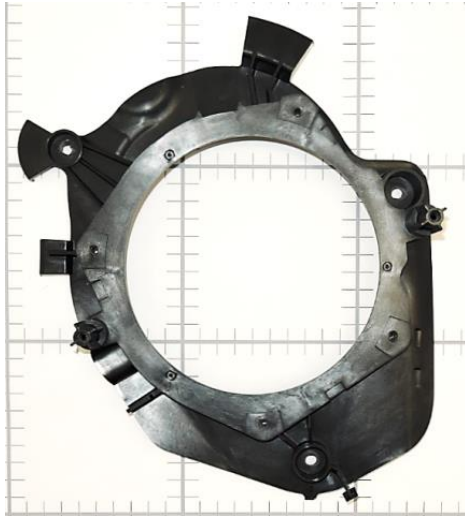
Passenger A-Pillar Speaker Mount Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
1500 Ton Injection Molding Press	13.44	4	0.25	125.63	CHN	\$0.12	99.99%	\$0.00

Passenger A-Pillar Speaker Mount Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, Passenger A-Pillar Speaker Mount	1	PPGF30	\$2.71	0.1525	0.1640	\$0.00	\$0.40

Assemble A-Pillar Speaker Mount



\...
\System Electronics
\Passenger A-Pillar Speaker Mount Asm
\Assemble A-Pillar Speaker Mount

Process Summary

Right First Time	99.97 %
Process Time (Sec)	25.75
Total Weight (kg)	0.00
Material Cost**	\$0.01
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.12
Q Burden	\$0.00
SG&A	\$0.02
Manufacturing Cost*	\$0.16

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble A-Pillar Speaker Mount



Assemble A-Pillar Speaker Mount

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Automated Asm	25.75	1	0.25	17.21	CHN	\$0.12	99.97%	\$0.00

Assemble A-Pillar Speaker Mount

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Foam, Passenger A-Pillar Speaker Foam	1	Commodity Item	Purchased	0.0005	-	\$0.01	\$0.00

Passenger A-Pillar Speaker Mount Installation



\...

\Zone 5 Electronics

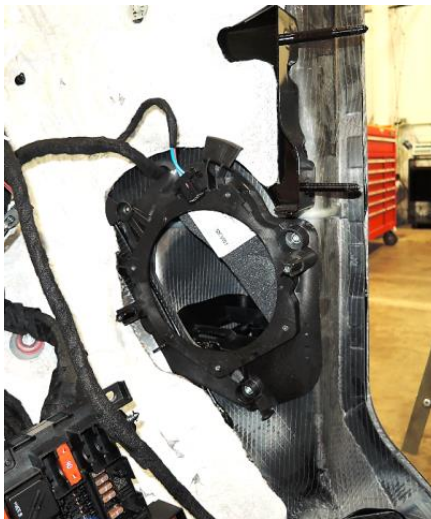
\System Electronics

\Passenger A-Pillar Speaker Mount Installation

Process Summary

Right First Time	99.37 %
Process Time (Sec)	51.00
Total Weight (kg)	0.01

Material Cost**	\$0.03
OEM Process Cost	\$1.29
Supplier Process Cost	\$0.00
Q Burden	\$0.10
SG&A	\$0.21
Manufacturing Cost*	\$1.63



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Passenger A-Pillar Speaker Mount Installation

Passenger A-Pillar Speaker Mount Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	51.00	1	1.00	91.41	GER	\$1.29	99.37%	\$0.10

Passenger A-Pillar Speaker Mount Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
M5x16mm-Torx Screw	3	Commodity Item	Purchased	0.0023	-	\$0.01	\$0.00

Passenger A-Pillar Speaker Asm



\...
 \Zone 5 Electronics
 \System Electronics
 \Passenger A-Pillar Speaker Asm
Assembly Summary

Parts	3
Fasteners	0
Part Numbers	3
Steps	9
Fastenings	2
Right First Time	99.90 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	0.52
Total Weight (kg)	0.30

Material Cost**	\$2.79
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.30
Q Burden	\$0.02
SG&A	\$0.16
Manufacturing Cost*	\$3.26

* Excluding tooling, ER&D, logistics, and profit margin
 ** Includes material cost and purchased parts cost

Passenger A-Pillar Speaker Asm



Passenger A-Pillar Speaker Asm

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Passenger A-Pillar Speaker Mount, Passenger A-Pill	1	1	0	1	0	99.99 %	0.00	0.00	0.00	0.10	0.0920
Assemble Passenger A-Pillar Speaker	1	2	2	7	2	99.91 %	0.00	0.00	0.42	0.00	0.2060

Passenger A-Pillar Speaker Asm

Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
Passenger A-Pillar Speaker Mount, Passenger A-Pill	\$0.00	\$0.23	\$0.00	\$0.00	\$0.00	\$0.15	\$0.00	\$0.06	\$0.44
Assemble Passenger A-Pillar Speaker	\$2.56	\$0.00	\$0.00	\$0.00	\$0.15	\$0.00	\$0.01	\$0.10	\$2.82

Detailed Summary

Parts	3
Fasteners	0
Part Numbers	3
Steps	9
Fastenings	2
Right First Time	99.9%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	0.42
Supplier Fab. Time (Min)	0.10
Total Weight (kg)	0.30
Purchased Part Cost	\$2.56
Material Cost	\$0.23
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$0.15
Supplier Fab. Cost	\$0.15
Q Burden	\$0.02
SG&A	\$0.16
Manufacturing Cost*	\$3.26

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Passenger A-Pillar Speaker Mount, Passenger A-Pill



\...

- \Passenger A-Pillar Speaker Asm
- \Passenger A-Pillar Speaker Mount, Passenger A-Pill
- \Passenger A-Pillar Speaker Mount Process

Process Summary

Right First Time	99.99 %
Process Time (Sec)	6.04
Total Weight (kg)	0.09

Material Cost**	\$0.23
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.15
Q Burden	\$0.00
SG&A	\$0.06
Manufacturing Cost*	\$0.44

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Passenger A-Pillar Speaker Mount, Passenger A-Pill



Passenger A-Pillar Speaker Mount Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
950 Ton Injection Molding Press	6.04	1	0.25	89.36	CHN	\$0.15	99.99%	\$0.00

Passenger A-Pillar Speaker Mount Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, Passenger A-Pillar Speaker Mount	1	PPGF25+MD15	\$2.45	0.0920	0.0950	\$0.00	\$0.23

Assemble Passenger A-Pillar Speaker



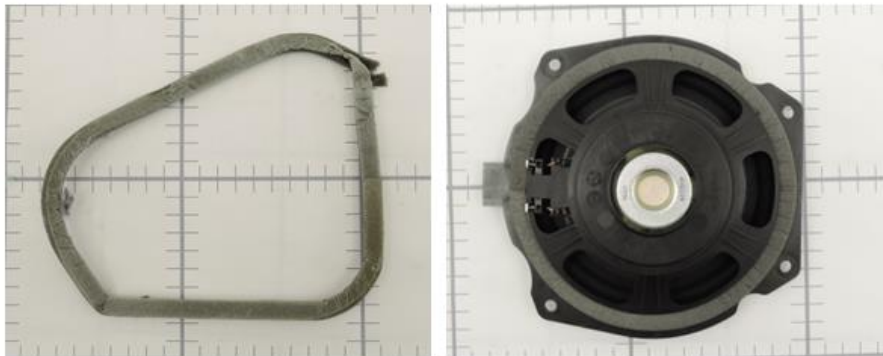
\...

- \System Electronics
- \Passenger A-Pillar Speaker Asm
- \Assemble Passenger A-Pillar Speaker

Process Summary

Right First Time	99.91 %
Process Time (Sec)	25.38
Total Weight (kg)	0.21

Material Cost**	\$2.56
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.15
Q Burden	\$0.01
SG&A	\$0.10
Manufacturing Cost*	\$2.82



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Passenger A-Pillar Speaker



Assemble Passenger A-Pillar Speaker

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	25.38	1	1.00	21.09	CHN	\$0.15	99.91 %	\$0.01

Assemble Passenger A-Pillar Speaker

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Foam, Passenger A-Pillar Speaker Asm	1	Commodity Item	Purchased	0.0019	-	\$0.01	\$0.00
Speaker, Passenger A-Pillar Speaker Asm	1	Commodity Item	Purchased	0.2041	-	\$2.55	\$0.00

Passenger A-Pillar Speaker Installation



\...
\Zone 5 Electronics
\System Electronics
\Passenger A-Pillar Speaker Installation

Process Summary

Right First Time	99.16 %
Process Time (Sec)	64.00
Total Weight (kg)	0.01

Material Cost**	\$0.04
OEM Process Cost	\$1.63
Supplier Process Cost	\$0.00
Q Burden	\$0.13
SG&A	\$0.26
Manufacturing Cost*	\$2.05



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Passenger A-Pillar Speaker Installation



Passenger A-Pillar Speaker Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	64.00	1	1.00	91.41	GER	\$1.63	99.16%	\$0.13

Passenger A-Pillar Speaker Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
M5x16mm-Torx Screw	4	Commodity Item	Purchased	0.0023	-	\$0.01	\$0.00

Driver A-Pillar Foam Asm



\...
 \Zone 5 Electronics
 \System Electronics
 \Driver A-Pillar Foam Asm

Assembly Summary

Parts	2
Fasteners	0
Part Numbers	2
Steps	7
Fastenings	0
Right First Time	99.93 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	0.19
Total Weight (kg)	0.02

Material Cost**	\$0.05
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.06
Q Burden	\$0.01
SG&A	\$0.02
Manufacturing Cost*	\$0.14

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Driver A-Pillar Foam Asm



Driver A-Pillar Foam Asm

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Driver A-Pillar Foam, Driver A-Pillar Foam Asm	1	1	0	3	0	99.96 %	0.00	0.00	0.00	0.05	0.0151
Assemble Driver A-Pillar Foam	1	1	0	3	0	99.97 %	0.00	0.00	0.13	0.00	0.0003

Driver A-Pillar Foam Asm

Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
Driver A-Pillar Foam, Driver A-Pillar Foam Asm	\$0.00	\$0.04	\$0.00	\$0.00	\$0.00	\$0.01	\$0.01	\$0.01	\$0.06
Assemble Driver A-Pillar Foam	\$0.01	\$0.00	\$0.00	\$0.00	\$0.05	\$0.00	\$0.01	\$0.01	\$0.08

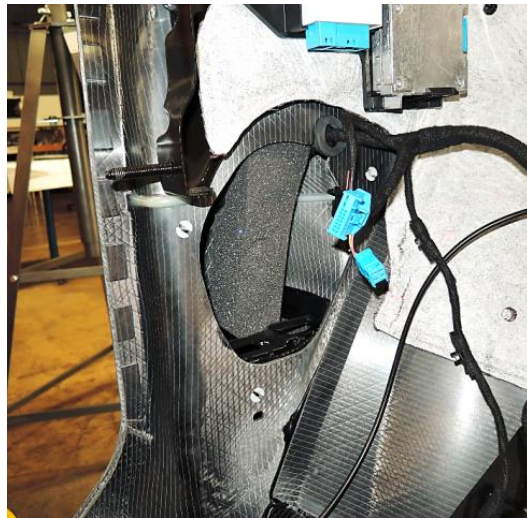
Detailed Summary

Parts	2
Fasteners	0
Part Numbers	2
Steps	7
Fastenings	0
Right First Time	99.93%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	0.13
Supplier Fab. Time (Min)	0.05
Total Weight (kg)	0.02
Purchased Part Cost	\$0.01
Material Cost	\$0.04
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$0.05
Supplier Fab. Cost	\$0.01
Q Burden	\$0.01
SG&A	\$0.02
Manufacturing Cost*	\$0.14

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Driver A-Pillar Foam, Driver A-Pillar Foam Asm



\...

\Driver A-Pillar Foam Asm

\Driver A-Pillar Foam, Driver A-Pillar Foam Asm

\A-Pillar Foam Asm Process

Process Summary

Right First Time	99.96 %
Process Time (Sec)	3.20
Total Weight (kg)	0.02

Material Cost**	\$0.04
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.01
Q Burden	\$0.01
SG&A	\$0.01
Manufacturing Cost*	\$0.06

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Driver A-Pillar Foam, Driver A-Pillar Foam Asm



A-Pillar Foam Asm Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
25Ton Trim Press	3.20	1	0.25	11.50	CZE	\$0.01	99.96%	\$0.01

A-Pillar Foam Asm Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, Driver A-Pillar Foam	1	Medium Density Foam	By Area	0.0151	-	\$0.00	\$0.04

Assemble Driver A-Pillar Foam

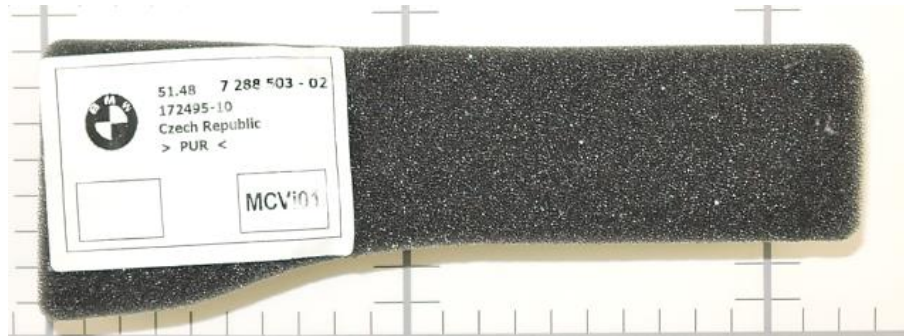


\...
 \System Electronics
 \Driver A-Pillar Foam Asm
 \Assemble Driver A-Pillar Foam

Process Summary

Right First Time	99.97 %
Process Time (Sec)	8.00
Total Weight (kg)	0.00

Material Cost**	\$0.01
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.05
Q Burden	\$0.01
SG&A	\$0.01
Manufacturing Cost*	\$0.08



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Driver A-Pillar Foam



Assemble Driver A-Pillar Foam

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	8.00	1	1.00	24.59	CZE	\$0.05	99.97%	\$0.01

Assemble Driver A-Pillar Foam

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Label, Driver A-Pillar Foam Asm	1	Commodity Item	Purchased	0.0003	-	\$0.01	\$0.00

Driver A-Pillar Foam Installation

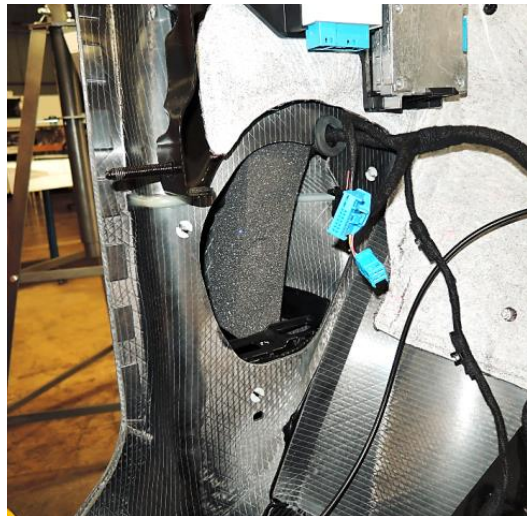


\...
\Zone 5 Electronics
\System Electronics
\Driver A-Pillar Foam Installation

Process Summary

Right First Time	99.96 %
Process Time (Sec)	12.00
Total Weight (kg)	0.00

Material Cost**	\$0.00
OEM Process Cost	\$0.30
Supplier Process Cost	\$0.00
Q Burden	\$0.01
SG&A	\$0.05
Manufacturing Cost*	\$0.36



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Driver A-Pillar Foam Installation



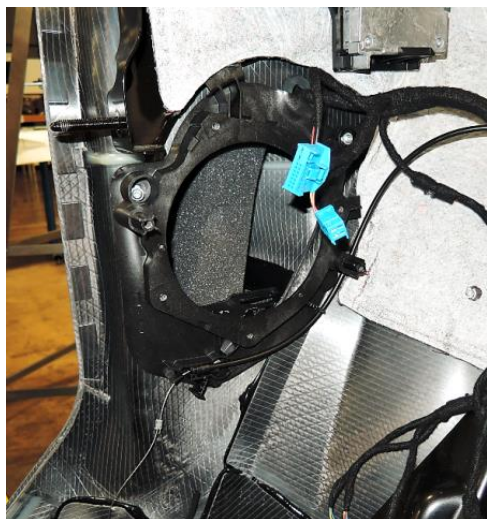
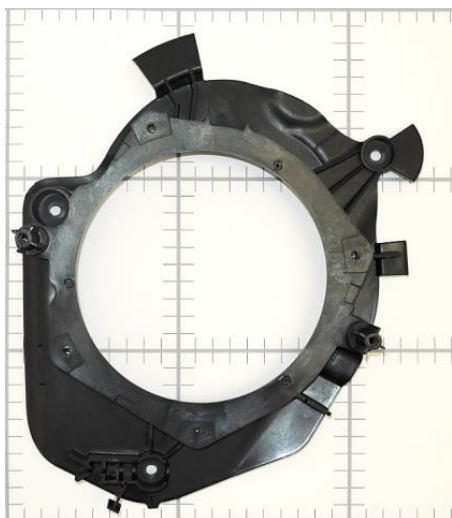
Driver A-Pillar Foam Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	12.00	1	1.00	91.41	GER	\$0.30	99.96%	\$0.01

Driver A-Pillar Foam Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
-------------	-----	----------	----------------------------	-----------------	----------------------------	---------------------	---------------

Driver A-Pillar Speaker Mount Asm



\...
 \Zone 5 Electronics
 \System Electronics
 \Driver A-Pillar Speaker Mount Asm
Assembly Summary

Parts	2
Fasteners	0
Part Numbers	2
Steps	6
Fastenings	1
Right First Time	99.96 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	0.49
Total Weight (kg)	0.15

Material Cost**	\$0.41
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.24
Q Burden	\$0.01
SG&A	\$0.10
Manufacturing Cost*	\$0.76

* Excluding tooling, ER&D, logistics, and profit margin
 ** Includes material cost and purchased parts cost

Driver A-Pillar Speaker Mount Asm



Driver A-Pillar Speaker Mount Asm

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Driver A-Pillar Speaker Mount, Driver A-Pillar Spe	1	1	0	1	0	99.99 %	0.00	0.00	0.00	0.06	0.1525
Assemble Driver A-Pillar Speaker Mount	1	1	1	4	1	99.97 %	0.00	0.00	0.43	0.00	0.0005

Driver A-Pillar Speaker Mount Asm

Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
Driver A-Pillar Speaker Mount, Driver A-Pillar Spe	\$0.00	\$0.40	\$0.00	\$0.00	\$0.00	\$0.12	\$0.00	\$0.08	\$0.60
Assemble Driver A-Pillar Speaker Mount	\$0.01	\$0.00	\$0.00	\$0.00	\$0.12	\$0.00	\$0.00	\$0.02	\$0.16

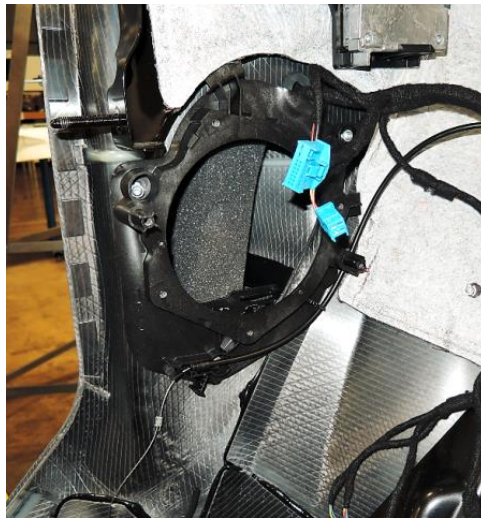
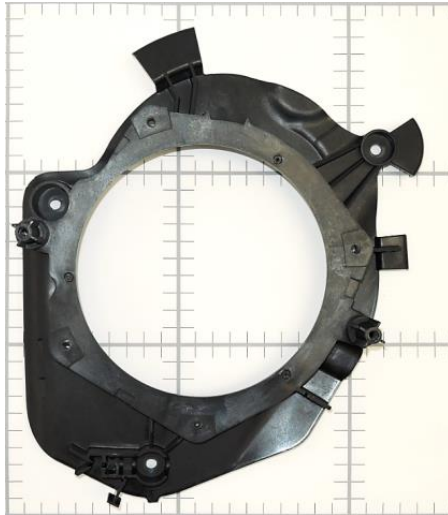
Detailed Summary

Parts	2
Fasteners	0
Part Numbers	2
Steps	6
Fastenings	1
Right First Time	99.96%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	0.43
Supplier Fab. Time (Min)	0.06
Total Weight (kg)	0.15
Purchased Part Cost	
	\$0.01
Material Cost	
	\$0.40
OEM Asm. Cost	
	\$0.00
OEM Fab. Cost	
	\$0.00
Supplier Asm. Cost	
	\$0.12
Supplier Fab. Cost	
	\$0.12
Q Burden	
	\$0.01
SG&A	
	\$0.10
Manufacturing Cost*	
	\$0.76

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Driver A-Pillar Speaker Mount, Driver A-Pillar Spe



\...

- \Driver A-Pillar Speaker Mount Asm
- \Driver A-Pillar Speaker Mount, Driver A-Pillar Spe
- \Driver A-Pillar Speaker Mount Asm Process

Process Summary

Right First Time	99.99 %
Process Time (Sec)	3.36
Total Weight (kg)	0.15
Material Cost**	\$0.40
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.12
Q Burden	\$0.00
SG&A	\$0.08
Manufacturing Cost*	\$0.60

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Driver A-Pillar Speaker Mount, Driver A-Pillar Spe



Driver A-Pillar Speaker Mount Asm Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
1500 Ton Injection Molding Press	13.44	4	0.25	125.63	CHN	\$0.12	99.99%	\$0.00

Driver A-Pillar Speaker Mount Asm Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, Driver A-Pillar Speaker Mount Asm	1	PPGF30	\$2.71	0.1525	0.1640	\$0.00	\$0.40

Assemble Driver A-Pillar Speaker Mount



\...

\System Electronics

\Driver A-Pillar Speaker Mount Asm

\Assemble Driver A-Pillar Speaker Mount

Process Summary

Right First Time	99.97 %
Process Time (Sec)	25.75
Total Weight (kg)	0.00

Material Cost**	\$0.01
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.12
Q Burden	\$0.00
SG&A	\$0.02
Manufacturing Cost*	\$0.16

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Driver A-Pillar Speaker Mount



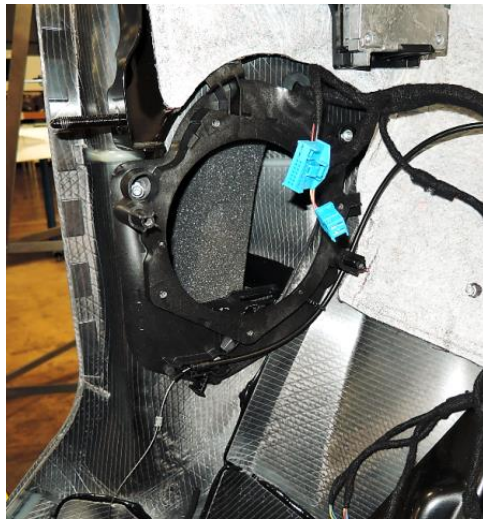
Assemble Driver A-Pillar Speaker Mount

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Automated Asm	25.75	1	0.25	17.21	CHN	\$0.12	99.97%	\$0.00

Assemble Driver A-Pillar Speaker Mount

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Foam, Driver A-Pillar Speaker Mount Asm	1	Commodity Item	Purchased	0.0005	-	\$0.01	\$0.00

Driver A-Pillar Speaker Mount Installation



\...

- \Zone 5 Electronics
- \System Electronics
- \Driver A-Pillar Speaker Mount Installation

Process Summary

Right First Time	99.37 %
Process Time (Sec)	51.00
Total Weight (kg)	0.01

Material Cost**	\$0.03
OEM Process Cost	\$1.29
Supplier Process Cost	\$0.00
Q Burden	\$0.10
SG&A	\$0.21
Manufacturing Cost*	\$1.63

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Driver A-Pillar Speaker Mount Installation



Driver A-Pillar Speaker Mount Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	51.00	1	1.00	91.41	GER	\$1.29	99.37%	\$0.10

Driver A-Pillar Speaker Mount Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
M5x16mm-Torx Screw	3	Commodity Item	Purchased	0.0023	-	\$0.01	\$0.00

Driver A-Pillar Speaker Asm



\...

- \Zone 5 Electronics
- \System Electronics
- \Driver A-Pillar Speaker Asm

Assembly Summary

Parts	3
Fasteners	0
Part Numbers	3
Steps	9
Fastenings	2
Right First Time	99.90 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	0.69
Total Weight (kg)	0.30

Material Cost**	\$2.80
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.36
Q Burden	\$0.02
SG&A	\$0.17
Manufacturing Cost*	\$3.34

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Driver A-Pillar Speaker Asm

Driver A-Pillar Speaker Asm

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Driver A-Pillar Speaker Mount, Driver A-Pillar Spe	1	1	0	1	0	99.99 %	0.00	0.00	0.00	0.10	0.0920
Assemble Driver A-Pillar Speaker	1	2	2	7	2	99.91 %	0.00	0.00	0.59	0.00	0.2070

Driver A-Pillar Speaker Asm

Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
Driver A-Pillar Speaker Mount, Driver A-Pillar Spe	\$0.00	\$0.24	\$0.00	\$0.00	\$0.00	\$0.15	\$0.00	\$0.06	\$0.45
Assemble Driver A-Pillar Speaker	\$2.56	\$0.00	\$0.00	\$0.00	\$0.21	\$0.00	\$0.01	\$0.11	\$2.89

Detailed Summary

Parts	3
Fasteners	0
Part Numbers	3
Steps	9
Fastenings	2
Right First Time	99.9%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	0.59
Supplier Fab. Time (Min)	0.10
Total Weight (kg)	0.30
Purchased Part Cost	
	\$2.56
Material Cost	
	\$0.24
OEM Asm. Cost	
	\$0.00
OEM Fab. Cost	
	\$0.00
Supplier Asm. Cost	
	\$0.21
Supplier Fab. Cost	
	\$0.15
Q Burden	
	\$0.02
SG&A	
	\$0.17
Manufacturing Cost*	
	\$3.34

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Driver A-Pillar Speaker Mount, Driver A-Pillar Spe



\...

\Driver A-Pillar Speaker Asm

\Driver A-Pillar Speaker Mount, Driver A-Pillar Spe

\Driver A-Pillar Speaker Mount Process

Process Summary

Right First Time	99.99 %
Process Time (Sec)	6.04
Total Weight (kg)	0.09

Material Cost**	\$0.24
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.15
Q Burden	\$0.00
SG&A	\$0.06
Manufacturing Cost*	\$0.45

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Driver A-Pillar Speaker Mount, Driver A-Pillar Spe



Driver A-Pillar Speaker Mount Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
950 Ton Injection Molding Press	6.04	1	0.25	89.36	CHN	\$0.15	99.99%	\$0.00

Driver A-Pillar Speaker Mount Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, Driver A-Pillar Speaker Mount	1	PPGF25+MD15	\$2.45	0.0920	0.0980	\$0.00	\$0.24

Assemble Driver A-Pillar Speaker



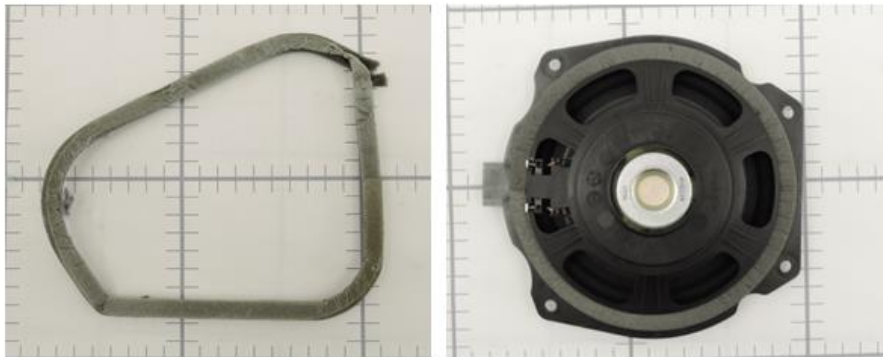
\...

- \System Electronics
- \Driver A-Pillar Speaker Asm
- \Assemble Driver A-Pillar Speaker

Process Summary

Right First Time	99.91 %
Process Time (Sec)	35.38
Total Weight (kg)	0.21

Material Cost**	\$2.56
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.21
Q Burden	\$0.01
SG&A	\$0.11
Manufacturing Cost*	\$2.89



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Driver A-Pillar Speaker



Assemble Driver A-Pillar Speaker

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	35.38	1	1.00	21.09	CHN	\$0.21	99.91 %	\$0.01

Assemble Driver A-Pillar Speaker

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Foam, Driver A-Pillar Speaker Asm	1	Commodity Item	Purchased	0.0022	-	\$0.01	\$0.00
Speaker, Driver A-Pillar Speaker Asm	1	Commodity Item	Purchased	0.2048	-	\$2.55	\$0.00

Driver A-Pillar Speaker Installation



\...

- \Zone 5 Electronics
- \System Electronics
- \Driver A-Pillar Speaker Installation

Process Summary

Right First Time	99.16 %
Process Time (Sec)	64.00
Total Weight (kg)	0.01

Material Cost**	\$0.04
OEM Process Cost	\$1.63
Supplier Process Cost	\$0.00
Q Burden	\$0.13
SG&A	\$0.26
Manufacturing Cost*	\$2.05

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Driver A-Pillar Speaker Installation



Driver A-Pillar Speaker Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	64.00	1	1.00	91.41	GER	\$1.63	99.16%	\$0.13

Driver A-Pillar Speaker Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
M5x16mm-Torx Screw	4	Commodity Item	Purchased	0.0023	-	\$0.01	\$0.00



\...

- \Zone 5 Electronics
- \System Electronics
- \Back-up Antenna Installation

Process Summary

Right First Time	99.75 %
Process Time (Sec)	19.00
Total Weight (kg)	0.09

Material Cost**	\$5.40
OEM Process Cost	\$0.48
Supplier Process Cost	\$0.00
Q Burden	\$0.04
SG&A	\$0.94
Manufacturing Cost*	\$6.86



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Back-up Antenna Installation

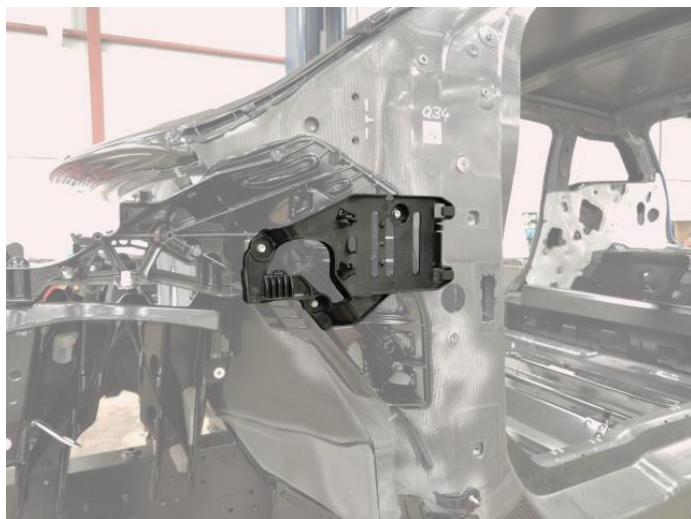
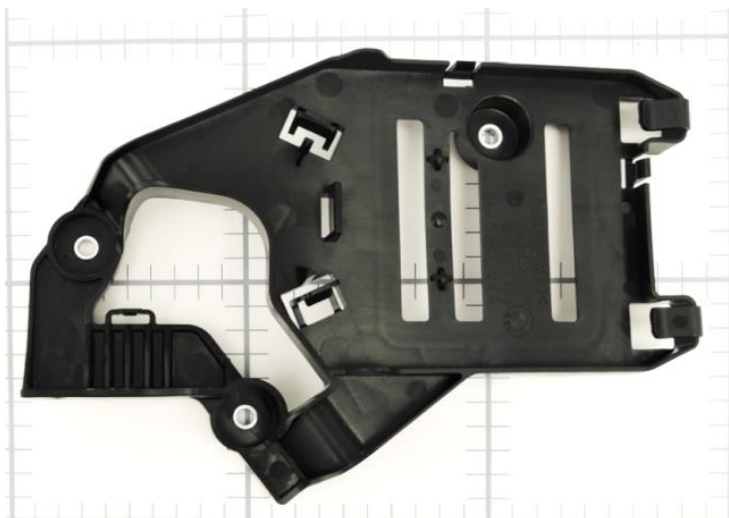


Back-up Antenna Installation									
Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden	
OEM Manual Asm	19.00	1	1.00	91.41	GER	\$0.48	99.75%	\$0.04	

Back-up Antenna Installation									
Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost		
Back-up Antenna Asm	1	See Appendix	-	0.0849	-	\$0.00	\$5.39		
M5x16mm-Torx Screw	1	Commodity Item	Purchased	0.0036	-	\$0.01	\$0.00		

[Click Here for TechInsights Electronics Report on Back-Up Antenna Asm](#)

Horn and EDME Mounting Bracket Asm



\...
 \Zone 5 Electronics
 \System Electronics
 \Horn and EDME Mounting Bracket Asm
Assembly Summary

Parts	4
Fasteners	0
Part Numbers	2
Steps	8
Fastenings	0
Right First Time	99.97 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	0.19
Total Weight (kg)	0.16

Material Cost**	\$0.78
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.27
Q Burden	\$0.00
SG&A	\$0.16
Manufacturing Cost*	\$1.21

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Horn and EDME Mounting Bracket Asm



Horn and EDME Mounting Bracket Asm

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
EDME Mounting Bracke	1	4	0	7	0	99.97 %	0.00	0.00	0.00	0.19	0.1598

Horn and EDME Mounting Bracket Asm

Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
EDME Mounting Bracke	\$0.09	\$0.69	\$0.00	\$0.00	\$0.00	\$0.27	\$0.00	\$0.16	\$1.21

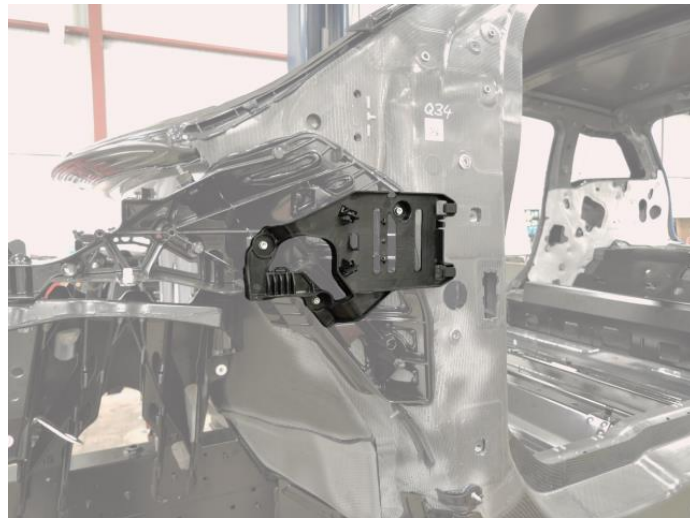
Detailed Summary

Parts	4
Fasteners	0
Part Numbers	2
Steps	8
Fastenings	0
Right First Time	99.97%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	0.00
Supplier Fab. Time (Min)	0.19
Total Weight (kg)	0.16
Purchased Part Cost	\$0.09
Material Cost	\$0.69
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$0.00
Supplier Fab. Cost	\$0.27
Q Burden	\$0.00
SG&A	\$0.16
Manufacturing Cost*	\$1.21

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

EDME Mounting Bracke



- \...
- \Horn and EDME Mounting Bracket Asm
- \ EDME Mounting Bracke
- \ EDME Mounting Bracket Process

Process Summary

Right First Time	99.97 %
Process Time (Sec)	11.65
Total Weight (kg)	0.16
Material Cost**	\$0.78
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.27
Q Burden	\$0.00
SG&A	\$0.16
Manufacturing Cost*	\$1.21

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

EDME Mounting Bracke



EDME Mounting Bracket Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
720 Ton Injection Molding	46.60	4	0.25	83.12	GER	\$0.27	99.97%	\$0.00

EDME Mounting Bracket Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
EDME Bracket Bushing	3	Commodity Item	Purchased	0.0011	-	\$0.03	\$0.00
EDME Mounting Bracket, Material	1	PA6 GF30	\$4.10	0.1565	0.1680	\$0.00	\$0.69



- \...
- \Zone 5 Electronics
- \System Electronics
- \EDME and Horn Installation

Process Summary

Right First Time	98.88 %
Process Time (Sec)	88.00
Total Weight (kg)	0.47

Material Cost**	\$52.10
OEM Process Cost	\$2.23
Supplier Process Cost	\$0.00
Q Burden	\$0.17
SG&A	\$8.10
Manufacturing Cost*	\$62.60



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

EDME and Horn Installation

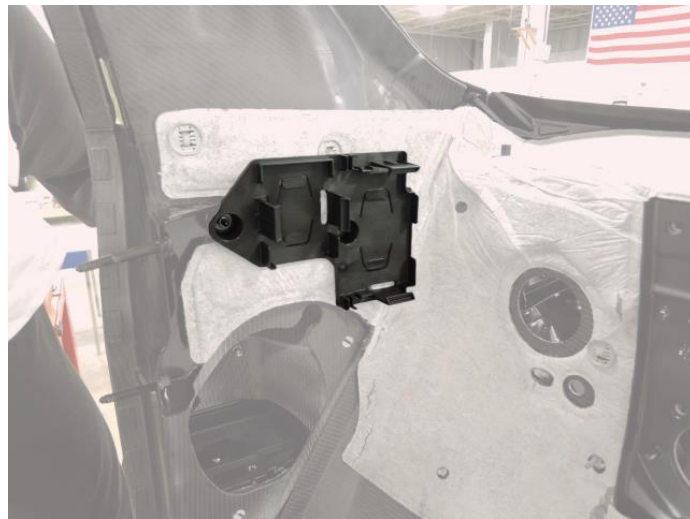
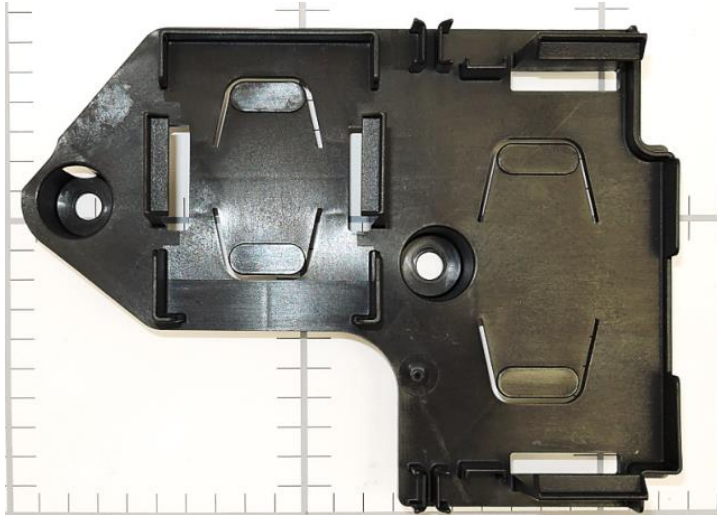
Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	88.00	1	1.00	91.41	GER	\$2.23	98.88 %	\$0.17

EDME and Horn Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
M5x15mm-Torx SEMS Bolt	3	Commodity Item	Purchased	0.0042	-	\$0.02	\$0.00
Horn Asm	1	Commodity Item	Purchased	0.1626	-	\$4.50	\$0.00
M6x6mm-Hex KEPS Nut	2	Commodity Item	Purchased	0.0049	-	\$0.02	\$0.00
Electrical Digital MotorElectronics Asm	1	See Appendix	-	0.2829	-	\$0.00	\$47.50

[Click Here for TechInsights Electronics Report on Electrical Digital Motor Asm](#)

KAFAS and Controller Mounting Bracket Asm



\...
\System Electronics
\KAFAS and Controller Mounting Bracket Asm
\KAFAS and Controller Mtg Bracket Asm Process

Process Summary

Right First Time	99.99 %
Process Time (Sec)	5.75
Total Weight (kg)	0.10

Material Cost**	\$0.42
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.09
Q Burden	\$0.00
SG&A	\$0.08
Manufacturing Cost*	\$0.59

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

KAFAS and Controller Mounting Bracket Asm

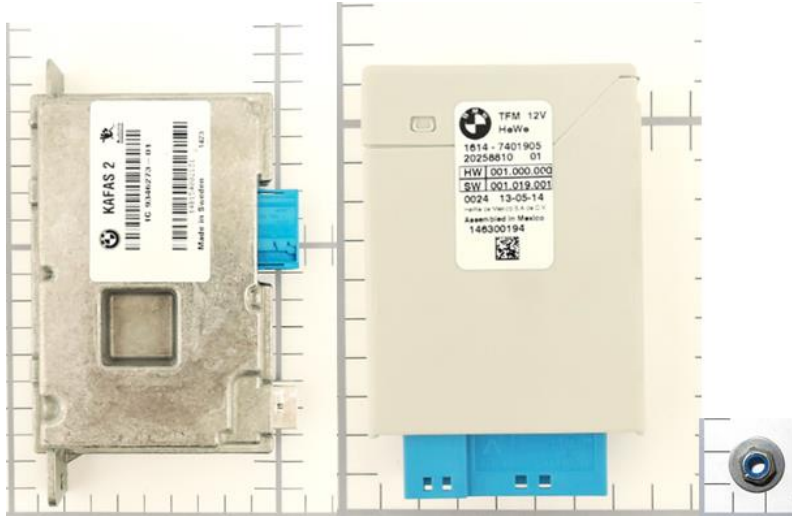


KAFAS and Conroller Mtg Bracket Asm Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
500 Ton Injection Molding Press	23.00	4	0.25	56.33	GER	\$0.09	99.99%	\$0.00

KAFAS and Conroller Mtg Bracket Asm Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, KAFAS and Controller Mounting Bracket As	1	PP GF30	\$2.71	0.1001	0.1080	\$0.00	\$0.42



- \...
- \Zone 5 Electronics
- \System Electronics
- \KAFAS and Controller Installation

Process Summary

Right First Time	99.43 %
Process Time (Sec)	48.00
Total Weight (kg)	0.39

Material Cost**	\$82.15
OEM Process Cost	\$1.22
Supplier Process Cost	\$0.00
Q Burden	\$0.09
SG&A	\$13.30
Manufacturing Cost*	\$96.76



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

KAFAS and Controller Installation



KAFAS and Controller Installation									
Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden	
OEM Manual Asm	48.00	1	1.00	91.41	GER	\$1.22	99.43%	\$0.09	

KAFAS and Controller Installation								
Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost	
M6x8mm-Nylock KEPS Nut	2	Commodity Item	Purchased	0.0045	-	\$0.14	\$0.00	
Hybrid Pressure Refueling Electronic Control Unit	1	See Appendix	-	0.0698	-	\$0.00	\$23.38	
Camera-based Driver Support Systems (KAFAS) Asm	1	See Appendix	-	0.3143	-	\$0.00	\$58.49	

[Click Here for TechInsights Electronics Report on Hybrid Pressure Refueling ECU](#)

[Click Here for TechInsights Electronics Report on Driver Support System](#)

Remote Control Receiver and Bracket Installation

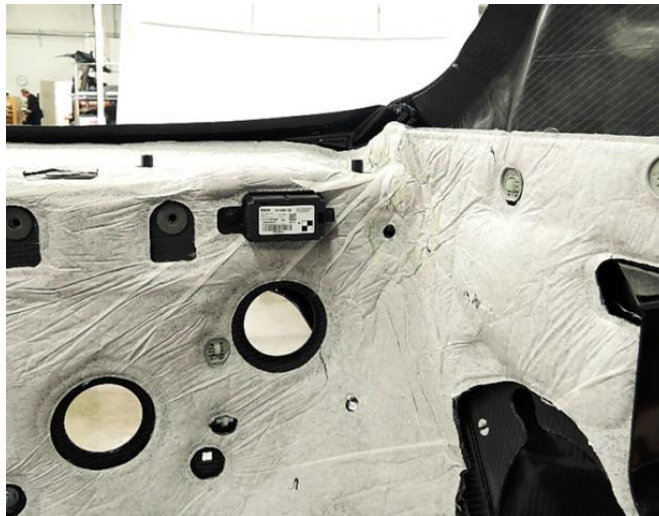


- \...
- \Zone 5 Electronics
- \System Electronics
- \Remote Control Receiver and Bracket Installation

Process Summary

Right First Time	99.91 %
Process Time (Sec)	13.00
Total Weight (kg)	0.05

Material Cost**	\$13.12
OEM Process Cost	\$0.33
Supplier Process Cost	\$0.00
Q Burden	\$0.01
SG&A	\$2.15
Manufacturing Cost*	\$15.61



* Excluding tooling, ER&D, logistics, and profit margin
 ** Includes material cost and purchased parts cost

Remote Control Receiver and Bracket Installation



Remote Control Receiver and Bracket Installation									
Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden	
OEM Manual Asm	13.00	1	1.00	91.41	GER	\$0.33	99.91 %	\$0.01	

Remote Control Receiver and Bracket Installation									
Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost		
Remote Control Receiver and Bracket Asm	1	See Appendix	-	0.0450	-	\$0.00	\$13.08		
Two Stage Push Pin	1	Commodity Item	Purchased	0.0007	-	\$0.04	\$0.00		

[Click Here for TechInsights Electronics Report on Remote Control Receiver Asm](#)

Side Wave Traps and Filter Installation



- \...
- \Zone 5 Electronics
- \System Electronics
- \Side Wave Traps and Filter Installation

Process Summary

Right First Time	99.25 %
Process Time (Sec)	43.00
Total Weight (kg)	0.09

Material Cost**	\$11.97
OEM Process Cost	\$1.09
Supplier Process Cost	\$0.00
Q Burden	\$0.11
SG&A	\$2.09
Manufacturing Cost*	\$15.26



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Side Wave Traps and Filter Installation



Side Wave Traps and Filter Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	43.00	1	1.00	91.41	GER	\$1.09	99.25%	\$0.11

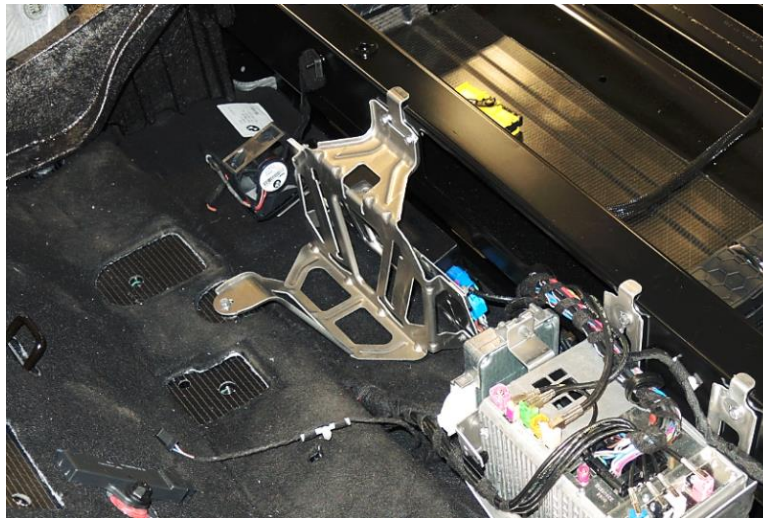
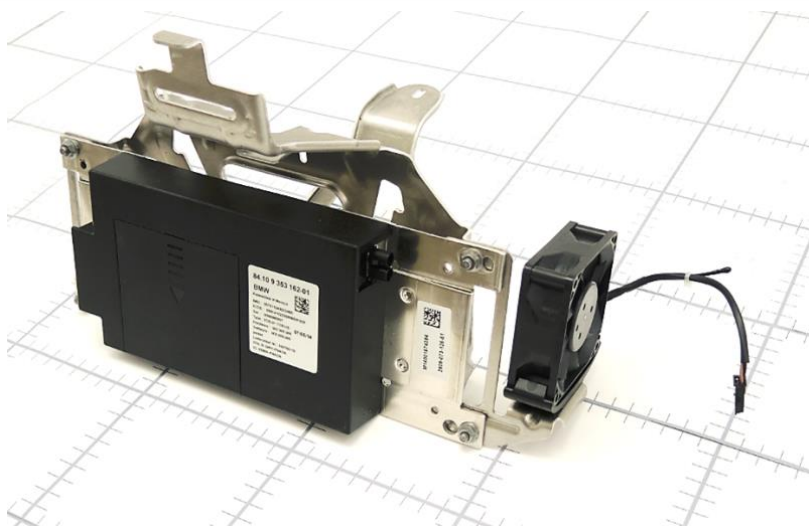
Side Wave Traps and Filter Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Wave Trap Asm	2	See Appendix	-	0.0251	-	\$0.00	\$1.68
Interference Suppression Filter Asm	1	See Appendix	-	0.0416	-	\$0.00	\$8.61

[Click Here for TechInsights Electronics Report on Wave Trap](#)

[Click Here for TechInsights Electronics Report on Interference Suppression Filter Asm](#)

Telematic Communication Box and Bracket Asm



\...

\Zone 5 Electronics

\System Electronics

\Telematic Communication Box and Bracket Asm

Assembly Summary

Parts	27
Fasteners	14
Part Numbers	16
Steps	101
Fastenings	29
Right First Time	97.11 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	4.65
Total Weight (kg)	0.81

Material Cost**	\$81.53
OEM Process Cost	\$0.00
Supplier Process Cost	\$1.84
Q Burden	\$0.44
SG&A	\$11.59
Manufacturing Cost*	\$95.40

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Telematic Communication Box and Bracket Asm



MUNRO
& ASSOCIATES, INC.

Telematic Communication Box and Bracket Asm

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Mounting Bracket Asm, Telematic Communication Box	1	8	7	31	7	99.43 %	0.00	0.00	0.65	0.39	0.2494
Telematic Communication Asm, Telematic Communication Box	1	14	17	55	17	98.52 %	0.00	0.00	2.45	0.44	0.4512
Assemble Telematic Communication Box to Bracket	1	4	4	11	4	99.14 %	0.00	0.00	0.65	0.00	0.0076
Assemble Fan	1	1	1	2	1	99.99 %	0.00	0.00	0.07	0.00	0.0990

Telematic Communication Box and Bracket Asm

Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
Mounting Bracket Asm, Telematic Communication Box	\$0.11	\$2.71	\$0.00	\$0.00	\$0.23	\$0.15	\$0.09	\$0.50	\$3.79
Telematic Communication Asm, Telematic Communication Box	\$4.77	\$65.36	\$0.00	\$0.00	\$1.06	\$0.15	\$0.22	\$10.79	\$82.35
Assemble Telematic Communication Box to Bracket	\$0.08	\$0.00	\$0.00	\$0.00	\$0.23	\$0.00	\$0.13	\$0.04	\$0.48
Assemble Fan	\$8.50	\$0.00	\$0.00	\$0.00	\$0.02	\$0.00	\$0.00	\$0.26	\$8.78

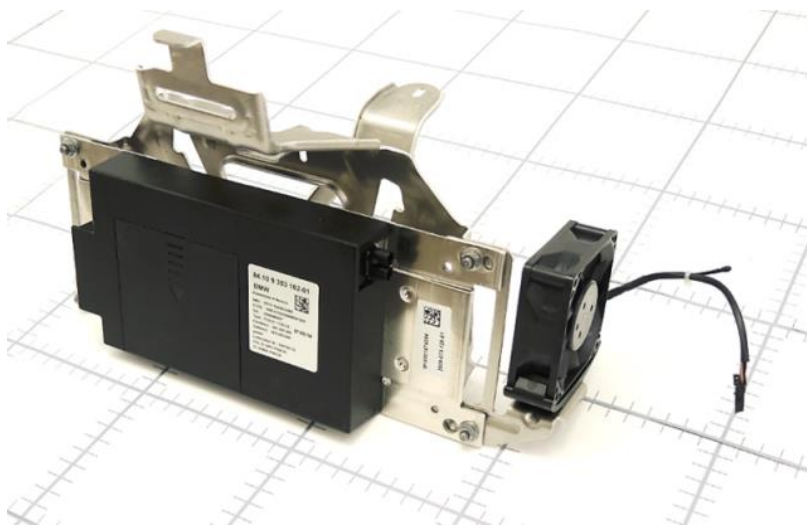
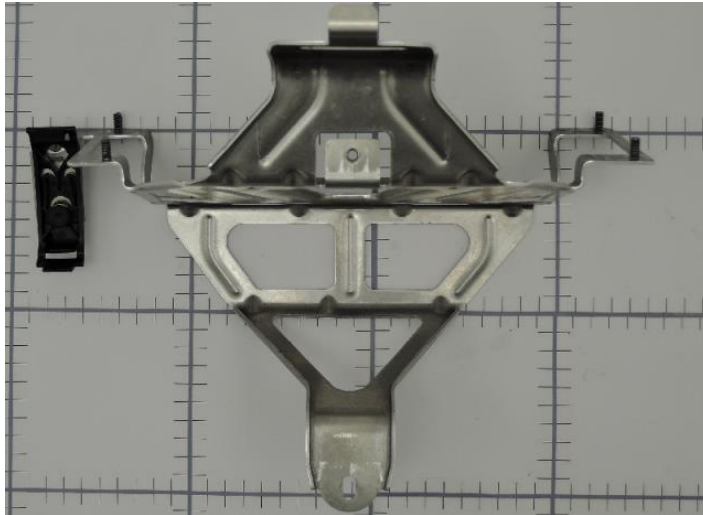
Detailed Summary

Parts	27
Fasteners	14
Part Numbers	16
Steps	101
Fastenings	29
Right First Time	97.11%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	3.82
Supplier Fab. Time (Min)	0.83
Total Weight (kg)	0.81
Purchased Part Cost	\$13.46
Material Cost	\$68.07
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$1.54
Supplier Fab. Cost	\$0.30
Q Burden	\$0.44
SG&A	\$11.59
Manufacturing Cost*	\$95.40

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Mounting Bracket Asm, Telematic Communication Box



\...
 \System Electronics
 \Telematic Communication Box and Bracket Asm
 \Mounting Bracket Asm, Telematic Communication Box
Assembly Summary

Parts	8
Fasteners	5
Part Numbers	5
Steps	31
Fastenings	7
Right First Time	99.43 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	1.04
Total Weight (kg)	0.25

Material Cost**	\$2.82
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.38
Q Burden	\$0.09
SG&A	\$0.50
Manufacturing Cost*	\$3.79

* Excluding tooling, ER&D, logistics, and profit margin
 ** Includes material cost and purchased parts cost

Mounting Bracket Asm, Telematic Communication Box



Mounting Bracket Asm, Telematic Communication Box

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Mounting Bracket, Mounting Bracket Asm	1	1	0	7	0	99.97 %	0.00	0.00	0.00	0.33	0.2340
Assemble Mounting Bracket	1	5	5	16	5	99.56 %	0.00	0.00	0.37	0.00	0.0068
Fan Mounting Bracket, Mounting Bracket Asm	1	1	0	1	0	99.99 %	0.00	0.00	0.00	0.06	0.0080
Assemble Fan Mounting Bracket	1	1	2	5	2	99.92 %	0.00	0.00	0.28	0.00	0.0006

Mounting Bracket Asm, Telematic Communication Box

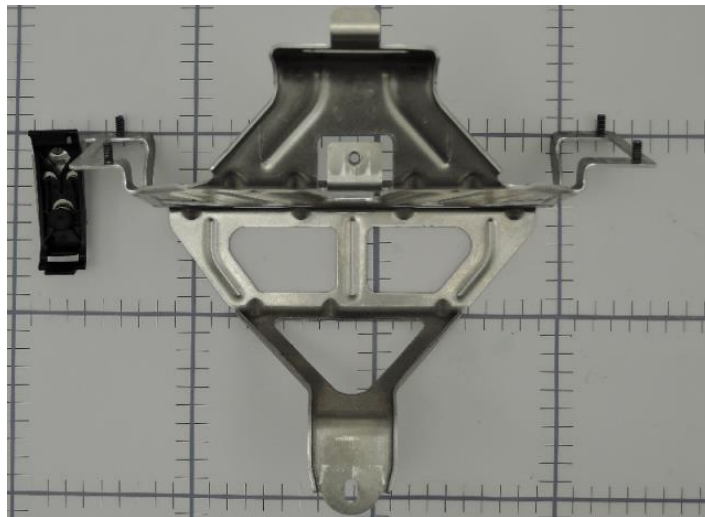
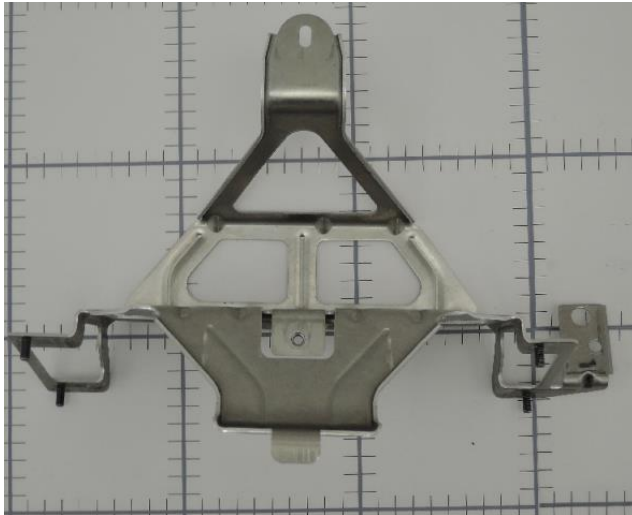
Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
Mounting Bracket, Mounting Bracket Asm	\$0.00	\$2.67	\$0.00	\$0.00	\$0.00	\$0.14	\$0.01	\$0.45	\$3.26
Assemble Mounting Bracket	\$0.09	\$0.00	\$0.00	\$0.00	\$0.13	\$0.00	\$0.07	\$0.02	\$0.31
Fan Mounting Bracket, Mounting Bracket Asm	\$0.00	\$0.04	\$0.00	\$0.00	\$0.00	\$0.01	\$0.00	\$0.01	\$0.06
Assemble Fan Mounting Bracket	\$0.02	\$0.00	\$0.00	\$0.00	\$0.10	\$0.00	\$0.01	\$0.02	\$0.15

Detailed Summary

Parts	8
Fasteners	5
Part Numbers	5
Steps	31
Fastenings	7
Right First Time	99.43%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	0.65
Supplier Fab. Time (Min)	0.39
Total Weight (kg)	0.25
Purchased Part Cost	\$0.11
Material Cost	\$2.71
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$0.23
Supplier Fab. Cost	\$0.15
Q Burden	\$0.09
SG&A	\$0.50
Manufacturing Cost*	\$3.79

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost



\...

- \Mounting Bracket Asm, Telematic Communication Box
- \Mounting Bracket, Mounting Bracket Asm
- \Mounting Bracket Process

Process Summary

Right First Time	99.97 %
Process Time (Sec)	19.81
Total Weight (kg)	0.23

Material Cost**	\$2.67
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.14
Q Burden	\$0.01
SG&A	\$0.45
Manufacturing Cost*	\$3.26

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Mounting Bracket, Mounting Bracket Asm



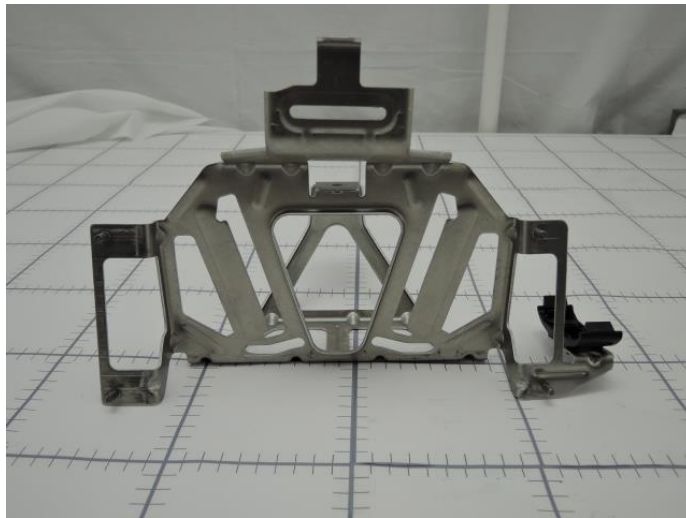
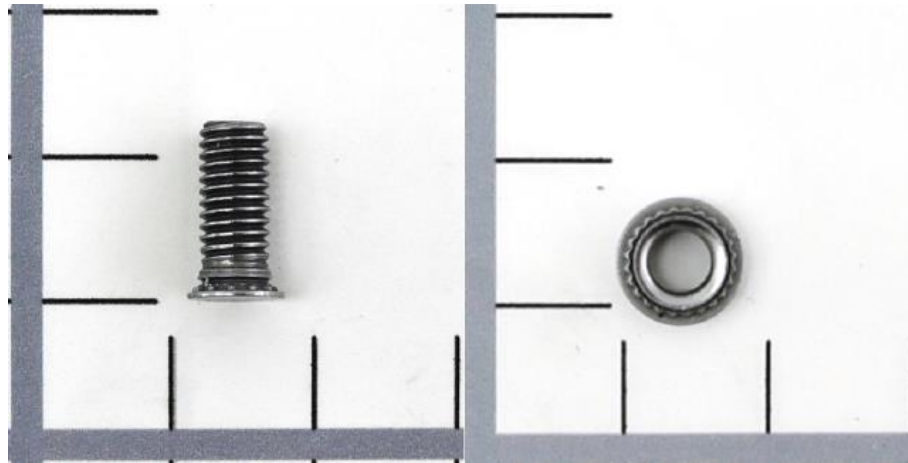
Mounting Bracket Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Wash	9.00	1	1.00	18.19		\$0.05	99.99%	\$0.00
Deburr	9.00	1	1.00	13.81		\$0.03	99.99%	\$0.00
1000 Ton Stamping Press	7.24	4	0.25	113.03	MEX	\$0.06	99.99%	\$0.00

Mounting Bracket Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Al 3003-O, Mounting Bracket	1	Aluminum 3003-O - Coil Stock	\$4.08	0.2340	0.6550	\$0.00	\$2.67

Assemble Mounting Bracket



\...

- \Telematic Communication Box and Bracket Asm
- \Mounting Bracket Asm, Telematic Communication Box
- \Assemble Mounting Bracket

Process Summary

Right First Time	99.56 %
Process Time (Sec)	22.00
Total Weight (kg)	0.01

Material Cost**	\$0.09
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.13
Q Burden	\$0.07
SG&A	\$0.02
Manufacturing Cost*	\$0.31

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Mounting Bracket



Assemble Mounting Bracket

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Automated Asm	22.00	1	0.25	21.52	MEX	\$0.13	99.56%	\$0.07

Assemble Mounting Bracket

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Threaded Rod, Mounting Bracket	4	Commodity Item	Purchased	0.0015	-	\$0.01	\$0.00
M4x4mm-Splined Threaded Insert	1	Commodity Item	Purchased	0.0008	-	\$0.05	\$0.00

Fan Mounting Bracket, Mounting Bracket Asm



\...

- \Mounting Bracket Asm, Telematic Communication Box
- \Fan Mounting Bracket, Mounting Bracket Asm
- \Fan Mounting Bracket Process

Process Summary

Right First Time	99.99 %
Process Time (Sec)	3.61
Total Weight (kg)	0.01

Material Cost**	\$0.04
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.01
Q Burden	\$0.00
SG&A	\$0.01
Manufacturing Cost*	\$0.06

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Fan Mounting Bracket, Mounting Bracket Asm



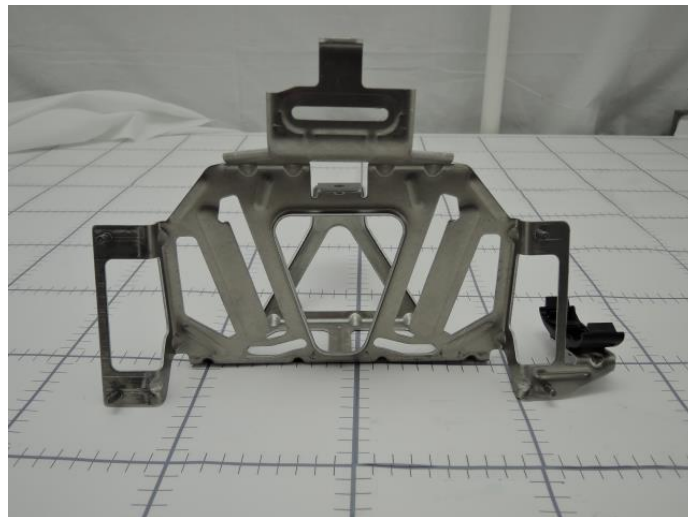
Fan Mounting Bracket Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
55Ton Injection Molding Press	28.88	8	0.25	14.51	MEX	\$0.01	99.99%	\$0.00

Fan Mounting Bracket Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
PA66, Fan Mounting Bracket	1	PA66	\$4.15	0.0080	0.0086	\$0.00	\$0.04

Assemble Fan Mounting Bracket



\...

- \Telematic Communication Box and Bracket Asm
- \Mounting Bracket Asm, Telematic Communication Box
- \Assemble Fan Mounting Bracket

Process Summary

Right First Time	99.92 %
Process Time (Sec)	17.00
Total Weight (kg)	0.00

Material Cost**	\$0.02
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.10
Q Burden	\$0.01
SG&A	\$0.02
Manufacturing Cost*	\$0.15

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost


Assemble Fan Mounting Bracket

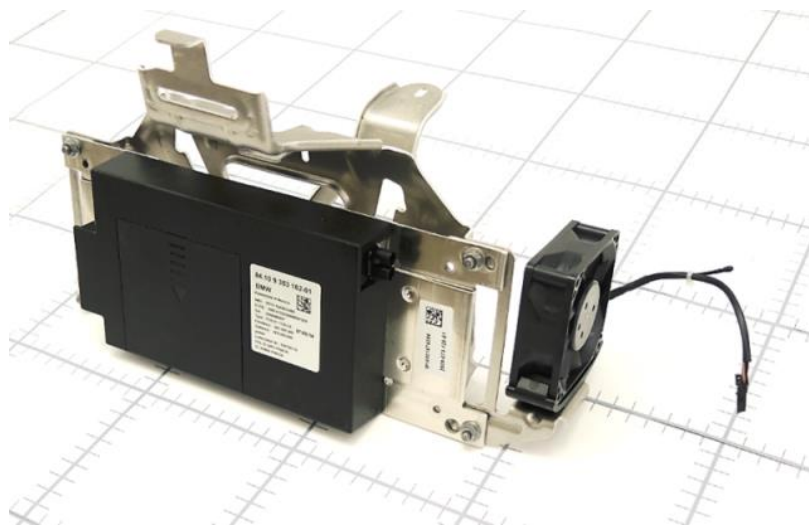


Assemble Fan Mounting Bracket

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	17.00	1	1.00	21.36	MEX	\$0.10	99.92 %	\$0.01

Assemble Fan Mounting Bracket

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
 Plastic Pin	1	Commodity Item	Purchased	0.0006	-	\$0.02	\$0.00



\...
 \System Electronics
 \Telematic Communication Box and Bracket Asm
 \Telematic Communication Asm, Telematic Communicati

Assembly Summary

Parts	14
Fasteners	5
Part Numbers	9
Steps	55
Fastenings	17
Right First Time	98.52 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	2.89
Total Weight (kg)	0.45

Material Cost**	\$70.13
OEM Process Cost	\$0.00
Supplier Process Cost	\$1.20
Q Burden	\$0.22
SG&A	\$10.79
Manufacturing Cost*	\$82.35

* Excluding tooling, ER&D, logistics, and profit margin
 ** Includes material cost and purchased parts cost

Telematic Communication Asm, Telematic Communicati



Telematic Communication Asm, Telematic Communicati												
Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)	
Telematic Communication Box, Telematic Communicati	1	1	0	1	0	99.99 %	0.00	0.00	0.00	0.07	0.1108	
Battery Asm, Telematic Communication Box Asm	1	3	2	5	2	99.95 %	0.00	0.00	0.30	0.00	0.0509	
Assemble Telematic Communication Box Battery	1	0	1	4	1	99.93 %	0.00	0.00	0.25	0.00	0.0000	
Telematic Communication Box Lid, Telematic Communi	1	1	0	1	0	99.99 %	0.00	0.00	0.00	0.04	0.0233	
Assemble Telematic Communication Box Lid	1	1	2	4	2	99.95 %	0.00	0.00	0.14	0.00	0.0001	
Assemble Telematic Communication Printed Circuit	1	2	2	6	2	99.72 %	0.00	0.00	0.38	0.00	0.1144	
Telematic Communication Box Mounting Bracket, Tele	1	1	4	17	4	99.89 %	0.00	0.00	0.37	0.33	0.1500	
Assemble Telematic Communication Mounting Bracket	1	5	6	13	6	99.12 %	0.00	0.00	1.02	0.00	0.0017	

Telematic Communication Asm, Telematic Communicati										
Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*	
Telematic Communication Box, Telematic Communicati	\$0.00	\$0.31	\$0.00	\$0.00	\$0.00	\$0.03	\$0.00	\$0.05	\$0.40	
Battery Asm, Telematic Communication Box Asm	\$4.54	\$0.00	\$0.00	\$0.00	\$0.11	\$0.00	\$0.01	\$0.15	\$4.81	
Assemble Telematic Communication Box Battery	\$0.00	\$0.00	\$0.00	\$0.00	\$0.09	\$0.00	\$0.01	\$0.01	\$0.11	
Telematic Communication Box Lid, Telematic Communi	\$0.00	\$0.08	\$0.00	\$0.00	\$0.00	\$0.01	\$0.00	\$0.01	\$0.11	
Assemble Telematic Communication Box Lid	\$0.10	\$0.00	\$0.00	\$0.00	\$0.05	\$0.00	\$0.01	\$0.01	\$0.17	
Assemble Telematic Communication Printed Circuit	\$0.02	\$64.31	\$0.00	\$0.00	\$0.35	\$0.00	\$0.04	\$10.35	\$75.07	
Telematic Communication Box Mounting Bracket, Tele	\$0.00	\$0.66	\$0.00	\$0.00	\$0.10	\$0.10	\$0.02	\$0.14	\$1.02	
Assemble Telematic Communication Mounting Bracket	\$0.11	\$0.00	\$0.00	\$0.00	\$0.36	\$0.00	\$0.13	\$0.06	\$0.67	

Detailed Summary

Parts	14
Fasteners	5
Part Numbers	9
Steps	55
Fastenings	17
Right First Time	98.52%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	2.45
Supplier Fab. Time (Min)	0.44
Total Weight (kg)	0.45
Purchased Part Cost	\$4.77
Material Cost	\$65.36
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$1.06
Supplier Fab. Cost	\$0.15
Q Burden	\$0.22
SG&A	\$10.79
Manufacturing Cost*	\$82.35

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Telematic Communication Box, Telematic Communicati



\...

- \Telematic Communication Asm, Telematic Communicati
- \Telematic Communication Box, Telematic Communicati
- \Telematic Communication Box Process

Process Summary

Right First Time	99.99 %
Process Time (Sec)	4.09
Total Weight (kg)	0.11

Material Cost**	\$0.31
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.03
Q Burden	\$0.00
SG&A	\$0.05
Manufacturing Cost*	\$0.40

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Telematic Communication Box, Telematic Communication Box



Telematic Communication Box Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
300 Ton Injection Molding Press	16.36	4	0.25	29.51	MEX	\$0.03	99.99%	\$0.00

Telematic Communication Box Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
ABS, Telematic Communication Box	1	ABS	\$2.60	0.1108	0.1191	\$0.00	\$0.31

Battery Asm, Telematic Communication Box Asm



\...

- \Telematic Communication Box and Bracket Asm
- \Telematic Communication Asm, Telematic Communicati
- \Battery Asm, Telematic Communication Box Asm

Assembly Summary

Parts	3
Fasteners	0
Part Numbers	2
Steps	5
Fastenings	2
Right First Time	99.95 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	0.30
Total Weight (kg)	0.05

Material Cost**	\$4.54
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.11
Q Burden	\$0.01
SG&A	\$0.15
Manufacturing Cost*	\$4.81

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Battery Asm, Telematic Communication Box Asm



Battery Asm, Telematic Communication Box Asm

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Battery Process	1	3	2	5	2	99.95 %	0.00	0.00	0.30	0.00	0.0509

Battery Asm, Telematic Communication Box Asm

Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
Battery Process	\$4.54	\$0.00	\$0.00	\$0.00	\$0.11	\$0.00	\$0.01	\$0.15	\$4.81

Detailed Summary

Parts	3
Fasteners	0
Part Numbers	2
Steps	5
Fastenings	2
Right First Time	99.95%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	0.30
Supplier Fab. Time (Min)	0.00
Total Weight (kg)	0.05
Purchased Part Cost	\$4.54
Material Cost	\$0.00
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$0.11
Supplier Fab. Cost	\$0.00
Q Burden	\$0.01
SG&A	\$0.15
Manufacturing Cost*	\$4.81

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

\...

\Telematic Communication Asm, Telematic Communicati
 \Battery Asm, Telematic Communication Box Asm
 \Battery Process

Process Summary

Right First Time	99.95 %
Process Time (Sec)	17.80
Total Weight (kg)	0.05

Material Cost**	\$4.54
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.11
Q Burden	\$0.01
SG&A	\$0.15
Manufacturing Cost*	\$4.81

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Battery Process



Battery Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	17.80	1	1.00	21.36	MEX	\$0.11	99.95%	\$0.01

Battery Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Battery, Battery Asm	1	Commodity Item	Purchased	0.0501	-	\$4.48	\$0.00
Foam Tape, Battery Asm	2	Commodity Item	Purchased	0.0004	-	\$0.03	\$0.00

Assemble Telematic Communication Box Battery



\...

- \Telematic Communication Box and Bracket Asm
- \Telematic Communication Asm, Telematic Communicati
- \Assemble Telematic Communication Box Battery

Process Summary

Right First Time	99.93 %
Process Time (Sec)	15.00
Total Weight (kg)	0.00
Material Cost**	\$0.00
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.09
Q Burden	\$0.01
SG&A	\$0.01
Manufacturing Cost*	\$0.11

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Telematic Communication Box Battery



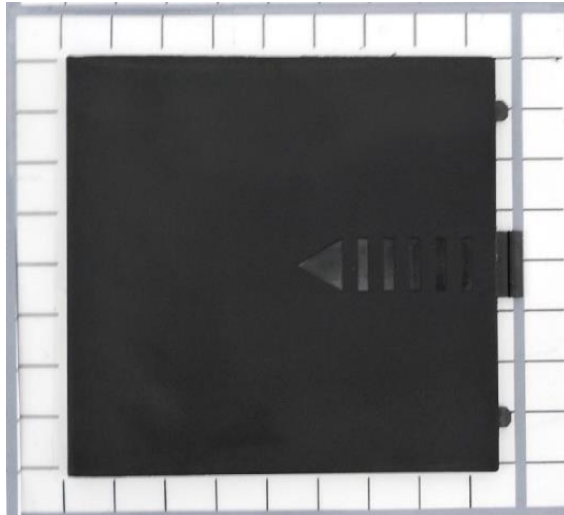
Assemble Telematic Communication Box Battery

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	15.00	1	1.00	21.36	MEX	\$0.09	99.93%	\$0.01

Assemble Telematic Communication Box Battery

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
-------------	-----	----------	----------------------------	-----------------	----------------------------	---------------------	---------------

Telematic Communication Box Lid, Telematic Communi



\...

- \Telematic Communication Asm, Telematic Communicati
- \Telematic Communication Box Lid, Telematic Communi
- \Telematic Communication Box Lid Process

Process Summary

Right First Time	99.99 %
Process Time (Sec)	2.67
Total Weight (kg)	0.02

Material Cost**	\$0.08
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.01
Q Burden	\$0.00
SG&A	\$0.01
Manufacturing Cost*	\$0.11



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Telematic Communication Box Lid, Telematic Communi



Telematic Communication Box Lid Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
150 Ton Injection Molding Press	10.68	4	0.25	18.36	MEX	\$0.01	99.99%	\$0.00

Telematic Communication Box Lid Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Telematic Communication Box Lid	1	PBT GF30	\$3.18	0.0233	0.0250	\$0.00	\$0.08

Assemble Telematic Communication Box Lid



\...

- \Telematic Communication Box and Bracket Asm
- \Telematic Communication Asm, Telematic Communicati
- \Assemble Telematic Communication Box Lid

Process Summary

Right First Time	99.95 %
Process Time (Sec)	8.25
Total Weight (kg)	0.00
Material Cost**	\$0.10
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.05
Q Burden	\$0.01
SG&A	\$0.01
Manufacturing Cost*	\$0.17

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Telematic Communication Box Lid



MUNRO
& ASSOCIATES, INC.

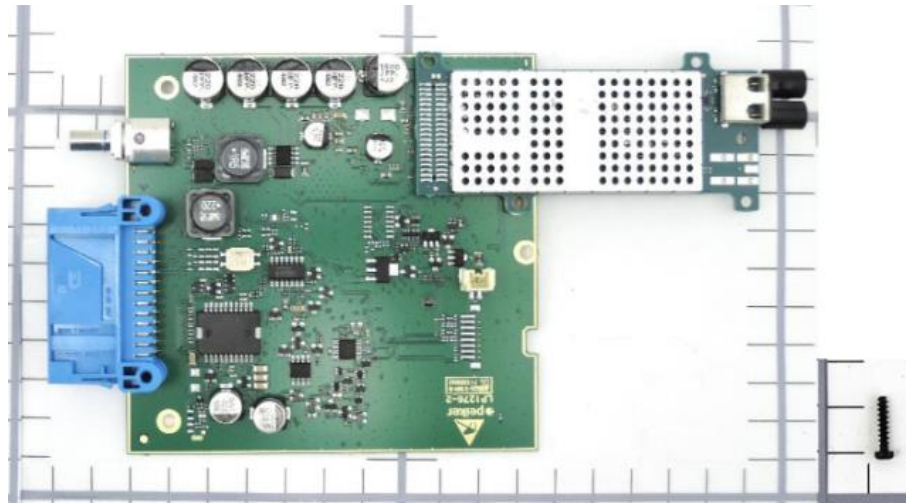
Assemble Telematic Communication Box Lid

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	8.25	1	1.00	21.36	MEX	\$0.05	99.95%	\$0.01

Assemble Telematic Communication Box Lid

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Label, Telematic Communication Box	1	Commodity Item	Purchased	0.0001	-	\$0.10	\$0.00

Assemble Telematic Communication Printed Circuit



- \...
- \Telematic Communication Box and Bracket Asm
- \Telematic Communication Asm, Telematic Communicati
- \Assemble Telematic Communication Printed Circuit

Process Summary

Right First Time	99.72 %
Process Time (Sec)	23.00
Total Weight (kg)	0.11

Material Cost**	\$64.33
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.35
Q Burden	\$0.04
SG&A	\$10.35
Manufacturing Cost*	\$75.07

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Telematic Communication Printed Circuit



Assemble Telematic Communication Printed Circuit

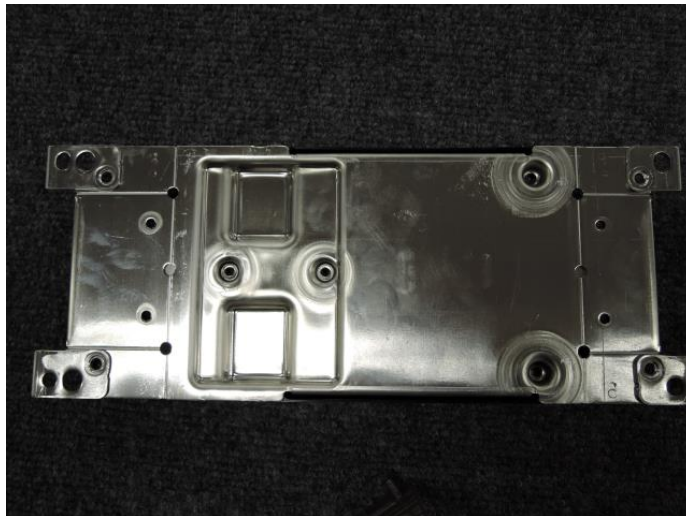
Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	23.00	1	1.00	54.32	GER	\$0.35	99.72 %	\$0.04

Assemble Telematic Communication Printed Circuit

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Telematic Communication Printed Circuit Board, Tel	1	See Appendix	-	0.1140	-	\$0.00	\$64.31
M3x11mm-Pan Head	1	Commodity Item	Purchased	0.0004	-	\$0.02	\$0.00

[Click Here for TechInsights Electronics Report on Telematics Communication Boards](#)

Telematic Communication Box Mounting Bracket, Tele



\...

- \Telematic Communication Asm, Telematic Communicati
- \Telematic Communication Box Mounting Bracket, Tele
- \Telematic Communication Box Mtg Bracket Process

Process Summary

Right First Time	99.89 %
Process Time (Sec)	41.82
Total Weight (kg)	0.15

Material Cost**	\$0.66
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.20
Q Burden	\$0.02
SG&A	\$0.14
Manufacturing Cost*	\$1.02

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Telematic Communication Box Mounting Bracket, Tele



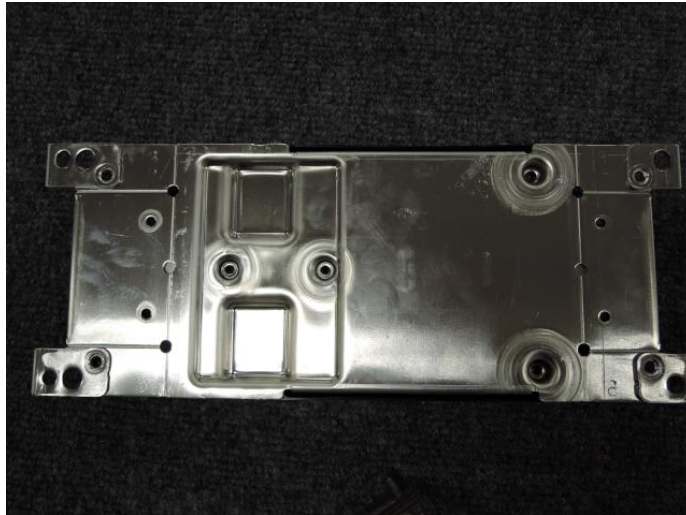
Telematic Communication Box Mtg Bracket Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Wash	9.00	1	1.00	18.19		\$0.05	99.99 %	\$0.00
Supplier Automated Asm	11.00	1	0.25	16.88	MEX	\$0.05	99.95 %	\$0.01
Folding Press	11.00	1	0.25	16.88	MEX	\$0.05	99.97 %	\$0.00
Deburr	9.00	1	1.00	13.81		\$0.03	99.99 %	\$0.00
300 Ton Stamping Press	1.82	1	0.25	41.16	MEX	\$0.02	99.99 %	\$0.00

Telematic Communication Box Mtg Bracket Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Box Mounting Bracket	1	Aluminum 5052-H32 - Coil Stock	\$3.35	0.1500	0.1960	\$0.00	\$0.66

Assemble Telematic Communication Mounting Bracket

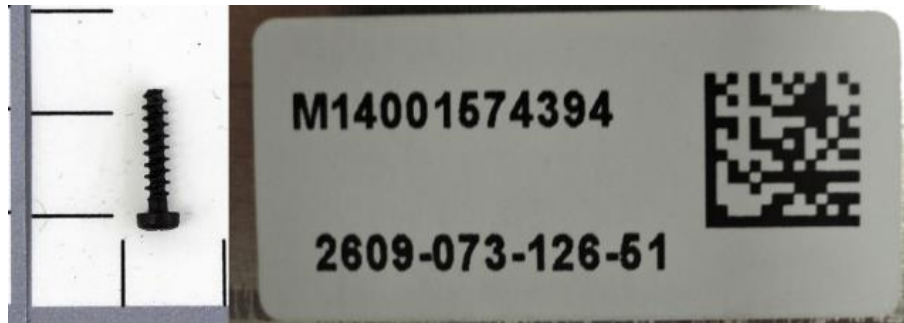


\...
 \Telematic Communication Box and Bracket Asm
 \Telematic Communication Asm, Telematic Communicati
 \Assemble Telematic Communication Mounting
 Bracket

Process Summary

Right First Time	99.12 %
Process Time (Sec)	61.00
Total Weight (kg)	0.00

Material Cost**	\$0.11
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.36
Q Burden	\$0.13
SG&A	\$0.06
Manufacturing Cost*	\$0.67



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Telematic Communication Mounting Bracket



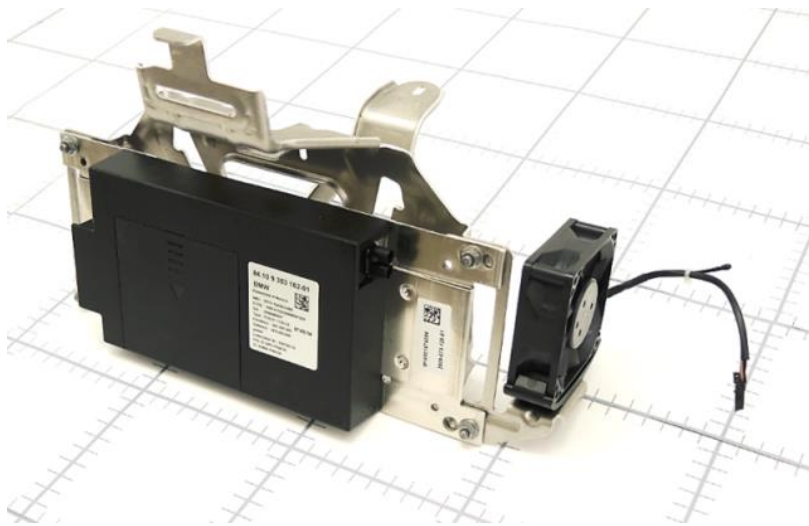
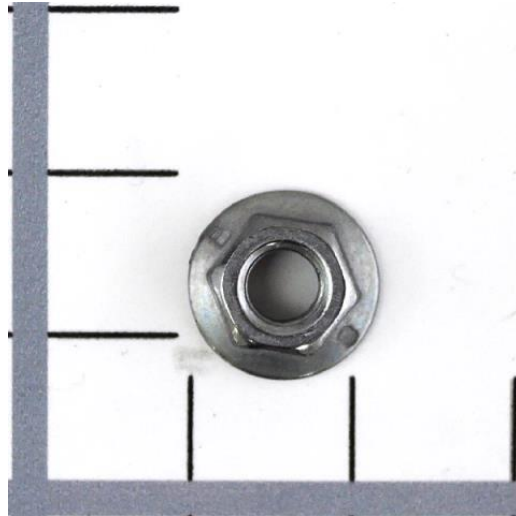
Assemble Telematic Communication Mounting Bracket

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	61.00	1	1.00	21.36	MEX	\$0.36	99.12 %	\$0.13

Assemble Telematic Communication Mounting Bracket

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Label, Peiker Supplier Label	1	Commodity Item	Purchased	0.0001	-	\$0.03	\$0.00
M3x11mm-Pan Head	4	Commodity Item	Purchased	0.0004	-	\$0.02	\$0.00

Assemble Telematic Communication Box to Bracket



\...

\System Electronics

\Telematic Communication Box and Bracket Asm

\Assemble Telematic Communication Box to Bracket

Process Summary

Right First Time	99.14 %
Process Time (Sec)	39.00
Total Weight (kg)	0.01

Material Cost**	\$0.08
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.23
Q Burden	\$0.13
SG&A	\$0.04
Manufacturing Cost*	\$0.48

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Telematic Communication Box to Bracket



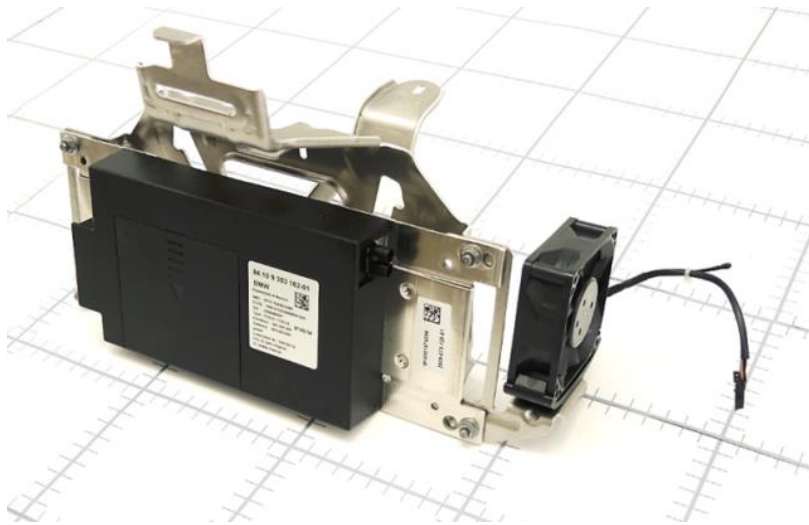
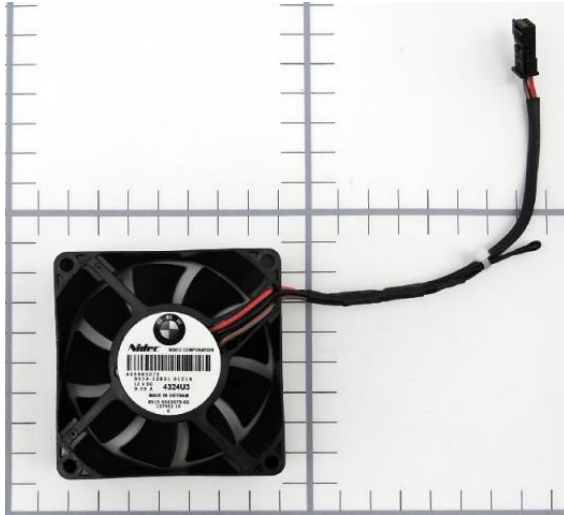
Assemble Telematic Communication Box to Bracket

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	39.00	1	1.00	21.36	MEX	\$0.23	99.14 %	\$0.13

Assemble Telematic Communication Box to Bracket

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
M5x5mm-Hex Flanged Nut	4	Commodity Item	Purchased	0.0019	-	\$0.02	\$0.00

Assemble Fan



\...

- \System Electronics
- \Telematic Communication Box and Bracket Asm
- \Assemble Fan

Process Summary

Right First Time	99.99 %
Process Time (Sec)	4.00
Total Weight (kg)	0.10

Material Cost**	\$8.50
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.02
Q Burden	\$0.00
SG&A	\$0.26
Manufacturing Cost*	\$8.78

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Fan

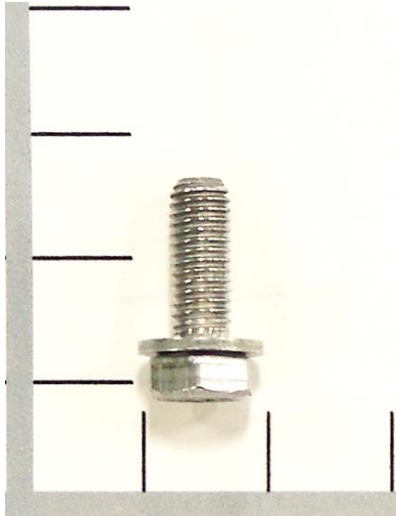


Assemble Fan

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	4.00	1	1.00	21.36	MEX	\$0.02	99.99%	\$0.00

Assemble Fan

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Fan, Telematic Communication Box and Bracket Asm	1	Commodity Item	Purchased	0.0990	-	\$8.50	\$0.00

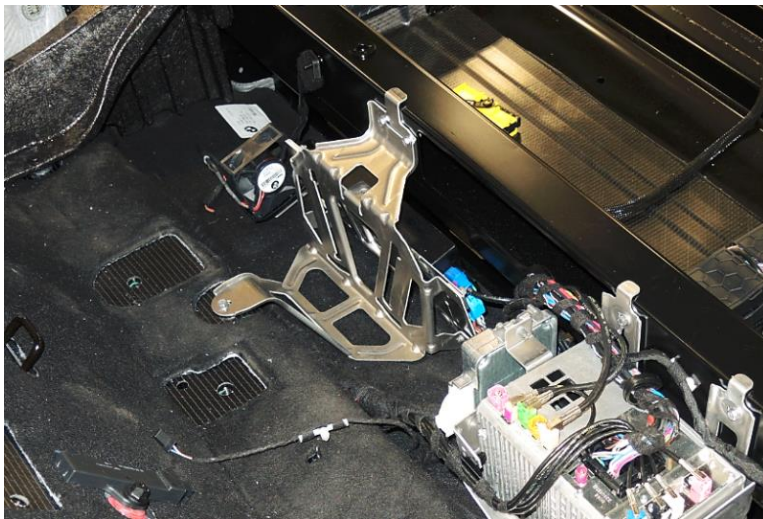


\...
 \Zone 5 Electronics
 \System Electronics
 \Bracket Installation

Process Summary

Right First Time	99.13 %
Process Time (Sec)	62.50
Total Weight (kg)	0.00

Material Cost**	\$0.01
OEM Process Cost	\$1.59
Supplier Process Cost	\$0.00
Q Burden	\$0.13
SG&A	\$0.25
Manufacturing Cost*	\$1.98



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Bracket Installation

Bracket Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	62.50	1	1.00	91.41	GER	\$1.59	99.13%	\$0.13

Bracket Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
M5x13mm-Hex SEMSTorx	1	Commodity Item	Purchased	0.0035	-	\$0.01	\$0.00

Touch Box Control Unit Installation

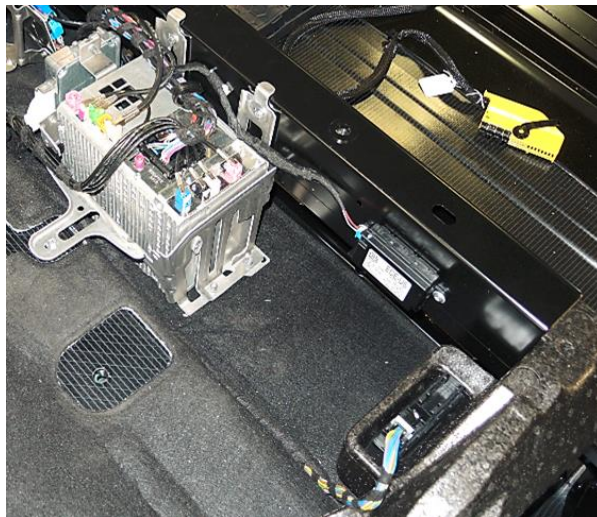


\...
 \Zone 5 Electronics
 \System Electronics
 \Touch Box Control Unit Installation

Process Summary

Right First Time	99.50 %
Process Time (Sec)	45.50
Total Weight (kg)	0.05

Material Cost**	\$17.42
OEM Process Cost	\$1.16
Supplier Process Cost	\$0.00
Q Burden	\$0.08
SG&A	\$2.96
Manufacturing Cost*	\$21.61



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Touch Box Control Unit Installation



Touch Box Control Unit Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	45.50	1	1.00	91.41	GER	\$1.16	99.50%	\$0.08

Touch Box Control Unit Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Touch Box Control Unit Asm	1	See Appendix	-	0.0423	-	\$0.00	\$17.36
M5x12mm-Tox Bolt	2	Commodity Item	Purchased	0.0016	-	\$0.03	\$0.00

[Click Here for TechInsights Electronics Report on Touch Controller](#)



\...
 \Zone 5 Electronics
 \System Electronics
 \Proximity Sensor Installation

Process Summary

Right First Time	99.73 %
Process Time (Sec)	33.50
Total Weight (kg)	0.05

Material Cost**	\$3.53
OEM Process Cost	\$0.85
Supplier Process Cost	\$0.00
Q Burden	\$0.04
SG&A	\$0.24
Manufacturing Cost*	\$4.66



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Proximity Sensor Installation

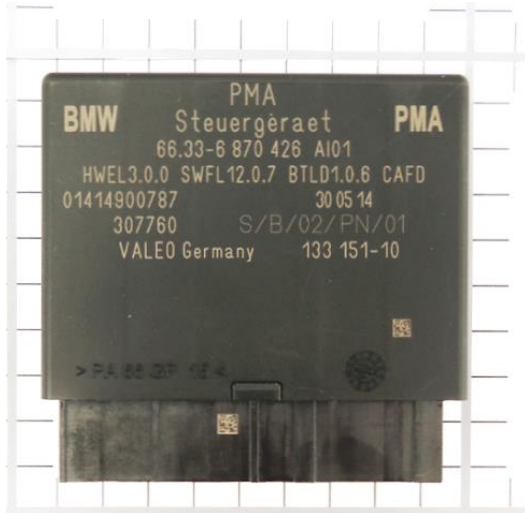


Proximity Sensor Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	33.50	1	1.00	91.41	GER	\$0.85	99.73%	\$0.04

Proximity Sensor Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Proximity Sensor Asm	1	Commodity Item	Purchased	0.0515	-	\$3.50	\$0.00
M5x11 Plastic Hex Flange Nut	1	Commodity Item	Purchased	0.0014	-	\$0.03	\$0.00



\...

- \Zone 5 Electronics
- \System Electronics
- \Parking Maneuvering Assistant Installation

Process Summary

Right First Time	99.90 %
Process Time (Sec)	12.50
Total Weight (kg)	0.07

Material Cost**	\$22.84
OEM Process Cost	\$0.32
Supplier Process Cost	\$0.00
Q Burden	\$0.02
SG&A	\$3.71
Manufacturing Cost*	\$26.88

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Parking Maneuvering Assistant Installation



MUNRO
& ASSOCIATES, INC.

Parking Maneuvering Assistant Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	12.50	1	1.00	91.41	GER	\$0.32	99.90%	\$0.02

Parking Maneuvering Assistant Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Parking Maneuvering Assistant Asm	1	See Appendix	-	0.0710	-	\$0.00	\$22.84

[Click Here for TechInsights Electronics Report on Parking Assist Module](#)

Antenna Amplifier Asm



\...
 \Zone 5 Electronics
 \System Electronics
 \Antenna Amplifier Asm

Assembly Summary

Parts	7
Fasteners	2
Part Numbers	6
Steps	25
Fastenings	6
Right First Time	99.36 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	0.69
Total Weight (kg)	0.03

Material Cost**	\$1.62
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.23
Q Burden	\$0.10
SG&A	\$0.28
Manufacturing Cost*	\$2.23

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Antenna Amplifier Asm



MUNRO
& ASSOCIATES, INC.

Antenna Amplifier Asm

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Assemble Antenna Amplifier Circuit	1	2	1	6	1	99.92 %	0.00	0.00	0.05	0.00	0.0095
Upper Housing, Antenna Amplifier	1	1	0	1	0	99.99 %	0.00	0.00	0.00	0.03	0.0052
Lower Housing, Antenna Amplifier	1	1	0	1	0	99.99 %	0.00	0.00	0.00	0.04	0.0049
Assemble Antenna Amplifier Housing	1	1	3	8	3	99.88 %	0.00	0.00	0.39	0.00	0.0001
Assemble Screw	1	2	2	7	2	99.58 %	0.00	0.00	0.18	0.00	0.0060

Antenna Amplifier Asm

Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
Assemble Antenna Amplifier Circuit	\$0.02	\$1.45	\$0.00	\$0.00	\$0.01	\$0.00	\$0.01	\$0.23	\$1.73
Upper Housing, Antenna Amplifier	\$0.00	\$0.02	\$0.00	\$0.00	\$0.00	\$0.01	\$0.00	\$0.00	\$0.04
Lower Housing, Antenna Amplifier	\$0.00	\$0.02	\$0.00	\$0.00	\$0.00	\$0.01	\$0.00	\$0.01	\$0.04
Assemble Antenna Amplifier Housing	\$0.05	\$0.00	\$0.00	\$0.00	\$0.14	\$0.00	\$0.02	\$0.02	\$0.23
Assemble Screw	\$0.06	\$0.00	\$0.00	\$0.00	\$0.05	\$0.00	\$0.06	\$0.01	\$0.18

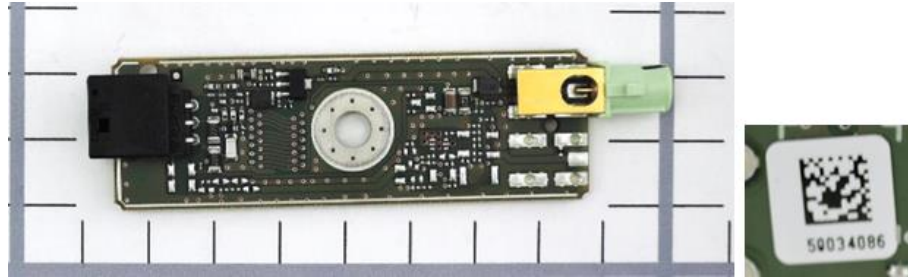
Detailed Summary

Parts	7
Fasteners	2
Part Numbers	6
Steps	25
Fastenings	6
Right First Time	99.36%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	0.63
Supplier Fab. Time (Min)	0.06
Total Weight (kg)	0.03
Purchased Part Cost	\$0.13
Material Cost	\$1.49
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$0.21
Supplier Fab. Cost	\$0.02
Q Burden	\$0.10
SG&A	\$0.28
Manufacturing Cost*	\$2.23

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Antenna Amplifier Circuit



- \...
- \System Electronics
- \Antenna Amplifier Asm
- \Assemble Antenna Amplifier Circuit

Process Summary

Right First Time	99.92 %
Process Time (Sec)	3.18
Total Weight (kg)	0.01

Material Cost**	\$1.47
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.01
Q Burden	\$0.01
SG&A	\$0.23
Manufacturing Cost*	\$1.73

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Antenna Amplifier Circuit



Assemble Antenna Amplifier Circuit

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Automated Asm	3.18	1	0.25	16.88	MEX	\$0.01	99.92 %	\$0.01

Assemble Antenna Amplifier Circuit

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Printed Circuit Board, Antenna Amplifier	1	See Appendix	-	0.0094	-	\$0.00	\$1.45
Label, BMW QR Code Small	1	Commodity Item	Purchased	0.0001	-	\$0.02	\$0.00

[Click Here for TechInsights Electronics Report on Antenna Amplifier Board](#)

Upper Housing, Antenna Amplifier



\...

- \Antenna Amplifier Asm
- \Upper Housing, Antenna Amplifier
- \Upper Housing, Process

Process Summary

Right First Time	99.99 %
Process Time (Sec)	1.56
Total Weight (kg)	0.01

Material Cost**	\$0.02
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.01
Q Burden	\$0.00
SG&A	\$0.00
Manufacturing Cost*	\$0.04

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Upper Housing, Antenna Amplifier

Upper Housing, Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
55Ton Injection Molding Press	6.24	4	0.25	23.71	GER	\$0.01	99.99%	\$0.00

Upper Housing, Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Upper Housing, Material	1	PC	\$3.97	0.0052	0.0060	\$0.00	\$0.02

Lower Housing, Antenna Amplifier



\...

- \Antenna Amplifier Asm
- \Lower Housing, Antenna Amplifier
- \Lower Housing, Process

Process Summary

Right First Time	99.99 %
Process Time (Sec)	2.18
Total Weight (kg)	0.00

Material Cost**	\$0.02
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.01
Q Burden	\$0.00
SG&A	\$0.01
Manufacturing Cost*	\$0.04

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Lower Housing, Antenna Amplifier



Lower Housing, Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
55Ton Injection Molding Press	8.72	4	0.25	23.71	GER	\$0.01	99.99%	\$0.00

Lower Housing, Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Lower Housing, Material	1	PC	\$3.97	0.0049	0.0050	\$0.00	\$0.02

Assemble Antenna Amplifier Housing



- \...
- \System Electronics
- \Antenna Amplifier Asm
- \Assemble Antenna Amplifier Housing

Process Summary

Right First Time	99.88 %
Process Time (Sec)	23.63
Total Weight (kg)	0.00

Material Cost**	\$0.05
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.14
Q Burden	\$0.02
SG&A	\$0.02
Manufacturing Cost*	\$0.23

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Antenna Amplifier Housing



Assemble Antenna Amplifier Housing

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	23.63	1	1.00	21.36	MEX	\$0.14	99.88 %	\$0.02

Assemble Antenna Amplifier Housing

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Label, BMW QR Code Mexico	1	Commodity Item	Purchased	0.0001	-	\$0.05	\$0.00

Assemble Screw



\...
\System Electronics
\Antenna Amplifier Asm
\Assemble Screw

Process Summary

Right First Time	99.58 %
Process Time (Sec)	11.00
Total Weight (kg)	0.01

Material Cost**	\$0.06
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.05
Q Burden	\$0.06
SG&A	\$0.01
Manufacturing Cost*	\$0.18



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Screw

Assemble Screw

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Automated Asm	11.00	1	0.25	16.88	MEX	\$0.05	99.58 %	\$0.06

Assemble Screw

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
M5x15mm-Pan Head Torx	2	Commodity Item	Purchased	0.0030	-	\$0.03	\$0.00

Assemble Antenna Amplifier



\...
 \Zone 5 Electronics
 \System Electronics
 \Assemble Antenna Amplifier

Process Summary

Right First Time	99.78 %
Process Time (Sec)	13.00
Total Weight (kg)	0.00

Material Cost**	\$0.00
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.20
Q Burden	\$0.03
SG&A	\$0.03
Manufacturing Cost*	\$0.26



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Antenna Amplifier



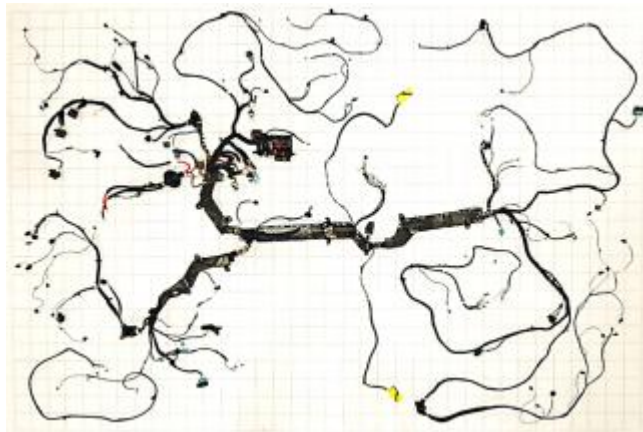
Assemble Antenna Amplifier

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	13.00	1	1.00	54.32	GER	\$0.20	99.78 %	\$0.03

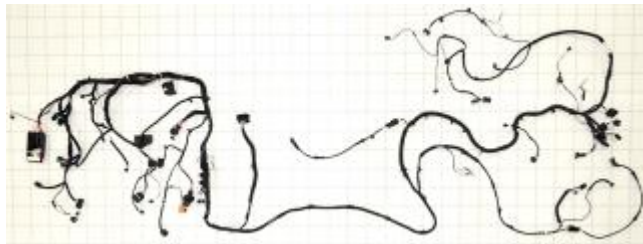
Assemble Antenna Amplifier

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
-------------	-----	----------	----------------------------	-----------------	----------------------------	---------------------	---------------

Body Wire Harnesses Overview



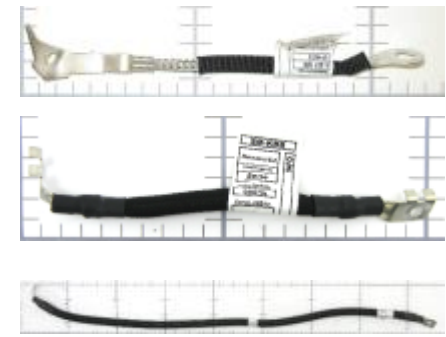
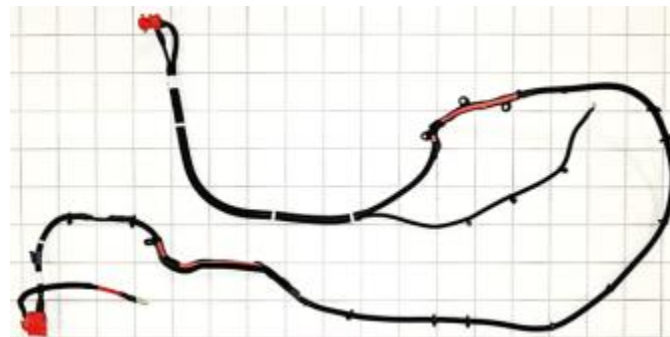
The body wiring group contains the 12 volt vehicle electrical wiring harnesses, 12 volt battery and the body controller/power distribution box. The harnesses consist of two primary parts the in vehicle harness (body harness) and the chassis mounted harness (underbody harness). The group also contains various ground straps and the 12 volt battery cable. The 12 volt battery is mounted in a stamped steel mounting bracket. The body domain controller includes the electronics control as well as circuit protection (fuse box).



All major components were costed in detail, while prices were applied to commodity items (i.e. seals, fasteners, latches, and seat belts).

Estimates are based on actual parts.

Photos: Background on 100mm grid paper.

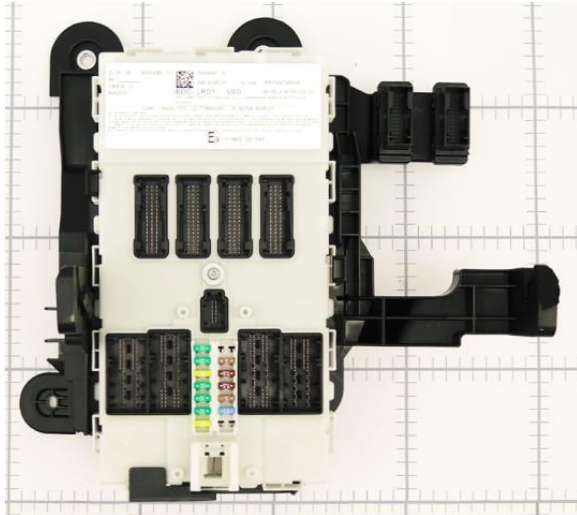


Summary

Parts	168
Fasteners	92
Part Numbers	87
Steps	1,008
Fastenings	444
Right First Time	75.76%
OEM Process Time (Hrs)	0.76
Supplier Process Time (Hrs)	0.30
Total Weight (kg)	32.18
Material Cost**	\$805.99
OEM Process Cost	\$69.61
Supplier Process Cost	\$11.04
Q Burden	\$4.16
SG&A	\$116.90
Manufacturing Cost*	\$1,007.70

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost



\...

- \Zone 5 Electronics
 - \Body Wire Harnesses
 - \Body Domain Controller and Bracket Asm
- ## Assembly Summary

Parts	36
Fasteners	3
Part Numbers	21
Steps	112
Fastenings	36
Right First Time	98.15 %
OEM Process Time (Min)	1.23
Supplier Process Time (Min)	3.62
Total Weight (kg)	1.24

Material Cost**	\$169.25
OEM Process Cost	\$1.88
Supplier Process Cost	\$2.00
Q Burden	\$0.28
SG&A	\$24.12
Manufacturing Cost*	\$197.53

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Body Domain Controller and Bracket Asm



MUNRO
& ASSOCIATES, INC.

Body Domain Controller and Bracket Asm

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Bracket Asm, Body Domain Controller and Bracket	1	7	5	17	5	99.77 %	0.00	0.00	0.57	0.16	0.4336
Isolator Cap, Body Mounting Isolator Asm	1	2	0	2	0	99.98 %	0.00	0.00	0.00	0.01	0.0013
Assemble Body Mounting Isolator	1	2	3	8	3	99.57 %	0.63	0.00	0.00	0.00	0.0095
Connector Asm, Body Domain Controller and Bracket	2	4	4	16	4	99.82 %	0.00	0.00	0.42	0.05	0.0198
Assemble Connector	1	0	2	5	2	99.92 %	0.25	0.00	0.00	0.00	0.0000
Body Domain Controller, Body Domain Controller and	1	16	16	37	16	99.52 %	0.00	0.00	1.79	0.14	0.7520
Assemble Body Domain Controller and Bracket Asm	1	1	2	6	2	99.75 %	0.35	0.00	0.00	0.00	0.0063

Body Domain Controller and Bracket Asm

Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
Bracket Asm, Body Domain Controller and Bracket	\$0.12	\$1.89	\$0.00	\$0.00	\$0.23	\$0.17	\$0.03	\$0.32	\$2.77
Isolator Cap, Body Mounting Isolator Asm	\$0.00	\$0.02	\$0.00	\$0.00	\$0.00	\$0.01	\$0.00	\$0.00	\$0.03
Assemble Body Mounting Isolator	\$0.11	\$0.00	\$0.96	\$0.00	\$0.00	\$0.00	\$0.06	\$0.14	\$1.28
Connector Asm, Body Domain Controller and Bracket	\$0.05	\$0.70	\$0.00	\$0.00	\$0.29	\$0.02	\$0.03	\$0.14	\$1.23
Assemble Connector	\$0.00	\$0.00	\$0.38	\$0.00	\$0.00	\$0.00	\$0.01	\$0.05	\$0.45
Body Domain Controller, Body Domain Controller and	\$0.65	\$164.88	\$0.00	\$0.00	\$0.79	\$0.19	\$0.07	\$23.24	\$189.82
Assemble Body Domain Controller and Bracket Asm	\$0.08	\$0.00	\$0.53	\$0.00	\$0.00	\$0.00	\$0.04	\$0.08	\$0.73

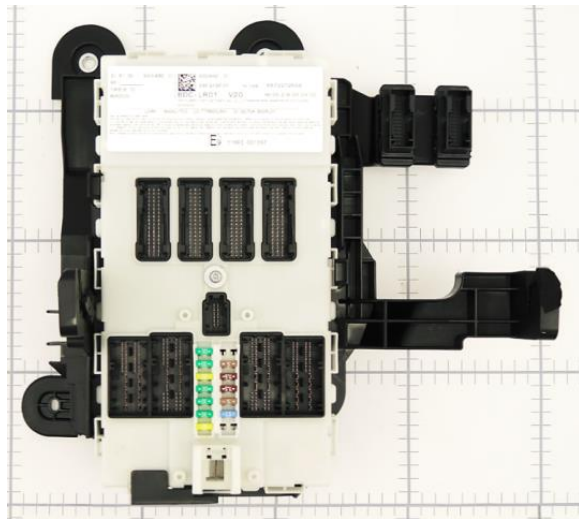
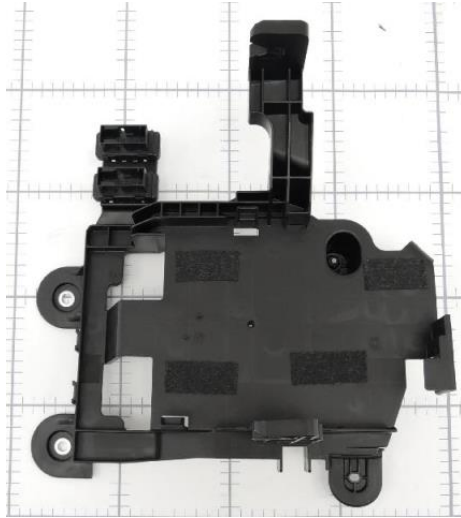
Detailed Summary

Parts	36
Fasteners	3
Part Numbers	21
Steps	112
Fastenings	36
Right First Time	98.15%
OEM Asm. Time (Min)	1.23
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	3.20
Supplier Fab. Time (Min)	0.41
Total Weight (kg)	1.24
Purchased Part Cost	
	\$1.06
Material Cost	\$168.19
OEM Asm. Cost	\$1.88
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$1.59
Supplier Fab. Cost	\$0.41
Q Burden	\$0.28
SG&A	\$24.12
Manufacturing Cost*	\$197.53

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Bracket Asm, Body Domain Controller and Bracket



\...

\Body Wire Harnesses

\Body Domain Controller and Bracket Asm

\Bracket Asm, Body Domain Controller and Bracket

Assembly Summary

Parts	7
Fasteners	0
Part Numbers	3
Steps	17
Fastenings	5
Right First Time	99.77 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	0.73
Total Weight (kg)	0.43

Material Cost**	\$2.01
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.40
Q Burden	\$0.03
SG&A	\$0.32
Manufacturing Cost*	\$2.77

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Bracket Asm, Body Domain Controller and Bracket



Bracket Asm, Body Domain Controller and Bracket

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Bracket, Bracket Asm	1	1	0	1	0	99.99 %	0.00	0.00	0.00	0.16	0.4300
Assemble Compression Sleeve	1	2	1	6	1	99.90 %	0.00	0.00	0.12	0.00	0.0016
Assemble Felt Tape	1	4	4	9	4	99.88 %	0.00	0.00	0.45	0.00	0.0020

Bracket Asm, Body Domain Controller and Bracket

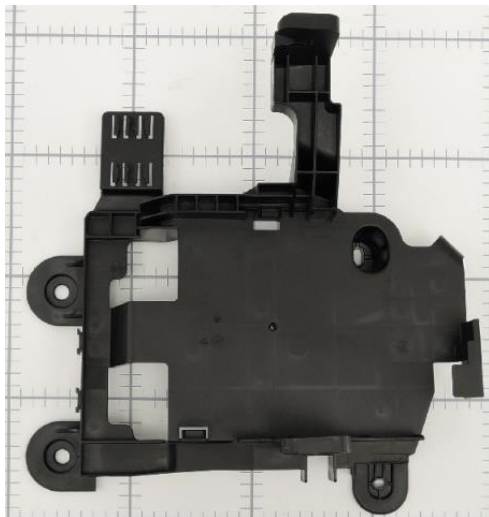
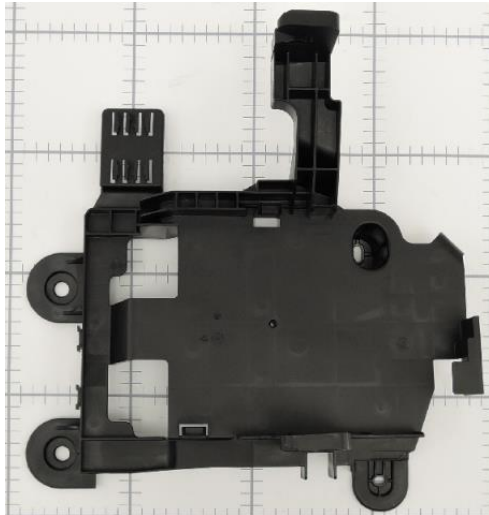
Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
Bracket, Bracket Asm	\$0.00	\$1.89	\$0.00	\$0.00	\$0.00	\$0.17	\$0.00	\$0.29	\$2.35
Assemble Compression Sleeve	\$0.08	\$0.00	\$0.00	\$0.00	\$0.05	\$0.00	\$0.01	\$0.01	\$0.15
Assemble Felt Tape	\$0.04	\$0.00	\$0.00	\$0.00	\$0.18	\$0.00	\$0.02	\$0.03	\$0.27

Detailed Summary

Parts	7
Fasteners	0
Part Numbers	3
Steps	17
Fastenings	5
Right First Time	99.77%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	0.57
Supplier Fab. Time (Min)	0.16
Total Weight (kg)	0.43
<hr/>	
Purchased Part Cost	\$0.12
Material Cost	\$1.89
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$0.23
Supplier Fab. Cost	\$0.17
Q Burden	\$0.03
SG&A	\$0.32
Manufacturing Cost*	\$2.77

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost



\...

- \Bracket Asm, Body Domain Controller and Bracket
- \Bracket, Bracket Asm
- \Bracket Process

Process Summary

Right First Time	99.99 %
Process Time (Sec)	9.59
Total Weight (kg)	0.43

Material Cost**	\$1.89
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.17
Q Burden	\$0.00
SG&A	\$0.29
Manufacturing Cost*	\$2.35

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Bracket, Bracket Asm

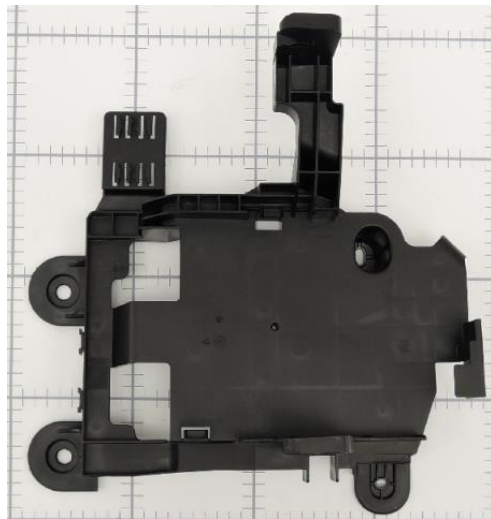
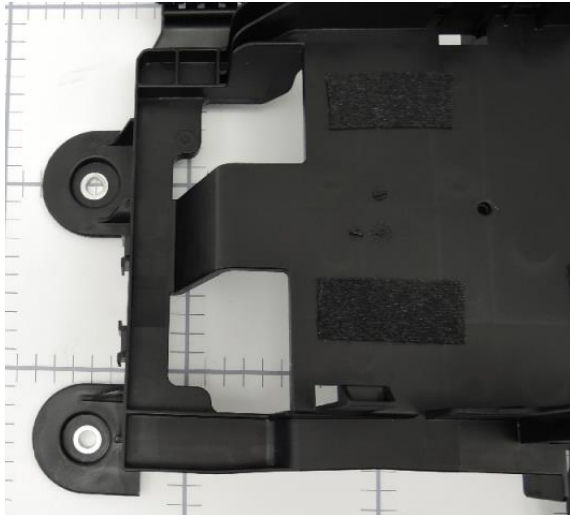
Bracket Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
720 Ton Injection Molding Press	19.18	2	0.25	64.65	AUT	\$0.17	99.99%	\$0.00

Bracket Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
PA6 GF30-35, Bracket	1	PA6 GF35	\$3.97	0.4300	0.4601	\$0.00	\$1.89

Assemble Compression Sleeve



\...

- \Body Domain Controller and Bracket Asm
- \Bracket Asm, Body Domain Controller and Bracket
- \Assemble Compression Sleeve

Process Summary

Right First Time	99.90 %
Process Time (Sec)	7.00
Total Weight (kg)	0.00

Material Cost**	\$0.08
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.05
Q Burden	\$0.01
SG&A	\$0.01
Manufacturing Cost*	\$0.15

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Compression Sleeve



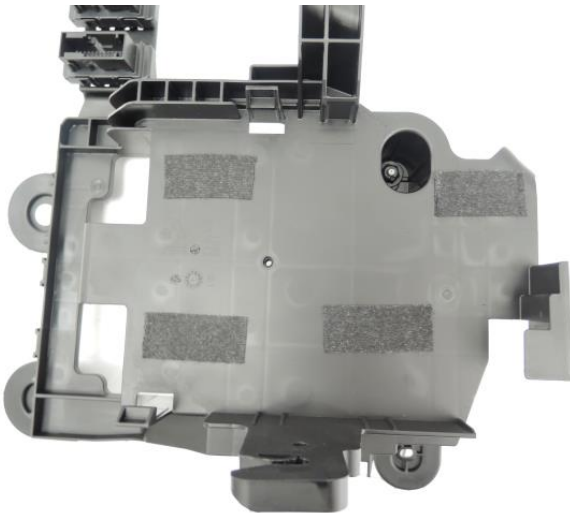
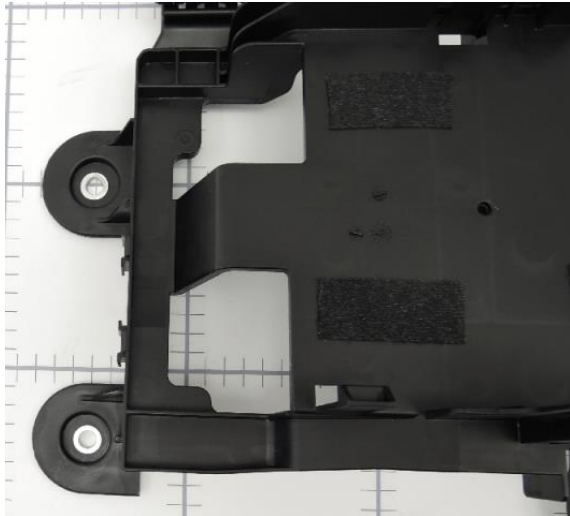
Assemble Compression Sleeve

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Automated Asm	7.00	1	0.25	24.44	AUT	\$0.05	99.90%	\$0.01

Assemble Compression Sleeve

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Compression Sleeve	2	Commodity Item	Purchased	0.0008	-	\$0.04	\$0.00

Assemble Felt Tape



\...

- \Body Domain Controller and Bracket Asm
- \Bracket Asm, Body Domain Controller and Bracket
- \Assemble Felt Tape

Process Summary

Right First Time	99.88 %
Process Time (Sec)	27.00
Total Weight (kg)	0.00

Material Cost**	\$0.04
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.18
Q Burden	\$0.02
SG&A	\$0.03
Manufacturing Cost*	\$0.27

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Felt Tape

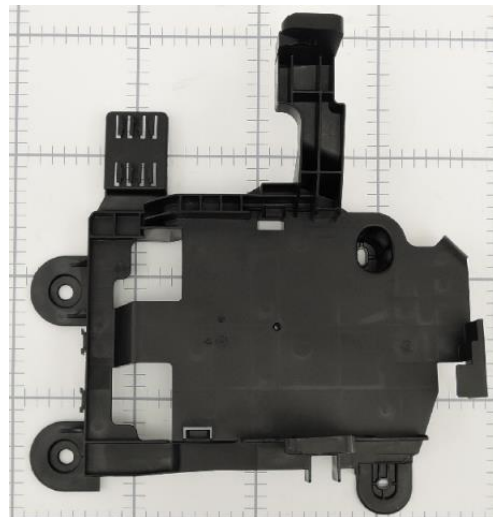


Assemble Felt Tape

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	27.00	1	0.25	24.44	AUT	\$0.18	99.88 %	\$0.02

Assemble Felt Tape

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Felt Tape	4	Commodity Item	Purchased	0.0005	-	\$0.01	\$0.00



\...

- \Body Domain Controller and Bracket Asm
- \Isolator Cap, Body Mounting Isolator Asm
- \Isolator Cap Process

Process Summary

Right First Time	99.98 %
Process Time (Sec)	0.75
Total Weight (kg)	0.00

Material Cost**	\$0.02
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.01
Q Burden	\$0.00
SG&A	\$0.00
Manufacturing Cost*	\$0.03

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Isolator Cap, Body Mounting Isolator Asm



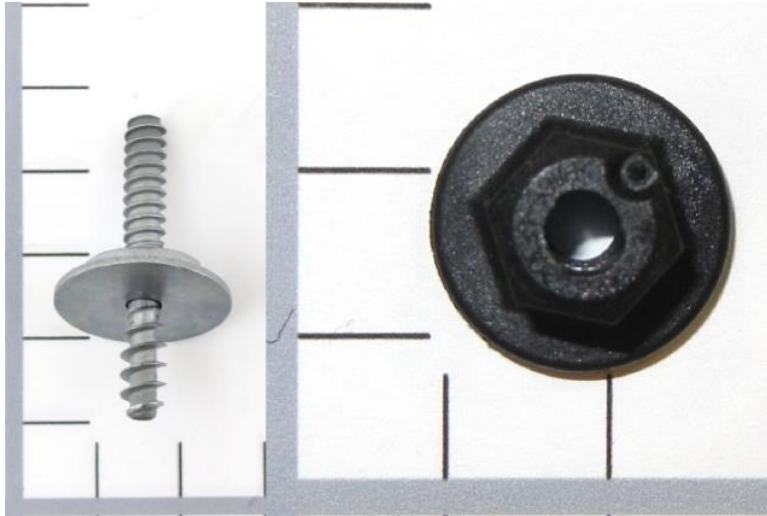
Isolator Cap Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
55Ton Injection Molding Press	18.00	24	0.25	32.08	GER	\$0.01	99.98 %	\$0.00

Isolator Cap Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
PC, Isolator Cap	1	PC	\$3.97	0.0009	0.0010	\$0.00	\$0.01
MVQ, Isolator Cap	1	MVQ	\$9.90	0.0004	0.0001	\$0.00	\$0.01

Assemble Body Mounting Isolator



\...

- \Body Wire Harnesses
- \Body Domain Controller and Bracket Asm
- \Assemble Body Mounting Isolator

Process Summary

Right First Time	99.57 %
Process Time (Sec)	38.00
Total Weight (kg)	0.01

Material Cost**	\$0.11
OEM Process Cost	\$0.96
Supplier Process Cost	\$0.00
Q Burden	\$0.06
SG&A	\$0.14
Manufacturing Cost*	\$1.28

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Body Mounting Isolator



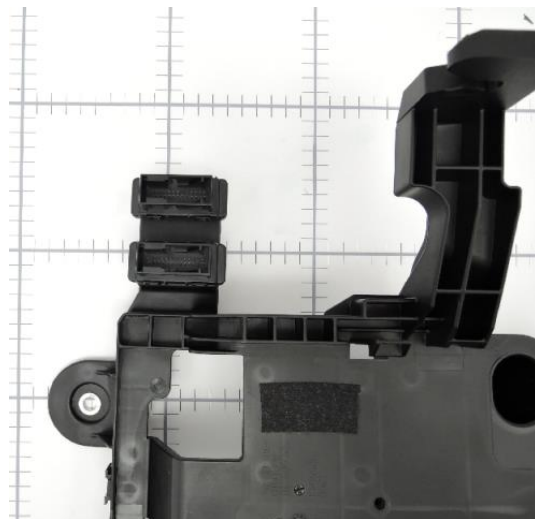
Assemble Body Mounting Isolator

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	38.00	1	1.00	91.41	GER	\$0.96	99.57%	\$0.06

Assemble Body Mounting Isolator

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Double Ended Stud With Captured Washer	1	Commodity Item	Purchased	0.0081	-	\$0.08	\$0.00
M5x11 Plastic Hex Flange Nut	1	Commodity Item	Purchased	0.0014	-	\$0.03	\$0.00

Connector Asm, Body Domain Controller and Bracket



\...

\Body Wire Harnesses

\Body Domain Controller and Bracket Asm

\Connector Asm, Body Domain Controller and Bracket

Assembly Summary

Parts	4
Fasteners	0
Part Numbers	4
Steps	16
Fastenings	4
Right First Time	99.82 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	0.47
Total Weight (kg)	0.02

Material Cost**	\$0.75
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.31
Q Burden	\$0.03
SG&A	\$0.14
Manufacturing Cost*	\$1.23

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Connector Asm, Body Domain Controller and Bracket



Connector Asm, Body Domain Controller and Bracket

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Connector Upper Housing Asm, Connector Asm	1	2	2	8	2	99.90 %	0.00	0.00	0.20	0.03	0.0143
Connector Lower Housing, Connector Asm	1	1	0	1	0	99.99 %	0.00	0.00	0.00	0.03	0.0054
Assemble Connector Lower Housing	1	1	2	5	2	99.93 %	0.00	0.00	0.22	0.00	0.0001

Connector Asm, Body Domain Controller and Bracket

Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
Connector Upper Housing Asm, Connector Asm	\$0.00	\$0.67	\$0.00	\$0.00	\$0.09	\$0.01	\$0.01	\$0.11	\$0.89
Connector Lower Housing, Connector Asm	\$0.00	\$0.03	\$0.00	\$0.00	\$0.00	\$0.01	\$0.00	\$0.01	\$0.05
Assemble Connector Lower Housing	\$0.05	\$0.00	\$0.00	\$0.00	\$0.20	\$0.00	\$0.01	\$0.03	\$0.29

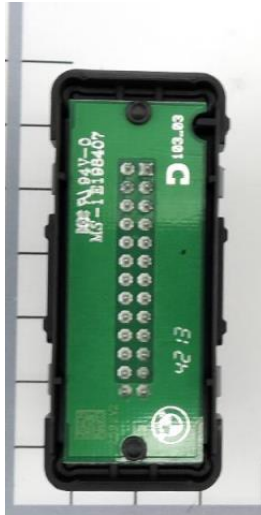
Detailed Summary

Parts	4
Fasteners	0
Part Numbers	4
Steps	16
Fastenings	4
Right First Time	99.82%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	0.42
Supplier Fab. Time (Min)	0.05
Total Weight (kg)	0.02
Purchased Part Cost	\$0.05
Material Cost	\$0.70
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$0.29
Supplier Fab. Cost	\$0.02
Q Burden	\$0.03
SG&A	\$0.14
Manufacturing Cost*	\$1.23

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Connector Upper Housing Asm, Connector Asm



- \...
- \Body Domain Controller and Bracket Asm
- \Connector Asm, Body Domain Controller and Bracket
- \Connector Upper Housing Asm, Connector Asm

Assembly Summary

Parts	2
Fasteners	0
Part Numbers	2
Steps	8
Fastenings	2
Right First Time	99.90 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	0.23
Total Weight (kg)	0.01

Material Cost**	\$0.67
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.10
Q Burden	\$0.01
SG&A	\$0.11
Manufacturing Cost*	\$0.89

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Connector Upper Housing Asm, Connector Asm



MUNRO
& ASSOCIATES, INC.

Connector Upper Housing Asm, Connector Asm

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Connector Upper Housing, Connector Asm	1	1	0	1	0	99.99 %	0.00	0.00	0.00	0.03	0.0082
Assemble Connector Upper Housing	1	1	2	6	2	99.91 %	0.00	0.00	0.20	0.00	0.0061

Connector Upper Housing Asm, Connector Asm

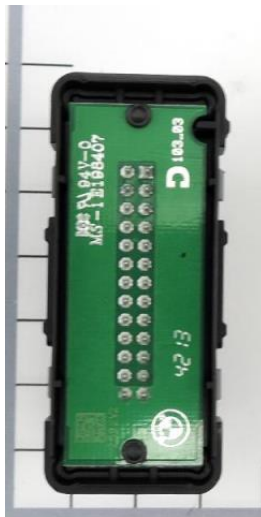
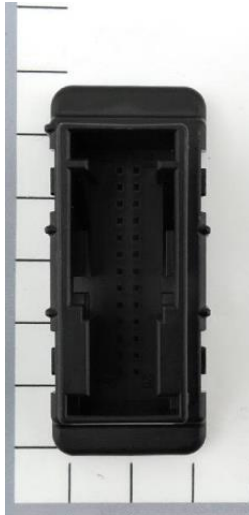
Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
Connector Upper Housing, Connector Asm	\$0.00	\$0.04	\$0.00	\$0.00	\$0.00	\$0.01	\$0.00	\$0.01	\$0.06
Assemble Connector Upper Housing	\$0.00	\$0.63	\$0.00	\$0.00	\$0.09	\$0.00	\$0.01	\$0.10	\$0.83

Detailed Summary

Parts	2
Fasteners	0
Part Numbers	2
Steps	8
Fastenings	2
Right First Time	99.9%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	0.20
Supplier Fab. Time (Min)	0.03
Total Weight (kg)	0.01
<hr/>	
Purchased Part Cost	\$0.00
Material Cost	\$0.67
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$0.09
Supplier Fab. Cost	\$0.01
Q Burden	\$0.01
SG&A	\$0.11
Manufacturing Cost*	\$0.89

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost



\...

- \Connector Upper Housing Asm, Connector Asm
- \Connector Upper Housing, Connector Asm
- \Connector Upper Housing Process

Process Summary

Right First Time	99.99 %
Process Time (Sec)	1.54
Total Weight (kg)	0.01

Material Cost**	\$0.04
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.01
Q Burden	\$0.00
SG&A	\$0.01
Manufacturing Cost*	\$0.06

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Connector Upper Housing, Connector Asm



MUNRO
& ASSOCIATES, INC.

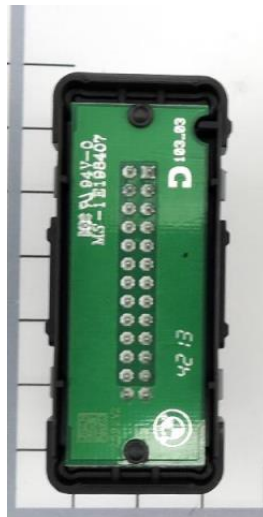
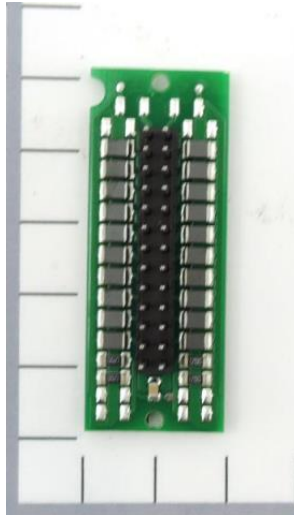
Connector Upper Housing Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
55Ton Injection Molding Press	12.32	8	0.25	23.71	GER	\$0.01	99.99%	\$0.00

Connector Upper Housing Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, Connector Upper Housing	1	PBT+ASA GF15	\$4.28	0.0082	0.0090	\$0.00	\$0.04

Assemble Connector Upper Housing



\...

- \Connector Asm, Body Domain Controller and Bracket
- \Connector Upper Housing Asm, Connector Asm
- \Assemble Connector Upper Housing

Process Summary

Right First Time	99.91 %
Process Time (Sec)	12.00
Total Weight (kg)	0.01

Material Cost**	\$0.63
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.09
Q Burden	\$0.01
SG&A	\$0.10
Manufacturing Cost*	\$0.83

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Connector Upper Housing



Assemble Connector Upper Housing

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Automated Asm	12.00	1	0.25	25.62	GER	\$0.09	99.91 %	\$0.01

Assemble Connector Upper Housing

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Signal Termination Board, Connector Asm	1	See Appendix	-	0.0061	-	\$0.00	\$0.63

[Click Here for TechInsights Electronics Report on Single Termination Board, Connector Asm](#)



\...

- \Connector Asm, Body Domain Controller and Bracket
- \Connector Lower Housing, Connector Asm
- \Connector Lower Housing Process

Process Summary

Right First Time	99.99 %
Process Time (Sec)	1.51
Total Weight (kg)	0.01

Material Cost**	\$0.03
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.01
Q Burden	\$0.00
SG&A	\$0.01
Manufacturing Cost*	\$0.05

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Connector Lower Housing, Connector Asm



MUNRO
& ASSOCIATES, INC.

Connector Lower Housing Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
55Ton Injection Molding Press	12.08	8	0.25	23.71	GER	\$0.01	99.99%	\$0.00

Connector Lower Housing Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, Connector Lower Housing	1	PBT+ASA GF15	\$4.28	0.0054	0.0060	\$0.00	\$0.03

Assemble Connector Lower Housing



\...

- \Body Domain Controller and Bracket Asm
- \Connector Asm, Body Domain Controller and Bracket
- \Assemble Connector Lower Housing

Process Summary

Right First Time	99.93 %
Process Time (Sec)	13.38
Total Weight (kg)	0.00

Material Cost**	\$0.05
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.20
Q Burden	\$0.01
SG&A	\$0.03
Manufacturing Cost*	\$0.29



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Connector Lower Housing

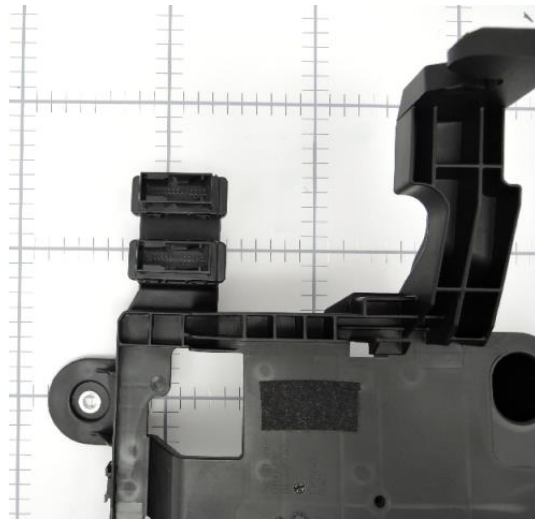


Assemble Connector Lower Housing

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	13.38	1	1.00	54.32	GER	\$0.20	99.93%	\$0.01

Assemble Connector Lower Housing

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Label, Supplier Date Label	1	Commodity Item	Purchased	0.0001	-	\$0.05	\$0.00



\...

- \Body Wire Harnesses
- \Body Domain Controller and Bracket Asm
- \Assemble Connector

Process Summary

Right First Time	99.92 %
Process Time (Sec)	15.00
Total Weight (kg)	0.00

Material Cost**	\$0.00
OEM Process Cost	\$0.38
Supplier Process Cost	\$0.00
Q Burden	\$0.01
SG&A	\$0.05
Manufacturing Cost*	\$0.45

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Connector



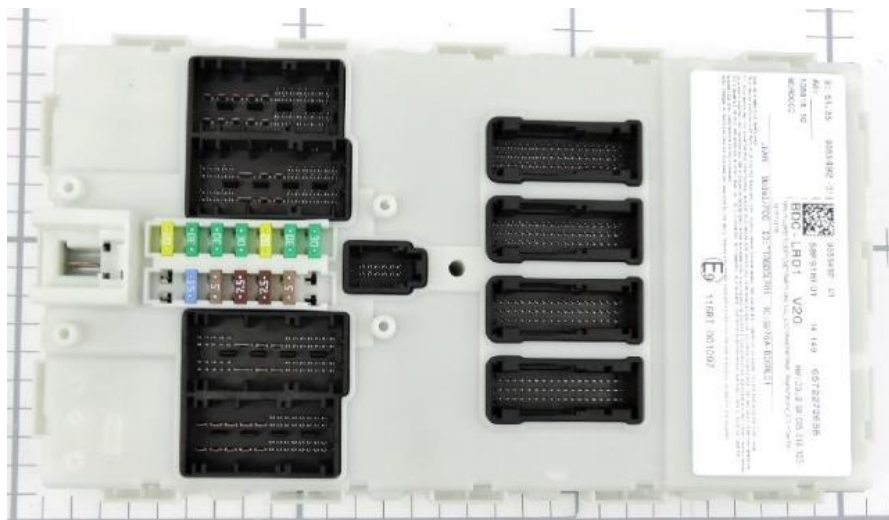
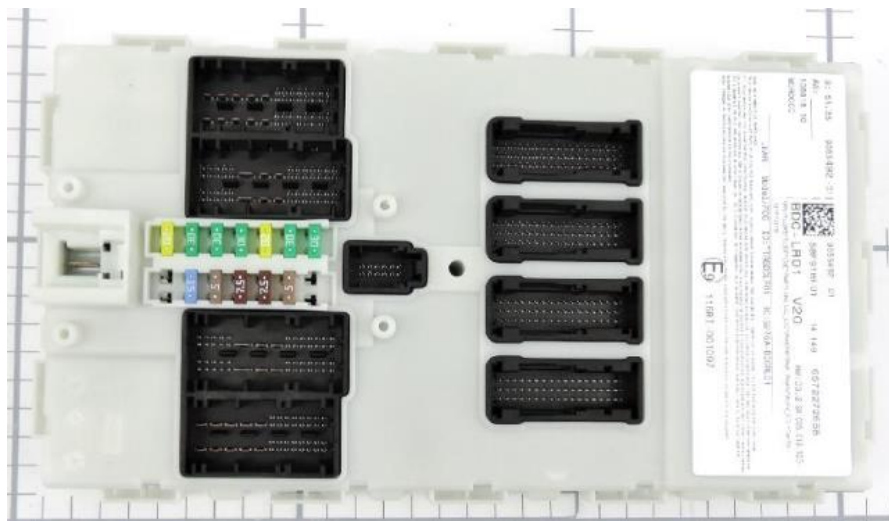
Assemble Connector

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	15.00	1	1.00	91.41	GER	\$0.38	99.92 %	\$0.01

Assemble Connector

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
-------------	-----	----------	----------------------------	-----------------	----------------------------	---------------------	---------------

Body Domain Controller, Body Domain Controller and



- \...
 - \Body Wire Harnesses
 - \Body Domain Controller and Bracket Asm
 - \Body Domain Controller, Body Domain Controller and
- ## Assembly Summary

Parts	16
Fasteners	0
Part Numbers	9
Steps	37
Fastenings	16
Right First Time	99.52 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	1.93
Total Weight (kg)	0.75

Material Cost**	\$165.53
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.98
Q Burden	\$0.07
SG&A	\$23.24
Manufacturing Cost*	\$189.82

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Body Domain Controller, Body Domain Controller and



Body Domain Controller, Body Domain Controller and

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Upper Housing Body Domain Controller, Body Domain	1	1	0	1	0	99.99 %	0.00	0.00	0.00	0.07	0.1567
Assemble Upper Housing and Printed Circuit Board	1	13	13	27	13	99.61 %	0.00	0.00	1.57	0.00	0.4852
Lower Housing Body Domain Controller	1	1	0	1	0	99.99 %	0.00	0.00	0.00	0.07	0.1100
Assemble Lower Housing	1	1	3	6	3	99.93 %	0.00	0.00	0.22	0.00	0.0001

Body Domain Controller, Body Domain Controller and

Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
Upper Housing Body Domain Controller, Body Domain	\$0.00	\$0.41	\$0.00	\$0.00	\$0.00	\$0.10	\$0.00	\$0.07	\$0.58
Assemble Upper Housing and Printed Circuit Board	\$0.60	\$164.17	\$0.00	\$0.00	\$0.69	\$0.00	\$0.06	\$23.10	\$188.61
Lower Housing Body Domain Controller	\$0.00	\$0.30	\$0.00	\$0.00	\$0.00	\$0.09	\$0.00	\$0.06	\$0.45
Assemble Lower Housing	\$0.05	\$0.00	\$0.00	\$0.00	\$0.10	\$0.00	\$0.01	\$0.02	\$0.17

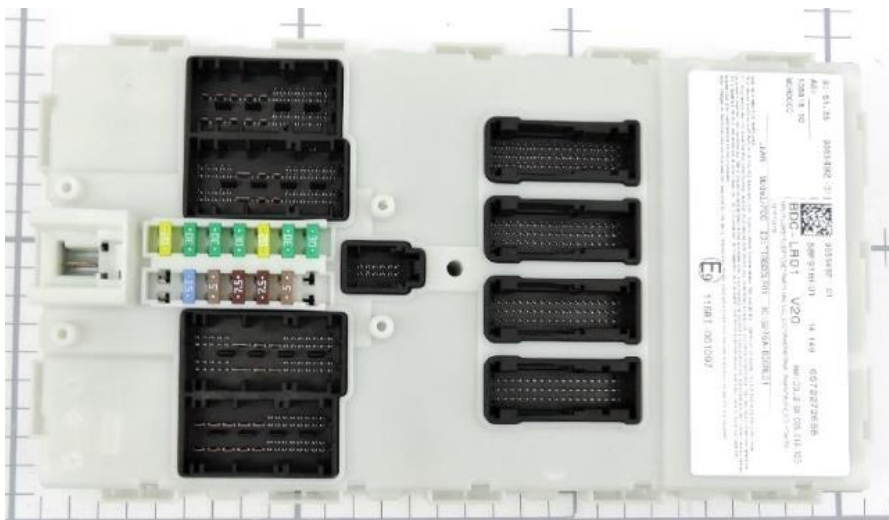
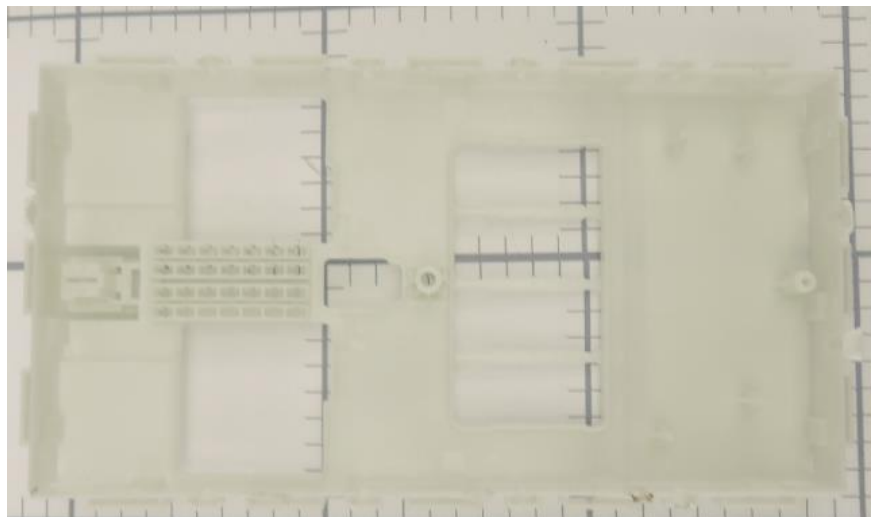
Detailed Summary

Parts	16
Fasteners	0
Part Numbers	9
Steps	37
Fastenings	16
Right First Time	99.52%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	1.79
Supplier Fab. Time (Min)	0.14
Total Weight (kg)	0.75
Purchased Part Cost	
	\$0.65
Material Cost	\$164.88
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$0.79
Supplier Fab. Cost	\$0.19
Q Burden	\$0.07
SG&A	\$23.24
Manufacturing Cost*	\$189.82

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Upper Housing Body Domain Controller, Body Domain



\...

- \Body Domain Controller, Body Domain Controller and
- \Upper Housing Body Domain Controller, Body Domain
- \Upper Housing Body Domain Controller Process

Process Summary

Right First Time	99.99 %
Process Time (Sec)	4.29
Total Weight (kg)	0.16

Material Cost**	\$0.41
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.10
Q Burden	\$0.00
SG&A	\$0.07
Manufacturing Cost*	\$0.58

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Upper Housing Body Domain Controller, Body Domain



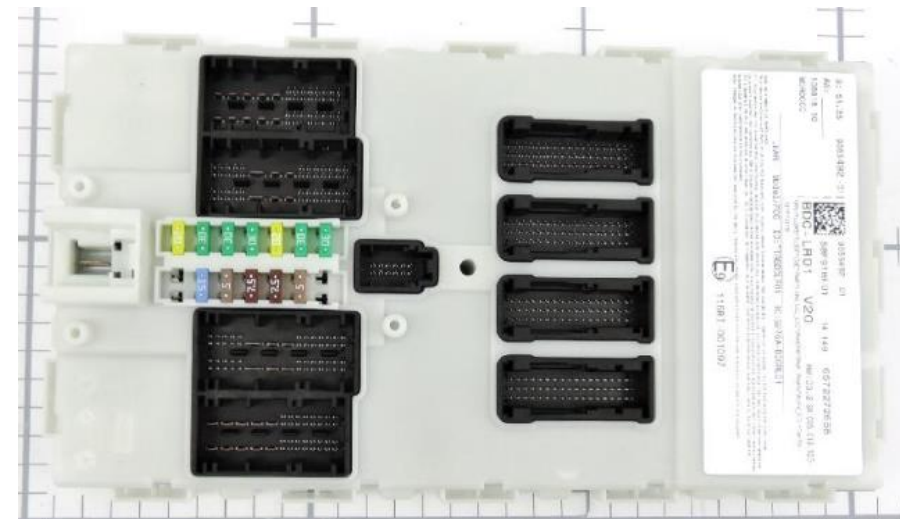
Upper Housing Body Domain Controller Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
950 Ton Injection Molding Press	17.16	4	0.25	83.17	MAR	\$0.10	99.99%	\$0.00

Upper Housing Body Domain Controller Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, Upper Housing Body Domain Controller	1	PP (GF+MD)30	\$2.51	0.1567	0.1650	\$0.00	\$0.41

Assemble Upper Housing and Printed Circuit Board



\...

- \Body Domain Controller and Bracket Asm
- \Body Domain Controller, Body Domain Controller and
- \Assemble Upper Housing and Printed Circuit Board

Process Summary

Right First Time	99.61 %
Process Time (Sec)	94.00
Total Weight (kg)	0.49

Material Cost**	\$164.77
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.69
Q Burden	\$0.06
SG&A	\$23.10
Manufacturing Cost*	\$188.61

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Upper Housing and Printed Circuit Board



Assemble Upper Housing and Printed Circuit Board

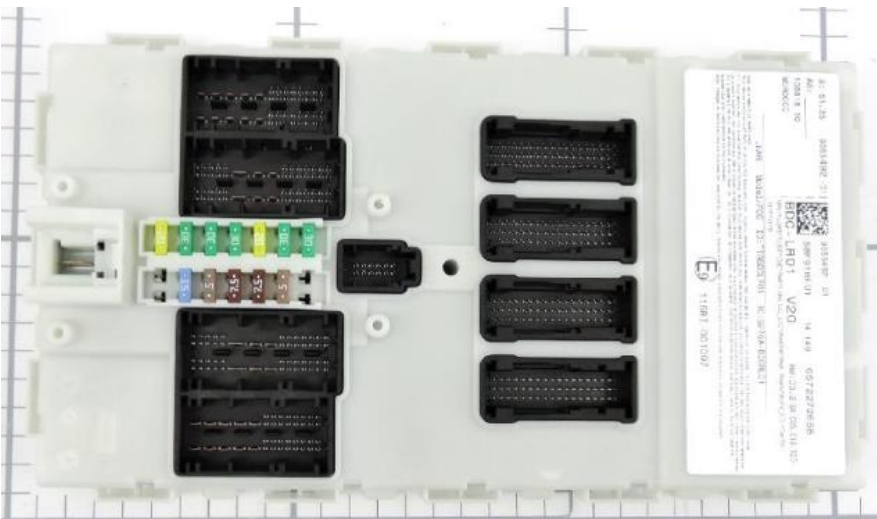
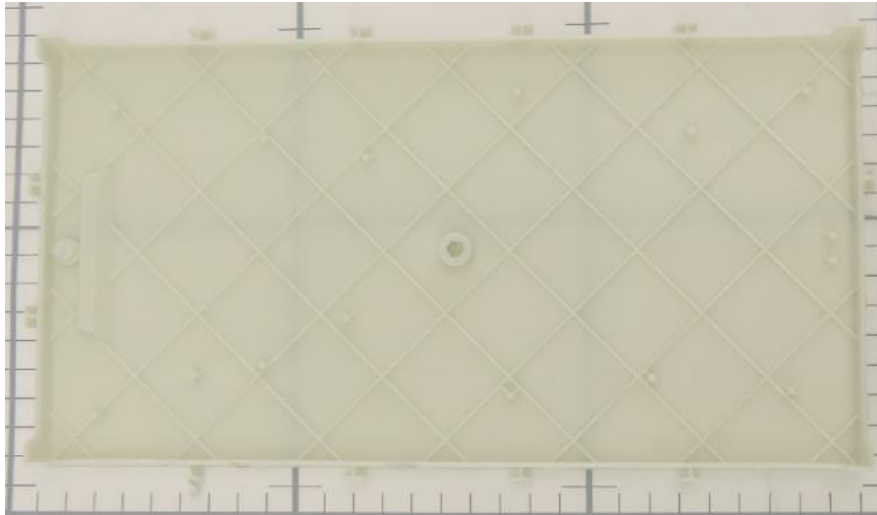
Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	94.00	1	1.00	26.36	MAR	\$0.69	99.61 %	\$0.06

Assemble Upper Housing and Printed Circuit Board

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Body Domain Controller Printed Circuit Board, Body	1	See Appendix	-	0.4780	-	\$0.00	\$164.17
7.5 Fuse	2	Commodity Item	Purchased	0.0006	-	\$0.05	\$0.00
20 Fuse	2	Commodity Item	Purchased	0.0006	-	\$0.05	\$0.00
5 Fuse	2	Commodity Item	Purchased	0.0006	-	\$0.05	\$0.00
15 Fuse	1	Commodity Item	Purchased	0.0006	-	\$0.05	\$0.00
30 Fuse	5	Commodity Item	Purchased	0.0006	-	\$0.05	\$0.00

[Click Here for TechInsights Electronics Report on Body Domain Controller](#)

Lower Housing Body Domain Controller



\...

- \Body Domain Controller, Body Domain Controller and
- \Lower Housing Body Domain Controller
- \Lower Housing Body Domain Controller Process

Process Summary

Right First Time	99.99 %
Process Time (Sec)	4.07
Total Weight (kg)	0.11

Material Cost**	\$0.30
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.09
Q Burden	\$0.00
SG&A	\$0.06
Manufacturing Cost*	\$0.45

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Lower Housing Body Domain Controller



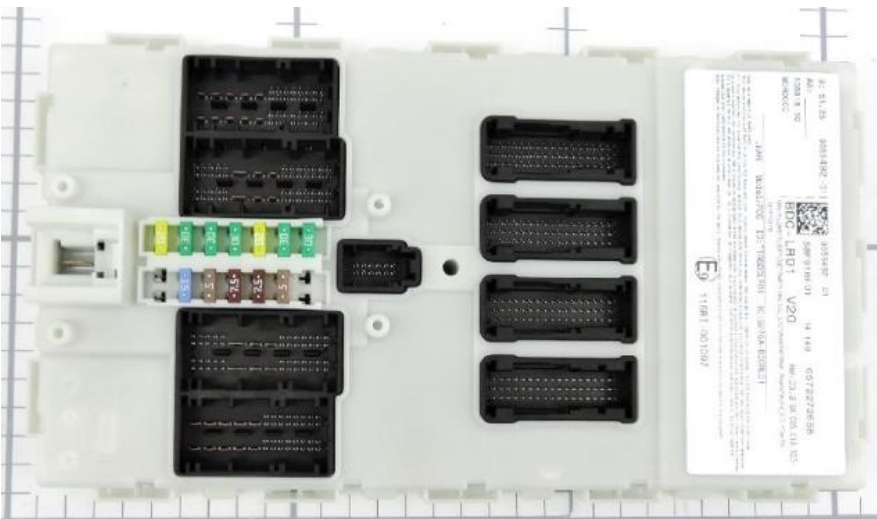
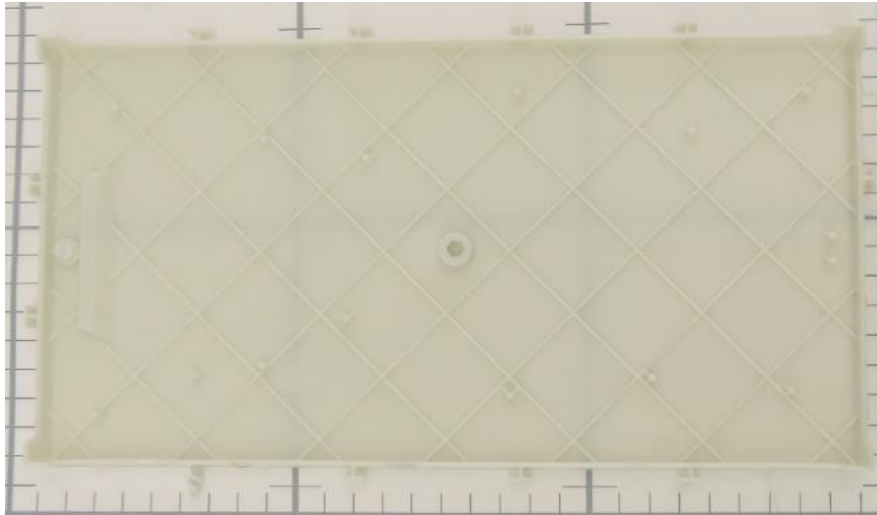
Lower Housing Body Domain Controller Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
950 Ton Injection Molding Press	16.28	4	0.25	83.17	MAR	\$0.09	99.99%	\$0.00

Lower Housing Body Domain Controller Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, Lower Housing Body Domain Controller	1	PP (GF+MD)30	\$2.51	0.1100	0.1180	\$0.00	\$0.30

Assemble Lower Housing



\...

- \Body Domain Controller and Bracket Asm
- \Body Domain Controller, Body Domain Controller and
- \Assemble Lower Housing

Process Summary

Right First Time	99.93 %
Process Time (Sec)	13.38
Total Weight (kg)	0.00

Material Cost**	\$0.05
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.10
Q Burden	\$0.01
SG&A	\$0.02
Manufacturing Cost*	\$0.17

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Lower Housing



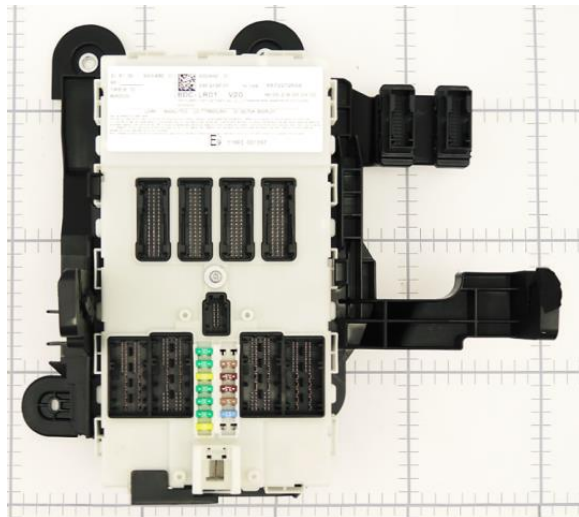
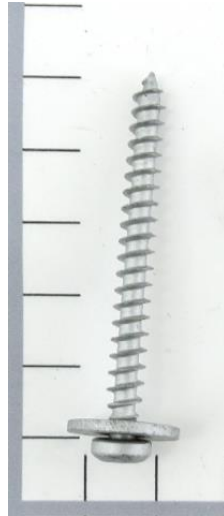
Assemble Lower Housing

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	13.38	1	1.00	26.36	MAR	\$0.10	99.93%	\$0.01

Assemble Lower Housing

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Label, Lear Supplier	1	Commodity Item	Purchased	0.0001	-	\$0.05	\$0.00

Assemble Body Domain Controller and Bracket Asm



\...

\Body Wire Harnesses

\Body Domain Controller and Bracket Asm

\Assemble Body Domain Controller and Bracket Asm

Process Summary

Right First Time	99.75 %
Process Time (Sec)	21.00
Total Weight (kg)	0.01

Material Cost**	\$0.08
OEM Process Cost	\$0.53
Supplier Process Cost	\$0.00
Q Burden	\$0.04
SG&A	\$0.08
Manufacturing Cost*	\$0.73

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Body Domain Controller and Bracket Asm



Assemble Body Domain Controller and Bracket Asm

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	21.00	1	1.00	91.41	GER	\$0.53	99.75%	\$0.04

Assemble Body Domain Controller and Bracket Asm

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
M5x48mm-Torx SEMS Screw	1	Commodity Item	Purchased	0.0063	-	\$0.08	\$0.00



\...
 \Zone 5 Electronics
 \Body Wire Harnesses
 \Fuse Box Installation

Process Summary

Right First Time	98.93 %
Process Time (Sec)	199.50
Total Weight (kg)	0.02

Material Cost**	\$0.08
OEM Process Cost	\$5.07
Supplier Process Cost	\$0.00
Q Burden	\$0.16
SG&A	\$0.71
Manufacturing Cost*	\$6.02



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Fuse Box Installation

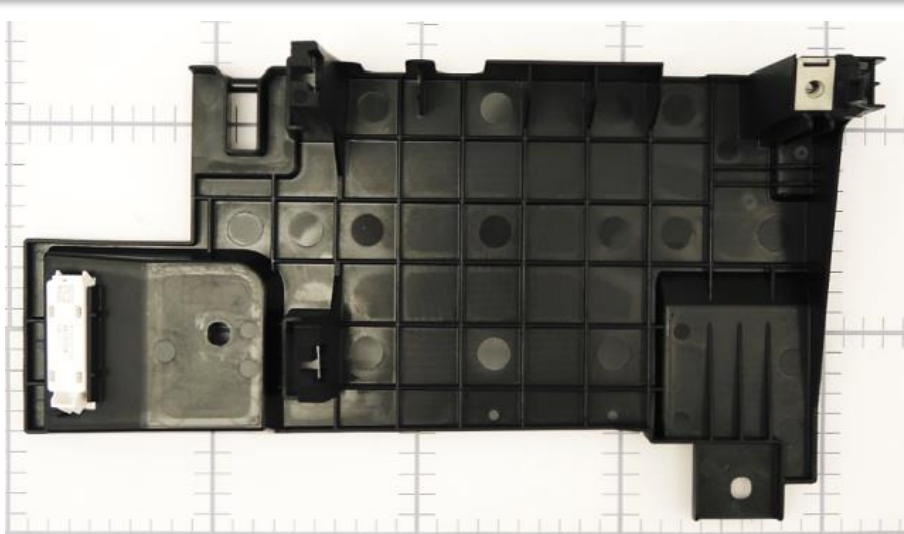
Fuse Box Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	199.50	1	1.00	91.41	GER	\$5.07	98.93%	\$0.16

Fuse Box Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
M8x18mm-Torx Bolt	2	Commodity Item	Purchased	0.0122	-	\$0.04	\$0.00

PDC Mounting Tray Asm



\...

- \Zone 5 Electronics
- \Body Wire Harnesses
- \PDC Mounting Tray Asm

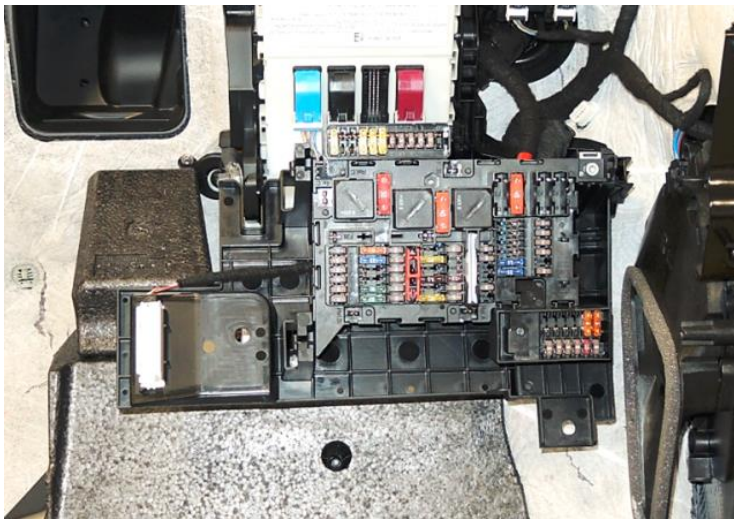
Assembly Summary

Parts	3
Fasteners	1
Part Numbers	3
Steps	7
Fastenings	2
Right First Time	99.93 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	0.39
Total Weight (kg)	0.38

Material Cost**	\$1.41
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.40
Q Burden	\$0.01
SG&A	\$0.11
Manufacturing Cost*	\$1.93

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost



PDC Mounting Tray Asm



PDC Mounting Tray Asm

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
PDC Mounting Tray	1	1	0	1	0	99.99 %	0.00	0.00	0.00	0.15	0.3585
Assemble Body Domain Controller and Bracket	1	2	2	5	2	99.94 %	0.00	0.00	0.23	0.00	0.0166

PDC Mounting Tray Asm

Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
PDC Mounting Tray	\$0.00	\$0.14	\$0.00	\$0.00	\$0.00	\$0.20	\$0.00	\$0.05	\$0.39
Assemble Body Domain Controller and Bracket	\$1.27	\$0.00	\$0.00	\$0.00	\$0.20	\$0.00	\$0.01	\$0.07	\$1.54

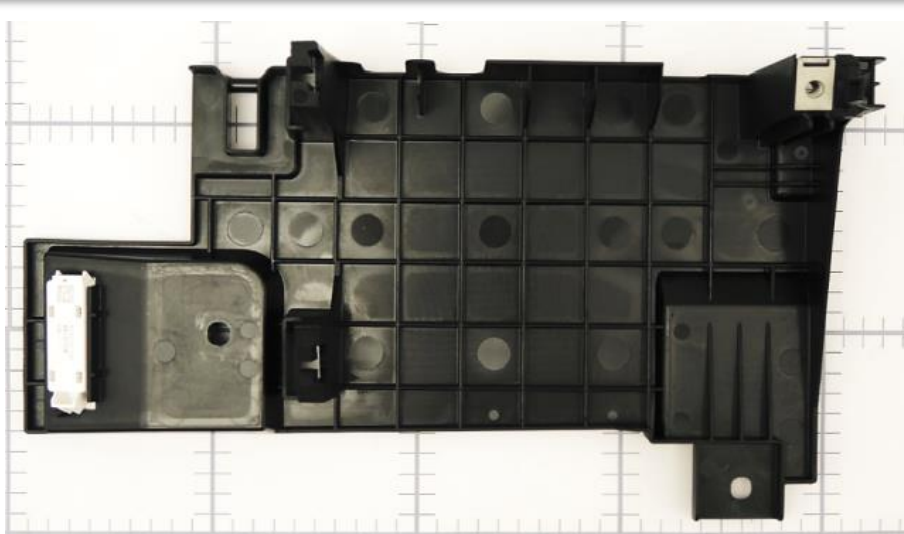
Detailed Summary

Parts	3
Fasteners	1
Part Numbers	3
Steps	7
Fastenings	2
Right First Time	99.93%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	0.23
Supplier Fab. Time (Min)	0.15
Total Weight (kg)	0.38
Purchased Part Cost	\$1.27
Material Cost	\$0.14
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$0.20
Supplier Fab. Cost	\$0.20
Q Burden	\$0.01
SG&A	\$0.11
Manufacturing Cost*	\$1.93

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

PDC Mounting Tray



- \...
- \PDC Mounting Tray Asm
- \PDC Mounting Tray
- \PDC Mounting Tray Process

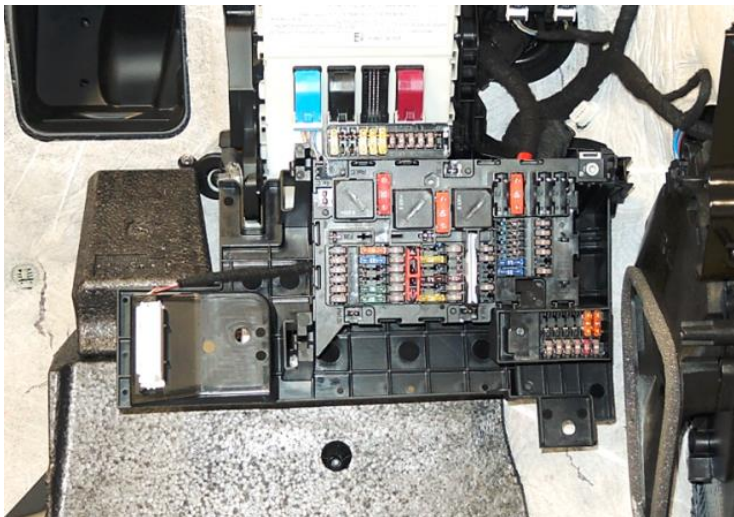
Process Summary

Right First Time	99.99 %
Process Time (Sec)	9.20
Total Weight (kg)	0.36

Material Cost**	\$0.14
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.20
Q Burden	\$0.00
SG&A	\$0.05
Manufacturing Cost*	\$0.39

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost



PDC Mounting Tray

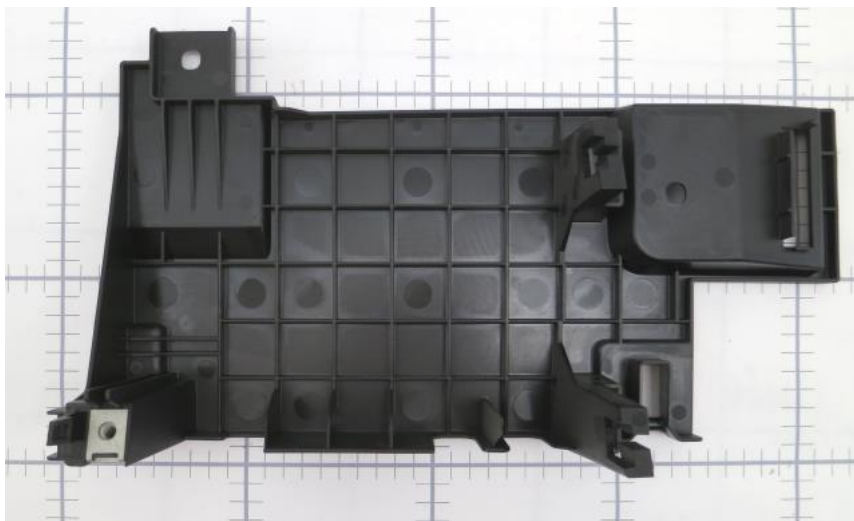
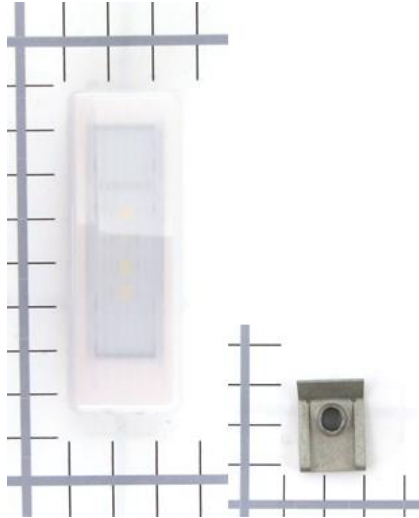
PDC Mounting Tray Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
950 Ton Injection Molding Press	18.40	2	0.25	78.93	AUT	\$0.20	99.99%	\$0.00

PDC Mounting Tray Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, PDC Mounting Tray	1	PA6 GF30	\$4.10	0.3585	0.3600	\$0.00	\$0.14

Assemble Body Domain Controller and Bracket



- \...
- \Body Wire Harnesses
- \PDC Mounting Tray Asm
- \Assemble Body Domain Controller and Bracket

Process Summary

Right First Time	99.94 %
Process Time (Sec)	14.00
Total Weight (kg)	0.02

Material Cost**	\$1.27
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.20
Q Burden	\$0.01
SG&A	\$0.07
Manufacturing Cost*	\$1.54

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Body Domain Controller and Bracket



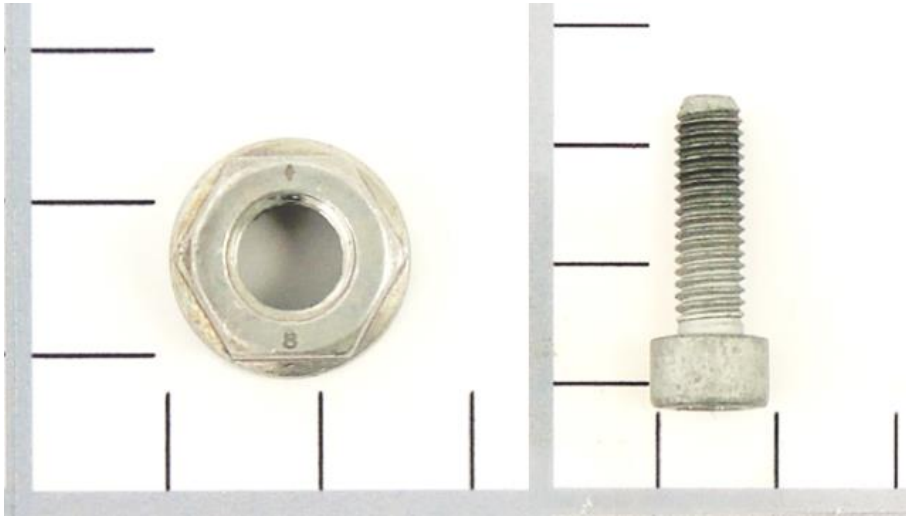
Assemble Body Domain Controller and Bracket

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	14.00	1	1.00	50.30	AJT	\$0.20	99.94 %	\$0.01

Assemble Body Domain Controller and Bracket

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Compartment Light	1	Commodity Item	Purchased	0.0117	-	\$1.25	\$0.00
M6 U-Nut	1	Commodity Item	Purchased	0.0049	-	\$0.02	\$0.00

PDC Mounting Tray Installation



\...
\Zone 5 Electronics
\Body Wire Harnesses
\PDC Mounting Tray Installation

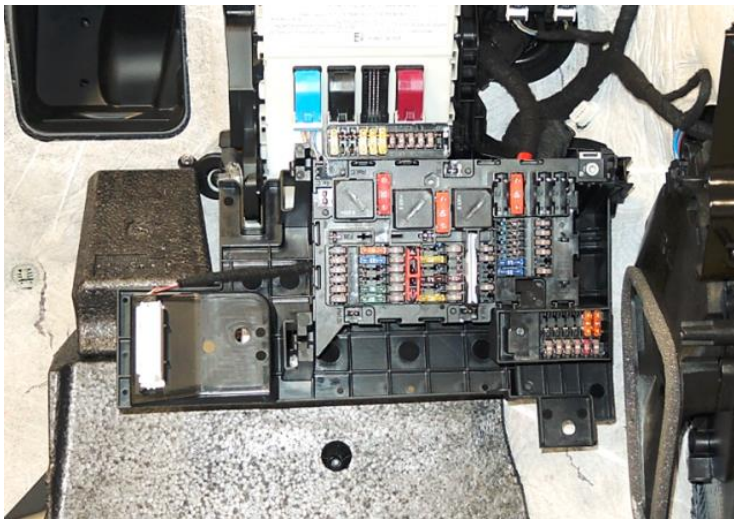
Process Summary

Right First Time	99.44 %
Process Time (Sec)	65.50
Total Weight (kg)	0.01

Material Cost**	\$0.06
OEM Process Cost	\$1.66
Supplier Process Cost	\$0.00
Q Burden	\$0.08
SG&A	\$0.23
Manufacturing Cost*	\$2.04

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost



PDC Mounting Tray Installation



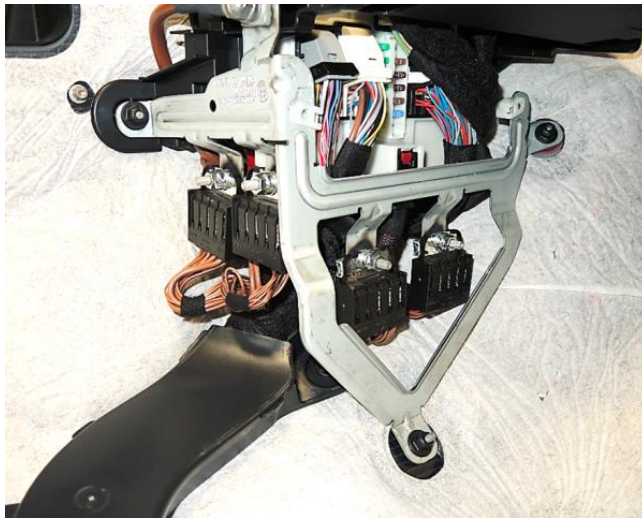
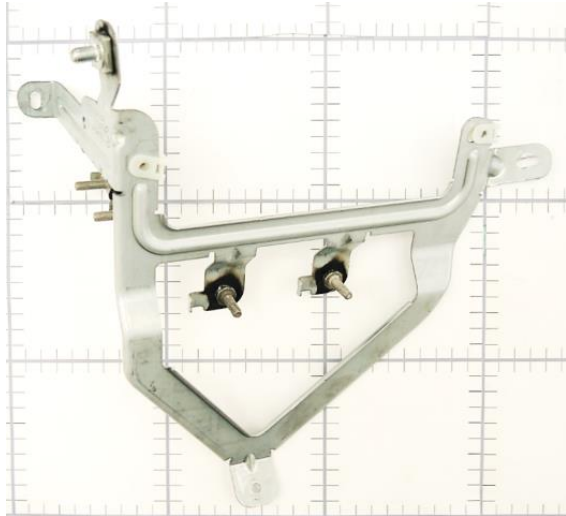
PDC Mounting Tray Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	65.50	1	1.00	91.41	GER	\$1.66	99.44 %	\$0.08

PDC Mounting Tray Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
M8x8mm-Flanged Hex Nut	1	Commodity Item	Purchased	0.0063	-	\$0.04	\$0.00
M6x20mm-Torx Bolt	1	Commodity Item	Purchased	0.0064	-	\$0.02	\$0.00

Fuse Box Bracket Asm



\...

- \Zone 5 Electronics
- \Body Wire Harnesses
- \Fuse Box Bracket Asm

Assembly Summary

Parts	8
Fasteners	7
Part Numbers	4
Steps	30
Fastenings	6
Right First Time	99.77 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	1.20
Total Weight (kg)	0.41

Material Cost**	\$2.21
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.96
Q Burden	\$0.03
SG&A	\$0.43
Manufacturing Cost*	\$3.64

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Fuse Box Bracket Asm



Fuse Box Bracket Asm

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Stamping, Fuse Box Bracket Asm	1	1	0	7	0	99.97 %	0.00	0.00	0.00	0.43	0.3820
Assemble Fuse Box Bracket	1	7	6	22	6	99.81 %	0.00	0.00	0.77	0.00	0.0310

Fuse Box Bracket Asm

Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
Stamping, Fuse Box Bracket Asm	\$0.00	\$2.11	\$0.00	\$0.00	\$0.00	\$0.64	\$0.01	\$0.39	\$3.14
Assemble Fuse Box Bracket	\$0.10	\$0.00	\$0.00	\$0.00	\$0.32	\$0.00	\$0.03	\$0.05	\$0.50

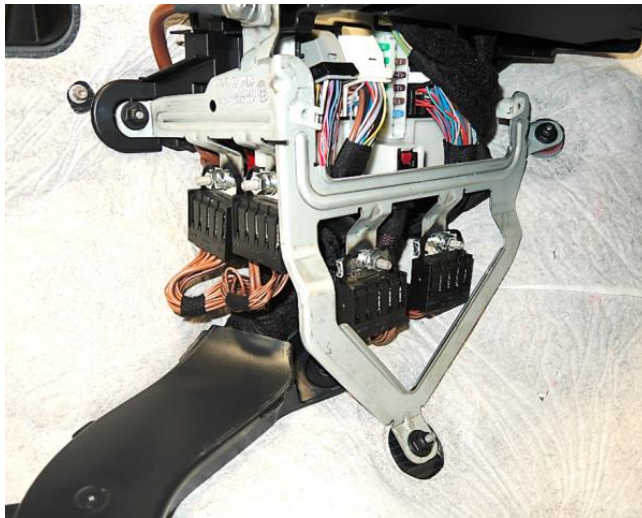
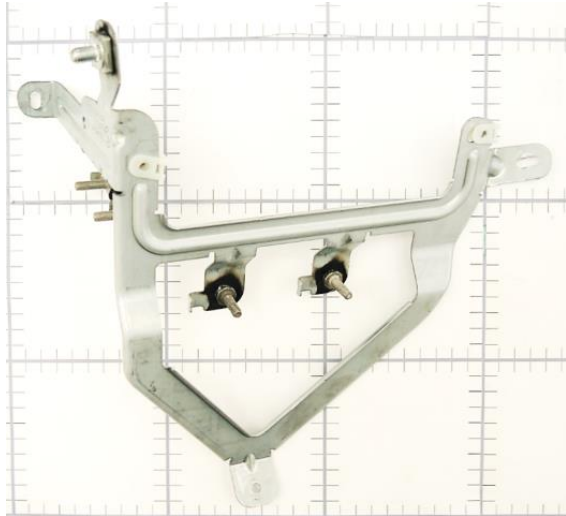
Detailed Summary

Parts	8
Fasteners	7
Part Numbers	4
Steps	30
Fastenings	6
Right First Time	99.77%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	0.77
Supplier Fab. Time (Min)	0.43
Total Weight (kg)	0.41
Purchased Part Cost	\$0.10
Material Cost	\$2.11
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$0.32
Supplier Fab. Cost	\$0.64
Q Burden	\$0.03
SG&A	\$0.43
Manufacturing Cost*	\$3.64

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Stamping, Fuse Box Bracket Asm



\...

- \Fuse Box Bracket Asm
- \Stamping, Fuse Box Bracket Asm
- \Stamping, Fuse Box Bracket Asm Process

Process Summary

Right First Time	99.97 %
Process Time (Sec)	25.50
Total Weight (kg)	0.38

Material Cost**	\$2.11
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.64
Q Burden	\$0.01
SG&A	\$0.39
Manufacturing Cost*	\$3.14

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Stamping, Fuse Box Bracket Asm



Stamping, Fuse Box Bracket Asm Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Wash	9.00	1	0.25	11.90	POL	\$0.03	99.99%	\$0.00
Deburr	9.00	1	0.25	27.46	POL	\$0.07	99.99%	\$0.00
2500 Ton Stamping Press	7.50	1	0.50	261.04	POL	\$0.54	99.99%	\$0.00

Stamping, Fuse Box Bracket Asm Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Fuse Box Bracket, Material	1	Steel 1018 - Galvanized - Coil Stock	\$1.28	0.3820	1.6480	\$0.00	\$2.11

Assemble Fuse Box Bracket

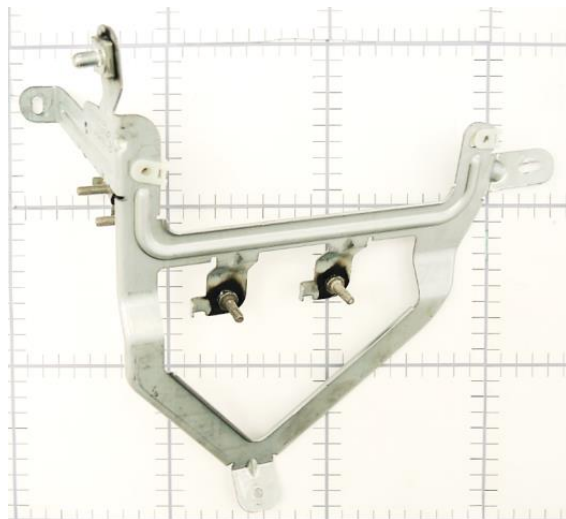


- \...
- \Body Wire Harnesses
- \Fuse Box Bracket Asm
- \Assemble Fuse Box Bracket

Process Summary

Right First Time	99.81 %
Process Time (Sec)	46.40
Total Weight (kg)	0.03

Material Cost**	\$0.10
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.32
Q Burden	\$0.03
SG&A	\$0.05
Manufacturing Cost*	\$0.50



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Fuse Box Bracket



Assemble Fuse Box Bracket

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Spot Welding Station	28.40	1	0.25	24.04	POL	\$0.19	99.86%	\$0.02
Supplier Manual Asm	18.00	1	1.00	26.36	POL	\$0.13	99.95%	\$0.01

Assemble Fuse Box Bracket

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
M6 x 19mm - Weld Stud	4	Commodity Item	Purchased	0.0050	-	\$0.01	\$0.00
M8 x 11mm - SquareHead Weld Stud	1	Commodity Item	Purchased	0.0050	-	\$0.02	\$0.00
J - Nut - Plastic	2	Commodity Item	Purchased	0.0030	-	\$0.02	\$0.00

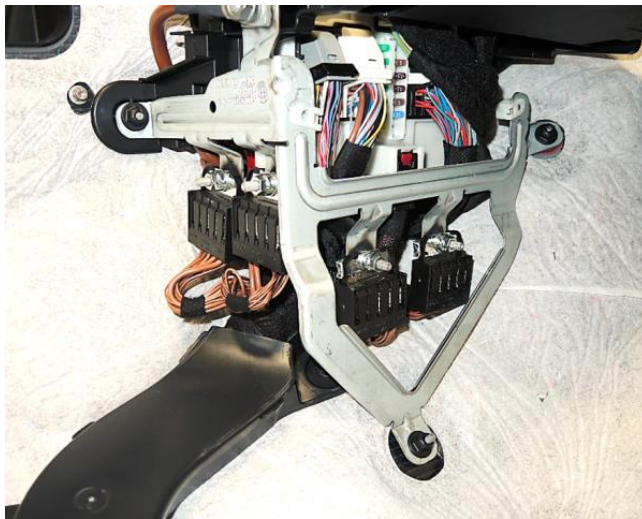


\...
 \Zone 5 Electronics
 \Body Wire Harnesses
 \Fuse Box Bracket Installation

Process Summary

Right First Time	98.25 %
Process Time (Sec)	130.00
Total Weight (kg)	0.04

Material Cost**	\$0.29
OEM Process Cost	\$3.30
Supplier Process Cost	\$0.00
Q Burden	\$0.26
SG&A	\$0.47
Manufacturing Cost*	\$4.33



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Fuse Box Bracket Installation



Fuse Box Bracket Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	130.00	1	1.00	91.41	GER	\$3.30	98.25%	\$0.26

Fuse Box Bracket Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
M6x10mm-Flanged Hex Nut	4	Commodity Item	Purchased	0.0061	-	\$0.04	\$0.00
M8x10mm-Flanged Hex Nut	1	Commodity Item	Purchased	0.0083	-	\$0.04	\$0.00
M5x11 Plastic Hex Flange Nut	3	Commodity Item	Purchased	0.0014	-	\$0.03	\$0.00



- \...
- \Zone 5 Electronics
- \Body Wire Harnesses
- \Power Distribution Center Asm

Assembly Summary

Parts	23
Fasteners	12
Part Numbers	14
Steps	49
Fastenings	10
Right First Time	98.83 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	2.50
Total Weight (kg)	0.24

Material Cost**	\$4.84
OEM Process Cost	\$0.00
Supplier Process Cost	\$1.78
Q Burden	\$0.18
SG&A	\$0.57
Manufacturing Cost*	\$7.38

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Power Distribution Center Asm



Power Distribution Center Asm

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Housing, Power Distribution Box	1	10	0	18	0	99.86 %	0.00	0.00	0.00	0.62	0.1289
Fuse Panel, PowerDistribution	1	7	6	16	6	99.82 %	0.00	0.00	0.95	0.01	0.0580
Isolator, Power Distribution Box	1	2	0	2	0	99.98 %	0.00	0.00	0.00	0.07	0.0369
Assemble Power Distribution Box	1	4	4	10	4	99.16 %	0.00	0.00	0.85	0.00	0.0176

Power Distribution Center Asm

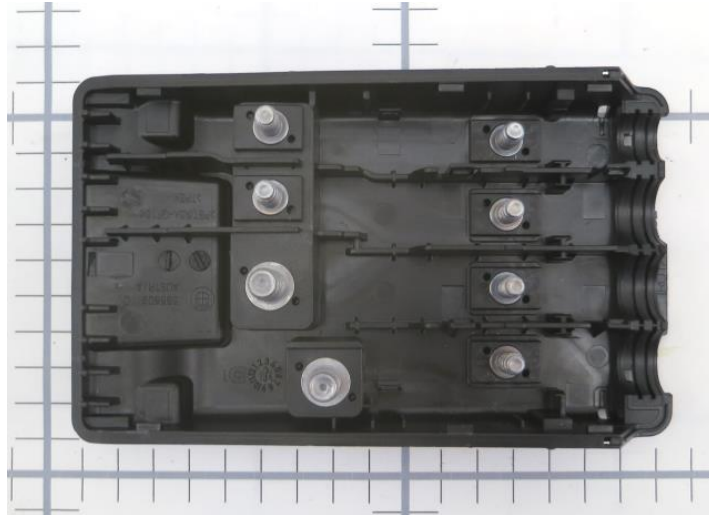
Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
Housing, Power Distribution Box	\$0.18	\$0.38	\$0.00	\$0.00	\$0.00	\$0.25	\$0.02	\$0.09	\$0.92
Fuse Panel, PowerDistribution	\$2.95	\$1.09	\$0.00	\$0.00	\$0.80	\$0.00	\$0.03	\$0.35	\$5.22
Isolator, Power Distribution Box	\$0.00	\$0.16	\$0.00	\$0.00	\$0.00	\$0.03	\$0.00	\$0.03	\$0.22
Assemble Power Distribution Box	\$0.08	\$0.00	\$0.00	\$0.00	\$0.71	\$0.00	\$0.13	\$0.10	\$1.02

Detailed Summary

Parts	23
Fasteners	12
Part Numbers	14
Steps	49
Fastenings	10
Right First Time	98.83%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	1.80
Supplier Fab. Time (Min)	0.70
Total Weight (kg)	0.24
Purchased Part Cost	\$3.21
Material Cost	\$1.63
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$1.51
Supplier Fab. Cost	\$0.28
Q Burden	\$0.18
SG&A	\$0.57
Manufacturing Cost*	\$7.38

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

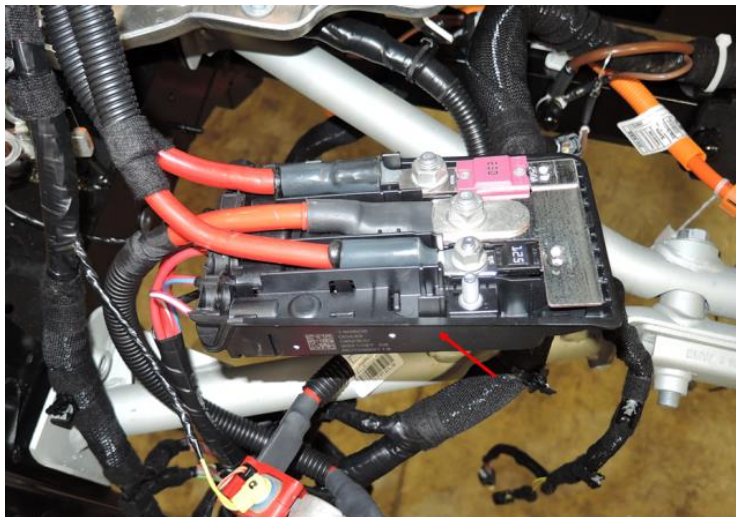


- \...
- \Power Distribution Center Asm
- \Housing, Power Distribution Box
- \Housing, Power Distribution Center Process

Process Summary

Right First Time	99.86 %
Process Time (Sec)	37.40
Total Weight (kg)	0.13

Material Cost**	\$0.56
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.25
Q Burden	\$0.02
SG&A	\$0.09
Manufacturing Cost*	\$0.92



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Housing, Power Distribution Box

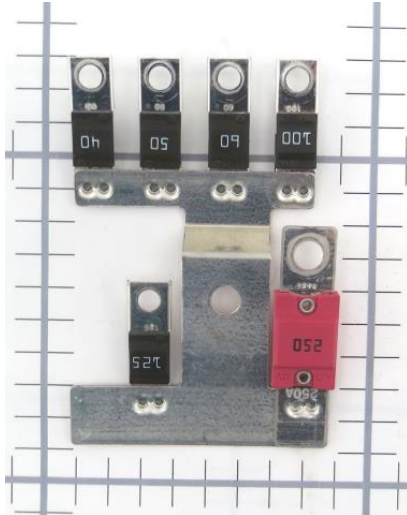


Housing, Power Distribution Center Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
110 Ton Injection Molding Press	149.60	4	0.25	23.70	AUT	\$0.25	99.86%	\$0.02

Housing, Power Distribution Center Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
M8x10mm-Terminal Stud	6	Commodity Item	Purchased	0.0050	-	\$0.02	\$0.00
M8x15mm-Terminal Stud	2	Commodity Item	Purchased	0.0080	-	\$0.03	\$0.00
Material-1, Housing, PowerDistribution Center	1	PBT GF20	\$3.33	0.0813	0.0870	\$0.00	\$0.37
Material-2, Housing, PowerDistribution Box	1	TPE	\$2.54	0.0016	0.0020	\$0.00	\$0.01



- \...
- \Body Wire Harnesses
- \Power Distribution Center Asm
- \Fuse Panel, Power Distribution

Assembly Summary

Parts	7
Fasteners	0
Part Numbers	7
Steps	16
Fastenings	6
Right First Time	99.82 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	0.96
Total Weight (kg)	0.06

Material Cost**	\$4.04
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.80
Q Burden	\$0.03
SG&A	\$0.35
Manufacturing Cost*	\$5.22

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Fuse Panel, Power Distribution



Fuse Panel, Power Distribution

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
Fuse Panel Buss Bar	1	1	0	1	0	99.99 %	0.00	0.00	0.00	0.01	0.0320
Assemble Fuse Panel	1	6	6	14	6	99.83 %	0.00	0.00	0.95	0.00	0.0260

Fuse Panel, Power Distribution

Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
Fuse Panel Buss Bar	\$0.00	\$1.09	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.15	\$1.25
Assemble Fuse Panel	\$2.95	\$0.00	\$0.00	\$0.00	\$0.80	\$0.00	\$0.03	\$0.20	\$3.97

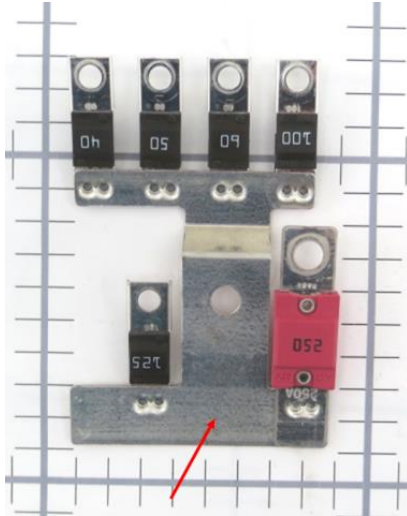
Detailed Summary

Parts	7
Fasteners	0
Part Numbers	7
Steps	16
Fastenings	6
Right First Time	99.82%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	0.95
Supplier Fab. Time (Min)	0.01
Total Weight (kg)	0.06
Purchased Part Cost	\$2.95
Material Cost	\$1.09
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$0.80
Supplier Fab. Cost	\$0.00
Q Burden	\$0.03
SG&A	\$0.35
Manufacturing Cost*	\$5.22

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Fuse Panel Buss Bar



- \...
- \Fuse Panel, Power Distribution
- \Fuse Panel Buss Bar
- \Fuse Panel Buss Bar Process

Process Summary

Right First Time	99.99 %
Process Time (Sec)	0.60
Total Weight (kg)	0.03

Material Cost**	\$1.09
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.00
Q Burden	\$0.00
SG&A	\$0.15
Manufacturing Cost*	\$1.25

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Fuse Panel Buss Bar



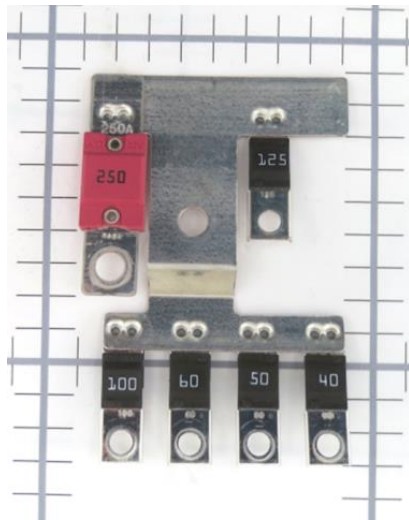
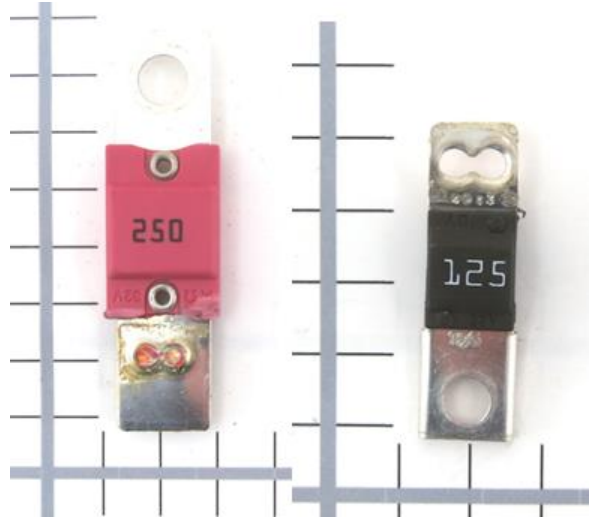
Fuse Panel Buss Bar Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
25Ton Stamping Press	0.60	1	0.25	20.36	AJT	\$0.00	99.99%	\$0.00

Fuse Panel Buss Bar Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, Fuse Panel Buss Bar	1	Nickel Plated Copper Sheet (1.15mm)	\$14.80	0.0320	0.0740	\$0.00	\$1.09

Assemble Fuse Panel



\...
 \Power Distribution Center Asm
 \Fuse Panel, Power Distribution
 \Assemble Fuse Panel

Process Summary

Right First Time	99.83 %
Process Time (Sec)	57.00
Total Weight (kg)	0.03

Material Cost**	\$2.95
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.80
Q Burden	\$0.03
SG&A	\$0.20
Manufacturing Cost*	\$3.97

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Fuse Panel

Assemble Fuse Panel

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	57.00	1	1.00	50.30	AUT	\$0.80	99.83%	\$0.03

Assemble Fuse Panel

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Small Fuse 40 Amp	1	Commodity Item	Purchased	0.0031	-	\$0.40	\$0.00
Small Fuse 50 Amp	1	Commodity Item	Purchased	0.0031	-	\$0.40	\$0.00
Small Fuse 60 Amp	1	Commodity Item	Purchased	0.0031	-	\$0.40	\$0.00
Small Fuse 100 Amp	1	Commodity Item	Purchased	0.0031	-	\$0.50	\$0.00
Small Fuse 125 Amp	1	Commodity Item	Purchased	0.0031	-	\$0.50	\$0.00
Large Fuse 250 Amp	1	Commodity Item	Purchased	0.0105	-	\$0.75	\$0.00

Isolator, Power Distribution Box



\...

- \Power Distribution Center Asm
- \Isolator, Power Distribution Box
- \Housing, Power Distribution Center Process

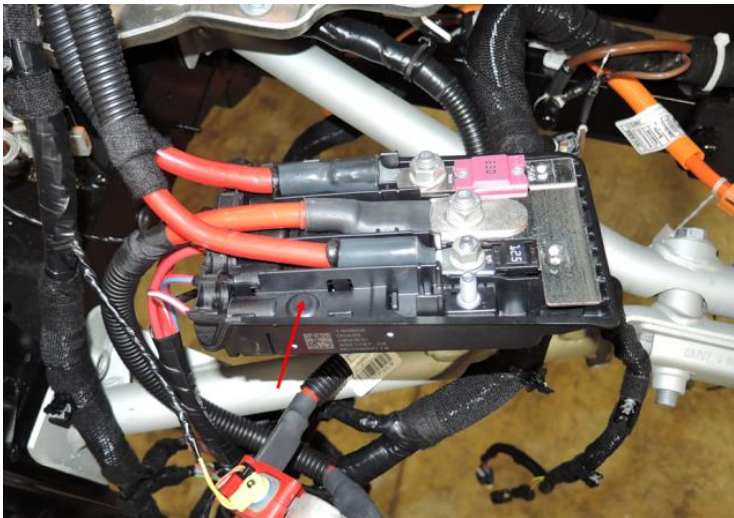
Process Summary

Right First Time	99.98 %
Process Time (Sec)	3.95
Total Weight (kg)	0.04

Material Cost**	\$0.16
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.03
Q Burden	\$0.00
SG&A	\$0.03
Manufacturing Cost*	\$0.22

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost



Isolator, Power Distribution Box



Housing, Power Distribution Center Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
110 Ton Injection Molding Press	15.80	4	0.25	23.70	AJT	\$0.03	99.98 %	\$0.00

Housing, Power Distribution Center Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material-1, Isolator, Power Distribution Center	1	PBT GF20	\$3.33	0.0337	0.0350	\$0.00	\$0.15
Material-2, Isolator, Power Distribution Box	1	TPE	\$2.54	0.0032	0.0035	\$0.00	\$0.01

Assemble Power Distribution Box



- \...
- \Body Wire Harnesses
- \Power Distribution Center Asm
- \Assemble Power Distribution Box

Process Summary

Right First Time	99.16 %
Process Time (Sec)	51.00
Total Weight (kg)	0.02

Material Cost**	\$0.08
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.71
Q Burden	\$0.13
SG&A	\$0.10
Manufacturing Cost*	\$1.02

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Power Distribution Box



Assemble Power Distribution Box

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	51.00	1	1.00	50.30	AUT	\$0.71	99.16%	\$0.13

Assemble Power Distribution Box

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
M5 Hex Flange Nut	4	Commodity Item	Purchased	0.0044	-	\$0.02	\$0.00

Cover, Power Distribution Center



\...

- \Body Wire Harnesses
- \Cover, Power Distribution Center
- \Cover, Power Distribution Center Process

Process Summary

Right First Time	99.98 %
Process Time (Sec)	5.26
Total Weight (kg)	0.06

Material Cost**	\$0.27
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.03
Q Burden	\$0.00
SG&A	\$0.04
Manufacturing Cost*	\$0.35

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Cover, Power Distribution Center

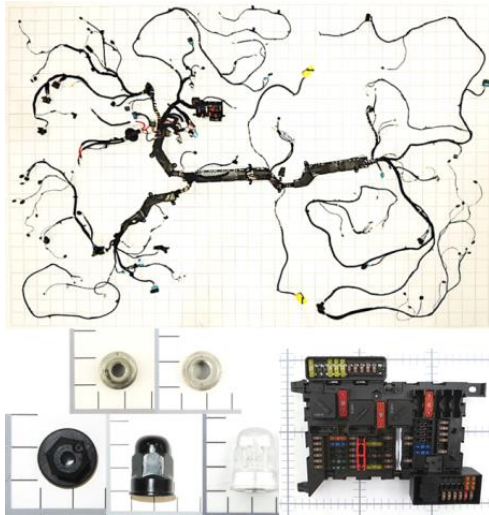


Cover, Power Distribution Center Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
110 Ton Injection Molding Press	21.04	4	0.25	23.70	AJT	\$0.03	99.98 %	\$0.00

Cover, Power Distribution Center Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material-1, Cover, Power Distribution Center	1	PBT GF20	\$3.33	0.0574	0.0620	\$0.00	\$0.26
Material-2, Cover, PowerDistribution Box	1	TPE	\$2.54	0.0015	0.0020	\$0.00	\$0.01



- \...
- \Zone 5 Electronics
- \Body Wire Harnesses
- \Main Wire Harness Installation

Process Summary

Right First Time	91.84 %
Process Time (Sec)	1218.50
Total Weight (kg)	13.00

Material Cost**	\$373.98
OEM Process Cost	\$29.26
Supplier Process Cost	\$1.00
Q Burden	\$1.28
SG&A	\$53.79
Manufacturing Cost*	\$459.31



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Main Wire Harness Installation



Main Wire Harness Installation

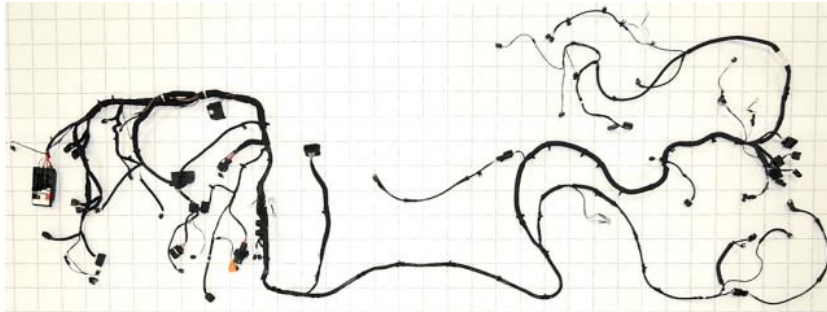
Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	1152.50	1	1.00	91.41	GER	\$29.26	92.39%	\$1.19
Supplier Manual Asm	66.00	1	1.00	54.32	GER	\$1.00	99.41%	\$0.09

Main Wire Harness Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Main Wire Harness Asm	1	See Appendix	-	12.1393	-	\$0.00	\$348.51
M5x11mm-Plastic Hex Flange Nut	2	Commodity Item	Purchased	0.0014	-	\$0.03	\$0.00
M5x11mm-Plastic Hex Flange Nut	3	Commodity Item	Purchased	0.0014	-	\$0.03	\$0.00
M5x11mm-Plastic Hex Flange Nut	2	Commodity Item	Purchased	0.0014	-	\$0.03	\$0.00
M10x25mm-Acom Nut	3	Commodity Item	Purchased	0.0088	-	\$0.04	\$0.00
M10x25mm-Aluminum Acom Nut	1	Commodity Item	Purchased	0.0088	-	\$0.04	\$0.00
M8x8mm-Flanged Hex Nut	2	Commodity Item	Purchased	0.0063	-	\$0.04	\$0.00
M6x8mm-Hex Nut	1	Commodity Item	Purchased	0.0045	-	\$0.02	\$0.00
Main Fuse Block	1	Commodity Item	Purchased	0.7960	-	\$25.00	\$0.00

[Click Here for Munro & Associates Wire Harness Report on Main Wire Harness](#)

Driver Underbody Wire Harness Installation



- \...
- \Zone 5 Electronics
- \Body Wire Harnesses
- \Driver Underbody Wire Harness Installation

Process Summary

Right First Time	95.67 %
Process Time (Sec)	544.00
Total Weight (kg)	5.05

Material Cost**	\$154.94
OEM Process Cost	\$13.81
Supplier Process Cost	\$0.00
Q Burden	\$0.66
SG&A	\$23.58
Manufacturing Cost*	\$192.99

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Driver Underbody Wire Harness Installation

Driver Underbody Wire Harness Installation

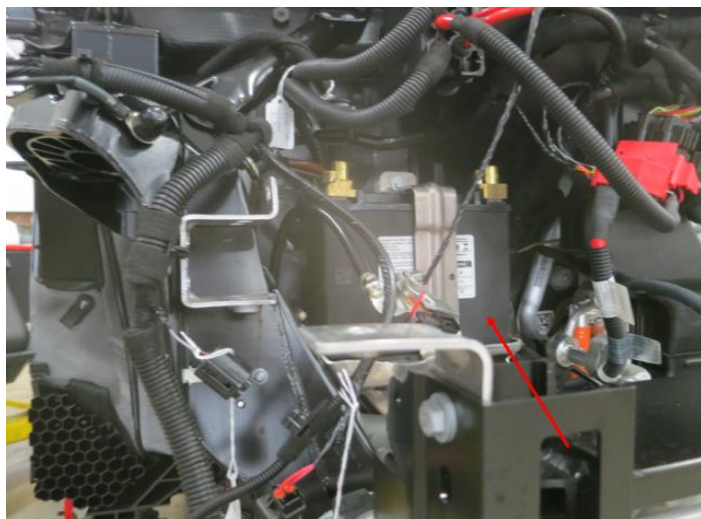
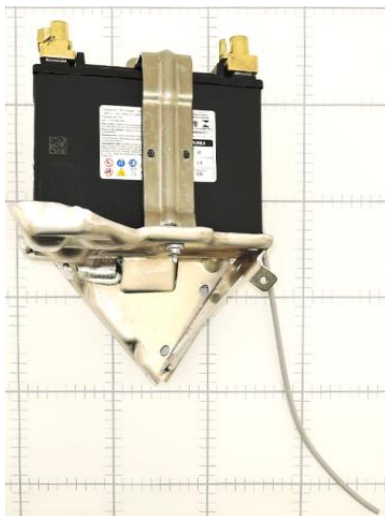
Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	544.00	1	1.00	91.41	GER	\$13.81	95.67%	\$0.66

Driver Underbody Wire Harness Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Underbody Wire Harness Asm DS	1	See Appendix	-	4.9680	-	\$0.00	\$154.49
M5x11mm-Plastic Hex Flange Nut	3	Commodity Item	Purchased	0.0014	-	\$0.03	\$0.00
M10x25mm-Acom Nut	1	Commodity Item	Purchased	0.0088	-	\$0.04	\$0.00
M10x25mm-Acom Nut	2	Commodity Item	Purchased	0.0088	-	\$0.04	\$0.00
M10x25mm-Acom Nut	3	Commodity Item	Purchased	0.0088	-	\$0.04	\$0.00
M10x25mm-Aluminum Acom Nut	1	Commodity Item	Purchased	0.0088	-	\$0.04	\$0.00
M10x25mm-Aluminum Acom Nut	1	Commodity Item	Purchased	0.0088	-	\$0.04	\$0.00
M10x25mm-Acom Nut	1	Commodity Item	Purchased	0.0088	-	\$0.04	\$0.00

[Click Here for Munro & Associates Wire Harness Report on Driver Underbody Wire Harness](#)

12V Battery and Bracket Asm



\...
 \Zone 5 Electronics
 \Body Wire Harnesses
 \12V Battery and Bracket Asm

Assembly Summary

Parts	19
Fasteners	6
Part Numbers	15
Steps	140
Fastenings	13
Right First Time	98.22 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	9.07
Total Weight (kg)	9.03

Material Cost**	\$36.60
OEM Process Cost	\$0.00
Supplier Process Cost	\$4.86
Q Burden	\$0.27
SG&A	\$2.18
Manufacturing Cost*	\$43.91

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

12V Battery and Bracket Asm



12V Battery and Bracket Asm

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
12V Battery Tray Asm	1	6	5	66	5	99.45 %	0.00	0.00	1.32	0.83	0.6930
12V Battery Hold Down	1	1	0	7	0	99.97 %	0.00	0.00	0.00	0.33	0.1093
12VN Battery Terminal	1	2	0	20	0	99.89 %	0.00	0.00	0.00	2.35	0.0999
12VP Battery Terminal	1	2	0	20	0	99.89 %	0.00	0.00	0.00	2.35	0.1078
Assemble 12V Battery & Tray	1	8	8	23	8	99.02 %	0.00	0.00	1.88	0.00	8.0200

12V Battery and Bracket Asm

Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
12V Battery Tray Asm	\$0.04	\$2.66	\$0.00	\$0.00	\$0.99	\$0.38	\$0.08	\$0.57	\$4.72
12V Battery Hold Down	\$0.00	\$0.43	\$0.00	\$0.00	\$0.00	\$0.16	\$0.01	\$0.08	\$0.68
12VN Battery Terminal	\$0.00	\$0.27	\$0.00	\$0.00	\$0.00	\$0.81	\$0.02	\$0.15	\$1.25
12VP Battery Terminal	\$0.00	\$0.29	\$0.00	\$0.00	\$0.00	\$0.81	\$0.02	\$0.15	\$1.27
Assemble 12V Battery & Tray	\$32.91	\$0.00	\$0.00	\$0.00	\$1.70	\$0.00	\$0.15	\$1.23	\$35.98

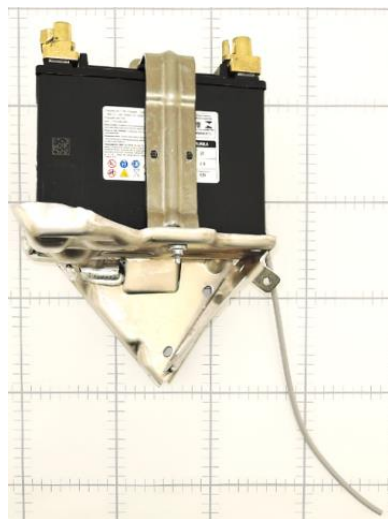
Detailed Summary

Parts	19
Fasteners	6
Part Numbers	15
Steps	140
Fastenings	13
Right First Time	98.22%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	3.20
Supplier Fab. Time (Min)	5.87
Total Weight (kg)	9.03
Purchased Part Cost	
	\$32.95
Material Cost	\$3.65
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$2.70
Supplier Fab. Cost	\$2.17
Q Burden	\$0.27
SG&A	\$2.18
Manufacturing Cost*	\$43.91

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

12V Battery Tray Asm



\...

- \Body Wire Harnesses
- \12V Battery and Bracket Asm
- \12V Battery Tray Asm

Assembly Summary

Parts	6
Fasteners	2
Part Numbers	5
Steps	66
Fastenings	5
Right First Time	99.45 %
OEM Process Time (Min)	0.00
Supplier Process Time (Min)	2.15
Total Weight (kg)	0.69

Material Cost**	\$2.70
OEM Process Cost	\$0.00
Supplier Process Cost	\$1.37
Q Burden	\$0.08
SG&A	\$0.57
Manufacturing Cost*	\$4.72

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

12V Battery Tray Asm



MUNRO
& ASSOCIATES, INC.

12V Battery Tray Asm

Name	Qty	Parts	Fasteners	Steps	Fastenings	Right First Time	OEM Asm. Time (Min)	OEM Fab. Time (Min)	Supplier Asm. Time (Min)	Supplier Fab. Time (Min)	Total Weight (kg)
12V Battery Tray Part-A	1	1	0	7	0	99.97 %	0.00	0.00	0.00	0.33	0.4536
12V Battery Tray Part-B	1	1	0	7	0	99.97 %	0.00	0.00	0.00	0.16	0.0561
12V Battery Tray Part-C	1	1	0	7	0	99.97 %	0.00	0.00	0.00	0.16	0.0883
12V Battery Tray Part-D	1	1	0	7	0	99.97 %	0.00	0.00	0.00	0.16	0.0620
Assemble Battery Tray	1	2	5	34	5	99.57 %	0.00	0.00	1.32	0.00	0.0130

12V Battery Tray Asm

Name	Purchased Part Cost	Material Cost	OEM Asm. Cost	OEM Fab. Cost	Supplier Asm. Cost	Supplier Fab. Cost	Q Burden	SG&A	Manufacturing Cost*
12V Battery Tray Part-A	\$0.00	\$1.52	\$0.00	\$0.00	\$0.00	\$0.16	\$0.01	\$0.24	\$1.93
12V Battery Tray Part-B	\$0.00	\$0.35	\$0.00	\$0.00	\$0.00	\$0.07	\$0.00	\$0.06	\$0.48
12V Battery Tray Part-C	\$0.00	\$0.47	\$0.00	\$0.00	\$0.00	\$0.07	\$0.00	\$0.08	\$0.62
12V Battery Tray Part-D	\$0.00	\$0.32	\$0.00	\$0.00	\$0.00	\$0.08	\$0.00	\$0.06	\$0.46
Assemble Battery Tray	\$0.04	\$0.00	\$0.00	\$0.00	\$0.99	\$0.00	\$0.06	\$0.14	\$1.24

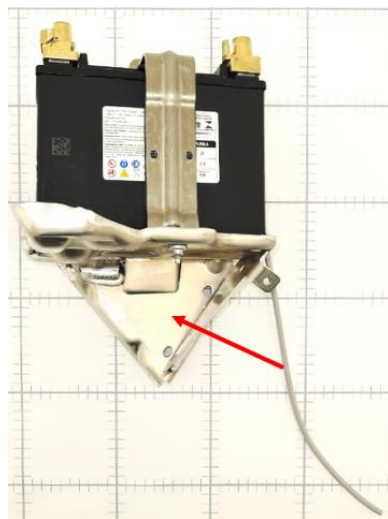
Detailed Summary

Parts	6
Fasteners	2
Part Numbers	5
Steps	66
Fastenings	5
Right First Time	99.45%
OEM Asm. Time (Min)	0.00
OEM Fab. Time (Min)	0.00
Supplier Asm. Time (Min)	1.32
Supplier Fab. Time (Min)	0.83
Total Weight (kg)	0.69
Purchased Part Cost	\$0.04
Material Cost	\$2.66
OEM Asm. Cost	\$0.00
OEM Fab. Cost	\$0.00
Supplier Asm. Cost	\$0.99
Supplier Fab. Cost	\$0.38
Q Burden	\$0.08
SG&A	\$0.57
Manufacturing Cost*	\$4.72

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

12V Battery Tray Part-A



\...

\12V Battery Tray Asm

\12V Battery Tray Part-A

\12V Battery Tray Part-A Process

Process Summary

Right First Time	99.97 %
Process Time (Sec)	19.82
Total Weight (kg)	0.45
Material Cost**	\$1.52
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.16
Q Burden	\$0.01
SG&A	\$0.24
Manufacturing Cost*	\$1.93

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

12V Battery Tray Part-A

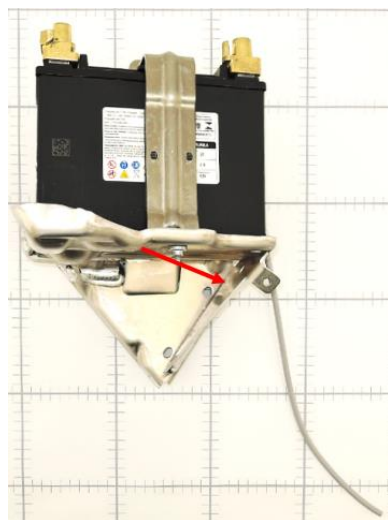
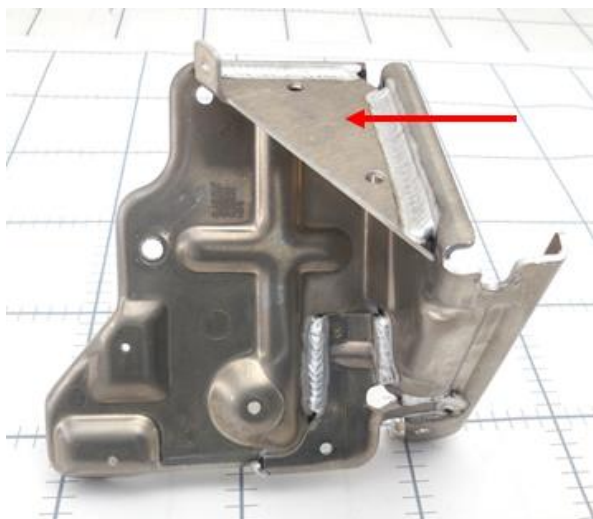
12V Battery Tray Part-A Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Wash	9.00	1	0.25	20.00	GER	\$0.05	99.99%	\$0.00
Deburr	9.00	1	0.25	35.68	GER	\$0.09	99.99%	\$0.00
300 Ton Stamping Press	1.82	1	0.25	49.57	GER	\$0.03	99.99%	\$0.00

12V Battery Tray Part-A Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, 12V Battery Tray Part-A	1	Aluminum 6061 - Coil Stock	\$2.80	0.4536	0.5430	\$0.00	\$1.52

12V Battery Tray Part-B



\...

\12V Battery Tray Asm

\12V Battery Tray Part-B

\12V Battery Tray Part-B Process

Process Summary

Right First Time	99.97 %
Process Time (Sec)	9.60
Total Weight (kg)	0.06
Material Cost**	\$0.35
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.07
Q Burden	\$0.00
SG&A	\$0.06
Manufacturing Cost*	\$0.48

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

12V Battery Tray Part-B

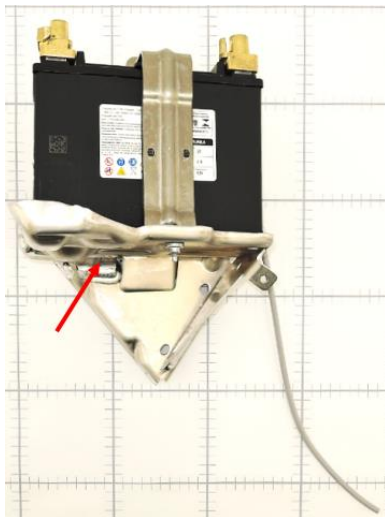
12V Battery Tray Part-B Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Wash	5.00	1	0.25	20.00	GER	\$0.03	99.99%	\$0.00
Deburr	4.00	1	0.25	31.36	GER	\$0.03	99.99%	\$0.00
25 Ton Stamping Press	0.60	1	0.25	21.63	GER	\$0.00	99.99%	\$0.00

12V Battery Tray Part-B Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, 12V Battery Tray Part-B	1	Aluminum 6061 - Coil Stock	\$2.80	0.0561	0.1250	\$0.00	\$0.35

12V Battery Tray Part-C



\...

\12V Battery Tray Asm

\12V Battery Tray Part-C

\12V Battery Tray Part-C Process

Process Summary

Right First Time	99.97 %
Process Time (Sec)	9.67
Total Weight (kg)	0.09
Material Cost**	\$0.47
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.07
Q Burden	\$0.00
SG&A	\$0.08
Manufacturing Cost*	\$0.62

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

12V Battery Tray Part-C

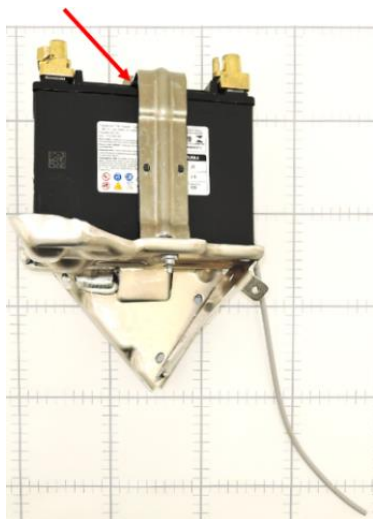
12V Battery Tray Part-C Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Wash	5.00	1	0.25	20.00	GER	\$0.03	99.99%	\$0.00
Deburr	4.00	1	0.25	31.36	GER	\$0.03	99.99%	\$0.00
60 Ton Stamping Press	0.67	1	0.25	25.22	GER	\$0.00	99.99%	\$0.00

12V Battery Tray Part-C Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, 12V Battery Tray Part-C	1	Aluminum 6061 - Coil Stock	\$2.80	0.0883	0.1680	\$0.00	\$0.47

12V Battery Tray Part-D



- \...
- \12V Battery Tray Asm
- \12V Battery Tray Part-D
- \12V Battery Tray Part-D Process

Process Summary

Right First Time	99.97 %
Process Time (Sec)	10.71
Total Weight (kg)	0.08
Material Cost**	\$0.32
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.08
Q Burden	\$0.00
SG&A	\$0.06
Manufacturing Cost*	\$0.46

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

12V Battery Tray Part-D

12V Battery Tray Part-D Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Wash	5.00	1	0.25	20.00	GER	\$0.03	99.99%	\$0.00
Deburr	4.00	1	0.25	31.36	GER	\$0.03	99.99%	\$0.00
200 Ton Stamping Press	1.71	1	0.25	39.32	GER	\$0.02	99.99%	\$0.00

12V Battery Tray Part-D Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, 12V Battery Tray Part-D	1	Aluminum 6061 - Coil Stock	\$2.80	0.0820	0.1130	\$0.00	\$0.32

No Commodity Items Required for This Process



\...

\12V Battery and Bracket Asm

\12V Battery Tray Asm

\Assemble Battery Tray

Process Summary

Right First Time	99.57 %
Process Time (Sec)	79.28
Total Weight (kg)	0.01
Material Cost**	\$0.04
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.99
Q Burden	\$0.06
SG&A	\$0.14
Manufacturing Cost*	\$1.24

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble Battery Tray

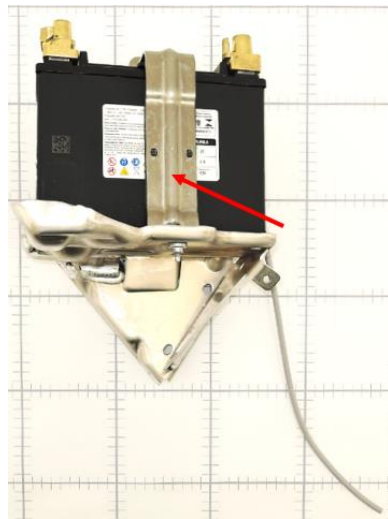
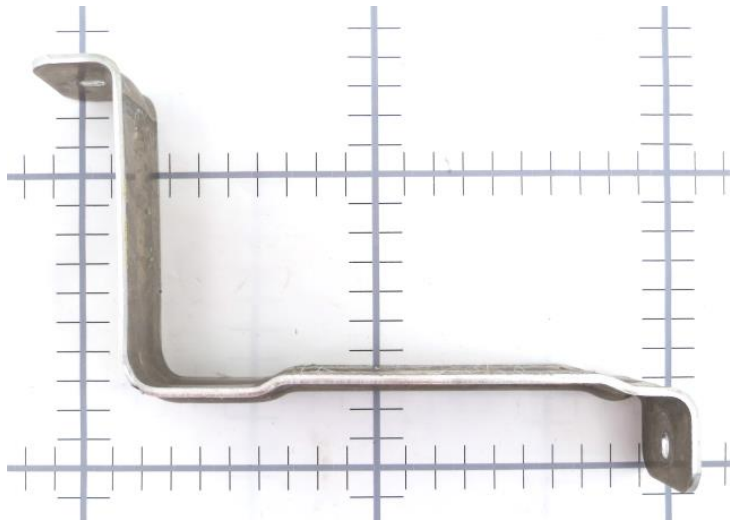
Assemble Battery Tray

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Robotic Aluminum Weld	79.28	1	0.25	45.17	CZE	\$0.99	99.57%	\$0.06

Assemble Battery Tray

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
M6 Clinch Nut	2	Commodity Item	Purchased	0.0065	-	\$0.02	\$0.00

12V Battery Hold Down



\...

\12V Battery and Bracket Asm

\12V Battery Hold Down

\12V Battery Hold Down Process

Process Summary

Right First Time	99.97 %
Process Time (Sec)	19.82
Total Weight (kg)	0.11

Material Cost**	\$0.43
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.16
Q Burden	\$0.01
SG&A	\$0.08
Manufacturing Cost*	\$0.68

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

12V Battery Hold Down

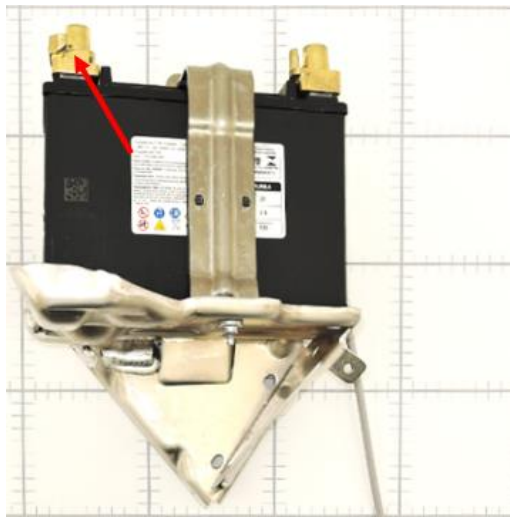
12V Battery Hold Down Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Wash	9.00	1	0.25	20.00	GER	\$0.05	99.99%	\$0.00
Deburr	9.00	1	0.25	35.68	GER	\$0.09	99.99%	\$0.00
300 Ton Stamping Press	1.82	1	0.25	49.57	GER	\$0.03	99.99%	\$0.00

12V Battery Hold Down Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, 12V Battery Hold Down	1	Aluminum 6061 - Coil Stock	\$2.80	0.1093	0.1520	\$0.00	\$0.43

12V N Battery Terminal



\...

\12V Battery and Bracket Asm

\12V N Battery Terminal

\12V N Battery Terminal Process

Process Summary

Right First Time	99.89 %
Process Time (Sec)	141.28
Total Weight (kg)	0.10

Material Cost**	\$0.27
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.81
Q Burden	\$0.02
SG&A	\$0.15
Manufacturing Cost*	\$1.25

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

12V N Battery Terminal

12V N Battery Terminal Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Cure	122.00	1	0.25	17.08	GER	\$0.58	99.97 %	\$0.01
Dip Coating	2.96	1	0.25	40.99	GER	\$0.03	99.98 %	\$0.00
Wash	5.00	1	0.25	30.69	GER	\$0.04	99.99 %	\$0.00
Deburr	4.00	1	0.25	31.36	GER	\$0.03	99.99 %	\$0.00
CNC Machining	6.19	1	0.25	49.86	GER	\$0.09	99.98 %	\$0.00
260 Ton DieCast Machine	18.08	16	1.00	117.01	GER	\$0.04	99.99 %	\$0.00

12V N Battery Terminal Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, Coating, Negative Battery Terminal	1	Paint - Basecoat		By Area	0.0000	\$0.00	\$0.02
Material, 12V N Battery Terminal	1	Zn - Zamak 5	\$2.49	0.0999	0.1010	\$0.00	\$0.25

12V P Battery Terminal



\...

\12V Battery and Bracket Asm

\12V P Battery Terminal

\12V P Battery Terminal Process

Process Summary

Right First Time	99.89 %
Process Time (Sec)	141.28
Total Weight (kg)	0.11
Material Cost**	\$0.29
OEM Process Cost	\$0.00
Supplier Process Cost	\$0.81
Q Burden	\$0.02
SG&A	\$0.15
Manufacturing Cost*	\$1.27

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

12V P Battery Terminal

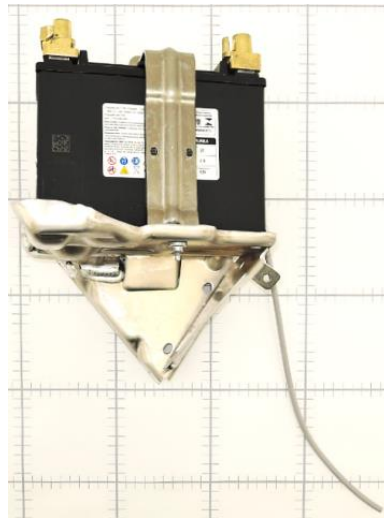
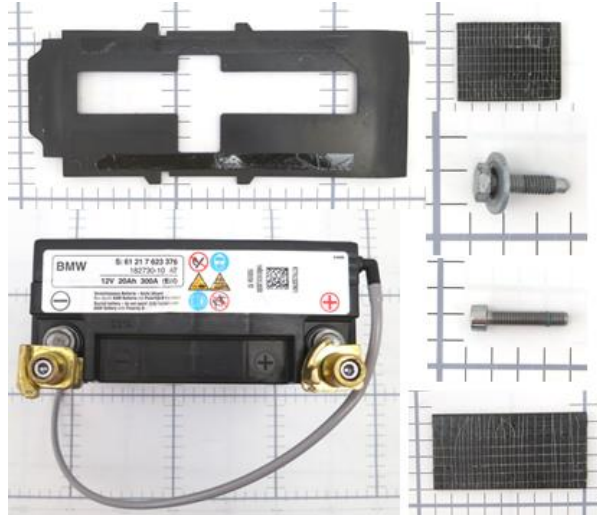
12V P Battery Terminal Process

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Cure	122.00	1	0.25	17.08	GER	\$0.58	99.97 %	\$0.01
Dip Coating	2.96	1	0.25	40.99	GER	\$0.03	99.98 %	\$0.00
Wash	5.00	1	0.25	30.69	GER	\$0.04	99.99 %	\$0.00
Deburr	4.00	1	0.25	31.36	GER	\$0.03	99.99 %	\$0.00
CNC Machining	6.19	1	0.25	49.86	GER	\$0.09	99.98 %	\$0.00
260 Ton DieCast Machine	18.08	16	1.00	117.01	GER	\$0.04	99.99 %	\$0.00

12V P Battery Terminal Process

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Material, Coating, Negative Battery Terminal	1	Paint - Basecoat		By Area	0.0000	-	\$0.00
Material, 12VP Battery Terminal	1	Zn - Zamak 5	\$2.49	0.1078	0.1090	\$0.00	\$0.27

Assemble 12V Battery & Tray



- \...
- \Body Wire Harnesses
- \12V Battery and Bracket Asm
- \Assemble 12V Battery & Tray

Process Summary

Right First Time	99.02 %
Process Time (Sec)	112.75
Total Weight (kg)	8.02
Material Cost**	\$32.91
OEM Process Cost	\$0.00
Supplier Process Cost	\$1.70
Q Burden	\$0.15
SG&A	\$1.23
Manufacturing Cost*	\$35.98

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Assemble 12V Battery & Tray

Assemble 12V Battery & Tray

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
Supplier Manual Asm	112.75	1	1.00	54.32	GER	\$1.70	99.02 %	\$0.15

Assemble 12V Battery & Tray

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
12V Battery Isolator, Large	1	Commodity Item	Purchased	0.0685	-	\$0.16	\$0.00
12V Battery	1	Commodity Item	Purchased	7.8870	-	\$32.50	\$0.00
12V Battery Isolator, Medium	1	Commodity Item	Purchased	0.0186	-	\$0.03	\$0.00
12V Battery Isolator, Small	1	Commodity Item	Purchased	0.0123	-	\$0.02	\$0.00
M6x25 Hex SEMS Bolt	2	Commodity Item	Purchased	0.0090	-	\$0.03	\$0.00
M6x30 Socket Head Bolt	2	Commodity Item	Purchased	0.0078	-	\$0.07	\$0.00

12V Battery and Bracket Installation



\...

- \Zone 5 Electronics
- \Body Wire Harnesses
- \12V Battery and Bracket Installation

Process Summary

Right First Time	99.35 %
Process Time (Sec)	69.00
Total Weight (kg)	0.02

Material Cost**	\$0.09
OEM Process Cost	\$1.75
Supplier Process Cost	\$0.00
Q Burden	\$0.10
SG&A	\$0.25
Manufacturing Cost*	\$2.19

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

12V Battery and Bracket Installation

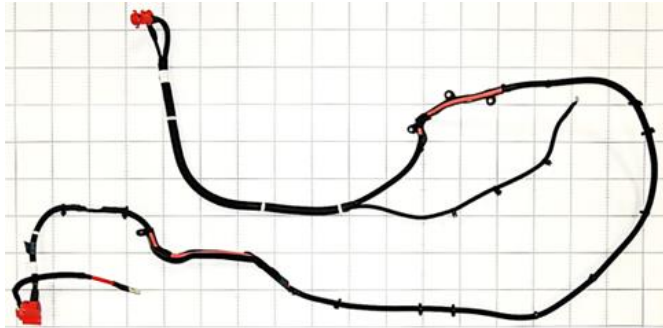
12V Battery and Bracket Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	69.00	1	1.00	91.41	GER	\$1.75	99.35%	\$0.10

12V Battery and Bracket Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
M8x30mm-Flanged Torx Bolt	3	Commodity Item	Purchased	0.0073	-	\$0.03	\$0.00

Positive Battery Cable Wire Harness Installation



\...

- \Zone 5 Electronics
- \Body Wire Harnesses
- \Positive Battery Cable Wire Harness Installation

Process Summary

Right First Time	98.00 %
Process Time (Sec)	194.00
Total Weight (kg)	1.63

Material Cost**	\$28.46
OEM Process Cost	\$4.93
Supplier Process Cost	\$0.00
Q Burden	\$0.30
SG&A	\$4.65
Manufacturing Cost*	\$38.33

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Positive Battery Cable Wire Harness Installation



Positive Battery Cable Wire Harness Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	194.00	1	1.00	91.41	GER	\$4.93	98.00%	\$0.30

Positive Battery Cable Wire Harness Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Positive Battery Cable Wire Harness Asm	1	See Appendix	-	1.6020	-	\$0.00	\$28.20
M5x11mm-Plastic Hex Flange Nut	3	Commodity Item	Purchased	0.0014	-	\$0.03	\$0.00
M6x14mm-Button Head Torx Bolt	3	Commodity Item	Purchased	0.0048	-	\$0.05	\$0.00
M6x8mm-Hex Nut	1	Commodity Item	Purchased	0.0045	-	\$0.02	\$0.00

[Click Here for Munro & Associates Wire Harness Report on Positive Battery Cable Wire Harness Asm](#)

Negative Battery Cable Installation



- \...
- \Zone 5 Electronics
- \Body Wire Harnesses
- \Negative Battery Cable Installation

Process Summary

Right First Time	99.73 %
Process Time (Sec)	32.00
Total Weight (kg)	0.31

Material Cost**	\$10.77
OEM Process Cost	\$0.81
Supplier Process Cost	\$0.00
Q Burden	\$0.04
SG&A	\$1.62
Manufacturing Cost*	\$13.24



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Negative Battery Cable Installation



Negative Battery Cable Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	32.00	1	1.00	91.41	GER	\$0.81	99.73%	\$0.04

Negative Battery Cable Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Negative Battery Cable Asm	1	See Appendix	-	0.3040	-	\$0.00	\$10.73
M10x25mm-Acom Nut	1	Commodity Item	Purchased	0.0088	-	\$0.04	\$0.00

[Click Here for Munro & Associates Wire Harness Report on Negative Battery Cable Asm](#)

Ground, Chassis to Power Module Installation



\...

\Zone 5 Electronics

\Body Wire Harnesses

\Ground, Chassis to Power Module Installation

Process Summary

Right First Time	99.75 %
Process Time (Sec)	25.00
Total Weight (kg)	0.35

Material Cost**	\$6.95
OEM Process Cost	\$0.63
Supplier Process Cost	\$0.00
Q Burden	\$0.04
SG&A	\$1.06
Manufacturing Cost*	\$8.68

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost



Ground, Chassis to Power Module Installation



Ground, Chassis to Power Module Installation									
Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden	
OEM Manual Asm	25.00	1	1.00	91.41	GER	\$0.63	99.75%	\$0.04	

Ground, Chassis to Power Module Installation									
Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost		
Ground, Chassis to Power Module Asm	1	See Appendix	-	0.3396	-	\$0.00	\$6.91		
M10x25mm-Aluminum Acom Nut	1	Commodity Item	Purchased	0.0088	-	\$0.04	\$0.00		

[Click Here for Munro & Associates Wire Harness Report on Ground, Chassis to Power Module Asm](#)

Ground, Motor Asm to Power Module Installation



- \...
- \Zone 5 Electronics
- \Body Wire Harnesses
- \Ground, Motor Asm to Power Module Installation

Process Summary

Right First Time	99.54 %
Process Time (Sec)	33.00
Total Weight (kg)	0.08

Material Cost**	\$3.49
OEM Process Cost	\$0.84
Supplier Process Cost	\$0.00
Q Burden	\$0.07
SG&A	\$0.60
Manufacturing Cost*	\$5.00



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Ground, Motor Asm to Power Module Installation

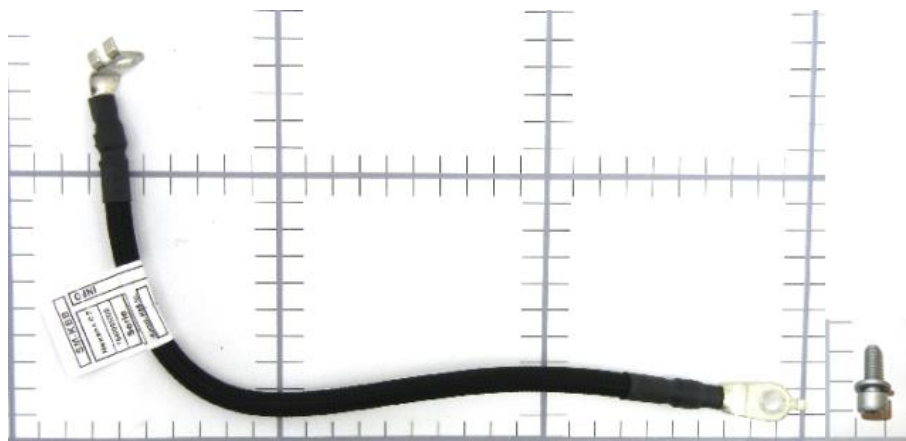


Ground, Motor Asm to Power Module Installation									
Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden	
OEM Manual Asm	33.00	1	1.00	91.41	GER	\$0.84	99.54 %	\$0.07	

Ground, Motor Asm to Power Module Installation									
Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost		
Ground, Motor Asm to Power Module Asm	1	See Appendix	-	0.0652	-	\$0.00	\$3.43		
M6x16mm-Torx Bolt	2	Commodity Item	Purchased	0.0068	-	\$0.03	\$0.00		

[Click Here for Munro & Associates Wire Harness Report on Ground, Motor Asm to Power Module Asm](#)

Ground, Power Module to Chassis Installation



- \...
- \Zone 5 Electronics
- \Body Wire Harnesses
- \Ground, Power Module to Chassis Installation

Process Summary

Right First Time	99.74 %
Process Time (Sec)	22.00
Total Weight (kg)	0.08

Material Cost**	\$2.76
OEM Process Cost	\$0.56
Supplier Process Cost	\$0.00
Q Burden	\$0.04
SG&A	\$0.46
Manufacturing Cost*	\$3.82



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Ground, Power Module to Chassis Installation



Ground, Power Module to Chassis Installation

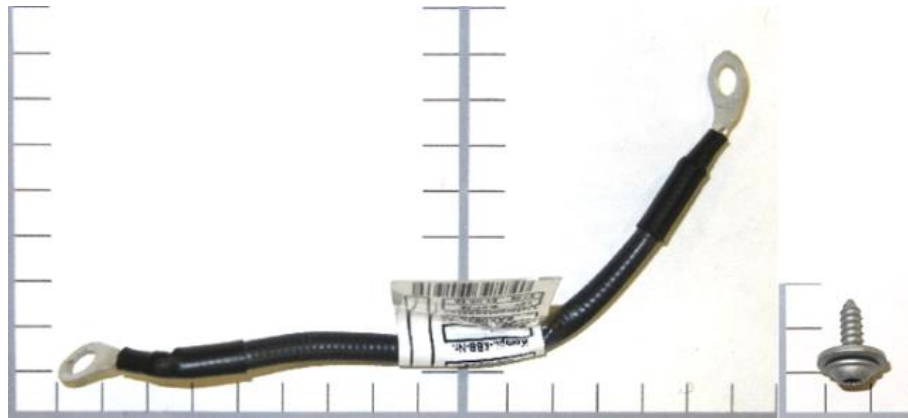
Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	22.00	1	1.00	91.41	GER	\$0.56	99.74 %	\$0.04

Ground, Power Module to Chassis Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Ground, Power Module to Chassis	1	See Appendix	-	0.0746	-	\$0.00	\$2.73
M6x14- Socket Head SEMS Bolt	1	Commodity Item	Purchased	0.0066	-	\$0.03	\$0.00

[Click Here for Munro & Associates Wire Harness Report on Ground, Power Module to Chassis](#)

Ground, Rear X Brace To Heat Shield Installation



\...

- \Zone 5 Electronics
- \Body Wire Harnesses
- \Ground, Rear X Brace To Heat Shield Installation

Process Summary

Right First Time	99.75 %
Process Time (Sec)	23.00
Total Weight (kg)	0.01

Material Cost**	\$1.09
OEM Process Cost	\$0.58
Supplier Process Cost	\$0.00
Q Burden	\$0.04
SG&A	\$0.23
Manufacturing Cost*	\$1.94

* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost



Ground, Rear X Brace To Heat Shield Installation



Ground, Rear X Brace To Heat Shield Installation									
Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden	
OEM Manual Asm	23.00	1	1.00	91.41	GER	\$0.58	99.75%	\$0.04	

Ground, Rear X Brace To Heat Shield Installation									
Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost		
Ground, Rear X Brace To Heat Shield Asm	1	See Appendix	-	0.0089	-	\$0.00	\$1.07		
M5x14mm-Torx SEMS Screw	1	Commodity Item	Purchased	0.0047	-	\$0.02	\$0.00		

[Click Here for Munro & Associates Wire Harness Report on Ground, Rear X Brace To Heat Shield Asm](#)

Ground, Chassis to Exhaust Heat Shield Installatio



\...

- \Zone 5 Electronics
- \Body Wire Harnesses
- \Ground, Chassis to Exhaust Heat Shield Installatio

Process Summary

Right First Time	99.54 %
Process Time (Sec)	40.00
Total Weight (kg)	0.03

Material Cost**	\$1.04
OEM Process Cost	\$1.02
Supplier Process Cost	\$0.00
Q Burden	\$0.07
SG&A	\$0.28
Manufacturing Cost*	\$2.41



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Ground, Chassis to Exhaust Heat Shield Installation



Ground, Chassis to Exhaust Heat Shield Installation									
Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden	
OEM Manual Asm	40.00	1	1.00	91.41	GER	\$1.02	99.54 %	\$0.07	

Ground, Chassis to Exhaust Heat Shield Installation								
Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost	
Ground, Chassis to Exhaust Heat Shield Asm	1	See Appendix	-	0.0116	-	\$0.00	\$0.98	
M6x16mm-Torx Bolt	1	Commodity Item	Purchased	0.0068	-	\$0.03	\$0.00	
M6x16mm-Torx Bolt	1	Commodity Item	Purchased	0.0068	-	\$0.03	\$0.00	

[Click Here for Munro & Associates Wire Harness Report on Ground, Chassis To Exhaust Heat Shield](#)



\...
\Zone 5 Electronics
\Body Wire Harnesses
\Ground, Chassis to Engine Installation

Process Summary

Right First Time	99.54 %
Process Time (Sec)	39.00
Total Weight (kg)	0.06

Material Cost**	\$2.27
OEM Process Cost	\$0.99
Supplier Process Cost	\$0.00
Q Burden	\$0.07
SG&A	\$0.45
Manufacturing Cost*	\$3.78



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Ground, Chassis to Engine Installation



Ground, Chassis to Engine Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	39.00	1	1.00	91.41	GER	\$0.99	99.54 %	\$0.07

Ground, Chassis to Engine Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Ground, Chassis to Engine Asm	1	See Appendix	-	0.0422	-	\$0.00	\$2.21
M6x16mm-Torx Bolt	1	Commodity Item	Purchased	0.0068	-	\$0.03	\$0.00
M6x16mm-Torx Bolt	1	Commodity Item	Purchased	0.0068	-	\$0.03	\$0.00

[Click Here for Munro & Associates Wire Harness Report on Ground, Chassis to Engine](#)

Ground, AC Compressor To Motor Installation



\...

\Zone 5 Electronics

\Body Wire Harnesses

\Ground, AC Compressor To Motor Installation

Process Summary

Right First Time	99.54 %
Process Time (Sec)	39.00
Total Weight (kg)	0.04

Material Cost**	\$1.08
OEM Process Cost	\$0.99
Supplier Process Cost	\$0.00
Q Burden	\$0.07
SG&A	\$0.28
Manufacturing Cost*	\$2.42



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Ground, AC Compressor To Motor Installation

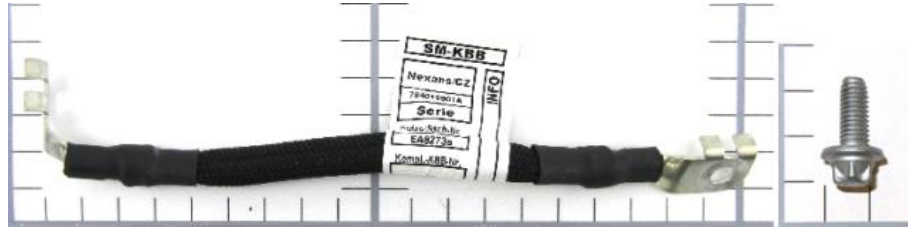
Ground, AC Compressor To Motor Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	39.00	1	1.00	91.41	GER	\$0.99	99.54 %	\$0.07

Ground, AC Compressor To Motor Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Ground, AC Compressor To Motor	1	See Appendix	-	0.0200	-	\$0.00	\$1.01
M6x16mm- Torx Bolt	1	Commodity Item	Purchased	0.0068	-	\$0.03	\$0.00
M8x16mm-Torx Bolt	1	Commodity Item	Purchased	0.0096	-	\$0.04	\$0.00

[Click Here for Munro & Associates Wire Harness Report on Ground, AC Compressor To Motor](#)



\...
 \Zone 5 Electronics
 \Body Wire Harnesses
 \Ground, Chassis to Motor Installation

Process Summary

Right First Time	99.54 %
Process Time (Sec)	39.00
Total Weight (kg)	0.06

Material Cost**	\$2.05
OEM Process Cost	\$0.99
Supplier Process Cost	\$0.00
Q Burden	\$0.07
SG&A	\$0.42
Manufacturing Cost*	\$3.53



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Ground, Chassis to Motor Installation



Ground, Chassis to Motor Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	39.00	1	1.00	91.41	GER	\$0.99	99.54 %	\$0.07

Ground, Chassis to Motor Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Ground, Chassis to Motor Asm	1	See Appendix	-	0.0426	-	\$0.00	\$1.99
M6x16mm-Torx Bolt	1	Commodity Item	Purchased	0.0068	-	\$0.03	\$0.00
M6x16mm-Torx Bolt	1	Commodity Item	Purchased	0.0068	-	\$0.03	\$0.00

[Click Here for Munro & Associates Wire Harness Report on Ground, Chassis to Motor](#)

Steering Column Ground Strap Installation



\...

- \Zone 5 Electronics
- \Body Wire Harnesses
- \Steering Column Ground Strap Installation

Process Summary

Right First Time	99.75 %
Process Time (Sec)	21.00
Total Weight (kg)	0.04

Material Cost**	\$2.01
OEM Process Cost	\$0.53
Supplier Process Cost	\$0.00
Q Burden	\$0.04
SG&A	\$0.35
Manufacturing Cost*	\$2.93



* Excluding tooling, ER&D, logistics, and profit margin

** Includes material cost and purchased parts cost

Steering Column Ground Strap Installation



Steering Column Ground Strap Installation

Symbol Name	Overall Cycle Time (Sec)	Parts / Cycle	Number of Operators	Workcell Rate (\$/Hr)	Country	Process Cost	Right First Time	Q Burden
OEM Manual Asm	21.00	1	1.00	91.41	GER	\$0.53	99.75%	\$0.04

Steering Column Ground Strap Installation

Symbol Name	Qty	Material	Material Cost / kg (\$/kg)	Net Weight (kg)	Gross Material Weight (kg)	Purchased Part Cost	Material Cost
Ground, Chassis to Steering Rack Asm	1	See Appendix	-	0.0323	-	\$0.00	\$1.97
M10x25mm-Acom Nut	1	Commodity Item	Purchased	0.0088	-	\$0.04	\$0.00

[Click Here for Munro & Associates Wire Harness Report on Steering Column Ground Strap Asm](#)

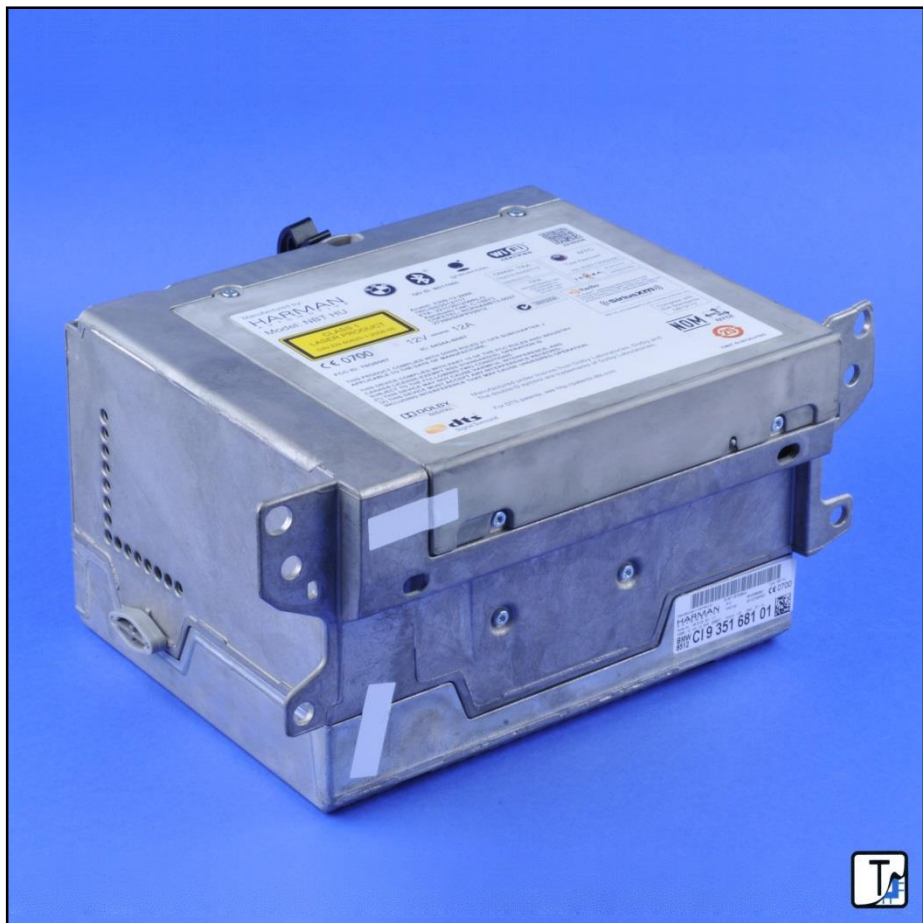
Appendix Reports

TechInsights Electronics Reports

BMW i3 Digital Radio Module HBB125

Satellite Radio, WiFi 802.11a/b/g, Bluetooth 3.0

Report #15200-150210-RBb



Product Description

The HBB125 is the digital radio module included in models of the BMW i3. Along with the ubiquitous AM / FM radio, the HBB125 adds a 200 GB hard drive and Sirius / XM radio. Connectivity is provided via GPS, WiFi 802.11 a/b/g and Bluetooth 3.0, with CAN and USB 2.0 protocols also present in this device, but not user accessible. At its core are three different processors: Intel E660T "Atom" processor, Texas Instruments Jacinto Automotive Applications processor and Nvidia GeForce 8 (G-98) Graphics processor. In addition, over 9.8 GB of system memory has been implemented in the form of SDRAM, Flash and EEPROM from companies that include Micron, Spansion, STMicroelectronics, Microchip, Atmel and ISSI.

DISCLAIMER: All company names, product names, and service names mentioned are used for identification purposes only and may be registered trademarks, trademarks, or service marks of their respective owners. All analyses are done without participation, authorization, or endorsement of the manufacturer. Any cost analyses presented in this material are estimates prepared by TechInsights from generally available data. While TechInsights believes that these estimates reflect the probable costs, the actual producer did not supply the data, and therefore the actual costs may be different from these estimates. Furthermore, TechInsights extends no warranties with respect to any information in this document, and shall bear no liability whatsoever for the use of the information.

Copyright © 2015, TechInsights. All rights reserved. Do not reproduce, distribute, disseminate, photocopy, fax, transmit, download to a shared database, or otherwise copy, transfer, sell, publish, or send this material, or any portion thereof, by any means without the express written permission of TechInsights.

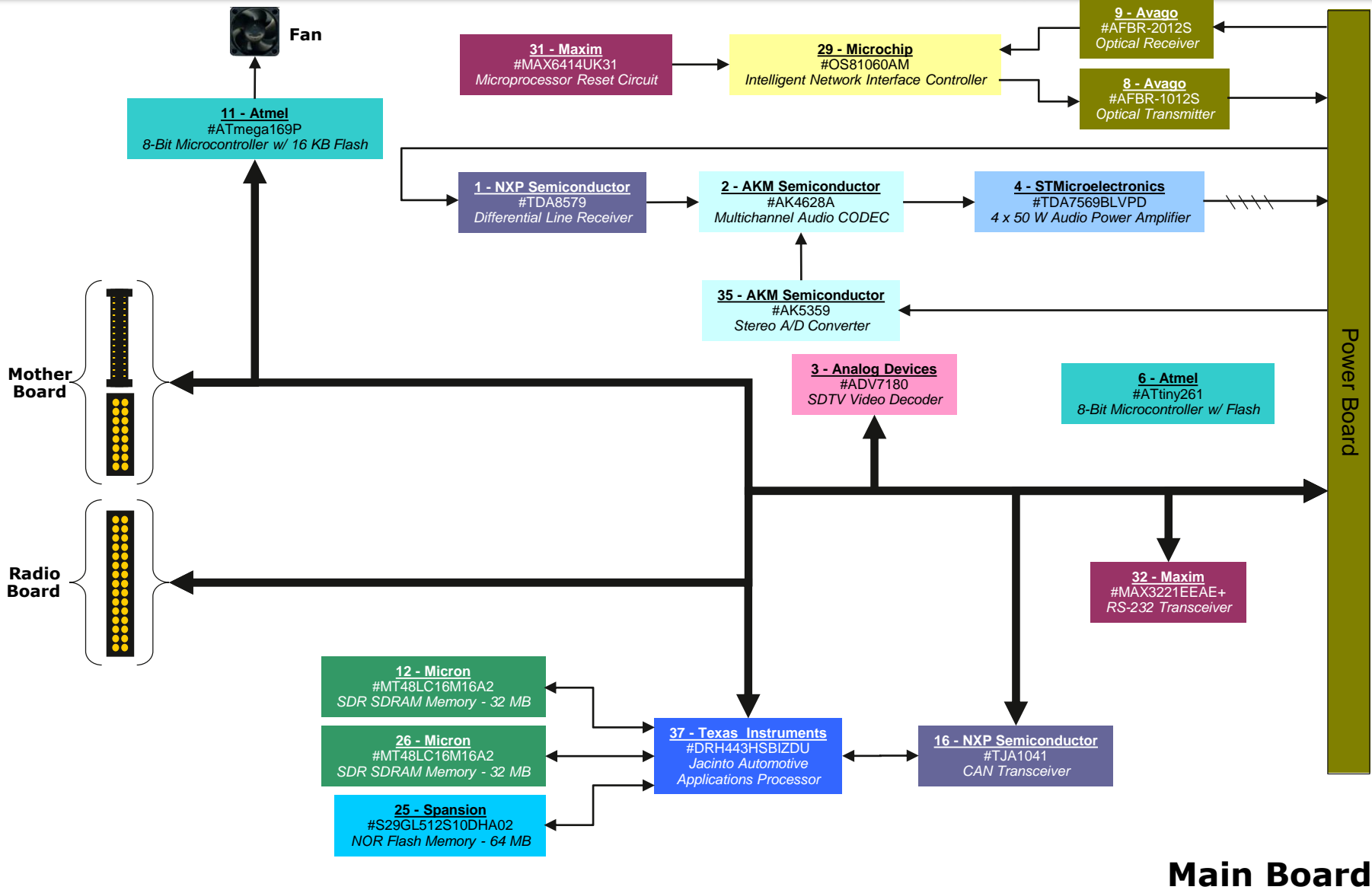
Product Overview



Product Description		Integrated Circuit Metrics					
Product Type	Automotive	IC Die Count**	119				
Brand	BMW (Harman)	IC Package Count**	117				
Product Name & Model #	i3 Digital Radio Module, HBB125	Cost Metrics					
Official Release Date	5/2/2014						
Weight (grams)	1790				Retail Price	\$2,700.00	
Dimensions (mm)	230 x 190 x 116				Total Manufacturing Cost	\$558.65	
Product Features		Electronics Cost**	\$435.39				
		Manufacturing Cost Breakdown					
Connectivity	AM/FM Radio, Satellite Radio, WiFi 802.11a/b/g, Bluetooth 3.0, GPS	Integrated Circuits	\$273.32	48.9%			
Processors	(1) Intel E660T 1.3 GHz Atom Processor (2) Texas Instruments Jacinto Automotive Applications Processor (3) NXP Semi SAF3560 Terrestrial Digital Radio Processor (4) NXP Semi SAF7741 Car Radio Digital Signal Processor (5) Ublox UBX-G6000 GPS Baseband Processor (6) Nvidia EMP9 (G-98) Graphics Processor	Modules, Discretes & Connectors	\$83.23	14.9%			
		Substrates	\$18.72	3.4%			
		Component Insertion	\$17.89	3.2%			
		Card Test	\$8.74	1.6%			
		Hard Drive*	\$29.14	5.2%			
		Sirius XM Radio Module	\$48.03	8.6%			
Storage	200 GB Hard Drive 9.8 GB Total Solid-State Storage (not user-accessible)	Non-Electronic Parts	\$57.31	10.3%			
Interface	None (User interface located elsewhere in the vehicle)	Final Assembly & Test	\$22.27	4.0%			
Sensors	Temperature	Total \$558.65 100.0%					
Key Subsystems							
Sirius XM Radio Module	STMicroelectronics STA280BB Baseband Processor & STA210N3A Satellite Radio Tuner						
Drives	Hard Drive: Automotive-Grade 2.5" 200 GB SATA, 8 MB Cache, 4200 RPM						

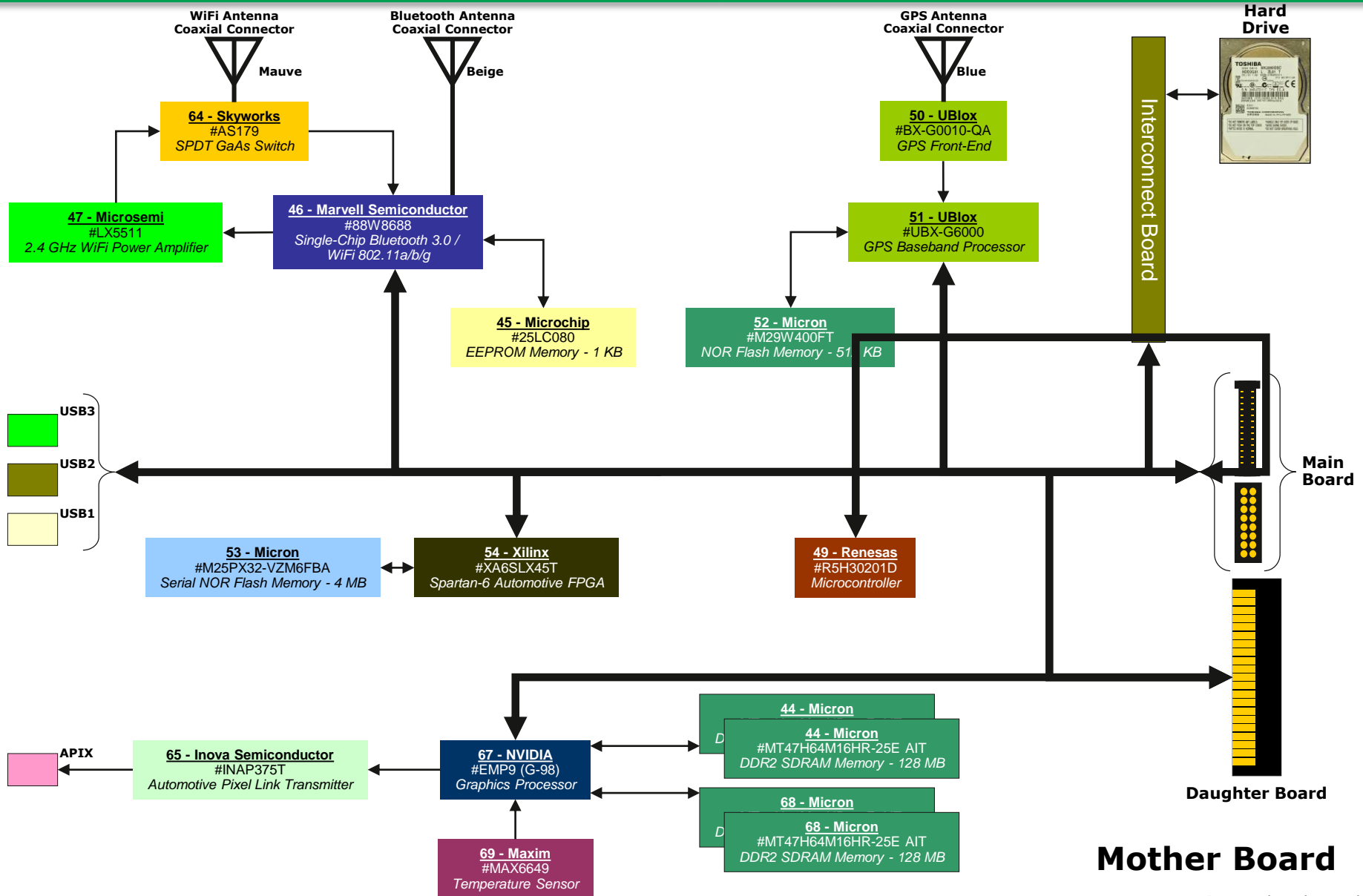
*Line Item Cost Only
**Including Subsystems

Block Diagram



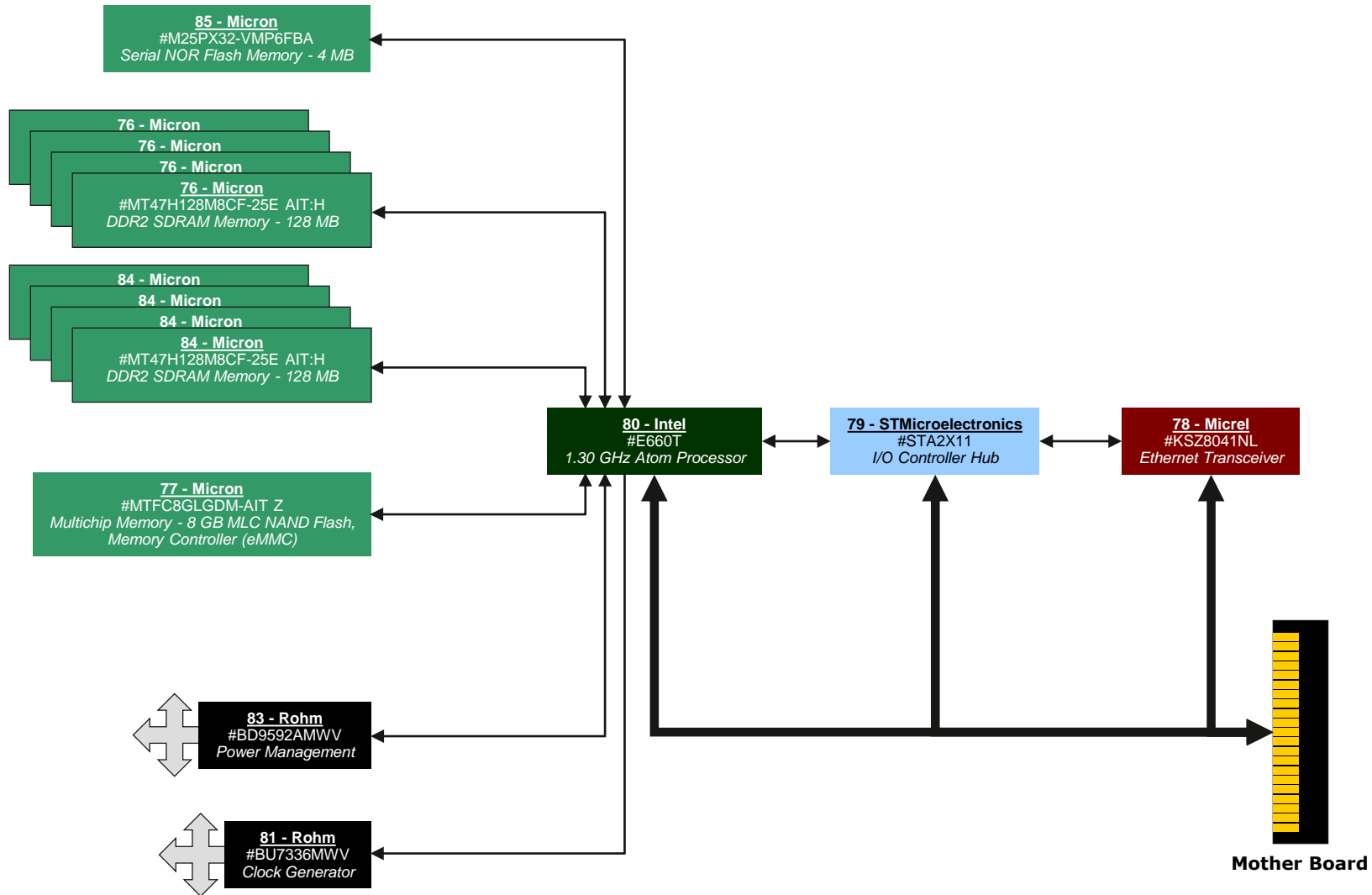
Main Board

Block Diagram



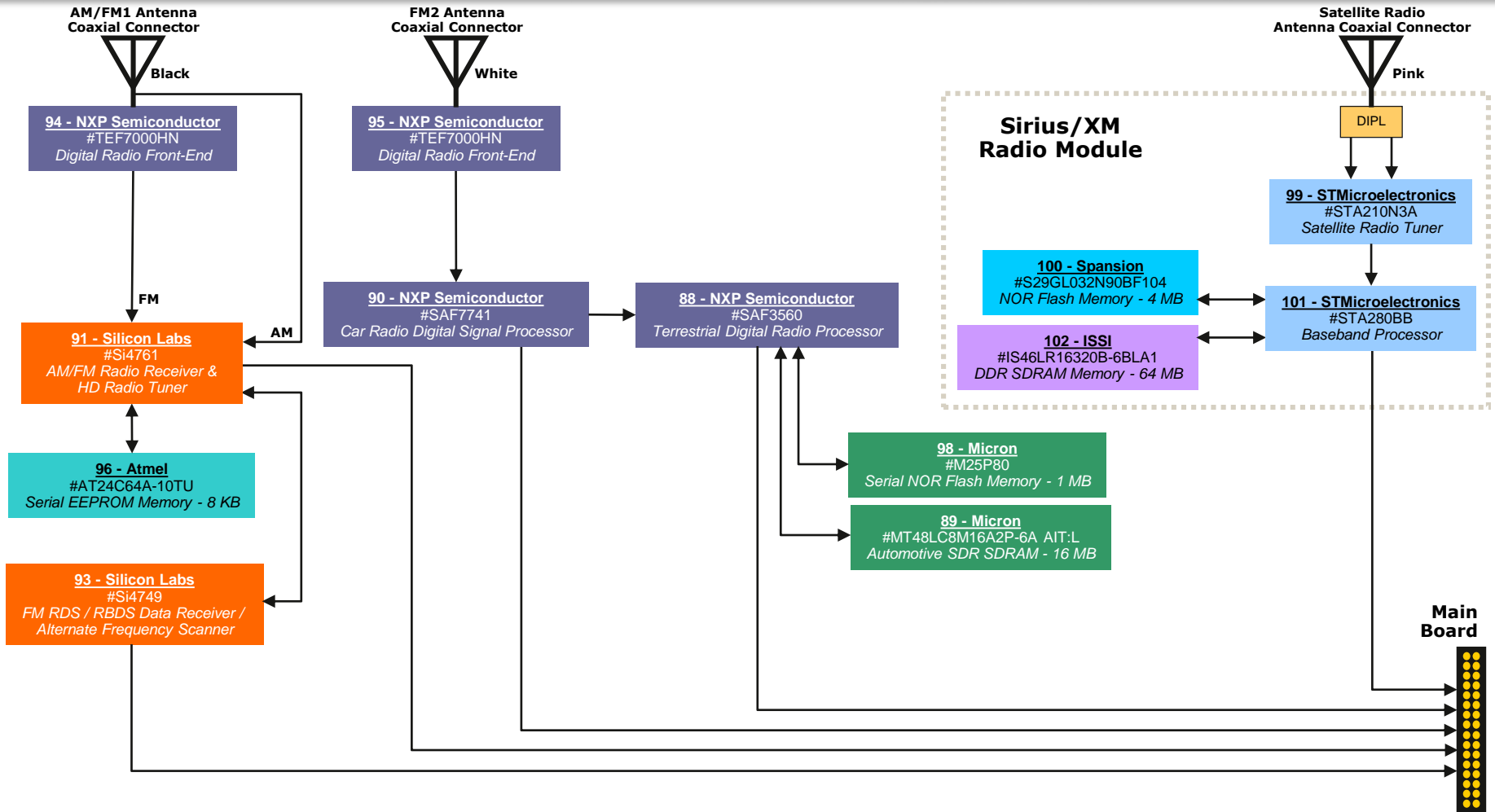
Mother Board

Block Diagram



Daughter Board

Block Diagram



Radio Board

Product Labels



MUNRO
& ASSOCIATES, INC.

Manufactured by:

HARMAN
AUTOMOTIVE

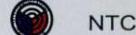


2239256

Model: NBT HU

QD ID: B017665

OMAN - TRA
TRA/TA-R/0557/12
02/05/2012



NTC

Type Approved

No.: ESD-1206229C

TRA
REGISTERED No:
ER0086285/12
DEALER No:
0014517/08



TA-2012/723

APPROVED



N1374



HD Radio™ Technology Manufactured Under License from iBiquity Digital Corp. U.S. and Foreign Patents. The HD and HD Radio logos are proprietary trademarks of iBiquity Digital Corp.



XM/ HD unit equipped in US / Canada products only

Complies with
IDA Standards
DB19172

**CLASS 1
LASER PRODUCT**
DIN EN 60825-1:2008-05

Anatel: 2309-12-2886
TRC/SS/2012/117
ETA: 2211/2012/WRLO
Aprobado CNC C-10873
COFETEL: RCPHANB13-0027
27390/SDPPI/2012

CE 0700

12V == 12A

FCC ID: T8GB067

IC: 6434A-B067

THIS PRODUCT COMPLIES WITH DHHS RULES 21 CFR SUBCHAPTER J APPLICABLE TO THE DATE OF MANUFACTURE.

THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES AND INDUSTRY CANADA LICENSE-EXEMPT RSS STANDARD(S). OPERATION IS SUBJECT TO THE FOLLOWING TWO CONDITIONS:

- (1) THIS DEVICE MAY NOT CAUSE HARMFUL INTERFERENCE, AND
- (2) THIS DEVICE MUST ACCEPT ANY INTERFERENCE RECEIVED, INCLUDING INTERFERENCE THAT MAY CAUSE UNDESIRABLE OPERATION.



Manufactured under license from Dolby Laboratories. Dolby and The double-D symbol are trademarks of Dolby Laboratories.



For DTS patents, see <http://patents.dts.com>



CMIIT ID:2012DJ7022



Manufactured in Germany by: B125F10E7638643 Type: NBT HU

HARMAN S-ID: 061629963921 **CE 0700**
AUTOMOTIVE MAC-Adr.: 001CD75BF503

Model No.: HB B125 EC: 111
100991 10 HW: 22 SNR: 2596571 Version: US Date: 23 / 14

BMW **C19 351 681 01**

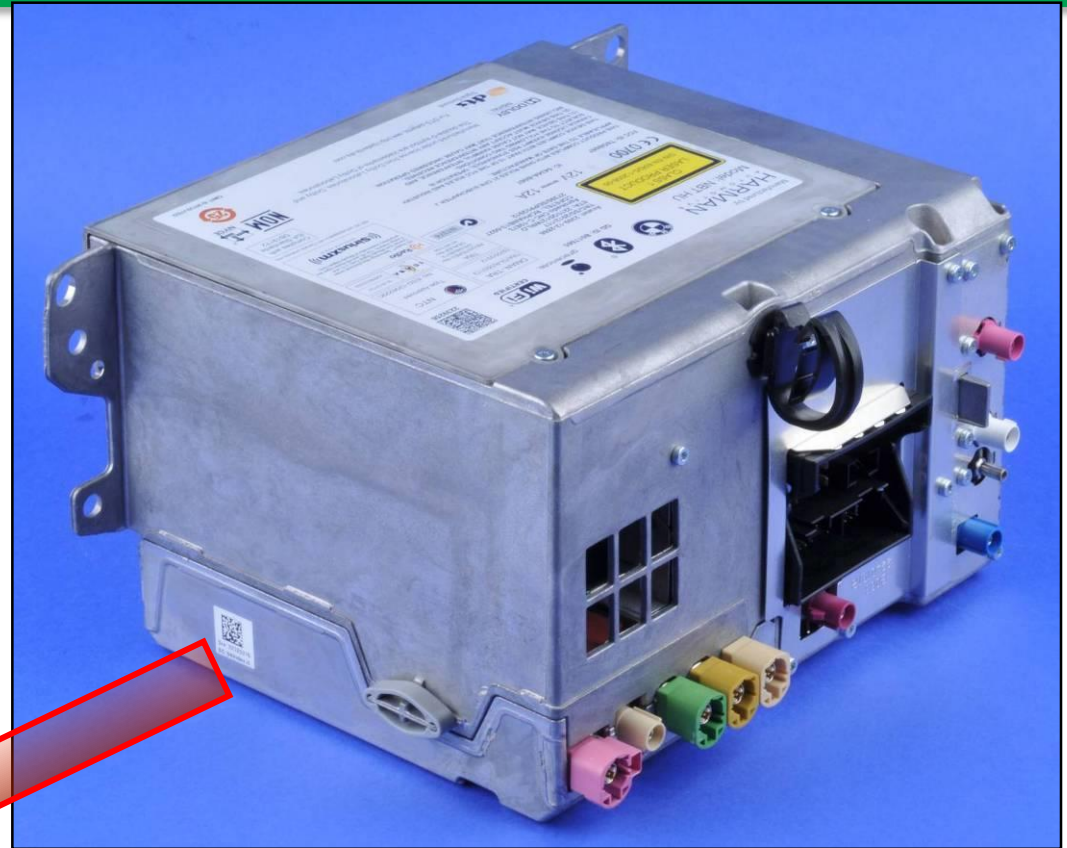
6512

BMW 13 Digital Radio Module
HBB125 #15200-150210-RBb -
Page 354

Product Labels



MUNRO
& ASSOCIATES, INC.



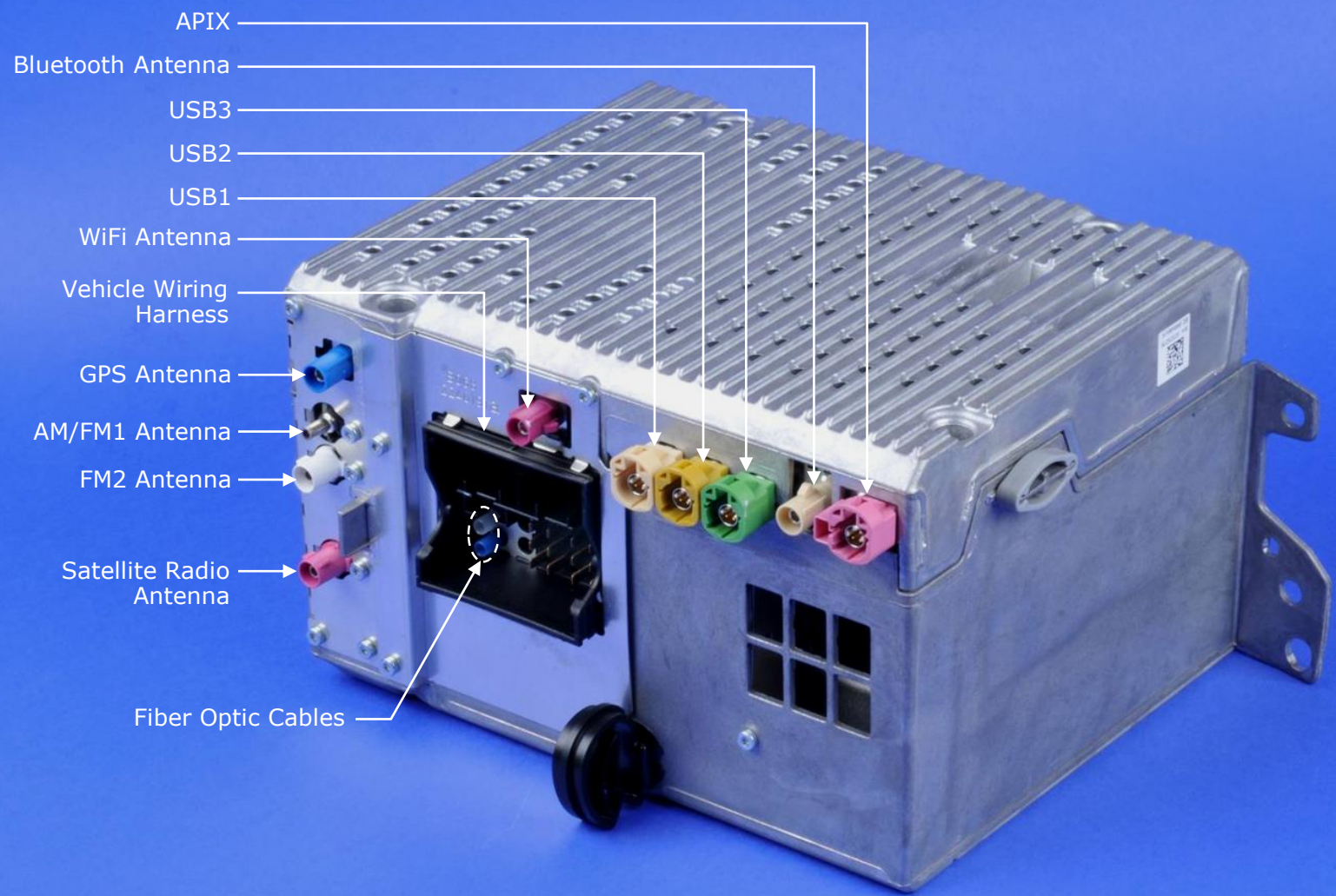
Exterior Features



MUNRO
& ASSOCIATES, INC.



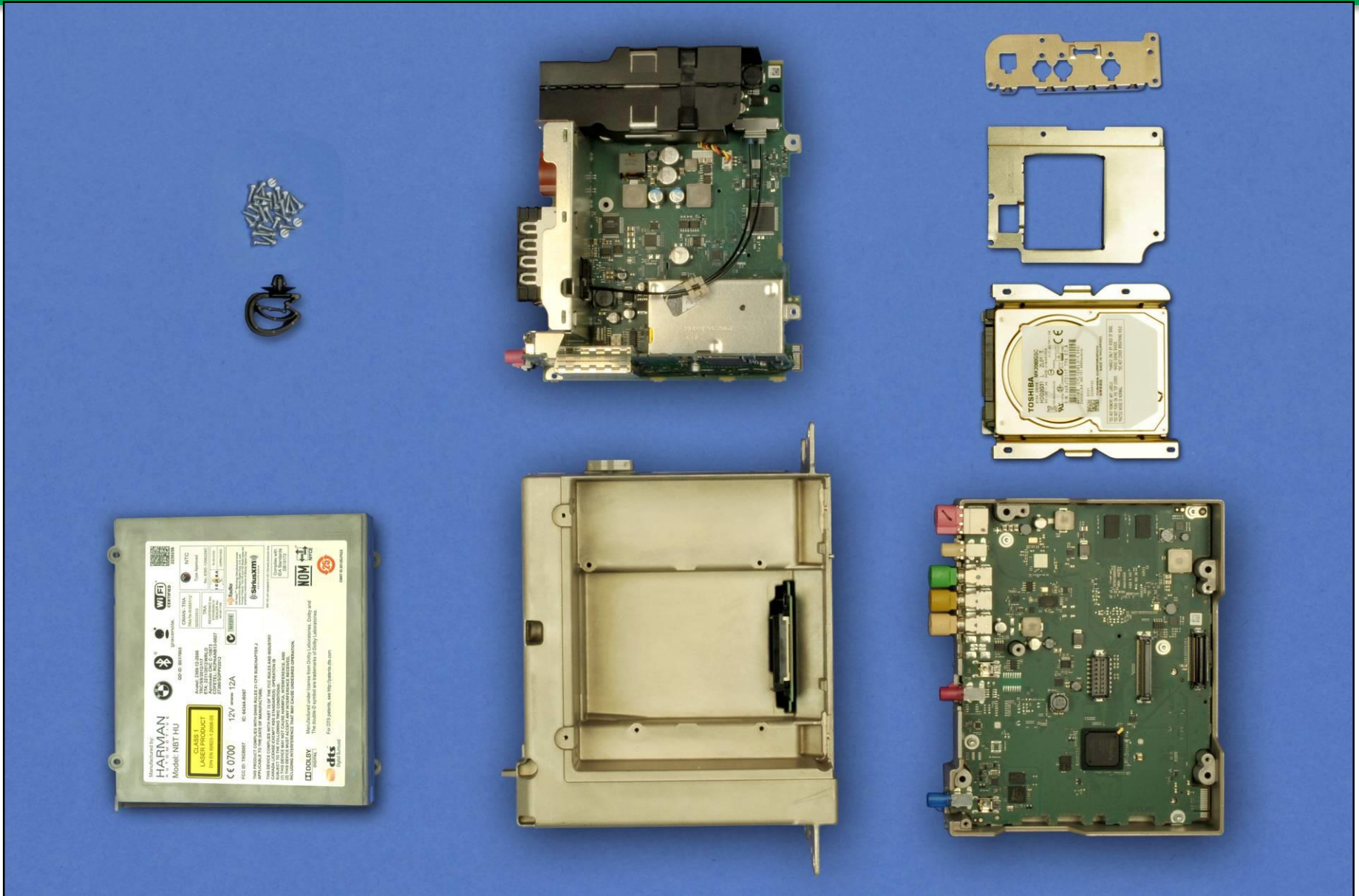
Exterior Features



Major Components (Side 2)



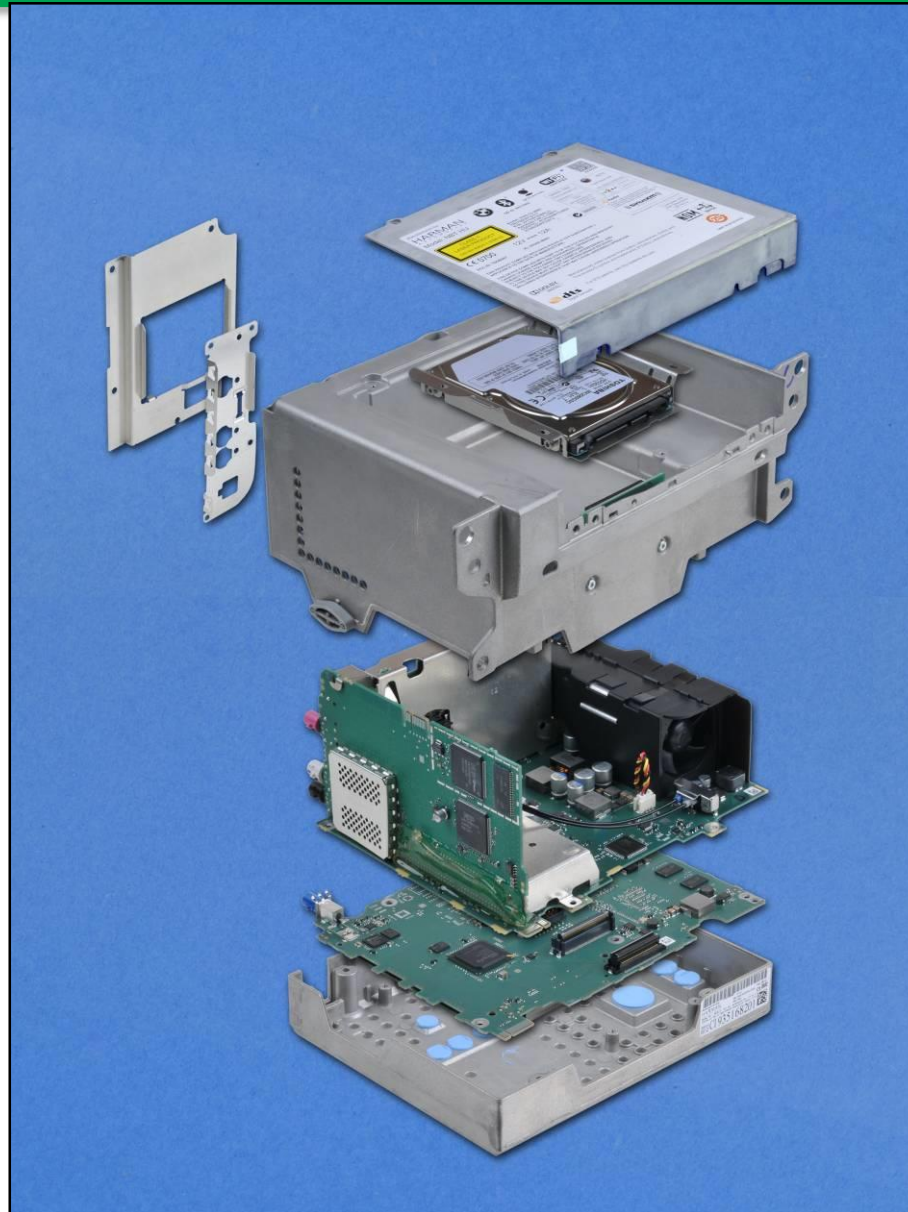
MUNRO
& ASSOCIATES, INC.



Component Arrangement



MUNRO
& ASSOCIATES, INC.



Teardown Sequence



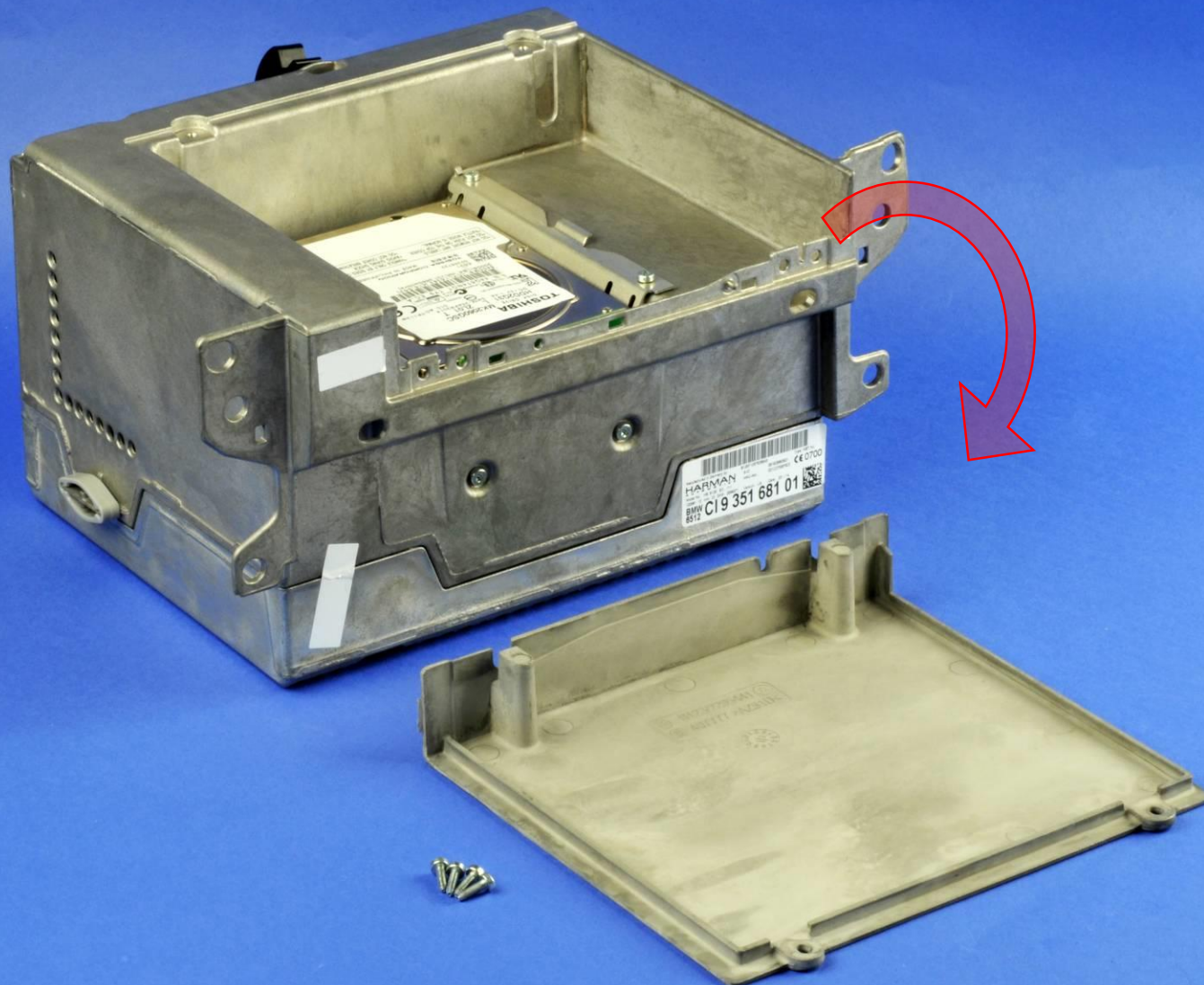
MUNRO
& ASSOCIATES, INC.



Teardown Sequence



MUNRO
& ASSOCIATES, INC.

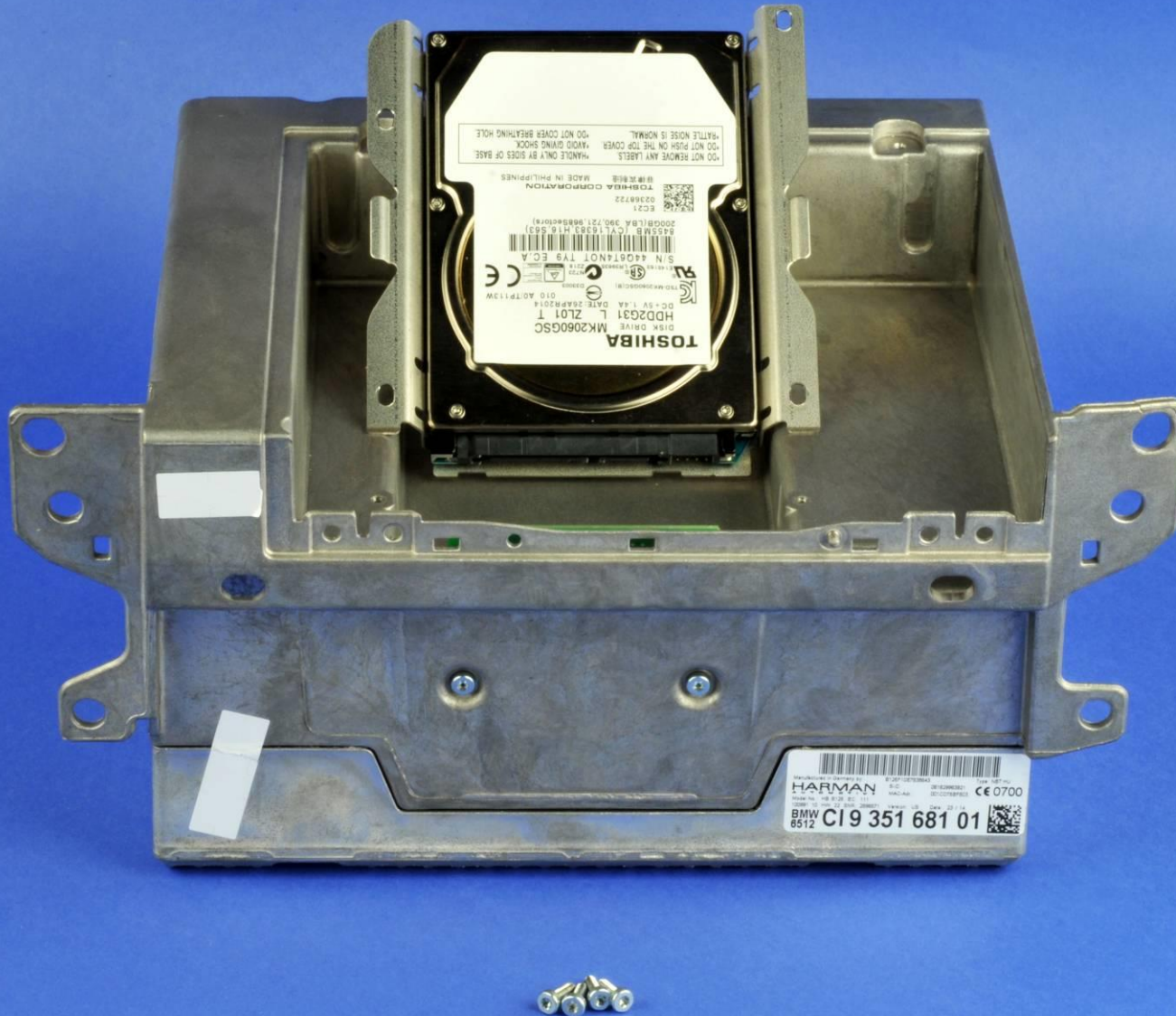


BMW 13 Digital Radio Module
HBB125 #15200-150210-RBb -
Page 362

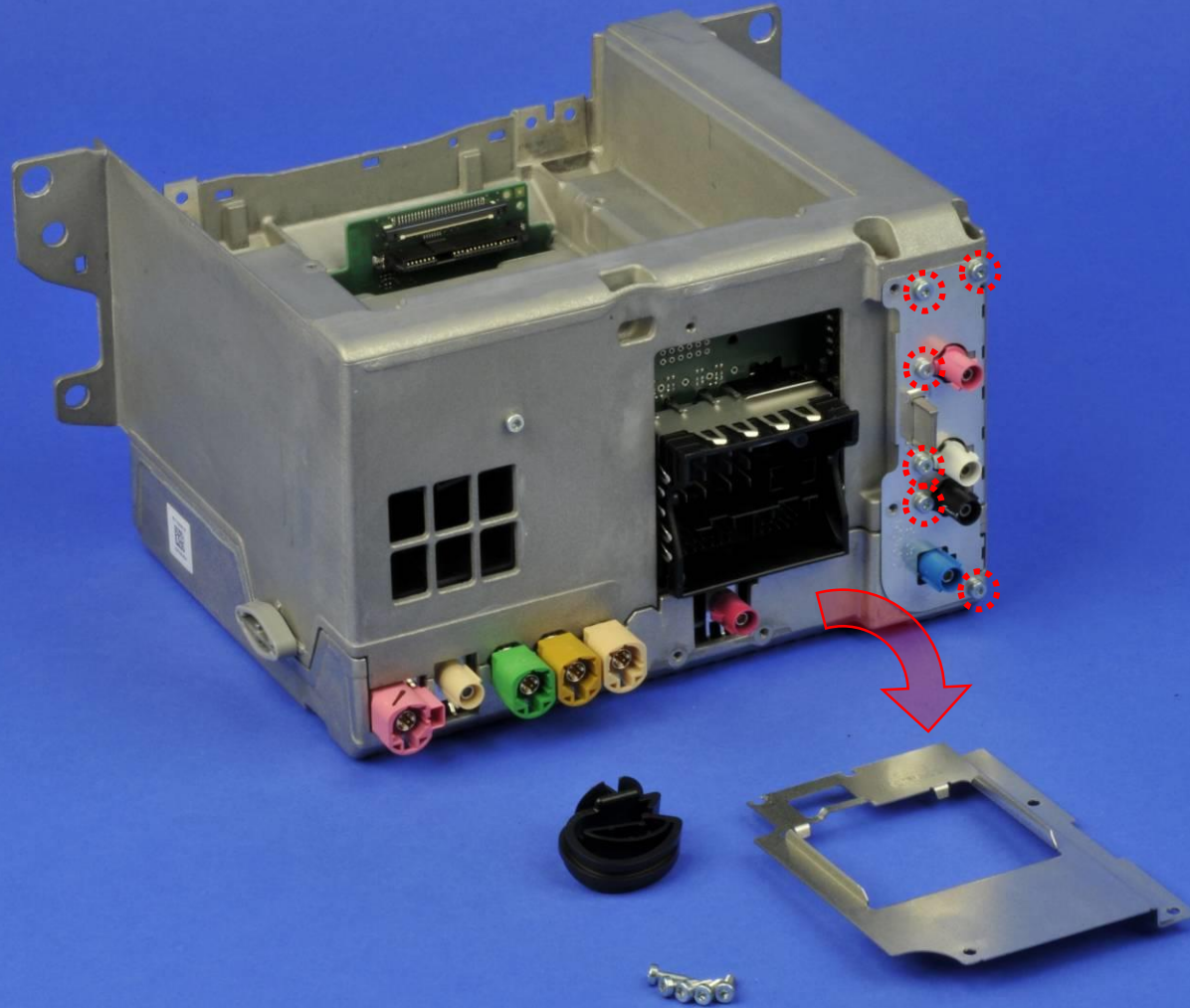
Teardown Sequence



MUNRO
& ASSOCIATES, INC.



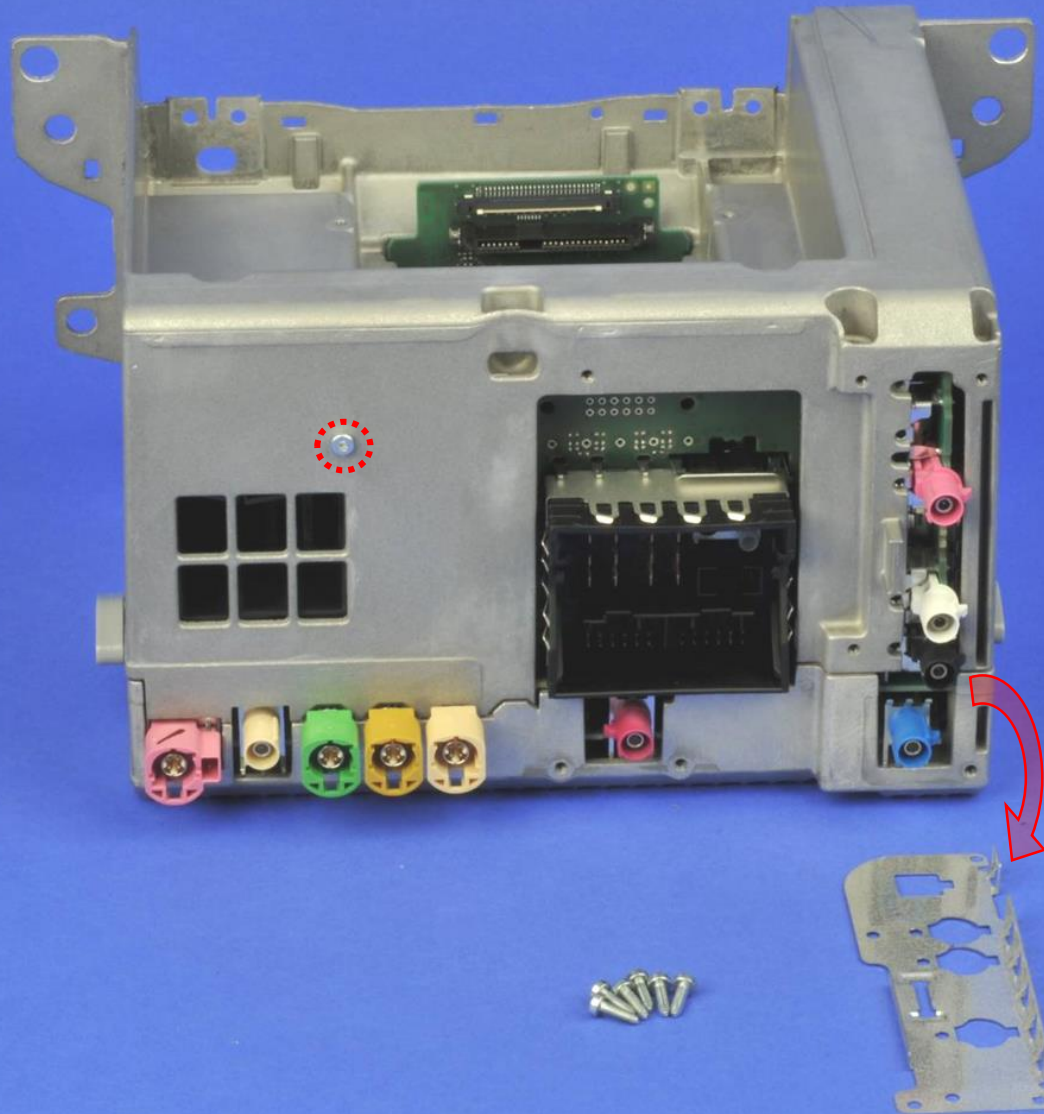
Teardown Sequence



Teardown Sequence



MUNRO
& ASSOCIATES, INC.



Teardown Sequence



MUNRO
& ASSOCIATES, INC.

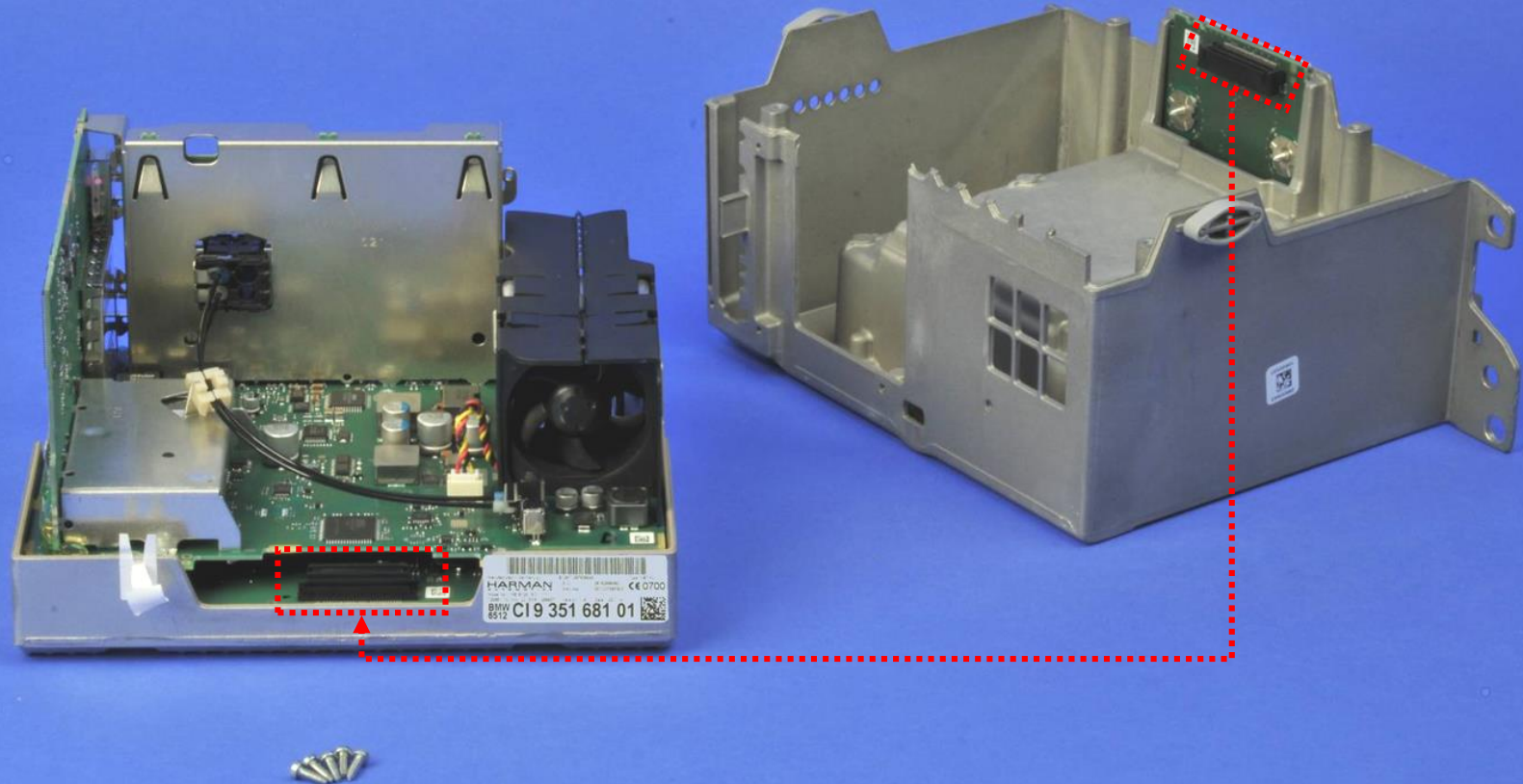


BMW 13 Digital Radio Module
HBB125 #15200-150210-RBb -
Page 367

Teardown Sequence



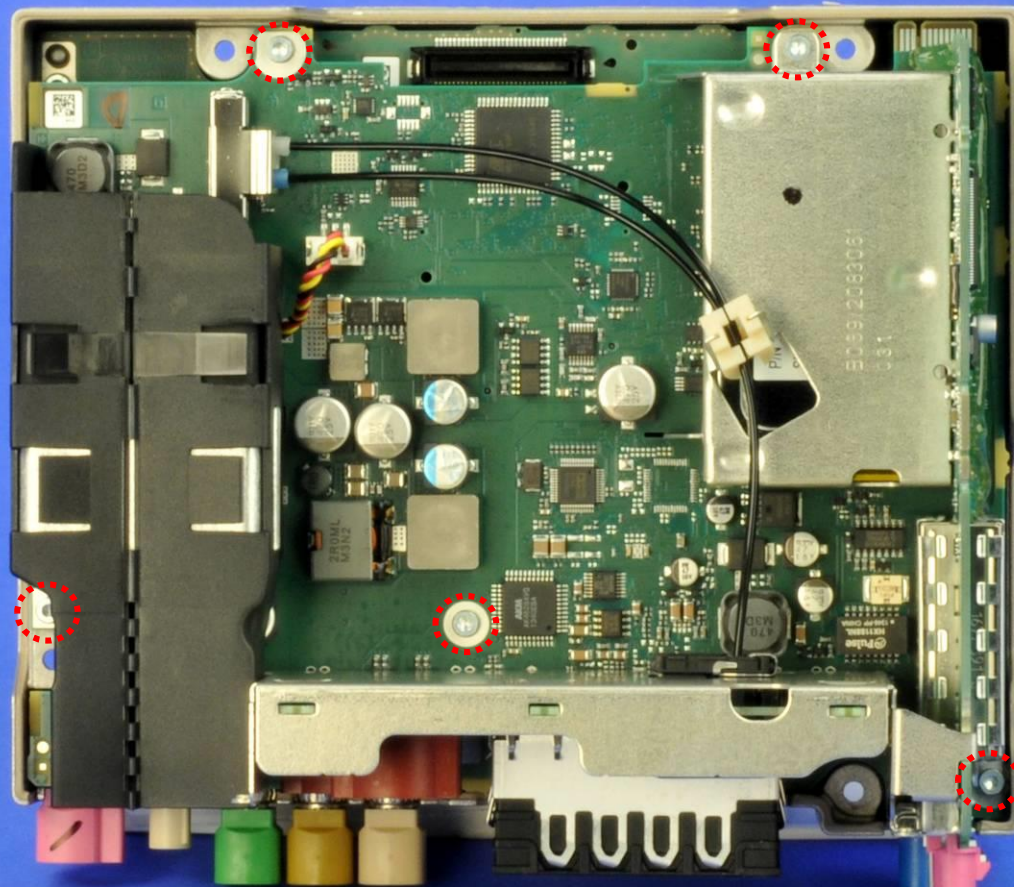
MUNRO
& ASSOCIATES, INC.



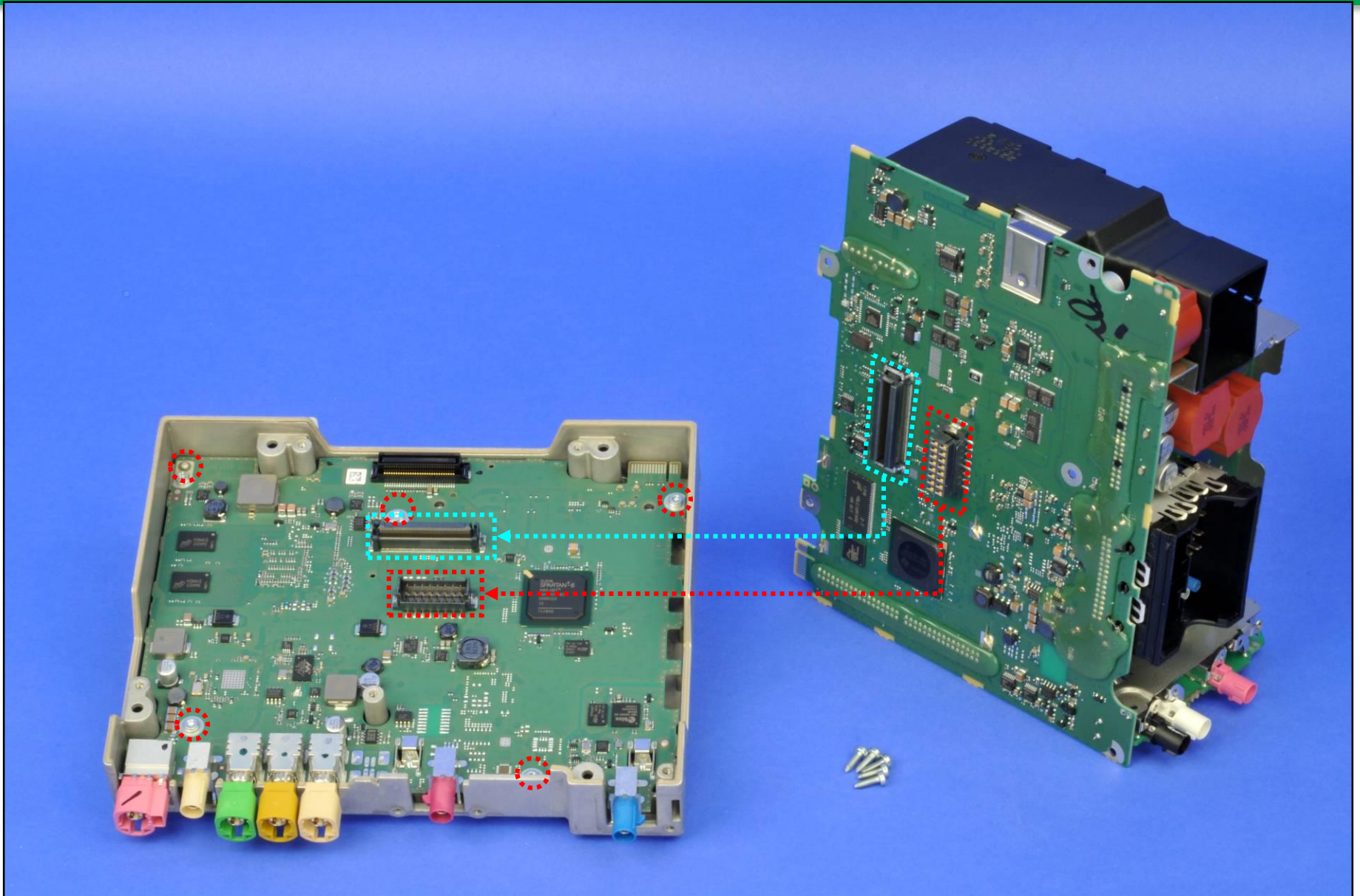
Teardown Sequence



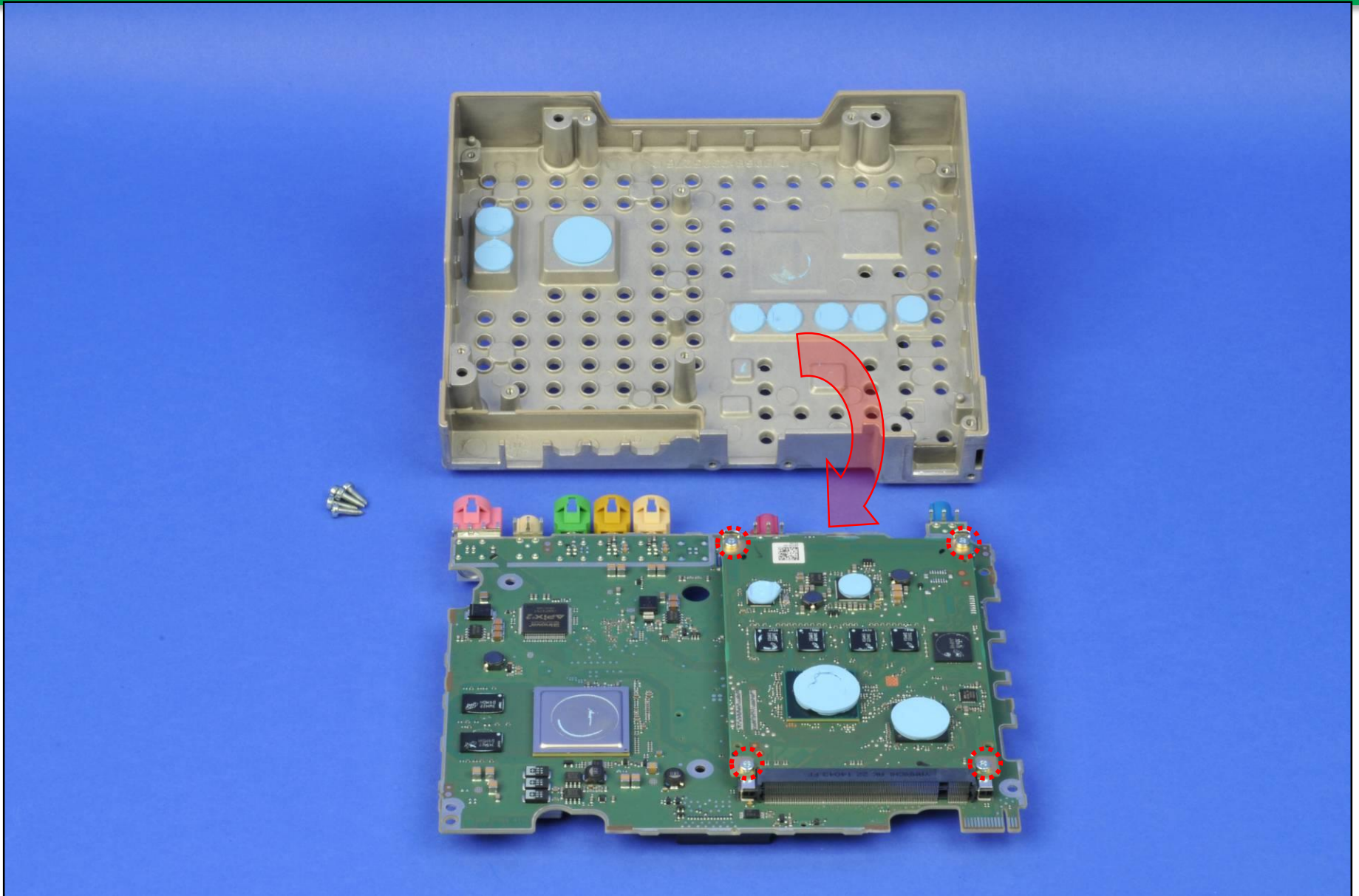
MUNRO
& ASSOCIATES, INC.



Teardown Sequence



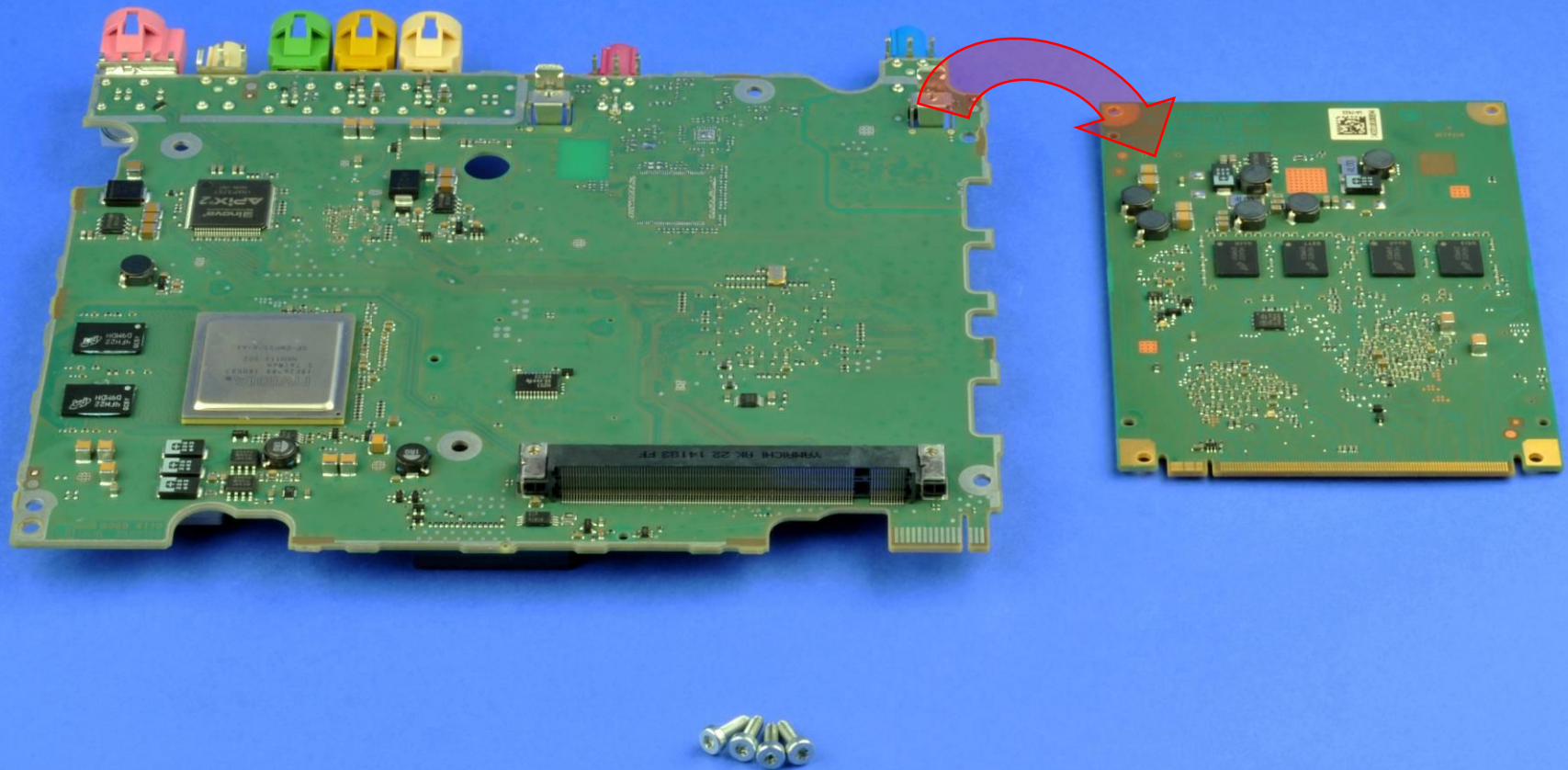
Teardown Sequence



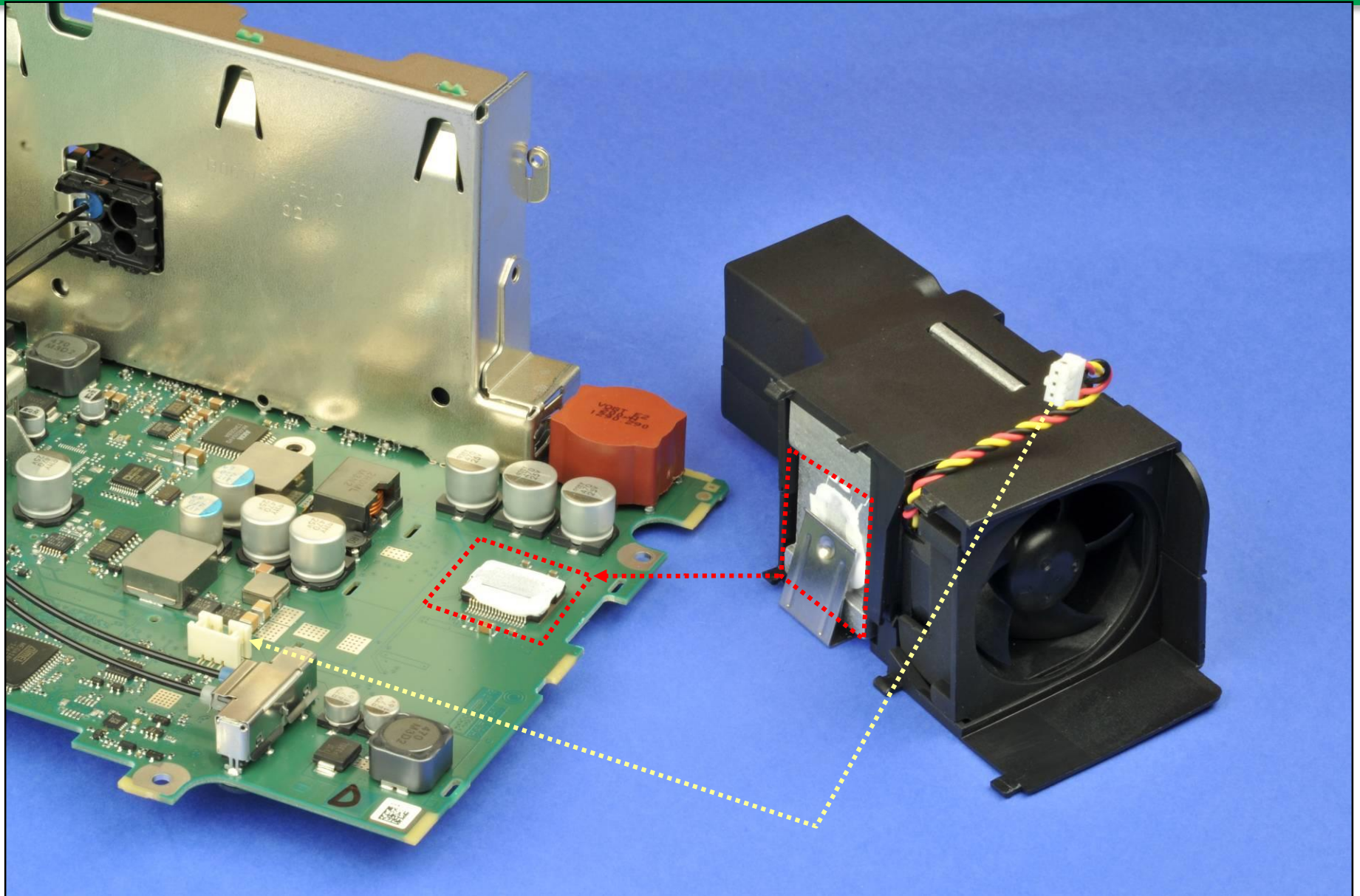
Teardown Sequence



MUNRO
& ASSOCIATES, INC.



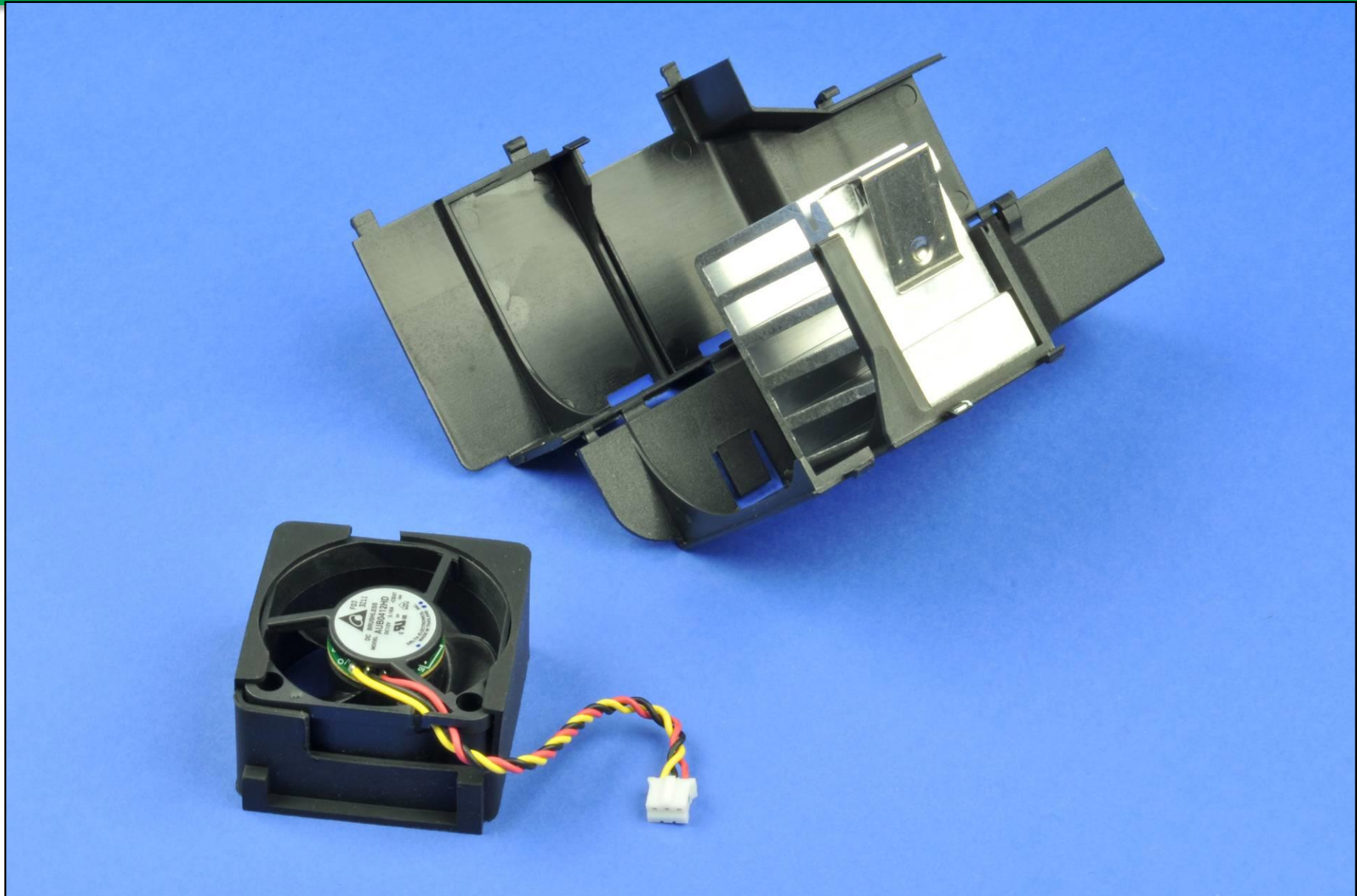
Teardown Sequence



Teardown Sequence



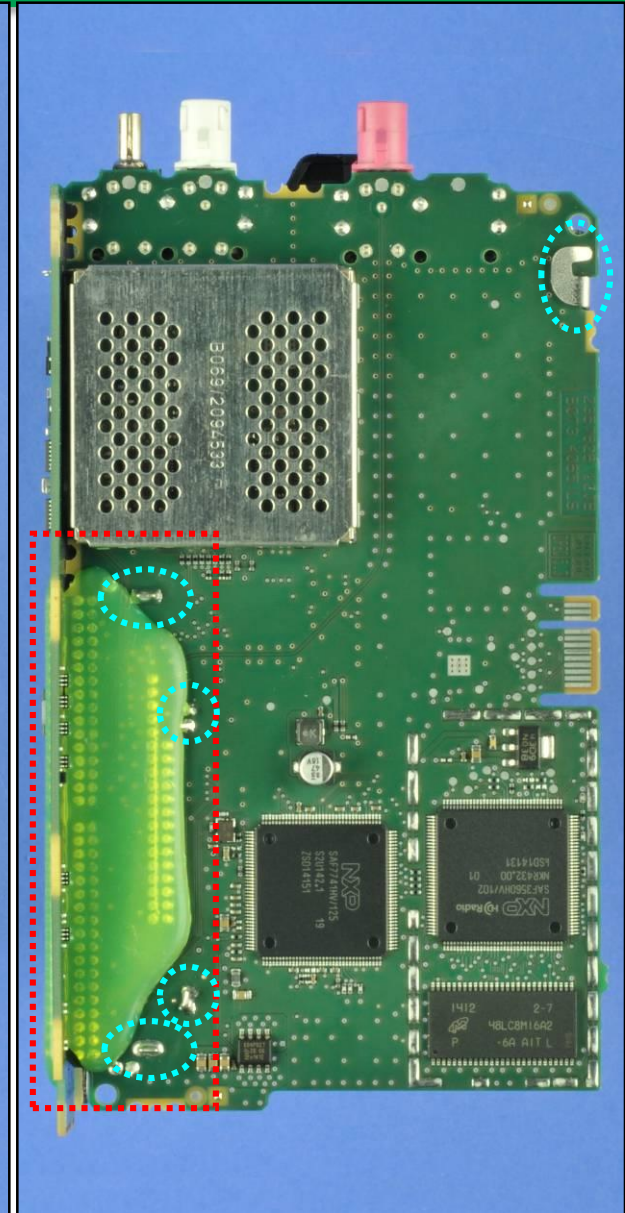
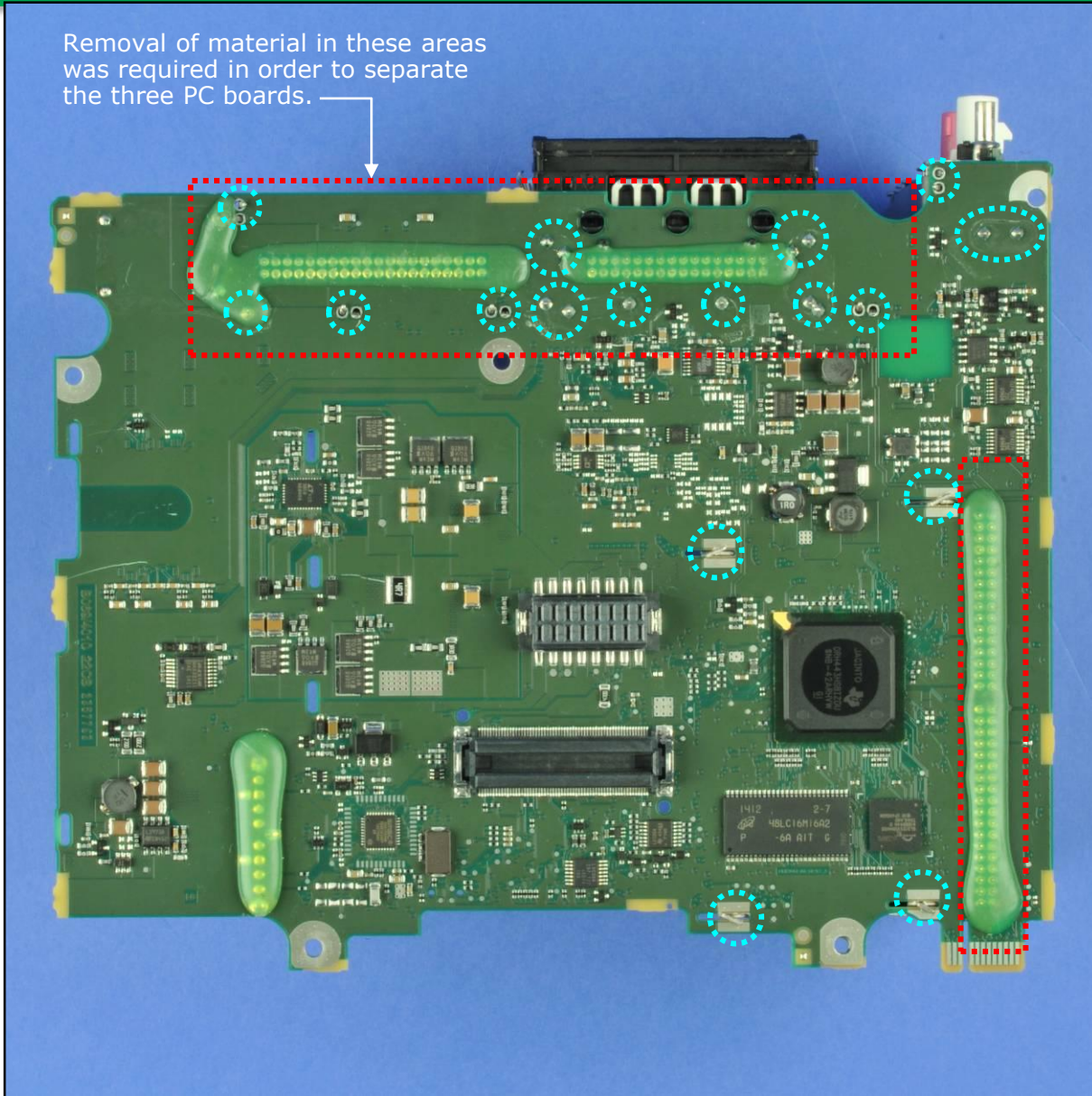
MUNRO
& ASSOCIATES, INC.



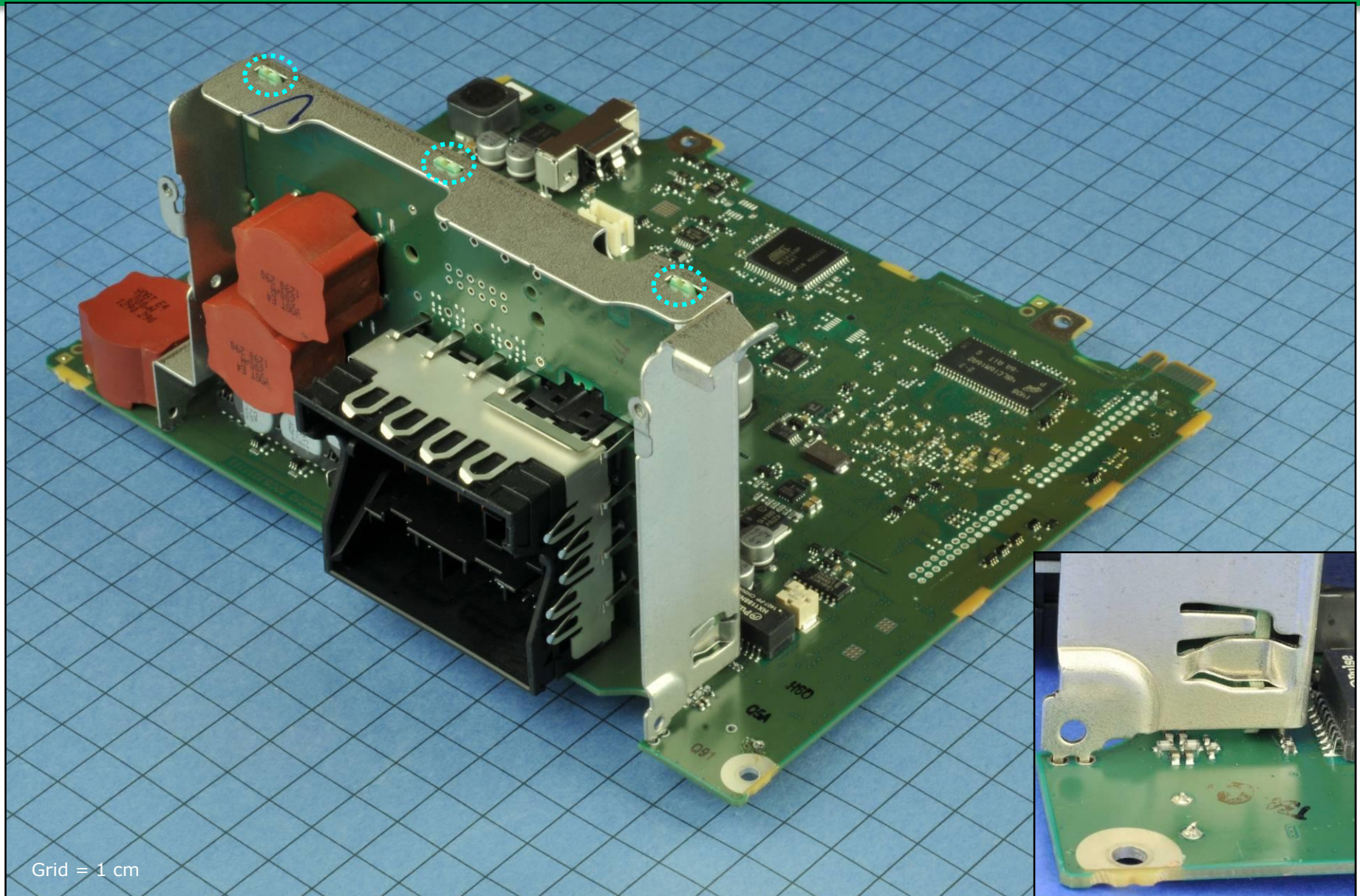
Teardown Sequence



Removal of material in these areas was required in order to separate the three PC boards.



Teardown Sequence

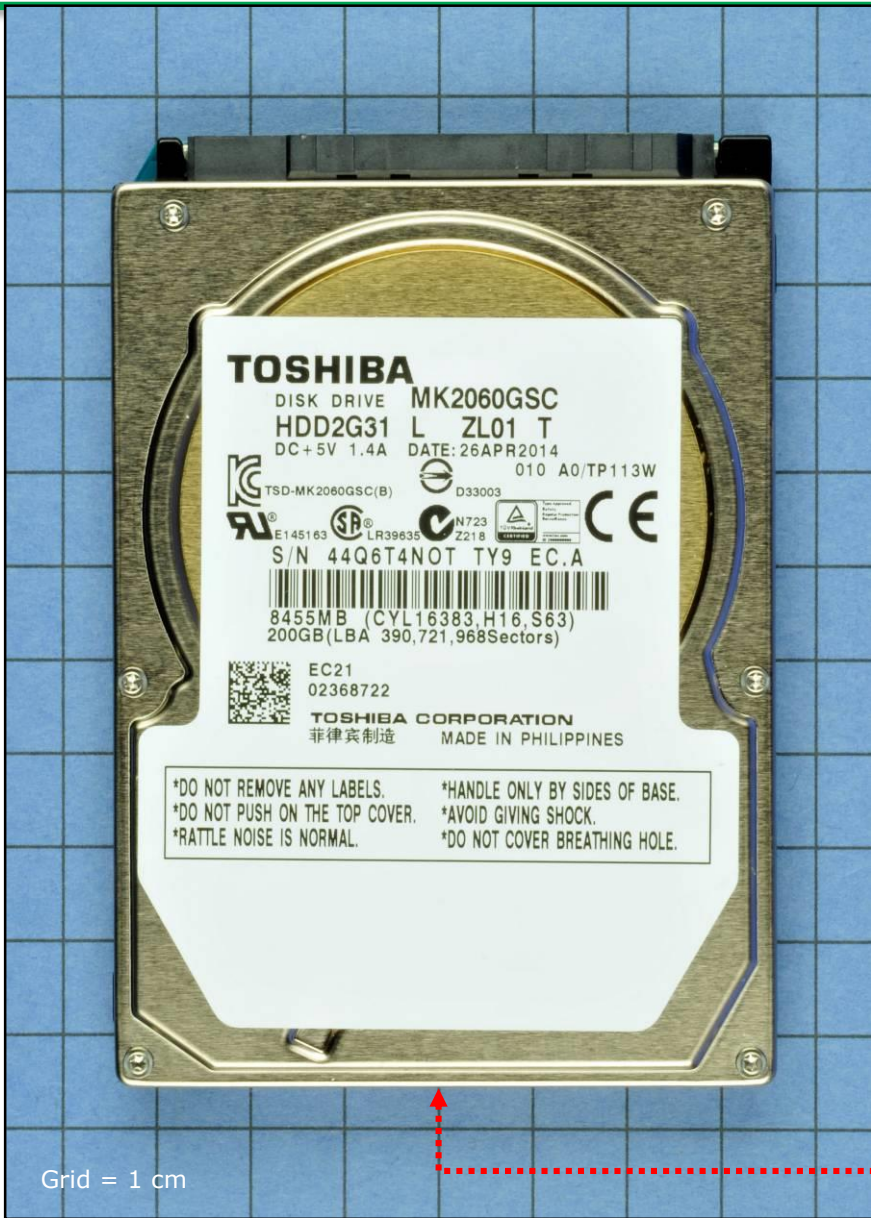


Grid = 1 cm

Hard Drive Subsystem

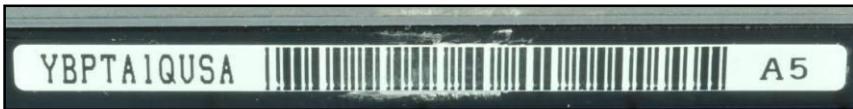


MUNRO
& ASSOCIATES, INC.



Grid = 1 cm

Hard Drive	
Brand	Toshiba
Part Number	MK2060GSC
Module Dimensions	100 x 69.6 x 9.5
Weight (grams)	88.40
Estimated Module Line Item Price	\$29.14

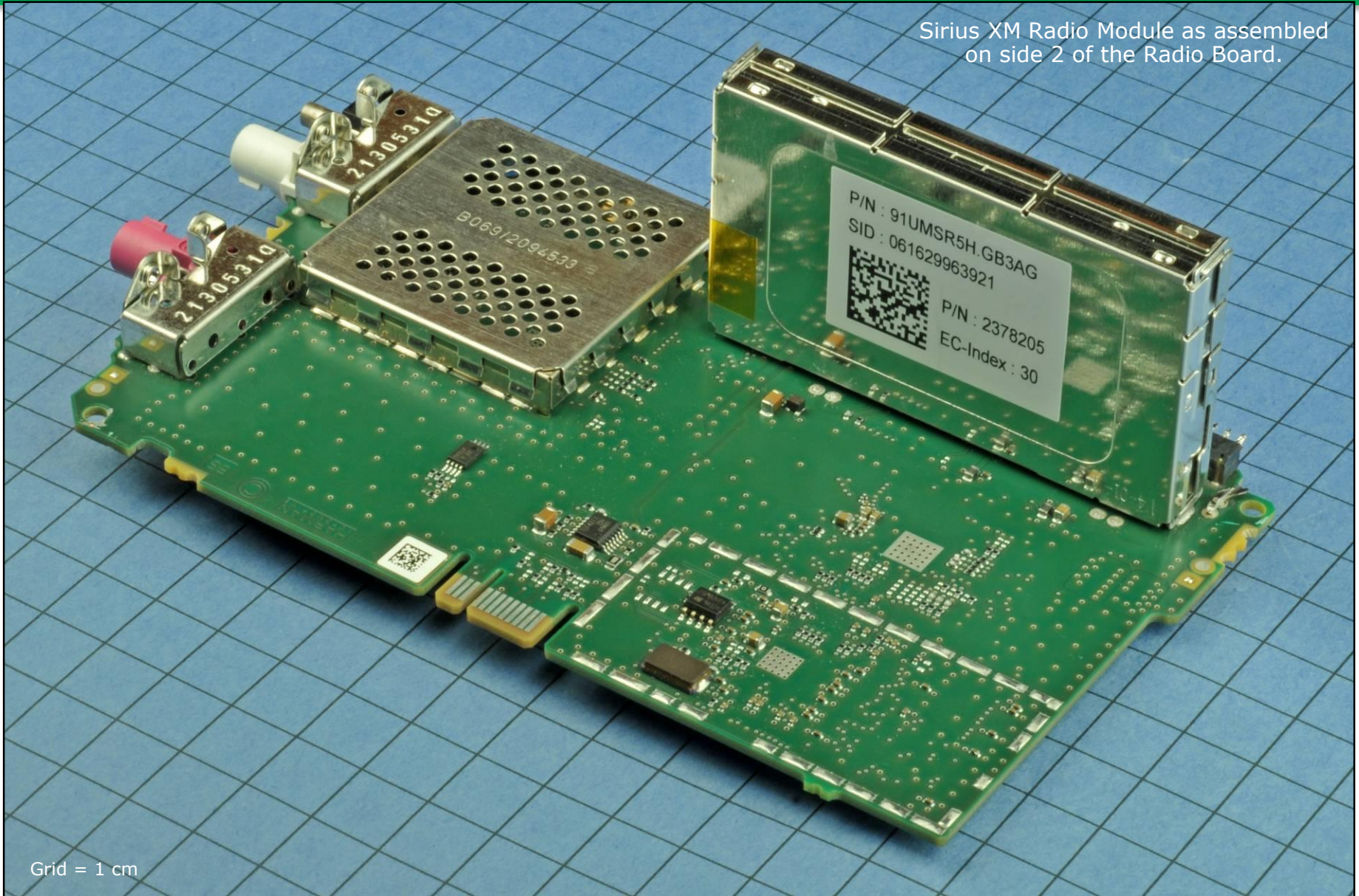


Sirius XM Radio Module



MUNRO
& ASSOCIATES, INC.

Sirius XM Radio Module as assembled
on side 2 of the Radio Board.



Grid = 1 cm

Sirius XM Radio Board (Side 1)



MUNRO
& ASSOCIATES, INC.

99 - STMicroelectronics
#STA210N3A
Satellite Radio Tuner

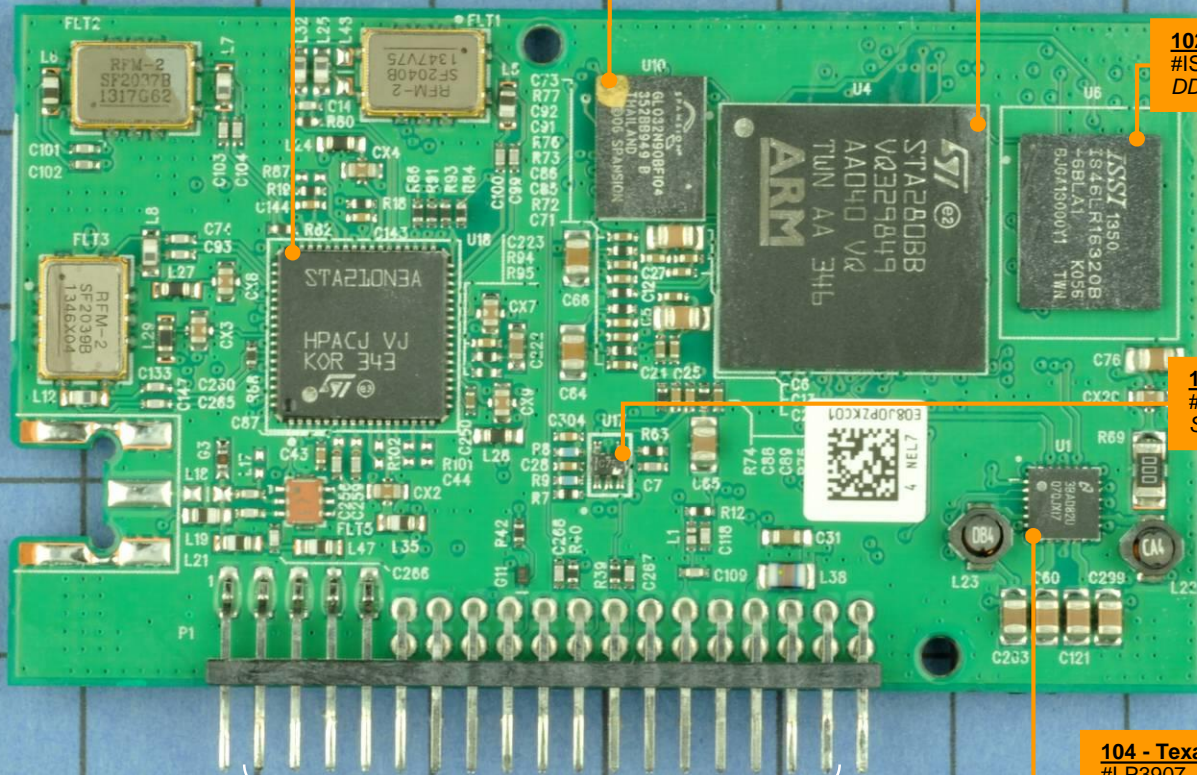
100 - Spansion
#S29GL032N90BF104
NOR Flash Memory - 4 MB

101 - STMicroelectronics
#STA280BB
Baseband Processor

102 - ISSI
#IS46LR16320B-6BLA1
DDR SDRAM Memory - 64 MB

103 - Texas Instruments
#SN74LVC1G17
Single Schmitt-Trigger Buffer

104 - Texas Instruments
#LP3907
Dual DC/DC & Dual Linear Regulators



Radio Board

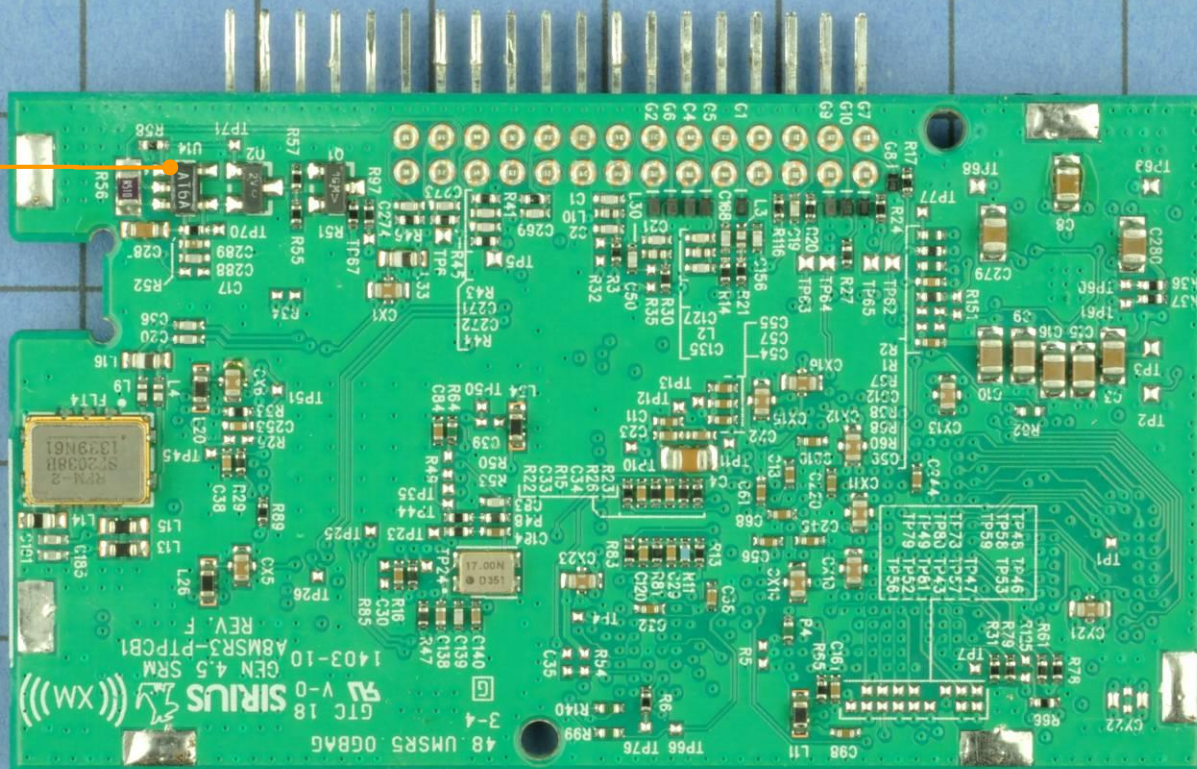
Grid = 1 cm

Sirius XM Radio Board (Side 2)



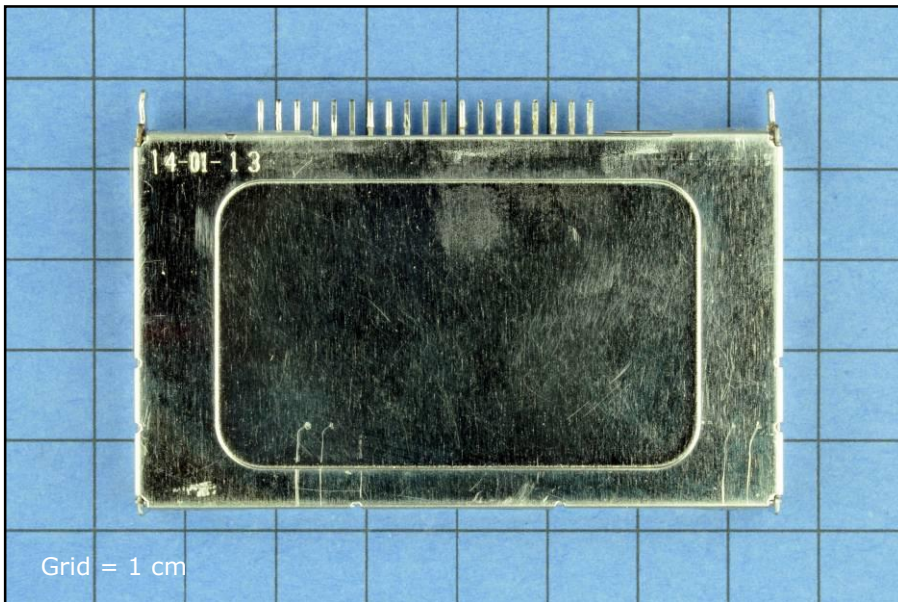
MUNRO
& ASSOCIATES, INC.

105 - Texas Instruments
#LMC7101Q-Q1
Operational Amplifier



Grid = 1 cm

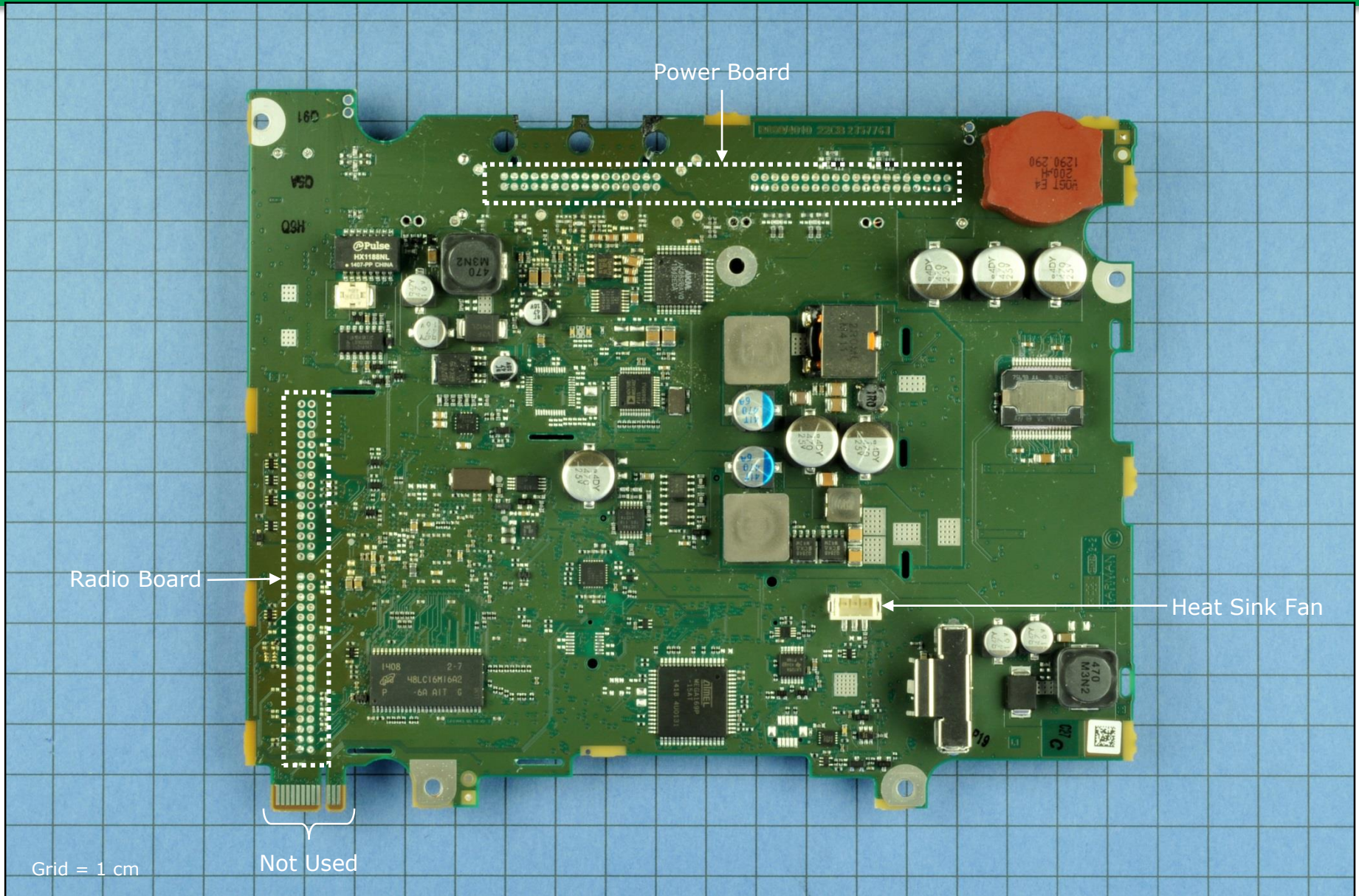
Sirius XM Radio Module



Grid = 1 cm

Sirius XM Radio Module		
Brand	Sirius	
Part Number	91UMSR5H.GB3AG	
Module Dimensions	71.5 x 45.3 x 10.3	
Weight (grams)	41.50	
Estimated Costs	Electronic Parts	\$31.65
	Non-Electronic Parts	\$0.10
	Assembly	\$1.52
	Test	\$0.35
	Gross Margin	\$14.41
Estimated Module Price		\$48.03

Main Board (Side 1)



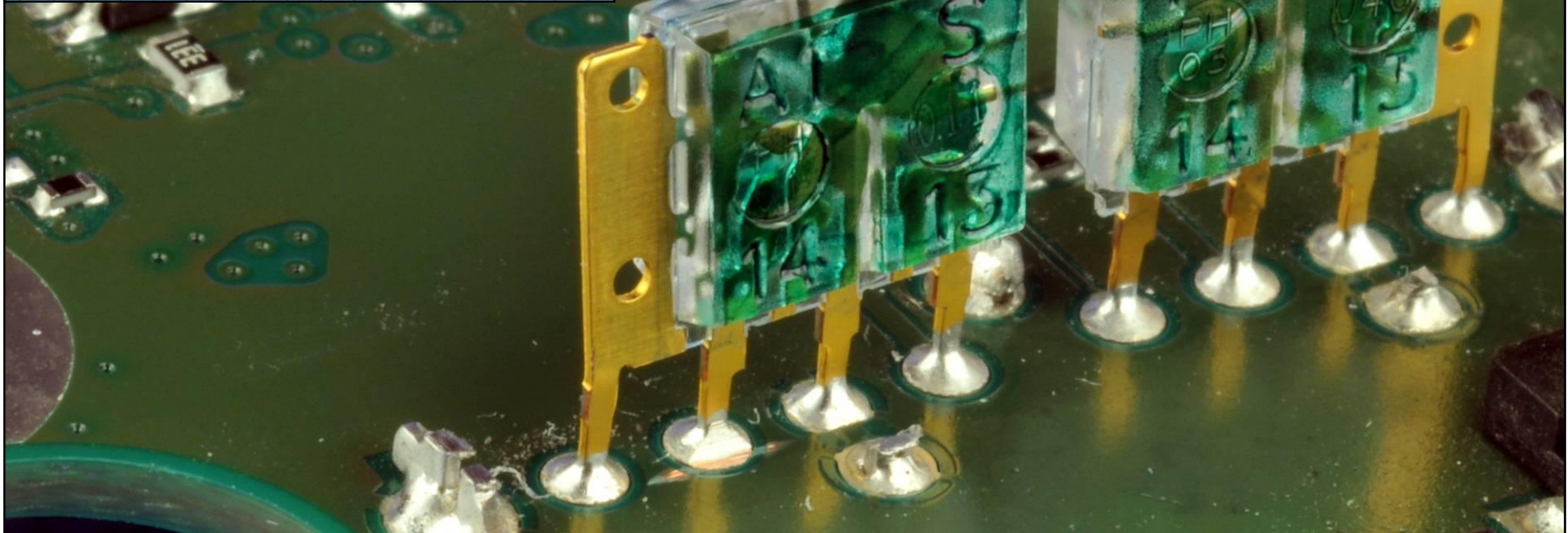
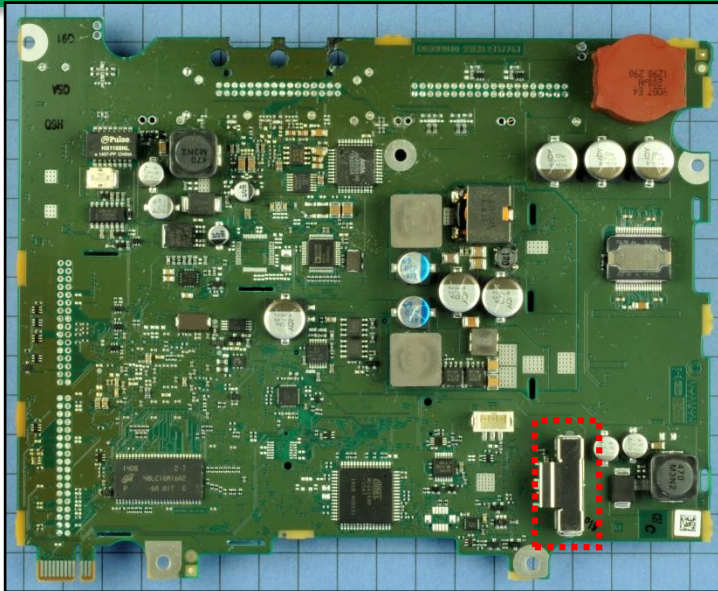
Grid = 1 cm

Not Used

Main Board (Side 1)

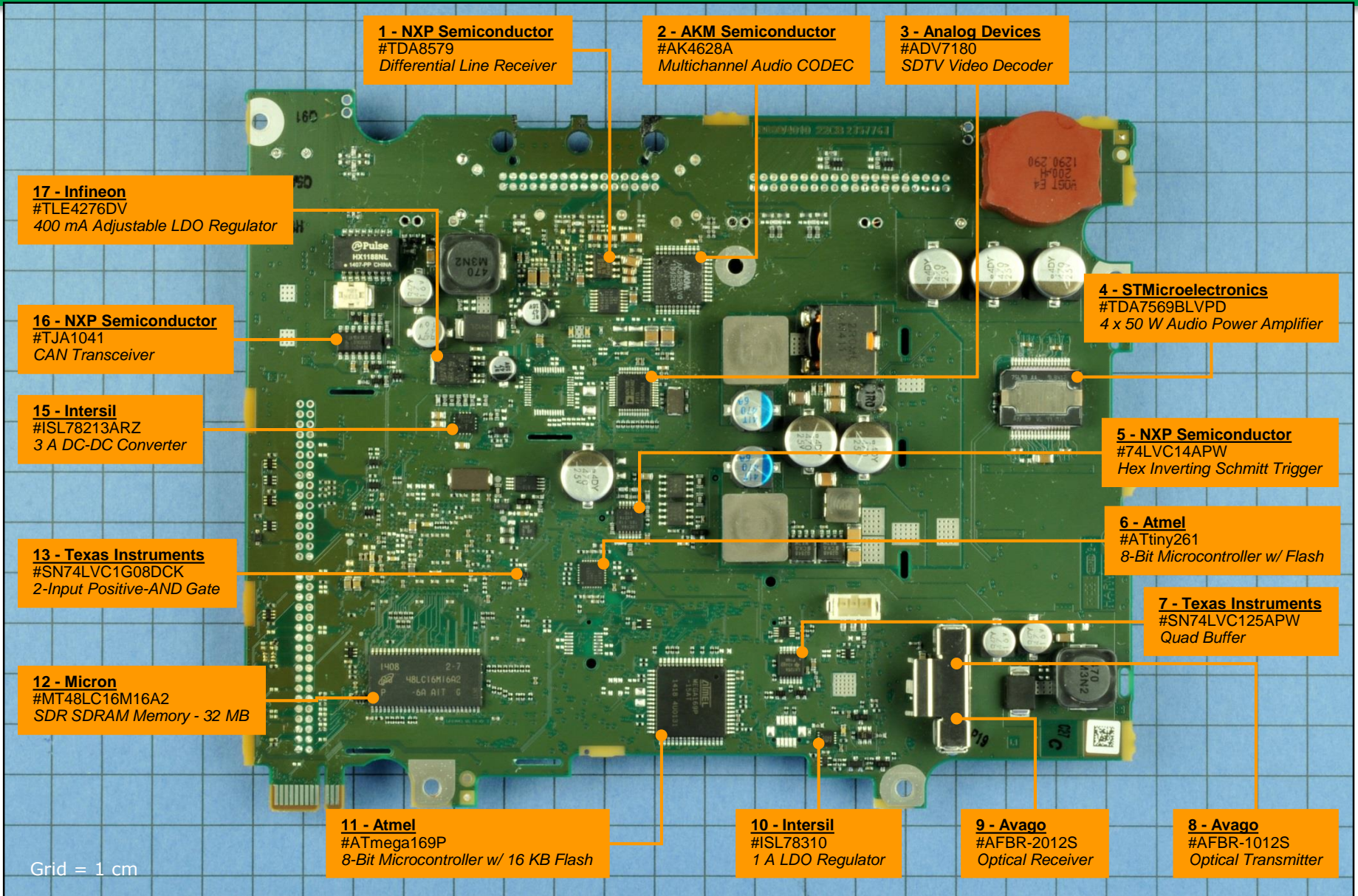


MUNRO
& ASSOCIATES, INC.



BMW i5 Digital Radio Module
HBB125 #15200-150210-RBb -
Page 383

Main Board (Side 1 IC Identification)



Grid = 1 cm

Main Board (Side 1 IC Identification)



18 - Texas Instruments
#SN74HC4066PW
Quad Bilateral Switch

24 - Maxim
#MAX4835ETT18BD2+T
250 mA / 1.8 V LDO Regulator

21 - NXP Semiconductor
#74LVC1G14GW
Single Schmitt-Trigger Inverter

13 - Texas Instruments
#SN74LVC1G08DCK
2-Input Positive-AND Gate

19 - Texas Instruments
#SN74LVC1G08IDCK
2-Input Positive-AND Gate

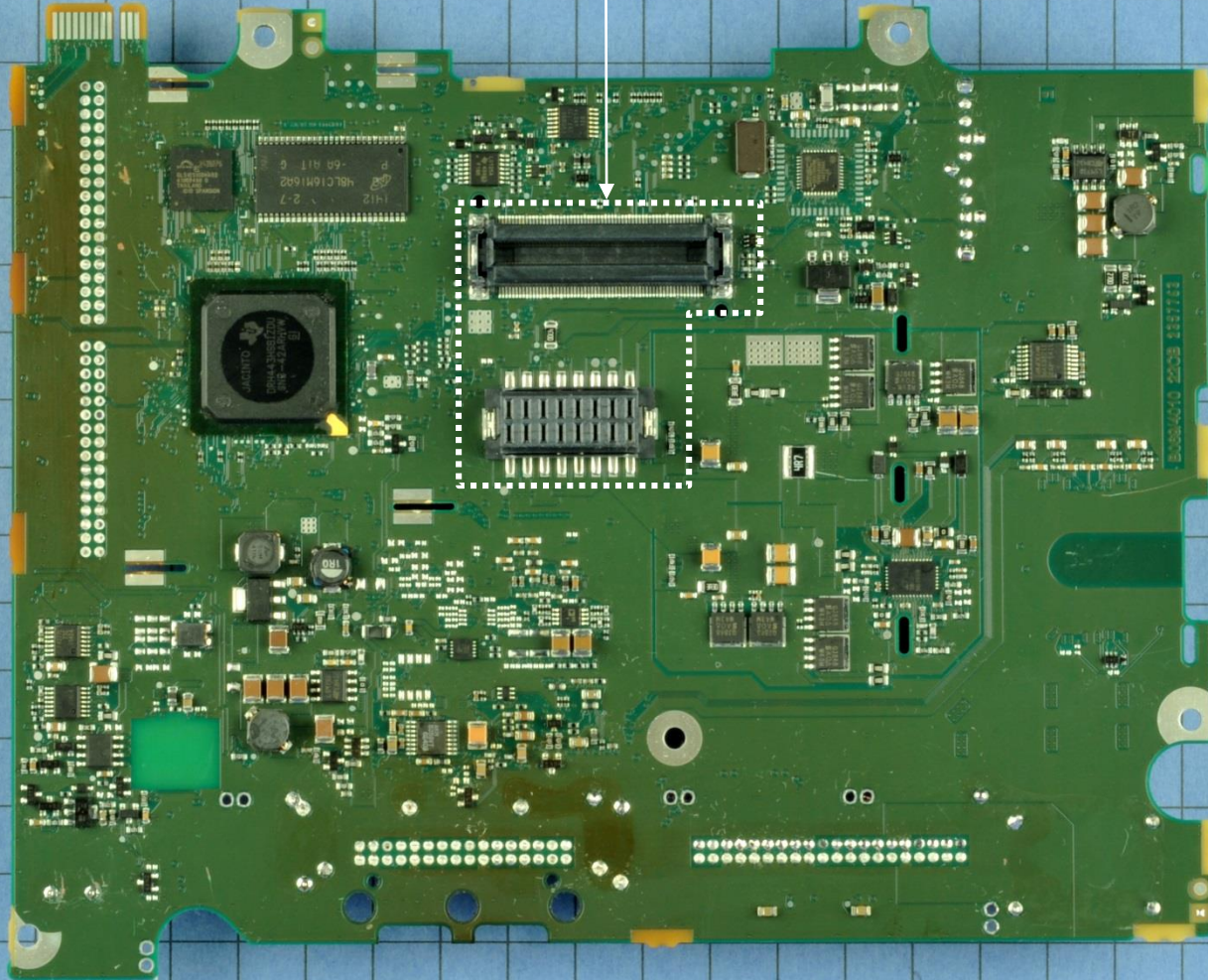
20 - Texas Instruments
#SN74LVC2G125-Q1
Dual Bus Buffer

Grid = 1 cm

Main Board (Side 2)

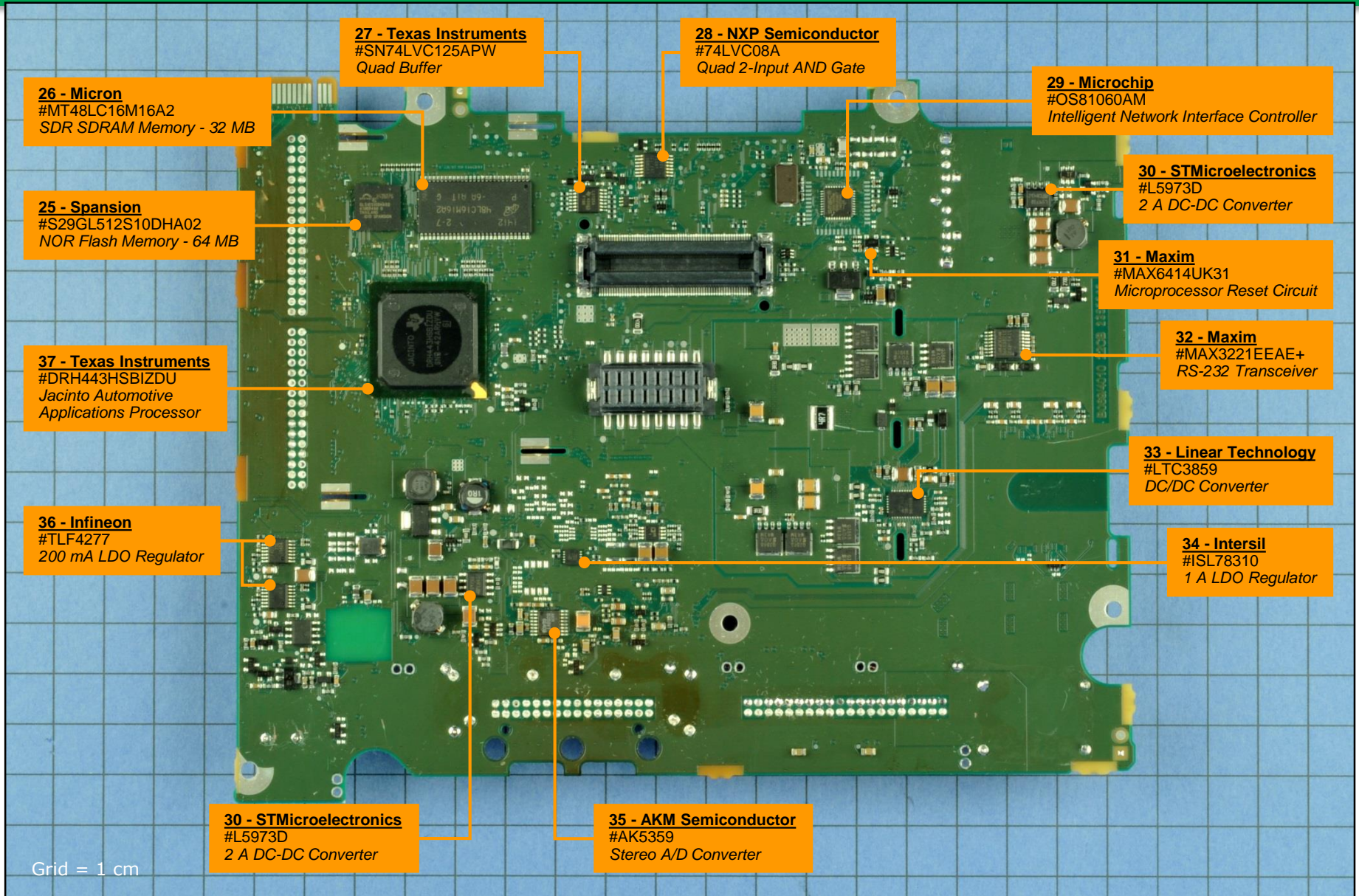


Mother Board



Grid = 1 cm

Main Board (Side 2 IC Identification)



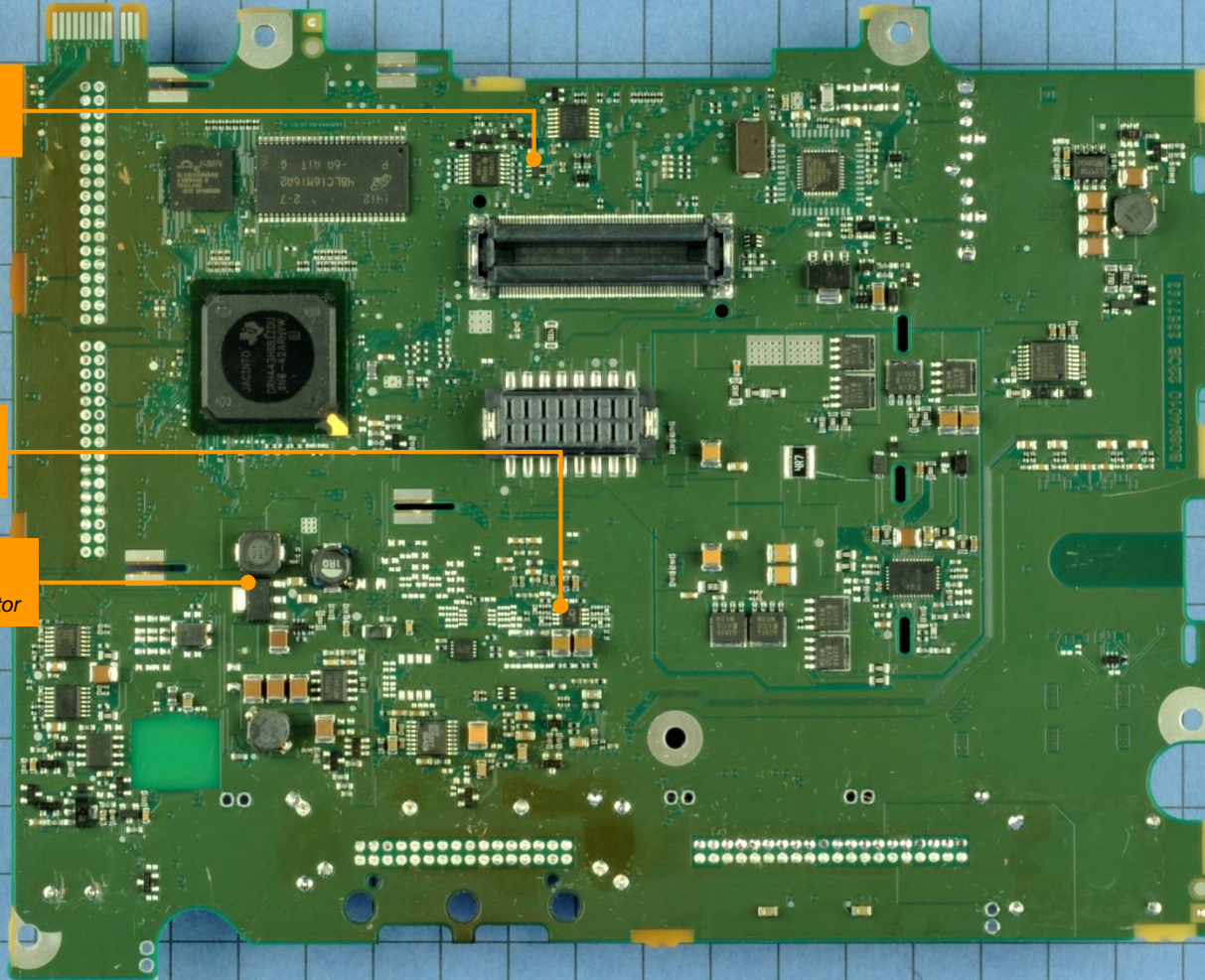
Main Board (Side 2 IC Identification)



38 - Texas Instruments
#SN74LVC1G08IDCK
2-Input Positive-AND Gate

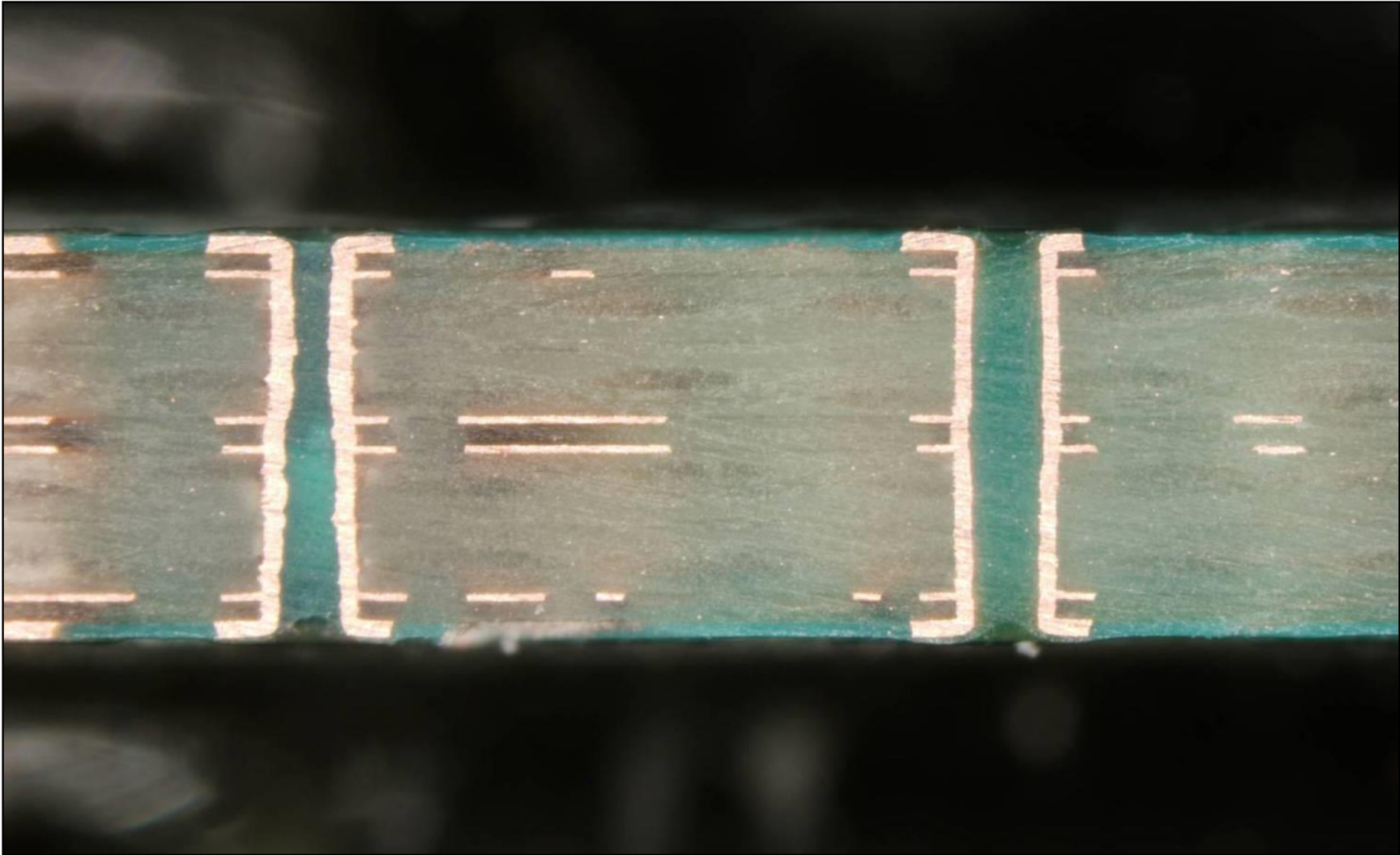
42 - Analog Devices
#ADA4851-2WYRMZ-R7
Operational Amplifier

41 - Infineon
#TLE4266
150 mA / 5 V LDO Regulator



Grid = 1 cm

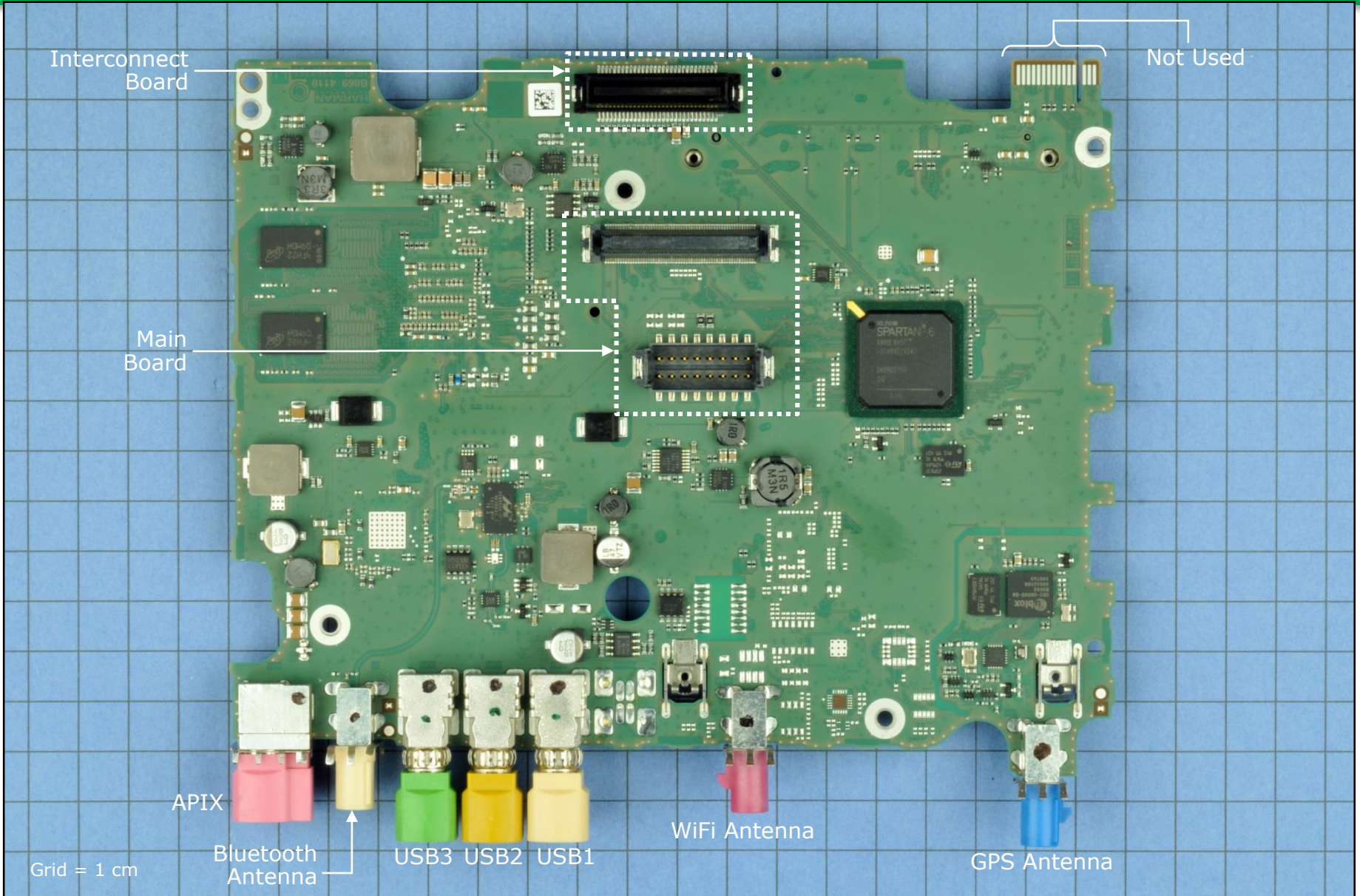
Main Board Cross-Section



Mother Board (Side 1)



MUNRO
& ASSOCIATES, INC.



Not Used

Interconnect Board

Main Board

APIX

Bluetooth Antenna

USB3

USB2

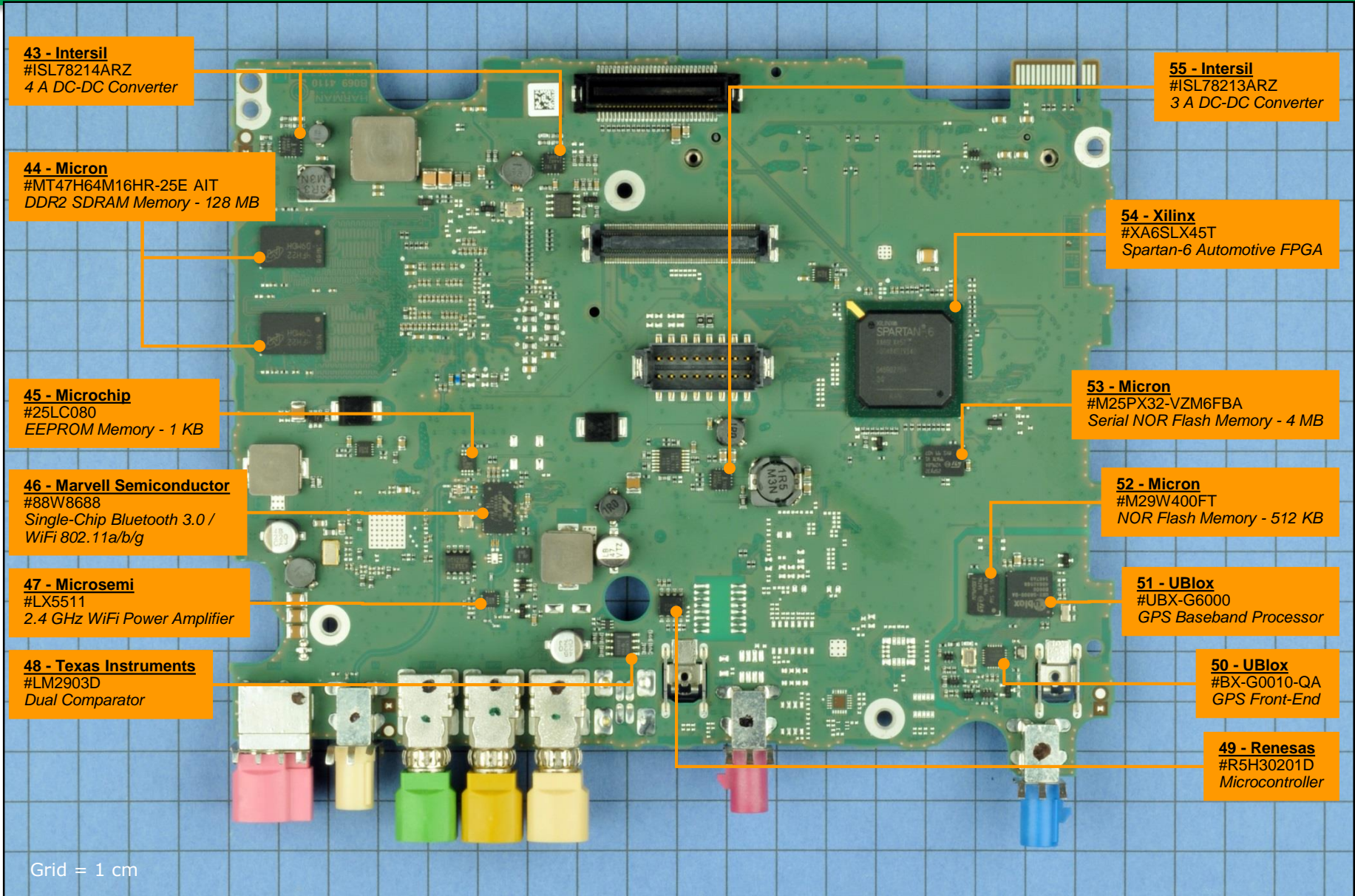
USB1

WiFi Antenna

GPS Antenna

Grid = 1 cm

Mother Board (Side 1 IC Identification)

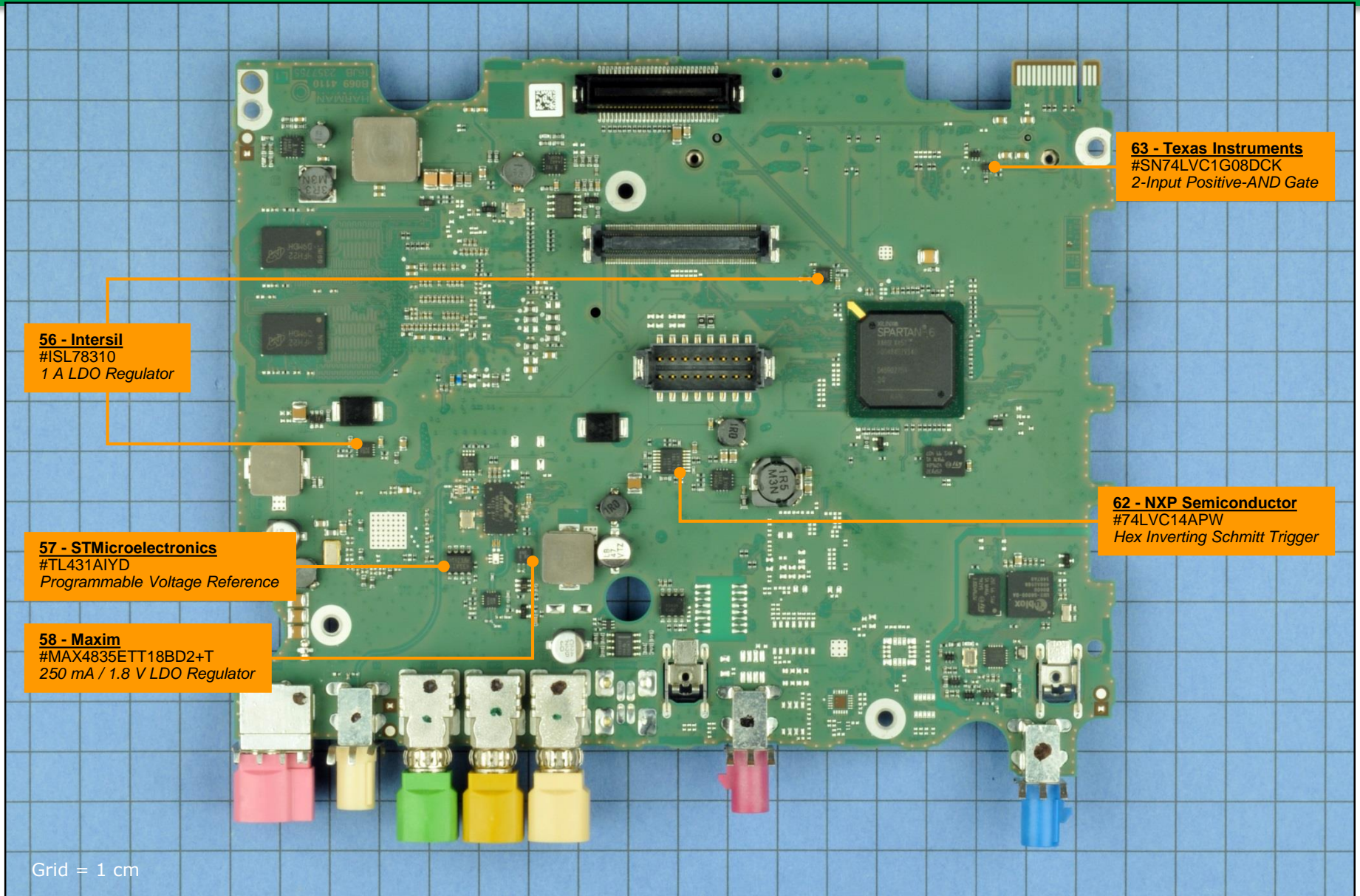


Grid = 1 cm

Mother Board (Side 1 IC Identification)



MUNRO
& ASSOCIATES, INC.



56 - Intersil
#ISL78310
1 A LDO Regulator

57 - STMicroelectronics
#TL431AIYD
Programmable Voltage Reference

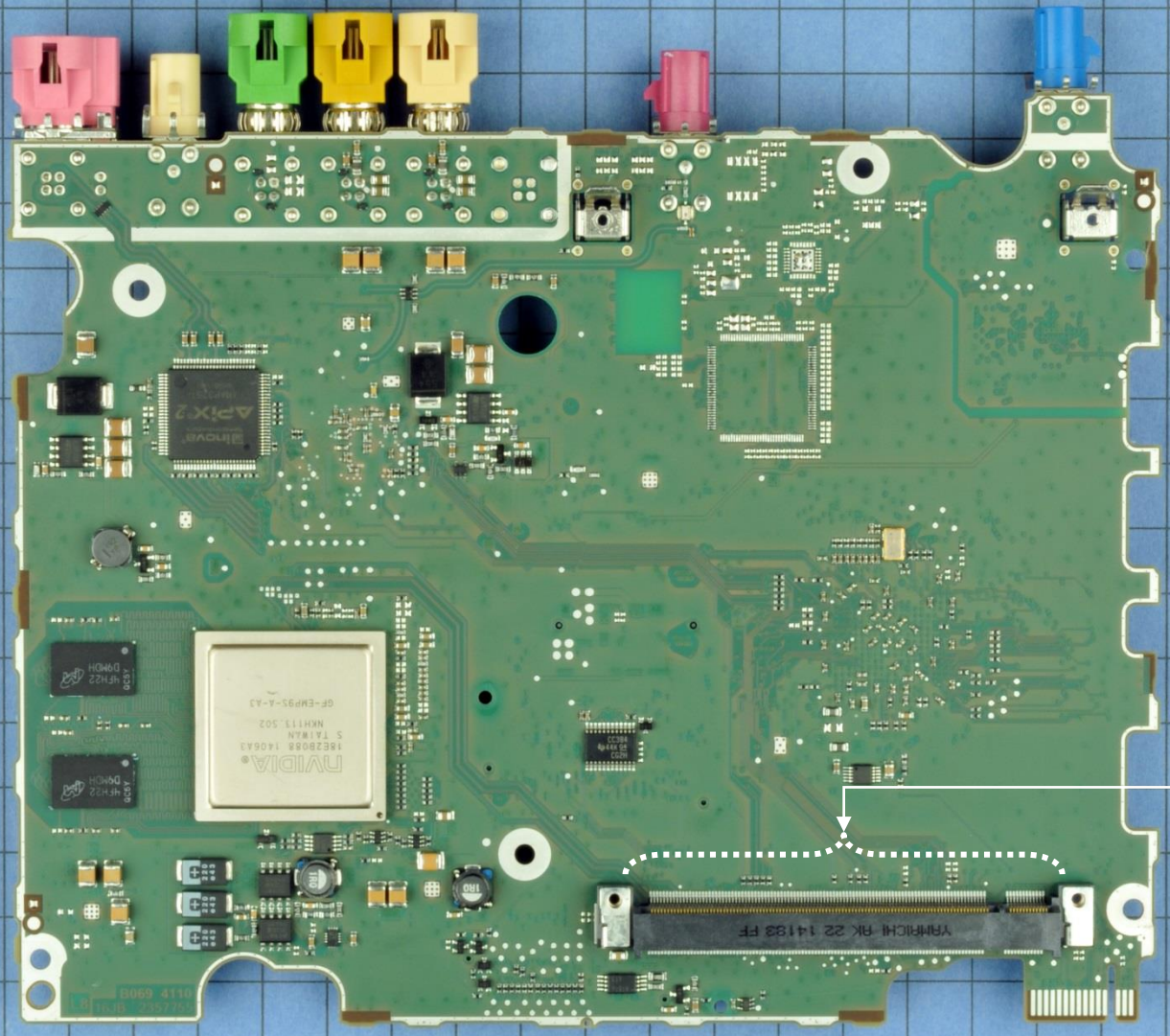
58 - Maxim
#MAX4835ETT18BD2+T
250 mA / 1.8 V LDO Regulator

63 - Texas Instruments
#SN74LVC1G08DCK
2-Input Positive-AND Gate

62 - NXP Semiconductor
#74LVC14APW
Hex Inverting Schmitt Trigger

Grid = 1 cm

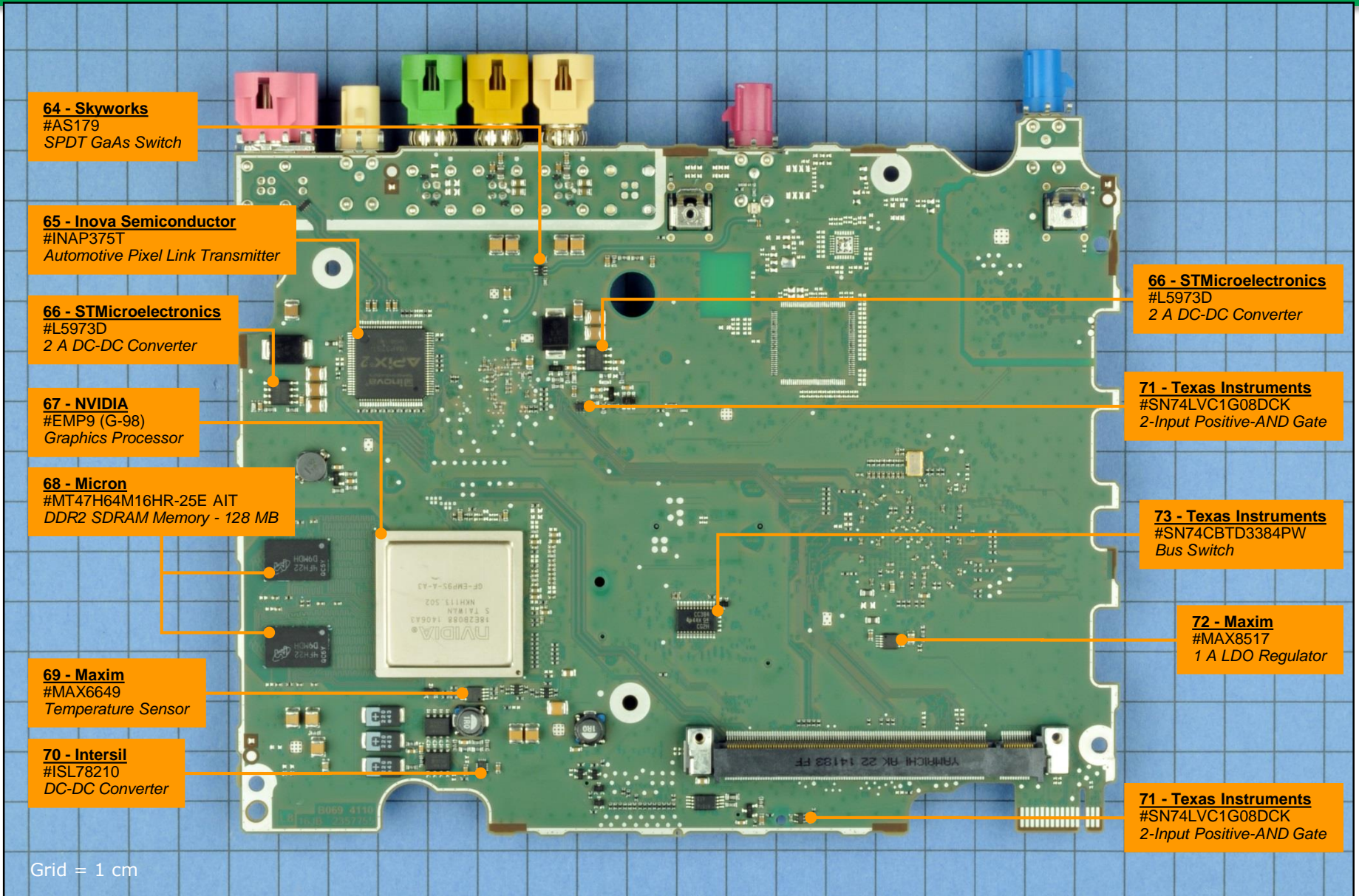
Mother Board (Side 2)



Daughter Board

Grid = 1 cm

Mother Board (Side 2 IC Identification)



64 - Skyworks
#AS179
SPDT GaAs Switch

65 - Inova Semiconductor
#INAP375T
Automotive Pixel Link Transmitter

66 - STMicroelectronics
#L5973D
2 A DC-DC Converter

67 - NVIDIA
#EMP9 (G-98)
Graphics Processor

68 - Micron
#MT47H64M16HR-25E AIT
DDR2 SDRAM Memory - 128 MB

69 - Maxim
#MAX6649
Temperature Sensor

70 - Intersil
#ISL78210
DC-DC Converter

66 - STMicroelectronics
#L5973D
2 A DC-DC Converter

71 - Texas Instruments
#SN74LVC1G08DCK
2-Input Positive-AND Gate

73 - Texas Instruments
#SN74CBTD3384PW
Bus Switch

72 - Maxim
#MAX8517
1 A LDO Regulator

71 - Texas Instruments
#SN74LVC1G08DCK
2-Input Positive-AND Gate

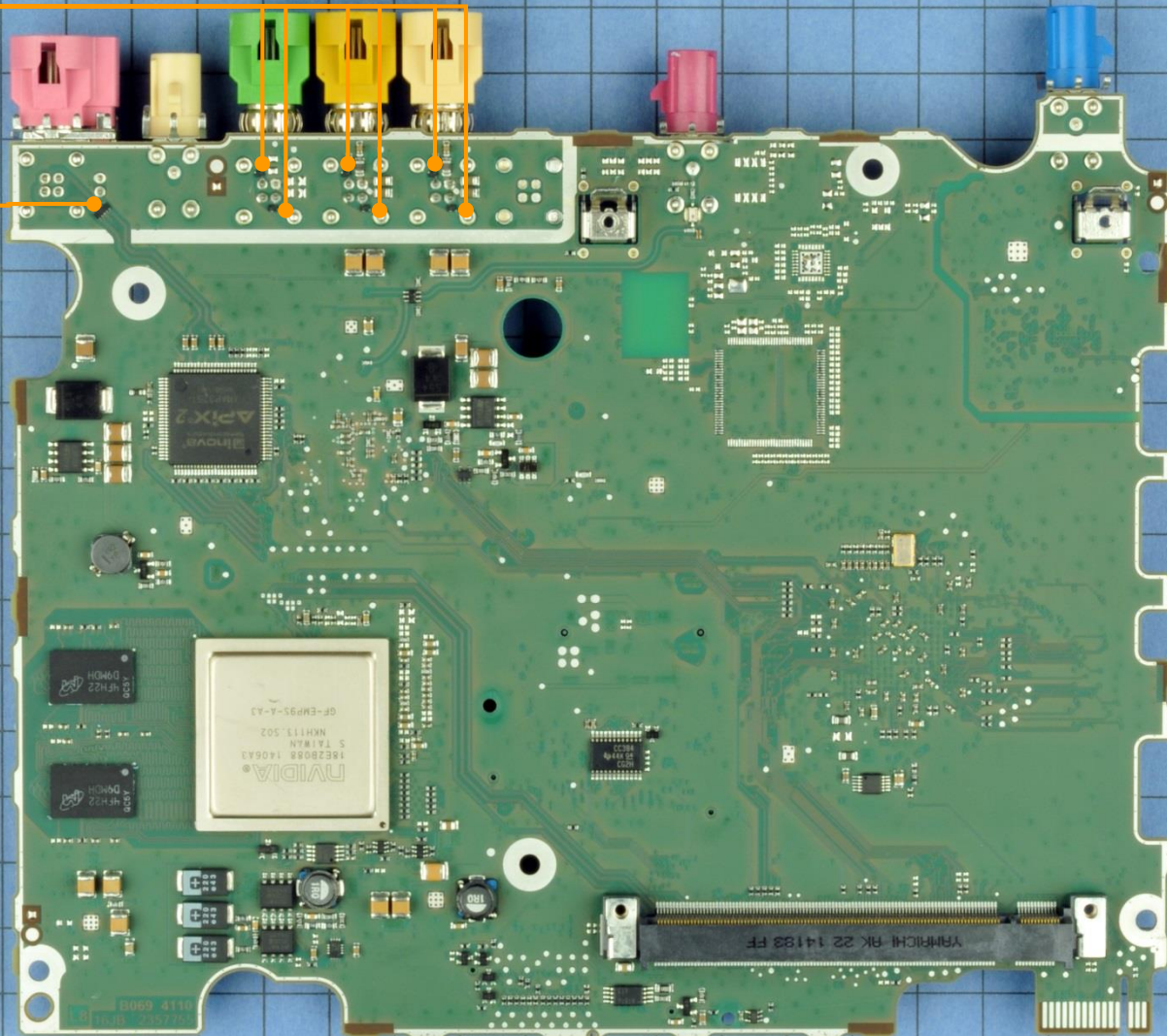
Grid = 1 cm

Mother Board (Side 2 IC Identification)



74 - Unknown
#E8 ?
ESD Protection ?

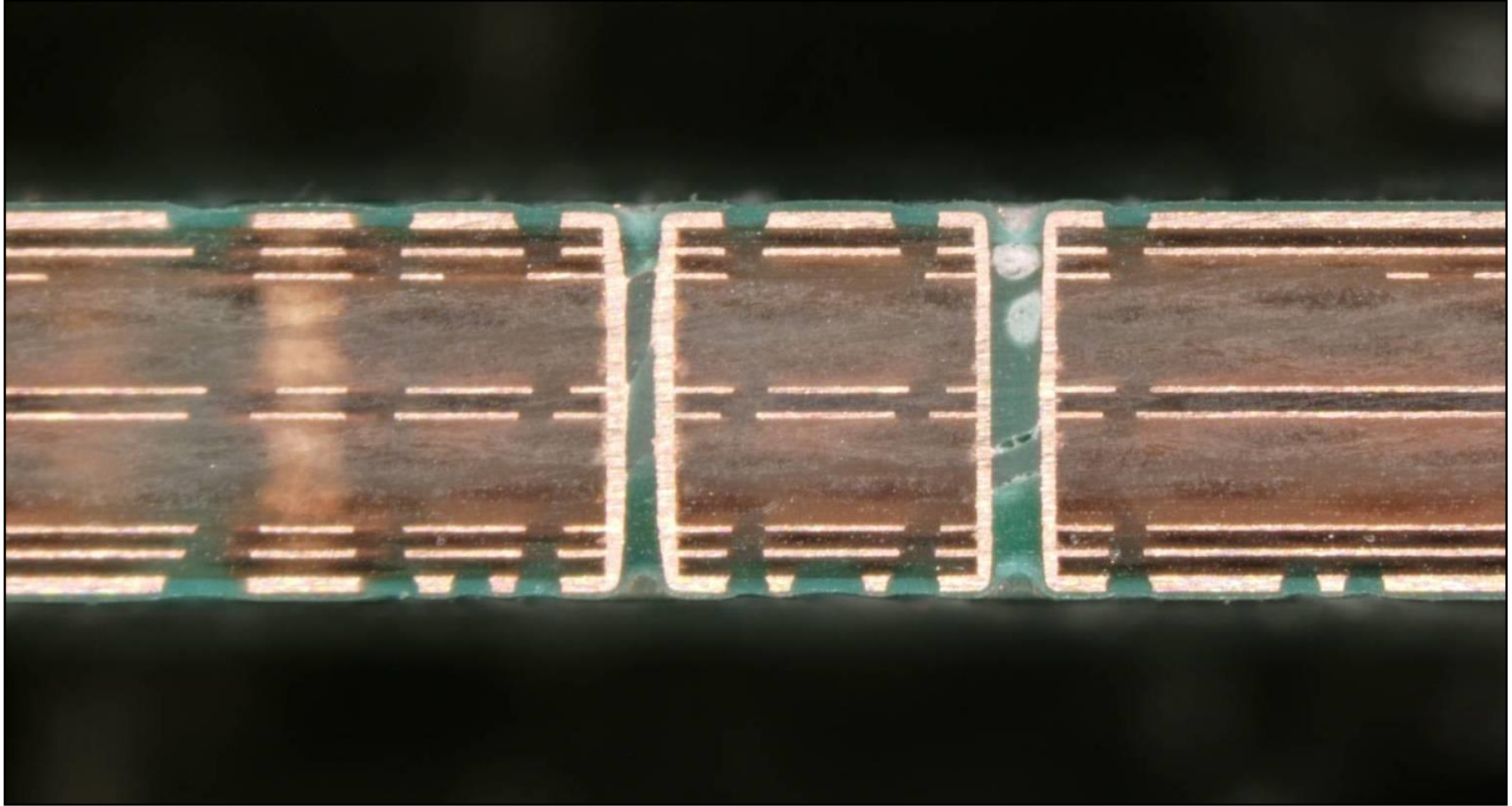
75 - Unknown
#HSA ?
EMI Filter ?



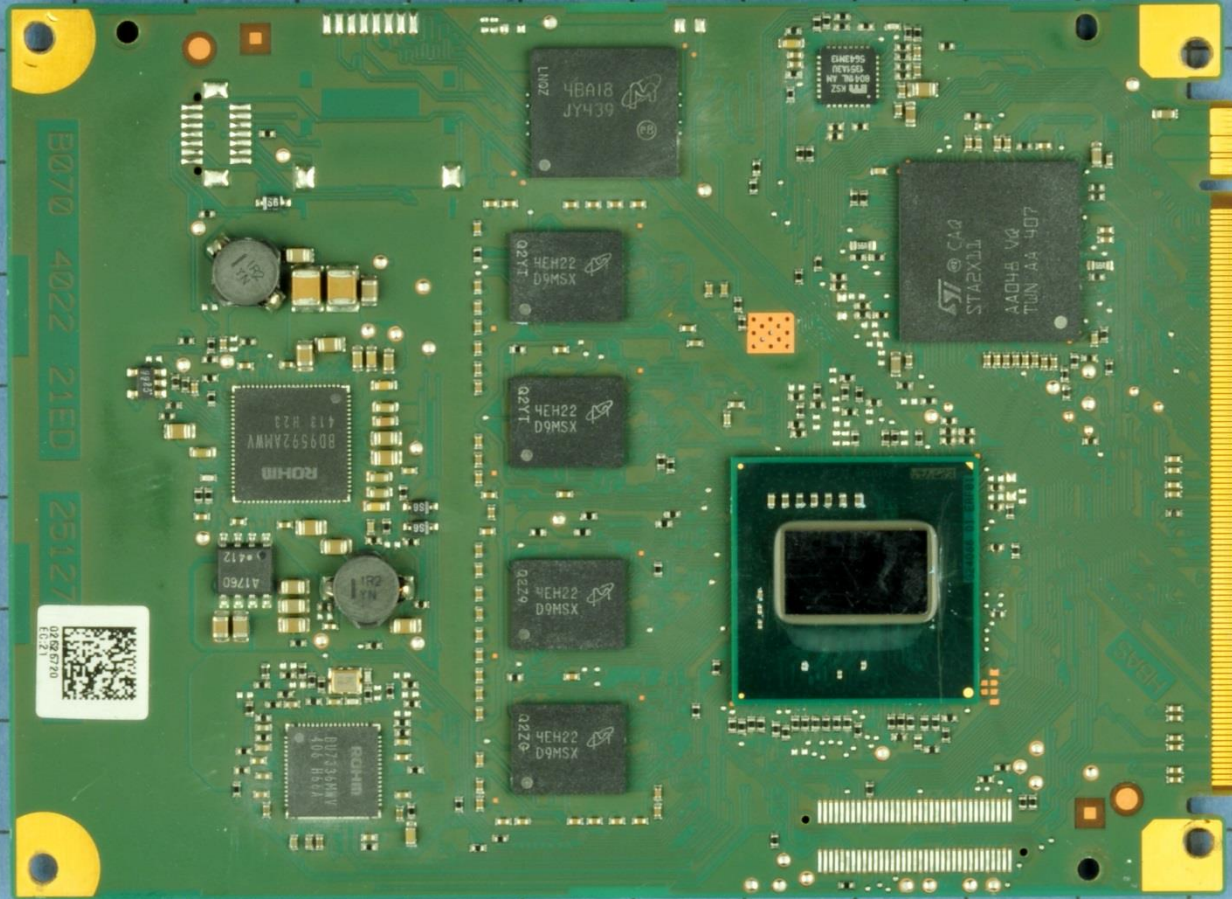
Grid = 1 cm

? = Unconfirmed

Mother Board (Cross-Section)



Daughter Board (Side 1)



Mother Board

Grid = 1 cm

Daughter Board (Side 1 IC Identification)



76 - Micron
#MT47H128M8CF-25E AIT:H
DDR2 SDRAM Memory - 128 MB

77 - Micron
#MTFC8GLGDM-AIT Z
Multichip Memory - 8 GB MLC NAND Flash, Memory Controller (eMMC) (3-Die Pkg.)

78 - Micrel
#KSZ8041NL
Ethernet Transceiver

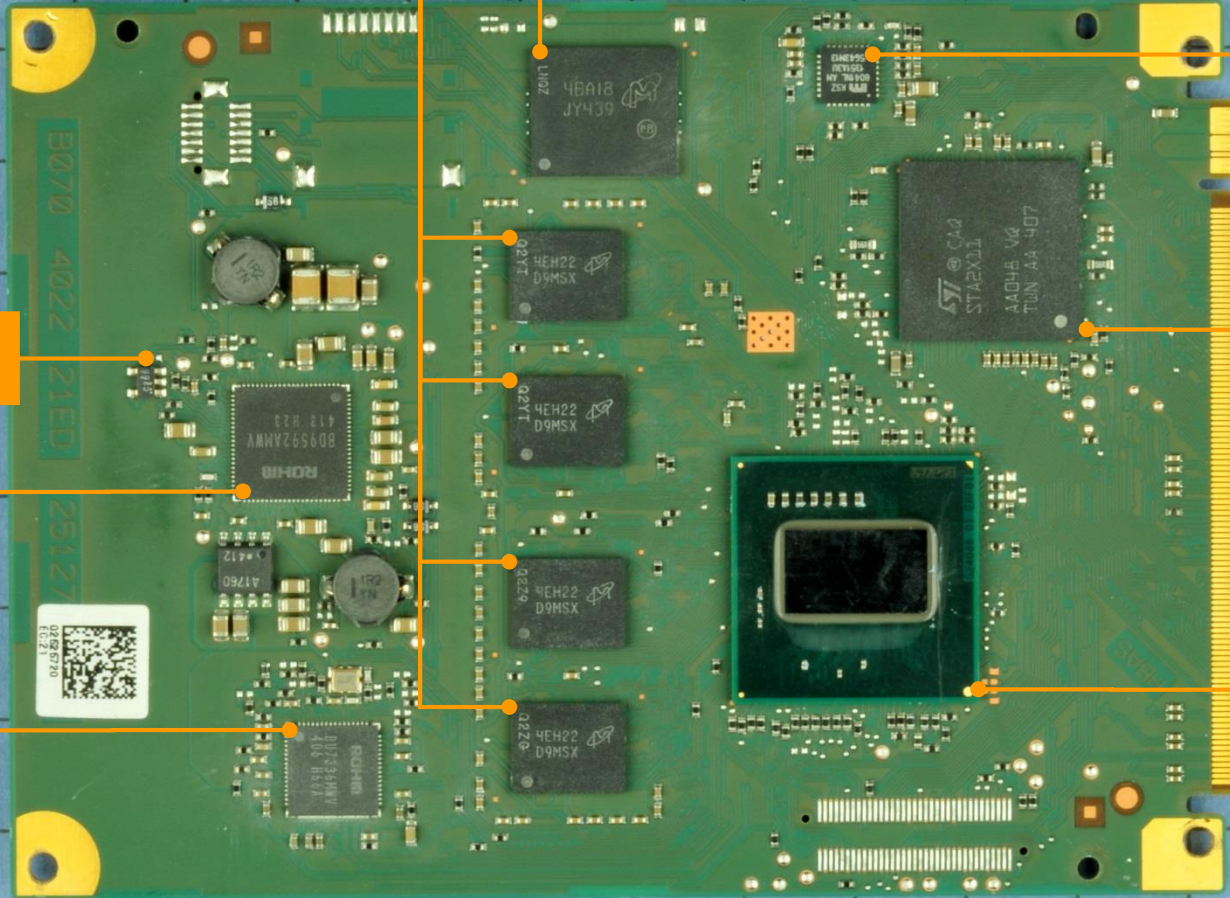
79 - STMicroelectronics
#STA2X11
I/O Controller Hub

80 - Intel
#E660T
1.30 GHz Atom Processor

82 - Texas Instruments
#SN74LVC1G125DBV
Single Buffer

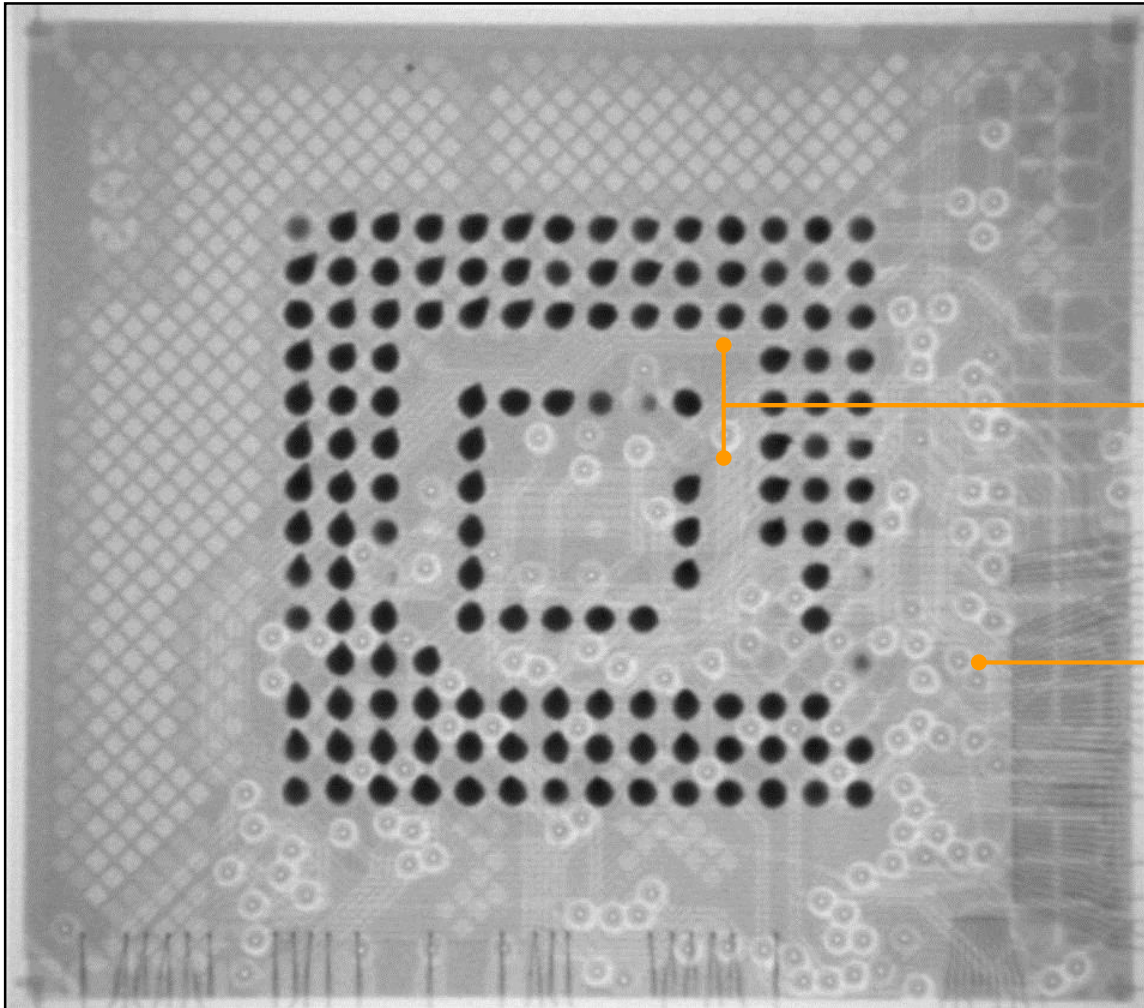
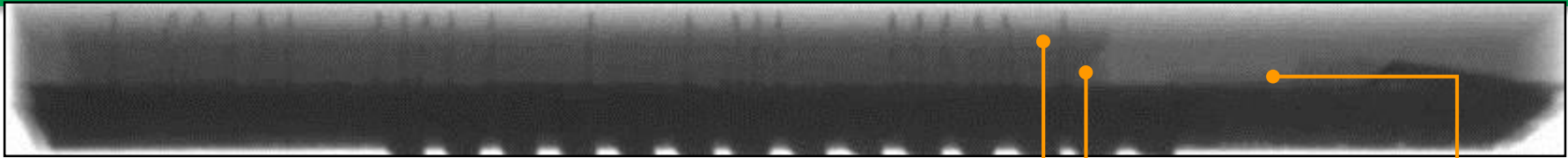
83 - Rohm
#BD9592AMWV
Power Management

81 - Rohm
#BU7336MWV
Clock Generator



Grid = 1 cm

Daughter Board (Side 1 X-Rays)

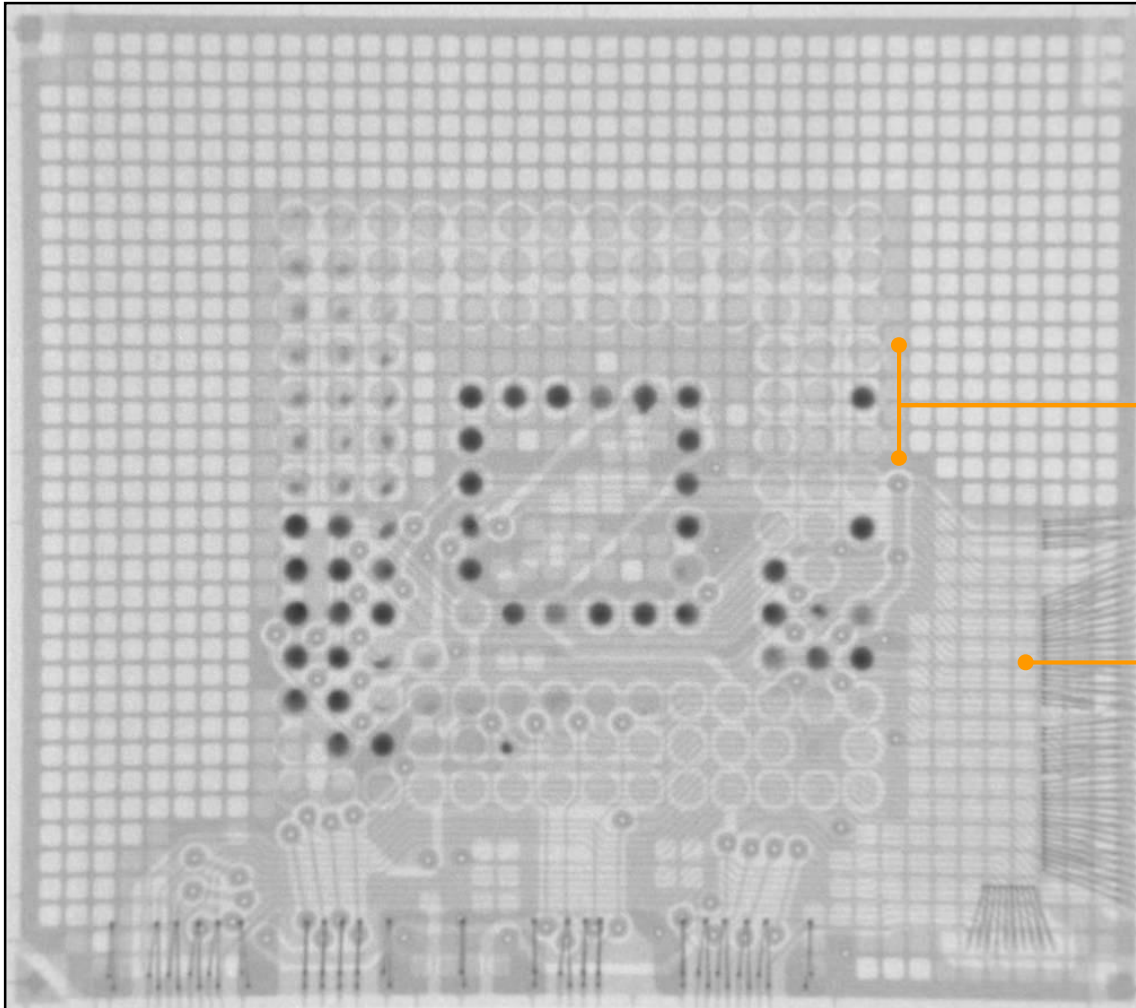
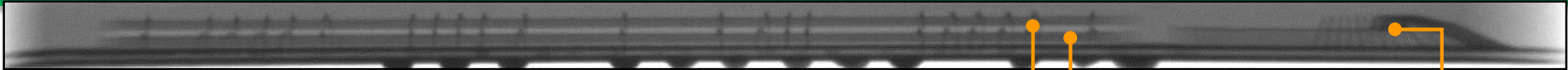


77.1 - Micron
#L73A
MLC NAND Flash
Memory - 4 GB
Die Size: 10.3 x 8.8 mm

77.2 - Micron
#PS8200
Memory Controller
Die Size: 4.7 x 1.8 mm

77 - Micron
#MTFC8GLGDM-AIT Z
Multichip Memory - 8 GB MLC NAND Flash,
Memory Controller (eMMC) (3-Die Pkg.)
Pkg Size: 13 x 11.5 mm

Daughter Board (Side 1 X-Rays)

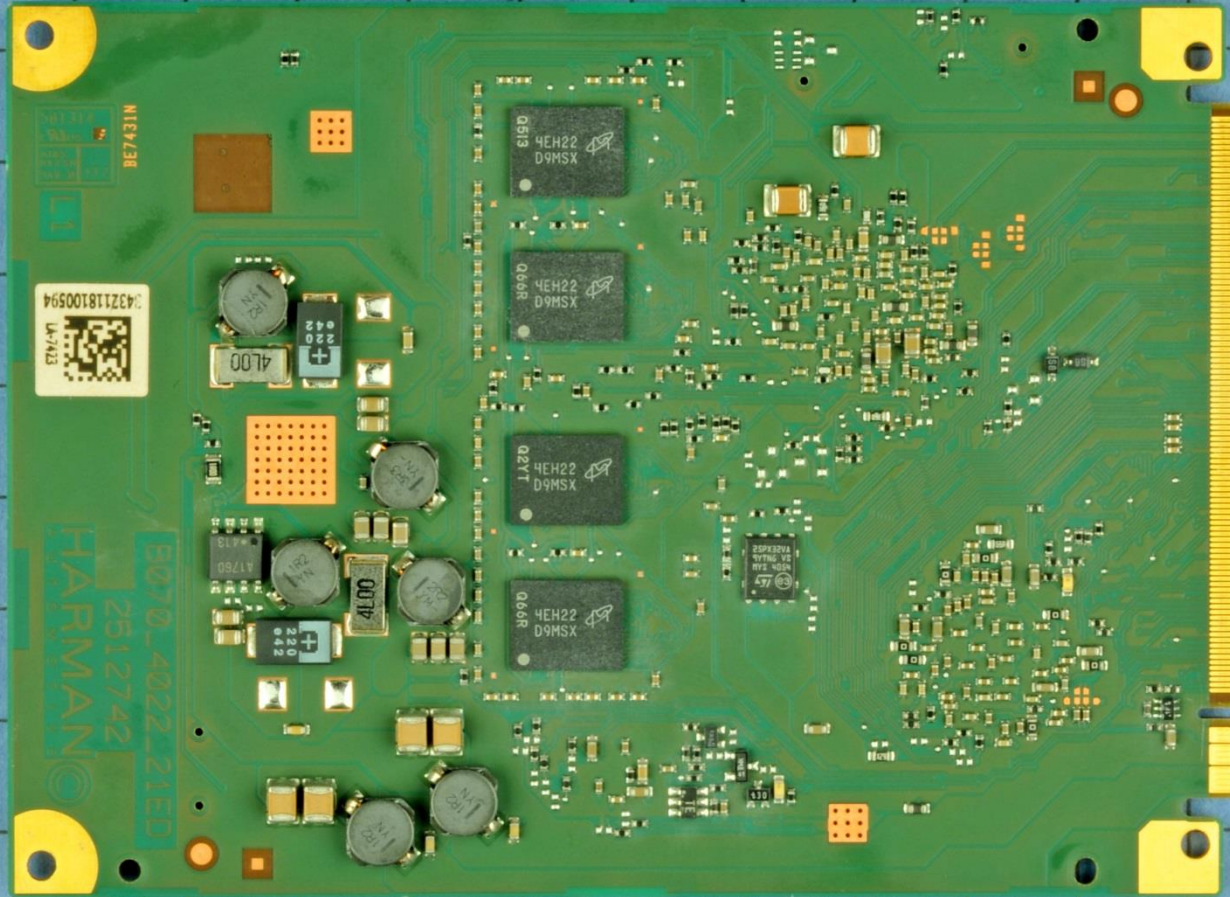


77.1 - Micron
#L73A
MLC NAND Flash
Memory - 4 GB
Die Size: 10.3 x 8.8 mm

77.2 - Micron
#PS8200
Memory Controller
Die Size: 4.7 x 1.8 mm

77 - Micron
#MTFC8GLUDM-AIT
Multichip Memory - 8 GB MLC NAND Flash,
Memory Controller (eMMC) (3-Die Pkg.)
Pkg Size: 13 x 11.5 mm

Daughter Board (Side 2)

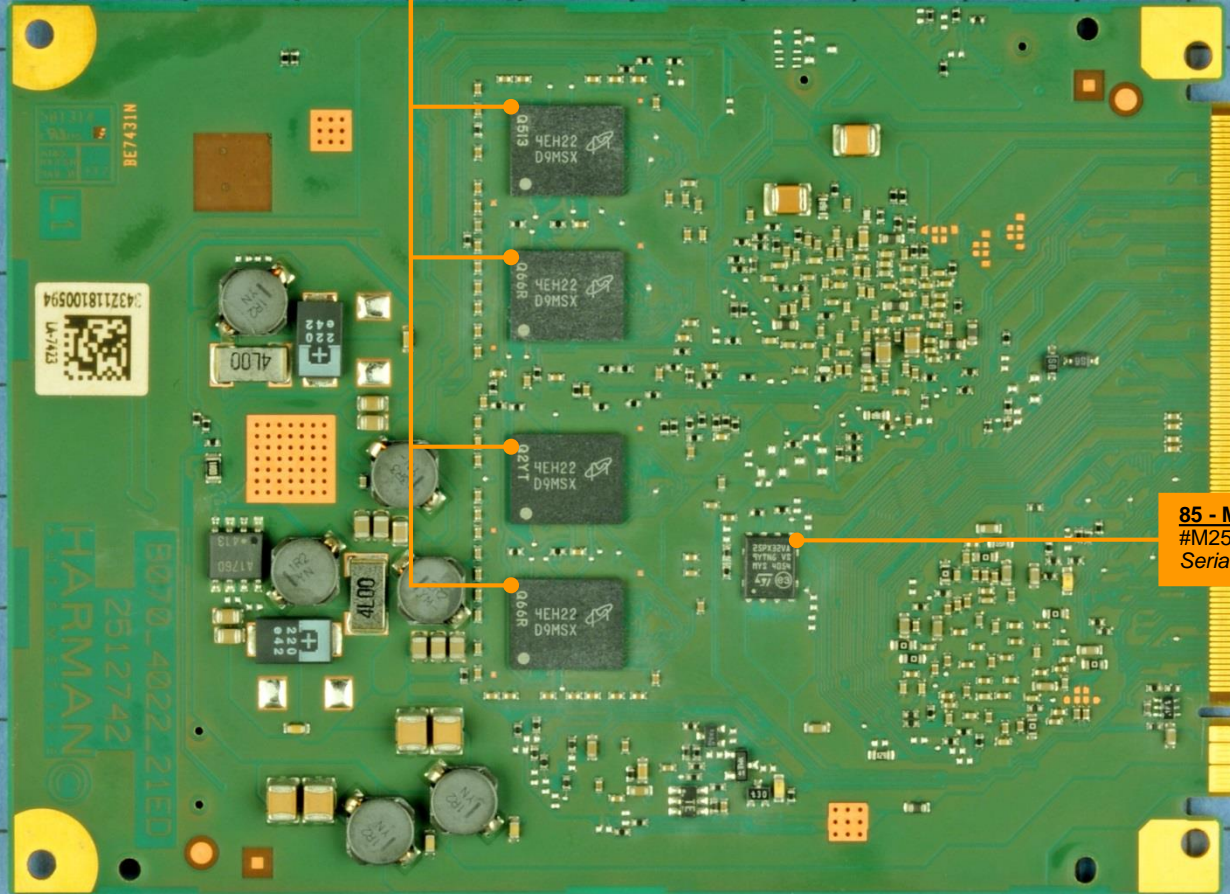


Grid = 1 cm

Daughter Board (Side 2 IC Identification)



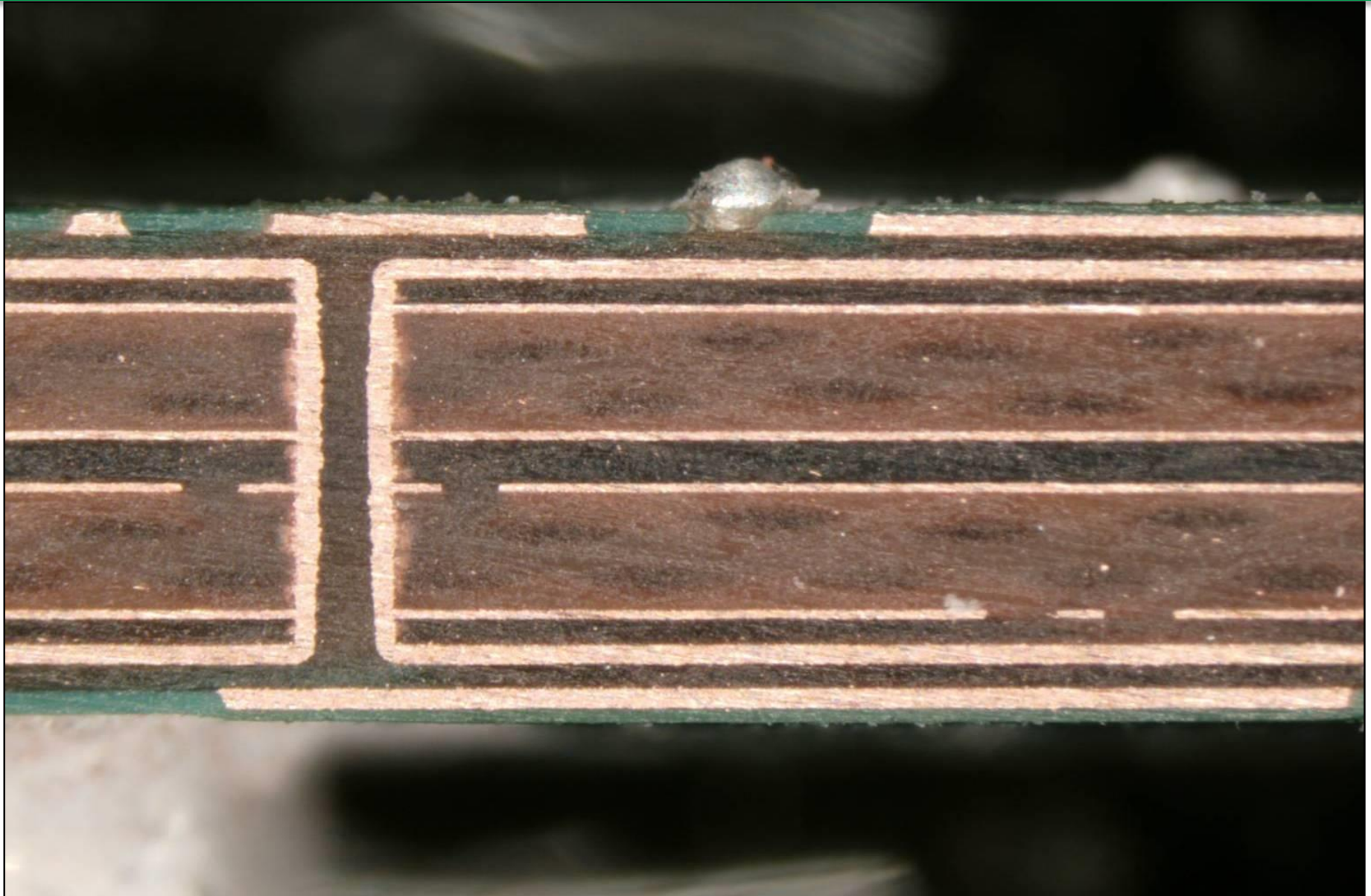
84 - Micron
#MT47H128M8CF-25E AIT:H
DDR2 SDRAM Memory - 128 MB



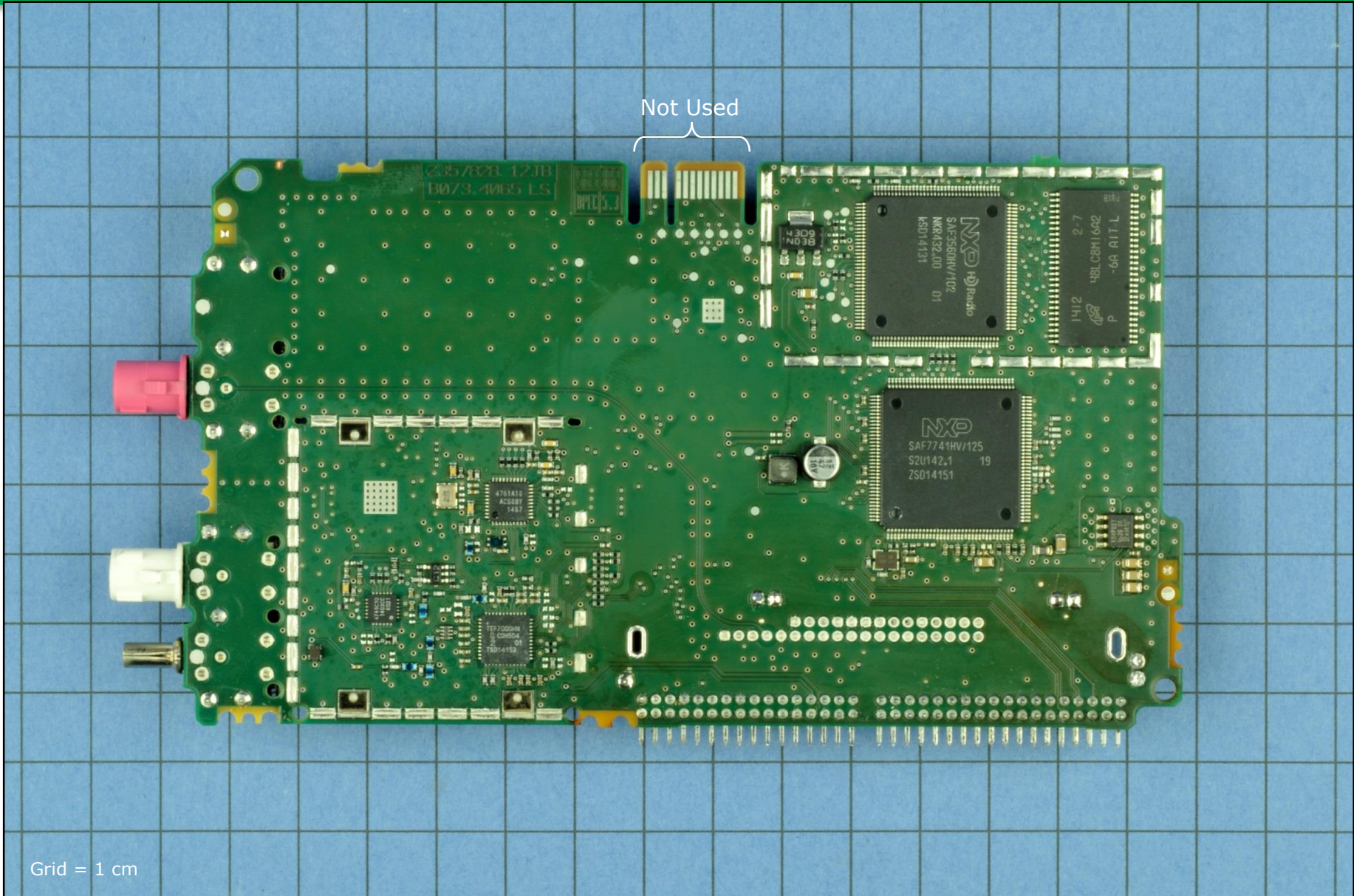
85 - Micron
#M25PX32-VMP6FBA
Serial NOR Flash Memory - 4 MB

Grid = 1 cm

Daughter Board (Cross-Section)

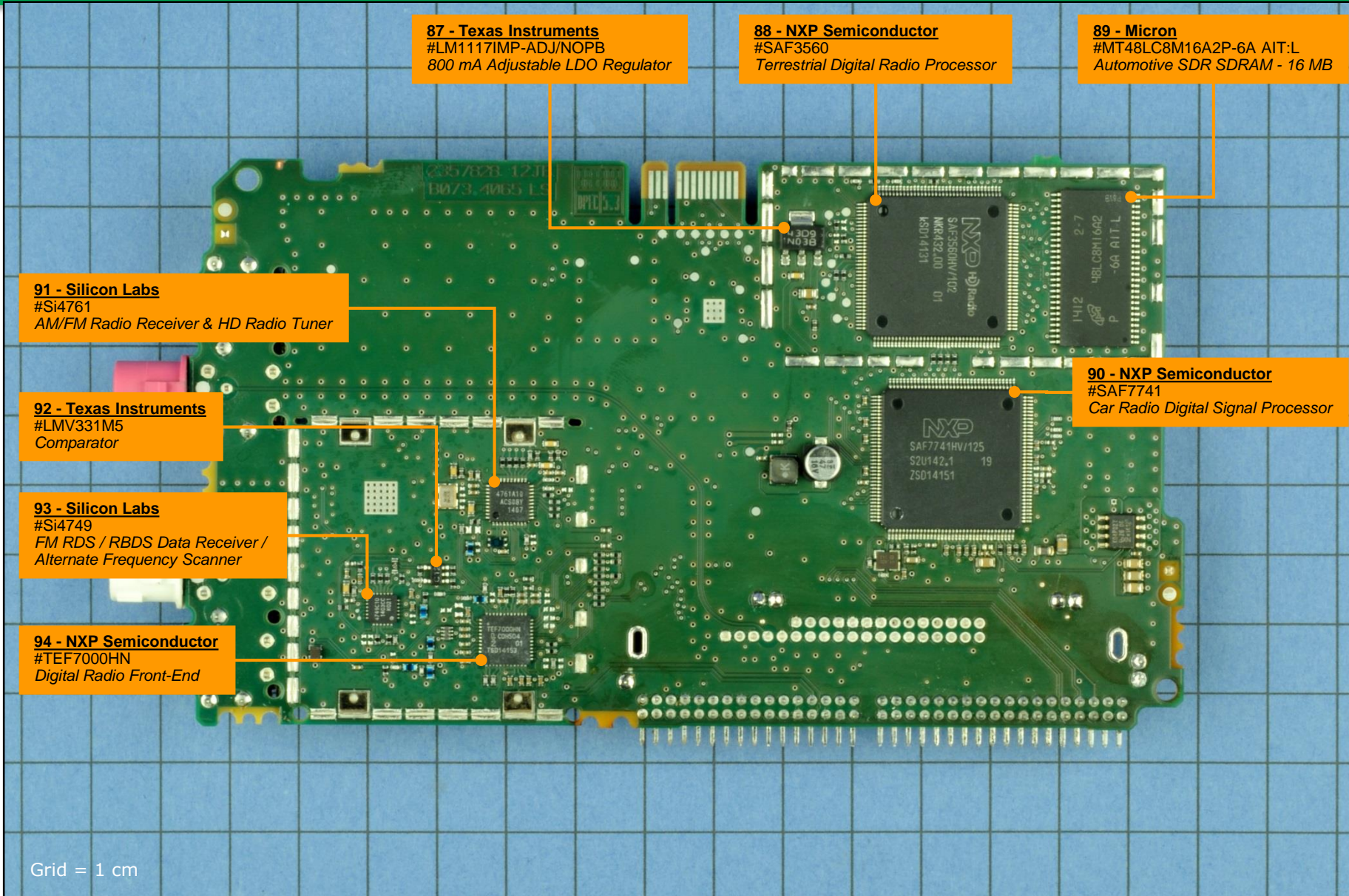


Radio Board (Side 1)



Grid = 1 cm

Radio Board (Side 1 IC Identification)



87 - Texas Instruments
#LM1117IMP-ADJ/NOPB
800 mA Adjustable LDO Regulator

88 - NXP Semiconductor
#SAF3560
Terrestrial Digital Radio Processor

89 - Micron
#MT48LC8M16A2P-6A AIT:L
Automotive SDR SDRAM - 16 MB

91 - Silicon Labs
#Si4761
AM/FM Radio Receiver & HD Radio Tuner

92 - Texas Instruments
#LMV331M5
Comparator

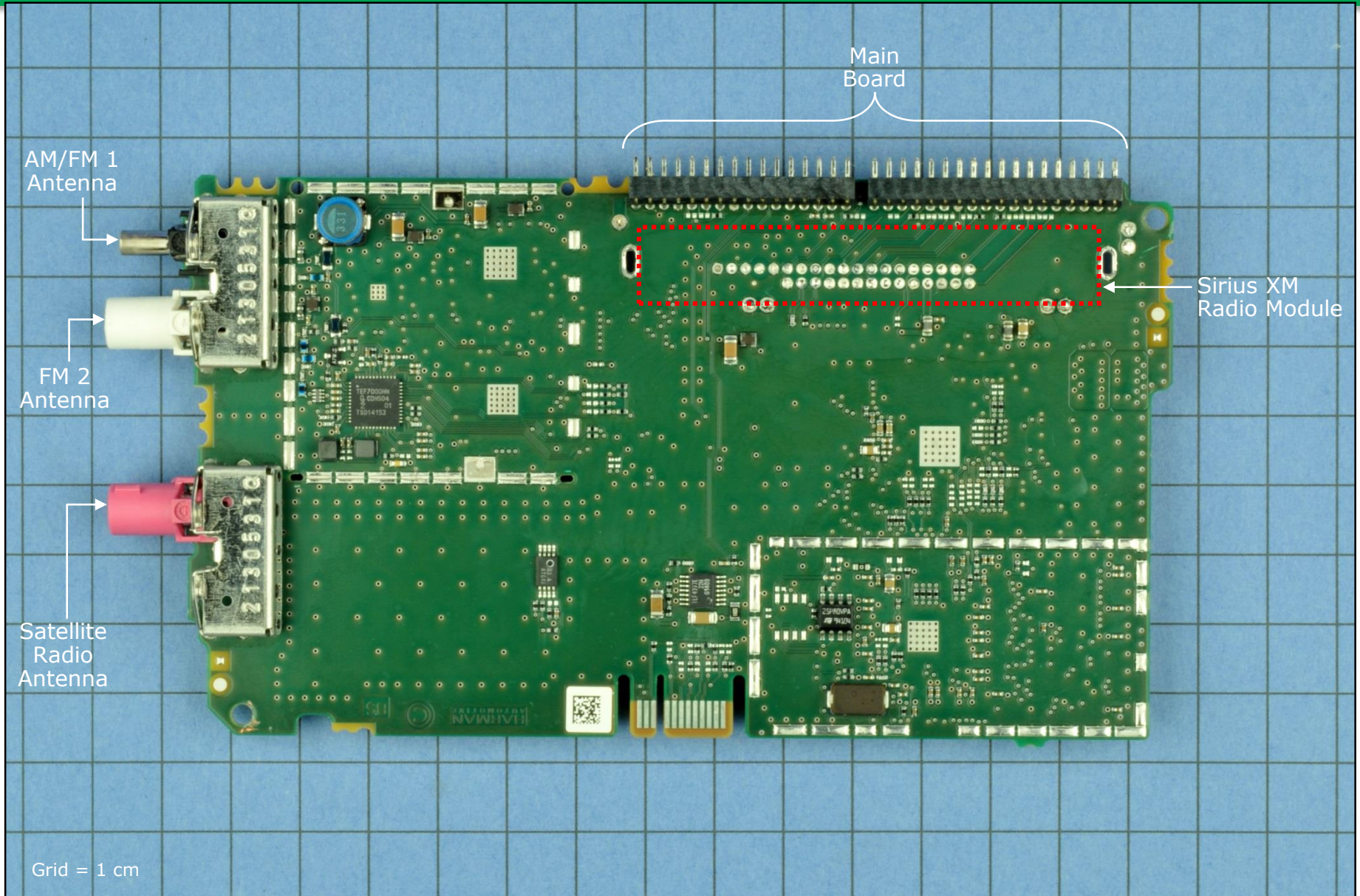
93 - Silicon Labs
#Si4749
FM RDS / RBDS Data Receiver /
Alternate Frequency Scanner

94 - NXP Semiconductor
#TEF7000HN
Digital Radio Front-End

90 - NXP Semiconductor
#SAF7741
Car Radio Digital Signal Processor

Grid = 1 cm

Radio Board (Side 2)



AM/FM 1 Antenna

FM 2 Antenna

Satellite Radio Antenna

Main Board

Sirius XM Radio Module

Grid = 1 cm

Radio Board (Side 2 IC Identification)



95 - NXP Semiconductor
#TEF7000HN
Digital Radio Front-End

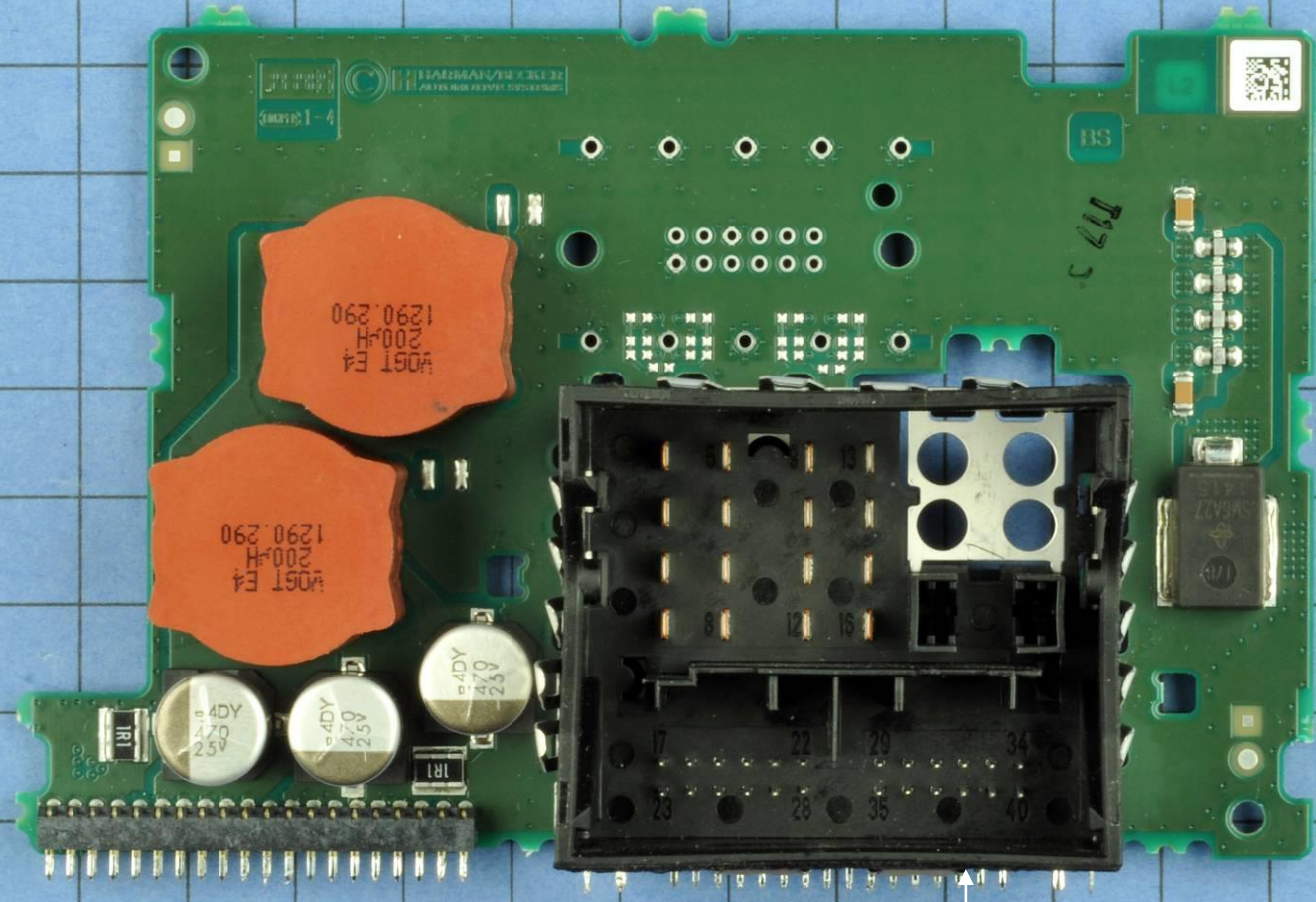
96 - Atmel
#AT24C64A-10TU
Serial EEPROM Memory - 8 KB

97 - Infineon
#TLF4277
200 mA LDO Regulator

98 - Micron
#M25P80
Serial NOR Flash Memory - 1 MB

Grid = 1 cm

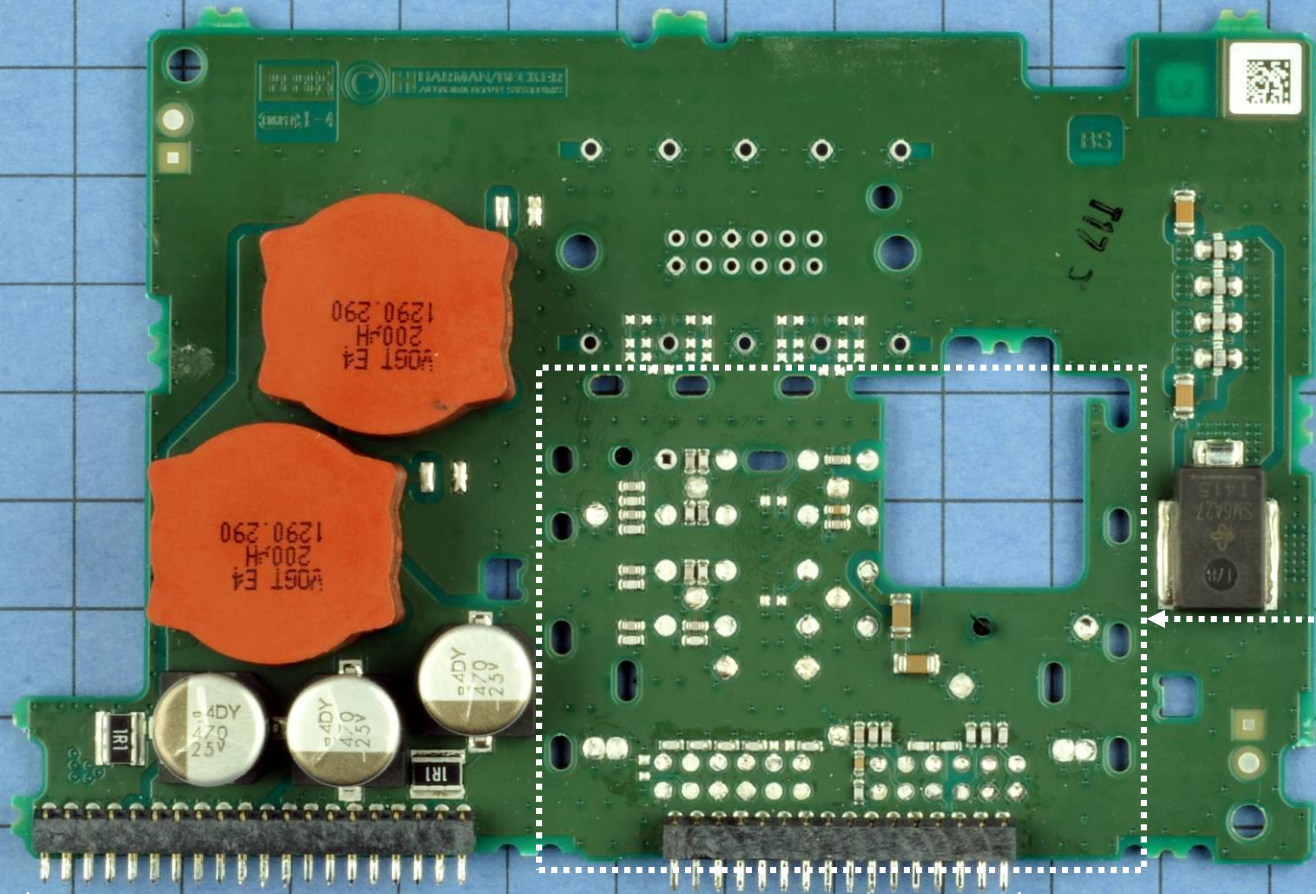
Power Board with Connector (Side 1)



Grid = 1 cm

To Vehicle Wiring Harness

Power Board (Side 1)

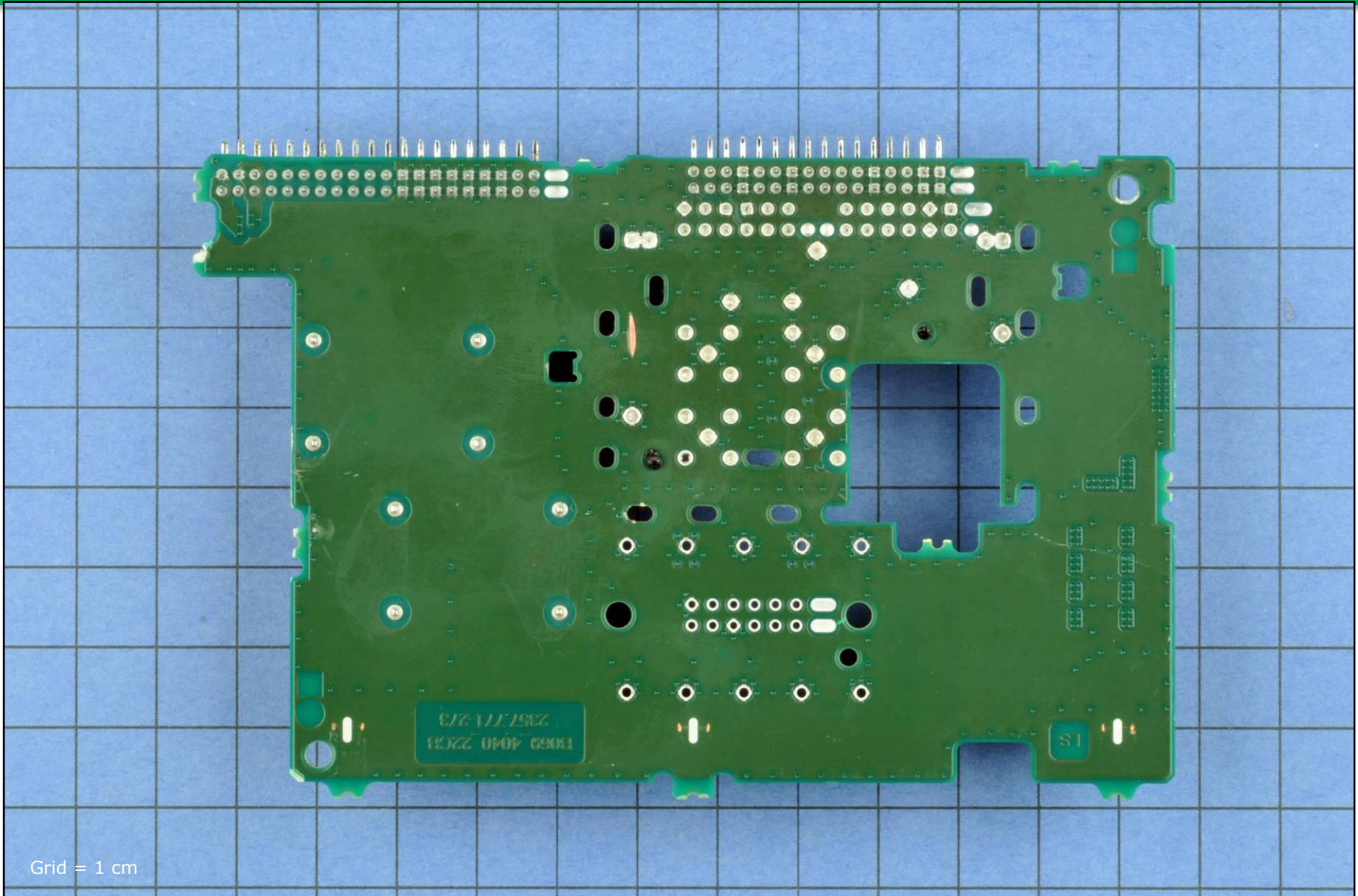


Vehicle Wiring
Harness
Connector
removed

Main Board

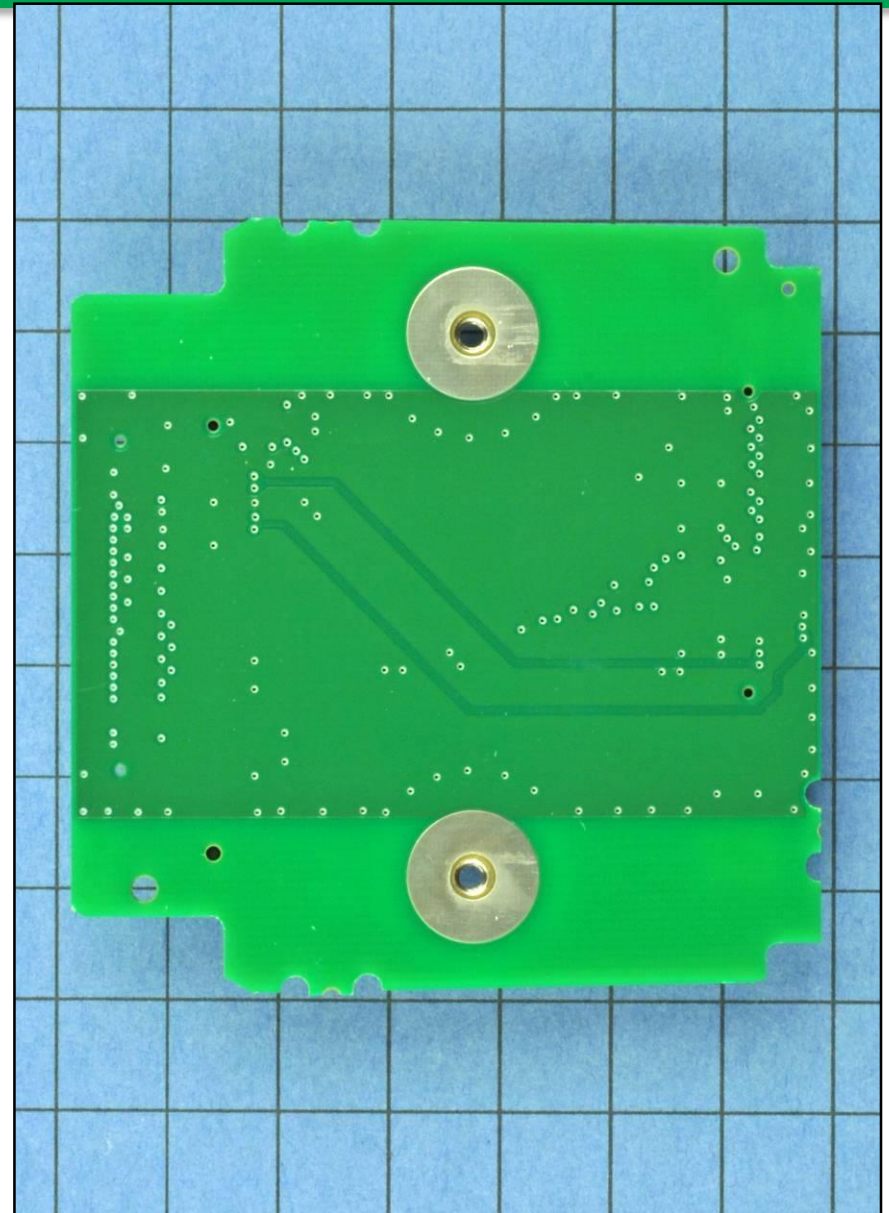
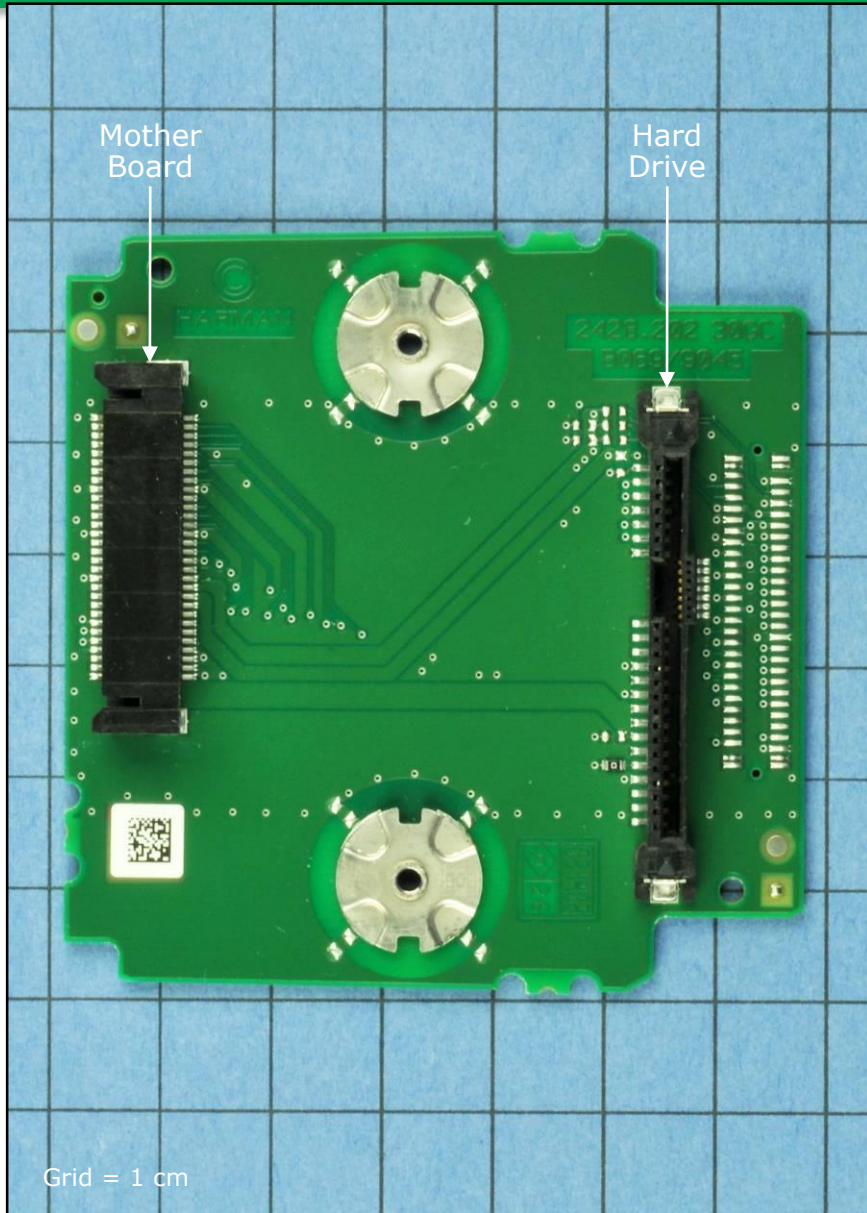
Grid = 1 cm

Power Board (Side 2)



Grid = 1 cm

Interconnect Board



Substrate Data

Substrates

Assembly Name	Manufacturer	Core Material	Mfg. Technology	Layers	Area (cm ²)	Min. Trace Pitch (mm)	Min. Trace Width (mm)	ThruVia Land Dia (mm)	ThruVia Hole Dia (mm)	BlindVia Land Dia (mm)	BlindVia Hole Dia (mm)	Thickness (mm)	Routing Density	Estimated Costs
Daughter Board	AT&S	FR4	8 Layer buildup FR4 / HF	8	87.1	0.25	0.10			0.30	0.05	1.3	39.5	\$ 5.21
Interconnect Board	CircuiTech P	FR4	4 Layer conventional FR4 / HF	4	41.1	0.20	0.10	0.60	0.45			1.4	19.3	\$ 0.76
Main Board	Compeq	FR4	6 Layer conventional FR4 / HF	6	223.0	0.20	0.10	0.60	0.25			1.4	21.6	\$ 3.57
Mother Board	AT&S	FR4	8 Layer conventional FR4 / HF	8	219.0	0.25	0.10	0.40	0.20			1.3	31.6	\$ 5.15
Power Board	Compeq	FR4	6 Layer conventional FR4 / HF	6	81.4	0.40	0.15	0.70	0.40			1.5	9.8	\$ 1.82
Radio Board	Denka	FR4	6 Layer conventional FR4 / HF	6	107.1	0.30	0.10	0.50	0.30			1.6	20.3	\$ 2.21

Integrated Circuit Components



MUNRO
& ASSOCIATES, INC.

Location	Package Info										Die Info						Estimated Costs			
	Pkg Ref. #	Pkg Qty	Brand Name	Part Number	Pkg Description	Form	Pin Count	Length (mm)	Width (mm)	Height (mm)	Die Ref #	Die Qty	Brand Name	Part Number	Description	Length (mm)	Width (mm)	Each	Total	
Main Board, Side 1	1	1	NXP Semiconductor	TD48579	Differential Line Receiver	SOP	8	4.90	3.90	1.60	1.1	1	NXP Semiconductor	TD48579	Differential Line Receiver	2.10	1.80	\$ 0.253	\$ 0.253	
	2	1	AKM Semiconductor	AK4628A	Multichannel Audio CODEC	QFP	44	10.00	9.90	1.50	2.1	1	AKM Semiconductor	5616	Multichannel Audio CODEC	3.60	3.20	\$ 2.559	\$ 2.559	
	3	1	Analog Devices	ADV7180	SDTV Video Decoder	QFP	48	6.80	6.80	1.60	3.1	1	Analog Devices	TV718_D	SDTV Video Decoder	3.40	3.30	\$ 2.973	\$ 2.973	
	4	1	STMicroelectronics	TD47569BLVPD	4 x 50 W Audio Power Amplifier	SOP	36	15.90	11.20	3.40	4.1	1	STMicroelectronics	LK75AA	4 x 50 W Audio Power Amplifier	6.50	5.00	\$ 6.181	\$ 6.181	
	5	1	NXP Semiconductor	74LVC144PW	Hex Inverting Schmitt Trigger	SOP	14	5.00	4.40	1.10	5.1	1	NXP Semiconductor	C5181	Hex Inverting Schmitt Trigger	0.66	0.55	\$ 0.107	\$ 0.107	
	6	1	Atmel	ATtiny261	8-Bit Microcontroller w/ Flash	QFN	32	5.00	5.00	1.00	6.1	1	Atmel	AT35462	8-Bit Microcontroller w/ Flash	2.10	1.90	\$ 1.303	\$ 1.303	
	7	1	Texas Instruments	SN74LVC125APW	Quad Buffer	SOP	14	5.00	4.40	1.00	7.1	1	Texas Instruments	LVC125K	Quad Buffer	1.00	0.80	\$ 0.126	\$ 0.126	
	8	1	Avago	AFBR-1012S	Optical Transmitter	TO	4	7.10	5.60	2.70	9.1	1	Avago	M1293012	Optical Transmitter	1.50	1.00	\$ 0.775	\$ 0.775	
	9	1	Avago	AFBR-2012S	Optical Receiver	TO	4	7.10	5.60	2.70	9.1	1	Avago	M1384	Optical Receiver	1.70	1.00	\$ 0.808	\$ 0.808	
	10	1	Intersil	ISL78310	1 A LDO Regulator	DFN	10	3.00	3.00	1.00	10.1	1	Intersil	53698A01	1 A LDO Regulator	1.30	1.10	\$ 0.129	\$ 0.129	
	11	1	Atmel	ATmega169P	8-Bit Microcontroller w/ 16 KB Flash	QFP	64	13.80	13.80	1.10	11.1	1	Atmel	AT35504	8-Bit Microcontroller w/ 16 KB Flash	3.90	3.60	\$ 4.196	\$ 4.196	
	12	1	Micron	MT48LC16M16A2	SDR SDRAM Memory - 32 MB	TSOP	54	22.30	10.00	1.20	12.1	1	Micron	T36	SDR SDRAM Memory - 32 MB	5.40	3.20	\$ 2.054	\$ 2.054	
	13	3	Texas Instruments	SN74LVC1G08DCK	2-Input Positive-AND Gate	SOP	5	2.10	1.20	1.00	13.1	1	Texas Instruments	LD8E	2-Input Positive-AND Gate	0.50	0.50	\$ 0.042	\$ 0.127	
	15	1	Intersil	ISL78134RZ	3 A DC-DC Converter	QFN	16	4.00	4.00	1.00	15.1	1	Intersil	53699A01	3 A DC-DC Converter	2.00	2.00	\$ 0.294	\$ 0.294	
	16	1	NXP Semiconductor	TJA1041	CAN Transceiver	SOP	14	8.80	3.90	1.70	16.1	1	NXP Semiconductor	CF1142A	CAN Transceiver	3.20	1.90	\$ 1.211	\$ 1.211	
	17	1	Infineon	TLE4276DV	400 mA Adjustable LDO Regulator	TO	5	6.50	6.10	2.40	17.1	1	Infineon	TLE4276DV	400 mA Adjustable LDO Regulator	2.10	1.80	\$ 0.233	\$ 0.233	
	18	1	Texas Instruments	SN74HC4066PW	Quad Bilateral Switch	SOP	14	5.20	4.40	1.00	18.1	1	Texas Instruments	LC705E	Quad Bilateral Switch	0.90	0.90	\$ 0.127	\$ 0.127	
	19	1	Texas Instruments	SN74LVC1G08DCK	2-Input Positive-AND Gate	SOP	5	2.10	1.20	1.00	19.1	1	Texas Instruments	LD8E	2-Input Positive-AND Gate	0.50	0.50	\$ 0.042	\$ 0.042	
	20	1	Texas Instruments	SN74LVC2G125-Q1	Dual Bus Buffer	SOP	8	2.30	2.00	0.80	20.1	1	Texas Instruments	LG2125D	Dual Bus Buffer	0.80	0.60	\$ 0.072	\$ 0.072	
	21	1	NXP Semiconductor	74LVC1G14GW	Single Schmitt-Trigger Inverter	SOP	5	2.10	1.20	1.00	21.1	1	NXP Semiconductor	CP32	Single Schmitt-Trigger Inverter	0.40	0.30	\$ 0.037	\$ 0.037	
	24	1	Maxim	MAX483SETT18BD2+T	250 mA / 1.8 V LDO Regulator	DFN	6	3.00	3.00	0.80	24.1	1	Maxim	A524Z-S	250 mA / 1.8 V LDO Regulator	2.30	1.10	\$ 0.164	\$ 0.164	
	Main Board, Side 2	25	1	Spansion	S29GL512S10DHA02	NOR Flash Memory - 64 MB	BGA	64	9.00	9.00	1.00	25.1	1	Spansion	98290A	NOR Flash Memory - 64 MB	6.70	4.90	\$ 3.275	\$ 3.275
		26	1	Micron	MT48LC16M16A2	SDR SDRAM Memory - 32 MB	TSOP	54	22.30	10.00	1.20	26.1	1	Micron	T36	SDR SDRAM Memory - 32 MB	5.40	3.20	\$ 2.054	\$ 2.054
		27	1	Texas Instruments	SN74LVC125APW	Quad Buffer	SOP	14	5.00	4.40	1.00	27.1	1	Texas Instruments	LVC125K	Quad Buffer	1.00	0.80	\$ 0.126	\$ 0.126
28		1	NXP Semiconductor	74LVC08A	Quad 2-Input AND Gate	SOP	14	5.00	4.40	1.00	28.1	1	NXP Semiconductor	PS70D7	Quad 2-Input AND Gate	0.60	0.50	\$ 0.105	\$ 0.105	
29		1	Microchip	QS8100A0M	Intelligent Network Interface Controller	QFN	40	5.70	5.70	0.90	29.1	1	Microchip	QS8726D	Intelligent Network Interface Controller	2.90	2.50	\$ 1.793	\$ 1.793	
30		2	STMicroelectronics	L5973D	2 A DC-DC Converter	SOP	8	5.00	3.80	1.60	30.1	1	STMicroelectronics	CUD73E	2 A DC-DC Converter	2.70	1.90	\$ 0.292	\$ 0.585	
31		1	Maxim	MAX6414UK31	Microprocessor Reset Circuit	SOP	5	3.00	1.60	1.30	31.1	1	Maxim	M5602-Z	Microprocessor Reset Circuit	0.90	0.90	\$ 0.069	\$ 0.069	
32		1	Maxim	MAX3221EAE+	RS-232 Transceiver	SOP	16	6.10	5.10	1.90	32.1	1	Maxim	R560V-1	RS-232 Transceiver	4.00	2.30	\$ 1.467	\$ 1.467	
33		1	Linear Technology	LTC3859	DC/DC Converter	QFN	38	7.00	5.00	0.80	33.1	1	Linear Technology	BF3859	DC/DC Converter	2.60	1.50	\$ 0.390	\$ 0.390	
34		1	Intersil	ISL78310	1 A LDO Regulator	DFN	10	3.00	3.00	1.00	34.1	1	Intersil	53698A01	1 A LDO Regulator	1.30	1.10	\$ 0.129	\$ 0.129	
35		1	AKM Semiconductor	AK5359	Stereo A/D Converter	TSOP	16	5.00	4.30	1.00	35.1	1	AKM Semiconductor	5841	Stereo A/D Converter	2.10	1.70	\$ 0.798	\$ 0.798	
36		2	Infineon	TLF4277	200 mA LDO Regulator	SOP	14	5.10	3.90	1.40	36.1	1	Infineon	TLF4277	200 mA LDO Regulator	2.50	2.10	\$ 0.324	\$ 0.648	
37		1	Texas Instruments	DR1443HSBZDU	Jacinto Automotive Applications Processor	BGA	352	23.00	23.00	1.90	37.1	1	Texas Instruments	F761977B	Automotive Applications Processor	7.00	6.80	\$ 29.371	\$ 29.371	
38		1	Texas Instruments	SN74LVC1G08DCK	2-Input Positive-AND Gate	SOP	5	2.10	1.20	1.00	38.1	1	Texas Instruments	LD8E	2-Input Positive-AND Gate	0.50	0.50	\$ 0.042	\$ 0.042	
41		1	Infineon	TLE4266	150 mA / 5 V LDO Regulator	SOP	4	6.40	3.40	1.60	41.1	1	Infineon	TLE4266	150 mA / 5 V LDO Regulator	1.60	1.30	\$ 0.333	\$ 0.333	
42		1	Analog Devices	ADA4851-2WYRMZ-R7	Operational Amplifier	SOP	8	2.90	2.90	1.00	42.1	1	Analog Devices	ADA4851_2R1	Operational Amplifier	1.10	0.80	\$ 0.093	\$ 0.093	

Note: Continued on next page...
Supplemental information, such as IC package & die markings, is included in the Excel Bill of Materials (BOM) spreadsheet.

Integrated Circuit Components

-Continued



Location	Package Info										Die Info								Estimated Costs	
	Pkg Ref. #	Pkg Qty	Brand Name	Part Number	Pkg Description	Form	Pin Count	Length (mm)	Width (mm)	Height (mm)	Die Ref #	Die Qty	Brand Name	Part Number	Description	Length (mm)	Width (mm)	Each	Total	
Mother Board, Side 1	43	2	Intersil	ISL78214ARZ	4 A DC-DC Converter	QFN	16	4.00	4.00	1.00	43.1	1	Intersil	ISL8012	4 A DC-DC Converter	2.00	2.00	\$ 0.300	\$ 0.600	
	44	2	Micron	MT47H64M16HR-25E AIT	DDR2 SDRAM Memory - 128 MB	BGA	84	12.60	8.00	1.00	44.1	1	Micron	MT47H64M16HR-25E AIT	DDR2 SDRAM Memory - 128 MB	7.50	5.50	\$ 2.413	\$ 4.827	
	45	1	Microchip	Z5LC080	EEPROM Memory - 1 KB	SOP	8	3.00	2.90	1.00	45.1	1	Microchip	H4 B00 B5 C5 B85	EEPROM Memory - 1 KB	1.70	1.30	\$ 0.312	\$ 0.312	
	46	1	Marvell Semiconductor	88W9688	Single-Chip Bluetooth 3.0 / WiFi 802.11a/b/g	BGA	152	10.00	6.00	0.74	46.1	1	Marvell Semiconductor	141E	Single-Chip Bluetooth 3.0 / WiFi 802.11a/b/g	8.10	4.00	\$ 7.809	\$ 7.809	
	47	1	Microsemi	LX5511	2.4 GHz WiFi Power Amplifier	QFN	16	3.00	3.00	1.00	47.1	1	Microsemi	LX5511	2.4 GHz WiFi Power Amplifier	0.93	0.64	\$ 0.198	\$ 0.198	
	48	1	Texas Instruments	LM2903D	Dual Comparator	SOP	8	5.00	3.90	1.50	48.1	1	Texas Instruments	TLM393B	Dual Comparator	0.80	0.70	\$ 0.082	\$ 0.082	
	49	1	Renesas	R5H30201D	Microcontroller	SOP	8	5.00	3.80	1.50	49.1	1	Renesas	R5H30201D	Microcontroller	2.50	2.40	\$ 1.027	\$ 1.027	
	50	1	UBlox	BX-G0010-DA	GPS Front-End	QFN	24	4.00	4.00	0.90	50.1	1	UBlox	G010	GPS Front-End	2.20	1.80	\$ 1.198	\$ 1.198	
	51	1	UBlox	UBX-G0000	GPS Baseband Processor	BGA	100	9.00	9.00	0.70	51.1	1	UBlox	UBX-5100	GPS Baseband Processor	4.00	3.00	\$ 4.918	\$ 4.918	
	52	1	Micron	M29W400FT	NOR Flash Memory - 512 KB	BGA	48	8.00	6.00	0.80	52.1	1	Micron	P3JC	NOR Flash Memory - 512 KB	3.30	1.60	\$ 0.379	\$ 0.379	
	53	1	Micron	M25PX32-V2M8FBA	Serial NOR Flash Memory - 4 MB	BGA	24	8.00	6.00	0.80	53.1	1	Micron	M5JF1	Serial NOR Flash Memory - 4 MB	3.80	3.30	\$ 0.397	\$ 0.397	
	54	1	Xilinx	XA6SLX45T	Spartan-6 Automotive FPGA	BGA	484	23.00	23.00	2.30	54.1	1	Xilinx	X6933	Spartan-6 Automotive FPGA	7.50	7.20	\$ 31.790	\$ 31.790	
	55	1	Intersil	ISL78213ARZ	3 A DC-DC Converter	QFN	16	4.00	4.00	1.00	55.1	1	Intersil	S3608A01	3 A DC-DC Converter	2.00	2.00	\$ 0.294	\$ 0.294	
	56	2	Intersil	ISL78210	1 A LDO Regulator	DFN	10	3.00	3.00	1.00	56.1	1	Intersil	S3698A01	1 A LDO Regulator	1.30	1.10	\$ 0.129	\$ 0.257	
	57	1	STMicroelectronics	TL431A1VD	Programmable Voltage Reference	SOP	8	5.10	4.10	1.50	57.1	1	STMicroelectronics	COB 431	Programmable Voltage Reference	1.40	1.10	\$ 0.124	\$ 0.124	
	58	1	Maxim	MAX4835ETT18BD2+T	250 mA / 1.8 V LDO Regulator	DFN	6	3.00	3.00	0.80	58.1	1	Maxim	A524Z-S	250 mA / 1.8 V LDO Regulator	2.30	1.10	\$ 0.164	\$ 0.164	
	62	1	NXP Semiconductor	74LVC14APW	Hex Inverting Schmitt Trigger	SOP	14	5.00	4.40	0.90	62.1	1	NXP Semiconductor	C5181	Hex Inverting Schmitt Trigger	0.66	0.55	\$ 0.107	\$ 0.107	
	63	1	Texas Instruments	SN74LVC1G08DCK	2-Input Positive-AND Gate	SOP	5	2.10	1.20	1.00	63.1	1	Texas Instruments	LO8E	2-Input Positive-AND Gate	0.50	0.50	\$ 0.042	\$ 0.042	
Mother Board, Side 2	64	1	Skyworks	AS179	SPDT GaAs Switch	SOP	6	2.00	1.20	0.90	64.1	1	Skyworks	AS179	SPDT GaAs Switch	0.40	0.30	\$ 0.303	\$ 0.303	
	65	1	Inova Semiconductor	INAP375T	Automotive Pixel Link Transmitter	QFN	100	13.90	13.80	1.40	65.1	1	Inova Semiconductor	INAP375T	Automotive Pixel Link Transmitter	3.00	2.80	\$ 3.444	\$ 3.444	
	66	2	STMicroelectronics	L5973D	2 A DC-DC Converter	SOP	8	5.00	3.90	1.60	66.1	1	STMicroelectronics	QUD70E	2 A DC-DC Converter	2.70	1.90	\$ 0.292	\$ 0.585	
	67	1	NVIDIA	EM99 (G-98)	Graphics Processor	BGA	969	29.10	29.10	3.00	67.1	1	NVIDIA	G-98	Graphics Processor	9.60	9.10	\$ 30.753	\$ 30.753	
	68	2	Micron	MT47H64M16HR-25E AIT	DDR2 SDRAM Memory - 128 MB	BGA	84	12.60	8.00	1.00	68.1	1	Micron	MT47H64M16HR-25E AIT	DDR2 SDRAM Memory - 128 MB	7.50	5.50	\$ 2.413	\$ 4.827	
	69	1	Maxim	MAX6649	Temperature Sensor	SOP	8	3.00	3.00	0.90	69.1	1	Maxim	TS47K-2	Temperature Sensor	2.10	1.50	\$ 0.590	\$ 0.590	
	70	1	Intersil	ISL78210	DC-DC Converter	QFN	16	2.60	1.80	0.60	70.1	1	Intersil	ISL78210	DC-DC Converter	2.00	1.20	\$ 0.191	\$ 0.191	
	71	2	Texas Instruments	SN74LVC1G08DCK	2-Input Positive-AND Gate	SOP	5	2.10	1.20	1.00	71.1	1	Texas Instruments	LO8E	2-Input Positive-AND Gate	0.50	0.50	\$ 0.042	\$ 0.085	
	72	1	Maxim	MAX8517	1 A LDO Regulator	TSOP	10	3.00	3.00	1.00	72.1	1	Maxim	PM63Y	1 A LDO Regulator	1.60	1.50	\$ 0.175	\$ 0.175	
	73	1	Texas Instruments	SN74CBTD3384PW	Bus Switch	SOP	24	7.90	4.40	1.00	73.1	1	Texas Instruments	CBTD3384D	Bus Switch	1.90	1.50	\$ 0.277	\$ 0.277	
	74	6	Unknown	E8 ?	ESD Protection ?	DFN	4	1.20	0.80	0.40	74.1	1	Unknown	E8 ?	ESD Protection ?	0.20	0.20	\$ 0.046	\$ 0.246	
	75	1	Unknown	HSA ?	EMI Filter ?	DFN	10	2.60	1.10	0.50	75.1	1	Unknown	HSA ?	EMI Filter ?	0.70	0.50	\$ 0.065	\$ 0.065	
Daughter Board, Side 1	76	4	Micron	MT47H128M8CF-25E AIT-H	DDR2 SDRAM Memory - 128 MB	BGA	60	10.00	8.00	0.90	76.1	1	Micron	MT47H128M8CF-25E AIT-H	DDR2 SDRAM Memory - 128 MB	7.50	5.40	\$ 1.189	\$ 4.758	
	77	1	Micron	MTFC8GLDGM-AIT Z	Multichip Memory - 8 GB MLC NAND Flash, Mer	BGA Stacked 2+1	153	13.00	11.50	0.90	77.1	2	Micron	L73A	MLC NAND Flash Memory - 4 GB	10.30	8.80	\$ 5.971	\$ 11.942	
	78	1	Micrel	KS28041NL	Ethernet Transceiver	BGA	32	5.00	5.00	0.90	78.1	1	Micrel	KS8041	Ethernet Transceiver	1.60	1.40	\$ 0.763	\$ 0.763	
	79	1	STMicroelectronics	STA2X11	I/O Controller Hub	BGA	361	16.00	16.00	1.30	79.1	1	STMicroelectronics	V710CA	I/O Controller Hub	5.30	5.20	\$ 10.607	\$ 10.607	
	80	1	Intel	E660T	1.30 GHz Atom Processor	BGA	676	22.00	22.00	2.30	80.1	1	Intel	BPTOCB	1.30 GHz Atom Processor	12.80	7.50	\$ 38.532	\$ 38.532	
	81	1	Rohm	BU7336MMV	Clock Generator	QFN	64	8.00	8.00	1.00	81.1	1	Rohm	PC505	Clock Generator	3.20	3.10	\$ 2.328	\$ 2.328	
Daughter Board, Side 2	82	1	Texas Instruments	SN74LVC1G125DBV	Single Buffer	SOP	5	3.00	1.70	1.20	82.1	1	Texas Instruments	L125D	Single Buffer	0.50	0.50	\$ 0.048	\$ 0.048	
	83	1	Rohm	BD9592AMVW	Power Management	QFN	88	10.00	10.00	1.00	83.1	1	Rohm	VZ422	Power Management	5.80	5.80	\$ 6.613	\$ 6.613	
	84	4	Micron	MT47H128M8CF-25E AIT-H	DDR2 SDRAM Memory - 128 MB	BGA	60	10.00	8.00	0.90	84.1	1	Micron	MT47H128M8CF-25E AIT-H	DDR2 SDRAM Memory - 128 MB	7.50	5.40	\$ 1.189	\$ 4.758	
	85	1	Micron	M25PX32-VMP6FBA	Serial NOR Flash Memory - 4 MB	QFN	8	5.90	5.00	0.90	85.1	1	Micron	M5JF1	Serial NOR Flash Memory - 4 MB	3.80	3.30	\$ 0.354	\$ 0.354	
Radio Board, Side 1	87	1	Texas Instruments	LM1117MP-ADJ/NOBP	800 mA Adjustable LDO Regulator	SOP	4	6.50	3.60	1.60	87.1	1	Texas Instruments	UK6	800 mA Adjustable LDO Regulator	2.00	1.20	\$ 0.150	\$ 0.150	
	88	1	NXP Semiconductor	SAF3560	Terrestrial Digital Radio Processor	QFN	144	19.90	19.80	1.50	88.1	1	NXP Semiconductor	TV123181C	Terrestrial Digital Radio Processor	3.60	3.60	\$ 8.645	\$ 8.645	
	89	1	Micron	MT48LCM16A2P-6A AIT-L	Automotive SDR SDRAM - 16 MB	SOP	54	22.30	10.10	1.00	89.1	1	Micron	T55A	Automotive SDR SDRAM - 16 MB	5.40	3.20	\$ 2.058	\$ 2.058	
	90	1	NXP Semiconductor	SAF7741	Car Radio Digital Signal Processor	QFN	144	19.90	19.90	1.50	90.1	1	NXP Semiconductor	UV0073501F	Car Radio Digital Signal Processor	5.10	5.00	\$ 9.625	\$ 9.625	
	91	1	Silicon Labs	Si4761	AM/FM Radio Receiver & HD Radio Tuner	QFN	40	6.00	6.00	0.90	91.1	1	Silicon Labs	Si4750AS	AM/FM Radio Receiver & HD Radio Tuner	2.90	2.70	\$ 1.973	\$ 1.973	
	92	1	Texas Instruments	LMV331MS	Comparator	SOP	5	3.00	1.60	1.00	92.1	1	Texas Instruments	LMV331	Comparator	0.40	0.40	\$ 0.043	\$ 0.043	
Radio Board, Side 2	93	1	Silicon Labs	Si4749	FM RDS / RBDs Data Receiver / Alternate Freq	QFN	24	4.00	4.00	0.90	93.1	1	Silicon Labs	Si4720	FM RDS / RBDs Data Receiver / Alternate Freq	2.00	1.80	\$ 1.118	\$ 1.118	
	94	1	NXP Semiconductor	TEF7000HN	Digital Radio Front-End	QFN	48	7.00	7.00	1.00	94.1	1	NXP Semiconductor	V0045501.F6	Digital Radio Front-End	3.60	3.40	\$ 3.319	\$ 3.319	
Totals	95	1	NXP Semiconductor	TEF7000HN	Digital Radio Front-End	QFN	48	7.00	7.00	1.00	95.1	1	NXP Semiconductor	V0045501.F6	Digital Radio Front-End	3.60	3.40	\$ 3.319	\$ 3.319	
	96	1	Atmel	AT24C64A-10TU	Serial EEPROM Memory - 8 KB	TSOP	8	4.50	3.00	0.90	96.1	1	Atmel	AT355	Serial EEPROM Memory - 8 KB	1.60	1.60	\$ 0.194	\$ 0.194	
	97	1	Infineon	TLF4277	200 mA LDO Regulator	SOP	14	5.10	3.90	1.40	97.1	1	Infineon	TLF4277	200 mA LDO Regulator	2.50	2.10	\$ 0.324	\$ 0.324	
	98	1	Micron	M25P80	Serial NOR Flash Memory - 1 MB	SOP	8	5.00	3.80	1.50	98.1	1	Micron	M3JB1	Serial NOR Flash Memory - 1 MB	3.40	1.50	\$ 0.175	\$ 0.175	
Totals		110					6014				112								\$273.32	

Note: Supplemental information, such as IC package & die markings, is included in the Excel Bill of Materials (BOM) spreadsheet.

Subsystem IC Components



Note: The ICs listed below are for reference only.
Their costs are integrated into the cost of the individual subsystems.

Location	Package Info										Die Info						Estimated Costs		
	Pkg Ref. #	Pkg Qty	Brand Name	Part Number	Pkg Description	Form	Pin Count	Length (mm)	Width (mm)	Height (mm)	Die Ref #	Die Qty	Brand Name	Part Number	Description	Length (mm)	Width (mm)	Each	Total
Sirius XM Radio Module: Sirius XM Radio Board	99	1	STMicroelectronics	STA210N3A	Satellite Radio Tuner	QFN	68	9.60	9.60	0.90	99.1	1	STMicroelectronics	A195AA	Satellite Radio Tuner	5.30	3.30	\$ 5.484	\$ 5.484
	100	1	Spansion	S29GL032N90BF104	NOR Flash Memory - 4 MB	BGA	48	8.20	8.20	0.90	100.1	1	Spansion	98M68B	NOR Flash Memory - 4 MB	4.60	3.40	\$ 1.446	\$ 1.446
	101	1	STMicroelectronics	STA280BB	Baseband Processor	BGA	289	15.00	15.00	1.10	101.1	1	STMicroelectronics	V587B	Baseband Processor	5.70	5.10	\$ 12.024	\$ 12.024
	102	1	ISSI	IS46LR16320B-6BLA1	DDR SDRAM Memory - 64 MB	BGA	60	10.00	8.00	0.60	102.1	1	ISSI	K056MP1F	DDR SDRAM Memory - 64 MB	8.30	6.60	\$ 3.316	\$ 3.316
	103	1	Texas Instruments	SN74LVC1G17	Single Schmitt-Trigger Buffer	SOP	5	1.90	1.20	0.90	103.1	1	Texas Instruments	L17D	Single Schmitt-Trigger Buffer	0.50	0.50	\$ 0.042	\$ 0.042
	104	1	Texas Instruments	LP3907	Dual DC/DC & Dual Linear Regulator	QFN	24	4.00	4.00	0.80	104.1	1	Texas Instruments	320C	Dual DC/DC & Dual Linear Regulator	2.50	2.50	\$ 1.230	\$ 1.230
	105	1	Texas Instruments	LMC7101Q-Q1	Operational Amplifier	SOP	5	3.00	1.60	1.00	105.1	1	Texas Instruments	LM7101C	Operational Amplifier	1.10	0.90	\$ 0.078	\$ 0.078
Totals		7					499					7							\$23.62

Note: Supplemental information, such as IC package & die markings, is included in the Excel Bill of Materials (BOM) spreadsheet.

Modular Components



MUNRO
& ASSOCIATES, INC.

Location	Qty	Brand Name	Part Number	Description	Package			Estimated Costs	
					Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	NDK	NX5032GA	Crystal: Ceramic - 28.636 NDK	2	5.00	3.20	\$ 0.200	\$ 0.200
	1	Delta Electronics	AUB0412HD	Fan: Large - Heat Sink	3	40.00	40.00	\$ 2.530	\$ 2.530
	1	Unknown	7534/1809131 C	Shielding: Large - Main Connector	4	51.30	41.00	\$ 0.040	\$ 0.040
	1	NDK	NX8045GB	Crystal: Ceramic - 24.000 NDK	2	8.00	4.50	\$ 0.200	\$ 0.200
	1	Pulse	HX1188NL	Transformer: Transformer - LAN	16	12.70	6.80	\$ 2.000	\$ 2.000
Main Board, Side 2	1	NDK	NX8045GB	Crystal: Ceramic - 16.934 NDK	2	8.00	4.50	\$ 0.200	\$ 0.200
	1	TDK-EPC	B82789C513N2	Transformer: CAN	4	5.00	3.70	\$ 0.500	\$ 0.500
Radio Board, Side 1	1	Unknown	Unknown	Shielding: Large - Digital Radio FE	1	43.00	42.30	\$ 0.040	\$ 0.040
	1	NDK	Unknown	Crystal: Ceramic - 36.400 NDK	4	3.20	2.50	\$ 0.200	\$ 0.200
	1	NDK	Unknown	Crystal: Ceramic - 41.600 NDK	4	3.20	2.50	\$ 0.200	\$ 0.200
Radio Board, Side 2	1	NDK	Unknown	Crystal: Ceramic - 28.224 NDK	2	7.90	4.50	\$ 0.200	\$ 0.200
	2	Unknown	Unknown	Shielding / Bracket - Antenna Connectors	1	25.00	11.50	\$ 0.020	\$ 0.040
	1	Unknown	Unknown	Shielding: Large - Digital Radio FE	1	43.00	42.30	\$ 0.040	\$ 0.040
Mother Board, Side 1	1	Unknown	A3ZPL	Crystal: Ceramic - A3ZPL	2	3.20	1.50	\$ 0.200	\$ 0.200
	1	NDK	Unknown	Crystal: Ceramic - T10.000 NDK	4	5.00	3.20	\$ 0.200	\$ 0.200
	1	NDK	Unknown	Crystal: Ceramic - 27.000 NDK	4	3.20	2.50	\$ 0.200	\$ 0.200
	1	NDK	Unknown	Crystal: Ceramic - 26.000 NDK	4	3.20	2.50	\$ 0.200	\$ 0.200
	1	Unknown	26000 K343YS	Crystal: Ceramic - 26000	4	3.20	2.50	\$ 0.200	\$ 0.200
	1	Murata	XNCHH	Oscillator: TCXO	6	2.50	2.00	\$ 0.620	\$ 0.620
Mother Board, Side 2	1	NDK	Unknown	Crystal: Ceramic - T66.000 NDK	4	5.00	3.20	\$ 0.200	\$ 0.200
Daughter Board, Side 1	1	NDK	Unknown	Crystal: Ceramic - 25.000 NDK	4	2.50	2.00	\$ 0.200	\$ 0.200
Daughter Board, Side 2	2	Unknown	4L00	Crystal: Metal	2	6.40	3.00	\$ 0.170	\$ 0.340
TOTALS	24				83				\$8.75

Active Discrete Components



MUNRO
& ASSOCIATES, INC.

Location	Qty	Functional Description	Package					Estimated Costs	
			Form	Top Marking	Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	2	Small Active	MOSFET - Si4453	4453 AB W43B	8	4.90	3.90	\$0.500	\$1.000
	7	Small Active	Transistor, Small - 3N WUUs	3N WUUs	6	2.10	1.20	\$0.030	\$0.209
	2	Small Active	MOSFET - SQJ848	QJ848 CK W42M	4	4.80	4.30	\$0.360	\$0.720
	4	Small Active	Diode, SMT	S6	2	1.67	1.37	\$0.015	\$0.060
	1	Small Active	Diode, SMT - Y	Y	2	1.60	1.10	\$0.015	\$0.015
	7	Small Active	Transistor, Small	1GW 3d, A COKS, 1 KS 42, 5CW 41	3	2.90	1.30	\$0.030	\$0.209
	7	Small Active	Transistor, Small	38 WNS, 39 A4S, t08, t06	3	2.00	1.20	\$0.030	\$0.209
	1	Small Active	Transistor, Small - TE	TE	6	2.90	1.50	\$0.030	\$0.030
	1	Small Active	Transistor, Small - 3S WNs	3S WNs	6	2.10	1.20	\$0.030	\$0.030
	5	Small Active	Transistor, Small - Dt3	Dt3	6	2.10	1.20	\$0.030	\$0.150
	1	Small Active	MOSFET - uPA1816	A1816 412	8	4.40	3.00	\$0.260	\$0.260
Main Board, Side 2	5	Small Active	Transistor, Small - Dt3	Dt3	6	2.10	1.20	\$0.030	\$0.150
	2	Small Active	Diode, SMT	EO S4	2	2.80	1.80	\$0.015	\$0.030
	8	Small Active	MOSFET - SQJ848	QJ848 BF W41M	4	4.80	4.30	\$0.360	\$2.880
	1	Small Active	MOSFET - SQ4401EY	Q4401E AT W43B	8	4.90	3.90	\$0.500	\$0.500
	4	Small Active	Transistor, Small	t06, 1Gt, t30, 39 A4 s	3	2.00	1.20	\$0.030	\$0.120
	15	Small Active	Transistor, Small	8P T, 1GW 3d, A7W 3d, t16 3d, 21 Z12 V3, tAN 3o	3	2.90	1.30	\$0.030	\$0.449
	3	Small Active	Diode, SMT	BK W39, HU AN	2	2.50	1.50	\$0.015	\$0.045
	6	Small Active	Diode, SMT	S6, 44, L2	2	1.67	1.37	\$0.015	\$0.089
	1	Small Active	Transistor, Large	AM W41	4	4.40	2.40	\$0.150	\$0.150
	1	Small Active	Transistor, Small - BC847BS	1Ft	6	2.10	1.20	\$0.030	\$0.030
	1	Small Active	Transistor, Large - FZT651	FZT 651	4	6.50	3.50	\$0.180	\$0.180
	2	Small Active	Transistor, Small - 3N WUUs	3N WUUs	6	2.10	1.20	\$0.030	\$0.060
	2	Small Active	Transistor, Small - TF	TF	6	2.90	1.50	\$0.030	\$0.060
	Radio Board, Side 1	1	Small Active	MOSFET - PHK04P02T	K04P02T NXP 26 06 n1412	8	5.00	4.14	\$0.180
Radio Board, Side 2	1	Small Active	Transistor, Small	A7W 3d	3	2.90	1.30	\$0.030	\$0.030
Power Board, Side 1	4	Small Active	Diode, SMT - MELF	None	2	3.34	1.71	\$0.030	\$0.120
	1	Small Active	TVS Diode, SMT - SM6A27	SM6A27 1405	2	13.30	8.40	\$1.410	\$1.410
Mother Board, Side 1	1	Small Active	MOSFET - Si4453	4453 AR W39B	8	5.00	4.00	\$0.500	\$0.500
	2	Small Active	Diode, SMT - SSC54	S54 44	2	6.80	5.90	\$0.170	\$0.340
	2	Small Active	Transistor, Small - TE, TF	TE, TF	6	2.90	1.50	\$0.030	\$0.060
	8	Small Active	Transistor, Small	M8W 3d, A7W 3d, 1GW 3d, WOs 36	3	2.90	1.30	\$0.030	\$0.239
	1	Small Active	Diode, SMT - MELF	None	2	3.10	1.50	\$0.030	\$0.030
Mother Board, Side 2	2	Small Active	MOSFET - SQ4840	Q4840 AJ W39B	8	5.00	3.80	\$0.090	\$0.180
	1	Small Active	MOSFET - uPA1816	A1816 351	8	4.40	3.00	\$0.090	\$0.090
	7	Small Active	Transistor, Small	t30, t06, 13t	3	2.10	1.20	\$0.030	\$0.209
	1	Small Active	Transistor, Small	TF	6	2.90	1.50	\$0.030	\$0.030
	2	Small Active	Diode, SMT - SSC54	S54 44	2	6.80	5.90	\$0.170	\$0.340
	2	Small Active	Transistor, Small - Ht9	Ht9	6	2.10	1.20	\$0.030	\$0.060
	2	Small Active	Transistor, Small - 3Ft	3Ft	6	2.10	1.20	\$0.030	\$0.060
	2	Small Active	Transistor, Small - Dt3	Dt3	6	2.10	1.20	\$0.030	\$0.060
	5	Small Active	Transistor, Small	1GW 3d, M8W 3d	3	2.90	1.30	\$0.030	\$0.150
Daughter Board, Side 1	1	Small Active	MOSFET - uPA1760	A1760 344	8	5.00	4.30	\$0.090	\$0.090
	3	Small Active	Diode, SMT	S6	2	1.67	1.37	\$0.015	\$0.045
Daughter Board, Side 2	1	Small Active	Transistor, Small - BC847BS	1Ft	6	2.10	1.20	\$0.090	\$0.090
	2	Small Active	Diode, SMT	S6	2	1.67	1.37	\$0.015	\$0.030
	1	Small Active	Transistor, Small	XM5 3N	3	2.90	1.30	\$0.030	\$0.030
	2	Small Active	Transistor, Small	3N SWs, t30	3	2.10	1.20	\$0.030	\$0.060
	1	Small Active	Transistor, Small - TE	TE	6	2.90	1.50	\$0.030	\$0.030
	2	Small Active	LED, Single	None	2	1.20	0.80	\$0.050	\$0.100
	1	Small Active	MOSFET - uPA1760	A1760 344	8	5.00	4.30	\$0.090	\$0.090
TOTALS	148				583				\$12.28

Passive Discrete Components



Location	Qty	Functional Description	Package		Estimated Costs	
			Form	Pin Count	Each	Total
Main Board, Side 1	1	Capacitor	Poly Small SM	2	\$0.070	\$0.070
	6	Capacitor	Electrolytic, Medium - 47uF	2	\$0.040	\$0.240
	8	Capacitor	Electrolytic, Large - 470uF	2	\$0.130	\$1.040
	1	Coil	SMT, Large - 2ROML M3N2	3	\$0.580	\$0.580
	2	Coil	SMT, Small - M3D2	2	\$0.290	\$0.580
	1	Coil	SMT, Large - 200uH	4	\$0.900	\$0.900
	2	Coil	SMT, Large - Shielded	2	\$0.400	\$0.800
	1	Coil	SMT, Small - Shielded	2	\$0.360	\$0.360
	1	Coil	SMT, Small - 1uH	2	\$0.250	\$0.250
	2	Capacitor	Tantalum / Niobium, Large	2	\$0.150	\$0.300
	490	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$1.960
Main Board, Side 2	1	Coil	SMT, Small	2	\$0.050	\$0.050
	459	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$1.836
	4	Coil	SMT, Small	2	\$0.250	\$1.000
Radio Board, Side 1	159	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.636
	1	Capacitor	Electrolytic, Medium - 47uF	2	\$0.040	\$0.040
	6	Small Passive	Coil, Inductor	2	\$0.008	\$0.048
	3	Coil	SMT, Small	2	\$0.050	\$0.150
	1	Small Passive	Ferrite Array	8	\$0.007	\$0.007
Radio Board, Side 2	9	Coil	SMT, Small	2	\$0.250	\$2.250
	204	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.816
	1	Small Passive	Ferrite Array	8	\$0.007	\$0.007
	4	Small Passive	Coil, Inductor	2	\$0.008	\$0.032
Power Board, Side 1	39	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.156
	3	Capacitor	Electrolytic, Large - 470uF	2	\$0.130	\$0.390
	2	Coil	SMT, Large - 200uH	4	\$0.900	\$1.800
	2	Small Passive	Resistor - 1R1	2	\$0.004	\$0.008
Mother Board, Side 1	3	Coil	SMT, Large - 1.5uH	2	\$0.400	\$1.200
	2	Filter	Ceramic, Small	6	\$0.065	\$0.130
	8	Small Passive	Coil, Inductor	2	\$0.008	\$0.064
	6	Coil	SMT, Small	2	\$0.250	\$1.500
	1	Coil	SMT, Small - M3D2	2	\$0.290	\$0.290
	3	Capacitor	Electrolytic, Medium	2	\$0.040	\$0.120
510	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$2.040	
Mother Board, Side 2	3	Capacitor	Tantalum / Niobium, Small	2	\$0.050	\$0.150
	3	Coil	SMT, Small	2	\$0.250	\$0.750
	2	Small Passive	Coil, Inductor	2	\$0.008	\$0.016
	1	Filter	Ceramic, Small	2	\$0.065	\$0.065
	395	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$1.580
Daughter Board, Side 1	318	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$1.272
	2	Coil	SMT, Small - 1R2 YL	2	\$0.250	\$0.500
Daughter Board, Side 2	382	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$1.528
	2	Capacitor	Tantalum / Niobium, Small	2	\$0.050	\$0.100
	6	Coil	SMT, Small	2	\$0.250	\$1.500
Interconnect Board, Side 1	1	Small Passive	Resistor	2	\$0.004	\$0.004
TOTALS	3061			6149		\$29.12

Connectors



MUNRO
& ASSOCIATES, INC.

Location	Qty	Form	Package			Estimated Costs	
			Pin Count	Length (mm)	Width (mm)	Each	Total
Interconnect Board, Side 1	1	Bd to Bd: Female - Hard Drive	29	45.70	5.50	\$1.530	\$1.530
	2	Connector: Threaded Insert, Gnd	1	13.20	13.20	\$0.020	\$0.040
	1	Bd to Bd: Male - Mother Brd	60	31.50	6.20	\$1.730	\$1.730
Main Board, Side 1	1	Bd to Bd: Male - Heat Sink Fan	3	9.90	5.00	\$0.060	\$0.060
Main Board, Side 2	1	Bd to Bd: Male - Mother Board16	16	23.80	9.80	\$1.190	\$1.190
	1	Bd to Bd: Female - Mother Board120	120	35.00	7.50	\$2.100	\$2.100
Mother Board, Side 1	1	Connector: Accessory - APIX	6	27.40	14.10	\$1.240	\$1.240
	2	Connector: Gnd Pin / Standoff	1	12.50	8.10	\$0.140	\$0.280
	1	Bd to Bd: Male - Main120	120	35.00	7.50	\$2.100	\$2.100
	1	Bd to Bd: Female - Main16	16	23.80	9.80	\$1.190	\$1.190
	1	Bd to Bd: Male - Interconnect	60	33.10	7.80	\$1.730	\$1.730
	3	Connector: USB - USB1 - 3	4	32.90	11.00	\$1.140	\$3.420
	3	Connector: Antenna Coax - BT, WLAN, GPS	1	24.00	9.50	\$1.140	\$3.420
Mother Board, Side 2	1	Connector: Edge - Daughter Brd	230	75.80	10.70	\$4.890	\$4.890
Power Board, Side 1	1	Connector: Vehicle Wiring Harness	40	49.70	43.00	\$2.450	\$2.450
	1	Bd to Bd: Male - Header, Main32	32	32.20	4.20	\$0.460	\$0.460
	1	Bd to Bd: Male - Header, Main40	40	38.50	4.20	\$0.910	\$0.910
Radio Board, Side 2	1	Bd to Bd: Male - Header, Main36	36	36.00	4.60	\$0.460	\$0.460
	1	Bd to Bd: Male - Header, Main32	32	32.30	4.60	\$0.460	\$0.460
	3	Connector: Antenna Coax - AM/FM1, FM2, Sat Radio	1	27.00	8.90	\$1.140	\$3.420
TOTALS	28		862				\$33.08

Electronic Assembly Metrics



Electronic Assembly Metrics by Assembly											
General Area	Assembly Name	Substrate Area (sq.cm)	Metal Layers	Circuit Area (sq.cm)	Routing Density (cm of routing per sq.cm of substrate)	Number of Components	Number of Connections	Component Density (Components/sq.cm)	Connection Density (Connections/sq.cm)	Avg. Pin Count	Assembly Weight (grams)
Main Electronics	Daughter Board	87.1	8	696.8	39.5	743	3346	8.5	38.4	4.5	43.00
Main Electronics	Interconnect Board	41.1	4	164.4	19.3	5	93	0.1	2.3	18.6	19.80
Main Electronics	Main Board	223.0	6	1338.0	21.6	1119	3592	5.0	16.1	3.2	262.60
Main Electronics	Mother Board	219.0	8	1752.0	31.6	1036	5017	4.7	22.9	4.8	173.10
Main Electronics	Power Board	81.4	6	488.4	9.8	54	218	0.7	2.7	4.0	115.80
Main Electronics	Radio Board	107.1	6	642.6	20.3	414	1425	3.9	13.3	3.4	152.10
Main Electronics Totals		758.7	38	5082.2		3371	13691	4.4	18.0	4.1	766.40
Subsystem Electronics	Sirius XM Radio Module: Sirius XM Radio Board	25.9	8	207.2	40.9	279	1158	10.8	44.7	4.2	41.50
Subsystem Electronics Totals		25.9	8	207.2		279	1158	10.8	44.7	4.2	41.50
System Totals		784.6	46	5289.4		3650	14849	4.7	18.9	4.1	807.90

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Electronics Costs by Assembly										
General Area	Assembly Name	Total	Integrated Circuits	Modular & Odd Form Components	Small Active Components	Passive Components	Connector Components	Substrates	Insertion	Card Test
Main Electronics	Daughter Board	\$ 99.45	\$ 82.37	\$ 0.54	\$ 0.56	\$ 4.90	\$ -	\$ 5.21	\$ 3.89	\$ 1.98
Main Electronics	Interconnect Board	\$ 4.50	\$ -	\$ -	\$ -	\$ 0.00	\$ 3.30	\$ 0.76	\$ 0.05	\$ 0.38
Main Electronics	Main Board	\$ 102.68	\$ 64.85	\$ 5.67	\$ 7.63	\$ 9.97	\$ 3.35	\$ 3.57	\$ 5.86	\$ 1.79
Main Electronics	Mother Board	\$ 138.75	\$ 95.16	\$ 1.82	\$ 2.35	\$ 7.90	\$ 18.27	\$ 5.15	\$ 5.54	\$ 2.57
Main Electronics	Power Board	\$ 10.74	\$ -	\$ -	\$ 1.53	\$ 2.35	\$ 3.82	\$ 1.82	\$ 0.31	\$ 0.91
Main Electronics	Radio Board	\$ 45.77	\$ 30.94	\$ 0.72	\$ 0.21	\$ 3.99	\$ 4.34	\$ 2.21	\$ 2.25	\$ 1.11
Main Electronics Totals		\$ 401.89	\$ 273.32	\$ 8.75	\$ 12.28	\$ 29.12	\$ 33.08	\$ 18.72	\$ 17.89	\$ 8.74
Subsystem Electronics	Hard Drive	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Subsystem Electronics	Sirius XM Radio Module	\$ 33.49	\$ 23.62	\$ 5.43	\$ 0.21	\$ 1.26	\$ 0.19	\$ 0.95	\$ 1.49	\$ 0.35
Subsystem Electronics Totals		\$ 33.49	\$ 23.62	\$ 5.43	\$ 0.21	\$ 1.26	\$ 0.19	\$ 0.95	\$ 1.49	\$ 0.35
	System Totals	\$ 435.39	\$ 296.93	\$ 14.18	\$ 12.49	\$ 30.38	\$ 33.26	\$ 19.67	\$ 19.38	\$ 9.09

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



MUNRO
& ASSOCIATES, INC.

Counts by Assembly													
General Area	Assembly Name	IC Package Count	IC Connections	Modular/Odd Form Components	Modular/Odd Form Component Connections	Small Active Components	Small Active Component Connections	Passive Components	Passive Component Connections	Connectors	Connector Connections	Subsystem IOs	Opportunities
Main Electronics	Daughter Board	16	1867	3	8	14	51	710	1420	0	0	0	4089
Main Electronics	Interconnect Board	0	0	0	0	0	0	1	2	4	91	0	98
Main Electronics	Main Board	41	1104	7	33	89	355	979	1961	3	139	0	4711
Main Electronics	Mother Board	41	2502	7	28	38	156	937	1882	13	449	0	6053
Main Electronics	Power Board	0	0	0	0	5	10	46	96	3	112	0	272
Main Electronics	Radio Board	12	541	7	14	2	11	388	788	5	71	0	1839
Main Electronics Totals		110	6014	24	83	148	583	3061	6149	28	862	0	17062
Subsystem Electronics	Hard Drive	0	0	0	0	0	0	0	0	0	0	26	26
Subsystem Electronics	Sirius XM Radio Module	7	499	6	52	12	26	253	548	1	33	33	1470
Subsystem Electronics Totals		7	499	6	52	12	26	253	548	1	33	59	1496
	System Totals	117	6513	30	135	160	609	3314	6697	29	895	59	18558

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



MUNRO
& ASSOCIATES, INC.

IC Metrics											
General Area	Assembly Name	IC Die Count	IC Package Count	Number of Package Connections	Die Area (sq. mm)	Substrate Tiling Density (die area / substrate area)	Package Area (sq. mm)	Die Area/Package Area Ratio	Package Connections per sq. cm of Package Area	Volatlie Memory (KBytes)	Non-Volatile Memory (KBytes)
Main Electronics	Daughter Board	18	16	1867	695.9	0.08	1753.1	0.40	106.5	1048576	8392704
Main Electronics	Main Board	41	41	1104	267.9	0.01	2173.8	0.12	50.8	65536	65536
Main Electronics	Mother Board	41	41	2502	432.1	0.02	2512.0	0.17	99.6	524288	4609
Main Electronics	Radio Board	12	12	541	107.1	0.01	1245.9	0.09	43.4	16384	1032
Main Electronics Totals		112	110	6014	1503.0		7684.7	0.20	78.3	1654784	8463881
Subsystems	Sirius XM Radio Module	7	7	499	124.5		471.1	0.26	1.1	65536	4096
Subsystem Electronics Totals		7	7	499	124.5		471.1	0.26	105.9	65536	4096
System Totals		119	117	6513	1627.5		8155.8	0.20	79.9	1720320	8467977

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

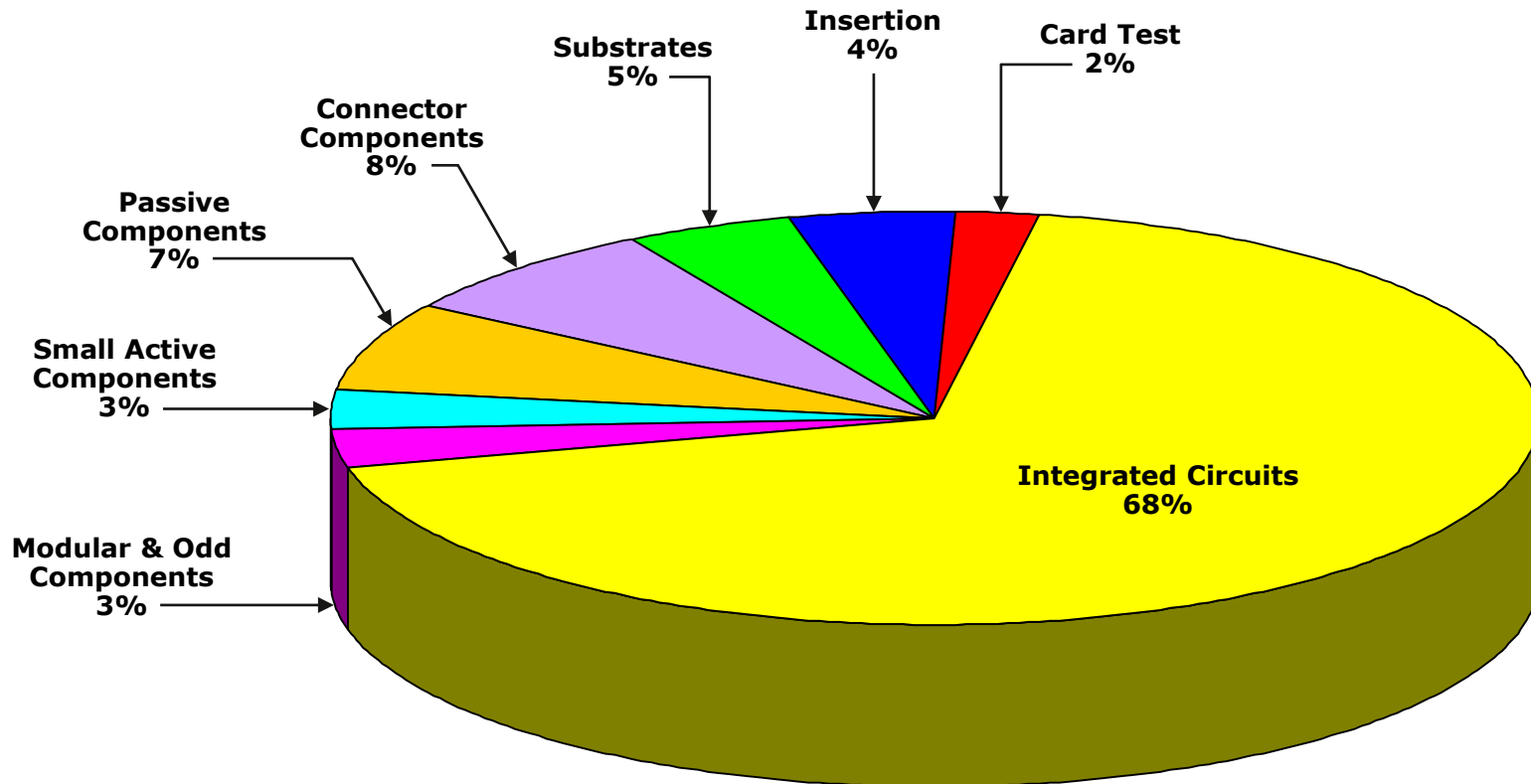
Electronic Costs Breakdown



Estimated Cost of Electronics

(Includes XM Radio Subsystem Electronics, but not Hard Drive)

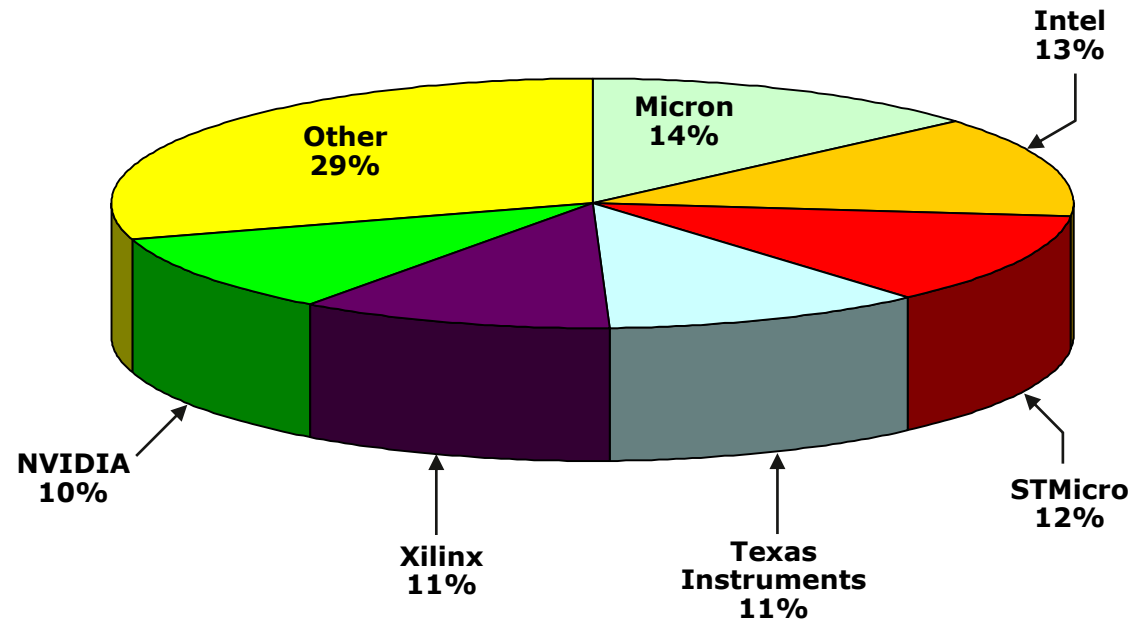
\$435.39



Vendor IC Cost Distribution

Pkg. Brand	Cost
Micron	\$40.25
Intel	\$38.53
STMicroelectronics	\$35.59
Texas Instruments	\$32.11
Xilinx	\$31.79
NVIDIA	\$30.75
Other	
NXP Semiconductor	\$26.73
Rohm	\$8.94
Marvell Semiconductor	\$7.81
Atmel	\$5.69
UBlox	\$5.22
Spansion	\$4.72
Inova Semiconductor	\$3.44
AKM Semiconductor	\$3.36
ISSI	\$3.32
Silicon Labs	\$3.09
Analog Devices	\$3.07

* Includes Subsystem Vendors & Associated Costs



Non-Electronic Cost Estimate



MUNRO
& ASSOCIATES, INC.

Subsystem	Part ID No.	Qty	Description	Fabrication Process	Material	Dimensions (mm)	Weight (grams)	Est'd Cost Each	Est'd Extended Cost	
Heat Sink	15	1	Housing, Heat Sink / Fan	Molded	PA 66 = Polyamide	116.3 x 103.2 x 35.9	19.40	1.440	1.440	
	16	1	Enclosure, Fan	Molded	Rubber	44.8 x 42.7 x 22.1	5.60	0.170	0.170	
	17	1	Heat Sink	Extruded + Cut	Aluminum	44.7 x 43 x 25.1	58.20	2.070	2.070	
	18	1	Clip, Heat Sink	Stamped + Formed	Steel	21.7 x 15 x 10.4	2.20	0.090	0.090	
	19	1	Compound, Heat Sink			x	1.00	0.030	0.030	
Housing	1	1	Housing, Main	Cast + Machined + Tapped	AZ91D = Magnesium Alloy	229 x 157 x 98	397.20	28.090	28.090	
	2	1	Housing, Lower	Cast + Tapped	AZ91D = Magnesium Alloy	180 x 143 x 33	205.90	10.850	10.850	
	3	1	Housing, Cover	Cast	AZ91D = Magnesium Alloy	153.7 x 142.7 x 27.8	102.90	6.030	6.030	
	4	1	Bracket, Hard Drive	Stamped + Formed	Steel	101.4 x 94.9 x 16.8	60.40	1.740	1.740	
	6	1	Bracket, Main Connector	Stamped + Formed	Steel	96.6 x 75.6 x 12.5	21.90	0.920	0.920	
	7	1	Bracket, Antenna Connectors	Stamped + Formed	Steel	96.6 x 30.7 x 8.3	6.60	0.290	0.290	
	8	1	Bracket, Power Board	Stamped + Formed + Tapped	Steel	109.9 x 82 x 21.4	70.40	2.070	2.070	
	9	1	Bracket, Sirius / XM Module	Stamped + Formed	Steel	74.1 x 43.8 x 27.1	27.50	1.080	1.080	
	10	1	Bracket, Fiber Optic Cable	Stamped + Formed	Steel	25 x 6.2 x 9.3	1.40	0.060	0.060	
	11	1	Guide, Fiber Optic Cable	Molded	Plastic	23.3 x 9 x 8.4	0.50	0.020	0.020	
	12	1	Retainer, Fiber Optic Cable	Stamped + Formed	Steel	22.9 x 11.1 x 8	0.70	0.040	0.040	
	13	1	Retainer, FB Cable @ Main Connector	Stamped + Formed	Steel	16.6 x 11 x 3.6	0.30	0.030	0.030	
	14	1	Guide, FB Cable	Molded	Rubber	12 x 10.8 x 9.2	0.40	0.020	0.020	
	Misc	20	12	Thermal Pads	Die-Cut	Silicon	x	0.00	0.040	0.480
21		2	Slide	Molded	Plastic	24.7 x 11.3 x 5.9	1.40	0.020	0.040	
22		1	Strain Relief	Molded	POM	33.8 x 30 x 18.1	3.30	0.120	0.120	
23		2	Fiber Optic Cables	Extruded + Coated	Glass	185 x 3.8 x 1.5	1.40	0.240	0.480	
24		1	Seal	Dispensed	Conductive Foam	x	1.50	0.080	0.080	
25		4	RTV	Dispensed	Silicon	x	4.00	0.010	0.040	
26		44	Screws	Extruded + Threaded	Steel	x	0.00	0.010	0.440	
27		1	Tape, Kapton	Die-Cut	Polyimide + Adhesive	23 x 13.2 x 0.05	0.01	0.020	0.020	
28		1	Label, Main	Die-Cut + Printed	Paper + Adhesive	130 x 110 x 0.07	1.10	0.260	0.260	
29		2	Label, Large	Die-Cut + Printed	Plastic + Adhesive	50.1 x 20.4 x 0.05	0.20	0.050	0.100	
30		10	Label, Small	Die-Cut + Printed	Plastic + Adhesive	x	0.00	0.020	0.200	
31		1	Tape, White	Die-Cut	Plastic + Adhesive	52 x 10.3 x 0.07	0.01	0.010	0.010	
Total		99					Estimated Cost		\$57.31	

Final Ass'y Labor & Test Cost Estimate

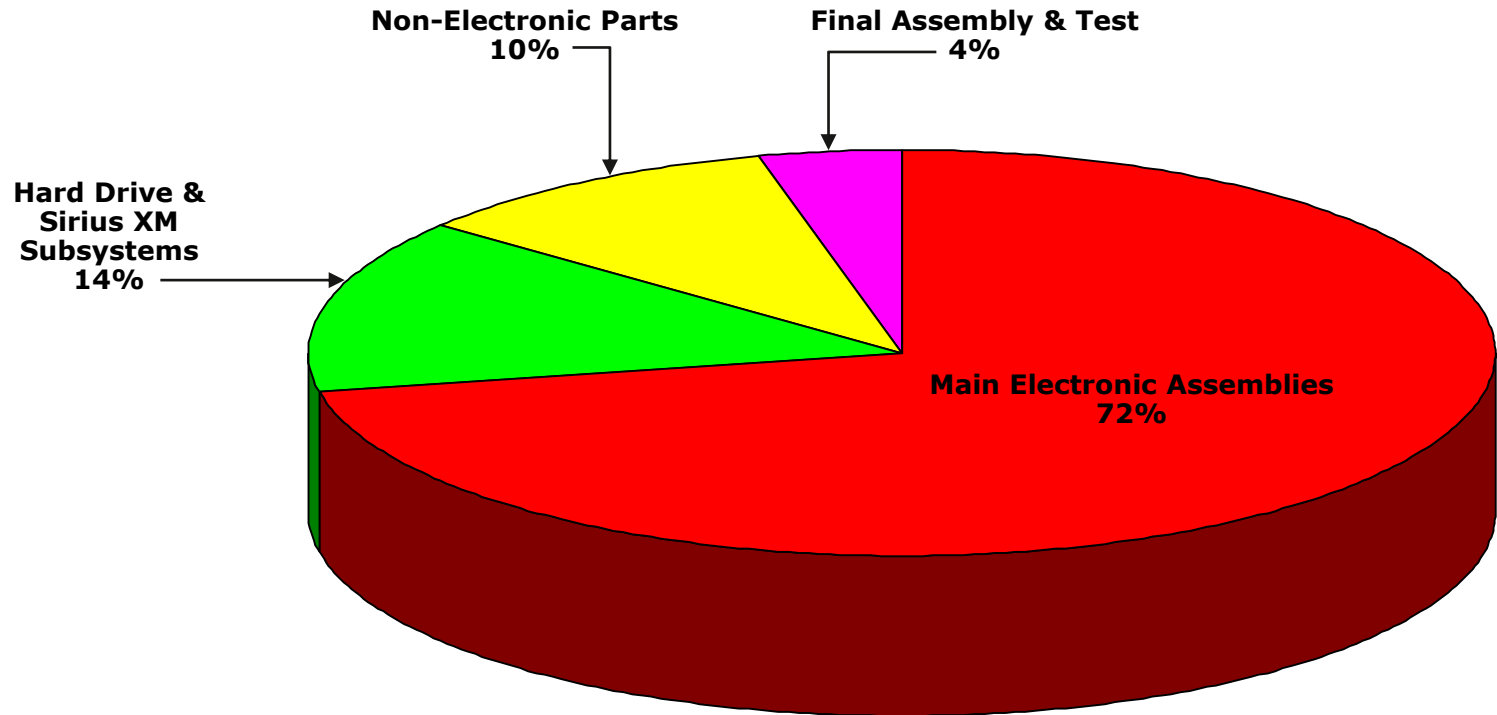


Final Assembly & Test	
Made in	Germany
Number of parts	114
Est'd number of steps	422
Est'd time (seconds)	1645
Est'd final assembly cost	\$ 21.02
Est'd final test cost	\$ 1.25

Cost Summary

Estimated Cost Totals	
Main Electronic Assemblies	\$ 401.89
Hard Drive & Sirius XM subsystems	\$ 77.17
Non-Electronic Parts	\$ 57.31
Final Assembly & Test	\$ 22.27
Total	\$ 558.65

Cost Total Notes:
Estimated final assembly cost includes labor only.
Total cost does not include Non-recurring, R&D, G&A, IP licensing fees/royalties, software, sales & marketing, distribution.
Assumes fully scaled production.



Cost Estimation Process (Overview & Discussion)



Cost modeling is tricky business. Multiple variables affect the actual production costs a manufacturer will experience, including development expenses, unit volumes, supply-and-demand in component markets, die yield-curve maturity, OEM purchasing power, and even variations in accounting practices. Different cost modeling methods employ different assumptions about how to handle these and other variables, but we can identify two basic approaches: that which seeks to track short-term variations in the inputs to the production process, and that which strives to maintain comparability of the output of the model across product families and over time.

TechInsights' philosophy in cost modeling is to emphasize consistency across products and comparability over time, rather than to track short-term fluctuations. During the past eight years, we have developed an estimation process that, while necessarily lacking an insider's knowledge of the cost factors that impact any one manufacturer, is reasonably accurate in its prediction of unit costs in high-volume production environments. We do not claim that the model will produce the "right" answer for your firm's environment. However, TechInsights does give customers a key analytical tool with a complete set of data in our Bill of Materials (BOM). The BOM allows readers to 1) scrutinize the assumptions behind our cost model and 2) modify the results based on substitution of their own component cost estimates where they have better information based on inside knowledge.

Our estimation process decomposes overall system cost into three major categories: Electronics, Mechanical, and Final Assembly. We begin by creating a complete electronics bill-of-materials (BOM). Each component from the largest ASIC to the smallest discrete resistor is entered into a BOM table with identifying attributes such as size, pitch, I/O count, package type, manufacturer, part number, estimated placement cost, and die size (if the component is an IC). Integrated circuit costs are calculated from measured die area. Using assumptions for wafer size, process type, number of die per wafer, defect density, and profit margin in combination with die area, an estimate of semiconductor cost is derived. Costs for discrete components and interconnect are derived from assumption tables which relate BOM line items to specific cost estimates by component type and estimates for part placement costs are included. For LCD display costs, we employ a model which tabulates expected cost from measurements of glass area, LCD type, and total pixel resolution. When market costs are available from alternative sources, LCD panel costs are taken from and referenced to these sources.

Costs of non-electronic components such as molded plastic enclosures and metallic components are measured in terms of weight, size, thickness, type of material, and complexity to arrive at their estimated cost. Other system items such as optics, antennae, batteries and displays are costed from a set of assumption tables derived from a combination of industry data, average high volume costs, and external sources. For final assembly, we re-build the torn-down product, tabulating stepwise assembly times as the reconstruction proceeds, to reach a total assembly time. Using a labor rate assumption for the country of origin, we then calculate final assembly cost.

The three major categories for system cost contributors can be broken down into the subcategories of ICs, other electronics parts, displays, batteries (as appropriate), camera modules, electronics assembly, non-electronic elements, and final assembly. By adding the cost estimates for each of these subcategories, an overall estimated cost is derived for the system under evaluation. Product packaging and accessories (CDs, cables, etc.) are also documented and estimated for their contribution to total cost as appropriate.

We believe our cost estimates generally fall within 15 percent of the "right answer," which itself can vary depending on the market and OEM-specific factors mentioned earlier. While the TechInsights cost model is imperfect, it yields important insights into technology and business dynamics along with good first-order contributions to system cost by component type. Additionally, the consistency of approach and gradual modification to assumptions (smoothing out frequently-shifting pricing factors) hopefully yields a credible, but user-modifiable, view of OEM high volume cost-to-produce.

Please feel free to contact us at support@techinsights.com with any comments, questions, or proposed corrections with respect to our cost estimates. We welcome your input.

In our product teardowns, we gather a series of metrics for product profiling and comparison. Some metrics focus on system characteristics such as total silicon area, total system semiconductor storage capacity, and total connection count. Other metrics reflect more subtle aspects of electronics assembly such as connection density, average component I/O count, and silicon tiling density. Taken as a whole, the metrics allow deeper comparison and benchmarking across multiple disciplines and multiple products. Key metrics we gather on products are described below along with their definitions and what they tend to say about the system under study. Most metrics can be used both in comparing similar products for benchmarking purposes or for quantifying differences in levels of complexity between dissimilar product types. Data fall into two categories; either “raw” measured data or ratios of these measured data sets.

Total Silicon Area : This metric describes the total area of silicon as measured from X-ray or direct measurement of ICs. The area is an expression of the enclosed bare die area and excludes packaging area. The aggregate silicon area is a good benchmark to show how integrated a design might be when making comparisons to similar systems. Total silicon area also reflects the major cost driver for most systems we examine.

Silicon Tiling Density : Ratio of Total Silicon Area to total printed circuit board “projected” area (i.e. the simple board area and not the cumulative surface area of both sides of the board). This metric directly reflects the level of efficiency and aggressiveness in integrated circuit packing and placement. Single digit Silicon Tiling Density is typical but silicon coverage of 10% - 20% has been seen in some of the most advanced products we have examined. Higher Tiling Densities often correspond with the use of chip scale packaging (CSPs) or other small form-factor IC packaging technologies. High density circuit boards are also often a supporting technology.

Number of Parts : Total component count including ICs, passives, modules, connectors, etc., each separated out in our reporting.

Number of Connections : The total number of connections corresponds to the total number of interconnects introduced by the aggregate component set and reflects any electrical connection observed (solder joints, adhesive interconnect, or connector terminal interfaces).

Opportunity Count : Opportunity Count is the total number of parts plus the total number of connections; the name reflects that each of these constituent elements represents an opportunity for failure. A high opportunity count means more complex and riskier electronics assembly.

Average Pin Count (APC) : Ratio of total number of component terminals to total number of parts, at the system level. This metric reflects the ‘average’ terminal complexity of the components and often provide a signature of integration level and/or “digital-ness” of the overall product. Low APCs reflect a high number of discretely or other low-pincount devices often characteristic of analog circuitry. Conversely, high APCs are characteristic of highly integrated, high-pincount assemblies, often those composed largely of digital integrated circuits.

Connection Density : This metric is a ratio of the total Number of Connections to total printed circuit board assembly area, in units of connections per sq. inch. The metric provides data related to the Silicon Tiling Density above, but with an emphasis on complexity of I/O interconnect. For example, with a fixed Connection Density, high tiling density of low-pincount memory chips is more readily achieved than comparable silicon tiling of high pincount logic.

Part Density : This metric is a ratio of the total Number of Parts to total printed circuit board assembly area, in units of components per sq. inch. The metric provides data related to the Silicon Tiling Density and Connection Density as described above, but with an emphasis on density and complexity of component packing efficiency. For example, low Part Density of high-pincount devices can pose an equal challenge in Connection Density to high Part Density of low-pincount devices. High Part Density does reflect challenges in surface mount assembly in terms of (typically) precision of placement, number of placements, and engineering of part clearances.

Routing Density (heuristic estimate) = $3 * (\text{Average Pin Count}) * \sqrt{\text{Part Density}}$. The Routing Density metric is an empirically derived relationship that characterizes the wiring density of the interconnect used to support the interconnection of components in a planar electronic assembly (i.e. the circuit board). Architectural issues such as bussing or other factors affecting the regularity of wiring impact the actual Routing Density needed to support a given application, but the metric provides a ready measure of wiring complexity.

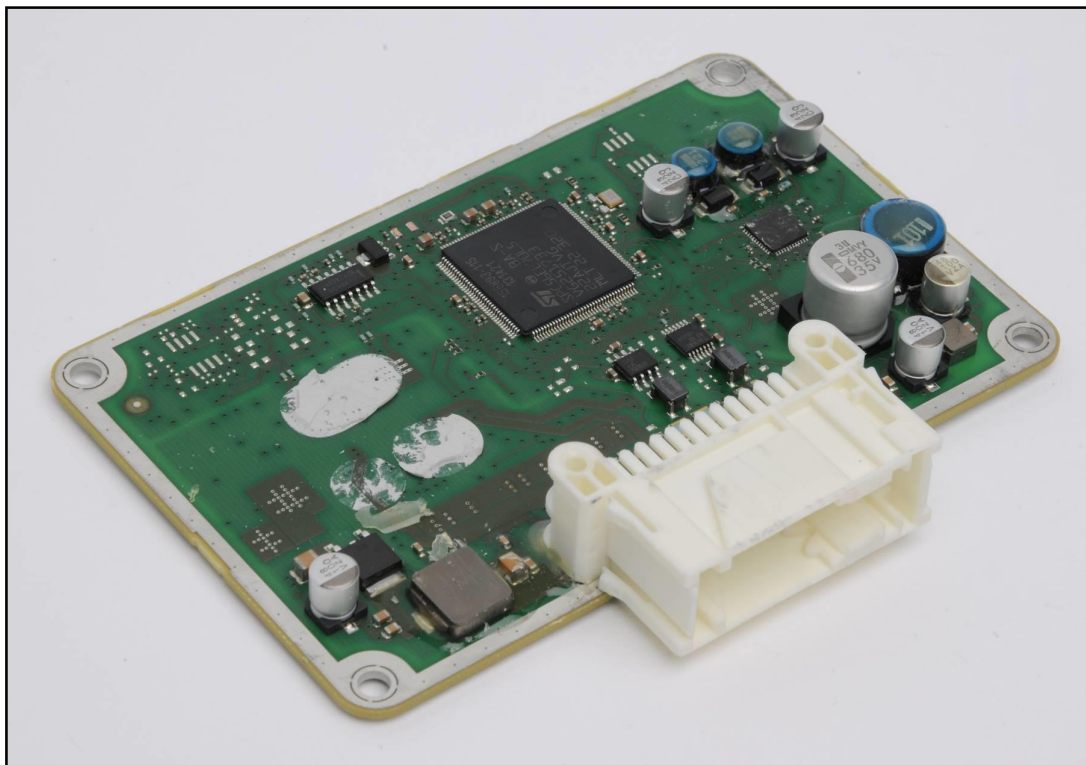
***[Click Here to Return to
Cost Analysis Page 53](#)***

Deep Dive Report

BMW i3 Optional Equipment Board

5567

Report #15900-141205-SBb



Product Description

This Optional Equipment Board is used to take input from sensors on the 2014 BMW i3 for the appropriate processing. Key ICs include an STMicroelectronics #SPC56EL70L5 32-bit auto architecture microcontroller, (2) Infineon #BTS5180 Dual-channel smart high-side power switches, and two transceivers. It is possible, but unconfirmed, that this board processes data from the Steering Angle Sensor or Ride Height Sensors.

DISCLAIMER: All company names, product names, and service names mentioned are used for identification purposes only and may be registered trademarks, trademarks, or service marks of their respective owners. All analyses are done without participation, authorization, or endorsement of the manufacturer. Any cost analyses presented in this material are estimates prepared by TechInsights from generally available data. While TechInsights believes that these estimates reflect the probable costs, the actual producer did not supply the data, and therefore the actual costs may be different from these estimates. Furthermore, TechInsights extends no warranties with respect to any information in this document, and shall bear no liability whatsoever for the use of the information.

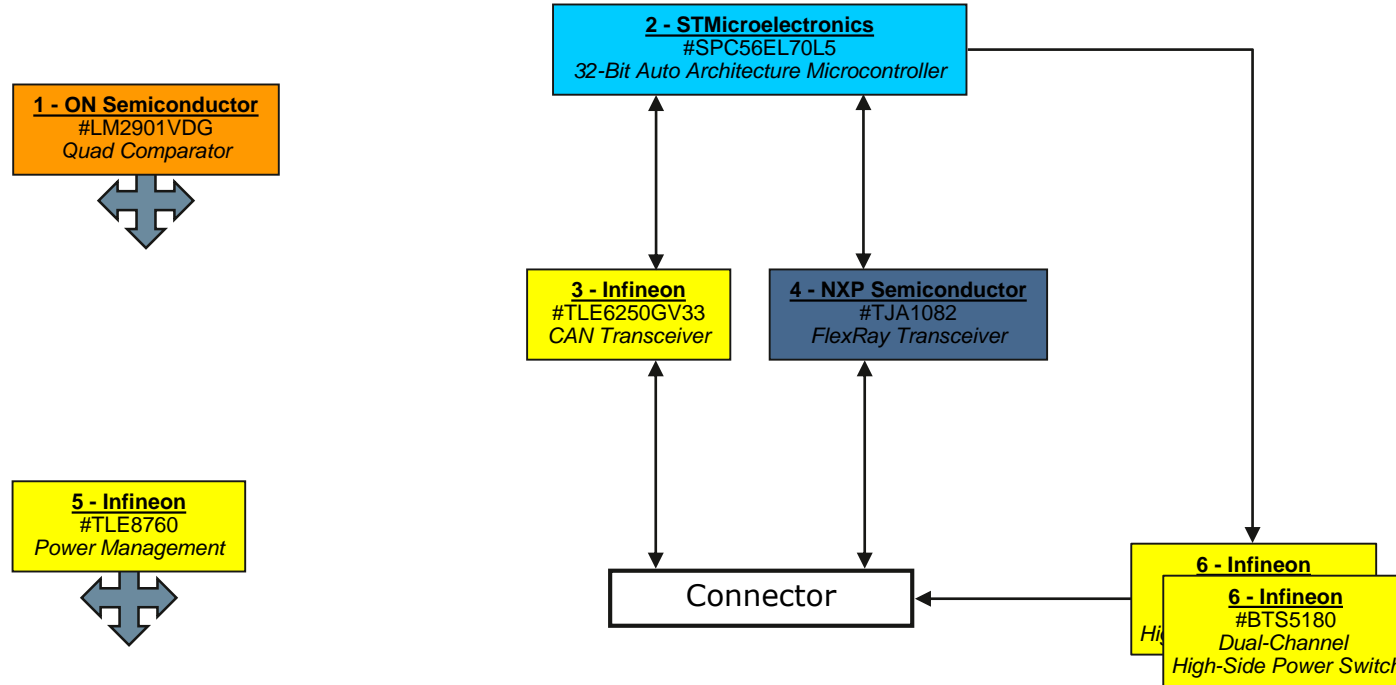
Copyright © 2015, TechInsights. All rights reserved. Do not reproduce, distribute, disseminate, photocopy, fax, transmit, download to a shared database, or otherwise copy, transfer, sell, publish, or send this material, or any portion thereof, by any means without the express written permission of TechInsights.

Product Overview



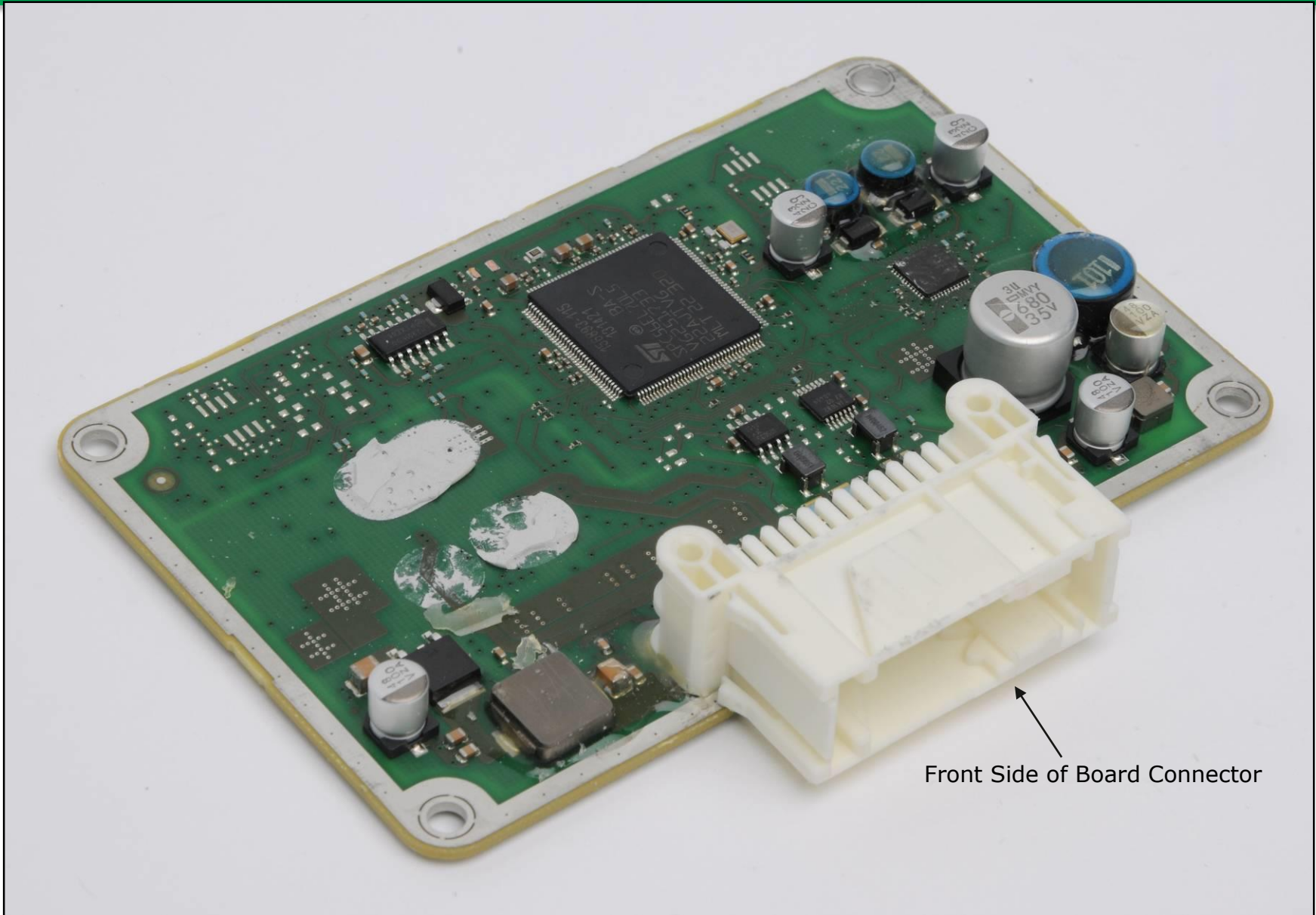
Product Description		Integrated Circuit Metrics		
Product Type	Custom	IC Die Count	7	
Brand	BMW	IC Package Count	7	
Product Name & Model #	i3 Optional Equipment Board	Cost Metrics		
Official Release Date	5/2/2014			
Weight (grams)	55.4 (Measured)	Retail Price		
Product Dimensions (mm)	122.06 x 91.43 x 17.7 mm (Measured at Longest/Widest/Thickest Points)	Total Manufacturing Cost	\$31.89	
Product Features		Electronics Cost	\$31.89	
		Manufacturing Cost Breakdown		
Processor	STMicroelectronics #SPC56EL70L5 32-Bit Auto Architecture Microcontroller	Integrated Circuits	\$16.47	51.6%
Communications	Infineon #TLE6250GV33 CAN & NXP #TJA1082 FlexRay Transceivers	Modules, Discretes & Connectors	\$11.72	36.8%
Power	Infineon #TLE8760 Power Management IC	Substrates	\$1.46	4.6%
		Component Insertion	\$1.51	4.7%
		Card Test	\$0.73	2.3%
		Total	\$31.89	100.0%

Block Diagram



Estimated block diagram based on observation of this specific product implementation, manufacturer's data sheets where available, and best engineering judgment. Certain details of the interface circuitry are not reflected in this block diagram. Partitioning and connectivity are speculative.

Exterior Features

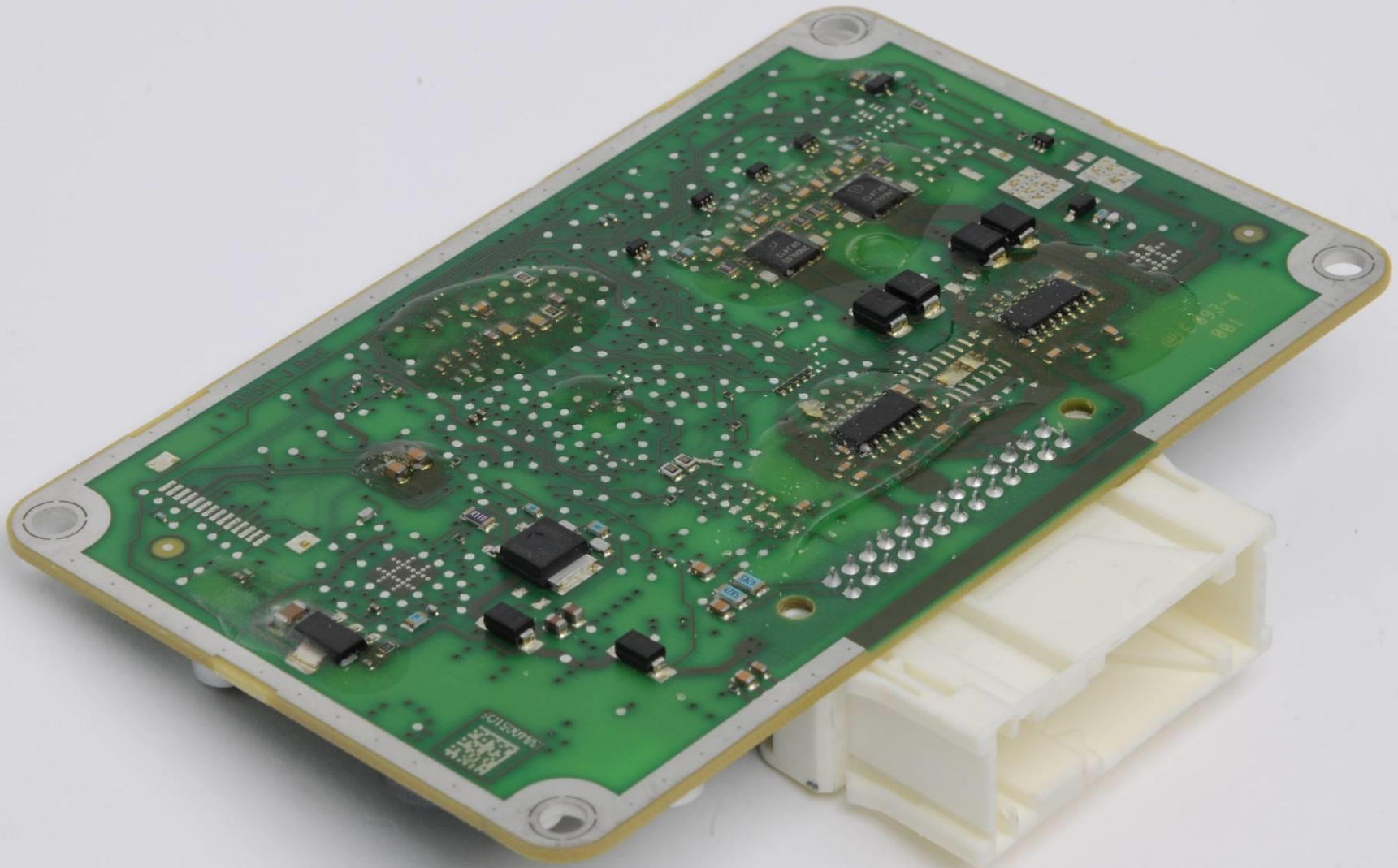


Front Side of Board Connector

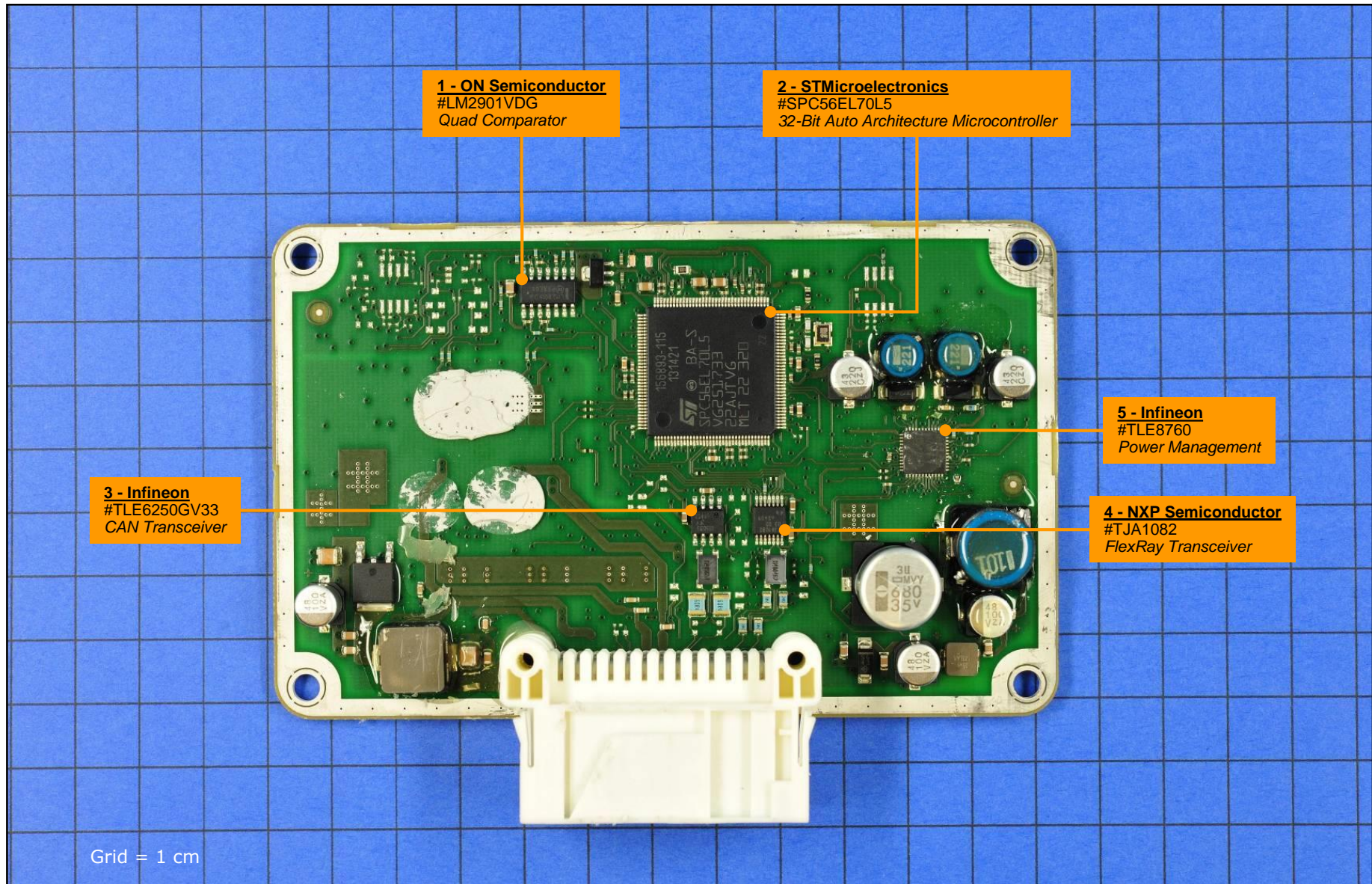
Exterior Features



MUNRO
& ASSOCIATES, INC.



Main Board (Side 1 IC Identification)



1 - ON Semiconductor
#LM2901VDG
Quad Comparator

2 - STMicroelectronics
#SPC56EL70L5
32-Bit Auto Architecture Microcontroller

3 - Infineon
#TLE6250GV33
CAN Transceiver

5 - Infineon
#TLE8760
Power Management

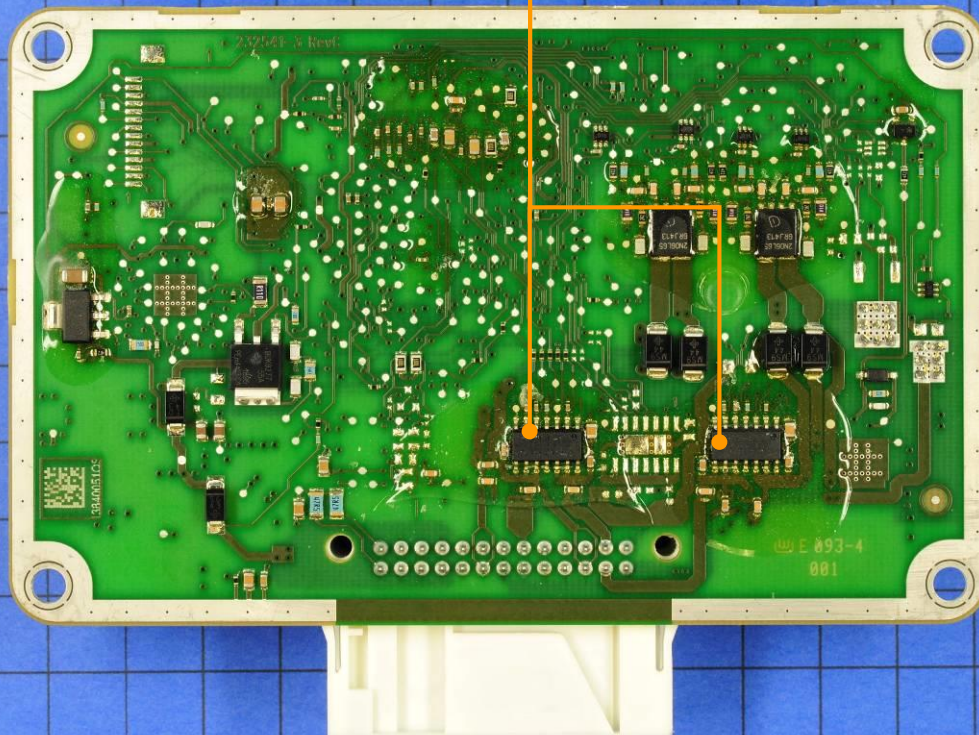
4 - NXP Semiconductor
#TJA1082
FlexRay Transceiver

Grid = 1 cm

Main Board (Side 2 IC Identification)

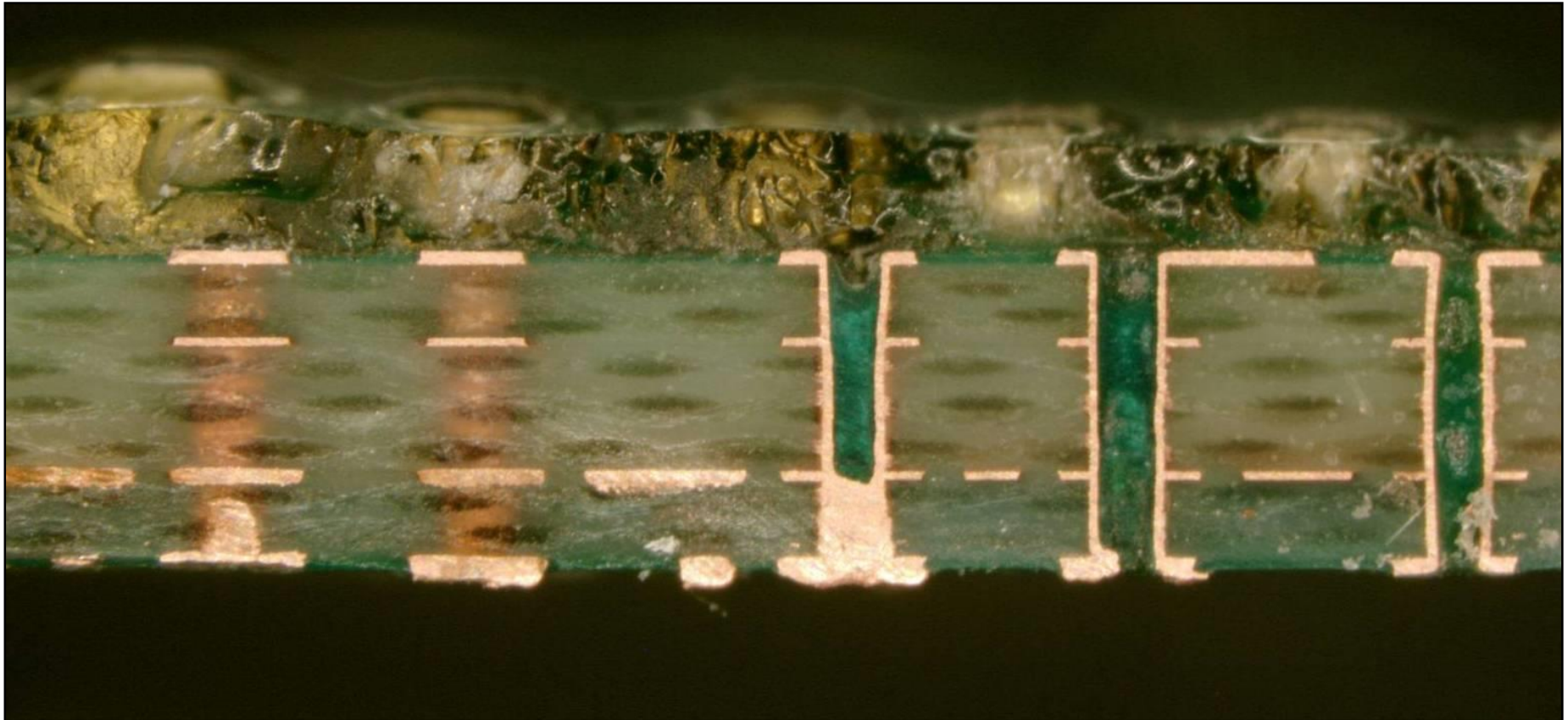


6 - Infineon
#BTS5180
Dual-Channel High-Side Power Switch



Grid = 1 cm

Main Board Cross-Section



Substrate Data

Substrates

Assembly Name	Manufacturer	Core Material	Mfg. Technology	Layers	Area (cm ²)	Min. Trace Pitch (mm)	Min. Trace Width (mm)	ThruVia Land Dia (mm)	ThruVia Hole Dia (mm)	BlindVia Land Dia (mm)	BlindVia Hole Dia (mm)	Thickness (mm)	Routing Density	Estimated Costs
Main Board	Unknown	FR4	4 Layer Conventional FR4 / HF	4	93.9	0.48	0.22	0.62	0.36			1.5	16.2	\$ 1.46

Integrated Circuit Components



MUNRO
& ASSOCIATES, INC.

Location	Package Info										Die Info						Estimated Costs		
	Pkg Ref. #	Pkg Qty	Brand Name	Part Number	Pkg Description	Form	Pin Count	Length (mm)	Width (mm)	Height (mm)	Die Ref #	Die Qty	Brand Name	Part Number	Description	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	1	ON Semiconductor	LM2901VDG	Quad Comparator	SOP	14	8.60	3.80	1.30	1.1	1	ON Semiconductor	139 (M)	Quad Comparator	1.29	1.17	\$ 0.150	\$ 0.150
	2	1	STMicroelectronics	SPC56EL70L5	32-Bit Microcontroller	QFP	144	20.00	20.00	1.50	2.1	1	STMicroelectronics	FL62X2	32-Bit Microcontroller	7.51	6.53	\$ 12.320	\$ 12.320
	3	1	Infineon	TLE6250GV33	CAN Transceiver	SOP	8	5.00	3.50	1.50	3.1	1	Infineon	S0964 ?	CAN Transceiver	2.08	2.00	\$ 0.273	\$ 0.273
	4	1	NXP Semiconductor	TJA1082	FlexRay Transceiver	TSOP	14	5.10	4.40	0.95	4.1	1	NXP Semiconductor	CF1401B	FlexRay Transceiver	2.54	1.94	\$ 0.342	\$ 0.342
	5	1	Infineon	TLE8760	Power Management	QFP	48	6.50	6.50	1.00	5.1	1	Infineon	S1234A25	Power Management	3.96	3.66	\$ 2.786	\$ 2.786
Main Board, Side 2	6	2	Infineon	BTS5180	Dual-Channel High-Side Po	SOP	14	8.65	2.65	1.70	6.1	1	Infineon	L8303B1	Dual-Channel High-Side	2.38	1.73	\$ 0.298	\$ 0.596
Totals	7						256					7							\$16.47

Note: Supplemental information, such as IC package & die markings, is included in the Excel Bill of Materials (BOM) spreadsheet.

Modular Components



Location	Qty	Brand Name	Part Number	Description	Package			Estimated Costs	
					Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Unknown	Unknown	Crystal: Metal	4	3.00	2.50	\$ 0.170	\$ 0.170
TOTALS	1				4				\$0.17

Active Discrete Components

Location	Qty	Functional Description	Package					Estimated Costs	
			Form	Top Marking	Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	3	Small Active	Diode, SMT	SG 43 (graphic)	3	4.11	2.96	\$0.060	\$0.180
	1	Small Active	MOSFET	CD S44	2	4.00	2.50	\$0.090	\$0.090
	1	Small Active	MOSFET	4P03L11 GSB416 (Infineon logo)	2	6.50	6.00	\$0.350	\$0.350
Main Board, Side 2	5	Small Active	Transistor, Small	R1t	6	2.00	1.00	\$0.030	\$0.150
	1	Small Active	Transistor, Small	8C F	3	2.50	1.50	\$0.030	\$0.030
	1	Small Active	Transistor, Large	S 1415 16 BCP55	3	6.00	3.00	\$0.150	\$0.150
	2	Small Active	MOSFET	2N06L65 GRJ413 (Infineon logo)	8	5.50	5.00	\$0.310	\$0.620
	1	Small Active	MOSFET	BUK9277 55A 1895 PEm1403C1	4	6.50	5.50	\$0.350	\$0.350
	4	Small Active	Diode, SMT	MS9 44 (graphic)	2	4.50	3.00	\$0.060	\$0.240
	2	Small Active	Diode, SMT	SG 43 (graphic)	2	4.00	2.50	\$0.060	\$0.120
TOTALS	21				81				\$2.28

Passive Discrete Components

Location	Qty	Functional Description	Package		Estimated Costs	
			Form	Pin Count	Each	Total
Main Board, Side 1	5	Coil	SMT, Small	2	\$0.250	\$1.250
	2	Coil	SMT, Large	2	\$1.350	\$2.700
	1	Capacitor	Electrolytic, Medium	2	\$0.320	\$0.320
	5	Capacitor	Electrolytic, Small	2	\$0.080	\$0.400
	104	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.416
	2	Coil	SMT, CMC	4	\$0.690	\$1.380
Main Board, Side 2	143	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.572
TOTALS	262			528		\$7.04

Connectors

Location	Qty	Form	Package			Estimated Costs	
			Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Connector: Vehicle Wiring	26	48.38	15.88	\$2.240	\$2.240
TOTALS	1		26				\$2.24

Electronic Assembly Metrics

Electronic Assembly Metrics by Assembly											
General Area	Assembly Name	Substrate Area (sq.cm)	Metal Layers	Circuit Area (sq.cm)	Routing Density (cm of routing per sq.cm of substrate)	Number of Components	Number of Connections	Component Density (Components/sq.cm)	Connection Density (Connections/sq.cm)	Avg. Pin Count	Assembly Weight (grams)
Main Electronics	Main Board	93.9	4	375.8	16.2	292	895	3.1	9.5	3.1	54.80
	System Totals	93.9	4	375.76		292	895	3.1	9.5	3.1	54.80

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Electronics Costs by Assembly										
General Area	Assembly Name	Total	Integrated Circuits	Modular & Odd Form Components	Small Active Components	Passive Components	Connector Components	Substrates	Insertion	Card Test
Main Electronics	Main Board	\$ 31.89	\$ 16.47	\$ 0.17	\$ 2.28	\$ 7.04	\$ 2.24	\$ 1.46	\$ 1.51	\$ 0.73
	System Totals	\$ 31.89	\$ 16.47	\$ 0.17	\$ 2.28	\$ 7.04	\$ 2.24	\$ 1.46	\$ 1.51	\$ 0.73

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Counts by Assembly												
General Area	Assembly Name	IC Package Count	IC Connections	Modular/Odd Form Components	Modular/Odd Form Component Connections	Small Active Components	Small Active Component Connections	Passive Components	Passive Component Connections	Connectors	Connector Connections	Opportunities
Main Electronics	Main Board	7	256	1	4	21	81	262	528	1	26	1187
	System Totals	7	256	1	4	21	81	262	528	1	26	1187

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



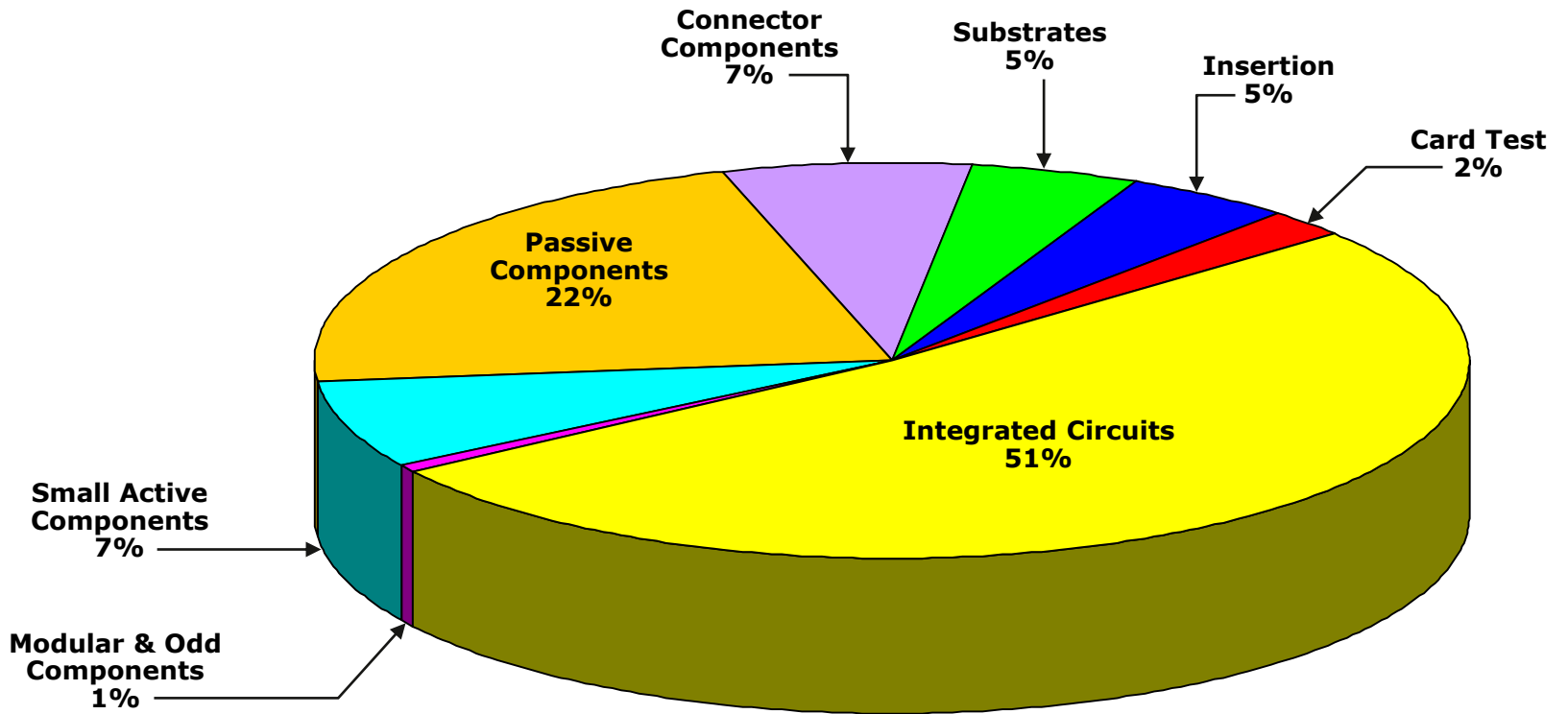
IC Metrics											
General Area	Assembly Name	IC Die Count	IC Package Count	Number of Package Connections	Die Area (sq.mm)	Substrate Tiling Density (die area / substrate area)	Package Area (sq.mm)	Die Area/Package Area Ratio	Package Connections per sq.cm of Package Area	Volatile Memory (KBytes)	Non-Volatile Memory (KBytes)
Main Electronics	Main Board	7	7	256	82.4	0.01	560.7	0.15	45.7	0	0
	System Totals	7	7	256	82.4		560.7	0.15	45.7	0	0

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Costs Breakdown

**Estimated Cost
of Electronics**

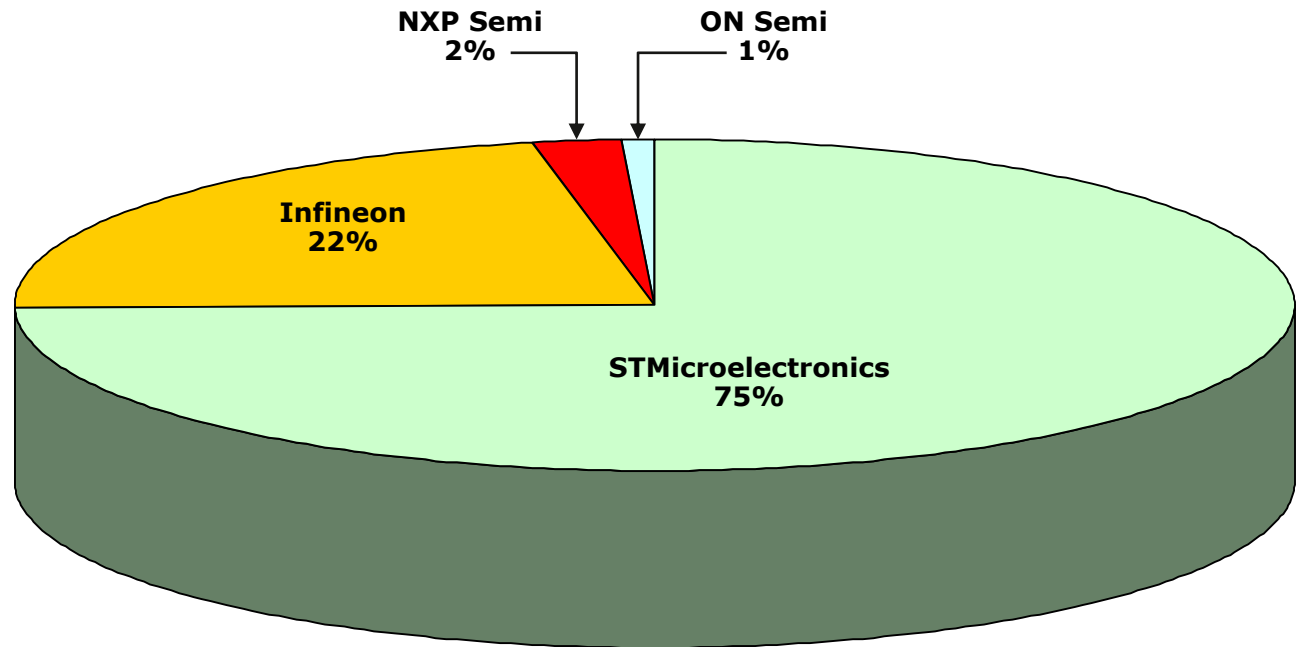
\$31.89



NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Vendor IC Cost Distribution

Pkg. Brand	Cost
STMicroelectronics	\$12.32
Infineon	\$3.66
NXP Semiconductor	\$0.34
ON Semiconductor	\$0.15



NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Estimated Cost Totals	
Main Electronic Assemblies	\$ 31.89
Total	\$ 31.89

Cost Total Notes:
Estimated final assembly cost includes labor only.
Total cost does not include Non-recurring, R&D, G&A, IP licensing fees/royalties, software, sales & marketing, distribution.
Assumes fully scaled production.

Cost Estimation Process

(Overview & Discussion)



Cost modeling is tricky business. Multiple variables affect the actual production costs a manufacturer will experience, including development expenses, unit volumes, supply-and-demand in component markets, die yield-curve maturity, OEM purchasing power, and even variations in accounting practices. Different cost modeling methods employ different assumptions about how to handle these and other variables, but we can identify two basic approaches: that which seeks to track short-term variations in the inputs to the production process, and that which strives to maintain comparability of the output of the model across product families and over time.

TechInsights' philosophy in cost modeling is to emphasize consistency across products and comparability over time, rather than to track short-term fluctuations. During the past eight years, we have developed an estimation process that, while necessarily lacking an insider's knowledge of the cost factors that impact any one manufacturer, is reasonably accurate in its prediction of unit costs in high-volume production environments. We do not claim that the model will produce the "right" answer for your firm's environment. However, TechInsights does give customers a key analytical tool with a complete set of data in our Bill of Materials (BOM). The BOM allows readers to 1) scrutinize the assumptions behind our cost model and 2) modify the results based on substitution of their own component cost estimates where they have better information based on inside knowledge.

Our estimation process decomposes overall system cost into three major categories: Electronics, Mechanical, and Final Assembly. We begin by creating a complete electronics bill-of-materials (BOM). Each component from the largest ASIC to the smallest discrete resistor is entered into a BOM table with identifying attributes such as size, pitch, I/O count, package type, manufacturer, part number, estimated placement cost, and die size (if the component is an IC). Integrated circuit costs are calculated from measured die area. Using assumptions for wafer size, process type, number of die per wafer, defect density, and profit margin in combination with die area, an estimate of semiconductor cost is derived. Costs for discrete components and interconnect are derived from assumption tables which relate BOM line items to specific cost estimates by component type and estimates for part placement costs are included. For LCD display costs, we employ a model which tabulates expected cost from measurements of glass area, LCD type, and total pixel resolution. When market costs are available from alternative sources, LCD panel costs are taken from and referenced to these sources.

Costs of non-electronic components such as molded plastic enclosures and metallic components are measured in terms of weight, size, thickness, type of material, and complexity to arrive at their estimated cost. Other system items such as optics, antennae, batteries and displays are costed from a set of assumption tables derived from a combination of industry data, average high volume costs, and external sources. For final assembly, we re-build the torn-down product, tabulating stepwise assembly times as the reconstruction proceeds, to reach a total assembly time. Using a labor rate assumption for the country of origin, we then calculate final assembly cost.

The three major categories for system cost contributors can be broken down into the subcategories of ICs, other electronics parts, displays, batteries (as appropriate), camera modules, electronics assembly, non-electronic elements, and final assembly. By adding the cost estimates for each of these subcategories, an overall estimated cost is derived for the system under evaluation. Product packaging and accessories (CDs, cables, etc.) are also documented and estimated for their contribution to total cost as appropriate.

We believe our cost estimates generally fall within 15 percent of the "right answer," which itself can vary depending on the market and OEM-specific factors mentioned earlier. While the TechInsights cost model is imperfect, it yields important insights into technology and business dynamics along with good first-order contributions to system cost by component type. Additionally, the consistency of approach and gradual modification to assumptions (smoothing out frequently-shifting pricing factors) hopefully yields a credible, but user-modifiable, view of OEM high volume cost-to-produce.

Please feel free to contact us at support@techinsights.com with any comments, questions, or proposed corrections with respect to our cost estimates. We welcome your input.

In our product teardowns, we gather a series of metrics for product profiling and comparison. Some metrics focus on system characteristics such as total silicon area, total system semiconductor storage capacity, and total connection count. Other metrics reflect more subtle aspects of electronics assembly such as connection density, average component I/O count, and silicon tiling density. Taken as a whole, the metrics allow deeper comparison and benchmarking across multiple disciplines and multiple products. Key metrics we gather on products are described below along with their definitions and what they tend to say about the system under study. Most metrics can be used both in comparing similar products for benchmarking purposes or for quantifying differences in levels of complexity between dissimilar product types. Data fall into two categories; either “raw” measured data or ratios of these measured data sets.

Total Silicon Area : This metric describes the total area of silicon as measured from X-ray or direct measurement of ICs. The area is an expression of the enclosed bare die area and excludes packaging area. The aggregate silicon area is a good benchmark to show how integrated a design might be when making comparisons to similar systems. Total silicon area also reflects the major cost driver for most systems we examine.

Silicon Tiling Density : Ratio of Total Silicon Area to total printed circuit board “projected” area (i.e. the simple board area and not the cumulative surface area of both sides of the board). This metric directly reflects the level of efficiency and aggressiveness in integrated circuit packing and placement. Single digit Silicon Tiling Density is typical but silicon coverage of 10% - 20% has been seen in some of the most advanced products we have examined. Higher Tiling Densities often correspond with the use of chip scale packaging (CSPs) or other small form-factor IC packaging technologies. High density circuit boards are also often a supporting technology.

Number of Parts : Total component count including ICs, passives, modules, connectors, etc., each separated out in our reporting.

Number of Connections : The total number of connections corresponds to the total number of interconnects introduced by the aggregate component set and reflects any electrical connection observed (solder joints, adhesive interconnect, or connector terminal interfaces).

Opportunity Count : Opportunity Count is the total number of parts plus the total number of connections; the name reflects that each of these constituent elements represents an opportunity for failure. A high opportunity count means more complex and riskier electronics assembly.

Average Pin Count (APC) : Ratio of total number of component terminals to total number of parts, at the system level. This metric reflects the ‘average’ terminal complexity of the components and often provide a signature of integration level and/or “digital-ness” of the overall product. Low APCs reflect a high number of discrettes or other low-pincount devices often characteristic of analog circuitry. Conversely, high APCs are characteristic of highly integrated, high-pincount assemblies, often those composed largely of digital integrated circuits.

Connection Density : This metric is a ratio of the total Number of Connections to total printed circuit board assembly area, in units of connections per sq. inch. The metric provides data related to the Silicon Tiling Density above, but with an emphasis on complexity of I/O interconnect. For example, with a fixed Connection Density, high tiling density of low-pincount memory chips is more readily achieved than comparable silicon tiling of high pincount logic.

Part Density : This metric is a ratio of the total Number of Parts to total printed circuit board assembly area, in units of components per sq. inch. The metric provides data related to the Silicon Tiling Density and Connection Density as described above, but with an emphasis on density and complexity of component packing efficiency. For example, low Part Density of high-pincount devices can pose an equal challenge in Connection Density to high Part Density of low-pincount devices. High Part Density does reflect challenges in surface mount assembly in terms of (typically) precision of placement, number of placements, and engineering of part clearances.

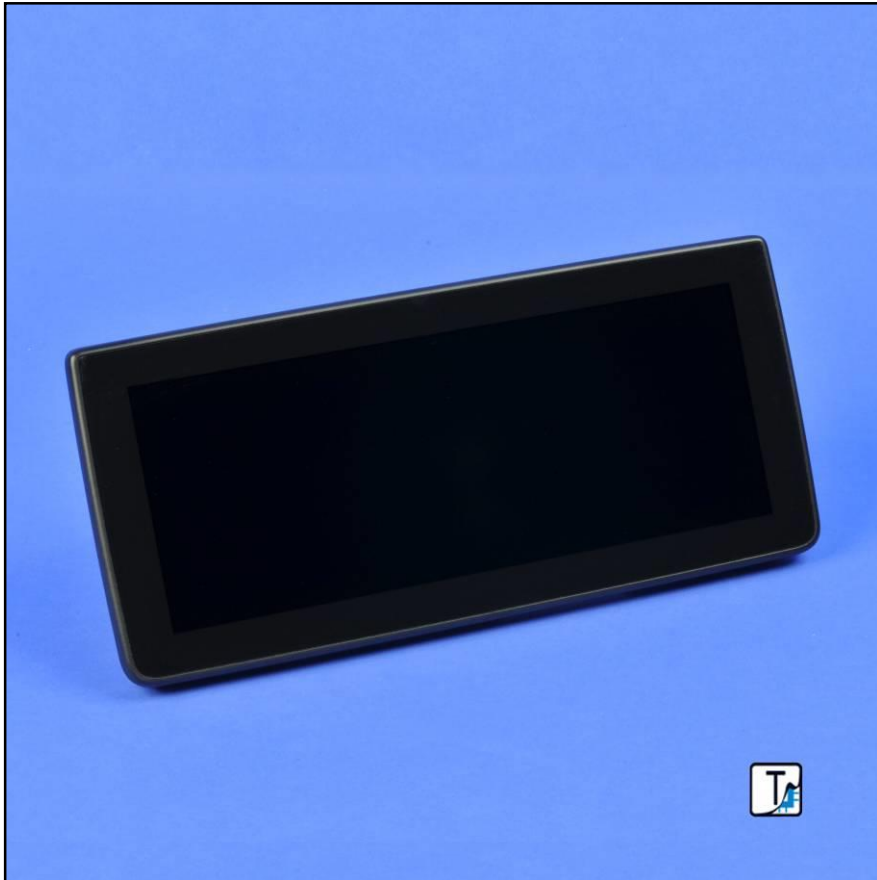
Routing Density (heuristic estimate) = $3 * (\text{Average Pin Count}) * \sqrt{\text{Part Density}}$. The Routing Density metric is an empirically derived relationship that characterizes the wiring density of the interconnect used to support the interconnection of components in a planar electronic assembly (i.e. the circuit board). Architectural issues such as bussing or other factors affecting the regularity of wiring impact the actual Routing Density needed to support a given application, but the metric provides a ready measure of wiring complexity.

***Click Here to Return to
Cost Analysis Page 60***

CMI BMW i3 10.2" Infotainment Display

2113 / 9306743-04

Report #15900-141006-RBc



Product Description

Model 9306743-04 is a 10.2" LCD display manufactured for BMW by CMI (Chi Mei Innolux) and included in 2014 i3 models equipped with the optional Technology + Driving Assistant Package. This package provides drivers with real-time navigation and traffic information during trips as well as access to BMW Online (business, stock, weather updates) and BMW Apps. The device uses a Fujitsu "Indigo-L" MB88F333BA graphics controller to drive a TFT-LCD display featuring 1280 x 480 resolution, 16M colors, and Himax PA3271A and PA6538C display drivers. Communication protocols used are the Automotive PIXel (APIX) link and Serial Peripheral Interface (SPI).

DISCLAIMER: All company names, product names, and service names mentioned are used for identification purposes only and may be registered trademarks, trademarks, or service marks of their respective owners. All analyses are done without participation, authorization, or endorsement of the manufacturer. Any cost analyses presented in this material are estimates prepared by TechInsights from generally available data. While TechInsights believes that these estimates reflect the probable costs, the actual producer did not supply the data, and therefore the actual costs may be different from these estimates. Furthermore, TechInsights extends no warranties with respect to any information in this document, and shall bear no liability whatsoever for the use of the information.

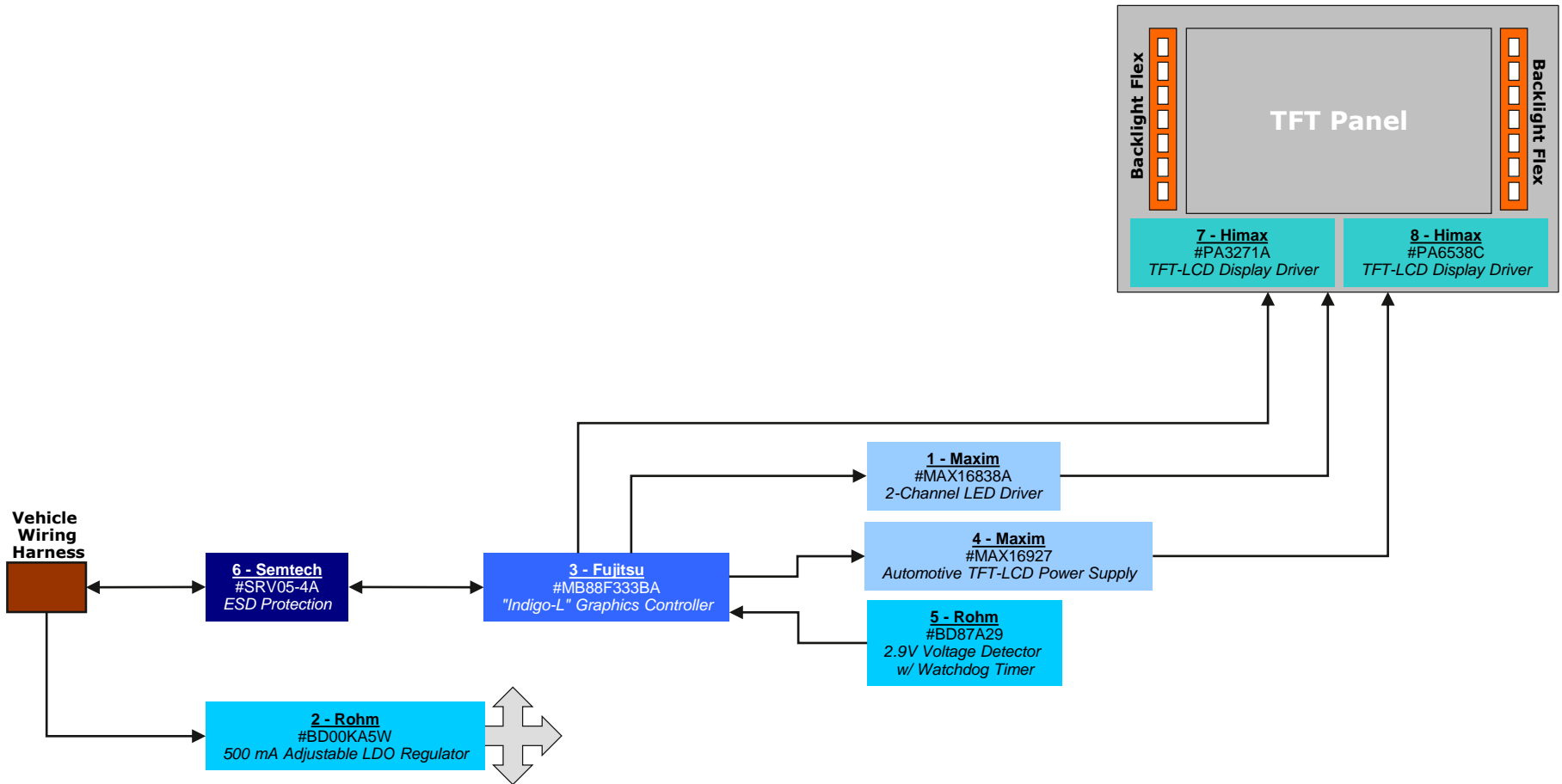
Copyright © 2015, TechInsights. All rights reserved. Do not reproduce, distribute, disseminate, photocopy, fax, transmit, download to a shared database, or otherwise copy, transfer, sell, publish, or send this material, or any portion thereof, by any means without the express written permission of TechInsights.

Product Overview



Product Description		Integrated Circuit Metrics		
Product Type	Automotive	IC Die Count**	10	
Brand	BMW, manufactured by CMI (Chi Mei Innolux)	IC Package Count**	10	
Product Name & Model #	i3 Infotainment Display, 9306743-04	Cost Metrics		
Official Release Date	5/21/2014 ?			
Weight (grams)	908.8 (Measured)	Retail Price		
Product Dimensions (mm)	286.5 x 131.0 x 57.3 (Measured)	Total Manufacturing Cost	\$129.34	
Product Features		Electronics Cost**	\$59.11	
		Manufacturing Cost Breakdown		
Communications	Synchronous Serial I/F (SPI) Automotive PIXel (APIX) Link	Integrated Circuits	\$18.43	14.2%
		Modules, Discretes & Connectors	\$4.75	3.7%
Graphics Controller	Fujitsu "Indigo-L" MB88F333BA	Substrates	\$1.25	1.0%
		Component Insertion	\$1.66	1.3%
Connectivity	None	Card Test	\$0.63	0.5%
		Display Subsystem	\$93.77	72.5%
User Interface	None	Non-Electronic Parts	\$8.31	6.4%
		Final Assembly & Test	\$0.54	0.4%
		Total	\$129.34	100.0%
		**Including Subsystems		
Key Subsystems				
Display	10.2" TFT-LCD, 1280 x 480 Pixels, 16M Colors			

Block Diagram

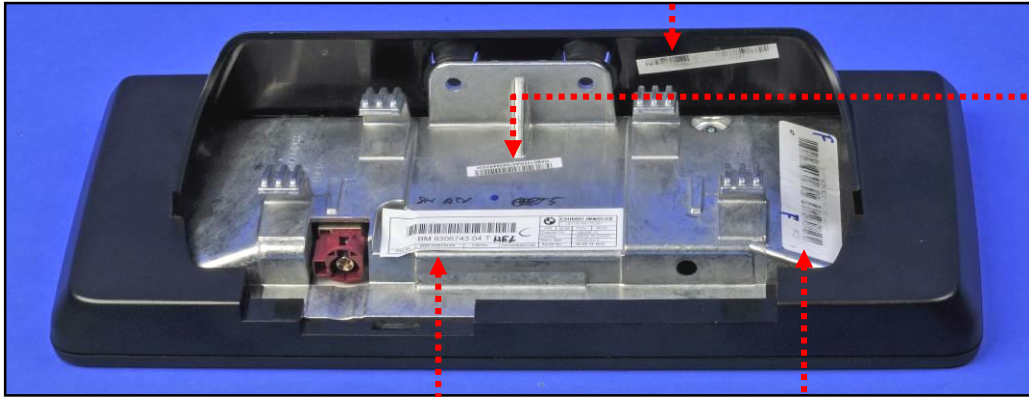


Estimated block diagram based on observation of this specific product implementation, manufacturer's data sheets where available, and best engineering judgment. Certain details of the interface circuitry are not reflected in this block diagram. Partitioning and connectivity are speculative.

Product Labels

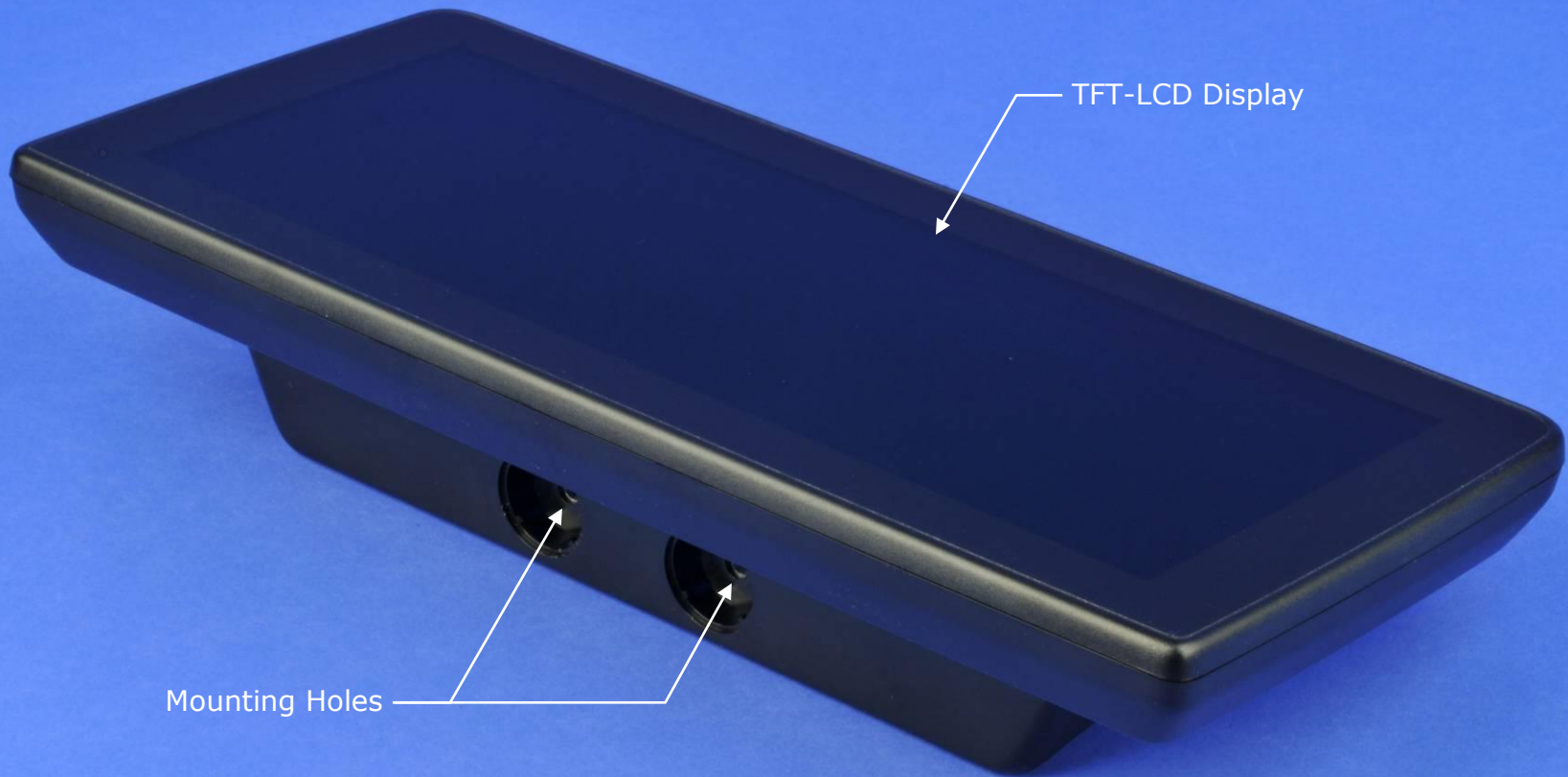


MUNRO
& ASSOCIATES, INC.

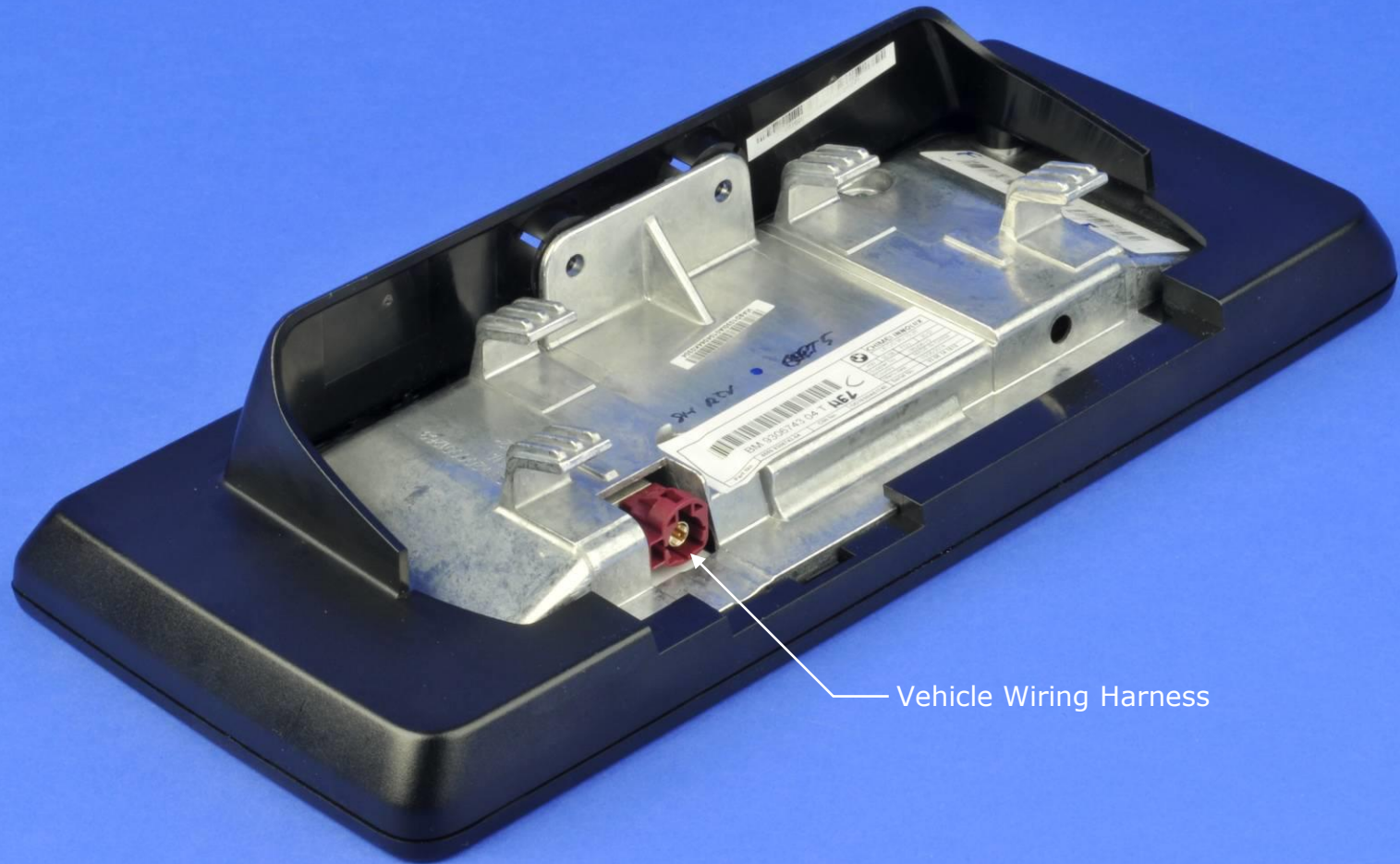


 BM 9306743 04 T NEZ			 CHIMEI INNOLUX L6 CID MU 10 25"				
Part No.	6550 9306743-04	CMI No.	GD1030IA01740	HW	00 08	FDV	30 07
				Supplier No.	185206-10		
				Country	MADE IN CHINA		
				Manu date	03/05/2014		
				Serial No.	03 05 14 1512		

Exterior Features

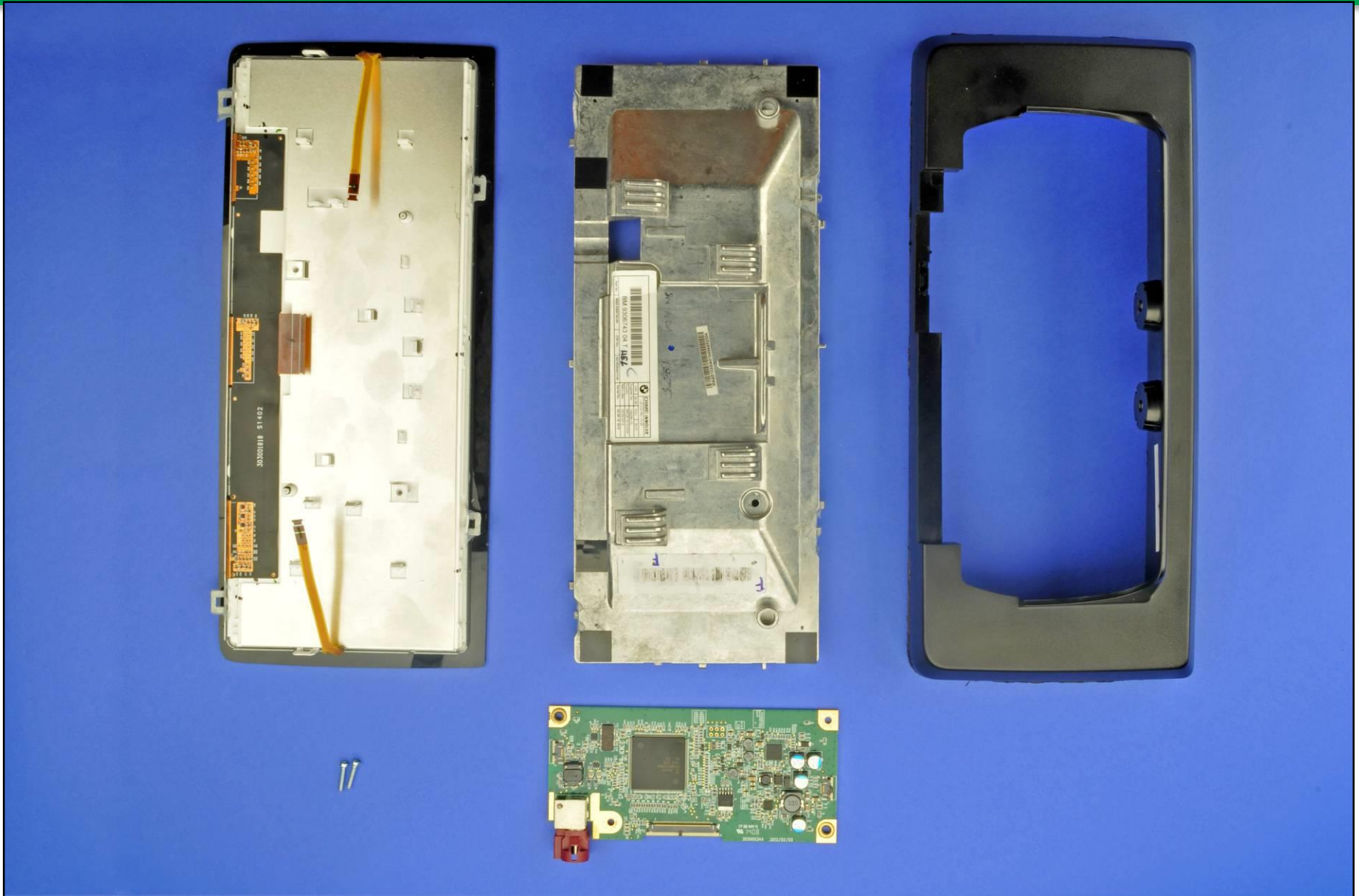


Exterior Features

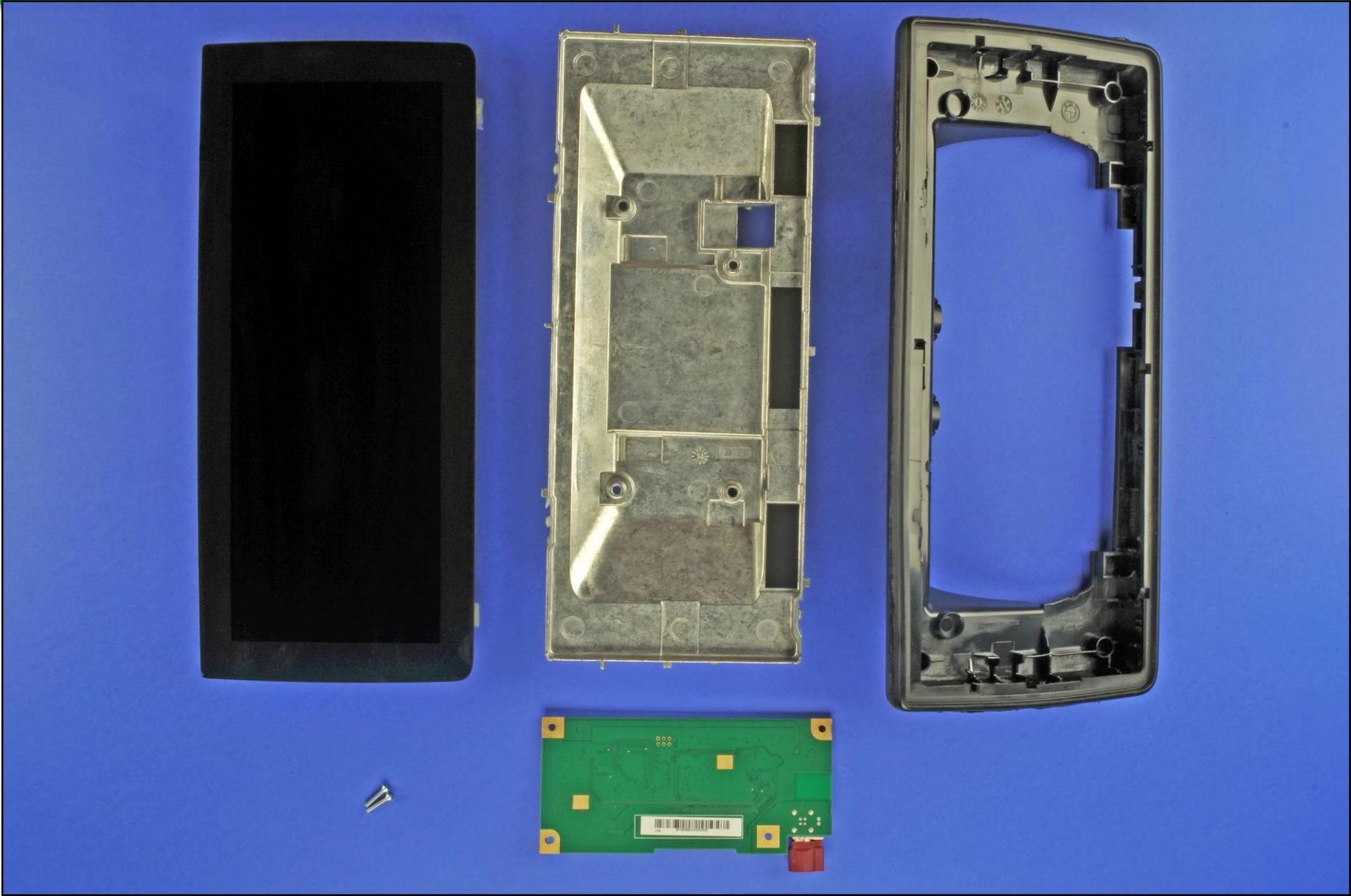


Vehicle Wiring Harness

Major Components (Side 1)



Major Components (Side 2)



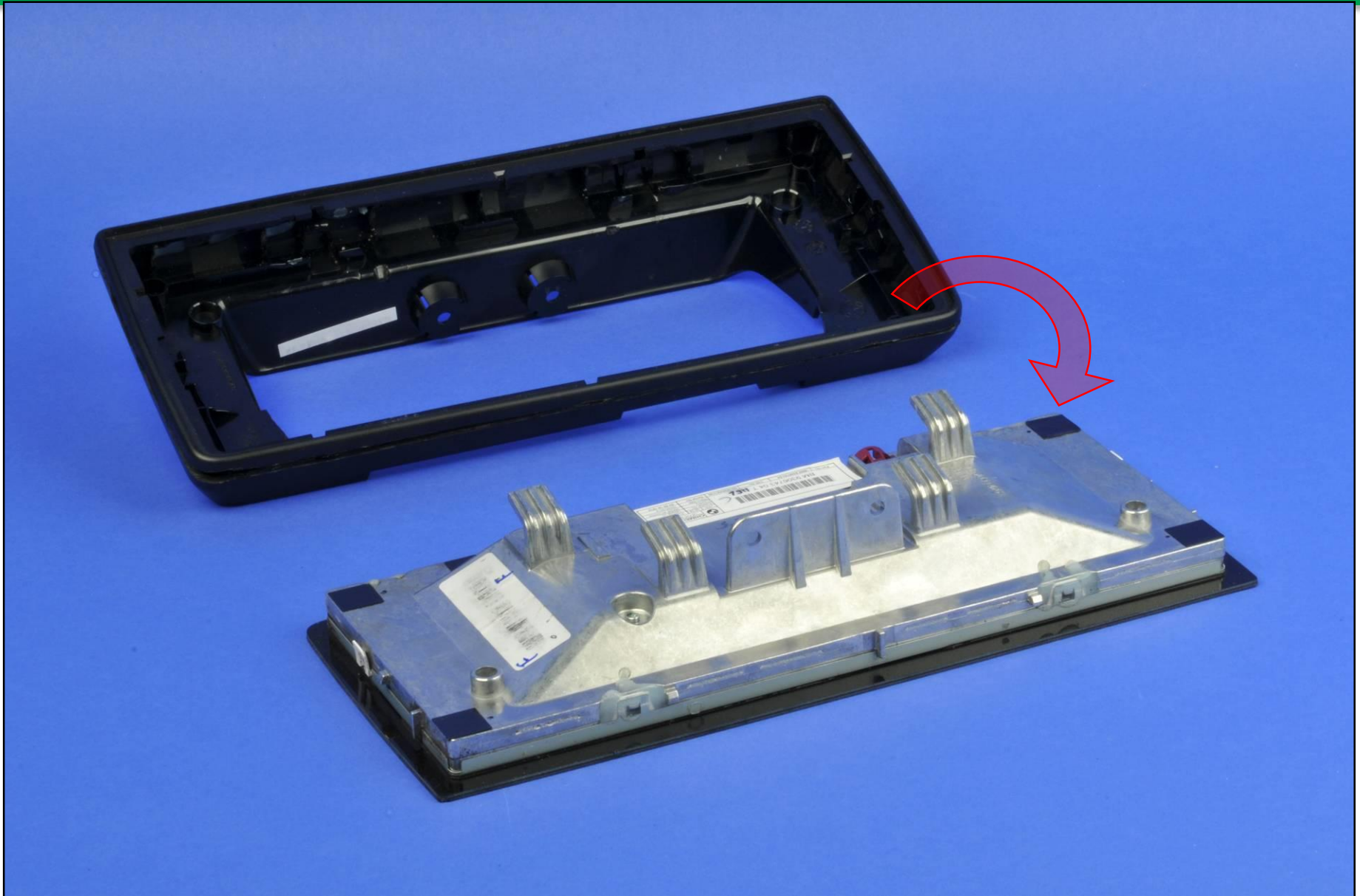
Component Arrangement



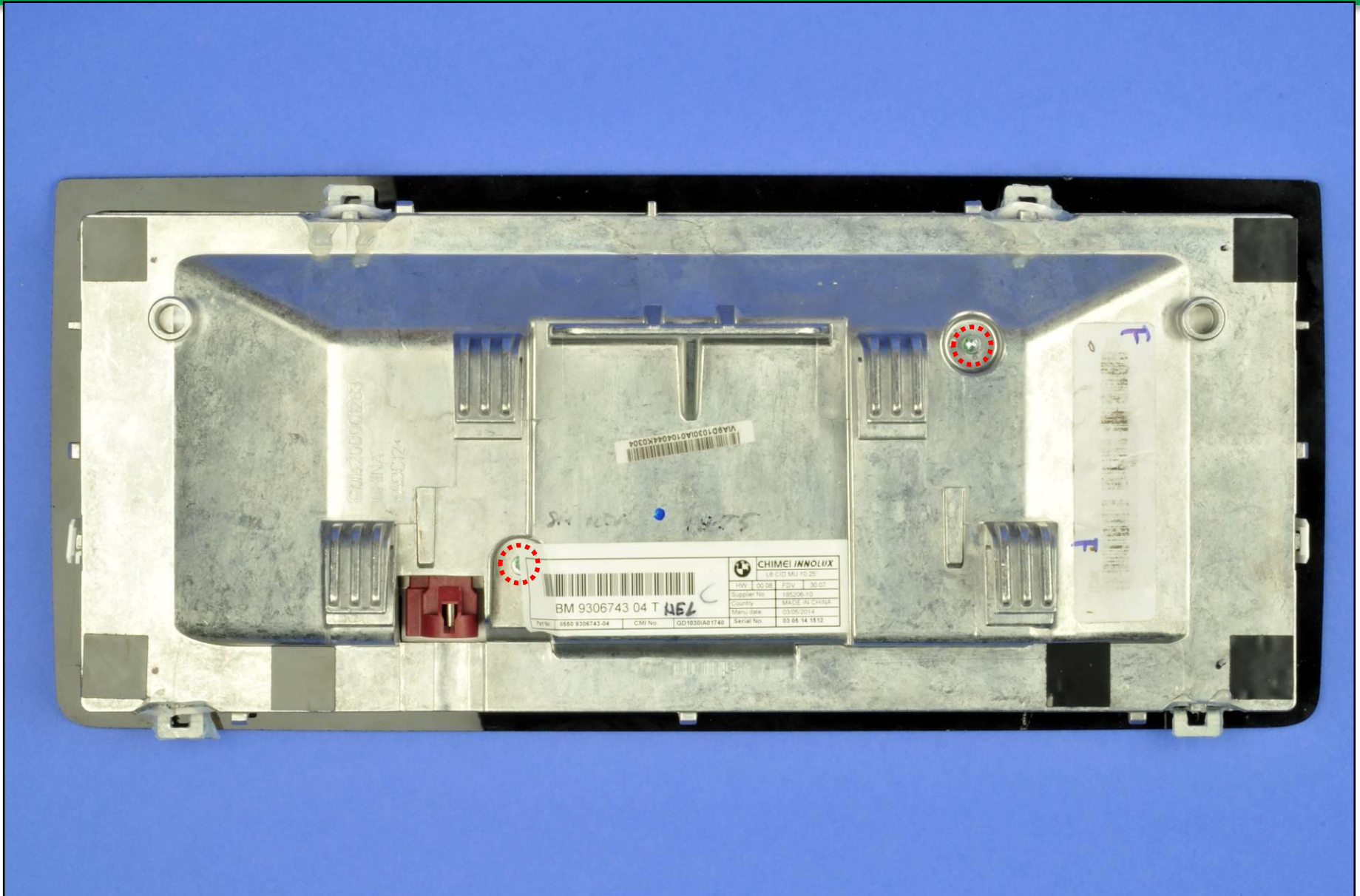
MUNRO
& ASSOCIATES, INC.



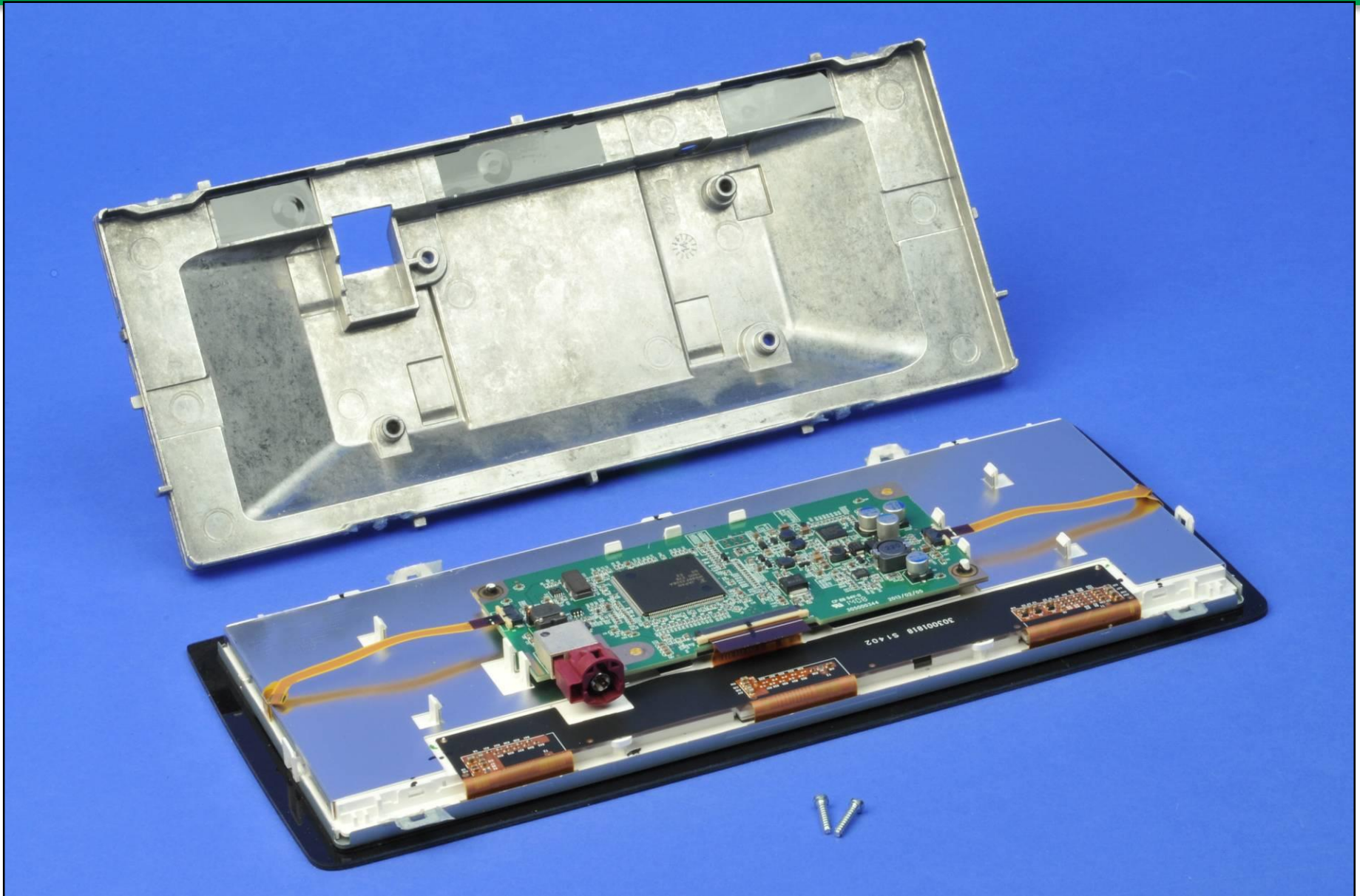
Teardown Sequence



Teardown Sequence



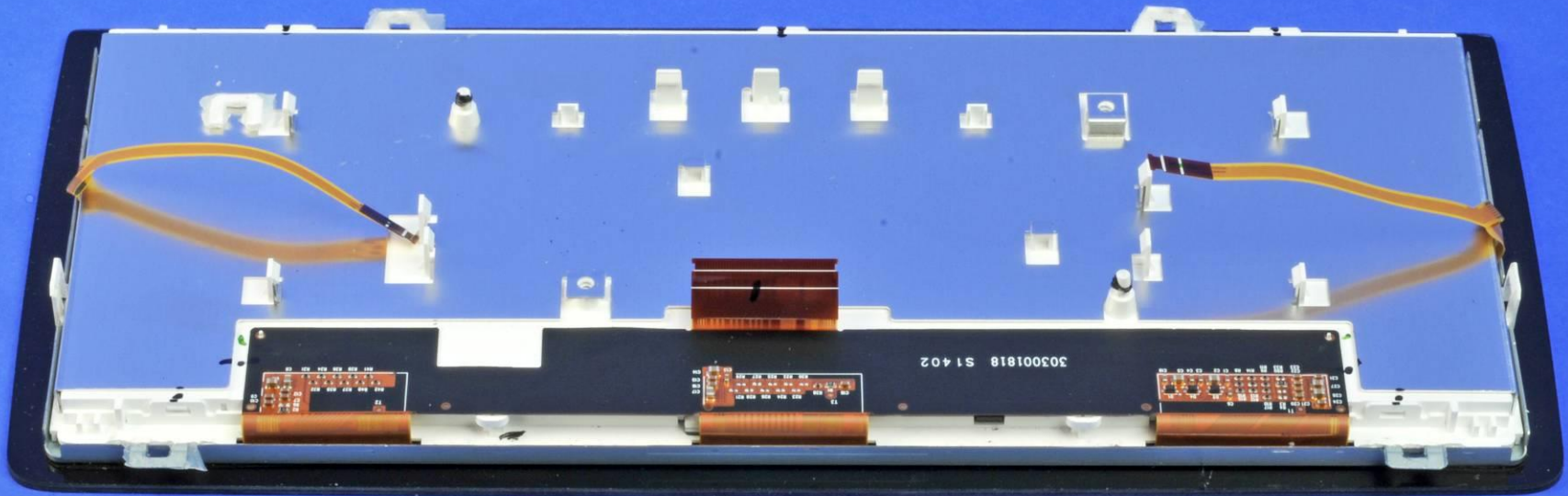
Teardown Sequence



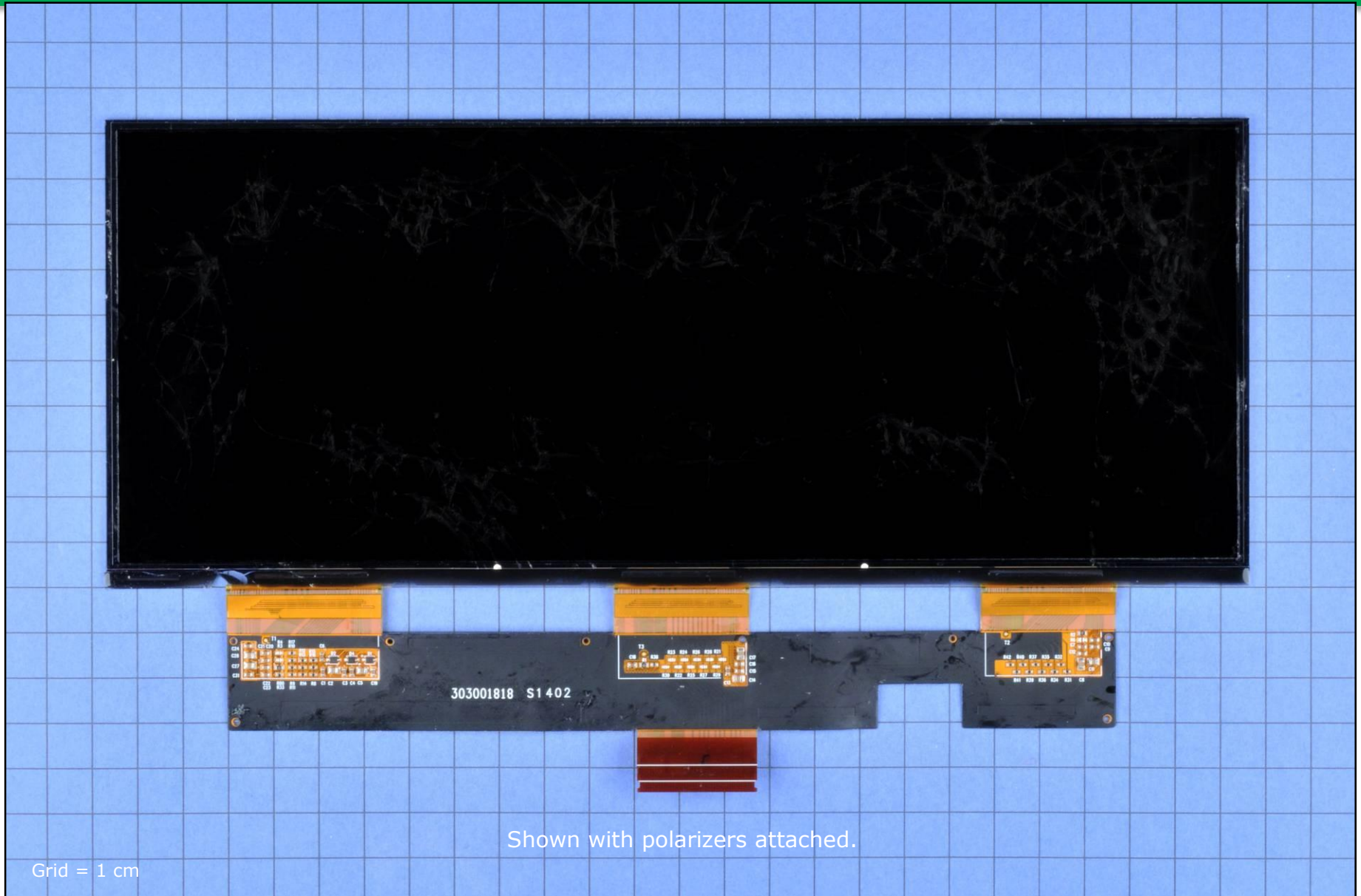
Teardown Sequence



MUNRO
& ASSOCIATES, INC.



Display Subsystem



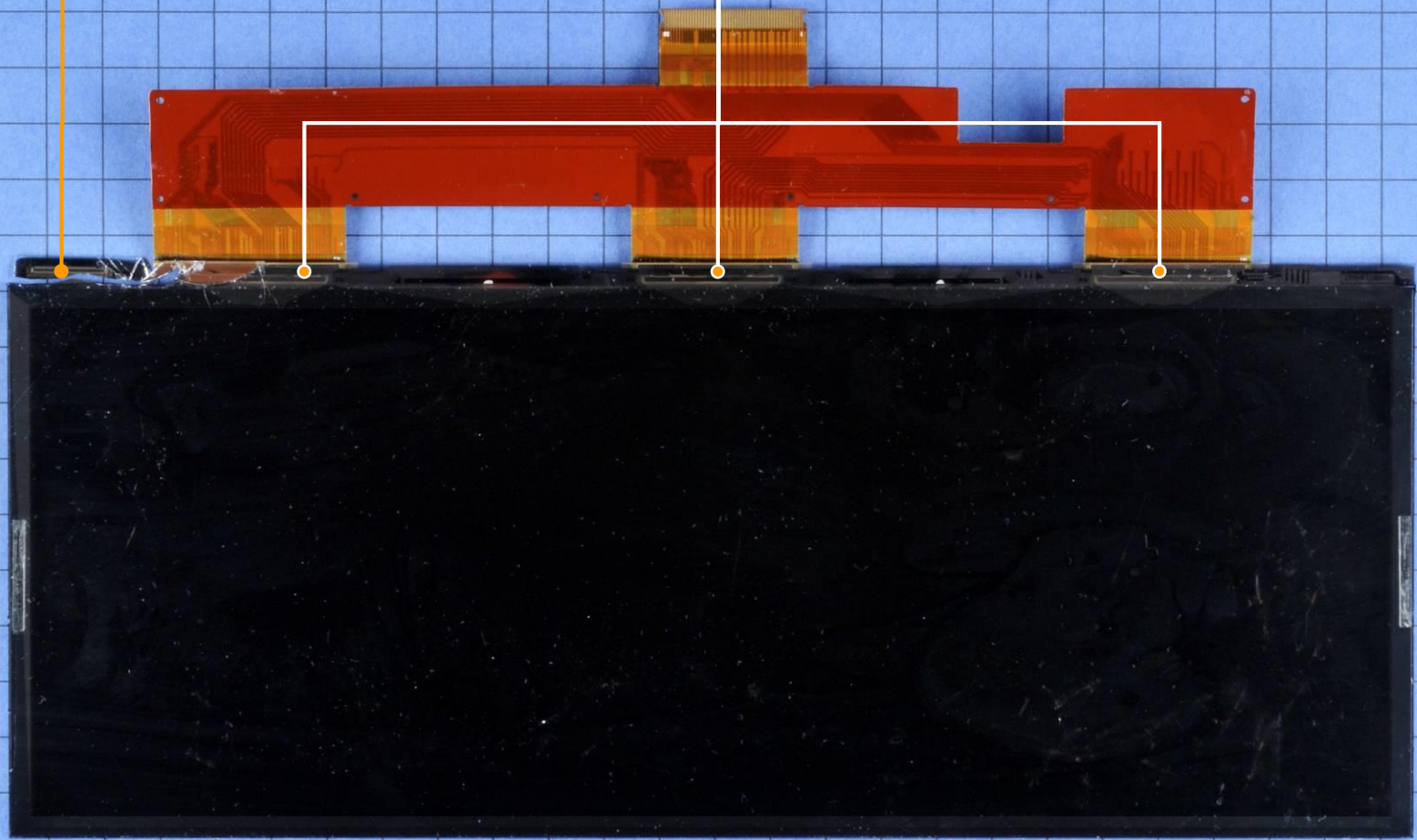
Grid = 1 cm

Shown with polarizers attached.

Display Subsystem

7 - Himax
#PA3271A
TFT-LCD Display Driver

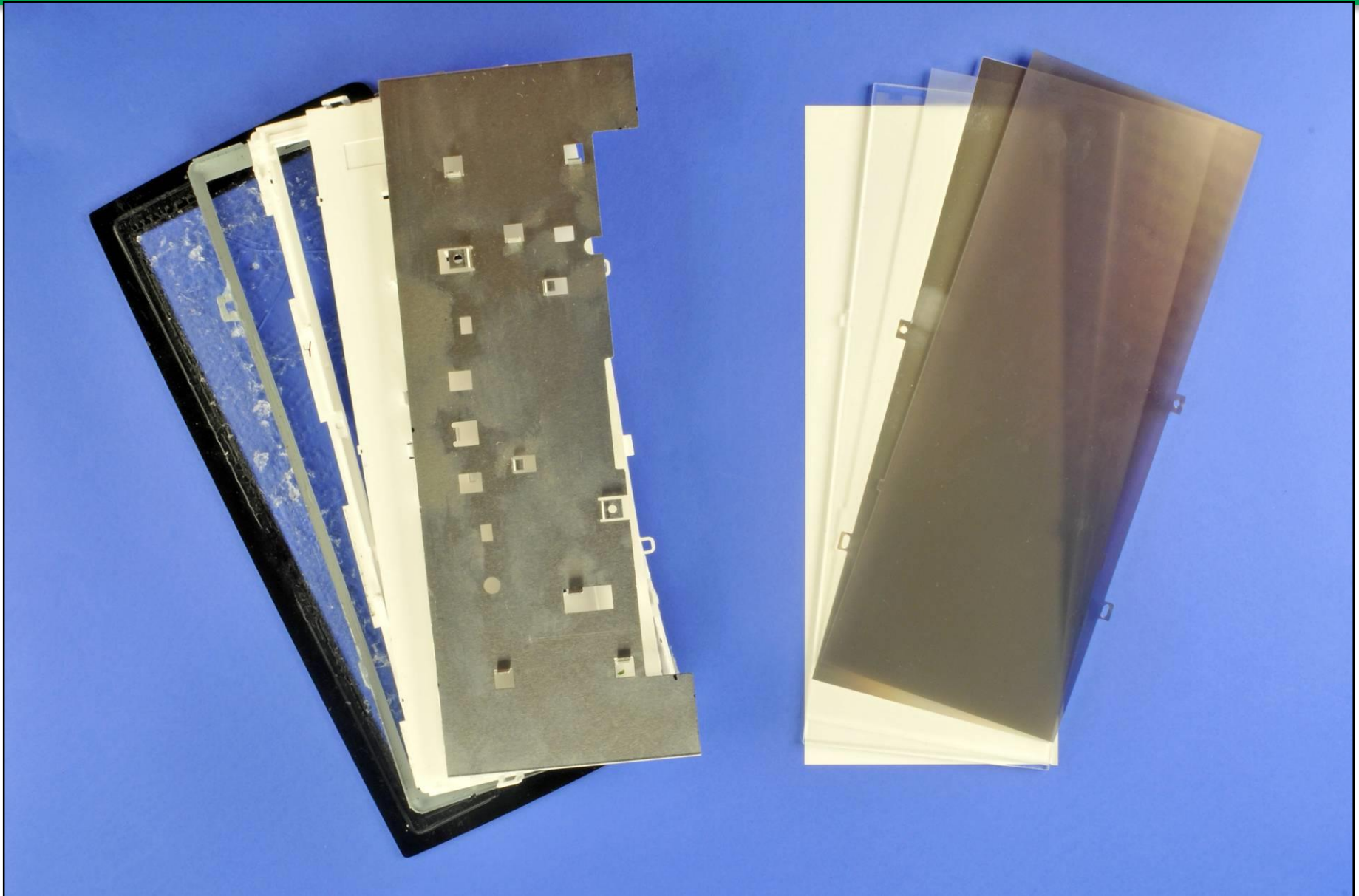
8 - Himax
#PA6538C
TFT-LCD Display Driver



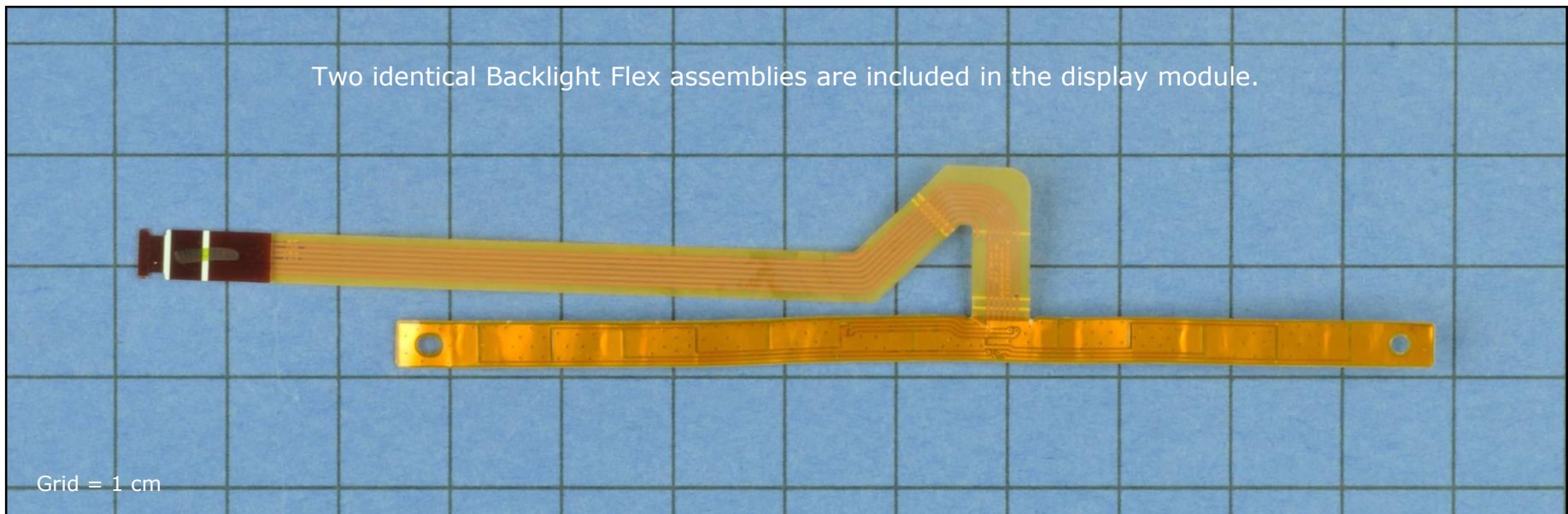
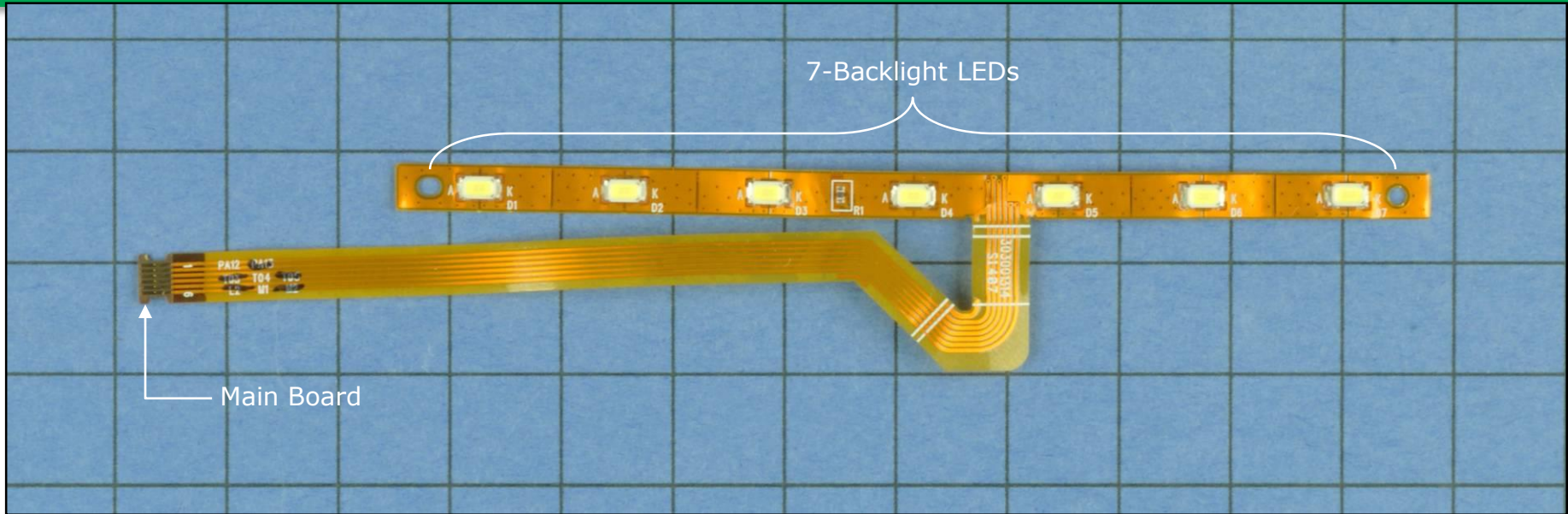
Shown with polarizers attached.

Grid = 1 cm

Display Subsystem



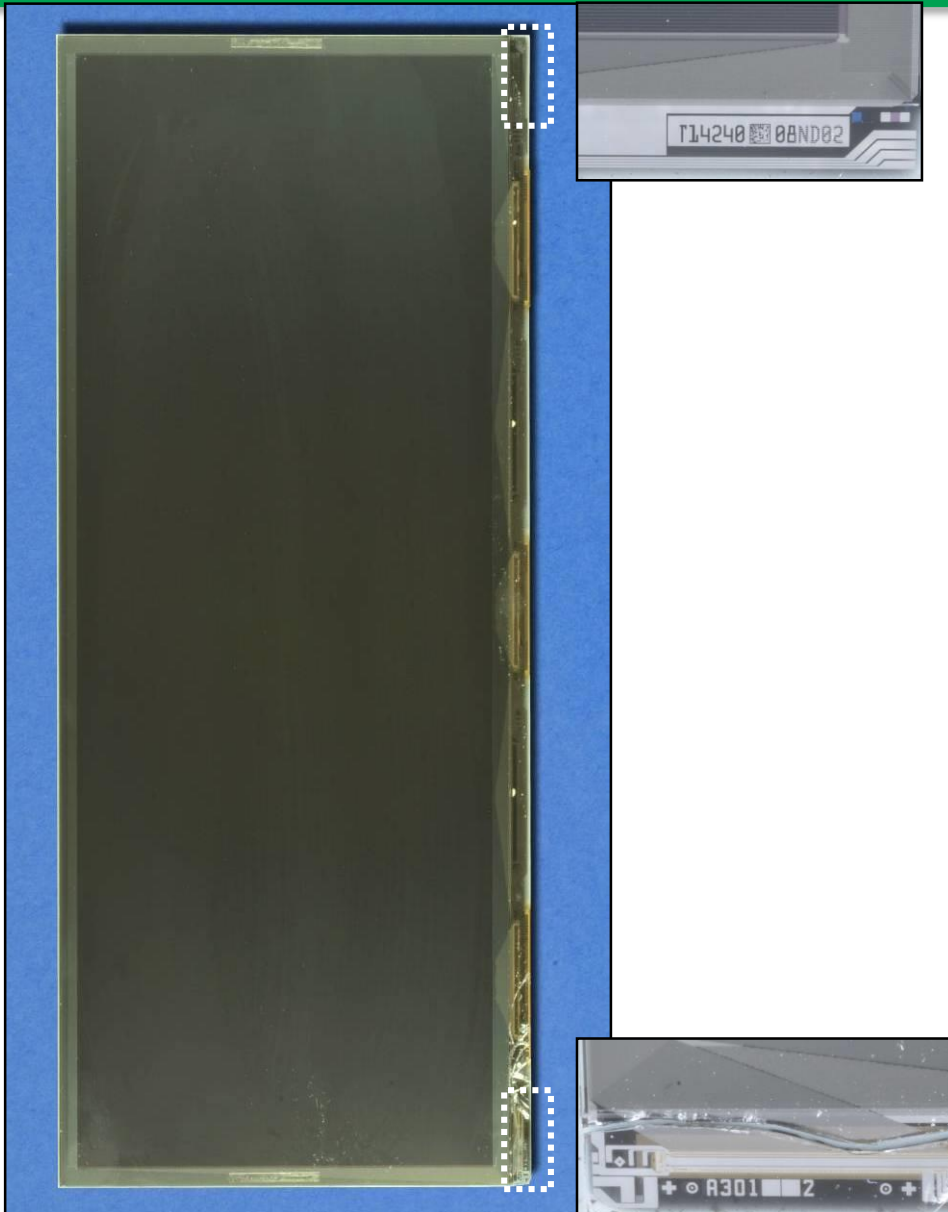
Display Subsystem



Display Subsystem



MUNRO
& ASSOCIATES, INC.

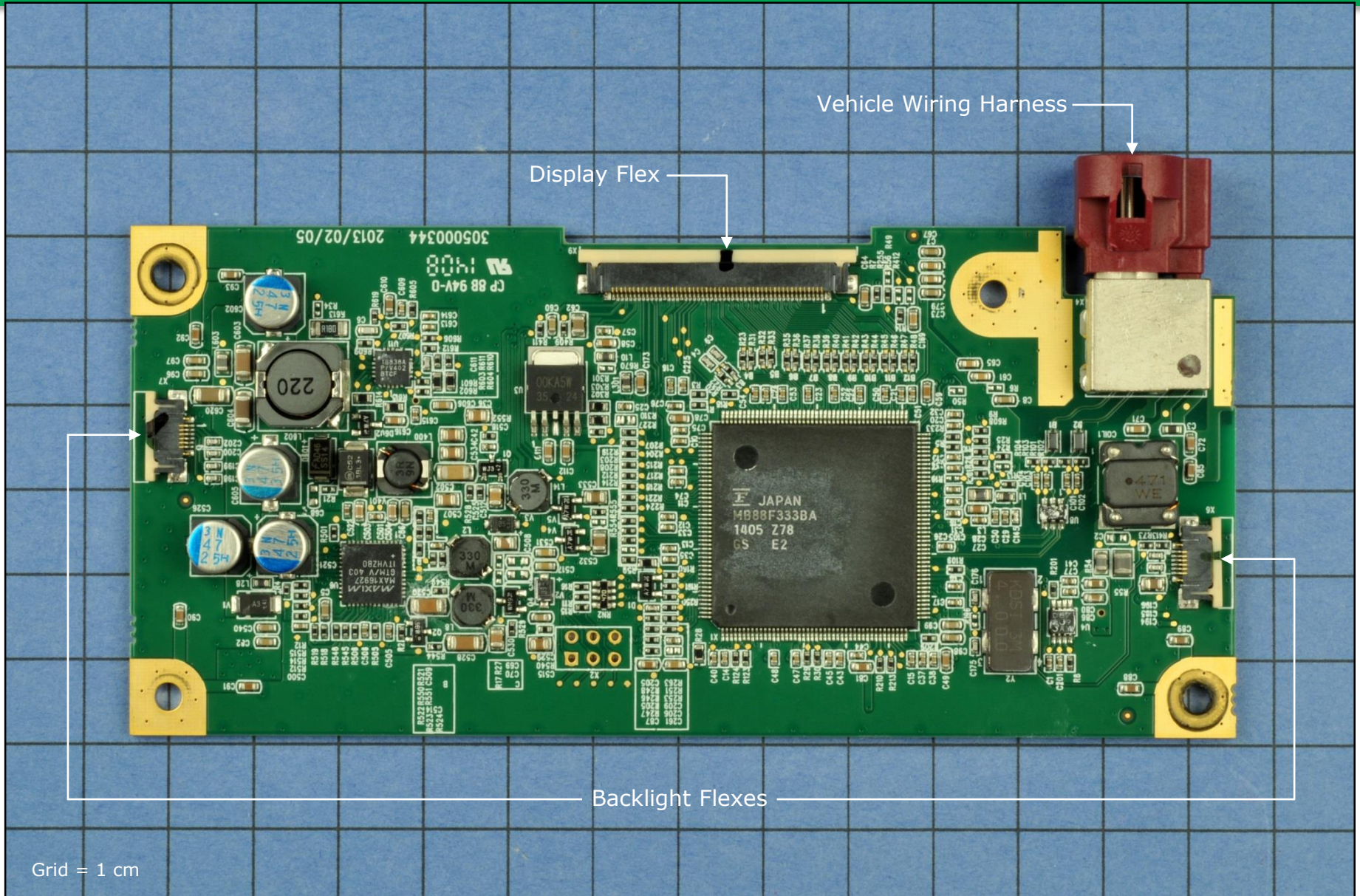


Display Module		
Brand	Unknown	
Part Number	Unknown	
Module Dimensions	264 x 109.3 x 18.1	
Weight (grams)	499.60	
Panel Metrics	View Size (mm)	92 x 244
	Type	TFT w/Chip-in-Glass
	Colors	16777216
	Rows / Columns	480 / 1280
	Backlighting Scheme	Edge lit - 2-flexes, 7 white LEDs ea
Estimated Costs	Panel(s)	\$14.04
	Electronic Parts	\$31.60
	Circuit Assembly	\$0.55
	Non-Electronic Parts	\$14.51
	Final Assembly	\$0.00
	Test	\$0.25
	Gross Margin	\$32.82
Estimated Module Price		\$93.77

Main Board (Side 1)



MUNRO
& ASSOCIATES, INC.



Grid = 1 cm

Main Board (Side 1 IC Identification)

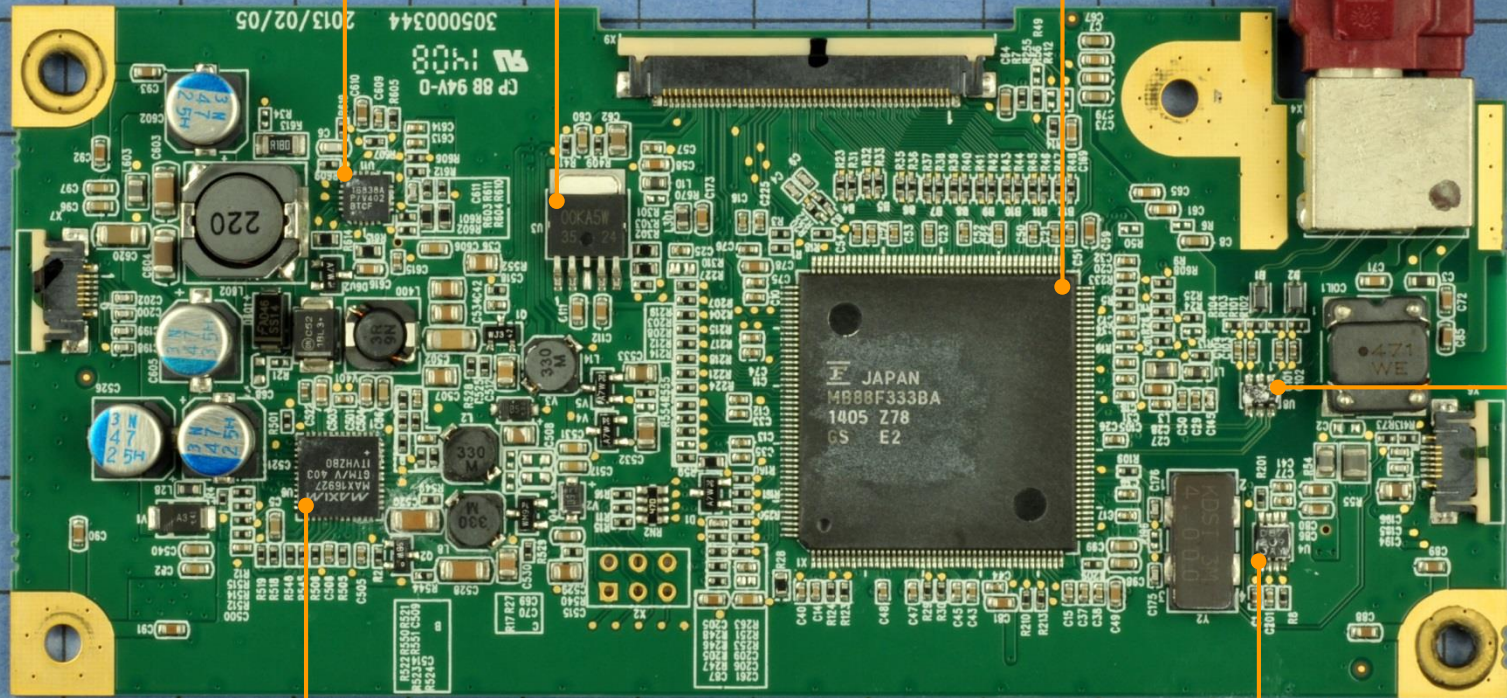


MUNRO
& ASSOCIATES, INC.

2 - Rohm
#BD00KA5W
500 mA Adjustable LDO Regulator

1 - Maxim
#MAX16838A
2-Channel LED Driver

3 - Fujitsu
#MB88F333BA
"Indigo-L" Graphics Controller



4 - Maxim
#MAX16927
Automotive TFT-LCD Power Supply

5 - Rohm
#BD87A29
2.9V Voltage Detector w/ Watchdog Timer

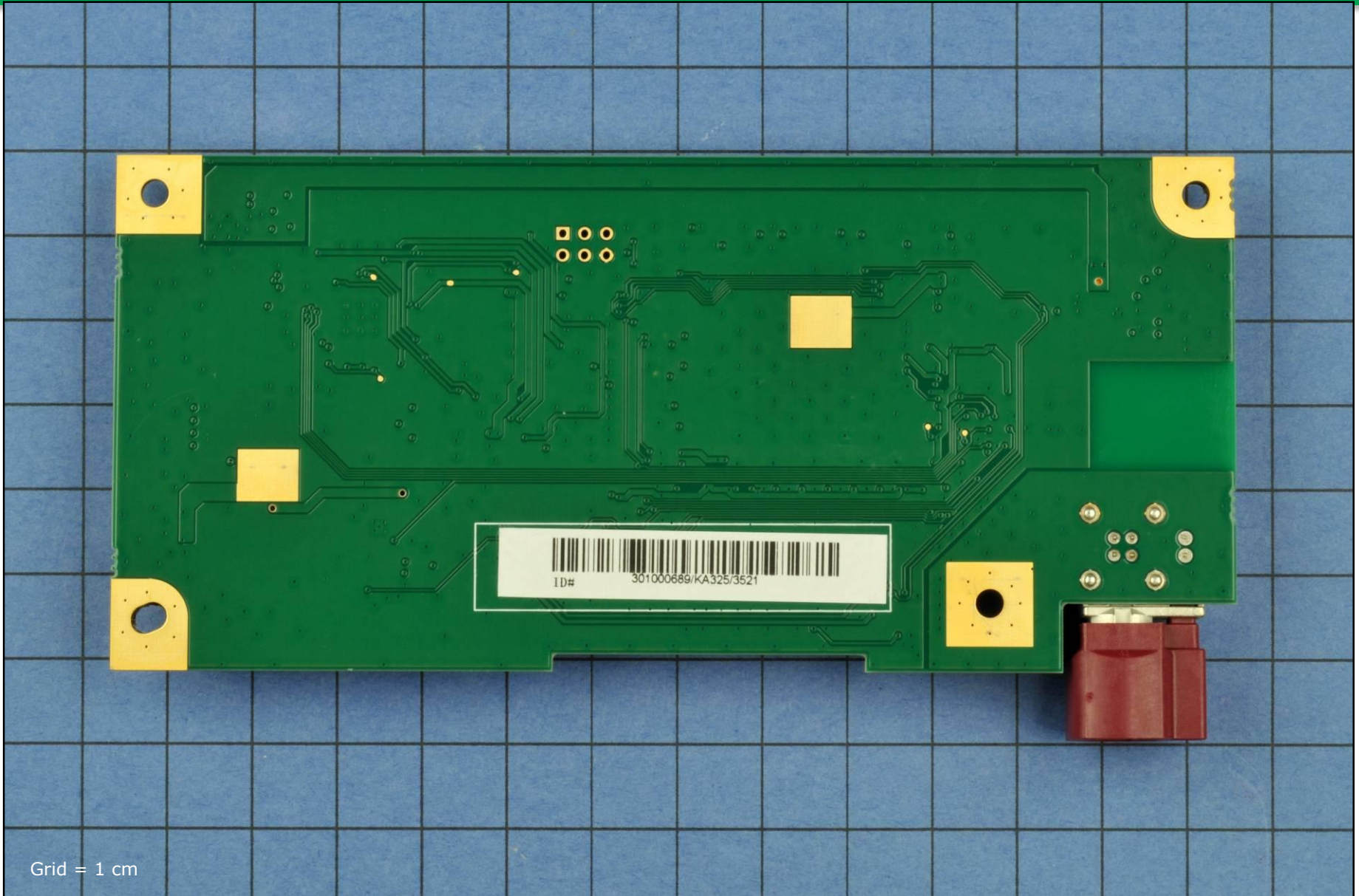
6 - Semtech
#SRV05-4A
ESD Protection

Grid = 1 cm

Main Board (Side 2)

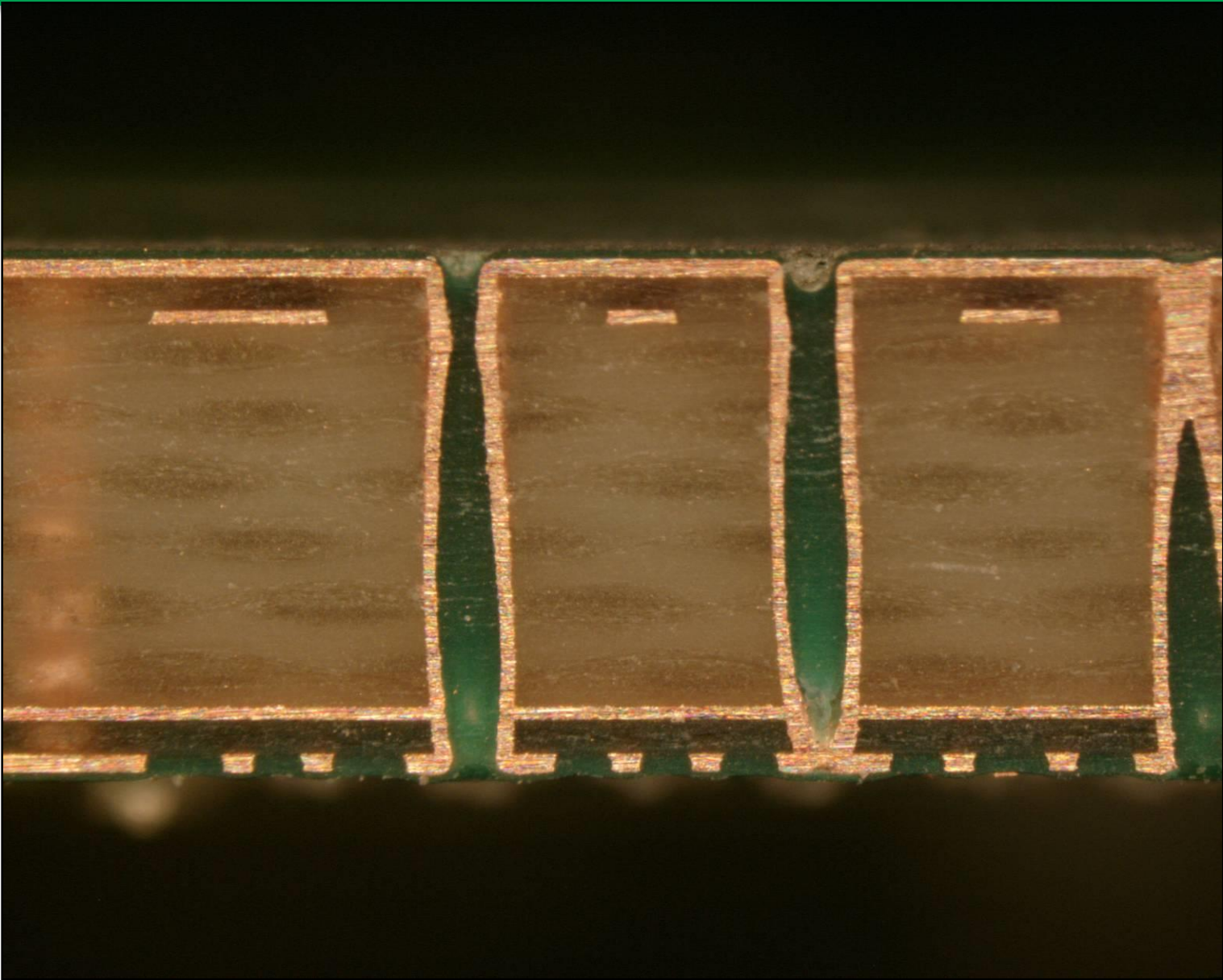


MUNRO
& ASSOCIATES, INC.



Grid = 1 cm

Main Board Cross-Section



Substrate Data



Substrates

Assembly Name	Manufacturer	Core Material	Mfg. Technology	Layers	Area (cm ²)	Min. Trace Pitch (mm)	Min. Trace Width (mm)	ThruVia Land Dia (mm)	ThruVia Hole Dia (mm)	BlindVia Land Dia (mm)	BlindVia Hole Dia (mm)	Thickness (mm)	Routing Density	Estimated Costs
Main Brd	Shenzhen Kinwong Electronic Co LTD	FR4	4 Layer conventional FR4 / HF	4	75.6	0.60	0.30	0.60	0.35			1.6	18.7	\$ 1.25

Integrated Circuit Components



MUNRO
& ASSOCIATES, INC.

Location	Package Info									Die Info							Estimated Costs		
	Pkg Ref. #	Pkg Qty	Brand Name	Part Number	Pkg Description	Form	Pin Count	Length (mm)	Width (mm)	Height (mm)	Die Ref #	Die Qty	Brand Name	Part Number	Description	Length (mm)	Width (mm)	Each	Total
Main Brd, Side 1	1	1	Maxim	MAX16838A	2-Channel LED Driver	QFN	20	4.00	4.00	0.85	1.1	1	Maxim	5P22Z	2-Channel LED Driver	2.20	1.90	\$ 1.500	\$ 1.500
	2	1	Rohm	BD00KA5W	500 mA Adjustable LDO Regulator	TO	5	6.70	5.50	2.40	2.1	1	Rohm	CU102	500 mA Adjustable LDO Regulator	1.50	1.50	\$ 0.171	\$ 0.171
	3	1	Fujitsu	MB88F333BA	"Indigo-L" Graphics Controller	QFP	176	24.00	24.00	1.40	3.1	1	Fujitsu	MB88F333	"Indigo-L" Graphics Controller	6.70	6.70	\$ 12.100	\$ 12.100
	4	1	Maxim	MAX1692Z	Automotive TFT-LCD Power Supply	QFN	48	7.00	7.00	0.80	4.1	1	Maxim	AP14Z	Automotive TFT-LCD Power Supply	3.50	2.90	\$ 4.130	\$ 4.130
	5	1	Rohm	BD87A29	2.9V Voltage Detector w/ Watchdog Timer	SOP	8	3.00	2.70	0.80	5.1	1	Rohm	CL476	Voltage Detector w/ Watchdog Timer	1.50	1.40	\$ 0.440	\$ 0.440
	6	1	Semtech	SRV05-4A	ESD Protection	SOP	6	3.10	1.50	1.10	6.1	1	Semtech	SRV05-4A	ESD Protection	1.40	0.70	\$ 0.087	\$ 0.087
Totals		6					263					6							\$18.43

Note: Supplemental information, such as IC package & die markings, is included in the Excel Bill of Materials (BOM) spreadsheet.

Subsystem IC Components



Note: The ICs listed below are for reference only.
Their costs are integrated into the cost of the individual subsystems.

Location	Package Info									Die Info						Estimated Costs			
	Pkg Ref. #	Pkg Qty	Brand Name	Part Number	Pkg Description	Form	Pin Count	Length (mm)	Width (mm)	Height (mm)	Die Ref #	Die Qty	Brand Name	Part Number	Description	Length (mm)	Width (mm)	Each	Total
Display Module: Display Flex	7	1	Himax	PA3271A	TFT-LCD Display Driver	Flip Chip, Adhesive	662	13.60	1.00	0.25	7.1	1	Himax	PA3271A	TFT-LCD Display Driver	13.60	1.00	\$ 2.270	\$ 2.270
	8	3	Himax	PA6538C	TFT-LCD Display Driver	Flip Chip, Adhesive	1495	25.00	1.40	0.23	8.1	1	Himax	PA6538C	TFT-LCD Display Driver	25.00	1.40	\$ 5.500	\$ 16.500
Totals		4					5147					4							\$18.77

Note: Supplemental information, such as IC package & die markings, is included in the Excel Bill of Materials (BOM) spreadsheet.

Modular Components



Location	Qty	Brand Name	Part Number	Description	Package			Estimated Costs	
					Pin Count	Length (mm)	Width (mm)	Each	Total
Main Brd, Side 1	1	KDS Daishinku	DSX151GAL	Resonator: Resonator	2	11.80	5.50	\$ 0.180	\$ 0.180
	1	Unknown	471 WE	Transformer: Transformer	4	10.00	8.70	\$ 1.890	\$ 1.890
TOTALS	2				6				\$2.07

Active Discrete Components



Location	Qty	Functional Description	Package					Estimated Costs	
			Form	Top Marking	Pin Count	Length (mm)	Width (mm)	Each	Total
Main Brd, Side 1	7	Small Active	Transistor, Small	A7W 3d, 6BW 3o, WM9 3d, WJ3 42	3	2.80	1.30	\$0.030	\$0.209
	2	Small Active	Diode, SMT	B5 t3d	2	2.70	1.70	\$0.015	\$0.030
	1	Small Active	Diode, SMT	A3 t3	2	3.70	2.60	\$0.015	\$0.015
	1	Small Active	Diode, SMT	ON C52 1BL3.	2	4.20	3.60	\$0.015	\$0.015
	1	Small Active	Diode, SMT	AD46 SS14	2	4.30	2.70	\$0.015	\$0.015
TOTALS	12				31				\$0.28

Passive Discrete Components



Location	Qty	Functional Description	Package		Estimated Costs	
			Form	Pin Count	Each	Total
Main Brd, Side 1	1	Capacitor	Electrolytic, Small	2	\$0.040	\$0.040
	2	Small Passive	Coil, Inductor	4	\$0.008	\$0.016
	5	Coil	SMT, Small	2	\$0.050	\$0.250
	3	Capacitor	Electrolytic, Small	2	\$0.040	\$0.120
	1	Small Passive	Res Array - 472	8	\$0.007	\$0.007
	1	Small Passive	Res - R180	2	\$0.004	\$0.004
	279	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$1.116
TOTALS	292			594		\$1.55

Connectors

Location	Qty	Form	Package			Estimated Costs	
			Pin Count	Length (mm)	Width (mm)	Each	Total
Main Brd, Side 1	2	Connector: ZIF - Backlight Flexes	6	10.60	4.60	\$0.092	\$0.184
	1	Connector: ZIF - Display Flex	50	30.70	5.40	\$0.400	\$0.400
	1	Connector: Vehicle Wiring Harness	6	27.50	15.60	\$0.250	\$0.250
TOTALS	4		68				\$0.83

Electronic Assembly Metrics



MUNRO
& ASSOCIATES, INC.

Electronic Assembly Metrics by Assembly

General Area	Assembly Name	Substrate Area (sq.cm)	Metal Layers	Circuit Area (sq.cm)	Routing Density (cm of routing per sq.cm of substrate)	Number of Components	Number of Connections	Component Density (Components/sq.cm)	Connection Density (Connections/sq.cm)	Avg. Pin Count	Assembly Weight (grams)
Main Electronics	Main Brd	75.6	4	302.4	18.7	316	962	4.2	12.7	3.0	47.60
Main Electronics Totals		75.6	4	302.4		316	962	4.2	12.7	3.0	47.60
Subsystem Electronics	Display Module: Backlight Flex1	8.4	2	16.8	5.9	8	16	1.0	1.9	2.0	0.30
Subsystem Electronics	Display Module: Backlight Flex2	8.4	2	16.8	5.9	8	16	1.0	1.9	2.0	0.30
Subsystem Electronics	Display Module: Display Flex	56.5	2	113.0	272.6	59	5257	1.0	93.0	89.1	3.20
Subsystem Electronics Totals		73.3	6	146.6		75	5289	1.0	72.2	70.5	3.80
	System Totals	148.9	10	449		391	6251	2.6	42.0	16.0	51.40

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Electronics Costs by Assembly										
General Area	Assembly Name	Total	Integrated Circuits	Modular & Odd Form Components	Small Active Components	Passive Components	Connector Components	Substrates	Insertion	Card Test
Main Electronics	Main Brd	\$ 26.71	\$ 18.43	\$ 2.07	\$ 0.28	\$ 1.55	\$ 0.83	\$ 1.25	\$ 1.66	\$ 0.63
Main Electronics Totals		\$ 26.71	\$ 18.43	\$ 2.07	\$ 0.28	\$ 1.55	\$ 0.83	\$ 1.25	\$ 1.66	\$ 0.63
Subsystem Electronics	Display Module	\$ 32.40	\$ 18.77	\$ -	\$ 0.75	\$ 0.22	\$ -	\$ 11.87	\$ 0.55	\$ 0.25
Subsystem Electronics Totals		\$ 32.40	\$ 18.77	\$ -	\$ 0.75	\$ 0.22	\$ -	\$ 11.87	\$ 0.55	\$ 0.25
	System Totals	\$ 59.11	\$ 37.20	\$ 2.07	\$ 1.03	\$ 1.77	\$ 0.83	\$ 13.12	\$ 2.21	\$ 0.88

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Counts by Assembly

General Area	Assembly Name	IC Package Count	IC Connections	Modular/Odd Form Components	Modular/Odd Form Component Connections	Small Active Components	Small Active Component Connections	Passive Components	Passive Component Connections	Connectors	Connector Connections	Subsystem IOs	Opportunities
Main Electronics	Main Brd	6	263	2	6	12	31	292	594	4	68	0	1278
Main Electronics Totals		6	263	2	6	12	31	292	594	4	68	0	1278
Subsystem Electronics	Display Module	4	5147	0	0	17	34	54	108	0	0	50	5414
Subsystem Electronics Totals		4	5147	0	0	17	34	54	108	0	0	50	5414
	System Totals	10	5410	2	6	29	65	346	702	4	68	50	6692

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics

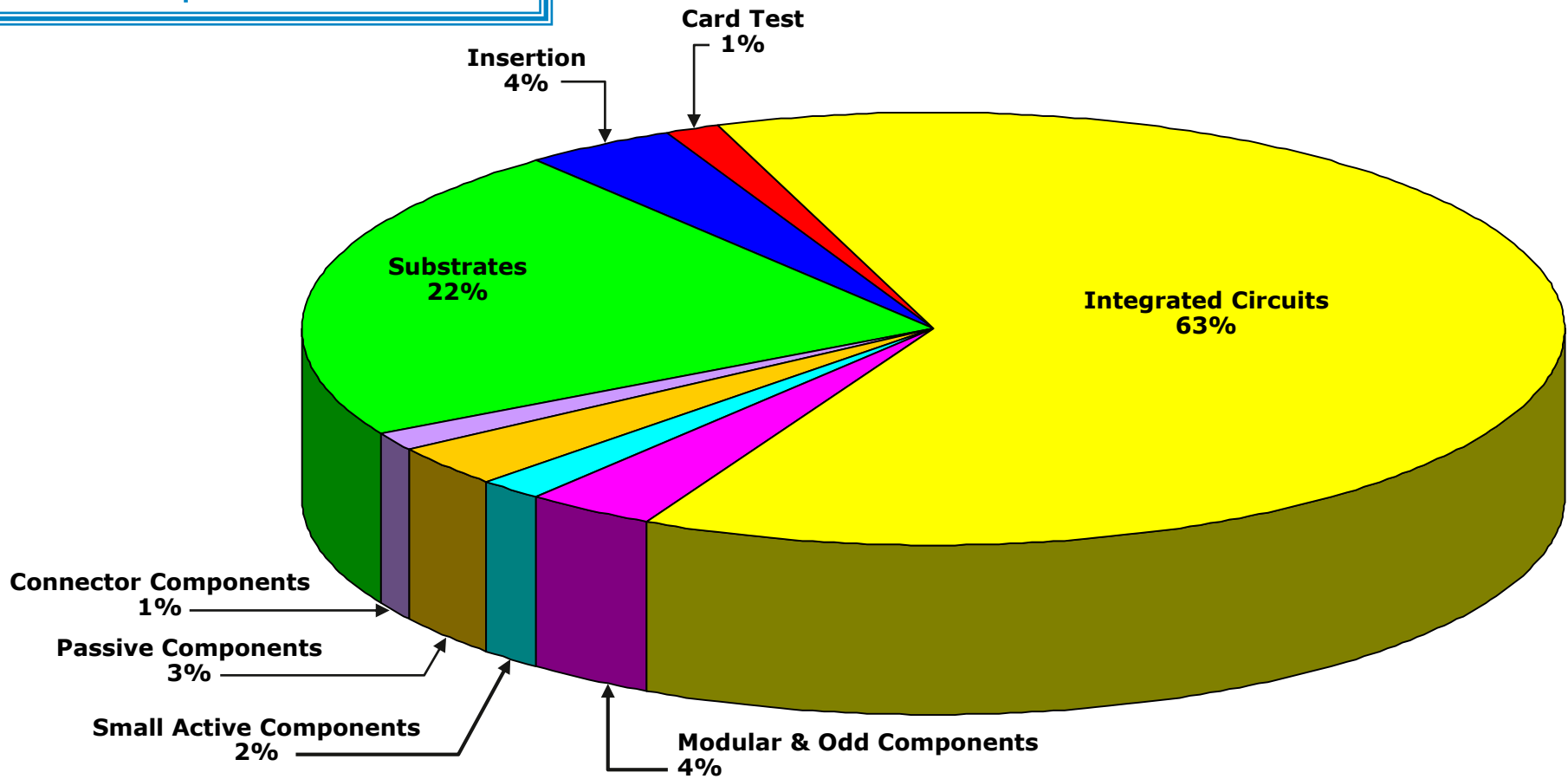


IC Metrics											
General Area	Assembly Name	IC Die Count	IC Package Count	Number of Package Connections	Die Area (sq.mm)	Substrate Tiling Density (die area / substrate area)	Package Area (sq.mm)	Die Area/Package Area Ratio	Package Connections per sq.cm of Package Area	Volatile Memory (KBytes)	Non-Volatile Memory (KBytes)
Main Electronics	Main Brd	6	6	263	64.6	0.01	690.6	0.09	38.1	0	0
Main Electronics Totals		6	6	263	64.6		690.6	0.09	38.1	0	0
Subsystems	Display Module	4	4	5147	118.6		118.6	1.00	43.4	0	0
Subsystem Electronics Totals		4	4	5147	118.6		118.6	1.00	4339.8	0	0
System Totals		10	10	5410	183.2		809.2	0.23	668.6	0	0

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Costs Breakdown

**Estimated Cost
of Electronics**
(Includes Subsystem Electronics)
\$59.11

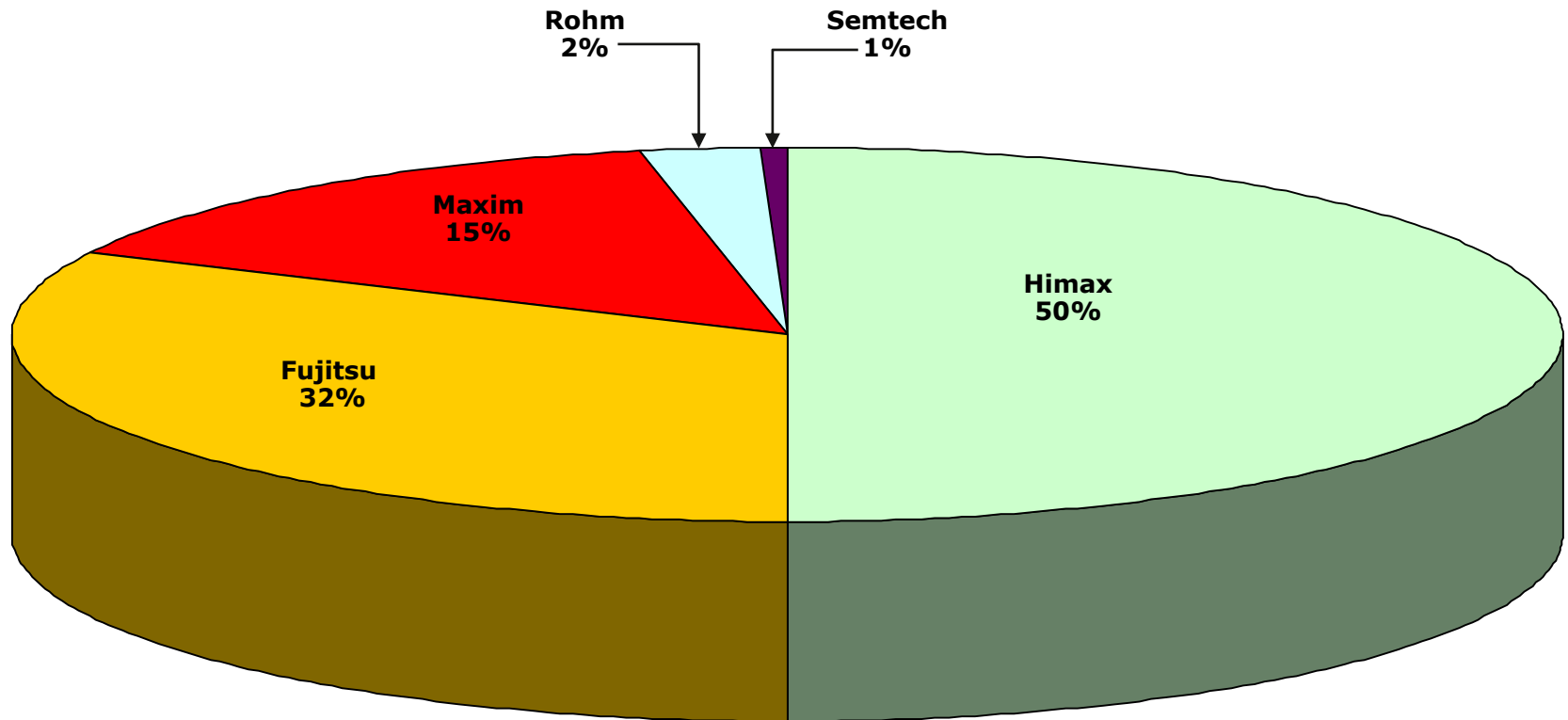


NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Vendor IC Cost Distribution

Pkg. Brand	Cost
Himax	\$18.77
Fujitsu	\$12.10
Maxim	\$5.63
Rohm	\$0.61
Semtech	\$0.09

* Includes Subsystem Vendors & Associated Costs



NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Non-Electronic Cost Estimate



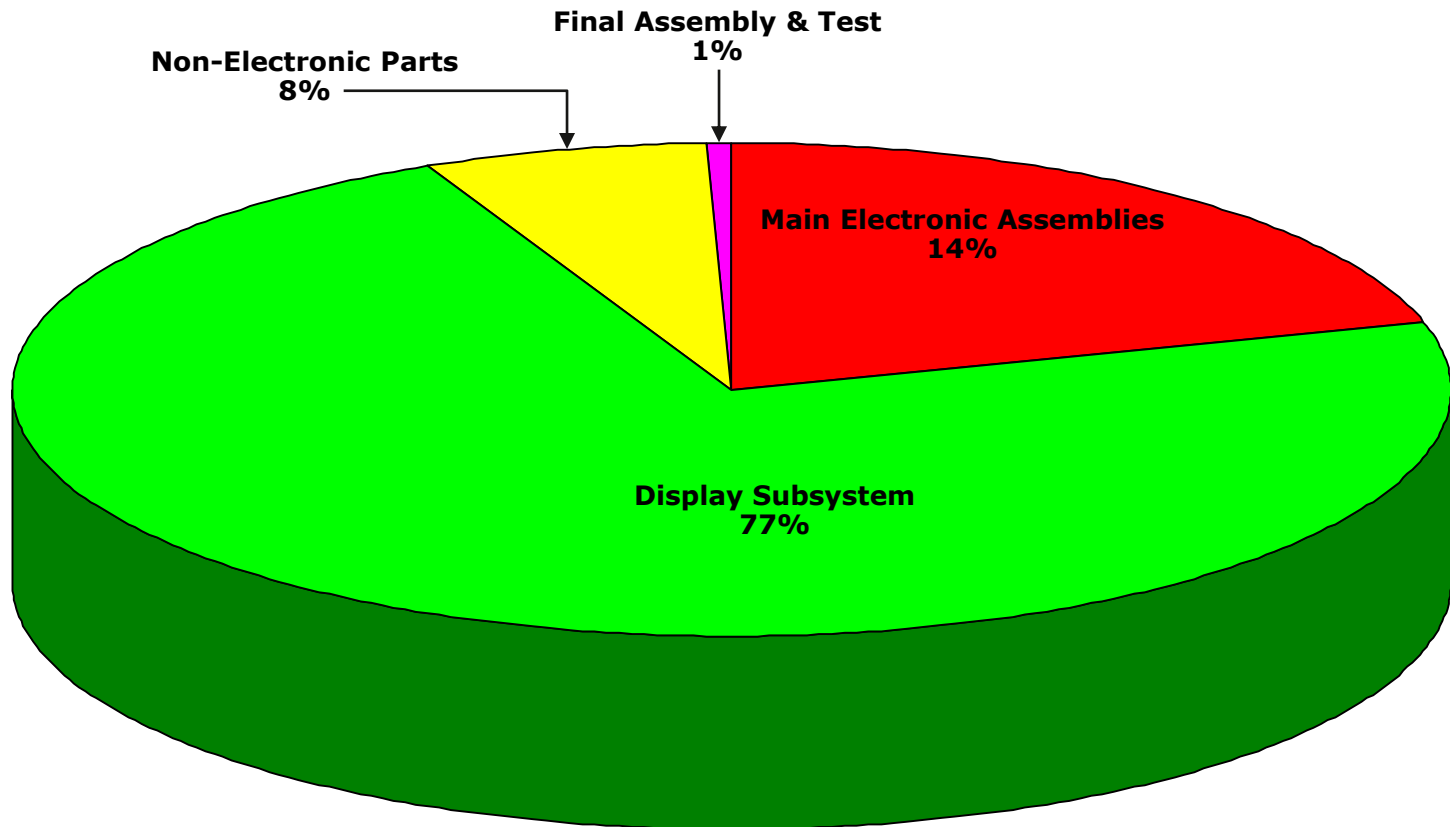
Subsystem	Part ID No.	Qty	Description	Fabrication Process	Material	Dimensions (mm)	Weight (grams)	Est'd Cost Each	Est'd Extended Cost	
Housing	1	1	Housing, Front	Molded	ABS	290 x 127.8 x 13.9	24.00	1.080	1.080	
	2	1	Housing, Rear	Molded	ABS	286 x 127.5 x 54.3	110.00	2.070	2.070	
	3	1	Housing, Inner	Cast	Aluminum	271 x 115 x 44	221.20	4.680	4.680	
Misc	4	2	Label, Bar Code - Large	Die-Cut + Printed	Paper	69.8 x 19.8 x 0.06	0.30	0.060	0.120	
	5	3	Label, Bar Code - Small	Die-Cut + Printed	Paer	37.9 x 5.5 x 0.06	0.15	0.050	0.150	
	6	1	Tape, Kapton	Die-Cut	Kapton	32.9 x 7.1 x 0.02	0.03	0.020	0.020	
	7	1	Label, QR Code	Die-Cut + Printed	Paper	9.7 x 7.8 x 0.06	0.02	0.030	0.030	
	8	6	Pad, Isolation	Die-Cut	Plastic	14 x 14 x 0.3	0.60	0.010	0.060	
	9	3	Tape, Black	Die-Cut	Plastic	39.5 x 13.2 x 0.07	0.03	0.010	0.030	
	10	2	Screw	Extruded + Threaded	Steel	13.5 x 4.1 x 2.6	0.60	0.020	0.040	
	11	3	RTV	Dispensed	Silicone	x	3.00	0.010	0.030	
Total		24						Estimated Cost		\$8.31

Final Ass'y Labor & Test Cost Estimate

Final Assembly & Test	
Made in	China
Number of parts	29
Est'd number of steps	93
Est'd time (seconds)	316
Est'd final assembly cost	\$ 0.24
Est'd final test cost	\$ 0.30

Cost Summary

Estimated Cost Totals	
Main Electronic Assemblies	\$ 26.71
Display(s)	\$ 93.77
Non-Electronic Parts	\$ 8.31
Final Assembly & Test	\$ 0.54
Total	\$ 129.34



Cost Estimation Process (Overview & Discussion)



MUNRO
& ASSOCIATES, INC.

Cost modeling is tricky business. Multiple variables affect the actual production costs a manufacturer will experience, including development expenses, unit volumes, supply-and-demand in component markets, die yield-curve maturity, OEM purchasing power, and even variations in accounting practices. Different cost modeling methods employ different assumptions about how to handle these and other variables, but we can identify two basic approaches: that which seeks to track short-term variations in the inputs to the production process, and that which strives to maintain comparability of the output of the model across product families and over time.

TechInsights' philosophy in cost modeling is to emphasize consistency across products and comparability over time, rather than to track short-term fluctuations. During the past eight years, we have developed an estimation process that, while necessarily lacking an insider's knowledge of the cost factors that impact any one manufacturer, is reasonably accurate in its prediction of unit costs in high-volume production environments. We do not claim that the model will produce the "right" answer for your firm's environment. However, TechInsights does give customers a key analytical tool with a complete set of data in our Bill of Materials (BOM). The BOM allows readers to 1) scrutinize the assumptions behind our cost model and 2) modify the results based on substitution of their own component cost estimates where they have better information based on inside knowledge.

Our estimation process decomposes overall system cost into three major categories: Electronics, Mechanical, and Final Assembly. We begin by creating a complete electronics bill-of-materials (BOM). Each component from the largest ASIC to the smallest discrete resistor is entered into a BOM table with identifying attributes such as size, pitch, I/O count, package type, manufacturer, part number, estimated placement cost, and die size (if the component is an IC). Integrated circuit costs are calculated from measured die area. Using assumptions for wafer size, process type, number of die per wafer, defect density, and profit margin in combination with die area, an estimate of semiconductor cost is derived. Costs for discrete components and interconnect are derived from assumption tables which relate BOM line items to specific cost estimates by component type and estimates for part placement costs are included. For LCD display costs, we employ a model which tabulates expected cost from measurements of glass area, LCD type, and total pixel resolution. When market costs are available from alternative sources, LCD panel costs are taken from and referenced to these sources.

Costs of non-electronic components such as molded plastic enclosures and metallic components are measured in terms of weight, size, thickness, type of material, and complexity to arrive at their estimated cost. Other system items such as optics, antennae, batteries and displays are costed from a set of assumption tables derived from a combination of industry data, average high volume costs, and external sources. For final assembly, we re-build the torn-down product, tabulating stepwise assembly times as the reconstruction proceeds, to reach a total assembly time. Using a labor rate assumption for the country of origin, we then calculate final assembly cost.

The three major categories for system cost contributors can be broken down into the subcategories of ICs, other electronics parts, displays, batteries (as appropriate), camera modules, electronics assembly, non-electronic elements, and final assembly. By adding the cost estimates for each of these subcategories, an overall estimated cost is derived for the system under evaluation. Product packaging and accessories (CDs, cables, etc.) are also documented and estimated for their contribution to total cost as appropriate.

We believe our cost estimates generally fall within 15 percent of the "right answer," which itself can vary depending on the market and OEM-specific factors mentioned earlier. While the TechInsights cost model is imperfect, it yields important insights into technology and business dynamics along with good first-order contributions to system cost by component type. Additionally, the consistency of approach and gradual modification to assumptions (smoothing out frequently-shifting pricing factors) hopefully yields a credible, but user-modifiable, view of OEM high volume cost-to-produce.

Please feel free to contact us at support@techinsights.com with any comments, questions, or proposed corrections with respect to our cost estimates. We welcome your input.

In our product teardowns, we gather a series of metrics for product profiling and comparison. Some metrics focus on system characteristics such as total silicon area, total system semiconductor storage capacity, and total connection count. Other metrics reflect more subtle aspects of electronics assembly such as connection density, average component I/O count, and silicon tiling density. Taken as a whole, the metrics allow deeper comparison and benchmarking across multiple disciplines and multiple products. Key metrics we gather on products are described below along with their definitions and what they tend to say about the system under study. Most metrics can be used both in comparing similar products for benchmarking purposes or for quantifying differences in levels of complexity between dissimilar product types. Data fall into two categories; either “raw” measured data or ratios of these measured data sets.

Total Silicon Area : This metric describes the total area of silicon as measured from X-ray or direct measurement of ICs. The area is an expression of the enclosed bare die area and excludes packaging area. The aggregate silicon area is a good benchmark to show how integrated a design might be when making comparisons to similar systems. Total silicon area also reflects the major cost driver for most systems we examine.

Silicon Tiling Density : Ratio of Total Silicon Area to total printed circuit board “projected” area (i.e. the simple board area and not the cumulative surface area of both sides of the board). This metric directly reflects the level of efficiency and aggressiveness in integrated circuit packing and placement. Single digit Silicon Tiling Density is typical but silicon coverage of 10% - 20% has been seen in some of the most advanced products we have examined. Higher Tiling Densities often correspond with the use of chip scale packaging (CSPs) or other small form-factor IC packaging technologies. High density circuit boards are also often a supporting technology.

Number of Parts : Total component count including ICs, passives, modules, connectors, etc., each separated out in our reporting.

Number of Connections : The total number of connections corresponds to the total number of interconnects introduced by the aggregate component set and reflects any electrical connection observed (solder joints, adhesive interconnect, or connector terminal interfaces).

Opportunity Count : Opportunity Count is the total number of parts plus the total number of connections; the name reflects that each of these constituent elements represents an opportunity for failure. A high opportunity count means more complex and riskier electronics assembly.

Average Pin Count (APC) : Ratio of total number of component terminals to total number of parts, at the system level. This metric reflects the ‘average’ terminal complexity of the components and often provide a signature of integration level and/or “digital-ness” of the overall product. Low APCs reflect a high number of discrettes or other low-pincount devices often characteristic of analog circuitry. Conversely, high APCs are characteristic of highly integrated, high-pincount assemblies, often those composed largely of digital integrated circuits.

Connection Density : This metric is a ratio of the total Number of Connections to total printed circuit board assembly area, in units of connections per sq. inch. The metric provides data related to the Silicon Tiling Density above, but with an emphasis on complexity of I/O interconnect. For example, with a fixed Connection Density, high tiling density of low-pincount memory chips is more readily achieved than comparable silicon tiling of high pincount logic.

Part Density : This metric is a ratio of the total Number of Parts to total printed circuit board assembly area, in units of components per sq. inch. The metric provides data related to the Silicon Tiling Density and Connection Density as described above, but with an emphasis on density and complexity of component packing efficiency. For example, low Part Density of high-pincount devices can pose an equal challenge in Connection Density to high Part Density of low-pincount devices. High Part Density does reflect challenges in surface mount assembly in terms of (typically) precision of placement, number of placements, and engineering of part clearances.

Routing Density (heuristic estimate) = $3 * (\text{Average Pin Count}) * \sqrt{\text{Part Density}}$. The Routing Density metric is an empirically derived relationship that characterizes the wiring density of the interconnect used to support the interconnection of components in a planar electronic assembly (i.e. the circuit board). Architectural issues such as bussing or other factors affecting the regularity of wiring impact the actual Routing Density needed to support a given application, but the metric provides a ready measure of wiring complexity.

***Click Here to Return to
Cost Analysis Page 74***

Deep Dive Report

BMW i3 Back-up Antenna Assembly

2245

Report #15900-150224-PKb



Product Description

This report concerns the Back-up Antenna Assembly for the 2014 BMW i3. This module features a secondary PCB antenna housed in a molded plastic top enclosure and a metal internal support.

DISCLAIMER: All company names, product names, and service names mentioned are used for identification purposes only and may be registered trademarks, trademarks, or service marks of their respective owners. All analyses are done without participation, authorization, or endorsement of the manufacturer. Any cost analyses presented in this material are estimates prepared by TechInsights from generally available data. While TechInsights believes that these estimates reflect the probable costs, the actual producer did not supply the data, and therefore the actual costs may be different from these estimates. Furthermore, TechInsights extends no warranties with respect to any information in this document, and shall bear no liability whatsoever for the use of the information.

Copyright © 2015, TechInsights. All rights reserved. Do not reproduce, distribute, disseminate, photocopy, fax, transmit, download to a shared database, or otherwise copy, transfer, sell, publish, or send this material, or any portion thereof, by any means without the express written permission of TechInsights.

Product Overview



Product Description		Integrated Circuit Metrics		
Product Type	Automotive	IC Die Count	0	
Brand	BMW	IC Package Count	0	
Product Name & Model #	i3 Back-up Antenna Assembly	Cost Metrics		
Official Release Date	5/2/2014			
Weight (grams)	8.5 (Measured)	Retail Price		
Product Dimensions (mm)	99.4 x 65.0 x 27.0 (Measured at Longest/Widest/Thickest Points)	Total Manufacturing Cost	\$5.39	
Product Features		Electronics Cost	\$1.35	
		Manufacturing Cost Breakdown		
		Discretes	\$0.01	0.2%
		Connectors	\$1.14	21.2%
		Substrates	\$0.11	2.0%
		Component Insertion	\$0.03	0.6%
		Card Test	\$0.06	1.1%
		Non-Electronics	\$3.76	69.8%
		Final Assembly & Test	\$0.28	5.2%
				Total



Estimated block diagram based on observation of this specific product implementation, manufacturer's data sheets where available, and best engineering judgment. Certain details of the interface circuitry are not reflected in this block diagram. Partitioning and connectivity are speculative.

BMW
BU9230911 04
108594 10

28330448



3217

09 - 04 - 14
ASSEMBLED IN MEXICO

Exterior Features



MUNRO
& ASSOCIATES, INC.



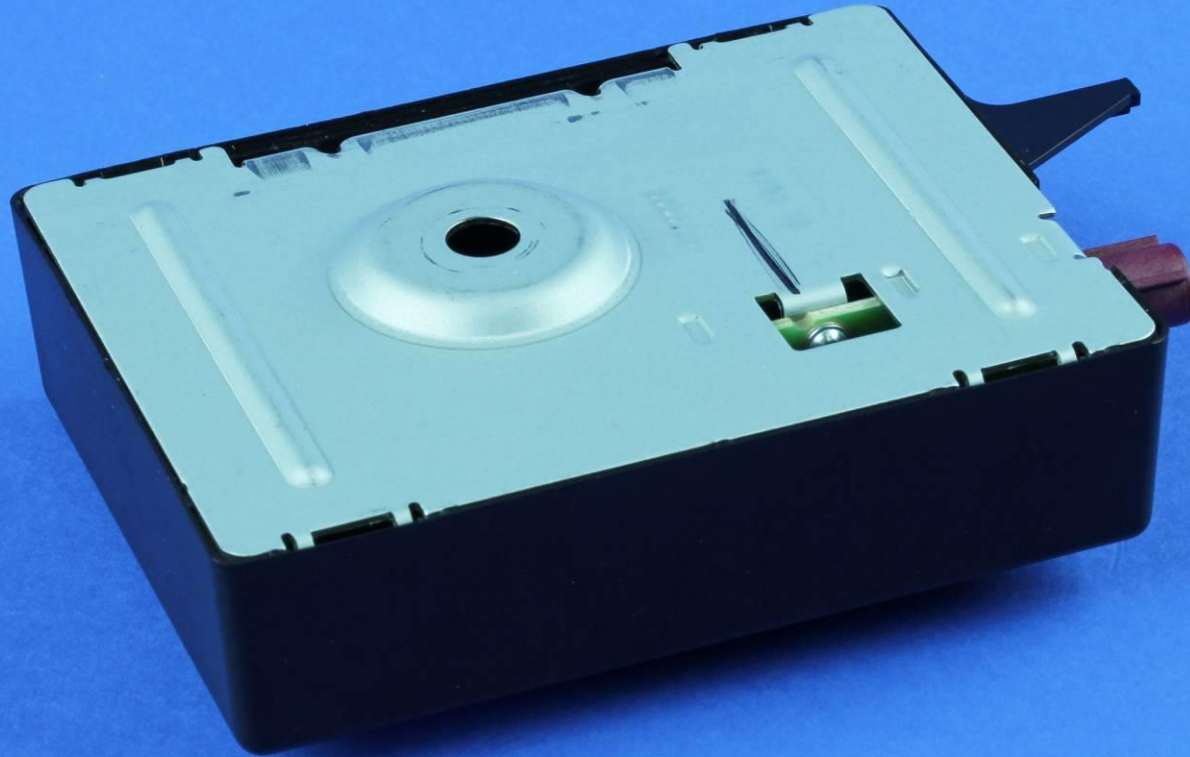
BMW 13 Back-up Antenna Asm.
2245 #15900-150224-PKb - Page

501

Exterior Features



MUNRO
& ASSOCIATES, INC.



BMW 13 Back-up Antenna Asm.
2245 #15900-150224-PKb - Page

502

Major Components (Side 1)



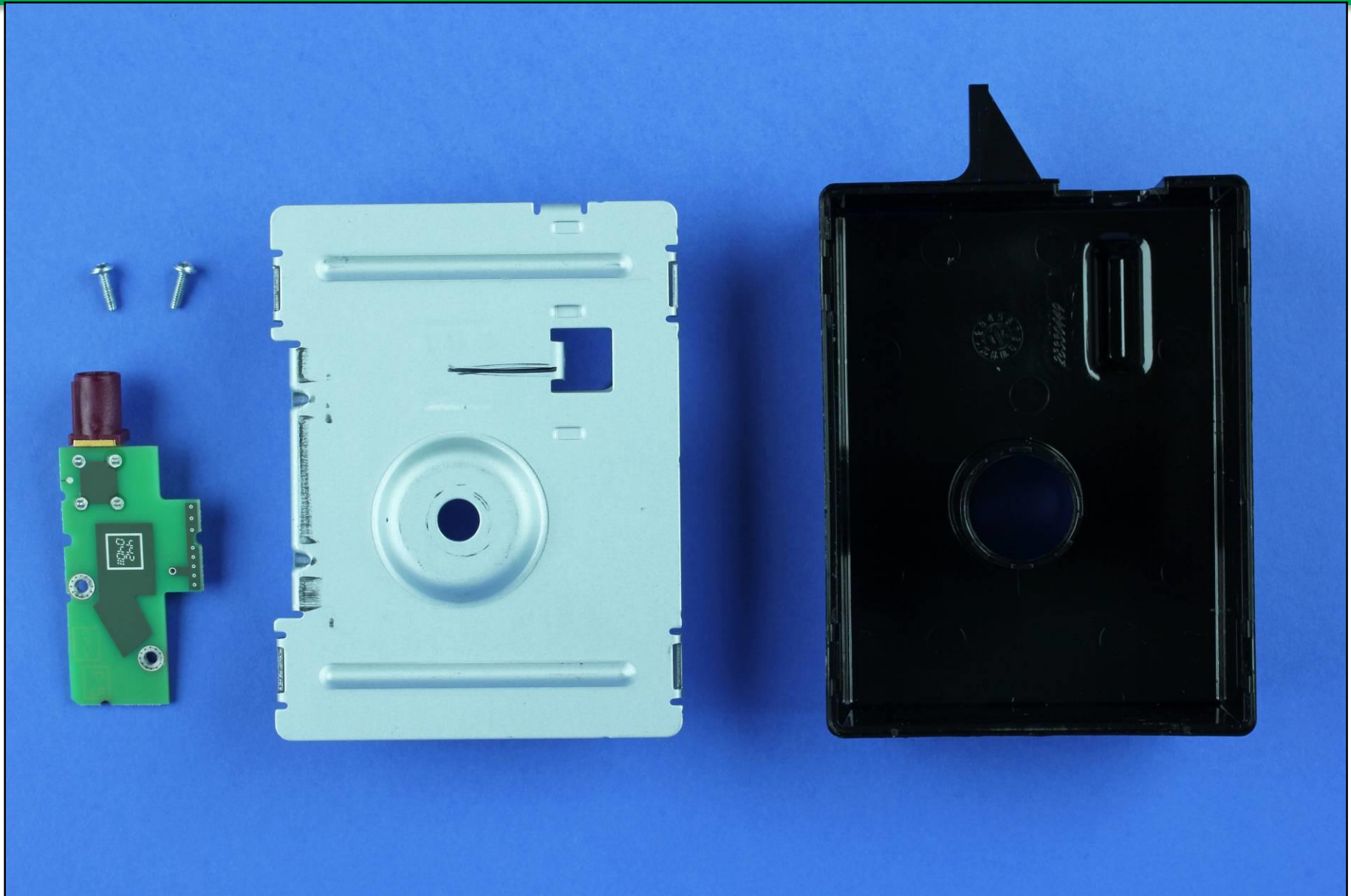
MUNRO
& ASSOCIATES, INC.



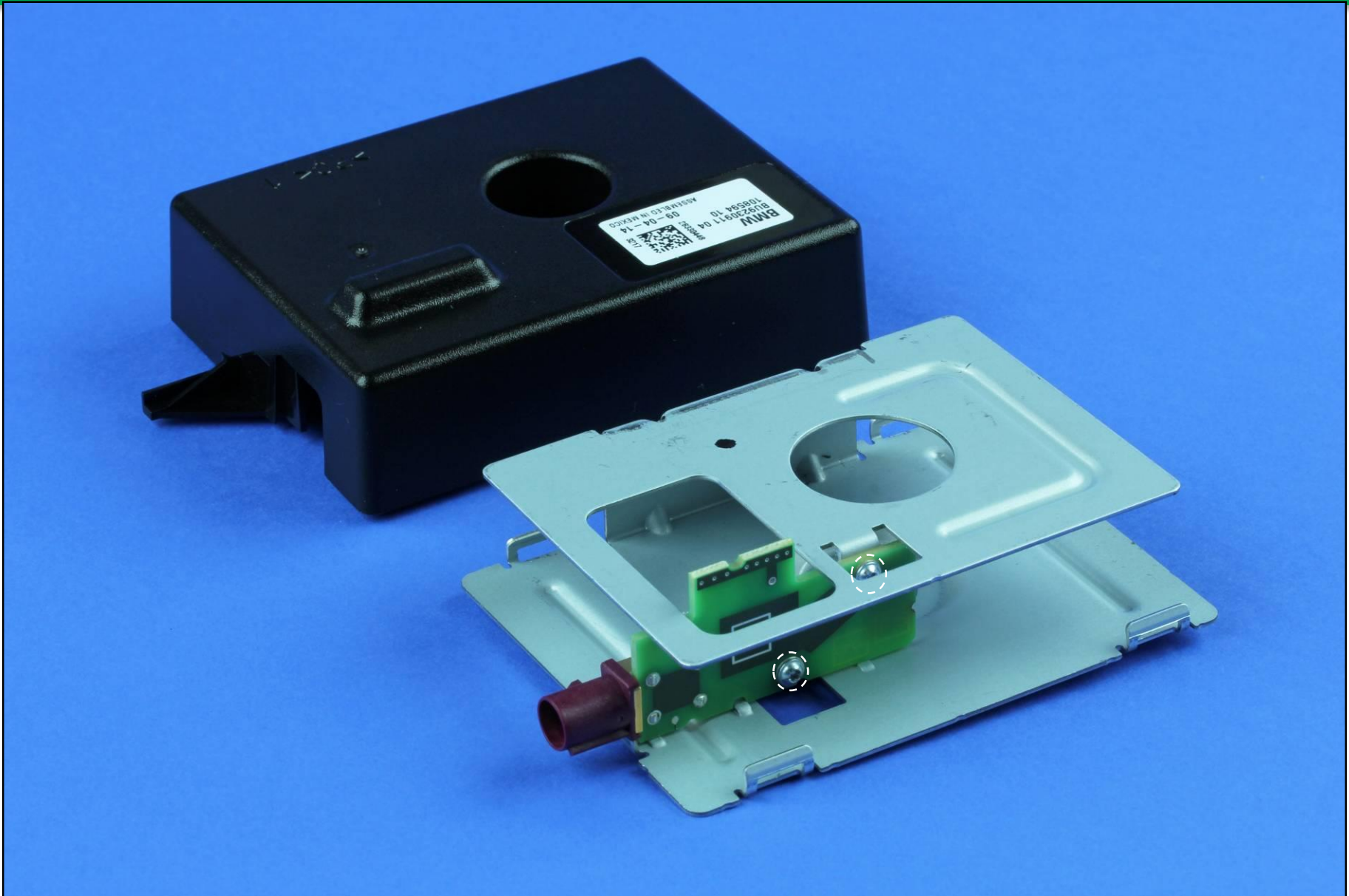
Major Components (Side 2)



MUNRO
& ASSOCIATES, INC.



Teardown Sequence



Teardown Sequence



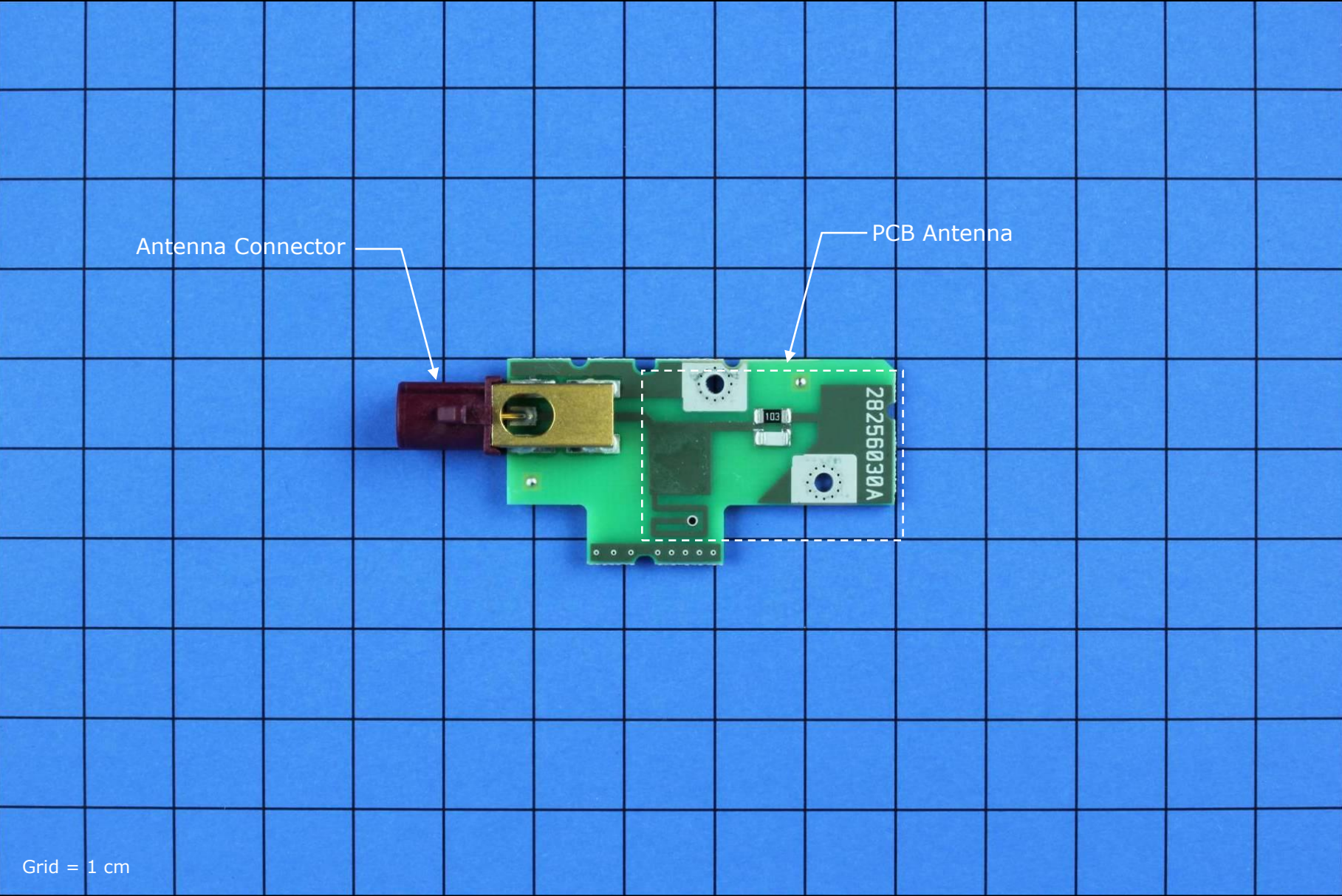
MUNRO
& ASSOCIATES, INC.



Main Board (Side 1)

Antenna Connector

PCB Antenna

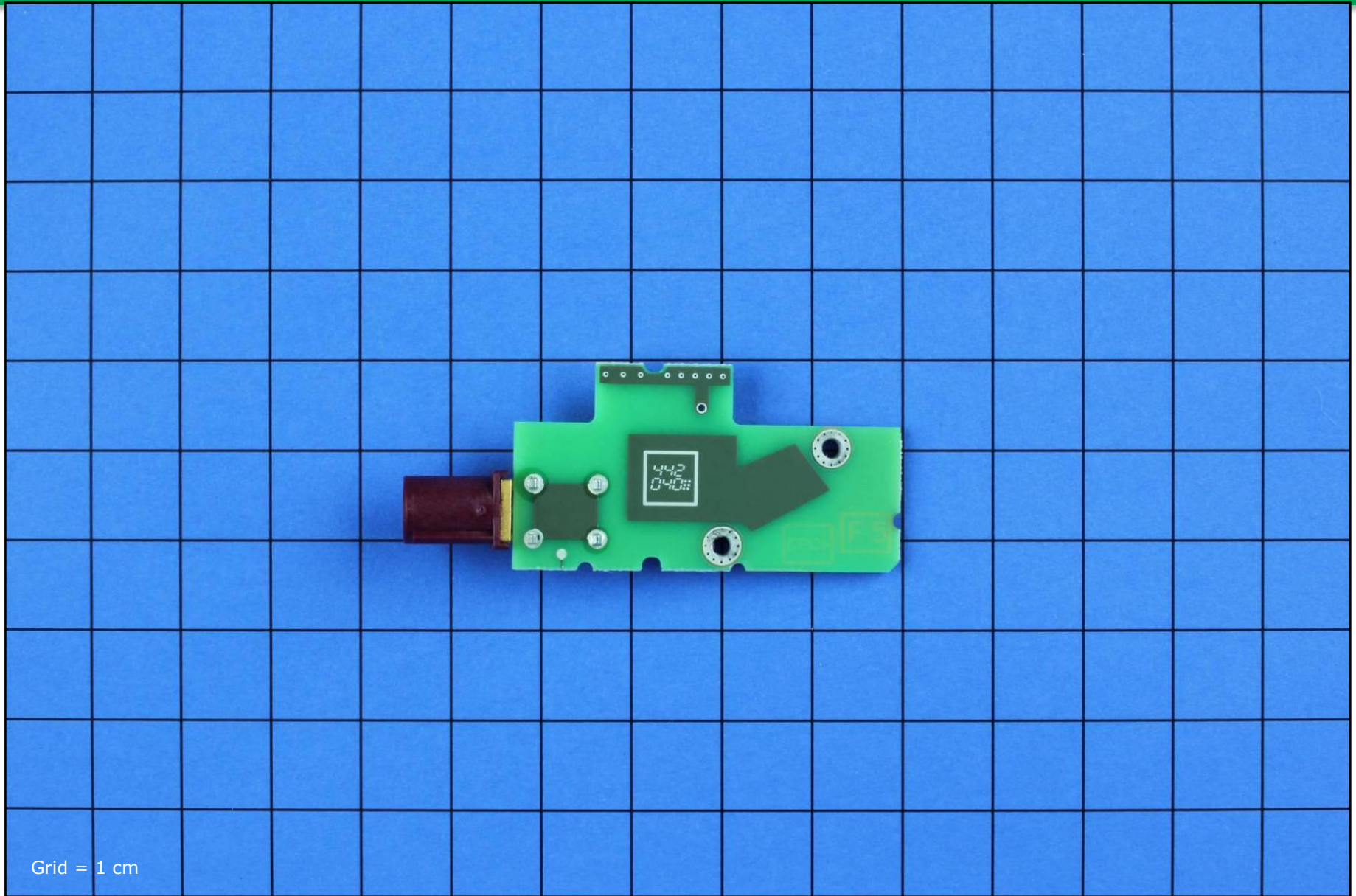


Grid = 1 cm

Main Board (Side 2)

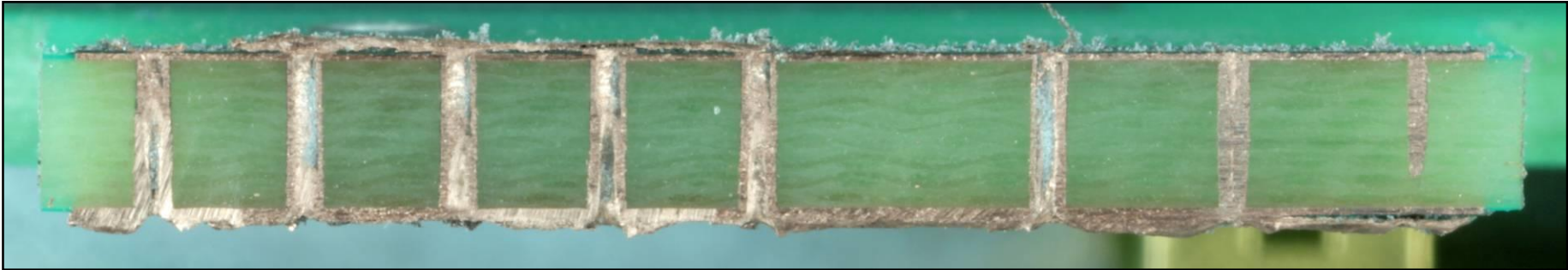


MUNRO
& ASSOCIATES, INC.



Grid = 1 cm

Main Board Cross-Section



Substrate Data



Substrates

Assembly Name	Manufacturer	Core Material	Mfg. Technology	Layers	Area (cm ²)	Min. Trace Pitch (mm)	Min. Trace Width (mm)	ThruVia Land Dia (mm)	ThruVia Hole Dia (mm)	BlindVia Land Dia (mm)	BlindVia Hole Dia (mm)	Thickness (mm)	Routing Density	Estimated Costs
Antenna Board	Unknown	FR4	2 Layer conventional FR4 / HF	2	7.6	1.28	0.65	1.29	0.81			1.6	3.1	\$ 0.11

Passive Discrete Components



Location	Qty	Functional Description	Package		Estimated Costs	
			Form	Pin Count	Each	Total
	2	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.008
TOTALS	2			4		\$0.01

Connectors



Location	Qty	Form	Package			Estimated Costs	
			Pin Count	Length (mm)	Width (mm)	Each	Total
Antenna Board, Side 1	1	Jack: Antenna	1	23.50	8.57	\$1.140	\$1.140
TOTALS	1		1				\$1.14

Electronic Assembly Metrics



Electronic Assembly Metrics by Assembly

General Area	Assembly Name	Substrate Area (sq.cm)	Metal Layers	Circuit Area (sq.cm)	Routing Density (cm of routing per sq.cm of substrate)	Number of Components	Number of Connections	Component Density (Components/sq.cm)	Connection Density (Connections/sq.cm)	Avg. Pin Count	Assembly Weight (grams)
Main Electronics	Antenna Board	7.6	2	15.2	3.1	3	5	0.4	0.7	1.7	4.90
	System Totals	7.6	2	15.2		3	5	0.4	0.7	1.7	4.90

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Electronics Costs by Assembly										
General Area	Assembly Name	Total	Integrated Circuits	Modular & Odd Form Components	Small Active Components	Passive Components	Connector Components	Substrates	Insertion	Card Test
Main Electronics	Antenna Board	\$ 1.35	\$ -	\$ -	\$ -	\$ 0.01	\$ 1.14	\$ 0.11	\$ 0.03	\$ 0.06
	System Totals	\$ 1.35	\$ -	\$ -	\$ -	\$ 0.01	\$ 1.14	\$ 0.11	\$ 0.03	\$ 0.06

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Counts by Assembly												
General Area	Assembly Name	IC Package Count	IC Connections	Modular/Odd Form Components	Modular/Odd Form Component Connections	Small Active Components	Small Active Component Connections	Passive Components	Passive Component Connections	Connectors	Connector Connections	Opportunities
Main Electronics	Antenna Board	0	0	0	0	0	0	2	4	1	1	8
	System Totals	0	0	0	0	0	0	2	4	1	1	8

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

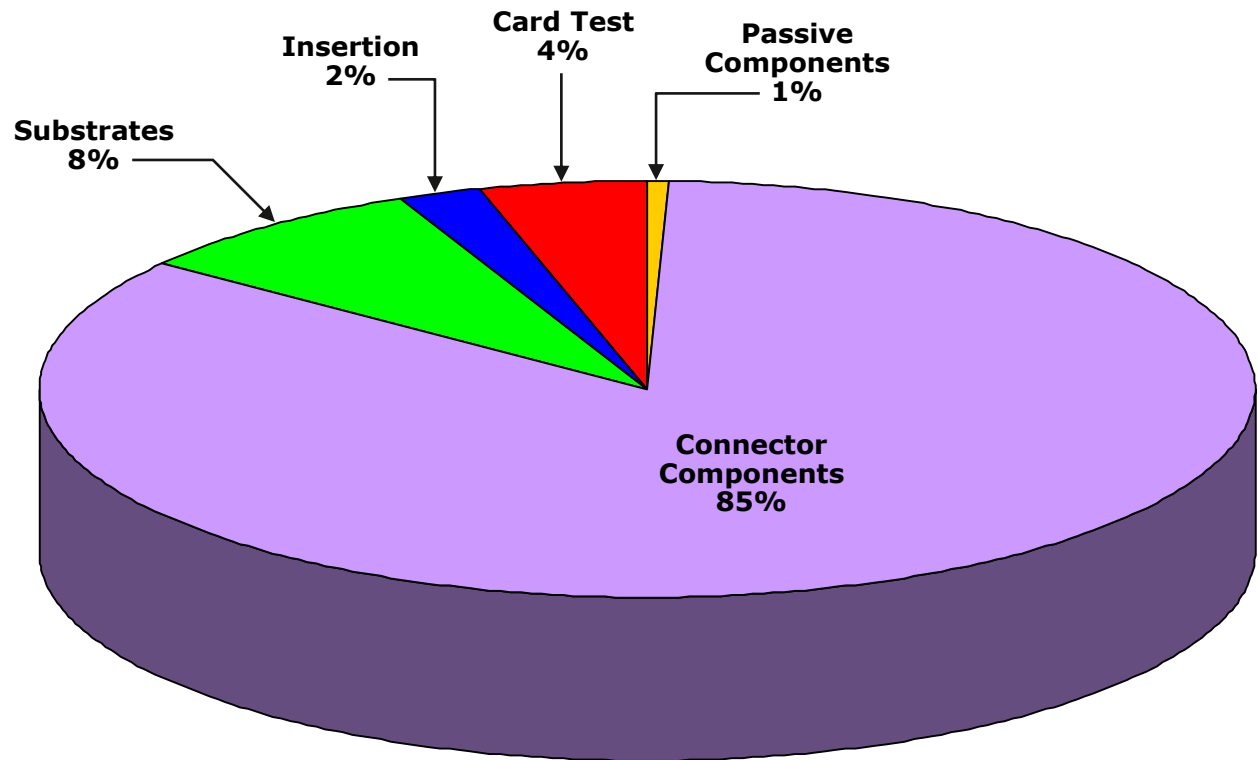
Electronic Costs Breakdown



Estimated Cost of Electronics

(Includes Subsystem Electronics)

\$1.35



NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Non-Electronic Cost Estimate



Subsystem	Part ID No.	Qty	Description	Fabrication Process	Material	Dimensions (mm)	Weight (grams)	Est'd Cost Each	Est'd Extended Cost	
Miscellaneous	1	1	Internal Support	Stamped + Formed	Metal	83.5 x 63.4 x 21.7	55.90	2.270	2.270	
	2	1	Cover	Molded	PC	99.4 x 65 x 25.7	23.60	1.380	1.380	
	3	1	Medium Label	Die-Cut + Printed	Plastic	25 x 14.41	0.10	0.050	0.050	
	4	1	Small Label	Die-Cut + Printed	Plastic	6.6 x 6.3	0.05	0.020	0.020	
	5	2	Screw	Cast + Machined	Metal	7.72 x 4 x 4	0.36	0.020	0.040	
Total		6						Estimated Cost		\$3.76

Final Ass'y Labor & Test Cost Estimate



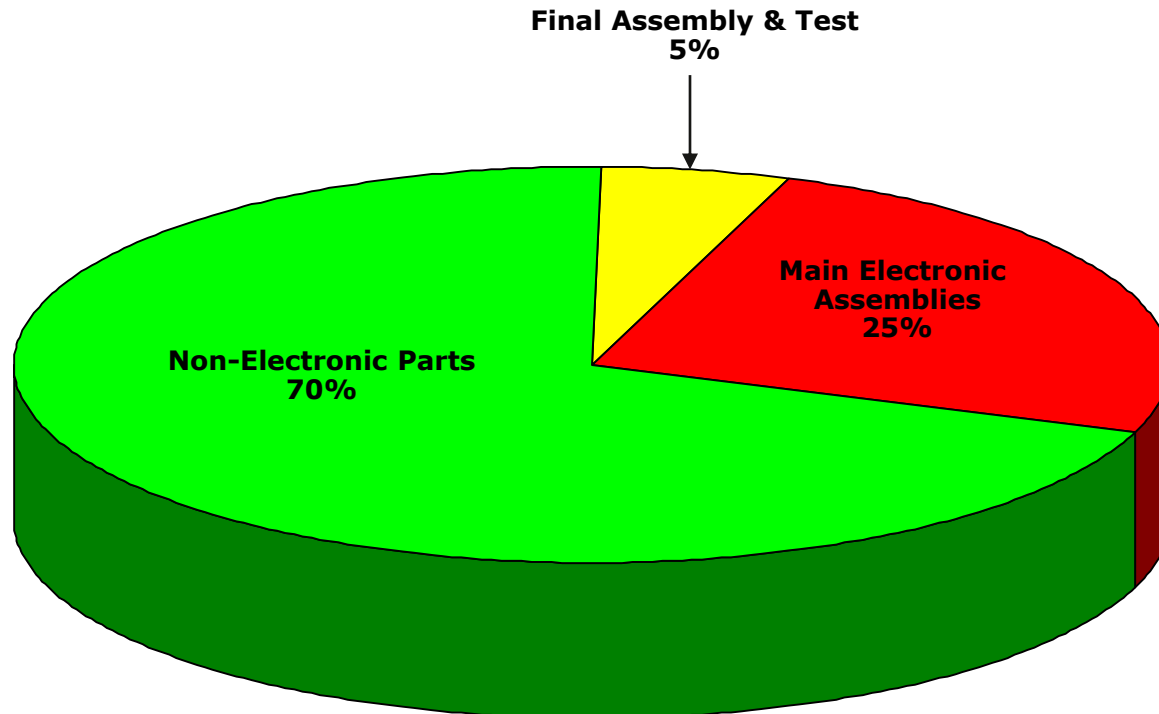
Final Assembly & Test	
Made in	Mexico
Number of parts	7
Est'd number of steps	26
Est'd time (seconds)	96
Est'd final assembly cost	\$ 0.08
Est'd final test cost	\$ 0.20

Cost Summary



Estimated Cost Totals	
Main Electronic Assemblies	\$ 1.35
Non-Electronic Parts	\$ 3.76
Final Assembly & Test	\$ 0.28
Total	\$ 5.39

Cost Total Notes:
Estimated final assembly cost includes labor only.
Total cost does not include Non-recurring, R&D, G&A, IP licensing fees/royalties, software, sales & marketing, distribution.
Assumes fully scaled production.



Cost Estimation Process (Overview & Discussion)



MUNRO
& ASSOCIATES, INC.

Cost modeling is tricky business. Multiple variables affect the actual production costs a manufacturer will experience, including development expenses, unit volumes, supply-and-demand in component markets, die yield-curve maturity, OEM purchasing power, and even variations in accounting practices. Different cost modeling methods employ different assumptions about how to handle these and other variables, but we can identify two basic approaches: that which seeks to track short-term variations in the inputs to the production process, and that which strives to maintain comparability of the output of the model across product families and over time.

TechInsights' philosophy in cost modeling is to emphasize consistency across products and comparability over time, rather than to track short-term fluctuations. During the past eight years, we have developed an estimation process that, while necessarily lacking an insider's knowledge of the cost factors that impact any one manufacturer, is reasonably accurate in its prediction of unit costs in high-volume production environments. We do not claim that the model will produce the "right" answer for your firm's environment. However, TechInsights does give customers a key analytical tool with a complete set of data in our Bill of Materials (BOM). The BOM allows readers to 1) scrutinize the assumptions behind our cost model and 2) modify the results based on substitution of their own component cost estimates where they have better information based on inside knowledge.

Our estimation process decomposes overall system cost into three major categories: Electronics, Mechanical, and Final Assembly. We begin by creating a complete electronics bill-of-materials (BOM). Each component from the largest ASIC to the smallest discrete resistor is entered into a BOM table with identifying attributes such as size, pitch, I/O count, package type, manufacturer, part number, estimated placement cost, and die size (if the component is an IC). Integrated circuit costs are calculated from measured die area. Using assumptions for wafer size, process type, number of die per wafer, defect density, and profit margin in combination with die area, an estimate of semiconductor cost is derived. Costs for discrete components and interconnect are derived from assumption tables which relate BOM line items to specific cost estimates by component type and estimates for part placement costs are included. For LCD display costs, we employ a model which tabulates expected cost from measurements of glass area, LCD type, and total pixel resolution. When market costs are available from alternative sources, LCD panel costs are taken from and referenced to these sources.

Costs of non-electronic components such as molded plastic enclosures and metallic components are measured in terms of weight, size, thickness, type of material, and complexity to arrive at their estimated cost. Other system items such as optics, antennae, batteries and displays are costed from a set of assumption tables derived from a combination of industry data, average high volume costs, and external sources. For final assembly, we re-build the torn-down product, tabulating stepwise assembly times as the reconstruction proceeds, to reach a total assembly time. Using a labor rate assumption for the country of origin, we then calculate final assembly cost.

The three major categories for system cost contributors can be broken down into the subcategories of ICs, other electronics parts, displays, batteries (as appropriate), camera modules, electronics assembly, non-electronic elements, and final assembly. By adding the cost estimates for each of these subcategories, an overall estimated cost is derived for the system under evaluation. Product packaging and accessories (CDs, cables, etc.) are also documented and estimated for their contribution to total cost as appropriate.

We believe our cost estimates generally fall within 15 percent of the "right answer," which itself can vary depending on the market and OEM-specific factors mentioned earlier. While the TechInsights cost model is imperfect, it yields important insights into technology and business dynamics along with good first-order contributions to system cost by component type. Additionally, the consistency of approach and gradual modification to assumptions (smoothing out frequently-shifting pricing factors) hopefully yields a credible, but user-modifiable, view of OEM high volume cost-to-produce.

Please feel free to contact us at support@techinsights.com with any comments, questions, or proposed corrections with respect to our cost estimates. We welcome your input.

In our product teardowns, we gather a series of metrics for product profiling and comparison. Some metrics focus on system characteristics such as total silicon area, total system semiconductor storage capacity, and total connection count. Other metrics reflect more subtle aspects of electronics assembly such as connection density, average component I/O count, and silicon tiling density. Taken as a whole, the metrics allow deeper comparison and benchmarking across multiple disciplines and multiple products. Key metrics we gather on products are described below along with their definitions and what they tend to say about the system under study. Most metrics can be used both in comparing similar products for benchmarking purposes or for quantifying differences in levels of complexity between dissimilar product types. Data fall into two categories; either “raw” measured data or ratios of these measured data sets.

Total Silicon Area : This metric describes the total area of silicon as measured from X-ray or direct measurement of ICs. The area is an expression of the enclosed bare die area and excludes packaging area. The aggregate silicon area is a good benchmark to show how integrated a design might be when making comparisons to similar systems. Total silicon area also reflects the major cost driver for most systems we examine.

Silicon Tiling Density : Ratio of Total Silicon Area to total printed circuit board “projected” area (i.e. the simple board area and not the cumulative surface area of both sides of the board). This metric directly reflects the level of efficiency and aggressiveness in integrated circuit packing and placement. Single digit Silicon Tiling Density is typical but silicon coverage of 10% - 20% has been seen in some of the most advanced products we have examined. Higher Tiling Densities often correspond with the use of chip scale packaging (CSPs) or other small form-factor IC packaging technologies. High density circuit boards are also often a supporting technology.

Number of Parts : Total component count including ICs, passives, modules, connectors, etc., each separated out in our reporting.

Number of Connections : The total number of connections corresponds to the total number of interconnects introduced by the aggregate component set and reflects any electrical connection observed (solder joints, adhesive interconnect, or connector terminal interfaces).

Opportunity Count : Opportunity Count is the total number of parts plus the total number of connections; the name reflects that each of these constituent elements represents an opportunity for failure. A high opportunity count means more complex and riskier electronics assembly.

Average Pin Count (APC) : Ratio of total number of component terminals to total number of parts, at the system level. This metric reflects the ‘average’ terminal complexity of the components and often provide a signature of integration level and/or “digital-ness” of the overall product. Low APCs reflect a high number of discrettes or other low-pincount devices often characteristic of analog circuitry. Conversely, high APCs are characteristic of highly integrated, high-pincount assemblies, often those composed largely of digital integrated circuits.

Connection Density : This metric is a ratio of the total Number of Connections to total printed circuit board assembly area, in units of connections per sq. inch. The metric provides data related to the Silicon Tiling Density above, but with an emphasis on complexity of I/O interconnect. For example, with a fixed Connection Density, high tiling density of low-pincount memory chips is more readily achieved than comparable silicon tiling of high pincount logic.

Part Density : This metric is a ratio of the total Number of Parts to total printed circuit board assembly area, in units of components per sq. inch. The metric provides data related to the Silicon Tiling Density and Connection Density as described above, but with an emphasis on density and complexity of component packing efficiency. For example, low Part Density of high-pincount devices can pose an equal challenge in Connection Density to high Part Density of low-pincount devices. High Part Density does reflect challenges in surface mount assembly in terms of (typically) precision of placement, number of placements, and engineering of part clearances.

Routing Density (heuristic estimate) = $3 * (\text{Average Pin Count}) * \sqrt{\text{Part Density}}$. The Routing Density metric is an empirically derived relationship that characterizes the wiring density of the interconnect used to support the interconnection of components in a planar electronic assembly (i.e. the circuit board). Architectural issues such as bussing or other factors affecting the regularity of wiring impact the actual Routing Density needed to support a given application, but the metric provides a ready measure of wiring complexity.

***Click Here to Return to
Cost Analysis Page 130***

Deep Dive Report

BMW i3 Electrical Digital Motor Assembly

2249

Report #15900-150210-SBb



Product Description

The Digital Motor Control Assembly is part of the system electronics for the 2014 BMW i3. It is responsible for control of the engine torque, accelerator pedal, shifting, electric fans, power management for the electrical systems, and the vacuum pump. The Digital Motor Control Assembly is connected to the CAN, LIN, and FlexRay busses. The Infineon TC1793 Microcontroller is used to process information going through the NXP Semiconductor CAN, LIN, and FlexRay transceivers.

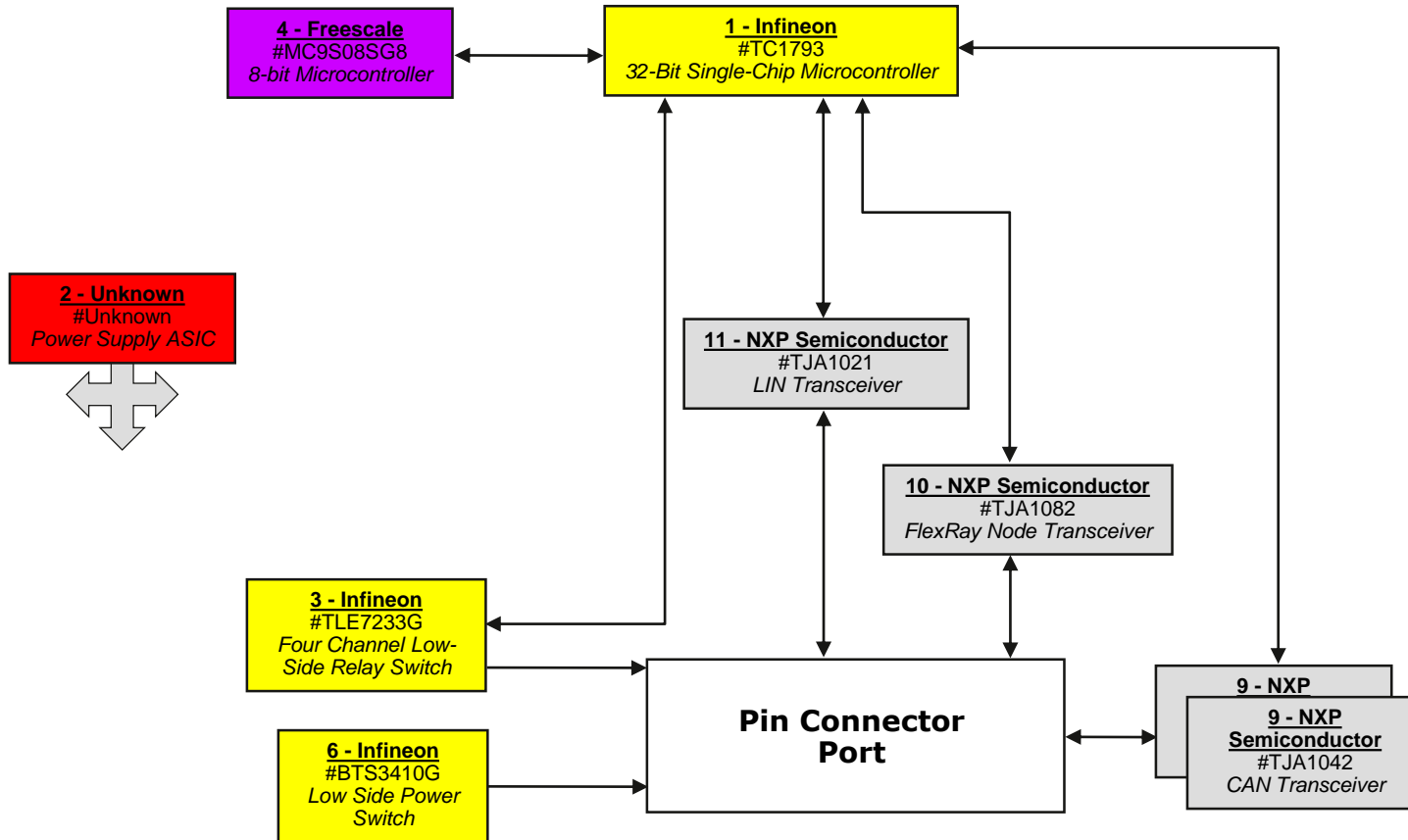
DISCLAIMER: All company names, product names, and service names mentioned are used for identification purposes only and may be registered trademarks, trademarks, or service marks of their respective owners. All analyses are done without participation, authorization, or endorsement of the manufacturer. Any cost analyses presented in this material are estimates prepared by TechInsights from generally available data. While TechInsights believes that these estimates reflect the probable costs, the actual producer did not supply the data, and therefore the actual costs may be different from these estimates. Furthermore, TechInsights extends no warranties with respect to any information in this document, and shall bear no liability whatsoever for the use of the information.

Copyright © 2015, TechInsights. All rights reserved. Do not reproduce, distribute, disseminate, photocopy, fax, transmit, download to a shared database, or otherwise copy, transfer, sell, publish, or send this material, or any portion thereof, by any means without the express written permission of TechInsights.

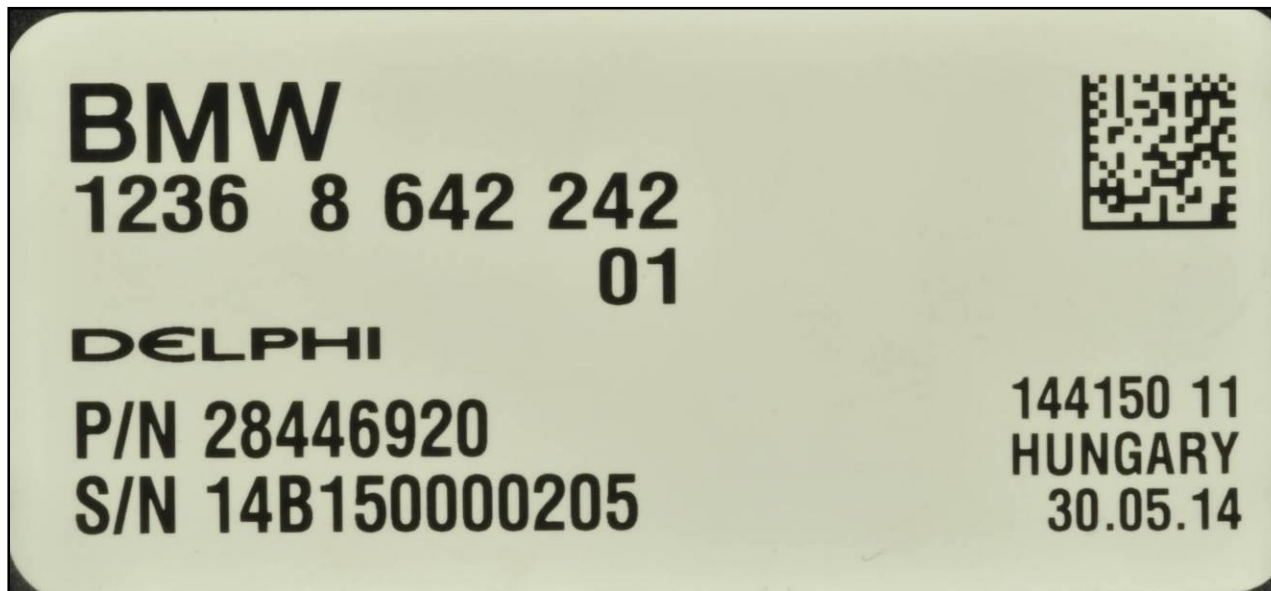
Product Overview

Product Description		Integrated Circuit Metrics		
Product Type	Automotive	IC Die Count	11	
Brand	Delphi	IC Package Count	10	
Product Name & Model #	Electrical Digital Motor Assembly 28446920	Cost Metrics		
Official Release Date	5/2/2014			
Weight (grams)	283.2	Retail Price		
Product Dimensions (mm)	151.07 x 136.3 x 33.37	Total Manufacturing Cost	\$47.50	
Product Features		Electronics Cost	\$39.10	
		Manufacturing Cost Breakdown		
Microcontrollers	Infineon #TC1793 32-Bit Single-Chip Microcontroller, Freescale #Unknown Microcontroller	Integrated Circuits	\$27.97	58.9%
Transceivers	NXP Semiconductor #TJA1021 LIN Transceiver, #TJA1082 FlexRay Node Transceiver, #TJA1042 CAN Transceiver	Modules, Discretes & Connectors	\$7.01	14.8%
Communication	CAN, LIN, FlexRay Busses	Substrates	\$1.62	3.4%
		Component Insertion	\$1.70	3.6%
		Card Test	\$0.81	1.7%
		Non-Electronic Parts	\$7.72	16.3%
		Final Assembly & Test	\$0.67	1.4%
		Total	\$47.50	100.0%

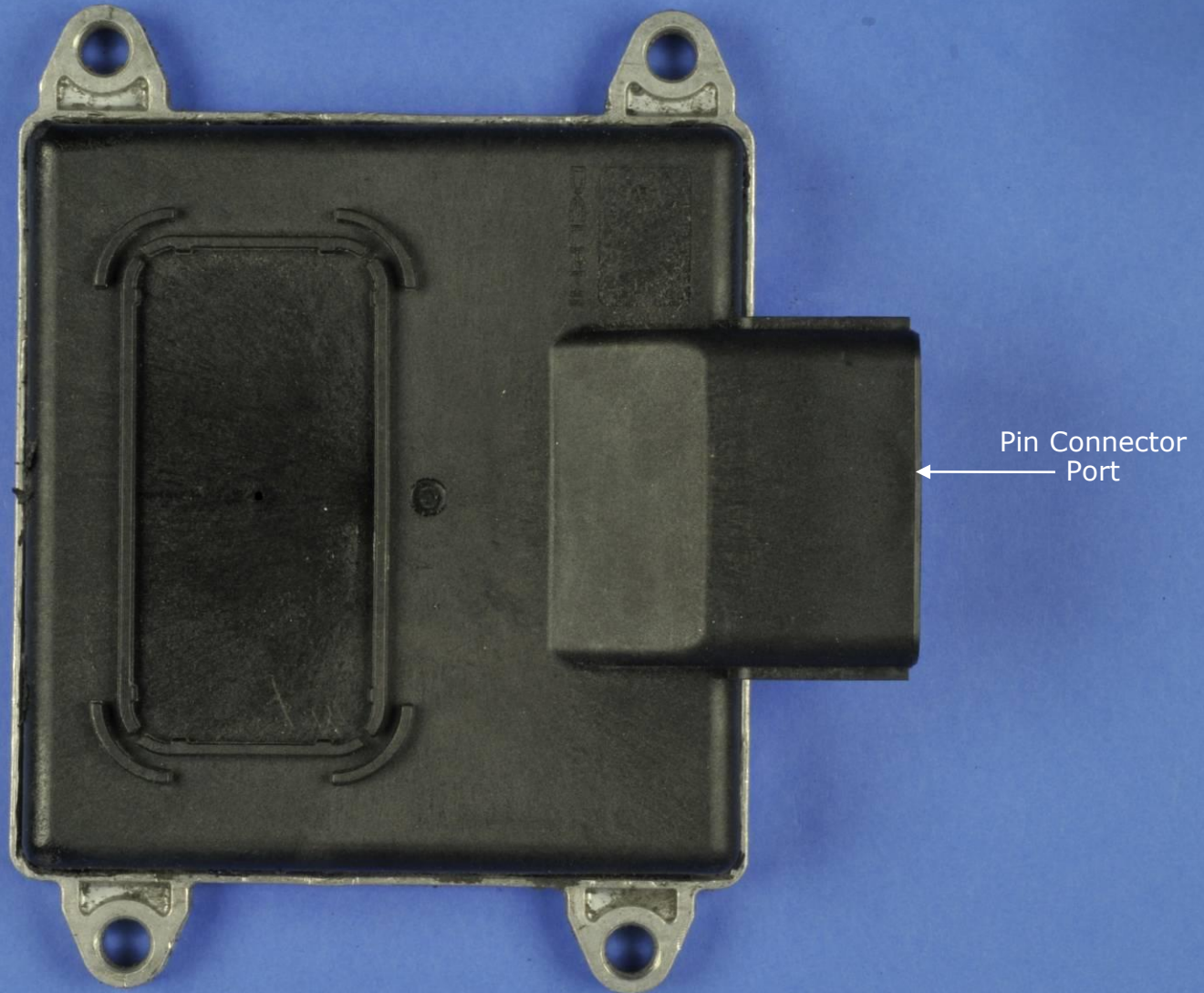
Block Diagram



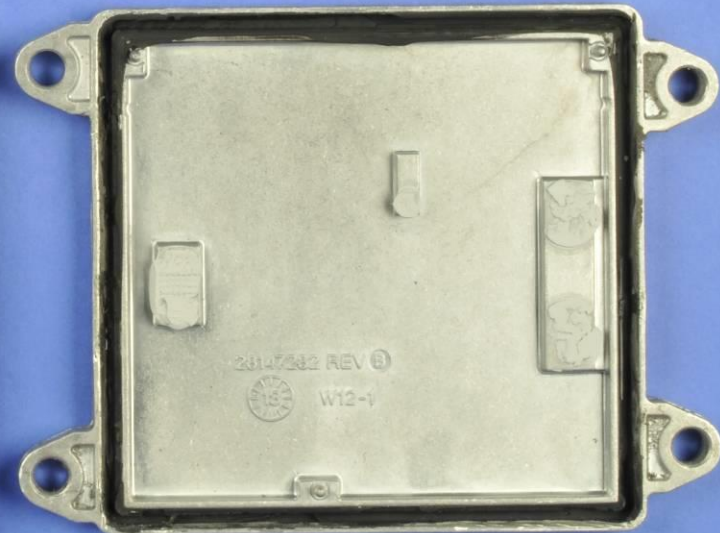
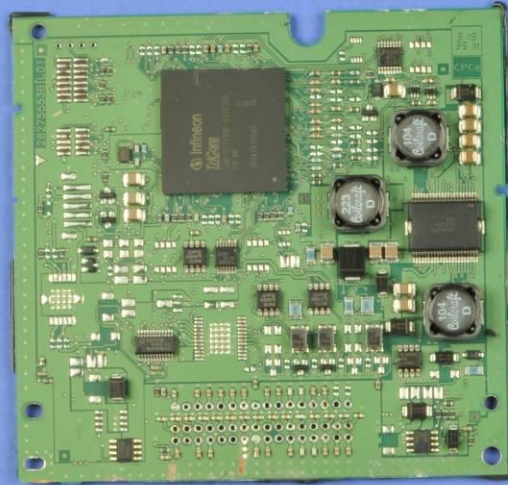
Estimated block diagram based on observation of this specific product implementation, manufacturer's data sheets where available, and best engineering judgment. Certain details of the interface circuitry are not reflected in this block diagram. Partitioning and connectivity are speculative.



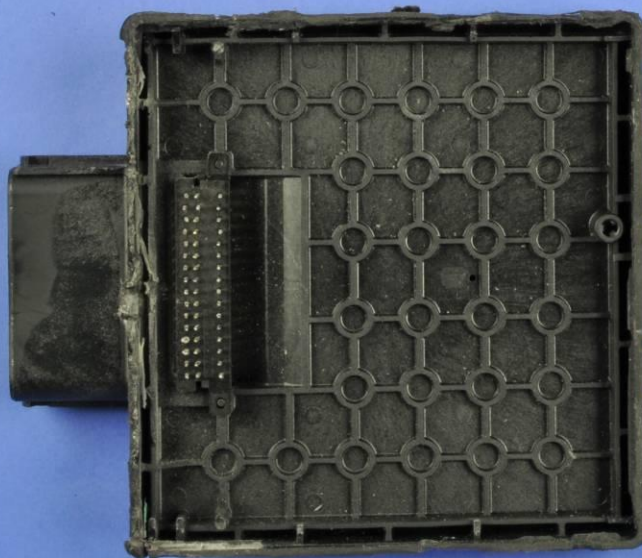
Exterior Features



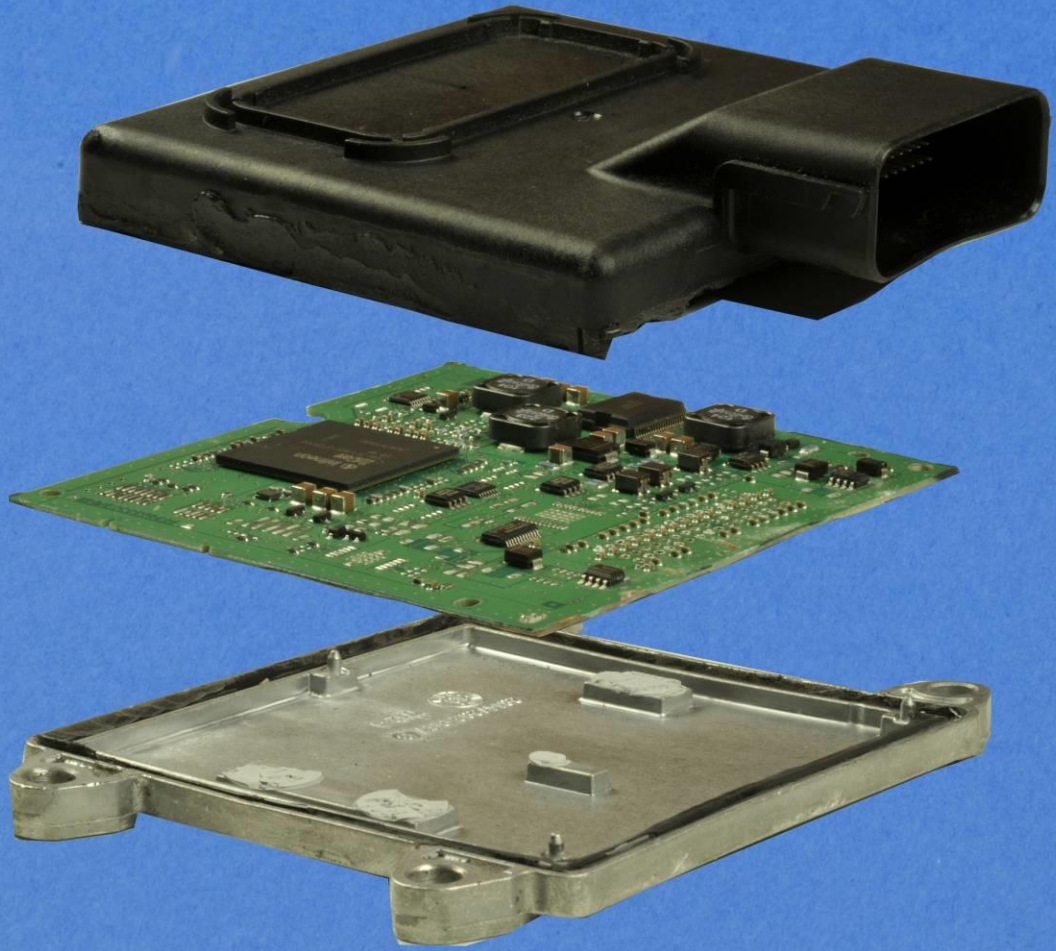
Major Components (Side 1)



Major Components (Side 2)



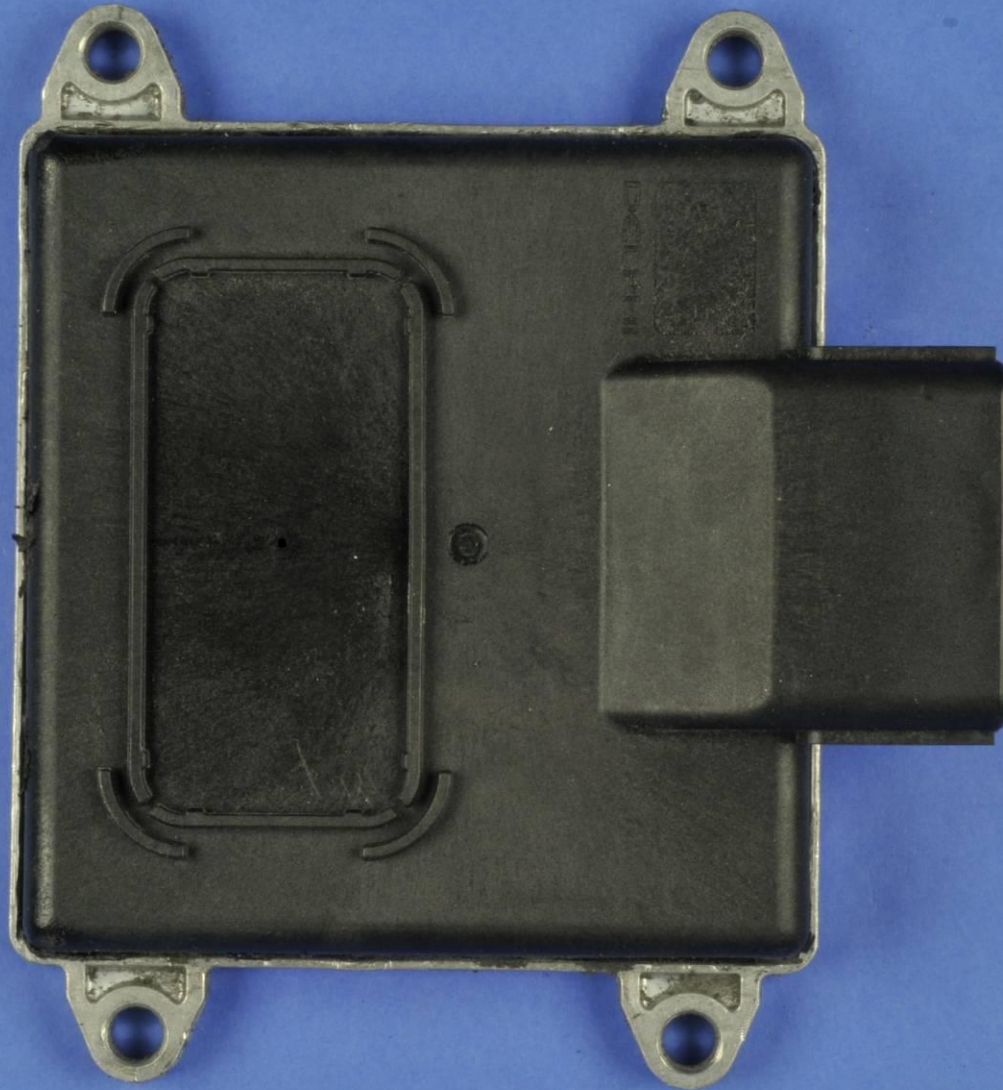
Component Arrangement



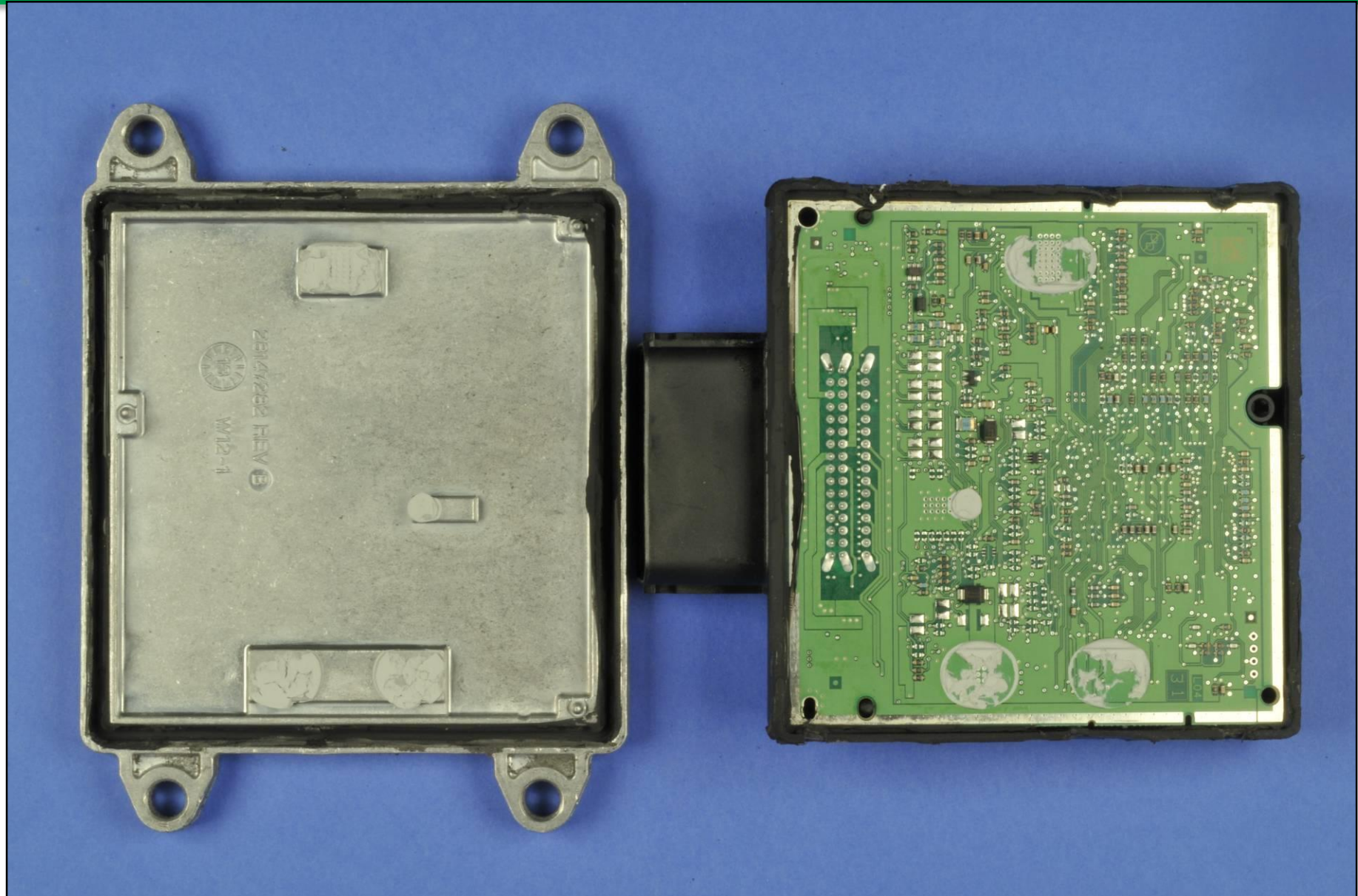
Teardown Sequence



MUNRO
& ASSOCIATES, INC.



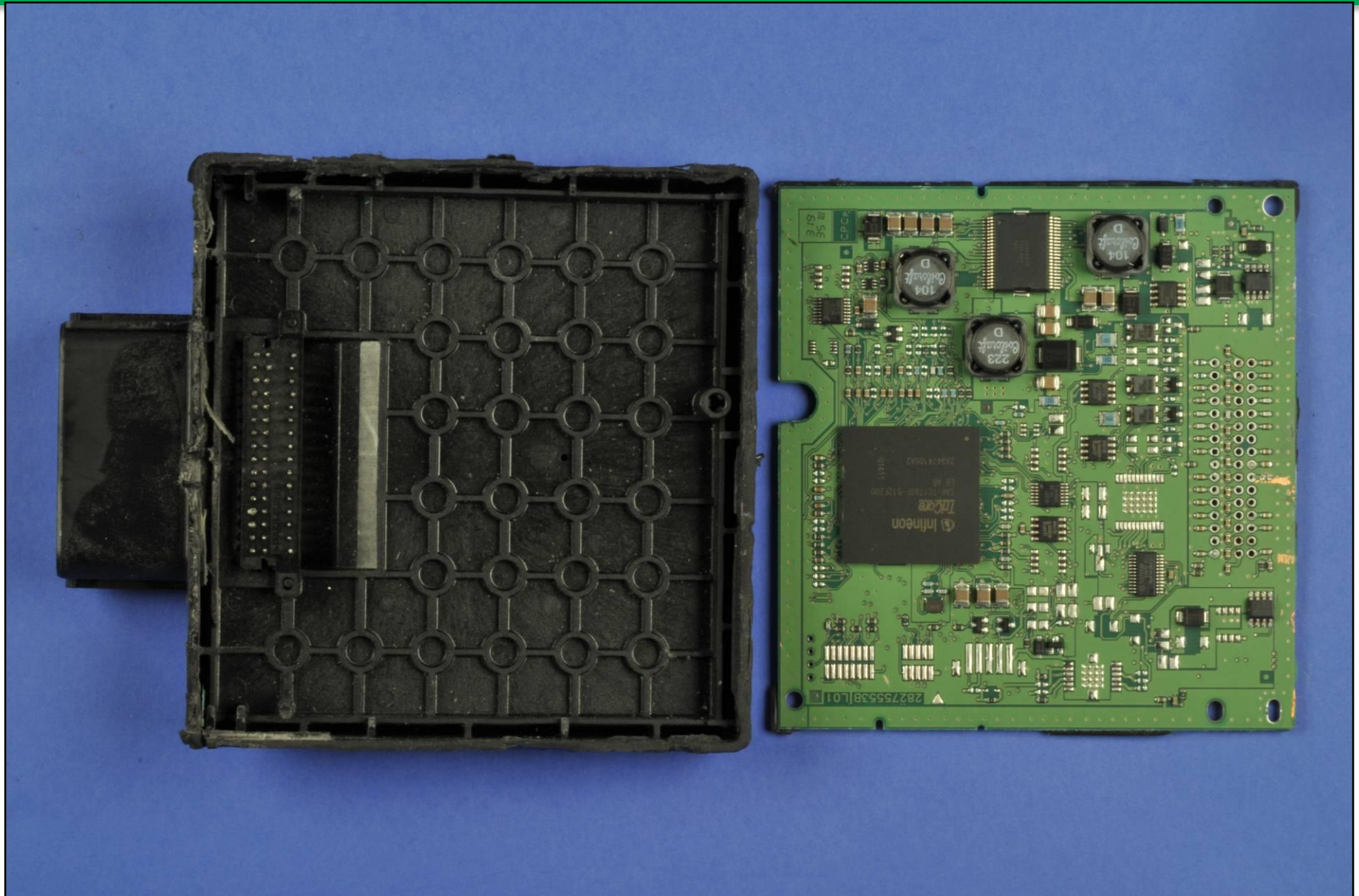
Teardown Sequence



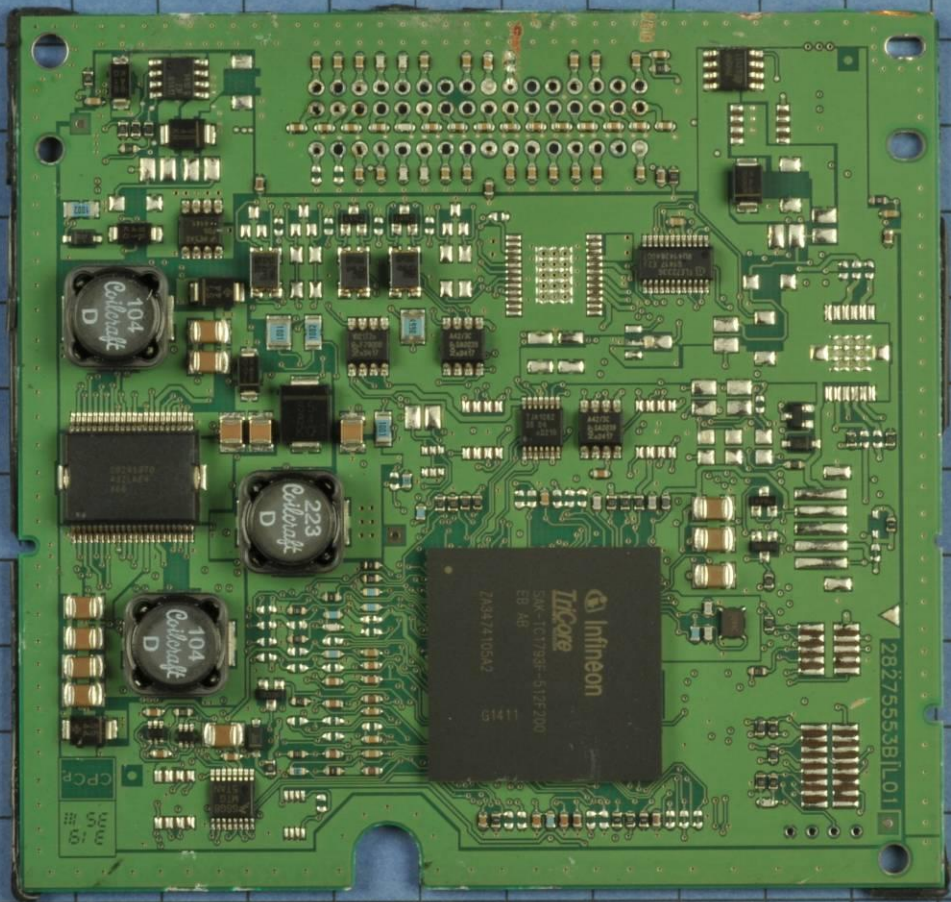
Teardown Sequence



MUNRO
& ASSOCIATES, INC.

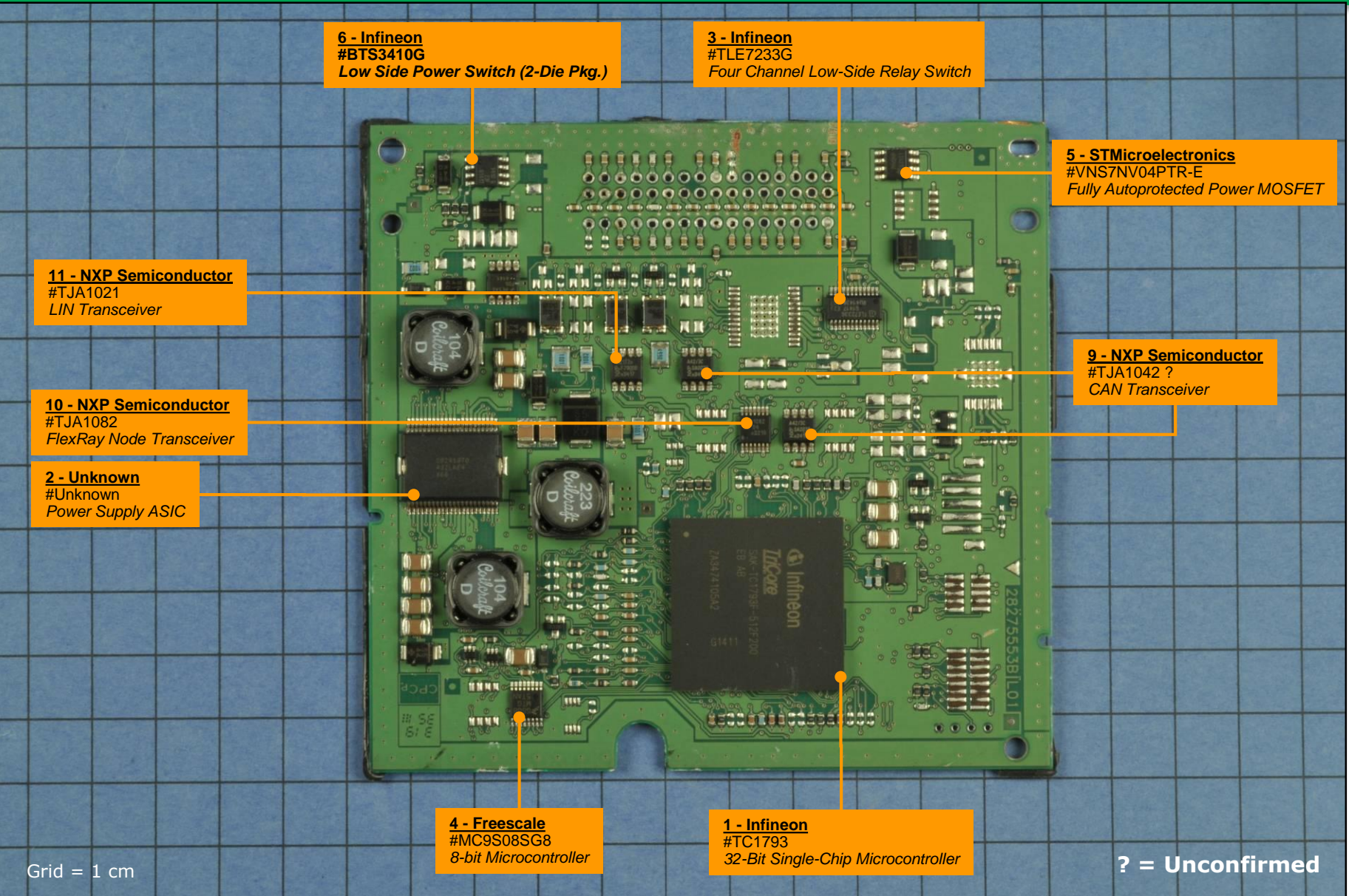


Main Board (Side 1)



Grid = 1 cm

Main Board (Side 1 IC Identification)



6 - Infineon
#BTS3410G
Low Side Power Switch (2-Die Pkg.)

3 - Infineon
#TLE7233G
Four Channel Low-Side Relay Switch

5 - STMicroelectronics
#VNS7NV04PTR-E
Fully Autoprotected Power MOSFET

11 - NXP Semiconductor
#TJA1021
LIN Transceiver

9 - NXP Semiconductor
#TJA1042 ?
CAN Transceiver

10 - NXP Semiconductor
#TJA1082
FlexRay Node Transceiver

2 - Unknown
#Unknown
Power Supply ASIC

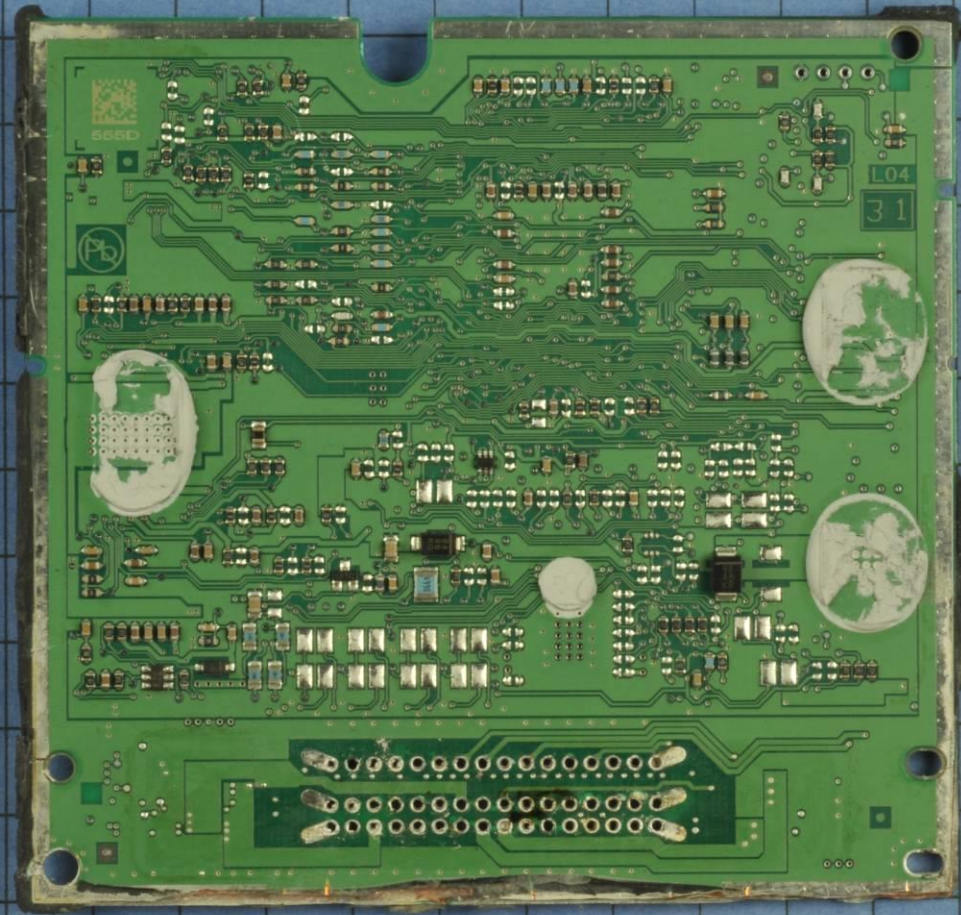
4 - Freescale
#MC9S08SG8
8-bit Microcontroller

1 - Infineon
#TC1793
32-Bit Single-Chip Microcontroller

? = Unconfirmed

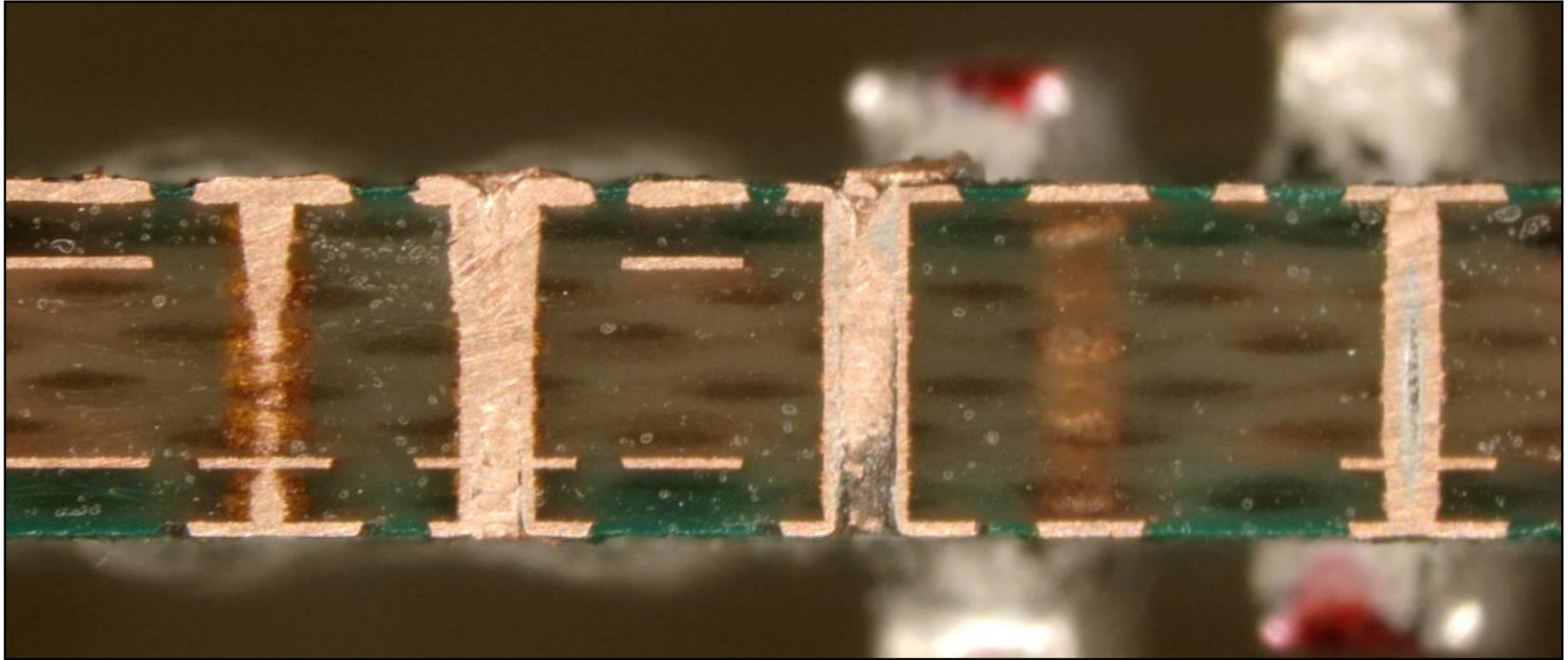
Grid = 1 cm

Main Board (Side 2)



Grid = 1 cm

Main Board Cross-Section



Substrate Data

Substrates

Assembly Name	Manufacturer	Core Material	Mfg. Technology	Layers	Area (cm ²)	Min. Trace Pitch (mm)	Min. Trace Width (mm)	ThruVia Land Dia (mm)	ThruVia Hole Dia (mm)	BlindVia Land Dia (mm)	BlindVia Hole Dia (mm)	Thickness (mm)	Routing Density	Estimated Costs
Main Board	Unknown	FR4	4 Layer Conventional FR4 / HF	4	108.1	0.48	0.15	0.62	0.24			1.4	20.2	\$ 1.62

Integrated Circuit Components



MUNRO
& ASSOCIATES, INC.

Location	Package Info										Die Info						Estimated Costs			
	Pkg Ref. #	Pkg Qty	Brand Name	Part Number	Pkg Description	Form	Pin Count	Length (mm)	Width (mm)	Height (mm)	Die Ref #	Die Qty	Brand Name	Part Number	Description	Length (mm)	Width (mm)	Each	Total	
Main Board, Side 1	1	1	Infineon	TC1793	32-Bit Single-Chip Microcontroller	BGA	416	26.98	26.96	1.96	1.1	1	Infineon	2F0?PC12	32-Bit Single-Chip Microcontroller	9.39	7.56	\$ 21.090	\$ 21.090	
	2	1	Unknown	Unknown	Power Supply ASIC	SOP	44	15.86	10.78	3.31	2.1	1	Unknown	C2PS_2 IO	Power Supply ASIC	5.27	4.07	\$ 4.070	\$ 4.070	
	3	1	Infineon	TLE7233G	Four Channel Low-Side Relay Switch	SOP	24	8.84	3.87	1.88	3.1	1	Infineon	TLE7233G	Four Channel Low-Side Relay Switch	2.20	1.64	\$ 0.320	\$ 0.320	
	4	1	Freescale	MC9S08SG8	8-bit Microcontroller	SOP	16	5.21	4.23	1.04	4.1	1	Freescale	M84G	8-bit Microcontroller	2.30	2.06	\$ 1.133	\$ 1.133	
	5	1	STMicroelectronics	VNS7NV04PTR-E	Fully Autoprotected Power MOSFET	SOP	8	5.03	3.96	1.60	5.1	1	STMicroelectronics	LQ02 ?25N?	Fully Autoprotected Power MOSFET	2.54	2.19	\$ 0.140	\$ 0.140	
	6	1	Infineon	BTS3410G	Low Side Power Switch	MCP - 2 Chips	8	4.81	3.86	1.94	6.1	1	Infineon	ERYO	Power Switch	1.58	1.35	\$ 0.130	\$ 0.130	
	9	2	NXP Semiconductor	TJA1042 ?	CAN Transceiver	SOP	8	5.06	4.13	1.59	9.1	1	NXP Semiconductor	CF1361D	CAN Transceiver	2.09	1.46	\$ 0.220	\$ 0.440	
	10	1	NXP Semiconductor	TJA1082	FlexRay Node Transceiver	SOP	14	5.14	4.31	0.99	10.1	1	NXP Semiconductor	CF1401B	FlexRay Node Transceiver	2.52	1.91	\$ 0.340	\$ 0.340	
	11	1	NXP Semiconductor	TJA1021	LIN Transceiver	SOP	8	5.12	4.34	1.50	11.1	1	NXP Semiconductor	CF1271B	LIN Transceiver	1.76	1.39	\$ 0.180	\$ 0.180	
	Totals		10					554					11							\$27.97

Note: Supplemental information, such as IC package & die markings, is included in the Excel Bill of Materials (BOM) spreadsheet.

Modular Components



Location	Qty	Brand Name	Part Number	Description	Package			Estimated Costs	
					Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Unknown	None	Crystal: Ceramic	4	3.24	2.50	\$ 0.200	\$ 0.200
TOTALS	1				4				\$0.20

Active Discrete Components



Location	Qty	Functional Description	Package					Estimated Costs	
			Form	Top Marking	Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Small Active	Diode, SMT	D5F	2	2.59	1.69	\$0.015	\$0.015
	2	Small Active	Diode, SMT	98 48 KR	2	4.31	3.42	\$0.040	\$0.080
	2	Small Active	Diode, SMT	88 41 KQ	2	4.07	2.52	\$0.040	\$0.080
	2	Small Active	Diode, SMT	F2F	2	2.62	1.65	\$0.015	\$0.030
	2	Small Active	Diode, SMT	S5 44	2	4.20	3.43	\$0.040	\$0.080
	1	Small Active	Diode, SMT	67 90 K0	2	4.08	2.49	\$0.040	\$0.040
	2	Small Active	Transistor, Small	TAN 43	3	2.86	1.11	\$0.030	\$0.060
	1	Small Active	Transistor, Small	YBS 30	3	3.01	1.28	\$0.030	\$0.030
	1	Large Active	Diode, DIODE VARACTOR	55 84 KQ	2	6.81	5.84	\$0.390	\$0.390
	1	Small Active	Transistor, Small	A4W 41	3	2.85	1.20	\$0.030	\$0.030
	2	Small Active	MOSFET	.42 1CS	6	2.06	1.68	\$0.090	\$0.180
	1	Small Active	MOSFET, Dual	FPE3AS FDS 4141	8	5.09	3.85	\$0.090	\$0.090
2	Small Active	Transistor, Small	WJS 42	3	2.88	1.28	\$0.030	\$0.060	
Main Board, Side 2	1	Small Active	MOSFET	.42 WPS	6	2.05	1.16	\$0.090	\$0.090
	1	Small Active	Diode, SMT	98 48 KR	2	4.30	3.35	\$0.040	\$0.040
	1	Small Active	Diode, SMT	84 96 KQ	2	4.12	2.58	\$0.040	\$0.040
	1	Small Active	Diode, SMT	F2F	2	2.65	1.50	\$0.015	\$0.015
	1	Small Active	Transistor, Small	Tan 43	3	2.83	1.24	\$0.030	\$0.030
	1	Small Active	MOSFET	K2 80	1	2.94	1.89	\$0.090	\$0.090
TOTALS	26				76				\$1.47

Passive Discrete Components

Location	Qty	Functional Description	Package		Estimated Costs	
			Form	Pin Count	Each	Total
Main Board, Side 1	11	Small Passive	Inductor	2	\$0.008	\$0.088
	138	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.552
	1	Coil	SMT, Dual Coil	4	\$0.080	\$0.080
	1	Coil	SMT, Dual Coil	4	\$0.080	\$0.080
	1	Coil	SMT, Dual Coil	4	\$0.080	\$0.080
	2	Coil	SMT, Power Inductor	2	\$0.400	\$0.800
	1	Coil	SMT, Power Inductor	2	\$0.400	\$0.400
Main Board, Side 2	4	Small Passive	Inductor	2	\$0.008	\$0.032
	129	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.516
TOTALS	288			582		\$2.63

Connectors



Location	Qty	Form	Package			Estimated Costs	
			Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Connector, Pin Port	48	55.25	11.36	\$2.700	\$2.700
TOTALS	1		48				\$2.70

Electronic Assembly Metrics

Electronic Assembly Metrics by Assembly											
General Area	Assembly Name	Substrate Area (sq.cm)	Metal Layers	Circuit Area (sq.cm)	Routing Density (cm of routing per sq.cm of substrate)	Number of Components	Number of Connections	Component Density (Components/sq.cm)	Connection Density (Connections/sq.cm)	Avg. Pin Count	Assembly Weight (grams)
Main Electronics	Main Board	108.1	4	432.3	20.2	326	1264	3.0	11.7	3.9	55.50
	System Totals	108.1	4	432.28		326	1264	3.0	11.7	3.9	55.50

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Electronics Costs by Assembly										
General Area	Assembly Name	Total	Integrated Circuits	Modular & Odd Form Components	Small Active Components	Passive Components	Connector Components	Substrates	Insertion	Card Test
Main Electronics	Main Board	\$ 39.10	\$ 27.97	\$ 0.20	\$ 1.47	\$ 2.63	\$ 2.70	\$ 1.62	\$ 1.70	\$ 0.81
	System Totals	\$ 39.10	\$ 27.97	\$ 0.20	\$ 1.47	\$ 2.63	\$ 2.70	\$ 1.62	\$ 1.70	\$ 0.81

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Counts by Assembly												
General Area	Assembly Name	IC Package Count	IC Connections	Modular/Odd Form Components	Modular/Odd Form Component Connections	Small Active Components	Small Active Component Connections	Passive Components	Passive Component Connections	Connectors	Connector Connections	Opportunities
Main Electronics	Main Board	10	554	1	4	26	76	288	582	1	48	1590
	System Totals	10	554	1	4	26	76	288	582	1	48	1590

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics

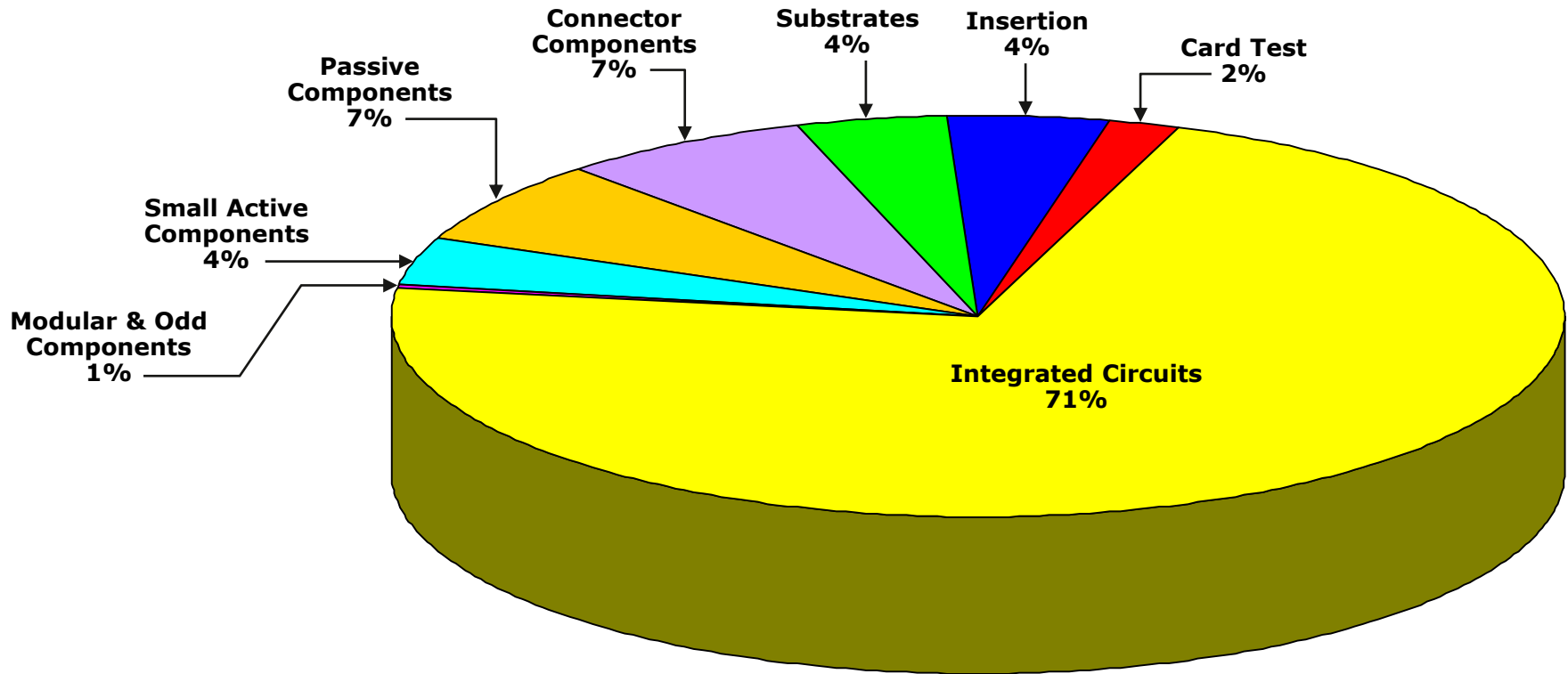


IC Metrics											
General Area	Assembly Name	IC Die Count	IC Package Count	Number of Package Connections	Die Area (sq.mm)	Substrate Tiling Density (die area / substrate area)	Package Area (sq.mm)	Die Area/Package Area Ratio	Package Connections per sq.cm of Package Area	Volatile Memory (KBytes)	Non-Volatile Memory (KBytes)
Main Electronics	Main Board	11	10	554	123.8	0.01	1079.3	0.11	51.3	0	0
	System Totals	11	10	554	123.8		1079.3	0.11	51.3	0	0

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Costs Breakdown

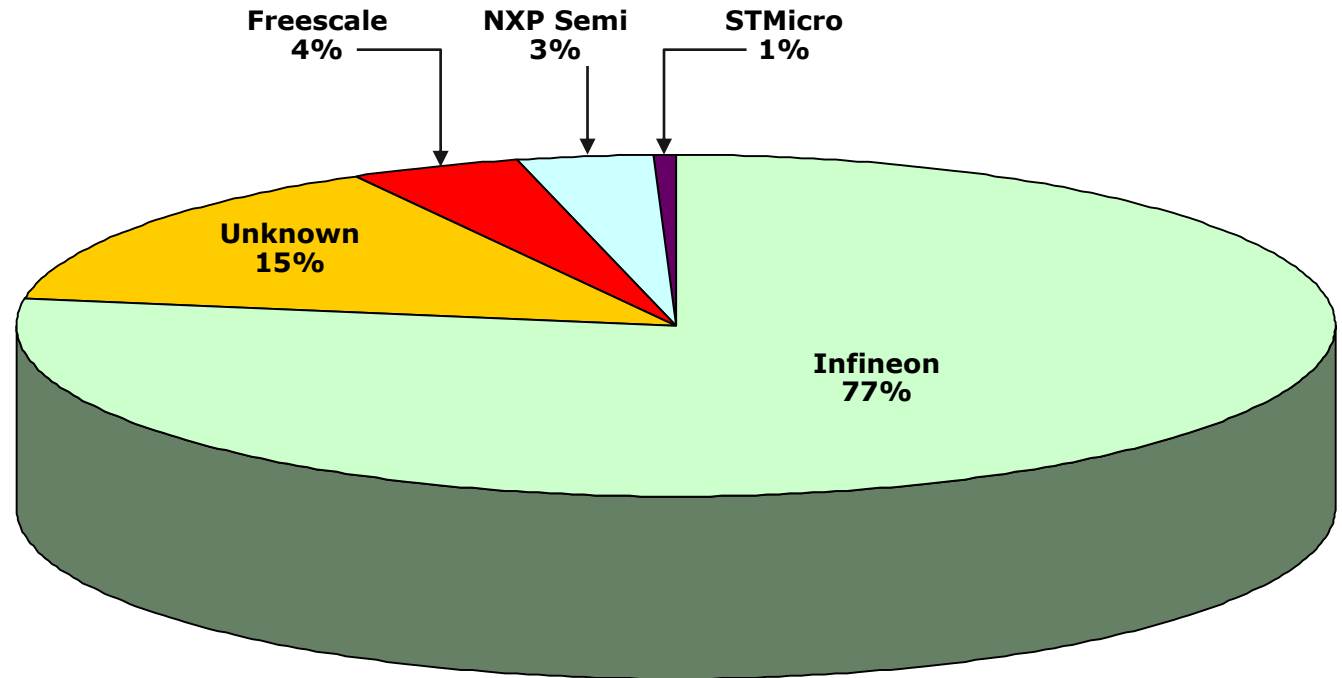
**Estimated Cost
of Electronics**
(Includes Subsystem Electronics)
\$39.10



NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Vendor IC Cost Distribution

Pkg. Brand	Cost
Infineon	\$21.67
Unknown	\$4.07
Freescale	\$1.13
NXP Semiconductor	\$0.96
STMicroelectronics	\$0.14



NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Non-Electronic Cost Estimate



MUNRO
& ASSOCIATES, INC.

Subsystem	Part ID No.	Qty	Description	Fabrication Process	Material	Dimensions (mm)	Weight (grams)	Est'd Cost Each	Est'd Extended Cost	
Enclosures	3	1	Bottom Aluminum Enclosure	Cast	Aluminum	151.1 x 113.64 x 8.99	116.40	2.450	2.450	
	4	1	Top Enclosure	Molded + Pulls	PC + GF30	132.94 x 113.03 x 25.53	105.10	5.140	5.140	
Miscellaneous	1	1	Label	Die-Cut + Printed	Plastic + Adhesive	69.82 x 32.32 x 0.07	0.30	0.090	0.090	
	2	1	Label	Die-Cut + Printed	Plastic + Adhesive	45.9 x 13.33 x 0.08	0.10	0.040	0.040	
Total		4						Estimated Cost		\$7.72

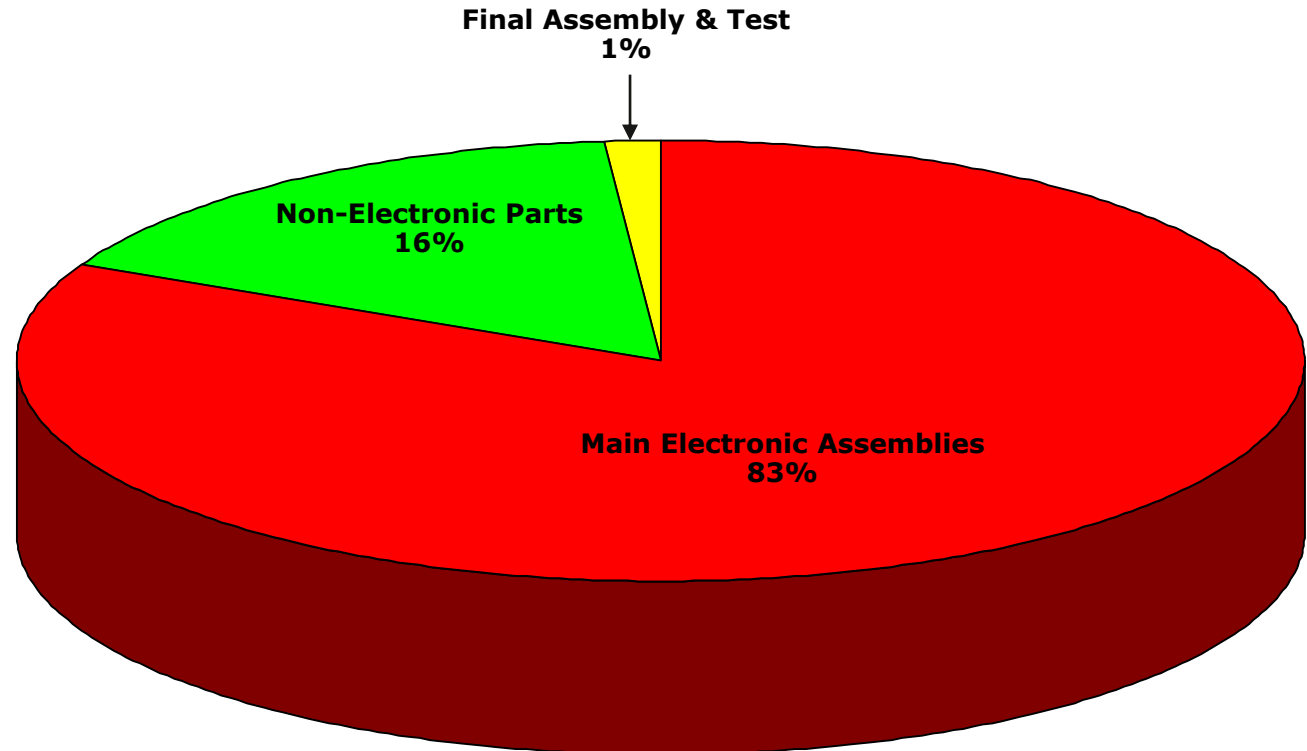
Final Ass'y Labor & Test Cost Estimate

Final Assembly & Test	
Made in	Hungary
Number of parts	6
Est'd number of steps	20
Est'd time (seconds)	69
Est'd final assembly cost	\$ 0.17
Est'd final test cost	\$ 0.50

Cost Summary

Estimated Cost Totals	
Main Electronic Assemblies	\$ 39.10
Non-Electronic Parts	\$ 7.72
Final Assembly & Test	\$ 0.67
Total	\$ 47.50

Cost Total Notes:
Estimated final assembly cost includes labor only.
Total cost does not include Non-recurring, R&D, G&A, IP licensing fees/royalties, software, sales & marketing, distribution.
Assumes fully scaled production.



Cost Estimation Process

(Overview & Discussion)



Cost modeling is a tricky business. Multiple variables affect the actual production costs a manufacturer will experience, including development expenses, unit volumes, supply-and-demand in component markets, die yield-curve maturity, OEM purchasing power, and even variations in accounting practices. Different cost modeling methods employ different assumptions about how to handle these and other variables, but we can identify two basic approaches: that which seeks to track short-term variations in the inputs to the production process, and that which strives to maintain comparability of the output of the model across product families and over time.

TechInsights' philosophy in cost modeling is to emphasize consistency across products and comparability over time, rather than to track short-term fluctuations. During the past eight years, we have developed an estimation process that, while necessarily lacking an insider's knowledge of the cost factors that impact any one manufacturer, is reasonably accurate in its prediction of unit costs in high-volume production environments. We do not claim that the model will produce the "right" answer for your firm's environment. However, TechInsights does give customers a key analytical tool with a complete set of data in our Bill of Materials (BOM). The BOM allows readers to 1) scrutinize the assumptions behind our cost model and 2) modify the results based on substitution of their own component cost estimates where they have better information based on inside knowledge.

Our estimation process decomposes overall system cost into three major categories: Electronics, Mechanical, and Final Assembly. We begin by creating a complete electronics bill-of-materials (BOM). Each component from the largest ASIC to the smallest discrete resistor is entered into a BOM table with identifying attributes such as size, pitch, I/O count, package type, manufacturer, part number, estimated placement cost, and die size (if the component is an IC). Integrated circuit costs are calculated from measured die area. Using assumptions for wafer size, process type, number of die per wafer, defect density, and profit margin in combination with die area, an estimate of semiconductor cost is derived. Costs for discrete components and interconnect are derived from assumption tables which relate BOM line items to specific cost estimates by component type and estimates for part placement costs are included. For LCD display costs, we employ a model which tabulates expected cost from measurements of glass area, LCD type, and total pixel resolution. When market costs are available from alternative sources, LCD panel costs are taken from and referenced to these sources.

Costs of non-electronic components such as molded plastic enclosures and metallic components are measured in terms of weight, size, thickness, type of material, and complexity to arrive at their estimated cost. Other system items such as optics, antennae, batteries and displays are costed from a set of assumption tables derived from a combination of industry data, average high volume costs, and external sources. For final assembly, we re-build the torn-down product, tabulating stepwise assembly times as the reconstruction proceeds, to reach a total assembly time. Using a labor rate assumption for the country of origin, we then calculate final assembly cost.

The three major categories for system cost contributors can be broken down into the subcategories of ICs, other electronics parts, displays, batteries (as appropriate), camera modules, electronics assembly, non-electronic elements, and final assembly. By adding the cost estimates for each of these subcategories, an overall estimated cost is derived for the system under evaluation. Product packaging and accessories (CDs, cables, etc.) are also documented and estimated for their contribution to total cost as appropriate.

We believe our cost estimates generally fall within 15 percent of the "right answer," which itself can vary depending on the market and OEM-specific factors mentioned earlier. While the TechInsights cost model is imperfect, it yields important insights into technology and business dynamics along with good first-order contributions to system cost by component type. Additionally, the consistency of approach and gradual modification to assumptions (smoothing out frequently-shifting pricing factors) hopefully yields a credible, but user-modifiable, view of OEM high volume cost-to-produce.

Please feel free to contact us at support@techinsights.com with any comments, questions, or proposed corrections with respect to our cost estimates. We welcome your input.

In our product teardowns, we gather a series of metrics for product profiling and comparison. Some metrics focus on system characteristics such as total silicon area, total system semiconductor storage capacity, and total connection count. Other metrics reflect more subtle aspects of electronics assembly such as connection density, average component I/O count, and silicon tiling density. Taken as a whole, the metrics allow deeper comparison and benchmarking across multiple disciplines and multiple products. Key metrics we gather on products are described below along with their definitions and what they tend to say about the system under study. Most metrics can be used both in comparing similar products for benchmarking purposes or for quantifying differences in levels of complexity between dissimilar product types. Data fall into two categories; either “raw” measured data or ratios of these measured data sets.

Total Silicon Area : This metric describes the total area of silicon as measured from X-ray or direct measurement of ICs. The area is an expression of the enclosed bare die area and excludes packaging area. The aggregate silicon area is a good benchmark to show how integrated a design might be when making comparisons to similar systems. Total silicon area also reflects the major cost driver for most systems we examine.

Silicon Tiling Density : Ratio of Total Silicon Area to total printed circuit board “projected” area (i.e. the simple board area and not the cumulative surface area of both sides of the board). This metric directly reflects the level of efficiency and aggressiveness in integrated circuit packing and placement. Single digit Silicon Tiling Density is typical but silicon coverage of 10% - 20% has been seen in some of the most advanced products we have examined. Higher Tiling Densities often correspond with the use of chip scale packaging (CSPs) or other small form-factor IC packaging technologies. High density circuit boards are also often a supporting technology.

Number of Parts : Total component count including ICs, passives, modules, connectors, etc., each separated out in our reporting.

Number of Connections : The total number of connections corresponds to the total number of interconnects introduced by the aggregate component set and reflects any electrical connection observed (solder joints, adhesive interconnect, or connector terminal interfaces).

Opportunity Count : Opportunity Count is the total number of parts plus the total number of connections; the name reflects that each of these constituent elements represents an opportunity for failure. A high opportunity count means more complex and riskier electronics assembly.

Average Pin Count (APC) : Ratio of total number of component terminals to total number of parts, at the system level. This metric reflects the ‘average’ terminal complexity of the components and often provide a signature of integration level and/or “digital-ness” of the overall product. Low APCs reflect a high number of discrettes or other low-pincount devices often characteristic of analog circuitry. Conversely, high APCs are characteristic of highly integrated, high-pincount assemblies, often those composed largely of digital integrated circuits.

Connection Density : This metric is a ratio of the total Number of Connections to total printed circuit board assembly area, in units of connections per sq. inch. The metric provides data related to the Silicon Tiling Density above, but with an emphasis on complexity of I/O interconnect. For example, with a fixed Connection Density, high tiling density of low-pincount memory chips is more readily achieved than comparable silicon tiling of high pincount logic.

Part Density : This metric is a ratio of the total Number of Parts to total printed circuit board assembly area, in units of components per sq. inch. The metric provides data related to the Silicon Tiling Density and Connection Density as described above, but with an emphasis on density and complexity of component packing efficiency. For example, low Part Density of high-pincount devices can pose an equal challenge in Connection Density to high Part Density of low-pincount devices. High Part Density does reflect challenges in surface mount assembly in terms of (typically) precision of placement, number of placements, and engineering of part clearances.

Routing Density (heuristic estimate) = $3 * (\text{Average Pin Count}) * \sqrt{\text{Part Density}}$. The Routing Density metric is an empirically derived relationship that characterizes the wiring density of the interconnect used to support the interconnection of components in a planar electronic assembly (i.e. the circuit board). Architectural issues such as bussing or other factors affecting the regularity of wiring impact the actual Routing Density needed to support a given application, but the metric provides a ready measure of wiring complexity.

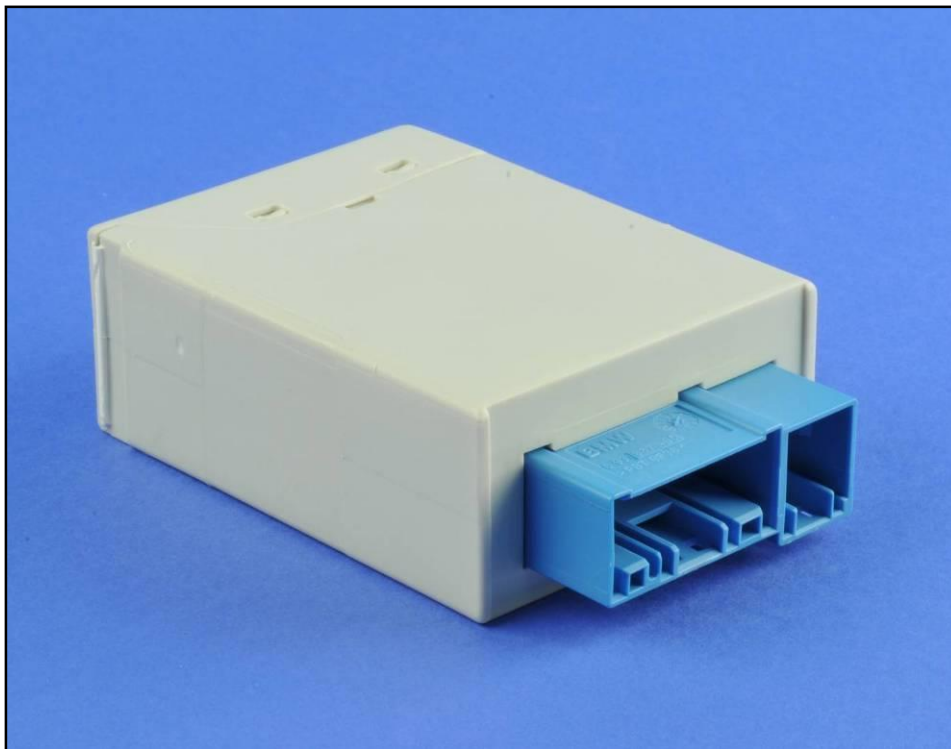
[Click Here to Return to Cost Analysis Page 137](#)

Deep Dive Report

BMW i3 Hybrid Pressure Refueling ECU

2253

Report #15900-150204-RRb



Product Description

This report concerns the Hybrid Pressure Refueling Electronic Control Unit (ECU) of the 2014 BMW i3. This device monitors the vehicle's current operating condition via a pressure temperature sensor in the fuel tank and then controls the pressure reduction by opening a valve. The Hybrid Pressure Refueling ECU then activates the fuel filler flap, which allows the vehicle to be refueled. This device features a Renesas #uPD70f3548 32-bit microcontroller, NXP semiconductor #TJA1043T high-speed CAN transceiver, Atmel #ATA6663 LIN transceiver, ON Semiconductor #NCV4299 150 mA low-dropout voltage regulator, and STMicroelectronics #VND5050AJ-E double-channel high side driver with analog current sense.

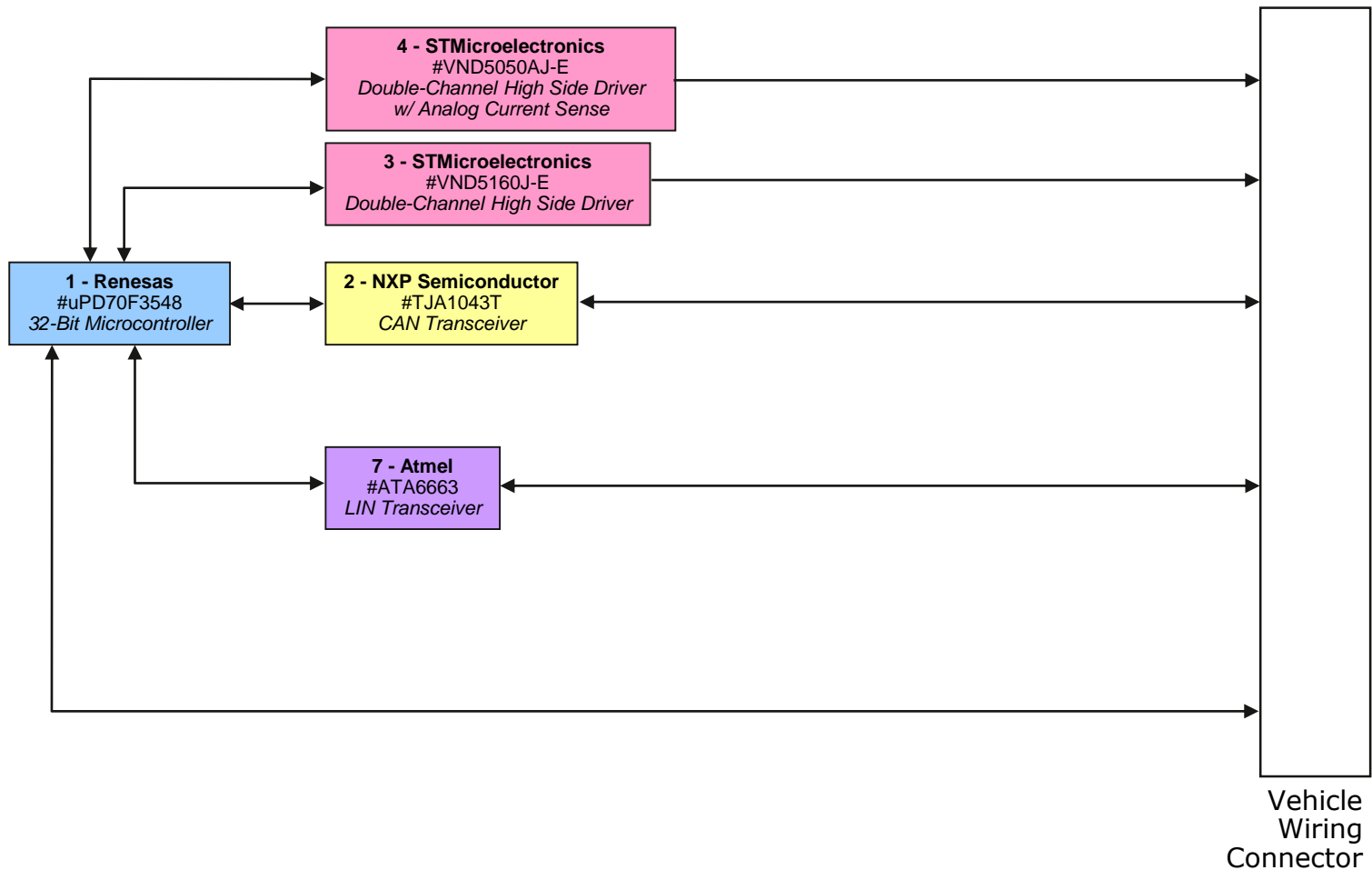
DISCLAIMER: All company names, product names, and service names mentioned are used for identification purposes only and may be registered trademarks, trademarks, or service marks of their respective owners. All analyses are done without participation, authorization, or endorsement of the manufacturer. Any cost analyses presented in this material are estimates prepared by TechInsights from generally available data. While TechInsights believes that these estimates reflect the probable costs, the actual producer did not supply the data, and therefore the actual costs may be different from these estimates. Furthermore, TechInsights extends no warranties with respect to any information in this document, and shall bear no liability whatsoever for the use of the information.

Copyright © 2015, TechInsights. All rights reserved. Do not reproduce, distribute, disseminate, photocopy, fax, transmit, download to a shared database, or otherwise copy, transfer, sell, publish, or send this material, or any portion thereof, by any means without the express written permission of TechInsights.

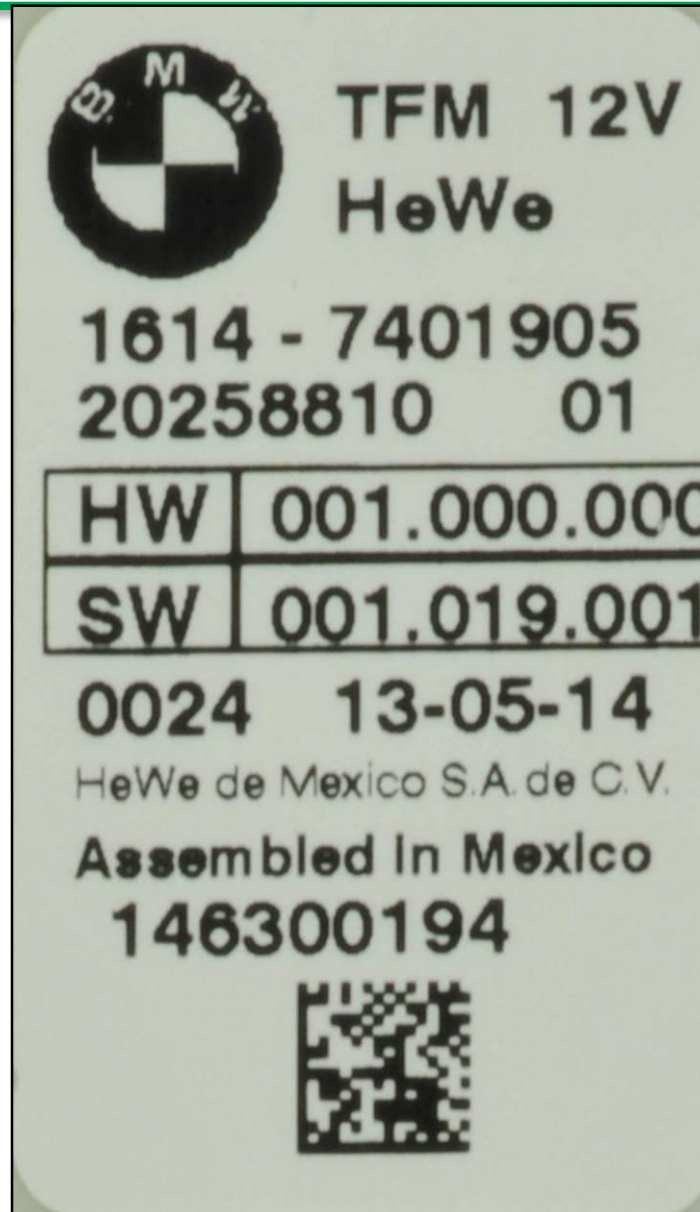
Product Overview

Product Description		Integrated Circuit Metrics		
Product Type	Automotive	IC Die Count	9	
Brand	BMW	IC Package Count	8	
Product Name & Model #	i3 Hybrid Pressure Refueling ECU	Cost Metrics		
Official Release Date	5/2/2014			
Weight (grams)	69.7 (Measured)	Retail Price		
Product Dimensions (mm)	99.62 x 63.6 x 31.84 (Measured at Longest/Widest/Thickest Points)	Total Manufacturing Cost	\$23.38	
Product Features		Electronics Cost	\$21.67	
		Manufacturing Cost Breakdown		
Connectivity	NXP Semiconductor #TJA1043T High-Speed CAN Transceiver, Atmel #ATA6663 LIN Transceiver	Integrated Circuits	\$12.78	54.7%
Processor	Renesas #uPD70f3548 32-Bit Microcontroller	Modules, Discretes & Connectors	\$6.64	28.4%
Voltage Regulation	ON Semiconductor #NCV4299 150 mA Low-Dropout Voltage Regulator	Substrates	\$0.84	3.6%
		Component Insertion	\$0.99	4.2%
		Card Test	\$0.42	1.8%
		Non-Electronic Parts	\$1.48	6.3%
		Final Assembly & Test	\$0.23	1.0%
		Total	\$23.38	100.0%

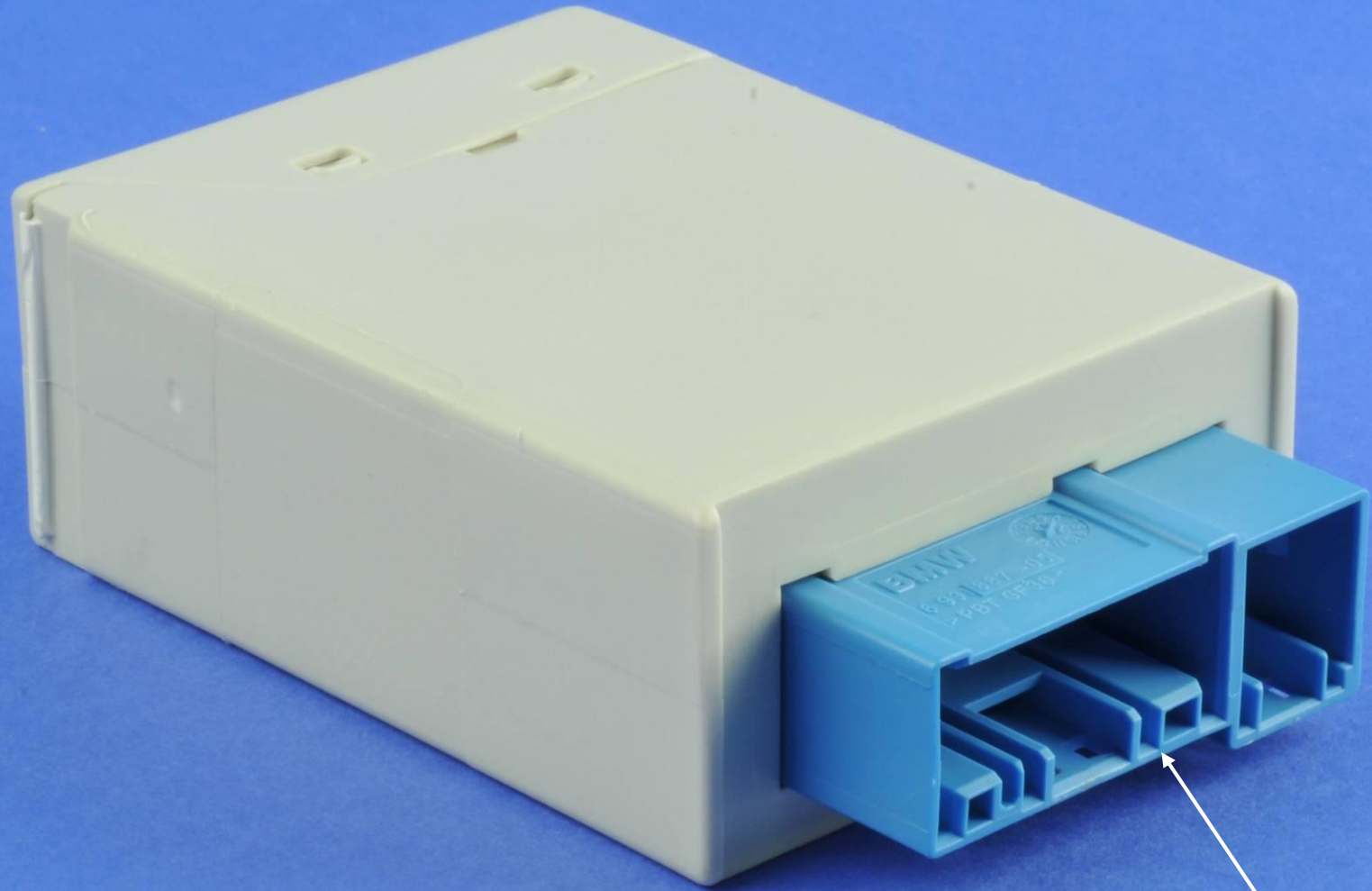
Block Diagram



Estimated block diagram based on observation of this specific product implementation, manufacturer's data sheets where available, and best engineering judgment. Certain details of the interface circuitry are not reflected in this block diagram. Partitioning and connectivity are speculative.



Exterior Features



Connects to Range Extender Module

Exterior Features



MUNRO
& ASSOCIATES, INC.



Major Components (Side 1)



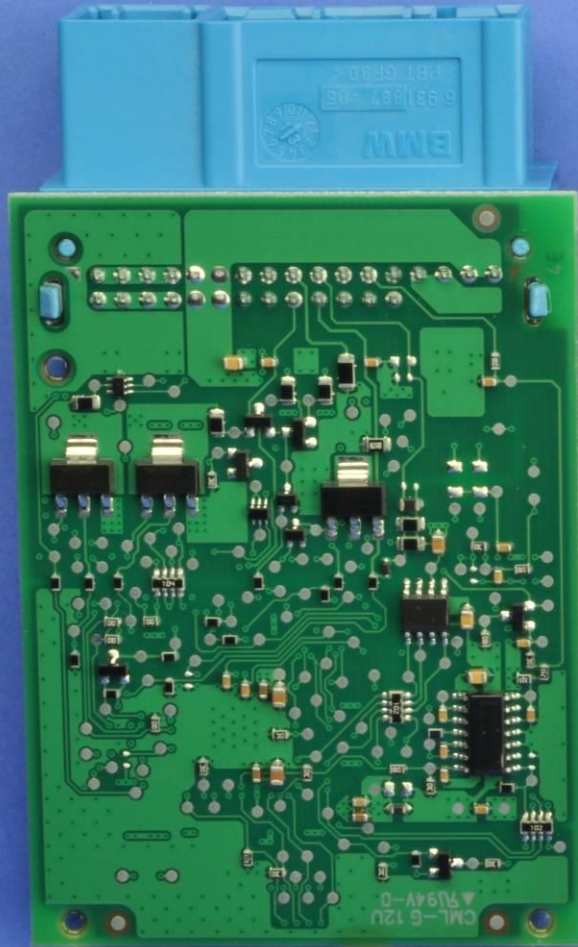
MUNRO
& ASSOCIATES, INC.



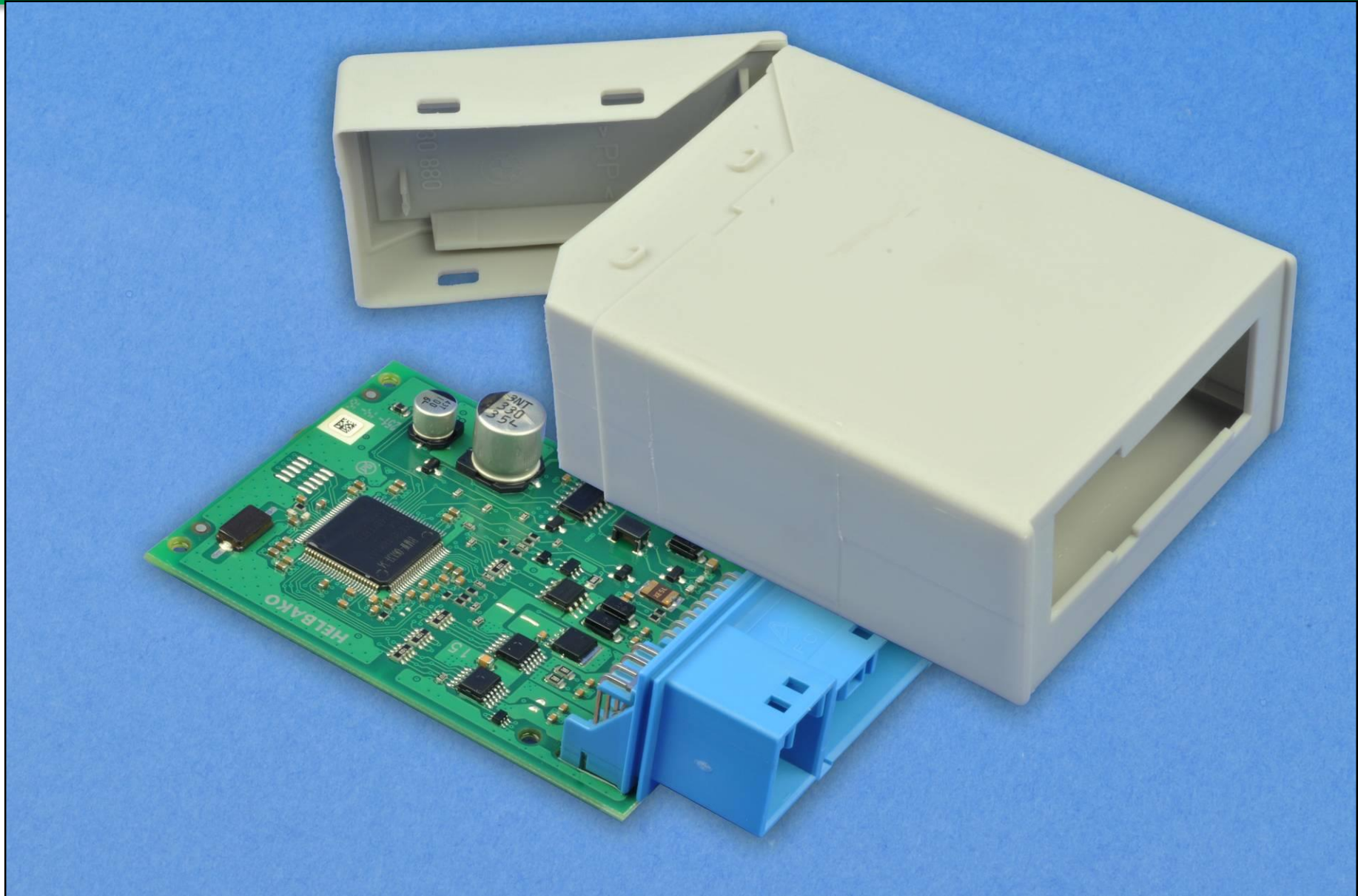
Major Components (Side 2)



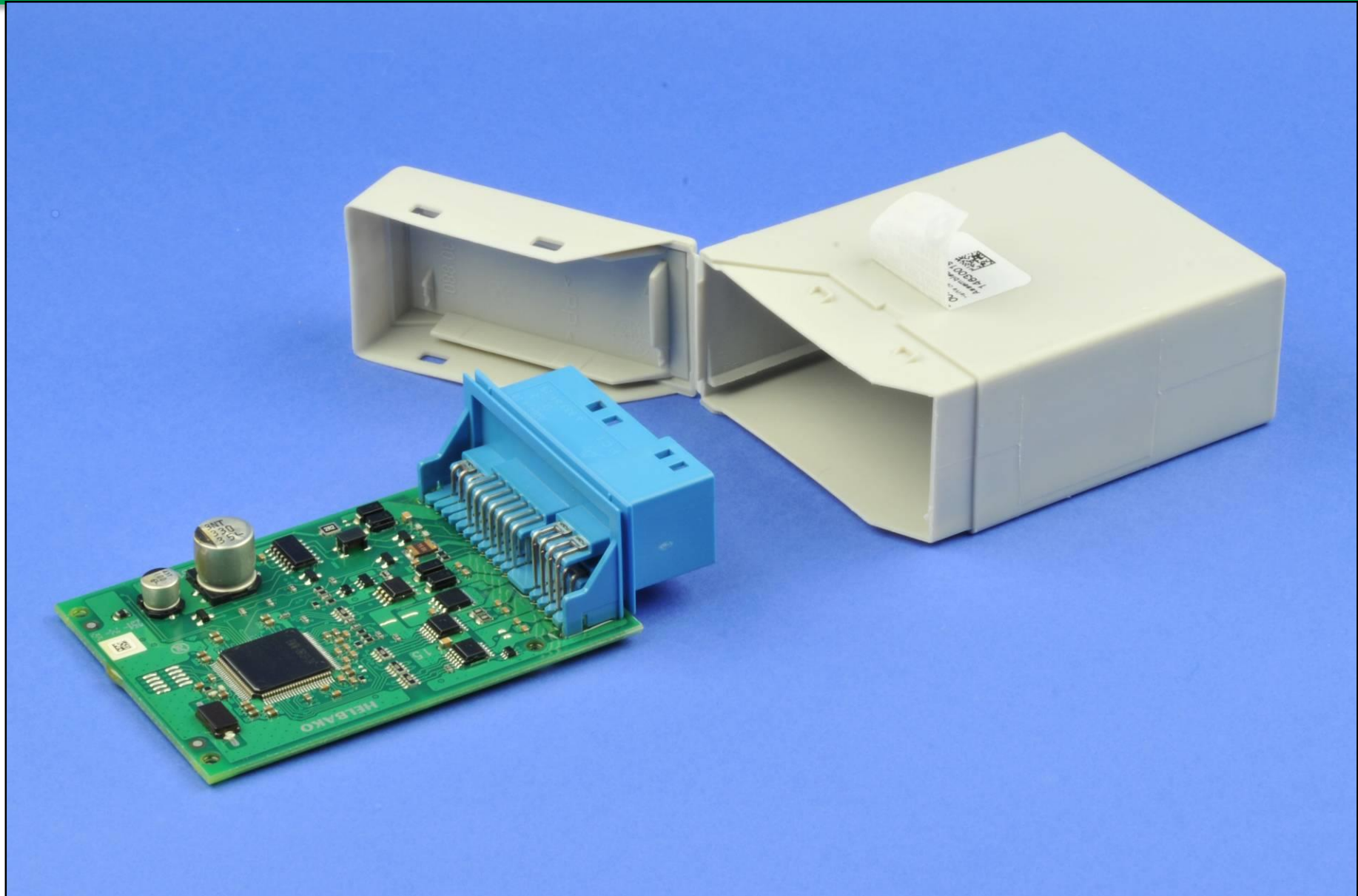
MUNRO
& ASSOCIATES, INC.



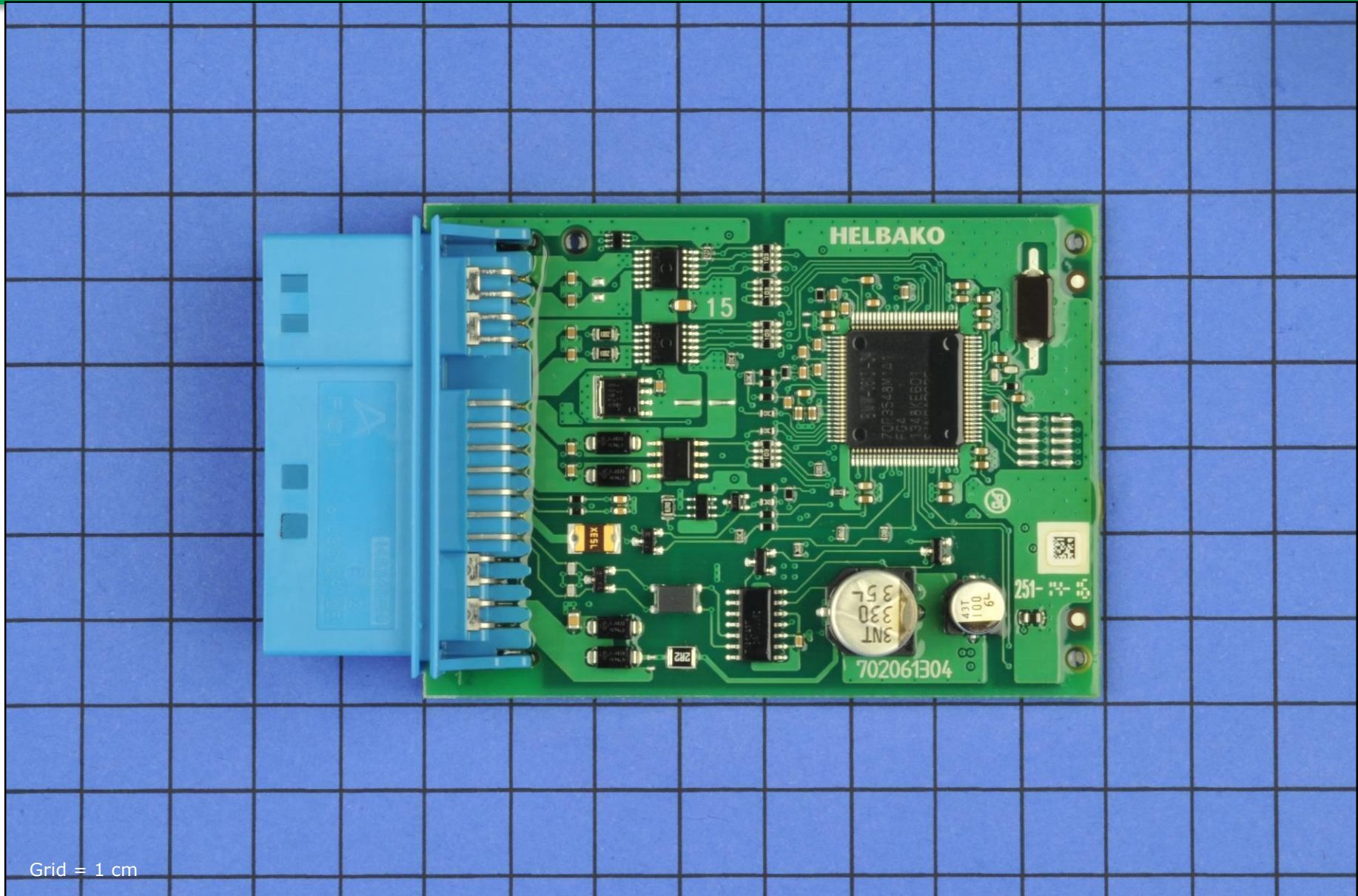
Component Arrangement



Teardown Sequence

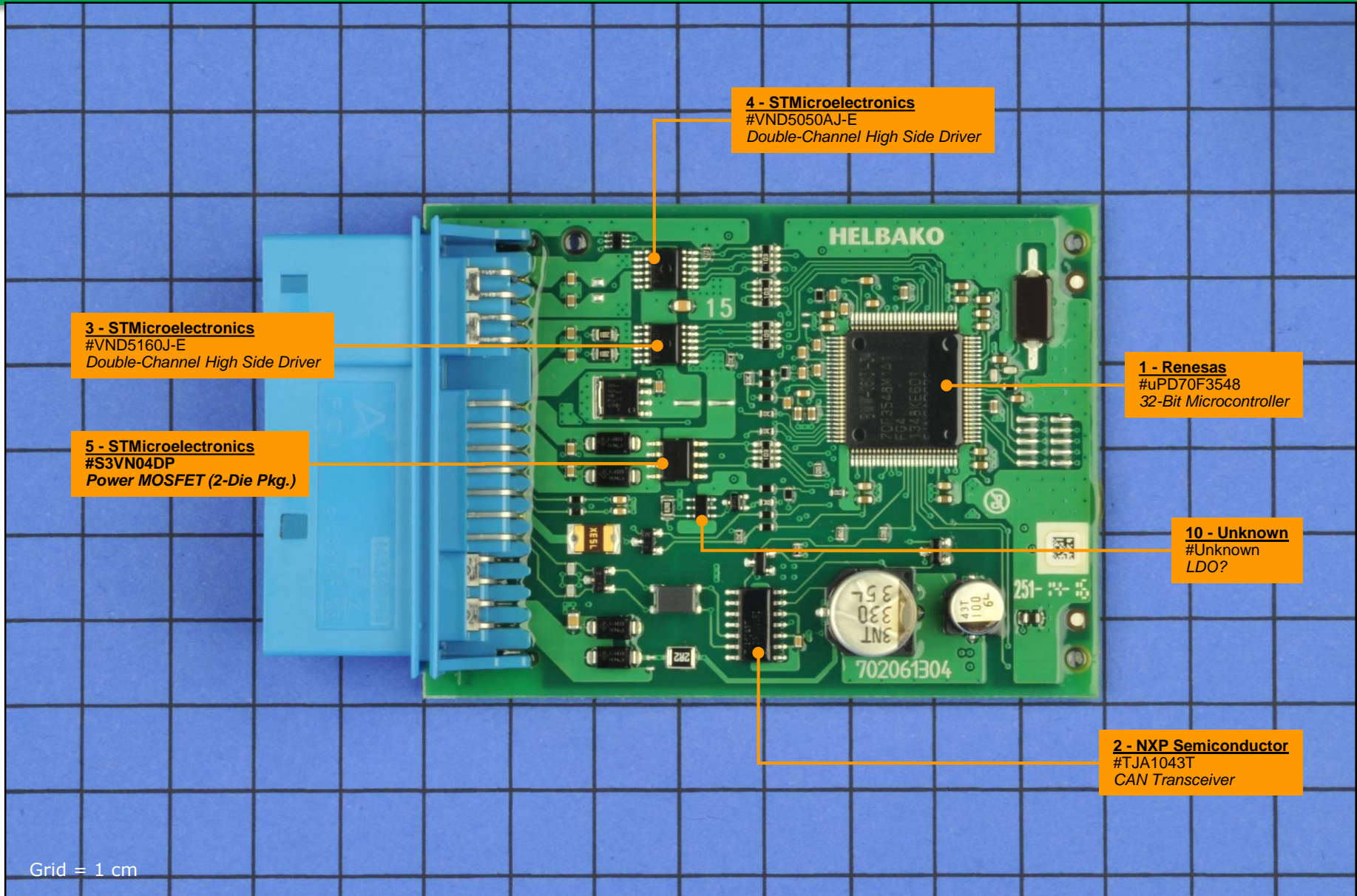


Main Board (Side 1)



Grid = 1 cm

Main Board (Side 1 IC Identification)



4 - STMicroelectronics
#VND5050AJ-E
Double-Channel High Side Driver

3 - STMicroelectronics
#VND5160J-E
Double-Channel High Side Driver

1 - Renesas
#uPD70F3548
32-Bit Microcontroller

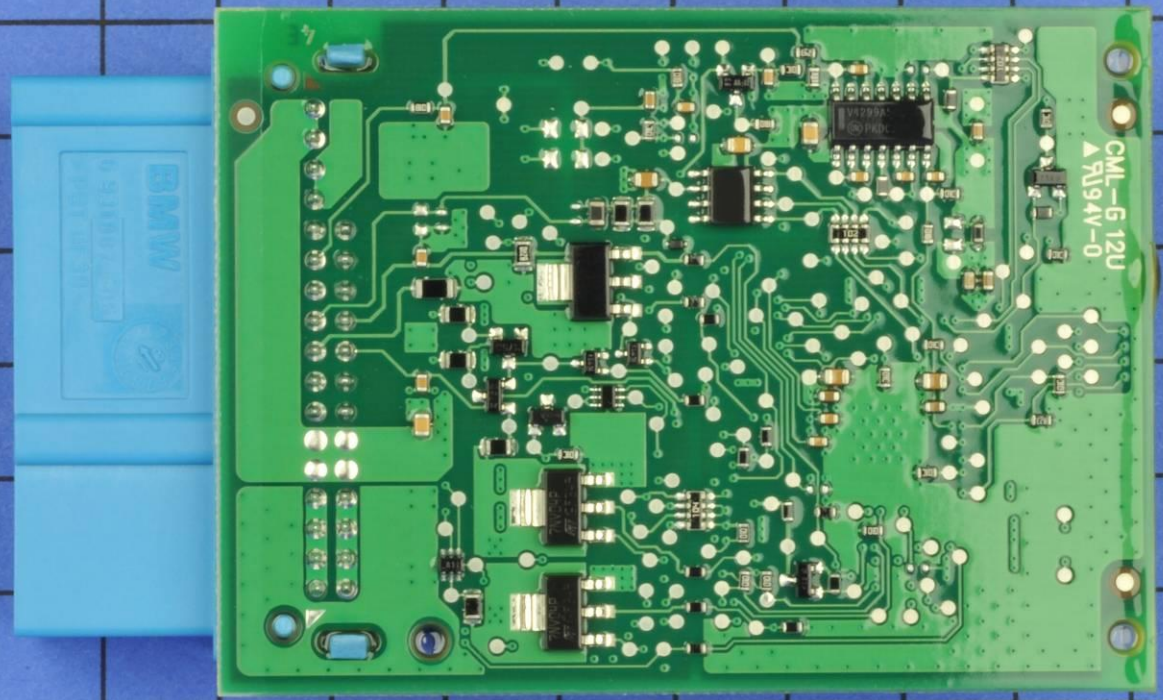
5 - STMicroelectronics
#S3VN04DP
Power MOSFET (2-Die Pkg.)

10 - Unknown
#Unknown
LDO?

2 - NXP Semiconductor
#TJA1043T
CAN Transceiver

Grid = 1 cm

Main Board (Side 2)



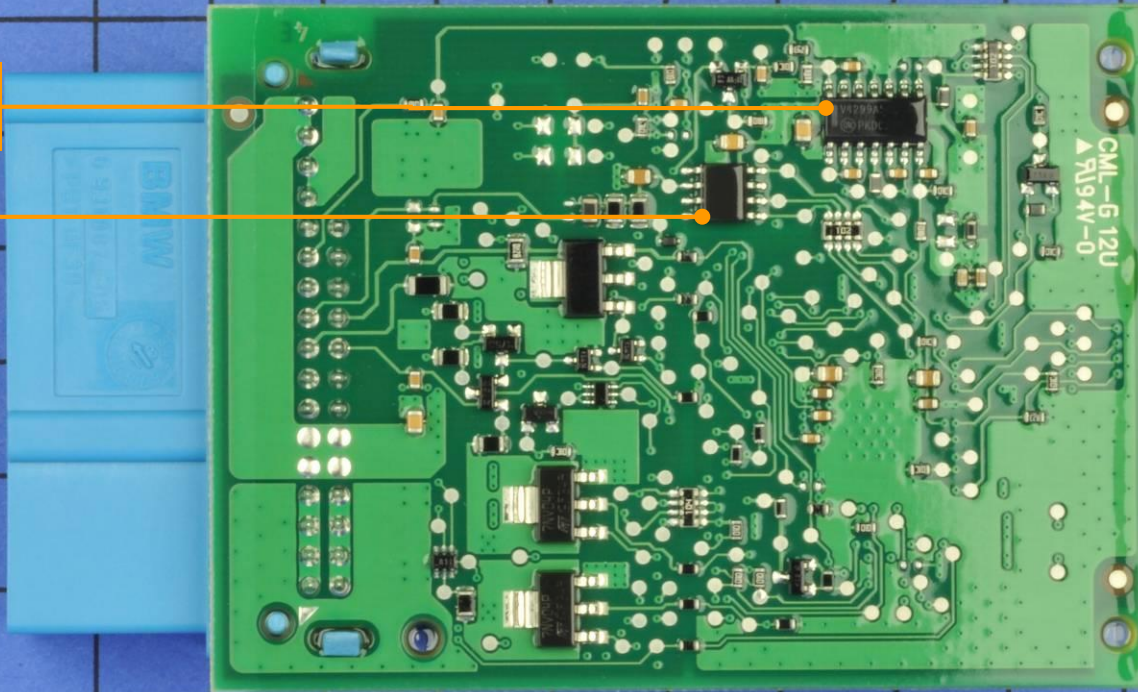
Grid = 1 cm

Main Board (Side 2 IC Identification)



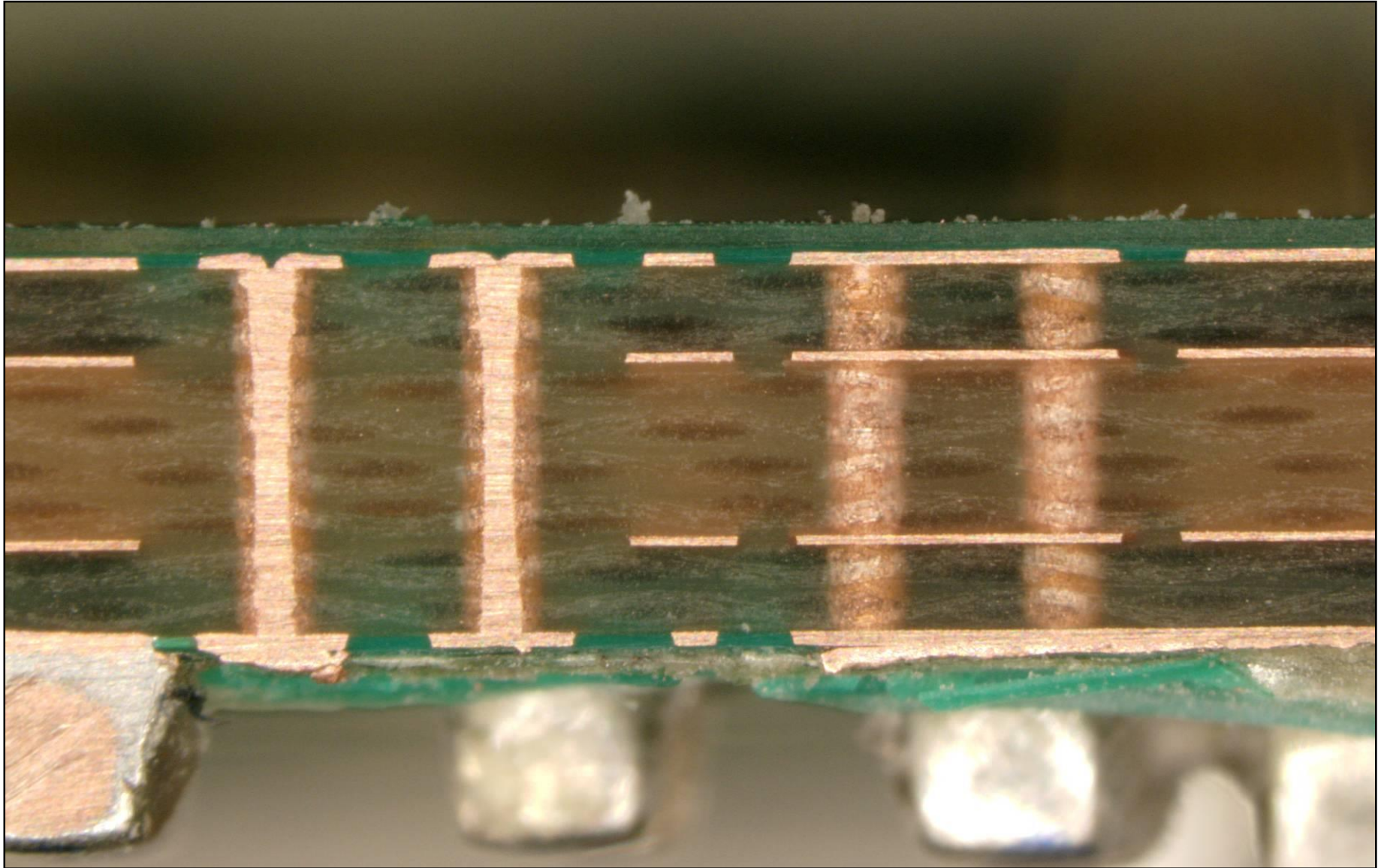
6 - ON Semiconductor
#NCV4299
150 mA LDO Regulator

7 - Atmel
#ATA6663
LIN Transceiver



Grid = 1 cm

Main Board Cross-Section



Substrate Data

Substrates

Assembly Name	Manufacturer	Core Material	Mfg. Technology	Layers	Area (cm ²)	Min. Trace Pitch (mm)	Min. Trace Width (mm)	ThruVia Land Dia (mm)	ThruVia Hole Dia (mm)	BlindVia Land Dia (mm)	BlindVia Hole Dia (mm)	Thickness (mm)	Routing Density	Estimated Costs
Main Board	Helbako	FR4	4 Layer Conventional FR4 / HF	4	45.6	0.45	0.13	0.60	0.30			1.7	20.4	\$ 0.84

Integrated Circuit Components



MUNRO
& ASSOCIATES, INC.

Location	Package Info									Die Info						Estimated Costs			
	Pkg Ref. #	Pkg Qty	Brand Name	Part Number	Pkg Description	Form	Pin Count	Length (mm)	Width (mm)	Height (mm)	Die Ref #	Die Qty	Brand Name	Part Number	Description	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	1	Renesas	uPD70F3548	32-Bit Microcontroller	QFP	100	13.87	13.84	1.57	1.1	1	Renesas	70F4002	32-Bit Microcontroller	6.52	5.51	\$ 10.780	\$ 10.780
	2	1	NXP Semiconductor	TJA1043T	CAN Transceiver	SOP	14	8.72	3.95	1.55	2.1	1	NXP Semiconductor	TJA1043T	CAN transceiver	2.50	1.65	\$ 0.283	\$ 0.283
	3	1	STMicroelectronics	VND5160J-E	Double-Channel High Side Driver	SOP	12	4.86	3.71	1.50	3.1	1	STMicroelectronics	VNG2A	Double-Channel High Side Driver	2.95	1.48	\$ 0.272	\$ 0.272
	4	1	STMicroelectronics	VND5050AJ-E	Double-Channel High Side Driver	SOP	12	4.91	3.73	1.49	4.1	1	STMicroelectronics	None	Double-Channel High Side Driver	3.82	1.84	\$ 0.399	\$ 0.399
	5	1	STMicroelectronics	VNS3NV04DP-E	Power MOSFET	MCP - 2 Chips	8	4.95	3.71	1.41	5.1	2	STMicroelectronics	VN56A	MOSFET	2.32	1.67	\$ 0.211	\$ 0.422
Main Board, Side 2	6	1	ON Semiconductor	NCV4299	150 mA LDO Regulator	SOP	14	8.77	3.71	1.55	6.1	1	ON Semiconductor	NCV4299A	150 mA LDO Regulator	2.81	2.61	\$ 0.433	\$ 0.433
	7	1	Atmel	ATA6663	LIN Transceiver	SOP	8	4.93	3.63	1.41	7.1	1	Atmel	ATA6663	LIN Transceiver	1.64	1.22	\$ 0.143	\$ 0.143
Main Board, Side 1	10	1	Unknown	Unknown	Unknown	SOP	6	3.01	1.46	0.87	10.1	1	Unknown	T305B	Unknown	0.58	0.56	\$ 0.046	\$ 0.046
Totals		8					174					9							\$12.78

Note: Supplemental information, such as IC package & die markings, is included in the Excel Bill of Materials (BOM) spreadsheet.

Modular Components



Location	Qty	Brand Name	Part Number	Description	Package			Estimated Costs	
					Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	NDK	NX8045GE	Crystal: Ceramic	2	7.11	4.41	\$ 0.200	\$ 0.200
TOTALS	1				2				\$0.20

Active Discrete Components



Location	Qty	Functional Description	Package					Estimated Costs	
			Form	Top Marking	Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Small Active	MOSFET	QJ463 Siliconix Logo AA(TRIANGLE) W38B	5	4.54	4.30	\$0.280	\$0.280
	4	Small Active	Diode, SMT	SG 39 General Semiconductor	2	4.06	2.49	\$0.015	\$0.060
	5	Small Active	Transistor, Small	37 75 V3, 74 s 3N, 31 WE s, 1FW 3d, tAN 41,	3	2.84	1.30	\$0.030	\$0.150
Main Board, Side 2	2	Small Active	MOSFET	7NV04P ST Logo GF349	4	6.48	3.36	\$0.440	\$0.880
	1	Small Active	MOSFET	SG 1325 N ST4140	4	6.56	3.36	\$0.440	\$0.440
	2	Small Active	Transistor, Small	2D WE s	3	1.99	1.49	\$0.030	\$0.060
	6	Small Active	Transistor, Small	37 75 V3, Y6 9, 1FW 39, YA s 3N	3	2.72	1.19	\$0.030	\$0.179
TOTALS	21				64				\$2.05

Passive Discrete Components

Location	Qty	Functional Description	Package		Estimated Costs	
			Form	Pin Count	Each	Total
Main Board, Side 1	3	Small Passive	Diode Array	6	\$0.040	\$0.120
	1	Misc	Fuse	2	\$0.085	\$0.085
	1	Coil	SMT, Small	4	\$0.750	\$0.750
	1	Capacitor	Electrolytic, Small	2	\$0.050	\$0.050
	1	Capacitor	Electrolytic, Small	2	\$0.060	\$0.060
	4	Small Passive	Cap, Res, Ferrite Array	8	\$0.007	\$0.030
	16	Small Passive	Res	2	\$0.004	\$0.064
	58	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.232
Main Board, Side 2	3	Small Passive	Cap, Res, Ferrite Array	6	\$0.007	\$0.022
	22	Small Passive	Res	2	\$0.004	\$0.088
	48	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.192
TOTALS	158			366		\$1.69

Connectors

Location	Qty	Form	Package			Estimated Costs	
			Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Connector: Vehicle Wiring	26	51.81	29.86	\$2.700	\$2.700
TOTALS	1		26				\$2.70

Electronic Assembly Metrics

Electronic Assembly Metrics by Assembly											
General Area	Assembly Name	Substrate Area (sq.cm)	Metal Layers	Circuit Area (sq.cm)	Routing Density (cm of routing per sq.cm of substrate)	Number of Components	Number of Connections	Component Density (Components/sq.cm)	Connection Density (Connections/sq.cm)	Avg. Pin Count	Assembly Weight (grams)
Main Electronics	Main Board	45.6	4	182.3	20.4	189	632	4.2	13.9	3.3	36.80
	System Totals	45.6	4	182.32		189	632	4.1	13.9	3.3	36.80

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics

Electronics Costs by Assembly										
General Area	Assembly Name	Total	Integrated Circuits	Modular & Odd Form Components	Small Active Components	Passive Components	Connector Components	Substrates	Insertion	Card Test
Main Electronics	Main Board	\$ 21.67	\$ 12.78	\$ 0.20	\$ 2.05	\$ 1.69	\$ 2.70	\$ 0.84	\$ 0.99	\$ 0.42
	System Totals	\$ 21.67	\$ 12.78	\$ 0.20	\$ 2.05	\$ 1.69	\$ 2.70	\$ 0.84	\$ 0.99	\$ 0.42

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Counts by Assembly												
General Area	Assembly Name	IC Package Count	IC Connections	Modular/Odd Form Components	Modular/Odd Form Component Connections	Small Active Components	Small Active Component Connections	Passive Components	Passive Component Connections	Connectors	Connector Connections	Opportunities
Main Electronics	Main Board	8	174	1	2	21	64	158	366	1	26	821
	System Totals	8	174	1	2	21	64	158	366	1	26	821

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



IC Metrics											
General Area	Assembly Name	IC Die Count	IC Package Count	Number of Package Connections	Die Area (sq.mm)	Substrate Tiling Density (die area / substrate area)	Package Area (sq.mm)	Die Area/Package Area Ratio	Package Connections per sq.cm of Package Area	Volatile Memory (KBytes)	Non-Volatile Memory (KBytes)
Main Electronics	Main Board	9	8	174	68.9	0.02	335.9	0.20	51.8	0	0
	System Totals	9	8	174	68.9		335.9	0.20	51.8	0	0

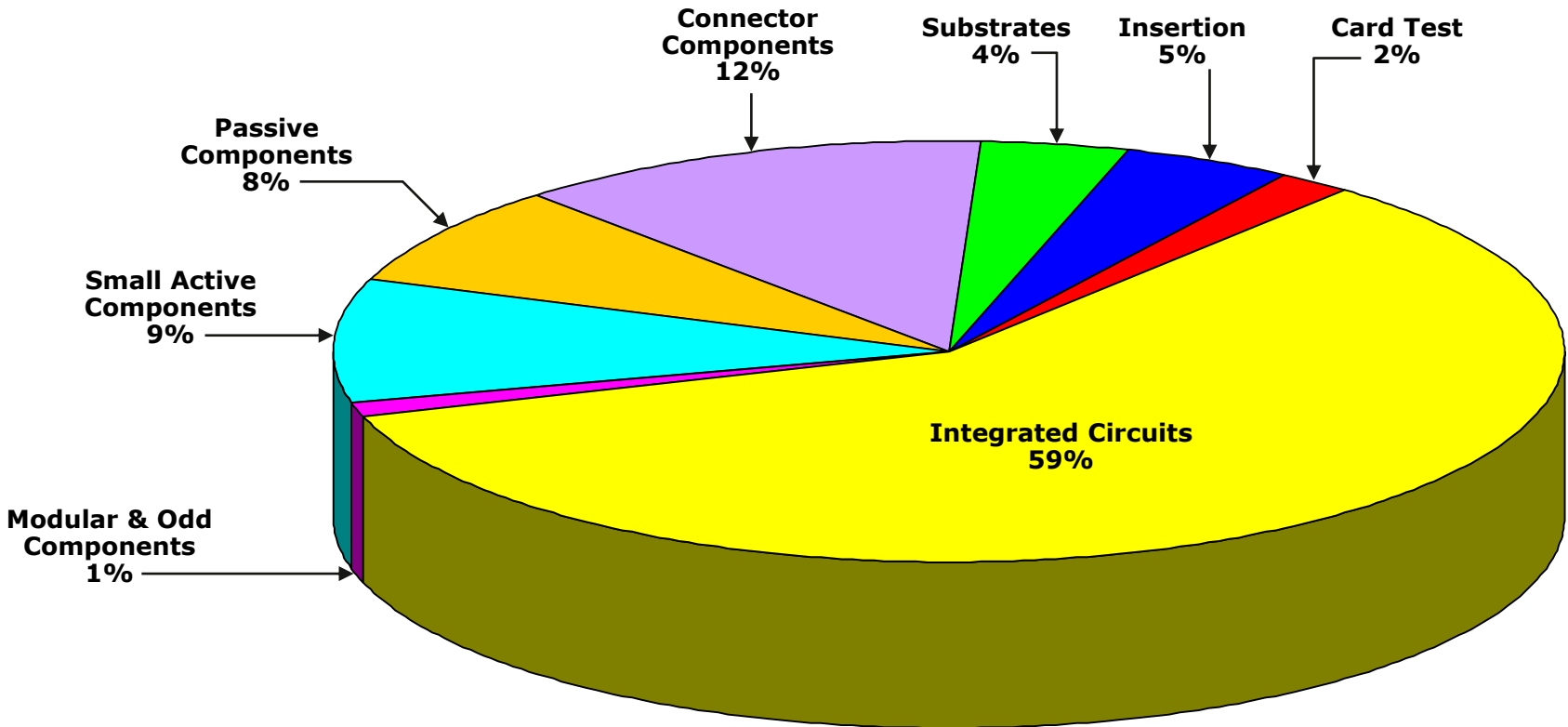
NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Costs Breakdown



**Estimated Cost
of Electronics**

\$21.67

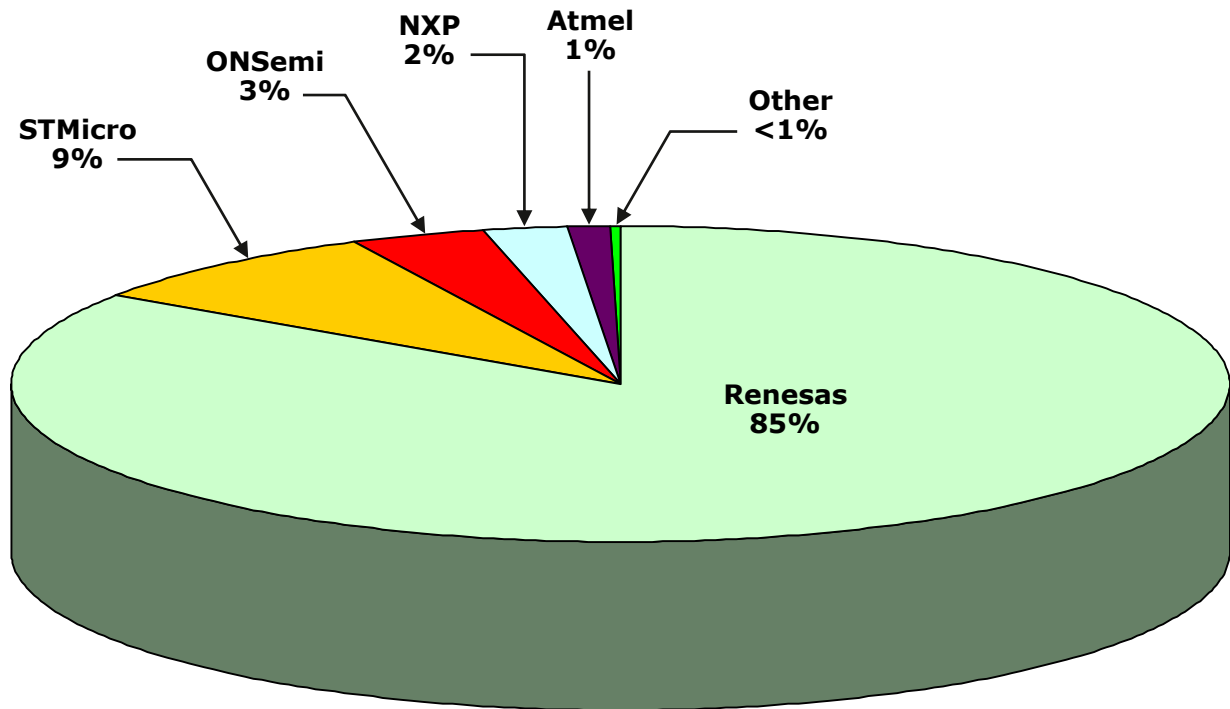


NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Vendor IC Cost Distribution



Pkg. Brand	Cost
Renesas	\$10.78
STMicroelectronics	\$1.09
ON Semiconductor	\$0.43
NXP Semiconductor	\$0.28
Atmel	\$0.14
Unknown	\$0.05



NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Non-Electronic Cost Estimate



Subsystem	Part ID No.	Qty	Description	Fabrication Process	Material	Dimensions (mm)	Weight (grams)	Est'd Cost Each	Est'd Extended Cost	
Enclosures	1	1	Plastic Housing	Molded + Pulls	Plastic	84.56 x 63.69 x 31.64	32.80	1.430	1.430	
	2	1	Product Label	Die-Cut + Printed	Plastic + Adhesive	37.9 x 22.11 x 0.03	0.05	0.050	0.050	
Total		2						Estimated Cost		\$1.48

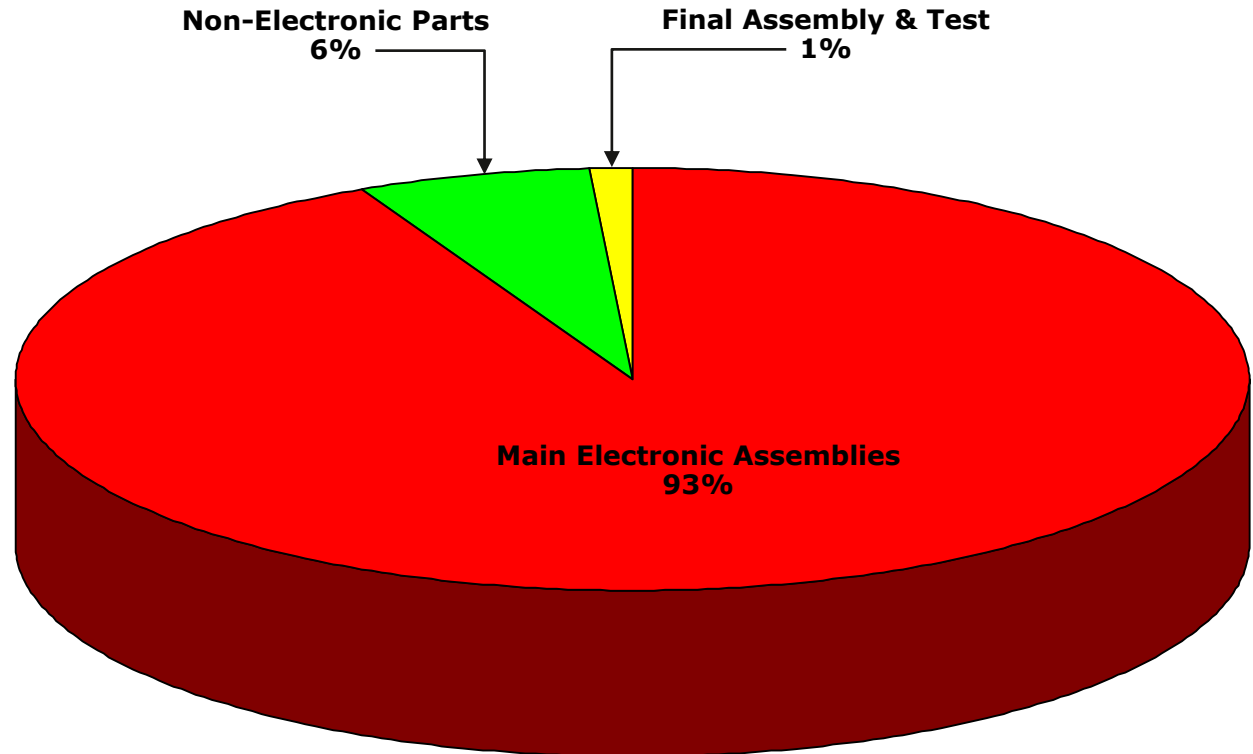
Final Ass'y Labor & Test Cost Estimate

Final Assembly & Test	
Made in	Mexico
Number of parts	4
Est'd number of steps	12
Est'd time (seconds)	36
Est'd final assembly cost	\$ 0.03
Est'd final test cost	\$ 0.20

Cost Summary

Estimated Cost Totals	
Main Electronic Assemblies	\$ 21.67
Non-Electronic Parts	\$ 1.48
Final Assembly & Test	\$ 0.23
Total	\$ 23.38

Cost Total Notes:
Estimated final assembly cost includes labor only.
Total cost does not include Non-recurring, R&D, G&A, IP licensing fees/royalties, software, sales & marketing, distribution.
Assumes fully scaled production.



Cost Estimation Process

(Overview & Discussion)



Cost modeling is a tricky business. Multiple variables affect the actual production costs a manufacturer will experience, including development expenses, unit volumes, supply-and-demand in component markets, die yield-curve maturity, OEM purchasing power, and even variations in accounting practices. Different cost modeling methods employ different assumptions about how to handle these and other variables, but we can identify two basic approaches: that which seeks to track short-term variations in the inputs to the production process, and that which strives to maintain comparability of the output of the model across product families and over time.

TechInsights' philosophy in cost modeling is to emphasize consistency across products and comparability over time, rather than to track short-term fluctuations. During the past eight years, we have developed an estimation process that, while necessarily lacking an insider's knowledge of the cost factors that impact any one manufacturer, is reasonably accurate in its prediction of unit costs in high-volume production environments. We do not claim that the model will produce the "right" answer for your firm's environment. However, TechInsights does give customers a key analytical tool with a complete set of data in our Bill of Materials (BOM). The BOM allows readers to 1) scrutinize the assumptions behind our cost model and 2) modify the results based on substitution of their own component cost estimates where they have better information based on inside knowledge.

Our estimation process decomposes overall system cost into three major categories: Electronics, Mechanical, and Final Assembly. We begin by creating a complete electronics bill-of-materials (BOM). Each component from the largest ASIC to the smallest discrete resistor is entered into a BOM table with identifying attributes such as size, pitch, I/O count, package type, manufacturer, part number, estimated placement cost, and die size (if the component is an IC). Integrated circuit costs are calculated from measured die area. Using assumptions for wafer size, process type, number of die per wafer, defect density, and profit margin in combination with die area, an estimate of semiconductor cost is derived. Costs for discrete components and interconnect are derived from assumption tables which relate BOM line items to specific cost estimates by component type and estimates for part placement costs are included. For LCD display costs, we employ a model which tabulates expected cost from measurements of glass area, LCD type, and total pixel resolution. When market costs are available from alternative sources, LCD panel costs are taken from and referenced to these sources.

Costs of non-electronic components such as molded plastic enclosures and metallic components are measured in terms of weight, size, thickness, type of material, and complexity to arrive at their estimated cost. Other system items such as optics, antennae, batteries and displays are costed from a set of assumption tables derived from a combination of industry data, average high volume costs, and external sources. For final assembly, we re-build the torn-down product, tabulating stepwise assembly times as the reconstruction proceeds, to reach a total assembly time. Using a labor rate assumption for the country of origin, we then calculate final assembly cost.

The three major categories for system cost contributors can be broken down into the subcategories of ICs, other electronics parts, displays, batteries (as appropriate), camera modules, electronics assembly, non-electronic elements, and final assembly. By adding the cost estimates for each of these subcategories, an overall estimated cost is derived for the system under evaluation. Product packaging and accessories (CDs, cables, etc.) are also documented and estimated for their contribution to total cost as appropriate.

We believe our cost estimates generally fall within 15 percent of the "right answer," which itself can vary depending on the market and OEM-specific factors mentioned earlier. While the TechInsights cost model is imperfect, it yields important insights into technology and business dynamics along with good first-order contributions to system cost by component type. Additionally, the consistency of approach and gradual modification to assumptions (smoothing out frequently-shifting pricing factors) hopefully yields a credible, but user-modifiable, view of OEM high volume cost-to-produce.

Please feel free to contact us at support@techinsights.com with any comments, questions, or proposed corrections with respect to our cost estimates. We welcome your input.

In our product teardowns, we gather a series of metrics for product profiling and comparison. Some metrics focus on system characteristics such as total silicon area, total system semiconductor storage capacity, and total connection count. Other metrics reflect more subtle aspects of electronics assembly such as connection density, average component I/O count, and silicon tiling density. Taken as a whole, the metrics allow deeper comparison and benchmarking across multiple disciplines and multiple products. Key metrics we gather on products are described below along with their definitions and what they tend to say about the system under study. Most metrics can be used both in comparing similar products for benchmarking purposes or for quantifying differences in levels of complexity between dissimilar product types. Data fall into two categories; either “raw” measured data or ratios of these measured data sets.

Total Silicon Area : This metric describes the total area of silicon as measured from X-ray or direct measurement of ICs. The area is an expression of the enclosed bare die area and excludes packaging area. The aggregate silicon area is a good benchmark to show how integrated a design might be when making comparisons to similar systems. Total silicon area also reflects the major cost driver for most systems we examine.

Silicon Tiling Density : Ratio of Total Silicon Area to total printed circuit board “projected” area (i.e. the simple board area and not the cumulative surface area of both sides of the board). This metric directly reflects the level of efficiency and aggressiveness in integrated circuit packing and placement. Single digit Silicon Tiling Density is typical but silicon coverage of 10% - 20% has been seen in some of the most advanced products we have examined. Higher Tiling Densities often correspond with the use of chip scale packaging (CSPs) or other small form-factor IC packaging technologies. High density circuit boards are also often a supporting technology.

Number of Parts : Total component count including ICs, passives, modules, connectors, etc., each separated out in our reporting.

Number of Connections : The total number of connections corresponds to the total number of interconnects introduced by the aggregate component set and reflects any electrical connection observed (solder joints, adhesive interconnect, or connector terminal interfaces).

Opportunity Count : Opportunity Count is the total number of parts plus the total number of connections; the name reflects that each of these constituent elements represents an opportunity for failure. A high opportunity count means more complex and riskier electronics assembly.

Average Pin Count (APC) : Ratio of total number of component terminals to total number of parts, at the system level. This metric reflects the ‘average’ terminal complexity of the components and often provide a signature of integration level and/or “digital-ness” of the overall product. Low APCs reflect a high number of discrettes or other low-pincount devices often characteristic of analog circuitry. Conversely, high APCs are characteristic of highly integrated, high-pincount assemblies, often those composed largely of digital integrated circuits.

Connection Density : This metric is a ratio of the total Number of Connections to total printed circuit board assembly area, in units of connections per sq. inch. The metric provides data related to the Silicon Tiling Density above, but with an emphasis on complexity of I/O interconnect. For example, with a fixed Connection Density, high tiling density of low-pincount memory chips is more readily achieved than comparable silicon tiling of high pincount logic.

Part Density : This metric is a ratio of the total Number of Parts to total printed circuit board assembly area, in units of components per sq. inch. The metric provides data related to the Silicon Tiling Density and Connection Density as described above, but with an emphasis on density and complexity of component packing efficiency. For example, low Part Density of high-pincount devices can pose an equal challenge in Connection Density to high Part Density of low-pincount devices. High Part Density does reflect challenges in surface mount assembly in terms of (typically) precision of placement, number of placements, and engineering of part clearances.

Routing Density (heuristic estimate) = $3 * (\text{Average Pin Count}) * \sqrt{\text{Part Density}}$. The Routing Density metric is an empirically derived relationship that characterizes the wiring density of the interconnect used to support the interconnection of components in a planar electronic assembly (i.e. the circuit board). Architectural issues such as bussing or other factors affecting the regularity of wiring impact the actual Routing Density needed to support a given application, but the metric provides a ready measure of wiring complexity.

***Click Here to Return to
Cost Analysis Page 141***

Deep Dive Report

BMW i3 Driver Support System

Camera-Based KAFAS 2 (2254)

Report #15900-150209-DHb



Product Description

The Autoliv-sourced Driver Support System in the 2014 BMW i3 consists of a KAFAS 2 control module that works in conjunction with a forward-pointing video camera to provide five possible functions: Speed Limit Indication (SLI), Non-Passing Indication (NPI), Lane Departure Warning (LDW), High Beam Assist (HBA), and Forward Collision Warnings (FCW). The module is controlled by Mobileye's computer vision algorithms running on an #STME-EyeQ2 64-bit RISC system-on-chip as well as a Freescale #SPC5604CVLL6 32-bit microcontroller. Memory includes a 16 MB of NOR flash from a Spansion #S29GL128N11FFA02 and 64 MB of AIT LPDDR3 SDRAM from a Micron #MT46H16M32LFB5-6. Communications are provided by (2) NXP Semiconductor #TJA1051 CAN transceivers.

DISCLAIMER: All company names, product names, and service names mentioned are used for identification purposes only and may be registered trademarks, trademarks, or service marks of their respective owners. All analyses are done without participation, authorization, or endorsement of the manufacturer. Any cost analyses presented in this material are estimates prepared by TechInsights from generally available data. While TechInsights believes that these estimates reflect the probable costs, the actual producer did not supply the data, and therefore the actual costs may be different from these estimates. Furthermore, TechInsights extends no warranties with respect to any information in this document, and shall bear no liability whatsoever for the use of the information.

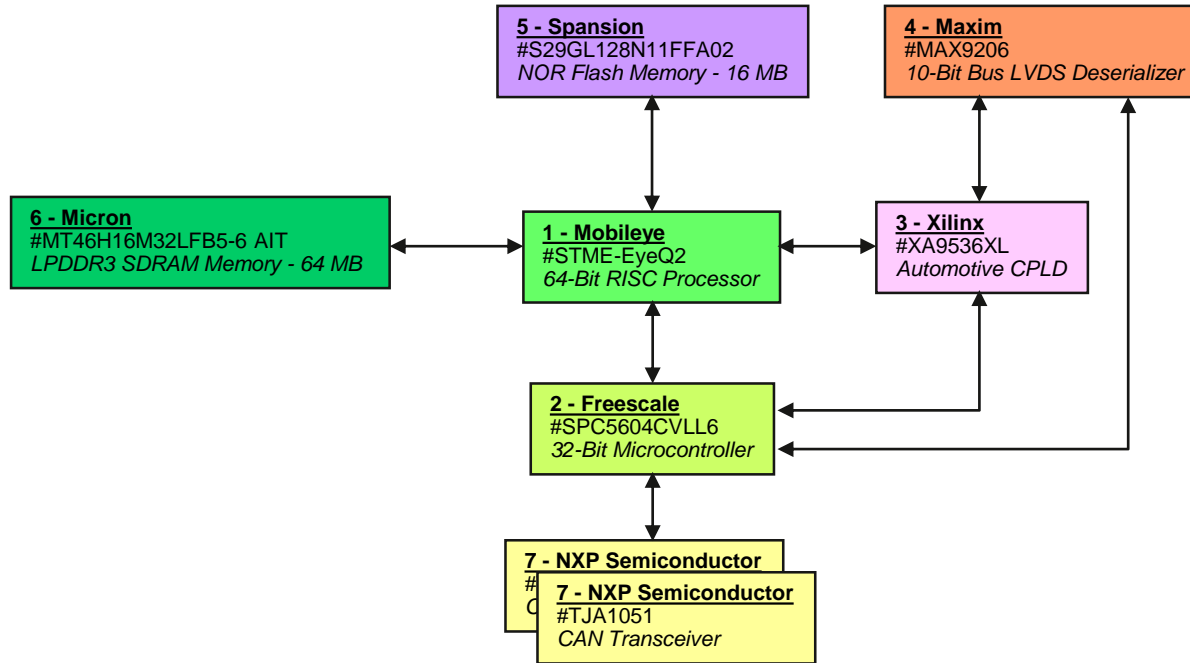
Copyright © 2015, TechInsights. All rights reserved. Do not reproduce, distribute, disseminate, photocopy, fax, transmit, download to a shared database, or otherwise copy, transfer, sell, publish, or send this material, or any portion thereof, by any means without the express written permission of TechInsights.

Product Overview

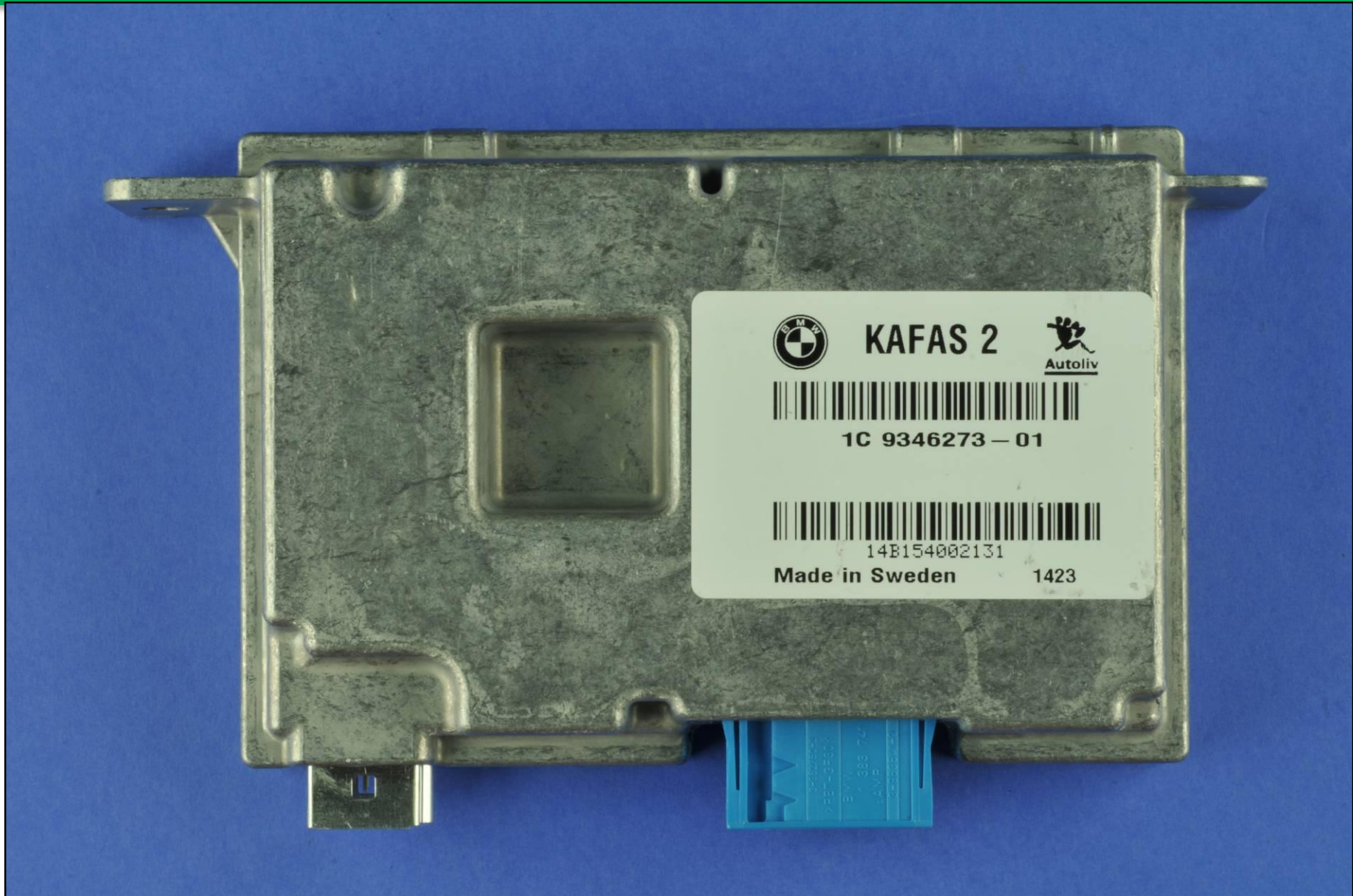


Product Description		Integrated Circuit Metrics		
Product Type	Automotive	IC Die Count	16	
Brand	BMW / Autoliv	IC Package Count	16	
Product Name & Model #	Camera-Based Driver Support System (KAFAS 2)	Cost Metrics		
Official Release Date	5/2/2014			
Weight (grams)	314 (Measured)	Retail Price		
Product Dimensions (mm)	155.02 x 93.59 x 29.59 (Measured at Longest/Widest/Thickest Points)	Total Manufacturing Cost	\$58.49	
Product Features		Electronics Cost	\$50.58	
		Manufacturing Cost Breakdown		
Communications	CAN, SPI	Integrated Circuits	\$39.42	67.4%
Processors	Mobileye #STME-EyeQ2 64-Bit RISC Processor; Freescale #SPC5604CVLL6 32-Bit Microcontroller	Modules, Discretes & Connectors	\$6.29	10.8%
Memory	Spansion #S29GL128N11FFA02 NOR Flash Memory - 16 MB; Micron #MT46H16M32LFB5-6 AIT LPDDR3 SDRAM Memory - 64 MB	Substrates	\$2.00	3.4%
		Component Insertion	\$1.88	3.2%
		Card Test	\$1.00	1.7%
		Non-Electronic Parts	\$5.93	10.1%
		Final Assembly & Test	\$1.97	3.4%
		Total	\$58.49	100.0%

Block Diagram



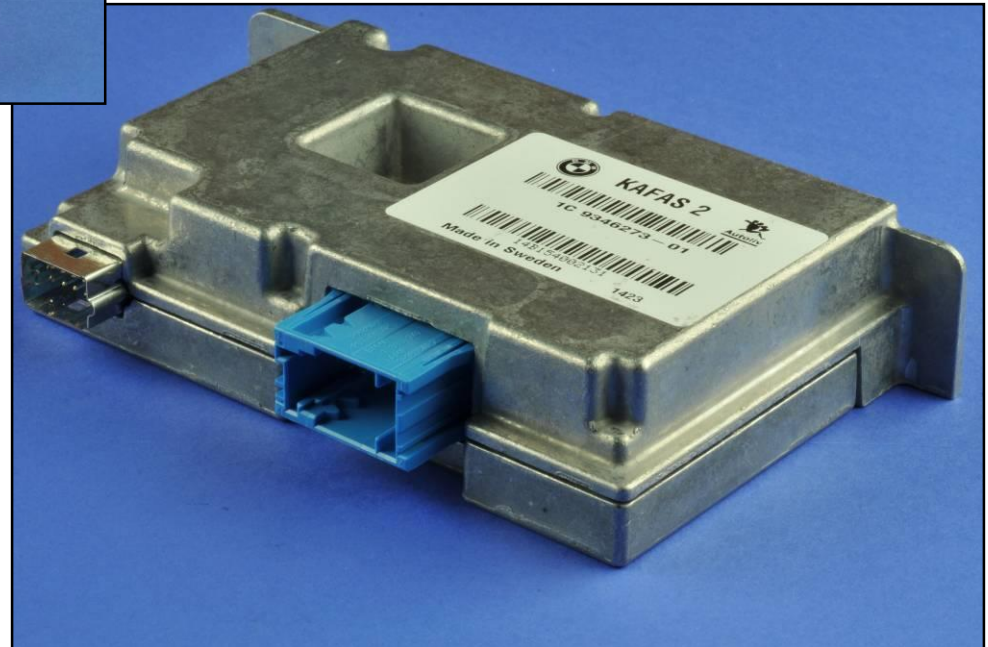
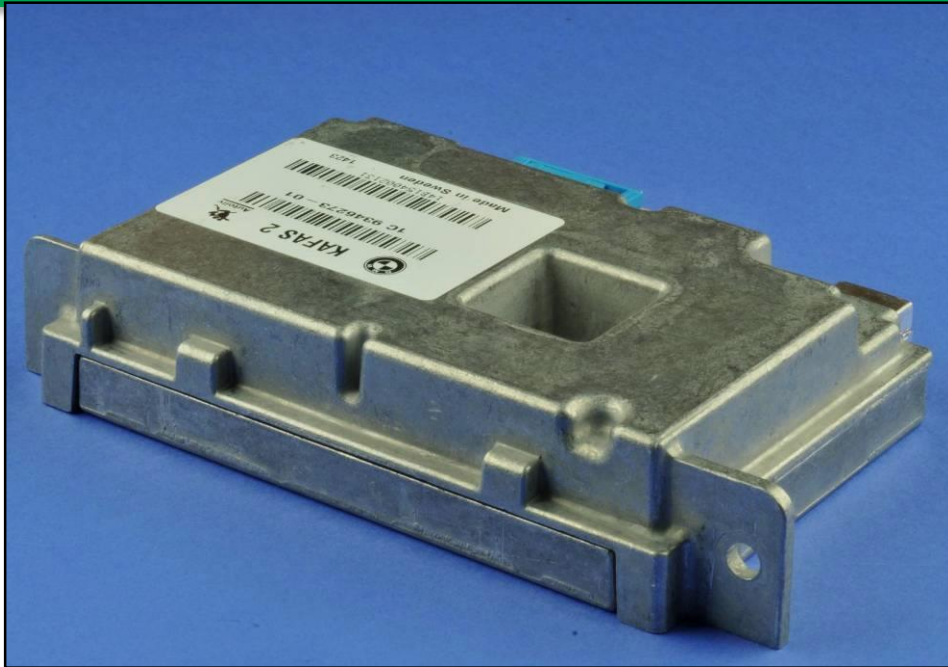
Estimated block diagram based on observation of this specific product implementation, manufacturer's data sheets where available, and best engineering judgment. Certain details of the interface circuitry are not reflected in this block diagram. Partitioning and connectivity are speculative.



Exterior Features



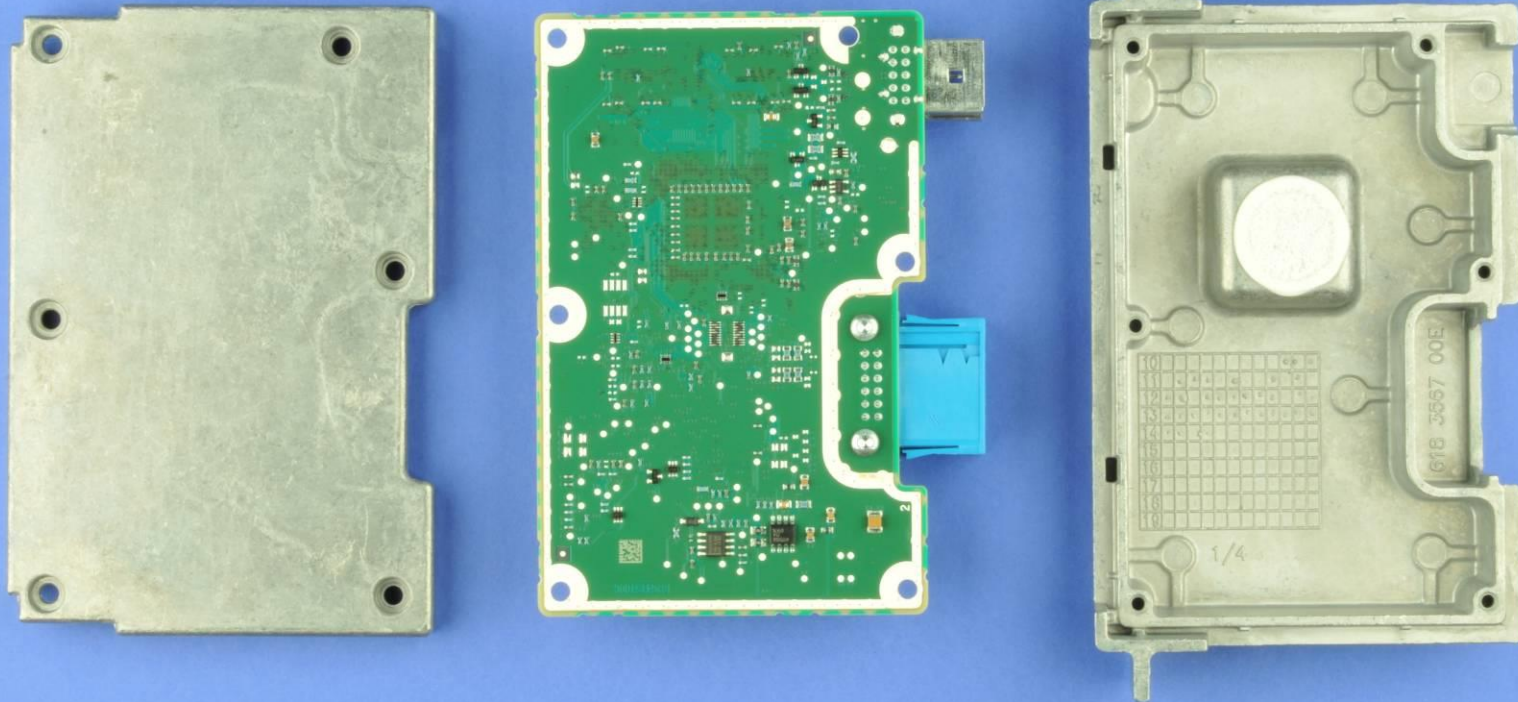
MUNRO
& ASSOCIATES, INC.



Major Components (Side 1)



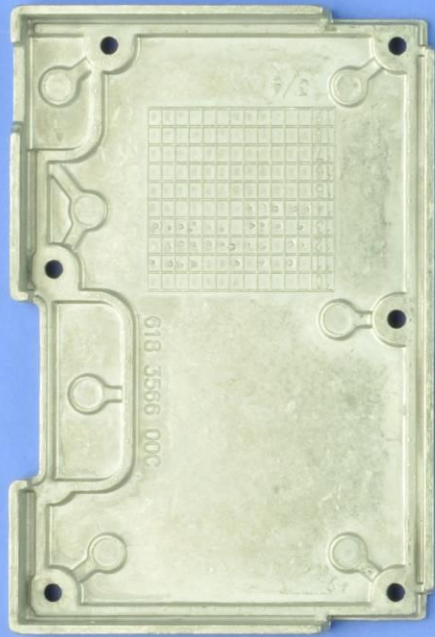
MUNRO
& ASSOCIATES, INC.



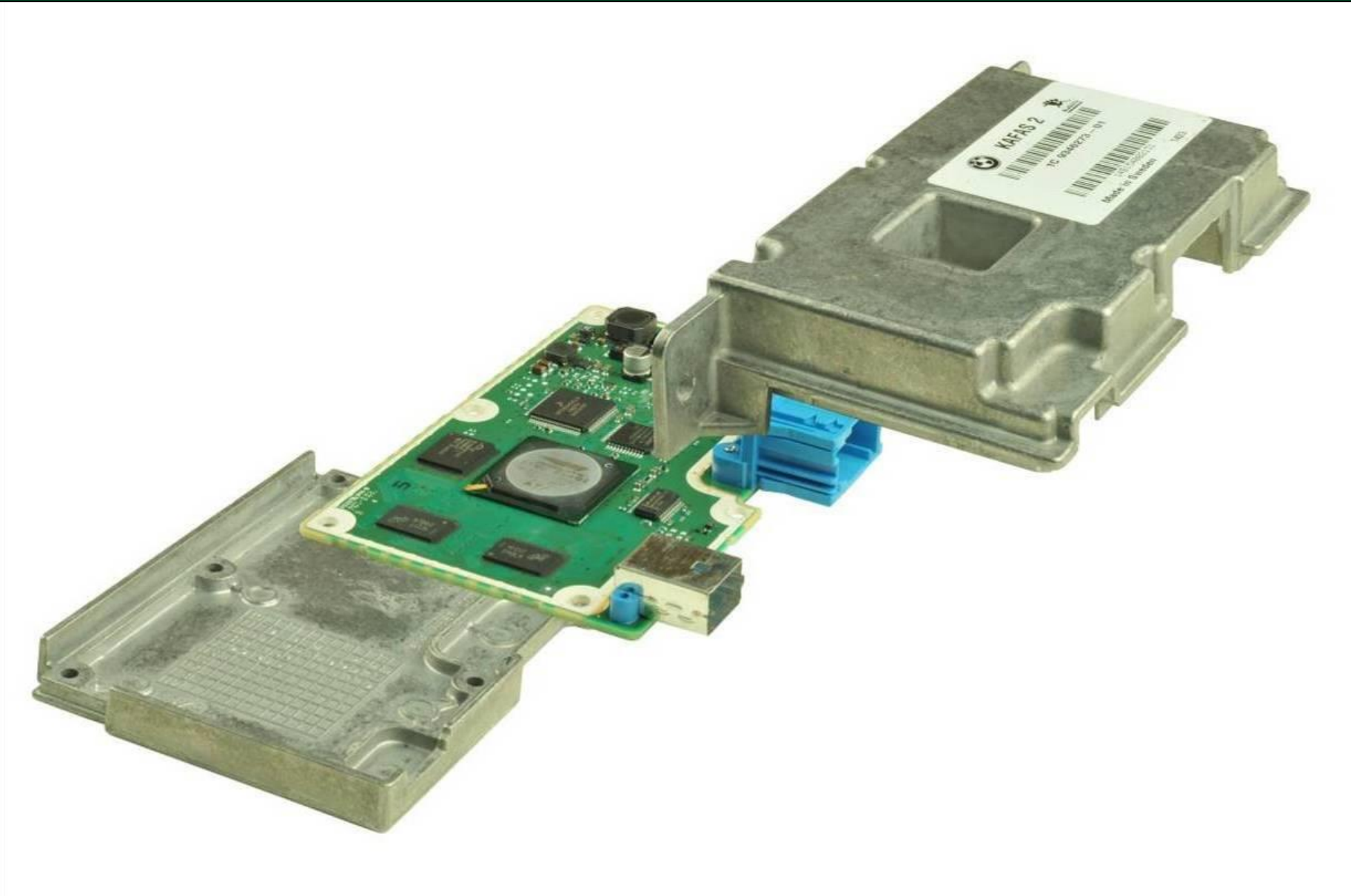
Major Components (Side 2)



MUNRO
& ASSOCIATES, INC.



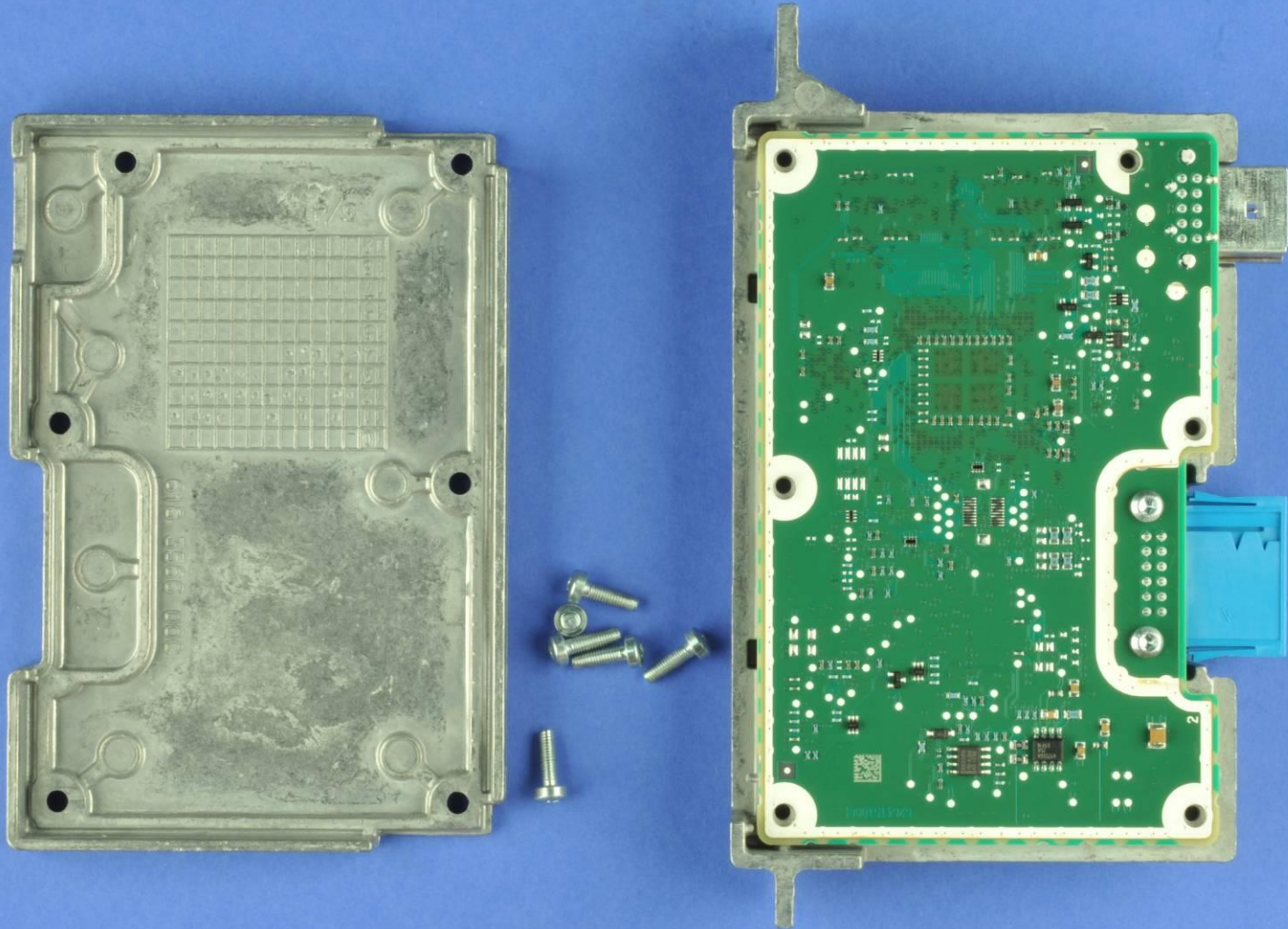
Component Arrangement



Teardown Sequence



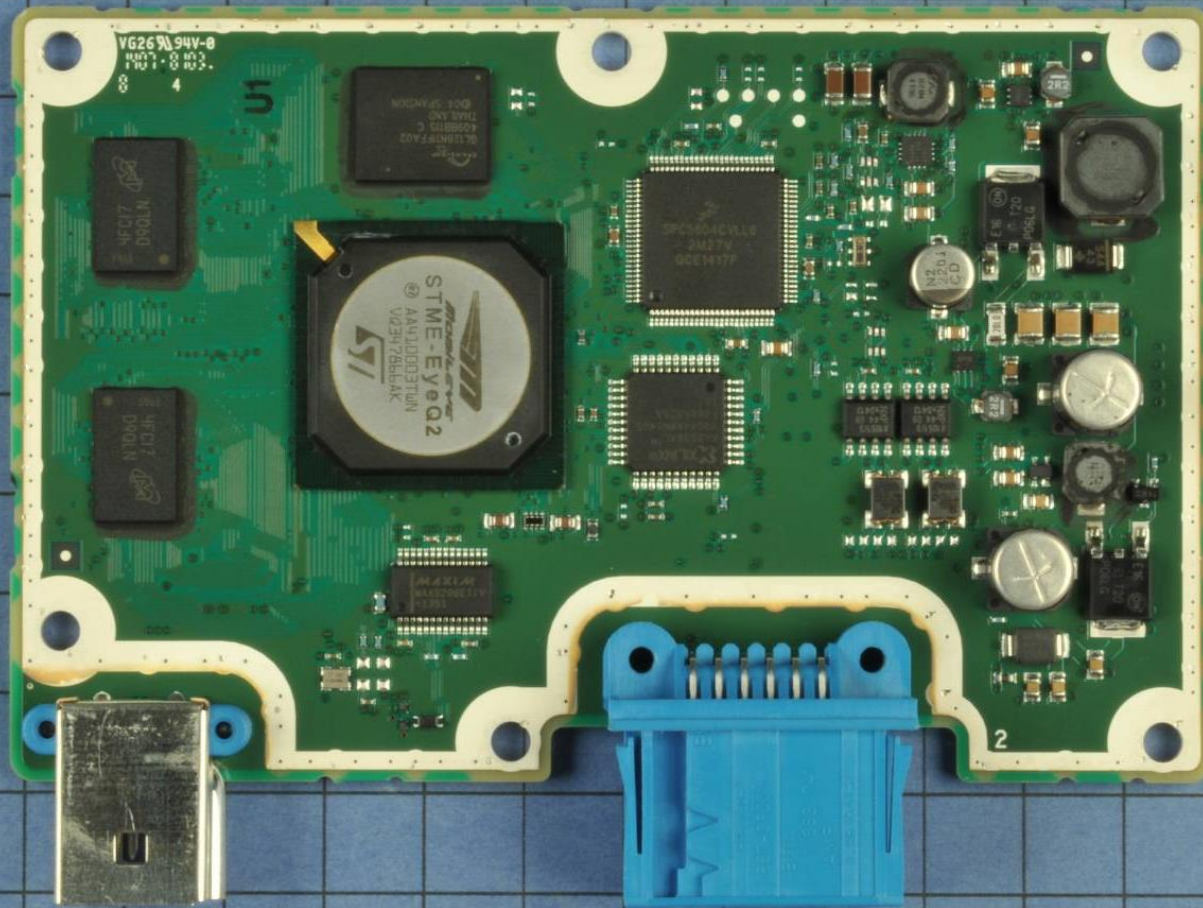
MUNRO
& ASSOCIATES, INC.



Main Board (Side 1)



MUNRO
& ASSOCIATES, INC.

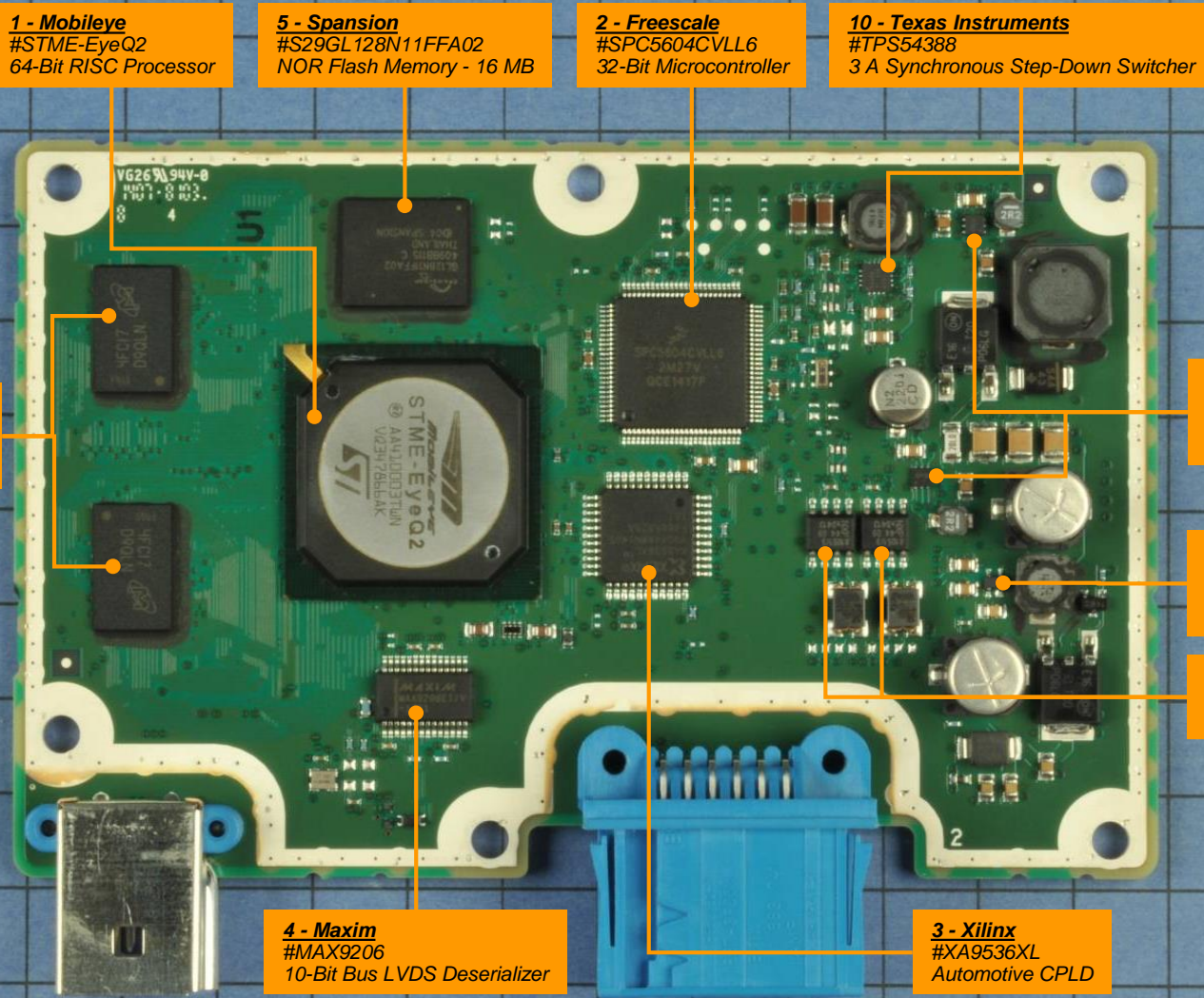


Connector: Vehicle
Wiring 2

Connector: Vehicle
Wiring 1

Grid = 1 cm

Main Board (Side 1 IC Identification)



1 - Mobileye
#STME-EyeQ2
64-Bit RISC Processor

5 - Spansion
#S29GL128N11FFA02
NOR Flash Memory - 16 MB

2 - Freescale
#SPC5604CVLL6
32-Bit Microcontroller

10 - Texas Instruments
#TPS54388
3 A Synchronous Step-Down Switcher

6 - Micron
#MT46H16M32LFB5-6
AIT LPDDR3 SDRAM
Memory - 64 MB

9 - Texas Instruments
#TPS62260TDRVRQ1
600 mA Step-Down
DC-DC Converter

8 - ON Semiconductor
#NCP562SQ25T1
2.5 V / 80 mA
LDO Regulator

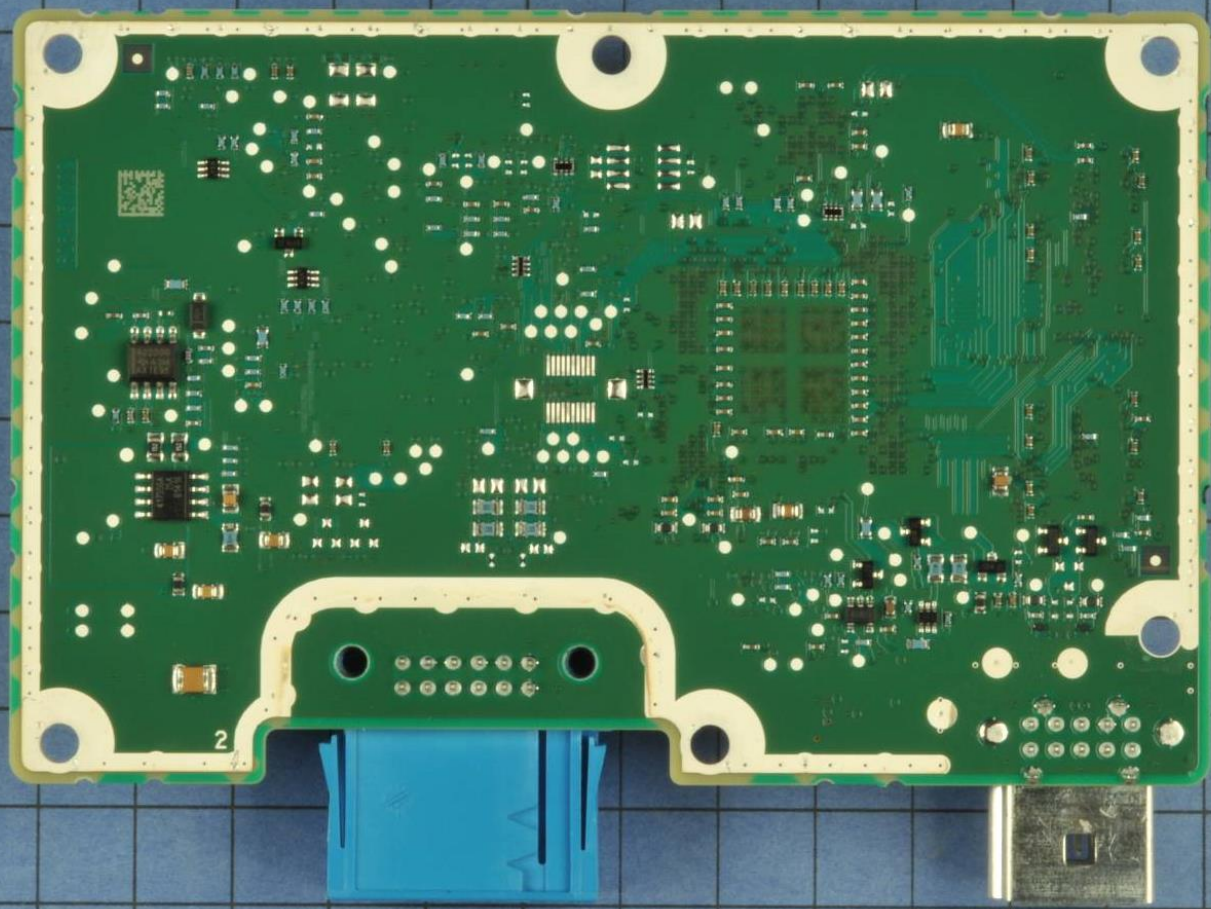
7 - NXP Semiconductor
#TJA1051
CAN Transceiver

4 - Maxim
#MAX9206
10-Bit Bus LVDS Deserializer

3 - Xilinx
#XA9536XL
Automotive CPLD

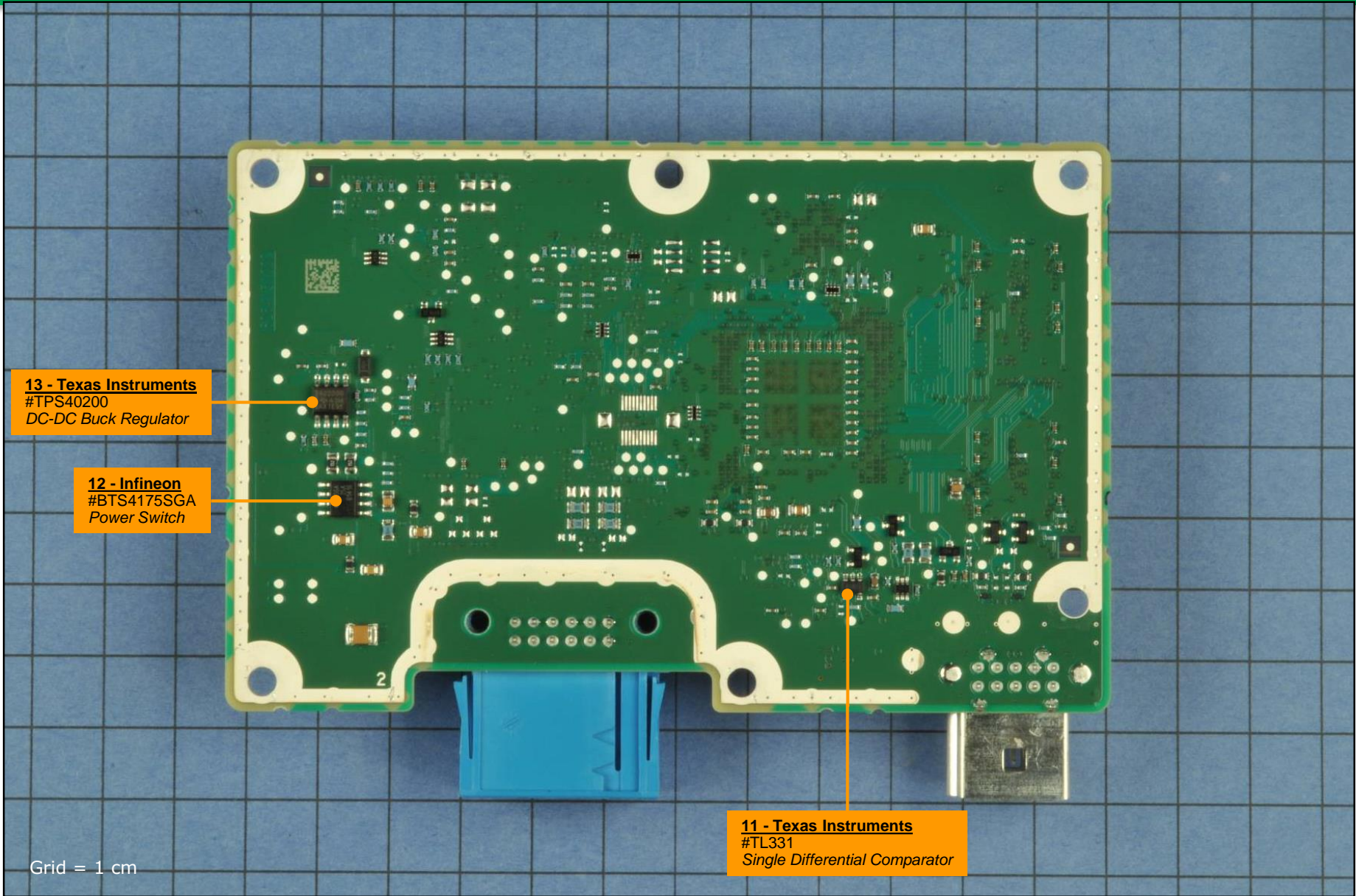
Grid = 1 cm

Main Board (Side 2)



Grid = 1 cm

Main Board (Side 2 IC Identification)



13 - Texas Instruments
#TPS40200
DC-DC Buck Regulator

12 - Infineon
#BTS4175SGA
Power Switch

11 - Texas Instruments
#TL331
Single Differential Comparator

Grid = 1 cm

Main Board Cross-Section



Substrate Data

Substrates

Assembly Name	Manufacturer	Core Material	Mfg. Technology	Layers	Area (cm ²)	Min. Trace Pitch (mm)	Min. Trace Width (mm)	ThruVia Land Dia (mm)	ThruVia Hole Dia (mm)	BlindVia Land Dia (mm)	BlindVia Hole Dia (mm)	Thickness (mm)	Routing Density	Estimated Costs
Main Board	Unknown	FR4	6 Layer Conventional FR4 / HF	6	92.9	0.25	0.10	0.60	0.30			1.8	29.9	\$ 2.00

Integrated Circuit Components



MUNRO
& ASSOCIATES, INC.

Location	Package Info										Die Info						Estimated Costs		
	Pkg Ref. #	Pkg Qty	Brand Name	Part Number	Pkg Description	Form	Pin Count	Length (mm)	Width (mm)	Height (mm)	Die Ref #	Die Qty	Brand Name	Part Number	Description	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	1	Mobileye	STME-EyeQ2	64-Bit RISC Processor	BGA	561	27.01	26.94	2.12	1.1	1	Mobileye / STMicroelect	A1838A	64-Bit RISC Processor	7.83	7.41	\$ 21.138	\$ 21.138
	2	1	Freescale	SPC5604CVLL6	32-Bit Microcontroller	QFP	100	16.29	16.04	1.25	2.1	1	Freescale	M72U	32-Bit Microcontroller	4.55	4.28	\$ 5.889	\$ 5.889
	3	1	Xilinx	XA9536XL	Automotive CPLD	QFP	44	12.55	12.14	1.08	3.1	1	Xilinx	X8400	Automotive CPLD	3.16	1.49	\$ 1.816	\$ 1.816
	4	1	Maxim	MAX9206	10-Bit Bus LVDS Deserializer	TSOP	28	10.35	7.53	1.71	4.1	1	Maxim	H506Z	10-Bit Bus LVDS Deserializer	2.32	1.86	\$ 0.390	\$ 0.390
	5	1	Spansion	S29GL128N11FFA02	NOR Flash Memory - 16 MB	BGA (UF)	64	13.08	11.15	1.15	5.1	1	Spansion	98U07B	NOR Flash Memory - 16 MB	7.63	3.77	\$ 2.848	\$ 2.848
	6	2	Micron	MT46H16M32LFB5-6 AI	LPDDR3 SDRAM Memory - 64 MB	BGA (UF)	90	13.16	8.12	0.88	6.1	1	Micron	16M	LPDDR3 SDRAM Memory - 64 MB	5.60	5.11	\$ 2.994	\$ 5.988
	7	2	NXP Semiconductor	TJA1051	CAN Transceiver	SOP	8	6.13	4.99	1.62	7.1	1	NXP Semiconductor	cf1371C	CAN Transceiver	1.92	1.44	\$ 0.207	\$ 0.415
	8	1	ON Semiconductor	NCP562SQ25T1	2.5 V / 80 mA LDO Regulator	SOP	4	2.58	2.23	0.98	8.1	1	ON Semiconductor	BX71 2011	2.5 V / 80 mA LDO Regulator	0.98	0.85	\$ 0.068	\$ 0.068
	9	2	Texas Instruments	TPS62260TDRVRQ1	600 mA Step-Down DC-DC Converter	DFN	6	2.02	2.02	0.98	9.1	1	Texas Instruments	TPS6226XB1	600 mA Step-Down DC-DC Converter	1.44	0.86	\$ 0.092	\$ 0.185
	10	1	Texas Instruments	TPS54388	3 A Synchronous Step-Down Switcher	DFN	16	3.04	3.03	1.04	10.1	1	Texas Instruments	TPS54388	3 A Synchronous Step-Down Switcher	1.59	1.58	\$ 0.205	\$ 0.205
Main Board, Side 2	11	1	Texas Instruments	TL331	Single Differential Comparator	SOP	5	3.01	2.80	1.23	11.1	1	Texas Instruments	TL331A	Single Differential Comparator	0.87	0.72	\$ 0.068	\$ 0.068
	12	1	Infineon	BTS4175SGA	Power Switch	TSOP	8	6.33	5.11	1.20	12.1	1	Infineon	L227B1	Power Switch	2.29	1.81	\$ 0.257	\$ 0.257
	13	1	Texas Instruments	TPS40200	DC-DC Buck Regulator	TSOP	8	6.16	4.96	1.60	13.1	1	Texas Instruments	TPS40200A	DC-DC Buck Regulator	1.43	1.39	\$ 0.153	\$ 0.153
Totals		16					1046					16							\$39.42

Note: Supplemental information, such as IC package & die markings, is included in the Excel Bill of Materials (BOM) spreadsheet.

Modular Components



Location	Qty	Brand Name	Part Number	Description	Package			Estimated Costs	
					Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Unknown	27.00Y B44ML	Oscillator: TCXO	4	2.55	2.03	\$ 0.620	\$ 0.620
	1	Unknown	80.Q	Crystal: Ceramic	6	3.22	1.14	\$ 0.200	\$ 0.200
TOTALS	2				10				\$0.82

Active Discrete Components



MUNRO
& ASSOCIATES, INC.

Location	Qty	Functional Description	Package					Estimated Costs	
			Form	Top Marking	Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Small Active	Transistor, Small	Y4W 44	3	2.85	2.22	\$0.030	\$0.030
	2	Small Active	MOSFET	On logo E16 T20 P06LG	3	10.04	6.40	\$0.270	\$0.540
	1	Small Active	TVS Diode, SMT	ST logo MTY	2	5.68	3.67	\$0.300	\$0.300
	2	Small Active	Diode, SMT	E3	2	1.06	0.67	\$0.015	\$0.030
	1	Small Active	Diode, SMT	S44 43	1	5.39	3.42	\$0.110	\$0.110
Main Board, Side 2	3	Small Active	Transistor, Small	3Ft, Ht9,	3	2.25	2.12	\$0.030	\$0.090
	2	Small Active	Transistor, Small	SKs 44	3	3.04	2.42	\$0.030	\$0.060
	4	Small Active	Transistor, Small	5BW 39, W27 44	3	2.97	2.00	\$0.030	\$0.120
	2	Small Active	Diode, SMT	E3	2	1.02	0.60	\$0.015	\$0.030
	1	Small Active	Diode, SMT	CDH	2	2.60	1.65	\$0.015	\$0.015
TOTALS	19				49				\$1.32

Passive Discrete Components



Location	Qty	Functional Description	Package		Estimated Costs	
			Form	Pin Count	Each	Total
Main Board, Side 1	1	Small Passive	Cap, Res, Ferrite Array	8	\$0.007	\$0.007
	1	Coil	SMT, Small	2	\$0.050	\$0.050
	2	Coil	SMT, Small	2	\$0.050	\$0.100
	2	Coil	SMT, Small	2	\$0.050	\$0.100
	1	Coil	SMT, Small	2	\$0.090	\$0.090
	2	Coil	SMT, Small	2	\$0.050	\$0.100
	1	Capacitor	Electrolytic, Small	2	\$0.040	\$0.040
	2	Capacitor	Electrolytic, Small	2	\$0.080	\$0.160
	72	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.288
Main Board, Side 2	4	Small Passive	Cap, Res, Ferrite Array	8	\$0.007	\$0.030
	194	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.776
TOTALS	282			594		\$1.74

Connectors

Location	Qty	Form	Package			Estimated Costs	
			Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 2	1	Connector: Vehicle Wiring 2	10	22.97	20.04	\$1.050	\$1.050
	1	Connector: Vehicle Wiring 1	12	30.34	16.78	\$1.350	\$1.350
TOTALS	2		22				\$2.40

Electronic Assembly Metrics



Electronic Assembly Metrics by Assembly

General Area	Assembly Name	Substrate Area (sq.cm)	Metal Layers	Circuit Area (sq.cm)	Routing Density (cm of routing per sq.cm of substrate)	Number of Components	Number of Connections	Component Density (Components/sq.cm)	Connection Density (Connections/sq.cm)	Avg. Pin Count	Assembly Weight (grams)
Main Electronics	Main Board	92.9	6	557.4	29.9	321	1721	3.5	18.5	5.4	64.90
	System Totals	92.9	6	557.4		321	1721	3.5	18.5	5.4	64.90

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Electronics Costs by Assembly										
General Area	Assembly Name	Total	Integrated Circuits	Modular & Odd Form Components	Small Active Components	Passive Components	Connector Components	Substrates	Insertion	Card Test
Main Electronics	Main Board	\$ 50.58	\$ 39.42	\$ 0.82	\$ 1.32	\$ 1.74	\$ 2.40	\$ 2.00	\$ 1.88	\$ 1.00
	System Totals	\$ 50.58	\$ 39.42	\$ 0.82	\$ 1.32	\$ 1.74	\$ 2.40	\$ 2.00	\$ 1.88	\$ 1.00

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Counts by Assembly												
General Area	Assembly Name	IC Package Count	IC Connections	Modular/Odd Form Components	Modular/Odd Form Component Connections	Small Active Components	Small Active Component Connections	Passive Components	Passive Component Connections	Connectors	Connector Connections	Opportunities
Main Electronics	Main Board	16	1046	2	10	19	49	282	594	2	22	2042
	System Totals	16	1046	2	10	19	49	282	594	2	22	2042

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



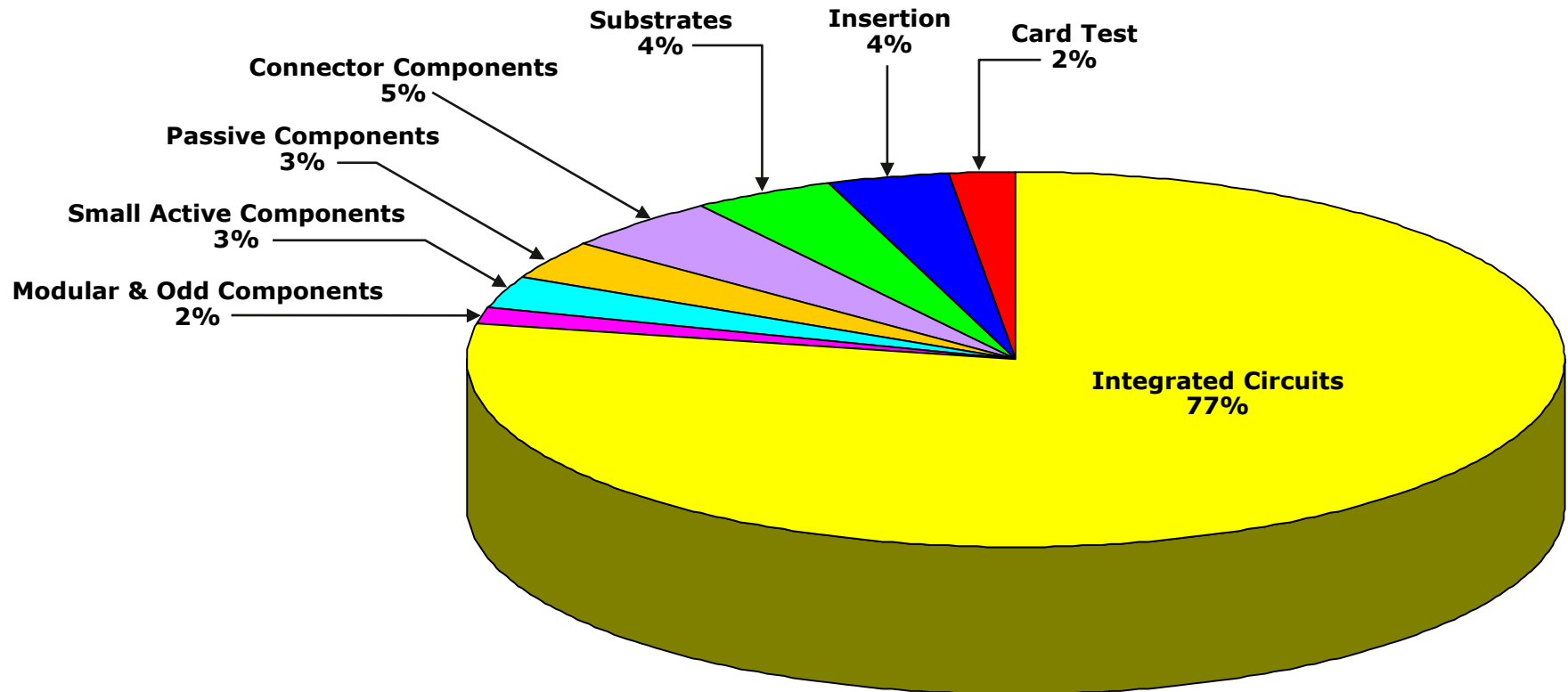
IC Metrics											
General Area	Assembly Name	IC Die Count	IC Package Count	Number of Package Connections	Die Area (sq.mm)	Substrate Tiling Density (die area / substrate area)	Package Area (sq.mm)	Die Area/Package Area Ratio	Package Connections per sq.cm of Package Area	Volatlie Memory (KBytes)	Non-Volatile Memory (KBytes)
Main Electronics	Main Board	16	16	1046	190.6	0.02	1734.4	0.11	60.3	131072	16384
	System Totals	16	16	1046	190.6		1734.4	0.11	60.3	131072	16384

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Costs Breakdown

Estimated Cost of Electronics

\$50.58

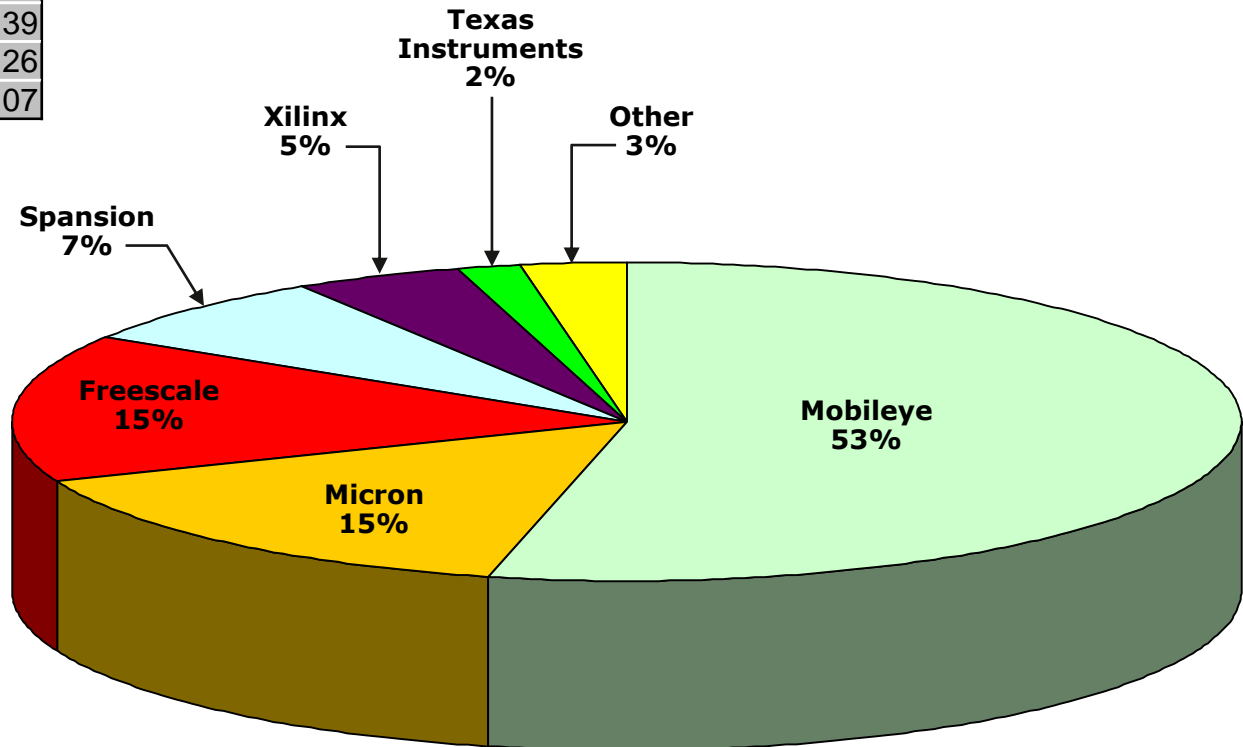


NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Vendor IC Cost Distribution



Pkg. Brand	Cost
Mobileye	\$21.14
Micron	\$5.99
Freescale	\$5.89
Spansion	\$2.85
Xilinx	\$1.82
Texas Instruments	\$0.61
Other	
NXP Semiconductor	\$0.41
Maxim	\$0.39
Infineon	\$0.26
ON Semiconductor	\$0.07



NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Non-Electronic Cost Estimate



Subsystem	Part ID No.	Qty	Description	Fabrication Process	Material	Dimensions (mm)	Weight (grams)	Est'd Cost Each	Est'd Extended Cost	
Enclosures	1	1	Top	Cast	Metal	126.54 x 85.57 x 11.15	87.50	2.050	2.050	
	2	1	Bottom	Cast + Tapped + Pulls	Metal	155.02 x 85.56 x 29.63	153.60	3.660	3.660	
	3	1	Label	Die-Cut + Printed	Plastic + Adhesive	60.05 x 39.85 x 0.06	0.30	0.080	0.080	
	4	5	Screw	Stamped	Metal	12.37 x 5.82 x 9.85	4.00	0.020	0.100	
	5	2	Screw	Stamped	Metal	10.63 x 5.39 x 8.22	1.00	0.020	0.040	
Total		10						Estimated Cost		\$5.93

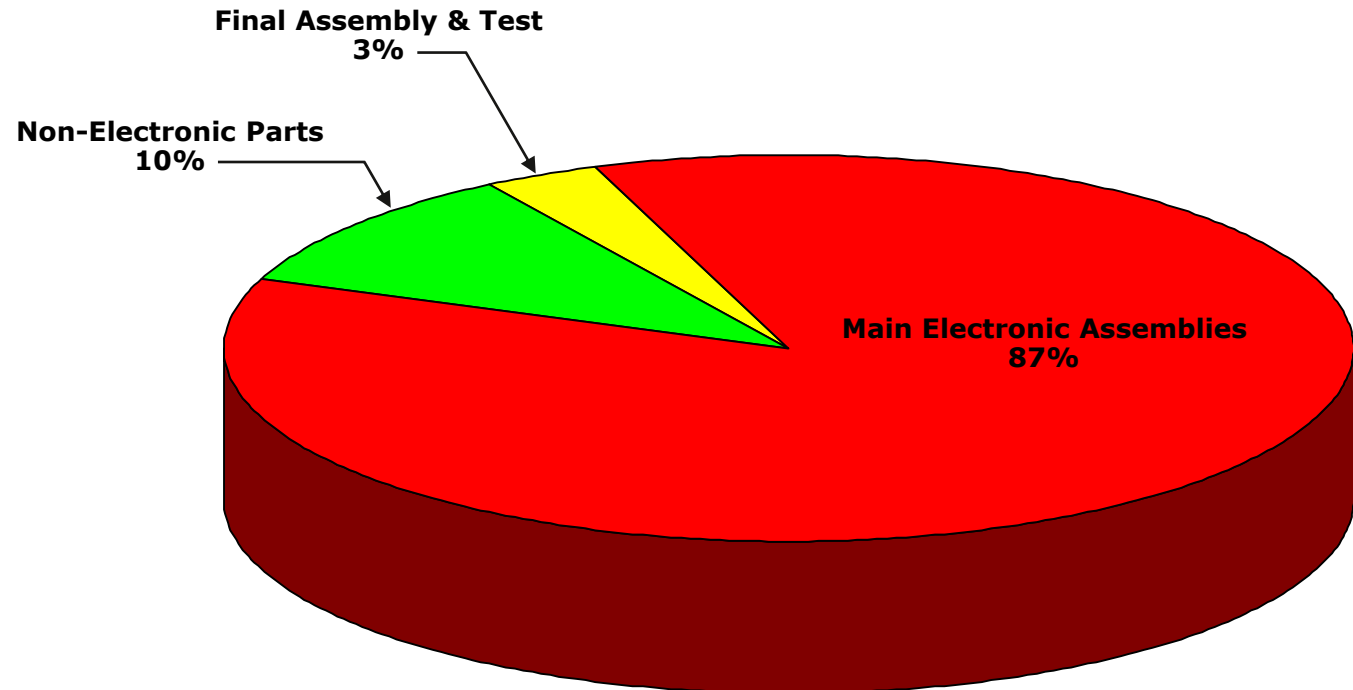
Final Ass'y Labor & Test Cost Estimate

Final Assembly & Test	
Made in	Sweden
Number of parts	11
Est'd number of steps	34
Est'd time (seconds)	106
Est'd final assembly cost	\$ 1.47
Est'd final test cost	\$ 0.50

Cost Summary

Estimated Cost Totals	
Main Electronic Assemblies	\$ 50.58
Non-Electronic Parts	\$ 5.93
Final Assembly & Test	\$ 1.97
Total	\$ 58.49

Cost Total Notes:
Estimated final assembly cost includes labor only.
Total cost does not include Non-recurring, R&D, G&A, IP licensing fees/royalties, software, sales & marketing, distribution.
Assumes fully scaled production.



Cost Estimation Process

(Overview & Discussion)



Cost modeling is a tricky business. Multiple variables affect the actual production costs a manufacturer will experience, including development expenses, unit volumes, supply-and-demand in component markets, die yield-curve maturity, OEM purchasing power, and even variations in accounting practices. Different cost modeling methods employ different assumptions about how to handle these and other variables, but we can identify two basic approaches: that which seeks to track short-term variations in the inputs to the production process, and that which strives to maintain comparability of the output of the model across product families and over time.

TechInsights' philosophy in cost modeling is to emphasize consistency across products and comparability over time, rather than to track short-term fluctuations. During the past eight years, we have developed an estimation process that, while necessarily lacking an insider's knowledge of the cost factors that impact any one manufacturer, is reasonably accurate in its prediction of unit costs in high-volume production environments. We do not claim that the model will produce the "right" answer for your firm's environment. However, TechInsights does give customers a key analytical tool with a complete set of data in our Bill of Materials (BOM). The BOM allows readers to 1) scrutinize the assumptions behind our cost model and 2) modify the results based on substitution of their own component cost estimates where they have better information based on inside knowledge.

Our estimation process decomposes overall system cost into three major categories: Electronics, Mechanical, and Final Assembly. We begin by creating a complete electronics bill-of-materials (BOM). Each component from the largest ASIC to the smallest discrete resistor is entered into a BOM table with identifying attributes such as size, pitch, I/O count, package type, manufacturer, part number, estimated placement cost, and die size (if the component is an IC). Integrated circuit costs are calculated from measured die area. Using assumptions for wafer size, process type, number of die per wafer, defect density, and profit margin in combination with die area, an estimate of semiconductor cost is derived. Costs for discrete components and interconnect are derived from assumption tables which relate BOM line items to specific cost estimates by component type and estimates for part placement costs are included. For LCD display costs, we employ a model which tabulates expected cost from measurements of glass area, LCD type, and total pixel resolution. When market costs are available from alternative sources, LCD panel costs are taken from and referenced to these sources.

Costs of non-electronic components such as molded plastic enclosures and metallic components are measured in terms of weight, size, thickness, type of material, and complexity to arrive at their estimated cost. Other system items such as optics, antennae, batteries and displays are costed from a set of assumption tables derived from a combination of industry data, average high volume costs, and external sources. For final assembly, we re-build the torn-down product, tabulating stepwise assembly times as the reconstruction proceeds, to reach a total assembly time. Using a labor rate assumption for the country of origin, we then calculate final assembly cost.

The three major categories for system cost contributors can be broken down into the subcategories of ICs, other electronics parts, displays, batteries (as appropriate), camera modules, electronics assembly, non-electronic elements, and final assembly. By adding the cost estimates for each of these subcategories, an overall estimated cost is derived for the system under evaluation. Product packaging and accessories (CDs, cables, etc.) are also documented and estimated for their contribution to total cost as appropriate.

We believe our cost estimates generally fall within 15 percent of the "right answer," which itself can vary depending on the market and OEM-specific factors mentioned earlier. While the TechInsights cost model is imperfect, it yields important insights into technology and business dynamics along with good first-order contributions to system cost by component type. Additionally, the consistency of approach and gradual modification to assumptions (smoothing out frequently-shifting pricing factors) hopefully yields a credible, but user-modifiable, view of OEM high volume cost-to-produce.

Please feel free to contact us at support@techinsights.com with any comments, questions, or proposed corrections with respect to our cost estimates. We welcome your input.

In our product teardowns, we gather a series of metrics for product profiling and comparison. Some metrics focus on system characteristics such as total silicon area, total system semiconductor storage capacity, and total connection count. Other metrics reflect more subtle aspects of electronics assembly such as connection density, average component I/O count, and silicon tiling density. Taken as a whole, the metrics allow deeper comparison and benchmarking across multiple disciplines and multiple products. Key metrics we gather on products are described below along with their definitions and what they tend to say about the system under study. Most metrics can be used both in comparing similar products for benchmarking purposes or for quantifying differences in levels of complexity between dissimilar product types. Data fall into two categories; either “raw” measured data or ratios of these measured data sets.

Total Silicon Area : This metric describes the total area of silicon as measured from X-ray or direct measurement of ICs. The area is an expression of the enclosed bare die area and excludes packaging area. The aggregate silicon area is a good benchmark to show how integrated a design might be when making comparisons to similar systems. Total silicon area also reflects the major cost driver for most systems we examine.

Silicon Tiling Density : Ratio of Total Silicon Area to total printed circuit board “projected” area (i.e. the simple board area and not the cumulative surface area of both sides of the board). This metric directly reflects the level of efficiency and aggressiveness in integrated circuit packing and placement. Single digit Silicon Tiling Density is typical but silicon coverage of 10% - 20% has been seen in some of the most advanced products we have examined. Higher Tiling Densities often correspond with the use of chip scale packaging (CSPs) or other small form-factor IC packaging technologies. High density circuit boards are also often a supporting technology.

Number of Parts : Total component count including ICs, passives, modules, connectors, etc., each separated out in our reporting.

Number of Connections : The total number of connections corresponds to the total number of interconnects introduced by the aggregate component set and reflects any electrical connection observed (solder joints, adhesive interconnect, or connector terminal interfaces).

Opportunity Count : Opportunity Count is the total number of parts plus the total number of connections; the name reflects that each of these constituent elements represents an opportunity for failure. A high opportunity count means more complex and riskier electronics assembly.

Average Pin Count (APC) : Ratio of total number of component terminals to total number of parts, at the system level. This metric reflects the ‘average’ terminal complexity of the components and often provide a signature of integration level and/or “digital-ness” of the overall product. Low APCs reflect a high number of discrettes or other low-pincount devices often characteristic of analog circuitry. Conversely, high APCs are characteristic of highly integrated, high-pincount assemblies, often those composed largely of digital integrated circuits.

Connection Density : This metric is a ratio of the total Number of Connections to total printed circuit board assembly area, in units of connections per sq. inch. The metric provides data related to the Silicon Tiling Density above, but with an emphasis on complexity of I/O interconnect. For example, with a fixed Connection Density, high tiling density of low-pincount memory chips is more readily achieved than comparable silicon tiling of high pincount logic.

Part Density : This metric is a ratio of the total Number of Parts to total printed circuit board assembly area, in units of components per sq. inch. The metric provides data related to the Silicon Tiling Density and Connection Density as described above, but with an emphasis on density and complexity of component packing efficiency. For example, low Part Density of high-pincount devices can pose an equal challenge in Connection Density to high Part Density of low-pincount devices. High Part Density does reflect challenges in surface mount assembly in terms of (typically) precision of placement, number of placements, and engineering of part clearances.

Routing Density (heuristic estimate) = $3 * (\text{Average Pin Count}) * \sqrt{\text{Part Density}}$. The Routing Density metric is an empirically derived relationship that characterizes the wiring density of the interconnect used to support the interconnection of components in a planar electronic assembly (i.e. the circuit board). Architectural issues such as bussing or other factors affecting the regularity of wiring impact the actual Routing Density needed to support a given application, but the metric provides a ready measure of wiring complexity.

***[Click Here to Return to
Cost Analysis Page 141](#)***

Deep Dive Report

BMW i3 Remote Control Receiver Assembly

2258

Report #15900-150203-PKb



Product Description

This report concerns the Continental Automotive-sourced Remote Control Receiver Assembly for the 2014 BMW i3 Remote Keyless Entry System (RKE). This is a remote control RF module that operates on the 70-cm band (433.20 MHz, 433.92 MHz, and 434.64 MHz receive channels). It features a Renesas #78F1817 16-bit single-chip microcontroller, with connectivity provided by an Atmel #ATA5830N UHF ASK/FSK transceiver (430 MHz receive band) and an Atmel #ATA6663 LIN transceiver.

DISCLAIMER: All company names, product names, and service names mentioned are used for identification purposes only and may be registered trademarks, trademarks, or service marks of their respective owners. All analyses are done without participation, authorization, or endorsement of the manufacturer. Any cost analyses presented in this material are estimates prepared by TechInsights from generally available data. While TechInsights believes that these estimates reflect the probable costs, the actual producer did not supply the data, and therefore the actual costs may be different from these estimates. Furthermore, TechInsights extends no warranties with respect to any information in this document, and shall bear no liability whatsoever for the use of the information.

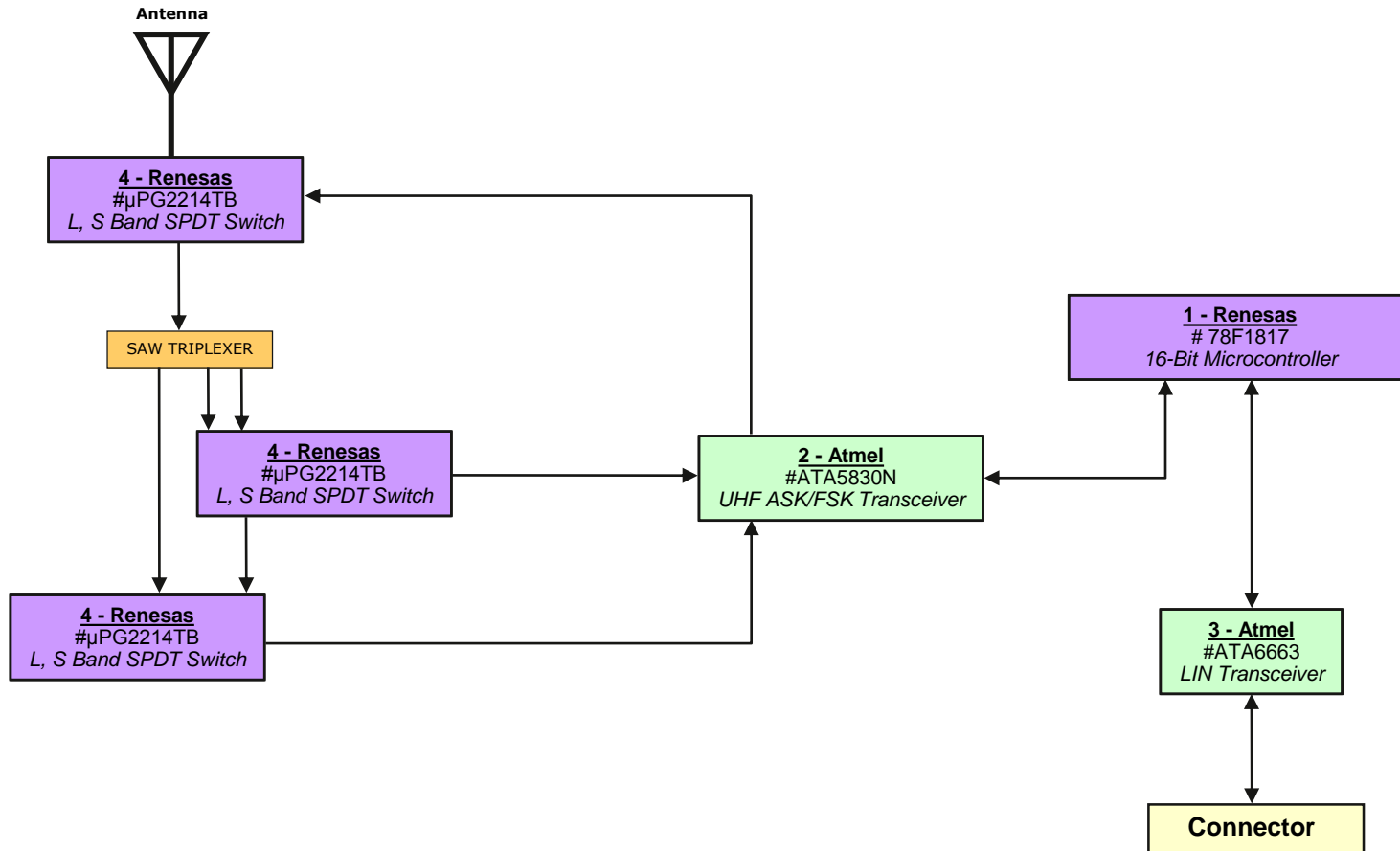
Copyright © 2015, TechInsights. All rights reserved. Do not reproduce, distribute, disseminate, photocopy, fax, transmit, download to a shared database, or otherwise copy, transfer, sell, publish, or send this material, or any portion thereof, by any means without the express written permission of TechInsights.

Product Overview



Product Description		Integrated Circuit Metrics		
Product Type	Automotive	IC Die Count	6	
Brand	BMW / Continental Automotive	IC Package Count	6	
Product Name & Model #	BMW i3 Remote Control Receiver Asm	Cost Metrics		
Official Release Date	5/2/2014			
Weight (grams)	45.0 (Measured)	Retail Price		
Product Dimensions (mm)	94.4 x 45.7 x 41.3 (Measured at Longest/Widest/Thickest Points)	Total Manufacturing Cost	\$13.08	
Product Features		Electronics Cost	\$8.39	
		Manufacturing Cost Breakdown		
Microcontroller	Renesas #78F1817 16-Bit Microcontroller	Integrated Circuits	\$5.60	42.8%
Connectivity	Atmel #ATA5830N UHF ASK/FSK Transceiver (430 MHz receive band), Atmel #ATA6663 LIN Transceiver	Modules, Discretes & Connectors	\$1.56	11.9%
		Substrates	\$0.43	3.3%
		Component Insertion	\$0.57	4.4%
		Card Test	\$0.22	1.7%
		Non-Electronics	\$3.27	25.0%
		Final Assembly & Test	\$1.43	10.9%
		Total	\$13.08	100.0%

Block Diagram



Estimated block diagram based on observation of this specific product implementation, manufacturer's data sheets where available, and best engineering judgment. Certain details of the interface circuitry are not reflected in this block diagram. Partitioning and connectivity are speculative.

BMW 9319081-02

FCC ID: KR5A2C35029700
Model: A2C35029700
IC: 7812D-35029700

FBD-3 Stand-alone
BMW AG
D-80788 München

434 MHz
RoHS



Continental
A2C90360200



050414

A2C35029700 see owner's manual

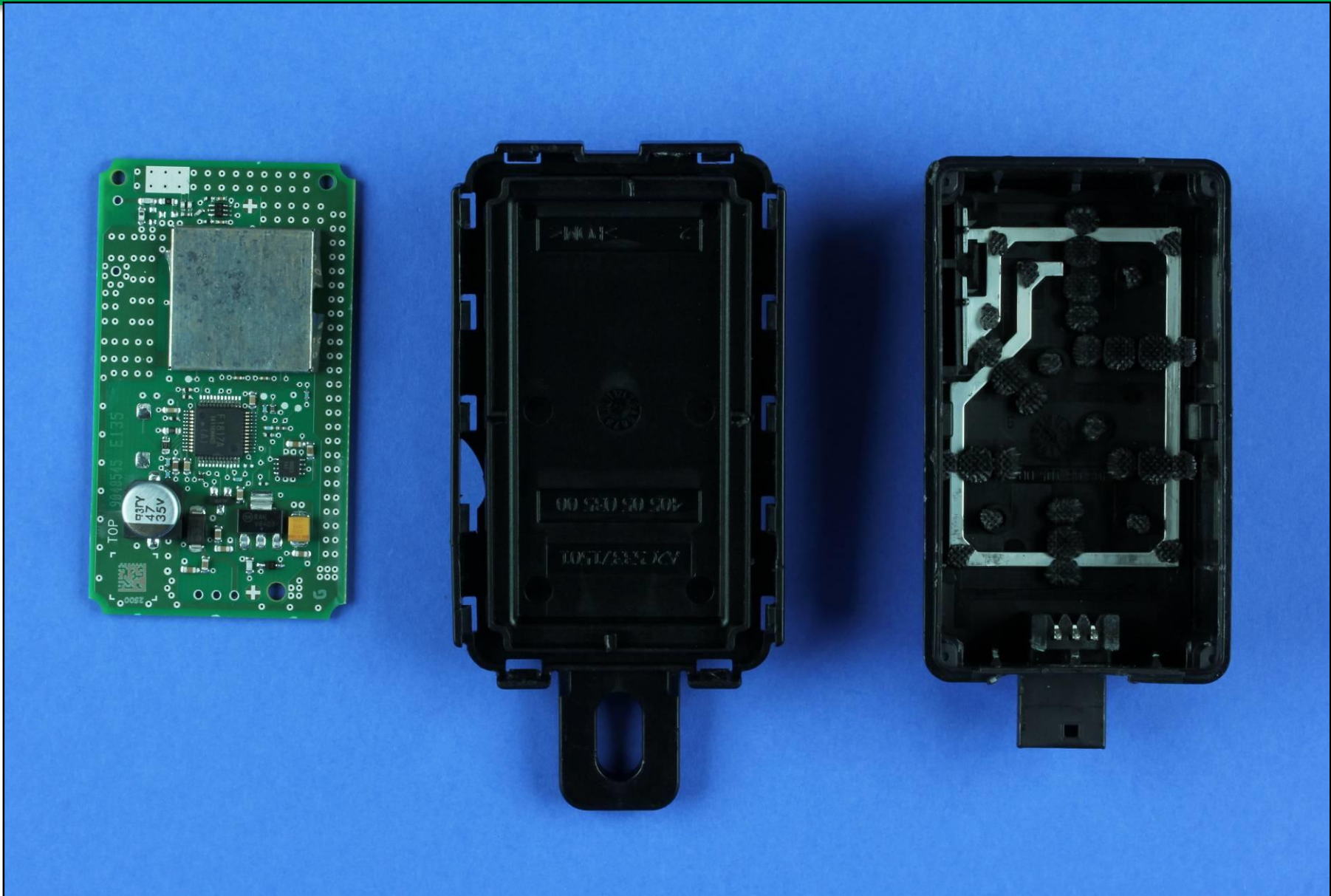


FB931908102

Major Components (Side 1)



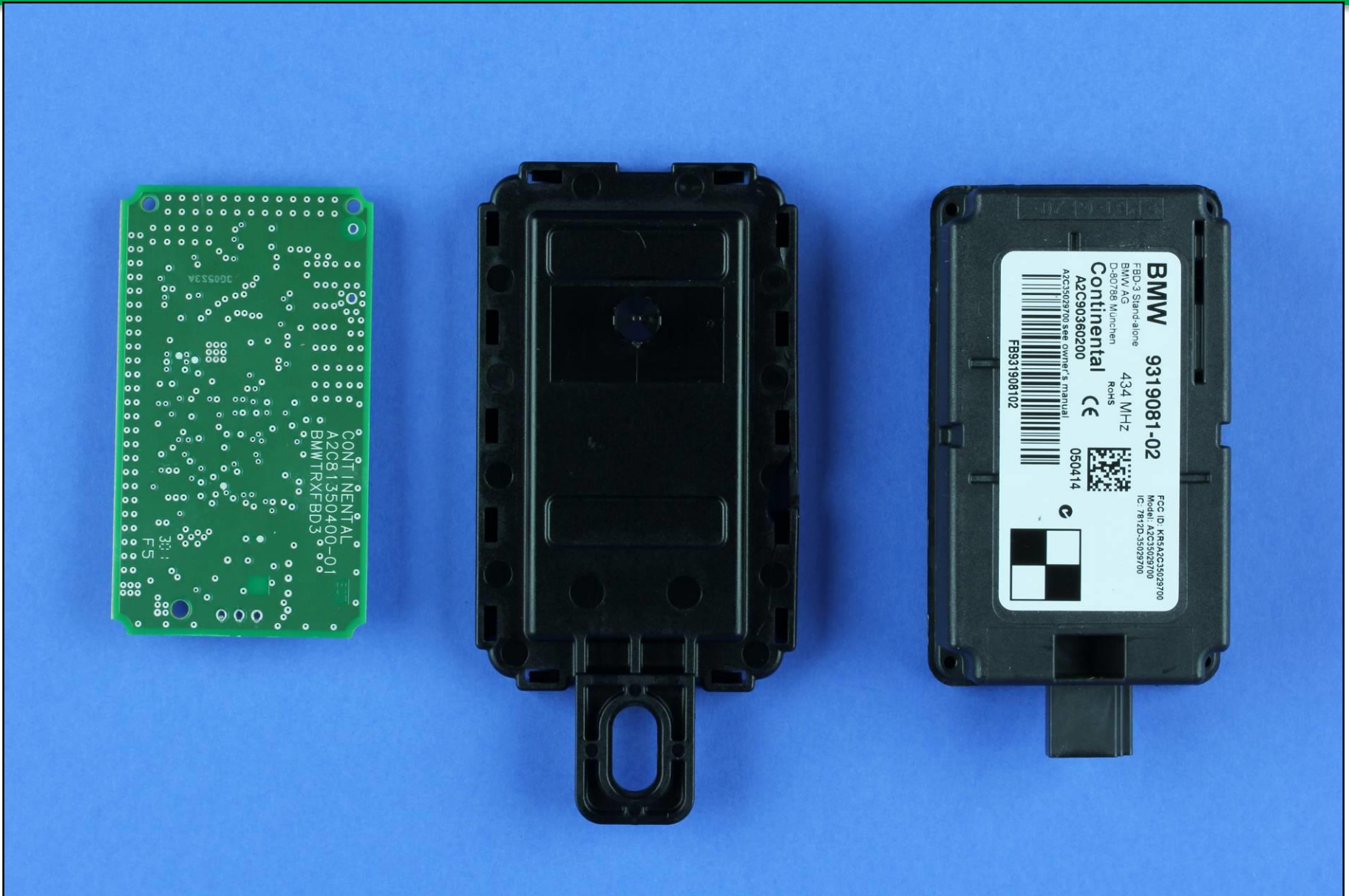
MUNRO
& ASSOCIATES, INC.



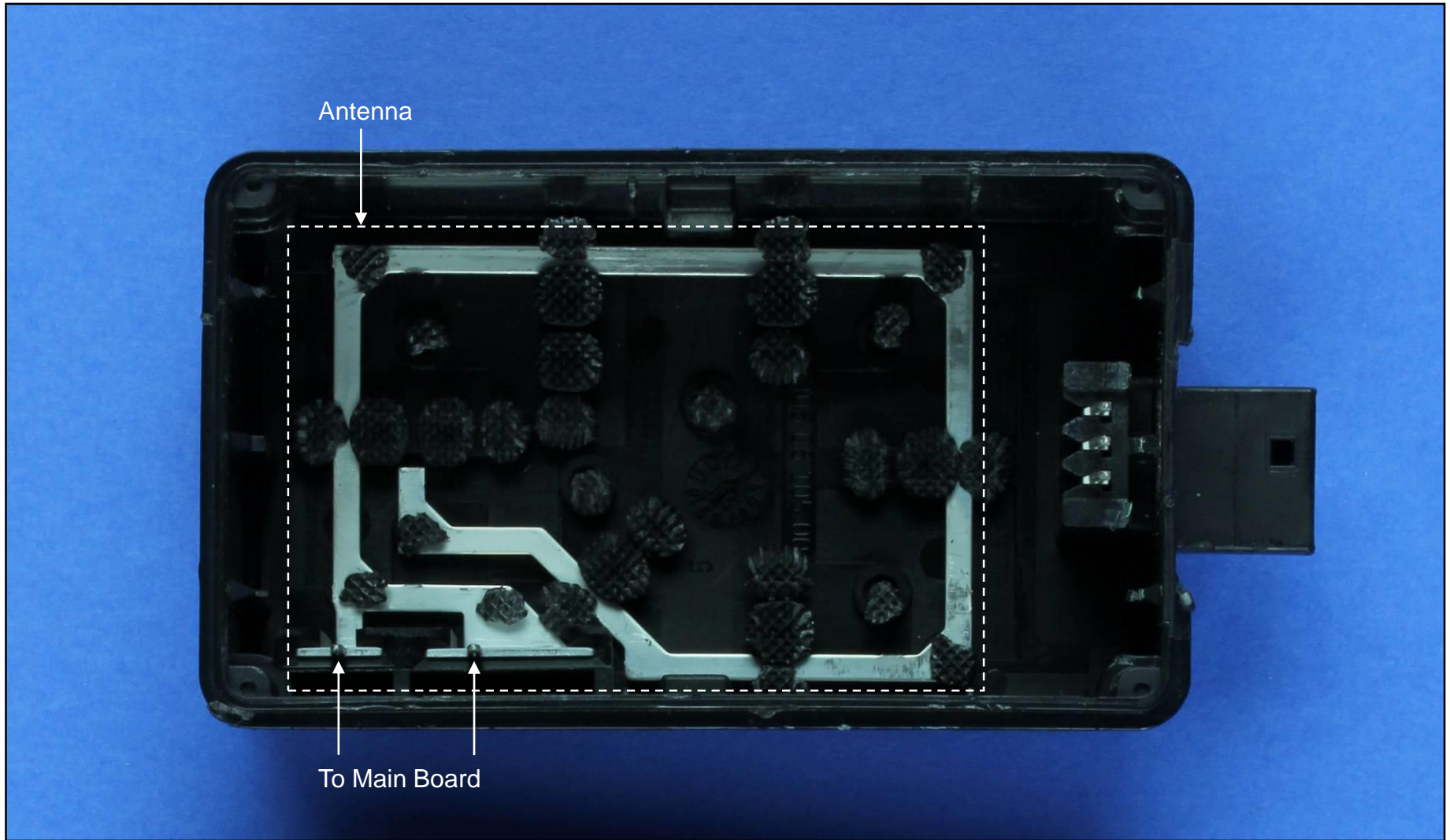
Major Components (Side 2)



MUNRO
& ASSOCIATES, INC.



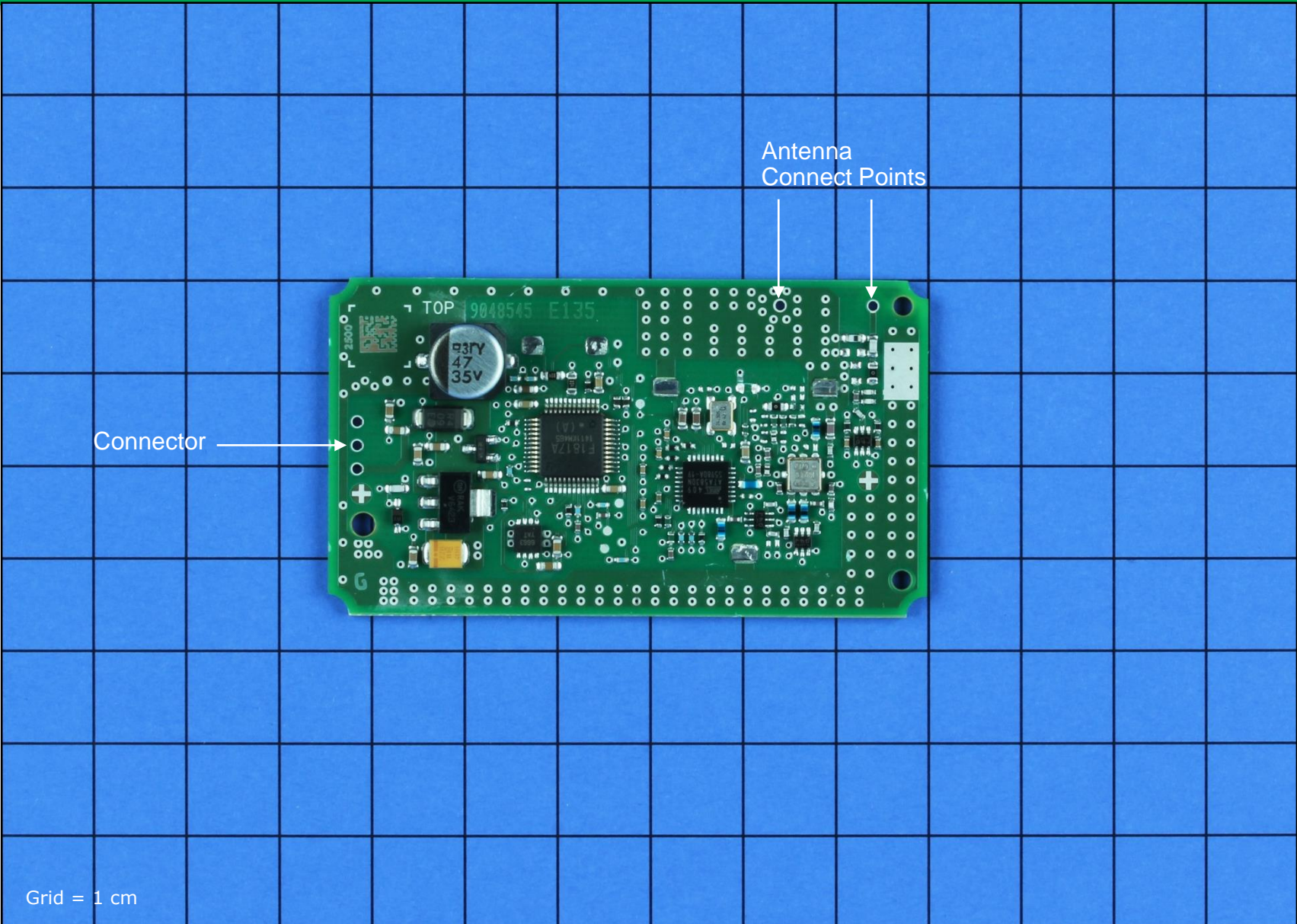
Antenna Detail



Antenna

To Main Board

Main Board (Side 1)

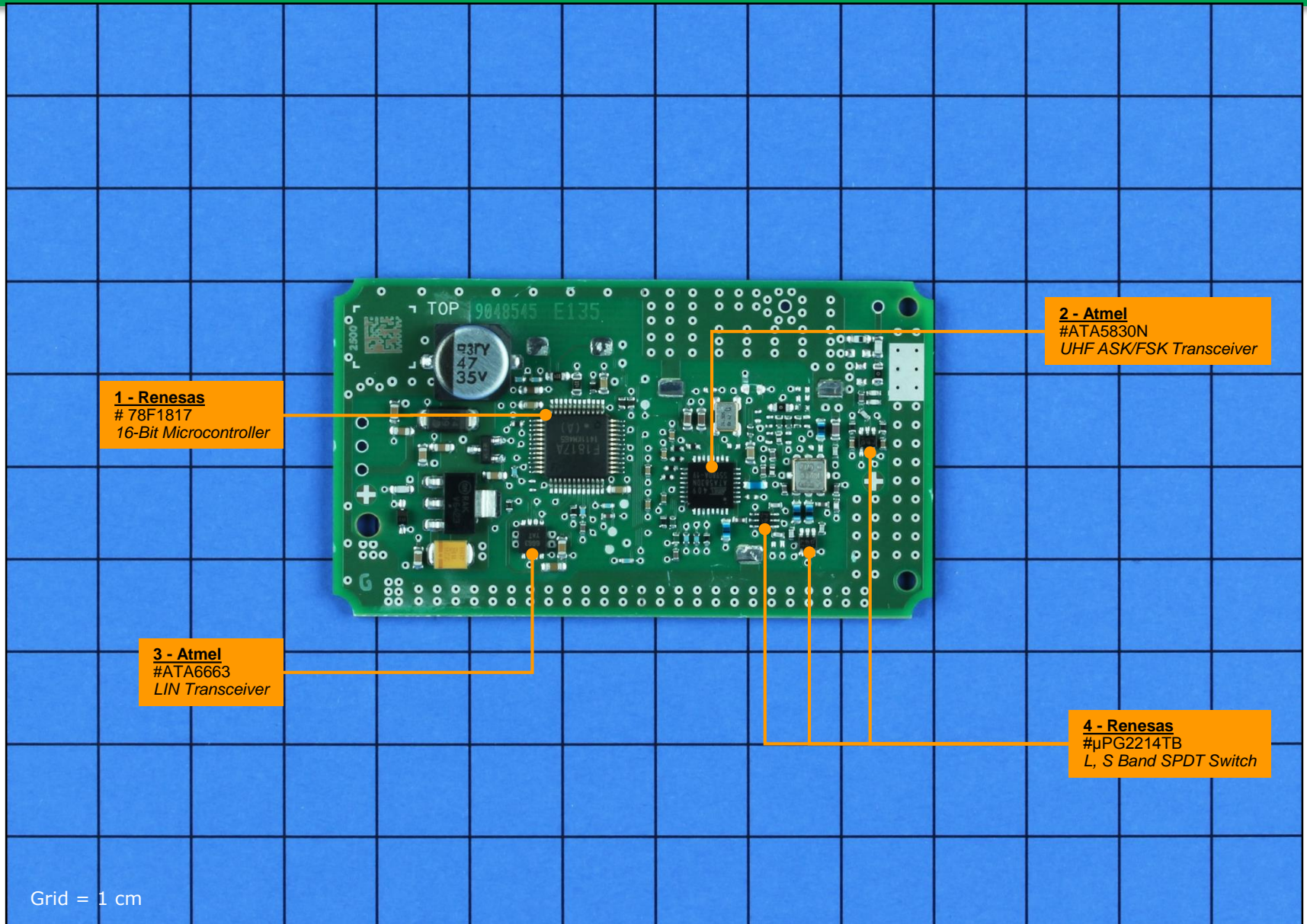


Connector →

Antenna
Connect Points

Grid = 1 cm

Main Board (Side 1 IC Identification)



1 - Renesas
78F1817
16-Bit Microcontroller

2 - Atmel
#ATA5830N
UHF ASK/FSK Transceiver

3 - Atmel
#ATA6663
LIN Transceiver

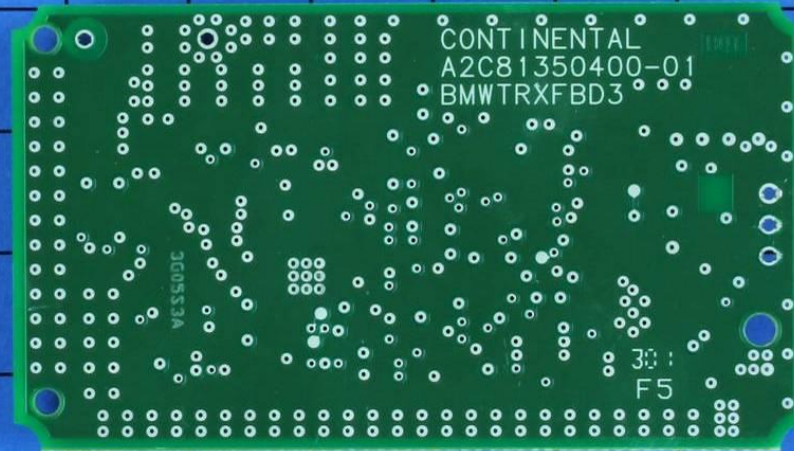
4 - Renesas
#μPG2214TB
L, S Band SPDT Switch

Grid = 1 cm

Main Board (Side 2)



MUNRO
& ASSOCIATES, INC.

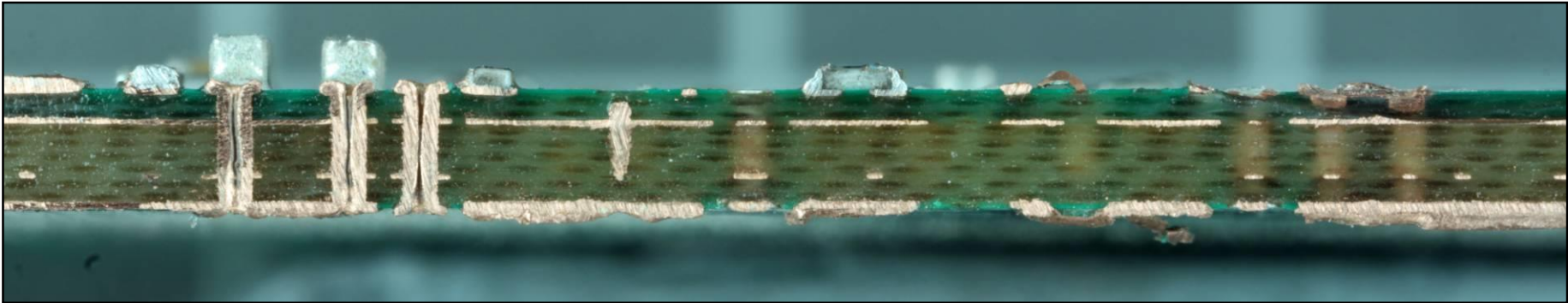


Grid = 1 cm

Main Board Cross-Section



MUNRO
& ASSOCIATES, INC.



Substrate Data

Substrates

Assembly Name	Manufacturer	Core Material	Mfg. Technology	Layers	Area (cm ²)	Min. Trace Pitch (mm)	Min. Trace Width (mm)	ThruVia Land Dia (mm)	ThruVia Hole Dia (mm)	BlindVia Land Dia (mm)	BlindVia Hole Dia (mm)	Thickness (mm)	Routing Density	Estimated Costs
Main Board	Continental	FR4	4 Layer conventional FR4 / HF	4	23.4	0.40	0.20	0.60	0.35			1.7	18.9	\$ 0.43

Integrated Circuit Components



MUNRO
& ASSOCIATES, INC.

Location	Package Info										Die Info						Estimated Costs		
	Pkg Ref. #	Pkg Qty	Brand Name	Part Number	Pkg Description	Form	Pin Count	Length (mm)	Width (mm)	Height (mm)	Die Ref #	Die Qty	Brand Name	Part Number	Description	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	1	Renesas	78F1817	16-Bit Microcontroller	QFP	48	8.50	8.50	1.50	1.1	1	Renesas	1845	16-Bit Microcontroller	3.51	2.93	\$ 3.250	\$ 3.250
	2	1	Atmel	ATA5830N	UHF ASK/FSK Transceiver	QFN	32	4.95	4.95	0.97	2.1	1	Atmel	ATA5830N	UHF ASK/FSK Transceiver	3.07	3.05	\$ 1.980	\$ 1.980
	3	1	Atmel	ATA6663	LIN Transceiver	DFN	8	2.95	2.95	0.90	3.1	1	Atmel	ATA6663	LIN Transceiver	1.60	1.20	\$ 0.154	\$ 0.154
	4	3	Renesas	μPG2214TB	L, S Band SPDT Switch	SOP	6	2.80	2.70	0.93	4.1	1	Renesas	μPG2214TB	L, S Band SPDT Switch	0.39	0.38	\$ 0.073	\$ 0.220
Totals	6						106					6							\$5.60

Note: Supplemental information, such as IC package & die markings, is included in the Excel Bill of Materials (BOM) spreadsheet.

Modular Components



Location	Qty	Brand Name	Part Number	Description	Package			Estimated Costs	
					Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Unknown	Unknown	Shielding: Large	1	20.40	20.00	\$ 0.040	\$ 0.040
	1	TDK-EPC	B3532	Filter: SAW - Triplexer	8	3.80	3.80	\$ 0.290	\$ 0.290
	1	NDK	NX5032GA-24.305M-STD-CSK-4 ?	Crystal: Ceramic	4	3.10	2.40	\$ 0.200	\$ 0.200
	1	Unknown	Unknown	Antenna: Structure	2			\$ 0.250	\$ 0.250
TOTALS	4				15				\$0.78

Active Discrete Components



Location	Qty	Functional Description	Package					Estimated Costs	
			Form	Top Marking	Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Small Active	Transistor, Small	WLs 3D	3	3.10	2.90	\$0.030	\$0.030
	1	Small Active	Transistor, Large	ON logo RAK V6423	4	6.90	6.50	\$0.250	\$0.250
	1	Small Active	Diode, SMT	AM	2	2.00	1.20	\$0.015	\$0.015
	1	Small Active	Diode, SMT	R4 09 E	2	5.20	2.80	\$0.060	\$0.060
TOTALS	4				11				\$0.35

Passive Discrete Components



Location	Qty	Functional Description	Package		Estimated Costs	
			Form	Pin Count	Each	Total
Main Board, Side 1	1	Capacitor	Tantalum / Niobium, Small	2	\$0.050	\$0.050
	8	Small Passive	Coil, Inductor	2	\$0.008	\$0.064
	80	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.320
TOTALS	89			178		\$0.43

Electronic Assembly Metrics



Electronic Assembly Metrics by Assembly

General Area	Assembly Name	Substrate Area (sq.cm)	Metal Layers	Circuit Area (sq.cm)	Routing Density (cm of routing per sq.cm of substrate)	Number of Components	Number of Connections	Component Density (Components/sq.cm)	Connection Density (Connections/sq.cm)	Avg. Pin Count	Assembly Weight (grams)
Main Electronics	Main Board	23.4	4	93.6	18.9	103	310	4.4	13.3	3.0	10.50
	System Totals	23.4	4	93.6		103	310	4.4	13.2	3.0	10.50

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Electronics Costs by Assembly										
General Area	Assembly Name	Total	Integrated Circuits	Modular & Odd Form Components	Small Active Components	Passive Components	Connector Components	Substrates	Insertion	Card Test
Main Electronics	Main Board	\$ 8.39	\$ 5.60	\$ 0.78	\$ 0.35	\$ 0.43	\$ -	\$ 0.43	\$ 0.57	\$ 0.22
	System Totals	\$ 8.39	\$ 5.60	\$ 0.78	\$ 0.35	\$ 0.43	\$ -	\$ 0.43	\$ 0.57	\$ 0.22

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Counts by Assembly												
General Area	Assembly Name	IC Package Count	IC Connections	Modular/Odd Form Components	Modular/Odd Form Component Connections	Small Active Components	Small Active Component Connections	Passive Components	Passive Component Connections	Connectors	Connector Connections	Opportunities
Main Electronics	Main Board	6	106	4	15	4	11	89	178	0	0	413
	System Totals	6	106	4	15	4	11	89	178	0	0	413

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



IC Metrics											
General Area	Assembly Name	IC Die Count	IC Package Count	Number of Package Connections	Die Area (sq.mm)	Substrate Tiling Density (die area / substrate area)	Package Area (sq.mm)	Die Area/Package Area Ratio	Package Connections per sq.cm of Package Area	Volatile Memory (KBytes)	Non-Volatile Memory (KBytes)
Main Electronics	Main Board	6	6	106	22.0	0.01	128.1	0.17	82.7	0	0
	System Totals	6	6	106	22.0		128.1	0.17	82.7	0	0

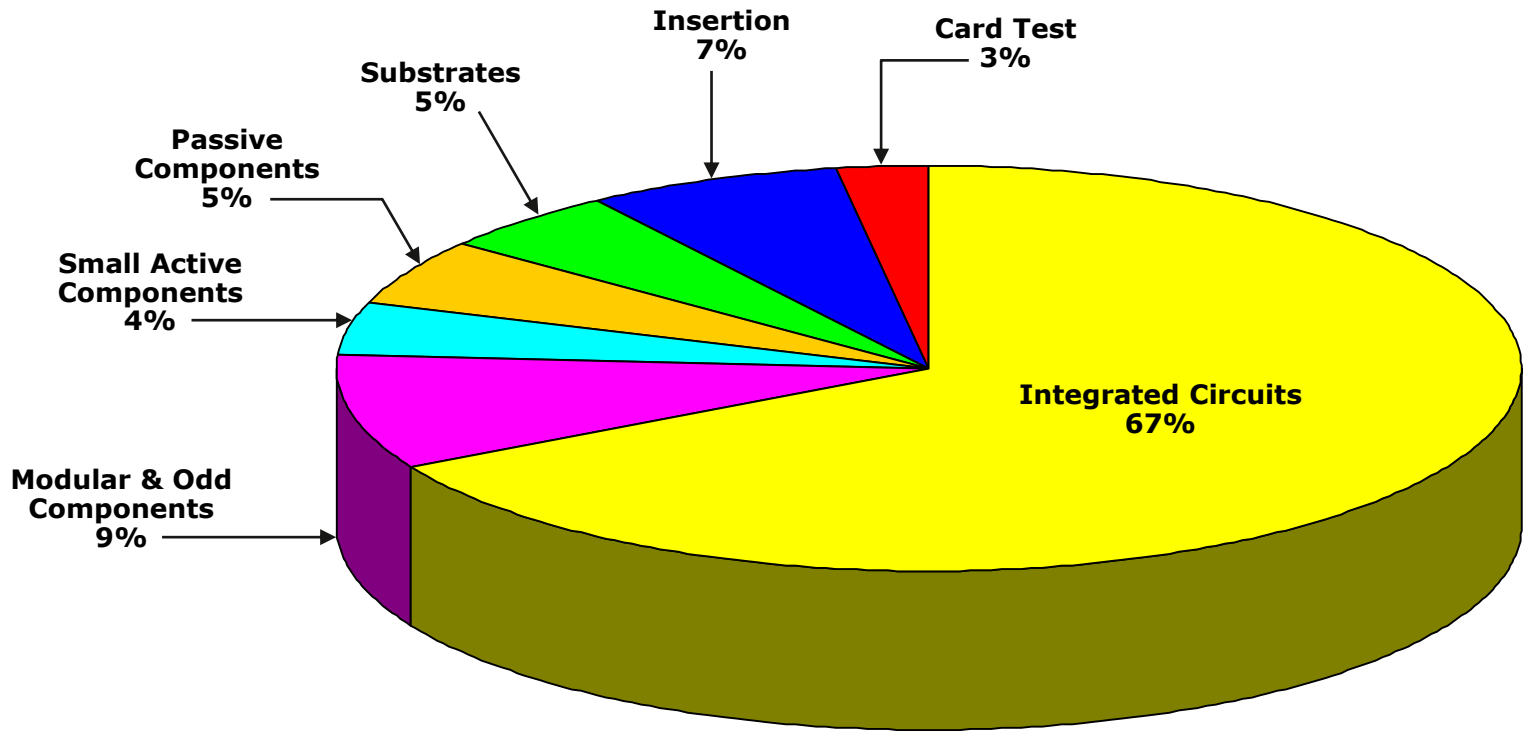
NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Costs Breakdown



**Estimated Cost
of Electronics**

\$8.39



NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Non-Electronic Cost Estimate



Subsystem	Part ID No.	Qty	Description	Fabrication Process	Material	Dimensions (mm)	Weight (grams)	Est'd Cost Each	Est'd Extended Cost	
Miscellaneous	1	1	Top Enclosure	Molded + Printed + Pulls	POM	81 x 42.1 x 24	17.00	1.820	1.820	
	2	1	Bottom Enclosure	Molded + Pulls	POM	94.6 x 45.9 x 19.9	12.60	1.350	1.350	
	3	1	Large Label	Die-Cut + Printed	Plastic + Adhesive	49.7 x 24.9	0.10	0.100	0.100	
Total		3						Estimated Cost		\$3.27

Final Ass'y Labor & Test Cost Estimate

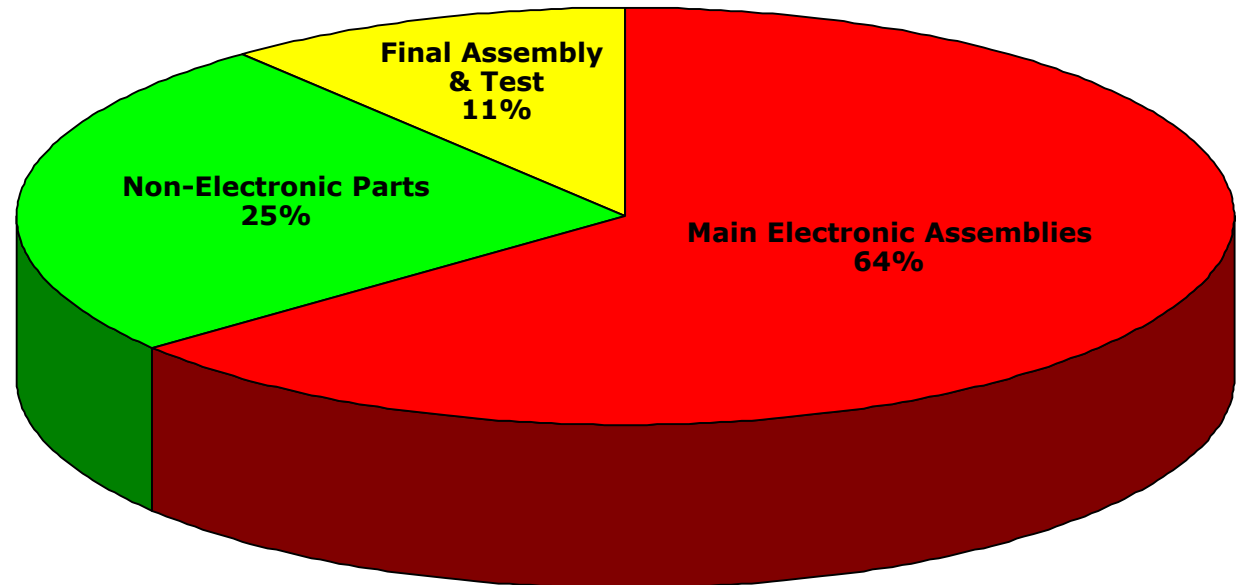


Final Assembly & Test	
Made in	Germany
Number of parts	7
Est'd number of steps	25
Est'd time (seconds)	96
Est'd final assembly cost	\$ 1.23
Est'd final test cost	\$ 0.20

Cost Summary

Estimated Cost Totals	
Main Electronic Assemblies	\$ 8.39
Non-Electronic Parts	\$ 3.27
Final Assembly & Test	\$ 1.43
Total	\$ 13.08

Cost Total Notes:
Estimated final assembly cost includes labor only.
Total cost does not include Non-recurring, R&D, G&A, IP licensing fees/royalties, software, sales & marketing, distribution.
Assumes fully scaled production.



Cost Estimation Process (Overview & Discussion)



MUNRO
& ASSOCIATES, INC.

Cost modeling is tricky business. Multiple variables affect the actual production costs a manufacturer will experience, including development expenses, unit volumes, supply-and-demand in component markets, die yield-curve maturity, OEM purchasing power, and even variations in accounting practices. Different cost modeling methods employ different assumptions about how to handle these and other variables, but we can identify two basic approaches: that which seeks to track short-term variations in the inputs to the production process, and that which strives to maintain comparability of the output of the model across product families and over time.

TechInsights' philosophy in cost modeling is to emphasize consistency across products and comparability over time, rather than to track short-term fluctuations. During the past eight years, we have developed an estimation process that, while necessarily lacking an insider's knowledge of the cost factors that impact any one manufacturer, is reasonably accurate in its prediction of unit costs in high-volume production environments. We do not claim that the model will produce the "right" answer for your firm's environment. However, TechInsights does give customers a key analytical tool with a complete set of data in our Bill of Materials (BOM). The BOM allows readers to 1) scrutinize the assumptions behind our cost model and 2) modify the results based on substitution of their own component cost estimates where they have better information based on inside knowledge.

Our estimation process decomposes overall system cost into three major categories: Electronics, Mechanical, and Final Assembly. We begin by creating a complete electronics bill-of-materials (BOM). Each component from the largest ASIC to the smallest discrete resistor is entered into a BOM table with identifying attributes such as size, pitch, I/O count, package type, manufacturer, part number, estimated placement cost, and die size (if the component is an IC). Integrated circuit costs are calculated from measured die area. Using assumptions for wafer size, process type, number of die per wafer, defect density, and profit margin in combination with die area, an estimate of semiconductor cost is derived. Costs for discrete components and interconnect are derived from assumption tables which relate BOM line items to specific cost estimates by component type and estimates for part placement costs are included. For LCD display costs, we employ a model which tabulates expected cost from measurements of glass area, LCD type, and total pixel resolution. When market costs are available from alternative sources, LCD panel costs are taken from and referenced to these sources.

Costs of non-electronic components such as molded plastic enclosures and metallic components are measured in terms of weight, size, thickness, type of material, and complexity to arrive at their estimated cost. Other system items such as optics, antennae, batteries and displays are costed from a set of assumption tables derived from a combination of industry data, average high volume costs, and external sources. For final assembly, we re-build the torn-down product, tabulating stepwise assembly times as the reconstruction proceeds, to reach a total assembly time. Using a labor rate assumption for the country of origin, we then calculate final assembly cost.

The three major categories for system cost contributors can be broken down into the subcategories of ICs, other electronics parts, displays, batteries (as appropriate), camera modules, electronics assembly, non-electronic elements, and final assembly. By adding the cost estimates for each of these subcategories, an overall estimated cost is derived for the system under evaluation. Product packaging and accessories (CDs, cables, etc.) are also documented and estimated for their contribution to total cost as appropriate.

We believe our cost estimates generally fall within 15 percent of the "right answer," which itself can vary depending on the market and OEM-specific factors mentioned earlier. While the TechInsights cost model is imperfect, it yields important insights into technology and business dynamics along with good first-order contributions to system cost by component type. Additionally, the consistency of approach and gradual modification to assumptions (smoothing out frequently-shifting pricing factors) hopefully yields a credible, but user-modifiable, view of OEM high volume cost-to-produce.

Please feel free to contact us at support@techinsights.com with any comments, questions, or proposed corrections with respect to our cost estimates. We welcome your input.

In our product teardowns, we gather a series of metrics for product profiling and comparison. Some metrics focus on system characteristics such as total silicon area, total system semiconductor storage capacity, and total connection count. Other metrics reflect more subtle aspects of electronics assembly such as connection density, average component I/O count, and silicon tiling density. Taken as a whole, the metrics allow deeper comparison and benchmarking across multiple disciplines and multiple products. Key metrics we gather on products are described below along with their definitions and what they tend to say about the system under study. Most metrics can be used both in comparing similar products for benchmarking purposes or for quantifying differences in levels of complexity between dissimilar product types. Data fall into two categories; either “raw” measured data or ratios of these measured data sets.

Total Silicon Area : This metric describes the total area of silicon as measured from X-ray or direct measurement of ICs. The area is an expression of the enclosed bare die area and excludes packaging area. The aggregate silicon area is a good benchmark to show how integrated a design might be when making comparisons to similar systems. Total silicon area also reflects the major cost driver for most systems we examine.

Silicon Tiling Density : Ratio of Total Silicon Area to total printed circuit board “projected” area (i.e. the simple board area and not the cumulative surface area of both sides of the board). This metric directly reflects the level of efficiency and aggressiveness in integrated circuit packing and placement. Single digit Silicon Tiling Density is typical but silicon coverage of 10% - 20% has been seen in some of the most advanced products we have examined. Higher Tiling Densities often correspond with the use of chip scale packaging (CSPs) or other small form-factor IC packaging technologies. High density circuit boards are also often a supporting technology.

Number of Parts : Total component count including ICs, passives, modules, connectors, etc., each separated out in our reporting.

Number of Connections : The total number of connections corresponds to the total number of interconnects introduced by the aggregate component set and reflects any electrical connection observed (solder joints, adhesive interconnect, or connector terminal interfaces).

Opportunity Count : Opportunity Count is the total number of parts plus the total number of connections; the name reflects that each of these constituent elements represents an opportunity for failure. A high opportunity count means more complex and riskier electronics assembly.

Average Pin Count (APC) : Ratio of total number of component terminals to total number of parts, at the system level. This metric reflects the ‘average’ terminal complexity of the components and often provide a signature of integration level and/or “digital-ness” of the overall product. Low APCs reflect a high number of discrettes or other low-pincount devices often characteristic of analog circuitry. Conversely, high APCs are characteristic of highly integrated, high-pincount assemblies, often those composed largely of digital integrated circuits.

Connection Density : This metric is a ratio of the total Number of Connections to total printed circuit board assembly area, in units of connections per sq. inch. The metric provides data related to the Silicon Tiling Density above, but with an emphasis on complexity of I/O interconnect. For example, with a fixed Connection Density, high tiling density of low-pincount memory chips is more readily achieved than comparable silicon tiling of high pincount logic.

Part Density : This metric is a ratio of the total Number of Parts to total printed circuit board assembly area, in units of components per sq. inch. The metric provides data related to the Silicon Tiling Density and Connection Density as described above, but with an emphasis on density and complexity of component packing efficiency. For example, low Part Density of high-pincount devices can pose an equal challenge in Connection Density to high Part Density of low-pincount devices. High Part Density does reflect challenges in surface mount assembly in terms of (typically) precision of placement, number of placements, and engineering of part clearances.

Routing Density (heuristic estimate) = $3 * (\text{Average Pin Count}) * \sqrt{\text{Part Density}}$. The Routing Density metric is an empirically derived relationship that characterizes the wiring density of the interconnect used to support the interconnection of components in a planar electronic assembly (i.e. the circuit board). Architectural issues such as bussing or other factors affecting the regularity of wiring impact the actual Routing Density needed to support a given application, but the metric provides a ready measure of wiring complexity.

***Click Here to Return to
Cost Analysis Page 143***

Deep Dive Report

BMW i3 Wave Trap

2255

Report #15900-150212-PKb



Product Description:

This report concerns the Wave Trap assembly from the 2014 BMW i3.

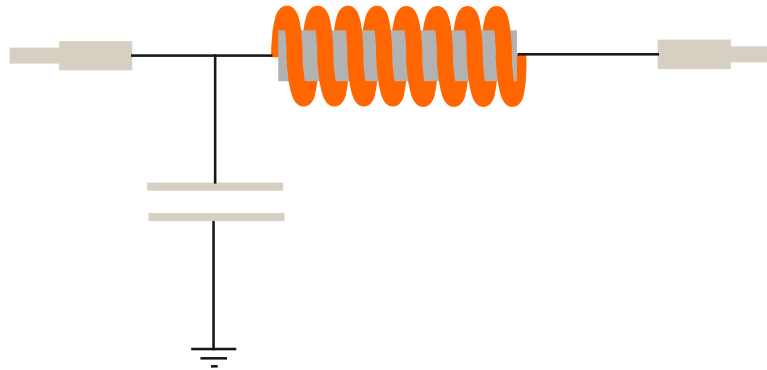
DISCLAIMER: All company names, product names, and service names mentioned are used for identification purposes only and may be registered trademarks, trademarks, or service marks of their respective owners. All analyses are done without participation, authorization, or endorsement of the manufacturer. Any cost analyses presented in this material are estimates prepared by TechInsights from generally available data. While TechInsights believes that these estimates reflect the probable costs, the actual producer did not supply the data, and therefore the actual costs may be different from these estimates. Furthermore, TechInsights extends no warranties with respect to any information in this document, and shall bear no liability whatsoever for the use of the information.

Copyright © 2015, TechInsights. All rights reserved. Do not reproduce, distribute, disseminate, photocopy, fax, transmit, download to a shared database, or otherwise copy, transfer, sell, publish, or send this material, or any portion thereof, by any means without the express written permission of TechInsights.

Product Overview



Product Description		Integrated Circuit Metrics		
Product Type	Automotive	IC Die Count	0	
Brand	BMW	IC Package Count	0	
Product Name & Model #	i3 Driver Side Wave Trap Asm	Cost Metrics		
Official Release Date	5/2/2014			
Weight (grams)	25.1 (Measured)	Retail Price		
Product Dimensions	61.5 x 34.3 x 23.6 (Measured at Longest/Widest/Thickest Points)	Total Manufacturing Cost	\$1.68	
Product Features		Electronics Cost	\$0.62	
		Manufacturing Cost Breakdown		
		Discretes & Connectors	\$0.42	25.0%
		Substrates	\$0.13	7.7%
		Component Insertion	\$0.02	1.2%
		Card Test	\$0.06	3.6%
		Non-Electronics	\$0.76	45.2%
		Final Assembly & Test	\$0.29	17.3%
		Total		\$1.68



Estimated block diagram based on observation of this specific product implementation, manufacturer's data sheets where available, and best engineering judgment. Certain details of the interface circuitry are not reflected in this block diagram. Partitioning and connectivity are speculative.

BMW
SY9231466 02
108594 10

28255372



0541

F ★

05 - 04 - 14

ASSEMBLED IN MEXICO

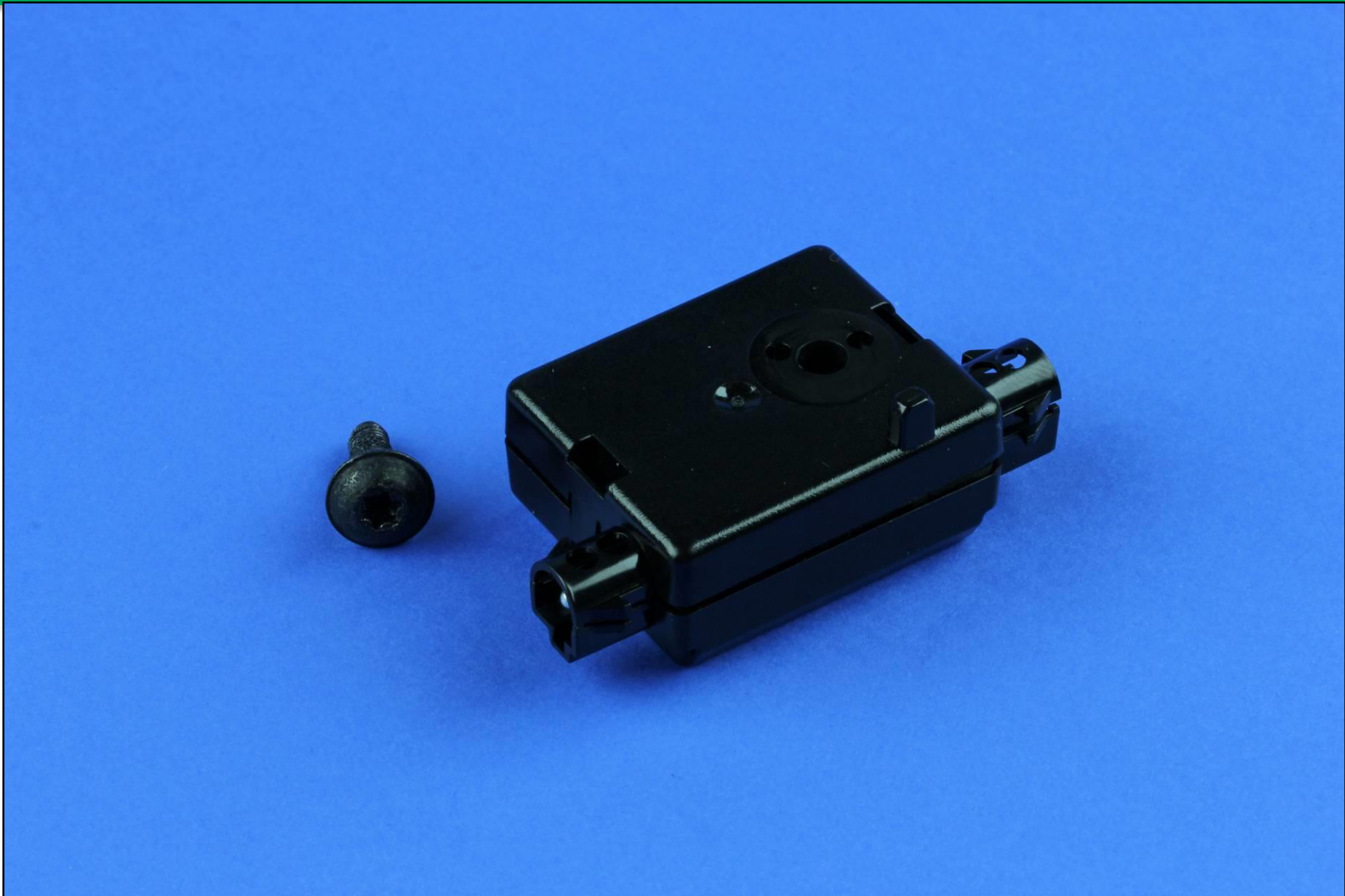
Exterior Features



Exterior Features



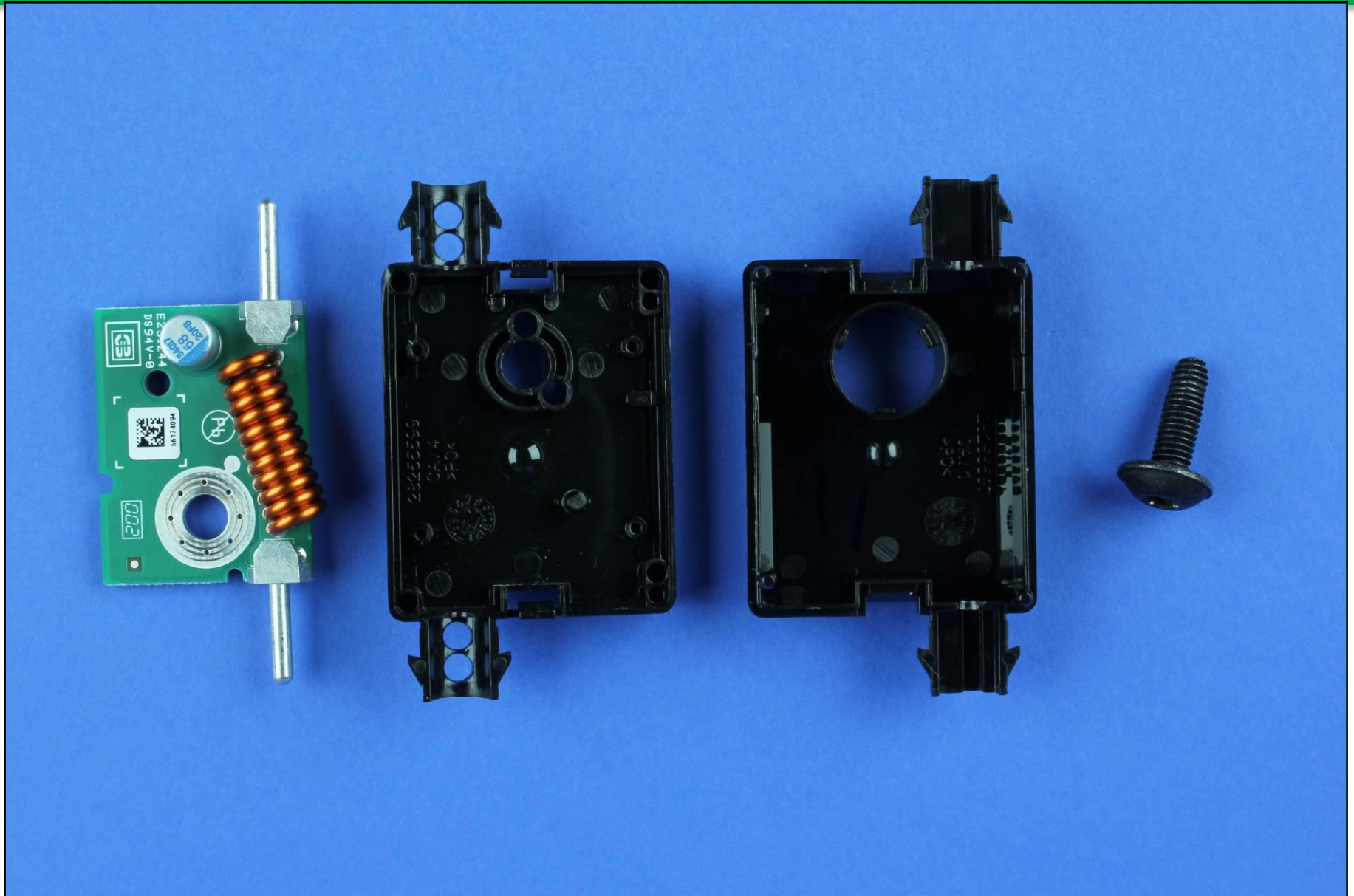
MUNRO
& ASSOCIATES, INC.



Major Components (Side 1)



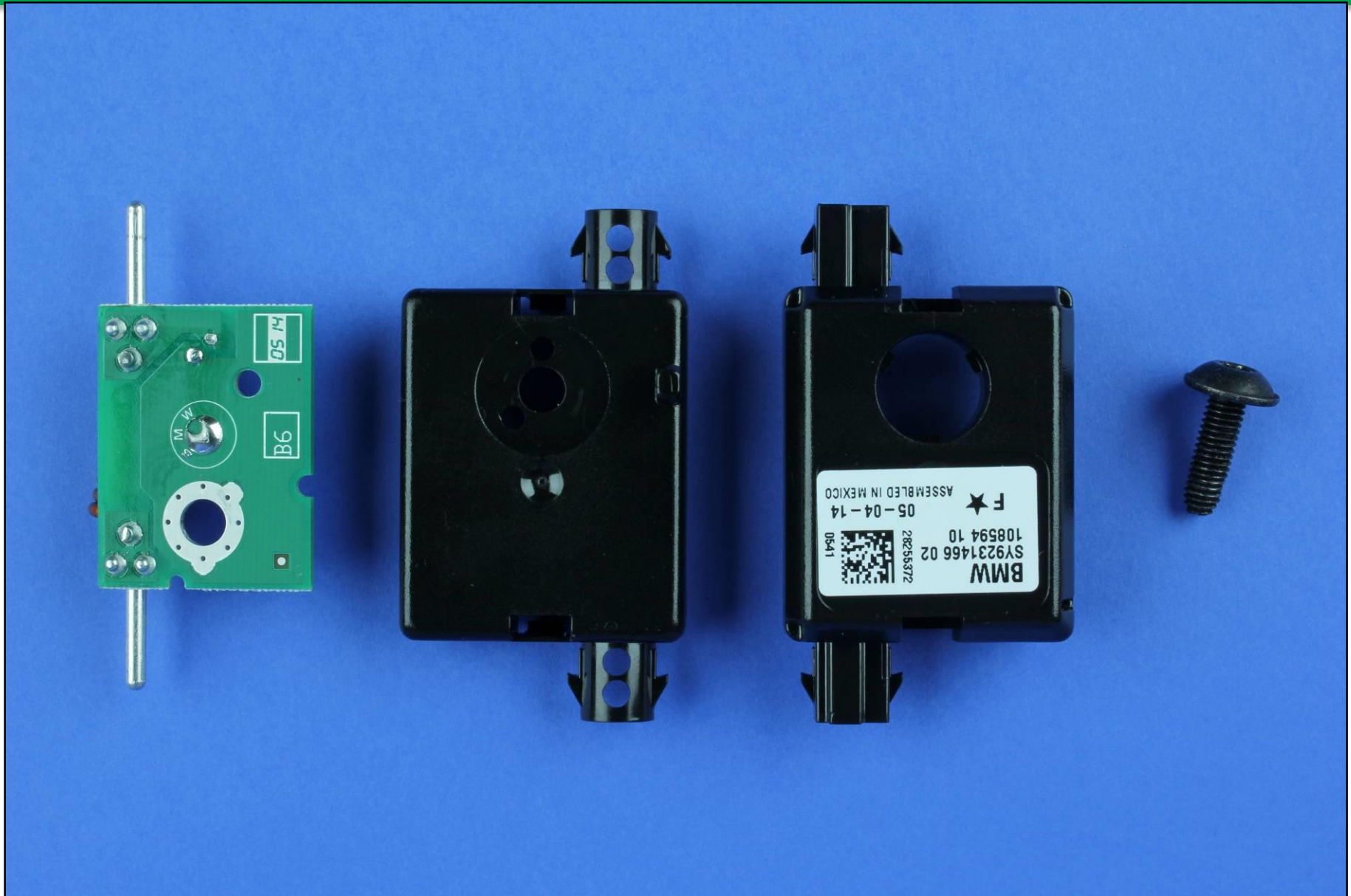
MUNRO
& ASSOCIATES, INC.



Major Components (Side 2)



MUNRO
& ASSOCIATES, INC.

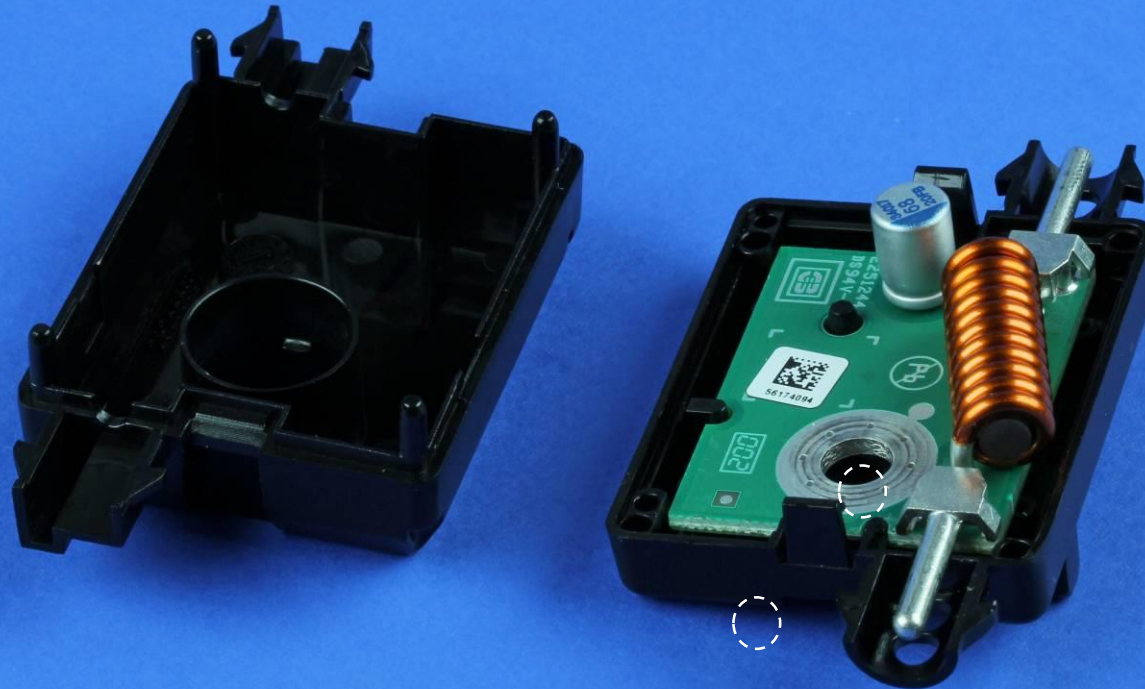


BMW i3 Wave Trap #15900-150212-PKb – Page 656

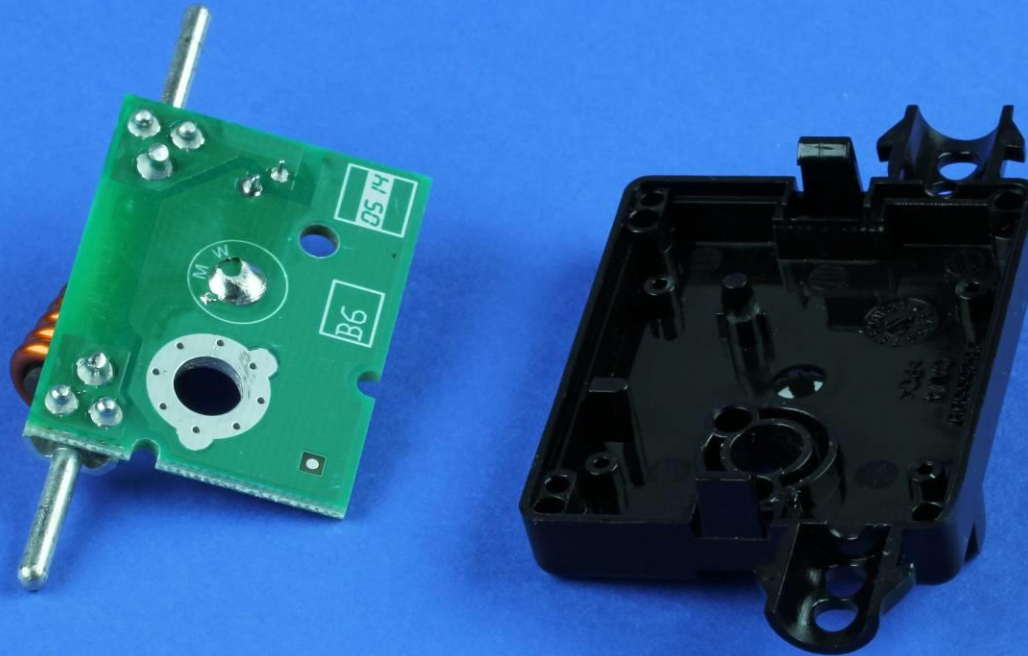
Teardown Sequence



MUNRO
& ASSOCIATES, INC.



Teardown Sequence



Main Board (Side 1)



MUNRO
& ASSOCIATES, INC.



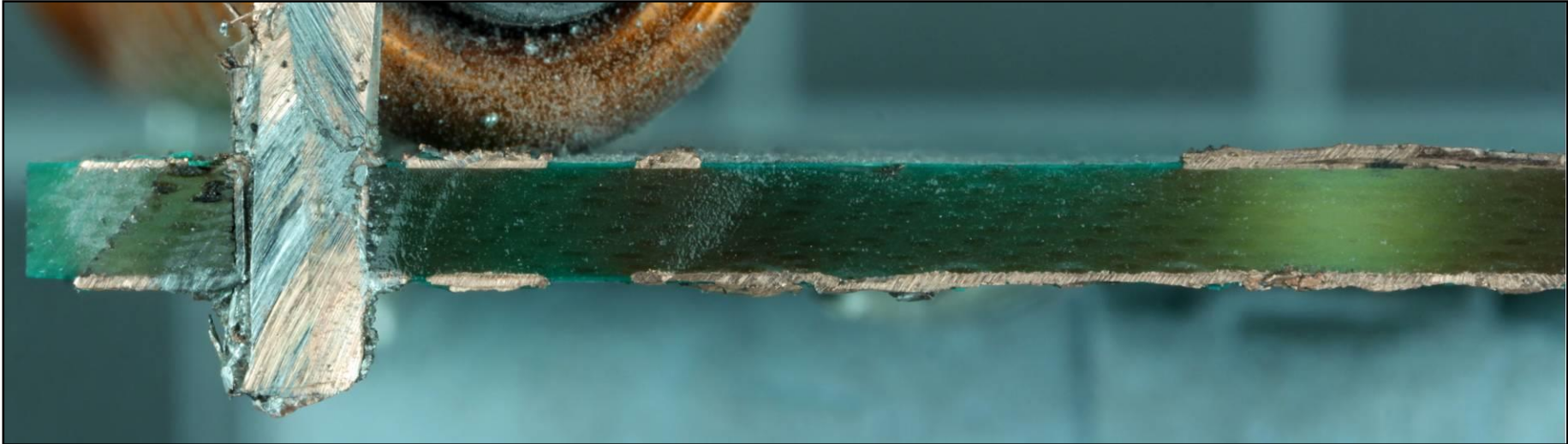
Grid = 1cm

Main Board (Side 2)



Grid = 1cm

Main Board Cross-Section



Substrate Data

Substrates

Assembly Name	Manufacturer	Core Material	Mfg. Technology	Layers	Area (cm ²)	Min. Trace Pitch (mm)	Min. Trace Width (mm)	ThruVia Land Dia (mm)	ThruVia Hole Dia (mm)	BlindVia Land Dia (mm)	BlindVia Hole Dia (mm)	Thickness (mm)	Routing Density	Estimated Costs
Main Board	Kunshan Yuanmao Electronics	FR4	2 Layer conventional FR4 / HF	2	8.6	1.28	0.72	2.50	1.60			1.7	3.1	\$ 0.13

Passive Discrete Components



Location	Qty	Functional Description	Package		Estimated Costs	
			Form	Pin Count	Each	Total
Main Board, Side 1	1	Capacitor	Electrolytic, Small	2	\$0.080	\$0.080
	1	Coil	Throughhole	2	\$0.250	\$0.250
TOTALS	2			4		\$0.33

Connectors



Location	Qty	Form	Package			Estimated Costs	
			Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	2	Connector: Pin	1	17.10	7.80	\$0.040	\$0.080
TOTALS	2		2				\$0.08

Electronic Assembly Metrics



Electronic Assembly Metrics by Assembly											
General Area	Assembly Name	Substrate Area (sq.cm)	Metal Layers	Circuit Area (sq.cm)	Routing Density (cm of routing per sq.cm of substrate)	Number of Components	Number of Connections	Component Density (Components/sq.cm)	Connection Density (Connections/sq.cm)	Avg. Pin Count	Assembly Weight (grams)
Main Electronics	Main Board	8.6	2	17.2	3.1	4	6	0.5	0.7	1.5	11.50
	System Totals	8.6	2	17.2		4	6	0.5	0.7	1.5	11.50

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Electronics Costs by Assembly										
General Area	Assembly Name	Total	Integrated Circuits	Modular & Odd Form Components	Small Active Components	Passive Components	Connector Components	Substrates	Insertion	Card Test
Main Electronics	Main Board	\$ 0.62	\$ -	\$ -	\$ -	\$ 0.33	\$ 0.08	\$ 0.13	\$ 0.02	\$ 0.06
	System Totals	\$ 0.62	\$ -	\$ -	\$ -	\$ 0.33	\$ 0.08	\$ 0.13	\$ 0.02	\$ 0.06

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



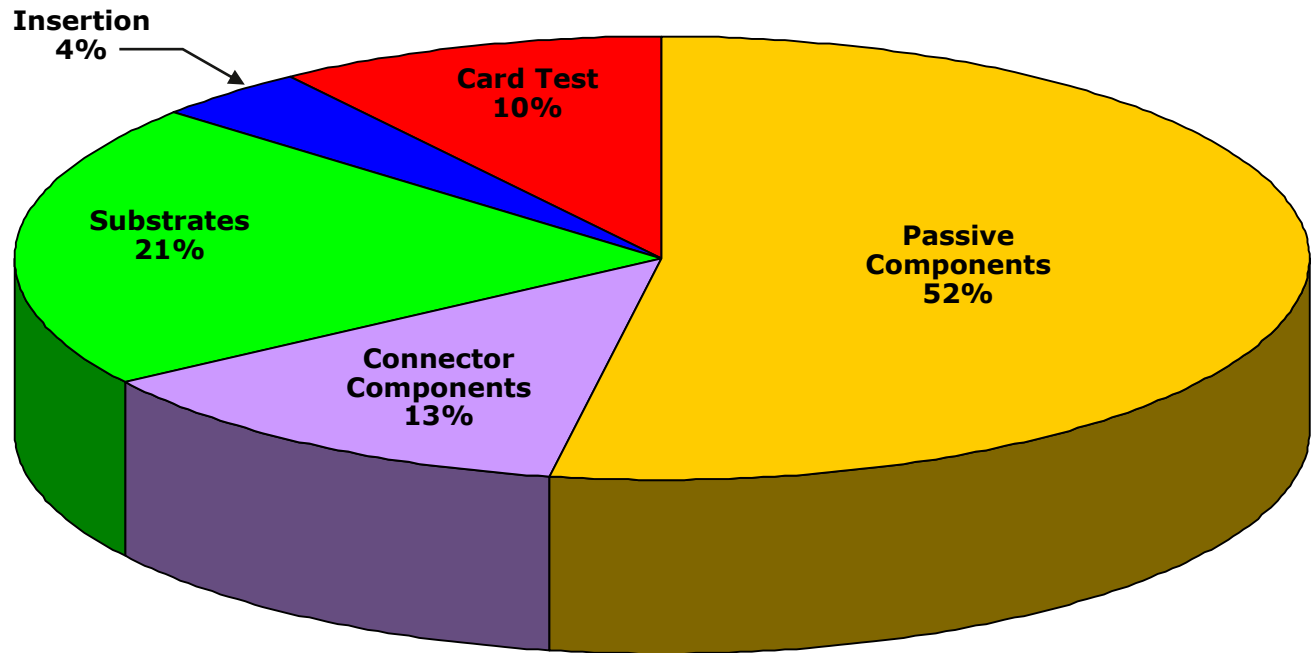
Counts by Assembly												
General Area	Assembly Name	IC Package Count	IC Connections	Modular/Odd Form Components	Modular/Odd Form Component Connections	Small Active Components	Small Active Component Connections	Passive Components	Passive Component Connections	Connectors	Connector Connections	Opportunities
Main Electronics	Main Board	0	0	0	0	0	0	2	4	2	2	10
	System Totals	0	0	0	0	0	0	2	4	2	2	10

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Costs Breakdown

**Estimated Cost
of Electronics**

\$0.62



NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Non-Electronic Cost Estimate



Subsystem	Part ID No.	Qty	Description	Fabrication Process	Material	Dimensions (mm)	Weight (grams)	Est'd Cost Each	Est'd Extended Cost	
Miscellaneous	1	1	Top Cover	Molded	PC	61.5 x 34.3 x 17.1	5.50	0.320	0.320	
	2	1	Bottom Cover	Molded	PC	61.7 x 34.2 x 17	4.60	0.270	0.270	
	3	1	Medium Label	Die-Cut + Printed	Plastic + Adhesive	25.3 x 14.4	0.10	0.080	0.080	
	4	1	Small Label	Die-Cut + Printed	Plastic + Adhesive	6.4 x 6.3	0.05	0.040	0.040	
	5	1	Screw	Cast + Machined + Painted	Metal	19.2 x 11.7 x 11.7	3.50	0.050	0.050	
Total		5							Estimated Cost	\$0.76

Final Ass'y Labor & Test Cost Estimate

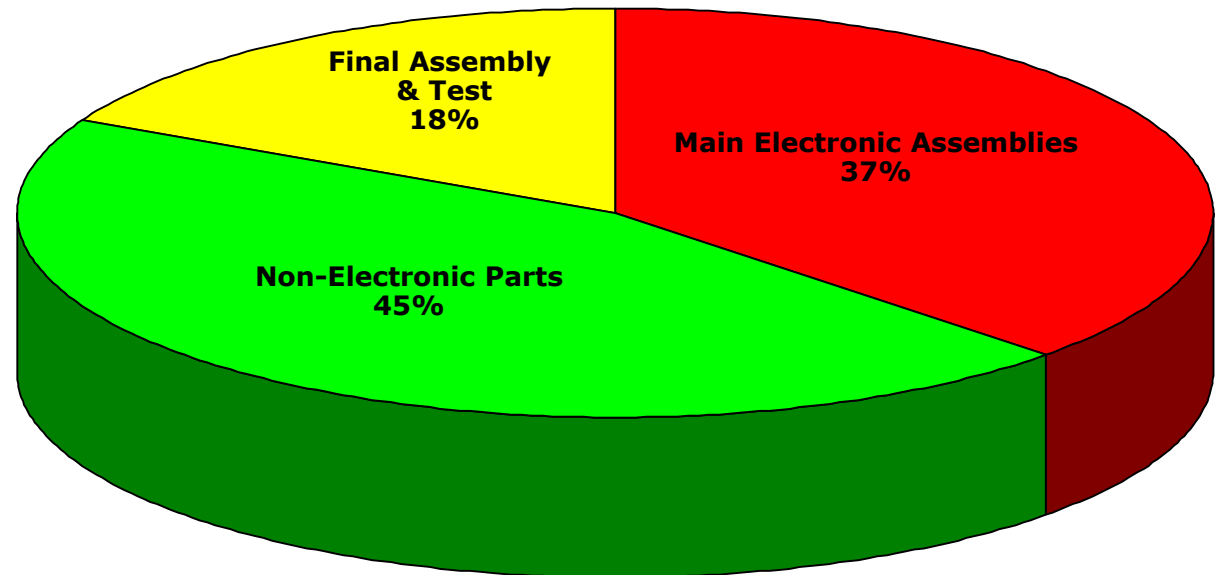


Final Assembly & Test	
Made in	Mexico
Number of parts	6
Est'd number of steps	22
Est'd time (seconds)	54
Est'd final assembly cost	\$ 0.09
Est'd final test cost	\$ 0.20

Cost Summary

Estimated Cost Totals	
Main Electronic Assemblies	\$ 0.62
Non-Electronic Parts	\$ 0.76
Final Assembly & Test	\$ 0.29
Total	\$ 1.68

Cost Total Notes:
Estimated final assembly cost includes labor only.
Total cost does not include Non-recurring, R&D, G&A, IP licensing fees/royalties, software, sales & marketing, distribution.
Assumes fully scaled production.



Cost Estimation Process (Overview & Discussion)



Cost modeling is a tricky business. Multiple variables affect the actual production costs a manufacturer will experience, including development expenses, unit volumes, supply-and-demand in component markets, die yield-curve maturity, OEM purchasing power, and even variations in accounting practices. Different cost modeling methods employ different assumptions about how to handle these and other variables, but we can identify two basic approaches: that which seeks to track short-term variations in the inputs to the production process, and that which strives to maintain comparability of the output of the model across product families and over time.

TechInsights' philosophy in cost modeling is to emphasize consistency across products and comparability over time, rather than to track short-term fluctuations. During the past eight years, we have developed an estimation process that, while necessarily lacking an insider's knowledge of the cost factors that impact any one manufacturer, is reasonably accurate in its prediction of unit costs in high-volume production environments. We do not claim that the model will produce the "right" answer for your firm's environment. However, TechInsights does give customers a key analytical tool with a complete set of data in our Bill of Materials (BOM). The BOM allows readers to 1) scrutinize the assumptions behind our cost model and 2) modify the results based on substitution of their own component cost estimates where they have better information based on inside knowledge.

Our estimation process decomposes overall system cost into three major categories: Electronics, Mechanical, and Final Assembly. We begin by creating a complete electronics bill-of-materials (BOM). Each component from the largest ASIC to the smallest discrete resistor is entered into a BOM table with identifying attributes such as size, pitch, I/O count, package type, manufacturer, part number, estimated placement cost, and die size (if the component is an IC). Integrated circuit costs are calculated from measured die area. Using assumptions for wafer size, process type, number of die per wafer, defect density, and profit margin in combination with die area, an estimate of semiconductor cost is derived. Costs for discrete components and interconnect are derived from assumption tables which relate BOM line items to specific cost estimates by component type and estimates for part placement costs are included. For LCD display costs, we employ a model which tabulates expected cost from measurements of glass area, LCD type, and total pixel resolution. When market costs are available from alternative sources, LCD panel costs are taken from and referenced to these sources.

Costs of non-electronic components such as molded plastic enclosures and metallic components are measured in terms of weight, size, thickness, type of material, and complexity to arrive at their estimated cost. Other system items such as optics, antennae, batteries and displays are costed from a set of assumption tables derived from a combination of industry data, average high volume costs, and external sources. For final assembly, we re-build the torn-down product, tabulating stepwise assembly times as the reconstruction proceeds, to reach a total assembly time. Using a labor rate assumption for the country of origin, we then calculate final assembly cost.

The three major categories for system cost contributors can be broken down into the subcategories of ICs, other electronics parts, displays, batteries (as appropriate), camera modules, electronics assembly, non-electronic elements, and final assembly. By adding the cost estimates for each of these subcategories, an overall estimated cost is derived for the system under evaluation. Product packaging and accessories (CDs, cables, etc.) are also documented and estimated for their contribution to total cost as appropriate.

We believe our cost estimates generally fall within 15 percent of the "right answer," which itself can vary depending on the market and OEM-specific factors mentioned earlier. While the TechInsights cost model is imperfect, it yields important insights into technology and business dynamics along with good first-order contributions to system cost by component type. Additionally, the consistency of approach and gradual modification to assumptions (smoothing out frequently-shifting pricing factors) hopefully yields a credible, but user-modifiable, view of OEM high volume cost-to-produce.

Please feel free to contact us at support@techinsights.com with any comments, questions, or proposed corrections with respect to our cost estimates. We welcome your input.

In our product teardowns, we gather a series of metrics for product profiling and comparison. Some metrics focus on system characteristics such as total silicon area, total system semiconductor storage capacity, and total connection count. Other metrics reflect more subtle aspects of electronics assembly such as connection density, average component I/O count, and silicon tiling density. Taken as a whole, the metrics allow deeper comparison and benchmarking across multiple disciplines and multiple products. Key metrics we gather on products are described below along with their definitions and what they tend to say about the system under study. Most metrics can be used both in comparing similar products for benchmarking purposes or for quantifying differences in levels of complexity between dissimilar product types. Data fall into two categories; either “raw” measured data or ratios of these measured data sets.

Total Silicon Area : This metric describes the total area of silicon as measured from X-ray or direct measurement of ICs. The area is an expression of the enclosed bare die area and excludes packaging area. The aggregate silicon area is a good benchmark to show how integrated a design might be when making comparisons to similar systems. Total silicon area also reflects the major cost driver for most systems we examine.

Silicon Tiling Density : Ratio of Total Silicon Area to total printed circuit board “projected” area (i.e. the simple board area and not the cumulative surface area of both sides of the board). This metric directly reflects the level of efficiency and aggressiveness in integrated circuit packing and placement. Single digit Silicon Tiling Density is typical but silicon coverage of 10% - 20% has been seen in some of the most advanced products we have examined. Higher Tiling Densities often correspond with the use of chip scale packaging (CSPs) or other small form-factor IC packaging technologies. High density circuit boards are also often a supporting technology.

Number of Parts : Total component count including ICs, passives, modules, connectors, etc., each separated out in our reporting.

Number of Connections : The total number of connections corresponds to the total number of interconnects introduced by the aggregate component set and reflects any electrical connection observed (solder joints, adhesive interconnect, or connector terminal interfaces).

Opportunity Count : Opportunity Count is the total number of parts plus the total number of connections; the name reflects that each of these constituent elements represents an opportunity for failure. A high opportunity count means more complex and riskier electronics assembly.

Average Pin Count (APC) : Ratio of total number of component terminals to total number of parts, at the system level. This metric reflects the ‘average’ terminal complexity of the components and often provide a signature of integration level and/or “digital-ness” of the overall product. Low APCs reflect a high number of discretely or other low-pincount devices often characteristic of analog circuitry. Conversely, high APCs are characteristic of highly integrated, high-pincount assemblies, often those composed largely of digital integrated circuits.

Connection Density : This metric is a ratio of the total Number of Connections to total printed circuit board assembly area, in units of connections per sq. inch. The metric provides data related to the Silicon Tiling Density above, but with an emphasis on complexity of I/O interconnect. For example, with a fixed Connection Density, high tiling density of low-pincount memory chips is more readily achieved than comparable silicon tiling of high pincount logic.

Part Density : This metric is a ratio of the total Number of Parts to total printed circuit board assembly area, in units of components per sq. inch. The metric provides data related to the Silicon Tiling Density and Connection Density as described above, but with an emphasis on density and complexity of component packing efficiency. For example, low Part Density of high-pincount devices can pose an equal challenge in Connection Density to high Part Density of low-pincount devices. High Part Density does reflect challenges in surface mount assembly in terms of (typically) precision of placement, number of placements, and engineering of part clearances.

Routing Density (heuristic estimate) = $3 * (\text{Average Pin Count}) * \sqrt{\text{Part Density}}$. The Routing Density metric is an empirically derived relationship that characterizes the wiring density of the interconnect used to support the interconnection of components in a planar electronic assembly (i.e. the circuit board). Architectural issues such as bussing or other factors affecting the regularity of wiring impact the actual Routing Density needed to support a given application, but the metric provides a ready measure of wiring complexity.

[Click Here to Return to Cost Analysis Page 145](#)

Deep Dive Report

BMW i3 Interference Suppression Filter Assembly

2256

Report #15900-150216-RRb



Product Description

The Interference Suppression Filter Assembly of the BMW i3 is a module that suppresses noise induced by other devices in the vehicle. This module consists of line filters using capacitors and inductors. It also has two interface connectors, one at each end. The printed circuit board (PCB) itself is protected by top and bottom plastic enclosures.

DISCLAIMER: All company names, product names, and service names mentioned are used for identification purposes only and may be registered trademarks, trademarks, or service marks of their respective owners. All analyses are done without participation, authorization, or endorsement of the manufacturer. Any cost analyses presented in this material are estimates prepared by TechInsights from generally available data. While TechInsights believes that these estimates reflect the probable costs, the actual producer did not supply the data, and therefore the actual costs may be different from these estimates. Furthermore, TechInsights extends no warranties with respect to any information in this document, and shall bear no liability whatsoever for the use of the information.

Copyright © 2015, TechInsights. All rights reserved. Do not reproduce, distribute, disseminate, photocopy, fax, transmit, download to a shared database, or otherwise copy, transfer, sell, publish, or send this material, or any portion thereof, by any means without the express written permission of TechInsights.

Product Overview

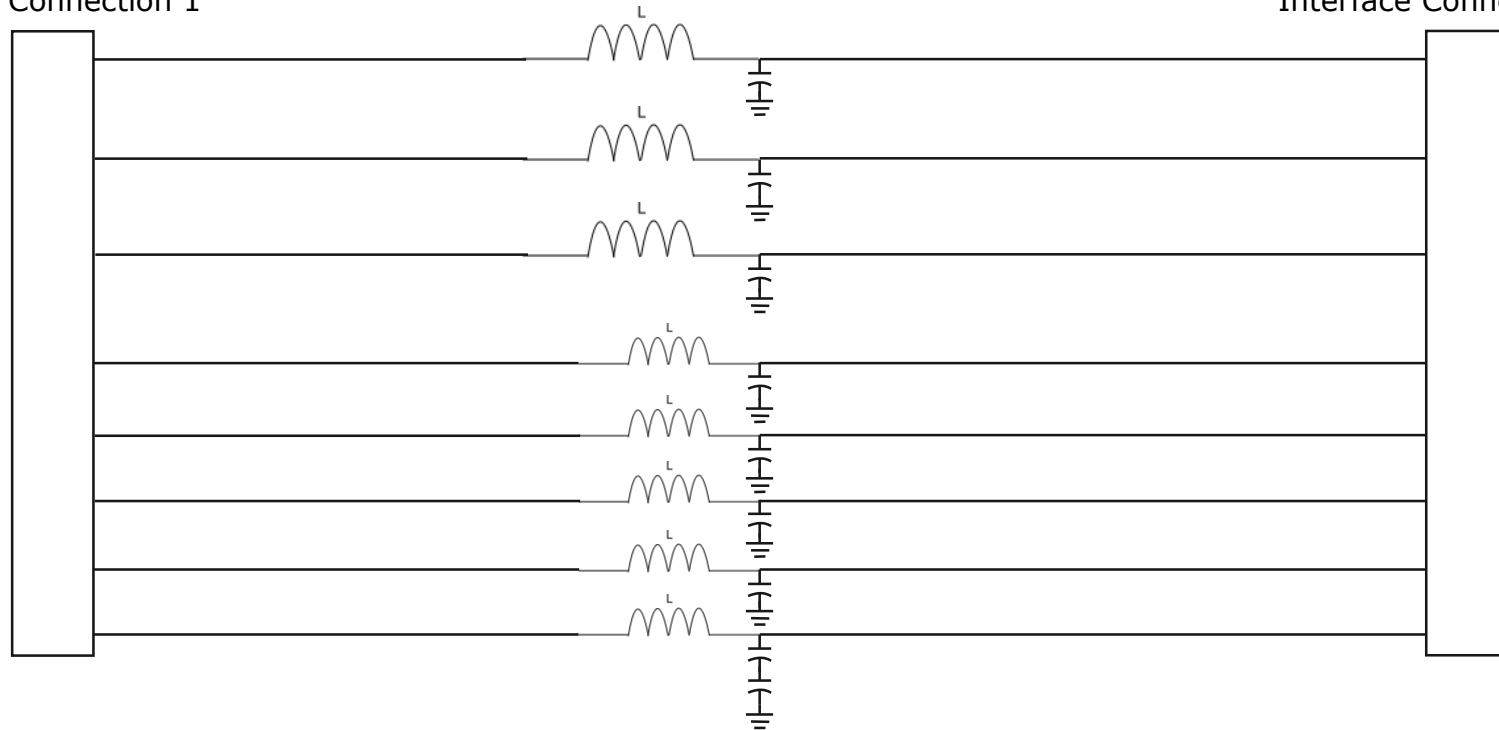


Product Description		Integrated Circuit Metrics	
Product Type	Automotive	IC Die Count	0
Brand	BMW	IC Package Count	0
Product Name & Model #	i3 Interference Suppression Filter Assembly	Cost Metrics	
Official Release Date	5/2/2014		
Weight (grams)	41.6 (Measured)	Retail Price	
Product Dimensions (mm)	81.86 x 50.77 x 22.97 (Measured at Longest/Widest/Thickest Points)	Total Manufacturing Cost	\$8.61
Product Features		Electronics Cost	\$5.79
		Manufacturing Cost Breakdown	
Operating System	N/A	Passive Components	\$1.13 13.1%
Communications	N/A	Connectors	\$3.90 45.3%
Connectivity	N/A	Substrates	\$0.43 5.0%
		Component Insertion	\$0.12 1.4%
Interface	N/A	Card Test	\$0.21 2.4%
		Non-Electronic Parts	\$1.27 14.8%
		Final Assembly & Test	\$1.55 18.0%
		Total	\$8.61 100.0%

Block Diagram

Interface Connection 1

Interface Connection 2





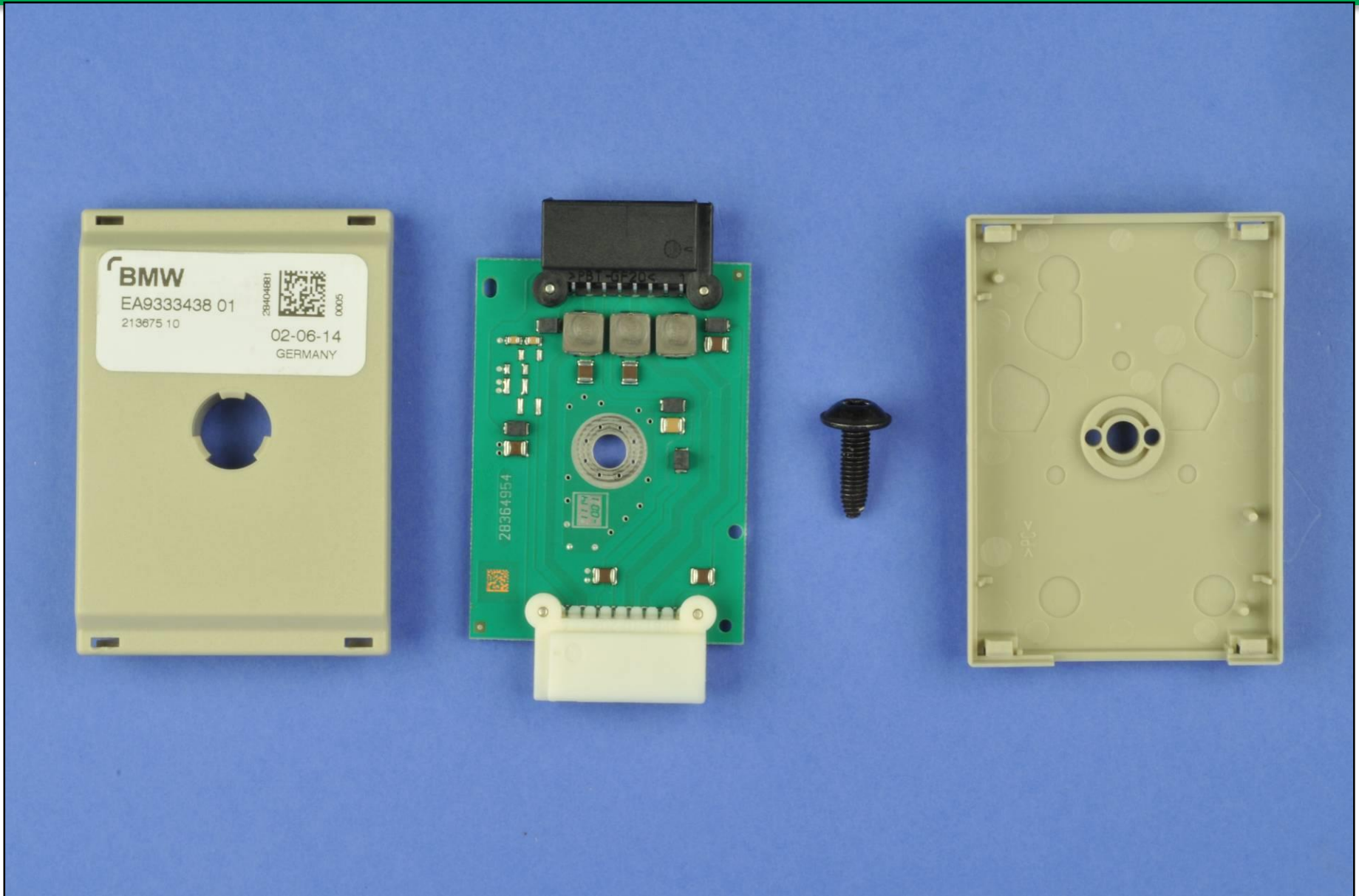
Exterior Features



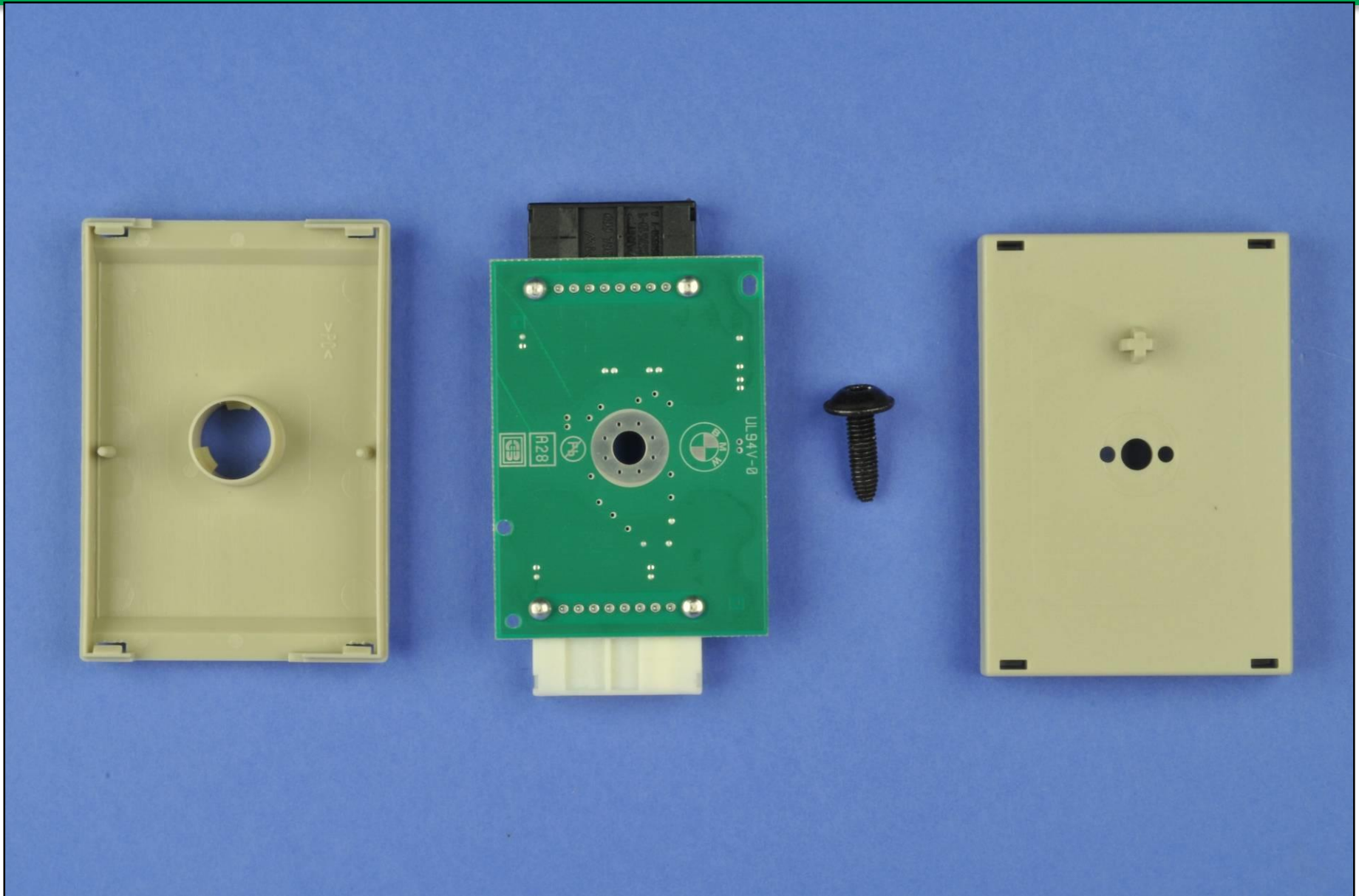
Exterior Features



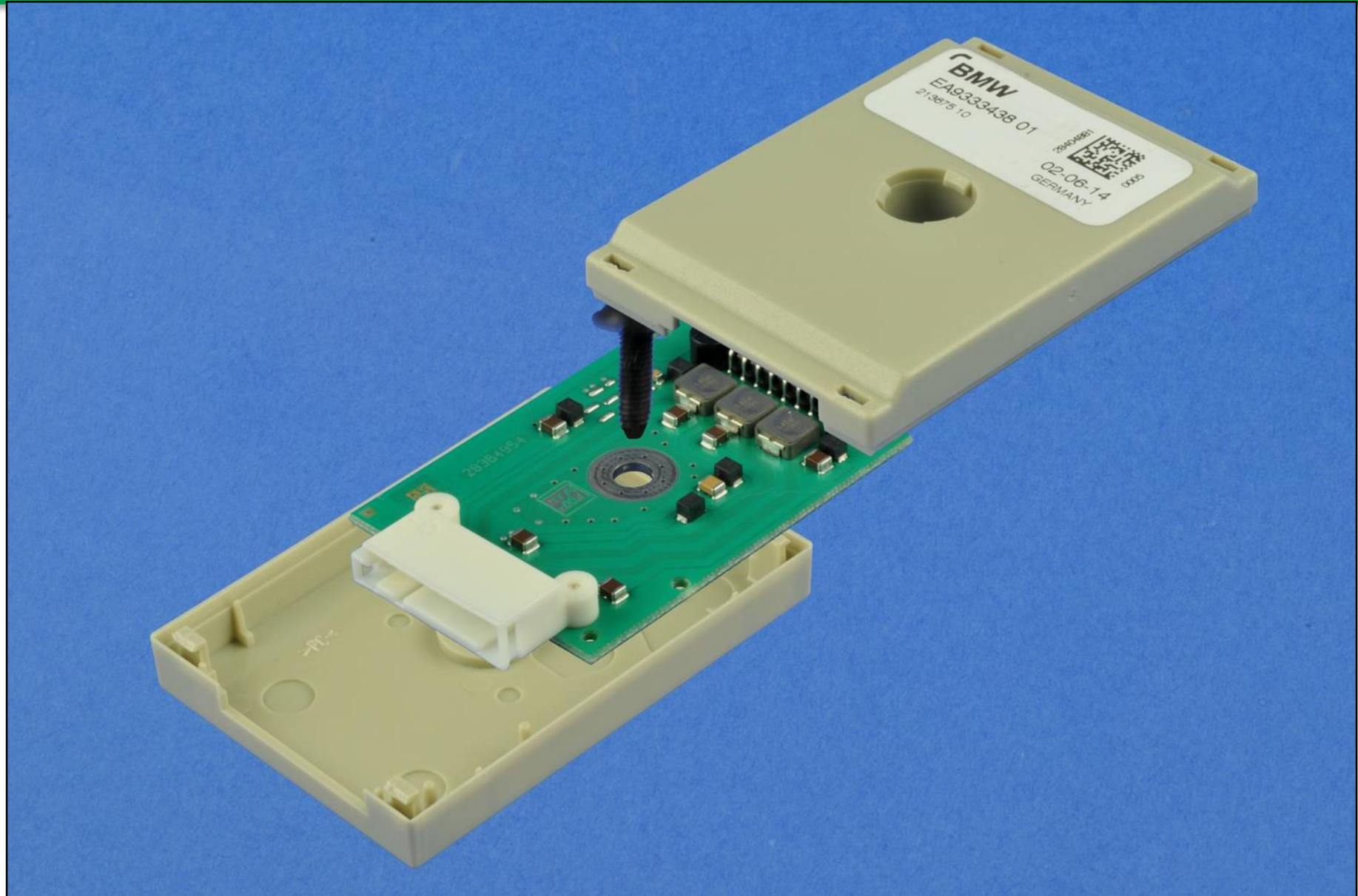
Major Components (Side 1)



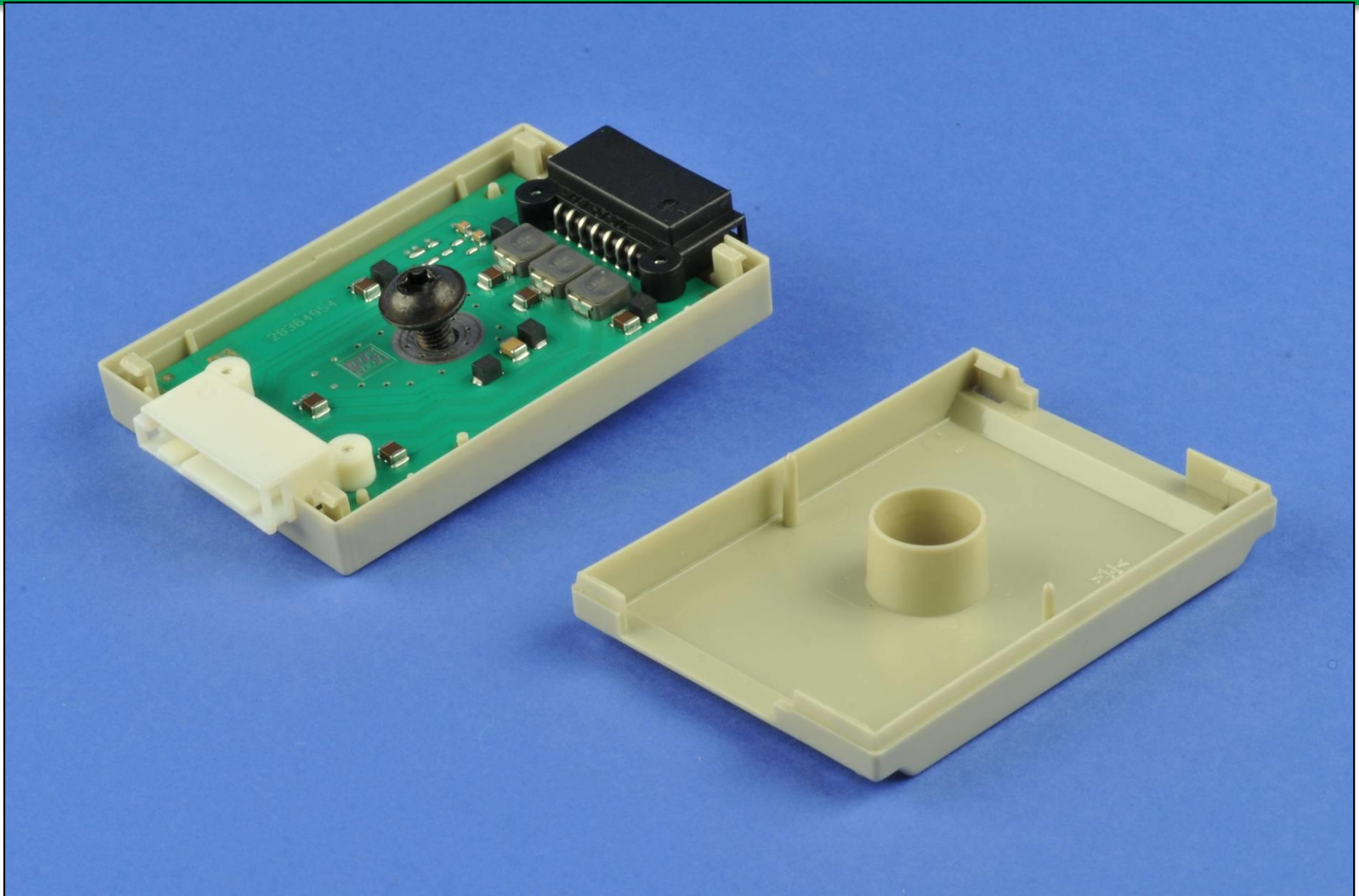
Major Components (Side 2)



Component Arrangement



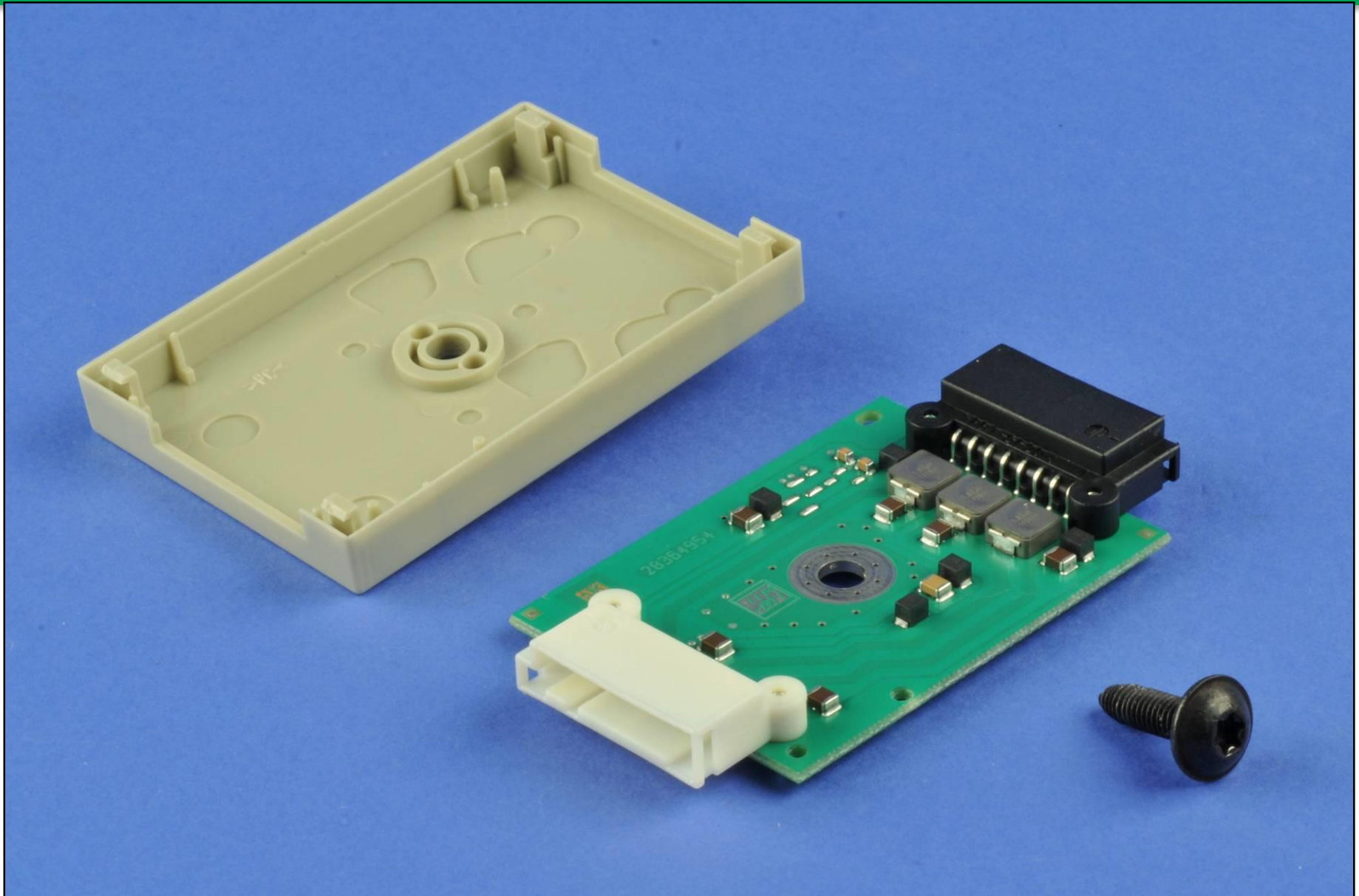
Teardown Sequence



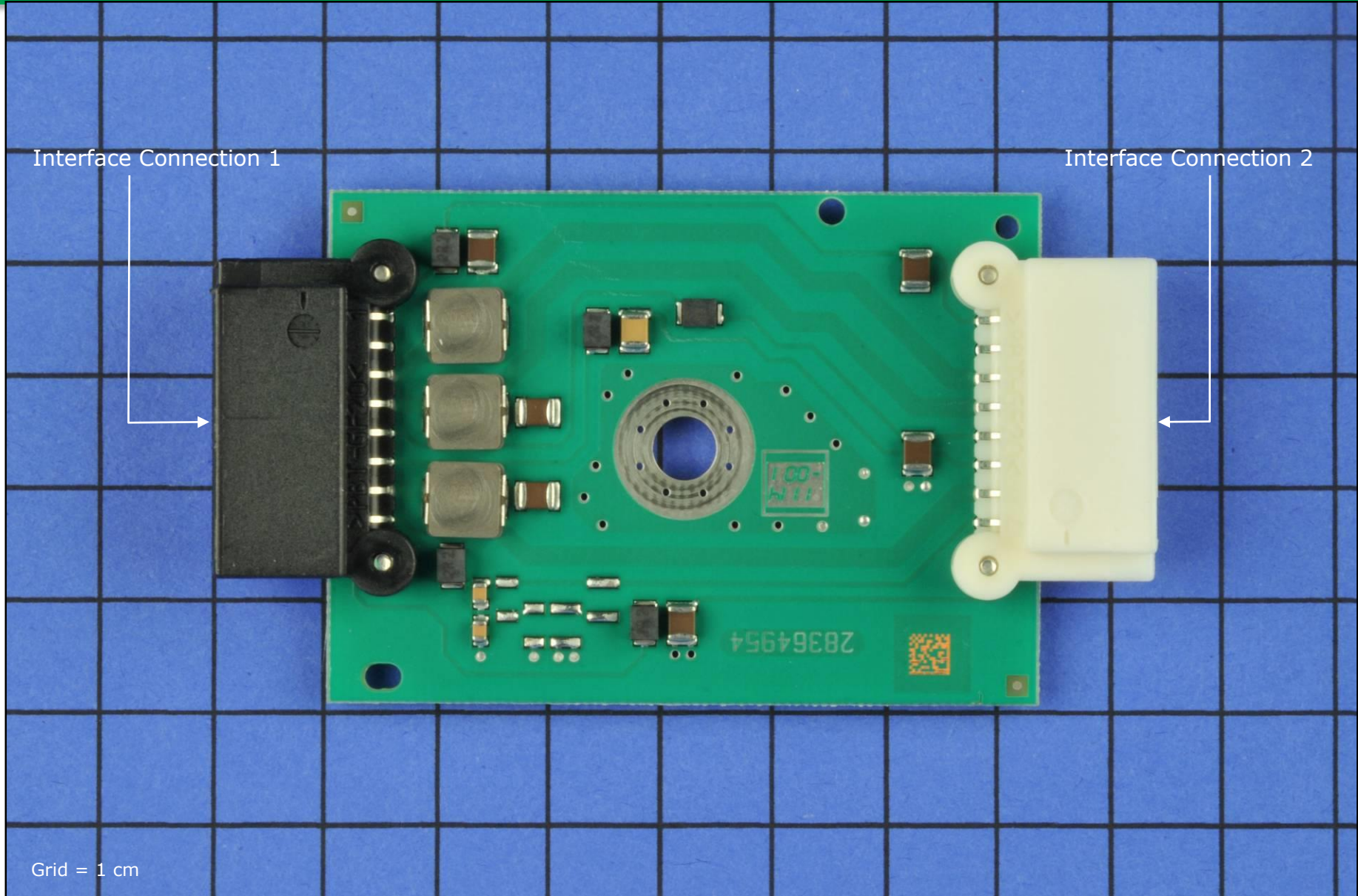
Teardown Sequence



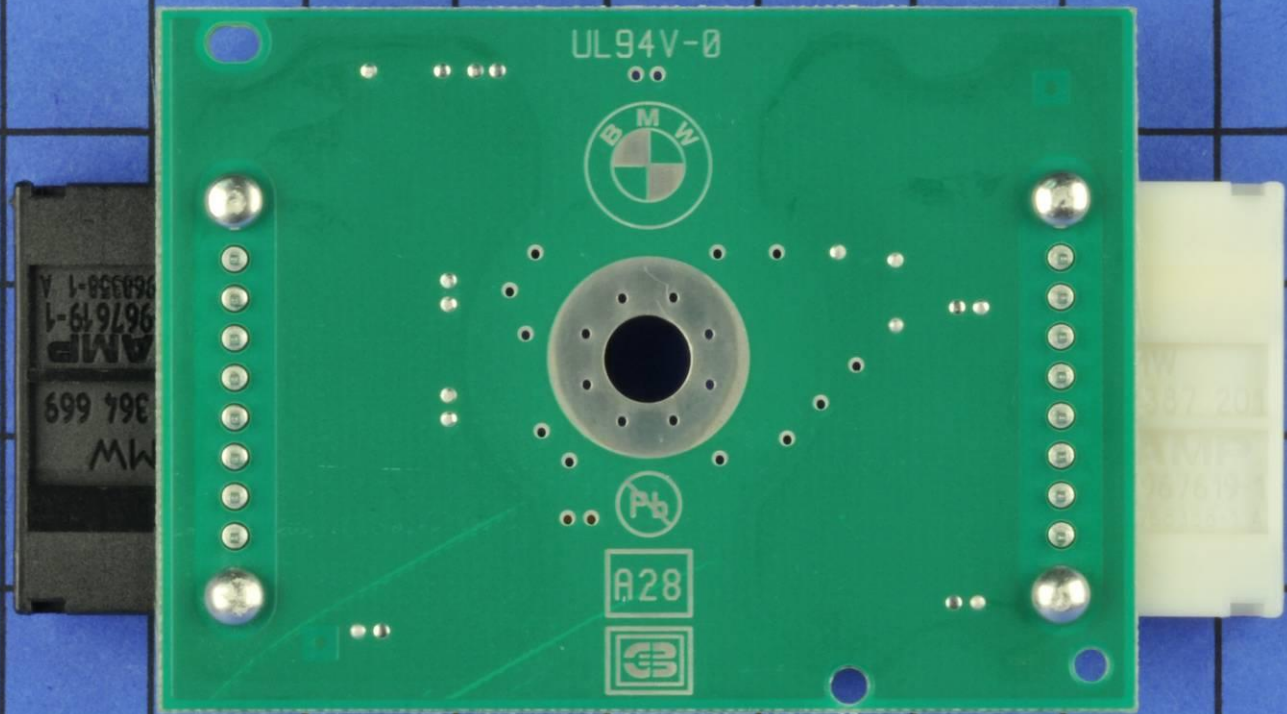
MUNRO
& ASSOCIATES, INC.



Main Board (Side 1)

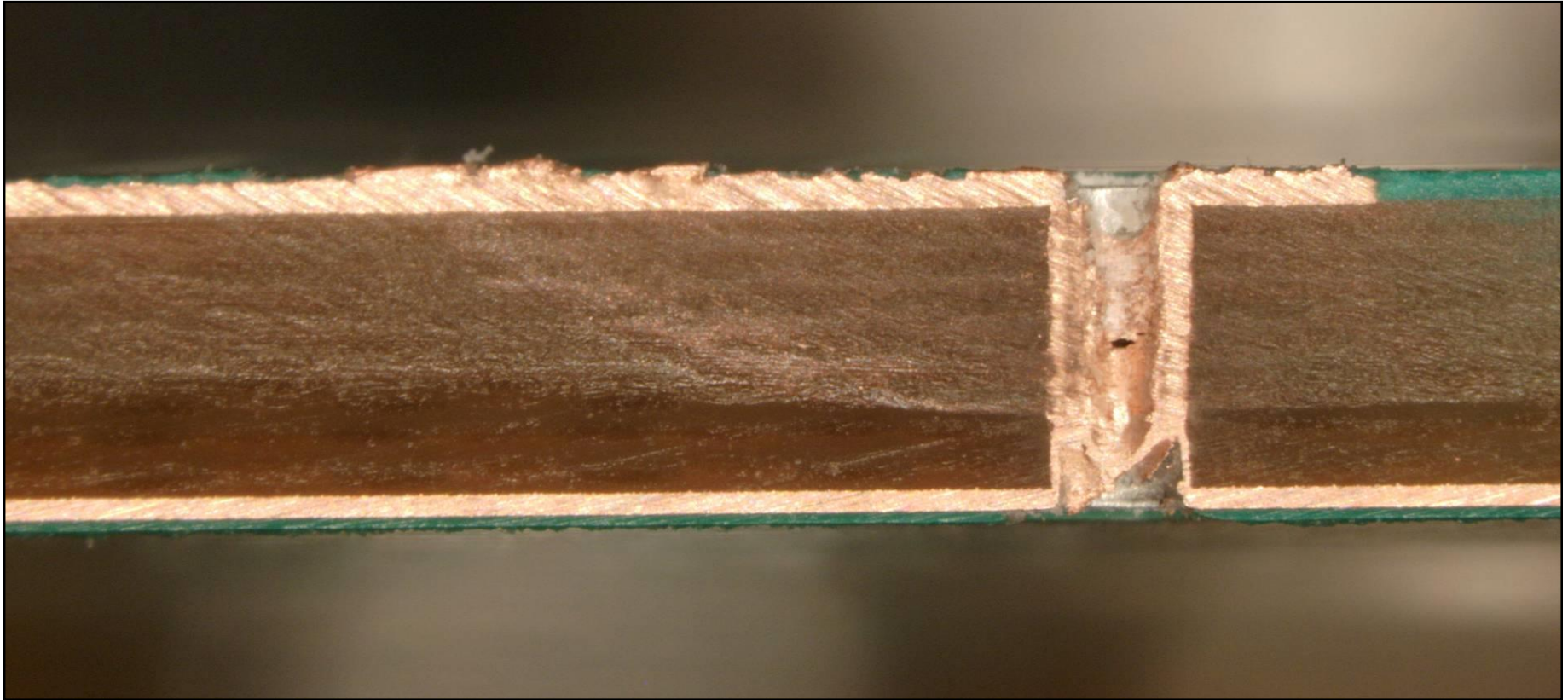


Main Board (Side 2)



Grid = 1 cm

Main Board Cross-Section



Substrate Data

Substrates

Assembly Name	Manufacturer	Core Material	Mfg. Technology	Layers	Area (cm ²)	Min. Trace Pitch (mm)	Min. Trace Width (mm)	ThruVia Land Dia (mm)	ThruVia Hole Dia (mm)	BlindVia Land Dia (mm)	BlindVia Hole Dia (mm)	Thickness (mm)	Routing Density	Estimated Costs
Main Board	Unknown	FR4	2 Layer Conventional FR4 / HF	2	28.6	1.47	0.46	0.85	0.60			1.6	6.4	\$ 0.43

Passive Discrete Components

Location	Qty	Functional Description	Package		Estimated Costs	
			Form	Pin Count	Each	Total
Main Board, Side 1	3	Coil	SMT, Large	2	\$0.280	\$0.840
	5	Coil	SMT, Small	2	\$0.050	\$0.250
	9	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.036
TOTALS	17			34		\$1.13

Connectors



Location	Qty	Form	Package			Estimated Costs	
			Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	2	Connector: Interface	8	31.20	17.53	\$1.950	\$3.900
TOTALS	2		16				\$3.90

Electronic Assembly Metrics

Electronic Assembly Metrics by Assembly											
General Area	Assembly Name	Substrate Area (sq.cm)	Metal Layers	Circuit Area (sq.cm)	Routing Density (cm of routing per sq.cm of substrate)	Number of Components	Number of Connections	Component Density (Components/sq.cm)	Connection Density (Connections/sq.cm)	Avg. Pin Count	Assembly Weight (grams)
Main Electronics	Main Board	28.6	2	57.2	6.4	19	50	0.7	1.8	2.6	16.60
	System Totals	28.6	2	57.2		19	50	0.7	1.7	2.6	16.60

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Electronics Costs by Assembly										
General Area	Assembly Name	Total	Integrated Circuits	Modular & Odd Form Components	Small Active Components	Passive Components	Connector Components	Substrates	Insertion	Card Test
Main Electronics	Main Board	\$ 5.79	\$ -	\$ -	\$ -	\$ 1.13	\$ 3.90	\$ 0.43	\$ 0.12	\$ 0.21
	System Totals	\$ 5.79	\$ -	\$ -	\$ -	\$ 1.13	\$ 3.90	\$ 0.43	\$ 0.12	\$ 0.21

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics

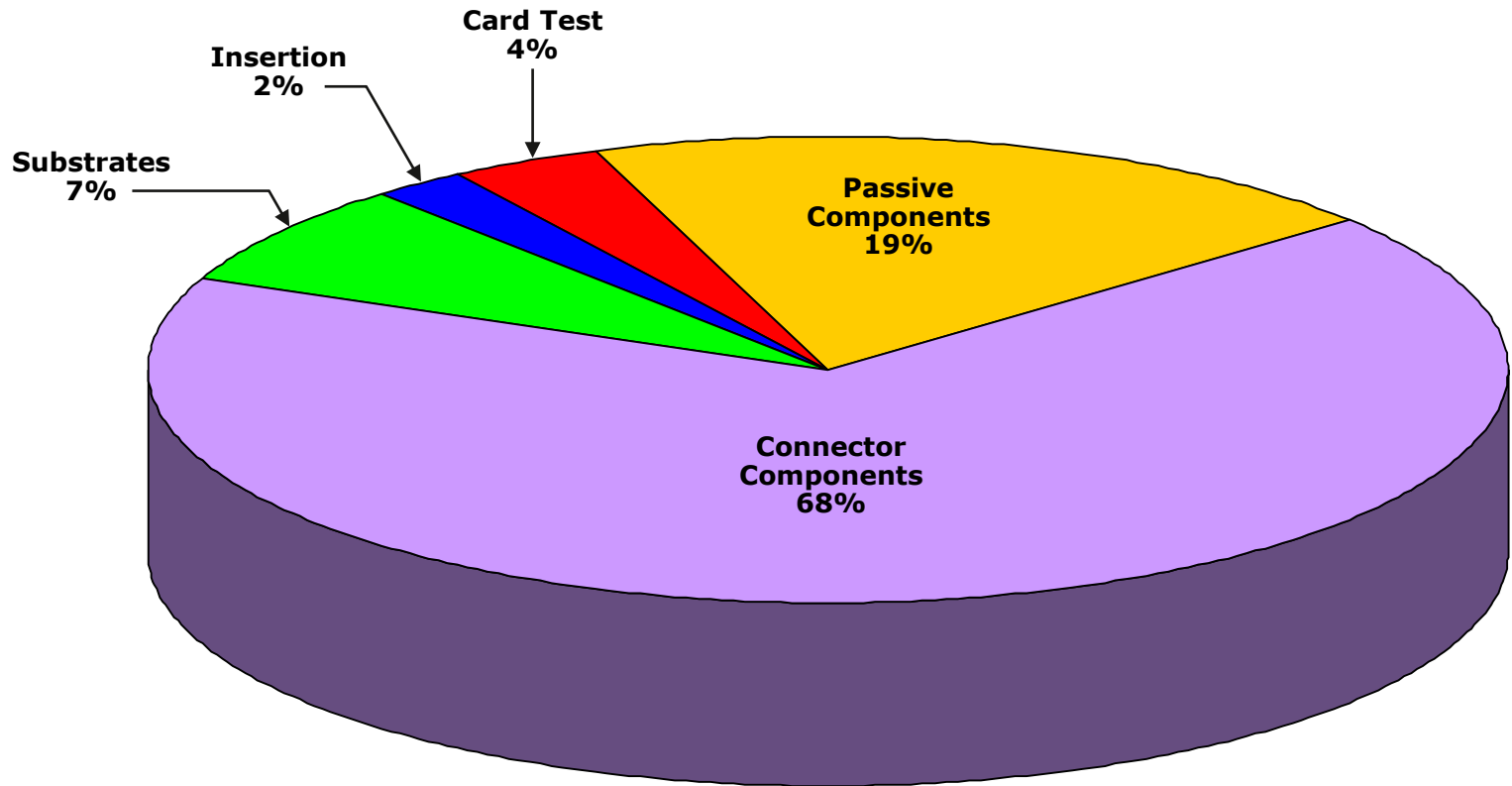
Counts by Assembly												
General Area	Assembly Name	IC Package Count	IC Connections	Modular/Odd Form Components	Modular/Odd Form Component Connections	Small Active Components	Small Active Component Connections	Passive Components	Passive Component Connections	Connectors	Connector Connections	Opportunities
Main Electronics	Main Board	0	0	0	0	0	0	17	34	2	16	69
	System Totals	0	0	0	0	0	0	17	34	2	16	69

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Costs Breakdown



**Estimated Cost
of Electronics**
(Includes Subsystem Electronics)
\$5.79



NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Non-Electronic Cost Estimate



Subsystem	Part ID No.	Qty	Description	Fabrication Process	Material	Dimensions (mm)	Weight (grams)	Est'd Cost Each	Est'd Extended Cost	
Enclosures	1	1	Housing, Top	Molded	PC	73.11 x 50.75 x 11.08	8.80	0.510	0.510	
	2	1	Housing, Bottom	Molded	PC	73.2 x 50.67 x 9.26	9.50	0.560	0.560	
	3	1	Screw	Extruded + Formed + Coated	Metal	11.9 x 11.9 x 19.8	3.50	0.050	0.050	
	4	1	Label (large)	Die-Cut + Printed	Plastic	43.89 x 19.82 x 0.06	0.05	0.060	0.060	
	5	1	Label (small)	Die-Cut + Printed	Plastic	18.14 x 5.05 x 0.06	0.03	0.050	0.050	
Miscellaneous	6	4	Screws	Extruded + Formed	Metal	3.8 x 3.8 x 7.65	0.40	0.010	0.040	
Total		9						Estimated Cost		\$1.27

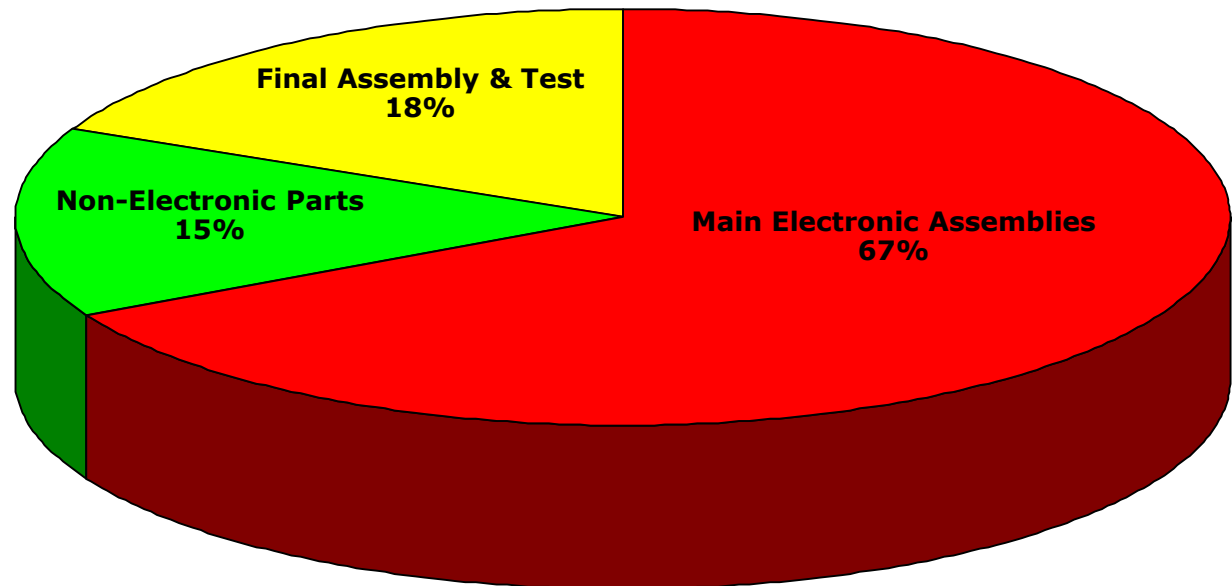
Final Ass'y Labor & Test Cost Estimate

Final Assembly & Test	
Made in	Germany
Number of parts	12
Est'd number of steps	36
Est'd time (seconds)	108
Est'd final assembly cost	\$ 1.35
Est'd final test cost	\$ 0.20

Cost Summary

Estimated Cost Totals	
Main Electronic Assemblies	\$ 5.79
Non-Electronic Parts	\$ 1.27
Final Assembly & Test	\$ 1.55
Total	\$ 8.61

Cost Total Notes:
Estimated final assembly cost includes labor only.
Total cost does not include Non-recurring, R&D, G&A, IP licensing fees/royalties, software, sales & marketing, distribution.
Assumes fully scaled production.



Cost Estimation Process

(Overview & Discussion)



Cost modeling is tricky business. Multiple variables affect the actual production costs a manufacturer will experience, including development expenses, unit volumes, supply-and-demand in component markets, die yield-curve maturity, OEM purchasing power, and even variations in accounting practices. Different cost modeling methods employ different assumptions about how to handle these and other variables, but we can identify two basic approaches: that which seeks to track short-term variations in the inputs to the production process, and that which strives to maintain comparability of the output of the model across product families and over time.

TechInsights' philosophy in cost modeling is to emphasize consistency across products and comparability over time, rather than to track short-term fluctuations. During the past eight years, we have developed an estimation process that, while necessarily lacking an insider's knowledge of the cost factors that impact any one manufacturer, is reasonably accurate in its prediction of unit costs in high-volume production environments. We do not claim that the model will produce the "right" answer for your firm's environment. However, TechInsights does give customers a key analytical tool with a complete set of data in our Bill of Materials (BOM). The BOM allows readers to 1) scrutinize the assumptions behind our cost model and 2) modify the results based on substitution of their own component cost estimates where they have better information based on inside knowledge.

Our estimation process decomposes overall system cost into three major categories: Electronics, Mechanical, and Final Assembly. We begin by creating a complete electronics bill-of-materials (BOM). Each component from the largest ASIC to the smallest discrete resistor is entered into a BOM table with identifying attributes such as size, pitch, I/O count, package type, manufacturer, part number, estimated placement cost, and die size (if the component is an IC). Integrated circuit costs are calculated from measured die area. Using assumptions for wafer size, process type, number of die per wafer, defect density, and profit margin in combination with die area, an estimate of semiconductor cost is derived. Costs for discrete components and interconnect are derived from assumption tables which relate BOM line items to specific cost estimates by component type and estimates for part placement costs are included. For LCD display costs, we employ a model which tabulates expected cost from measurements of glass area, LCD type, and total pixel resolution. When market costs are available from alternative sources, LCD panel costs are taken from and referenced to these sources.

Costs of non-electronic components such as molded plastic enclosures and metallic components are measured in terms of weight, size, thickness, type of material, and complexity to arrive at their estimated cost. Other system items such as optics, antennae, batteries and displays are costed from a set of assumption tables derived from a combination of industry data, average high volume costs, and external sources. For final assembly, we re-build the torn-down product, tabulating stepwise assembly times as the reconstruction proceeds, to reach a total assembly time. Using a labor rate assumption for the country of origin, we then calculate final assembly cost.

The three major categories for system cost contributors can be broken down into the subcategories of ICs, other electronics parts, displays, batteries (as appropriate), camera modules, electronics assembly, non-electronic elements, and final assembly. By adding the cost estimates for each of these subcategories, an overall estimated cost is derived for the system under evaluation. Product packaging and accessories (CDs, cables, etc.) are also documented and estimated for their contribution to total cost as appropriate.

We believe our cost estimates generally fall within 15 percent of the "right answer," which itself can vary depending on the market and OEM-specific factors mentioned earlier. While the TechInsights cost model is imperfect, it yields important insights into technology and business dynamics along with good first-order contributions to system cost by component type. Additionally, the consistency of approach and gradual modification to assumptions (smoothing out frequently-shifting pricing factors) hopefully yields a credible, but user-modifiable, view of OEM high volume cost-to-produce.

Please feel free to contact us at support@techinsights.com with any comments, questions, or proposed corrections with respect to our cost estimates. We welcome your input.

Metrics (Overview & Discussion)



In our product teardowns, we gather a series of metrics for product profiling and comparison. Some metrics focus on system characteristics such as total silicon area, total system semiconductor storage capacity, and total connection count. Other metrics reflect more subtle aspects of electronics assembly such as connection density, average component I/O count, and silicon tiling density. Taken as a whole, the metrics allow deeper comparison and benchmarking across multiple disciplines and multiple products. Key metrics we gather on products are described below along with their definitions and what they tend to say about the system under study. Most metrics can be used both in comparing similar products for benchmarking purposes or for quantifying differences in levels of complexity between dissimilar product types. Data fall into two categories; either “raw” measured data or ratios of these measured data sets.

Total Silicon Area : This metric describes the total area of silicon as measured from X-ray or direct measurement of ICs. The area is an expression of the enclosed bare die area and excludes packaging area. The aggregate silicon area is a good benchmark to show how integrated a design might be when making comparisons to similar systems. Total silicon area also reflects the major cost driver for most systems we examine.

Silicon Tiling Density : Ratio of Total Silicon Area to total printed circuit board “projected” area (i.e. the simple board area and not the cumulative surface area of both sides of the board). This metric directly reflects the level of efficiency and aggressiveness in integrated circuit packing and placement. Single digit Silicon Tiling Density is typical but silicon coverage of 10% - 20% has been seen in some of the most advanced products we have examined. Higher Tiling Densities often correspond with the use of chip scale packaging (CSPs) or other small form-factor IC packaging technologies. High density circuit boards are also often a supporting technology.

Number of Parts : Total component count including ICs, passives, modules, connectors, etc., each separated out in our reporting.

Number of Connections : The total number of connections corresponds to the total number of interconnects introduced by the aggregate component set and reflects any electrical connection observed (solder joints, adhesive interconnect, or connector terminal interfaces).

Opportunity Count : Opportunity Count is the total number of parts plus the total number of connections; the name reflects that each of these constituent elements represents an opportunity for failure. A high opportunity count means more complex and riskier electronics assembly.

Average Pin Count (APC) : Ratio of total number of component terminals to total number of parts, at the system level. This metric reflects the ‘average’ terminal complexity of the components and often provide a signature of integration level and/or “digital-ness” of the overall product. Low APCs reflect a high number of discrettes or other low-pincount devices often characteristic of analog circuitry. Conversely, high APCs are characteristic of highly integrated, high-pincount assemblies, often those composed largely of digital integrated circuits.

Connection Density : This metric is a ratio of the total Number of Connections to total printed circuit board assembly area, in units of connections per sq. inch. The metric provides data related to the Silicon Tiling Density above, but with an emphasis on complexity of I/O interconnect. For example, with a fixed Connection Density, high tiling density of low-pincount memory chips is more readily achieved than comparable silicon tiling of high pincount logic.

Part Density : This metric is a ratio of the total Number of Parts to total printed circuit board assembly area, in units of components per sq. inch. The metric provides data related to the Silicon Tiling Density and Connection Density as described above, but with an emphasis on density and complexity of component packing efficiency. For example, low Part Density of high-pincount devices can pose an equal challenge in Connection Density to high Part Density of low-pincount devices. High Part Density does reflect challenges in surface mount assembly in terms of (typically) precision of placement, number of placements, and engineering of part clearances.

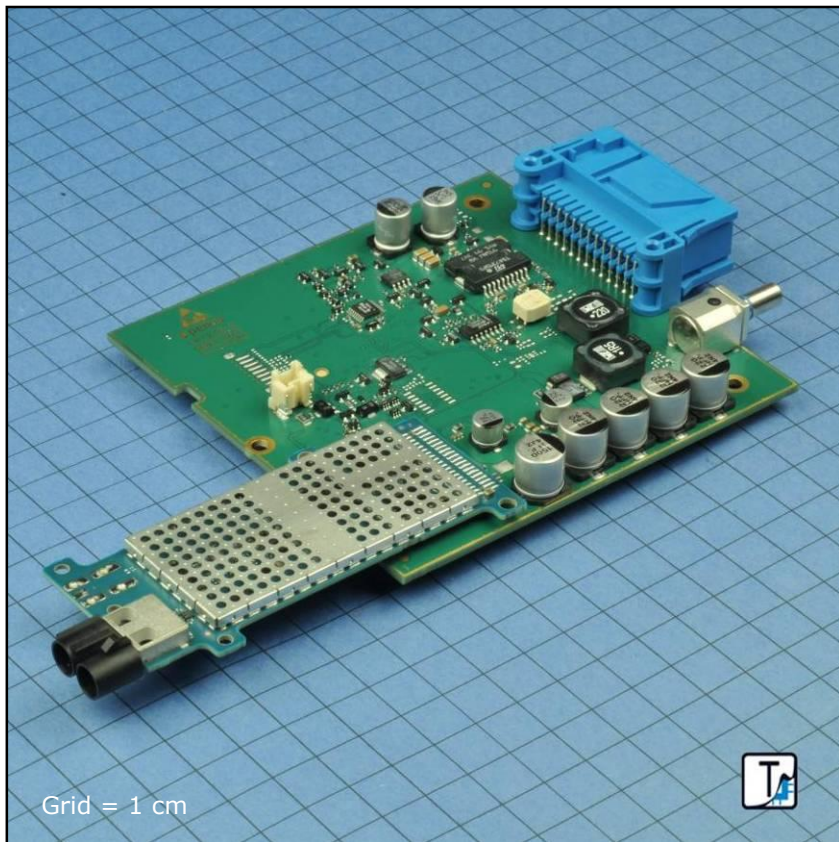
Routing Density (heuristic estimate) = $3 * (\text{Average Pin Count}) * \sqrt{\text{Part Density}}$. The Routing Density metric is an empirically derived relationship that characterizes the wiring density of the interconnect used to support the interconnection of components in a planar electronic assembly (i.e. the circuit board). Architectural issues such as bussing or other factors affecting the regularity of wiring impact the actual Routing Density needed to support a given application, but the metric provides a ready measure of wiring complexity.

***Click Here to Return to
Cost Analysis Page 145***

Deep Dive Report

BMW i3 Telematics Communication Boards

Quad-Band GSM/EDGE; W-CDMA/HSPA (850/1900 MHz)
Report #15900-141103-RBd



Product Description

The Telematics Communication Boards for the BMW i3 are comprised of two distinct printed circuit board (PCB) assemblies: the Main Board and the Radio Board. The Main Board, which uses a Freescale MC9S12XEQ384VAL 16-bit microcontroller, acts as a bus communication/audio/logic hub. The Radio Board handles quad-band GSM and W-CDMA Band II & Band V communication protocols via a Qualcomm MDM6200 baseband processor and Samsung K521G12ACI multichip memory device containing 128 MB SLC flash and 64 MB DDR SDRAM memory. Radio frequency (RF) output power is provided by three Avago power amplifier modules: ACPM-5002, ACPM-5005, and ACPM-7868; while Sony provides two antenna switches: CXM3553 (SP12T) and CXG1189 (SPDT).

DISCLAIMER: All company names, product names, and service names mentioned are used for identification purposes only and may be registered trademarks, trademarks, or service marks of their respective owners. All analyses are done without participation, authorization, or endorsement of the manufacturer. Any cost analyses presented in this material are estimates prepared by TechInsights from generally available data. While TechInsights believes that these estimates reflect the probable costs, the actual producer did not supply the data, and therefore the actual costs may be different from these estimates. Furthermore, TechInsights extends no warranties with respect to any information in this document, and shall bear no liability whatsoever for the use of the information.

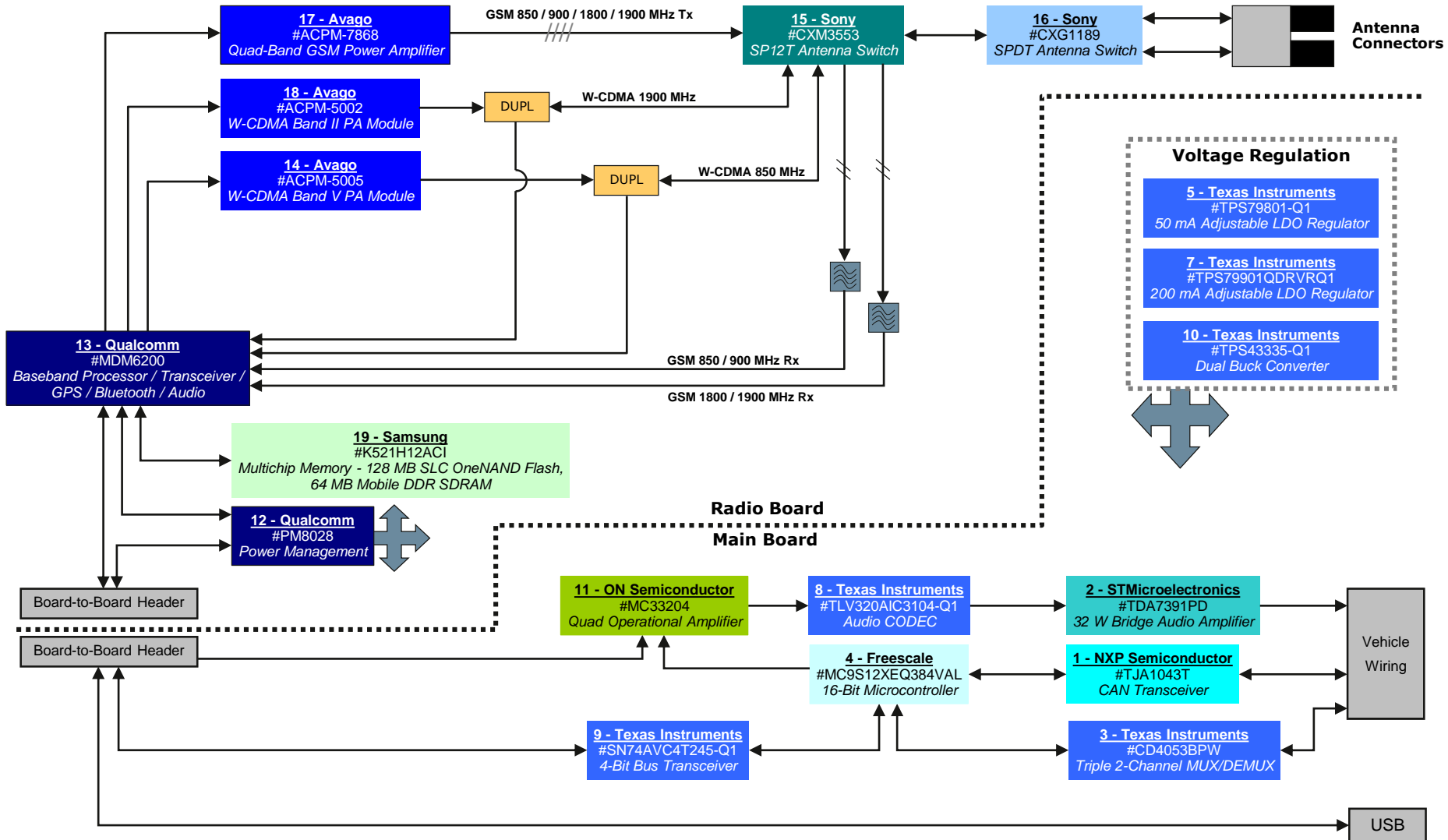
Copyright © 2015, TechInsights. All rights reserved. Do not reproduce, distribute, disseminate, photocopy, fax, transmit, download to a shared database, or otherwise copy, transfer, sell, publish, or send this material, or any portion thereof, by any means without the express written permission of TechInsights.

Product Overview



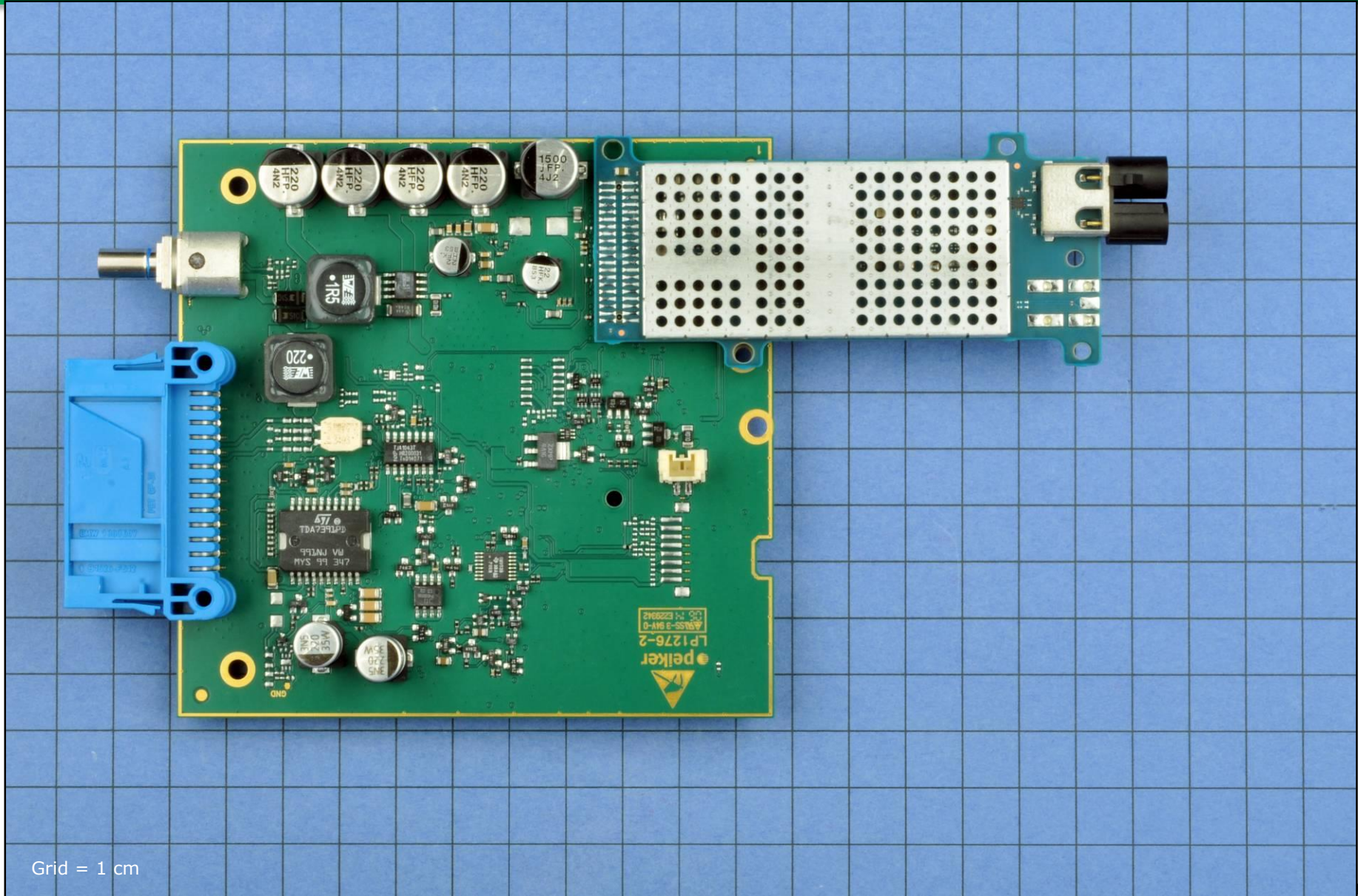
Product Description		Integrated Circuit Metrics		
Product Type	Automotive	IC Die Count	28	
Brand	BMW	IC Package Count	20	
Product Name & Model #	i3 Telematics PCB Assembly	Cost Metrics		
Official Release Date	Unknown	Retail Price		
Weight (grams)	113.6 (Measured)	Total Manufacturing Cost	\$64.31	
Product Dimensions (mm)	190 x 102.1 x 21.7 (Measured at Longest/Widest/Thickest Points)	Electronics Cost	\$63.79	
Product Features		Manufacturing Cost Breakdown		
Communications	Quad-Band GSM W-CDMA/HSPA (850/1900 MHz)	Integrated Circuits	\$40.17	62.5%
Processor	Qualcomm MDM6200 Baseband Freescale MC9S12XEQ384VAL 16-Bit Microcontroller	Modules, Discretes & Connectors	\$11.98	18.6%
Storage	128 MB SLC OneNAND Flash 64 MB Mobile DDR SDRAM	Substrates	\$4.84	7.5%
Connectivity	None	Component Insertion	\$4.73	7.4%
		Card Test	\$2.07	3.2%
		Final Assembly & Test	\$0.52	0.8%
		Total	\$64.31	100.0%

Block Diagram



Estimated block diagram based on observation of this specific product implementation, manufacturer's data sheets where available, and best engineering judgment. Certain details of the interface circuitry are not reflected in this block diagram. Partitioning and connectivity are speculative.

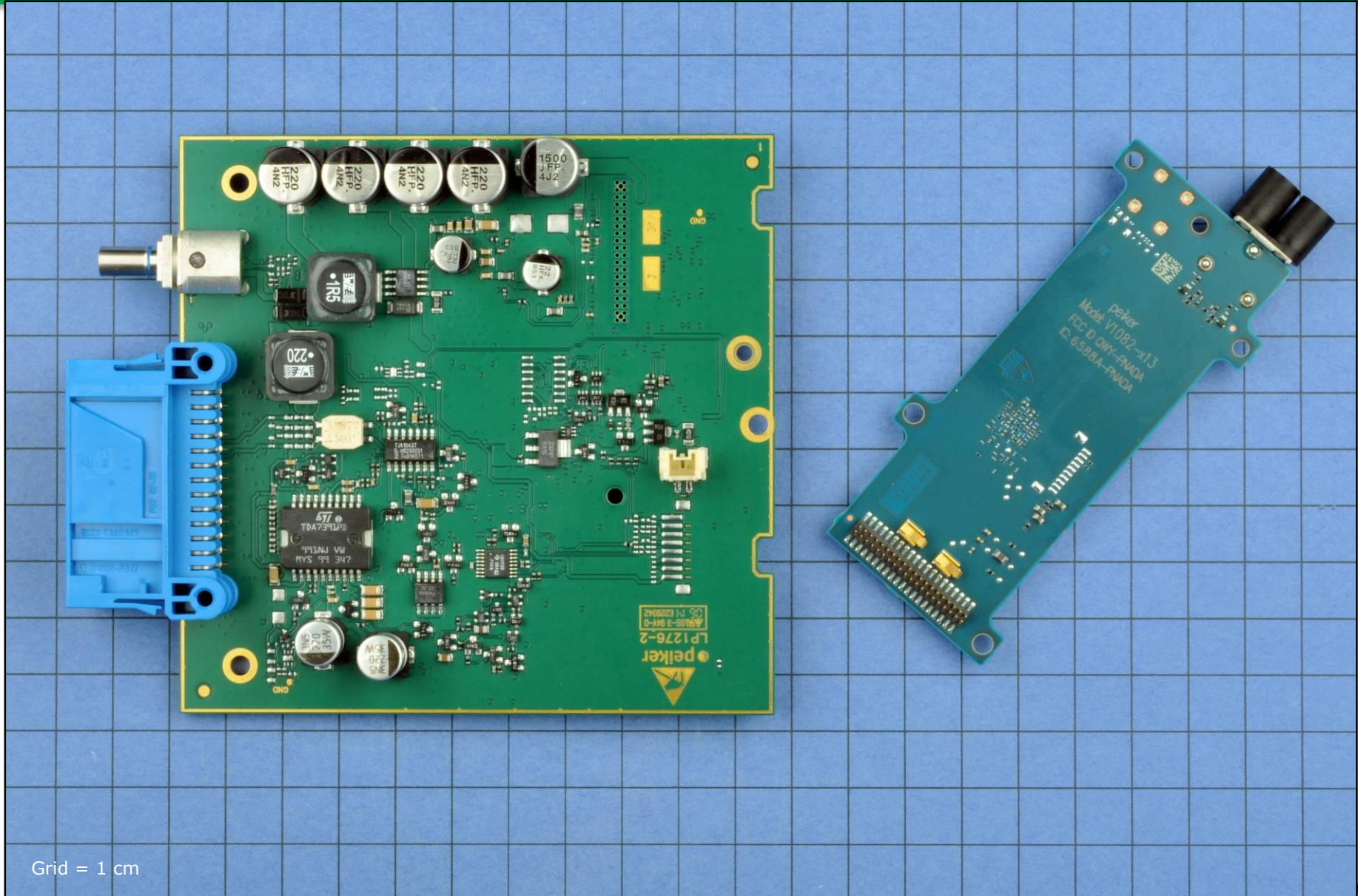
Teardown Sequence



Grid = 1 cm

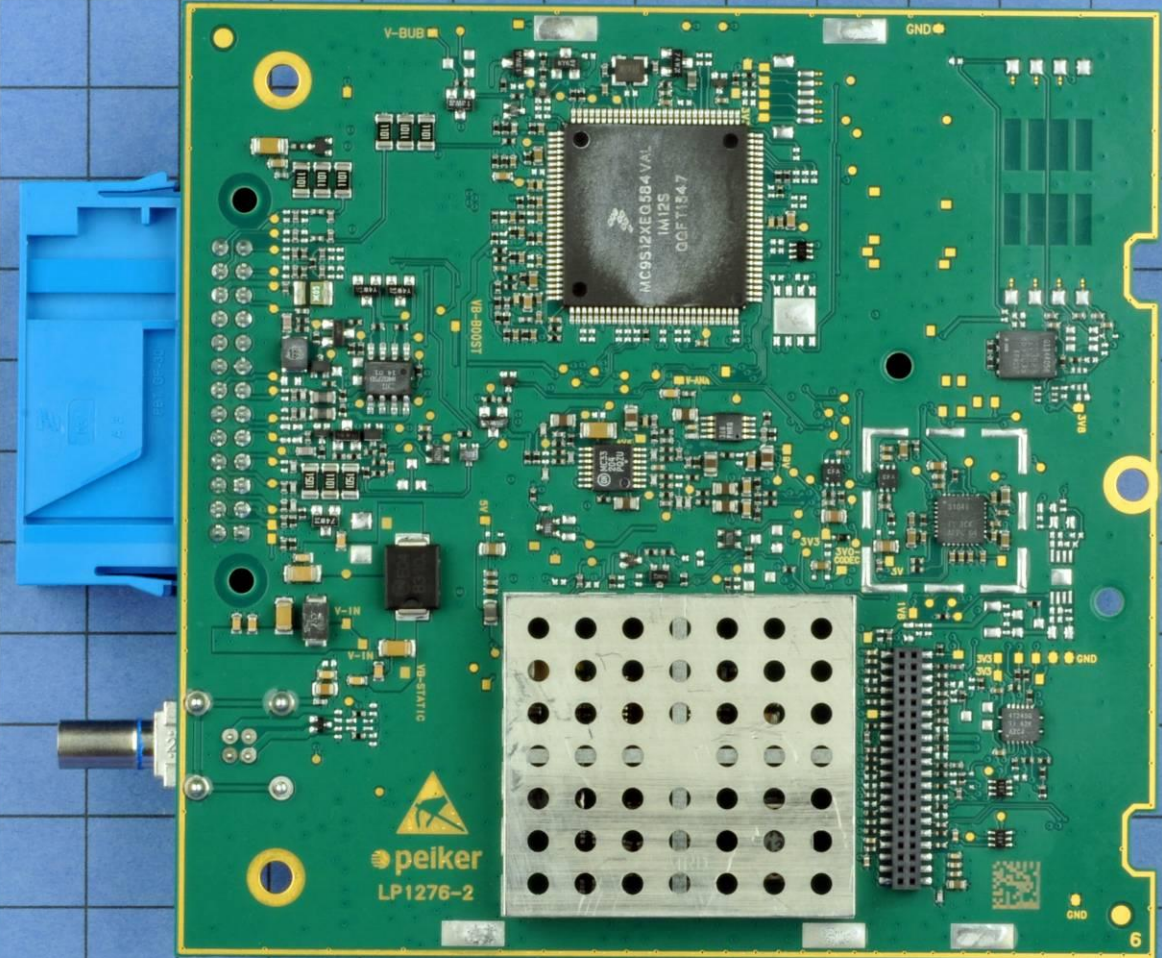
m.

Teardown Sequence



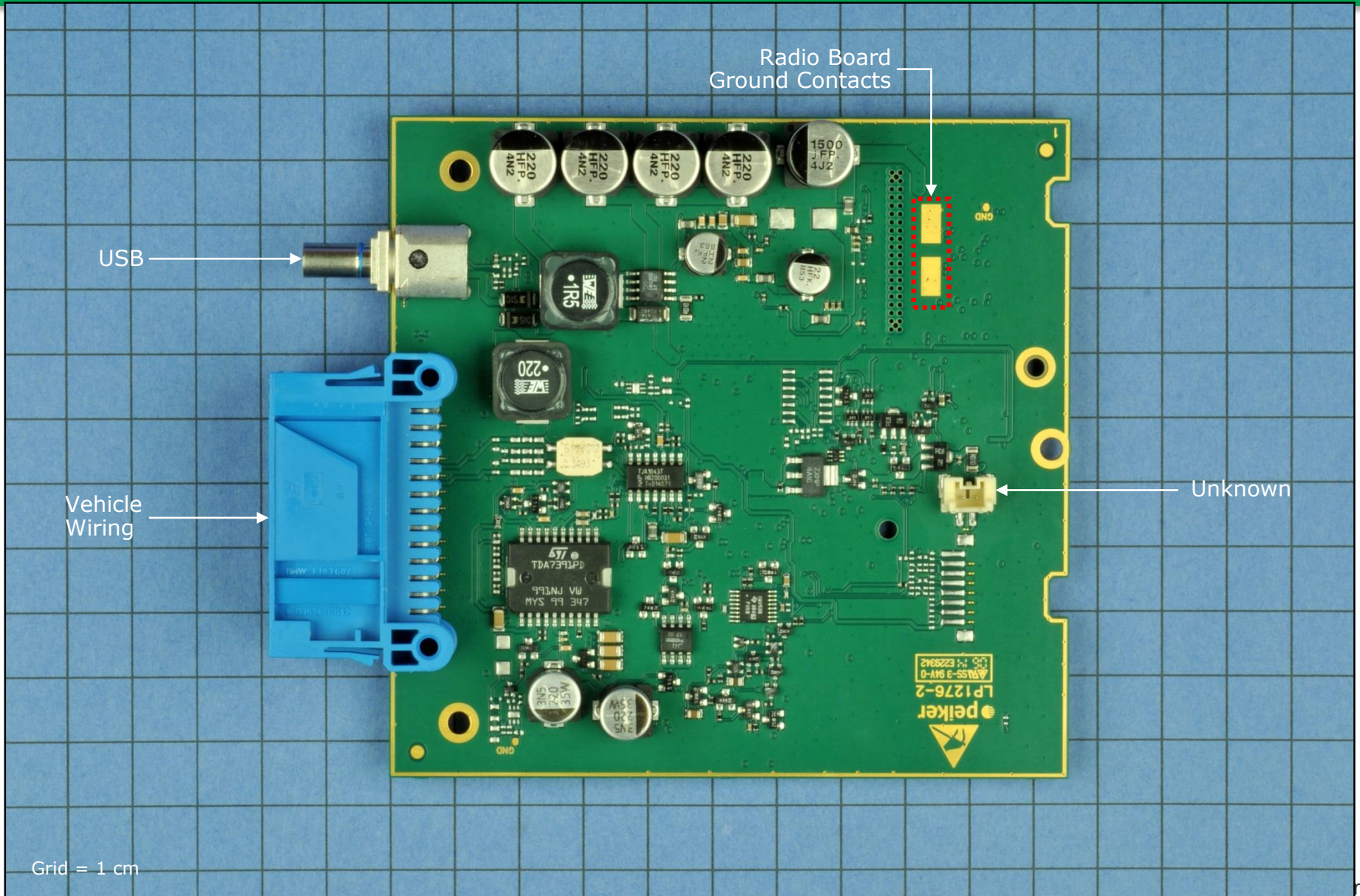
Grid = 1 cm

Teardown Sequence

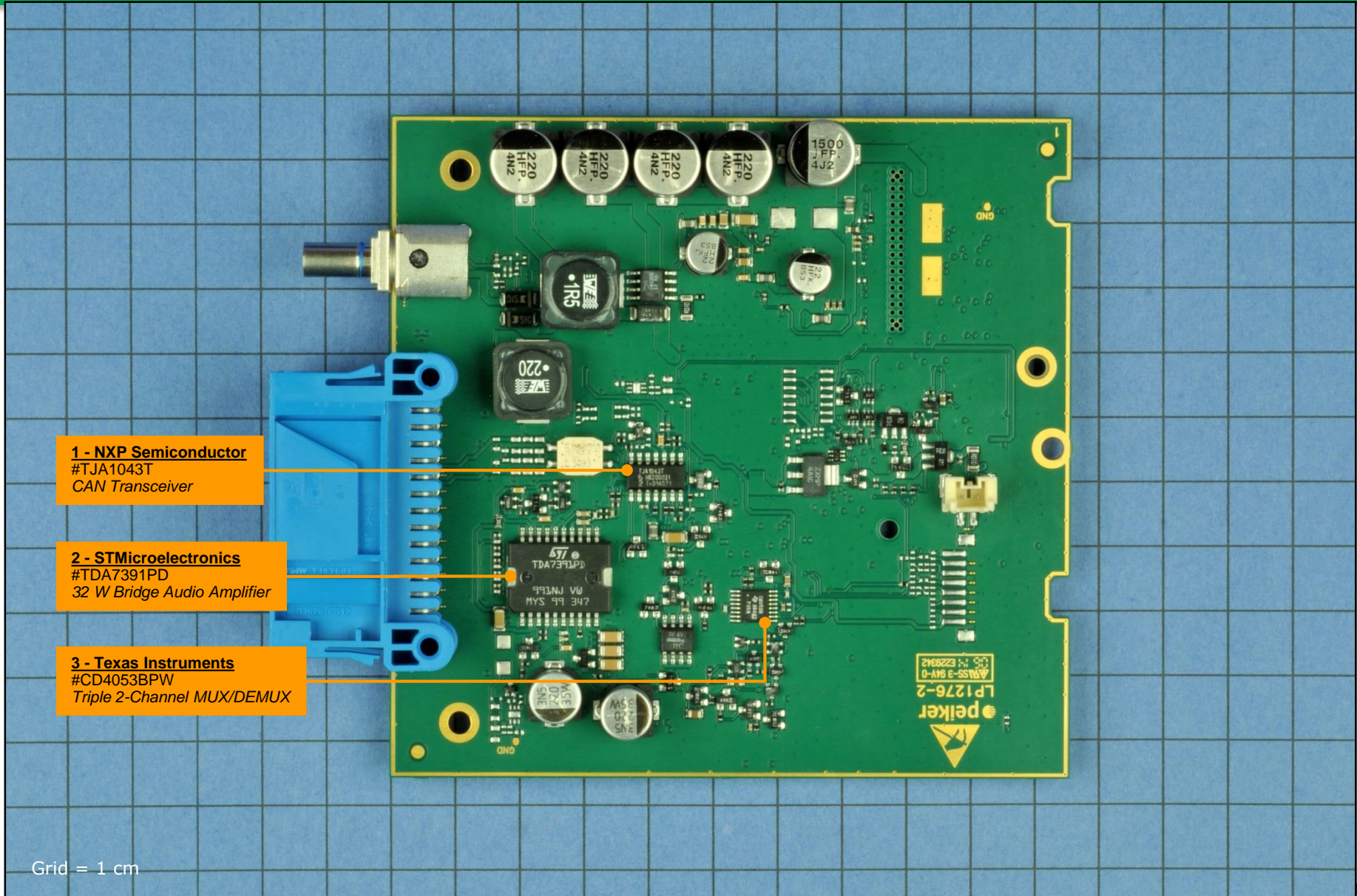


Grid = 1 cm

Main Board (Side 1)



Main Board (Side 1 IC Identification)



1 - NXP Semiconductor
#TJA1043T
CAN Transceiver

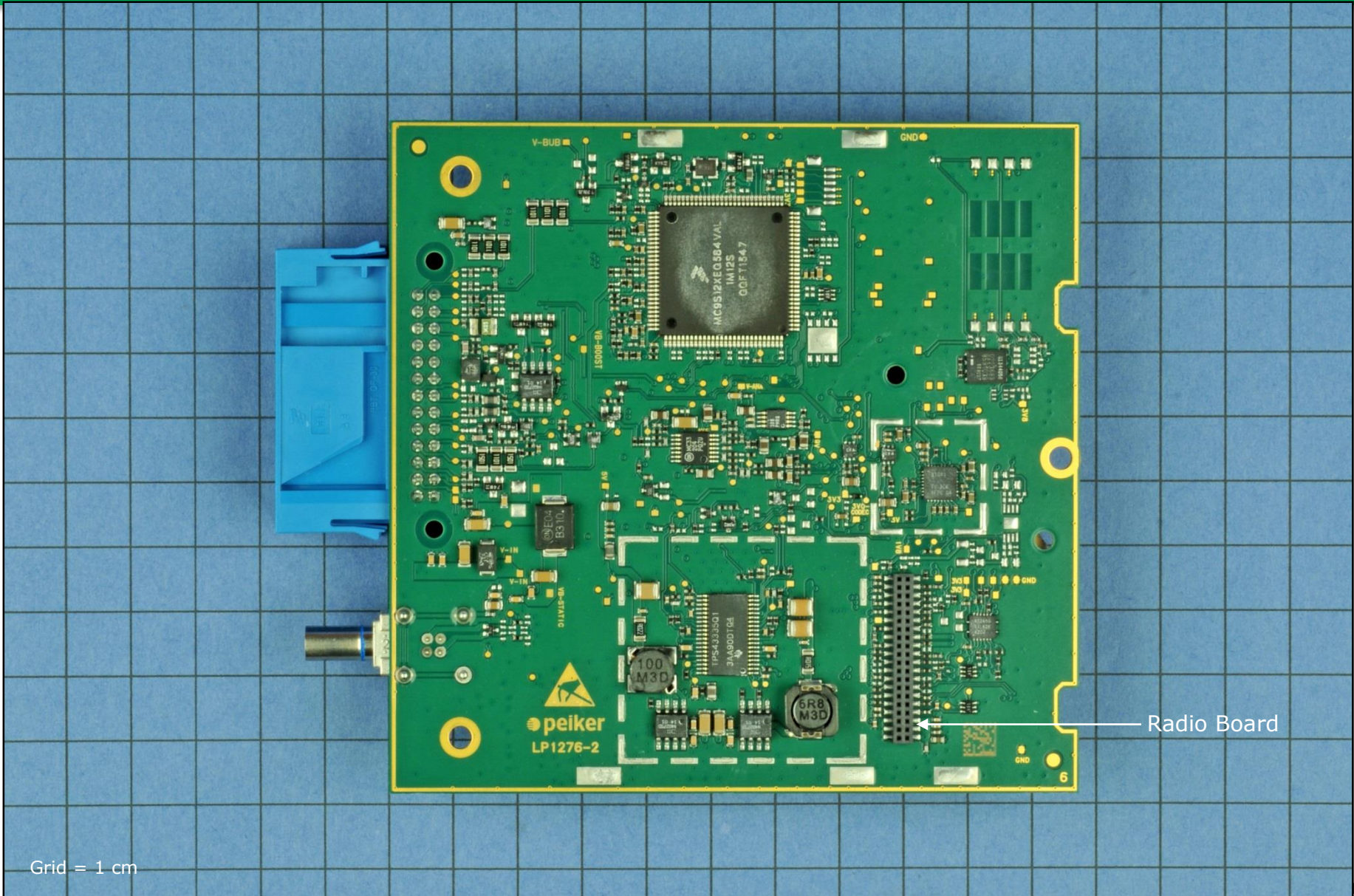
2 - STMicroelectronics
#TDA7391PD
32 W Bridge Audio Amplifier

3 - Texas Instruments
#CD4053BPW
Triple 2-Channel MUX/DEMUX

Grid = 1 cm

m.

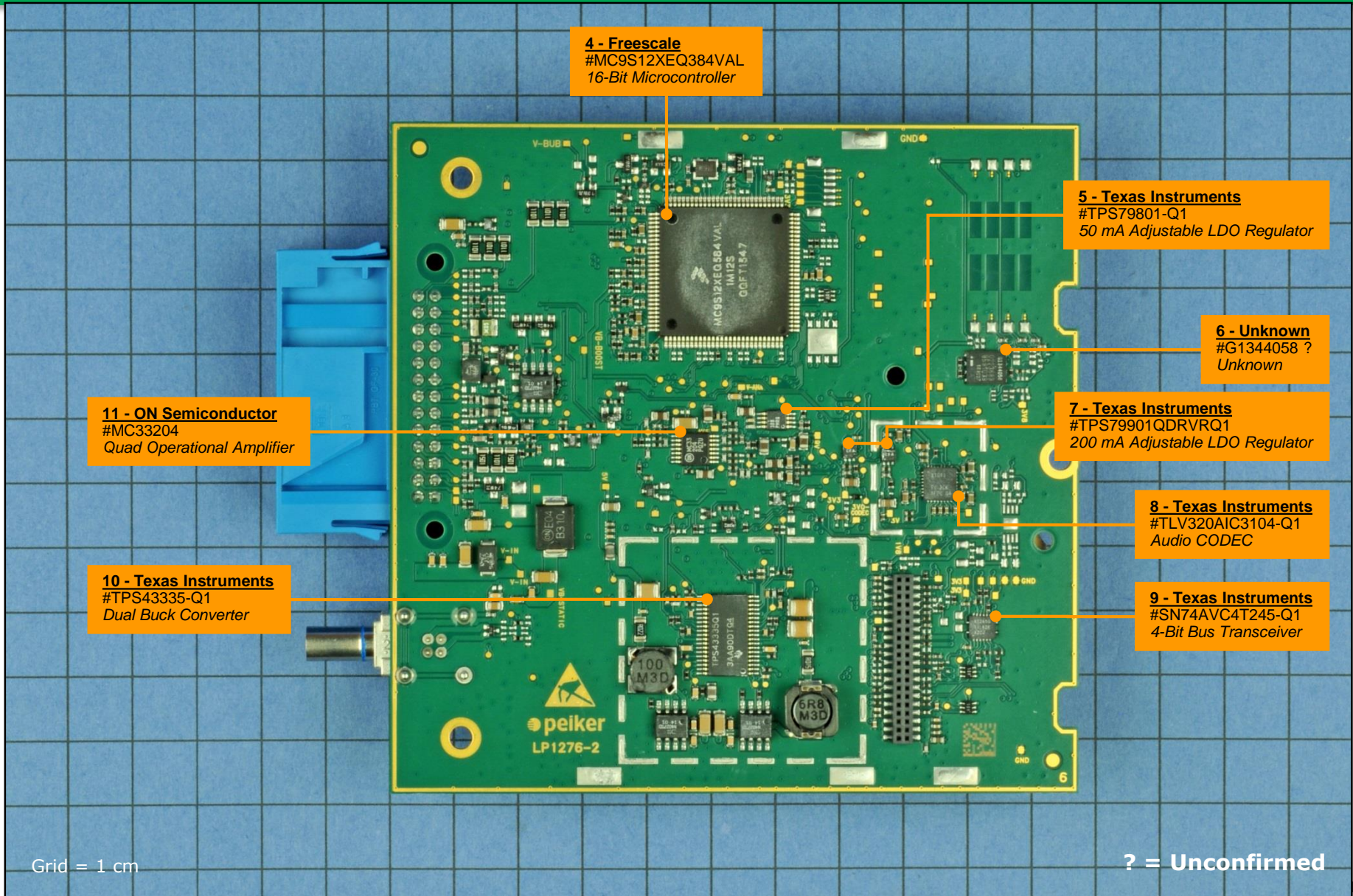
Main Board (Side 2)



Grid = 1 cm

m.

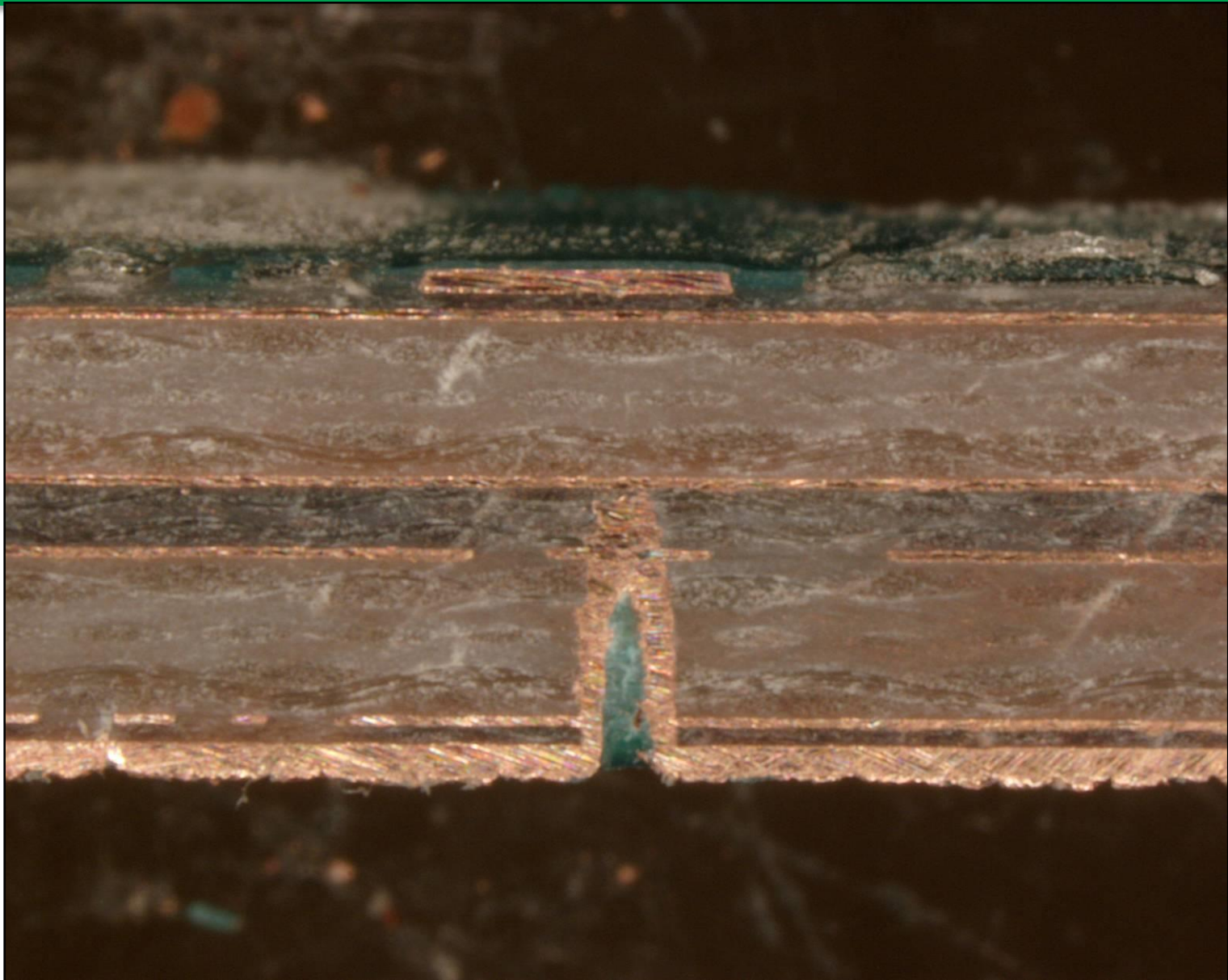
Main Board (Side 2 IC Identification)



Main Board Cross-Section



MUNRO
& ASSOCIATES, INC.



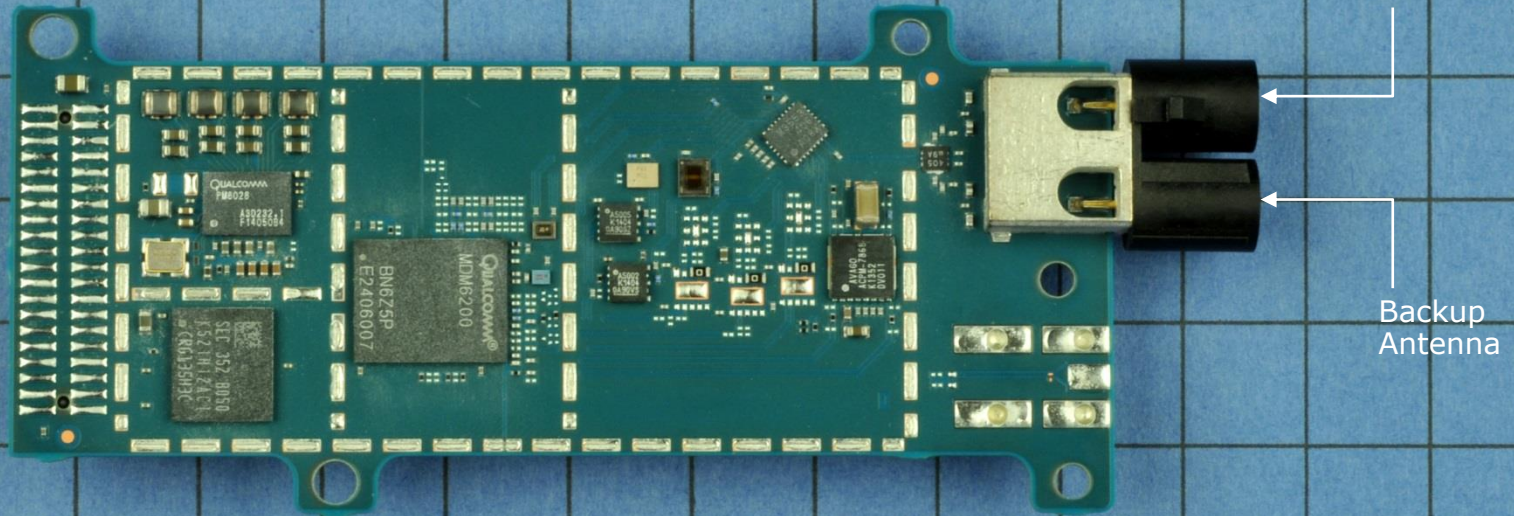
ematics Comm.

Boards 5623 #15900-141103-
RBd - Page 712

Radio Board (Side 1)



MUNRO
& ASSOCIATES, INC.



Main Antenna

Backup Antenna

Grid = 1 cm

m.

Radio Board (Side 1 IC Identification)



13 - Qualcomm
#MDM6200
Baseband Processor / Transceiver /
GPS / Bluetooth / Audio (2-Die Pkg.)

14 - Avago
#ACPM-5005
W-CDMA Band V Power Amplifier Module
(2-Die Pkg.)

12 - Qualcomm
#PM8028
Power Management

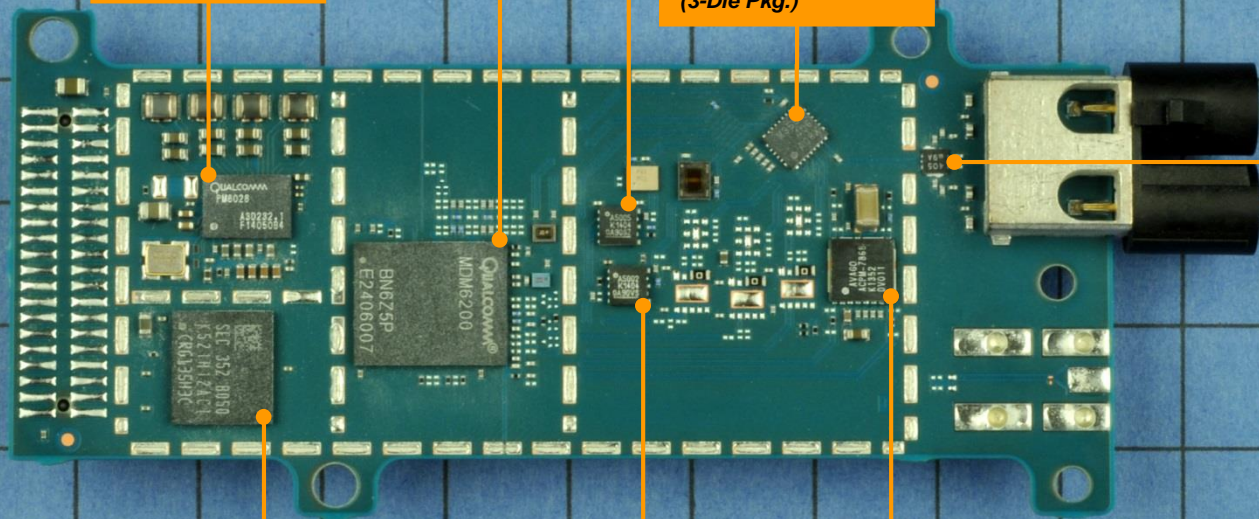
15 - Sony
#CXM3553
SP12T Antenna Switch
(3-Die Pkg.)

16 - Sony
#CXG1189
SPDT Antenna Switch

19 - Samsung
#K521H12ACI
Multichip Memory - 128 MB SLC OneNAND Flash,
64 MB Mobile DDR SDRAM (2-Die Pkg.)

17 - Avago
#ACPM-7868
Quad-Band GSM Power Amplifier
(3-Die Pkg.)

18 - Avago
#ACPM-5002
W-CDMA Band II Power Amplifier Module
(2-Die Pkg.)



Grid = 1 cm

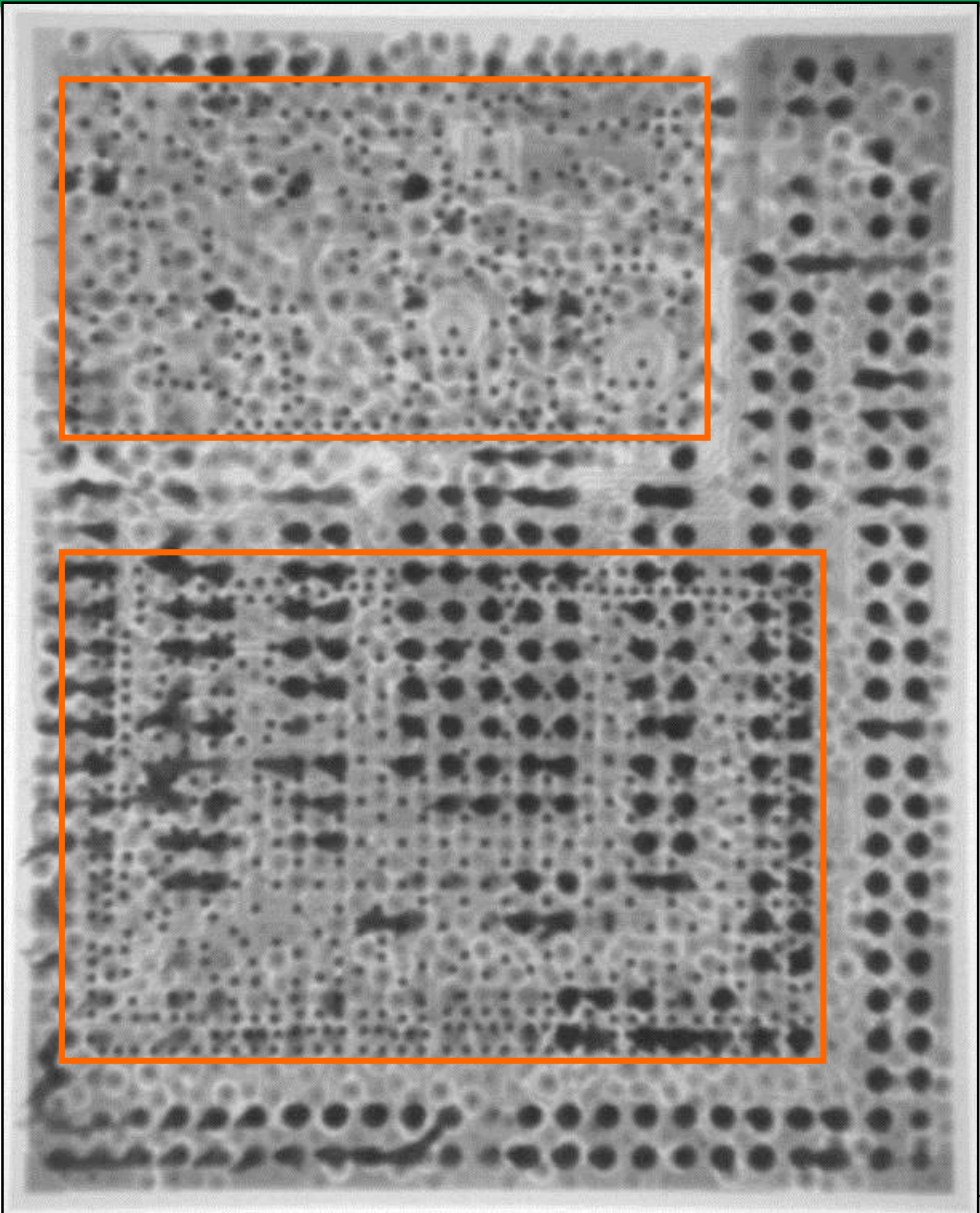
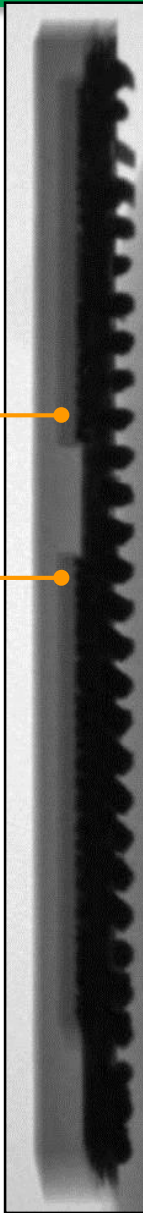
Radio Board (Side 1 X-Rays)



13 - Qualcomm
#MDM6200
Baseband Processor / Transceiver / GPS / Bluetooth / Audio
(2-Die Pkg.)
Pkg Size: 12.2 x 9.8 mm

13.2 - Qualcomm
#HG11-VF535-220
RF Transceiver
Die Size: 6.6 x 4.0 mm

13.1 - Qualcomm
#HG11-VP230
Baseband Processor
Die Size: 7.6 x 5.2 mm



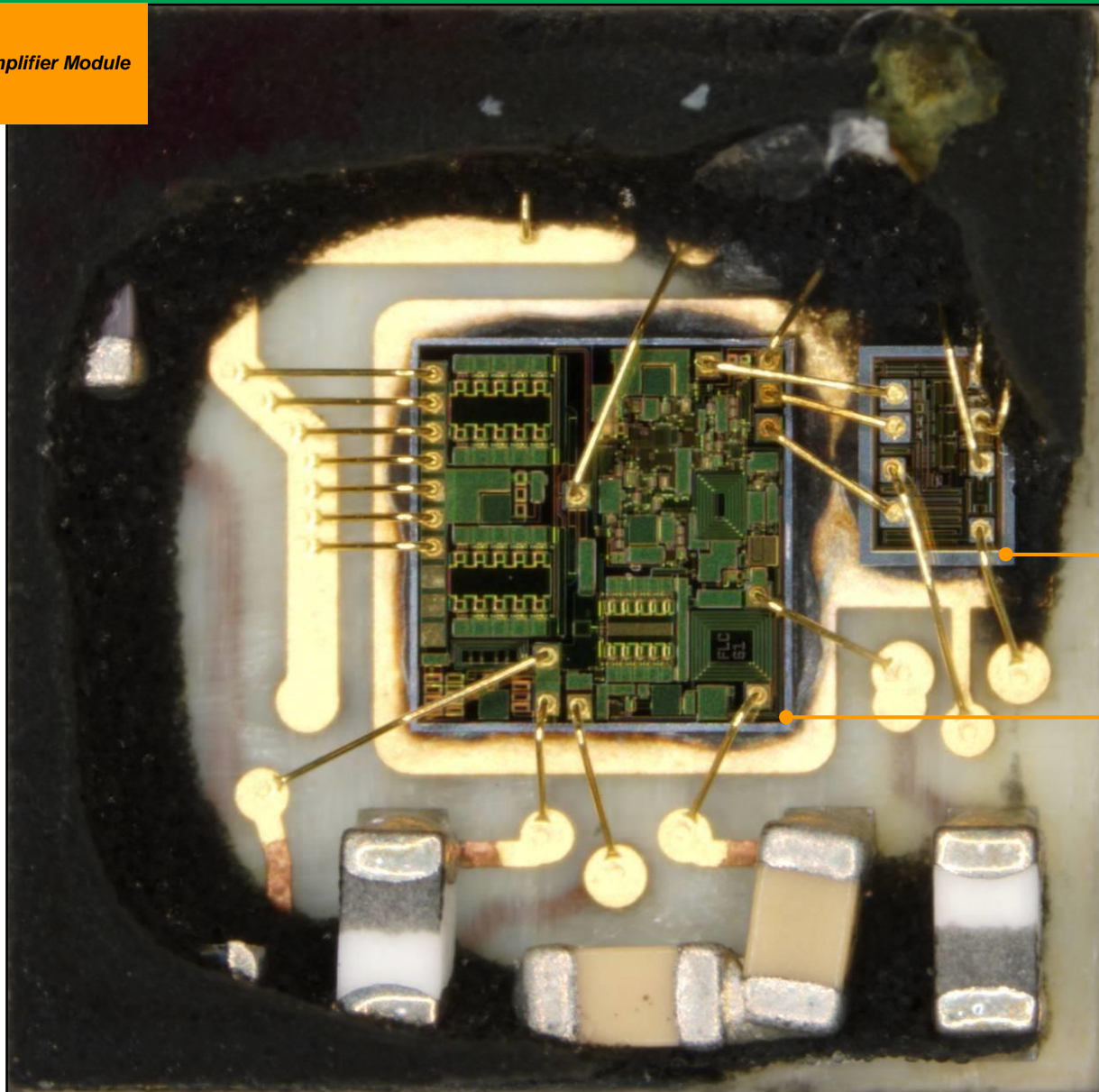
m.

Radio Board (Side 1 Die Photos)



MUNRO
& ASSOCIATES, INC.

14 - Avago
#ACPM-5005
W-CDMA Band V Power Amplifier Module
(2-Die Pkg.)
Pkg Size: 3.0 x 3.0 mm



14.2 - Avago
#LJ5
Bias Control
Die Size: 0.6 x 0.4 mm

14.1 - Avago
#FLC 61
RF Power Amplifier
Die Size: 1.1 x 1.1 mm

BMW i3 Telematics Comm.

Boards 5623 #15900-141103-

RBd - Page 716

Radio Board (Side 1 Die Photos)

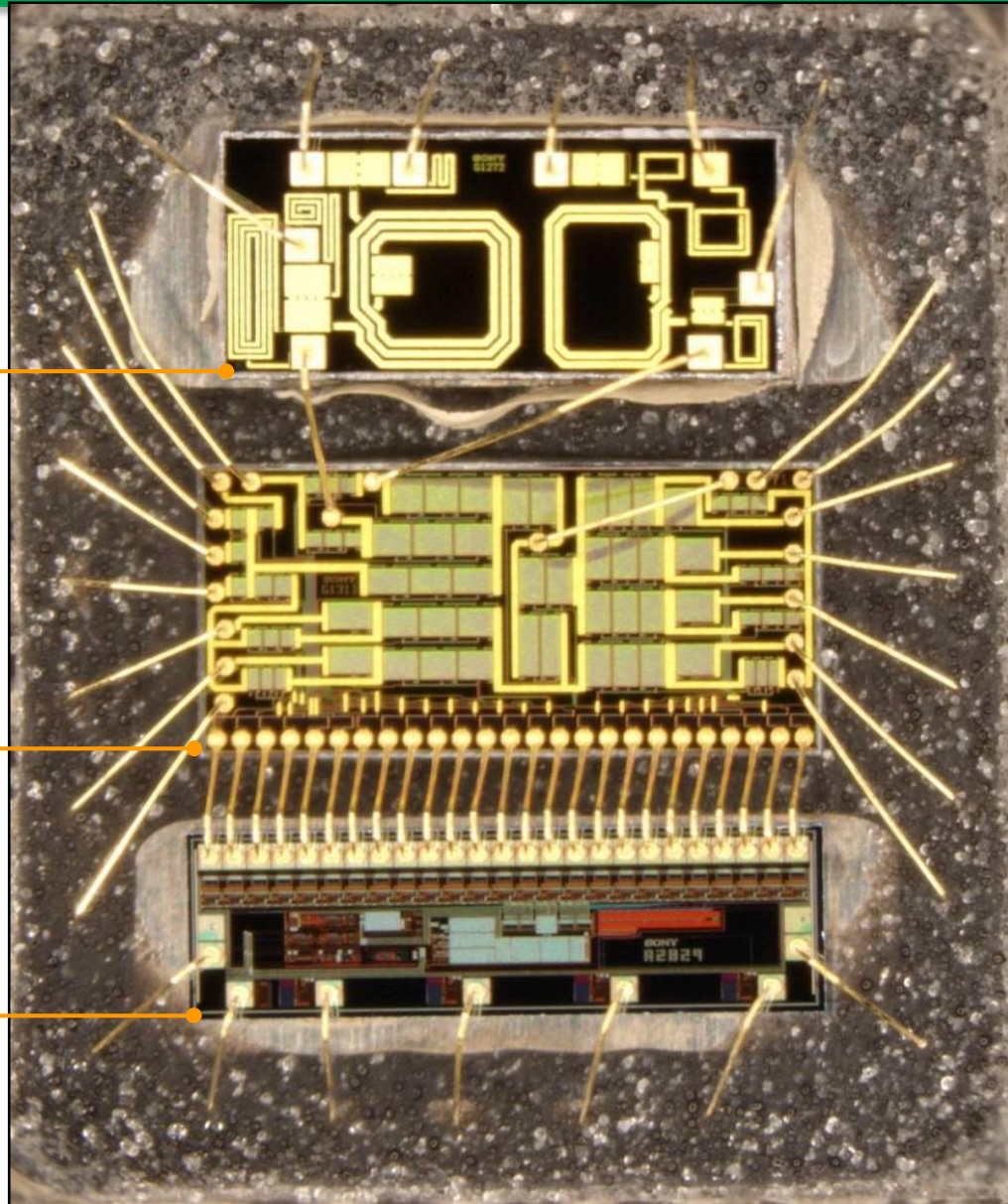


15 - Sony
#CXM3553
SP12T Antenna Switch (3-Die Pkg.)
Pkg Size: 4.0 x 3.4 mm

15.3 - Sony
#G1272
Dual Low Pass Filter
Die Size: 1.8 x 0.8 mm

15.1 - Sony
#G1311
SP12T Switch
Die Size: 2.0 x 0.9 mm

15.2 - Sony
#A2829
CMOS Decoder
Die Size: 2.1 x 0.7 mm



Radio Board (Side 1 Die Photos)



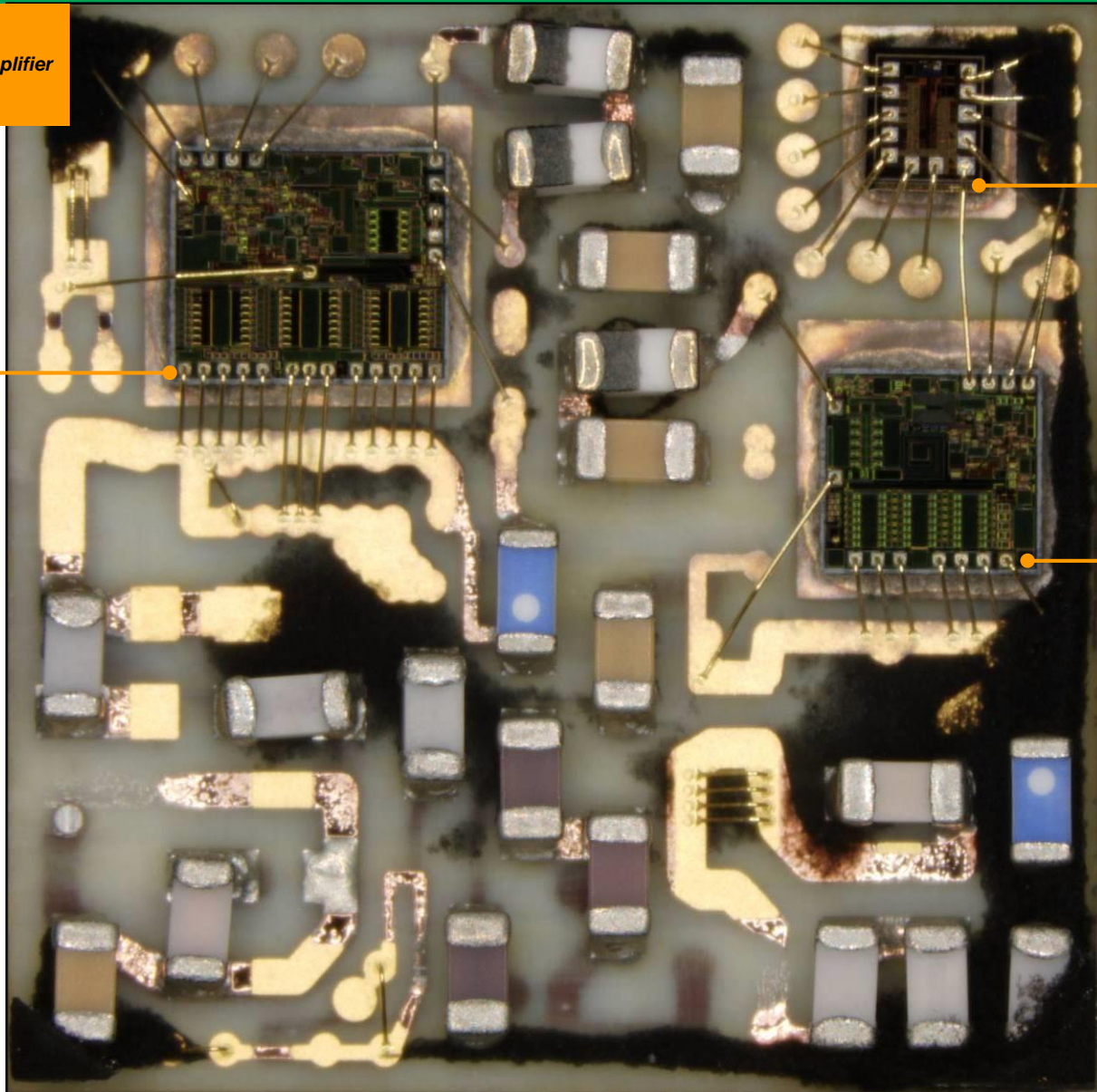
MUNRO
& ASSOCIATES, INC.

17 - Avago
#ACPM-7868
Quad-Band GSM Power Amplifier
(3-Die Pkg.)
Pkg Size: 5.0 x 5.0 mm

17.1 - Avago
#WSL
RF Power Amplifier
Die Size: 1.3 x 1.1 mm

17.3 - Avago
#4CW2A
Bias Control
Die Size: 0.7 x 0.6 mm

17.2 - Avago
#WSH1
RF Power Amplifier
Die Size: 1.0 x 0.9 mm

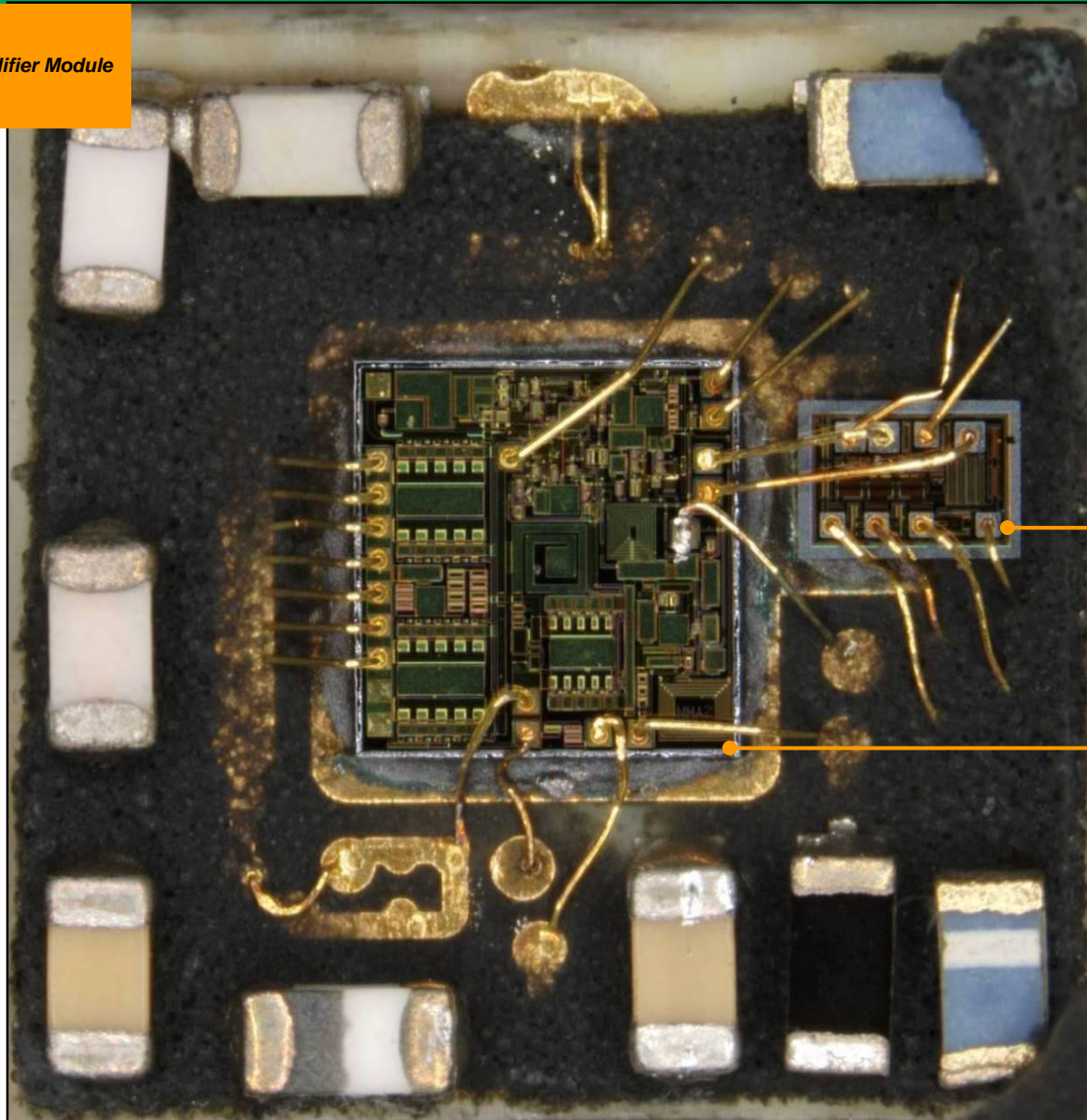


Radio Board (Side 1 Die Photos)



MUNRO
& ASSOCIATES, INC.

18 - Avago
#ACPM-5002
W-CDMA Band II Power Amplifier Module
(2-Die Pkg.)
Pkg Size: 3.0 x 3.0 mm



18.2 - Avago
#HJ5
Bias Control
Die Size: 0.6 x 0.4 mm

18.1 - Avago
#2YHN
RF Power Amplifier
Die Size: 1.1 x 1.0 mm

BMW i3 Telematics Comm.
Boards 5623 #15900-141103-
RBd - Page 719

Radio Board (Side 1 X-Rays)



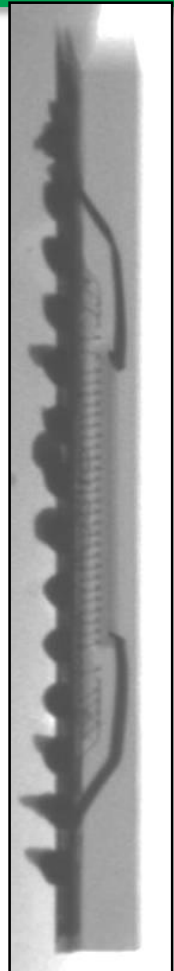
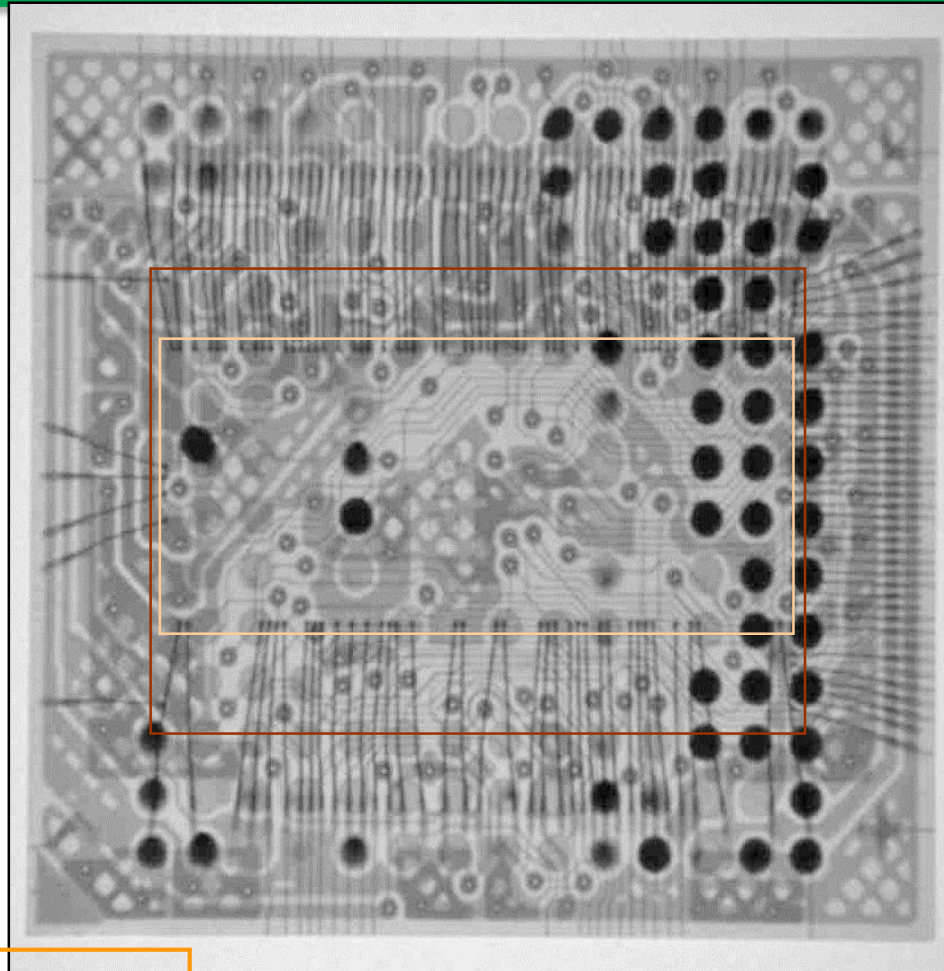
MUNRO
& ASSOCIATES, INC.

19 - Samsung

#K521H12ACI

Multichip Memory - 128 MB SLC OneNAND Flash,
64 MB Mobile DDR SDRAM (2-Die Pkg.)

Pkg Size: 9 x 8 mm



19.1 - Samsung

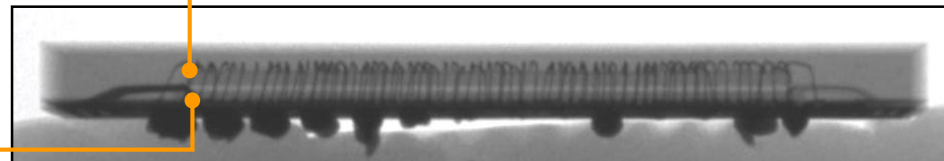
#K4X51323PK

Mobile DDR SDRAM Memory - 64 MB
Die Size: 6.3 x 2.7 mm

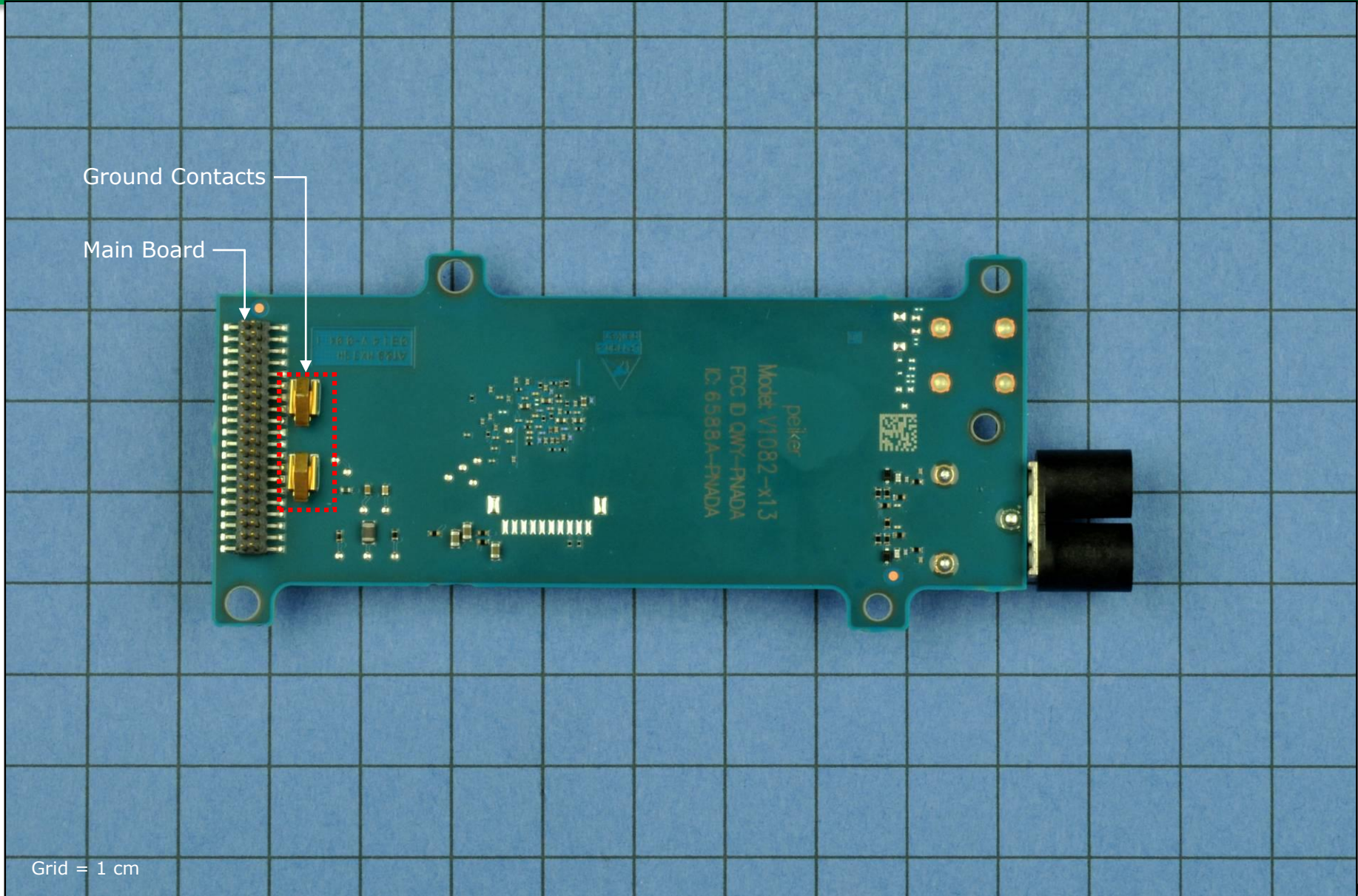
19.2 - Samsung

#KFG1G16Q2D

SLC OneNAND Flash Memory - 128 MB
Die Size: 6.5 x 4.2 mm



Radio Board (Side 2)

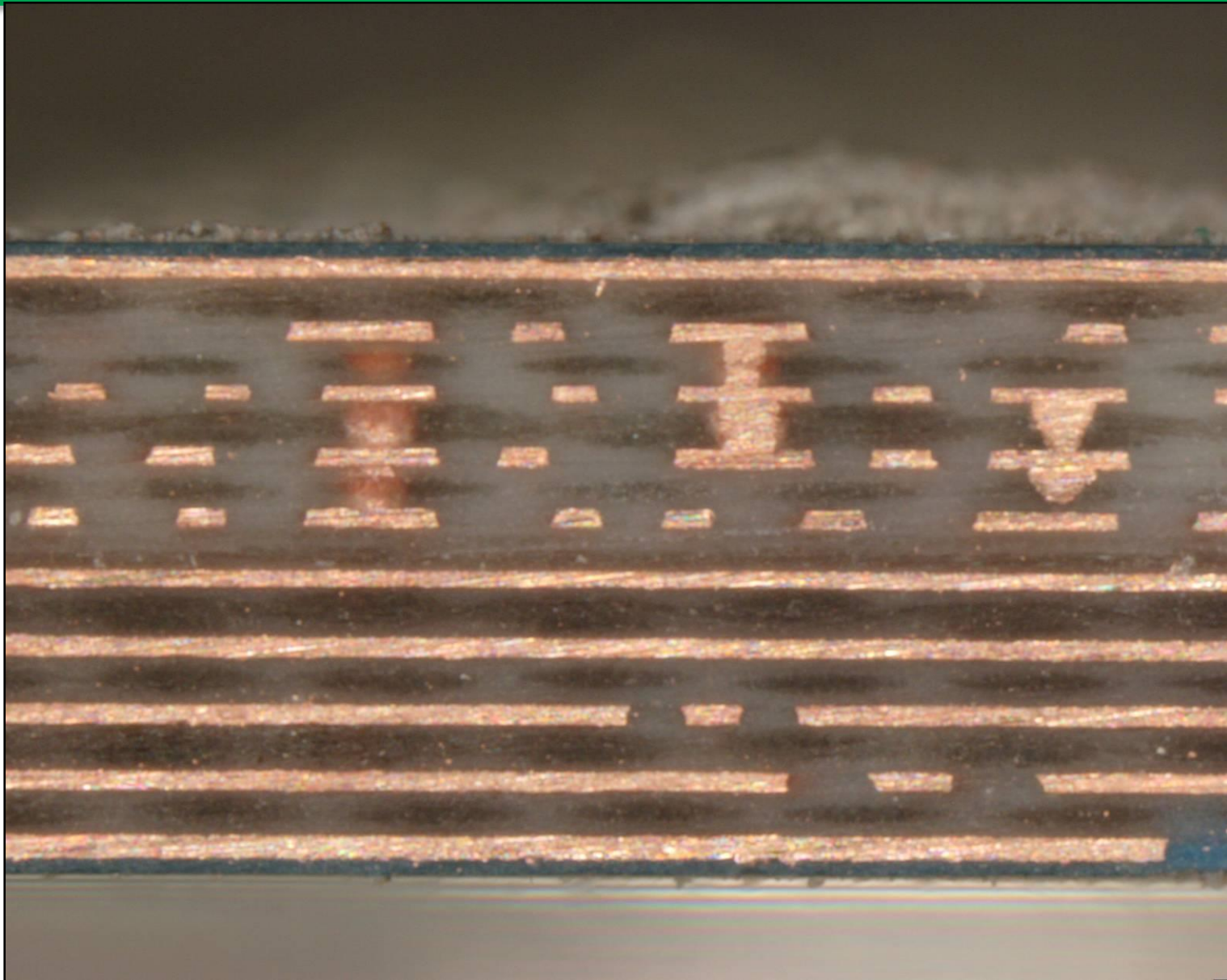


Ground Contacts

Main Board

Grid = 1 cm

Radio Board Cross-Section



ematics Comm.

Boards 5623 #15900-141103-
RBd - Page 722

Substrate Data

Substrates

Assembly Name	Manufacturer	Core Material	Mfg. Technology	Layers	Area (cm ²)	Min. Trace Pitch (mm)	Min. Trace Width (mm)	ThruVia Land Dia (mm)	ThruVia Hole Dia (mm)	BlindVia Land Dia (mm)	BlindVia Hole Dia (mm)	Thickness (mm)	Routing Density	Estimated Costs
Main Board	Shenzhen Sunshine	FR4	6 Layer conventional FR4 / HF	6	102.1	0.30	0.15	0.60	0.30			1.6	20.4	\$ 2.13
Radio Board	AT&S	FR4	10 Layer buildup FR4 / HF	10	29.1	0.30	0.10			0.25	0.10	1.3	48.5	\$ 2.71

Integrated Circuit Components



MUNRO
& ASSOCIATES, INC.

Location	Package Info										Die Info						Estimated Costs		
	Pkg Ref. #	Pkg Qty	Brand Name	Part Number	Pkg Description	Form	Pin Count	Length (mm)	Width (mm)	Height (mm)	Die Ref #	Die Qty	Brand Name	Part Number	Description	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	1	NXP Semiconductor	TJA1043T	CAN Transceiver	SOP	14	8.80	3.90	1.40	1.1	1	NXP Semiconductor	cP1381e	CAN Transceiver	2.50	1.70	\$ 0.315	\$ 0.315
	2	1	STMicroelectronics	TDA7391PD	32 W Bridge Audio Amplifier	SOP	20	16.10	10.90	3.40	2.1	1	STMicroelectronics	CL009C851A5	32 W Bridge Audio Amplifier	4.10	3.30	\$ 3.080	\$ 3.080
	3	1	Texas Instruments	CD4053BPW	Triple 2-Channel MUX/DEMUX	SOP	16	5.10	4.30	0.90	3.1	1	Texas Instruments	CD4053BA	Triple 2-Channel MUX/DEMUX	1.70	1.50	\$ 0.211	\$ 0.211
Main Board, Side 2	4	1	Freescaple	MC9S12XEQ384VAL	16-Bit Microcontroller	QFP	112	19.70	19.70	1.40	4.1	1	Freescaple	M12S	16-Bit Microcontroller	5.60	5.17	\$ 6.408	\$ 6.408
	5	1	Texas Instruments	TPS79801-Q1	50 mA Adjustable LDO Regulator	SOP	8	3.10	2.90	0.90	5.1	1	Texas Instruments	3010C	50 mA Adjustable LDO Regulator	1.80	1.60	\$ 0.189	\$ 0.189
	6	1	Unknown	G1344058 ?	Unknown	DFN	8	6.10	5.00	0.90	6.1	1	Unknown	M76518	Unknown	2.60	2.40	\$ 0.354	\$ 0.354
	7	2	Texas Instruments	TPS79901QDRVROQ1	200 mA Adjustable LDO Regulator	DFN	6	2.00	2.00	0.80	7.1	1	Texas Instruments	TPS799A	200 mA Adjustable LDO Regulator	1.30	1.00	\$ 0.095	\$ 0.190
	8	1	Texas Instruments	TLV320AIC3104-Q1	Audio CODEC	QFN	32	5.00	5.00	0.90	8.1	1	Texas Instruments	T1AIC39	Audio CODEC	3.40	2.70	\$ 1.786	\$ 1.786
	9	1	Texas Instruments	SN74AVC4T245-Q1	4-Bit Bus Transceiver	QFN	16	4.00	3.50	0.90	9.1	1	Texas Instruments	4T245	4-Bit Bus Transceiver	1.30	1.20	\$ 0.162	\$ 0.162
	10	1	Texas Instruments	TPS43335-Q1	Dual Buck Converter	TSOP	38	12.60	6.00	1.00	10.1	1	Texas Instruments	TPS43330	Dual Buck Converter	3.60	2.90	\$ 2.140	\$ 2.140
11	1	ON Semiconductor	MC33204	Quad Operational Amplifier	TSOP	14	5.20	4.30	0.90	11.1	1	ON Semiconductor	33204	Quad Operational Amplifier	2.40	1.90	\$ 0.293	\$ 0.293	
Radio Board, Side 1	12	1	Qualcomm	PM8028	Power Management	BGA	136	7.00	5.00	0.60	12.1	1	Qualcomm	HG11-VK495-200	Power Management	5.80	3.10	\$ 2.311	\$ 2.311
	13	1	Qualcomm	MDM6200	Baseband Processor / Transceiver / GPS / Blu	BGA Stacked 2	486	12.20	9.80	0.80	13.1	1	Qualcomm	HG11-VP230	Baseband Processor	7.60	5.20	\$ 11.754	\$ 11.754
	14	1	Avago	ACPM-5005	W-CDMA Band V Power Amplifier Module	MCP - 2 Chips	10	3.00	3.00	1.00	14.1	1	Avago	FLC 61	RF Power Amplifier	1.10	1.10	\$ 0.308	\$ 0.308
											14.2	1	Avago	LJ5	Bias Control	0.60	0.40	\$ 0.022	\$ 0.022
	15	1	Sony	CXM3553	SP12T Antenna Switch	MCP - 3 Chips	30	4.00	3.40	0.80	15.1	1	Sony	G1311	SP12T Switch	2.00	0.90	\$ 0.632	\$ 0.632
											15.2	1	Sony	A2829	CMOS Decoder	2.10	0.70	\$ 0.136	\$ 0.136
	16	1	Sony	CXG1189	SPDT Antenna Switch	QFN	12	2.00	2.00	0.40	15.3	1	Sony	G1272	Dual Low Pass Filter	1.80	0.80	\$ 0.502	\$ 0.502
											16.1	1	Sony	G1189A	SPDT Antenna Switch	1.00	0.90	\$ 0.220	\$ 0.220
	17	1	Avago	ACPM-7868	Quad-Band GSM Power Amplifier	MCP - 3 Chips	11	5.00	5.00	1.00	17.1	1	Avago	WSL	RF Power Amplifier	1.30	1.10	\$ 0.784	\$ 0.784
											17.2	1	Avago	WSH1	RF Power Amplifier	1.00	0.90	\$ 0.308	\$ 0.308
	18	1	Avago	ACPM-5002	W-CDMA Band II Power Amplifier Module	MCP - 2 Chips	10	3.00	3.00	1.00	17.3	1	Avago	4YW2A	Bias Control	0.70	0.60	\$ 0.066	\$ 0.066
18.1											1	Avago	2YHN	RF Power Amplifier	1.10	1.00	\$ 0.299	\$ 0.299	
19	1	Samsung	K521H12ACI	Multichip Memory - 128 MB SLC OneNAND Fla	BGA Stacked 2	153	9.00	8.00	0.70	18.2	1	Avago	HJ5	Bias Control	0.60	0.40	\$ 0.024	\$ 0.024	
										19.1	1	Samsung	K4X51323PK	Mobile DDR SDRAM Memory - 64 MB	6.30	2.70	\$ 0.971	\$ 0.971	
										19.2	1	Samsung	KFG1G16QZD	SLC OneNAND Flash Memory - 128 MB	6.50	4.20	\$ 1.717	\$ 1.717	
Totals	20						1138					28							\$40.17

Note: Supplemental information, such as IC package & die markings, is included in the Excel Bill of Materials (BOM) spreadsheet.

Modular Components



Location	Qty	Brand Name	Part Number	Description	Package			Estimated Costs	
					Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 2	1	Unknown	D163M	Crystal: Ceramic - D163M	4	3.20	2.50	\$ 0.200	\$ 0.200
	1	Unknown	Unknown	Shielding: Large	1	37.40	34.20	\$ 0.620	\$ 0.620
Radio Board, Side 1	1	TDK-EPC	B7956	Filter: BAW/SAW - Duplexer - WCDMA Band II	9	3.00	2.50	\$ 0.290	\$ 0.290
	1	Taiyo Yuden	FAR-D5NE-811M50-P1A6Q	Filter: SAW - Duplexer, Band V	9	2.50	2.00	\$ 0.290	\$ 0.290
	1	TDK-EPC	B9508	Filter: Dual SAW Diplexer - GSM 1800 / 1900	10	1.80	1.40	\$ 0.110	\$ 0.110
	1	TDK-EPC	B9405	Filter: SAW, Rx - GSM900	5	1.40	1.10	\$ 0.070	\$ 0.070
	1	Kyocera	CX3225SB	Crystal: Ceramic - 19200 K404Y	4	3.20	2.50	\$ 0.200	\$ 0.200
	1	Unknown	Unknown	Shielding: Large	1	64.00	31.00	\$ 0.040	\$ 0.040
TOTALS	8				43				\$1.82

Active Discrete Components



MUNRO
& ASSOCIATES, INC.

Location	Qty	Functional Description	Package					Estimated Costs	
			Form	Top Marking	Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Small Active	MOSFET - DMP4050SSD-13	DIODES INC logo P4050SD 13 52	8	5.10	3.80	\$0.090	\$0.090
	1	Small Active	Diode, SMT	F1	2	1.20	0.80	\$0.015	\$0.015
	8	Small Active	Transistor, Small	K3B A5,K1R AN,3B	3	2.20	1.20	\$0.030	\$0.239
	18	Small Active	Transistor, Small	75t 41,Y1 09,C38 A6,74W 3d,KY6 A6,2GM C,1GM C	3	2.90	1.20	\$0.030	\$0.538
	2	Small Active	Transistor, Small	25,26	3	1.60	0.80	\$0.030	\$0.060
	4	Small Active	Transistor, Small	13W 3o,75W 37,Y4W 37,34P A9,	3	2.90	1.20	\$0.030	\$0.120
	1	Small Active	Transistor, Small	H0t	6	2.10	1.20	\$0.030	\$0.030
	1	Small Active	Transistor, Small	3t1	6	2.10	1.20	\$0.030	\$0.030
	2	Small Active	Transistor - 2SB1189	BD W3d	4	4.50	2.50	\$0.030	\$0.060
	1	Small Active	MOSFET - ZXMP4A16	ZXMP 4A16	4	6.70	3.60	\$0.090	\$0.090
	1	Small Active	Diode, SMT - MBRA340T3	ON A34 RC46.	2	4.30	2.70	\$0.015	\$0.015
	1	Small Active	MOSFET - DMC4028SSD	DIODES INC logo C4028SD 13 52	8	5.00	3.90	\$0.090	\$0.090
	3	Small Active	Transistor, Small	N20	6	2.00	1.20	\$0.030	\$0.090
	Main Board, Side 2	1	Small Active	Diode, TVS - SM4T39CAY	STM logo e3 CNY Z348	2	4.10	2.90	\$0.080
1		Small Active	Diode, Rectifier, SMT - MBRS3100T3	ON SEMI logo E04 B310	2	7.60	6.00	\$0.100	\$0.100
1		Small Active	Diode, SMT	N1	2	1.10	0.80	\$0.015	\$0.015
5		Small Active	Transistor, Small	3B	3	2.20	1.20	\$0.030	\$0.150
3		Small Active	Transistor, Small	H0t	6	2.10	1.20	\$0.030	\$0.090
2		Small Active	Transistor, Small	N20	6	2.10	1.20	\$0.030	\$0.060
7		Small Active	Transistor, Small	25, P5 4D	3	1.60	0.80	\$0.030	\$0.209
11		Small Active	Transistor, Small	13W 3o,KY6 A6,74W 3d,Y4W 37,2GM C,1GM C,K3B A5	3	2.90	1.20	\$0.030	\$0.329
3		Small Active	MOSFET - DMN4027SSD	DIODES INC logo N4027SD 14 01	8	0.00	0.00	\$0.090	\$0.270
Radio Board, Side 2	2	Small Active	Diode, SMT	F1	2	1.20	0.80	\$0.015	\$0.030
TOTALS	80				291				\$2.80

Passive Discrete Components

Location	Qty	Functional Description	Package		Estimated Costs	
			Form	Pin Count	Each	Total
Main Board, Side 1	126	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.504
	2	Coil	SMT, Small	2	\$0.050	\$0.100
	9	Capacitor	Electrolytic, Medium	2	\$0.060	\$0.539
	1	Coil	Choke, Common Mode - 51uH	4	\$0.280	\$0.280
	2	Capacitor	Tantalum / Niobium, Small	2	\$0.050	\$0.100
Main Board, Side 2	1	Coil	SMT, Small	2	\$0.050	\$0.050
	1	Misc	Fuse	2	\$0.040	\$0.040
	2	Coil	SMT, Small	2	\$0.050	\$0.100
	393	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$1.572
Radio Board, Side 1	17	Small Passive	Coil, Inductor	2	\$0.008	\$0.136
	141	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.564
Radio Board, Side 2	7	Small Passive	Coil, Inductor	2	\$0.008	\$0.056
	88	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.352
TOTALS	790			1582		\$4.39

Connectors

Location	Qty	Form	Package			Estimated Costs	
			Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Connector: USB	4	25.20	11.00	\$0.120	\$0.120
	1	Connector: Vehicle Wiring	26	43.10	26.40	\$0.600	\$0.600
	1	Bd to Bd: Male - unknown	2	7.90	5.80	\$0.030	\$0.030
Main Board, Side 2	1	Bd to Bd: Female - Radio Brd	40	25.90	3.10	\$0.220	\$0.220
Radio Board, Side 1	1	Connector: Antenna Coax, Fakra	2	21.90	12.50	\$1.720	\$1.720
Radio Board, Side 2	2	Connector: Spring - Formed	1	5.30	2.80	\$0.030	\$0.060
	1	Bd to Bd: Male - Main Brd	40	25.40	3.40	\$0.220	\$0.220
TOTALS	8		116				\$2.97

Electronic Assembly Metrics



Electronic Assembly Metrics by Assembly											
General Area	Assembly Name	Substrate Area (sq. cm)	Metal Layers	Circuit Area (sq. cm)	Routing Density (cm of routing per sq. cm of substrate)	Number of Components	Number of Connections	Component Density (Components/sq. cm)	Connection Density (Connections/sq. cm)	Avg. Pin Count	Assembly Weight (grams)
Main Electronics	Main Board	102.1	6	612.6	20.4	633	1730	6.2	16.9	2.7	90.70
Main Electronics	Radio Board	29.1	10	291.0	48.5	273	1440	9.4	49.5	5.3	23.00
	System Totals	131.2	16	903.6		906	3170	6.9	24.2	3.5	113.70

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Electronics Costs by Assembly

General Area	Assembly Name	Total	Integrated Circuits	Modular & Odd Form Components	Small Active Components	Passive Components	Connector Components	Substrates	Insertion	Card Test
Main Electronics	Main Board	\$ 29.40	\$ 15.13	\$ 0.82	\$ 2.77	\$ 3.29	\$ 0.97	\$ 2.13	\$ 3.24	\$ 1.06
Main Electronics	Radio Board	\$ 34.38	\$ 25.04	\$ 1.00	\$ 0.03	\$ 1.11	\$ 2.00	\$ 2.71	\$ 1.48	\$ 1.01
	System Totals	\$ 63.79	\$ 40.17	\$ 1.82	\$ 2.80	\$ 4.39	\$ 2.97	\$ 4.84	\$ 4.73	\$ 2.07

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Counts by Assembly												
General Area	Assembly Name	IC Package Count	IC Connections	Modular/Odd Form Components	Modular/Odd Form Component Connections	Small Active Components	Small Active Component Connections	Passive Components	Passive Component Connections	Connectors	Connector Connections	Opportunities
Main Electronics	Main Board	12	290	2	5	78	287	537	1076	4	72	2363
Main Electronics	Radio Board	8	848	6	38	2	4	253	506	4	44	1713
	System Totals	20	1138	8	43	80	291	790	1582	8	116	4076

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



MUNRO
& ASSOCIATES, INC.

IC Metrics											
General Area	Assembly Name	IC Die Count	IC Package Count	Number of Package Connections	Die Area (sq.mm)	Substrate Tiling Density (die area / substrate area)	Package Area (sq.mm)	Die Area/Package Area Ratio	Package Connections per sq.cm of Package Area	Volatile Memory (KBytes)	Non-Volatile Memory (KBytes)
Main Electronics	Main Board	12	12	290	86.7	0.01	804.3	0.11	36.1	0	0
Main Electronics	Radio Board	16	8	848	139.4	0.05	287.2	0.49	295.3	65536	131072
	System Totals	28	20	1138	226.1		1091.4	0.21	104.3	65536	131072

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

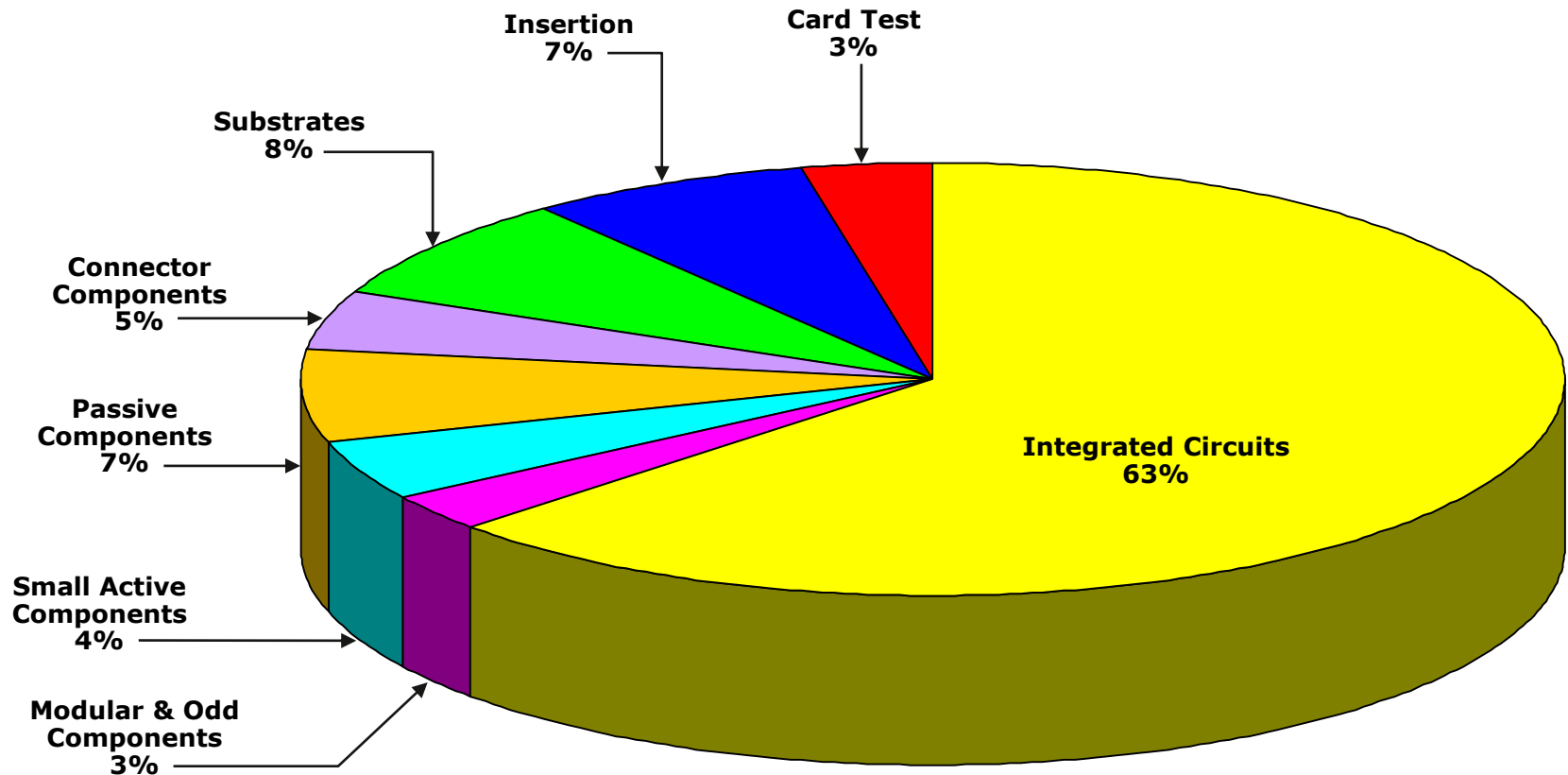
BMW i3 Telematics Comm.
Boards 5623 #15900-141103-
RbD - Page 732

Electronic Costs Breakdown

**Estimated Cost
of Electronics**

\$63.79

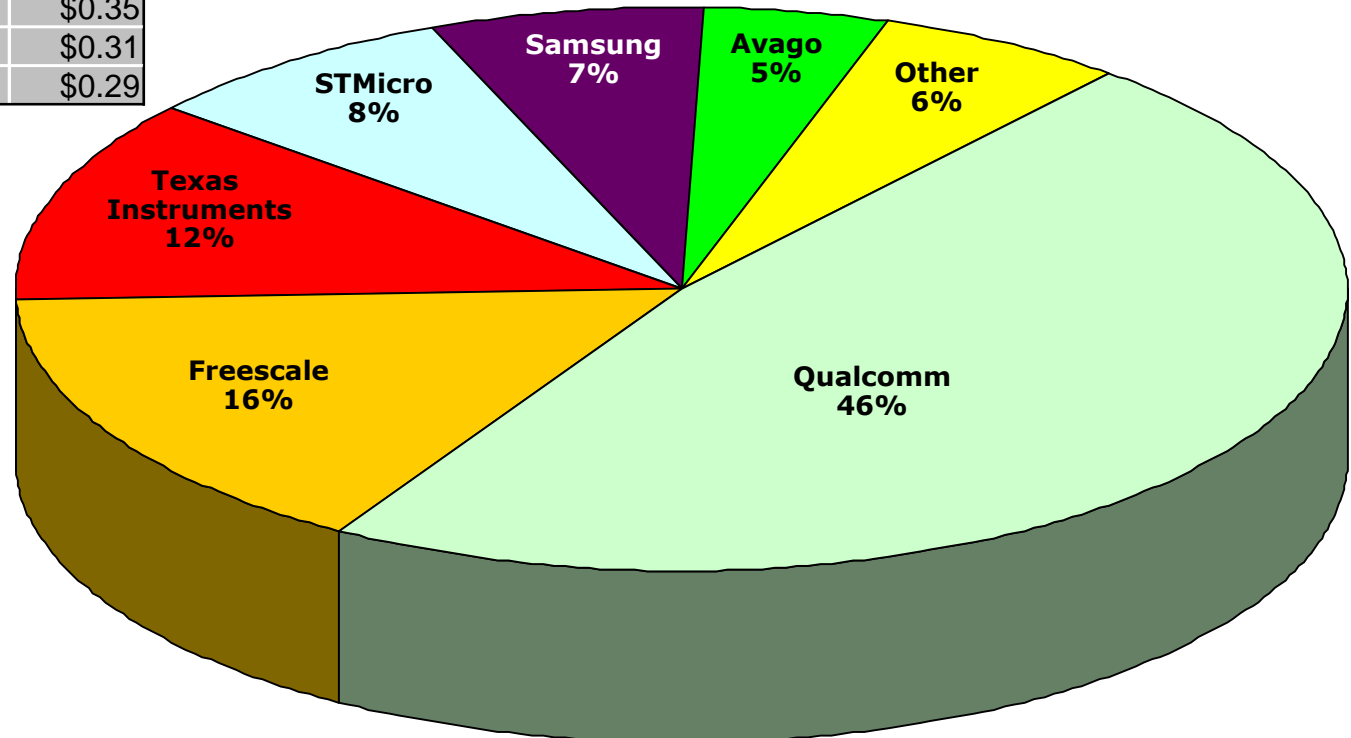
**Note: This analysis only contains the
Substrates, so the Cost of Electronics is also
equal to the Cost Total**



NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Vendor IC Cost Distribution

Pkg. Brand	Cost
Qualcomm	\$19.05
Freescale	\$6.41
Texas Instruments	\$4.68
STMicroelectronics	\$3.08
Samsung	\$2.69
Avago	\$1.81
Other	
Sony	\$1.49
Unknown	\$0.35
NXP Semiconductor	\$0.31
ON Semiconductor	\$0.29



NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Cost Summary



Estimated Cost Totals	
Main Electronic Assemblies	\$ 63.79
Final Assembly & Test	\$ 0.52
Total	\$ 64.31

Cost Total Notes:
Estimated final assembly cost includes labor only.
Total cost does not include Non-recurring, R&D, G&A, IP licensing fees/royalties, software, sales & marketing, distribution.
Assumes fully scaled production.

Cost Estimation Process

(Overview & Discussion)



Cost modeling is tricky business. Multiple variables affect the actual production costs a manufacturer will experience, including development expenses, unit volumes, supply-and-demand in component markets, die yield-curve maturity, OEM purchasing power, and even variations in accounting practices. Different cost modeling methods employ different assumptions about how to handle these and other variables, but we can identify two basic approaches: that which seeks to track short-term variations in the inputs to the production process, and that which strives to maintain comparability of the output of the model across product families and over time.

TechInsights' philosophy in cost modeling is to emphasize consistency across products and comparability over time, rather than to track short-term fluctuations. During the past eight years, we have developed an estimation process that, while necessarily lacking an insider's knowledge of the cost factors that impact any one manufacturer, is reasonably accurate in its prediction of unit costs in high-volume production environments. We do not claim that the model will produce the "right" answer for your firm's environment. However, TechInsights does give customers a key analytical tool with a complete set of data in our Bill of Materials (BOM). The BOM allows readers to 1) scrutinize the assumptions behind our cost model and 2) modify the results based on substitution of their own component cost estimates where they have better information based on inside knowledge.

Our estimation process decomposes overall system cost into three major categories: Electronics, Mechanical, and Final Assembly. We begin by creating a complete electronics bill-of-materials (BOM). Each component from the largest ASIC to the smallest discrete resistor is entered into a BOM table with identifying attributes such as size, pitch, I/O count, package type, manufacturer, part number, estimated placement cost, and die size (if the component is an IC). Integrated circuit costs are calculated from measured die area. Using assumptions for wafer size, process type, number of die per wafer, defect density, and profit margin in combination with die area, an estimate of semiconductor cost is derived. Costs for discrete components and interconnect are derived from assumption tables which relate BOM line items to specific cost estimates by component type and estimates for part placement costs are included. For LCD display costs, we employ a model which tabulates expected cost from measurements of glass area, LCD type, and total pixel resolution. When market costs are available from alternative sources, LCD panel costs are taken from and referenced to these sources.

Costs of non-electronic components such as molded plastic enclosures and metallic components are measured in terms of weight, size, thickness, type of material, and complexity to arrive at their estimated cost. Other system items such as optics, antennae, batteries and displays are costed from a set of assumption tables derived from a combination of industry data, average high volume costs, and external sources. For final assembly, we re-build the torn-down product, tabulating stepwise assembly times as the reconstruction proceeds, to reach a total assembly time. Using a labor rate assumption for the country of origin, we then calculate final assembly cost.

The three major categories for system cost contributors can be broken down into the subcategories of ICs, other electronics parts, displays, batteries (as appropriate), camera modules, electronics assembly, non-electronic elements, and final assembly. By adding the cost estimates for each of these subcategories, an overall estimated cost is derived for the system under evaluation. Product packaging and accessories (CDs, cables, etc.) are also documented and estimated for their contribution to total cost as appropriate.

We believe our cost estimates generally fall within 15 percent of the "right answer," which itself can vary depending on the market and OEM-specific factors mentioned earlier. While the TechInsights cost model is imperfect, it yields important insights into technology and business dynamics along with good first-order contributions to system cost by component type. Additionally, the consistency of approach and gradual modification to assumptions (smoothing out frequently-shifting pricing factors) hopefully yields a credible, but user-modifiable, view of OEM high volume cost-to-produce.

Please feel free to contact us at support@techinsights.com with any comments, questions, or proposed corrections with respect to our cost estimates. We welcome your input.

BMW i3 Telematics Comm.
Boards 5623 #15900-141103-
RBd - Page 736

Metrics (Overview & Discussion)



In our product teardowns, we gather a series of metrics for product profiling and comparison. Some metrics focus on system characteristics such as total silicon area, total system semiconductor storage capacity, and total connection count. Other metrics reflect more subtle aspects of electronics assembly such as connection density, average component I/O count, and silicon tiling density. Taken as a whole, the metrics allow deeper comparison and benchmarking across multiple disciplines and multiple products. Key metrics we gather on products are described below along with their definitions and what they tend to say about the system under study. Most metrics can be used both in comparing similar products for benchmarking purposes or for quantifying differences in levels of complexity between dissimilar product types. Data fall into two categories; either “raw” measured data or ratios of these measured data sets.

Total Silicon Area : This metric describes the total area of silicon as measured from X-ray or direct measurement of ICs. The area is an expression of the enclosed bare die area and excludes packaging area. The aggregate silicon area is a good benchmark to show how integrated a design might be when making comparisons to similar systems. Total silicon area also reflects the major cost driver for most systems we examine.

Silicon Tiling Density : Ratio of Total Silicon Area to total printed circuit board “projected” area (i.e. the simple board area and not the cumulative surface area of both sides of the board). This metric directly reflects the level of efficiency and aggressiveness in integrated circuit packing and placement. Single digit Silicon Tiling Density is typical but silicon coverage of 10% - 20% has been seen in some of the most advanced products we have examined. Higher Tiling Densities often correspond with the use of chip scale packaging (CSPs) or other small form-factor IC packaging technologies. High density circuit boards are also often a supporting technology.

Number of Parts : Total component count including ICs, passives, modules, connectors, etc., each separated out in our reporting.

Number of Connections : The total number of connections corresponds to the total number of interconnects introduced by the aggregate component set and reflects any electrical connection observed (solder joints, adhesive interconnect, or connector terminal interfaces).

Opportunity Count : Opportunity Count is the total number of parts plus the total number of connections; the name reflects that each of these constituent elements represents an opportunity for failure. A high opportunity count means more complex and riskier electronics assembly.

Average Pin Count (APC) : Ratio of total number of component terminals to total number of parts, at the system level. This metric reflects the ‘average’ terminal complexity of the components and often provide a signature of integration level and/or “digital-ness” of the overall product. Low APCs reflect a high number of discrettes or other low-pincount devices often characteristic of analog circuitry. Conversely, high APCs are characteristic of highly integrated, high-pincount assemblies, often those composed largely of digital integrated circuits.

Connection Density : This metric is a ratio of the total Number of Connections to total printed circuit board assembly area, in units of connections per sq. inch. The metric provides data related to the Silicon Tiling Density above, but with an emphasis on complexity of I/O interconnect. For example, with a fixed Connection Density, high tiling density of low-pincount memory chips is more readily achieved than comparable silicon tiling of high pincount logic.

Part Density : This metric is a ratio of the total Number of Parts to total printed circuit board assembly area, in units of components per sq. inch. The metric provides data related to the Silicon Tiling Density and Connection Density as described above, but with an emphasis on density and complexity of component packing efficiency. For example, low Part Density of high-pincount devices can pose an equal challenge in Connection Density to high Part Density of low-pincount devices. High Part Density does reflect challenges in surface mount assembly in terms of (typically) precision of placement, number of placements, and engineering of part clearances.

Routing Density (heuristic estimate) = $3 * (\text{Average Pin Count}) * \sqrt{\text{Part Density}}$. The Routing Density metric is an empirically derived relationship that characterizes the wiring density of the interconnect used to support the interconnection of components in a planar electronic assembly (i.e. the circuit board). Architectural issues such as bussing or other factors affecting the regularity of wiring impact the actual Routing Density needed to support a given application, but the metric provides a ready measure of wiring complexity.

***[Click Here to Return to
Cost Analysis Page 177](#)***

Deep Dive Report

BMW i3 Touch Controller

65829347470-02 (2155)

Report #15900-141114-RBc



Product Description

The 65859347470-02 is the Touch Controller included in the 2014 BMW model i3. A relatively simple device, the Touch Controller is composed of a Freescale SC667332 16-bit microcontroller, NXP UJA1076A CAN (Controller Area Network) transceiver, and Texas Instruments TPS57040 500 mA step-down converter.

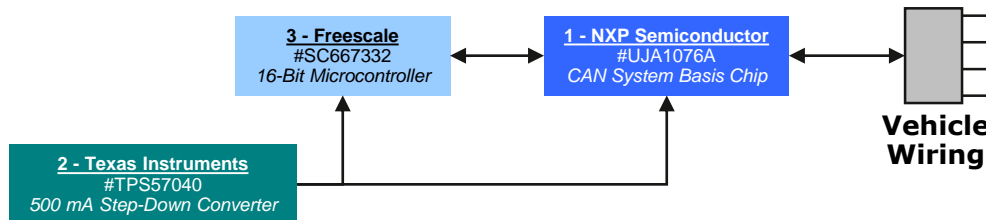
DISCLAIMER: All company names, product names, and service names mentioned are used for identification purposes only and may be registered trademarks, trademarks, or service marks of their respective owners. All analyses are done without participation, authorization, or endorsement of the manufacturer. Any cost analyses presented in this material are estimates prepared by TechInsights from generally available data. While TechInsights believes that these estimates reflect the probable costs, the actual producer did not supply the data, and therefore the actual costs may be different from these estimates. Furthermore, TechInsights extends no warranties with respect to any information in this document, and shall bear no liability whatsoever for the use of the information.

Copyright © 2015, TechInsights. All rights reserved. Do not reproduce, distribute, disseminate, photocopy, fax, transmit, download to a shared database, or otherwise copy, transfer, sell, publish, or send this material, or any portion thereof, by any means without the express written permission of TechInsights.

Product Overview

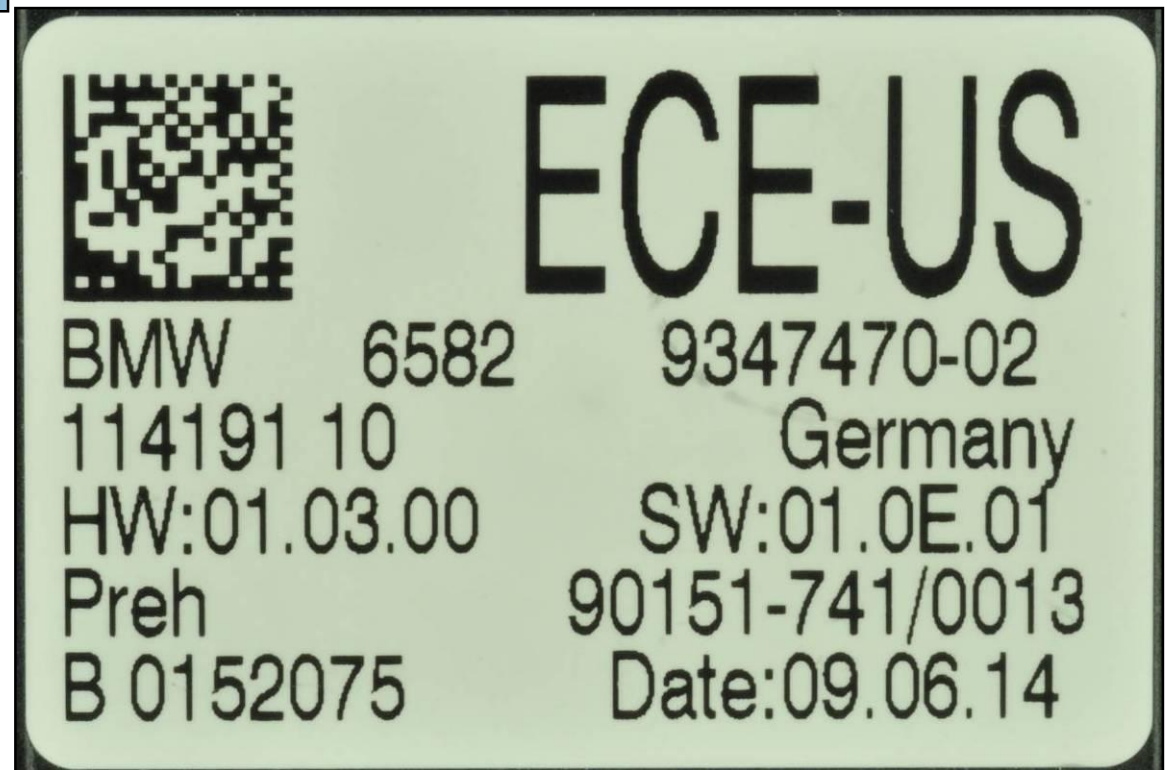
Product Description		Integrated Circuit Metrics		
Product Type	Automotive	IC Die Count	3	
Brand	BMW	IC Package Count	3	
Product Name & Model #	i3 Touch Controller 65829347470-02	Cost Metrics		
Official Release Date	Unknown			
Weight (grams)	42.2 (Measured)	Retail Price		
Product Dimensions (mm)	95.9 x 52.4 x 21.6 (Measured)	Total Manufacturing Cost	\$17.36	
Product Features		Electronics Cost	\$15.29	
		Manufacturing Cost Breakdown		
Processor	Freescale SC667332 16-Bit Microcontroller	Integrated Circuits	\$12.15	70.0%
Communications	NXP UJA1076A CAN Transceiver	Modules, Discretes & Connectors	\$1.62	9.3%
		Substrates	\$0.54	3.1%
		Component Insertion	\$0.72	4.1%
Voltage Regulator	Texas Instruments TPS57040 500 mA Step-Down Converter	Card Test	\$0.27	1.6%
		Non-Electronic Parts	\$1.44	8.3%
		Final Assembly & Test	\$0.62	3.6%
		Total	\$17.36	100.0%

Block Diagram

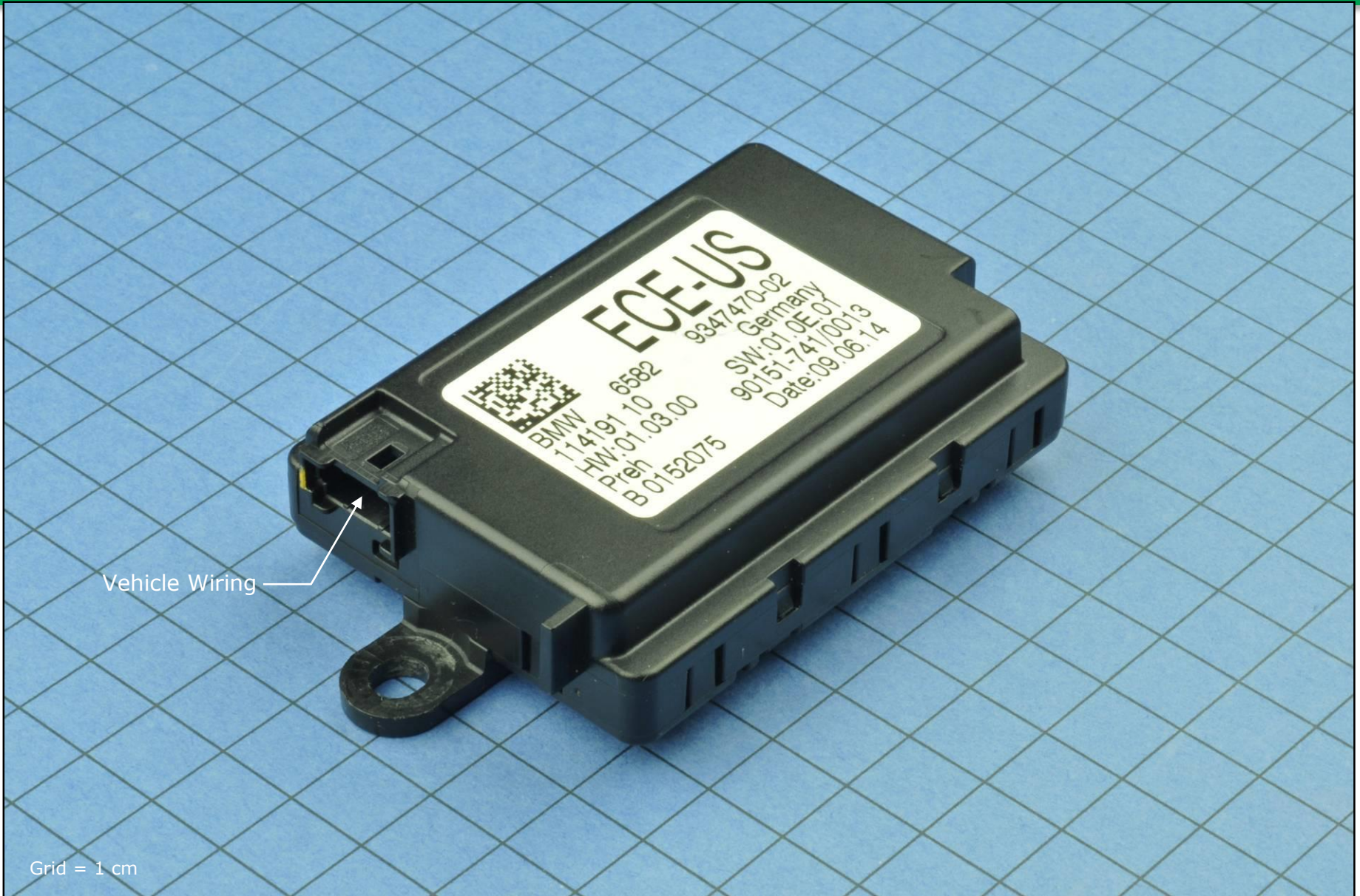


Estimated block diagram based on observation of this specific product implementation, manufacturer's data sheets where available, and best engineering judgment. Certain details of the interface circuitry are not reflected in this block diagram. Partitioning and connectivity are speculative.

Product Label



Exterior Features

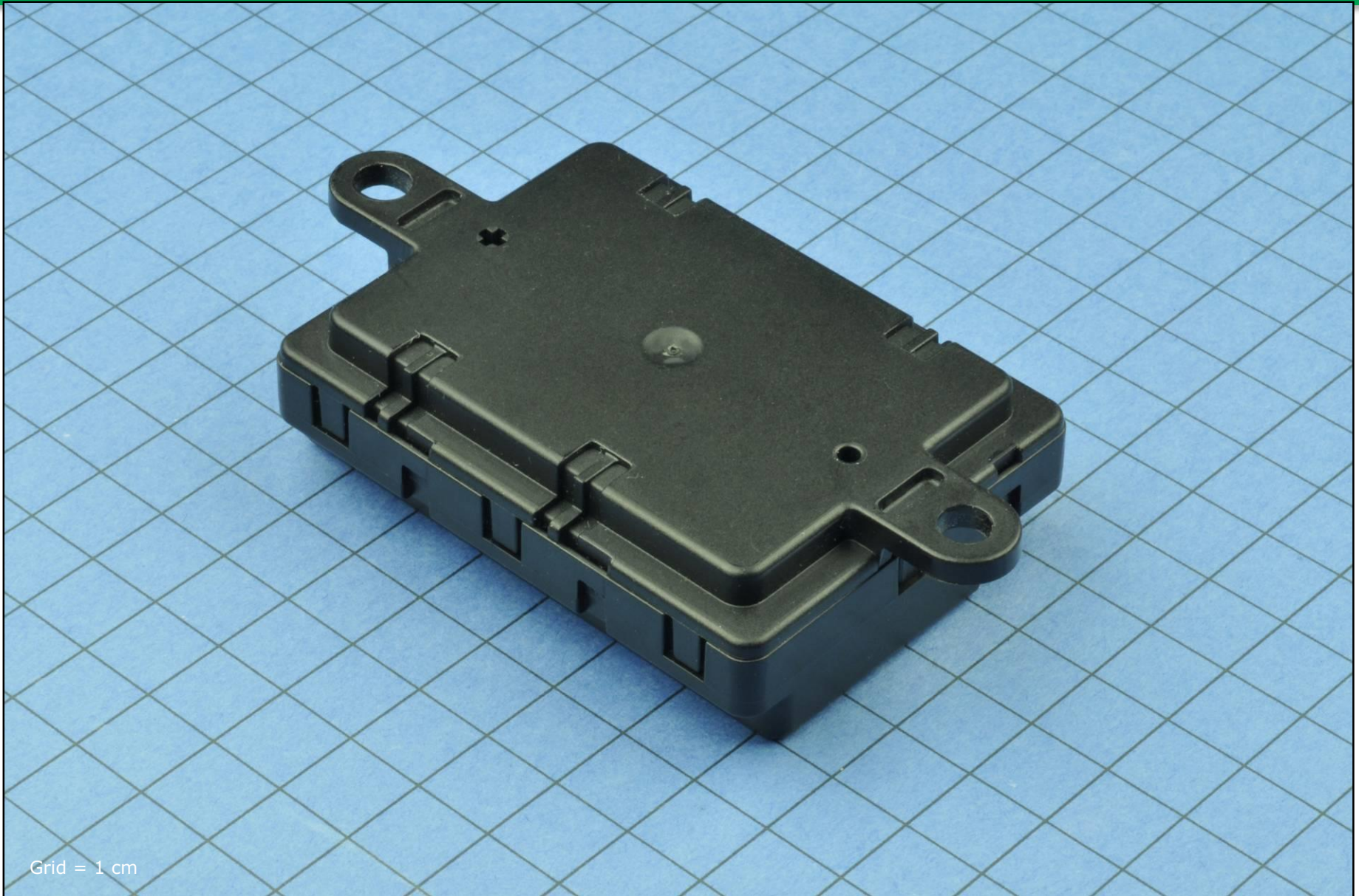


Grid = 1 cm

Exterior Features



MUNRO
& ASSOCIATES, INC.

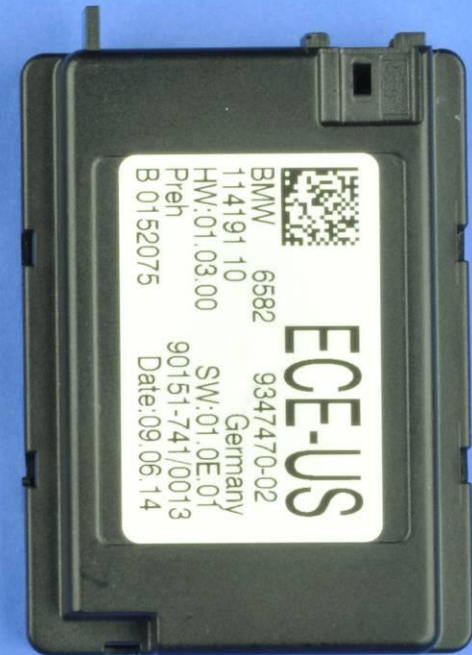


Grid = 1 cm

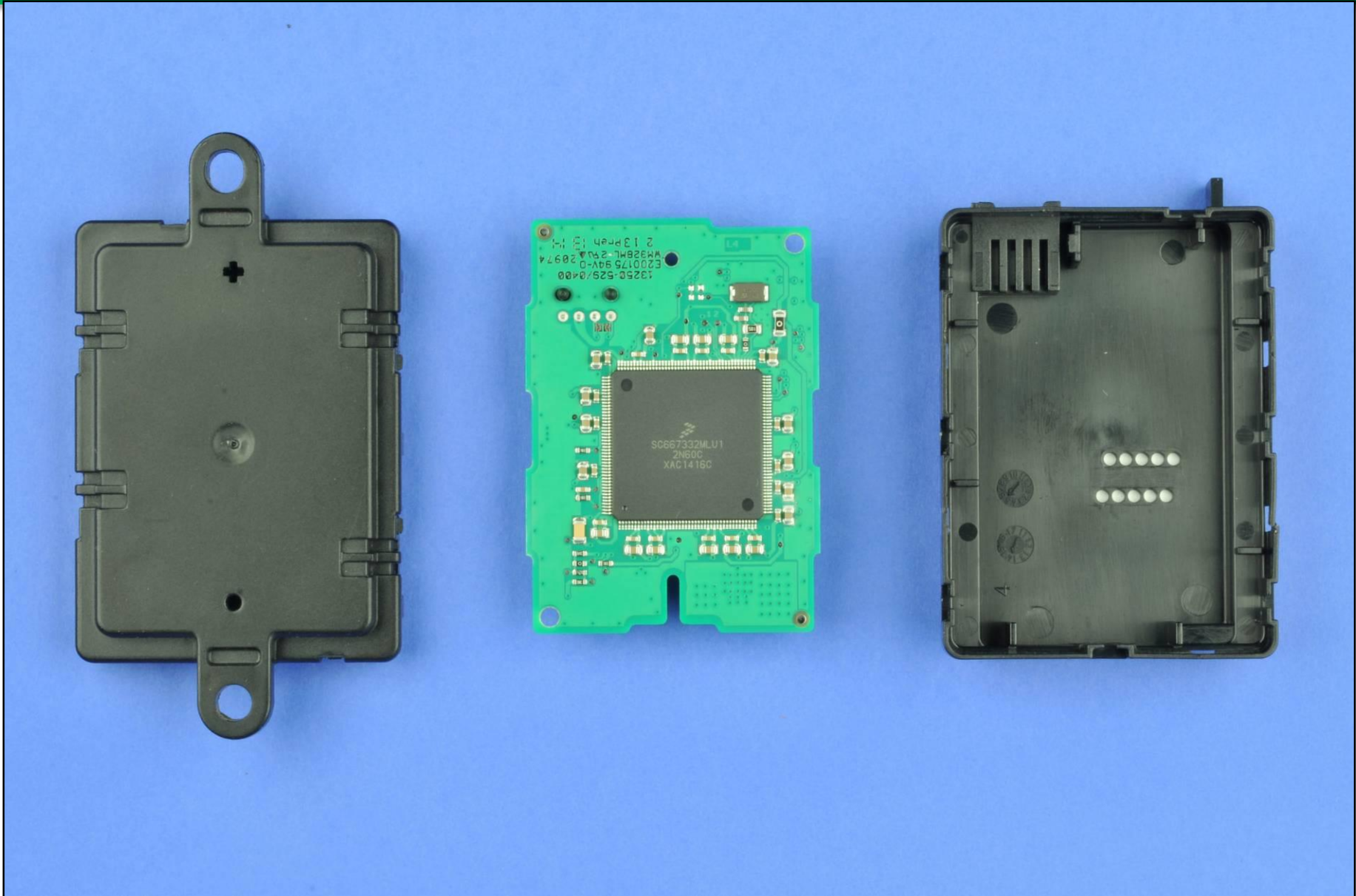
Major Components (Side 1)



MUNRO
& ASSOCIATES, INC.



Major Components (Side 2)



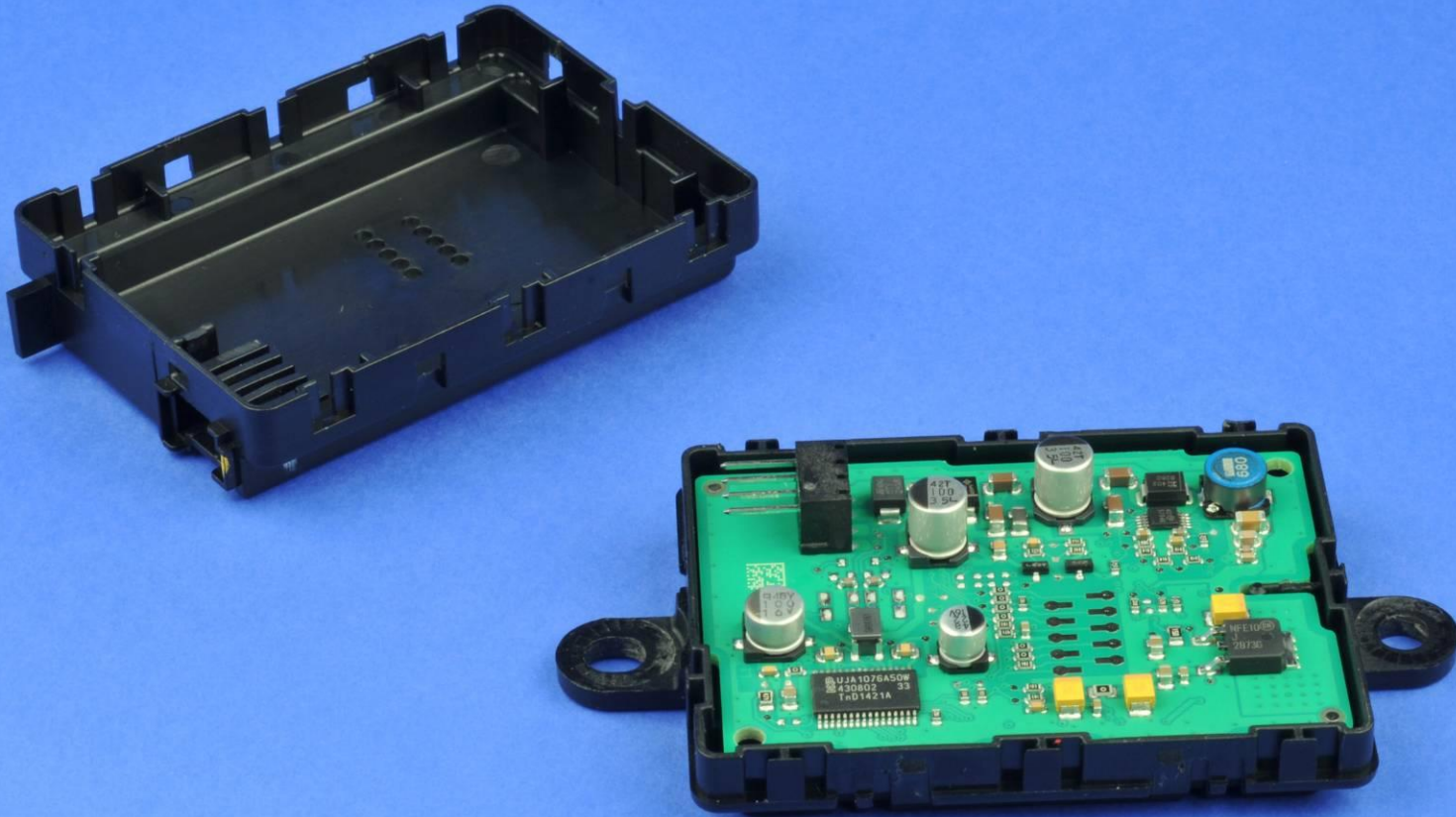
Component Arrangement



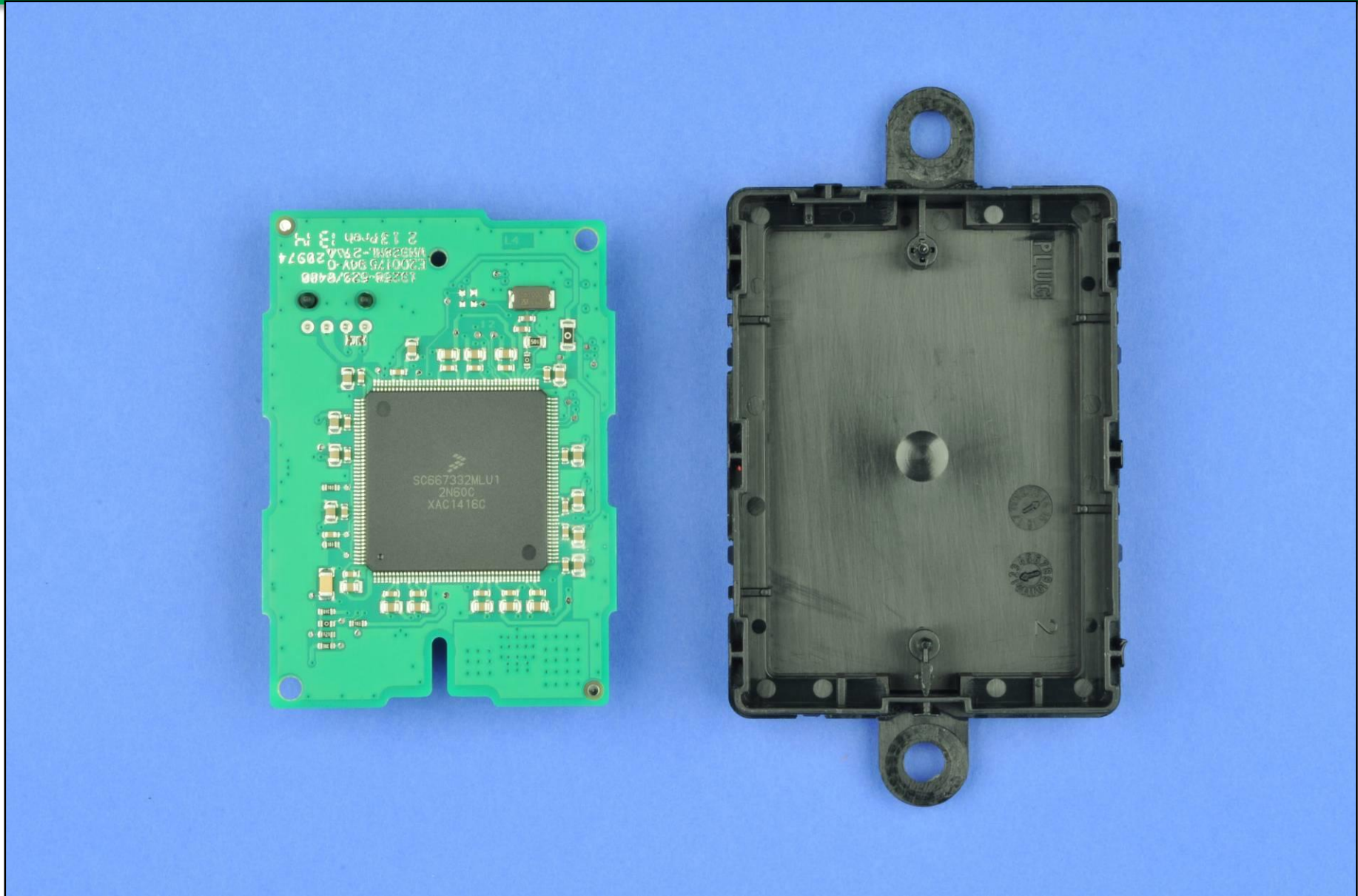
Teardown Sequence



MUNRO
& ASSOCIATES, INC.



Teardown Sequence

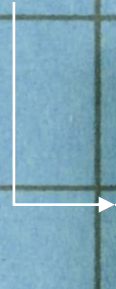


Main Board (Side 1 & IC Identification)



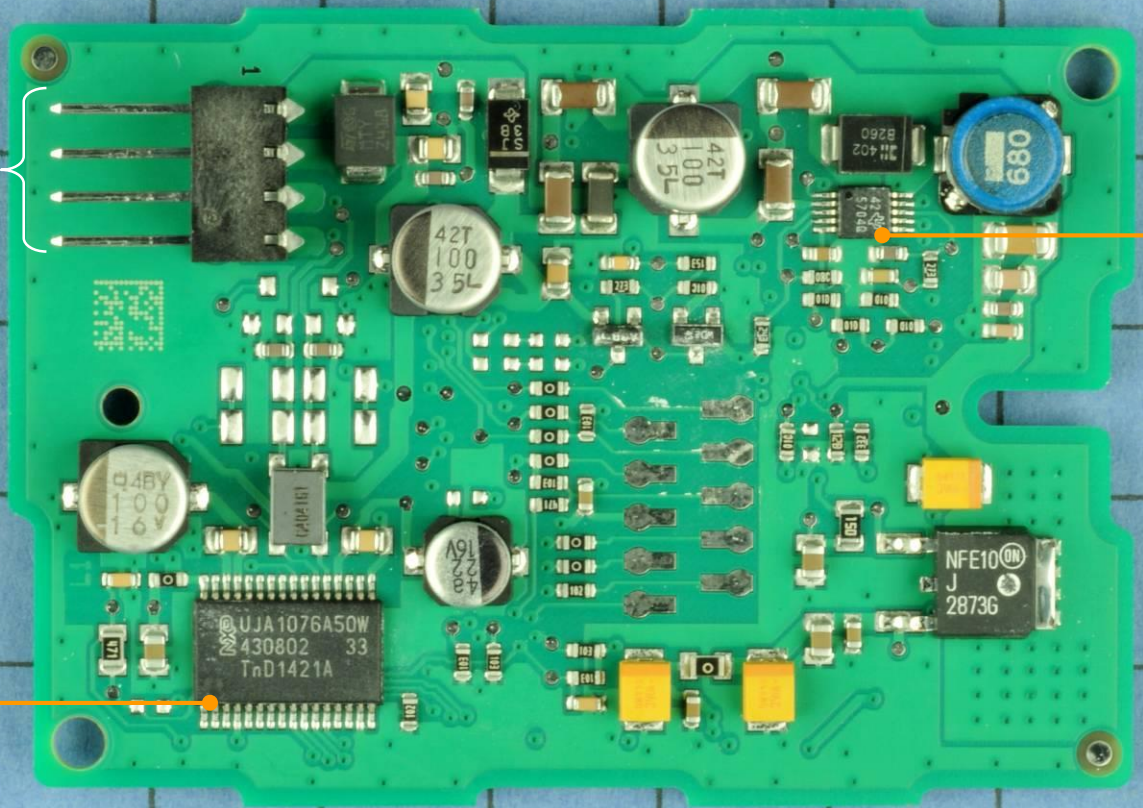
MUNRO
& ASSOCIATES, INC.

Vehicle Wiring



1 - NXP Semiconductor
#UJA1076A
CAN System Basis Chip

2 - Texas Instruments
#TPS57040
500 mA Step-Down Converter

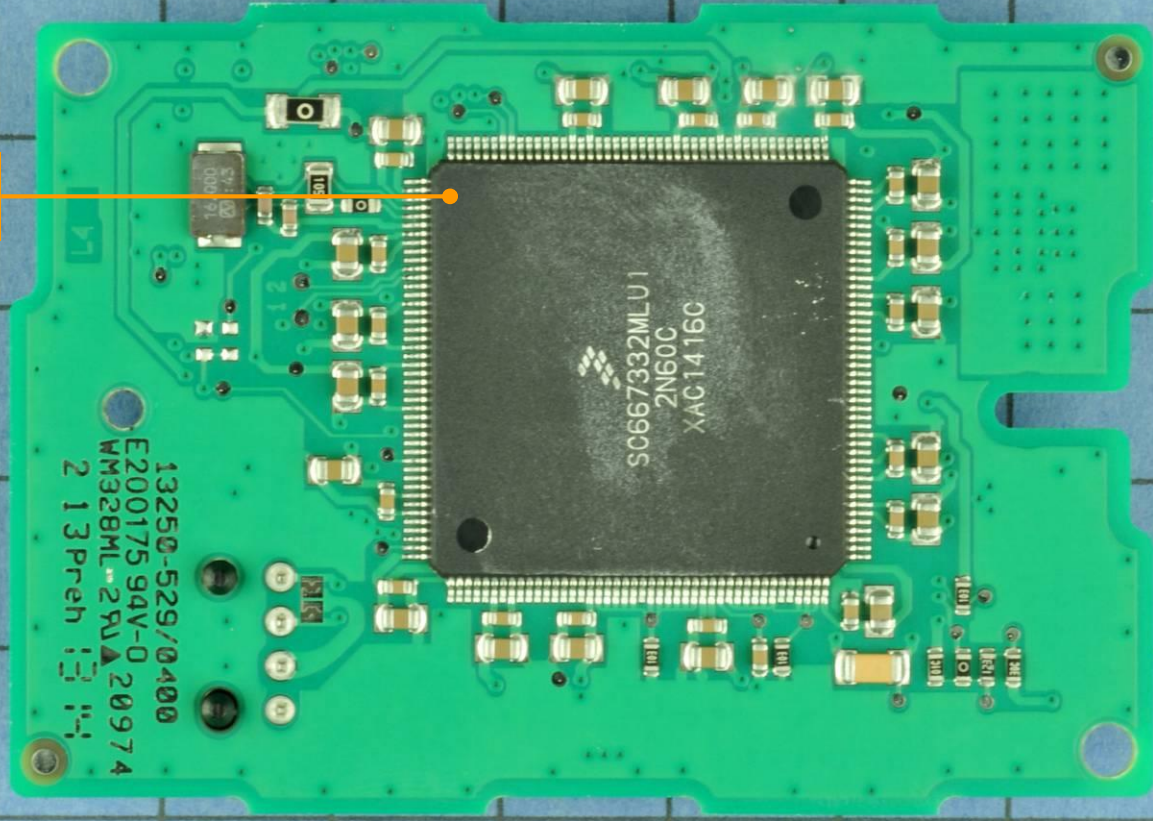


Grid = 1 cm

Main Board (Side 2 & IC Identification)

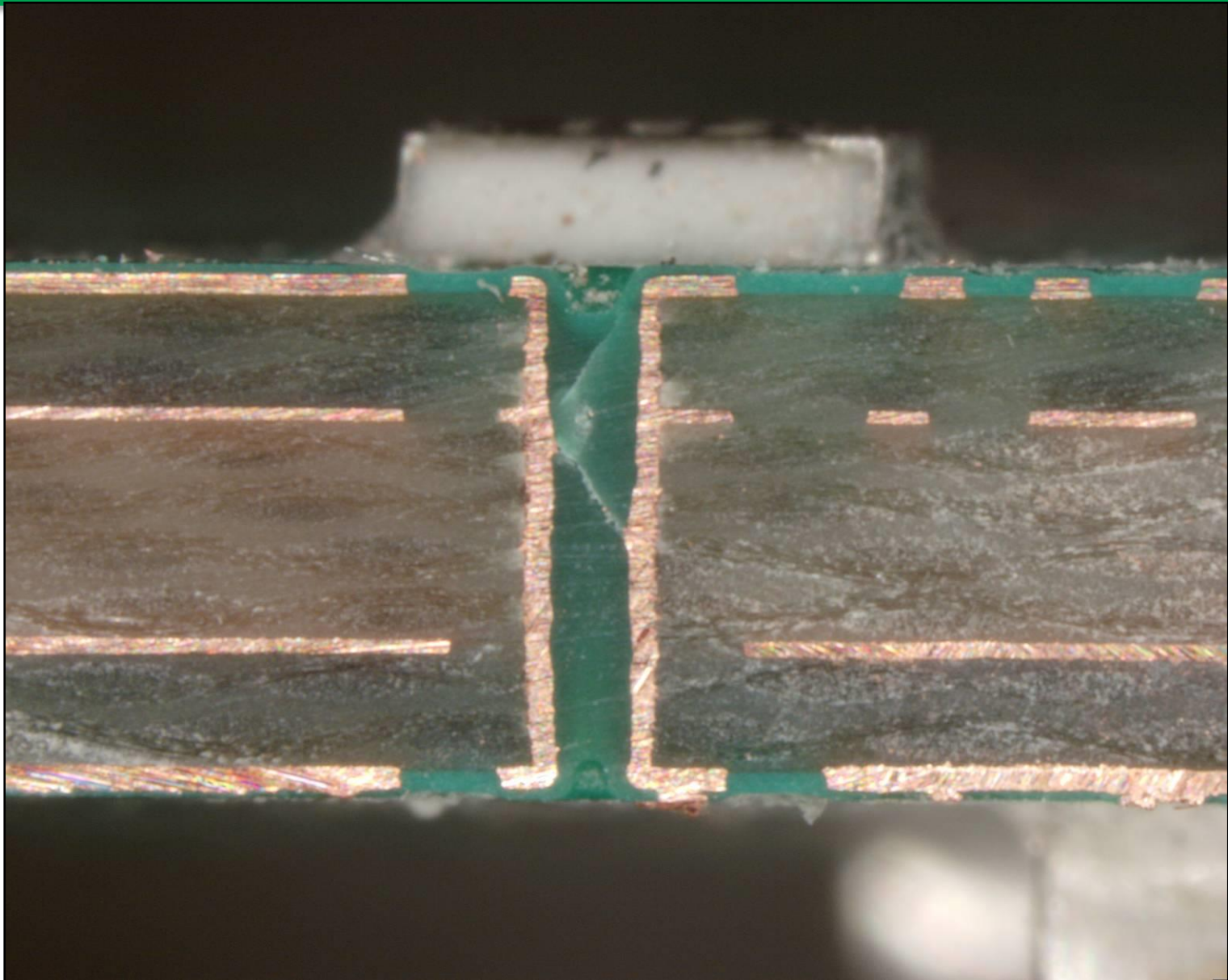


3 - Freescale
#SC667332
16-Bit Microcontroller



Grid = 1 cm

Main Board Cross-Section



Substrate Data

Substrates

Assembly Name	Manufacturer	Core Material	Mfg. Technology	Layers	Area (cm ²)	Min. Trace Pitch (mm)	Min. Trace Width (mm)	ThruVia Land Dia (mm)	ThruVia Hole Dia (mm)	BlindVia Land Dia (mm)	BlindVia Hole Dia (mm)	Thickness (mm)	Routing Density	Estimated Costs
Main Board	WORLD MASTERY TECHNOLOGY LTD	FR4	4 Layer conventional FR4 / HF	4	29.1	0.40	0.20	0.70	0.30			1.5	23.4	\$ 0.54

Integrated Circuit Components



MUNRO
& ASSOCIATES, INC.

Location	Package Info									Die Info						Estimated Costs			
	Pkg Ref. #	Pkg Qty	Brand Name	Part Number	Pkg Description	Form	Pin Count	Length (mm)	Width (mm)	Height (mm)	Die Ref #	Die Qty	Brand Name	Part Number	Description	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	1	NXP Semiconductor	UJA1076A	CAN System Basis Chip	TSOP	32	11.10	6.00	0.90	1.1	1	NXP Semiconductor	cF1501A	CAN System Basis Chip	4.10	3.10	\$ 2.393	\$ 2.393
	2	1	Texas Instruments	TPS57040	500 mA Step-Down Converter	SOP	10	3.10	2.90	0.90	2.1	1	Texas Instruments	TPS54060B	500 mA Step-Down Converter	1.60	1.50	\$ 0.190	\$ 0.190
Main Board, Side 2	3	1	Freescale	SC667332	16-Bit Microcontroller	QFP	176	23.90	23.90	1.40	3.1	1	Freescale	N60C	16-Bit Microcontroller	6.90	6.12	\$ 9.570	\$ 9.570
Totals		3					218					3							\$12.15

Note: Supplemental information, such as IC package & die markings, is included in the Excel Bill of Materials (BOM) spreadsheet.

Modular Components



Location	Qty	Brand Name	Part Number	Description	Package			Estimated Costs	
					Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Unknown	G404161	Transformer: Transformer, Isolation	4	4.50	3.20	\$ 0.300	\$ 0.300
Main Board, Side 2	1	NDK	NX5032	Crystal: Ceramic - NX5032	2	5.00	3.20	\$ 0.200	\$ 0.200
TOTALS	2				6				\$0.50

Active Discrete Components



Location	Qty	Functional Description	Package					Estimated Costs	
			Form	Top Marking	Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Small Active	Transistor, Large - NJD2873T4G	NTE10 ON SEMI logo J 2873G	3	6.50	6.10	\$0.150	\$0.150
	2	Small Active	Transistor, Small	WD s 43, A6B J	3	3.00	1.30	\$0.030	\$0.060
	1	Small Active	Diode, Rectifier, SMT - B260	DIODES INC logo 402 B260	2	4.30	3.50	\$0.015	\$0.015
	1	Small Active	Diode, SMT	SJ 3B VISHAY logo	2	4.00	2.60	\$0.015	\$0.015
	1	Small Active	Diode, TVS, SMT - SM6TY	MTY Z 418	2	4.10	3.70	\$0.015	\$0.015
TOTALS	6				15				\$0.25

Passive Discrete Components

Location	Qty	Functional Description	Package		Estimated Costs	
			Form	Pin Count	Each	Total
Main Board, Side 1	3	Capacitor	Tantalum, Small	2	\$0.050	\$0.150
	1	Coil	SMT, Small	2	\$0.050	\$0.050
	4	Capacitor	Electrolytic, Small	2	\$0.040	\$0.160
	62	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.248
Main Board, Side 2	52	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.208
TOTALS	122			244		\$0.82

Connectors

Location	Qty	Form	Package			Estimated Costs	
			Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Bd to Bd: Male Header - Vehicle Wiring	4	13.50	10.00	\$0.040	\$0.040
TOTALS	1		4				\$0.04

Electronic Assembly Metrics



Electronic Assembly Metrics by Assembly											
General Area	Assembly Name	Substrate Area (sq.cm)	Metal Layers	Circuit Area (sq.cm)	Routing Density (cm of routing per sq.cm of substrate)	Number of Components	Number of Connections	Component Density (Components/sq.cm)	Connection Density (Connections/sq.cm)	Avg. Pin Count	Assembly Weight (grams)
Main Electronics	Main Board	29.1	4	116.4	23.4	134	487	4.6	16.7	3.6	18.70
	System Totals	29.1	4	116.4		134	487	4.6	16.7	3.6	18.70

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Electronics Costs by Assembly										
General Area	Assembly Name	Total	Integrated Circuits	Modular & Odd Form Components	Small Active Components	Passive Components	Connector Components	Substrates	Insertion	Card Test
Main Electronics	Main Board	\$ 15.29	\$ 12.15	\$ 0.50	\$ 0.25	\$ 0.82	\$ 0.04	\$ 0.54	\$ 0.72	\$ 0.27
	System Totals	\$ 15.29	\$ 12.15	\$ 0.50	\$ 0.25	\$ 0.82	\$ 0.04	\$ 0.54	\$ 0.72	\$ 0.27

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Counts by Assembly												
General Area	Assembly Name	IC Package Count	IC Connections	Modular/Odd Form Components	Modular/Odd Form Component Connections	Small Active Components	Small Active Component Connections	Passive Components	Passive Component Connections	Connectors	Connector Connections	Opportunities
Main Electronics	Main Board	3	218	2	6	6	15	122	244	1	4	621
	System Totals	3	218	2	6	6	15	122	244	1	4	621

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics

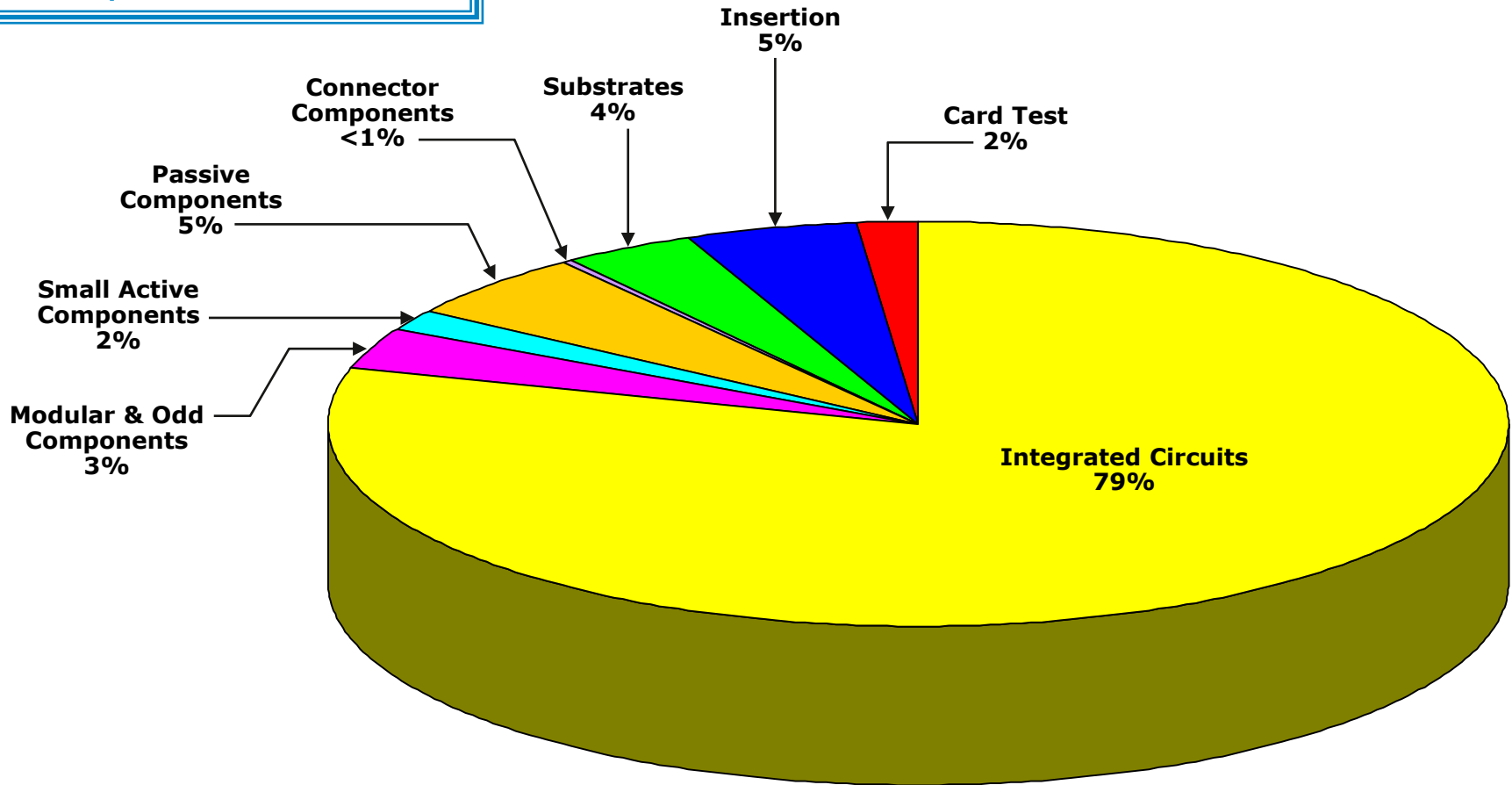


IC Metrics												
General Area	Assembly Name	IC Die Count	IC Package Count	Number of Package Connections	Die Area (sq.mm)	Substrate Tiling Density (die area / substrate area)	Package Area (sq.mm)	Die Area/Package Area Ratio	Package Connections per sq.cm of Package Area	Volatile Memory (KBytes)	Non-Volatile Memory (KBytes)	
Main Electronics	Main Board	3	3	218	57.3	0.02	646.8	0.09	33.7	0	0	
	System Totals	3	3	218	57.3		646.8	0.09	33.7	0	0	

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Costs Breakdown

**Estimated Cost
of Electronics**
(Includes Subsystem Electronics)
\$15.29

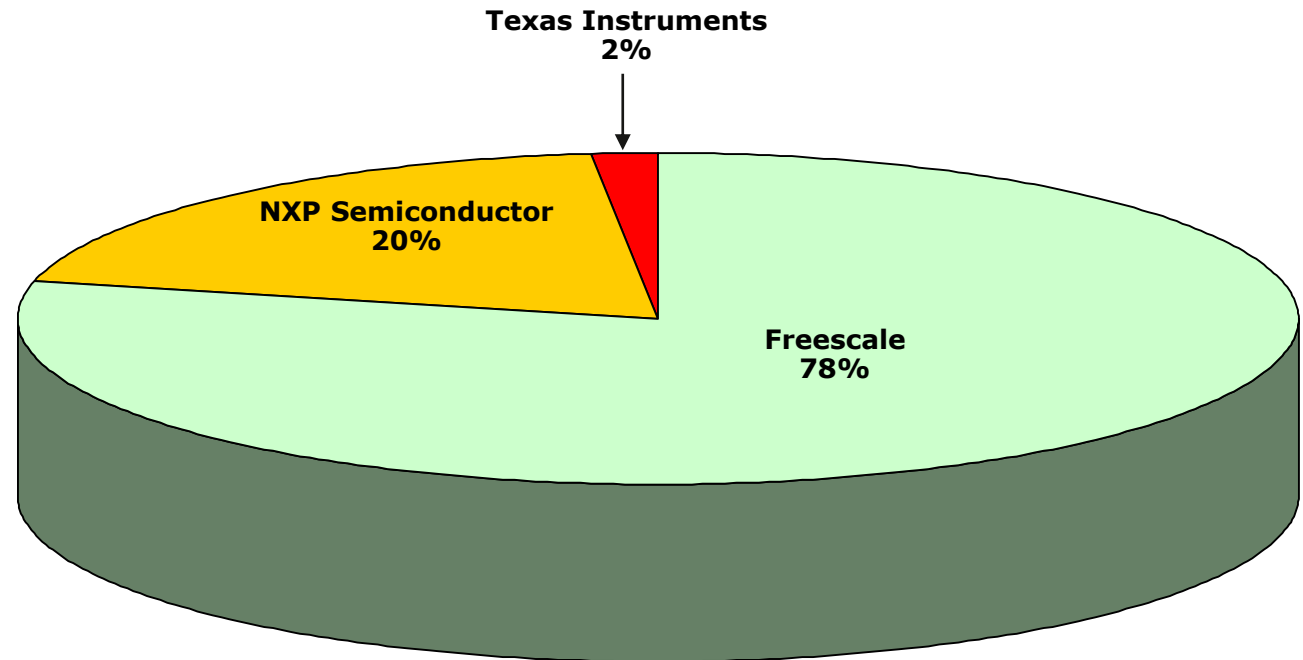


NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Vendor IC Cost Distribution

Pkg. Brand	Cost
Freescale	\$9.57
NXP Semiconductor	\$2.39
Texas Instruments	\$0.19

* Includes Subsystem Vendors & Associated Costs



NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Non-Electronic Cost Estimate



Subsystem	Part ID No.	Qty	Description	Fabrication Process	Material	Dimensions (mm)	Weight (grams)	Est'd Cost Each	Est'd Extended Cost	
Housing	1	1	Housing, Lower	Molded	Plastic + Adhesive	96 x 51.9 x 11.9	10.40	0.490	0.490	
	2	1	Housing, Upper	Molded	Plastic	76 x 52.3 x 15.4	13.00	0.900	0.900	
	3	1	Label, Nameplate	Die-Cut + Printed	Plastic + Adhesive	45 x 30 x 0.07	0.10	0.050	0.050	
Total		3						Estimated Cost		\$1.44

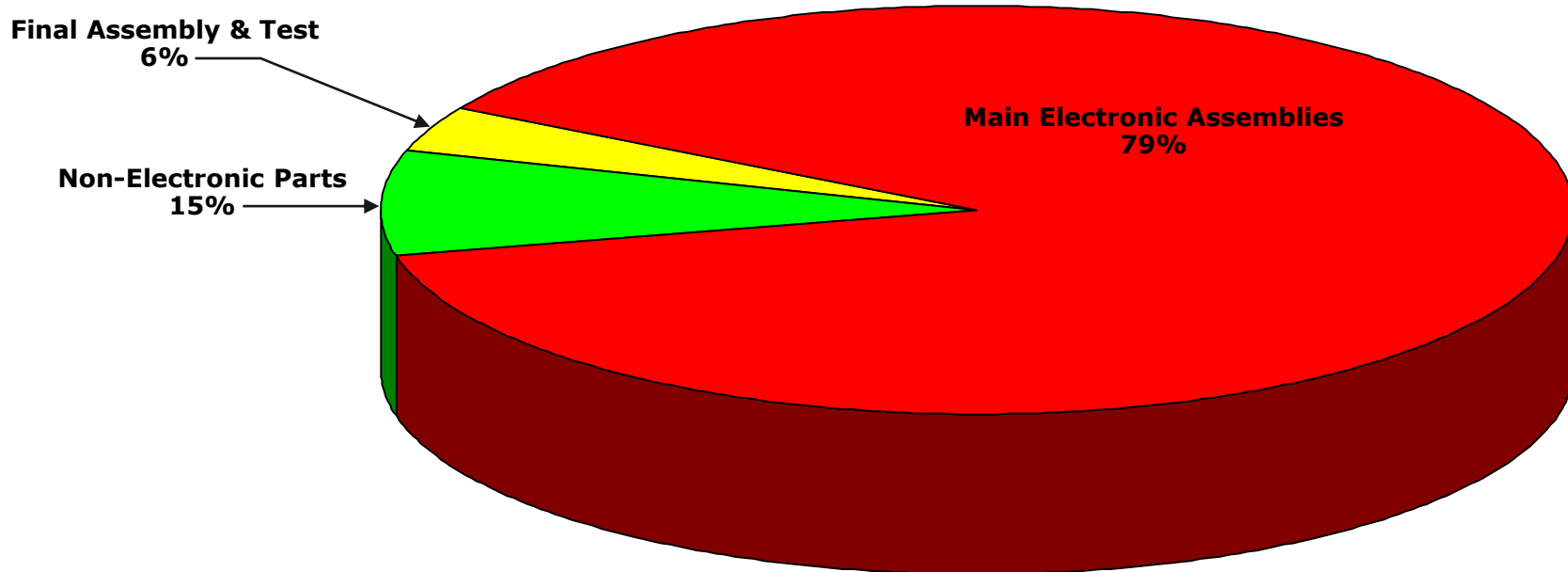
Final Ass'y Labor & Test Cost Estimate

Final Assembly & Test	
Made in	Germany
Number of parts	4
Est'd number of steps	12
Est'd time (seconds)	41
Est'd final assembly cost	\$ 0.52
Est'd final test cost	\$ 0.10

Cost Summary

Estimated Cost Totals	
Main Electronic Assemblies	\$ 15.29
Non-Electronic Parts	\$ 1.44
Final Assembly & Test	\$ 0.62
Total	\$ 17.36

Cost Total Notes:
Estimated final assembly cost includes labor only.
Total cost does not include Non-recurring, R&D, G&A, IP licensing fees/royalties, software, sales & marketing, distribution.
Assumes fully scaled production.



Cost Estimation Process

(Overview & Discussion)



Cost modeling is a tricky business. Multiple variables affect the actual production costs a manufacturer will experience, including development expenses, unit volumes, supply-and-demand in component markets, die yield-curve maturity, OEM purchasing power, and even variations in accounting practices. Different cost modeling methods employ different assumptions about how to handle these and other variables, but we can identify two basic approaches: that which seeks to track short-term variations in the inputs to the production process, and that which strives to maintain comparability of the output of the model across product families and over time.

TechInsights' philosophy in cost modeling is to emphasize consistency across products and comparability over time, rather than to track short-term fluctuations. During the past eight years, we have developed an estimation process that, while necessarily lacking an insider's knowledge of the cost factors that impact any one manufacturer, is reasonably accurate in its prediction of unit costs in high-volume production environments. We do not claim that the model will produce the "right" answer for your firm's environment. However, TechInsights does give customers a key analytical tool with a complete set of data in our Bill of Materials (BOM). The BOM allows readers to 1) scrutinize the assumptions behind our cost model and 2) modify the results based on substitution of their own component cost estimates where they have better information based on inside knowledge.

Our estimation process decomposes overall system cost into three major categories: Electronics, Mechanical, and Final Assembly. We begin by creating a complete electronics bill-of-materials (BOM). Each component from the largest ASIC to the smallest discrete resistor is entered into a BOM table with identifying attributes such as size, pitch, I/O count, package type, manufacturer, part number, estimated placement cost, and die size (if the component is an IC). Integrated circuit costs are calculated from measured die area. Using assumptions for wafer size, process type, number of die per wafer, defect density, and profit margin in combination with die area, an estimate of semiconductor cost is derived. Costs for discrete components and interconnect are derived from assumption tables which relate BOM line items to specific cost estimates by component type and estimates for part placement costs are included. For LCD display costs, we employ a model which tabulates expected cost from measurements of glass area, LCD type, and total pixel resolution. When market costs are available from alternative sources, LCD panel costs are taken from and referenced to these sources.

Costs of non-electronic components such as molded plastic enclosures and metallic components are measured in terms of weight, size, thickness, type of material, and complexity to arrive at their estimated cost. Other system items such as optics, antennae, batteries and displays are costed from a set of assumption tables derived from a combination of industry data, average high volume costs, and external sources. For final assembly, we re-build the torn-down product, tabulating stepwise assembly times as the reconstruction proceeds, to reach a total assembly time. Using a labor rate assumption for the country of origin, we then calculate final assembly cost.

The three major categories for system cost contributors can be broken down into the subcategories of ICs, other electronics parts, displays, batteries (as appropriate), camera modules, electronics assembly, non-electronic elements, and final assembly. By adding the cost estimates for each of these subcategories, an overall estimated cost is derived for the system under evaluation. Product packaging and accessories (CDs, cables, etc.) are also documented and estimated for their contribution to total cost as appropriate.

We believe our cost estimates generally fall within 15 percent of the "right answer," which itself can vary depending on the market and OEM-specific factors mentioned earlier. While the TechInsights cost model is imperfect, it yields important insights into technology and business dynamics along with good first-order contributions to system cost by component type. Additionally, the consistency of approach and gradual modification to assumptions (smoothing out frequently-shifting pricing factors) hopefully yields a credible, but user-modifiable, view of OEM high volume cost-to-produce.

Please feel free to contact us at support@techinsights.com with any comments, questions, or proposed corrections with respect to our cost estimates. We welcome your input.

Metrics (Overview & Discussion)



In our product teardowns, we gather a series of metrics for product profiling and comparison. Some metrics focus on system characteristics such as total silicon area, total system semiconductor storage capacity, and total connection count. Other metrics reflect more subtle aspects of electronics assembly such as connection density, average component I/O count, and silicon tiling density. Taken as a whole, the metrics allow deeper comparison and benchmarking across multiple disciplines and multiple products. Key metrics we gather on products are described below along with their definitions and what they tend to say about the system under study. Most metrics can be used both in comparing similar products for benchmarking purposes or for quantifying differences in levels of complexity between dissimilar product types. Data fall into two categories; either “raw” measured data or ratios of these measured data sets.

Total Silicon Area : This metric describes the total area of silicon as measured from X-ray or direct measurement of ICs. The area is an expression of the enclosed bare die area and excludes packaging area. The aggregate silicon area is a good benchmark to show how integrated a design might be when making comparisons to similar systems. Total silicon area also reflects the major cost driver for most systems we examine.

Silicon Tiling Density : Ratio of Total Silicon Area to total printed circuit board “projected” area (i.e. the simple board area and not the cumulative surface area of both sides of the board). This metric directly reflects the level of efficiency and aggressiveness in integrated circuit packing and placement. Single digit Silicon Tiling Density is typical but silicon coverage of 10% - 20% has been seen in some of the most advanced products we have examined. Higher Tiling Densities often correspond with the use of chip scale packaging (CSPs) or other small form-factor IC packaging technologies. High density circuit boards are also often a supporting technology.

Number of Parts : Total component count including ICs, passives, modules, connectors, etc., each separated out in our reporting.

Number of Connections : The total number of connections corresponds to the total number of interconnects introduced by the aggregate component set and reflects any electrical connection observed (solder joints, adhesive interconnect, or connector terminal interfaces).

Opportunity Count : Opportunity Count is the total number of parts plus the total number of connections; the name reflects that each of these constituent elements represents an opportunity for failure. A high opportunity count means more complex and riskier electronics assembly.

Average Pin Count (APC) : Ratio of total number of component terminals to total number of parts, at the system level. This metric reflects the ‘average’ terminal complexity of the components and often provide a signature of integration level and/or “digital-ness” of the overall product. Low APCs reflect a high number of discrettes or other low-pincount devices often characteristic of analog circuitry. Conversely, high APCs are characteristic of highly integrated, high-pincount assemblies, often those composed largely of digital integrated circuits.

Connection Density : This metric is a ratio of the total Number of Connections to total printed circuit board assembly area, in units of connections per sq. inch. The metric provides data related to the Silicon Tiling Density above, but with an emphasis on complexity of I/O interconnect. For example, with a fixed Connection Density, high tiling density of low-pincount memory chips is more readily achieved than comparable silicon tiling of high pincount logic.

Part Density : This metric is a ratio of the total Number of Parts to total printed circuit board assembly area, in units of components per sq. inch. The metric provides data related to the Silicon Tiling Density and Connection Density as described above, but with an emphasis on density and complexity of component packing efficiency. For example, low Part Density of high-pincount devices can pose an equal challenge in Connection Density to high Part Density of low-pincount devices. High Part Density does reflect challenges in surface mount assembly in terms of (typically) precision of placement, number of placements, and engineering of part clearances.

Routing Density (heuristic estimate) = $3 * (\text{Average Pin Count}) * \sqrt{\text{Part Density}}$. The Routing Density metric is an empirically derived relationship that characterizes the wiring density of the interconnect used to support the interconnection of components in a planar electronic assembly (i.e. the circuit board). Architectural issues such as bussing or other factors affecting the regularity of wiring impact the actual Routing Density needed to support a given application, but the metric provides a ready measure of wiring complexity.

***Click Here to Return to
Cost Analysis Page 189***

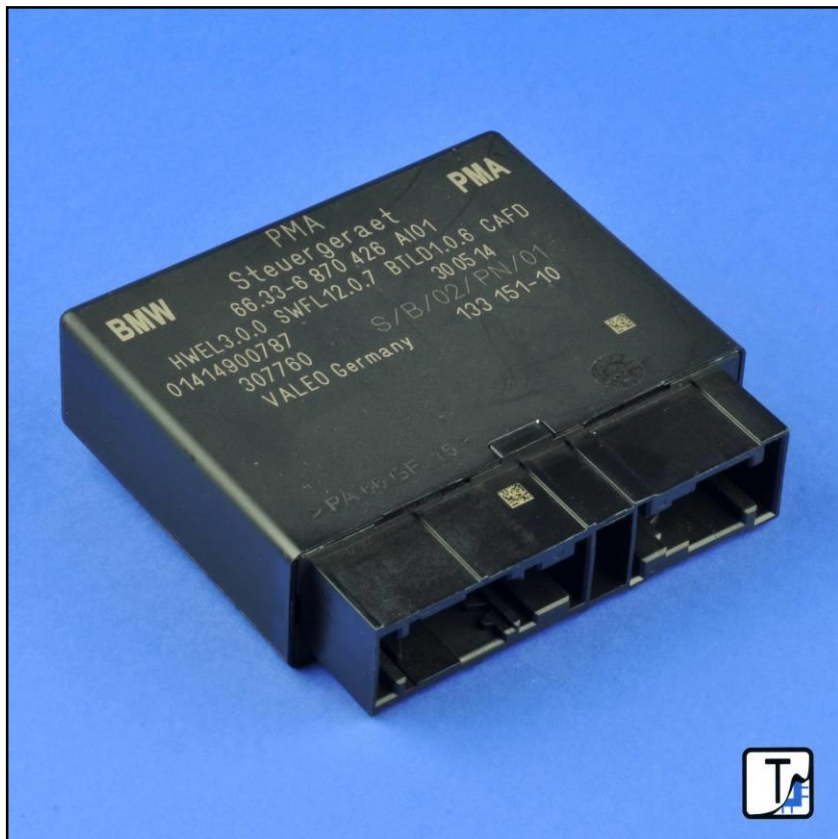
Deep Dive Report

BMW i3 Parking Assist Module

66.33_6870426

2158

Report #15900-150114-RBb



Product Description

One of the features commonly included on new automobiles is parking assistance. The 66.33 6870426 module facilitates this function on the 2014 BMW i3. This relatively simple module consists of a single printed circuit board assembly (PCBA) that measures 82.2 x 59.5 mm. It slides into a polyamide housing and is held in place by a connector with four locking tabs that secure it to the housing. A total of four integrated circuits (ICs) are used on this board. The two main ICs are a SPC564L60L3 32-bit microcontroller from STMicroelectronics and a UPITOAC custom ASIC by On Semiconductor. The two remaining ICs are an NXP Semiconductor TJA1042T/3 controller area network (CAN) transceiver and a TLE4473-GV53 dual low-drop-out (LDO) regulator from Infineon.

DISCLAIMER: All company names, product names, and service names mentioned are used for identification purposes only and may be registered trademarks, trademarks, or service marks of their respective owners. All analyses are done without participation, authorization, or endorsement of the manufacturer. Any cost analyses presented in this material are estimates prepared by TechInsights from generally available data. While TechInsights believes that these estimates reflect the probable costs, the actual producer did not supply the data, and therefore the actual costs may be different from these estimates. Furthermore, TechInsights extends no warranties with respect to any information in this document, and shall bear no liability whatsoever for the use of the information.

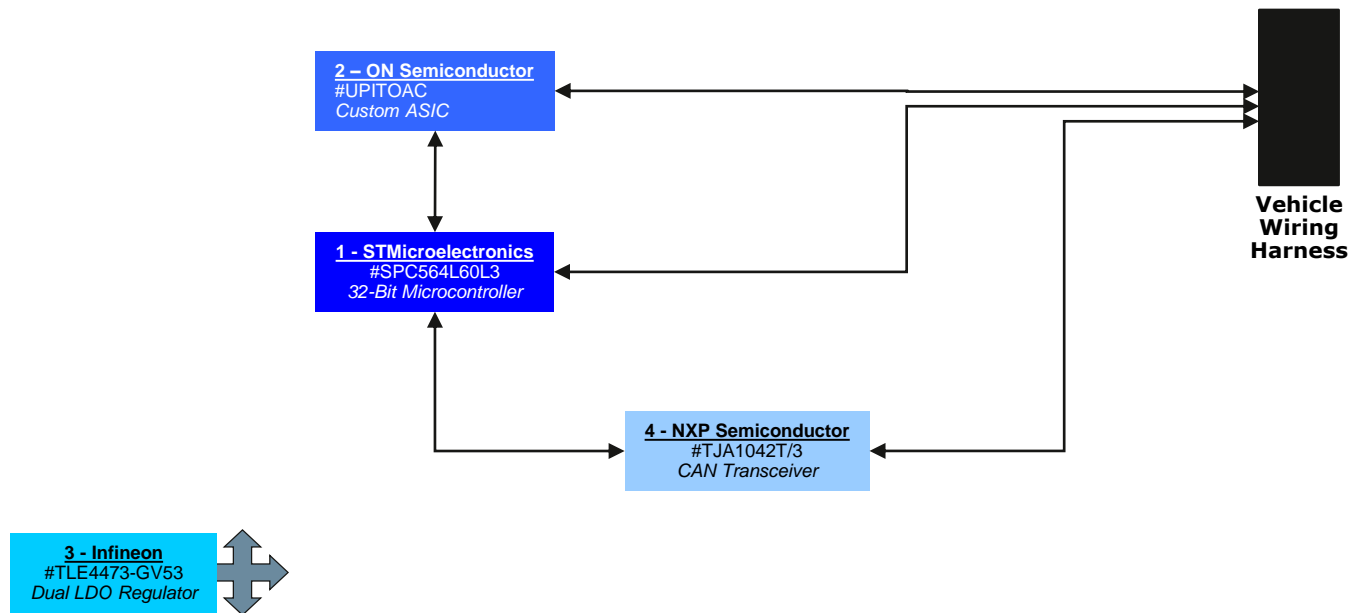
Copyright © 2015, TechInsights. All rights reserved. Do not reproduce, distribute, disseminate, photocopy, fax, transmit, download to a shared database, or otherwise copy, transfer, sell, publish, or send this material, or any portion thereof, by any means without the express written permission of TechInsights.

Product Overview

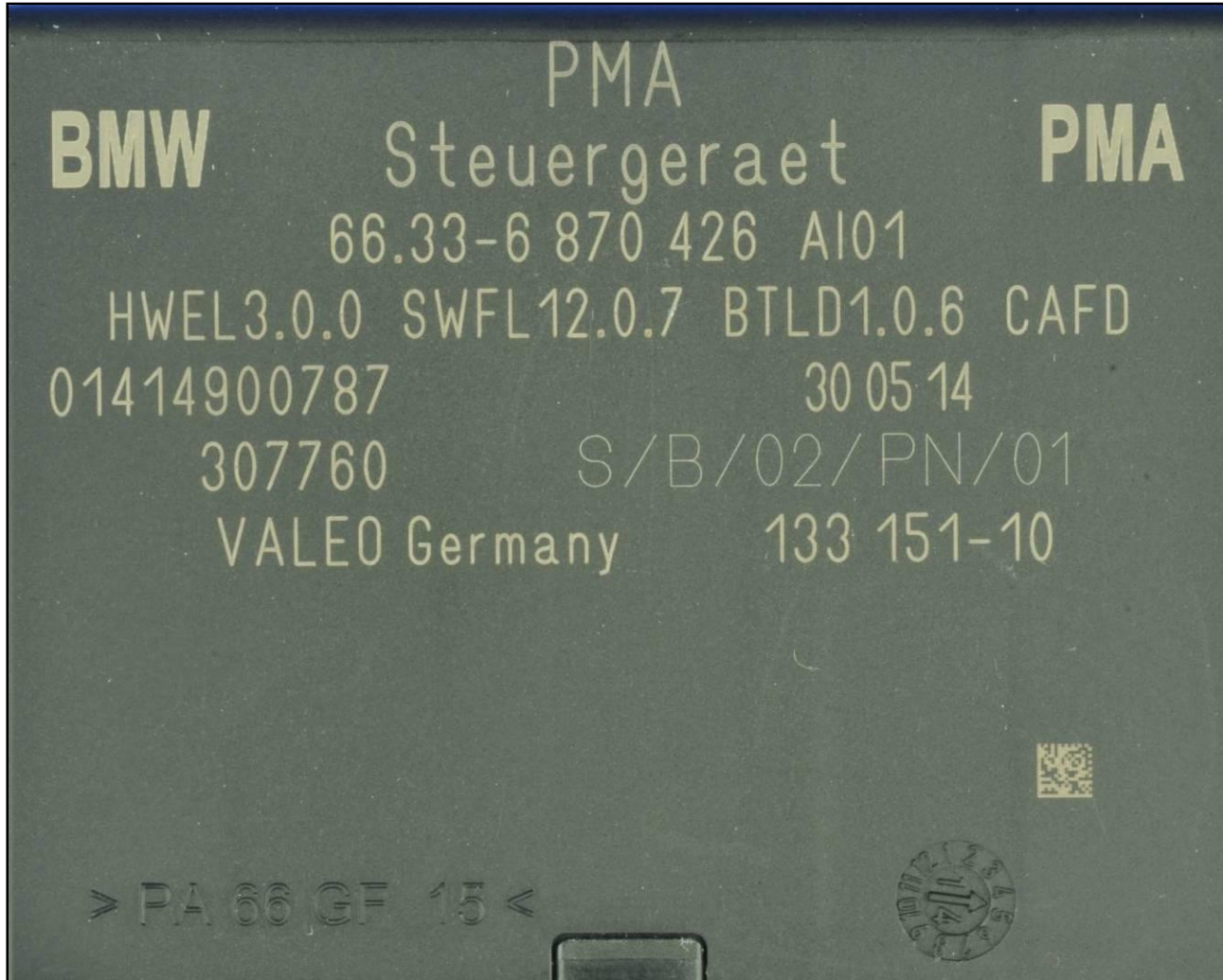


Product Description		Integrated Circuit Metrics		
Product Type	Automotive	IC Die Count	4	
Brand	BMW	IC Package Count	4	
Product Name & Model #	i3 Parking Assist Module, 2158, 66.33_6870426	Cost Metrics		
Official Release Date	Unknown			
Weight (grams)	70.9 (Measured)	Retail Price		
Product Dimensions (mm)	85.1 x 82 x 24.2 (Measured)	Total Manufacturing Cost	\$22.84	
Product Features		Electronics Cost	\$20.66	
		Manufacturing Cost Breakdown		
Processor	STMicroelectronics SPC564L60L3 32-Bit Microcontroller ON Semiconductor UPITOAC Custom ASIC	Integrated Circuits	\$15.15	66.3%
Communications	NXP Semiconductor TJA1042/3 CAN Transceiver	Modules, Discretes & Connectors	\$3.41	14.9%
Voltage Regulator	Infineon TLE4473-GV53 Dual LDO Regulator	Substrates	\$0.89	3.9%
		Component Insertion	\$0.76	3.3%
		Card Test	\$0.45	2.0%
		Non-Electronic Parts	\$1.96	8.6%
		Final Assembly & Test	\$0.22	1.0%
		Total	\$22.84	100.0%

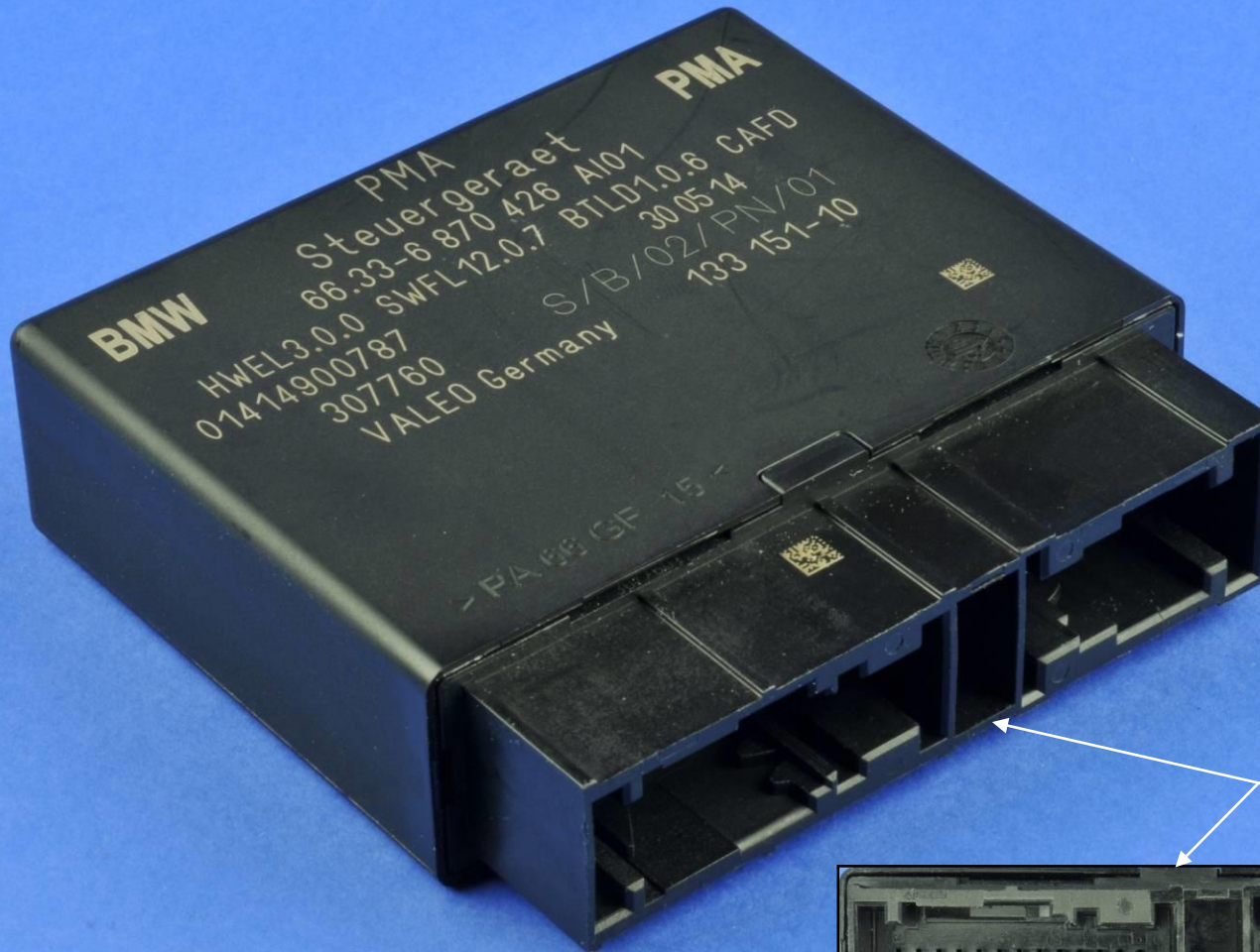
Block Diagram



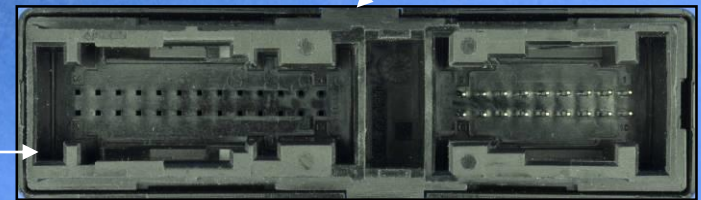
Estimated block diagram based on observation of this specific product implementation, manufacturer's data sheets where available, and best engineering judgment. Certain details of the interface circuitry are not reflected in this block diagram. Partitioning and connectivity are speculative.



Exterior Features



One side is not loaded.

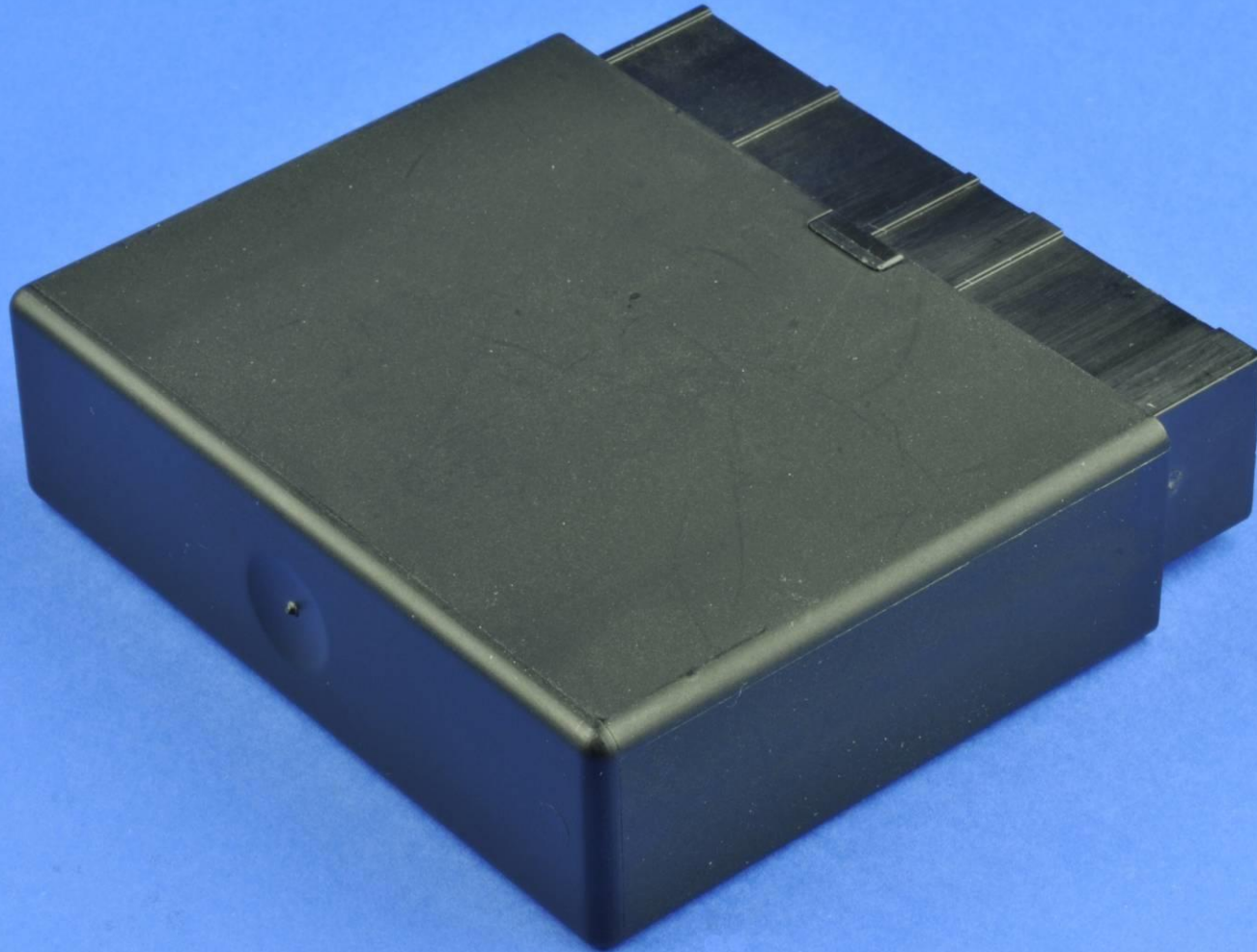


Vehicle Wiring
Harness

Exterior Features



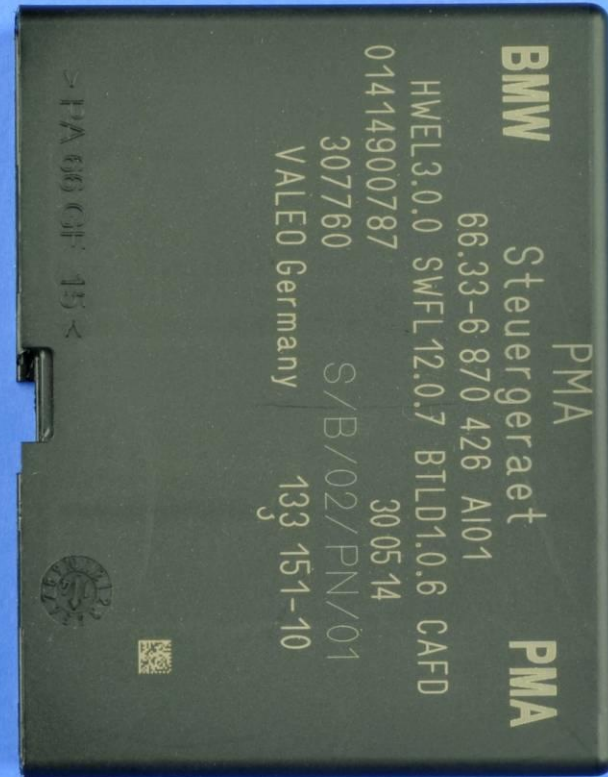
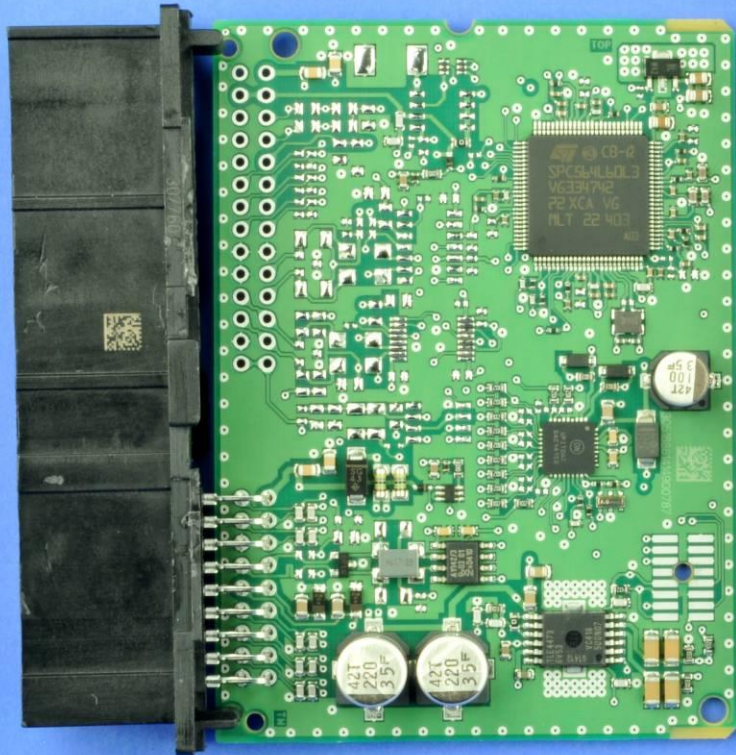
MUNRO
& ASSOCIATES, INC.



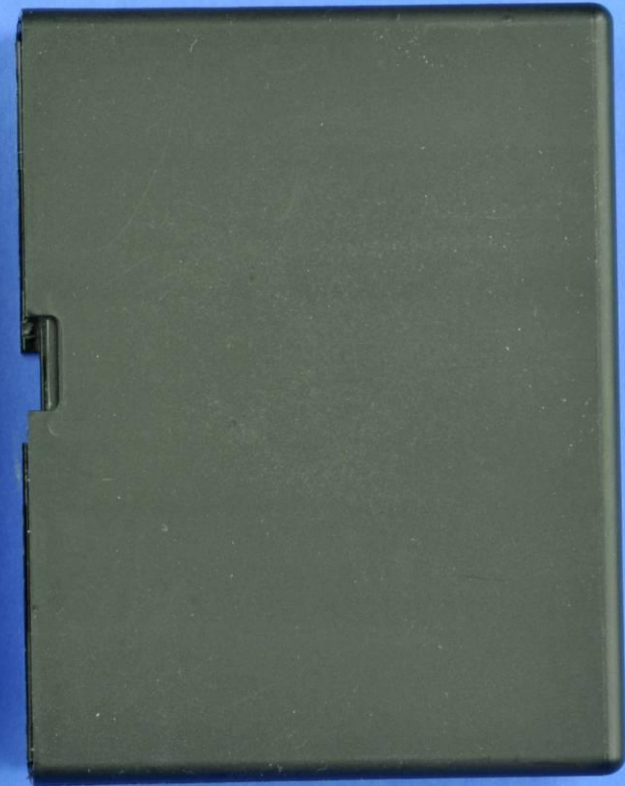
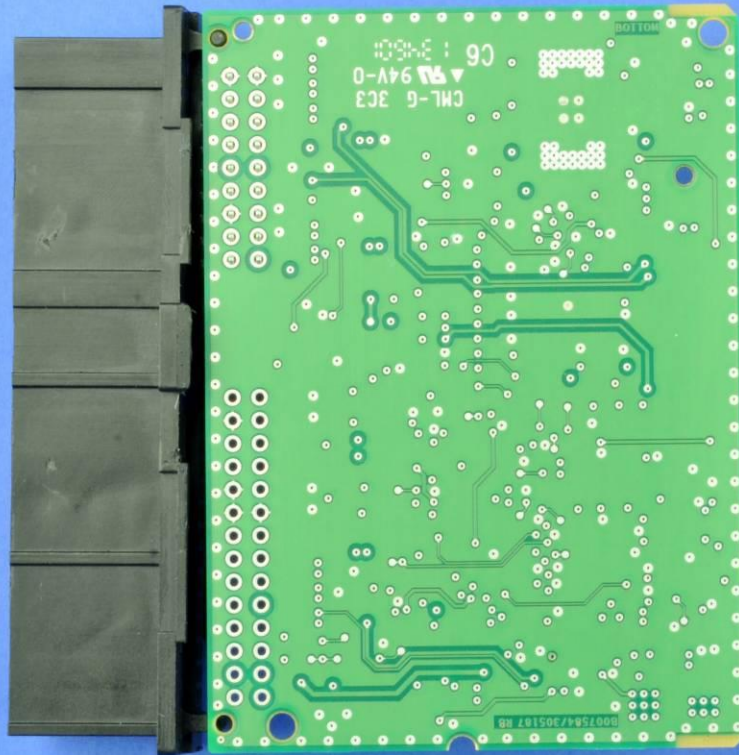
Major Components (Side 1)



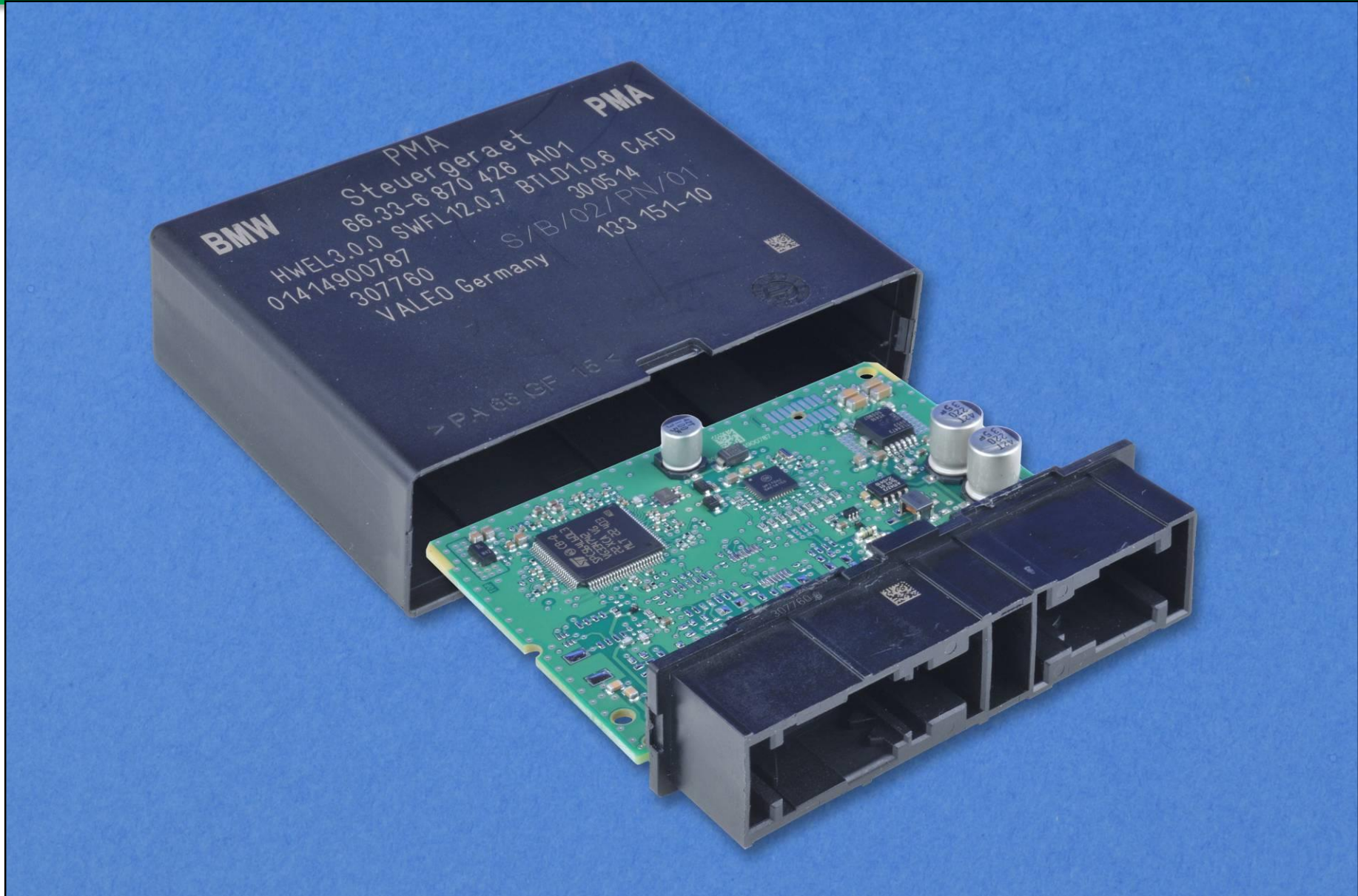
MUNRO
& ASSOCIATES, INC.



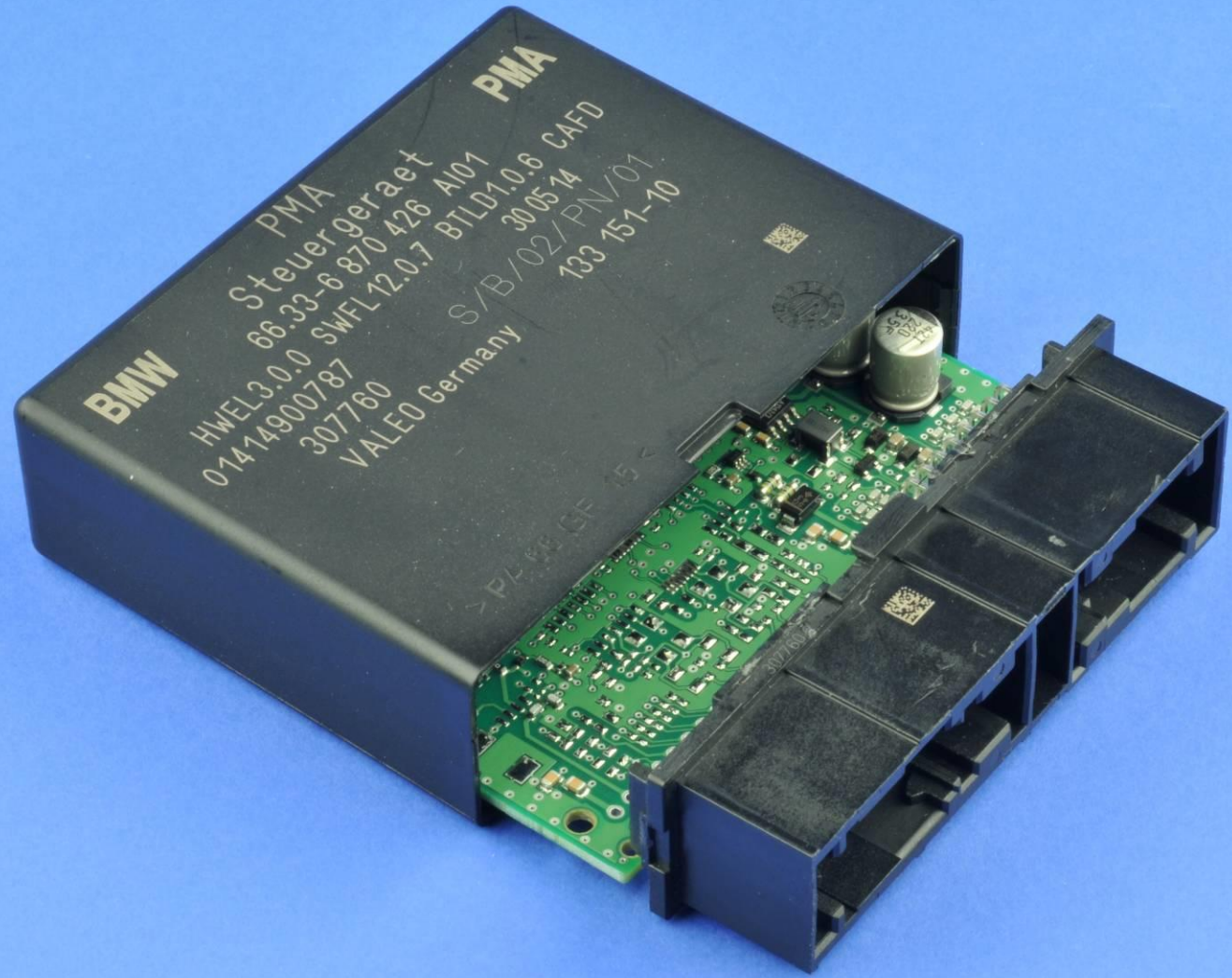
Major Components (Side 2)



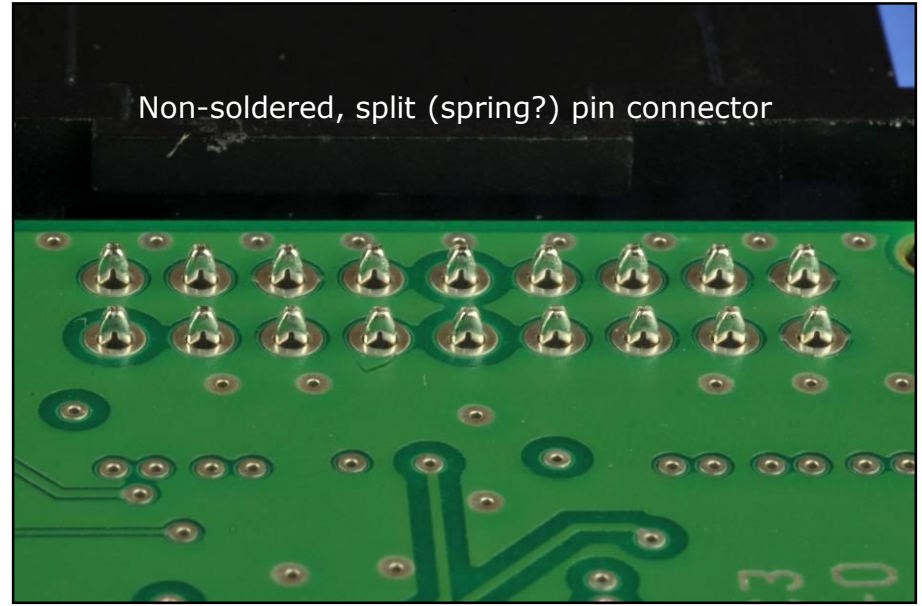
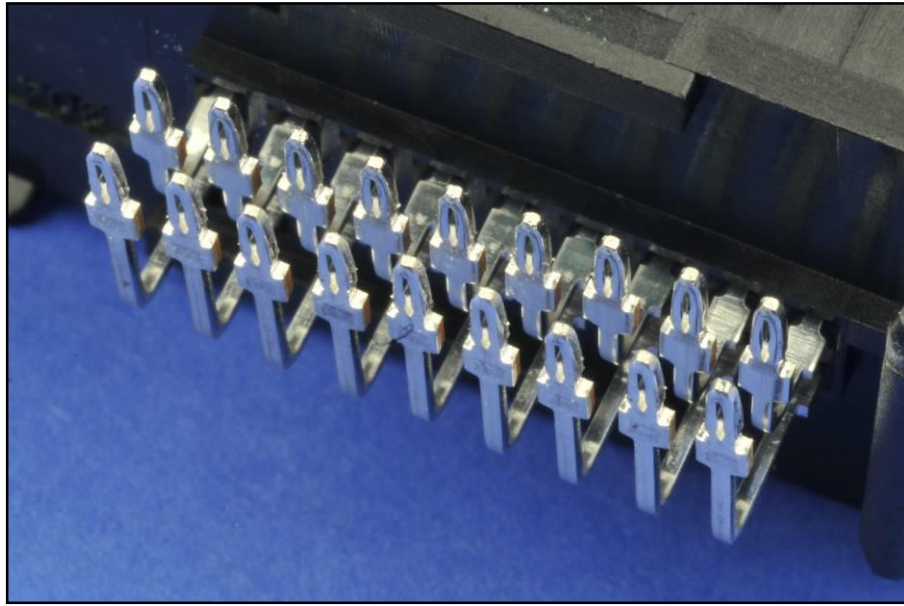
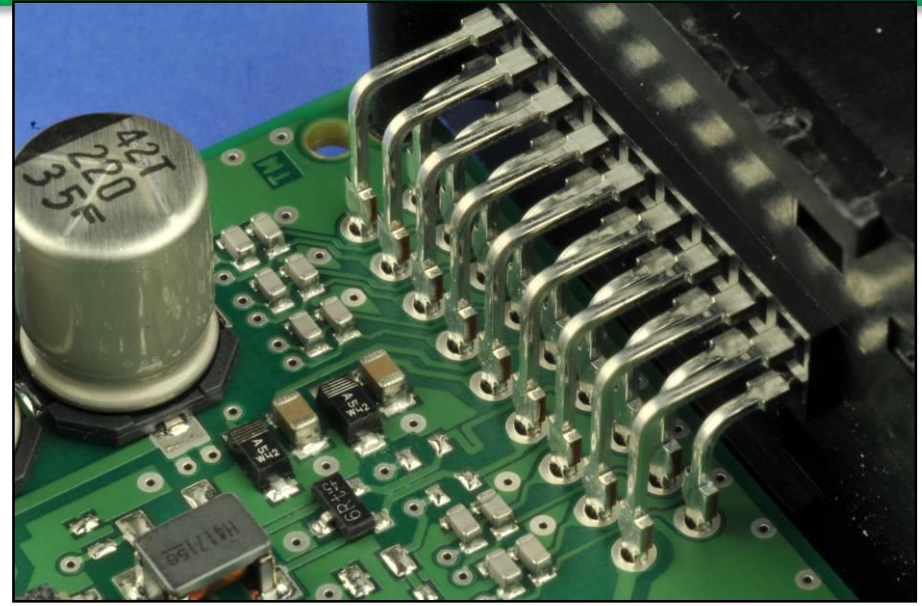
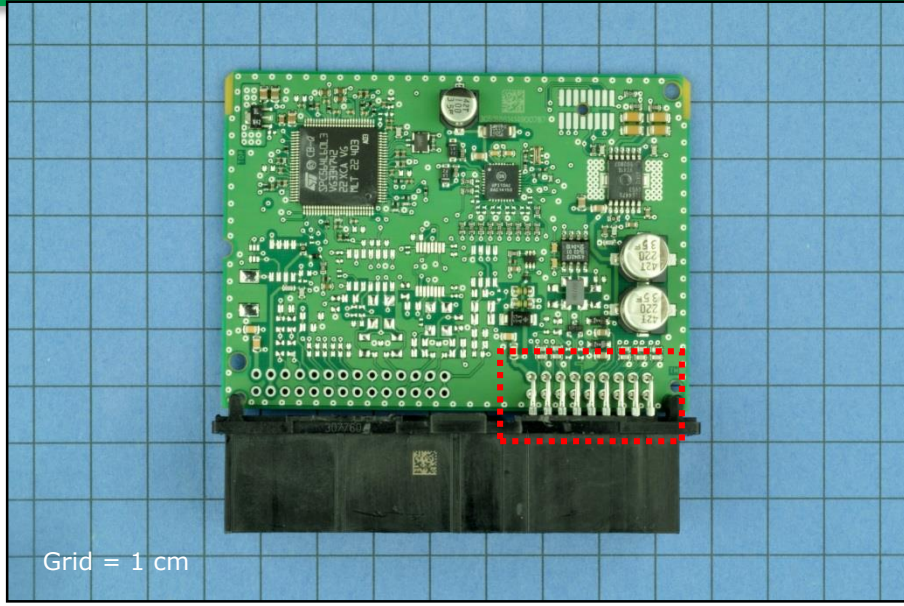
Component Arrangement



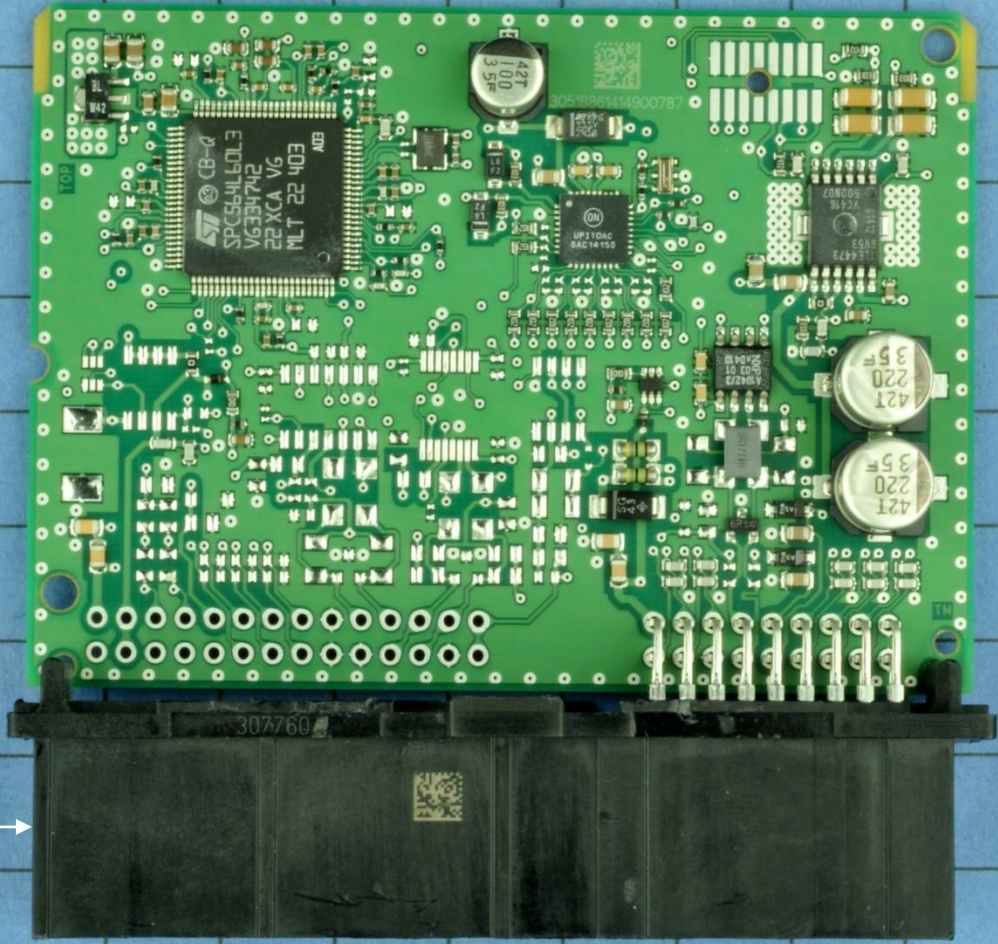
Teardown Sequence



Teardown Sequence



Main Board (Side 1)



Vehicle Wiring
Harness →

Grid = 1 cm

Main Board (Side 1 IC Identification)

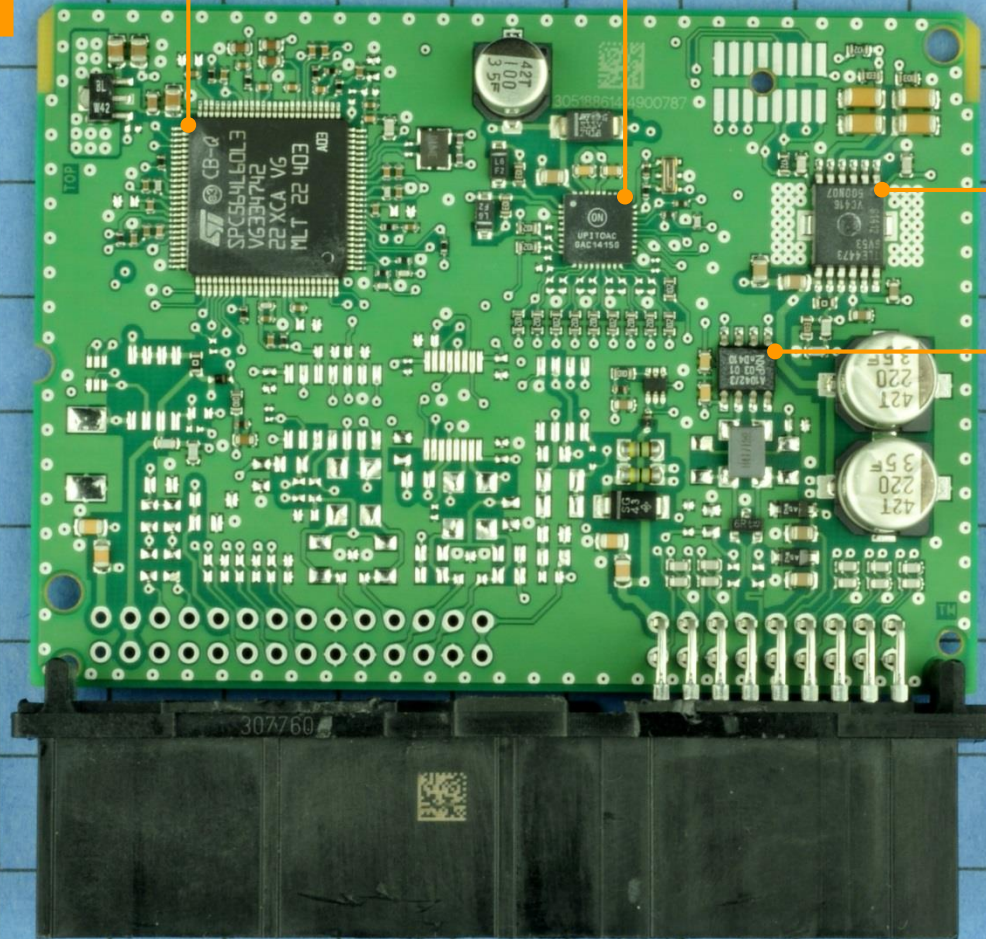


1 - STMicroelectronics
#SPC564L60L3
32-Bit Microcontroller

2 - ON Semiconductor
#UP1TOAC
Custom ASIC

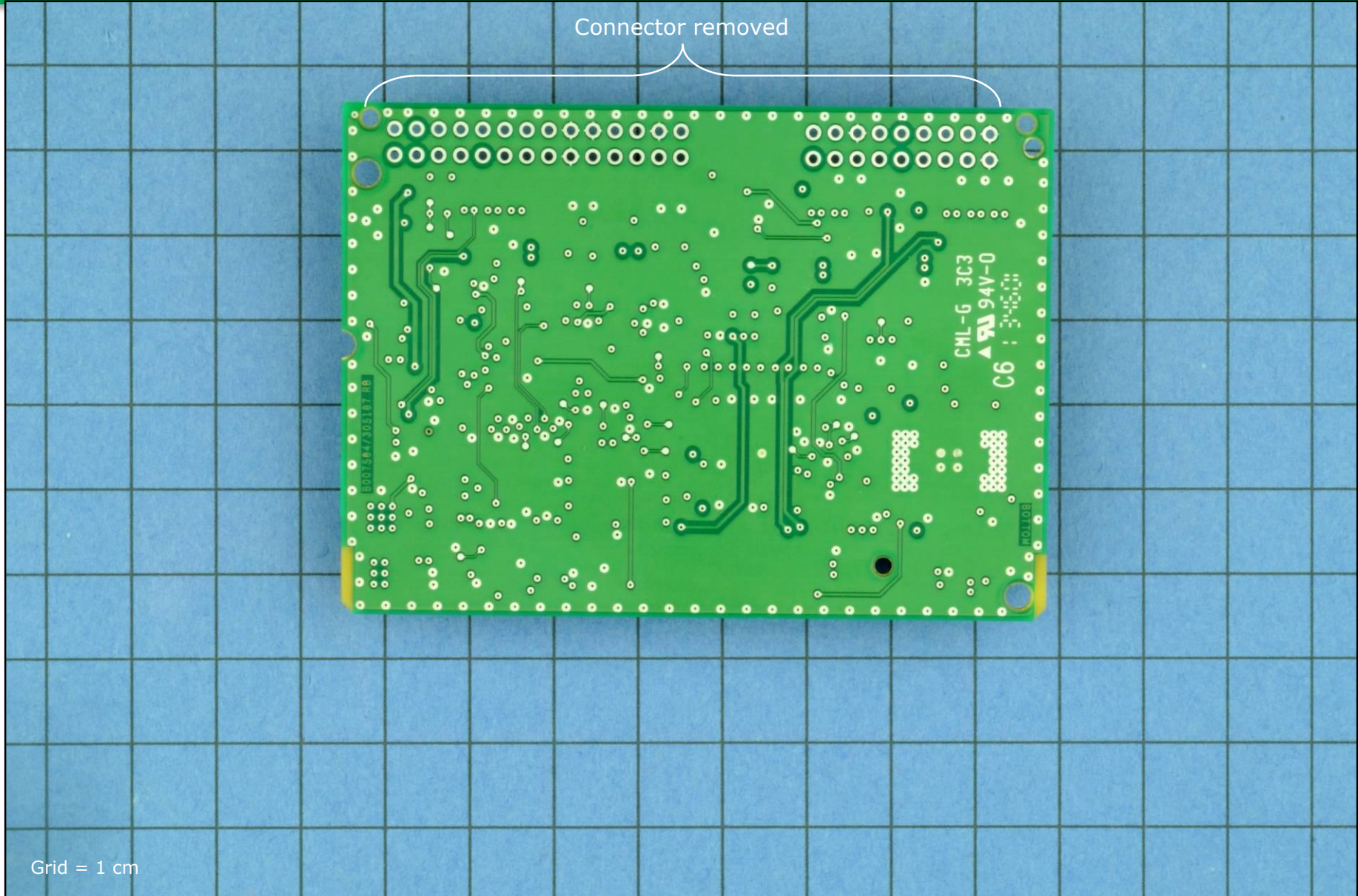
3 - Infineon
#TLE4473-GV53
Dual LDO Regulator

4 - NXP Semiconductor
#TJA1042T/3
CAN Transceiver



Grid = 1 cm

Main Board (Side 2)



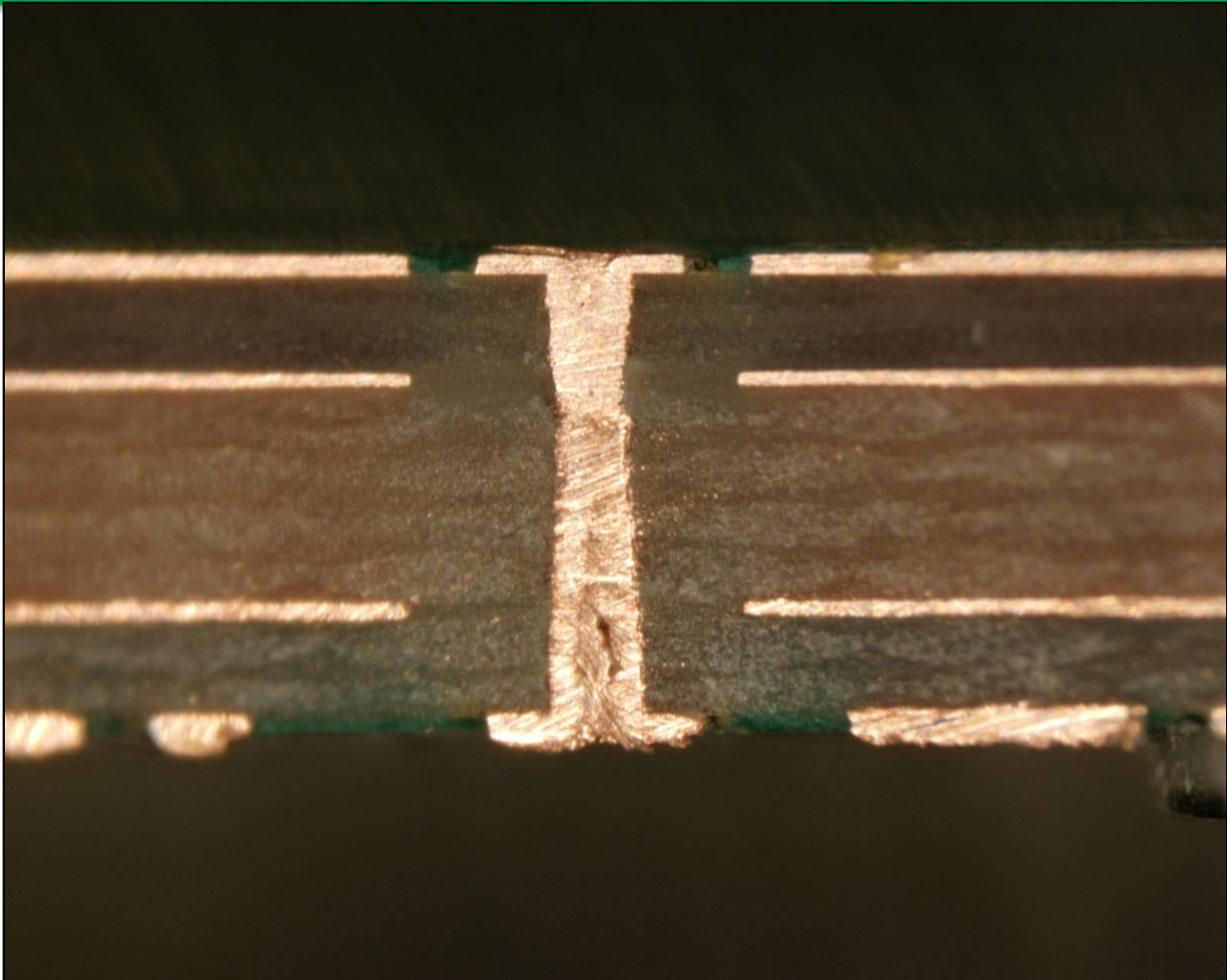
Connector removed

Grid = 1 cm

Main Board Cross-Section



MUNRO
& ASSOCIATES, INC.



Substrate Data

Substrates

Assembly Name	Manufacturer	Core Material	Mfg. Technology	Layers	Area (cm ²)	Min. Trace Pitch (mm)	Min. Trace Width (mm)	ThruVia Land Dia (mm)	ThruVia Hole Dia (mm)	BlindVia Land Dia (mm)	BlindVia Hole Dia (mm)	Thickness (mm)	Routing Density	Estimated Costs
Main Board	CML	FR4	4 Layer Conventional FR4 / HF	4	48.4	0.30	0.20	0.80	0.35			1.6	16.8	\$ 0.89

Integrated Circuit Components



Location	Package Info										Die Info						Estimated Costs		
	Pkg Ref. #	Pkg Qty	Brand Name	Part Number	Pkg Description	Form	Pin Count	Length (mm)	Width (mm)	Height (mm)	Die Ref #	Die Qty	Brand Name	Part Number	Description	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	1	STMicroelectronics	SPC564L60L3	32-Bit Microcontroller	QFP	100	14.00	14.00	1.40	1.1	1	STMicroelectronics	476A0 SRM06	32-Bit Microcontroller	6.20	6.10	\$ 9.180	\$ 9.180
	2	1	ON Semiconductor	UPITOAC	Custom ASIC	QFN	36	6.00	6.00	0.90	2.1	1	ON Semiconductor	UPIT_0	Custom ASIC	3.60	3.40	\$ 4.260	\$ 4.260
	3	1	Infineon	TLE4473-GV53	Dual LDO Regulator	SOP	14	7.40	6.60	2.40	3.1	1	Infineon	TLE4473-GV53	Dual LDO Regulator	3.90	2.40	\$ 1.490	\$ 1.490
	4	1	NXP Semiconductor	TJA1042T/3	CAN Transceiver	SOP	8	5.00	3.90	1.40	4.1	1	NXP Semiconductor	cF1361D	CAN Transceiver	2.10	1.50	\$ 0.220	\$ 0.220
Totals		4					158					4							\$15.15

Note: Supplemental information, such as IC package & die markings, is included in the Excel Bill of Materials (BOM) spreadsheet.

Modular Components



Location	Qty	Brand Name	Part Number	Description	Package			Estimated Costs	
					Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Unknown	A. Q	Crystal: Ceramic	6	3.30	1.30	\$ 0.200	\$ 0.200
	1	Unknown	D164E	Crystal: Ceramic	4	3.20	2.50	\$ 0.200	\$ 0.200
TOTALS	2				10				\$0.40

Active Discrete Components



Location	Qty	Functional Description	Package					Estimated Costs	
			Form	Top Marking	Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Small Active	Transistor, Small - Dual	44 W1s	6	2.10	1.20	\$0.030	\$0.030
	1	Small Active	Transistor, Small	BL W42	4	4.50	2.50	\$0.030	\$0.030
	1	Small Active	Transistor, Small	6Rt 45	3	2.90	1.20	\$0.030	\$0.030
	2	Small Active	Diode, SMT	STM S11Y Z418, SG 43 VISHAY	2	4.20	2.60	\$0.015	\$0.030
	2	Small Active	Diode, SMT	A5 W42	2	2.50	1.60	\$0.015	\$0.030
	2	Small Active	Diode, SMT	L4	2	2.10	1.20	\$0.015	\$0.030
TOTALS	9				25				\$0.18

Passive Discrete Components

Location	Qty	Functional Description	Package		Estimated Costs	
			Form	Pin Count	Each	Total
Main Board, Side 1	2	Capacitor	Niobium, Small	2	\$0.050	\$0.100
	1	Coil	SMT, CMC	4	\$0.510	\$0.510
	1	Capacitor	Electrolytic, Small	2	\$0.040	\$0.040
	2	Capacitor	Electrolytic, Medium	2	\$0.060	\$0.120
	2	Resistor	MELF - 4.7-ohm	2	\$0.015	\$0.030
	119	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.476
TOTALS	127			256		\$1.28

Connectors

Location	Qty	Form	Package			Estimated Costs	
			Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Connector: Vehicle Wiring Harness	18	82.80	21.70	\$1.560	\$1.560
TOTALS	1		18				\$1.56

Electronic Assembly Metrics



Electronic Assembly Metrics by Assembly

General Area	Assembly Name	Substrate Area (sq. cm)	Metal Layers	Circuit Area (sq. cm)	Routing Density (cm of routing per sq. cm of substrate)	Number of Components	Number of Connections	Component Density (Components/sq. cm)	Connection Density (Connections/sq. cm)	Avg. Pin Count	Assembly Weight (grams)
Main Electronics	Main Board	48.4	4	193.6	16.8	143	467	3.0	9.7	3.3	42.80
	System Totals	48.4	4	193.6		143	467	3.0	9.6	3.3	42.80

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Electronics Costs by Assembly										
General Area	Assembly Name	Total	Integrated Circuits	Modular & Odd Form Components	Small Active Components	Passive Components	Connector Components	Substrates	Insertion	Card Test
Main Electronics	Main Board	\$ 20.66	\$ 15.15	\$ 0.40	\$ 0.18	\$ 1.28	\$ 1.56	\$ 0.89	\$ 0.76	\$ 0.45
	System Totals	\$ 20.66	\$ 15.15	\$ 0.40	\$ 0.18	\$ 1.28	\$ 1.56	\$ 0.89	\$ 0.76	\$ 0.45

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Counts by Assembly												
General Area	Assembly Name	IC Package Count	IC Connections	Modular/Odd Form Components	Modular/Odd Form Component Connections	Small Active Components	Small Active Component Connections	Passive Components	Passive Component Connections	Connectors	Connector Connections	Opportunities
Main Electronics	Main Board	4	158	2	10	9	25	127	256	1	18	610
	System Totals	4	158	2	10	9	25	127	256	1	18	610

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics

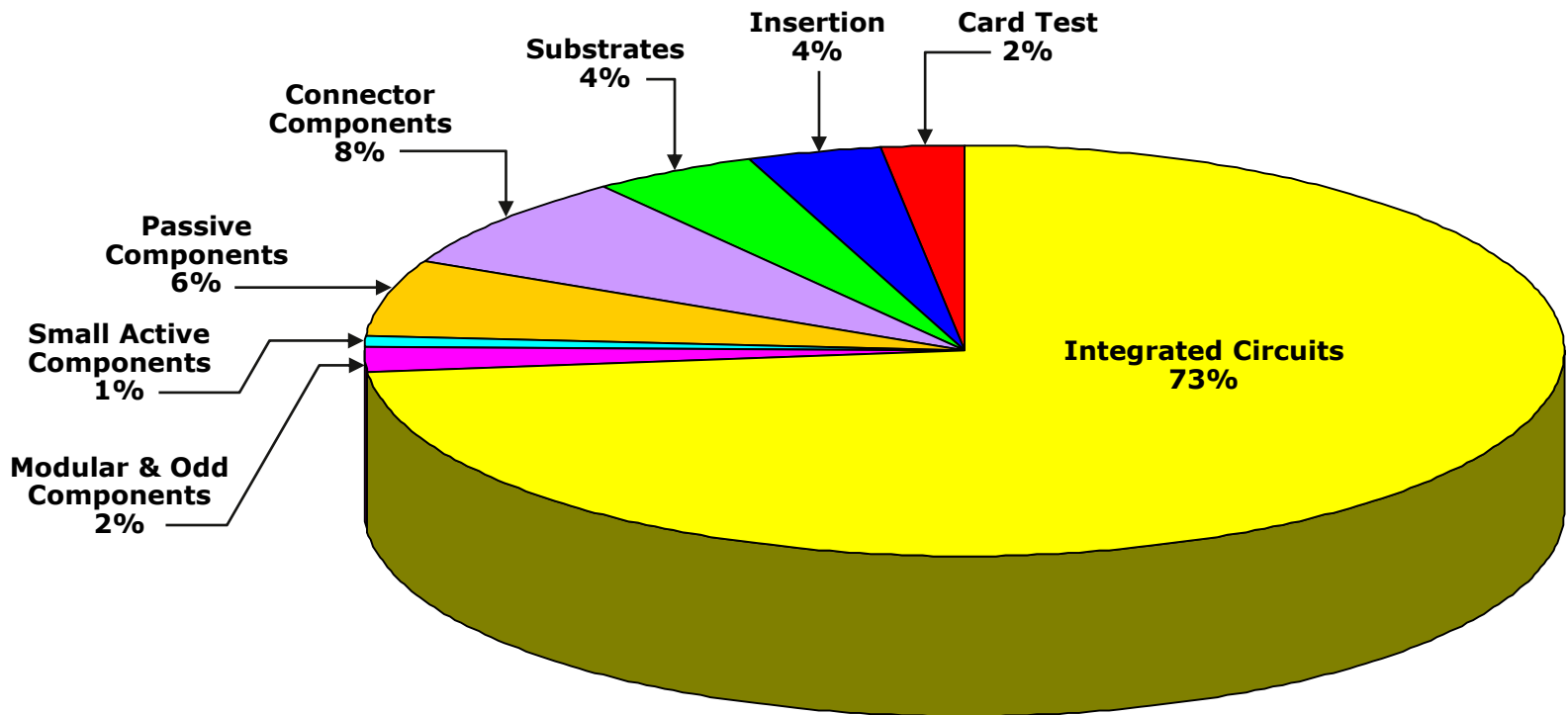


IC Metrics												
General Area	Assembly Name	IC Die Count	IC Package Count	Number of Package Connections	Die Area (sq.mm)	Substrate Tiling Density (die area / substrate area)	Package Area (sq.mm)	Die Area/Package Area Ratio	Package Connections per sq.cm of Package Area	Volatile Memory (KBytes)	Non-Volatile Memory (KBytes)	
Main Electronics	Main Board	4	4	158	62.6	0.01	300.3	0.21	52.6	0	0	
	System Totals	4	4	158	62.6		300.3	0.21	52.6	0	0	

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Costs Breakdown

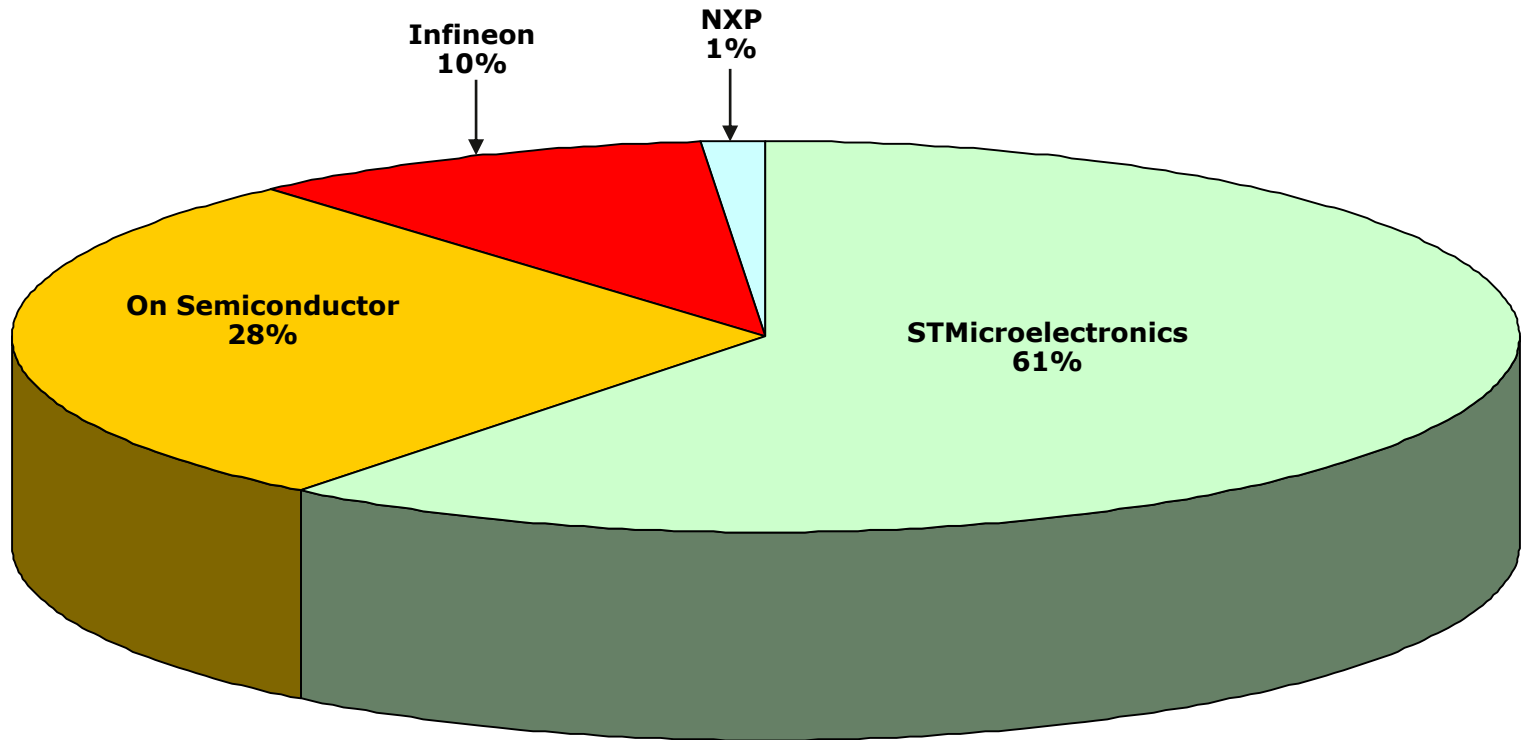
**Estimated Cost
of Electronics**
(Includes Subsystem Electronics)
\$20.66



NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Vendor IC Cost Distribution

Pkg. Brand	Cost
STMicroelectronics	\$9.18
ON Semiconductor	\$4.26
Infineon	\$1.49
NXP Semiconductor	\$0.22



NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Non-Electronic Cost Estimate



Subsystem	Part ID No.	Qty	Description	Fabrication Process	Material	Dimensions (mm)	Weight (grams)	Est'd Cost Each	Est'd Extended Cost	
Housing	1	1	Housing	Molded + Printed	PA 66 GF 15	85.2 x 64.9 x 24.3	28.00	1.960	1.960	
Total		1						Estimated Cost		\$1.96

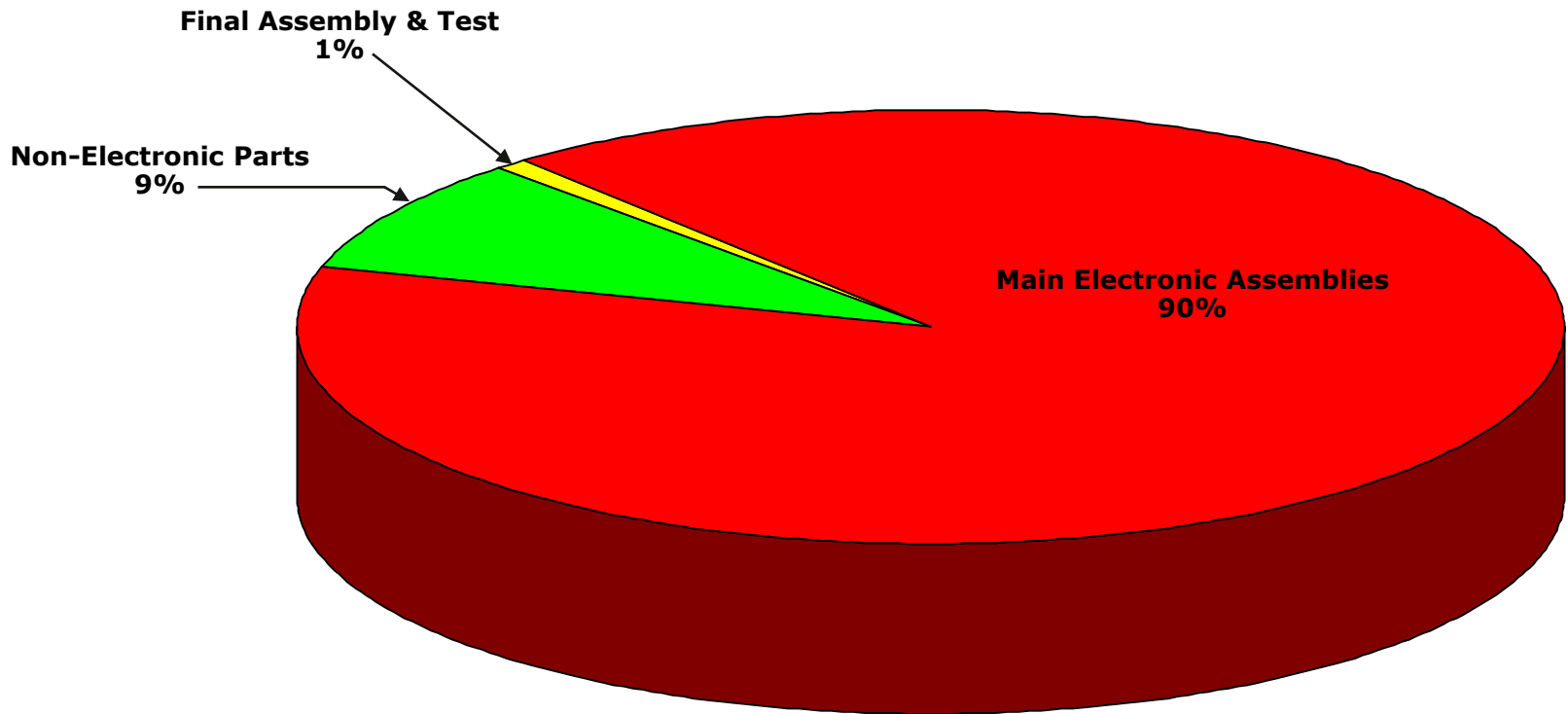
Final Ass'y Labor & Test Cost Estimate

Final Assembly & Test	
Made in	China
Number of parts	2
Est'd number of steps	6
Est'd time (seconds)	20
Est'd final assembly cost	\$ 0.02
Est'd final test cost	\$ 0.20

Cost Summary

Estimated Cost Totals	
Main Electronic Assemblies	\$ 20.66
Non-Electronic Parts	\$ 1.96
Final Assembly & Test	\$ 0.22
Total	\$ 22.84

Cost Total Notes:
Estimated final assembly cost includes labor only.
Total cost does not include Non-recurring, R&D, G&A, IP licensing fees/royalties, software, sales & marketing, distribution.
Assumes fully scaled production.



Cost Estimation Process

(Overview & Discussion)



Cost modeling is a tricky business. Multiple variables affect the actual production costs a manufacturer will experience, including development expenses, unit volumes, supply-and-demand in component markets, die yield-curve maturity, OEM purchasing power, and even variations in accounting practices. Different cost modeling methods employ different assumptions about how to handle these and other variables, but we can identify two basic approaches: that which seeks to track short-term variations in the inputs to the production process, and that which strives to maintain comparability of the output of the model across product families and over time.

TechInsights' philosophy in cost modeling is to emphasize consistency across products and comparability over time, rather than to track short-term fluctuations. During the past eight years, we have developed an estimation process that, while necessarily lacking an insider's knowledge of the cost factors that impact any one manufacturer, is reasonably accurate in its prediction of unit costs in high-volume production environments. We do not claim that the model will produce the "right" answer for your firm's environment. However, TechInsights does give customers a key analytical tool with a complete set of data in our Bill of Materials (BOM). The BOM allows readers to 1) scrutinize the assumptions behind our cost model and 2) modify the results based on substitution of their own component cost estimates where they have better information based on inside knowledge.

Our estimation process decomposes overall system cost into three major categories: Electronics, Mechanical, and Final Assembly. We begin by creating a complete electronics bill-of-materials (BOM). Each component from the largest ASIC to the smallest discrete resistor is entered into a BOM table with identifying attributes such as size, pitch, I/O count, package type, manufacturer, part number, estimated placement cost, and die size (if the component is an IC). Integrated circuit costs are calculated from measured die area. Using assumptions for wafer size, process type, number of die per wafer, defect density, and profit margin in combination with die area, an estimate of semiconductor cost is derived. Costs for discrete components and interconnect are derived from assumption tables which relate BOM line items to specific cost estimates by component type and estimates for part placement costs are included. For LCD display costs, we employ a model which tabulates expected cost from measurements of glass area, LCD type, and total pixel resolution. When market costs are available from alternative sources, LCD panel costs are taken from and referenced to these sources.

Costs of non-electronic components such as molded plastic enclosures and metallic components are measured in terms of weight, size, thickness, type of material, and complexity to arrive at their estimated cost. Other system items such as optics, antennae, batteries and displays are costed from a set of assumption tables derived from a combination of industry data, average high volume costs, and external sources. For final assembly, we re-build the torn-down product, tabulating stepwise assembly times as the reconstruction proceeds, to reach a total assembly time. Using a labor rate assumption for the country of origin, we then calculate final assembly cost.

The three major categories for system cost contributors can be broken down into the subcategories of ICs, other electronics parts, displays, batteries (as appropriate), camera modules, electronics assembly, non-electronic elements, and final assembly. By adding the cost estimates for each of these subcategories, an overall estimated cost is derived for the system under evaluation. Product packaging and accessories (CDs, cables, etc.) are also documented and estimated for their contribution to total cost as appropriate.

We believe our cost estimates generally fall within 15 percent of the "right answer," which itself can vary depending on the market and OEM-specific factors mentioned earlier. While the TechInsights cost model is imperfect, it yields important insights into technology and business dynamics along with good first-order contributions to system cost by component type. Additionally, the consistency of approach and gradual modification to assumptions (smoothing out frequently-shifting pricing factors) hopefully yields a credible, but user-modifiable, view of OEM high volume cost-to-produce.

Please feel free to contact us at support@techinsights.com with any comments, questions, or proposed corrections with respect to our cost estimates. We welcome your input.

Metrics (Overview & Discussion)



In our product teardowns, we gather a series of metrics for product profiling and comparison. Some metrics focus on system characteristics such as total silicon area, total system semiconductor storage capacity, and total connection count. Other metrics reflect more subtle aspects of electronics assembly such as connection density, average component I/O count, and silicon tiling density. Taken as a whole, the metrics allow deeper comparison and benchmarking across multiple disciplines and multiple products. Key metrics we gather on products are described below along with their definitions and what they tend to say about the system under study. Most metrics can be used both in comparing similar products for benchmarking purposes or for quantifying differences in levels of complexity between dissimilar product types. Data fall into two categories; either “raw” measured data or ratios of these measured data sets.

Total Silicon Area : This metric describes the total area of silicon as measured from X-ray or direct measurement of ICs. The area is an expression of the enclosed bare die area and excludes packaging area. The aggregate silicon area is a good benchmark to show how integrated a design might be when making comparisons to similar systems. Total silicon area also reflects the major cost driver for most systems we examine.

Silicon Tiling Density : Ratio of Total Silicon Area to total printed circuit board “projected” area (i.e. the simple board area and not the cumulative surface area of both sides of the board). This metric directly reflects the level of efficiency and aggressiveness in integrated circuit packing and placement. Single digit Silicon Tiling Density is typical but silicon coverage of 10% - 20% has been seen in some of the most advanced products we have examined. Higher Tiling Densities often correspond with the use of chip scale packaging (CSPs) or other small form-factor IC packaging technologies. High density circuit boards are also often a supporting technology.

Number of Parts : Total component count including ICs, passives, modules, connectors, etc., each separated out in our reporting.

Number of Connections : The total number of connections corresponds to the total number of interconnects introduced by the aggregate component set and reflects any electrical connection observed (solder joints, adhesive interconnect, or connector terminal interfaces).

Opportunity Count : Opportunity Count is the total number of parts plus the total number of connections; the name reflects that each of these constituent elements represents an opportunity for failure. A high opportunity count means more complex and riskier electronics assembly.

Average Pin Count (APC) : Ratio of total number of component terminals to total number of parts, at the system level. This metric reflects the ‘average’ terminal complexity of the components and often provide a signature of integration level and/or “digital-ness” of the overall product. Low APCs reflect a high number of discrettes or other low-pincount devices often characteristic of analog circuitry. Conversely, high APCs are characteristic of highly integrated, high-pincount assemblies, often those composed largely of digital integrated circuits.

Connection Density : This metric is a ratio of the total Number of Connections to total printed circuit board assembly area, in units of connections per sq. inch. The metric provides data related to the Silicon Tiling Density above, but with an emphasis on complexity of I/O interconnect. For example, with a fixed Connection Density, high tiling density of low-pincount memory chips is more readily achieved than comparable silicon tiling of high pincount logic.

Part Density : This metric is a ratio of the total Number of Parts to total printed circuit board assembly area, in units of components per sq. inch. The metric provides data related to the Silicon Tiling Density and Connection Density as described above, but with an emphasis on density and complexity of component packing efficiency. For example, low Part Density of high-pincount devices can pose an equal challenge in Connection Density to high Part Density of low-pincount devices. High Part Density does reflect challenges in surface mount assembly in terms of (typically) precision of placement, number of placements, and engineering of part clearances.

Routing Density (heuristic estimate) = $3 * (\text{Average Pin Count}) * \sqrt{\text{Part Density}}$. The Routing Density metric is an empirically derived relationship that characterizes the wiring density of the interconnect used to support the interconnection of components in a planar electronic assembly (i.e. the circuit board). Architectural issues such as bussing or other factors affecting the regularity of wiring impact the actual Routing Density needed to support a given application, but the metric provides a ready measure of wiring complexity.

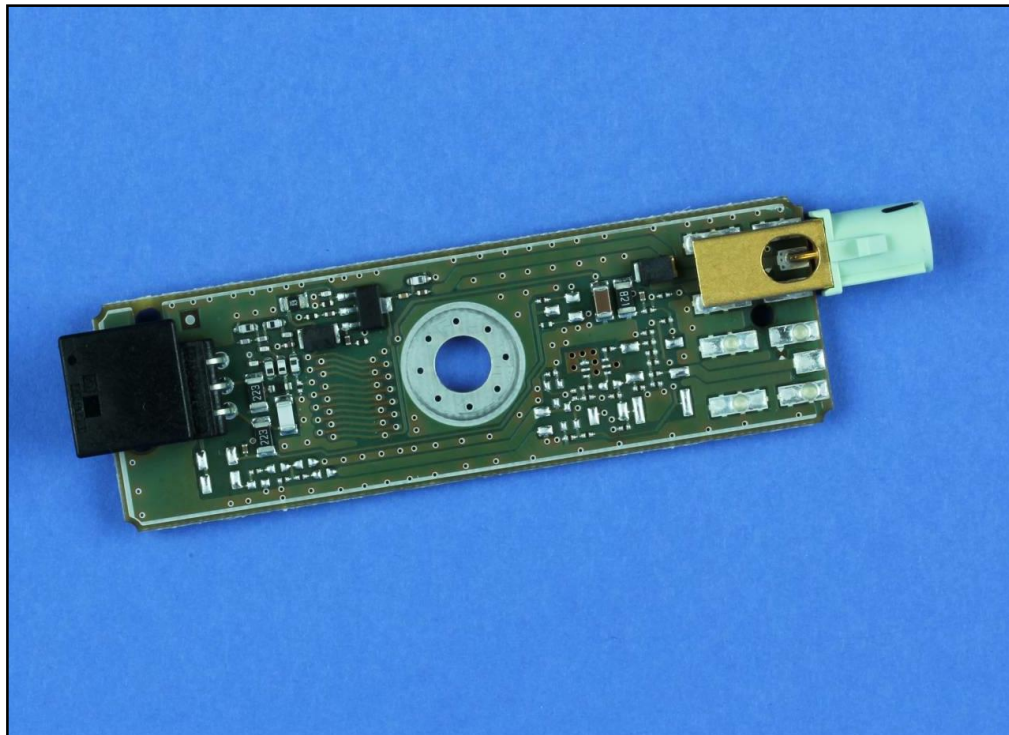
***Click Here to Return to
Cost Analysis Page 193***

Deep Dive Report

BMW i3 Antenna Amplifier Board

5356

Report #15900-150129-PKc



Product Description

The Antenna Amplifier Board serves as the front-end module for amplifying the signal from the remote control in the 2014 BMW i3. It features a remote control receiver connector, low-noise RF transistor, and an antenna connector.

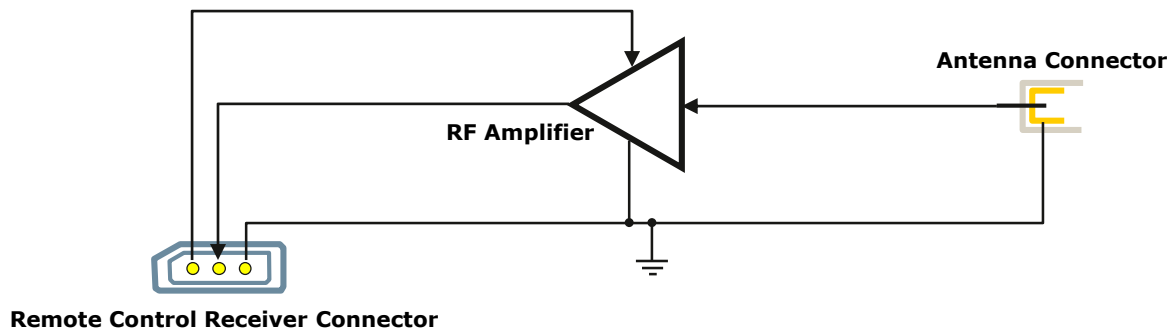
DISCLAIMER: All company names, product names, and service names mentioned are used for identification purposes only and may be registered trademarks, trademarks, or service marks of their respective owners. All analyses are done without participation, authorization, or endorsement of the manufacturer. Any cost analyses presented in this material are estimates prepared by TechInsights from generally available data. While TechInsights believes that these estimates reflect the probable costs, the actual producer did not supply the data, and therefore the actual costs may be different from these estimates. Furthermore, TechInsights extends no warranties with respect to any information in this document, and shall bear no liability whatsoever for the use of the information.

Copyright © 2015, TechInsights. All rights reserved. Do not reproduce, distribute, disseminate, photocopy, fax, transmit, download to a shared database, or otherwise copy, transfer, sell, publish, or send this material, or any portion thereof, by any means without the express written permission of TechInsights.

Product Overview



Product Description		Integrated Circuit Metrics		
Product Type	Automotive	IC Die Count	0	
Brand	BMW	IC Package Count	0	
Product Name & Model #	Antenna Amplifier Board	Cost Metrics		
Official Release Date	5/2/2014			
Weight (grams)	9.4 (Measured)	Retail Price		
Product Dimensions	88.2 x 23.2 x 9.9 (Measured at Longest/Widest/Thickest Points)	Total Manufacturing Cost	\$1.45	
		Electronics Cost	\$1.45	
		Manufacturing Cost Breakdown		
Connectors	Remote Control Receiver Connector, Antenna Connector	Small Active Discretes	\$0.20	13.8%
Amplifier	Low-Noise RF Transistor	Passive Discretes	\$0.21	14.5%
		Connectors	\$0.44	30.3%
		Substrate	\$0.25	17.2%
		Insertion	\$0.23	15.9%
		Card Test	\$0.12	8.3%
		Total	\$1.45	100.0%

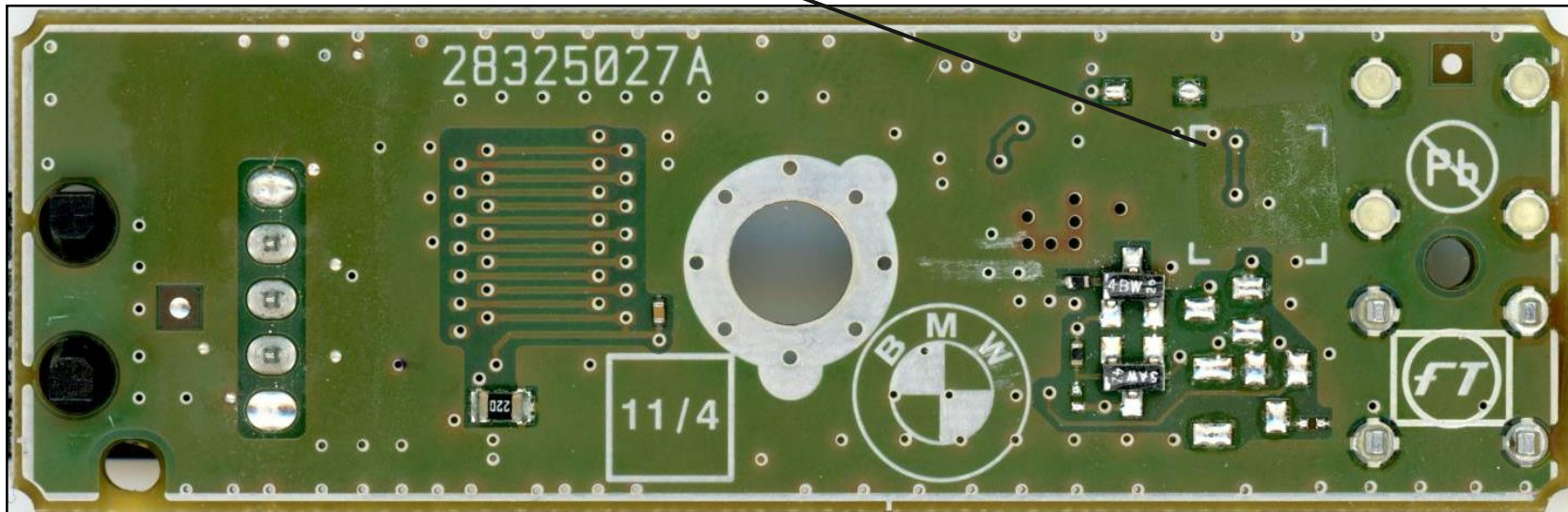


Estimated block diagram based on observation of this specific product implementation, manufacturer's data sheets where available, and best engineering judgment. Certain details of the interface circuitry are not reflected in this block diagram. Partitioning and connectivity are speculative.

Product Label



MUNRO
& ASSOCIATES, INC.



tenna Amplifier

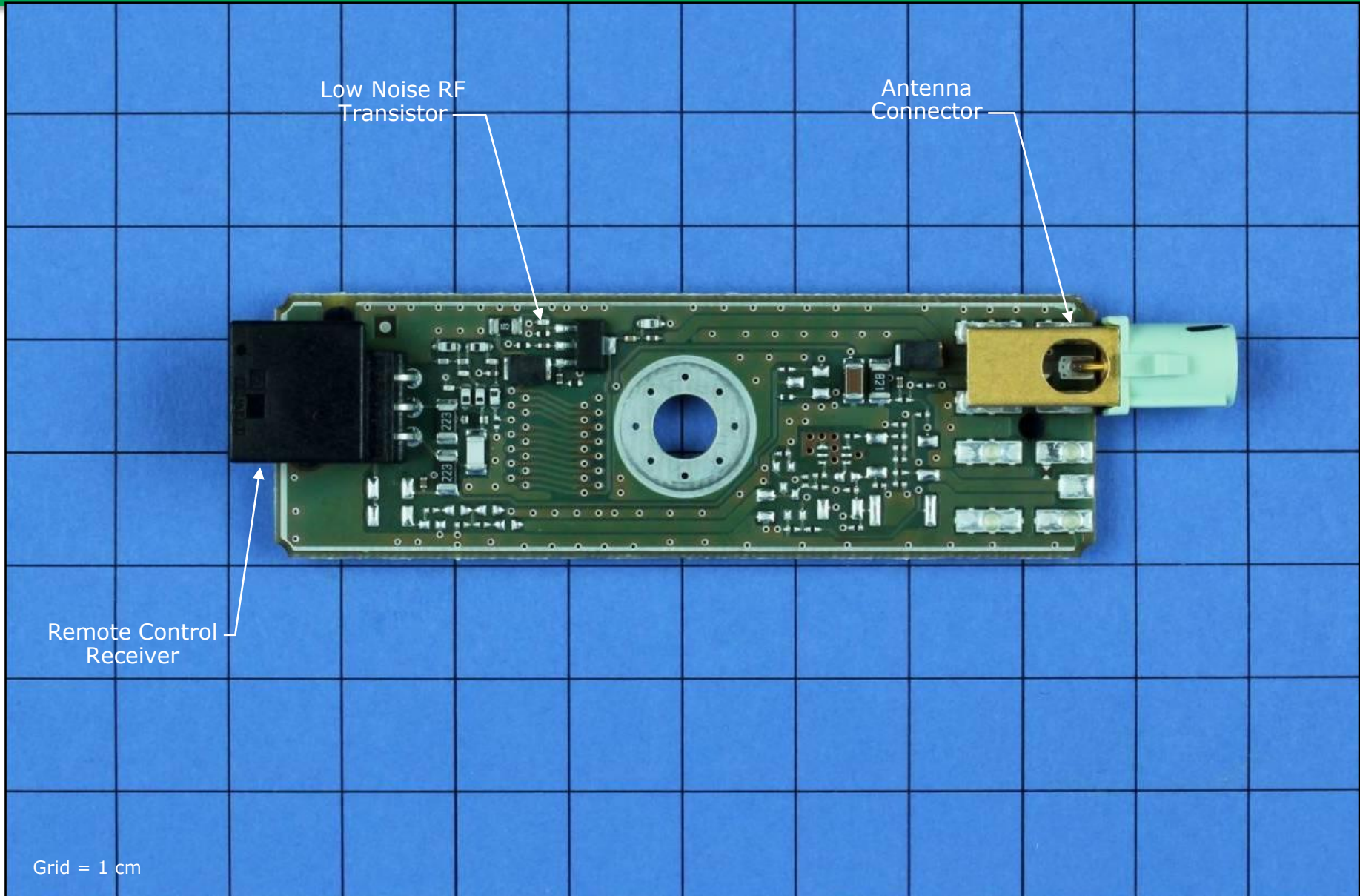
Board, 5356 #15900-150129-

PKc - Page 807

Antenna Amplifier Board (Side 1)



MUNRO
& ASSOCIATES, INC.



Low Noise RF
Transistor

Antenna
Connector

Remote Control
Receiver

Grid = 1 cm

er

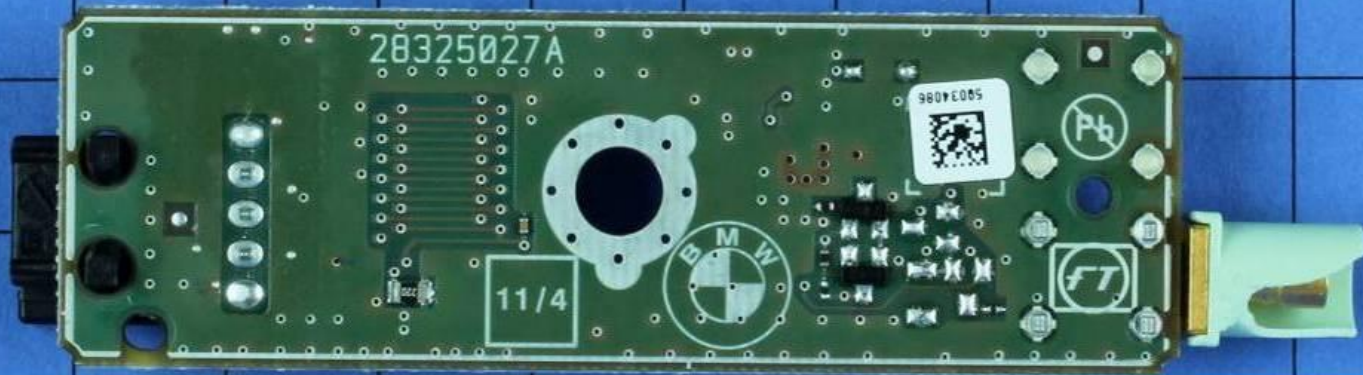
Board, 5356 #15900-150129-

PKc - Page 808

Antenna Amplifier Board (Side 2)



MUNRO
& ASSOCIATES, INC.

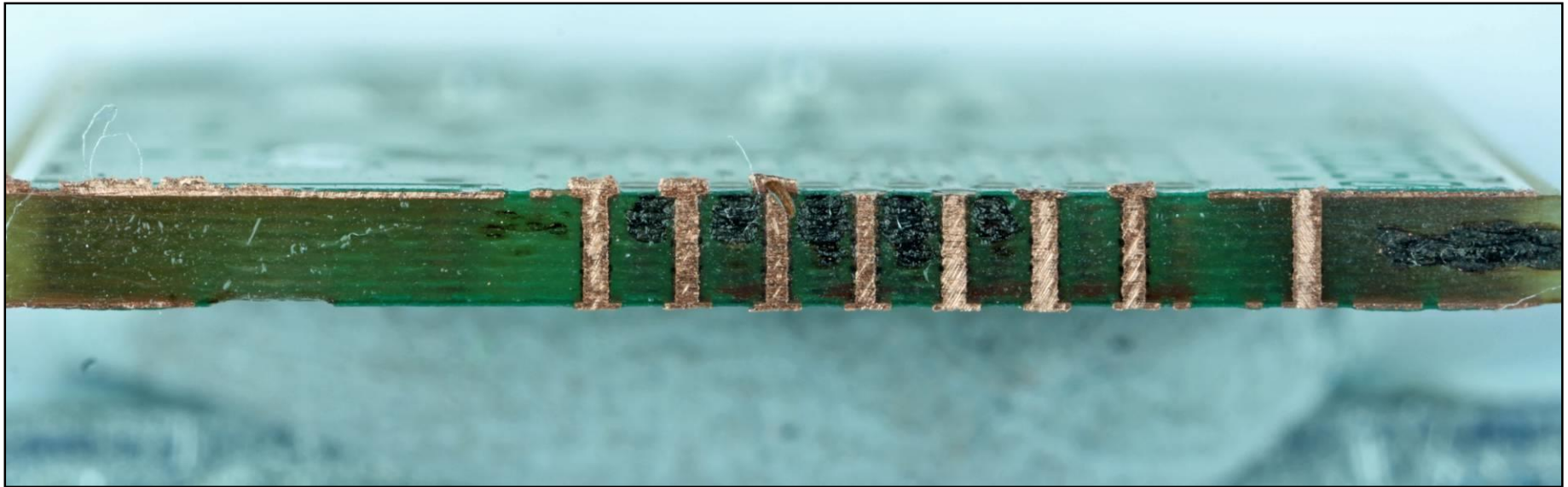


Grid = 1 cm

Antenna Amplifier Board Cross-Section



MUNRO
& ASSOCIATES, INC.



Substrate Data



Substrates

Assembly Name	Manufacturer	Core Material	Mfg. Technology	Layers	Area (cm ²)	Min. Trace Pitch (mm)	Min. Trace Width (mm)	ThruVia Land Dia (mm)	ThruVia Hole Dia (mm)	BlindVia Land Dia (mm)	BlindVia Hole Dia (mm)	Thickness (mm)	Routing Density	Estimated Costs
Antenna Amplifier Board	Unknown	FR4	2 Layer conventional FR4 / HF	2	16.4	0.50	0.12	0.50	0.30			1.7	7.4	\$ 0.25

Active Discrete Components



Location	Qty	Functional Description	Package					Estimated Costs	
			Form	Top Marking	Pin Count	Length (mm)	Width (mm)	Each	Total
Antenna Amplifier Board, Side 1	1	Small Active	Transistor, Small	FG S43	4	4.50	4.20	\$0.140	\$0.140
Antenna Amplifier Board, Side 2	1	Small Active	Transistor, Small	SAW 4Z	3	3.10	2.90	\$0.030	\$0.030
	1	Small Active	Transistor, Small	4BW 2o	3	3.10	2.90	\$0.030	\$0.030
TOTALS	3				10				\$0.20

Passive Discrete Components



Location	Qty	Functional Description	Package		Estimated Costs	
			Form	Pin Count	Each	Total
Antenna Amplifier Board, Side 1	24	Small Passive	Cap, Res, Ferrite	1	\$0.004	\$0.096
	6	Small Passive	Coil, Inductor	2	\$0.008	\$0.048
	1	Coil	SMT, Small	2	\$0.050	\$0.050
Antenna Amplifier Board, Side 2	4	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.016
TOTALS	35			46		\$0.21

Connectors

Location	Qty	Form	Package			Estimated Costs	
			Pin Count	Length (mm)	Width (mm)	Each	Total
Antenna Amplifier Board, Side 1	1	Jack: Antenna	1	23.40	9.90	\$0.360	\$0.360
	1	Connector: Remote Control Receiver	6	16.70	12.20	\$0.080	\$0.080
TOTALS	2		7				\$0.44

Electronic Assembly Metrics



MUNRO
& ASSOCIATES, INC.

Electronic Assembly Metrics by Assembly

General Area	Assembly Name	Substrate Area (sq.cm)	Metal Layers	Circuit Area (sq.cm)	Routing Density (cm of routing per sq.cm of substrate)	Number of Components	Number of Connections	Component Density (Components/sq.cm)	Connection Density (Connections/sq.cm)	Avg. Pin Count	Assembly Weight (grams)
Main Electronics	Antenna Amplifier Board	16.4	2	32.8	7.4	40	63	2.4	3.9	1.6	9.40
	System Totals	16.4	2	32.76		40	63	2.4	3.8	1.6	9.40

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

BMW i3 Antenna Amplifier Board, 5356 #15900-150129-PKc - Page 815

Electronic Assembly Metrics



Electronics Costs by Assembly

General Area	Assembly Name	Total	Integrated Circuits	Modular & Odd Form Components	Small Active Components	Passive Components	Connector Components	Substrates	Insertion	Card Test
Main Electronics	Antenna Amplifier Board	\$ 1.45	\$ -	\$ -	\$ 0.20	\$ 0.21	\$ 0.44	\$ 0.25	\$ 0.23	\$ 0.12
	System Totals	\$ 1.45	\$ -	\$ -	\$ 0.20	\$ 0.21	\$ 0.44	\$ 0.25	\$ 0.23	\$ 0.12

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Counts by Assembly												
General Area	Assembly Name	IC Package Count	IC Connections	Modular/Ocid Form Components	Modular/Ocid Form Component Connections	Small Active Components	Small Active Component Connections	Passive Components	Passive Component Connections	Connectors	Connector Connections	Opportunities
Main Electronics	Antenna Amplifier Board	0	0	0	0	3	10	35	46	2	7	103
	System Totals	0	0	0	0	3	10	35	46	2	7	103

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

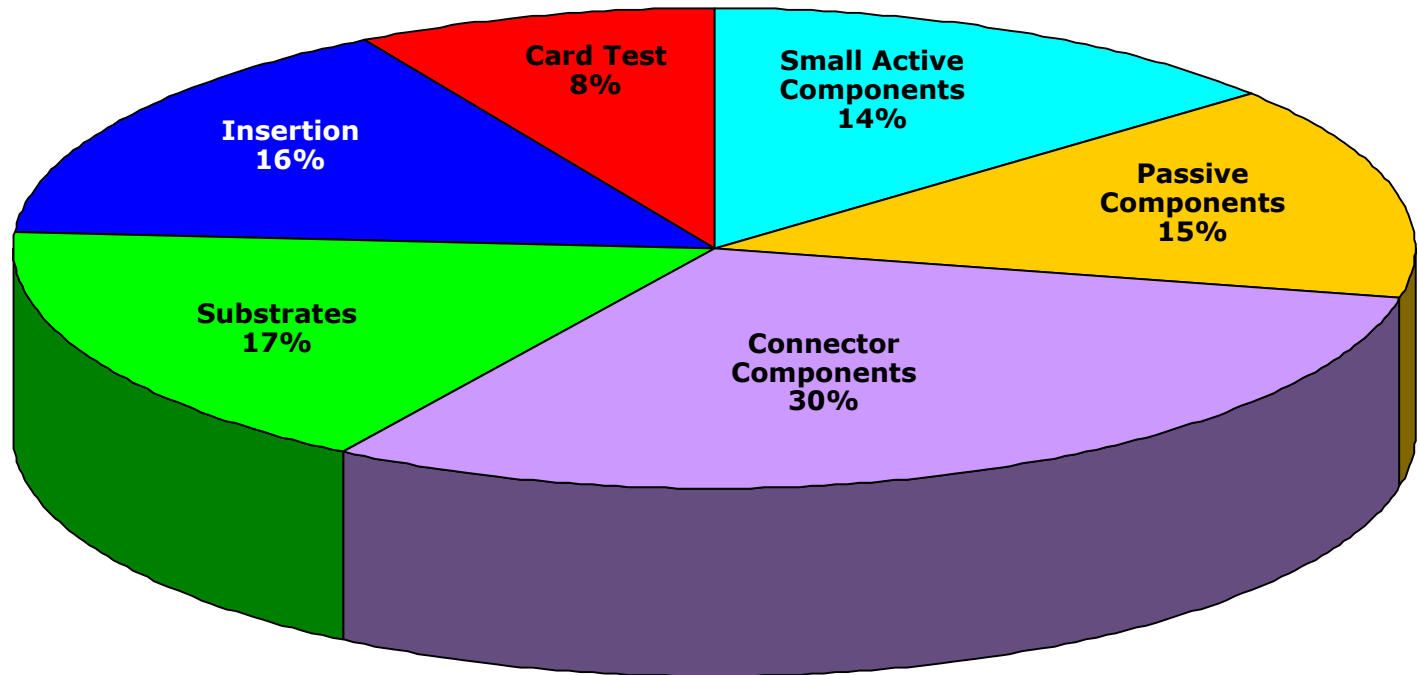
Electronic Costs Breakdown



Estimated Cost of Electronics

(Includes Subsystem Electronics)

\$1.45



NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Estimated Cost Totals	
Main Electronic Assemblies	\$ 1.45
Total	\$ 1.45

Cost Total Notes:
Estimated final assembly cost includes labor only.
Total cost does not include Non-recurring, R&D, G&A, IP licensing fees/royalties, software, sales & marketing, distribution.
Assumes fully scaled production.

Cost Estimation Process (Overview & Discussion)



Cost modeling is a tricky business. Multiple variables affect the actual production costs a manufacturer will experience, including development expenses, unit volumes, supply-and-demand in component markets, die yield-curve maturity, OEM purchasing power, and even variations in accounting practices. Different cost modeling methods employ different assumptions about how to handle these and other variables, but we can identify two basic approaches: that which seeks to track short-term variations in the inputs to the production process, and that which strives to maintain comparability of the output of the model across product families and over time.

TechInsights' philosophy in cost modeling is to emphasize consistency across products and comparability over time, rather than to track short-term fluctuations. During the past eight years, we have developed an estimation process that, while necessarily lacking an insider's knowledge of the cost factors that impact any one manufacturer, is reasonably accurate in its prediction of unit costs in high-volume production environments. We do not claim that the model will produce the "right" answer for your firm's environment. However, TechInsights does give customers a key analytical tool with a complete set of data in our Bill of Materials (BOM). The BOM allows readers to 1) scrutinize the assumptions behind our cost model and 2) modify the results based on substitution of their own component cost estimates where they have better information based on inside knowledge.

Our estimation process decomposes overall system cost into three major categories: Electronics, Mechanical, and Final Assembly. We begin by creating a complete electronics bill-of-materials (BOM). Each component from the largest ASIC to the smallest discrete resistor is entered into a BOM table with identifying attributes such as size, pitch, I/O count, package type, manufacturer, part number, estimated placement cost, and die size (if the component is an IC). Integrated circuit costs are calculated from measured die area. Using assumptions for wafer size, process type, number of die per wafer, defect density, and profit margin in combination with die area, an estimate of semiconductor cost is derived. Costs for discrete components and interconnect are derived from assumption tables which relate BOM line items to specific cost estimates by component type and estimates for part placement costs are included. For LCD display costs, we employ a model which tabulates expected cost from measurements of glass area, LCD type, and total pixel resolution. When market costs are available from alternative sources, LCD panel costs are taken from and referenced to these sources.

Costs of non-electronic components such as molded plastic enclosures and metallic components are measured in terms of weight, size, thickness, type of material, and complexity to arrive at their estimated cost. Other system items such as optics, antennae, batteries and displays are costed from a set of assumption tables derived from a combination of industry data, average high volume costs, and external sources. For final assembly, we re-build the torn-down product, tabulating stepwise assembly times as the reconstruction proceeds, to reach a total assembly time. Using a labor rate assumption for the country of origin, we then calculate final assembly cost.

The three major categories for system cost contributors can be broken down into the subcategories of ICs, other electronics parts, displays, batteries (as appropriate), camera modules, electronics assembly, non-electronic elements, and final assembly. By adding the cost estimates for each of these subcategories, an overall estimated cost is derived for the system under evaluation. Product packaging and accessories (CDs, cables, etc.) are also documented and estimated for their contribution to total cost as appropriate.

We believe our cost estimates generally fall within 15 percent of the "right answer," which itself can vary depending on the market and OEM-specific factors mentioned earlier. While the TechInsights cost model is imperfect, it yields important insights into technology and business dynamics along with good first-order contributions to system cost by component type. Additionally, the consistency of approach and gradual modification to assumptions (smoothing out frequently-shifting pricing factors) hopefully yields a credible, but user-modifiable, view of OEM high volume cost-to-produce.

Please feel free to contact us at support@techinsights.com with any comments, questions, or proposed corrections with respect to our cost estimates. We welcome your input.

In our product teardowns, we gather a series of metrics for product profiling and comparison. Some metrics focus on system characteristics such as total silicon area, total system semiconductor storage capacity, and total connection count. Other metrics reflect more subtle aspects of electronics assembly such as connection density, average component I/O count, and silicon tiling density. Taken as a whole, the metrics allow deeper comparison and benchmarking across multiple disciplines and multiple products. Key metrics we gather on products are described below along with their definitions and what they tend to say about the system under study. Most metrics can be used both in comparing similar products for benchmarking purposes or for quantifying differences in levels of complexity between dissimilar product types. Data fall into two categories; either “raw” measured data or ratios of these measured data sets.

Total Silicon Area : This metric describes the total area of silicon as measured from X-ray or direct measurement of ICs. The area is an expression of the enclosed bare die area and excludes packaging area. The aggregate silicon area is a good benchmark to show how integrated a design might be when making comparisons to similar systems. Total silicon area also reflects the major cost driver for most systems we examine.

Silicon Tiling Density : Ratio of Total Silicon Area to total printed circuit board “projected” area (i.e. the simple board area and not the cumulative surface area of both sides of the board). This metric directly reflects the level of efficiency and aggressiveness in integrated circuit packing and placement. Single digit Silicon Tiling Density is typical but silicon coverage of 10% - 20% has been seen in some of the most advanced products we have examined. Higher Tiling Densities often correspond with the use of chip scale packaging (CSPs) or other small form-factor IC packaging technologies. High density circuit boards are also often a supporting technology.

Number of Parts : Total component count including ICs, passives, modules, connectors, etc., each separated out in our reporting.

Number of Connections : The total number of connections corresponds to the total number of interconnects introduced by the aggregate component set and reflects any electrical connection observed (solder joints, adhesive interconnect, or connector terminal interfaces).

Opportunity Count : Opportunity Count is the total number of parts plus the total number of connections; the name reflects that each of these constituent elements represents an opportunity for failure. A high opportunity count means more complex and riskier electronics assembly.

Average Pin Count (APC) : Ratio of total number of component terminals to total number of parts, at the system level. This metric reflects the ‘average’ terminal complexity of the components and often provide a signature of integration level and/or “digital-ness” of the overall product. Low APCs reflect a high number of discretely or other low-pincount devices often characteristic of analog circuitry. Conversely, high APCs are characteristic of highly integrated, high-pincount assemblies, often those composed largely of digital integrated circuits.

Connection Density : This metric is a ratio of the total Number of Connections to total printed circuit board assembly area, in units of connections per sq. inch. The metric provides data related to the Silicon Tiling Density above, but with an emphasis on complexity of I/O interconnect. For example, with a fixed Connection Density, high tiling density of low-pincount memory chips is more readily achieved than comparable silicon tiling of high pincount logic.

Part Density : This metric is a ratio of the total Number of Parts to total printed circuit board assembly area, in units of components per sq. inch. The metric provides data related to the Silicon Tiling Density and Connection Density as described above, but with an emphasis on density and complexity of component packing efficiency. For example, low Part Density of high-pincount devices can pose an equal challenge in Connection Density to high Part Density of low-pincount devices. High Part Density does reflect challenges in surface mount assembly in terms of (typically) precision of placement, number of placements, and engineering of part clearances.

Routing Density (heuristic estimate) = $3 * (\text{Average Pin Count}) * \sqrt{\text{Part Density}}$. The Routing Density metric is an empirically derived relationship that characterizes the wiring density of the interconnect used to support the interconnection of components in a planar electronic assembly (i.e. the circuit board). Architectural issues such as bussing or other factors affecting the regularity of wiring impact the actual Routing Density needed to support a given application, but the metric provides a ready measure of wiring complexity.

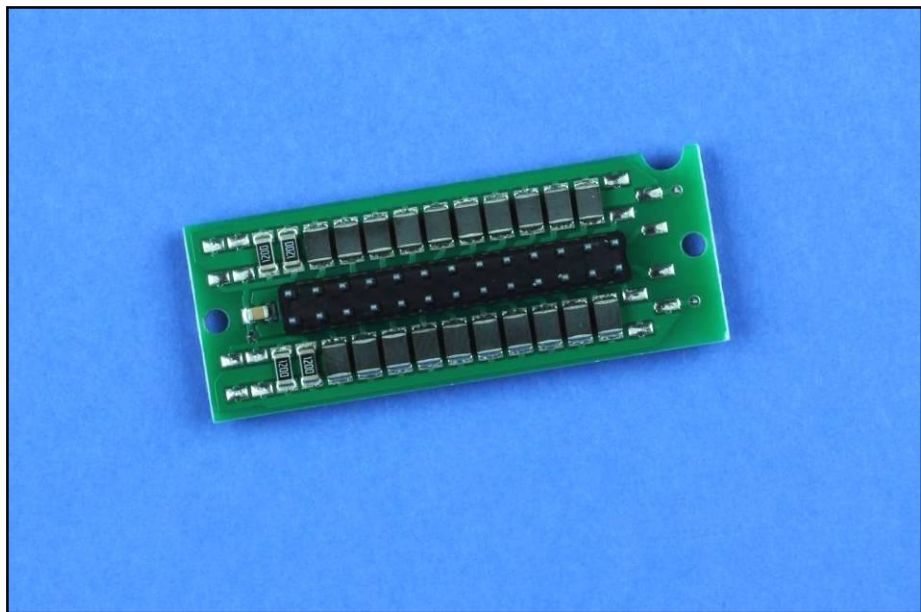
***Click Here to Return to
Cost Analysis Page 198***

Deep Dive Report

BMW i3 Signal Termination Board, Connector Assembly

5824

Report #15900-150224-PKb



Product Description

This report concerns the Signal Termination Board, Connector Assembly for the 2014 BMW i3. This board features (20) ferrites and a 26-pin connector, and is used reduce EMI.

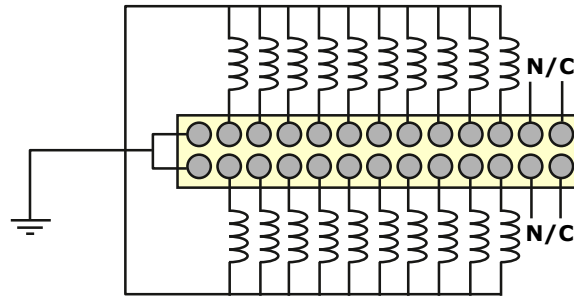
DISCLAIMER: All company names, product names, and service names mentioned are used for identification purposes only and may be registered trademarks, trademarks, or service marks of their respective owners. All analyses are done without participation, authorization, or endorsement of the manufacturer. Any cost analyses presented in this material are estimates prepared by TechInsights from generally available data. While TechInsights believes that these estimates reflect the probable costs, the actual producer did not supply the data, and therefore the actual costs may be different from these estimates. Furthermore, TechInsights extends no warranties with respect to any information in this document, and shall bear no liability whatsoever for the use of the information.

Copyright © 2015, TechInsights. All rights reserved. Do not reproduce, distribute, disseminate, photocopy, fax, transmit, download to a shared database, or otherwise copy, transfer, sell, publish, or send this material, or any portion thereof, by any means without the express written permission of TechInsights.

Product Overview

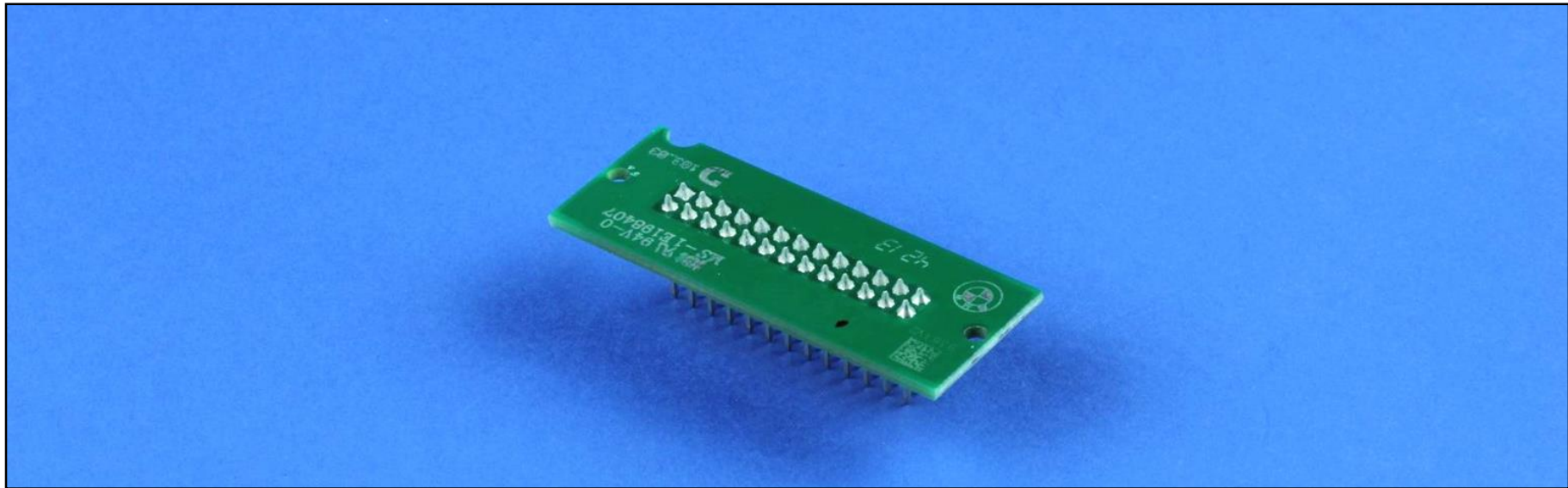
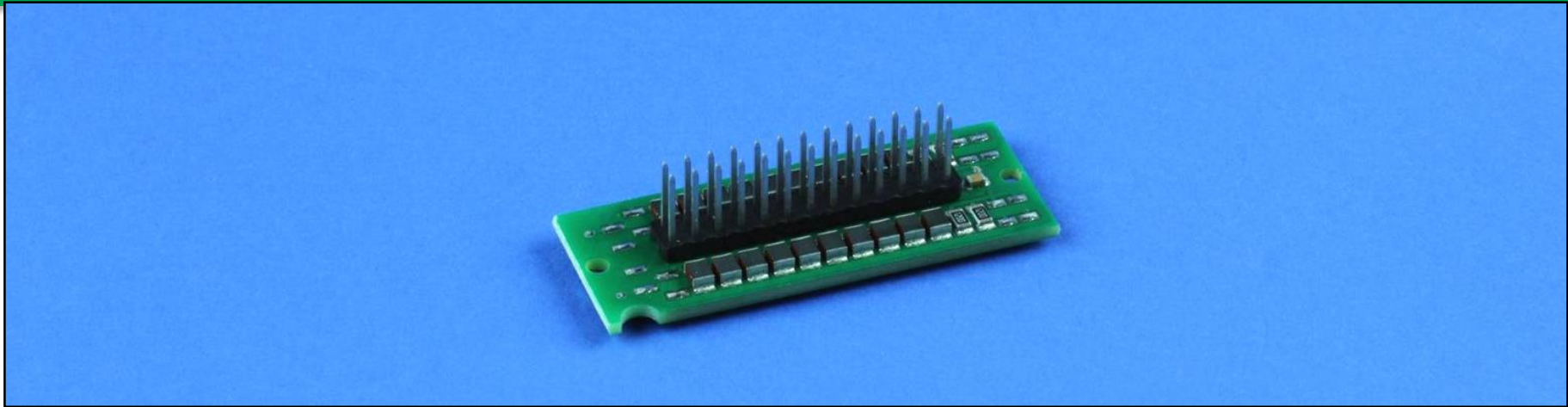


Product Description		Integrated Circuit Metrics		
Product Type	Automotive	IC Die Count		
Brand	BMW	IC Package Count		
Product Name & Model #	i3 Signal Termination Board, Connector Asm	Cost Metrics		
Official Release Date	5/2/2014			
Weight (grams)	6.1 (Measured)	Retail Price		
Product Dimensions	50.0 x 19.0 x 13.9 (Measured at Longest/Widest/Thickest Points)	Total Manufacturing Cost	\$0.63	
Product Features		Electronics Cost	\$0.63	
		Manufacturing Cost Breakdown		
		Passive Discretetes	\$0.18	28.6%
		Connectors	\$0.10	15.9%
		Substrates	\$0.14	22.2%
		Component Insertion	\$0.14	22.2%
		Card Test	\$0.07	11.1%
		Total		\$0.63

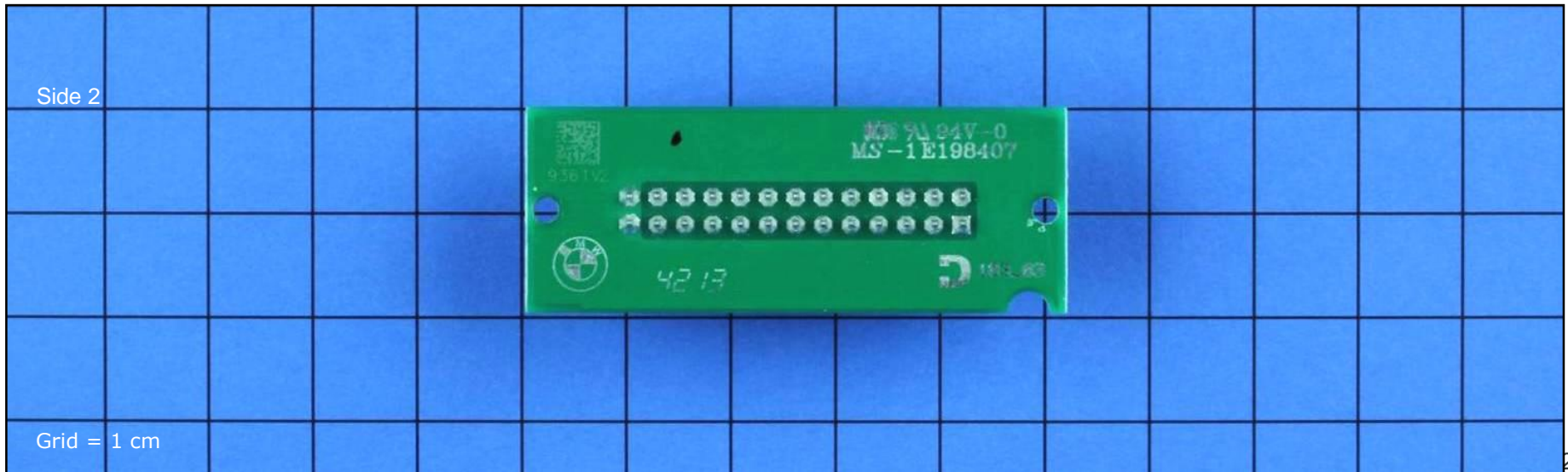
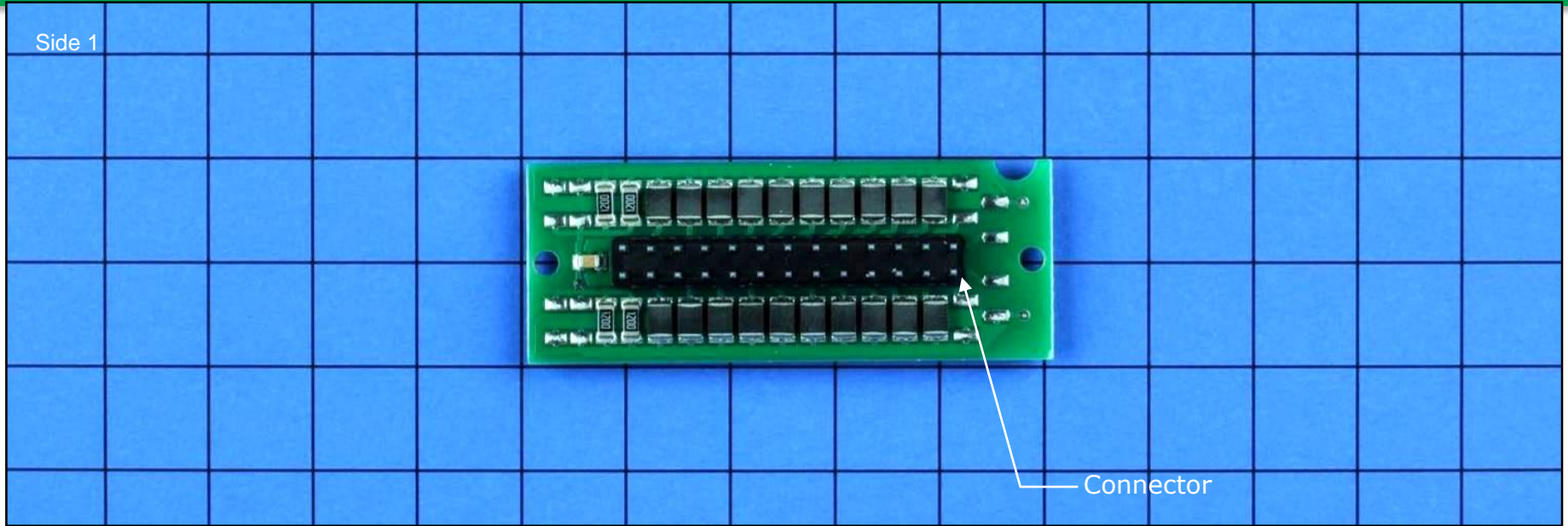


Estimated block diagram based on observation of this specific product implementation, manufacturer's data sheets where available, and best engineering judgment. Certain details of the interface circuitry are not reflected in this block diagram. Partitioning and connectivity are speculative.

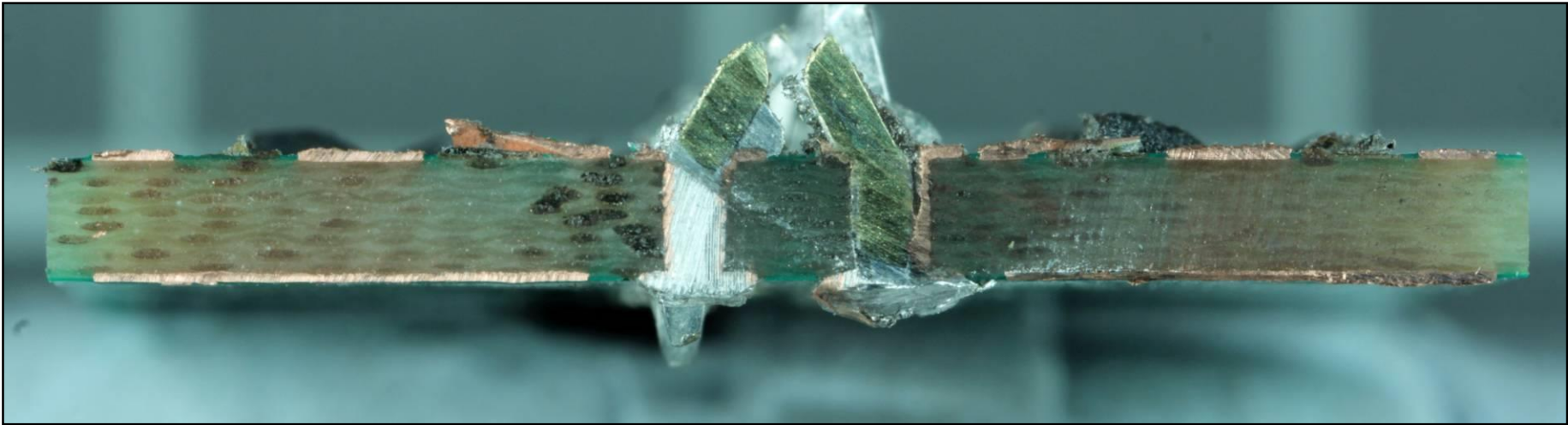
Exterior Features



Main Board (Sides 1 & 2)



Main Board Cross-Section



Substrate Data



Substrates

Assembly Name	Manufacturer	Core Material	Mfg. Technology	Layers	Area (cm ²)	Min. Trace Pitch (mm)	Min. Trace Width (mm)	ThruVia Land Dia (mm)	ThruVia Hole Dia (mm)	BlindVia Land Dia (mm)	BlindVia Hole Dia (mm)	Thickness (mm)	Routing Density	Estimated Costs
Main Board	Million Sources	FR4	2 Layer conventional FR4 / HF	2	9.3	0.80	0.50	1.50	0.62			1.6	14.7	\$ 0.14

Passive Discrete Components



Location	Qty	Functional Description	Package		Estimated Costs	
			Form	Pin Count	Each	Total
Main Board, Side 1	20	Small Passive	Coil, Inductor	2	\$0.008	\$0.160
	5	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.020
TOTALS	25			50		\$0.18

Connectors



Location	Qty	Form	Package			Estimated Costs	
			Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Bd to Bd: Male Header	26	33.30	4.90	\$0.100	\$0.100
TOTALS	1		26				\$0.10

Electronic Assembly Metrics



MUNRO
& ASSOCIATES, INC.

Electronic Assembly Metrics by Assembly											
General Area	Assembly Name	Substrate Area (sq.cm)	Metal Layers	Circuit Area (sq.cm)	Routing Density (cm of routing per sq.cm of substrate)	Number of Components	Number of Connections	Component Density (Components/sq.cm)	Connection Density (Connections/sq.cm)	Avg. Pin Count	Assembly Weight (grams)
Main Electronics	Main Board	9.3	2	18.6	14.7	26	76	2.8	8.2	2.9	6.10
	System Totals	9.3	2	18.6		26	76	2.8	8.2	2.9	6.10

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Signal Termination Board 5824

#15900-150224-PKb – Page

832

Electronic Assembly Metrics



Electronics Costs by Assembly										
General Area	Assembly Name	Total	Integrated Circuits	Modular & Odd Form Components	Small Active Components	Passive Components	Connector Components	Substrates	Insertion	Card Test
Main Electronics	Main Board	\$ 0.63	\$ -	\$ -	\$ -	\$ 0.18	\$ 0.10	\$ 0.14	\$ 0.14	\$ 0.07
	System Totals	\$ 0.63	\$ -	\$ -	\$ -	\$ 0.18	\$ 0.10	\$ 0.14	\$ 0.14	\$ 0.07

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Signal Termination Board 5824

#15900-150224-PKb – Page

833

Electronic Assembly Metrics



Counts by Assembly												
General Area	Assembly Name	IC Package Count	IC Connections	Modular/Odd Form Components	Modular/Odd Form Component Connections	Small Active Components	Small Active Component Connections	Passive Components	Passive Component Connections	Connectors	Connector Connections	Opportunities
Main Electronics	Main Board	0	0	0	0	0	0	25	50	1	26	102
	System Totals	0	0	0	0	0	0	25	50	1	26	102

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Signal Termination Board 5824

#15900-150224-PKb – Page

834

Cost Summary



Estimated Cost Totals	
Main Electronic Assemblies	\$ 0.63
Total	\$ 0.63

Cost Total Notes:
Estimated final assembly cost includes labor only.
Total cost does not include Non-recurring, R&D, G&A, IP licensing fees/royalties, software, sales & marketing, distribution.
Assumes fully scaled production.

Cost Estimation Process (Overview & Discussion)



MUNRO
& ASSOCIATES, INC.

Cost modeling is tricky business. Multiple variables affect the actual production costs a manufacturer will experience, including development expenses, unit volumes, supply-and-demand in component markets, die yield-curve maturity, OEM purchasing power, and even variations in accounting practices. Different cost modeling methods employ different assumptions about how to handle these and other variables, but we can identify two basic approaches: that which seeks to track short-term variations in the inputs to the production process, and that which strives to maintain comparability of the output of the model across product families and over time.

TechInsights' philosophy in cost modeling is to emphasize consistency across products and comparability over time, rather than to track short-term fluctuations. During the past eight years, we have developed an estimation process that, while necessarily lacking an insider's knowledge of the cost factors that impact any one manufacturer, is reasonably accurate in its prediction of unit costs in high-volume production environments. We do not claim that the model will produce the "right" answer for your firm's environment. However, TechInsights does give customers a key analytical tool with a complete set of data in our Bill of Materials (BOM). The BOM allows readers to 1) scrutinize the assumptions behind our cost model and 2) modify the results based on substitution of their own component cost estimates where they have better information based on inside knowledge.

Our estimation process decomposes overall system cost into three major categories: Electronics, Mechanical, and Final Assembly. We begin by creating a complete electronics bill-of-materials (BOM). Each component from the largest ASIC to the smallest discrete resistor is entered into a BOM table with identifying attributes such as size, pitch, I/O count, package type, manufacturer, part number, estimated placement cost, and die size (if the component is an IC). Integrated circuit costs are calculated from measured die area. Using assumptions for wafer size, process type, number of die per wafer, defect density, and profit margin in combination with die area, an estimate of semiconductor cost is derived. Costs for discrete components and interconnect are derived from assumption tables which relate BOM line items to specific cost estimates by component type and estimates for part placement costs are included. For LCD display costs, we employ a model which tabulates expected cost from measurements of glass area, LCD type, and total pixel resolution. When market costs are available from alternative sources, LCD panel costs are taken from and referenced to these sources.

Costs of non-electronic components such as molded plastic enclosures and metallic components are measured in terms of weight, size, thickness, type of material, and complexity to arrive at their estimated cost. Other system items such as optics, antennae, batteries and displays are costed from a set of assumption tables derived from a combination of industry data, average high volume costs, and external sources. For final assembly, we re-build the torn-down product, tabulating stepwise assembly times as the reconstruction proceeds, to reach a total assembly time. Using a labor rate assumption for the country of origin, we then calculate final assembly cost.

The three major categories for system cost contributors can be broken down into the subcategories of ICs, other electronics parts, displays, batteries (as appropriate), camera modules, electronics assembly, non-electronic elements, and final assembly. By adding the cost estimates for each of these subcategories, an overall estimated cost is derived for the system under evaluation. Product packaging and accessories (CDs, cables, etc.) are also documented and estimated for their contribution to total cost as appropriate.

We believe our cost estimates generally fall within 15 percent of the "right answer," which itself can vary depending on the market and OEM-specific factors mentioned earlier. While the TechInsights cost model is imperfect, it yields important insights into technology and business dynamics along with good first-order contributions to system cost by component type. Additionally, the consistency of approach and gradual modification to assumptions (smoothing out frequently-shifting pricing factors) hopefully yields a credible, but user-modifiable, view of OEM high volume cost-to-produce.

Please feel free to contact us at support@techinsights.com with any comments, questions, or proposed corrections with respect to our cost estimates. We welcome your input.

Signal Termination Board 5824

#15900-150224-PKb – Page

836

In our product teardowns, we gather a series of metrics for product profiling and comparison. Some metrics focus on system characteristics such as total silicon area, total system semiconductor storage capacity, and total connection count. Other metrics reflect more subtle aspects of electronics assembly such as connection density, average component I/O count, and silicon tiling density. Taken as a whole, the metrics allow deeper comparison and benchmarking across multiple disciplines and multiple products. Key metrics we gather on products are described below along with their definitions and what they tend to say about the system under study. Most metrics can be used both in comparing similar products for benchmarking purposes or for quantifying differences in levels of complexity between dissimilar product types. Data fall into two categories; either “raw” measured data or ratios of these measured data sets.

Total Silicon Area : This metric describes the total area of silicon as measured from X-ray or direct measurement of ICs. The area is an expression of the enclosed bare die area and excludes packaging area. The aggregate silicon area is a good benchmark to show how integrated a design might be when making comparisons to similar systems. Total silicon area also reflects the major cost driver for most systems we examine.

Silicon Tiling Density : Ratio of Total Silicon Area to total printed circuit board “projected” area (i.e. the simple board area and not the cumulative surface area of both sides of the board). This metric directly reflects the level of efficiency and aggressiveness in integrated circuit packing and placement. Single digit Silicon Tiling Density is typical but silicon coverage of 10% - 20% has been seen in some of the most advanced products we have examined. Higher Tiling Densities often correspond with the use of chip scale packaging (CSPs) or other small form-factor IC packaging technologies. High density circuit boards are also often a supporting technology.

Number of Parts : Total component count including ICs, passives, modules, connectors, etc., each separated out in our reporting.

Number of Connections : The total number of connections corresponds to the total number of interconnects introduced by the aggregate component set and reflects any electrical connection observed (solder joints, adhesive interconnect, or connector terminal interfaces).

Opportunity Count : Opportunity Count is the total number of parts plus the total number of connections; the name reflects that each of these constituent elements represents an opportunity for failure. A high opportunity count means more complex and riskier electronics assembly.

Average Pin Count (APC) : Ratio of total number of component terminals to total number of parts, at the system level. This metric reflects the ‘average’ terminal complexity of the components and often provide a signature of integration level and/or “digital-ness” of the overall product. Low APCs reflect a high number of discretely or other low-pincount devices often characteristic of analog circuitry. Conversely, high APCs are characteristic of highly integrated, high-pincount assemblies, often those composed largely of digital integrated circuits.

Connection Density : This metric is a ratio of the total Number of Connections to total printed circuit board assembly area, in units of connections per sq. inch. The metric provides data related to the Silicon Tiling Density above, but with an emphasis on complexity of I/O interconnect. For example, with a fixed Connection Density, high tiling density of low-pincount memory chips is more readily achieved than comparable silicon tiling of high pincount logic.

Part Density : This metric is a ratio of the total Number of Parts to total printed circuit board assembly area, in units of components per sq. inch. The metric provides data related to the Silicon Tiling Density and Connection Density as described above, but with an emphasis on density and complexity of component packing efficiency. For example, low Part Density of high-pincount devices can pose an equal challenge in Connection Density to high Part Density of low-pincount devices. High Part Density does reflect challenges in surface mount assembly in terms of (typically) precision of placement, number of placements, and engineering of part clearances.

Routing Density (heuristic estimate) = $3 * (\text{Average Pin Count}) * \sqrt{\text{Part Density}}$. The Routing Density metric is an empirically derived relationship that characterizes the wiring density of the interconnect used to support the interconnection of components in a planar electronic assembly (i.e. the circuit board). Architectural issues such as bussing or other factors affecting the regularity of wiring impact the actual Routing Density needed to support a given application, but the metric provides a ready measure of wiring complexity.

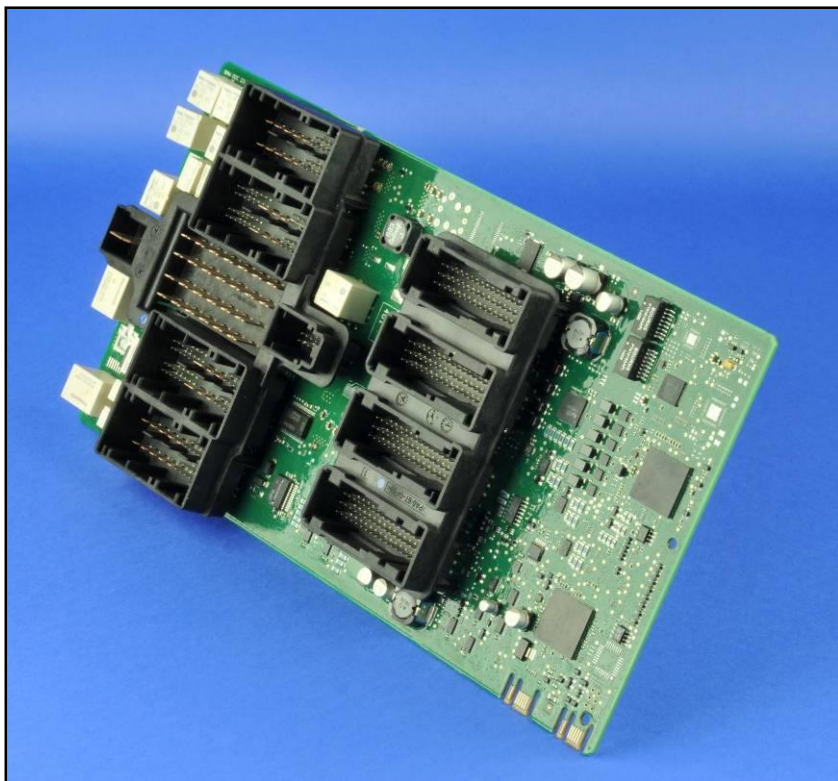
***Click Here to Return to
Cost Analysis Page 236***

Deep Dive Report

BMW i3 Body Domain Controller Board

5837

Report #15900-141103-KTb



Product Description

The Body Domain Controller Board for the 2014 BMW i3 (BDC-LR01) incorporates the comfort access and immobilizer systems. It is protected by plastic enclosures.

DISCLAIMER: All company names, product names, and service names mentioned are used for identification purposes only and may be registered trademarks, trademarks, or service marks of their respective owners. All analyses are done without participation, authorization, or endorsement of the manufacturer. Any cost analyses presented in this material are estimates prepared by TechInsights from generally available data. While TechInsights believes that these estimates reflect the probable costs, the actual producer did not supply the data, and therefore the actual costs may be different from these estimates. Furthermore, TechInsights extends no warranties with respect to any information in this document, and shall bear no liability whatsoever for the use of the information.

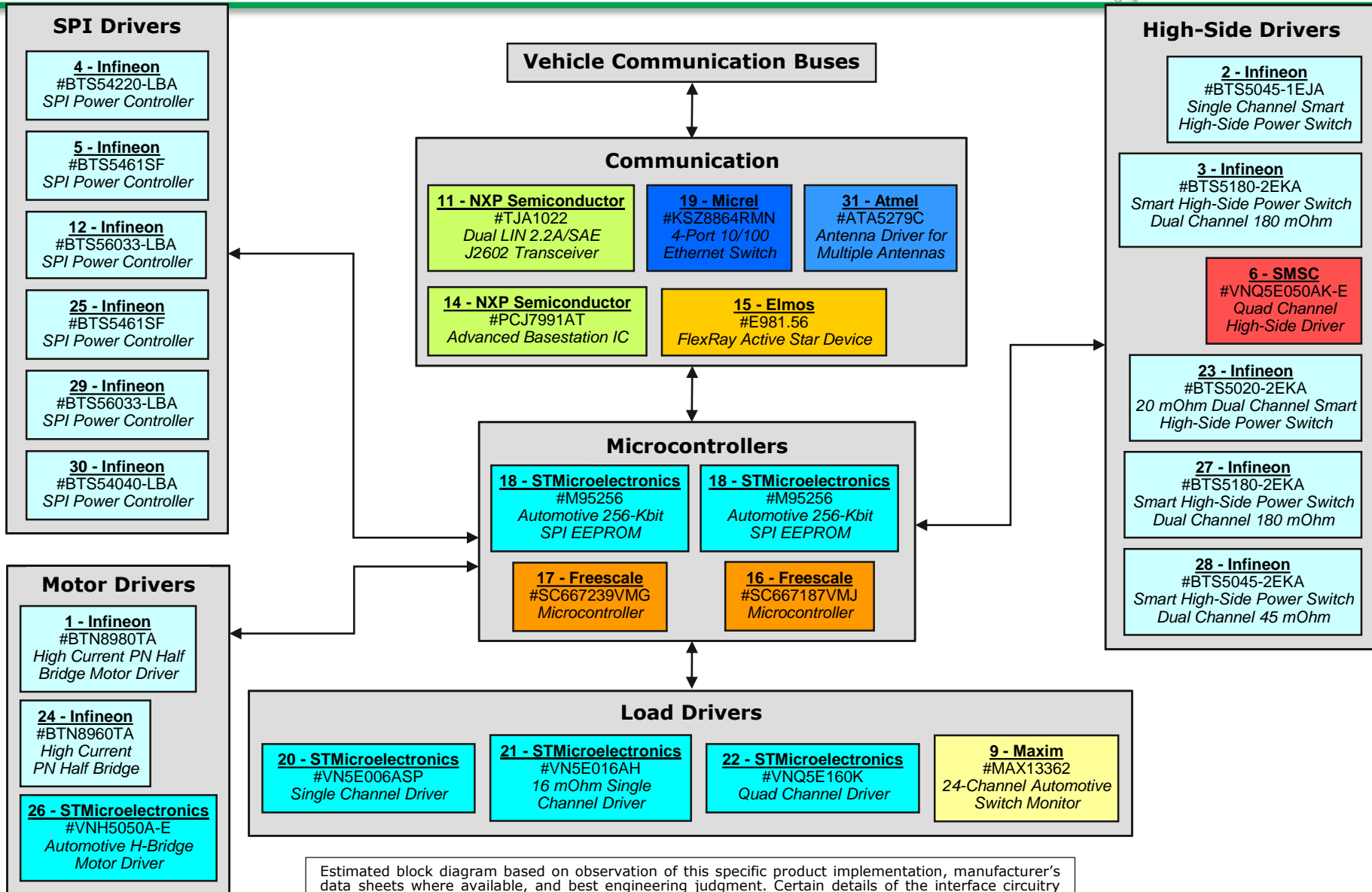
Copyright © 2015, TechInsights. All rights reserved. Do not reproduce, distribute, disseminate, photocopy, fax, transmit, download to a shared database, or otherwise copy, transfer, sell, publish, or send this material, or any portion thereof, by any means without the express written permission of TechInsights.

Product Overview




Product Description		Integrated Circuit Metrics		
Product Type	Automotive	IC Die Count	71	
Brand	BMW	IC Package Count	62	
Product Name & Model #	i3 Body Domain Controller BDC-LR01	Cost Metrics		
Official Release Date	5/2/2014			
Weight (grams)	478 (Measured)	Retail Price		
Product Dimensions (mm)	270 x 140 x 1.7 (Measured at Longest/Widest/Thickest)	Total Manufacturing Cost	\$164.17	
Product Features		Electronics Cost	\$151.98	
		Manufacturing Cost Breakdown		
Processors	Freescale #SC667187VMJ & #SC667239VMG MCUs	Integrated Circuits	\$77.09	47.0%
Communications	N/A	Modules, Discretes & Connectors	\$54.75	33.3%
Connectivity	SPI, CAN, ISO	Substrates	\$7.22	4.4%
		Component Insertion	\$9.45	5.8%
Battery Life	N/A	Card Test	\$3.47	2.1%
		Non-Electronic Parts	\$11.66	7.1%
		Final Assembly & Test	\$0.53	0.3%
		Total	\$164.17	100.0%

Block Diagram



Estimated block diagram based on observation of this specific product implementation, manufacturer's data sheets where available, and best engineering judgment. Certain details of the interface circuitry are not reflected in this block diagram. Partitioning and connectivity are speculative.

S: 61.35 9355492 -01 |  9355492 01
AW: _____ | 58F91BF01 14 149 6672272658
106818 10
MOROCCO | **BDC - LR01 V20** HW:D3.2 SW:005.019.120
*Pflin*LcWB*Tc30F*CaE*PwR*LcXe_LcL_LcC*WwSRA*WwF_WwR2*AcPV_ECL*CanB2
_EthP*EthS

LEAR Model/FCC ID:TTRBDCLR01 IC:6276A-BDCRL01

Test de STAVENTS of COMPLIANCE:
This device complies with Part 15 of the FCC Rules and with Industry Canada license-exempt RSS standards). Operation is subject to the following two conditions:
(1) this device may not cause harmful interference; and (2) this device must accept any interference received, including interference that may cause undesired operation.
Le present appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence.L'exploitation est autorisee aux deux conditions suivantes:
(1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioelectrique subi, meme si le brouillage est susceptible d'en compromettre le fonctionnement.
Note: changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.



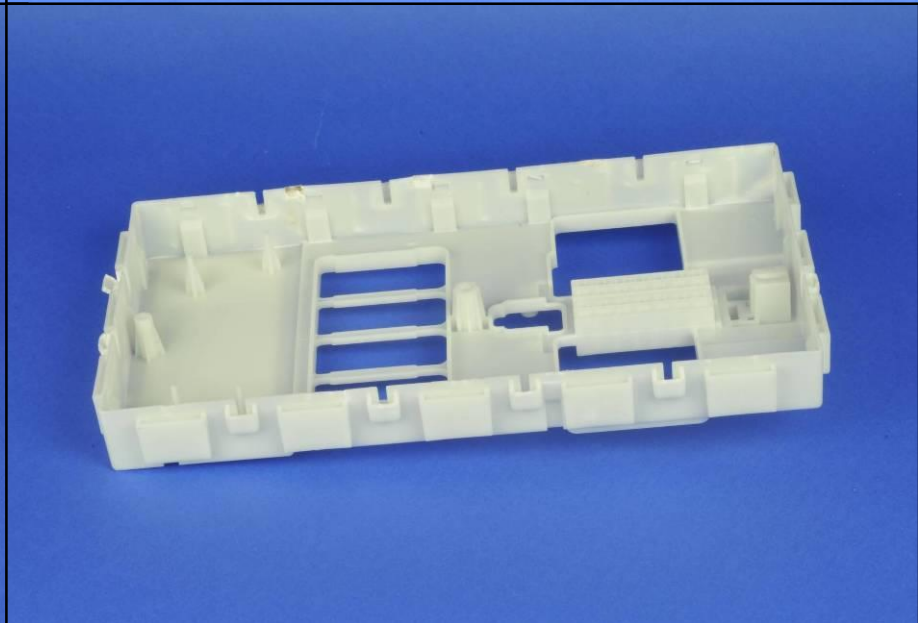
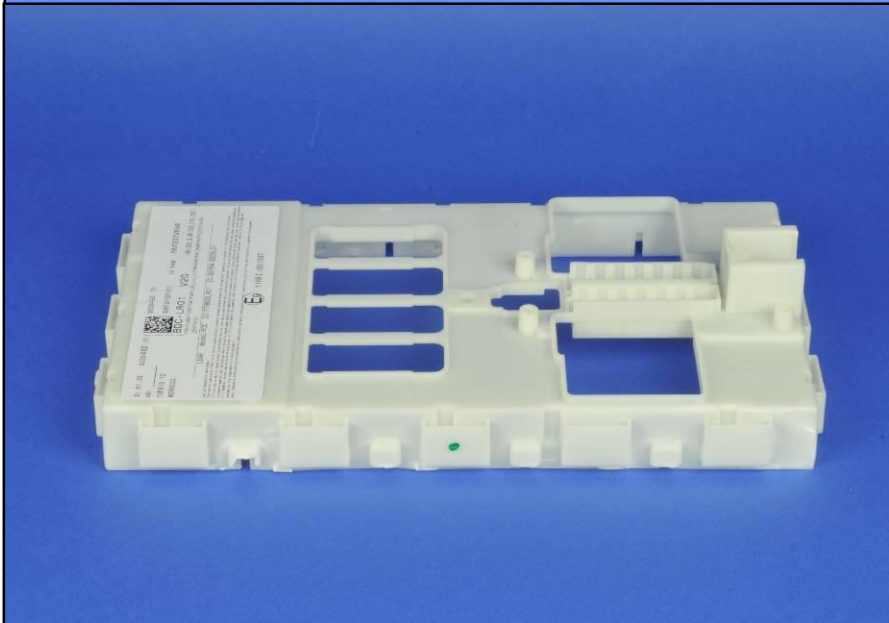
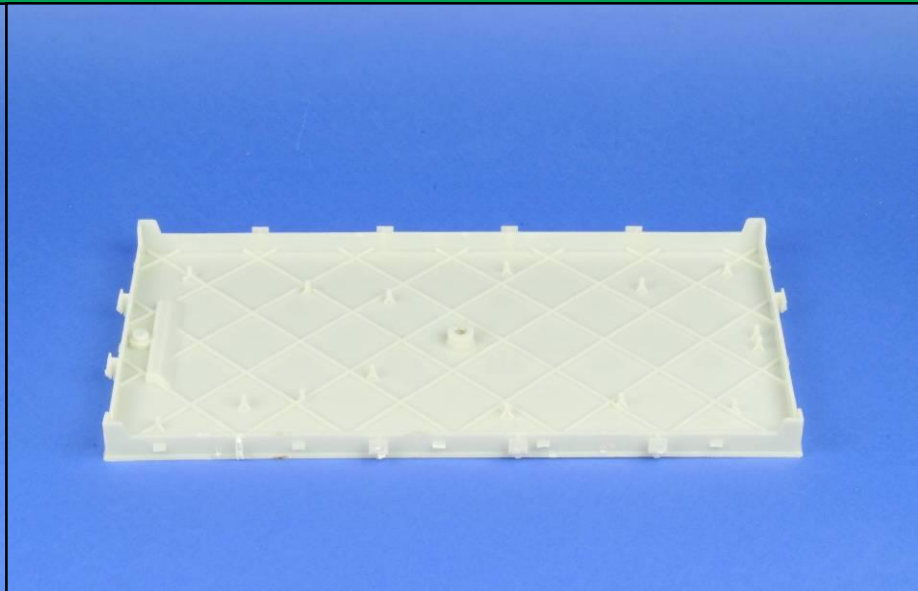
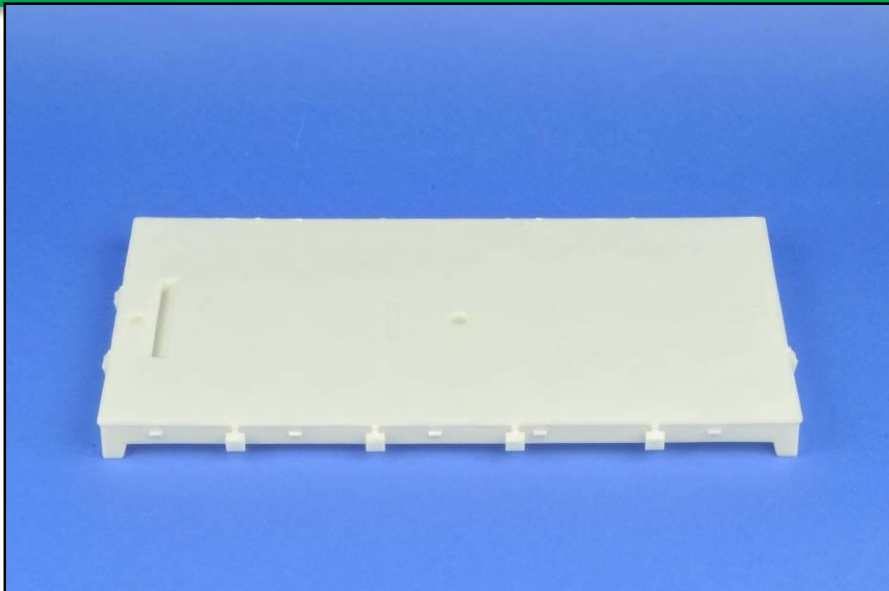
116RI-001097

ain

Exterior Features



MUNRO
& ASSOCIATES, INC.



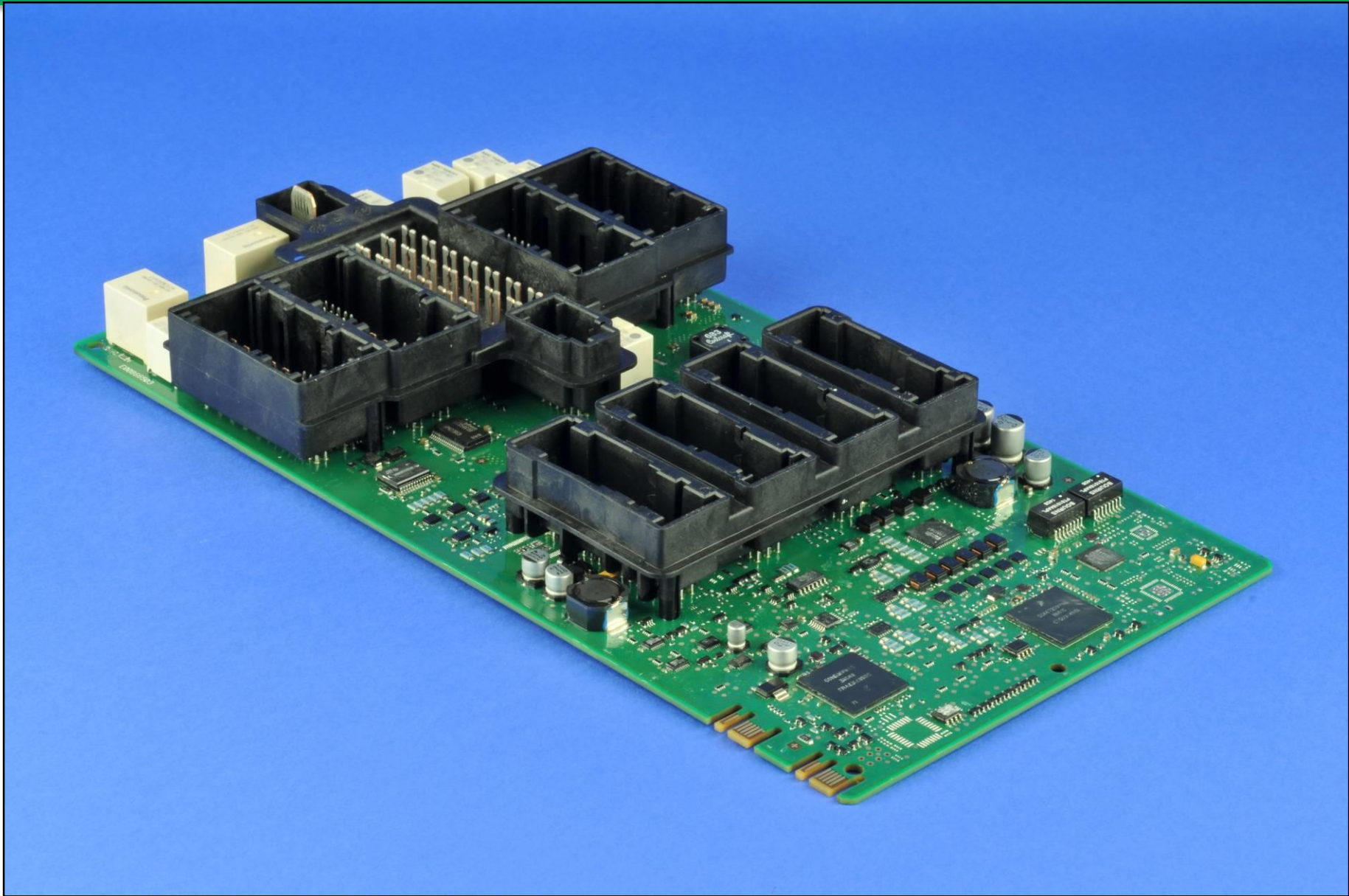
ain

Controller PCB #15900-141103-KTb - Page 843

Exterior Features



MUNRO
& ASSOCIATES, INC.



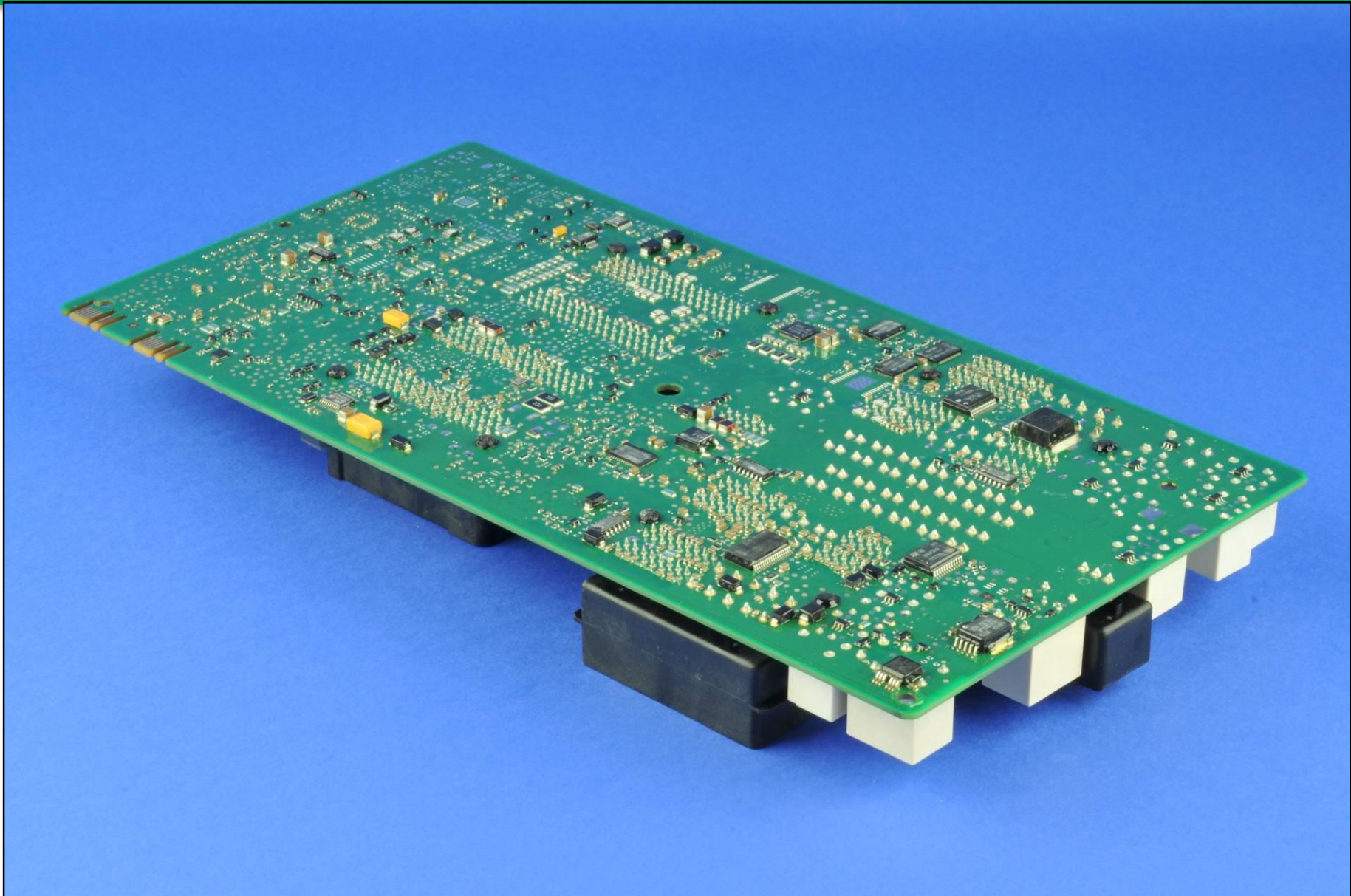
ain

Controller PCB #15900-141103-KTb - Page 844

Exterior Features



MUNRO
& ASSOCIATES, INC.



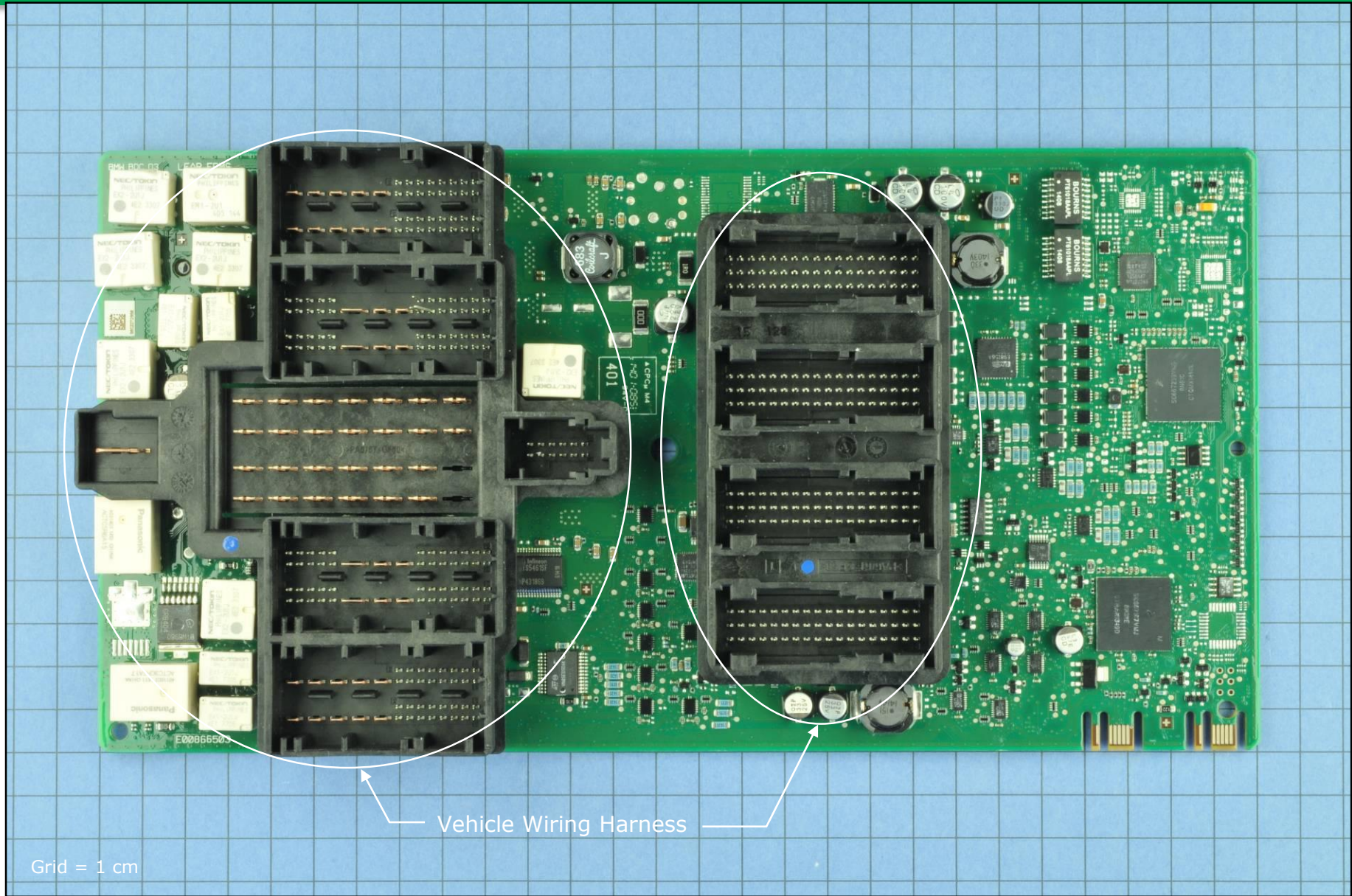
ain

Controller PCB #15900-141103-KTb - Page 845

Main Board (Side 1)



MUNRO
& ASSOCIATES, INC.



Main Board (Side 1 IC Identification)



MUNRO
& ASSOCIATES, INC.

1 - Infineon
#BTN8980TA
High Current PN Half Bridge
Motor Driver (3-Die Pkg.)

8 - NXP Semiconductor
#74HC4051
8-Channel Analog
Multiplexer/Demultiplexer

12 - Infineon
#BTS56033-LBA
SPI Power Controller

15 - Elmos
#E981.56
FlexRay Active Star Device

2 - Infineon
#BTS5045-1EJA
Single Channel Smart
High-Side Power Switch

3 - Infineon
#BTS5180-2EKA
Smart High-Side Power Switch
Dual Channel

4 - Infineon
#BTS54220-LBA
SPI Power Controller

9 - Maxim
#MAX13362
24-Channel Automotive
Switch Monitor

14 - NXP Semiconductor
#PCJ7991AT
Advanced Basestation IC

Grid = 1 cm

ain

Controller PCB #15900-141103-KTb - Page 847

Main Board (Side 1 IC Identification)



MUNRO
& ASSOCIATES, INC.

5 - Infineon
#BTS5461SF
SPI Power Controller (2-Die Pkg.)

11 - NXP Semiconductor
#TJA1022
Dual LIN 2.2A/SAE J2602 Transceiver

6 - Standard Microsystems Corporation (SMSC)
#VNQ5E050AK-E
Quad Channel High-Side Driver

7 - Texas Instruments
#SN74HC4851
8-Channel Analog Multiplexer/Demultiplexer

13 - Maxim
#Unknown
Unknown

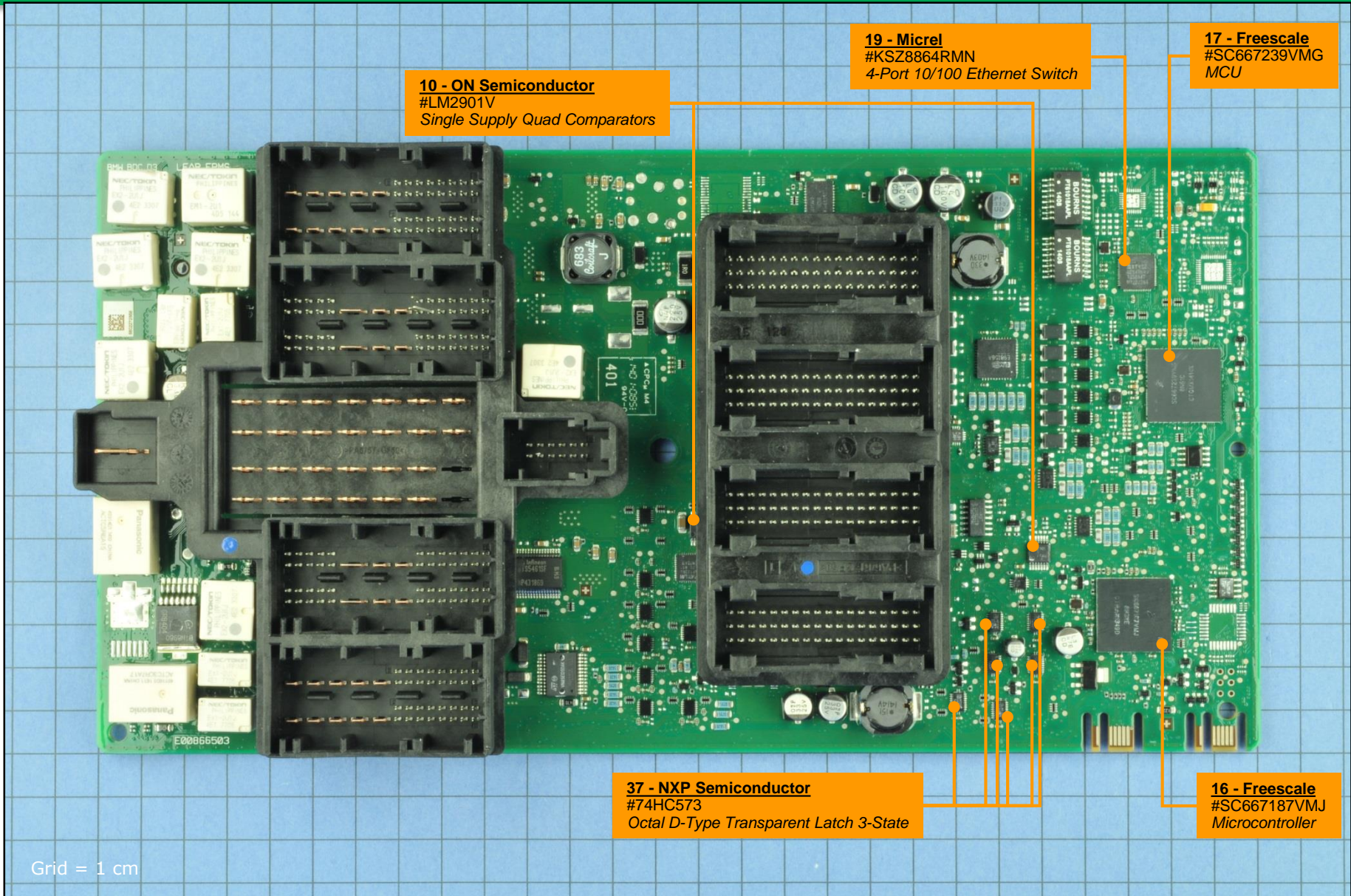
18 - STMicroelectronics
#M95256
Automotive 256-Kbit SPI EEPROM

Grid = 1 cm

ain

Controller PCB #15900-141103-KTb - Page 848

Main Board (Side 1 IC Identification)

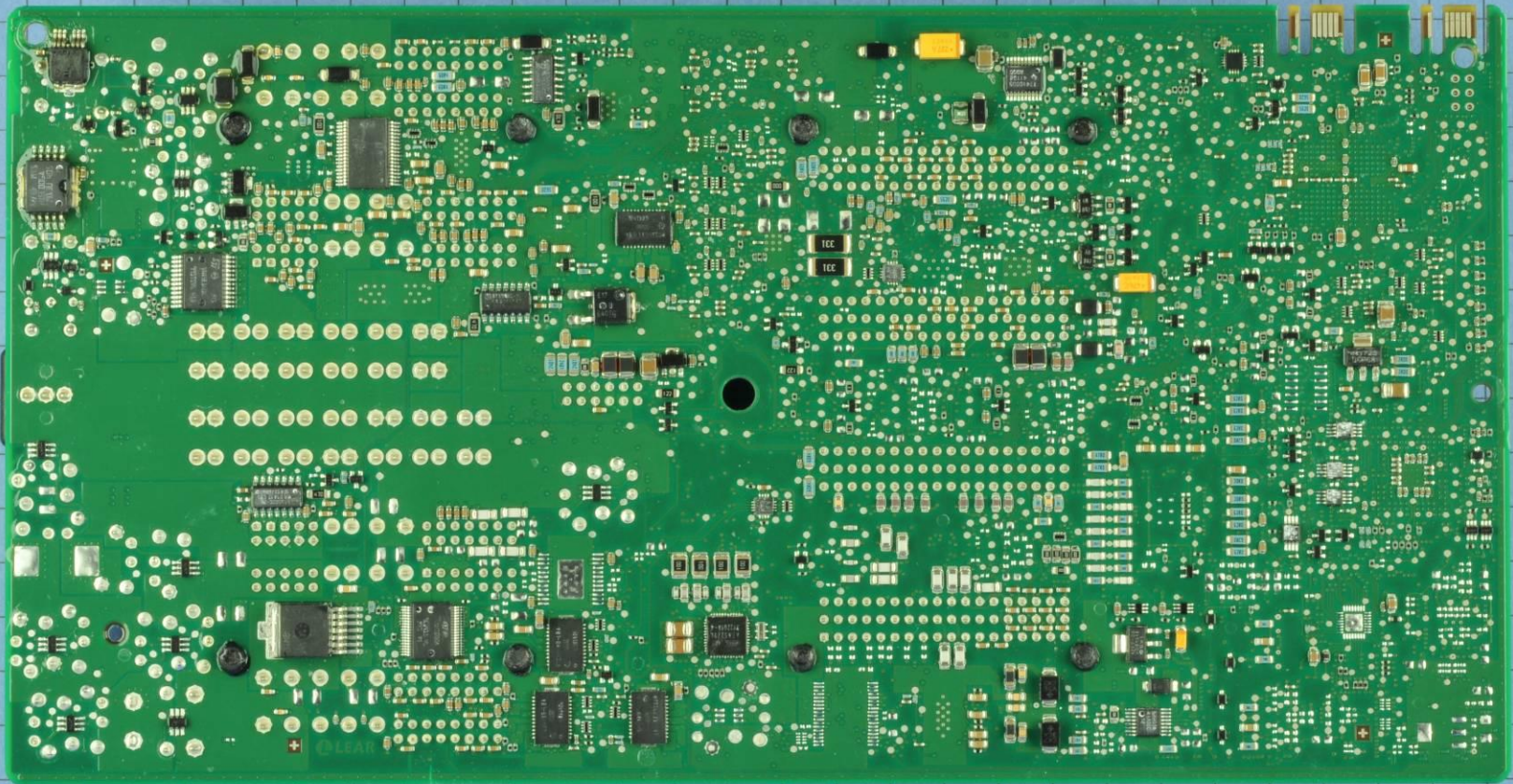


ain

Main Board (Side 2)



MUNRO
& ASSOCIATES, INC.



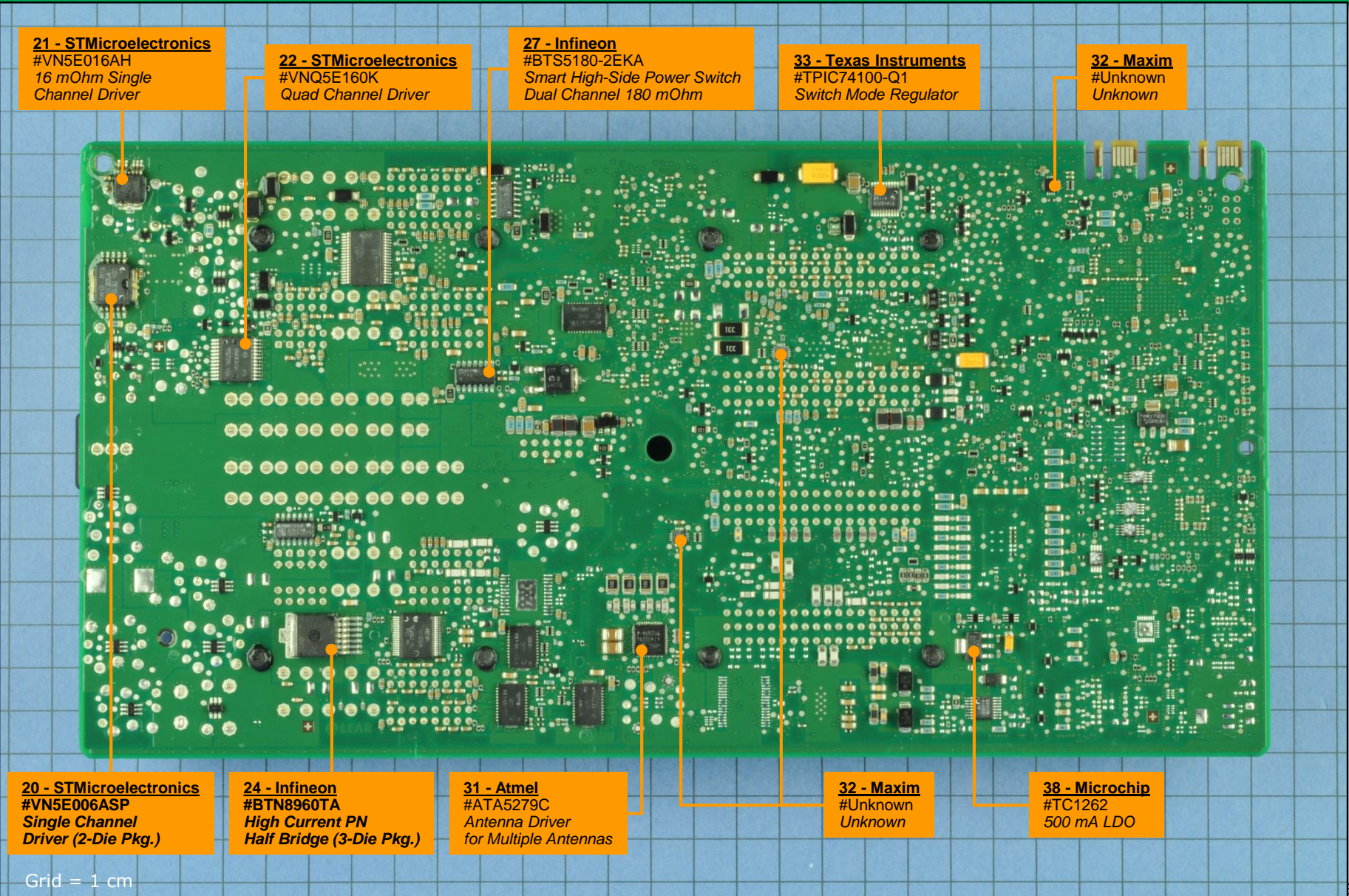
Grid = 1 cm

ain

Main Board (Side 2 IC Identification)



MUNRO
& ASSOCIATES, INC.



21 - STMicroelectronics
#VN5E016AH
16 mOhm Single
Channel Driver

22 - STMicroelectronics
#VNQ5E160K
Quad Channel Driver

27 - Infineon
#BTS5180-2EKA
Smart High-Side Power Switch
Dual Channel 180 mOhm

33 - Texas Instruments
#TPIC74100-Q1
Switch Mode Regulator

32 - Maxim
#Unknown
Unknown

20 - STMicroelectronics
#VN5E006ASP
Single Channel
Driver (2-Die Pkg.)

24 - Infineon
#BTN8960TA
High Current PN
Half Bridge (3-Die Pkg.)

31 - Atmel
#ATA5279C
Antenna Driver
for Multiple Antennas

32 - Maxim
#Unknown
Unknown

38 - Microchip
#TC1262
500 mA LDO

Grid = 1 cm

ain

Main Board (Side 2 IC Identification)

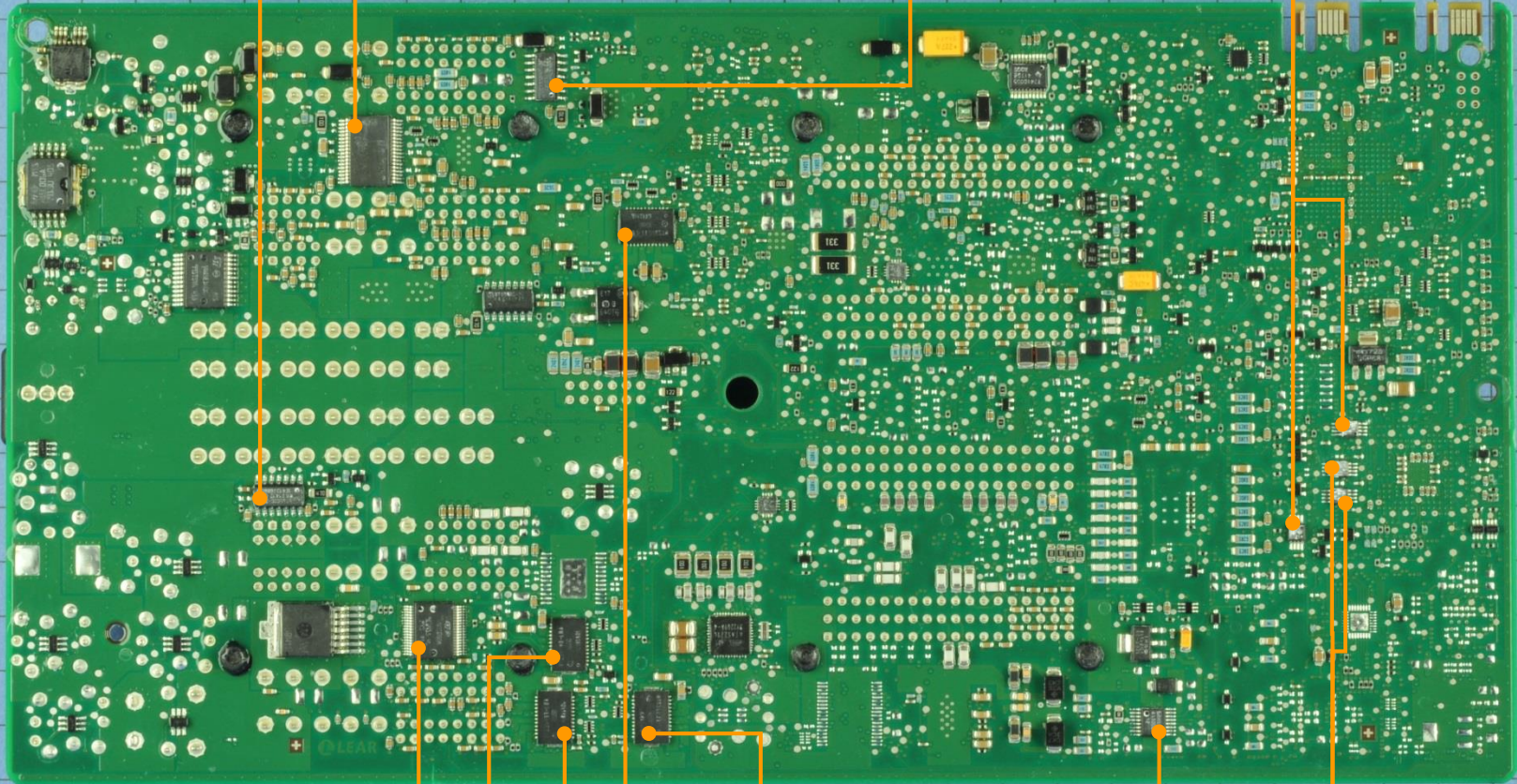


23 - Infineon
#BTS5020-2EKA
20 mOhm Dual Channel Smart High-Side Power Switch

25 - Infineon
#BTS5461SF
SPI Power Controller (2-Die Pkg.)

28 - Infineon
#BTS5045-2EKA
Smart High-Side Power Switch Dual Channel 45mOhm

35 - NXP Semiconductor
#74LVC3G07
Triple Buffer



26 - STMicroelectronics
#VNH5050A-E
Automotive H-Bridge Motor Driver (3-Die Pkg.)

30 - Infineon
#BTS54040-LBA
SPI Power Controller

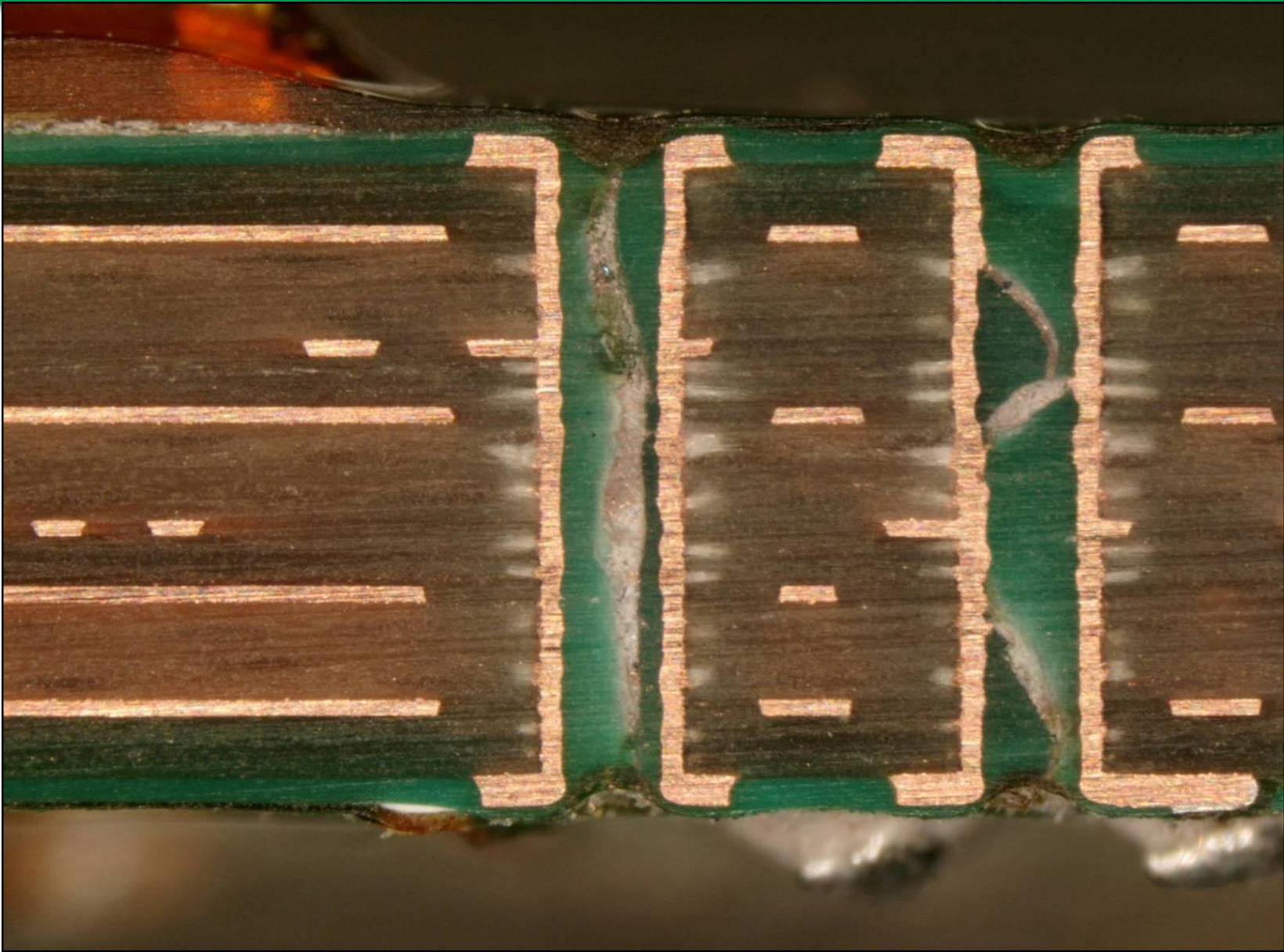
29 - Infineon
#BTS56033-LBA
SPI Power Controller

34 - Elmos
#E522.01A
Step-Down Converter

36 - NXP Semiconductor
#74LVC1G53-Q100
2-Ch MUX/ DeMUX

Grid = 1 cm

Main Board Cross-Section



ly Domain

Substrate Data

Substrates

Assembly Name	Manufacturer	Core Material	Mfg. Technology	Layers	Area (cm ²)	Min. Trace Pitch (mm)	Min. Trace Width (mm)	ThruVia Land Dia (mm)	ThruVia Hole Dia (mm)	BlindVia Land Dia (mm)	BlindVia Hole Dia (mm)	Thickness (mm)	Routing Density	Estimated Costs
Main Board	Unknown	FR4	8 Layer conventional FR4 / HF	8	378.0	0.30	0.10	0.60	0.25			1.8	23.3	\$ 7.22

Integrated Circuit Components



MUNRO
& ASSOCIATES, INC.

Location	Package Info										Die Info						Estimated Costs			
	Pkg Ref. #	Pkg Qty	Brand Name	Part Number	Pkg Description	Form	Pin Count	Length (mm)	Width (mm)	Height (mm)	Die Ref #	Die Qty	Brand Name	Part Number	Description	Length (mm)	Width (mm)	Each	Total	
Main Board, Side 1	1	1	Infineon	BTN8980TA	High Current PN Half Bridge Motor Driver	MCP - 3 Chips	7	10.00	9.25	4.40	1.1	1	Infineon	S1072S	High Current PN Half Bridge Motor Driver	1.74	1.27	\$ 0.940	\$ 0.940	
	2	1	Infineon	BTS5045-1EJA	Single Channel Smart High-Side Power Switch	SOP	8	5.00	3.87	1.58	2.1	1	Infineon	Unknown	MOSFET	3.14	2.90	\$ 0.180	\$ 0.180	
	3	1	Infineon	BTS180-2EKA	Smart High-Side Power Switch Dual Channel	SOP	14	8.88	3.89	1.48	3.1	1	Infineon	Unknown	MOSFET	2.15	2.00	\$ 0.090	\$ 0.090	
	4	1	Infineon	BTS5420-LBA	SPI Power Controller	DFN	36	9.50	6.00	1.00	4.1	1	Infineon	L8307B11	Single Channel Smart High-Side Power Switch	2.02	1.68	\$ 0.210	\$ 0.210	
	5	1	Infineon	BTS5461SF	SPI Power Controller	MCP - 2 Chips	36	12.88	7.38	2.40	5.1	1	Infineon	L8303B1	Dual Channel Smart High-Side Power Switch	2.35	1.70	\$ 0.280	\$ 0.280	
	6	1	Standard Microsystems	VN95E050AAKE	Quad Channel High-Side Driver	SOP	24	10.50	7.40	2.27	6.1	1	Standard Microsystems	L8370A2	SPI Power Controller	6.70	2.90	\$ 3.793	\$ 3.793	
	7	6	Texas Instruments	SN74HC4851	8-Channel Analog Multiplexer/Demultiplexer	QFN	16	3.58	2.58	0.90	7.1	1	Texas Instruments	S6008A14	SPI Power Controller	3.48	1.93	\$ 2.090	\$ 2.090	
	8	2	NXP Semiconductor	74HC4051	8-Channel Analog Multiplexer/Demultiplexer	QFN	16	3.55	2.52	0.85	8.1	1	NXP Semiconductor	Unknown	MOSFET	5.00	3.57	\$ 0.360	\$ 0.360	
	9	1	Maxim	MAX13362	24-Channel Automotive Switch Monitor	QFN	40	6.00	6.00	0.75	9.1	1	Maxim	VN95A	Quad Channel High-Side Driver	5.00	3.07	\$ 2.729	\$ 2.729	
	10	2	ON Semiconductor	LM2901V	Single Supply Quad Comparators	TSOP	14	5.13	4.52	1.00	10.1	1	ON Semiconductor	LC783A	8-Channel Analog Multiplexer/Demultiplexer	1.87	0.98	\$ 0.182	\$ 0.182	
	11	5	NXP Semiconductor	TJA1022	Dual LIN 2.2A/SAE J2602 Transceiver	DFN	14	4.50	3.00	0.85	11.1	1	NXP Semiconductor	LC702F	8-Channel Analog Multiplexer/Demultiplexer	1.28	0.93	\$ 0.154	\$ 0.308	
	12	1	Infineon	BTS36033-LBA	SPI Power Controller	DFN	18	9.41	6.00	1.00	12.1	1	Infineon	AB01Z	24-Channel Automotive Switch Monitor	3.63	3.37	\$ 0.860	\$ 0.860	
	13	2	Maxim	Unknown	Unknown	QFN	16	3.00	3.00	0.74	13.1	1	Maxim	139	Single Supply Quad Comparators	1.24	1.16	\$ 0.146	\$ 0.292	
	14	1	NXP Semiconductor	PCJ7991AT	Advanced Basestation IC	SOP	14	8.80	3.80	1.42	14.1	1	NXP Semiconductor	CP1571A	Dual LIN 2.2A/SAE J2602 Transceiver	1.90	1.25	\$ 0.182	\$ 0.912	
	15	1	Elmos	E981.56	FlexRay Active Star Device	QFN	44	8.99	8.99	0.93	15.1	1	ELAN Microelectronics	8374A2	Six Channel High-Side Smart Power Switch	4.70	2.40	\$ 1.921	\$ 1.921	
	16	1	Freescale	SC667187VMJ	Microcontroller	BGA	256	17.00	17.00	1.20	16.1	1	Freescale	AB08A-0	Unknown	1.59	1.59	\$ 0.220	\$ 0.440	
	17	1	Freescale	SC667239VMG	Microcontroller	BGA	208	16.97	16.97	1.20	17.1	1	Freescale	KA61CV0	Advanced Basestation IC/Basestation IC	1.74	1.68	\$ 0.695	\$ 0.695	
	18	2	STMicroelectronics	M95256	Automotive 32 KB SPI EEPROM	SOP	8	5.00	4.00	1.85	18.1	1	STMicroelectronics	E98156A	FlexRay Active Star Device	5.43	5.07	\$ 5.227	\$ 5.227	
	19	1	Micrel	KS2864RMN	4-Port 10/100 Ethernet Switch	DFN	64	8.00	8.00	0.85	19.1	1	Micrel	SC667187VMJ	Microcontroller	6.65	5.51	\$ 12.072	\$ 12.072	
Main Board, Side 2	20	1	STMicroelectronics	VN5E006ASP	Single Channel Driver	MCP - 2 Chips	10	9.30	7.60	3.50	20.1	1	STMicroelectronics	TL0916F	Microcontroller	7.38	6.25	\$ 12.839	\$ 12.839	
	21	1	STMicroelectronics	VN5E016AH	16 mOhm Single Channel Driver	SOP	6	6.30	6.00	2.30	21.1	1	STMicroelectronics	M95256	Automotive 32 KB SPI EEPROM	0.60	0.39	\$ 0.060	\$ 0.120	
	22	1	STMicroelectronics	VN95E160K	Quad Channel Driver	TSOP	24	10.55	7.70	2.20	22.1	1	STMicroelectronics	KS8985	4-Port 10/100 Ethernet Switch	3.74	2.94	\$ 3.111	\$ 3.111	
	23	1	Infineon	BTS5020-2EKA	20 mOhm Dual Channel Smart High-Side Power S	SOP	14	8.65	3.90	1.50	23.1	1	Infineon	VN85A	Quad Channel Driver	3.80	2.20	\$ 1.539	\$ 1.539	
	24	1	Infineon	BTN8960TA	High Current PN Half Bridge	MCP - 3 Chips	7	10.00	9.25	4.40	24.1	1	Infineon	L8300D1	20 mOhm Dual Channel Smart High-Side Power S	4.00	1.94	\$ 1.374	\$ 1.374	
	25	1	Infineon	BTS5461SF	SPI Power Controller	MCP - 2 Chips	36	12.80	7.60	2.45	24.2	1	Infineon	S1072R	High Current PN Half Bridge	1.70	1.27	\$ 0.905	\$ 0.905	
	26	1	STMicroelectronics	VNH5050A-E	Automotive H-Bridge Motor Driver	MCP - 3 Chips	36	10.10	7.50	2.20	24.3	1	Infineon	Unknown	MOSFET	2.90	2.85	\$ 0.173	\$ 0.173	
	27	1	Infineon	BTS180-2EKA	Smart High-Side Power Switch Dual Channel 180	SOP	14	8.65	3.90	1.50	25.1	1	Infineon	Unknown	MOSFET	1.63	1.52	\$ 0.052	\$ 0.052	
	28	1	Infineon	BTS5045-2EKA	Smart High-Side Power Switch Dual Channel 45m	SOP	14	8.65	3.90	1.50	28.1	1	Infineon	S6008A14	SPI Power Controller	3.48	1.93	\$ 1.940	\$ 1.940	
	29	3	Infineon	BTS56033-LBA	SPI Power Controller	DFN	18	9.50	6.00	1.00	29.1	1	Infineon	Unknown	MOSFET	5.08	3.58	\$ 0.379	\$ 0.379	
	30	1	Infineon	BTS54040-LBA	SPI Power Controller	DFN	18	9.50	6.00	1.00	30.1	1	Infineon	VNU5A	Automotive H-Bridge Motor Driver	4.57	2.80	\$ 2.487	\$ 2.487	
	31	1	Almél	ATAS279C	Antenna Driver for Multiple Antennas	QFN	48	7.00	7.00	0.20	31.1	1	Almél	VNU4A	MOSFET	2.84	1.64	\$ 0.092	\$ 0.184	
	32	3	Maxim	Unknown	Unknown	QFN	16	3.00	3.00	0.85	32.1	1	Maxim	L8303B1	Smart High-Side Power Switch Dual Channel 180	2.36	1.71	\$ 0.278	\$ 0.278	
	33	1	Texas Instruments	TPIC74100-Q1	Switch Mode Regulator	SOP	20	6.50	4.50	1.20	33.1	1	Texas Instruments	L8302B1	Smart High-Side Power Switch Dual Channel 45m	2.84	1.93	\$ 0.346	\$ 0.346	
	34	1	Elmos	E522.01A	Step-Down Converter	SOP	16	5.10	4.30	0.97	34.1	1	Elmos	L8374A2	SPI Power Controller	4.70	2.42	\$ 1.816	\$ 5.447	
	35	2	NXP Semiconductor	74LVC3G07	Triple Buffer	SOP	8	3.12	3.12	0.90	35.1	1	NXP Semiconductor	L8371AZ	SPI Power Controller	4.40	2.31	\$ 1.658	\$ 1.658	
	36	2	NXP Semiconductor	74LVC1G53-Q100	2-Ch MUX/ DeMUX	SOP	8	3.12	3.12	0.90	36.1	1	NXP Semiconductor	AT75010	Antenna Driver for Multiple Antennas	3.98	3.85	\$ 2.991	\$ 2.991	
	Main Board, Side 1	37	6	NXP Semiconductor	74HC573	Octal D-Type Transparent Latch 3-State	QFN	20	4.58	2.54	0.95	37.5	1	NXP Semiconductor	AB08A-0	Unknown	1.59	1.59	\$ 0.220	\$ 0.660
	Main Board, Side 2	38	1	Microchip	TC1262	500 mA LDO	TO	3	6.70	3.70	1.80	38.1	1	Microchip	TPIC74100	Switch Mode Regulator	3.24	1.82	\$ 1.158	\$ 1.158
Totals		62					1563					71							\$77.09	

Note: Supplemental information, such as IC package & die markings, is included in the Excel Bill of Materials (BOM) spreadsheet.

Modular Components



MUNRO
& ASSOCIATES, INC.

Location	Qty	Brand Name	Part Number	Description	Package			Estimated Costs	
					Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Unknown	Unknown	Crystal: Ceramic	4	2.50	2.00	\$ 0.200	\$ 0.200
	2	Unknown	Unknown	Crystal: Ceramic	4	2.50	2.00	\$ 0.200	\$ 0.400
	1	Unknown	Unknown	Filter: SAW	6	3.30	1.30	\$ 0.070	\$ 0.070
	2	Bourns	PT61018APL	Transformer: Transformer	16	12.73	6.81	\$ 0.500	\$ 1.000
	6	NEC/TOKIN	EX2-2U1J	Relay: Automotive DUAL	10	13.70	13.60	\$ 1.550	\$ 9.300
	1	NEC/TOKIN	EM1-2UT	Relay: Automotive	6	16.35	14.33	\$ 1.550	\$ 1.550
	4	NEC/TOKIN	EX1-2U1J	Relay: Automotive	5	13.69	12.14	\$ 1.200	\$ 4.800
	1	Panasonic	ACTC5R6A15	Relay: Automotive	7	17.70	13.00	\$ 1.550	\$ 1.550
	1	Panasonic	ACTC3CR7A17	Relay: Automotive	6	17.73	12.93	\$ 1.550	\$ 1.550
Main Board, Side 2	1	Unknown	Unknown	Crystal: Ceramic	6	3.30	1.30	\$ 0.200	\$ 0.200
TOTALS	20				155				\$20.62

Active Discrete Components



Location	Qty	Functional Description	Package					Estimated Costs	
			Form	Top Marking	Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	8	Small Active	Transistor, Small	WH5 44	3	2.84	1.23	\$0.030	\$0.239
	6	Small Active	Transistor, Small	A4t	3	2.14	1.20	\$0.030	\$0.179
	1	Small Active	Transistor, Small	Z2W 44	3	2.75	1.29	\$0.030	\$0.030
	3	Small Active	Transistor, Small	1Ft	3	2.10	1.10	\$0.030	\$0.090
	2	Small Active	Transistor, Small	84t	3	2.10	1.20	\$0.030	\$0.060
	6	Small Active	MOSFET	A42/3 01 05 D414	8	3.00	3.00	\$0.150	\$0.900
	2	Small Active	Transistor, Small	82t	3	2.11	1.09	\$0.030	\$0.060
	1	Small Active	Transistor, Large	W43/25 BCP68	3	6.67	3.46	\$0.150	\$0.150
	2	Small Active	Diode, SMT	AN	2	1.70	1.20	\$0.015	\$0.030
	1	Small Active	Transistor, Small	3FW 44	3	3.19	1.30	\$0.030	\$0.030
	2	Small Active	Transistor, Small	i30	3	2.09	1.08	\$0.030	\$0.060
	2	Small Active	Diode, SMT	16L M44	2	3.44	2.00	\$0.015	\$0.030
	1	Small Active	Transistor, Small	XGS	5	2.15	1.32	\$0.030	\$0.030
	2	Transistor, MOSFET		Q9945B AM W42M	8	5.00	3.88	\$0.150	\$0.300
	1	Small Active	Transistor, Small	X2s	6	2.00	1.28	\$0.030	\$0.030
	1	Small Active	Transistor, Large	AM W42	3	4.19	2.11	\$0.150	\$0.150
	1	Small Active	Diode, SMT	BVP 42	2	4.15	2.62	\$0.015	\$0.015
	1	Small Active	Diode, SMT	AB i42	2	3.77	2.64	\$0.015	\$0.015
	3	Small Active	Transistor, Small	75t	3	2.13	1.22	\$0.030	\$0.090
	2	Small Active	Diode, SMT	R4 12 E	2	4.35	2.85	\$0.015	\$0.030
	2	Small Active	Transistor, Large	On Logo E17 B 640TG	3	6.20	6.10	\$0.150	\$0.300
	8	Small Active	Transistor, Small	5BW 44	3	2.76	1.30	\$0.030	\$0.239
	8	Small Active	Transistor, Small	t08	3	2.08	1.23	\$0.030	\$0.239
	9	Small Active	Transistor, Small	83t	3	2.11	1.90	\$0.030	\$0.269
	7	Small Active	Transistor, Small	A6t	3	2.12	1.15	\$0.030	\$0.209
	6	Small Active	MOSFET Dual	2iH	6	2.00	1.15	\$0.090	\$0.540
	16	Small Active	Transistor, Small	t07	3	1.99	1.08	\$0.030	\$0.478
	2	Small Active	Transistor, Small	A1t	3	2.10	1.08	\$0.030	\$0.060
	2	Small Active	Transistor, Small	SCW 43	3	2.93	1.30	\$0.030	\$0.060
	Main Board, Side 2	1	Small Active	Diode, SMT	BVP 42	2	4.15	2.62	\$0.015
10		Small Active	Dual	JW6K	6	3.02	1.62	\$0.030	\$0.299
2		Small Active	Transistor Dual	Dt9	3	2.00	1.20	\$0.030	\$0.060
1		Small Active	Transistor, Small	EKGD	3	2.00	1.30	\$0.030	\$0.030
1		Small Active	Transistor, Small	W43/25 BCP68	3	6.50	3.50	\$0.030	\$0.030
1		Small Active	Transistor, Small	84t	3	2.15	1.18	\$0.030	\$0.030
2		Small Active	Transistor, Small	1Ft	3	2.10	1.00	\$0.030	\$0.060
3		Small Active	Transistor, Small	WH5 44	3	3.00	1.30	\$0.030	\$0.090
5		Small Active	Transistor, Small	82t	3	2.10	1.20	\$0.030	\$0.150
1		Small Active	Diode, SMT	16L M44	2	3.47	2.10	\$0.015	\$0.015
2		Small Active	Transistor, Small	X2	6	2.08	1.30	\$0.030	\$0.060
1		Small Active	Diode, SMT	AN i42	2	3.76	2.69	\$0.015	\$0.015
1		Small Active	Diode, SMT	V B7G 05C 5V6	2	4.60	2.70	\$0.015	\$0.015
7		Small Active	Diode, SMT	AN	2	1.60	1.20	\$0.015	\$0.104
5		Small Active	Transistor, Small	A1t	3	2.10	1.28	\$0.030	\$0.150
1		Small Active	Transistor, Large	On Logo E17 B 640TG	3	6.20	6.10	\$0.150	\$0.150
3		Small Active	Transistor, Small	75t	3	2.10	1.22	\$0.030	\$0.090
4		Small Active	Transistor, Small	A6t	3	2.10	1.20	\$0.030	\$0.120
1		Small Active	Diode, SMT	None	2	4.26	3.74	\$0.015	\$0.015
4		Small Active	Diode, SMT	R4 12 E	2	4.24	2.63	\$0.015	\$0.060
1		Small Active	Transistor, Small	6BW 43	3	2.83	1.22	\$0.030	\$0.030
4		Small Active	Transistor, Small	A4t	3	2.00	1.20	\$0.030	\$0.120
5	Small Active	Transistor, Small	AM W42	3	4.40	2.52	\$0.030	\$0.150	
10	Small Active	Transistor, Small	5BW 44	3	2.79	1.27	\$0.030	\$0.299	
8	Small Active	Transistor, Small	83t	3	2.15	1.23	\$0.030	\$0.239	
10	Small Active	Transistor, Small	t08	3	2.00	1.20	\$0.030	\$0.299	
2	Small Active	Diode, SMT	CK7 3CA	2	4.46	3.56	\$0.015	\$0.030	
TOTALS	204				685				\$7.63

Passive Discrete Components



Location	Qty	Functional Description	Package		Estimated Costs	
			Form	Pin Count	Each	Total
Main Board, Side 1	1	Capacitor	Tantalum / Niobium, Small	2	\$0.050	\$0.050
	1	Coil	SMT, Large	2	\$0.280	\$0.280
	1	Coil	SMT, Large	2	\$0.280	\$0.280
	1	Coil	SMT, Large	2	\$0.280	\$0.280
	2	Capacitor	Electrolytic, Medium	2	\$0.060	\$0.120
	1	Capacitor	Electrolytic, Medium	2	\$0.060	\$0.060
	1	Capacitor	Electrolytic, Medium	2	\$0.060	\$0.060
	1	Capacitor	Electrolytic, Small	2	\$0.040	\$0.040
	2	Capacitor	Electrolytic, Small	2	\$0.040	\$0.080
	1	Capacitor	Electrolytic, Small	2	\$0.040	\$0.040
	1	Capacitor	Electrolytic, Small	2	\$0.040	\$0.040
	436	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$1.744
	1	Coil	SMT, Small	2	\$0.050	\$0.050
	10	Coil	SMT, Small	4	\$0.090	\$0.900
	1	Coil	SMT, Small	2	\$0.050	\$0.050
	1	Coil	SMT, Small	2	\$0.050	\$0.050
	1	Capacitor	Tantalum / Niobium, Small	2	\$0.050	\$0.050
49	Small Passive	Cap, Res, Ferrite Array	8	\$0.007	\$0.363	
Main Board, Side 2	966	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$3.864
	30	Small Passive	Cap, Res, Ferrite Array	8	\$0.007	\$0.222
	2	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.008
	1	Small Passive	Cap, Res, Ferrite	2	\$0.004	\$0.004
	1	Capacitor	Tantalum / Niobium, Small	2	\$0.050	\$0.050
	2	Coil	SMT, Small	2	\$0.050	\$0.100
	1	Capacitor	Tantalum / Niobium, Small	2	\$0.050	\$0.050
TOTALS	1515			3524		\$8.83

Connectors



Location	Qty	Form	Package			Estimated Costs	
			Pin Count	Length (mm)	Width (mm)	Each	Total
Main Board, Side 1	1	Connector: Vehicle Wiring	216	108.08	58.00	\$7.590	\$7.590
	1	Connector: Vehicle Wiring	256	139.15	126.13	\$10.080	\$10.080
TOTALS	2		472				\$17.67

Electronic Assembly Metrics



MUNRO
& ASSOCIATES, INC.

Electronic Assembly Metrics by Assembly											
General Area	Assembly Name	Substrate Area (sq.cm)	Metal Layers	Circuit Area (sq.cm)	Routing Density (cm of routing per sq.cm of substrate)	Number of Components	Number of Connections	Component Density (Components/sq.cm)	Connection Density (Connections/sq.cm)	Avg. Pin Count	Assembly Weight (grams)
Main Electronics	Main Board	378.0	8	3024.0	23.3	1803	6399	4.8	16.9	3.6	195.00
	System Totals	378.0	8	3024		1803	6399	4.8	16.9	3.5	195.00

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

BMW i3 Body Domain
Controller PCB #15900-
141103-KTb - Page 860

Electronic Assembly Metrics



Electronics Costs by Assembly										
General Area	Assembly Name	Total	Integrated Circuits	Modular & Odd Form Components	Small Active Components	Passive Components	Connector Components	Substrates	Insertion	Card Test
Main Electronics	Main Board	\$ 151.98	\$ 77.09	\$ 20.62	\$ 7.63	\$ 8.83	\$ 17.67	\$ 7.22	\$ 9.45	\$ 3.47
	System Totals	\$ 151.98	\$ 77.09	\$ 20.62	\$ 7.63	\$ 8.83	\$ 17.67	\$ 7.22	\$ 9.45	\$ 3.47

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



Counts by Assembly												
General Area	Assembly Name	IC Package Count	IC Connections	Modular/Odd Form Components	Modular/Odd Form Component Connections	Small Active Components	Small Active Component Connections	Passive Components	Passive Component Connections	Connectors	Connector Connections	Opportunities
Main Electronics	Main Board	62	1563	20	155	204	685	1515	3524	2	472	8202
	System Totals	62	1563	20	155	204	685	1515	3524	2	472	8202

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Electronic Assembly Metrics



IC Metrics												
General Area	Assembly Name	IC Die Count	IC Package Count	Number of Package Connections	Die Area (sq.mm)	Substrate Tiling Density (die area / substrate area)	Package Area (sq.mm)	Die Area/Package Area Ratio	Package Connections per sq.cm of Package Area	Volatile Memory (KBytes)	Non-Volatile Memory (KBytes)	
Main Electronics	Main Board	71	62	1563	456.2	0.01	2514.2	0.18	62.2	0	64	
	System Totals	71	62	1563	456.2		2514.2	0.18	62.2	0	64	

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

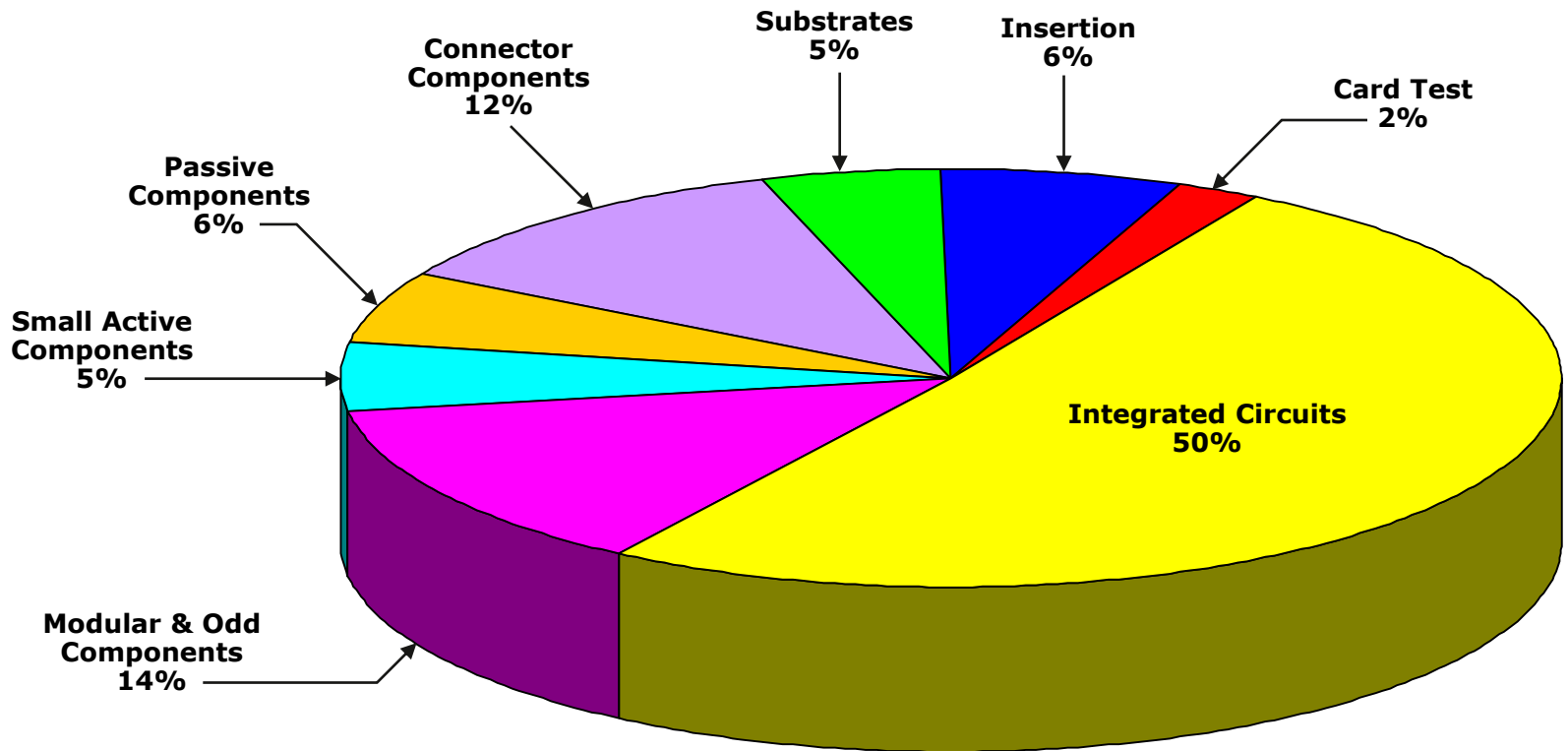
Electronic Costs Breakdown



Estimated Cost of Electronics

(Includes Subsystem Electronics)

\$151.98

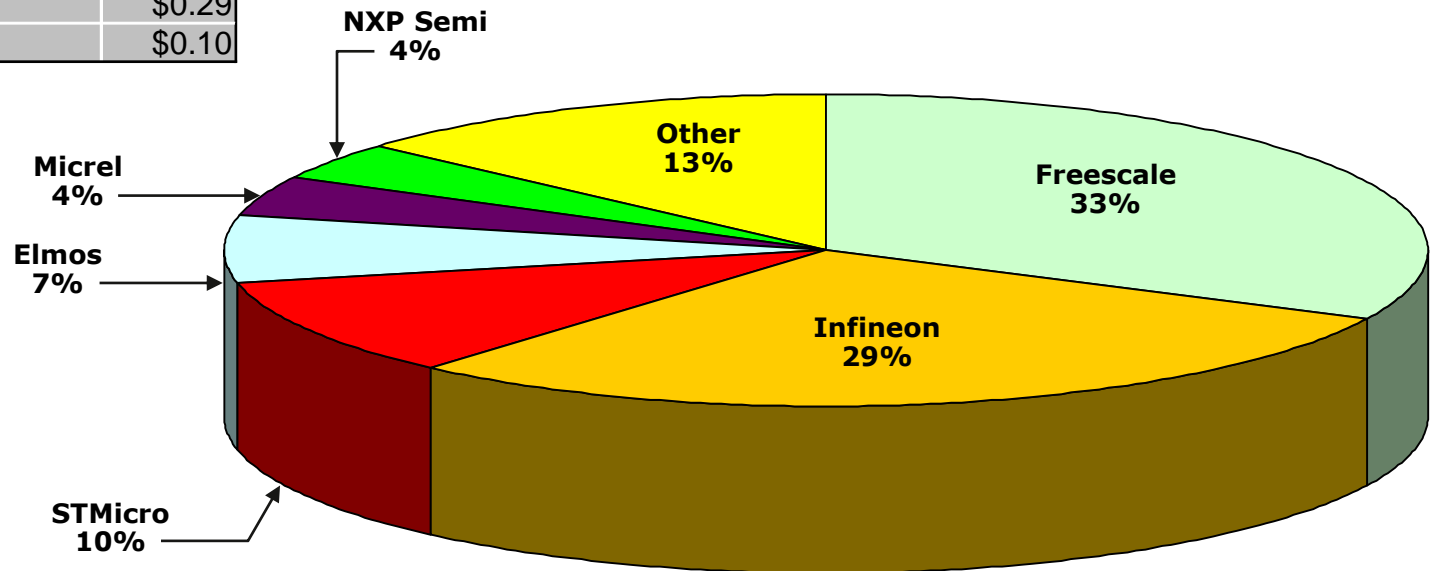


NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Vendor IC Cost Distribution

* Includes Subsystem Vendors & Associated Costs

Pkg. Brand	Cost
Freescale	\$24.91
Infineon	\$22.42
STMicroelectronics	\$7.89
Elmos	\$5.45
Micrel	\$3.11
NXP Semiconductor	\$3.00
Other	
Atmel	\$2.99
Standard Microsystems	\$2.73
Texas Instruments	\$2.25
Maxim	\$1.96
ON Semiconductor	\$0.29
Microchip	\$0.10



NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Non-Electronic Cost Estimate



Subsystem	Part ID No.	Qty	Description	Fabrication Process	Material	Dimensions (mm)	Weight (grams)	Est'd Cost Each	Est'd Extended Cost	
Enclosures	1	1	Top Cover	Molded	PP-(GF+M)30	289 x 156 x 57	154.00	6.350	6.350	
	2	1	Bottom Cover	Molded	PP-(GF+M)30	284 x 153 x 18.4	110.00	5.280	5.280	
Miscellaneous	3	1	Label	Die-Cut + Printed	Plastic + Adhesive	139 x 55.2 x 0.06	0.07	0.030	0.030	
Total		3						Estimated Cost		\$11.66

Final Ass'y Labor & Test Cost Estimate

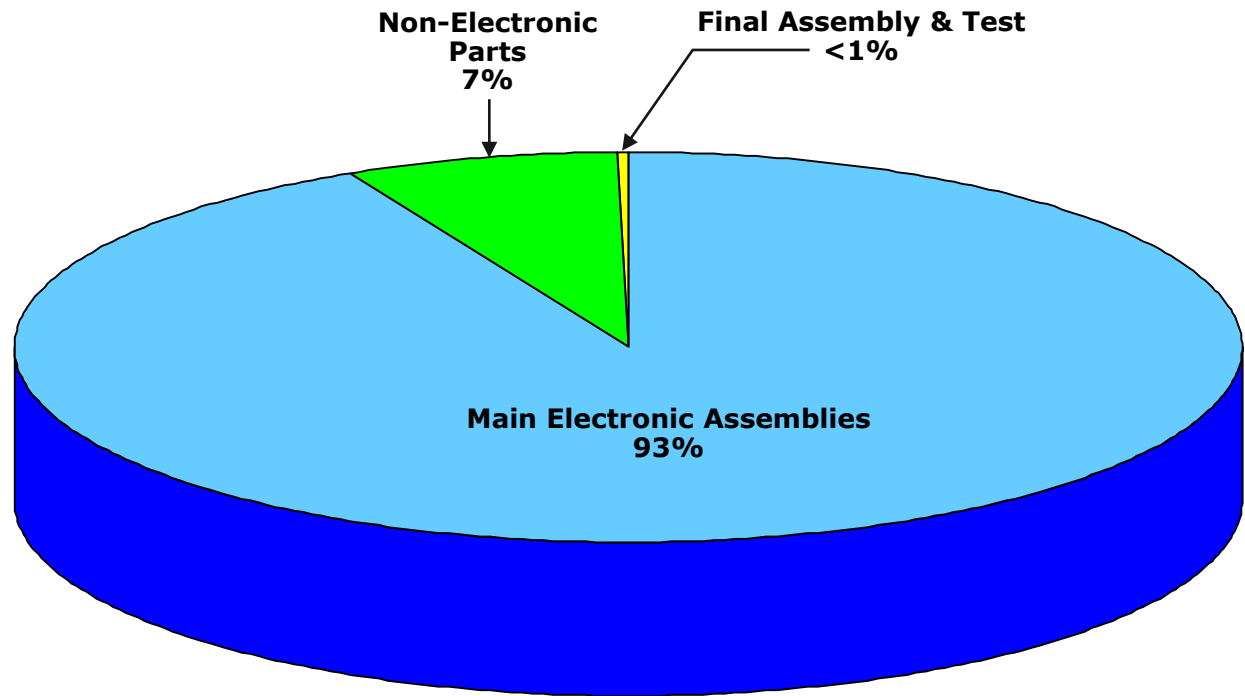


Final Assembly & Test	
Made in	Morocco
Number of parts	4
Est'd number of steps	12
Est'd time (seconds)	36
Est'd final assembly cost	\$ 0.03
Est'd final test cost	\$ 0.50

Cost Summary

Estimated Cost Totals	
Main Electronic Assemblies	\$ 151.98
Non-Electronic Parts	\$ 11.66
Final Assembly & Test	\$ 0.53
Total	\$ 164.17

Cost Total Notes:
Estimated final assembly cost includes labor only.
Total cost does not include Non-recurring, R&D, G&A, IP licensing fees/royalties, software, sales & marketing, distribution.
Assumes fully scaled production.



Cost Estimation Process (Overview & Discussion)



Cost modeling is tricky business. Multiple variables affect the actual production costs a manufacturer will experience, including development expenses, unit volumes, supply-and-demand in component markets, die yield-curve maturity, OEM purchasing power, and even variations in accounting practices. Different cost modeling methods employ different assumptions about how to handle these and other variables, but we can identify two basic approaches: that which seeks to track short-term variations in the inputs to the production process, and that which strives to maintain comparability of the output of the model across product families and over time.

TechInsights' philosophy in cost modeling is to emphasize consistency across products and comparability over time, rather than to track short-term fluctuations. During the past eight years, we have developed an estimation process that, while necessarily lacking an insider's knowledge of the cost factors that impact any one manufacturer, is reasonably accurate in its prediction of unit costs in high-volume production environments. We do not claim that the model will produce the "right" answer for your firm's environment. However, TechInsights does give customers a key analytical tool with a complete set of data in our Bill of Materials (BOM). The BOM allows readers to 1) scrutinize the assumptions behind our cost model and 2) modify the results based on substitution of their own component cost estimates where they have better information based on inside knowledge.

Our estimation process decomposes overall system cost into three major categories: Electronics, Mechanical, and Final Assembly. We begin by creating a complete electronics bill-of-materials (BOM). Each component from the largest ASIC to the smallest discrete resistor is entered into a BOM table with identifying attributes such as size, pitch, I/O count, package type, manufacturer, part number, estimated placement cost, and die size (if the component is an IC). Integrated circuit costs are calculated from measured die area. Using assumptions for wafer size, process type, number of die per wafer, defect density, and profit margin in combination with die area, an estimate of semiconductor cost is derived. Costs for discrete components and interconnect are derived from assumption tables which relate BOM line items to specific cost estimates by component type and estimates for part placement costs are included. For LCD display costs, we employ a model which tabulates expected cost from measurements of glass area, LCD type, and total pixel resolution. When market costs are available from alternative sources, LCD panel costs are taken from and referenced to these sources.

Costs of non-electronic components such as molded plastic enclosures and metallic components are measured in terms of weight, size, thickness, type of material, and complexity to arrive at their estimated cost. Other system items such as optics, antennae, batteries and displays are costed from a set of assumption tables derived from a combination of industry data, average high volume costs, and external sources. For final assembly, we re-build the torn-down product, tabulating stepwise assembly times as the reconstruction proceeds, to reach a total assembly time. Using a labor rate assumption for the country of origin, we then calculate final assembly cost.

The three major categories for system cost contributors can be broken down into the subcategories of ICs, other electronics parts, displays, batteries (as appropriate), camera modules, electronics assembly, non-electronic elements, and final assembly. By adding the cost estimates for each of these subcategories, an overall estimated cost is derived for the system under evaluation. Product packaging and accessories (CDs, cables, etc.) are also documented and estimated for their contribution to total cost as appropriate.

We believe our cost estimates generally fall within 15 percent of the "right answer," which itself can vary depending on the market and OEM-specific factors mentioned earlier. While the TechInsights cost model is imperfect, it yields important insights into technology and business dynamics along with good first-order contributions to system cost by component type. Additionally, the consistency of approach and gradual modification to assumptions (smoothing out frequently-shifting pricing factors) hopefully yields a credible, but user-modifiable, view of OEM high volume cost-to-produce.

Please feel free to contact us at support@techinsights.com with any comments, questions, or proposed corrections with respect to our cost estimates. We welcome your input.

In our product teardowns, we gather a series of metrics for product profiling and comparison. Some metrics focus on system characteristics such as total silicon area, total system semiconductor storage capacity, and total connection count. Other metrics reflect more subtle aspects of electronics assembly such as connection density, average component I/O count, and silicon tiling density. Taken as a whole, the metrics allow deeper comparison and benchmarking across multiple disciplines and multiple products. Key metrics we gather on products are described below along with their definitions and what they tend to say about the system under study. Most metrics can be used both in comparing similar products for benchmarking purposes or for quantifying differences in levels of complexity between dissimilar product types. Data fall into two categories; either “raw” measured data or ratios of these measured data sets.

Total Silicon Area : This metric describes the total area of silicon as measured from X-ray or direct measurement of ICs. The area is an expression of the enclosed bare die area and excludes packaging area. The aggregate silicon area is a good benchmark to show how integrated a design might be when making comparisons to similar systems. Total silicon area also reflects the major cost driver for most systems we examine.

Silicon Tiling Density : Ratio of Total Silicon Area to total printed circuit board “projected” area (i.e. the simple board area and not the cumulative surface area of both sides of the board). This metric directly reflects the level of efficiency and aggressiveness in integrated circuit packing and placement. Single digit Silicon Tiling Density is typical but silicon coverage of 10% - 20% has been seen in some of the most advanced products we have examined. Higher Tiling Densities often correspond with the use of chip scale packaging (CSPs) or other small form-factor IC packaging technologies. High density circuit boards are also often a supporting technology.

Number of Parts : Total component count including ICs, passives, modules, connectors, etc., each separated out in our reporting.

Number of Connections : The total number of connections corresponds to the total number of interconnects introduced by the aggregate component set and reflects any electrical connection observed (solder joints, adhesive interconnect, or connector terminal interfaces).

Opportunity Count : Opportunity Count is the total number of parts plus the total number of connections; the name reflects that each of these constituent elements represents an opportunity for failure. A high opportunity count means more complex and riskier electronics assembly.

Average Pin Count (APC) : Ratio of total number of component terminals to total number of parts, at the system level. This metric reflects the ‘average’ terminal complexity of the components and often provide a signature of integration level and/or “digital-ness” of the overall product. Low APCs reflect a high number of discrettes or other low-pincount devices often characteristic of analog circuitry. Conversely, high APCs are characteristic of highly integrated, high-pincount assemblies, often those composed largely of digital integrated circuits.

Connection Density : This metric is a ratio of the total Number of Connections to total printed circuit board assembly area, in units of connections per sq. inch. The metric provides data related to the Silicon Tiling Density above, but with an emphasis on complexity of I/O interconnect. For example, with a fixed Connection Density, high tiling density of low-pincount memory chips is more readily achieved than comparable silicon tiling of high pincount logic.

Part Density : This metric is a ratio of the total Number of Parts to total printed circuit board assembly area, in units of components per sq. inch. The metric provides data related to the Silicon Tiling Density and Connection Density as described above, but with an emphasis on density and complexity of component packing efficiency. For example, low Part Density of high-pincount devices can pose an equal challenge in Connection Density to high Part Density of low-pincount devices. High Part Density does reflect challenges in surface mount assembly in terms of (typically) precision of placement, number of placements, and engineering of part clearances.

Routing Density (heuristic estimate) = $3 * (\text{Average Pin Count}) * \sqrt{\text{Part Density}}$. The Routing Density metric is an empirically derived relationship that characterizes the wiring density of the interconnect used to support the interconnection of components in a planar electronic assembly (i.e. the circuit board). Architectural issues such as bussing or other factors affecting the regularity of wiring impact the actual Routing Density needed to support a given application, but the metric provides a ready measure of wiring complexity.

***Click Here to Return to
Cost Analysis Page 249***



Munro & Associates Wire Harness Reports

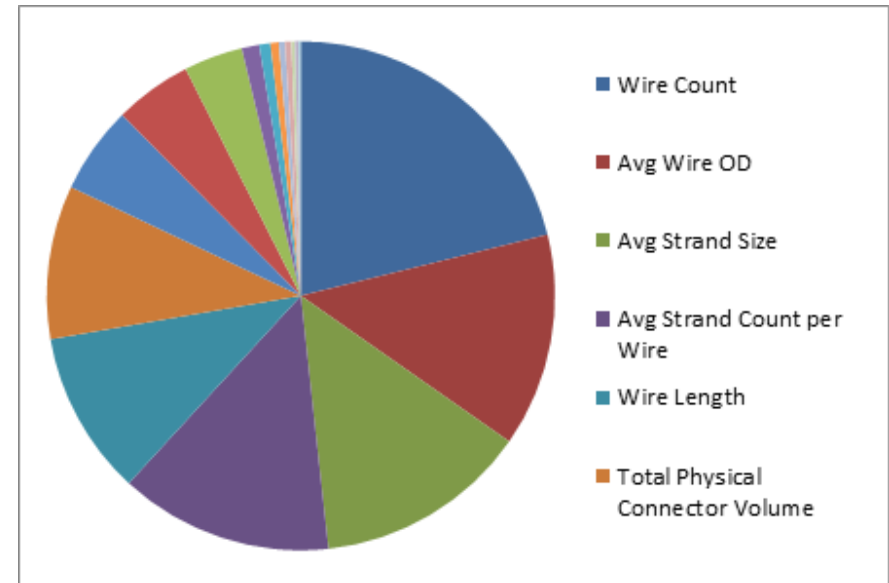
Wire Harness Cost Analysis

Main Wire Harness Wire Harness

- The Design Profit[®] based Wire Harness Coster generates cost estimates of various components and assembly processes for the majority of wire harnesses found in today's manufactured products. The Wire Harness Coster rolls up these costs to deliver an estimate of the total manufactured cost.
- Costs are based on several factors including: commodity items, components, burdened machine rates, processing speeds, burdened labor rates, and cost of poor quality drivers.
- The Wire Harness Coster consistently generates a cost estimate for a given wire harness without the need to completely disassemble or destroy the wire harness. Minimal disassembly may be required to capture various attributes and identify overall circuit routing. Inputs to the coster include: connector data (size, cavity count, locking mechanisms and sealing attributes), wire data (sizes quantities and lengths), coverings (type, size and length), fasteners, brackets, troughs, etc.
- The Wire Harness Coster separates the parts and processes to more easily delineate Bill of Material (BOM) costs and build processing costs.

Factors Influencing Cost:

1. Wire count is the primary factor driving cost as it affects the amount of wire, the size of connectors, and the number of assembly processes.
2. Wire selection (wire OD, strand size, strand count / wire) is significant as it directly relates to conductor cross section, and therefore the amount of copper or aluminum used in the harness.
3. Wire length is another major cost factor as it both relates to material cost and to assembly time, as longer lengths require more handling.
4. The total physical connector size is a major cost factor as connectors are a large portion of harness part costs. Total physical connector size also tends to drive assembly costs.



Relative influence of factors on harness costs
(Data based on L32 two-level Taguchi analysis
of the Wire Harness Coster)

Main Wire Harness Overview

The Main Wire Harness consists of 517 wires and cables joining 115 pin/blade connectors and 16 coax connectors. 65 of the wires are 1.1 mm OD, 298 are 1.3 mm OD, 61 are 1.5 mm OD, 24 are 1.7 mm OD, 7 are 1.9 mm OD, 21 are 2.2 mm OD, 13 are 2.8 mm OD, four are 2.9 mm OD, six are 3.4 mm OD, two are 4.0 mm OD and one is 9.2 mm OD. All wires are copper stranded. There are also one 9.4 mm OD and one 10.5 mm OD aluminum stranded cables.

There are 38 twisted wire pairs and 35 ultrasonically welded splices. The Harness has seven 3.3 mm coax cables and 6 multi-conductor cables of various configurations as well.

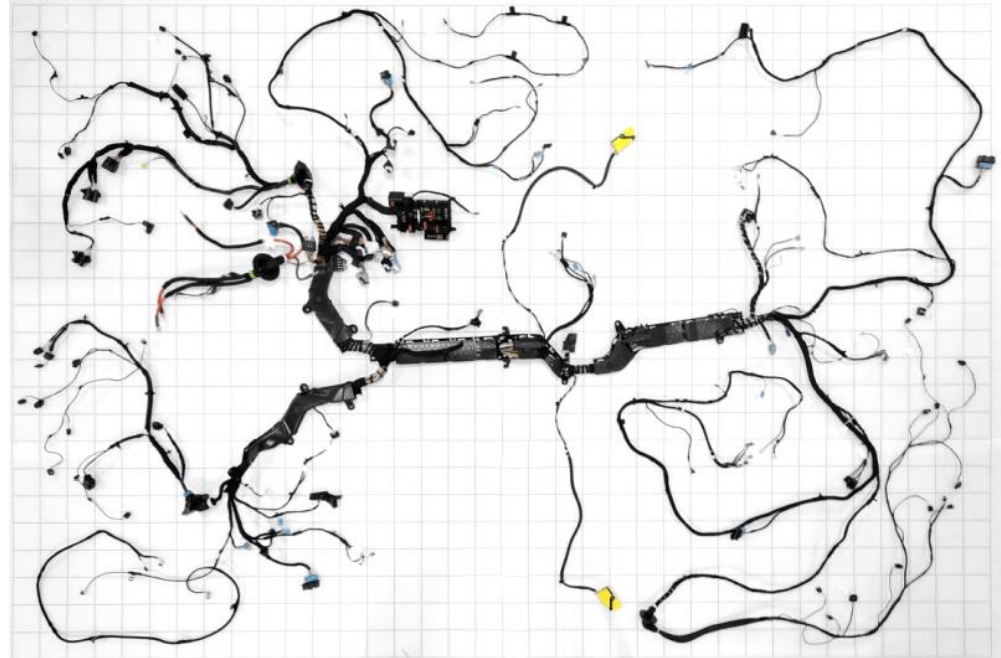
The largest pin/blade connector has 104 cavities populated with 51 terminals. Sixty percent of these connectors are unsealed. The remaining coax connectors are Rosenberger HSD and FAKRA designs.

The harness covering consists of a combination of cloth tape, standard electrical tape, convolute tubing and molded troughs. There are 71 taped on clips, 49 zip-tie clips, 6 grommets, and 3 labels. The overall weight of the harness is 12.1393 kg.

All major components are analyzed in detail, while prices are applied to commodity items (i.e. clips, terminals).

Estimates are based on actual parts.

Photos: Background on 100mm grid paper.



Design Profit[®]

EXECUTIVE SUMMARY Harness Overview

	2229 - Main Wire Harness
Parts	1,407
Steps	8693
Assembly Time (min)	576.85
Total Weight (kg)	12.1393
Purchased Part Cost	\$171.29
Supplier Asm. Cost	\$166.52
Q Burden	\$10.70
Total Cost	\$348.51

Design Profit[®]

EXECUTIVE SUMMARY Wire, Cable & Splices

	2229 - Main Wire Harness
Wire & Cable Count	517
Splice Count	35
Wire Length Total (cm)	113958.6
Harness Total Weight	12.1393 kg
Cu Conductor Mass	6.8264 kg
Cu to Harness Mass (%)	56.23 %
Al Conductor Mass	0.1624 kg
Al to Harness Mass (%)	1.34 %
Wire Cost	\$97.41

Design Profit[®]

EXECUTIVE SUMMARY Connectors & Terminals

	2229 - Main Wire Harness
Connector Assemblies	115
Sealed Connectors	46
Terminal Cavities	1375
Unpopulated Cavities	605
Connector Body Cost	\$15.20
Coax Connectors	16
Coax Connector Cost	\$9.68
Pin & Blade Terminals	881
Ring Terminals	9
Battery Terminals	0
Terminal Strips	9
Total Terminal Count	899
Terminal Cost	\$20.61

Design Profit[®]

EXECUTIVE SUMMARY Labels, Clips, Tape & Coverings

	2229 - Main Wire Harness
Label Count	3
Label Area cm2	96.0
Label Cost	\$0.24
Clip Count	120
Clip Cost	\$4.31
Tape Tacks	266
Taped Length cm	4804.3
Tape Actual Length cm	16579.5
Tape Cost	\$7.80
Tube & Wrap Count	30
Heat Shrink Count	45
Covering Count Total	75
Covering Length cm	775.3
Covering Cost	\$6.13



Design Profit[®]


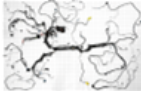

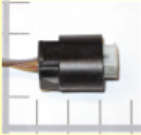






EXECUTIVE SUMMARY Miscellaneous Parts

	2229 - Main Wire Harness
Bracket Count	1
Bracket Cost	\$0.15
Trough Count	6
Trough Cost	\$2.16
Fuse Count	0
Fuse Cost	\$0.00
Grommet Count	6
Grommet Cost	\$4.52
Misc Part Count	18
Misc Part Cost	\$2.52

Wire Harness Costed Bill of Materials




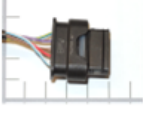

Harness CBOM

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
	Main Harness	\$171.2921	1	1	Each	\$171.2921
Media:						
						
	C01	\$0.1800	1	1	Each	\$0.1800
Media:						
						
	C02	\$0.1500	1	1	Each	\$0.1500
Media:						
						
	Tape, Std C01	\$0.0155	1	47.2	cm	\$0.0155
Media:						
						
	Clip, Tape on X-Tree 1 Tab	\$0.0200	1	1	Each	\$0.0200
Media:						
						


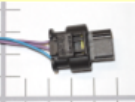



Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack	\$0.0048	1	9.8	cm	\$0.0048
Media: 	Tape, Std C02	\$0.0108	1	33.1	cm	\$0.0108
Media: 	Tape, Std B01-02	\$0.0077	1	23.6	cm	\$0.0077
Media: 	C03	\$0.2000	1	1	Each	\$0.2000
Media: 	Tape, Std C03	\$0.0108	1	33.1	cm	\$0.0108



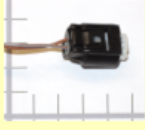


Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Tape, Std B01-03	\$0.0070	1	21.3	cm	\$0.0070
Media:						
■	C04	\$0.1500	1	1	Each	\$0.1500
Media:						
■	Tape, Std C04	\$0.0049	1	14.9	cm	\$0.0049
Media:						
■	C05	\$0.1500	1	1	Each	\$0.1500
Media:						
■	Tape, Std C05	\$0.0070	1	21.3	cm	\$0.0070
Media:						


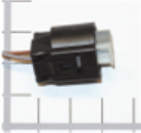

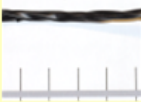






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Std B04-06	\$0.0062	1	18.9	cm	\$0.0062
Media: 	Tape, Std B01-05	\$0.0150	1	45.8	cm	\$0.0150
Media: 	C06	\$0.1500	1	1	Each	\$0.1500
Media: 	Tape, Std C06	\$0.0109	1	33.3	cm	\$0.0109
Media: 	Tape, Std B01-06	\$0.0107	1	32.7	cm	\$0.0107

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
	C07	\$0.1500	1	1	Each	\$0.1500
Media:						
	Tape, Std C07	\$0.0053	1	16.1	cm	\$0.0053
Media:						
	C08	\$0.2600	1	1	Each	\$0.2600
Media:						
	Heat Shrink, Adhesive Lined	\$0.0165	1	3.6	cm	\$0.0165
Media:						
	Tape, Std C08	\$0.0092	1	28.1	cm	\$0.0092
Media:						


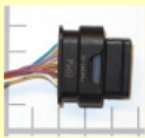


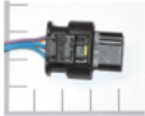
Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media: </p>	Tape, Std B07-08	\$0.0191	1	58.1	cm	\$0.0191
 <p>Media: </p>	Tape, Std B01-08	\$0.0227	1	69.2	cm	\$0.0227
 <p>Media: </p>	C09	\$0.1800	1	1	Each	\$0.1800
 <p>Media: </p>	Tape, Std C09	\$0.0109	1	33.3	cm	\$0.0109
 <p>Media: </p>	Heat Shrink, Adhesive Lined	\$0.0172	2	5	cm	\$0.0344


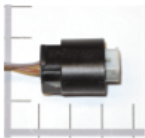



Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Tape, Std B01-09	\$0.0172	1	52.3	cm	\$0.0172
Media:						
■	C10	\$0.2000	1	1	Each	\$0.2000
Media:						
■	Tape, Std C10	\$0.0077	1	23.6	cm	\$0.0077
Media:						
■	Tape, Std B01-10	\$0.0090	1	27.5	cm	\$0.0090
Media:						
■	C11	\$0.1500	1	1	Each	\$0.1500
Media:						




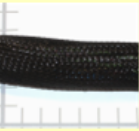

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Std	\$0.0123	1	37.6	cm	\$0.0123
Media: 	C12	\$0.1800	1	1	Each	\$0.1800
Media: 	Tape, Std C12	\$0.0118	1	36.0	cm	\$0.0118
Media: 	Clip, Tape on X-Tree 1 Tab	\$0.0200	1	1	Each	\$0.0200
Media: 	Tape, Tack	\$0.0048	1	9.8	cm	\$0.0048




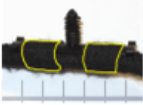
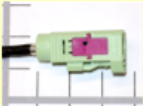
Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Fabric B01-02A	\$0.0160	1	32.5	cm	\$0.0160
Media: 	Grommet, Rubber B01-12A	\$0.6100	1	1	Each	\$0.6100
Media: 	Tape, Fabric B01-02A Grommet	\$0.0433	1	87.9	cm	\$0.0433
Media: 	Braided Sleeve B01-12A	\$0.5009	1	40	cm	\$0.5009
Media: 	Tape, Tack	\$0.0105	2	21.4	cm	\$0.0210

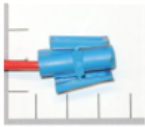




Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Heat Shrink, Adhesive Lined	\$0.0155	4	4.5	cm	\$0.0620
Media: 	Tape, Fabric B01-02B	\$0.2819	1	573.1	cm	\$0.2819
Media: 	Clip, Tape on X-Tree 2 Tabs	\$0.0300	4	1	Each	\$0.1200
Media: 	Tape, Tack	\$0.0080	8	16.3	cm	\$0.0643
Media: 	CX13	\$0.4400	1	1	Each	\$0.4400





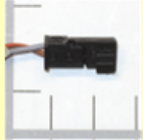



Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	C14	\$0.0900	1	1	Each	\$0.0900
Media:						
■	Tape, Fabric CX13	\$0.0251	1	50.9	cm	\$0.0251
Media:						
■	Clip, Tape on X-Tree 1 Tab	\$0.0200	1	1	Each	\$0.0200
Media:						
■	Tape, Tack	\$0.0048	1	9.8	cm	\$0.0048
Media:						
■	Tape, Fabric B13-14	\$0.0405	1	82.3	cm	\$0.0405
Media:						






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	Clip, Tape on X-Tree 1 Tab	\$0.0200	2	1	Each	\$0.0400
 Media: 	Tape, Tack	\$0.0080	2	16.3	cm	\$0.0161
 Media: 	C15	\$0.0300	1	1	Each	\$0.0300
 Media: 	Tape, Fabric B13-15	\$0.0503	1	102.2	cm	\$0.0503
 Media: 	Clip, Tape on X-Tree 1 Tab	\$0.0200	1	1	Each	\$0.0200

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Tape, Tack	\$0.0080	1	16.3	cm	\$0.0080
Media:						
■	Clip, Strap on Stud	\$0.0400	1	1	Each	\$0.0400
Media:						
■	Tape, Tack	\$0.0080	2	16.3	cm	\$0.0161
Media:						
■	CX16	\$0.5800	1	1	Each	\$0.5800
Media:						
■	CX17	\$0.5800	1	1	Each	\$0.5800
Media:						











Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media: </p>	CX18	\$0.5800	1	1	Each	\$0.5800
 <p>Media: </p>	CX19	\$0.5800	1	1	Each	\$0.5800
 <p>Media: </p>	Tape, Fabric CX16-CX19	\$0.0110	4	22.3	cm	\$0.0440
 <p>Media: </p>	Tape, Fabric B16-B19	\$0.0665	1	135.2	cm	\$0.0665
 <p>Media: </p>	Clip, Tape on X-Tree 1 Tab	\$0.0200	2	1	Each	\$0.0400



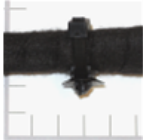

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media:</p> 	Tape, Tack	\$0.0080	2	16.3	cm	\$0.0161
 <p>Media:</p> 	C20	\$0.1200	1	1	Each	\$0.1200
 <p>Media:</p> 	Tape, Fabric C20	\$0.0260	1	52.8	cm	\$0.0260
 <p>Media:</p> 	Tape, Fabric B13-B20	\$0.1585	1	322.2	cm	\$0.1585
 <p>Media:</p> 	Clip, Tape on X-Tree 1 Tab	\$0.0200	4	1	Each	\$0.0800






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack	\$0.0080	4	16.3	cm	\$0.0321
Media: 	Clip, Strap on X-Tree, Large	\$0.0500	1	1	Each	\$0.0500
Media: 	Tape, Tack	\$0.0080	2	16.3	cm	\$0.0161
Media: 	Clip, Zip Tie	\$0.0400	1	1	Each	\$0.0400
Media: 	C21	\$0.2900	1	1	Each	\$0.2900






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Braided Sleeve C21	\$0.1997	1	15	cm	\$0.1997
Media:						
■	Tape, Tack	\$0.0080	1	16.3	cm	\$0.0080
Media:						
■	Tape, Fabric B13-B21	\$0.0633	1	128.6	cm	\$0.0633
Media:						
■	Clip, Strap on X-Tree, Large	\$0.0500	1	1	Each	\$0.0500
Media:						
■	Clip, Strap on X-Tree	\$0.0400	1	1	Each	\$0.0400
Media:						

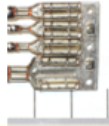


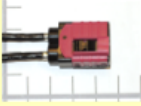

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack	\$0.0080	4	16.3	cm	\$0.0321
Media: 	Tape, Fabric B01-B21	\$0.0556	1	113.1	cm	\$0.0556
Media: 	Clip, Strap on X-Tree	\$0.0400	2	1	Each	\$0.0800
Media: 	Tape, Tack	\$0.0080	4	16.3	cm	\$0.0321
Media: 	C22	\$0.1200	1	1	Each	\$0.1200

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Term Strip 5 Pin	\$0.0800	1	1	Each	\$0.0800
Media:						
■	Terminal Strip Cover	\$0.0800	1	1	Each	\$0.0800
Media:						
■	Tape, Tack	\$0.0130	1	26.4	cm	\$0.0130
Media:						
■	CX23	\$0.7400	1	1	Each	\$0.7400
Media:						
■	Tape, Fabric C22-CX23	\$0.0122	1	24.7	cm	\$0.0122
Media:						










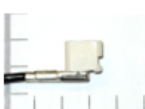
Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	C24	\$0.0600	1	1	Each	\$0.0600
Media: 	Tape, Tack	\$0.0087	1	17.6	cm	\$0.0087
Media: 	Tape, Fabric B01-E24	\$0.0699	1	142.1	cm	\$0.0699
Media: 	Clip, Strap on X-Tree	\$0.0400	2	1	Each	\$0.0800
Media: 	Tape, Tack	\$0.0080	4	16.3	cm	\$0.0321

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	CX25	\$0.5800	1	1	Each	\$0.5800
 Media: 	CX26	\$0.5800	1	1	Each	\$0.5800
 Media: 	CX27	\$0.5800	1	1	Each	\$0.5800
 Media: 	CX28	\$0.5800	1	1	Each	\$0.5800
 Media: 	CX29	\$0.5800	1	1	Each	\$0.5800


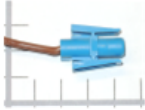








Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Fabric CX25-CX29	\$0.0180	1	36.5	cm	\$0.0180
Media: 	Clip, Strap on X-Tree, Large	\$0.0500	1	1	Each	\$0.0500
Media: 	Tape, Tack	\$0.0080	2	16.3	cm	\$0.0161
Media: 	Tape, Fabric B01-B29	\$0.0217	1	44.1	cm	\$0.0217
Media: 	C30	\$0.1300	1	1	Each	\$0.1300

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
	C31	\$0.0900	1	1	Each	\$0.0900
Media:						
	Tape, Fabric C30	\$0.0151	1	30.6	cm	\$0.0151
Media:						
	Clip, Tape on X-Tree 1 Tab	\$0.0200	1	1	Each	\$0.0200
Media:						
	Tape, Tack	\$0.0057	1	11.6	cm	\$0.0057
Media:						
	Tape, Fabric B30-31	\$0.0152	1	30.9	cm	\$0.0152
Media:						






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	C32	\$0.4800	1	1	Each	\$0.4800
 Media: 	Braided Sleeve B30-32	\$0.1011	1	13	cm	\$0.1011
 Media: 	Tape, Tack	\$0.0086	3	17.5	cm	\$0.0258
 Media: 	Clip, Tape on X-Tree 1 Tab	\$0.0200	2	1	Each	\$0.0400
 Media: 	Tape, Tack	\$0.0075	2	15.3	cm	\$0.0151



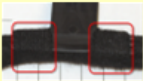
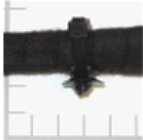
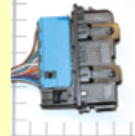
Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Tape, Fabric B30-32	\$0.0309	1	62.8	cm	\$0.0309
Media:						
■	C33	\$0.1200	1	1	Each	\$0.1200
Media:						
■	Tape, Fabric C33	\$0.0246	1	50.0	cm	\$0.0246
Media:						
■	Tape, Fabric B30-33	\$0.1237	1	251.4	cm	\$0.1237
Media:						
■	Clip, Tape on X-Tree 1 Tab	\$0.0200	4	1	Each	\$0.0800
Media:						





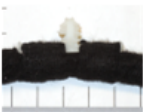
Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack	\$0.0080	4	16.3	cm	\$0.0321
Media: 	Clip, Strap on X-Tree, Large	\$0.0500	1	1	Each	\$0.0500
Media: 	Tape, Tack	\$0.0080	2	16.3	cm	\$0.0161
Media: 	Clip, Zip Tie	\$0.0400	1	1	Each	\$0.0400
Media: 	C34	\$0.2900	1	1	Each	\$0.2900


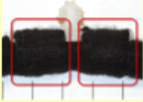



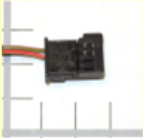




Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media: 	Braided Sleeve C34	\$0.1864	1	14	cm	\$0.1864
■ Media: 	Tape, Tack	\$0.0080	2	16.3	cm	\$0.0161
■ Media: 	Tape, Fabric B30-34	\$0.0445	1	90.4	cm	\$0.0445
■ Media: 	Clip, Strap on X-Tree, Large	\$0.0500	1	1	Each	\$0.0500
■ Media: 	Clip, Strap on X-Tree	\$0.0400	1	1	Each	\$0.0400






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media:</p> 	Tape, Tack	\$0.0080	4	16.3	cm	\$0.0321
 <p>Media:</p> 	C35	\$0.1200	1	1	Each	\$0.1200
 <p>Media:</p> 	C36	\$0.0600	1	1	Each	\$0.0600
 <p>Media:</p> 	Tape, Fabric C36	\$0.0076	1	15.5	cm	\$0.0076
 <p>Media:</p> 	Tape, Fabric C36	\$0.0097	1	19.7	cm	\$0.0097





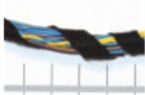


Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Label	\$0.0800	1	1	Each	\$0.0800
Media:						
■	Tape, Fabric B35-36	\$0.0877	1	178.3	cm	\$0.0877
Media:						
■	Clip, Tape on X-Tree 2 Tabs	\$0.0300	4	1	Each	\$0.1200
Media:						
■	Tape, Tack	\$0.0062	8	12.6	cm	\$0.0496
Media:						
■	Tape, Fabric B30-36	\$0.0240	1	48.7	cm	\$0.0240
Media:						


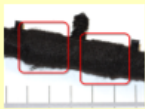
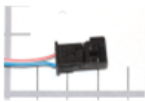

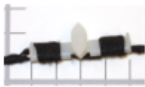
Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media:</p> 	Clip, Tape on X-Tree 2 Tabs	\$0.0300	1	1	Each	\$0.0300
 <p>Media:</p> 	Tape, Tack	\$0.0091	2	18.5	cm	\$0.0182
 <p>Media:</p> 	C37	\$0.3200	1	1	Each	\$0.3200
 <p>Media:</p> 	Tape, Fabric C37	\$0.0100	1	20.2	cm	\$0.0100
 <p>Media:</p> 	Tape, Fabric B30-37	\$0.0655	1	133.1	cm	\$0.0655

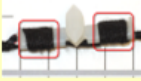




Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Clip, Tape on X-Tree 2 Tabs	\$0.0300	2	1	Each	\$0.0600
Media:						
■	Tape, Tack	\$0.0091	4	18.5	cm	\$0.0364
Media:						
■	C38	\$0.0600	1	1	Each	\$0.0600
Media:						
■	Tape, Fabric C38	\$0.0081	1	16.4	cm	\$0.0081
Media:						
■	Clip, Tape on, 2 Tabs	\$0.0300	1	1	Each	\$0.0300
Media:						











Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack	\$0.0049	2	10.1	cm	\$0.0099
Media: 	Tape, Fabric B30-38	\$0.0344	1	69.8	cm	\$0.0344
Media: 	C39	\$0.1800	1	1	Each	\$0.1800
Media: 	Tape, Fabric C39	\$0.0046	1	9.4	cm	\$0.0046
Media: 	Tape, Fabric B01-39	\$0.0153	1	31.2	cm	\$0.0153


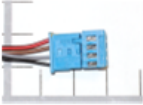



Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
	C40	\$0.7200	1	1	Each	\$0.7200
Media:						
	Heat Shrink	\$0.0075	2	2.3	cm	\$0.0151
Media:						
	Tape, Fabric C40	\$0.0138	1	28.0	cm	\$0.0138
Media:						
	Heat Shrink, Adhesive Lined	\$0.0138	2	4	cm	\$0.0276
Media:						
	Tape, Tack	\$0.0025	2	5.0	cm	\$0.0049
Media:						






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Fabric B40	\$0.0080	1	16.2	cm	\$0.0080
Media: 	C41	\$0.0800	1	1	Each	\$0.0800
Media: 	Tape, Fabric C41	\$0.0093	1	18.9	cm	\$0.0093
Media: 	Heat Shrink, Adhesive Lined	\$0.0138	2	4	cm	\$0.0276
Media: 	Tape, Tack	\$0.0025	2	5.0	cm	\$0.0049



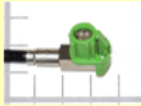


Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	Tape, Fabric B41	\$0.0191	1	38.8	cm	\$0.0191
						
■ Media:	Clip, Tape on X-Tree 1 Tab	\$0.0200	1	1	Each	\$0.0200
						
■ Media:	Tape, Tack	\$0.0080	1	16.3	cm	\$0.0080
						
■ Media:	Tape, Fabric B40-41	\$0.0170	1	34.5	cm	\$0.0170
						
■ Media:	Clip, Tape on X-Tree 2 Tabs	\$0.0300	1	1	Each	\$0.0300
						


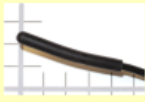
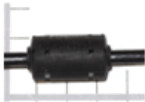


Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	C42	\$0.0400	1	1	Each	\$0.0400
Media: 	CX43	\$0.7400	1	1	Each	\$0.7400
Media: 	CX44	\$0.7400	1	1	Each	\$0.7400
Media: 	Tape, Fabric CX43.44	\$0.0142	1	28.9	cm	\$0.0142
Media: 	Tape, Fabric B40.44	\$0.0174	1	35.3	cm	\$0.0174

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	CX45	\$0.5800	1	1	Each	\$0.5800
Media:						
■	Coax Termination Overmold	\$0.0400	1	1	Each	\$0.0400
Media:						
■	Ferrite, Overmolded	\$0.2300	1	1	Each	\$0.2300
Media:						
■	C46	\$0.2900	1	1	Each	\$0.2900
Media:						
■	Tape, Fabric C46	\$0.0069	1	13.9	cm	\$0.0069
Media:						






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media:</p>	Heat Shrink, Adhesive Lined	\$0.0138	2	4	cm	\$0.0276
 <p>Media:</p>	Tape, Tack	\$0.0025	2	5.0	cm	\$0.0049
 <p>Media:</p>	Tape, Fabric B01-46	\$0.0280	1	56.9	cm	\$0.0280
 <p>Media:</p>	Tape, Tack	\$0.0207	2	42.0	cm	\$0.0413
 <p>Media:</p>	Molded Trough B01-46	\$0.5502	1	1	Each	\$0.5502

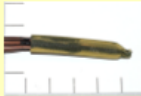




Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
<input type="checkbox"/>	Molded Trough Material	\$0.4640	1	1	Each	\$0.4640
Media:						
<input type="checkbox"/>	Zip Tie, Large	\$0.0200	2	1	Each	\$0.0400
Media:						
<input type="checkbox"/>	Tape, Tack	\$0.0207	1	42.0	cm	\$0.0207
Media:						
<input type="checkbox"/>	C47	\$0.0600	1	1	Each	\$0.0600
Media:						
<input type="checkbox"/>	Tape, Fabric C36	\$0.0175	1	35.5	cm	\$0.0175
Media:						








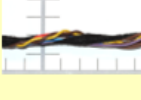


Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media:</p>	Heat Shrink, Adhesive Lined	\$0.0193	1	4.2	cm	\$0.0193
 <p>Media:</p>	C49	\$0.7600	1	1	Each	\$0.7600
 <p>Media:</p>	Tape, Fabric C49	\$0.0224	1	45.6	cm	\$0.0224
 <p>Media:</p>	C48	\$0.6100	1	1	Each	\$0.6100
 <p>Media:</p>	Tape, Tack	\$0.0062	2	12.6	cm	\$0.0124

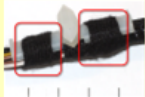




Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media: </p>	Zip Tie	\$0.0100	1	1	Each	\$0.0100
 <p>Media: </p>	Braided Sleeve C48	\$0.4486	1	67	cm	\$0.4486
 <p>Media: </p>	Clip, Zip Tie	\$0.0400	1	1	Each	\$0.0400
 <p>Media: </p>	Tape, Fabric C48	\$0.0192	1	39.0	cm	\$0.0192
 <p>Media: </p>	Clip, Tape on, 2 Tabs	\$0.0300	1	1	Each	\$0.0300






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Tape, Tack	\$0.0062	2	12.6	cm	\$0.0124
Media:						
■	Clip, Strap on X-Tree, Large	\$0.0500	1	1	Each	\$0.0500
Media:						
■	Tape, Tack	\$0.0062	2	12.6	cm	\$0.0124
Media:						
■	Tape, Fabric B01-49	\$0.0046	1	9.4	cm	\$0.0046
Media:						
■	Molded Trough B01-49	\$0.6643	1	1	Each	\$0.6643
Media:						


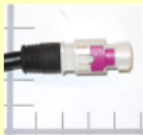





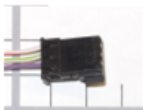


Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
<input type="checkbox"/>	Molded Trough Material	\$0.5460	1	1	Each	\$0.5460
Media:						
<input type="checkbox"/>	Zip Tie, Large	\$0.0200	2	1	Each	\$0.0400
Media:						
<input type="checkbox"/>	Tape, Tack	\$0.0247	1	50.3	cm	\$0.0247
Media:						
<input type="checkbox"/>	C50	\$0.1400	1	1	Each	\$0.1400
Media:						
<input type="checkbox"/>	Tape, Fabric C50	\$0.0200	1	40.7	cm	\$0.0200
Media:						


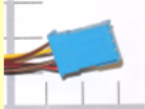



Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media: </p>	CX51	\$0.6400	1	1	Each	\$0.6400
 <p>Media: </p>	Ferrite, Overmolded	\$0.2300	1	1	Each	\$0.2300
 <p>Media: </p>	Tape, Fabric CX51	\$0.0095	1	19.3	cm	\$0.0095
 <p>Media: </p>	C52	\$0.0700	1	1	Each	\$0.0700
 <p>Media: </p>	C53	\$0.1100	1	1	Each	\$0.1100






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Tape, Fabric B50-53	\$0.0165	1	33.6	cm	\$0.0165
Media:						
■	C54	\$0.0800	1	1	Each	\$0.0800
Media:						
■	C55	\$0.1000	1	1	Each	\$0.1000
Media:						
■	Tape, Fabric C55	\$0.0064	1	13.0	cm	\$0.0064
Media:						
■	Tape, Fabric B50-55	\$0.0535	1	108.7	cm	\$0.0535
Media:						











Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Clip, Tape on X-Tree 1 Tab	\$0.0200	1	1	Each	\$0.0200
Media: 	Tape, Tack	\$0.0048	1	9.8	cm	\$0.0048
Media: 	C57	\$0.0600	1	1	Each	\$0.0600
Media: 	Tape, Fabric C56	\$0.0122	1	24.7	cm	\$0.0122
Media: 	C56	\$0.6400	1	1	Each	\$0.6400


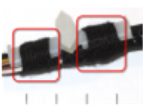
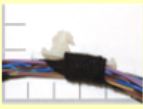



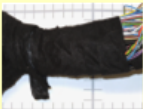
Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media: </p>	Tape, Tack	\$0.0062	2	12.6	cm	\$0.0124
 <p>Media: </p>	Zip Tie	\$0.0100	1	1	Each	\$0.0100
 <p>Media: </p>	Braided Sleeve C66	\$0.4018	1	60	cm	\$0.4018
 <p>Media: </p>	Clip, Zip Tie	\$0.0400	1	1	Each	\$0.0400
 <p>Media: </p>	Tape, Fabric C66	\$0.0273	1	55.5	cm	\$0.0273








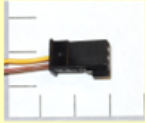


Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media:</p> 	Clip, Tape on, 2 Tabs	\$0.0300	1	1	Each	\$0.0300
 <p>Media:</p> 	Tape, Tack	\$0.0062	2	12.6	cm	\$0.0124
 <p>Media:</p> 	Clip, Tape on X-Tree 1 Tab	\$0.0200	1	1	Each	\$0.0200
 <p>Media:</p> 	Tape, Tack	\$0.0048	1	9.8	cm	\$0.0048
 <p>Media:</p> 	Tape, Fabric B01-57	\$0.0795	1	161.6	cm	\$0.0795






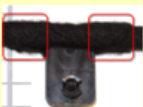



Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	Tape, Tack	\$0.0260	1	52.8	cm	\$0.0260
 Media: 	C58	\$0.5400	1	1	Each	\$0.5400
 Media: 	Tape, Fabric, C68	\$0.0088	1	17.9	cm	\$0.0088
 Media: 	C59	\$0.0600	1	1	Each	\$0.0600
 Media: 	Tape, Fabric, C69	\$0.0037	1	7.6	cm	\$0.0037






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media:</p> 	Tape, Fabric, B58-69	\$0.2023	1	411.1	cm	\$0.2023
 <p>Media:</p> 	Clip, Strap on X-Tree, Large	\$0.0500	3	1	Each	\$0.1500
 <p>Media:</p> 	Tape, Tack	\$0.0070	6	14.2	cm	\$0.0419
 <p>Media:</p> 	Clip, Strap on Stud Mount	\$0.0400	3	1	Each	\$0.1200
 <p>Media:</p> 	Tape, Tack	\$0.0070	6	14.2	cm	\$0.0419









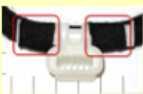
Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	CX60	\$0.5800	1	1	Each	\$0.5800
Media:						
■	Tape, Fabric, CX60	\$0.0237	2	48.1	cm	\$0.0473
Media:						
■	Clip, Strap on Stud Mount, Large	\$0.0500	1	1	Each	\$0.0500
Media:						
■	Tape, Tack	\$0.0046	2	9.4	cm	\$0.0093
Media:						
■	C61	\$0.5400	1	1	Each	\$0.5400
Media:						



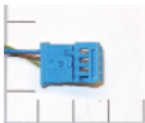

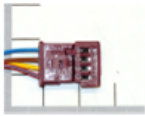
Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media:</p> 	Tape, Fabric, B58-61	\$0.0136	1	27.6	cm	\$0.0136
 <p>Media:</p> 	C62	\$0.2500	1	1	Each	\$0.2500
 <p>Media:</p> 	Tape, Fabric, C62	\$0.0066	1	13.4	cm	\$0.0066
 <p>Media:</p> 	Clip, Strap on Stud Mount Large	\$0.0500	1	1	Each	\$0.0500
 <p>Media:</p> 	Tape, Tack	\$0.0074	2	15.1	cm	\$0.0148


Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Fabric, B58-62AB	\$0.0279	1	56.8	cm	\$0.0279
Media: 	Heat Shrink, Adhesive Lined	\$0.0145	2	4.2	cm	\$0.0289
Media: 	C63	\$0.0600	1	1	Each	\$0.0600
Media: 	Tape, Fabric, C63	\$0.0100	1	20.3	cm	\$0.0100
Media: 	C64	\$0.0700	1	1	Each	\$0.0700


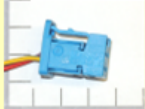

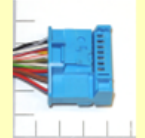

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Fabric, C64	\$0.0100	1	20.3	cm	\$0.0100
Media: 	C65	\$0.0600	1	1	Each	\$0.0600
Media: 	Tape, Fabric, C65	\$0.0100	1	20.3	cm	\$0.0100
Media: 	Tape, Fabric, B63-65	\$0.0263	1	53.5	cm	\$0.0263
Media: 	Clip, Tape-on, Edge Biter, Two Tabs	\$0.0500	2	1	Each	\$0.1000










Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Tape, Tack	\$0.0062	4	12.6	cm	\$0.0247
Media:						
■	C66	\$0.0900	1	1	Each	\$0.0900
Media:						
■	Tape, Fabric, C23	\$0.0093	1	18.8	cm	\$0.0093
Media:						
■	C67	\$0.2300	1	1	Each	\$0.2300
Media:						
■	Tape, Fabric, C24	\$0.0073	1	14.9	cm	\$0.0073
Media:						











Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media: </p>	Tape, Fabric, B66-67	\$0.0034	1	7.0	cm	\$0.0034
 <p>Media: </p>	C68	\$0.4900	1	1	Each	\$0.4900
 <p>Media: </p>	Tape, Fabric, C68	\$0.0408	1	82.9	cm	\$0.0408
 <p>Media: </p>	Grommet, Rubber	\$0.3500	1	1	Each	\$0.3500
 <p>Media: </p>	Tape, Fabric, Grommet	\$0.0134	1	27.2	cm	\$0.0134



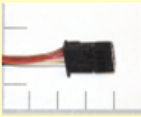


Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
	C69	\$0.1300	1	1	Each	\$0.1300
Media:						
	Tape, Fabric, C69	\$0.0115	1	23.4	cm	\$0.0115
Media:						
	Tape, Fabric, B63-69	\$0.0616	1	125.3	cm	\$0.0616
Media:						
	C70	\$0.0500	1	1	Each	\$0.0500
Media:						
	Tape, Fabric, C70	\$0.0135	1	27.3	cm	\$0.0135
Media:						






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	Clip, Tape-on, Edge Biter, Two Tabs	\$0.0500	1	1	Each	\$0.0500
						
■ Media:	Tape, Tack	\$0.0062	2	12.6	cm	\$0.0124
						
■ Media:	C71	\$0.0700	1	1	Each	\$0.0700
						
■ Media:	Tape, Fabric, C71	\$0.0051	1	10.4	cm	\$0.0051
						
■ Media:	Tape, Fabric, B70-71	\$0.0196	1	39.9	cm	\$0.0196
						




Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	Clip, Tape-on, Edge Biter, Two Tabs	\$0.0500	1	1	Each	\$0.0500
						
■ Media:	Tape, Tack	\$0.0062	2	12.6	cm	\$0.0124
						
■ Media:	C72	\$0.3700	1	1	Each	\$0.3700
						
■ Media:	Tape, Fabric, C72	\$0.0258	1	52.5	cm	\$0.0258
						
■ Media:	Clip, Tape-on, Edge Biter, Two Tabs	\$0.0500	1	1	Each	\$0.0500
						

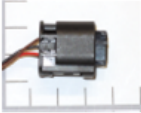




Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Tape, Tack	\$0.0062	2	12.6	cm	\$0.0124
Media:						
■	Molded Bracket, C72	\$0.1548	1	1	Each	\$0.1548
Media:						
■	Molded BracketMaterial, C72	\$0.1440	1	1	Each	\$0.1440
Media:						
■	Tape, Fabric, B70-72	\$0.0168	1	34.1	cm	\$0.0168
Media:						
■	Tape, Fabric, B58-72	\$0.0176	1	35.7	cm	\$0.0176
Media:						






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	C73	\$0.1800	1	1	Each	\$0.1800
Media:						
■	Tape, C73	\$0.0120	1	36.5	cm	\$0.0120
Media:						
■	Clip, Tape on X-Tree 1 Tab	\$0.0200	1	1	Each	\$0.0200
Media:						
■	Tape, Tack	\$0.0049	1	10.1	cm	\$0.0049
Media:						
■	C74	\$0.1500	1	1	Each	\$0.1500
Media:						





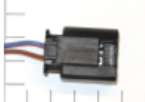
Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, C74	\$0.0041	1	12.4	cm	\$0.0041
Media: 	Tape, B73-74	\$0.0136	1	41.5	cm	\$0.0136
Media: 	Clip, Tape on X-Tree 1 Tab	\$0.0200	1	1	Each	\$0.0200
Media: 	Tape, Tack	\$0.0049	1	10.1	cm	\$0.0049
Media: 	C75	\$0.1700	1	1	Each	\$0.1700











Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, C75	\$0.0051	1	15.5	cm	\$0.0051
Media: 	C76	\$0.1500	1	1	Each	\$0.1500
Media: 	Tape, C76	\$0.0023	1	7.1	cm	\$0.0023
Media: 	Tape, B75-76	\$0.0093	1	28.4	cm	\$0.0093
Media: 	C77	\$0.1800	1	1	Each	\$0.1800



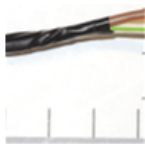


Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, C77	\$0.0051	1	15.7	cm	\$0.0051
						
Media: 	Tape, B75-77	\$0.0081	1	24.7	cm	\$0.0081
						
Media: 	Clip, Tape on X-Tree 1 Tab	\$0.0200	1	1	Each	\$0.0200
						
Media: 	Tape, Tack	\$0.0049	1	10.1	cm	\$0.0049
						
Media: 	C78	\$0.1200	1	1	Each	\$0.1200
						






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, C78	\$0.0051	1	15.5	cm	\$0.0051
Media: 	C79	\$0.1700	1	1	Each	\$0.1700
Media: 	Tape, C79	\$0.0036	1	11.1	cm	\$0.0036
Media: 	Tape, B78-79	\$0.0035	1	10.7	cm	\$0.0035
Media: 	C80	\$0.3200	1	1	Each	\$0.3200






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, C80	\$0.0080	1	24.2	cm	\$0.0080
Media: 	Convolute, C8	\$0.0195	1	9	cm	\$0.0195
Media: 	Tape, Tack	\$0.0068	2	13.8	cm	\$0.0136
Media: 	Tape, B78-80	\$0.0212	1	64.7	cm	\$0.0212
Media: 	Convolute, B78-80	\$0.0734	1	31.5	cm	\$0.0734




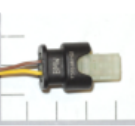






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack	\$0.0080	2	16.3	cm	\$0.0161
Media: 	Clip, Strap on X-Tree, Large	\$0.0500	1	1	Each	\$0.0500
Media: 	Tape, Tack	\$0.0080	2	16.3	cm	\$0.0161
Media: 	Clip, Strap on X-Tree	\$0.0400	1	1	Each	\$0.0400
Media: 	Tape, Tack	\$0.0080	2	16.3	cm	\$0.0161






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media: </p>	Clip, Zip Tie	\$0.0400	1	1	Each	\$0.0400
 <p>Media: </p>	C81	\$0.1500	1	1	Each	\$0.1500
 <p>Media: </p>	Tape, C81	\$0.0041	1	12.4	cm	\$0.0041
 <p>Media: </p>	Tape, B73-81	\$0.0461	1	140.4	cm	\$0.0461
 <p>Media: </p>	Convolute, B73-81	\$0.0882	1	21	cm	\$0.0882











Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack	\$0.0124	3	25.1	cm	\$0.0371
Media: 	C82	\$0.1700	1	1	Each	\$0.1700
Media: 	Tape, C82	\$0.0170	1	52.0	cm	\$0.0170
Media: 	Clip, Tape on X-Tree 1 Tab	\$0.0200	1	1	Each	\$0.0200
Media: 	Tape, Tack	\$0.0049	1	10.1	cm	\$0.0049



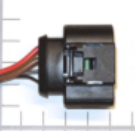
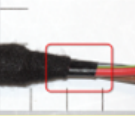

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media: </p>	Clip, Edge Biter, Zip Tie	\$0.0700	1	1	Each	\$0.0700
 <p>Media: </p>	C83	\$0.4500	1	1	Each	\$0.4500
 <p>Media: </p>	Tape, C83	\$0.0088	1	26.7	cm	\$0.0088
 <p>Media: </p>	Tape, B82-83	\$0.0068	1	20.8	cm	\$0.0068
 <p>Media: </p>	Self Closing Braided Sleeve, B73-83	\$0.3239	1	17.5	cm	\$0.3239






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Clip, Strap on X-Tree, Large	\$0.0500	1	1	Each	\$0.0500
Media:						
■	Tape, Tack	\$0.0124	4	25.1	cm	\$0.0495
Media:						
■	C84	\$0.2400	1	1	Each	\$0.2400
Media:						
■	Tape, C84	\$0.0016	2	4.8	cm	\$0.0032
Media:						
■	Self Closing Braided Sleeve, C84	\$0.1864	1	14	cm	\$0.1864
Media:						




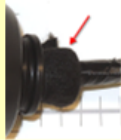






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack	\$0.0087	2	17.6	cm	\$0.0173
Media: 	Tape, Fabric, B73-84	\$0.0638	1	129.7	cm	\$0.0638
Media: 	Tape, B73-84	\$0.0076	1	23.1	cm	\$0.0076
Media: 	Grommet, Rubber B73-84	\$1.0700	1	1	Each	\$1.0700
Media: 	Tape, Fabric B73-84 Grommet	\$0.0555	1	112.8	cm	\$0.0555






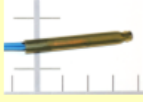




Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media: </p>	Tape, Fabric, Grommet	\$0.0054	1	11.0	cm	\$0.0054
 <p>Media: </p>	Tape, Tack, Grommet	\$0.0087	2	17.6	cm	\$0.0173
 <p>Media: </p>	Tape, Fabric, C28	\$0.0220	1	44.7	cm	\$0.0220
 <p>Media: </p>	C85	\$0.0600	1	1	Each	\$0.0600
 <p>Media: </p>	Tape, Fabric, C85	\$0.0151	1	30.7	cm	\$0.0151






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media:</p> 	Clip, Tape on X-Tree 1 Tab	\$0.0200	1	1	Each	\$0.0200
 <p>Media:</p> 	Tape, Tack	\$0.0048	1	9.8	cm	\$0.0048
 <p>Media:</p> 	Heat Shrink, Adhesive Lined	\$0.0145	1	4.2	cm	\$0.0145
 <p>Media:</p> 	Tape, Tack	\$0.0048	1	9.8	cm	\$0.0048
 <p>Media:</p> 	Molded Trough B58-85 Upper	\$0.2362	1	1	Each	\$0.2362






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
<input type="checkbox"/>	Molded Trough Material	\$0.1870	1	1	Each	\$0.1870
Media:						
<input checked="" type="checkbox"/>	Molded Trough B58-85 Lower	\$0.3082	1	1	Each	\$0.3082
Media:						
<input type="checkbox"/>	Molded Trough Material	\$0.2460	1	1	Each	\$0.2460
Media:						
<input checked="" type="checkbox"/>	Tape, Fabric, B58-85A/B	\$0.0378	1	76.8	cm	\$0.0378
Media:						
<input checked="" type="checkbox"/>	Tape, Tack	\$0.0048	1	9.8	cm	\$0.0048
Media:						






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Heat Shrink, Adhesive Lined	\$0.0145	4	4.2	cm	\$0.0579
Media: 	Heat Shrink, Adhesive Lined	\$0.0193	1	4.2	cm	\$0.0193
Media: 	C86	\$0.2900	1	1	Each	\$0.2900
Media: 	Heat Shrink, Adhesive Lined	\$0.0193	1	4.2	cm	\$0.0193
Media: 	Heat Shrink, Adhesive Lined	\$0.0145	1	4.2	cm	\$0.0145


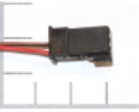


Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media: 	Tape, Fabric, B58-86	\$0.0420	1	85.3	cm	\$0.0420
■ Media: 	C87	\$0.0700	1	1	Each	\$0.0700
■ Media: 	Heat Shrink, Adhesive Lined	\$0.0165	1	3.6	cm	\$0.0165
■ Media: 	Tape, Fabric, C87	\$0.0249	1	50.5	cm	\$0.0249
■ Media: 	Clip, Tape on X-Tree 1 Tab	\$0.0200	1	1	Each	\$0.0200


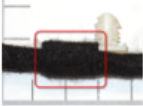

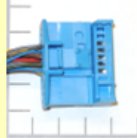






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack	\$0.0056	1	11.3	cm	\$0.0056
Media: 	C88	\$0.0600	1	1	Each	\$0.0600
Media: 	Tape, Fabric, C88	\$0.0088	1	17.8	cm	\$0.0088
Media: 	Tape, Fabric, B87-88	\$0.0284	1	57.8	cm	\$0.0284
Media: 	Clip, Tape on X-Tree 1 Tab	\$0.0200	1	1	Each	\$0.0200


Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	Tape, Tack	\$0.0062	1	12.6	cm	\$0.0062
 Media: 	C89	\$0.0400	1	1	Each	\$0.0400
 Media: 	Tape, Fabric, C88	\$0.0067	1	13.7	cm	\$0.0067
 Media: 	C90	\$0.1000	1	1	Each	\$0.1000
 Media: 	Tape, Fabric, B89-90	\$0.0221	1	45.0	cm	\$0.0221


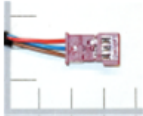

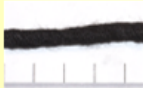

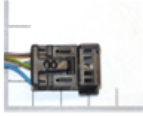




Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media:</p> 	Clip, Tape on X-Tree 1 Tab	\$0.0200	1	1	Each	\$0.0200
 <p>Media:</p> 	Tape, Tack	\$0.0056	1	11.3	cm	\$0.0056
 <p>Media:</p> 	Tape, Fabric, B87-90	\$0.0257	1	52.1	cm	\$0.0257
 <p>Media:</p> 	Clip, Tape on X-Tree 1 Tab	\$0.0200	1	1	Each	\$0.0200
 <p>Media:</p> 	Tape, Tack	\$0.0074	1	15.1	cm	\$0.0074








Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
	C91	\$0.0700	1	1	Each	\$0.0700
Media:						
	Tape, Fabric, C91	\$0.0166	1	33.7	cm	\$0.0166
Media:						
	C92	\$0.0800	1	1	Each	\$0.0800
Media:						
	Tape, Fabric, C92	\$0.0056	1	11.4	cm	\$0.0056
Media:						
	Braided Sleeve	\$0.0223	1	4	cm	\$0.0223
Media:						


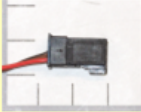
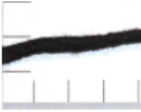


Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Fabric, B87-90	\$0.0041	1	8.4	cm	\$0.0041
Media: 						
Media: 	Tape, Fabric, B87-90	\$0.0023	1	4.7	cm	\$0.0023
Media: 						
Media: 	Tape, Fabric, B87-92	\$0.0570	1	115.8	cm	\$0.0570
Media: 						
Media: 	Clip, Tape on X-Tree 1 Tab	\$0.0200	3	1	Each	\$0.0600
Media: 						
Media: 	Tape, Tack	\$0.0074	3	15.1	cm	\$0.0223
Media: 						






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media:</p>	Heat Shrink, Adhesive Lined	\$0.0145	1	4.2	cm	\$0.0145
 <p>Media:</p>	C93	\$0.0600	1	1	Each	\$0.0600
 <p>Media:</p>	Tape, Fabric, C93	\$0.0075	1	15.3	cm	\$0.0075
 <p>Media:</p>	Tape, Fabric, B87-93	\$0.0531	1	108.0	cm	\$0.0531
 <p>Media:</p>	Clip, Tape on X-Tree 1 Tab	\$0.0200	1	1	Each	\$0.0200





Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	Tape, Tack	\$0.0074	1	15.1	cm	\$0.0074
						
■ Media:	C94	\$0.0600	1	1	Each	\$0.0600
						
■ Media:	Tape, Fabric, C94	\$0.1001	1	203.4	cm	\$0.1001
						
■ Media:	Clip, Tape on X-Tree 1 Tab	\$0.0200	4	1	Each	\$0.0800
						
■ Media:	Tape, Tack	\$0.0056	4	11.3	cm	\$0.0223
						











Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Clip, Strap on X-Tree, Large	\$0.0500	4	1	Each	\$0.2000
Media:						
■	Tape, Tack	\$0.0056	8	11.3	cm	\$0.0445
Media:						
■	Tape, Fabric, B87-94	\$0.1098	1	223.1	cm	\$0.1098
Media:						
■	Clip, Strap on X-Tree, Large	\$0.0500	3	1	Each	\$0.1500
Media:						
■	Tape, Tack	\$0.0062	6	12.6	cm	\$0.0371
Media:						











Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media:</p> 	Clip, Strap on X-Tree, Large	\$0.0500	1	1	Each	\$0.0500
 <p>Media:</p> 	Tape, Tack	\$0.0062	2	12.6	cm	\$0.0124
 <p>Media:</p> 	C95	\$0.0700	1	1	Each	\$0.0700
 <p>Media:</p> 	Tape, Fabric, C95	\$0.0081	1	16.5	cm	\$0.0081
 <p>Media:</p> 	Tape, Fabric, B87-95	\$0.0078	1	15.8	cm	\$0.0078

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
	C96	\$0.1900	1	1	Each	\$0.1900
Media:						
	Tape, Fabric, C96	\$0.0071	1	14.5	cm	\$0.0071
Media:						
	C97	\$0.1900	1	1	Each	\$0.1900
Media:						
	Tape, Fabric, C97	\$0.0058	1	11.9	cm	\$0.0058
Media:						
	Tape, Fabric, B96-97	\$0.0026	1	5.3	cm	\$0.0026
Media:						

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	C98	\$0.5800	1	1	Each	\$0.5800
Media: 	Tape, Fabric, C98	\$0.0295	1	59.9	cm	\$0.0295
Media: 	Grommet, Rubber	\$0.3500	1	1	Each	\$0.3500
Media: 	Tape, Fabric, Grommet	\$0.0134	1	27.2	cm	\$0.0134
Media: 	C99	\$0.1200	1	1	Each	\$0.1200


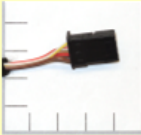

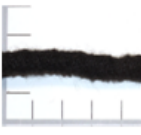




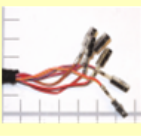
Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	Tape, Fabric, C99	\$0.0102	1	20.8	cm	\$0.0102
■ Media:	Tape, Fabric, B98-99	\$0.0195	1	39.6	cm	\$0.0195
■ Media:	Tape, Fabric, B87-99	\$0.0342	1	69.6	cm	\$0.0342
■ Media:	Clip, Strap on X-Tree, Large	\$0.0500	1	1	Each	\$0.0500
■ Media:	Tape, Tack	\$0.0136	2	27.6	cm	\$0.0272


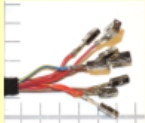



Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	C100	\$0.0800	1	1	Each	\$0.0800
 Media: 	Tape, Fabric, C100	\$0.0466	1	94.7	cm	\$0.0466
 Media: 	C101	\$0.2700	1	1	Each	\$0.2700
 Media: 	Tape, Fabric, C101	\$0.0346	1	70.1	cm	\$0.0346
 Media: 	C102	\$0.1800	1	1	Each	\$0.1800

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Fabric, C102	\$0.0240	1	48.7	cm	\$0.0240
Media: 	C103	\$0.2400	1	1	Each	\$0.2400
Media: 	Tape, Fabric, C103	\$0.0239	1	48.6	cm	\$0.0239
Media: 	C104	\$0.3000	1	1	Each	\$0.3000
Media: 	Tape, Fabric, C104	\$0.0234	1	47.6	cm	\$0.0234











Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	C105	\$0.2200	1	1	Each	\$0.2200
 Media: 	Tape, Tack	\$0.0025	1	5.0	cm	\$0.0025
 Media: 	Tape, Fabric, C105	\$0.0225	1	45.7	cm	\$0.0225
 Media: 	C106	\$0.2100	1	1	Each	\$0.2100
 Media: 	Tape, Fabric, C106	\$0.0179	1	36.4	cm	\$0.0179

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
	C107	\$0.3000	1	1	Each	\$0.3000
Media:						
						
	Tape, Fabric, C107	\$0.0110	1	22.4	cm	\$0.0110
Media:						
						
	C108	\$0.1400	1	1	Each	\$0.1400
Media:						
						
	Tape, Tack	\$0.0021	1	4.3	cm	\$0.0021
Media:						
						
	Tape, Fabric, C108	\$0.0126	1	25.6	cm	\$0.0126
Media:						
						











Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media:</p> 	C109	\$0.0800	1	1	Each	\$0.0800
 <p>Media:</p> 	Tape, Tack	\$0.0021	1	4.3	cm	\$0.0021
 <p>Media:</p> 	Tape, Fabric, C109	\$0.0055	1	11.2	cm	\$0.0055
 <p>Media:</p> 	Tape, Fabric, B100-109AB	\$0.0549	1	111.7	cm	\$0.0549
 <p>Media:</p> 	Heat Shrink, Adhesive Lined	\$0.0145	1	4.2	cm	\$0.0145

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	Tape, Fabric, B87-109	\$0.0194	1	39.4	cm	\$0.0194
 Media: 	C110	\$0.3500	1	1	Each	\$0.3500
 Media: 	Tape, Fabric, C110	\$0.0450	1	91.5	cm	\$0.0450
 Media: 	C111	\$0.5700	1	1	Each	\$0.5700
 Media: 	Tape, Fabric, C111	\$0.0403	1	81.9	cm	\$0.0403











Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
	C112	\$0.3100	1	1	Each	\$0.3100
Media:						
	Tape, Fabric, C112	\$0.0195	1	39.6	cm	\$0.0195
Media:						
	C113	\$0.1900	1	1	Each	\$0.1900
Media:						
	Tape, Fabric, C113	\$0.0186	1	37.9	cm	\$0.0186
Media:						
	Tape, Fabric, B110-113	\$0.0104	1	21.2	cm	\$0.0104
Media:						

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	Tape, Fabric, B87-113	\$0.0494	1	100.3	cm	\$0.0494
 Media: 	Clip, Strap on Stud	\$0.0400	1	1	Each	\$0.0400
 Media: 	Tape, Tack	\$0.0198	2	40.2	cm	\$0.0396
 Media: 	C114	\$0.4400	1	1	Each	\$0.4400
 Media: 	Tape, Fabric, C114	\$0.0364	1	73.9	cm	\$0.0364




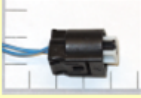
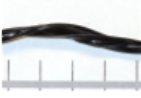
Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	C115	\$0.4500	1	1	Each	\$0.4500
 Media: 	Tape, Fabric, C115	\$0.0417	1	84.7	cm	\$0.0417
 Media: 	Tape, Fabric, B87-115	\$0.0422	1	85.8	cm	\$0.0422
 Media: 	C116	\$0.1200	1	1	Each	\$0.1200
 Media: 	Tape, Std C116	\$0.0047	1	14.3	cm	\$0.0047

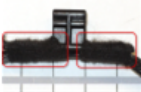

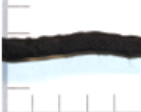

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	C117	\$0.1700	1	1	Each	\$0.1700
Media:						
■	Tape, Std C118	\$0.0030	1	9.1	cm	\$0.0030
Media:						
■	Tape, Std B116-117	\$0.0086	1	26.1	cm	\$0.0086
Media:						
■	C118	\$0.1500	1	1	Each	\$0.1500
Media:						
■	Tape, Std C118	\$0.0175	1	53.5	cm	\$0.0175
Media:						





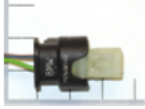
Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Clip, Tape-on, Edge Biter, Two Tabs	\$0.0500	2	1	Each	\$0.1000
Media: 	Tape, Tack	\$0.0049	4	10.1	cm	\$0.0198
Media: 	Tape, Std B116-118	\$0.0126	1	38.5	cm	\$0.0126
Media: 	Tape, Fabric, B116-118	\$0.0149	1	30.3	cm	\$0.0149
Media: 	Tape, Tack	\$0.0049	1	10.1	cm	\$0.0049

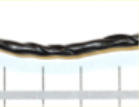




Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Clip, Zip Tie	\$0.0400	1	1	Each	\$0.0400
Media: 	Tube, Convolute B116-118	\$0.0546	1	13	cm	\$0.0546
Media: 	Tape, Tack	\$0.0113	3	23.0	cm	\$0.0339
Media: 	Clip, Zip Tie	\$0.0400	1	1	Each	\$0.0400
Media: 	C119	\$0.1200	1	1	Each	\$0.1200

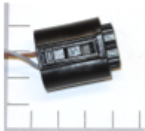




Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Std C119	\$0.0052	1	15.8	cm	\$0.0052
Media: 	Tape, Std B116-119	\$0.0095	1	28.9	cm	\$0.0095
Media: 	Tube, Convolute B116-119	\$0.0672	1	16	cm	\$0.0672
Media: 	Tape, Tack	\$0.0113	3	23.0	cm	\$0.0339
Media: 	Clip, Zip Tie	\$0.0400	1	1	Each	\$0.0400




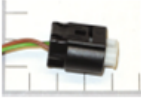



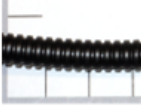


Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	C120	\$0.1200	1	1	Each	\$0.1200
Media: 	Tape, Std C120	\$0.0015	1	4.5	cm	\$0.0015
Media: 	Tape, Std B116-120	\$0.0065	1	19.9	cm	\$0.0065
Media: 	Tube, Convolute B116-120	\$0.0462	1	11.0	cm	\$0.0462
Media: 	Clip, Tape on X-Tree 2 Tabs	\$0.0500	1	1	Each	\$0.0500








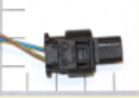


Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media: </p>	Tape, Tack	\$0.0113	3	23.0	cm	\$0.0339
 <p>Media: </p>	C121	\$0.1500	1	1	Each	\$0.1500
 <p>Media: </p>	Tape, Std C121	\$0.0074	1	22.6	cm	\$0.0074
 <p>Media: </p>	Tube, Convolute C121	\$0.0318	1	19	cm	\$0.0318
 <p>Media: </p>	Clip, Strap on X-Tree, Large	\$0.0500	1	1	Each	\$0.0500






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
	Tape, Tack	\$0.0113	4	23.0	cm	\$0.0453
Media:						
	C122	\$0.1500	1	1	Each	\$0.1500
Media:						
	Tape, Std C122	\$0.0044	1	13.5	cm	\$0.0044
Media:						
	C123	\$0.1200	1	1	Each	\$0.1200
Media:						
	Tape, Std C123	\$0.0022	1	6.8	cm	\$0.0022
Media:						






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tube, Convolute B121-123	\$0.0433	1	20	cm	\$0.0433
Media: 	Tape, Tack	\$0.0062	3	12.6	cm	\$0.0185
Media: 	Clip, Edge Biter, Zip Tie	\$0.0700	1	1	Each	\$0.0700
Media: 	C124	\$0.4400	1	1	Each	\$0.4400
Media: 	Tape, Std C124	\$0.0069	1	21.1	cm	\$0.0069

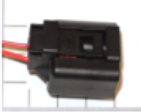
Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	C125	\$0.0600	1	1	Each	\$0.0600
Media:						
■	Heat Shrink, Adhesive Lined	\$0.0152	1	3.3	cm	\$0.0152
Media:						
■	Tape, Std B121-125	\$0.0022	1	6.8	cm	\$0.0022
Media:						
■	Tube, Convolute B121-125	\$0.0433	1	20	cm	\$0.0433
Media:						
■	Tape, Tack	\$0.0062	3	12.6	cm	\$0.0185
Media:						










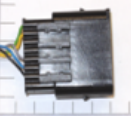
Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media: </p>	Clip, Zip Tie	\$0.0400	1	1	Each	\$0.0400
 <p>Media: </p>	C126	\$0.1500	1	1	Each	\$0.1500
 <p>Media: </p>	Tape, Std C126	\$0.0126	1	38.5	cm	\$0.0126
 <p>Media: </p>	Clip, Tape-on, Edge Biter, Two Tabs	\$0.0500	1	1	Each	\$0.0500
 <p>Media: </p>	Tape, Tack	\$0.0062	2	12.6	cm	\$0.0124


Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	Tape, Std B116-126	\$0.0227	1	69.2	cm	\$0.0227
 Media: 	Braided Sleeve B116-126	\$0.4063	1	17	cm	\$0.4063
 Media: 	Clip, Strap on X-Tree	\$0.0400	1	1	Each	\$0.0400
 Media: 	Tape, Tack	\$0.0113	4	23.0	cm	\$0.0453
 Media: 	C127	\$0.4400	1	1	Each	\$0.4400

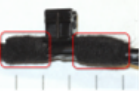
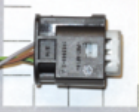



Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Std C127	\$0.0036	1	10.9	cm	\$0.0036
Media: 	C128	\$0.4900	1	1	Each	\$0.4900
Media: 	Tape, Std C128	\$0.0036	1	10.9	cm	\$0.0036
Media: 	Tape, Std B127-128	\$0.0047	1	14.3	cm	\$0.0047
Media: 	Clip, Tape-on, Edge Biter, Two Tabs	\$0.0500	1	1	Each	\$0.0500











Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Tape, Tack	\$0.0062	2	12.6	cm	\$0.0124
Media:						
■	C129	\$0.1800	1	1	Each	\$0.1800
Media:						
■	Tape, Std C129	\$0.0112	1	34.2	cm	\$0.0112
Media:						
■	Clip, Tape-on, Edge Biter, Two Tabs	\$0.0500	1	1	Each	\$0.0500
Media:						
■	Tape, Tack	\$0.0062	2	12.6	cm	\$0.0124
Media:						






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media:</p> 	Tape, Std B127-129	\$0.0146	1	44.4	cm	\$0.0146
 <p>Media:</p> 	Braided Sleeve B127-131	\$0.4257	1	23	cm	\$0.4257
 <p>Media:</p> 	Clip, Tape-on, Edge Biter, Two Tabs	\$0.0500	1	1	Each	\$0.0500
 <p>Media:</p> 	Tape, Tack	\$0.0142	4	28.9	cm	\$0.0569
 <p>Media:</p> 	C130	\$0.5000	1	1	Each	\$0.5000











Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Std C130	\$0.0045	1	13.8	cm	\$0.0045
Media: 	Braided Sleeve C130	\$0.0932	1	7.0	cm	\$0.0932
Media: 	Tape, Tack	\$0.0074	2	15.1	cm	\$0.0148
Media: 	C131	\$0.6200	1	1	Each	\$0.6200
Media: 	Tape, Std C131	\$0.0045	1	13.8	cm	\$0.0045

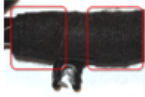




Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	Braided Sleeve C131	\$0.0932	1	7.0	cm	\$0.0932
 Media: 	Tape, Tack	\$0.0074	2	15.1	cm	\$0.0148
 Media: 	Tape, Std B127-131	\$0.0094	1	28.8	cm	\$0.0094
 Media: 	Braided Sleeve B127-131	\$0.3705	1	15.5	cm	\$0.3705
 Media: 	Clip, Tape-on, Edge Biter, Two Tabs	\$0.0500	2	1	Each	\$0.1000











Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Tape, Tack	\$0.0142	4	28.9	cm	\$0.0569
Media:						
■	C132	\$0.5700	1	1	Each	\$0.5700
Media:						
■	Tape, Std C132	\$0.0045	1	13.8	cm	\$0.0045
Media:						
■	Braided Sleeve C132	\$0.0932	1	7.0	cm	\$0.0932
Media:						
■	Tape, Tack	\$0.0074	2	15.1	cm	\$0.0148
Media:						



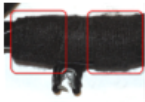
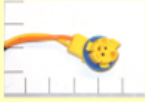

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media:</p> 	C133	\$0.6200	1	1	Each	\$0.6200
 <p>Media:</p> 	Tape, Std C132	\$0.0045	1	13.8	cm	\$0.0045
 <p>Media:</p> 	Braided Sleeve C132	\$0.0932	1	7.0	cm	\$0.0932
 <p>Media:</p> 	Tape, Tack	\$0.0074	2	15.1	cm	\$0.0148
 <p>Media:</p> 	Tape, Std B127-133	\$0.0122	1	37.2	cm	\$0.0122






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Braided Sleeve B127-133	\$0.3346	1	14	cm	\$0.3346
Media:						
■	Clip, Tape-on, Edge Biter, Two Tabs	\$0.0500	1	1	Each	\$0.0500
Media:						
■	Tape, Tack	\$0.0142	2	28.9	cm	\$0.0284
Media:						
■	C134	\$0.1000	1	1	Each	\$0.1000
Media:						
■	Tape, Std C134	\$0.0060	1	18.2	cm	\$0.0060
Media:						






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Std B127-134	\$0.0476	1	145.1	cm	\$0.0476
Media: 	Clip, Tape-on, Edge Biter, Two Tabs	\$0.0500	1	1	Each	\$0.0500
Media: 	Tape, Tack	\$0.0111	2	22.6	cm	\$0.0223
Media: 	C135	\$0.2200	1	1	Each	\$0.2200
Media: 	Tape, Std C135	\$0.0104	1	31.8	cm	\$0.0104



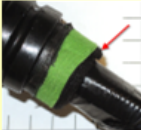
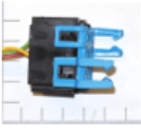

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	Braided Sleeve C135	\$0.2546	1	16	cm	\$0.2546
						
■ Media:	Tape, Tack	\$0.0087	2	17.6	cm	\$0.0173
						
■ Media:	Tape, Std B116-135	\$0.0148	1	45.1	cm	\$0.0148
						
■ Media:	Grommet, Rubber B116-135	\$1.0700	1	1	Each	\$1.0700
						
■ Media:	Tape, Fabric B116-135 Grommet	\$0.0637	1	129.4	cm	\$0.0637
						

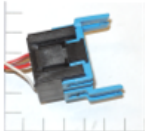




Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Fabric, Grommet	\$0.0054	1	11.0	cm	\$0.0054
Media: 	Tape, Fabric, Grommet	\$0.0054	1	11.0	cm	\$0.0054
Media: 	Tape, Tack, Grommet	\$0.0185	2	37.7	cm	\$0.0371
Media: 	C136	\$0.2000	1	1	Each	\$0.2000
Media: 	Tape, Fabric, C136	\$0.0085	1	17.4	cm	\$0.0085






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	C137	\$0.2000	1	1	Each	\$0.2000
Media:						
■	Tape, Fabric, C137	\$0.0085	1	17.4	cm	\$0.0085
Media:						
■	Tape, Tack	\$0.0037	1	7.5	cm	\$0.0037
Media:						
■	Tape, Fabric, B136-137	\$0.0125	1	25.4	cm	\$0.0125
Media:						
■	Tape, Fabric, C136	\$0.0506	1	102.9	cm	\$0.0506
Media:						











Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Fabric, C136	\$0.0233	1	47.4	cm	\$0.0233
Media: 	C138	\$1.1500	1	1	Each	\$1.1500
Media: 	Heat Shrink, Adhesive Lined	\$0.0310	1	4.5	cm	\$0.0310
Media: 	Tape, Fabric, C138	\$0.0558	1	113.5	cm	\$0.0558
Media: 	Label	\$0.0800	1	1	Each	\$0.0800

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
	C139	\$1.1900	1	1	Each	\$1.1900
Media:						
	Braided Sleeve	\$0.1127	1	9	cm	\$0.1127
Media:						
	Tape, Tack	\$0.0111	2	22.6	cm	\$0.0223
Media:						
	C140	\$0.6500	1	1	Each	\$0.6500
Media:						
	Heat Shrink, Adhesive Lined	\$0.0296	1	4.3	cm	\$0.0296
Media:						






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Grommet, Rubber B138-144	\$1.0700	1	1	Each	\$1.0700
Media: 	Tape, Fabric B138-144 Grommet	\$0.0637	1	129.4	cm	\$0.0637
Media: 	Tape, Fabric, Grommet	\$0.0054	1	11.0	cm	\$0.0054
Media: 	Tape, Fabric, Grommet	\$0.0054	1	11.0	cm	\$0.0054
Media: 	Tape, Tack, Grommet	\$0.0185	2	37.7	cm	\$0.0371










Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	C141	\$1.1500	1	1	Each	\$1.1500
Media:						
■	Heat Shrink, Adhesive Lined	\$0.0310	1	4.5	cm	\$0.0310
Media:						
■	Tube, Convolute C141	\$0.1365	1	32.5	cm	\$0.1365
Media:						
■	Tape, Tack	\$0.0117	2	23.9	cm	\$0.0235
Media:						
■	C142	\$1.0500	1	1	Each	\$1.0500
Media:						






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media:</p> 	Heat Shrink, Adhesive Lined	\$0.0241	1	3.5	cm	\$0.0241
 <p>Media:</p> 	Tube, Convolute C142	\$0.1365	1	32.5	cm	\$0.1365
 <p>Media:</p> 	Tape, Tack	\$0.0117	2	23.9	cm	\$0.0235
 <p>Media:</p> 	Tape, Tack	\$0.0161	1	32.7	cm	\$0.0161
 <p>Media:</p> 	Clip, Zip Tie	\$0.0400	1	1	Each	\$0.0400

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	C143	\$0.0600	1	1	Each	\$0.0600
Media:						
■	Heat Shrink, Adhesive Lined	\$0.0147	1	3.2	cm	\$0.0147
Media:						
■	Tape, Fabric, C143	\$0.0205	1	41.6	cm	\$0.0205
Media:						
■	C144	\$0.0600	1	1	Each	\$0.0600
Media:						
■	Heat Shrink, Adhesive Lined	\$0.0147	1	3.2	cm	\$0.0147
Media:						










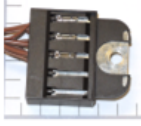
Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	C145	\$0.6500	1	1	Each	\$0.6500
						
■ Media:	Heat Shrink, Adhesive Lined	\$0.0296	1	4.3	cm	\$0.0296
						
■ Media:	Label	\$0.0800	1	1	Each	\$0.0800
						
■ Media:	Tape, Tack	\$0.0074	1	15.1	cm	\$0.0074
						
■ Media:	Tape, Tack	\$0.0074	1	15.1	cm	\$0.0074
						


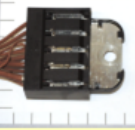
Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
	C146	\$0.5900	1	1	Each	\$0.5900
Media:						
	Tape, Fabric, C146	\$0.0390	1	79.2	cm	\$0.0390
Media:						
	C147	\$0.4300	1	1	Each	\$0.4300
Media:						
	Tape, Fabric, C115	\$0.0476	1	96.8	cm	\$0.0476
Media:						
	C148	\$0.3200	1	1	Each	\$0.3200
Media:						




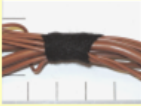



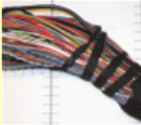


Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media: 	C149	\$0.4200	1	1	Each	\$0.4200
■ Media: 	C150	\$0.3300	1	1	Each	\$0.3300
■ Media: 	C151	\$0.3900	1	1	Each	\$0.3900
■ Media: 	Term Strip, 9x3.2mm, Flat	\$0.0800	4	1	Each	\$0.3200
■ Media: 	Term Strip, 9x3.2mm, Offset	\$0.0900	4	1	Each	\$0.3600






Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	Splice Block & Terminal Cover	\$0.0600	4	1	Each	\$0.2400
 Media: 	Tape, Tack	\$0.0068	4	13.8	cm	\$0.0272
 Media: 	Tape, Fabric, B87-151, A	\$0.0558	1	113.5	cm	\$0.0558
 Media: 	Tape, Fabric, B87-151, B	\$0.0272	1	55.2	cm	\$0.0272
 Media: 	Tape, Fabric, B87-151, B	\$0.1107	1	225.0	cm	\$0.1107


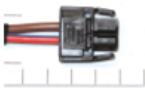








Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
<input checked="" type="checkbox"/>	Molded Trough B87-151 Lower	\$0.2499	1	1	Each	\$0.2499
Media:						
<input type="checkbox"/>	Molded Trough Material	\$0.1900	1	1	Each	\$0.1900
Media:						
<input checked="" type="checkbox"/>	Molded Trough B87-151 Upper	\$0.1529	1	1	Each	\$0.1529
Media:						
<input type="checkbox"/>	Molded Trough Material	\$0.1100	1	1	Each	\$0.1100
Media:						
<input checked="" type="checkbox"/>	Zip Tie	\$0.0100	2	1	Each	\$0.0200
Media:						

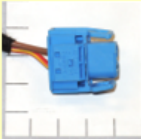
Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
	C152	\$0.0800	1	1	Each	\$0.0800
Media:						
						
	Tape, Fabric, C152	\$0.0154	1	31.2	cm	\$0.0154
Media:						
						
	Tape, Fabric, B87-152	\$0.0789	1	160.3	cm	\$0.0789
Media:						
						
	C153	\$0.3200	1	1	Each	\$0.3200
Media:						
						
	Tape, Fabric, C153	\$0.0182	1	37.0	cm	\$0.0182
Media:						
						

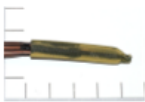



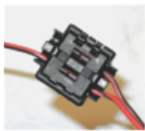
Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	C154	\$0.0900	1	1	Each	\$0.0900
 Media: 	Tape, Fabric, C154	\$0.0182	1	37.0	cm	\$0.0182
 Media: 	Tape, Fabric, B153-154	\$0.0499	1	101.4	cm	\$0.0499
 Media: 	Clip, Tape on X-Tree 1 Tab	\$0.0200	1	1	Each	\$0.0200
 Media: 	Tape, Tack	\$0.0080	1	16.3	cm	\$0.0080



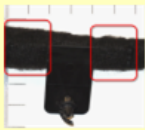

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media: 	Heat Shrink, Adhesive Lined	\$0.0193	2	4.2	cm	\$0.0386
■ Media: 	Heat Shrink, Adhesive Lined	\$0.0145	2	4.2	cm	\$0.0289
■ Media: 	Tape, Tack	\$0.0037	1	7.5	cm	\$0.0037
■ Media: 	Heat Shrink, Adhesive Lined	\$0.0145	4	4.2	cm	\$0.0579
■ Media: 	Splice, Insulation Cutting	\$0.0500	1	1	Each	\$0.0500

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media: 	Tape, Fabric, Splices 1-9	\$0.0687	1	139.7	cm	\$0.0687
■ Media: 	Clip, Strap on X-Tree, Large	\$0.0500	1	1	Each	\$0.0500
■ Media: 	Tape, Tack	\$0.0136	2	27.6	cm	\$0.0272
■ Media: 	Washer Hose w/Connections	\$1.5300	1	629	cm	\$1.5300
■	Wire 1.1 OD/7- 0.18 OD Strands	\$0.0649	65	196.3	cm	\$4.2197
■	Wire 1.3 OD/7- 0.25 OD Strands	\$0.1341	298	241.1	cm	\$39.9641
■	Wire 1.5 OD/16- 0.18 OD Strands	\$0.1210	61	188	cm	\$7.3826
■	Wire 1.7 OD/24- 0.19 OD Strands	\$0.2346	24	228.6	cm	\$5.6296
■	Wire 1.9 OD/29- 0.16 OD Strands	\$0.2681	7	301.7	cm	\$1.8770
■	Wire 2.2 OD/30- 0.25 OD Strands	\$0.4468	21	204.2	cm	\$9.3832
■	Wire 2.8 OD/50- 0.25 OD Strands	\$0.7662	13	204.9	cm	\$9.9607
■	Wire 2.9 OD/44- 0.24 OD Strands	\$0.9691	4	324	cm	\$3.8765
■	Wire 3.4 OD/56- 0.30 OD Strands	\$0.5446	6	85.7	cm	\$3.2676
■	Wire 4.0 OD/83- 0.3 OD Strands	\$2.2730	2	225.3	cm	\$4.5460




Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Wire 9.2 OD/ 196- 0.38 OD Strands	\$1.9962	1	59	cm	\$1.9962
Media: 	Wire ALU 9.4 OD/ 132- 0.47 OD Strands	\$0.3196	1	86.5	cm	\$0.3196
Media: 	Wire ALU 10.5 OD/ 204- 0.47 OD Strands	\$0.5572	1	114	cm	\$0.5572
Media: 	Wire 4x2x0.24 mm2, 7mm OD, Shielded	\$0.9617	1	193.5	cm	\$0.9617
Media: 	Wire Coax 3.3 OD/ 7-0.27 mm OD	\$0.0419	7	280.4	cm	\$0.2933

Wire Harness Costed Bill of Materials

2229 - Main Wire Harness

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Wire w/SH 4.6 OD/ 4x7- 0.16 OD Strands	\$0.3312	1	57	cm	\$0.3312
Media:						
■	Wire w/SH 4.7 OD/ 3x7- 0.254 OD Strands	\$0.4598	3	317.5	cm	\$1.3795
Media:						
■	Wire w/SH 6.0 OD/ 4x19- 0.182 OD Strands	\$1.4623	1	177	cm	\$1.4623
Media:						

Assembly Process

2229 - Main Wire Harness

Symbol Name	Assembly Time	Q Burden	Assembly Cost	Qty	Q Burden (Total)	Assembly Cost (Total)
Wire Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Twisting Machine	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Twisting 1.1mm OD	77.1500 sec	\$0.00	\$0.37	1	\$0.00	\$0.37
Wire Twisting 1.1mm OD	527.1000 sec	\$0.00	\$2.54	1	\$0.00	\$2.54
Wire Twisting 1.1mm OD	9.1250 sec	\$0.00	\$0.04	1	\$0.00	\$0.04
Wire Twisting 1.1mm OD	53.4500 sec	\$0.00	\$0.26	1	\$0.00	\$0.26
Wire Twisting 1.1mm OD	31.8500 sec	\$0.00	\$0.15	1	\$0.00	\$0.15
Wire Twisting 1.1mm OD	21.2250 sec	\$0.00	\$0.10	1	\$0.00	\$0.10
Wire Prep - Cut, Strip, Crimp Terminals	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Common Wire Gauge Crimp	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Cut & Strip Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire	4.0000 sec	\$0.00	\$0.02	428	\$0.60	\$8.24
Cut & Strip Wire	1.0000 sec	\$0.00	\$0.00	428	\$0.60	\$2.06
Wire Crimp Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Ends	2.0000 sec	\$0.00	\$0.01	844	\$1.18	\$8.12
Terminal, Contact	2.0000 sec	\$0.00	\$0.01	844	\$1.18	\$8.12
Crimp Terminal	1.0000 sec	\$0.00	\$0.00	844	\$1.18	\$4.06
Common Wire Gauge Ultrasonic Weld	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Ultrasonic Weld Machine	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Terminal, Contact	2.0000 sec	\$0.00	\$0.01	3	\$0.00	\$0.03
Place Wire Ends	3.0000 sec	\$0.00	\$0.01	3	\$0.00	\$0.04
Ultrasonic Weld	3.0000 sec	\$0.00	\$0.01	3	\$0.01	\$0.04
Common Wire Gauge Ring Terminal	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Crimp Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Ends	2.0000 sec	\$0.00	\$0.01	9	\$0.01	\$0.09
Terminal, Contact	2.0000 sec	\$0.00	\$0.01	9	\$0.01	\$0.09
Crimp Terminal	1.0000 sec	\$0.00	\$0.00	9	\$0.01	\$0.04
Solder Station	3.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Terminal, Contact	5.0000 sec	\$0.00	\$0.02	9	\$0.01	\$0.22
Solder Joint	5.0000 sec	\$0.00	\$0.02	9	\$0.03	\$0.22
Heat Shrink	5.0000 sec	\$0.00	\$0.02	9	\$0.01	\$0.22
Heat Gun	4.0000 sec	\$0.00	\$0.02	9	\$0.00	\$0.17
Shrink Tube	5.0000 sec	\$0.00	\$0.02	9	\$0.01	\$0.22
Coaxial Cable	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire End Processing Machine	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00

***[Click Here to Return to
Cost Analysis Page 295](#)***

Wire Harness Cost Analysis

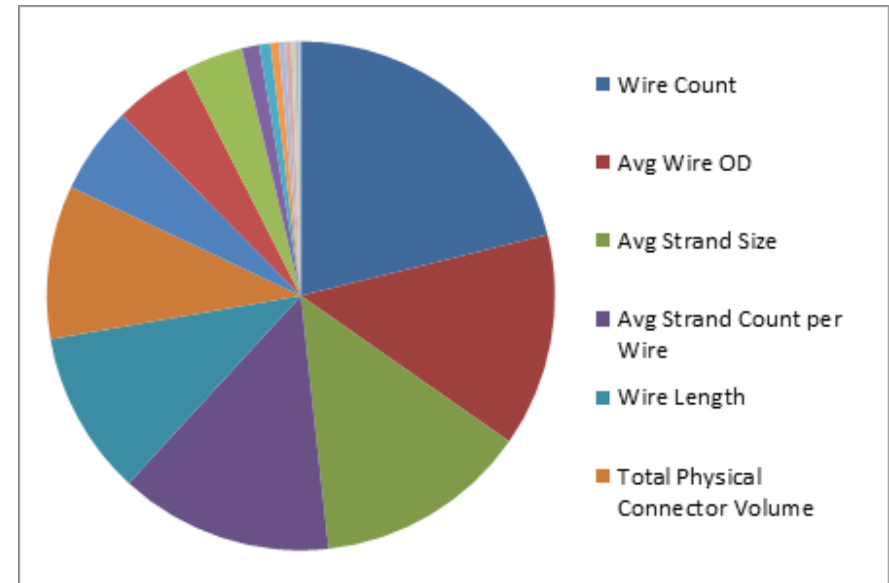
Driver Underbody Wire Harness

Assembly Wire Harness

- The Design Profit[®] based Wire Harness Coster generates cost estimates of various components and assembly processes for the majority of wire harnesses found in today's manufactured products. The Wire Harness Coster rolls up these costs to deliver an estimate of the total manufactured cost.
- Costs are based on several factors including: commodity items, components, burdened machine rates, processing speeds, burdened labor rates, and cost of poor quality drivers.
- The Wire Harness Coster consistently generates a cost estimate for a given wire harness without the need to completely disassemble or destroy the wire harness. Minimal disassembly may be required to capture various attributes and identify overall circuit routing. Inputs to the coster include: connector data (size, cavity count, locking mechanisms and sealing attributes), wire data (sizes quantities and lengths), coverings (type, size and length), fasteners, brackets, troughs, etc.
- The Wire Harness Coster separates the parts and processes to more easily delineate Bill of Material (BOM) costs and build processing costs.

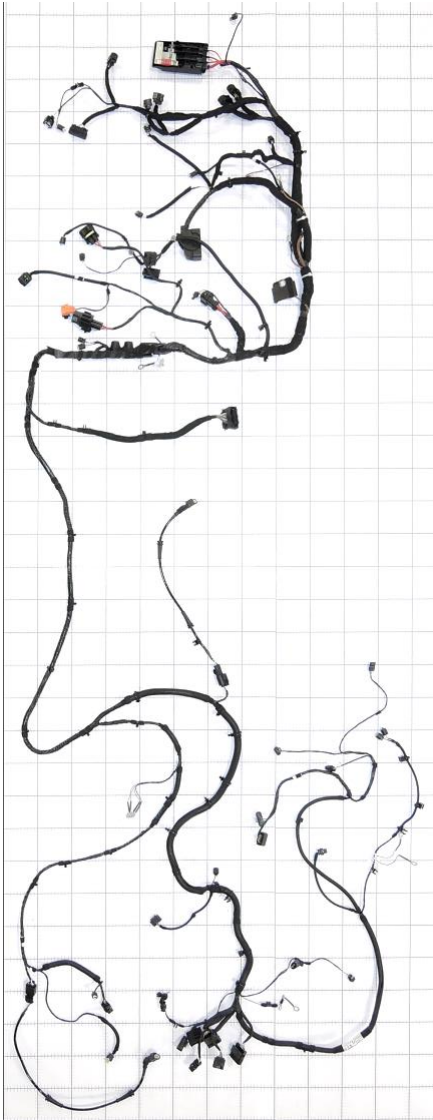
Factors Influencing Cost:

1. Wire count is the primary factor driving cost as it affects the amount of wire, the size of connectors, and the number of assembly processes.
2. Wire selection (wire OD, strand size, strand count / wire) is significant as it directly relates to conductor cross section, and therefore the amount of copper or aluminum used in the harness.
3. Wire length is another major cost factor as it both relates to material cost and to assembly time, as longer lengths require more handling.
4. The total physical connector size is a major cost factor as connectors are a large portion of harness part costs. Total physical connector size also tends to drive assembly costs.



Relative influence of factors on harness costs
(Data based on L32 two-level Taguchi analysis
of the Wire Harness Coster)

Driver Underbody Wire Harness



The Driver Underbody Wire Harness Assembly consists of 196 wires joining 55 connectors and 17 eyelets. 118 of the wires are 1.3 mm OD, 54 wires are 1.5 mm OD, four are 1.7 mm OD, three are 2.0 mm OD, two are 2.2 mm OD, six are 2.75 mm OD, two are 3.4 mm OD, and five wires are 4.0 mm OD each having copper strands. There are also two 7.4 mm OD wires that have aluminum strands. There are 22 twisted wire pairs and 21 ultrasonically welded splices.

The overall weight of the harness is 4.9088 kg.

54 of the 55 connectors are sealed. The largest connector has 48 cavities populated with 26 terminals and has a slide lock to keep it in place.

The harness covering consists of a combination of cloth tape, standard electrical tape, heat shrink tube and convoluted tube.

There are 18 edge biter clips, 51 X-tree clips, and one label.

All major components are analyzed in detail, while prices are applied to commodity items (i.e. clips, terminals).

Estimates are based on actual parts.

Photos: Background on 100mm grid paper.

Design Profit[®]

EXECUTIVE SUMMARY Harness Overview

2232 - Driver Underbody Wire Harness Asm	
Parts	726
Steps	3776
Assembly Time (min)	244.05
Total Weight (kg)	4.9088
Purchased Part Cost	\$80.05
Supplier Asm. Cost	\$70.45
Q Burden	\$3.99
Total Cost	\$154.49

Design Profit[®]

EXECUTIVE SUMMARY Wire, Cable & Splices

	2232 - Driver Underbody Wire Harness Asm
Wire & Cable Count	196
Splice Count	21
Wire Length Total (cm)	44018.2
Harness Total Weight	4.9088 kg
Cu Conductor Mass	2.9486 kg
Cu to Harness Mass (%)	60.07 %
Al Conductor Mass	0.0874 kg
Al to Harness Mass (%)	1.78 %
Wire Cost	\$43.06

Design Profit[®]

EXECUTIVE SUMMARY Connectors & Terminals

2232 - Driver Underbody Wire Harness Asm	
Connector Assemblies	55
Sealed Connectors	54
Terminal Cavities	424
Unpopulated Cavities	117
Connector Body Cost	\$11.34
Coax Connectors	0
Coax Connector Cost	\$0.00
Pin & Blade Terminals	307
Ring Terminals	17
Battery Terminals	0
Terminal Strips	0
Total Terminal Count	324
Terminal Cost	\$7.03

Design Profit[®]

EXECUTIVE SUMMARY Labels, Clips, Tape & Coverings

2232 - Driver Underbody Wire Harness Asm	
Label Count	1
Label Area cm2	32.0
Label Cost	\$0.08
Clip Count	69
Clip Cost	\$4.00
Tape Tacks	188
Taped Length cm	2047.6
Tape Actual Length cm	7983.9
Tape Cost	\$3.23
Tube & Wrap Count	39
Heat Shrink Count	38
Covering Count Total	77
Covering Length cm	1061.5
Covering Cost	\$8.71

Design Profit[®]

EXECUTIVE SUMMARY Miscellaneous Parts

2232 - Driver Underbody Wire Harness Asm	
Bracket Count	0
Bracket Cost	\$0.00
Trough Count	1
Trough Cost	\$0.31
Fuse Count	0
Fuse Cost	\$0.00
Grommet Count	0
Grommet Cost	\$0.00
Misc Part Count	1
Misc Part Cost	\$0.01

Wire Harness Costed Bill of Materials

Harness CBOM

2232 - Driver Underbody Wire Harness Asm

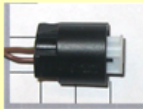
	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Main Harness	\$80.0476	1	1	Each	\$80.0476

Media:



■	C01	\$0.1600	1	1	Each	\$0.1600
---	-----	----------	---	---	------	----------

Media:



■	C02	\$0.1300	1	1	Each	\$0.1300
---	-----	----------	---	---	------	----------

Media:



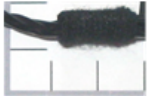




■	Clip, Tape-on, Edge Biter, Two Tabs, C01	\$0.0500	1	1	Each	\$0.0500
---	--	----------	---	---	------	----------

Media:








Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	Tape, Tack, C01	\$0.0049	2	10.1	cm	\$0.0099
						
■ Media:	Tape, Std, C01	\$0.0063	1	19.1	cm	\$0.0063
						
■ Media:	Tape, Std, C02	\$0.0053	1	16.2	cm	\$0.0053
						
■ Media:	Tape, Std, B01-02	\$0.0047	1	14.3	cm	\$0.0047
						
■ Media:	Tape, Std, B01-02	\$0.0037	1	11.2	cm	\$0.0037
						






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Std, B01-02	\$0.0016	1	5.0	cm	\$0.0016
Media: 	C03	\$0.3700	1	1	Each	\$0.3700
Media: 	C04	\$0.3700	1	1	Each	\$0.3700
Media: 	Tape, Fabric, C03	\$0.0084	1	17.1	cm	\$0.0084
Media: 	Self Closing Sleeve, C03	\$0.1305	1	9.8	cm	\$0.1305

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	Tape, Fabric, C03	\$0.0068	1	13.8	cm	\$0.0068
						
■ Media:	Tape, Fabric, C04	\$0.0059	1	12.1	cm	\$0.0059
						
■ Media:	Self Closing Sleeve, C04	\$0.1305	1	9.8	cm	\$0.1305
						
■ Media:	Tape, Fabric, C04	\$0.0046	1	9.3	cm	\$0.0046
						
■ Media:	Tape, Std, B01-04	\$0.0060	1	18.3	cm	\$0.0060
						



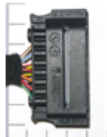
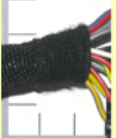

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Self Closing Sleeve, B01-04	\$0.3517	1	19	cm	\$0.3517
Media: 	Tape, Fabric, B01-04	\$0.0059	1	12.1	cm	\$0.0059
Media: 	Clip, Tape-on, Edge Biter, Two Tabs, B01-04	\$0.0500	1	1	Each	\$0.0500
Media: 	Tape, Tack, B01-04	\$0.0107	2	21.7	cm	\$0.0214
Media: 	Tape, Tack, B01-04	\$0.0019	1	5.7	cm	\$0.0019






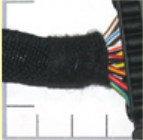



Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Fabric, B01-04	\$0.0073	1	14.9	cm	\$0.0073
Media: 	C05	\$0.4800	1	1	Each	\$0.4800
Media: 	C06	\$0.4300	1	1	Each	\$0.4300
Media: 	Tape, Tack, C05	\$0.0079	1	16.0	cm	\$0.0079
Media: 	Self Closing Sleeve, C05	\$0.1065	1	8	cm	\$0.1065






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	Tape, Tack, C06	\$0.0079	1	16.0	cm	\$0.0079
 Media: 	Tape, Std, C05	\$0.0041	1	12.5	cm	\$0.0041
 Media: 	Tape, Tack, C06	\$0.0079	1	16.0	cm	\$0.0079
 Media: 	Self Closing Sleeve, C06	\$0.1065	1	8	cm	\$0.1065
 Media: 	Tape, Tack, C06	\$0.0079	1	16.0	cm	\$0.0079

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Tape, Std, C06	\$0.0035	1	10.6	cm	\$0.0035
Media:						
■	Tape, Fabric, B05-06	\$0.0073	1	14.9	cm	\$0.0073
Media:						
■	Self Closing Sleeve, B05-06	\$0.1114	1	7	cm	\$0.1114
Media:						
■	Tape, Fabric, B05-06	\$0.0073	1	14.9	cm	\$0.0073
Media:						
■	Tape, Std, B05-06	\$0.0080	1	24.2	cm	\$0.0080
Media:						

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Std, B05-06	\$0.0027	1	8.1	cm	\$0.0027
Media: 						
Media: 	Tape, Std, B05-06	\$0.0019	1	5.6	cm	\$0.0019
Media: 						
Media: 	Tape, Std, B05-06	\$0.0016	1	4.8	cm	\$0.0016
Media: 						
Media: 	Clip, Tape-on X-TreeMod, B01-06	\$0.0600	1	1	Each	\$0.0600
Media: 						
Media: 	Tape, Tack, B01-06	\$0.0116	2	23.6	cm	\$0.0232
Media: 						


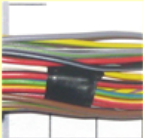




Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	Clip, Tape-on X-Tree Mod, B01-06	\$0.0600	1	1	Each	\$0.0600
■ Media:	Tape, Tack, B01-06	\$0.0116	2	23.6	cm	\$0.0232
■ Media:	Self Closing Sleeve, B01-06	\$0.2869	1	15.5	cm	\$0.2869
■ Media:	Tape, Tack, B01-06	\$0.0108	1	22.0	cm	\$0.0108
■ Media:	Tape, Tack, B01-06	\$0.0108	1	22.0	cm	\$0.0108

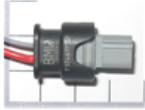




Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media: </p>	Tape, Tack, B01-06	\$0.0043	1	13.2	cm	\$0.0043
 <p>Media: </p>	Tape, Std, B01-06	\$0.0054	1	16.5	cm	\$0.0054
 <p>Media: </p>	Tape, Std, B01-06	\$0.0038	1	11.6	cm	\$0.0038
 <p>Media: </p>	Tape, Std, B01-06	\$0.0047	1	14.4	cm	\$0.0047
 <p>Media: </p>	Tape, Std, B01-06	\$0.0059	1	18.0	cm	\$0.0059





Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	C07	\$0.0900	1	1	Each	\$0.0900
Media: 	C08a	\$0.1800	1	1	Each	\$0.1800
Media: 	C08b	\$0.0600	1	1	Each	\$0.0600
Media: 	C08c	\$0.0600	1	1	Each	\$0.0600
Media: 	C08d	\$0.0600	1	1	Each	\$0.0600










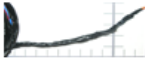
Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Std, C07	\$0.0098	1	29.9	cm	\$0.0098
Media: 	Heat Shrink, C08a	\$0.0255	1	3.7	cm	\$0.0255
Media: 	Heat Shrink, C08b	\$0.0170	1	3.7	cm	\$0.0170
Media: 	Heat Shrink, C08c	\$0.0170	1	3.7	cm	\$0.0170
Media: 	Heat Shrink, C08d	\$0.0127	1	3.7	cm	\$0.0127

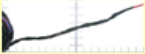

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Std, B07-08	\$0.0150	1	45.8	cm	\$0.0150
Media: 						
Media: 	Tape, Std, B07-08	\$0.0055	1	16.7	cm	\$0.0055
Media: 						
Media: 	C09	\$0.1200	1	1	Each	\$0.1200
Media: 						
Media: 	C10	\$0.0500	1	1	Each	\$0.0500
Media: 						
Media: 	Tape, Std, C09	\$0.0065	1	19.7	cm	\$0.0065
Media: 						











Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Std, C10	\$0.0072	1	21.9	cm	\$0.0072
Media: 						
Media: 	Tape, Std, B01-10	\$0.0180	1	55.0	cm	\$0.0180
Media: 						
Media: 	Tape, Std, B01-10	\$0.0058	1	17.6	cm	\$0.0058
Media: 						
Media: 	Tape, Std, B01-10	\$0.0047	1	14.5	cm	\$0.0047
Media: 						
Media: 	Tape, Std, B01-10	\$0.0014	1	4.4	cm	\$0.0014
Media: 						



Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	C11	\$0.4900	1	1	Each	\$0.4900
 Media: 	C12	\$0.4900	1	1	Each	\$0.4900
 Media: 	Tape, Tack, C11	\$0.0071	1	14.5	cm	\$0.0071
 Media: 	SelfClosing Sleeve, C11	\$0.0932	1	7	cm	\$0.0932
 Media: 	Tape, Tack, C11	\$0.0071	1	14.5	cm	\$0.0071






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media:</p> 	Tape, Std, C11	\$0.0032	1	9.7	cm	\$0.0032
 <p>Media:</p> 	Tape, Tack, C12	\$0.0071	1	14.5	cm	\$0.0071
 <p>Media:</p> 	Self Closing Sleeve, C12	\$0.0865	1	6.5	cm	\$0.0865
 <p>Media:</p> 	Tape, Tack, C12	\$0.0071	1	14.5	cm	\$0.0071
 <p>Media:</p> 	Tape, Tack, C12	\$0.0048	1	9.7	cm	\$0.0048






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	Tape, Std, C12	\$0.0038	1	11.4	cm	\$0.0038
						
■ Media:	Tape, Std, B11-12	\$0.0050	1	15.1	cm	\$0.0050
						
■ Media:	Tape, Tack, B11-12	\$0.0031	1	9.4	cm	\$0.0031
						
■ Media:	Tape, Tack, B11-12	\$0.0038	1	11.4	cm	\$0.0038
						
■ Media:	Tape, Tack, B01-12	\$0.0152	1	30.9	cm	\$0.0152
						


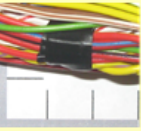

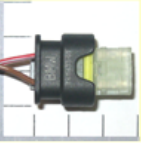
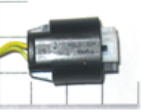
Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Self Closing Sleeve, B01-12	\$0.3824	1	16	cm	\$0.3824
Media: 	Tape, Tack, B01-12	\$0.0152	1	30.9	cm	\$0.0152
Media: 	Tape, Tack, B01-12	\$0.0152	2	30.9	cm	\$0.0304
Media: 	Clip, Zip Tie, B01-12	\$0.0400	2	1	Each	\$0.0800
Media: 	Tape, Std, B11-12	\$0.0050	1	15.1	cm	\$0.0050






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack, B01-12	\$0.0031	1	9.4	cm	\$0.0031
Media: 	Tape, Tack, B01-12	\$0.0031	1	9.4	cm	\$0.0031
Media: 	Heat Shrink, Adhesive Lined, B01-12	\$0.0172	1	5	cm	\$0.0172
Media: 	C15	\$0.1400	1	1	Each	\$0.1400
Media: 	C16	\$0.1600	1	1	Each	\$0.1600






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack, C15	\$0.0049	1	10.1	cm	\$0.0049
Media: 	SelfClosing Sleeve, C15	\$0.2996	1	22.5	cm	\$0.2996
Media: 	Tape, Tack, C15	\$0.0049	1	10.1	cm	\$0.0049
Media: 	Tape, Tack, C15	\$0.0014	1	4.4	cm	\$0.0014
Media: 	Tape, Tack, C16	\$0.0056	1	11.3	cm	\$0.0056





Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Self Closing Sleeve, C16	\$0.1797	1	13.5	cm	\$0.1797
Media:						
■	Tape, Tack, C16	\$0.0056	1	11.3	cm	\$0.0056
Media:						
■	Tape, Std, C16	\$0.0052	1	16.0	cm	\$0.0052
Media:						
■	Tape, Tack, B15-16	\$0.0062	1	12.6	cm	\$0.0062
Media:						
■	Self Closing Sleeve, B15-16	\$0.5059	1	38	cm	\$0.5059
Media:						






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Clip, Tape-on, Edge Biter, Two Tabs, B15-16	\$0.0500	2	1	Each	\$0.1000
Media:						
■	Tape, Tack, B15-16	\$0.0074	4	15.1	cm	\$0.0297
Media:						
■	Tape, Tack, B15-16	\$0.0062	1	12.6	cm	\$0.0062
Media:						
■	Tape, Std, C16	\$0.0025	1	7.6	cm	\$0.0025
Media:						
■	Tape, Std, C16	\$0.0025	1	7.6	cm	\$0.0025
Media:						


Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	C13	\$0.0400	1	1	Each	\$0.0400
						
■ Media:	C14	\$0.1200	1	1	Each	\$0.1200
						
■ Media:	Heat Shrink, Adhesive Lined, C13	\$0.0110	1	3.2	cm	\$0.0110
						
■ Media:	Tape, Tack, C14	\$0.0049	1	10.1	cm	\$0.0049
						
■ Media:	Self Closing Sleeve, C14	\$0.0932	1	7	cm	\$0.0932
						






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack, C14	\$0.0049	1	10.1	cm	\$0.0049
Media: 	Tape, Std, C14	\$0.0025	1	7.6	cm	\$0.0025
Media: 	Tape, Tack, B01-16	\$0.0158	1	32.0	cm	\$0.0158
Media: 	Self Closing Sleeve, B01-16	\$0.5949	1	24.5	cm	\$0.5949
Media: 	Tape, Tack, B01-16	\$0.0158	1	32.0	cm	\$0.0158











Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack, B01-16	\$0.0091	1	27.6	cm	\$0.0091
Media: 	Tape, Tack, B01-16	\$0.0091	1	27.6	cm	\$0.0091
Media: 	Tape, Std, B01-16	\$0.0096	1	29.2	cm	\$0.0096
Media: 	C19	\$2.2800	1	1	Each	\$2.2800
Media: 	C20	\$0.1600	1	1	Each	\$0.1600








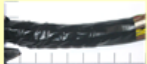


Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
	C21	\$0.1800	1	1	Each	\$0.1800
Media:						
						
	Tape, Tack, C19	\$0.0115	1	23.4	cm	\$0.0115
Media:						
						
	Self Closing Sleeve, C19	\$0.5975	1	25	cm	\$0.5975
Media:						
						
	Tape, Tack, C19	\$0.0115	1	23.4	cm	\$0.0115
Media:						
						
	Tape, Tack, C19	\$0.0115	1	23.4	cm	\$0.0115
Media:						
						


Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	Tape, Tack, C19	\$0.0115	1	23.4	cm	\$0.0115
 Media: 	Clip, Zip Tie, C19	\$0.0400	1	1	Each	\$0.0400
 Media: 	Tape, Std, C19	\$0.0375	1	114.5	cm	\$0.0375
 Media: 	Tape, Std, C19	\$0.0085	1	26.0	cm	\$0.0085
 Media: 	Tube, Convolute, C20	\$0.0669	1	40	cm	\$0.0669






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack, C20	\$0.0051	1	10.3	cm	\$0.0051
Media: 	Tape, Tack, C20	\$0.0051	2	10.3	cm	\$0.0101
Media: 	Clip, Tape-on X-Tree Std, C20	\$0.0200	2	1	Each	\$0.0400
Media: 	Tape, Tack, C20	\$0.0051	1	10.3	cm	\$0.0051
Media: 	Tape, Std, C20	\$0.0144	1	43.8	cm	\$0.0144











Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	Heat Shrink, Adhesive Lined, C21	\$0.0142	1	6.2	cm	\$0.0142
						
■ Media:	Tape, Tack, B19-21	\$0.0126	1	25.5	cm	\$0.0126
						
■ Media:	Self Closing Sleeve, B19-21	\$0.2988	1	12.5	cm	\$0.2988
						
■ Media:	Tape, Tack, B19-21	\$0.0126	1	25.5	cm	\$0.0126
						
■ Media:	Clip, Zip Tie, B19-21	\$0.0800	1	1	Each	\$0.0800
						











Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Std, B19-21	\$0.0171	1	52.2	cm	\$0.0171
Media: 						
Media: 	Tape, Tack, B19-21	\$0.0061	1	18.6	cm	\$0.0061
Media: 						
Media: 	Tape, Std, B19-21	\$0.0015	1	4.7	cm	\$0.0015
Media: 						
Media: 	C17	\$0.5500	1	1	Each	\$0.5500
Media: 						
Media: 	Heat Shrink, Adhesive Lined, C21	\$0.0255	1	3.7	cm	\$0.0255
Media: 						


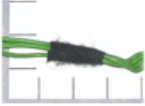

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
	C18	\$0.1800	1	1	Each	\$0.1800
Media:						
						
	Heat Shrink, Adhesive Lined, C21	\$0.0142	1	3.1	cm	\$0.0142
Media:						
						
	Tape, Tack, B01-21	\$0.0161	1	32.7	cm	\$0.0161
Media:						
						
	Self Closing Sleeve, B01-21	\$0.2966	1	12	cm	\$0.2966
Media:						
						
	Tape, Tack, B01-21	\$0.0161	1	32.7	cm	\$0.0161
Media:						
						










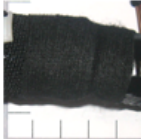
Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Clip, Zip Tie, B01-21	\$0.0800	1	1	Each	\$0.0800
Media: 	Tape, Std, B01-21	\$0.0186	1	56.8	cm	\$0.0186
Media: 	Heat Shrink, Adhesive Lined, 19-21	\$0.0169	1	4.9	cm	\$0.0169
Media: 	Tape, Tack, B19-21	\$0.0016	1	4.8	cm	\$0.0016
Media: 	Heat Shrink, Adhesive Lined, B19-21	\$0.0169	1	4.9	cm	\$0.0169








Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
	C22	\$2.3800	1	1	Each	\$2.3800
Media:						
	Tape, Tack, C22	\$0.0033	1	6.7	cm	\$0.0033
Media:						
	Tape, Tack, C22	\$0.0284	1	57.8	cm	\$0.0284
Media:						
	Self Closing Sleeve - Main Trunk	\$0.5832	1	21	cm	\$0.5832
Media:						
	Tape, Tack, Main Trunk	\$0.0182	1	37.1	cm	\$0.0182
Media:						





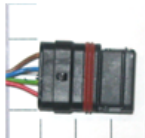
Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	Tape, Tack, Main Trunk	\$0.0182	1	37.1	cm	\$0.0182
 Media: 	Clip, Tape-on, Two Tabs, Main Trunk	\$0.1000	1	1	Each	\$0.1000
 Media: 	Tape, Tack, Main Trunk	\$0.0182	1	37.1	cm	\$0.0182
 Media: 	Tape, Tack, Main Trunk	\$0.0182	1	37.1	cm	\$0.0182
 Media: 	Clip, Zip Tie, Main Trunk	\$0.0400	1	1	Each	\$0.0400

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Tape, Std, Main Trunk	\$0.0319	1	97.3	cm	\$0.0319
Media:						
■	Tape, Tack, Main Trunk	\$0.0043	1	13.2	cm	\$0.0043
Media:						
■	Tape, Tack, Main Trunk	\$0.0084	1	25.8	cm	\$0.0084
Media:						
■	C23	\$0.1800	1	1	Each	\$0.1800
Media:						
■	C24	\$0.1400	1	1	Each	\$0.1400
Media:						


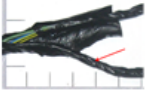

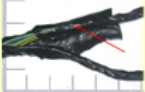

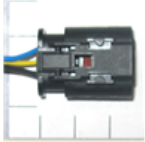




Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	Tape, Std, C23	\$0.0085	1	26.0	cm	\$0.0085
						
■ Media:	Tape, Std, C24	\$0.0136	1	41.4	cm	\$0.0136
						
■ Media:	Tape, Tack, C24	\$0.0049	1	10.1	cm	\$0.0049
						
■ Media:	Clip, Tape-on Rosebud or X-Tree Std, C24	\$0.0200	1	1	Each	\$0.0200
						
■ Media:	Tape, Std, B23-24	\$0.0035	1	10.6	cm	\$0.0035
						





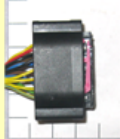
Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	Tape, Std, B23-24	\$0.0024	1	7.4	cm	\$0.0024
 Media: 	Tape, Std, B23-24	\$0.0016	1	4.8	cm	\$0.0016
 Media: 	C25	\$0.1200	1	1	Each	\$0.1200
 Media: 	Tape, Std, C25	\$0.0039	1	11.8	cm	\$0.0039
 Media: 	Tape, Std, B23-25	\$0.0161	1	49.0	cm	\$0.0161

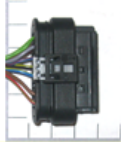




Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack, B23-25	\$0.0068	2	13.8	cm	\$0.0136
Media: 	Clip, Tape-on Rosebud or X-Tree Std, B23-25	\$0.0200	2	1	Each	\$0.0400
Media: 	Heat Shrink, Adhesive Lined, B23-25	\$0.0172	1	5	cm	\$0.0172
Media: 	Tape, Std, B23-25	\$0.0061	1	18.7	cm	\$0.0061
Media: 	C26	\$0.4000	1	1	Each	\$0.4000

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	C27	\$0.4000	1	1	Each	\$0.4000
Media:						
■	Tape, Std, C26	\$0.0063	1	19.3	cm	\$0.0063
Media:						
■	Tape, Std, C27	\$0.0023	1	7.1	cm	\$0.0023
Media:						
■	Tape, Std, B26-27	\$0.0202	1	61.4	cm	\$0.0202
Media:						
■	Tape, Tack, B26-27	\$0.0062	1	12.6	cm	\$0.0062
Media:						






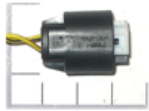




Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Clip, Tape-on Rosebud or X-Tree Std, B26-27	\$0.0200	1	1	Each	\$0.0200
Media:						
■	Tube, Convolute, B23-27	\$0.1211	1	52	cm	\$0.1211
Media:						
■	Tape, Tack, B23-27	\$0.0078	1	15.8	cm	\$0.0078
Media:						
■	Tape, Tack, B23-27	\$0.0078	1	15.8	cm	\$0.0078
Media:						
■	Tape, Tack, B23-27	\$0.0078	1	15.8	cm	\$0.0078
Media:						





Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	Clip, Zip Tie, B23-27	\$0.0800	1	1	Each	\$0.0800
 Media: 	Tape, Std, B23-27	\$0.0264	1	80.6	cm	\$0.0264
 Media: 	C28	\$0.1500	1	1	Each	\$0.1500
 Media: 	C29	\$0.1500	1	1	Each	\$0.1500
 Media: 	Tape, Std, C28	\$0.0015	1	4.5	cm	\$0.0015






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Std, C29	\$0.0015	1	4.5	cm	\$0.0015
Media: 	Tape, Tack, B28-29	\$0.0051	2	10.3	cm	\$0.0101
Media: 	Tape, Tack, B28-29	\$0.0051	3	10.3	cm	\$0.0152
Media: 	Tube, Convolute, B28-29	\$0.0535	1	32	cm	\$0.0535
Media: 	Clip, Edge Biter, Zip Tie, B28-29	\$0.0700	3	1	Each	\$0.2100






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Tape, Std, B28-29	\$0.0179	1	54.6	cm	\$0.0179
Media:						
■	C30	\$0.0600	1	1	Each	\$0.0600
Media:						
■	C31	\$0.0600	1	1	Each	\$0.0600
Media:						
■	Heat Shrink, Adhesive Lined, C30	\$0.0076	1	3.3	cm	\$0.0076
Media:						
■	Heat Shrink, Adhesive Lined, C31	\$0.0076	1	3.3	cm	\$0.0076
Media:						






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	Tape, Std, B28-31	\$0.0082	1	25.1	cm	\$0.0082
						
■ Media:	Clip, EdgeBiter, Zip Tie, B28-31	\$0.0700	1	1	Each	\$0.0700
						
■ Media:	C32	\$0.1100	1	1	Each	\$0.1100
						
■ Media:	Tube, Convolute, C32	\$0.0385	1	23	cm	\$0.0385
						
■ Media:	Tape, Tack, C32	\$0.0053	1	10.8	cm	\$0.0053
						


Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	Tape, Tack, C32	\$0.0053	1	10.8	cm	\$0.0053
						
■ Media:	Tape, Std, C32	\$0.0098	1	29.9	cm	\$0.0098
						
■ Media:	Tape, Tack, B23-32	\$0.0105	1	21.4	cm	\$0.0105
						
■ Media:	Tape, Tack, B23-32	\$0.0105	1	21.4	cm	\$0.0105
						
■ Media:	Tape, Tack, B23-32	\$0.0105	1	21.4	cm	\$0.0105
						








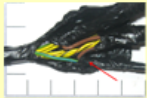

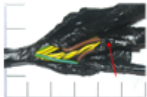
Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack, B23-32	\$0.0105	2	21.4	cm	\$0.0210
Media: 	Clip, Tape-on X-TreeMod, B23-32	\$0.0600	1	1	Each	\$0.0600
Media: 	Tape, Tack, B23-32	\$0.0105	2	21.4	cm	\$0.0210
Media: 	Clip, Tape-on X-TreeMod, B23-32	\$0.0600	1	1	Each	\$0.0600
Media: 	Tape, Tack, B23-32	\$0.0105	1	21.4	cm	\$0.0105


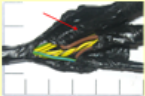





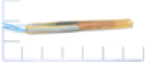

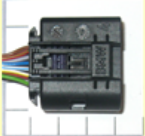
Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media:</p> 	Tube, Convolute, B23-32	\$0.2359	1	79	cm	\$0.2359
 <p>Media:</p> 	Tube, HeatProof Foil & Fabric, B23-32	\$0.0758	1	10.5	cm	\$0.0758
 <p>Media:</p> 	Tape, Std, B23-32	\$0.0647	1	197.3	cm	\$0.0647
 <p>Media:</p> 	Tape, Tack, B23-32	\$0.0012	1	3.8	cm	\$0.0012
 <p>Media:</p> 	Tape, Tack, B23-32	\$0.0021	1	6.3	cm	\$0.0021











Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media:</p> 	Tape, Tack, B23-32	\$0.0024	1	7.3	cm	\$0.0024
 <p>Media:</p> 	Heat Shrink, Adhesive Lined, B23-32	\$0.0165	1	4.8	cm	\$0.0165
 <p>Media:</p> 	Heat Shrink, Adhesive Lined, B23-32	\$0.0172	1	5	cm	\$0.0172
 <p>Media:</p> 	Heat Shrink, Adhesive Lined, B23-32	\$0.0172	1	5	cm	\$0.0172
 <p>Media:</p> 	C33	\$0.3600	1	1	Each	\$0.3600

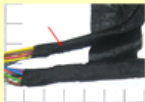


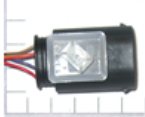

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
	C34	\$0.3600	1	1	Each	\$0.3600
Media:						
	Tape, Fabric, C33	\$0.0063	1	12.7	cm	\$0.0063
Media:						
	Tape, Fabric, C34	\$0.0115	1	23.5	cm	\$0.0115
Media:						
	Tape, Fabric, B33-34	\$0.0192	1	39.0	cm	\$0.0192
Media:						
	Tape, Fabric, B33-34	\$0.0054	1	11.0	cm	\$0.0054
Media:						











Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Fabric, B33-34	\$0.0058	1	11.7	cm	\$0.0058
Media: 	Heat Shrink, Adhesive Lined, B33-34	\$0.0165	1	4.8	cm	\$0.0165
Media: 	Heat Shrink, Adhesive Lined, B33-34	\$0.0165	1	4.8	cm	\$0.0165
Media: 	C35	\$0.2200	1	1	Each	\$0.2200
Media: 	C36	\$0.5200	1	1	Each	\$0.5200


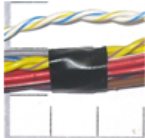


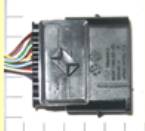
Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
	C37	\$0.4600	1	1	Each	\$0.4600
Media:						
	Tape, Fabric, C35	\$0.0103	1	20.9	cm	\$0.0103
Media:						
	Heat Shrink, Adhesive Lined, B33-34	\$0.0172	1	5	cm	\$0.0172
Media:						
	Tape, Fabric, C36	\$0.0103	1	20.9	cm	\$0.0103
Media:						
	Heat Shrink, Adhesive Lined, C36	\$0.0169	1	4.9	cm	\$0.0169
Media:						




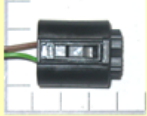

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Heat Shrink, Adhesive Lined, C36	\$0.0169	1	4.9	cm	\$0.0169
Media: 	Tape, Tack, C36	\$0.0032	1	9.7	cm	\$0.0032
Media: 	Tape, Fabric, C37	\$0.0064	1	13.0	cm	\$0.0064
Media: 	Tape, Fabric, B36-37	\$0.0092	1	18.7	cm	\$0.0092
Media: 	C38	\$0.4700	1	1	Each	\$0.4700

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	Tape, Fabric, C38	\$0.0139	1	28.3	cm	\$0.0139
						
■ Media:	Zip Tie	\$0.0100	1	1	Each	\$0.0100
						
■ Media:	Tape, Std, B23-38	\$0.0248	1	75.6	cm	\$0.0248
						
■ Media:	C41	\$0.0900	1	1	Each	\$0.0900
						
■ Media:	C42	\$0.0900	1	1	Each	\$0.0900
						








Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	Tape, Std, C41	\$0.0018	1	5.5	cm	\$0.0018
						
■ Media:	Tape, Std, C42	\$0.0091	1	27.8	cm	\$0.0091
						
■ Media:	Clip, Tape-on, Edge Biter, Two Tabs, C42	\$0.0500	1	1	Each	\$0.0500
						
■ Media:	Tape, Tack, C42	\$0.0049	2	10.1	cm	\$0.0099
						
■ Media:	Tape, Std, B41-42	\$0.0069	1	20.9	cm	\$0.0069
						


Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
	C39	\$0.0900	1	1	Each	\$0.0900
Media:						
	C40	\$0.0600	1	1	Each	\$0.0600
Media:						
	Tape, Std, C39	\$0.0125	1	38.1	cm	\$0.0125
Media:						
	Clip, Tape-on, Edge Biter, Two Tabs, C39	\$0.0500	1	1	Each	\$0.0500
Media:						
	Tape, Tack, C39	\$0.0049	2	10.1	cm	\$0.0099
Media:						











Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	Heat Shrink, Adhesive Lined, C40	\$0.0121	1	3.5	cm	\$0.0121
						
■ Media:	Clip, Tape-on, Edge Biter, Two Tabs, C40	\$0.0500	1	1	Each	\$0.0500
						
■ Media:	Tape, Tack, C40	\$0.0049	2	10.1	cm	\$0.0099
						
■ Media:	Tape, Tack, C40	\$0.0033	1	6.7	cm	\$0.0033
						
■ Media:	Tube, Convolute, B23-42	\$0.1821	1	37	cm	\$0.1821
						





Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	Tape, Tack, B23-42	\$0.0134	1	27.3	cm	\$0.0134
 Media: 	Clip, Zip Tie, B23-42	\$0.0800	1	1	Each	\$0.0800
 Media: 	Tape, Tack, B23-42	\$0.0134	1	27.3	cm	\$0.0134
 Media: 	Clip, EdgeBiter, Zip Tie, B23-42	\$0.0700	1	1	Each	\$0.0700
 Media: 	Tape, Tack, B23-42	\$0.0134	1	27.3	cm	\$0.0134






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Clip, Edge Biter, Zip Tie, B23-42	\$0.0700	1	1	Each	\$0.0700
Media: 	Tape, Tack, B23-42	\$0.0134	1	27.3	cm	\$0.0134
Media: 	Clip, Edge Biter, Zip Tie, B23-42	\$0.0700	1	1	Each	\$0.0700
Media: 	Tape, Tack, B23-42	\$0.0134	1	27.3	cm	\$0.0134
Media: 	Tape, Std, B23-42	\$0.0270	1	82.2	cm	\$0.0270

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	C43	\$0.1500	1	1	Each	\$0.1500
						
■ Media:	C44	\$0.2300	1	1	Each	\$0.2300
						
■ Media:	Tape, Std, C43	\$0.0016	1	5.0	cm	\$0.0016
						
■ Media:	Tape, Tack, C44	\$0.0048	1	9.7	cm	\$0.0048
						
■ Media:	Tube, Convolute, C44	\$0.0368	1	22	cm	\$0.0368
						






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media:</p> 	Tape, Tack, C44	\$0.0048	1	9.7	cm	\$0.0048
 <p>Media:</p> 	Tape, Tack, C44	\$0.0056	1	11.3	cm	\$0.0056
 <p>Media:</p> 	Clip, Tape-on Rosebud or X-Tree Std, C44	\$0.0200	1	1	Each	\$0.0200
 <p>Media:</p> 	Tape, Std, C44	\$0.0078	1	23.9	cm	\$0.0078
 <p>Media:</p> 	Tube, Convolute, B23-44	\$0.3543	1	72	cm	\$0.3543











Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media: 	Tape, Tack, B23-44	\$0.0134	1	27.3	cm	\$0.0134
■ Media: 	Tape, Tack, B23-44	\$0.0134	1	27.3	cm	\$0.0134
■ Media: 	Clip, Zip Tie, B23-44	\$0.0800	1	1	Each	\$0.0800
■ Media: 	Tape, Tack, B23-44	\$0.0134	1	27.3	cm	\$0.0134
■ Media: 	Clip, Zip Tie, B23-44	\$0.0800	1	1	Each	\$0.0800






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	Tape, Tack, B23-44	\$0.0134	1	27.3	cm	\$0.0134
 Media: 	Clip, Zip Tie, B23-44	\$0.0800	1	1	Each	\$0.0800
 Media: 	Tape, Tack, B23-44	\$0.0134	1	27.3	cm	\$0.0134
 Media: 	Clip, Zip Tie, B23-44	\$0.0800	1	1	Each	\$0.0800
 Media: 	Tape, Tack, B23-44	\$0.0134	1	27.3	cm	\$0.0134








Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Clip, Zip Tie, B23-44	\$0.0800	1	1	Each	\$0.0800
Media: 	Tape, Tack, B23-44	\$0.0134	1	27.3	cm	\$0.0134
Media: 	Clip, Zip Tie, B23-44	\$0.0800	1	1	Each	\$0.0800
Media: 	Tape, Std, B23-44	\$0.0506	1	154.1	cm	\$0.0506
Media: 	Heat Shrink, Adhesive Lined, B23-44	\$0.0169	1	4.9	cm	\$0.0169





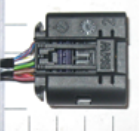
Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media: </p>	Tape, Tack, B23-44	\$0.0040	1	8.2	cm	\$0.0040
 <p>Media: </p>	C45	\$0.1200	1	1	Each	\$0.1200
 <p>Media: </p>	Tape, Std, C45	\$0.0028	1	8.5	cm	\$0.0028
 <p>Media: </p>	Tape, Std, B23-45	\$0.0498	1	152.0	cm	\$0.0498
 <p>Media: </p>	Tape, Tack, B23-45	\$0.0133	1	27.0	cm	\$0.0133

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack, B23-45	\$0.0133	1	27.0	cm	\$0.0133
Media: 	Tape, Tack, B23-45	\$0.0133	1	27.0	cm	\$0.0133
Media: 	Tube, Convolute, B23-45	\$0.1230	1	25	cm	\$0.1230
Media: 	Clip, Zip Tie, B23-45	\$0.0800	1	1	Each	\$0.0800
Media: 	C46	\$0.3400	1	1	Each	\$0.3400





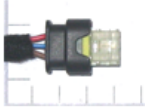
Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media:</p> 	C47	\$0.1200	1	1	Each	\$0.1200
 <p>Media:</p> 	Tape, Std, C46	\$0.0038	1	11.6	cm	\$0.0038
 <p>Media:</p> 	Tape, Std, C47	\$0.0032	1	9.9	cm	\$0.0032
 <p>Media:</p> 	Tape, Std, B46-47	\$0.0108	1	32.9	cm	\$0.0108
 <p>Media:</p> 	Tape, Tack, B46-47	\$0.0105	1	21.4	cm	\$0.0105

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack, B46-47	\$0.0105	1	21.4	cm	\$0.0105
Media: 	Tube, Convolute, B46-47	\$0.0537	1	18	cm	\$0.0537
Media: 	Heat Shrink, Adhesive Lined, B46-47	\$0.0172	1	5	cm	\$0.0172
Media: 	Heat Shrink, Adhesive Lined, B46-47	\$0.0172	1	5	cm	\$0.0172
Media: 	C48	\$0.1200	1	1	Each	\$0.1200


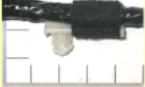



Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Std, C48	\$0.0194	1	59.3	cm	\$0.0194
Media: 						
Media: 	Tape, Tack, C48	\$0.0068	1	13.8	cm	\$0.0068
Media: 						
Media: 	Tape, Tack, C48	\$0.0068	1	13.8	cm	\$0.0068
Media: 						
Media: 	Tube, Convolute, C48	\$0.0260	1	12	cm	\$0.0260
Media: 						
Media: 	Tape, Std, B46-48	\$0.0044	1	13.4	cm	\$0.0044
Media: 						

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	Tape, Tack, B46-48	\$0.0065	1	13.2	cm	\$0.0065
						
■ Media:	Clip, Tape-on Rosebud or X-Tree Std, B46-48	\$0.0200	1	1	Each	\$0.0200
						
■ Media:	C49	\$0.1200	1	1	Each	\$0.1200
						
■ Media:	Tape, Std, C49	\$0.0194	1	59.3	cm	\$0.0194
						
■ Media:	Tape, Tack, B46-49	\$0.0068	1	13.8	cm	\$0.0068
						






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media: 	Clip, Tape-on Rosebud or X-Tree Std, B46-49	\$0.0200	1	1	Each	\$0.0200
■ Media: 	Tape, Tack, B46-49	\$0.0068	1	13.8	cm	\$0.0068
■ Media: 	Tape, Tack, B46-49	\$0.0068	1	13.8	cm	\$0.0068
■ Media: 	Clip, Tape-on X-Tree Mod, B46-49	\$0.0600	1	1	Each	\$0.0600
■ Media: 	Tape, Tack, B46-49	\$0.0068	1	13.8	cm	\$0.0068

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack, B46-49	\$0.0068	1	13.8	cm	\$0.0068
Media: 	Clip, Tape-on X-Tree Mod, B46-49	\$0.0600	1	1	Each	\$0.0600
Media: 	Tape, Tack, B46-49	\$0.0068	1	13.8	cm	\$0.0068
Media: 	Tape, Tack, B46-49	\$0.0068	1	13.8	cm	\$0.0068
Media: 	Clip, Tape-on X-Tree Mod, B46-49	\$0.0600	1	1	Each	\$0.0600






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack, B46-49	\$0.0111	1	22.6	cm	\$0.0111
Media: 	Tape, Tack, B46-49	\$0.0111	1	22.6	cm	\$0.0111
Media: 	Clip, Tape-on X-Tree Mod, B46-49	\$0.0600	1	1	Each	\$0.0600
Media: 	Tape, Tack, B46-49	\$0.0111	1	22.6	cm	\$0.0111
Media: 	Tape, Tack, B46-49	\$0.0111	1	22.6	cm	\$0.0111






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Tube, Convolute, B46-49	\$0.0567	1	19	cm	\$0.0567
Media:						
■	Tape, Std, B46-49	\$0.0553	1	168.5	cm	\$0.0553
Media:						
■	C50	\$0.1800	1	1	Each	\$0.1800
Media:						
■	C51	\$0.1800	1	1	Each	\$0.1800
Media:						
■	C52	\$0.1800	1	1	Each	\$0.1800
Media:						






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	C53	\$0.1800	1	1	Each	\$0.1800
						
■ Media:	Heat Shrink, Adhesive Lined, C60	\$0.0114	1	3.3	cm	\$0.0114
						
■ Media:	Heat Shrink, Adhesive Lined, C61	\$0.0114	1	3.3	cm	\$0.0114
						
■ Media:	Heat Shrink, Adhesive Lined, C62	\$0.0114	1	3.3	cm	\$0.0114
						
■ Media:	Heat Shrink, Adhesive Lined, C63	\$0.0114	1	3.3	cm	\$0.0114
						








Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	Tape, Std, B50-53	\$0.0079	1	24.0	cm	\$0.0079
						
■ Media:	Tape, Tack, B46-53	\$0.0068	1	13.8	cm	\$0.0068
						
■ Media:	Tape, Tack, B46-53	\$0.0068	1	13.8	cm	\$0.0068
						
■ Media:	Clip, Tape-on X-TreeMod, B46-53	\$0.0600	1	1	Each	\$0.0600
						
■ Media:	Tape, Tack, B46-53	\$0.0105	1	21.4	cm	\$0.0105
						











Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media: </p>	Tape, Tack, B46-53	\$0.0105	1	21.4	cm	\$0.0105
 <p>Media: </p>	Tube, Convolute, B46-53	\$0.0361	1	8.6	cm	\$0.0361
 <p>Media: </p>	Tape, Std, B46-53	\$0.0215	1	65.5	cm	\$0.0215
 <p>Media: </p>	Heat Shrink, Adhesive Lined, B46-53	\$0.0169	1	4.9	cm	\$0.0169
 <p>Media: </p>	Tape, Tack, B23-53	\$0.0111	1	22.6	cm	\$0.0111






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	Tape, Tack, B23-53	\$0.0111	1	22.6	cm	\$0.0111
 Media: 	Clip, Tape-on X-Tree Mod, B23-53	\$0.0600	1	1	Each	\$0.0600
 Media: 	Tape, Tack, B23-53	\$0.0111	1	22.6	cm	\$0.0111
 Media: 	Tape, Tack, B23-53	\$0.0111	1	22.6	cm	\$0.0111
 Media: 	Clip, Tape-on X-Tree Mod, B23-53	\$0.0600	1	1	Each	\$0.0600






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack, B23-53	\$0.0111	1	22.6	cm	\$0.0111
Media: 	Tape, Tack, B23-53	\$0.0111	1	22.6	cm	\$0.0111
Media: 	Clip, Tape-on X-Tree Mod, B23-53	\$0.0600	1	1	Each	\$0.0600
Media: 	Tape, Tack, B23-53	\$0.0111	1	22.6	cm	\$0.0111
Media: 	Tape, Tack, B23-53	\$0.0111	1	22.6	cm	\$0.0111










Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media: 	Clip, Tape-on X-Tree Mod, B23-53	\$0.0600	1	1	Each	\$0.0600
■ Media: 	Tape, Tack, B23-53	\$0.0111	1	22.6	cm	\$0.0111
■ Media: 	Tape, Tack, B23-53	\$0.0111	1	22.6	cm	\$0.0111
■ Media: 	Clip, Tape-on X-Tree Mod, B23-53	\$0.0600	1	1	Each	\$0.0600
■ Media: 	Tape, Tack, B23-53	\$0.0111	1	22.6	cm	\$0.0111





Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	Tape, Tack, B23-53	\$0.0111	1	22.6	cm	\$0.0111
 Media: 	Clip, Tape-on X-Tree Mod, B23-53	\$0.0600	1	1	Each	\$0.0600
 Media: 	Clip, Zip Tie, B23-53	\$0.0800	1	1	Each	\$0.0800
 Media: 	Tape, Std, B23-53	\$0.1210	1	369.0	cm	\$0.1210
 Media: 	C54	\$1.2500	1	1	Each	\$1.2500

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Self Closing Sleeve, C54	\$0.7219	1	39	cm	\$0.7219
Media:						
■	Tape, Tack, C54	\$0.0093	1	18.8	cm	\$0.0093
Media:						
■	Tape, Tack, C54	\$0.0093	1	18.8	cm	\$0.0093
Media:						
■	Clip, Tape-on, Edge Biter, Two Tabs, C54	\$0.0500	1	1	Each	\$0.0500
Media:						
■	Tape, Tack, C54	\$0.0124	1	25.1	cm	\$0.0124
Media:						






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack, C54	\$0.0124	1	25.1	cm	\$0.0124
Media: 	Clip, Tape-on, Edge Biter, Two Tabs, C54	\$0.0500	1	1	Each	\$0.0500
Media: 	Tape, Tack, C54	\$0.0124	1	25.1	cm	\$0.0124
Media: 	Tape, Tack, C54	\$0.0087	1	17.6	cm	\$0.0087
Media: 	Clip, Tape-on, Edge Biter, Two Tabs, C54	\$0.0500	1	1	Each	\$0.0500

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media: 	Tape, Tack, C54	\$0.0074	1	15.1	cm	\$0.0074
■ Media: 	Tape, Tack, C54	\$0.0074	1	15.1	cm	\$0.0074
■ Media: 	Tape, Std, C54	\$0.0255	1	77.7	cm	\$0.0255
■ Media: 	Tape, Std, C54	\$0.0040	1	12.2	cm	\$0.0040
■ Media: 	Tape, Std, C54	\$0.0073	1	22.1	cm	\$0.0073






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Heat Shrink, Adhesive Lined, B46-53	\$0.0179	1	5.2	cm	\$0.0179
Media: 	Molded Trough	\$0.3080	1	1	Each	\$0.3080
Media: 	Molded Trough Material	\$0.2500	1	1	Each	\$0.2500
Media: 	Tape, Tack, B23-54	\$0.0117	1	23.9	cm	\$0.0117
Media: 	Tape, Tack, B23-54	\$0.0117	1	23.9	cm	\$0.0117




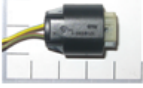

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media: 	Clip, Tape-on, Two Tabs, Main Trunk	\$0.1000	1	1	Each	\$0.1000
■ Media: 	Tape, Fabric B23-54	\$0.0820	1	166.7	cm	\$0.0820
■ Media: 	Tape, Std, B23-54	\$0.0364	1	110.9	cm	\$0.0364
■ Media: 	Heat Shrink, Adhesive Lined, B23-54	\$0.0169	1	4.9	cm	\$0.0169
■ Media: 	Heat Shrink, Adhesive Lined, B23-54	\$0.0169	1	4.9	cm	\$0.0169






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Heat Shrink, Adhesive Lined, E23-54	\$0.0169	1	4.9	cm	\$0.0169
Media: 	Heat Shrink, Adhesive Lined, E23-54	\$0.0169	1	4.9	cm	\$0.0169
Media: 	C55	\$0.1500	1	1	Each	\$0.1500
Media: 	C56	\$0.1500	1	1	Each	\$0.1500
Media: 	Tape, Tack, C65	\$0.0025	1	5.0	cm	\$0.0025







Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack, C56	\$0.0025	1	5.0	cm	\$0.0025
Media: 	Tape, Fabric B55-56	\$0.0067	1	13.6	cm	\$0.0067
Media: 	Tape, Tack, B55-56	\$0.0049	1	10.1	cm	\$0.0049
Media: 	Clip, Tape-on Rosebud or X-Tree Std, B46-49	\$0.0200	1	1	Each	\$0.0200
Media: 	C57	\$0.2000	1	1	Each	\$0.2000






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Fabric C57	\$0.0055	1	11.2	cm	\$0.0055
Media: 						
Media: 	Tape, Fabric B55-57	\$0.0088	1	17.9	cm	\$0.0088
Media: 						
Media: 	Tape, Tack, B55-57	\$0.0074	1	15.1	cm	\$0.0074
Media: 						
Media: 	Tape, Tack, B55-57	\$0.0033	1	10.1	cm	\$0.0033
Media: 						
Media: 	Tape, Std, B23-57	\$0.0232	1	70.7	cm	\$0.0232
Media: 						











Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media: 	C58	\$0.1800	1	1	Each	\$0.1800
■ Media: 	C59	\$0.1800	1	1	Each	\$0.1800
■ Media: 	Heat Shrink, Adhesive Lined, C58	\$0.0110	1	3.2	cm	\$0.0110
■ Media: 	Heat Shrink, Adhesive Lined, C59	\$0.0110	1	3.2	cm	\$0.0110
■ Media: 	Label, C58	\$0.0800	1	1	Each	\$0.0800






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	Tape, Tack, B58-59	\$0.0082	1	16.7	cm	\$0.0082
 Media: 	Tape, Tack, B58-59	\$0.0033	1	10.1	cm	\$0.0033
 Media: 	Tape, Std, B23-59	\$0.0716	1	218.4	cm	\$0.0716
 Media: 	Clip, Zip Tie, B23-59	\$0.0800	1	1	Each	\$0.0800
 Media: 	C60	\$0.1200	1	1	Each	\$0.1200




Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	C61	\$0.2100	1	1	Each	\$0.2100
Media:						
■	Tape, Tack, C60	\$0.0071	1	14.5	cm	\$0.0071
Media:						
■	Clip, Tape-on Rosebud or X-Tree Std, C60	\$0.0200	1	1	Each	\$0.0200
Media:						
■	Tape, Tack, C60	\$0.0065	1	13.2	cm	\$0.0065
Media:						
■	Tape, Tack, C60	\$0.0065	1	13.2	cm	\$0.0065
Media:						


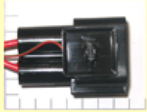



Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media:	Tube, Convolute, C60	\$0.0466	1	21.5	cm	\$0.0466
						
■ Media:	Tape, Std, C60	\$0.0089	1	27.2	cm	\$0.0089
						
■ Media:	Tape, Tack, C61	\$0.0049	1	10.1	cm	\$0.0049
						
■ Media:	Clip, Tape-on Rosebud or X-Tree Std, C61	\$0.0200	1	1	Each	\$0.0200
						
■ Media:	Tape, Std, C61	\$0.0053	1	16.2	cm	\$0.0053
						









Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Tape, Std, B60-61	\$0.0078	1	23.9	cm	\$0.0078
Media:						
■	C62	\$0.5400	1	1	Each	\$0.5400
Media:						
■	Tape, Std, C62	\$0.0067	1	20.3	cm	\$0.0067
Media:						
■	Tape, Fabric, B60-62	\$0.0101	1	20.5	cm	\$0.0101
Media:						
■	C63	\$0.2500	1	1	Each	\$0.2500
Media:						






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	Clip, Zip Tie, C63	\$0.0800	1	1	Each	\$0.0800
 Media: 	Tape, Std, C63	\$0.0199	1	60.6	cm	\$0.0199
 Media: 	Clip, Zip Tie, B60-63	\$0.0800	1	1	Each	\$0.0800
 Media: 	Tape, Std, B60-63	\$0.0219	1	66.8	cm	\$0.0219
 Media: 	Tape, Tack, B23-63	\$0.0148	1	30.2	cm	\$0.0148

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Self Closing Sleeve, B23-63	\$0.1315	1	5.5	cm	\$0.1315
Media: 	Tape, Tack, B23-63	\$0.0148	1	30.2	cm	\$0.0148
Media: 	Tape, Std, B23-63	\$0.0154	1	47.0	cm	\$0.0154
Media: 	C64	\$0.1200	1	1	Each	\$0.1200
Media: 	C65	\$0.2000	1	1	Each	\$0.2000






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Std, C64	\$0.0058	1	17.6	cm	\$0.0058
Media: 	SelfClosing Sleeve - B64-65	\$0.3466	1	14.5	cm	\$0.3466
Media: 	Tape, Tack, B64-65	\$0.0117	1	23.9	cm	\$0.0117
Media: 	Tape, Tack, B64-65	\$0.0117	1	23.9	cm	\$0.0117
Media: 	Tape, Tack, B64-65	\$0.0117	1	23.9	cm	\$0.0117

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Tape, Std, B64-66	\$0.0169	1	51.5	cm	\$0.0169
Media:						
■	Tape, Std, B64-66	\$0.0127	1	38.8	cm	\$0.0127
Media:						
■	Clip, Zip Tie, C63	\$0.0800	1	1	Each	\$0.0800
Media:						
■	C66	\$0.1500	1	1	Each	\$0.1500
Media:						
■	C67	\$0.1500	1	1	Each	\$0.1500
Media:						






Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Media: </p>	C68	\$0.1800	1	1	Each	\$0.1800
 <p>Media: </p>	Tape, Std, C66	\$0.0118	1	36.1	cm	\$0.0118
 <p>Media: </p>	Tube, Convolute, C66	\$0.0469	1	28	cm	\$0.0469
 <p>Media: </p>	Tape, Tack, C66	\$0.0054	1	11.1	cm	\$0.0054
 <p>Media: </p>	Tape, Tack, C66	\$0.0054	1	11.1	cm	\$0.0054

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Media: 	Tape, Tack, C66	\$0.0054	1	11.1	cm	\$0.0054
■ Media: 	Clip, Zip Tie, C66	\$0.0800	1	1	Each	\$0.0800
■ Media: 	Tape, Std, C67	\$0.0128	1	26.0	cm	\$0.0128
■ Media: 	Tape, Std, C68	\$0.0025	1	5.2	cm	\$0.0025
■ Media: 	Tape, Std, B66-68	\$0.0035	1	7.2	cm	\$0.0035


Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Media: 	C69	\$0.2200	1	1	Each	\$0.2200
 Media: 	Tape, Std, C69	\$0.0022	1	6.8	cm	\$0.0022
 Media: 	Tube, Convolute - B66-69	\$0.1304	1	56	cm	\$0.1304
 Media: 	Tape, Tack, B66-69	\$0.0080	1	16.3	cm	\$0.0080
 Media: 	Tape, Tack, B66-69	\$0.0080	1	16.3	cm	\$0.0080






Wire Harness Costed Bill of Materials


2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Media: 	Tape, Tack, B66-69	\$0.0080	1	16.3	cm	\$0.0080
Media: 	Tape, Tack, B66-69	\$0.0080	1	16.3	cm	\$0.0080
Media: 	Clip, Zip Tie, B66-69	\$0.0800	1	1	Each	\$0.0800
Media: 	Clip, Edge Biter, Zip Tie, B66-69	\$0.0700	1	1	Each	\$0.0700
Media: 	Tape, Std, B66-69	\$0.0324	1	98.8	cm	\$0.0324
	Wire 1.3 OD/7- 0.25 OD Strands	\$0.1221	118	219.6	cm	\$14.4136
	Wire 1.5 OD/16- 0.18 OD Strands	\$0.1658	54	257.6	cm	\$8.9549
	Wire 1.7 OD/24- 0.19 OD Strands	\$0.1621	4	158	cm	\$0.6485
	Wire 2.0 OD/32- 0.20 OD Strands	\$0.3643	3	244	cm	\$1.0928

Wire Harness Costed Bill of Materials

2232 - Driver Underbody Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
	Wire 2.2 OD/30- 0.25 OD Strands	\$0.3282	2	150	cm	\$0.6564
	Wire 2.75 OD/50- 0.25 OD Strands	\$1.4883	6	398	cm	\$8.9298
	Wire 3.4 OD/56- 0.30 OD Strands	\$0.8706	2	137	cm	\$1.7412
	Wire 4.0 OD/83- 0.3 OD Strands	\$1.2107	5	120	cm	\$6.0533
	Wire ALU 7.4 OD/84- 0.47 OD Strands	\$0.2861	2	111	cm	\$0.5722

Media: 

Wire Harness Costed Bill of Process



MUNRO
& ASSOCIATES, INC.

Assembly Process

2232 - Driver Underbody Wire Harness Asm

Symbol Name	Assembly Time	Q Burden	Assembly Cost	Qty	Q Burden (Total)	Assembly Cost (Total)
Wire Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Twisting Machine	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Twisting	11.4000 sec	\$0.00	\$0.05	18	\$0.00	\$0.99
Wire Twisting	25.6300 sec	\$0.00	\$0.12	2	\$0.00	\$0.25
Wire Twisting	20.6750 sec	\$0.00	\$0.10	2	\$0.00	\$0.20
Wire Cut & Strip Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire	4.0000 sec	\$0.00	\$0.02	196	\$0.27	\$3.77
Cut & Strip Wire	1.0000 sec	\$0.00	\$0.00	196	\$0.27	\$0.94
Wire Crimp Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Ends	2.0000 sec	\$0.00	\$0.01	324	\$0.45	\$3.12
Terminal, Contact	2.0000 sec	\$0.00	\$0.01	324	\$0.45	\$3.12
Crimp Terminal	1.0000 sec	\$0.00	\$0.00	324	\$0.45	\$1.56
Terminal, Contact	2.0000 sec	\$0.00	\$0.01	17	\$0.02	\$0.16
Heat Shrink	5.0000 sec	\$0.00	\$0.02	17	\$0.02	\$0.41
Heat Gun	4.0000 sec	\$0.00	\$0.02	1	\$0.00	\$0.02
Shrink Tube	5.0000 sec	\$0.00	\$0.02	17	\$0.01	\$0.41
Splice Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Place Wire Ends	3.0000 sec	\$0.00	\$0.01	68	\$0.10	\$0.98
Ultrasonic Splice	3.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Heat Shrink	5.0000 sec	\$0.00	\$0.02	21	\$0.03	\$0.51
Heat Gun	4.0000 sec	\$0.00	\$0.02	21	\$0.00	\$0.40
Shrink Tube	5.0000 sec	\$0.00	\$0.02	21	\$0.01	\$0.51
Wiring Board	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Grab Wire	4.0000 sec	\$0.00	\$0.02	196	\$0.27	\$3.77
Route Wire (avg length)	15.2280 sec	\$0.00	\$0.07	196	\$0.27	\$14.36
CDI	1.0000 sec	\$0.00	\$0.00	496	\$0.01	\$2.39
Connector	4.0000 sec	\$0.00	\$0.02	55	\$0.08	\$1.06
Insert Wire Contact (qty/connector)	4.0000 sec	\$0.00	\$0.02	307	\$0.43	\$5.91
Snap (qty/connector)	1.0000 sec	\$0.00	\$0.00	68	\$0.01	\$0.33
Test, Wire Harness	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Electrical Test Equipment	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Grasp & Position Connector	3.0000 sec	\$0.00	\$0.01	72	\$0.10	\$1.04
Mate Connectors to test equip	2.0000 sec	\$0.00	\$0.01	72	\$0.01	\$0.69
Test Harness	2.0000 sec	\$0.00	\$0.01	196	\$0.07	\$1.89
Coverings & Tape Winding	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00

Wire Harness Costed Bill of Process



MUNRO
& ASSOCIATES, INC.

2232 - Driver Underbody Wire Harness Asm

Symbol Name	Assembly Time	Q Burden	Assembly Cost	Qty	Q Burden (Total)	Assembly Cost (Total)
Label	8.0000 sec	\$0.00	\$0.04	1	\$0.00	\$0.04
Apply Label	800.0000 sec	\$0.01	\$3.85	1	\$0.01	\$3.85
Coverings	7.0000 sec	\$0.00	\$0.03	39	\$0.05	\$1.31
Part Manipulation	3.0000 sec	\$0.00	\$0.01	91	\$0.02	\$1.31
Trough, Molded	6.0000 sec	\$0.00	\$0.03	1	\$0.00	\$0.03
Cable & Wire Manipulation	3.0000 sec	\$0.00	\$0.01	5	\$0.00	\$0.07
Push Cable & Wire in Place	3.0000 sec	\$0.00	\$0.01	5	\$0.01	\$0.07
Snap Cable Clip	1.0000 sec	\$0.00	\$0.00	2	\$0.00	\$0.01
Clip, Tape on X-Tree 2 Tabs	6.0000 sec	\$0.00	\$0.03	27	\$0.04	\$0.78
Tape Tack	5.0000 sec	\$0.00	\$0.02	54	\$0.08	\$1.30
Manip Harness to Avoid X-Tree	9.0000 sec	\$0.00	\$0.04	27	\$0.04	\$1.17
Clip, Tape on X-Tree 1 Tab	4.0000 sec	\$0.00	\$0.02	12	\$0.02	\$0.23
Tape Tack	5.0000 sec	\$0.00	\$0.02	12	\$0.02	\$0.29
Manip Harness to Avoid X-Tree	9.0000 sec	\$0.00	\$0.04	12	\$0.02	\$0.52
Clip, Zip Tie	7.0000 sec	\$0.00	\$0.03	30	\$0.04	\$1.01
Zip Tool	3.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Zip Tie, Pull Tight & Trim	2.0000 sec	\$0.00	\$0.01	30	\$0.01	\$0.29
Tape Tack	5.0000 sec	\$0.00	\$0.02	122	\$0.17	\$2.93
Tape Wind Branches & Figtails	1061.5000 sec	\$0.00	\$5.11	1	\$0.00	\$5.11
Route Branch Thru Wind Head	4.0000 sec	\$0.00	\$0.02	69	\$0.10	\$1.33
Report Totals						
	Count: 55					
				3,779	\$3.99	\$70.45

***[Click Here to Return to
Cost Analysis Page 297](#)***

Wire Harness Cost Analysis

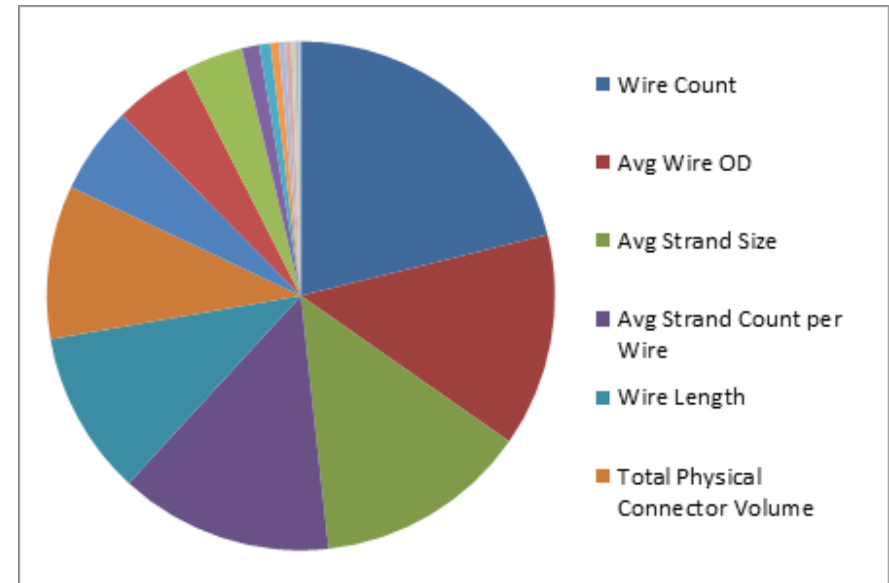
Positive Battery Cable Wire

Harness Asm Wire Harness

- The Design Profit[®] based Wire Harness Coster generates cost estimates of various components and assembly processes for the majority of wire harnesses found in today's manufactured products. The Wire Harness Coster rolls up these costs to deliver an estimate of the total manufactured cost.
- Costs are based on several factors including: commodity items, components, burdened machine rates, processing speeds, burdened labor rates, and cost of poor quality drivers.
- The Wire Harness Coster consistently generates a cost estimate for a given wire harness without the need to completely disassemble or destroy the wire harness. Minimal disassembly may be required to capture various attributes and identify overall circuit routing. Inputs to the coster include: connector data (size, cavity count, locking mechanisms and sealing attributes), wire data (sizes quantities and lengths), coverings (type, size and length), fasteners, brackets, troughs, etc.
- The Wire Harness Coster separates the parts and processes to more easily delineate Bill of Material (BOM) costs and build processing costs.

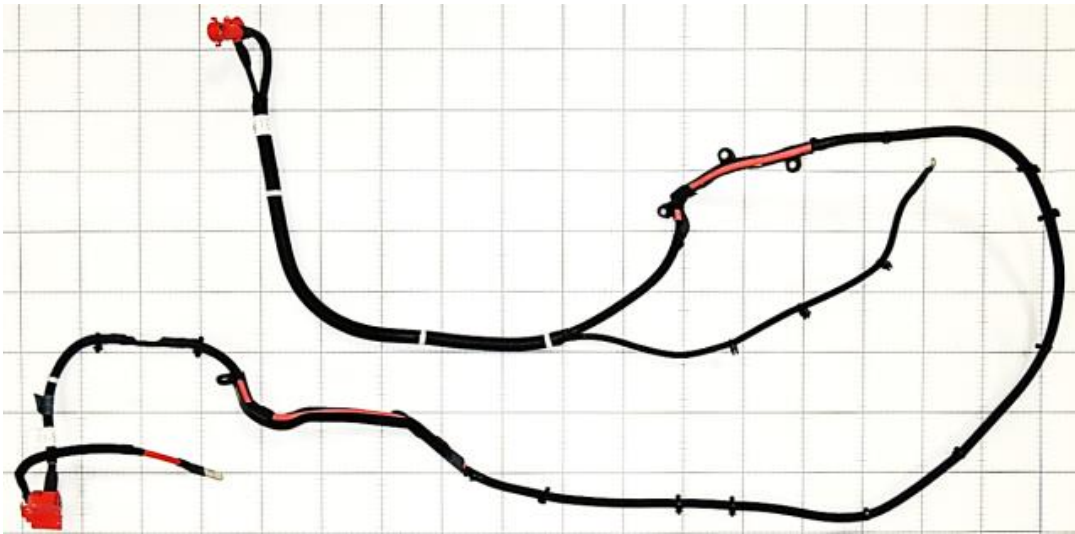
Factors Influencing Cost:

1. Wire count is the primary factor driving cost as it affects the amount of wire, the size of connectors, and the number of assembly processes.
2. Wire selection (wire OD, strand size, strand count / wire) is significant as it directly relates to conductor cross section, and therefore the amount of copper or aluminum used in the harness.
3. Wire length is another major cost factor as it both relates to material cost and to assembly time, as longer lengths require more handling.
4. The total physical connector size is a major cost factor as connectors are a large portion of harness part costs. Total physical connector size also tends to drive assembly costs.



Relative influence of factors on harness costs
(Data based on L32 two-level Taguchi analysis
of the Wire Harness Coster)

Positive Battery Cable Wire Harness Asm



The Positive Battery Cable Wire Harness Asm consists of 4 Cables joining a positive battery terminal with three ring terminals. The positive battery cable features a disconnect safety device which is tied to the supplemental restraints

The cables consist of a 10.3 mm copper stranded cable and two aluminum stranded cables; one is 7.4 mm and the second is 10.5 mm in diameter. The overall weight of the harness is 1.6020 kg.

Both eyelet and battery terminal are crimped and soldered.

The harness is completely covered with convolute, troughs, tape and heat shrink tubing.

All major components are analyzed in detail, while prices are applied to commodity items (i.e. clips, terminals).

Estimates are based on actual parts.

Photos: Background on 100mm grid paper.

Design Profit[®]

EXECUTIVE SUMMARY Harness Overview

2233 - Positive Battery Cable Wire Harness Asm	
Parts	72
Steps	209
Assembly Time (min)	20.28
Total Weight (kg)	1.6020
Purchased Part Cost	\$22.11
Supplier Asm. Cost	\$5.86
Q Burden	\$0.24
Total Cost	\$28.20

Design Profit[®]

EXECUTIVE SUMMARY Wire, Cable & Splices

	2233 - Positive Battery Cable Wire Harness Asm
Wire & Cable Count	4
Splice Count	1
Wire Length Total (cm)	623.0
Harness Total Weight	1.6020 kg
Cu Conductor Mass	0.2837 kg
Cu to Harness Mass (%)	17.71 %
Al Conductor Mass	0.4315 kg
Al to Harness Mass (%)	26.93 %
Wire Cost	\$6.33

Design Profit[®]

EXECUTIVE SUMMARY Connectors & Terminals

	2233 - Positive Battery Cable Wire Harness Asm
Connector Assemblies	1
Sealed Connectors	0
Terminal Cavities	0
Unpopulated Cavities	0
Connector Body Cost	\$0.30
Coax Connectors	0
Coax Connector Cost	\$0.00
Pin & Blade Terminals	0
Ring Terminals	6
Battery Terminals	1
Terminal Strips	0
Total Terminal Count	7
Terminal Cost	\$6.70

Design Profit[®]

EXECUTIVE SUMMARY Labels, Clips, Tape & Coverings

2233 - Positive Battery Cable Wire Harness Asm	
Label Count	4
Label Area cm2	128.0
Label Cost	\$0.32
Clip Count	14
Clip Cost	\$0.65
Tape Tacks	5
Taped Length cm	46.0
Tape Actual Length cm	424.6
Tape Cost	\$0.17
Tube & Wrap Count	7
Heat Shrink Count	7
Covering Count Total	14
Covering Length cm	476.0
Covering Cost	\$1.68



Design Profit®

EXECUTIVE SUMMARY Miscellaneous Parts

	2233 - Positive Battery Cable Wire Harness Asm
Bracket Count	0
Bracket Cost	\$0.00
Trough Count	2
Trough Cost	\$0.46
Fuse Count	0
Fuse Cost	\$0.00
Grommet Count	0
Grommet Cost	\$0.00
Misc Part Count	12
Misc Part Cost	\$0.28

Wire Harness Costed Bill of Materials

Harness CBOM

2233 - Positive Battery Cable Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Main Harness	\$22.1114	1	1	Each	\$22.1114

Media:



■	C01	\$1.1000	1	1	Each	\$1.1000
---	-----	----------	---	---	------	----------

Media:



■	Heat Shrink - C01	\$0.0358	1	5.2	cm	\$0.0358
---	-------------------	----------	---	-----	----	----------

Media:



■	Tube, Convolute	\$0.0669	1	22.4	cm	\$0.0669
---	-----------------	----------	---	------	----	----------

Media:



■	Tape, Std	\$0.0091	1	18.4	cm	\$0.0091
---	-----------	----------	---	------	----	----------

Media:





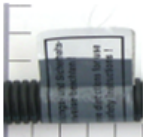


Wire Harness Costed Bill of Materials

2233 - Positive Battery Cable Wire Harness Asm

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 C02 Media: 	\$2.2000	1	1	Each	\$2.2000
 Heat Shrink C02a Media: 	\$0.0379	1	5.5	cm	\$0.0379
 Heat Shrink C02b Media: 	\$0.0331	1	4.8	cm	\$0.0331
 Connector, Battery Safety Terminal Media: 	\$3.8400	1	1	Each	\$3.8400
 Tube, Convolute Media: 	\$0.0731	1	24.5	cm	\$0.0731




Wire Harness Costed Bill of Materials

2233 - Positive Battery Cable Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Tape, Tack	\$0.0096	1	19.5	cm	\$0.0096
Media:						
■	Label	\$0.0800	1	1	Each	\$0.0800
Media:						
■	Label	\$0.0800	1	1	Each	\$0.0800
Media:						
■	Double Ended Splice Terminal	\$1.9800	1	1	Each	\$1.9800
Media:						
■	Non-Drying Butyl	\$0.0300	3	1	Each	\$0.0900
Media:						






Wire Harness Costed Bill of Materials

2233 - Positive Battery Cable Wire Harness Asm

	Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■	Heat Shrink - Splice	\$0.0865	1	17	cm	\$0.0865
Media:						
■	Tape, Std - Splice 01	\$0.0121	1	37.0	cm	\$0.0121
Media:						
■	Tape, Std - Splice 02	\$0.0142	1	43.2	cm	\$0.0142
Media:						
■	Tape, Std - Splice 03	\$0.0094	1	19.0	cm	\$0.0094
Media:						
■	Clip, Zip Tie	\$0.0400	1	1	Each	\$0.0400
Media:						






Wire Harness Costed Bill of Materials

2233 - Positive Battery Cable Wire Harness Asm

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
<input type="checkbox"/> Tube, Convolute Media: 	\$0.0370	1	12.4	cm	\$0.0370
<input type="checkbox"/> Clip, Zip Tie Media: 	\$0.0400	1	1	Each	\$0.0400
<input type="checkbox"/> Molded Trough 01 Media: 	\$0.2382	1	1	Each	\$0.2382
<input type="checkbox"/> Molded Trough 02 Material Media: 	\$0.0100	1	1	Each	\$0.0100
<input type="checkbox"/> Molded Trough 01AMaterial Media: 	\$0.1300	1	1	Each	\$0.1300











Wire Harness Costed Bill of Materials

2233 - Positive Battery Cable Wire Harness Asm

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Zip Tie</p>	\$0.0100	2	1	Each	\$0.0200
 <p>Tape, Std - MT01</p>	\$0.0060	1	18.2	cm	\$0.0060
 <p>Tube, Convolute</p>	\$0.5225	1	175	cm	\$0.5225
 <p>Clip, Zip Tie</p>	\$0.0400	9	1	Each	\$0.3600
 <p>Tape, Std - MT02</p>	\$0.0072	1	22.0	cm	\$0.0072


Wire Harness Costed Bill of Materials

2233 - Positive Battery Cable Wire Harness Asm

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Molded Trough 02 Media: 	\$0.2257	1	1	Each	\$0.2257
 Brass Insert, Bracket Media: 	\$0.0300	3	1	Each	\$0.0900
 Molded Trough 02 Material Media: 	\$0.0800	1	1	Each	\$0.0800
 Zip Tie Media: 	\$0.0100	2	1	Each	\$0.0200
 Tape, Std - MT02.1 Media: 	\$0.0098	1	29.8	cm	\$0.0098











Wire Harness Costed Bill of Materials

2233 - Positive Battery Cable Wire Harness Asm

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Tape, Std - MT02.2 Media: 	\$0.0139	1	42.3	cm	\$0.0139
 Tube, Convolute Media: 	\$0.0761	1	25.5	cm	\$0.0761
 Tape, Tack Media: 	\$0.0096	1	19.5	cm	\$0.0096
 C03 Media: 	\$0.6500	1	1	Each	\$0.6500
 Heat Shrink Media: 	\$0.0255	1	3.7	cm	\$0.0255


Wire Harness Costed Bill of Materials

2233 - Positive Battery Cable Wire Harness Asm

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Tube, Convolute Media: 	\$0.1712	1	73.5	cm	\$0.1712
 Tape, Std Media: 	\$0.0058	1	17.6	cm	\$0.0058
 Clip, Edge Biter, Zip Tie Media: 	\$0.0700	3	1	Each	\$0.2100
 Label Media: 	\$0.0800	1	1	Each	\$0.0800
 C04 Media: 	\$2.5000	1	1	Each	\$2.5000






Wire Harness Costed Bill of Materials

2233 - Positive Battery Cable Wire Harness Asm

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Non-Drying Butyl Media: 	\$0.0300	2	1	Each	\$0.0600
■ Heat Shrink Media: 	\$0.0328	1	10	cm	\$0.0328
■ Heat Shrink Media: 	\$0.0890	1	17.5	cm	\$0.0890
■ Tube, Convolute Media: 	\$0.3888	1	79	cm	\$0.3888
■ Tape, Std Media: 	\$0.0144	1	43.9	cm	\$0.0144

Wire Harness Costed Bill of Materials

2233 - Positive Battery Cable Wire Harness Asm

	Name	Purchased Part			Unit of Measure	Purchased Part Cost (Total)
		Cost	Item Qty	Measure		
■	Tape, Tack	\$0.0155	3	31.4	cm	\$0.0464
Media:						
■	Label	\$0.0800	1	1	Each	\$0.0800
Media:						
■	Wire 10.3 OD/272- 0.40 OD Strands	\$2.0134	2	37.5	cm	\$4.0269
Media:						
■	Wire ALU 7.4 OD/84- 0.47 OD Strands	\$0.4227	1	164	cm	\$0.4227
Media:						
■	Wire ALU 10.5 OD/204- 0.47 OD Strands	\$1.8771	1	384	cm	\$1.8771
Media:						

Wire Harness Costed Bill of Process



Assembly Process

2233 - Positive Battery Cable Wire Harness Asm

Symbol Name	Assembly Time	Q Burden	Assembly Cost	Qty	Q Burden (Total)	Assembly Cost (Total)
Wire Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Cut & Strip Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire	4.0000 sec	\$0.00	\$0.02	4	\$0.01	\$0.08
Cut & Strip Wire	1.0000 sec	\$0.00	\$0.00	4	\$0.01	\$0.02
Wire Crimp Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Ends	2.0000 sec	\$0.00	\$0.01	5	\$0.01	\$0.05
Terminal, Contact	2.0000 sec	\$0.00	\$0.01	5	\$0.01	\$0.05
Crimp Terminal	1.0000 sec	\$0.00	\$0.00	5	\$0.01	\$0.02
Place wire ends	3.0000 sec	\$0.00	\$0.01	3	\$0.00	\$0.04
Eyelets or Ring Terminals	3.0000 sec	\$0.00	\$0.01	3	\$0.00	\$0.04
Part Manipulation	3.0000 sec	\$0.00	\$0.01	3	\$0.01	\$0.04
Ultrasonic Weld Machine	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Ultrasonic Weld	3.0000 sec	\$0.00	\$0.01	3	\$0.01	\$0.04
Part Manipulation	3.0000 sec	\$0.00	\$0.01	3	\$0.01	\$0.04
Wiring Board	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Grab Wire	4.0000 sec	\$0.00	\$0.02	4	\$0.01	\$0.08
Route Wire (avg length)	9.3450 sec	\$0.00	\$0.04	4	\$0.01	\$0.18
Insert Wire Contact (qty/connector)	4.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.04
Manual Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Contact	4.0000 sec	\$0.00	\$0.02	5	\$0.01	\$0.10
Adhesive Gun	3.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Apply Adhesive	5.0000 sec	\$0.00	\$0.02	5	\$0.01	\$0.12
Test, Wire Harness	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Electrical Test Equipment	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Grasp & Position Connector	3.0000 sec	\$0.00	\$0.01	4	\$0.01	\$0.06
Mate Connectors to test equip	2.0000 sec	\$0.00	\$0.01	4	\$0.00	\$0.04
Test Harness	2.0000 sec	\$0.00	\$0.01	4	\$0.00	\$0.04
Coverings & Tape Winding	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Label	8.0000 sec	\$0.00	\$0.04	4	\$0.01	\$0.15
Apply Label	32.0000 sec	\$0.01	\$0.15	1	\$0.01	\$0.15
Heat Shrink	5.0000 sec	\$0.00	\$0.02	7	\$0.01	\$0.17
Heat Gun	4.0000 sec	\$0.00	\$0.02	1	\$0.00	\$0.02
Shrink Tube	5.0000 sec	\$0.00	\$0.02	7	\$0.00	\$0.17
Coverings	7.0000 sec	\$0.00	\$0.03	7	\$0.01	\$0.24
Part Manipulation	3.0000 sec	\$0.00	\$0.01	48	\$0.01	\$0.69

Wire Harness Costed Bill of Process



2233 - Positive Battery Cable Wire Harness Asm						
Symbol Name	Assembly Time	Q Burden	Assembly Cost	Qty	Q Burden (Total)	Assembly Cost (Total)
Trough, Molded	6.0000 sec	\$0.00	\$0.03	2	\$0.01	\$0.06
Cable & Wire Manipulation	3.0000 sec	\$0.00	\$0.01	6	\$0.00	\$0.09
Push Cable & Wire in Place	3.0000 sec	\$0.00	\$0.01	6	\$0.03	\$0.09
Clip, Zip Tie	7.0000 sec	\$0.00	\$0.03	4	\$0.01	\$0.13
Zip Tool	3.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Zip Tie, Pull Tight & Trim	2.0000 sec	\$0.00	\$0.01	4	\$0.00	\$0.04
Snap Cable Clip	1.0000 sec	\$0.00	\$0.00	2	\$0.00	\$0.01
Clip, Zip Tie	7.0000 sec	\$0.00	\$0.03	13	\$0.02	\$0.44
Zip Tool	3.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Zip Tie, Pull Tight & Trim	2.0000 sec	\$0.00	\$0.01	13	\$0.00	\$0.13
Tape Tack	5.0000 sec	\$0.00	\$0.02	5	\$0.01	\$0.12
Tape Wind Branches & Pigtails	424.6000 sec	\$0.00	\$2.04	1	\$0.00	\$2.04
Report Totals	Count: 47			213	\$0.24	\$5.86

***[Click Here to Return to
Cost Analysis Page 325](#)***

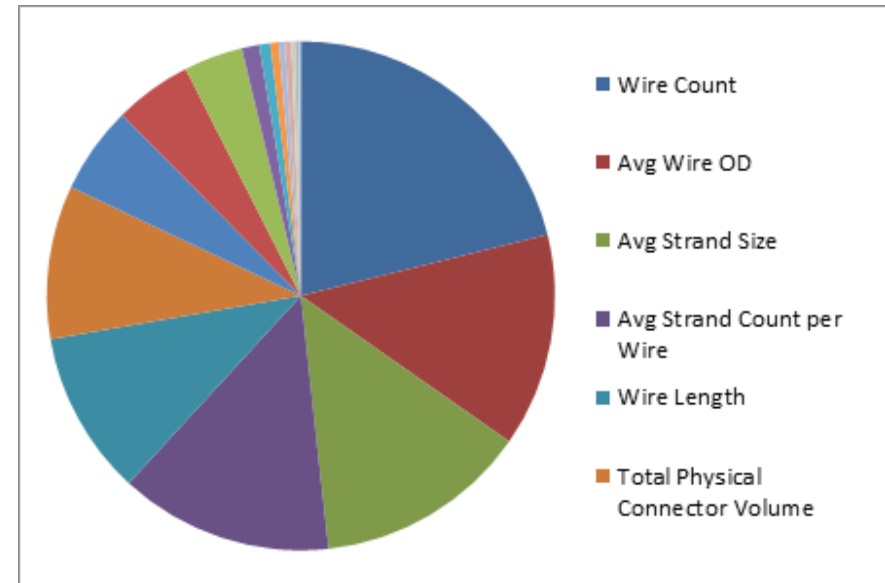
Wire Harness Cost Analysis

Negative Battery Cable Asm Wire Harness

- The Design Profit[®] based Wire Harness Coster generates cost estimates of various components and assembly processes for the majority of wire harnesses found in today's manufactured products. The Wire Harness Coster rolls up these costs to deliver an estimate of the total manufactured cost.
- Costs are based on several factors including: commodity items, components, burdened machine rates, processing speeds, burdened labor rates, and cost of poor quality drivers.
- The Wire Harness Coster consistently generates a cost estimate for a given wire harness without the need to completely disassemble or destroy the wire harness. Minimal disassembly may be required to capture various attributes and identify overall circuit routing. Inputs to the coster include: connector data (size, cavity count, locking mechanisms and sealing attributes), wire data (sizes quantities and lengths), coverings (type, size and length), fasteners, brackets, troughs, etc.
- The Wire Harness Coster separates the parts and processes to more easily delineate Bill of Material (BOM) costs and build processing costs.

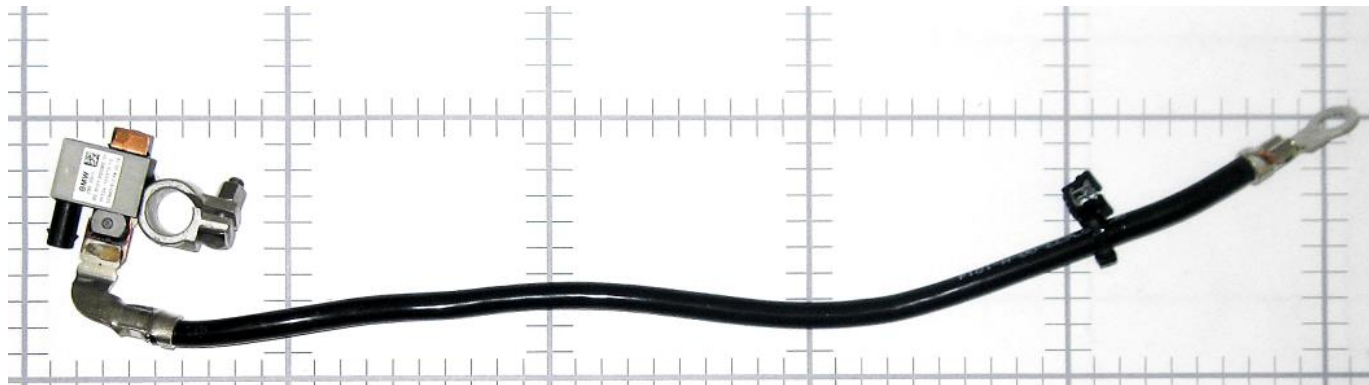
Factors Influencing Cost:

1. Wire count is the primary factor driving cost as it affects the amount of wire, the size of connectors, and the number of assembly processes.
2. Wire selection (wire OD, strand size, strand count / wire) is significant as it directly relates to conductor cross section, and therefore the amount of copper or aluminum used in the harness.
3. Wire length is another major cost factor as it both relates to material cost and to assembly time, as longer lengths require more handling.
4. The total physical connector size is a major cost factor as connectors are a large portion of harness part costs. Total physical connector size also tends to drive assembly costs.



Relative influence of factors on harness costs
(Data based on L32 two-level Taguchi analysis
of the Wire Harness Coster)

Negative Battery Cable Asm



The Negative Battery Cable Asm consists of 1 cable joining an eyelet and negative battery terminal. The battery terminal has an integrated current sensor.

The Cable is 10.3 mm in diameter and has 272 twisted copper strands. The overall weight of the harness is 0.3040 kg.

Both eyelet and battery terminal are crimped and soldered.

The harness has no coverings or heat shrink.

All major components are analyzed in detail, while prices are applied to commodity items (i.e. clips, terminals).

Estimates are based on actual parts.

Photos: Background on 100mm grid paper.

Design Profit[®]

EXECUTIVE SUMMARY Harness Overview

	2238 - Negative Battery Cable Asm
Parts	5
Steps	28
Assembly Time (min)	1.48
Total Weight (kg)	0.3040
Purchased Part Cost	\$10.27
Supplier Asm. Cost	\$0.43
Q Burden	\$0.03
Total Cost	\$10.73

Design Profit[®]

EXECUTIVE SUMMARY Wire, Cable & Splices

	2238 - Negative Battery Cable Asm
Wire & Cable Count	1
Splice Count	0
Wire Length Total (cm)	45.0
Harness Total Weight	0.3040 kg
Cu Conductor Mass	0.1702 kg
Cu to Harness Mass (%)	56.00 %
Al Conductor Mass	0.0000 kg
Al to Harness Mass (%)	0.00 %
Wire Cost	\$2.42

Design Profit[®]

EXECUTIVE SUMMARY Connectors & Terminals

	2238 - Negative Battery Cable Asm
Connector Assemblies	0
Sealed Connectors	0
Terminal Cavities	0
Unpopulated Cavities	0
Connector Body Cost	\$0.00
Coax Connectors	0
Coax Connector Cost	\$0.00
Pin & Blade Terminals	0
Ring Terminals	2
Battery Terminals	0
Terminal Strips	0
Total Terminal Count	2
Terminal Cost	\$2.20

Design Profit[®]

EXECUTIVE SUMMARY Labels, Clips, Tape & Coverings

2238 - Negative Battery Cable Asm	
Label Count	0
Label Area cm2	0.0
Label Cost	\$0.00
Clip Count	1
Clip Cost	\$0.07
Tape Tacks	0
Taped Length cm	0.0
Tape Actual Length cm	0.0
Tape Cost	\$0.00
Tube & Wrap Count	0
Heat Shrink Count	0
Covering Count Total	0
Covering Length cm	0.0
Covering Cost	\$0.00

Design Profit[®]

EXECUTIVE SUMMARY Miscellaneous Parts

	2238 - Negative Battery Cable Asm
Bracket Count	0
Bracket Cost	\$0.00
Trough Count	0
Trough Cost	\$0.00
Fuse Count	0
Fuse Cost	\$0.00
Grommet Count	0
Grommet Cost	\$0.00
Misc Part Count	1
Misc Part Cost	\$5.58

Wire Harness Costed Bill of Materials

Harness CBOM

2238 - Negative Battery Cable Asm

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Main Harness	\$10.2696	1	1	Each	\$10.2696

Media:



■ C01	\$1.1000	1	1	Each	\$1.1000
-------	----------	---	---	------	----------

Media:



■ C02	\$1.1000	1	1	Each	\$1.1000
-------	----------	---	---	------	----------

Media:



■ Negative Terminal w/Current Sensor	\$5.5800	1	1	Each	\$5.5800
--------------------------------------	----------	---	---	------	----------

Media:





■ Clip, Edge Biter, Zip Tie	\$0.0700	1	1	Each	\$0.0700
-----------------------------	----------	---	---	------	----------

Media:



Wire Harness Costed Bill of Materials

2238 - Negative Battery Cable Asm

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Wire 10.3 OD/272- 0.40 OD Strands	\$2.4161	1	45	cm	\$2.4161
Media: 					

Wire Harness Costed Bill of Process



MUNRO
& ASSOCIATES, INC.

Assembly Process

2238 - Negative Battery Cable Asm

Symbol Name	Assembly Time	Q Burden	Assembly Cost	Qty	Q Burden (Total)	Assembly Cost (Total)
Wire Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Cut & Strip Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire	4.0000 sec	\$0.00	\$0.02	1	\$0.00	\$0.02
Cut & Strip Wire	1.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Crimp Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Ends	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Terminal, Contact	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Crimp Terminal	1.0000 sec	\$0.00	\$0.00	2	\$0.00	\$0.01
Manual Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Contact (qty/connector)	4.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.04
Soldering Iron	3.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Solder Joint	5.0000 sec	\$0.00	\$0.02	2	\$0.01	\$0.05
Negative Terminal Material	6.0000 sec	\$0.00	\$0.03	1	\$0.00	\$0.03
C02	6.0000 sec	\$0.00	\$0.03	1	\$0.00	\$0.03
Brazing Torch	6.0000 sec	\$0.00	\$0.03	1	\$0.00	\$0.03
Brazing	3.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Test, Wire Harness	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Electrical Test Equipment	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Grasp & Position Connector	3.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.03
Mate Connectors to test equip	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Test Harness & Sensor	10.0000 sec	\$0.00	\$0.05	1	\$0.00	\$0.05
Coverings & Tape Winding	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Clip, Zip Tie	7.0000 sec	\$0.00	\$0.03	1	\$0.00	\$0.03
Zip Tool	3.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Zip Tie, Pull Tight & Trim	2.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01

Report Totals

Count: 25

32

\$0.03

\$0.43

**[Click Here to Return to
Cost Analysis Page 327](#)**

Wire Harness Cost Analysis

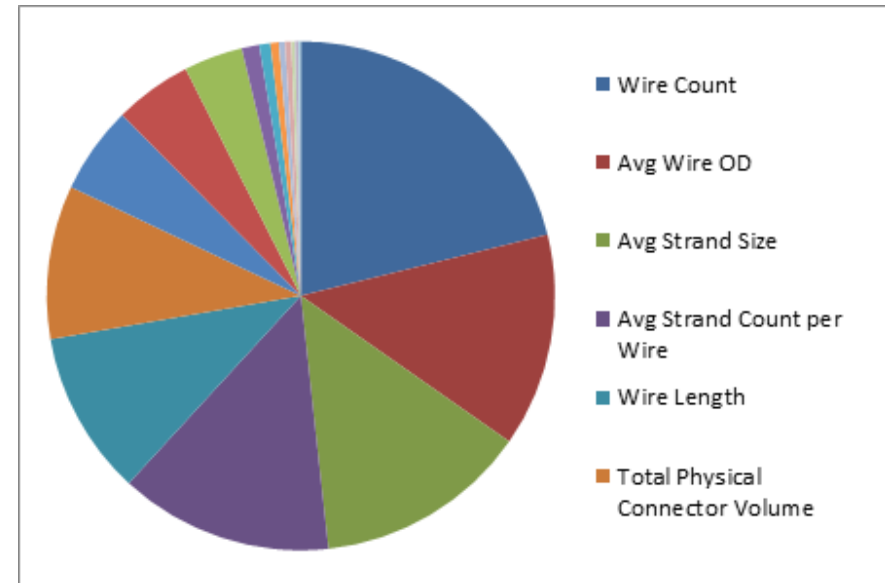
Ground, Chassis to Power Module

Asm Wire Harness

- The Design Profit[®] based Wire Harness Coster generates cost estimates of various components and assembly processes for the majority of wire harnesses found in today's manufactured products. The Wire Harness Coster rolls up these costs to deliver an estimate of the total manufactured cost.
- Costs are based on several factors including: commodity items, components, burdened machine rates, processing speeds, burdened labor rates, and cost of poor quality drivers.
- The Wire Harness Coster consistently generates a cost estimate for a given wire harness without the need to completely disassemble or destroy the wire harness. Minimal disassembly may be required to capture various attributes and identify overall circuit routing. Inputs to the coster include: connector data (size, cavity count, locking mechanisms and sealing attributes), wire data (sizes quantities and lengths), coverings (type, size and length), fasteners, brackets, troughs, etc.
- The Wire Harness Coster separates the parts and processes to more easily delineate Bill of Material (BOM) costs and build processing costs.

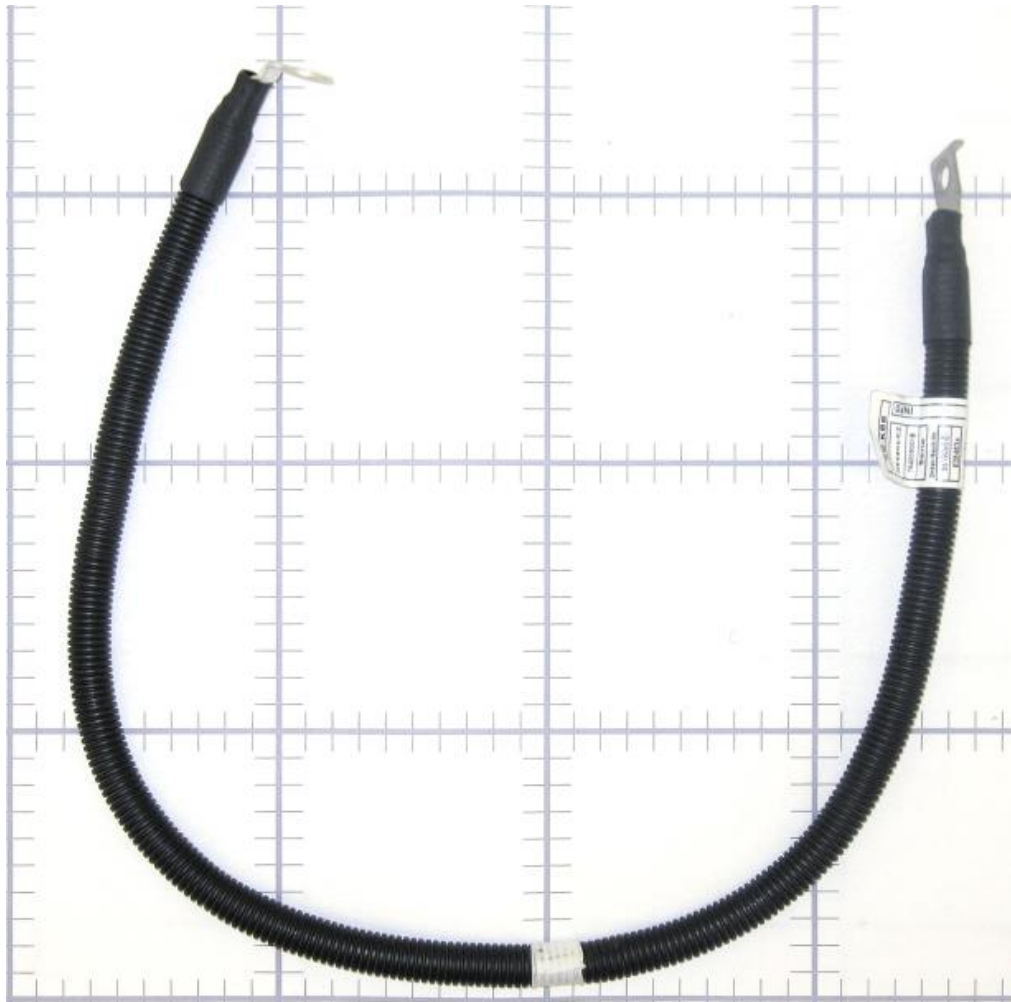
Factors Influencing Cost:

1. Wire count is the primary factor driving cost as it affects the amount of wire, the size of connectors, and the number of assembly processes.
2. Wire selection (wire OD, strand size, strand count / wire) is significant as it directly relates to conductor cross section, and therefore the amount of copper or aluminum used in the harness.
3. Wire length is another major cost factor as it both relates to material cost and to assembly time, as longer lengths require more handling.
4. The total physical connector size is a major cost factor as connectors are a large portion of harness part costs. Total physical connector size also tends to drive assembly costs.



Relative influence of factors on harness costs
(Data based on L32 two-level Taguchi analysis
of the Wire Harness Coster)

Ground, Chassis to Power Module Asm



The Ground, Chassis to Power Module Asm consists of 1 cable joining 2 eyelets.

The Cable is 10.5 mm in diameter and has 276 twisted copper strands. The overall weight of the harness is 0.3396 kg.

Both eyelets are crimped and soldered.

The harness is fully covered in convoluted tube with heat shrink coverings on both ends. One label is attached.

All major components are analyzed in detail, while prices are applied to commodity items (i.e. clips, terminals).

Estimates are based on actual parts.

Photos: Background on 100mm grid paper.

Design Profit[®]

EXECUTIVE SUMMARY Harness Overview

	b0230 - Ground, Chassis to Power Module Asm
Parts	8
Steps	40
Assembly Time (min)	2.44
Total Weight (kg)	0.3396
Purchased Part Cost	\$6.17
Supplier Asm. Cost	\$0.70
Q Burden	\$0.04
Total Cost	\$6.91

Design Profit[®]

EXECUTIVE SUMMARY Wire, Cable & Splices

	b0230 - Ground, Chassis to Power Module Asm
Wire & Cable Count	1
Splice Count	0
Wire Length Total (cm)	84.0
Harness Total Weight	0.3396 kg
Cu Conductor Mass	0.2612 kg
Cu to Harness Mass (%)	76.91 %
Al Conductor Mass	0.0000 kg
Al to Harness Mass (%)	0.00 %
Wire Cost	\$3.59

Design Profit[®]

EXECUTIVE SUMMARY Connectors & Terminals

	b0230 - Ground, Chassis to Power Module Asm
Connector Assemblies	0
Sealed Connectors	0
Terminal Cavities	0
Unpopulated Cavities	0
Connector Body Cost	\$0.00
Coax Connectors	0
Coax Connector Cost	\$0.00
Pin & Blade Terminals	0
Ring Terminals	2
Battery Terminals	0
Terminal Strips	0
Total Terminal Count	2
Terminal Cost	\$2.20

Design Profit[®]

EXECUTIVE SUMMARY Labels, Clips, Tape & Coverings

b0230 - Ground, Chassis to Power Module Asm	
Label Count	1
Label Area cm2	32.0
Label Cost	\$0.08
Clip Count	0
Clip Cost	\$0.00
Tape Tacks	1
Taped Length cm	0.0
Tape Actual Length cm	19.1
Tape Cost	\$0.01
Tube & Wrap Count	1
Heat Shrink Count	2
Covering Count Total	3
Covering Length cm	88.6
Covering Cost	\$0.28

Design Profit[®]






EXECUTIVE SUMMARY Miscellaneous Parts

	b0230 - Ground, Chassis to Power Module Asm
Bracket Count	0
Bracket Cost	\$0.00
Trough Count	0
Trough Cost	\$0.00
Fuse Count	0
Fuse Cost	\$0.00
Grommet Count	0
Grommet Cost	\$0.00
Misc Part Count	0
Misc Part Cost	\$0.00

Wire Harness Costed Bill of Materials




Harness CBOM

b0230 - Ground, Chassis to Power Module Asm

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
<input type="checkbox"/> Main Harness Media: 	\$6.1692	1	1	Each	\$6.1692
<input type="checkbox"/> C01 Media: 	\$1.1000	1	1	Each	\$1.1000
<input type="checkbox"/> C02 Media: 	\$1.1000	1	1	Each	\$1.1000
<input type="checkbox"/> Tube, Convolute Media: 	\$0.2359	1	79	cm	\$0.2359
<input type="checkbox"/> Heat Shrink Media: 	\$0.0244	1	4.8	cm	\$0.0244

Wire Harness Costed Bill of Materials

b0230 - Ground, Chassis to Power Module Asm

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
<div style="display: flex; align-items: flex-start;"> <div style="margin-right: 10px;">■</div> <div>Heat Shrink</div> </div> <div style="margin-top: 5px;">Media: </div>	\$0.0244	1	4.8	cm	\$0.0244
<div style="display: flex; align-items: flex-start;"> <div style="margin-right: 10px;">■</div> <div>Tape, Tack</div> </div> <div style="margin-top: 5px;">Media: </div>	\$0.0094	1	19.1	cm	\$0.0094
<div style="display: flex; align-items: flex-start;"> <div style="margin-right: 10px;">■</div> <div>Label</div> </div> <div style="margin-top: 5px;">Media: </div>	\$0.0800	1	1	Each	\$0.0800
<div style="display: flex; align-items: flex-start;"> <div style="margin-right: 10px;">■</div> <div>Wire 10.5 OD/276-0.36 OD Strands</div> </div>	\$3.5917	1	84	cm	\$3.5917

Wire Harness Costed Bill of Process



Assembly Process

b0230 - Ground, Chassis to Power Module Asm

Symbol Name	Assembly Time	Q Burden	Assembly Cost	Qty	Q Burden (Total)	Assembly Cost (Total)
Wire Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Cut & Strip Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire	4.0000 sec	\$0.00	\$0.02	1	\$0.00	\$0.02
Cut & Strip Wire	1.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Crimp Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Ends	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Terminal, Contact	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Crimp Terminal	1.0000 sec	\$0.00	\$0.00	2	\$0.00	\$0.01
Manual Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Contact (qty/connector)	4.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.04
Soldering Iron	3.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Solder Joint	5.0000 sec	\$0.00	\$0.02	2	\$0.01	\$0.05
Test, Wire Harness	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Electrical Test Equipment	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Grasp & Position Connector	3.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.03
Mate Connectors to test equip	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Test Harness	2.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Coverings & Tape Winding	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Coverings	7.0000 sec	\$0.00	\$0.03	1	\$0.00	\$0.03
Part Manipulation	3.0000 sec	\$0.00	\$0.01	9	\$0.00	\$0.13
Heat Shrink	5.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.05
Heat Gun	4.0000 sec	\$0.00	\$0.02	1	\$0.00	\$0.02
Shrink Tube	5.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.05
Label	8.0000 sec	\$0.00	\$0.04	1	\$0.00	\$0.04
Apply Label	8.0000 sec	\$0.01	\$0.04	1	\$0.01	\$0.04
Tape Tack	5.0000 sec	\$0.00	\$0.02	1	\$0.00	\$0.02
Tape Wind Branches & Pigtails	19.1000 sec	\$0.00	\$0.09	1	\$0.00	\$0.09

Report Totals

Count: 27

44

\$0.04

\$0.70

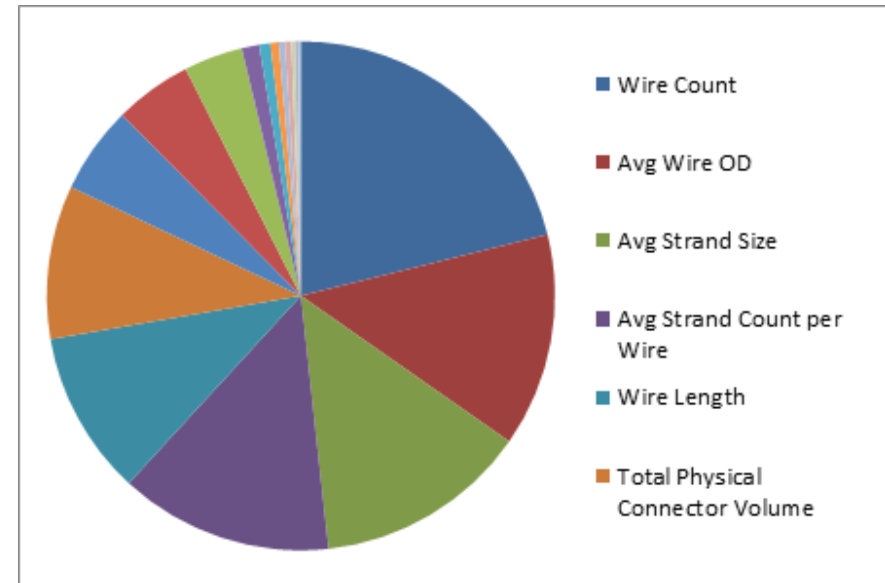
***Click Here to Return to
Cost Analysis Page 329***

Wire Harness Cost Analysis Ground, Motor Asm to Power Module Asm Wire Harness

- The Design Profit[®] based Wire Harness Coster generates cost estimates of various components and assembly processes for the majority of wire harnesses found in today's manufactured products. The Wire Harness Coster rolls up these costs to deliver an estimate of the total manufactured cost.
- Costs are based on several factors including: commodity items, components, burdened machine rates, processing speeds, burdened labor rates, and cost of poor quality drivers.
- The Wire Harness Coster consistently generates a cost estimate for a given wire harness without the need to completely disassemble or destroy the wire harness. Minimal disassembly may be required to capture various attributes and identify overall circuit routing. Inputs to the coster include: connector data (size, cavity count, locking mechanisms and sealing attributes), wire data (sizes quantities and lengths), coverings (type, size and length), fasteners, brackets, troughs, etc.
- The Wire Harness Coster separates the parts and processes to more easily delineate Bill of Material (BOM) costs and build processing costs.

Factors Influencing Cost:

1. Wire count is the primary factor driving cost as it affects the amount of wire, the size of connectors, and the number of assembly processes.
2. Wire selection (wire OD, strand size, strand count / wire) is significant as it directly relates to conductor cross section, and therefore the amount of copper or aluminum used in the harness.
3. Wire length is another major cost factor as it both relates to material cost and to assembly time, as longer lengths require more handling.
4. The total physical connector size is a major cost factor as connectors are a large portion of harness part costs. Total physical connector size also tends to drive assembly costs.



Relative influence of factors on harness costs
(Data based on L32 two-level Taguchi analysis
of the Wire Harness Coster)



- The Ground, Motor Asm to Power Module Asm consists of 1 wire joining 2 eyelets.
- The wire is 10.5 mm in diameter and has 276 twisted copper strands. The overall weight of the harness is 0.0652 kg.
- Both eyelets are crimped and soldered.
- The harness is fully covered in a braided sleeve with heat shrink coverings on both ends.
- All major components are analyzed in detail, while prices are applied to commodity items (i.e. clips, terminals).
- *Estimates are based on actual parts.*
- *Photos: Background on 100mm grid paper.*

Design Profit[®]

EXECUTIVE SUMMARY Harness Overview

0274 - Ground, Motor Asm to Power Module Asm	
Parts	7
Steps	31
Assembly Time (min)	1.68
Total Weight (kg)	0.0652
Purchased Part Cost	\$2.91
Supplier Asm. Cost	\$0.49
Q Burden	\$0.04
Total Cost	\$3.43

Design Profit[®]

EXECUTIVE SUMMARY Wire, Cable & Splices

	0274 - Ground, Motor Asm to Power Module Asm
Wire & Cable Count	1
Splice Count	0
Wire Length Total (cm)	12.1
Harness Total Weight	0.0652 kg
Cu Conductor Mass	0.0376 kg
Cu to Harness Mass (%)	57.70 %
Al Conductor Mass	0.0000 kg
Al to Harness Mass (%)	0.00 %
Wire Cost	\$0.52

Design Profit[®]

EXECUTIVE SUMMARY Connectors & Terminals

	0274 - Ground, Motor Asm to Power Module Asm
Connector Assemblies	0
Sealed Connectors	0
Terminal Cavities	0
Unpopulated Cavities	0
Connector Body Cost	\$0.00
Coax Connectors	0
Coax Connector Cost	\$0.00
Pin & Blade Terminals	0
Ring Terminals	2
Battery Terminals	0
Terminal Strips	0
Total Terminal Count	2
Terminal Cost	\$2.20

Design Profit[®]

EXECUTIVE SUMMARY Labels, Clips, Tape & Coverings

0274 - Ground, Motor Asm to Power Module Asm	
Label Count	1
Label Area cm2	32.0
Label Cost	\$0.08
Clip Count	0
Clip Cost	\$0.00
Tape Tacks	0
Taped Length cm	0.0
Tape Actual Length cm	0.0
Tape Cost	\$0.00
Tube & Wrap Count	1
Heat Shrink Count	2
Covering Count Total	3
Covering Length cm	15.8
Covering Cost	\$0.11

Design Profit[®]

EXECUTIVE SUMMARY Miscellaneous Parts

	0274 - Ground, Motor Asm to Power Module Asm
Bracket Count	0
Bracket Cost	\$0.00
Trough Count	0
Trough Cost	\$0.00
Fuse Count	0
Fuse Cost	\$0.00
Grommet Count	0
Grommet Cost	\$0.00
Misc Part Count	0
Misc Part Cost	\$0.00

Wire Harness Costed Bill of Materials

Harness CBOM

0274 - Ground, Motor Asm to Power Module Asm

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Main Harness	\$2.9076	1	1	Each	\$2.9076

Media:



■ C01	\$1.1000	1	1	Each	\$1.1000
-------	----------	---	---	------	----------

Media:



■ C02	\$1.1000	1	1	Each	\$1.1000
-------	----------	---	---	------	----------

Media:



■ Braided Sleeve	\$0.0629	1	9.4	cm	\$0.0629
------------------	----------	---	-----	----	----------

Media:





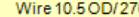
■ Heat Shrink	\$0.0220	1	3.2	cm	\$0.0220
---------------	----------	---	-----	----	----------

Media:



Wire Harness Costed Bill of Materials

0274 - Ground, Motor Asm to Power Module Asm

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Heat Shrink</p>	\$0.0220	1	3.2	cm	\$0.0220
<p>Media:</p>  <p>Label</p>	\$0.0800	1	1	Each	\$0.0800
 <p>Wire 10.5 OD/276-0.36 OD Strands</p>	\$0.5174	1	12.1	cm	\$0.5174

Wire Harness Costed Bill of Process



Assembly Process

0274 - Ground, Motor Asm to Power Module Asm

Symbol Name	Assembly Time	Q Burden	Assembly Cost	Qty	Q Burden (Total)	Assembly Cost (Total)
Wire Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Cut & Strip Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire	4.0000 sec	\$0.00	\$0.02	1	\$0.00	\$0.02
Cut & Strip Wire	1.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Crimp Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Ends	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Terminal, Contact	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Crimp Terminal	1.0000 sec	\$0.00	\$0.00	2	\$0.00	\$0.01
Manual Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Contact (qty/connector)	4.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.04
Soldering Iron	3.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Solder Joint	5.0000 sec	\$0.00	\$0.02	2	\$0.01	\$0.05
Test, Wire Harness	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Electrical Test Equipment	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Grasp & Position Connector	3.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.03
Mate Connectors to test equip	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Test Harness	2.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Coverings & Tape Winding	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Coverings	7.0000 sec	\$0.00	\$0.03	1	\$0.00	\$0.03
Part Manipulation	3.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.03
Heat Shrink	5.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.05
Heat Gun	4.0000 sec	\$0.00	\$0.02	1	\$0.00	\$0.02
Shrink Tube	5.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.05
Label	8.0000 sec	\$0.00	\$0.04	1	\$0.00	\$0.04
Apply Label	8.0000 sec	\$0.01	\$0.04	1	\$0.01	\$0.04

Report Totals

Count: 25

35

\$0.04

\$0.49

***[Click Here to Return to
Cost Analysis Page 331](#)***

Wire Harness Cost Analysis

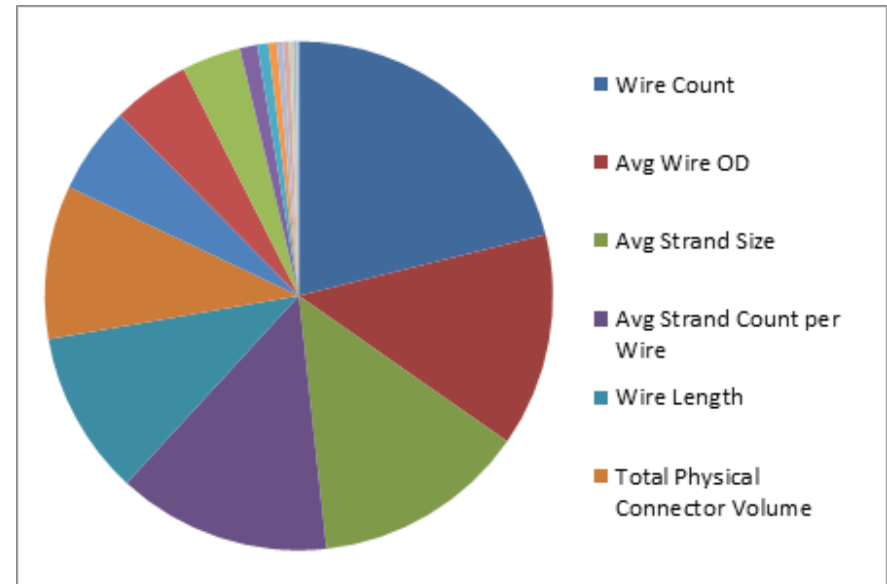
Ground, Power Module To Chassis

Wire Harness

- The Design Profit[®] based Wire Harness Coster generates cost estimates of various components and assembly processes for the majority of wire harnesses found in today's manufactured products. The Wire Harness Coster rolls up these costs to deliver an estimate of the total manufactured cost.
- Costs are based on several factors including: commodity items, components, burdened machine rates, processing speeds, burdened labor rates, and cost of poor quality drivers.
- The Wire Harness Coster consistently generates a cost estimate for a given wire harness without the need to completely disassemble or destroy the wire harness. Minimal disassembly may be required to capture various attributes and identify overall circuit routing. Inputs to the coster include: connector data (size, cavity count, locking mechanisms and sealing attributes), wire data (sizes quantities and lengths), coverings (type, size and length), fasteners, brackets, troughs, etc.
- The Wire Harness Coster separates the parts and processes to more easily delineate Bill of Material (BOM) costs and build processing costs.

Factors Influencing Cost:

1. Wire count is the primary factor driving cost as it affects the amount of wire, the size of connectors, and the number of assembly processes.
2. Wire selection (wire OD, strand size, strand count / wire) is significant as it directly relates to conductor cross section, and therefore the amount of copper or aluminum used in the harness.
3. Wire length is another major cost factor as it both relates to material cost and to assembly time, as longer lengths require more handling.
4. The total physical connector size is a major cost factor as connectors are a large portion of harness part costs. Total physical connector size also tends to drive assembly costs.



Relative influence of factors on harness costs
(Data based on L32 two-level Taguchi analysis
of the Wire Harness Coster)

Ground, Power Module To Chassis



- The Ground, Power Module To Chassis consists of 1 wire joining 2 eyelets.
- The wire is 8 mm in diameter and has 126 twisted copper strands. The overall weight of the harness is 0.0746 kg.
- Both eyelets are crimped and soldered.
- The harness is fully covered in a braided sleeve with heat shrink coverings on both ends.
- All major components are analyzed in detail, while prices are applied to commodity items (i.e. clips, terminals).
- *Estimates are based on actual parts.*
- *Photos: Background on 100mm grid paper.*

Design Profit[®]

EXECUTIVE SUMMARY **Harness Overview**

	0275 - Ground, Power Module To Chassis
Parts	7
Steps	32
Assembly Time (min)	1.73
Total Weight (kg)	0.0746
Purchased Part Cost	\$2.19
Supplier Asm. Cost	\$0.50
Q Burden	\$0.04
Total Cost	\$2.73

Design Profit[®]

EXECUTIVE SUMMARY Wire, Cable & Splices

	0275 - Ground, Power Module To Chassis
Wire & Cable Count	1
Splice Count	0
Wire Length Total (cm)	30.5
Harness Total Weight	0.0746 kg
Cu Conductor Mass	0.0457 kg
Cu to Harness Mass (%)	61.31 %
Al Conductor Mass	0.0000 kg
Al to Harness Mass (%)	0.00 %
Wire Cost	\$0.72

Design Profit[®]

EXECUTIVE SUMMARY Connectors & Terminals

	0275 - Ground, Power Module To Chassis
Connector Assemblies	0
Sealed Connectors	0
Terminal Cavities	0
Unpopulated Cavities	0
Connector Body Cost	\$0.00
Coax Connectors	0
Coax Connector Cost	\$0.00
Pin & Blade Terminals	0
Ring Terminals	2
Battery Terminals	0
Terminal Strips	0
Total Terminal Count	2
Terminal Cost	\$1.21

Design Profit[®]

EXECUTIVE SUMMARY Labels, Clips, Tape & Coverings

	0275 - Ground, Power Module To Chassis
Label Count	1
Label Area cm2	32.0
Label Cost	\$0.08
Clip Count	0
Clip Cost	\$0.00
Tape Tacks	0
Taped Length cm	0.0
Tape Actual Length cm	0.0
Tape Cost	\$0.00
Tube & Wrap Count	1
Heat Shrink Count	2
Covering Count Total	3
Covering Length cm	33.3
Covering Cost	\$0.18

Design Profit[®]


EXECUTIVE SUMMARY Miscellaneous Parts

	0275 - Ground, Power Module To Chassis
Bracket Count	0
Bracket Cost	\$0.00
Trough Count	0
Trough Cost	\$0.00
Fuse Count	0
Fuse Cost	\$0.00
Grommet Count	0
Grommet Cost	\$0.00
Misc Part Count	0
Misc Part Cost	\$0.00

Wire Harness Costed Bill of Materials

Harness CBOM

0275 - Ground, Power Module To Chassis

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Main Harness	\$2.1883	1	1	Each	\$2.1883


Media:



 C01	\$0.5800	1	1	Each	\$0.5800
---	----------	---	---	------	----------


Media:



 C02	\$0.6300	1	1	Each	\$0.6300
---	----------	---	---	------	----------

Media:



 Braided Sleeve	\$0.1419	1	25.5	cm	\$0.1419
--	----------	---	------	----	----------

Media:





 Heat Shrink	\$0.0179	1	3.9	cm	\$0.0179
---	----------	---	-----	----	----------

Media:



Wire Harness Costed Bill of Materials

0275 - Ground, Power Module To Chassis

		Purchased Part					Purchased Part
		Cost	Item Qty	Measure	Unit of Measure	Cost (Total)	
■	Heat Shrink	\$0.0179	1	3.9	cm	\$0.0179	
Media:							
■	Label	\$0.0800	1	1	Each	\$0.0800	
Media:							
■	Wire 8.0 OD/ 126-0.37 OD Strands	\$0.7175	1	30.5	cm	\$0.7175	

Wire Harness Costed Bill of Process



MUNRO
& ASSOCIATES, INC.

Assembly Process

0275 - Ground, Power Module To Chassis

Symbol Name	Assembly Time	Q Burden	Assembly Cost	Qty	Q Burden (Total)	Assembly Cost (Total)
Wire Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Cut & Strip Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire	4.0000 sec	\$0.00	\$0.02	1	\$0.00	\$0.02
Cut & Strip Wire	1.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Crimp Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Ends	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Terminal, Contact	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Crimp Terminal	1.0000 sec	\$0.00	\$0.00	2	\$0.00	\$0.01
Manual Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Contact (qty/connector)	4.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.04
Soldering Iron	3.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Solder Joint	5.0000 sec	\$0.00	\$0.02	2	\$0.01	\$0.05
Test, Wire Harness	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Electrical Test Equipment	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Grasp & Position Connector	3.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.03
Mate Connectors to test equip	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Test Harness	2.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Coverings & Tape Winding	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Coverings	7.0000 sec	\$0.00	\$0.03	1	\$0.00	\$0.03
Part Manipulation	3.0000 sec	\$0.00	\$0.01	3	\$0.00	\$0.04
Heat Shrink	5.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.05
Heat Gun	4.0000 sec	\$0.00	\$0.02	1	\$0.00	\$0.02
Shrink Tube	5.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.05
Label	8.0000 sec	\$0.00	\$0.04	1	\$0.00	\$0.04
Apply Label	8.0000 sec	\$0.01	\$0.04	1	\$0.01	\$0.04

Report Totals

Count: 25

36

\$0.04

\$0.50

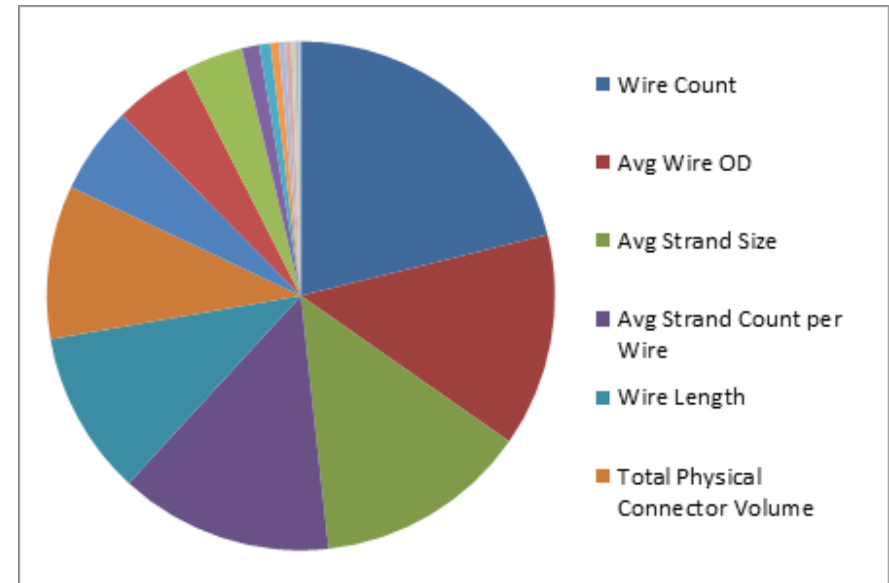
***Click Here to Return to
Cost Analysis Page 333***

Wire Harness Cost Analysis Ground, Rear X Brace To Heat Shield Asm Wire Harness

- The Design Profit[®] based Wire Harness Coster generates cost estimates of various components and assembly processes for the majority of wire harnesses found in today's manufactured products. The Wire Harness Coster rolls up these costs to deliver an estimate of the total manufactured cost.
- Costs are based on several factors including: commodity items, components, burdened machine rates, processing speeds, burdened labor rates, and cost of poor quality drivers.
- The Wire Harness Coster consistently generates a cost estimate for a given wire harness without the need to completely disassemble or destroy the wire harness. Minimal disassembly may be required to capture various attributes and identify overall circuit routing. Inputs to the coster include: connector data (size, cavity count, locking mechanisms and sealing attributes), wire data (sizes quantities and lengths), coverings (type, size and length), fasteners, brackets, troughs, etc.
- The Wire Harness Coster separates the parts and processes to more easily delineate Bill of Material (BOM) costs and build processing costs.

Factors Influencing Cost:

1. Wire count is the primary factor driving cost as it affects the amount of wire, the size of connectors, and the number of assembly processes.
2. Wire selection (wire OD, strand size, strand count / wire) is significant as it directly relates to conductor cross section, and therefore the amount of copper or aluminum used in the harness.
3. Wire length is another major cost factor as it both relates to material cost and to assembly time, as longer lengths require more handling.
4. The total physical connector size is a major cost factor as connectors are a large portion of harness part costs. Total physical connector size also tends to drive assembly costs.



Relative influence of factors on harness costs
(Data based on L32 two-level Taguchi analysis
of the Wire Harness Coster)

Ground, Rear X Brace To Heat Shield Asm



- The Ground, Rear X Brace To Heat Shield Asm consists of 1 wire joining 2 eyelets.
- The wire is 2.5 mm in diameter and is made up of twisted copper strands. The overall weight of the harness is 0.0089 kg.
- Both eyelets are crimped and soldered.
- The harness is fully covered in a Silicone Coated Fiberglass Sleeve with heat shrink coverings on both ends.
- All major components are analyzed in detail, while prices are applied to commodity items (i.e. clips, terminals).
- *Estimates are based on actual parts.*
- *Photos: Background on 100mm grid paper.*

Design Profit[®]

EXECUTIVE SUMMARY Harness Overview

0208 - Ground, Rear X Brace To Heat Shield Asm	
Parts	7
Steps	31
Assembly Time (min)	1.68
Total Weight (kg)	0.0089
Purchased Part Cost	\$0.55
Supplier Asm. Cost	\$0.49
Q Burden	\$0.04
Total Cost	\$1.07

Design Profit[®]

EXECUTIVE SUMMARY Wire, Cable & Splices

	0208 - Ground, Rear X Brace To Heat Shield Asm
Wire & Cable Count	1
Splice Count	0
Wire Length Total (cm)	14.3
Harness Total Weight	0.0089 kg
Cu Conductor Mass	0.0044 kg
Cu to Harness Mass (%)	49.07 %
Al Conductor Mass	0.0000 kg
Al to Harness Mass (%)	0.00 %
Wire Cost	\$0.06

Design Profit[®]

EXECUTIVE SUMMARY Connectors & Terminals

	0208 - Ground, Rear X Brace To Heat Shield Asm
Connector Assemblies	0
Sealed Connectors	0
Terminal Cavities	0
Unpopulated Cavities	0
Connector Body Cost	\$0.00
Coax Connectors	0
Coax Connector Cost	\$0.00
Pin & Blade Terminals	0
Ring Terminals	2
Battery Terminals	0
Terminal Strips	0
Total Terminal Count	2
Terminal Cost	\$0.12

Design Profit[®]

EXECUTIVE SUMMARY Labels, Clips, Tape & Coverings

	0208 - Ground, Rear X Brace To Heat Shield Asm
Label Count	1
Label Area cm2	32.0
Label Cost	\$0.08
Clip Count	0
Clip Cost	\$0.00
Tape Tacks	0
Taped Length cm	0.0
Tape Actual Length cm	0.0
Tape Cost	\$0.00
Tube & Wrap Count	1
Heat Shrink Count	2
Covering Count Total	3
Covering Length cm	18.2
Covering Cost	\$0.29



Design Profit[®]


EXECUTIVE SUMMARY Miscellaneous Parts

	0208 - Ground, Rear X Brace To Heat Shield Asm
Bracket Count	0
Bracket Cost	\$0.00
Trough Count	0
Trough Cost	\$0.00
Fuse Count	0
Fuse Cost	\$0.00
Grommet Count	0
Grommet Cost	\$0.00
Misc Part Count	0
Misc Part Cost	\$0.00

Wire Harness Costed Bill of Materials


Harness CBOM

0208 - Ground, Rear X Brace To Heat Shield Asm

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Main Harness	\$0.5512	1	1	Each	\$0.5512


Media:



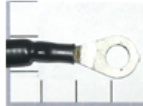
 C01	\$0.0600	1	1	Each	\$0.0600
---	----------	---	---	------	----------

Media:



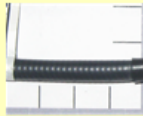
 C02	\$0.0600	1	1	Each	\$0.0600
---	----------	---	---	------	----------

Media:



 Silicone Coated Fiberglass Sleeve	\$0.2696	1	12.8	cm	\$0.2696
---	----------	---	------	----	----------

Media:





 Heat Shrink	\$0.0089	1	2.7	cm	\$0.0089
---	----------	---	-----	----	----------

Media:



Wire Harness Costed Bill of Materials

0208 - Ground, Rear X Brace To Heat Shield Asm

Name	Purchased Part		Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
	Cost					
<div style="display: flex; align-items: flex-start;"> <div style="margin-right: 10px;">■</div> <div>Heat Shrink</div> </div> <p>Media:</p> 	\$0.0089		1	2.7	cm	\$0.0089
<div style="display: flex; align-items: flex-start;"> <div style="margin-right: 10px;">■</div> <div>Label</div> </div> <p>Media:</p> 	\$0.0800		1	1	Each	\$0.0800
<div style="display: flex; align-items: flex-start;"> <div style="margin-right: 10px;">■</div> <div>Wire 2.5 OD/ 19- 0.43 OD Strands</div> </div>	\$0.0607		1	14.3	cm	\$0.0607

Wire Harness Costed Bill of Process



Assembly Process

0208 - Ground, Rear X Brace To Heat Shield Asm

Symbol Name	Assembly Time	Q Burden	Assembly Cost	Qty	Q Burden (Total)	Assembly Cost (Total)
Wire Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Cut & Strip Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire	4.0000 sec	\$0.00	\$0.02	1	\$0.00	\$0.02
Cut & Strip Wire	1.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Crimp Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Ends	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Terminal, Contact	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Crimp Terminal	1.0000 sec	\$0.00	\$0.00	2	\$0.00	\$0.01
Manual Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Contact (qty/connector)	4.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.04
Soldering Iron	3.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Solder Joint	5.0000 sec	\$0.00	\$0.02	2	\$0.01	\$0.05
Test, Wire Harness	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Electrical Test Equipment	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Grasp & Position Connector	3.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.03
Mate Connectors to test equip	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Test Harness	2.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Coverings & Tape Winding	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Coverings	7.0000 sec	\$0.00	\$0.03	1	\$0.00	\$0.03
Part Manipulation	3.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.03
Heat Shrink	5.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.05
Heat Gun	4.0000 sec	\$0.00	\$0.02	1	\$0.00	\$0.02
Shrink Tube	5.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.05
Label	8.0000 sec	\$0.00	\$0.04	1	\$0.00	\$0.04
Apply Label	8.0000 sec	\$0.01	\$0.04	1	\$0.01	\$0.04

Report Totals

Count: 25

35

\$0.04

\$0.49

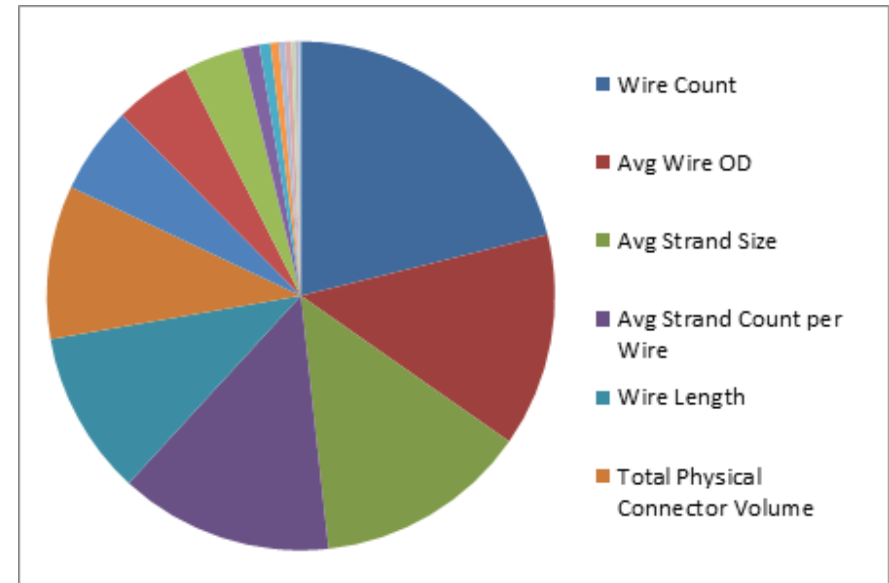
***Click Here to Return to
Cost Analysis Page 335***

Wire Harness Cost Analysis Ground, Chassis to Exhaust Heat Shield Wire Harness

- The Design Profit[®] based Wire Harness Coster generates cost estimates of various components and assembly processes for the majority of wire harnesses found in today's manufactured products. The Wire Harness Coster rolls up these costs to deliver an estimate of the total manufactured cost.
- Costs are based on several factors including: commodity items, components, burdened machine rates, processing speeds, burdened labor rates, and cost of poor quality drivers.
- The Wire Harness Coster consistently generates a cost estimate for a given wire harness without the need to completely disassemble or destroy the wire harness. Minimal disassembly may be required to capture various attributes and identify overall circuit routing. Inputs to the coster include: connector data (size, cavity count, locking mechanisms and sealing attributes), wire data (sizes quantities and lengths), coverings (type, size and length), fasteners, brackets, troughs, etc.
- The Wire Harness Coster separates the parts and processes to more easily delineate Bill of Material (BOM) costs and build processing costs.

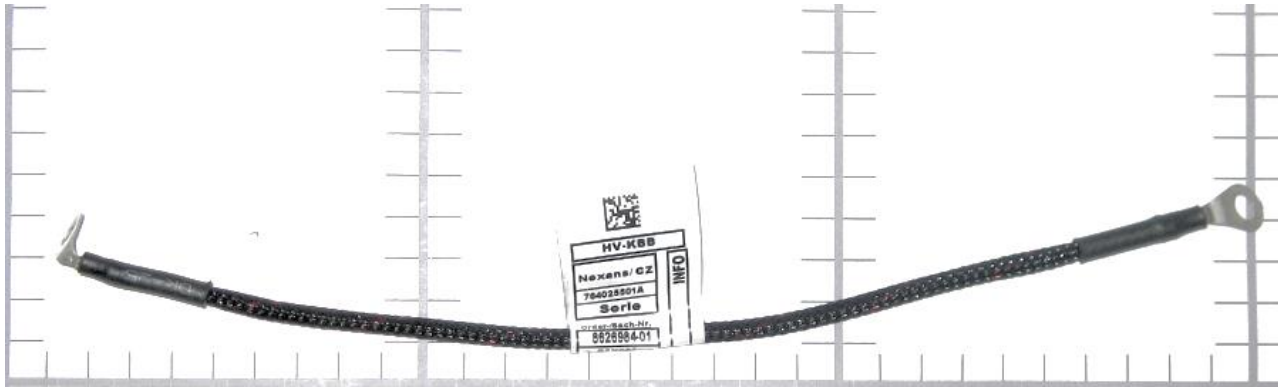
Factors Influencing Cost:

1. Wire count is the primary factor driving cost as it affects the amount of wire, the size of connectors, and the number of assembly processes.
2. Wire selection (wire OD, strand size, strand count / wire) is significant as it directly relates to conductor cross section, and therefore the amount of copper or aluminum used in the harness.
3. Wire length is another major cost factor as it both relates to material cost and to assembly time, as longer lengths require more handling.
4. The total physical connector size is a major cost factor as connectors are a large portion of harness part costs. Total physical connector size also tends to drive assembly costs.



Relative influence of factors on harness costs
(Data based on L32 two-level Taguchi analysis
of the Wire Harness Coster)

Ground, Chassis to Exhaust Heat Shield



- The Ground, Chassis to Exhaust Heat Shield consists of 1 wire joining 2 eyelets.
- The wire is 2.8 mm in diameter and is composed of twisted copper strands. The overall weight of the harness is 0.0116 kg.
- Both eyelets are crimped and soldered.
- The harness is fully covered in a braided poly sleeve with heat shrink coverings on both ends.
- All major components are analyzed in detail, while prices are applied to commodity items (i.e. clips, terminals).
- *Estimates are based on actual parts.*
- *Photos: Background on 100mm grid paper.*

Design Profit[®]

EXECUTIVE SUMMARY Harness Overview

	0231 - Ground, Chassis to Exhaust Heat Shield
Parts	7
Steps	32
Assembly Time (min)	1.73
Total Weight (kg)	0.0116
Purchased Part Cost	\$0.44
Supplier Asm. Cost	\$0.50
Q Burden	\$0.04
Total Cost	\$0.98

Design Profit[®]

EXECUTIVE SUMMARY Wire, Cable & Splices

	0231 - Ground, Chassis to Exhaust Heat Shield
Wire & Cable Count	1
Splice Count	0
Wire Length Total (cm)	26.3
Harness Total Weight	0.0116 kg
Cu Conductor Mass	0.0071 kg
Cu to Harness Mass (%)	61.59 %
Al Conductor Mass	0.0000 kg
Al to Harness Mass (%)	0.00 %
Wire Cost	\$0.10

Design Profit[®]

EXECUTIVE SUMMARY Connectors & Terminals

	0231 - Ground, Chassis to Exhaust Heat Shield
Connector Assemblies	0
Sealed Connectors	0
Terminal Cavities	0
Unpopulated Cavities	0
Connector Body Cost	\$0.00
Coax Connectors	0
Coax Connector Cost	\$0.00
Pin & Blade Terminals	0
Ring Terminals	2
Battery Terminals	0
Terminal Strips	0
Total Terminal Count	2
Terminal Cost	\$0.12

Design Profit[®]

EXECUTIVE SUMMARY Labels, Clips, Tape & Coverings

	0231 - Ground, Chassis to Exhaust Heat Shield
Label Count	1
Label Area cm2	32.0
Label Cost	\$0.08
Clip Count	0
Clip Cost	\$0.00
Tape Tacks	0
Taped Length cm	0.0
Tape Actual Length cm	0.0
Tape Cost	\$0.00
Tube & Wrap Count	1
Heat Shrink Count	2
Covering Count Total	3
Covering Length cm	31.3
Covering Cost	\$0.14



Design Profit[®]

EXECUTIVE SUMMARY Miscellaneous Parts

	0231 - Ground, Chassis to Exhaust Heat Shield
Bracket Count	0
Bracket Cost	\$0.00
Trough Count	0
Trough Cost	\$0.00
Fuse Count	0
Fuse Cost	\$0.00
Grommet Count	0
Grommet Cost	\$0.00
Misc Part Count	0
Misc Part Cost	\$0.00

Wire Harness Costed Bill of Materials

Harness CBOM

0231 - Ground, Chassis to Exhaust Heat Shield

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
<input type="checkbox"/> Main Harness	\$0.4411	1	1	Each	\$0.4411

Media:



<input type="checkbox"/> C01	\$0.0600	1	1	Each	\$0.0600
------------------------------	----------	---	---	------	----------

Media:



<input type="checkbox"/> C02	\$0.0600	1	1	Each	\$0.0600
------------------------------	----------	---	---	------	----------

Media:



<input type="checkbox"/> Braided Sleeve	\$0.1199	1	25.3	cm	\$0.1199
---	----------	---	------	----	----------

Media:








<input type="checkbox"/> Heat Shrink	\$0.0098	1	3.0	cm	\$0.0098
--------------------------------------	----------	---	-----	----	----------

Media:



Wire Harness Costed Bill of Materials

0231 - Ground, Chassis to Exhaust Heat Shield

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Heat Shrink Media: 	\$0.0098	1	3	cm	\$0.0098
 Label Media: 	\$0.0800	1	1	Each	\$0.0800
 Wire 2.8 OD/ 50-0.25 OD Strands	\$0.0983	1	26.3	cm	\$0.0983

Wire Harness Costed Bill of Process



Assembly Process

0231 - Ground, Chassis to Exhaust Heat Shield

Symbol Name	Assembly Time	Q Burden	Assembly Cost	Qty	Q Burden (Total)	Assembly Cost (Total)
Wire Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Cut & Strip Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire	4.0000 sec	\$0.00	\$0.02	1	\$0.00	\$0.02
Cut & Strip Wire	1.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Crimp Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Ends	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Terminal, Contact	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Crimp Terminal	1.0000 sec	\$0.00	\$0.00	2	\$0.00	\$0.01
Manual Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Contact (qty/connector)	4.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.04
Soldering Iron	3.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Solder Joint	5.0000 sec	\$0.00	\$0.02	2	\$0.01	\$0.05
Test, Wire Harness	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Electrical Test Equipment	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Grasp & Position Connector	3.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.03
Mate Connectors to test equip	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Test Harness	2.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Coverings & Tape Winding	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Coverings	7.0000 sec	\$0.00	\$0.03	1	\$0.00	\$0.03
Part Manipulation	3.0000 sec	\$0.00	\$0.01	3	\$0.00	\$0.04
Heat Shrink	5.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.05
Heat Gun	4.0000 sec	\$0.00	\$0.02	1	\$0.00	\$0.02
Shrink Tube	5.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.05
Label	8.0000 sec	\$0.00	\$0.04	1	\$0.00	\$0.04
Apply Label	8.0000 sec	\$0.01	\$0.04	1	\$0.01	\$0.04

Report Totals

Count: 25

36

\$0.04

\$0.50

***[Click Here to Return to
Cost Analysis Page 337](#)***

Wire Harness Cost Analysis

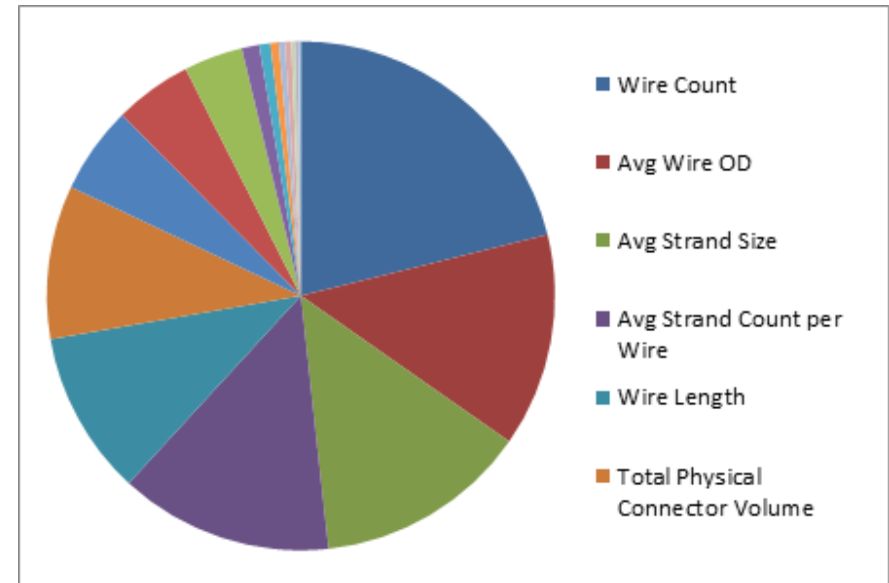
Ground, Chassis to Engine Wire

Harness

- The Design Profit[®] based Wire Harness Coster generates cost estimates of various components and assembly processes for the majority of wire harnesses found in today's manufactured products. The Wire Harness Coster rolls up these costs to deliver an estimate of the total manufactured cost.
- Costs are based on several factors including: commodity items, components, burdened machine rates, processing speeds, burdened labor rates, and cost of poor quality drivers.
- The Wire Harness Coster consistently generates a cost estimate for a given wire harness without the need to completely disassemble or destroy the wire harness. Minimal disassembly may be required to capture various attributes and identify overall circuit routing. Inputs to the coster include: connector data (size, cavity count, locking mechanisms and sealing attributes), wire data (sizes quantities and lengths), coverings (type, size and length), fasteners, brackets, troughs, etc.
- The Wire Harness Coster separates the parts and processes to more easily delineate Bill of Material (BOM) costs and build processing costs.

Factors Influencing Cost:

1. Wire count is the primary factor driving cost as it affects the amount of wire, the size of connectors, and the number of assembly processes.
2. Wire selection (wire OD, strand size, strand count / wire) is significant as it directly relates to conductor cross section, and therefore the amount of copper or aluminum used in the harness.
3. Wire length is another major cost factor as it both relates to material cost and to assembly time, as longer lengths require more handling.
4. The total physical connector size is a major cost factor as connectors are a large portion of harness part costs. Total physical connector size also tends to drive assembly costs.



Relative influence of factors on harness costs
(Data based on L32 two-level Taguchi analysis
of the Wire Harness Coster)

Ground, Chassis to Engine



- The Ground, Chassis to Engine consists of 1 wire joining 2 eyelets.
- The wire is 8 mm in diameter and is composed of 126 twisted copper strands. The overall weight of the harness is 0.0422 kg.
- Both eyelets are crimped and soldered.
- The harness is fully covered in a braided sleeve with heat shrink coverings on both ends.
- All major components are analyzed in detail, while prices are applied to commodity items (i.e. clips, terminals).
- *Estimates are based on actual parts.*
- *Photos: Background on 100mm grid paper.*

Design Profit[®]

EXECUTIVE SUMMARY Harness Overview

	0232 - Ground, Chassis to Engine
Parts	7
Steps	31
Assembly Time (min)	1.68
Total Weight (kg)	0.0422
Purchased Part Cost	\$1.69
Supplier Asm. Cost	\$0.49
Q Burden	\$0.04
Total Cost	\$2.21

Design Profit[®]

EXECUTIVE SUMMARY Wire, Cable & Splices

	0232 - Ground, Chassis to Engine
Wire & Cable Count	1
Splice Count	0
Wire Length Total (cm)	14.0
Harness Total Weight	0.0422 kg
Cu Conductor Mass	0.0210 kg
Cu to Harness Mass (%)	49.75 %
Al Conductor Mass	0.0000 kg
Al to Harness Mass (%)	0.00 %
Wire Cost	\$0.33

Design Profit®

EXECUTIVE SUMMARY Connectors & Terminals

	0232 - Ground, Chassis to Engine
Connector Assemblies	0
Sealed Connectors	0
Terminal Cavities	0
Unpopulated Cavities	0
Connector Body Cost	\$0.00
Coax Connectors	0
Coax Connector Cost	\$0.00
Pin & Blade Terminals	0
Ring Terminals	2
Battery Terminals	0
Terminal Strips	0
Total Terminal Count	2
Terminal Cost	\$1.18

Design Profit[®]

EXECUTIVE SUMMARY Labels, Clips, Tape & Coverings

	0232 - Ground, Chassis to Engine
Label Count	1
Label Area cm2	32.0
Label Cost	\$0.08
Clip Count	0
Clip Cost	\$0.00
Tape Tacks	0
Taped Length cm	0.0
Tape Actual Length cm	0.0
Tape Cost	\$0.00
Tube & Wrap Count	1
Heat Shrink Count	2
Covering Count Total	3
Covering Length cm	18.8
Covering Cost	\$0.10

Design Profit[®]

EXECUTIVE SUMMARY Miscellaneous Parts

	0232 - Ground, Chassis to Engine
Bracket Count	0
Bracket Cost	\$0.00
Trough Count	0
Trough Cost	\$0.00
Fuse Count	0
Fuse Cost	\$0.00
Grommet Count	0
Grommet Cost	\$0.00
Misc Part Count	0
Misc Part Cost	\$0.00

Wire Harness Costed Bill of Materials

Harness CBOM

0232 - Ground, Chassis to Engine

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Main Harness	\$1.6895	1	1	Each	\$1.6895

Media:



■ C01	\$0.6300	1	1	Each	\$0.6300
-------	----------	---	---	------	----------

Media:



■ C02	\$0.5500	1	1	Each	\$0.5500
-------	----------	---	---	------	----------

Media:



■ Braided Sleeve	\$0.0612	1	11	cm	\$0.0612
------------------	----------	---	----	----	----------

Media:





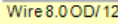
■ Heat Shrink	\$0.0179	1	3.9	cm	\$0.0179
---------------	----------	---	-----	----	----------

Media:



Wire Harness Costed Bill of Materials

0232 - Ground, Chassis to Engine

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 <p>Heat Shrink</p>	\$0.0179	1	3.9	cm	\$0.0179
 <p>Label</p>	\$0.0800	1	1	Each	\$0.0800
 <p>Wire 8.0 OD/ 126-0.37 OD Strands</p>	\$0.3293	1	14	cm	\$0.3293

Wire Harness Costed Bill of Process



Assembly Process

0232 - Ground, Chassis to Engine

Symbol Name	Assembly Time	Q Burden	Assembly Cost	Qty	Q Burden (Total)	Assembly Cost (Total)
Wire Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Cut & Strip Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire	4.0000 sec	\$0.00	\$0.02	1	\$0.00	\$0.02
Cut & Strip Wire	1.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Crimp Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Ends	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Terminal, Contact	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Crimp Terminal	1.0000 sec	\$0.00	\$0.00	2	\$0.00	\$0.01
Manual Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Contact (qty/connector)	4.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.04
Soldering Iron	3.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Solder Joint	5.0000 sec	\$0.00	\$0.02	2	\$0.01	\$0.05
Test, Wire Harness	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Electrical Test Equipment	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Grasp & Position Connector	3.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.03
Mate Connectors to test equip	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Test Harness	2.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Coverings & Tape Winding	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Coverings	7.0000 sec	\$0.00	\$0.03	1	\$0.00	\$0.03
Part Manipulation	3.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.03
Heat Shrink	5.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.05
Heat Gun	4.0000 sec	\$0.00	\$0.02	1	\$0.00	\$0.02
Shrink Tube	5.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.05
Label	8.0000 sec	\$0.00	\$0.04	1	\$0.00	\$0.04
Apply Label	8.0000 sec	\$0.01	\$0.04	1	\$0.01	\$0.04

Report Totals

Count: 25

35

\$0.04

\$0.49

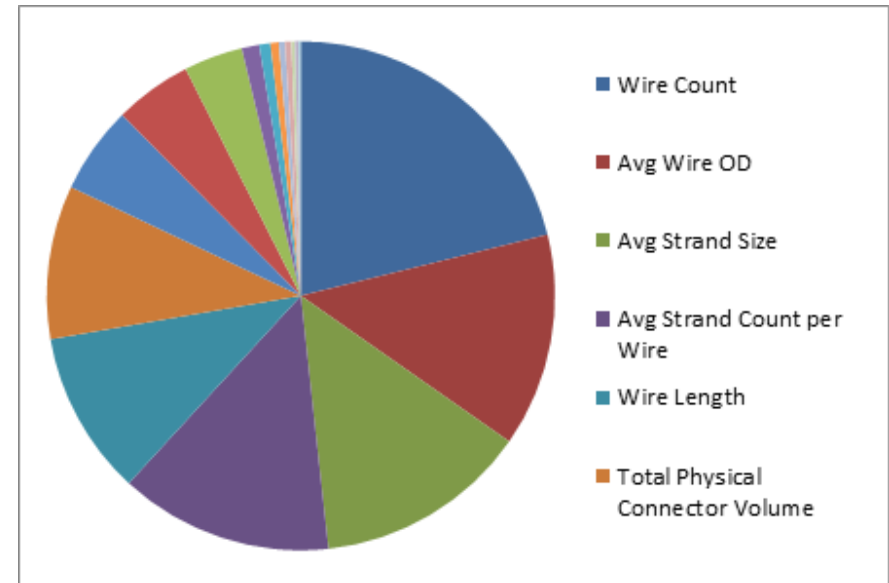
***Click Here to Return to
Cost Analysis Page 339***

Wire Harness Cost Analysis Ground, AC Compressor To Motor Wire Harness

- The Design Profit[®] based Wire Harness Coster generates cost estimates of various components and assembly processes for the majority of wire harnesses found in today's manufactured products. The Wire Harness Coster rolls up these costs to deliver an estimate of the total manufactured cost.
- Costs are based on several factors including: commodity items, components, burdened machine rates, processing speeds, burdened labor rates, and cost of poor quality drivers.
- The Wire Harness Coster consistently generates a cost estimate for a given wire harness without the need to completely disassemble or destroy the wire harness. Minimal disassembly may be required to capture various attributes and identify overall circuit routing. Inputs to the coster include: connector data (size, cavity count, locking mechanisms and sealing attributes), wire data (sizes quantities and lengths), coverings (type, size and length), fasteners, brackets, troughs, etc.
- The Wire Harness Coster separates the parts and processes to more easily delineate Bill of Material (BOM) costs and build processing costs.

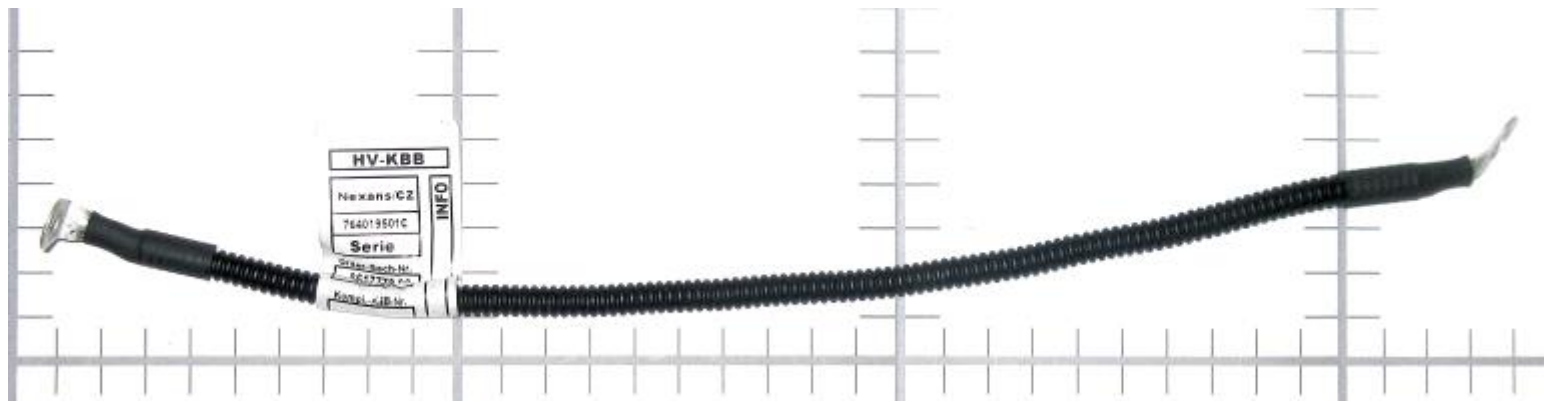
Factors Influencing Cost:

1. Wire count is the primary factor driving cost as it affects the amount of wire, the size of connectors, and the number of assembly processes.
2. Wire selection (wire OD, strand size, strand count / wire) is significant as it directly relates to conductor cross section, and therefore the amount of copper or aluminum used in the harness.
3. Wire length is another major cost factor as it both relates to material cost and to assembly time, as longer lengths require more handling.
4. The total physical connector size is a major cost factor as connectors are a large portion of harness part costs. Total physical connector size also tends to drive assembly costs.



Relative influence of factors on harness costs
(Data based on L32 two-level Taguchi analysis
of the Wire Harness Coster)

Ground, AC Compressor to Motor



- The Ground, AC Compressor to Motor consists of 1 wire joining 2 eyelets.
- The wire is 3.4 mm in diameter and has twisted copper strands. The overall weight of the harness is 0.0200 kg.
- Both eyelets are crimped and soldered.
- The harness is fully covered in a Convolute tube with heat shrink coverings on both ends.
- All major components are analyzed in detail, while prices are applied to commodity items (i.e. clips, terminals).
- *Estimates are based on actual parts.*
- *Photos: Background on 100mm grid paper.*

Design Profit[®]

EXECUTIVE SUMMARY **Harness Overview**

	0255 - Ground, AC Compressor To Motor
Parts	7
Steps	32
Assembly Time (min)	1.73
Total Weight (kg)	0.0200
Purchased Part Cost	\$0.47
Supplier Asm. Cost	\$0.50
Q Burden	\$0.04
Total Cost	\$1.01

Design Profit[®]

EXECUTIVE SUMMARY Wire, Cable & Splices

	0255 - Ground, AC Compressor To Motor
Wire & Cable Count	1
Splice Count	0
Wire Length Total (cm)	31.0
Harness Total Weight	0.0200 kg
Cu Conductor Mass	0.0136 kg
Cu to Harness Mass (%)	67.91 %
Al Conductor Mass	0.0000 kg
Al to Harness Mass (%)	0.00 %
Wire Cost	\$0.20

Design Profit[®]

EXECUTIVE SUMMARY Connectors & Terminals

	0255 - Ground, AC Compressor To Motor
Connector Assemblies	0
Sealed Connectors	0
Terminal Cavities	0
Unpopulated Cavities	0
Connector Body Cost	\$0.00
Coax Connectors	0
Coax Connector Cost	\$0.00
Pin & Blade Terminals	0
Ring Terminals	2
Battery Terminals	0
Terminal Strips	0
Total Terminal Count	2
Terminal Cost	\$0.12



Design Profit[®]

EXECUTIVE SUMMARY Labels, Clips, Tape & Coverings

	0255 - Ground, AC Compressor To Motor
Label Count	1
Label Area cm2	32.0
Label Cost	\$0.08
Clip Count	0
Clip Cost	\$0.00
Tape Tacks	0
Taped Length cm	0.0
Tape Actual Length cm	0.0
Tape Cost	\$0.00
Tube & Wrap Count	1
Heat Shrink Count	2
Covering Count Total	3
Covering Length cm	33.8
Covering Cost	\$0.07

Design Profit[®]

EXECUTIVE SUMMARY Miscellaneous Parts

	0255 - Ground, AC Compressor To Motor
Bracket Count	0
Bracket Cost	\$0.00
Trough Count	0
Trough Cost	\$0.00
Fuse Count	0
Fuse Cost	\$0.00
Grommet Count	0
Grommet Cost	\$0.00
Misc Part Count	0
Misc Part Cost	\$0.00

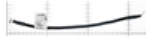
Wire Harness Costed Bill of Materials

Harness CBOM

0255 - Ground, AC Compressor To Motor

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Main Harness	\$0.4736	1	1	Each	\$0.4736

Media:



■ C01	\$0.0600	1	1	Each	\$0.0600
-------	----------	---	---	------	----------

Media:



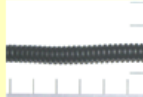
■ C02	\$0.0600	1	1	Each	\$0.0600
-------	----------	---	---	------	----------

Media:



■ Tube, Convolute	\$0.0469	1	28	cm	\$0.0469
-------------------	----------	---	----	----	----------

Media:






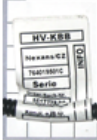

■ Heat Shrink	\$0.0133	1	2.9	cm	\$0.0133
---------------	----------	---	-----	----	----------

Media:



Wire Harness Costed Bill of Materials

0255 - Ground, AC Compressor To Motor

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Heat Shrink Media: 	\$0.0133	1	2.9	cm	\$0.0133
 Label Media: 	\$0.0800	1	1	Each	\$0.0800
 Wire 3.4 OD/ 56- 0.30 OD Strands	\$0.1970	1	31	cm	\$0.1970

Wire Harness Costed Bill of Process



Assembly Process

0255 - Ground, AC Compressor To Motor

Symbol Name	Assembly Time	Q Burden	Assembly Cost	Qty	Q Burden (Total)	Assembly Cost (Total)
Wire Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Cut & Strip Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire	4.0000 sec	\$0.00	\$0.02	1	\$0.00	\$0.02
Cut & Strip Wire	1.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Crimp Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Ends	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Terminal, Contact	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Crimp Terminal	1.0000 sec	\$0.00	\$0.00	2	\$0.00	\$0.01
Manual Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Contact (qty/connector)	4.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.04
Soldering Iron	3.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Solder Joint	5.0000 sec	\$0.00	\$0.02	2	\$0.01	\$0.05
Test, Wire Harness	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Electrical Test Equipment	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Grasp & Position Connector	3.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.03
Mate Connectors to test equip	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Test Harness	2.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Coverings & Tape Winding	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Coverings	7.0000 sec	\$0.00	\$0.03	1	\$0.00	\$0.03
Part Manipulation	3.0000 sec	\$0.00	\$0.01	3	\$0.00	\$0.04
Heat Shrink	5.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.05
Heat Gun	4.0000 sec	\$0.00	\$0.02	1	\$0.00	\$0.02
Shrink Tube	5.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.05
Label	8.0000 sec	\$0.00	\$0.04	1	\$0.00	\$0.04
Apply Label	8.0000 sec	\$0.01	\$0.04	1	\$0.01	\$0.04

Report Totals

Count: 25

36

\$0.04

\$0.50

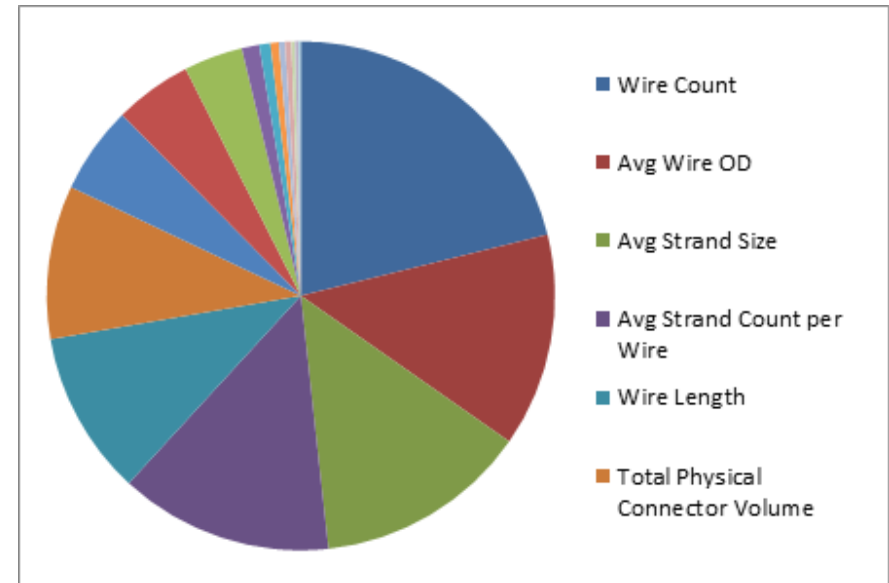
***Click Here to Return to
Cost Analysis Page 341***

Wire Harness Cost Analysis Ground, Chassis to Motor Wire Harness

- The Design Profit[®] based Wire Harness Coster generates cost estimates of various components and assembly processes for the majority of wire harnesses found in today's manufactured products. The Wire Harness Coster rolls up these costs to deliver an estimate of the total manufactured cost.
- Costs are based on several factors including: commodity items, components, burdened machine rates, processing speeds, burdened labor rates, and cost of poor quality drivers.
- The Wire Harness Coster consistently generates a cost estimate for a given wire harness without the need to completely disassemble or destroy the wire harness. Minimal disassembly may be required to capture various attributes and identify overall circuit routing. Inputs to the coster include: connector data (size, cavity count, locking mechanisms and sealing attributes), wire data (sizes quantities and lengths), coverings (type, size and length), fasteners, brackets, troughs, etc.
- The Wire Harness Coster separates the parts and processes to more easily delineate Bill of Material (BOM) costs and build processing costs.

Factors Influencing Cost:

1. Wire count is the primary factor driving cost as it affects the amount of wire, the size of connectors, and the number of assembly processes.
2. Wire selection (wire OD, strand size, strand count / wire) is significant as it directly relates to conductor cross section, and therefore the amount of copper or aluminum used in the harness.
3. Wire length is another major cost factor as it both relates to material cost and to assembly time, as longer lengths require more handling.
4. The total physical connector size is a major cost factor as connectors are a large portion of harness part costs. Total physical connector size also tends to drive assembly costs.



Relative influence of factors on harness costs
(Data based on L32 two-level Taguchi analysis
of the Wire Harness Coster)

Ground, Chassis to Motor



- The Ground, Chassis to Motor consists of 1 wire joining 2 eyelets.
- The wire is 5 mm in diameter and consists of braided wire strands. The overall weight of the harness is 0.0426 kg.
- Both eyelets are crimped and soldered.
- The harness is fully covered in a braided sleeve with heat shrink coverings on both ends.
- All major components are analyzed in detail, while prices are applied to commodity items (i.e. clips, terminals).
- *Estimates are based on actual parts.*
- *Photos: Background on 100mm grid paper.*

Design Profit[®]

EXECUTIVE SUMMARY **Harness Overview**

	0233 - Ground, Chassis to Motor
Parts	7
Steps	31
Assembly Time (min)	1.68
Total Weight (kg)	0.0426
Purchased Part Cost	\$1.47
Supplier Asm. Cost	\$0.49
Q Burden	\$0.04
Total Cost	\$1.99

Design Profit[®]

EXECUTIVE SUMMARY Wire, Cable & Splices

	0233 - Ground, Chassis to Motor
Wire & Cable Count	1
Splice Count	0
Wire Length Total (cm)	15.5
Harness Total Weight	0.0426 kg
Cu Conductor Mass	0.0087 kg
Cu to Harness Mass (%)	20.40 %
Al Conductor Mass	0.0000 kg
Al to Harness Mass (%)	0.00 %
Wire Cost	\$0.13

Design Profit®

EXECUTIVE SUMMARY Connectors & Terminals

	0233 - Ground, Chassis to Motor
Connector Assemblies	0
Sealed Connectors	0
Terminal Cavities	0
Unpopulated Cavities	0
Connector Body Cost	\$0.00
Coax Connectors	0
Coax Connector Cost	\$0.00
Pin & Blade Terminals	0
Ring Terminals	2
Battery Terminals	0
Terminal Strips	0
Total Terminal Count	2
Terminal Cost	\$1.16

Design Profit[®]

EXECUTIVE SUMMARY Labels, Clips, Tape & Coverings

	0233 - Ground, Chassis to Motor
Label Count	1
Label Area cm2	32.0
Label Cost	\$0.08
Clip Count	0
Clip Cost	\$0.00
Tape Tacks	0
Taped Length cm	0.0
Tape Actual Length cm	0.0
Tape Cost	\$0.00
Tube & Wrap Count	1
Heat Shrink Count	2
Covering Count Total	3
Covering Length cm	18.5
Covering Cost	\$0.10

Design Profit[®]


EXECUTIVE SUMMARY Miscellaneous Parts

	0233 - Ground, Chassis to Motor
Bracket Count	0
Bracket Cost	\$0.00
Trough Count	0
Trough Cost	\$0.00
Fuse Count	0
Fuse Cost	\$0.00
Grommet Count	0
Grommet Cost	\$0.00
Misc Part Count	0
Misc Part Cost	\$0.00

Wire Harness Costed Bill of Materials

Harness CBOM

0233 - Ground, Chassis to Motor

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Main Harness	\$1.4707	1	1	Each	\$1.4707


Media:



 C01	\$0.5800	1	1	Each	\$0.5800
---	----------	---	---	------	----------

Media:



 C02	\$0.5800	1	1	Each	\$0.5800
---	----------	---	---	------	----------


Media:



 Braided Sleeve	\$0.0651	1	11.7	cm	\$0.0651
--	----------	---	------	----	----------

Media:








 Heat Shrink	\$0.0156	1	3.4	cm	\$0.0156
---	----------	---	-----	----	----------

Media:



Wire Harness Costed Bill of Materials

0233 - Ground, Chassis to Motor

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
 Heat Shrink Media: 	\$0.0156	1	3.4	cm	\$0.0156
 Label Media: 	\$0.0800	1	1	Each	\$0.0800
 Wire 5.0 OD/ 16x 63-0.08 OD Strands	\$0.1312	1	15.5	cm	\$0.1312

Wire Harness Costed Bill of Process



Assembly Process

0233 - Ground, Chassis to Motor

Symbol Name	Assembly Time	Q Burden	Assembly Cost	Qty	Q Burden (Total)	Assembly Cost (Total)
Wire Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Cut & Strip Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire	4.0000 sec	\$0.00	\$0.02	1	\$0.00	\$0.02
Cut & Strip Wire	1.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Crimp Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Ends	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Terminal, Contact	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Crimp Terminal	1.0000 sec	\$0.00	\$0.00	2	\$0.00	\$0.01
Manual Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Contact (qty/connector)	4.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.04
Soldering Iron	3.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Solder Joint	5.0000 sec	\$0.00	\$0.02	2	\$0.01	\$0.05
Test, Wire Harness	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Electrical Test Equipment	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Grasp & Position Connector	3.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.03
Mate Connectors to test equip	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Test Harness	2.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Coverings & Tape Winding	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Coverings	7.0000 sec	\$0.00	\$0.03	1	\$0.00	\$0.03
Part Manipulation	3.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.03
Heat Shrink	5.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.05
Heat Gun	4.0000 sec	\$0.00	\$0.02	1	\$0.00	\$0.02
Shrink Tube	5.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.05
Label	8.0000 sec	\$0.00	\$0.04	1	\$0.00	\$0.04
Apply Label	8.0000 sec	\$0.01	\$0.04	1	\$0.01	\$0.04

Report Totals

Count: 25

35

\$0.04

\$0.49

[Click Here to Return to Cost Analysis Page 343](#)

Wire Harness Cost Analysis

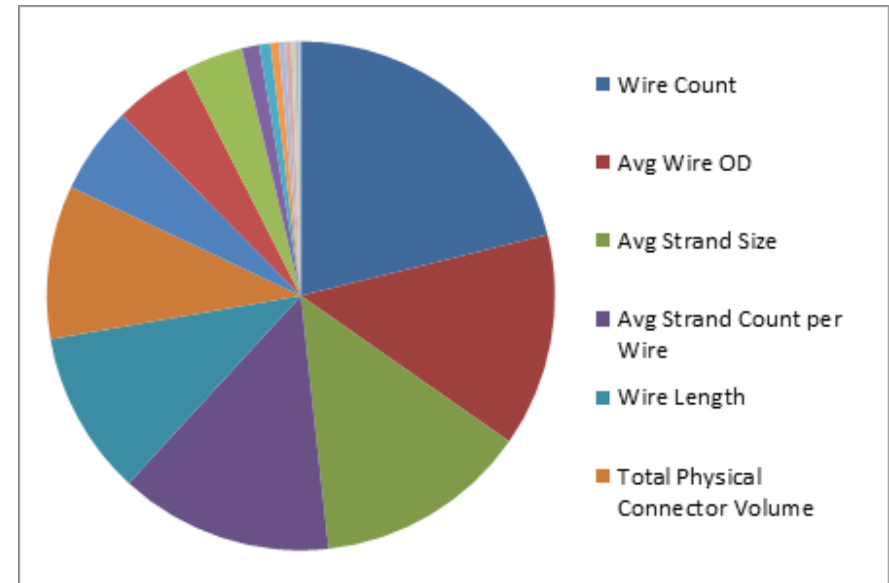
Steering Column Ground Strap

Asm Wire Harness

- The Design Profit[®] based Wire Harness Coster generates cost estimates of various components and assembly processes for the majority of wire harnesses found in today's manufactured products. The Wire Harness Coster rolls up these costs to deliver an estimate of the total manufactured cost.
- Costs are based on several factors including: commodity items, components, burdened machine rates, processing speeds, burdened labor rates, and cost of poor quality drivers.
- The Wire Harness Coster consistently generates a cost estimate for a given wire harness without the need to completely disassemble or destroy the wire harness. Minimal disassembly may be required to capture various attributes and identify overall circuit routing. Inputs to the coster include: connector data (size, cavity count, locking mechanisms and sealing attributes), wire data (sizes quantities and lengths), coverings (type, size and length), fasteners, brackets, troughs, etc.
- The Wire Harness Coster separates the parts and processes to more easily delineate Bill of Material (BOM) costs and build processing costs.

Factors Influencing Cost:

1. Wire count is the primary factor driving cost as it affects the amount of wire, the size of connectors, and the number of assembly processes.
2. Wire selection (wire OD, strand size, strand count / wire) is significant as it directly relates to conductor cross section, and therefore the amount of copper or aluminum used in the harness.
3. Wire length is another major cost factor as it both relates to material cost and to assembly time, as longer lengths require more handling.
4. The total physical connector size is a major cost factor as connectors are a large portion of harness part costs. Total physical connector size also tends to drive assembly costs.



Relative influence of factors on harness costs
(Data based on L32 two-level Taguchi analysis
of the Wire Harness Coster)

Steering Column Ground Strap Asm



The Steering Column Ground Strap Asm consists of 1 wire joining 2 eyelets.

The wire is 5 mm in diameter and has 1008 braided and tinned wire strands. The overall weight of the harness is 0.0323 kg.

Both eyelets are crimped and soldered.

The harness is fully covered in a Fabric Sleeve.

All major components are analyzed in detail, while prices are applied to commodity items (i.e. clips, terminals).

Estimates are based on actual parts.

Photos: Background on 100mm grid paper.

Design Profit[®]

EXECUTIVE SUMMARY Harness Overview

2239 - Steering Column Ground Strap Asm	
Parts	5
Steps	26
Assembly Time (min)	1.28
Total Weight (kg)	0.0323
Purchased Part Cost	\$1.56
Supplier Asm. Cost	\$0.37
Q Burden	\$0.03
Total Cost	\$1.97

Design Profit[®]

EXECUTIVE SUMMARY Wire, Cable & Splices

	2239 - Steering Column Ground Strap Asm
Wire & Cable Count	1
Splice Count	0
Wire Length Total (cm)	11.5
Harness Total Weight	0.0323 kg
Cu Conductor Mass	0.0064 kg
Cu to Harness Mass (%)	19.97 %
Al Conductor Mass	0.0000 kg
Al to Harness Mass (%)	0.00 %
Wire Cost	\$0.10

Design Profit®

EXECUTIVE SUMMARY Connectors & Terminals

	2239 - Steering Column Ground Strap Asm
Connector Assemblies	0
Sealed Connectors	0
Terminal Cavities	0
Unpopulated Cavities	0
Connector Body Cost	\$0.00
Coax Connectors	0
Coax Connector Cost	\$0.00
Pin & Blade Terminals	0
Ring Terminals	2
Battery Terminals	0
Terminal Strips	0
Total Terminal Count	2
Terminal Cost	\$1.30

Design Profit[®]

EXECUTIVE SUMMARY Labels, Clips, Tape & Coverings

2239 - Steering Column Ground Strap Asm	
Label Count	1
Label Area cm2	32.0
Label Cost	\$0.08
Clip Count	0
Clip Cost	\$0.00
Tape Tacks	0
Taped Length cm	0.0
Tape Actual Length cm	0.0
Tape Cost	\$0.00
Tube & Wrap Count	1
Heat Shrink Count	0
Covering Count Total	1
Covering Length cm	9.1
Covering Cost	\$0.08



Design Profit[®]

EXECUTIVE SUMMARY Miscellaneous Parts

	2239 - Steering Column Ground Strap Asm
Bracket Count	0
Bracket Cost	\$0.00
Trough Count	0
Trough Cost	\$0.00
Fuse Count	0
Fuse Cost	\$0.00
Grommet Count	0
Grommet Cost	\$0.00
Misc Part Count	0
Misc Part Cost	\$0.00

Wire Harness Costed Bill of Materials

Harness CBOM

2239 - Steering Column Ground Strap Asm

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
■ Main Harness	\$1.5624	1	1	Each	\$1.5624

Media:



■ C01	\$0.5500	1	1	Each	\$0.5500
-------	----------	---	---	------	----------

Media:



■ C02	\$0.7500	1	1	Each	\$0.7500
-------	----------	---	---	------	----------

Media:



■ Braided Sleeve	\$0.0826	1	9.1	cm	\$0.0826
------------------	----------	---	-----	----	----------

Media:



■ Label	\$0.0800	1	1	Each	\$0.0800
---------	----------	---	---	------	----------

Media:



Wire Harness Costed Bill of Materials



2239 - Steering Column Ground Strap Asm

Name	Purchased Part Cost	Item Qty	Measure	Unit of Measure	Purchased Part Cost (Total)
Wire 5.0 OD/ 16x 63- 0.08 OD Strands	\$0.0974	1	11.5	cm	\$0.0974

Wire Harness Costed Bill of Process



Assembly Process

2239 - Steering Column Ground Strap Asm

Symbol Name	Assembly Time	Q Burden	Assembly Cost	Qty	Q Burden (Total)	Assembly Cost (Total)
Wire Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Cut & Strip Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire	4.0000 sec	\$0.00	\$0.02	1	\$0.00	\$0.02
Cut & Strip Wire	1.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Wire Crimp Machine, Automatic	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Ends	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Terminal, Contact	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Crimp Terminal	1.0000 sec	\$0.00	\$0.00	2	\$0.00	\$0.01
Manual Operation	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Insert Wire Contact (qty/connector)	4.0000 sec	\$0.00	\$0.02	2	\$0.00	\$0.04
Soldering Iron	3.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Solder Joint	5.0000 sec	\$0.00	\$0.02	2	\$0.01	\$0.05
Test, Wire Harness	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Electrical Test Equipment	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Grasp & Position Connector	3.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.03
Mate Connectors to test equip	2.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.02
Test Harness	2.0000 sec	\$0.00	\$0.01	1	\$0.00	\$0.01
Coverings & Tape Winding	0.0000 sec	\$0.00	\$0.00	1	\$0.00	\$0.00
Coverings	7.0000 sec	\$0.00	\$0.03	1	\$0.00	\$0.03
Part Manipulation	3.0000 sec	\$0.00	\$0.01	2	\$0.00	\$0.03
Label	8.0000 sec	\$0.00	\$0.04	1	\$0.00	\$0.04
Apply Label	8.0000 sec	\$0.01	\$0.04	1	\$0.01	\$0.04

Report Totals

Count: 22

30 \$0.03 \$0.37

***Click Here to Return to
Cost Analysis Page 345***

BMW i3 Plant Assembly Line Videos:

- <https://www.youtube.com/watch?v=gt1k3BLN7pw>
- <https://www.youtube.com/watch?v=1u7XiBnwPCw>
- <https://www.youtube.com/watch?v=htuVoxuMQFQ>
- <https://www.youtube.com/watch?v=kfISmVGCjxg>
- <https://www.youtube.com/watch?v=29VHdcOvnK8>
- https://www.youtube.com/watch?v=x3brfAEs_RY
- <https://www.youtube.com/watch?v=Zyf9JhfXu5k>

Tesla Motors Inspires BMW To Share Battery Technology:

- <http://www.fool.com/investing/general/2014/07/17/tesla-motors-inc-inspires-bmw-to-share-battery-tec.aspx>

Efficiency And Performance Meet In BMW's i3

- <http://www.greenbiz.com/blog/2014/06/30/efficiency-and-performance-meet-bmws-i3>