Timer/Counter/Analyzer

PM6690

Service Manual

FLUKE ®

4822 872 20306
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GENERAL INFORMATION

Method of Notation

This manual contains directions and information that apply to the PM6690 Timer/Counter/Analyzer. In order to simplify the references, the following designation system is used throughout the manual:

– PM6690 is abbreviated to *'90'*.

Warranty

The Warranty Statement is included in the Getting Started Manual.

Declaration of Conformity

The complete text with formal statements concerning product identification, manufacturer and standards used for type testing is available on request.

Hardware Versions

This Service Manual provides Source of Supply information for the Fluke Model PM6690 Timer/Counter/Analyzer, which may contain an OLD version of the Main CCA, called Version A, or a NEW version of the Main CCA, called Version B. Both the old and the new version of the Main CCA have the same part number. All orders for the old version of the Main CCA will be filled with the new version of the Main CCA. When the old version of the Main CCA is returned to the factory for repair, the new version of the Main CCA will be returned in place of the old version of the Main CCA, if the microprocessor has to be replaced.

Devices with serial numbers up to and including 916779 are equipped with a Triscend microprocessor, whereas devices with higher serial numbers have a Sharp microprocessor. Both are based on an ARM7 core, and from the operator's point of view the behavior is not affected. However, essential parts of the main PCB differ, and the corresponding sections of the service manual are consequently affected. Even though large parts of the hardware are common to both versions, we have preferred to divide the pertinent chapters into separate sections, where certain parts are repeated, all in order to improve legibility and simplify troubleshooting.

Version A refers to devices equipped with the Triscend microprocessor.
Version B refers to devices equipped with the Sharp microprocessor.

The chapters that need special attention are:

Chapter 4, Circuit Descriptions
Chapter 6, Repair
Chapter 8, Replacement Parts
Chapter 9, Schematic Diagrams

■ Firmware Compatibility

Despite the relatively large hardware differences, we have managed to integrate the firmware, so that future upgrades can be applied to both versions by means of the same hex file. Thus there is no need to check the serial number or else find out which processor is inside the cover. Just proceed according to the instructions given in Chapter 5, Corrective & Preventive Maintenance.

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Contents

Chapter 1

Safety Instructions

WARNING: These servicing instructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other than that specified in the Operators Manual unless you are fully qualified to do so.

Caution and Warning Statements

Introduction

Read this chapter carefully before you check, adjust or repair the instrument.

It is essential for your own safety to know the restrictions that are applicable to all equipment that can be connected to line power. Therefore, read the section on *Safety Precautions* below.

In addition to the general statements given in this chapter you will find specific caution and warning statements where necessary throughout the manual.

Safety Precautions

This instrument has been designed and tested for Measurement Category I, Pollution Degree 2, in accordance with EN/IEC 61010-1:2001 and CAN/CSA-C22.2 No. 61010-1-04 (including approval). It has been supplied in a safe condition.

This manual contains information and instructions that should be followed by the user and the service technician to ensure safe operation and repair in order to keep the instrument in a safe condition. It is essential that you follow generally accepted safety procedures in addition to the safety precautions specified in this manual.

The instrument is designed to be used by trained personnel only. Removing the cover for repair, maintenance, and adjustment of the instrument must be done by qualified personnel who are aware of the hazards involved.

The warranty commitments are rendered void if unauthorized access to the interior of the instrument has taken place during the given warranty period.

CAUTION: Indicates where incorrect procedures can cause damage to, or destruction of equipment or other property.

WARNING: Indicates a potential danger that requires correct procedures or practices to prevent personal injury.

Symbols

Shows where the protective ground terminal is connected inside the instrument. **Never** remove or loosen this screw.

Indicates that the operator should consult the manual.

You can, for instance, find such a symbol on the front panel below the A and B inputs. It points out that the damage level for the input voltage decreases from 350 V_p to 12 V_{rms} when you switch the input impedance from 1 MΩ to 50 Ω.

If in Doubt about Safety

Whenever you suspect that it is unsafe to use the instrument, you must make it inoperative by doing the following:

– Disconnecting the line cord

– Clearly marking the instrument to prevent its further operation by unauthorized personnel

For example, the instrument is likely to be unsafe if it is visibly damaged.

Grounding

Grounding faults in the line voltage supply will make any instrument connected to it dangerous. Before connecting any unit to the power line, you must ensure that the protective ground functions correctly. Only then can a unit be connected to the power line and only by using a three-wire line cord. No other method of grounding is permitted. Extension cords must always have a protective ground conductor.

CAUTION: If a unit is moved from a cold to a warm environment, condensation may cause a shock hazard. Ensure, therefore, that the grounding requirements are strictly met.

WARNING: Never interrupt the grounding cord. Any interruption of the protective ground connection inside or outside the instrument or disconnection of the protective ground terminal is likely to make the instrument dangerous.

Operation

Orientation and Cooling

The instrument can be operated in any position desired. Make sure that the air flow through the ventilation slots at the top, and side panels is not obstructed. Leave 5 centimeters (2 inches) of space around the counter.

Fold-Down Support

For bench-top use, a fold-down support is available for use underneath the counter. This support can also be used as a handle to carry the instrument.

Rackmount Adapter

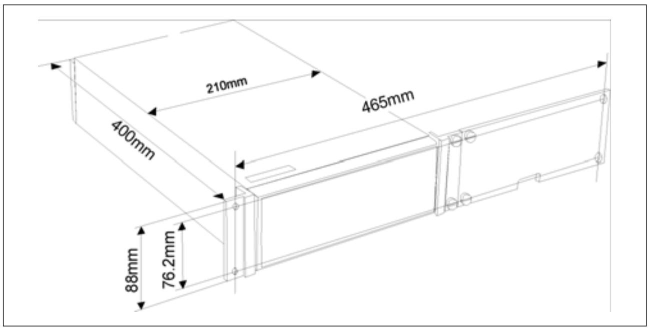


Fig. 1-1 *Dimensions for rackmounting hardware.*

If you have ordered a 19-inch rack-mount kit for your instrument, it has to be assembled after delivery of the instrument. The rackmount kit consists of the following:

– 2 brackets, (short, left; long, right)
– 4 screws, M5 x 8
– 4 screws, M6 x 8

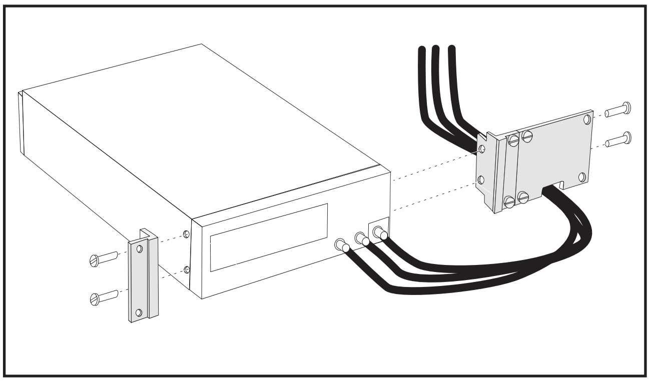


Fig. 1-2 *Fitting the rack mount brackets on the counter.*

WARNING: Do not perform any internal service or adjustment of this instrument unless you are qualified to do so.

Before you remove the cover, disconnect mains cord and wait for one minute.

Capacitors inside the instrument can hold their charge even if the instrument has been separated from all voltage sources.

■ Assembling the Rackmount Kit

– Make sure the power cord is disconnected from the instrument.
– Turn the instrument upside down. See Fig. 1-3.
– Undo the two screws (A) and remove them from the cover.
– Remove the rear feet by undoing the two screws (B).
– Remove the four decorative plugs (C) that cover the screw holes on the right and left side of the front panel.
– Grip the front panel and gently push at the rear.
– Pull the instrument out of the cover.

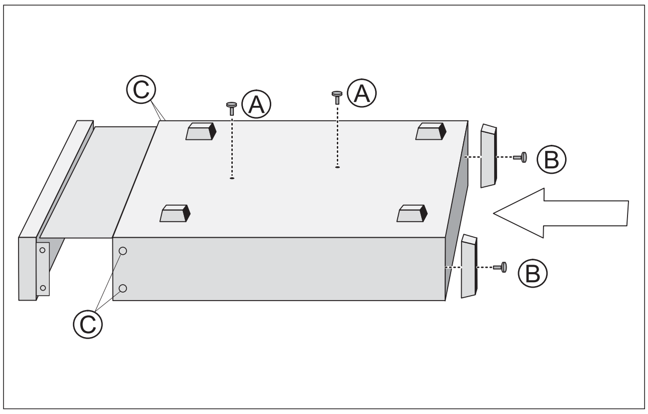


Fig. 1-3 *Remove the screws and push the counter out of the cover.*

– Remove the four feet from the cover.

Use a screwdriver as shown in the following illustration or a pair of pliers to remove the springs holding each foot, then push out the feet.

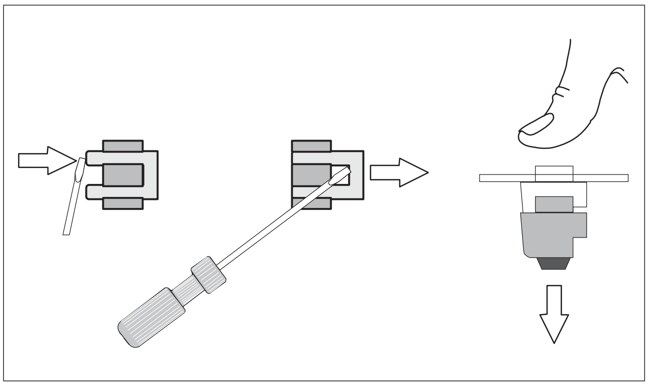


Fig. 1-4 *Removing feet from the cover.*

– Push the instrument back into the cover. See Fig. 1-3.
– Mount the two rear feet with the screws (B) to the rear panel.
– Put the two screws (A) back.
– Fasten the brackets at the left and right side with the screws included as illustrated in Fig. 1-1.
– Fasten the instrument in the rack via screws in the four rack-mounting holes

The long bracket has an opening so that cables for Input A, B, and C can be routed inside the rack.

■ Reversing the Rackmount Kit

The instrument may also be mounted to the right in the rack. To do so, first remove the plate on the long bracket and fasten it on the short one, then perform the preceding steps.

Line Voltage

■ Setting

The Counter may be connected to any AC supply with a voltage rating of 90 to 265 V_{rms}, 45 to 440 Hz. The counter automatically adjusts itself to the input line voltage.

■ Fuse

The secondary supply voltages are electronically protected against overload or short circuit. The primary line voltage side is protected by a fuse located on the power supply unit. The fuse rating covers the full voltage range. Consequently there is no need for the user to replace the fuse under any operating conditions, nor is it accessible from the outside.

CAUTION: If this fuse is blown, it is likely that the power supply is badly damaged. Replace the complete power supply unit. Do not replace the fuse.

Chapter 2

Performance Check

General Information

> **WARNING: Before turning on the instrument, ensure that it has been installed in accordance with the Installation Instructions outlined in Chapter 1 of the Operators Manual.**

This performance procedure is intended for:

– checking the instrument's specification.

– incoming inspection to determine the acceptability of newly purchased instruments and recently recalibrated instruments.

– checking the necessity of recalibration after the specified recalibration intervals.

NOTE: The procedure does not check every facet of the instrument's calibration; rather, it is concerned primarily with those parts of the instrument which are essential for determining the function of the instrument.

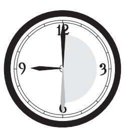
It is not necessary to remove the instrument cover to perform this procedure.

Test Equipment

Type of Equipment	Required Specifications
Reference Oscillator	10 MHz, $1*10^{-8}$ (e.g. 908) for calibrating PM6690/_1_
	10 MHz, $1*10^{-9}$ (e.g. 909) for calibrating PM6690/_5_ & PM6690/_6_
Voltage Calibrator	DC -50 V to +50 V (e.g. 5500A) for calibrating the built-in voltage reference, alternatively corresponding DC power supply + DVM with uncertainty <0.1 %
LF Synthesizer	Square/ Sine up to 10 MHz, 10 V_{RMS}
Pulse Generator	2 ns rise time, 5 V peak, >10 MHz, continuous & one-shot trigger
Oscilloscope	350 MHz, <3% voltage uncertainty
RF Signal Generator	10 MHz to 3 or 8 GHz dep. on prescaler option, 10 MHz ext.ref.
Power Splitter	50 Ω 6 dB BNC
T Adapter (F-M-F)	BNC
Termination	50 Ω feedthrough BNC
Lowpass Filter	50 kHz (for 1 MΩ load)
BNC Cables	5 to 7 pcs of suitable lengths

Table 2-1 *Recommended equipment for calibration and performance check.*

Preparations



Power up your instrument at least 30 minutes before checking to let it reach normal operating temperature. Failure to do so may result in certain test steps not meeting equipment specifications.

Front Panel Controls

Internal Self-Tests

The test programs forming the self-diagnosis can be activated from the front panel as follows:

– Press **USER OPT**

– Press **Test**.

– Press **Test Mode**.

– Select one of the six tests available by pressing the softkey below the label with the name of the test function. Five of the tests (RAM, ROM, Logic, Display, and Interface) are individual. They are briefly described below. The sixth, named **All**, performs all five individual tests in sequence.

- **All** - all tests performed in sequence
- **RAM** - test of RAM memory
- **ROM** - test of ROM memory
- **Logic** - test of counter ASIC and other logic circuits.
- **Display** - test of graphic display module
- **Interface** - test of GPIB and USB

– Press **Start Test**.

– If a fault is detected, an error message appears on the display and the program halts. Note any error messages.

– If no faults are detected, the instrument returns to the normal measurement mode.

Keyboard Test

See Table 2-3. This test verifies that the timer/counter responds when you press any key. It is not a functional test. Such tests are performed later in this chapter. The important thing here is that something changes on the display when you press a key. Consequently you can press the keys in almost any order without paying attention to the exact response, but for those who want to be more systematic there is a table overleaf, where all keys are exercised at least once.

Press the keys as described in the first column and look at the display for the text in the second column. Some keys change more text on the display than described here. The display text mentioned here is the one mostly associated with the selected key.

NOTE: For the instrument to respond correctly, this test must be carried out in sequence and you must start with the DEFAULT setting. Do as follows:

– Press **USER OPT**.

– Press **Save/Recall**.

– Press **Recall Setup**.

– Press **Default**.

See Table 2-2 for the complete list of default settings.

PARAMETER	VALUE/SETTING
Input A & B	
Trigger Level	AUTO
Trigger Slope	POS
Impedance	1 MΩ
Attenuator	1x
Coupling	AC
Filter	OFF
Arming	
Start	OFF
Start Slope	POS
Start Arm Delay	200 µs
Stop	OFF
Stop Slope	POS
Hold-Off	
Hold-Off State	OFF
Hold-Off Time	200 µs
Time-Out	
Time-Out State	OFF
Time-Out Time	100 ms
Statistics	
Statistics	OFF
No. of Samples	100
No. of Bins	20
Pacing State	OFF
Pacing Time	20 ms
Mathematics	
Mathematics	OFF
Math Constants	K=1, L=0, M=1
Limits	
Limit State	OFF
Limit Mode	ABOVE
Lower Limit	0
Upper Limit	0
Burst	
Sync Delay	200 µs
Start Delay	200 µs
Meas. Time	200 µs
Freq. Limit	300 MHz
Miscellaneous	
Function	FREQ A
Meas. Time	200 ms
Smart Time Interval	OFF
Auto Trig Low Freq	100 Hz
Timebase Reference	INT

Table 2-2 *Default settings for functions and parameters.*

KEY(S)	DISPLAY	NOTES	P/F
STANDBY	**Off**	Red standby LED On (Key common to ON)	
ON	**Backlight On**	Red standby LED Off (Key common to STANDBY)	
INPUT A	**Input A:**	Menu for setting Slope, Coupling, Impedance etc.	
Man	**Trig xx mV**		
Trig	**Trig: xx mV**	Menu for entering numeric values	
0.123V	**Trig: 0.123 V**		
◀ (5 times)	**Trig: _ V**		
4.567	**Trig: 4.567 V**		
◀ (5 times)	**Trig: _ V**		
8.9	**Trig: 8.9 V**		
±	**Trig: -8.9 V**		
mV	**Trig: -8.9 mV**		
V	**Trig: -8.9 V**		
AUTOSET	**Menu** disappears		
INPUT B	**Input B:**	Menu for setting Slope, Coupling, Impedance etc.	
SETTINGS	**Settings:**	Menu for setting Meas Time, Hold-Off, Ref. Source etc.	
ENTER	**Meas Time: 200 ms**		
▲	**Meas Time: 500 ms**		
▼	**Meas Time: 200 ms**		
EXIT/OK	**Settings:**	Menu for setting Meas Time, Hold-Off, Ref. Source etc.	
EXIT/OK	**Menu** disappears		
MATH/LIM	**Math/Limit:**	Menu for selecting post-processing formula and alarm limit	
USER OPT	**User options:**	Menu for Calibration, Memory Management, Interface etc.	
CANCEL	**Menu** disappears		
HOLD/RUN	**Hold**	At upper right corner	
HOLD/RUN	**Hold** disappears		
MEAS FUNC	**Measure function:**	Menu for selecting measurement function	
▶	**Period**	Cursor position marked by text inversion	
ENTER	**Single A**		
EXIT/OK	**Menu** disappears	Period Single A: at upper left corner	
STAT/PLOT	**Period Single A MEAN:**	Aux parameters: Max, Min, P-P, Adev, Std	
VALUE	**Stat** parameters disappear		

Table 2-3 *Keyboard test.*

Short Form Specification Test

Sensitivity and Frequency Range

– Recall the DEFAULT settings.
– Press **INPUT A**.
– Select **50** Ω input impedance, **1x** attenuation, **MAN**ual trigger and **Trig**ger level **0 V**.
– Connect a signal from a HF generator to a BNC power splitter.
– Connect the power splitter to Input A of your counter and an oscilloscope.
– Set the input impedance to 50 Ω on the oscilloscope.
– Adjust the amplitude according to the following table. Read the level on the oscilloscope. The timer/counter should display the correct frequency.
– Connect the signal to Input B.
– Press **INPUT B**.
– Select **50** Ω input impedance, **1x** attenuation, **MAN**ual trigger and **Trig**ger level **0 V**.
– Press **MEAS FUNC → Freq → Freq A →B**
– Repeat the measurements above for Input B.

Frequency (MHz)	Level		Pass/Fail	
	mV_{rms}	dBm	Input A	Input B
10	15	–23		
50	15	–23		
100	15	–23		
200	15	–23		
300	25	–19		

Table 2-5 *Sensitivity for inputs A & B at various frequencies*

Voltage

– Recall the DEFAULT settings.
– Press **MEAS FUNC → Volt → Vpp → A**
– Press **INPUT A** and select **DC** coupling. Do not apply an input signal to Input A yet.
– Press **EXIT/OK**.
– The display should now indicate (disregard the main parameter V_{PP}):
V_{MIN} = 0 ± 0.015 V and
V_{MAX} = 0 ± 0.015 V
– Adjust the current limit of the voltage source to <200 mA.
– Connect +2.500 V_{DC} to Channel A, using the external low-pass filter on the input.
– The display should now indicate:
V_{MIN} = 2.500 ± 0.040 V and
V_{MAX} = 2.500 ± 0.040 V
– Repeat the measurement with inverted polarity.
– Press **INPUT A** and select **10x**.
– Press **EXIT/OK**.

> **CAUTION: Before the next step, make sure the input impedance is still 1 MΩ. Applying more than 12 V without proper current limiting may cause extensive damage to the main PCB, if the impedance is set to 50 Ω.**

– Change the DC level to +50.00 V.
– The display should now indicate:
V_{MIN} = 50.00 ± 0.65 V and
V_{MAX} = 50.00 ± 0.65 V
– Repeat the measurement with inverted polarity.
– Disconnect the DC voltage from Channel A.
– Remove the external low-pass filter.
– Press **INPUT A** and select **1x**.
– Press **EXIT/OK**.
– Connect a sinusoidal signal to Input A with an amplitude of 4.000 Vpp and a frequency of 100 kHz.
– The display should now indicate: 4.000 ± 0.150 V_{PP}.
– Press **INPUT A** and select **10x**.
– Press **EXIT/OK**.
– Change the amplitude to 18.00 V_{PP}.
– The display should now indicate:
18.00 ± 0.84 V_{PP}.
– Disconnect the signal from Channel A.
– Press **MEAS FUNC → Volt → Vpp →B**
– Press **INPUT B** and select **DC** coupling. Do not apply an input signal to Input B yet.
– Press **EXIT/OK**.
– The display should now indicate (disregard the main parameter V_{PP}):
V_{MIN} = 0 ± 0.015 V and
V_{MAX} = 0 ± 0.015 V
– Proceed by repeating the measurements for Input B as described above for Input A.

Trigger Indicators vs. Trigger Levels

Trigger Level (manually set)	Trigger Indicator	Pass	
		Input A	Input B
+1 V	off		
-1 V	on		
0.0 V	blinking		

Table 2-4 *Trigger indicator check.*

NOTE: This test must be performed in the sequence given.
– Recall the DEFAULT settings.

– Press **INPUT A** and select **MAN**ual trigger level and **50** Ω input impedance.

– Connect the LF synthesizer to Input A. Use the following settings (into 50 Ω):
Sine, 10 kHz, 0.9 V_{PP}, and +0.50 V_{DC}.

– Verify that the three modes for the trigger indicator are working properly by changing the trigger level:
  – Press the **Trig** key and enter +1 V via the keyboard, then verify by pressing **EXIT/OK.** Check the trigger indicator according to Table 2-4.
  – Press the **Trig** key and enter –1 V via the keyboard by pressing the **±** key, then verify by pressing **EXIT/OK**. Check the trigger indicator according to Table 2-4.
  – Press the **Trig** key and enter 0 via the keyboard, then verify by pressing **EXIT/OK**. Check the trigger indicator according to Table 2-4.

– Apply the signal to Input B instead.

– Press **MEAS FUNC** → **Freq** → **Freq (A)** → **B**

– Press **INPUT B** and select **MAN**ual trigger level and **50** Ω input impedance..

– Repeat the trigger level settings above to verify the three trigger indicator modes for Input B.

Input Controls

– Recall the DEFAULT settings.

– Connect the LF synthesizer to Input A. Use the same settings as in the previous test.

– Press **INPUT A** and select **DC** and **50** Ω.

– Press **EXIT/OK**.

– Check the V_{max} and V_{min} voltage levels on the display according to the first row in Table 2-6.

– Perform the rest of the settings in sequence, and read the corresponding V_{max} and V_{min} values. Remember that all these values are approximate and serve only as indicators of state changes.

Settings	V_{max}	V_{min}	Pass/Fail	
			Input A	Input B
INPUT A, DC, 50 Ω	+950 mV	+50 mV		
AC	+450 mV	-450 mV		
10X	+0.45 V	-0.45 V		
1 MΩ	>+0.45 V	<-0.45 V		

Table 2-6 *Input controls check.*

– Connect the generator to Input B.

– Press **MEAS FUNC** → **Freq** → **Freq (A)** → **B**

– Press **INPUT B** and select **DC** and **50** Ω.

– Press **EXIT/OK**.

– Check the V_{max} and V_{min} voltage levels on the display according to the first row in Table 2-6.

– Perform the rest of the settings in sequence, and read the corresponding V_{max} and V_{min} values.

Reference Oscillators

X-tal oscillators are affected by a number of external conditions like ambient temperature and supply voltage. Aging is also an important factor. Therefore it is hard to give limits for the allowed frequency deviation. The user himself must decide the limits depending on his application, and recalibrate the oscillator accordingly.

To check the accuracy of the oscillator you must have a calibrated reference signal that is at least five times more stable than the oscillator that you are testing. See Table 2-7 and the list of test equipment on page 2-2. If you use a non-10 MHz reference, you can use the mathematics in the timer/counter to multiply the reading.

– Recall the DEFAULT settings. See page 2-2

– Connect the reference to input A

– Check the readout against the accuracy requirements of your application.

■ Acceptance Test

Oscillator	Frequency Readout	Suitable Reference	P/F
Standard (PM6690/_1_)	10.00000000 MHz ± 150 Hz	908	
OCXO (PM6690/_5_)	10.00000000 MHz ± 1 Hz	909	
OCXO (PM6690/_6_)	10.00000000 MHz ± 0.25 Hz	909	

Table 2-7 *Acceptance test for oscillators.*

Table 2-7 can serve as an acceptance test and gives a worst case figure after 30 minutes warm-up time. All deviations that can occur in a year are added together.

Resolution Test

– Connect the pulse generator to a power splitter.

– Connect one side of the power splitter to Input A on the counter using a coaxial cable.

– Connect the other side of the power splitter to Input B on the counter.

Settings for the pulse generator:

– Amplitude = 2 V_{PP}, (high level +2V and low level 0 V)

– Period = approx. 1 μs

– Duration = approx. 50 ns

– Rise time = 2 ns

Restore the timer/counter's default settings and make the following changes:

– Function = **Time A-B**

– Press **STAT/PLOT** key to the right of the display.

– Settings for **INPUT A** and **INPUT B**:

50 Ω input impedance

MANual trigger level

Selected Function	Action	Display	P/F
FREQ A		10 MHz 2)	
FREQ B		10 MHz 2)	
FREQ C		- - - - - - - - - - - - - - 3)	
FREQ RATIO A/B		1.0000000	
FREQ RATIO C/B		0.0000000 3)	
PER SINGLE A		100 ns 2)	
PER SINGLE B		100 ns 2)	
PER AVERAGE A		100 ns 2)	
PER AVERAGE B		100 ns 2)	
PULSE POS A		50.000 ns 1)	
PULSE NEG A		50.000 ns 1)	
TIME INT A to B		0 ± 1 ns	
	Select NEG SLOPE B	50.000 ns 1)	
RISE TIME A	Select AUTO trigger	30.000 ns 2)	
FALL TIME A		30.000 ns 2)	
PHASE A rel B		180° or -180° 1)	
PHASE B rel A		180° or -180° 1)	
PHASE A rel A		0°	
DUTY POS A		0.500000 1)	
DUTY NEG A		0.500000 1)	
VOLT MAX A		+0.75 V 2)	
VOLT MIN A		-0.75 V 2)	

Table 2-8 *Measuring functions check*
1) Value depends on the symmetry of the signal.
2) Exact value depends on input signal.
3) If an RF option is installed.

Trig level = 0.5V

DC coupling

The standard deviation (**Std**) should be <100 ps.

Rear Inputs/Outputs

10 MHz OUT

– Connect an oscilloscope to the 10 MHz output on the rear of the counter. Use a coaxial cable and 50 Ω termination.

– The output voltage should be sinusoidal and above 1 V_{RMS} (2.8 V_{p-p}).

EXT REF FREQ INPUT

– Recall the DEFAULT settings.

– Connect a stable 10 MHz signal (e.g REF OUT from another counter) to input A.

– Connect a 10 MHz, 100 mV_{RMS}, (0.28 V_{P-P}) signal from the LF synthesizer to EXT REF IN.

– Select Ext Ref. by keying in the following sequence: **SETTINGS → Timebase Ref → Ext**

– The display should show 10 MHz.

– Change the external reference frequency to 5 and 1 MHz.

– The counting should continue, and the display should still show 10 MHz.

EXT ARM INPUT

– Proceed from the test above.

– Select **MAN**ual trigger.

– Settings for the pulse generator:
single shot pulse, manual trigger,
amplitude TTL = 0 - 2 V_{PP}, and
duration = 10 ns.

– Connect the pulse generator to Ext Arm Input.

– Activate start arming by keying in the following sequence:
SETTINGS → Start Chan → E

– The counter does not measure.

– Apply one single pulse to Ext Arm Input.

– The counter measures once and shows 10 MHz on the display.

Measuring Functions

– Connect a 10 MHz sine wave signal with approx. 1 V_{RMS} amplitude into 50 Ω via a power splitter to Input A and Input B, e.g. from 10 MHz Out on the rear panel.

– Recall the DEFAULT settings.

Select the following settings for the timer/counter via **INPUT A** and **INPUT B**:

– **50** Ω impedance for A and B.

– **MAN**ual trigger.

– Check that the timer/counter performs the correct measurement by displaying the result as shown under the "Display" column in Table 2-8.
– Select function via **MEAS FUNC**

Check of HOLD OFF Function

– Recall the DEFAULT settings.
– Select **Period Single A**.

Select the following common timer/counter settings for both Input A and Input B via the hard menu keys **INPUT A** and **INPUT B**:

– **50** Ω impedance.
– **DC** coupling.
– **MAN**ual trigger, **x1** attenuation.
– Press **SETTINGS** and activate **Hold Off**. Select **Hold Off On** and set the **Trigger Hold Off** time to the minimum value 20 ns.
– Connect the rear panel output marked 10 MHz OUT to Input A.
– Increase the **Trigger Hold Off** time in steps by means of the **UP** cursor key and note the results:

If Trigger Hold Off time <100 ns the result is about 100 ns, i.e. the same value as without Hold Off.

If Trigger Hold Off time >100 ns the result is about 100 ns + Trig Hold Off time.

– Connect the signal to Input B, select **Period Single B** and repeat the tests above.

RF Options

Input C Check

To verify the specification of the different RF prescalers (Input C), use the following basic test setup:

– Connect the output of a signal generator covering the specified frequency range to the RF input of the counter.
– Connect the 10 MHz REF OUT from the generator to the EXT REF IN on the rear panel of the counter.
– Choose **Meas Ref** from the **SETTINGS** menu and select **External**.
– Choose **Freq C** from the **MEAS FUNC** menu.
– Generate a sine wave in accordance with the tables.
– Verify that the counter is counting correctly. (The last digits will be unstable)

Frequency	Amplitude		P/F
MHz	mV_{RMS}	dBm	
100-300	20	-21	
300-2500	10	-27	
2500-2700	20	-21	
2700-3000	40	-15	

Table 2-9 *RF input sensitivity, 3 GHz Option.*

Frequency	Amplitude		P/F
MHz	mV_{RMS}	dBm	
300-500	20	-21	
500-3000	10	-27	
3000-4500	20	-21	
4500-6000	40	-15	
6000-8000	80	-9	

Table 2-10 *RF input sensitivity, 8 GHz Option.*

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Chapter 3

Disassembly

The terms in the following figure are used in all descriptions in this manual.

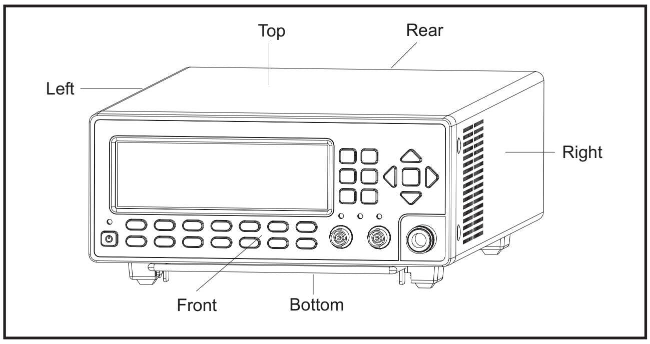

Figure 3-1 *Terms used in this manual.*

The PM6690 can be equipped with a number of options and accessories. Built-in timebase and prescaler options can be identified by pressing **USER OPT** → **About** on the front panel.

The following built-in options exist or are planned:

– Option PM6690/6__ 3 GHz RF Prescaler Input

– Option PM6690/7__ 8 GHz RF Prescaler Input

– Option PM6690/_5_ Very High Stability OCXO

– Option PM6690/_6_ Ultra-High Stability OCXO

The location of these optional parts is illustrated in Fig. 3-2 and Fig 3-3.

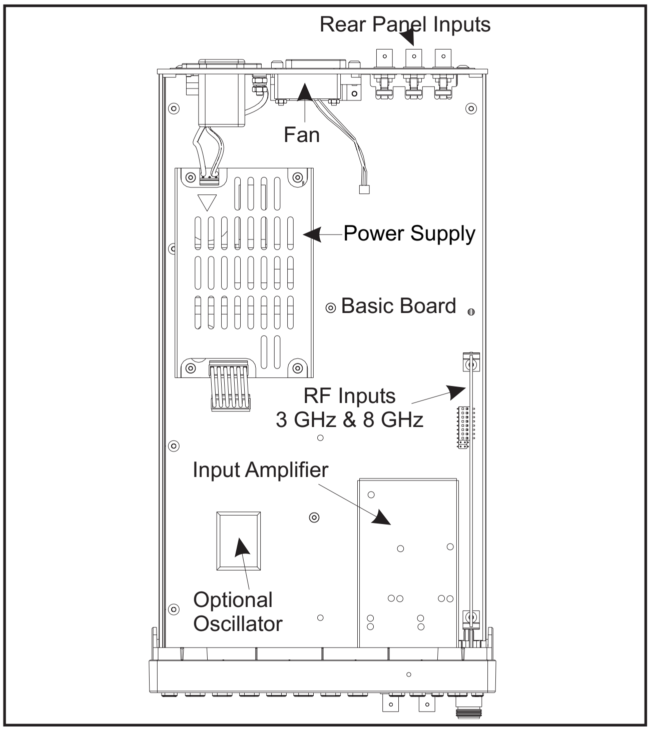

Figure 3-2 *Interior layout including 3 GHz or 8 GHz prescaler option.*

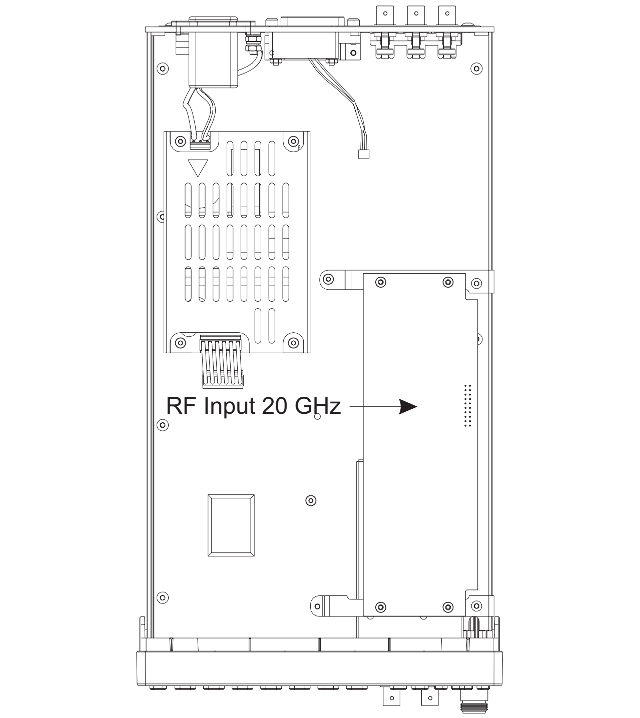

Figure 3-3 *Interior layout with 20 GHz prescaler option.*

Removing the Cover

WARNING: Do not perform any internal service or adjustment of this instrument unless you are qualifyed to do so.

WARNING: When you remove the cover you will expose live parts and accessible terminals which can cause death.

WARNING: Although the power switch is in the OFF position, line voltage is present inside the instrument. Use extreme caution.

WARNING: Capacitors inside the instrument can hold their charge even if the instrument has been separated from all voltage sources.

– Make sure the power cord is disconnected from the counter.

– Turn the counter upside down.

– Remove the two screws at the bottom and the two screws in the rear feet.

– Remove the four decorative plugs (C) that cover the four screw holes on the right and left side of the front panel.

– Grip the front panel and gently push at the rear.

– Pull the interior unit out of the cover.

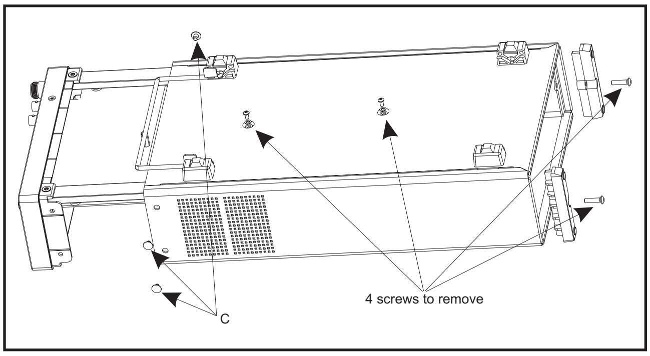

Figure 3-5 *Remove the screws and pull out the main PCB.*

Reinstalling the Cover

– Push the counter gently back into the cover.

– Turn it upside down

– Fit the two screws at the bottom.

– Fit the two rear feet with their screws to the rear panel.

– Fit the four decorative plugs.

Fan

– Disconnect the power cable.

– Remove the cover from the counter. See page 3-2.

– Remove the four screws, nuts and washers that fix the fan to the rear panel.

– Disconnect the fan power supply connector from the main PCB and remove the fan.

– When reinstalling the fan, make sure the air-flow arrow on the fan points to the rear of the counter and the black wire is oriented toward the rear panel.

Prescaler Options

– Disconnect the power cable.

– Remove the cover from the counter. See page 3-2.

– Disconnect the cable from the mini-coax connector on the RF input.

– Press the clips apart and lift the RF input PCA straight up and out.

– When installing the RF input, make sure the connector pins fit exactly in the holes of the connector housing.

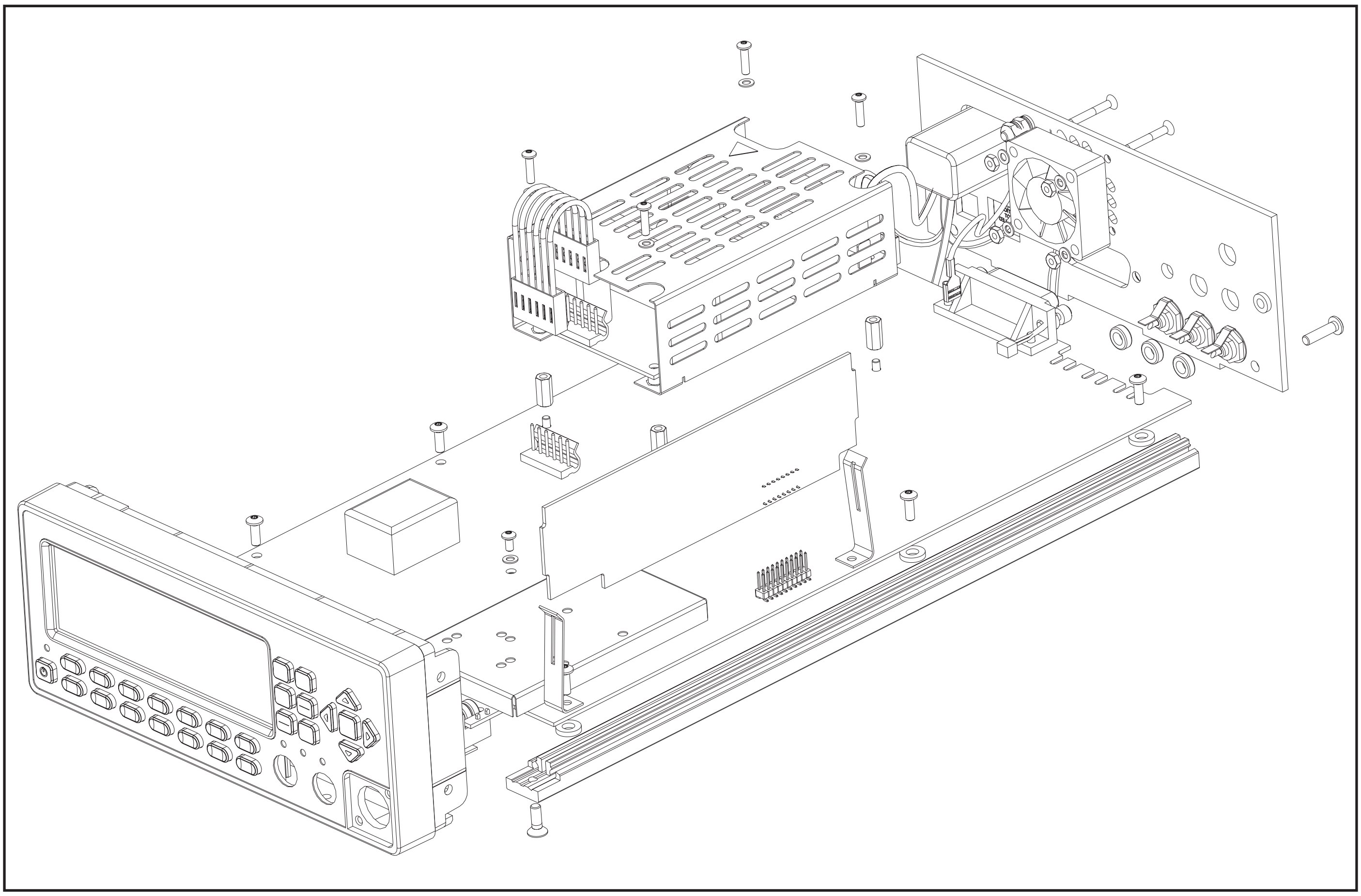

Figure 3-4 *The fan is fixed with four screws and nuts. The 3 GHz & 8 GHz prescalers are fixed with snap-in clips. The OCXO is soldered to the main board.*

– Reconnect the RF input cable.

OCXO Options

– Disconnect the power cable.

– Remove the cover from the counter. See page 3-2.

– Turn the instrument upside down.

– Locate the five solder joints and remove the OCXO with conventional desoldering technique for plated-through holes.

Chapter 4

Circuit Descriptions

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Version A

The descriptions in this section apply to instruments having a Triscend microprocessor.

See General Information on page III for details on relevant serial numbers etc.

Block Diagram Description

General

The PM6690 Timer/Counter consists of three main units:

– Front unit
– Main printed circuit board
– Rear panel unit

Several options exist:

– Prescalers on separate PCBs covering different frequency ranges (3 GHz and 8 GHz)
– Two OCXO timebases (very high & ultra-high stability)
– Rackmount kit

The chassis of the counter consists of a front piece molded in aluminum, an aluminum rear panel, and two extruded aluminum bars that hold the front and rear panels together. This unit can be slid into the aluminum cover of the instrument.

The main circuit board is fixed to the two bars. The display circuit board is fixed to the front piece. A detachable connector joins the electronics of the front unit and the main board, and the molded front piece is fixed with screws to the two aluminum bars. The rear panel is also fixed to the bars with screws.

The front unit contains all functions needed for the user communication: keyboard, display and input BNCs. All other electrical functions are on the main board. The rear panel has no PCB. The connectors here are all soldered directly to the main circuit board.

Block Diagram

Figure 4-1 contains a block diagram of the electrical functions of the counter. They are divided among the main circuit board, the display board, the rear panel and the optional prescaler board. See the schematic diagrams in Chapter 9 for complete information.

Most functions are placed on the main board:

– Input amplifiers with trigger level circuits
– Power supply
– Measurement logic
– Microcomputer circuitry
– GPIB interface
– USB interface
– External reference input
– External arming input

The rear panel unit is made of aluminum with a number of mounted connectors, a fan and a power line inlet with filter. Most connectors are soldered directly to the main board.

NOTE: Schematic diagrams in this chapter are simplified. For complete information, see Chapter 9.

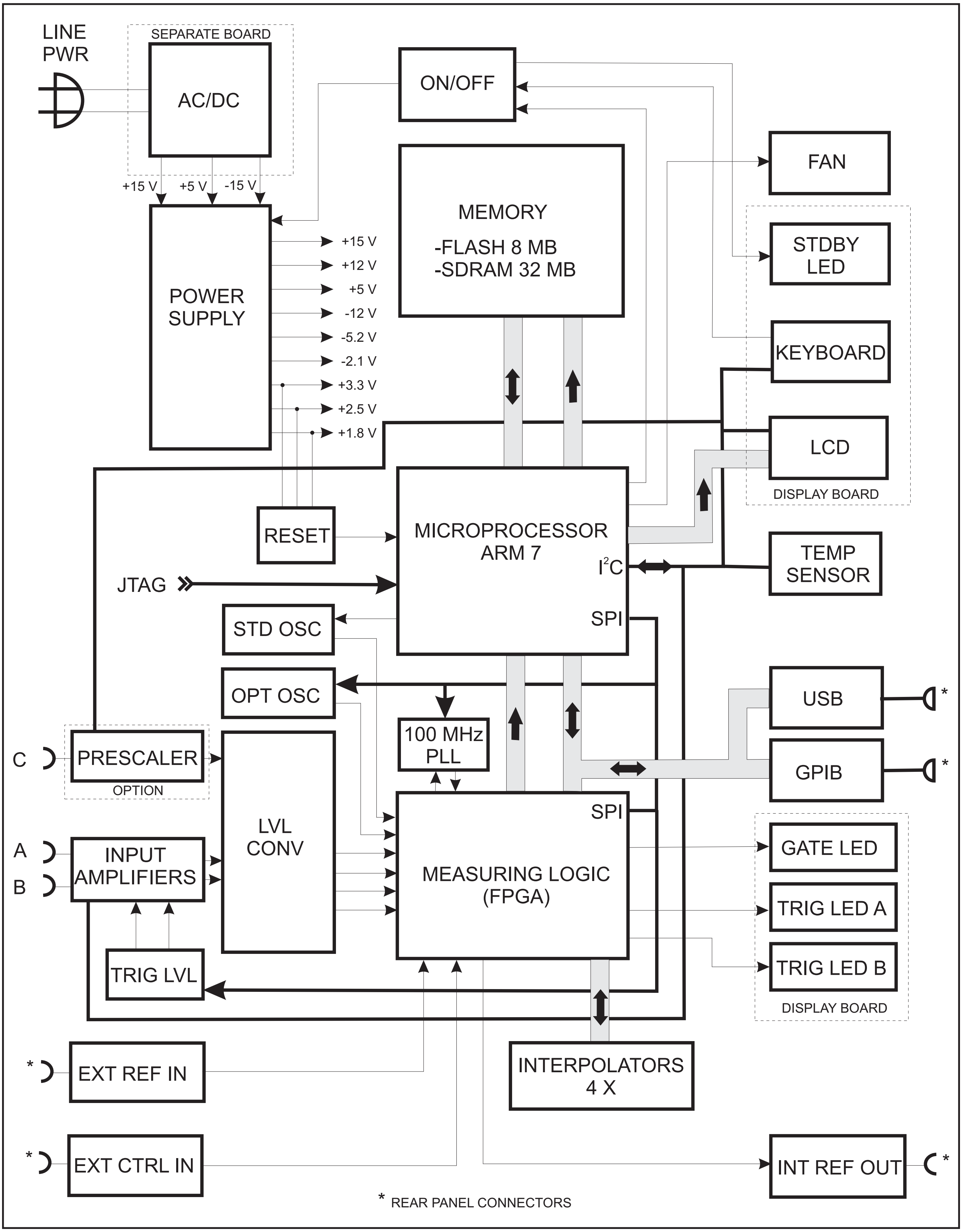

Figure 4-1 *Block diagram of the '90'.*

Hardware Functional Description

Front Unit

The front unit consists of a front piece in molded aluminum, a silicon rubber keypad with conducting contact surfaces, a graphic LCD with LED backlight, and a PCB having etched gold-plated keyboard contacts and a dedicated LCD power supply.

Display

The display is a 320*97 pixels graphical LCD with LED backlight. The LCD controller is part of the processor, and it sends data and control signals to the drivers in the LCD module. Display ON is controlled via the I^2C bus and the keyboard IC. The LCD voltages are generated by a DC/DC converter. Five different voltages are generated. A control signal from the processor switches the converter ON/OFF and also sets the contrast of the display.

The 4 LEDs on the display board are controlled from the measuring logic and the ON/OFF circuit.

Keyboard

The PCB covers the back of the front unit. The keys are laid out as a crosspoint switch matrix consisting of 25 regular push buttons plus a special power button. When one of the buttons is depressed, the dedicated keyboard IC U3 responds by sending an interrupt to the processor. The processor scans the keyboard over the I^2C bus to find out which button calls for attention. The power button differs from the others by having a dual function. In *Standby Mode* it turns on the ON/OFF circuit directly, but when the counter is ON, it is read as any other button. Then the processor turns off the counter. This arrangement is necessary since the processor is inactive in standby mode.

Main Board

Input Amplifiers

Input amplifiers A and B are identical with >300 MHz bandwidth. They are controlled by the processor with relays etc. The analog input signal is transformed to a digital signal. The output signals are LVPECL (+2.4 V and +1.2 V approximately) and fed to the measuring logic.

For a block diagram of the input amplifiers, see Figure 4-2.

■ Impedance Selector

This stage selects 1 MΩ or 50 Ω input impedance with a relay. In 50 Ω mode 11 resistors are used for dissipating the input power, up to a maximum of 2.9 W (12 V_{rms}).

■ Attenuator

This stage has two parts, a fixed preattenuator (approximate attenuation 2.5×) and a cascaded relay-operated 1×/10× step attenuator. The variable capacitors are used for adjusting the frequency response of the attenuators.

■ AC/DC

This stage selects AC or DC coupling with a relay.

■ Limiter

The voltage limiter protects the impedance converter against overvoltage. The ±5 V applied to the input BNC is divided to approximately ±2.1 V by the attenuator. The limiter clamps the voltage to approximately ±2.8 V.

■ Impedance Converter

Split-band technique is used for achieving good frequency response over a wide range. The HF signal is fed via an AC-coupled FET stage. The LF signal (bandwidth DC to approximately 10 kHz) goes via an operational amplifier. The signals are added together at the source of the FET. The output signal from the buffer stage (see below) is fed back to the operational amplifier. A trimmer potentiometer is used for equalizing the gain in the two signal paths (approximately ×0.9).

■ Filter

A lowpass RC filter with an approximate cutoff frequency of 100 kHz can be switched in via a transistor.

■ Buffer

Before the signal is fed to the *Crossover Switch*, it passes a current-amplifying buffer stage that can drive the following low impedance stages.

Crossover Switch

This stage uses relays to direct the signal to the two comparators. The following combinations are possible:

- IN A to COMP A and IN B to COMP B
- IN A to both COMP A and COMP B
- IN B to both COMP A and COMP B

Comparator

The comparator converts the analog signal to a binary logic signal, with ECL levels (-0.9 V and –1.7 V). The trigger point is set by a voltage from the trigger level circuitry. Temperature-compensated circuitry generates the voltages that control the hysteresis of the comparator. A trimmer potentiometer adjusts the hysteresis window.

Trigger Level Generation

Two 12-bit DACs in a single IC generate the two trigger levels for Channel A resp. Channel B. A 2.5 V DC reference IC supplies the reference voltage to the DACs. The DACs are controlled by the processor over the SPI bus. The ±5 V dynamic range at the BNC of the input amplifier is converted to approximately ±2.1 V at the comparator. This range must be covered by the DAC. The voltage step from the DAC is approximately 1.2 mV, corresponding to 2.9 mV per step at the BNC. *Closed Case Calibration* (CCC) is used for adjusting the trigger levels. A known reference level is applied to the BNC and the processor finds out the appropriate setting of the DAC to match the reference level.

Logic Level Conversion

The signals from the comparators must be converted from ECL levels to LVPECL levels. There are three converter circuits. One for Channel A , one for Channel B and one for the Set-Reset channel. The two main channels are fed to a Set-Reset flip-flop to make one-channel measurements with variable hysteresis possible. There is also a converter for the signal from an optional prescaler. It has PECL levels (+4.1 V and +3.4 V) that are converted to LVTTL levels (+2.4 V and 0 V).

Oscillator Circuits

The processor has a 32768 Hz crystal. An internal PLL in the processor uses the 32 kHz signal to make the internal processor clock, approximately 30 MHz. The USB IC has a 6 MHz crystal to make an internal clock and the GPIB IC has a 40 MHz crystal to make an internal clock.

The measurement reference oscillator (timebase) for the timer/counter is a 10 MHz crystal oscillator or an optional oven-controlled crystal oscillator (OCXO). Only one of these is mounted. The user can also select an external reference signal, connected to the *External Reference Input* BNC on the rear panel.

The standard oscillator consists of an inverter and a crystal. The processor controls the frequency of the oscillator with a PWM signal. The PWM signal is filtered to a DC level that controls the capacitance of a capacitance diode. The varying capacitance changes the frequency of the oscillator. The standard oscillator is adjusted with *Closed Case Calibration*. Apply a 10 MHz reference signal to Input A. The processor will find the correct PWM signal to make the internal reference frequency equal to the external reference frequency.

The optional oven-controlled oscillator is a complete oscillator in a small hermetic metal box. An internal accurate DC voltage is available for use as a reference for a 12-bit DAC. The filtered output voltage from the DAC sets the frequency of the oven oscillator. The processor controls the DAC via the SPI bus. The same *Closed Case Calibration* as for the standard oscillator is used. The oven oscillator is kept warm if the line power is connected to the timer/counter, even if it is switched off (in standby mode).

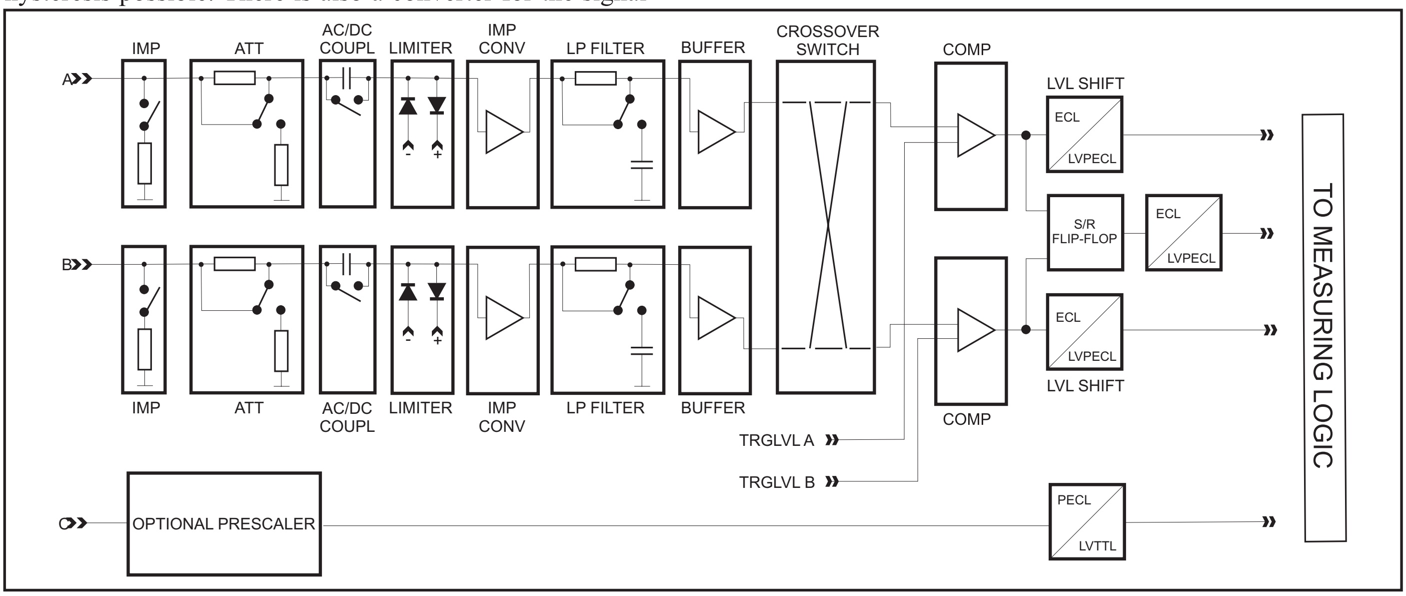

Figure 4-2 *Input amplifier block diagram.*

The 10 MHz reference signal is multiplied in a PLL to 100 MHz. The 100 MHz signal is used in the measuring logic as a reference. The processor controls the PLL IC with the SPI bus. A 100 MHz LC oscillator is used as the controlled element where part of the C is a variable capacitance diode. Its capacitance is controlled with a DC voltage from the PLL IC, thus changing the frequency. The 10 MHz reference signal is applied to the PLL IC as its reference and the 100 MHz output frequency is exactly 10 times the reference frequency.

External Reference Input

A 1, 2, 5 or 10 MHz reference signal can be connected to the rear panel BNC. After amplification in an operational amplifier narrow pulses are made in two D flip-flops, one narrow pulse for each input cycle. These pulses are fed to the 10 MHz crystal filter. After the filter a reconstructed 10 MHz signal is available. A variable capacitor is used for adjusting the filter.

Internal Reference Output

The selected 10 MHz reference signal (standard/oven oscillator or external reference) is available on the rear panel. The 10 MHz reference signal that is used internally by the dedicated counter circuit (FPGA) logic is also sent to an output pin on the FPGA. It is filtered to a sine wave and amplified in an output buffer stage having 50 Ω drive capability.

Measuring Logic

The measuring logic consists of an FPGA, four interpolators and an external control input on the rear panel. The FPGA core uses +1.8 V supply voltage and the I/Os use +3.3 V supply voltage.

The FPGA is controlled by the processor over a 16-bit microprocessor bus. Input signals (A, B, prescaler etc) and reference clock (internal 10 MHz oscillator or external reference) are selected inside the FPGA. The logic for all measuring functions and support functions (trigger indicators, start delay, pacing etc) are inside the FPGA. A 100 MHz reference clock is generated by a PLL circuit giving 10 ns basic measurement resolution. To increase the measurement resolution further, external interpolators are used. The measuring logic also controls three LEDs on the display board; a GATE LED indicating that a measurement is in progress, and two trigger indicators telling that the comparators are triggering on the input signals. A separate 32-bit bus is used for transferring measurement data from the FPGA to the processor. Some control signals to the hardware come from the FPGA due to a shortage of processor pins.

The four external interpolators are identical. Depending on the selected measurement function 0, 2, 3 or 4 interpolators are used. A pulse representing the time from an event on the input to the following rising edge of the 100 MHz reference is fed to the interpolator. During the pulse time a constant current is charging a capacitor. The voltage on the capacitor is measured with a 10-bit ADC. The capacitor is discharged and the interpolator is ready for a new measurement.

An external control input BNC is located on the rear panel. A signal applied to this connector can be used for controlling the start of a measurement, for instance. A comparator converts the analog input signal to a logic signal.

Processor Circuits

The processor is a Triscend A7S. It contains an ARM7 core and peripherals. It runs on a 30 MHz internal clock. The core uses 2.5 V supply voltage and the I/Os use 3.3 V supply voltage.

A separate memory bus communicates with a 16-bit 8 MByte flash memory and a 32-bit 32 MByte SDRAM. The flash memory contains the program, data for loading the FPGA, and stored data (calibration data etc.). At power-up the code is copied from the flash to the SDRAM. It is run from the SDRAM for faster execution.

The processor has a JTAG interface with a connector on the circuit board.

A reset IC monitors the three main logic supply voltages, +3.3 V, +2.5 V and + 1.8 V. If a supply voltage fails, the processor will be reset.

The regular 16-bit microprocessor bus is used for controlling the FPGA, the GPIB interface and the USB interface. A separate 32-bit bus is used for fetching measurement data from the measuring logic.

Two other buses are also used, an SPI bus and an I^2C bus. The SPI bus is an *output only* bus and the processor controls the 100 MHz PLL, the trigger level DACs, and the DAC for the optional oven oscillator. The I^2C bus is bidirectional and used for communication with the temperature measurement IC, the display board (keyboard + LCD), the prescaler (optional), and the relays and filters in the input amplifier.

The temperature reading over the I^2C bus is used for controlling the fan speed. A PWM output is utilized. The signal is filtered and the resulting DC voltage controls the fan.

Another PWM output is used for controlling the frequency of the standard crystal oscillator.

The LCD controller is a peripheral inside the processor. This controller sends signals and data to the driver circuits in the LCD on the display board.

The processor also controls the OFF switch. Only a signal from the processor can switch off the power. The OFF button on the front panel is read by the processor. ON is handled without the processor, since it cannot respond to external stimulus in standby mode.

Power Supply

This timer/counter has no primary power switch. If connected to line power there are live parts inside the cabinet, and some supply voltages are present on the main circuit board, even if the secondary power switch on the front panel has been turned off (standby mode).

A semi-protected AC/DC module is placed on spacers over the main circuit board. It delivers three regulated DC voltages to the counter, + 15 V, + 5 V and –15 V. When the counter is connected to line power, these voltages are always present. There is a + 5 V trimmer potentiometer on the AC/DC module.

The ON/OFF circuit is active as soon as the counter is connected to line power. The instrument automatically powers up when line power is applied. Only the processor can switch the circuit to OFF state (standby mode). Then only the power button on the front panel can switch the instrument to ON. Once connected to line power and in OFF state (standby mode), supply voltage +12 VU is distributed to the oven oscillator to keep it warm. In standby mode a red LED is lit on the front panel. To keep the AC/DC module stable in this mode, a dummy load is connected to draw a quiescent current of 0.1 A at +5 V.

The three main voltages are +15 V, +5 V and –15 V from the AC/DC module. All other supply voltages are generated from them and are, except for +12 VU to the oven oscillator, switched off in standby mode.

Linear regulators are used for generating stable voltages with low noise and without spikes. Some of them have a resistor net at the input to dissipate part of the heat generated. Thus the regulator itself will run cooler. The following voltages are generated in this way:

+3.3 VA from +5 VU
-5.2 VA from -15 VU
-5.2 VI from -12 VA
-2.1 V from -12 VA
-12 VA from -15 VU
+12 VA from +15 VU
+12 VU from + 15 VU, to oven oscillator, not switched off in standby mode

For digital and general use supply voltages are generated by DC/DC converters:

+3.3 VD from +5 VU
+5 VD from +5 VU via a switch IC
+15 VD from +15 VU via a switch transistor
+2.5 V from +5 VU
+1.8 V from +5 VU

Communication Interfaces

Both a GPIB and a USB interface are available for communication with external bus controllers. The connectors are located on the rear panel.

The GPIB consists of an IC. Only 8 bits of the 16-bit microprocessor bus is used. Due to different supply voltages for the processor (+3.3 V) and the GPIB circuit (+5 V), a buffer IC is used for isolating the +5 V GPIB IC from the processor bus. A 40 MHz crystal is used for generating a local clock.

The USB consists of an IC. It communicates with the processor over the 16-bit microprocessor bus. A 6 MHz crystal is used for generating a local clock.

Rear Panel Unit

The rear panel is made of aluminum. A number of connectors mounted on this unit are accessible to the user, see Figure 4-3.

I/O:

– GPIB communication connector.

– USB communication connector

INPUTS:

– External reference (BNC)

– External arming (BNC)

– Power supply inlet including EMI filter

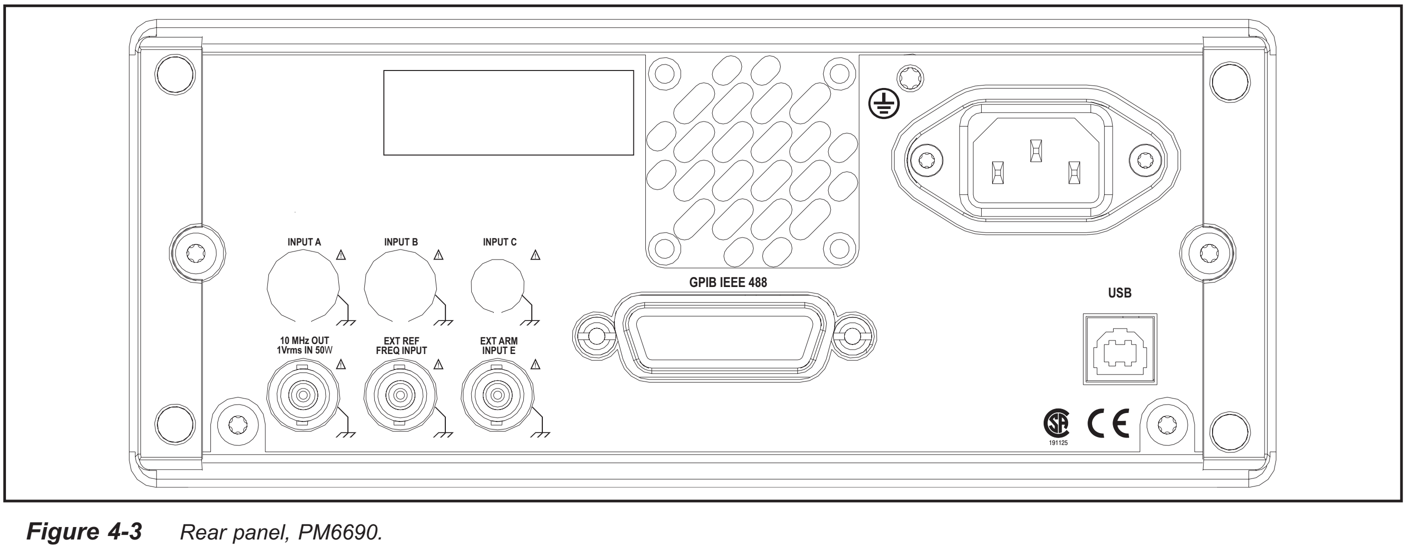

Figure 4-3 *Rear panel, PM6690.*

– Optional main inputs replacing corresponding front panel inputs

OUTPUTS:

– Internal reference 10 MHz (BNC)

Prescaler Circuit Board

There are several different optional prescalers available with different frequency ranges. The prescaler is located on a separate circuit board that is connected to the main circuit board with a PCB connector.

A typical prescaler consists of a limiter, an amplifier, a frequency divider, and a detector. The limiter and the amplifier condition the input signal so that the amplitude to the divider is constant. The divider scales the input signal so that it can be handled by the measuring logic on the main circuit board. A detector switches off the output signal from the divider if the input level is too low for the divider to work correctly (dividers often oscillate without input signal).

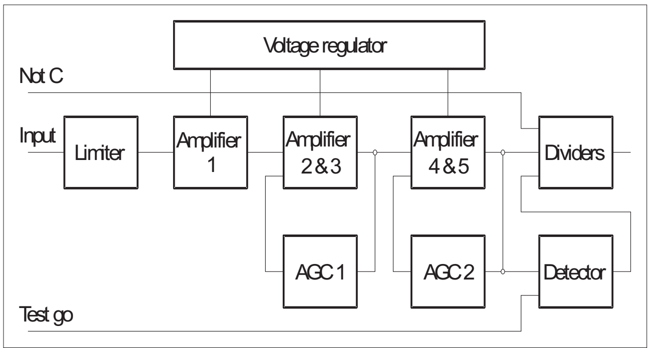

Figure 4-6 *Typical prescaler option, block diagram*

Test Routines

Built-in Test Routines

The test routines are those accessible via the USER OPT key.

– Press USER OPT → Test → Test Mode

– Choose one of the five alternatives:

1. All - Perform the four basic tests below in sequence
2. Memory - Test RAM and ROM
3. Logic - Test measuring logic circuits
4. Display - Test the graphic LCD display
5. Interface - Test the two standard interfaces, GPIB and USB

Power-On Tests

Certain tests are automatically performed at power-up. Errors, if any, are reported on the display.

Version B

The descriptions in this section apply to instruments having a Sharp microprocessor.

See General Information on page III for details on relevant serial numbers etc.

Block Diagram Description

General

The PM6690 Timer/Counter consists of three main units:

– Front unit
– Main printed circuit board
– Rear panel unit

Several options exist:

– Prescalers on separate PCBs covering different frequency ranges (3 GHz and 8 GHz)
– Two OCXO timebases (very high & ultra-high stability)
– Rackmount kit

The chassis of the counter consists of a front piece molded in aluminum, an aluminum rear panel, and two extruded aluminum bars that hold the front and rear panels together. This unit can be slid into the aluminum cover of the instrument.

The main circuit board is fixed to the two bars. The display circuit board is fixed to the front piece. A detachable connector joins the electronics of the front unit and the main board, and the molded front piece is fixed with screws to the two aluminum bars. The rear panel is also fixed to the bars with screws.

The front unit contains all functions needed for the user communication: keyboard, display and input BNCs. All other electrical functions are on the main board. The rear panel has no PCB. The connectors here are all soldered directly to the main circuit board.

Block Diagram

Figure 4-7 contains a block diagram of the electrical functions of the counter. They are divided among the main circuit board, the display board, the rear panel and the optional prescaler board. See the schematic diagrams in Chapter 9 for complete information.

Most functions are placed on the main board:

– Input amplifiers with trigger level circuits
– Power supply
– Measurement logic
– Microcomputer circuitry
– GPIB interface
– USB interface
– External reference input
– External arming input

The rear panel unit is made of aluminum with a number of mounted connectors, a fan and a power line inlet with filter. Most connectors are soldered directly to the main board.

NOTE: Schematic diagrams in this chapter are simplified. For complete information, see Chapter 9.

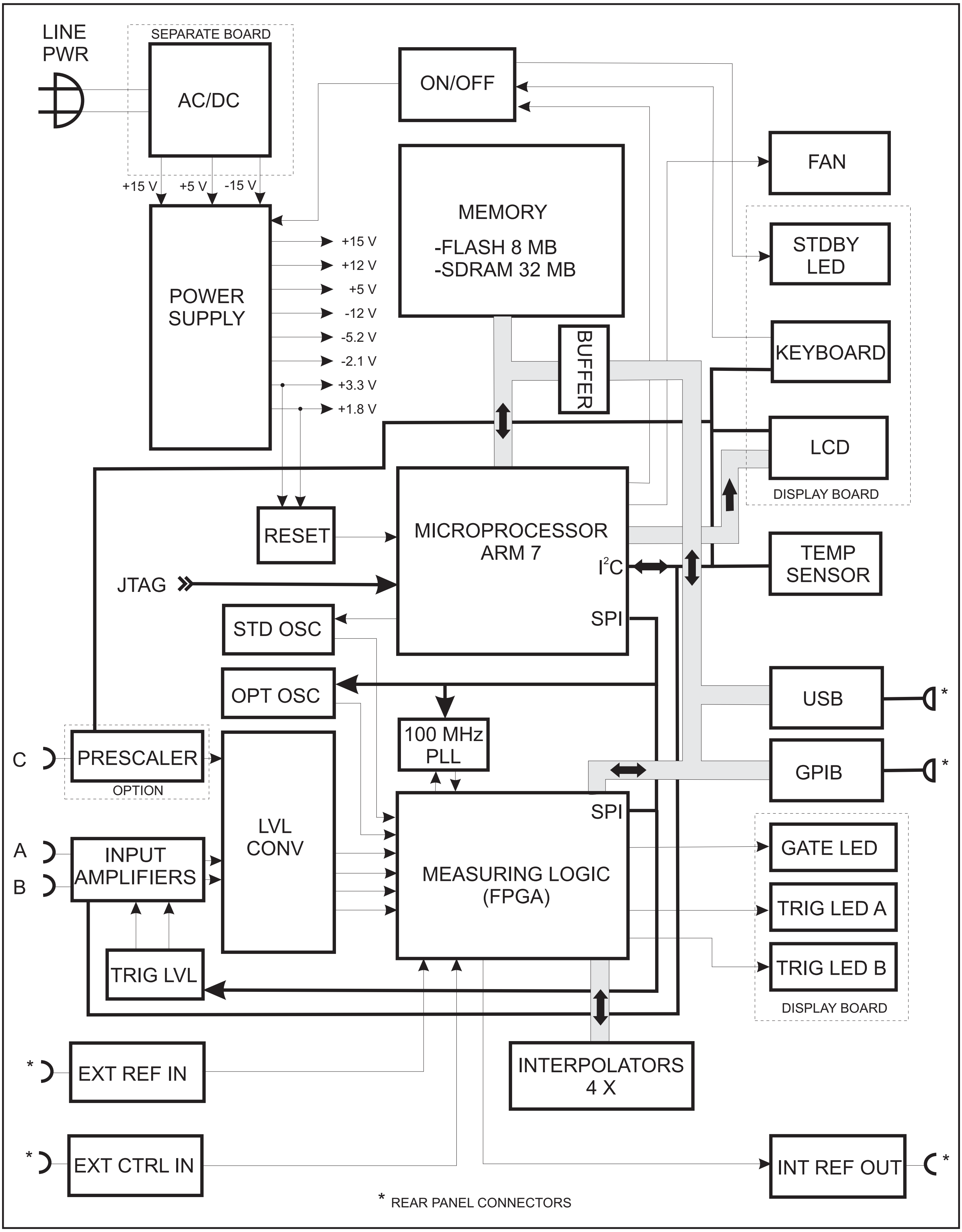

Figure 4-7 *Block diagram of the '90'.*

Hardware Functional Description

Front Unit

The front unit consists of a front piece in molded aluminum, a silicon rubber keypad with conducting contact surfaces, a graphic LCD with LED backlight, and a PCB having etched gold-plated keyboard contacts and a dedicated LCD power supply.

Display

The display is a 320*97 pixels graphical LCD with LED backlight. The LCD controller is part of the processor, and it sends data and control signals to the drivers in the LCD module. Display ON is controlled via the I^2C bus and the keyboard IC. The LCD voltages are generated by a DC/DC converter. Five different voltages are generated. A control signal from the processor switches the converter ON/OFF and also sets the contrast of the display.

The 4 LEDs on the display board are controlled from the measuring logic and the ON/OFF circuit.

Keyboard

The PCB covers the back of the front unit. The keys are laid out as a crosspoint switch matrix consisting of 25 regular push buttons plus a special power button. When one of the buttons is depressed, the dedicated keyboard IC U3 responds by sending an interrupt to the processor. The processor scans the keyboard over the I^2C bus to find out which button calls for attention. The power button differs from the others by having a dual function. In *Standby Mode* it turns on the ON/OFF circuit directly, but when the counter is ON, it is read as any other button. Then the processor turns off the counter. This arrangement is necessary since the processor is inactive in standby mode.

Main Board

Input Amplifiers

Input amplifiers A and B are identical with >300 MHz bandwidth. They are controlled by the processor with relays etc. The analog input signal is transformed to a digital signal. The output signals are LVPECL (+2.4 V and +1.2 V approximately) and fed to the measuring logic.

For a block diagram of the input amplifiers, see Figure 4-8.

■ Impedance Selector

This stage selects 1 MΩ or 50 Ω input impedance with a relay. In 50 Ω mode 11 resistors are used for dissipating the input power, up to a maximum of 2.9 W (12 V_{rms}).

■ Attenuator

This stage has two parts, a fixed preattenuator (approximate attenuation 2.5×) and a cascaded relay-operated 1×/10× step attenuator. The variable capacitors are used for adjusting the frequency response of the attenuators.

■ AC/DC

This stage selects AC or DC coupling with a relay.

■ Limiter

The voltage limiter protects the impedance converter against overvoltage. The ±5 V applied to the input BNC is divided to approximately ±2.1 V by the attenuator. The limiter clamps the voltage to approximately ±2.8 V.

■ Impedance Converter

Split-band technique is used for achieving good frequency response over a wide range. The HF signal is fed via an AC-coupled FET stage. The LF signal (bandwidth DC to approximately 10 kHz) goes via an operational amplifier. The signals are added together at the source of the FET. The output signal from the buffer stage (see below) is fed back to the operational amplifier. A trimmer potentiometer is used for equalizing the gain in the two signal paths (approximately ×0.9).

■ Filter

A lowpass RC filter with an approximate cutoff frequency of 100 kHz can be switched in via a transistor.

■ Buffer

Before the signal is fed to the *Crossover Switch*, it passes a current-amplifying buffer stage that can drive the following low impedance stages.

■ **Crossover Switch**

This stage uses relays to direct the signal to the two comparators. The following combinations are possible:

- IN A to COMP A and IN B to COMP B
- IN A to both COMP A and COMP B
- IN B to both COMP A and COMP B

■ **Comparator**

The comparator converts the analog signal to a binary logic signal, with ECL levels (-0.9 V and –1.7 V). The trigger point is set by a voltage from the trigger level circuitry. Temperature-compensated circuitry generates the voltages that control the hysteresis of the comparator. A trimmer potentiometer adjusts the hysteresis window.

■ **Trigger Level Generation**

Two 12-bit DACs in a single IC generate the two trigger levels for Channel A resp. Channel B. A 2.5 V DC reference IC supplies the reference voltage to the DACs. The DACs are controlled by the processor over the SPI bus. The ±5 V dynamic range at the BNC of the input amplifier is converted to approximately ±2.1 V at the comparator. This range must be covered by the DAC. The voltage step from the DAC is approximately 1.2 mV, corresponding to 2.9 mV per step at the BNC. *Closed Case Calibration* (CCC) is used for adjusting the trigger levels. A known reference level is applied to the BNC and the processor finds out the appropriate setting of the DAC to match the reference level.

■ **Logic Level Conversion**

The signals from the comparators must be converted from ECL levels to LVPECL levels. There are three converter circuits. One for Channel A , one for Channel B and one for the Set-Reset channel. The two main channels are fed to a Set-Reset flip-flop to make one-channel measurements with variable hysteresis possible. There is also a converter for the signal from an optional prescaler. It has PECL levels (+4.1 V and +3.4 V) that are converted to LVTTL levels (+2.4 V and 0 V).

Oscillator Circuits

The processor has an 11.2896 MHz crystal. An internal PLL in the processor uses the signal to make the internal processor clock, approximately 50.8 MHz. The USB IC has a 6 MHz crystal to make an internal clock and the GPIB IC has a 40 MHz crystal to make an internal clock.

The measurement reference oscillator (timebase) for the timer/counter is a 10 MHz crystal oscillator or an optional oven-controlled crystal oscillator (OCXO). Only one of these is mounted. The user can also select an external reference signal, connected to the *External Reference Input* BNC on the rear panel.

The standard oscillator consists of an inverter and a crystal. The processor controls the frequency of the oscillator with a PWM signal. The PWM signal is filtered to a DC level that controls the capacitance of a capacitance diode. The varying capacitance changes the frequency of the oscillator. The standard oscillator is adjusted with *Closed Case Calibration*. Apply a 10 MHz reference signal to Input A. The processor will find the correct PWM signal to make the internal reference frequency equal to the external reference frequency.

The optional oven-controlled oscillator is a complete oscillator in a small hermetic metal box. An internal accurate DC voltage is available for use as a reference for a 12-bit DAC. The filtered output voltage from the DAC sets the frequency of the oven oscillator. The processor controls the DAC via the SPI bus. The same *Closed Case Calibration* as for the standard oscillator is used. The oven oscillator is kept warm if the line power is connected to the timer/counter, even if it is switched off (in standby mode).

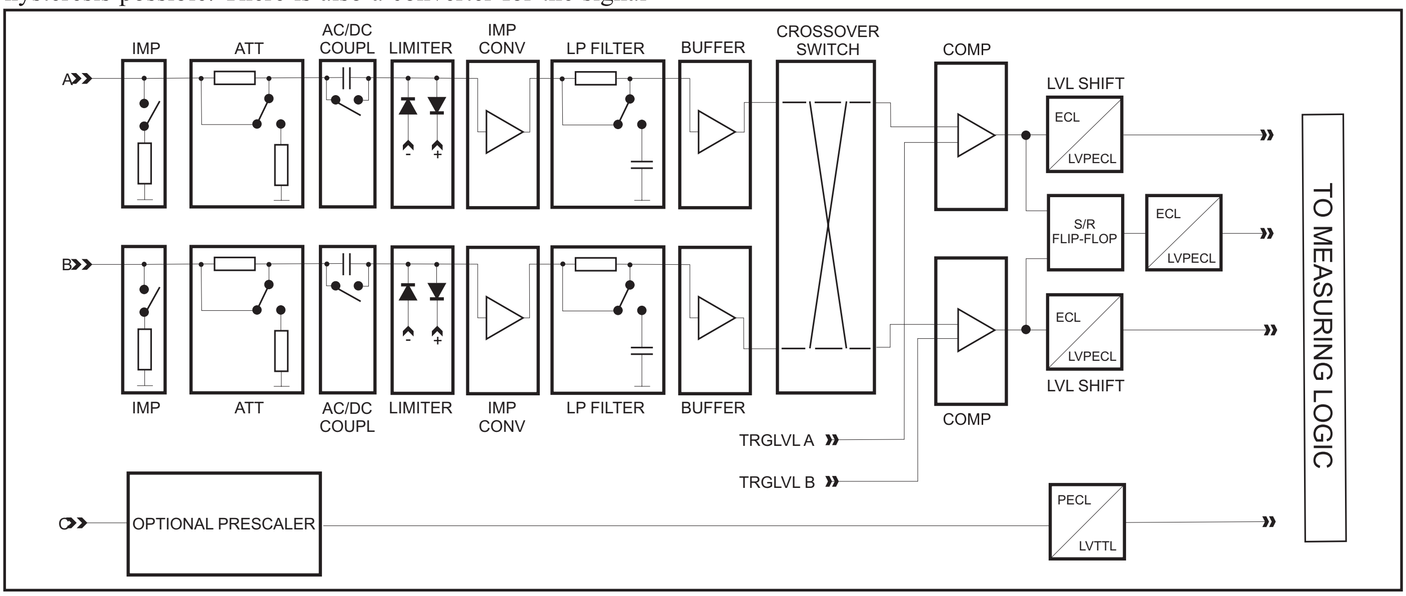

Figure 4-8 *Input amplifier block diagram.*

The 10 MHz reference signal is multiplied in a PLL to 100 MHz. The 100 MHz signal is used in the measuring logic as a reference. The processor controls the PLL IC with the SPI bus. A 100 MHz LC oscillator is used as the controlled element where part of the C is a variable capacitance diode. Its capacitance is controlled with a DC voltage from the PLL IC, thus changing the frequency. The 10 MHz reference signal is applied to the PLL IC as its reference and the 100 MHz output frequency is exactly 10 times the reference frequency.

External Reference Input

A 1, 2, 5 or 10 MHz reference signal can be connected to the rear panel BNC. After amplification in an operational amplifier narrow pulses are made in two D flip-flops, one narrow pulse for each input cycle. These pulses are fed to the 10 MHz crystal filter. After the filter a reconstructed 10 MHz signal is available. A variable capacitor is used for adjusting the filter.

Internal Reference Output

The selected 10 MHz reference signal (standard/oven oscillator or external reference) is available on the rear panel. The 10 MHz reference signal that is used internally by the dedicated counter circuit (FPGA) logic is also sent to an output pin on the FPGA. It is filtered to a sine wave and amplified in an output buffer stage having 50 Ω drive capability.

Measuring Logic

The measuring logic consists of an FPGA, four interpolators and an external control input on the rear panel. The FPGA core uses +1.8 V supply voltage and the I/Os use +3.3 V supply voltage.

The FPGA is controlled by the processor over a 32-bit microprocessor bus. Input signals (A, B, prescaler etc) and reference clock (internal 10 MHz oscillator or external reference) are selected inside the FPGA. The logic for all measuring functions and support functions (trigger indicators, start delay, pacing etc) are inside the FPGA. A 100 MHz reference clock is generated by a PLL circuit giving 10 ns basic measurement resolution. To increase the measurement resolution further, external interpolators are used. The measuring logic also controls three LEDs on the display board; a GATE LED indicating that a measurement is in progress, and two trigger indicators telling that the comparators are triggering on the input signals.

The four external interpolators are identical. Depending on the selected measurement function 0, 2, 3 or 4 interpolators are used. A pulse representing the time from an event on the input to the following rising edge of the 100 MHz reference is fed to the interpolator. During the pulse time a constant current is charging a capacitor. The voltage on the capacitor is measured with a 10-bit ADC. The capacitor is discharged and the interpolator is ready for a new measurement.

An external control input BNC is located on the rear panel. A signal applied to this connector can be used for controlling the start of a measurement, for instance. A comparator converts the analog input signal to a logic signal.

Processor Circuits

The processor is a Sharp LH79524. It contains an ARM7 core and peripherals. It runs on a 50.8 MHz internal clock. The processor that uses 3.3 V supply voltage has an internal circuit that generates 1.8 V for the core. The I/Os use 3.3 V.

The 32-bit microprocessor bus communicates with a 16-bit 8 MByte flash memory and a 32-bit 32 MByte SDRAM. The flash memory contains the program, data for loading the FPGA, and stored data (calibration data etc.). At power-up the code is copied from the flash to the SDRAM for faster execution.

Buffers isolate the memory part of the microprocessor bus from the rest of the bus. Outside the buffers are the FPGA, the GPIB interface and the USB interface.

The processor has a JTAG interface with a connector on the circuit board.

A reset IC monitors the two main logic supply voltages, +3.3 V and + 1.8 V. If a supply voltage fails, the processor will be reset.

Two other buses are also used, an SPI bus and an I^2C bus. The SPI bus is an *output only* bus and the processor controls the 100 MHz PLL, the trigger level DACs, and the DAC for the optional oven oscillator. The I^2C bus is bidirectional and used for communication with the temperature measurement IC, the display board (keyboard + LCD), the prescaler (optional), and the relays and filters in the input amplifier.

The temperature reading over the I^2C bus is used for controlling the fan speed. A PWM output is utilized. The signal is filtered and the resulting DC voltage controls the fan.

Another PWM output is used for controlling the frequency of the standard crystal oscillator.

The LCD controller is a peripheral inside the processor. This controller sends signals and data to the driver circuits in the LCD on the display board.

The processor also controls the OFF switch. Only a signal from the processor can switch off the power. The OFF button on the front panel is read by the processor. ON is handled without the processor, since it cannot respond to external stimulus in standby mode.

Power Supply

This timer/counter has no primary power switch. If connected to line power there are live parts inside the cabinet, and some supply voltages are present on the main circuit board, even if the secondary power switch on the front panel has been turned off (standby mode).

A semi-protected AC/DC module is placed on spacers over the main circuit board. It delivers three regulated DC voltages to the counter, + 15 V, + 5 V and –15 V. When the counter is connected to line power, these voltages are always present. There is a + 5 V trimmer potentiometer on the AC/DC module.

The ON/OFF circuit is active as soon as the counter is connected to line power. The instrument automatically powers up when line power is applied. Only the processor can switch the circuit to OFF state (standby mode). Then only the power button on the front panel can switch the instrument to ON. Once connected to line power and in OFF state (standby mode), supply voltage +12 VU is distributed to the oven oscillator to keep it warm. In standby mode a red LED is lit on the front panel. To keep the AC/DC module stable in this mode, a dummy load is connected to draw a quiescent current of 0.1 A at +5 V.

The three main voltages are +15 V, +5 V and –15 V from the AC/DC module. All other supply voltages are generated from them and are, except for +12 VU to the oven oscillator, switched off in standby mode.

Linear regulators are used for generating stable voltages with low noise and without spikes. Some of them have a resistor net at the input to dissipate part of the heat generated. Thus the regulator itself will run cooler. The following voltages are generated in this way:

+3.3 VA from +5 VU
-5.2 VA from -15 VU
-5.2 VI from -12 VA
-2.1 V from -12 VA
-12 VA from -15 VU
+12 VA from +15 VU

+12 VU from + 15 VU, to oven oscillator, not switched off in standby mode

For digital and general use supply voltages are generated by DC/DC converters:

+3.3 VD from +5 VU
+5 VD from +5 VU via a switch IC
+15 VD from +15 VU via a switch transistor
+1.8 V from +5 VU

Communication Interfaces

Both a GPIB and a USB interface are available for communication with external bus controllers. The connectors are located on the rear panel.

The GPIB consists of an IC. Only 8 bits of the 32-bit microprocessor bus is used. Due to different supply voltages for the processor (+3.3 V) and the GPIB circuit (+5 V), a buffer IC is used for isolating the +5 V GPIB IC from the processor bus. A 40 MHz crystal is used for generating a local clock.

The USB consists of an IC. It communicates with the processor over the 32-bit microprocessor bus, but only 16 bits are used. A 6 MHz crystal is used for generating a local clock.

Rear Panel Unit

The rear panel is made of aluminum. A number of connectors mounted on this unit are accessible to the user, see Figure 4-9.

I/O:

– GPIB communication connector.
– USB communication connector

INPUTS:

– External reference (BNC)
– External arming (BNC)
– Power supply inlet including EMI filter
– Optional main inputs replacing corresponding front panel inputs

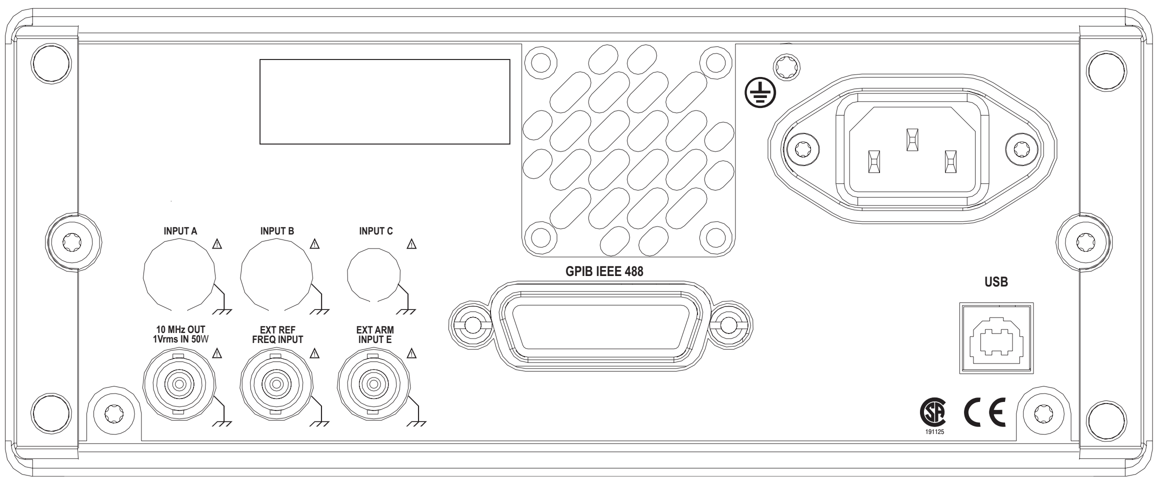

Figure 4-9 *Rear panel, PM6690.*

OUTPUTS:

– Internal reference 10 MHz (BNC)

Prescaler Circuit Board

There are several different optional prescalers available with different frequency ranges. The prescaler is located on a separate circuit board that is connected to the main circuit board with a PCB connector.

A typical prescaler consists of a limiter, an amplifier, a frequency divider, and a detector. The limiter and the amplifier condition the input signal so that the amplitude to the divider is constant. The divider scales the input signal so that it can be handled by the measuring logic on the main circuit board. A detector switches off the output signal from the divider if the input level is too low for the divider to work correctly (dividers often oscillate without input signal).

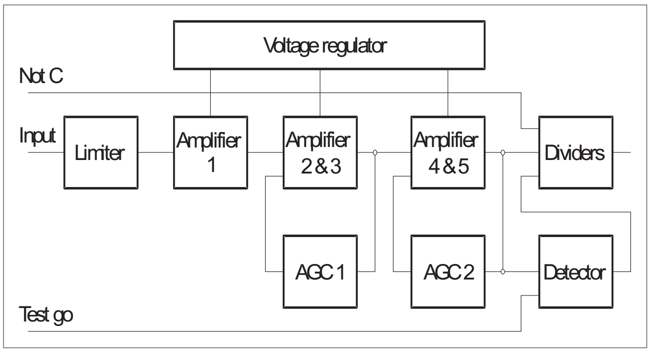

Figure 4-10 *Typical prescaler option, block diagram*

Test Routines

Built-in Test Routines

The test routines are those accessible via the USER OPT key.

– Press USER OPT → Test → Test Mode

– Choose one of the five alternatives:

1. All - Perform the four basic tests below in sequence
2. Memory - Test RAM and ROM
3. Logic - Test measuring logic circuits
4. Display - Test the graphic LCD display
5. Interface - Test the two standard interfaces, GPIB and USB

Power-On Tests

Certain tests are automatically performed at power-up. Errors, if any, are reported on the display.

Chapter 5

Corrective & Preventive Maintenance

Introduction

This chapter contains information about measures to be taken for keeping the instrument in operative condition, or in other words, what you can do to maintain the measurement accuracy, improve certain characteristics and prevent a breakdown.

Traditional troubleshooting is described in Chapter 6 - Repair.

Calibration

The single most important factor for maintaining the high performance of your instrument is calibration on a regular basis. A timer/counter is mainly used for time/frequency-related measurements, so knowing the characteristics of your timebase reference is vital to reliable results.

Scheduled calibration of the built-in timebase reference is highly recommended in applications where external, more accurate, frequency references are not available. Suitable calibration intervals depend on the chosen timebase option and the acceptable inaccuracy, but once a year is often a good starting point.

The '90' has also limited voltage measurement capabilities, and when these features are utilized, the voltage reference should also be calibrated, preferably at the same time as the frequency reference.

Both frequency and voltage calibration can be performed without removing the cover, and the procedures are described in Chapter 7, where you can also find information about calculating calibration intervals for different timebase references.

Instructions for Firmware Upgrade

The firmware is stored in a FLASH PROM, so it is possible to upgrade via one of the standard instrument interfaces (GPIB or USB) without opening the case. USB is standard on most PCs, but GPIB communication requires a special controller board and dedicated SW from NI or CEC. A 'readme.txt' file contains information not covered by these instructions. The relevant files are available through the service organization.

– Make sure the National Instruments NI-VISA 3.2 or later is installed with USB support, even though you are going to use the GPIB interface for the upgrade.
– Establish a communication link between your PC and the instrument over GPIB or USB by using a dedicated application program, for instance NIMax from National Instruments. No other instruments should be connected to the same bus. Firmware upgrade over USB works with firmware version V1.07 or above installed in the instrument.
– Send *IDN? to the instrument and watch the response. If the ID string is OK you can exit the communication program and start the upgrading procedure.
– Download the latest firmware file (example name: CNT_90_109_csl.hex) and the latest loader SW (example name: Loader.exe) to a common directory on your PC.
– Start the Loader.exe program.
– Press "Load" to open the firmware file. Follow the instructions on screen. The update is automatic, and process information can be seen on the PC screen as well as on the instrument display. Do not interrupt the process too early as it may take between a few minutes up to an hour, mostly depending on different possible hardware combinations. A thermometer indicator on the PC monitor gives status reports. The crucial part of the process is when the message "FLASH updating (uninterruptible)" is displayed. Do not under any circumstances interrupt the loader while this message is visible. If the process fails during this part, it may be impossible to control the instrument from the bus as well as from the front panel. Then you have to load new firmware over the JTAG connection to the processor, a method that only the factory can apply.
– After a successful update, the counter is reset (if previous firmware is V1.01 and above). The message "Firmware update complete. Loader is trying to connect to the counter again" is displayed on the PC monitor. Confirm by pressing OK.
– Press OK again when the message "Counter found" is displayed.
– Press EXIT to leave the loader program.
– If the counter is not reset by the Loader program, turn the counter off and on when the update is complete.

NOTE 1: With some firmware revisions and GPIB cards the Loader gives an error message:
"Counter I/O error. Loader shutting down" after the successful update. This is a loader fault and does not harm the upgrade process.

– To remove the SRQ indicator on the front panel, which might be present in such cases, start a GPIB communication tool and send the command "*PSC 1" and run a full power cycle (OFF/ON).

NOTE 2: Some firmware revisions need a full power cycle to resume proper operation. If the instrument does not measure correctly after firmware upgrade, turn the instrument OFF and ON to initialize the hardware properly.

– After the update, enter the calibration menu (password 62951413) and run "Calibrate internals".

Utility Program

Purpose

This service tool is used for configuring the timer/counter, whenever information stored in firmware about serial number and oscillator type etc. has been lost, for example after replacement of the main PCB. It is also used for defining a new factory calibration.

Availability and System Requirements

The utility program can be obtained from the manufacturer or your local service organization free of charge and can be run on any PC with Windows 2K or XP equipped with a GPIB interface from National Instruments. It is distributed as a compressed file called *PM6690.zip* containing all the necessary installation and data files including a *readme.txt* file with additional information.

Installation

– Unpack the *zip* file in an empty directory by using *Winzip*.

– Delete the original *zip* file if you want to save memory space.

– Run the *setup.exe* program and follow the on-screen instructions.

Running the Application

After installation you can start the utility application by running the program *PM6690 Utility.exe* from the chosen directory. Refer to the *readme.txt* file for closer information on topics not covered by the application user interface.

Fan Replacement

This instrument is equipped with a speed-controlled fan as standard to sustain the specified operating temperature range. If your instrument is operating in a 24 h/day system, you should replace the fan every second year to maintain maximum reliability. For part-time applications and where low ambient temperatures prevail, an extended service interval is acceptable.

Follow the instructions on page 3-3 to replace the fan.

Other Important Information

There are no batteries of any kind in this instrument, so in general it is only necessary to remove the cover when the fan is to be replaced, or when a real fault calls for traditional troubleshooting.

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Chapter 6

Repair

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Version A

The descriptions in this section apply to instruments having a Triscend microprocessor.

See General Information on page III for details on relevant serial numbers etc.

Troubleshooting

General

The '90' is a highly integrated Timer/Counter in which a dedicated FPGA counter circuit handles the signal processing, and a microcontroller does the postprocessing and supervising jobs. A number of additional functional units support these basic tasks, for instance power supply, reference oscillator, wideband input amplifiers, comparators, memory (RAM & ROM), digital/analog converters, etc.

The units are treated from a troubleshooting point of view in this chapter, which means that units described earlier should be considered faultless before troubleshooting on units described later.

> **WARNING: Live parts and accessible terminals which can be dangerous to life are always exposed inside the unit when it is connected to the line power. Use extreme caution when handling, testing or adjusting the counter.**

Where to Start

After reading the safety instructions, continue with this chapter for troubleshooting and repair instructions. When you have fixed the instrument, always do the Safety Inspection and Test after Repair, as described later in this Chapter. Then do the checks in Chapter 2, Performance Check. Recalibrate if required by following the adjustment instructions in Chapter 7, Calibration Adjustments.

	Positive ECL	Negative ECL	CMOS	TTL
Supply voltage	+5 V	-5 V	+5 V	+5 V
Signal ground	0 V	0 V	0 V	0 V
Input voltage				
High, VIH	>+3.9 V	>-1.1 V	>+4 V	>+2 V
Low, VIL	<+3.5 V	<-1.5 V	<+1 V	<+0.8 V
Output voltage				
High, VOH	>+4 V	>-1 V	>+4.9 V	>+2.7 V
Low, VOL	<+3.3 V	<-1.7 V	<+0.05 V	<+0.4 V
Bias ref. voltage, VBB	+3.7 V	-1.3 V	-	-

Table 6-1 *Logic levels.*

Logic Levels

The '90' contains logic of different families. The levels of the standard families are listed in Table 6-1. In addition to these families there is also low-level logic requiring lower supply voltages, e.g. +3.3 V, +2.5 V and +1.8 V.

Required Test Equipment

To be able to test the instrument properly using this manual you will need the equipment listed in Table 2-1. The list contains the critical parameter specifications.

Operating Conditions

Power voltage must be between 90 V_{AC} and 260 V_{AC}. The instrument adapts automatically to the applied voltage.

Basic Functional Units

These are the units that are described in this chapter with reference to the page where the section starts:

- Power Supply (p. 6-4)
- Input Amplifiers (p. 6-8)
- Timebase Reference Circuits (p. 6-12)
- Prescalers (p.6-15)
- Microprocessor & Memories (p. 6-15)
- Microprocessor Bus & Interfaces (p. 6-21)
- Measurement Logic (p. 6-27)

Power Supply

The DC voltages needed in the instrument are generated from the three main voltages of the AC/DC module.

The instrument has only a secondary power switch, i.e. the AC/DC module is always operating if line power is applied. The three output DC voltages (+5 V, +15 V, -15 V) from the module are present on the main circuit board. When switched off, the instrument is in the standby mode. In this mode only the ON/OFF circuitry and the optional oven oscillator are powered.

The AC/DC module should not be repaired. Not even the built-in fuse should be replaced. Built-in circuits protect against external overloads, so a blown fuse indicates that a severe internal fault has occurred. Replace the complete module instead.

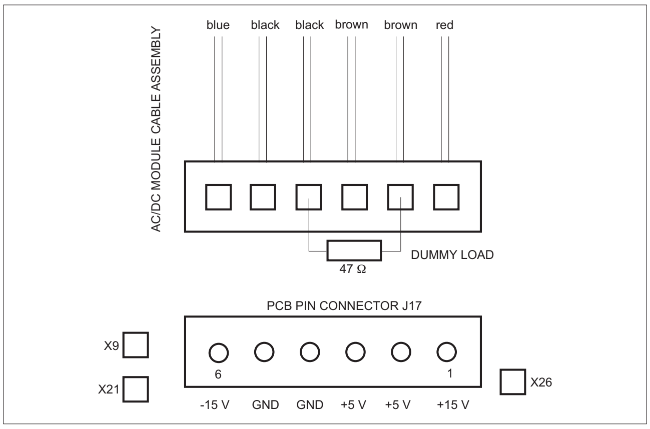

Figure 6-2 *Dummy load connection.*

Test the AC/DC module by measuring the three DC voltages in TP9 (+5.1 ± 0.05 V), TP21 (-15 ± 1 V) and TP26 (+15 ± 1 V) on the main circuit board. See Figure 6-2. Note that there is a +5 V trimmer on the module. If the +5 V is not correct, disconnect the cable to J17 on the main circuit board. Put a 47 Ω 1 W resistor on the connector according to Figure 6-2. Measure on the connector +5.1 ± 0.05 V, +15 ± 1 V and -15 ± 1 V.

It can be difficult to measure the resistance in the supply connector J17 on the main circuit board, because charges are kept by capacitors some time after line power is removed. Remove the cable from the AC/DC module. The resistance between +5 V and ground should be approximately 700 Ω. See Figure 6-2. In a timer/counter with all capacitors uncharged, +15 V and -15 V should be at least MΩ.

Another way to test J17 is to connect 3 DC voltages from a separate bench power supply directly to J17 (suitable connector MOLEX 09-91-0600). See Figure 6-2. The currents drawn from the different supply voltages depend on options installed. Before making this measurement, you should remove any prescaler option.

A timer/counter without options gives the following typical results:

+5 V	0.7 A
+15 V	0.25 A
- 15 V	0.4 A

The oven oscillator increases the + 15 V current between 0.35 A (cold) and 0.1 A (warm).

A block diagram of the secondary power supply is shown in Figure 6-1. All secondary voltages are switched off in standby mode except +12 VU for the optional oven oscillator.

The ON/OFF circuitry controls the ON and OFF of the secondary voltages. Its own supply voltage is always ON, as long as the instrument is connected to line power. See Figure 6-6.

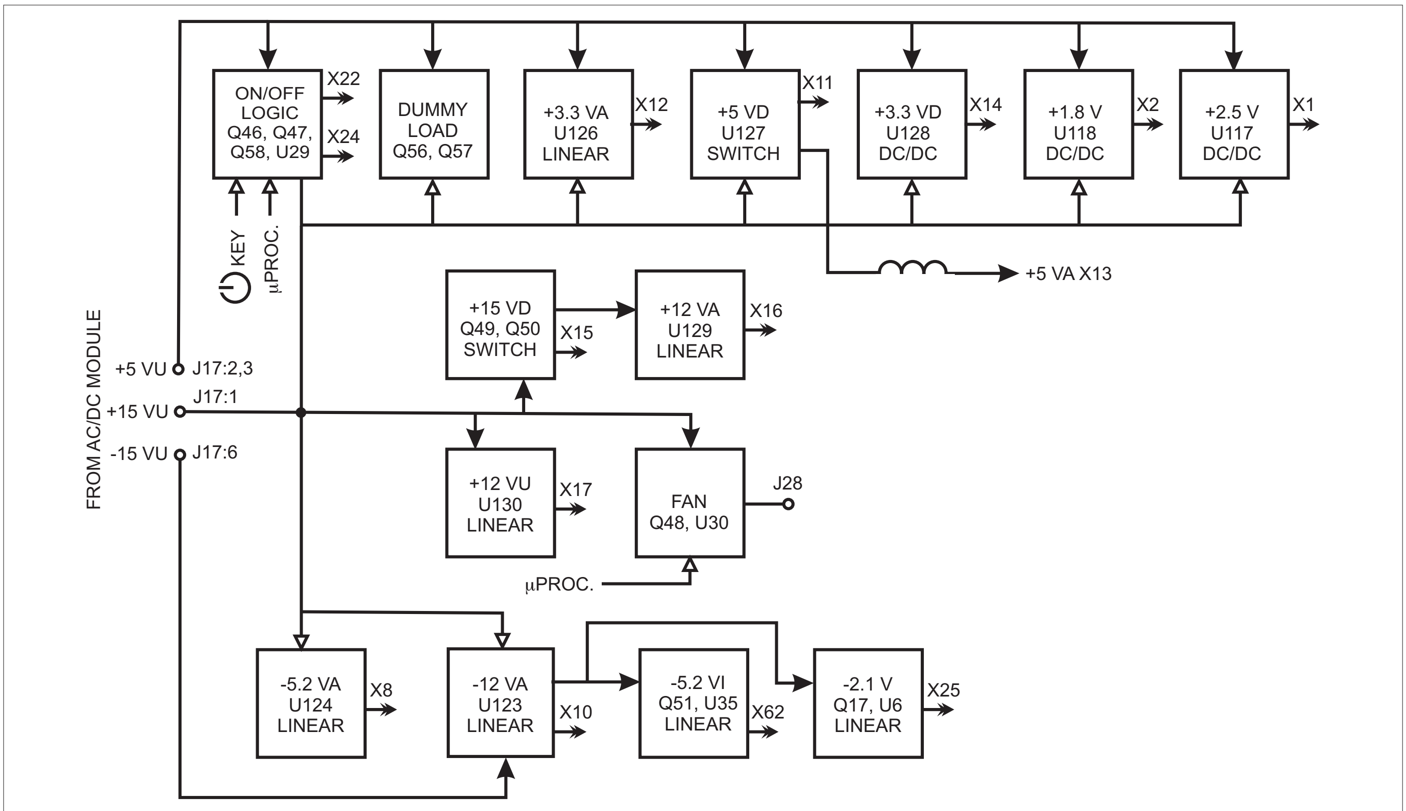

Figure 6-1 *Power distribution*

On connection of line power, R478 and C389 keep the RESETN input of the flip-flop U29 low. This sets the QN output of U29 high. Via Q47 (output signal low) and Q58 (output signal high) the secondary power supply will be set in ON mode. To switch to the standby mode, the processor sets the SETN input of U29 low. This results in the QN output being low and the secondary power supply being set to standby mode via Q47 (output signal high) and Q58 (output signal low). In standby mode a bleeder circuit on +5 VU is connected. It draws approximately 100 mA to stabilize the AC/DC module. The standby LED on the front panel is switched on. To switch to ON mode from standby mode, a negative pulse, generated by pressing the ON/OFF key on the front panel, is connected to the RESETN input of U29.

Linear regulators are used for some voltages to ensure minimum noise. Check the TPs below:

TP12: +3.3 VA (from +5 VU)
TP8: -5.2 VA (from -15 VU)
TP10: -12 VA (from -15 VU)
TP62: -5.2 VI (from -12 VA)
TP25: -2.1 V (from -12 VA)
TP16: +12 VA (from +15 VD)

TP17: +12 VU (from +15 VU) (to oven oscillator, not switched off in standby mode)

For digital and general use some voltages are generated by DC/DC converters. Check the following TPs:

TP14: +3.3 VD (from +5 VU)
TP1: +2.5 V (from +5 VU)
TP2: +1.8 V (from +5 VU)

Some voltages derived directly from the AC/DC module are used as secondary supply voltages without further regulation, and they have semiconductor switches in series to make it possible to shut them off in standby mode. Check the TPs below:

TP15: +15 VD (from +15 VU)
TP11: +5 VD (from +5 VU)
TP13: +5 VA (from +5 VD)

These 13 secondary voltages are used all over the instrument. All secondary supply voltage lines are segmented into branches with ferrite beads. See the schematics. This makes it easier to isolate short circuits by removing ferrite beads temporarily.

Figure 6-3 *PCB1 survey*

Fan Control

The fan is connected to +15 VU over a speed control circuit. It is only ON if a control signal from the processor is present. The first 8 minutes after power-up the fan will run at a fixed speed, fed with +8.3 V. After that the fan is temperature controlled. The processor reads the temperature from U39 via the I^2C bus. Depending on the temperature, the fan is fed with a DC voltage between 8 and 13.5 V. The processor uses a PWM signal that is filtered to control the fan.

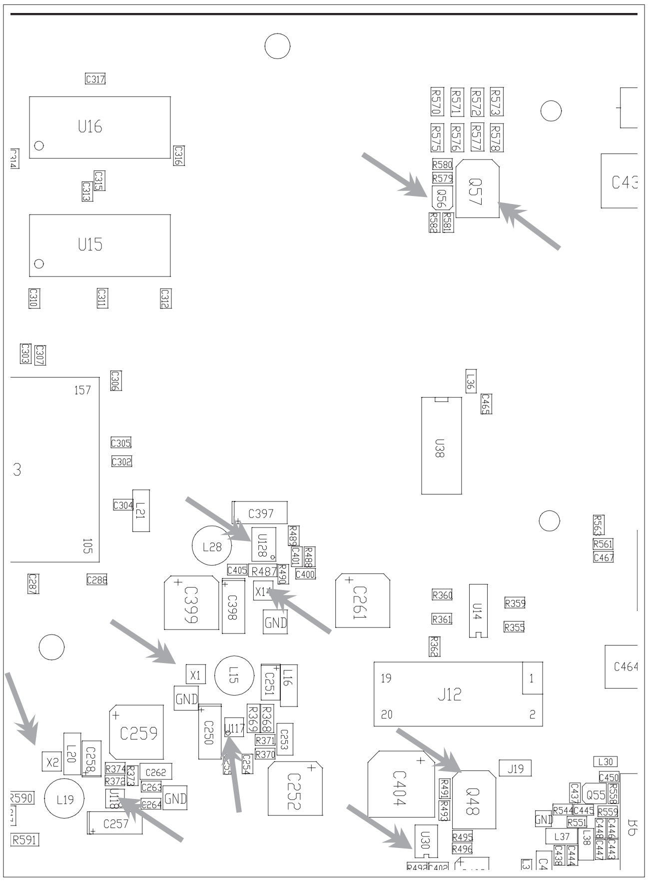

Figure 6-5 *Important power supply locations #2.*

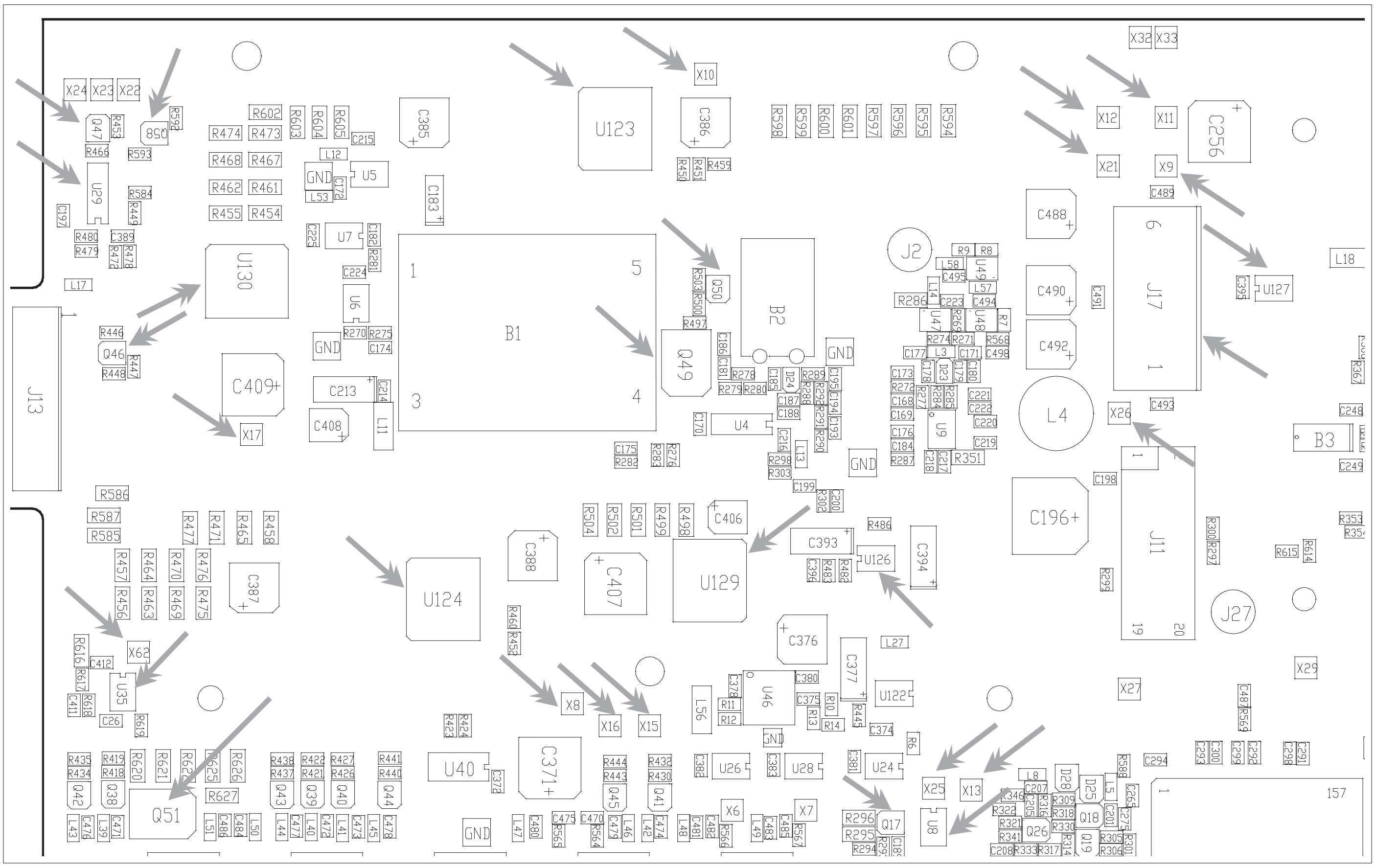

Figure 6-4 *Important power supply locations #1.*

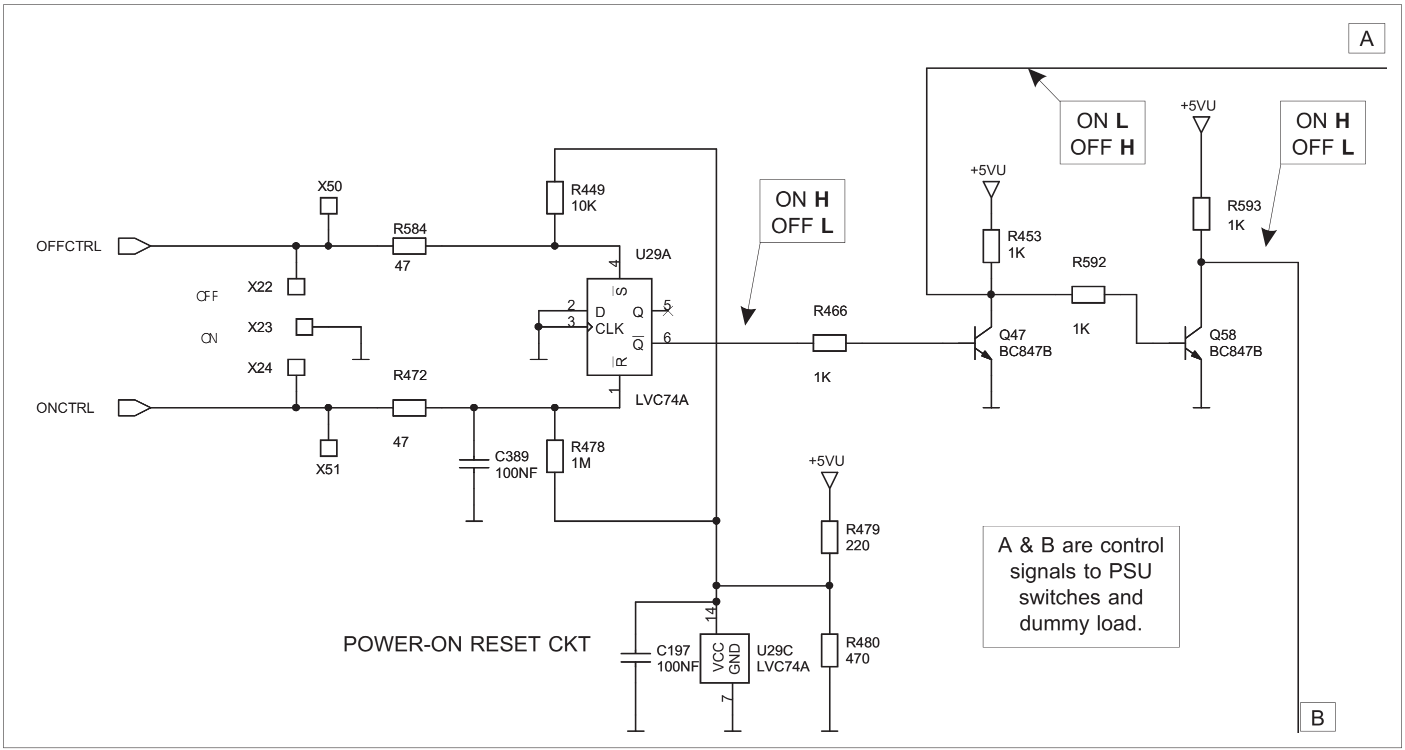

Figure 6-6 *ON/OFF logic*

Input Amplifiers

The input amplifiers for Channel A and Channel B are identical. A trigger level circuit belongs to each amplifier. The trigger level is adjusted to match the hardware during the voltage calibration procedure, see Chapter 7. Note that the input amplifiers must be adjusted according to Chapter 7 (step response, sensitivity etc). The description refers to both channels (Channel B information within parentheses).

Recall the timer/counter default setting. Select the measurement function *Time A-B*. Set both input channels to DC, Man Trig = 0.000 V. No signals connected.

The RF shield must be removed before measuring on the input amplifiers. It is soldered to two of the shield clips. Don't forget to put the shield back afterwards and secure it by resoldering.

First measure some DC values. U3 pin 9 (pin 13) should be near 0.000 V. The same applies to the trigger level, U3 pin 10 (pin 12). The voltage to ground at the point where R171 (R243) and R172 (R244) are connected should be approximately -0.8 V.

Connect a 1 kHz square wave with amplitude 1 V_{pp} in 1 MΩ to Input A (Input B). Measure at the following points (see also figure cc) and use the ground pads that are distributed over the PC board:

Test Points	Approximate Voltage
R140 to R141 (R212 to R213)	1.00 V_{pp}
R156 to C109 (R229 to C140)	0.40 V_{pp}
U1 pin 2 (U2 pin 2)	0.20 V_{pp}
U1 pin 3 (U2 pin 3)	0.20 V_{pp}
U1 pin 6 (U2 pin 6)	-1.00 V_{dc}
R151 to R157 (R223 to R230)	0.40 V_{pp}
U3 pin 9 (U3 pin 13)	0.40 V_{pp}
R309 and R314 (R313 and R315)	ECL levels -1.0 V and -1.7 V
R301 both sides (R304 both sides)	LVPECL levels 1.6 V and 2.6 V

Test the trigger level by manually setting the following trigger levels. Check the voltage at X6 (X7) and U3 pin 10 (pin 12).

Set Level	Approximate Voltage
+1 V	+0.41 V
+4 V	+1.65 V
-4 V	-1.65 V
-1 V	-0.41 V

Set the timer/counter to default. Select the measuring function single period. Connect the 1 kHz square wave to channel A (B). Measure with oscilloscope at X6 (X7). See figure dd for a typical signal.

If any repair work has been done on the input amplifiers, both adjustment and voltage calibration must be performed afterwards. If any repair work has been done on the trigger level circuits, at least voltage calibration must be performed afterwards. See Chapter 7.

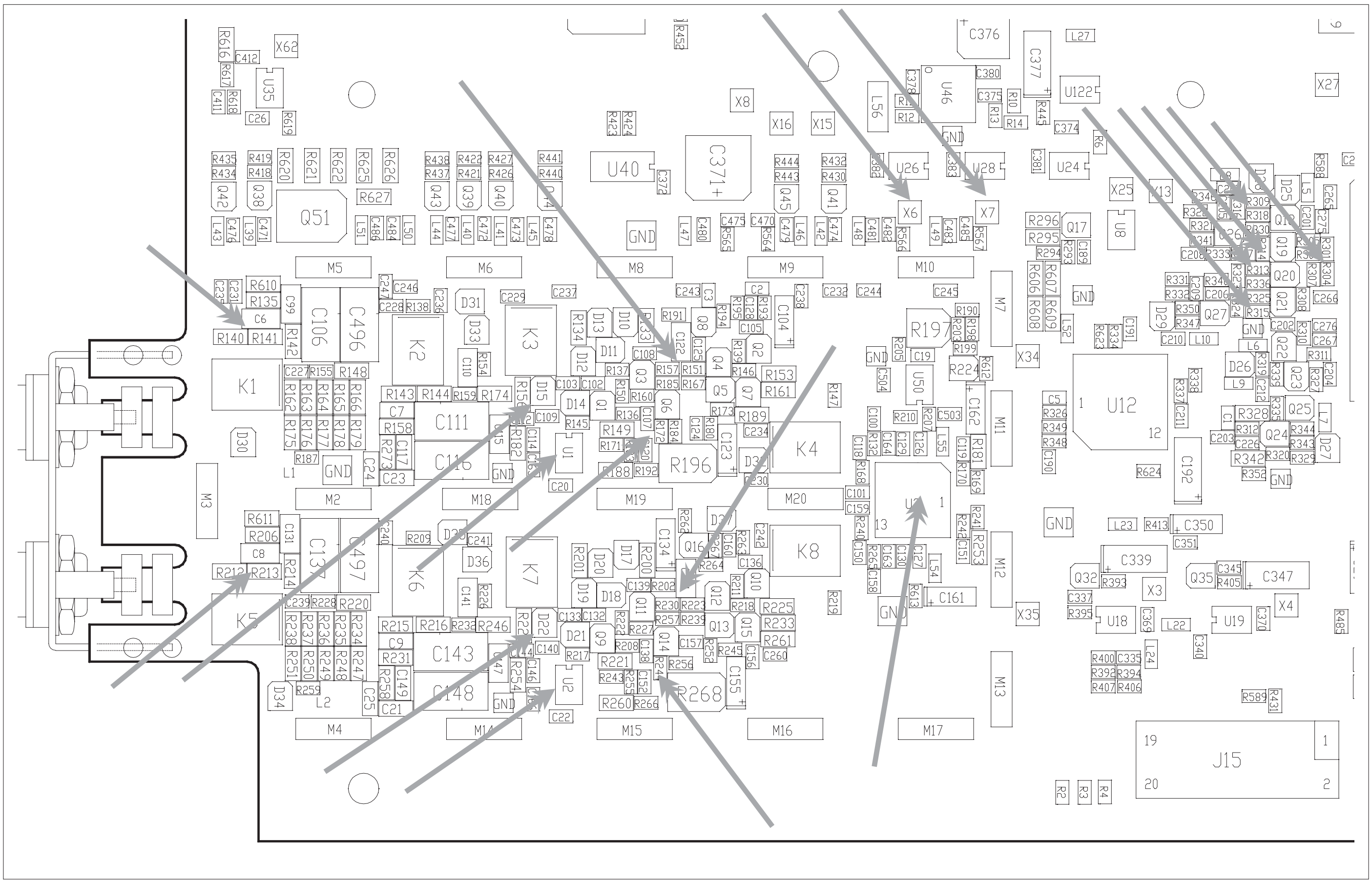

Figure 6-7 *Test points for troubleshooting the input amplifiers.*

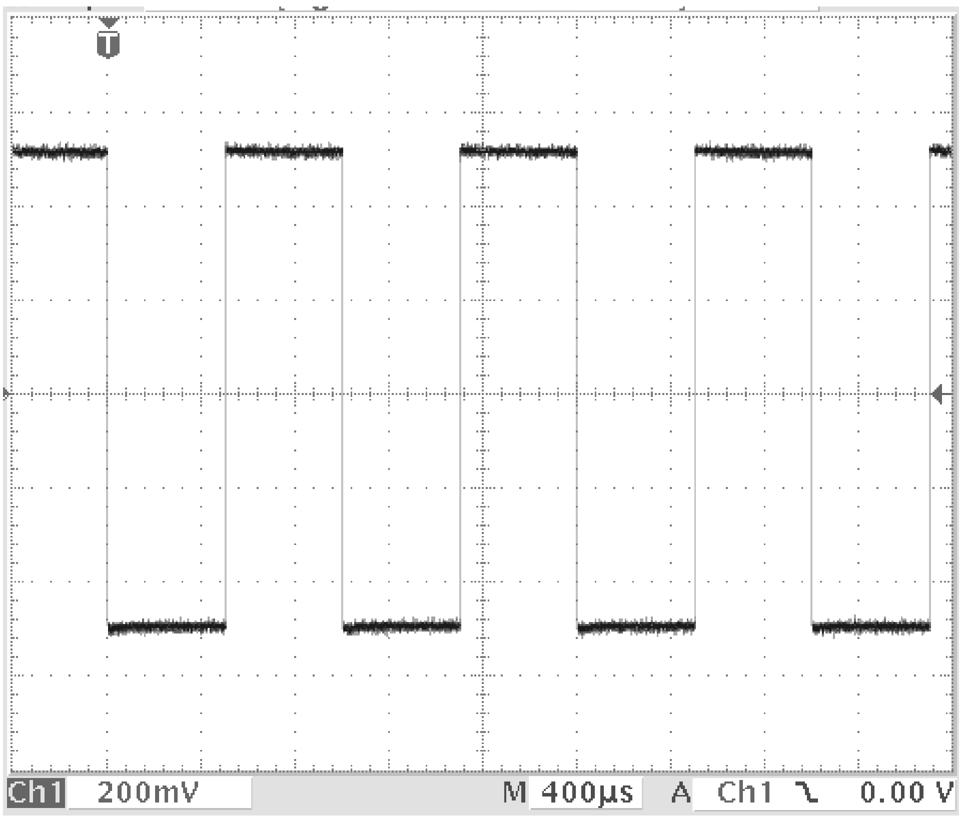

Figure 6-8 *Oscillogram showing the signal at the interconnection of R140 (R212) and R141 (R213).*

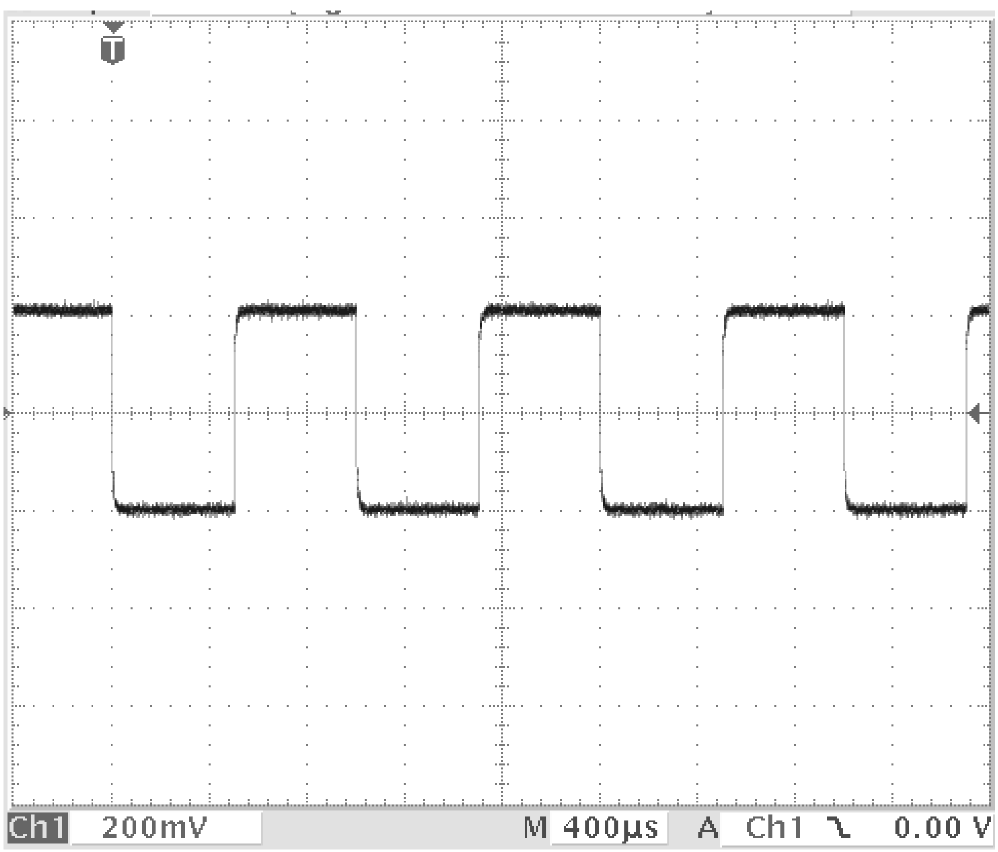

Figure 6-9 *Oscillogram showing the signal at the interconnection of R156 (R229) and C109 (C140).*

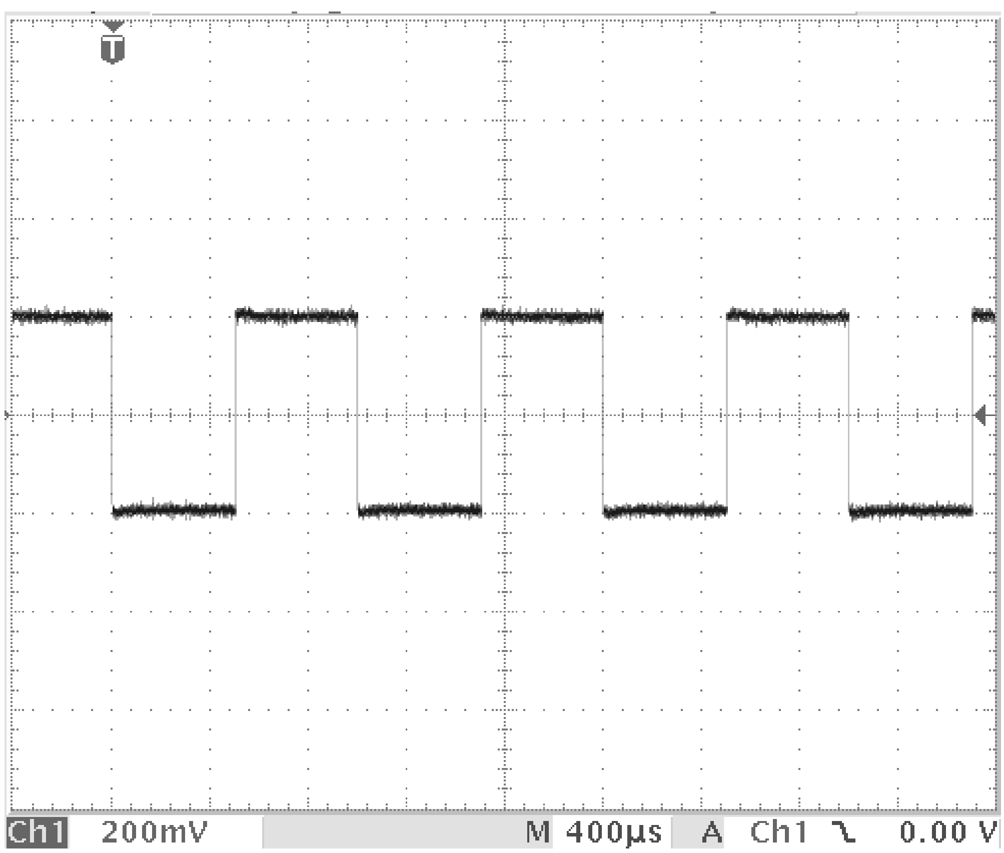

Figure 6-10 *Oscillogram showing the signal at U3:9 (U3:13).*

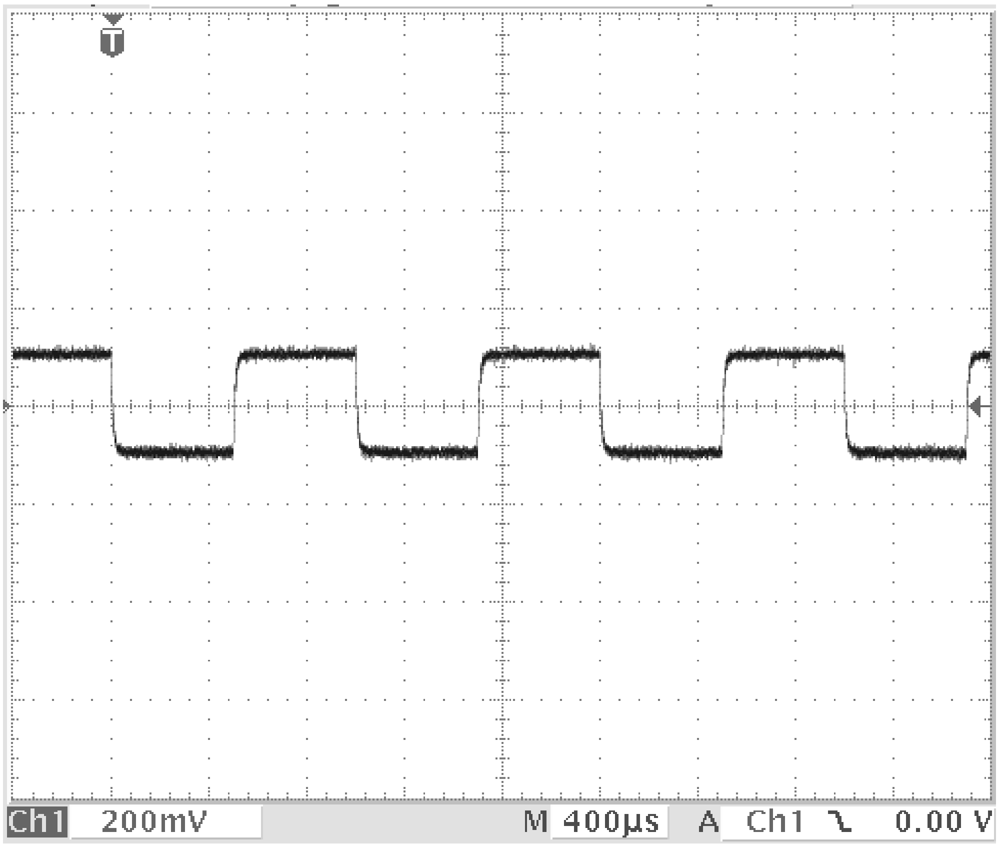

Figure 6-11 *Oscillogram showing the signal at U1:2 (U2:2).*

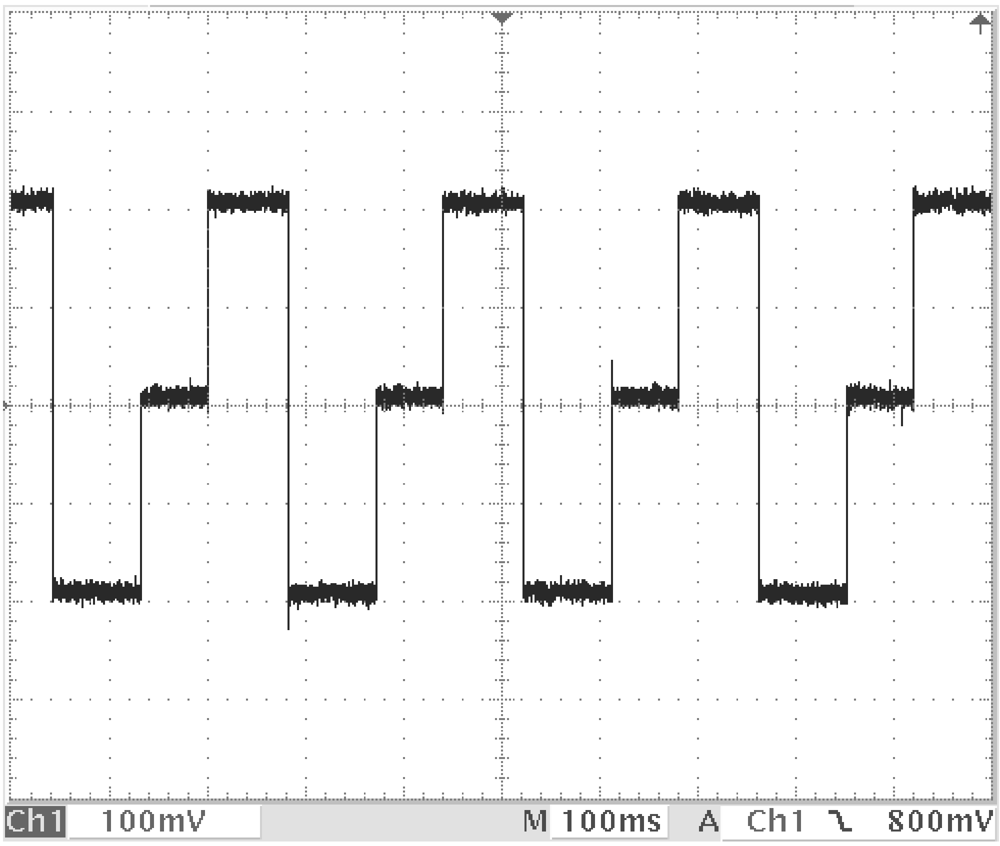

Figure 6-12 *Oscillogram showing the signal at X6, Period Single A.*

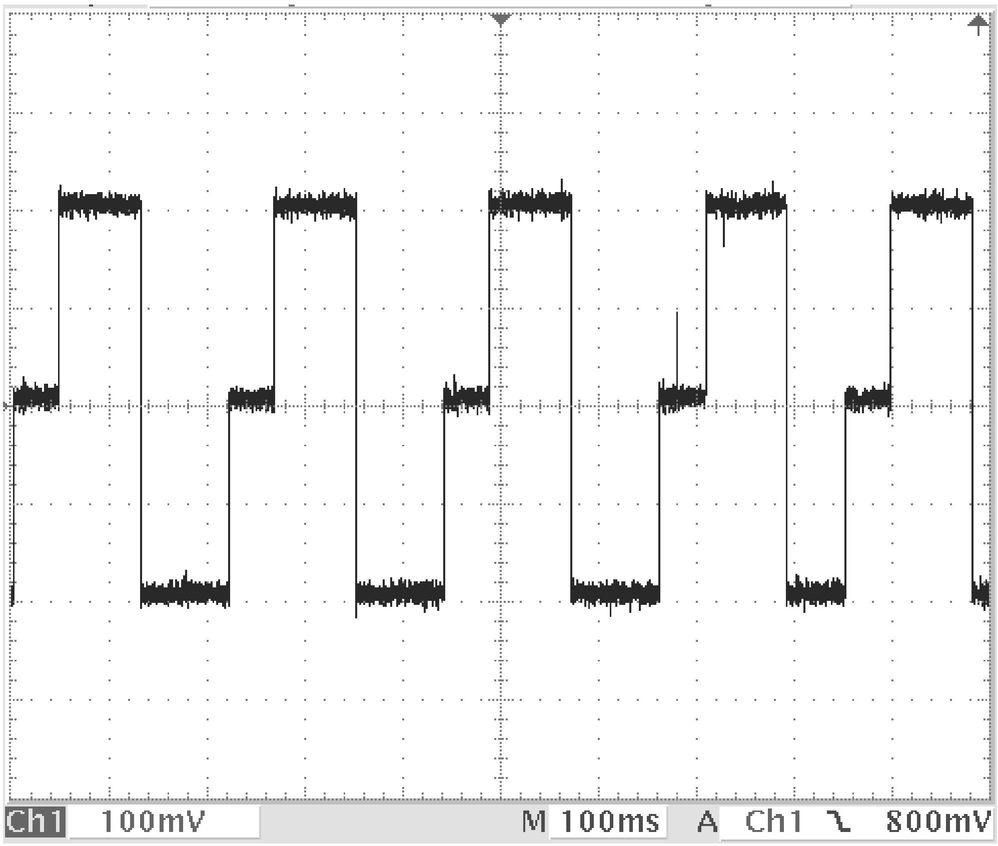

Figure 6-13 *Oscillogram showing the signal at X7, Period Single B.*

Timebase Reference Circuits

The measurement reference is either a 10 MHz signal from an internal oscillator (standard crystal oscillator or optional oven-controlled crystal oscillator) on the main circuit board or a signal from the external reference input that accepts the following frequencies: 1, 5 and 10 MHz. A frequency multiplier transforms the external signal to 10 MHz. The selected 10 MHz reference is always available at the internal reference output. See Figure 6-14.

The main PCB is prepared for both types of internal timebase, but only one of them is mounted. The selection is made at the factory. You have to run the utility program (see page 5-3), if the oscillator is to be changed. *Closed Case Calibration* is used for adjusting the oscillator. On power-up the processor outputs the setting that is stored as the correct one for 10.000000 MHz. It will take some time for the oven oscillator to reach the correct frequency. A calibration must be performed if the adjusting voltage should move during operation, not only on power-up.

The selection between the on board oscillator and the external reference is made in the FPGA. The 10 MHz signal from the other source is switched off.

Connect a 10 MHz signal to the external reference input. Use the **SETTINGS** menu to alternate between internal and external oscillator. Check for correct signals at U4:6 for the standard oscillator, at U4:8 for ther oven oscillator and at U33:3 for the external reference. Check also that the selected timebase reference is present at the internal reference output BNC connector on the rear panel.

Standard Oscillator

See Figure 6-14 and Figure 6-16.

The control signal (U4:1) must be high. The frequency is controlled by a PWM signal from the processor. After filtering the resulting DC voltage changes the capacitance of D24. A DC level between 0 V and +3.3 V at R289 should somewhere within the adjustment range give 10.000000 MHz. Check the output signal and frequency at U4:6.

If the standard oscillator is repaired, a new calibration must be performed. See Chapter 7. A new factory calibration by means of the utility program should also be performed.

Optional Oven Oscillator

See Figure 6-14, Figure 6-15 and Figure 6-16.

The oven oscillator is a self-contained unit, enclosed in a metal box and soldered to the main circuit board. It cannot be repaired and must be replaced with a new oscillator if it is faulty.

Let the oven oscillator warm up 10 minutes before starting measurements. The 12 V supply voltage can be checked at

X17. The oven oscillator should be powered also in standby mode.

The oven oscillator outputs a 10 MHz signal if powered. It should be 1.3 V_{pp} measured at R282. If not selected, a gate (U4) stops the signal, the control signal (U4:9) is then low. The frequency is controlled by a DAC (U5). Its reference voltage is derived from the oscillator, approximately +5 V (C174). The polarity of the reference voltage is reversed in an op amp (U6), and the voltage at U5:1 should be -5 V. The output voltage from the DAC should be between 0 and V_{ref}, measured at R281. The DAC is controlled by the processor via the SPI bus.

The frequency adjustment range should be wide enough to allow for more than 10 years of oscillator aging. The oscillator must be replaced if the normal control voltage range cannot make the oscillator output 10.000000 MHz.

As a last resort to exclude external causes of malfunction, desolder the oven oscillator from the main circuit board. Place it upside down and connect +12 V and ground according to Figure x. A cold oven oscillator draws approximately 0.30 - 0.35 A. During heating the current consumption varies. After 10 minutes it should stabilize on less than 0.1 A. The output V_{ref} should be approximately +5 V and the 10 MHz sinewave output signal should have an amplitude of more than 2.5 V_{pp} measured with a 1 MΩ, 10x probe. The control input has an internal bias to keep the output frequency in the middle of the range. Adjust the control voltage between 0 V and +5 V and check the output frequency range with a frequency counter. The minimum trimming range should be ±5 Hz. 10.000000 MHz must be reached somewhere between 0 V and +5 V.

If the oven oscillator circuitry is repaired, a new calibration must be performed. See Chapter 7. A new factory calibration by means of the utility program should also be performed.

External Reference Input

See Figure 6-14 and Figure 6-17.

The input signal is amplified in U31. The output signal from the amplifier should be a square wave with logic levels, reproducing the timing characteristics of the input signal. Check the signal at U32:11. U32 generates a short pulse (approximately 40 ns) for each input cycle, check at U32:9. These pulses generate a broad spectrum of harmonics, and the following high-Q 10 MHz crystal filter allows only a 10 MHz sinewave to pass. Measure at X19. Note that the trimmer C442 is used for maximizing the amplitude at X19. Check that the amplitude is not less than 1 V_{pp}. If external reference is not selected, the gate U33 stops the 10 MHz signal. The control signal on U33:1 is then low.

100 MHz Multiplier

See Figure 6-14 and Figure 6-16.

100 MHz is used in the measuring logic, mainly as a reference clock, but also for other purposes. A PLL is used for multiplying the 10 MHz reference to 100 MHz. On power-up the processor sets up the PLL IC (U9) via the SPI bus. An output signal, PLL LOCK, tells the processor if the loop is locked (high level). A VCO, consisting of an inverter (U47) and an LC circuit in the feedback loop, is controlled by the PLL IC. The DC voltage from U9:2 is filtered and controls a capacitance diode. The VCO frequency changes with the capacitance. The loop can handle the switching of 10 MHz reference, from internal to external and vice versa. There is no need for a new setup. If external reference is selected and no such signal is connected to the instrument, the PLL will be un-

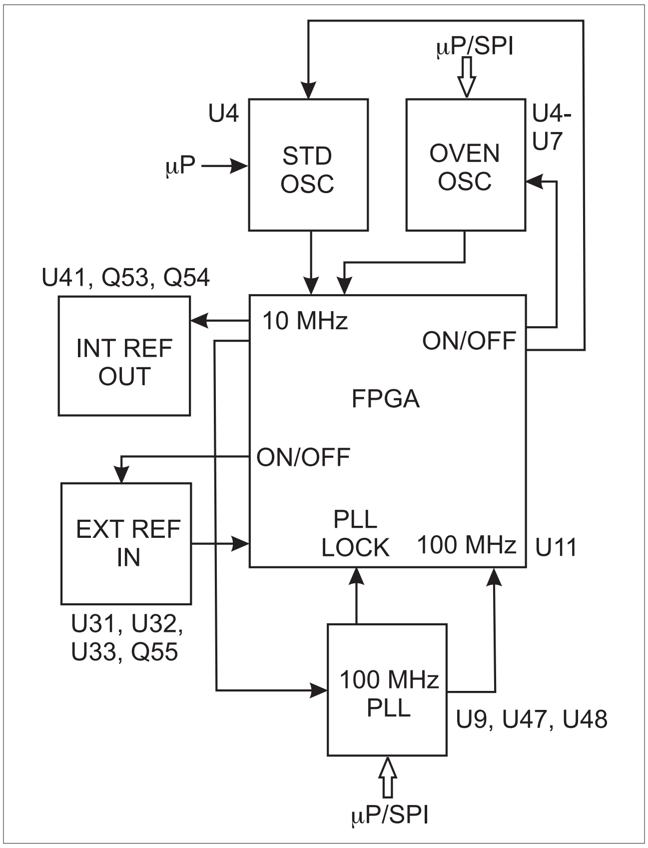

Figure 6-14 *Timebase reference system.*

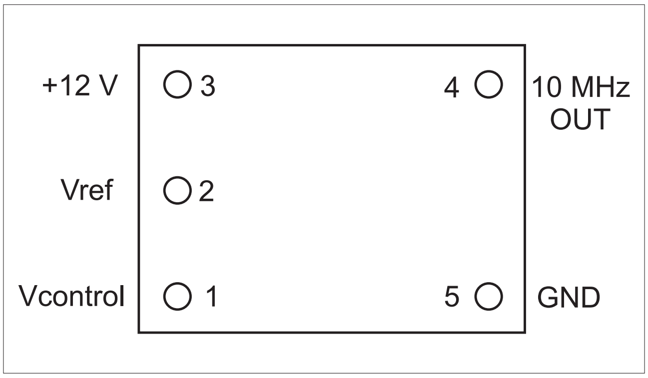

Figure 6-15 *Oven oscillator pinning (seen from bottom side).*

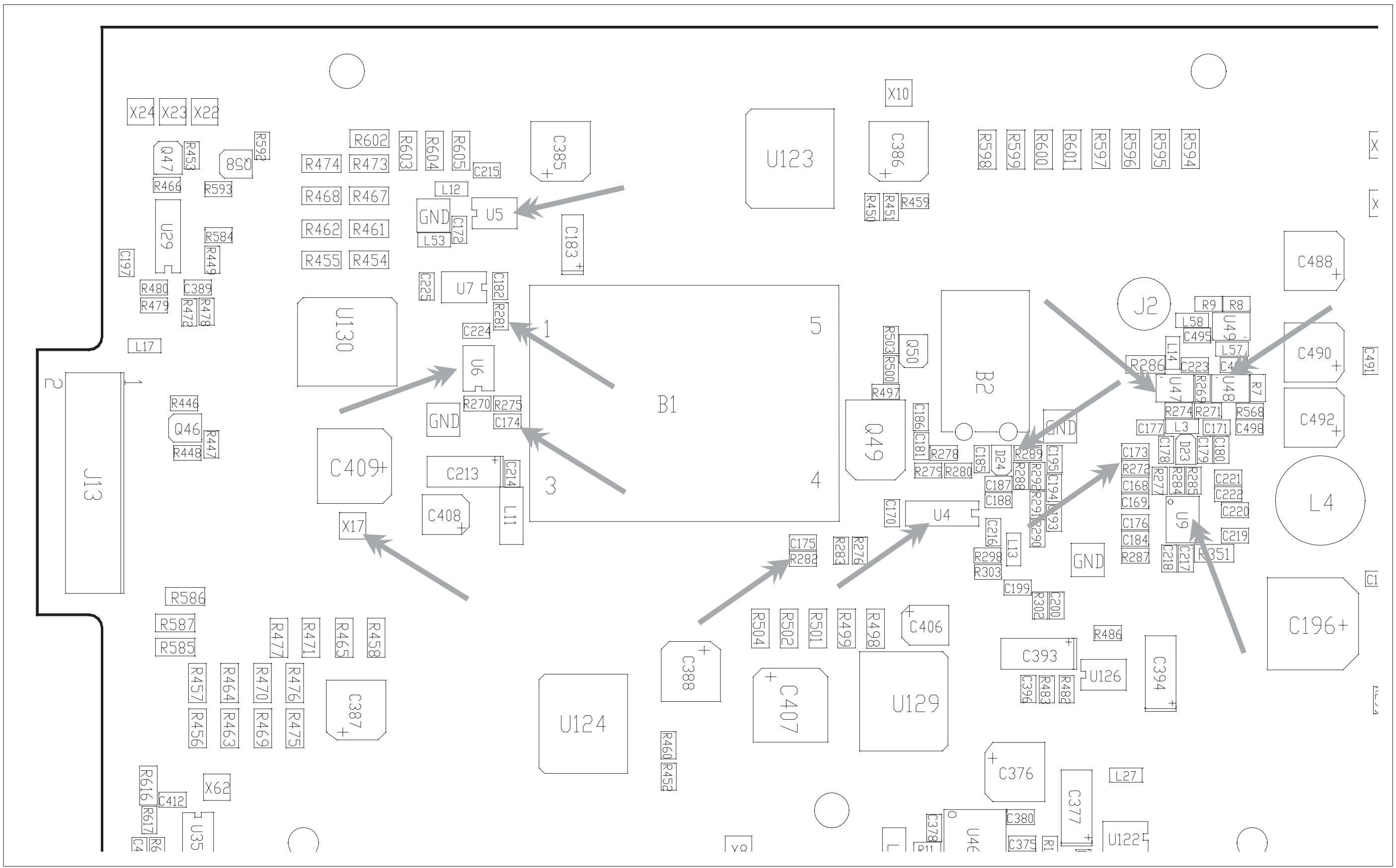

Figure 6-16 *Important locations in the internal timebase reference circuits.*

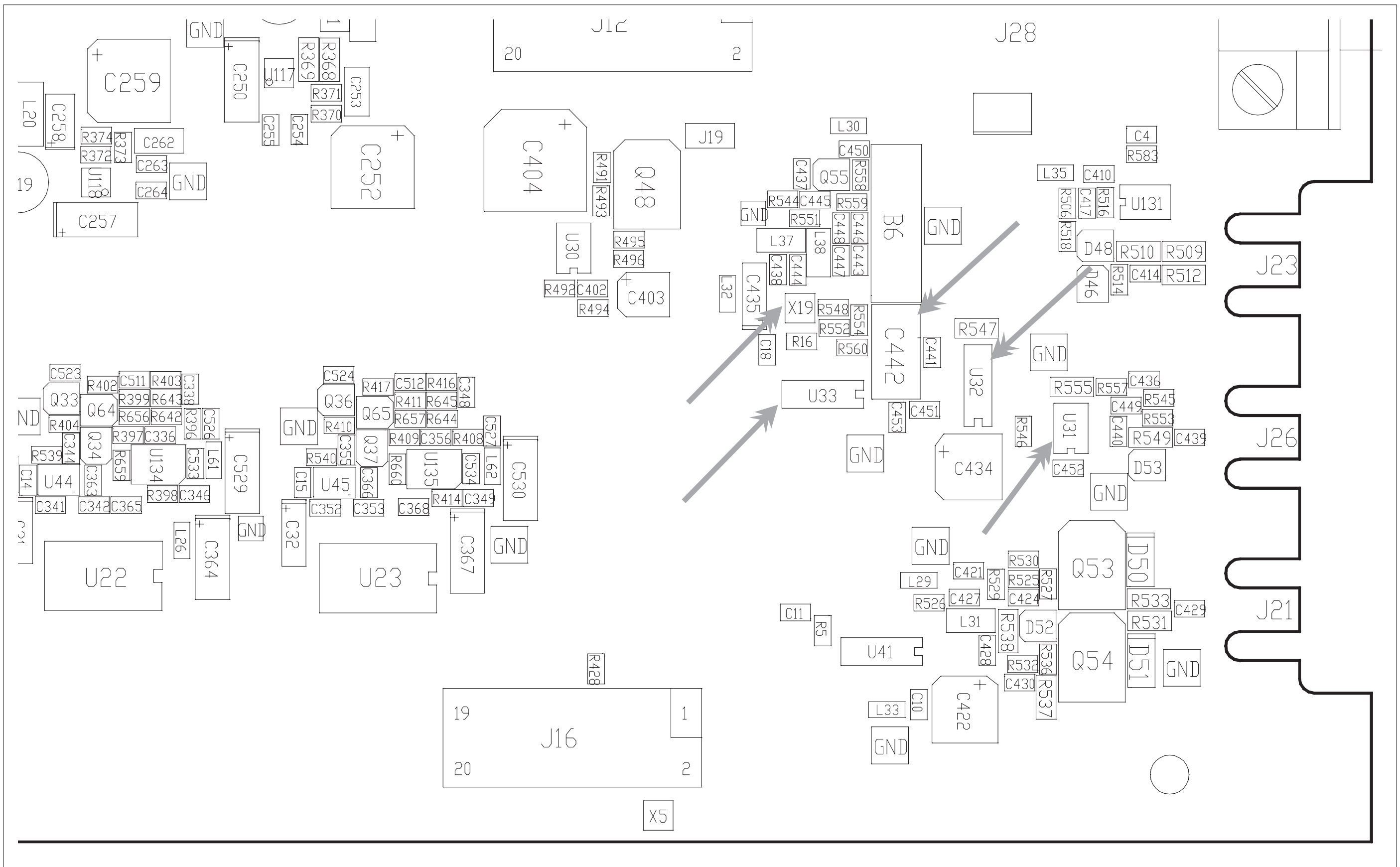

Figure 6-17 *Important locations in the external timebase reference circuits.*

locked, and the VCO will go to one of the extremes. The typical range of the VCO is 95 to 105 MHz, thus giving an error of typically 5 % in the measuring results.

Check the loop voltage (DC) at R272. It should be 1.6 - 2.2 V. Check the 100 MHz signal at U48:4. It should be locked to the incoming 10 MHz at U9:8. Check the lock condition with a 2-channel oscilloscope. Trigger on the 10 MHz channel. Then the signal on the other channel shall be fixed, i.e. not moving along the time axis. Check the PLL LOCK signal at U9:14 (lock is high).

Prescalers

The optional prescalers are not to be repaired. The faulty unit should be sent to the factory, and an exchange unit will be returned.

The best way to isolate the fault is to use another, functioning, timer/counter with the same prescaler. Interchange the prescalers and see if the problem follows the prescaler or the timer/counter.

First measure with Channels A and B and check that the result is OK. Select the function *Frequency C*. Connect a signal according to Table 6-2 to Input C. Check the following pins on the prescaler connector J15 on the main circuit board.

Pin 1 +5 V supply
Pin 5 +12 V supply
Pin 7 ON/OFF, ON is 0 V
Pin 11 test signal, should be 0 V
Pin 12 code 0, see Table 6-2
Pin 14 code 1, see Table 6-2
Pin 16 code 2, see Table 6-2
Pin 4 prescaler output signal, PECL levels (+4.1 V and +3.4 V)

	OPTION		
	3 GHz	8 GHz	14 GHz
Frequency (GHz)	1	1	5
Level (dBm)	0	0	0
Division Factor	16	256	128
Code 0	0	0	1
Code 1	1	0	0
Code 2	0	1	1

Table 6-2 *Prescaler characteristics.*

Measure with oscilloscope and probe at pin 4. The output frequency should be the input frequency divided by the factor in the table. Check with a frequency counter.

Note: The 3 GHz option has a sensitivity trimmer. See page 7-14 for information on how to adjust it.

Microprocessor & Memories

Startup Process

The processor in this instrument is a 32-bit ARM7TDMI. It is housed in an IC (U13) together with peripheral units (SRAM, timers, I^2C bus interface, SPI bus interface, LCD controller etc). The complete IC is a Triscend design and of type A7S20.

A separate memory bus on the processor is connected to one 16-bit Flash PROM (U17) and two 16-bit SDRAMs (U16 and U15). The two SDRAMs are connected to form a 32-bit wide memory.

A Reset IC (U116) monitors +3.3 VD, +2.5 V and +1.8V. The reset signal is active low and kept low for approximately 160 to 180 ms after the voltages are OK. Measure at X33. The ramp-up time for +3.3 VD is approximately 2 ms, for 2.5 V approximately 4 ms and for 1.8 V approximately 3 ms.

The rising edge of the reset signal marks the start of the boot sequence. All I/Os on the processor are set high with a weak (high-ohmic) pull-up. The fan will run at full speed (R492). The memory controller in the processor is set up. The processor reads in the Flash PROM for the initialization data at certain addresses. Check CE0 at U13 pin 16. When the data is found, the processor loads it inside the processor IC. The I/Os will be set up. The fan will stop running because the pin is set low. The 32 kHz oscillator will start running (check at R357) and an internal PLL will generate 30 MHz internal and external clock, check X29.

After the initialization the processor starts executing code from address 0 in the Flash PROM. The program copies the code from the Flash PROM to the SDRAM. When done it starts executing from the SDRAM. Check SDCE0 at U13:26. The Flash is not used for executing code after this, only occasionally for storing data that should be non-volatile.

See Figure 6-21 to Figure 6-23 for a survey of a typical instrument startup.

The LCD is switched on. The LCD controller in the processor generates the control signals for the LCD. See Figure 6-24 to Figure 6-29. Note the different timing for the signals. The I^2C bus is used for switching the LCD on. The ON signal can be checked at R34 on the display board. It should be high. The LCD voltages must also be switched on. It is done by a control signal from the processor. Check the signal at R33 on the display board. It should be high. Negative pulses on this signal are used for adjusting the contrast of the LCD, i.e. the LCD voltages. The range is 14.9 V to 17.5 V measured at X1 on the display board. Set the contrast so X1 is 16.2 V. Check the LCD voltages at X2 (14.7 V), X3 (13.3 V), X4 (2.9 V) and X5 (1.5 V). See Figure 6-19.

The FPGA (U11) has to be programmed. The I^2C bus is used for controlling the loading of the FPGA, the pins PROGN (U40:9) INITN (U40:7) and DONE (U40:8) are used. The clock (U11:155) and data (U11:153) are controlled by the

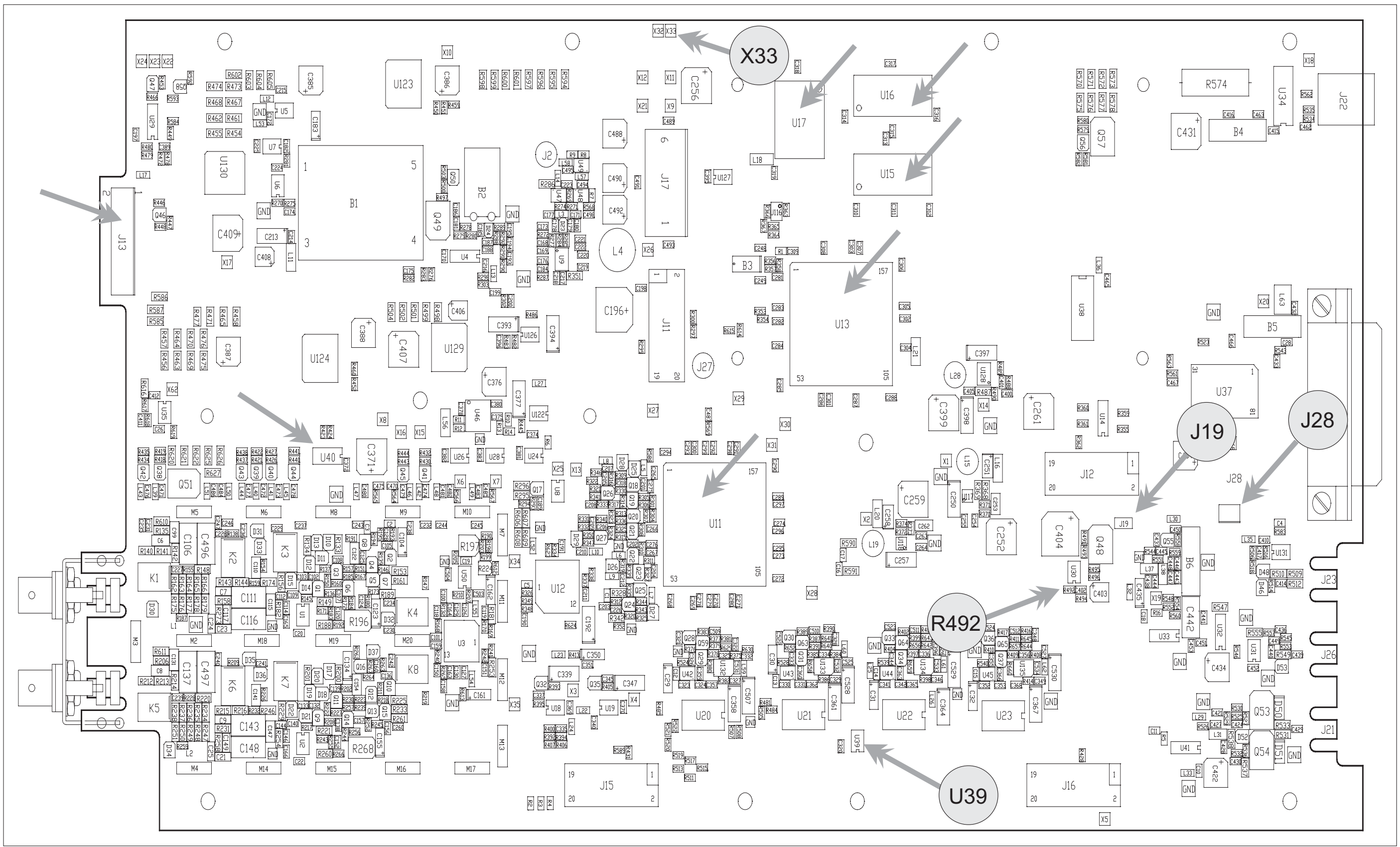

Figure 6-18 *Important locations on PCB 1 during startup.*

processor. See Figure 6-22. The loading starts when PROGN is set low. The FPGA responds with a negative pulse on INITN and setting DONE low. After loading 1442016 bits, which takes approximately 2.2 s, the FPGA sets DONE high if the loading was successful. If an error is detected, INITN is set low. One clock pulse after DONE is set high all I/Os on the FPGA are defined. If the loading of the FPGA is not successful, the program just goes on with the rest of the startup procedure.

The fan is set to 8.4 V. See Figure 6-23. Measure on J19 or J28. The input amplifiers are initialized and a "click" from the relays is heard. The I^2C bus is used for controlling the relays.

Note: The I^2C bus is of the utmost importance for the start of the instrument. The FPGA, the LCD and the relays in the input amplifiers all need a faultless I^2C bus to work properly.

Note: If the Flash PROM is exchanged, it must be replaced by a preprogrammed Flash PROM. Voltage and timebase calibration must be performed anew. The utility program must be used for transferring the calibration results to new factory calibrations. The serial number and the oscillator option must also be programmed by the utility program.

The fan is kept at +8.4 V for the first 8.3 minutes. After that the fan is temperature controlled. The processor reads the temperature via the I^2C bus every 10th second. IC U39 measures the temperature.

The keys on the display board are read over the I^2C bus. If a key is pressed, the I^2C bus circuit U3 notices that and sends an interrupt to the processor. Check at J13:9; low is interrupt. The processor then scans the keys via the I^2C bus to find the depressed key. See Figure 6-30. During the scanning there may appear some extra interrupts. This is not an error condition.

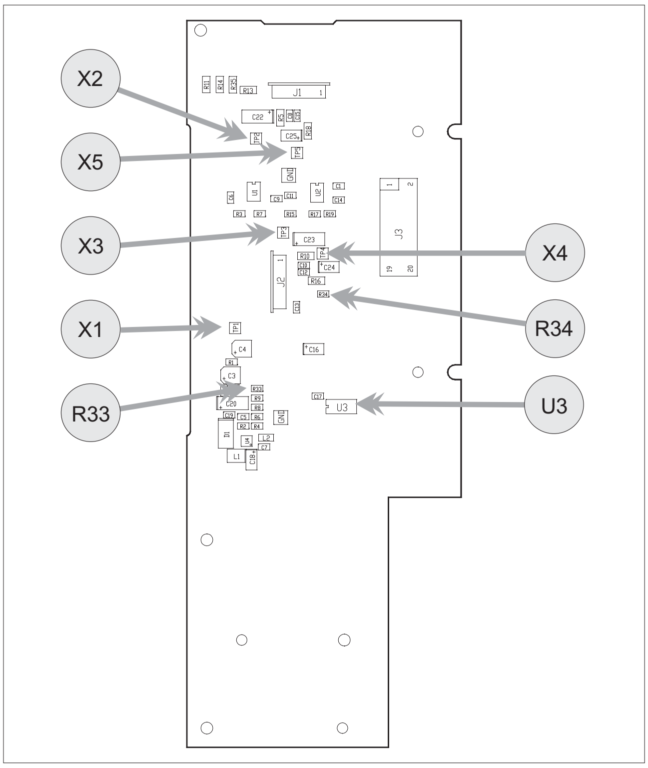

Figure 6-19 *Important locations on PCB 2 during startup.*

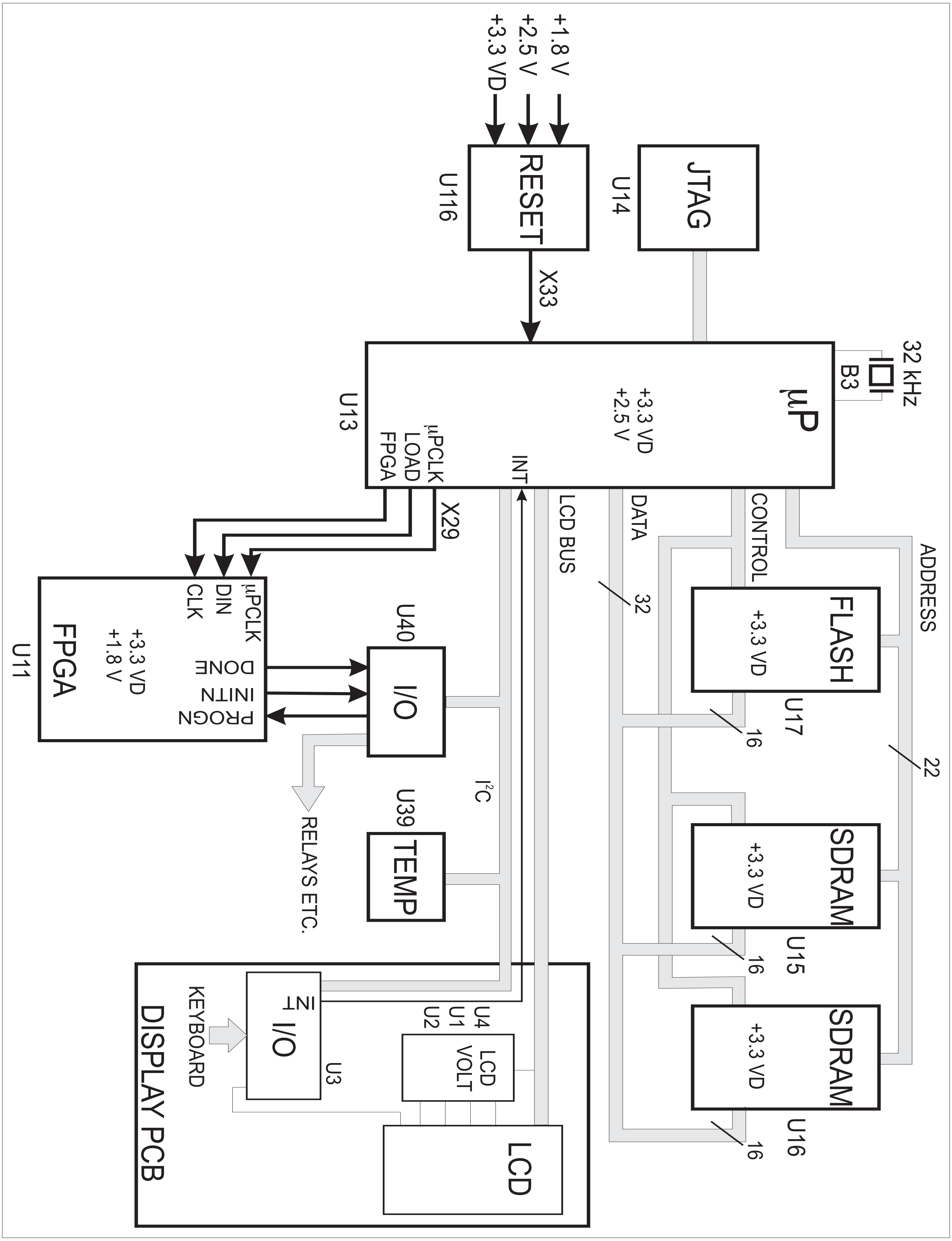

Figure 6-20 *Microprocessor, memories - startup.*

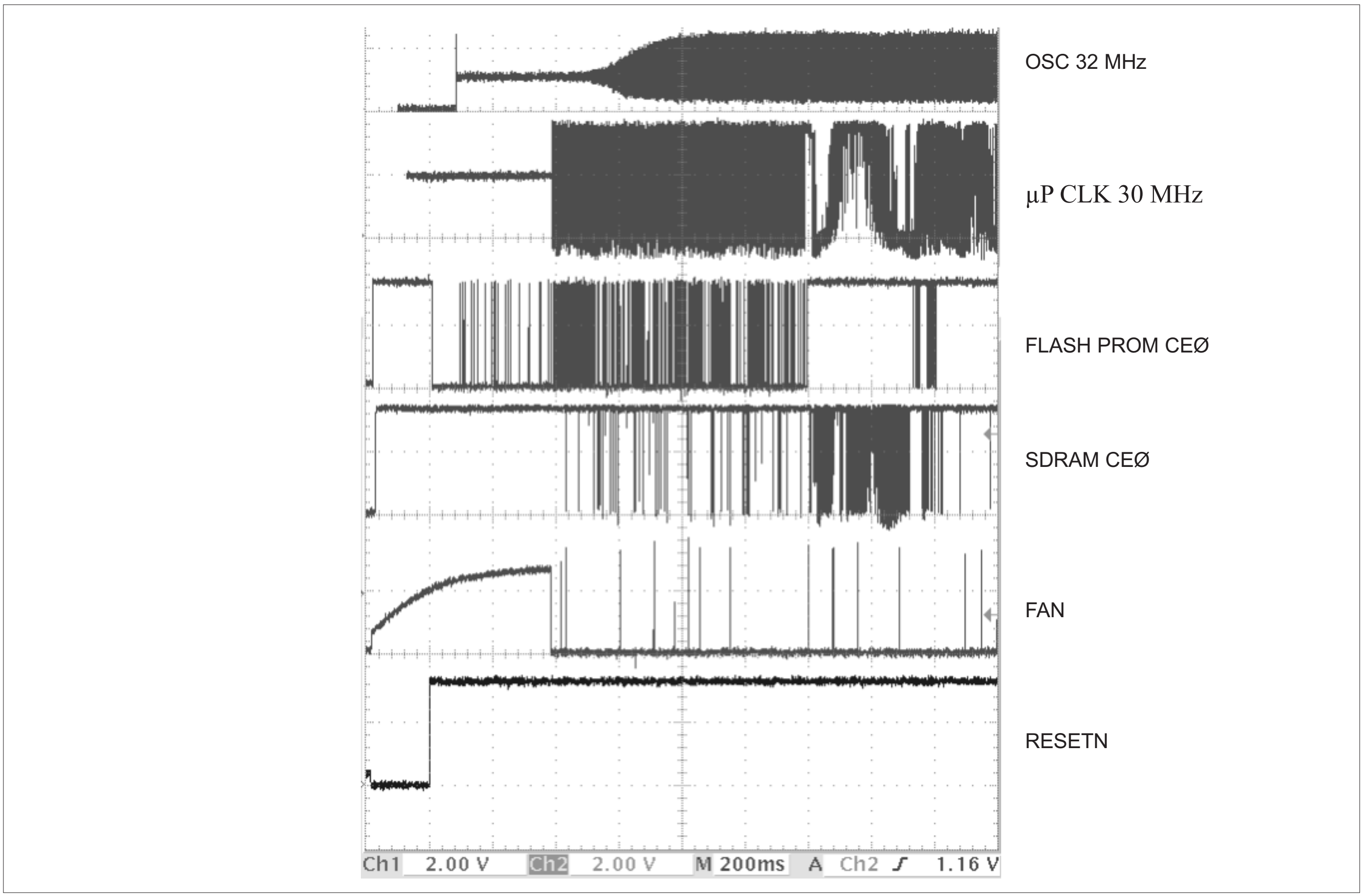

Figure 6-21 *Startup timing - processor, memories, fan.*

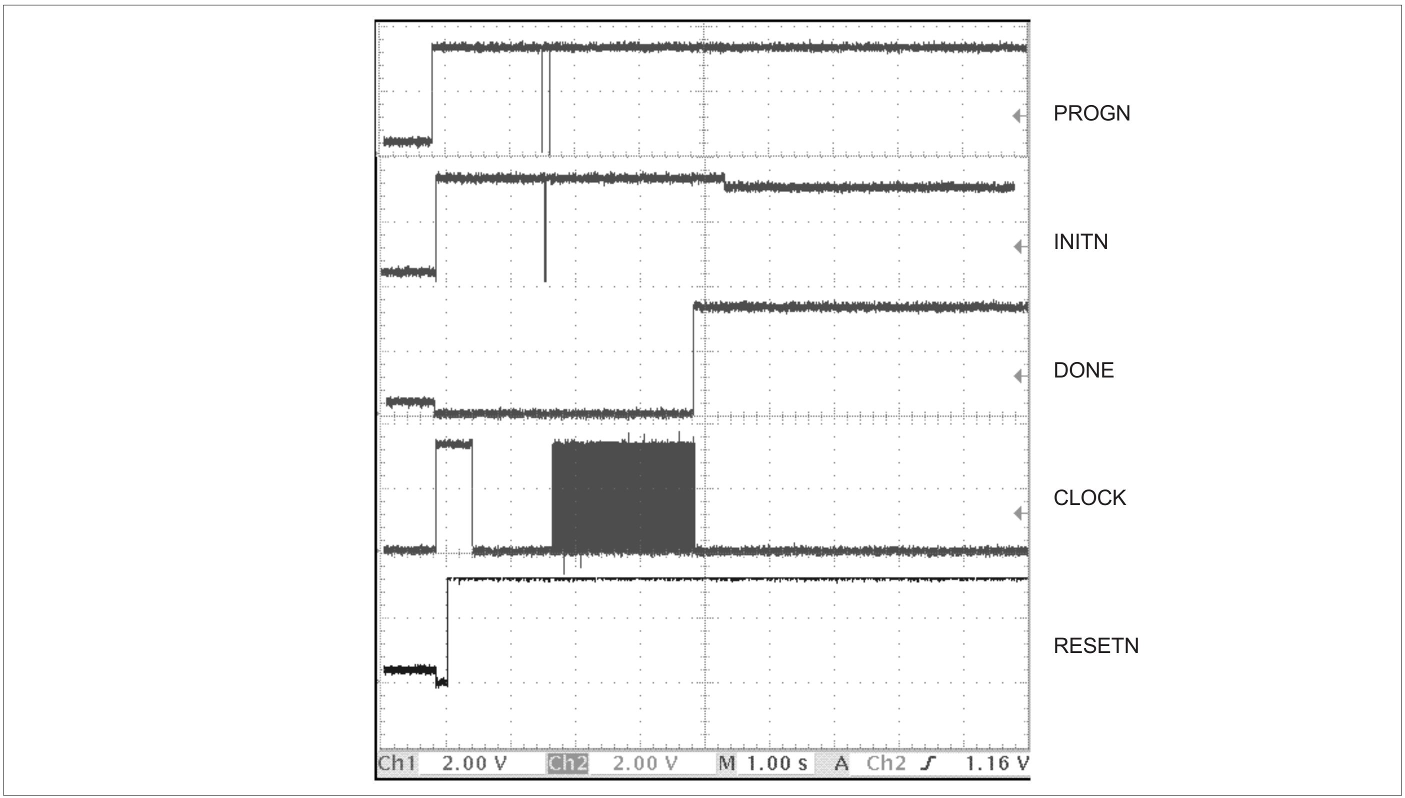

Figure 6-22 *FPGA loading.*

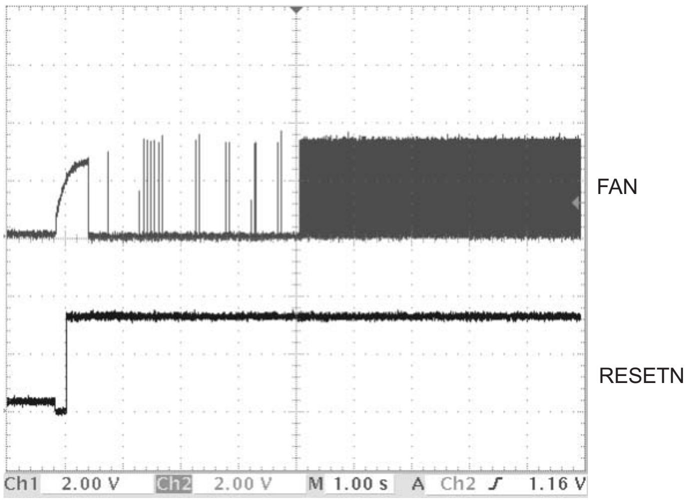

Figure 6-23 *Fan startup - extended timescale.*

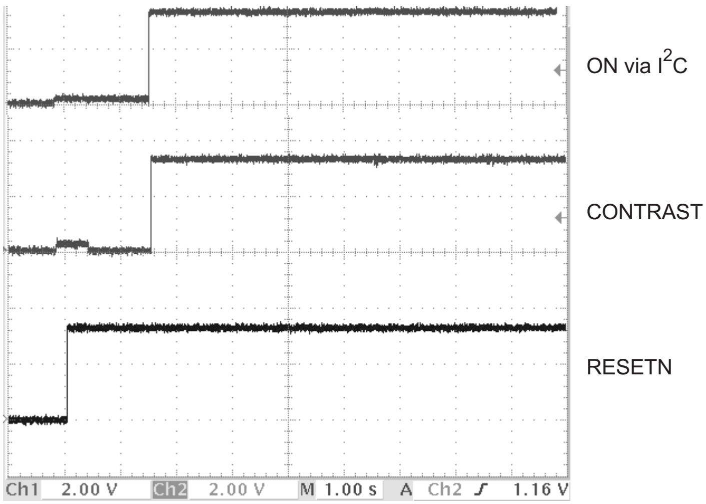

Figure 6-24 *LCD control signals, ocillogram #1.*

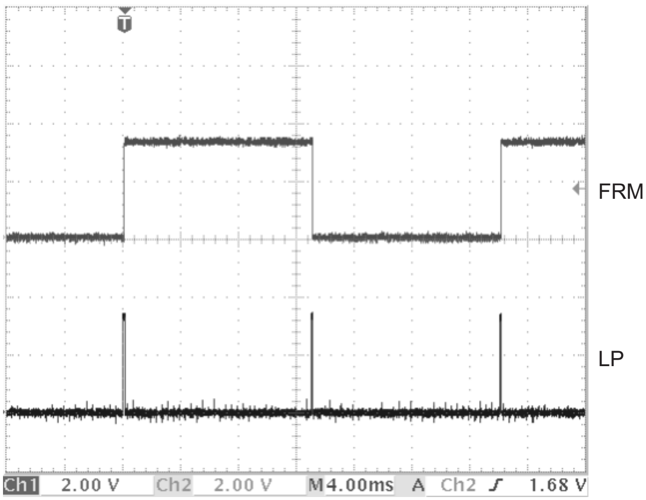

Figure 6-25 *LCD control signals, oscillogram #2.*

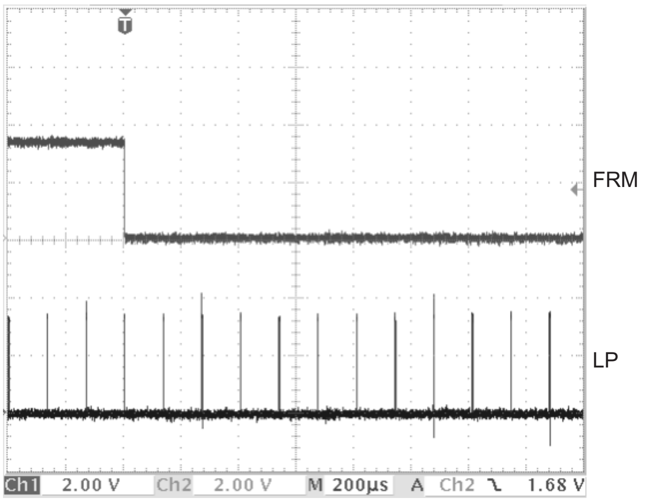

Figure 6-26 *LCD control signals, oscillogram #3.*

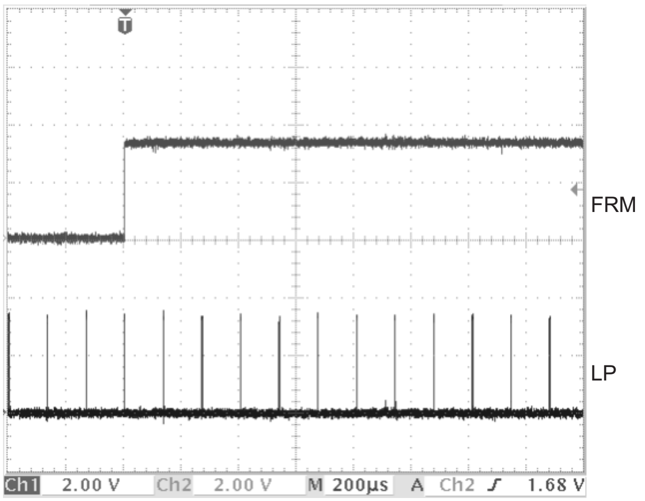

Figure 6-27 *LCD control signals, oscillogram #4.*

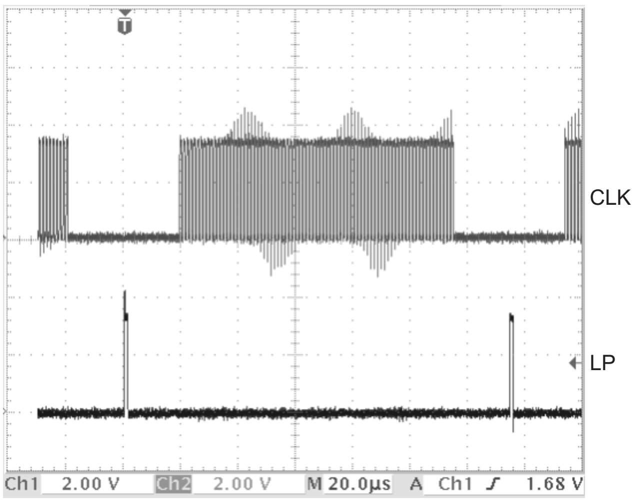

Figure 6-28 *LCD control signals, oscillogram #5.*

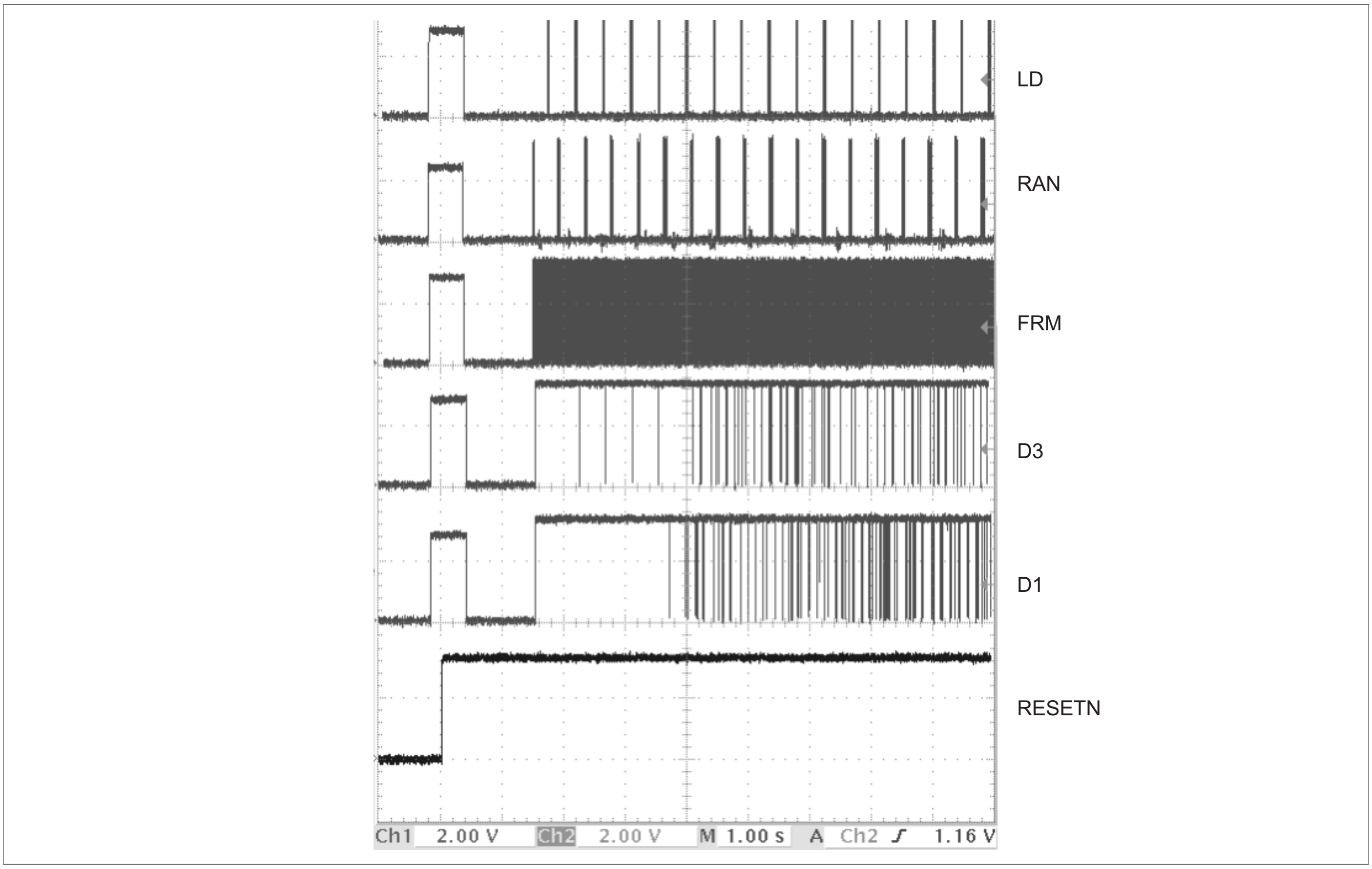

Figure 6-29 *LCD control signals, oscillogram #6.*

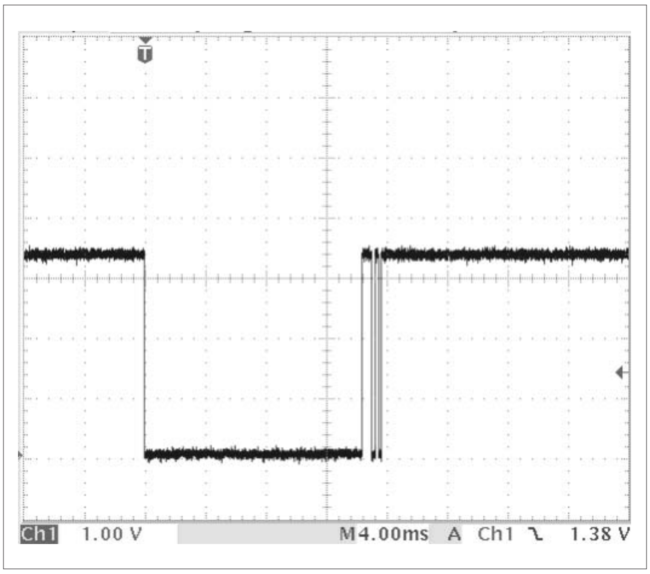

Figure 6-30 *Keyboard interrupt.*

Microprocessor Bus & Interfaces

The instrument has a conventional 16-bit microprocessor bus with 16 bits bidirectional data signals, 5 bits address signals, Chip Selects and wrn and rdn signals. It connects the processor to the FPGA, the GPIB and the USB. See Figure 6-34.

The FPGA connection has 16 data bits, 5 address bits, chip select, wrn and rdn. The FPGA is controlled by the processor via the bus. Measuring functions are selected, for instance. The FPGA is controlled between each measurement or block of measurements. An interrupt signal from the FPGA is connected to the processor. See Figure 6-36 for a typical timing diagram.

The connection to the USB has 16 data bits, 1 address bit, chip select, wrn and rdn. An interrupt signal from the USB IC is connected to the processor. See Figure 6-38 for a typical timing diagram. The USB IC is a complete USB unit. It is not powered from the USB bus. The USB IC (U34) has a 6 MHz oscillator. Check at C416.

The connection to the GPIB has 8 bits, 5 address bits, chip select, wrn, rdn and a special control signal for the level shifting IC (U38). U38 is a buffer between the logic level of +3.3 V for the processor and the logic level of +5 V for the GPIB IC (U37). An interrupt signal from the GPIB IC is connected to the processor. See figure ee for a typical timing diagram. The GPIB IC is a complete GPIB unit. The GPIB IC (U37) has a 40 MHz oscillator. Check at TP20.

Only the selected interface is involved in communication on the microprocessor bus.

Since both interfaces consist of only one IC each, troubleshooting is fairly simple. Check that the oscillator (40 MHz or 6 MHz) is running. Check that the processor communicates with the selected IC. Make sure the external controller (GPIB or USB) and the interconnection cable used are OK.

There is a separate bus for transfer of the measurement result data from the FPGA to the processor. This bus is 32 bits wide and has a clock of its own, FCLK (U11:101). A signal from the processor, FEMPTY (X28), indicates to the FPGA that a new packet of 8 words of 32 bits can be transferred. This is done with the FWR signal (X30) together with the FCLK. The FPGA can call for attention via an interrupt request signal, FFIQ (X31). This is done when the FPGA would like to transfer a packet to the processor. See Figure 6-41 for a typical timing diagram.

Another bus from the microprocessor is the SPI bus. It is a serial bus with one data signal and one clock signal that are common for all ICs connected to the bus. A separate load signal for each IC controls the loading of the data. Connected to the SPI bus are (See Figure 6-42 to Figure 6-45):

- The 100 MHz PLL IC (U9). The SPI bus is used only for initialization after power on.
- The optional oven oscillator IC (U5). The SPI bus is used for initialization after power on and during a timebase calibration.
- The trigger levels IC (U46).

The last bus is the I²C bus. It is also a serial bus with two signals, SDA and SCL. Each connected IC has a unique address. The message sent includes the address, and only the addressed IC will listen to the message and respond by sending an acknowledge to the master. Then it will react accordingly.

Introduction to the I²C Bus

The I²C bus is a 2-line serial bus for the communication between the ICs. The microprocessor controls the communication by means of the clock line SCL. One or more slaves can read or write on the data line SDA.

The SDA and SCL are high at standby. All ICs connected to the bus can sink SDA to low as they are interconnected via open collector outputs. The microprocessor starts and stops the communication by sending terms of start and stop:

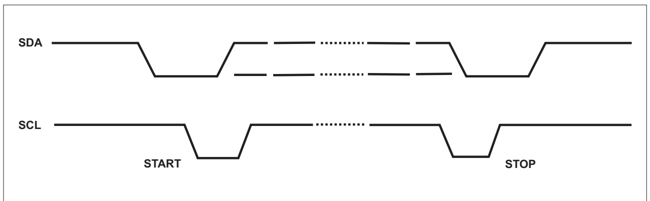

Figure 6-31 *Terms of start and stop.*

During transmission the SDA can be changed only when the SCL is low.

The microprocessor always begins to send the address information. The format of this address information is seven address bits, one read/write bit, and one acknowledge bit.

The addressed slave accepts by keeping the SDA line low while the acknowledge bit (ACKN in) is sent by the microprocessor.

Example of addressing (address 30H):

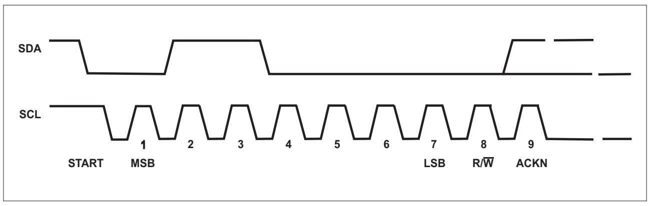

Figure 6-32 *Addressing.*

The read/write bit R/$\overline{\text{W}}$ has the following meaning:

R/$\overline{\text{W}}$ = 1 means information from the slave to the µprocessor
R/$\overline{\text{W}}$ = 0 means information from the µprocessor to the slave.

The data information is sent after the address information. The format of the data information is eight data bits followed by one acknowledge bit. The reciever accepts by keeping the SDA line low while the acknowledge bit (ACKN in) is sent.

Example of data transmission (data 9BH):

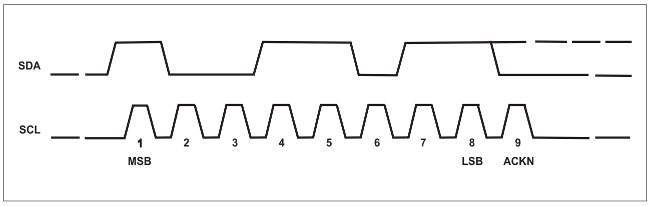

Figure 6-33 *Data transmission.*

The processor is the Master on the I²C bus. Slaves on the bus are:

- The digital I/O IC U40 with address 20hex. It controls the loading of the FPGA at initialization after power on, it controls the relays and filters in the input amplifiers, and it reads the prescaler code at initialization after power on.
- The temperature measuring IC U39 with address 48hex.
- The digital I/O IC U3 with address 21hex. It switches the LCD display on after power-on initialization, it scans the keyboard on the display circuit board.

The bus is connected to the prescaler connector J15 for future use.

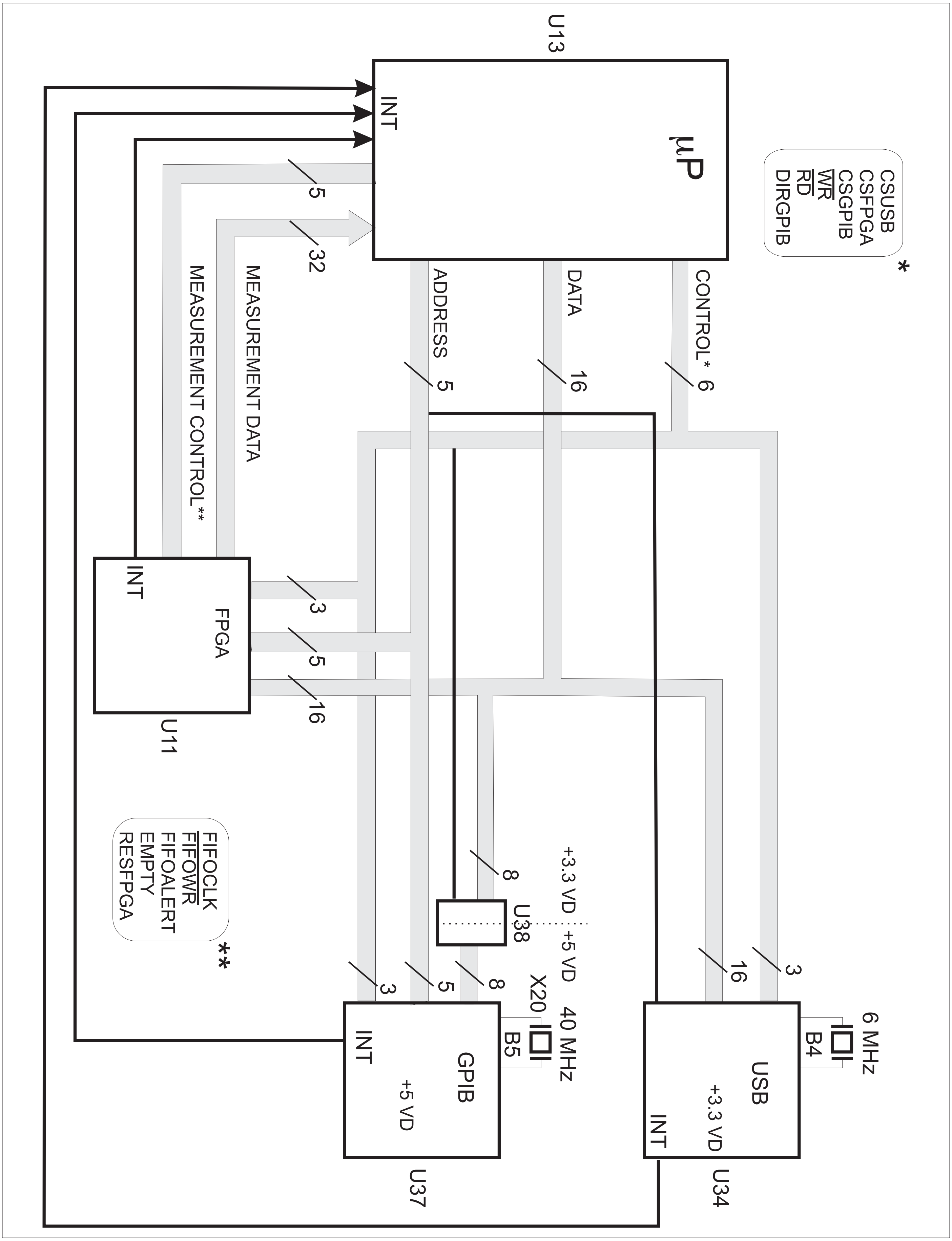

Figure 6-34 *Microprocessor bus and interfaces.*

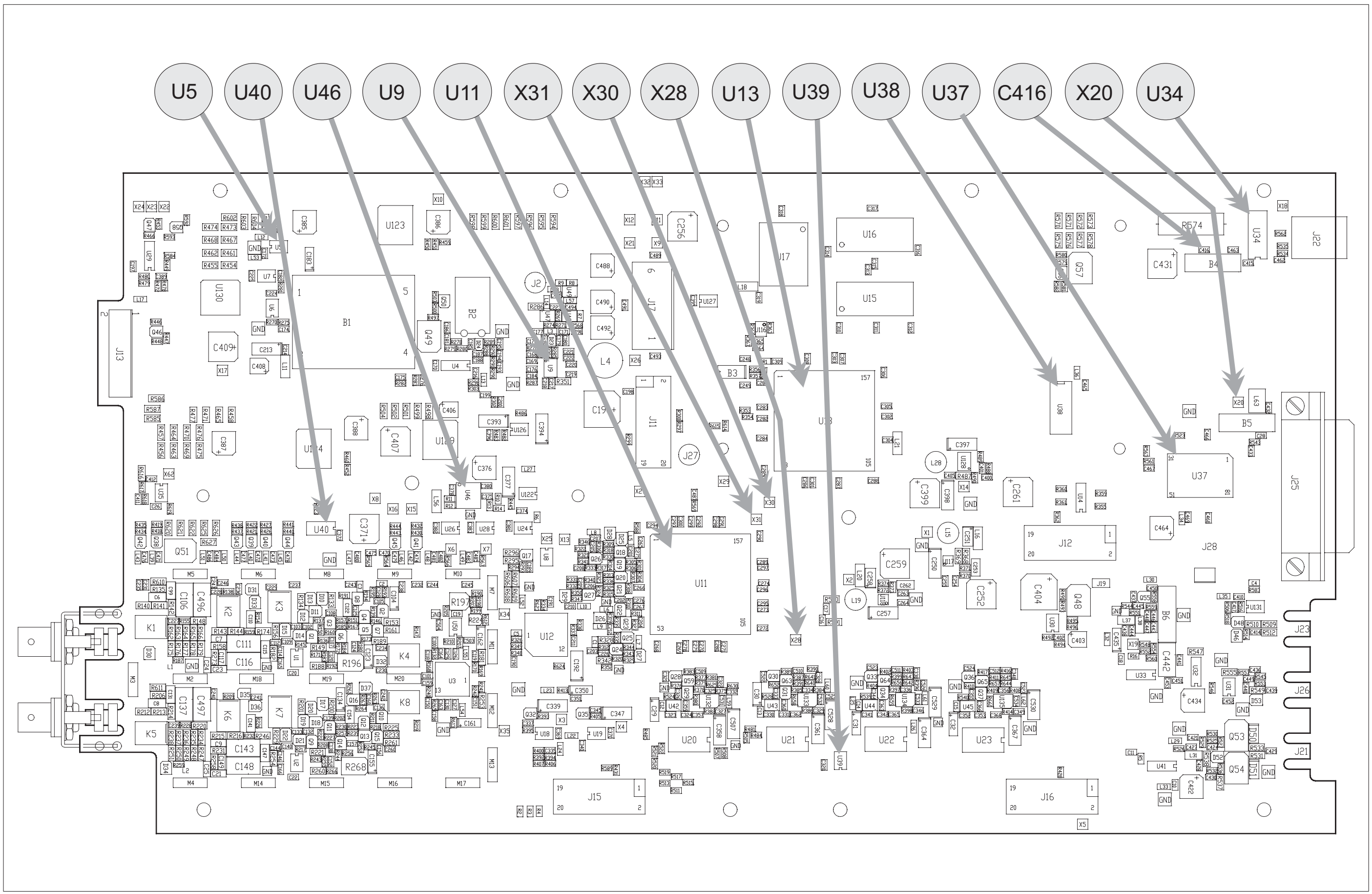

Figure 6-35 *Important locations for the microprocessor and its buses and interfaces.*

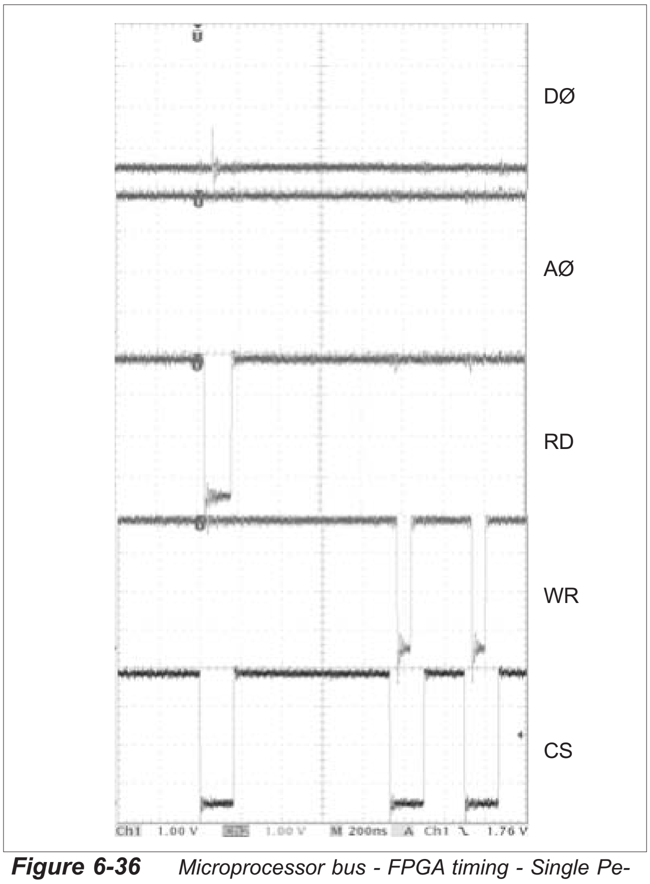

Figure 6-36 *Microprocessor bus - FPGA timing - Single Period.*

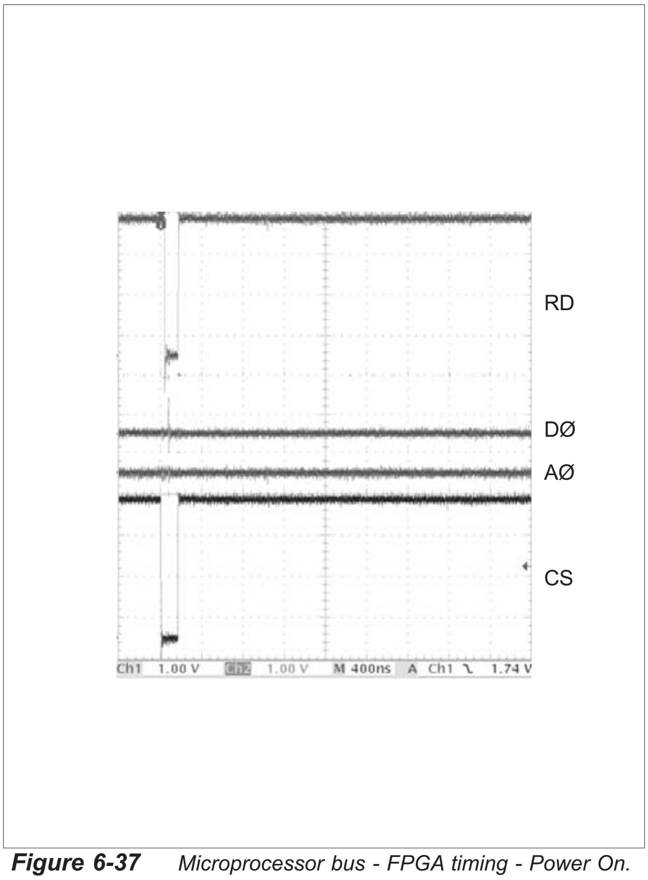

Figure 6-37 *Microprocessor bus - FPGA timing - Power On.*

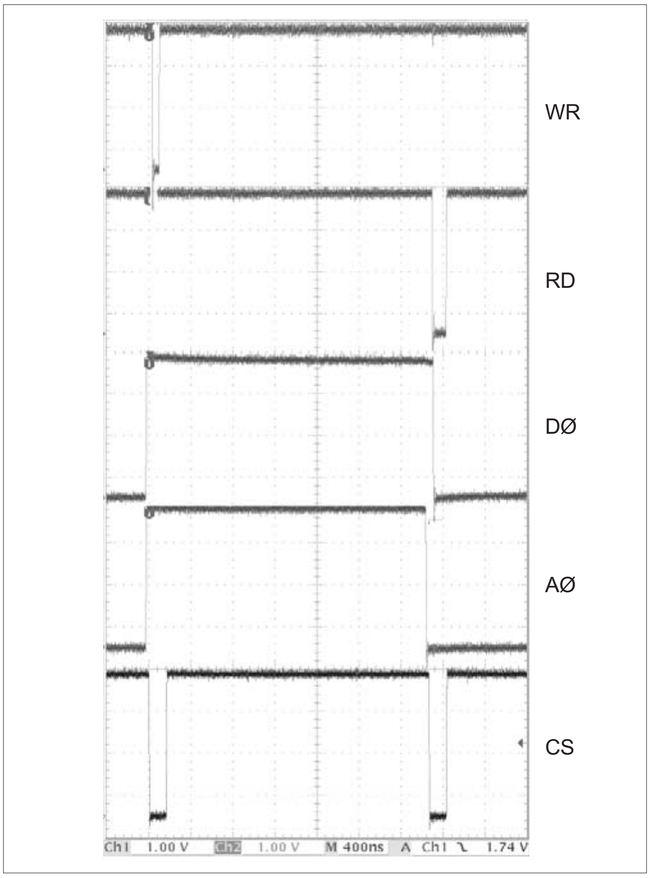

Figure 6-38 *Microprocessor bus - USB timing - Power On.*

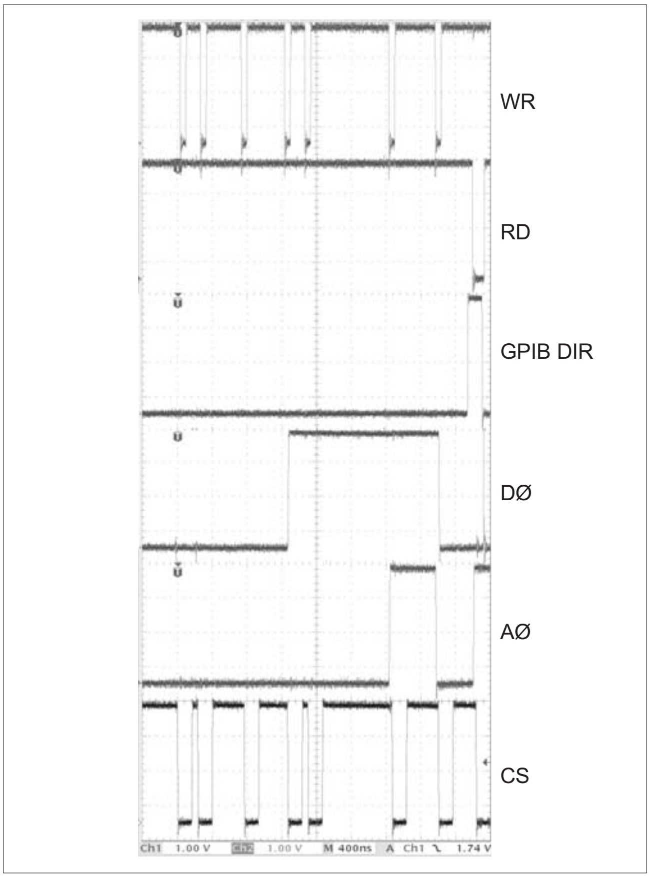

Figure 6-39 *Microprocessor bus - GPIB timing - Power On.*

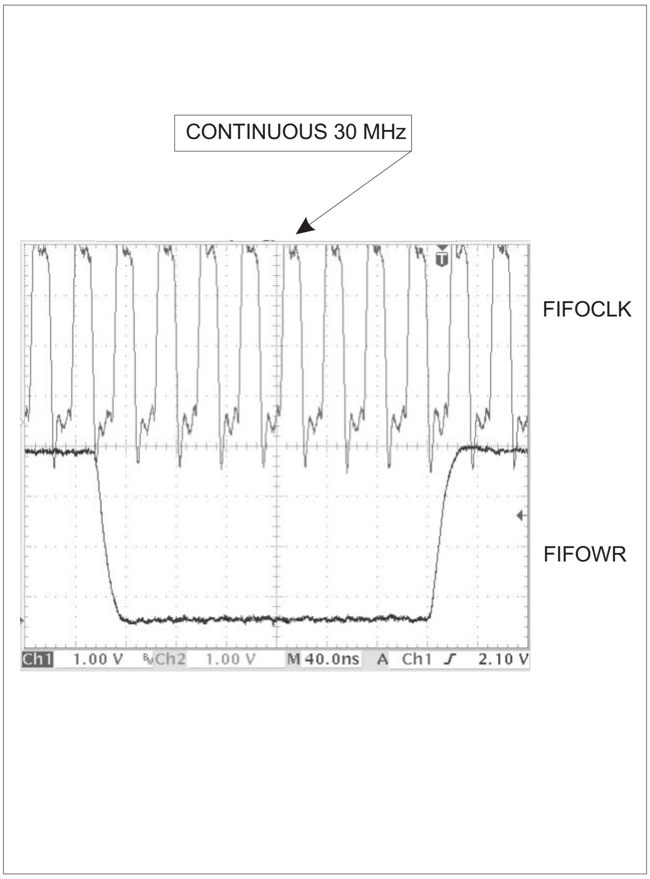

Figure 6-40 *FIFO timing #1.*

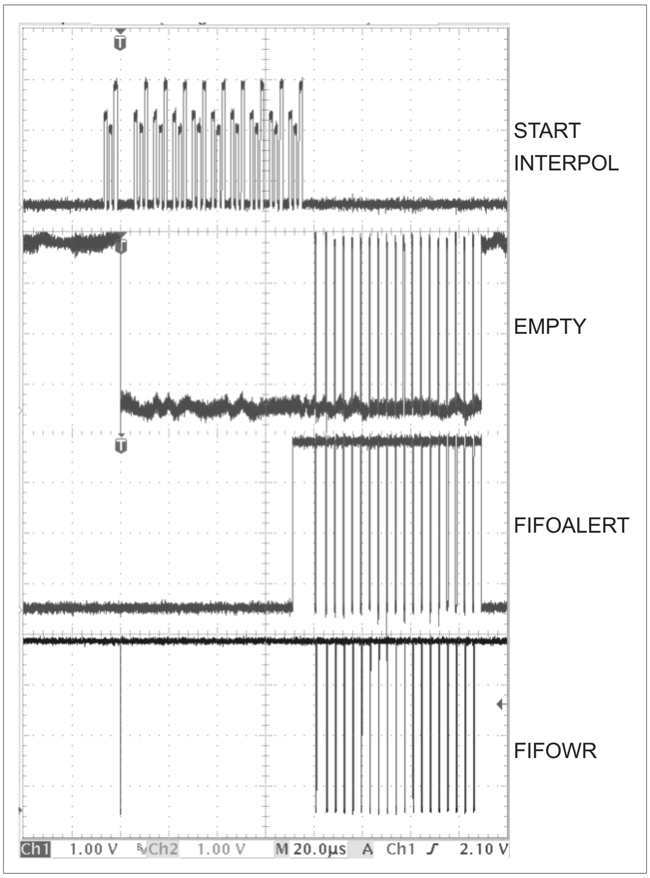

Figure 6-41 *FIFO timing #2.*

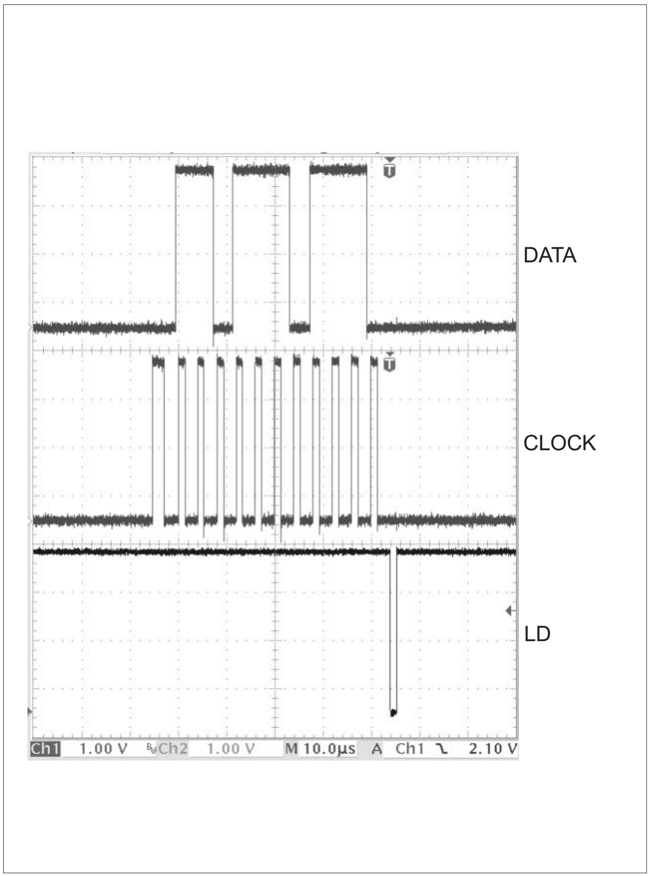

Figure 6-42 *SPI bus activity - oven.*

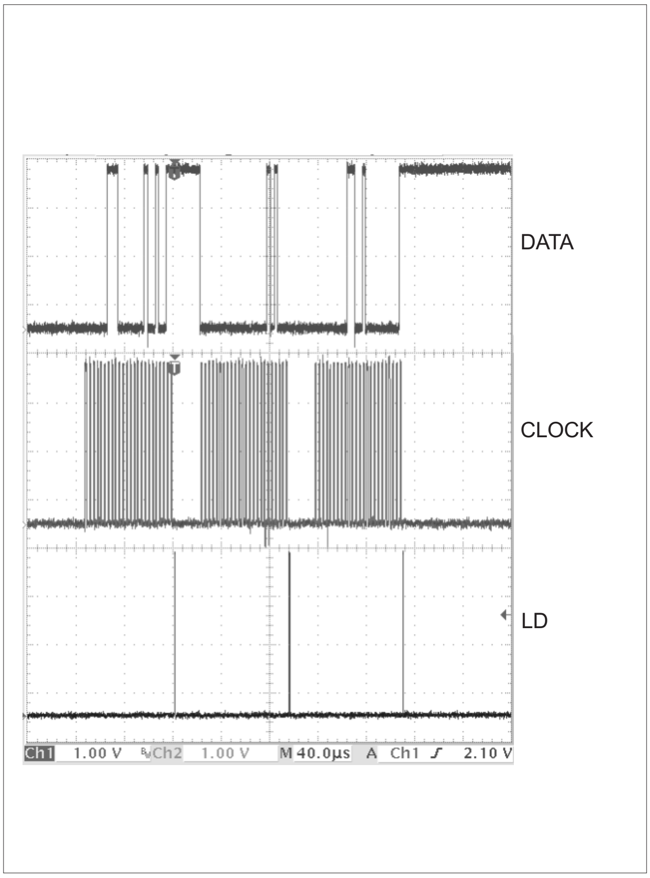

Figure 6-43 *SPI bus activity - PLL.*

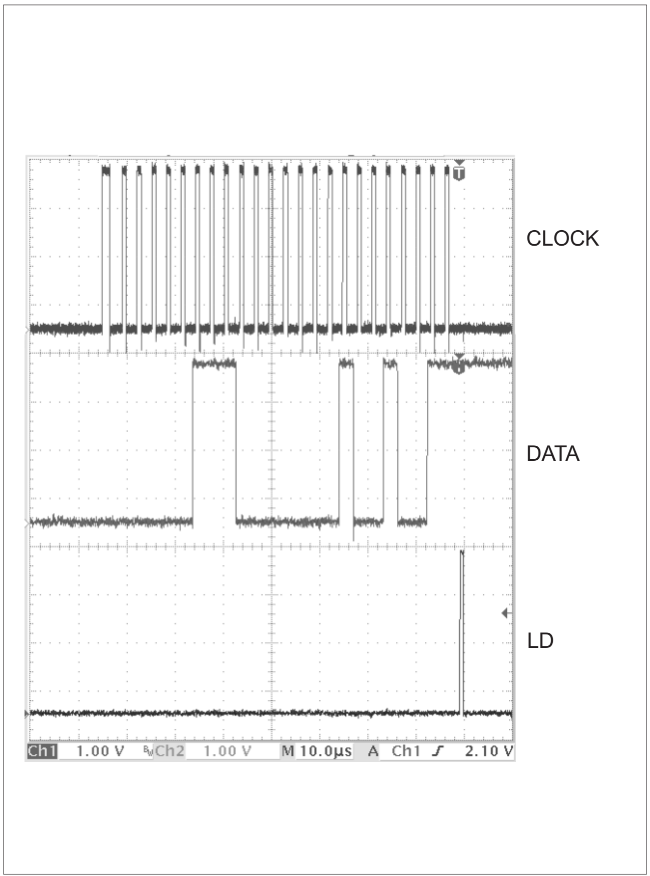

Figure 6-44 *SPI bus activity - PLL - first transfer close-up.*

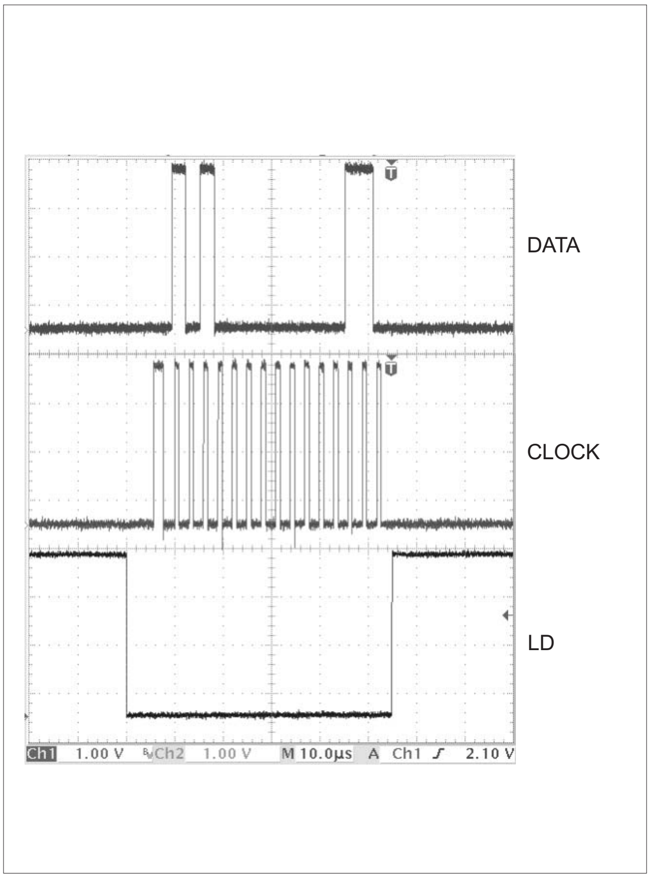

Figure 6-45 *SPI bus activity - trglvl.*

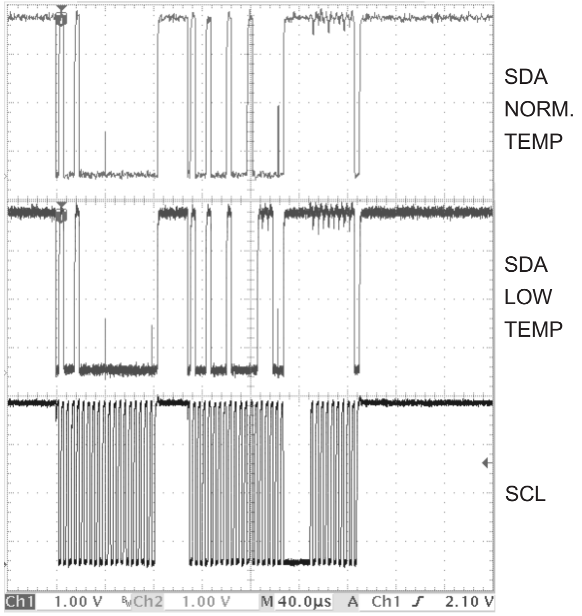

Figure 6-46 *I²C bus activity - reading the temperature.*

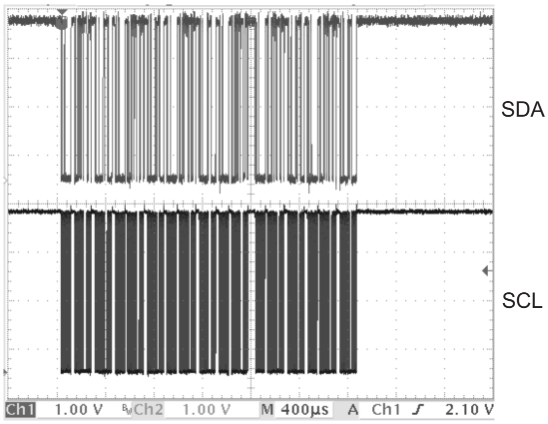

Figure 6-47 *I²C bus activity - depressing the EXIT key.*

Measuring Logic

The measurements are made in the FPGA. Only four interpolators are external to the FPGA. They increase the basic measurement resolution from 10 ns (100 MHz measurement clock) to less than 100 ps. Different combinations of interpolators are used for different measurement functions; two, three or four in conjunction. The input signals come from the input amplifiers. A, B and SR are differential LVPECL inputs. C, the prescaler input, is a single-ended LVTTL input. The measuring logic also provides three LEDs on the front panel with control signals.

The interpolator transforms a pulse width between 20 and 33 ns to a voltage. This voltage is read by an ADC. The interpolator is calibrated by reference pulses having a width of 20 and 30 ns . The measurement pulse varies between 22 and 32 ns typically. The ADC has two reference voltages, the lower limit and the upper limit. The interpolated voltage must never fall outside these limits.

Select the default setting from the front panel. Apply a 10 MHz sinewave signal (stable low jitter signal) to input A. The signal should be found at the pins of the FPGA. Check that the measurement signal is present on pins 17 and 18 (differential input) on the FPGA U11.The trigger indicator LED A on the front panel should blink. The gate indicator on the front panel should also blink and the display should show the measurement result. In this setting the S/R flip-flop U12 is used. Check that the measurement signal is present on pins 30 and 31 (differential input) on the FPGA U11.

Move the 10 MHz sinewave signal to input B. Change the measurement function to Frequency B. Check that the measurement signal is present on pins 20 and 21 (differential input) on the FPGA U11. The trigger level LED B and the gate indicator LED should blink and the display should show the measurement result.

Move the 10 MHz sinewave signal back to input A. Change the measurement function to Period Single A. Now the S/R flip-flop should not be used, check the control signal at R623, it should be -1.6 V (on is -1.0 V). Select statistics. The std deviation should be less than 100 ps.

Change the measurement function to Time Interval A - A. Select Statistics Mode. Check that the standard deviation is less than 100 ps. Measure at pin 8 of the ADCs U23, U22, U21 and U20. Two types are current, ADC10461 and ADC1061. See Figure 6-49 for a typical timing diagram with ADC10461. Figure 6-50 shows an example with ADC1061. Check the upper (TP3) and lower (TP4) voltage limits of the ADCs. They should be approximately 3.5 - 3.6 V and 1.1 - 1.4 V. The important thing is that the lowest voltage pulse on any pin 8 of the ADCs (U23, U22, U21, U20) should be at least 0.2 V above the lower limit and that the highest voltage pulse on any pin 8 of the ADCs should be at least 0.3 V below the upper limit. If an interpolator has a voltage pulse outside the limits the measurement result will be wrong. Figure cc shows the signals on an ADC.

The signal from the prescaler is connected to pin 22 (single-ended) of U11. It comes via a level converter. Check the input signal to the converter at R335 (PECL levels).

If the FPGA or a part in the interpolators has been changed or repaired, a calibration of internals must be performed afterwards. See Chapter 7.

Note The interpolator design has varied slightly in the course of time, but the pulses in Figures 6-49 and 6-50 are very little affected.

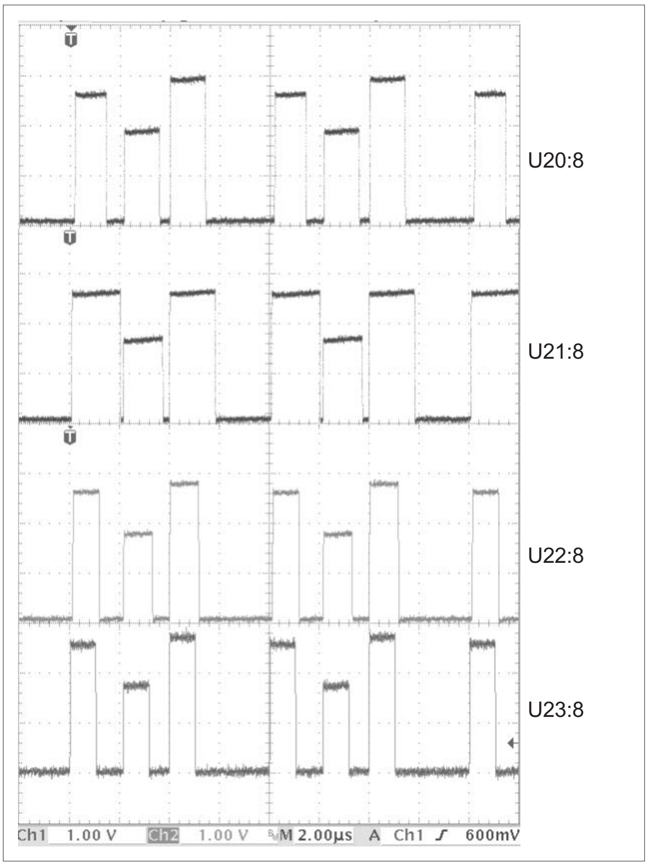

Figure 6-49 *ADC 10461 behavior. Time A-A, 10 MHz in.*

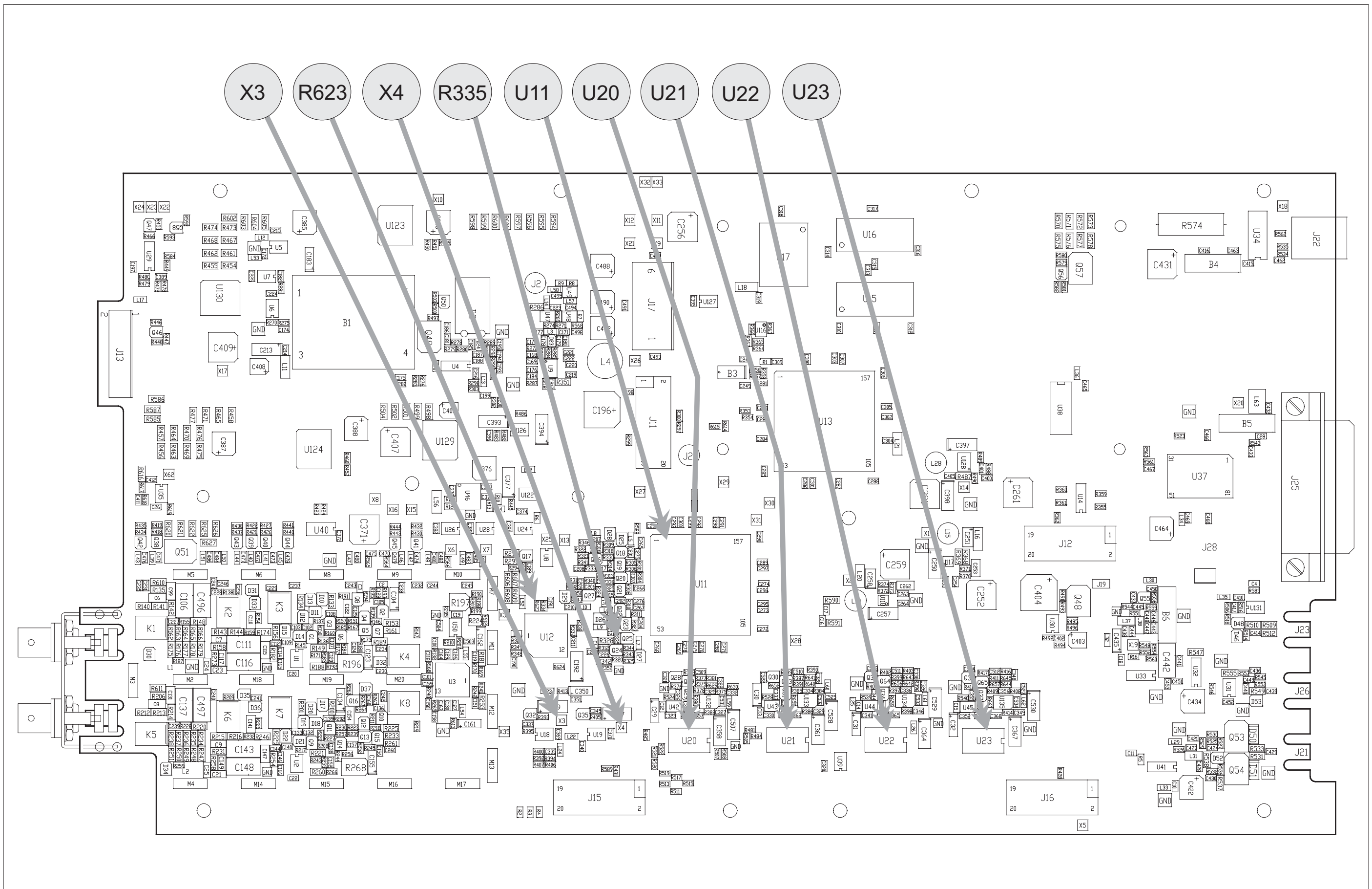

Figure 6-48 *Important locations for the measuring logic.*

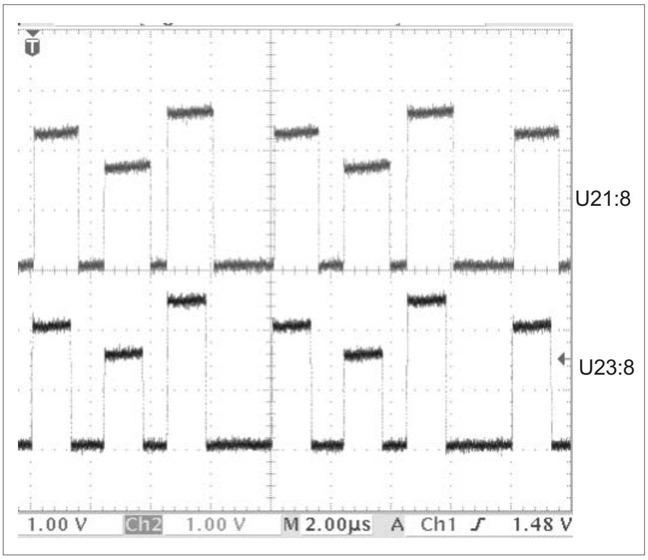

Figure 6-50 *ADC 1061 behavior. Time A-A, 10 MHz in.*

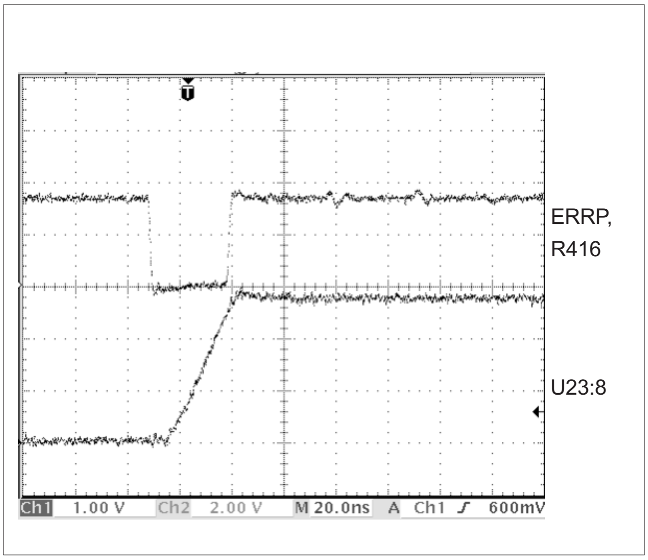

Figure 6-52 *Close-up of error pulse and S/H output.*

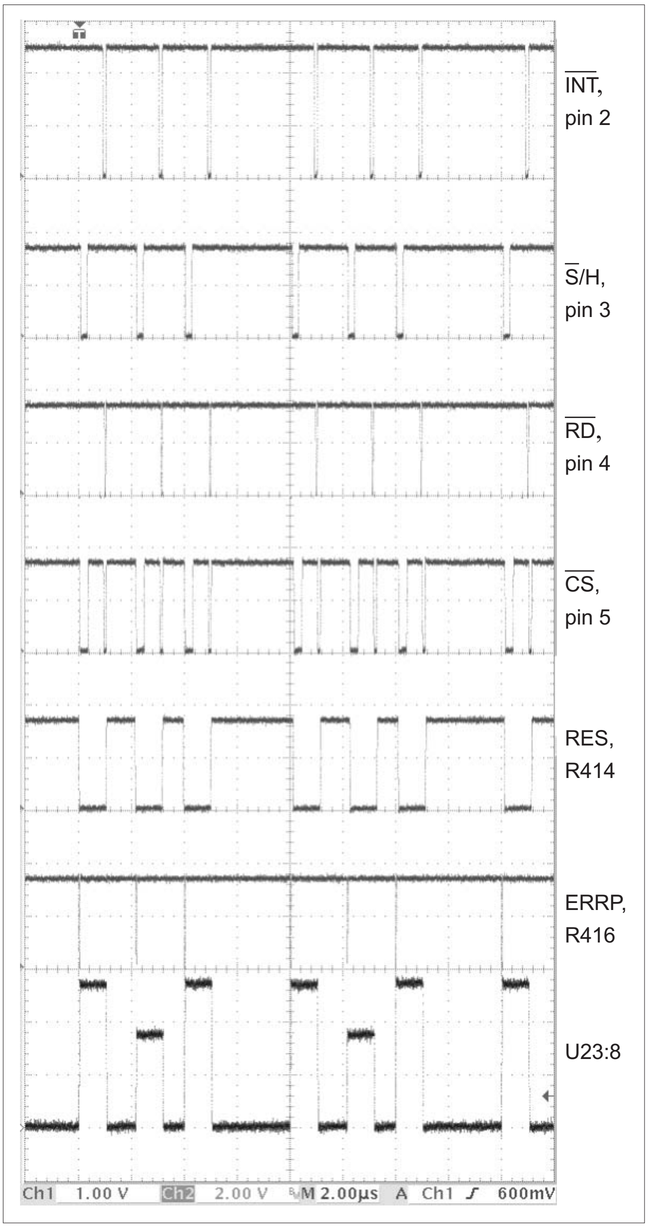

Figure 6-51 *Different signals around an ADC.*

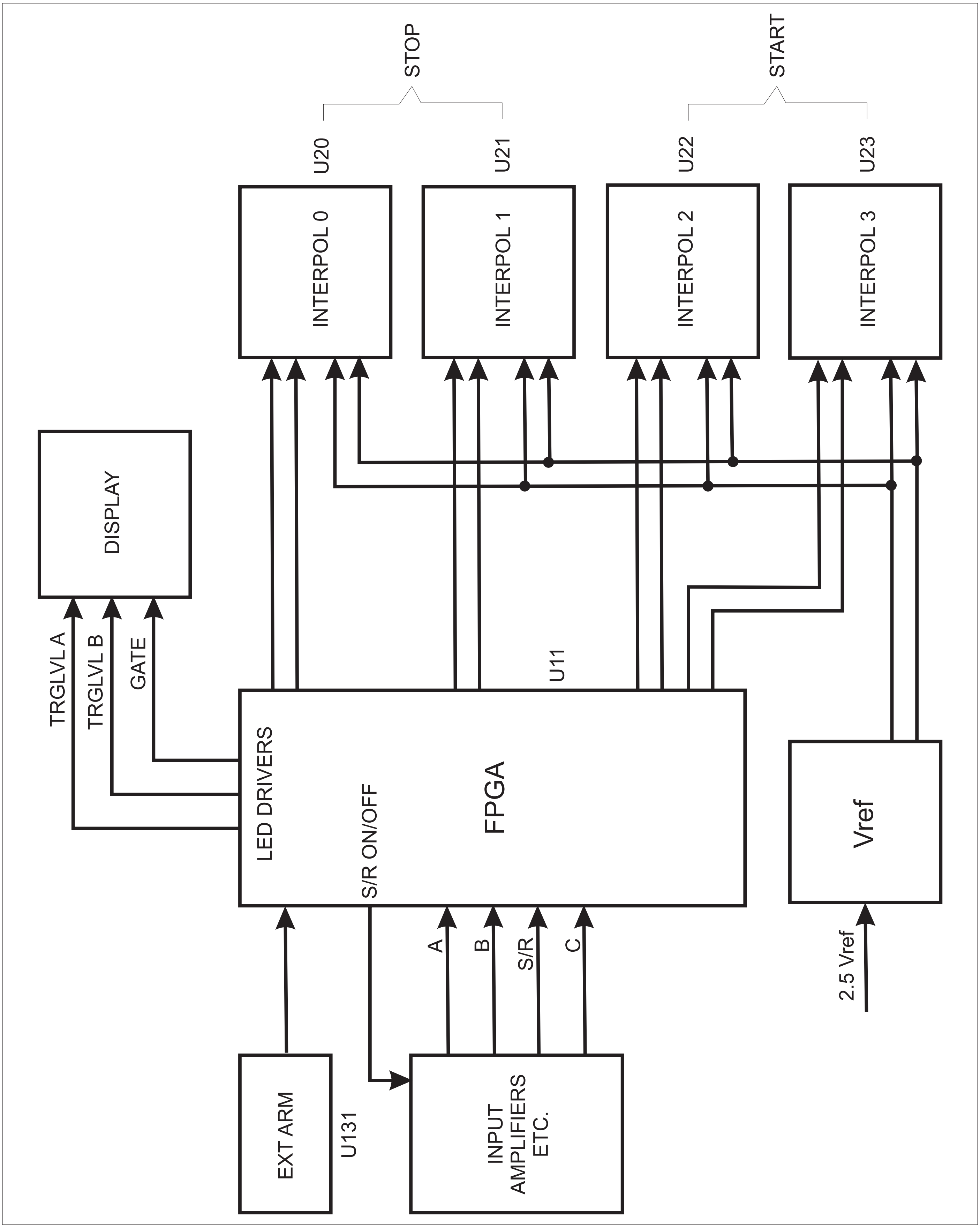

Figure 6-53 *Measuring logic, block diagram.*

Version B

The descriptions in this section apply to instruments having a Sharp microprocessor.

See General Information on page III for details on relevant serial numbers etc.

Troubleshooting

General

The '90' is a highly integrated Timer/Counter in which a dedicated FPGA counter circuit handles the signal processing, and a microcontroller does the postprocessing and supervising jobs. A number of additional functional units support these basic tasks, for instance power supply, reference oscillator, wideband input amplifiers, comparators, memory (RAM & ROM), digital/analog converters, etc.

The units are treated from a troubleshooting point of view in this chapter, which means that units described earlier should be considered faultless before troubleshooting on units described later.

> **WARNING: Live parts and accessible terminals which can be dangerous to life are always exposed inside the unit when it is connected to the line power. Use extreme caution when handling, testing or adjusting the counter.**

Where to Start

After reading the safety instructions, continue with this chapter for troubleshooting and repair instructions. When you have fixed the instrument, always do the Safety Inspection and Test after Repair, as described later in this Chapter. Then do the checks in Chapter 2, Performance Check. Recalibrate if required by following the adjustment instructions in Chapter 7, Calibration Adjustments.

	Positive ECL	Negative ECL	CMOS	TTL
Supply voltage	+5 V	-5 V	+5 V	+5 V
Signal ground	0 V	0 V	0 V	0 V
Input voltage				
High, VIH	>+3.9 V	>-1.1 V	>+4 V	>+2 V
Low, VIL	<+3.5 V	<-1.5 V	<+1 V	<+0.8 V
Output voltage				
High, VOH	>+4 V	>-1 V	>+4.9 V	>+2.7 V
Low, VOL	<+3.3 V	<-1.7 V	<+0.05 V	<+0.4 V
Bias ref. voltage, VBB	+3.7 V	-1.3 V	-	-

Table 6-3 *Logic levels.*

Logic Levels

The '90' contains logic of different families. The levels of the standard families are listed in Table 6-3. In addition to these families there is also low-level logic requiring lower supply voltages, e.g. +3.3 V and +1.8 V.

Required Test Equipment

To be able to test the instrument properly using this manual you will need the equipment listed in Table 2-1. The list contains the critical parameter specifications.

Operating Conditions

Power voltage must be between 90 V_{AC} and 260 V_{AC}. The instrument adapts automatically to the applied voltage.

Basic Functional Units

These are the units that are described in this chapter with reference to the page where the section starts:

- Power Supply (p. 6-32)
- Input Amplifiers (p. 6-36)
- Timebase Reference Circuits (p. 6-40)
- Prescalers (p.6-43)
- Microprocessor & Memories (p. 6-43)
- Microprocessor Bus & Interfaces (p. 6-49)
- Measurement Logic (p. 6-55)

Power Supply

The DC voltages needed in the instrument are generated from the three main voltages of the AC/DC module.

The instrument has only a secondary power switch, i.e. the AC/DC module is always operating if line power is applied. The three output DC voltages (+5 V, +15 V, -15 V) from the module are present on the main circuit board. When switched off, the instrument is in the standby mode. In this mode only the ON/OFF circuitry and the optional oven oscillator are powered.

The AC/DC module should not be repaired. Not even the built-in fuse should be replaced. Built-in circuits protect against external overloads, so a blown fuse indicates that a severe internal fault has occurred. Replace the complete module instead.

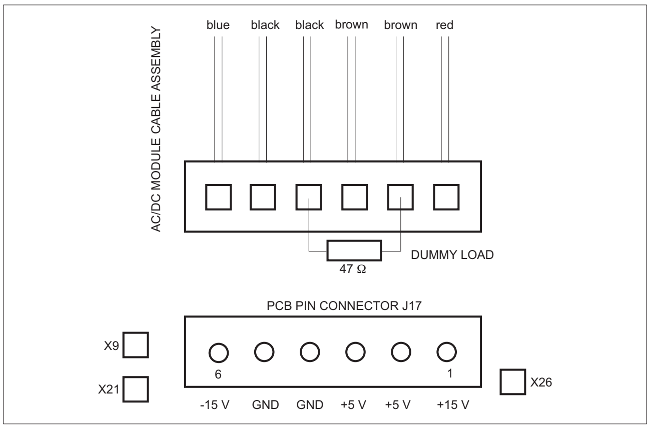

Figure 6-55 *Dummy load connection.*

Test the AC/DC module by measuring the three DC voltages in TP9 (+5.1 ± 0.05 V), TP21 (-15 ± 1 V) and TP26 (+15 ± 1 V) on the main circuit board. See Figure 6-55. Note that there is a +5 V trimmer on the module. If the +5 V is not correct, disconnect the cable to J17 on the main circuit board. Put a 47 Ω 1 W resistor on the connector according to Figure 6-55. Measure on the connector +5.1 ± 0.05 V, +15 ± 1 V and -15 ± 1 V.

It can be difficult to measure the resistance in the supply connector J17 on the main circuit board, because charges are kept by capacitors some time after line power is removed. Remove the cable from the AC/DC module. The resistance between +5 V and ground should be approximately 700 Ω. See Figure 6-55. In a timer/counter with all capacitors uncharged, +15 V and -15 V should be >1 MΩ.

Another way to test J17 is to connect 3 DC voltages from a separate bench power supply directly to J17 (suitable connector MOLEX 09-91-0600). See Figure 6-55. The currents drawn from the different supply voltages depend on options installed. Before making this measurement, you should remove any prescaler option.

A timer/counter without options gives the following typical results:

+5 V	0.7 A
+15 V	0.3 A
- 15 V	0.4 A

The oven oscillator increases the + 15 V current between 0.35 A (cold) and 0.1 A (warm).

A block diagram of the secondary power supply is shown in Figure 6-54. All secondary voltages are switched off in standby mode except +12 VU for the optional oven oscillator.

The ON/OFF circuitry controls the ON and OFF of the secondary voltages. Its own supply voltage is always ON, as long as the instrument is connected to line power. See Figure 6-59.

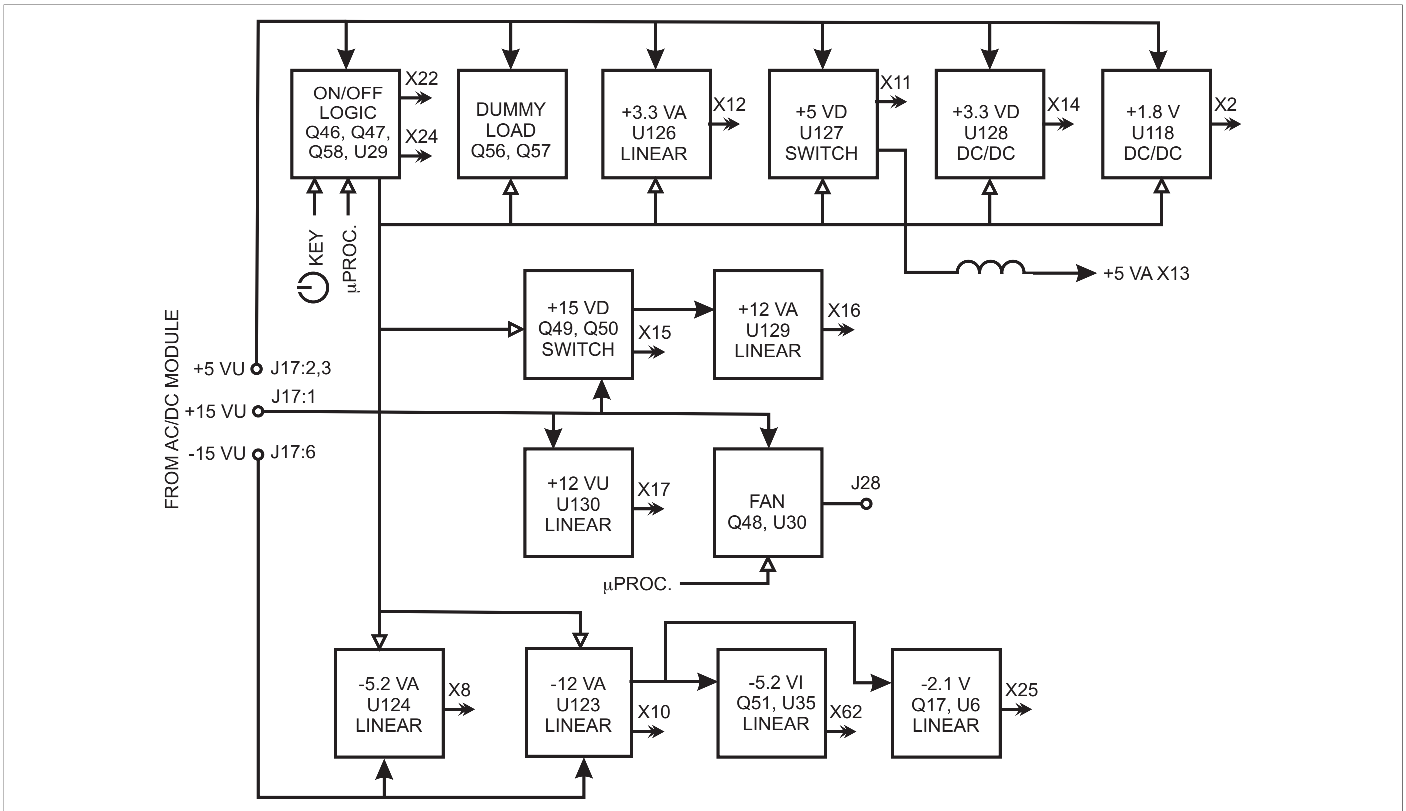

Figure 6-54 *Power distribution*

On connection of line power, R478 and C389 keep the RESETN input of the flip-flop U29 low. This sets the QN output of U29 high. Via Q47 (output signal low) and Q58 (output signal high) the secondary power supply will be set in ON mode. To switch to the standby mode, the processor sets the SETN input of U29 low. This results in the QN output being low and the secondary power supply being set to standby mode via Q47 (output signal high) and Q58 (output signal low). In standby mode a bleeder circuit on +5 VU is connected. It draws approximately 100 mA to stabilize the AC/DC module. The standby LED on the front panel is switched on. To switch to ON mode from standby mode, a negative pulse, generated by pressing the ON/OFF key on the front panel, is connected to the RESETN input of U29.

Linear regulators are used for some voltages to ensure minimum noise. Check the TPs below:

X12: +3.3 VA (from +5 VU)
X8: -5.2 VA (from -15 VU)
X10: -12 VA (from -15 VU)
X62: -5.2 VI (from -12 VA)
X25: -2.1 V (from -12 VA)
X16: +12 VA (from +15 VD)

X17: +12 VU (from +15 VU) (to oven oscillator, not switched off in standby mode)

For digital and general use some voltages are generated by DC/DC converters. Check the following TPs:

X14: +3.3 VD (from +5 VU)
X2: +1.8 V (from +5 VU)

Some voltages derived directly from the AC/DC module are used as secondary supply voltages without further regulation, and they have semiconductor switches in series to make it possible to shut them off in standby mode. Check the TPs below:

X15: +15 VD (from +15 VU)
X11: +5 VD (from +5 VU)
X13: +5 VA (from +5 VD)

These 12 secondary voltages are used all over the instrument. All secondary supply voltage lines are segmented into branches with ferrite beads. See the schematics. This makes it easier to isolate short circuits by removing ferrite beads temporarily.

The microprocessor, U13, has an internal linear regulator that generates +1.8 V from +3.3 V. This voltage is used by the processor core and can be checked at X66.

Figure 6-56 *PCB1 survey*

Fan Control

The fan is connected to +15 VU over a speed control circuit. It is only ON if a control signal from the processor is present. The first 8 minutes after power-up the fan will run at a fixed speed, fed with +8.3 V. After that the fan is temperature controlled. The processor reads the temperature from U39 via the I^2C bus. Depending on the temperature, the fan is fed with a DC voltage between 8 and 13.5 V. The processor uses a PWM signal that is filtered to control the fan.

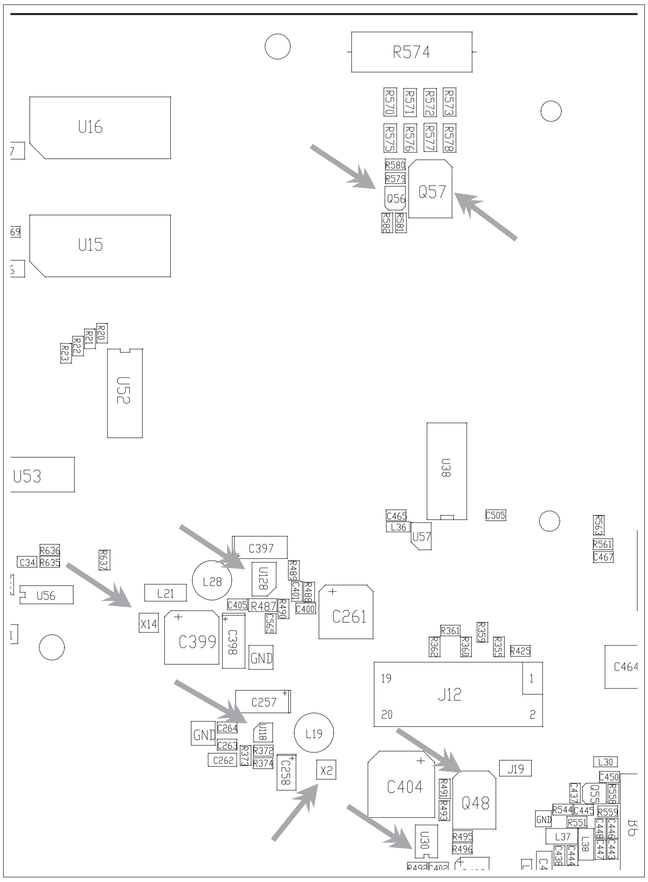

Figure 6-58 *Important power supply locations #2.*

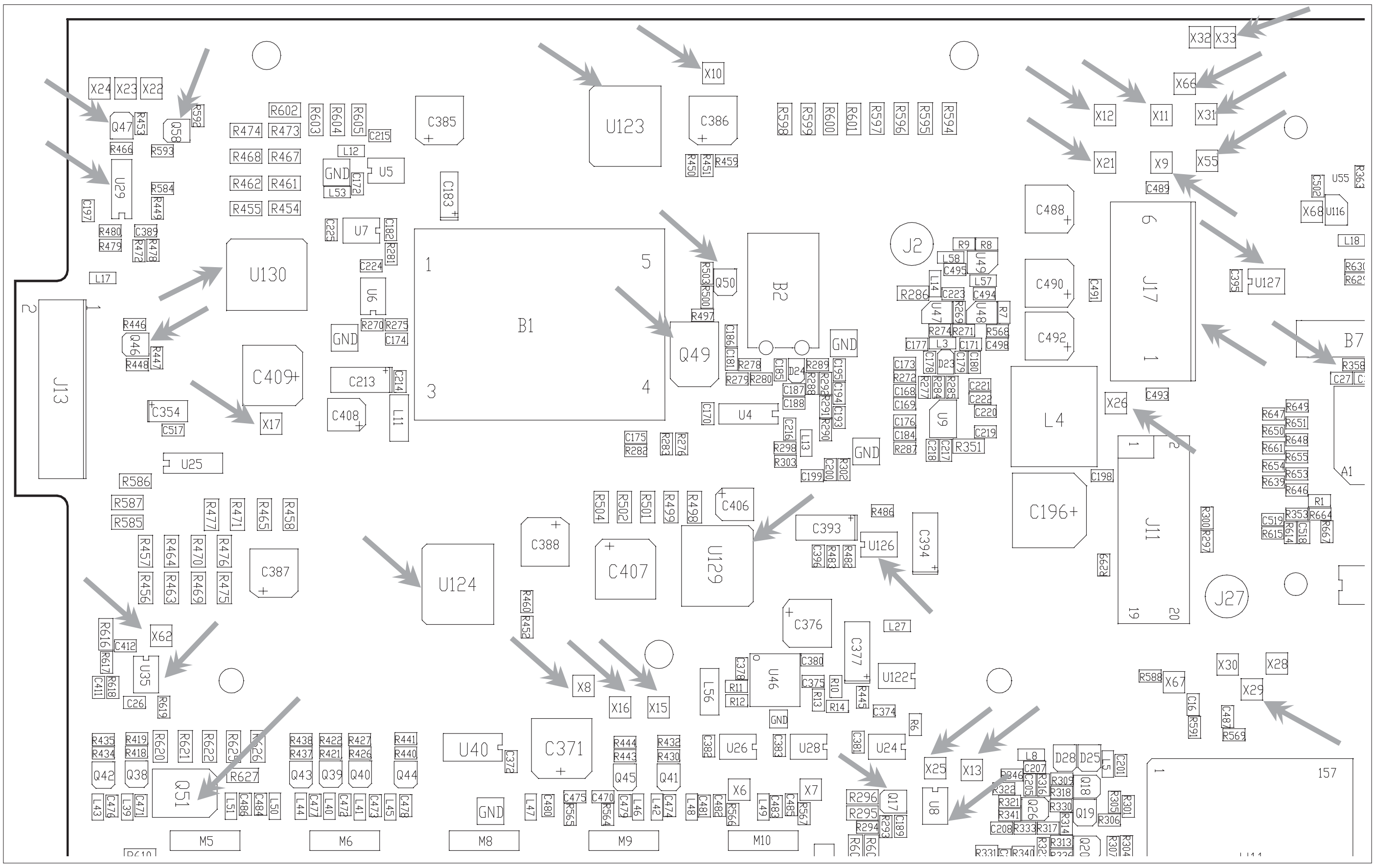

Figure 6-57 *Important power supply locations #1.*

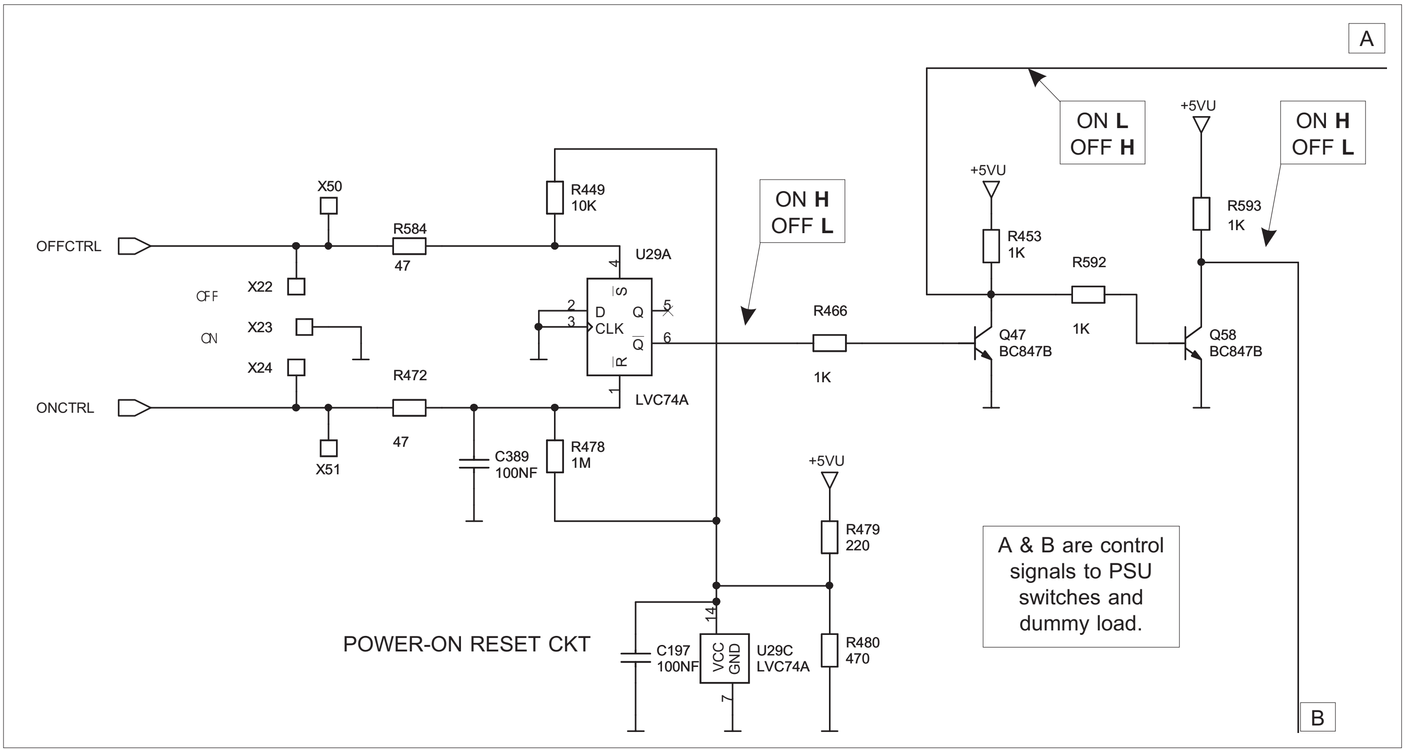

Figure 6-59 *ON/OFF logic*

Input Amplifiers

The input amplifiers for Channel A and Channel B are identical. A trigger level circuit belongs to each amplifier. The trigger level is adjusted to match the hardware during the voltage calibration procedure, see Chapter 7. Note that the input amplifiers must be adjusted according to Chapter 7 (step response, sensitivity etc). The description refers to both channels (Channel B information within parentheses).

Recall the timer/counter default setting. Select the measurement function *Time A-B*. Set both input channels to DC, Man Trig = 0.000 V. No signals connected.

The RF shield must be removed before measuring on the input amplifiers. It is soldered to two of the shield clips. Don't forget to put the shield back afterwards and secure it by resoldering.

First measure some DC values. U3 pin 9 (pin 13) should be near 0.000 V. The same applies to the trigger level, U3 pin 10 (pin 12). The voltage to ground at the point where R171 (R243) and R172 (R244) are connected should be approximately -0.8 V.

Connect a 1 kHz square wave with amplitude 1 V_{pp} in 1 MΩ to Input A (Input B). Measure at the following points (see also Figure 6-60) and use the ground pads that are distributed over the PC board:

Test Points	Approximate Voltage
R140 to R141 (R212 to R213)	1.00 V_{pp}
R156 to C109 (R229 to C140)	0.40 V_{pp}
U1 pin 2 (U2 pin 2)	0.20 V_{pp}
U1 pin 3 (U2 pin 3)	0.20 V_{pp}
U1 pin 6 (U2 pin 6)	-1.00 V_{dc}
R151 to R157 (R223 to R230)	0.40 V_{pp}
U3 pin 9 (U3 pin 13)	0.40 V_{pp}
R309 and R314 (R313 and R315)	ECL levels -1.0 V and -1.7 V
R301 both sides (R304 both sides)	LVPECL levels 1.6 V and 2.6 V

Test the trigger level by manually setting the following trigger levels. Check the voltage at X6 (X7) and U3 pin 10 (pin 12).

Set Level	Approximate Voltage
+1 V	+0.41 V
+4 V	+1.65 V
-4 V	-1.65 V
-1 V	-0.41 V

Set the timer/counter to default. Select the measuring function Single Period. Connect the 1 kHz square wave to channel A (B). Measure with oscilloscope at X6 (X7). See Figure 6-65 (Figure 6-66) for a typical signal.

If any repair work has been done on the input amplifiers, both adjustment and voltage calibration must be performed afterwards. If any repair work has been done on the trigger level circuits, at least voltage calibration must be performed afterwards. See Chapter 7.

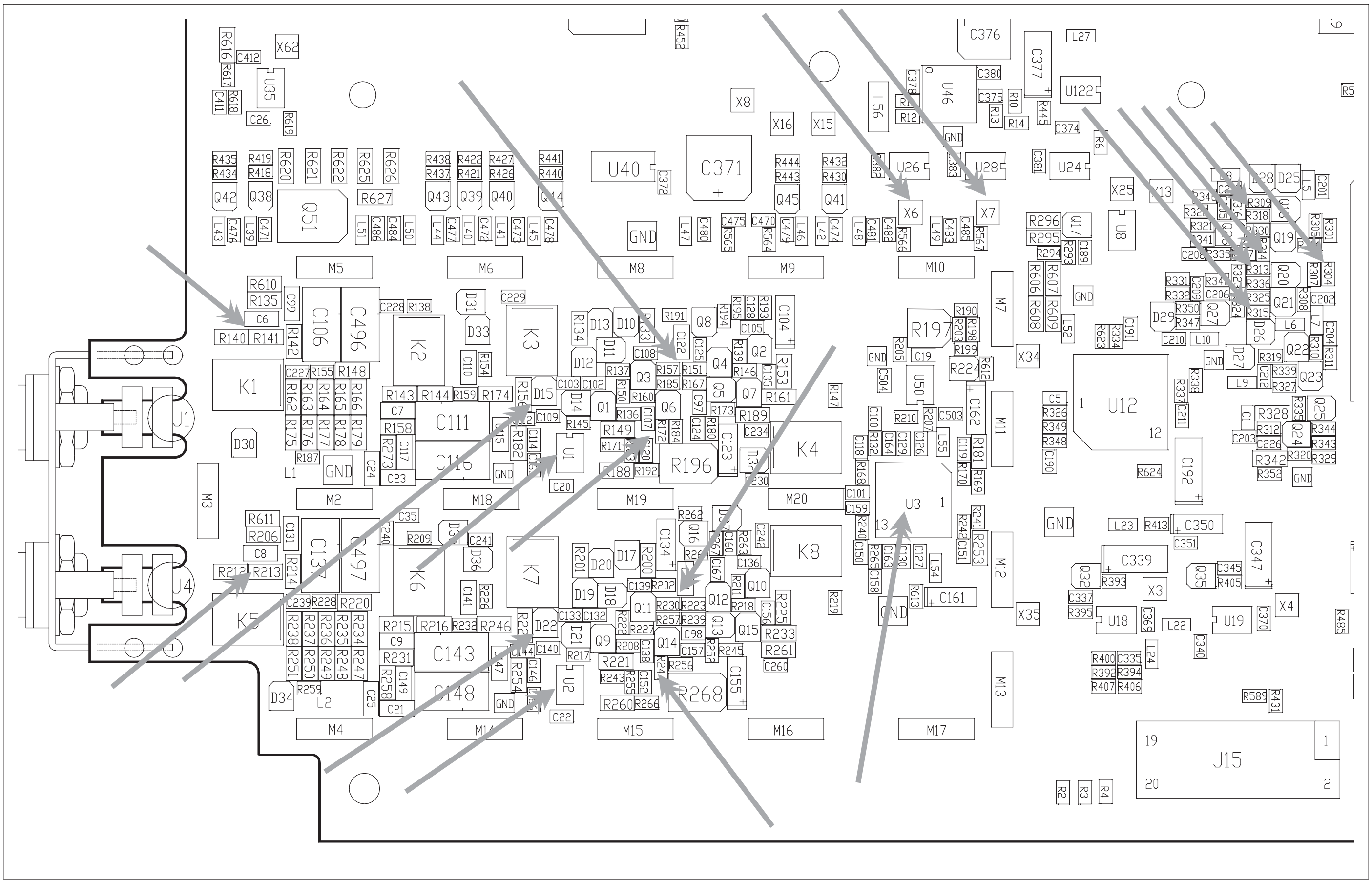

Figure 6-60 *Test points for troubleshooting the input amplifiers.*

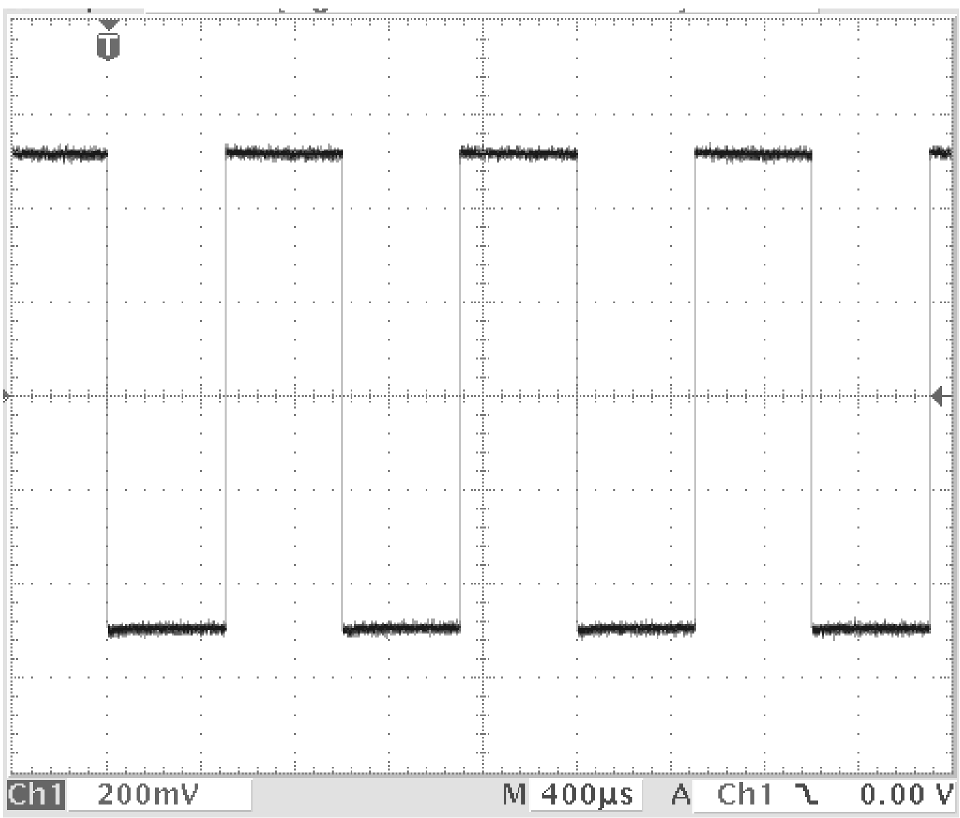

Figure 6-61 *Oscillogram showing the signal at the interconnection of R140 (R212) and R141 (R213).*

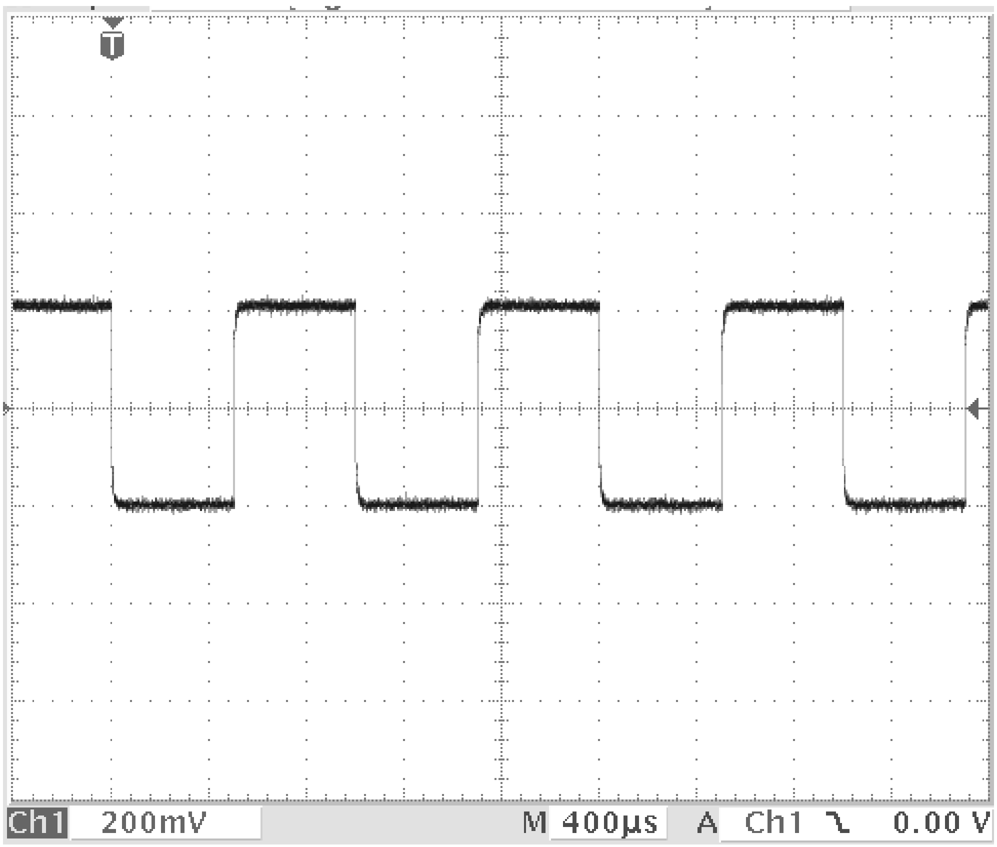

Figure 6-62 *Oscillogram showing the signal at the interconnection of R156 (R229) and C109 (C140).*

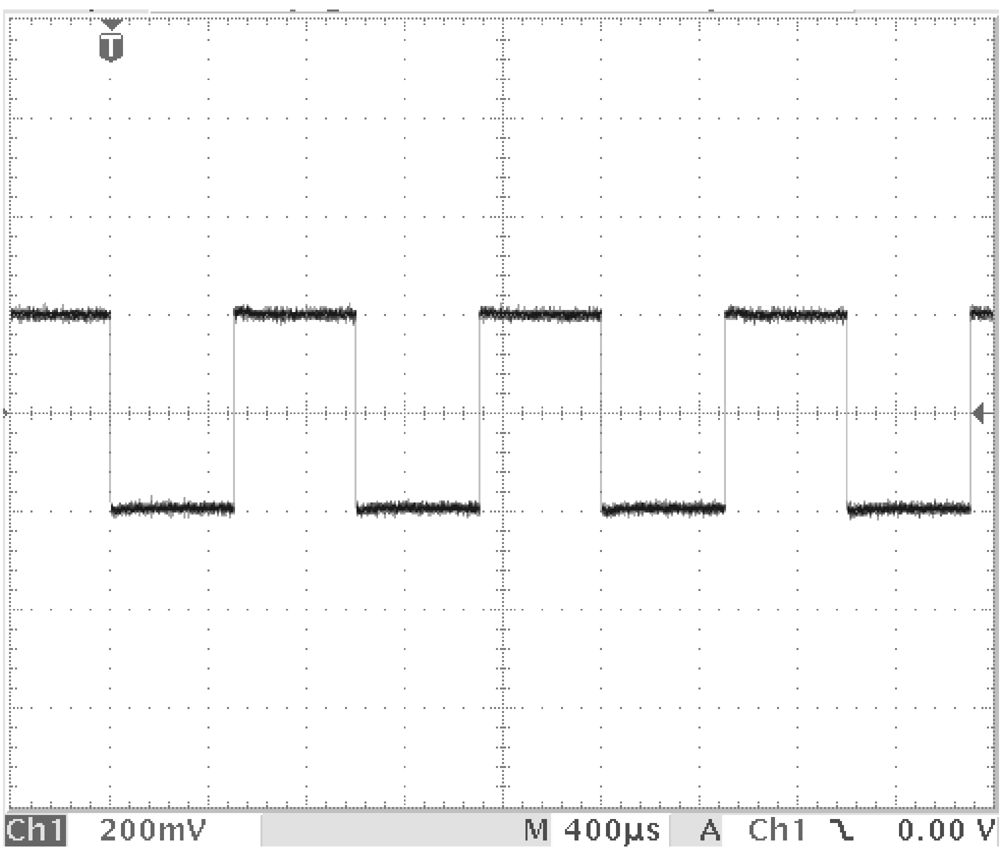

Figure 6-63 *Oscillogram showing the signal at U3:9 (U3:13).*

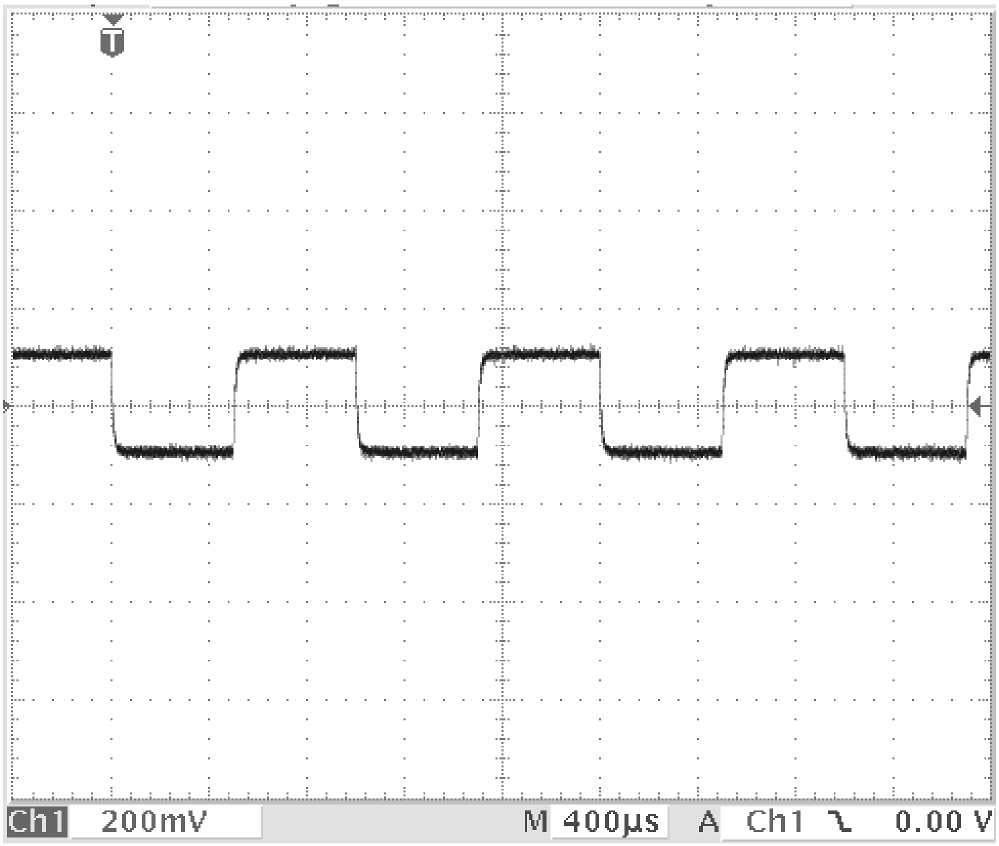

Figure 6-64 *Oscillogram showing the signal at U1:2 (U2:2).*

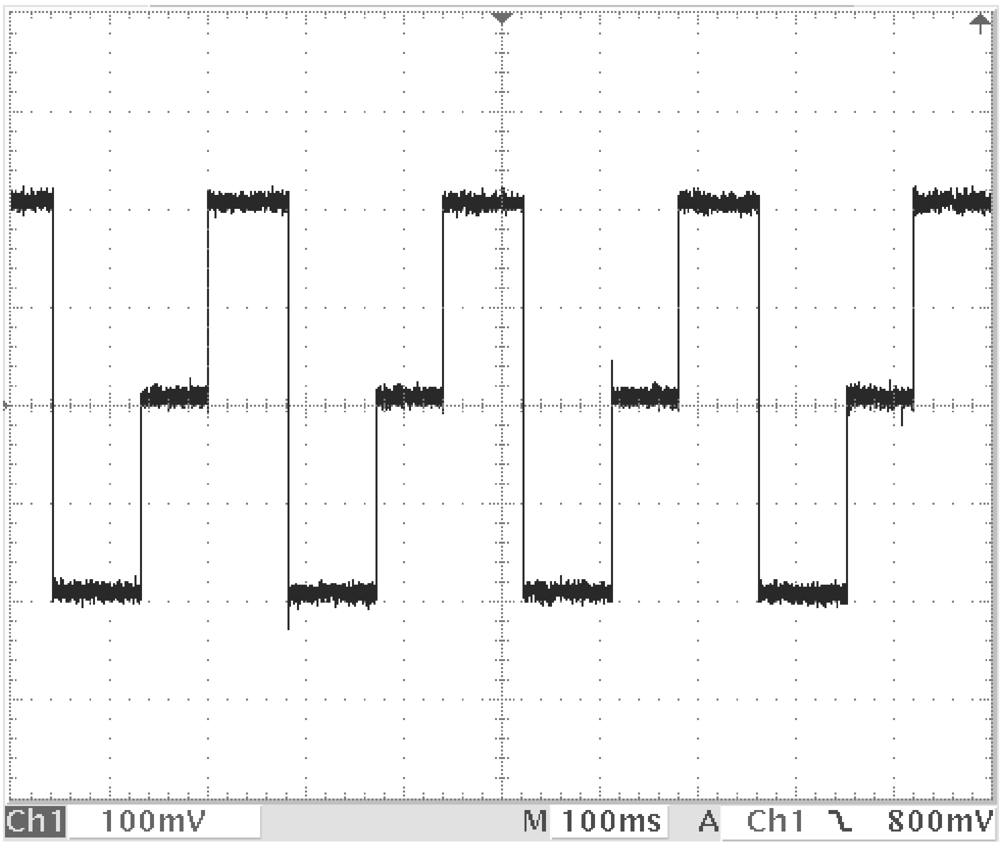

Figure 6-65 *Oscillogram showing the signal at X6, Period Single A.*

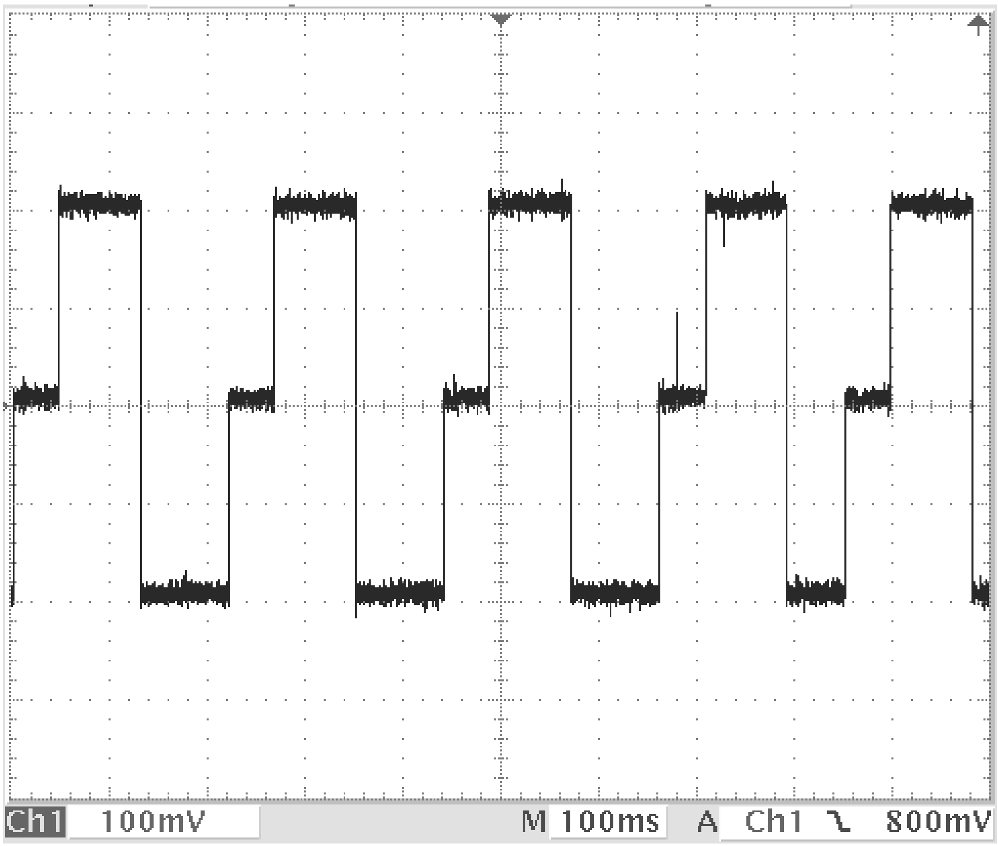

Figure 6-66 *Oscillogram showing the signal at X7, Period Single B.*

Timebase Reference Circuits

The measurement reference is either a 10 MHz signal from an internal oven-controlled crystal oscillator on the main circuit board or a signal from the external reference input that accepts the following frequencies: 1, 5 and 10 MHz. A frequency multiplier transforms the external signal to 10 MHz. The selected 10 MHz reference is always available at the internal reference output. See Figure 6-67.

The main PCB is prepared for both types of internal timebase, but only one of them is mounted. The selection is made at the factory. You have to run the utility program if the oscillator is to be changed. *Closed Case Calibration* is used to adjust the oscillator. On power-up the processor outputs the setting that is stored as the correct one for 10.000000 MHz. It will take some time for the oven oscillator to reach the correct frequency. A calibration must be performed if the adjusting voltage should move during operation, not only on power-up.

The selection between the on board oscillator and the external reference is made in the FPGA. The 10 MHz signal from the other source is switched off.

Connect a 10 MHz signal to the external reference input. Use the **SETTINGS** menu to alternate between internal and external oscillator. Check for correct signals at U4:6 for the standard oscillator, at U4:8 for the oven oscillator and at U33:3 for the external reference. Check also that the selected timebase reference is present at the internal reference output BNC connector on the rear panel.

Oven Oscillator

See Figure 6-68 and Figure 6-69.

The oven oscillator is a self-contained unit, enclosed in a metal box and soldered to the main circuit board. It cannot be repaired and must be replaced with a new oscillator if it is faulty.

Let the oven oscillator warm up 10 minutes before starting measurements. The 12 V supply voltage can be checked at X17. The oven oscillator should be powered also in standby mode.

The oven oscillator outputs a 10 MHz signal if powered. It should be 1.3 V_{pp} measured at R282. If not selected, a gate (U4) stops the signal, the control signal (U4:9) is then low. The frequency is controlled by a DAC (U5). Its reference voltage is derived from the oscillator, approximately +5 V (C174). The polarity of the reference voltage is reversed in an op amp (U6), and the voltage at U5:1 should be -5 V. The output voltage from the DAC should be between 0 and V_{ref}, measured at R281. The DAC is controlled by the processor via the SPI bus.

The frequency adjustment range should be wide enough to allow for more than 10 years of oscillator aging. The oscillator must be replaced if the normal control voltage range cannot make the oscillator output 10.000000 MHz.

As a last resort to exclude external causes of malfunction, desolder the oven oscillator from the main circuit board. Place it upside down and connect +12 V and ground according to Figure 6-68. A cold oven oscillator draws approximately 0.30 - 0.35 A. During heating the current consumption varies. After 10 minutes it should stabilize on less than 0.1 A. The output V_{ref} should be approximately +5 V and the 10 MHz sinewave output signal should have an amplitude of more than 2.5 V_{pp} measured with a 1 MΩ, 10x probe. The control input has an internal bias to keep the output frequency in the middle of the range. Adjust the control voltage between 0 V and +5 V and check the output frequency range with a frequency counter. The minimum trimming range should be ±5 Hz. 10.000000 MHz must be reached somewhere between 0 V and +5 V.

If the oven oscillator circuitry is repaired, a new calibration must be performed. See Chapter 7. A new factory calibration by means of the utility program should also be performed.

External Reference Input

See Figure 6-67 and Figure 6-70.

The input signal is amplified in U31. The output signal from the amplifier should be a square wave with logic levels, reproducing the timing characteristics of the input signal. Check the signal at U32:11. U32 generates a short pulse (approximately 40 ns) for each input cycle, check at U32:9. These pulses generate a broad spectrum of harmonics, and the following high-Q 10 MHz crystal filter allows only a 10 MHz sinewave to pass. Measure at X19. Note that the trimmer C442 is used for maximizing the amplitude at X19. Check that the amplitude is not less than 1 V_{pp}. If external reference is not selected, the gate U33 stops the 10 MHz signal. The control signal on U33:1 is then low.

100 MHz Multiplier

See Figure 6-67 and Figure 6-69.

100 MHz is used in the measuring logic, mainly as a reference clock, but also for other purposes. A PLL is used for multiplying the 10 MHz reference to 100 MHz. On power-up the processor sets up the PLL IC (U9) via the SPI bus. An output signal, PLL LOCK, tells the processor if the loop is locked (high level). A VCO, consisting of an inverter (U47) and an LC circuit in the feedback loop, is controlled by the PLL IC. The DC voltage from U9:2 is filtered and controls a capacitance diode. The VCO frequency changes with the capacitance. The loop can handle the switching of 10 MHz reference, from internal to external and vice versa. There is no need for a new setup. If external reference is selected and no such signal is connected to the instrument, the PLL will be un-

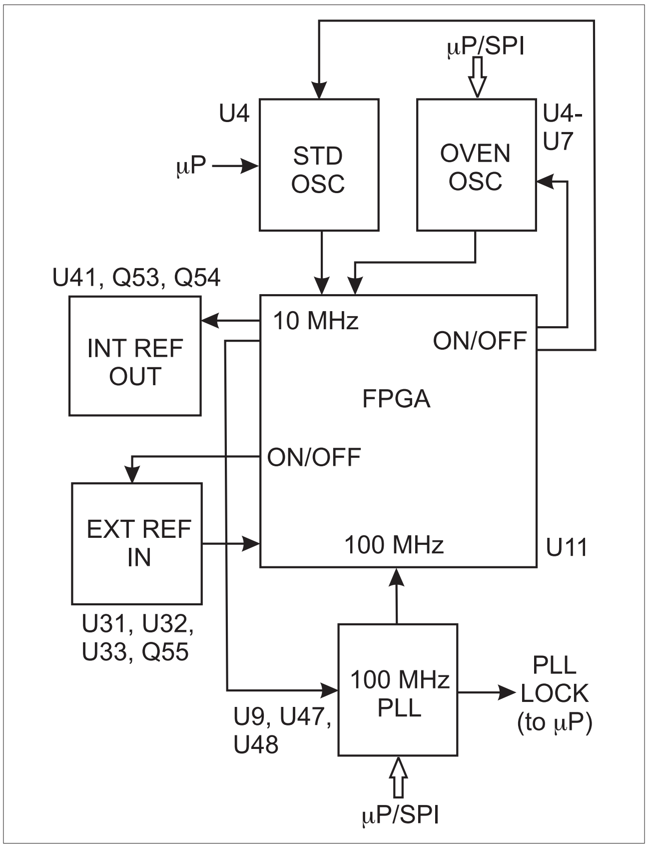

Figure 6-67 Timebase reference system.

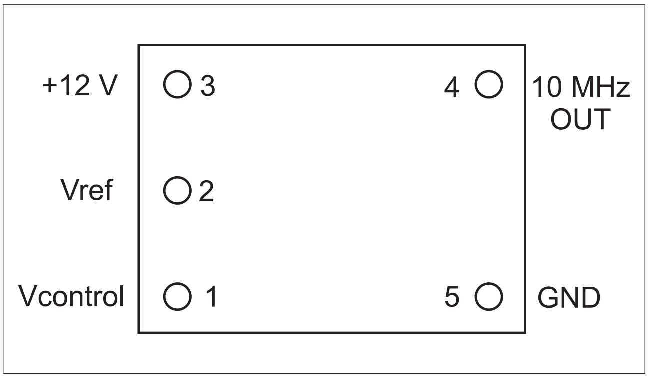

Figure 6-68 Oven oscillator pinning (seen from bottom side).

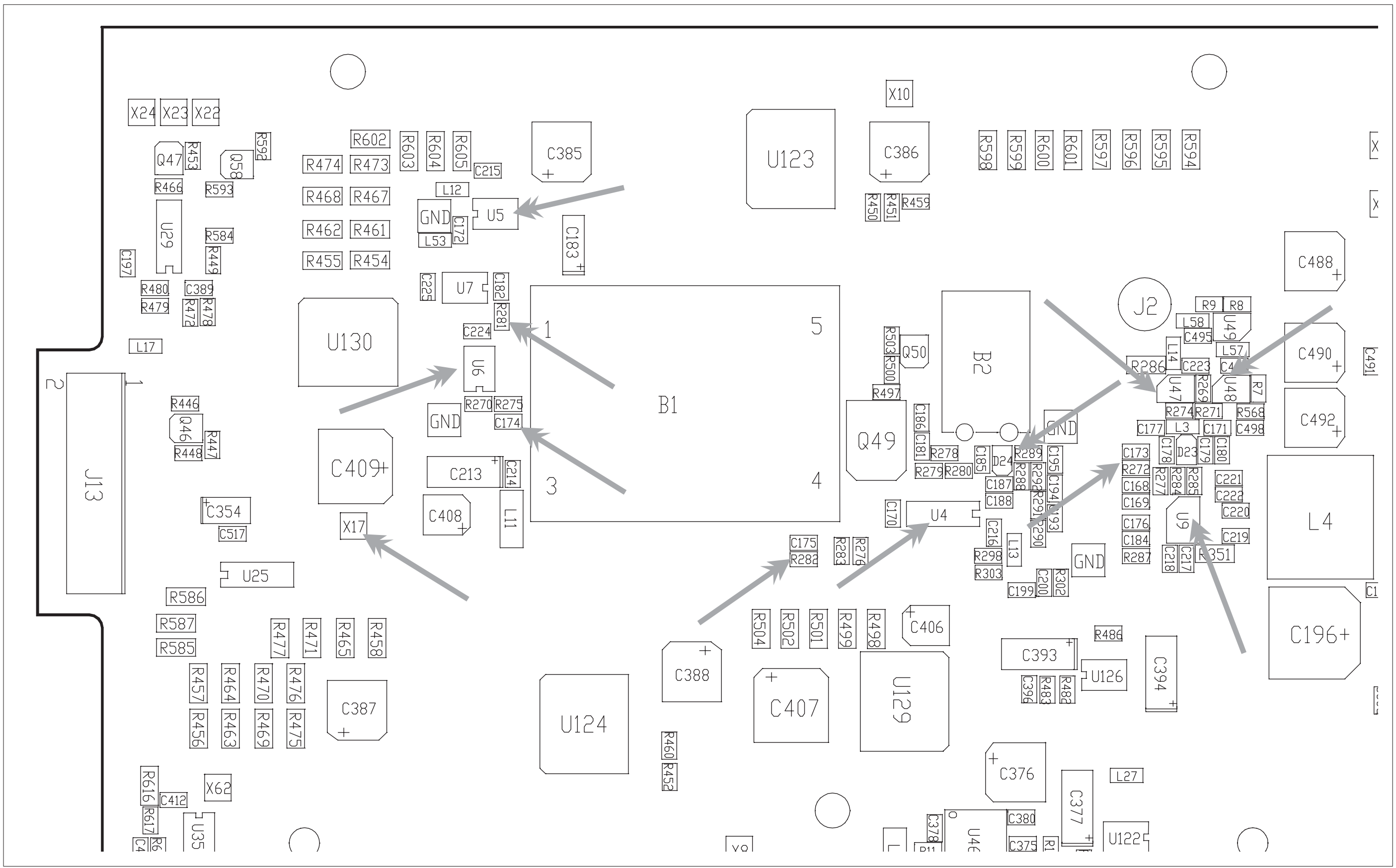

Figure 6-69 *Important locations in the internal timebase reference circuits.*

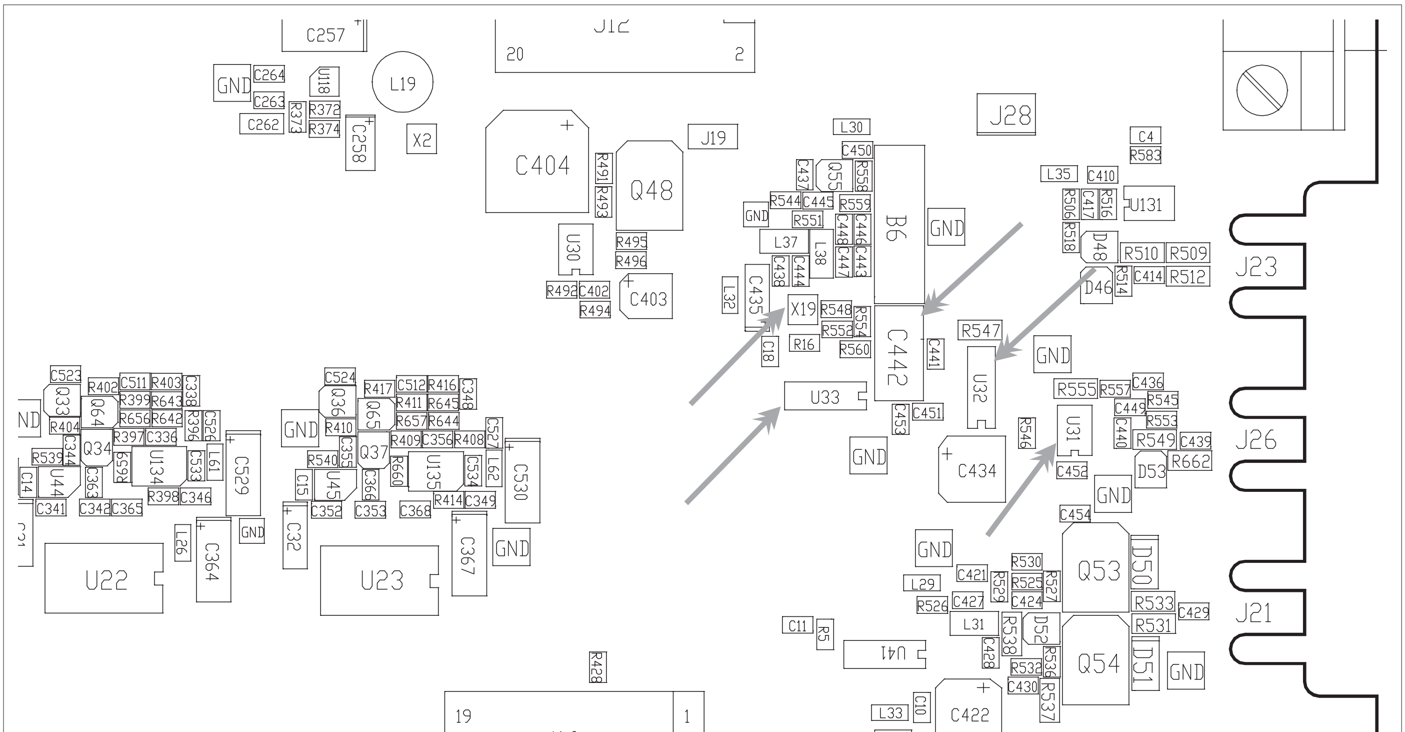

Figure 6-70 *Important locations in the external timebase reference circuits.*

locked, and the VCO will go to one of the extremes. The typical range of the VCO is 95 to 105 MHz, thus giving an error of typically 5 % in the measuring results.

Check the loop voltage (DC) at R272. It should be 1.6 - 2.2 V. Check the 100 MHz signal at U48:4. It should be locked to the incoming 10 MHz at U9:8. Check the lock condition with a 2-channel oscilloscope. Trigger on the 10 MHz channel. Then the signal on the other channel shall be fixed, i.e. not moving along the time axis. Check the PLL LOCK signal at U9:14 (lock is high).

Prescaler

The optional prescalers are not to be repaired. The faulty unit should be sent to the factory, and an exchange unit will be returned.

The best way to isolate the fault is to use another, functioning, timer/counter with the same prescaler. Interchange the prescalers and see if the problem follows the prescaler or the timer/counter.

First measure with Channels A and B and check that the result is OK. Select the function *Frequency C*. Connect a signal according to Table 6-2 to Input C. Check the following pins on the prescaler connector J15 on the main circuit board.

Pin 1 +5 V supply
Pin 5 +12 V supply
Pin 7 ON/OFF, ON is 0 V
Pin 11 test signal, should be 0 V
Pin 12 code 0, see Table 6-2
Pin 14 code 1, see Table 6-2
Pin 16 code 2, see Table 6-2
Pin 4 prescaler output signal, PECL levels (+4.1 V and +3.4 V)

	PRESCALER 2.7 GHz
Frequency (GHz)	1
Level (dBm)	0
Division Factor	16
Code 0	0
Code 1	1
Code 2	0

Table 6-4 *Prescaler characteristics.*

Measure with oscilloscope and probe at pin 4. The output frequency should be the input frequency divided by the factor in the table. Check with a frequency counter.

Note: The 2.7 GHz option has a sensitivity trimmer. See page 7-14 for information on how to adjust it.

Microprocessor & Memories

Startup Process

The processor in this instrument is a Sharp LH79524 with a 32-bit ARM720T core. It is housed in an IC (U13) together with peripheral units like SRAM, timers, I^2C bus interface, SPI bus interface and LCD controller.

The 32-bit microprocessor bus is connected to one 16-bit Flash PROM (U17) and two 16-bit SDRAMs (U15 & U16). The two SDRAMs are organized as one 32-bit wide memory. The microprocessor bus is also, via bidirectional buffers, connected to an FPGA, a USB IC and a GPIB IC.

A reset IC (U116) monitors +3.3 VD and +1.8 V. The reset signal is active low and is kept low for approximately 160 to 180 ms after the voltages have settled and been approved. Measure at X33. The ramp-up time for +3.3 VD is approximately 3 ms.

The processor has an internal linear regulator that generates the core voltage (+1.8 V) from the +3.3 VD I/O voltage. Check +1.8 V at X66.

The rising edge of the reset signal marks the start of the boot sequence. All I/Os on the processor are set to inputs. The 11.2896 MHz oscillator will start running (check at R358). An internal PLL generates 1.88 MHz (reset value) as microprocessor clock (check at X29). The processor will start reading in the Flash PROM. The initializing of the processor and the peripherals will start.

The I/Os will be set up, the processor clock will be set to 50.8 MHz (check at X29). The SDRAMs will start, and the code is copied from the Flash PROM to the SDRAMs. From now on the code is executed from the SDRAMs. Then all the other subsystems are initialized: I^2C bus, LCD controller, SPI bus, fan etc. The FPGA is also programmed by the processor.

The progress of the initialization can be followed at two test points, X55 and X31.

Test Point	Reset	I/O Setup	SDRAM Execute	I^2C Init	Init Ready
X55	float. inp.	1	0	1	0
X31	float. inp.	1	1	0	0

See Figures 6-74 to 6-76 for a survey of a typical instrument startup.

The LCD is switched on. The LCD controller in the processor generates the control signals for the LCD. See Figures 6-77 to 6-81and 6-83. Note the different timing for the signals. The I^2C bus is used for switching the LCD on. The ON signal can be checked at R34 on the display board. It should be high. The LCD voltages must also be switched on. It is done by a control signal from the processor. Check the signal at R33 on the display board. It should be high. Negative pulses on this signal are used for adjusting the contrast of the LCD, i.e. the LCD

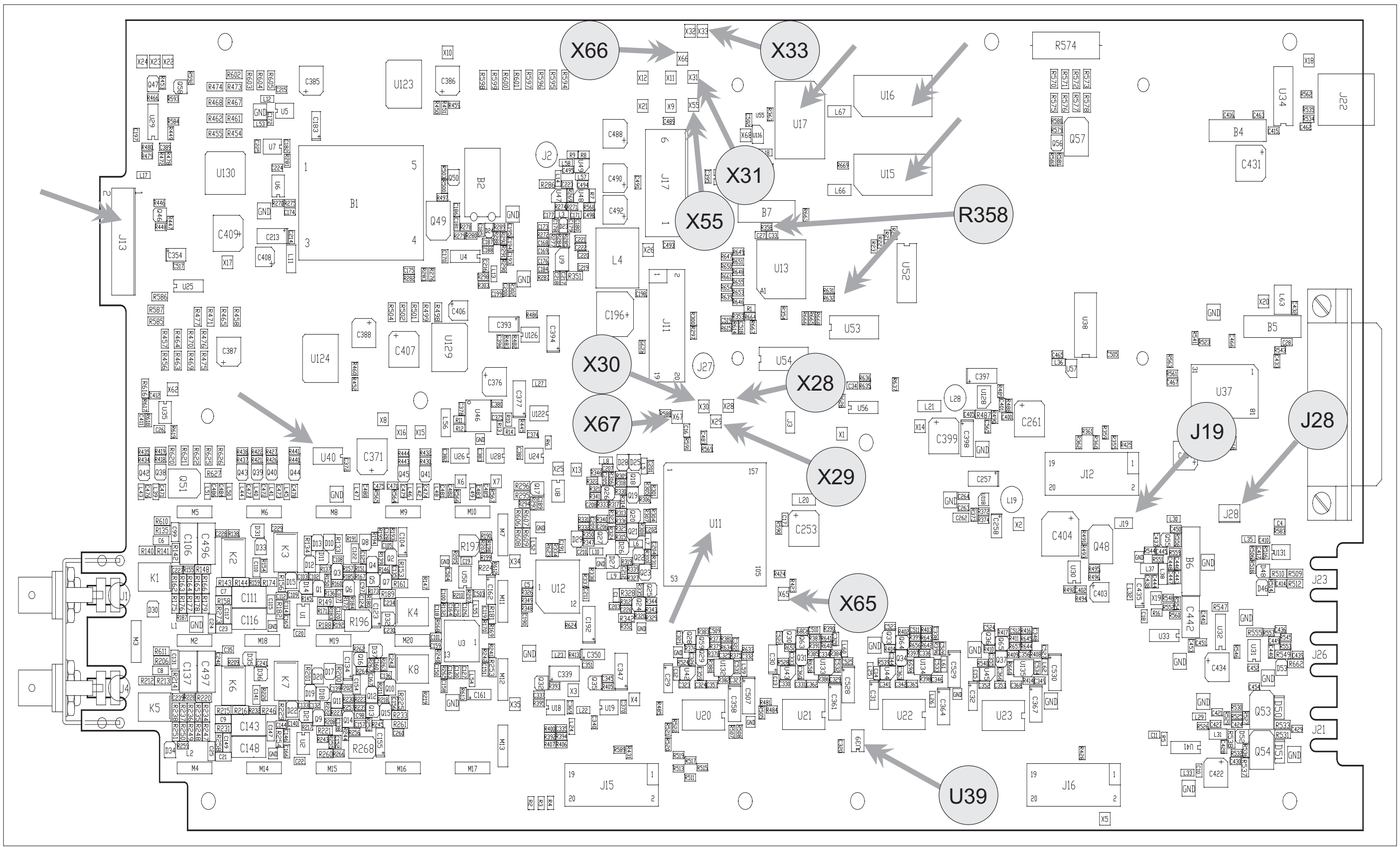

Figure 6-71 *Important locations on PCB 1 during startup.*

voltages. The range is 14.9 V to 17.5 V measured at X1 on the display board. Set the contrast so X1 is 16.2 V. Check the LCD voltages at X2 (14.7 V), X3 (13.3 V), X4 (2.9 V) and X5 (1.5 V). See Figure 6-72.

The FPGA (U11) is programmed by the processor. The used pins are PROGN, INITN, DONE (X65), Clock and Data. See Figure 6-75. The loading starts when PROGN is set low. Then the processor checks that INITN is low and sets PROGN high again. The FPGA responds by setting DONE low. After loading, which takes approximately 1.4 s, the FPGA sets DONE high (check X65), if the loading was successful. If an error is detected, INITN is set low. One clock pulse after DONE is set high, all I/Os on the FPGA are defined. If the loading of the FPGA is not successful, the program just goes on with the rest of the startup procedure. At test point X67 the FPGA will output approximately 14 Hz. This signal shows that the FPGA is working and will be switched off about 8 minutes after power-up.

The fan is set to 8.4 V. Measure on J19 or J28. The input amplifiers are initialized and a "click" from the relays is heard. The I^2C bus is used for controlling the relays.

Note: The I^2C bus is of the utmost importance for the start of the instrument. The keys, the LCD and the relays in the input amplifiers all need a faultless I^2C bus to work properly.

Note: If the Flash PROM is exchanged, it must be replaced by a preprogrammed Flash PROM. Voltage and timebase calibration must be performed anew. The utility program must be used for transferring the calibration results to new factory calibrations. The serial number and the oscillator option must also be programmed by the utility program.

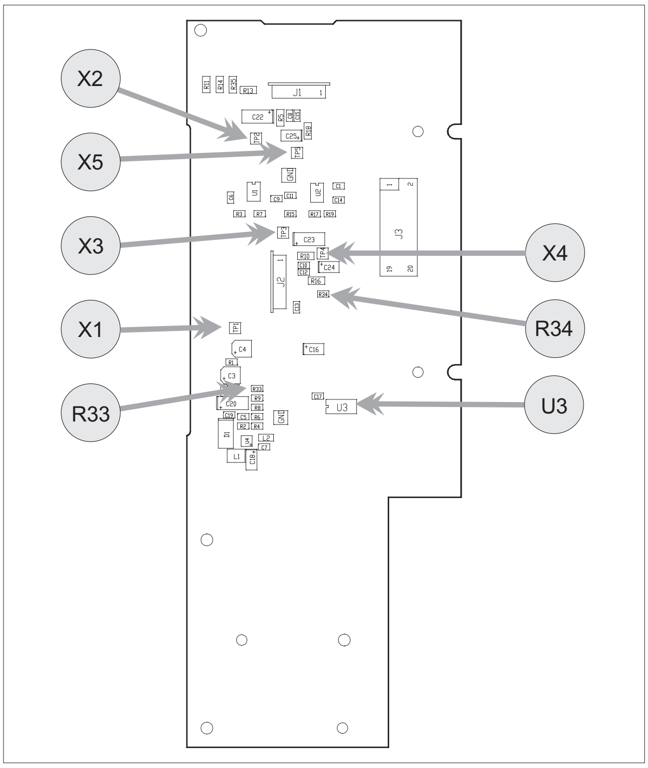

Figure 6-72 *Important locations on PCB 2 during startup.*

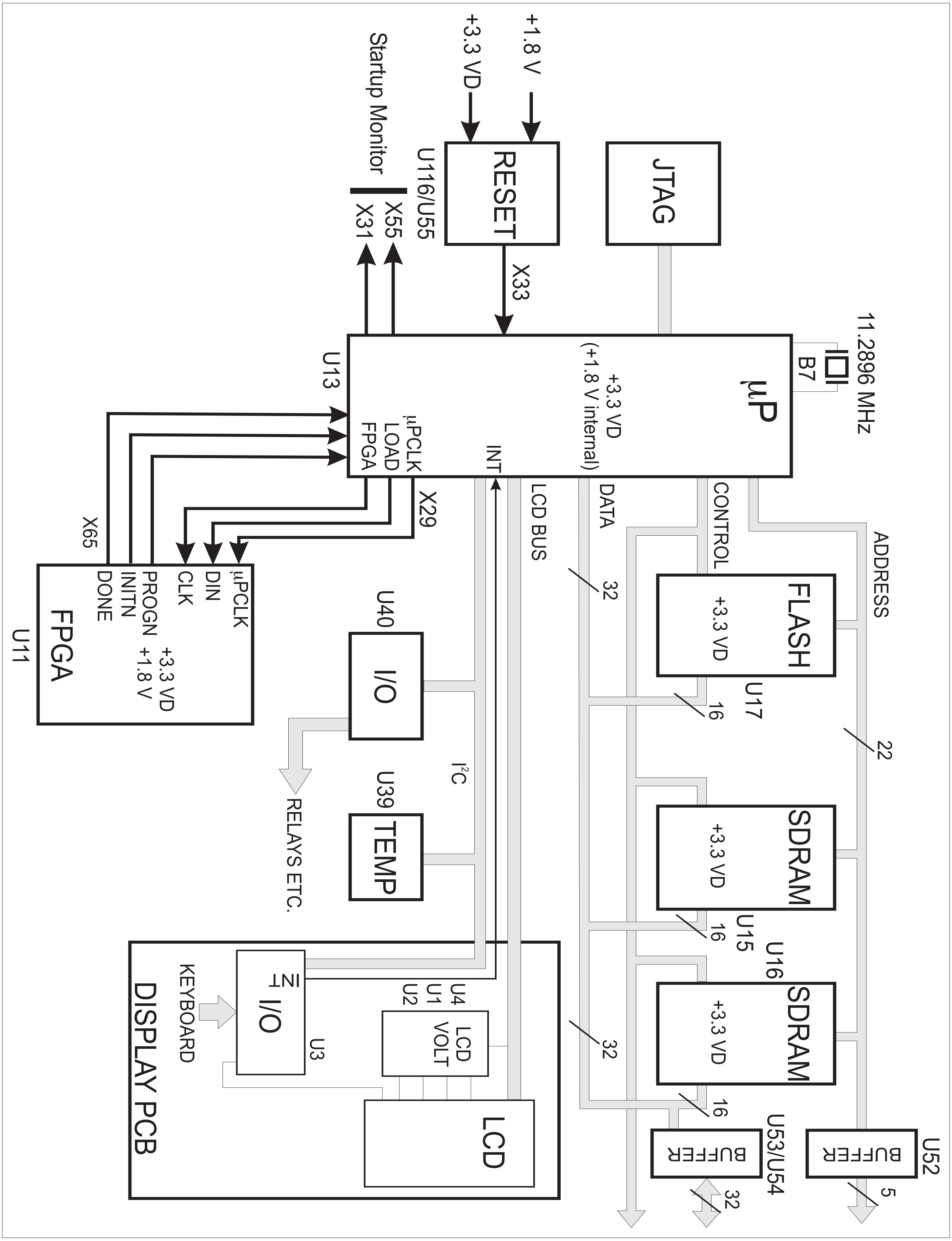

Figure 6-73 *Microprocessor, memories - startup.*

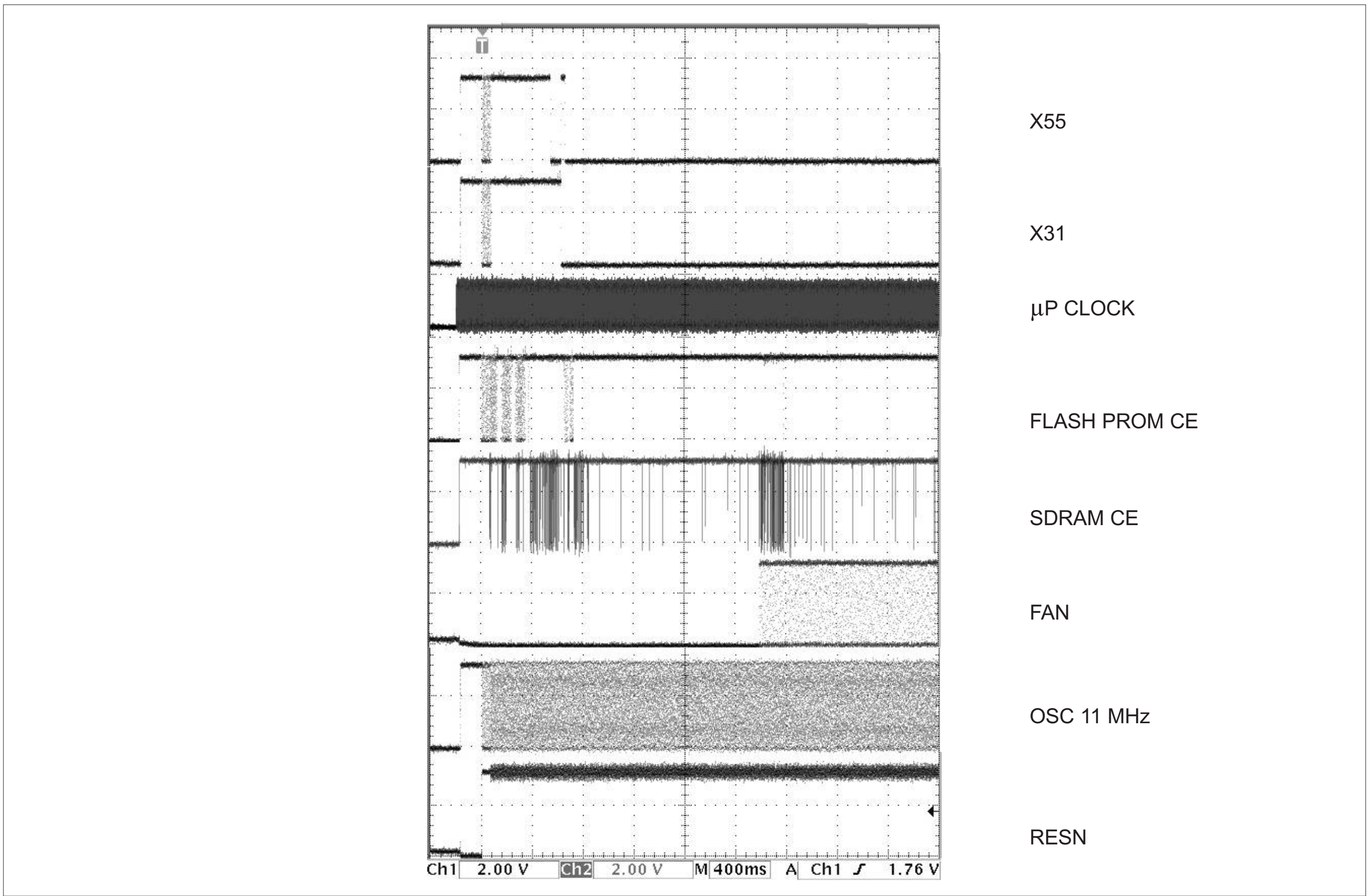

Figure 6-74 *Startup timing - processor, memories, fan.*

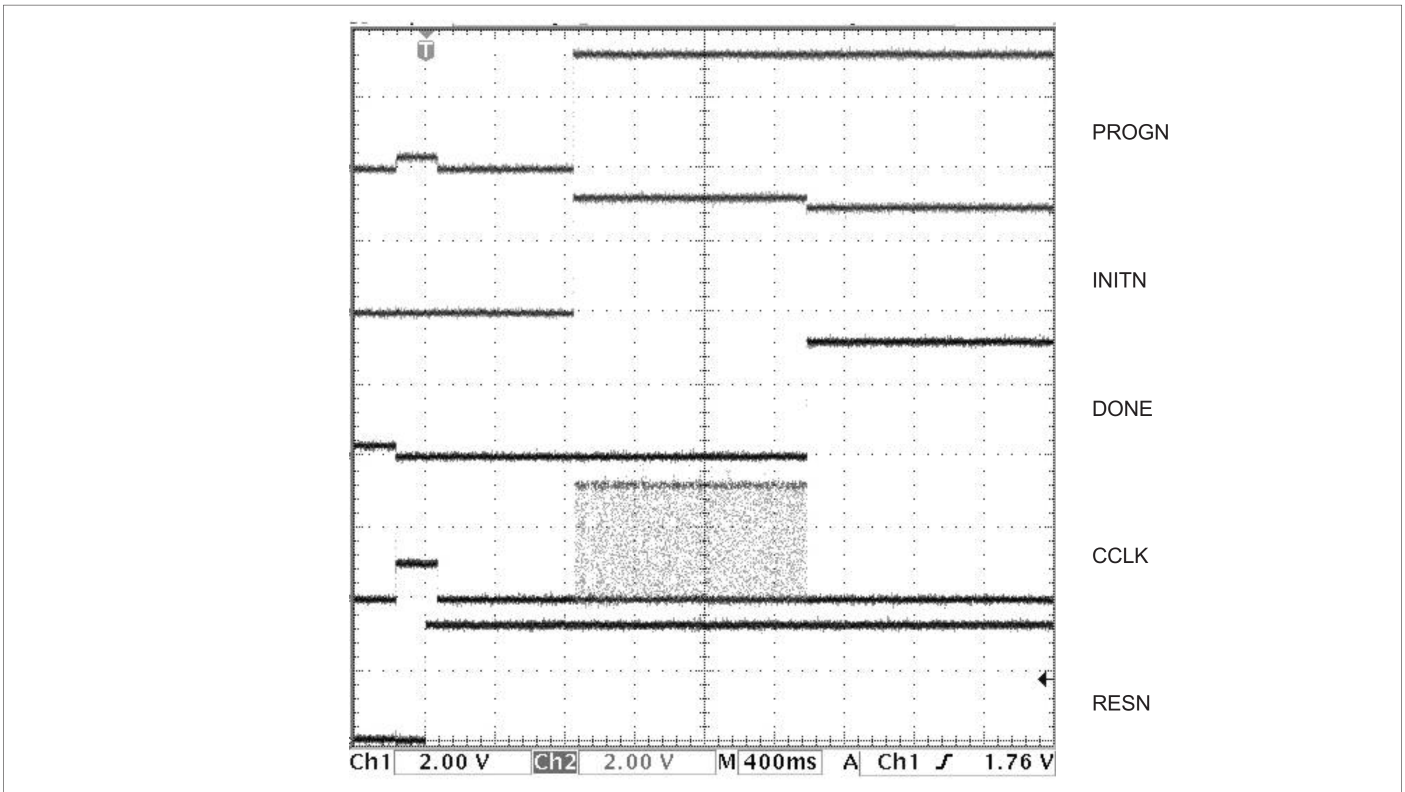

Figure 6-75 *FPGA loading.*

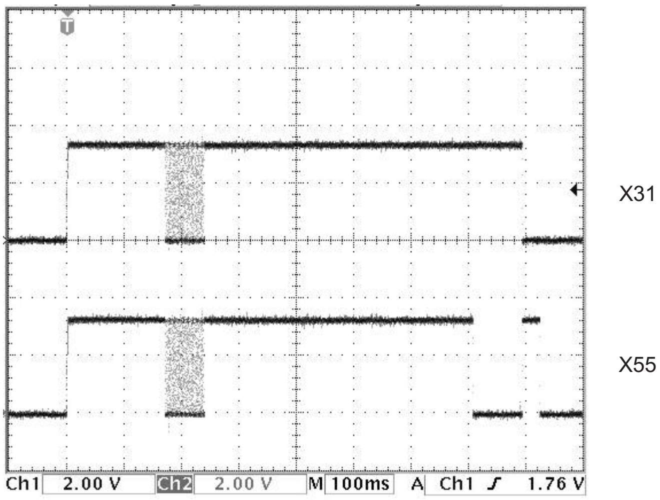

Figure 6-76 *Startup indicator test points.*

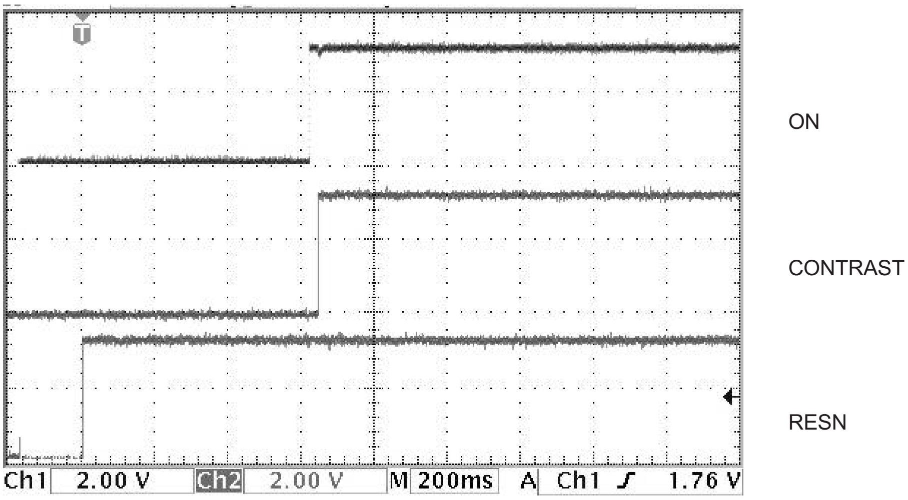

Figure 6-77 *LCD control signals, ocillogram #1.*

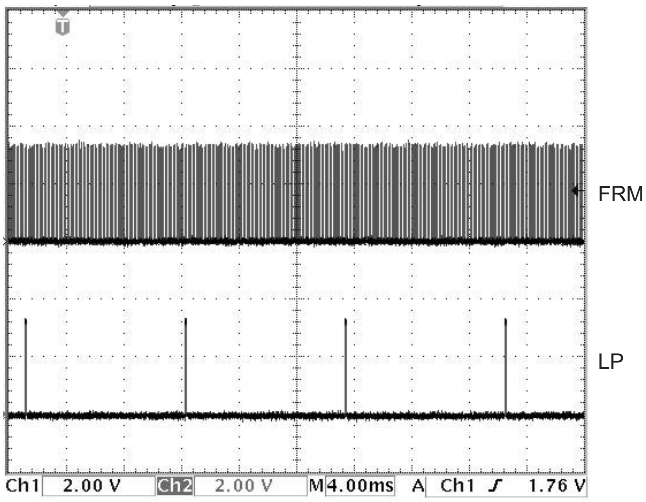

Figure 6-78 *LCD control signals, oscillogram #2.*

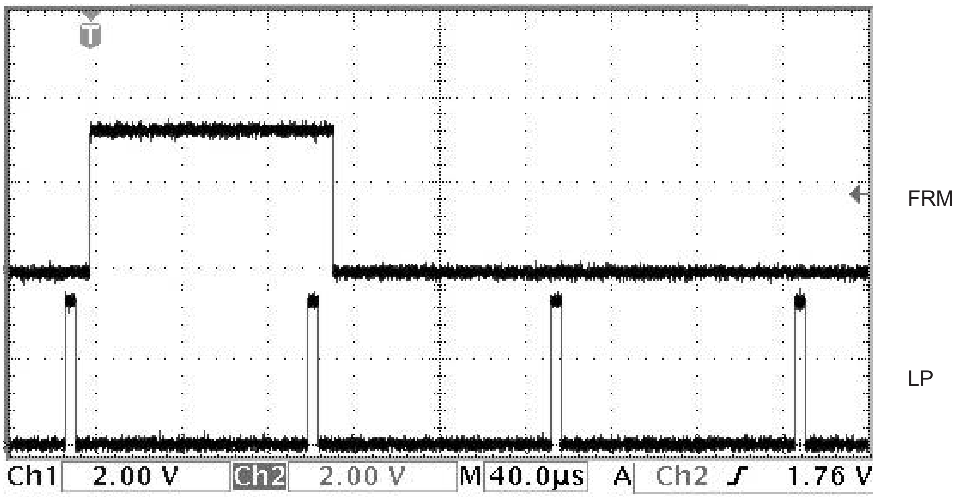

Figure 6-79 *LCD control signals, oscillogram #3.*

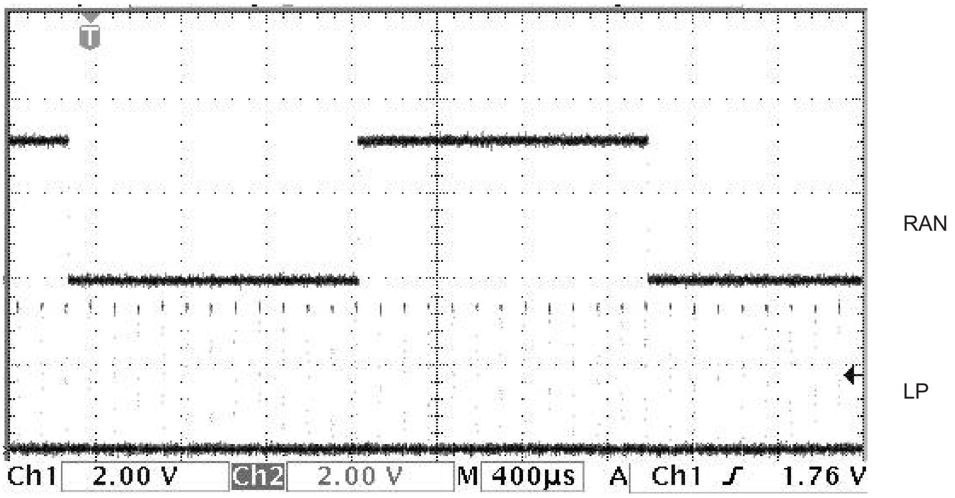

Figure 6-80 *LCD control signals, oscillogram #4.*

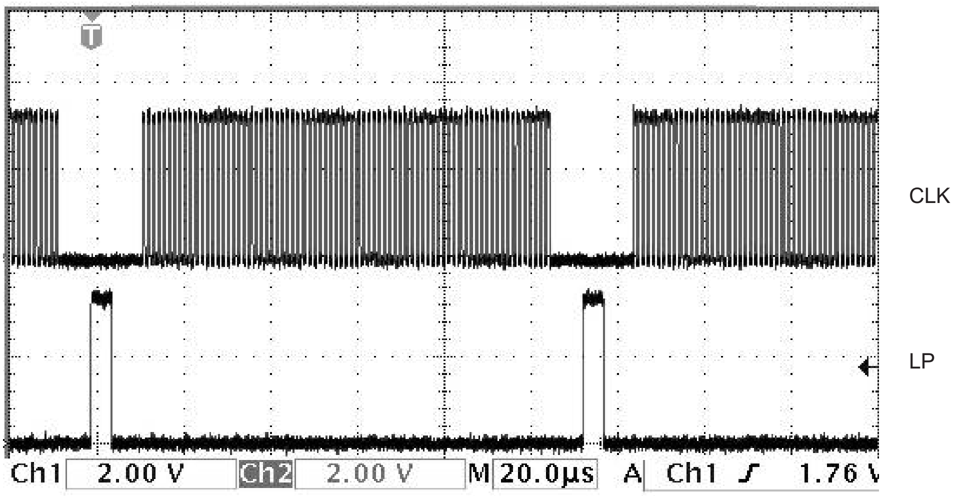

Figure 6-81 *LCD control signals, oscillogram #5.*

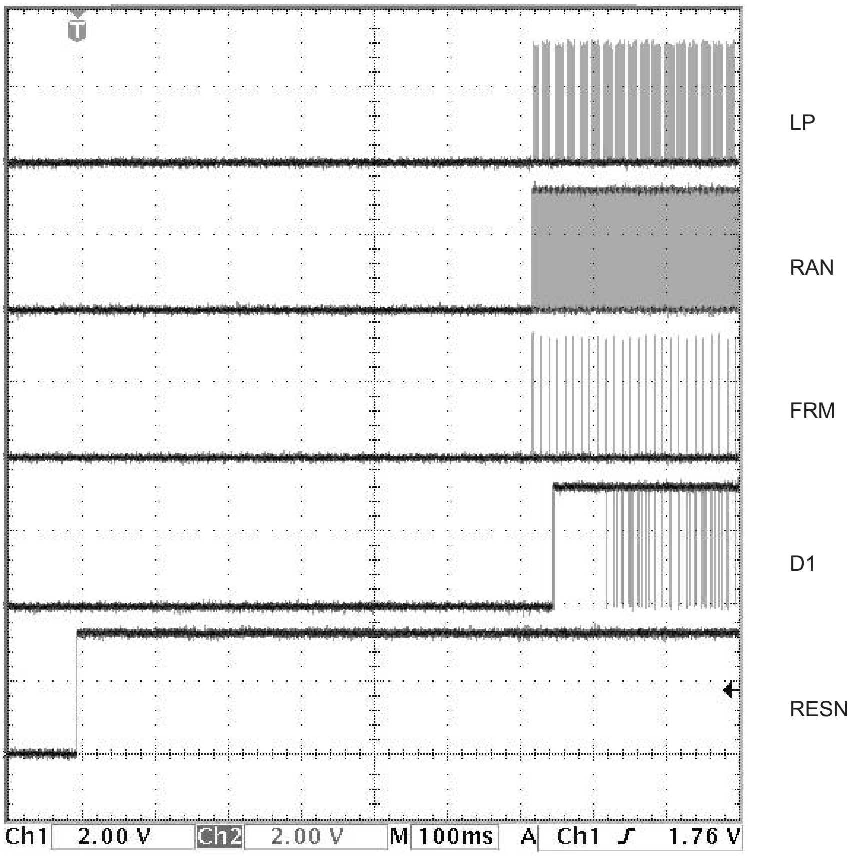

Figure 6-83 *LCD control signals, oscillogram #6.*

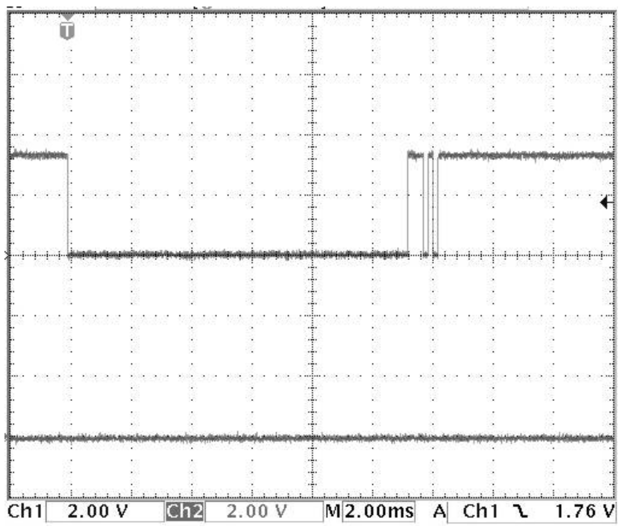

Figure 6-82 *Keyboard interrupt .*

The fan is kept at +8.4 V for the first 8.3 minutes. After that the fan is temperature controlled. The processor reads the temperature via the I^2C bus every 10th second. IC U39 measures the temperature.

The keys on the display board are read over the I^2C bus. If a key is pressed, the I^2C bus circuit U3 notices that and sends an interrupt to the processor. Check at J13:9; low is interrupt. The processor then scans the keys via the I^2C bus to find the depressed key. See Figure 6-82. During the scanning there may appear some extra interrupts. This is not an error condition.

Microprocessor Bus & Interfaces

The microprocessor bus is divided into two parts with buffers. The inner part consists of the Flash PROM and the SDRAMs. Buffers isolate the inner part from long lines in order to make the SDRAM work safely. The buffers of the 32-bit data bus are bidirectional and a control signal opens the buffers only during reads and writes (U56:8, low to open buffers). The direction of the buffers is controlled by the *rdn* from the processor.

The outer part consists of the 32-bit data bus and the 5-bit address bus. It connects the processor (U13) to the FPGA (U11), the GPIB and the USB. See Figure 6-87.

The FPGA connection has 32 data bits, 5 address bits, chip select, *wrn* and *rdn*. The FPGA is controlled by the processor via the bus; measurement functions are selected, for instance. The FPGA is controlled between each measurement or block of measurements. An interrupt signal from the FPGA is connected to the processor. See Figure 6-89 for a typical timing diagram.

The connection to the USB has 16 data bits, 1 address bit, chip select, wrn and rdn. An interrupt signal from the USB IC is connected to the processor. See Figure 6-90 for a typical timing diagram. The USB IC is a complete USB unit. It is not powered from the USB bus. The USB IC (U34) has a 6 MHz oscillator. Check at C416.

The connection to the GPIB has 8 data bits, 5 address bits, chip select, wrn, rdn and a special control signal for the level shifting IC (U38). U38 is a buffer between the logic level of +3.3 V for the processor and the logic level of +5 V for the GPIB IC (U37). An interrupt signal from the GPIB IC is connected to the processor. See Figure 6-91 for a typical timing diagram. The GPIB IC is a complete GPIB unit. The GPIB IC (U37) has a 40 MHz oscillator. Check at TP20.

Only the selected interface is involved in communication on the microprocessor bus.

Since both interfaces consist of only one IC each, troubleshooting is fairly simple. Check that the oscillator (40 MHz or 6 MHz) is running. Check that the processor communicates with the selected IC. Make sure the external controller (GPIB or USB) and the interconnection cable used are OK.

The transfer of measurement results from the FPGA to the microprocessor goes via the 32-bit microprocessor bus and normal *reads*. There are some extra handshake pins to facilitate the transfer. An interrupt signal is sent to the microprocessor if results are to be read, ALERT, X30. X28 (EMPTY) indicates that it is allowed to read results, and the microprocessor sets a signal high to indicate that it is reading results, UPRD, U11:203. Results are always read in packets of 8 words. See Figure 6-92 for a typical timing diagram.

Another bus from the microprocessor is the SPI bus. It is a serial bus with one data signal and one clock signal that are common to all ICs connected to the bus. A separate load signal for each IC controls the loading of the data. Connected to the SPI bus are (See Figure 6-93 to Figure 6-96):

- The 100 MHz PLL IC (U9). The SPI bus is used only for initialization after power on.
- The optional oven oscillator IC (U5). The SPI bus is used for initialization after power on and during a timebase calibration.
- The trigger levels IC (U46).

The last bus is the I^2C bus. It is also a serial bus with two signals, SDA and SCL. Each connected IC has a unique address. The message sent includes the address, and only the addressed IC will listen to the message and respond by sending an acknowledge to the master. Then it will react accordingly.

Introduction to the I^2C Bus

The I^2C bus is a 2-line serial bus for the communication between the ICs. The microprocessor controls the communication by means of the clock line SCL. One or more slaves can read or write on the data line SDA.

The SDA and SCL are high at standby. All ICs connected to the bus can sink SDA to low as they are interconnected via open collector outputs. The microprocessor starts and stops the communication by sending terms of start and stop:

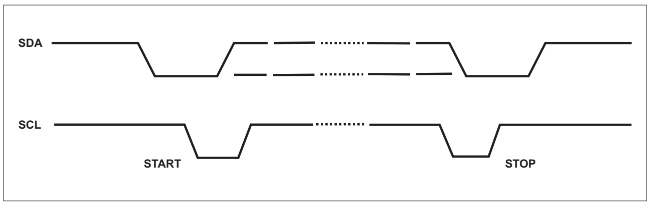

Figure 6-84 *Terms of start and stop.*

During transmission the SDA can be changed only when the SCL is low.

The microprocessor always begins to send the address information. The format of this address information is seven address bits, one read/write bit, and one acknowledge bit.

The addressed slave accepts by keeping the SDA line low while the acknowledge bit (ACKN in) is sent by the microprocessor.

Example of addressing (address 30H):

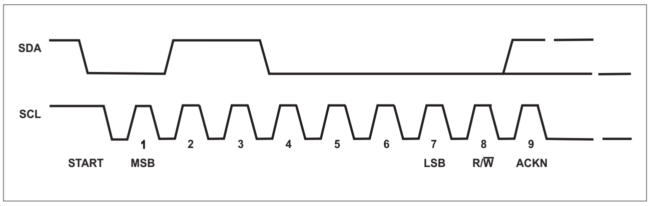

Figure 6-85 *Addressing.*

The read/write bit R/$\overline{W}$ has the following meaning:

R/$\overline{W}$ = 1 means information from the slave to the µprocessor
R/$\overline{W}$ = 0 means information from the µprocessor to the slave.

The data information is sent after the address information. The format of the data information is eight data bits followed by one acknowledge bit. The reciever accepts by keeping the SDA line low while the acknowledge bit (ACKN in) is sent.

Example of data transmission (data 9BH):

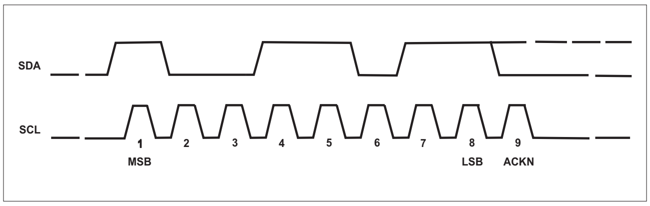

Figure 6-86 *Data transmission.*

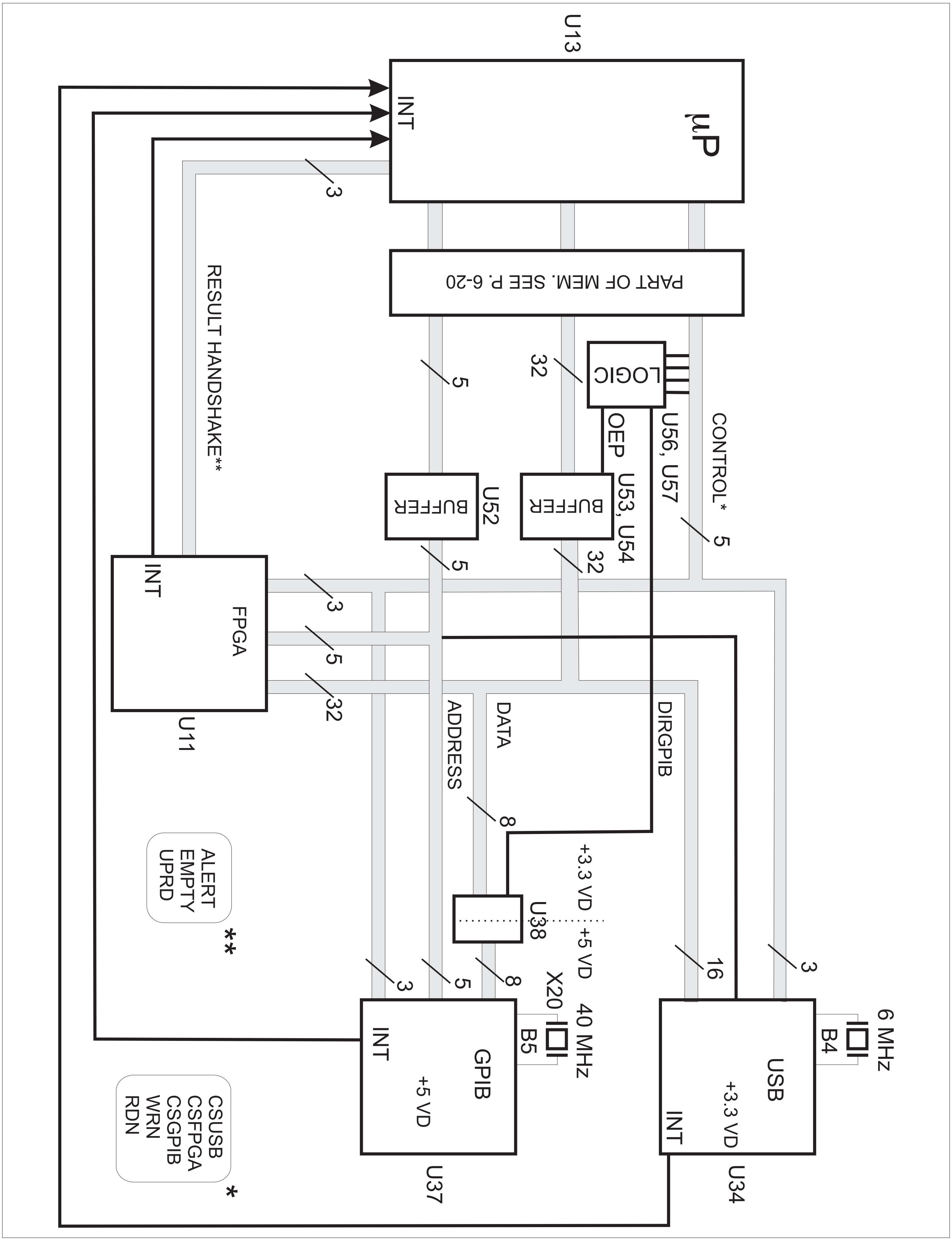

Figure 6-87 *Microprocessor bus and interfaces.*

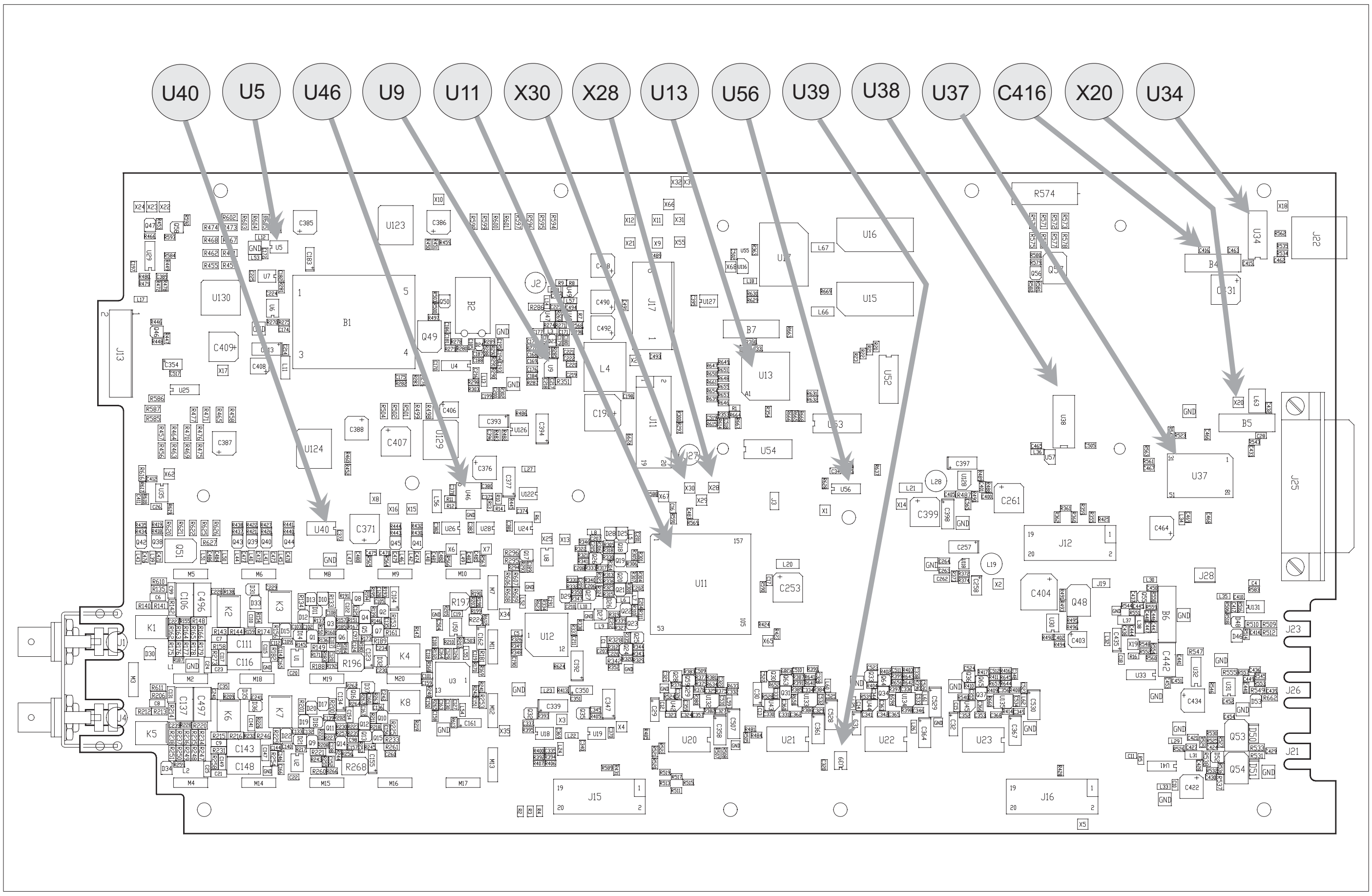

Figure 6-88 *Important locations for the microprocessor and its buses and interfaces.*

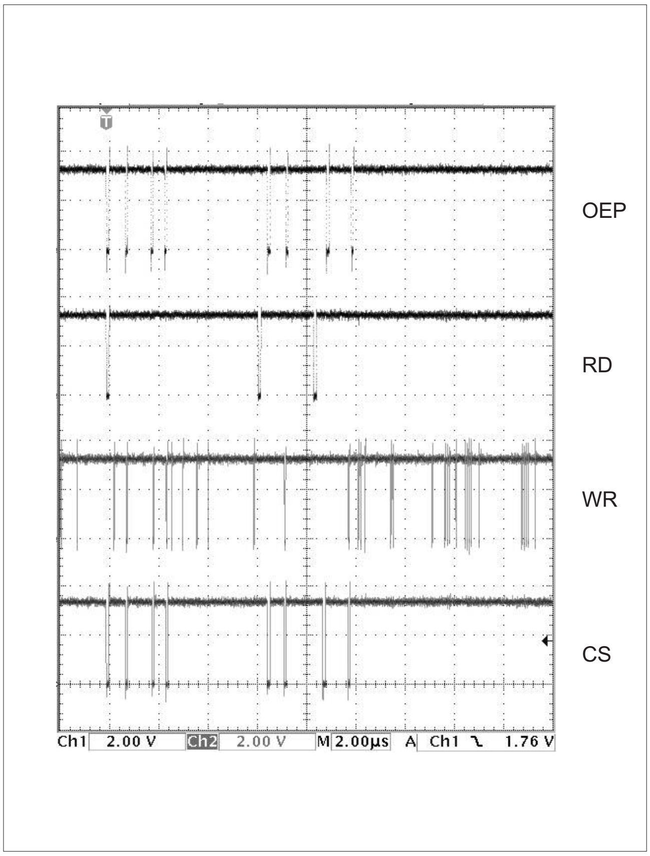

Figure 6-89 *Microprocessor bus - FPGA timing - Single Period - Hold, after Restart.*

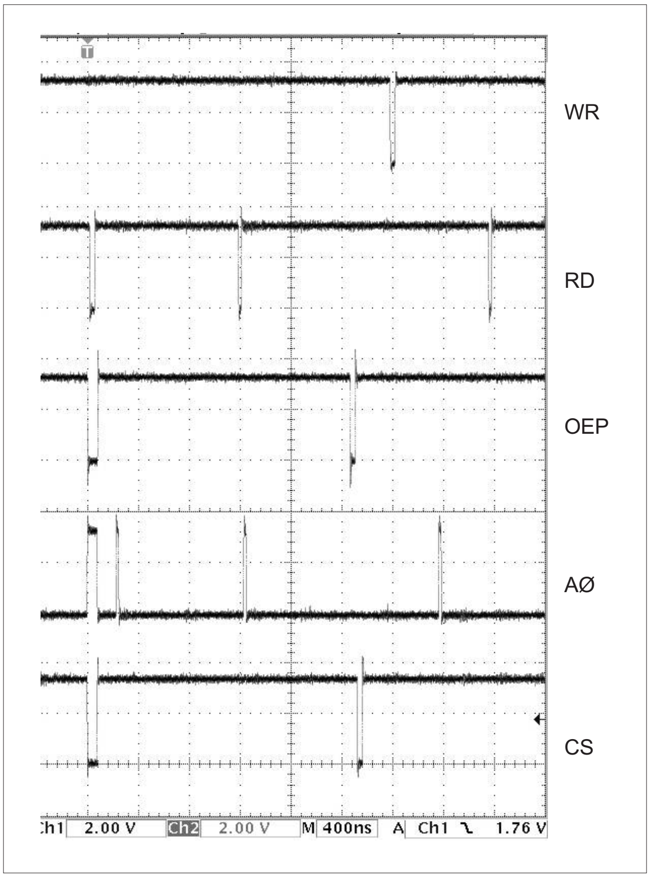

Figure 6-90 *Microprocessor bus - USB timing - Power On.*

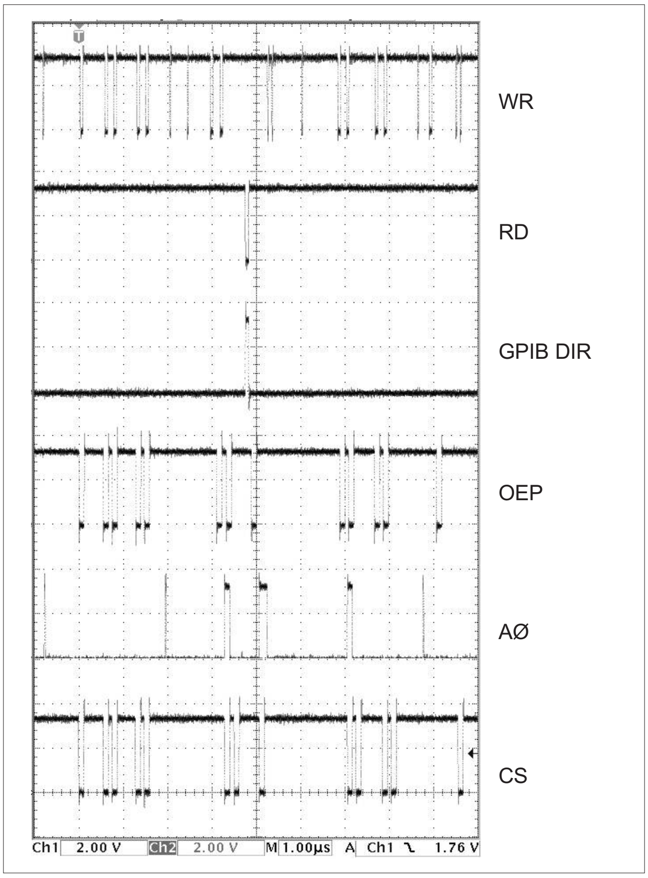

Figure 6-91 *Microprocessor bus - GPIB timing - Power On.*

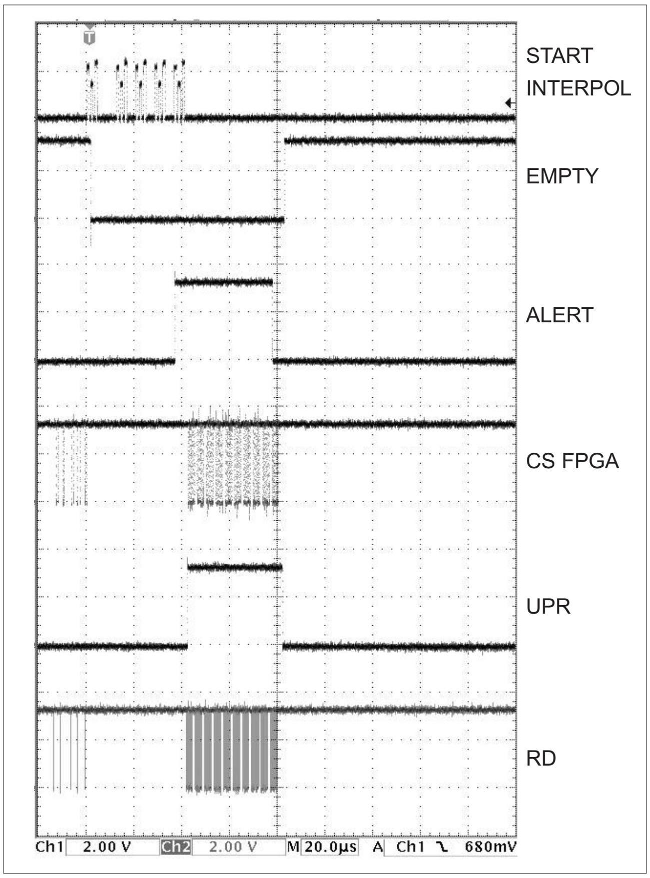

Figure 6-92 *FIFO timing - Block:5, Single Period, 10 MHz.*

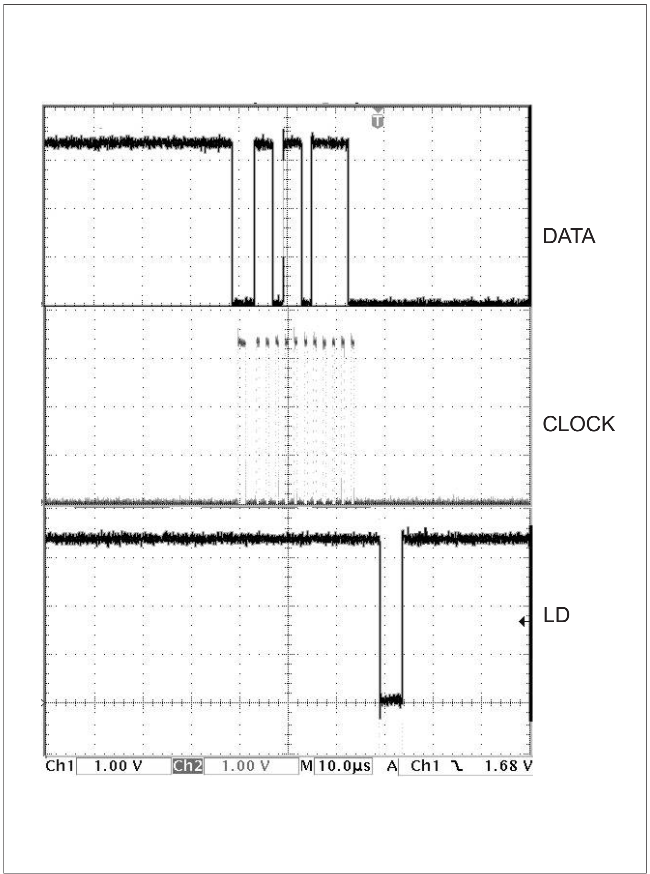

Figure 6-93 *SPI bus activity - oven - directly after power-up.*

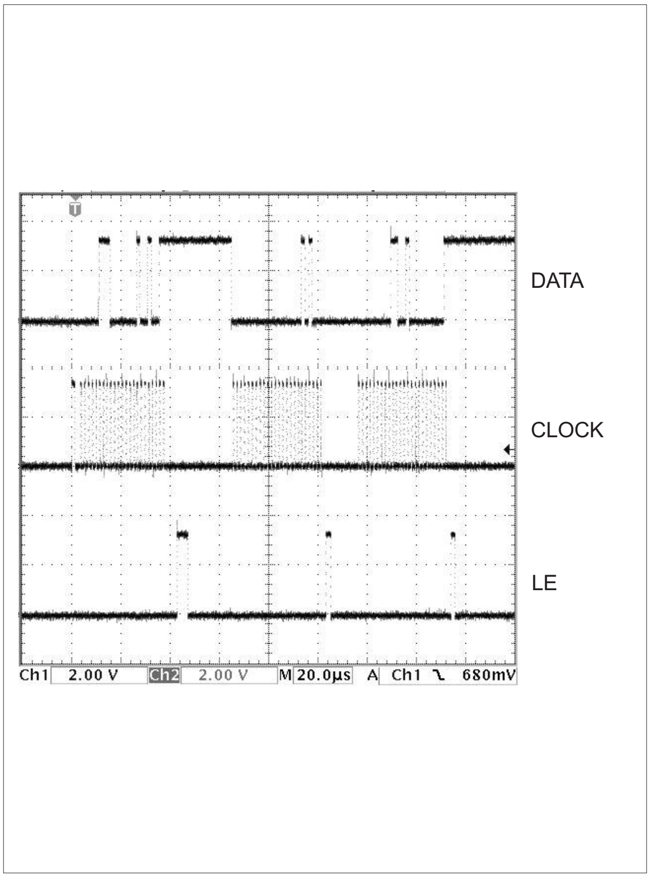

Figure 6-94 *SPI bus activity - PLL - directly after power-up.*

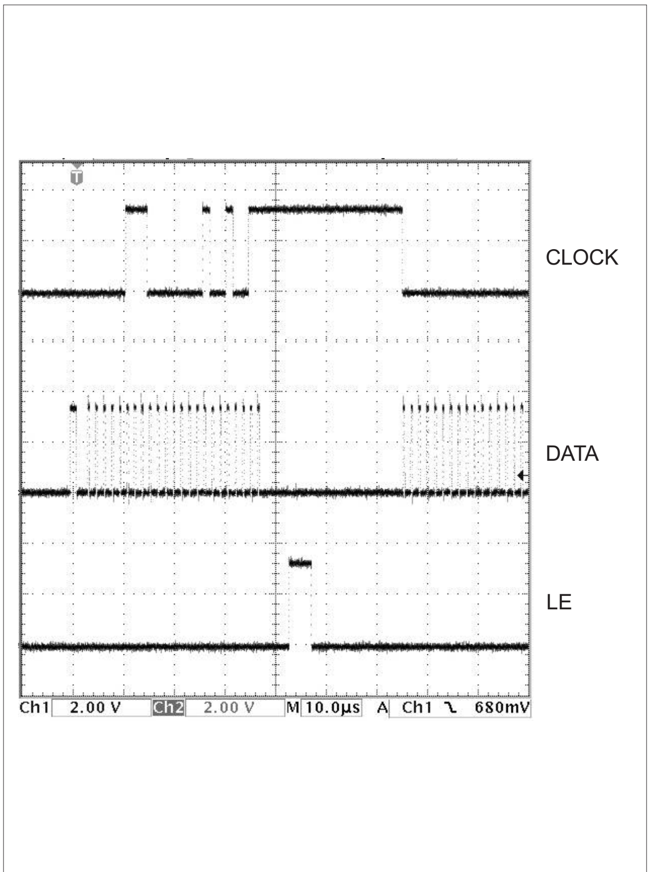

Figure 6-95 *SPI bus activity - PLL - first transfer close-up.*

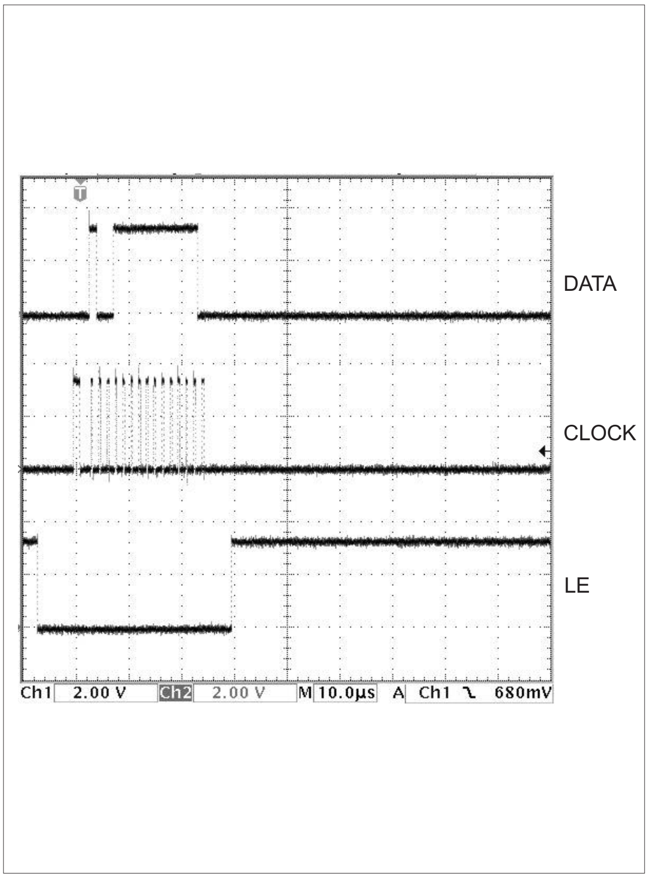

Figure 6-96 *SPI bus activity - trglvl.*

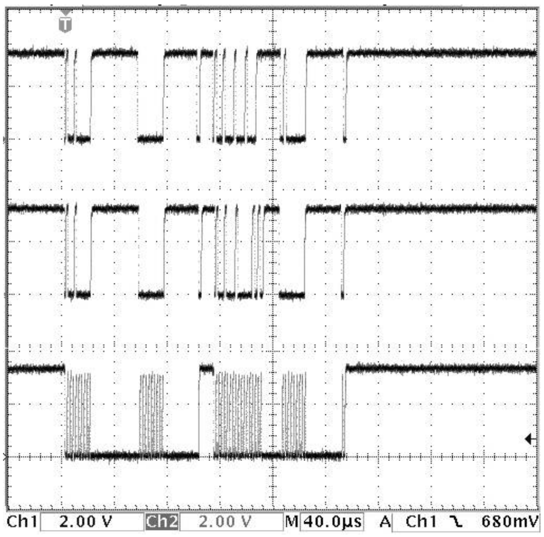

Figure 6-97 *I^2C bus activity - reading the temperature.*

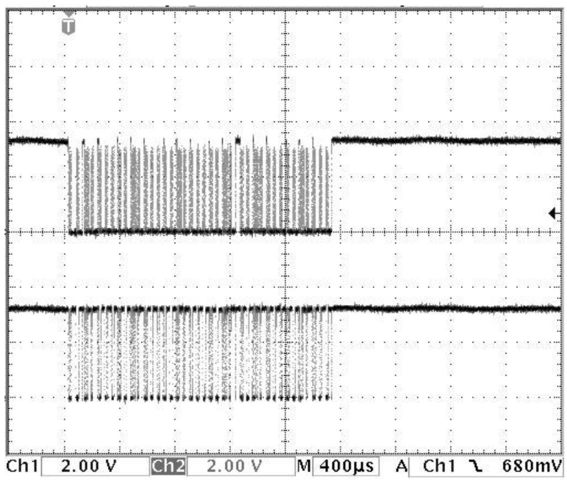

Figure 6-98 *I^2C bus activity - depressing the EXIT key.*

■ The I^2C Bus in the '90'

The processor is the Master on the I^2C bus. Slaves on the bus are:

- The digital I/O IC U40 with address 20hex. It controls the relays and filters in the input amplifiers.
- The temperature measuring IC U39 with address 48hex.
- The digital I/O IC U3 with address 21hex. It switches the LCD display on after power-on initialization, it scans the keyboard on the display circuit board.

The bus is connected to the prescaler connector J15 for future use.

See Figure 6-97 and Figure 6-98.

Measuring Logic

The measurements are made in the FPGA. Only four interpolators are external to the FPGA. They increase the basic measurement resolution from 10 ns (100 MHz measurement clock) to less than 100 ps. Different combinations of interpolators are used for different measurement functions; two, three or four in conjunction. The input signals come from the input amplifiers. A, B and SR are differential LVPECL inputs. C, the prescaler input, is a single-ended LVTTL input. The measuring logic also provides three LEDs on the front panel with control signals.

The interpolator transforms a pulse width between 20 and 33 ns to a voltage. This voltage is read by an ADC. The interpolator is calibrated by reference pulses having a width of 20 and 30 ns . The measurement pulse varies between 22 and 32 ns typically. The ADC has two reference voltages, the lower limit and the upper limit. The interpolated voltage must never fall outside these limits.

Select the default setting from the front panel. Apply a 10 MHz sinewave signal (stable low jitter signal) to input A. The signal should be found at the pins of the FPGA. Check that the measurement signal is present on pins 10 and 11 (differential input) on the FPGA U11.The trigger indicator LED A on the front panel should blink. The gate indicator on the front panel should also blink and the display should show the measurement result. In this setting the S/R flip-flop U12 is used. Check that the measurement signal is present on pins 45 and 46 (differential input) on the FPGA U11.

Move the 10 MHz sinewave signal to input B. Change the measurement function to Frequency B. Check that the measurement signal is present on pins 20 and 21 (differential input) on the FPGA U11. The trigger level LED B and the gate indicator LED should blink and the display should show the measurement result.

Move the 10 MHz sinewave signal back to input A. Change the measurement function to Period Single A. Now the S/R flip-flop should not be used, check the control signal at R623, it should be -1.6 V (on is -1.0 V). Select statistics. The std deviation should be less than 100 ps.

Change the measurement function to Time Interval A - A. Select Statistics Mode. Check that the standard deviation is less than 100 ps. Measure at pin 8 of the ADCs U23, U22, U21 and U20. See Figure 6-100 for a typical timing diagram. Check the upper (TP3) and lower (TP4) voltage limits of the ADCs. They should be approximately 3.5 - 3.6 V and 1.0 - 1.4 V. The important thing is that the lowest voltage pulse on any pin 8 of the ADCs (U23, U22, U21, U20) should be at least 0.2 V above the lower limit and that the highest voltage pulse on any pin 8 of the ADCs should be at least 0.3 V below the upper limit. If an interpolator has a voltage pulse outside the limits the measurement result will be wrong. Figure 6-101 shows the signals on an ADC.

The signal from the prescaler is connected to pin 22 (single-ended) of U11. It comes via a level converter. Check the input signal to the converter at R335 (PECL levels).

If the FPGA or a part in the interpolators has been changed or repaired, a calibration of internals must be performed afterwards. See Chapter 7.

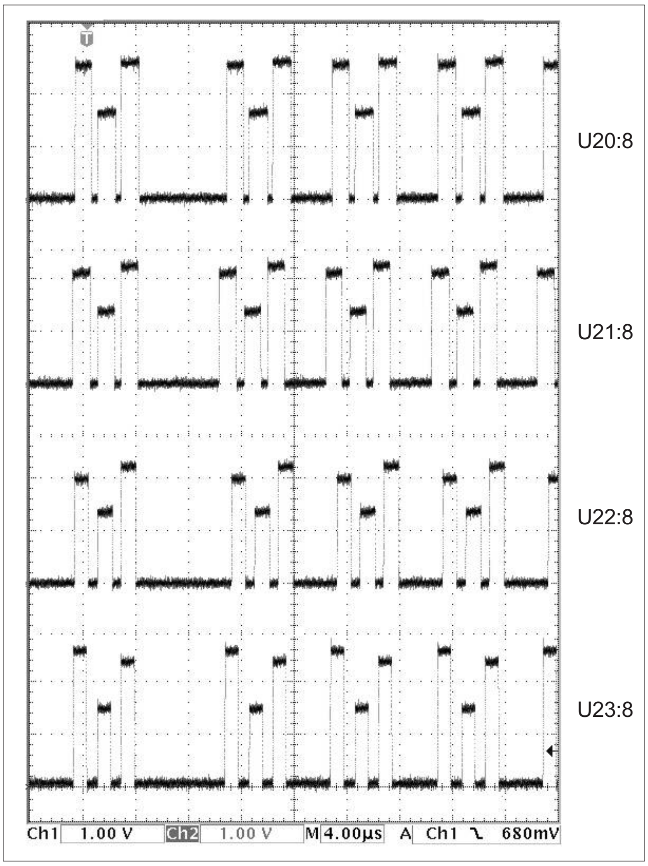

Figure 6-100 *ADC 10461 behavior. Time A-A Smart, 10 MHz in, block measurement.*

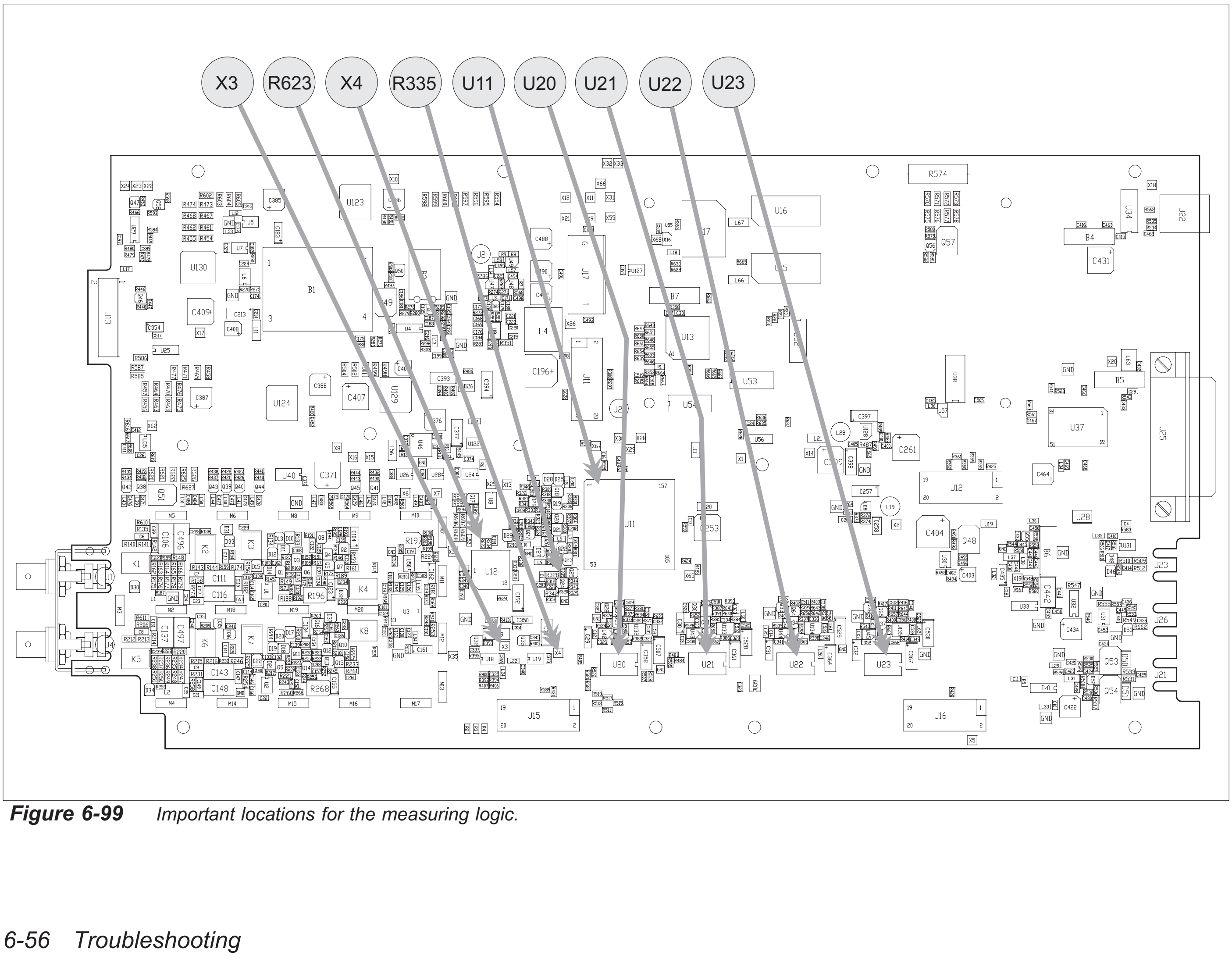

Figure 6-99 *Important locations for the measuring logic.*

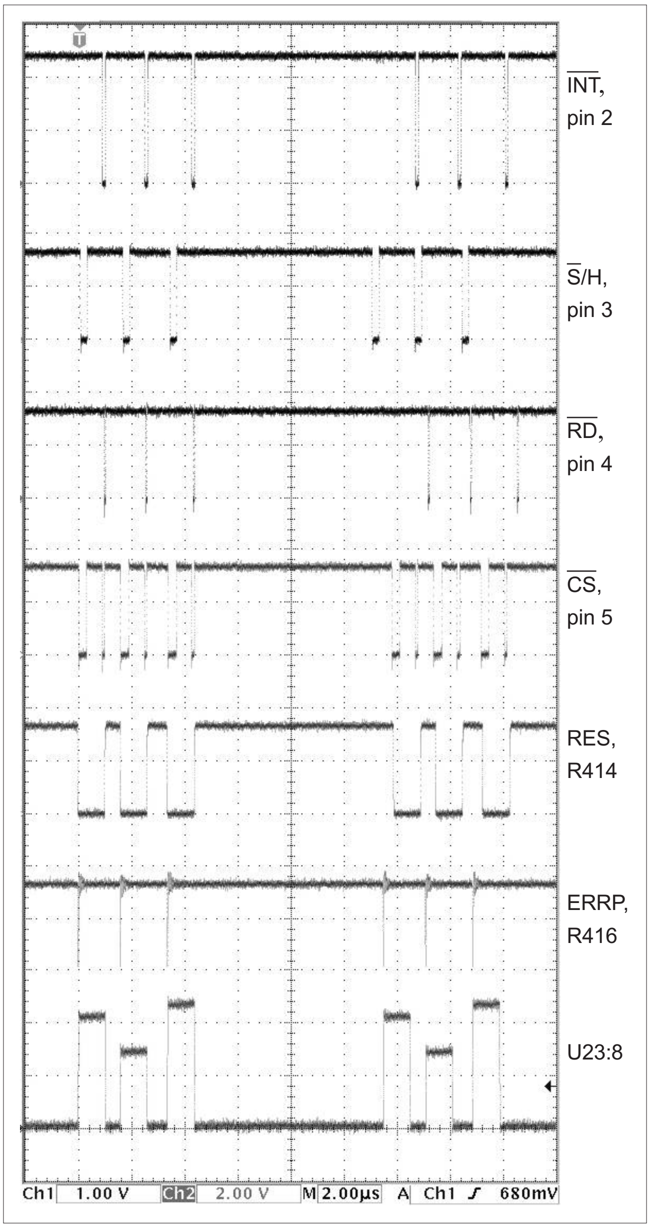

Figure 6-101 *Different signals around an ADC.*

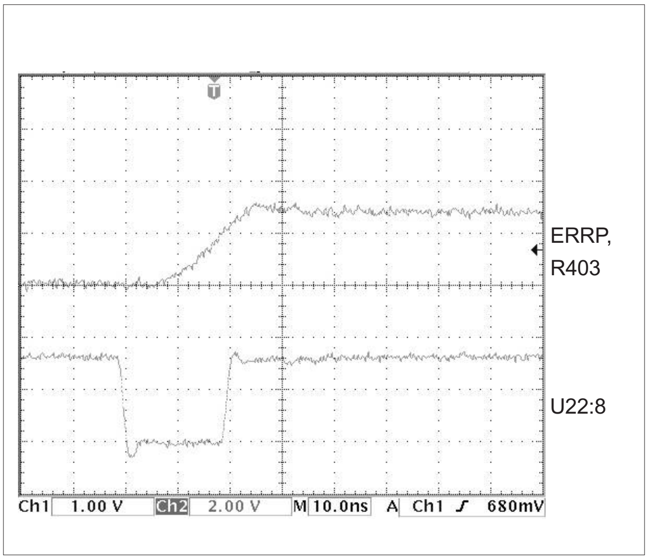

Figure 6-102 *Close-up of error pulse and S/H output.*

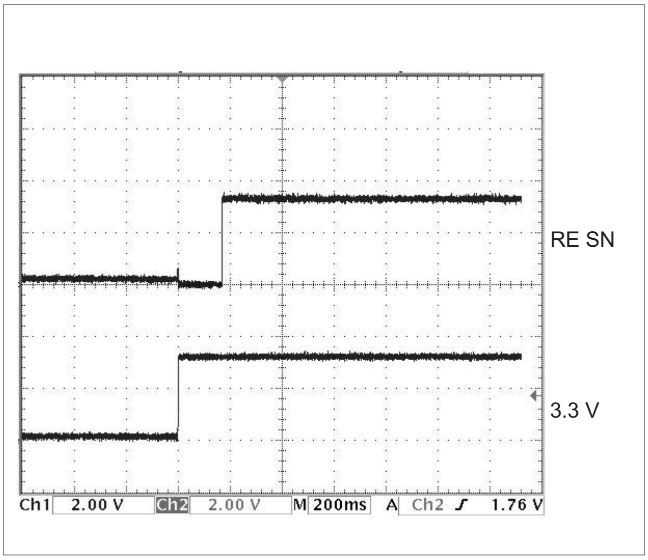

Figure 6-103 *Power-up & Reset.*

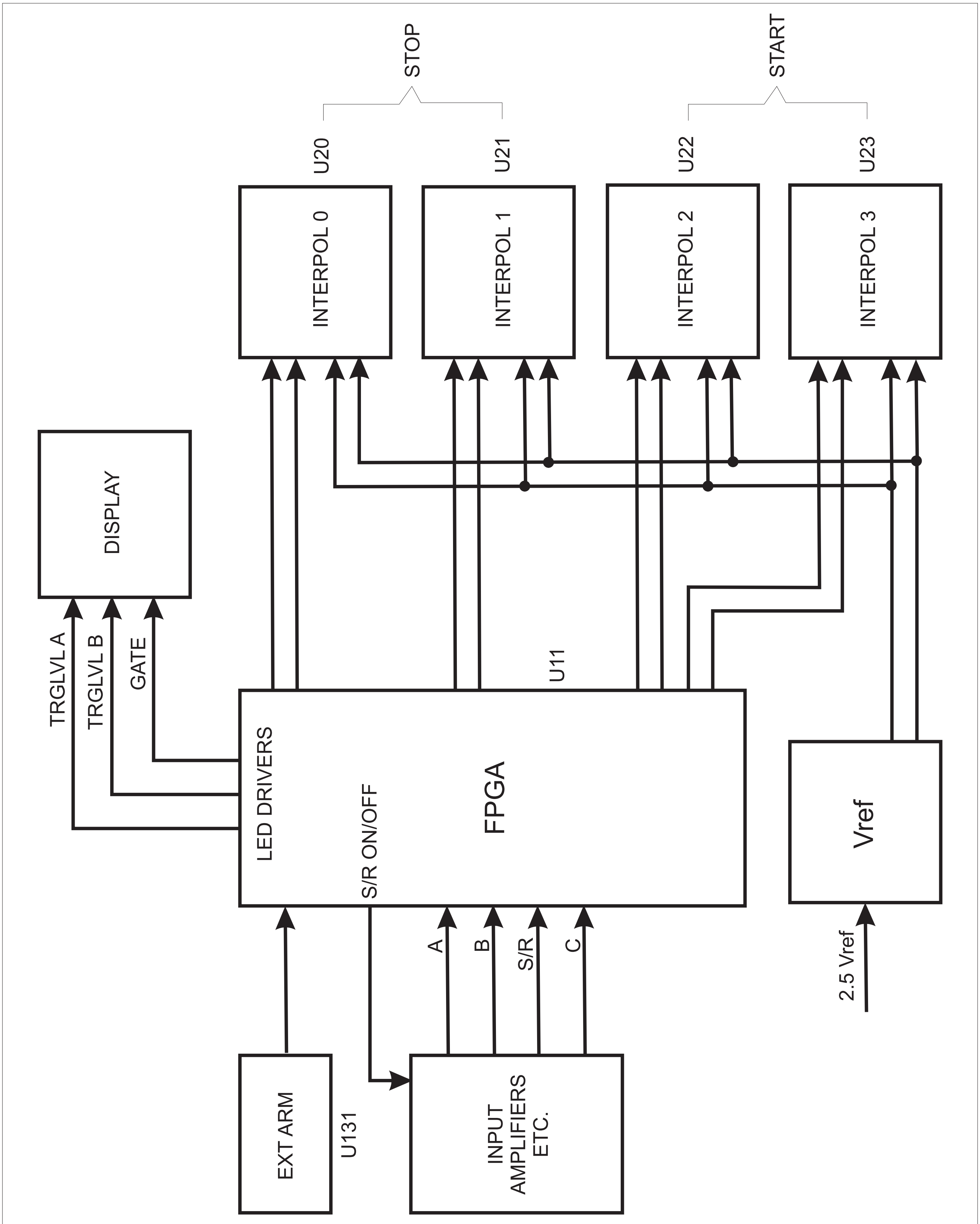

Figure 6-104 *Measuring logic, block diagram.*

Safety Inspection and Test After Repair

General Directives

After repair in the primary circuits, make sure that you have not reduced the creepage distances and clearances.

Before soldering, component pins must be bent on the solder side of the board. Replace insulating guards and plates.

Safety Components

Components in the primary circuits are important to the safety of the instrument and may only be replaced by components obtained from your local service organization.

Check the Protective Ground Connection

Visually check the correct connection and condition and measure the resistance between the protective lead at the plug and the cabinet. The resistance must not be more than 0.5 Ω. During measurement, the power cord should be moved. Any variations in resistance shows a defect.

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Chapter 7

Calibration Adjustments

Calibration

To maintain the performance of the timer/counter, we recommend that you calibrate the timebase of your instrument every year, or more often if you require greater timebase accuracy.

If your applications utilize the voltage measurement capabilities of this counter series, you should also calibrate the voltage ranges with a good calibrator.

Calibration should be performed with traceable references and instruments at a certified calibration laboratory. Contact your local service center for information on calibration facilities in your neighborhood.

As both timebase and voltage calibration are closed-case menu-controlled procedures that require no manual adjustments on the DUT, you can perform the task on your own without infringing the safety regulations, provided you possess the required skill and have access to the necessary calibration equipment.

To know the present status of your instrument, test your counter from time to time. The test can be made according to the information in Chapter 2, "Performance Check."

General Principles

The inherent meaning of calibration is to measure and record the deviation of a parameter from a known reference. Data from subsequent calibrations under similar ambient conditions form the calibration history, from which you can draw conclusions regarding aging characteristics.

Consequently calibration does not necessarily include the next natural step in the procedure, i.e. adjustment in order to make the instrument meet the original specifications.

The calibration procedure for these instruments also implies automatic adjustment, so if you want a continuous history record, you should follow the simple rules of thumb below that summarize the basics of all calibration, frequency as well as voltage.

- Place the instrument in its calibration environment, preferably at an ambient temperature of +23 ± 2 °C and power it up.
- Let the instrument assume its final internal operating temperature. Allow at least a warm-up period of two hours before proceeding.
- Measure the deviation and record the value. Use a reference source whose uncertainty is at least an order of magnitude less than that of the DUT.

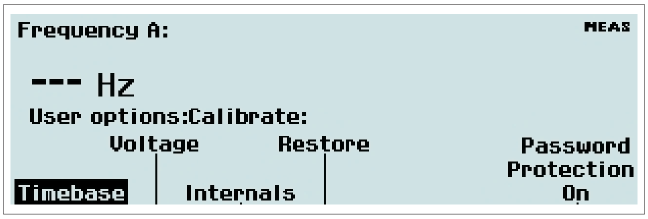
Model	90	90	90
Option Timebase type	Standard UCXO	PM6690/_5_ OCXO	PM6690/_6_ OCXO
Total uncertainty, for operating temperature 0°C to 50°C, @ 2σ (95 %) confidence interval:			
-1 month after calibration	$<1.2 \times 10^{-5}$	$<2 \times 10^{-8}$	$<0.7 \times 10^{-8}$
-3 months after calibration	$<1.2 \times 10^{-5}$	$<4 \times 10^{-8}$	$<1.2 \times 10^{-8}$
-1 year after calibration	$<1.2 \times 10^{-5}$	$<6 \times 10^{-8}$	$<1.8 \times 10^{-8}$
-2 years after calibration	$<1.5 \times 10^{-5}$	$<1.2 \times 10^{-7}$	$<3.6 \times 10^{-8}$
Typical total uncertainty, for operating temperature 20°C to 26°C, @ 2σ (95 %) confidence interval:			
-1 month after calibration	$<4 \times 10^{-6}$	$<2 \times 10^{-8}$	$<0.7 \times 10^{-8}$
-3 months after calibration	$<4 \times 10^{-6}$	$<4 \times 10^{-8}$	$<1.2 \times 10^{-8}$
-1 year after calibration	$<7 \times 10^{-6}$	$<6 \times 10^{-8}$	$<1.7 \times 10^{-8}$
-2 years after calibration	$<1.2 \times 10^{-5}$	$<1.2 \times 10^{-7}$	$<3.5 \times 10^{-8}$

For complete specifications see Chapter 8 of the Operators Manual.

Table 7-1 *Suitable calibration intervals depend on the total uncertainty of different timebase options and the requirements of your application.*

- Start the calibration & adjustment procedure and follow the instructions.
- Measure the deviation and record the value.
- Check that the parameter meets its specification.

The Calibration Submenu



When used for the first time, this submenu can be activated from the **USER OPT** menu after first entering the fixed password 62951413. All calibrations that can be performed manually are controlled from here. Internal delays can be compensated for as well as aging of the timebase and voltage references. All calibration procedures are performed without having to remove the instrument cover. In this way it is easier to keep the calibration environment as close to the operating environment as possible. No special tools are necessary, and live parts are not exposed to the operator, who is guided through the procedures by instructions on the instrument display. The whole concept is known as *Closed-Case Calibration*.

NOTE: The timer/counter must have been switched on for at least one hour before you start any calibration.

When the instrument leaves the factory, the calibration data is stored as *factory calibration* that cannot be changed by the user.

There is one active set of calibration data. It can be a user set or the factory set. If a user set is active and a new user calibration procedure is initiated, then the older set of data is stored to make it possible to return to the earlier calibration status.

Password Protection ON/OFF

The default setting on delivery for the password protection is **ON** but can be changed to **OFF** after the first-time use if so desired. Activate or deactivate the password with this key.

Internals

Certain internal delays are measured in order to correct the results of real measurements. This is done without applying external signals. This procedure needs only be run after firmware upgrading, or if repair work has been done on the measuring logic or the analog interpolators.

Press **Start Calib** to run the procedure. The new calibration will be the active calibration.

■ Calibration via the GPIB or the USB

The calibration can also be performed by sending commands over one of the interface buses.

Always end the commands with the *Operation Complete Query* ∗OPC?

Use the following command sequence:

:CAL:DEL:INIT;∗OPC?
:CAL:DEL:START;∗OPC?
:SYST:ERR? -- check for errors --
:CAL:DEL:STOR

Timebase

A reference frequency with adequate accuracy must be connected to Channel A. Timebase calibration should be performed regularly at intervals that depend on the timebase itself and the user application. Read more about the procedure under *Frequency Reference* below.

Voltage

A sequence of voltage levels from a dedicated calibrator must be applied to Channel A and Channel B. Voltage calibration should be performed regularly if the user application calls for traceable voltage measurements. Read more about the procedure under *Voltage Reference* below.

Restore

You can make a stored set of calibration data, either a user set or the factory set, the active calibration. If the previous active calibration was a new user calibration, then it will be lost.

Frequency Reference

The frequency of the reference crystal oscillator is the main parameter that influences the accuracy of a counter. External conditions, such as ambient temperature and supply voltage, affect the frequency, but aging is also an important factor. Note that frequency adjustment only compensates for deviation due to aging.

Some important points

The two optional high-stability oscillators, type OCXO, have been built into an oven to keep the oscillator temperature as stable as possible. Continuous operation is also important for optimum stability. Option PM6690/_6_, for example, has an aging/24h that is 1×10^{-10} when operating continuously. After a power interruption, the oscillator drift is higher and the specification of 1x10^{-10} per 24h is reached only after 48h of continuous operation.

– The frequency uncertainty for standard oscillators is mainly dependent on the ambient temperature. Variations in ambient temperature between 0 °C and +50 °C may cause a frequency change of up to 100 Hz, whereas the aging per month is only 5 Hz. During warm-up the temperature increase inside the counter will affect the oscillator for about two hours.

■ How often should you calibrate?

In the table on the preceding page you can see the uncertainty of your time base oscillator for various MTBRC (Mean Time Between Recalibration) intervals.

Compare the requirements of your application with the values in the table, and select the proper MTBRC accordingly.

Please note that the frequency uncertainty when operating in a temperature controlled environment is different from field use. See the two sections in the table.

☞ *When adjusted, keep in mind that the reference crystal oscillator will be compensated only for frequency deviation caused by aging.*

Timebase Calibration Procedure

■ Test Equipment

The instrumentation outlined here is an example of equipment meeting the minimum requirements for calibrating the different timebase options. You are free to choose other equipment as long as its performance is adequate for the purpose.

A suitable reference oscillator can be derived from a number of sources, the specifications of which determine the type of DUT timebase option that can be calibrated.

The table suggests a number of possible combinations. Remember this rule of thumb: the reference should be at least five times better than the DUT for a reliable calibration result.

DUT Option	Reference Oscillator
Standard	PM6690/_5_
PM6690/_5_	909
PM6690/_6_	909

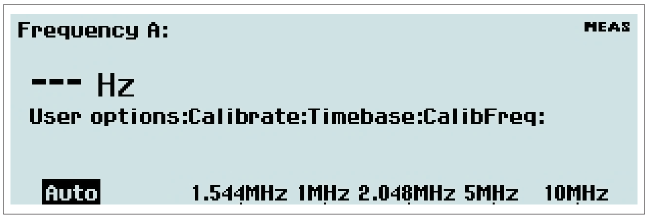
Table 7-2 *Reference Oscillator requirements.*

■ Work Instructions

– Determine the minimum requirements of the reference oscillator and make a signal meeting these requirements available at your test site.

NOTE: You can use a number of different calibration frequencies for the DUT: 1 MHz, 1.544 MHz, 2.048 MHz, 5 MHz and 10 MHz.

– Place the DUT in its calibration environment, preferably at an ambient temperature of +23 ± 2 °C and power it up.



– Recall the default settings by keying in the following sequence:
USER OPT→ Save/Recall →
Recall Setup → Default

– Let the DUT assume its final internal operating temperature. Allow at least a warm-up period of two hours before proceeding.

– Connect the reference oscillator signal to Input A on the DUT.

– Select 10 s measuring time (under **SETTINGS**) and measure the frequency.

NOTE: Use a measuring time that is long enough to meet the required resolution (see Table 7-1) or use statistics to find the mean value of multiple measurements.

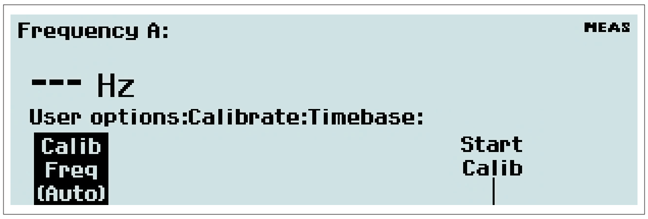
– Calculate the relative deviation of the internal timebase as $\Delta_{rel} = -(f_{meas} - f_{ref})/f_{ref}$.

– Translate this value to an absolute deviation Δ_{abs} of the internal 10 MHz timebase by using the expression:
$\Delta_{abs} = \Delta_{rel} \times 10^7$ (Hz)

– Note this value as the calibration state before adjustment, and decide if an adjustment is necessary according to the applicable criteria.

– Stop here if an adjustment is not necessary. Otherwise go on.

– Go to the *Calibration Submenu* and select **Timebase**.



– Press **Calib Freq** and select one of the possible frequencies, or let the counter decide on its own by accepting the preselected **Auto** setting.

– Start the calibration procedure by pressing **Start Calib** and follow the instructions on the display.

– You must enter a date at the end of the procedure in order to make the result the active user calibration.

– Measure the external reference frequency once more, and calculate the deviation of the internal timebase in the same way as before the adjustment. Note this value as the calibration state after adjustment.

– Compare the two deviation values, and check that the calibration procedure has been successful.

– Fill out the calibration protocol if required.

■ Timebase Calibration via the GPIB or the USB

The frequency calibration can also be performed by sending commands over one of the interface buses.

Always end the commands with the *Operation Complete Query* ∗OPC?

Use the following command sequence:

:CAL:ROSC:INIT; ∗OPC?
:CAL:ROSC:FREQ <num. value>; ∗OPC? -- select and connect reference frequency --
:CAL:ROSC:START; ∗OPC?
:SYST:ERR? -- check for errors --
:CAL:ROSC:STOR yyyymmdd --enter calibration date --

Voltage Reference

Although a counter/timer is chiefly an instrument for measuring time and frequency related parameters, this instrument also has voltage measurement capabilities that you can benefit from. Under certain circumstances you can do without a DVM in a test system, but then you have to calibrate and adjust the built-in voltage reference regularly to ensure the specified uncertainty.

Voltage Calibration Procedure

■ Test Equipment

You should preferably use a dedicated DC voltage calibrator with an uncertainty at least a magnitude less than the measurement specification (see Chapter 8 of the Operators Manual).

Alternatively you can use a stable laboratory power supply with an external precision voltage divider, for instance a ten-turn potentiometer, in combination with an adequately accurate DVM for verification.

Note: In contrast to a DVM the counter/timer has a wide-bandwidth input, and the voltage calculation principle is based on peak-to-peak measurements rather than mean value or RMS measurements. This means that HF noise that is often present at the output of standard calibrators and power supplies must be filtered out when the test voltages are applied to the counter input. Always use shielded test leads that are as short as possible.

■ Work Instructions

– Arrange your test setup according to the outline given above.

  Note: Both Input A and Input B should be calibrated. If you want a traceability record you should apply a number of positive and negative DC voltages covering the dynamic range and write down the deviations. Use the following list:
  +50 V, +20 V, +5 V, +2 V, +0.5 V, 0 V, -0.5 V, -2 V, -5 V, -20 V, -50 V
– Key in the following sequence on the DUT.
  USER OPT → **Calibrate** → (Enter Password if enabled) → **Voltage** → **Start Calib**
– Follow the step-by-step instructions on the display.
– You must enter a date at the end of the procedure in order to make the result the active user calibration.
– If you want a traceability record, verify the calibration/adjustment procedure by applying the same list of voltages as above and write down the deviations.
– Fill out the calibration protocol if required.

■ Voltage Calibration via the GPIB or the USB

The following DC voltages should be applied to the timer/counter in this order: +50, +20, +5, +2, +0.5, 0, -0.5, -2, -5, -20, -50 V, first to Input A(1) and then to Input B(2).

If you cannot generate the exact voltage, a voltage in the vicinity of the required voltage can be used, but the value must be sent in the bus command; two values between +50 and +5 V, seven values between +5 V and -5 V, and two values between -5 V and -50 V. One value should be near zero.

Always end the commands with the *Operation Complete Query* ∗OPC?

Use the following command sequence, and apply the correct DC voltage to the specified input before each command:

:CAL:VOLT:INIT;∗OPC?
:CAL:VOLT:INP1:VAL 50.0000;∗OPC?
:CAL:VOLT:INP2:VAL 50.0000;∗OPC?
:CAL:VOLT:INP1:VAL 20.0000;∗OPC?
:CAL:VOLT:INP2:VAL 20.0000;∗OPC?
∗
∗
:CAL:VOLT:INP1:VAL -50.0000;∗OPC?
:CAL:VOLT:INP2:VAL -50.0000;∗OPC?
:SYST:ERR? -- check for errors --
:CAL:VOLT:STOR yyyymmdd -- enter calibration date --

Calibration Subsystem Command Reference

```
:CALibration
    DELays
            :INITialize
            :STARt
            :STORe
    :ROSCillator
            :FREQuency          ␣  <Numeric Value>
                        :AUTO␣  <Boolean>
            :INITialize
            :LOAD
                        :FACTory
                        :USER
            :STARt
            :STORe              ␣  <YYYYMMDD>
    :VOLTage
            :INITialize
            :INPut1
                        :VAL    ␣  <Numeric Value>
            :INPut2
                        :VAL    ␣  <Numeric Value>
            :LOAD
                        :FACTory
                        :USER
            :STORe              ␣  <YYYYMMDD>
```

:CALibration :DELays :INITialize

Calibration of Internal Delays

Initializes the calibration process.

:CALibration :DELays :STARt

Calibration of Internal Delays

Starts the calibration process.

:CALibration :DELays :STORe

Calibration of Internal Delays

Ends the calibration process and stores the calibration factors.

:CALibration :ROSCillator :FREQuency ␣<Numeric value>

Calibration of Reference Oscillator

Selects the reference frequency used for the timebase calibration. AUTO is automatically set to OFF.

Parameters:

<Numeric value> = (1E+6 | 1.544E+6 |2.048E+6 | 5E+6 | 10E+6)

Returned format: <Numeric value>↵

***RST condition:** Not affecting this setting

:CALibration :ROSCillator :FREQuency :AUTO
⎵<Boolean>

Calibration of Reference Oscillator

Switches the AUTO mode ON/OFF for the reference frequency calibration. If ON, the timer/counter measures the applied reference frequency before the start of the calibration process and adjusts the calculation algorithm accordingly.

Parameters:

<Boolean> = (1 | ON / 0 | OFF)

Returned format: 1 | 0 ↲

***RST condition:** Not affecting this setting

:CALibration :ROSCillator :INITialize

Calibration of Reference Oscillator

Initializes the calibration process.

:CALibration :ROSCillator :LOAD :FACTory

Restore Factory Calibration

Recalls the calibration factors stored by the factory before delivery or after service.

:CALibration :ROSCillator :LOAD :USER

Restore User Calibration

Recalls the calibration factors last stored by the user.

:CALibration :ROSCillator :STARt

Start Calibration

Starts the calibration process after an external reference source has been connected to Input A.

:CALibration :ROSCillator :STORe

␣<YYYYMMDD>

Store User Calibration

Ends the calibration process and stores the calibration factors using the date code YYYYMMDD, that is year (4 digits), month (2 digits), and day (2 digits).

Example:

SEND→ `:CAL:ROSC:STOR 20040731`

:CALibration :VOLTage :INITialize

Calibration of Reference Voltage

Initializes the voltage calibration process.

:CALibration :VOLTage :INPut«[1]|2» :VAL

␣<Numeric Value>

DC Voltage Calibration

Calibrates a DC voltage within the range -50 V - +50 V if the corresponding voltage from a voltage reference source is applied to the input that is addressed in the command.

Example for Input A (1):

SEND→ `:CAL:VOLT:INP:VAL 5`

+5 V is applied to input A before sending the command.

Example for Input B (2):

SEND→ `CAL:VOLT:INP2:VAL -20`

-20 V is applied to input B before sending the command.

Note: The DC voltages must be sent in a prescribed order. See page 7-5.

:CALibration :VOLTage :LOAD :FACTory

Restore Factory Calibration

Recalls the calibration factors stored by the factory before delivery or after service.

:CALibration :VOLTage :LOAD :USER

Restore User Calibration

Recalls the calibration factors last stored by the user.

:CALibration :VOLTage :STORe

␣<YYYYMMDD>

Store User Calibration

Ends the calibration process and stores the calibration factors using the date code YYYYMMDD, that is year (4 digits), month (2 digits), and day (2 digits).

Example:

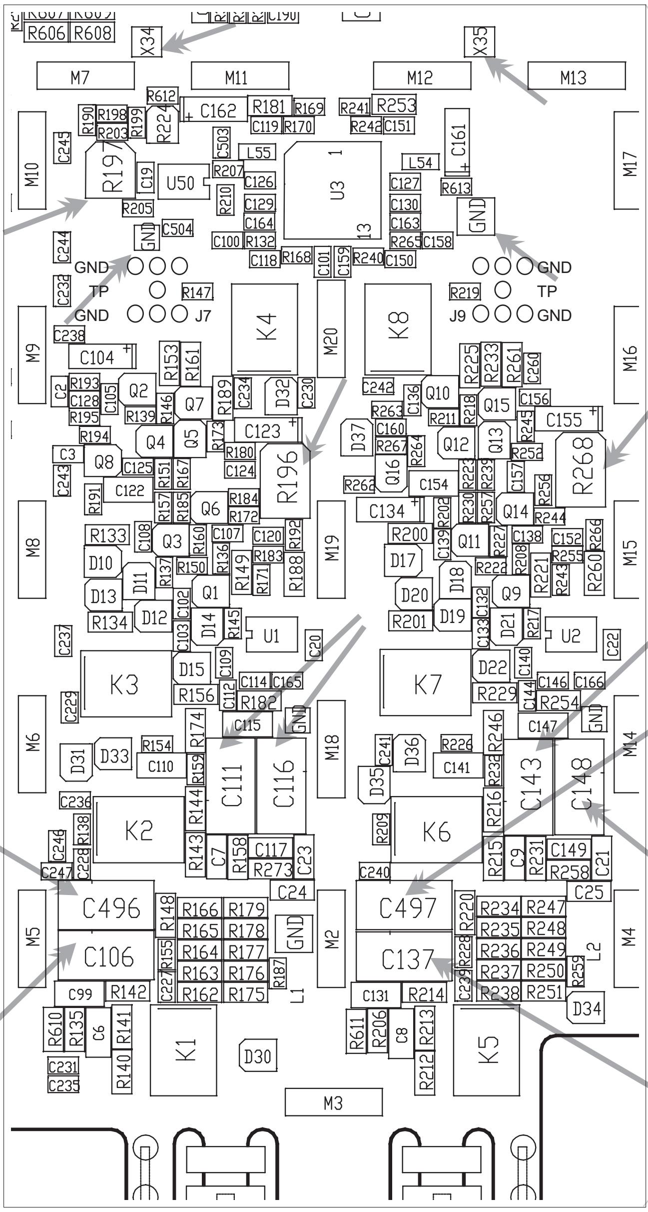
SEND→ `:CAL:VOLT:STOR 20040731`

Adjustments

Preparations

Before beginning the adjustments, power up the instrument after removing the cover (see Chapter 3) and leave it on for at least 60 minutes to let it reach normal operating temperature.

> **WARNING: Live parts and accessible terminals which can be dangerous to life are always exposed inside the unit when it is connected to the line power. Use extreme caution when handling, testing or adjusting the timer/counter.**



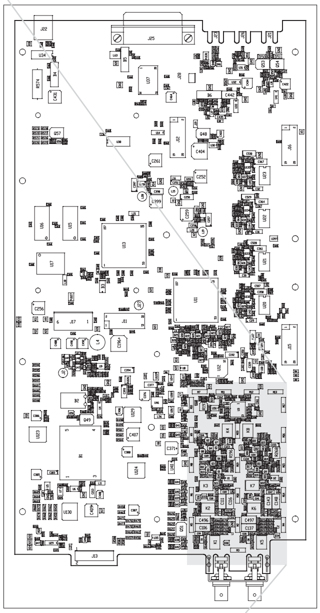


Figure 7-2 *Test points and trimmers for the input amplifiers.*

Input Amplifiers

Check the power supply voltages according to the instructions on page 7-13 before proceeding to the next step.

All adjustments on the input amplifiers must be made in the specified order.

The input amplifiers are enclosed in an RF shield consisting of a metal lid that is soldered to two of the shield clips on the main circuit board. Without these solder joints there is a risk of the lid coming off, should the instrument be subjected to heavy bumps.

There are two alternative ways to adjust the input amplifiers. One is to remove the shield to gain access to all trimmers and test points on the top side of the main circuit board. Don't forget to put the shield back and restore the solder joints. The other way is to access the trimmers via the holes in the shield lid and to use the test points on the bottom side of the main circuit board. Place the instrument on end to get access to both sides of the main circuit board.

Step Response X1

■ Setup

- Do as described under *Preparations* above.
- Select default settings by keying in **USER OPT → Save/Recall → Recall Setup → Default**
- Select for Input A of the timer/counter: Manual Trig, DC, 50 Ω, Att x1. Select *Single Period* as measurement function.
- Connect a symmetrical pulse signal with fast rise/fall time, 100 µs period time and 5 V amplitude from a pulse generator to a power splitter.
- Connect one side of the power splitter to Input A on the timer/counter and connect the other side of the power splitter to Input A on the oscilloscope.
- Connect a 10X 500 Ω probe to Input B on the oscilloscope.
- Set the oscilloscope to 10 µs/div and Input A to 50 Ω, DC, 0.5 V/div and Input B to 50 Ω, DC, 100 mV/div (including probe).

■ Adjustment

- Connect the probe tip to the center hole of J7. The surrounding holes are suitable ground connections. See Figure 7-2.
- Adjust C106 and C496 until the pulses on the oscilloscope look the same. Use Temex 4192 adjustment tool.

Repeat all steps above for Input B on the timer/counter. Connect the probe tip to J9. Adjust C137 and C497.

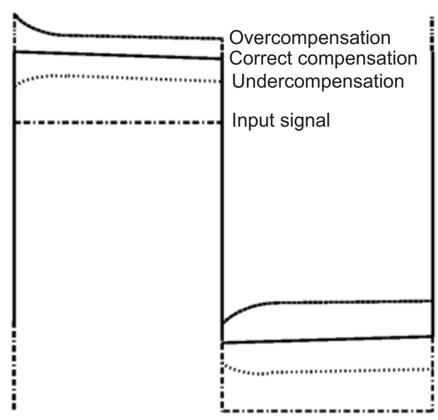


Figure 7-3 Linearity compensation.

Step Response X10

■ Setup

- Keep the settings on the timer/counter and the oscilloscope from *Step Response X1*.
- Select *Att X10* for Input A on the timer/counter.
- Reconnect the signal from the power splitter to Input A on the timer/counter.
- Set Input B on the oscilloscope to 20 mV/div (including probe).

■ Adjustment

- Connect the probe tip to the center hole of J7. The surrounding holes are suitable ground connections. See Figure 7-2.
- Adjust C111 and C116 until the pulses on the oscilloscope look the same. Use a screwdriver type of adjustment tool.

Repeat all steps above for Input B on the timer/counter. Connect the probe tip to J9. Adjust C143 and C148.

Linearity

■ Setup

- Keep the settings on the timer/counter and the oscilloscope from *Step Response X10*.
- Select *Att X1* for Input A on the timer/counter.
- Change the period time of the pulse signal from the pulse generator to 2 ms.
- Reconnect the signal from the power splitter to Input A on the timer/counter.
- Set the oscilloscope to 200 µs/div and Input B to 100 mV/div (including probe).

■ Adjustment

– Connect the probe tip to the center hole of J7.The surrounding holes are suitable ground connections. See Figure 7-2.

– Adjust R196 until the pulses on the oscilloscope look the same. See Figure 7-3. Use a screwdriver type of adjustment tool.

– Check *Step Response X1*, repeat *Step Response X1* and *Linearity* several times if necessary.

Repeat all steps above for Input B on the timer/counter. Connect the probe tip to J9. Adjust R268.

Sensitivity

■ Setup

– Keep the settings on the counter from *Linearity*.

■ Adjustment

– Connect the DMM to the test points X34 (+) and X35 (-). See Figure 7-2.

– Adjust R197 until the DMM reads +17 ± 0.2 mV. Use a screwdriver type of adjustment tool.

Don't forget to resolder the RF shield.

Power Supply

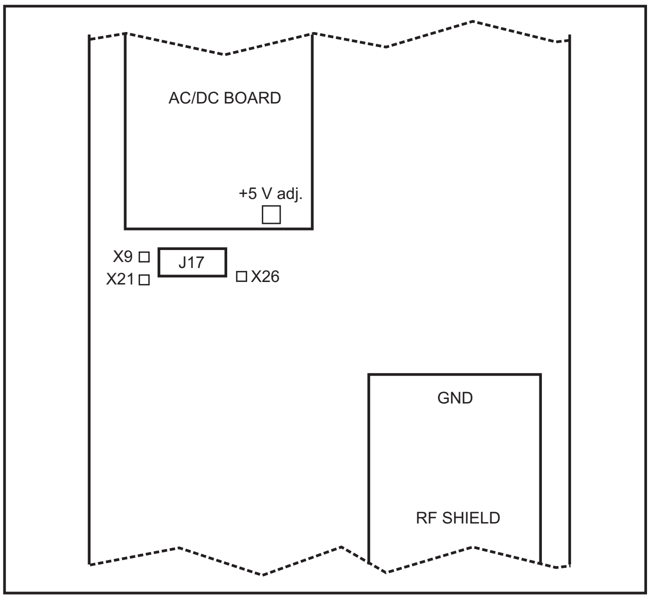


Figure 7-4 *Adjusting +5 V and checking +15 V and -15 V.*

■ Setup

– Do as described under *Preparations* above.

– Select default settings by keying in **USER OPT** → **Save/Recall** → **Recall Setup** → **Default**

■ Adjustment

– Connect the DMM to test point X9 and ground (metal shield lid over input amplifiers). See Figure 6-4 and Figure 7-4.

– Adjust the +5 V trimmer on the AC/DC power supply board with a screwdriver type of adjustment tool until the DMM reads +5.10 ± 0.005 V.

– Check that the voltage from the AC/DC power supply at X26 is +15 ± 0.7 V.

– Check that the voltage from the AC/DC power supply at X21 is -15 ± 0.7 V.

Note: Adjusting the +5 V does not affect other settings in the instrument.

External Reference Input

■ Setup

– Do as described under *Preparations* above.

– Select default settings by keying in **USER OPT** → **Save/Recall** → **Recall Setup** → **Default**

– Connect a 1 MHz sinewave signal with amplitude 0.1 V_{rms} (0.28 V_{pp}) into 50 Ω from an LF synthesizer to the external reference input. Use a 50 Ω termination on the input.

– Set an oscilloscope with X10 probe to 10 µs/div, 100 mV/div (including probe) and AC coupling.

■ Adjustment

– Connect the probe to X19. There are two ground pads in the vicinity. See Figure 7-5.

– Adjust C442 to maximum amplitude. Use a screwdriver type of adjustment tool.

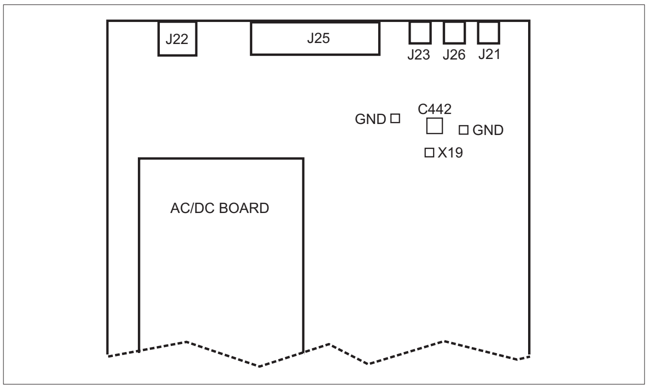


Figure 7-5 *Adjusting the external reference input.*

Internal Reference Oscillators

Adjustment of the different timebase oscillators is described under *Calibration* earlier in this chapter.

RF Input 3 GHz

Note: The 8 GHz prescaler can not be adjusted.

■ Setup

– Do as described under *Preparations* above.

– Select default settings by keying in **USER OPT** → **Save/Recall** → **Recall Setup** → **Default**

– Select measurement function FREQUENCY C.

– Set the signal generator to 1000 ± 25 MHz with amplitude 5.9 ± 0.5 mV_{rms} (-31.5 ± 0.5 dBm)

■ Adjustment

– Connect the signal to Input C on the timer/counter.

NOTE: Before beginning any adjustments, the RF input must have been in operation for at least a few minutes to let it reach normal operating temperature.

– Turn the potentiometer on the prescaler board fully counterclockwise. See Figure 7-6.

– Check that the timer/counter stops measuring.

– Turn the potentiometer slowly clockwise until the timer/counter starts measuring.

– Check the display of the timer/counter, it shall show 1000 ± 25 MHz.

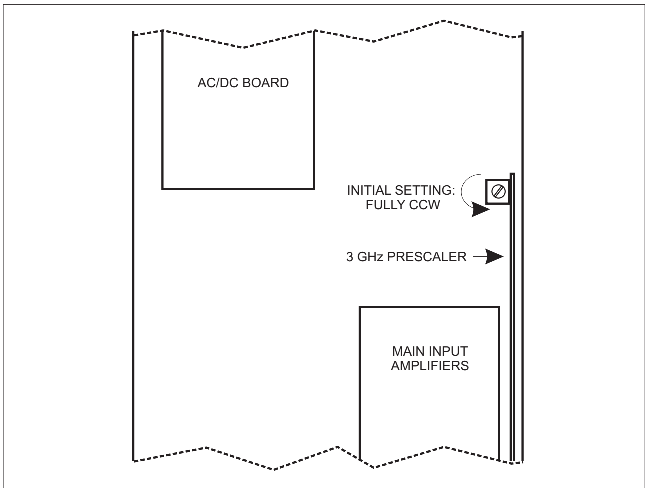


Figure 7-6 *Adjusting the 3 GHz RF prescaler.*

Chapter 8

Replacement Parts

Introduction

Note: There are two variants of the main PCB, Version A and Version B. Refer to page III for closer information.

Standard Parts

Electrical and mechanical replacement parts can be obtained through your local service organization or representative. However, many of the standard components can be obtained from other local suppliers. Before purchasing or ordering replacements parts, check the parts list for value, tolerance, rating, and description.

If the value of the physical component differs from what is described in the parts list, you should always replace the part with the same value as originally mounted.

NOTE: Physical size and shape of a component may affect the performance of the instrument, particularly at high frequencies. Always use direct replacements unless it is known that a substitute will not degrade the performance of the instrument.

Special Parts

In addition to standard electronic components, the following special components are used:

– Components that are manufactured or selected by Fluke to meet specific performance requirements.

– Components that are important for the safety of the instrument.

Both types of components may be replaced only by components obtained through your local service organization.

Timebase reference oscillators, except those based on standard crystals, cannot be repaired in the field but are replaced by means of a factory exchange procedure. The same repair method applies to the prescaler options.

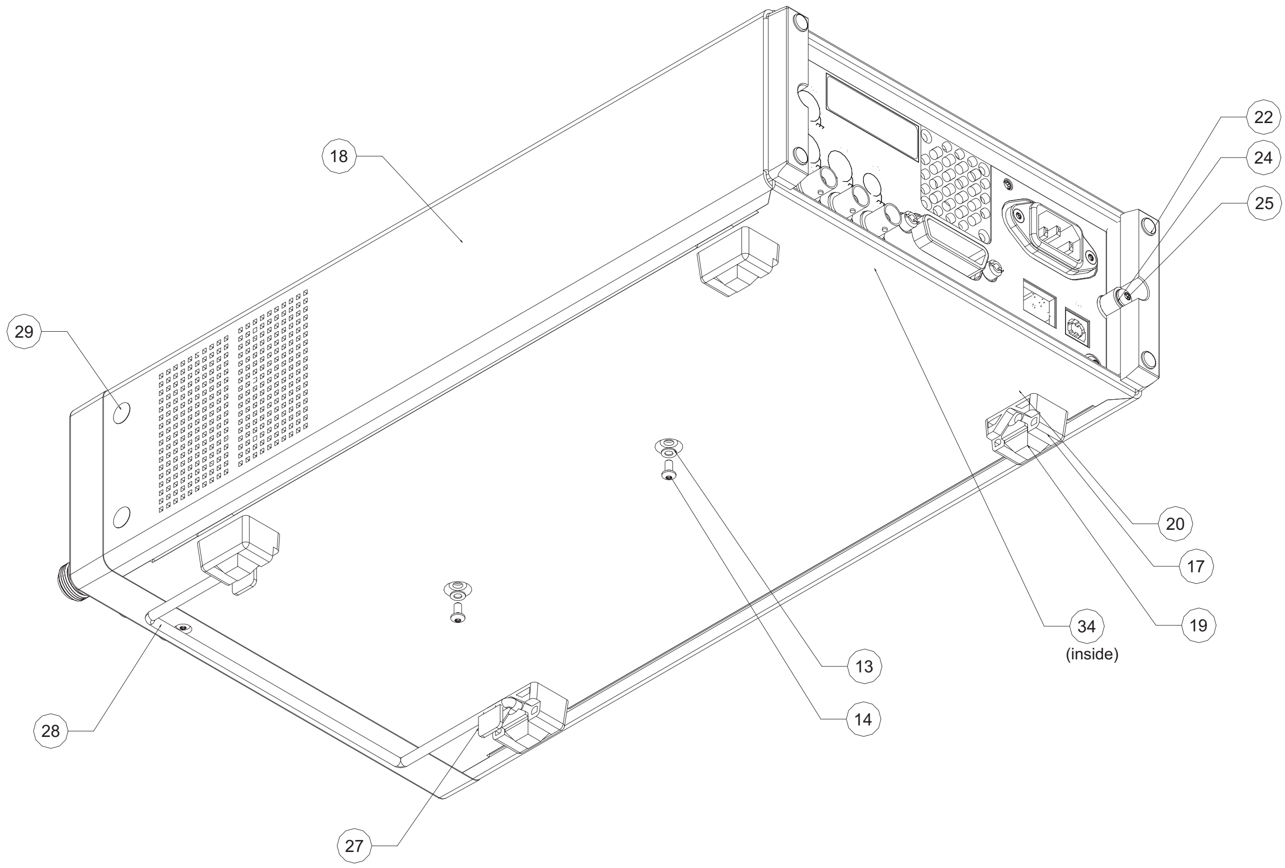


Figure 8-1 *Case.*

Mechanical Parts

Item	Figure	Description	Part number
13	8-1	Washer 3,2 ST FZ	252261024004
14	8-1	Screw MRT 3x6	482250211658
17, 19, 20, 27	8-1	Case feet, complete kit	403110066480
18	8-1	Cover assembly	403110066440
22	8-1	Rear foot	532246241719
24	8-1	Spring washer M4 KBA 4.3	252261024006
25	8-1	Screw MRT 4x16	532250221491
28	8-1	Stand-up bracket	403110048770
29	8-1	Plug grey decorative M5	403110502860
34	8-1	Shielding strip	403110055450
3	8-2	Profile support	403110053200
4	8-2	Main board	403110066470
5	8-2	Shield main board	403110065990
6	8-2	Toroid core	532252610545
9	8-2	Washer 4x10x2 PA6-6	403110049600
10	8-2	Screw RTK ST3.5x10	252220207024
12	8-2	Distance nut M3x12	403110059470
13	8-2	Washer 3,2 ST FZ	252261024004
14	8-2	Screw MRT 3x6	482250211658
15	8-2	Screw MFT-TT 4x12	532250213553
16	8-2	Power Module	403110066170
21	8-2	Screw MRT-TT 4x16	532250213552
23	8-2	Cable assembly, power supply	403110066150
30	8-2	Distance nut M3x14	403110048880
33	8-2	Shield, power supply	403110066430
35	8-2	Screw M3x12	532250221642
36	8-2	Profile support	403110053210
37	8-2	Warning label, high voltage	403111645530
38	8-2	Shielding strip USB	403110055470
61	8-2	Connector BNC	532226710004

Item	Figure	Description	Part number
65	8-2	Solder lug	403110058390
70	8-2	Holder BNC	403110065870
1	8-3	Rear plate 90-ser	403110065890
2	8-3	Rear overlay 90-ser	403110066080
3	8-3	Connector BNC	532226710004
4	8-3	Screw MFT-TT 3x8	482250211713
5	8-3	Screw MFT 4x16	252220306037
6	8-3	Solder lug	403110058390
8	8-3	Lock washer AZ4.3 ST FZ	252262027007
9	8-3	Spring washer M4 KBA4.3	482253080076
12	8-3	Nut M4	482250510825
13	8-3	Mains filter	403110066450
14	8-3	Fan 12VDC 40x40x15mm	403110502850
15	8-3	Screw MFX 3x22	403110503450
16	8-3	Washer 3,2 ST FZ	252261024004
17	8-3	Nut M3	482250510758
18	8-3	Grounding wire	403110066460
2	8-4	Display	403110065800
2	8-4	Keypad	403110065980
7	8-4	Front unit board, complete	403110066160
8	8-4	Front overlay PM6690	403110066060
13	8-4	Washer 3,2 ST FZ	252261024004
18	8-4	Cover assembly	403110066440
26	8-4	Screw MRT-TT 3x8	482250211691
32	8-4	Gasket, display	403110066120

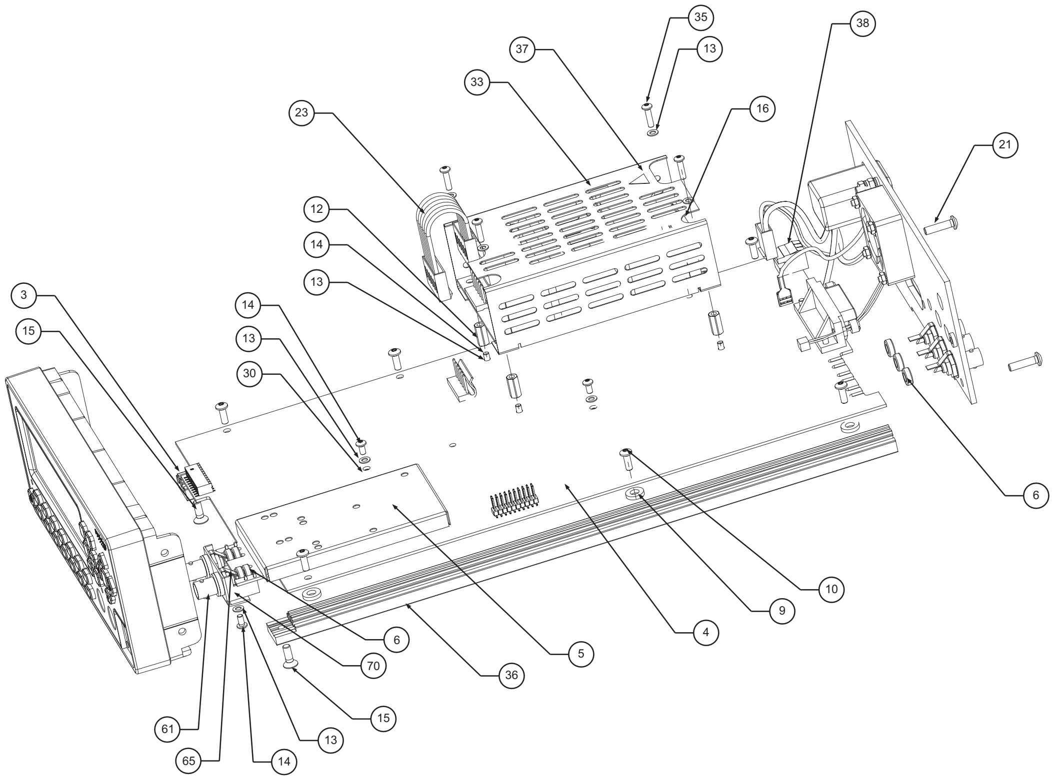


Figure 8-2 *Exploded view of chassis.*

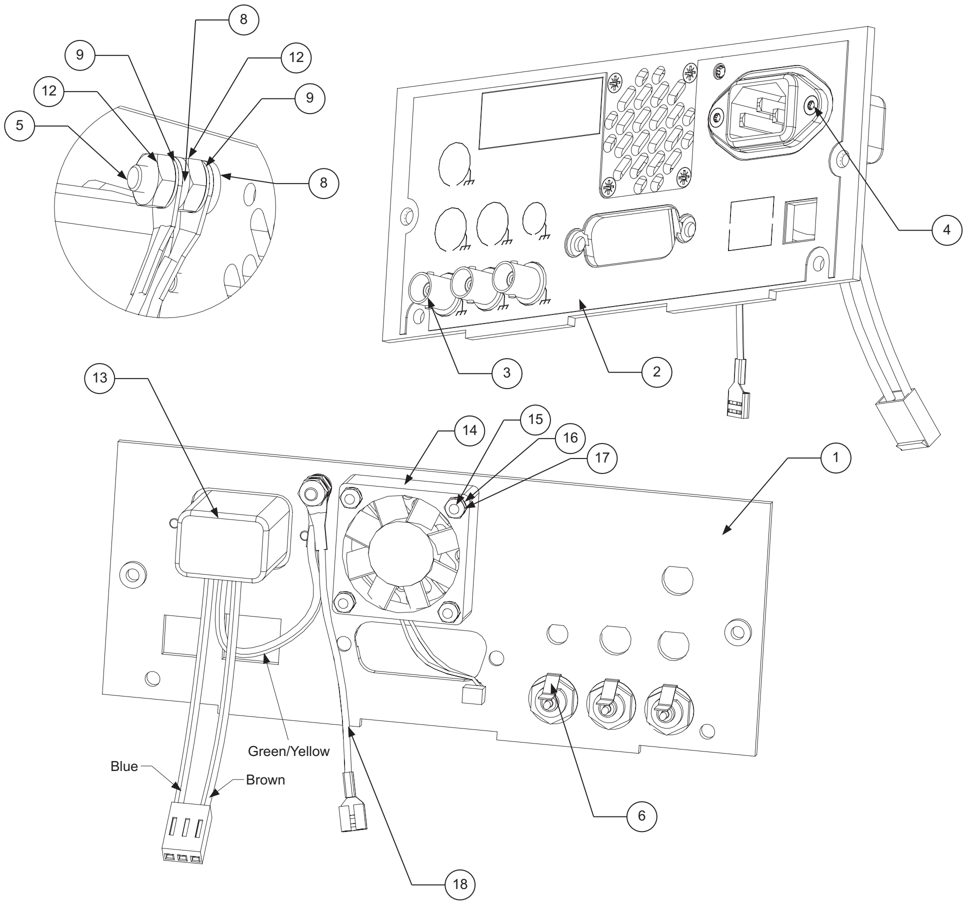


Figure 8-3 *Rear panel.*

Main Board, Version A

Pos	Description	Part Number
	Main board complete	403110066470
B1	OCXO (PM6690/_5_)	403110065330
B1	OCXO (PM6690/_6_)	403110065340
B3	CRYSTAL 32kHz MC-406	242254301419
B4	CRYSTAL 6MHz HC49/USM SMD	403110056520
B5	CRYSTAL 40MHz HC49/USM SMD	403110056540
B6	CRYSTAL 10MHz HC49/USM SMD	403110056530
C1	CAPACITOR 47pF 5% 50V NP0 0805	222286115479
C10	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C100	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C101	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C102	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C103	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C104	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C105	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C106	CAPACITOR TRIM 2.5-10pF 500VDC AT2320-2	202280000247
C107	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C108	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C109	CAPACITOR 47pF 5% 50V NP0 0805	222286115479
C110	CAPACITOR 22nF 10% 200V X7R 1206	532212614081
C111	CAPACITOR TRIM 3-10pF TZBX4Z100BB110	532212550306
C114	CAPACITOR 27pF 5% 50V NP0 0805	402230160221
C115	CAPACITOR 3.9pF ±0.25pF 500V NP0 1206	225201471398
C116	CAPACITOR TRIM 3-10pF TZBX4Z100BB110	532212550306
C117	CAPACITOR 3.9pF ±0.25pF 500V NP0 1206	225201471398
C118	CAPACITOR 39pF 5% 50V NP0 0805	222286115399
C119	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C12	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C120	CAPACITOR 220pF 5% 50V NP0 0805	402230160331
C122	CAPACITOR 22nF 10% 200V X7R 1206	532212614081
C123	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C124	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C125	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C126	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C127	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C128	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C129	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C13	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C130	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C131	CAPACITOR 3.9pF ±0.25pF 500V NP0 1206	225201471398
C132	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C133	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C134	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C136	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C137	CAPACITOR TRIM 2.5-10pF 500VDC AT2320-2	202280000247
C138	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C139	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C14	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C140	CAPACITOR 47pF 5% 50V NP0 0805	222286115479
C141	CAPACITOR 22nF 10% 200V X7R 1206	532212614081
C143	CAPACITOR TRIM 3-10pF TZBX4Z100BB110	532212550306
C146	CAPACITOR 27pF 5% 50V NP0 0805	402230160221
C147	CAPACITOR 3.9pF ±0.25pF 500V NP0 1206	225201471398
C148	CAPACITOR TRIM 3-10pF TZBX4Z100BB110	532212550306
C149	CAPACITOR 3.9pF ±0.25pF 500V NP0 1206	225201471398
C15	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C150	CAPACITOR 39pF 5% 50V NP0 0805	222286115399
C151	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C152	CAPACITOR 220pF 5% 50V NP0 0805	402230160331
C154	CAPACITOR 22nF 10% 200V X7R 1206	532212614081

Pos	Description	Part Number
C155	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C156	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C157	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C158	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C159	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C16	CAPACITOR 22pF 5% 50V NP0 0805	402230160211
C160	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C161	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C162	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C163	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C164	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C165	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C166	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C168	CAPACITOR 1nF 20% 50V X7R 0805	222286148102
C169	CAPACITOR 1nF 20% 50V X7R 0805	222286148102
C17	CAPACITOR 100pF 5% 50V NP0 0805	532212232531
C170	CAPACITOR 100pF 5% 50V NP0 0805	532212232531
C171	CAPACITOR 100pF 5% 50V NP0 0805	532212232531
C172	CAPACITOR 1nF 20% 50V X7R 0805	222286148102
C173	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C174	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C175	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C176	CAPACITOR 100pF 5% 50V NP0 0805	532212232531
C177	CAPACITOR 33pF 5% 50V NP0 0805	222286115339
C178	CAPACITOR 22pF 5% 50V NP0 0805	402230160211
C179	CAPACITOR 22pF 5% 50V NP0 0805	402230160211
C180	CAPACITOR 33pF 5% 50V NP0 0805	222286115339
C181	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C182	CAPACITOR 33pF 5% 50V NP0 0805	222286115339
C183	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C184	CAPACITOR 100pF 5% 50V NP0 0805	532212232531
C185	CAPACITOR 15pF 5% 50V NP0 0805	402230160191
C186	CAPACITOR 68pF 1% 50V NP0 0805	222286118689
C187	CAPACITOR 47pF 5% 50V NP0 0805	222286115479
C188	CAPACITOR 68pF 1% 50V NP0 0805	222286118689
C189	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C19	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C190	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C191	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C192	CAPACITOR 100µF 6.3V	202202900655
C193	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C194	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C195	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C197	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C2	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C20	CAPACITOR 27pF 5% 50V NP0 0805	402230160221
C201	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C202	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C203	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C204	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C205	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C206	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C207	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C208	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C209	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C21	CAPACITOR 3.9pF ±0.25pF 500V NP0 1206	225201471398
C210	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C211	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C212	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C213	CAPACITOR 6.80 µF 20% 16V 6.0X3.2 MOLD	532212410687

Pos	Description	Part Number
C214	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C215	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C216	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C217	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C218	CAPACITOR 10pF 5% 50V NP0 0805	222286115109
C219	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C22	CAPACITOR 27pF 5% 50V NP0 0805	402230160221
C220	CAPACITOR 10pF 5% 50V NP0 0805	222286115109
C221	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C222	CAPACITOR 10pF 5% 50V NP0 0805	222286115109
C223	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C224	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C225	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C226	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C227	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C228	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C229	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C23	CAPACITOR 3.9pF ±0.25pF 500V NP0 1206	225201471398
C230	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C231	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C232	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C235	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C236	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C237	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C238	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C239	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C24	CAPACITOR 10pF 5% 500V NP0 1206	532212613643
C240	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C241	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C242	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C243	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C244	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C245	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C246	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C247	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C248	CAPACITOR 27pF 5% 50V NP0 0805	402230160221
C249	CAPACITOR 27pF 5% 50V NP0 0805	402230160221
C25	CAPACITOR 10pF 5% 500V NP0 1206	532212613643
C250	CAPACITOR 100µF 6.3V	202202900655
C251	CAPACITOR 22µF 6.3V	202202900654
C252	CAPACITOR 220µF 20% 10V 0810 SMD	222215364221
C253	CAPACITOR 680pF 20% 63V NP0 1206	222286315681
C254	CAPACITOR 220pF 5% 50V NP0 0805	402230160331
C255	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C256	CAPACITOR 220µF 20% 10V 0810 SMD	222215364221
C257	CAPACITOR 100µF 6.3V	202202900655
C258	CAPACITOR 22µF 6.3V	202202900654
C259	CAPACITOR 220µF 20% 10V 0810 SMD	222215364221
C26	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C261	CAPACITOR 220µF 20% 10V 0810 SMD	222215364221
C262	CAPACITOR 680pF 20% 63V NP0 1206	222286315681
C263	CAPACITOR 220pF 5% 50V NP0 0805	402230160331
C264	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C265	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C266	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C267	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C268	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C269	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C270	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C271	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C272	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C273	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C274	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C275	CAPACITOR 100nF 20% 25V X7R 0805	532212613638

Pos	Description	Part Number
C276	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C278	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C279	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C28	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C280	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C281	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C282	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C283	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C284	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C285	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C286	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C287	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C288	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C289	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C29	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C290	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C291	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C292	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C293	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C294	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C295	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C296	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C297	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C298	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C299	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C3	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C30	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C300	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C301	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C302	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C303	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C304	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C305	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C306	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C307	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C308	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C309	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C31	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C310	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C311	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C312	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C313	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C314	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C315	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C316	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C317	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C318	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C319	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C32	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C320	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C321	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C322	CAPACITOR 100pF 5% 50V NP0 0805	532212232531
C323	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C324	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C326	CAPACITOR 68pF 1% 50V NP0 0805	222286118689
C327	CAPACITOR 100pF 5% 50V NP0 0805	532212232531
C328	CAPACITOR 100pF 5% 50V NP0 0805	532212232531
C329	CAPACITOR 100pF 5% 50V NP0 0805	532212232531
C330	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C331	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C332	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C333	CAPACITOR 68pF 1% 50V NP0 0805	222286118689
C335	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C337	CAPACITOR 10pF 5% 50V NP0 0805	222286115109

Pos	Description	Part Number
C338	CAPACITOR 100pF 5% 50V NP0 0805	532212232531
C339	CAPACITOR 15 µF 20%6.3V 6.0X3.2 MOLD	532212411418
C340	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C341	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C342	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C344	CAPACITOR 68pF 1% 50V NP0 0805	222286118689
C345	CAPACITOR 10pF 5% 50V NP0 0805	222286115109
C346	CAPACITOR 100pF 5% 50V NP0 0805	532212232531
C347	CAPACITOR 15 µF 20%6.3V 6.0X3.2 MOLD	532212411418
C348	CAPACITOR 100pF 5% 50V NP0 0805	532212232531
C349	CAPACITOR 100pF 5% 50V NP0 0805	532212232531
C350	CAPACITOR 1 µF 20% 16V 3.2X1.6 MOLD	403102151080
C351	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C352	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C353	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C355	CAPACITOR 68pF 1% 50V NP0 0805	222286118689
C357	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C358	CAPACITOR 15 µF 20%6.3V 6.0X3.2 MOLD	532212411418
C359	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C360	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C361	CAPACITOR 15 µF 20%6.3V 6.0X3.2 MOLD	532212411418
C362	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C363	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C364	CAPACITOR 15 µF 20%6.3V 6.0X3.2 MOLD	532212411418
C365	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C366	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C367	CAPACITOR 15 µF 20%6.3V 6.0X3.2 MOLD	532212411418
C368	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C369	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C370	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C371	CAPACITOR 220µF 20% 10V 0810 SMD	222215364221
C372	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C374	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C375	CAPACITOR 1nF 20% 50V X7R 0805	222286148102
C376	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C377	CAPACITOR 15 µF 20%6.3V 6.0X3.2 MOLD	532212411418
C378	CAPACITOR 1nF 20% 50V X7R 0805	222286148102
C380	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C381	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C382	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C383	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C385	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C386	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C387	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C388	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C389	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C393	CAPACITOR 100µF 6.3V	202202900655
C394	CAPACITOR 100µF 6.3V	202202900655
C395	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C396	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C397	CAPACITOR 100µF 6.3V	202202900655
C398	CAPACITOR 100µF 6.3V	202202900655
C399	CAPACITOR 220µF 20% 10V 0810 SMD	222215364221
C400	CAPACITOR 1nF 20% 50V X7R 0805	222286148102
C401	CAPACITOR 100pF 5% 50V NP0 0805	532212232531
C402	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C403	CAPACITOR 4.7µF 20% 35V 0405 SMD	222215360478
C404	CAPACITOR 220µF 20% 35V 1012 SMD	222215360221
C405	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C406	CAPACITOR 4.7µF 20% 35V 0405 SMD	222215360478
C407	CAPACITOR 220µF 20% 10V 0810 SMD	222215364221
C408	CAPACITOR 4.7µF 20% 35V 0405 SMD	222215360478
C409	CAPACITOR 220µF 20% 10V 0810 SMD	222215364221
C410	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C411	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C412	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C414	CAPACITOR 10pF 5% 50V NP0 0805	222286115109
C415	CAPACITOR 22pF 5% 50V NP0 0805	402230160211
C416	CAPACITOR 22pF 5% 50V NP0 0805	402230160211
C417	CAPACITOR 10pF 5% 50V NP0 0805	222286115109
C421	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C422	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C424	CAPACITOR 1nF 20% 50V X7R 0805	222286148102
C427	CAPACITOR 33pF 5% 50V NP0 0805	222286115339
C428	CAPACITOR 82pF 5% 50V NP0 0805	222286115829
C429	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C430	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C431	CAPACITOR 220µF 20% 10V 0810 SMD	222215364221
C432	CAPACITOR 33pF 5% 50V NP0 0805	222286115339
C433	CAPACITOR 22pF 5% 50V NP0 0805	402230160211
C434	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C435	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C436	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C437	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C438	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C439	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C440	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C441	CAPACITOR 10pF 5% 50V NP0 0805	222286115109
C442	CAPACITOR TRIM 3-10pF TZBX4Z100BB110	532212550306
C443	CAPACITOR 2.2pF±0.25pF 50V NP0 0805	402230160091
C444	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C445	CAPACITOR 15pF 5% 50V NP0 0805	402230160191
C446	CAPACITOR 15pF 5% 50V NP0 0805	402230160191
C447	CAPACITOR 33pF 5% 50V NP0 0805	222286115339
C448	CAPACITOR 33pF 5% 50V NP0 0805	222286115339
C449	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C450	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C451	CAPACITOR 100pF 5% 50V NP0 0805	532212232531
C452	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C453	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C462	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C463	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C464	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C465	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C466	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C467	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C468	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C469	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C470	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C471	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C472	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C473	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C474	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C475	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C476	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C477	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C478	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C479	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C480	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C481	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C483	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C484	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C486	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C487	CAPACITOR 22pF 5% 50V NP0 0805	402230160211
C488	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C489	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C490	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C491	CAPACITOR 100nF 20% 25V X7R 0805	532212613638

Pos	Description	Part Number
C492	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C493	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C494	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C496	CAPACITOR TRIM 2.5-10pF 500VDC AT2320-2	202280000247
C497	CAPACITOR TRIM 2.5-10pF 500VDC AT2320-2	202280000247
C498	CAPACITOR 22pF 5% 50V NP0 0805	402230160211
C5	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C503	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C504	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C507	CAPACITOR 6.80 µF 20% 16V 6.0X3.2 MOLD	532212410687
C522	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C523	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C524	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C525	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C526	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C527	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C528	CAPACITOR 6.80 µF 20% 16V 6.0X3.2 MOLD	532212410687
C529	CAPACITOR 6.80 µF 20% 16V 6.0X3.2 MOLD	532212410687
C530	CAPACITOR 6.80 µF 20% 16V 6.0X3.2 MOLD	532212410687
C531	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C532	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C533	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C534	CAPACITOR 10nF 20% 50V X7R 0805	222286148103
C6	CAPACITOR 1.5pF ±0.25pF 500V NP0 1206	225201471158
C7	CAPACITOR 1.5pF ±0.25pF 500V NP0 1206	225201471158
C8	CAPACITOR 1.5pF ±0.25pF 500V NP0 1206	225201471158
C9	CAPACITOR 1.5pF ±0.25pF 500V NP0 1206	225201471158
C99	CAPACITOR 3.9pF ±0.25pF 500V NP0 1206	225201471398
D10	DIODE 0.10A BAV99 SOT23	532213034337
D11	DIODE 0.10A BAV99 SOT23	532213034337
D12	DIODE 0.10A BAV99 SOT23	532213034337
D13	DIODE 0.10A BAV99 SOT23	532213034337
D14	DIODE 0.10A BAT18 35V 1PF SOT23	532213032076
D15	DIODE 0.10A BAT18 35V 1PF SOT23	532213032076
D17	DIODE 0.10A BAV99 SOT23	532213034337
D18	DIODE 0.10A BAV99 SOT23	532213034337
D19	DIODE 0.10A BAV99 SOT23	532213034337
D20	DIODE 0.10A BAV99 SOT23	532213034337
D21	DIODE 0.10A BAT18 35V 1PF SOT23	532213032076
D22	DIODE 0.10A BAT18 35V 1PF SOT23	532213032076
D23	DIODE VARACTOR SMV1255-073 SC07	403105000001
D24	DIODE VARACTOR SMV1255-073 SC07	403105000001
D25	DIODE 0.10A BAV99 SOT23	532213034337
D26	DIODE 0.10A BAV99 SOT23	532213034337
D27	DIODE 0.10A BAV99 SOT23	532213034337
D28	DIODE 0.10A BAV99 SOT23	532213034337
D29	DIODE 0.10A BAV99 SOT23	532213034337
D30	DIODE 0.10A BAV99 SOT23	532213034337
D31	DIODE 0.10A BAV99 SOT23	532213034337
D32	DIODE 0.10A BAV99 SOT23	532213034337
D33	DIODE 0.10A BAV99 SOT23	532213034337
D34	DIODE 0.10A BAV99 SOT23	532213034337
D35	DIODE 0.10A BAV99 SOT23	532213034337
D36	DIODE 0.10A BAV99 SOT23	532213034337
D37	DIODE 0.10A BAV99 SOT23	532213034337
D46	DIODE 0.10A BAV99 SOT23	532213034337
D48	DIODE 0.10A BAV99 SOT23	532213034337
D50	DIODE BYD17G 400V 1.5A SOD87	933812240701
D51	DIODE BYD17G 400V 1.5A SOD87	933812240701
D52	DIODE 0.10A BAV99 SOT23	532213034337
D53	DIODE-SCH 0.2A BAT54S SOT23 SMD	482213082262
J12	CONNECTOR 20POL HEADER SMD 15-91-0200	242202505569
J13	CONNECTOR 2x10 POL SMD	242202518436
J15	CONNECTOR 20POL HEADER SMD 15-91-0200	242202505569

Pos	Description	Part Number
J17	CONNECTOR 6POS 39-28-1065	242202508091
J22	CONNECTOR 4POL USB PCB	242203300291
J25	CONNECTOR 24 POL 57LE-20240-77OOD35G	242202504832
J28	CONNECTOR HEADER 2POS SMD AMP 6-176125-2	403110571100
K1	RELAY SMD UD2 5V	242213207707
K2	RELAY SMD UD2 5V	242213207707
K3	RELAY SMD UD2 5V	242213207707
K4	RELAY SMD UD2 5V	242213207707
K5	RELAY SMD UD2 5V	242213207707
K6	RELAY SMD UD2 5V	242213207707
K7	RELAY SMD UD2 5V	242213207707
K8	RELAY SMD UD2 5V	242213207707
L10	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L11	FILTER-EMI BLM41PF800S	242254900035
L12	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L13	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L14	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L15	CHOKE 4.3µH 1.6A	242253600772
L16	FILTER-EMI BLM41PF800S	242254900035
L17	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L18	FILTER-EMI BLM41PF800S	242254900035
L19	CHOKE 4.3µH 1.6A	242253600772
L20	FILTER-EMI BLM41PF800S	242254900035
L21	FILTER-EMI BLM41PF800S	242254900035
L22	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L23	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L24	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L25	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L26	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L27	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L28	CHOKE 4.3µH 1.6A	242253600772
L29	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L3	CHOKE 100nH SMD	242253600773
L30	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L31	CHOKE 4.70µH 5% LQH1N4R7J	242253594048
L32	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L33	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L34	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L35	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L36	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L37	CHOKE 4.70µH 5% LQH1N4R7J	242253594048
L38	CHOKE 4.70µH 5% LQH1N4R7J	242253594048
L39	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L40	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L41	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133

Pos	Description	Part Number
L42	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L43	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L44	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L45	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L46	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L47	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L48	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L49	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L5	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L50	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L51	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L52	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L53	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L54	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L55	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L56	FILTER-EMI BLM41PF800S	242254900035
L57	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L59	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L6	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L60	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L61	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L62	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L63	CHOKE 1µH 20% B82412-A1102-M	241254100458
L7	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L8	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
L9	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6Ohm	242254943133
M10	SHIELD-CLIP SMD	242201520096
M11	SHIELD-CLIP SMD	242201520096
M12	SHIELD-CLIP SMD	242201520096
M13	SHIELD-CLIP SMD	242201520096
M14	SHIELD-CLIP SMD	242201520096
M15	SHIELD-CLIP SMD	242201520096
M16	SHIELD-CLIP SMD	242201520096
M17	SHIELD-CLIP SMD	242201520096
M18	SHIELD-CLIP SMD	242201520096
M19	SHIELD-CLIP SMD	242201520096
M2	SHIELD-CLIP SMD	242201520096
M20	SHIELD-CLIP SMD	242201520096
M3	SHIELD-CLIP SMD	242201520096
M4	SHIELD-CLIP SMD	242201520096
M5	SHIELD-CLIP SMD	242201520096
M6	SHIELD-CLIP SMD	242201520096
M7	SHIELD-CLIP SMD	242201520096
M8	SHIELD-CLIP SMD	242201520096

Pos	Description	Part Number
M9	SHIELD-CLIP SMD	242201520096
Q1	TRANSISTOR BF513 .03A20V SOT23	482213060686
Q10	TRANSI-HF N SMD BFR93A 35mA 12V SOT23	532213060705
Q11	TRANSISTOR 25 MA BFR92A 20V SOT23	532213060647
Q12	TRANSISTOR BFT92 25MA 15V SOT23	933347730701
Q13	TRANSISTOR 25 MA BFR92A 20V SOT23	532213060647
Q14	TRANSISTOR 25 MA BFR92A 20V SOT23	532213060647
Q15	TRANSISTOR BFT93 35MA 12V SOT23	933347740701
Q16	TRANSISTOR 25 MA BFR92A 20V SOT23	532213060647
Q17	TRANSISTOR 0.5A BC807-25 45V SOT23	532213060845
Q18	TRANSISTOR BFS17 .05A 15V SOT23	532213040781
Q19	TRANSISTOR BFS17 .05A 15V SOT23	532213040781
Q2	TRANSISTOR HF N SMD BFR93A 35mA 12V SOT23	532213060705
Q20	TRANSISTOR BFS17 .05A 15V SOT23	532213040781
Q21	TRANSISTOR BFS17 .05A 15V SOT23	532213040781
Q22	TRANSISTOR BFS17 .05A 15V SOT23	532213040781
Q23	TRANSISTOR BFS17 .05A 15V SOT23	532213040781
Q24	TRANSISTOR BSR12 0.1A 15V SOT23	532213044743
Q25	TRANSISTOR BSR12 0.1A 15V SOT23	532213044743
Q26	TRANSISTOR BC847B .1A45V SOT23	482213060511
Q27	TRANSISTOR BC847B .1A45V SOT23	482213060511
Q28	TRANSISTOR BF513 .03A20V SOT23	482213060686
Q29	TRANSISTOR BFT92 25MA 15V SOT23	933347730701
Q3	TRANSISTOR 25 MA BFR92A 20V SOT23	532213060647
Q30	TRANSISTOR BF513 .03A20V SOT23	482213060686
Q31	TRANSISTOR BFT92 25MA 15V SOT23	933347730701
Q32	TRANSISTOR BC847B .1A45V SOT23	482213060511
Q33	TRANSISTOR BF513 .03A20V SOT23	482213060686
Q34	TRANSISTOR BFT92 25MA 15V SOT23	933347730701
Q35	TRANSISTOR BC847B .1A45V SOT23	482213060511
Q36	TRANSISTOR BF513 .03A20V SOT23	482213060686
Q37	TRANSISTOR BFT92 25MA 15V SOT23	933347730701
Q38	TRANSISTOR 0.5A BC807-25 45V SOT23	532213060845
Q39	TRANSISTOR 0.5A BC807-25 45V SOT23	532213060845
Q4	TRANSISTOR BFT92 25MA 15V SOT23	933347730701
Q40	TRANSISTOR 0.5A BC807-25 45V SOT23	532213060845
Q41	TRANSISTOR 0.5A BC807-25 45V SOT23	532213060845
Q42	TRANSISTOR 0.5A BC807-25 45V SOT23	532213060845
Q43	TRANSISTOR 0.5A BC807-25 45V SOT23	532213060845
Q44	TRANSISTOR 0.5A BC807-25 45V SOT23	532213060845
Q45	TRANSISTOR 0.5A BC807-25 45V SOT23	532213060845
Q46	TRANSISTOR BC847B .1A45V SOT23	482213060511
Q47	TRANSISTOR BC847B .1A45V SOT23	482213060511
Q48	TRANSISTOR BCP51 1.5A 45V SOT223	532213062639
Q49	TRANSISTOR BCP51 1.5A 45V SOT223	532213062639
Q5	TRANSISTOR 25 MA BFR92A 20V SOT23	532213060647
Q50	TRANSISTOR BC847B .1A45V SOT23	482213060511
Q51	TRANSISTOR BCP51 1.5A 45V SOT223	532213062639
Q53	TRANSI-NPN SMD BFG16A SOT223 1.5GHz 1W	934002210701
Q54	TRANSI-NPN SMD BFG16A SOT223 1.5GHz 1W	934002210701
Q55	TRANSISTOR BFS17 .05A 15V SOT23	532213040781
Q56	TRANSISTOR 0.5A BC807-25 45V SOT23	532213060845
Q57	TRANSI-LF N BCP54 1A 45V SOT223 1.33W	933917180115
Q58	TRANSISTOR BC847B .1A45V SOT23	482213060511
Q59	TRANSISTOR BFT92 25MA 15V SOT23	933347730701
Q6	TRANSISTOR 25 MA BFR92A 20V SOT23	532213060647
Q63	TRANSISTOR BFT92 25MA 15V SOT23	933347730701
Q64	TRANSISTOR BFT92 25MA 15V SOT23	933347730701
Q65	TRANSISTOR BFT92 25MA 15V SOT23	933347730701
Q7	TRANSISTOR BFT93 35MA 12V SOT23	933347740701
Q8	TRANSISTOR 25 MA BFR92A 20V SOT23	532213060647
Q9	TRANSISTOR BF513 .03A20V SOT23	482213060686
R1	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020

Pos	Description	Part Number
R10	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R11	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R12	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R13	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R132	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R133	RESISTOR 470 Ohm 1% .125W 100PPM 1206	482205154701
R134	RESISTOR 470 Ohm 1% .125W 100PPM 1206	482205154701
R135	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R136	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R137	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R138	RESISTOR 000 Ohm 0.1W 100PPM 0805	403100200000
R139	RESISTOR 1kOhm 1% 0.1W 100PPM 0805	532211712498
R14	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R140	RESISTOR 47 Ohm 1% .125W 100PPM 1206	532211680448
R141	RESISTOR 470 kOhm 1% .125W 100PPM 1206	482205154704
R142	RESISTOR 120 kOhm 1% .125W 100PPM 1206	482205151204
R143	RESISTOR 680 kOhm 1% .125W 100PPM 1206	532211711787
R144	RESISTOR 220 kOhm 1% .125W 100PPM 1206	482205152204
R145	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R146	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R147	RESISTOR 330 Ohm 1% 0.1W 100PPM 0805	532211712508
R148	RESISTOR 680 kOhm 1% .125W 100PPM 1206	532211711787
R149	RESISTOR 10 MOhm 10% 0.25W RC-01 1206	482205110105
R150	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R151	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R153	RESISTOR 3.30 Ohm 1% .125W 100PPM 1206	532211711788
R154	RESISTOR 100 kOhm 1% 0.1W 100PPM 0805	532211712501
R155	RESISTOR 47 kOhm 1% 0.1W 100PPM 0805	403100247030
R156	RESISTOR 470 kOhm 1% .125W 100PPM 1206	482205154704
R157	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R158	RESISTOR 1.00 MOhm 1% 0.125W 100PPM 1206	482205110105
R159	RESISTOR 100 kOhm 1% 0.1W 100PPM 0805	532211712501
R16	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R160	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R161	RESISTOR 3.30 Ohm 1% .125W 100PPM 1206	532211711788
R162	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R163	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R164	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R165	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R166	RESISTOR 150 Ohm 1% 0.125W 100PPM 1206	482205151501
R167	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R168	RESISTOR 82 Ohm 1% 0.1W 100PPM 0805	403100282090
R169	RESISTOR 68 Ohm 1% 0.1W 100PPM 0805	403100268090
R170	RESISTOR 68 Ohm 1% 0.1W 100PPM 0805	403100268090
R171	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R172	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R173	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R174	RESISTOR 12.0 kOhm 1% .125W 100PPM 1206	532211710968
R175	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R176	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R177	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R178	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R179	RESISTOR 150 Ohm 1% 0.125W 100PPM 1206	482205151501
R180	RESISTOR 1kOhm 1% 0.1W 100PPM 0805	532211712498
R181	RESISTOR 150 Ohm 1% 0.125W 100PPM 1206	482205151501
R182	RESISTOR 470 kOhm 1% .125W 100PPM 1206	482205154704
R183	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R184	RESISTOR 220 Ohm 1% 0.1W 100PPM 0805	403100222010
R185	RESISTOR 1kOhm 1% 0.1W 100PPM 0805	532211712498
R187	RESISTOR 27 Ohm 1% 0.1W 100PPM 0805	403100227090
R188	RESISTOR 470 kOhm 1% .125W 100PPM 1206	482205154704
R189	RESISTOR 470 kOhm 1% .125W 100PPM 1206	482205154704
R190	RESISTOR 1kOhm 1% 0.1W 100PPM 0805	532211712498
R191	RESISTOR 1 MOhm 1% 0.1W 100PPM 0805	403100210050

Pos	Description	Part Number
R192	RESISTOR 000 Ohm 0.1W 100PPM 0805	403100200000
R193	RESISTOR 330 Ohm 1% 0.1W 100PPM 0805	532211712508
R194	RESISTOR 27 Ohm 1% 0.1W 100PPM 0805	403100227090
R195	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R196	POTENTIOMETER 100 kOhm 3304X-1-104	212236200842
R197	POTENTIOMETER 2 kOhm 25% 4mm	403101000001
R198	RESISTOR 15 kOhm 1% 0.1W 100PPM 0805	403100215030
R199	RESISTOR 47 kOhm 1% 0.1W 100PPM 0805	403100247030
R2	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R200	RESISTOR 470 Ohm 1% .125W 100PPM 1206	482205154701
R201	RESISTOR 470 Ohm 1% .125W 100PPM 1206	482205154701
R202	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R203	RESISTOR 1.5 kOhm 1% 0.1W 100PPM 0805	403100215020
R205	RESISTOR 180 kOhm 1% 0.1W 100PPM 0805	403100218040
R206	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R207	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R208	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R209	RESISTOR 000 Ohm 0.1W 100PPM 0805	403100200000
R210	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R211	RESISTOR 1kOhm 1% 0.1W 100PPM 0805	532211712498
R212	RESISTOR 47 Ohm 1% .125W 100PPM 1206	532211680448
R213	RESISTOR 470 kOhm 1% .125W 100PPM 1206	482205154704
R214	RESISTOR 120 kOhm 1% .125W 100PPM 1206	482205151204
R215	RESISTOR 680 kOhm 1% .125W 100PPM 1206	532211711787
R216	RESISTOR 220 kOhm 1% .125W 100PPM 1206	482205152204
R217	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R218	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R219	RESISTOR 330 Ohm 1% 0.1W 100PPM 0805	532211712508
R220	RESISTOR 680 kOhm 1% .125W 100PPM 1206	532211711787
R221	RESISTOR 10 MOhm 10% 0.25W RC-01 1206	482205110105
R222	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R223	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R224	SENSOR-TEMP KTY82/120	532213010682
R225	RESISTOR 3.30 Ohm 1% .125W 100PPM 1206	532211711788
R226	RESISTOR 100 kOhm 1% 0.1W 100PPM 0805	532211712501
R227	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R228	RESISTOR 47 kOhm 1% 0.1W 100PPM 0805	403100247030
R229	RESISTOR 470 kOhm 1% .125W 100PPM 1206	482205154704
R230	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R231	RESISTOR 1.00 MOhm 1% 0.125W 100PPM 1206	482205110105
R232	RESISTOR 100 kOhm 1% 0.1W 100PPM 0805	532211712501
R233	RESISTOR 3.30 Ohm 1% .125W 100PPM 1206	532211711788
R234	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R235	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R236	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R237	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R238	RESISTOR 150 Ohm 1% 0.125W 100PPM 1206	482205151501
R239	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R240	RESISTOR 82 Ohm 1% 0.1W 100PPM 0805	403100282090
R241	RESISTOR 68 Ohm 1% 0.1W 100PPM 0805	403100268090
R242	RESISTOR 68 Ohm 1% 0.1W 100PPM 0805	403100268090
R243	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R244	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R245	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R246	RESISTOR 12.0 kOhm 1% .125W 100PPM 1206	532211710968
R247	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R248	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R249	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R250	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R251	RESISTOR 150 Ohm 1% 0.125W 100PPM 1206	482205151501
R252	RESISTOR 1 kOhm 1% 0.1W 100PPM 0805	532211712498
R253	RESISTOR 150 Ohm 1% 0.125W 100PPM 1206	482205151501
R254	RESISTOR 470 kOhm 1% .125W 100PPM 1206	482205154704
R255	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499

Pos	Description	Part Number
R256	RESISTOR 220 Ohm 1% 0.1W 100PPM 0805	403100222010
R257	RESISTOR 1 kOhm 1% 0.1W 100PPM 0805	532211712498
R258	RESISTOR 120 kOhm 1% .125W 100PPM 1206	482205151204
R259	RESISTOR 27 Ohm 1% 0.1W 100PPM 0805	403100227090
R260	RESISTOR 470 kOhm 1% .125W 100PPM 1206	482205154704
R261	RESISTOR 470 kOhm 1% .125W 100PPM 1206	482205154704
R262	RESISTOR 1 MOhm 1% 0.1W 100PPM 0805	403100210050
R263	RESISTOR 330 Ohm 1% 0.1W 100PPM 0805	532211712508
R264	RESISTOR 27 Ohm 1% 0.1W 100PPM 0805	403100227090
R265	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R266	RESISTOR 000 Ohm 0.1W 100PPM 0805	403100200000
R267	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R268	POTENTIOMETER 100 kOhm 3304X-1-104	212236200842
R269	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R270	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R271	RESISTOR 220 Ohm 1% 0.1W 100PPM 0805	403100222010
R272	RESISTOR 3.3 kOhm 1% 0.1W 100PPM 0805	403100233020
R273	RESISTOR 120 kOhm 1% .125W 100PPM 1206	482205151204
R274	RESISTOR 1 MOhm 1% 0.1W 100PPM 0805	403100210050
R275	RESISTOR 10kOhm 1% 0.1W 100PPM 0805	532211712499
R276	RESISTOR 47 kOhm 1% 0.1W 100PPM 0805	403100247030
R277	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R278	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R279	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R280	RESISTOR 1 MOhm 1% 0.1W 100PPM 0805	403100210050
R281	RESISTOR 1kOhm 1% 0.1W 100PPM 0805	532211712498
R282	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R283	RESISTOR 47 kOhm 1% 0.1W 100PPM 0805	403100247030
R284	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R285	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R286	RESISTOR 470 Ohm 1% .125W 100PPM 1206	482205154701
R287	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R288	RESISTOR 100 kOhm 1% 0.1W 100PPM 0805	532211712501
R289	RESISTOR 100 kOhm 1% 0.1W 100PPM 0805	532211712501
R290	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R291	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R292	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R293	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R294	RESISTOR 47 kOhm 1% 0.1W 100PPM 0805	403100247030
R295	RESISTOR 100 Ohm 1% 0.125W 100PPM 1206	482205151001
R296	RESISTOR 100 Ohm 1% 0.125W 100PPM 1206	482205151001
R3	RESISTOR 10kOhm 1% 0.1W 100PPM 0805	532211712499
R303	RESISTOR 47 kOhm 1% 0.1W 100PPM 0805	403100247030
R305	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R306	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R307	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R308	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R309	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R310	RESISTOR 68 Ohm 1% 0.1W 100PPM 0805	403100268090
R311	RESISTOR 68 Ohm 1% 0.1W 100PPM 0805	403100268090
R312	RESISTOR 22 Ohm 1% 0.1W 100PPM 0805	532211712507
R313	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R314	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R315	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R316	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R317	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R318	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R319	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R320	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R321	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R322	RESISTOR 39 kOhm 1% 0.1W 100PPM 0805	403100239030
R323	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R324	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R325	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R326	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R327	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R328	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R329	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R331	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R332	RESISTOR 39 kOhm 1% 0.1W 100PPM 0805	403100239030
R333	RESISTOR 270 Ohm 1% 0.1W 100PPM 0805	403100227010
R334	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R335	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R337	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R338	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R339	RESISTOR 150 Ohm 1% 0.1W 100PPM 0805	403100215010
R340	RESISTOR 270 Ohm 1% 0.1W 100PPM 0805	403100227010
R341	RESISTOR 22 Ohm 1% 0.1W 100PPM 0805	532211712507
R342	RESISTOR 820 Ohm 1% .125W 100PPM 1206	532211682264
R343	RESISTOR 68 Ohm 1% 0.1W 100PPM 0805	403100268090
R344	RESISTOR 68 Ohm 1% 0.1W 100PPM 0805	403100268090
R346	RESISTOR 680 Ohm 1% 0.1W 100PPM 0805	532211712509
R347	RESISTOR 22 Ohm 1% 0.1W 100PPM 0805	532211712507
R348	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R349	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R350	RESISTOR 680 Ohm 1% 0.1W 100PPM 0805	532211712509
R351	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R352	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R353	RESISTOR 3.3 kOhm 1% 0.1W 100PPM 0805	403100233020
R354	RESISTOR 3.3 kOhm 1% 0.1W 100PPM 0805	403100233020
R355	RESISTOR 10kOhm 1% 0.1W 100PPM 0805	532211712499
R356	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R357	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R358	RESISTOR 1 MOhm 1% 0.1W 100PPM 0805	403100210050
R359	RESISTOR 10kOhm 1% 0.1W 100PPM 0805	532211712499
R360	RESISTOR 10kOhm 1% 0.1W 100PPM 0805	532211712499
R361	RESISTOR 10kOhm 1% 0.1W 100PPM 0805	532211712499
R362	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R363	RESISTOR 10kOhm 1% 0.1W 100PPM 0805	532211712499
R364	RESISTOR 22 kOhm 1% 0.1W 100PPM 0805	403100222030
R365	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R367	RESISTOR 22 kOhm 1% 0.1W 100PPM 0805	403100222030
R368	RESISTOR 220 kOhm 1% .125W 100PPM 1206	482205152204
R369	RESISTOR 220 kOhm 1% .125W 100PPM 1206	482205152204
R370	RESISTOR 33 kOhm 1% 0.1W 100PPM 0805	403100233030
R371	RESISTOR 47 kOhm 1% 0.1W 100PPM 0805	403100247030
R372	RESISTOR 68 kOhm 1% 0.1W 100PPM 0805	403100268030
R373	RESISTOR 33 kOhm 1% 0.1W 100PPM 0805	403100233030
R374	RESISTOR 47 kOhm 1% 0.1W 100PPM 0805	403100247030
R375	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R376	RESISTOR 82 Ohm 1% 0.1W 100PPM 0805	403100282090
R377	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R378	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R379	RESISTOR 1.5 kOhm 1% 0.1W 100PPM 0805	403100215020
R380	RESISTOR 10 Ohm 1% 0.1W 100PPM 0805	403100210090
R381	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R382	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R383	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R384	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R385	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R386	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R387	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R389	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R390	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R391	RESISTOR 1.5 kOhm 1% 0.1W 100PPM 0805	403100215020
R392	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R393	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R394	RESISTOR 15 kOhm 1% 0.1W 100PPM 0805	403100215030

Pos	Description	Part Number
R395	RESISTOR 33 kOhm 1% 0.1W 100PPM 0805	403100233030
R396	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R397	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R398	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R399	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R4	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R400	RESISTOR 47 kOhm 1% 0.1W 100PPM 0805	403100247030
R402	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R403	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R404	RESISTOR 82 Ohm 1% 0.1W 100PPM 0805	403100282090
R405	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R406	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R407	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R408	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R409	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R410	RESISTOR 82 Ohm 1% 0.1W 100PPM 0805	403100282090
R411	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R413	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R414	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R416	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R417	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R418	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R419	RESISTOR 6.8 kOhm 1% 0.1W 100PPM 0805	403100268020
R421	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R422	RESISTOR 6.8 kOhm 1% 0.1W 100PPM 0805	403100268020
R423	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R424	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R426	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R427	RESISTOR 6.8 kOhm 1% 0.1W 100PPM 0805	403100268020
R430	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R431	RESISTOR 000 Ohm 0.1W 100PPM 0805	403100200000
R432	RESISTOR 6.8 kOhm 1% 0.1W 100PPM 0805	403100268020
R434	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R435	RESISTOR 6.8 kOhm 1% 0.1W 100PPM 0805	403100268020
R437	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R438	RESISTOR 6.8 kOhm 1% 0.1W 100PPM 0805	403100268020
R440	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R441	RESISTOR 6.8 kOhm 1% 0.1W 100PPM 0805	403100268020
R443	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R444	RESISTOR 6.8 kOhm 1% 0.1W 100PPM 0805	403100268020
R445	RESISTOR 1.5 kOhm 1% 0.1W 100PPM 0805	403100215020
R446	RESISTOR 470 Ohm 1% 0.1W 100PPM 0805	403100247010
R447	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R448	RESISTOR 680 Ohm 1% 0.1W 100PPM 0805	532211712509
R449	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R450	RESISTOR 1 kOhm 1% 0.1W 100PPM 0805	532211712498
R451	RESISTOR 330 Ohm 1% 0.1W 100PPM 0805	532211712508
R452	RESISTOR 1 kOhm 1% 0.1W 100PPM 0805	532211712498
R453	RESISTOR 1 kOhm 1% 0.1W 100PPM 0805	532211712498
R454	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R455	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R456	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R457	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R458	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R459	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R460	RESISTOR 3.3 kOhm 1% 0.1W 100PPM 0805	403100233020
R461	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R462	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R463	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R464	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R465	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R466	RESISTOR 1 kOhm 1% 0.1W 100PPM 0805	532211712498
R467	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R468	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109

Pos	Description	Part Number
R469	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R470	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R471	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R472	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R473	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R474	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R475	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R476	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R477	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R478	RESISTOR 1 MOhm 1% 0.1W 100PPM 0805	403100210050
R479	RESISTOR 220 Ohm 1% 0.1W 100PPM 0805	403100222010
R480	RESISTOR 470 Ohm 1% 0.1W 100PPM 0805	403100247010
R481	RESISTOR 1kOhm 1% 0.1W 100PPM 0805	532211712498
R482	RESISTOR 3.3 kOhm 1% 0.1W 100PPM 0805	403100233020
R483	RESISTOR 3.3 kOhm 1% 0.1W 100PPM 0805	403100233020
R484	RESISTOR 1kOhm 1% 0.1W 100PPM 0805	532211712498
R485	RESISTOR 1kOhm 1% 0.1W 100PPM 0805	532211712498
R486	RESISTOR 1kOhm 1% 0.1W 100PPM 0805	532211712498
R487	RESISTOR 470 kOhm 1% .125W 100PPM 1206	482205154704
R488	RESISTOR 15 kOhm 1% 0.1W 100PPM 0805	403100215030
R489	RESISTOR 330 kOhm 1% 0.1W 100PPM 0805	403100233040
R490	RESISTOR 150 kOhm 1% 0.1W 100PPM 0805	403100215040
R491	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R492	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R493	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R494	RESISTOR 1 MOhm 1% 0.1W 100PPM 0805	403100210050
R495	RESISTOR 33 kOhm 1% 0.1W 100PPM 0805	403100233030
R496	RESISTOR 10kOhm 1% 0.1W 100PPM 0805	532211712499
R497	RESISTOR 1 kOhm 1% 0.1W 100PPM 0805	532211712498
R498	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R499	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R500	RESISTOR 1 kOhm 1% 0.1W 100PPM 0805	532211712498
R501	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R502	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R503	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R504	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R505	RESISTOR 1 kOhm 1% 0.1W 100PPM 0805	532211712498
R506	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R507	RESISTOR 330 Ohm 1% 0.1W 100PPM 0805	532211712508
R508	RESISTOR 330 Ohm 1% 0.1W 100PPM 0805	532211712508
R509	RESISTOR 470 Ohm 1% .125W 100PPM 1206	482205154701
R510	RESISTOR 470 Ohm 1% .125W 100PPM 1206	482205154701
R511	RESISTOR 330 Ohm 1% 0.1W 100PPM 0805	532211712508
R512	RESISTOR 470 Ohm 1% .125W 100PPM 1206	482205154701
R513	RESISTOR 330 Ohm 1% 0.1W 100PPM 0805	532211712508
R514	RESISTOR 1.5 kOhm 1% 0.1W 100PPM 0805	403100215020
R515	RESISTOR 330 Ohm 1% 0.1W 100PPM 0805	532211712508
R516	RESISTOR 15 kOhm 1% 0.1W 100PPM 0805	403100215030
R517	RESISTOR 330 Ohm 1% 0.1W 100PPM 0805	532211712508
R518	RESISTOR 1kOhm 1% 0.1W 100PPM 0805	532211712498
R519	RESISTOR 330 Ohm 1% 0.1W 100PPM 0805	532211712508
R520	RESISTOR 330 Ohm 1% 0.1W 100PPM 0805	532211712508
R521	RESISTOR 330 Ohm 1% 0.1W 100PPM 0805	532211712508
R522	RESISTOR 330 Ohm 1% 0.1W 100PPM 0805	532211712508
R523	RESISTOR 1 kOhm 1% 0.1W 100PPM 0805	532211712498
R524	RESISTOR 22 Ohm 1% 0.1W 100PPM 0805	532211712507
R525	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R526	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R527	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R528	RESISTOR 22 Ohm 1% 0.1W 100PPM 0805	532211712507
R529	RESISTOR 3.3 kOhm 1% 0.1W 100PPM 0805	403100233020
R530	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R531	RESISTOR 100 Ohm 1% 0.125W 100PPM 1206	482205151001
R532	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020

Pos	Description	Part Number
R533	RESISTOR 100 Ohm 1% 0.125W 100PPM 1206	482205151001
R534	RESISTOR 22 Ohm 1% 0.1W 100PPM 0805	532211712507
R535	RESISTOR 22 Ohm 1% 0.1W 100PPM 0805	532211712507
R536	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R537	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R538	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R539	RESISTOR 22 Ohm 1% 0.1W 100PPM 0805	532211712507
R540	RESISTOR 22 Ohm 1% 0.1W 100PPM 0805	532211712507
R543	RESISTOR 1 MOhm 1% 0.1W 100PPM 0805	403100210050
R544	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R545	RESISTOR 1.5 kOhm 1% 0.1W 100PPM 0805	403100215020
R546	RESISTOR 1.5 kOhm 1% 0.1W 100PPM 0805	403100215020
R547	RESISTOR 470 Ohm 1% .125W 100PPM 1206	482205154701
R548	RESISTOR 100 kOhm 1% 0.1W 100PPM 0805	532211712501
R549	RESISTOR 1kOhm 1% 0.1W 100PPM 0805	532211712498
R551	RESISTOR 3.3 kOhm 1% 0.1W 100PPM 0805	403100233020
R552	RESISTOR 1 kOhm 1% 0.1W 100PPM 0805	532211712498
R553	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R554	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R555	RESISTOR 470 Ohm 1% .125W 100PPM 1206	482205154701
R557	RESISTOR 15 Ohm 1% 0.1W 100PPM 0805	403100215090
R558	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R559	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R560	RESISTOR 100 kOhm 1% 0.1W 100PPM 0805	532211712501
R561	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R562	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R563	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R564	RESISTOR 330 Ohm 1% 0.1W 100PPM 0805	532211712508
R565	RESISTOR 330 Ohm 1% 0.1W 100PPM 0805	532211712508
R566	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R567	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R568	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R569	RESISTOR 150 Ohm 1% 0.1W 100PPM 0805	403100215010
R570	RESISTOR 100 Ohm 1% 0.125W 100PPM 1206	482205151001
R571	RESISTOR 100 Ohm 1% 0.125W 100PPM 1206	482205151001
R572	RESISTOR 100 Ohm 1% 0.125W 100PPM 1206	482205151001
R573	RESISTOR 100 Ohm 1% 0.125W 100PPM 1206	482205151001
R575	RESISTOR 100 Ohm 1% 0.125W 100PPM 1206	482205151001
R576	RESISTOR 100 Ohm 1% 0.125W 100PPM 1206	482205151001
R577	RESISTOR 100 Ohm 1% 0.125W 100PPM 1206	482205151001
R578	RESISTOR 100 Ohm 1% 0.125W 100PPM 1206	482205151001
R579	RESISTOR 1.5 kOhm 1% 0.1W 100PPM 0805	403100215020
R580	RESISTOR 3.3 kOhm 1% 0.1W 100PPM 0805	403100233020
R581	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R582	RESISTOR 10kOhm 1% 0.1W 100PPM 0805	532211712499
R583	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R584	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	532211712505
R585	RESISTOR 150 Ohm 1% 0.125W 100PPM 1206	482205151501
R586	RESISTOR 150 Ohm 1% 0.125W 100PPM 1206	482205151501
R587	RESISTOR 150 Ohm 1% 0.125W 100PPM 1206	482205151501
R589	RESISTOR 100 kOhm 1% 0.1W 100PPM 0805	532211712501
R590	RESISTOR 150 Ohm 1% 0.125W 100PPM 1206	482205151501
R591	RESISTOR 150 Ohm 1% 0.125W 100PPM 1206	482205151501
R592	RESISTOR 1kOhm 1% 0.1W 100PPM 0805	532211712498
R593	RESISTOR 1kOhm 1% 0.1W 100PPM 0805	532211712498
R594	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R595	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R596	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R597	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R598	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R599	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R6	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R600	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R601	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R602	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R603	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R604	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R605	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	482205110109
R606	RESISTOR 100 Ohm 1% 0.125W 100PPM 1206	482205151001
R607	RESISTOR 100 Ohm 1% 0.125W 100PPM 1206	482205151001
R608	RESISTOR 100 Ohm 1% 0.125W 100PPM 1206	482205151001
R609	RESISTOR 100 Ohm 1% 0.125W 100PPM 1206	482205151001
R610	RESISTOR 1.2 MOhm 1% 0.125W 1206	403100112050
R611	RESISTOR 1.2 MOhm 1% 0.125W 1206	403100112050
R612	RESISTOR 1 kOhm 1% 0.1W 100PPM 0805	532211712498
R613	RESISTOR 1 kOhm 1% 0.1W 100PPM 0805	532211712498
R614	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R615	RESISTOR 100 Ohm 1% 0.1W 100PPM 0805	532211712497
R616	RESISTOR 820 Ohm 1% .125W 100PPM 1206	532211682264
R617	RESISTOR 6.8 kOhm 1% 0.1W 100PPM 0805	403100268020
R618	RESISTOR 10 kOhm 1% 0.1W 100PPM 0805	532211712499
R619	RESISTOR 1 kOhm 1% 0.1W 100PPM 0805	532211712498
R620	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R621	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R622	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R623	RESISTOR 470 Ohm 1% 0.1W 100PPM 0805	403100247010
R624	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R625	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R626	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R627	RESISTOR 120 Ohm 1% 0.125W 100PPM 1206	482205110121
R629	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R630	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R640	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R641	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R642	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R643	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R644	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R645	RESISTOR 2.2 kOhm 1% 0.1W 100PPM 0805	403100222020
R652	RESISTOR 82 Ohm 1% 0.1W 100PPM 0805	403100282090
R656	RESISTOR 1.5 kOhm 1% 0.1W 100PPM 0805	403100215020
R657	RESISTOR 1.5 kOhm 1% 0.1W 100PPM 0805	403100215020
R658	RESISTOR 10 Ohm 1% 0.1W 100PPM 0805	403100210090
R659	RESISTOR 10 Ohm 1% 0.1W 100PPM 0805	403100210090
R660	RESISTOR 10 Ohm 1% 0.1W 100PPM 0805	403100210090
U1	IC-OPAMP LMC6081	932220497682
U11	IC-FPGA	932220399682
U116	IC-ANA MAX6355TWUT-T	932220433682
U117	IC-REG MAX1927REUB	932220434682
U118	IC-REG MAX1927REUB	932220434682
U12	IC-DIG ECLIPS MC10E104	932202821682
U122	IC-REF 2.5V LT1009CD-2.5 2.5V±0.2% 15ppm	932207993701
U123	IC-REG LM2991S	932220425682
U124	IC-REG LM2991S	932220425682
U126	IC-REG LP2951	932207501682
U127	IC-SWITCH MIC2505-1BM	932220437682
U128	IC-ANA SMPS CTR LTC3412	932220430682
U129	IC-REG LM2940CS-12	932211044682
U13	IC-CPU TA7S20-60QC	932220406682
U130	IC-REG LM2940CS-12	932211044682
U131	IC-COMP MAX961 SO8 4.5ns	932219434682
U132	IC-ANA ADG719 SPDT-SWITCH MSOP-8	403106000008
U133	IC-ANA ADG719 SPDT-SWITCH MSOP-8	403106000008
U134	IC-ANA ADG719 SPDT-SWITCH MSOP-8	403106000008
U135	IC-ANA ADG719 SPDT-SWITCH MSOP-8	403106000008
U14	IC-CMOS SN74LVC125AD	932220193682
U15	IC-SRAM K4S281632D	932220429682
U16	IC-SRAM K4S281632D	932220429682
U17	IC-PROM Am29LV640MH	932220405682

Pos	Description	Part Number
U18	IC-OPAMP OPA277	932214746682
U19	IC-OPAMP OPA277	932214746682
U2	IC-OPAMP LMC6081	932220497682
U20	IC-OMV ADC 10BIT ADC1061C1WM SO20	932218755682
U21	IC-OMV ADC 10BIT ADC1061C1WM SO20	932218755682
U22	IC-OMV ADC 10BIT ADC1061C1WM SO20	932218755682
U23	IC-OMV ADC 10BIT ADC1061C1WM SO20	932218755682
U24	IC-OPAMP OPA277	932214746682
U26	IC-OPAMP OPA277	932214746682
U28	IC-OPAMP OPA277	932214746682
U29	IC-CMOS 74LVC74AD	935260734701
U3	IC-COMP ADCMP565BP	932220403682
U30	IC-OP AMP LM358 x2 SMD SO8	532220982941
U31	IC-OPAMP LMH6624	932220398682
U32	IC-CMOS 74LVC74AD	935260734701
U33	IC-CMOS 74ALVC00	932220496682
U34	IC-DIG BUS ISP1181B	935271360701
U35	IC-OP AMP LM358 x2 SMD SO8	532220982941
U37	IC-DIG BUS TNT4882	932220397682
U38	IC-CMOS TRANSL3-5V 74LVC4245AD	935260749701
U39	IC-DIG TEMP SENSOR LM75	932212511682
U4	IC-CMOS 74ALVC00	932220496682
U40	IC-DIG BUS I2C PCA9555PW	935269569701

Pos	Description	Part Number
U41	IC-CMOS 74HCT126D SMD SO14	933757050701
U42	IC-OP AMP KM4100IT5 SOT23-5 260MHz	403106000002
U43	IC-OP AMP KM4100IT5 SOT23-5 260MHz	403106000002
U44	IC-OP AMP KM4100IT5 SOT23-5 260MHz	403106000002
U45	IC-OP AMP KM4100IT5 SOT23-5 260MHz	403106000002
U46	IC-CONV DAC MAX5156BCEE 12bit dual	403106000001
U47	IC-CMOS 74LVC1G04GV LOG 1xINV	935271788125
U48	IC-CMOS 74LVC1G04GV LOG 1xINV	935271788125
U5	IC-DAC 12BIT LTC8043	932220498682
U50	IC-OP AMP TLE2022C SMD SO	932207300701
U6	IC-OP AMP OPA277	932214746682
U7	IC-OP AMP OPA277	932214746682
U8	IC-OP AMP LM358 x2 SMD SO8	532220982941
U9	IC-ANALOG-PLL 200MHz ADF4001BRU	932220404682

Front Unit

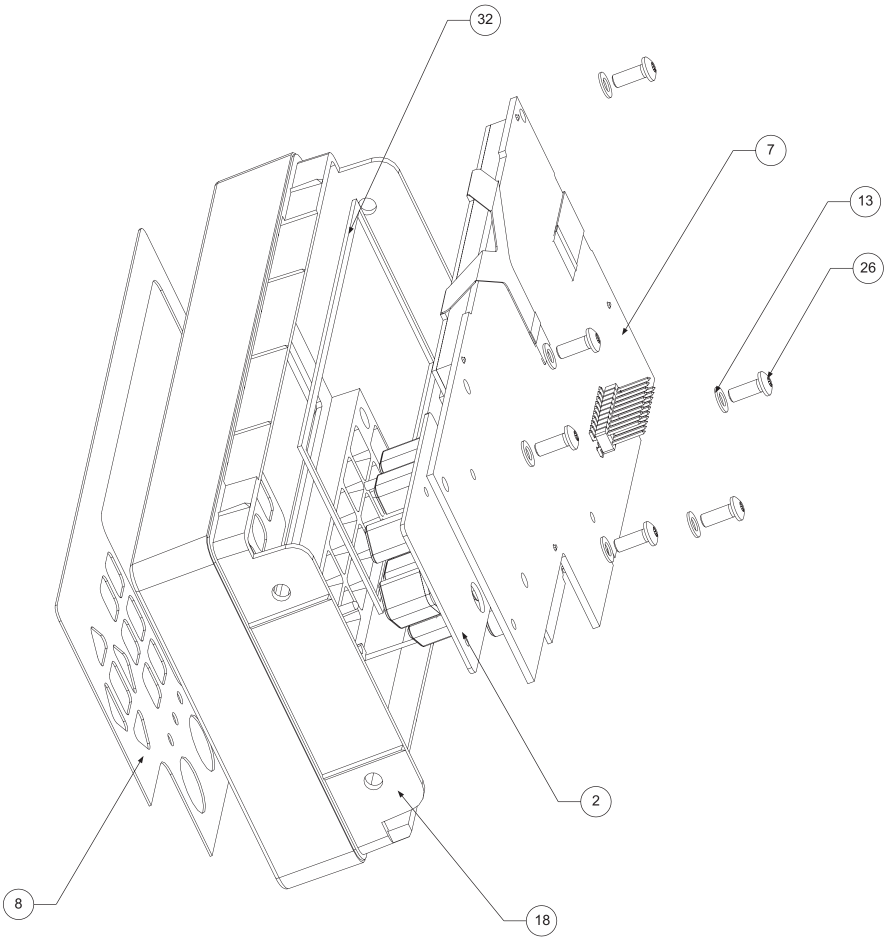


Figure 8-4 *Display assembly.*

Pos.	Description	Part number
	Display board complete.	403110066160
C1	CAPACITOR 100nF 20% 25V X7R 0805	222291016749
C10	CAPACITOR 100nF 20% 25V X7R 0805	222291016749
C11	CAPACITOR 100nF 20% 25V X7R 0805	222291016749
C12	CAPACITOR 100nF 20% 25V X7R 0805	222291016749
C13	CAPACITOR 100nF 20% 25V X7R 0805	222291016749
C14	CAPACITOR 100nF 20% 25V X7R 0805	222291016749
C15	CAPACITOR 100nF 20% 25V X7R 0805	222291016749
C16	CAPACITOR 22µF 6.3V	202202900654
C17	CAPACITOR 100nF 20% 25V X7R 0805	222291016749
C18	CAPACITOR 22µF 6.3V	202202900654
C19	CAPACITOR 100nF 20% 25V X7R 0805	222291016749
C20	CAPACITOR 2.20 UF 20% 35V 6.0X3.2 MOLD	403102172280
C21	CAPACITOR 100nF 20% 25V X7R 0805	222291016749
C22	CAPACITOR 2.20 UF 20% 35V 6.0X3.2 MOLD	403102172280
C23	CAPACITOR 2.20 UF 20% 35V 6.0X3.2 MOLD	403102172280
C24	CAPACITOR 22µF 6.3V	202202900654
C25	CAPACITOR 22µF 6.3V	202202900654
C3	CAPACITOR 4.7µF 20% 35V 0405 SMD	222215360478
C4	CAPACITOR 4.7µF 20% 35V 0405 SMD	222215360478
C5	CAPACITOR 33pF 5% 50V NP0 0805	222286115339
C6	CAPACITOR 100nF 20% 25V X7R 0805	222291016749
C7	CAPACITOR 100nF 20% 25V X7R 0805	222291016749
C8	CAPACITOR 100nF 20% 25V X7R 0805	222291016749
C9	CAPACITOR 100nF 20% 25V X7R 0805	222291016749
D1	DIODE 10BQ030	932220426682
D2	LED 3mm RED FLATTOP	932221032682
D3	LED 3mm GREEN FLATTOP	932221031682
D4	LED 3mm GREEN FLATTOP	932221031682
D5	LED 3mm GREEN FLATTOP	932221031682
E1	DISPLAY 90-SER	403110065800
J1	CONNECTOR 20POL FPC SMD	242202518448
J2	CONNECTOR 20POL FPC SMD	242202518448
J3	CONNECTOR 20POL HEADER SMD 15-91-0200	242202505569
L1	CHOKE 10uH SMD	942253600592
L2	FILTER-EMI BLM21A102SPT Z=1KOhm 0.2A R=0.6ohm	242254943133
R1	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	403100247090
R10	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	403100110090
R11	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	403100110090
R13	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	403100110090
R14	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	403100110090
R15	RESISTOR 33 kOhm 1% 0.1W 100PPM 0805	403100233030
R16	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	403100110090
R17	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R18	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	403100110090
R19	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R2	RESISTOR 1 MOhm 1% 0.1W 100PPM 0805	403100210050
R20	RESISTOR 47 Ohm 1% 0.1W 100PPM 0805	403100247090
R3	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R33	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R34	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R4	RESISTOR 470 kOhm 1% 0.1W 100PPM 0805	403100247040
R5	RESISTOR 10.0 Ohm 1% 0.125W 100PPM 1206	403100110090
R7	RESISTOR 4.7 kOhm 1% 0.1W 100PPM 0805	403100247020
R8	RESISTOR 820 Ohm 1% 0.1W 100PPM 0805	403100282040
R9	RESISTOR 100kOhm 1% 0.1W 100PPM 0805	403100210040
U1	IC-OP AMP LM358 x2 SMD SO8	933965740685
U2	IC-OP AMP LM358 x2 SMD SO8	933965740685
U3	IC-DIG BUS I2C PCA9555PW	935269569701
U4	IC-ANA SMPS CTR TPS61045	932220427682

Main Board, Version B

Pos	Description	Part Number
B1	OSCILLATOR 10MHZ OCXO P/N 738Y4084	403110061800
B2	CRYSTAL 10MHz HC-49U/13	532224282118
B4	CRYSTAL 6MHz HC49/USM SMD	403110056520
B5	CRYSTAL 40MHz HC49/USM SMD	403110056540
B6	CRYSTAL 10MHz HC49/USM SMD	403110056530
B7	CRYSTAL 11.2896 MHz HC49/USM SMD	403110056560
C1	CAPACITOR 47pF 5% 50V NP0 0805	222286115479
C10	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C100	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C101	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C102	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C103	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C104	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C105	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C106	CAPACITOR-TRIM 2.5-10pF 500VDC AT2320-2	532212550689
C107	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C108	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C109	CAPACITOR 47pF 5% 50V NP0 0805	222286115479
C11	CAPACITOR 22pF 5% 50V NP0 0805	532212232658
C110	CAPACITOR 22nF 10% 200V X7R 1206	532212614081
C111	CAPACITOR-TRIM 3-10pF TZBX4Z100BB110	532212550306
C114	CAPACITOR 27pF 5% 50V NP0 0805	222286115279
C115	CAPACITOR 3.9pF ±0.25pF 500V NP0 1206	225201471398
C116	CAPACITOR-TRIM 3-10pF TZBX4Z100BB110	532212550306
C117	CAPACITOR 3.9pF ±0.25pF 500V NP0 1206	225201471398
C118	CAPACITOR 39pF 5% 50V NP0 0805	222286115399
C119	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C12	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C120	CAPACITOR 220pF 5% 50V NP0 0805	482212233575
C122	CAPACITOR 22nF 10% 200V X7R 1206	532212614081
C123	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C124	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C125	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C126	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C127	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C128	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C129	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C13	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C130	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C131	CAPACITOR 3.9pF ±0.25pF 500V NP0 1206	225201471398
C132	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C133	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C134	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C135	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C136	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C137	CAPACITOR-TRIM 2.5-10pF 500VDC AT2320-2	532212550689
C138	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C139	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C14	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C140	CAPACITOR 47pF 5% 50V NP0 0805	222286115479
C141	CAPACITOR 22nF 10% 200V X7R 1206	532212614081
C143	CAPACITOR-TRIM 3-10pF TZBX4Z100BB110	532212550306
C146	CAPACITOR 27pF 5% 50V NP0 0805	222286115279
C147	CAPACITOR 3.9pF ±0.25pF 500V NP0 1206	225201471398
C148	CAPACITOR-TRIM 3-10pF TZBX4Z100BB110	532212550306
C149	CAPACITOR 3.9pF ±0.25pF 500V NP0 1206	225201471398
C15	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C150	CAPACITOR 39pF 5% 50V NP0 0805	222286115399
C151	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C152	CAPACITOR 220pF 5% 50V NP0 0805	482212233575
C154	CAPACITOR 22nF 10% 200V X7R 1206	532212614081
C155	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C156	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C157	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C158	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C159	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C16	CAPACITOR 22pF 5% 50V NP0 0805	532212232658
C160	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C161	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C162	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C163	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C164	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C165	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C166	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C167	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C168	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C169	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C17	CAPACITOR 100pF 5% 50V NP0 0805	222286115101
C170	CAPACITOR 100pF 5% 50V NP0 0805	222286115101
C171	CAPACITOR 100pF 5% 50V NP0 0805	222286115101
C172	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C173	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C174	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C175	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C176	CAPACITOR 100pF 5% 50V NP0 0805	222286115101
C177	CAPACITOR 33pF 5% 50V NP0 0805	222286115339
C178	CAPACITOR 22pF 5% 50V NP0 0805	532212232658
C179	CAPACITOR 22pF 5% 50V NP0 0805	532212232658
C180	CAPACITOR 33pF 5% 50V NP0 0805	222286115339
C181	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C182	CAPACITOR 33pF 5% 50V NP0 0805	222286115339
C183	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C184	CAPACITOR 100pF 5% 50V NP0 0805	222286115101
C185	CAPACITOR 15pF 5% 50V NP0 0805	222286115159
C186	CAPACITOR 68pF 1% 50V NPO 0805	222286118689
C187	CAPACITOR 47pF 5% 50V NP0 0805	222286115479
C188	CAPACITOR 68pF 1% 50V NPO 0805	222286118689
C189	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C19	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C190	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C191	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C192	CAPACITOR 100µF 6.3V	202202900655
C193	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C194	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C195	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C197	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C2	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C20	CAPACITOR 27pF 5% 50V NP0 0805	222286115279
C201	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C202	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C203	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C204	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C205	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C206	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C207	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C208	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C209	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C21	CAPACITOR 3.9pF ±0.25pF 500V NP0 1206	225201471398
C210	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C211	CAPACITOR 10nF 20% 50V X7R 0805	532212234098

Pos	Description	Part Number
C212	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C213	CAPACITOR 6.80 µF 20% 16V 6.0X3.2 MOLD	532212410687
C214	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C215	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C216	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C217	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C218	CAPACITOR 10pF 5% 50V NP0 0805	222286115109
C219	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C22	CAPACITOR 27pF 5% 50V NP0 0805	222286115279
C220	CAPACITOR 10pF 5% 50V NP0 0805	222286115109
C221	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C222	CAPACITOR 10pF 5% 50V NP0 0805	222286115109
C223	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C224	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C225	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C226	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C227	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C228	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C229	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C23	CAPACITOR 3.9pF ±0.25pF 500V NP0 1206	225201471398
C230	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C231	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C232	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C235	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C236	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C237	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C238	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C239	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C24	CAPACITOR 10pF 5% 500V NP0 1206	532212613643
C240	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C241	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C242	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C243	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C244	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C245	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C246	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C247	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C248	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C249	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C25	CAPACITOR 10pF 5% 500V NP0 1206	532212613643
C253	CAPACITOR 220µF 20% 10V 0810 SMD	222215364221
C257	CAPACITOR 100µF 6.3V	202202900655
C258	CAPACITOR 22µF 6.3V	202202900654
C26	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C261	CAPACITOR 220µF 20% 10V 0810 SMD	222215364221
C262	CAPACITOR 680pF 20% 63V NP0 1206	482212612075
C263	CAPACITOR 220pF 5% 50V NP0 0805	482212233575
C264	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C265	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C266	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C267	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C268	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C269	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C27	CAPACITOR 27pF 5% 50V NP0 0805	222286115279
C270	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C271	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C272	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C273	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C274	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C275	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C276	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C277	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C28	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C280	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C281	CAPACITOR 100nF 10% 16V X7R 0603	403102030104
C282	CAPACITOR 100nF 10% 16V X7R 0603	403102030104
C283	CAPACITOR 100nF 10% 16V X7R 0603	403102030104
C284	CAPACITOR 100nF 10% 16V X7R 0603	403102030104
C285	CAPACITOR 470pF 10% 50V X7R 0402	403102040471
C286	CAPACITOR 470pF 10% 50V X7R 0402	403102040471
C287	CAPACITOR 470pF 10% 50V X7R 0402	403102040471
C288	CAPACITOR 100nF 10% 16V X7R 0603	403102030104
C289	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C29	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	403102132280
C29	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C290	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C291	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C292	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C293	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C294	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C295	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C296	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C297	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C298	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C299	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C3	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C30	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C300	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C301	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C302	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C303	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C304	CAPACITOR 100nF 10% 16V X7R 0603	403102030104
C305	CAPACITOR 100nF 10% 16V X7R 0603	403102030104
C306	CAPACITOR 100nF 10% 16V X7R 0603	403102030104
C309	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
C31	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C310	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C311	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C312	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C313	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C314	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C315	CAPACITOR 100nF 20% 25V X7R 0805	222291016749
C315	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C316	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C317	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C318	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C319	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C32	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C320	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C321	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C322	CAPACITOR 100pF 5% 50V NP0 0805	222286115101
C323	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C324	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C326	CAPACITOR 68pF 1% 50V NPO 0805	222286118689
C327	CAPACITOR 100pF 5% 50V NP0 0805	222286115101
C328	CAPACITOR 100pF 5% 50V NP0 0805	222286115101
C329	CAPACITOR 100pF 5% 50V NP0 0805	222286115101
C33	CAPACITOR 27pF 5% 50V NP0 0805	222286115279
C330	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C331	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C332	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C333	CAPACITOR 68pF 1% 50V NPO 0805	222286118689
C335	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C337	CAPACITOR 10pF 5% 50V NP0 0805	222286115109
C338	CAPACITOR 100pF 5% 50V NP0 0805	222286115101
C339	CAPACITOR 15 µF 20%6.3V 6.0X3.2 MOLD	532212411418
C34	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C340	CAPACITOR 100nF 20% 25V X7R 0805	532212613638

Pos	Description	Part Number
C341	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C342	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C343	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C344	CAPACITOR 68pF 1% 50V NPO 0805	222286118689
C345	CAPACITOR 10pF 5% 50V NP0 0805	222286115109
C346	CAPACITOR 100pF 5% 50V NP0 0805	222286115101
C347	CAPACITOR 15 µF 20%6.3V 6.0X3.2 MOLD	532212411418
C348	CAPACITOR 100pF 5% 50V NP0 0805	222286115101
C349	CAPACITOR 100pF 5% 50V NP0 0805	222286115101
C35	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C350	CAPACITOR 1 µF 20% 16V 3.2X1.6 MOLD	532212410686
C351	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C352	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C353	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C354	CAPACITOR 22µF 6.3V	202202900654
C355	CAPACITOR 68pF 1% 50V NPO 0805	222286118689
C357	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C358	CAPACITOR 15 µF 20%6.3V 6.0X3.2 MOLD	532212411418
C359	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C36	CAPACITOR 22µF 6.3V	202202900654
C360	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C361	CAPACITOR 15 µF 20%6.3V 6.0X3.2 MOLD	532212411418
C362	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C363	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C364	CAPACITOR 15 µF 20%6.3V 6.0X3.2 MOLD	532212411418
C365	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C366	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C367	CAPACITOR 15 µF 20%6.3V 6.0X3.2 MOLD	532212411418
C368	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C369	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C37	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C370	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C371	CAPACITOR 220µF 20% 10V 0810 SMD	222215364221
C372	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C373	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C374	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C375	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C376	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C377	CAPACITOR 15 µF 20%6.3V 6.0X3.2 MOLD	532212411418
C378	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C379	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C380	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C381	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C382	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C383	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C385	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C386	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C387	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C388	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C389	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C390	CAPACITOR 100µF 6.3V	202202900655
C391	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C392	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C393	CAPACITOR 100µF 6.3V	202202900655
C394	CAPACITOR 100µF 6.3V	202202900655
C395	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C396	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C397	CAPACITOR 100µF 6.3V	202202900655
C398	CAPACITOR 100µF 6.3V	202202900655
C399	CAPACITOR 220µF 20% 10V 0810 SMD	222215364221
C400	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C401	CAPACITOR 100pF 5% 50V NP0 0805	222286115101
C402	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C404	CAPACITOR 220µF 20% 35V 1012 SMD	222215360221
C405	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C406	CAPACITOR 4.7µF 20% 35V 0405 SMD	222215360478
C407	CAPACITOR 220µF 20% 10V 0810 SMD	222215364221
C408	CAPACITOR 4.7µF 20% 35V 0405 SMD	222215360478
C409	CAPACITOR 220µF 20% 10V 0810 SMD	222215364221
C410	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C411	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C412	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C413	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C414	CAPACITOR 10pF 5% 50V NP0 0805	222286115109
C415	CAPACITOR 22pF 5% 50V NP0 0805	532212232658
C416	CAPACITOR 22pF 5% 50V NP0 0805	532212232658
C417	CAPACITOR 10pF 5% 50V NP0 0805	222286115109
C418	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C419	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C420	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C421	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C422	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C423	CAPACITOR 100µF 6.3V	202202900655
C424	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C425	CAPACITOR 100µF 6.3V	202202900655
C427	CAPACITOR 33pF 5% 50V NP0 0805	222286115339
C428	CAPACITOR 82pF 5% 50V NP0 0805	222286115829
C429	CAPACITOR 100nF 20% 25V X7R 0805	222291016749
C429	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C430	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C431	CAPACITOR 15 µF 20%6.3V 6.0X3.2 MOLD	532212411418
C432	CAPACITOR 33pF 5% 50V NP0 0805	222286115339
C433	CAPACITOR 22pF 5% 50V NP0 0805	532212232658
C434	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C435	CAPACITOR 2.20 µF 20%6.3V 3.2X1.6 MOLD	532212410685
C436	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C437	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C438	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C439	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C440	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C441	CAPACITOR 10pF 5% 50V NP0 0805	222286115109
C442	CAPACITOR-TRIM 3-10pF TZBX4Z100BB110	532212550306
C443	CAPACITOR 2.2pF±0.25pF 50V NP0 0805	222286115228
C444	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C445	CAPACITOR 15pF 5% 50V NP0 0805	222286115159
C446	CAPACITOR 15pF 5% 50V NP0 0805	222286115159
C447	CAPACITOR 33pF 5% 50V NP0 0805	222286115339
C448	CAPACITOR 33pF 5% 50V NP0 0805	222286115339
C449	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C450	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C451	CAPACITOR 100pF 5% 50V NP0 0805	222286115101
C452	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C453	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C454	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C462	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C463	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C464	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C465	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C466	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C467	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C468	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C469	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C470	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C471	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C472	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C473	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C474	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C475	CAPACITOR 10nF 20% 50V X7R 0805	532212234098

Pos	Description	Part Number
C476	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C477	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C478	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C479	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C480	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C481	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C483	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C484	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C486	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C487	CAPACITOR 22pF 5% 50V NP0 0805	532212232658
C488	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C489	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C490	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C491	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C492	CAPACITOR 22µF 20% 35V 0605 SMD	222215360229
C493	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C494	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C496	CAPACITOR-TRIM 2.5-10pF 500VDC AT2320-2	532212550689
C497	CAPACITOR-TRIM 2.5-10pF 500VDC AT2320-2	532212550689
C498	CAPACITOR 22pF 5% 50V NP0 0805	532212232658
C499	CAPACITOR 22µF 6.3V	202202900654
C5	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C500	CAPACITOR 100µF 6.3V	202202900655
C501	CAPACITOR 470pF 10% 50V X7R 0402	403102040471
C503	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C504	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C505	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C506	CAPACITOR 470pF 10% 50V X7R 0402	403102040471
C507	CAPACITOR 6.80 µF 20% 16V 6.0X3.2 MOLD	532212410687
C508	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
C513	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
C514	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
C515	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
C516	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
C517	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C522	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C523	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C524	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C525	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C526	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C527	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C528	CAPACITOR 6.80 µF 20% 16V 6.0X3.2 MOLD	532212410687
C529	CAPACITOR 6.80 µF 20% 16V 6.0X3.2 MOLD	532212410687
C530	CAPACITOR 6.80 µF 20% 16V 6.0X3.2 MOLD	532212410687
C531	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C532	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C533	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C534	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C535	CAPACITOR 100nF 10% 16V X7R 0603	403102030104
C537	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C538	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C539	CAPACITOR 100µF 6.3V	202202900655
C540	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C541	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C542	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C543	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C544	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C545	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C546	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C547	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C548	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C549	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C560	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C561	CAPACITOR 100µF 6.3V	202202900655

Pos	Description	Part Number
C562	CAPACITOR 100µF 6.3V	202202900655
C563	CAPACITOR 100µF 6.3V	202202900655
C564	CAPACITOR 100µF 6.3V	202202900655
C565	CAPACITOR 22pF 5% 50V NP0 0805	532212232658
C566	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C567	CAPACITOR 100nF 20% 25V X7R 0805	532212613638
C568	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
C569	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
C570	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
C571	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
C572	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
C573	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C575	CAPACITOR 100µF 6.3V	202202900655
C576	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C577	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C578	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C579	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C580	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C581	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C582	CAPACITOR 1nF 20% 50V X7R 0805	532212234123
C6	CAPACITOR 1.5pF ±0.25pF 500V NP0 1206	225201471158
C7	CAPACITOR 1.5pF ±0.25pF 500V NP0 1206	225201471158
C8	CAPACITOR 1.5pF ±0.25pF 500V NP0 1206	225201471158
C9	CAPACITOR 1.5pF ±0.25pF 500V NP0 1206	225201471158
C97	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C98	CAPACITOR 10nF 20% 50V X7R 0805	532212234098
C99	CAPACITOR 3.9pF ±0.25pF 500V NP0 1206	225201471398
D10	DIODE 0.10A BAV99 SOT23	532213034337
D11	DIODE 0.10A BAV99 SOT23	532213034337
D12	DIODE 0.10A BAV99 SOT23	532213034337
D13	DIODE 0.10A BAV99 SOT23	532213034337
D14	DIODE 0.10A BAT18 35V 1PF SOT23	532213032076
D15	DIODE 0.10A BAT18 35V 1PF SOT23	532213032076
D17	DIODE 0.10A BAV99 SOT23	532213034337
D18	DIODE 0.10A BAV99 SOT23	532213034337
D19	DIODE 0.10A BAV99 SOT23	532213034337
D20	DIODE 0.10A BAV99 SOT23	532213034337
D21	DIODE 0.10A BAT18 35V 1PF SOT23	532213032076
D22	DIODE 0.10A BAT18 35V 1PF SOT23	532213032076
D23	DIODE VARACTOR SMV1255-073 SC07	403105000001
D24	DIODE VARACTOR SMV1255-073 SC07	403105000001
D25	DIODE 0.10A BAV99 SOT23	933215370701
D25	DIODE 0.10A BAV99 SOT23	532213034337
D26	DIODE 0.10A BAV99 SOT23	532213034337
D27	DIODE 0.10A BAV99 SOT23	532213034337
D28	DIODE 0.10A BAV99 SOT23	532213034337
D29	DIODE 0.10A BAV99 SOT23	532213034337
D30	DIODE 0.10A BAV99 SOT23	532213034337
D31	DIODE 0.10A BAV99 SOT23	532213034337
D32	DIODE 0.10A BAV99 SOT23	532213034337
D33	DIODE 0.10A BAV99 SOT23	532213034337
D34	DIODE 0.10A BAV99 SOT23	532213034337
D35	DIODE 0.10A BAV99 SOT23	532213034337
D36	DIODE 0.10A BAV99 SOT23	532213034337
D37	DIODE 0.10A BAV99 SOT23	532213034337
D46	DIODE 0.10A BAV99 SOT23	532213034337
D48	DIODE 0.10A BAV99 SOT23	532213034337
D50	DIODE BYD17G 400V 1.5A SOD87	933812240701
D51	DIODE BYD17G 400V 1.5A SOD87	933812240701
D52	DIODE 0.10A BAV99 SOT23	532213034337
D53	DIODE-SCH 0.2A BAT54S SOT23 SMD	482213082262
J12	CONNECTOR 20POL HEADER SMD 15-91-0200	242202505569
J13	CONNECTOR 2x10 POL SMD	242202518436
J15	CONNECTOR 20POL HEADER SMD 15-91-0200	242202505569

Pos	Description	Part Number
J17	CONNECTOR 6POS 39-28-1065	242202508091
J22	CONNECTOR 4POL USB PCB	242203300291
J25	CONNECTOR 24 POL 57LE-20240-77OOD35G	532226760148
J28	CONNECTOR HEADER 2POS SMD AMP 6-176125-2	403110571100
J3	CONNECTOR 2 POL F095 SINGLE ROW	532226544074
K1	RELAY SMD UD2 5V	242213207707
K2	RELAY SMD UD2 5V	242213207707
K3	RELAY SMD UD2 5V	242213207707
K4	RELAY SMD UD2 5V	242213207707
K5	RELAY SMD UD2 5V	242213207707
K6	RELAY SMD UD2 5V	242213207707
K7	RELAY SMD UD2 5V	242213207707
K8	RELAY SMD UD2 5V	242213207707
L10	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L11	FILTER-EMI BLM41PF800S	242254900035
L12	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L13	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L14	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L16	FILTER-EMI BLM41PF800S	242254900035
L17	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L18	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L19	CHOKE 4.3µH 1.6A	242253600772
L20	FILTER-EMI BLM41PF800S	242254900035
L21	FILTER-EMI BLM41PF800S	242254900035
L22	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L23	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L24	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L25	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L26	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L27	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L28	CHOKE 4.3µH 1.6A	242253600772
L29	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L3	CHOKE 100nH SMD	242253600773
L30	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L31	CHOKE 4.70µH 5% LQH1N4R7J	242253594048
L32	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L33	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L34	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L35	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L36	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L37	CHOKE 4.70µH 5% LQH1N4R7J	242253594048
L38	CHOKE 4.70µH 5% LQH1N4R7J	242253594048
L39	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L40	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L41	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133

Pos	Description	Part Number
L42	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L43	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L44	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L45	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L46	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L47	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L48	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L49	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L5	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L50	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L51	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L52	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L53	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L54	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L55	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L56	FILTER-EMI BLM41PF800S	242254900035
L57	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L59	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L6	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L60	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L61	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L62	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L63	CHOKE 1µH 20% B82412-A1102-M	241254100458
L66	FILTER-EMI BLM41PF800S	242254900035
L67	FILTER-EMI BLM41PF800S	242254900035
L7	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L8	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
L9	FILTER-EMI BLM21A102SPT Z=1Kohm 0.2A R=0.6ohm	242254943133
M10	SHIELD-CLIP SMD	242201520096
M11	SHIELD-CLIP SMD	242201520096
M12	SHIELD-CLIP SMD	242201520096
M13	SHIELD-CLIP SMD	242201520096
M14	SHIELD-CLIP SMD	242201520096
M15	SHIELD-CLIP SMD	242201520096
M16	SHIELD-CLIP SMD	242201520096
M17	SHIELD-CLIP SMD	242201520096
M18	SHIELD-CLIP SMD	242201520096
M19	SHIELD-CLIP SMD	242201520096
M2	SHIELD-CLIP SMD	242201520096
M20	SHIELD-CLIP SMD	242201520096
M3	SHIELD-CLIP SMD	242201520096
M4	SHIELD-CLIP SMD	242201520096
M5	SHIELD-CLIP SMD	242201520096
M6	SHIELD-CLIP SMD	242201520096

Pos	Description	Part Number
M7	SHIELD-CLIP SMD	242201520096
M8	SHIELD-CLIP SMD	242201520096
M9	SHIELD-CLIP SMD	242201520096
Q1	TRANSISTOR BF513 .03A20V SOT23	482213060686
Q10	TRANSI-HF N SMD BFR93A 35mA 12V SOT23	532213060705
Q11	TRANSISTOR 25 MA BFR92A 20V SOT23	532213060647
Q12	TRANSISTOR BFT92 25MA 15V SOT23	532213044711
Q13	TRANSISTOR 25 MA BFR92A 20V SOT23	532213060647
Q14	TRANSISTOR 25 MA BFR92A 20V SOT23	532213060647
Q15	TRANSISTOR BFT93 35MA 12V SOT23	532213044824
Q16	TRANSISTOR 25 MA BFR92A 20V SOT23	532213060647
Q17	TRANSISTOR 0.5A BC807-25 45V SOT23	532213060845
Q18	TRANSISTOR BFS17 .05A 15V SOT23	532213040781
Q19	TRANSISTOR BFS17 .05A 15V SOT23	532213040781
Q2	TRANSI-HF N SMD BFR93A 35mA 12V SOT23	532213060705
Q20	TRANSISTOR BFS17 .05A 15V SOT23	532213040781
Q21	TRANSISTOR BFS17 .05A 15V SOT23	532213040781
Q22	TRANSISTOR BFS17 .05A 15V SOT23	532213040781
Q23	TRANSISTOR BFS17 .05A 15V SOT23	532213040781
Q24	TRANSISTOR BSR12 0.1A 15V SOT23	532213044743
Q25	TRANSISTOR BSR12 0.1A 15V SOT23	532213044743
Q26	TRANSISTOR BC847B .1A45V SOT23	482213060511
Q27	TRANSISTOR BC847B .1A45V SOT23	482213060511
Q28	TRANSISTOR BF513 .03A20V SOT23	482213060686
Q29	TRANSISTOR BFT92 25MA 15V SOT23	532213044711
Q3	TRANSISTOR 25 MA BFR92A 20V SOT23	532213060647
Q30	TRANSISTOR BF513 .03A20V SOT23	482213060686
Q31	TRANSISTOR BFT92 25MA 15V SOT23	532213044711
Q32	TRANSISTOR BC847B .1A45V SOT23	482213060511
Q33	TRANSISTOR BF513 .03A20V SOT23	482213060686
Q34	TRANSISTOR BFT92 25MA 15V SOT23	532213044711
Q35	TRANSISTOR BC847B .1A45V SOT23	482213060511
Q36	TRANSISTOR BF513 .03A20V SOT23	482213060686
Q37	TRANSISTOR BFT92 25MA 15V SOT23	532213044711
Q38	TRANSISTOR 0.5A BC807-25 45V SOT23	532213060845
Q4	TRANSISTOR BFT92 25MA 15V SOT23	532213044711
Q40	TRANSISTOR 0.5A BC807-25 45V SOT23	532213060845
Q41	TRANSISTOR 0.5A BC807-25 45V SOT23	532213060845
Q42	TRANSISTOR 0.5A BC807-25 45V SOT23	933628570701
Q42	TRANSISTOR 0.5A BC807-25 45V SOT23	532213060845
Q43	TRANSISTOR 0.5A BC807-25 45V SOT23	532213060845
Q44	TRANSISTOR 0.5A BC807-25 45V SOT23	532213060845
Q45	TRANSISTOR 0.5A BC807-25 45V SOT23	532213060845
Q46	TRANSISTOR BC847B .1A45V SOT23	482213060511
Q47	TRANSISTOR BC847B .1A45V SOT23	482213060511
Q48	TRANSISTOR BCP51 1.5A 45V SOT223	532213062639
Q49	TRANSISTOR BCP51 1.5A 45V SOT223	532213062639
Q5	TRANSISTOR 25 MA BFR92A 20V SOT23	532213060647
Q50	TRANSISTOR BC847B .1A45V SOT23	482213060511
Q51	TRANSISTOR BCP51 1.5A 45V SOT223	532213062639
Q53	TRANSI-NPN SMD BFG16A SOT223 1.5GHz 1W	934002210701
Q54	TRANSI-NPN SMD BFG16A SOT223 1.5GHz 1W	934002210701
Q55	TRANSISTOR BFS17 .05A 15V SOT23	532213040781
Q56	TRANSISTOR 0.5A BC807-25 45V SOT23	532213060845
Q57	TRANSI-LF N BCP54 1A 45V SOT223 1.33W	933917180115
Q58	TRANSISTOR BC847B .1A45V SOT23	482213060511
Q59	TRANSISTOR BFT92 25MA 15V SOT23	532213044711
Q6	TRANSISTOR 25 MA BFR92A 20V SOT23	532213060647
Q63	TRANSISTOR BFT92 25MA 15V SOT23	532213044711
Q64	TRANSISTOR BFT92 25MA 15V SOT23	532213044711
Q65	TRANSISTOR BFT92 25MA 15V SOT23	532213044711
Q7	TRANSISTOR BFT93 35MA 12V SOT23	532213044824
Q8	TRANSISTOR 25 MA BFR92A 20V SOT23	532213060647
Q9	TRANSISTOR BF513 .03A20V SOT23	482213060686

Pos	Description	Part Number
R1	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R10	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R11	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R12	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R13	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R132	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R133	RESISTOR 470 ohm 1% .125W 100PPM 1206	482205154701
R134	RESISTOR 470 ohm 1% .125W 100PPM 1206	482205154701
R135	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R136	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R137	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R138	RESISTOR 000 ohm 0.1W 100PPM 0805	403100200000
R139	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R14	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R140	RESISTOR 47 ohm 1% .125W 100PPM 1206	532211680448
R141	RESISTOR 470 kohm 1% .125W 100PPM 1206	532211680447
R142	RESISTOR 120 Kohm 1% .125W 100PPM 1206	482205151204
R143	RESISTOR 680 kohm 1% .125W 100PPM 1206	532211711787
R144	RESISTOR 220 kohm 1% .125W 100PPM 1206	482205152204
R145	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R146	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R147	RESISTOR 330 OHM 1% 0.1W 100PPM 0805	403100233010
R148	RESISTOR 680 kohm 1% .125W 100PPM 1206	532211711787
R149	RESISTOR 10 MOHM 10% 0.25W RC-01 1206	482205110106
R150	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R151	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R153	RESISTOR 3.30 ohm 1% .125W 100PPM 1206	532211711788
R154	RESISTOR 100kohm 1% 0.1W 100PPM 0805	532211712501
R155	RESISTOR 47 KOHM 1% 0.1W 100PPM 0805	403100247030
R156	RESISTOR 470 kohm 1% .125W 100PPM 1206	532211680447
R157	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R158	RESISTOR 1.00Mohm 1% 0.125W 100PPM 1206	482205110105
R159	RESISTOR 100kohm 1% 0.1W 100PPM 0805	532211712501
R16	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R160	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R161	RESISTOR 3.30 ohm 1% .125W 100PPM 1206	532211711788
R162	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R163	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R164	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R165	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R166	RESISTOR 150 ohm 1% 0.125W 100PPM 1206	482205151501
R167	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R168	RESISTOR 68 OHM 1% 0.1W 100PPM 0805	403100268090
R170	RESISTOR 68 OHM 1% 0.1W 100PPM 0805	403100268090
R171	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R172	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R173	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R174	RESISTOR 12.0kohm 1% .125W 100PPM 1206	532211710968
R175	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R176	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R177	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R178	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R179	RESISTOR 150 ohm 1% 0.125W 100PPM 1206	482205151501
R180	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R181	RESISTOR 150 ohm 1% 0.125W 100PPM 1206	482205151501
R182	RESISTOR 470 kohm 1% .125W 100PPM 1206	532211680447
R183	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R184	RESISTOR 220 ohm 1% 0.1W 100PPM 0805	403100222010
R185	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R187	RESISTOR 27 ohm 1% 0.1W 100PPM 0805	403100227090
R188	RESISTOR 470 kohm 1% .125W 100PPM 1206	532211680447
R189	RESISTOR 470 kohm 1% .125W 100PPM 1206	532211680447
R190	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R191	RESISTOR 1 MOHM 1% 0.1W 100PPM 0805	403100210050

Pos	Description	Part Number
R192	RESISTOR 000 ohm 0.1W 100PPM 0805	403100200000
R193	RESISTOR 330 OHM 1% 0.1W 100PPM 0805	403100233010
R194	RESISTOR 27 ohm 1% 0.1W 100PPM 0805	403100227090
R195	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R196	POTENTIOMETER 100kohm 3304X-1-104	532210110841
R197	POTENTIOMETER 2 KOHM 25% 4mm	403101000001
R198	RESISTOR 15 KOHM 1% 0.1W 100PPM 0805	403100215030
R199	RESISTOR 47 KOHM 1% 0.1W 100PPM 0805	403100247030
R2	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R20	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R200	RESISTOR 470 ohm 1% .125W 100PPM 1206	482205154701
R201	RESISTOR 470 ohm 1% .125W 100PPM 1206	482205154701
R202	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R203	RESISTOR 1.5 KOHM 1% 0.1W 100PPM 0805	403100215020
R205	RESISTOR 180kohm 1% 0.1W 100PPM 0805	403100218040
R206	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R207	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R208	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R209	RESISTOR 000 ohm 0.1W 100PPM 0805	403100200000
R21	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R210	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R211	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R212	RESISTOR 47 ohm 1% .125W 100PPM 1206	532211680448
R213	RESISTOR 470 kohm 1% .125W 100PPM 1206	532211680447
R214	RESISTOR 120 Kohm 1% .125W 100PPM 1206	482205151204
R215	RESISTOR 680 kohm 1% .125W 100PPM 1206	532211711787
R216	RESISTOR 220 kohm 1% .125W 100PPM 1206	482205152204
R217	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R218	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R219	RESISTOR 330 OHM 1% 0.1W 100PPM 0805	403100233010
R22	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R220	RESISTOR 680 kohm 1% .125W 100PPM 1206	532211711787
R221	RESISTOR 10 MOHM 10% 0.25W RC-01 1206	482205110106
R222	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R223	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R224	SENSOR-TEMP KTY82/120	532213010682
R225	RESISTOR 3.30 ohm 1% .125W 100PPM 1206	532211711788
R226	RESISTOR 100kohm 1% 0.1W 100PPM 0805	532211712501
R227	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R228	RESISTOR 47 KOHM 1% 0.1W 100PPM 0805	403100247030
R229	RESISTOR 470 kohm 1% .125W 100PPM 1206	532211680447
R23	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R230	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R231	RESISTOR 1.00Mohm 1% 0.125W 100PPM 1206	482205110105
R232	RESISTOR 100kohm 1% 0.1W 100PPM 0805	532211712501
R233	RESISTOR 3.30 ohm 1% .125W 100PPM 1206	532211711788
R234	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R235	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R236	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R237	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R238	RESISTOR 150 ohm 1% 0.125W 100PPM 1206	482205151501
R239	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R240	RESISTOR 82 OHM 1% 0.1W 100PPM 0805	403100282090
R241	RESISTOR 68 OHM 1% 0.1W 100PPM 0805	403100268090
R242	RESISTOR 68 OHM 1% 0.1W 100PPM 0805	403100268090
R243	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R244	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R245	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R246	RESISTOR 12.0kohm 1% .125W 100PPM 1206	532211710968
R247	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R248	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R249	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R250	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R251	RESISTOR 150 ohm 1% 0.125W 100PPM 1206	482205151501

Pos	Description	Part Number
R252	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R253	RESISTOR 150 ohm 1% 0.125W 100PPM 1206	482205151501
R254	RESISTOR 470 kohm 1% .125W 100PPM 1206	532211680447
R255	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R256	RESISTOR 220 ohm 1% 0.1W 100PPM 0805	403100222010
R257	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R258	RESISTOR 120 Kohm 1% .125W 100PPM 1206	482205151204
R259	RESISTOR 27 ohm 1% 0.1W 100PPM 0805	403100227090
R260	RESISTOR 470 kohm 1% .125W 100PPM 1206	532211680447
R261	RESISTOR 470 kohm 1% .125W 100PPM 1206	532211680447
R263	RESISTOR 330 OHM 1% 0.1W 100PPM 0805	403100233010
R264	RESISTOR 27 ohm 1% 0.1W 100PPM 0805	403100227090
R265	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R266	RESISTOR 000 ohm 0.1W 100PPM 0805	403100200000
R267	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R268	POTENTIOMETER 100kohm 3304X-1-104	532210110841
R269	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R270	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R271	RESISTOR 220 ohm 1% 0.1W 100PPM 0805	403100222010
R272	RESISTOR 3.3 KOHM 1% 0.1W 100PPM 0805	403100233020
R273	RESISTOR 120 Kohm 1% .125W 100PPM 1206	482205151204
R274	RESISTOR 1 MOHM 1% 0.1W 100PPM 0805	403100210050
R275	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R277	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R278	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R279	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	403100247090
R279	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R280	RESISTOR 1 MOHM 1% 0.1W 100PPM 0805	403100210050
R281	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R282	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R283	RESISTOR 47 KOHM 1% 0.1W 100PPM 0805	403100247030
R284	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R285	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R286	RESISTOR 470 ohm 1% .125W 100PPM 1206	482205154701
R287	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R288	RESISTOR 100kohm 1% 0.1W 100PPM 0805	532211712501
R289	RESISTOR 100kohm 1% 0.1W 100PPM 0805	532211712501
R290	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R291	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R292	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R293	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R294	RESISTOR 47 KOHM 1% 0.1W 100PPM 0805	403100247030
R295	RESISTOR 100 ohm 1% 0.125W 100PPM 1206	482205151001
R296	RESISTOR 100 ohm 1% 0.125W 100PPM 1206	482205151001
R3	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R303	RESISTOR 47 KOHM 1% 0.1W 100PPM 0805	403100247030
R305	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R306	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R307	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R308	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R309	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R310	RESISTOR 68 OHM 1% 0.1W 100PPM 0805	403100268090
R311	RESISTOR 68 OHM 1% 0.1W 100PPM 0805	403100268090
R312	RESISTOR 22 ohm 1% 0.1W 100PPM 0805	532211712507
R313	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R314	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R315	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R316	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R317	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R318	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R319	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R320	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R321	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R322	RESISTOR 39 KOHM 1% 0.1W 100PPM 0805	403100239030

Pos	Description	Part Number
R323	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R324	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R325	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R326	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R327	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R328	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R329	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R331	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R332	RESISTOR 39 KOHM 1% 0.1W 100PPM 0805	403100239030
R333	RESISTOR 270 OHM 1% 0.1W 100PPM 0805	403100227010
R334	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R335	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R337	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R338	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R339	RESISTOR 150 ohm 1% 0.1W 100PPM 0805	403100215010
R340	RESISTOR 270 OHM 1% 0.1W 100PPM 0805	403100227010
R341	RESISTOR 22 ohm 1% 0.1W 100PPM 0805	532211712507
R342	RESISTOR 820 ohm 1% .125W 100PPM 1206	532211682264
R343	RESISTOR 68 OHM 1% 0.1W 100PPM 0805	403100268090
R344	RESISTOR 68 OHM 1% 0.1W 100PPM 0805	403100268090
R346	RESISTOR 680 ohm 1% 0.1W 100PPM 0805	532211712509
R347	RESISTOR 22 ohm 1% 0.1W 100PPM 0805	532211712507
R348	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R349	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R350	RESISTOR 680 ohm 1% 0.1W 100PPM 0805	532211712509
R351	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R352	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R353	RESISTOR 3.3 KOHM 1% 0.1W 100PPM 0805	403100233020
R354	RESISTOR 3.3 KOHM 1% 0.1W 100PPM 0805	403100233020
R355	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R358	RESISTOR 1 MOHM 1% 0.1W 100PPM 0805	403100210050
R359	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R360	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R361	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R362	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R363	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R372	RESISTOR 68 KOHM 1% 0.1W 100PPM 0805	403100268030
R373	RESISTOR 33 KOHM 1% 0.1W 100PPM 0805	403100233030
R374	RESISTOR 47 KOHM 1% 0.1W 100PPM 0805	403100247030
R375	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R376	RESISTOR 82 OHM 1% 0.1W 100PPM 0805	403100282090
R377	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R378	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R379	RESISTOR 1.5 KOHM 1% 0.1W 100PPM 0805	403100215020
R380	RESISTOR 10 ohm 1% 0.1W 100PPM 0805	532211712502
R381	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R382	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R383	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R384	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R385	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R386	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R387	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R389	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R390	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R391	RESISTOR 1.5 KOHM 1% 0.1W 100PPM 0805	403100215020
R392	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R393	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R394	RESISTOR 15 KOHM 1% 0.1W 100PPM 0805	403100215030
R395	RESISTOR 33 KOHM 1% 0.1W 100PPM 0805	403100233030
R396	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R397	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R398	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R399	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R4	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499

Pos	Description	Part Number
R400	RESISTOR 47 KOHM 1% 0.1W 100PPM 0805	403100247030
R402	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R403	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R404	RESISTOR 82 OHM 1% 0.1W 100PPM 0805	403100282090
R405	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R406	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R407	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R408	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R409	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R410	RESISTOR 82 OHM 1% 0.1W 100PPM 0805	403100282090
R411	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R413	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R414	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R416	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R417	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R418	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R419	RESISTOR 6.8 KOHM 1% 0.1W 100PPM 0805	403100268020
R421	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R422	RESISTOR 6.8 KOHM 1% 0.1W 100PPM 0805	403100268020
R423	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R424	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R425	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R426	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R427	RESISTOR 6.8 KOHM 1% 0.1W 100PPM 0805	403100268020
R430	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R431	RESISTOR 000 ohm 0.1W 100PPM 0805	403100200000
R432	RESISTOR 6.8 KOHM 1% 0.1W 100PPM 0805	403100268020
R434	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R435	RESISTOR 6.8 KOHM 1% 0.1W 100PPM 0805	403100268020
R437	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R438	RESISTOR 6.8 KOHM 1% 0.1W 100PPM 0805	403100268020
R440	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R441	RESISTOR 6.8 KOHM 1% 0.1W 100PPM 0805	403100268020
R443	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R444	RESISTOR 6.8 KOHM 1% 0.1W 100PPM 0805	403100268020
R445	RESISTOR 1.5 KOHM 1% 0.1W 100PPM 0805	403100215020
R446	RESISTOR 470 OHM 1% 0.1W 100PPM 0805	403100247010
R447	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R448	RESISTOR 680 ohm 1% 0.1W 100PPM 0805	532211712509
R449	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R450	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R451	RESISTOR 330 OHM 1% 0.1W 100PPM 0805	403100233010
R452	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R453	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R454	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R455	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R456	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R457	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R458	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R459	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R460	RESISTOR 3.3 KOHM 1% 0.1W 100PPM 0805	403100233020
R461	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R462	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R463	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R464	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R465	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R466	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R467	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R468	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R469	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R470	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R471	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R472	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R473	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109

Pos	Description	Part Number
R474	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R475	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R476	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R477	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R478	RESISTOR 1 MOHM 1% 0.1W 100PPM 0805	403100210050
R479	RESISTOR 220 ohm 1% 0.1W 100PPM 0805	403100222010
R480	RESISTOR 470 OHM 1% 0.1W 100PPM 0805	403100247010
R481	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R482	RESISTOR 3.3 KOHM 1% 0.1W 100PPM 0805	403100233020
R483	RESISTOR 3.3 KOHM 1% 0.1W 100PPM 0805	403100233020
R484	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R485	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R486	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R487	RESISTOR 470 kohm 1% .125W 100PPM 1206	532211680447
R488	RESISTOR 15 KOHM 1% 0.1W 100PPM 0805	403100215030
R489	RESISTOR 330 KOHM 1% 0.1W 100PPM 0805	403100233040
R490	RESISTOR 150 KOHM 1% 0.1W 100PPM 0805	403100215040
R491	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R492	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R493	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R494	RESISTOR 1 MOHM 1% 0.1W 100PPM 0805	403100210050
R495	RESISTOR 33 KOHM 1% 0.1W 100PPM 0805	403100233030
R496	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R497	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R498	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R499	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R5	RESISTOR 150 ohm 1% 0.1W 100PPM 0805	403100215010
R500	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R501	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R502	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R503	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R504	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R505	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R506	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R507	RESISTOR 330 OHM 1% 0.1W 100PPM 0805	403100233010
R508	RESISTOR 330 OHM 1% 0.1W 100PPM 0805	403100233010
R509	RESISTOR 470 ohm 1% .125W 100PPM 1206	482205154701
R510	RESISTOR 470 ohm 1% .125W 100PPM 1206	482205154701
R511	RESISTOR 330 OHM 1% 0.1W 100PPM 0805	403100233010
R512	RESISTOR 470 ohm 1% .125W 100PPM 1206	482205154701
R513	RESISTOR 330 OHM 1% 0.1W 100PPM 0805	403100233010
R514	RESISTOR 1.5 KOHM 1% 0.1W 100PPM 0805	403100215020
R515	RESISTOR 330 OHM 1% 0.1W 100PPM 0805	403100233010
R516	RESISTOR 15 KOHM 1% 0.1W 100PPM 0805	403100215030
R517	RESISTOR 330 OHM 1% 0.1W 100PPM 0805	403100233010
R518	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R519	RESISTOR 330 OHM 1% 0.1W 100PPM 0805	403100233010
R520	RESISTOR 330 OHM 1% 0.1W 100PPM 0805	403100233010
R521	RESISTOR 330 OHM 1% 0.1W 100PPM 0805	403100233010
R522	RESISTOR 330 OHM 1% 0.1W 100PPM 0805	403100233010
R523	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R524	RESISTOR 22 ohm 1% 0.1W 100PPM 0805	532211712507
R525	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R526	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R527	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R528	RESISTOR 22 ohm 1% 0.1W 100PPM 0805	532211712507
R529	RESISTOR 3.3 KOHM 1% 0.1W 100PPM 0805	403100233020
R530	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R531	RESISTOR 100 ohm 1% 0.125W 100PPM 1206	482205151001
R532	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R533	RESISTOR 100 ohm 1% 0.125W 100PPM 1206	482205151001
R534	RESISTOR 22 ohm 1% 0.1W 100PPM 0805	532211712507
R535	RESISTOR 22 ohm 1% 0.1W 100PPM 0805	532211712507
R536	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R537	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R538	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R539	RESISTOR 22 ohm 1% 0.1W 100PPM 0805	532211712507
R540	RESISTOR 22 ohm 1% 0.1W 100PPM 0805	532211712507
R541	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R543	RESISTOR 1 MOHM 1% 0.1W 100PPM 0805	403100210050
R544	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R545	RESISTOR 1.5 KOHM 1% 0.1W 100PPM 0805	403100215020
R546	RESISTOR 1.5 KOHM 1% 0.1W 100PPM 0805	403100215020
R547	RESISTOR 470 ohm 1% .125W 100PPM 1206	482205154701
R548	RESISTOR 91kohm 1% 0.1W 100PPM 0805	403100291030
R549	RESISTOR 470 ohm 1% .125W 100PPM 1206	482205154701
R551	RESISTOR 3.3 KOHM 1% 0.1W 100PPM 0805	403100233020
R552	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R553	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R554	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R555	RESISTOR 470 ohm 1% .125W 100PPM 1206	482205154701
R557	RESISTOR 15 OHM 1% 0.1W 100PPM 0805	403100215090
R558	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R559	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R560	RESISTOR 100kohm 1% 0.1W 100PPM 0805	532211712501
R561	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R562	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R563	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R564	RESISTOR 330 OHM 1% 0.1W 100PPM 0805	403100233010
R565	RESISTOR 330 OHM 1% 0.1W 100PPM 0805	403100233010
R566	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R567	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R568	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R569	RESISTOR 150 ohm 1% 0.1W 100PPM 0805	403100215010
R570	RESISTOR 100 ohm 1% 0.125W 100PPM 1206	482205151001
R571	RESISTOR 100 ohm 1% 0.125W 100PPM 1206	482205151001
R572	RESISTOR 100 ohm 1% 0.125W 100PPM 1206	482205151001
R573	RESISTOR 100 ohm 1% 0.125W 100PPM 1206	482205151001
R575	RESISTOR 100 ohm 1% 0.125W 100PPM 1206	482205151001
R576	RESISTOR 100 ohm 1% 0.125W 100PPM 1206	482205151001
R577	RESISTOR 100 ohm 1% 0.125W 100PPM 1206	482205151001
R578	RESISTOR 100 ohm 1% 0.125W 100PPM 1206	482205151001
R579	RESISTOR 1.5 KOHM 1% 0.1W 100PPM 0805	403100215020
R580	RESISTOR 3.3 KOHM 1% 0.1W 100PPM 0805	403100233020
R581	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R582	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R583	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R584	RESISTOR 47 ohm 1% 0.1W 100PPM 0805	532211712505
R585	RESISTOR 470 OHM 1% 0.1W 100PPM 0805	403100247010
R586	RESISTOR 470 OHM 1% 0.1W 100PPM 0805	403100247010
R587	RESISTOR 470 OHM 1% 0.1W 100PPM 0805	403100247010
R589	RESISTOR 100kohm 1% 0.1W 100PPM 0805	532211712501
R590	RESISTOR 150 ohm 1% 0.1W 100PPM 0805	403100215010
R591	RESISTOR 150 ohm 1% 0.1W 100PPM 0805	403100215010
R592	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R593	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R594	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R595	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R596	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R597	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R598	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R599	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R6	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R600	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R601	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R602	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R603	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R604	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109

Pos	Description	Part Number
R605	RESISTOR 10.0 ohm 1% 0.125W 100PPM 1206	482205110109
R606	RESISTOR 100 ohm 1% 0.125W 100PPM 1206	482205151001
R607	RESISTOR 100 ohm 1% 0.125W 100PPM 1206	482205151001
R608	RESISTOR 100 ohm 1% 0.125W 100PPM 1206	482205151001
R609	RESISTOR 100 ohm 1% 0.125W 100PPM 1206	482205151001
R610	RESISTOR 1.2 Mohm 1% 0.125W 1206	403100112050
R611	RESISTOR 1.2 Mohm 1% 0.125W 1206	403100112050
R612	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R613	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R614	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R615	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R616	RESISTOR 820 ohm 1% .125W 100PPM 1206	532211682264
R617	RESISTOR 6.8 KOHM 1% 0.1W 100PPM 0805	403100268020
R618	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R619	RESISTOR 1kohm 1% 0.1W 100PPM 0805	532211712498
R620	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R621	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R622	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R623	RESISTOR 470 OHM 1% 0.1W 100PPM 0805	403100247010
R624	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R625	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R626	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R627	RESISTOR 120 ohm 1% 0.125W 100PPM 1206	482205110121
R628	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R629	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R630	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R631	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R632	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R633	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R634	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R635	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R636	RESISTOR 4.7 KOHM 1% 0.1W 100PPM 0805	403100247020
R637	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R638	RESISTOR 10 ohm 1% 0.1W 100PPM 0805	532211712502
R639	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R640	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R641	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R642	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R643	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R644	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R645	RESISTOR 2.2 KOHM 1% 0.1W 100PPM 0805	403100222020
R646	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R647	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R648	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R649	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R650	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R651	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R652	RESISTOR 82 OHM 1% 0.1W 100PPM 0805	403100282090
R653	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R654	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R655	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R656	RESISTOR 1.5 KOHM 1% 0.1W 100PPM 0805	403100215020
R657	RESISTOR 1.5 KOHM 1% 0.1W 100PPM 0805	403100215020
R658	RESISTOR 10 ohm 1% 0.1W 100PPM 0805	532211712502
R659	RESISTOR 10 ohm 1% 0.1W 100PPM 0805	532211712502
R66	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R660	RESISTOR 10 ohm 1% 0.1W 100PPM 0805	532211712502
R661	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R662	RESISTOR 470 ohm 1% .125W 100PPM 1206	482205154701
R664	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R665	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R666	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499
R667	RESISTOR 100 ohm 1% 0.1W 100PPM 0805	532211712497
R668	RESISTOR 10kohm 1% 0.1W 100PPM 0805	532211712499

Pos	Description	Part Number
R669	RESISTOR 22 ohm 1% 0.1W 100PPM 0805	532211712507
U1	IC-OPAMP LMC6081	932220497682
U11	IC-FPGA	932220399682
U116	IC-ANA MAX6355TWUT-T	932220433682
U118	IC-REG MAX1927REUB	932220434682
U12	IC-DIG ECLIPS MC10E104	482220931775
U122	IC-REF 2.5V LT1009CD-2.5 2.5Vñ0.2% 15ppm	532220990434
U123	IC-REG LM2991S	932220425682
U124	IC-REG LM2991S	932220425682
U126	IC-REG LP2951	932207501682
U127	IC-SWITCH MIC2505-1BM	932220437682
U128	IC-ANA SMPS CTR LTC3412	932220430682
U129	IC-REG LM2940CS-12	932211044682
U13	IC-CPU LH79524	403106000012
U130	IC-REG LM2940CS-12	932211044682
U131	IC-COMP MAX961 SO8 4.5ns	932219434682
U132	IC-ANA ADG719 SPDT-SWITCH MSOP-8	403106000008
U133	IC-ANA ADG719 SPDT-SWITCH MSOP-8	403106000008
U134	IC-ANA ADG719 SPDT-SWITCH MSOP-8	403106000008
U135	IC-ANA ADG719 SPDT-SWITCH MSOP-8	403106000008
U15	IC-SRAM K4S281632D	932220429682
U16	IC-SRAM K4S281632D	932220429682
U17	IC-PROM Am29LV640MH	932220405682
U18	IC-OPAMP OPA277	932214746682
U19	IC-OPAMP OPA277	932214746682
U2	IC-OPAMP LMC6081	932220497682
U20	IC-OMV ADC 10BIT ADC1061C1WM SO20	932218755682
U21	IC-OMV ADC 10BIT ADC1061C1WM SO20	932218755682
U22	IC-OMV ADC 10BIT ADC1061C1WM SO20	932218755682
U23	IC-OMV ADC 10BIT ADC1061C1WM SO20	932218755682
U24	IC-OPAMP OPA277	932214746682
U25	IC-CMOS 74HCT126D SMD SO14	933757050701
U26	IC-OPAMP OPA277	932214746682
U28	IC-OPAMP OPA277	932214746682
U29	IC-CMOS 74LVC74AD	935260734701
U3	IC-COMP ADCMP565BP	932220403682
U30	IC-OP AMP LM358 x2 SMD SO8	482220960175
U31	IC-OPAMP LMH6624	932220398682
U32	IC-CMOS 74LVC74AD	935260734701
U33	IC-CMOS 74ALVC00	932220496682
U34	IC-DIG BUS ISP1181B	935271360701
U35	IC-OP AMP LM358 x2 SMD SO8	933965740685
U35	IC-OP AMP LM358 x2 SMD SO8	482220960175
U37	IC-DIG BUS TNT4882	932220397682
U38	IC-CMOS TRANSL3-5V 74LVC4245AD	935260749701
U39	IC-DIG TEMP SENSOR LM75	932212511682
U4	IC-CMOS 74ALVC00	932220496682
U40	IC-DIG BUS I2C PCA9555PW	935269569701
U41	IC-CMOS 74HCT126D SMD SO14	933757050701
U42	IC-OP AMP KM4100IT5 SOT23-5 260MHz	403106000002
U43	IC-OP AMP KM4100IT5 SOT23-5 260MHz	403106000002
U44	IC-OP AMP KM4100IT5 SOT23-5 260MHz	403106000002
U45	IC-OP AMP KM4100IT5 SOT23-5 260MHz	403106000002
U46	IC-CONV DAC MAX5156BCEE 12bit dual	403106000001
U47	IC-CMOS 74LVC1G04GV LOG 1xINV	935271788125
U48	IC-CMOS 74LVC1G04GV LOG 1xINV	935271788125
U5	IC-DAC 12BIT LTC8043	932220498682
U50	IC-OP AMP TLE2022C SMD SO	532220990433
U52	IC-CMOS 74LVC162245ADGG TSSOP48	403106000010
U53	IC-CMOS 74LVC162245ADGG TSSOP48	403106000010
U54	IC-CMOS 74LVC162245ADGG TSSOP48	403106000010
U56	IC-CMOS 74LVC08AD SO14	403106000009
U57	IC-CMOS 74LVC1G02GV NOR SOT753	403106000011
U6	IC-OPAMP OPA277	932214746682

Pos	Description	Part Number
U7	IC-OPAMP OPA277	932214746682
U8	IC-OP AMP LM358 x2 SMD SO8	933965740685
U8	IC-OP AMP LM358 x2 SMD SO8	482220960175
U9	IC-ANALOG-PLL 200MHz ADF4001BRU	932220404682

NOTE: The preceding parts lists for the two versions of the main PCB are both complete for the sake of simplicity. Consequently there is redundant information.

Parts Unique to Version A

Pos	Description	Part Number
B3	CRYSTAL 32kHz MC-406	242254301419
R364	RESISTOR 22 kOhm 1% 0.1W 100PPM 0805	403100222030
R367	RESISTOR 22 kOhm 1% 0.1W 100PPM 0805	403100222030
R549	RESISTOR 1 kOhm 1% 0.125W 1206	403100110020
U13	IC-CPU TA7S20-60QC	932220406682
U14	IC-CMOS SN74LVC125AD	932220193682

Parts Unique to Version B

Pos	Description	Part Number
B7	CRYSTAL 11.2896 MHz HC49/USM SMD	403110056560
C281	CAPACITOR 100nF 10% 16V X7R 0603	403102030104
C282	CAPACITOR 100nF 10% 16V X7R 0603	403102030104
C283	CAPACITOR 100nF 10% 16V X7R 0603	403102030104
C284	CAPACITOR 100nF 10% 16V X7R 0603	403102030104
C285	CAPACITOR 470pF 10% 50V X7R 0402	403102040471
C286	CAPACITOR 470pF 10% 50V X7R 0402	403102040471
C287	CAPACITOR 470pF 10% 50V X7R 0402	403102040471
C288	CAPACITOR 100nF 10% 16V X7R 0603	403102030104
C304	CAPACITOR 100nF 10% 16V X7R 0603	403102030104
C305	CAPACITOR 100nF 10% 16V X7R 0603	403102030104
C306	CAPACITOR 100nF 10% 16V X7R 0603	403102030104
C309	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
C501	CAPACITOR 470pF 10% 50V X7R 0402	403102040471
C506	CAPACITOR 470pF 10% 50V X7R 0402	403102040471
C508	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
C513	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
C514	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
C515	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
C516	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
C535	CAPACITOR 100nF 10% 16V X7R 0603	403102030104
C568	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
C569	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
C570	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
C571	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
C572	CAPACITOR 10nF 10% 25V X7R 0402	403102040103
R548	RESISTOR 91 kohm 1% 0.1W 100PPM 0805	403100291030
U13	IC-CPU LH79524	403106000012

Pos	Description	Part Number
U52	IC-CMOS 74LVC162245ADGG TSSOP48	403106000010
U53	IC-CMOS 74LVC162245ADGG TSSOP48	403106000010
U54	IC-CMOS 74LVC162245ADGG TSSOP48	403106000010
U56	IC-CMOS 74LVC08AD SO14	403106000009
U57	IC-CMOS 74LVC1G02GV NOR SOT753	403106000011

NOTE: The two tables above are meant to pinpoint the parts that are unique to the respective version. Consequently they are excerpts from the complete lists.

Parts Common to Version A and Version B

NOTE 1: Only parts with changed quantities are shown.

NOTE 2: **+** means that the part has been added.
- means that the part has been deleted.
Changes refer to Version A.

+ Pos	- Pos	Part Number
C36,C354,C499	C251	202202900654
C384,C390,C423,C425,C500, C539,C561,C562,C563,C564, C575	C250	202202900655
C253	C252,C256,C259,C431	222215364221
	C254	222286115221
C565		222286115229
C33,C27	C248,C249	222286115279
C302,C343,C373,C379,C391, C392,C413,C418,C419,C420, C502,C537,C538,C543,C544, C549,C560,C566,C573,C576, C577,C578,C579,C580,C582		222286148102
C34,C35,C37,C38,C248, C249,C301,C320,C581	C535	222286148103
	C253	222286115681
C277,C505,C517,C540,C541, C542,C545,C546,C547,C548, C567	C255,C278,C281,C282, C283,C284,C285,C286, C287,C288,C301,C302, C304,C305,C306,C307, C308,C309,C320	222291016749
	L15	242253600772
L66,L67	L18	242254900035
L18		242254943133
	R585,R586,R587,R590,R591	403100115010
	R368,R369	403100122040
R549,R662		403100147010
R637,R639,R644,R647,R648, R649,R650,R651,R653,R654, R655,R661,R667		403100210010
	R523	403100210020
R20,R21,R22,R23,R425, R541,R629,R630,R631,R632, R663,R664,R665,R666,R668		403100210030
R638		403100210090
R590,R591		403100215010
R633,R634	R356,R357,R365,R629,R630	403100222020
R669		403100222090
	R370	403100233030

+ Pos	- Pos	Part Number
R585,R586,R587		403100247010
R523,R628,R635,R636		403100247020
	R371	403100247030
C431		403102131590
	U117	932220434682
U25		933757050701

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Chapter 9

Schematic Diagrams

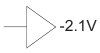
How to Read the Diagrams

This chapter contains circuit diagrams and component layout information.

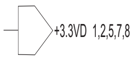
Signals

The signal designations reflect the functions. ADCDATA0, for instance, means DATA BIT 0 from the ADC (Analog/Digital Converter).

Three different types of graphic symbols are used to mark references for continued connection somewhere else in the diagram.



This arrow is used if the reference to a supply voltage is directed to a point located on the same sheet. The example means that the supply voltage -2.1V can also be found elsewhere on the same sheet.



This arrow is used if the reference to a supply voltage or a signal is directed to a point located on another sheet. The example means that the supply voltage +3.3VD goes to sheet 1, 2, 5, 7 and 8.

PLL LOCK

A broken line with a signal designation label means that this particular signal can also be found elsewhere on the same sheet.

Circuit Symbols

The diagrams are computer-drawn. The symbols conform to IEC standards. These symbols are designed to be logical and easy to read.

The component number is written above the symbol. The type number is written below the symbol

Inside the symbol there is sometimes an abbreviated description of the circuit's function.

Pin numbers are written outside the symbol and, if the circuit is complex, the pin functions are written inside.

A small circle on a pin indicates that the input/output inverts the signal.

The signal flow through the circuit is normally from left to right.

Resistors, Capacitors, Diodes, Transistors and Other Components.

These components are similar to the old-fashioned, hand-drawn symbols. They have their component numbers above or beside the symbol and their value or type number below the component number.

Component Numbers

Letters	Components
B	Crystals and crystal filters
C	Capacitors
D	Diodes
F	Fuses
J	Jumpers and connectors
K	Relays
L	Coils
P	Connectors
Q	Transistors
R	Resistors
U	ICs
X	Test points

The numbers that follow are sequential and serve as schematic diagram and layout identifiers together with the leading character.

Version A

The descriptions in this section apply to instruments having a Triscend microprocessor.

See General Information on page III for details on relevant serial numbers etc.

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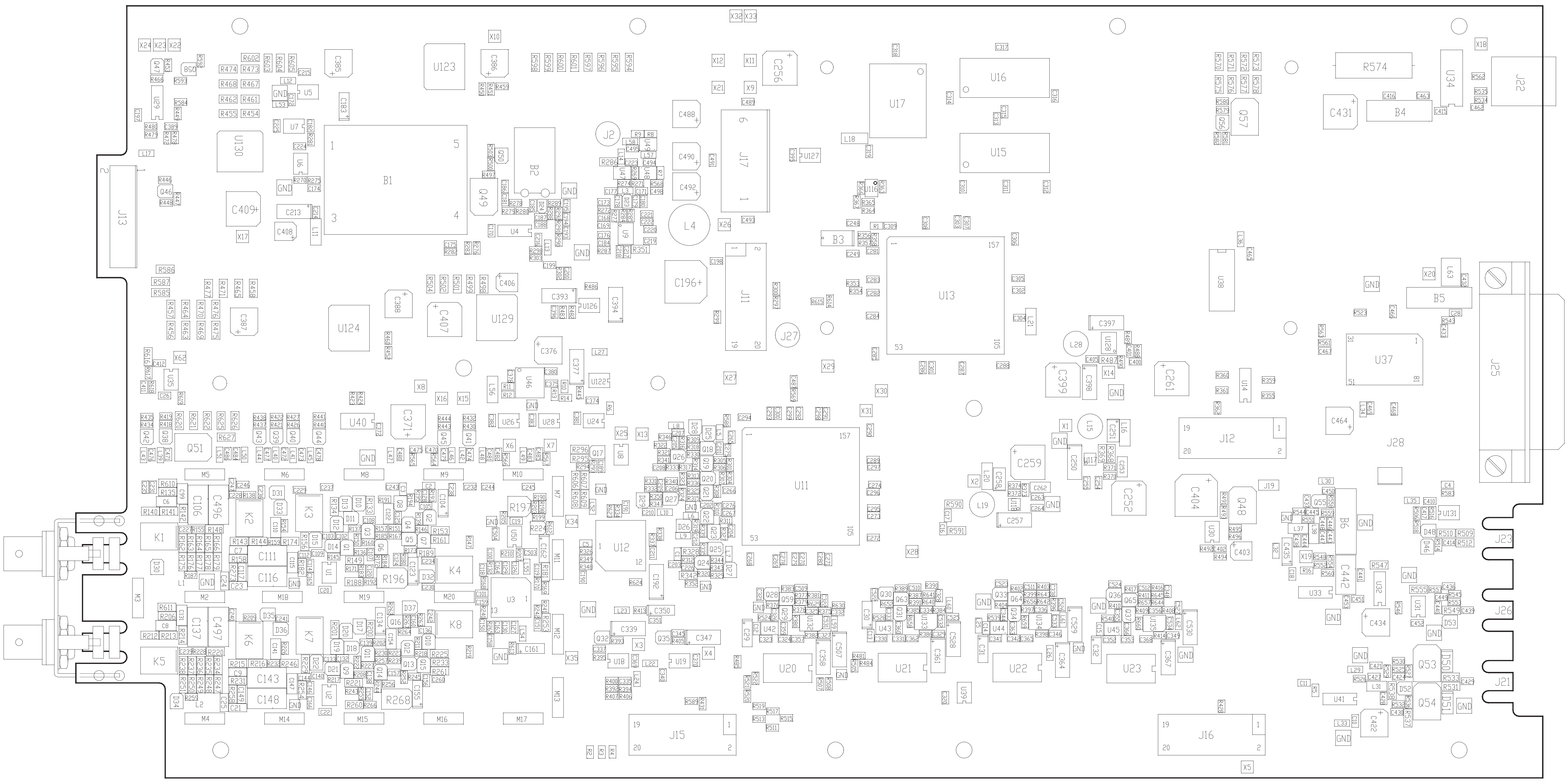
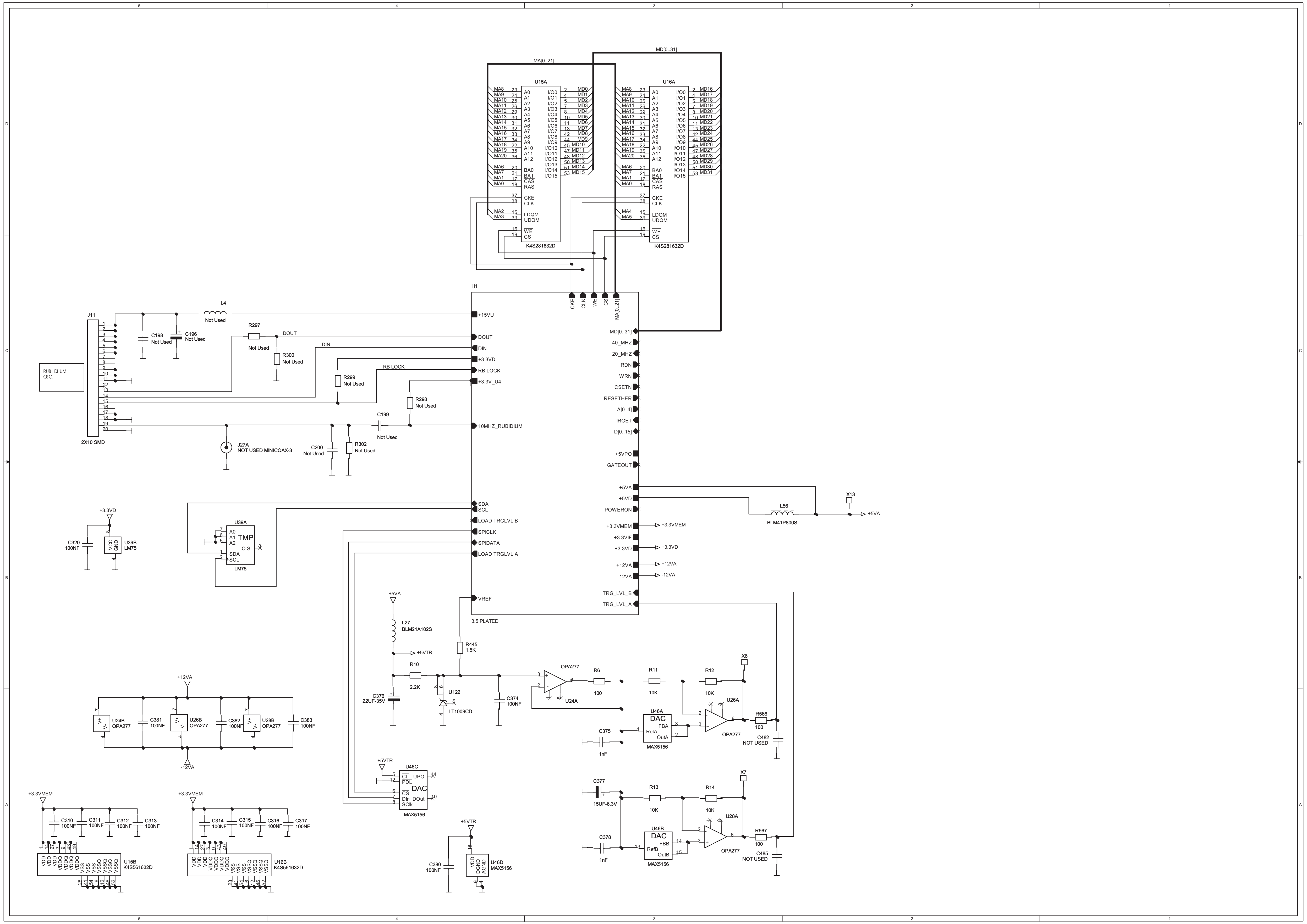
Main Board, PCB 1, Component Layout



Main Schematic



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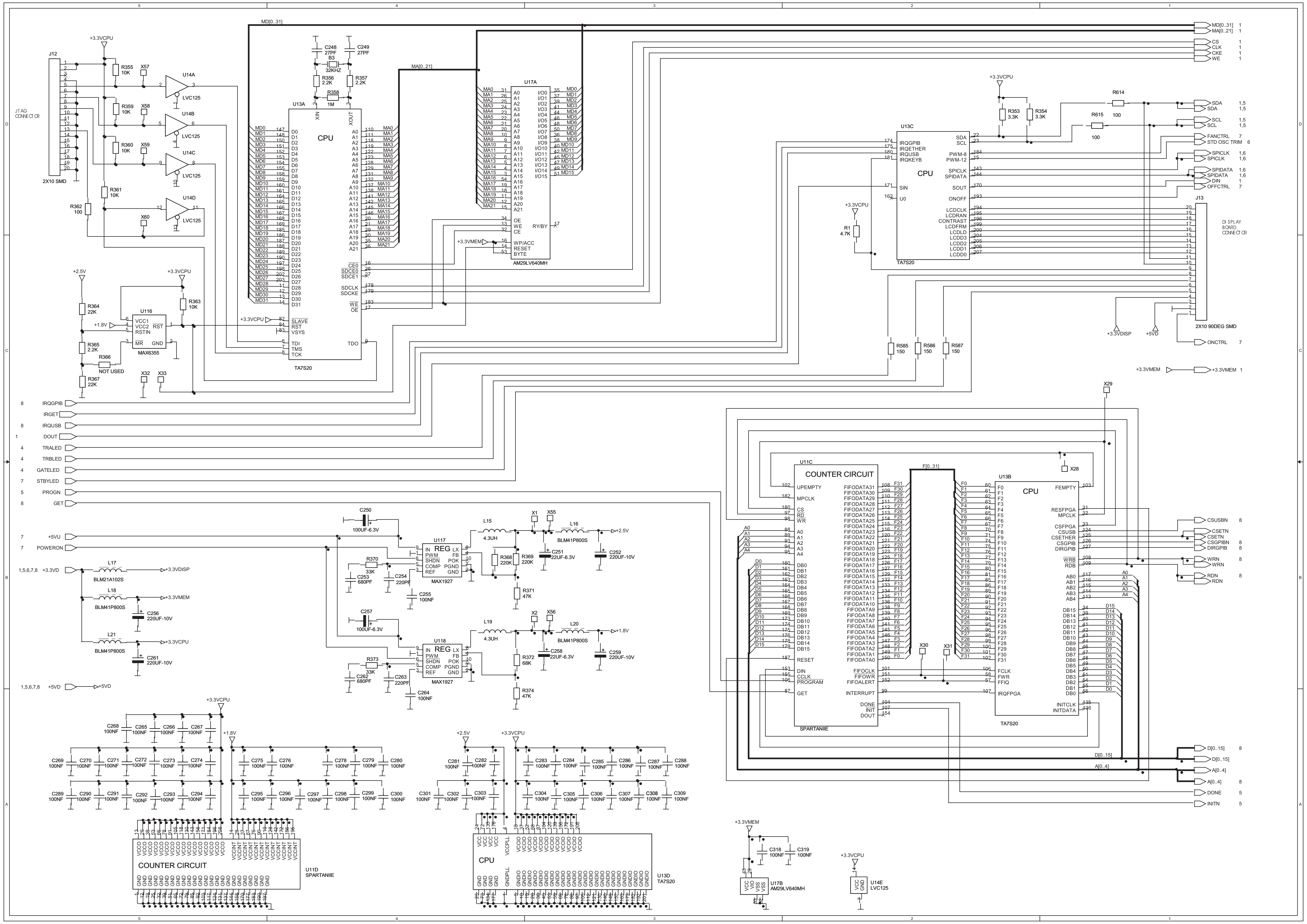

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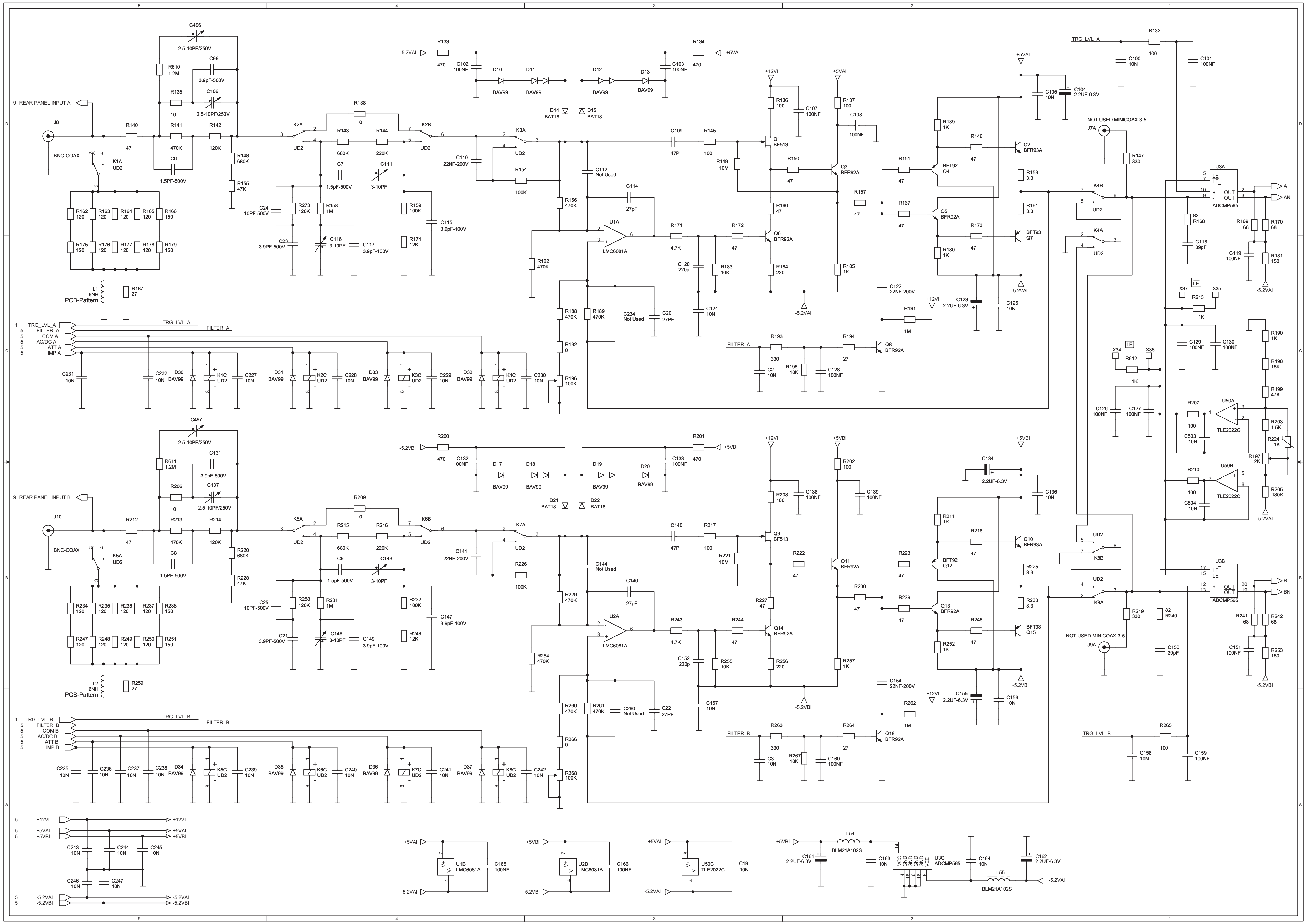

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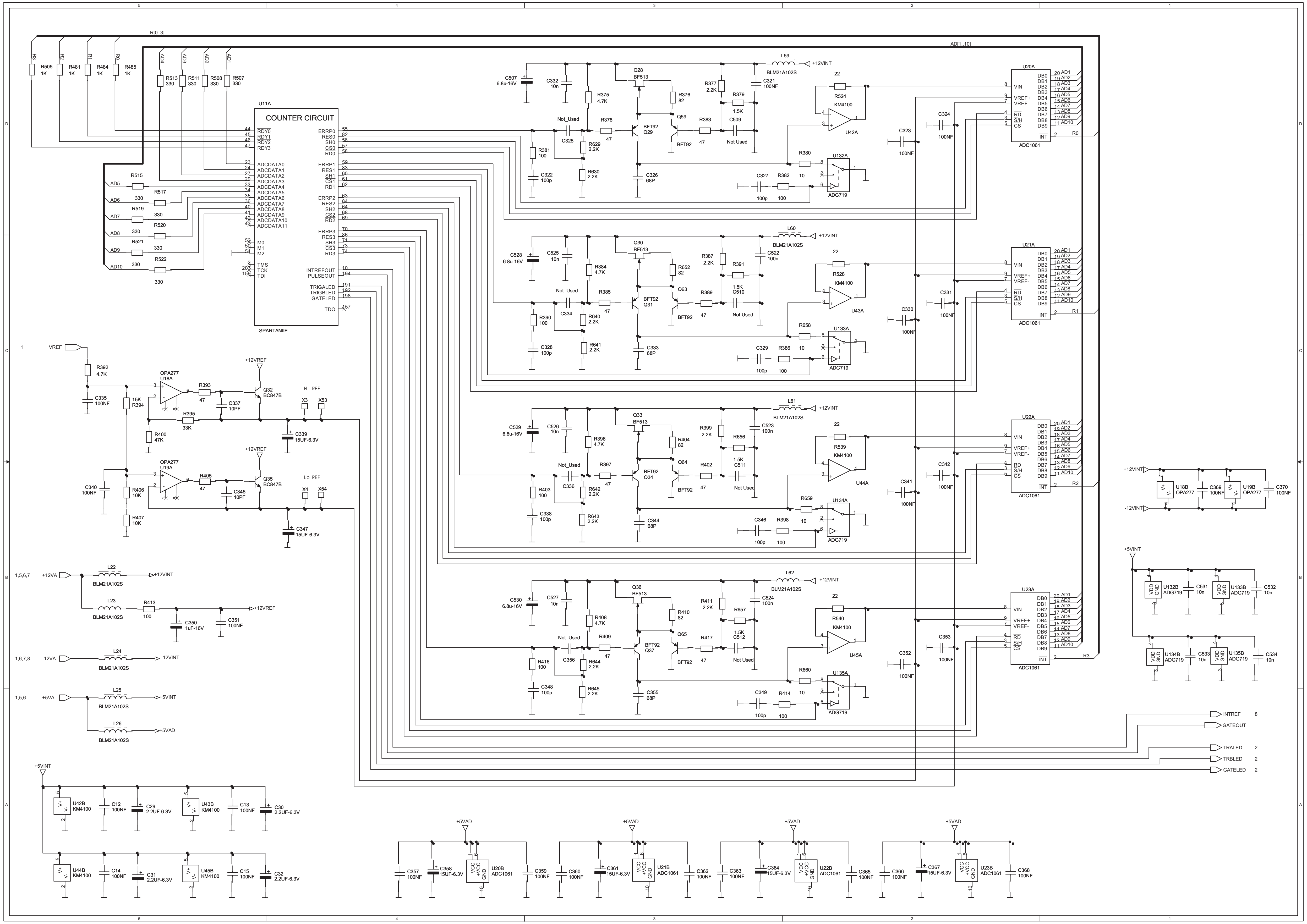

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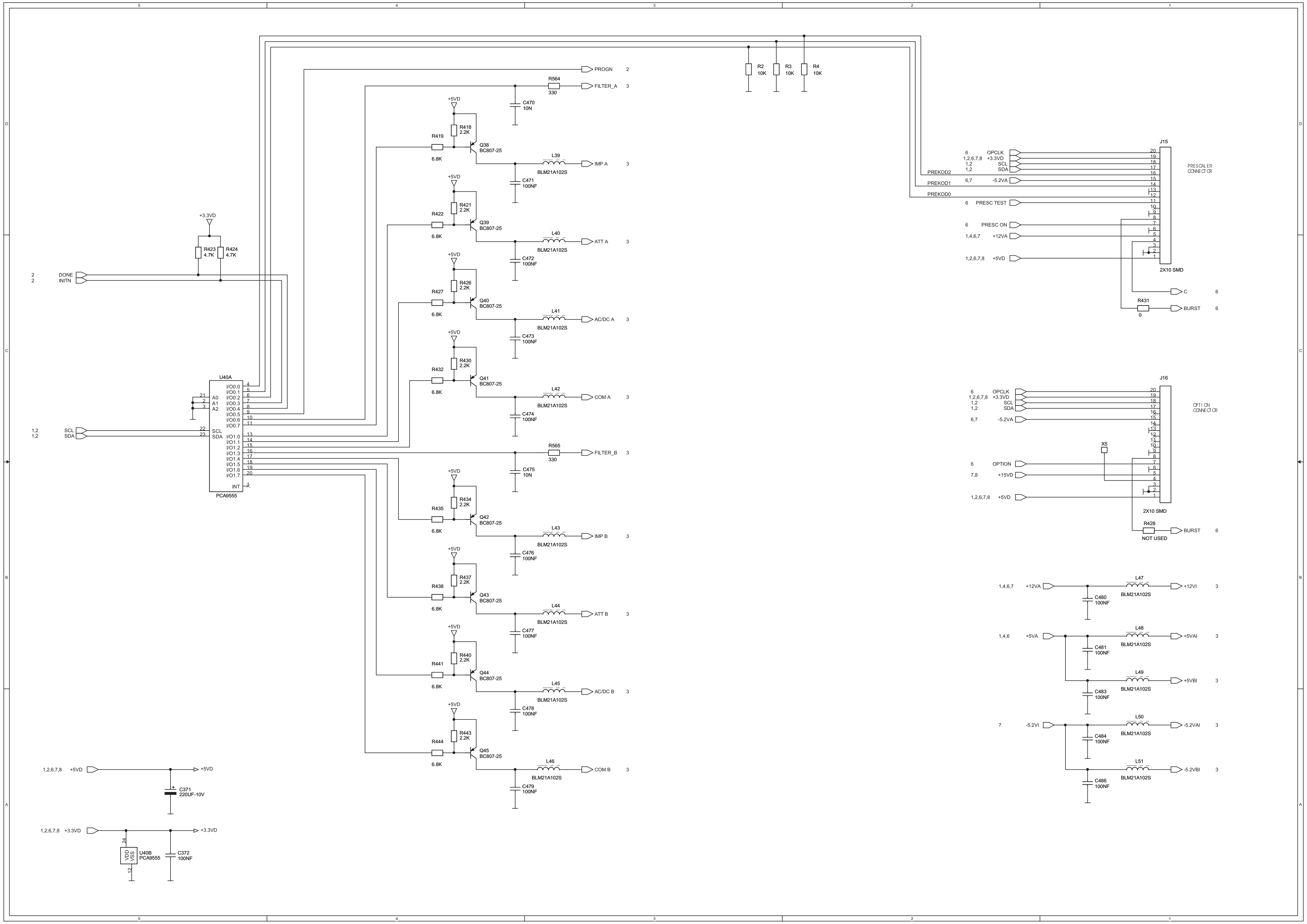
U40A
PCA9555
U40B
PCA9555
PROGN
FILTER_A
FILTER_B
IMP A
ATT A
AC/DC A
COM A
IMP B
ATT B
AC/DC B
COM B
DONE
INITN
SCL
SDA
PREKOD2
PREKOD1
PREKOD0
J15
PRESCALER CONNECTOR
2X10 SMD
J16
OPTION CONNECTOR
OPCLK
PRESC TEST
PRESC ON
OPTION
BURST
R431
R428
NOT USED
BLM21A102S
BC807-25
+12VA
+12VI
+5VA
+5VAI
+5VBI
-5.2VI
-5.2VAI
-5.2VBI
+5VD
+3.3VD
C371
220UF-10V
C372
100NF

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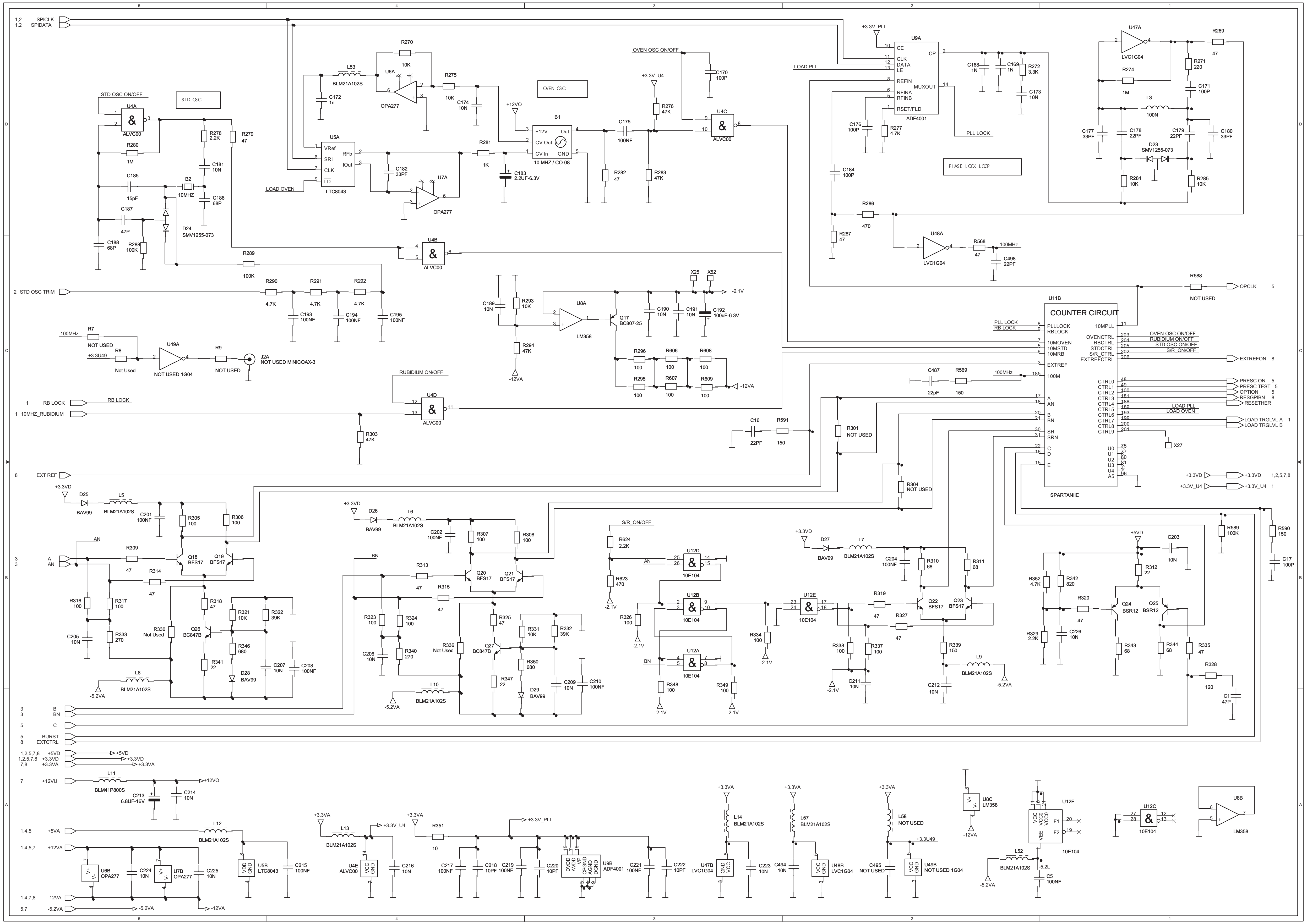

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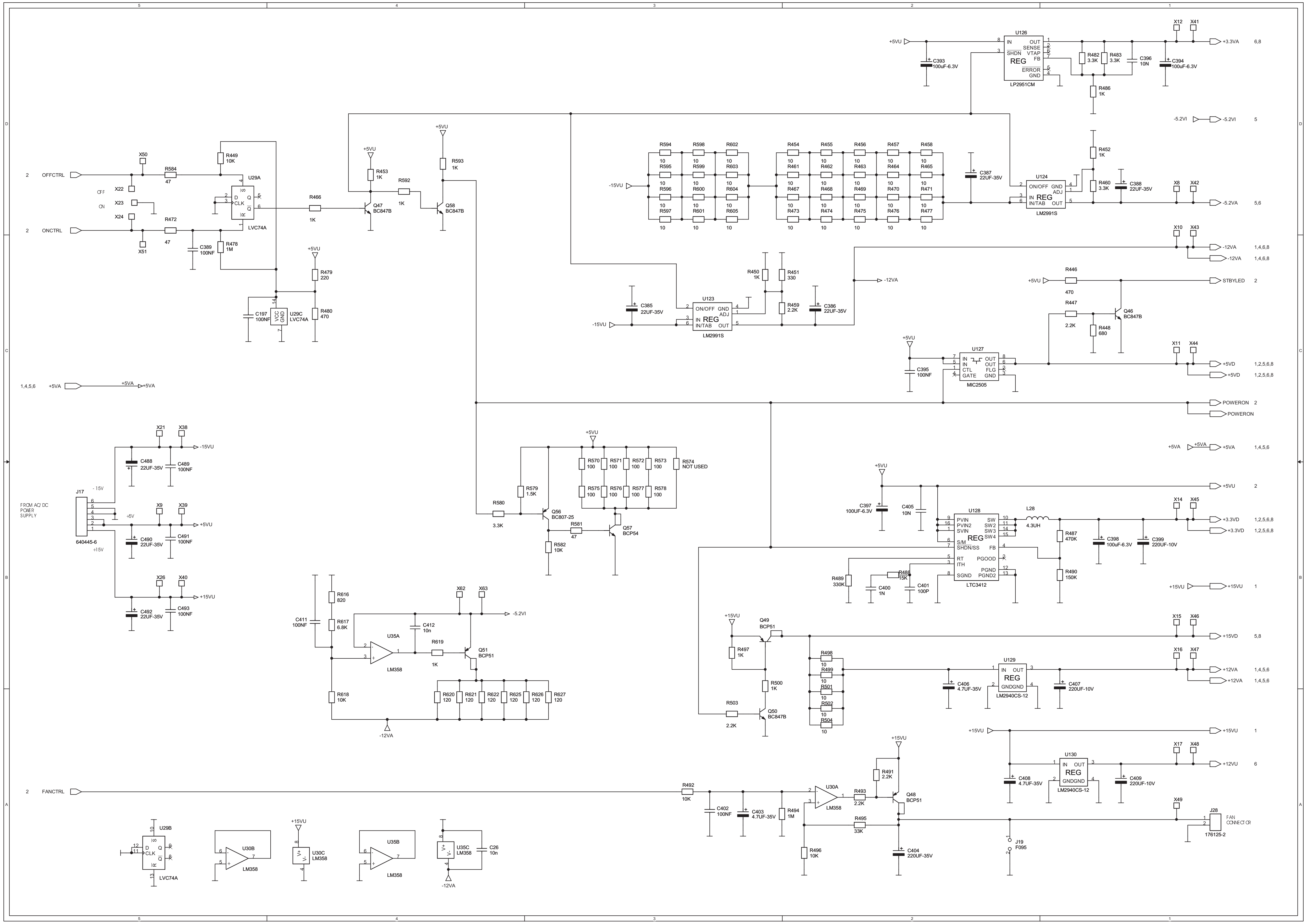

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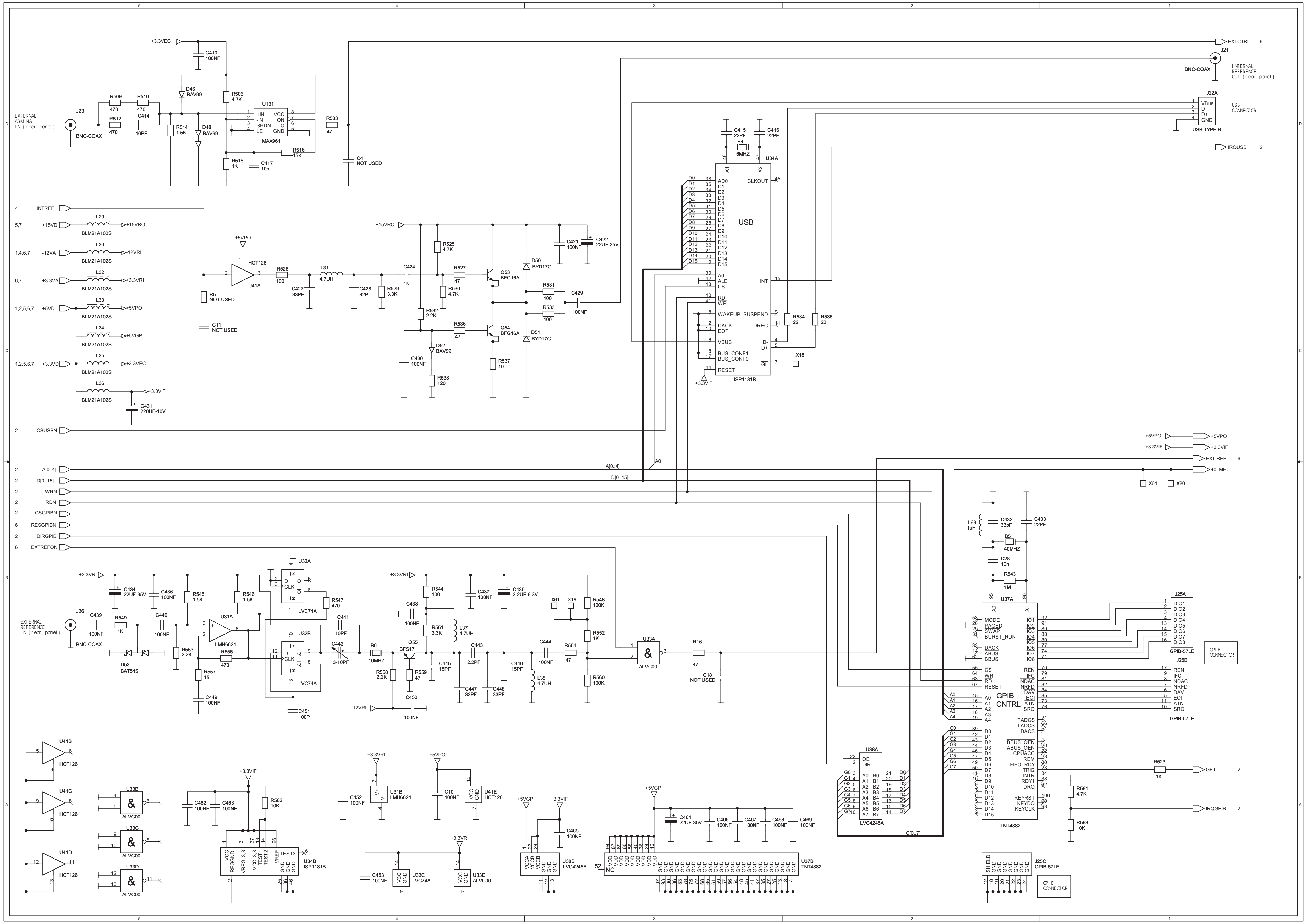
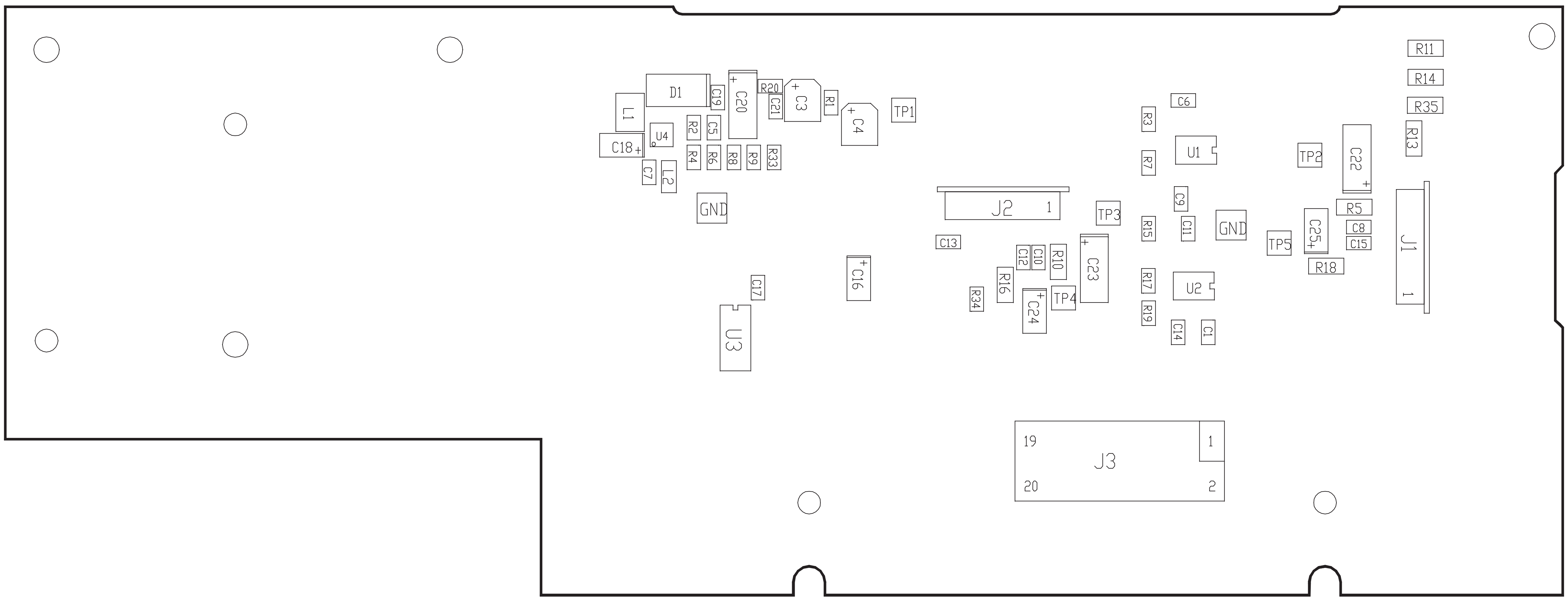
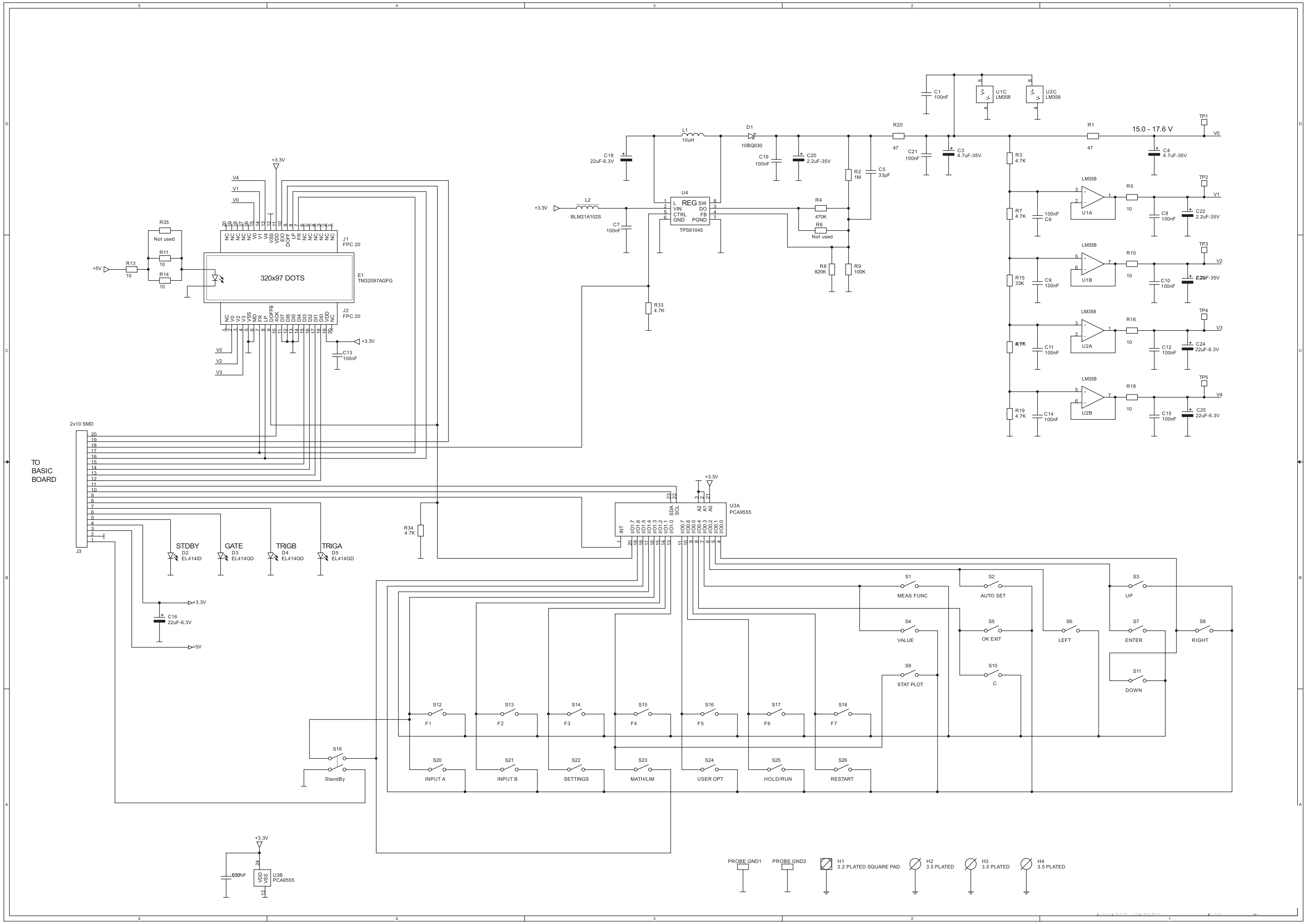

EXTERNAL ARMING IN (rear panel)
J23
BNC-COAX
MAX961
USB
ISP1181B
USB TYPE B
USB CONNECTOR
EXTCTRL
J21
INTERNAL REFERENCE OUT (rear panel)
IRQUSB
INTREF
CSUSBN
A[0..4]
D[0..15]
WRN
RDN
CSGPIBN
RESGPIBN
DIRGPIB
EXTREFON
EXTERNAL REFERENCE IN (rear panel)
J26
LMH6624
LVC74A
ALVC00
GPIB CNTRL
TNT4882
LVC4245A
GPIB-57LE
GPIB CONNECTOR
GET
IRQGPIB
EXT REF
40_MHz
HCT126

Display & Keyboard, PCB 2, Component Layout





320x97 DOTS
TM32097AGFG
TO BASIC BOARD
2x10 SMD
STDBY
GATE
TRIGB
TRIGA
TPS61045
PCA9555
15.0 - 17.6 V
MEAS FUNC
AUTO SET
UP
VALUE
OK EXIT
LEFT
ENTER
RIGHT
STAT PLOT
C
DOWN
F1
F2
F3
F4
F5
F6
F7
StandBy
INPUT A
INPUT B
SETTINGS
MATH/LIM
USER OPT
HOLD/RUN
RESTART
PROBE GND1
PROBE GND2
3.2 PLATED SQUARE PAD
3.5 PLATED

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Version B

The descriptions in this section apply to instruments having a Sharp microprocessor.

See General Information on page III for details on relevant serial numbers etc.

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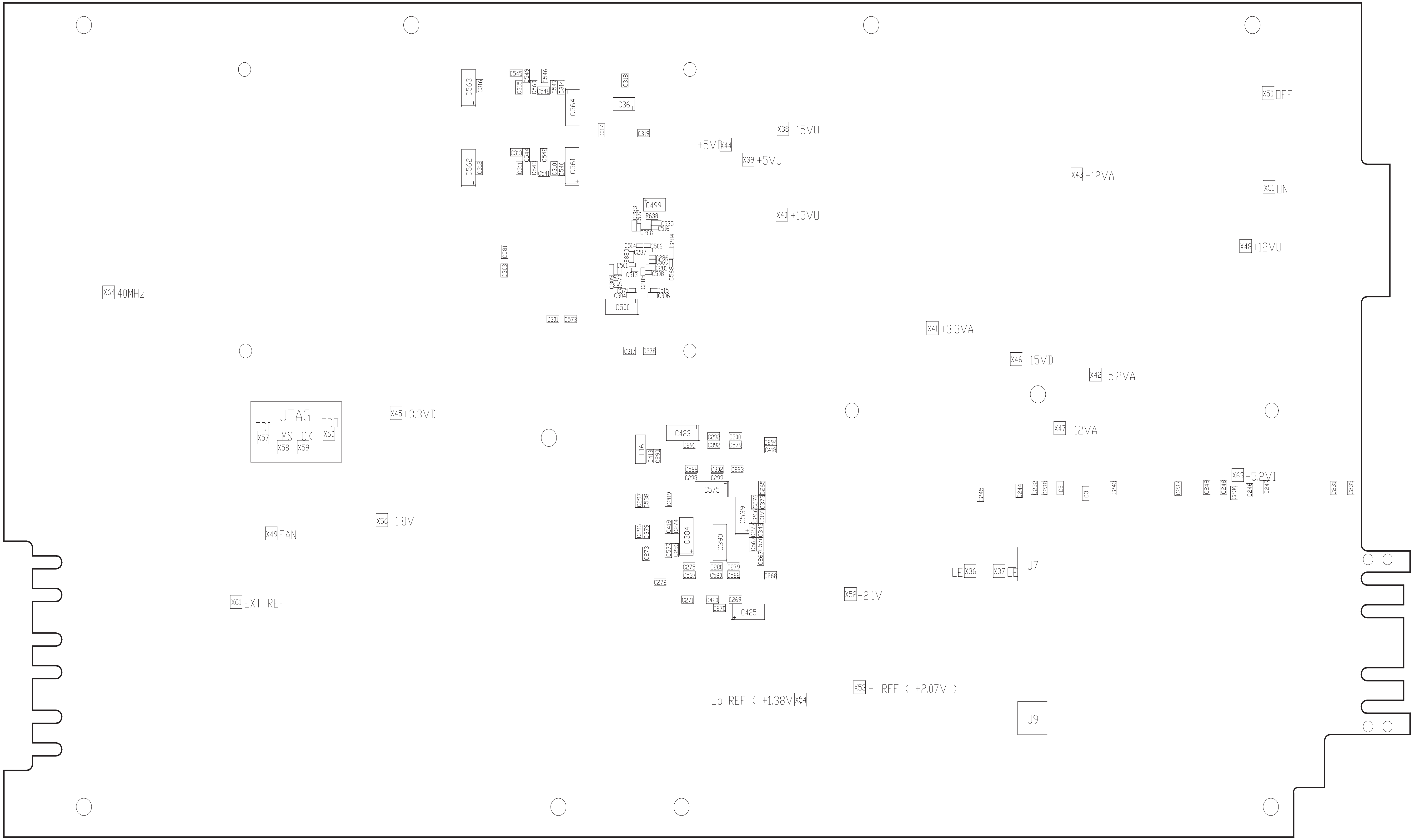
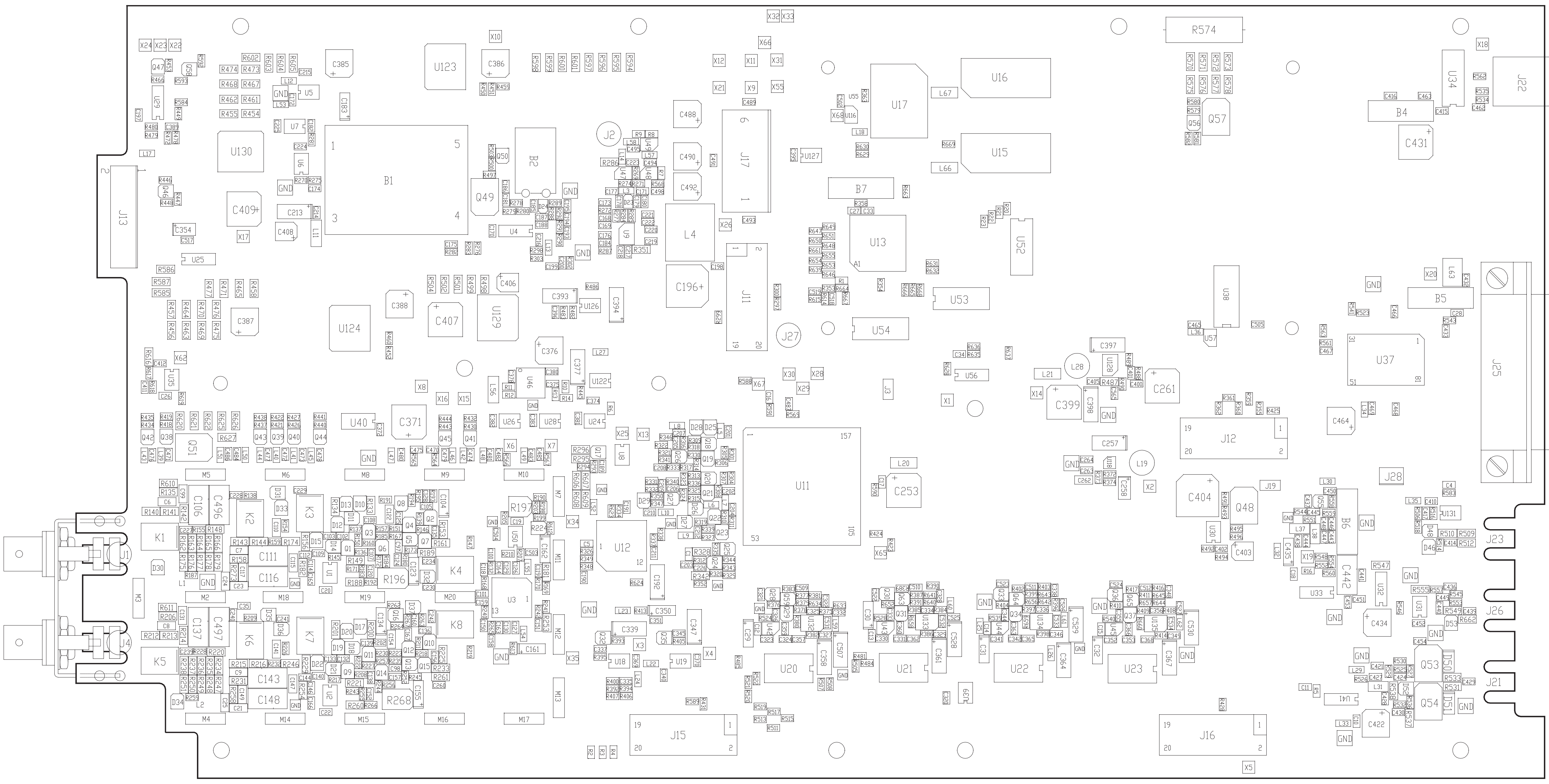
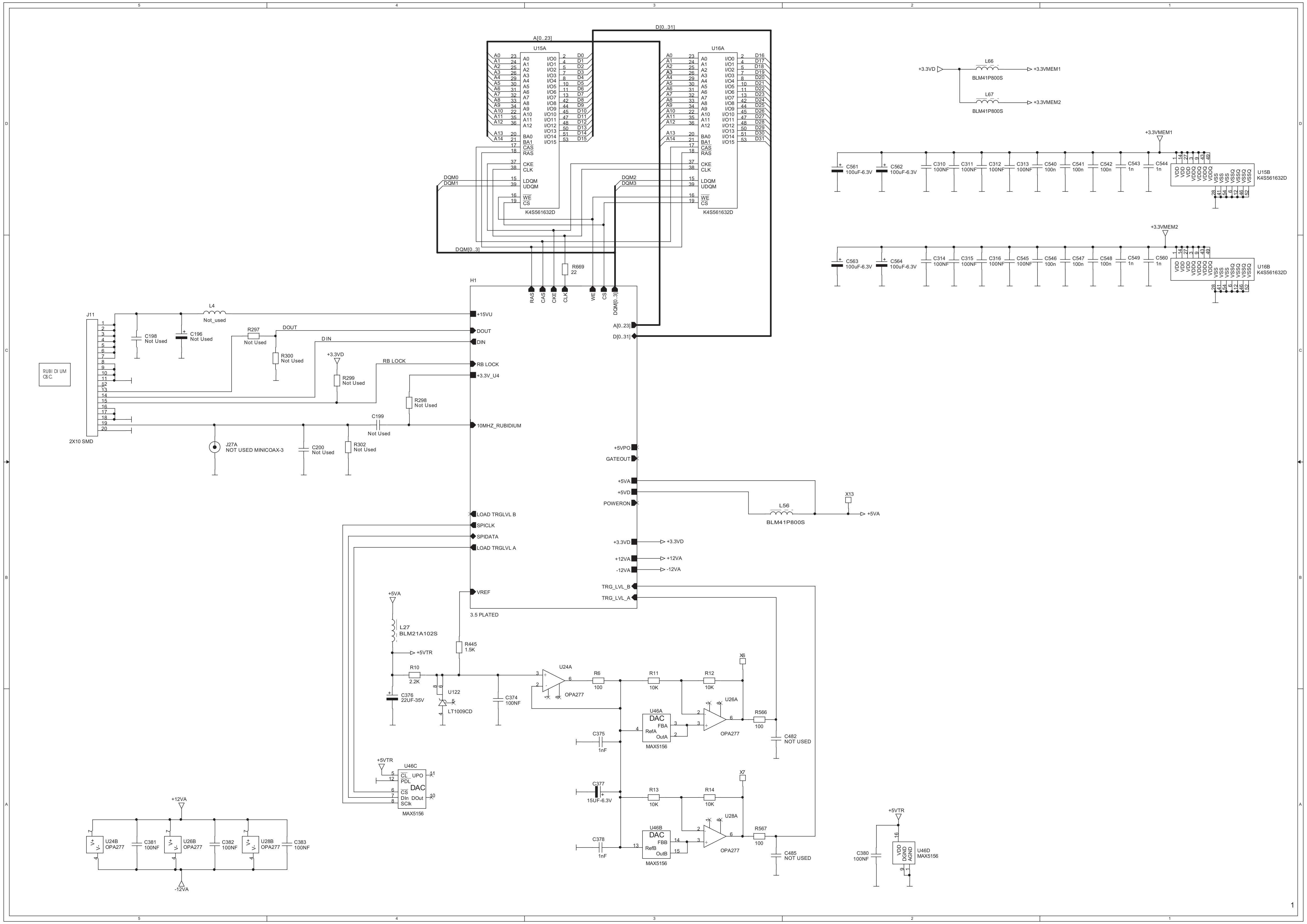


X50 OFF
X51 ON
X38 -15VU
X39 +5VU
+5VD X44
X40 +15VU
X43 -12VA
X48 +12VU
X64 40MHz
X41 +3.3VA
X46 +15VD
X42 -5.2VA
X47 +12VA
X63 -5.2VI
JTAG
TDI
TMS
TCK
TDO
X45 +3.3VD
X56 +1.8V
X49 FAN
X61 EXT REF
LE X36
X37 LE
J7
X52 -2.1V
X53 Hi REF (+2.07V)
Lo REF (+1.38V X54
J9

Main Board, PCB 1, Component Layout, Top Side





D[0..31]
A[0..23]
U15A
K4S561632D
U16A
K4S561632D
+3.3VD
L66
BLM41P800S
+3.3VMEM1
L67
BLM41P800S
+3.3VMEM2
U15B
K4S561632D
U16B
K4S561632D
DQM0
DQM1
DQM2
DQM3
DQM[0..3]
R669
22
H1
J11
2X10 SMD
RUBIDIUM OSC
L4
Not_used
C198
Not Used
C196
Not Used
R297
Not Used
DOUT
DIN
R300
Not Used
R299
Not Used
RB LOCK
R298
Not Used
C199
Not Used
J27A
NOT USED MINICOAX-3
C200
Not Used
R302
Not Used
+15VU
+3.3V_U4
10MHZ_RUBIDIUM
A[0..23]
D[0..31]
+5VPO
GATEOUT
+5VA
+5VD
POWERON
L56
BLM41P800S
X13
LOAD TRGLVL B
SPICLK
SPIDATA
LOAD TRGLVL A
+3.3VD
+12VA
-12VA
TRG_LVL_B
TRG_LVL_A
VREF
3.5 PLATED
L27
BLM21A102S
+5VTR
R445
1.5K
R10
2.2K
C376
22UF-35V
U122
LT1009CD
C374
100NF
U24A
OPA277
R6
100
R11
10K
R12
10K
X6
U26A
OPA277
U46A
DAC
MAX5156
R566
100
C482
NOT USED
C375
1nF
C377
15UF-6.3V
R13
10K
R14
10K
X7
U28A
OPA277
U46B
DAC
MAX5156
R567
100
C485
NOT USED
C378
1nF
U46C
DAC
MAX5156
U24B
OPA277
C381
100NF
U26B
OPA277
C382
100NF
U28B
OPA277
C383
100NF
+12VA
-12VA
U46D
MAX5156
C380
100NF

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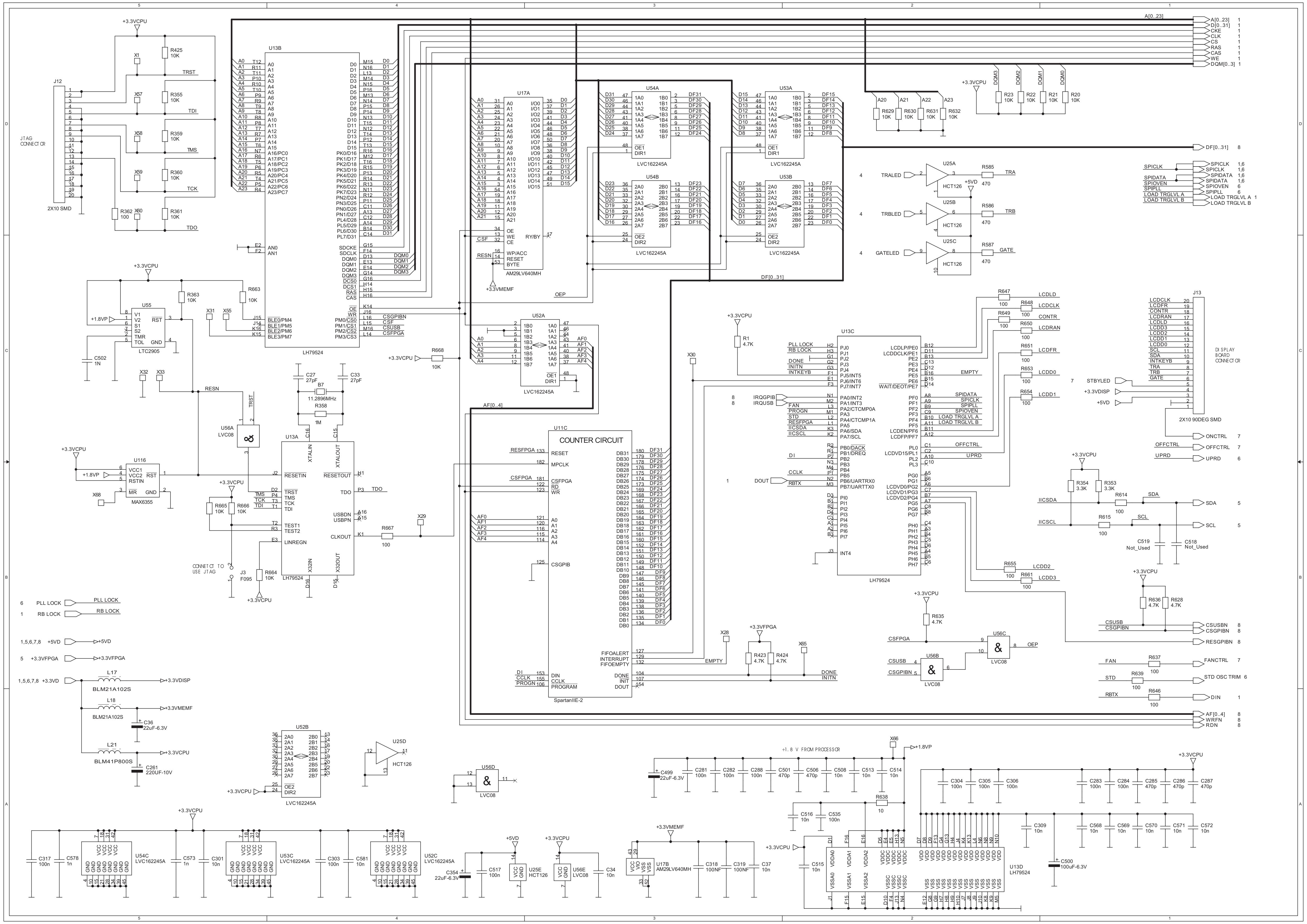
CPU, Memories and Parts of the Counter Circuit, PCB 1, sheet 1(7)



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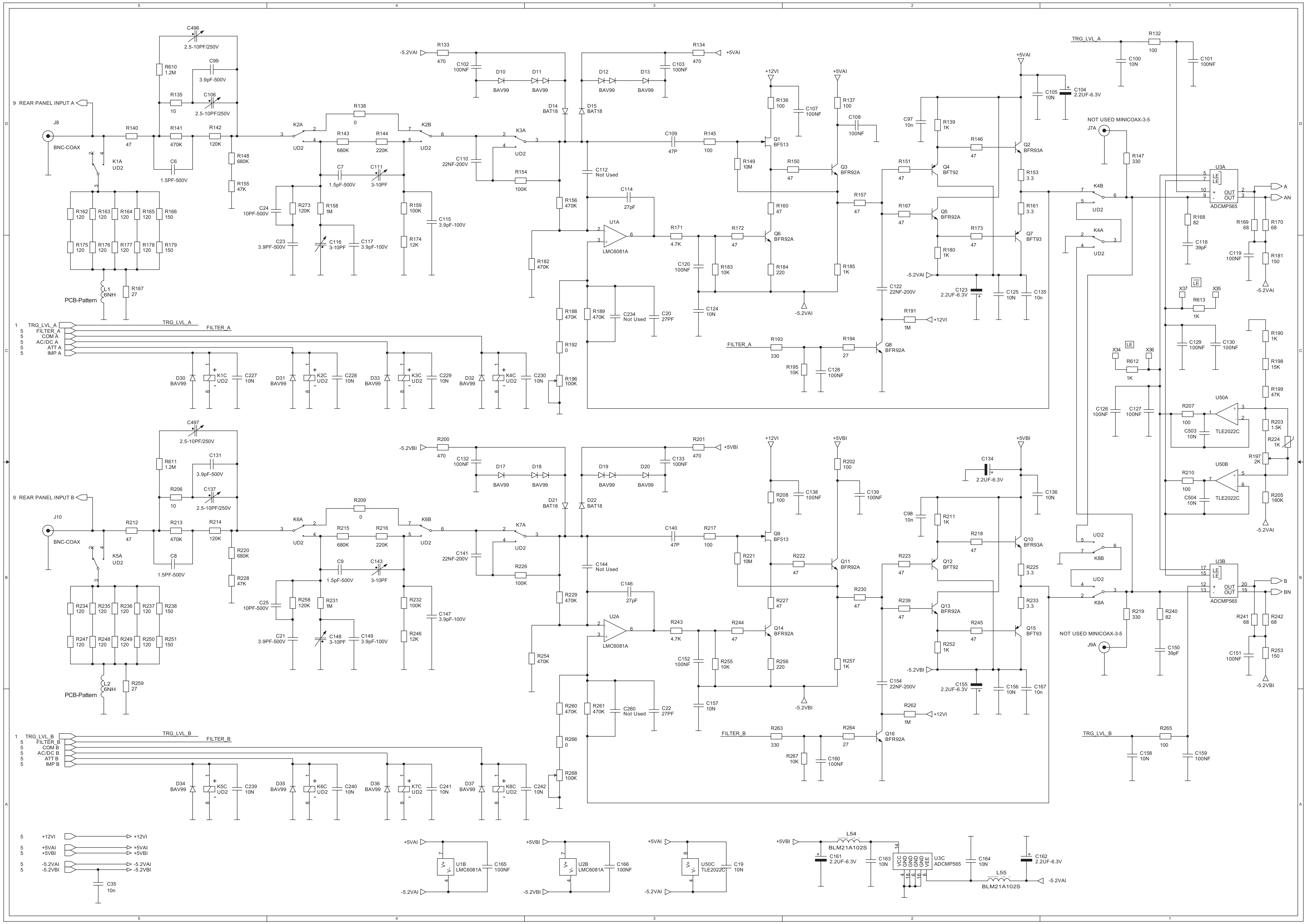
Input Amplifiers, PCB 1, sheet 2(7)



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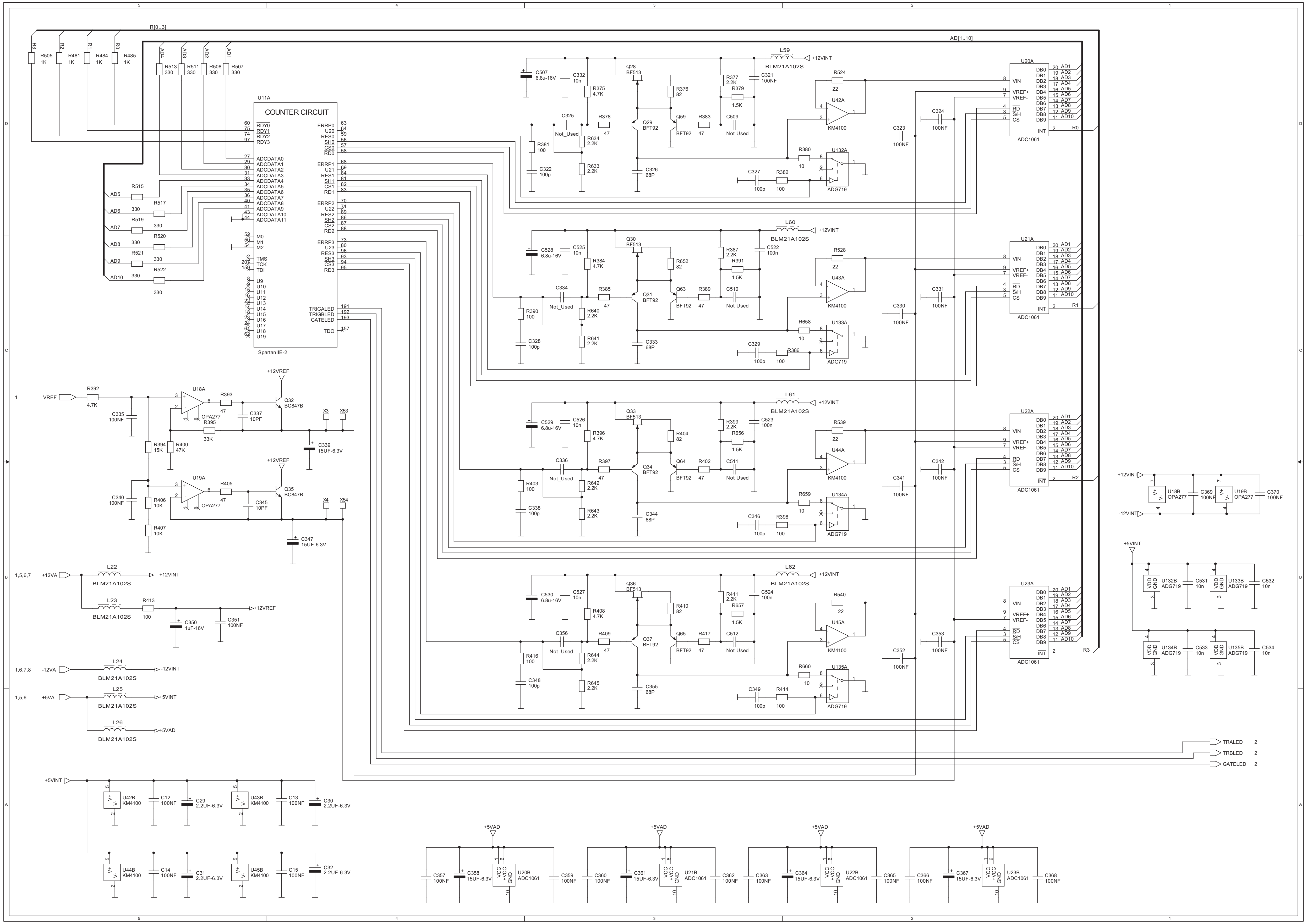

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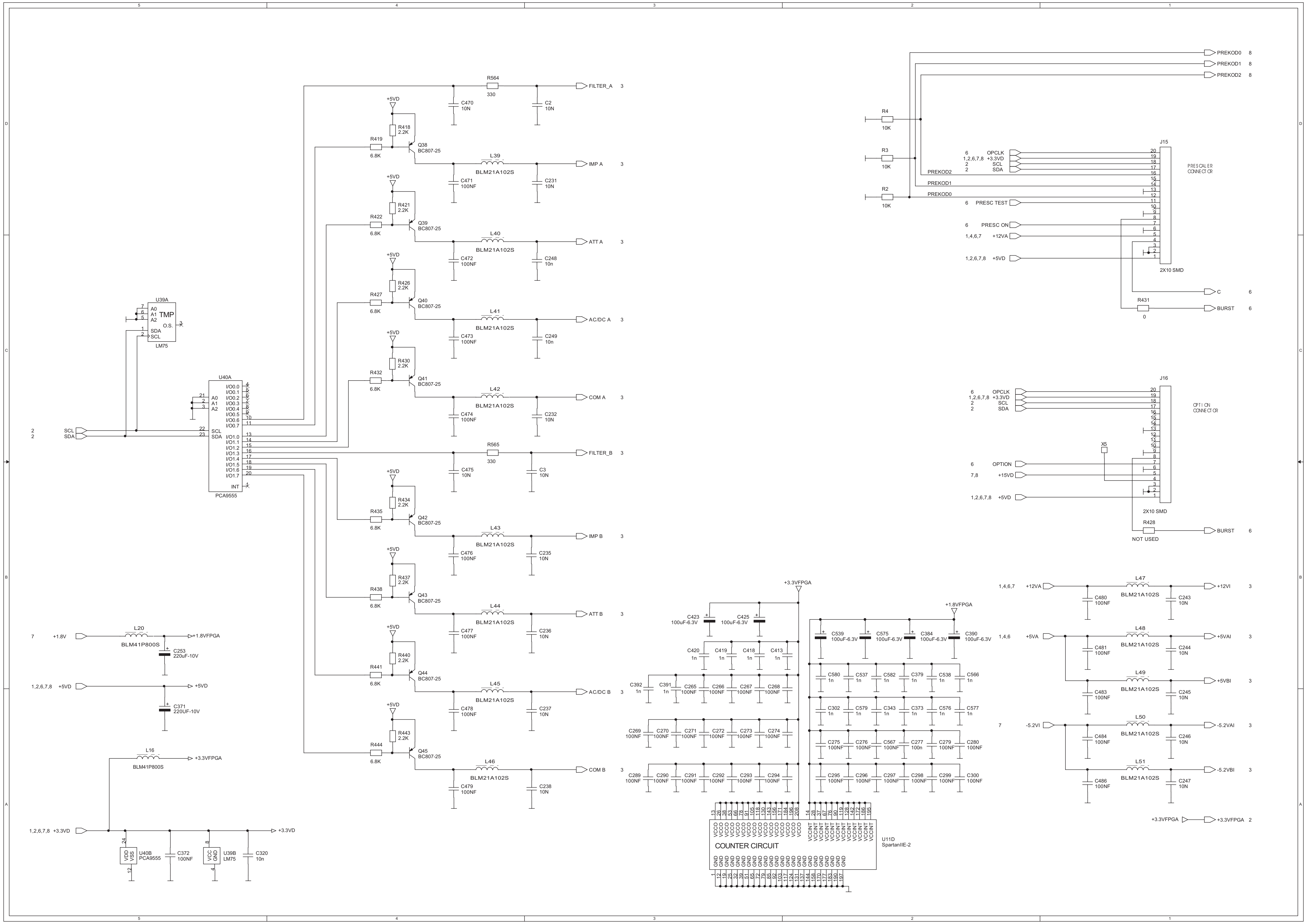

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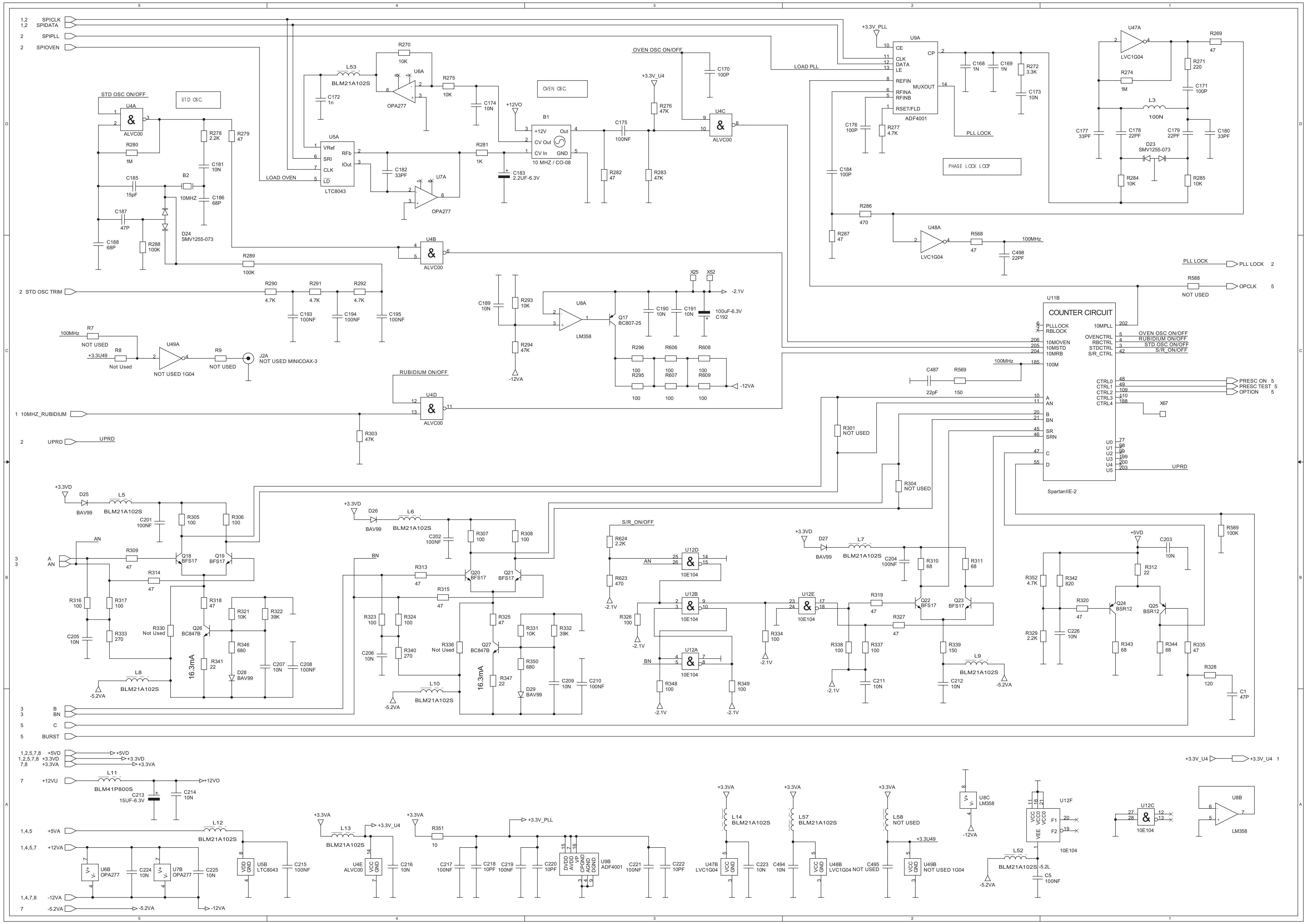
Oscillator Circuits, PCB 1, sheet 5(7)



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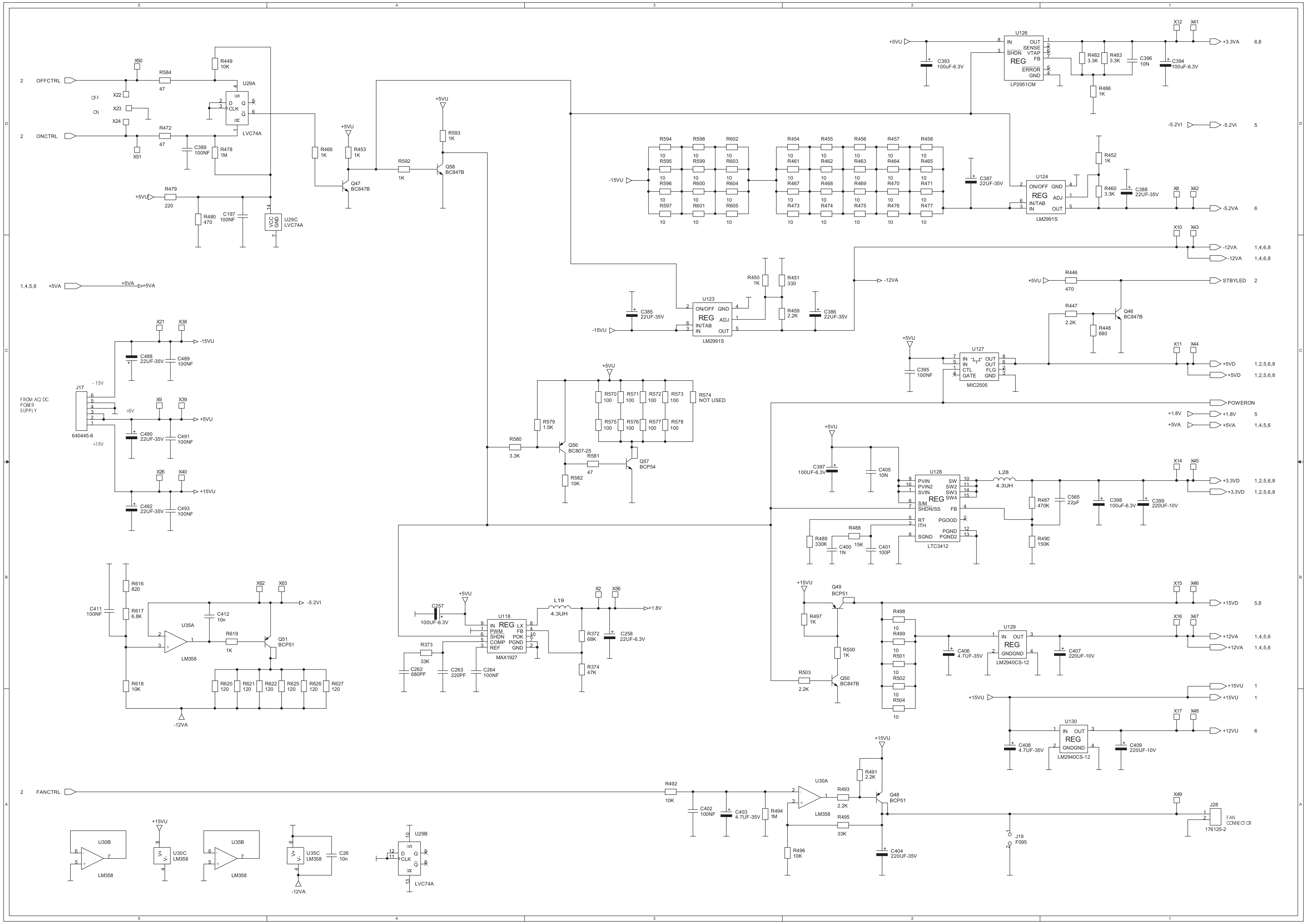
Supply Voltages, PCB 1, sheet 6(7)



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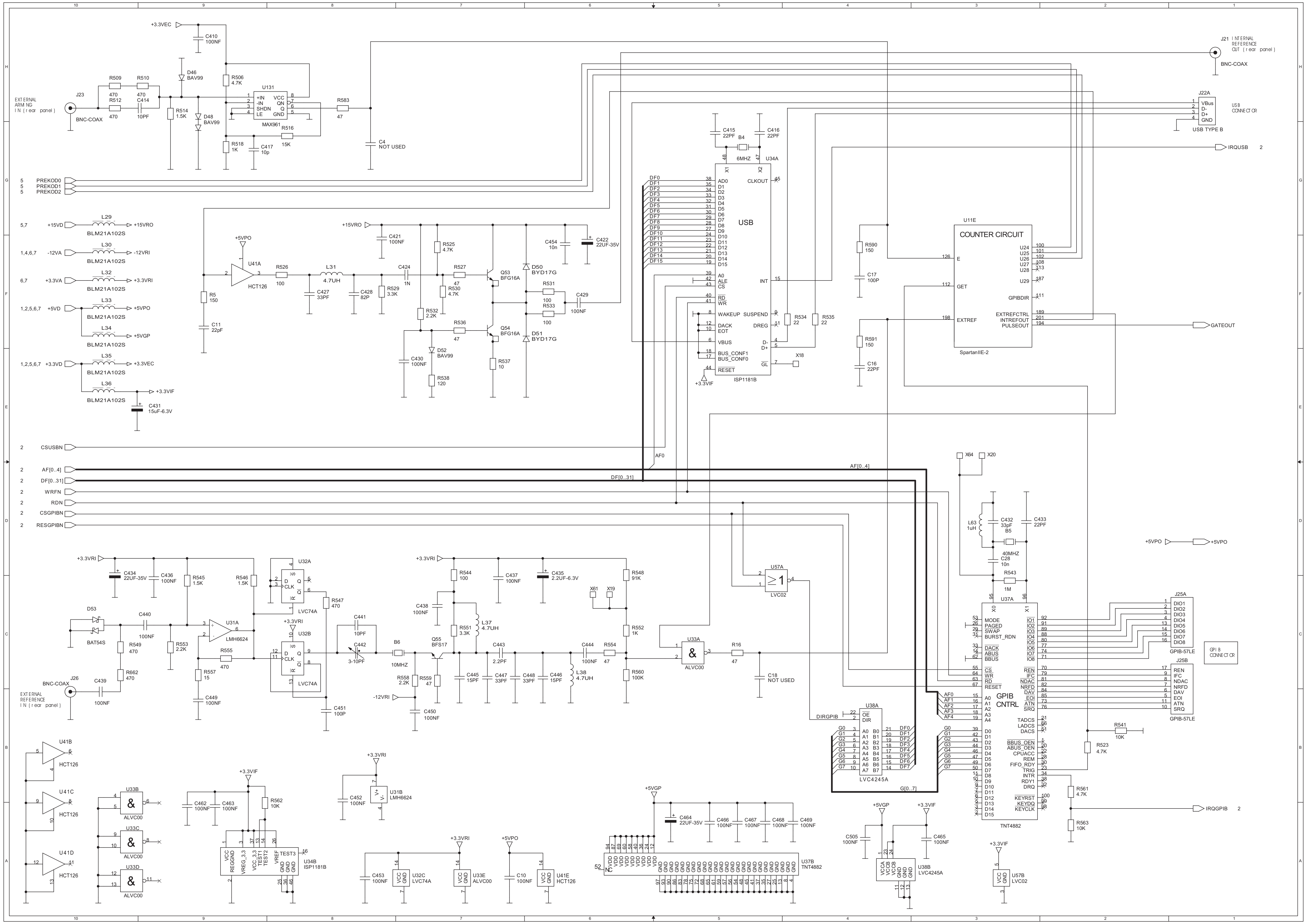
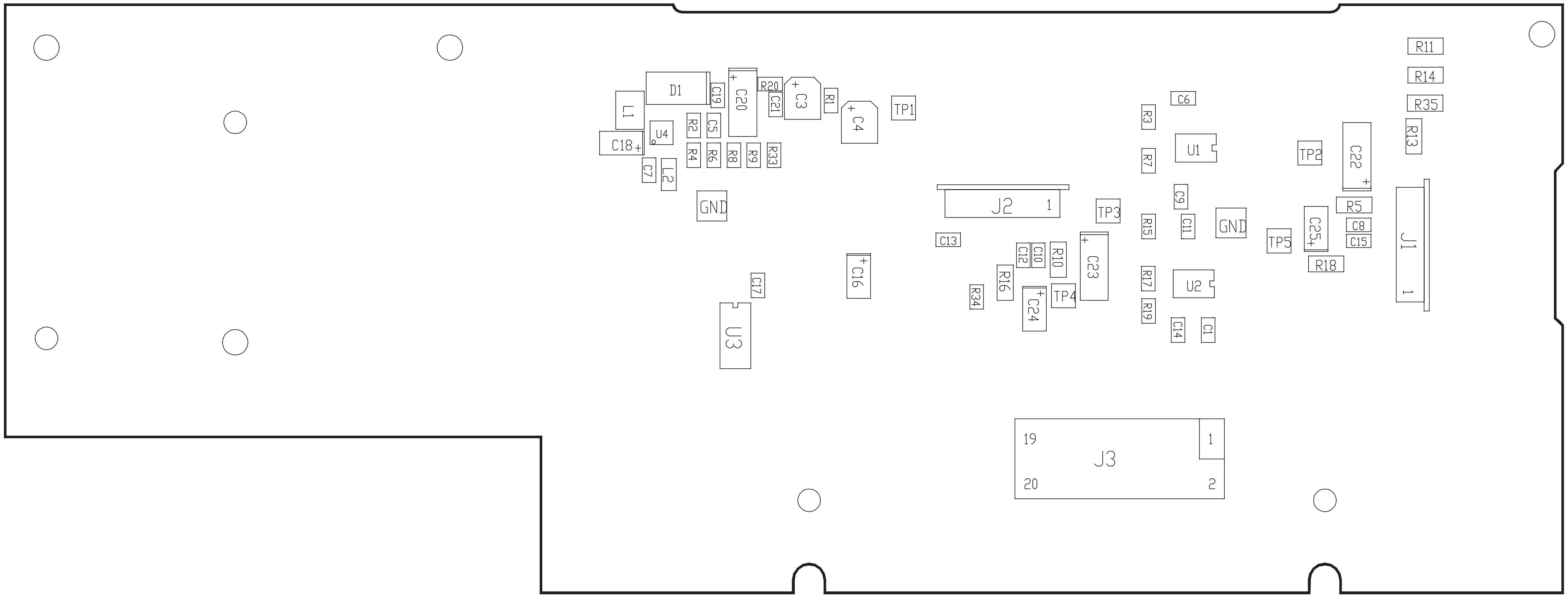
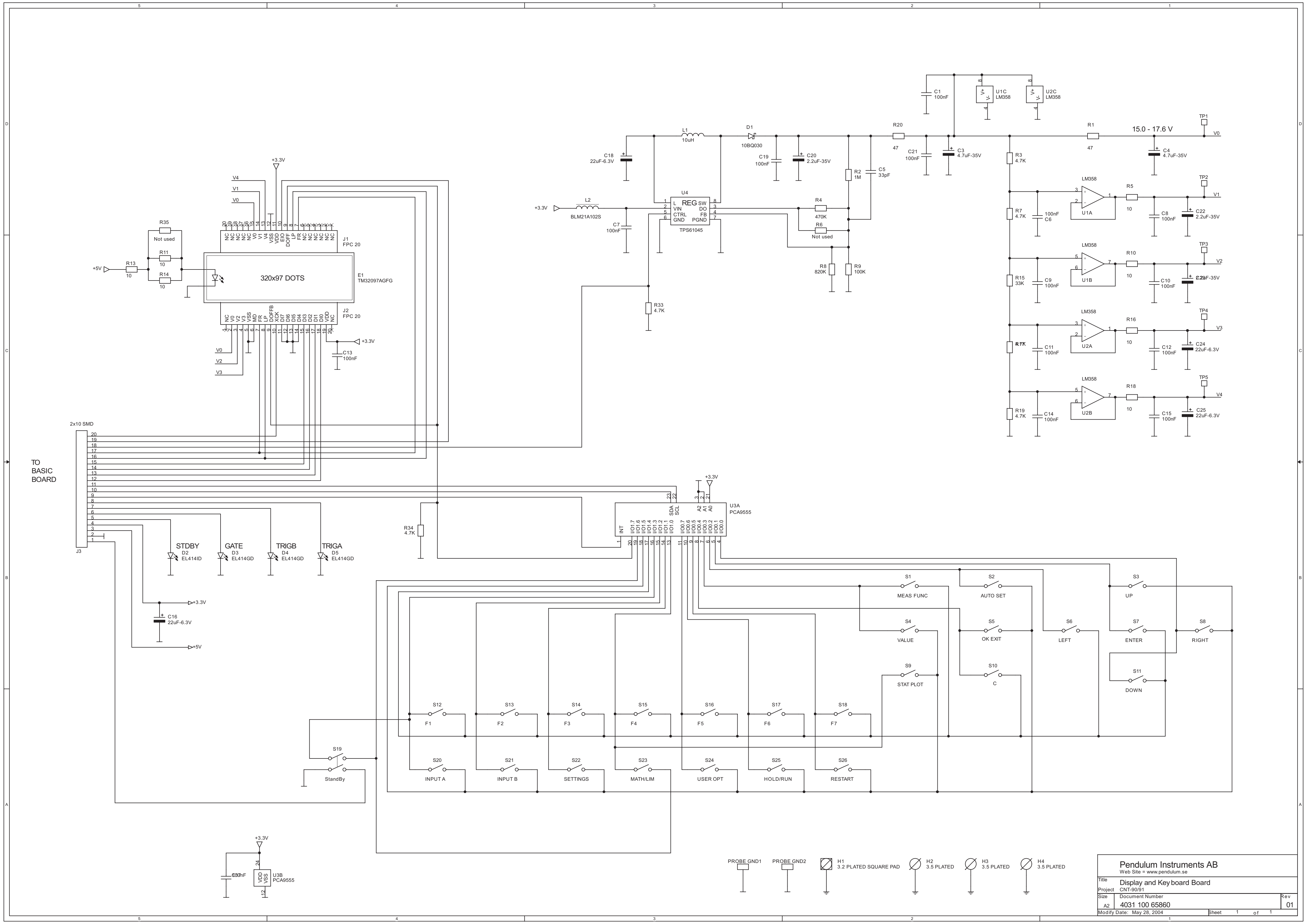


Display & Keyboard, PCB 2, *Component Layout*



Display & Keyboard, PCB 2



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Chapter 10

Appendix

How to Replace Surface Mounted Devices

Most of the components in this instrument are mounted on the surface of the board instead of through holes in the board. These components are not hard to replace but they require another technique. If you do not have special SMD desoldering equipment, follow the instructions below:

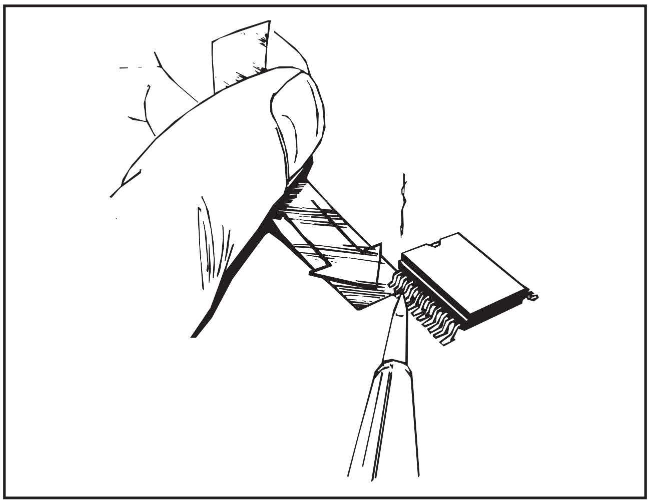

Figure 10-1 *Heat the leads and push a thin aluminum sheet between the leads and the pca.*

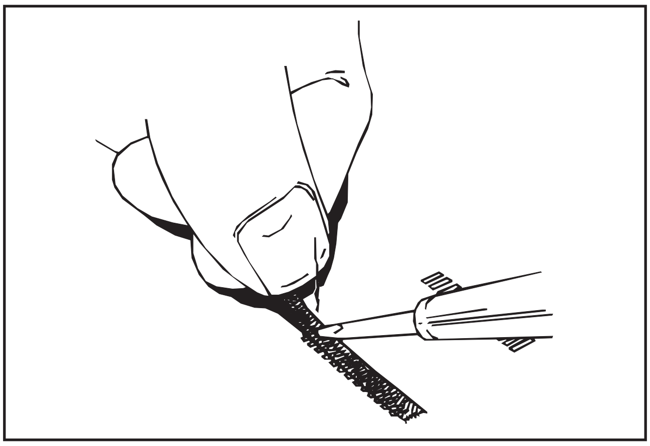

Figure 10-2 *When removed, clean the pads with desoldering braid.*

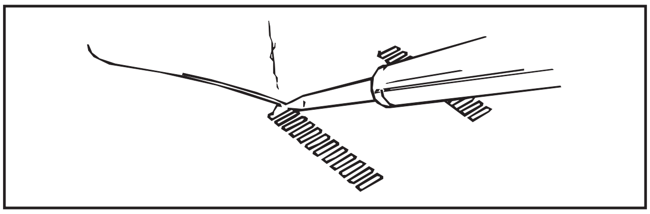

Figure 10-3 *Place solder on the pad.*

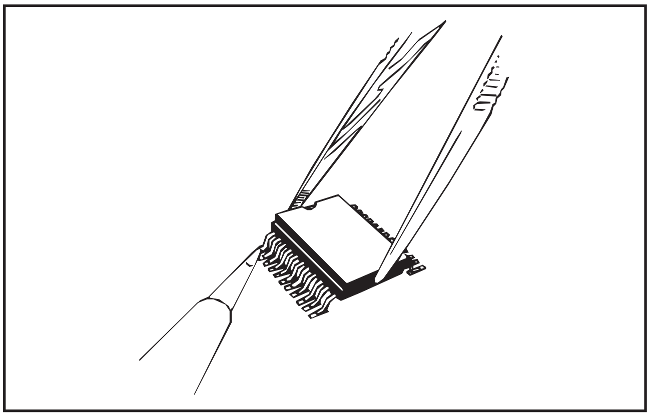

Figure 10-7 *Attach the IC to the pad with solder.*

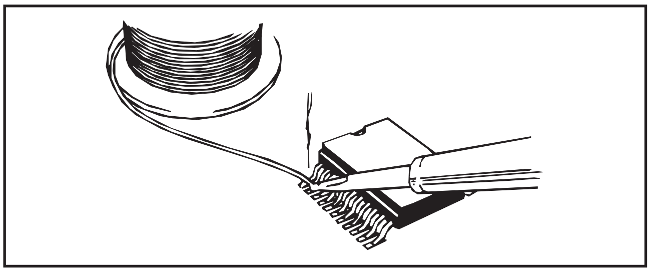

Figure 10-4 *Solder all leads with plenty of solder, don't worry about short-circuits at this stage.*

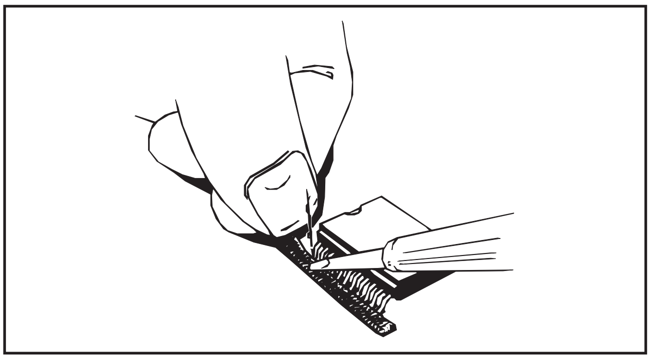

Figure 10-5 *Remove excessive solder with desoldering braid..*

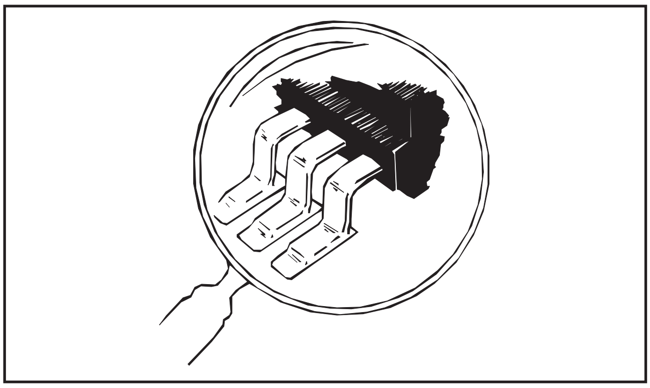

Figure 10-6 *Use a strong magnifying glas to make sure there are no short/circuits or unsoldered leads.*

Electrostatic Discharge

Almost all modern components have extremely thin conductors and metal oxide layers. If these layers are exposed to electrostatic discharge they will break down or perhaps even worse, be damaged in a way that inevitably will cause a breakdown later on. The Electro-Static Discharge sensitivity of MOS and CMOS semiconductors have been known quite a while, but nowadays bipolar semiconductors and even precision resistors are ESD sensitive. Consider therefore all components, pc-boards and sub-assemblies as sensitive to electrostatic discharge. The text below explains how you can minimize the risk of damage or destroying these devices by being aware of the problems, and learning how to handle these components.

ESD sensitive options are packed in conductive containers marked with this symbol.

- *Never open the container unless you are at an ESD protected work station.*
- *Use a wrist strap grounded via a high resistance.*
- *Use a grounded work mat on your workbench.*
- *Never let your clothes come in contact with ESD sensitive equipment even when you are wearing a grounded wrist strap.*
- *Never touch the component leads.*
- *Never touch open connectors.*
- *Use ESD-safe packing materials.*
- *Use the packing material only once.*
- *Keep paper and nonconductive plastics etc. away from your workbench. These may block the discharge path to ground.*

Glossary

C	
Calibration Adjustments	How to restore an instrument to perform in agreement with its specifications.
CSA	Canadian Standards Association
E	
EN 61010-1	International safety standard
F	
FLASH PROM	Electrically erasable and reprogrammable non-volatile semiconductor memory.
FPGA	Field Programmable Gate Array
G	
GPIB	General Purpose Instrumentation Bus used for interconnecting several measuring instruments to a common controller.
I	
I^2C-bus	An internal address and data bus for communication between microcontroller, measuring logic, and options.
IEC	International Electrical Commission
L	
LCD	Liquid Crystal Display
O	
OCXO	Oven-Controlled X-tal Oscillator
P	
PCA	Printed Circuit Assembly
PCB	Printed Circuit Board
Performance Check	A procedure to check that the instrument is functionally operational and performs to its specification. Must not require opening of cabinet. If the instrument passes the check it is considered calibrated.
PLL	Phase-Locked Loop
Prescaler	RF frequency divider
PWM	Pulse Width Modulation
U	
UCXO	Un-Compensated X-tal Oscillator
USB	The Universal Serial Bus is a simpler alternative to GPIB.

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Chapter 11

Index

Index

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