

## LTM4700 High Current, PolyPhase Step-Down Power $\mu$ Module Supply with Digital Power System Management 4xLTM4700, 400A

### DESCRIPTION

Demonstration circuit 2784A-C is a high efficiency, high density,  $\mu$ Module regulator with 4.5V to 16V input range. The output voltage is adjustable from 0.5V to 1.8V and it can supply 400A maximum load current. The demo board has four **LTM4700**  $\mu$ Module regulators, which is a dual 50A or single 100A step-down regulator with digital power system management. Please see LTM4700 data sheet for more detailed information.

DC2784A-C powers up to default settings and produces power based on configuration resistors without the need for any serial bus communication. This allows easy evaluation of the DC/DC converter. To fully explore the extensive power system management features of the part, download

the GUI software LTpowerPlay® onto your PC and use ADI's I<sup>2</sup>C/SMBus/PMBus dongle DC1613A to connect to the board. LTpowerPlay allows the user to reconfigure the part on the fly and store the configuration in EEPROM, view telemetry of voltage, current, temperature and fault status.

### GUI Download

The software can be downloaded from [LTpowerPlay](#).

For more details and instructions of LTpowerPlay, please refer to LTpowerPlay GUI for LTM4700 Quick Start Guide.

**[Design files for this circuit board are available.](#)**

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### BOARD PHOTO

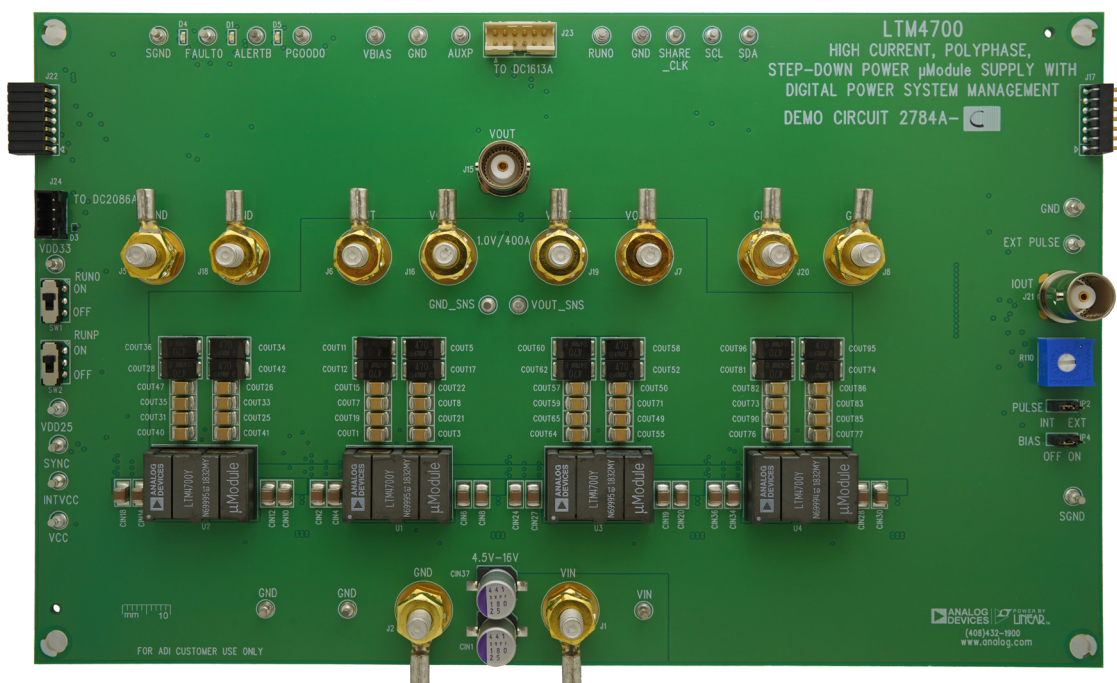


Figure 1. 4x LTM4700; 400A DC2784A-C Demo Circuit

# DEMO MANUAL DC2784A-C

## PERFORMANCE SUMMARY

Specifications are at  $T_A = 25^\circ\text{C}$

PARAMETER	CONDITIONS	VALUE
Input Voltage Range		4.5V to 16V
Output Voltage, $V_{OUT}$	$V_{IN} = 4.5\text{V to } 16\text{V}$ , $I_{OUT} = 0\text{A to } 400\text{A}$	0.5V to 1.8V, Default: 1.0V
Maximum Output Current, $I_{OUT}$	$V_{IN} = 4.5\text{V to } 16\text{V}$ , $V_{OUT} = 0.5\text{V to } 1.8\text{V}$	400A
Typical Efficiency	$V_{IN} = 12\text{V}$ , $V_{OUT} = 1.0\text{V}$ , $I_{OUT} = 400\text{A}$	88.4% (See Figure 5)
Default Switching Frequency		350kHz

## QUICK START PROCEDURE

Table 1. LTM4700 Demo Boards for Up to 400A Point-of-Load Regulation

MAXIMUM OUTPUT CURRENT	NUMBER OF OUTPUTS	NUMBER OF LTM4676 $\mu$ MODULE REGULATORS ON THE BOARD	DEMO BOARD NUMBER
50A	2	1	DC2702A-A
100A	1	1	DC2702A-B
200A	1	2	DC2784A-A
300A	1	3	DC2784A-B
400A	1	4	DC2784A-C

Demonstration circuit 2784A-C is easy to set up to evaluate the performance of the LTM4700EY. Refer to Figure 2 for the proper measurement equipment setup and follow the procedure below.

1. With power off, connect the input power supply to  $V_{IN}$  (4.5V to 16V) and GND (input return).
2. Connect the 1.0V output load between  $V_{OUT}$  and GND (initial load: no load).
3. Connect the DVMs to the input and outputs. Set default jumper position: JP1: ON; JP2: ON; JP3: ON.

4. Turn on the input power supply and check for the proper output voltages.  $V_{OUT}$  should be  $1.0\text{V} \pm 0.5\%$ .
5. Once the proper output voltages are established, adjust the loads within the operating range and observe the output voltage regulation, ripple voltage and other parameters.
6. Connect the dongle and control the output voltages from the GUI. See “LTpowerPlay GUI for the LTM4700 Quick Start Guide” for details.

Note: Internal bias circuit is enabled when  $V_{IN} > 7\text{V}$  and JP3 is ON.

Note: When measuring the output or input voltage ripple, do not use the long ground lead on the oscilloscope probe. See Figure 3 for the proper scope probe technique. Short, stiff leads need to be soldered to the (+) and (–) terminals of an output capacitor. The probe’s ground ring needs to touch the (–) lead and the probe tip needs to touch the (+) lead.

## QUICK START PROCEDURE

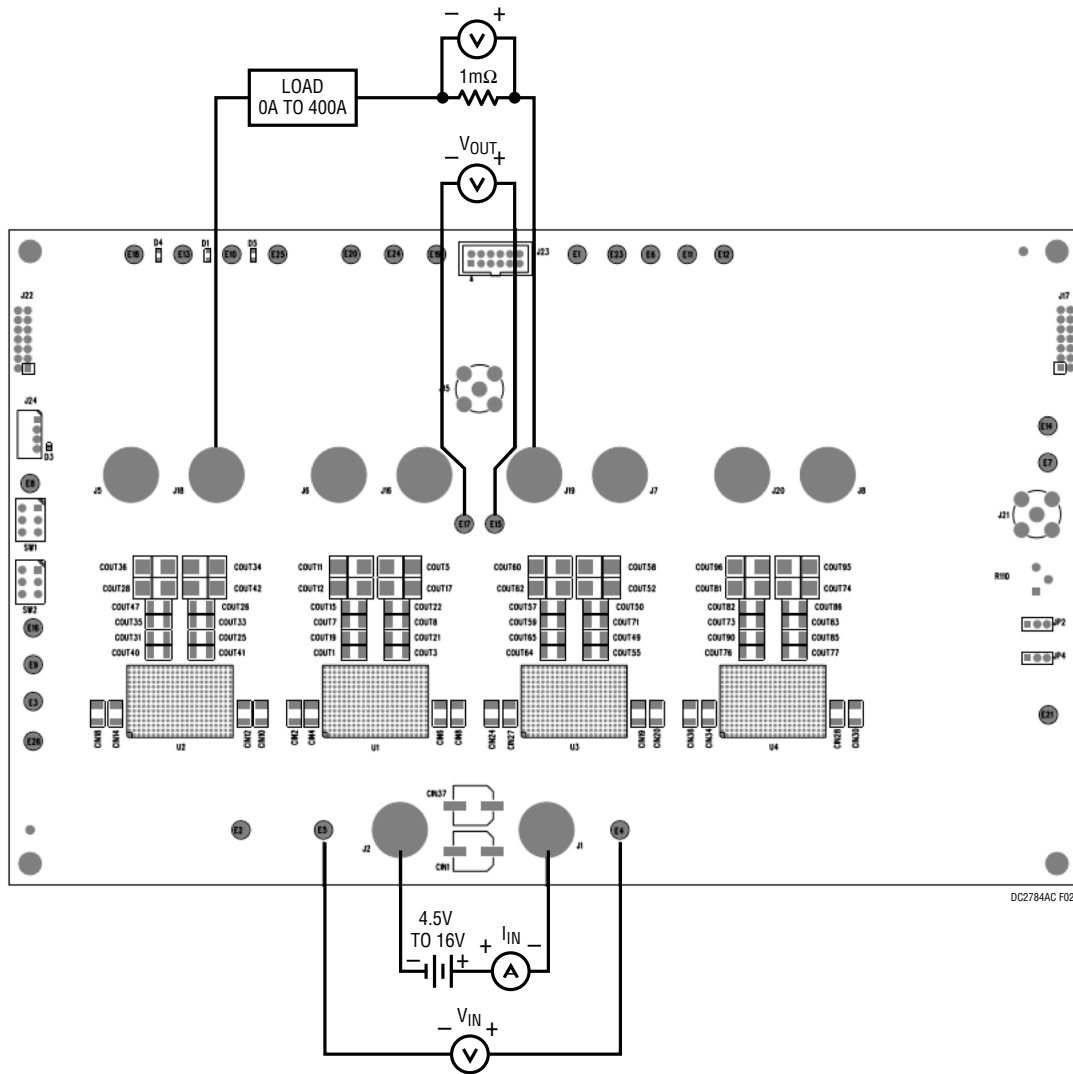


Figure 2. Proper Measurement Equipment Setup

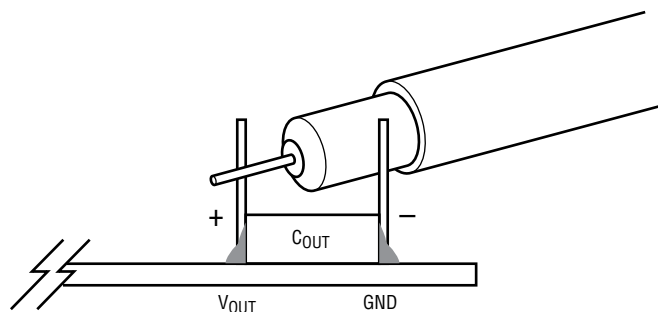


Figure 3. Measuring Output Voltage Ripple

## QUICK START PROCEDURE

### Connecting a PC to DC2784A-C

You can use a PC to reconfigure the power management features of the LTM4700 such as: nominal V<sub>OUT</sub>, margin set points, OV/UV limits, temperature fault limits,

sequencing parameters, the fault log, fault responses, GPIOs and other functionalities. The DC1613A dongle may be plugged when V<sub>IN</sub> is present.

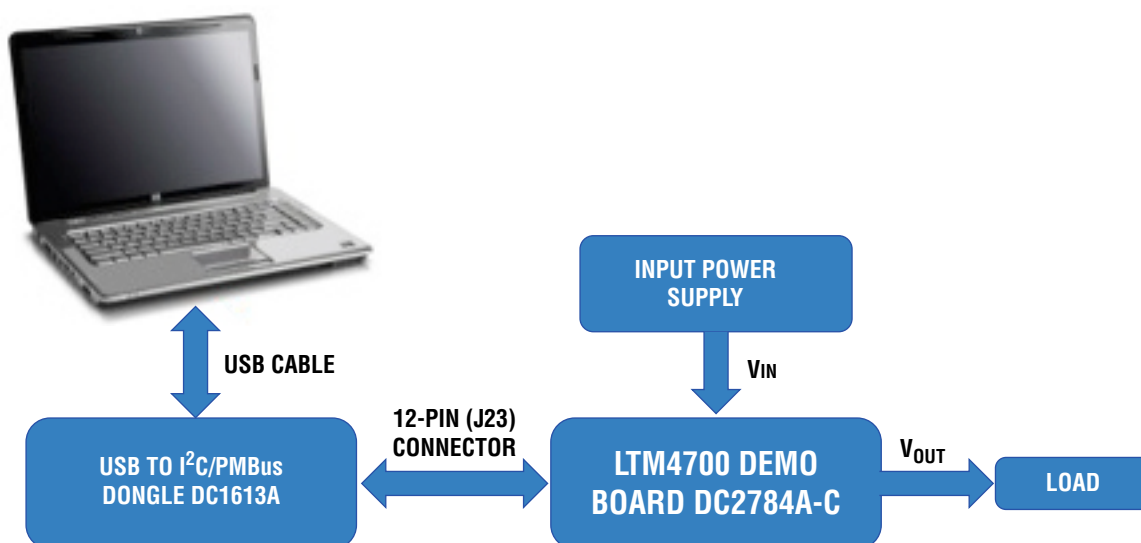


Figure 4. Demo Setup with PC

## QUICK START PROCEDURE

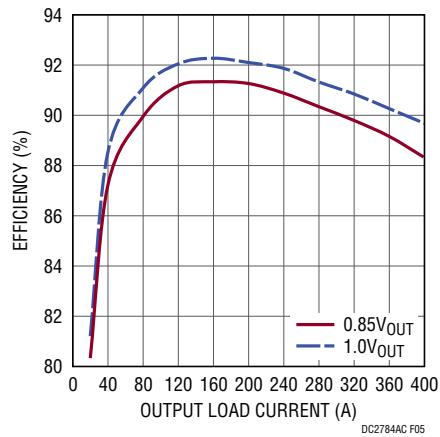


Figure 5. Efficiency vs Load Current at  $V_{IN} = 12V$ , 350kHz (RUNP is ON)

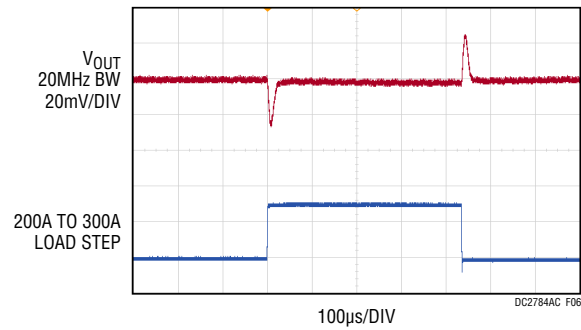


Figure 6. Output Voltage vs Load Current at  $V_{IN} = 12V$ ,  $V_{OUT} = 1.0V$

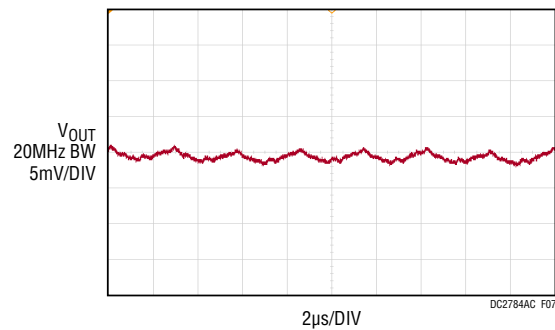


Figure 7. Output Voltage Ripple at  $V_{IN} = 12V$ ,  $V_{OUT} = 1.0V$ ,  $I_{OUT} = 400A$

## QUICK START PROCEDURE

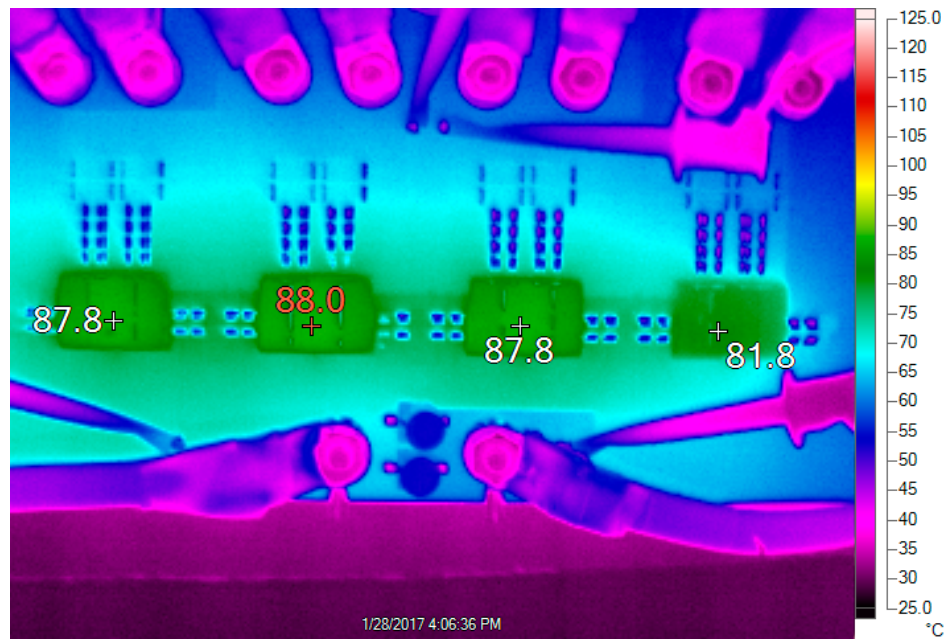


Figure 8. Thermal at  $V_{IN} = 12V$ ,  $V_{OUT} = 1.0V$ ,  $I_{OUT} = 260A$ ,  $T_A = 25^\circ C$ , No Airflow

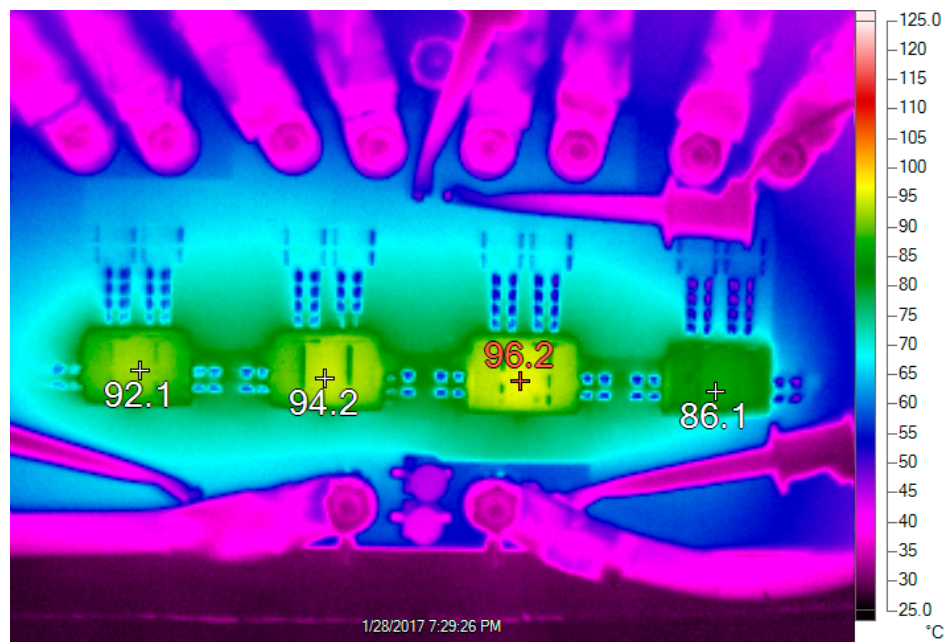


Figure 9. Thermal at  $V_{IN} = 12V$ ,  $V_{OUT} = 1.0V$ ,  $I_{OUT} = 400A$ ,  $T_A = 25^\circ C$ , 400LFM Airflow

## LTpowerPlay SOFTWARE GUI

LTpowerPlay is a powerful Windows based development environment that supports Analog Devices power system management ICs and  $\mu$ Modules, including the LTM4675, LTM4676, LTM4677, LTM4678, LTC3880, LTC3882 and LTC3883. The software supports a variety of different tasks. You can use LTpowerPlay to evaluate Analog Devices ICs by connecting to a demo board system. LTpowerPlay can also be used in an offline mode (with no hardware present) in order to build a multichip configuration file that can be saved and reloaded at a later time. LTpowerPlay provides unprecedented diagnostic and debug features. It becomes a valuable diagnostic tool during board bring-up to program or tweak the power

management scheme in a system, or to diagnose power issues when bringing up rails. LTpowerPlay utilizes the DC1613A USB-to-SMBus controller to communicate with one of many potential targets, including the LTM4675, LTM4676, LTM4677, LTM4678, LTC3880, LTC3882, LTC3883's demo system, or a customer board. The software also provides an automatic update feature to keep the software current with the latest set of device drivers and documentation. The LTpowerPlay software can be downloaded from [LTpowerPlay](#).

To access technical support documents for ADI Digital Power Products visit the LTpowerPlay Help menu. Online help also available through the LTpowerPlay.

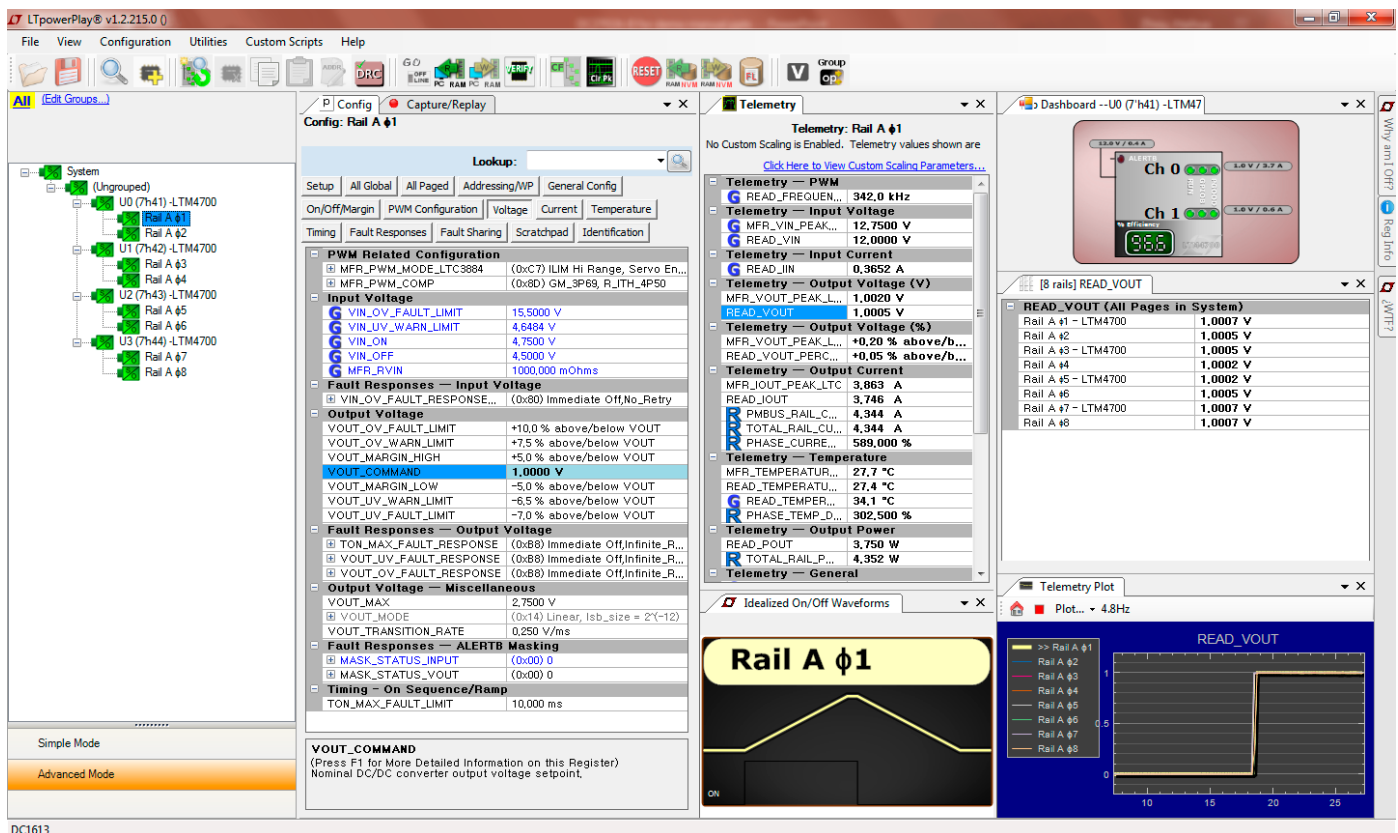
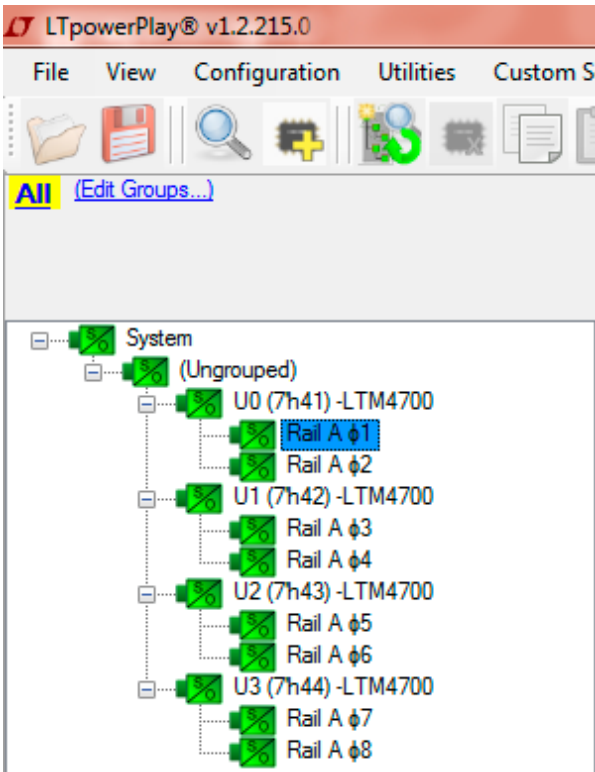


Figure 10. LTpowerPlay Main Interface

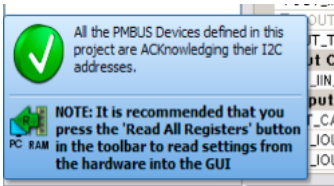
LTpowerPlay QUICK START PROCEDURE

The following procedure describes how to use LTpowerPlay to monitor and change the settings of LTM4700.

- 1. Download and install the LTpowerPlay GUI: [LTpowerPlay](#)
- 2. Launch the LTpowerPlay GUI.
  - a. The GUI should automatically identify the DC2784A-C. The system tree on the left hand side should look like this:



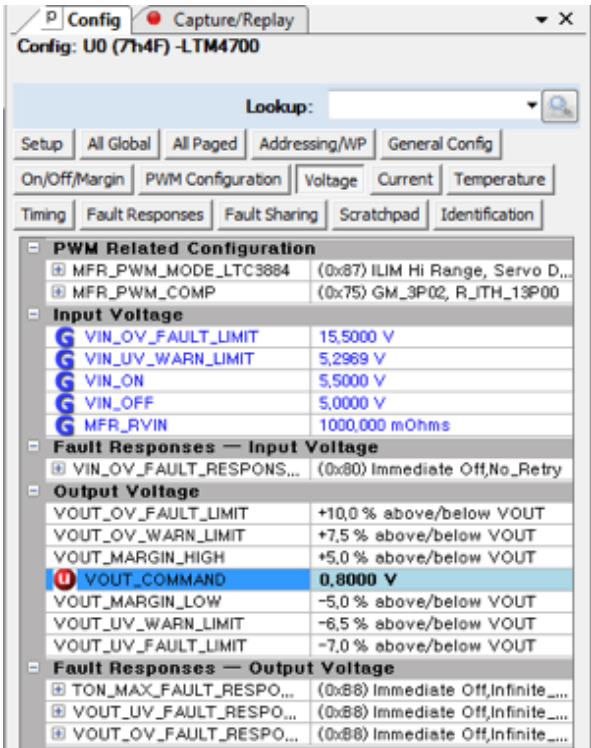
- b. A green message box shows for a few seconds in the lower left hand corner, confirming that LTM4700 is communicating:



- c. In the Toolbar, click the “R” (RAM to PC) icon to read the RAM from the LTM4700. This reads the configuration from the RAM of LTM4700 and loads it into the GUI.



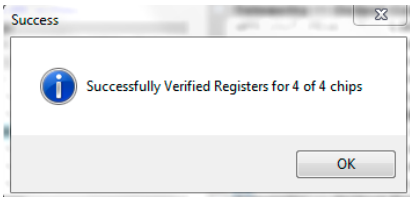
- d. If you want to change the output voltage to a different value, like 0.8V. In the Config tab, type in 0.8 in the VOUT\_COMMAND box, like this:



Then, click the “W” (PC to RAM) icon to write these register values to the LTM4700. After finishing this step, you will see the output voltage will change to 0.8V.



If the write is successful, you will see the following message:



- e. You can save the changes into the NVM. In the toolbar, click “RAM to NVM” button, as following
  - f. Save the demo board configuration to a (\*.proj) file. Click the Save icon and save the file. Name it whatever you want.



## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Required Circuit Components</b>				
1	4	CIN1, CIN16, CIN37, CIN38	CAP., 180µF, ALUM. POLY., 25V, 20%, 8x12mm SMD, E12	PANASONIC, 25SVPF180M
2	32	CIN2, CIN3, CIN4, CIN5, CIN6, CIN7, CIN8, CIN9, CIN10, CIN11, CIN12, CIN13, CIN14, CIN15, CIN17, CIN18, CIN19, CIN20, CIN21, CIN22, CIN23, CIN24, CIN26, CIN27, CIN28, CIN29, CIN30, CIN31, CIN32, CIN34, CIN35, CIN36	CAP., 22µF X6S 25V 10% 1210;	MURATA, GRM32EC81E226KE15L
3	86	COUT1, COUT2, COUT3, COUT6, COUT7, COUT8, COUT14, COUT15, COUT16, COUT18, COUT19, COUT20, COUT21, COUT22, COUT23, COUT24, COUT25, COUT26, COUT27, COUT29, COUT30, COUT31, COUT32, COUT33, COUT35, COUT37, COUT40, COUT41, COUT43, COUT46, COUT47, COUT93, COUT97, COUT98, COUT99, COUT100, COUT101, COUT102, COUT49, COUT50, COUT51, COUT53, COUT54, COUT55, COUT56, COUT57, COUT59, COUT61, COUT64, COUT65, COUT67, COUT70, COUT71, COUT72, COUT73, COUT76, COUT77, COUT79, COUT82, COUT83, COUT84, COUT85, COUT86, COUT87, COUT89, COUT90, COUT91, COUT92, COUT48, COUT94	CAP., 100µF X6S 6.3V 20%1210	MURATA, GRM32EC80J107ME20L
4	32	COUT4, COUT5, COUT9, COUT10, COUT11, COUT12, COUT13, COUT17, COUT28, COUT34, COUT36, COUT38, COUT39, COUT42, COUT44, COUT45, COUT52, COUT58, COUT60, COUT62, COUT63, COUT66, COUT68, COUT69, COUT74, COUT75, COUT78, COUT80, COUT81, COUT88, COUT95, COUT96,	CAP., 470µF, ALUM POLY, 2.5V, 20% SMD D3L	PANASONIC, EEF-GX0E471R
5	1	C14	CAP., X7R, 560pF, 25V, 5%, 0603	AVX, 06033C561JAT2A
6	4	C15, C28, C73, C74	CAP., X7R, 0.01µF, 25V, 5%, 0603	AVX, 06033C103JAT2A
7	4	C33, C35, C45, C57	CAP., X6S, 22µF, 6.3V, 20%, 0603	MURATA, GRM188C80J226ME15D
8	1	C64	CAP., X5R, 4.7µF, 16V, 10%, 0603	TDK, C1608X5R1C475K080AC
9	2	C65, C68	CAP., X7R, 1µF, 25V, 10%, 1206	KEMET, C1206C105K3RACTU
10	1	C66	CAP., X7R, 0.22µF, 16V, 10%, 0805	TDK, C2012X7R1C224K
11	1	C67	CAP., X5R, 0.1µF, 16V, 10%, 1206	AVX, 1206YD104KAT2A
12	1	C69	CAP., X7R, 1800pF, 25V, 5%, 0603	AVX, 06033C182JAT2A
13	1	C70	CAP., X7R, 1µF, 25V, 10%, 0805	AVX, 08053C105KAT2A
14	1	C71	CAP., X5R, 0.1µF, 16V, 10%, 0603	AVX, 0603YD104KAT2A
15	1	D1	LED, SUPER RED, WATERCLEAR, 0603	WURTH ELEKTRONIK, 150060SS75000
16	1	D3	DIODE SCHOTTKY 20V 500mA SOD882	NXP, PMEG2005AEL
17	2	D4, D5	LED, GREEN, WATERCLEAR, 0603	WURTH ELEKTRONIK, 150060GS75000
18	1	Q1	XSTR., MOSFET, P-CH, 20V, 5.9A, TO-236 (SOT-23)	VISHAY, Si2365EDS-T1-GE3
19	2	Q2, Q3	MOSFET N-CHANNEL 30V 90A TO252	TAIWAN SEMICONDUCTOR CORPORATION, TSM040N03CP ROG

# DEMO MANUAL DC2784A-C

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
20	1	Q4	XSTR., MOSFET, P-CH, 30V, 3.5A, SOT-23, AEC-Q101	DIODES INC., DMP3130L-7
21	2	Q5, Q6	XSTR., MOSFET, N-CH, 60V, 300mA, SOT-23	FAIRCHILD SEMI., 2N7002K
22	15	R10, R11, R12, R13, R14, R15, R18, R24, R94, R106, R116, R126, R142, R154, R210	RES., 10k, 5%, 1/10W, 0603	VISHAY, CRCW060310K0JNEA
23	5	R25, R32, R70, R125, R237	RES., 10 $\Omega$ , 1%, 1/10W, 0603	VISHAY, CRCW060310R0FKEA
24	1	R26	RES., 787 $\Omega$ , 1%, 1/10W, 0603	VISHAY, CRCW0603787RFKEA
25	1	R86	RES., 127 $\Omega$ , 1%, 1/10W, 0603	VISHAY, CRCW0603127RFKEA
26	4	R90, R108, R133, R159	RES., 0.001 $\Omega$ , 2W, 1%, 2512, SENSE, AEC-Q200	BOURNS INC., CRF-2512-FZ-R001ELF
27	1	R110	RES., 5k, 10%, 1/2W, THT 3/8" SQUARE, SINGLE TURN, TOP ADJ., TRIMPOT	BOURNS, 3386P-1-502-LF
28	2	R111, R115	RES., 20k, 5%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW060320K0JNEA
29	1	R113	RES., 1.65k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW06031K65FKEA
30	2	R118, R232	RES., 0.003 $\Omega$ 1% 1/2W 2010	VISHAY, WSL20103L000FEA
31	1	R123	RES., 1M, 5%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW06031M00JNEA
32	2	R124, R224	RES., 200 $\Omega$ , 1%, 1/10W, 0603	VISHAY, CRCW0603200RFKEA
33	1	R137	RES., 2.43k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW06032K43FKEA
34	1	R148	RES., 3.24k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW06033K24FKEA
35	1	R203	RES., 681k, 1%, 1/10W, 0603	VISHAY, CRCW0603681KFKEA
36	1	R204	RES., 3.3 $\Omega$ , 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW06033R30FKEA
37	1	R205	RES., 82.5 $\Omega$ , 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW060382R5FKEA
38	2	R213, R223	RES., 4.99k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW06034K99FKEA
39	1	R220	RES., 15.8k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW060315K8FKEA
40	1	R229	RES., 100k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW0603100KFKEA
41	1	R233	RES., 100 $\Omega$ , 1%, 1W, 0603, AEC-Q200	VISHAY, CRCW0603100RFKEA
42	1	R234	RES., 1.4k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW06031K40FKEA
43	1	R235	RES., 154k, 5%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW0603154KJNEA
44	1	R236	RES., 2 $\Omega$ , 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW06032R00FKEA
45	2	SW1, SW2	SWITCH, SUBMINATURE SLIDE	C&K COMPONENTS, JS202011CQN
46	2	U1, U2	IC, LTM4700EY	ANALOG DEVICES, LTM4700EY#PBF
47	2	U3, U4	IC, LTM4700EY	ANALOG DEVICES, LTM4700EY#PBF
48	1	U5	IC, MEMORY, EEPROM, 2Kb (256x8), TSSOP-8, 400kHz	MICROCHIP, 24LC025-I/ST
49	1	U6	IC, $\mu$ PWR LDO REG w/SHUTDOWN, SO-8	ANALOG DEVICES, LT1129CS8-5#PBF
50	1	U7	IC, TimerBlox: Voltage-Ctrl. PWM, TSOT23-6	ANALOG DEVICES, LTC6992CS6-1#PBF
51	1	U8	IC, SINGLE 100V, 85MHz, OP AMP, TSOT-23-5	ANALOG DEVICES, LT1803IS5#PBF

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Additional Demo Board Circuit Components</b>				
1	0	C16, C17, C29, C31, C32, C34, C36, C40, C41, C42, C43, C44, C46, C47, C48, C49, C50, C51, C52, C53, C54, C55, C56, C58	CAP., OPTION 0603	OPTION
2	0	D2	DIODE, OPTION, SOD-323	OPTION
3	0	R8, R27, R28, R29, R30, R31, R109, R117, R120, R121, R127, R130, R134, R138, R139, R140, R144, R145, R150, R151, R152, R155, R157, R160, R208, R216, R218, R219, R221, R226, R238, R239, R240, R241, R242, R243, R244, R245	RES., OPTION, 0603	OPTION
4	17	R9, R91, R92, R112, R114, R132, R135, R136, R146, R147, R149, R158, R202, R211, R215, R222, R227	RES., 0Ω, 1/10W, 0603	VISHAY, CRCW06030000Z0EA
5	0	R104, R105, R122, R128, R141, R143, R153, R156	RES., OPTION, 0805	OPTION
6	0	R217	RES., OPTION, 1206	OPTION
7	0	R230, R231	RES., OPTION, 2512	OPTION
<b>Hardware: For Demo Board Only</b>				
1	25	E1-E21, E23, E24, E25, E26	TEST POINT, TURRET, 0.064", MTG. HOLE	MILL-MAX, 2308-2-00-80-00-00-07-0
2	2	JP2, JP4	CONN., HEADER, 1X3, 2mm	WURTH ELEKTRONIK, 62000311121
3	2	XJP2, XJP4	CONN., SHUNT, FEMALE, 2 POS, 2mm	WURTH ELEKTRONIK, 60800213421
4	10	J1, J2, J5, J6, J7, J8, J16, J18, J19, J20	STUD, FASTENER, #10-32	PENNGENGINEERING, KFH-032-10ET
5	20	J1, J2, J5, J6, J7, J8, J16, J18, J19, J20 (X2)	NUT, HEX, STEEL, ZINC PLATE, 10-32	KEYSTONE, 4705
6	10	J1, J2, J5, J6, J7, J8, J16, J18, J19, J20	RING, LUG, CRIMP, #10, NON-INSULATED, SOLDERLESS TERMINALS	KEYSTONE, 8205
7	10	J1, J2, J5, J6, J7, J8, J16, J18, J19, J20	WASHER, FLAT, STEEL, ZINC PLATE, OD: 0.436 [11.1]	KEYSTONE, 4703
8	2	J15, J21	CONN., RF, BNC, RCPT, THT, STR, 5-PIN	AMPHENOL CONNEX, 112404
9	1	J17	CONN., HDR, MALE, 2x7, 2mm, R/A THT	MOLEX, 87760-1416
10	1	J22	CONN., HDR, FEMALE, 2x7, 2mm, R/A THT	SULLINS CON., NPPN072FJFN-RC
11	1	J23	CONN., HDR, SHROUDED, 2x6, 2mm, THT, VERT	FCI, 98414-G06-12ULF
12	1	J24	CONN., HDR, SHROUDED, 1x4, 2mm, R/A THT STR	HIROSE ELECTRIC CO., LTD., DF3A-4P-2DSA
13	4	MH1, MH2, MH3, MH4	STANDOFF, NYLON, SNAP-ON, 0.50"	WURTH ELEKTRONIK, 702935000

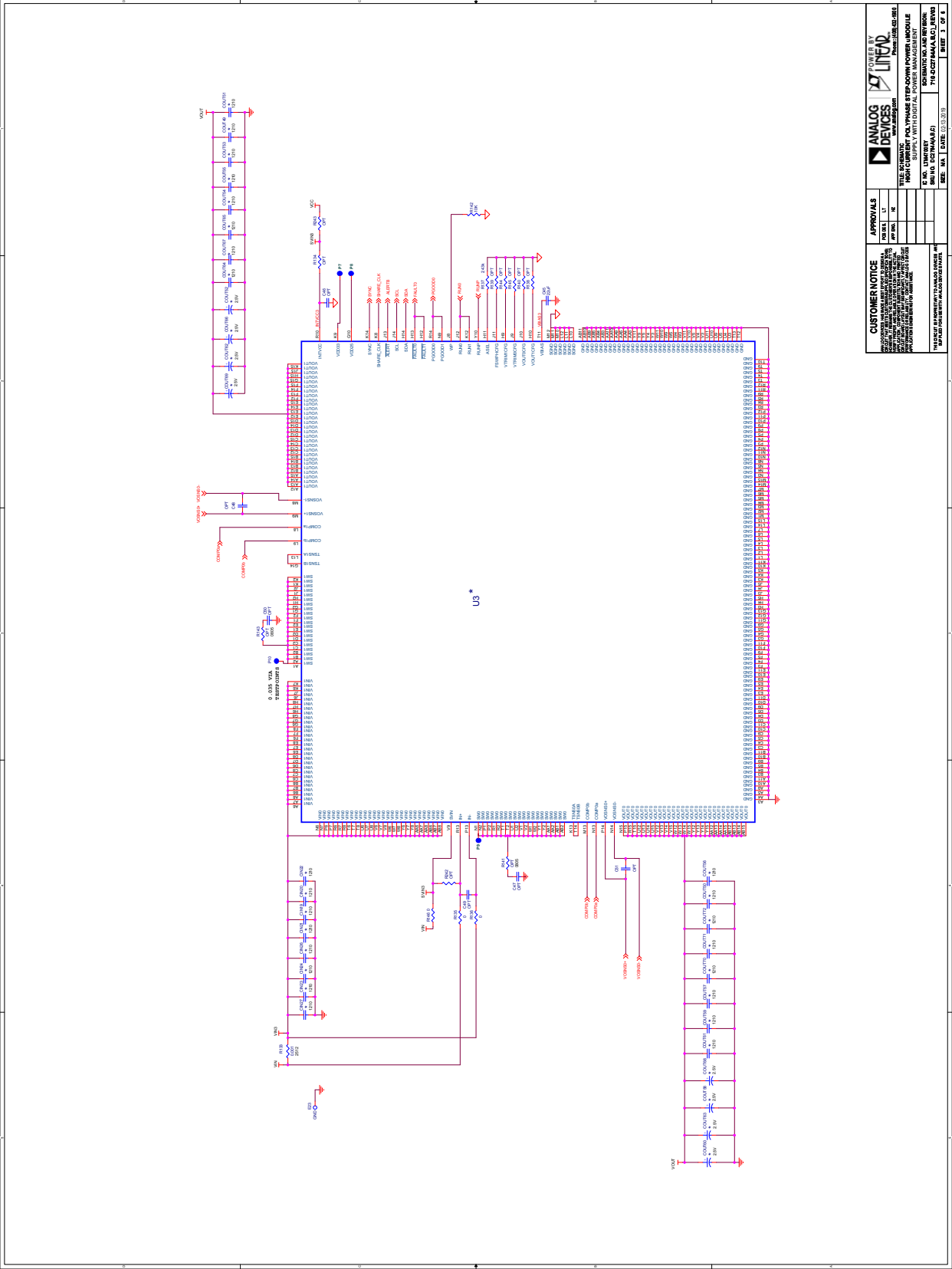
## SCHEMATIC DIAGRAM

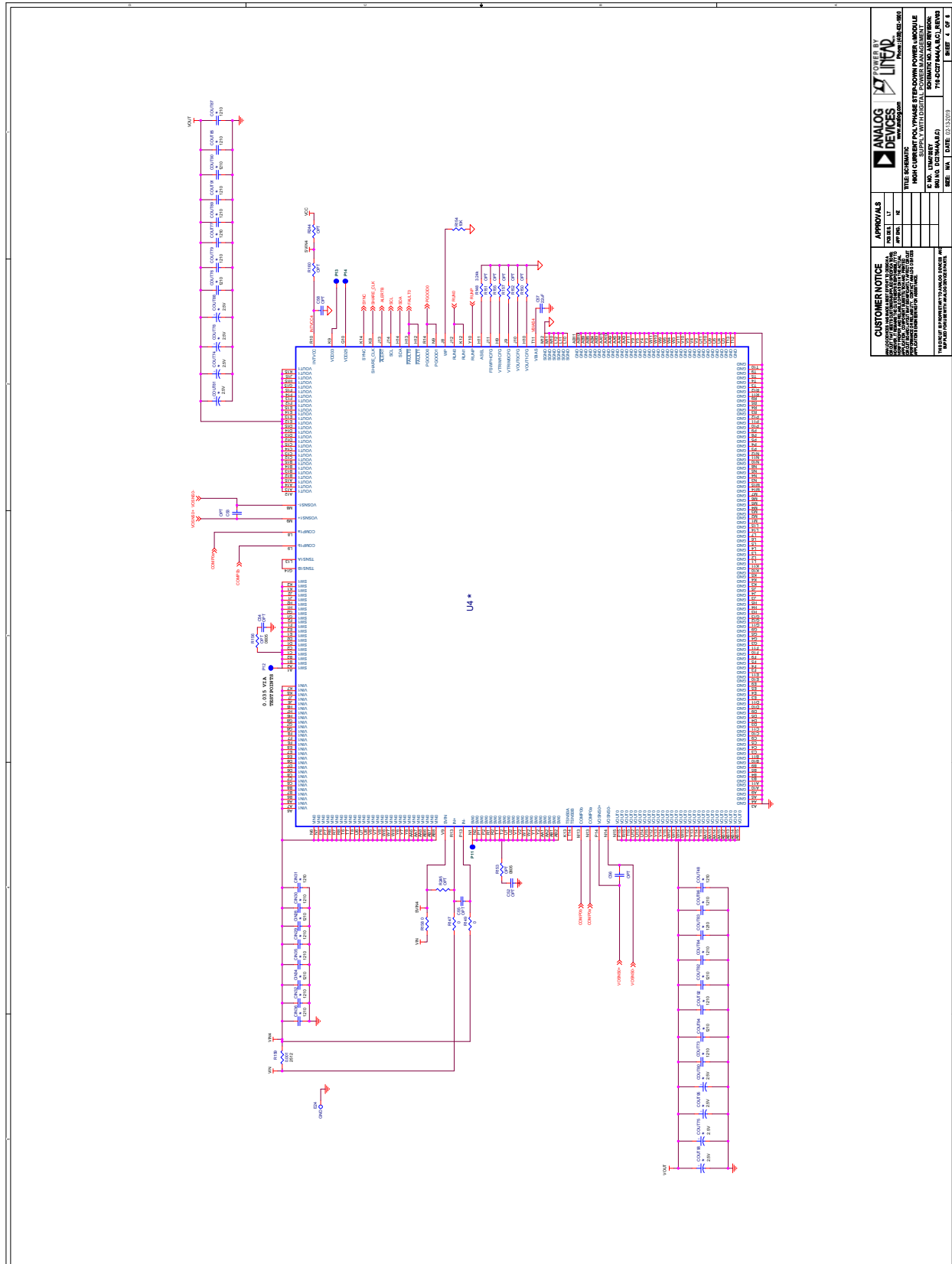




# DEMO MANUAL DC2784A-C

## SCHEMATIC DIAGRAM






## SCHEMATIC DIAGRAM



## SCHEMATIC DIAGRAM



<p><b>CUSTOMER NOTICE</b></p> <p>ANALOG DEVICES HAS A MARKET OFFER TO DEMONSTRATE THE BENEFITS OF THE ANALOG DEVICES' NEW 100% DIGITAL SIGNAL PROCESSOR (DSP) TECHNOLOGY. ANALOG DEVICES IS CURRENTLY SUPPLYING THE ANALOG DEVICES' NEW 100% DIGITAL SIGNAL PROCESSOR (DSP) TECHNOLOGY TO A LIMITED NUMBER OF CUSTOMERS. ANALOG DEVICES IS CURRENTLY SUPPLYING THE ANALOG DEVICES' NEW 100% DIGITAL SIGNAL PROCESSOR (DSP) TECHNOLOGY TO A LIMITED NUMBER OF CUSTOMERS. ANALOG DEVICES IS CURRENTLY SUPPLYING THE ANALOG DEVICES' NEW 100% DIGITAL SIGNAL PROCESSOR (DSP) TECHNOLOGY TO A LIMITED NUMBER OF CUSTOMERS.</p>	<p><b>APPROVALS</b></p> <p>FOR USE, LT</p> <p>APP BOLD, NZ</p>	<p><b>ANALOG DEVICES</b></p> <p></p> <p><b>POWER BY LINEAR</b></p> <p>Phone: (408)325-3800</p>	<p>POWER BY LINEAR</p>
<p><b>TITLE: SCHEMATIC</b></p> <p><b>HIGH CURRENT POLYPHASE STEP-DOWN POWER MODULE</b></p> <p><b>SUPPLY WITH DIGITAL POWER MANAGEMENT</b></p>	<p><b>K/NO. 17M00000</b></p> <p><b>SCHEMATIC NO AND REVISION:</b></p> <p><b>710-023784(A,B,C) REV 03</b></p>	<p><b>SKU: NA</b></p> <p><b>DATE: 02/03/2019</b></p> <p><b>SHEET # OF 3</b></p>	<p>POWER BY LINEAR</p>

**ESD Caution**

**ESD (electrostatic discharge) sensitive device.** Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

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