

LTM4700

High Current, PolyPhase® Step-Down Power μ Module Supply with Digital Power System Management 3 \times LTM4700, 300A

DESCRIPTION

Demonstration circuit 2784B-B is a high efficiency, high density, μ Module® regulator with 4.5V to 16V input range. The output voltage is adjustable from 0.5V to 1.8V and it can supply 300A maximum load current. The demo board has three LTM4700 μ 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.

DC2784B-B 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 I²C/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

Part marking is either ink mark or laser mark

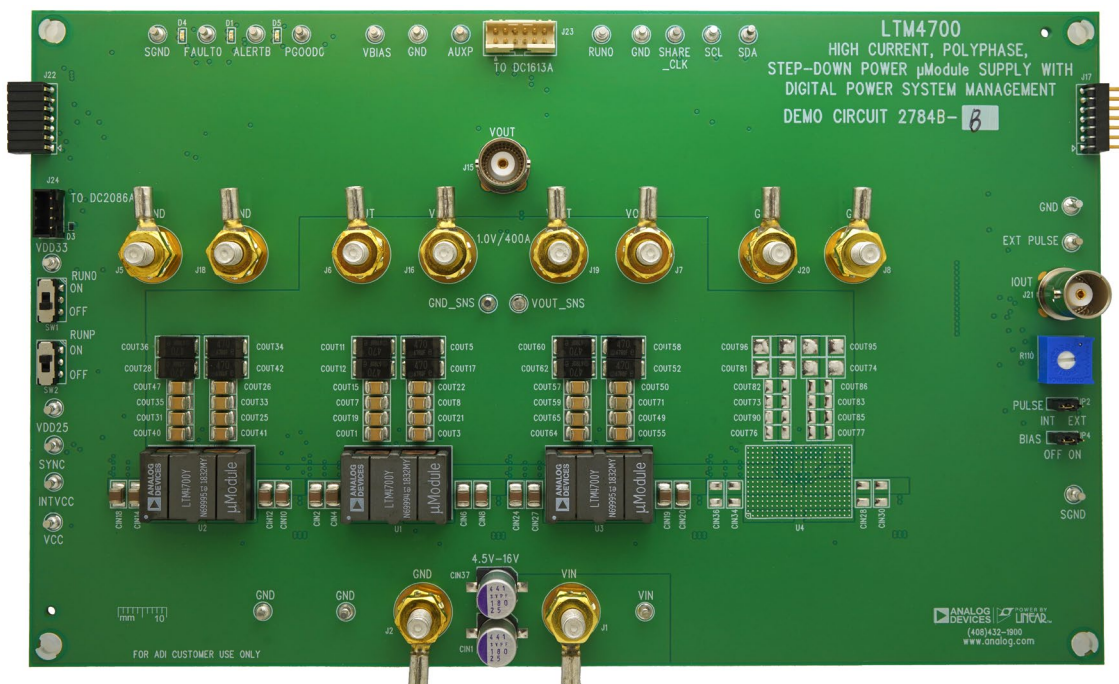


Figure 1. 3 \times LTM4700; 300A DC2784B-B Demo Circuit

DEMO MANUAL

DC2784B-B

PERFORMANCE SUMMARY

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

| PARAMETER | CONDITIONS | MIN | TYP | MAX | VALUE |
|-----------------------------------|---------------------------------------------------------------------------------|-----|---------------------|-----|-------|
| Input Voltage Range | | 4.5 | | 16 | V |
| Output Voltage, V_{OUT} | $V_{IN} = 4.5\text{V to } 16\text{V}$, $I_{OUT} = 0\text{A to } 300\text{A}$ | 0.5 | 1.0 | 1.8 | V |
| Maximum Output Current, I_{OUT} | $V_{IN} = 4.5\text{V to } 16\text{V}$, $V_{OUT} = 0.5\text{V to } 1.8\text{V}$ | | 300 | | A |
| Typical Efficiency | $V_{IN} = 12\text{V}$, $V_{OUT} = 1.0\text{V}$, $I_{OUT} = 300\text{A}$ | | 88.7 (See Figure 5) | | % |
| Default Switching Frequency | | | 350 | | kHz |

QUICK START PROCEDURE

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

| MAXIMUM OUTPUT CURRENT | NUMBER OF OUTPUTS | NUMBER OF LTM4700 μ Module REGULATORS ON THE BOARD | DEMO BOARD NUMBER |
|------------------------|-------------------|--------------------------------------------------------|-------------------|
| 50A | 2 | 1 | DC2702A-A |
| 100A | 1 | 1 | DC2702A-B |
| 200A | 1 | 2 | DC2784B-A |
| 300A | 1 | 3 | DC2784B-B |
| 400A | 1 | 4 | DC2784B-C |

Demonstration circuit 2784B-B 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

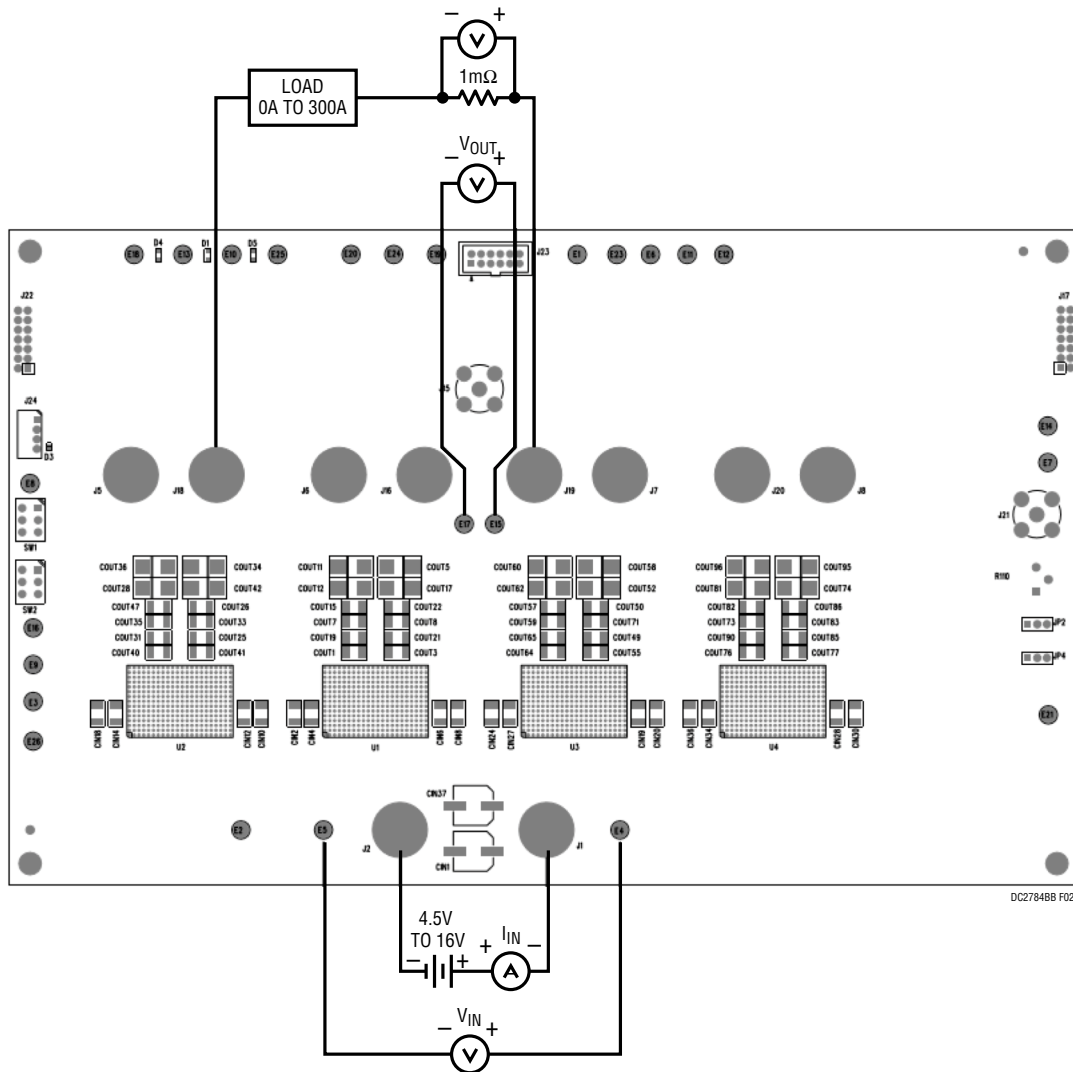


Figure 2. Proper Measurement Equipment Setup

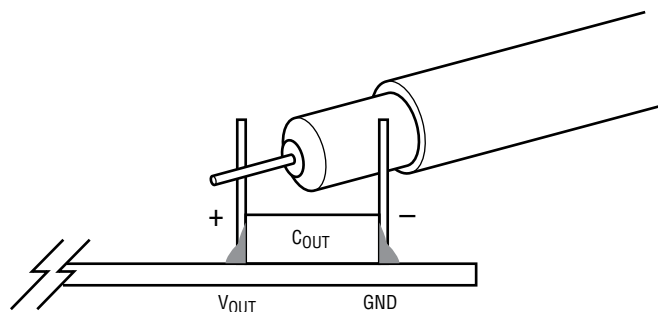


Figure 3. Measuring Output Voltage Ripple

QUICK START PROCEDURE

Connecting a PC to DC2784B-B

You can use a PC to reconfigure the power management features of the LTM4700 such as: nominal V_{OUT} , 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_{IN} is present.

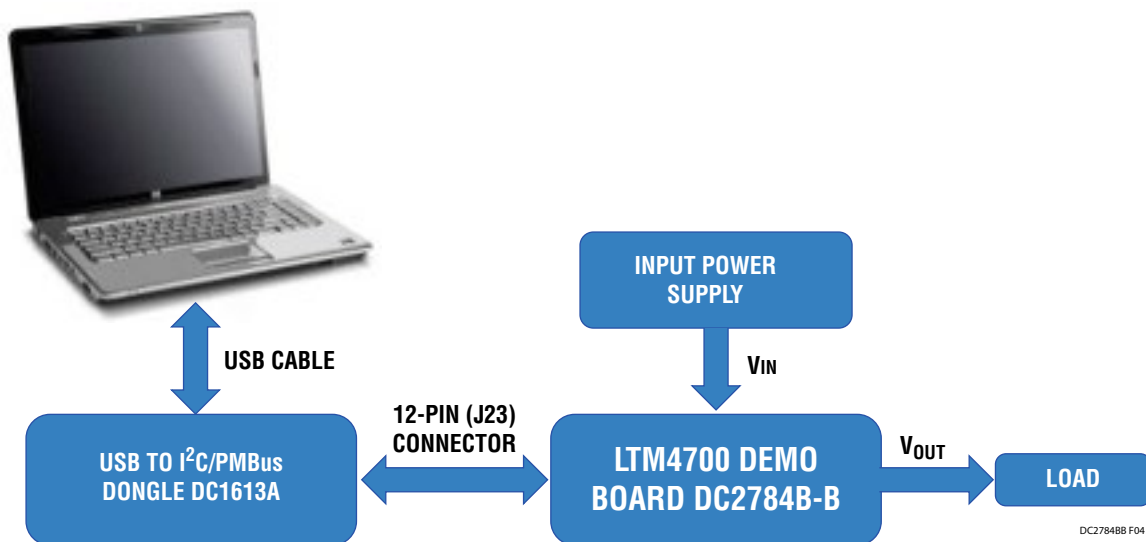


Figure 4. Demo Setup with PC

QUICK START PROCEDURE

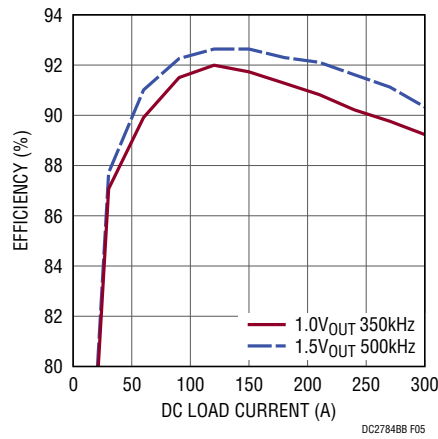


Figure 5. Efficiency vs Load Current at $V_{IN} = 12V$ (RUNP is ON)

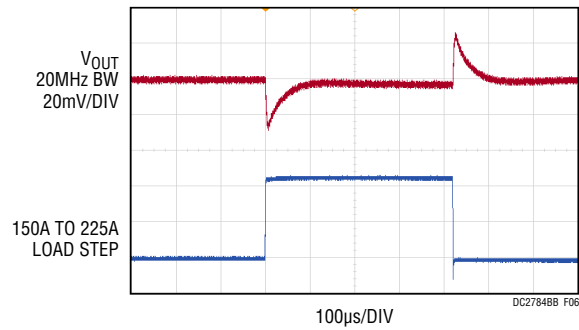


Figure 6. Output Voltage vs Load Current at $V_{IN} = 12V$, $V_{OUT} = 1.0V$

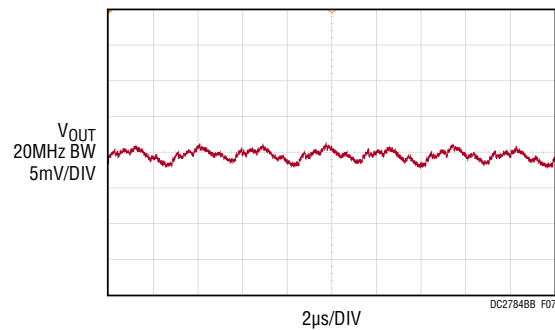


Figure 7. Output Voltage Ripple at $V_{IN} = 12V$, $V_{OUT} = 1.0V$, $I_{OUT} = 300A$

QUICK START PROCEDURE

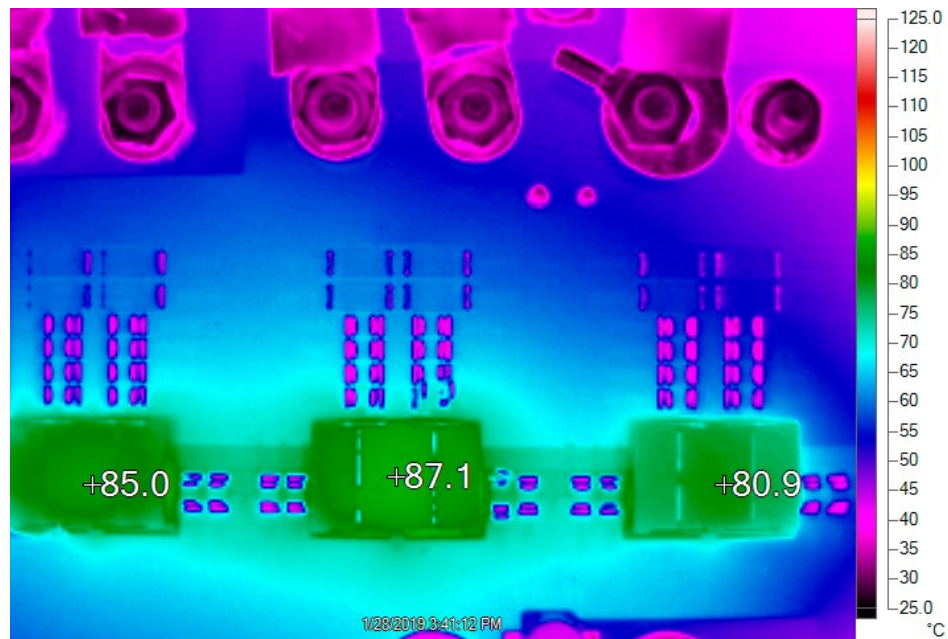


Figure 8. Thermal at $V_{IN} = 12V$, $V_{OUT} = 1.0V$, $I_{OUT} = 195A$, $T_A = 25^\circ C$, No Airflow

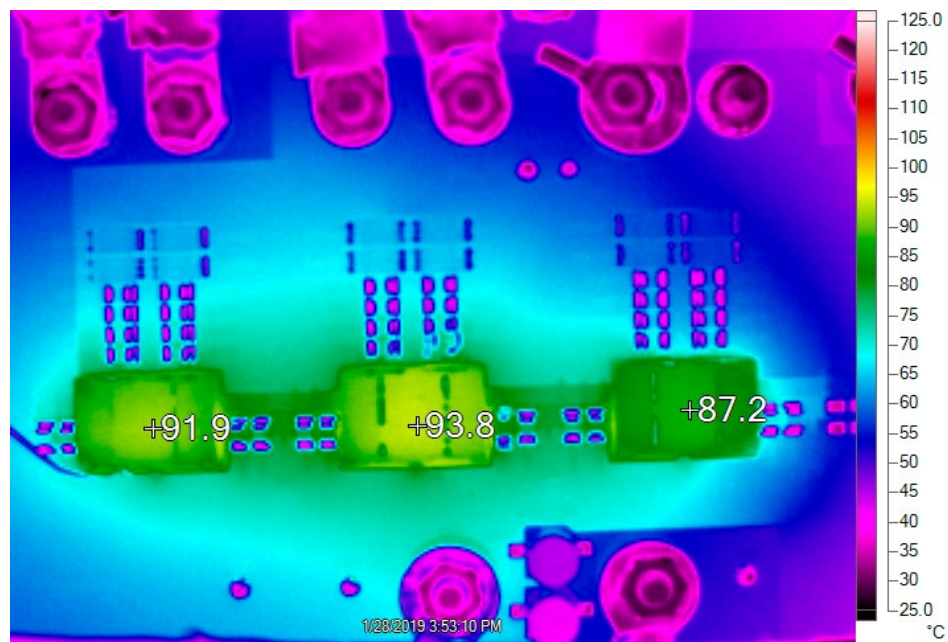


Figure 9. Thermal at $V_{IN} = 12V$, $V_{OUT} = 1.0V$, $I_{OUT} = 300A$, $T_A = 25^\circ C$, 400LFM Airflow

LTpowerPlay SOFTWARE GUI

LTpowerPlay is a powerful Windows-based development environment that supports Analog Devices power system management ICs and μ 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.

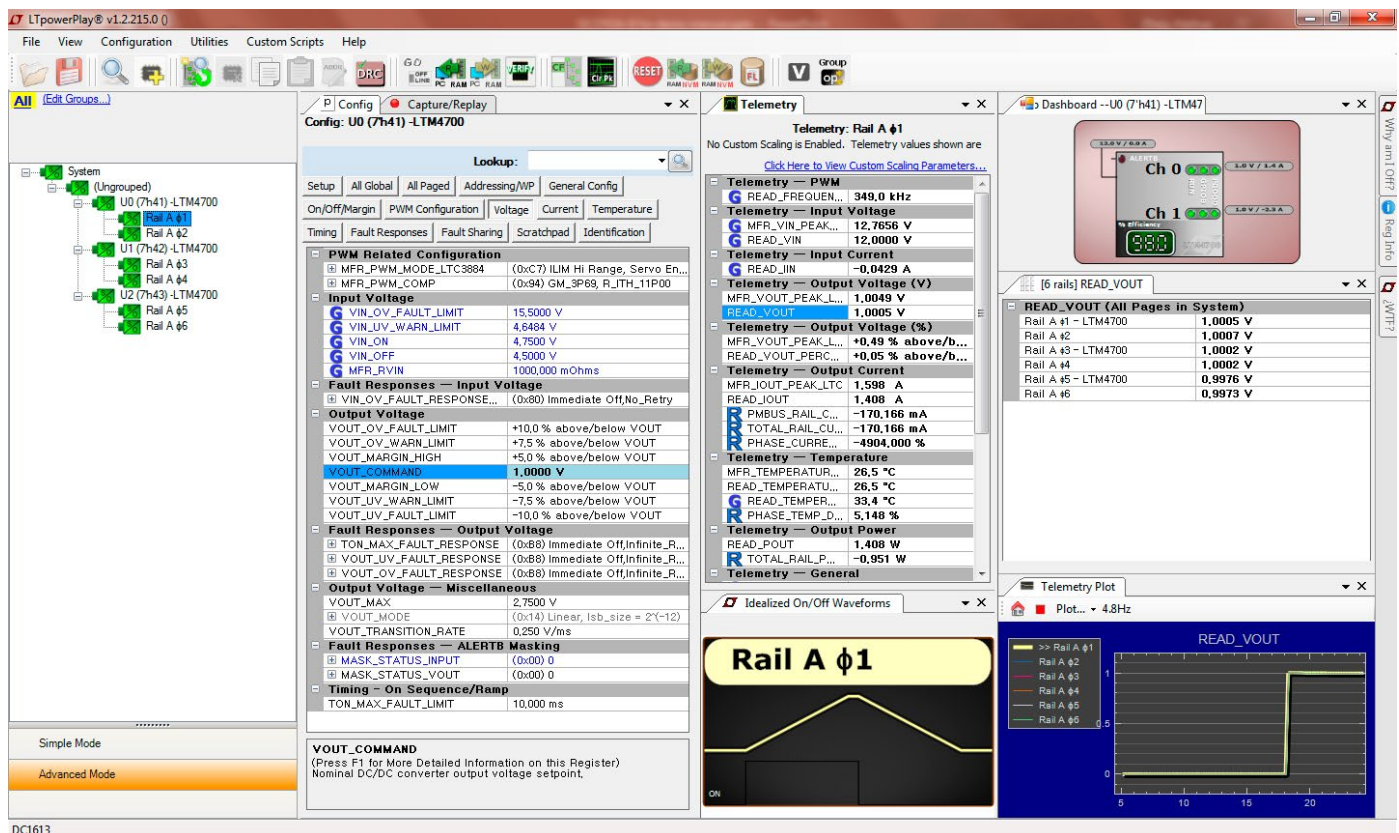


Figure 10. LTpowerPlay Main Interface

DEMO MANUAL

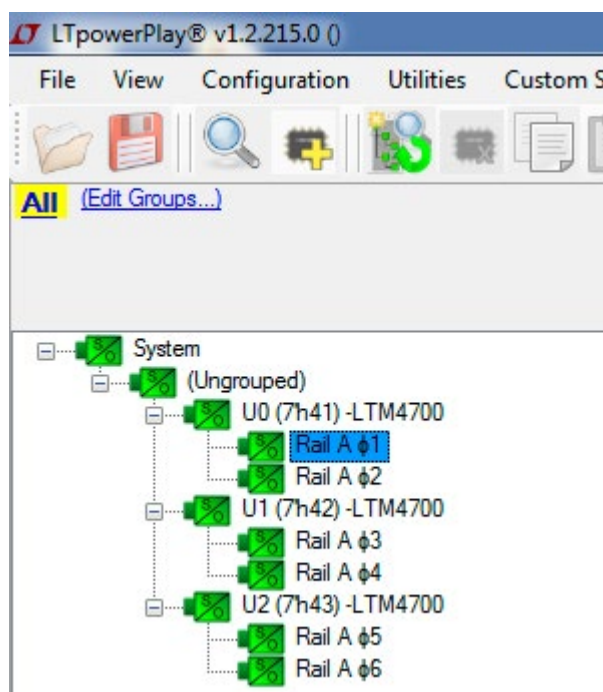
DC2784B-B

LTpowerPlay QUICK START PROCEDURE

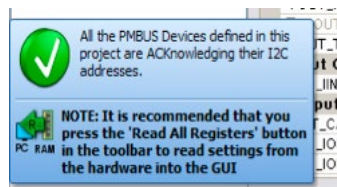
The following procedure describes how to use LTpowerPlay to monitor and change the settings of LTM4700.

1. Download and install the LTpowerPlay GUI: [LTpowerPlay](#)
2. Launch the LTpowerPlay GUI.

- a. The GUI should automatically identify the DC2784B-B. The system tree on the left hand side should look like this:



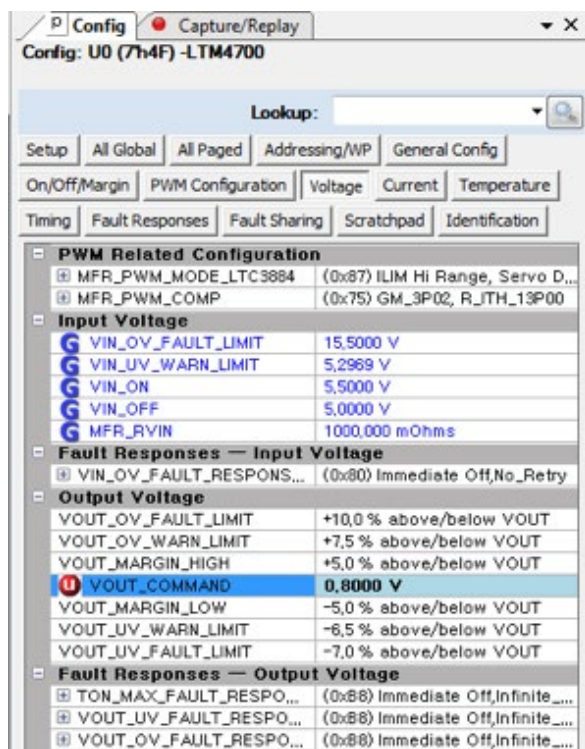
- b. A green message box shows for a few seconds in the lower left hand corner, confirming that LTM4700 is communicating:



- 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.



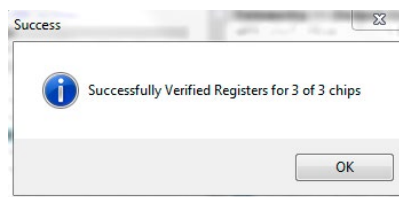
- d. If you want to change the output voltage to a different value, like 0.8V. In the Config tab, type in 0.8 in the VOUT_COMMAND box, like this:



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 |
|------------------------------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|---------------------------------------------------|
| Required Circuit Components | | | | |
| 1 | 4 | CIN1, CIN16, CIN37, CIN38 | CAP., 180μF, ALUM. POLY., 25V, 20%, 8mm ×12mm SMD, E12 | PANASONIC, 25SVPF180M |
| 2 | 16 | CIN2-CIN15, CIN17, CIN18 | CAP., 22μF X6S 25V 10% 1210; | MURATA, GRM32EC81E226KE15L |
| 3 | 8 | CIN19-CIN24, CIN26, CIN27 | CAP., 22μF X6S 25V 10% 1210 | MURATA, GRM32EC81E226KE15L |
| 4 | 54 | COUT1-COUT3, COUT6-COUT8, COUT14-COUT16, COUT18-COUT27, COUT29-COUT33, COUT35, COUT37, COUT40, COUT41, COUT43, COUT46, COUT47, COUT49-COUT51, COUT53-COUT57, COUT59, COUT61, COUT64, COUT65, COUT67, COUT70-COUT72, COUT93, COUT97-COUT102 | CAP., 100μF X6S 6.3V 20%1210 | MURATA, GRM32EC80J107ME20L |
| 5 | 24 | COUT4, COUT5, COUT9-COUT13, COUT17, COUT28, COUT34, COUT36, COUT38, COUT39, COUT42, COUT44, COUT45, COUT52, COUT58, COUT60, COUT62, COUT63, COUT66, COUT68, COUT69 | CAP., 470μF, ALUM POLY, 2.5V, 20% SMD D3L | PANASONIC, EEF-GX0E471R |
| 6 | 1 | C15 | CAP., X7R, 0.022μF, 25V, 5%, 0603 | AVX, 06033C223JAT2A |
| 7 | 3 | C28, C73, C74 | CAP., X7R, 0.01μF, 25V, 5%, 0603 | AVX, 06033C103JAT2A |
| 8 | 4 | C33, C35, C45, C57 | CAP., X6S, 22μF, 6.3V, 20%, 0603 | MURATA, GRM188C80J226ME15D |
| 9 | 1 | C64 | CAP., X5R, 4.7μF, 16V, 10%, 0603 | TDK, C1608X5R1C475K080AC |
| 10 | 2 | C65, C68 | CAP., X7R, 1μF, 25V, 10%, 1206 | KEMET, C1206C105K3RACTU |
| 11 | 1 | C66 | CAP., X7R, 0.22μF, 16V, 10%, 0805 | TDK, C2012X7R1C224K |
| 12 | 1 | C67 | CAP., X5R, 0.1μF, 16V, 10%, 1206 | AVX, 1206YD104KAT2A |
| 13 | 1 | C69 | CAP., X7R, 1800pF, 25V, 5%, 0603 | AVX, 06033C182JAT2A |
| 14 | 1 | C70 | CAP., X7R, 1μF, 25V, 10%, 0805 | AVX, 08053C105KAT2A |
| 15 | 1 | C71 | CAP., X5R, 0.1μF, 16V, 10%, 0603 | AVX, 0603YD104KAT2A |
| 16 | 1 | D1 | LED, SUPER RED, WATERCLEAR, 0603 | WURTH ELEKTRONIK, 150060SS75000 |
| 17 | 1 | D3 | DIODE SCHOTTKY 20V 500mA SOD882 | NXP, PMEG2005AEL |
| 18 | 2 | D4, D5 | LED, GREEN, WATERCLEAR, 0603 | WURTH ELEKTRONIK, 150060GS75000 |
| 19 | 1 | Q1 | XSTR., MOSFET, P-CH, 20V, 5.9A, TO-236 (SOT-23) | VISHAY, Si2365EDS-T1-GE3 |
| 20 | 2 | Q2, Q3 | MOSFET N-CHANNEL 30V 90A TO252 | TAIWAN SEMICONDUCTOR CORPORATION, TSM040N03CP ROG |
| 21 | 1 | Q4 | XSTR., MOSFET, P-CH, 30V, 3.5A, SOT-23, AEC-Q101 | DIODES INC., DMP3130L-7 |
| 22 | 2 | Q5, Q6 | XSTR., MOSFET, N-CH, 60V, 300mA, SOT-23 | FAIRCHILD SEMI., 2N7002K |
| 23 | 15 | R10-R15, R18, R24, R94, R106, R116, R126, R142, R154, R210 | RES., 10k, 5%, 1/10W, 0603 | VISHAY, CRCW060310K0JNEA |
| 24 | 5 | R25, R32, R70, R125, R237 | RES., 10Ω, 1%, 1/10W, 0603 | VISHAY, CRCW060310R0FKEA |
| 25 | 1 | R26 | RES., 787Ω, 1%, 1/10W, 0603 | VISHAY, CRCW0603787RFKEA |
| 26 | 1 | R86 | RES., 127Ω, 1%, 1/10W, 0603 | VISHAY, CRCW0603127RFKEA |
| 27 | 4 | R90, R108, R133, R159 | RES., 0.001Ω, 2W, 1%, 2512, SENSE, AEC-Q200 | BOURNS INC., CRF-2512-FZ-R001ELF |
| 28 | 1 | R110 | RES., 5k, 10%, 1/2W, THT 3/8" SQUARE, SINGLE TURN, TOP ADJ., TRIMPOT | BOURNS, 3386P-1-502-LF |

DEMO MANUAL

DC2784B-B

PARTS LIST

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|------|-----|------------|--------------------------------------------------|----------------------------------|
| 29 | 2 | R111, R115 | RES., 20k, 5%, 1/10W, 0603, AEC-Q200 | VISHAY, CRCW060320K0JNEA |
| 30 | 1 | R113 | RES., 1.65k, 1%, 1/10W, 0603, AEC-Q200 | VISHAY, CRCW06031K65FKEA |
| 31 | 2 | R118, R232 | RES 0.003Ω 1% 1/2W 2010 | VISHAY, WSL20103L000FEA |
| 32 | 1 | R123 | RES., 1M, 5%, 1/10W, 0603, AEC-Q200 | VISHAY, CRCW06031M00JNEA |
| 33 | 2 | R124, R224 | RES., 200Ω, 1%, 1/10W, 0603 | VISHAY, CRCW0603200RFKEA |
| 34 | 1 | R137 | RES., 2.43k, 1%, 1/10W, 0603, AEC-Q200 | VISHAY, CRCW06032K43FKEA |
| 35 | 1 | R148 | RES., 3.24k, 1%, 1/10W, 0603, AEC-Q200 | VISHAY, CRCW06033K24FKEA |
| 36 | 1 | R203 | RES., 681k, 1%, 1/10W, 0603 | VISHAY, CRCW0603681KFKEA |
| 37 | 1 | R204 | RES., 3.3Ω, 1%, 1/10W, 0603, AEC-Q200 | VISHAY, CRCW06033R30FKEA |
| 38 | 1 | R205 | RES., 82.5Ω, 1%, 1/10W, 0603, AEC-Q200 | VISHAY, CRCW060382R5FKEA |
| 39 | 2 | R213, R223 | RES., 4.99k, 1%, 1/10W, 0603, AEC-Q200 | VISHAY, CRCW06034K99FKEA |
| 40 | 1 | R220 | RES., 15.8k, 1%, 1/10W, 0603, AEC-Q200 | VISHAY, CRCW060315K8FKEA |
| 41 | 1 | R229 | RES., 100k, 1%, 1/10W, 0603, AEC-Q200 | VISHAY, CRCW0603100KFKEA |
| 42 | 1 | R233 | RES., 100Ω, 1%, 1W, 0603, AEC-Q200 | VISHAY, CRCW0603100RFKEA |
| 43 | 1 | R234 | RES., 1.4k, 1%, 1/10W, 0603, AEC-Q200 | VISHAY, CRCW06031K40FKEA |
| 44 | 1 | R235 | RES., 154k, 5%, 1/10W, 0603, AEC-Q200 | VISHAY, CRCW0603154KJNEA |
| 45 | 1 | R236 | RES., 2Ω, 1%, 1/10W, 0603, AEC-Q200 | VISHAY, CRCW06032R00FKEA |
| 46 | 2 | SW1, SW2 | SWITCH, SUBMINATURE SLIDE | C&K COMPONENTS, JS202011CQN |
| 47 | 2 | U1, U2 | IC, LTM4700EY | ANALOG DEVICES, LTM4700EY#PBF |
| 48 | 1 | U3 | IC, LTM4700EY | ANALOG DEVICES, LTM4700EY#PBF |
| 49 | 1 | U5 | IC, MEMORY, EEPROM, 2Kb (256×8), TSSOP-8, 400kHz | MICROCHIP, 24LC025-I/ST |
| 50 | 1 | U6 | IC, μPWR LDO REG W/SHUTDOWN, SO-8 | ANALOG DEVICES, LT1129CS8-5#PBF |
| 51 | 1 | U7 | IC, TIMERBLOX: VOLTAGE-CTRL. PWM, TSOT23-6 | ANALOG DEVICES, LTC6992CS6-1#PBF |
| 52 | 1 | U8 | IC, SINGLE 100V, 85MHz, OP AMP, TSOT-23-5 | ANALOG DEVICES, LT1803IS5#PBF |

Additional Demo Board Circuit Components

| | | | | |
|---|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|--------|
| 1 | 0 | COUT73, COUT76, COUT77, COUT79, COUT82, COUT83, COUT84, COUT85, COUT86, COUT87, COUT89, COUT90, COUT91, COUT92, COUT48, COUT94, CIN28, CIN29, CIN30, CIN31, CIN32, CIN34, CIN35, CIN36 | CAP., OPT, 1210 | OPT |
| 2 | 0 | c14, 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 |
| 3 | 0 | D2 | DIODE, OPTION, SOD-323 | OPTION |

PARTS LIST

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--------------------------|
| 4 | 0 | R8, R27-R31, R109, R117, R120, R121, R127, R130, R134, R138-R140, R144, R145, R150-R152, R155, R157, R160, R208, R216, R218, R219, R221, R226, R238-R245 | RES., OPTION, 0603 | OPTION |
| 5 | 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 |
| 6 | 0 | R104, R105, R122, R128, R141, R143, R153, R156 | RES., OPTION, 0805 | OPTION |
| 7 | 0 | R217 | RES., OPTION, 1206 | OPTION |
| 8 | 0 | R230, R231 | RES., OPTION, 2512 | OPTION |
| 9 | 0 | U4 | IC, OPT | OPT |
| 10 | | COUT74, COUT75, COUT78, COUT80, COUT81, COUT88, COUT95, COUT96 | OPT, D3L | OPTION |

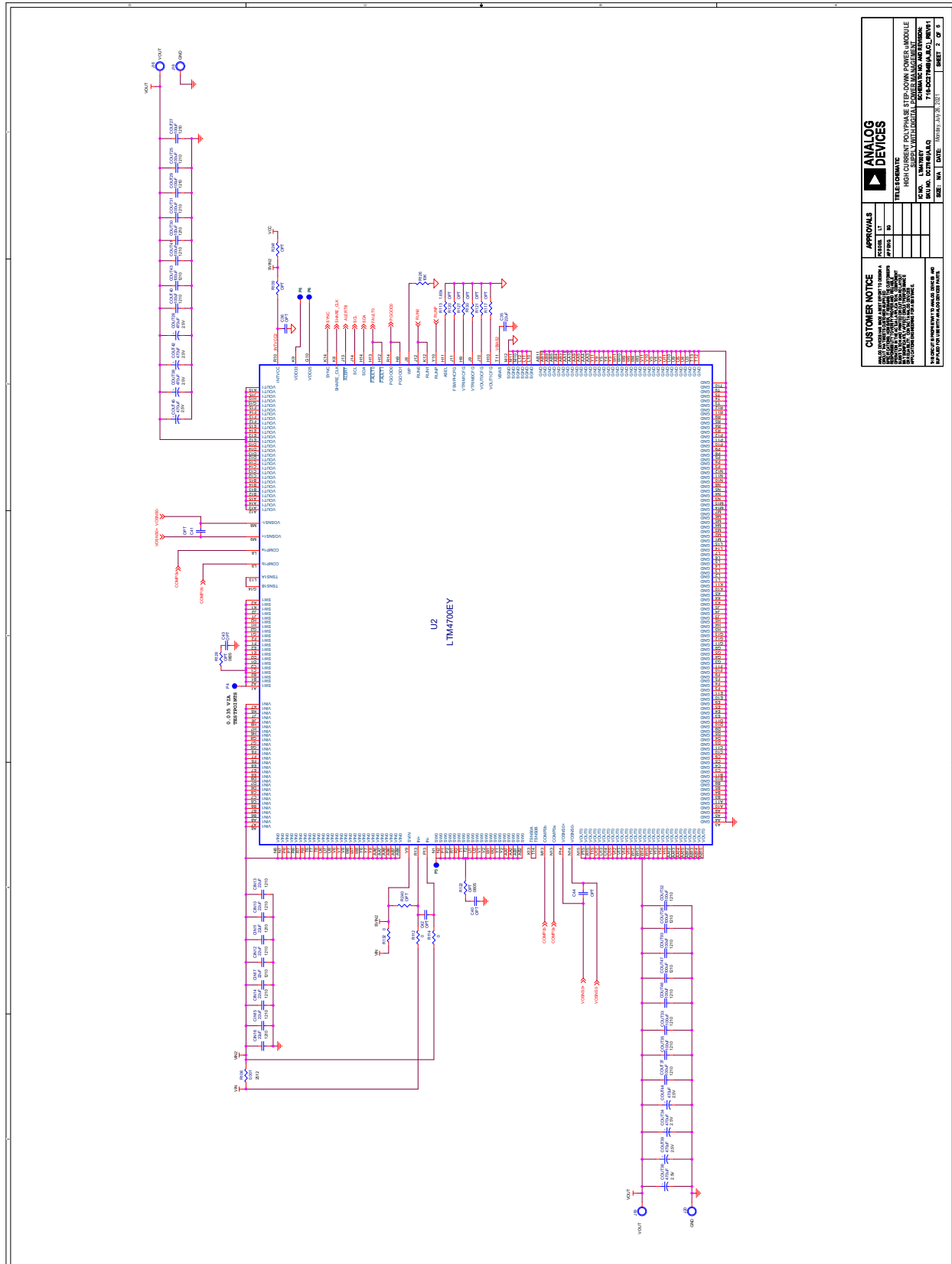
Hardware: For Demo Board Only

| | | | | |
|----|----|----------------------------------|------------------------------------------------------------|-----------------------------------------|
| 1 | 25 | E1-E21, E23-E26 | TEST POINT, TURRET, 0.064", MTG. HOLE | MILL-MAX, 2308-2-00-80-00-00-07-0 |
| 2 | 2 | JP2, JP4 | CONN., HEADER, 1×3, 2mm | WURTH ELEKTRONIK, 62000311121 |
| 3 | 2 | XJP2, XJP4 | CONN., SHUNT, FEMALE, 2-POS, 2mm | WURTH ELEKTRONIK, 60800213421 |
| 4 | 10 | J1, J2, J5-J8, J16, J18-J20 | STUD, FASTENER, #10-32 | PENNENGINEERING, KFH-032-10ET |
| 5 | 20 | J1, J2, J5-J8, J16, J18-J20 (×2) | NUT, HEX, STEEL, ZINC PLATE, 10-32 | KEYSTONE, 4705 |
| 6 | 10 | J1, J2, J5-J8, J16, J18-J20 | RING, LUG, CRIMP, #10, NON-INSULATED, SOLDERLESS TERMINALS | KEYSTONE, 8205 |
| 7 | 10 | J1, J2, J5-J8, J16, J18-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, 2×7, 2mm, R/A THT | MOLEX, 87760-1416 |
| 10 | 1 | J22 | CONN., HDR, FEMALE, 2×7, 2mm, R/A THT | SULLINS CON., NPPN072FJFN-RC |
| 11 | 1 | J23 | CONN., HDR, SHROUDED, 2×6, 2mm, THT, VERT | FCI, 98414-G06-12ULF |
| 12 | 1 | J24 | CONN., HDR, SHROUDED, 1×4, 2mm, R/A THT STR | HIROSE ELECTRIC CO., LTD., DF3A-4P-2DSA |
| 13 | 4 | MH1-MH4 | STANDOFF, NYLON, SNAP-ON, 0.50" | WURTH ELEKTRONIK, 702935000 |

SCHEMATIC DIAGRAM



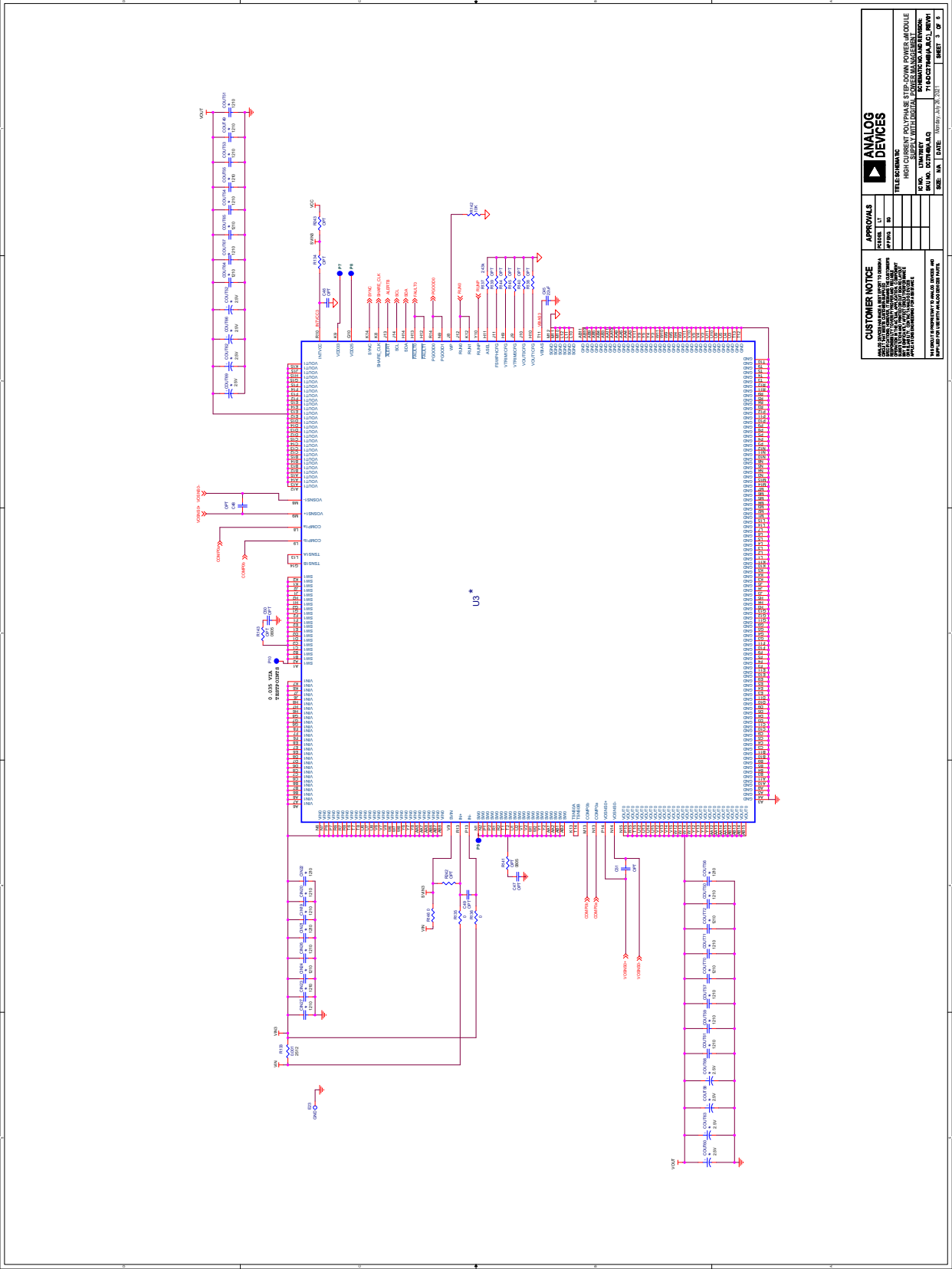
SCHEMATIC DIAGRAM



DEMO MANUAL

DC2784B-B

SCHEMATIC DIAGRAM



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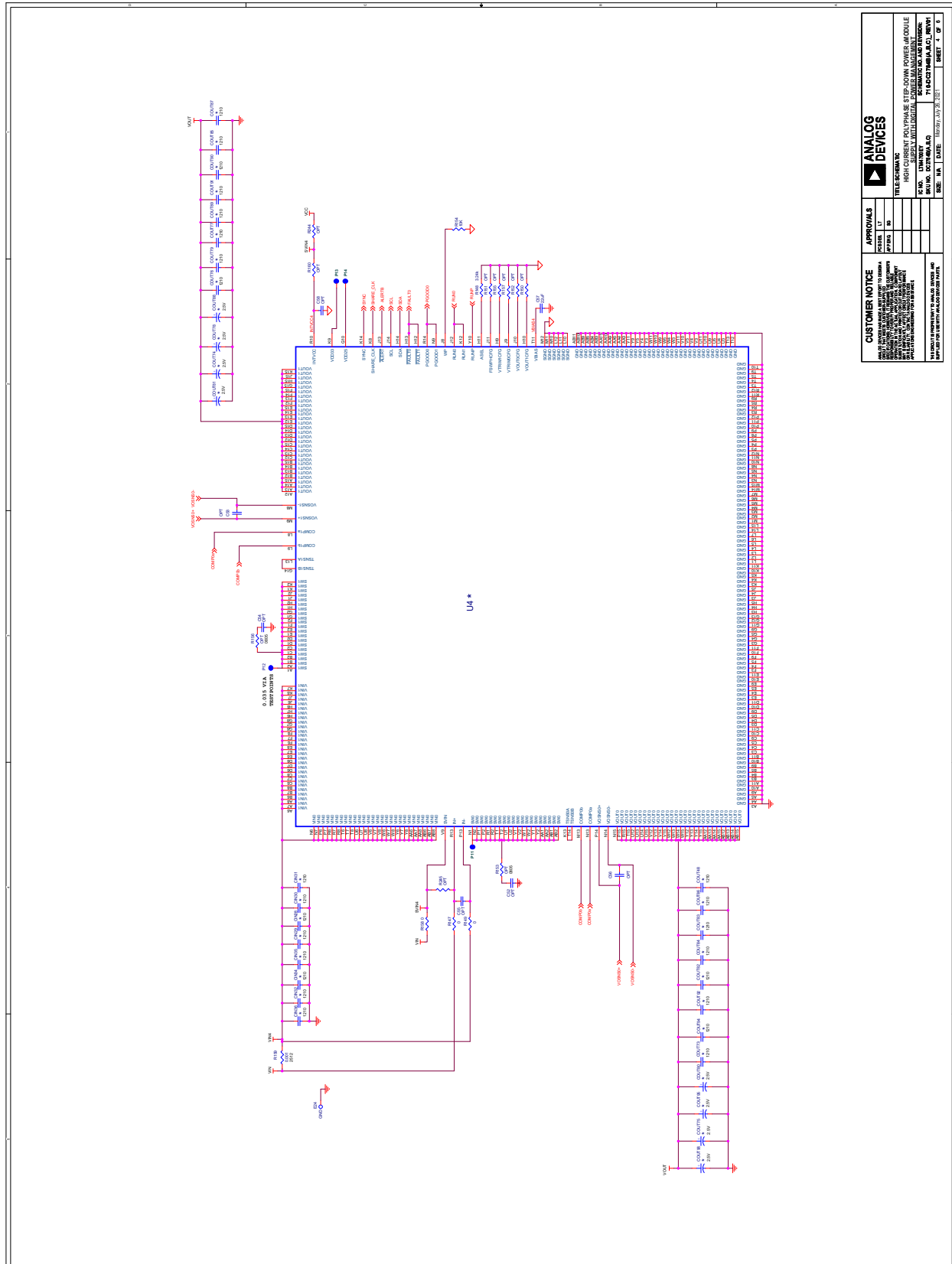
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SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM





DEMO MANUAL

DC2784B-B



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Rev. 0