

LTM4677

Dual 18A or Single 36A  $\mu$ Module Regulator with Digital Power System Management  
3x LTM4677; 108A

**DESCRIPTION**

Demonstration circuit 2143A-B 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 108A maximum load current. The demo board has three LTM<sup>®</sup>4677  $\mu$ Module<sup>®</sup> regulators, and the LTM4677 is a dual 18A or single 36A step-down regulator with PMBus power system management. Please see the LTM4677 data sheet for more detailed information

DC2143A-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<sup>™</sup> onto your PC and use

LTC'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: <http://www.linear.com/ltpowerplay>

For more details and instructions of LTpowerPlay, please refer to LTpowerPlay GUI for LTM4677 Quick Start Guide in this document.

**Design files for this circuit board are available at <http://www.linear.com/demo/DC2143A-B>**

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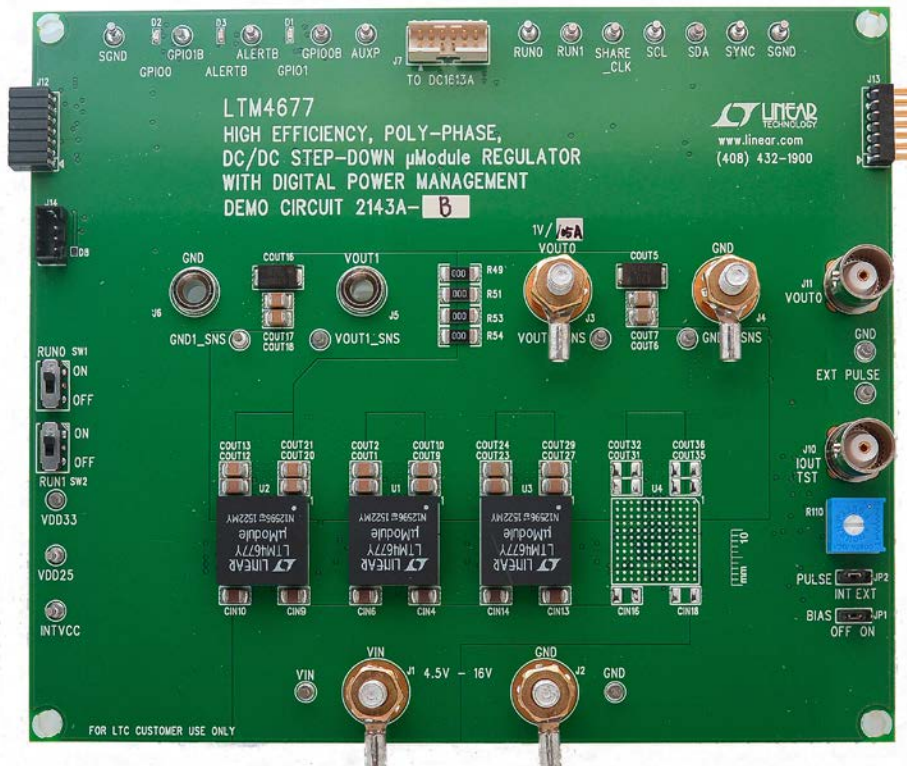


Figure 1. 3x LTM4677; 108A DC2143A-B Demo Circuit

# DEMO MANUAL DC2143A-B

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

| PARAMETER                          | CONDITION   | VALUE                     |
|------------------------------------|---|---------------------------|
| Input Voltage Range                |   | 4.5V to 16V               |
| Output Voltage, $V_{OUT0}$         | $V_{IN} = 4.5\text{V to }16\text{V}$ , $I_{OUT0} = 0\text{A to }108\text{A}$  | 0.5V to 1.8V, Default: 1V |
| Maximum Output Current, $I_{OUT0}$ | $V_{IN} = 4.5\text{V to }16\text{V}$ , $V_{OUT} = 0.5\text{V to }1.8\text{V}$ | 108A                      |
| Typical Efficiency                 | $V_{IN} = 12\text{V}$ , $V_{OUT} = 1.0\text{V}$ , $I_{OUT} = 108\text{A}$     | 81.5%                     |
| Default Switching Frequency        |   | 500kHz                    |

## QUICK START PROCEDURE

Table 1. LTM4677 Demo Cards for Up to 144A Point-of-Load Regulation

| MAXIMUM OUTPUT CURRENT | NUMBER OF OUTPUT VOLTAGES | NUMBER OF LTM4677 $\mu$ MODULE REGULATORS ON THE BOARD | DEMO BOARD NUMBER |
|------------------------|---------------------------|--|-------------------|
| Dual 18A               | 2                         | 1  | DC2066A           |
| 72A                    | 1                         | 2  | DC2143A-A         |
| 108A                   | 1                         | 3  | DC2143A-B         |
| 144A                   | 1                         | 4  | DC2143A-C         |

Demonstration circuit 2143A-B is easy to set up to evaluate the performance of the LTM4677EY. 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 switch position: SW1: ON; SW2: ON.
4. Turn on the input power supply and check for the proper output voltages.  $V_{OUT0}$  should be  $1.0\text{V} \pm 1\%$ .
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 LTM4677 Quick Start Guide for details.

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.

### Connecting a PC to DC2143A-B

You can use a PC to reconfigure the power management features of the LTM4677 such as: nominal  $V_{OUT}$ , margin set points, OV/UV limits, temperature fault limits, sequencing parameters, the fault log, fault responses, GPIOs and other functionality. The DC1613A dongle may be plugged when  $V_{IN}$  is present.

# QUICK START PROCEDURE

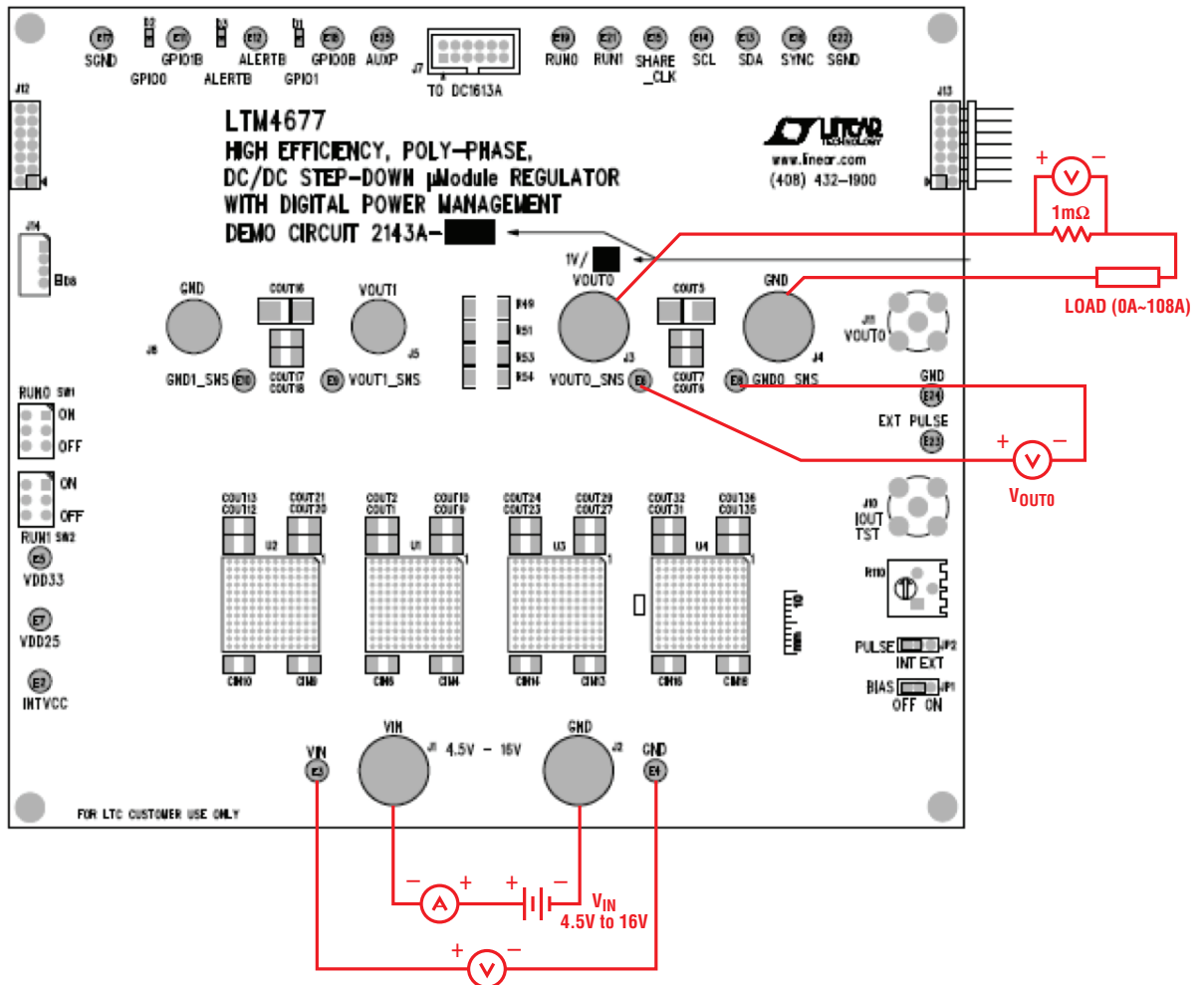


Figure 2. Proper Measurement Equipment Setup

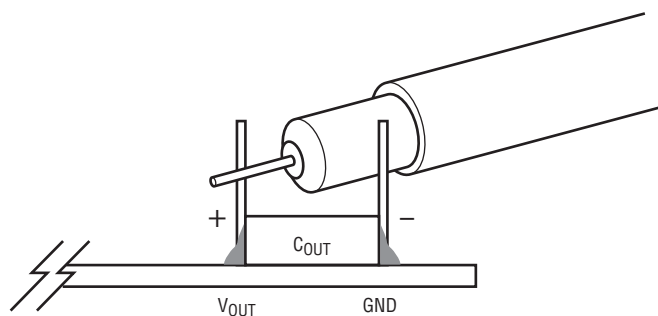


Figure 3. Measuring Output Voltage Ripple

## QUICK START PROCEDURE

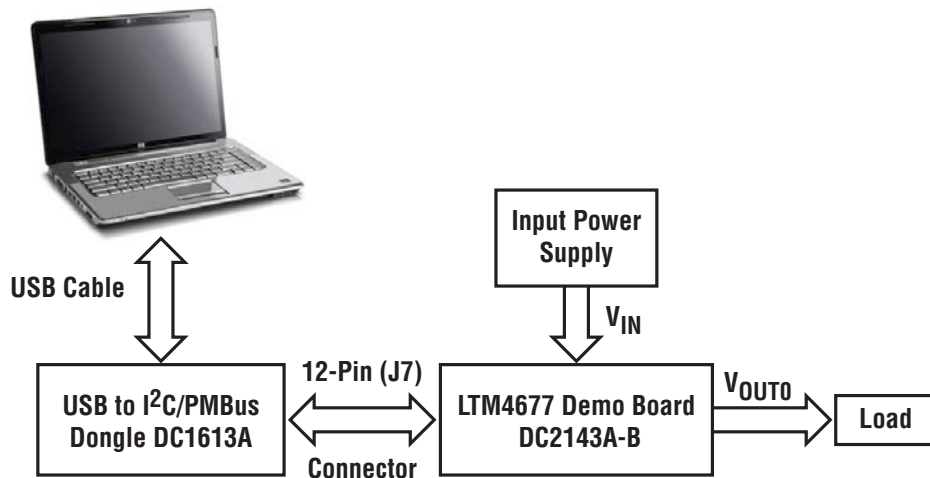


Figure 4. Demo Setup with PC

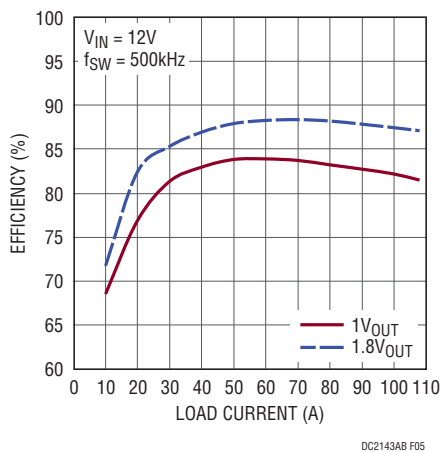


Figure 5. Efficiency vs Load Current for  $V_{OUT} = 1V$  and  $V_{OUT} = 1.8V$  at  $V_{IN} = 12V$ ,  $f_{SW} = 500kHz$

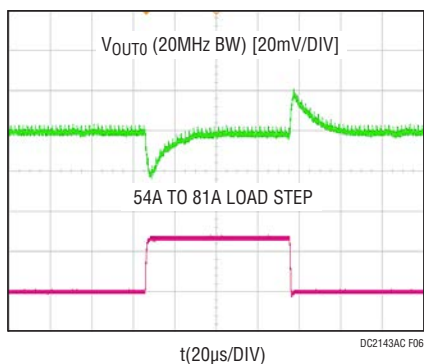


Figure 6. Output Voltage  $V_{OUTO}$  vs Load Current at  $V_{IN} = 12V$ ,  $V_{OUTO} = 1V$ ,  $f_{SW} = 500kHz$

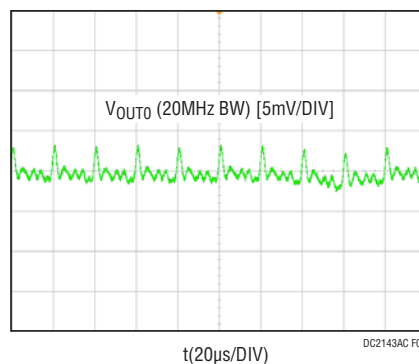


Figure 7. Output Voltage Ripple at  $V_{IN} = 12V$ ,  $V_{OUTO} = 1V$ ,  $I_{OUTO} = 108A$ ,  $f_{SW} = 500kHz$

**QUICK START PROCEDURE**

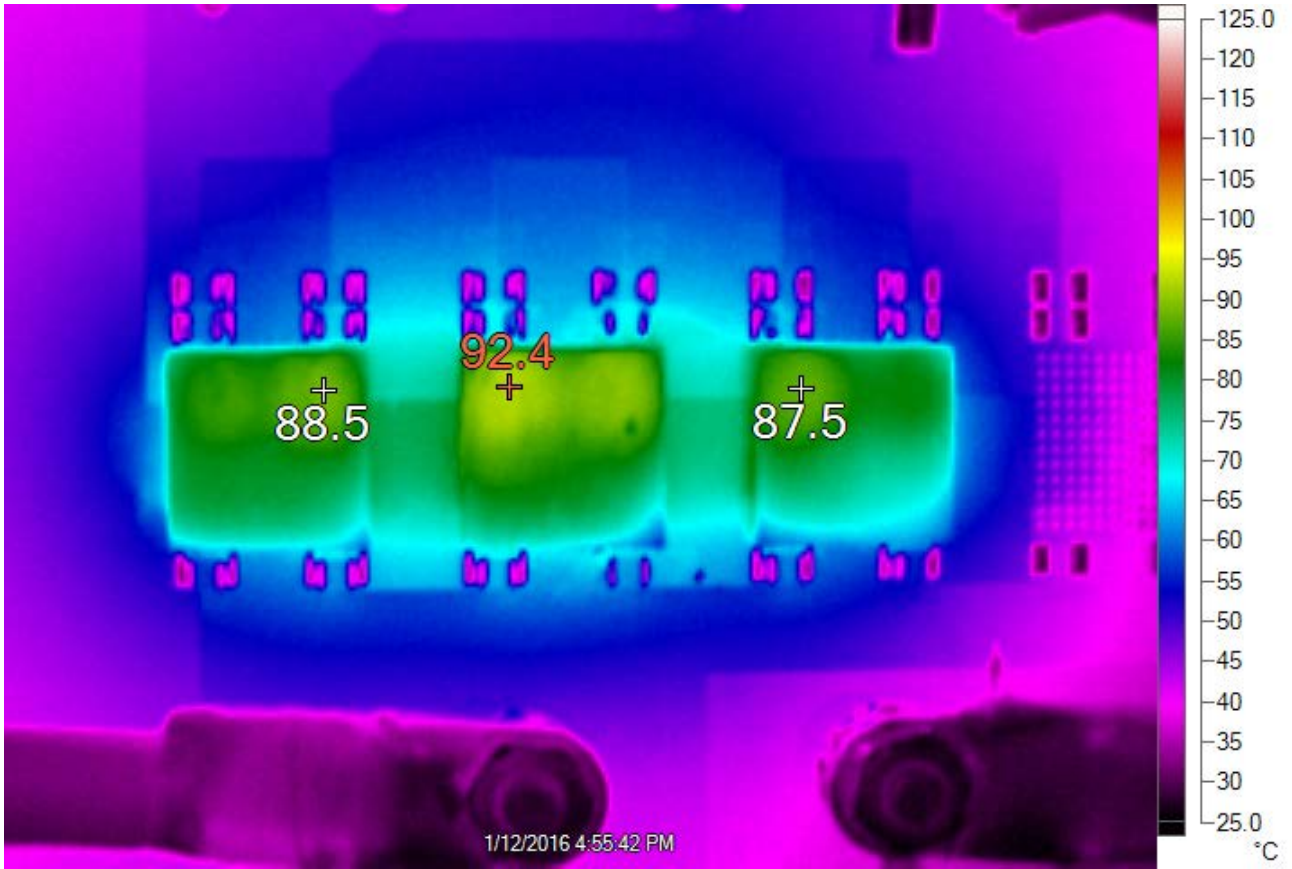


Figure 8. Thermal Performance at  $V_{IN} = 12V$ ,  $V_{OUT0} = 1V$ ,  $I_{OUT0} = 108A$ ,  $T_A = 23.8^{\circ}C$ , Air Flow 400LFM

## LTPOWERPLAY SOFTWARE GUI

LTpowerPlay is a powerful Windows based development environment that supports Linear Technology power system management ICs, including the LTM4677, LTC3880, LTC3883, LTC2974 and LTC2978. The software supports a variety of different tasks. You can use LTpowerPlay to evaluate Linear Technology 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 LTM4677, the LTC3880 and the 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:

<http://www.linear.com/ltpowerplay>

To access technical support documents for LTC Digital Power Products visit Help. View online help on the LTpowerPlay menu.

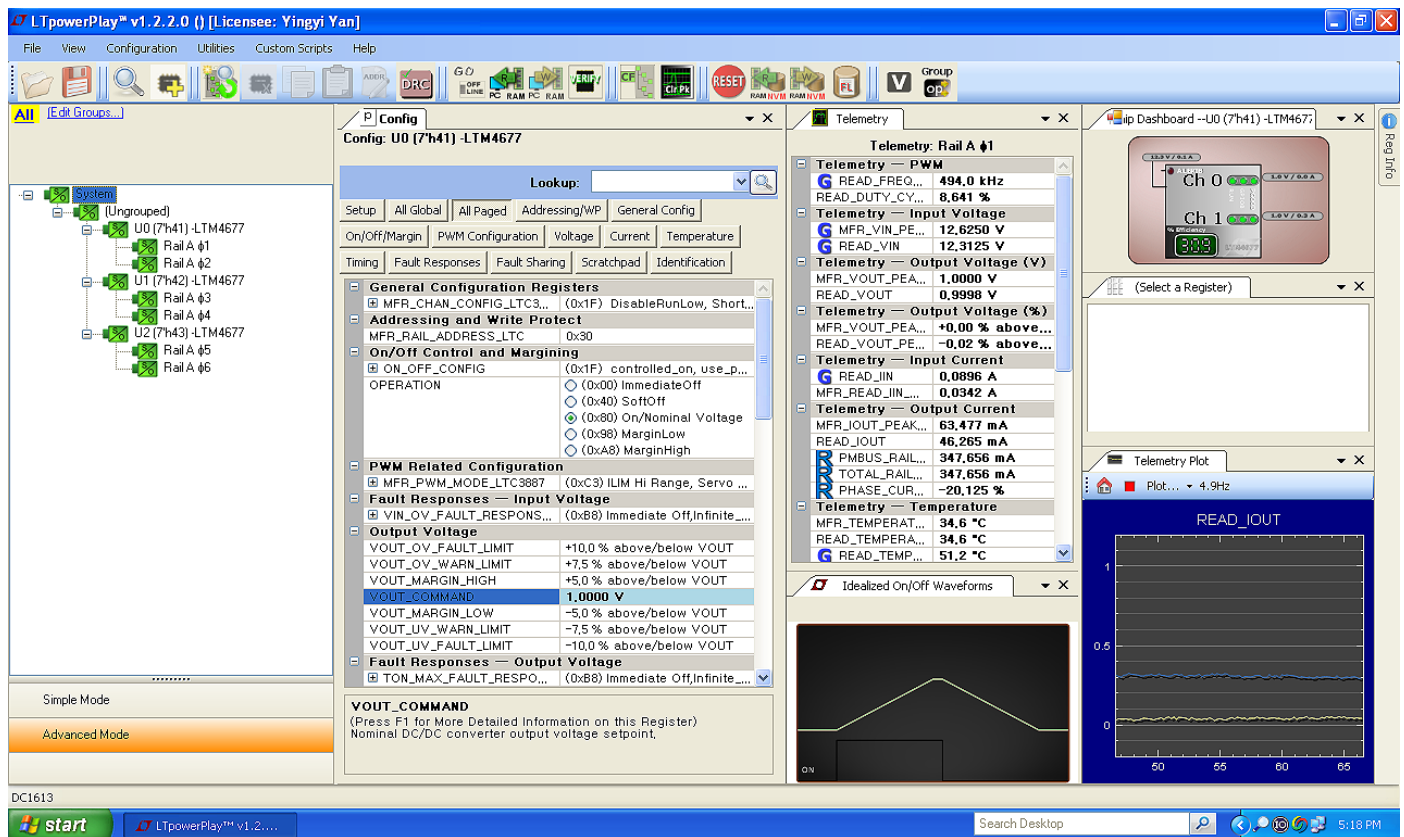
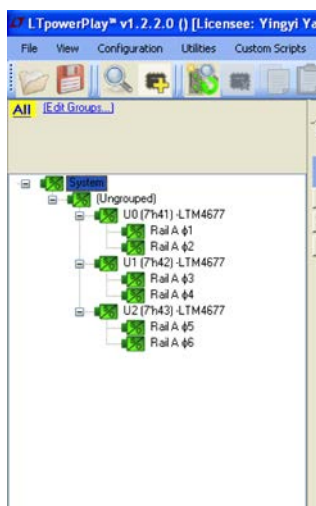


Figure 9. LTpowerPlay Main Interface

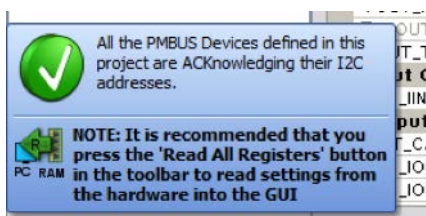
## LTPowerPLAY QUICK START PROCEDURE

The following procedure describes how to use LTPowerPlay to monitor and change the settings of LTM4677.

1. Download and install the LTPowerPlay GUI:
  - <http://www.linear.com/ltpowerplay>
2. Launch the LTPowerPlay GUI.
  - a. The GUI should automatically identify the DC2143A-B. The system tree on the left hand side should look like this:



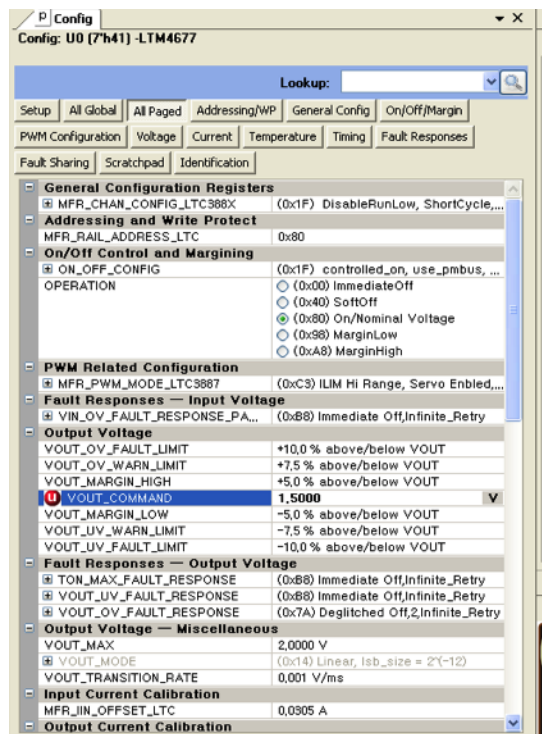
- b. A green message box shows for a few seconds in the lower left hand corner, confirming that LTM4677 is communicating:



- c. In the Toolbar, click the “R” (RAM to PC) icon to read the RAM from the TM4677. This reads the configuration from the RAM of LTM4677 and loads it into the GUI.



- d. If you want to change the output voltage to a different value, like 1.5V. In the Config tab, type in 1.5 in the VOUT\_COMMAND box, like this:



Then, click the “W” (PC to RAM) icon to write these register values to the LTM4677. After finishing this step, you will see the output voltage will change to 1.5V.



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.

# DEMO MANUAL DC2143A-B

## PARTS LIST

| ITEM                               | QTY | REFERENCE   | PART DESCRIPTION                        | MANUFACTURER/PART NUMBER        |
|------------------------------------|-----|---|---|---------------------------------|
| <b>Required Circuit Components</b> |     |   |   |                                 |
| 1                                  | 14  | CIN1, CIN2, CIN4, CIN5, CIN6, CIN7, CIN8, CIN9, CIN10, CIN11, CIN12, CIN13, CIN14, CIN15  | CAP, X5R, 10 $\mu$ F, 35V, 10%,1210     | MURATA, GRM32ER6YA106KA12L      |
| 2                                  | 1   | CIN3  | CAP, 150 $\mu$ F, 35V, ALUMINUM ELECTR. | SUN ELECT., 35CE150AX           |
| 3                                  | 22  | COUT1, COUT2, COUT3, COUT6, COUT7, COUT9, COUT10, COUT11, COUT12, COUT13, COUT14, COUT17, COUT18, COUT20, COUT21, COUT22 COUT23, COUT24, COUT25, COUT27, COUT29, COUT30 | CAP, X5R, 100 $\mu$ F, 6.3V, 20% 1210   | MURATA, GRM32ER60J107ME20K      |
| 4                                  | 8   | COUT4, COUT5, COUT8, COUT15, COUT16, COUT19, COUT26, COUT28,  | POSCAP, 470 $\mu$ F, 2.5V, SP-CAP, D3L  | PANASONIC, EEF-LX0E471E4        |
| 5                                  | 1   | C3  | CAP, X7R, 220pF, 16V, 10%, 0603         | AVX, 0603YC221KAT2A             |
| 6                                  | 1   | C4  | CAP, X7R, 6800pF, 16V, 10%,0603         | AVX, 0603YC682KAT2A             |
| 7                                  | 4   | C5, C12, C33, C34   | CAP, X5R, 0.01 $\mu$ F, 16V, 10%,0603   | AVX, 0603YD103KAT2A             |
| 8                                  | 1   | C32   | CAP, X5R, 0.1 $\mu$ F, 16V, 10%,0603    | MURATA, GRM188R61C104KA01D      |
| 9                                  | 1   | C64   | CAP, X5R, 4.7 $\mu$ F, 25V,10%, 0603    | MURATA, GRM188R61E475KE11D      |
| 10                                 | 2   | C65, C68  | CAP, X7R, 1 $\mu$ F, 25V,10%, 1206      | MURATA, GRM31MR71E105KA01L      |
| 11                                 | 1   | C66   | CAP, X5R, 0.22 $\mu$ F, 25V,10%, 0805   | AVX, 08053D224KAT2A             |
| 12                                 | 1   | C67   | CAP, X7R, 0.1 $\mu$ F, 25V,10%, 1206    | AVX, 12063C104KAT2A             |
| 13                                 | 1   | C69   | CAP, X7R, 150pF, 25V,10%, 0603          | AVX, 06033C151KAT2A             |
| 14                                 | 1   | C70   | CAP, X5R, 1 $\mu$ F, 25V,10%, 0805      | MURATA, GRM216R61E105KA12D      |
| 15                                 | 2   | D1, D2  | SMT Chip LED, GREEN                     | Würth Elektronik, 150060GS75000 |
| 16                                 | 1   | D3  | SMT Chip LED, RED                       | Würth Elektronik, 150060SS75000 |
| 17                                 | 1   | D8  | DIODE SCHOTTKY 20V 500MA SOD882 2-PIN   | NXP SEMI., PMEG2005AEL,315      |
| 18                                 | 1   | Q2  | MOSFET P-CH 20V 0.58A SOT-23            | VISHAY, SI2365EDS-T1-GE3        |
| 19                                 | 2   | Q3, Q4  | MOSFET N-CH 60V 115MA SOT-23            | FAIRCHILD, 2N7002K              |
| 20                                 | 2   | Q11, Q12  | MOSFET N-CH 30V 63A TO252               | VISHAY, SUD50N04-8M8P-4GE3      |
| 21                                 | 1   | Q19   | MOSFET P-CH 30V 3.5A SOT-23             | DIODES INC., DMP3130L-7         |
| 22                                 | 24  | R2, R4, R18, R25, R26, R30, R32, R47, R48, R50, R56, R58, R60, R72, R74, R104, R120, R121, R122, R131, R135, R143   | RES., CHIP, 0, 1%, 0603                 | VISHAY CRCW06030000Z0EA         |
| 23                                 | 15  | R6, R7, R8, R9, R10, R11, R12, R15, R35, R36, R39, R64, R78, R116, R130   | RES., CHIP, 10k, 1%, 0603               | VISHAY CRCW060310K0FKEA         |
| 24                                 | 1   | R14   | RES., CHIP, 2k, 1%, 0603                | VISHAY CRCW06032K00FKEA         |
| 25                                 | 4   | R16, R41, R125, R129  | RES., CHIP, 10, 1%, 0603                | VISHAY CRCW060310R0FKEA         |
| 26                                 | 1   | R19   | RES., CHIP, 787, 1%, 0603               | VISHAY CRCW0603787RFKFA         |
| 27                                 | 4   | R49, R51, R53, R54  | RES., CHIP, 0, 1%, 2010                 | VISHAY CRCW20100000Z0EF         |
| 28                                 | 2   | R85, R124   | RES., CHIP, 200, 1%, 0603               | VISHAY CRCW0603200RFKFA         |
| 29                                 | 1   | R86   | RES., CHIP, 127, 1%, 0603               | VISHAY CRCW0603127RFKFA         |
| 30                                 | 1   | R105  | RES., CHIP, 681k, 1%, 0603              | VISHAY CRCW0603681KFKFA         |
| 31                                 | 1   | R106  | RES., CHIP, 3.3, 1%, 0603               | VISHAY CRCW06033R30FKFA         |
| 32                                 | 1   | R107  | RES., CHIP, 82.5, 1%, 0603              | VISHAY CRCW060382R5FKFA         |
| 33                                 | 2   | R108, R118  | RES., CHIP, 0.01, 1%, 2010              | VISHAY, WSL2010R0100FEA         |
| 34                                 | 1   | R109  | RES., CHIP, 100k, 1%, 0603              | VISHAY CRCW0603100KFKFA         |
| 35                                 | 1   | R110  | TRIMMING POTENTIOMETER, 5k              | BOURNS, 3386P-1-502LF           |
| 36                                 | 2   | R111, R115  | RES., CHIP, 20k, 1%, 0603               | VISHAY CRCW060320K0FKFA         |
| 37                                 | 1   | R112  | RES., CHIP, 100, 1%, 0603               | VISHAY CRCW0603100RFKFA         |
| 38                                 | 1   | R113  | RES., CHIP, 1.4k, 1%, 0603              | VISHAY CRCW06031K40FKFA         |
| 39                                 | 1   | R114  | RES., CHIP, 154k, 1%, 0603              | VISHAY CRCW0603154KFKFA         |
| 40                                 | 1   | R117  | RES., CHIP, 2, 1%, 0603                 | VISHAY CRCW06032R00FKFA         |

dc2143abfa



## PARTS LIST

| ITEM | QTY | REFERENCE  | PART DESCRIPTION                | MANUFACTURER/PART NUMBER      |
|------|-----|------------|---------------------------------|-------------------------------|
| 41   | 1   | R123       | RES., CHIP, 1M, 1%, 0603        | VISHAY CRCW06031M00FKEA       |
| 42   | 2   | R134, R144 | RES., CHIP, 4.99k, 1%, 0603     | VISHAY CRCW06034K99FKEA       |
| 43   | 1   | R141       | RES., CHIP, 15.8k, 1%, 0603     | VISHAY CRCW060315K8FKEA       |
| 44   | 3   | U1, U2, U3 | IC, LTM4677EY                   | LINEAR TECH., LTM4677EY#PBF   |
| 45   | 1   | U6         | IC., LT1129CS8-5, S8            | LINEAR TECH. LT1129CS8-5#PBF  |
| 46   | 1   | U7         | IC., LTC6992-1, S6-TSOT         | LINEAR TECH. LTC6992CS6-1#PBF |
| 47   | 1   | U8         | IC., LT1803IS5, S5-TSOT         | LINEAR TECH. LT1803IS5#PBF    |
| 48   | 1   | U9         | IC., EEPROM 2KBIT 400KHZ 8TSSOP | MICROCHIP, 24LC025-I/ST       |
| 49   | 2   | R40, R42   | RES., CHIP, 1.65k, 1%, 0603     | VISHAY CRCW06031K65FKEA       |
| 50   | 2   | R65, R66   | RES., CHIP, 2.43k, 1%, 0603     | VISHAY CRCW06032K43FKEA       |

### Additional Demo Board Circuit Components

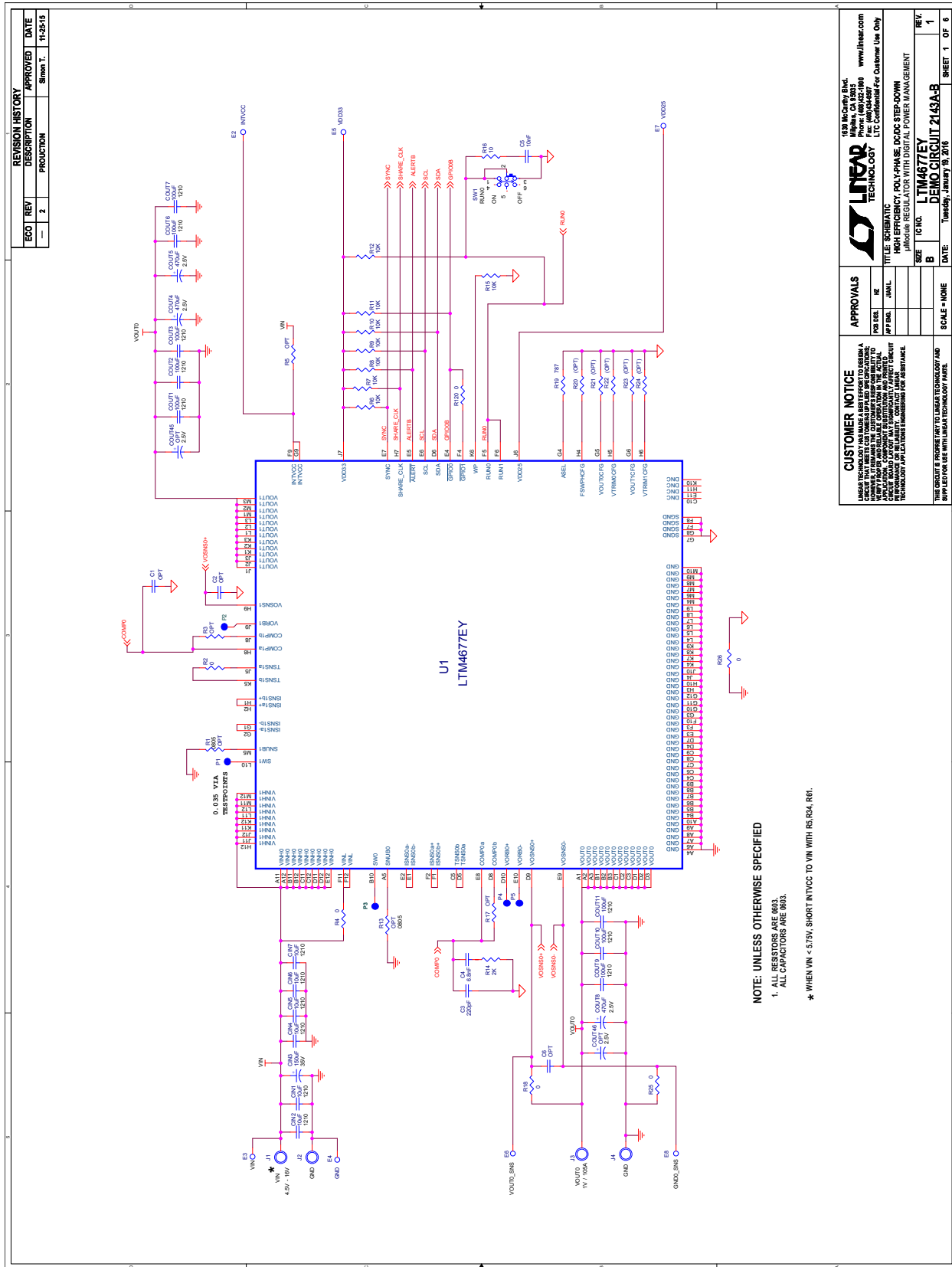
|    |   |  |                            |  |
|----|---|--|----------------------------|--|
| 1  | 0 | CIN16, CIN17, CIN18, CIN19,  | CAP, OPTIONAL 1210         |  |
| 2  | 0 | COUT31, COUT32, COUT33, COUT35,<br>COUT36, COUT37  | CAP, OPTIONAL 1210         |  |
| 3  | 0 | COUT34, COUT38   | OPTIONAL, D3L              |  |
| 4  | 0 | COUT39, COUT40, COUT41, COUT42,  | OPTIONAL D3L               |  |
| 5  |   | COUT43, COUT44, COUT45, COUT46   |                            |  |
| 6  | 0 | R80  | RES., CHIP, OPTIONAL, 0603 |  |
| 7  | 0 | R79  | RES., CHIP, OPTIONAL, 0603 |  |
| 8  | 0 | U4   | IC, OPTIONAL               |  |
| 9  | 0 | C1, C2, C6, C8, C9, C10, C11, C13, C14,  | OPTIONAL 0603              |  |
| 10 |   | C15, C16, C17, C18, C19, C20   |                            |  |
| 11 | 0 | C7   | OPTIONAL 0603              |  |
| 12 | 0 | D4, D5   | DIODE SOD323 OPTIONAL      |  |
| 13 | 0 | R1, R3, R5, R13, R17, R20, R21, R22, R23,<br>R24, R27, R28, R29, R31, R33, R34, R37, R38,<br>R43, R44, R45, R46, R57, R59, R61, R62, R63,<br>R67, R68, R69, R70, R71, R73, R75, R76, R77,<br>R81, R82, R83, R84, R119, R126, R127, R128,<br>R132, R133, R136, R137, R139, R140, R142 | RES., OPTIONAL 0603        |  |
| 14 | 0 | R102, R103   | RES., OPTIONAL 2512        |  |
| 15 | 0 | R138   | RES., OPTIONAL 1206        |  |

### Hardware: For Demo Board Only

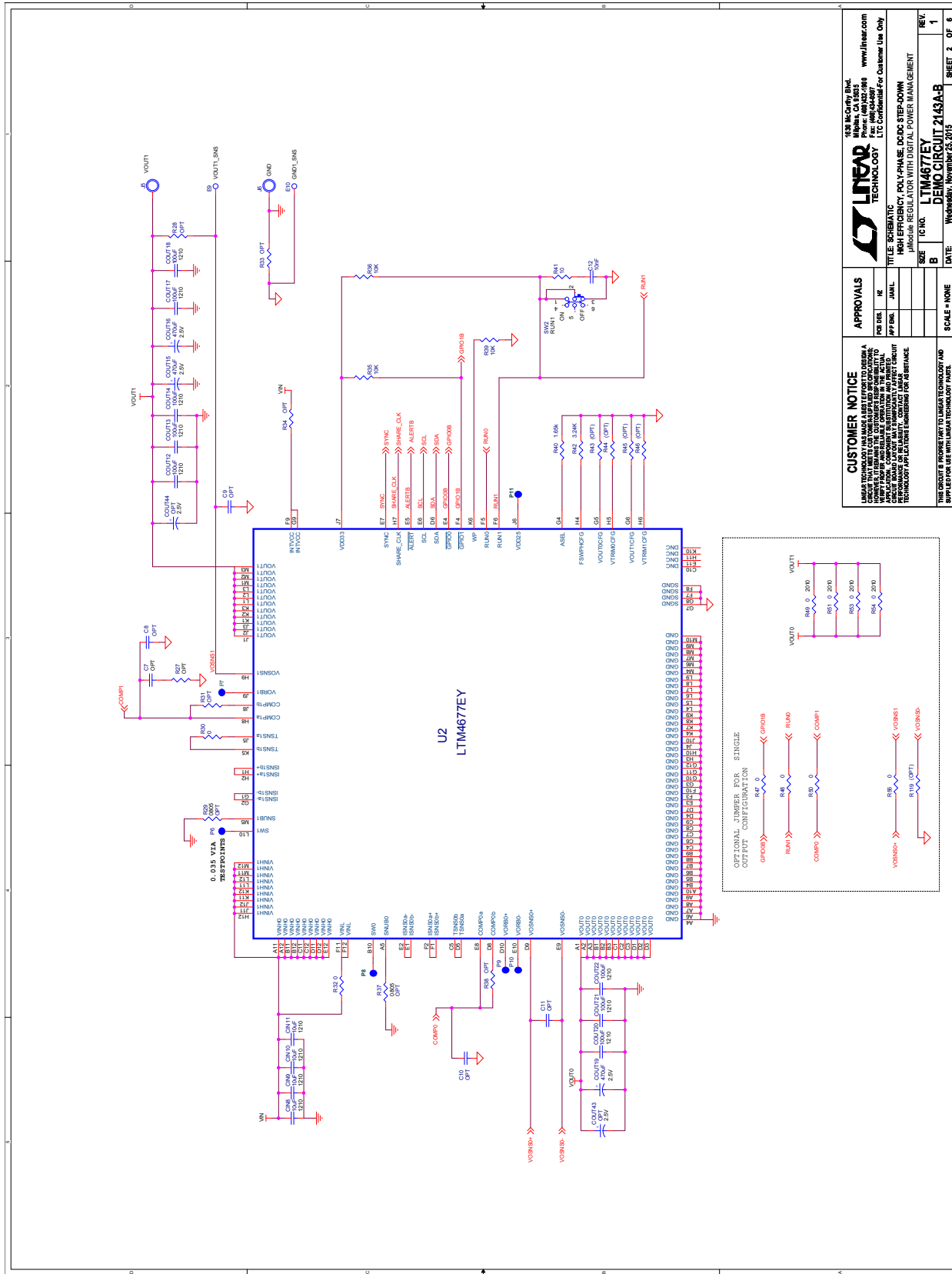
|    |    |                     |                                      |                                   |
|----|----|---------------------|--------------------------------------|-----------------------------------|
| 1  | 23 | E2-E19, E21-E25     | TESTPOINT, TURRET, .062"             | MILL-MAX, 2308-2-00-80-00-00-07-0 |
| 2  | 2  | JP1, JP2            | CONN., HEADER, 1X3, 2mm              | Wurth Elektronik, 62000311121     |
| 3  | 2  | JP1, JP2            | SHUNT, 2mm                           | Wurth Elektronik, 60800213421     |
| 4  | 4  | J1, J2, J3, J4      | STUD, TEST PIN                       | PEM, KFH-032-10                   |
| 5  | 8  | J1, J2, J3, J4 (x2) | NUT, BRASS 10-32                     | ANY, #10-32M/S                    |
| 6  | 4  | J1, J2, J3, J4      | RING, LUG #10                        | KEYSTONE, 8205                    |
| 7  | 4  | J1, J2, J3, J4      | WASHER, TIN PLATED BRASS             | ANY, #10                          |
| 8  | 2  | J5, J6              | JACK, BANANA                         | KEYSTONE, 575-4                   |
| 9  | 1  | J7                  | CONN HEADER 12POS 2MM STR DL PCB     | FCI, 98414-G06-12ULF              |
| 10 | 2  | J10, J11            | CONN, BNC, 5PINS                     | CONNEX, 112404                    |
| 11 | 1  | J12                 | CONN RECEPT 2MM DUAL R/A 14POS (F)   | SULLINS, NPPN072FJFN-RC           |
| 12 | 1  | J13                 | HEADER, 14POS 2MM R/A GOLD (M)       | MOLEX, 87760-1416                 |
| 13 | 1  | J14                 | HEADER, 4 PINS, SHROUDED             | HIROSE, DF3A-4P-2DSA              |
| 14 | 2  | SW1, SW2            | SWITCH, SLIDE DPDT 300MA 6V          | C&K., JS202011CQN                 |
| 15 | 4  | (STAND-OFF)         | STAND-OFF, NYLON 0.50" Tall, SNAP ON | WURTH ELEKTRONIK, 702935000       |
| 16 | 1  |                     | FAB, PRINTED CIRCUIT BOARD           | DEMO CIRCUIT 2143A                |
| 17 | 2  |                     | STENCIL (TOP AND BOTTOM)             | STENCIL DC2143A                   |

# DEMO MANUAL DC2143A-B

## SCHEMATIC DIAGRAM

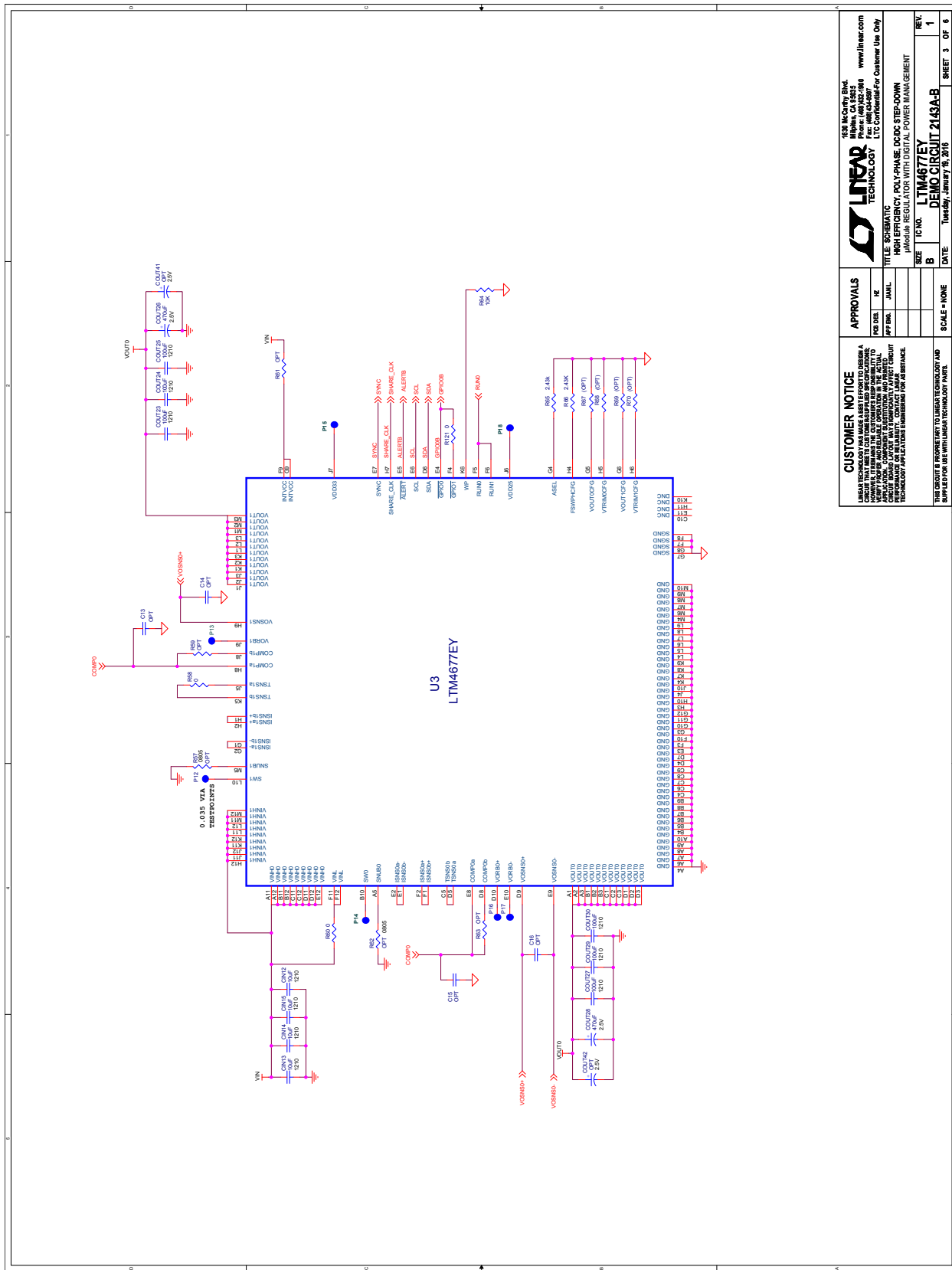


**SCHEMATIC DIAGRAM**



# DEMO MANUAL DC2143A-B

## SCHEMATIC DIAGRAM



**CUSTOMER NOTICE**  
 LINEAR TECHNOLOGY HAS MADE A BEST EFFORT TO DESIGN A CIRCUIT THAT WILL OPERATE AS PUBLISHED. OPERATING CONDITIONS MAY VARY FROM THE CONDITIONS IN THE ACTUAL CIRCUIT. LINEAR TECHNOLOGY IS NOT RESPONSIBLE FOR ANY TECHNOLOGY APPLICATIONS ERRORS OR PERFORMANCE DIFFERENCES.

**APPROVALS**

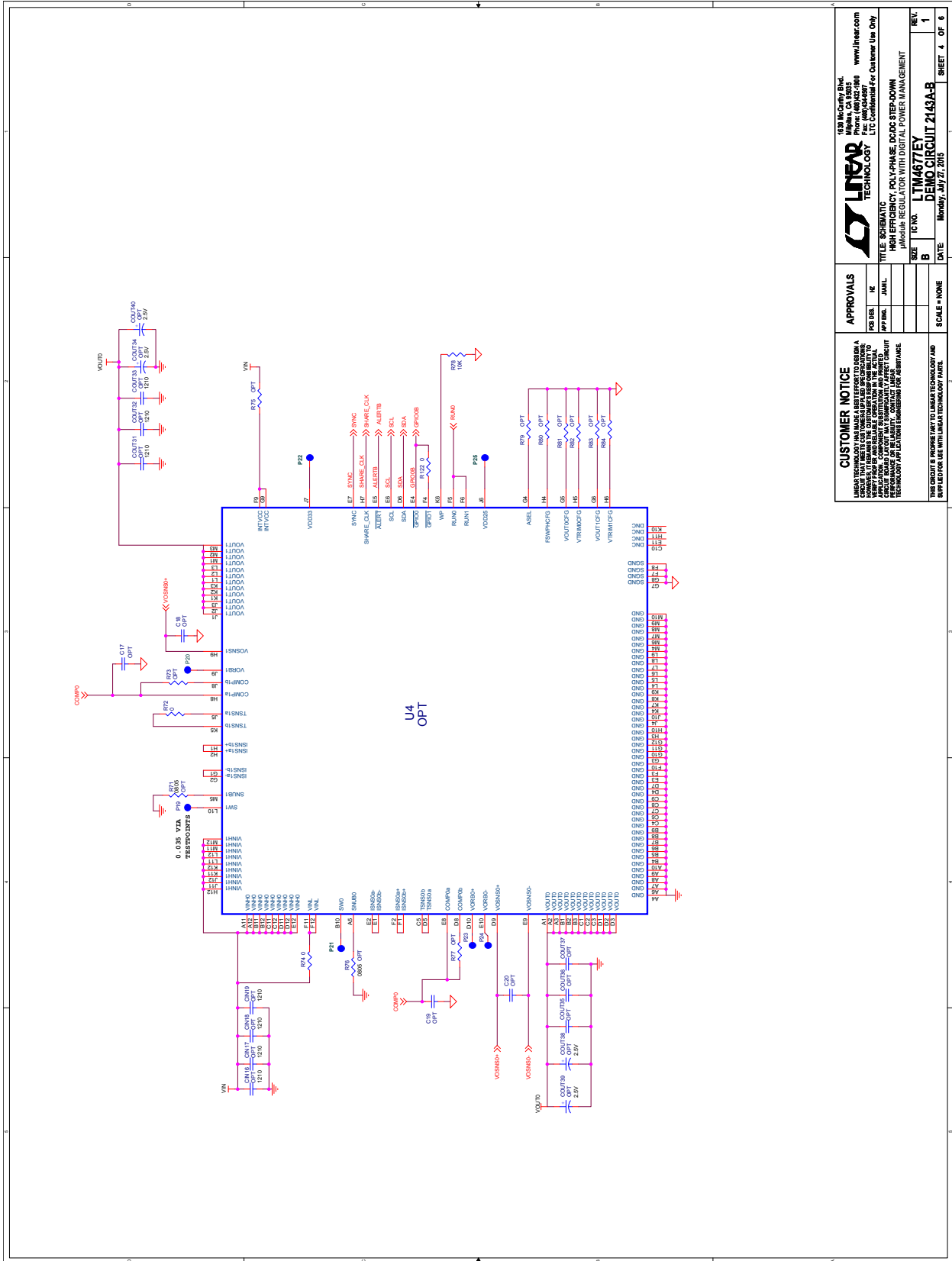
|          |          |
|----------|----------|
| DESIGNER | REVIEWER |
| DATE     | DATE     |

**LINEAR TECHNOLOGY**  
 1330 McCarty Blvd.  
 Fremont, CA 94538  
 Tel: (925) 462-7000  
 Fax: (925) 434-8070  
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**TITLE: SCHEMATIC**  
**HIGH EFFICIENCY POLY-PHASE DC/DC STEP-DOWN**  
**µModule REGULATOR WITH DIGITAL POWER MANAGEMENT**

**SIZE: B** **TC NO: LTM4677EY** **REV: 1**  
**DEMO CIRCUIT 2143A-B**  
**DATE: Tuesday, January 19, 2016** **SHEET: 3 OF 6**

SCHEMATIC DIAGRAM



**CUSTOMER NOTICE**  
 LINEAR TECHNOLOGY HAS MADE A REVISION TO DESIGN A...  
 THIS REVISION IS APPLICABLE TO THE ACTUAL...  
 TECHNOLOGY APPLICATIONS ENGINEERING FOR ASSISTANCE

**APPROVALS**

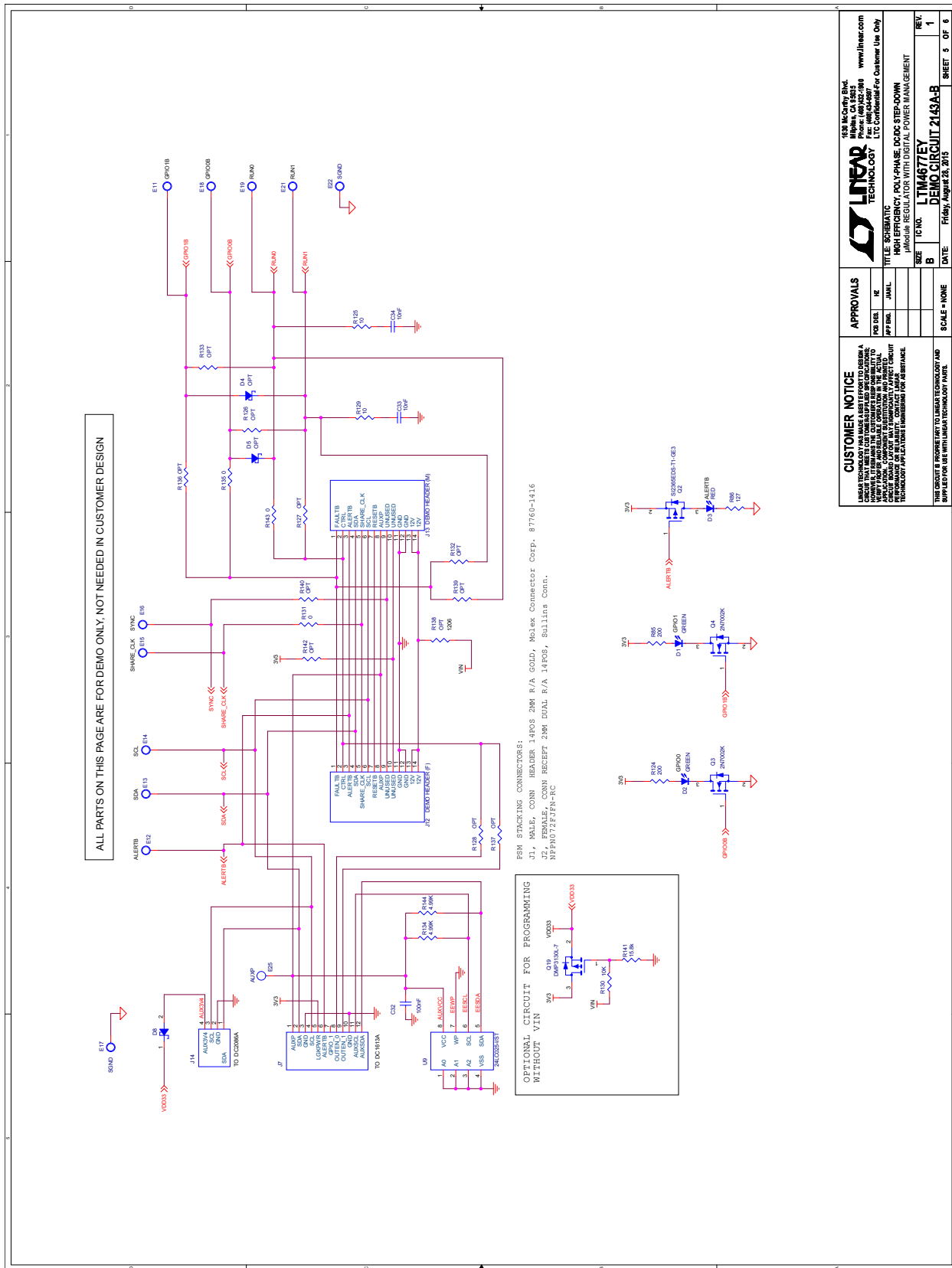
| NO. | DESIGNER | DATE |
|-----|----------|------|
|     |          |      |

**LINEAR TECHNOLOGY**  
 HIGH EFFICIENCY POLY-PHASE DC/DC STEP-DOWN...  
 LTM4677EY  
 DEMO CIRCUIT 2143A-B  
 DATE: Monday, July 27, 2015

SCALE = NONE  
 SHEET 4 OF 6

# DEMO MANUAL DC2143A-B

## SCHEMATIC DIAGRAM



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APPROVALS

|          |      |
|----------|------|
| DESIGNER | DATE |
| APPROVED | DATE |

SCALE = NONE

SHEET 5 OF 6

1930 McCarty Blvd.  
Foster City, CA 94024  
Tel: 650-961-6000  
Fax: 650-961-6007  
www.linear.com

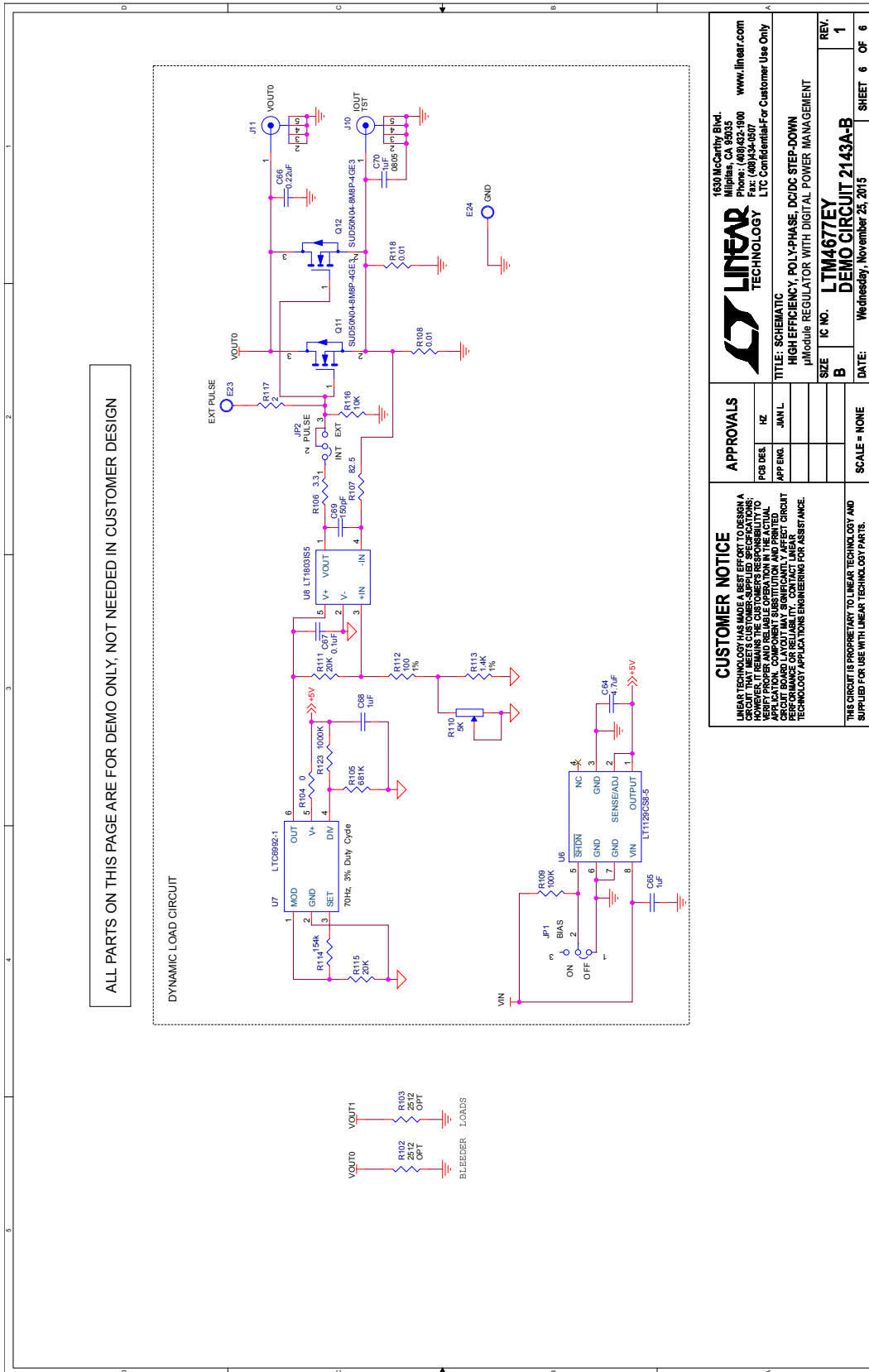
**LINEAR TECHNOLOGY**

TITLE: SCHEMATIC  
HIGH EFFICIENCY POLY-PHASE DC/DC STEP-DOWN  
µModule REGULATOR WITH DIGITAL POWER MANAGEMENT

SIZE: B  
TECH: LTM4677EY  
DATE: Friday, August 26, 2015

REV: 1

**SCHEMATIC DIAGRAM**



# DEMO MANUAL DC2143A-B

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Linear Technology  
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Milpitas, CA 95035

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Телефон: 8 (812) 309-75-97 (многоканальный)

Факс: 8 (812) 320-03-32

Электронная почта: [ocean@oceanchips.ru](mailto:ocean@oceanchips.ru)

Web: <http://oceanchips.ru/>

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, д. 2, корп. 4, лит. А