

# 26A Step-Down $\mu$ Module Regulator with PMBus Power System Management

## DESCRIPTION

Demonstration circuit 2087A is a single-output, high efficiency, high density,  $\mu$ Module<sup>®</sup> regulator with 4.5V to 16V input range. It can supply 26A maximum load current. The demo board has a LTM<sup>®</sup>4676  $\mu$ Module regulator, which is a dual 13A or single 26A step-down regulator with PMBus power system management. Please see LTM4676 data sheet for more detailed information.

DC2087A 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 LTM4676 Quick Start Guide.

**Design files for this circuit board are available at**

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

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## BOARD PHOTO

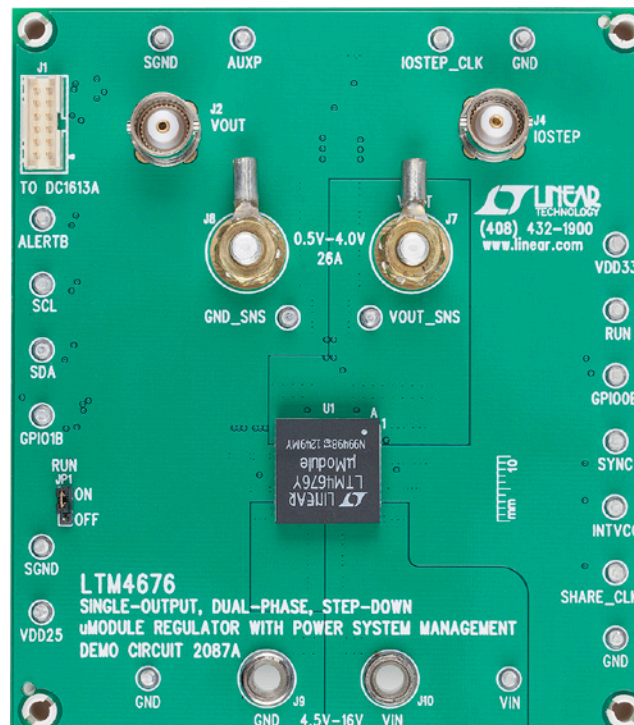


Figure 1. Single-Output LTM4676/DC2087A Demo Circuit

dc2087af

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

| PARAMETER                         | CONDITION  | VALUE                   |
|-----------------------------------|--|-------------------------|
| Input Voltage Range               |  | 4.5V to 16V             |
| Output Voltage, $V_{OUT}$         | $V_{IN} = 4.5$ to 16V, $I_{OUT} = 0\text{A}$ to 26A                      | 0.5V to 4V, Default: 1V |
| Maximum Output Current, $I_{OUT}$ | $V_{IN} = 4.5$ to 16V, $V_{OUT} = 0.5\text{V}$ to 4V                     | 26A                     |
| Typical Efficiency                | $V_{IN} = 12\text{V}$ , $V_{OUT} = 1.2\text{V}$ , $I_{OUT} = 26\text{A}$ | 83.2%                   |
| Default Switching Frequency       |  | 350kHz                  |

## QUICK START PROCEDURE

Table 1. LTM4676 Demo Cards for Up to 100A Point-of-Load Regulation

| MAXIMUM OUTPUT CURRENT | NUMBER OF OUTPUT VOLTAGES | NUMBER OF LTM4676 $\mu$ MODULE REGULATORS ON THE BOARD | DEMO BOARD NUMBER |
|------------------------|---------------------------|--|-------------------|
| 13A, 13A               | 2                         | 1  | DC1811A           |
| 26A                    | 1                         | 1  | DC2087A           |
| 50A                    | 1                         | 2  | DC1989A-A         |
| 75A                    | 1                         | 3  | DC1989A-B         |
| 100A                   | 1                         | 4  | DC1989A-C         |
| 100A                   | 1                         | 1(+3 $\times$ LTM4620A)                                | DC2106A-A         |
| 130A                   | 1                         | 1(+3 $\times$ LTM4630)                                 | DC2106A-B         |

Demonstration circuit 2087A is easy to set up to evaluate the performance of the LTM4676EY. 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–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.
4. Turn on the input power supply and check for the proper output voltages.  $V_{OUT}$  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 LTM4676 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 DC2087A

You can use a PC to reconfigure the power management features of the LTM4676 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

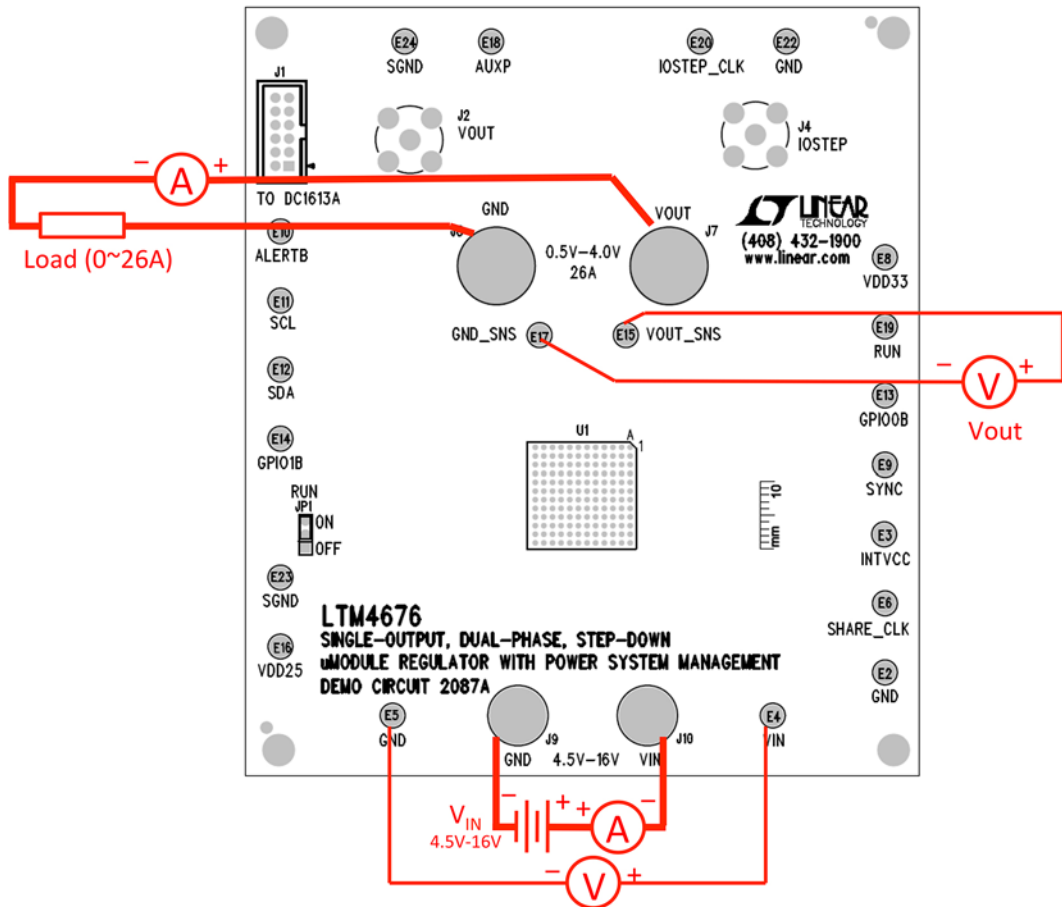


Figure 2. Proper Measurement Equipment Setup

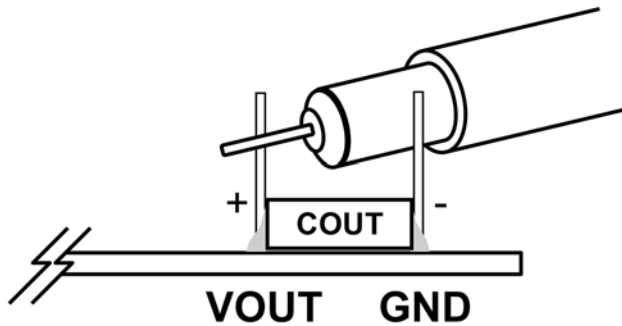


Figure 3. Proper Measurement Equipment Setup

QUICK START PROCEDURE

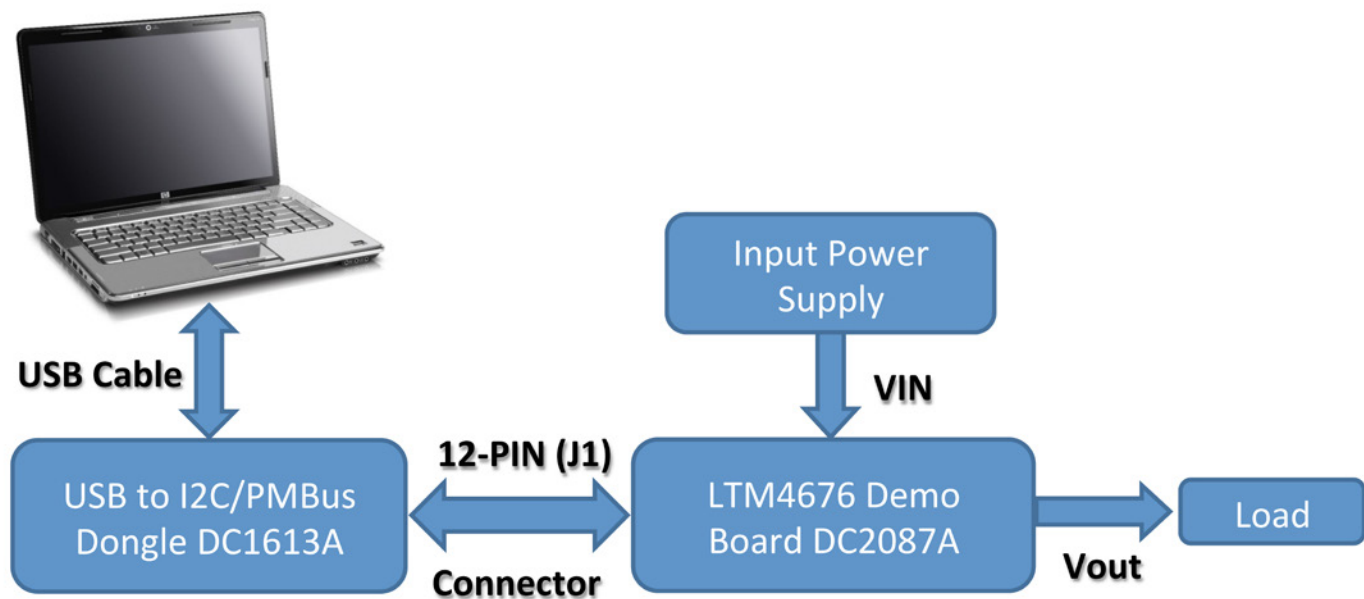


Figure 4. Demo setup with PC

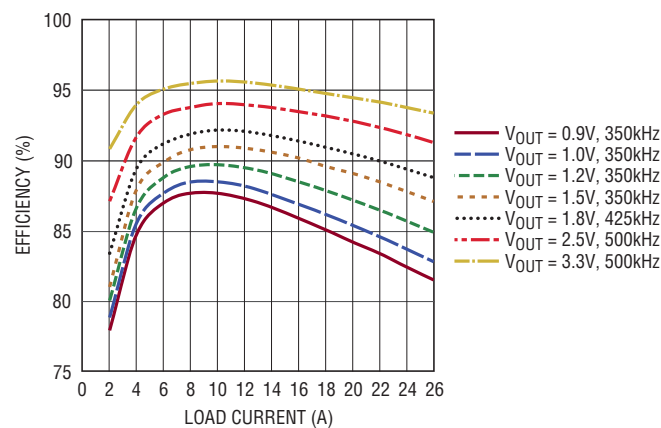


Figure 5. Efficiency vs Load Current at  $V_{IN} = 5V$

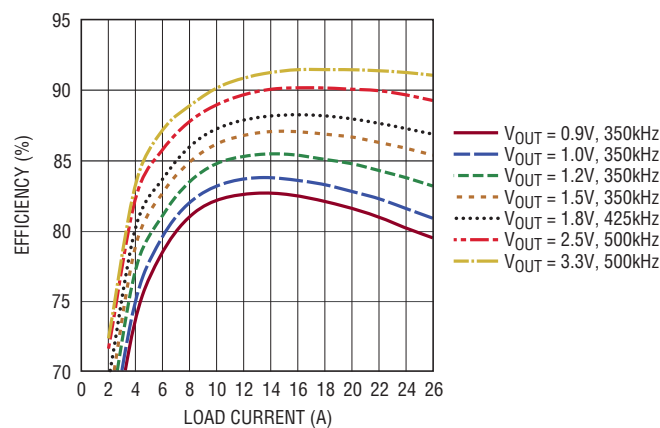


Figure 6. Efficiency vs Load Current at  $V_{IN} = 12V$

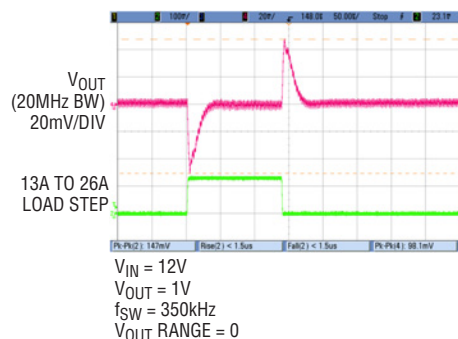


Figure 7. Output Voltage  $V_{OUT}$  vs Load Current

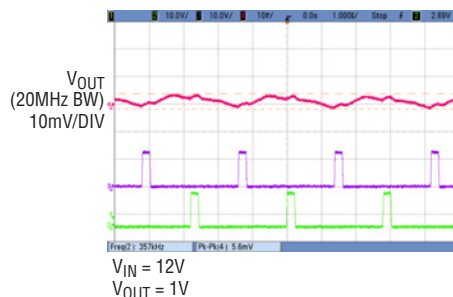


Figure 8. Output Voltage Ripple

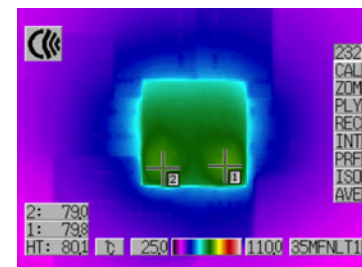


Figure 9. Thermal Performance

## LTpowerPlay SOFTWARE GUI

LTpowerPlay is a powerful Windows-based development environment that supports Linear Technology power system management ICs, including the LTM4676, LTC®3880, 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 LTM4676, 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.

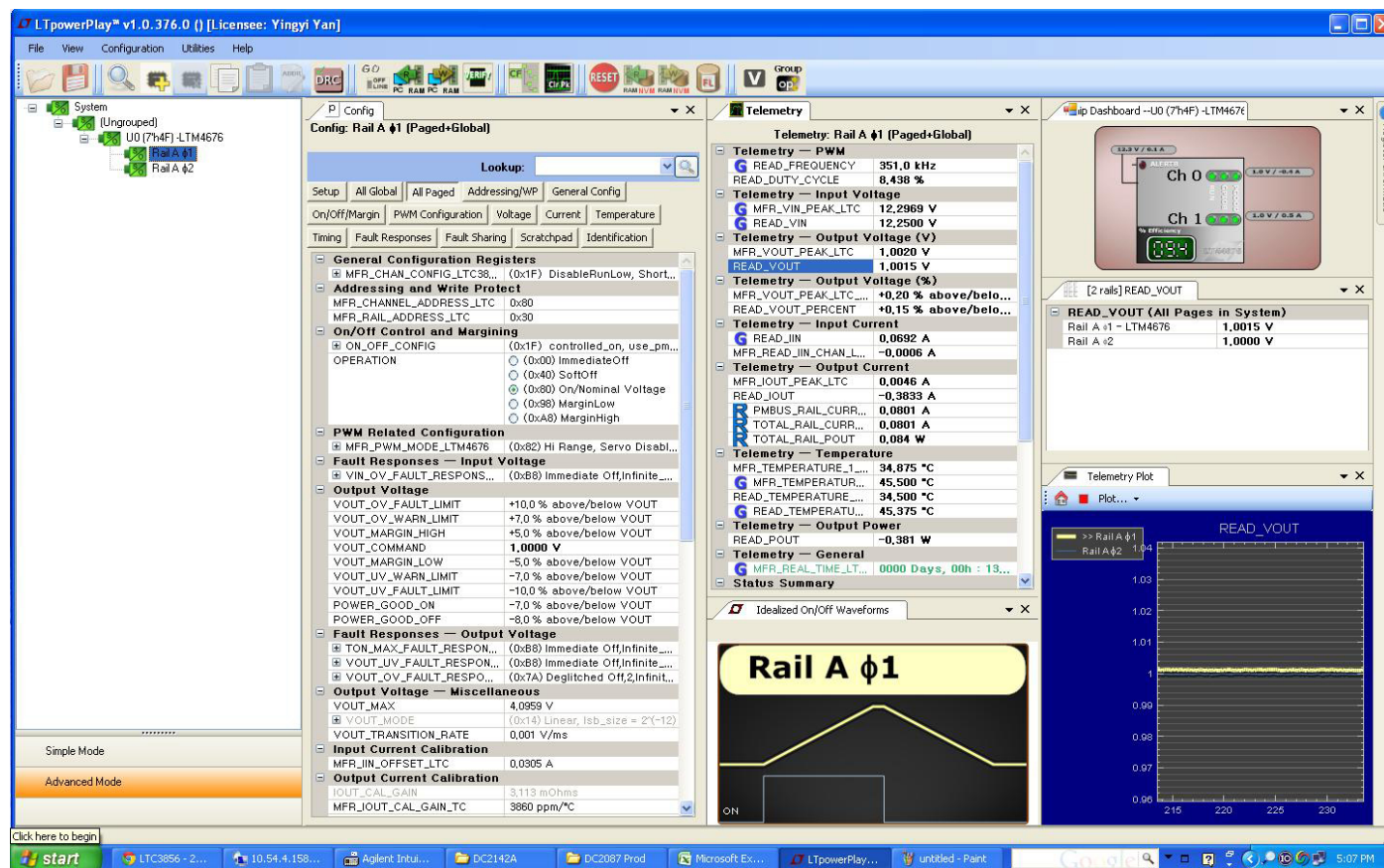


Figure 10. LTpowerPlay Main Interface



## LTpowerPlay QUICK START PROCEDURE

The following procedure describes how to use LTpowerPlay to monitor and change the settings of LTM4676.

1. Download and install the LTpowerPlay GUI:

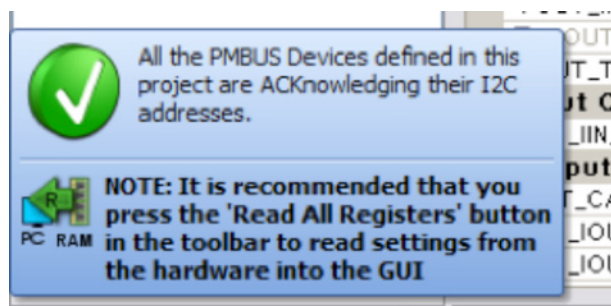
<http://www.linear.com/ltpowerplay>

2. Launch the LTpowerPlay GUI.

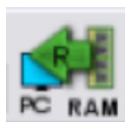
- a. The GUI should automatically identify the DC2087A. The system tree on the left hand side should look like this:



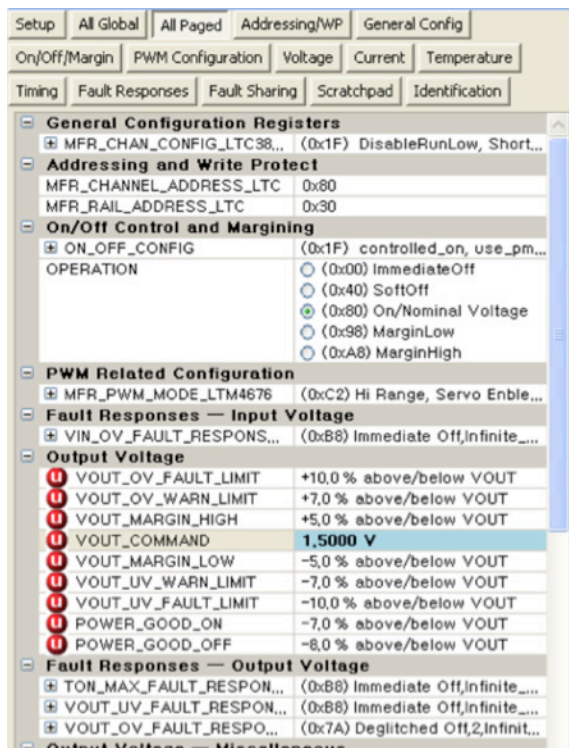
- b. A green message box shows for a few seconds in the lower left hand corner, confirming that LTM4676 is communicating:



- c. In the Toolbar, click the “R” (RAM to PC) icon to read the RAM from the LTM4676. This reads the configuration from the RAM of LTM4676 and loads it into the GUI.



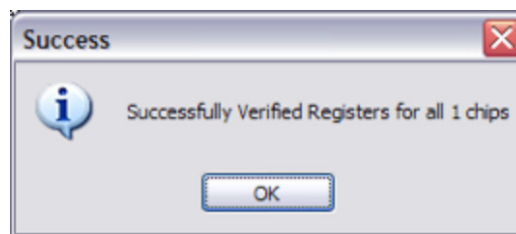
- d. If you want to change the output voltage to a different value, like 1.5V. In the Config tab, type in 1.5 in the VOUT\_COMMAND box, like this:



Then, click the “W” (PC to RAM) icon to write these register values to the LTM4676. 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 tool bar, 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   | 1   | CIN1                                   | CAP., 150μF, 35V, ALUMINUM ELECTR., | SUN ELECT., 35CE150AX             |
| 2   | 2   | CIN2, CIN4,                            | CAP., X5R, 10μF, 35V, 10%,1210      | MURATA, GRM32ER6YA106KA12         |
| 3   | 6   | COUT1-COUT3, COUT6-COUT8               | CAP., X5R, 100μF, 6.3V, 20% 1210    | MURATA, GRM32ER60J107ME20L        |
| 4   | 2   | COUT4, COUT5                           | CAP., 330μF, 6.3V, POSCAP,D3L       | SANYO, 6TPF330M9L                 |
| 5   | 1   | C14                                    | CAP., X7R, 2200pF, 25V, 10%, 0603   | MURATA, GRM188R71E222KA01D        |
| 6   | 1   | C15                                    | CAP., X7R, 68pF, 25V, 10%, 0603     | AVX., 06033A680KAT2A              |
| 7   | 1   | C20                                    | CAP., X5R, 0.1μF, 16V, 10%,0603     | MURATA, GRM188R61C104KA01D        |
| 8   | 1   | C21                                    | CAP., X5R, 1μF, 25V,10%, 0603       | MURATA, GRM188R61E105KA12D        |
| 9   | 1   | JP1                                    | HEADER 3 PIN 0.079 SINGLE ROW       | SAMTEC, TMM103-02-L-S             |
| 10  | 2   | J2, J4                                 | CONN, BNC, 5PINS                    | CONNEX, 112404                    |
| 11  | 1   | J1                                     | CONN HEADER 12POS 2MM STR DL PCB    | FCI 98414-G06-12ULF               |
| 12  | 2   | J9, J10                                | BANANA SMALL                        | KEYSTONE, 575-4                   |
| 13  | 2   | J7, J8                                 | STUD, TEST PIN                      | PEM KFH-032-10                    |
| 14  | 4   | J7, J8 X2                              | NUT, BRASS 10-32                    | ANY, #10-32M/S BR PL              |
| 15  | 2   | J7, J8                                 | RING, LUG #10                       | KEYSTONE, 8205                    |
| 16  | 2   | J7, J8                                 | WASHER, TIN PLATED BRASS            | ANY, #10 EXT BZ TN                |
| 17  | 1   | Q1                                     | MOSFET, N-CH 40V 50A TO-252         | VISHAY, SUD50N04-8M8P-4GE3        |
| 18  | 8   | R3, R5, R7, R9, R19, R25, R32, R40     | RES., CHIP, 0Ω, 1%, 0603            | NIC, NRC06Z0TR                    |
| 19  | 11  | R10-R15, R18, R24, R46, R47, R52       | RES., CHIP, 10k, 1%, 0603           | NIC, NRC06F1002TRF                |
| 20  | 1   | R27                                    | RES., CHIP, 22.6k, 1%, 0603         | VISHAY, CRCW060322K6FKEA          |
| 21  | 2   | R44, R45                               | RES., CHIP, 4.99k, 1%, 0603         | NIC, NRC06F4991TRF                |
| 22  | 1   | R22                                    | RES., CHIP, 4.75k, 1%, 0603         | VISHAY, CRCW06034K75FKEA          |
| 23  | 3   | R17, R35, R38                          | RES., CHIP, 0Ω, 0.5W, 1210          | VISHAY, CRCW12100000Z0EF          |
| 24  | 1   | R53                                    | RES., CHIP, 0.01, 1/2W, 1%, 2010    | VISHAY, WSL2010R0100FEA           |
| 25  | 1   | U1                                     | IC, LTM4676EY#PBF                   | LINEAR TECH. LTM4676EY#PBF        |
| 26  | 1   | U2                                     | IC, EEPROM 2KBIT 400KHZ SOT23-6     | MICROCHIP, 24LC025T-E/OT          |
| <b>Additional Demo Board Circuit Components</b> |     |  |                                     |                                   |
| 1   | 0   | C16, C17, COUT9, COUT10 (OPT)          | CAP., OPTIONAL                      | OPT                               |
| 2   | 0   | R4, R6, R8, R20, R23, R33, R34 (OPT)   | RES., 0603                          | OPT                               |
| 3   | 0   | R36, R37, R39, R16, R26, R28-R31 (OPT) | RES., CHIP OPTIONAL                 | OPT                               |
| 4   | 0   | R50 (OPT)                              | RES., CHIP, 30Ω, 1%, 2512           | OPT                               |
| <b>Hardware-For Demo Board Only</b>             |     |  |                                     |                                   |
| 1   | 21  | E2-E6, E8-E20, E22-E24                 | TESTPOINT, TURRET, 0.062"           | MILL-MAX, 2308-2-00-80-00-00-07-0 |
| 2   | 1   | XJP1                                   | SHUNT                               | SAMTEC, 2SN-BK-G                  |
| 3   | 4   | (STAND-OFF)                            | STAND-OFF, NYLON 0.50" tall         | KEYSTONE, 8833 (SNAP ON)          |
| 4   | 1   |  | FAB, PRINTED CIRCUIT BOARD          | DEMO CIRCUIT 2087A                |

## SCHEMATIC DIAGRAM

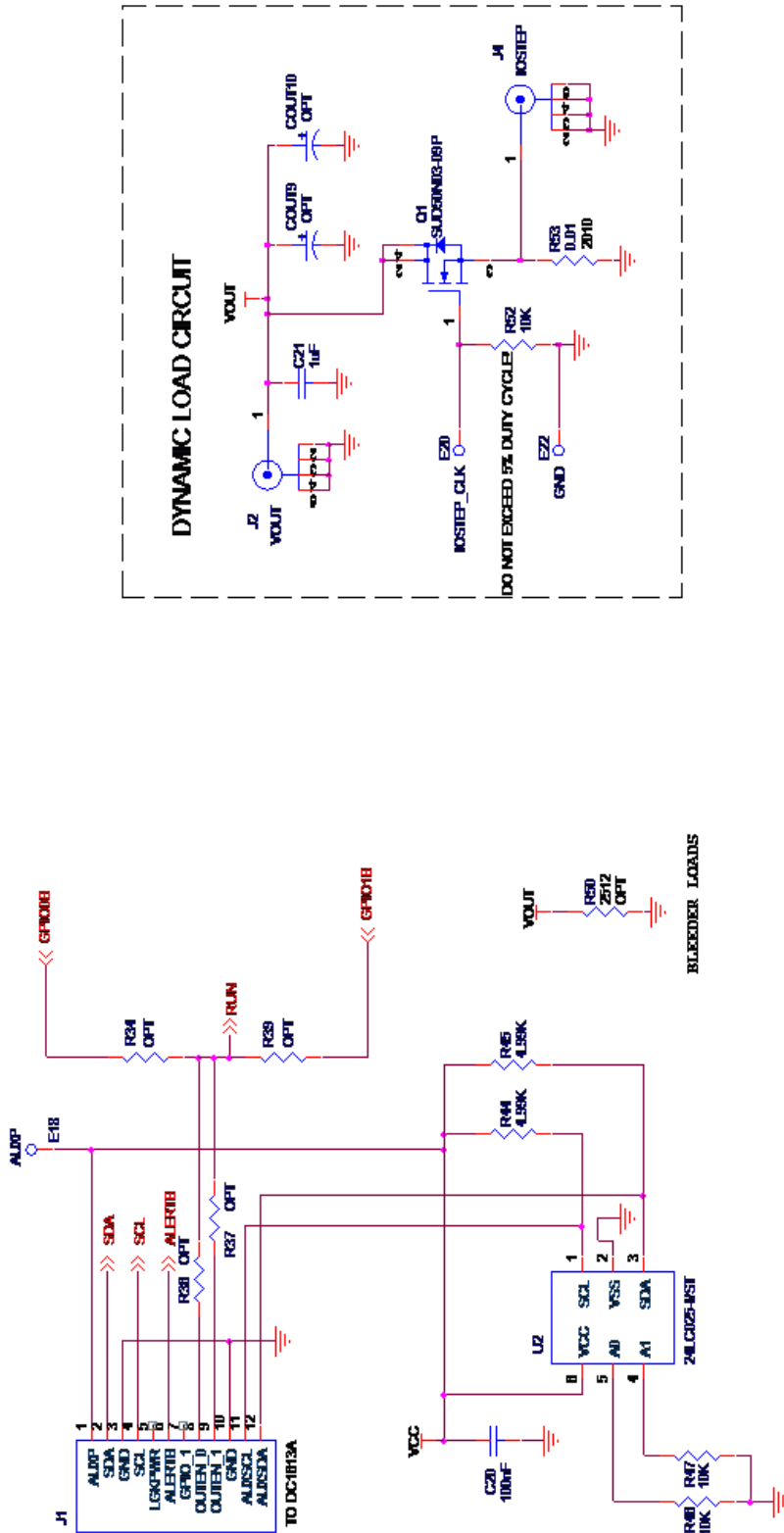
1. ALL RESISTORS ARE 0603.  
ALL CAPACITORS ARE 0603.

[illegible]



# SCHEMATIC DIAGRAM

ALL PARTS ON THIS PAGE ARE FOR DEMO ONLY, NOT NEEDED IN CUSTOMER DESIGN



|  |  |  |  |   |  |
|--|--|--|--|---|--|
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| <b>TITLE: SCHEMATIC</b><br><b>SINGLE-OUTPUT, DUAL-PHASE, STEP-DOWN</b><br><b>MODULE REGULATOR WITH POWER SYSTEM MANAGEMENT</b>   |  | <b>SIZE: B</b><br><b>IC NO. LTM4676EY</b><br><b>DEMO CIRCUIT 2087A</b>                         |  | <b>REV. 1</b><br><b>DATE: Thursday, September 05, 2013</b>  |  |
| <b>SCALE = NONE</b>  |  | <b>SHEET 1 OF 2</b>  |  | <b>SHEET 1 OF 2</b>   |  |

# DEMO MANUAL DC2087A

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dc2087af

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