

# LTC3607EMSE

## Dual 600mA 15V Monolithic Synchronous Step-Down Regulator Board

### DESCRIPTION

Demonstration circuit 1847 is a dual output regulator based on the **LTC<sup>®</sup>3607** monolithic dual channel synchronous buck regulator. The DC1847 has an input voltage range of 4.5V to 15V, with each regulator capable of delivering up to 600mA of output current. The DC1847 can operate in either Burst Mode<sup>®</sup> or pulse-skipping mode. In shutdown, the DC1847 can run off of less than 1 $\mu$ A total. The DC1847 is a very efficient circuit: up to 90%. The DC1847 uses the 16 Pin MSOP LTC3607 package, which has an exposed pad

on the bottom-side of the IC for good thermal performance. These features, plus a set operating frequency of 2.25MHz, make the DC1847 demo board an ideal circuit for use in industrial, automotive, or distributed power applications.

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

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### PERFORMANCE SUMMARY Specifications are at T<sub>A</sub> = 25°C

| PARAMETER                                          | CONDITIONS                                                      | VALUE                            |
|----------------------------------------------------|-----------------------------------------------------------------|----------------------------------|
| Minimum Input Voltages                             |                                                                 | 4.5V                             |
| Maximum Input Voltages                             |                                                                 | 15V                              |
| Run                                                | RUN Pin = GND                                                   | Shutdown                         |
|                                                    | RUN Pin = V <sub>IN</sub>                                       | Operating                        |
| Output Voltage V <sub>OUT1</sub> Regulation        | V <sub>IN1</sub> = 4.5V to 15V, I <sub>OUT1</sub> = 0A to 600mA | 1.2V $\pm$ 4% (1.152V to 1.148V) |
|                                                    |                                                                 | 1.5V $\pm$ 4% (1.44V to 1.56V)   |
|                                                    |                                                                 | 1.8V $\pm$ 4% (1.728V to 1.872V) |
| Typical Output Ripple V <sub>OUT1</sub>            | V <sub>IN1</sub> = 12V, I <sub>OUT1</sub> = 600mA (20MHz BW)    | < 20mV <sub>p-p</sub>            |
| Output Voltage V <sub>OUT2</sub> Regulation        | V <sub>IN2</sub> = 4.5V to 15V, I <sub>OUT2</sub> = 0A to 600mA | 2.5V $\pm$ 4% (2.425V to 2.6V)   |
|                                                    |                                                                 | 3.3V $\pm$ 4% (3.168V to 3.432V) |
|                                                    |                                                                 | 5V $\pm$ 4% (4.8V to 5.2V)       |
| Typical Output Ripple V <sub>OUT2</sub>            | V <sub>IN2</sub> = 12V, I <sub>OUT2</sub> = 600mA (20MHz BW)    | < 20mV <sub>p-p</sub>            |
| Mode Setting                                       | Mode Pin Floating                                               | Burst Mode                       |
|                                                    | Mode Pin Grounded                                               | Pulse-Skipping                   |
| Burst Mode Operation Output Current Thresholds     | Channel 1: PV <sub>IN1</sub> = 12V, V <sub>OUT1</sub> = 1.8V    | I <sub>OUT1</sub> < 480mA        |
|                                                    | Channel 2: PV <sub>IN2</sub> = 12V, V <sub>OUT2</sub> = 3.3V    | I <sub>OUT2</sub> < 360mA        |
| Pulse-Skipping Operation Output Current Thresholds | Channel 1: PV <sub>IN1</sub> = 12V, V <sub>OUT1</sub> = 1.8V    | I <sub>OUT1</sub> < 330mA        |
|                                                    | Channel 2: PV <sub>IN2</sub> = 12V, V <sub>OUT2</sub> = 3.3V    | I <sub>OUT2</sub> < 240mA        |
| Switching Frequency                                |                                                                 | 2.25MHz $\pm$ 20%                |

## QUICK START PROCEDURE

Demonstration circuit 1847A The DC1847 is easy to set up to evaluate the performance of the LTC3607. For a proper measurement equipment configuration, set up the circuit according to the diagram in Figure 1.

NOTE: When measuring the input or output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the input or output voltage ripple by touching the probe tip directly across the  $V_{IN}$  or  $V_{OUT}$  and GND terminals. See the proper scope probe technique in figure 2.

Please follow the procedure outlined below for proper operation.

1. Connect the input power supply to the  $PV_{IN1}/PV_{IN2}$  and GND terminals ( $V_{IN1}$  and  $V_{IN2}$  are separate nodes but are connected.). Connect the loads between the  $V_{OUT}$  and GND terminals. Refer to figure 1 for the proper measurement equipment setup.

Before proceeding to operation, insert jumper shunts xJP1 and xJP2 into the OFF positions of headers JP1 and JP2, shunt xJP3 into the pulse-skip position of MODE header JP3, and shunt xJP4 into the  $V_{OUT1}$  voltage options of choice of header JP4: 1.2V, 1.5V, or 1.8V, and shunt xJP5 into the  $V_{OUT2}$  voltage options of choice of header JP5: 2.5V, 3.3V, or 5V.

2. Apply 5.5V at  $PV_{IN1}$  or  $PV_{IN2}$  turret. Measure both  $V_{OUTS}$ ; they should read 0V. If desired, one can measure the shutdown supply current at this point. The supply current will be less than 1 $\mu$ A in shutdown.

3. Turn on  $V_{OUT1}$  and  $V_{OUT2}$  by shifting shunts xJP1 and xJP2 from the OFF positions to the ON positions. Both output voltages should be within a tolerance of  $\pm 2\%$ .
4. Vary the input voltages from 5.8V (the min.  $V_{IN}$  is dependent on  $V_{OUT}$ ) to 15V, and the load currents from 0 to 600 mA. Both output voltages should be within  $\pm 4\%$  tolerance.
5. Set the load current of both outputs to 600mA and the input voltages to 12V, and then measure each output ripple voltage (refer to figure 2 for proper measurement technique); they should each measure less than 20 mVAC. Also, observe the voltage waveform at either switch node (pin 5 for reg.1 and pin 8 for reg.2) of each regulator. The switching frequency should be about 2.25MHz  $\pm 20\%$  (period between 370ns and 555ns). Both switch node waveforms should be rectangular in shape, and 180° out-of-phase with each other.
6. For Burst Mode operation, change the shunt position of header JP3 to Burst Mode.
7. Regulators 1 ( $PV_{IN1}$ ) and 2 ( $PV_{IN2}$ ) are completely separated from each other; thus, they can be powered from different individual input supplies (if R11 is removed), as can the signal input supply,  $SV_{IN}$ . However,  $SV_{IN}$  must powered for either regulator to function ( $SV_{IN}$  is connected to  $PV_{IN1}$  through a filter on the demo board.).

When finished, insert shunts xJP1 and xJP2 to the OFF position(s) and disconnect the power.

**WARNING - IF THE POWER FOR THE DEMO BOARD IS CARRIED IN LONG LEADS, THE INPUT VOLTAGE AT THE PART COULD “RING”, WHICH COULD AFFECT THE OPERATION OF THE CIRCUIT OR EVEN EXCEED THE MAXIMUM VOLTAGE RATING OF THE IC. TO ELIMINATE THE RINGING, A SMALL TANTALUM CAPACITOR (FOR INSTANCE, AVX PART# TPSY226M035R0200) IS INSERTED ON THE PADS BETWEEN THE INPUT POWER AND RETURN TERMINALS ON THE BOTTOM OF THE DEMO BOARD. THE (GREATER) ESR OF THE TANTALUM CAPACITOR WILL DAMPEN THE (POSSIBLE) RINGING VOLTAGE CAUSED BY THE LONG INPUT LEADS. ON A NORMAL, TYPICAL PCB, WITH SHORT TRACES, THIS CAPACITOR IS NOT NEEDED.**

# QUICK START PROCEDURE

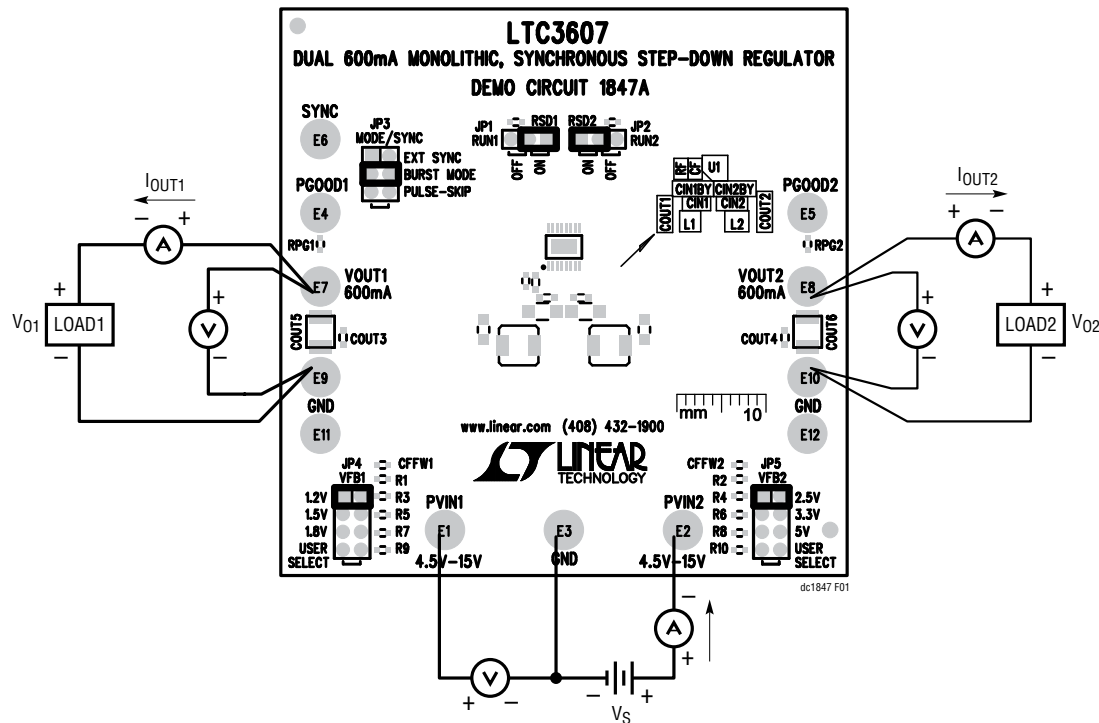


Figure 1. Proper Measurement Equipment Setup

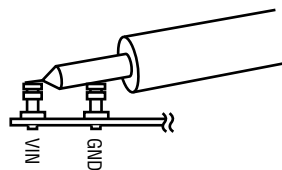


Figure 2. Measuring Input or Output Ripple

## QUICK START PROCEDURE

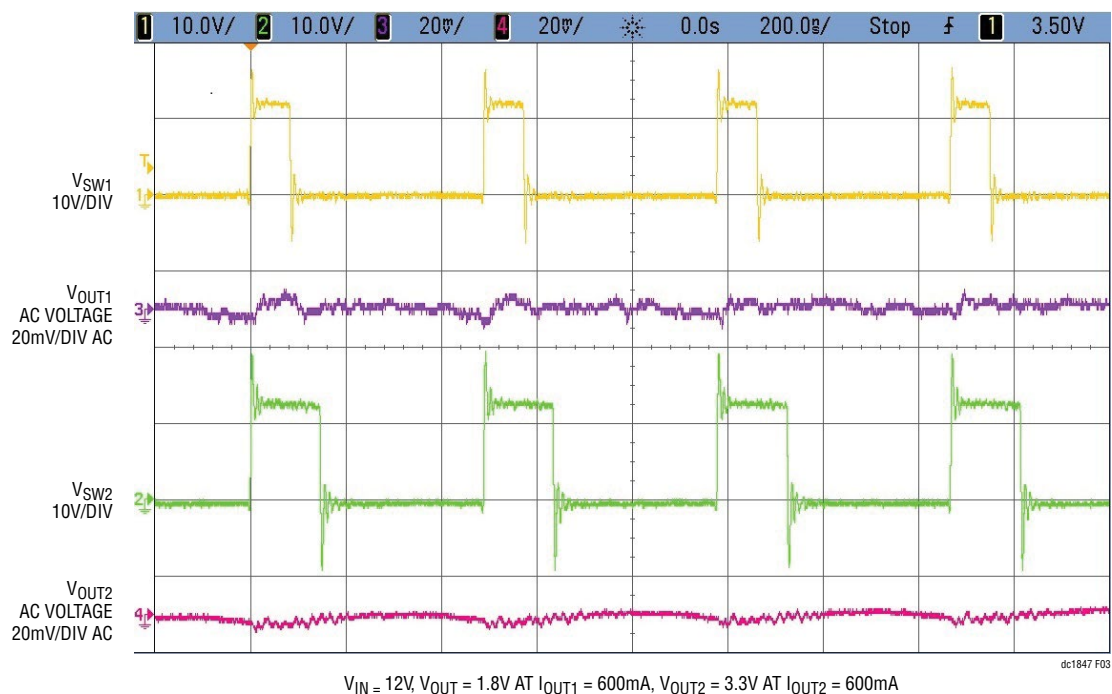


Figure 3. Switch Operation

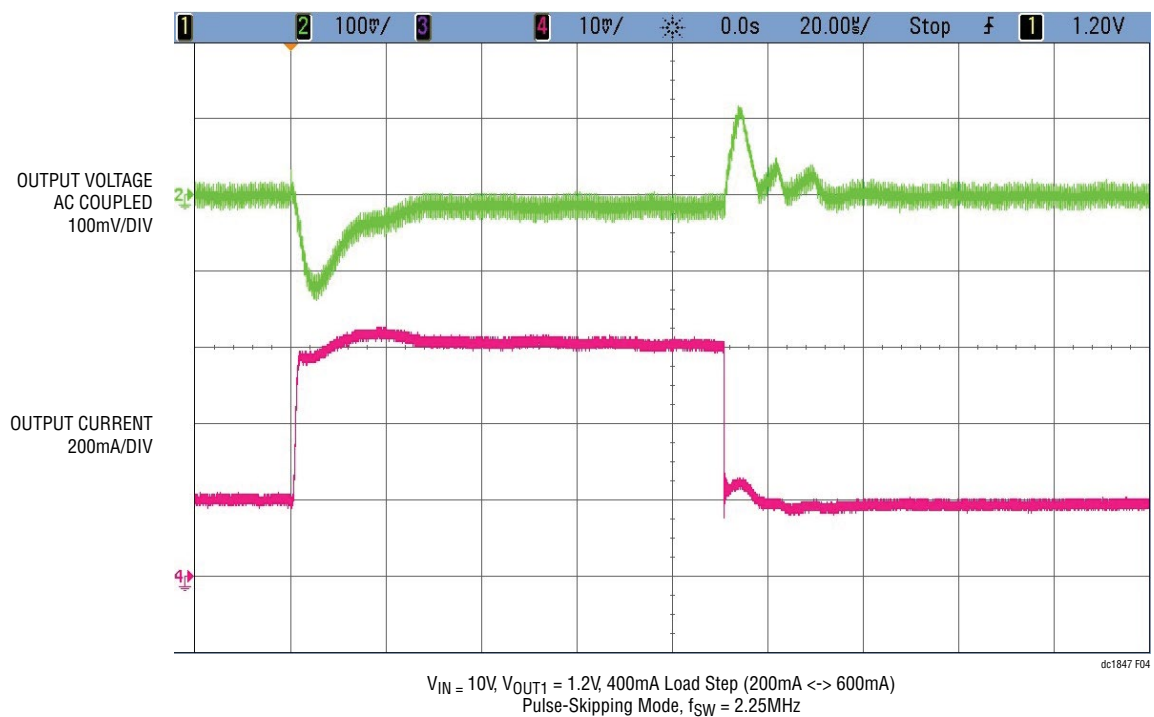


Figure 4. Load Step Response

## QUICK START PROCEDURE

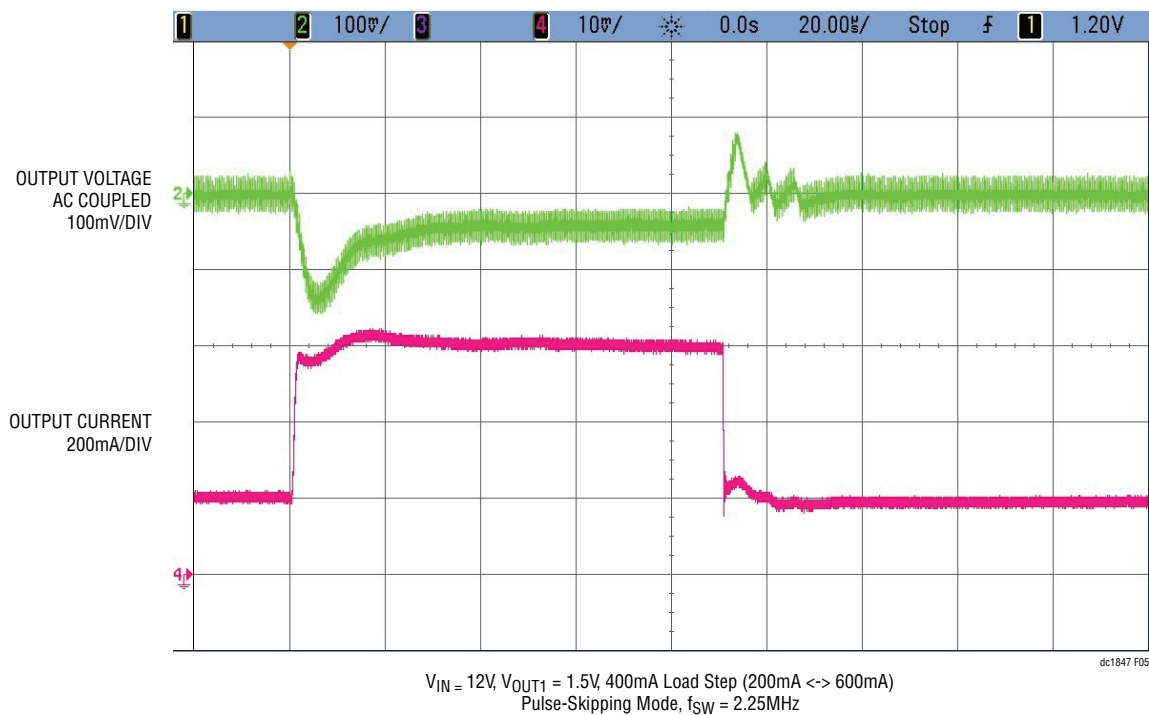


Figure 5. Load Step Response

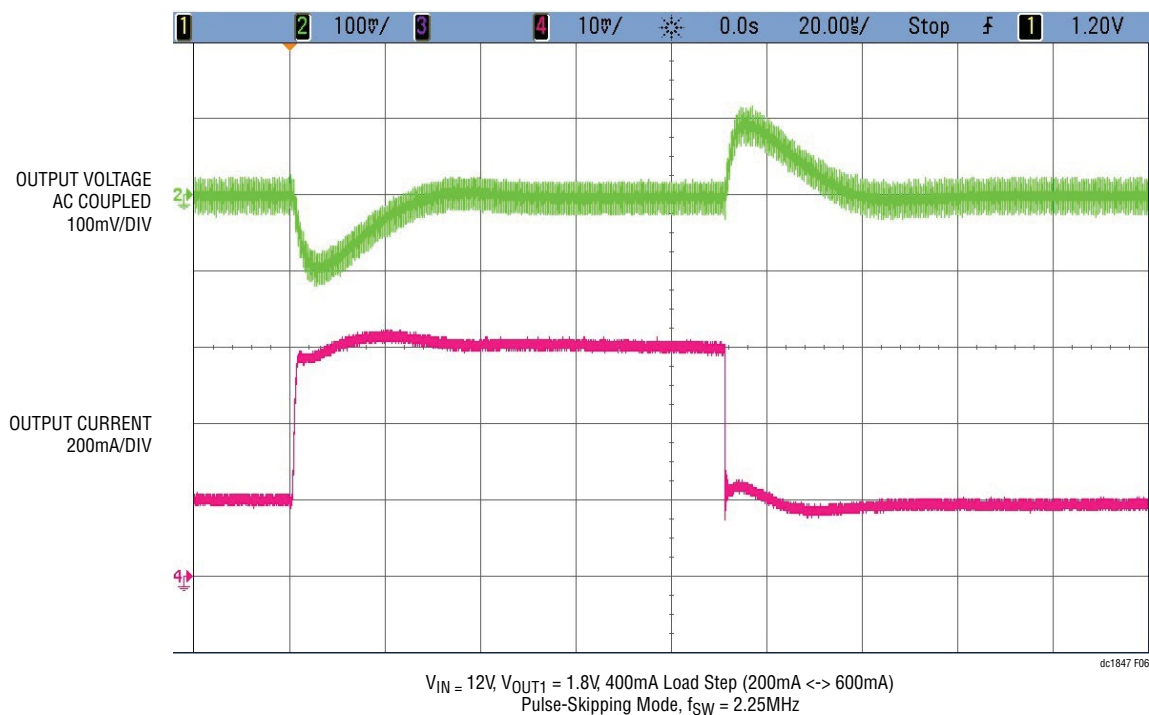


Figure 6. Load Step Response

## QUICK START PROCEDURE

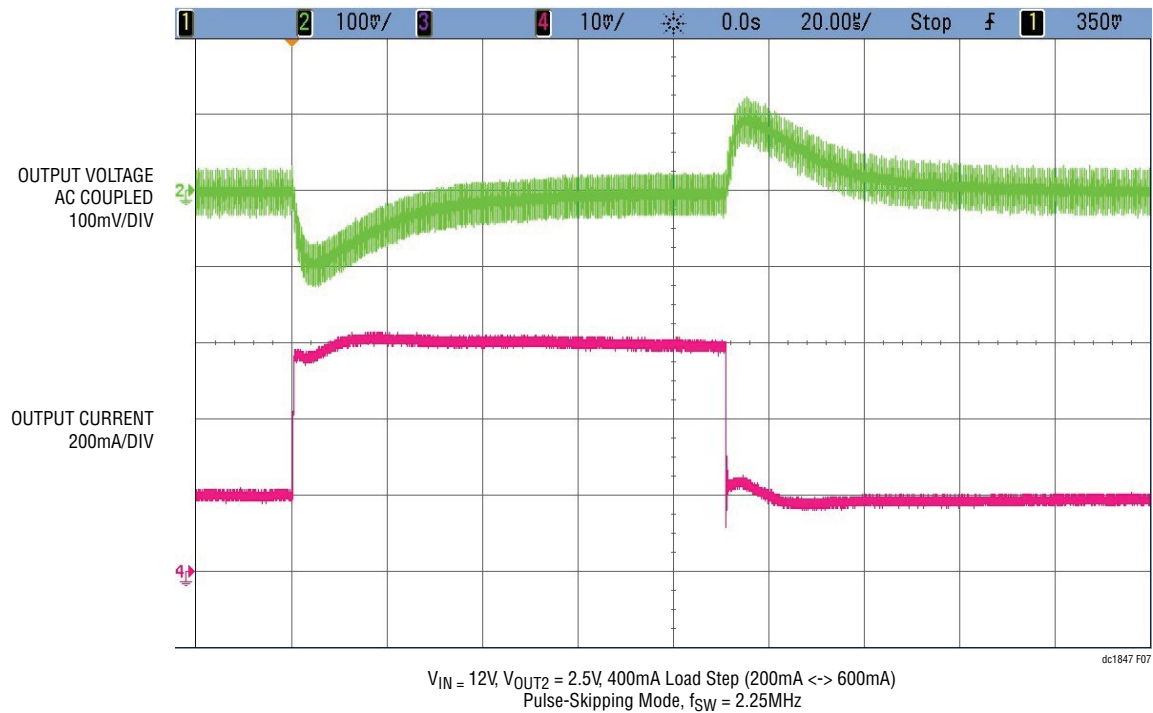


Figure 7. Load Step Response

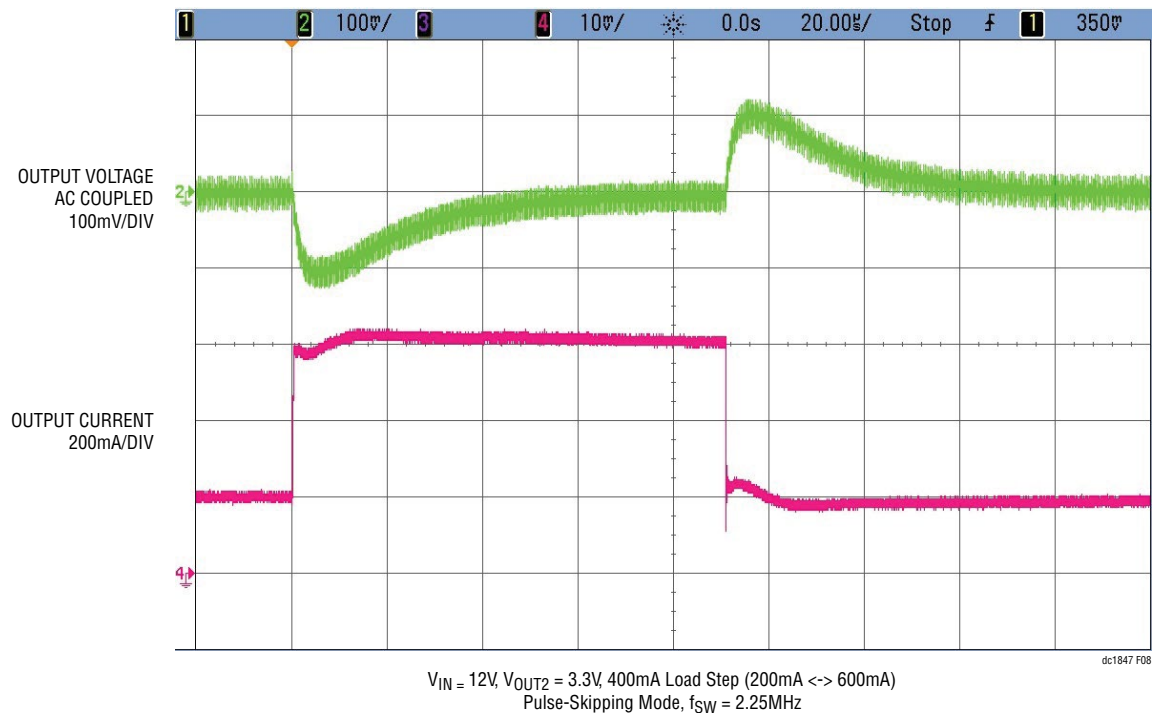


Figure 8. Load Step Response

## QUICK START PROCEDURE

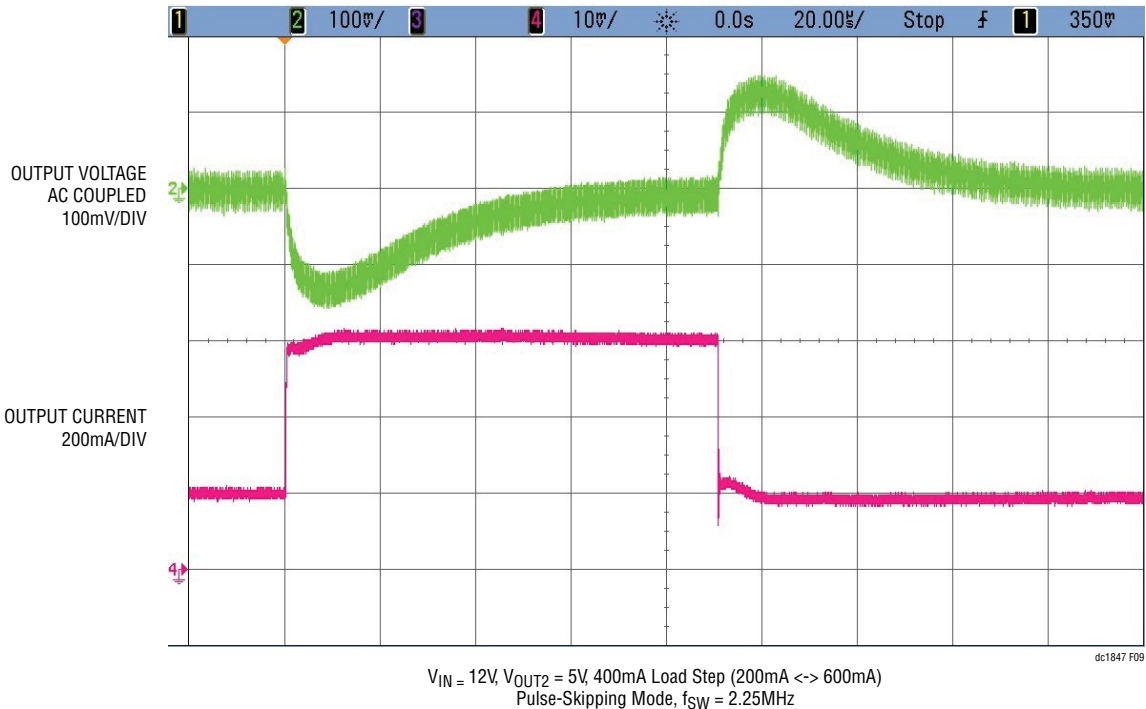


Figure 9. Load Step Response

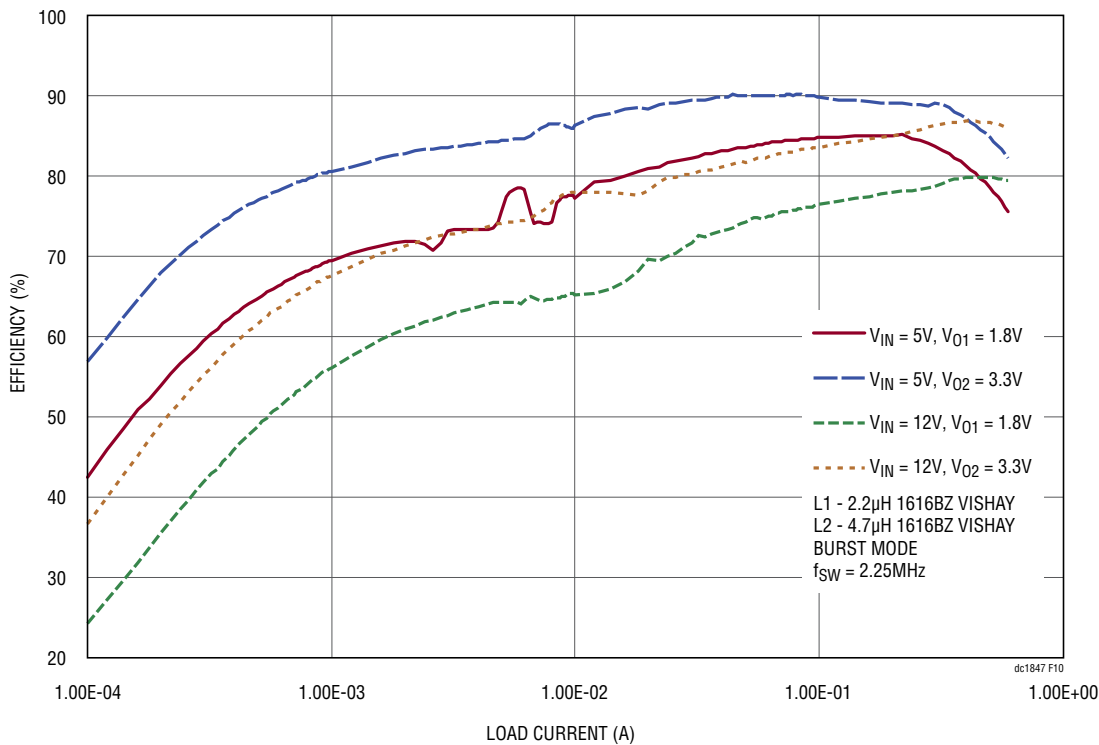


Figure 10. DC1847 Efficiency

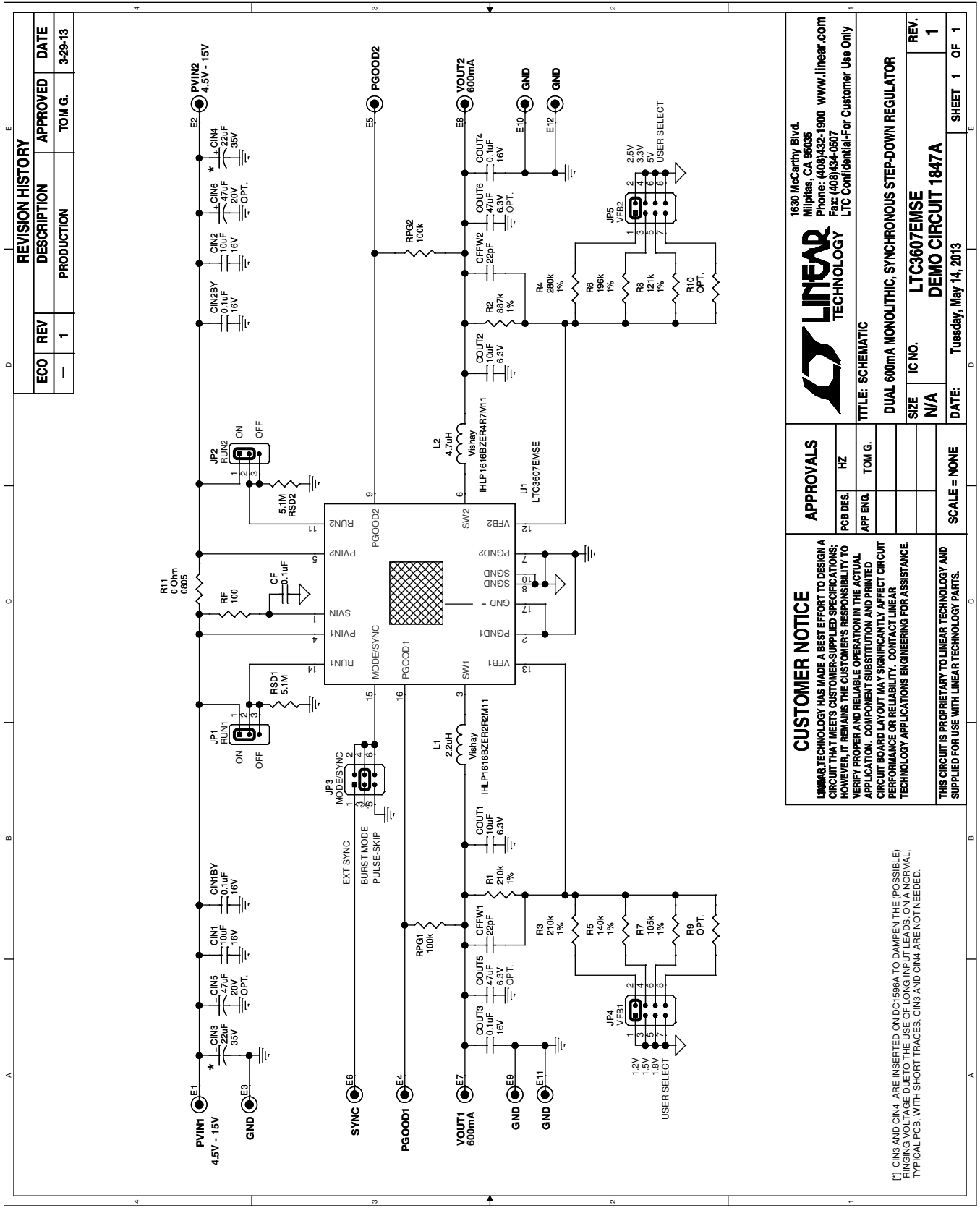
# DEMO MANUAL DC1847A

## PARTS LIST

| ITEM                                            | QTY | REFERENCE           | PART DESCRIPTION                   | MANUFACTURER/PART NUMBER         |
|-------------------------------------------------|-----|---------------------|------------------------------------|----------------------------------|
| <b>Required Circuit Components</b>              |     |                     |                                    |                                  |
| 1                                               | 2   | CFFW1, CFFW2        | CAP., NPO, 22pF, 25V, 5%, 0402     | AVX, 04025A220JAT2A              |
| 2                                               | 2   | CIN1BYP, CIN2BYP    | CAP., X7R, 0.1μF, 16V, 10%, 0603   | AVX, 0603YC104KAT2A              |
| 3                                               | 2   | COUT1, COUT2        | CAP., X5R, 10μF, 6.3V, 10%, 0805   | AVX, 08056D106KAT2A              |
| 4                                               | 2   | CIN1, CIN2          | CAP., X5R, 10μF, 16V, 10%, 1206    | AVX, 1206YD106KAT2A              |
| 5                                               | 1   | L1                  | Inductor, 2.2μH                    | VISHAY, IHLP1616BZER2R2M11       |
| 6                                               | 1   | L2                  | Inductor, 4.7μH                    | VISHAY, IHLP1616BZER4R7M11       |
| 7                                               | 1   | R1                  | RES., CHIP, 210k, 1%, 0402         | VISHAY, CRCW0402210KFKED         |
| 8                                               | 1   | R2                  | RES., CHIP, 887k, 1%, 0402         | VISHAY, CRCW0402887KFKED         |
| 9                                               | 1   | R6                  | RES., CHIP, 196k, 1%, 0402         | VISHAY, CRCW0402196KFKED         |
| 10                                              | 1   | R7                  | RES., CHIP, 105k, 1%, 0402         | VISHAY, CRCW0402105KFKED         |
| 11                                              | 1   | U1                  | IC., LTC3607EMSE, 16 Pin QFM 3 × 3 | Linear Tech., LTC3607EMSE        |
| <b>Additional Demo Board Circuit Components</b> |     |                     |                                    |                                  |
| 1                                               | 3   | COUT3, COUT4, CF    | CAP., X7R, 0.1μF, 16V, 10%, 0603   | AVX, 0603YC104KAT2A              |
| 2                                               | 2   | CIN3, CIN4          | CAP., TANT, 22μF, 35V, 20%, CASE Y | AVX, TPSY226M035R0200            |
| 3                                               | 0   | COUT5, COUT6 (OPT.) | CAP., X5R, 47μF, 6.3V, 10%, 1210   | AVX, 12106D476KAQ2A              |
| 4                                               | 0   | CIN5, CIN6 (OPT.)   | CAP., X5R, 47μF, 20V, 10%, 1812    |                                  |
| 5                                               | 1   | RF                  | RES., CHIP, 100, 1/16W, 5%, 0402   | VISHAY, CRCW0402100RJNED         |
| 6                                               | 1   | R3                  | RES., CHIP, 210k, 1%, 0402         | VISHAY, CRCW0402210KFKED         |
| 7                                               | 1   | R4                  | RES., CHIP, 280k, 1%, 0402         | VISHAY, CRCW0402280KFKED         |
| 8                                               | 1   | R5                  | RES., CHIP, 140k, 1%, 0402         | VISHAY, CRCW0402140KFKED         |
| 9                                               | 1   | R8                  | RES., CHIP, 121k, 1%, 0402         | VISHAY, CRCW0402105KFKED         |
| 10                                              | 0   | R9, R10 (OPT.)      | RES., 0402                         |                                  |
| 11                                              | 1   | R11                 | RES., CHIP, 0, 1%, 0805            | VISHAY, CRCW08050000Z0ED         |
| 12                                              | 2   | RSD1, RSD2          | RES., CHIP, 5.1M, 5%, 0402         | VISHAY, CRCW04025M10JNED         |
| 13                                              | 2   | RPG1, RPG2          | RES., CHIP, 100k, 1%, 0402         | VISHAY, CRCW0402100KFKED         |
| <b>Hardware: For Demo Board Only</b>            |     |                     |                                    |                                  |
| 1                                               | 12  | E1-E12              | Testpoint, TURRET, .094"           | MILL-MAX-2501-2-00-80-00-00-07-0 |
| 2                                               | 2   | JP1, JP2            | 0.079 SINGLE ROW HEADER, 3 PIN     | SAMTEC, TMM103-02-L-S            |
| 3                                               | 2   | JP4, JP5            | 0.079, 2 × 4 HEADER                | SAMTEC, TMM104-02-L-D            |
| 4                                               | 1   | JP3                 | 0.079, 2 × 3 HEADER                | SAMTEC, TMM103-02-L-D            |
| 5                                               | 5   | JP1-JP5             | SHUNT, FOR JP1-JP5                 | SAMTEC, 2SN-BK-G                 |



# SCHEMATIC DIAGRAM



| REVISION HISTORY |     |             |         |
|------------------|-----|-------------|---------|
| ECO              | REV | DESCRIPTION | DATE    |
| —                | 1   | PRODUCTION  | 3-29-13 |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |                                                                                                                                                                                               |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  | 1630 McCarthy Blvd.<br>Milpitas, CA 95035<br>Phone: (408)432-1900 www.linear.com<br>Fax: (408)434-0507<br>LTC Confidential-For Customer Use Only                                              |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  | <b>LINEAR TECHNOLOGY</b>                                                                                                                                                                      |  |
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| THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.                                                                                                                                                                                                                                                                                                                                              |  | SCALE = NONE<br>SHEET 1 OF 1                                                                                                                                                                  |  |

(1) CIN3 AND CIN4 ARE INSERTED ON DC1847A TO DAMPEN THE (POSSIBLE) RINGING VOLTAGE DUE TO THE USE OF LONG INPUT LEADS ON A NORMAL, TYPICAL PCB, WITH SHORT TRACES. CIN3 AND CIN4 ARE NOT NEEDED.

# DEMO MANUAL DC1847A

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dc1847af

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