

# LTC3867EUF

## High Efficiency Synchronous Buck Converter

### DESCRIPTION

Demonstration circuit 1928A is a single output synchronous buck converter featuring the [LTC®3867EUF](#) in a 24-lead 4mm x 4mm QFN package.

The DC1928A is configured with a sense resistor. Inductor DCR sensing circuit is optional. Using the inductor's DCR as the sense element instead of the onboard sense resistor saves cost, board space while improving efficiency. Using a sense resistor provides more accurate current limit.

The board has a lot of features including an internal 5V linear regulator for bias, output voltage remote-sense, programmable nonlinear control to improve load transient performance, programmable thermal shutdown, an

optional temperature compensated DCR sense circuit, and selectable continuous, pulse-skipping or Burst Mode® operation. Synchronization to an external clock is also possible.

The input voltage range is from 18V to 36V. The LTC3867 data sheet gives a complete description of the part, operation and application information and must be read in conjunction with this demo manual for DC1928A.

**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 / NOTES   | VALUE                     |
|---|--|---------------------------|
| Input Voltage Range                         |  | 18V ~ 36V                 |
| Output Voltage, V <sub>OUT</sub>            | V <sub>IN</sub> = 18V ~ 36V, I <sub>OUT</sub> = 0A ~ 12A, JP3: CCM                               | 12V ±2% (11.76V ~ 12.24V) |
| Default Operating Frequency (Typical)       |  | 250kHz                    |
| External Clock Sync. Frequency Range        |  | 200kHz to 780kHz          |
| Typical Full Load Efficiency (See Figure 3) | V <sub>IN</sub> = 24V, V <sub>OUT</sub> = 12V, I <sub>OUT1</sub> = 12A, f <sub>SW</sub> = 250kHz | 97.6%                     |

## QUICK START PROCEDURE

Demonstration circuit DC1928A is easy to set up to evaluate the performance of the LTC3867EUF. Please refer to Figure 2 for proper measurement equipment setup and follow the procedure below:

1. Place jumpers in the following positions for a typical application:

**JP2:** On

**JP3:** CCM

2. With power off, connect the input power supply, load and meters as shown in Figure 1. Preset the load to 0A and  $V_{IN}$  supply to 24V.

3. Turn on the power supply at the input.

**Note:** Make sure that the input voltage does not exceed 36V.

4. Check the output voltage. The output voltage should be between 11.76V and 12.24V.

Once the proper output voltage is established, adjust the load within the operating range and observe the output voltage regulation, output voltage ripple, efficiency and other parameters.

**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 VIN or VOUT and GND terminals. See Figure 2 for proper scope probe technique.

5. Change JP3 jumper position to select different operation modes. Set jumper to CCM, BURST or P.S. position to set forced continuous conduction, burst or pulse-skipping mode respectively. For synchronizing to an external clock source, set the jumper to BURST position and apply the clock signal to MODE/PLLIN turret.

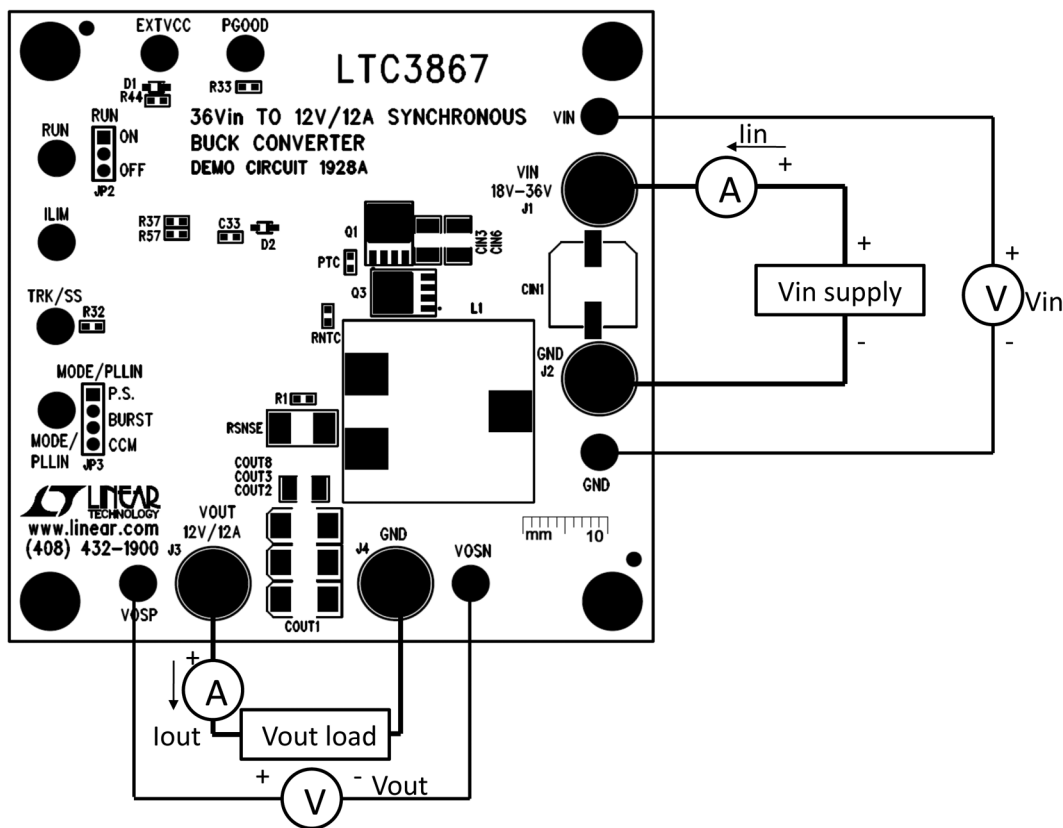


Figure 1. Test Setup of DC1928A

## QUICK START PROCEDURE

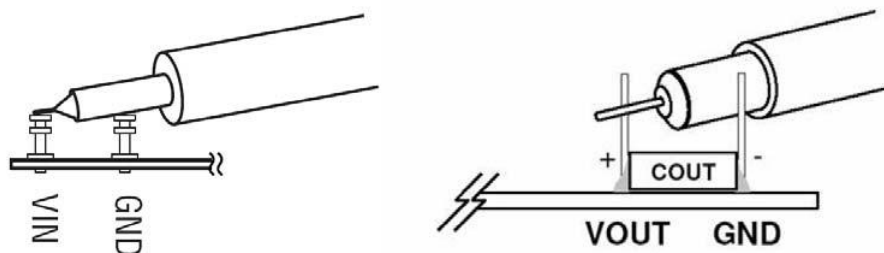


Figure 2. Measuring Input or Output Ripple Across Terminals or Directly Across Bulk Capacitor

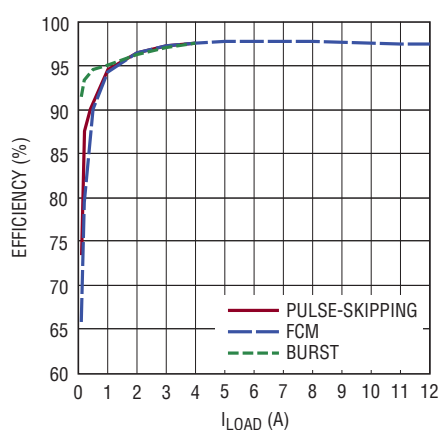


Figure 3. Measured Efficiency

## RAIL TRACKING

Demonstration circuit 1928A is configured for an onboard soft-start circuit. The soft-start ramp rate can be adjusted by changing the value of C24. Demonstration circuit 1928A

can also be modified to track an external reference. Refer to Table 1 for tracking options and to the data sheet for more details.

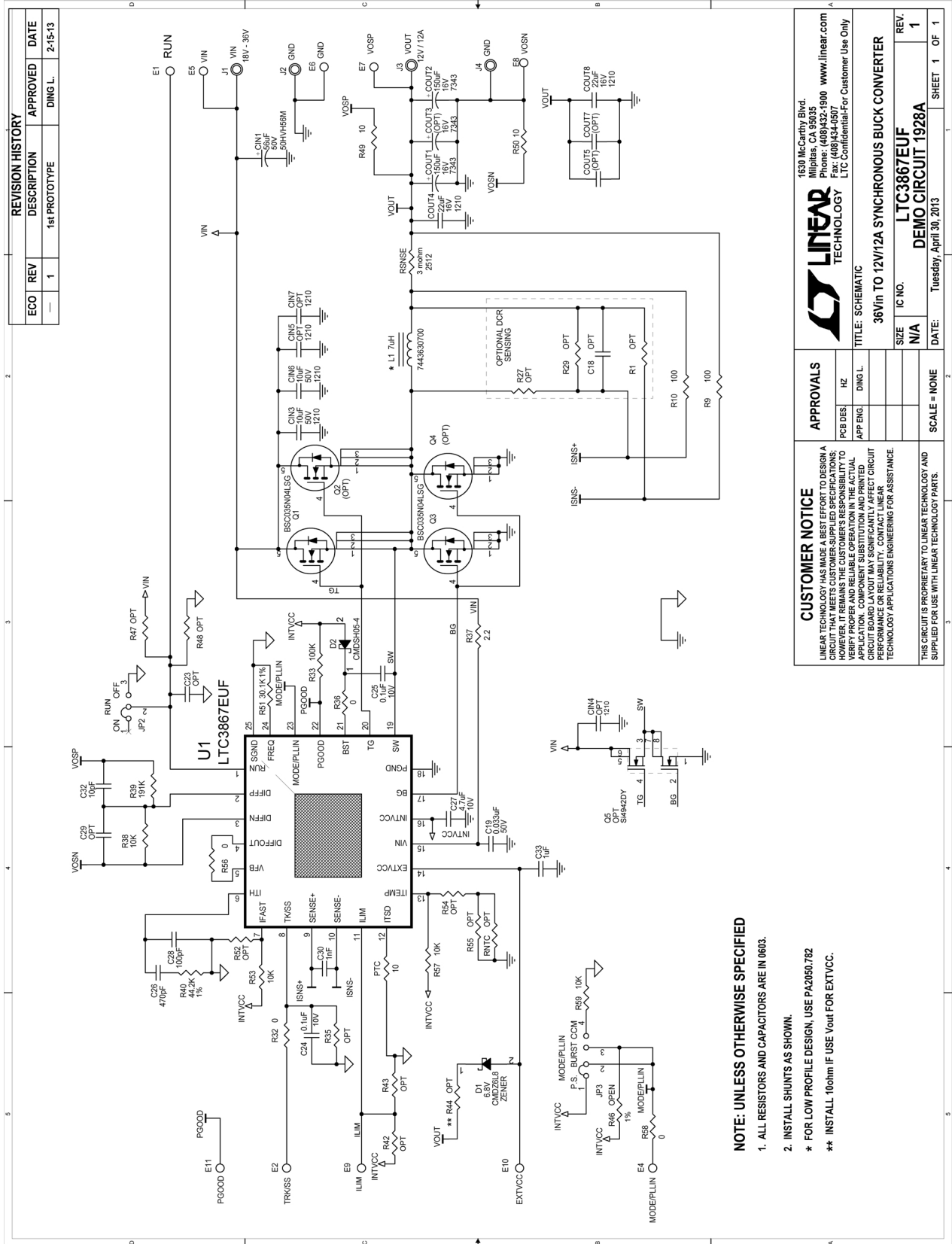
| CONFIGURATION                                  | TRK/SS RESISTORS AND CAPACITOR |      |       | RAIL TRACKING              |
|--|--------------------------------|------|-------|----------------------------|
|  | R32                            | R35  | C24   | TRK/SS PIN                 |
| Soft-Start without Tracking (Default)          | 0Ω                             | Open | 0.1μF | OPEN                       |
| V <sub>OUT</sub> Equals External Ramp          | 0Ω                             | Open | Open  | External Reference Applied |
| V <sub>OUT</sub> Tracking Scaled External Ramp | Resistor Divider               |      | Open  | External Reference Applied |

# DEMO MANUAL DC1928A

## PARTS LIST

| ITEM  | QTY | REFERENCE   | PART DESCRIPTION                     | MANUFACTURER/PART NUMBER         |
|---|-----|---|--------------------------------------|----------------------------------|
| <b>Required Circuit Components</b>              |     |   |                                      |                                  |
| 1   | 1   | CIN1  | CAP, ALUM, 56 $\mu$ F 20% 50V        | SUN ELECT 50HVH56M               |
| 2   | 2   | CIN3, CIN6  | CAP, X5R 10 $\mu$ F 20% 50V 1210     | TAIYO YUDEN UMK325BJ106MM-T      |
| 5   | 2   | COU1, COU2  | CAP, POSCAP 150 $\mu$ F 20% 16V 7343 | SANYO, 16TQC150MYF               |
| 7   | 2   | COU4, COU8  | CAP, X5R 22 $\mu$ F 20% 16V 1210     | AVX 1210YD226MAT2A               |
| 9   | 1   | C32   | CAP., X7R 10pF 10% 25V 0603          | AVX 06033C100KAT2A               |
| 10  | 1   | C33   | CAP, X5R 1 $\mu$ F 10% 50V 0603      | TDK C1608X5R1E105K               |
| 11  | 1   | C19   | CAP, X5R 0.033 $\mu$ F 10% 50V 0603  | AVX 06035D333KAT2A               |
| 12  | 1   | C30   | CAP, X7R 1nF 10% 25V 0603            | AVX 06033C102KAT                 |
| 13  | 2   | C24, C25  | CAP, X5R 0.1 $\mu$ F 10% 10V 0603    | AVX 0603ZD104KAT                 |
| 14  | 1   | C26   | CAP, COG 470pF 5% 50V 0603           | MURATA GCM1885C1H471JA16D        |
| 15  | 1   | C27   | CAP, X5R 4.7 $\mu$ F 10% 10V 0603    | AVX 0603ZD475KAT2A               |
| 16  | 1   | C28   | CAP, COG 100pF 5% 50V 0603           | TDK C1608COG1H101JK              |
| 17  | 1   | D1  | DIODE, 6.8V SOD-323                  | CENTRAL CMDZ6L8                  |
| 18  | 1   | D2  | DIODE, SOD-323                       | CENTRAL SEMI CMDSH05-4-LTC       |
| 23  | 1   | L1  | IND., 7 $\mu$ H                      | WURTH., 7443630700               |
| 24  | 2   | Q1, Q3  | XSTR, MOSFET LFPK                    | INFINEON BSC035N04LSG            |
| 28  | 1   | RSNSE   | RES, 3m $\Omega$ 1% 1W 2512          | PANASONIC ERJM1WTF3M0U           |
| 29  | 2   | R9, R10   | RES, 100 $\Omega$ 1% 1/10W 0603      | NIC NRC06F1000TRF                |
| 31  | 4   | R32, R36, R56, R58  | RES, 0 $\Omega$ 1/10W 0603           | VISHAY CRCW06030000Z0EA          |
| 32  | 1   | R33   | RES, 100k 1% 1/10W 0603              | NIC NRC06F1003TRF                |
| 33  | 1   | R37   | RES, 2.2 $\Omega$ 5% 1/10W 0603      | NIC NRC06F2R20TRF                |
| 34  | 1   | R39   | RES, 191K $\Omega$ 1% 0603           | VISHAY CRCW060375K0FKEA          |
| 35  | 4   | R38, R53, R57, R59  | RES, 10k 1% 0603                     | NIC NRC06F1002TRF                |
| 36  | 1   | R40   | RES, 44.2k 1% 0603                   | VISHAY CRCW060344K2FKEA          |
| 37  | 1   | R51   | RES, 30.1k 1% 0603                   | NIC NRC06f3012TRF                |
| 38  | 3   | R49, R50, PTC   | RES, 10 $\Omega$ 1% 0603             | NIC NRC06f10R0TRF                |
| 39  | 1   | U1  | IC., LTC3867EUF, QFN 4mm x 4mm       | LINEAR TECH. LTC3867EUF#PBF      |
| <b>Additional Demo Board Circuit Components</b> |     |   |                                      |                                  |
| 1   | 2   | COU5, COU7 (OPT)  |                                      |                                  |
| 2   | 3   | CIN4, CIN5, CIN7,   | CAP, X5R 22 $\mu$ F 20% 25V 1210     |                                  |
| 3   | 1   | COU3 (OPT)  | CAP, POSCAP 7343                     |                                  |
| 4   | 3   | C18, C23, C29 (OPT)   | CAP, 0603                            |                                  |
| 5   | 2   | Q2, Q4 (OPT)  | XSTR, MOSFET LFPK                    |                                  |
| 6   | 1   | Q5 (OPT)  | XSTR, MOSFET, DUAL N-CHANNEL         |                                  |
| 7   | 13  | R1, R27, R29, R35, R42, R43, R46-R48, R52, R54, R55, RNTC (OPT) | RES, 0603                            |                                  |
| <b>Hardware-For Demo Board Only</b>             |     |   |                                      |                                  |
| 1   | 8   | E1, E2, E4-E11  | TURRET, 0.094"                       | MILL-MAX 2501-2-00-80-00-00-07-0 |
| 2   | 1   | JP2   | HEADER, 3-PIN                        | SAMTEC TMM-103-02-L-S            |
| 3   | 1   | JP3   | HEADER, 4-PIN                        | SAMTEC TMM-104-02-L-S            |
| 4   | 4   | J1-J4   | JACK, BANANA                         | KEYSTONE 575-4                   |
| 5   | 2   | XJP2, XJP3  | SHUNT                                | SAMTEC 2SN-BK-G                  |
| 6   | 4   |   | STANDOFF, SNAP ON                    | KEYSTONE 8832                    |
| 7   | 1   |   | FAB, PRINTED CIRCUIT BOARD           | DEMO CIRCUIT 1928A               |

SCHEMATIC DIAGRAM



**NOTE: UNLESS OTHERWISE SPECIFIED**

1. ALL RESISTORS AND CAPACITORS ARE IN 0603.
2. INSTALL SHUNTS AS SHOWN.

\* FOR LOW PROFILE DESIGN, USE PA2050.782  
 \*\* INSTALL 100mΩ IF USE Vout FOR EXTVCC.

| REVISION HISTORY |     |               |         |
|------------------|-----|---------------|---------|
| ECO              | REV | DESCRIPTION   | DATE    |
| —                | 1   | 1st PROTOTYPE | 2-15-13 |

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**APPROVALS**

|         |         |
|---------|---------|
| POB DES | Hz      |
| APP ENG | DING L. |

SCALE = NONE

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**36Vin TO 12V/12A SYNCHRONOUS BUCK CONVERTER**

SIZE: IC NO. N/A

REV. 1

DATE: Tuesday, April 30, 2013

SHEET 1 OF 1



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# DEMO MANUAL DC1928A

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