

**LTC3862-2**  
**Low Noise PolyPhase® SEPIC**  
**DC/DC Converter****DESCRIPTION**

Demonstration circuit 1891A is a 2-phase high efficiency nonisolated SEPIC (single ended primary inductor converter) converter featuring the LTC®3862-2 switching controller. The DC1891A converts a 6V to 60V input to a 12V output and provides 6A of output current. The converter operates at 300kHz (600kHz output ripple) with efficiency around 90%. With a proper amount of airflow, the DC1891A converter can generate over 6A of output current. The DC1891A can be easily modified to generate output voltages in the range from 0.8V to 48V.

Also, the DC1891A can be optimized for specific input voltages. The narrowing of input voltage range can increase the converter's efficiency. Therefore, a narrow input voltage range is more desirable.

The LTC3862-2 can be synchronized to an external clock of up to 400kHz. Please refer to LTC3862-2 data sheet for design details and applications information.

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

LT, LT, LTC, LTM, Linear Technology, PolyPhase and the Linear logo are registered trademarks of Linear Technology Corporation. All other trademarks are the property of their respective owners.

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

| PARAMETER                       | CONDITIONS                                                             | VALUE                |
|---------------------------------|------------------------------------------------------------------------|----------------------|
| Minimum Input Voltage           | $I_{OUT} = 0\text{A to } 6\text{A}$                                    | 6V                   |
| Maximum Input Voltage           | $I_{OUT} = 0\text{A to } 6\text{A}$                                    | 60V                  |
| $V_{OUT}$                       | $V_{IN} = 6\text{V to } 60\text{V}, I_{OUT} = 0\text{A to } 6\text{A}$ | 12V $\pm 3\%$        |
| Typical Output Ripple $V_{OUT}$ | $V_{IN} = 6\text{V to } 60\text{V}, I_{OUT} = 0\text{A to } 6\text{A}$ | 100mV <sub>P-P</sub> |
| Nominal Switching Frequency     |                                                                        | 300kHz               |

## QUICK START PROCEDURE

Demonstration circuit 1891A is easy to set up to evaluate the performance of the LTC3862-2 circuit. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

**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 Figure 2 for the proper scope probe technique.

1. With power off, connect the input power supply to  $V_{IN}$  and GND. Make sure that the input power supply has sufficient current rating at minimum input voltage for the required output load.

2. Turn on the power at the input.

**NOTE:** Make sure that the input voltage does not exceed 60V.

3. Check for the proper output voltage.

$$V_{OUT} = 12V, \pm 3\%.$$

If there is no output, temporarily disconnect the load to make sure that the load is not set too high.

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

5. The DC1891A is equipped with an input capacitor  $C_{IN4}$  that is optional and is used to help with filtering when the board is connected to the lab supply with long leads. The capacitor  $C_{IN4}$  can be removed if the input power source is close and has low source impedance.

## CHANGING THE OUTPUT VOLTAGE

To set the output voltage lower or higher than 12V, change the bottom voltage divider resistor connected to the FB pin of U1 (see the Schematic Diagram). Also, check the MOSFET, output diode and capacitor voltage ratings if the output voltage is set higher than 12V.

The optional Q5 circuit is used to get the circuit running. Once the circuit is running, the 12V output is used to bias U1 via D2. The start-up circuit Q5 is turned off by Q6 when  $V_{OUT}$  gets to the level set by D3, R14 and R16 that activates Q6. Please contact the LTC factory for details.

## QUICK START PROCEDURE

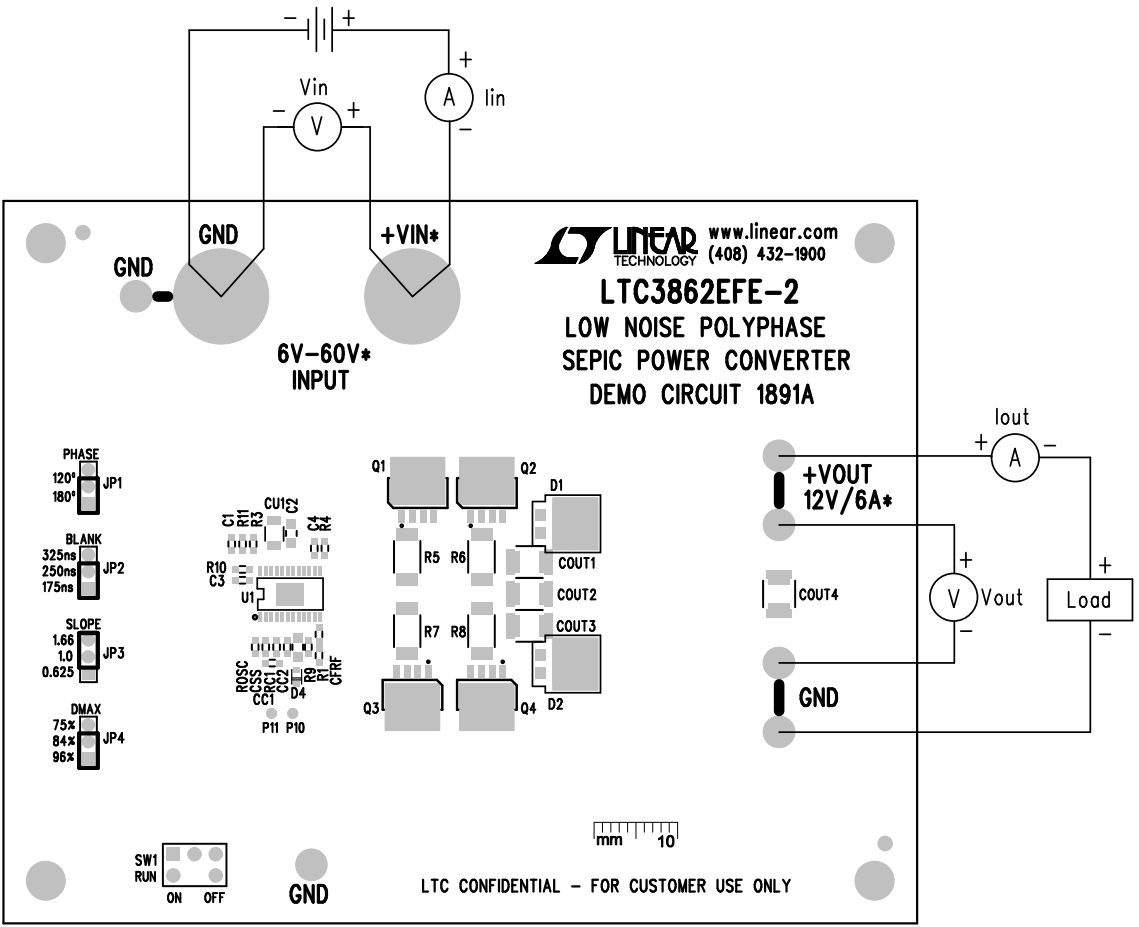


Figure 1. Proper Measurement Equipment Setup

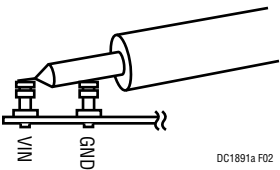
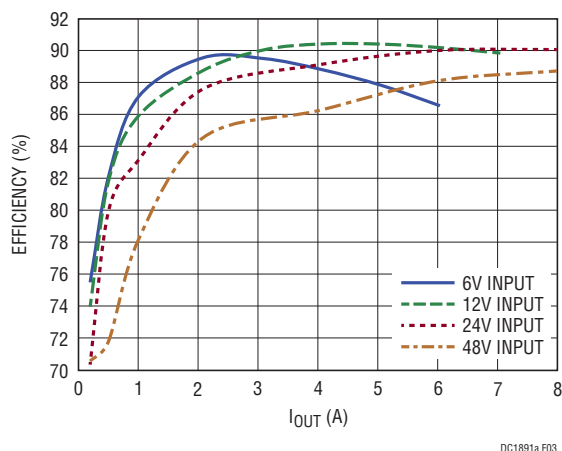


Figure 2. Measuring Input or Output Ripple

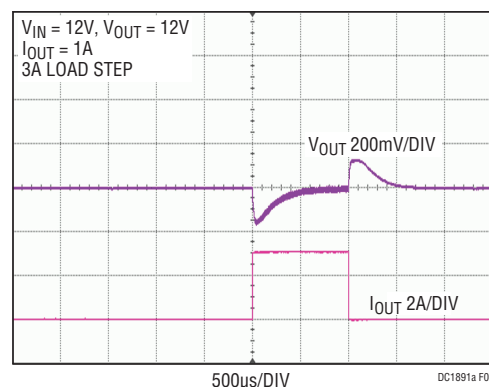
## QUICK START PROCEDURE



**Figure 3. Reducing the Input Voltage Range and Selecting More Optimal MOSFET, Diode and Inductor Can Optimize the Efficiency of DC1891A**

## OUTPUT LOAD STEP RESPONSE

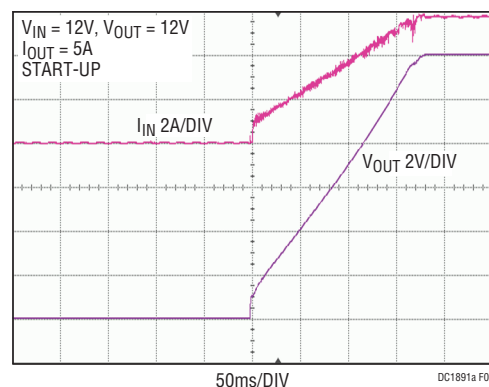
The load step response of DC1891A is very fast even though a relatively small amount of output capacitance is present (188 $\mu$ F ceramic and 440 $\mu$ F electrolytic). The load step transients are shown in Figure 4. To improve load step response further or to reduce the output ripple, more output capacitance can be added. Low ESR output capacitors will have the greatest effect on reducing the ripple and load step transients.



**Figure 4. Fast Transient Response of DC1891A is Achieved with a Small Amount of Output Capacitance**

## SOFT-START FUNCTION

The DC1891A features a soft-start circuit that controls the inrush current and output voltage ramp at start-up. The capacitor  $C_{SS}$  controls the start-up period. The start-up waveforms are shown in Figure 5.



**Figure 5. The DC1891A Ramps the Output Slowly at Start-Up without Generating an Input Current Surge**

## PARTS LIST

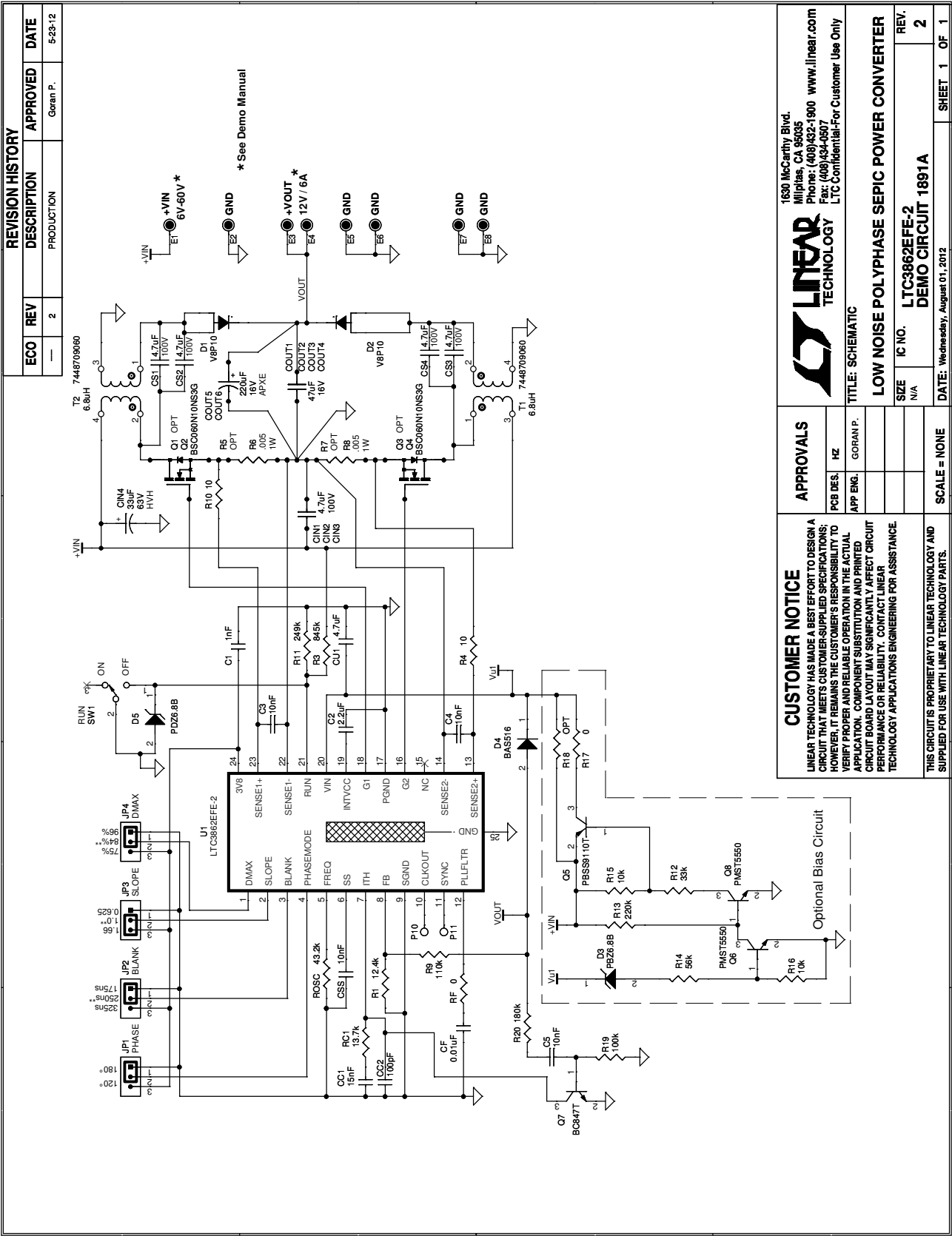
| ITEM                               | QTY | REFERENCE                | PART DESCRIPTION                      | MANUFACTURER/PART NUMBER           |
|------------------------------------|-----|--------------------------|---------------------------------------|------------------------------------|
| <b>Required Circuit Components</b> |     |                          |                                       |                                    |
| 1                                  | 1   | CC2                      | CAP, NPO 100pF, 25V, 5%, 0603         | AVX 06033A101JAT2A                 |
| 2                                  | 4   | C3, C4, CSS, C5          | CAP, X7R 0.01 $\mu$ F 25V 10% 0603    | AVX 06033C103KAT2A                 |
| 3                                  | 1   | CC1                      | CAP, X5R 0.015 $\mu$ F 25V 10% 0603   | AVX 06033D153KAT2A                 |
| 4                                  | 1   | C1                       | CAP, NPO 1000pF 25V 10% 0603          | AVX 06033A102JAT2A                 |
| 5                                  | 1   | C2                       | CAP, X5R, 2.2 $\mu$ F, 25V, 10%, 0805 | AVX 08053D225KAT2A                 |
| 6                                  | 1   | CIN4                     | CAP, 33 $\mu$ F, 63V                  | SUN ELECT, 63HVVH33MS              |
| 7                                  | 1   | CU1                      | CAP, X7R 4.7 $\mu$ F 50V 10% 1206     | MURATA GRM31CR71H475KA12L          |
| 8                                  | 7   | CS1 TO CS4, CIN1 TO CIN3 | CAP, X7S 4.7 $\mu$ F 100V 20% 1812    | TDK C4532X7S2A475M                 |
| 9                                  | 4   | COUT1 TO COUT4           | CAP, X7S 47 $\mu$ F 16V 20% 1812      | TDK CKG45NX7S1C476M                |
| 10                                 | 2   | COUT5, COUT6             | CAP, 220 $\mu$ F 16V APXE             | UNITED CHEMI-CON APX160ARA221MHA0G |
| 11                                 | 1   | CF                       | CAP, X7R 0.01 $\mu$ F 16V 10% 0603    | AVX 0603YC103KAT2A                 |
| 12                                 | 2   | D3, D5                   | ZENER DIODE, SOD-323                  | NXP SEMI PDZ6.8B                   |
| 13                                 | 1   | D4                       | DIODE, SOD-523                        | NXP SEMI BAS516                    |
| 14                                 | 2   | D1, D2                   | SCHOTTKY RECTIFIER, TO-277A           | VISHAY V8P10-M3/86A                |
| 15                                 | 2   | Q2, Q4                   | POWER MOSFET, PG-TDSON-8              | INFINEON BSC060N10NS3G             |
| 16                                 | 1   | Q5                       | PNP TRANSISTOR, SOT-23                | NXP SEMI PBSS9110T                 |
| 17                                 | 2   | Q6, Q8                   | NPN TRANSISTOR, SOT-323               | NXP SEMI PMST5550                  |
| 18                                 | 1   | Q7                       | NPN TRANSISTOR, SC-75                 | NXP SEMI BC847T                    |
| 19                                 | 1   | RC1                      | RES, CHIP 13.7k, 1% 0603              | VISHAY CRCW060313K7FKEA            |
| 20                                 | 1   | ROSC                     | RES, CHIP 43.2k, 1% 0603              | VISHAY CRCW060343K2FKED            |
| 21                                 | 2   | R4, R10                  | RES, CHIP 10 $\Omega$ 5% 0603         | VISHAY CRCW060310R0JNEA            |
| 22                                 | 2   | RF, R17                  | RES, CHIP 0 $\Omega$ , Jumper 0603    | VISHAY CRCW06030000Z0EA            |
| 23                                 | 1   | R9                       | RES, CHIP 110k, 1% 0805               | VISHAY CRCW0805110KFKEA            |
| 24                                 | 1   | R1                       | RES, CHIP 12.4k, 1% 0603              | VISHAY CRCW060312K4FKEA            |
| 25                                 | 1   | R3                       | RES, CHIP 845k, 1% 0603               | VISHAY CRCW0603845KFKEA            |
| 26                                 | 1   | R11                      | RES, CHIP 249k, 1% 0603               | VISHAY CRCW0603249KFKEA            |
| 27                                 | 2   | R6, R8                   | RES, 0.005 $\Omega$ , 1/2W, 1%, 2010  | VISHAY WSL20105L000FEA             |
| 28                                 | 1   | R12                      | RES, CHIP 33k, 1% 0603                | VISHAY CRCW060333K0FKEA            |
| 29                                 | 1   | R13                      | RES, CHIP 220k, 1% 0603               | VISHAY CRCW0603220KFKEA            |
| 30                                 | 1   | R14                      | RES, CHIP 56k, 1% 0603                | VISHAY CRCW060356K0FKEA            |
| 31                                 | 2   | R15, R16                 | RES, CHIP 10k, 1% 0603                | VISHAY CRCW060310K0FKEA            |
| 32                                 | 1   | R19                      | RES, CHIP 100k, 1% 0603               | NIC NRC06F1003TRF                  |
| 33                                 | 1   | R20                      | RES, CHIP 180k, 1% 0603               | VISHAY CRCW0603180KFKEA            |
| 34                                 | 2   | T1,T2                    | COUPLED INDUCTOR, 6.8 $\mu$ H         | WÜRTH 7448709068                   |
| 35                                 | 1   | U1                       | PWM CONTROLLER LTC3862EFE-2           | LINEAR TECHNOLOGY LTC3862EFE-2     |

# DEMO MANUAL DC1891A

## PARTS LIST

| ITEM                                            | QTY | REFERENCE       | PART DESCRIPTION             | MANUFACTURER/PART NUMBER         |
|-------------------------------------------------|-----|-----------------|------------------------------|----------------------------------|
| <b>Additional Demo Board Circuit Components</b> |     |                 |                              |                                  |
| 1                                               | 0   | Q1, Q3 (OPT)    | MOSFET, PG-TDSON-8           |                                  |
| 2                                               | 0   | R18 (OPT)       | RES, CHIP 0603               |                                  |
| 3                                               | 0   | R7, R5 (OPT)    | RES, CHIP 2010               |                                  |
| <b>Hardware: For Demo Board Only</b>            |     |                 |                              |                                  |
| 1                                               | 6   | E3 TO E8        | TESTPOINT, TURRET, 0.094"    | MILL-MAX 2501-2-00-80-00-00-07-0 |
| 2                                               | 2   | E1, E2          | STUD, TEST PIN               | PEM KFH-032-10ET                 |
| 3                                               | 4   | E1, E2 (2 each) | NUT BRASS, # 10-32 M/S BR PL | ANY 10-32                        |
| 4                                               | 2   | E1, E2          | RING, LUG # 10               | KEYSTONE, 8205                   |
| 5                                               | 2   | E1, E2          | WASHER #10, TIN PLATED BRASS | ANY #10EXT BZ TN                 |
| 6                                               | 4   | JP1 TO JP4      | HEADER, 3PIN 1 ROW 0.079CC   | SULLINS NRPN031PAEN-RC           |
| 7                                               | 4   | JP1 TO JP4      | SHUNT, 0.079" CENTER         | SAMTEC 2SN-BK-G                  |
| 8                                               | 1   | SW1             | SWITCHE, SEALED TOGGLE       | C&K GT11MCBE (THRU-HOLE)         |
| 9                                               | 4   | STAND-OFF       | STAND-OFF, NYLON 0.50" TALL  | KEYSTONE 8833(SNAP ON)           |
| 10                                              | 1   |                 | FAB, PRINTED CIRCUIT BOARD   | DEMO CIRCUIT 1891A               |

SCHEMATIC DIAGRAM



# DEMO MANUAL DC1891A

---

## DEMONSTRATION BOARD IMPORTANT NOTICE

Linear Technology Corporation (LTC) provides the enclosed product(s) under the following **AS IS** conditions:

This demonstration board (DEMO BOARD) kit being sold or provided by Linear Technology is intended for use for **ENGINEERING DEVELOPMENT OR EVALUATION PURPOSES ONLY** and is not provided by LTC for commercial use. As such, the DEMO BOARD herein may not be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including but not limited to product safety measures typically found in finished commercial goods. As a prototype, this product does not fall within the scope of the European Union directive on electromagnetic compatibility and therefore may or may not meet the technical requirements of the directive, or other regulations.

If this evaluation kit does not meet the specifications recited in the DEMO BOARD manual the kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY THE SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THIS INDEMNITY, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user releases LTC from all claims arising from the handling or use of the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge. Also be aware that the products herein may not be regulatory compliant or agency certified (FCC, UL, CE, etc.).

No License is granted under any patent right or other intellectual property whatsoever. **LTC assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or any other intellectual property rights of any kind.**

LTC currently services a variety of customers for products around the world, and therefore this transaction **is not exclusive**.

**Please read the DEMO BOARD manual prior to handling the product.** Persons handling this product must have electronics training and observe good laboratory practice standards. **Common sense is encouraged.**

This notice contains important safety information about temperatures and voltages. For further safety concerns, please contact a LTC application engineer.

Mailing Address:

Linear Technology  
1630 McCarthy Blvd.  
Milpitas, CA 95035

Copyright © 2004, Linear Technology Corporation

dc1891af