

## DESCRIPTION

Demonstration circuit 1677A is a dual 60V monolithic 1A step-down regulator featuring the LT<sup>®</sup>3988. The demo board operates from inputs up to 60V. The outputs are 5V, 1A and 3.3V, 1A. The wide input range of the LT3988 allows a variety of input sources, such as commercial vehicle batteries and industrial supplies. The switching frequency can be programmed either via oscillator resistor or external clock over a 250kHz to 2.5MHz range. When the circuit is synchronized to an external clock connected to the SYNC terminal, the  $R_T$  resistor (R2) should be chosen to set the LT3988 internal switching frequency within  $\pm 25\%$  of the final SYNC frequency.

The LT3988 internal boost diodes and loop compensation reduce the components count and solution size. The current mode control scheme creates fast transient response and good loop stability. The EN/UVLO pin can be used to set the part in micropower shutdown mode, reducing the

supply current to less than  $2\mu\text{A}$ . Users can populate R1 and R3 to provide a programmable undervoltage lockout. Both channels have cycle-by-cycle current limit and diode current sense, providing protection against shorted outputs.

The LT3988 data sheet gives a complete description of the part, operation and application information. The data sheet must be read in conjunction with this demo manual for demo circuit 1677A. The LT3988 is assembled in a 16-lead plastic MSOP package with an exposed pad for low thermal resistance. Proper board layout is essential for both proper operation and maximum thermal performance. See the data sheet section PCB Layout and Thermal Considerations.

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

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

## PERFORMANCE SUMMARY ( $T_A = 25^\circ\text{C}$ )

PARAMETER	CONDITIONS	VALUE
Minimum Input Voltage		7V
Maximum Input Voltage		60V
Output Voltage $V_{OUT1}$	$V_{IN} = 7V \sim 60V$	$5V \pm 3\%$
Output Voltage $V_{OUT2}$	$V_{IN} = 7V \sim 60V$	$3.3V \pm 3\%$
Switching Frequency	$R_T = 200k$	$250kHz \pm 10\%$
Maximum Output Current $I_{OUT1}$	$V_{IN} = 7V \sim 60V$	1A
Maximum Output Current $I_{OUT2}$	$V_{IN} = 7V \sim 60V$	1A
Voltage Ripple $V_{OUT1}$	$V_{IN} = 12V, I_{OUT1} = 1A$	$< 30mV$
Voltage Ripple $V_{OUT2}$	$V_{IN} = 12V, I_{OUT2} = 1A$	$< 30mV$

## QUICK START PROCEDURE

Demonstration circuit 1677A is easy to set up to evaluate the performance of the LT3988. Refer to Figure 2 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 3 for the proper scope technique.

1. Place JP1 on the ON position and JP2 on the RT position.
2. With power off, connect the input power supply to  $V_{IN1}$  and GND. Also connect the same or another input power supply to  $V_{IN2}$  and GND.
3. With power off, connect loads from  $V_{OUT1}$  to GND and  $V_{OUT2}$  to GND.

4. Turn on the power at the inputs.

**NOTE:** Make sure that the input voltages do not exceed 60V.

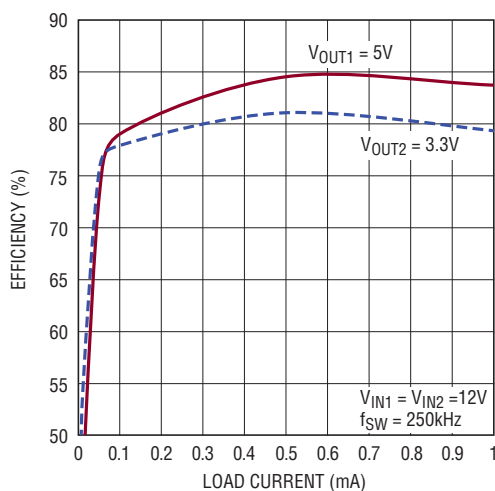
5. Check for the proper output voltages:

$$V_{OUT1} = 5V, V_{OUT2} = 3.3V.$$

**NOTE:** If there is no output, temporarily disconnect the load to make sure that the load is not set too high or is shorted.

6. Once the proper output voltages are established, adjust the loads within the operating ranges and observe the output voltage regulation, ripple voltage, efficiency and other parameters.

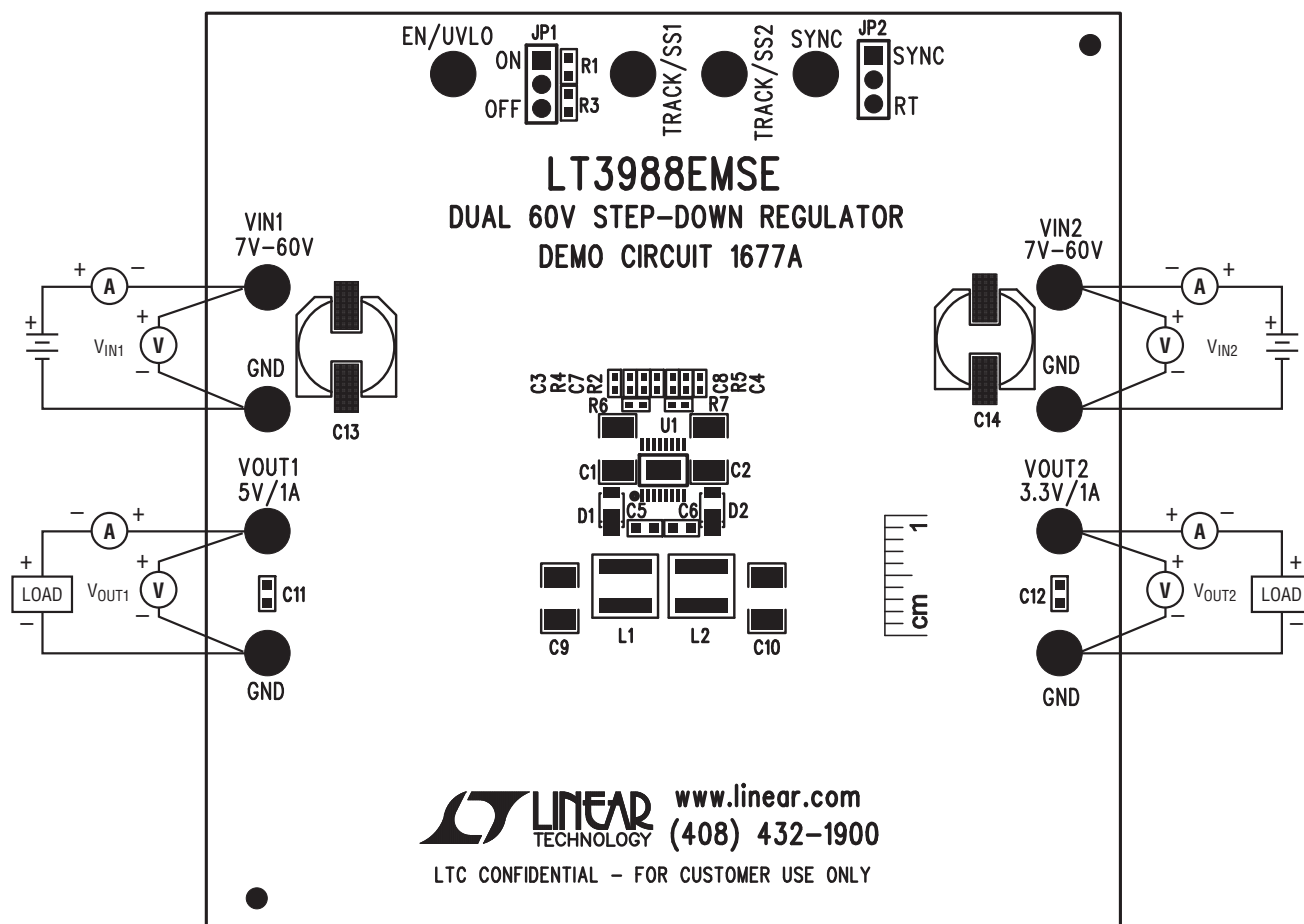
7. An external clock can be added to the SYNC terminal when SYNC function is used (JP2 on the SYNC position). Please make sure that  $R_T$  should be set to provide a frequency within  $\pm 25\%$  of the final SYNC frequency. See the data sheet section Switching Frequency.



DC1677a F01

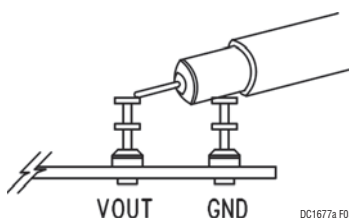
Figure 1. Efficiency vs Load Current

**QUICK START PROCEDURE**



DC1677a F02

Figure 2. Proper Measurement Equipment Setup



DC1677a F03

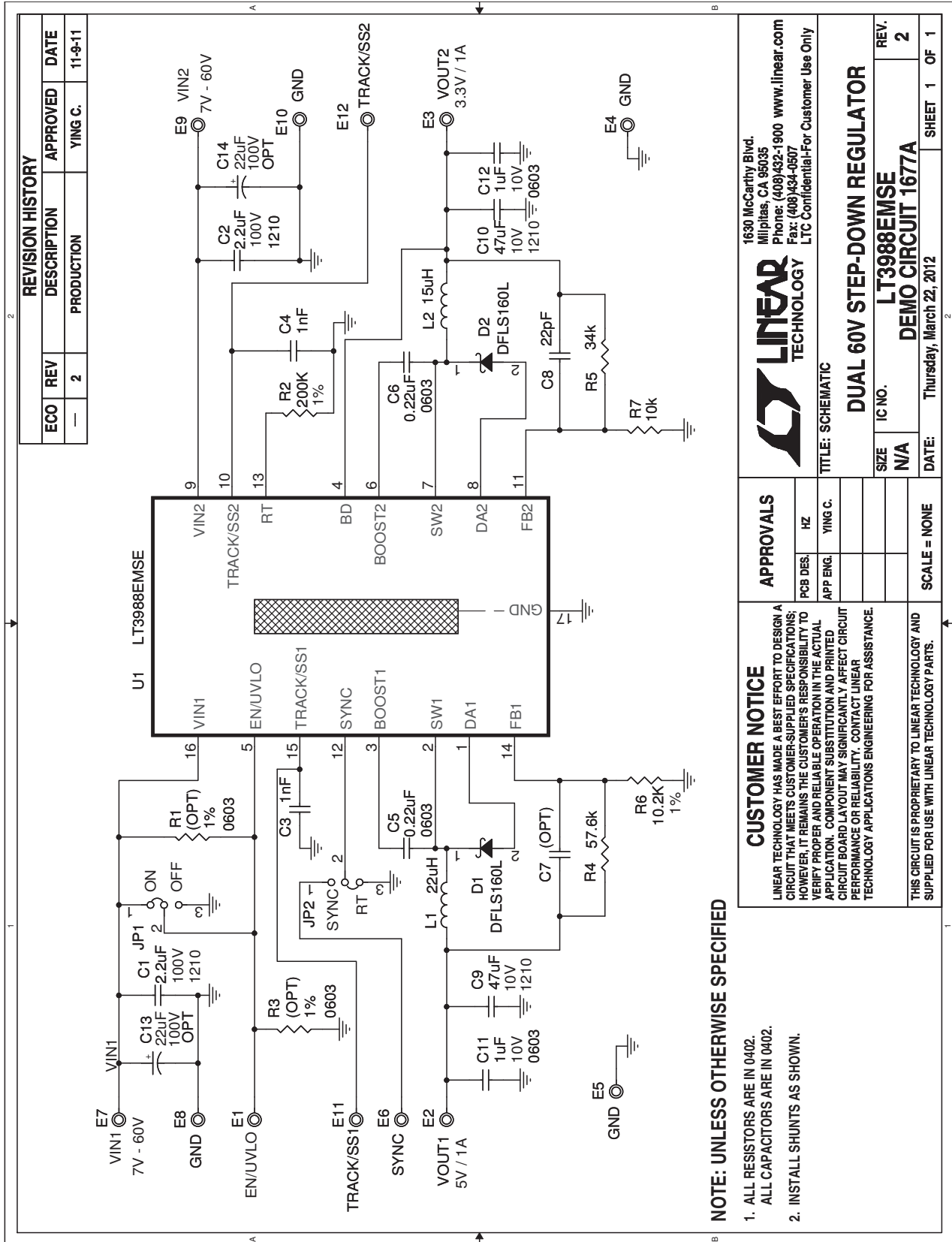
Figure 3. Measuring Input and Output Ripple

# DEMO MANUAL DC1677A

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Required Circuit Components</b>				
1	2	C1, C2	CAP, X7R, 2.2 $\mu$ F 100V, 20%, 1210	TDK, C3225X7R2A225M
2	2	C3, C4	CAP, X7R, 1000pF 50V, 5%, 0402	AVX, 04025C102JAT
3	2	C5, C6	CAP, X5R, 0.22 $\mu$ F 16V, 10%, 0603	AVX, 0603YD224KAT
4	1	C8	CAP, C0G, 22pF 16V, 0402, 5%	AVX, 0402YA220JAT2A
5	2	C9, C10	CAP, X7R, 47 $\mu$ F 10V, 1210	MURATA, GRM32ER71A476KE15L
6	2	C11, C12	CAP, X5R, 1 $\mu$ F 10V, 10%, 0603	AVX, 0603ZD105KAT2A
7	2	D1, D2	DIODE, SCHOTTKY 1.0A, POWERDI123	DIODE INC, DFLS160L
8	1	L2	IND, 15 $\mu$ H	COILCRAFT, XAL5050-153ME
9	1	L1	IND, 22 $\mu$ H	COILCRAFT, XAL5050-223ME
10	1	R2	RES, CHIP 200k 0402	VISHAY, CRCW0402200KFKEA
11	1	R4	RES, CHIP 57.6k 1%, 0402	VISHAY, CRCW040257K6FKEA
12	1	R5	RES, CHIP 34k 1%, 0402	VISHAY, CRCW040234K0FKEA
13	1	R7	RES, CHIP 10k 1%, 0402	VISHAY, CRCW040210K0FKEA
14	1	R6	RES, CHIP 10.2k 1%, 0402	VISHAY, CRCW040210K2FKEA
15	1	U1	IC, LT3988EMSE, MS16	LINEAR TECHNOLOGY, LT3988EMSE#PBF
<b>Additional Circuits</b>				
16	0	C13, C14 (OPT)	CAP, ALUM, 22 $\mu$ F 20% 100V, CE-BS	SUNCON, 100CE22BS
17	0	C7 (OPT)	CAP, 0402	
18	0	R1, R3 (OPT)	RES, CHIP 0603	
<b>Hardware (For Demo Board Only)</b>				
19	12	E1 TO E12	TESTPOINT, TURRET, 0.095"	MILL-MAX, 2501-2-00-80-00-00-07-0
20	2	JP1, JP2	2mm SINGLE ROW HEADER, 3 PIN	SAMTEC, TMM-103-02-L-S
21	2	JP1, JP2	SHUNT	SAMTEC, 2SN-BK-G

**SCHEMATIC DIAGRAM**



# DEMO MANUAL DC1677A

---

## 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