

# LTC3779

## High Voltage, High Efficiency 48V/10A Synchronous Buck-Boost Converter

### DESCRIPTION

Demonstration circuit 2456A is a high voltage, high efficiency synchronous buck-boost DC/DC converter with a 16V to 120V input voltage range. It can supply a 10A maximum load current with a 48V output. The demo board features the [LTC®3779EFE](#) controller. The constant frequency current mode architecture allows a phase-lockable frequency of up to 600kHz, while an optional output current feedback loop provides support for applications such as battery charging. With a wide input range, wide output range and seamless transfers between operation modes, the LTC3779 is ideal for Industrial, Automotive, Medical, Military and Avionics applications.

The light load operation mode of the converter is determined with the MODE pin. Use JP2 jumper to select pulse-skipping mode or forced continuous mode (CCM) operation. The switching frequency is pre-set at about 200kHz. The converter can also be externally synchronized to an external clock through the PLLIN pin (PLLIN terminal on the board). To shut down the converter, force the RUN pin below 1.2V (SW1: OFF). The power good output (PGOOD terminal) is low when the output voltage is outside of the  $\pm 10\%$  regulation window.

**Design files for this circuit board are available at <http://www.linear.com/demo/DC2456A>**

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

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

PARAMETER	CONDITION	VALUE
Input Voltage Range		16V to 120V
Output Voltage, $V_{OUT}$	$V_{IN} = 21\text{V to }120\text{V}$ , $I_{OUT} = 0\text{A to }10\text{A}$	48V $\pm 2\%$
Maximum Output Current, $I_{OUT}$	$V_{IN} = 21\text{V to }120\text{V}$ , $V_{OUT} = 48\text{V}$	10A
Default Operating Frequency		200kHz
Typical Efficiency	48V <sub>IN</sub> , 48V <sub>OUT</sub> , 10A	98.7%
	36V <sub>IN</sub> , 48V <sub>OUT</sub> , 10A	99.0%
	72V <sub>IN</sub> , 48V <sub>OUT</sub> , 10A	98.7%
Typical Output Ripple	48V <sub>IN</sub> , 48V <sub>OUT</sub> , 10A	480mV

## QUICK START PROCEDURE

Demonstration circuit 2456A is easy to set up to evaluate the performance of the LTC3779. Refer to Figure 1 for the proper measurement equipment setup and follow the procedure below:

1. With power off, connect the input power supply to  $V_{IN}$  (16V to 120V) and GND (input return).
2. Connect the 48V output load between  $V_{OUT}$  and GND (Initial load: no load).
3. Connect the DVMs to the input and the output.
4. Turn on the input power supply and then check for the proper output voltages.  $V_{OUT}$  should be  $48V \pm 2\%$ .
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.

Note: When measuring the output or input voltage ripple, do not use the long ground lead on the oscilloscope probe. See Figure 2 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.

Additional Note:

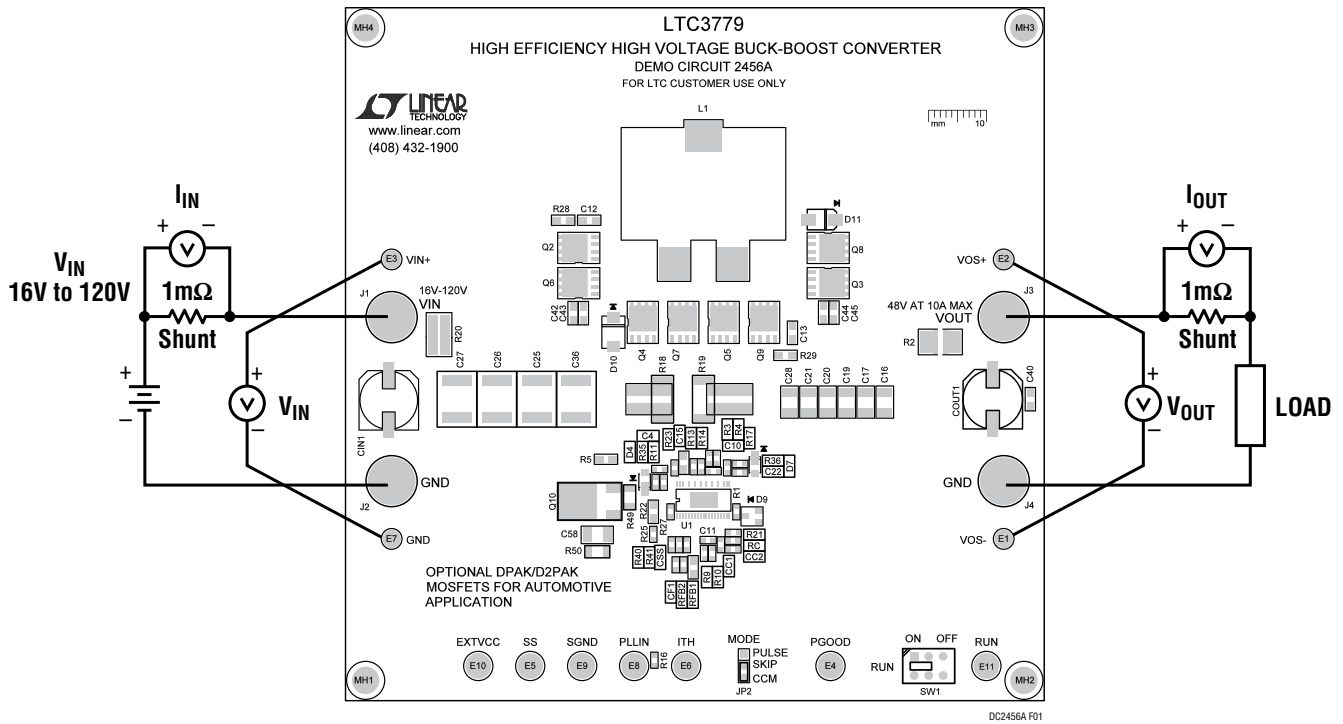
R2, R3, R4 and C10 is needed for additional/constant output current limit only. If this average current loop function is not used, short R2 and remove R3, R4 and C10; and then short IAVGSNSP and IAVGSNSN pins together, and tie them to V5.

## Output Current Derating

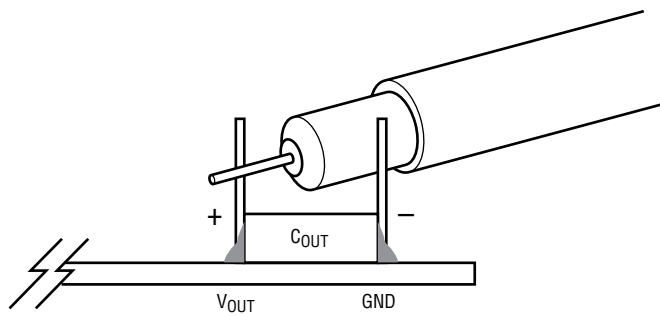
Demonstration circuit 2456A is designed to supply 48V output with a 10A maximum load current. Figure 3 shows the full load efficiency and loss vs. the input voltage. For thermal concern, hotspot temperature is limited below  $90^{\circ}\text{C}$  for input voltage range between 21V and 120V with 200LFM air flow. Figure 4 and Figure 5 show the thermal performance of Demonstration circuit 2456A with  $21V_{IN}$ ,  $48V_{OUT}$ , 10A load current and  $120V_{IN}$ ,  $48V_{OUT}$ , 10A load current, respectively. Further decreasing the input voltage below 21V with 10A load current is not recommended. For applications with input voltage range between 16V and 21V, the output current derating curve is shown as Figure 6. For input voltage range between 36V and 72V which is popular in Telecom Industry, Demonstration circuit 2456A can handle the 10A full load current without any forced air flow. Figure 7, Figure 8 and Figure 9 show the thermal performance at  $36V_{IN}$ ,  $48V_{IN}$  and  $72V_{IN}$ , respectively.

Besides the thermal performance, another limit factor for high output power capability is the saturation current of the power inductor. To supply  $48V_{OUT}$ , 10A load current with the input voltage below 21V,  $15\mu\text{H}$  inductor with P/N 60068 from Payton Planar Magnetics Ltd. is recommended. Please contact the manufacture for detail information. Figure 10 shows the thermal performance at  $18V_{IN}$ ,  $48V_{OUT}$ , 10A load current with 400LFM air flow. For applications with input voltage range between 16V and 18V, the output current derating curve is shown as Figure 6.

**QUICK START PROCEDURE**



**Figure 1. Proper Measurement Equipment Setup**



**Figure 2. Measuring Output Voltage Ripple**

## QUICK START PROCEDURE

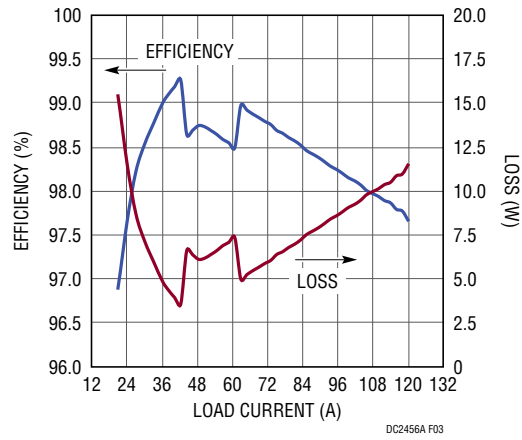


Figure 3. Efficiency and Loss vs Input Voltage ( $I_{OUT} = 10A$ )

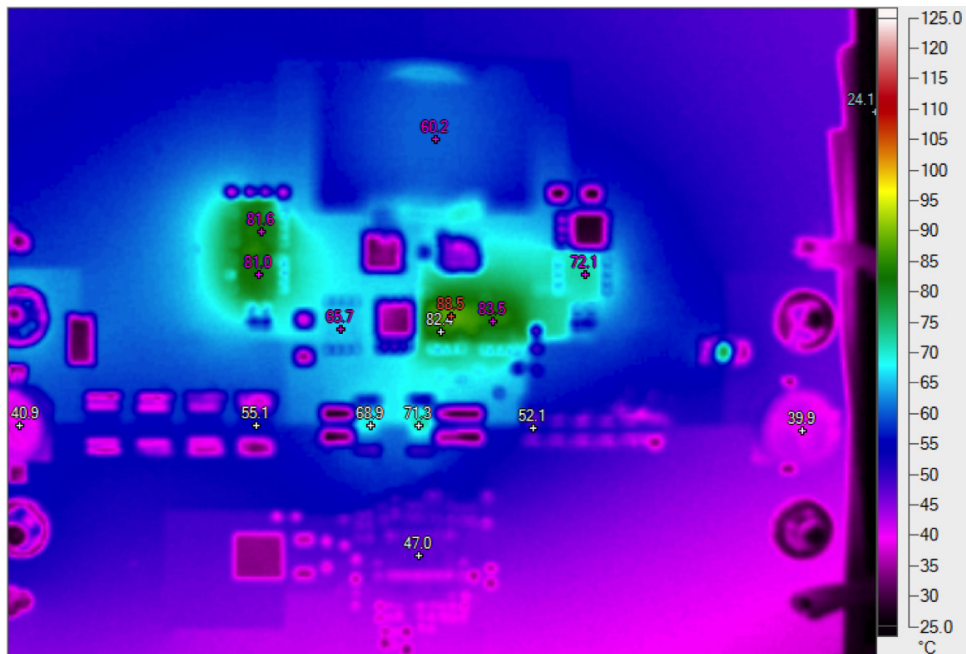
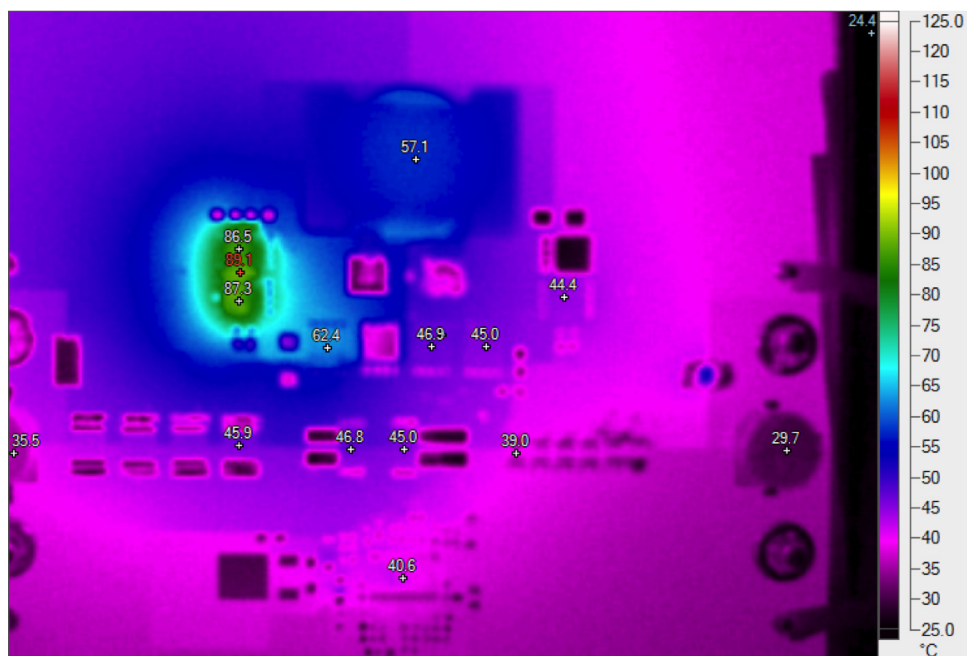
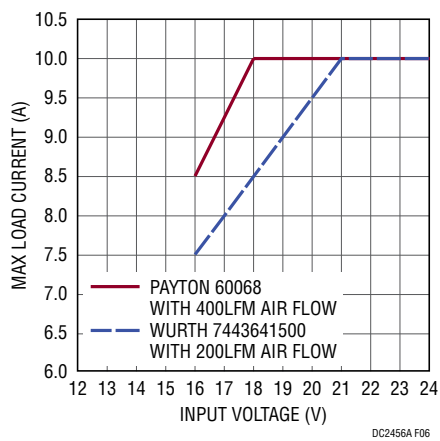


Figure 4. DC2456A Thermal Performance at  $21V_{IN}$ ,  $48V_{OUT}$ , 10A Load Current with 200LFM Air Flow

**QUICK START PROCEDURE**



**Figure 5. DC2456A Thermal Performance at 120V<sub>IN</sub>, 48V<sub>OUT</sub>, 10A Load Current with 200LFM Air Flow**



**Figure 6. DC2456A Output Current Derating vs Input Voltage ( $\Delta T_{MAX} = 65^{\circ}C$ )**

## QUICK START PROCEDURE

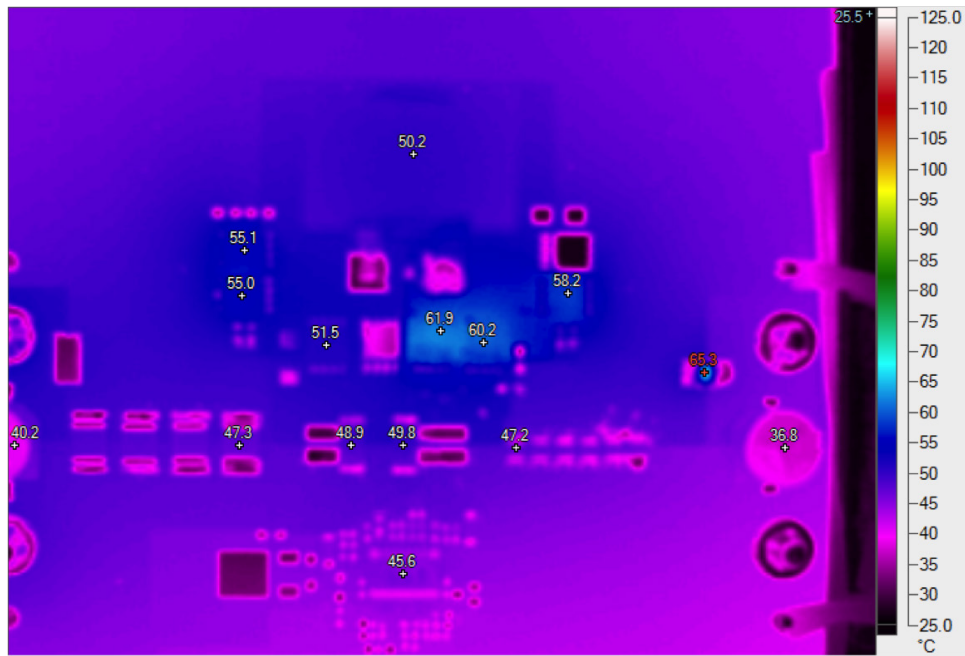


Figure 7. DC2456A Thermal Performance at 36V<sub>IN</sub>, 48V<sub>OUT</sub>, 10A Load Current with No Forced Air Flow

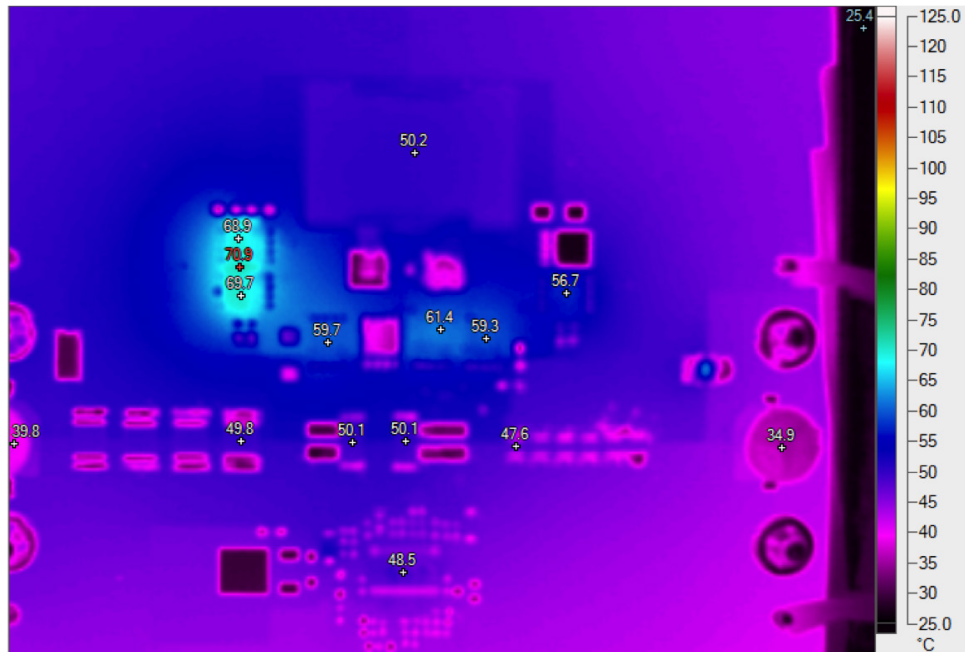
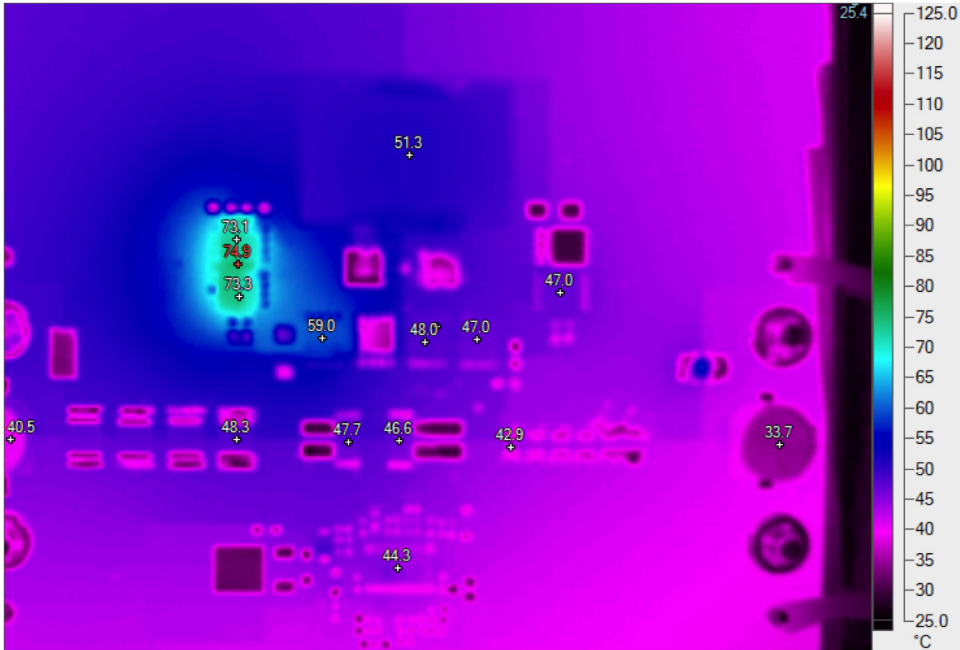


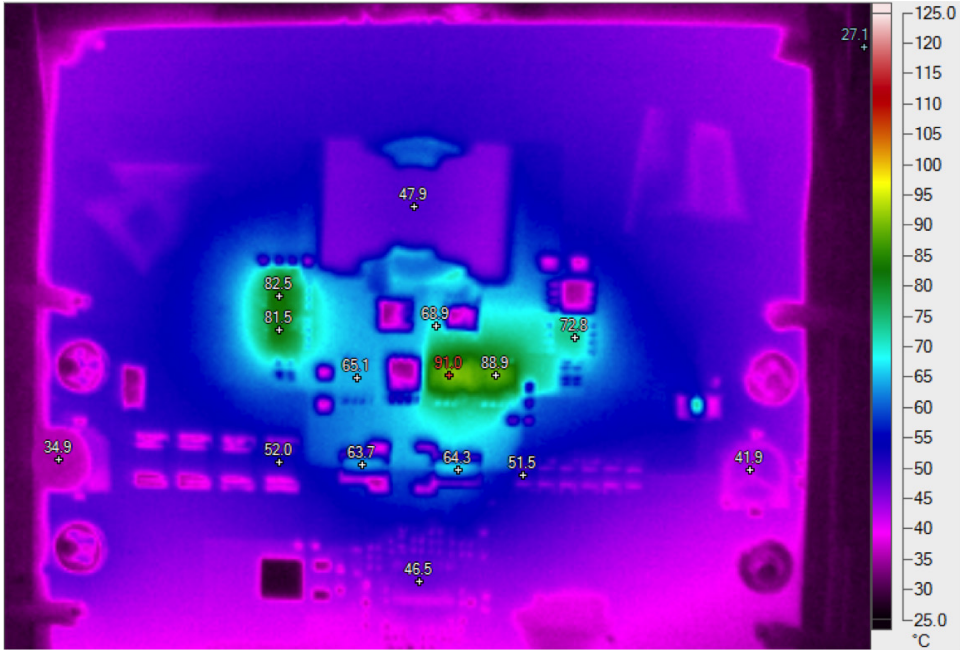
Figure 8. DC2456A Thermal Performance at 48V<sub>IN</sub>, 48V<sub>OUT</sub>, 10A Load Current with No Forced Air Flow



**QUICK START PROCEDURE**



**Figure 9. DC2456A Thermal Performance at 72V<sub>IN</sub>, 48V<sub>OUT</sub>, 10A Load Current with No Forced Air Flow**



**Figure 10. DC2456A Thermal Performance at 18V<sub>IN</sub>, 48V<sub>OUT</sub>, 10A Load Current with 400LFM Air Flow**

# DEMO MANUAL DC2456A

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
1	1	CC1	CAP, 0603 100pF 10% 50V C0G	AVX 06035A101KAT2A
2	1	CC2	CAP, 0603 10nF 10% 50V X7R	AVX 06035C103KAT2A
3	0	CF1	CAP, 0603 OPTION	OPTION
4	2	CIN1, CIN2	CAP, 10µF 20% 125V ELEC	SUNCON 125HVH10M
5	2	COUT1, COUT2	CAP, 56µF 20% 63V HYB POLYMER	UNITED CHEMI-CON HHXA630ARA560MJAO
6	2	C52, CSS	CAP, 0603 0.1µF 10% 50V X7R	AVX 06035C104KAT2A
7	2	C4, C22	CAP, 0603 0.22µF 20% 16V X7R	AVX 0603YC224MAT2A
8	0	C7, C8, C12, C13, C57	CAP, 0805 OPTION	OPTION
9	9	C9, C14, C25, C26, C27, C35, C36, C37, C48	CAP, 2220 1µF 10% 250V X7R	MURATA GRM55DR72E105KW01L
10	1	C10	CAP, 0603 4.7µF 10% 10V X5R	MURATA GRM188R61A475KE15D
11	1	C11	CAP, 0603 220pF 5% 100V C0G	MURATA GRM1885C2A221JA01D
12	6	C15, C40, C42, C43, C44, C45	CAP, 0805 0.1µF 10% 250V X7T	TDK CGA4J3X7T2E104K125AE
13	12	C16, C17, C19, C20, C21, C23, C28, C29, C30, C31, C32, C53	CAP, 1210 3.3µF 10% 50V X7R	AVX 12105C335K4T2A
14	1	C18	CAP, 1206 10µF 20% 6.3V X5R	AVX 1206D106MAT2A
15	1	C24	CAP, 0805 1µF 10% 50V X7R	AVX 08055C105KAT2A
16	0	C41, C46, C47, C54, C55	CAP, 0805 0.1µF 10% 250V X7T OPTION	TDK CGA4J3X7T2E104K125AE OPTION
17	1	C49	CAP, 0603 47nF 10% 50V X7R	MURATA GRM188R71H473KA61D
18	2	C50, C51	CAP, 1210 22µF 20% 16V X5R	AVX 1210YD226MAT2A
19	1	C56	CAP, 0603 1F 10% 50V X5R	TDK C1608X5R1H105K080AB
20	0	C58	CAP, 1210 OPTION	OPTION
21	2	D4, D7	DIODE, SCHOTTKY 1A 200V POWERDI123	DIODES INC. DFSL1200-7
22	1	D8	DIODE, ZENER 5.1V 350mW SOT23-3	DIODES INV. BZX84C5V1-7-F
23	0	D9	DIODE, OPTION	DIODES INC. BAS16-7-F OPTION
24	0	D10	DIODE, SCHOTTKY OPTION SMB	OPTION
25	0	D11	DIODE, SCHOTTKY OPTION SMA	OPTION
26	0	D12, D13	DIODE, SCHOTTKY OPTION POWERDI5	OPTION
27	4	E1, E2, E3, E7	TURRET	MILL-MAX 2308-2-00-80-00-00-07-0
28	7	E4, E5, E6, E8, E9, E10, E11	TURRET	MILL-MAX 2501-2-00-80-00-00-07-0
29	1	JP2	HEADER, 3PIN 2mm	SAMTEC TMM-103-02-L-S
30	4	J1, J2, J3, J4	JACK, BANANA	KEYSTONE 575-4
31	1	L1	IND, 15µH	WURTH 7443641500
32	0	L2	IND, OPTION	OPTION
33	1	L3	IND, 220µH	SUMIDA CDRH105RNP-221NC
34	4	MH1, MH2, MH3, MH4	STANDOFF, SNAP ON 9.525mm	KEYSTONE 8834
35	0	Q1, Q7, Q8	XSTR, OPTION	OPTION
36	2	Q2, Q6	XSTR, N-CHANNEL POWER MOSFET	INFINEON BSC110N15NS5
37	1	Q3	XSTR, N-CHANNEL POWER MOSFET	INFINEON BSC028N06NS
38	1	Q4	XSTR, N-CHANNEL POWER MOSFET	INFINEON BSC093N15NS5
39	2	Q5, Q9	XSTR, N-CHANNEL POWER MOSFET	INFINEON BSC066N06NS

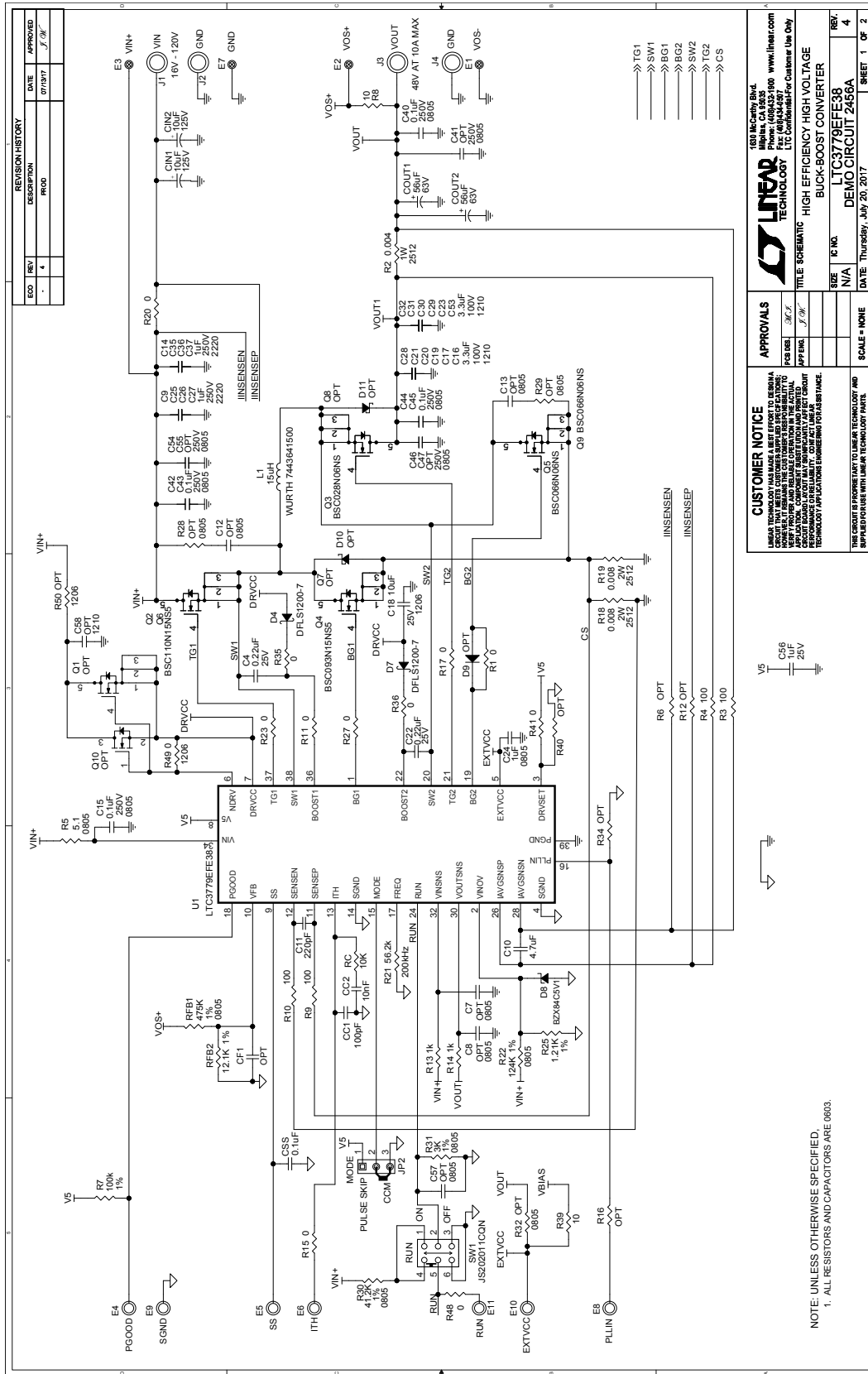


## PARTS LIST

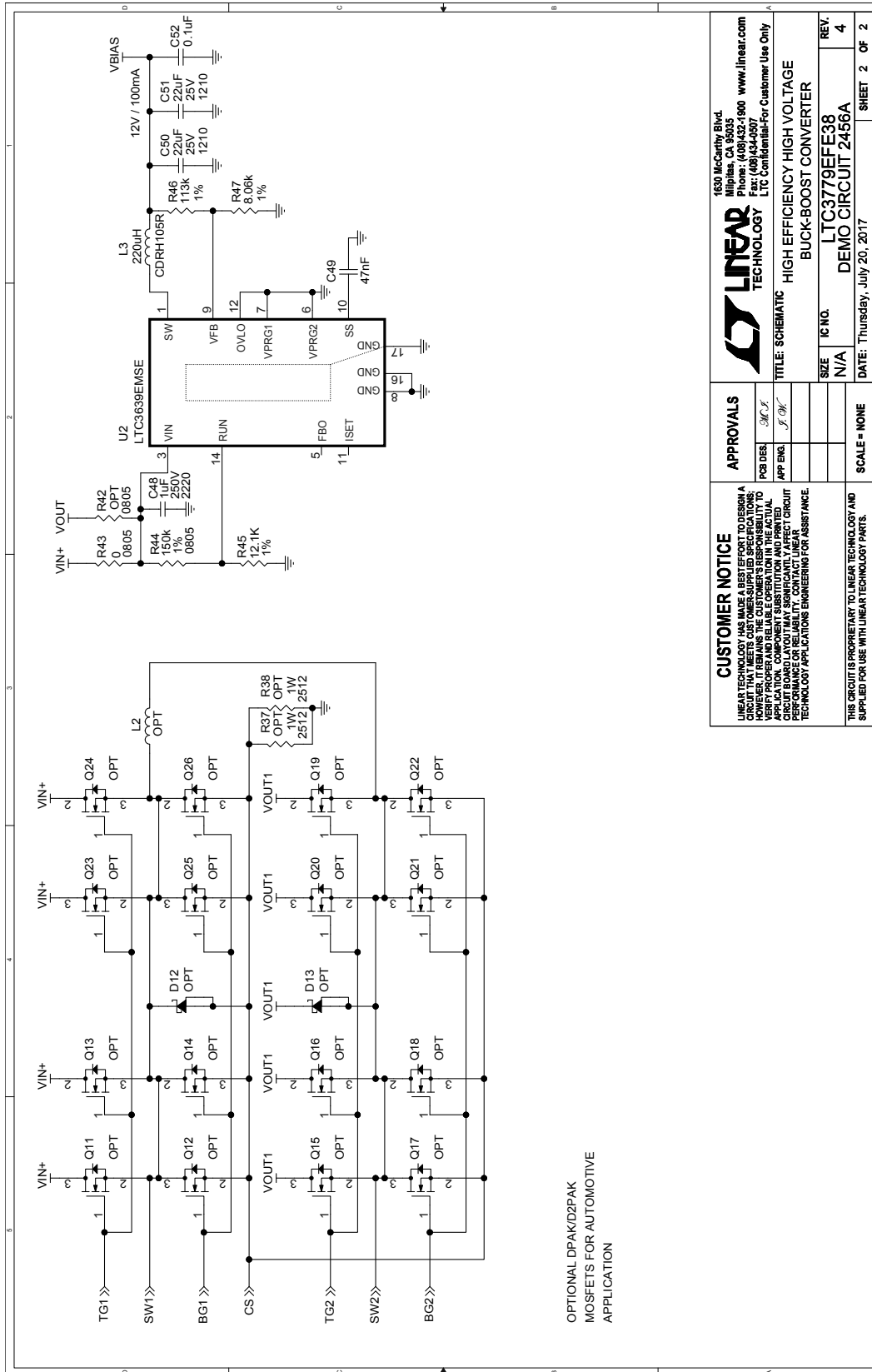
ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
40	0	Q11, Q12, Q13, Q14, Q15, Q16, Q17, Q18, Q19, Q20, Q21, Q22, Q23, Q24, Q25, Q26	AUTOMOTIVE MOSFET OPTION	OPTION
41	0	Q10	XSTR, OPTION TO-252	OPTION
42	1	RC	RES, 0603 10k $\Omega$ 5% 0.1W	VISHAY CRCW060310K0JNEA
43	1	RFB1	RES, 0805 475k $\Omega$ 1% 0.125W	VISHAY CRCW0805475KFKEA
44	2	RFB2, R45	RES, 0603 12.1k $\Omega$ 1% 0.1W	VISHAY CRCW060312K1FKEA
45	10	R1, R11, R15, R17, R23, R27, R35, R36, R41, R48	RES, 0 $\Omega$ JUMPER	VISHAY CRCW06030000Z0EA
46	1	R2	RES, 2512 0.004 $\Omega$ 1% 1W	PANASONIC ERJ-M1WSF4M0U
47	4	R3, R4, R9, R10	RES, 0603 100 $\Omega$ 1% 0.1W	VISHAY CRCW0603100RFKEA
48	1	R5	RE, 0805 5.1 $\Omega$ 5% 0.125W	VISHAY CRCW08055R10JNEA
49	0	R6, R12, R16, R34, R40	RES, 0603 OPTION	OPTION
50	1	R7	RES, 0603 100k $\Omega$ 1% 0.1W	VISHAY CRCW0603100KFKEA
51	2	R8, R39	RES, 0603 10 $\Omega$ 5% 0.1W	VISHAY CRCW060310R0JNEA
52	2	R13, R14	RES, 0603 1k $\Omega$ 1% 0.1W	VISHAY CRCW06031K00FKEA
53	2	R18, R19	RES, 2512 0.008 $\Omega$ 1% 2W	BOURNS CRE2512-FZ-R008E-2
54	1	R20	RES, 2512 0 $\Omega$ JUMPER	TEPRO RN5326
55	1	R21	RES, 0603 56.2k $\Omega$ 1% 0.1W	VISHAY CRCW060356K2FKEA
56	1	R22	RES, 0805 124k $\Omega$ 1% 0.125W	VISHAY CRCW0805124KFKEA
57	1	R25	RES, 0603 1.21k $\Omega$ 1% 0.1W	VISHAY CRCW06031K21FKEA
58	0	R28, R29, R32, R42	RES, 0805 OPTION	OPTION
59	1	R30	RES, 0805 41.2k $\Omega$ 1% 0.125W	VISHAY CRCW080541K2FKEA
60	1	R31	RES, 0805 3k $\Omega$ 1% 0.125W	VISHAY CRCW08053K00FKEA
61	0	R37, R38	RES, 2512 0.01 $\Omega$ 1% 1W OPTION	VISHAY WSL2512R0100FEA OPTION
62	1	R43	RES, 0805 0 $\Omega$ JUMPER	VISHAY CRCW08050000Z0EA
63	1	R44	RES, 0805 150k $\Omega$ 1% 0.125W	VISHAY CRCW0805150KFKEA
64	1	R46	RES, 0603 113k $\Omega$ 1% 0.1W	VISHAY CRCW0603113KFKEA
65	1	R47	RES, 0603 8.06k $\Omega$ 1% 0.1W	VISHAY CRCW06038K06FKEA
66	1	R49	RES, 1206 0 $\Omega$ JUMPER	VISHAY CRCW12060000Z0EA
67	0	R50	RES, 1206 OPT	OPTION
68	1	SW1	SWITCH, SUB-MINIATURE SLIDE 300mA 6V	C&K JS202011CQN
69	1	U1	IC, BUCK-BOOST CONVERTER	LINEAR TECH. LTC3779EFE38
70	1	U2	IC, SYNCHRONOUS STEP-DOWN REGULATOR	LINEAR TECH. LTC3639EMSE
71	1	XJP2	SHUNT 2mm	SAMTEC 2SN-BK-G

# DEMO MANUAL DC2456A

## SCHEMATIC DIAGRAM



**SCHEMATIC DIAGRAM**



OPTIONAL DPAK/D2PAK  
MOSFETS FOR AUTOMOTIVE  
APPLICATION

**LINEAR TECHNOLOGY**  
1630 McCarthy Blvd.  
Milpitas, CA 95035  
Phone: (408)432-1900 www.linear.com  
Fax: (408)434-9507  
LTC Confidential For Customer Use Only

**CUSTOMER NOTICE**  
LINEAR TECHNOLOGY HAS MADE A BEST EFFORT TO DESIGN A SCHEMATIC FOR THE CUSTOMER'S USE. HOWEVER, IT REMAINS THE CUSTOMER'S RESPONSIBILITY TO VERIFY PROPER AND RELIABLE OPERATION IN THE ACTUAL APPLICATION. THE CUSTOMER'S CHOICE OF COMPONENTS, CIRCUIT BOARD LAYOUT MAY SIGNIFICANTLY AFFECT CIRCUIT PERFORMANCE OR RELIABILITY. CONTACT LINEAR TECHNOLOGY APPLICATIONS ENGINEERING FOR ASSISTANCE.

**APPROVALS**

PCB DES.	J. M. J.
APP. ENG.	J. M. J.

**CUSTOMER NOTICE**  
THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.

**SCALE = NONE**

**SIZE** IC NO. **LTC379EFE38**

**REV.** **4**

**DATE:** Thursday, July 20, 2017

**SHEET 2 OF 2**

**TITLE:** SCHEMATIC HIGH EFFICIENCY HIGH VOLTAGE BUCK-BOOST CONVERTER

**DEMO CIRCUIT 2456A**

# DEMO MANUAL DC2456A

---

## 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