

LTC3887EUJ-1

Dual Output PolyPhase Step-Down DC/DC Converter with Digital Power System Management

DESCRIPTION

Demonstration circuit 2394A is a high current, high efficiency, dual output PolyPhase[®] synchronous buck converter featuring the LTC[®]3887EUJ-1, a dual-phase current mode controller. The LTC3887-1 has the PMBus interface and the power system management functions.

This demo board uses DrMOS devices in the power stage and operates over an input voltage range from 7V to 14V. The output voltage can be programmed from 0.8V to 1.8V (1V by default) with an output current of up to 30A per phase. The DC2394A is configured as dual output with DCR current sensing. It also has an on-board dynamic load circuit, which makes it easy to evaluate the transient performance.

The DC2394A powers up to default settings and produces power based on configuration resistors or with the configuration file loaded on its onboard EEPROM without the need for any serial bus communication. This allows easy evaluation of the DC/DC converter. To fully explore

the extensive power system management features of the LTC3887-1, download the GUI software LTpowerPlay[®] onto your PC and use LTC's I²C/SMBus/PMBus Dongle DC1613A to connect to the board. LTpowerPlay allows the user to reconfigure the part on the fly and store the configuration in EEPROM, view telemetry of voltage, current, temperature and fault status.

GUI DOWNLOAD

The software can be downloaded from:

<http://www.linear.com/ltpowerplay>

For more details and instructions of LTpowerPlay, please refer to "LTpowerPlay for LTC3880 Quick Start Guide".

Design files for this circuit board are available at
<http://www.linear.com/demo/DC2394A>

LT, LT, LTC, LTM, Linear Technology, PolyPhase, LTpowerPlay 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°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V _{IN}	Input Supply Range		7	12	14	V
F _{SW}	Factory Default Switching			350		kHz
V _{OUT0}	CH0 Output Voltage Range	I _{OUT0} = 0A TO 30A, V _{IN} = 7.0V to 14V	0.8	1.0	1.8	V
I _{OUT0}	CH0 Output Current Range		0		30	A
EFF	CH0 Full Load Efficiency	V _{IN} = 12V, V _{OUT0} = 1.0V, See Figures 4.		88.3		%
V _{OUT1}	CH1 Output Voltage Range	I _{OUT1} = 0A TO 30A, V _{IN} = 7.0V to 14V	0.8	1.0	1.8	V
I _{OUT1}	CH1 Output Current Range		0		30	A
EFF	CH1 Full Load Efficiency	V _{IN} = 12V, V _{OUT1} = 1.0V, See Figures 4.		88.3		%

QUICK START PROCEDURE

Demonstration circuit 2394A makes it easy to set up to evaluate the performances of the. Refer to Figure 2 for proper measurement equipment setup and follow the procedure below:

NOTE: Normal note text normal note text normal note text normal note text.

1. Make sure jumpers are in the following positions:

JUMPER	POSITION	FUNCTION
JP1	NC	GPIO0B to GPIO1B
JP2	NC	RUN0 to RUN1
JP3	INT	INT/EXT PULSE
JP4	OFF	EXTVCC_DRV
JP5	OFF	PULSE GENERATOR

2. With power off, connect the input power supply to V_{IN} and GND. Connect active load to the output.

3. Make sure both RUN switches (SW1, SW2) are OFF.

4. Turn on the power at the input.

NOTE. Make sure that the input voltage does not exceed 15V.

5. Turn on both SW2 (for RUN0), and SW1 (for RUN1) switches as desired.

6. Check for the correct output voltage from V_{OUT0}^+ (E6) to V_{OUT0}^- (E7) for CH0, V_{OUT1} (E8) to GND (E9) for CH1. $V_{OUT0}/V_{OUT1} = 1.0V \pm 0.5\%$ (1.005V ~ 0.995V)

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

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

8. Connect the dongle and control the output voltage from the GUI. See “LTpowerPlay QUICK START” session for details.

CONNECTING A PC TO DC2394A

You can use a PC to reconfigure the power management features of the LTC3887-1 such as: nominal V_{OUT} , margin set points, OV/UV limits, temperature fault limits, sequencing parameters, the fault log, fault responses, GPIO and other functionality. The DC1613A dongle may be plugged in regardless of whether or not V_{IN} is present. Dongle can be hot plugged.

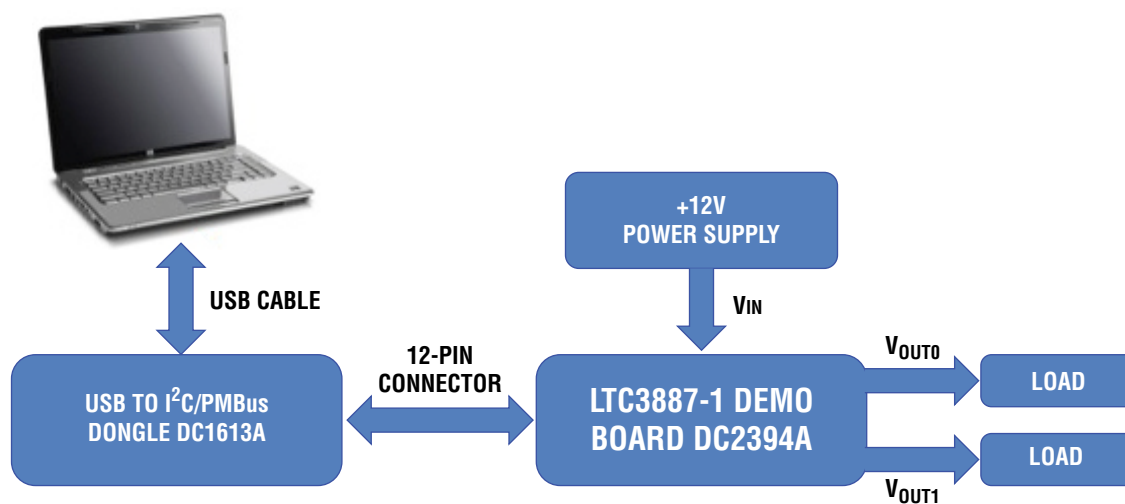


Figure 1. Demo Setup with PC

QUICK START PROCEDURE

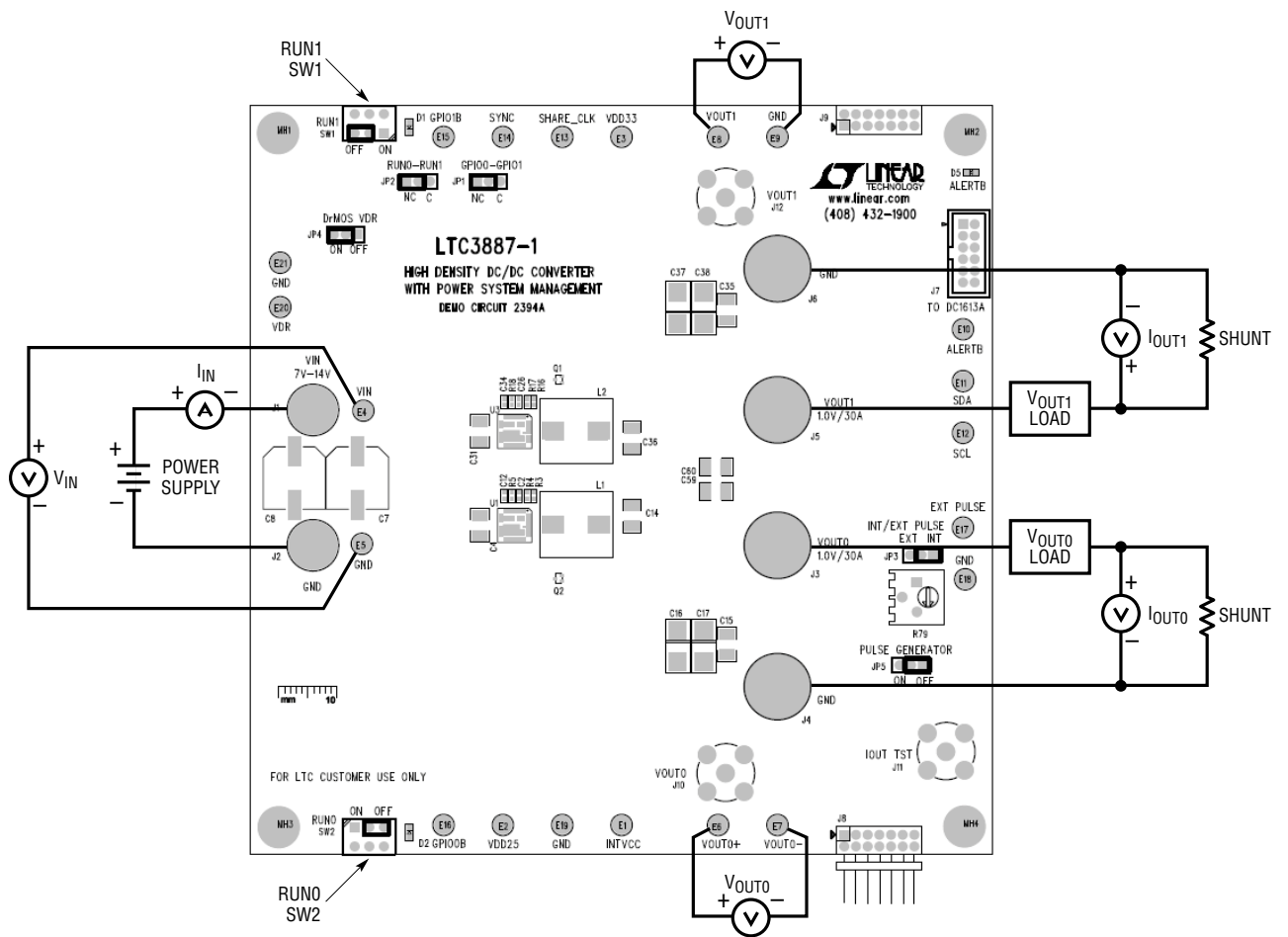


Figure 2. Power Test Setup

QUICK START PROCEDURE

MEASURING EFFICIENCY

To accurately measure efficiency of any configuration, do the following:

- Set JP4 to OFF position to disable the auxiliary circuits.
- Apply external 5V for VDR; record voltage and current;

- Measure V_{IN} across the input ceramic capacitor (C4 for CH0, C31 for CH1). Measure V_{OUT} across the output ceramic capacitor (C14 for CH0, C36 for CH1). Add external 5V loss into efficiency calculation.

MEASURING OUTPUT RIPPLE VOLTAGE

An accurate ripple measurement may be performed by using the below configuration across C14 for CH0, C36 for CH1.

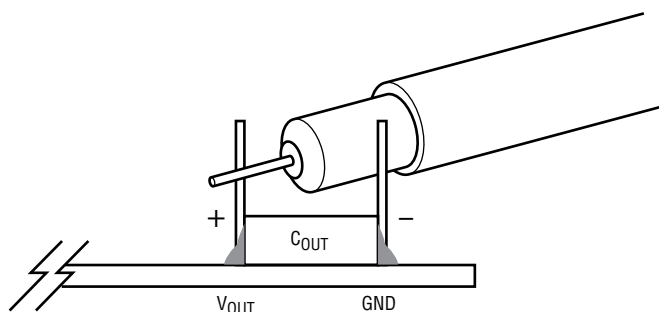


Figure 3. Measuring Output Voltage Ripple

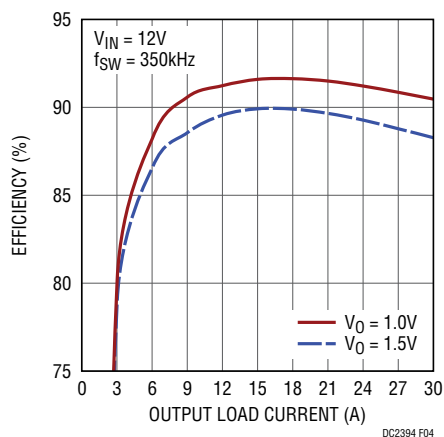


Figure 4. Typical Efficiency Curve of DC2394A, $V_{IN} = 12V$, $F_{SW} = 350kHz$

QUICK START PROCEDURE

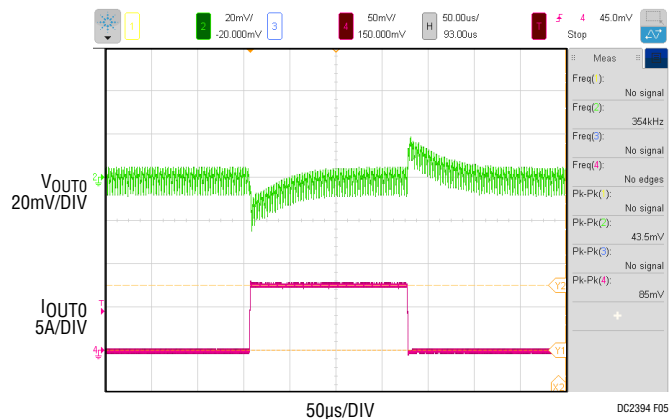


Figure 5. Load Transient Waveform of DC2394A, $V_{IN} = 12V$, $V_{OUT0} = 1.0V$, $F_{SW} = 350kHz$, 75% to 100% (7.5A) Load Step



Figure 6. Thermal Picture of DC2394A, $V_{IN} = 12V$, $V_{OUT0} = V_{OUT1} = 1.0V$, $I_{OUT0} = I_{OUT1} = 30A$, $F_{SW} = 350kHz$, No Airflow, $T_A = 25^\circ C$

LTpowerPlay SOFTWARE GUI

LTpowerPlay is a powerful Windows based development environment that supports Linear Technology® power system management ICs, including the LTC3880, LTC3883, LTC3882, LTC3887 and LTC3887-1. The software supports a variety of different tasks. You can use LTpowerPlay to evaluate Linear Technology ICs by connecting to a demo board system. LTpowerPlay can also be used in an offline mode (with no hardware present) in order to build a multichip configuration file that can be saved and reloaded at a later time. LTpowerPlay provides unprecedented diagnostic and debug features. It becomes a valuable diagnostic tool during board bring-up to program or tweak the power management scheme in a system, or to diagnose power

issues when bringing up rails. LTpowerPlay utilizes the DC1613A USB-to-SMBus controller to communicate with one of many potential targets, including the LTC3887-1's DC2394A demo system, or a customer board. The software also provides an automatic update feature to keep the software current with the latest set of device drivers and documentation. The LTpowerPlay software can be downloaded from:

<http://www.linear.com/ltpowerplay>

To access technical support documents for LTC Digital Power Products visit Help. View online help on the LTpowerPlay menu.

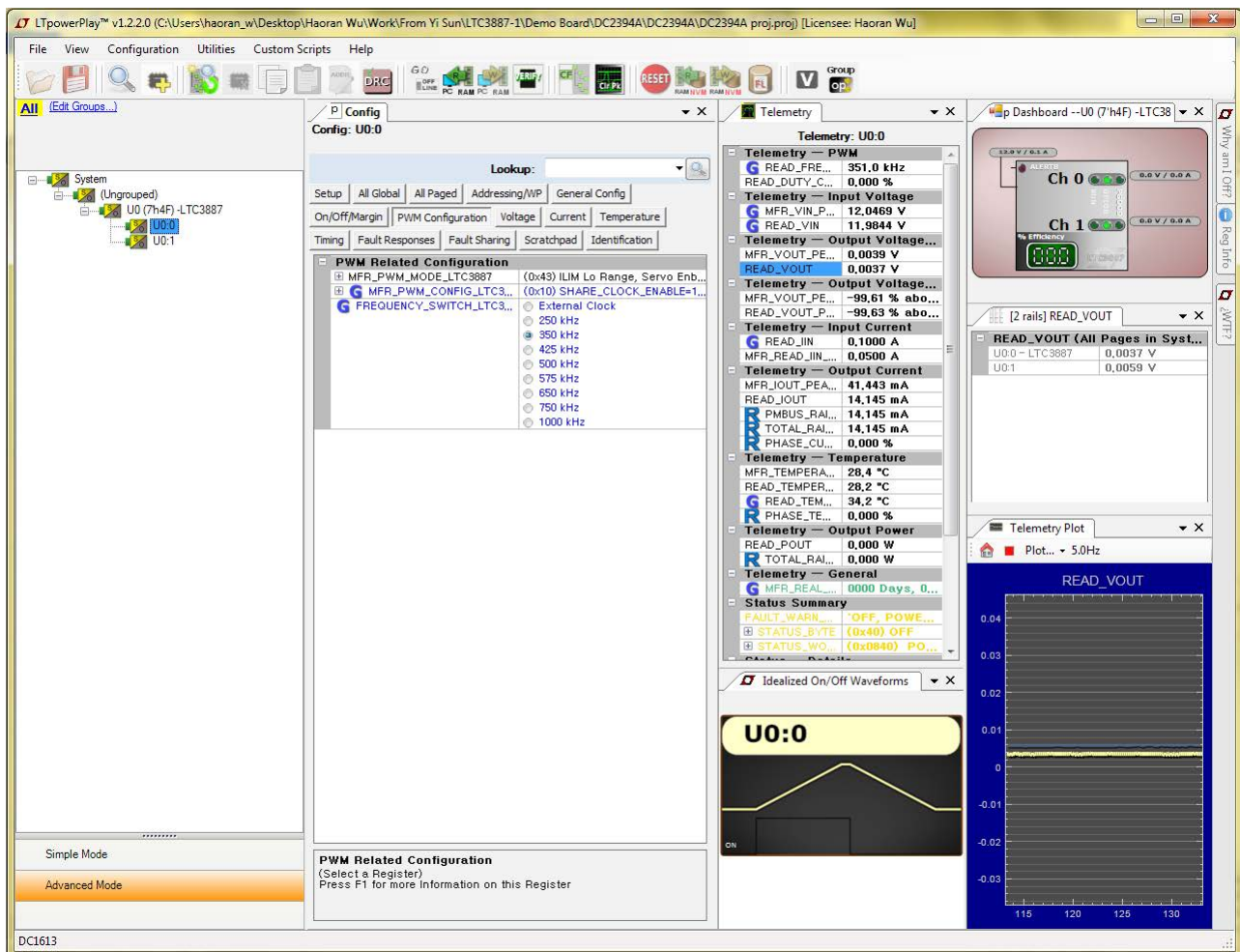


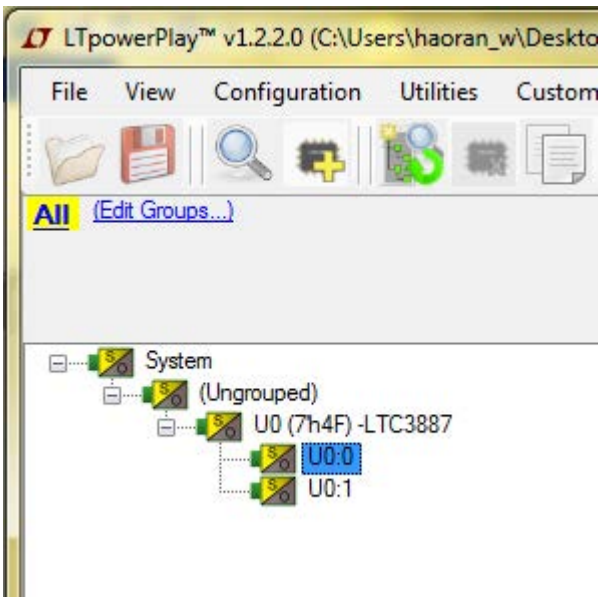
Figure 7. LTpowerPlay Main Interface*

* NOTE: In LTpowerPlay, LTC3887 and LTC3887-1 use the same template.

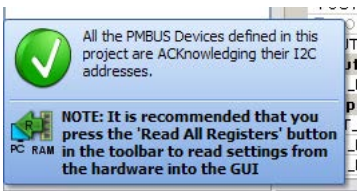
LTpowerPlay QUICK START PROCEDURE

The following procedure describes how to use LTpowerPlay to monitor and change the settings of LTC3887-1.

1. Download and install the LTpowerPlay GUI:
<http://www.linear.com/ltpowerplay>
2. Launch the LTpowerPlay GUI.
- a. The GUI should automatically identify the DC2394A. The system tree on the left hand side should look like this:



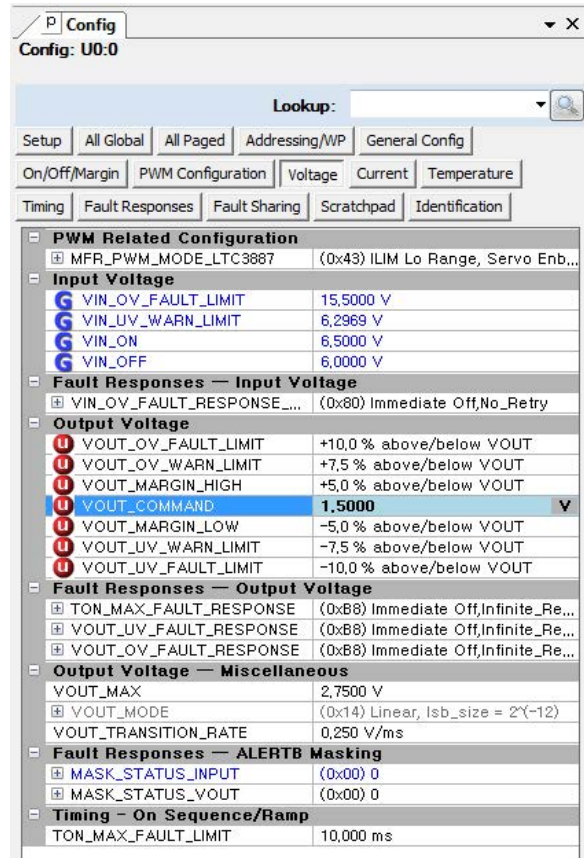
- b. A green message box shows for a few seconds in the lower left hand corner, confirming that the LTC3887-1 is communicating:



- c. In the Toolbar, click the “R” (RAM to PC) icon to read the RAM from the LTC3887-1. This reads the configuration from the RAM of LTC3887-1 and loads it into the GUI.



- d. If you want to change the output voltage to a different value, like 1.5V. In the Config tab, type in 1.5 in the VOUT_COMMAND box, like this:



Then, click the “W” (PC to RAM) icon to write these register values to the LTC3887-1. After finishing this step, you will see the output voltage will change to 1.5V.



If the write is successful, you will see the following message:



DEMO MANUAL DC2394A

LTpowerPlay QUICK START PROCEDURE

- e. You can save the changes into the NVM. In the tool bar, click “RAM to NVM” button, as following
- f. Save the demo board configuration to a (*.proj) file. Click the Save icon and save the file. Name it whatever you want.



PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	4	C4, C6, C31, C33	CAP., 22µF, X5R, 16V, 10%, 1210	MURATA, GRM32DR61C226KE18L
2	5	C5, C13, C39, C49, C51	CAP., 1µF, X5R, 16V, 10%, 0603	MURATA, GRM188R61C105KA93D
3	2	C7, C8	CAP., OS-CON, 330µF, 16V, 20%, F12	PANASONIC ELECTRONIC, 16SVP330M
4	4	C9, C18, C44, C47	CAP., 0.1µF, X7R, 16V, 10%, 0603	MURATA, GRM188R71C104KA01D
5	3	C10, C11, C56	CAP., 4.7µF, X5R, 16V, 10%, 0603	MURATA, GRM188R61C475KAAJD
6	12	C14, C15, C21, C22, C35, C36, C42, C43, C58, C59, C60, C61	CAP., X5R, 100µF, 6.3V, 20%, 1210	MURATA, GRM32ER60J107ME20L
7	8	C16, C17, C19, C20, C37, C38, C40, C41	CAP., POSCAP, 470µF, 2.5V, D2E SIZE	PANASONIC ELECTRONIC, 2R5TPE470M9
8	2	C23, C24	CAP., X7R, 2200pF, 25V, 10%, 0603	MURATA, GRM188R71E222KA01D
9	3	C28, C29, C50	CAP., NPO, 150pF, 50V, 5%, 0603	MURATA, GRM1885C1H151JA01D
10	2	L1, L2	IND., 0.17µH	PULSE., PA1320.171NL
11	2	R1, R12	RES., 24.9k, 1/16W, 1%, 0402	VISHAY, CRCW040224K9FKED
12	2	R2, R67	RES., 2Ω, 1/10W, 1%, 0603	VISHAY, CRCW06032R00FKEA
13	4	R3, R4, R16, R17	RES., 1k, 1/16W, 1%, 0402	VISHAY, CRCW04021K00FKED
14	2	R5, R18	RES., 0Ω, 1/16W, 0402	VISHAY, CRCW04020000Z0ED
15	4	R7, R8, R24, R25	RES., 2k, 1/10W, 1%, 0603	VISHAY, CRCW06032K00FKEA
16	6	R10, R13, R26, R49, R52, R55	RES., 0Ω, 1/10W, 0603	VISHAY, CRCW06030000Z0EA
17	2	R14, R15	RES., 17.8k, 1/10W, 1%, 0603	VISHAY, CRCW060317K8FKEA
18	2	U1, U3	I.C., MODULE, 60A, 31-LEAD, CLIP BOND PQFN, SPS, 5.0X5.0mm	FAIRCHILD SEMI., FDMF5820DC
19	1	U2	I.C., LTC3887-1EUJ#PBF, QFN, 6X6mm	LINEAR TECH., LTC3887EUJ-1#10E4-1PBF-ES
20	1	U4	I.C., EEPROM SERIAL-I ² C, 2k-BIT, TSSOP-8	MICROCHIP, 24LC025-I/ST
21	1	U5	I.C., LTC6992CS6-1, TSOT-23	LINEAR TECH., LTC6992CS6-1#PBF
22	1	U6	I.C., LT1803IS5, TSOT-23	LINEAR TECH., LT1803IS5#PBF
23	2	U7, U8	I.C., LT1129CS8-5, S8	LINEAR TECH., LT1129CS8-5#PBF
Additional Demo Board Circuit Components				
1	4	C1, C2, C25, C26,	CAP., 1µF, X5R, 16V, 10%, 0402	MURATA, GRM155R61C105KE01D
2	4	C3, C12, C27, C34,	CAP., 0.1µF, X5R, 16V, 10%, 0402	MURATA, GRM155R61C104KA88D
3	4	C30, C32, C45, C46	CAP., X7R, 0.01µF, 16V, 10%, 0603	MURATA, GRM188R71C103KA01D
4	2	C48, C55	CAP., X5R, 2.2µF, 16V, 10%, 0805	MURATA, GRM21BR61C225KA88L
5	1	C52	CAP., 4.7µF, X5R, 16V, 1206	MURATA, GRM31CR61C475KA01L
6	1	C53	CAP., 1µF, X7R, 16V, 10%, 0805	MURATA, GRM21BR71C105KA01L
7	2	C54, C57	CAP., 1µF, X5R, 16V, 10%, 1206	MURATA, GRM31MR61C105KA01L

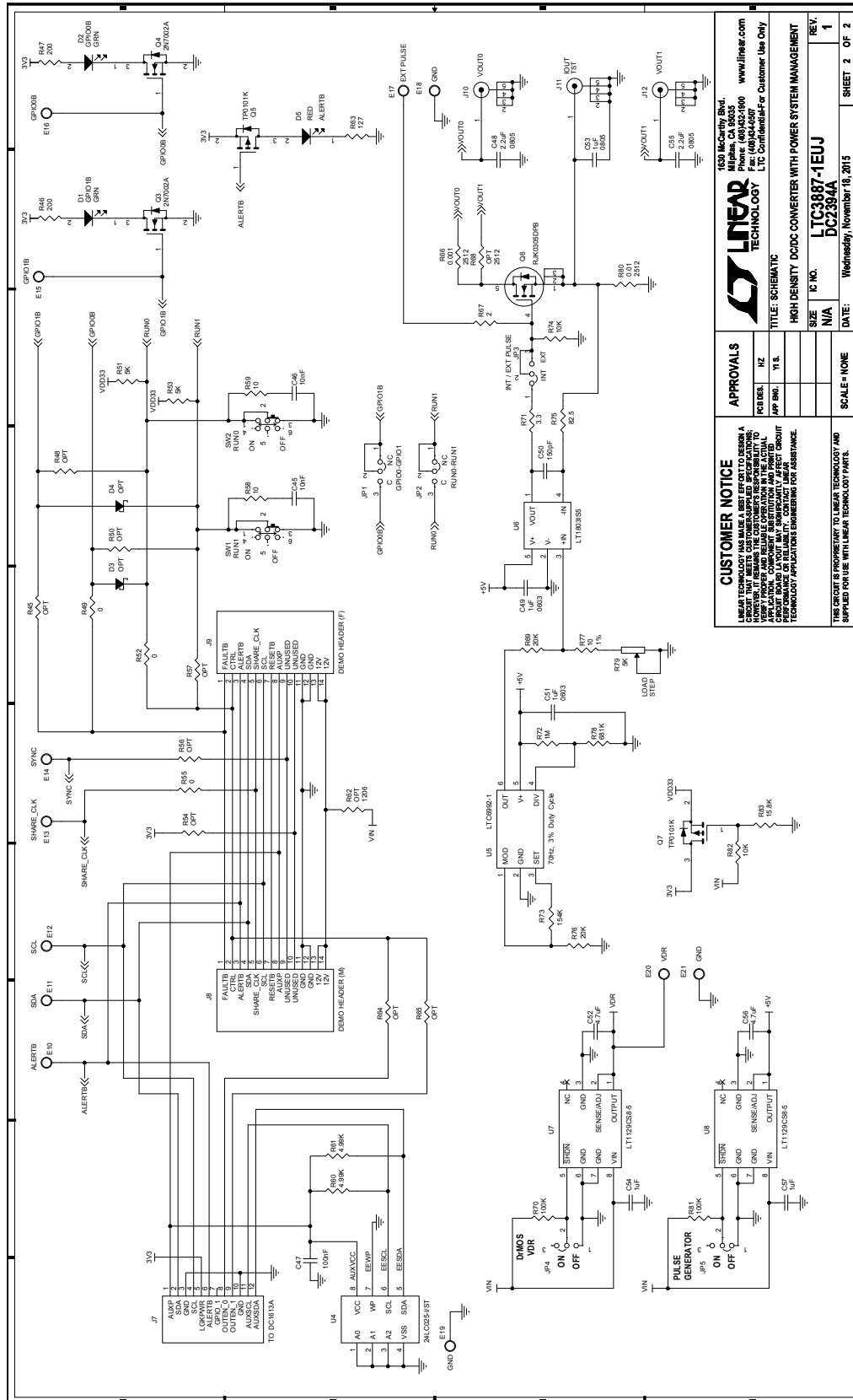
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
8	0	D3, D4	IND., OPTIONAL SOD-323	
9	2	D1, D2	SMT CHIP LED, GREEN	WURTH ELEKTRONIK, 150060GS75000
10	1	D5	SMT CHIP LED, RED	WURTH ELEKTRONIK, 150060RS75000
11	2	Q1, Q2	TRANS., PNP 40V 0.2A SC75-3 SOT-416	ON SEMI., MMBT3906TT1G
12	2	Q3, Q4	MOSFET, N-CH 60V 115MA SOT23-3	DIODES INC., 2N7002-7-F
13	2	Q5, Q7	MOSFET, P-CH 20V 0.58A SOT-23	VISHAY, SI2365EDS-T1-GE3
14	1	Q6	MOSFET, SPEED SRS 30V 30A LPAK	RENESAS, RJK0305DPB-02#J0
15	0	R6, R11, R21, R22, R23, R28, R30, R31, R33, R34, R36, R37, R39, R40, R45, R48, R50, R54, R56, R57, R62, R64, R65, R68	RES., OPTIONAL 0603	
16	11	R19, R20, R27, R29, R32, R35, R38, R51, R53, R60, R61	RES., 4.99k, 1/10W, 1%, 0603	VISHAY, CRCW06034K99FKEA
17	2	R46, R47	RES., 200Ω, 1/10W, 1%, 0603	VISHAY, CRCW0603200RFKEA
18	3	R58, R59, R77	RES., 10Ω, 1/10W, 1%, 0603	VISHAY, CRCW060310R0FKEA
19	1	R63	RES., 127Ω, 1/10W, 1%, 0603	VISHAY, CRCW0603127RFKEA
20	1	R66	RES., SENSE, 0.001Ω, 1W, 1%, 2512	PANASONIC, ERJM1WTF1M0U
21	2	R69, R76	RES., 20k, 1/10W, 1%, 0603	VISHAY, CRCW060320K0FKEA
22	2	R70, R81	RES., 100k, 1/10W, 1%, 0603	VISHAY, CRCW0603100KFKEA
23	1	R71	RES., 3.3Ω, 1/10W, 1%, 0603	VISHAY, CRCW06033R30FKEA
24	1	R72	RES., CHIP, 1M, 1%, 0603	VISHAY, CRCW06031M00FKEA
25	1	R73	RES., 154k, 1/10W, 1%, 0603	VISHAY, CRCW0603154KFKEA
26	2	R74, R82	RES., 10k, 1/10W, 1%, 0603	VISHAY, CRCW060310K0FKEA
27	1	R75	RES., 82.5Ω, 1/10W, 1%, 0603	VISHAY, CRCW060382R5FKEA
28	1	R78	RES., 681k, 1/10W, 1%, 0603	VISHAY, CRCW0603681KFKEA
29	1	R79	TRIMMER, 5kΩ 0.5W PC PIN	BOURNS, 3386P-1-502LF
30	1	R80	RES., SENSE, 0.01Ω, 1W, 1%, 2512	PANASONIC, ERJM1WSF10MU
31	1	R83	RES., 15.8k, 1/10W, 1%, 0603	VISHAY, CRCW060315K8FKEA

Hardware: For Demo Board Only

1	21	E1-E21	TEST POINT, TURRET, .064" MTG. HOLE	MILL-MAX, 2308-2-00-80-00-00-07-0
2	2	SW1, SW2	SWITCH, SLIDE DPDT 6VDC 0.3A PCMNT	C&K COMPONENTS, JS202011CQN
3	5	JP1-JP5	CONN., HEADER, 1X3, 2mm	WURTH ELEKTRONIK, 62000311121
4	2	J1, J2	JACK, BANANA	KEYSTONE, 575-4
5	8	J3-J6 (x 2)	STUD, TEST PIN	PEM KFH-032-10
6	8	J3-J6 (x 2)	NUT, BRASS 10-32	ANY, #10-32M/S
7	4	J3-J6	RING, LUG #10	KEYSTONE, 8205
8	4	J3-J6	WASHER, TIN PLATED BRASS	ANY, #10
9	1	J7	CONN. HEADER 12 POS 2mm STR DL PCB	FCI, 98414-G06-12ULF
10	1	J8	CONN., HEADER, 2X7, 2mm, R/A (M)	MOLEX, 87760-1416
11	1	J9	CONN., HEADER, 2X7, 2mm, R/A (F)	SULLINS, NPPN072FJFN-RC
12	3	J10, J11, J12	CONN, BNC, 5 PINS	CONNEX, 112404
13	3	XJP1, XJP2, XJP5	SHUNT, 2mm	WURTH ELEKTRONIK, 60800213421
14	4	MT1, MT2, MT3, MT4	STANDOFF, NYLON, SNAP-ON, 0.500"	WURTH ELEKTRONIK, 702936000

SCHEMATIC DIAGRAM



LINEAR TECHNOLOGY
 1630 McCarthy Blvd.
 Milpitas, CA 95035-5000
 Phone: (408) 432-5000
 Fax: (408) 434-6507
 www.linear.com
 LTC Confidential or Customer Use Only

CUSTOMER NOTICE
 LINEAR TECHNOLOGY HAS MADE A BEST EFFORT TO DESIGN A DEMO BOARD THAT IS FUNCTIONAL AND RELIABLE. HOWEVER, IT BEING THE CUSTOMER'S RESPONSIBILITY TO VERIFY A PROPER AND RELIABLE OPERATION IN THE ACTUAL APPLICATION. LINEAR TECHNOLOGY DOES NOT WARRANT THE CIRCUIT BOARD OR BOARD LAYOUT MAY SIGNIFICANTLY AFFECT CIRCUIT PERFORMANCE IN THE CUSTOMER'S APPLICATION. CONTACT YOUR TECHNOLOGY APPLICATIONS ENGINEERING FOR ASSISTANCE.

APPROVALS

DESIGNER	NZ
APP. ENG.	Y.S.
SCALE	NONE

TITLE: SCHEMATIC
HIGH DENSITY DC/DC CONVERTER WITH POWER SYSTEM MANAGEMENT

IC NO. **LTC3887-1EUJ**
DC2394A

DATE: **Wednesday, November 18, 2015**

REV: **1**
 SHEET 2 OF 2



Information furnished by Linear Technology Corporation is believed to be accurate and reliable. However, no responsibility is assumed for its use. Linear Technology Corporation makes no representation that the interconnection of its circuits as described herein will not infringe on existing patent rights.

DEMO MANUAL DC2394A

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