

LTC3880EUJ

Dual Phase Step-Down DC/DC Controller with Digital Power Management

DESCRIPTION

Demonstration circuit 1753B is a dual phase single-output, synchronous buck converter featuring the LTC[®]3880EUJ, a dual phase current mode controller with digital power system management. There are two versions of the board available:

- DC1753B-A: senses inductor current across a sense resistor and has a default switching Freq of 350kHz.
- DC1753B-B: senses inductor current with the inductor DCR and has a default switching Freq of 425kHz.

Either version can be populated with the LTC3880EUJ-1, which allows the user to provide bias power to the IC from an external power supply.

The output voltage of the board can be programmed from 0.5V to 3.3V, with output current up to 40A. The factory default setting for the output is 1.8V.

The DC1753B powers up to default settings and produces power based on configuration resistors without the need for any serial bus communication. This allows easy

evaluation of the DC/DC converter aspects of the LTC3880. To fully explore the extensive digital power management features of the part, download the LTpowerPlay™ GUI software 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 the LTpowerPlay for LTC3880 Quick Start Guide.

Design files for this circuit board are available at
<http://www.linear.com/demo/DC1753B>

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PERFORMANCE SUMMARY Specifications are at T_A = 25°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V _{IN}	Input Supply Range		6.5	12	24	V
V _{OUT}	Output Voltage Range	I _{OUT} = 0A to 20A, V _{IN} = 6.5V to 24V	0.5	1.8	3.3	V
V _{OUT_ACCURACY}	Output Voltage Accuracy	I _{OUT} = 0A to 20A, V _{IN} = 6.5V to 24V V _{OUT} for 0.5V to 3.3V		±0.5		%
I _{OUT}	Output Current Range		0		40	A
f _{SW, A}	Factory Default Switching, Freq: A (R _{SENSE})			350		kHz
f _{SW, B}	Factory Default Switching, Freq: B (DCR)			425		kHz
EFFICIENCY	Peak Efficiency	V _{OUT} = 1.8V, See Figures 6 and 7		91.8		%

QUICK START PROCEDURE

Demonstration circuit 1753B makes it easy to evaluate the performance of the LTC3880. Refer to Figure 3 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 output voltage ripple by touching the probe tip directly across the C20 or C23. See Figure 5 for the proper scope probe technique.

1. Make sure jumpers are in the following positions:

JUMPER	POSITION	FUNCTION
JP1	OFF	Write Protection of LTC3880
JP3	ON	LED Indicator
JP4	OFF	EXTVCC_DRV: External V _{CC} for the LTC3880-1
JP5	C	GPIO0B to GPIO1B: Tie GPIOs Together

2. With power off, connect the input power supply to V_{IN} and GND. Connect active load to outputs.
3. Make sure RUN switch is OFF.
4. Turn on the power at the input.

NOTE: Make sure that the input voltage does not exceed 24V.

5. Turn on the RUN switch as desired.
6. Check for the correct output voltages. V_{OUT} = 1.8V ± 0.5%.

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 voltages are 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 voltages from the GUI. See next section for details.

CONNECTING A PC TO DC1753B

You can use a PC to reconfigure the power management features of the LTC3880, such as: nominal V_{OUT}, margin set points, OV/UV limits, temperature fault limits, sequencing parameters, the fault log, fault responses, GPIOs and other functionality. The DC1613A dongle may be plugged in regardless of whether or not V_{IN} is present.

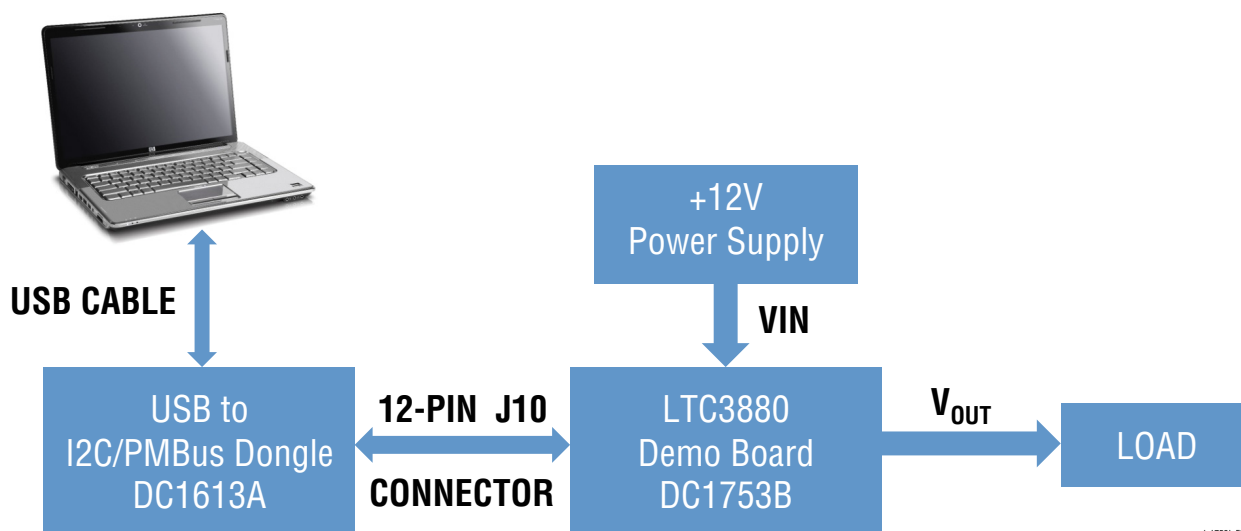


Figure 1. Demo Setup with PC

dc1753b-f01

QUICK START PROCEDURE

Plug the dongle into the correct connector. The dongle can be hot plugged.

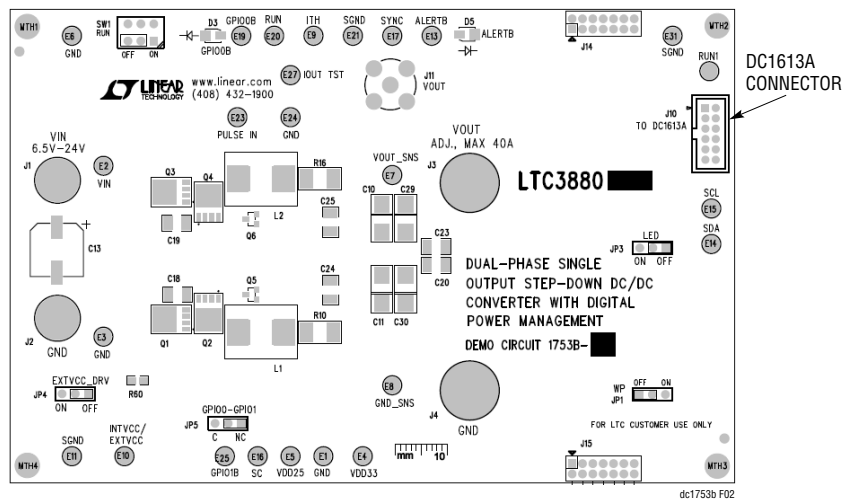


Figure 2. Dongle Connector Locations

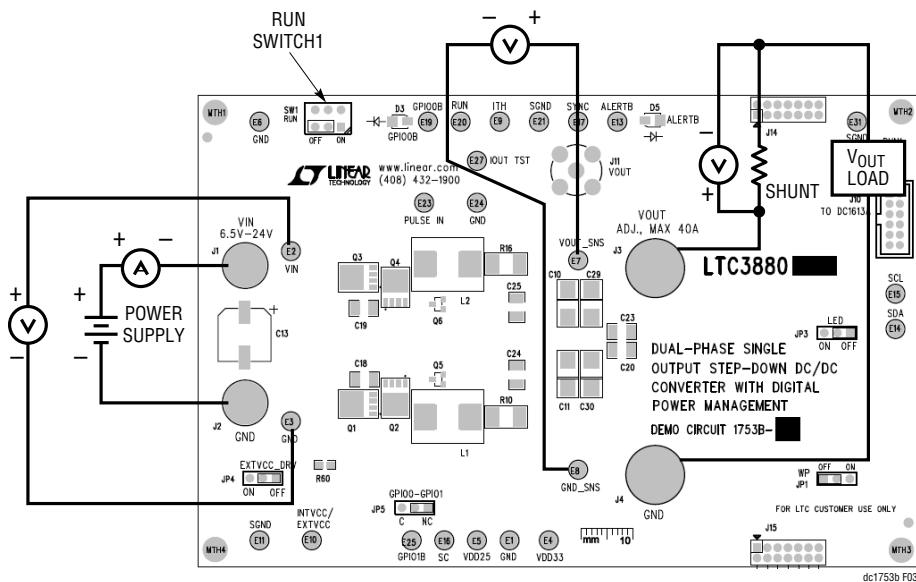


Figure 3. Dual Phase Single-Output Test Setup

QUICK START PROCEDURE

Combining DC1753B with Other Digital Power Demo Boards

The DC1753B may be plugged together in a multiboard array with other digital power boards using J7 and J8.

Measuring Efficiency

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

- Remove R65 (bleeder resistor on bottom side of board).
- Set JP3 to OFF to disable the regulator that provides power to LEDs.
- Measure VIN across the input ceramic capacitor (C18, C19). Measure VOUT across the output ceramic capacitor (C24, C25).

Evaluating the LTC3880-1

For applications that require the highest possible efficiency, the LTC3880-1 allows the user to supply the bias current and gate driver current from an external power supply. Connect the power supply, 4.8V to 5.2V, to the INTVCC/EXTVCC pin. Obtain a DC1753B with an LTC3880-1 installed from your Linear Technology Field Applications Engineer.

To use the on-board LDO to drive INTVCC, make the following modifications to the demo board:

- Set JP4 to ON so that U7 provides the drive to INTVCC. U7 takes the place of the external power supply.
- Install R60.

To accurately measure efficiency of a demo board containing an LTC3880-1:

- Drive INTVCC from an external source through the pin named: INTVCC/EXTVCC. Install R60, R65 if installed
- Set JP4 to OFF to disable U7.
- Set JP3 to OFF to disable the regulator that provides power to LEDs.
- Measure VIN across the input ceramic capacitor (C18, C19). Measure VOUT across the output ceramic capacitor (C24, C25).

Measuring Output Ripple Voltage

An accurate ripple measurement may be performed by using the configuration in Figure 5 across C20 or C23.

QUICK START PROCEDURE

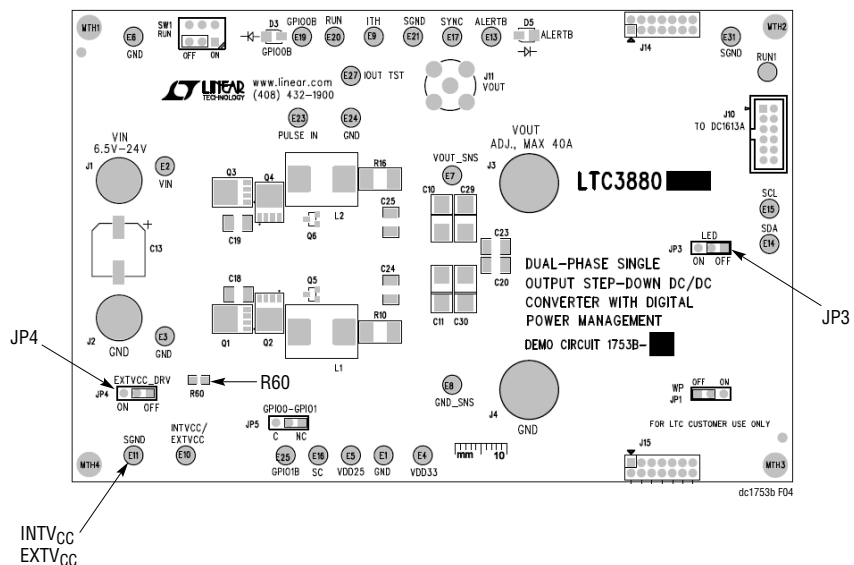


Figure 4. Jumper Locations: JP3, JP4, R60, INTVCC/EXTVCC Turret

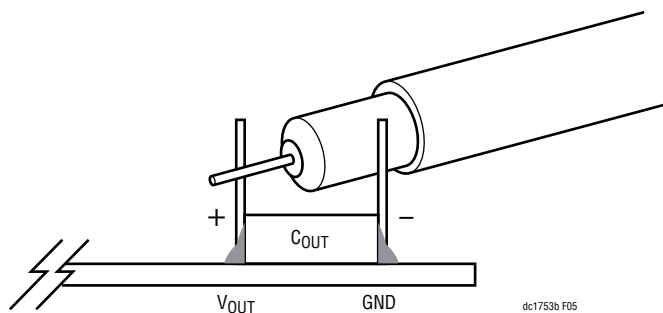


Figure 5. Measuring Output Voltage Ripple

QUICK START PROCEDURE

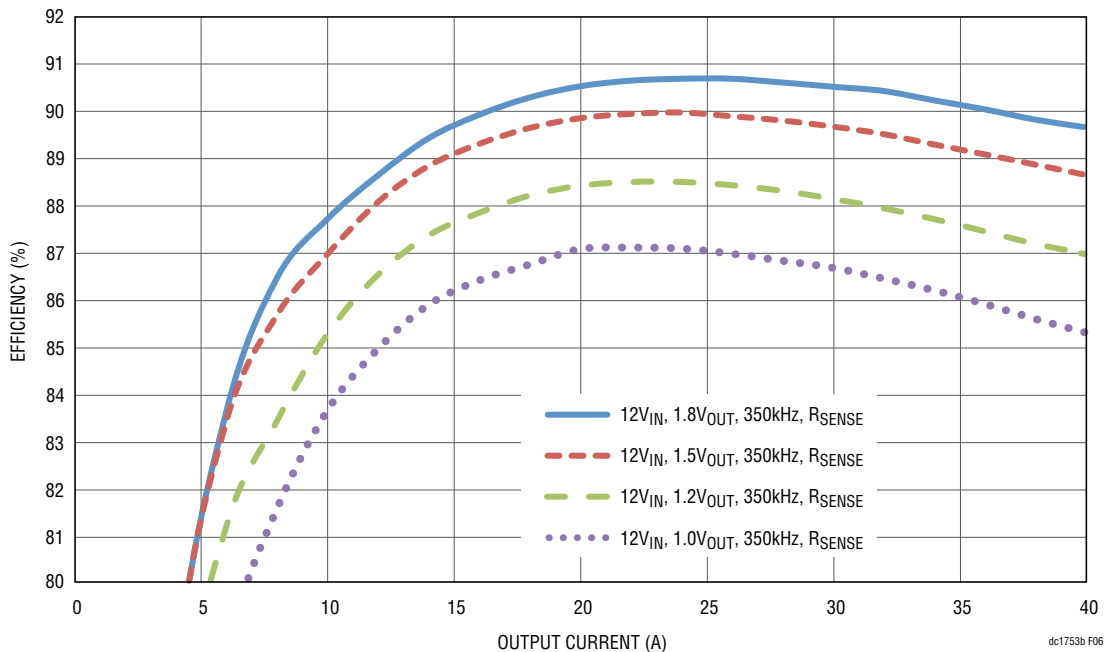


Figure 6. Typical Efficiency Curves, Sense Resistor Current Sensing, 12V_{IN}, f_{SW} = 350kHz

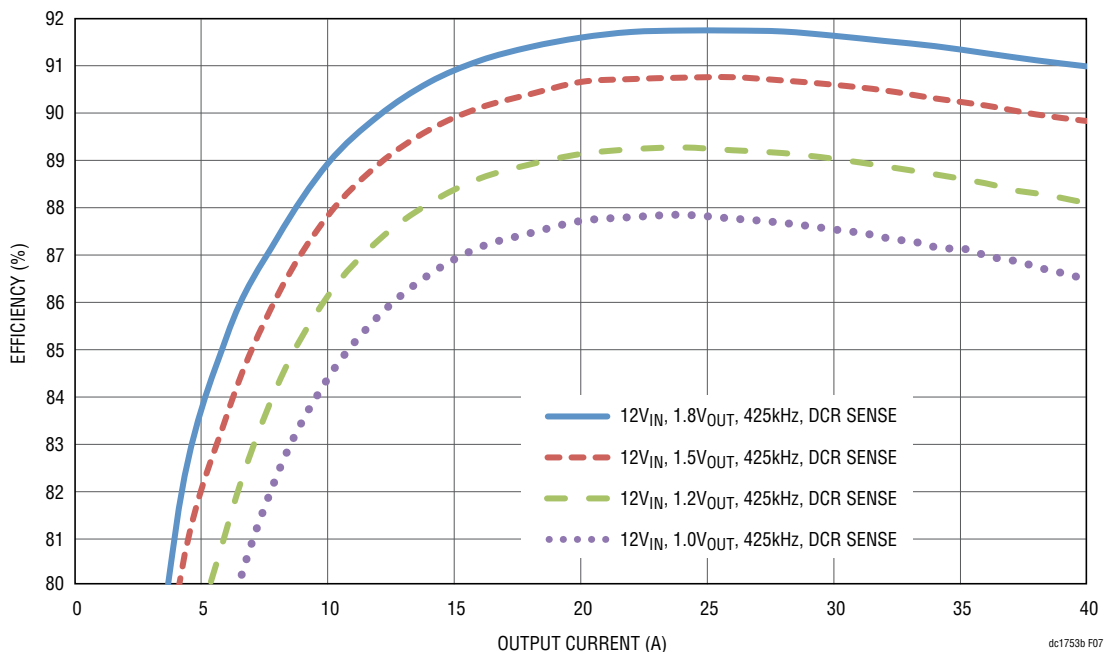


Figure 7. Typical Efficiency Curves, DCR Current Sensing, 12V_{IN}, f_{SW} = 425kHz

QUICK START PROCEDURE

LTpowerPlay Software GUI

LTpowerPlay is a powerful Windows based development environment that supports Linear Technology digital power ICs with EEPROM, including the LTC3880, LTC2974 and LTC2978, the quad and octal PMBus power supply managers. 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 LTC2974's DC1978A 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://linear.com/ltpowerplay>

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

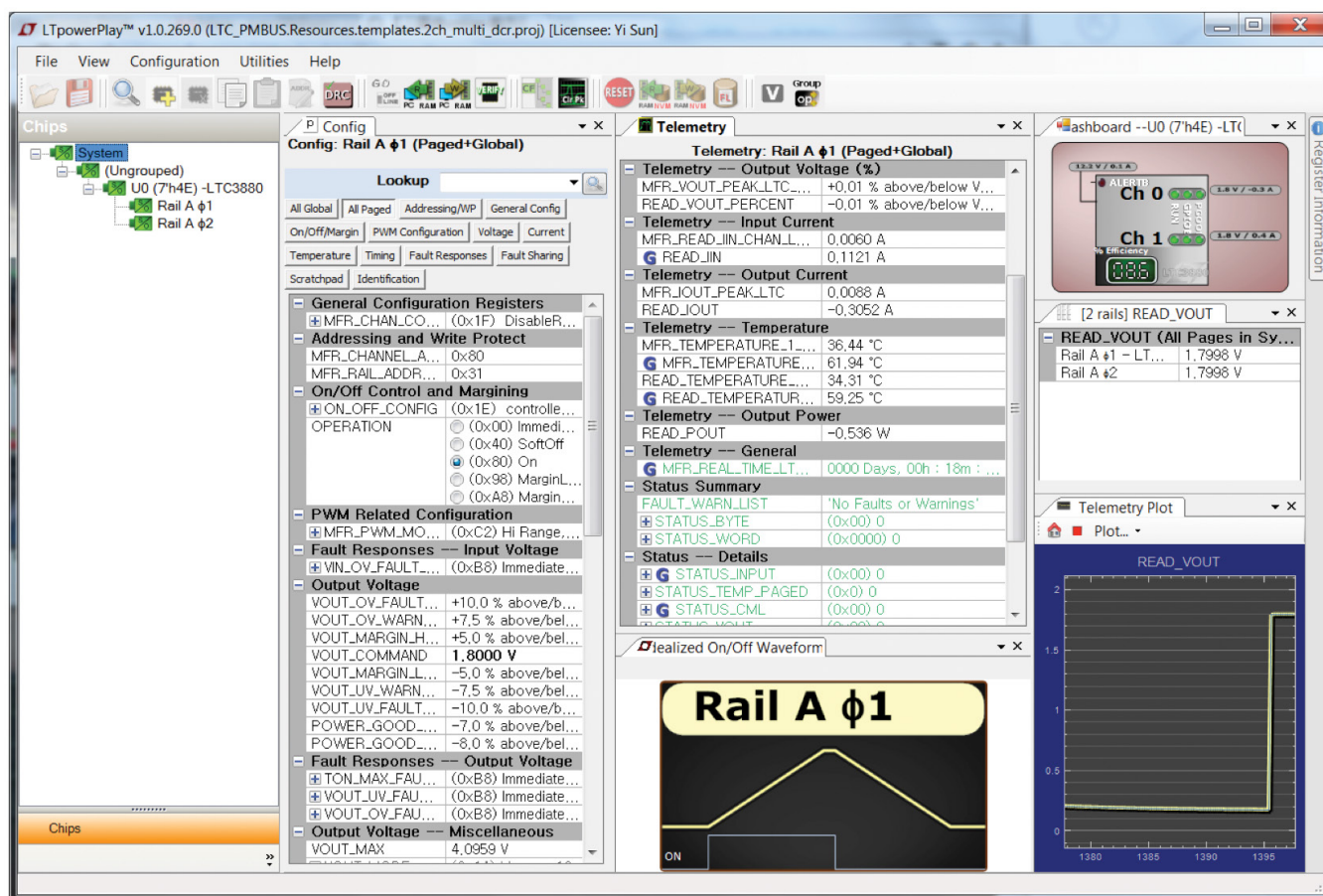


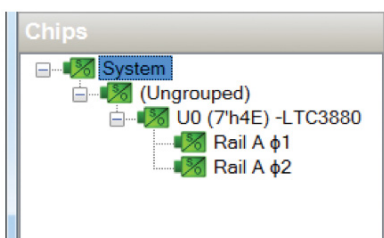
Figure 8. LTpowerPlay Software GUI

GUI QUICK START PROCEDURE

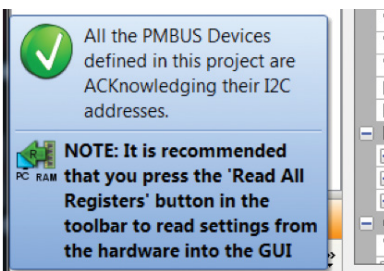
LTpowerPlay Software GUI

The following procedure describes how to use LTpowerPlay to monitor and change the settings of LTC3880.

1. Download and install the LTPowerPlay GUI:
 - <http://linear.com/ltpowerplay>
2. Launch the LTpowerPlay GUI.
 - a. The GUI should automatically identify the LTC3880. The system tree on the left hand side should look like this:



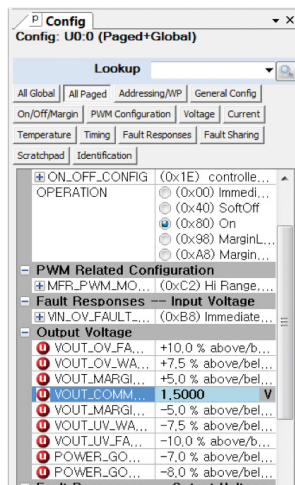
- b. A green message box shows for a few seconds in the lower left hand corner, confirming that the LTC3880 is communicating:



- c. In the tool bar, click the “R” (RAM to PC) icon to read the RAM from the LTC3880. This reads the configuration from the RAM of LTC3880 and loads it into the GUI.



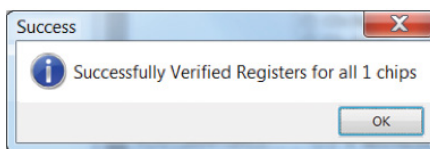
- d. To change the output voltage to a different value, like 1.5V: In the Config tab, type 1.5 in the VOUT_COMMAND box, like this:



Then, click the “W” (PC to RAM) icon to write these register values to the LTC3880. After finishing this step, you will see the output voltage will change to 1.5V.



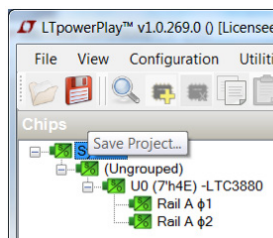
If the write is successful, this message appears:



- e. To save the changes into the NVM: In the tool bar, click the “RAM to NVM” button:



- f. Save the demo board configuration to a (*.proj) file by clicking the Save icon and save the file with a new file name.



GUI QUICK START PROCEDURE

Loading a LTC3880 Configuration (*.proj) File with the GUI

- In the upper left hand corner of the GUI: File > Open > browse to your *.proj file. This will load the file into the GUI.
- Click the “Go On Line” button to link the GUI to the existing LTC3880, as this:



- Click on the “W” (PC to RAM) button. This loads the configuration into LTC3880 RAM.
- Then, you can save the configuration to the EEPROM. Please see previous step f for details.

PARTS LIST DC1753B-A

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	3	C1, C2, C6	CAP., X7R, 0.1µF, 50V, 10%, 0603	AVX, 06035C104KAT2A
2	1	C17	CAP., X7R, 0.22µF, 25V, 10%, 0603	TDK, C1608X7R1E224K
3	2	C3, C9	CAP., X7R, 1µF, 16V, 10%, 0603	AVX, 0603YC105KAT2A
4	1	C5	CAP., X5R, 4.7µF, 25V, 0805	TAIYO YUDEN, TMK212BJ475KG-T
5	1	C8	CAP., X7R, 4700PF, 10%, 50V, 0603	AVX, 06035C472KAT2A
6	4	C10, C29, C11, C30	CAP, POSCAP, 330µF, 6.3V, D3L	SANYO, 6TPF330M9L
7	1	C13	CAP, OS-CON 150µF, 35V	SUNCON, 35HVP150M
8	4	C20, C23-25	CAP., X5R, 100µF, 6.3V, 1210	AVX, 12106D107MAT2A
9	2	C12, C14	CAP., X7R, 0.01µF, 10%, 50V, 0603	AVX, 06035C103KAT2A
10	2	C21, C22	CAP., X5R, 1000pF, 25, 10%, 0603	AVX, 06035C102JAT2A
11	2	C15, C16	CAP., X7R, 100pF, 5%, 50V, 0603	AVX, 06035C101KAT2A
12	4	C18, C19, C27, C28	CAP., X5R, 10µF, 35V, 1210	TAIYO YUDEN, GMK325BJ106KN
13	1	C48	CAP., X5R, 10µF, 6.3V 0603	TDK, C1608X5R0J106M
14	2	D1, D2	DIODE, SCHOTTKY, SOD-323	CENTRAL CMDSH-3TR
15	2	Q1, Q3	OPTIMOS3 POWER-TRANSISTOR, PG-TDSON-8	INFINEON, BSC050N03LS
16	2	Q2, Q4	OPTIMOS3 POWER-TRANSISTOR, PG-TDSON-8	INFINEON., BSC011N03LSI
17	2	Q5, Q6	TRANS, GP, SS, PNP, 40V, SOT-23	ON SEMI MMBT3906LT1G
18	1	Q11	MOSFET P-CH, 20V, 0.58A, SOT-23	VISHAY TP0101K-T1-E3
19	9	R5, R17, R39, R40-R42, R44, R45, R57	RES., CHIP, 10k, 5%, 0603	VISHAY, CRCW060310K0JNEA
20	1	R66	RES., CHIP, 24.3k, 1%, 0603	VISHAY, CRCW060324K3FKEA
21	10	R8, R25, R56, R59, R6, R29, R30, R34, R67, R63	RES., CHIP, 0 0603	YAGEO, RC0603FR-070RL
22	1	R3	RES., CHIP, 4.87k, 1%, 0603	AAC, CR16-4871FM
23	1	R24	RES., CHIP, 15.8k, 1%, 0603	VISHAY, CRCW060315K8FKEA
24	1	R52	RES., CHIP, 2, 1%, 0603	YAGEO, RC0603FR-072RL
25	2	R10, R16	RES., 0.002, 2512, 1%	PANASONIC, ERJ-M1WTF2M0U
26	4	R11, R12, R13, R14	RES., CHIP, 100, 1%, 0603	VISHAY, CRCW0603100RFKEA
27	2	L1, L2	INDUCTOR, 0.4µH	VITEC., 59PR9875
28	1	U4	IC, LTC3880EUJ, QFN 6mm × 6mm	LINEAR TECH., LTC3880EUJ#010J-1PBF

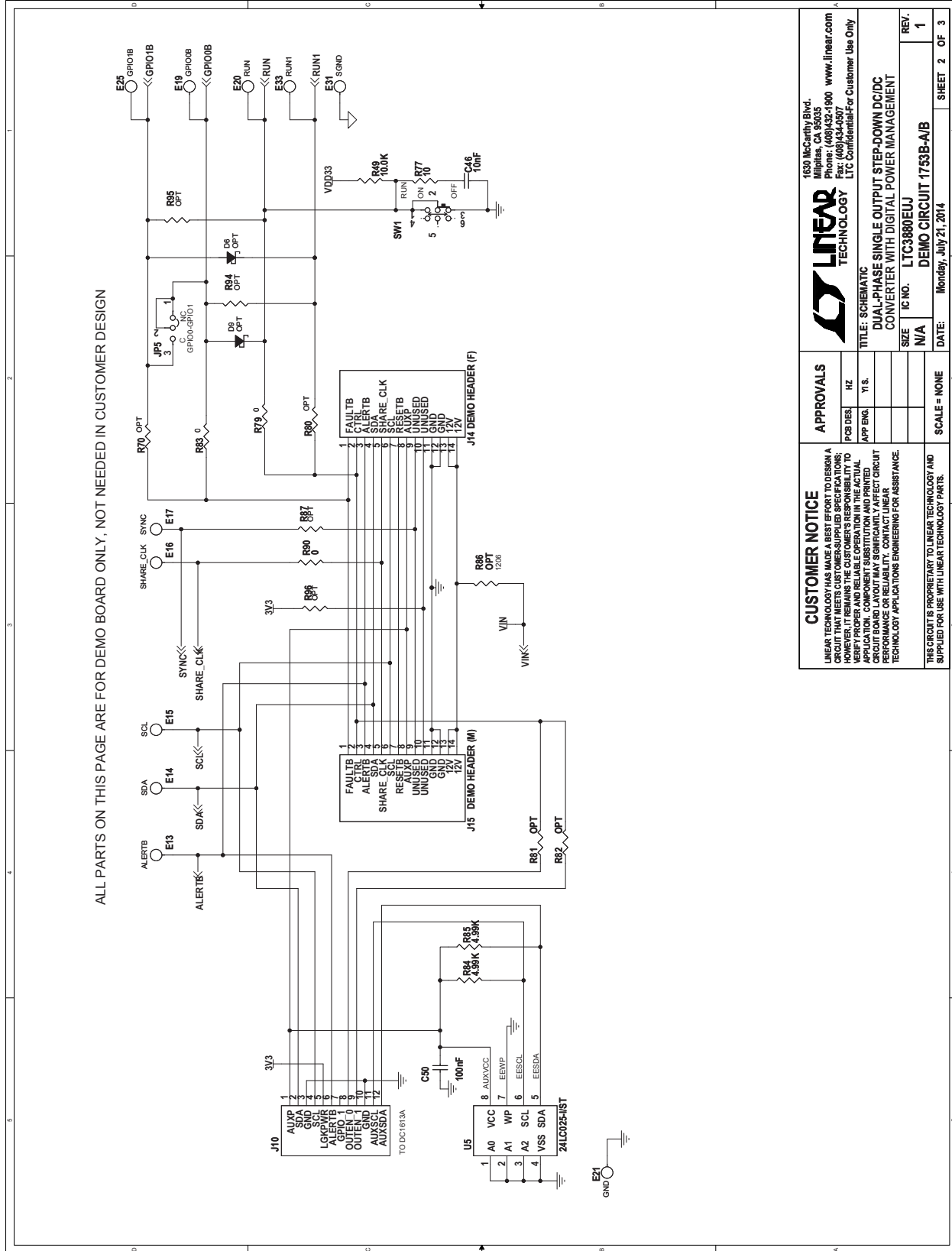
DEMO MANUAL DC1753B

PARTS LIST DC1753B-A

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Additional Circuit Components				
1	1	C50	CAP., X7R, 0.1µF, 50V, 10%, 0603	AVX, 06035C104KAT2A
2	1	C49	CAP., X5R, 4.7µF, 10V, 0603	AVX, 0603ZD475KAT2A
3	0	C42-C45	CAP, POSCAP, 330µF, 6.3V, D3L	
4	0	C4, C38	CAP., 0603	
5	0	C32, C34	CAP., 1210	
6	1	C46	CAP., X7R, 0.01µF, 10%, 50V, 0603	AVX, 06035C103KAT2A
7	1	C35	CAP., X5R, 10µF, 35V, 1206	TAIYO YUDEN, GMK316BJ106ML
8	1	C36	CAP., TANT LOW ESR, 3.3µF, 25V, 10%	AVX, TPSB335K025R2000
9	2	C37, C40	CAP., X7R, 1µF, 50V, 1206	AVX, 12065C105KAT2A
10	1	C41	CAP., X7R, 2.2µF, 16V, 0805	AVX, 0805YC223KAT2A
11	1	D3	LED GREEN S-GW TYPE SMD	PANASONIC LN1371SGTRP
12	1	D5	LED RED S-TYPE GULL WING SMD	PANASONIC LN1271RTR
13	0	D6, D9	DIODE, SCHOTTKY, SOD-323	CENTRAL CMDSH-3TR
14	1	Q15	MOSFET SPEED SRS 30V, 30A, LFPAK	RENESAS RJK0305DPB-00#J0
15	0	Q7, Q8, Q9, Q10	OPTIMOS3 POWER-TRANSISTOR, PG-TDSON-8	
16	1	Q14	MOSFET P-CH, 20V, 0.58A, SOT-23	VISHAY TP0101K-T1-E3
17	1	Q12	MOSFET N-CH, 60V, 115MA, SOT-23	FAIRCHILD 2N7002A
18	4	R49, R62, R64, R66	RES CHIP, 10k, 5%, 0603	VISHAY, CRCW060310K0JNEA
19	4	R48, R90, R83, R77	RES CHIP, 0, 0603	YAGEO, RC0603FR-070RL
20	0	R18, R20, R22, R23, R32, R73, R70, R1, R2, R7, R15, R94, R95, R81, R82, R96, R79, R80	RES., CHIP, 0603	
21	2	R84, R85	RES., CHIP, 4.99k, 1%, 0603	YEGEO, RC0603FR-074K99L
22	2	R50, R61	RES., CHIP, 1.5k, 1%, 0603	VISAY, CRCW06031K50FKEA
23	1	R53	RES., CHIP, 200, 1%, 0603	YAGEO, RC0603FR-07200RL
24	1	R55	RES., CHIP, 127, 1%, 0603	VISHAY, CRCW0603127RFKEA
25	0	R65	RES., CHIP, 30, 1%, 1W 2512	
26	1	R68	RES., CHIP, 0.01, 1%, 2010	VISHAY, WSL2010R0100FEA
27	0	R60	RES., 0805	
28	1	R38	RES., CHIP, 49.9, 1%, 0603	
29	1	U5	IC, 24LC025-I/ST, SOIC	MICROCHIP, 24LC025-I/ST
30	1	U6	IC, LT1129CS8-3.3 S8 PACKAGE	LINEAR TECH. LT1129CS8-3.3
31	1	U7	IC, LT1129CS8-5, S8 PACKAGE	LINEAR TECH, LT1129CS8-5
Hardware				
1	4	JP1, JP3-JP5	0.100" SINGLE ROW HEADER, 3 PIN	SAMTEC, TSW-103-07-L-S
2	4	JP1, JP3-JP5	SHUNT .100" BLK	SAMTEC, SNT-100-B-G
3	1	SW1	CONNECTOR, SUB MINIATURE SLIDE SWITCHES	C&K., JS202011CQN
4	2	J1, J2	JACK, BANANA	KEYSTONE 575-4
5	4	J3, J4(x2)	STUD, TESTPIN	PEM KFH-032-10
6	4	J3, J4(x2)	NUT, BRASS 10-32	ANY #10-32
7	1	J14	CONN., HEADER, 2x7, 2mm, R/A (F)	SULLINS, NPPN072FJFN-RC
8	1	J15	CONN., HEADER, 2x7, 2mm, R/A (M)	MOLEX, 87760-1416
9	0	J9 (OPT)	HEADER 14POS 2mm VERT GOLD	MOLEX 87831-1420
10	1	J10	CONN HEADER 12POS 2mm, STR DL PCB	FCI 98414-G06-12ULF
11	1	J11	CONN, BNC, 5 PINS	CONNEX, 112404
12	28	E1-E21, E23, E24, E25, E27, E31, E33	TESTPOINT, TURRET, .062"	MILL-MAX, 2308-2-00-80-00-00-07-0

dc1753bf

SCHEMATIC DIAGRAM



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<p>1630 McCarthy Blvd. Milpitas, CA 95035 Phone: (408)432-1900 www.linear.com Fax: (408)434-0907 LTC Confidential-For Customer Use Only</p>	
<p>TITLE: SCHEMATIC DUAL-PHASE SINGLE OUTPUT STEP-DOWN DC/DC CONVERTER WITH DIGITAL POWER MANAGEMENT</p>	
SIZE	IC NO. LTC3880EUJ
DATE	Monday, July 21, 2014
SCALE = NONE	REV. 1
SHEET 2 OF 3	

Figure 10. Demo Circuit 1753B Dual-Phase, Single-Output, Step-Down DC/DC Converter with Digital Power Management

SCHEMATIC DIAGRAM

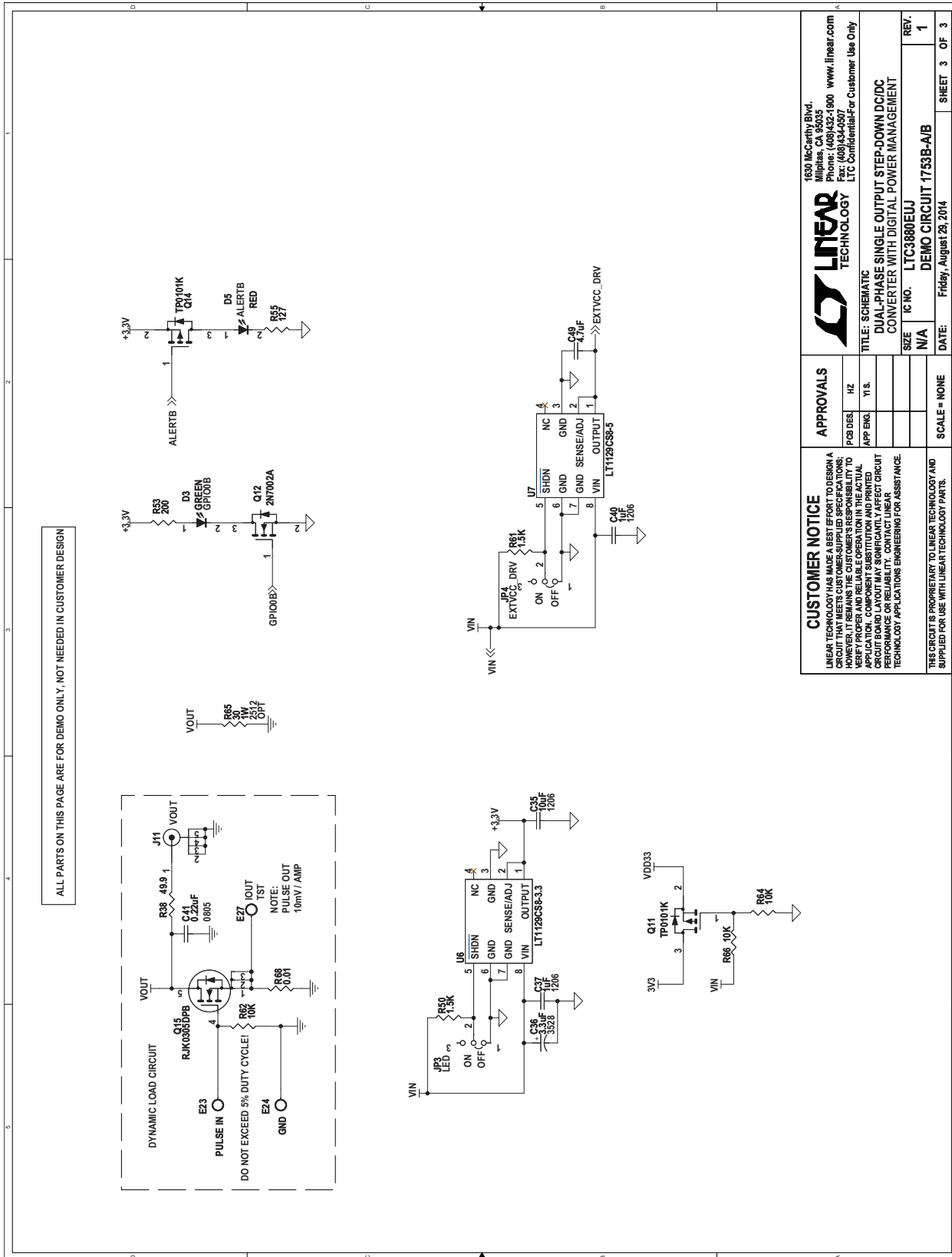


Figure 11. Demo Circuit 1753B Dual-Phase, Single-Output, Step-Down DC/DC Converter with Digital Power Management

DEMO MANUAL DC1753B

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.).

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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.

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