

# 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<sup>®</sup>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<sup>™</sup>](#) GUI software onto your PC and use LTC's I<sup>2</sup>C/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<sub>A</sub> = 25°C

| SYMBOL                    | PARAMETER                                                | CONDITIONS                                                                                       | MIN | TYP  | MAX | UNITS |
|---------------------------|----------------------------------------------------------|--------------------------------------------------------------------------------------------------|-----|------|-----|-------|
| V <sub>IN</sub>           | Input Supply Range                                       |                                                                                                  | 6.5 | 12   | 24  | V     |
| V <sub>OUT</sub>          | Output Voltage Range                                     | I <sub>OUT</sub> = 0A to 20A, V <sub>IN</sub> = 6.5V to 24V                                      | 0.5 | 1.8  | 3.3 | V     |
| V <sub>OUT_ACCURACY</sub> | Output Voltage Accuracy                                  | I <sub>OUT</sub> = 0A to 20A, V <sub>IN</sub> = 6.5V to 24V<br>V <sub>OUT</sub> for 0.5V to 3.3V |     | ±0.5 |     | %     |
| I <sub>OUT</sub>          | Output Current Range                                     |                                                                                                  | 0   |      | 40  | A     |
| f <sub>SW, A</sub>        | Factory Default Switching, Freq: A (R <sub>SENSE</sub> ) |                                                                                                  |     | 350  |     | kHz   |
| f <sub>SW, B</sub>        | Factory Default Switching, Freq: B (DCR)                 |                                                                                                  |     | 425  |     | kHz   |
| EFFICIENCY                | Peak Efficiency                                          | V <sub>OUT</sub> = 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 <sub>CC</sub> for the LTC3880-1 |
| JP5    | C        | GPIO0B to GPIO1B: Tie GPIOs Together                   |

2. With power off, connect the input power supply to V<sub>IN</sub> 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<sub>OUT</sub> = 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<sub>OUT</sub>, 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<sub>IN</sub> is present.

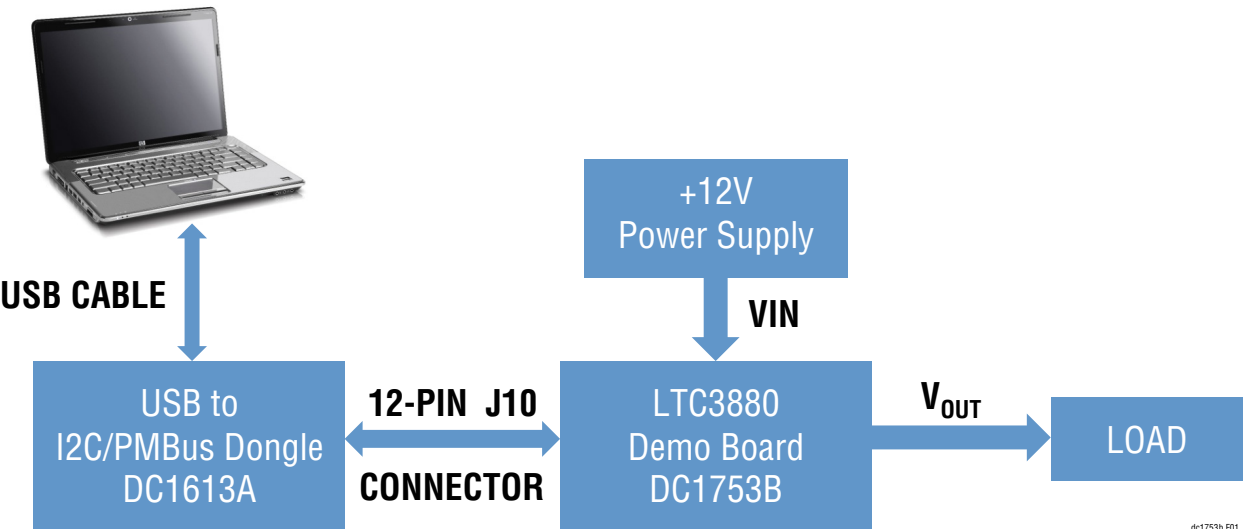


Figure 1. Demo Setup with PC

## QUICK START PROCEDURE

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

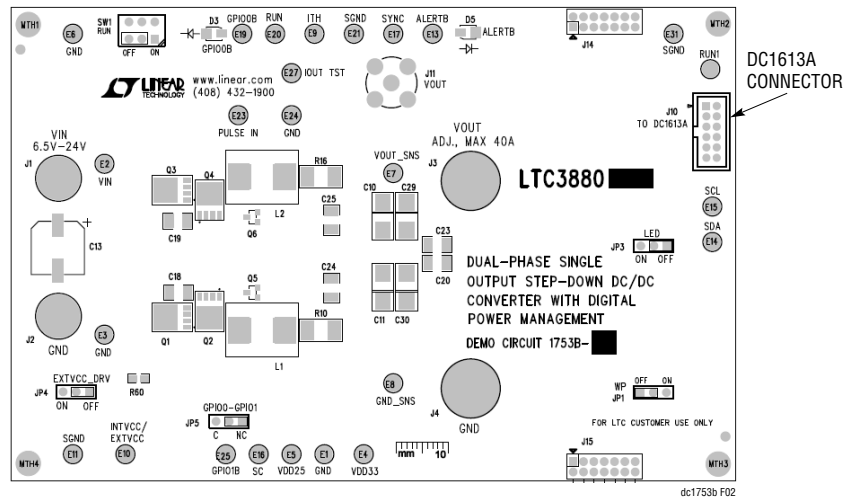


Figure 2. Dongle Connector Locations

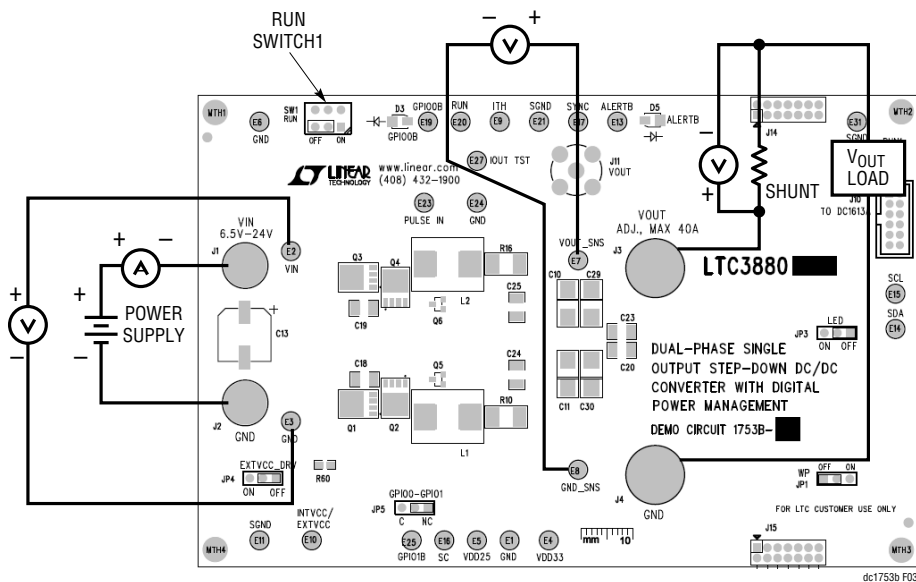


Figure 3. Dual Phase Single-Output Test Setup

## 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

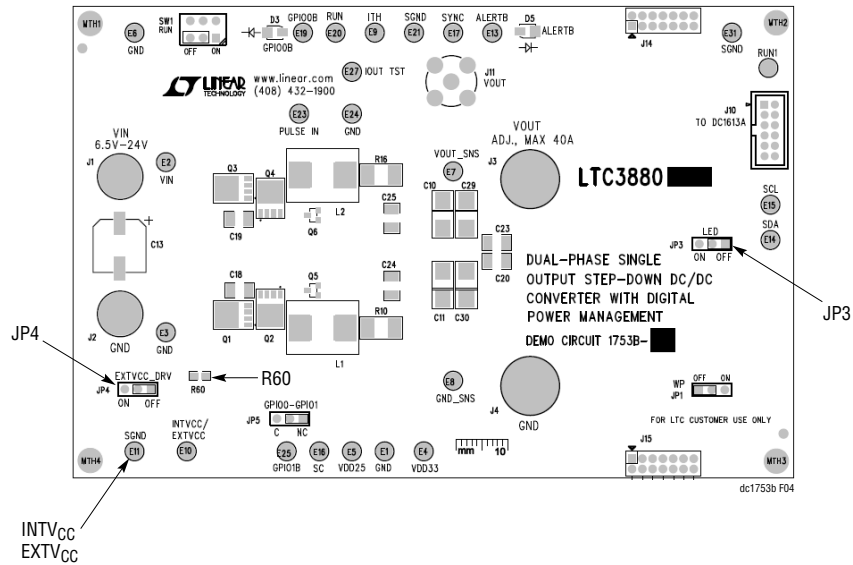


Figure 4. Jumper Locations: JP3, JP4, R60, INTVCC/EXTVCC Turret

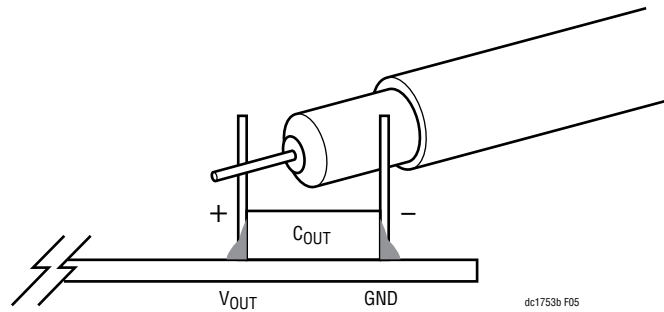


Figure 5. Measuring Output Voltage Ripple

QUICK START PROCEDURE

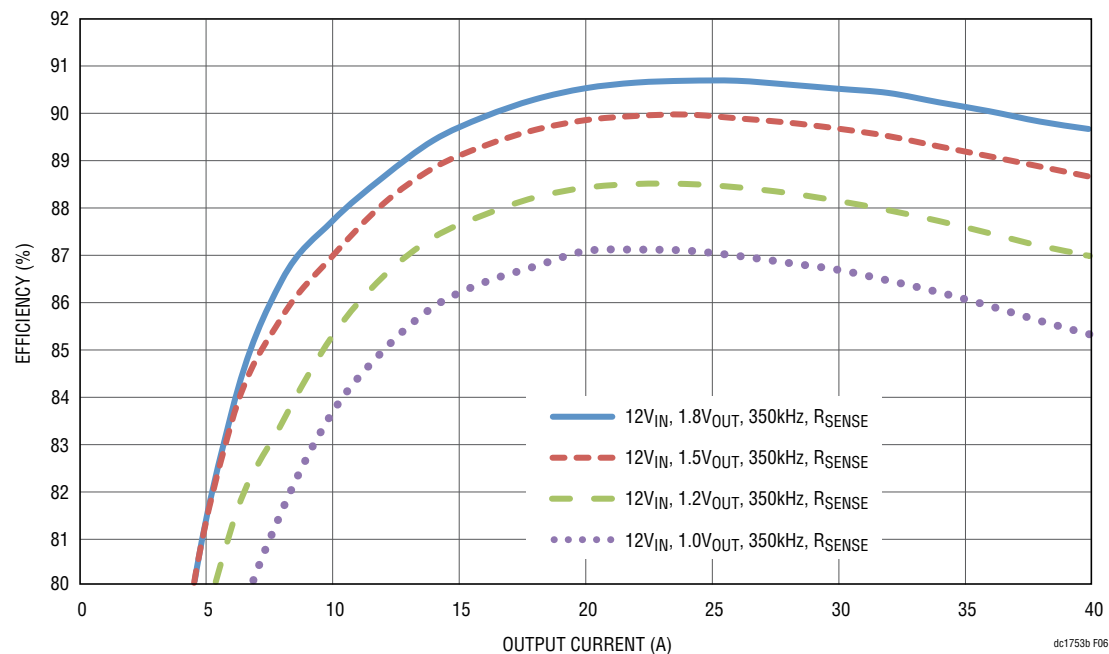


Figure 6. Typical Efficiency Curves, Sense Resistor Current Sensing, 12VIN, fSW = 350kHz

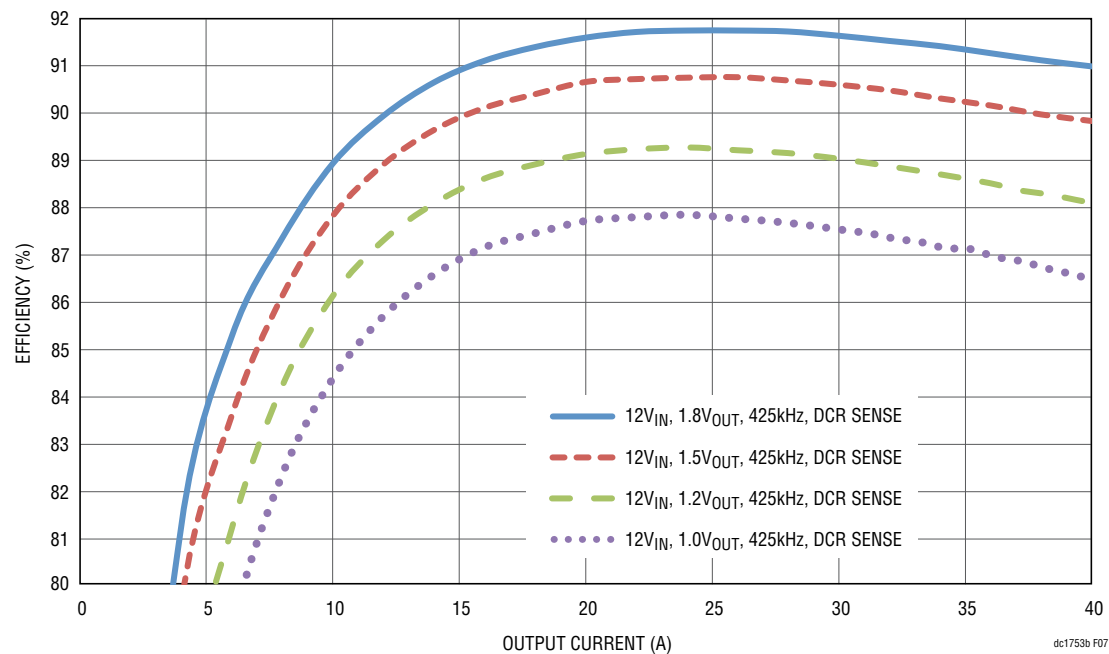


Figure 7. Typical Efficiency Curves, DCR Current Sensing, 12VIN, fSW = 425kHz

## 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.

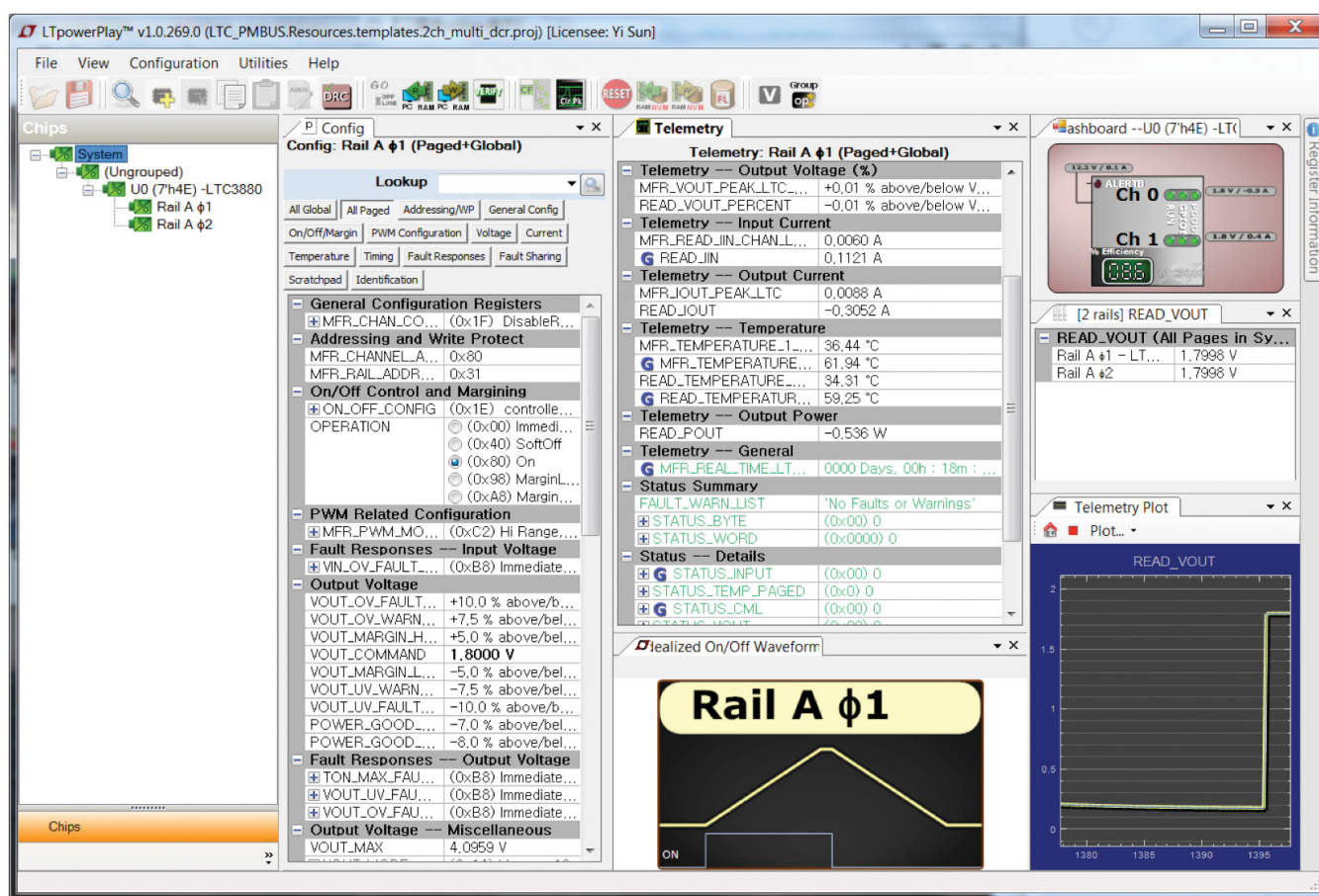


Figure 8. LTpowerPlay Software GUI

## GUI QUICK START PROCEDURE

### LTpowerPlay Software GUI

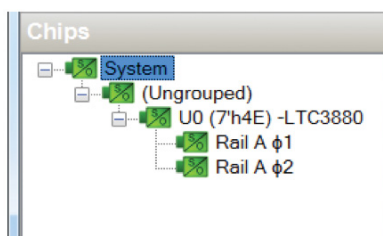
The following procedure describes how to use LTpowerPlay to monitor and change the settings of LTC3880.

1. Download and install the LTpowerPlay GUI:

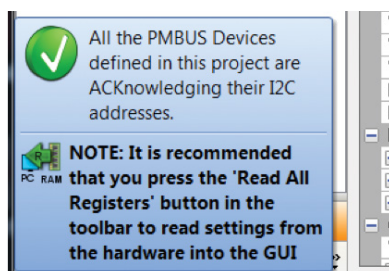
<http://linear.com/ltpowerplay>

2. Launch the LTpowerPlay GUI.

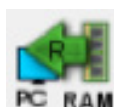
- a. The GUI should automatically identify the LTC3880. The system tree on the left hand side should look like this:



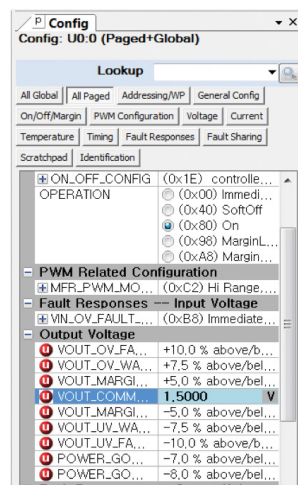
- b. A green message box shows for a few seconds in the lower left hand corner, confirming that the LTC3880 is communicating:



- 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.



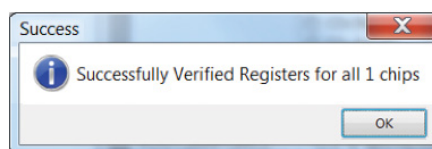
- d. To change the output voltage to a different value, like 1.5V: In the Config tab, type 1.5 in the VOUT\_COMMAND box, like this:



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.



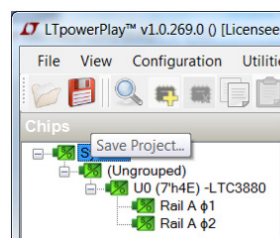
If the write is successful, this message appears:



- 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           |
|------------------------------------|-----|------------------------------------------------|---------------------------------------|------------------------------------|
| <b>Required Circuit Components</b> |     |                                                |                                       |                                    |
| 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          |
|--------------------------------------|-----|---------------------------------------------------------------------------------------|-----------------------------------------|-----------------------------------|
| <b>Additional Circuit Components</b> |     |                                                                                       |                                         |                                   |
| 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          |
| <b>Hardware</b>                      |     |                                                                                       |                                         |                                   |
| 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, 2 x 7, 2mm, R/A (F)      | SULLINS, NPPN072FJFN-RC           |
| 8                                    | 1   | J15                                                                                   | CONN., HEADER, 2 x 7, 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 |

## SCHEMATIC DIAGRAM

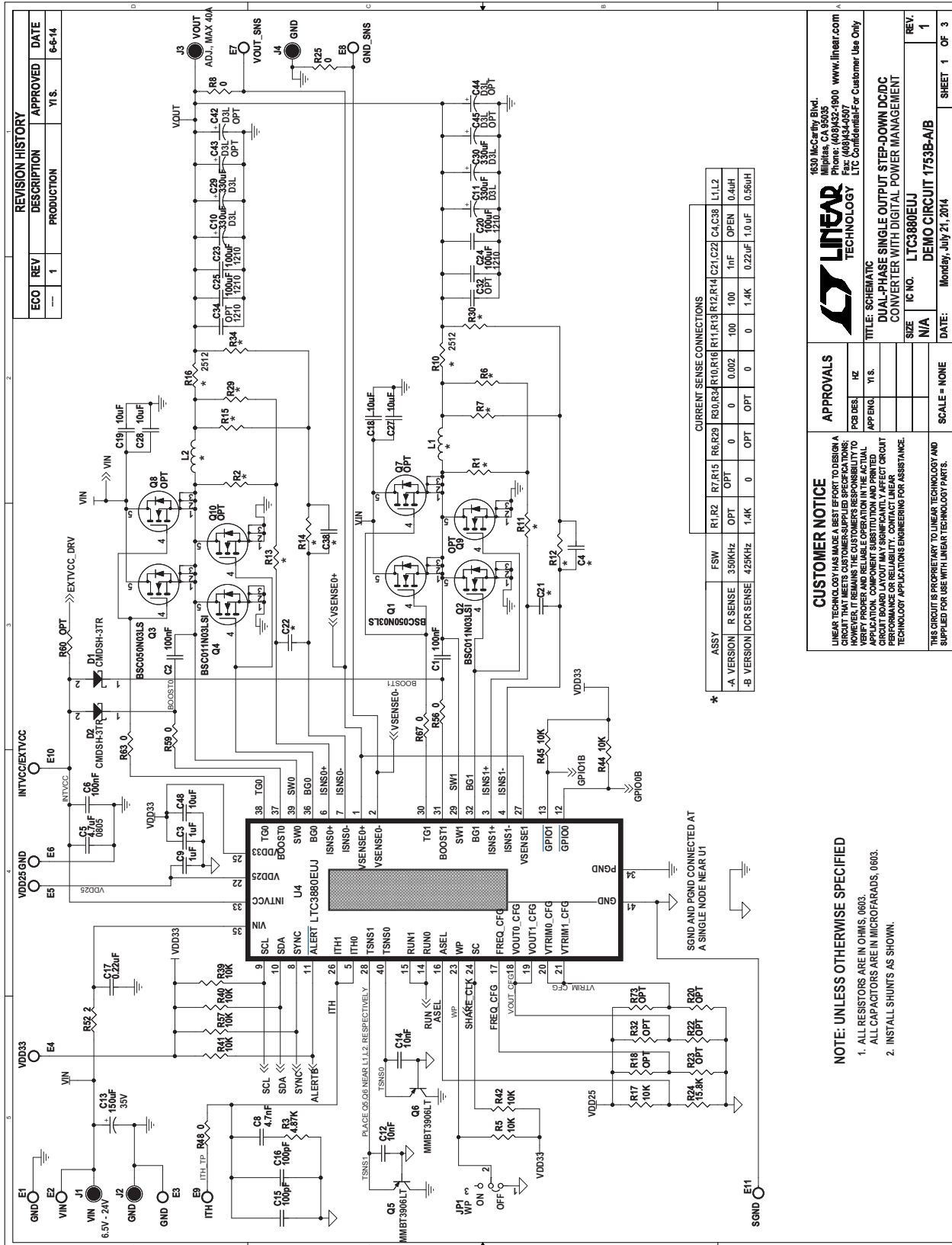
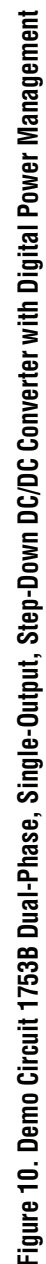
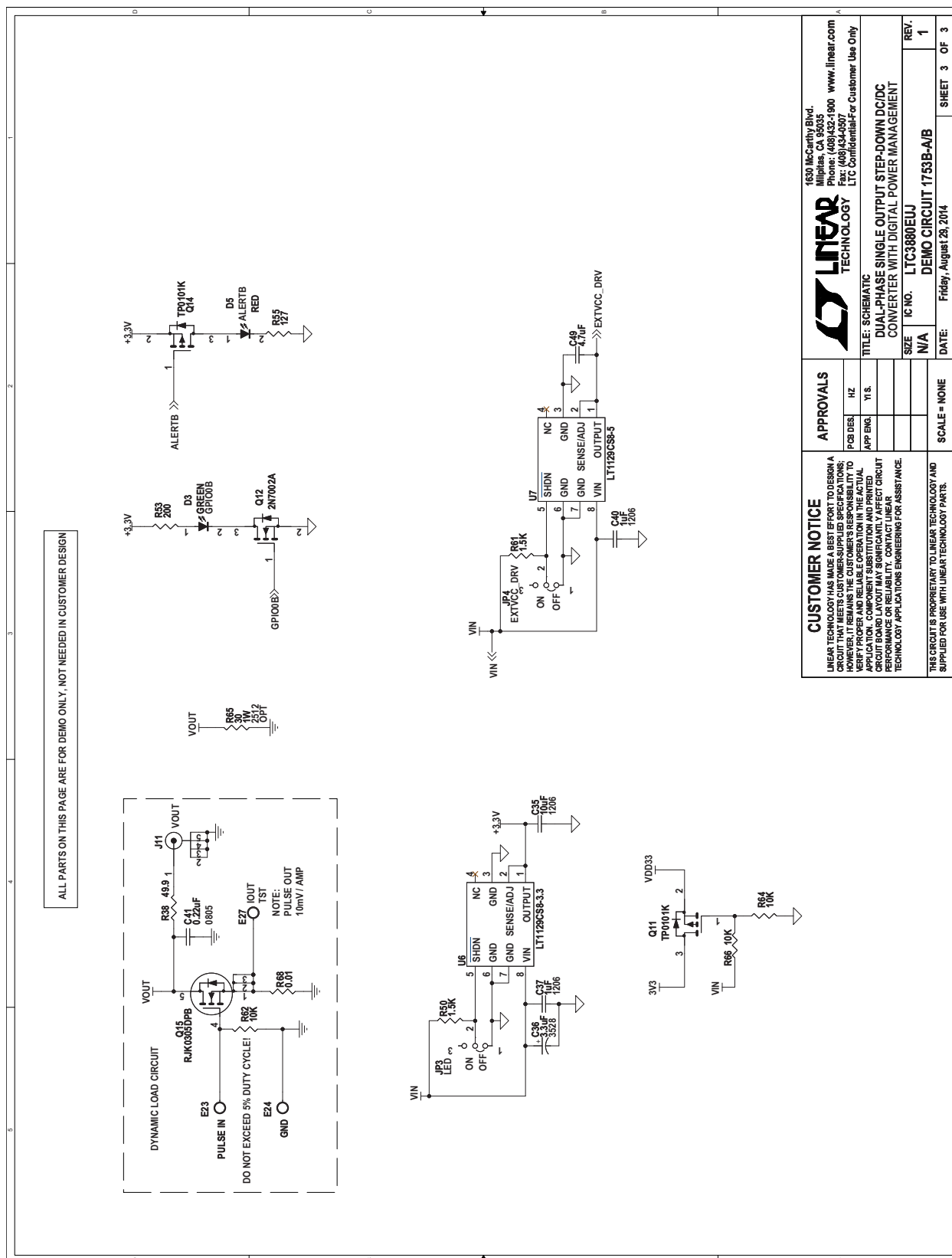


Figure 9. Demo Circuit 1753B Dual-Phase, Single-Output, Step-Down DC/DC Converter with Digital Power Management

## SCHEMATIC DIAGRAM



## SCHEMATIC DIAGRAM



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

# DEMO MANUAL DC1753B

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## DEMONSTRATION BOARD IMPORTANT NOTICE

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

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