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LT3756-2/LT3756-1
High Voltage LED Controller

DESCRIPTION

Demonstration circuit 1319B-A/1319B-B is a high voltage and high current LED driver controller. The V_{IN} pin input voltage is as high as 100V, and the LED output voltage is also as high as 100V. The demonstration circuit is assembled as a boost topology from 8V to 80V input and up to 80V LED output at 0.5A with an open-LED status pin (DC1319B-A) or a sync input pin (DC1319B-B). DC1319B features PWM dimming, analog dimming, shutdown, and open-LED overvoltage protection. Efficiency at 12V_{IN} is as high as 91% for 40W output.

The switching frequency is set at 300kHz to accommodate the automotive switching frequency range. Small ceramic input and output capacitors are used to save space and cost and a high voltage 100V external power switch and a 100V catch diode are used for up to 40W (80V at 0.5A) output as assembled. The open-LED overvoltage protection limits the output to approximately 92V if the LED string is opened.

Note: LED output voltages above 80V, but less than the open-LED voltage of 92V, are possible with limitations to low input voltage operation. Please consult the factory.

For low input voltage operation, the CTRL pin voltage is reduced as the input voltage drops below 10V, reducing

LED brightness and restraining the peak switch currents in order to limit inductor and switch size. UVLO turns the LEDs off when V_{IN} drops below 8V.

DC1319B PWM dimming is simple. The boost topology LED string returns to the LED terminal and the PWM dimming MOSFET turns the LED string on and off with an input to the PWM dimming terminal. For the highest PWM dimming ratio, it is recommended to use 100Hz as a PWM dimming frequency. Information regarding PWM dimming ratios and performance can be found in the LT3756-2/LT3756-1 data sheet in the Applications Information section.

Soft-start is provided with a simple and small capacitor to maintain control of the switch current during turn on for high power designs.

Modifications can be made to the DC1319B in order to convert the board from a boost topology LED driver to any other topology. Please consult the factory or LT3756-2/LT3756-1 data sheet for details regarding how to customize the DC1319B or how to design different topologies for custom specifications.

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DEMO MANUAL

DC1319B-A/DC1319B-B

DESCRIPTION

The LT3756-2/LT3756-1 data sheet gives a complete description of the part, operation and applications information. The data sheet must be read in conjunction with this Quick Start Guide for demonstration circuit DC1319B-A/DC1319B-B. The LT3756-2/LT3756-1 is assembled in a small 16-lead plastic MSOP or QFN package with a thermally

enhanced ground pad. Demonstration circuit 1319B-A/1319B-B uses the MSOP package. Proper board layout is essential for maximum thermal performance. See the data sheet section Layout Considerations.

Design files for this circuit board are available at www.linear.com. Type in the demo circuit number.

Table 1. Performance Summary

| PARAMETER | CONDITION | VALUE (TYPICAL) |
|-------------------------------|--|-----------------|
| Input Voltage PV_{IN} Range | Operating | 8V to 80V |
| Switching Frequency | $R8 = 37.4k$ | 300kHz |
| I_{LED} | | 0.5A |
| Efficiency | $PV_{IN} = 12V, V_{LED} = 80V, I_{LED} = 0.5A$ | 91% |
| Undervoltage Lockout | | 8V |
| Peak Switch Current Limit | $R_{S1} = 0.015\Omega$ | 6.6A |

QUICK START PROCEDURE

Demonstration circuit 1319B-A/1319B-B is easy to set up to evaluate the performance of the LT3756-2/LT3756-1. Follow the procedure below:

Note: PWM must be pulled high to work. If PWM is not used, connect PWM to a 5V source or to INTV_{CC} on the PCB using resistor R21. PWM must be pulled high to work. For DC1319B-B, the SYNC input can be left floating but is best tied to GND if not used.

1. Connect a string of LEDs with forward voltage less than 80V, but greater than the PV_{IN} voltage, to the LED⁺ and LED⁻ (BOOST) terminals on the PCB as shown in Figure 1.
2. Connect the shutdown terminal to GND.
3. With power off, connect the PV_{IN} power supply to the PV_{IN} and GND terminals within the ranges specified on the PCB. Make sure that the PV_{IN} DC input voltage does not exceed 80V or the forward voltage of the LED string.

4. Connect the PWM terminal. If PWM is not used, connect PWM to a 5V source or to INTV_{CC} on the PCB using resistor R21. PWM must be pulled high to work. For DC1319B-B, the SYNC input can be left floating but is best tied to GND if not used.
5. Turn the PV_{IN} power supply on.
6. Release the shutdown-to-GND connection.
7. Observe the LED string running at the programmed LED current.
8. For PWM dimming, connect a PWM (100Hz or higher) signal to the PWM terminal.
9. Observe the reduction of brightness in the LED string when PWM dimming.

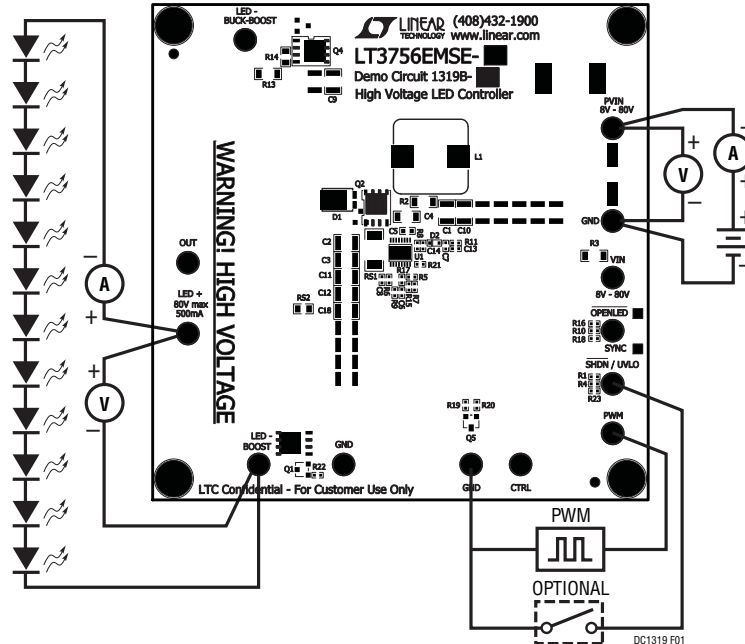


Figure 1. Test Setup for the DC1319B-A/DC1319B-B

OPERATION

Two ICs, LT3756-2/LT3756-1

The DC1319B features two build versions. DC1319B-A uses the LT3756EMSE-2 with an open-LED status and DC1319B-B which uses the LT3756EMSE-1 with sync. Each board is clearly marked indicating which IC is used. The schematic for each is attached to this document. The open-LED indicator has a pull-up resistor from the terminal to the internal 7V regulator INTV_{CC}. Note that when PWM and SYNC are both used, optimal PWM dimming occurs when there is at least a 200ns delay from the PWM rising edge and the SYNC rising edge—with the PWM edge occurring first. For more questions regarding this matter, please consult the factory.

Although DC1319B-A/DC1319B-B are assembled as boost topology LED drivers, they can be reconfigured for buck-boost mode, buck mode and SEPIC LED driver topologies. Please keep in mind that the chosen topology should reflect the relationship between the entire input voltage range and the LED voltage range. Other circuit requirements such as short circuit between terminals or ground can affect the choice of LED driver topology.

Terminal Options

DC1319B-A/DC1319B-B have both PV_{IN} and V_{IN} terminals. The schematic shows that the PV_{IN} and V_{IN} terminals are shorted together with a resistor. As assembled, only the PV_{IN} terminal needs 8V to 80V power in order for the board to operate. However, resistor R2 can be removed and the V_{IN} terminal can be connected to a supply that is separate from the PV_{IN} terminal. The V_{IN} terminal is tied directly to the V_{IN} pin.

The V_{OUT} terminal is available for the customer to monitor the state of the output capacitor directly. The V_{OUT} terminal can also be used as an input for buck mode topology.

The PWM terminal must be pulled high in order for the board to operate. It is preferable to tie the PWM terminal/pin to INTV_{CC} of the controller by shorting R21 if PWM dimming is not used, but for board evaluation it can be tied to an external 5V source as well.

OPERATION

The CTRL terminal is used for analog dimming. The CTRL pin is tied directly to the terminal and it is already being used to reduce the LED current when PV_{IN} drops too low. The CTRL pin voltage can easily be overridden with an external voltage supply and the resistor divider from PV_{IN} can be removed.

The shutdown/undervoltage terminal is used to shut down the demonstration circuit. Tie the terminal to GND and the converter stops switching. The PWMOUT pin goes low and the PWM dimming MOSFET is turned off. As long as the PWM dimming MOSFET is used properly, the LEDs do not turn on during shutdown.

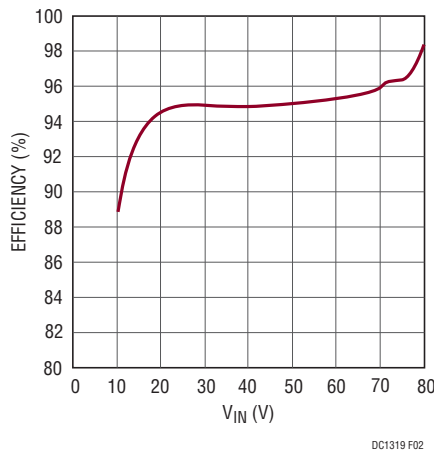


Figure 2. DC1319B-A/DC1319B-B Efficiency with 80V LEDs at 0.5A

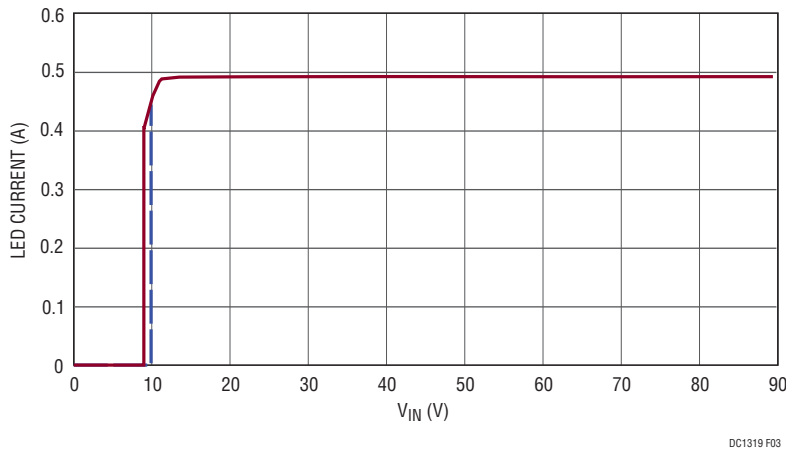


Figure 3. DC1319B-A/DC1319B-B LED Current Drops at Low V_{IN} (CTRL) and Turns Off at Lower V_{IN} (UVLO)

DEMO MANUAL

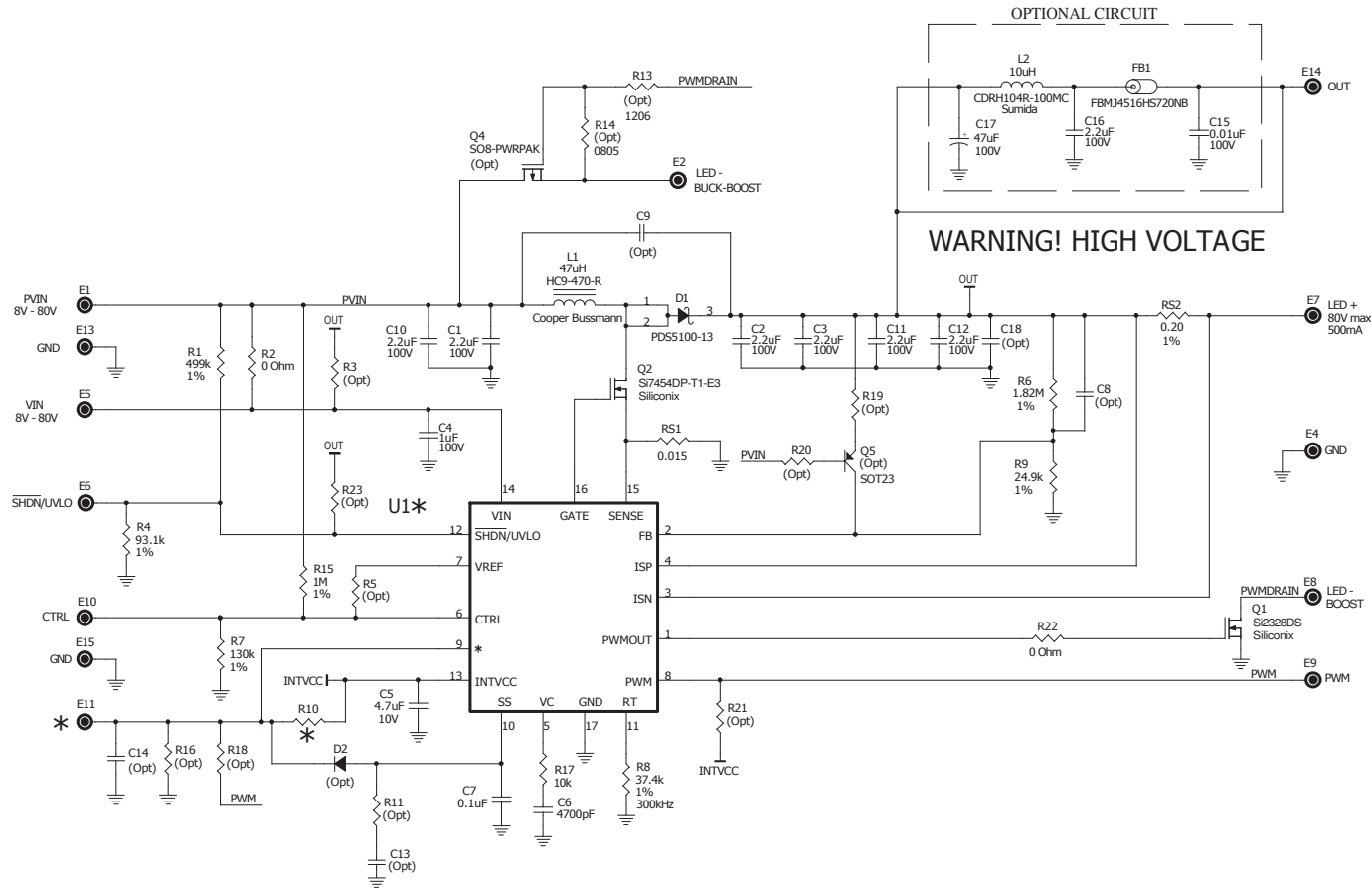
DC1319B-A/DC1319B-B

PARTS LIST

| QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|---------------------------------------|---|---|----------------------------------|
| REQUIRED ELECTRICAL COMPONENTS | | | |
| 6 | C1, C2, C3, C10, C11, C12 | Capacitor., X7R 2.2 μ F 100V 20% 1210 | TDK C3225X7R2A225M |
| 1 | C4 | Capacitor., X7R 1 μ F 100V 20% 1206 | AVX 12061C105MAT2A |
| 1 | C5 | Capacitor., X5R 4.7 μ F 10V 10% 0603 | Taiyo Yuden LMK107BJ475KA |
| 1 | C6 | Capacitor., X7R 4700pF 25V 20% 0402 | AVX 04023C472MAT2A |
| 1 | C7 | Capacitor., X5R 0.1 μ F 16V 20% 0402 | AVX 0402YD104MAT2A |
| 1 | D1 | Schottky Diode 5A PowerDi5 | Diodes Inc. PDS5100-13 |
| 1 | L1 | Inductor, 47 μ H HC9-SERIES | Cooper HC9-470-R |
| 1 | Q1 | MOSFET N-Channel, 100V | Siliconix Si2328DS |
| 1 | Q2 | MOSFET N-Channel, 100V | Siliconix Si7454DP-T1-E3 |
| 1 | R _{S1} | Resistor, 0.015 1/2W 1% 2010 | Vishay Dale WSL2010R0150FEA |
| 1 | R _{S2} | Resistor, 0.20 0.125W 1% 0805 | Vishay Dale WSL0805R2000FEA |
| 1 | R1 | Resistor, Chip 499k 0.06W 1% 0402 | Vishay CRCW0402499KFED |
| 1 | R4 | Resistor, Chip 93.1k 0.06W 1% 0402 | Vishay CRCW040293K1FKED |
| 1 | R6 | Resistor, Chip 1.82M 0.06W 1% 0402 | Vishay CRCW04021M82FKED |
| 1 | R8 | Resistor, Chip 37.4k 0.06W 1% 0402 | Vishay CRCW040237K4FKED |
| 1 | R9 | Resistor, Chip 24.9k 0.06W 1% 0402 | Vishay CRCW040224K9FKED |
| 1 | R17 | Resistor, Chip 10k 0.06W 5% 0402 | Vishay CRCW040210K0JNED |
| 1 | U1 (DC1319B-A Assembly) | IC, LED Driver MSOP(16)-MSE | Linear Tech. Corp. LT3756EMSE-2 |
| 1 | U1 (DC1319B-B Assembly) | IC, LED Driver MSOP(16)-MSE | Linear Tech. Corp. LT3756EMSE-1 |
| OPTIONAL ELECTRICAL COMPONENTS | | | |
| 0 | C8, C13, C14 (Opt) | Capacitor., 0402 | |
| 0 | C9, C16, C18 (Opt) | Capacitor., 1210 | |
| 0 | C15 (Opt) | Capacitor., X5R 0.01 μ F 100V 20% 0603 | TDK C1608X5R2A103M |
| 0 | C17 (Opt) | Capacitor., Alum 47 μ F 100V 25% | SUNCON 100CE47BS |
| 0 | D2 (Opt) | Diode, SOD-523 | |
| 0 | FB1 (Opt) | Ferrite Bead, 6A 1806 | Taiyo Yuden FBMJ4516HS720NB |
| 0 | L2 (Opt) | Inductor, 10 μ H CDRH104 | Sumida CDRH104R-100MC |
| 0 | Q4 (Opt) | MOSFET P SO8-PWRPAK-SGL | |
| 0 | Q5 (Opt) | PNP SOT23 | |
| 1 | R2 | Resistor/Jumper, Chip 0 Ω 1/4W 1A 1206 | Vishay CRCW1206000Z |
| 0 | R3, R13 (Opt) | Resistor, 1206 | |
| 0 | R5, R11, R16, R18, R19, R20, R21, R23 (Opt) | Resistor, 0402 | |
| 1 | R7 | Resistor, Chip 130k 0.06W 1% 0402 | Vishay CRCW0402130KFED |
| 1 | R10 (DC1319B-A assembly) | Resistor, Chip 100k 0.06W 5% 0402 | Vishay CRCW0402100KJNED |
| 0 | R10 (DC1319B-B assembly) | Resistor, 0402 | |
| 0 | R14 (Opt) | Resistor, 0805 | |
| 1 | R15 | Resistor, Chip 1M 0.06W 1% 0402 | Vishay CRCW04021M00FKED |
| 1 | R22 | Resistor/Jumper, Chip 0 Ohm 1/16W 1A 0402 | Vishay CRCW0402000Z |
| HARDWARE | | | |
| 13 | E1, E2, E4, E5, E6, E7, E8, E9, E10, E11, E13, E14, E15 | Turret, Testpoint | Mill Max 2501-2-00-80-00-00-07-0 |

This circuit is proprietary to Linear Technology and supplied for use with Linear Technology parts.
Customer Notice: Linear Technology has made a best effort to design a circuit that meets customer-supplied specifications; however, it remains the customer's responsibility to verify proper and reliable operation in the actual application. Component substitution and printed circuit board layout may significantly affect circuit performance or reliability. Contact Linear Applications Engineering for assistance.

| REVISION # | | | | REVISION HISTORY | | |
|------------|----|----|----|------------------|---------|----------|
| SD | PC | FD | AD | DESCRIPTION | DATE | APPROVED |
| 0 | 0 | 0 | 0 | 1st Release | 7/15/09 | KSz |



WARNING! HIGH VOLTAGE

| * ASSY | U1(IC) | U1-9 (Name) | E11 (Name) | R10 |
|--------|--------------|-------------|------------|------|
| -A | LT3756EMSE-2 | OPENLED | OPENLED | 100k |
| -B | LT3756EMSE-1 | SYNC | SYNC | OPT |

| APPROVALS | | LINEAR TECHNOLOGY CORPORATION | |
|----------------------------------|--|---|--------------------------|
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| ENGINEER: KSz | | www.linear.com LTC Confidential - For Customer Use Only | |
| APPROVED: | | Title: LT3756EMSE-2/-1 High Voltage LED Controller | |
| CHECKED: | | SD Document Number | Demo Circuit 1319B Rev 1 |
| Date: Friday, September 25, 2009 | | C:\ORCADWIN\CAPTURE\E1319B\1319B_01_REV1.DSN Sheet 1 of 1 | |

SCHEMATIC DIAGRAM

DC1319B-A/DC1319B-B DEMO MANUAL

DEMO MANUAL

DC1319B-A/DC1319B-B

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