LT3954
$40V_{IN}$ $40V_{OUT}$ LED Driver

DESCRIPTION

Demonstration circuit 2079A is a $40V_{IN}$, $40V_{OUT}$ LED driver. It generates its own PWMOUT waveform from its internal PWM generator for accurate PWM dimming with up to 33:1 brightness ratio. It accepts an input voltage from 5V to 30V and drives up to 32V of LEDs at 650mA (when PV_{IN} is less than V_{LED}). DC2079A features both PWM and analog dimming of the LED string. It has an OPENLED flag that indicates when the LED string has been removed.

DC2079A features high efficiency at 350kHz switching frequency. At high LED string voltages up to 32V and 650mA of LED current, the single switch controller has 94.6% efficiency (14V input). The LT3954 has an internal 40V, 5.4A switch that simplifies the schematic and layout.

Small ceramic input and output capacitors are used to save space and cost. The open LED overvoltage protection uses the IC's constant voltage regulation loop to regulate the output to approximately 35V if the LED string is opened although it may reach 38V peak during transient from running LEDs to open string.

For low input voltage operation, the CTRL pin voltage is reduced as the input voltage drops below 8.5V, 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 5.3V.

DC2079A PWM dimming is simplified when compared with other LED drivers. The LT3954 generates its own PWMOUT dimming waveform at a frequency determined by the capacitance on the PWM pin (C16 gives 300Hz for DC2079A). The PWMOUT duty cycle is determined by the voltage on the DIM terminal. Between 0V and 8V VDIM gives between 3% and 97% PWM duty cycle. Information regarding PWM dimming ratios and performance can be found in the LT3954 data sheet in the applications section. Analog dimming is also simple to use with a single voltage source on the CTRL terminal.

Modifications can be made to DC2079A in order to convert the board to power different LED strings or from an LED driver to a constant voltage regulator or battery charger. It can easily be changed from a boost topology to a SEPIC, buck mode, or buck-boost mode LED driver. Please consult the factory or the LT3954 data sheet for details. It can be modified to provide LED+ to GND short-circuit protection as well.

The LT3954 data sheet gives a complete description of the part, operation and applications information. The data sheet must be read in conjunction with this demo manual for demonstration circuit DC2079A. The LT3954EUHE is assembled in a 36-lead plastic QFN package with two thermal pads underneath the IC. Proper board layout is essential for maximum thermal performance. See the Layout Considerations section in the data sheet.

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

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

PARAMETER	CONDITION	VALUE (TYPICAL)
Input Voltage PVIN Range	Operating	5V to V_{LED} (Up to 40V)
Switching Frequency	R1 = 28.7k	350kHz
I_{LED}	RS1 = 0.39Ω 8.4V < PVIN < V_{LED} (40V)	645mA
Low PVIN I_{LED} (CTRL Foldback)	RS1 = 0.39Ω, PVIN = 6.0V RS1 = 0.39Ω , PVIN = 7.0V RS1 = 0.39Ω, PVIN = 8.0V	486mA 577mA 640mA
V_{LED} Range	R7 = 1M, R8 = 37.4k	PV_{IN} < V_{LED} < 32V
Open LED Voltage	R7 = 1M, R8 = 37.4k	34.8V
Typical Efficiency	PV_{IN} =14V, V_{LED} = 32V, I_{LED} = 645mA PWM = $INTV_{CC}$	94.6%
PVIN Undervoltage Lockout (Falling Turn-Off)	R3 = 499k and R4 = 147k	5.3V
PVIN Undervoltage Lockout (Rising Turn-On)	R3 = 499k and R4 = 147k	6.5V
$INTV_{CC}$	Operating	7.85V
Peak Switch Current Limit		5.4A
PWMOUT Dimming Duty Cycle	V_{DIM} = 8.0V V_{DIM} = 4.0V V_{DIM} = 1.5V V_{DIM} = 0V	97.5% 50% 10% 3.1%
Internal PWM Dimming Frequency	C16 = 0.047µF, 0V < V_{DIM} < 8V	300Hz

QUICK START PROCEDURE

Demonstration circuit DC2079A is easy to set up to evaluate the performance of the LT3954. Follow the procedure below:

1. Connect a string of LEDs that will run with forward voltage less than or equal to 32V, but greater than the intended PVIN, to the LED+ and LED– terminals on the PCB as shown in Figure 1.
2. Connect the EN/UVLO terminal to GND.
3. With power off, connect the input power supply to the PV_{IN} and GND terminals. Make sure that the PV_{IN} DC input voltage will not exceed 40V (or V_{LED}).
4. Connect the DIM terminal to a voltage between 0V and 8V to set the internal PWMOUT dimming duty cycle. If this terminal is left floating the converter will run with approximately 12% PWMOUT dimming duty cycle. Pull the PWM terminal high to $INTV_{CC}$ to set the converter at 100% duty cycle.
5. Turn the input power supply on and make sure the voltage is between 6.5V and 40V (or V_{LED}) to start.
6. Release the EN/UVLO-to-GND connection.
7. Observe the LED string running at the pro-grammed LED current and brightness related to the programmed PWMOUT duty cycle.
8. To change the brightness with PWM dimming, simply vary the V_{DIM} voltage between 0V and 8V with the PWM terminal floating.
9. To change the brightness with analog dimming, simply attach a voltage source on the CTRL terminal and reduce the voltage below 1.2V.
10. Observe the reduction of brightness in the LED string when PWM or analog dimming.

QUICK START PROCEDURE

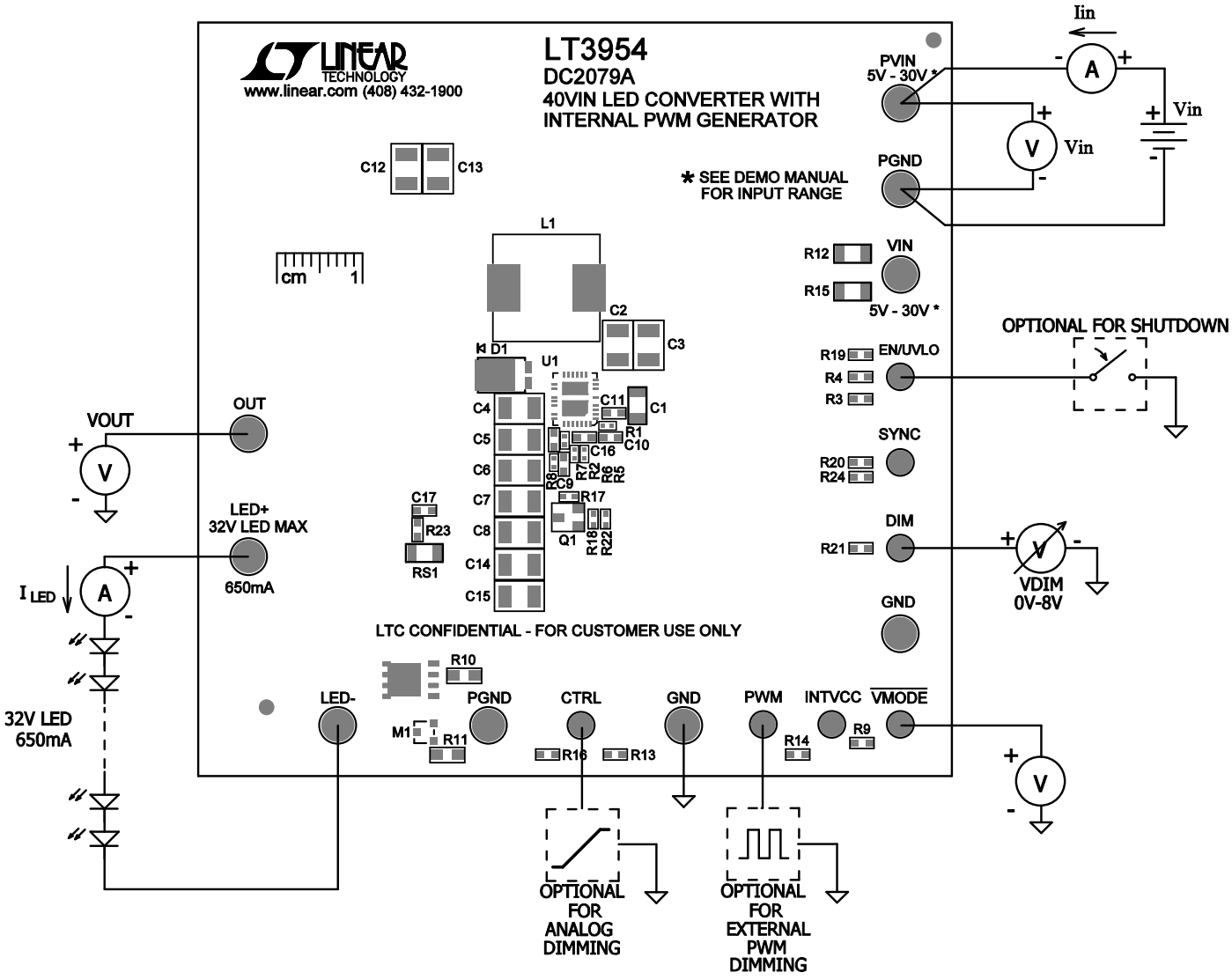


Figure 1. Test Procedure Setup Drawing for DC2079A

QUICK START PROCEDURE

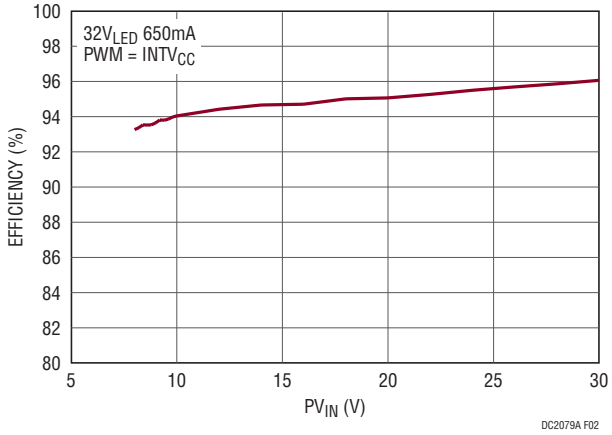


Figure 2. DC2079A Efficiency with 32V LEDs at 650mA and 100% PWMOUT Duty Cycle

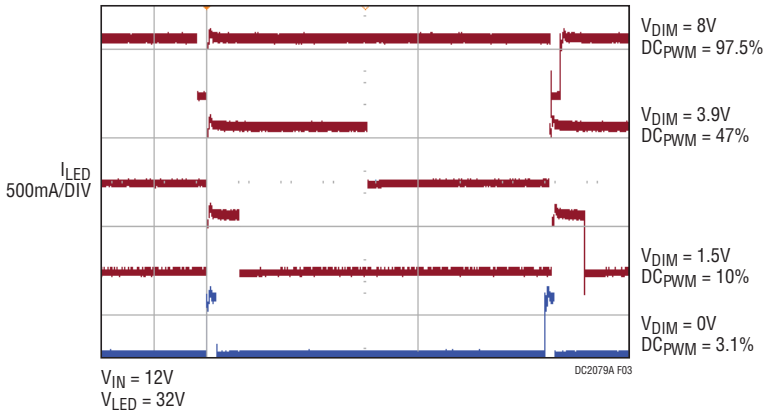


Figure 3. DC2079A 300Hz PWM Dimming Waveforms at Different PWMOUT Duty Cycles

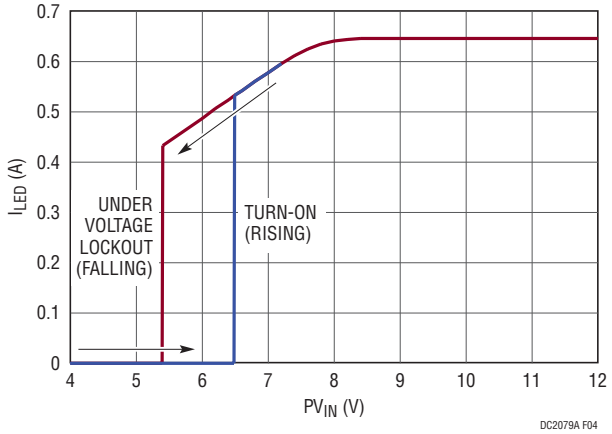
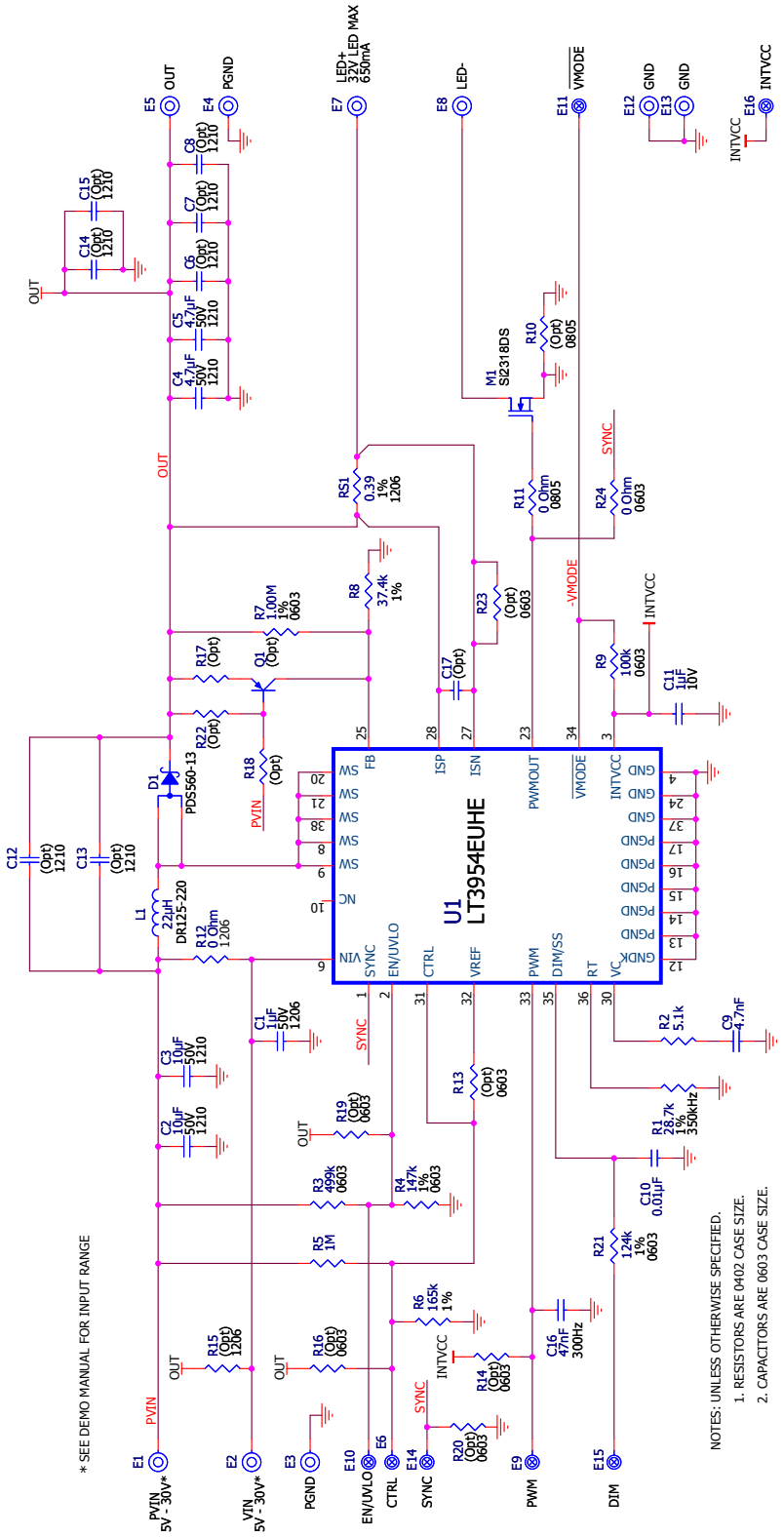


Figure 4. DC2079A CTRL LED Current Foldback at Low PV_{IN} with UVLO (Falling and Rising)

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	C1	Cap., X5R 1µF 50V 20% 1206	TDK C3216X5R1H105M
2	1	C2	Cap., X5R 10µF 50V 20% 1210	Taiyo Yuden UMK325BJ106MM-T
3	2	C4, C5	Cap., X5R 4.7µF 50V 20% 1210	Taiyo Yuden UMK325BJ475MM-T
4	1	C9	Cap., X7R 4.7nF 25V 20% 0603	AVX 06033C472MAT2A
5	1	C10	Cap., X7R 0.01µF 25V 10% 0603	AVX 06033C103KAT2A
6	1	C11	Cap., X7R 1µF 10V 10% 0603	Taiyo Yuden LMK107BJ105KA
7	1	C16	Cap., X7R 47nF 16V 20% 0603	Taiyo Yuden EMK107BJ473MA
8	1	D1	Schottky Diode 5A PowerDi5	Diodes Inc. PDS560-13
9	1	L1	Inductor, 22µH	Cooper Coiltronics DR125-220
10	1	M1	Mosfet N-Chan., 40V SOT23	Siliconix Si2318CDS-T1-GE3
11	1	RS1	Res., Chip 0.39, 0.25W 1% 1206	Panasonic ERJ-8RQFR39V
12	1	R1	Res., Chip 28.7k 0.06W 1% 0402	Vishay CRCW040228K7FKED
13	1	R2	Res., Chip 5.1k 0.06W 5% 0402	Vishay CRCW04025K10JNED
14	1	R7	Res., Chip 1.00M 0.06W 1% 0603	Vishay CRCW06031M00FKEA
15	1	R8	Res., Chip 37.4k 0.06W 1% 0402	Vishay CRCW040237K4FKED
16	1	R21	Res., Chip 124k 0.06W 1% 0603	Vishay CRCW0603124KFKEA
17	1	U1	I.C.,40Vin/ 40Vout LED Driver	Linear Tech. Corp. LT3954EUHE
Optional Circuit Components				
1	1	C3	Cap., X5R 10µF 50V 20% 1210	Taiyo Yuden UMK325BJ106MM-T
2	0	C6-C8, C12-C15	Cap., 1210	Optional
3	0	C17	Cap., 0603	Optional
4	0	Q1	Diode, SOT23	Optional
5	1	R3	Res., Chip 499k 0.06W 1% 0603	Vishay CRCW0603499KFKEA
6	1	R4	Res., Chip 147k 0.06W 1% 0603	Vishay CRCW0603147KFKEA
7	1	R5	Res., Chip 1M 0.06W 1% 0402	Vishay CRCW04021M00FKED
8	1	R6	Res., Chip 165k 0.06W 1% 0402	Vishay CRCW0402165KFKED
9	1	R9	Res., Chip 100k 0.06W 5% 0603	Vishay CRCW0603100KJNEA
10	0	R10	Res., 0805	Optional
11	1	R11	Res., Chip 0Ω 0.33W 6A 0805	Vishay CRCW08050000Z0EA
12	1	R12	Res., Chip 0Ω 0.5W 10A 1206	Vishay CRCW12060000Z0EA
13	0	R13, R14, R16, R19, R20, R23	Res., 0603	Optional
14	0	R15	Res., 1206	Optional
15	0	R17, R18, R22	Res., 0402	Optional
16	1	R24	Res., Chip 0Ω 0.25W 5A 0603	Vishay CRCW06030000Z0EA
Hardware				
1	9	E1-E5, E7, E8, E12, E13	Turret, Testpoint	Mill Max 2501-2-00-80-00-00-07-0
2	7	E6, E9-E11, E14-E16	Turret, Testpoint	Mill Max 2308-2-00-80-00-00-07-0

SCHEMATIC DIAGRAM



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