LT3761EMSE High Voltage LED Controller with Internal PWM Dimming

DESCRIPTION

DC1772A is a high voltage LED controller with internal PWM dimming. It generates its own PWMOUT waveform for accurate PWM dimming with up to 25:1 brightness ratio. It accepts an input voltage from 8V to 60V (8V UVLO and 9.1V rising turn-on), and drives up to 60V of LEDs at 1A (when PVIN is less than V_{LED}). DC1772A features both PWM and analog dimming of the LED string. It has an $\overline{\text{OPENLED}}$ flag that indicates when the LED string has been removed.

DC1772A features high efficiency at 350kHz switching frequency. At high LED string voltages up to 60V and 1A of LED current, the single switch controller has 94% efficiency. The open LED overvoltage protection uses the IC's constant voltage regulation loop to regulate the output to approximately 69.8V if the LED string is opened although it may reach 74V peak during transient from running LEDs to open. The maximum LED string voltage can be raised from 60V to 65V (or higher) with a simple change of feedback resistors.

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 PVIN drops below 8V.

DC1772A PWM dimming is simplified when compared with other LED drivers. The LT®3761 generates its own PWMOUT dimming waveform at a frequency determined by the capacitance on the PWM pin (C8 gives 300Hz for DC1772A). The PWMOUT duty cycle is determined by the voltage on the DIM terminal. Between 0V and 7.7V VDIM gives between 4% and 96% PWM duty cycle. Information regarding PWM dimming ratios and performance can be found in the LT3761 data sheet in the Applications Information section. Analog dimming is also simple to use with a single voltage source on the CTRL terminal.

Modifications can be made to DC1772A in order to convert the board to higher or lower power 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 LT3761 data sheet for details. It can be modified to provide LED+ to GND short-circuit protection as well.

The LT3761 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 DC1772A. The LT3761EMSE is assembled in a 16-lead plastic MSOP MSE package with a thermally enhanced ground pad. 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 http://www.linear.com/demo

PERFORMANCE SUMMARY Specifications are at T_A = 25°C

PARAMETER	CONDITION	VALUE (TYPICAL)
Input Voltage PVIN Range	Operating	8V to V_{LED} (Up to 60V)
Switching Frequency	R6 = 29.4k	350kHz
I_{LED}	RS2 = 0.25Ω 10V < PVIN < V_{LED} (60V)	1A
Low PVIN I_{LED} (CTRL Foldback)	RS2 = 0.25Ω PVIN = 8.5V RS2 = 0.25Ω PVIN = 9V	930mA 975mA
V_{LED} Range	R3 = 1M R4 = 18.2k	PVIN < V_{LED} < 60V
Open LED Voltage	R3 = 1M R4 = 18.2k	69.8V
Typical Efficiency	PVIN = 14V V_{LED} = 60V I_{LED} = 1A PWM = INTVCC	94%
PVIN Under Voltage Lockout (Falling Turn-Off)	R1 = 499k and R2 = 90.9k	8V
PVIN Under Voltage Lockout (Rising Turn-On)	R1 = 499k and R2 = 90.9k	9.1V
INTVCC	Operating	7.85V
Peak Switch Current Limit	RS1 = 0.008Ω	12.5A
PWMOUT Dimming Duty Cycle	VDIM = 7.7V VDIM = 4V VDIM = 1.5V VDIM = 0.4V	96% 50% 10% 4.3%
Internal PWM Dimming Frequency	C8 = 0.047µF 0V < VDIM < 7.7V	300Hz

QUICK START PROCEDURE

Demonstration circuit 1772A is easy to set up to evaluate the performance of the LT3761EMSE. Follow the procedure below:

1. Connect a string of LEDs that will run with forward voltage less than 60V, but greater than 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 PVIN and GND terminals. Make sure that the PVIN DC input voltage will not exceed 60V (or V_{LED}).
4. Connect the DIM terminal to a voltage between 0V and 7.7V 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 INTVCC to set the converter at 100% duty cycle.
5. Turn the input power supply on and make sure the voltage is between 8V and 60V (or V_{LED}).
6. Release the EN/UVLO-to-GND connection.
7. Observe the LED string running at the programmed LED current and brightness related to the programmed PWMOUT duty cycle.
8. To change the brightness with PWM dimming, simply vary the VDIM voltage between 0V and 7.7V 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

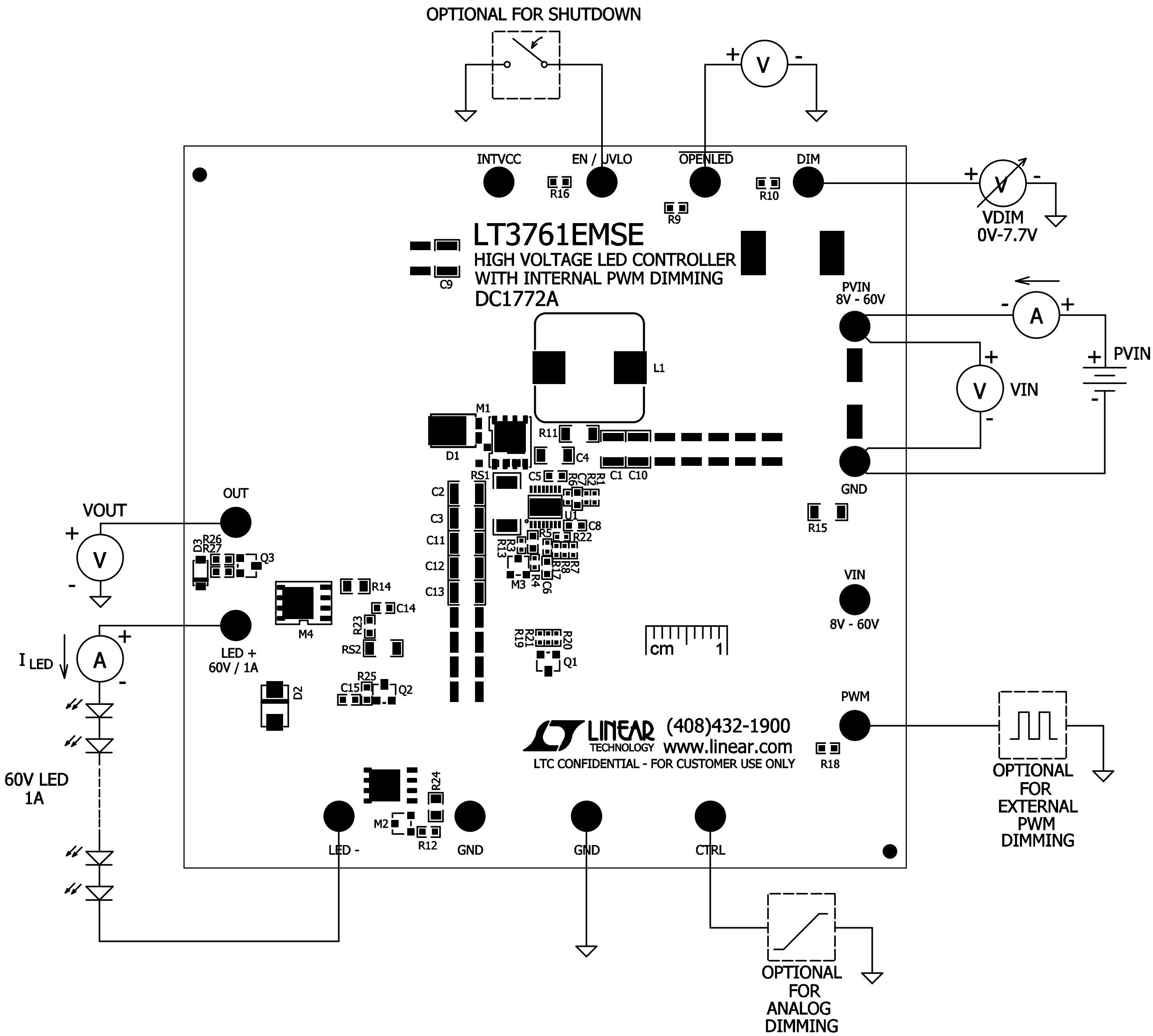


Figure 1. Test Procedure Setup Drawing for DC1772A

QUICK START PROCEDURE

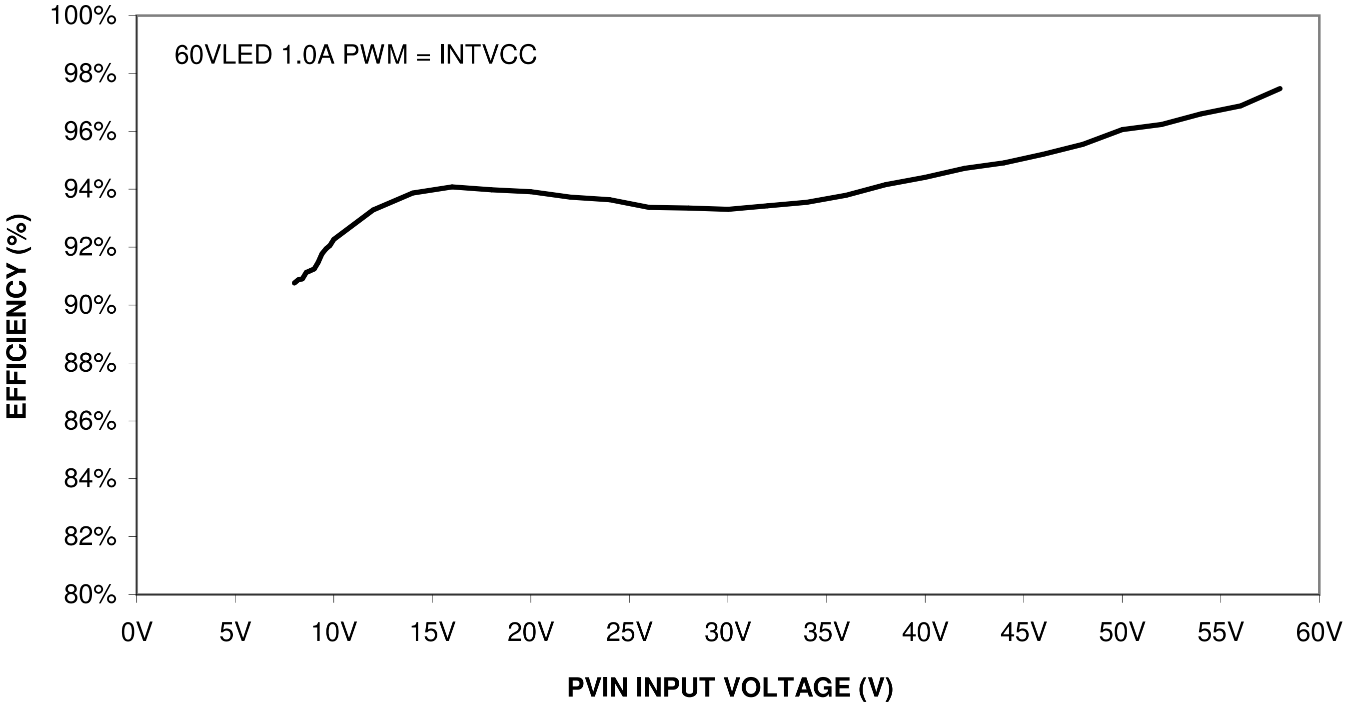


Figure 2. DC1772A Efficiency with 60V LEDs at 1A and 100% PWMOUT Duty Cycle

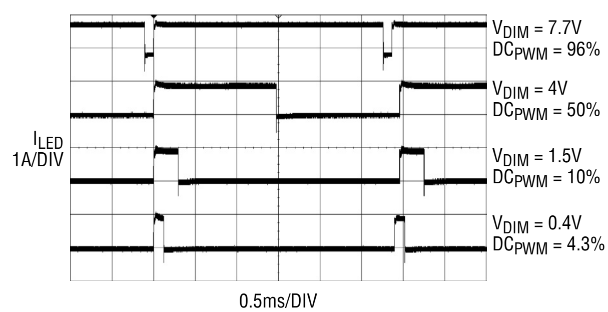


Figure 3. DC1772A 300Hz PWM Dimming Waveforms at Different PWMOUT Duty Cycles

QUICK START PROCEDURE

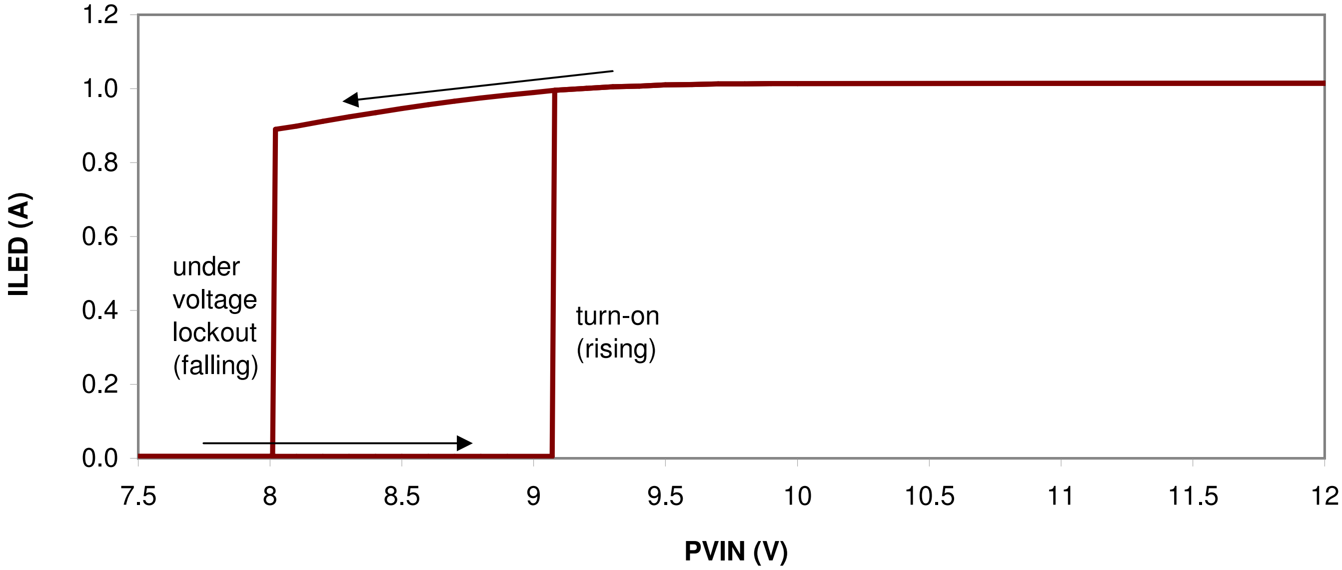
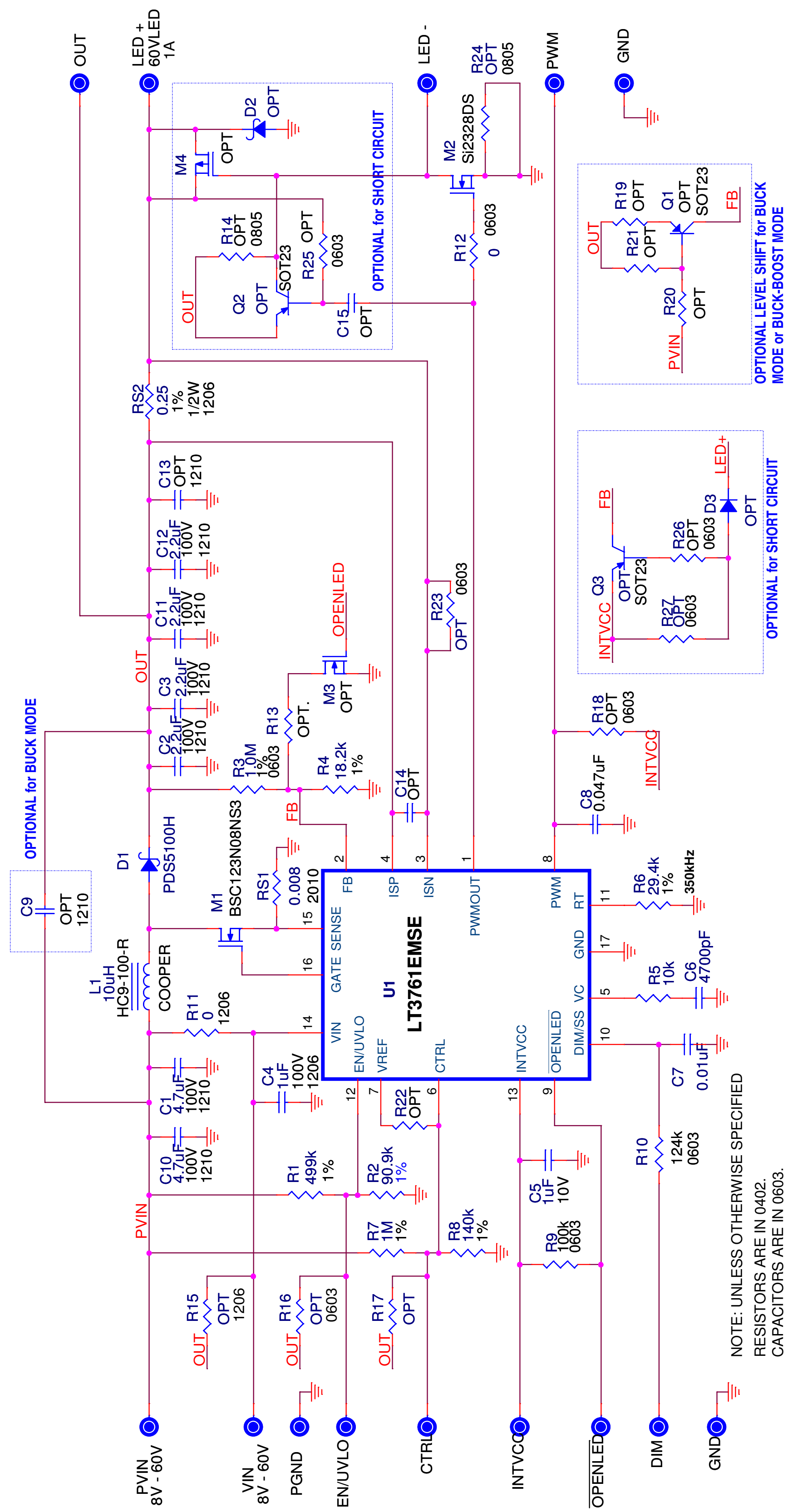


Figure 4. DC1772A CTRL LED Current Foldback at Low PVIN with UVLO Falling and Rising

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	2	C1, C10	Cap., X7S 4.7µF 100V 10% 1210	TDK C3225X7S2A475K
2	4	C2, C3, C11, C12	Cap., X7R 2.2µF 100V 10% 1210	TDK C3225X7R2A225K
3	1	C4	Cap., X7R 1µF 100V 20% 1206	TDK C3216X7R2A105M
4	1	C5	Cap., X5R 1µF 10V 10% 0603	AVX, 0603ZD105KAT2A
5	1	C6	Cap., X7R 4700pF 25V 20% 0603	AVX, 06033C472MATAT2A
6	1	C7	Cap., X5R 0.01µF 16V 20% 0603	AVX, 0603YD103MAT2A
7	1	C8	Cap., X7R 0.047µF 50V 10% 0603	AVX, 06035C473KAT2A
8	1	D1	Schottky Diode 5A PowerDi5	Diodes Inc. PDS5100H
9	1	L1	Inductor, 10µH HC9-SERIES/COOPER	Cooper Bussmann, HC9-100-R
10	1	M1	MOSFET N-Chan., 100V	Infineon, BSC123N08NS3G
11	1	M2	MOSFET N-Chan., 100V	Siliconix Si2328DS-T1-GE3
12	1	RS1	Res., Chip., 0.008Ω 1/2W 1% 2010	Vishay WSL20108L000FEA
13	1	RS2	Res., Chip., 0.25Ω 1/2W 1% 1206	Vishay WSL1206R2500FEA
14	1	R1	Res., Chip, 499k 0.06W 1% 0402	Vishay CRCW0402499KFKED
15	1	R2	Res., Chip, 90.9k, 0.06W 1% 0402	Vishay CRCW040290K9FKED
16	1	R3	Res., Chip, 1M, 0.1W 1% 0603	Vishay CRCW06031M00FKED
17	1	R4	Res., Chip, 18.2k, 0.06W 1% 0402	Vishay CRCW040218K2FKED
18	1	R5	Res., Chip 10k, 0.06W 5% 0402	Vishay CRCW040210K0JKED
19	1	R6	Res., Chip, 29.4k, 0.06W 1% 0402	Vishay CRCW040229K4FKED
20	1	R7	Res., Chip 1M, 0.06W 5% 0402	Vishay CRCW04021M00JKED
21	1	R8	Res., Chip, 140k, 0.06W 1% 0402	Vishay CRCW0402140KFKED
22	1	R9	Res., Chip 100k, 0.1W 5% 0603	Vishay CRCW0603100KJKEA
23	1	R10	Res., Chip, 124k, 0.1W 1% 0603	Vishay CRCW0603124KFKED
24	1	U1	I.C., LED Driver MSOP(16)-MSE	Linear Tech. Corp. LT3761EMSE
Optional Electrical Components				
1	0	C9, C13(OPT)	Cap., 1210	
2	0	C14, C15 (OPT)	Cap., 0603	
3	0	D2 (OPT)	Rectifier, ESIC SMA	
4	0	D3 (OPT)	Diode, 1N4148W, SOD-123	
5	0	M3 (OPT)	MOSFET N-Chan., SOT23	(OPT)
6	0	M4 (OPT)	MOSFET P SO8-PWR	(OPT)
7	0	Q1, Q2, Q3 (OPT)	PNP SOT23	(OPT)
8	1	R11	Res., Chip, 0Ω, 1206	Vishay CRCW12060000Z0EA
9	1	R12	Res., Chip 0Ω, 0603	Vishay CRCW06030000Z0ED
10	0	R13, R17, R19-22 (OPT)	Res., 0402	
11	0	R14, R24 (OPT)	Res., 0805	
12	0	R15 (OPT)	Res., 1206	
13	0	R16, R18, R23, R25-R27 (OPT)	Res., 0603	
Optional Hardware				
1	14	E1-E14	Turret, Testpoint	Mill Max 2501-2-00-80-00-00-07-0

SCHEMATIC DIAGRAM



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