LT3952AEFE
2MHz 60V LED Driver with Internal 4A Switch

DESCRIPTION

Demonstration circuit DC2361A is a 2MHz 60V LED driver with internal 4A switch featuring the LT3952A monolithic LED driver. It accepts an input voltage from 8V to 28V (with transient to 36V) and boosts to a single string of LEDs up to 40V at 330mA. DC2361A features an integrated 4A switch, constant current and constant voltage output control as well as input current limit and monitoring.

The LT3952A has a wide input voltage range down to 3V and up to 42V. It has adjustable switching frequency between 200kHz and 3MHz. It has an option for external frequency synchronization or spread spectrum frequency modulation. It has high PWM dimming capability from an external signal and can be PWM dimmed with an internally generated PWM oscillator and analog input signal. It can be analog dimmed with a control voltage on its control pin. LT3952A features both open LED and short LED (LED^+ to GND) protection as well as fault output flags for each. Although DC2361A is assembled as a boost LED driver, it can be altered to be run as a buck mode, buck-boost mode or boost-buck LED driver.

There is another demonstration circuit featuring LT3952A at 350kHz (DC2013A).

DC2361A features an option to turn on spread spectrum by simply changing the position of a jumper from NO SPREAD to SPREAD or to EXTERNAL SYNC.

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 45V if the LED string is opened although it may reach 49V peak during transient from running LEDs to open. There is a protection diode from LED^+ to GND to prevent negative ringing during a short-circuit with long wires.

There is undervoltage and overvoltage lockout that can be adjusted on the circuit with a few simple resistor choices.

There is a small EMI filter on the input of DC2361A. This EMI filter has a ferrite bead and very small cap to reduce high frequency EMI. The PCB layout contains a small hot-loop for minimized very high frequency EMI. The EMI filter can be used by connecting to the 'EMI VIN' terminal. However, if the EMI filter is not needed, the input connection can be directly to the PV_{IN} terminal. If the EMI filter is not used, it is recommended to remove the EMI filter if EMI measurements are being made from the PV_{IN} terminal for base EMI testing. It can be replaced for EMI testing at the EMI V_{IN} terminal.

The LT3952A 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 DC2361A. The LT3952AEFE is assembled in a 28-lead plastic TSSOP (FE) package with a thermally enhanced ground pad. Proper board layout is essential for maximum thermal performance. See the Layout Considerations section.

Design files for this circuit board are available.

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

PARAMETER	CONDITIONS	MIN	TYP	MAX
Input Voltage PV_{IN} and EMI V_{IN} Range	Operating V_{IN} = PV_{IN} V_{LED} > 36V	8V		28V
Switching Frequency	R5 = 40.2k		2MHz	
I_{LED}	R1 = 0.75Ω 8.0V < PV_{IN} < 36V V_{LED} > 36V		333mA	
V_{LED} range	R2 = 1M R3 = 26.7k	PV_{IN}		40V
Open LED Voltage V_{OUT}	R2 = 1M R3 = 26.7k		43.5V	
Typical Efficiency (100% PWM DC)	PV_{IN} = 14V V_{LED} = 40V I_{LED} = 333mA		90%	
Input Under Voltage Lockout (Falling Turn-Off)	R7 = 499k R8 = 71.5k R9 = 25.5k		7.6V	
Input Under Voltage Lockout (Rising Turn-On)	R7 = 499k R8 = 71.5k R9 = 25.5k		9.1V	
VISMON	Operating I_{LED} = 330mA		1.0V	
Peak Switch Current Limit	Operating		4A	

QUICK START PROCEDURE

Demonstration circuit 2361A is easy to set up to evaluate the performance of the LT3952A Follow the procedure below:

1. Connect a string of LEDs that will run with forward voltage less than or equal to 40V (at 330mA), but greater than PVIN, to the LED^+ and GND 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 EMI V_{IN} (or PV_{IN}) and GND terminals. Make sure that the DC input voltage will not exceed 28V (or V_{LED}).
4. Turn the input power supply on and make sure the voltage is between 8V and 28V (or V_{LED}) for proper operation.
5. Release the EN/UVLO-to-GND connection.
6. Observe the LED strings running at the programmed LED current.
7. To change the brightness with analog dimming, simply attach a voltage source to the CTRL terminal and set the voltage between 0V and 1.5V. See data sheet for details.
8. To change brightness with external PWM dimming, attach a 3V rectangular waveform with varying duty cycle to the PWM terminal.
9. To enable spread spectrum frequency modulation, simply change the position of the shunt on the SYNC/SPRD jumper to the SPREAD SPECTRUM position.

DEMO CIRCUIT OPTIONS

Demonstration circuit 2361A can be adjusted for higher or lower output voltage, different LED current, or different topology. The following options are for simple changes to the demonstration circuit. The data sheet gives more information regarding designing with the LT3952A. For more information, see the data sheet for details or contact Analo Devices customer support.

MAXIMUM LED VOLTAGE

DC2361A is set for 44V of overvoltage protection and the maximum LED string voltage used on the standard build should be 40V. LT3952A output voltage can be set higher with an adjustment to the OVP resistors. When raising output voltage, be sure not to violate the maximum duty cycle limit at 2MHz (or adjusted frequency), the 60V abs max output voltage of the part (including open LED output overshoot), and 4A peak switch current limit at low V_{IN}. See data sheet for details.

CURRENT OR VOLTAGE REGULATION

The LT3952A can be used for constant current or voltage regulation. If the load placed on the LED^+ to GND terminals allows V_{OUT} to climb high enough for V_{FB} = 1.2V, then the voltage regulation loop of the converter takes over. In this case, the compensation for a given channel should be adjusted for proper use as a constant voltage regulator. The IC can be used as a boost or SEPIC constant voltage regulator. Output voltage should remain below 60V when used as a constant voltage device.

LED CURRENT

LED current on DC2361A is set for 330mA with 0.75Ω resistor R1. For a different maximum LED current, change this resistor. $250mV/R_{LED} = I_{LED}$.

A change in LED current or input voltage may lead to higher or lower maximum switch current. The maximum switch current for this converter is 4A and is fixed internally.

OVERVOLTAGE PROTECTION

Overvoltage protection is set with the resistor pair R2 and R3 for the boost topology. For buck mode, buck-boost mode, and boost-buck see data sheet for details how to set the feedback resistors. Note that R19, R20, R21, and Q1 are provided as optional placeholders on the demonstration circuit for simple feedback resistor changes for these topologies.

UNDERVOLTAGE AND OVERVOLTAGE LOCKOUT

UVLO and OVLO can be adjusted by changing the values of R7, R8 and R9.

Resistors R10 and R11 are available for setting UVLO and OVLO separately.

DEMO CIRCUIT OPTIONS

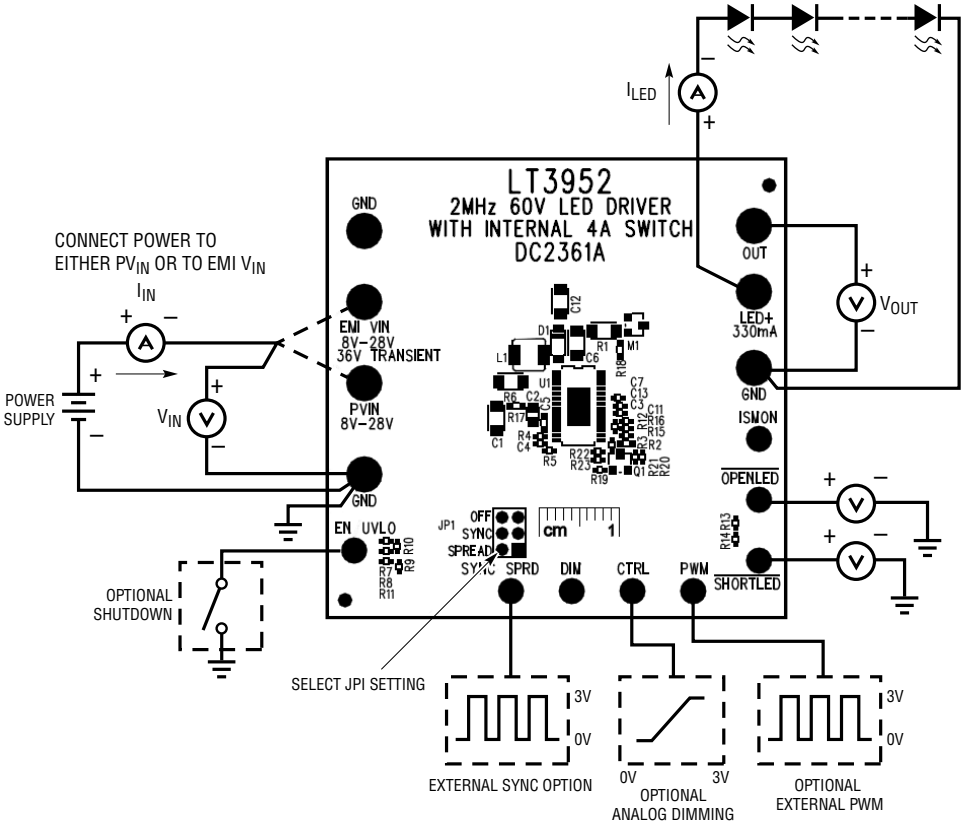


Figure 1. Test Procedure Setup Drawing for DC2361A

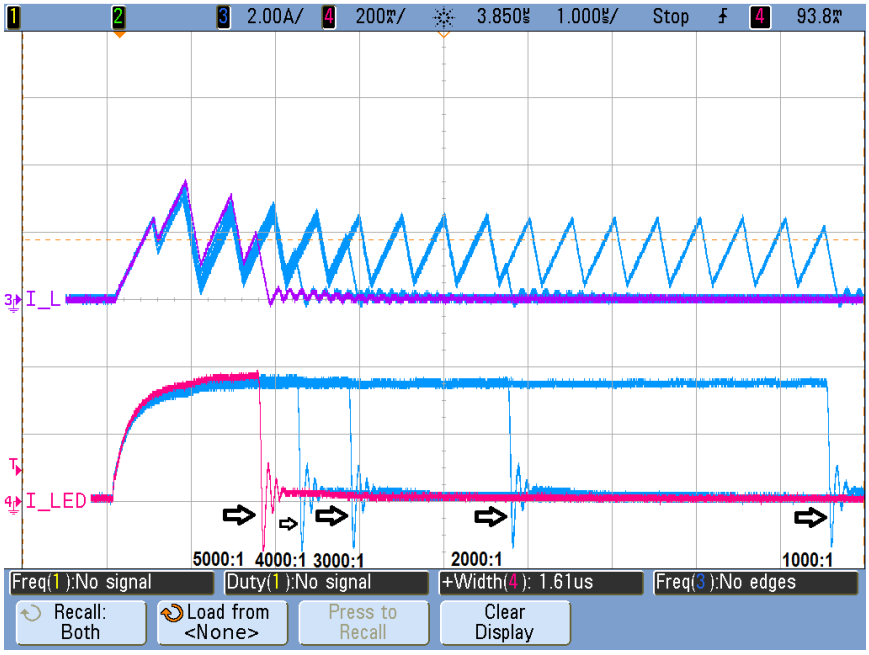


Figure 2. DC2361A 12V_{IN} 120Hz PWM Dimming Waveforms at Different PWM Duty Cycles with 5000:1 in Bold. I_{LED} Waveform (200mA/Div) Is on the Bottom (with 40V LED String) and IL1 Waveform (2A/Div) Is on the Top.

DEMO CIRCUIT OPTIONS

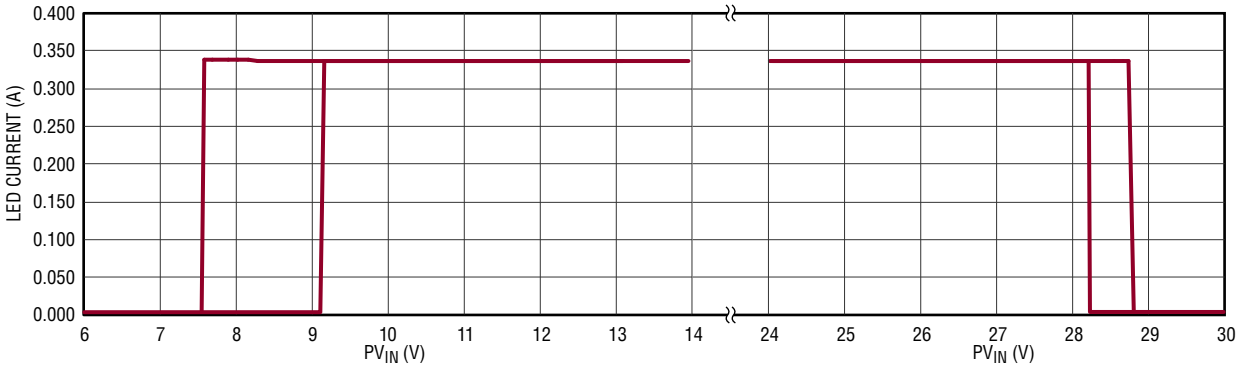


Figure 3. DC2361A UVLO and OVLO Falling and Rising

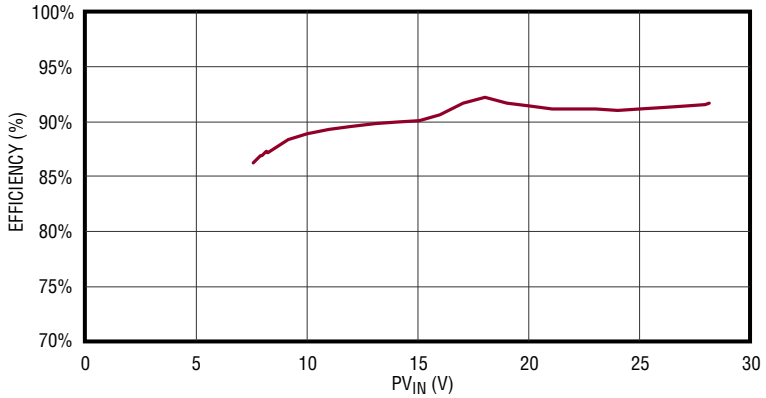
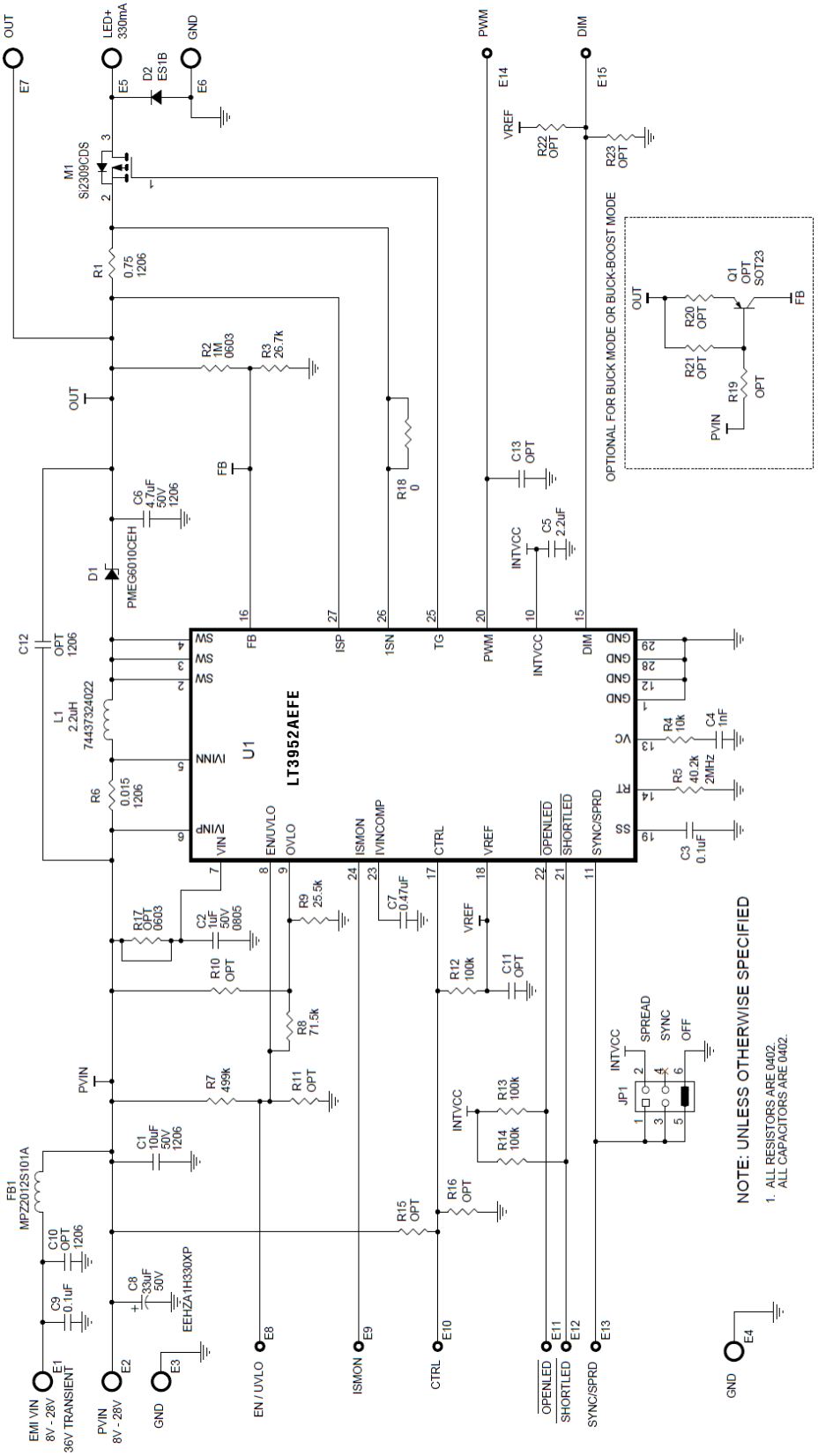


Figure 4. DC2361A Efficiency at Maximum I_{LED} vs PV_{IN} with 40V LEDs (at 330mA)

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	C1	CAP., 10µF, X5R, 50V, 10%, 1206	MURATA, GRM31CR61H106KA12L
2	1	C2	CAP., 1µF, X7R, 50V, 10%, 0805	MURATA, GRM21BR71H105KA12L
3	1	C3	CAP., 0.1µF, X7R, 10V, 10%, 0402	MURATA, GRM155R71A104KA01D
4	1	C4	CAP., 1000pF, X5R, 10V, 10%, 0402	MURATA, GRM155R61A102KA01D
5	1	C5	CAP., 2.2µF, X5R, 6.3V, 10%, 0603	MURATA, GRM188R60J225KE19D
6	1	C6	CAP., 4.7µF, X7R, 50V, 10%, 1206	MURATA, GRM31CR71H475KA12L
7	1	D1	DIODE, SCHOTTKY, RECTIFIER, 60V, 1A,SOD-123F	NXP, PMEG6010CEH,115
8	1	L1	IND., PWR., 2.2µH, 20%, 4020	Würth Elektronik, 74437324022
9	1	M1	XSTR., MOSFET, P-CH, 60V, SOT-23	VISHAY, Si2309CDS-T1-GE3
10	1	R1	RES., 0.75Ω, 1/2W, 1%, 1206	SUSUMU, RL1632R-R750-F
11	1	R2	RES., 1M, 1/10W, 1%, 0603	VISHAY, CRCW06031M00FKEA PANASONIC, ERJ3EKF1004V
12	1	R3	RES., 26.7k, 1/16W, 1%, 0402	VISHAY, CRCW040226K7FKED
13	1	R4	RES., 10k, 1/16W, 5%, 0402	VISHAY, CRCW040210K0JNED
14	1	R5	RES., 40.2k, 1/16W, 1%, 0402	VISHAY, CRCW040240K2FKED
15	1	U1	I.C., LED Driver, TSSOP-28	LINEAR TECH., LT3952AEFE#PBF
Optional Electrical Components				
1	1	C7	CAP., 0.47µF, X5R, 10V, 10%, 0402	MURATA, GRM155R61A474KE15D
2	1	C8	CAP., ALUM. ELECT.,33µF, 50V, 20%, D8 CASE	PANASONIC, EEHZA1H330XP
3	1	C9	CAP., 0.1µF, X7R, 10V, 10%, 0402	MURATA, GRM155R71A104KA01D
4	0	C10, C12(OPT)	CAP., OPTION, 1206	OPT.
5	0	C11, C13(OPT)	CAP., OPTION, 0402	
6	1	D2	DIODE, RECTIFIER, 100V, 1A, SMA	DIODES INC., ES1B-13-F
7	1	FB1	IND., BEAD, CHIP, 100Ω, ±25%, 0805	TDK, MPZ2012S101AT
8	0	Q1(OPT)	XSTR., OPTION, PNP, SOT-23	OPT.
9	1	R6	RES., SENSE, 0.015Ω, 1W, 1%, 1206	PANASONIC, ERJ8BWFR015V
10	1	R7	RES., 499k, 1/16W, 1%, 0402	VISHAY, CRCW0402499KFKEA
11	1	R8	RES., 71.5k, 1/16W, 1% 0402	VISHAY, CRCW040271K5FKED
12	1	R9	RES., 25.5k, 1/16W, 1% 0402	VISHAY, CRCW040225K5FKED
13	0	R10, R11, R15, R16, R19-R23(OPT)	RES., OPTION, 0402	OPT.
14	3	R12, R13, R14	RES., 100k, 1/16W, 1%, 0402	VISHAY, CRCW0402100KFKED NIC, NRC04F1003TRF
15	0	R17(OPT)	RES., OPTION, 0603	OPT.
16	1	R18	RES., 0Ω, 1/10W, 0603	VISHAY, CRCW06030000Z0EA NIC, NRC06ZOTRF
Hardware				
1	7	E1-E7	TEST POINT, TURRET, .094" MTG. HOLE	MILL-MAX, 2501-2-00-80-00-00-07-0
2	8	E8-E15	TEST POINT, TURRET, .064" MTG. HOLE	MILL-MAX, 2308-2-00-80-00-00-07-0
3	1	JP1	CONN., HEADER, 2 × 3, 2mm	Würth Elektronik, 62000621121
4	1	XJP1	SHUNT, 2mm	Würth Elektronik, 60800213421

SCHEMATIC DIAGRAM



ESD Caution

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

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