LT3922
36V 2A Synchronous 2MHz Boost LED Driver

DESCRIPTION

Demonstration circuit DC2247A is a 36V 2A synchronous 2MHz boost LED driver featuring the LT®3922. It drives a single string of LEDs at 330mA up to 34V when V_{IN} is between 7V and 28V. It runs down to $4V_{IN}$ with reduced I_{LED} and can withstand V_{IN} as high as 36V, but has overvoltage lockout (OVLO) set for 28V for this application. DC2247A runs at 2MHz switching frequency. Spread spectrum frequency modulation (SSFM) can be turned on with a simple jumper, reducing EMI. DC2247A comes with low EMI features including optimized layout, SSFM, and input and output filters. It passes CISPR 25 class 5 conducted and radiated EMI. It is protected against both open and short LED conditions and reports the faults.

The LT3922 has an input voltage range from 2.8V to 36V. Its internal synchronous 2A 40V switches allow up to 34V of LEDs on the output with room for overvoltage protection and overshoot during an open LED event. It has adjustable switching frequency between 200kHz and 2.5MHz. It can be synchronized to an external source or programmed with SSFM for low EMI. The PWMTG high side PWM MOSFET driver assists with short-circuit protection and versatility. LT3922 can be configured as boost, boost-buck, or buck mode LED driver and maintain all of its low-EMI, PWM dimming and fault diagnostic features.

The LT3922 can be PWM dimmed with an external PWM signal or an internally-generated PWM signal. DC2247A has a jumper that can be set to switch between internally-generated PWM signal, externally-generated PWM signal, and no PWM signal (100% on). It can be analog dimmed with a control voltage on its CTRL pin.

When run with both PWM dimming and SSFM, the spread spectrum aligns itself with the PWM signal for flicker-free operation.

Small ceramic input and output capacitors are used to save space and cost. The board is designed with tiny, high frequency capacitors on both sides of the V_{OUT} pins for a reduction in radiated EMI. The open LED overvoltage protection uses the IC's constant voltage regulation loop to regulate the output to approximately 37.5V if the LED string is opened although it may reach almost 40V 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. The output current can be monitored through the ISMON output pin.

Undervoltage and overvoltage lockout can be adjusted on the circuit with a few simple resistor choices.

There is an EMI filter on the input of DC2247A. There is also a small ferrite bead output filter. These filters, combined with proper board layout and SSFM are effective to help the PCB pass CISPR 25 class 5 conducted and radiated EMI. Please follow the recommended layout and four-layer thickness of DC2247A for low EMI applications.

The LT3922 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 DC2247A. The LT3922EUFD is assembled in a 28-lead plastic 4mm × 5mm QFN 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.analog.com/DC2247A

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage Low EMI V_{IN} Range	Operating I_{LED} > 0mA	4		28	V
Input Voltage Low EMI V_{IN} Range	Operating V_{LED} = 34V, I_{LED} = 330mA	7		28	V
Safe Input Voltage Low EMI V_{IN} Range		0		36	V
Switching Frequency	R2 = 45.3k, SSFM = OFF		2		MHz
Switching Frequency	R2 = 45.3k, SSFM = ON		2 to 2.5		MHz
I_{LED}	R1 = 0.3Ω, 7.0V < Low EMI V_{IN} < 28V, V_{LED} = 34V		330		mA
V_{LED} Range	R4 = 1M, R5 = 33.2k	V_{IN}		34	V
Open LED Voltage V_{OUT}	R4 = 1M, R5 = 33.2k, OPEN LOAD		37.5		V
Efficiency (100% PWM DC)	PVIN = 12V, V_{LED} = 34V, I_{LED} = 330mA		90		%
Efficiency with EMI Filters Removed	PVIN = 12V, V_{LED} = 34V, I_{LED} = 330mA		91		%
Internally-Generated PWM Dimming Range	Operating JP1 = INT, JP2 = INT	1/128		100%	
Internally-Generated PWM Dimming Frequency	Operating JP1 = INT, JP2 = INT R10 = 332k		122		Hz

QUICK START PROCEDURE

Demonstration circuit DC2247A is easy to set up to evaluate the performance of the LT3922 Follow the procedure below:

1. With power off, connect a string of LEDs that will run with forward voltage less than or equal to 34V (at 330mA) to the LED^+ and LED^- terminals on the PCB as shown in Figure 1.
2. Connect the EN/UVLO terminal to GND.
3. Set JP1 to ON and JP2 to EXT/ON for 100% always-on LED operation. Set JP3 to NO SSFM to run without SSFM or external synchronization.
4. With power off, connect the input power supply to the LOW EMI VIN and GND terminals. Make sure that the input voltage will not exceed 36V.
5. Turn the input power supply on and make sure the voltage is between 5V and 36V to start operation.
6. Release the EN/UVLO-to-GND connection.
7. Observe the LED string running at the programmed LED current.
8. 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.
9. To change brightness with external PWM dimming, set JP1 to EXT and JP2 to EXT/ON. Attach a 3V rectangular waveform with varying duty cycle to the PWM terminal.
10. To change brightness with internally-generated PWM dimming, set JP1 to INT and JP2 to INT. Adjust the setting of the VR1 variable resistor with a small flat-head screwdriver to toggle between 0% and 100% PWM dimming duty cycle in 1/128 steps.
11. To enable spread spectrum frequency modulation, set JP3 to SSFM ON.

QUICK START PROCEDURE

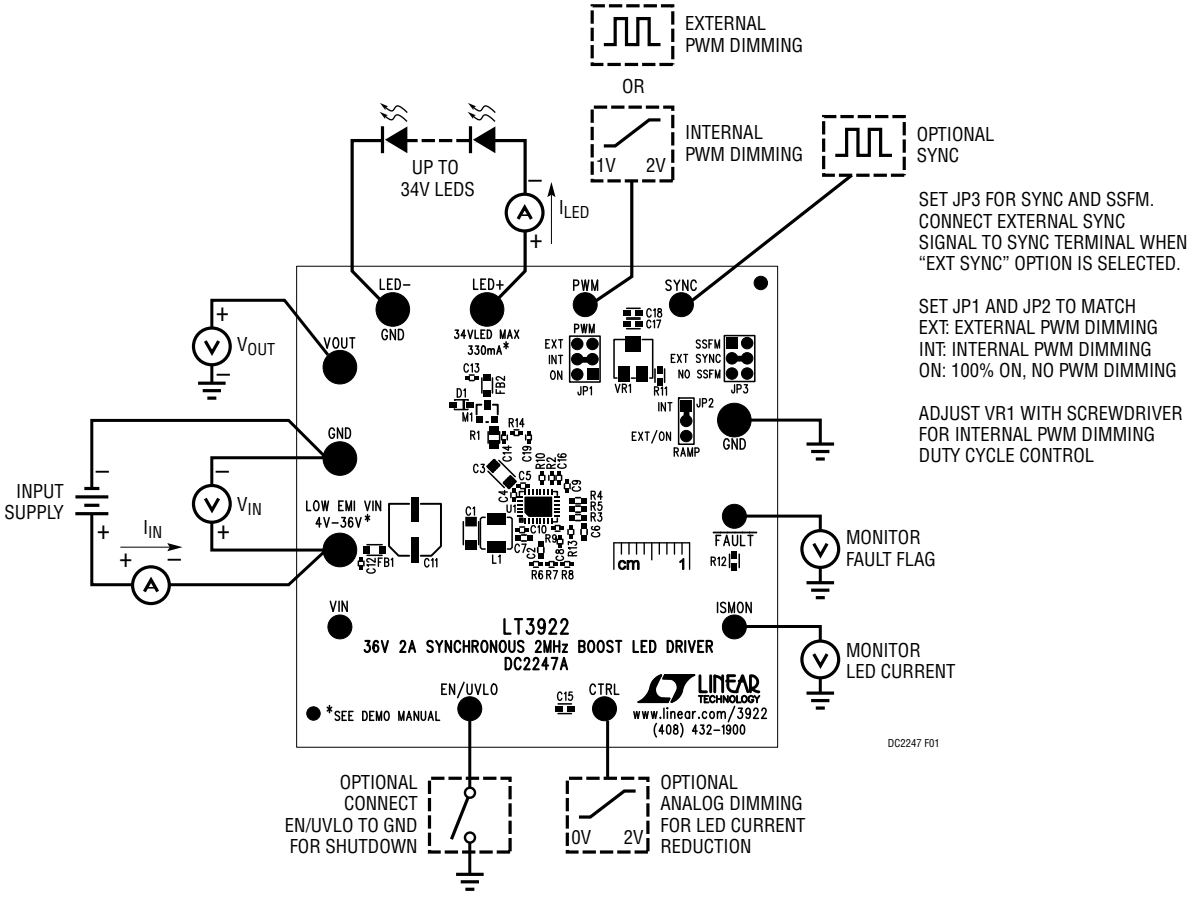


Figure 1. Test Procedure Setup Drawing for DC2247A

QUICK START PROCEDURE

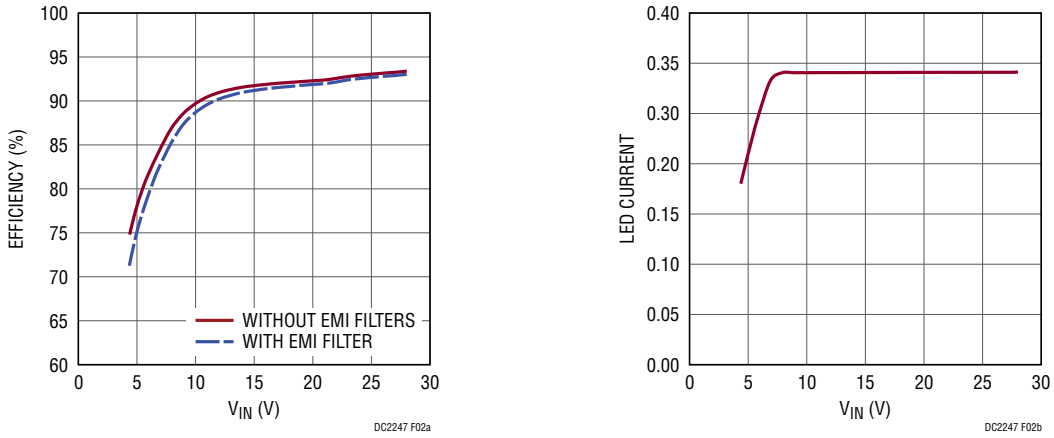


Figure 2. DC2247A Efficiency and LED Current Versus Input Voltage for 34V 330mA LED Load. Efficiency Remains High Through the Range Due to Synchronous Switching. At Low V_{IN}, I_{LED} Can Be Reduced Due to Peak Switch Current Limit

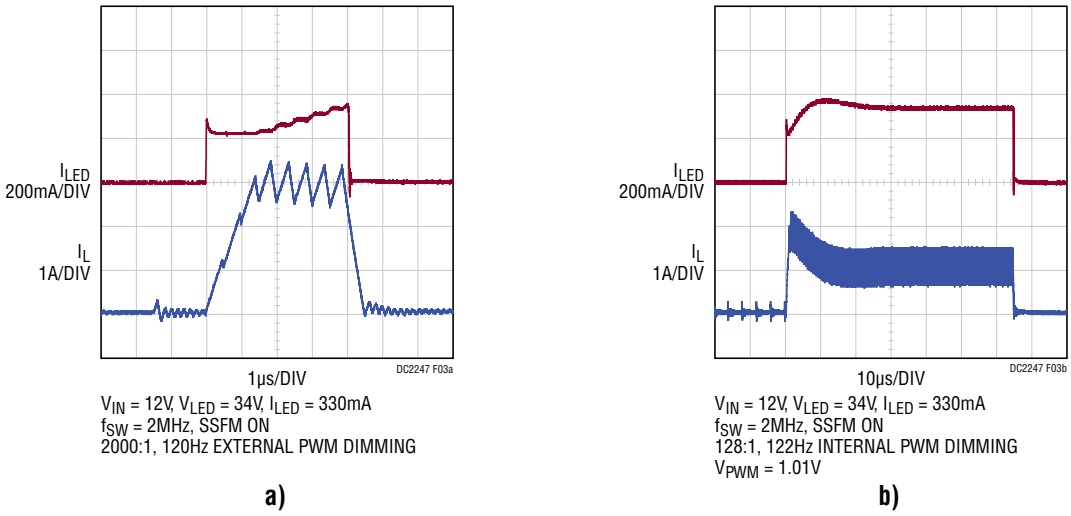


Figure 3. Infinite-Persist Scope Traces Show PWM Dimming and SSFM Working Together for Flicker-Free Brightness Control with both a) Externally and b) Internally Generated PWM Dimming

QUICK START PROCEDURE

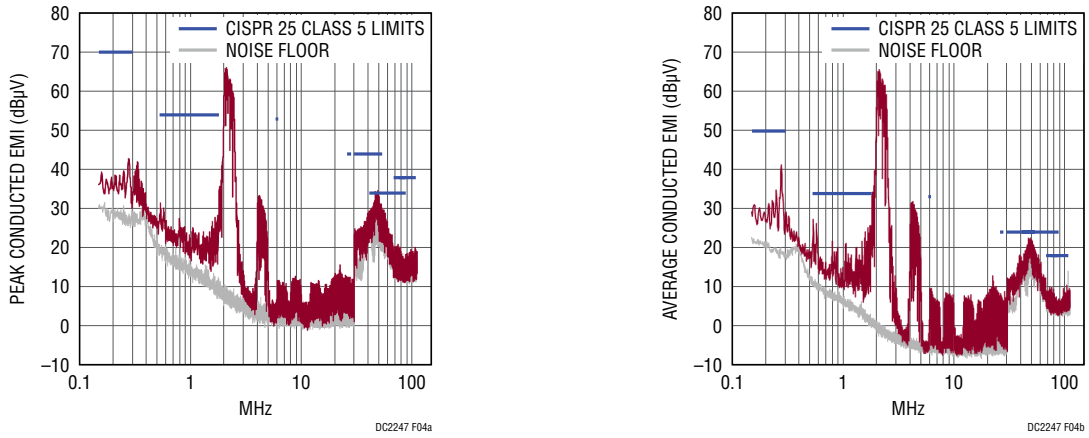


Figure 4. DC2247A Conducted Peak and Average EMI—Passes CISPR 25 Class 5 Limits.

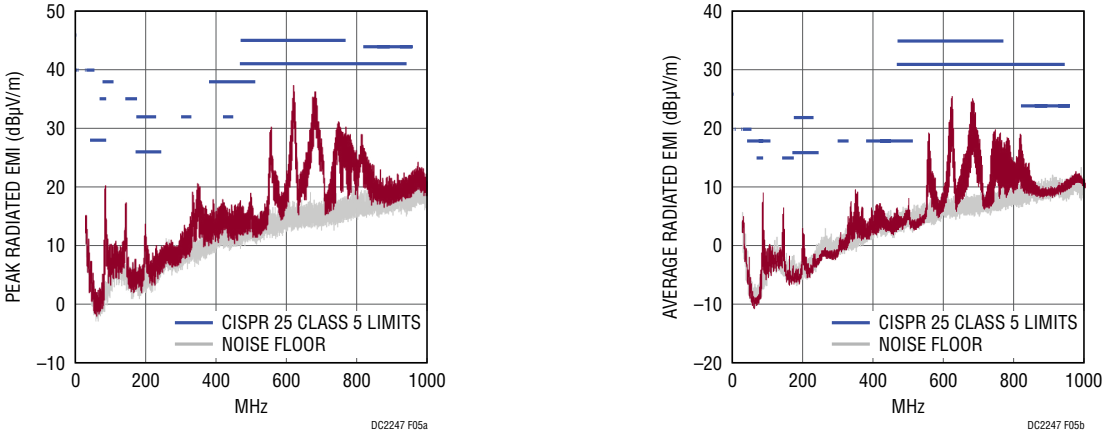


Figure 5. DC2247A Radiated Peak and Average EMI—30MHz to 1GHz—Passes CISPR 25 Class 5 Limits

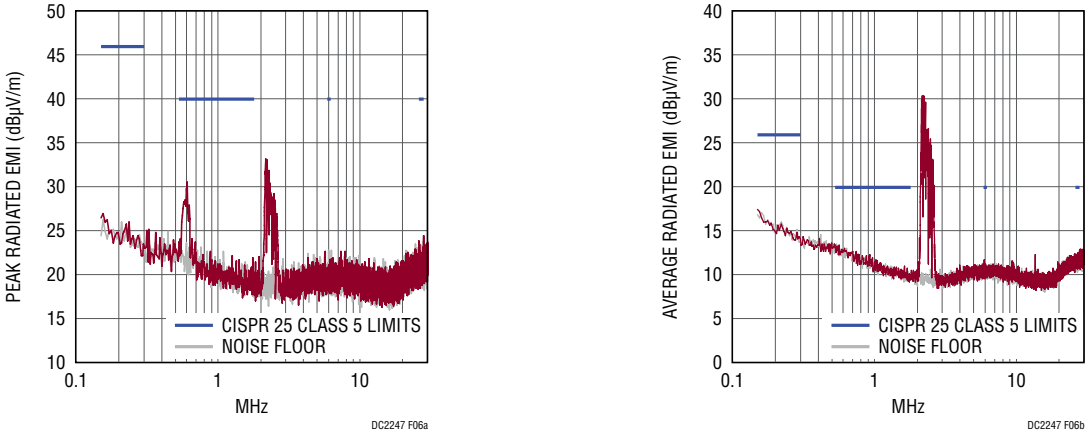
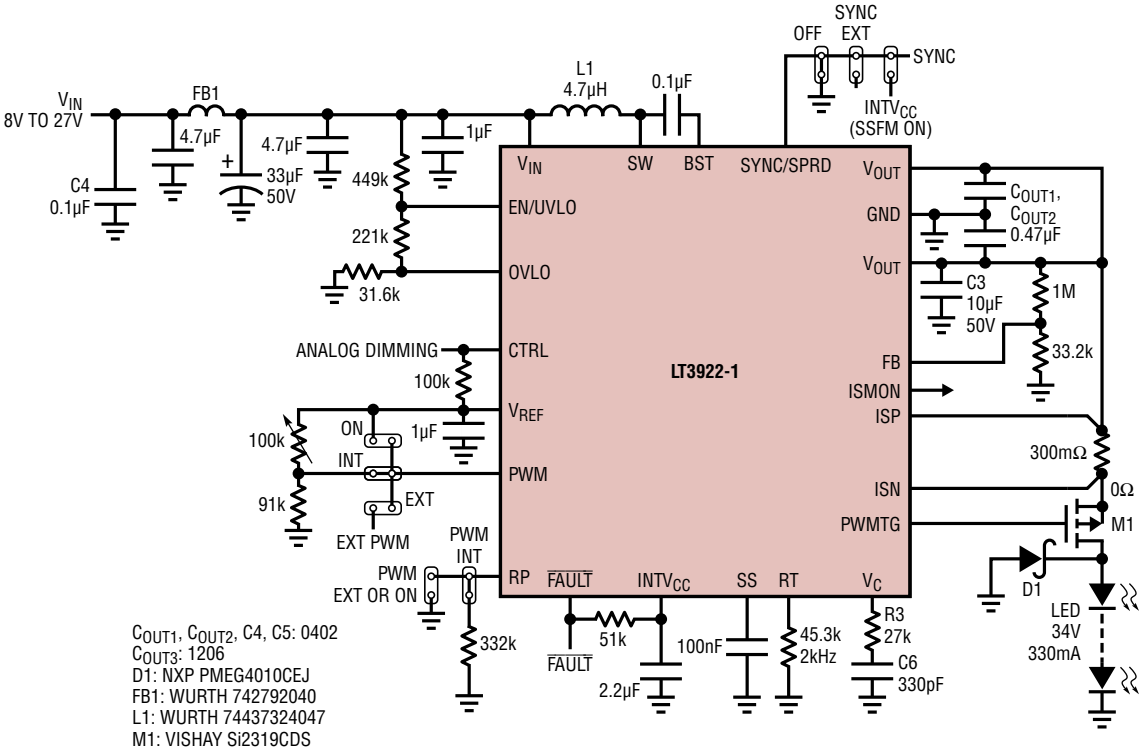


Figure 6. DC2247A Radiated Peak and Average EMI—150kHz to 30MHz—Passes CISPR 25 Class 5 Limits

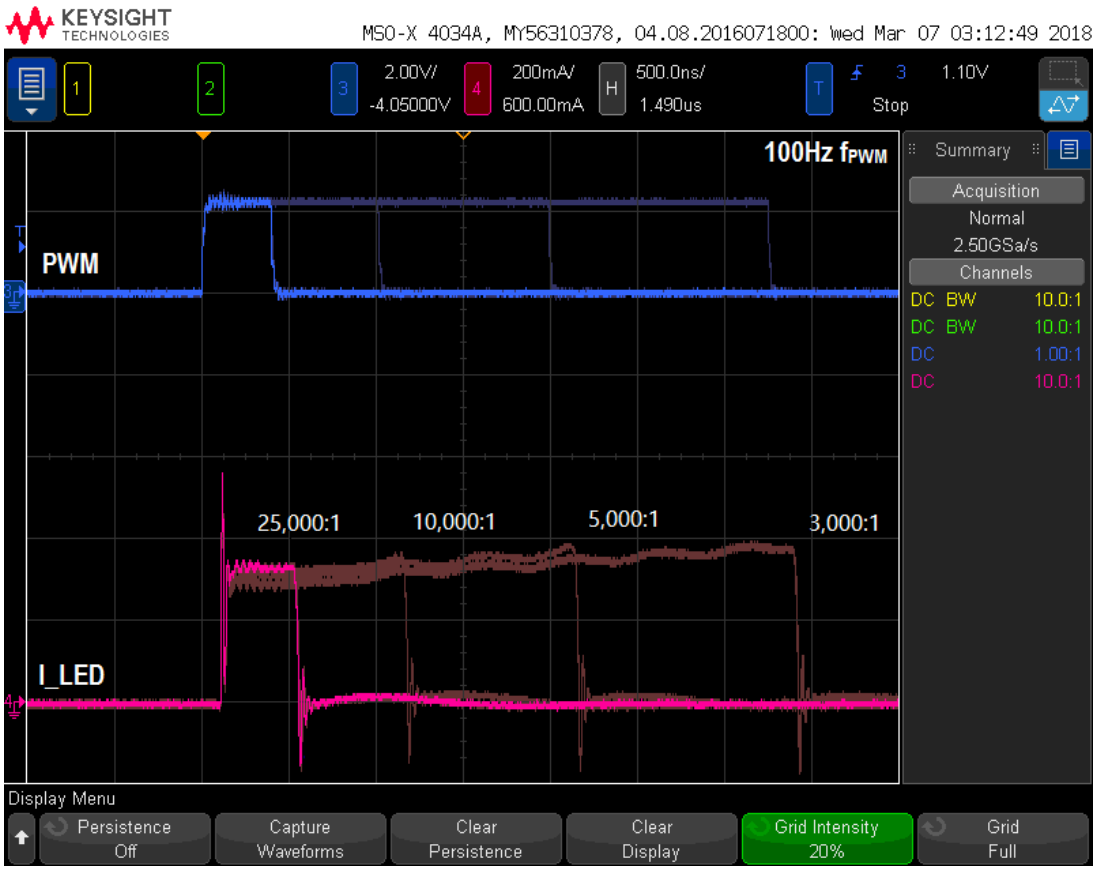
ALTERNATE ASSEMBLY

Retrofitting LT3922-1 on DC2247A for High PWM Dimming Ratio

DC2247A is assembled as a low EMI 2MHz step-up LED driver utilizing the LT3922, and comes equipped with small ferrite bead filters to reduce noise generated by the circuit. Removing the output ferrite bead filter improves PWM dimming performance, enabling up to 5,000:1 PWM dimming at 100Hz. For even higher ratio PWM dimming performance from DC2247A, the LT3922 can be replaced with LT3922-1 to allow for dimming ratios as high as 25,000:1 at 100Hz. The figure below shows how to modify DC2247A for high PWM dimming applications using the LT3922-1. Both C13 and C14 are removed from the circuit, and FB2 is replaced with a 0Ω short. In addition to the removal of the filtering circuitry, the output capacitor value has been increased (C3 = 10µF), and the compensation network is adjusted to optimize the circuit's performance (R3 = 27kΩ, C6 = 330pF). With these changes made to DC2247A, the LT3922-1 circuit can achieve dimming ratios as high as 25,000:1 at 100Hz dimming frequency.



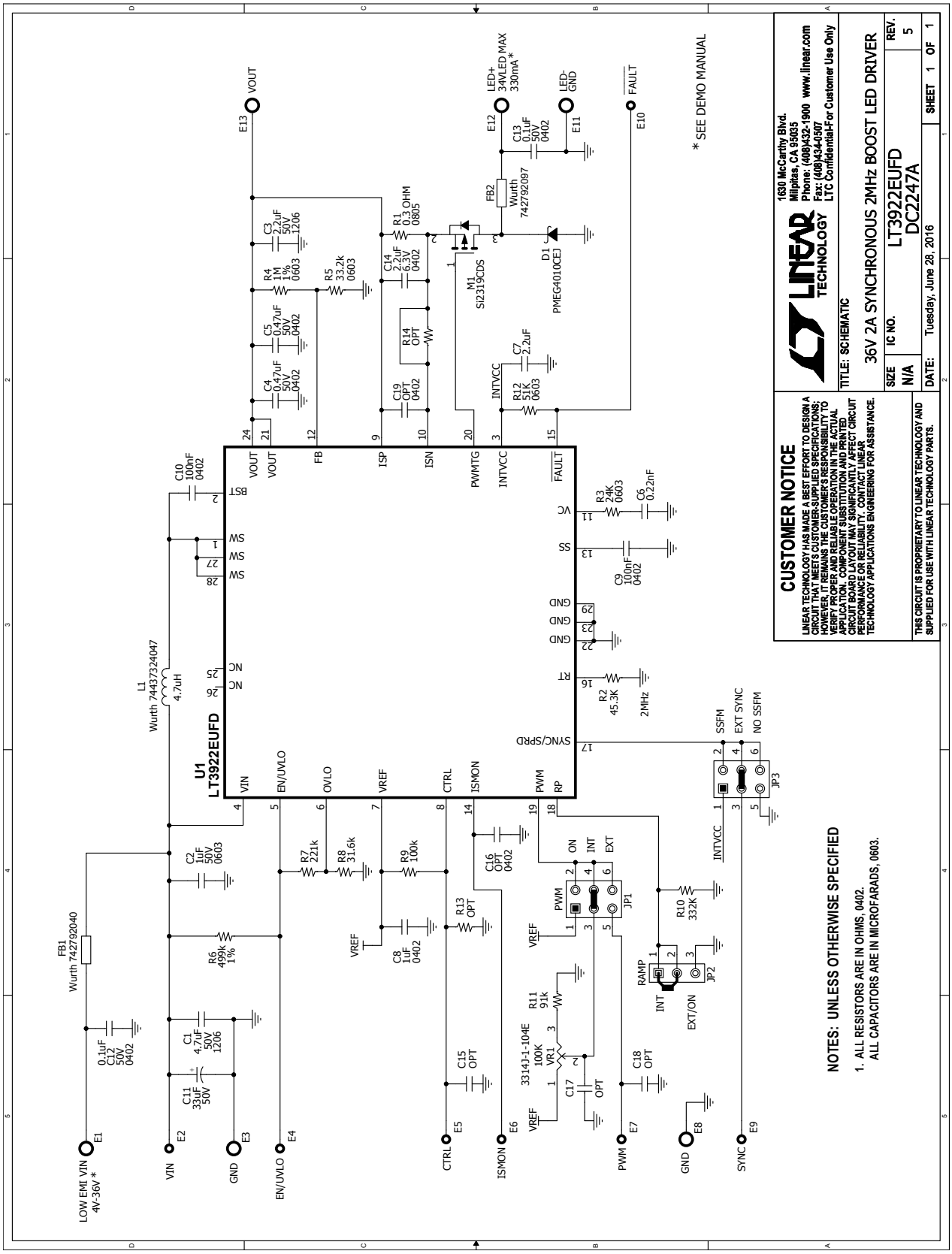
ALTERNATE ASSEMBLY



PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	C1	CAP., X5R, 4.7µF, 50V, 10%, 1206	MURATA, GRM31CR71H475KA12L
2	1	C2	CAP., X5R, 1µF, 50V, 10%, 0603	TDK, C1608X5R1H105K080AB
3	1	C3	CAP., X7R, 2.2µF, 50V, 10%, 1206	MURATA, GRM31CR71H225KA88K
4	2	C4, C5	CAP., X5R, 0.47µF, 50V, 10%, 0402	TAIYO YUDEN, UMK105ABJ474KV-F
5	1	C6	CAP., X7R, 220pF, 50V, 10%, 0603	MURATA, GRM188R71H221KA01D
6	1	C7	CAP., X7R, 2.2µF, 6.3V 10%, 0603	AVX, 06036C225KAT2A
7	1	C8	CAP., X5R, 1µF, 6.3V, 10%, 0402	MURATA, GRM155R60J105KE19D
8	2	C9, C10	CAP., X7R, 100nF, 6.3V, 10%, 0402	AVX, 04026C104KAT2A
21	1	L1	INDUCTOR, 4.7µH, 4.45mm x 4.06mm	WURTH ELEKTRONIK, 74437324047
22	1	M1	P-MOSFET, Si2319CDS, SOT23	VISHAY, SI2319CDS-T1-GE3
23	1	R1	RES, CHIP, 0.3, 1/3W, 1%, 0805	SUSUMU, RL1220S-R30-F
24	1	R2	RES, CHIP, 45.3k, 1/16W, 1%, 0402	VISHAY, CRCW040245K3FKED
25	1	R3	RES, CHIP, 24k, 1/10W, 1%, 0603	VISHAY, CRCW060324K0FKEA
26	1	R4	RES, CHIP, 1M, 1/10W, 1%, 0603	VISHAY, CRCW06031M00FKEA
27	1	R5	RES, CHIP, 33.2k, 1/10W, 1%, 0603	VISHAY, CRCW060333K2FKEA
28	1	R6	RES, CHIP, 499k, 1/16W, 1%, 0402	VISHAY, CRCW0402499KFKED
29	1	R7	RES, CHIP, 221k, 1/16W, 1%, 0402	VISHAY, CRCW0402221KFKED
30	1	R8	RES, CHIP, 31.6k, 1/16W, 1%, 0402	VISHAY, CRCW040231K6FKED
31	1	R9	RES, CHIP, 100k, 1/16W, 1%, 0402	VISHAY, CRCW0402100KFKED
32	1	R10	RES, CHIP, 332k, 1/16W, 1%, 0402	VISHAY, CRCW0402332KFKED
36	1	U1	I.C., LED DRIVER, 28QFN 4X5	LINEAR TECH., LT3922EUFD#PBF
Optional Demo Board Circuit Components				
9	1	C11	CAP., ALUM., 33µF, 50V, 20%, 6.3mm x 7.7mm	SUN ELECTRONIC INDUSTRIES CORPORATION, 50CE33BS
10	2	C12, C13	CAP., X7R, 0.1µF, 50V, 10%, 0402	MURATA, GRM155R71H104KE14D
11	1	C14	CAP., X5R, 2.2µF, 6.3V, 10%, 0402	MURATA, GRM155R60J225ME15D
12	0	C15, C17, C18 (OPT)	CAP., OPTION, 0603	
13	0	C16, C19 (OPT)	CAP., OPTION, 0402	
14	1	D1	DIODE, SCHOTTKY, 40V, 1A, SOD323F	NXP, PMEG4010CEJ, 115
17	1	FB1	CHIP, BEAD, 600Ω, 0805	WURTH ELEKTRONIK, 742792040
18	1	FB2	CHIP, BEAD, 1.5k, 0805	WURTH ELEKTRONIK, 742792097
33	1	R11	RES, CHIP, 91k, 1/10W, 5%, 0603	VISHAY, CRCW060391K0JNEA
34	1	R12	RES, CHIP, 51k, 1/10W, 1%, 0603	VISHAY, CRCW060351K0FKEA
35	0	R13, R14 (OPT)	RES, OPTION, 0402	
37	1	VR1	TRIMMER., 100k, 0.25W, SMD	BOURNS, 3314J-1-104E
Hardware: For Demo Board Only				
15	6	E1, E3, E8, E11-E13	TEST POINT, TURRET, 0.094" MTG. HOLE	MILL-MAX, 2501-2-00-80-00-00-07-0
16	7	E2, E4-E7, E9, E10	TEST POINT, TURRET, 0.061" MTG. HOLE	MILL-MAX, 2308-2-00-80-00-00-07-0
19	2	JP1, JP3	HEADER 3 PIN 0.079 DOUBLE ROW	WURTH ELEKTRONIK, 62000621121
20	1	JP2	HEADER 3 PIN 0.079 SINGLE ROW	WURTH ELEKTRONIK, 62000311121
38	3	XJP1, XJP2, XJP3	SHUNT, 0.079" CENTER	WURTH ELEKTRONIK, 60800213421

SCHEMATIC DIAGRAM



UG-1317 Rev B

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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