LT8391AIFE
60V 2MHz Synchronous 1.5A Buck-Boost LED Driver

DESCRIPTION

Demonstration circuit DC2575A is a 60V 2MHz synchronous buck-boost LED driver featuring the LT8391A. It accepts an input voltage from 4V to 60V and drives a single string of LEDs up to 16V at 1.5A. DC2575A runs at 2MHz switching frequency and features spread spectrum frequency modulation (SSFM) which can be enabled with a simple jumper. SSFM spreads the switching frequency from f_{SW} to f_{SW}+25% for reduced EMI. SSFM is not necessary in applications where EMI is not important.

DC2575A uses AEC-Q automotive-approved components such as power MOSFETs, diodes, input and output capacitors and inductors.

The LT8391A has an adjustable switching frequency between 600kHz and 2MHz. The jumper also allows external frequency synchronization.

The LT8391A can be PWM dimmed with an external PWM signal and an internally-generated PWM signal. DC2575A 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 either of its two control pins.

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

The LT8391A features both open LED and short LED (LED$^+$ to GND) protection as well as a fault output flag.

Small ceramic input and output capacitors are used to save space and cost. The board is designed with capacitors on both sides of the synchronous switches 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 18V if the LED string is opened. There is a protection diode from LED$^+$ to GND to prevent negative ringing during a short-circuit with long wires.

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

EMI filters and gate resistors on the demo circuit reduce this high power converter's EMI below CISPR 25 Class 5 limits. This is intended for automotive applications where CISPR 25 EMI standards are observed. In non-automotive applications, where EMI may not be as important, the input and output filters as well as the gate resistors can be removed for higher efficiency. Please note the optional EMI components in the parts list.

The LT8391A 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 DC2575A. The LT8391AIFE 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 data sheet section "Layout Considerations".

Design files for this circuit board are available.

QUICK START PROCEDURE

Table 1. Typical Performance Summary for DC2575A (LT8391A)

PARAMETER	CONDITIONS	MIN	TYP	MAX
Input Voltage PV_{IN} Range	Operating V_{LED} ≤16V	4V		60V
Switching Frequency (f_{SW})	R3 = 59.0k, JP1 = NO SSFM/SYNC		2.0MHz	
Spread Spectrum (SSFM) Frequency Range	JP1 = SSFM ON	f_{SW}		f_{SW} • 1.25
I_{LED}	R2 = 0.056Ω 7.0V < PV_{IN} < 60V V_{LED} ≤16V R9 = 90.9k, R10 = 113k		1.5A	
V_{LED} range	R5 = 1M, R6 = 54.9k	4.8V		16V
Open LED Voltage V_{OUT}	R5 = 1M, R6 = 54.9k		18.2V	
Typical Efficiency (100% PWM DC)	PV_{IN} = 13V, V_{LED} = 16V, I_{LED} = 1.5A		92%	
Internally-Generated PWM Dimming Range	JP2 = INT, JP3 = INT	1/128		100%
Internally-Generated PWM Dimming Frequency	JP2 = INT, JP3 = INT R30 = 301k, R3 = 59.0k		488Hz	
Peak Switch Current Limit Boost Region	R1 = 0.006Ω		8.3A	
Peak Switch Current Limit Buck Region	R1 = 0.006Ω		8.3A	
PV_{IN} Undervoltage Lockout (UVLO) falling	R7 = 383k, R8 = 165k		4.3V	
PV_{IN} Enable Turn-On (EN) Rising	R7 = 383k, R8 = 165k		5.1V	

Demonstration circuit 2575A is easy to set up to evaluate the performance of the LT8391A. Follow the procedure below:

1. With power off, connect a string of LEDs that will run with forward voltage less than or equal to 16V (at 1.5A) to the LED^+ and LED^- banana jacks on the PCB as shown in Figure 1.
2. Connect the EN/UVLO terminal to GND.
3. Set JP2 to EXT/ON and JP3 to ON for 100% always-on LED operation. Set JP1 to NO SSFM/SYNC to run without SSFM.
4. With power off, connect the input power supply to the PV_{IN} and GND banana jacks. Make sure that the DC input voltage will not exceed 60V.
5. Turn the input power supply on and make sure the voltage is between 4V and 60V for proper 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 either the CTRL1 or CTRL2 terminal and set the voltage between 0V and 1.5V. See data sheet for details.
9. To change brightness with external PWM dimming, set JP2 to EXT/ON and JP3 to EXT. Attach a 3V rectangular waveform with varying duty cycle to the PWM terminal.
10. To change brightness with internally-generated PWM dimming, set JP2 to INT and JP3 to INT. Adjust the setting of the VR1 variable resistor with a small flathead screwdriver to toggle between 0% and 100% PWM dimming duty cycle in 1/128 steps.
11. To enable spread spectrum frequency modulation, set JP1 to SSFM ON.

QUICK START PROCEDURE

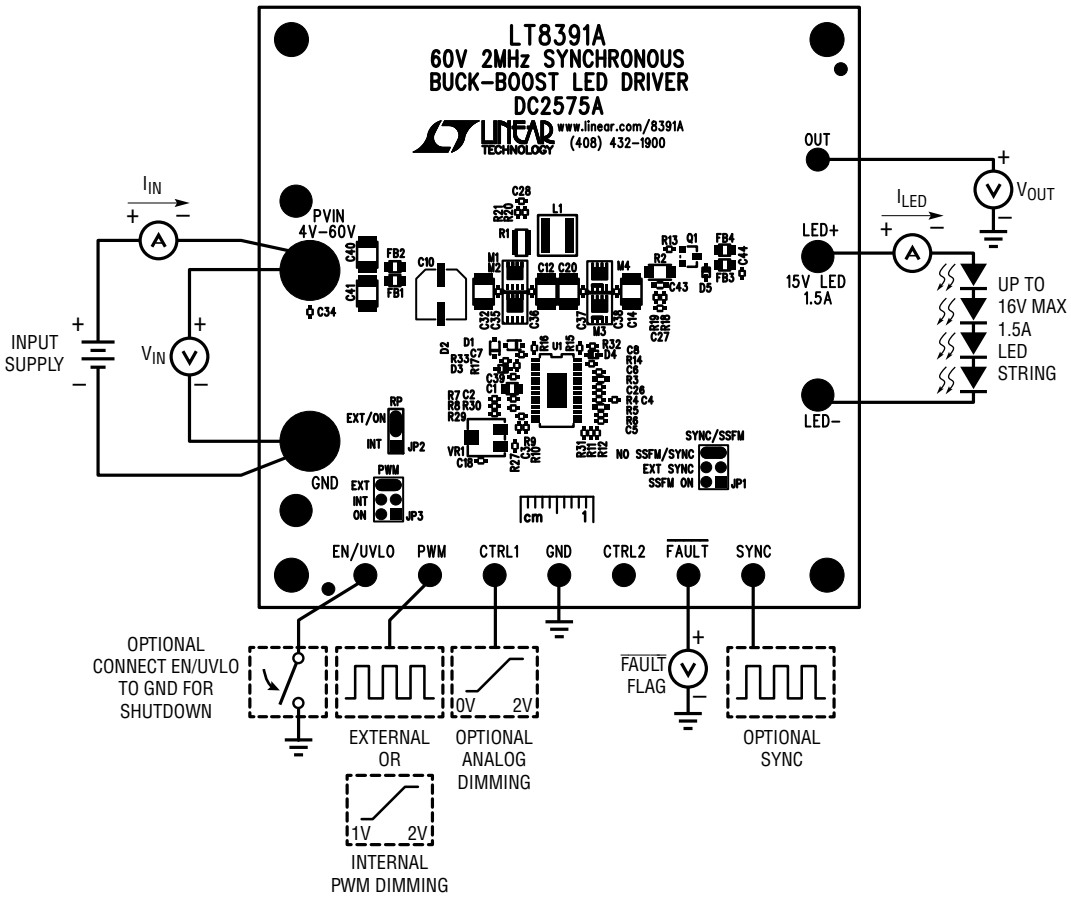


Figure 1. Test Procedure Setup Drawing for DC2575A

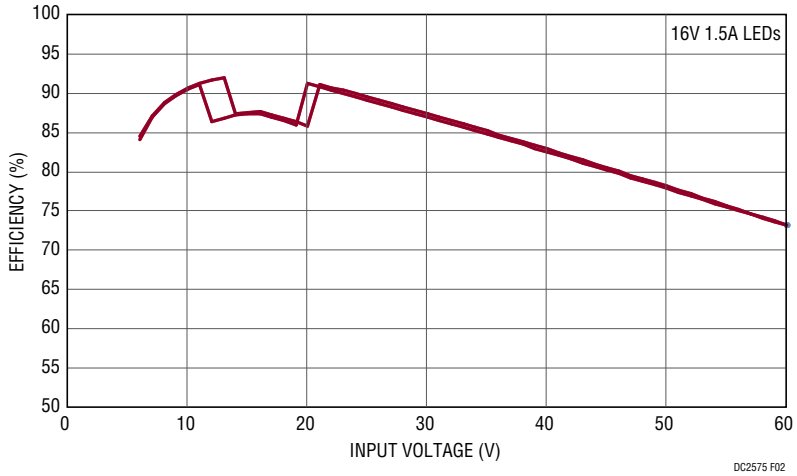


Figure 2. DC2575A Efficiency Versus Input Voltage for 16V 1.5A LED Load

QUICK START PROCEDURE

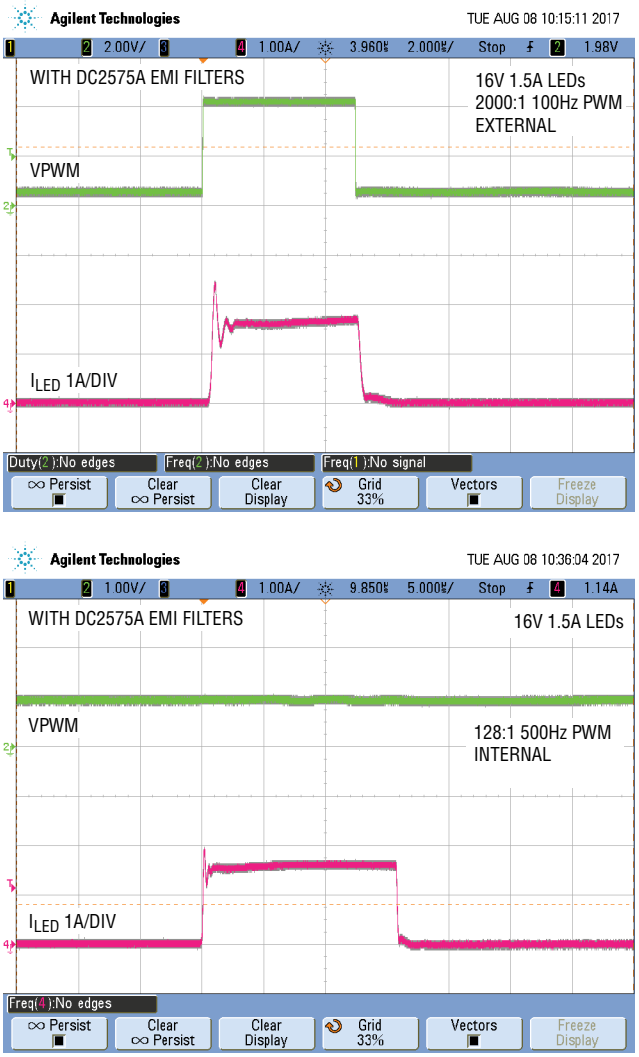


Figure 3. Infinite-Persist Scope Traces Show PWM Dimming and SSFM Working Together for Flicker-Free Brightness Control with Both (a) Externally- and (b) Internally-Generated PWM Dimming (with EMI Filters)

QUICK START PROCEDURE

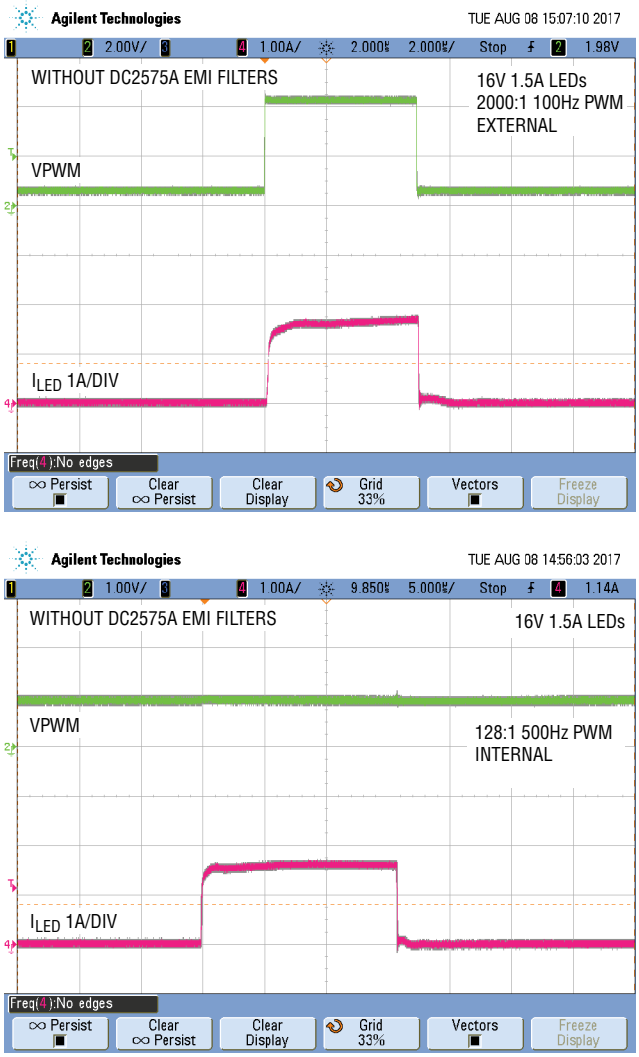


Figure 4. Infinite-Persist Scope Traces Show PWM Dimming and SSFM Working Together for Flicker-Free Brightness Control with Both (a) Externally- and (b) Internally-Generated PWM Dimming (with EMI Filters Removed)

QUICK START PROCEDURE

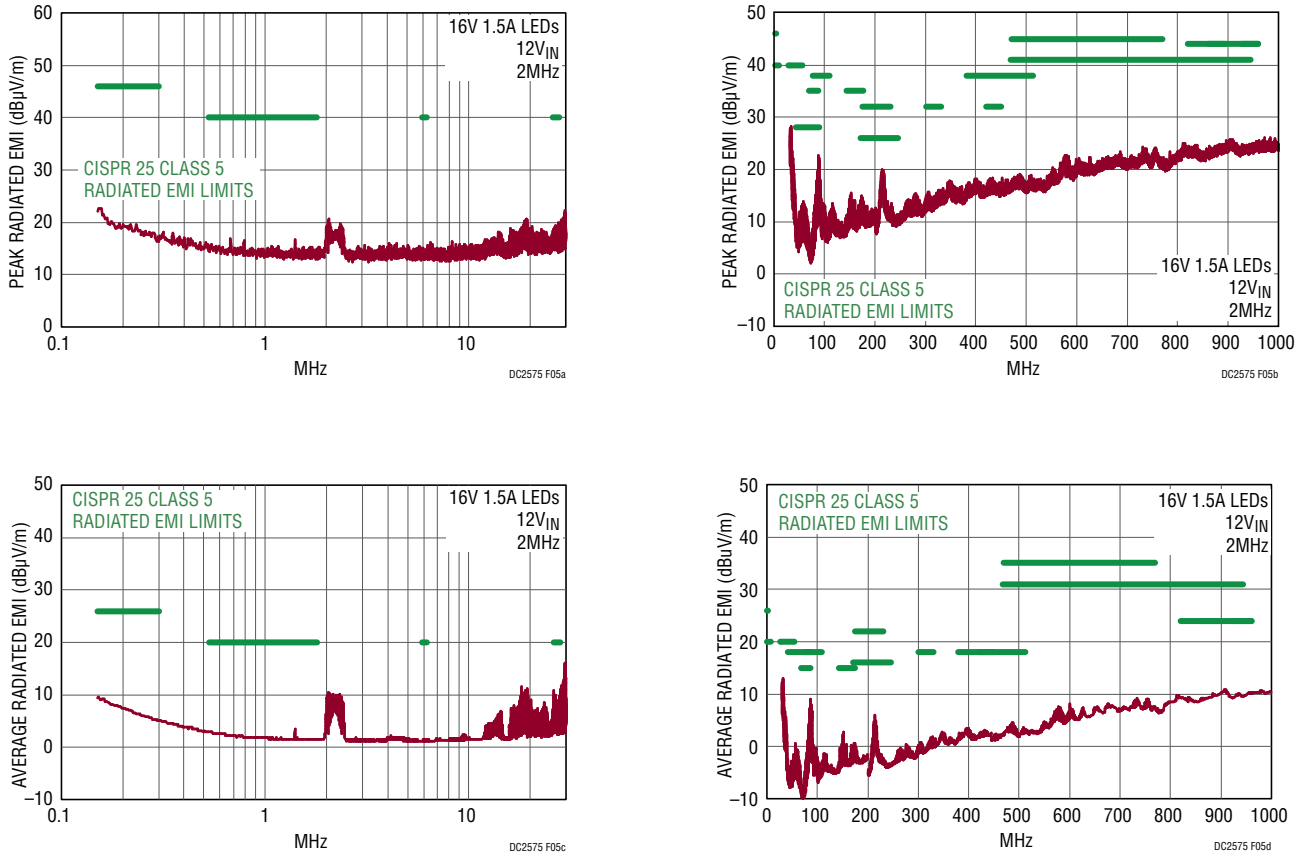


Figure 5. DC2575A (LT8391A) Passes CISPR 25 Class 5 Radiated EMI

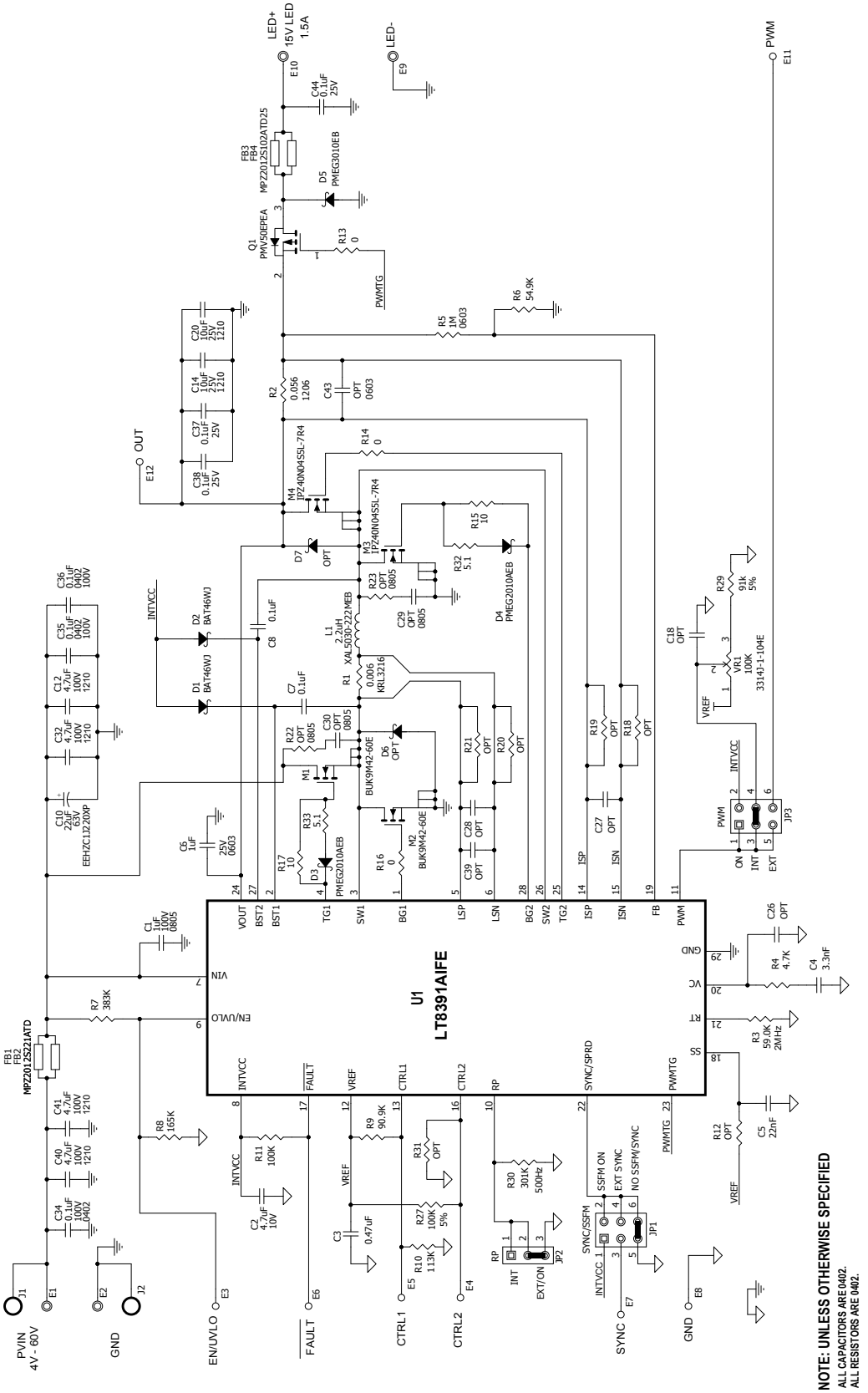
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	C1	CAP., 1µF, X7S, 100V, 10%, 0805	MURATA, GRJ21BC72A105KE11L
2	1	C2	CAP., 4.7µF, X5R, 10V, 10%, 0402	TDK, C1005X5R1A475K050BC
3	1	C3	CAP., 0.47µF, X5R, 16V, 10%, 0402	TAIYO YUDEN, EMK105ABJ474KV-F
4	1	C4	CAP., 3300pF, X7R, 16V, 10%, 0402	MURATA, GRM15XR71C332KA86D
5	1	C5	CAP., 0.022µF, X7R, 25V, 10%, 0402, AEC-Q200, NO SUBS. ALLOWED	MURATA, GCM155R71E223KA55D
6	1	C6	CAP., 1µF, X7R, 25V, 10%, 0603	MURATA, GRM188R71E105KA12D
7	2	C7, C8	CAP., 0.1µF, X7R, 25V, 10%, 0402, AEC-Q200, NO SUBS. ALLOWED	TDK, CGA2B3X7R1E104K050BB
8	1	C10	CAP., 22µF, ALUM., 63V, 20%, SMD 6.3mm × 7.7mm, D8, AEC-Q200	PANASONIC, EEHZC1J220XP
9	2	C12, C32	CAP., 4.7µF, X7S, 100V, 10%, 1210, AEC-Q200, NO SUBS. ALLOWED	MURATA, GCM32DC72A475KE02L
10	2	C14, C20	CAP., 10µF, X5R, 25V, 20%, 1210, AEC-Q200, NO SUBS. ALLOWED	MURATA, GCM32ER71E106KA57L
11	2	D1, D2	DIODE, SCHOTTKY, 100V, 250mA, SOD323F, AEC-Q101	NEXPERIA, BAT46WJ,115
12	2	M1, M2	XSTR., MOSFET, N-CH, 60V, 22A, LFPAK33-8, AEC-Q101	NEXPERIA, BUK9M42-60E
13	2	M3, M4	XSTR., MOSFET, N-CH, 40V, 40A, PG-TSDSON-8, AEC-Q101	INFINEON, IPZ40N04S5L-7R4
14	1	L1	IND., 2.2µH, PWR, 20%, 9.2A, 14.5mΩ, 5.48mm × 5.28mm, XAL5030, AEC-Q200	COILCRAFT, XAL5030-222MEC
15	1	Q1	XSTR., MOSFET, P-CH, 30V, 4.2A, SOT23-3 (TO-236AB), AEC-Q101	NEXPERIA, PMV50EPEA
16	1	R1	RES.,0.006Ω,1%,1.5W,1206, LONG-SIDE TERM.,KRL3216E, SENSE, AEC-Q200	SUSUMU, KRL3216E-C-R006-F-T1
17	1	R2	RES.,0.056Ω, 1%, 1/2W, 1206, SHORT-SIDE TERM., RL1632, SENSE	SUSUMU, RL1632R-R056-F
18	1	R3	RES., 59.0kΩ, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW040259K0FKED
19	1	R4	RES.,4.7kΩ, 5%, 1/16W,0402	NIC, NRC04J472TRF
20	1	R5	RES.,1MΩ, 1%, 1/10W, 0603	PANASONIC, ERJ3EKF1004V
21	1	R6	RES., 54.9kΩ, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW040254K9FKED
22	1	R7	RES., 383kΩ, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW0402383KFKED
23	1	R8	RES., 165kΩ, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW0402165KFKED
24	1	U1	IC,4-Switch Buck-Boost LED CTRLR,TSSOP-28FE	ANALOG DEVICES, LT8391AIFE#PBF
Optional Low EMI Electrical Components				
1	3	C34, C35, C36	CAP.,0.1uF,X5R,100V,10%,0402,NO SUBS. ALLOWED	MURATA, GRM155R62A104KE14D
2	3	C37, C38, C44	CAP.,0.1uF,X7R,25V,10%,0402,AEC-Q200, NO SUBS. ALLOWED	TDK, CGA2B3X7R1E104K050BB
3	2	C40, C41	CAP.,4.7uF,X7S,100V,10%,1210,AEC-Q200, NO SUBS. ALLOWED	MURATA, GCM32DC72A475KE02L
4	2	D3, D4	DIODE,SCHOTTKY,20V,1A,SOD523-2	NEXPERIA, PMEG2010AEB,115
5	2	FB1, FB2	IND.,220 OHMS,BEAD, FERRITE,25%,3A,40mOHMS,0805,AEC-Q200	TDK, MPZ2012S221ATD25
6	2	FB3, FB4	IND.,1k OHM,BEAD, FERRITE,25%,1.5A,150mOHMS,0805,AEC-Q200	TDK, MPZ2012S102ATD25
7	2	R15, R17	RES.,10 OHMS,5%,1/16W,0402	VISHAY, CRCW040210R0JNED
8	2	R32, R33	RES.,5.1,OHMS,1%,1/16W,0402,AEC-Q200	VISHAY, CRCW04025R10FKED

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Other Optional Electrical Components				
1	0	C18, C26, C27, C28, C39 (OPT)	CAP., OPTION, 0402	
2	0	C29, C30 (OPT)	CAP., 0805, OPTION	
3	0	C43 (OPT)	CAP., OPTION, 0603	
4	1	D5	DIODE, SCHOTTKY, 30V, 1A, SOD523-2, AEC-Q101	NEXPERIA, PMEG3010EB,115
5	0	D6, D7 (OPT)	DIODE, OPTION, SOD-123	
6	1	R9	RES., 90.9kΩ, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW040290K9FKED
7	1	R10	RES., 113kΩ, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW0402113KFKED
8	1	R11	RES., 100kΩ, 1%, 1/16W, 0402	NIC, NRC04F1003TRF
9	0	R12, R18, R19, R20, R21, R31 (OPT)	RES., OPTION, 0402	
10	3	R13, R14, R16	RES., 0Ω, 1/16W, 0402	VISHAY, CRCW04020000Z0ED
11	0	R22, R23 (OPT)	RES., OPTION, 0805	
12	1	R27	RES., 100kΩ, 5%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW0402100KJNED
13	1	R29	RES., 91kΩ, 5%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW040291K0JNED
14	1	R30	RES., 301kΩ, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW0402301KFKED
15	1	VR1	RES., 100kΩ, 20%, 1/4W, SMD 4mm SQUARE,TRIMPOT, J-HOOK, 1-TURN	BOURNS, 3314J-1-104E
Hardware				
1	2	J1, J2	CONN., BANANA JACK, FEMALE, THT, NON-INSULATED, SWAGE	KEYSTONE, 575-4
2	2	JP1, JP3	CONN., HDR, MALE, 2×3, 2mm, THT, STR	WURTH ELEKTRONIK, 62000621121
3	1	JP2	CONN., HDR, MALE, 1×3, 2mm, THT, STR	WURTH ELEKTRONIK, 62000311121
4	3	XJP1, XJP2, XJP3	CONN., SHUNT, FEMALE, 2 POS, 2mm	WURTH ELEKTRONIK, 60800213421
5	4	E1, E2, E9, E10	TEST POINT, TURRET, 0.094", MTG. HOLE	MILL-MAX, 2501-2-00-80-00-00-07-0
6	8	E3, E4, E5, E6, E7, E8, E11, E12	TEST POINT, TURRET, 0.064", MTG. HOLE	MILL-MAX, 2308-2-00-80-00-00-07-0
7	4	MH1, MH2, MH3, MH4	STANDOFF, NYLON, SNAP-ON, 0.375"	WURTH ELEKTRONIK, 702933000

SCHEMATIC DIAGRAM



ESD Caution
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