

LT3932
36V, 2A Synchronous Buck LED Driver

DESCRIPTION

Demonstration circuit DC2286A is a 36V, 2A synchronous 2MHz buck LED driver featuring the [LT[®]3932](#). It drives one or two series LEDs at 1A when V_{IN} is between 9V and 36V, and can run down to $4V_{IN}$ with a single LED (if UVLO is adjusted). DC2286A runs at 2MHz switching frequency. Spread spectrum frequency modulation (SSFM) can be enabled with a simple jumper, reducing EMI. DC2286A 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 LT3932 has an input voltage range from 9V to 36V. It has internal, synchronous 40V switches for high efficiency and small size. It has an adjustable switching frequency between 200kHz and 2MHz. It can be synchronized to an external source or programmed with SSFM for low EMI. The PWM TG high-side PWM MOSFET driver assists with short-circuit protection and versatility. Although the demo circuit is optimized for one or two LEDs, it can be altered to have as high as 33V of LEDs if V_{IN} is high-enough and circuit components are changed appropriately.

The LT3932 can be PWM dimmed with an external PWM signal or an internally-generated PWM signal. DC2286A 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 control pin.

When run with both PWM dimming and spread spectrum, 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 7V if the LED string is opened. 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 lockout can be adjusted on the circuit with a few simple resistor choices.

There is an EMI filter on the input of DC2286A. 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 recommend layout and four-layer thickness of DC2286A for low EMI applications.

The LT3932 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 DC2286A. The LT3932EUFD 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.linear.com/demo/DC2286A>

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PERFORMANCE SUMMARY Specifications are at $T_A = 25^\circ\text{C}$

PARAMETER	CONDITIONS	MIN	TYP	MAX
Input Voltage EMIVIN Range	Operating I_{LED}	9V		36V
Input Voltage EMIVIN Falling UVLO	Operating $V_{LED} = 6.6V$ $I_{LED} = 1A$		9V	
Input Voltage EMIVIN Rising Turn-On			10V	
Safe Input Voltage EMIVIN Range		0V		36V
Switching Frequency	$R5 = 45.3k$ SSFM = OFF		2MHz	
Switching Frequency	$R5 = 45.3k$ SSFM = ON		2MHz – 2.5MHz	
I_{LED}	$R1 = 0.1\Omega$ $8.0V < EMIVIN < 36V$ $V_{LED} = 6.6V$		1.0A	
V_{LED} range	$R7 = 69.8k$ $R8 = 10.0k$	3.0V		7.0V
Open LED Voltage V_{OUT}	$R7 = 69.8k$ $R8 = 10.0k$, OPEN LOAD		8.0V	
Efficiency (100% PWM DC)	$EMIVIN = 12V$ $V_{LED} = 6.6V$ $I_{LED} = 1.0A$		89%	
Internally-generated PWM dimming range	Operating JP3 = INT JP4 = INT	1/128		
Internally-generated PWM dimming frequency	Operating JP3 = INT JP4 = INT $R12 = 169k$		550Hz	

QUICK START PROCEDURE

Demonstration circuit DC2286A is easy to set up to evaluate the performance of the LT3932. Follow the procedure below:

1. With power off, connect a string of one or two LEDs that will run with forward voltage less than or equal to 7.0V (at 1A) to the LED⁺ and LED⁻ terminals on the PCB as shown in Figure 1.
2. Connect the EN/UVLO terminal to GND.
3. For always-on LED operation: Set JP3 and JP4 to "ON".
4. With power off, connect the input power supply to the EMIVIN 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 9V and 36V to start operation.
6. Release the EN/UVLO-to-GND connection.
7. Observe the LED string illuminated with 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 JP3 to EXT and JP4 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 JP3 to INT and JP4 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 JP2 to SSFM ON.

QUICK START PROCEDURE

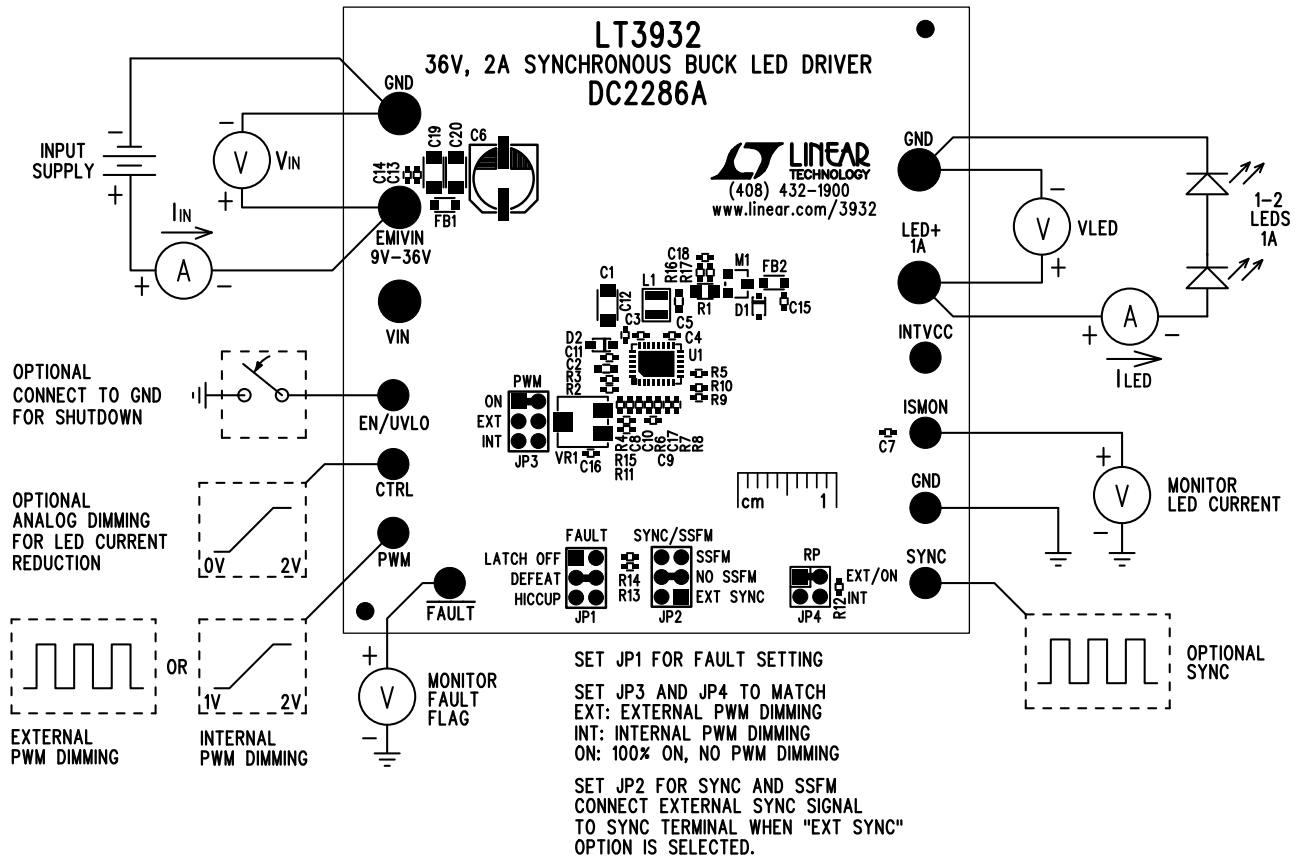


Figure 1. Test Procedure Setup Drawing for DC2286A

DEMO MANUAL DC2286A

QUICK START PROCEDURE

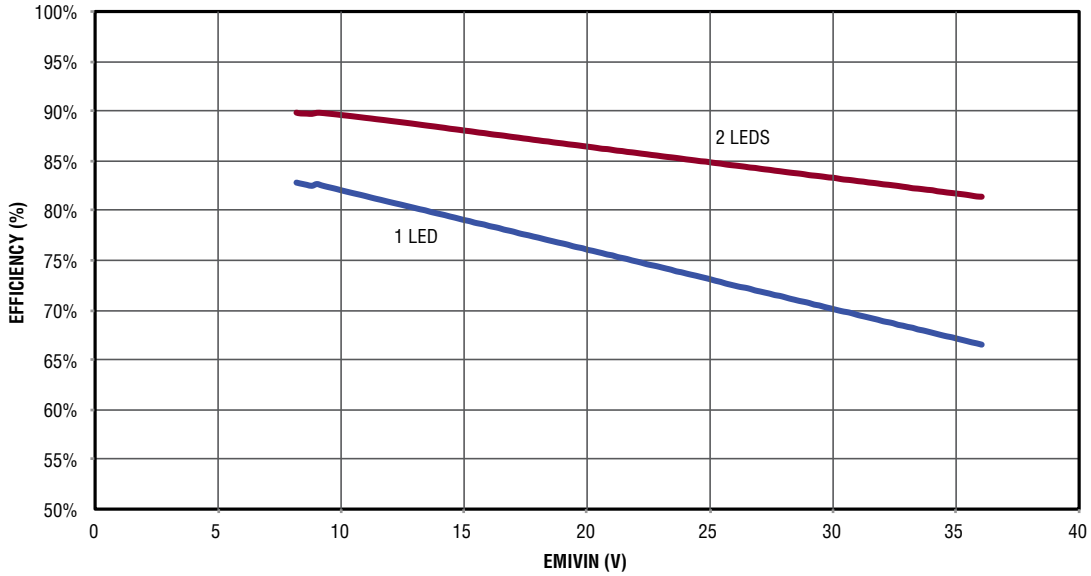


Figure 2. DC2286A Efficiency and LED Current vs Input Voltage for One and Two LEDs at 1A. Efficiency Remains High Through the Range Due to Synchronous Switching

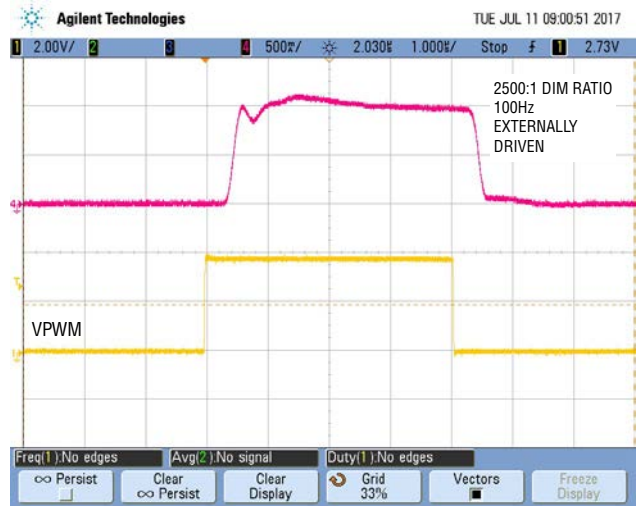
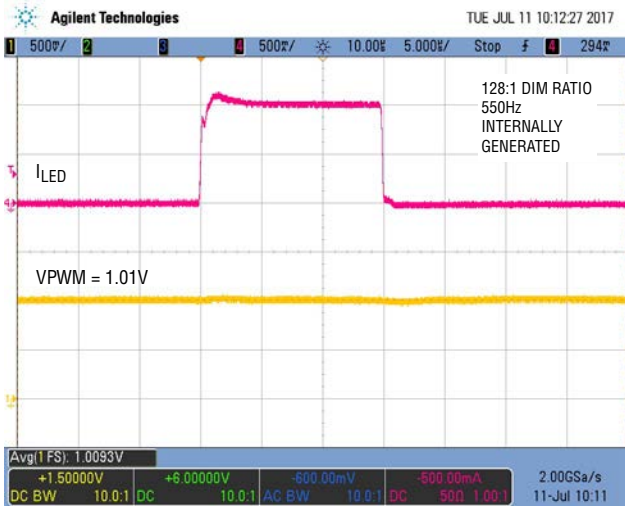
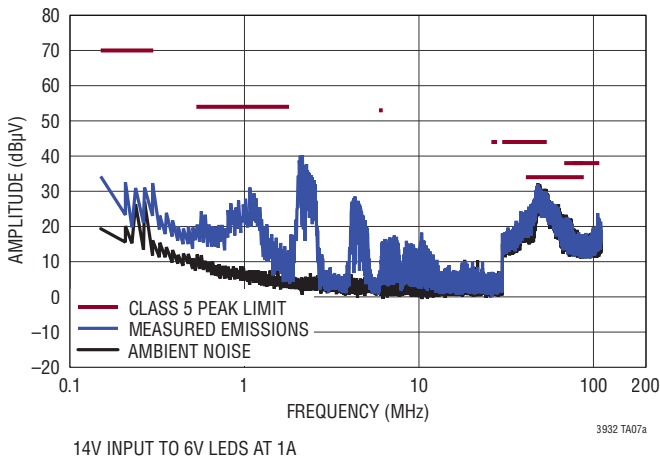


Figure 3. High Performance PWM Dimming with (a) Internally Generated PWM Dimming and (b) Externally Driven PWM Dimming

QUICK START PROCEDURE

CISPR25 Peak Conducted Emissions Test



CISPR25 Average Conducted Emissions Test

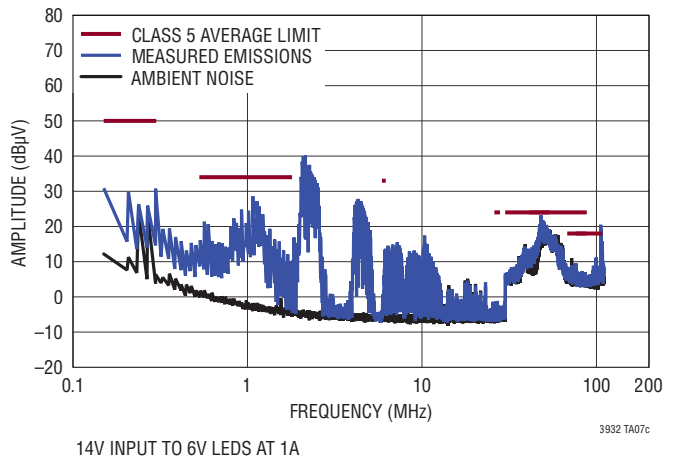
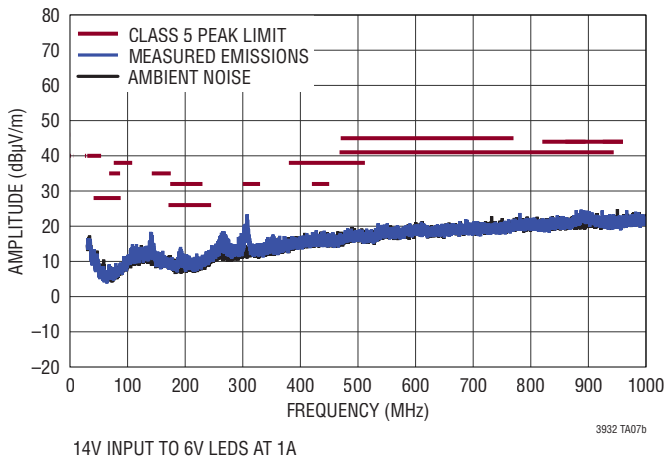


Figure 4. DC2286A Conducted Peak and Average EMI – Passes CISPR 25 Class 5 Limits

CISPR25 Peak Radiated Emissions Test



CISPR25 Average Radiated Emissions Test

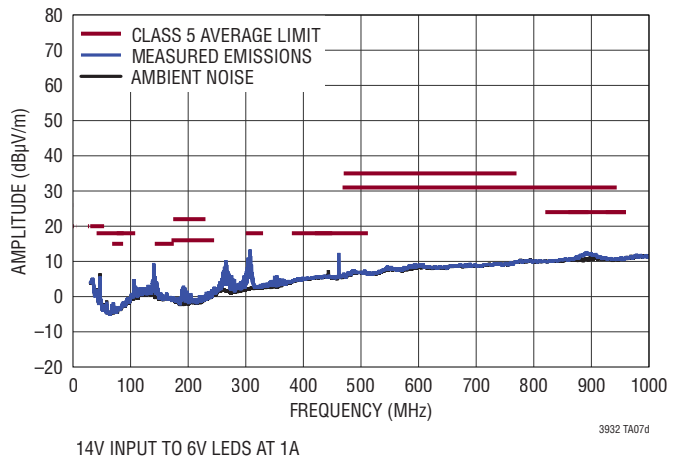


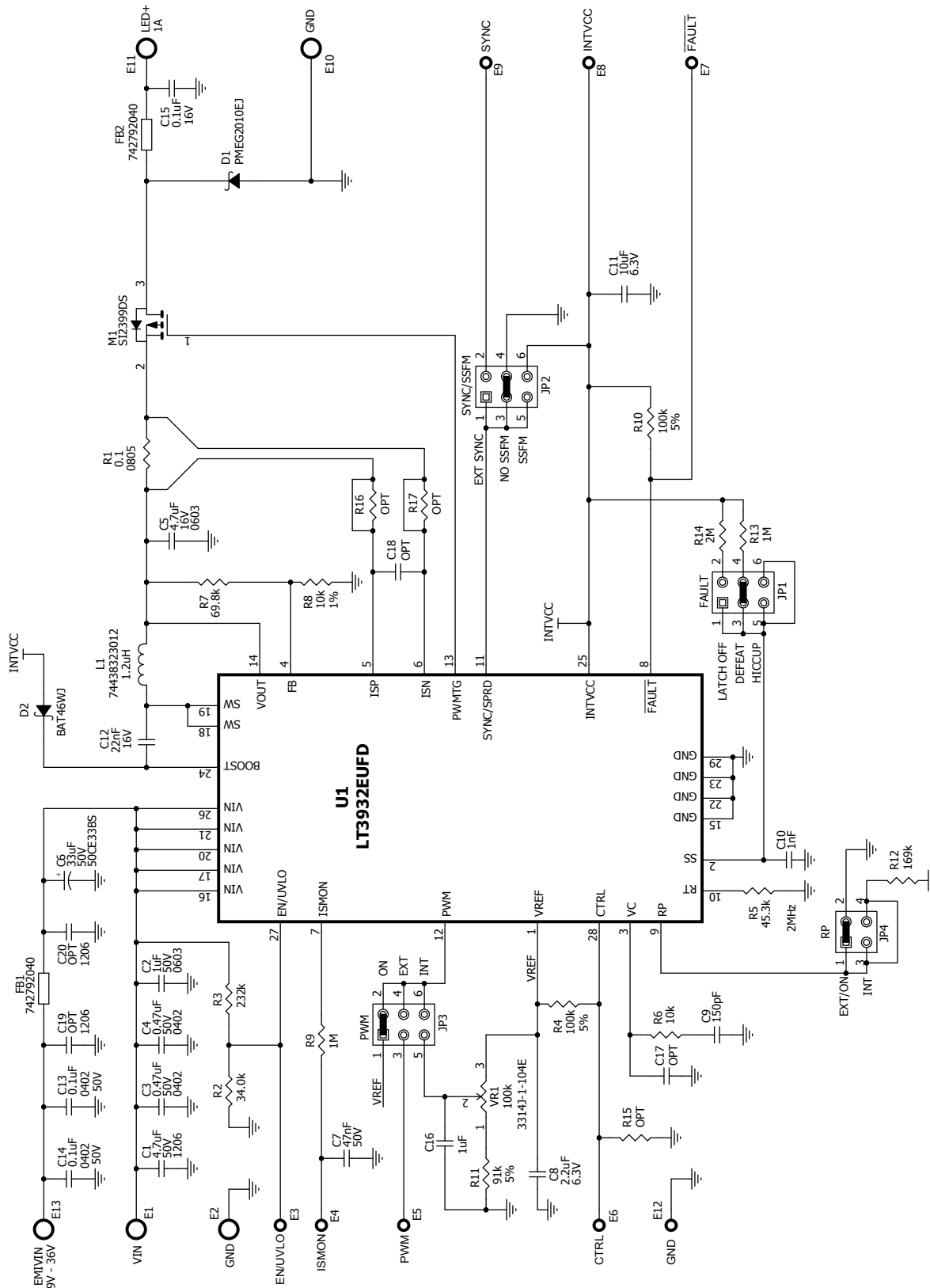
Figure 5. DC2286A Radiated Peak and Average EMI – 30MHz to 1GHz – Passes CISPR 25 Class 5 Limits

DEMO MANUAL DC2286A

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	C1	CAP, X7R, 4.7µF, 50V, 10%, 1206	MURATA, GRM31CR71H475KA12L
2	1	C2	CAP, X5R, 1µF, 50V, 10%, 0603	TDK, C1608X5R1H105K080AB
3	2	C3, C4	CAP, X7R, 0.47µF, 50V, 10%, 0402	TAIYO YUDEN, UMK105ABJ474KV-F
4	1	C5	CAP, X5R, 4.7µF, 16V, 10%, 0603	MURATA, GRM188R61C475KE11D
7	1	C8	CAP, X5R, 2.2µF, 25V, 10%, 0402	MURATA, GRT155R61E225KE13D
8	1	C9	CAP, NP0, 150pF, 25V, 10%, 0402	MURATA, GRM1555C1E151JA01D
9	1	C10	CAP, X7R, 1000pF, 25V, 10%, 0402	AVX, 04023C102KAT2A
10	1	C11	CAP, X5R, 10µF, 6.3V, 10%, 0402	TDK, C1005X5R0J106M050BC
11	1	C12	CAP, X7R, 0.022µF, 16V, 10%, 0402	MURATA, GRM155R71C223KA01D
25	1	L1	IND., 1.2µH	WURTH ELETRONIK, 74438323012
26	1	M1	XSTR., P-MOSFET, 20V, SOT-23	VISHAY, SI2399DS-T1-GE3
27	1	R1	RES., SENSE, 0.1Ω, 1W, 1%, 0805	SUSUMU, KRL1220E-M-R100-F-T5
28	1	R2	RES, CHIP, 34k, 1/16W, 1%, 0402	VISHAY, CRCW040234K0FKED
29	1	R3	RES, CHIP, 232k, 1/16W, 1%, 0402	VISHAY, CRCW0402232KFKED
31	1	R5	RES, CHIP, 45.3k, 1/16W, 1%, 0402	VISHAY, CRCW040245K3FKED
32	2	R6, R8	RES, CHIP, 10k, 1/16W, 1%, 0402	VISHAY, CRCW040210K0FKED
33	1	R7	RES, CHIP, 69.8k, 1/16W, 1%, 0402	VISHAY, CRCW040269K8FKED
39	1	U1	I.C., LED DRIVER, 28QFN-4x5	Linear Tech., LT3932EUFDF#PBF
Optional Electrical Components				
5	1	C6	CAP ALUM., 33µF, 50V, 6.3x7.7mm	SUN ELECT, 50CE33BS
6	1	C7	CAP, X7R, 0.047µF, 50V, 10%, 0402	MURATA, GCM155R71H473KE02D
11	1	C15	CAP, X7R, 0.1µF, 16V, 10%, 0402	MURATA, GRM155R71C104KA88J
12	2	C13, C14	CAP, X5R, 0.1µF, 50V, 10%, 0402	MURATA, GRM155R61H104KE14D
13	1	C15	CAP, X7R, 0.1µF, 16V, 10%, 0402	MURATA, GRM155R71C104KA88J
14	1	C16	CAP, X5R, 1µF, 16V, 10%, 0402	MURATA, GRM155R61C105KE01D
15	0	C17, C18 (OPT)	CAP, OPTION, 0402	
16	0	C19, C20 (OPT)	CAP, OPTION, 1206	
17	1	D1	DIODE, SCHOTTKY, 40V, 1.0A, SOD323F	NEXPERIA, PMEG4010CEJ
18	1	D2	DIODE, SCHOTTKY, 100V, SOD323F	NEXPERIA, BAT46WJ, 115
21	2	FB1, FB2	BEAD, FERRITE, 600Ω, 0805	WURTH ELETRONIK, 742792040
30	2	R4, R10	RES, CHIP, 100k, 1/16W, 5%, 0402	VISHAY, CRCW0402100KJNED
34	2	R9, R13	RES, CHIP, 1M, 1/16W, 1%, 0402	VISHAY, CRCW04021M00FKED
35	1	R11	RES, CHIP, 91k, 1/16W, 5%, 0402	VISHAY, CRCW040291K0JNED
36	1	R12	RES, CHIP, 169k, 1/16W, 1%, 0402	VISHAY, CRCW0402169KFKED
37	1	R14	RES, CHIP, 2M, 1/16W, 1%, 0402	VISHAY, CRCW04022M00FKED
38	0	R15, R16, R17 (OPT)	RES., OPT, 0402	
40	1	VR1	RES., TRIMMER, POT., 100k, 1/4W, 20%, 4.5mm, SMD	Bourns, 3314J-1-104E
Hardware: For Demo Board Only				
19	5	E1, E2, E11, E10, E13	TEST POINT, TURRET, .094" MTG. HOLE	MILL-MAX, 2501-2-00-80-00-00-07-0
20	8	E3 TO E9, E12	TEST POINT, TURRET, .064" MTG. HOLE	MILL-MAX, 2308-2-00-80-00-00-07-0
22	3	JP1, JP2, JP3	CONN., HEADER, 2x3, 2mm	WURTH ELETRONIK, 62000621121
23	1	JP4	CONN., HEADER, 2x2, 2mm	WURTH ELETRONIK, 62000421121
24	4	XJP1, XJP2, XJP3, XJP4	SHUNT, 2mm	WURTH ELETRONIK, 60800213421

SCHEMATIC DIAGRAM



NOTE: UNLESS OTHERWISE SPECIFIED

- 1. ALL RESISTORS ARE 0402, 1%.
- ALL CAPACITORS ARE 0402



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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