

TPS92690EVM Boost Evaluation Module

User's Guide



Literature Number: SLVU803
December 2012

1	N-Channel Controller for Dimmable LED Drives with Low-Side Current Sense	4
1.1	Introduction	4
2	Detailed Description	5
2.1	Description	5
2.1.1	Typical Applications	5
2.1.2	Features	5
3	Electrical Performance Specifications	7
4	Schematic	8
5	Performance Data and Typical Characteristic Curves	9
5.1	Efficiency	9
5.2	Line Regulation	9
5.3	Switch Node Voltage and LED Current Ripple	10
5.4	PWM Dimming	10
5.5	Start-up and Shut-down Response	11
5.6	Thermal Performance	12
6	TPS92690EVM PCB layout	13
A	Bill of Materials	14

List of Figures

4-1.	TPS92690EVM Schematic	8
5-1.	Efficiency	9
5-2.	Line Regulation	9
5-3.	Switching and LED Current	10
5-4.	PWM Dimming, $f_{\text{PWM}} = 200 \text{ Hz}$, Duty Cycle = 50%	10
5-5.	PWM Dimming, $f_{\text{PWM}} = 200 \text{ Hz}$, Duty Cycle = 5%	10
5-6.	PWM Dimming, $f_{\text{PWM}} = 200 \text{ Hz}$, Duty Cycle = 95%	11
5-7.	Start-up Waveform	11
5-8.	Shut-down Waveform	11
5-9.	Top Thermal Performance	12
5-10.	Bottom Thermal Performance	12
6-1.	Top Layer and Top Overlay (Top View)	13
6-2.	Bottom Layer and Bottom Overlay (Bottom View)	13

List of Tables

3-1.	TPS92690EVM Electrical Performance Specifications	7
A-1.	The TPS92690EVM Components List (According to the Schematic Shown in Figure 4-1)	14

N-Channel Controller for Dimmable LED Drives with Low-Side Current Sense

1.1 Introduction

The TPS92690EVM evaluation module (EVM) helps designers evaluate the operation and performance of the TPS92690 DC-DC N-channel MOSFET controller. The TPS92690 is designed to drive high-brightness light emitting diodes (LEDs) and features a wide input voltage range (4.5 V to 75 V), analog current adjust, PWM dimming, low-power shutdown, a precision reference, switching frequency synchronization, and low side LED current sense.

Detailed Description

2.1 Description

The TPS92690EVM provides a high-brightness LED driver based on the TPS92690 configured as a boost (step-up) regulator. It is designed to operate with an input voltage in the range of 8 V to 19 V with a 12-V nominal input voltage. This input voltage range is typical for automotive applications and common for many off the shelf AC-DC sources. The EVM is set up for a default output current of 500 mA with an output voltage range of 20 V to 35 V or approximately 7 to 10 LEDs, depending on the forward voltage of each.

2.1.1 Typical Applications

This converter design describes an application of the TPS92690 as an LED driver with the specifications listed below. For applications with a different input voltage range or different output voltage range, refer to the TPS92690 datasheet.

2.1.2 Features

2.1.2.1 Connector Description

This section describes the connectors and test points on the EVM and how to properly connect, setup, and use the TPS92690EVM.

2.1.2.1.1 J1, J4, J10 (VIN, GND)

These two test points and the screw down connector are for the input voltage supply to the converter. The leads to the input supply should be twisted and kept as short as possible to minimize voltage drop, inductance, and EMI transmission. Additional bulk capacitance between VIN and GND may be desirable if the supply leads are greater than twelve inches, particularly if pulse width modulation (PWM) dimming will be used. If using the screw down connector J1, pin 1 is VIN and pin 2 is GND.

2.1.2.1.2 J2, J3, J8 (LED+, LED-)

Connect the LED string between J3 and J8 with the anode of one end connected to LED+ and the cathode of the other end connected to LED-. Alternatively, the screw down connector J2 may be used. Pin 1 of J2 is LED- and pin 2 is LED+.

2.1.2.1.3 GND

An additional ground test point is provided for ease of use. Ground leads for voltage probes, function generators, or low power analog supplies may be connected to either GND test point.

2.1.2.1.4 PWM DIM

This test point is connected through a blocking diode to the nDIM pin of the TPS92690. Pulling this test point to ground will disable switching and turn the LEDs off. A square wave with a low level of ground and a high level greater than the nDIM pin threshold (greater than 1.24 V and up to 30 V) may be applied to this test point to dim using PWM. The average LED current is approximately equal to the positive duty cycle of the PWM signal multiplied by the steady state LED current. The PWM dimming frequency should be between 120 Hz and 1 kHz to maintain the best linearity.

2.1.2.1.5 SYNC

This test point connects directly to the SYNC pin of the TPS92690. Applying a square wave to this test point with a low level of ground and a high level between 2.5 V and 5 V synchronizes the switching frequency of the TPS92690 with the applied square wave. The falling edge of the applied square wave triggers an on time of the power FET. The synchronizing frequency should be at least 10% higher than the native switching frequency set by the resistor from the RT pin to ground.

2.1.2.1.6 SS/SD

The SS/SD test point can be used to disable the device and place it into low power shutdown. It may also be used for monitoring the soft-start function with a voltage probe. Pull this test point to ground to disable the circuit.

2.1.2.1.7 IADJ

The IADJ test point is connected directly to the IADJ pin of the TPS92690. A resistor divider from VREF sets the default level of the IADJ pin to 500 mV which results in a default LED current of 500 mA. A low power voltage supply can be connected to the IADJ test point to either increase or decrease the LED current. This provides the analog dimming functionality of the TPS92690.

2.1.2.1.8 SW

This test point is strictly for monitoring the switching waveform. It is connected directly to the drain of the power switching FET.

Electrical Performance Specifications

Table 3-1. TPS92690EVM Electrical Performance Specifications

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Input Characteristics					
Voltage range		8	12	19	V
Maximum input current	At $I_{OUT} = 500$ mA		2.4		A
Undervoltage lockout level	Input rising		7.8		V
	Input falling		5.5		V
Output Characteristics					
Output voltage, V_{OUT}	At $I_{OUT} = 500$ mA	20		35	V
Output load current, I_{OUT}	IADJ = 0 V to 1 V	2	500	1000	mA
Output current regulation	Line Regulation: Input voltage = 8 V to 19 V		0.5		%
Output current ripple	At $I_{OUT} = 500$ mA		25		mA _{pp}
Overvoltage protection level	Output rising		41.3		V
Systems Characteristics					
Switching frequency			420		kHz
Efficiency	Input voltage = 12 V, Load = 10 LEDs at 500 mA		94		%
PWM Dim frequency		120		1000	Hz

Schematic

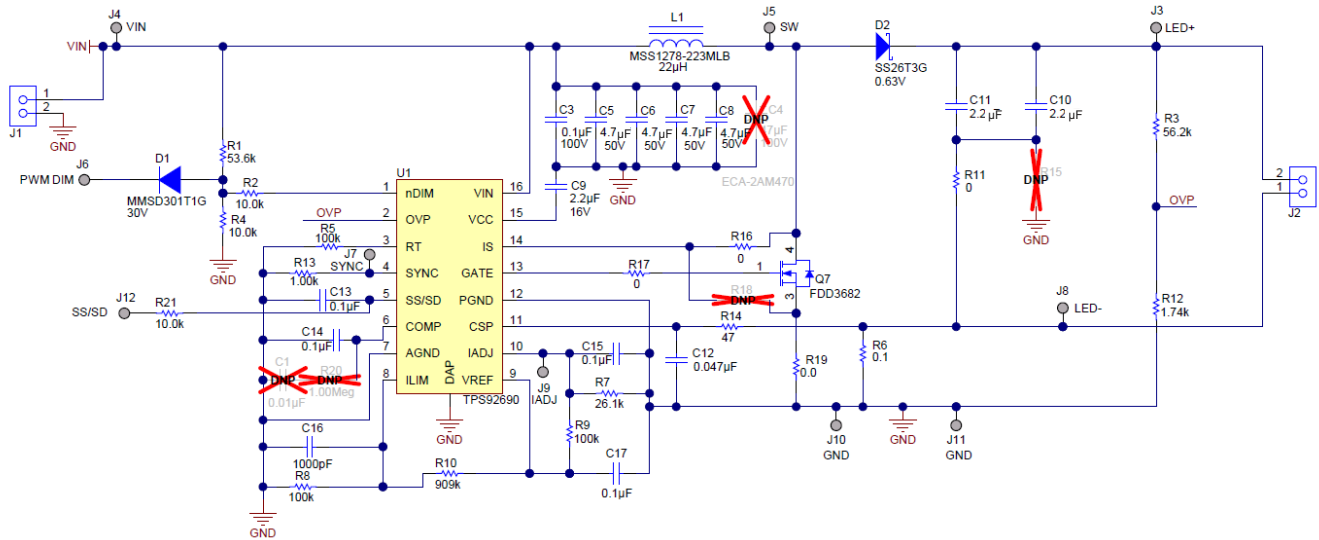


Figure 4-1. TPS92690EVM Schematic

Performance Data and Typical Characteristic Curves

Figure 5-1 through Figure 5-8 show typical performance curves for the TPS92690EVM.

5.1 Efficiency

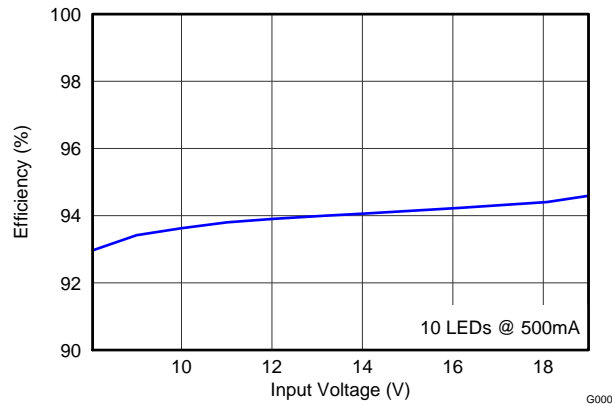


Figure 5-1. Efficiency

5.2 Line Regulation

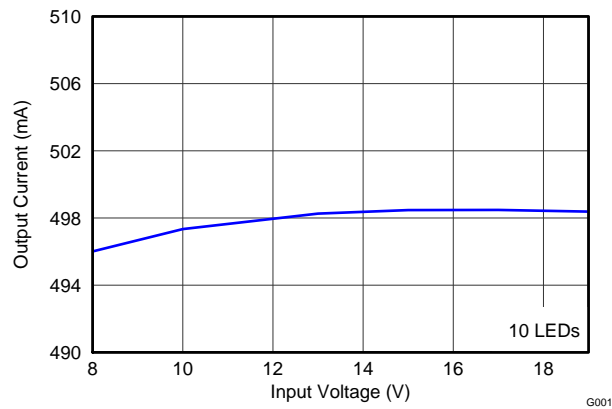


Figure 5-2. Line Regulation

5.3 Switch Node Voltage and LED Current Ripple

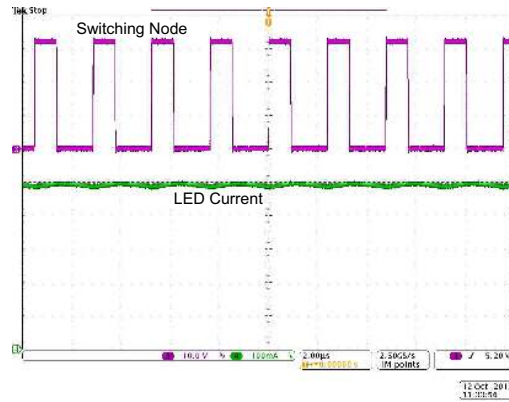


Figure 5-3. Switching and LED Current

5.4 PWM Dimming

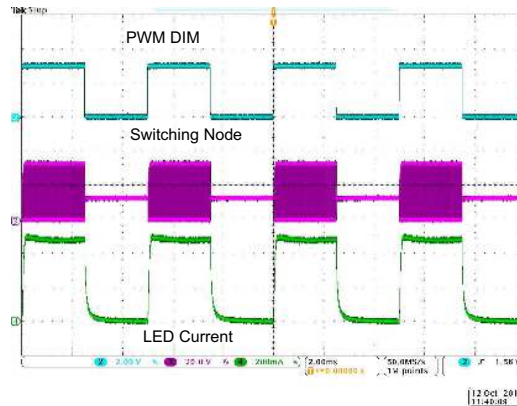


Figure 5-4. PWM Dimming, $f_{PWM} = 200$ Hz, Duty Cycle = 50%

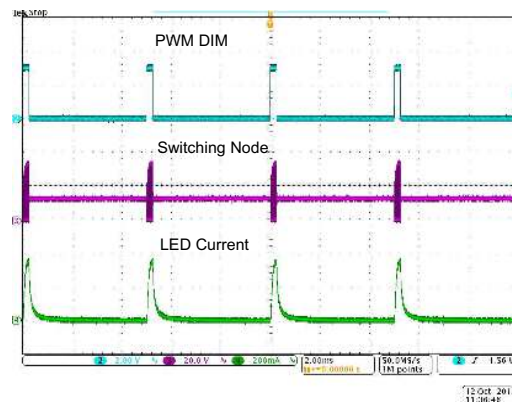


Figure 5-5. PWM Dimming, $f_{PWM} = 200$ Hz, Duty Cycle = 5%

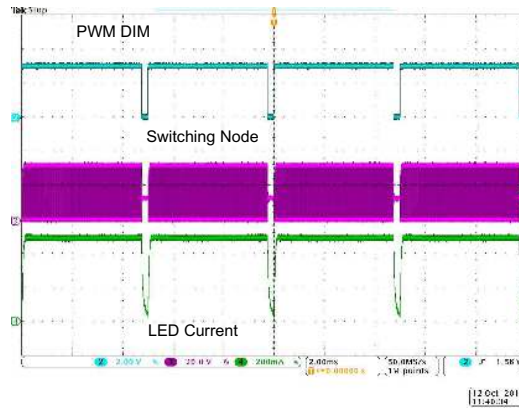


Figure 5-6. PWM Dimming, $f_{PWM} = 200 \text{ Hz}$, Duty Cycle = 95%

5.5 Start-up and Shut-down Response

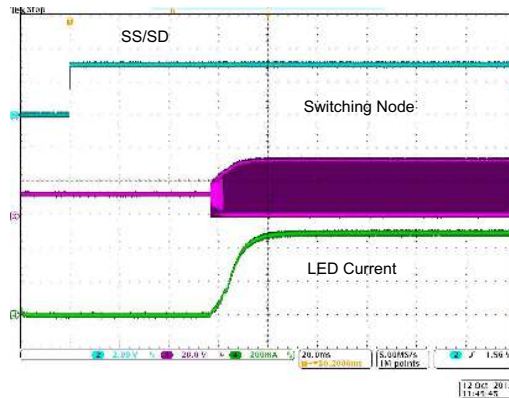


Figure 5-7. Start-up Waveform

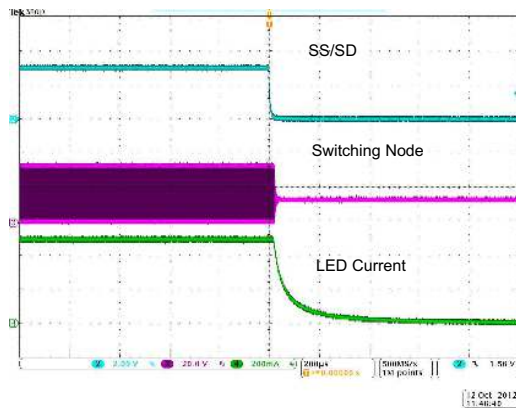


Figure 5-8. Shut-down Waveform

5.6 Thermal Performance

Figure 5-9 and Figure 5-10 show the steady state thermal performance of the EVM under the following conditions:

- Load of 10 LEDs
- $I_{LED} = 500\text{ mA}$
- $V_{IN} = 12\text{ V}_{DC}$

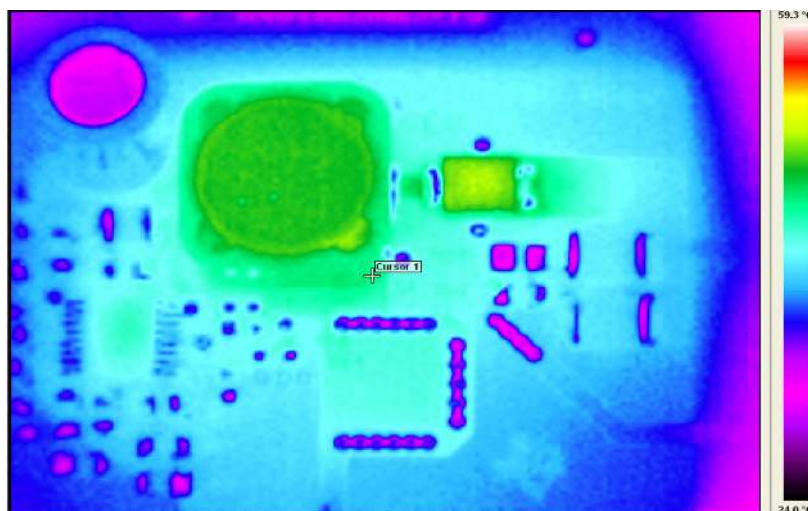


Figure 5-9. Top Thermal Performance

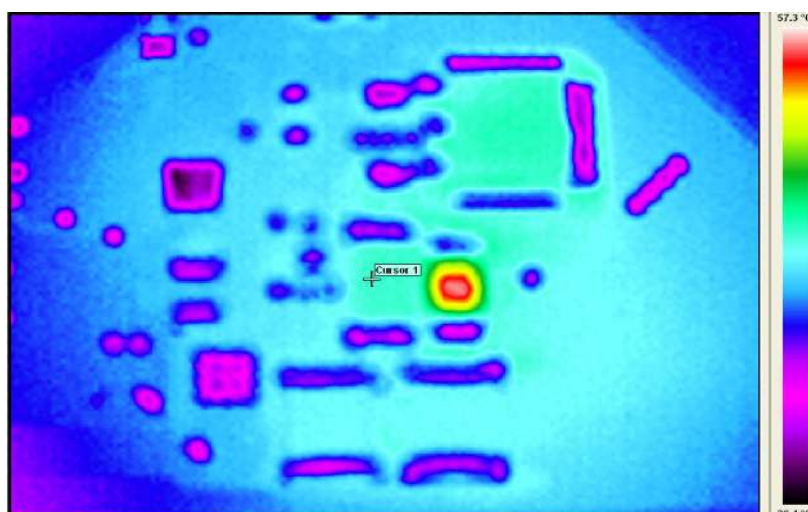


Figure 5-10. Bottom Thermal Performance

TPS92690EVM PCB layout

Figure 6-1 and Figure 6-2 show the design of the TPS92690EVM printed circuit board.

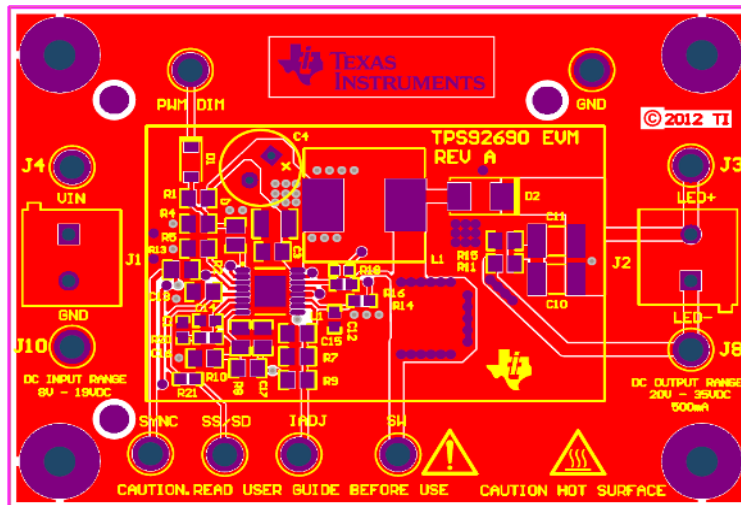


Figure 6-1. Top Layer and Top Overlay (Top View)

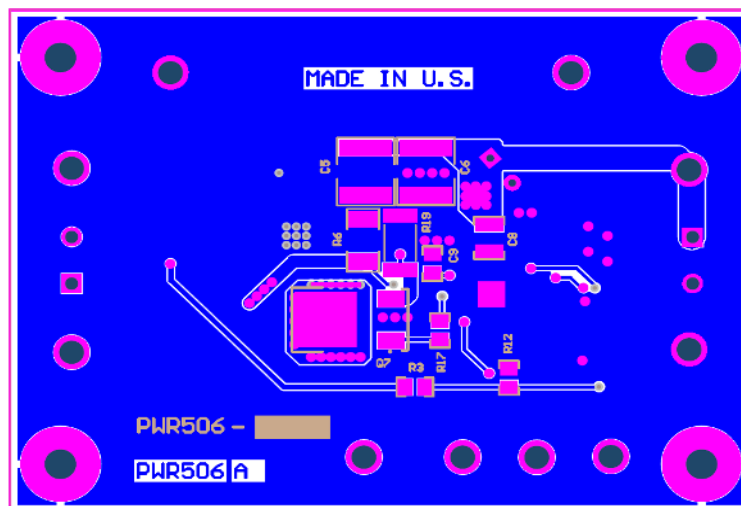


Figure 6-2. Bottom Layer and Bottom Overlay (Bottom View)

Bill of Materials

**Table A-1. The TPS92690EVM Components List
(According to the Schematic Shown in Figure 4-1)**

REFERENCE DESIGNATOR	QTY	VALUE	DESCRIPTION	SIZE	MFR	PART NUMBER
U1	1		DC-DC Controller with Low Side FET and Low Side Current Sense	eTSSOP-16	TI	TPS92690PWP
C3	1	0.1 μ F	Capacitor, Ceramic, 100 V, X7R	0805	Kemet	C0805C104K1RACTU
C5, C6	2	4.7 μ F	Capacitor, Ceramic, 50 V, X7R	2220	MuRata	GRM55ER71H475MA01L
C7, C8	2	4.7 μ F	Capacitor, Ceramic, 50 V, X7R	1210	MuRata	GRM32ER71H475KA88L
C9	1	2.2 μ F	Capacitor, Ceramic, 16 V, X7R	0805	MuRata	GRM21BR71C225KA12L
C10, C11	2	2.2 μ F	Capacitor, Ceramic, 50 V, X7R	1812	TDK	C4532X7R1H225M
C12	1	0.047 μ F	Capacitor, Ceramic, 50 V, X8R	0603	TDK	C1608X8R1H473K
C13, C15, C17	3	0.1 μ F	Capacitor, Ceramic, 50 V, X7R	0805	MuRata	GRM21BR71H104KA01L
C14	1	0.1 μ F	Capacitor, Ceramic, 25 V, X7R	0603	MuRata	GRM188R71E104KA01D
C16	1	1000 pF	Capacitor, Ceramic, 50 V, X7R	0805	Kemet	C0805C102K5RACTU
D1	1		Diode, Schottky, 30 V, 0.2 A	SOD-123	ON Semi	MMSD301T1G
D2	1		Diode, Schottky, 60 V, 2 A	SMB	ON Semi	SS26T3G
L1	1	22 μ H	Inductor, SMT, 6 A	12 mm x 12 mm	Coilcraft	MSS1278-223MLD
Q7	1		MOSFET, N-channel, 100 V, 32 A	D-PAK	Fairchild	FDD3682
R1	1	53.6 k Ω	Resistor, Chip, 1/8 W, 1%	0805	Std	Std
R2, R4	2	10 k Ω	Resistor, Chip, 1/8 W, 1%	0805	Std	Std
R3	1	56.2 k Ω	Resistor, Chip, 1/8 W, 1%	0805	Std	Std
R5, R8, R9	3	100 k Ω	Resistor, Chip, 1/8 W, 1%	0805	Std	Std
R6	1	0.1 Ω	Resistor, Chip, 1/2 W, 1%	2010	Dale	WSL2010R1000FEA
R7	1	26.1 k Ω	Resistor, Chip, 1/8 W, 1%	0805	Std	Std
R10	1	909 k Ω	Resistor, Chip, 1/8 W, 1%	0805	Std	Std
R11, R17	2	0 Ω	Resistor, Chip, 1/8 W, 1%	0805	Std	Std
R12	1	1.74 k Ω	Resistor, Chip, 1/8 W, 1%	0805	Std	Std
R13	1	1 k Ω	Resistor, Chip, 1/8 W, 1%	0805	Std	Std
R14	1	47 Ω	Resistor, Chip, 1/10 W, 5%	0603	Std	Std
R16	1	0 Ω	Resistor, Chip, 1/10 W, 5%	0603	Std	Std
R19	1	0 Ω	Resistor, Chip, 1 W, 1%	2512	Dale	CRCW25120000Z0EG
R21	1	10 k Ω	Resistor, Chip, 1/10 W, 5%	0603	Std	Std
C1	0		DNP			
C4	0		DNP			
R15	0		DNP			
R18	0		DNP			
R20	0		DNP			

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
OMAP Applications Processors	www.ti.com/omap
Wireless Connectivity	www.ti.com/wirelessconnectivity

Applications

Automotive and Transportation	www.ti.com/automotive
Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Video and Imaging	www.ti.com/video

TI E2E Community

e2e.ti.com