TPS92690EVM Boost Evaluation Module

User's Guide

Literature Number: SLVU803
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Contents

List of Figures

List of Tables

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

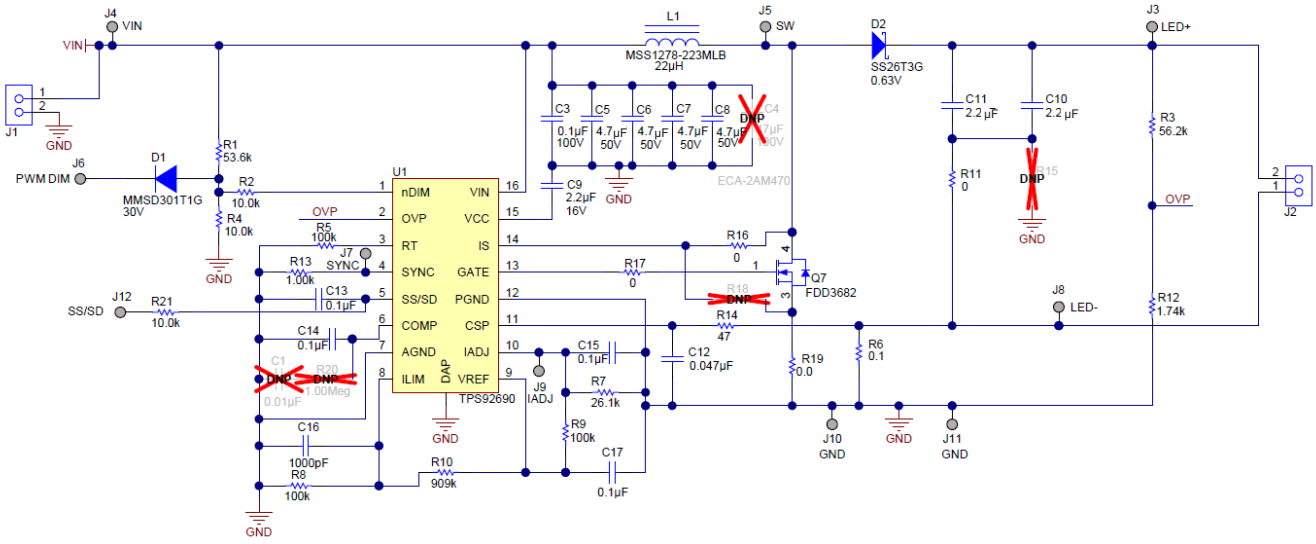

Figure 4-1. TPS92690EVM Schematic

Performance Data and Typical Characteristic Curves

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

5.1 Efficiency

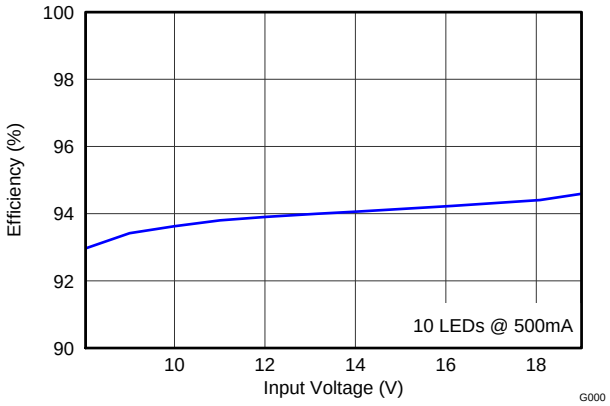

Figure 5-1. Efficiency

5.2 Line Regulation

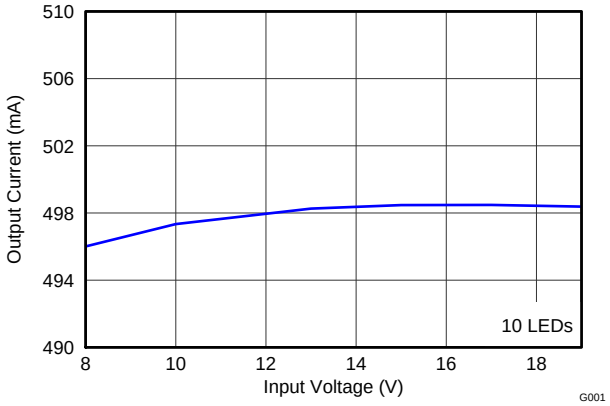

Figure 5-2. Line Regulation

5.3 Switch Node Voltage and LED Current Ripple

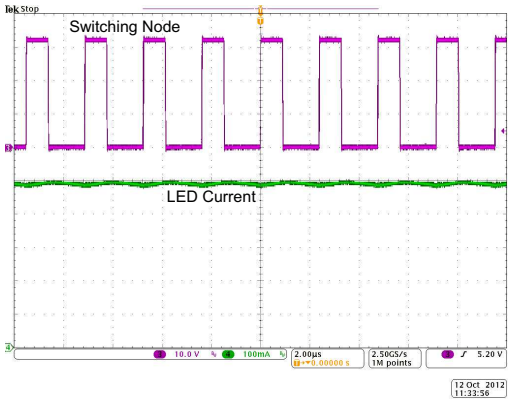

Figure 5-3. Switching and LED Current

5.4 PWM Dimming

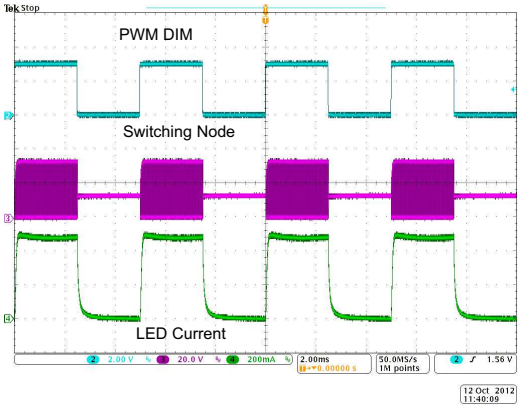

Figure 5-4. PWM Dimming, f_{PWM} = 200 Hz, Duty Cycle = 50%

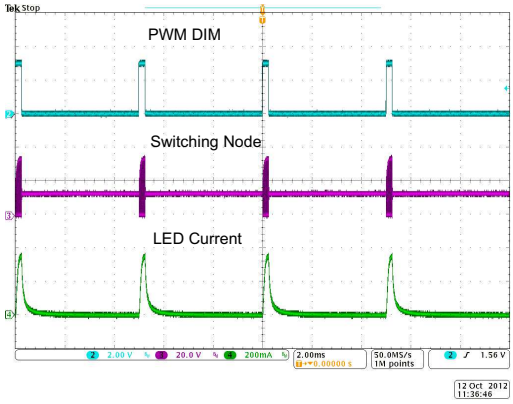

Figure 5-5. PWM Dimming, f_{PWM} = 200 Hz, Duty Cycle = 5%

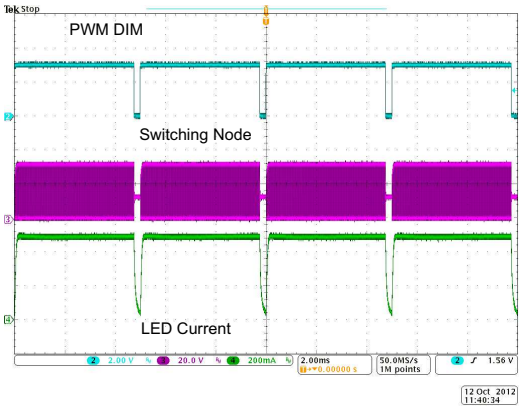

Figure 5-6. PWM Dimming, f_{PWM} = 200 Hz, Duty Cycle = 95%

5.5 Start-up and Shut-down Response

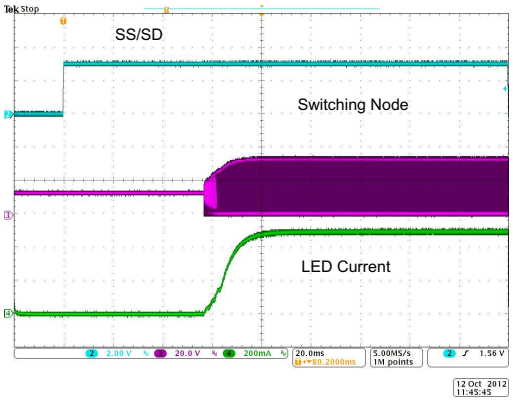

Figure 5-7. Start-up Waveform

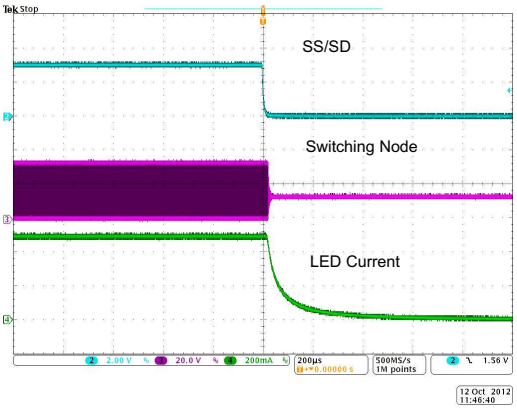

Figure 5-8. Shut-down Waveform

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 mA
- V_{IN} = 12 V_{DC}

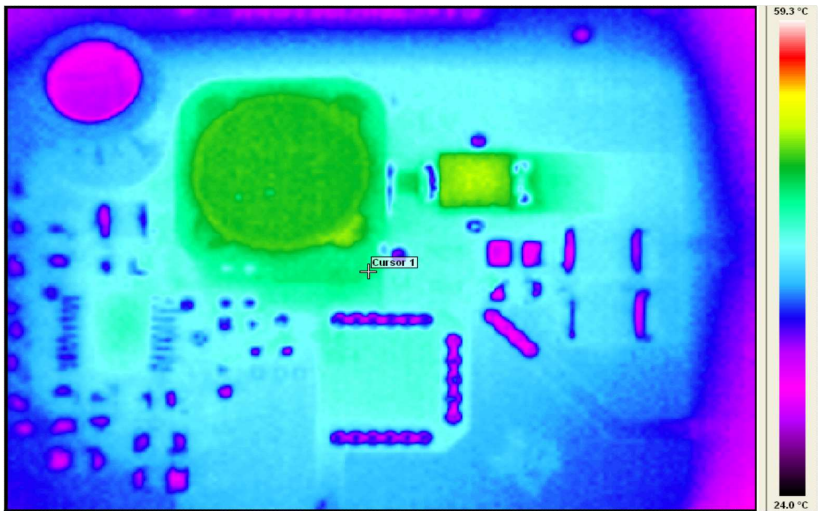

Figure 5-9. Top Thermal Performance

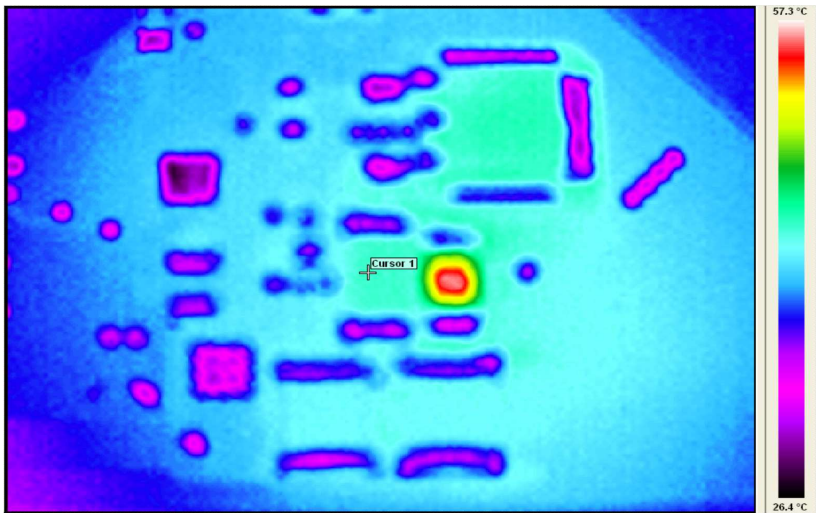

Figure 5-10. Bottom Thermal Performance

TPS92690EVM PCB layout

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

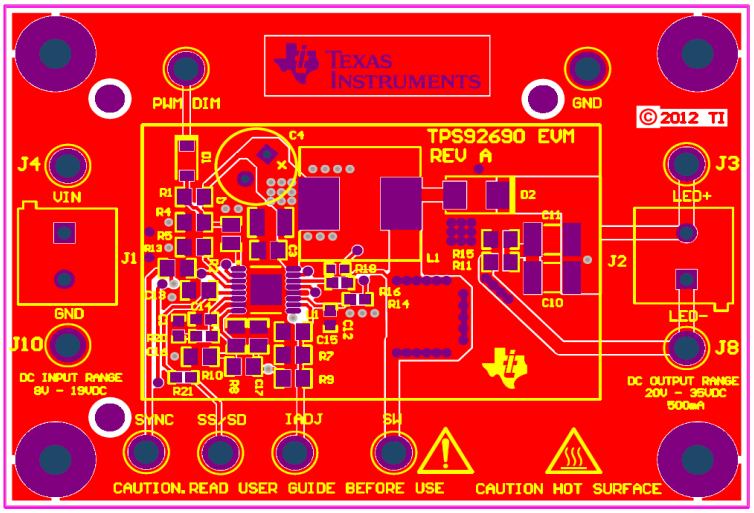

Figure 6-1. Top Layer and Top Overlay (Top View)

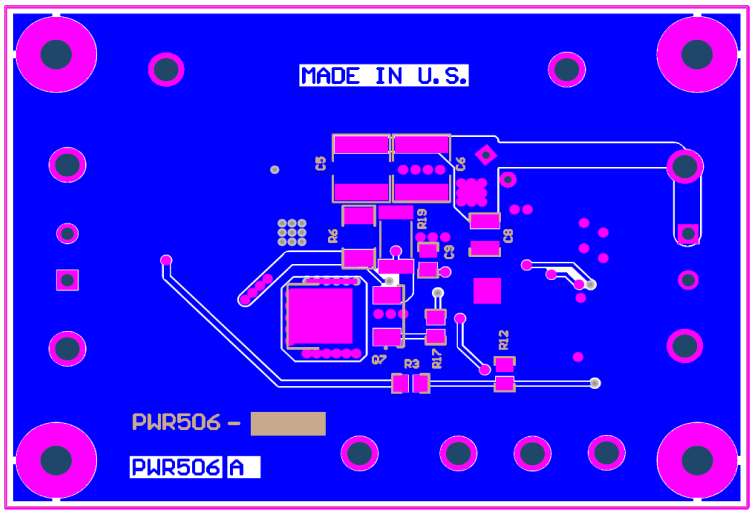

Figure 6-2. Bottom Layer and Bottom Overlay (Bottom View)

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 µF	Capacitor, Ceramic, 100 V, X7R	0805	Kemet	C0805C104K1RACTU
C5, C6	2	4.7 µF	Capacitor, Ceramic, 50 V, X7R	2220	MuRata	GRM55ER71H475MA01L
C7, C8	2	4.7 µF	Capacitor, Ceramic, 50 V, X7R	1210	MuRata	GRM32ER71H475KA88L
C9	1	2.2 µF	Capacitor, Ceramic, 16 V, X7R	0805	MuRata	GRM21BR71C225KA12L
C10, C11	2	2.2 µF	Capacitor, Ceramic, 50 V, X7R	1812	TDK	C4532X7R1H225M
C12	1	0.047 µF	Capacitor, Ceramic, 50 V, X8R	0603	TDK	C1608X8R1H473K
C13, C15, C17	3	0.1 µF	Capacitor, Ceramic, 50 V, X7R	0805	MuRata	GRM21BR71H104KA01L
C14	1	0.1 µF	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 µH	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 kΩ	Resistor, Chip, 1/8 W, 1%	0805	Std	Std
R2, R4	2	10 kΩ	Resistor, Chip, 1/8 W, 1%	0805	Std	Std
R3	1	56.2 kΩ	Resistor, Chip, 1/8 W, 1%	0805	Std	Std
R5, R8, R9	3	100 kΩ	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 kΩ	Resistor, Chip, 1/8 W, 1%	0805	Std	Std
R10	1	909 kΩ	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 kΩ	Resistor, Chip, 1/8 W, 1%	0805	Std	Std
R13	1	1 kΩ	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 kΩ	Resistor, Chip, 1/10 W, 5%	0603	Std	Std
C1	0		DNP			
C4	0		DNP			
R15	0		DNP			
R18	0		DNP			
R20	0		DNP			

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