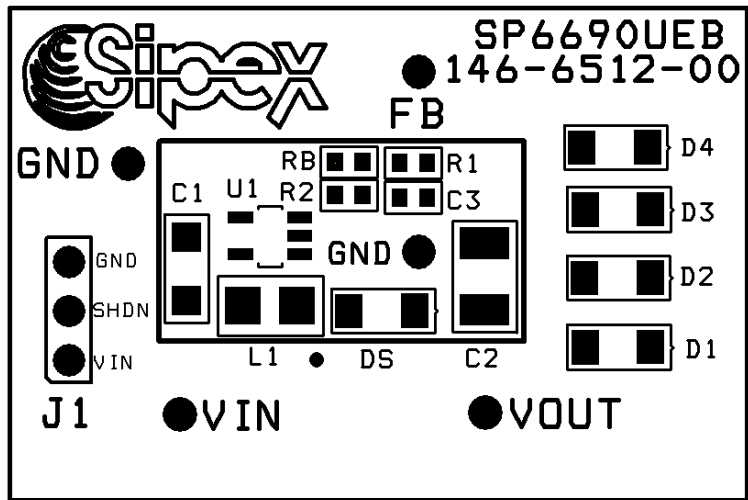




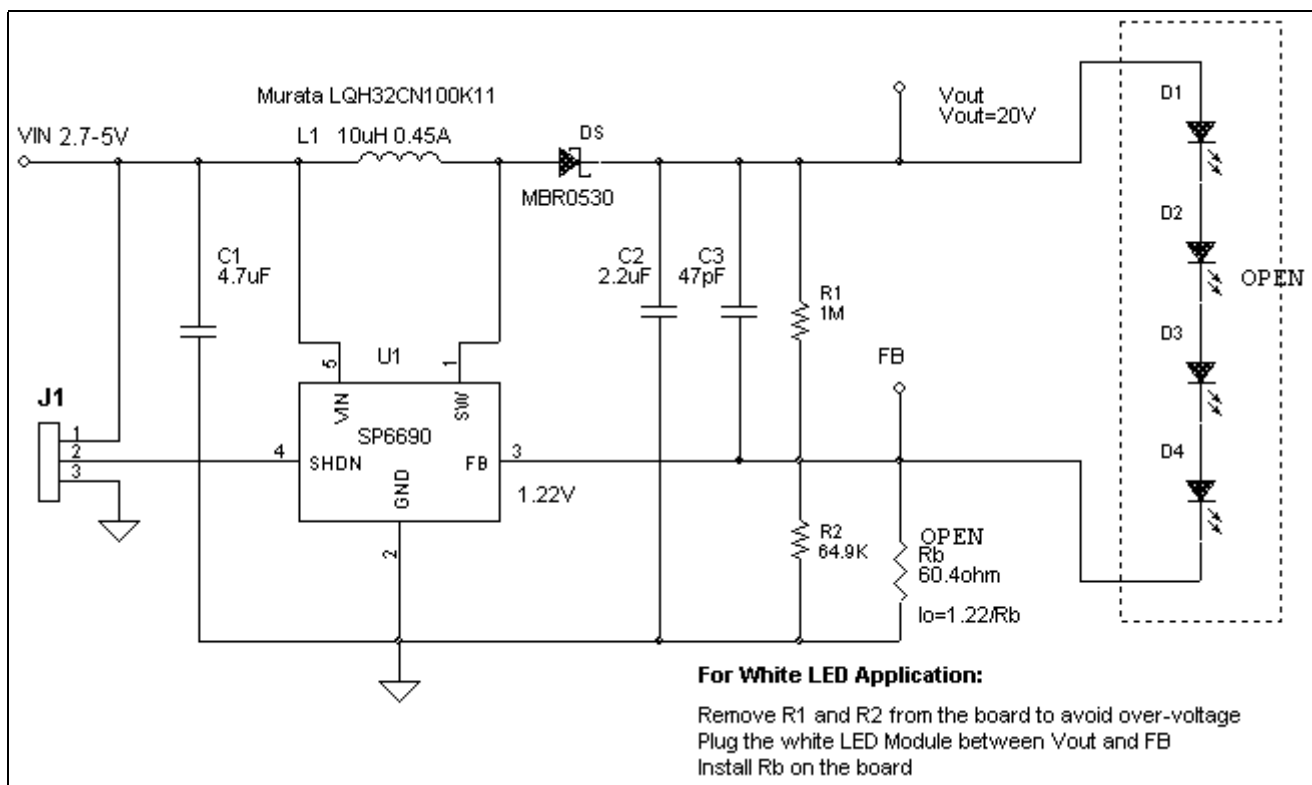
## SP6690 Evaluation Board Manual

- Ideal for series white LED driver
- High output voltage, up to 30V
- Low quiescent current: 20uA
- Ultra low shutdown current: 10nA
- High Efficiency: up to 80%
- SOT23-5 Package & SMT components for small, low profile Power Supply



### DESCRIPTION AND BOARD SCHEMATIC

The **SP6690 Evaluation Board** is designed to help the user evaluate the performance of the SP6690 as a series white LED driver. The evaluation board is a completely assembled and tested surface mount board which provides easy probe access points to all SP6690 Inputs and Outputs so that the user can quickly connect and measure electrical characteristics and waveforms.



## USING THE EVALUATION BOARD

### 1) Powering Up the SP6690 Circuit

The SP6690 Evaluation Board can be powered from inputs from a +1.2V to +5.0V. Connect with short leads directly to the “VIN” and “GND” posts. Monitor the Output Voltage and connect the Load between the “VOUT” post and the “GND” post.

### 2) Using the J1 Jumper: Enabling the SP6690 Output and using the Shutdown Mode

The SP6690 output will be enabled if the J1 Jumper is in the bottom or pin 1 to 2 position. If J1 is in the pin 2 to 3 or top position, the Shutdown pin is brought to GND, which puts the SP6690 in the low quiescent Shutdown Mode.

### 3) Using the Posts

Since the part might get damaged when the output is open loop, two divider resistors ( $R_1=1M$ ,  $R_2=64.9K$ ) are used to provide the feedback loop and set the output voltage. For the white LEDs application, these two resistors ( $R_1$ ,  $R_2$ ) need to be removed from the evaluation board first to avoid over-voltage and then plug the white LED module between “VOUT” and “FB” posts. The bias resistor  $R_b$  should also be installed on the board.

### 4) Inductor Selection

For SP6690, the internal switch will be turned off only after the inductor current reaches the typical dc current limit ( $I_{LIM}=350mA$ ). However, there is typically propagation delay of 200nS between the time when the current limit is reached and when the switch is actually turned off. During this 200nS delay, the peak inductor current will increase, exceeding the current limit by a small amount. The peak inductor current can be estimated by:

$$I_{pk} = I_{LIM} + \frac{V_{in(max)}}{L} \cdot 200nS$$

The larger the input voltage and the lower the inductor value, the greater the peak current.

In selecting an inductor, the saturation current specified for the inductor needs to be greater than the SP6690 peak current to avoid saturating the inductor, which would result in a loss in efficiency and could damage the inductor.

Choosing an inductor with low DCR decreases power losses and increase efficiency.

Refer to Table 1 for some suggested low ESR inductors.

Table 1. Suggested Low ESR inductor

MANUFACTURE	PART NUMBER	DCR ( $\Omega$ )	Current Rating (mA)
MURATA 770-436-1300	LQH32CN100K11 (10uH)	0.3	450
TDK 847-803-6100	NLC453232T-100K (22uH)	0.55	500

### 5) Diode Selection

A schottky diode with a low forward drop and fast switching speed is ideally used here to achieve high efficiency. In selecting a Schottky diode, the current rating of the schottky diode should be larger than the peak inductor current. Moreover, the reverse breakdown voltage of the schottky diode should be larger than the output voltage.

### 6) Capacitor Selection

Ceramic capacitors are recommended for their inherently low ESR, which will help produce low peak to peak output ripple, and reduce high frequency spikes.

For the typical application, 4.7uF input capacitor and 2.2uF output capacitor are sufficient. The input and output ripple could be further reduced by increasing the value of the input and output capacitors. Place all the capacitors as close to the SP6690 as possible for layout. For use as a voltage source, to reduce the output ripple, a small feedforward (47pF) across the top feedback resistor can be used to provide sufficient overdrive for the error comparator, thus reducing the output ripple.

Refer to Table 2 for some suggested low ESR capacitors.

Table 2. Suggested Low ESR capacitor

MANUFACTURE	PART NUMBER	CAP /VOLTAGE	SIZE /TYPE
MURATA 770-436-1300	GRM32RR71E 225KC01B	2.2uF /25V	1210 /X5R
MURATA 770-436-1300	GRM31CR61A 475KA01B	4.7uF /10V	1206 /X5R
TDK 847-803-6100	C3225X7R1E 225M	2.2uF /25V	1210 /X7R
TDK 847-803-6100	C3216X5R1A 475K	4.7uF /10V	1206 /X5R

## 7) LED Current Program

In the white LEDs application, the SP6690 is generally programmed as a current source. The bias resistor  $R_b$  is used to set the operating current of the white LED using the equation:

$$R_b = \frac{V_{FB}}{I_F}$$

where  $V_{FB}$  is the feedback pin voltage (1.22V),  $I_F$  is the operating current of the White LEDs. In order to achieve accurate LED current, 1% precision resistors are recommended. Table 3 below shows the  $R_b$  selection for different white LED currents. For example, to set the operating current to be 20mA,  $R_b$  is selected as 60.4 Ohm, as shown in the schematic.

Table 3. Bias Resistor Selection

$I_F$ (mA)	$R_b$ ( $\Omega$ )
5	243
10	121
12	102
15	80.6
20	60.4

## 8) Vout Programming

The SP6690 can be programmed as either a voltage source or a current source. To program the SP6690 as voltage source, the SP6690 requires 2 feedback resistors  $R_1$  &  $R_2$  to control the output voltage. The formula for the resistor selection are shown below.

$$R_1 = \left( \frac{V_{out}}{1.22} - 1 \right) \cdot R_2$$

## 9) Open Circuit Protection

When any white LED inside the white LED module fails or the LED module is disconnected from the circuit, the output and the feedback control will be open, thus resulting in a high output voltage, which may cause the SW pin voltage to exceed its maximum rating. In this case, a zener diode can be used at the output to limit the voltage on the SW pin and protect the part. The zener voltage should be larger than the maximum forward voltage of the White LED module.

## 10) Brightness Control

Dimming control can be achieved by applying a PWM control signal to the EN/PWM pin. The brightness of the white LEDs is controlled by increasing and decreasing the duty cycle of the PWM signal. A 0% duty cycle corresponds to zero LED current and a 100% duty cycle corresponds to full load current. While the operating frequency range of the PWM control is from 60Hz to 700Hz, the recommended maximum brightness frequency range of the PWM signal is from 60Hz to 200Hz. A repetition rate of at least 60Hz is required to prevent flicker. The magnitude of the PWM signal should be higher than the minimum SHDN voltage high.

## 11) Layout Consideration

Both the input capacitor and the output capacitor should be placed as close as possible to the IC. This can reduce the copper trace resistance which directly affects the input and output ripples. The feedback resistor network should be kept close to the FB pin to minimize copper trace connections that can inject noise into the system. The ground connection for the feedback resistor network should connect directly to the GND pin or to an analog ground plane that is tied directly to the GND pin. The inductor and the schottky diode should be placed as close as possible to the switch pin to minimize the noise coupling to the other circuits, especially the feedback network.

POWER SUPPLY DATA

For the standard evaluation board (4x20mA series white LEDs application), in which the output voltage is around 15V and output current is 20mA, the power supply data is provided in Fig 1. to Fig. 4. The white LEDs used here were from LUMEX (Part Number: SML-LX2832UWC-TR).

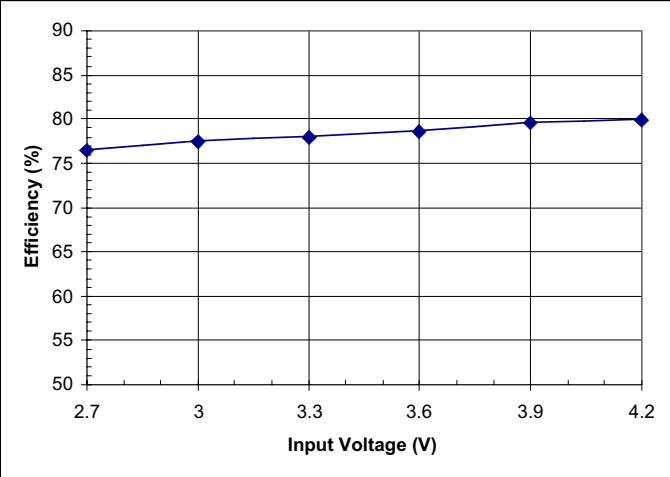


Fig. 1 Efficiency vs Input Voltage

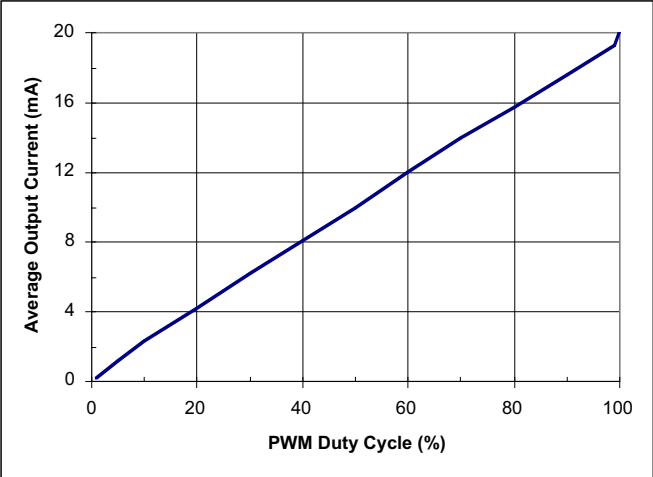


Fig. 2 Average Io vs SHDN duty cycle

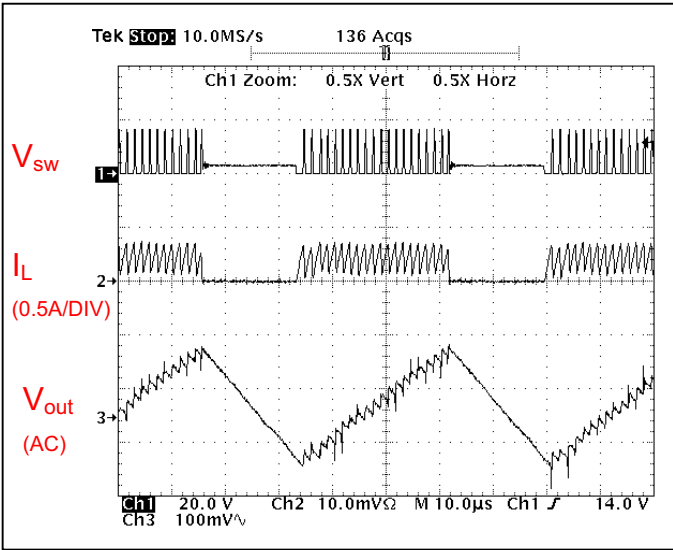


Fig. 3 Typical Switching Waveform (Vin=3.3V)

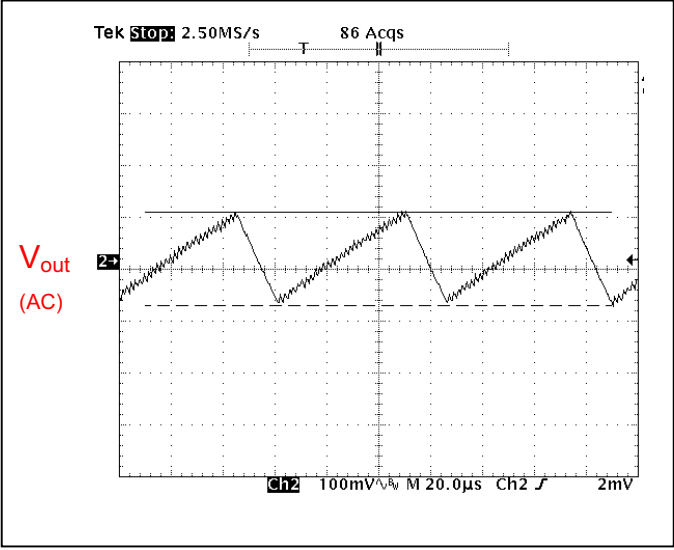


Fig. 4 Output Ripple (Vin=2.7V)

EVALUATION BOARD LAYOUT

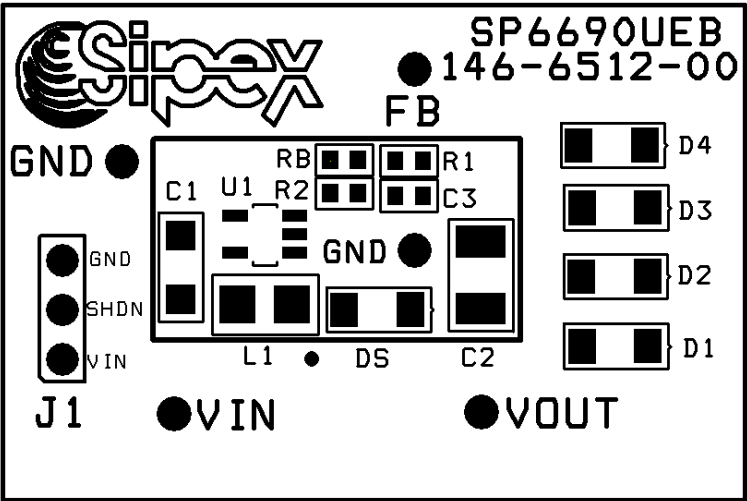


FIGURE 1: SP6690EB COMPONENT PLACEMENT

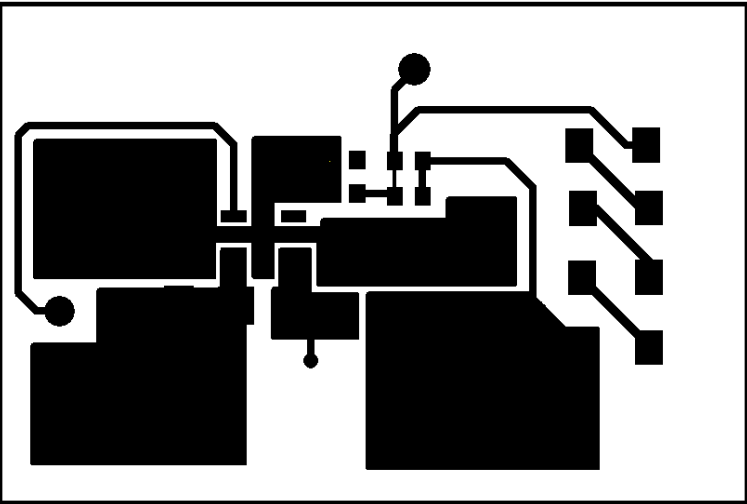


FIGURE 2: SP6690EB PC LAYOUT TOP SIDE

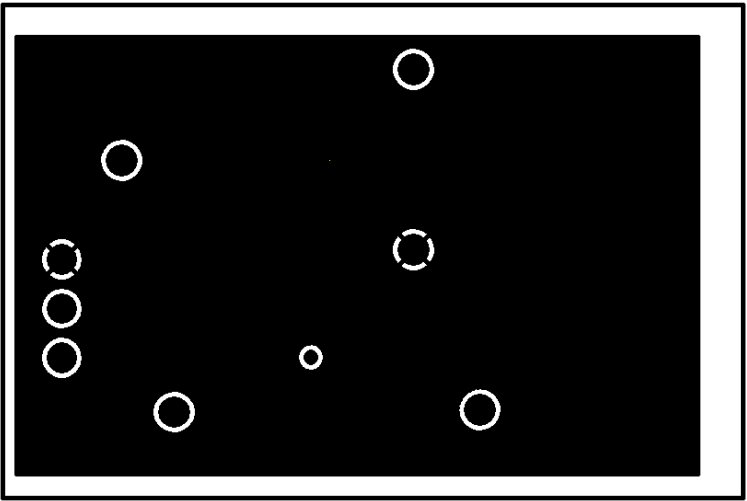


FIGURE 3: SP6690EB PC LAYOUT BOTTOM SIDE

**TABLE1: SP6690LEB LIST OF MATERIALS**

<b>SP6690 Evaluation Board List of Materials</b>						
Ref. Des.	Qty.	Manufacturer	Part Number	Layout Size LxWxH	Component	Vendor
	1	Sipex Corp.	146-6512-00	1"x1.5"	SP6690 Eval PC Board	Sipex 978-667-8700
U1	1	Sipex Corp.	SP6690EK	SOT23-5	5-pin SOT23 Step-Up DC/DC Conv	Sipex 978-667-8700
C1	1	Murata	GRM31CR61A475KA01B	1206	Ceramic 10V 4.7uF SM	Murata 770-436-1300
C2	1	Murata	GRM32RR71E225KC01B	1210	Ceramic 25V 2.2uF SM	Murata 770-436-1300
C3	1	Murata	GRM1885C1H470JA01B	603	Ceramic 47pF SM	Murata 770-436-1300
L1	1	Murata	LQH32CN100K11	3.2X2.5X2mm	10uH, 0.45A, 0.3 Ohm, SM Inductor	Murata 770-436-1300
R1	1	Panasonic	ERJ-3EKF1004	603	1M Ohm 1/16W 1% 0603 SM	800-Digi-Key
R2	1	Panasonic	ERJ-3EKF6492	603	64.9K Ohm 1/16W 1% 0603 SM	800-Digi-Key
Rb	1	Panasonic	ERJ-3EKF60R4V	603	Open	800-Digi-Key
DS	1	On-Semi	MBR-0530	SOD-123	Schottky Diode 30V, 0.5A	Onsemi
D1-D4	1			SOD-123	Open	
TP	5	Mill-Max	0300-115-01-4727100	.042 Dia	Test Point Female Pin	800-Digi-Key
J1	1	Sullins	PTC36SAAN	.23x.12	2-Pin Header	800-Digi-Key

**ORDERING INFORMATION**

<b>Model</b>	<b>Temperature Range</b>	<b>Package Type</b>
SP6690EB.....	-40°C to +85°C.....	SP6690 Evaluation Board
SP6690EU.....	-40°C to +85°C.....	5-pin SOT-23