

-
- EN/PWM R3 C2 C4 LEDA C5 D1 D2 D3 D4
- VIN R1 C1 UT RFB C6 GND J1
- VMODE R2 C3 LEDK J2 R6 R7 R8 R9
- SP6682UEB 146-6483-01

The diagram shows a detailed circuit for driving four LEDs with a total current of 60mA. The SP6682 IC is the core component, configured with various capacitors (C1-C6) and resistors (R1-R9). The input voltage is specified as 2.7-4.2V. The output is connected to four LEDs (D1-D4) in parallel, each with a 20Ω resistor (R6-R9). The SP6682 IC is configured with Vout, C1P, Vin, Vmode, FB, EN/PWM, C2P, C1N, GND, C2N, and EN/PWM pins. The output current is regulated to 60mA total.

USING THE EVALUATION BOARD

1) Powering Up the SP6682 Circuit

The SP6682 Evaluation Board can be powered from inputs from a +2.7V to +5.5V battery or a power supply. Connect with short leads directly to the “VIN” and “GND” posts.

2) Using the Jumpers and posts

There are two jumpers (J1 and J2) and seven posts on the Evaluation Board. The output of SP6682 is open as the default. If the customer has discrete white LEDs, the 5.1 ohm “RFB” resistor needs to be removed from the board first. Then the discrete white LEDs should be soldered to the D1-D4 positions and bias resistors should be soldered to the R6-R9 positions. For selection of the bias resistors, please refer to 3). If the customer has a white LED module, they can plug the two terminals of the module to the “LEDA” and “LEDK” posts. Note that a 5.1ohm bias resistor was put on the “RFB” position to regulate a 60mA output current as the default. If the output current is not 60mA in the customer’s application, an appropriate bias resistor should be selected to replace the 5.1ohm resistor. The value of the bias resistor could be calculated by equation (1).

3) Selecting the Bias Resistor

The bias resistor could be estimated by (1)

$$R_{FB} = V_{FB} / I_{LED_Total} = 0.3V / 60mA = 5\Omega \quad (1)$$

Where I_{LED_Total} is the total output current.

$$R_{6-9} = V_{FB} / I_{LED_D1-4} = 0.3V / 15mA = 20\Omega \quad (2)$$

Where I_{LED_D1-D4} is the operating current of D1-D4.

4) Selecting of V_{mode} and Divider Resistor

SP6682 can automatically change from X1.5 mode to X2 mode for highest efficiency. To use this feature, divider resistors should be chosen according to the specific application. The guideline for divider resistor selections is as follows. For high input voltage, the SP6682 will work in X1.5 mode, when the input voltage drops to V_{th} threshold voltage,

it will switch to X2 mode automatically. The V_{th} threshold voltage for mode change can be calculated by (3)

$$V_{th} = (V_F + 0.3 + m \cdot I_{LED} \cdot R_{out}) / 1.5 \quad (3)$$

Where V_F and m are the forward voltage and number of the white LEDs, R_{out} is the output resistance of the SP6682.

The equation for the voltage divider R_1 and R_2 with $V_{mode}=1.25V$ is:

$$V_{th} = 1.25V \cdot (1 + R_1 / R_2) \quad (4)$$

which can be expressed as R_1 :

$$R_1 = (V_{th} / 1.25 - 1) \cdot R_2 \quad (5)$$

For the typical Sp6682 Evaluation Board, using $V_F=3.6V$, $m=4$, $I_{LED}=15mA$, $R_{out}=16ohms$, the V_{th} will be 3.24V. Select $R_2=100kohm$, then $R_1=158kohm$.

5) Selecting of Capacitors

Ceramic capacitors are used on the evaluation board due to their inherently low ESR, which will help produce low peak to peak output ripple, and reduce high frequency spikes.

Selection of the flying capacitor is a trade-off between the output voltage ripple and the output current capability. Decreasing the flying capacitor will reduce the output voltage ripple because less charge will be delivered to the output capacitor. However, smaller flying capacitor leads to larger output resistance, thus decrease the output current capability and the circuit efficiency.

In the evaluation board, the input, output and flying capacitors are selected as 2.2uF ceramic capacitors. Input and output ripple could be further reduced by using larger low ESR input and output capacitor.

6) Brightness Control

Dimming control can be achieved by applying a PWM control signal to the ENABLE/PWM pin. The brightness of the white LEDs is controlled by increasing and decreasing the duty cycle of The PWM signal. The recommended frequency range of the PWM signal is from 60Hz to 200Hz. A repetition rate of at least 60Hz is required to prevent flicker.

POWER SUPPLY DATA

For a 4x15mA White LEDs application, in which the output current is 60mA, the power supply data is provided as Fig 1 to Fig 3. The white LEDs used here were from LUMEX (Part Number SML-LX2832UWC-TR). Figure 1 shows the input and output voltage ripples when the input voltage is 2.7V (SP6682 is in X2 mode), Figure 2 shows the input and output voltage ripple when the input voltage is 3.3V (SP6682 is in X1.5 mode). Figure 3 shows the typical efficiency curve in the input voltage range. Channel 1 is the input ripple and the channel 2 is the output ripple. Other applications, such as 80mA output current application (4 20mA white LEDs in parallel), have the similar characteristic.

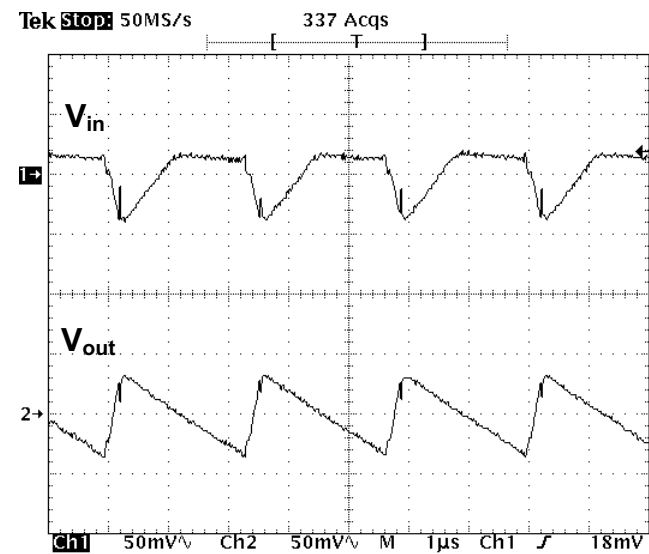


Figure 1. X2 Mode Voltage Ripple @ 2.7V

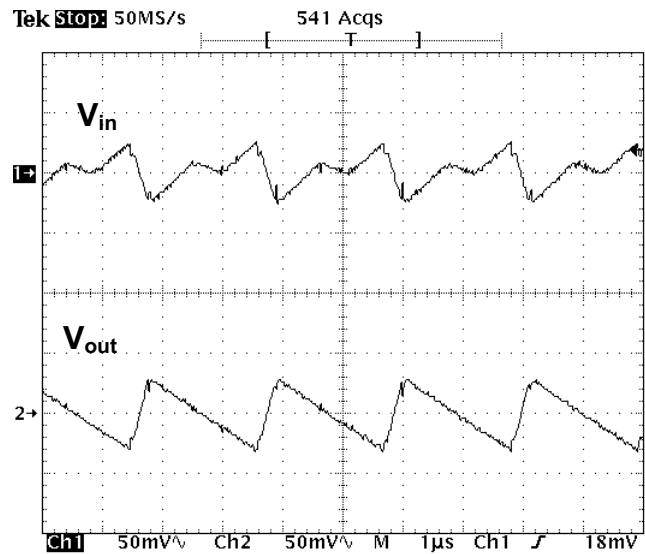


Figure 2. X1.5 Mode Voltage Ripple @ 3.3V

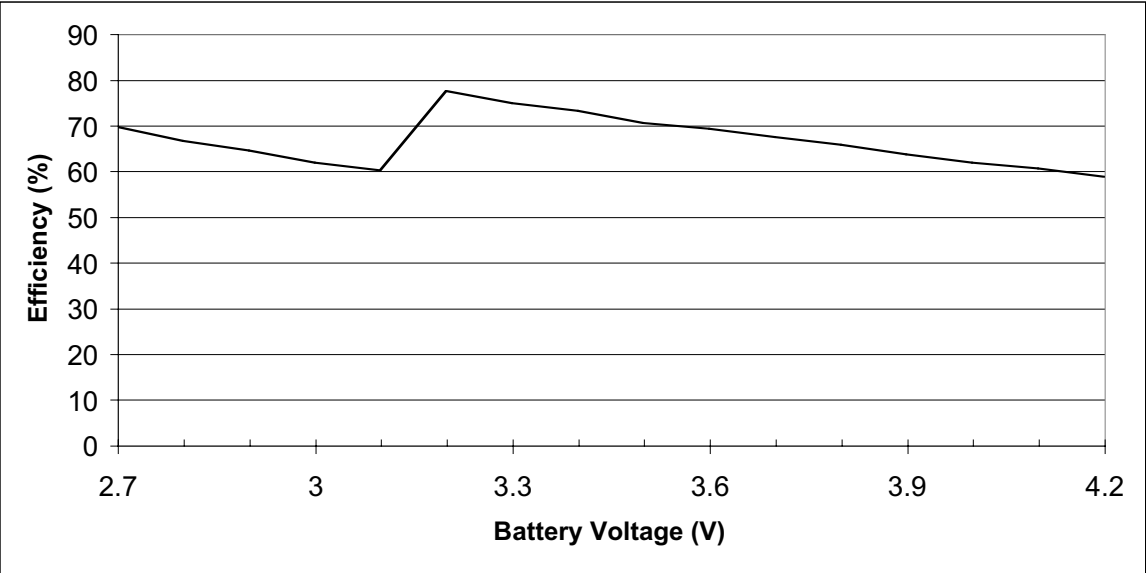


Figure 3. Efficiency vs Input Voltage

Evaluation Board Layout

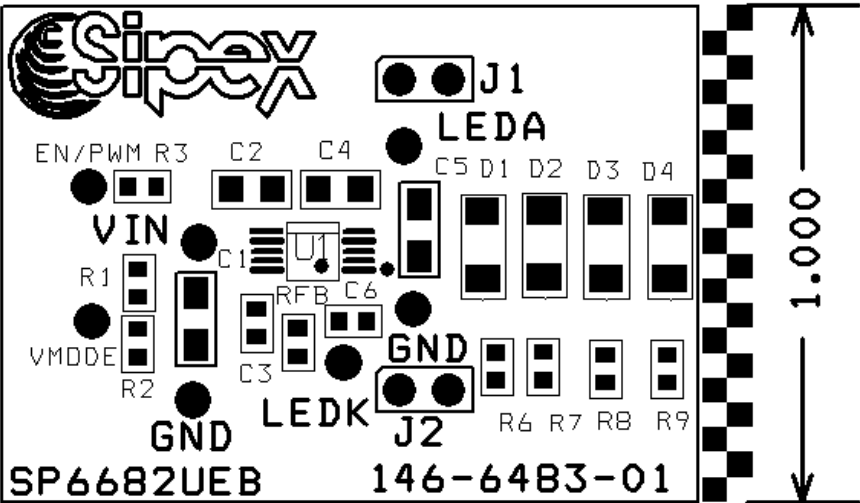


FIGURE 4: SP6682 COMPONENT PLACEMENT

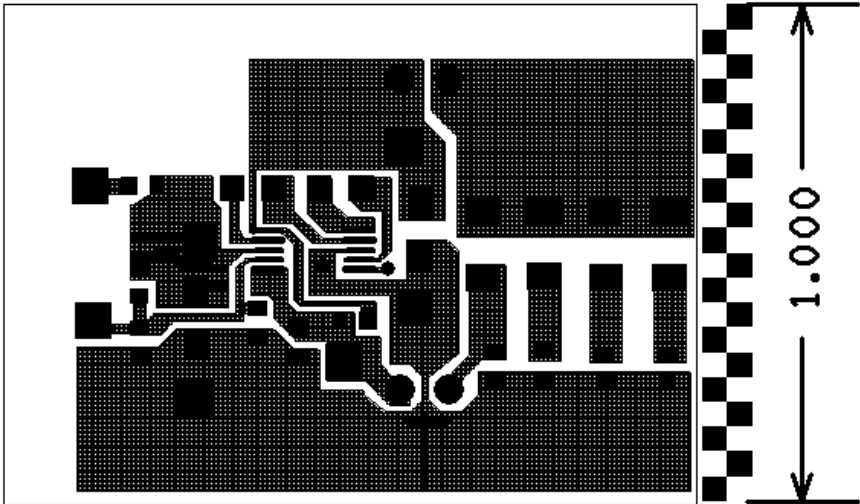


FIGURE 5: SP6682 PC LAYOUT TOP SIDE

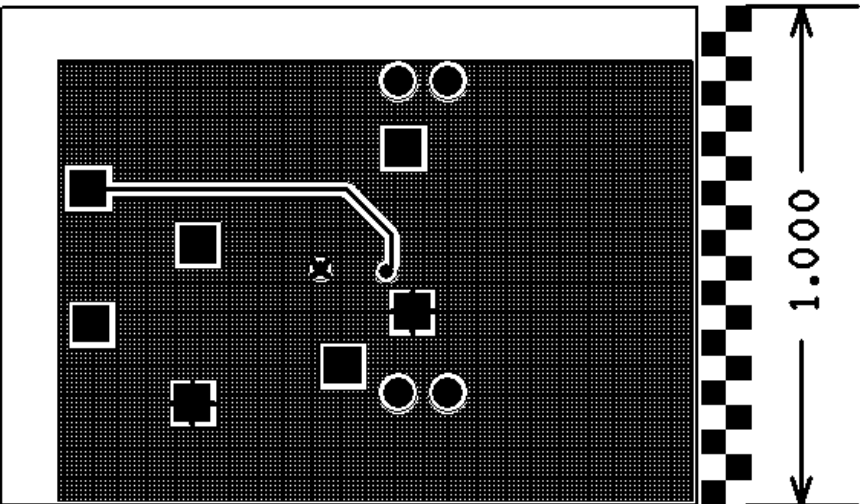


FIGURE 6: SP6682 PC LAYOUT BOTTOM SIDE

TABLE1: SP6682 BILL OF MATERIALS

SP6682 Evaluation Board List of Materials						
Ref. Des.	Qty.	Manufacturer	Part Number	Layout Size LxWxH	Component	Vendor
	1	Sipex Corp.	146-6483-01	1"x1.5"	SP6682 Eval PC Board	Sipex 978-667-8700
U1	1	Sipex Corp.	SP6682EU	MSOP-10	10 PIN High Efficiency Charge Pump Regulator	Sipex 978-667-8700
C1,C2,C4,C5	4	TDK Corp	TDKC2012X5R1A225K	805	2.2uF/10V/X5R/10% Ceramic	TDK 847-803-6100
C3,C6	2	TDK Corp	TDKC1608X7R1E104K	603	0.1uF/10V/X7R/10% Ceramic	TDK 847-803-6100
D1-D4					Open	
R1	1			603	154K/ 63mW/1%	800-Digi-Key
R2	1			603	100K/ 63mW/1%	800-Digi-Key
R3	1			603	1.0M/ 63mW/5%	800-Digi-Key
R6-R9				603	Open	
Rfb	1			603	5.1 Ohm/63mW/5%	800-Digi-Key
TP	7	Mill-Max	0300-115-01-4727100	.042 Dia	Test Point Female Pin	800-Digi-Key
J1,J2	1	Sullins	PTC36SAAN	.23x.12	2-Pin Header	800-Digi-Key