

40V Boost Converter / White LED Driver

DESCRIPTION

The SMC1605SQ is a high-efficiency step-up converter, an internally integrated 40V power MOSEFT, internal current limit as high as 1A, and it can drive up to 10 LEDs at 50mA output current. The device operates from an input voltage range of 2.7V to 6V, The incorporated 18-100KHz true PWM-Dimming feature by EN pin can be used to digitally program the LED current. For maximum protection, the SMC1605SQ has an internal OVP protection at 38V to prevent the chip from damages when the LED string is not connected to the output.

PART NUMBER INFORMATION

SMC 1605 SQ - TR G
 a b c d e

- a : Company name.
- b : Product Serial number.
- c : Package code SQ:SOT-23-6L
- d : Handling code TR:Tape&Reel
- e : Green produce code G:RoHS Compliant

FEATURES

- ◆ 38V OVP protection
- ◆ Drive up to 10 LEDs with 50mA
- ◆ Drive up to 40 LEDs in total
- ◆ 2.7V to 6V Input Voltage Range
- ◆ 1A current limit
- ◆ 200mV Feedback Voltage
- ◆ True PWM Brightness Control

APPLICATIONS

- ◆ USB Powe
- ◆ Power for OLED
- ◆ LED torch
- ◆ Satellite Set Top Box



SOT-23-6L

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C Unless otherwise noted)

Symbol	Parameter	Rating	Units
V _{IN}	SW Voltage	-0.3 ~ +40	V
V _{OUT}	EN, FB, SW Pin Voltage	-0.3 ~ 6.5	V
T _J	Operating Temperature Range	-40 ~ +85	°C
T _{STG}	Storage Temperature Range	-65 ~ +150	°C
θ _{JA}	Thermal Resistance Junction to Ambient ^{AC}	100	°C/W
θ _{JC}	Thermal Resistance Junction to Case	50	°C/W

Note: Exceeding these limits may damage the device. Exposure to absolute maximum rating conditions for long periods may affect device.

PIN DESCRIPTION

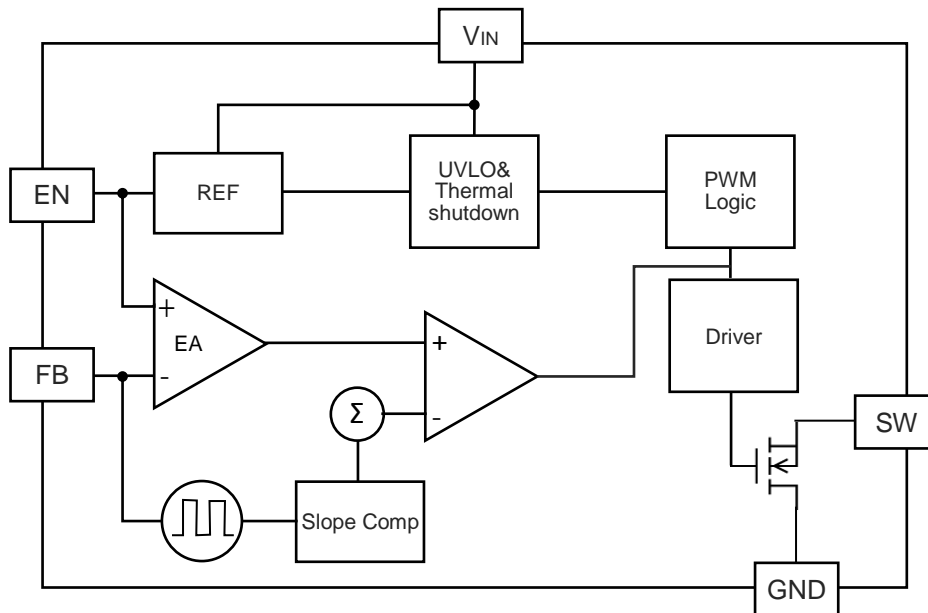
Pin	Name	Description
1	SW	Inductor Connection. Connect an inductor Between SW and V _{IN}
2	GND	Ground
3	FB	Feedback Input. Connect an external resistor divider from the output to FB and GND to set V _{OUT}
4	EN	Enable pin for the IC. Drive this pin high to enable the part, low to disable
5	NC	Not connected, leave this PIN floating
6	V _{IN}	Supply Voltage. Bypass with a 4.7µF ceramic capacitor to GND

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$, $V_{IN}=3.6\text{V}$, Unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{IN}	Input Voltage Range		2.7		6	V
V_{FB}	Feedback Voltage	$V_{IN} = V_{CTRL}=3.6\text{V}$	0.194	0.2	0.206	V
I_{FB}	Feedback Input Current				2	μA
I_Q	Quiescent Current	Switching at $I_{out}=0$		1	1.8	mA
		No Switching		0.2		mA
I_{SD}	Shutdown Supply Current	$V_{EN}=\text{GND}$		0	5	μA
f_{OSC}	Oscillator Frequency	$V_{IN}<4.3\text{V}$		800		KHz
D_{MAX}	Maximum Duty Cycle		90	93		%
$R_{DS(ON)}$	NMOS Switch On Resistance	$I_{SW}=100\text{mA}$		400		m Ω
I_{LIM}	NMOS Switch Current Limit	$V_{IN}=3.6\text{V}$, 10 LEDs		1		A
F_{DIM}	PWM Dimming Frequency		18		100	KHz
V_{IH}	EN Input High Voltage		1.2			V
V_{IL}	EN Input Low Voltage				0.6	V
T_{SD}	Thermal Shutdown	Rising, Hysteresis= 10°C		165		$^\circ\text{C}$

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FUNCTION BLOCK DIAGRAM



APPLICATION INFORMATION

◆ Inductor Selection

Using an inductor with a smaller inductance value forces discontinuous PWM when the inductor current ramps down to zero before the end of each switching cycle. This reduces the boost converter's maximum output current, causes large input voltage ripple and reduces efficiency. Large inductance value provides much more output current and higher conversion efficiency. For these reasons, a 15 μ H to 22 μ H inductor value range is recommended. A 15 μ H inductor optimized the efficiency for most application while maintaining low inductor peak to peak ripple. Below table lists the recommended inductor for the SMC1605.

Designator	Recommended Inductors L(μ H)	Saturation Current (mA)
LI	4.7- 15	>1500

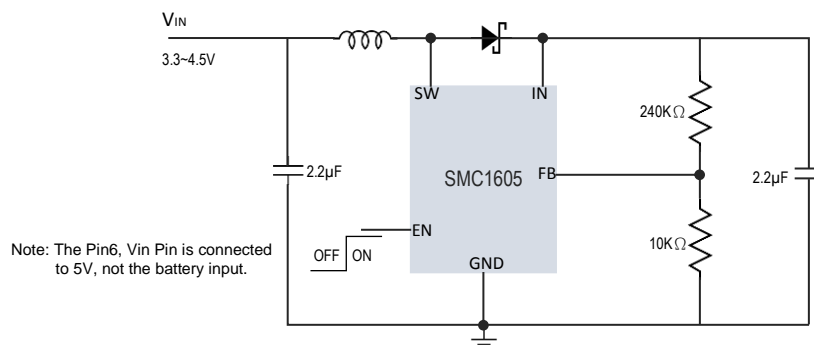
◆ Schottky Diode Selection

A high-speed rectifying Schottky with low parasitic capacitance is recommended for SMC1605 for maximum efficiency due to its high switching frequency. The diode average and peak current rating must be larger than the average output current and peak inductor current to ensure reliability. In addition, the diode's reverse breakdown voltage must exceed the open LED protection voltage.

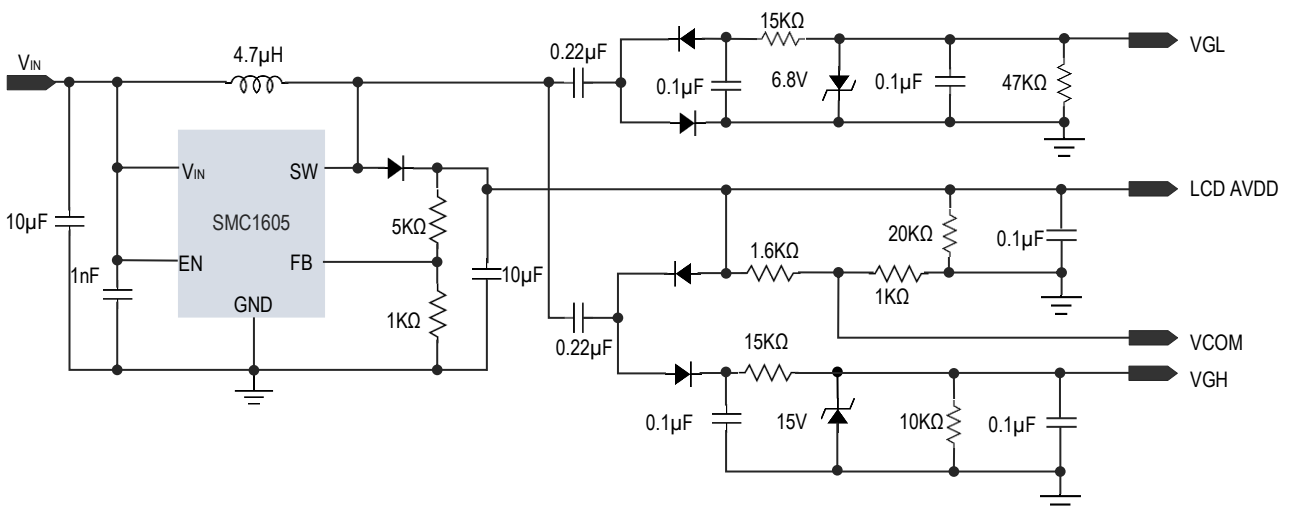
◆ Input and Output Capacitor Selection

The output capacitor is mainly selected to meet the requirements for the output ripple and loop stability. The output requires a capacitor in the range of 2.2 μ F to 10 μ F.

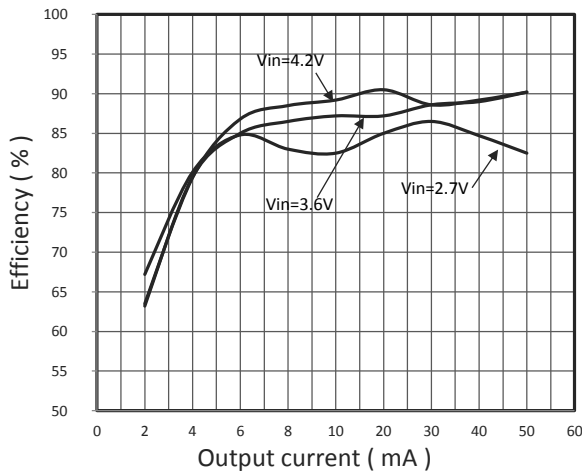
USB POWERAPPLICATION CIRCUIT



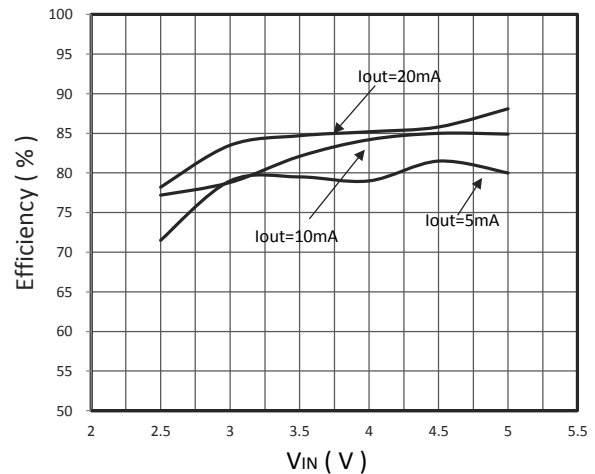
TFT BAISE APPLICATION CIRCUIT



TYPICAL CHARACTERISTICS ($T_A=25^{\circ}\text{C}$ unless otherwise noted)

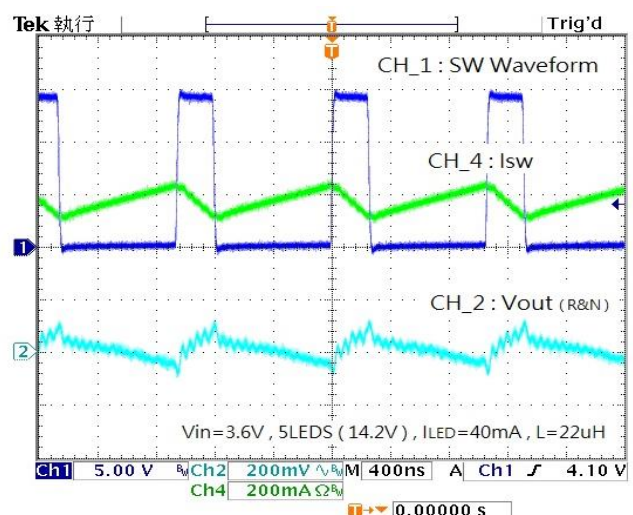
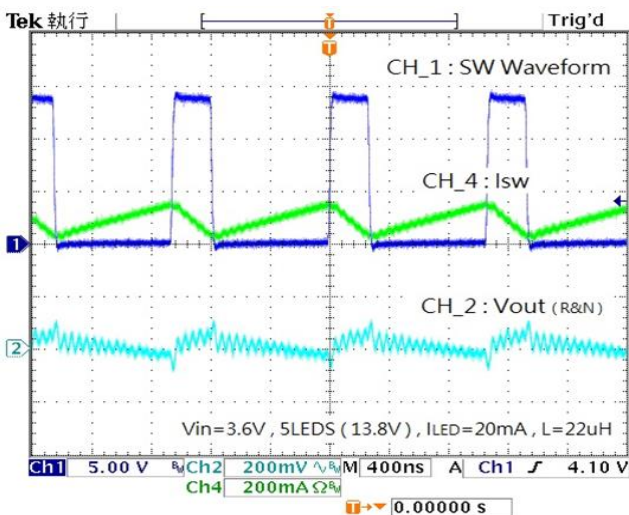


Efficiency of Driving 6 LEDs



Efficiency of Driving 10 LEDs

OPERATING WAVEFORMS (Typical values are at $T_A=25^{\circ}\text{C}$ unless otherwise noted)



FUNCTIONAL DESCRIPTIONS

The SMC1605 is a high efficiency boost LED driver with a small package size. The device is ideal for driving 2-25 LEDs for backlight application in smartphone and 7-inch tablet PC. The device integrates a 38V/1A switch FET and operates in pulse width modulation (PWM) with a 0.8MHz fixed switching frequency. The duty cycle of the converter is set by the error amplifier output and the current signal applied to the PWM control comparator. The feedback loop regulates the FB pin to a low reference voltage (200mV typical), reducing the power dissipation in the current sense resistor.

◆ Output Open Circuit Protection

Output open circuit protection circuitry prevents IC damage as the result of output open circuit. The SMC1605 monitors the voltage at the SW pin and FB pin during each switching cycle. The circuitry turns off the switch FET and shuts down the IC when both of the following conditions persist for 8 switching clock cycles: the SW voltage exceeds the V_{OVP} threshold, which is 38V and the FB voltage is less than half of regulation voltage. The output voltage falls to the level of the input supply. The device remains in shutdown mode until it is enabled by toggling the EN pin logic. The output voltage plus the 200mV reference voltage cannot exceed the

minimum OVP threshold or Output Voltage+200 mV
 $\leq V_{OVP(MIN)}$.

R_{SET} =current sense resistor. The output current tolerance depends on the FB accuracy and the current sensor resistor accuracy.

◆Shutdown

The SMC1605 enters shutdown mode when the EN voltage is logic low for more than 3ms. During shutdown, the input supply current for the device is less than $1\mu A$ ($_{MAX}$). Although the internal FET does not switch in shutdown, there is still a DC current path between the input and the output through the inductor and Schottky diode. For LED driving application, the minimum forward input voltage to ensure that the LEDs remain off in shutdown. However, in the typical application with two or more LEDs, the forward voltage is large enough to reverse bias the Schottky and keep leakage current low.

◆LED Driving Current Setting

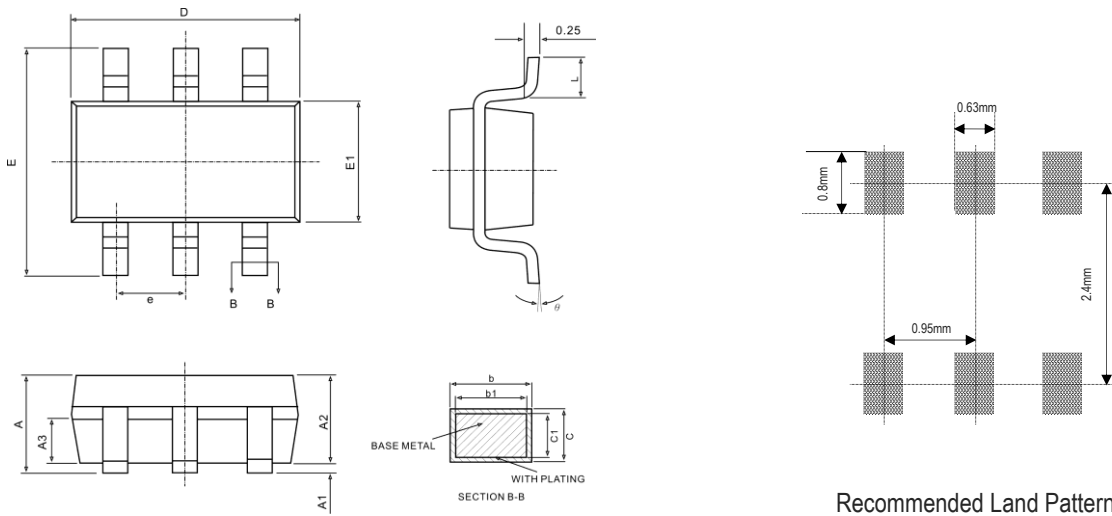
The FB voltage is regulated by a low 0.2V reference voltage. The LED current is set externally using a current-sense resistor in series with the LED string. The value of the R_{SET} is calculated using Equation

$$I_{LED} = \frac{0.2V}{R_{SET}}$$
 Where I_{LED} =output current of LEDs,

◆PWM Dimming Control Output Voltage Programming

When the CTRL pin is constantly high, the FB voltage is regulated to 200mV typically. However, the EN pin allows a PWM signal to reduce this regulation voltage; therefore, it achieves LED brightness dimming or output voltage programming (only to make output voltage lower). The relationship between the duty cycle and FB voltage is given by Equation. $V_{FB} = \text{Duty} * 200mV$ Where Duty=duty cycle of the PWM signal, 200mV=internal reference voltage. This PWM dimming eliminates the audible noise which often occurs when the output current is pulsed in replica of the frequency and duty cycle of PWM control. Unlike other scheme which filters the PWM signal for analog dimming, SMC1605 regulation voltage is independent of the PWM logic voltage level which often has large variations For optimum performance, use the PWM dimming frequency in the range of 18kHz to 100kHz.

■ SOT-23-6L PACKAGE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	-	1.250	-	0.049
A1	0.040	0.100	0.002	0.004
A2	1.000	1.200	0.039	0.047
A3	0.550	0.750	0.022	0.030
b	0.380	0.480	0.015	0.019
b1	0.370	0.430	0.015	0.017
c	0.110	0.210	0.004	0.008
c1	0.100	0.160	0.004	0.006
D	2.720	3.120	0.107	0.123
E	2.600	3.000	0.102	0.118
E1	1.400	1.800	0.055	0.071
e	0.950 BSC		0.037 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°