

GENERAL DESCRIPTION

The SGM6605 is a constant frequency, current mode, synchronous step-up switching regulator. It can be used for generating 5V at 400mA from a 3.3V rail or a Li-Ion battery.

High switching frequency minimizes the sizes of inductor and capacitor. Integrated power MOSFETs and internal compensation make the SGM6605 simple to use and fit the total solution into a compact space.

For light load current, the SGM6605 enters into the power-save mode to maintain high efficiency. Anti-ringing control circuitry reduces EMI concerns by damping the inductor in discontinuous mode. The SGM6605 provides true output disconnect and this allows V_{OUT} to go to zero volts during shutdown without drawing any current from the input source. The SGM6605 supports 1.8V logic for control.

The output voltage of SGM6605-ADJ can be programmed by an external resistor divider, and that of SGM6605-5.0 is fixed internally on the chip. The device is available in the Green SOT-23-6 package. It operates over an ambient temperature range of -40°C to $+85^{\circ}\text{C}$.

FEATURES

- 90% Efficient Synchronous Boost Converter
- Device Quiescent Current: 30 μA (TYP)
- Less than 1 μA Shutdown Current
- Input Voltage Range: 2.7V to 5.5V
- 5.0V Fixed Output Voltage
- Adjustable Output Voltage Up to 5.2V
- Output Voltage Clamping: 6V
- Power-Save Mode for Improved Efficiency at Low Output Power
- Load Disconnect During Shutdown
- 1.8V Logic on EN Pin for Control
- Low Reverse Leakage Current when $V_{OUT} > V_{IN}$
- Over-Temperature Protection
- Available in Green SOT-23-6 Package
- -40°C to $+85^{\circ}\text{C}$ Operating Temperature Range

APPLICATIONS

- Single-Cell Li Battery Powered Products
- Portable Audio Players
- Cellular Phones
- Personal Medical Products

TYPICAL APPLICATION

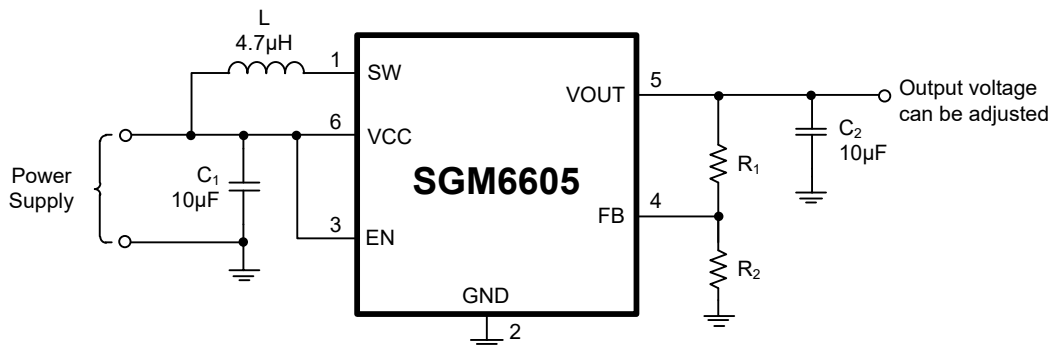


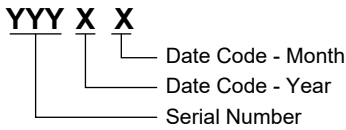
Figure 1. Typical Application Circuit

PACKAGE/ORDERING INFORMATION

MODEL	V _{OUT} (V)	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM6605	Adjustable	SOT-23-6	-40°C to +85°C	SGM6605-ADJYN6G/TR	SI6XX	Tape and Reel, 3000
	5.0	SOT-23-6	-40°C to +85°C	SGM6605-5.0YN6G/TR	SI8XX	Tape and Reel, 3000

MARKING INFORMATION

NOTE: XX = Date Code.



Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

ABSOLUTE MAXIMUM RATINGS

- Input Voltage Range on SW, VOUT, VCC, FB, EN -0.3V to 6V
- Package Thermal Resistance
- SOT-23-6, θ_{JA} 150°C/W
- Junction Temperature +150°C
- Storage Temperature Range -65°C to +150°C
- Lead Temperature (Soldering, 10s) +260°C
- ESD Susceptibility
- HBM 4000V
- MM 250V

RECOMMENDED OPERATING CONDITIONS

- Operating Temperature Range -40°C to +85°C

OVERSTRESS CAUTION

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

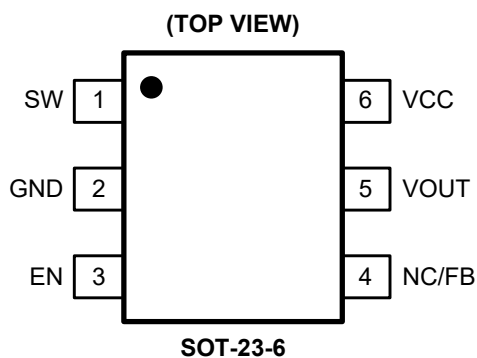
ESD SENSITIVITY CAUTION

This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because even small parametric changes could cause the device not to meet the published specifications.

DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

PIN CONFIGURATION



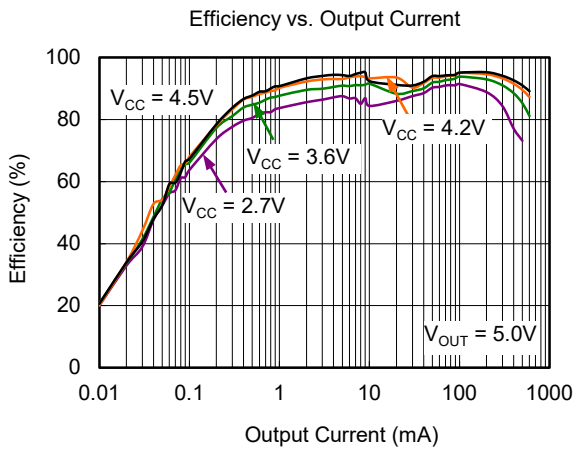
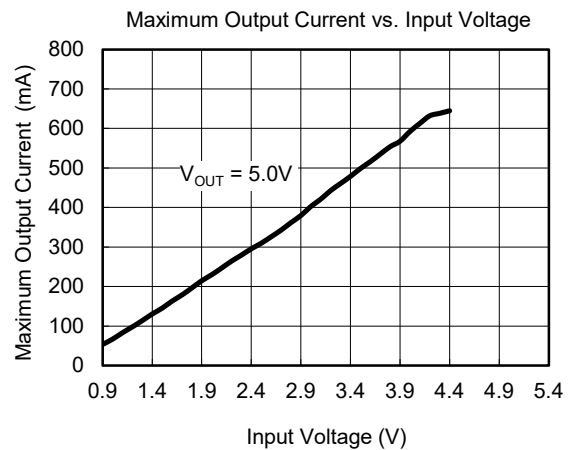
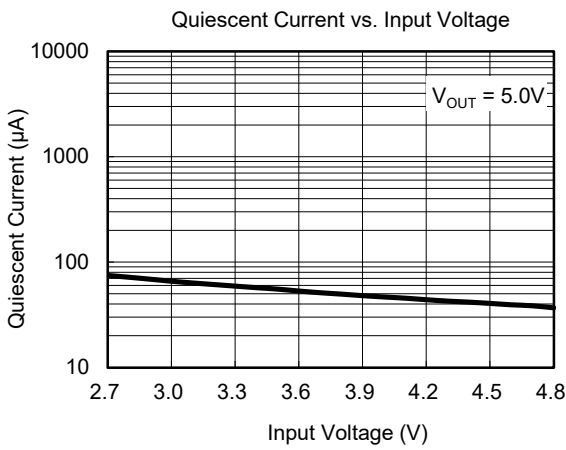
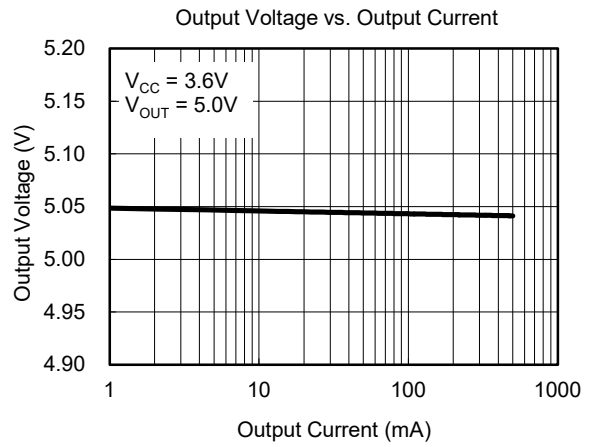
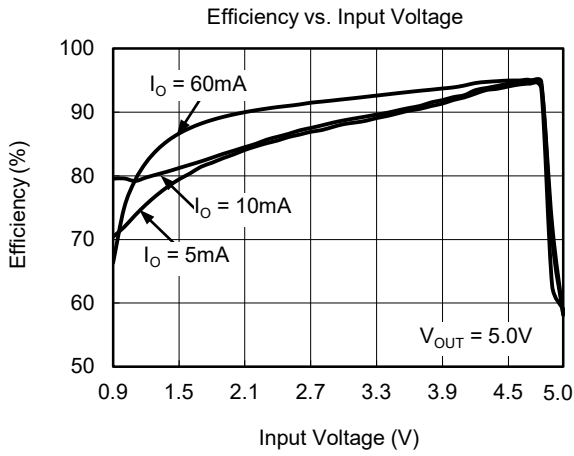
PIN DESCRIPTION

PIN	NAME	FUNCTION
1	SW	Boost and Rectifying Switch Input.
2	GND	Ground.
3	EN	Enable Input. (1/VCC enabled, 0/GND disabled)
4	NC	No Connect. It should be left floating. (SGM6605-5.0)
	FB	Output Voltage Feedback Pin. Voltage feedback for programming the output voltage. (SGM6605-ADJ)
5	VOUT	Boost Converter Output.
6	VCC	Boost Converter Supply Voltage.

ELECTRICAL CHARACTERISTICS(Full = -40°C to +85°C, typical values are at $T_A = +25^\circ\text{C}$, unless otherwise noted.)

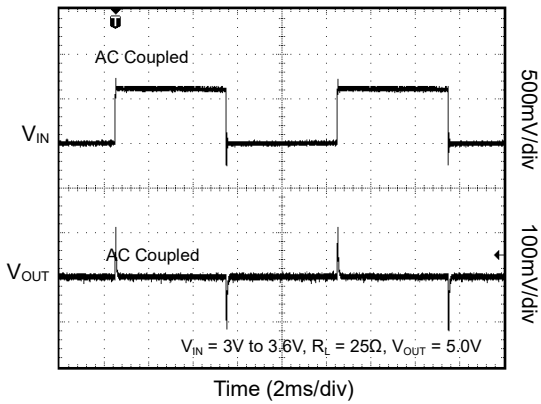
PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
DC/DC Stage							
Output Voltage Range	V_{OUT}		Full	3.0		5.2	V
Input Voltage Range	V_{IN}		+25°C	2.7		5.5	V
Feedback Voltage	V_{FB}		Full	485	500	519	mV
Oscillator Frequency	f		Full	870	1200	1470	kHz
Switch Current Limit	I_{SW}		Full	0.75	1.1	1.45	A
Start-Up Current Limit			+25°C		300		mA
Boost Switch-On Resistance		$V_{OUT} = 5V$	+25°C		400		mΩ
Rectifying Switch-On Resistance		$V_{OUT} = 5V$	+25°C		530		mΩ
Output Voltage Accuracy		$V_{CC} = 2.7V, I_O = 10mA$	Full			3.8	%
Line Regulation		$V_{CC} = 2.7V$ to $V_{OUT} - 0.5V, I_O = 10mA$	Full		0.5	1	%
Load Regulation			+25°C		0.5		%
Quiescent Current	V_{CC}	$V_{EN} = V_{CC} = 2.7V, I_O = 0mA$	Full		0.1	1	μA
	V_{OUT}	$V_{EN} = V_{CC} = 2.7V, I_O = 0mA, V_{OUT} = 5V$	+25°C		30	55	
Shutdown Current		$V_{EN} = 0V, V_{CC} = 2.7V$	+25°C			1	μA
Control Stage							
EN Input Low Voltage	V_{IL}		Full			0.4	V
EN Input High Voltage	V_{IH}		Full	1.6			V
EN Input Current		Clamped on GND or VCC	Full			1	μA
Over-Temperature Protection					150		°C
Over-Temperature Hysteresis					20		°C

TYPICAL PERFORMANCE CHARACTERISTICS

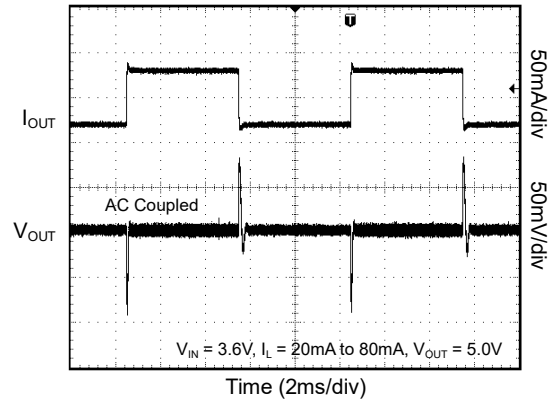


TYPICAL PERFORMANCE CHARACTERISTICS (continued)

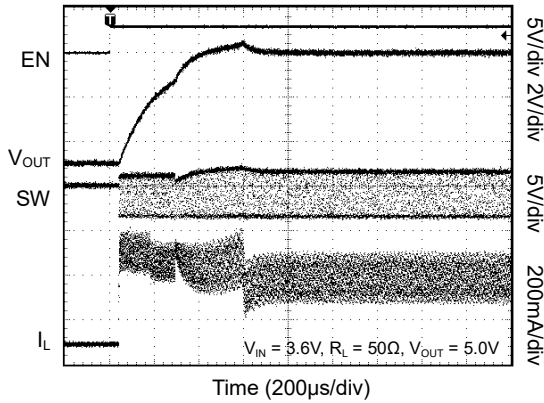
Line Transient Response



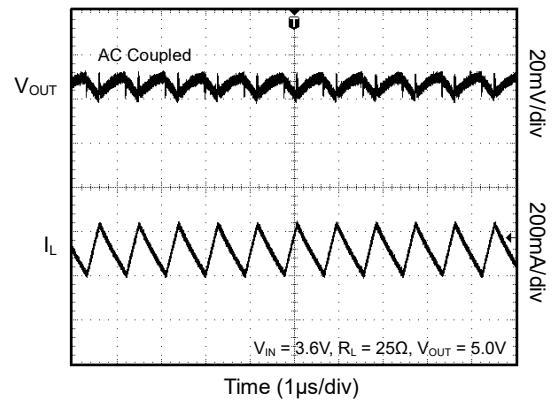
Load Transient Response



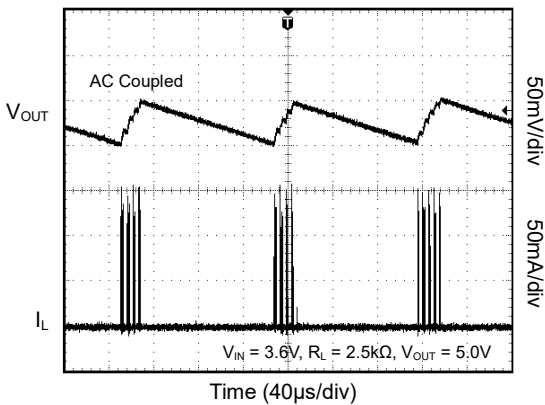
Start-Up after Enable



Output Voltage in Continuous Mode



Output Voltage in Power-Save Mode



TYPICAL APPLICATION CIRCUITS

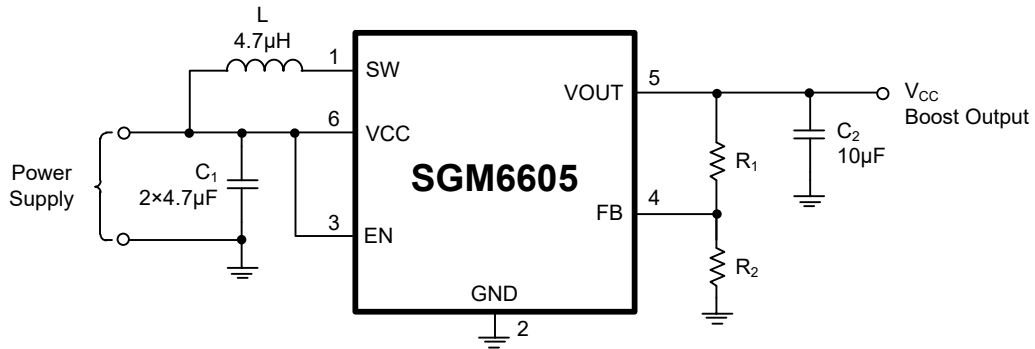


Figure 2. Power Supply Solution for Maximum Output Power Operating from a Single or Dual Alkaline Cell

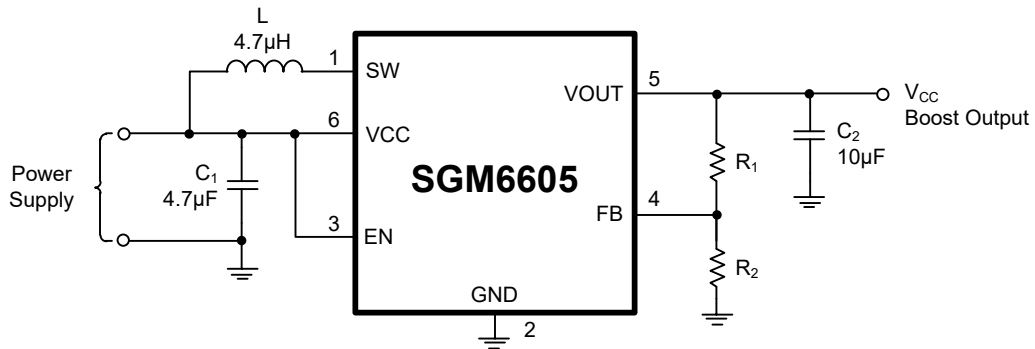


Figure 3. Power Supply Solution Having Small Total Solution Size

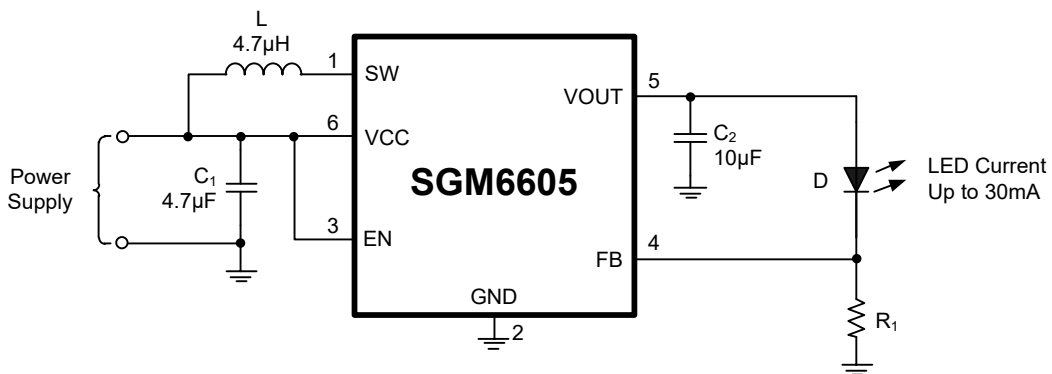


Figure 4. Power Supply Solution for Powering White LEDs in Lighting Applications

TYPICAL APPLICATION CIRCUITS (continued)

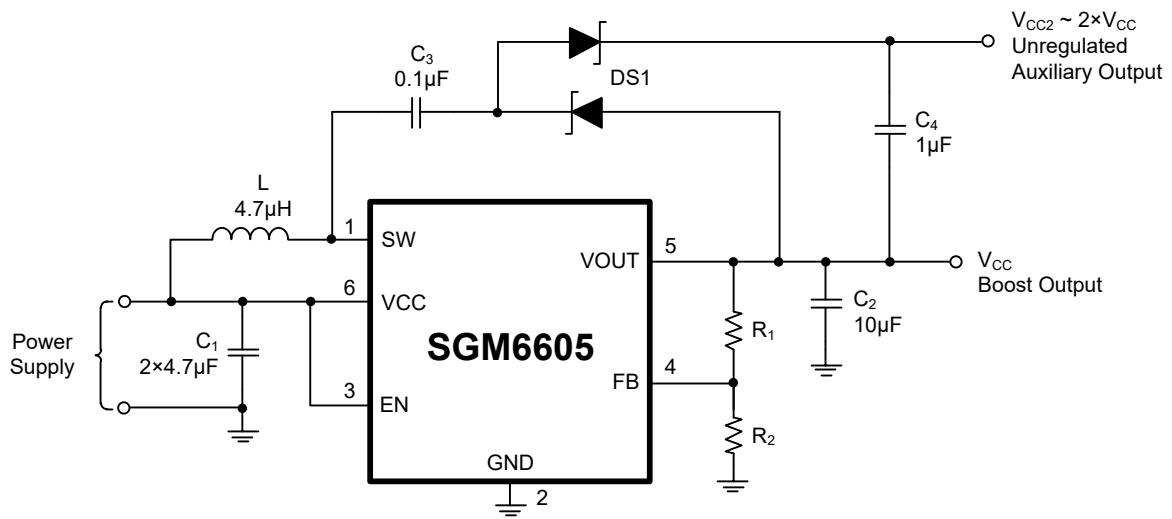


Figure 5. Power Supply Solution with Auxiliary Positive Output Voltage

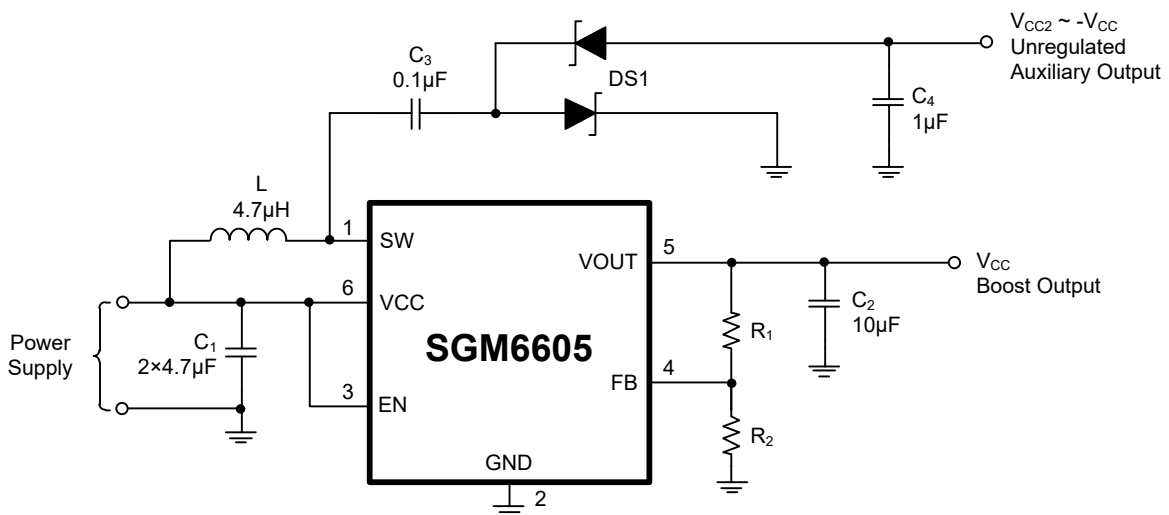


Figure 6. Power Supply Solution with Auxiliary Negative Output Voltage

TYPICAL APPLICATION CIRCUITS (continued)

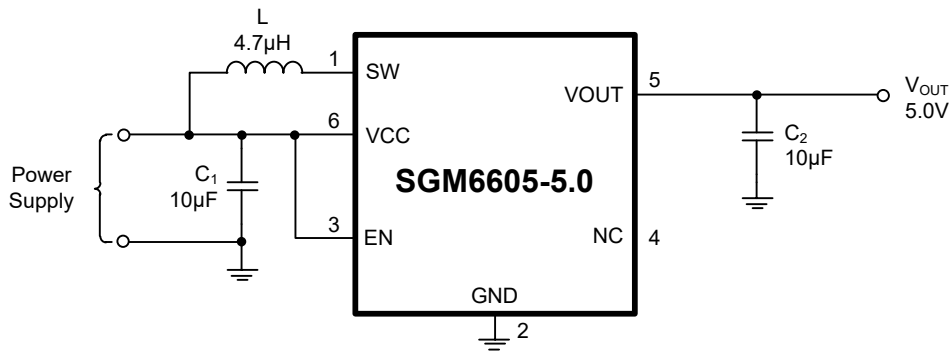


Figure 7. Basic Application Circuit for the Fixed Output Versions

APPLICATION INFORMATION

Design Procedure

The SGM6605 DC/DC converter is intended for systems powered by dual to triple-cell alkaline, NiCd and NiMH battery with a typical terminal voltage between 2.7V and 5.5V. It can also be used in systems powered by one-cell Li-Ion or Li-Polymer with a typical voltage between 3.0V and 4.2V.

Programming Output Voltage

In Figure 1, the output voltage of the SGM6605 DC/DC converter can be adjusted with an external resistor divider. The typical value of the voltage at the FB pin is 500mV. The maximum recommended value for the output voltage is 5.2V. R_1 and R_2 are calculated using Equation 1:

$$R_1 = R_2 \times \left(\frac{V_{OUT}}{V_{FB}} - 1 \right) = R_2 \times \left(\frac{V_{OUT}}{500\text{mV}} - 1 \right) \quad (1)$$

R_2 is recommended to be 100k Ω . For example, if an output voltage of 5V is needed, a 900k Ω resistor should be chosen for R_1 .

Inductor Selection

A boost converter normally requires two main passive components for storing energy during the conversion. A boost inductor and a storage capacitor at the output are required. To select the boost inductor, it is recommended to keep the possible peak inductor current below the current limit threshold of the power switch in the chosen configuration. The highest peak current through the inductor and the switch depends on the output load, the input (V_{CC}), and the output voltage (V_{OUT}). Estimation of the maximum average inductor current is done using Equation 2:

$$I_L = I_O \times \frac{V_{OUT}}{V_{CC} \times 0.8} \quad (2)$$

For example, for an output current of 75mA at 5V, at least an average current of 170mA flows through the inductor at a minimum input voltage of 2.7V.

The second parameter for choosing the inductor is the desired current ripple in the inductor. Normally, it is advisable to work with a ripple of less than 20% of the average inductor current. A smaller ripple reduces the magnetic hysteresis losses in the inductor, as well as output voltage ripple and EMI. But in the same way, regulation time rises at load changes. In addition, a larger inductor increases the total system costs. With these parameters, it is possible to calculate the value for the inductor by using Equation 3:

$$L = \frac{V_{CC} \times (V_{OUT} - V_{CC})}{\Delta I_L \times f \times V_{OUT}} \quad (3)$$

Parameter f is the switching frequency and ΔI_L is the ripple current in the inductor. In typical applications, a 4.7 μH inductance is recommended. The device has been optimized to operate with inductance values between 2.2 μH and 10 μH . Nevertheless, operation with higher inductance values may be possible in some applications. Detailed stability analysis is then recommended. Care must be taken because load transients and losses in the circuit can lead to higher currents as estimated in Equation 3. Also, the losses in the inductor which include magnetic hysteresis losses and copper losses are a major parameter for total circuit efficiency.

Input Capacitor

At least a 10 μF input capacitor is recommended to improve transient behavior of the regulator and EMI behavior of the total power supply circuit. A ceramic capacitor or a tantalum capacitor with a 100nF ceramic capacitor in parallel, placed close to the IC, is recommended.

APPLICATION INFORMATION (continued)**Output Capacitor**

The major parameter necessary to define the output capacitor is the maximum allowed output voltage ripple of the converter. This ripple is determined by two parameters of the capacitor, the capacitance and the ESR. It is possible to calculate the minimum capacitance needed for the defined ripple, supposing that the ESR is zero, by using Equation 4:

$$C_{\text{MIN}} = \frac{I_{\text{O}} \times (V_{\text{OUT}} - V_{\text{CC}})}{f \times \Delta V \times V_{\text{OUT}}} \quad (4)$$

Parameter f is the switching frequency and ΔV is the maximum allowed ripple.

With a chosen ripple voltage of 10mV, a minimum capacitance of 4.5 μ F is needed. In this value range, ceramic capacitors are a good choice. The ESR and the additional ripple created are negligible. It is calculated using Equation 5:

$$\Delta V_{\text{ESR}} = I_{\text{O}} \times R_{\text{ESR}} \quad (5)$$

The total ripple is the sum of the ripple caused by the capacitance and the ripple caused by the ESR of the capacitor. Additional ripple is caused by load transients. This means that the output capacitor has to completely supply the load during the charging phase of the inductor.

The value of the output capacitance depends on the speed of the load transients and the load current during the load change. With the calculated minimum value of 4.5 μ F and load transient considerations, the recommended output capacitance value is in the range of 4.7 μ F to 22 μ F.

Care must be taken on capacitance loss caused by derating due to the applied DC voltage and the frequency characteristic of the capacitor. For example, larger form factor capacitors (in 1206 size) have their self resonant frequencies in the same frequency range as the SGM6605 operating frequency. So the effective capacitance of the capacitors used may be significantly lower. Therefore, the recommendation is to use smaller capacitors in parallel instead of one larger capacitor.

Layout Considerations

As for all switching power supplies, the layout is an important step in the design, especially at high-peak currents and high switching frequencies. If the layout is not carefully done, the regulator could show stability problems as well as EMI problems. Therefore, use wide and short traces for the main current path and for the power ground tracks. The input capacitor, output capacitor, and the inductor should be placed as close as possible to the IC. Use a common ground node for power ground and a different one for control ground to minimize the effects of ground noise. Connect these ground nodes at any place close to the ground pin of the IC.

The feedback divider should be placed as close as possible to the ground pin of the IC. To lay out the control ground, it is recommended to use short traces as well, separated from the power ground traces. This avoids ground shift problems, which can occur due to superimposition of power ground current and control ground current.

Thermal Information

Implementation of integrated circuits in low-profile and fine-pitch surface-mount packages typically requires special attention to power dissipation. Many system-dependent issues such as thermal coupling, airflow, added heat sinks and convection surfaces, and the presence of other heat-generating components affect the power-dissipation limits of a given component.

Three basic approaches for enhancing thermal performance follow.

1. Improving the power dissipation capability of the PCB design.
2. Improving the thermal coupling of the component to the PCB.
3. Introducing airflow in the system.

REVISION HISTORY

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

JULY 2020 – REV.A.3 to REV.A.4

Changed Maximum Output Voltage 1, 4, 5, 10

FEBRUARY 2018 – REV.A.2 to REV.A.3

Update the Typical Performance Characteristics
Efficiency vs. Input Voltage ($V_{OUT} = 5.0V$) 5

DECEMBER 2013 – REV.A.1 to REV.A.2

Update the Electrical Characteristics
Switch Current Limit 4

JUNE 2013 – REV.A to REV.A.1

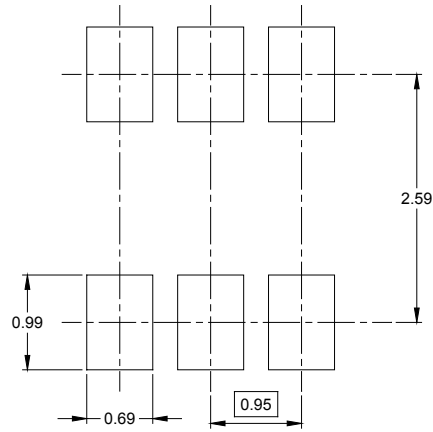
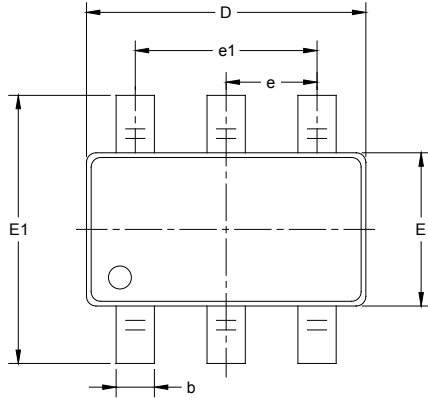
Update the Typical Performance Characteristics
Efficiency vs. Output Current and Output Voltage vs. Output Current 6

Changes from Original (JANUARY 2013) to REV.A

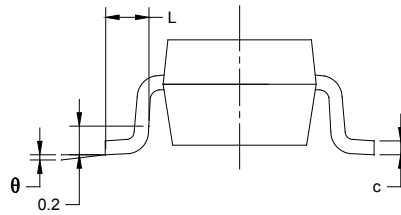
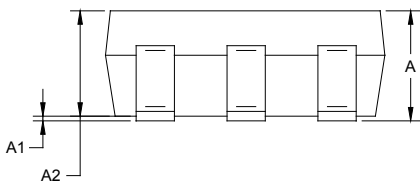
Changed from product preview to production data All

PACKAGE OUTLINE DIMENSIONS

SOT-23-6



RECOMMENDED LAND PATTERN (Unit: mm)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC	
e1	1.900 BSC		0.075 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOT-23-6	7"	9.5	3.17	3.23	1.37	4.0	4.0	2.0	8.0	Q3

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PACKAGE INFORMATION

CARTON BOX DIMENSIONS



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF CARTON BOX

Reel Type	Length (mm)	Width (mm)	Height (mm)	Pizza/Carton
7" (Option)	368	227	224	8
7"	442	410	224	18

DD0002