SGM6000
1.75V to 5.5V Input, 300nA I_Q, 700mA Synchronous Buck Converter

GENERAL DESCRIPTION

The SGM6000 family is a low voltage, efficient and miniature synchronous Buck converter with ultra-low 300nA quiescent current. The device features 6nA (TYP) shutdown current and 300nA quiescent current to further extend the operation lifetime of battery powered applications. The device can support up to 700mA load range with 96% peak efficiencies. The SGM6000 extends the high efficiency operation area and offers ultra-low quiescent current over 1.75V to 5.5V input voltage rage. SGM6000 is best suited for battery powered application to extend the operation lifetime.

The SGM6000 is available in a Green WLCSP-1.31×0.89-6B package.

APPLICATIONS

Portable, Space-Constrained Consumer Products
Wearable Electronics
Headphones and Earbuds
Ultra-Low-Power IoT, NB IoT, and Bluetooth
Single Li-ion (Li+) and Coin Cell Battery Products
Wired or Wireless Industrial Products

FEATURES

- **1.75V to 5.5V Input Voltage Range**
- **Programmable Output Voltage**
  - **SGM6000A: VSET Pin Selectable Output Voltage from 0.7V to 3.3V**
  - **SGM6000B: Fixed V_{OUT} among 0.6V, 0.8V, 1.2V and 1.8V**
- **300nA Ultra-Low Quiescent Supply Current**
- **6nA Shutdown Current**
- **700mA Output Current**
- **96% Peak Efficiency and over 88% at 10μA**
- **±2.6% Output Voltage Accuracy across Temperature**
- **Protect System in Multiple Use Case**
  - **Active Discharge Feature**
- **Minimized External Components**
- **Available in a Green WLCSP-1.31×0.89-6B Package**

TYPICAL APPLICATION

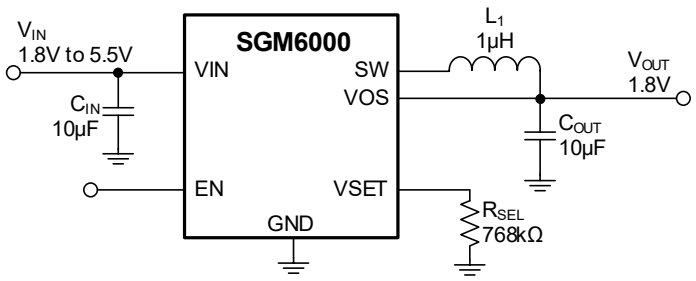


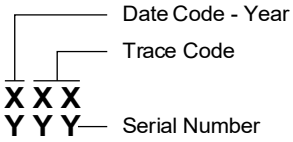
Figure 1. Typical Application Circuit

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM6000A	WLCSP-1.31×0.89-6B	-40℃ to +85℃	SGM6000AYG/TR	XXX 1GI	Tape and Reel, 3000
SGM6000B-0.6	WLCSP-1.31×0.89-6B	-40℃ to +85℃	SGM6000B-0.6YG/TR	XXX 1LD	Tape and Reel, 3000
SGM6000B-0.8	WLCSP-1.31×0.89-6B	-40℃ to +85℃	SGM6000B-0.8YG/TR	XXX 1LE	Tape and Reel, 3000
SGM6000B-1.2	WLCSP-1.31×0.89-6B	-40℃ to +85℃	SGM6000B-1.2YG/TR	XXX 1LF	Tape and Reel, 3000
SGM6000B-1.8	WLCSP-1.31×0.89-6B	-40℃ to +85℃	SGM6000B-1.8YG/TR	XXX 1LG	Tape and Reel, 3000

MARKING INFORMATION

NOTE: X = Date Code. 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

VIN, EN, VSET, NC, VOS to GND Voltage ..... -0.3V to 6V
SW RMS Current ..... -1.6A_{RMS} to 1.6A_{RMS}
SW to GND Voltage (1) ..... -0.3V to V_{IN} + 0.3V
Package Thermal Resistance
WLCSP-1.31×0.89-6B, θ_{JA} ..... 150.4℃/W
WLCSP-1.31×0.89-6B, θ_{JB} ..... 49.1℃/W
WLCSP-1.31×0.89-6B, θ_{JC} ..... 51℃/W
Junction Temperature ..... +150℃
Storage Temperature Range ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃
ESD Susceptibility (2) (3)
HBM ..... ±4000V
CDM ..... ±1000V

NOTES:

1. SW pin has internal clamps to GND and IN. These diodes may be forward biased during switching transitions. During these transitions, the max SW current should be within the Max RMS Current rating for safe operation.

2. For human body model (HBM), all pins comply with ANSI/ESDA/JEDEC JS-001 specifications.

3. For charged device model (CDM), all pins comply with ANSI/ESDA/JEDEC JS-002 specifications.

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

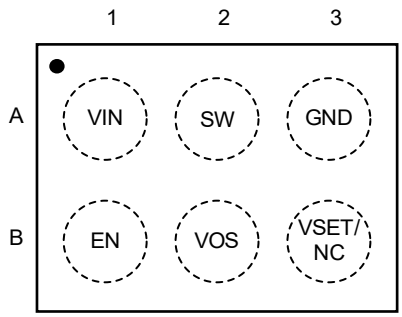
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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

(TOP VIEW)



WLCSP-1.31×0.89-6B

PIN DESCRIPTION

PIN	NAME	TYPE	FUNCTION
A1	VIN	I	Power Supply Input. Connect a ceramic capacitor (C_{IN}) close to this pin and GND.
A2	SW	O	Switching Node Output. Connect it to the filter inductor.
A3	GND	G	Ground Pin. Connect the CIN and COUT ground terminals close to this pin.
B1	EN	I	Enable Input. Active High Enable Input. Apply a logic high voltage to enable the device or a logic low to disable it.
B2	VOS	O	Output Voltage Sense Input. This pin is internally connected to the feedback loop and a MOSFET to discharge the output (V_{OUT}) when the device is disabled. Connect it with a short trace to the output capacitor.
B3	VSET/NC	I	SGM6000A: Output Voltage Select Input. Connect an accurate resistor between this pin and GND to select a pre-defined output voltage based on Table 1. SGM6000B: No Connect. Leave floating.

NOTE: I = input, O = output, G = ground.

ELECTRICAL CHARACTERISTICS

(V_{IN} = 3.3V, V_{OUT} = 1.8V, T_A = -40℃ to +85℃, C_{IN} = 10μF, and C_{OUT} = 22μF, unless otherwise noted. (1))

PARAMETER	SYMBOL	CONDITION		MIN	TYP	MAX	UNITS
Supply							
Input Voltage Range	V_{IN_RANGE}	Guaranteed by output accuracy		1.75		5.5	V
Shutdown Current	I_{IN_SD}	V_{EN} = 0V, T_A = +25℃			0.006	0.1	μA
Quiescent Supply Current into VIN	I_{Q_VIN}	V_{EN} = V_{IN}, not switching V_{OUT} = 106% of target voltage, V_{OUT_TARGET} = 2.5V, T_A = +25℃			300	600	nA
Quiescent Supply Current into VOS	I_{Q_VOS}	V_{EN} = V_{IN}, not switching V_{OUT} = 106% of target voltage, V_{OUT_TARGET} = 2.5V, T_A = +25℃			25		nA
Input Under-Voltage Lockout	V_{UVLO}	V_{IN} rising			1.7	1.75	V
	V_{UVLO_HYS}	Hysteresis			18		mV
Output							
Output Voltage Range	V_{OUT_RANGE}	Guaranteed by output accuracy		0.6		3.3	V
Output Accuracy	V_{OUT_ACC}	V_{OS} falling, when SW begins switching above 1MHz, V_{OUT} = 0.6V to 3.3V, V_{IN} = 5.5V (2)	T_A = +25℃	-1.2		+1.2	%
			T_A = -40℃ to +85℃	-2.6		+2.6	
DC Line Regulation	V_{LREG}	V_{OUT} = 1.8V, V_{IN} = 2.0V to 5.5V, I_{OUT} = 10mA to 160mA			±1.5		%
Soft-Start							
Soft-Start Slew Rate	dV/dt	V_{OUT} = 1.8V, no load			5		mV/μs
Switching Frequency							
SW Leakage Current	I_{LEAK_SW}	V_{SW} = V_{IN} = 5.5V, T_A = +25℃			9	120	nA
Inductor Peak Current Limit	I_{PEAK_SW}			1000	1200	1400	mA
Resistance							
High-side R_{DSON}	R_{DS_H}	V_{IN} = 3.3V			87	130	mΩ
Low-side R_{DSON}	R_{DS_L}	V_{IN} = 3.3V			40	70	mΩ
Active Discharge Resistance	R_{OUT_DIS}	V_{EN} = 0V		50	80	190	Ω
Zero-Crossing Threshold	I_{ZX_SW}	V_{OUT} = 1.2V, percent of I_{PEAK_SW}			5		%
Enable							
Enable Input Leakage	I_{LEAK_EN}	V_{EN} = 5.5V, T_A = +25℃			10	100	nA
Enable Voltage Threshold	V_{EN_R}	V_{EN} rising		0.8			V
	V_{EN_F}	V_{EN} falling				0.4	
SGM6000A							
Select Resistor Detection Time	t_{RSEL}	C_{SEL} < 2pF		240	440	900	μs
Required Select Resistor Accuracy	R_{SEL}	Use the nearest ±1% resistor from Table 1		-1		+1	%
Thermal Shutdown							
Thermal Shutdown	T_{SD}	T_J rising when output turns off			160		℃
Thermal Shutdown Threshold	T_{SD_TH}	T_J falling when output turns on			145		℃

NOTES:

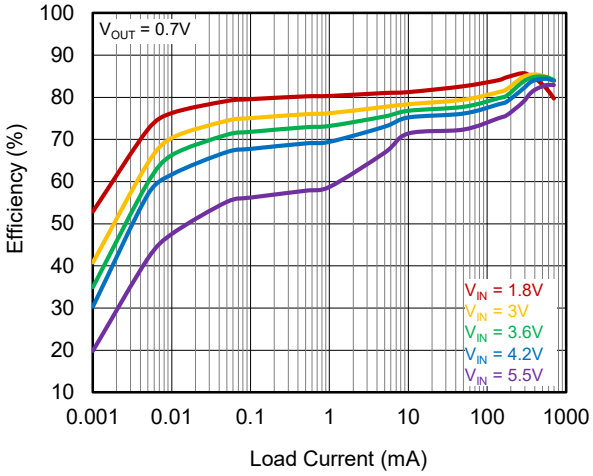
1. Limits over the specified operating temperature and supply voltage range are guaranteed by design and characterization, and production tested at room temperature only.

2. Output Accuracy in low-power mode (LPM) and does not include load, line, or ripple.

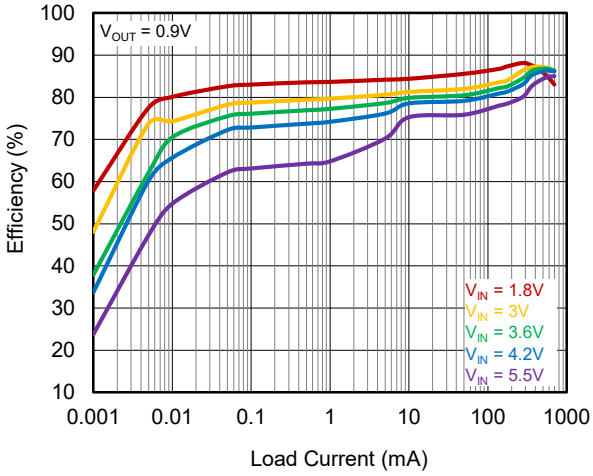
TYPICAL PERFORMANCE CHARACTERISTICS

V_{IN} = 3.6V, V_{OUT} = 1.8V, L_1 = 1μH, C_{IN} = 10μF, C_{OUT} = 10μF, T_A = +25°C, unless otherwise noted.

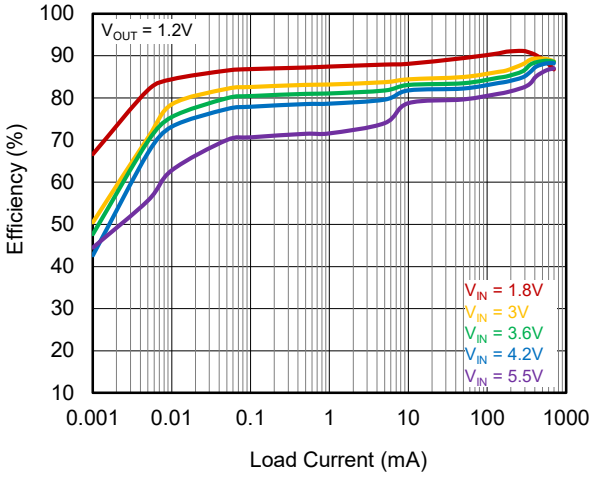
Efficiency vs. Load Current



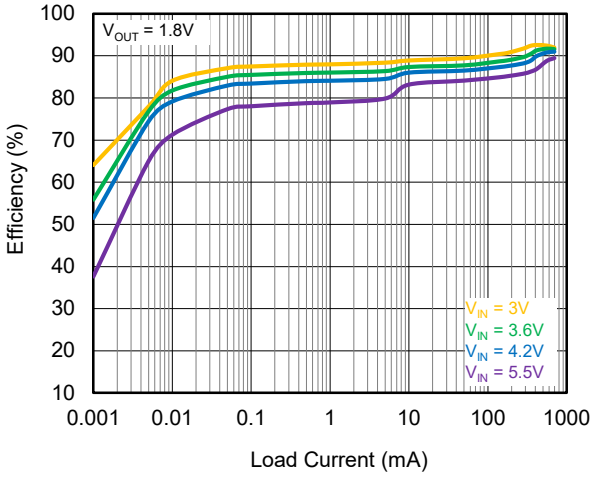
Efficiency vs. Load Current



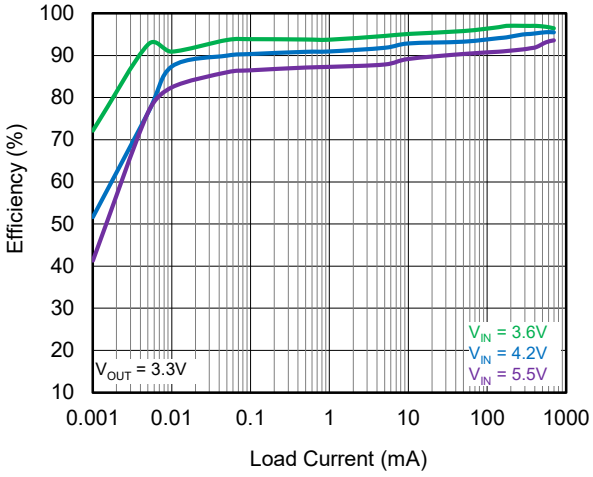
Efficiency vs. Load Current



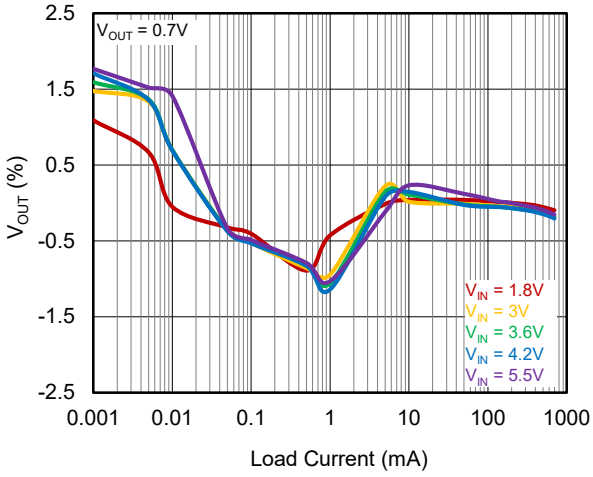
Efficiency vs. Load Current



Efficiency vs. Load Current



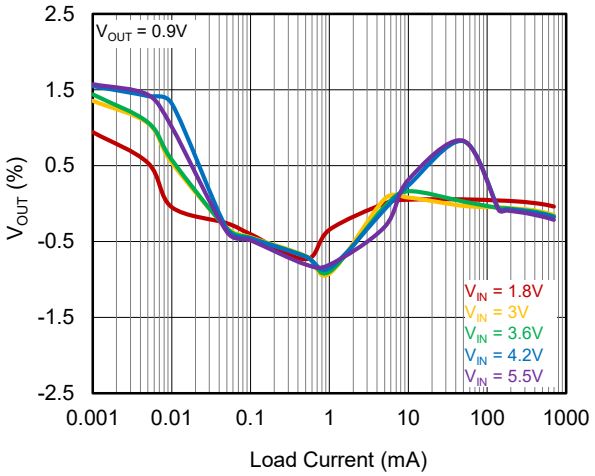
Load Regulation vs. Load Current



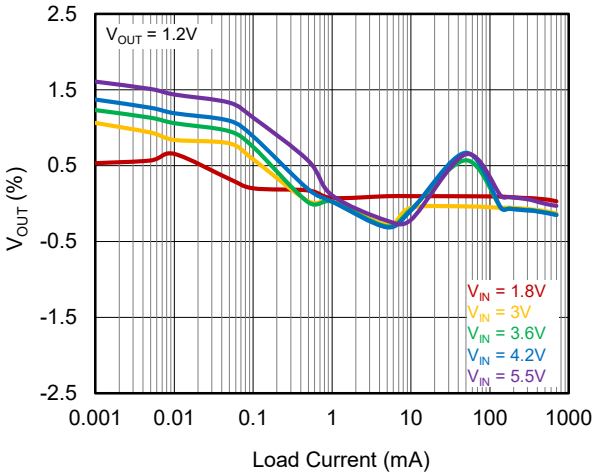
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

V_{IN} = 3.6V, V_{OUT} = 1.8V, L_1 = 1μH, C_{IN} = 10μF, C_{OUT} = 10μF, T_A = +25°C, unless otherwise noted.

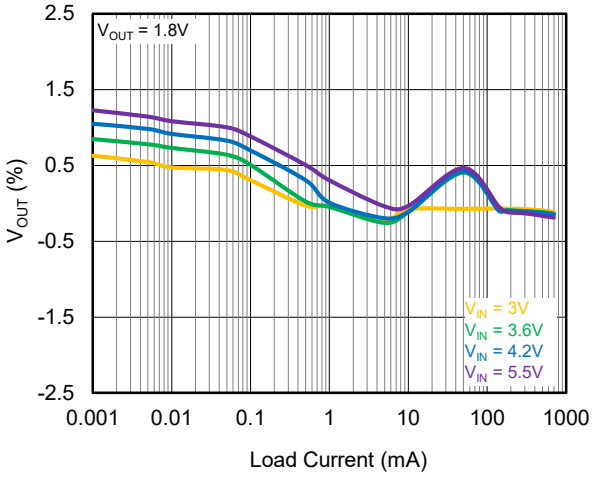
Load Regulation vs. Load Current



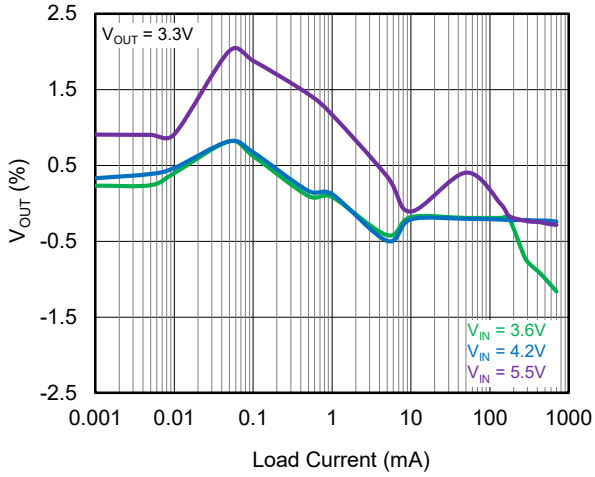
Load Regulation vs. Load Current



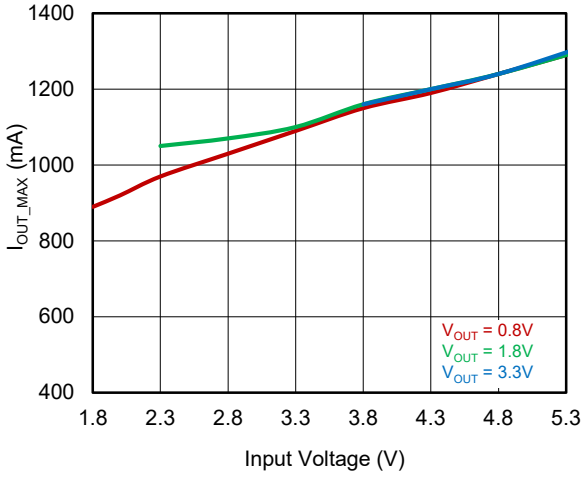
Load Regulation vs. Load Current



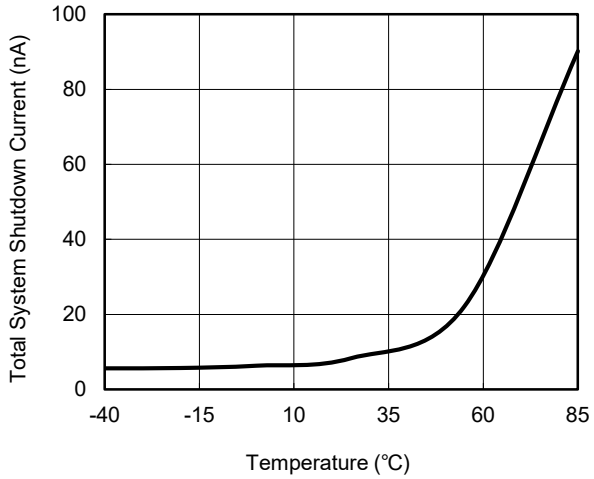
Load Regulation vs. Load Current



I_{OUT_MAX} vs. Input Voltage



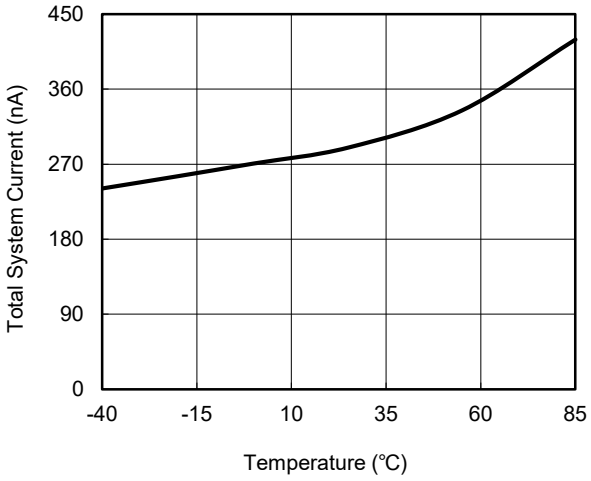
Total System Shutdown Current vs. Temperature



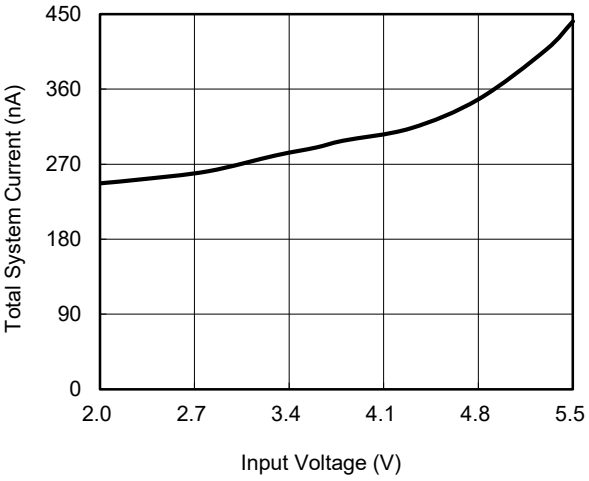
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

V_{IN} = 3.6V, V_{OUT} = 1.8V, L_1 = 1μH, C_{IN} = 10μF, C_{OUT} = 10μF, T_A = +25°C, unless otherwise noted.

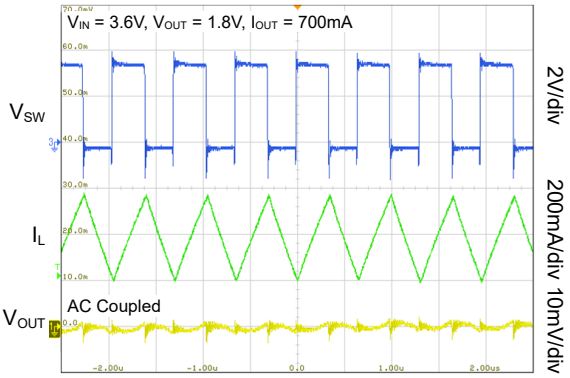
Total System Current vs. Temperature



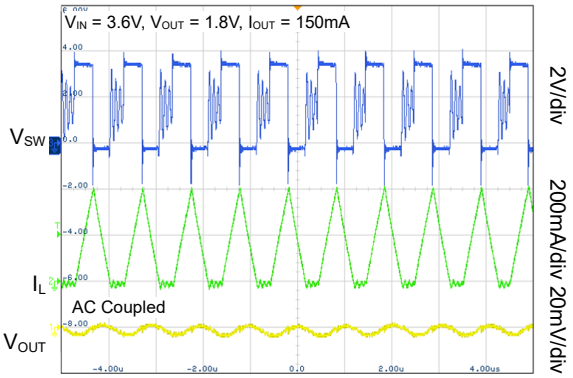
Total System Current vs. Input Voltage



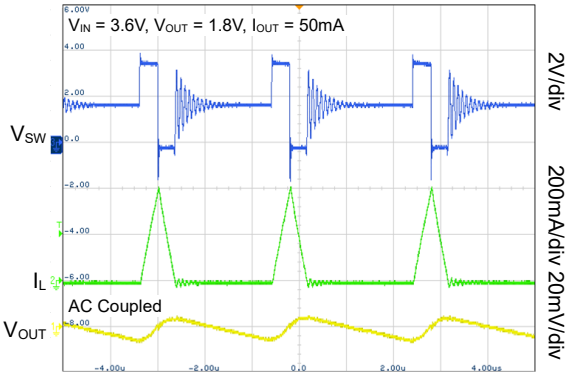
Heavy Load Switching Waveform



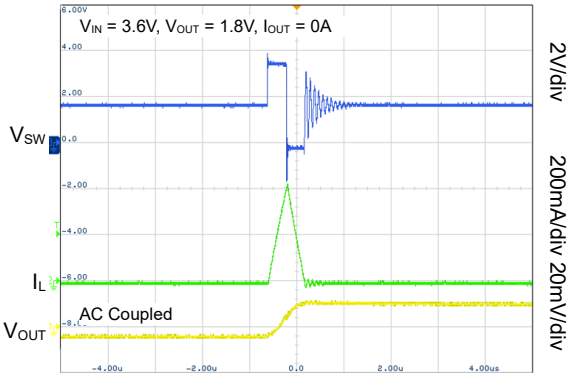
Light Load Switching Waveform



Light Load Switching Waveform



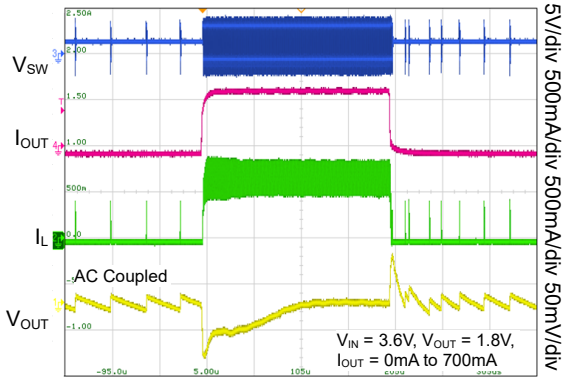
Ultra Light Load Switching Waveform



TYPICAL PERFORMANCE CHARACTERISTICS (continued)

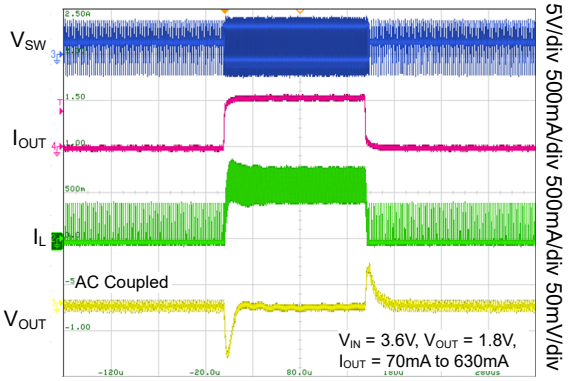
V_{IN} = 3.6V, V_{OUT} = 1.8V, L_1 = 1μH, C_{IN} = 10μF, C_{OUT} = 10μF, T_A = +25°C, unless otherwise noted.

0% - 100% Load Transient



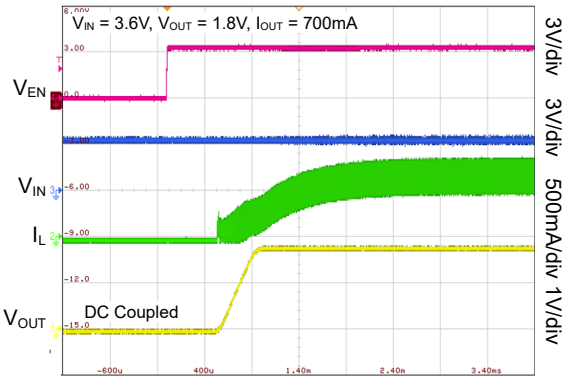
Time (50μs/div)

10% - 90% Load Transient



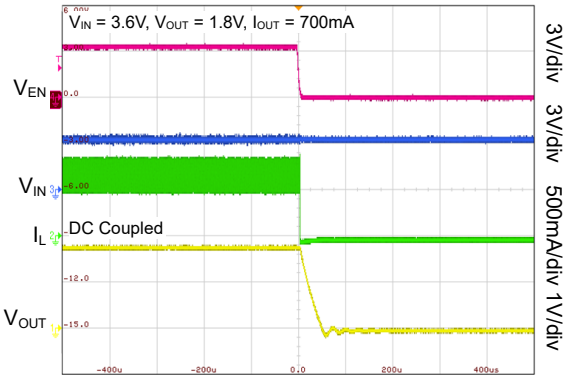
Time (50μs/div)

Startup



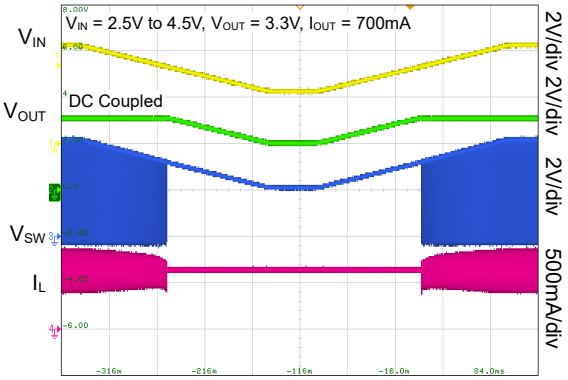
Time (500μs/div)

Shutdown



Time (500μs/div)

100% Mode Line Transient



Time (50ms/div)

FUNCTIONAL BLOCK DIAGRAM

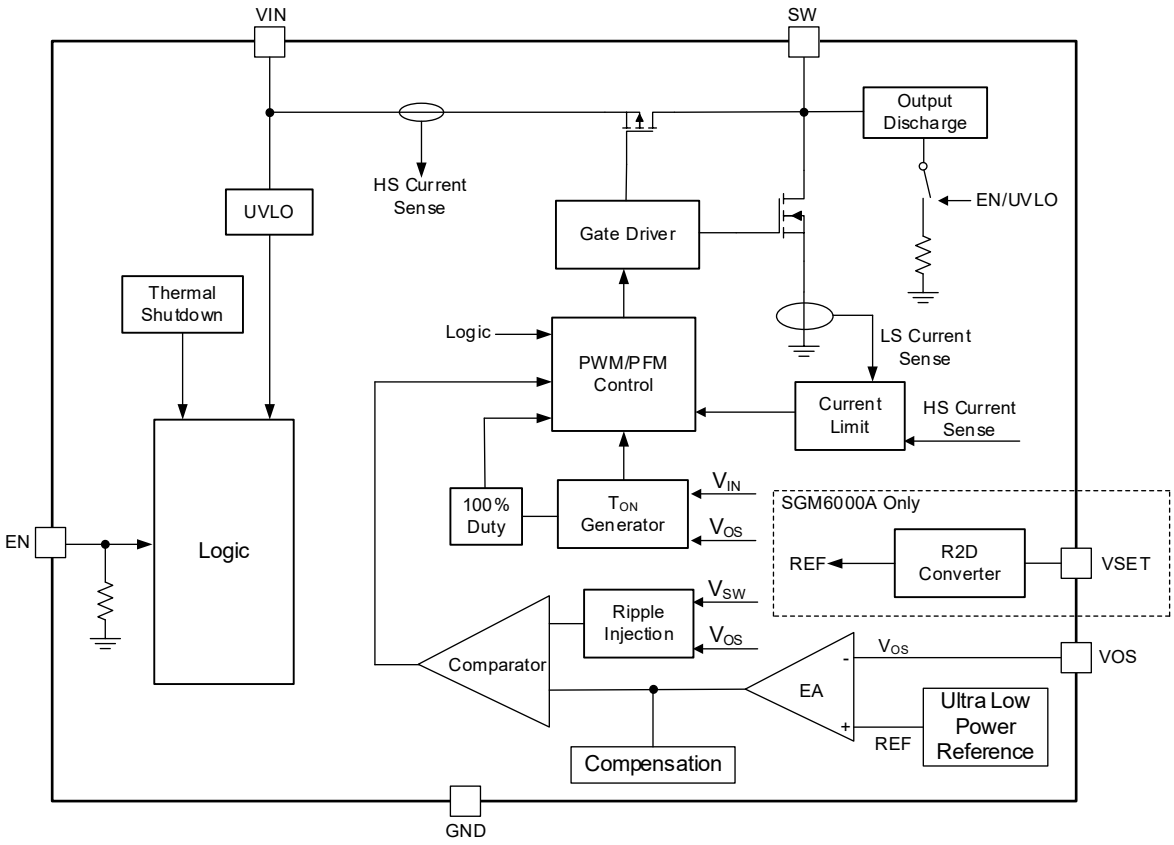


Figure 2. Block Diagram

DETAILED DESCRIPTION (continued)

The SGM6000 is a highly efficient, ultra-low I_Q (300nA) Buck converter that converts the input voltages (1.8V to 5.5V) to output voltages (0.6V to 3.3V). SGM6000A versions use an external resistor to set the output voltage upon startup. SGM6000B versions outputs only fixed output voltage. The SGM6000 automatically improve the performance by changing between PSM, DCM, CCM based on the load current. The device supports 100% duty cycle limitation.

Active discharge resistor pulls the output to ground when the EN pin is toggled to logic low.

Voltage Configuration

The SGM6000A includes a VSET pin to configure the output voltage on startup. Resistors with tolerance 1% (or better) should be chosen, with nominal values specified in Table 1.

The SGM6000B offers a fixed output voltage without R_{SEL} programming. The SGM6000B's UVLO is 1.7V (TYP, V_{IN} rising) with 18mV (TYP) hysteresis.

Enabling Device

A dedicated EN pin can be driven by a digital signal is used in this device. It's advised to activate the device via this pin after exiting VIN UVLO. When the EN pin is connected to VIN pin, the device is used for hard VIN power on. However, if VIN increases slower than 5V/ms, users should ensure the device is enabled only after VIN passes the UVLO threshold. This can be achieved with a basic RC network, as illustrated in Figure 3.

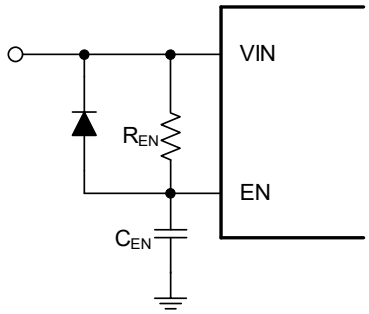


Figure 3. RC Circuit at EN

Table 1. SGM6000A RSEL Selection Table

Target Output Voltage (V)	R_{SEL} (kΩ)
2.5	OPEN
2	909
1.8	768
1.5	634
1.3	536
1.25	452
1.2	383
1.15	324
1.1	267
1.05	226
1	191
0.95	162
0.9	133
0.85	113
0.8	95.3
0.75	80.6
0.7	66.5
3.3	56.2
3	47.5
2.8	40.2
2.75	34
2.5	28
2	23.7
1.8	20
1.5	16.9
1.25	14
1.2	11.8
1.15	10
1.1	8.45
1	7.15
0.95	5.9
0.9	4.99
0.8	Short to GND

APPLICATION INFORMATION

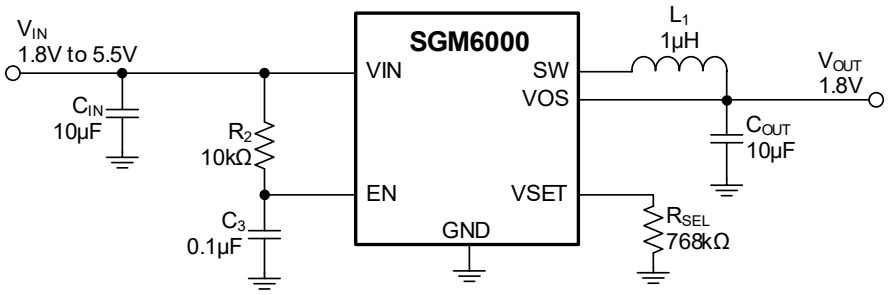


Figure 4. SGM6000 Typical Application Schematics

Inductor Selection

The ripple current affects the overall efficiency of the SGM6000 so that the inductor value is recommended based on Table 2.

Table 2. Inductor Selection

Peak Current, Part Number	Inductance Range (μH)
1.2A	1.0 to 2.2

Input Capacitor

The peak current offered by the input power source or battery is reduced by the input capacitor (C_{IN}). The lower impedance of C_{IN} should be implemented to optimize switching noise issue in the IC. It is recommended to select 10μF ceramic capacitors for most SGM6000 applications with X5R or X7R temperature characteristics because of their small size and low ESR. Using more C_{IN} to avoid trigger the UVLO when operating at VIN close to the UVLO.

Output Capacitor

C_{OUT} with low impedance at the switching frequency is necessary to reduce output voltage ripple and maintain loop stability. It is recommended to select a 10μF ceramic capacitor with X5R or X7R temperature characteristics because of their small size and low ESR. Ensure the capacitor maintains stable capacitance across temperature and under DC bias. The minimum equivalent capacitance of the output capacitor should not be less than 3μF. For general use, a 10μF ceramic capacitor is suggested. When aiming for lower V_{OUT} levels, using a 22μF output capacitors is advised.

Layout Information

1. Place the input capacitor (C_{IN}) as close as possible to the IN pin and GND pin.

2. Keep the SW node short and small to minimize parasitic capacitance and radiated emissions.

3. Connect the C_{IN}, inductor, and C_{OUT} closely with short, direct, wide traces.

4. Connect both GND pins under the IC to COUT ground directly.

5. Route VOS to COUT avoiding the main power path between inductor and COUT and noisy traces.

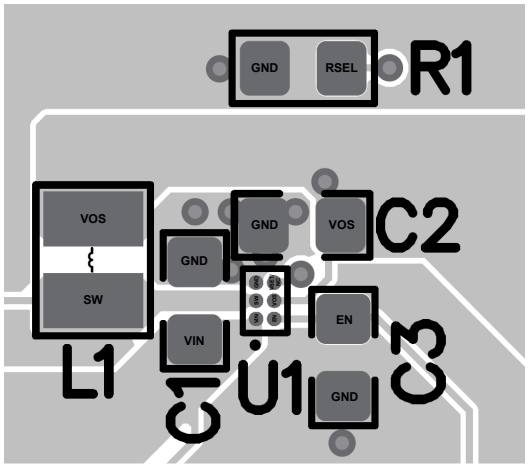


Figure 5. Top View

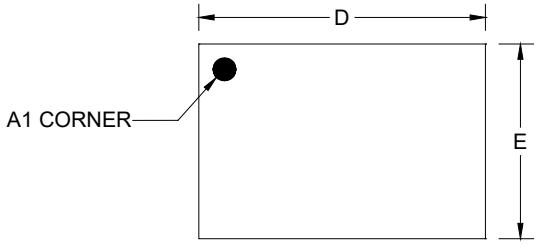
REVISION HISTORY

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

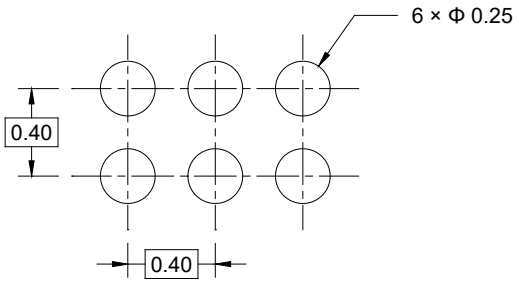
Changes from Original to REV.A (SEPTEMBER 2025)	Page
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

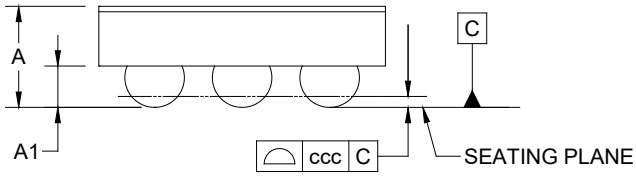
WLCSP-1.31×0.89-6B



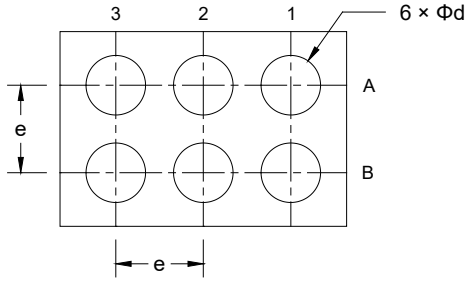
TOP VIEW



RECOMMENDED LAND PATTERN (Unit: mm)



SIDE VIEW



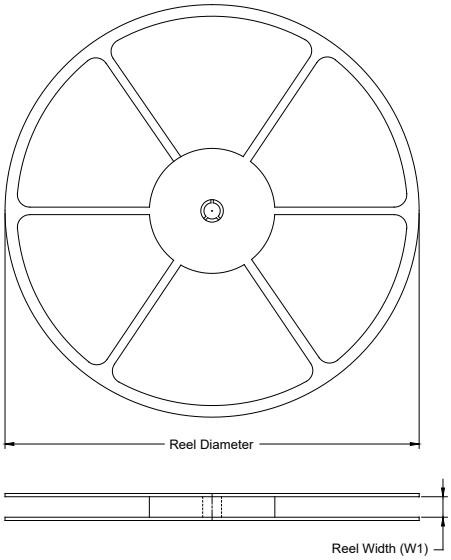
BOTTOM VIEW

Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	-	-	0.500
A1	0.169	-	0.209
D	1.280	-	1.340
E	0.860	-	0.920
d	0.242	-	0.302
e	0.400 BSC		
ccc	0.050		

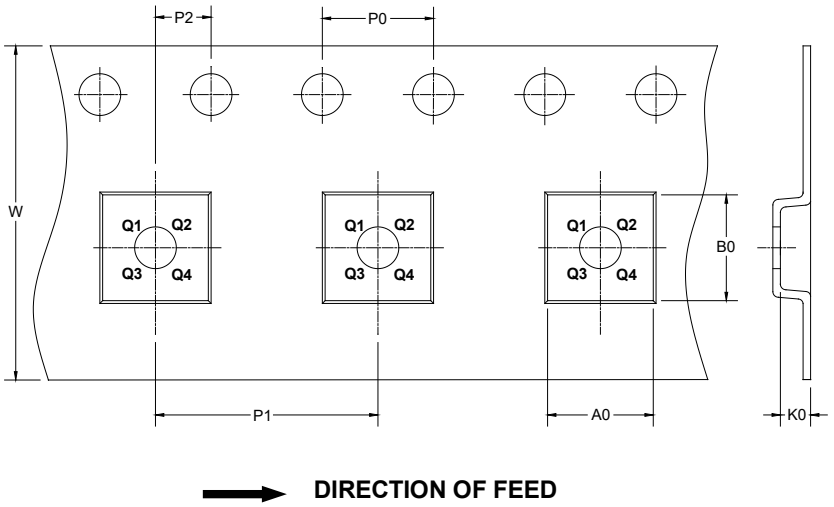
NOTE: This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



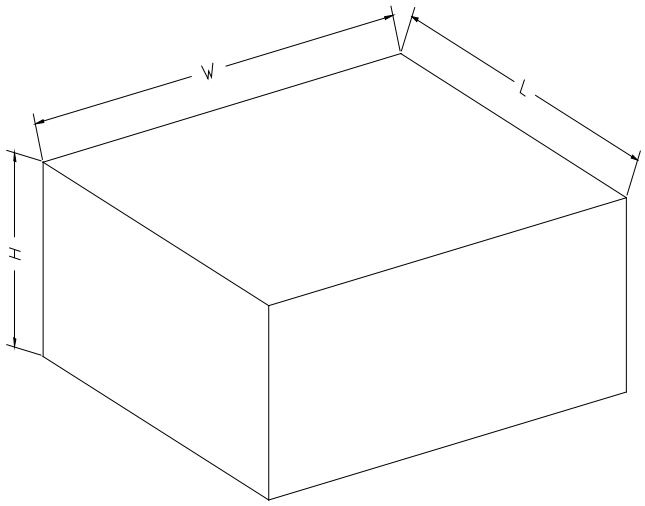
NOTE: The picture is only for reference. Please make the object as the standard.

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
WLCSP-1.31×0.89-6B	7"	9.5	1.01	1.43	0.61	4.0	4.0	2.0	8.0	Q2

DD0001

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