SGM66056
Tiny, 2.2MHz, Fixed Output Synchronous Step-Up Converter with a 2.5A Switch

GENERAL DESCRIPTION

The SGM66056 is an internally compensated, 2.2MHz switching frequency, current mode, synchronous step-up (boost) switching regulator. This device turns into power-save mode to maintain high efficiency by lowering switching frequency. Anti-ringing control circuitry reduces EMI concerns by damping the inductor in discontinuous mode. Its output is disconnected by the rectifier circuit during shutdown, with no input to output leakage.

The SGM66056 is available in a Green WLCSP-1.21×1.21-9B package. It operates over an ambient temperature range of -40℃ to +85℃.

FEATURES

- **93% Efficiency Synchronous Boost Converter**
- **Device Quiescent Current: 34μA (TYP)**
- **Less than 1μA Shutdown Current**
- **Operating Input Voltage Range: 2.5V to 4.5V**
- **Fixed Output Voltage: 5.0V**
- **Output Voltage Clamping: 5.7V**
- **Power-Save Mode for Improved Efficiency at Low Output Power**
- **Load Disconnect during Shutdown**
- **Low Reverse Leakage Current when $V_{OUT} > V_{IN}$**
- **Over-Temperature Protection**
- **Available in a Green WLCSP-1.21×1.21-9B Package**
- **-40℃ to +85℃ Operating Temperature Range**

APPLICATIONS

Class-D Audio Amplifier and USB OTG Supply
Boost for Low-Voltage Li-Ion Batteries
Smart Phones, Tablets, Portable Devices, Wearables

TYPICAL APPLICATION

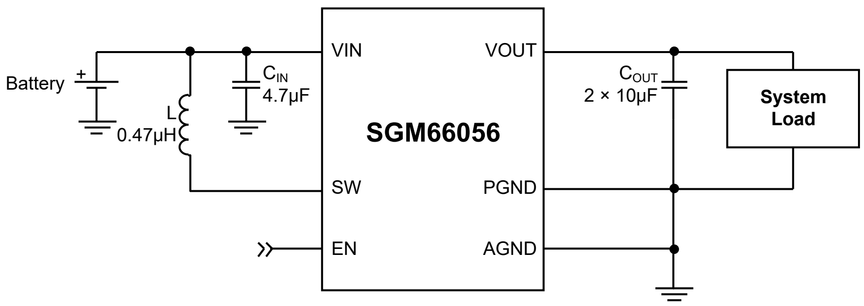


Figure 1. Typical Application Circuit

PACKAGE/ORDERING INFORMATION

MODEL	V_{OUT} (V)	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM66056	5.0	WLCSP-1.21×1.21-9B	-40℃ to +85℃	SGM66056-5.0YG/TR	C03 XXXX	Tape and Reel, 3000

MARKING INFORMATION

NOTE: XXXX = Date Code.

YYY — Serial Number
XX XX
Date Code - Week
Date Code - Year

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

Voltage on VIN Pin .... -0.3V to 5.5V
Voltage on VOUT Pin 6V
SW Node (DC)... -0.3V to 6V
SW Node (Transient: 10ns, 3MHz) .... -1V to 8V
Voltage on Other Pins.......................................-0.3V to 6V (1)
Package Thermal Resistance
WLCSP-1.21×1.21-9B, θ_{JA}. ....90℃/W
Junction Temperature...+150℃
Storage Temperature Range ....-65℃ to +150℃
Lead Temperature (Soldering, 10s)............................+260℃
ESD Susceptibility
HBM...4000V
CDM 1000V

NOTE: 1. Lesser of 6V or V_{IN} + 0.3V.

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

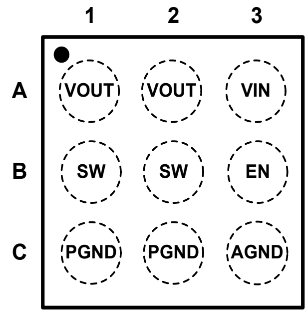
This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its 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-1.21×1.21-9B

PIN DESCRIPTION

PIN	NAME	FUNCTION
A1, A2	VOUT	Output Voltage. These pins are the output voltage terminal; connect directly to C_{OUT}.
A3	VIN	Input Voltage. Connect to Li-Ion battery input power source.
B1, B2	SW	Switching Node. Connect to inductor.
B3	EN	Enable. When this pin is high, the circuit is enabled.
C1, C2	PGND	Power Ground. This is the power return for the IC. C_{OUT} capacitor should be returned with the shortest path possible to these pins.
C3	AGND	Analog Ground. This is the signal ground reference for the IC. All voltage levels are measured with respect to this pin – connect to PGND at a single point.

ELECTRICAL CHARACTERISTICS

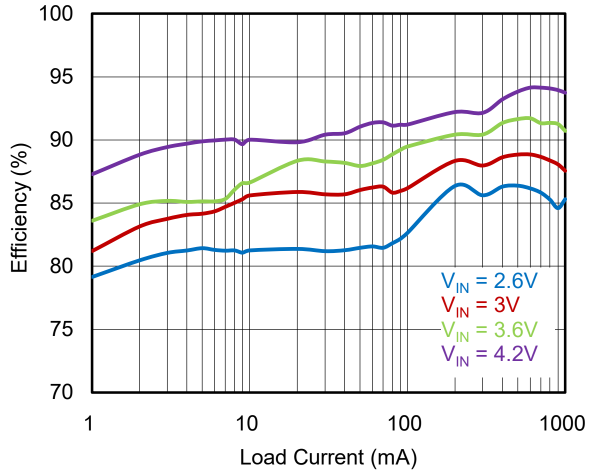
(V_{IN} = 3.6V, Full = -40℃ to +85℃, typical values are at T_A = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
DC/DC STAGE							
Input Voltage Range	V_{IN}		+25℃	2.5		4.5	V
Switching Frequency	f		Full	1.80	2.20	2.55	MHz
Switch Current Limit	I_L		+25℃	1.85	2.5	3.5	A
Boost Switch On-Resistance		V_{OUT} = 5.0V	+25℃		50	65	mΩ
Rectifying Switch On-Resistance		V_{OUT} = 5.0V	+25℃		60	80	mΩ
Output Voltage		SGM66056-5.0	Full	4.96	5.06	5.18	V
Line Regulation		V_{IN} = 2.5V to V_{OUT} - 0.5V	+25℃		0.1		%
Load Regulation			+25℃		0.3		%
Quiescent Current	I_Q	V_{EN} = V_{IN} = 3.6V, not switching	+25℃		34	53	μA
Shutdown Current		V_{EN} = 0V, V_{IN} = 3.6V	+25℃			1	μA
CONTROL STAGE							
EN Input Low Voltage	V_{IL}		Full			0.4	V
EN Input High Voltage	V_{IH}		Full	1.3			V
EN Input Current		Clamped to GND or VIN	Full	-1		1	μA
Over-Temperature Protection					150		℃
Over-Temperature Hysteresis					20		℃

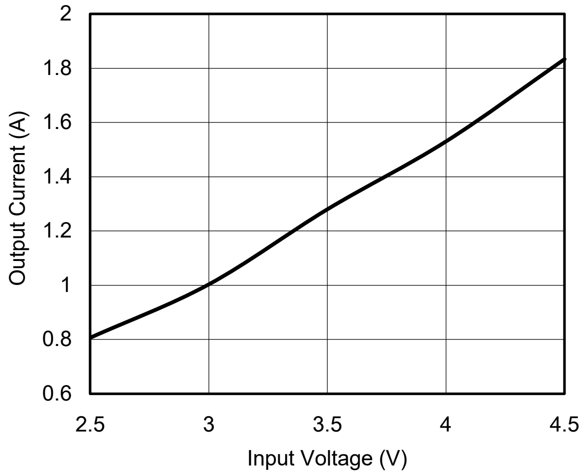
TYPICAL PERFORMANCE CHARACTERISTICS

At T_A = +25℃, V_{IN} = 3.6V, C_{IN} = 4.7μF, C_{OUT} = 20μF, unless otherwise noted.

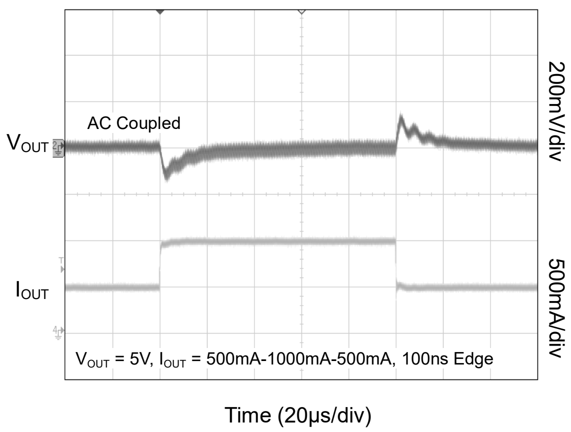
Efficiency vs. Load Current



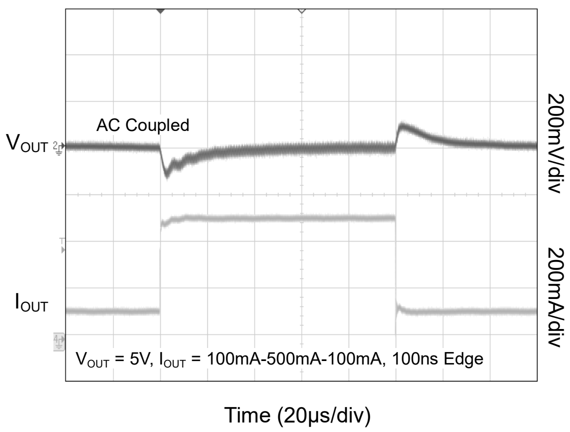
Maximum Output Current vs. Input Voltage



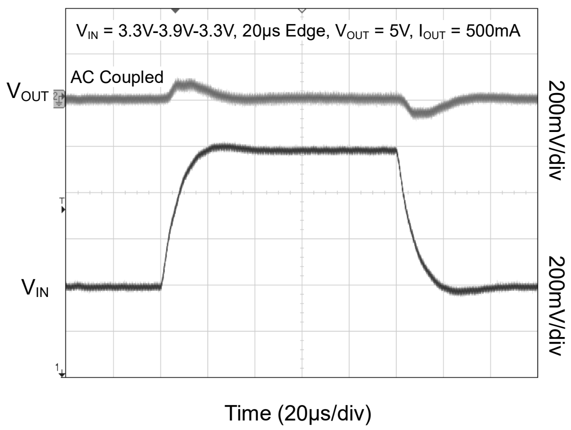
Load Transient Response



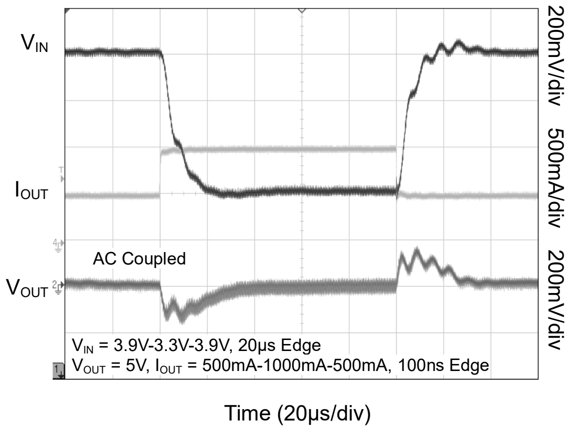
Load Transient Response



Line Transient Response



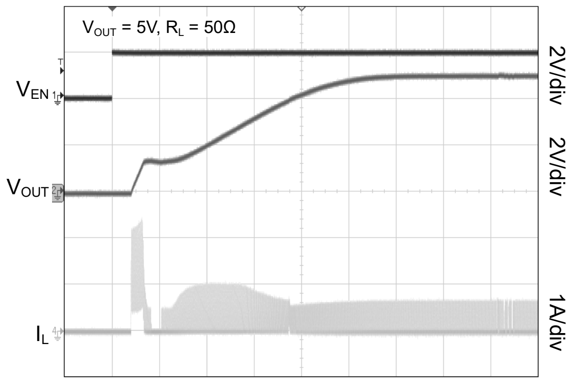
Simultaneous Line/Load Transient Response



TYPICAL PERFORMANCE CHARACTERISTICS (continued)

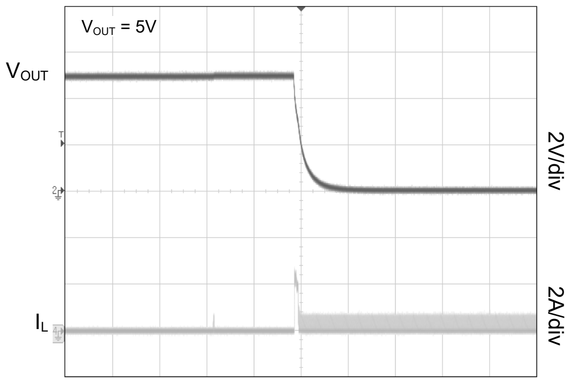
At T_A = +25℃, V_{IN} = 3.6V, C_{IN} = 4.7μF, C_{OUT} = 20μF, unless otherwise noted.

Start-Up after Enable



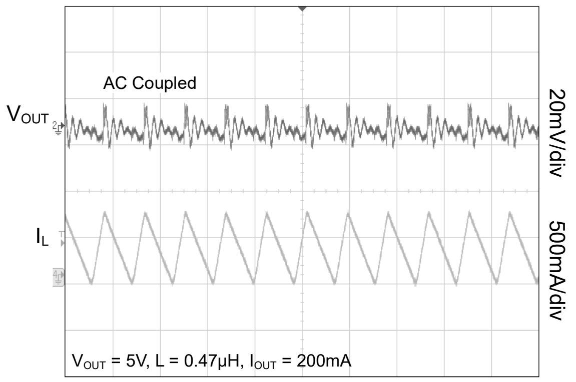
Time (100μs/div)

Output Short Protection



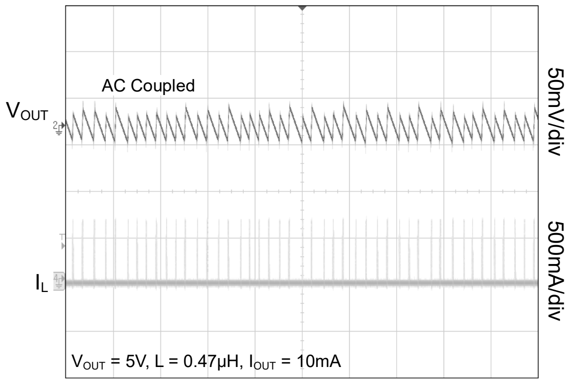
Time (100μs/div)

Switching Waveform at Heavy Load



Time (500ns/div)

Switching Waveform at Light Load



Time (100μs/div)

FUNCTIONAL BLOCK DIAGRAM

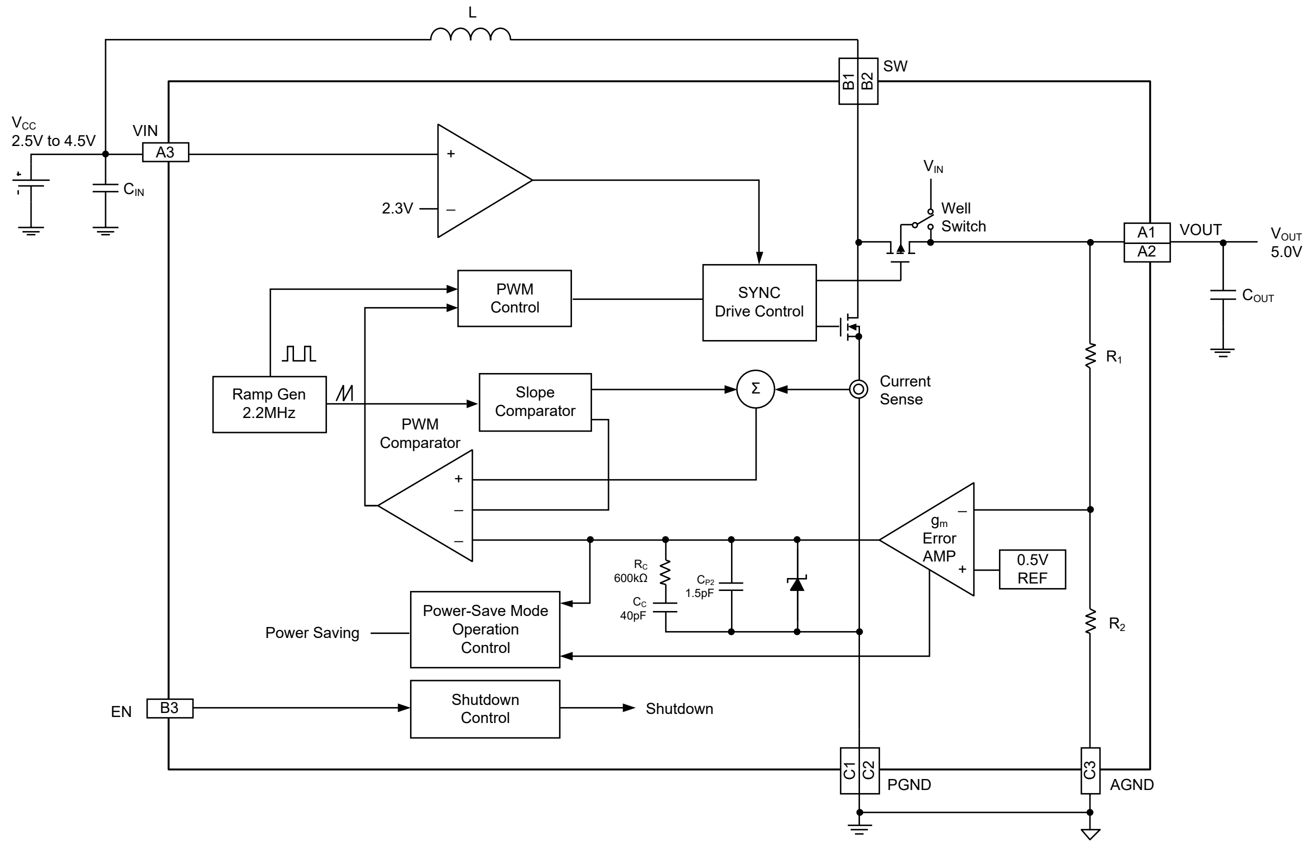


Figure 2. Block Diagram

APPLICATION INFORMATION

The SGM66056 is a boost DC/DC converter operating in 2.5V to 4.5V supply range, for generating a regulated output voltage which can be set to as low as 10% above the supply voltage. An inductor, an output storage capacitor and an input decoupling capacitor should be selected to ensure proper performance desired in a specific application circuit.

Inductor Selection

Both average current and peak current should be evaluated in inductor selection. The maximum average inductor current is estimated using Equation 1:

$$I_L = I_{OUT} \times \frac{V_{OUT}}{V_{IN} \times 0.8} \quad (1)$$

For example, for an output current of 300mA at 5V, at least an average current of 750mA flows through the inductor at a minimum input voltage of 2.5V.

Choosing a proper inductance for a given current ripple value is readily done in design practice. A smaller ripple reduces the magnetic hysteresis losses in the inductor, as well as output voltage ripple and EMI. Though regulation settling time may rise when load changes. The minimum inductance value for the inductor at given condition is estimated by using Equation 2:

$$L = \frac{V_{IN} \times (V_{OUT} - V_{IN})}{\Delta I_L \times f \times V_{OUT}} \quad (2)$$

where f is the switching frequency and ΔI_L is the ripple current in the inductor, which normally is 20% of the average inductor current or is a design specified value. In typical applications, a 0.47μH inductance is recommended. Nevertheless, 1μH inductance may be possible when load current is less than 300mA. After choosing an inductor, peak current at maximum loading and lowest input voltage is suggested to be evaluated, which should be lower than the switch current limit of this device as well as the inductor saturation current.

Input Capacitor

At least a 4.7μF input capacitor is recommended to improve transient behavior of the regulator and EMI behavior. A ceramic capacitor or a tantalum capacitor with a 100nF ceramic capacitor in parallel, placed close to the IC, is recommended.

Output Capacitor

The capacitance and the ESR define the output voltage ripple. Supposing that the ESR is zero, the minimum capacitance can be estimated by using Equation 3:

$$C_{MIN} = \frac{I_{OUT} \times (V_{OUT} - V_{IN})}{f \times \Delta V \times V_{OUT}} \quad (3)$$

where f is the switching frequency and ΔV is the maximum allowed voltage ripple.

The ESR and the additional ripple related to ESR may be negligible if a low ESR ceramic capacitor is used. This part of ESR component is calculated using Equation 4:

$$\Delta V_{ESR} = I_{OUT} \times R_{ESR} \quad (4)$$

The total ripple is the sum of the ripple caused by the capacitance and the ripple caused by the ESR of the capacitor. Additional voltage change may be caused by load transients; 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 20μF and load transient considerations, the recommended output capacitance value is in the range of 20μF to 47μF.

The capacitance loss due to the DC biasing and the high frequency performance has to be counted for de-rating. For example, larger form factor capacitors (in 1206 size) have their self-resonant frequencies in the same frequency range as the SGM66056 operating frequency. The effective capacitance of the capacitor may be significantly lower than its rating.

APPLICATION INFORMATION (continued)

Layout Considerations

Careful layout is always important to ensure good performance and stable operation to any kind of switching regulators. Place the capacitors close to the device, use the GND pin of the device as the center of star-connection to other grounds, and minimize the trace area of SW node. These measures reduce transient current loops and lower the possible parasitic ringing.

If a resistor divider is employed, the center tap to FB trace should have sufficient clearance from noisy PCB traces, as the FB node is sensitive and easily picks up noise.

Thermal Information

Implementation of integrated circuits in low-profile and fine-pitch surface-mount packages typically requires 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.

Common approaches for enhancing thermal performance are listed below for convenient reference:

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.

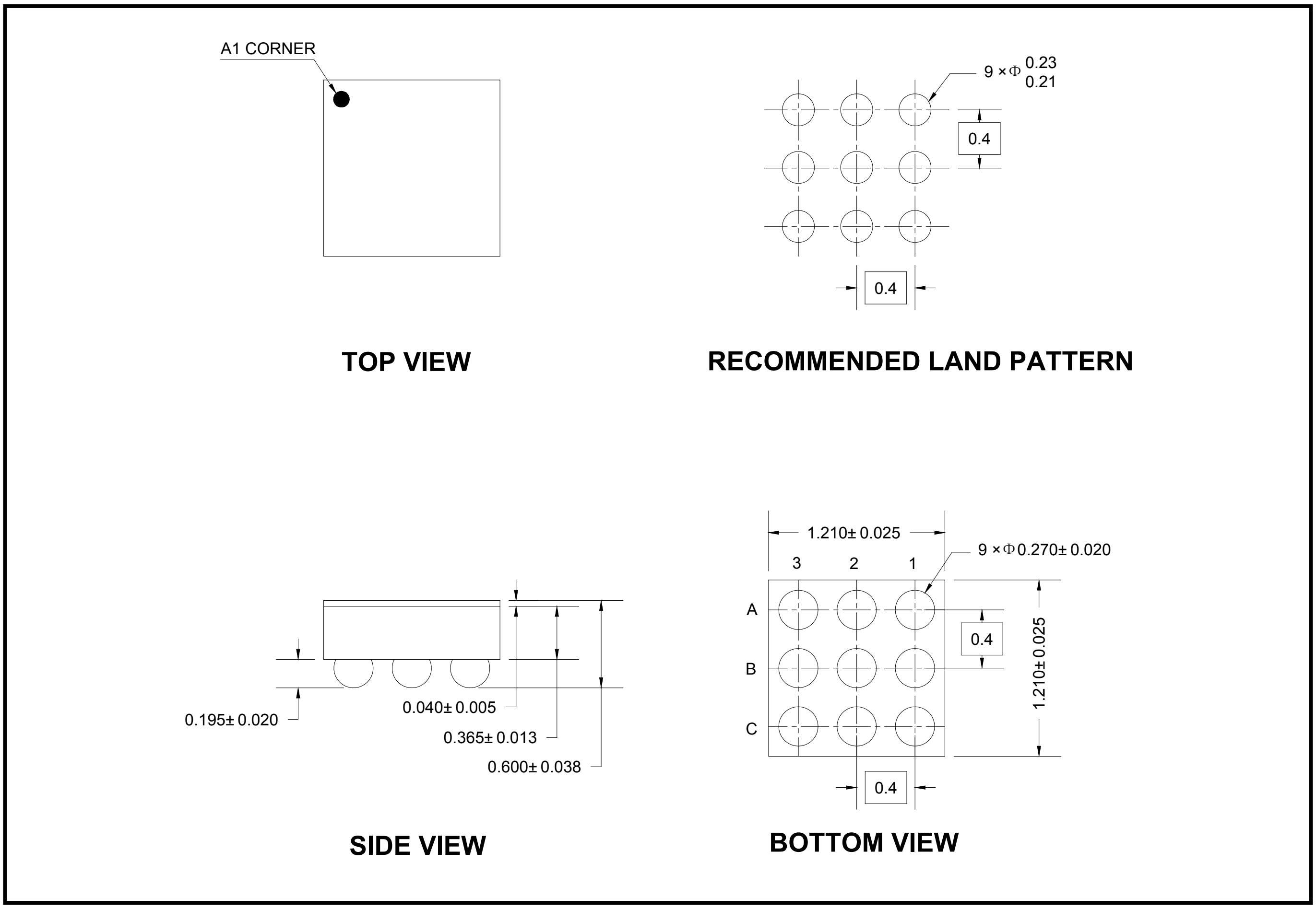
REVISION HISTORY

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

Changes from Original (JULY 2019) to REV.A	Page
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

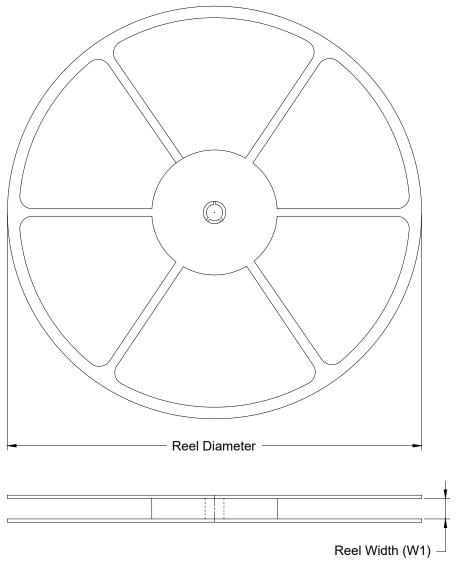
WLCSP-1.21×1.21-9B



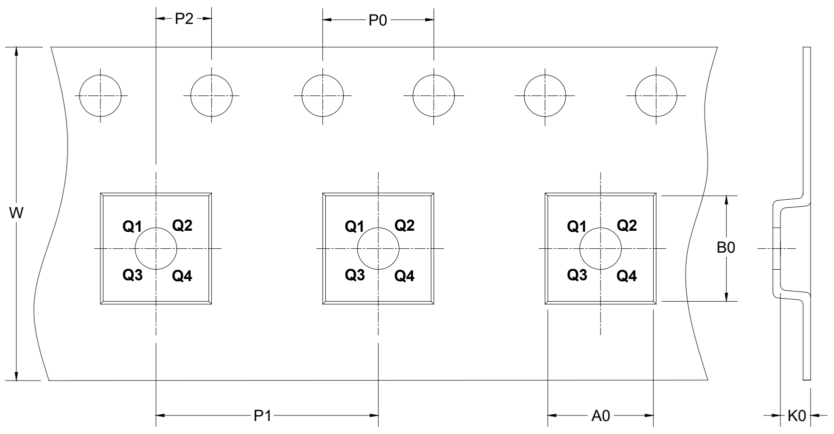
NOTE: All linear dimensions are in millimeters.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



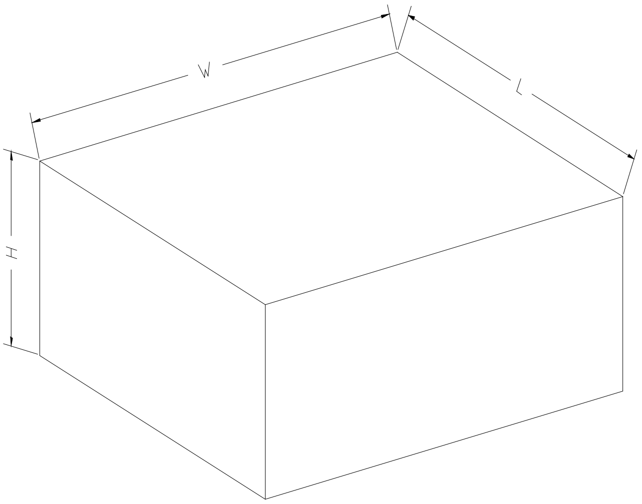
NOTE: The picture is only for reference. Please make the object as the standard.

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-1.21×1.21-9B	7″	9.2	1.33	1.33	0.74	4.0	4.0	2.0	8.0	Q1

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