SGM66099
Synchronous Boost Converter with Ultra-Low Quiescent Current

GENERAL DESCRIPTION

The SGM66099 is an ultra-low quiescent current synchronous boost converter. 0.9V to 5.2V operating input voltage is suitable for Li-Mn battery, NiMH and Li-Ion rechargeable batteries. The 0.6μA quiescent current maximizes the light load efficiency and also increases the effective battery operation time. In addition, the high-side synchronous rectifier provides output disconnect feature which minimizes unnecessary current drawn from the battery during shutdown mode.

The SGM66099 is able to deliver 300mA output current from 3.3V to 5V conversion, and achieves 93% peak efficiency at 200mA load. It has an adjustable output voltage from 2.5V to 5.2V.

The device offers down mode where the desired output voltage is regulated even when input voltage is higher than the output. In addition, when the input voltage is 300mV above the output voltage set point, the device enters pass-through mode.

The device integrates various protection features such as over-voltage protection and thermal shutdown. In addition, the synchronous rectifier supports short circuit protection which further improves the robustness of the device.

The SGM66099 offers both adjustable output voltage version and fixed output voltage versions. It is available in Green WLCSP-1.22×0.83-6B and TDFN-2×2-6AL packages.

FEATURES

- **Operating Input Voltage Range: 0.9V to 5.2V**
- **Ultra-low Quiescent Current**
  - **0.6μA Ultra Low I_Q into VOUT Pin**
  - **0.05μA Ultra Low I_Q into VIN Pin**
- **1.2MHz Fixed Frequency Operation**
- **Adjustable Output Voltage from 2.5V to 5.2V**
- **Fixed Output Voltage Versions Available**
- **Power-Save Mode for Improved Efficiency at Low Output Power**
- **Regulated Output Voltage in Down Mode**
- **True Disconnection During Shutdown**
- **Up to 75% Efficiency at 10μA Load with Fixed Output Voltage Version**
- **Up to 93% Efficiency from 10mA to 300mA Load**
- **-40℃ to +85℃ Operating Ambient Temperature Range**
- **Available in Green WLCSP-1.22×0.83-6B and TDFN-2×2-6AL Packages**

APPLICATIONS

LCD and LED Bias

Portable and Wearable Applications
Low Power Wireless Applications
Battery Powered Systems

TYPICAL APPLICATION

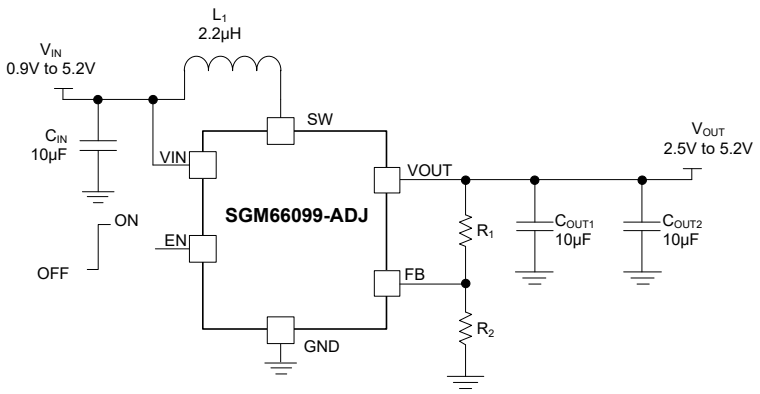

Figure 1. Typical Application Circuit

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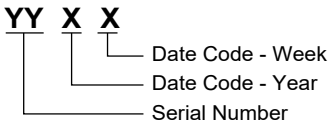
PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM66099-2.5	WLCSP-1.22×0.83-6B	-40℃ to +85℃	SGM66099-2.5YG/TR	FAXX	Tape and Reel, 3000
	TDFN-2×2-6AL	-40℃ to +85℃	SGM66099-2.5YTDI6G/TR	MG0 XXXX	Tape and Reel, 3000
SGM66099-3.0	WLCSP-1.22×0.83-6B	-40℃ to +85℃	SGM66099-3.0YG/TR	FBXX	Tape and Reel, 3000
	TDFN-2×2-6AL	-40℃ to +85℃	SGM66099-3.0YTDI6G/TR	MG1 XXXX	Tape and Reel, 3000
SGM66099-3.3	WLCSP-1.22×0.83-6B	-40℃ to +85℃	SGM66099-3.3YG/TR	FCXX	Tape and Reel, 3000
	TDFN-2×2-6AL	-40℃ to +85℃	SGM66099-3.3YTDI6G/TR	MG2 XXXX	Tape and Reel, 3000
SGM66099-3.6	WLCSP-1.22×0.83-6B	-40℃ to +85℃	SGM66099-3.6YG/TR	FDXX	Tape and Reel, 3000
	TDFN-2×2-6AL	-40℃ to +85℃	SGM66099-3.6YTDI6G/TR	MG3 XXXX	Tape and Reel, 3000
SGM66099-4.5	WLCSP-1.22×0.83-6B	-40℃ to +85℃	SGM66099-4.5YG/TR	FEXX	Tape and Reel, 3000
	TDFN-2×2-6AL	-40℃ to +85℃	SGM66099-4.5YTDI6G/TR	MG4 XXXX	Tape and Reel, 3000
SGM66099-5.0	WLCSP-1.22×0.83-6B	-40℃ to +85℃	SGM66099-5.0YG/TR	F9XX	Tape and Reel, 3000
	TDFN-2×2-6AL	-40℃ to +85℃	SGM66099-5.0YTDI6G/TR	MF8 XXXX	Tape and Reel, 3000
SGM66099-ADJ	WLCSP-1.22×0.83-6B	-40℃ to +85℃	SGM66099-ADJYG/TR	FFXX	Tape and Reel, 3000
	TDFN-2×2-6AL	-40℃ to +85℃	SGM66099-ADJYTDI6G/TR	MG5 XXXX	Tape and Reel, 3000

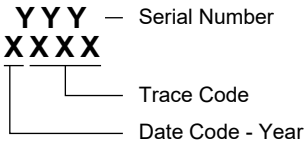
MARKING INFORMATION

NOTE: XX = Date Code. XXXX = Date Code and Trace Code.

WLCSP-1.22×0.83-6B



TDFN-2×2-6AL



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.

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ABSOLUTE MAXIMUM RATINGS

VIN, SW, VOUT, FB, EN to GND ..... -0.3V to 6.0V
Package Thermal Resistance
WLCSP-1.22×0.83-6B, θ_{JA} ..... 143℃/W
TQFN-2×2-6AL, θ_{JA} ..... 105℃/W
Junction Temperature ..... +150℃
Storage Temperature ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃
ESD Susceptibility
HBM 4000V
MM 400V
CDM 1000V

RECOMMENDED OPERATING CONDITIONS

Input Voltage Range ..... 0.9V (1) to 5.2V
Output Voltage Range ..... 2.5V to 5.2V
Operating Ambient Temperature Range ..... -40℃ to +85℃
Operating Junction Temperature Range ..... -40℃ to +125℃

NOTE 1: Refer to the “Startup and Low Supply Voltage Operation” for detailed description.

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.

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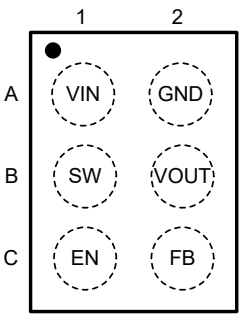
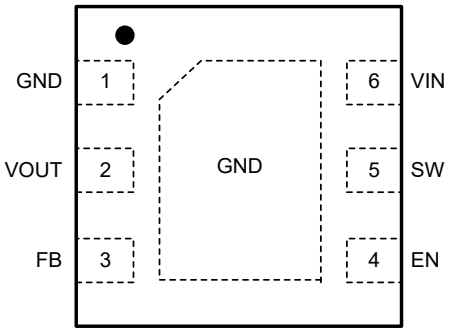
PIN CONFIGURATIONS

(TOP VIEW)



WLCSP-1.22×0.83-6B

(TOP VIEW)



TDFN-2×2-6AL

PIN DESCRIPTION

PIN		NAME	TYPE	FUNCTION
WLCSP-1.22×0.83-6B	TDFN-2×2-6AL			
A1	6	VIN	P	Power Supply Input.
A2	1	GND	G	Ground.
B1	5	SW	O	Switch Pin of the Converter. It is connected to the inductor.
B2	2	VOUT	O	Boost Converter Output.
C1	4	EN	I	Enable Logic Input. Logic high voltage enables the device; logic low voltage disables the device. Do not leave it floating.
C2	3	FB	I	Voltage Feedback of Adjustable Output Voltage. Connect to the center tap of a resistor divider to program the output voltage. Connect to the GND pin for fixed output voltage versions.
—	Exposed Pad	GND	—	Connect to GND.

NOTE: I: input, O: output, G: ground, P: power for the circuit.

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ELECTRICAL CHARACTERISTICS

(V_{IN} = 0.9V to 5.2V, C_{IN} = 10μF, C_{OUT} = 20μF, Full = -40℃ to +85℃, typical values are at V_{IN} = 3.7V, T_A = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
Power Supply							
Input Voltage Range	V_{IN}		+25℃	0.9		5.2	V
Quiescent Current into VIN Pin	I_Q	No load, not switching	Full		0.05	0.2	μA
Quiescent Current into VOUT Pin		No load, not switching, boost or down mode	Full		0.6	1.1	μA
Shutdown Current into VIN Pin	I_{SD}	EN = GND, V_{IN} = 3.6V	Full		0.1	1	μA
Output							
Output Voltage Range	V_{OUT}		Full	2.5		5.2	V
Output Voltage		SGM66099-5.0, V_{IN} < V_{OUT}, PWM mode	Full	4.85	5.00	5.09	V
		SGM66099-5.0, V_{IN} < V_{OUT}, PFM mode	+25℃		5.08		V
		SGM66099-4.5, V_{IN} < V_{OUT}, PWM mode	Full	4.37	4.50	4.58	V
		SGM66099-4.5, V_{IN} < V_{OUT}, PFM mode	+25℃		4.57		V
		SGM66099-3.6, V_{IN} < V_{OUT}, PWM mode	Full	3.50	3.60	3.67	V
		SGM66099-3.6, V_{IN} < V_{OUT}, PFM mode	+25℃		3.65		V
		SGM66099-3.3, V_{IN} < V_{OUT}, PWM mode	Full	3.21	3.30	3.35	V
		SGM66099-3.3, V_{IN} < V_{OUT}, PFM mode	+25℃		3.35		V
		SGM66099-3.0, V_{IN} < V_{OUT}, PWM mode	Full	2.92	3.00	3.05	V
		SGM66099-3.0, V_{IN} < V_{OUT}, PFM mode	+25℃		3.04		V
		SGM66099-2.5, V_{IN} < V_{OUT}, PWM mode	Full	2.44	2.50	2.54	V
		SGM66099-2.5, V_{IN} < V_{OUT}, PFM mode	+25℃		2.54		V
Feedback Reference Voltage	V_{REF}	V_{IN} < V_{OUT}, PWM mode	Full	0.975	1.000	1.025	V
		V_{IN} < V_{OUT}, PFM mode	+25℃		1.020		V
Output Over-Voltage Protection Threshold	V_{OVP}	V_{OUT} rising	+25℃	5.50	5.8	5.95	V
OVP Hysteresis			+25℃		100		mV
Leakage Current into FB Pin	I_{FB_LKG}	V_{FB} = 1.1V	Full		10	50	nA
Switching							
Switching Frequency	f_{SW}	V_{IN} = 3.7V	Full	1	1.2	1.35	MHz
Power Switch							
Low-side Switch On-Resistance	$R_{DS(ON)\_LS}$	V_{OUT} = 5.0V (TDFN)	+25℃		280	400	mΩ
		V_{OUT} = 5.0V (WLCSP)	+25℃		220	310	mΩ
		V_{OUT} = 3.3V (TDFN)	+25℃		340	480	mΩ
		V_{OUT} = 3.3V (WLCSP)	+25℃		290	390	mΩ
Rectifier On-Resistance	$R_{DS(ON)\_HS}$	V_{OUT} = 5.0V (TDFN)	+25℃		270	350	mΩ
		V_{OUT} = 5.0V (WLCSP)	+25℃		250	350	mΩ
		V_{OUT} = 3.3V (TDFN)	+25℃		350		mΩ
		V_{OUT} = 3.3V (WLCSP)	+25℃		330		mΩ
Current Limit Threshold	I_{LIM}	V_{OUT} > 2.5V, boost operation	+25℃	0.89	1.3	1.62	A
		V_{OUT} = 2.5V, boost operation	+25℃	0.57	0.8	1.06	A

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ELECTRICAL CHARACTERISTICS (continued)

(V_{IN} = 0.9V to 5.2V, C_{IN} = 10μF, C_{OUT} = 20μF, Full = -40℃ to +85℃, typical values are at V_{IN} = 3.7V, T_A = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
Control Logic							
EN Input Low Voltage Threshold	V_{IL}	V_{IN} ≤ 1.5V	Full			0.18 × V_{IN}	V
		V_{IN} > 1.5V	Full			0.4	V
EN Input High Voltage Threshold	V_{IH}	V_{IN} ≤ 1.5V	Full	0.8 × V_{IN}			V
		V_{IN} > 1.5V	Full	1.2			V
Leakage Current into EN Pin	I_{EN_LKG}	V_{EN} = 5.0V	+25℃			300	nA
Over-Temperature Protection					150		℃
Over-Temperature Hysteresis					25		℃

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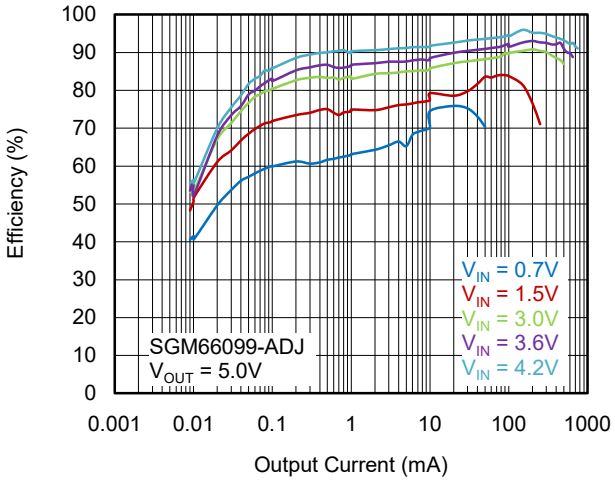
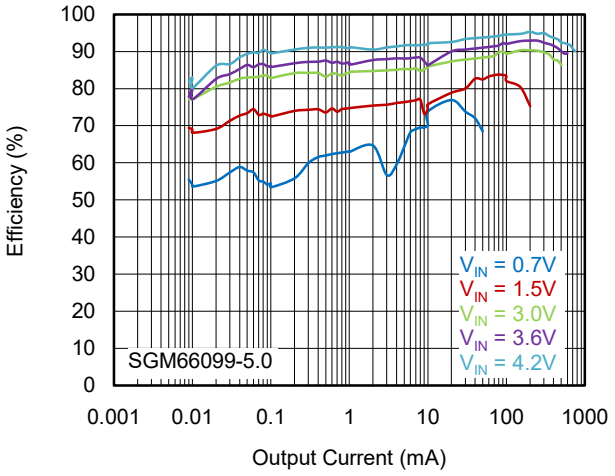
TYPICAL PERFORMANCE CHARACTERISTICS

T_A = +25℃, C_{IN} = 10μF, C_{OUT} = 20μF, unless otherwise noted.

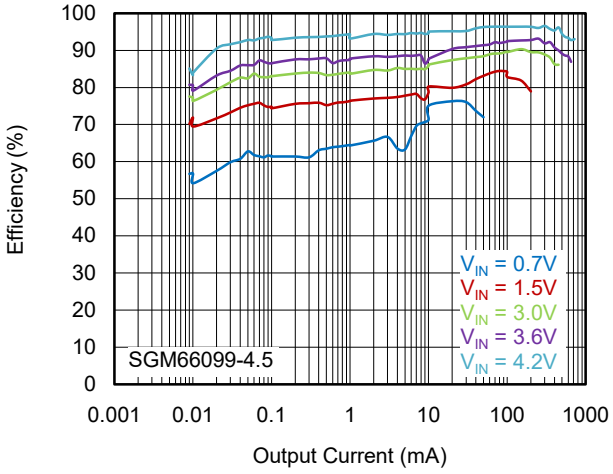
Load Efficiency with Different Inputs



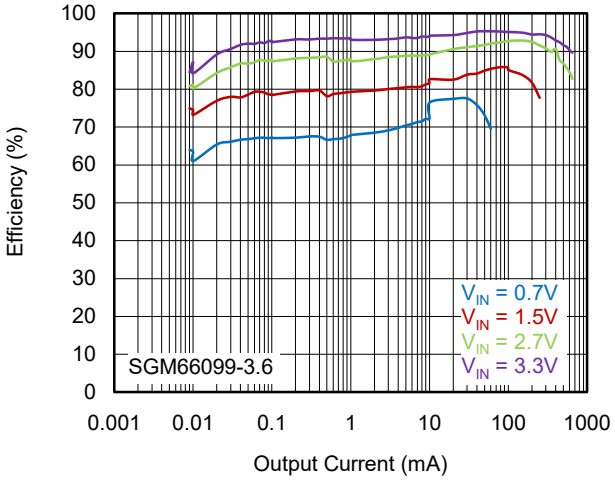
Load Efficiency with Different Inputs



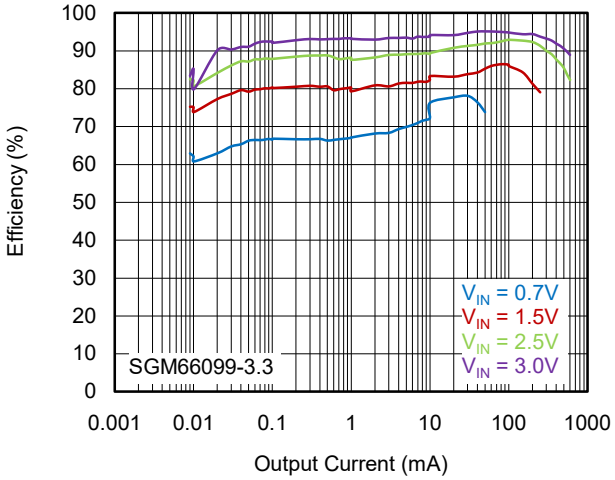
Load Efficiency with Different Inputs



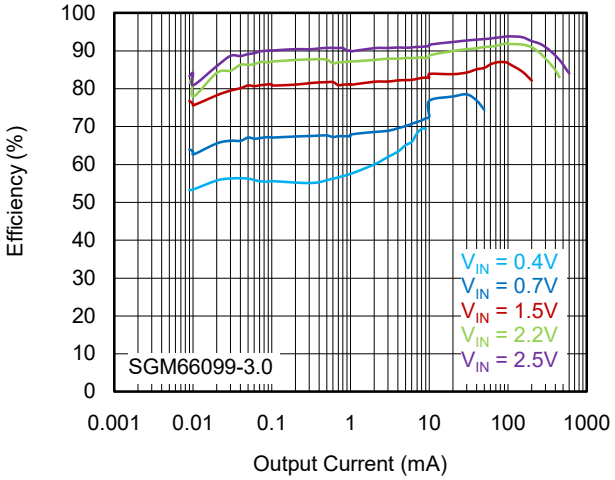
Load Efficiency with Different Inputs



Load Efficiency with Different Inputs



Load Efficiency with Different Inputs



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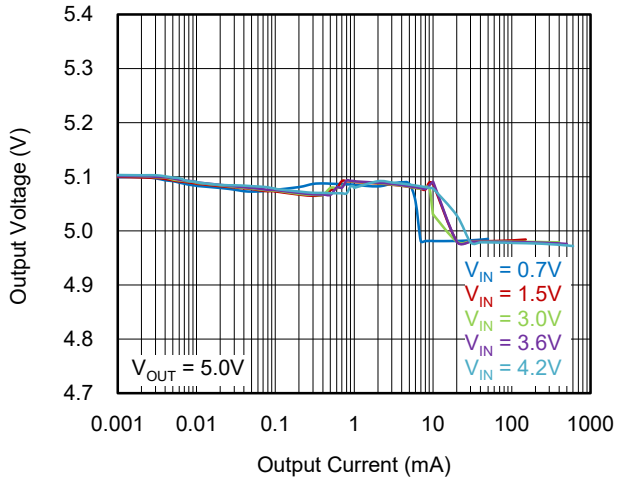
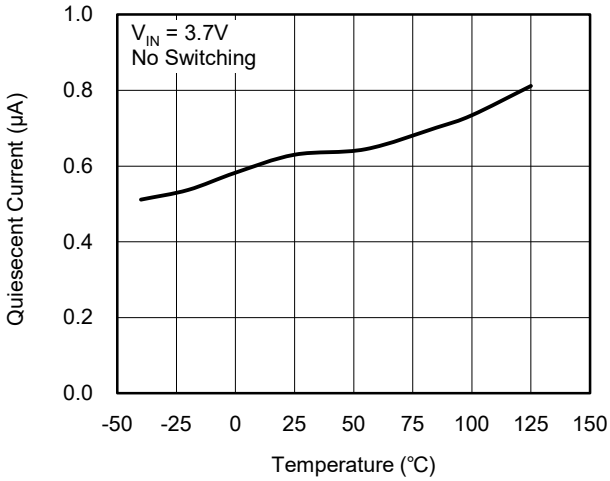
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_A = +25℃, C_{IN} = 10μF, C_{OUT} = 20μF, unless otherwise noted.

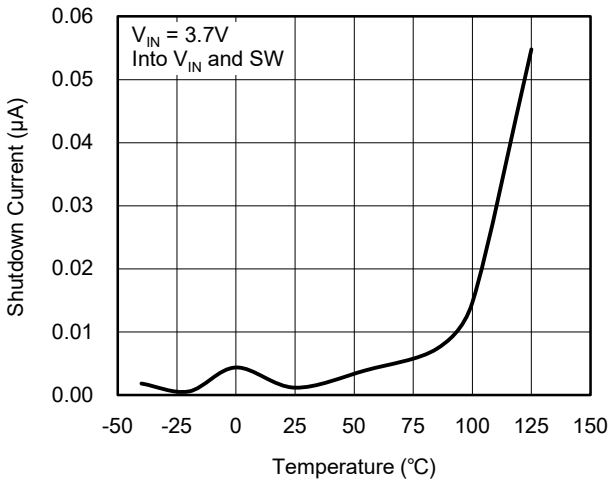
Load Regulation



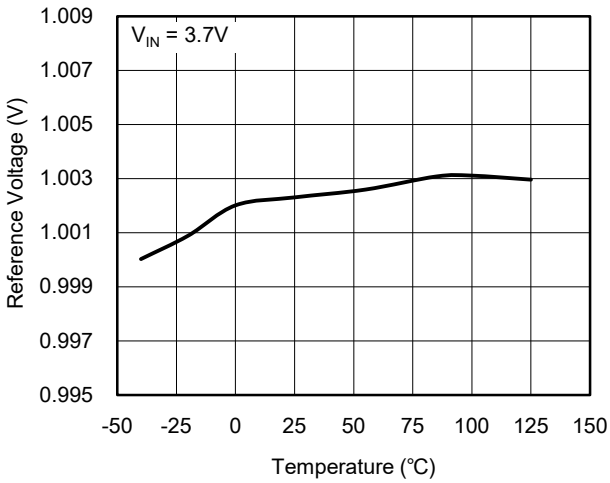
Quiescent Current into VOUT Pin vs. Temperature



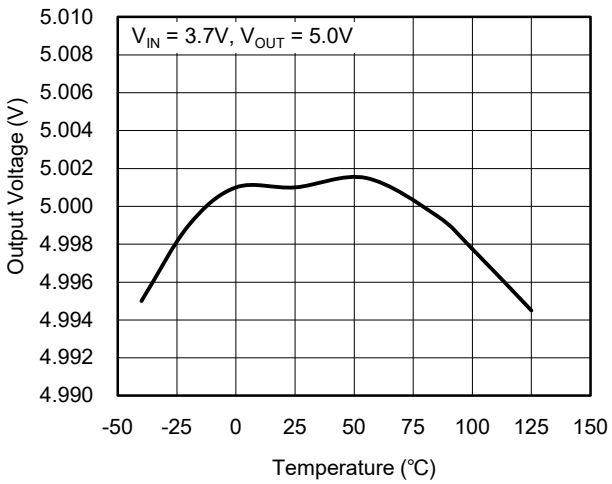
Shutdown Current vs. Temperature



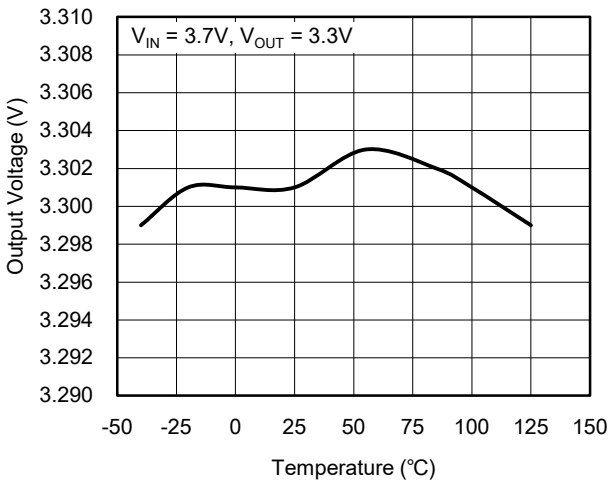
Reference Voltage vs. Temperature



Output Voltage vs. Temperature



Output Voltage vs. Temperature



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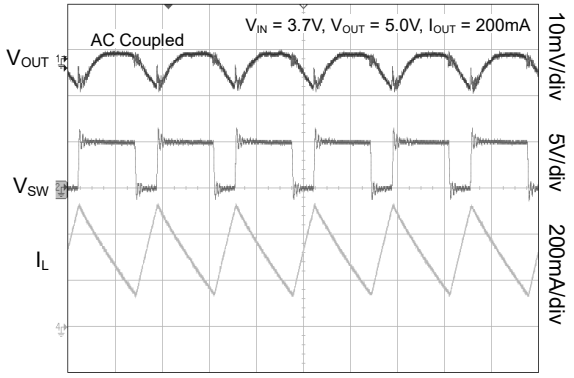
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

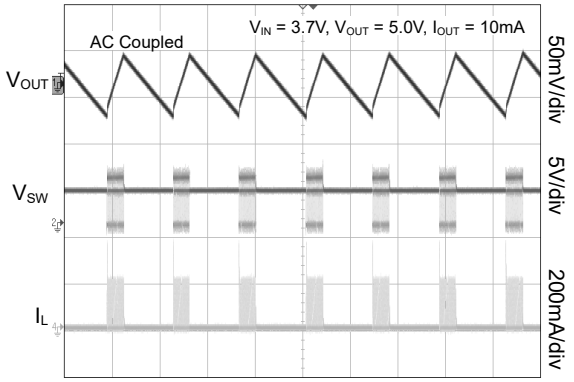
T_A = +25℃, C_{IN} = 10μF, C_{OUT} = 20μF, unless otherwise noted.

Switching Waveform at Heavy Load



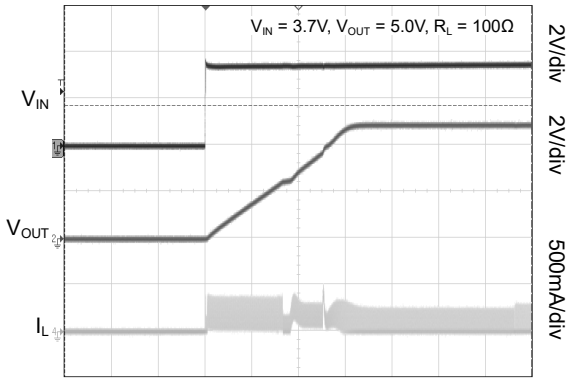
Time (500ns/div)

Switching Waveform at Light Load



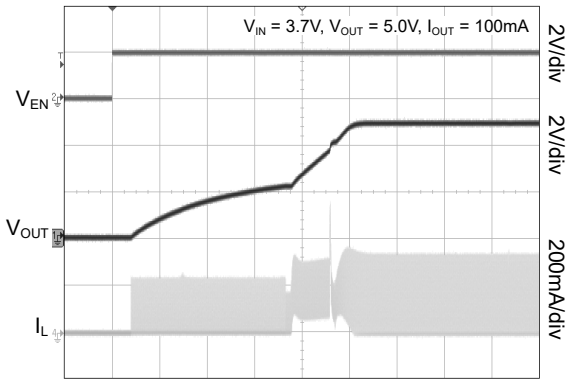
Time (50μs/div)

Startup by VIN Pin



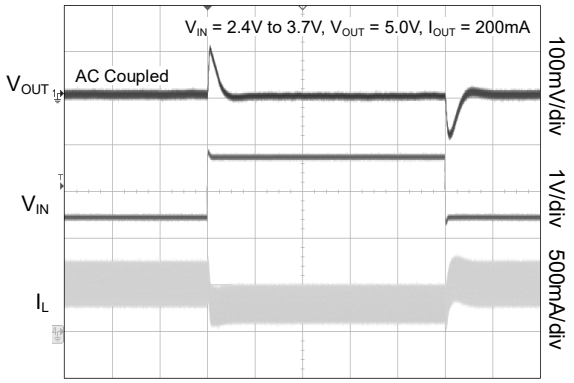
Time (500μs/div)

Startup by EN Pin



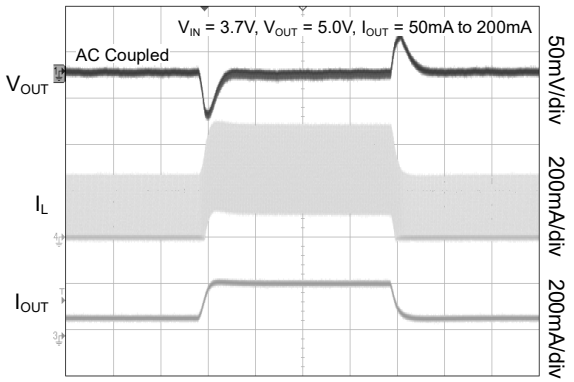
Time (500μs/div)

Line Transient Response



Time (200μs/div)

Load Transient Response



Time (200μs/div)

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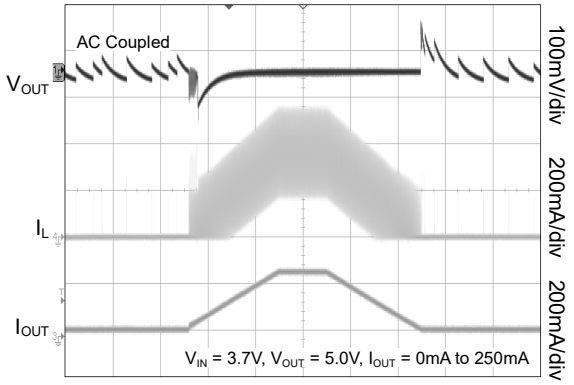
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

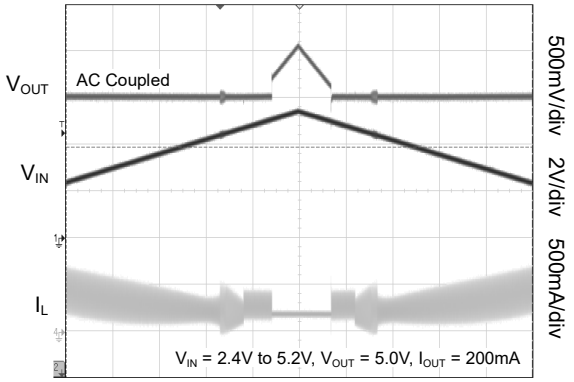
T_A = +25℃, C_{IN} = 10μF, C_{OUT} = 20μF, unless otherwise noted.

Load Regulation



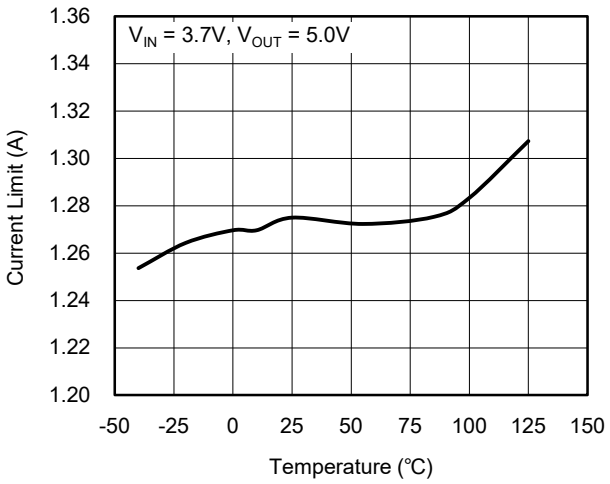
Time (50ms/div)

Line Regulation



Time (50ms/div)

Current Limit vs. Temperature



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FUNCTIONAL BLOCK DIAGRAM

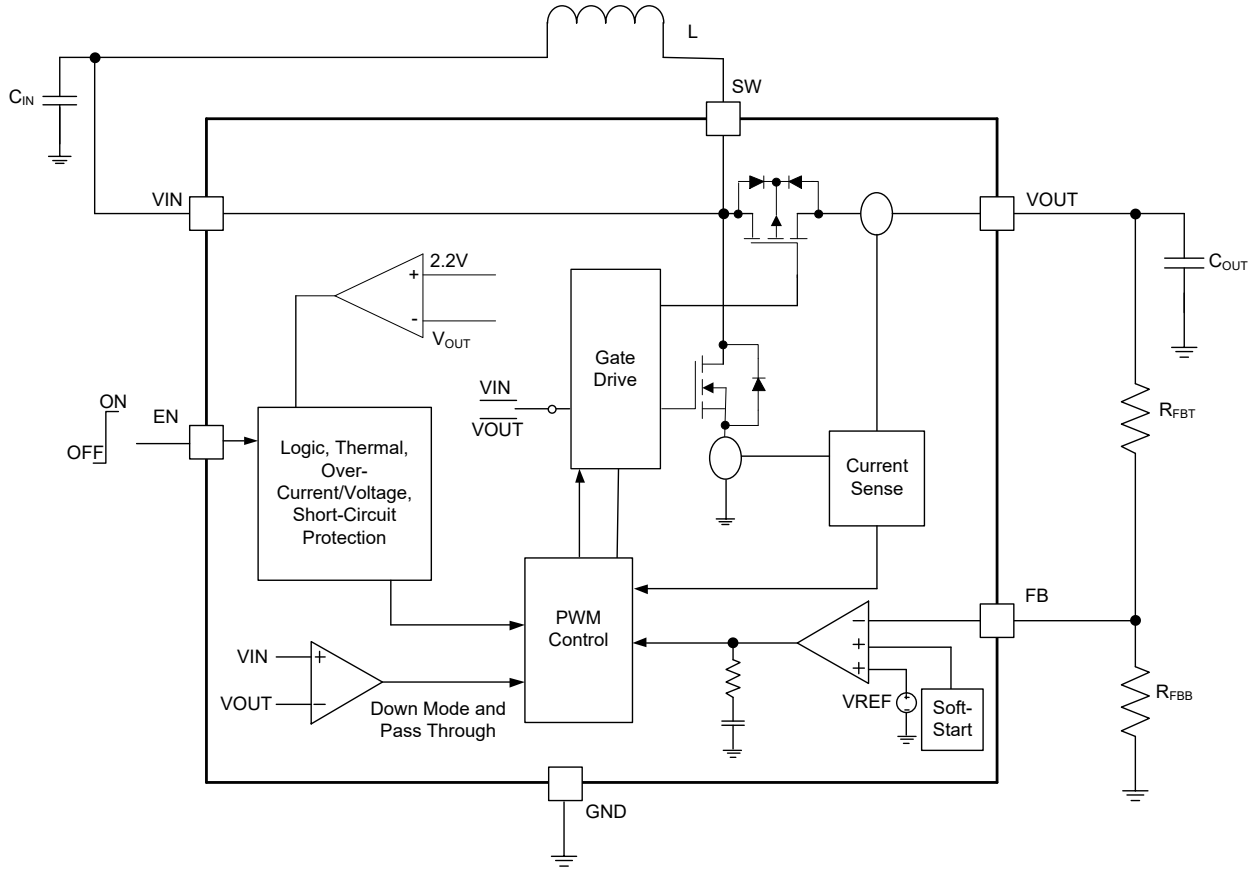

Figure 2. Block Diagram

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DETAILED DESCRIPTION

The SGM66099 synchronous boost converter is designed for Li-Ion battery powered systems, where the compact solution size and battery operation time are key criterions. The device employs peak current mode control with 1.3A (TYP) peak switch current limit. The SGM66099 is capable of disconnecting the output from input when the device is disabled to avoid unnecessary current consumption. The integrated down mode and pass-through mode ensure a smooth operation when input voltage is close to or higher than the set output voltage. The device is available in adjustable output voltage version.

Startup and Enable

Logic high on EN pin enables the SGM66099, while a logic low disables the device. During logic low state, the device stops operation, and the output voltage is completely disconnected from the input voltage. During logic low state, the shutdown current is less than 1μA

The SGM66099 is able to start up from 0.9V input voltage with larger than 3kΩ load. Before the output voltage reaches 2.2V during the startup phase, the switch current is limited to about 200mA. Therefore, if the load during startup is too heavy, the device will fail to charge the output voltage to above 2.2V after soft-start time expires, and it will not be able to start up successfully.

Over-Current and Short Circuit Protection

The SGM66099 implements cycle-by-cycle current limit during an over-current event. When the current limit threshold I_{LIM} is reached, the low-side power MOSFET is turned off to prevent the inductor current from further increase. During over-current event, the output voltage will drop until a constant power state is reached between input and output. If the current limit causes the output to drop below the input voltage, the SGM66099 enters down mode, where the peak current is still limited by I_{LIM} cycle-by-cycle. If the output continues dropping below 2.2V, the device enters startup process again.

During the output short-to-ground case, as output voltage declines below 2.2V, the SGM66099 reduces the current limit to about 200mA to reduce power dissipation within the device. As the short circuit condition is removed, the device resumes operation and goes through a soft-start sequence to regulate the set output voltage.

Over-Voltage Protection

SGM66099 integrates over-voltage protection (OVP) to protect the device in case of feedback resistor short-to-ground or incorrect feedback resistor value being populated. The SGM66099 stops switching when the OVP threshold of 5.8V (TYP) is reached. The device implements 100mV OVP hysteresis. When the output voltage is 100mV lower than the OVP threshold, the device resumes switching.

Power-Save Mode under Light Load Condition

SGM66099 enters power-save mode under light load condition.

Down Mode and Pass-Through Mode

SGM66099 offers down mode feature where the device can still regulate the set output voltage even when the input voltage is higher than output voltage. If the input voltage continues increasing in down mode, the device automatically enters pass-through mode. Care should be taken in pass-through mode, where the input voltage should not exceed the recommended maximum input voltage.

In down mode, the control logic pulls the gate of PMOS to the input voltage rather than ground. This method allows effective control of inductor current when V_{IN} > V_{OUT}. Thermal consideration should be taken in down mode, where the voltage drop across the PMOS increases as the delta of V_{IN} and V_{OUT} increases.

In pass-through mode, the complimentary switching action stops. The gate of PMOS is pulled to ground for always-on and the low-side switch remains off. The output voltage equals to the input voltage minus the voltage drop across the DC resistance (DCR) of the inductor and the on-resistance of the rectifying PMOS.

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DETAILED DESCRIPTION (continued)

The SGM66099 enters down mode when the input voltage is equal to or higher than V_{OUT} - 100mV. It remains in down mode until V_{IN} > V_{OUT} + 0.3V and then goes automatically into pass-through mode. In pass-through mode, the high-side PMOS is always turned on to pass the input voltage to the output. As V_{IN} drops below 1% above the target output voltage, the device exits pass-through mode and returns to down mode. The device exits down mode and returns to normal boost switching operation as V_{IN} drops 150mV below the target output voltage.

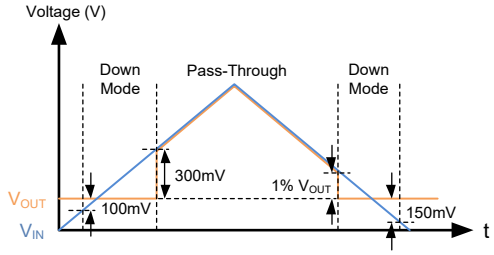

Figure 3. Down Mode and Pass-Through Mode

Thermal Shutdown

A thermal shutdown function is implemented to prevent damage caused by excessive heat and power dissipation. Once a junction temperature of +150℃ (TYP) is exceeded, the device is shut down. The device is released from shutdown automatically when the junction temperature decreases by 25℃.

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REVISION HISTORY

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

FEBRUARY 2021 – REV.A.4 to REV.B	Page
Updated FB pin function	4, 14

JUNE 2020 – REV.A.3 to REV.A.4	Page
Deleted Temperature Grade X	All

OCTOBER 2019 – REV.A.2 to REV.A.3	Page
Added RC circuit for EN pin and corresponding description	1, 12, 14, 15
Updated Typical Performance Characteristics	7

JULY 2019 – REV.A.1 to REV.A.2	Page
Added Temperature Grade X	All

APRIL 2019 – REV.A to REV.A.1	Page
Updated FB pin function	4, 13

Changes from Original (DECEMBER 2018) to REV.A	Page
Changed from product preview to production data	All

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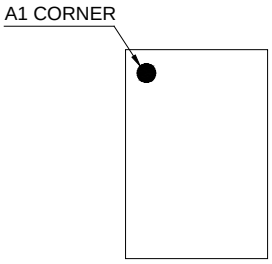
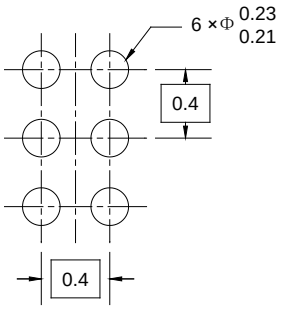
PACKAGE OUTLINE DIMENSIONS

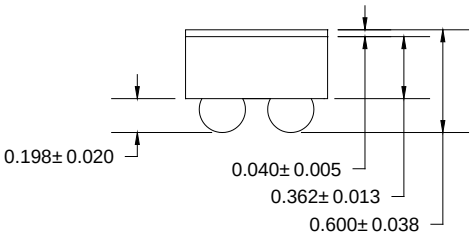
WLCSP-1.22×0.83-6B



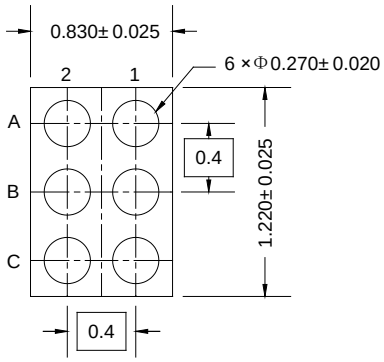
TOP VIEW



RECOMMENDED LAND PATTERN



SIDE VIEW



BOTTOM VIEW

NOTE: All linear dimensions are in millimeters.

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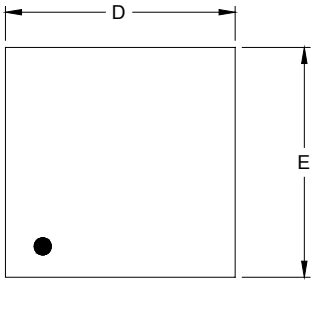
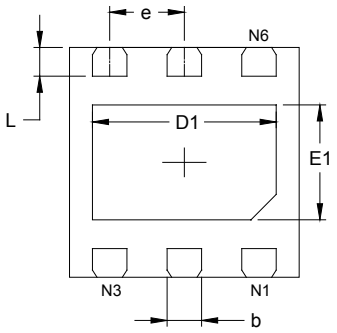
PACKAGE OUTLINE DIMENSIONS

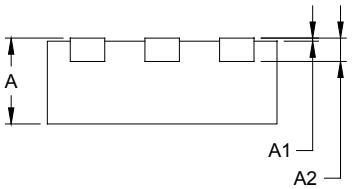
TDFN-2×2-6AL



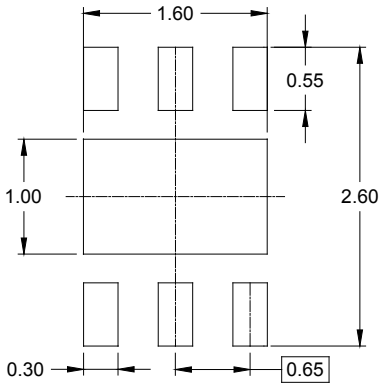
TOP VIEW



BOTTOM VIEW



SIDE VIEW



RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A2	0.203 REF		0.008 REF	
D	1.900	2.100	0.075	0.083
D1	1.500	1.700	0.059	0.067
E	1.900	2.100	0.075	0.083
E1	0.900	1.100	0.035	0.043
b	0.250	0.350	0.010	0.014
e	0.650 BSC		0.026 BSC	
L	0.174	0.326	0.007	0.013

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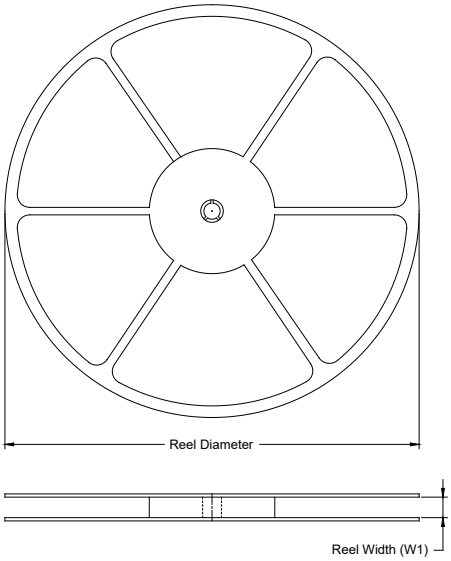
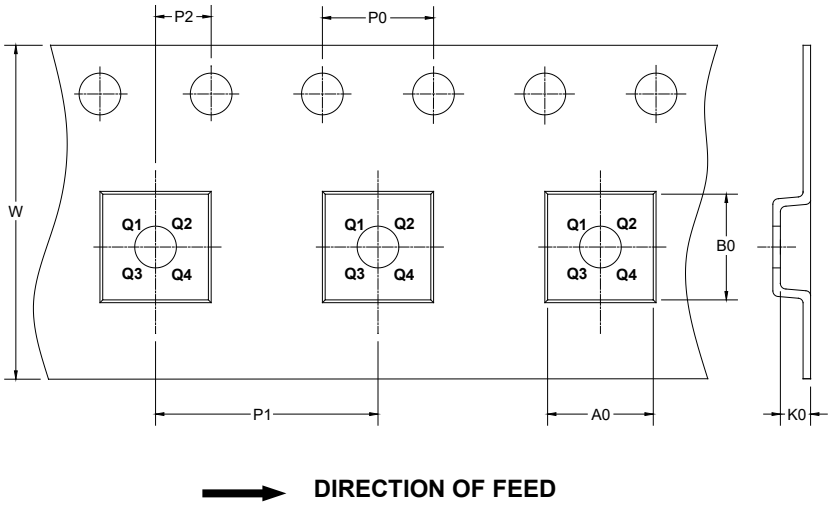
TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



DIRECTION OF FEED

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-1.22×0.83-6B	7″	9.5	0.91	1.31	0.71	4.0	4.0	2.0	8.0	Q1
TDFN-2×2-6AL	7″	9.5	2.30	2.30	1.10	4.0	4.0	2.0	8.0	Q1

DD0001

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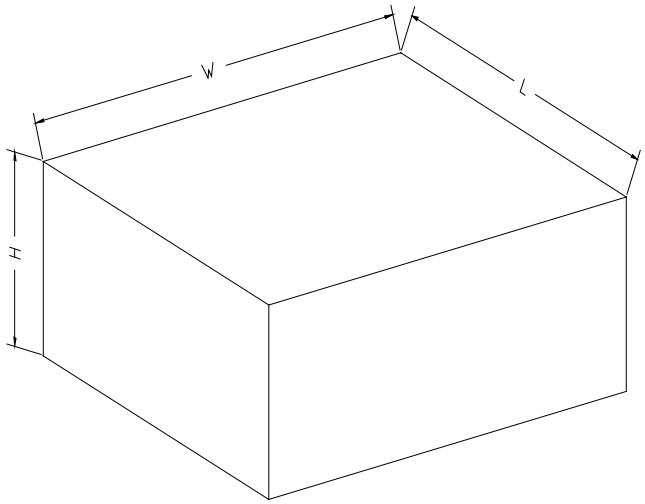
CARTON BOX DIMENSIONS



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

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单击下面可查看定价，库存，交付和生命周期等信息

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