SGM66024
5.2V Output, 990mA Valley Switch Current, 30μA I_Q Synchronous Boost Converter

GENERAL DESCRIPTION

The SGM66024 is a 990mA (TYP) valley current limit synchronous Boost converter capable of starting up from 2.16V, and operating down to 1.3V after startup. The device supports adjustable output voltage ranging from 2.7V to 5.2V.

The SGM66024 implements valley current mode control, and operates with 1.39MHz (TYP) switching frequency. At light load, the device automatically switches to PFM mode to improve overall system efficiency. The device implements proprietary architecture to consume 30μA (TYP) quiescent current into VOUT pin.

The SGM66024 implements true load disconnect feature which eliminates unnecessary current drawn when the device is disabled. Shutdown current is as low as 0.002μA (TYP) during shutdown to extend the input source operation time. The device also implements various protection features such as over-current protection, over-voltage protection, short-circuit protection and thermal shutdown.

The SGM66024 is available in a Green SOT-23-6 package.

FEATURES

- **Operation Input Voltage Range: 1.3V to 5.2V**
- **2.16V Minimal Startup V_{IN}**
- **Operation Output Voltage Range: 2.7V to 5.2V**
- **Integrated 437mΩ (LS), 566mΩ (HS) Power MOSFET**
- **990mA (TYP) Valley Current Limit**
- **> 96% Efficiency at 3V Input to 3.6V Output with 50mA**
- **30μA (TYP) Quiescent Current into V_{OUT}**
- **1.39MHz (TYP) Switching Frequency**
- **Auto PFM Mode in Light Load Operation**
- **True Load Disconnect**
- **Short-Circuit Protection**
- **Output Over-Current and Over-Voltage Protections**
- **Thermal Shutdown**
- **Available in a Green SOT-23-6 Package**

APPLICATIONS

LED Bias
System Bias
Bluetooth Bias

TYPICAL APPLICATION

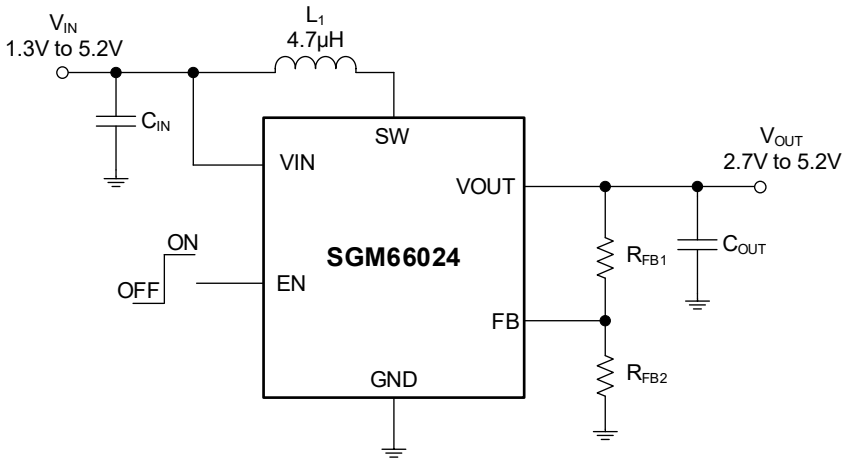


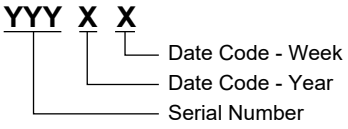
Figure 1. Typical Application Circuit

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM66024	SOT-23-6	-40℃ to +125℃	SGM66024XN6G/TR	08YXX	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

VIN, EN, SW, FB, VOUT Voltages ..... -0.3V to 6V
Package Thermal Resistance
SOT-23-6, θ_{JA} ..... 140.5℃/W
SOT-23-6, θ_{JB} ..... 32.6℃/W
SOT-23-6, θ_{JC} ..... 80.9℃/W
Junction Temperature ..... +150℃
Storage Temperature Range ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃
ESD Susceptibility
HBM 3000V
CDM 1000V

RECOMMENDED OPERATING CONDITIONS

Input Voltage Range ..... 1.3V to 5.2V
Operating Junction Temperature Range ..... -40℃ to +125℃

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.

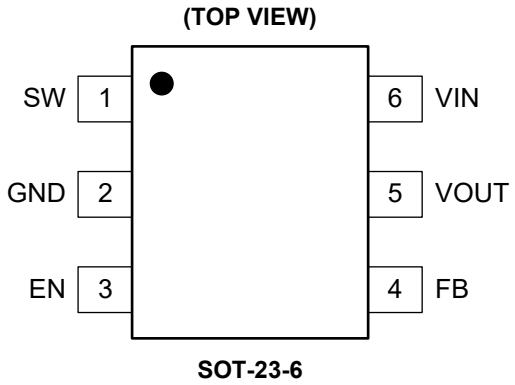
ESD SENSITIVITY CAUTION

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	Switch Node. Drain connection of low-side power FET.
2	GND	GND Node. Source connection of low-side power FET and control stage GND reference.
3	EN	Enable Input. Logic high to enable it and logic low to disable it. Do not leave this pin floating.
4	FB	Feedback Node. Connect a voltage divider from VOUT to this node.
5	VOUT	Output Voltage Node. Connect the load and output capacitors to this pin.
6	VIN	Input Voltage Node. Connect the input source and input capacitors to this pin.

ELECTRICAL CHARACTERISTICS

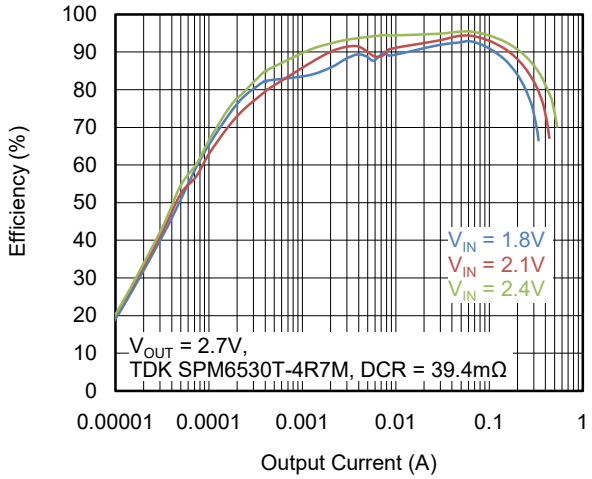
(V_{IN} = 3.0V, V_{OUT} = 3.6V, T_J = -40℃ to +125℃, typical values are at T_J = +25℃, unless otherwise noted.)

PARAMETER		SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage		V_{IN}		1.3		5.2	V
VIN Under-Voltage Lockout		V_{IN_UVLO}	V_{IN} rising, T_J = -40℃ to +85℃		1.70	2.11	V
			V_{IN} falling, T_J = -40℃ to +85℃		0.98	1.20	
VIN Under-Voltage Lockout		V_{IN_UVLO}	V_{IN} rising		1.70	2.16	V
			V_{IN} falling		0.98	1.30	
Quiescent Current	VIN Pin	I_Q	IC enabled, no load, no switching, V_{IN} = 2.2V to 5.2V, V_{FB} = V_{REF} + 0.1V, T_J = -40℃ to +85℃		1.2	6	μA
	VOUT Pin		IC enabled, no load, no switching, V_{OUT} = 2.7V to 5.2V, V_{FB} = V_{REF} + 0.1V, T_J = -40℃ to +85℃		30	74	
Shutdown Current		I_{SD}	IC disabled, V_{IN} = 1.8V, T_J = -40℃ to +85℃		0.002	0.3	μA
Output Voltage		V_{OUT}		2.7		5.2	V
Reference Voltage		V_{REF}		478	494	513	mV
Switching Frequency		f_{SW}		1.01	1.39	1.77	MHz
Low-side FET On-Resistance		R_{DSON_LS}			437		mΩ
High-side FET On-Resistance		R_{DSON_HS}			566		
Current Limit		I_{LIM}	Valley current limit	700	990	1290	mA
Soft-Start Time		t_{SS}	From EN to VOUT regulation, C_{OUT_EFF} = 6μF, no load		450		μs
EN Pin Input Threshold		V_{IH}	EN rising			1.20	V
		V_{IL}	EN falling, T_J = -40℃ to +85℃	0.40			
			EN falling	0.35			
Thermal Shutdown		T_{SD}	T_J rising		150		℃
Thermal Shutdown Hysteresis		T_{SD_HYS}	T_J falling below T_{SD}		20		℃

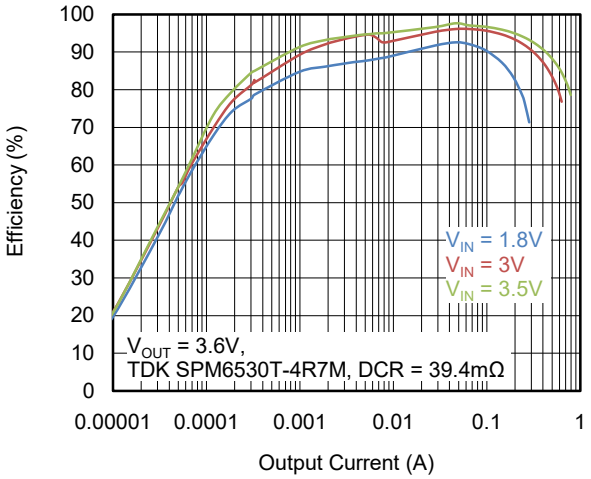
TYPICAL PERFORMANCE CHARACTERISTICS

At T_A = +25℃, V_{IN} = 3.0V and V_{OUT} = 3.6V, unless otherwise noted.

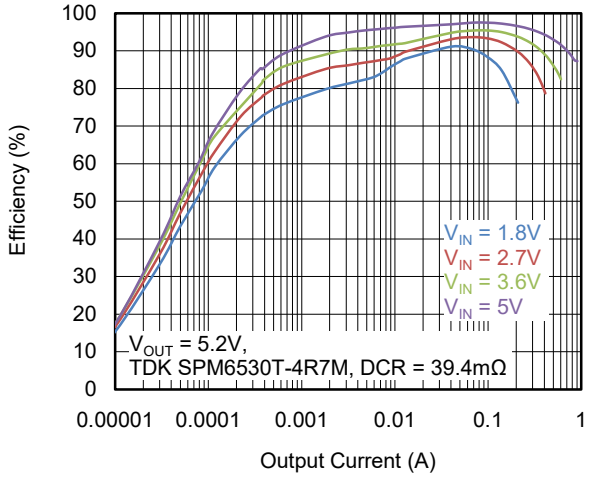
Efficiency vs. Output Current



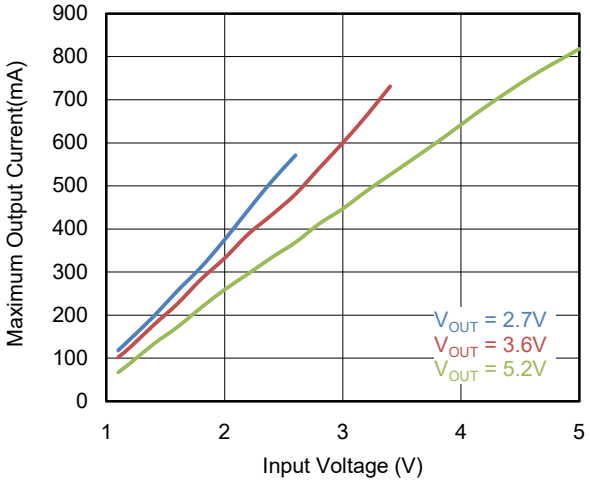
Efficiency vs. Output Current



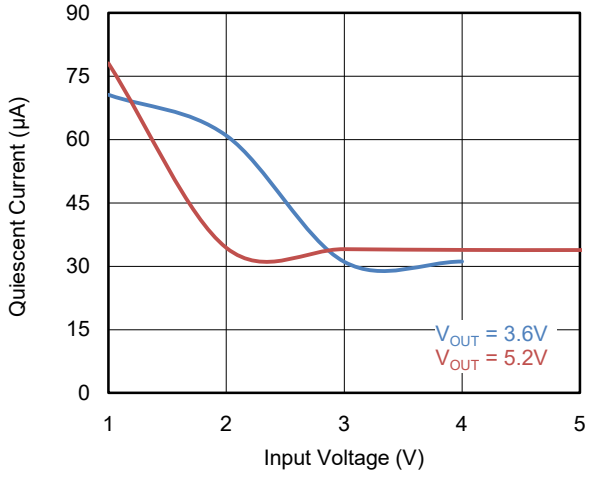
Efficiency vs. Output Current



Maximum Output Current vs. Input Voltage



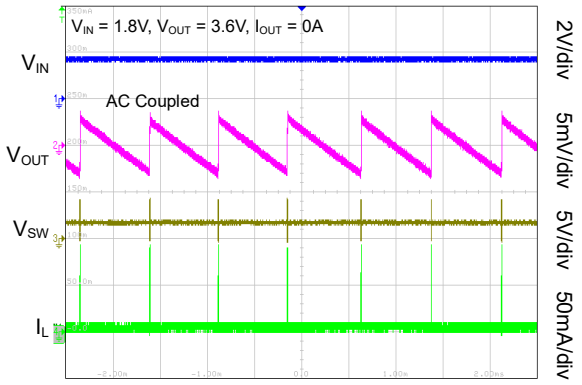
Quiescent Current into VOUT Pin vs. Input Voltage



TYPICAL PERFORMANCE CHARACTERISTICS (continued)

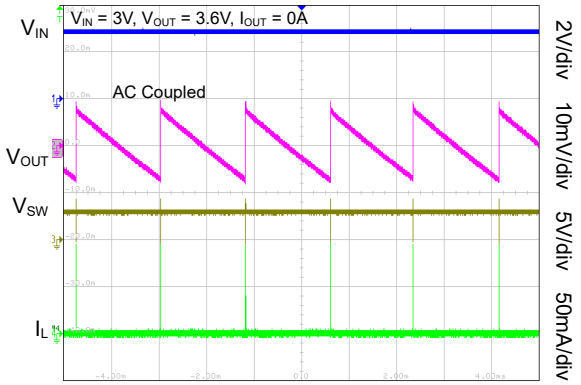
At T_A = +25℃, V_{IN} = 3.0V and V_{OUT} = 3.6V, unless otherwise noted.

Output Voltage Ripple at Light Load



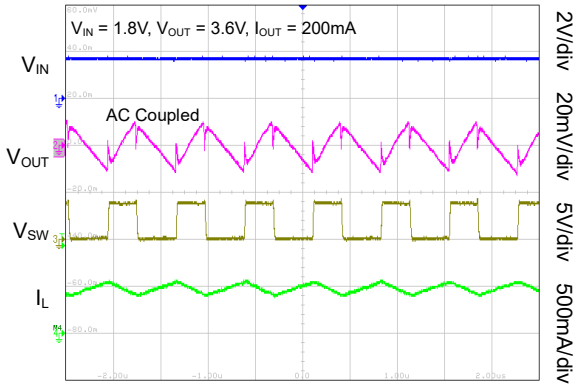
Time (500μs/div)

Output Voltage Ripple at Light Load



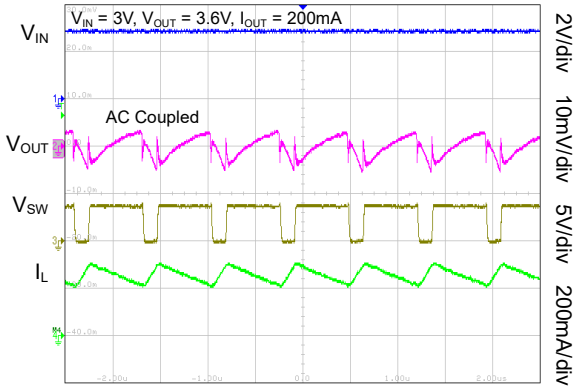
Time (1ms/div)

Output Voltage Ripple at Heavy Load



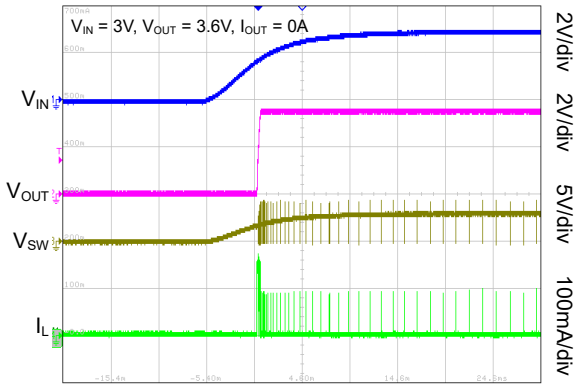
Time (500ns/div)

Output Voltage Ripple at Heavy Load



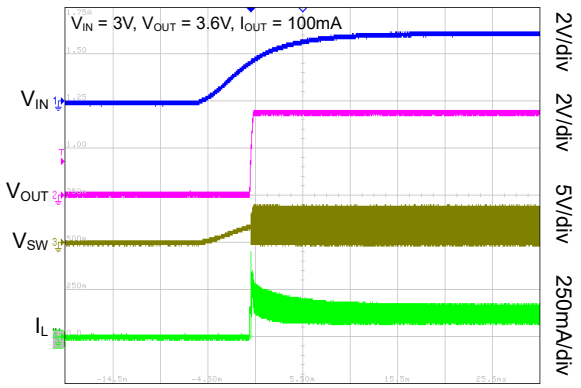
Time (500ns/div)

VIN Power On



Time (5ms/div)

VIN Power On

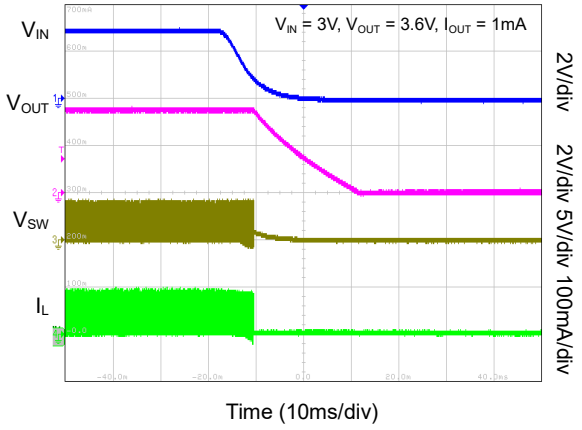


Time (5ms/div)

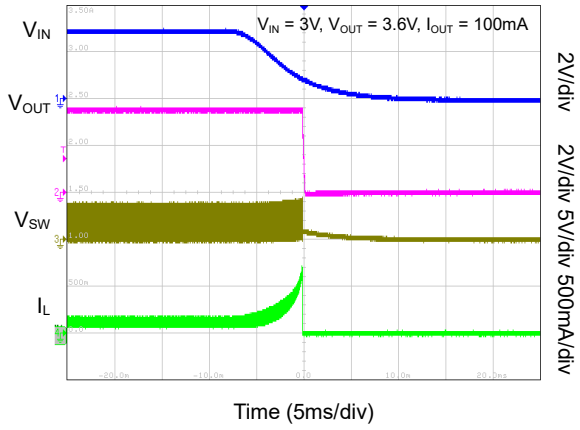
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_{IN} = 3.0V and V_{OUT} = 3.6V, unless otherwise noted.

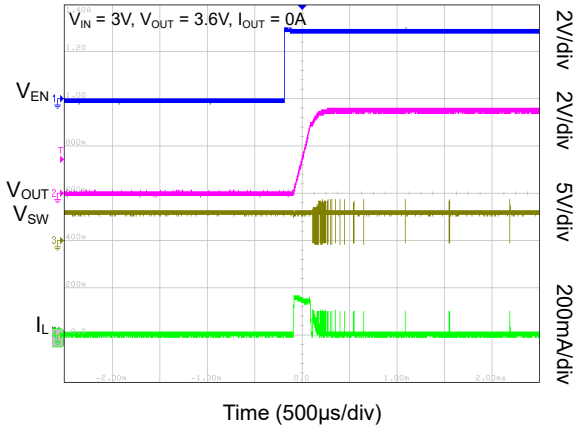
VIN Power Off



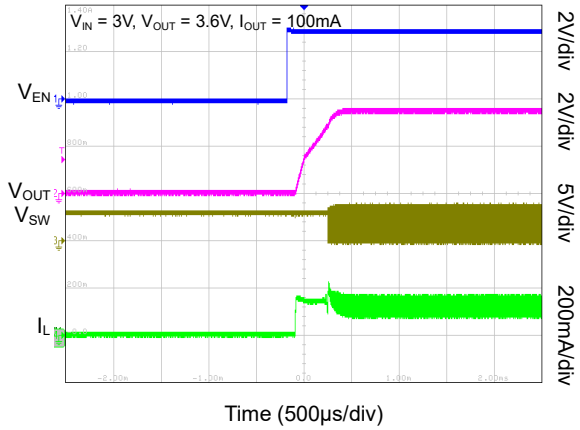
VIN Power Off



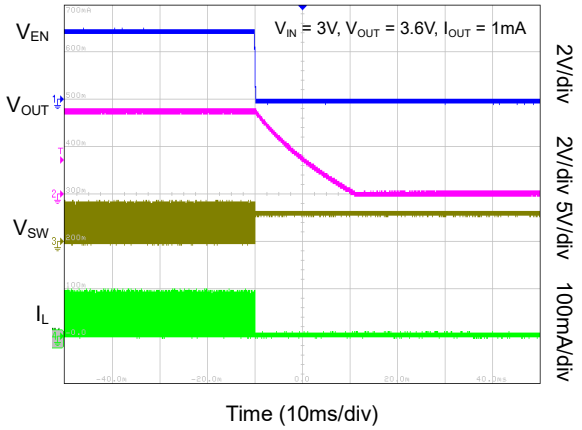
EN Startup



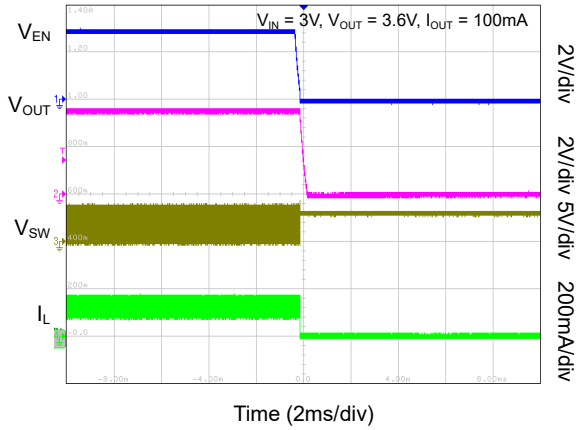
EN Startup



EN Shutdown



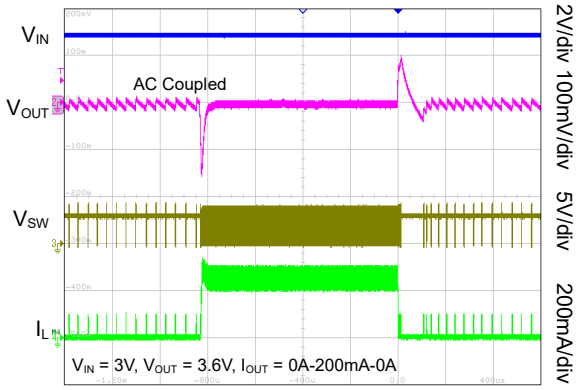
EN Shutdown



TYPICAL PERFORMANCE CHARACTERISTICS (continued)

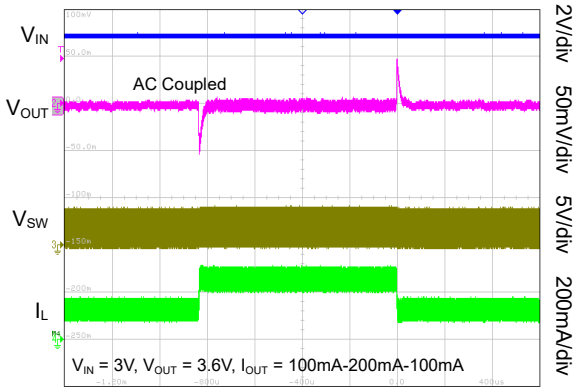
At T_A = +25℃, V_{IN} = 3.0V and V_{OUT} = 3.6V, unless otherwise noted.

Load Transient



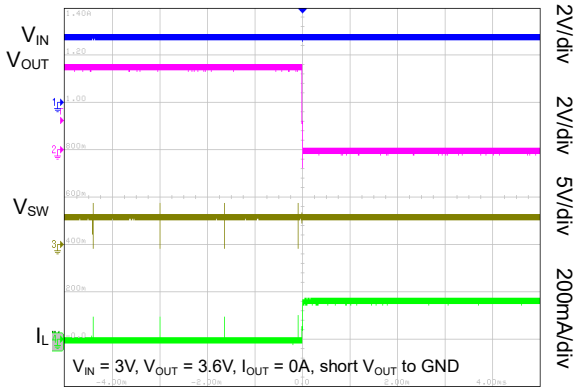
Time (200μs/div)

Load Transient



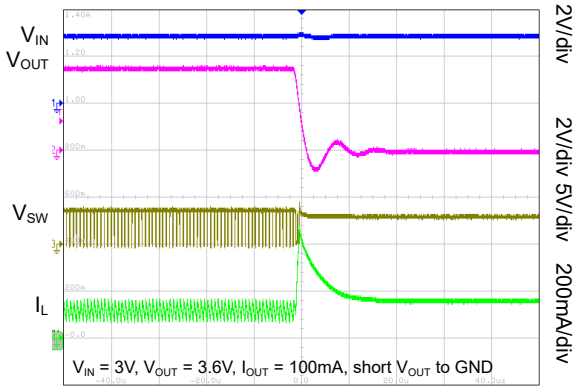
Time (200μs/div)

Short-Circuit Protection Entry



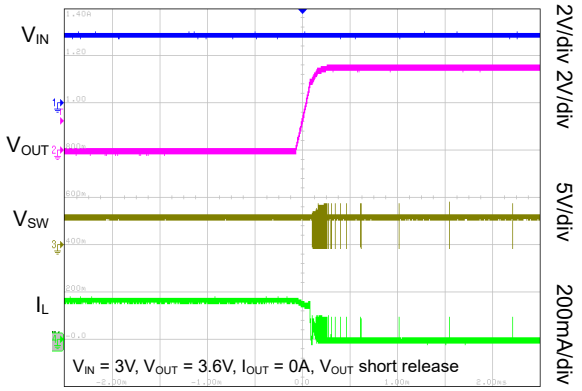
Time (1ms/div)

Short-Circuit Protection Entry



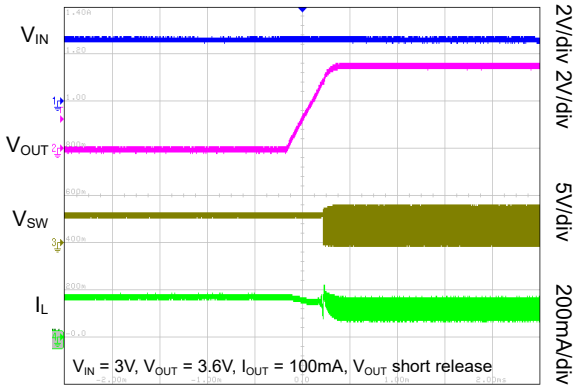
Time (10μs/div)

Short-Circuit Protection Recovery



Time (500μs/div)

Short-Circuit Protection Recovery



Time (500μs/div)

FUNCTIONAL BLOCK DIAGRAM

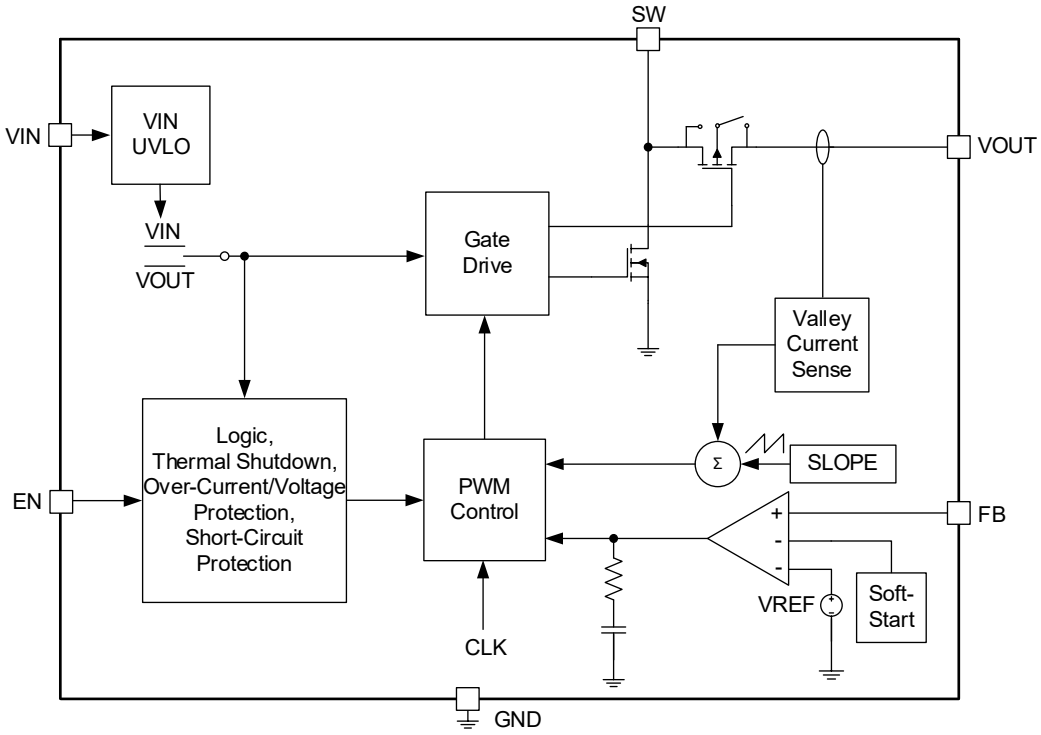


Figure 2. Block Diagram

DETAILED DESCRIPTION

Overview

The SGM66024 is a fully-integrated synchronous Boost DC/DC converter with fixed frequency valley current mode control scheme, which supports output voltage up to 5.2V with 990mA valley current limit. It is capable of starting up from 2.16V input voltage and operating down to 1.3V input after startup. True load disconnect is realized when the device shuts down with 0.002μA (TYP) current consumed in shutdown mode.

Input Under-Voltage Lockout (UVLO)

An input under-voltage lockout feature is implemented to stop the operation of the device when the input voltage is lower than 0.98V (TYP). A hysteresis is applied to make sure that the device cannot be turned on again unless the input voltage rises above 1.70V (TYP).

Device Enable

The SGM66024 implements the EN pin to control the turn-on and turn-off of the device. A logic signal above 1.20V applied on EN pin turns on the device, and a logic signal below 0.35V turns off the device.

Soft-Start

When the input voltage is valid, and EN pin is toggled to logic high, the device enters pre-charge phase with a limited current of 180mA (TYP) to charge the output capacitors. As the output voltage reaches the input voltage, the SGM66024 starts switching to boost the output voltage and the pre-charge phase is terminated. The soft-start sequence reduces the inrush current during startup.

Device Shutdown

The SGM66024 enters shutdown mode when EN pin is pulled low or the input voltage is lower than the UVLO threshold. True load disconnect is implemented to minimize the shutdown current.

Over-Current Protection

The SGM66024 has a built-in 990mA (TYP) valley current limit. If an overload occurs, the inductor valley current will be clamped to the valley current limit. Under this condition, the output voltage of SGM66024 will be decreased to maintain a constant power operation.

Over-Voltage Protection

SGM66024 integrates over-voltage protection (OVP) to protect the device in the event of feedback resistor short-to-ground or the feedback resistor value is incorrect. The SGM66024 stops switching when the OVP threshold of 5.5V (TYP) is reached. When the output voltage is 300mV (TYP) lower than the OVP threshold, the device resumes switching.

Short-Circuit Protection

If the load current further increases and the output voltage drops below the input voltage, the SGM66024 will enter into short-circuit protection. The output current will be limited to 180mA (TYP) and switching will be stopped to protect the device. Once the short-circuit condition disappears, the SGM66024 will be restarted automatically through the soft-start procedure.

Thermal Shutdown

To protect the device from overheating damage, thermal protection is included in the device. If the junction temperature exceeds the thermal shutdown threshold, the device will stop switching. When the device temperature drops below the threshold minus hysteresis, the switching will be resumed automatically.

APPLICATION INFORMATION

Output Voltage Configuration

The SGM66024 supports output voltage up to 5.2V, and a resistor divider connected to the FB pin is used to configure the output voltage. The resistive divider value is calculated via Equation 1.

$$\frac{V_{OUT} - V_{FB}}{R_{FB1}} = \frac{V_{FB}}{R_{FB2}} \quad (1)$$

For simplicity, 100kΩ is recommended for R_{FB2}. A 620kΩ resistor for R_{FB1} configures the output voltage to 3.6V. A lower value of R_{FB1} and R_{FB2} increases the noise immunity. A higher value of R_{FB1} and R_{FB2} reduces the quiescent current which can benefit the light load efficiency.

Inductor Selection

Inductor is an essential element for current DC/DC switch mode power supplies regardless of topology. Inductor serves as the energy storage element for power conversion. Inductance and saturation current of inductor are two most important criterions for inductor selection. For general design guidance, the selected inductance should provide a peak-to-peak ripple current that is around 30% of the average inductor current at full load and nominal input voltage. The average inductor current for a Boost converter is the input current. Equation 2 shows the calculation of inductance selection, where f_{SW} is the switching frequency and ΔI_L is the inductor ripple current.

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

The 990mA (TYP) valley current limit and the inductor current ripple should be considered when selecting the saturation current of the inductor.

The inductor also affects the close loop response of the DC/DC converter. The SGM66024 is an internally compensated device, and the loop response is optimized for inductor in the range of 2.2μH to 10μH.

Input Capacitor Selection

The input capacitor of Boost converter has continuous current throughout the entire switching cycle and a 10μF ceramic capacitor is recommended to place as close as possible between the VIN pin and GND pin. For applications where the SGM66024 is located far away from the input source, a 47μF or higher capacitance capacitor is recommended to damp the wiring harness inductance.

Output Capacitor Selection

The output capacitors of Boost converter dictate the output voltage ripple and load transient response. Equation 3 is used to estimate the necessary capacitance to achieve desired output voltage ripple, where ΔV is the maximum allowed ripple.

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

Since SGM66024 is an internally compensated device, the loop response is optimized for capacitor in the range of 4.7μF to 22μF. Due to the DC bias nature of ceramic capacitors, care should be taken by verifying manufacturer's datasheet to ensure enough effective capacitance at desired output voltage.

APPLICATION INFORMATION (continued)

Layout Considerations

In addition to component selection, layout is a critical step to ensure the performance of any switch mode power supplies. Poor layout could result in system instability, EMI failure, and device damage. Thus, place the inductor, input and output capacitors as close to the IC as possible, and use wide and short traces for current carrying traces to minimize PCB inductance. For Boost converter, the current loop of the output capacitor from VOUT pin back to the GND pin of the device should be as small as possible.

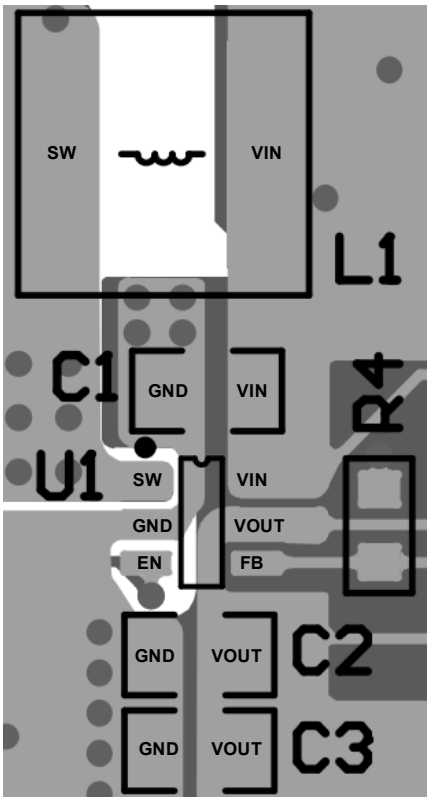


Figure 3. Layout Example

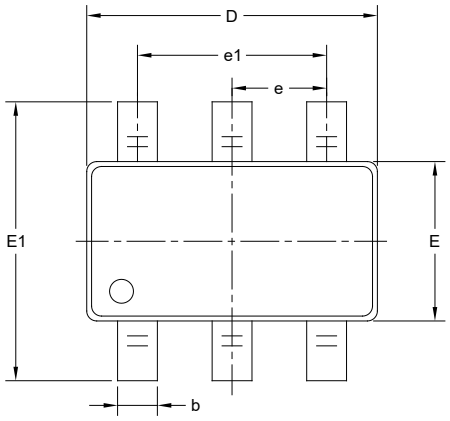
REVISION HISTORY

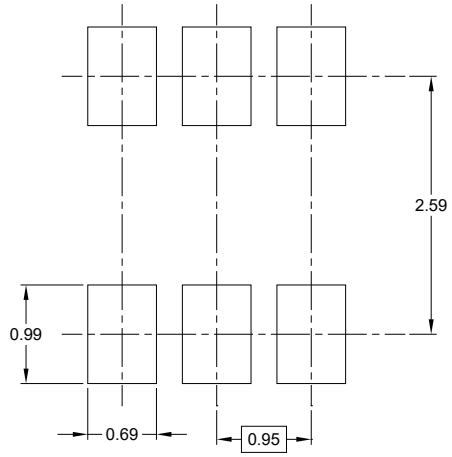
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (MAY 2024) to REV.A	Page
Changed from product preview to production data	All

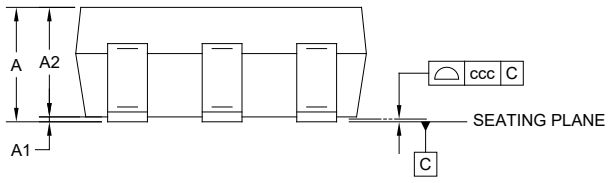
PACKAGE OUTLINE DIMENSIONS

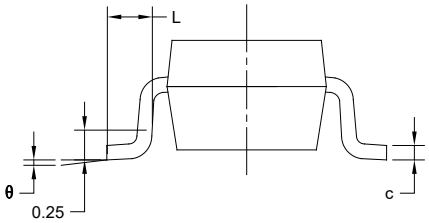
SOT-23-6





RECOMMENDED LAND PATTERN (Unit: mm)



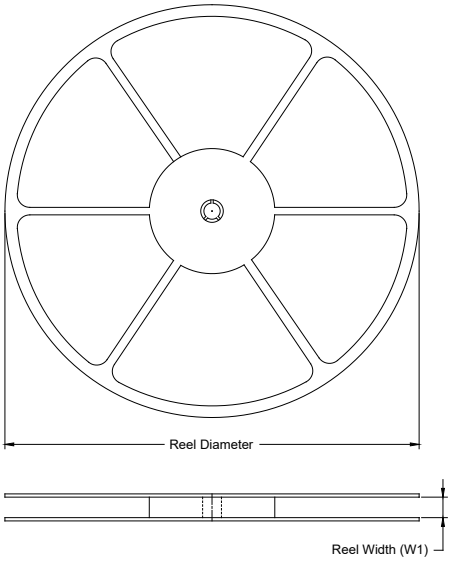


Symbol	Dimensions In Millimeters		
	MIN	MOD	MAX
A	-	-	1.450
A1	0.000	-	0.150
A2	0.900	-	1.300
b	0.300	-	0.500
c	0.080	-	0.220
D	2.750	-	3.050
E	1.450	-	1.750
E1	2.600	-	3.000
e	0.950 BSC		
e1	1.900 BSC		
L	0.300	-	0.600
θ	0°	-	8°
ccc	0.100		

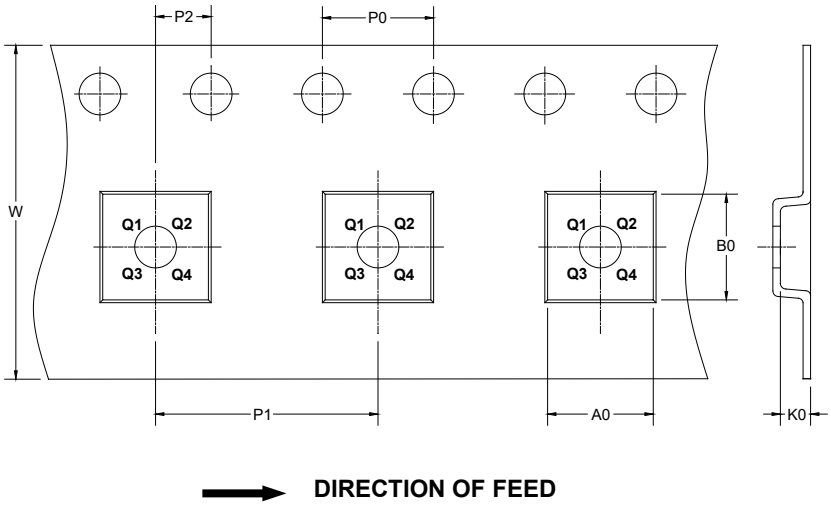
NOTES:
1. This drawing is subject to change without notice.
2. The dimensions do not include mold flashes, protrusions or gate burrs.
3. Reference JEDEC MO-178.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



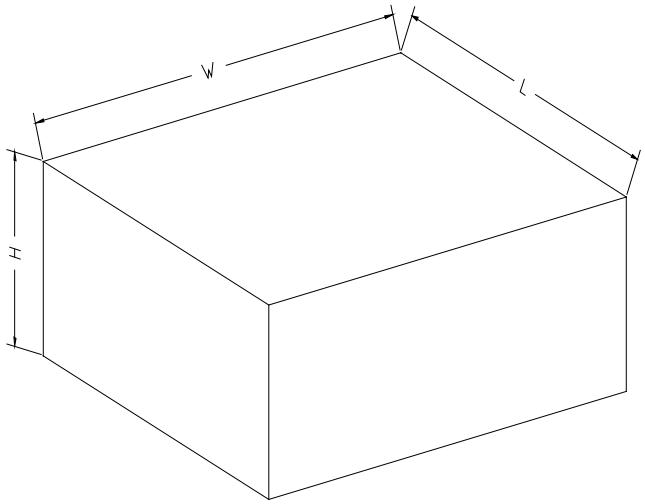
NOTE: The picture is only for reference. Please make the object as the standard.

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	3.23	3.17	1.37	4.0	4.0	2.0	8.0	Q3

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