# SGM2590/SGM2590D
# Power Distribution Switches

## GENERAL DESCRIPTION

The SGM2590 and SGM2590D are single channel power distribution switches. The switch is controlled by the EN pin and operates from 2.5V to 6V supply voltage. It can be used in USB power distribution applications.

The SGM2590 and SGM2590D integrate programmable current limit to protect the upstream power supply from damage during over-current or short-circuit condition. It also has the function of over-temperature protection.

The device is designed with soft-start circuit to cope with inrush currents when large capacitive loads are connected.

The SGM2590D further reduces the total solution size by integrating a 47Ω pull-down resistor for output discharge when the switch is shut down by EN.

SGM2590 and SGM2590D are available in a Green SOT-23-5 package.

## APPLICATIONS

General Purpose Power Switching
USB Bus/Self-Powered Hub
USB Peripheral
ACPI Power Distribution
Smart Phone
LCD TV

## FEATURES

- **High-side N-MOSFET**
- **On-Resistance: 65mΩ (TYP)**
- **Programmable Current Limit Range: 0.1A to 3A**
  **1.5A at $R_{ILIM}$ = 4.53kΩ**
- **Input Voltage Range: 2.5V to 6V**
- **Quiescent Current: 27μA (TYP)**
- **Shutdown Current: 0.28μA (TYP)**
- **Soft-Start Function**
- **Over-Temperature Protection**
- **Under-Voltage Lockout Protection for VIN**
- **No Reversed Leakage Current (Reverse Blocking)**
- **Quick Output Discharge (SGM2590D Only)**
- **1.2MΩ Pull-Down Resistor at EN Pin**
- **Available in a Green SOT-23-5 Package**

## TYPICAL APPLICATION

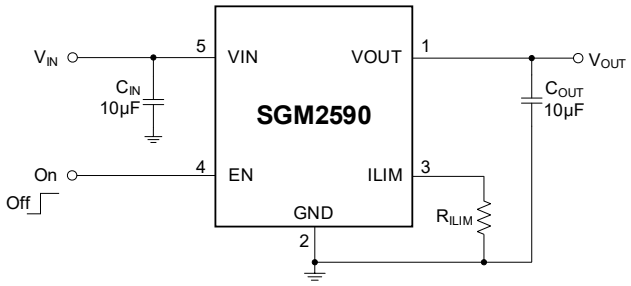


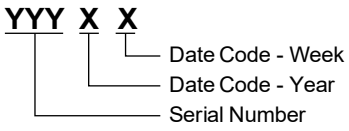

**Figure 1. Typical Application Circuit**

# PACKAGE/ORDERING INFORMATION

| MODEL | PACKAGE DESCRIPTION | SPECIFIED TEMPERATURE RANGE | ORDERING NUMBER | PACKAGE MARKING | PACKING OPTION |
|---|---|---|---|---|---|
| SGM2590 | SOT-23-5 | -40℃ to +125℃ | SGM2590XN5G/TR | 0FDXX | Tape and Reel, 3000 |
| SGM2590D | SOT-23-5 | -40℃ to +125℃ | SGM2590DXN5G/TR | 0EWXX | 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 ..... 6.5V
All Other Pins ..... 6V
Package Thermal Resistance
SOT-23-5, $\theta_{JA}$ ..... 190℃/W
SOT-23-5, $\theta_{JC}$ ..... 91℃/W
Junction Temperature ..... +150℃
Storage Temperature Range ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃
ESD Susceptibility
HBM ..... 2000V
CDM ..... 1000V

## RECOMMENDED OPERATING CONDITIONS

Input Voltage Range ..... 2.5V to 6V
EN Voltage Range ..... -0.3V to 5.5V
All Other Pins ..... 0V to 5.5V
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.

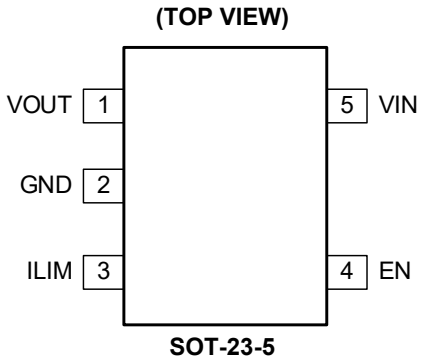
## ESD SENSITIVITY CAUTION

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 | VOUT | Output Voltage. |
| 2 | GND | Ground. |
| 3 | ILIM | Current Limit Programming Pin. Connect a resistor $R_{ILIM}$ from this pin to GND to set the overload current limit threshold: $I_{LIM} = \frac{6612}{R_{ILIM}^{0.982}}$ (A) If the ILIM pin is connected to GND directly, the current limit function is not available. |
| 4 | EN | Chip Enable. Active-high for SGM2590 and SGM2590D. They have integrated a 1.2MΩ pull-down resistor at this pin. |
| 5 | VIN | Power Input Voltage. |

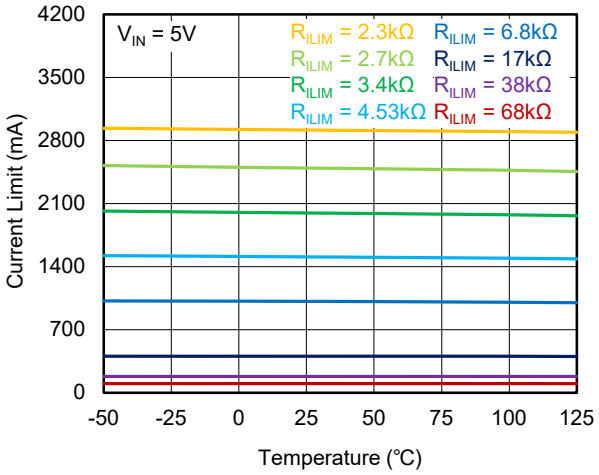
## ELECTRICAL CHARACTERISTICS

($T_J$ = -40℃ to +125℃, typical values are at $T_J$ = +25℃, $V_{IN}$ = 5V, unless otherwise noted.)

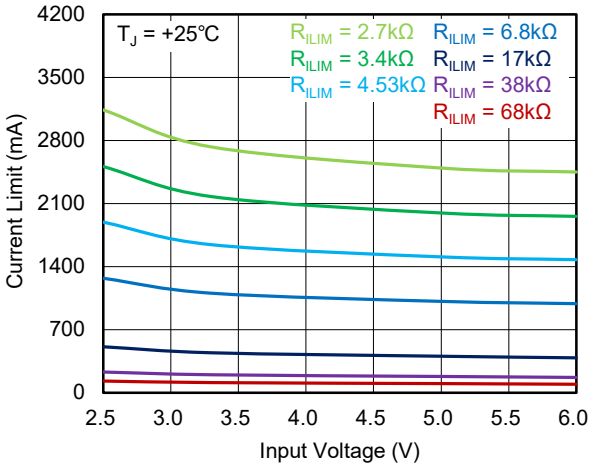
| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Input Voltage Range | $V_{IN}$ | | 2.5 | | 6 | V |
| Under-Voltage Lockout Threshold | $V_{UVLO}$ | $V_{IN}$ rising | | 2.23 | 2.40 | V |
| Under-Voltage Lockout Threshold Hysteresis | $V_{UVLO\_HYS}$ | $V_{IN}$ falling | | 100 | | mV |
| Quiescent Current | $I_Q$ | Switch on, $V_{OUT}$ = open | | 27 | 60 | μA |
| Shutdown Current | $I_{SD}$ | Switch off, $V_{OUT}$ = open | | 0.28 | 5 | μA |
| Output Leakage Current | $I_{LEAKAGE}$ | Switch off, $V_{OUT}$ = 6V, $V_{IN}$ = 0V, $T_J$ = -40℃ to +85℃ | | 0.21 | 1.5 | μA |
| | | Switch off, $V_{OUT}$ = 6V, $V_{IN}$ = 0V, $T_J$ = -40℃ to +125℃ | | 0.21 | 6 | |
| Enable Input Threshold | $V_{IH}$ | | 1.2 | | | V |
| | $V_{IL}$ | $T_J$ = -40℃ to +85℃ | | | 0.4 | |
| | | $T_J$ = -40℃ to +125℃ | | | 0.3 | |
| Pull-Down Resistor at EN Pin | $R_{PULL\_DOWN}$ | | | 1.2 | | MΩ |
| On-Resistance | $R_{DSON}$ | $I_{OUT}$ = 200mA, $T_J$ = -40℃ to +85℃ | | 65 | 98 | mΩ |
| | | $I_{OUT}$ = 200mA, $T_J$ = -40℃ to +125℃ | | 65 | 125 | |
| Output Turn-On Delay Time | $t_{ON}$ | $R_L$ = 100Ω, $C_{OUT}$ = 0.1μF | | 1.1 | | ms |
| Output Turn-Off Delay Time | $t_{OFF}$ | $R_L$ = 100Ω, $C_{OUT}$ = 0.1μF, SGM2590 | | 32 | | μs |
| | | $R_L$ = 100Ω, $C_{OUT}$ = 0.1μF, SGM2590D | | 27 | | |
| Output Turn-On Rise Time | $t_R$ | $R_L$ = 100Ω, $C_{OUT}$ = 0.1μF | | 1.3 | | ms |
| Output Turn-Off Fall Time | $t_F$ | $R_L$ = 100Ω, $C_{OUT}$ = 0.1μF, SGM2590 | | 27 | | μs |
| | | $R_L$ = 100Ω, $C_{OUT}$ = 0.1μF, SGM2590D | | 13 | | |
| Current Limit Threshold | $I_{LIM}$ | $R_{ILIM}$ = 68kΩ, $T_J$ = -40℃ to +125℃ | 45 | 105 | 150 | mA |
| | | $R_{ILIM}$ = 68kΩ, $T_J$ = +25℃ | 50 | 105 | 140 | |
| | | $R_{ILIM}$ = 38kΩ, $T_J$ = -40℃ to +125℃ | 115 | 185 | 255 | |
| | | $R_{ILIM}$ = 38kΩ, $T_J$ = +25℃ | 120 | 185 | 250 | |
| | | $R_{ILIM}$ = 17kΩ, $T_J$ = -40℃ to +125℃ | 320 | 405 | 470 | |
| | | $R_{ILIM}$ = 17kΩ, $T_J$ = +25℃ | 330 | 405 | 465 | |
| | | $R_{ILIM}$ = 6.8kΩ, $T_J$ = -40℃ to +125℃ | 870 | 1005 | 1130 | |
| | | $R_{ILIM}$ = 6.8kΩ, $T_J$ = +25℃ | 895 | 1005 | 1115 | |
| | | $R_{ILIM}$ = 4.53kΩ, $T_J$ = -40℃ to +125℃ | 1310 | 1495 | 1675 | |
| | | $R_{ILIM}$ = 4.53kΩ, $T_J$ = +25℃ | 1340 | 1495 | 1655 | |
| | | $R_{ILIM}$ = 3.4kΩ, $T_J$ = -40℃ to +125℃ | 1735 | 1980 | 2210 | |
| | | $R_{ILIM}$ = 3.4kΩ, $T_J$ = +25℃ | 1780 | 1980 | 2185 | |
| | | $R_{ILIM}$ = 2.7kΩ, $T_J$ = -40℃ to +125℃ | 2260 | 2480 | 2675 | |
| | | $R_{ILIM}$ = 2.7kΩ, $T_J$ = +25℃ | 2310 | 2480 | 2650 | |
| | | $R_{ILIM}$ = 2.3kΩ, $T_J$ = -40℃ to +125℃ | 2660 | 2885 | 3110 | |
| | | $R_{ILIM}$ = 2.3kΩ, $T_J$ = +25℃ | 2690 | 2885 | 3090 | |
| Reverse Protection Threshold | $V_{REV}$ | $V_{OUT}$-$V_{IN}$ rising | 7 | 24 | 39 | mV |
| Reverse Protection Threshold Hysteresis | $V_{REV\_HYS}$ | $V_{OUT}$ falling | | 16 | | mV |
| VOUT Shutdown Discharge Resistance (SGM2590D Only) | $R_{DIS}$ | Switch off, sink 2mA into OUT | | 47 | | Ω |
| Thermal Shutdown Temperature | $T_{SD}$ | $T_J$ increasing | | 156 | | ℃ |
| Thermal Shutdown Hysteresis | $T_{HYS}$ | | | 55 | | ℃ |

## TYPICAL PERFORMANCE CHARACTERISTICS

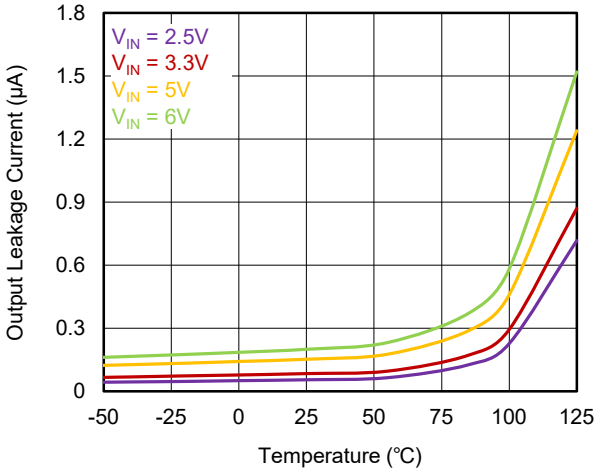
Current Limit vs. Temperature



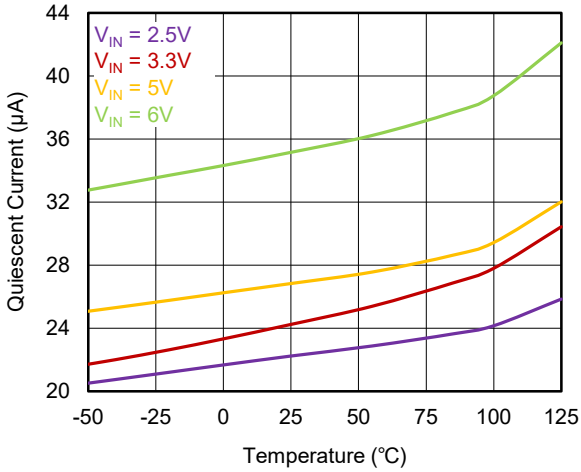

Current Limit vs. Input Voltage



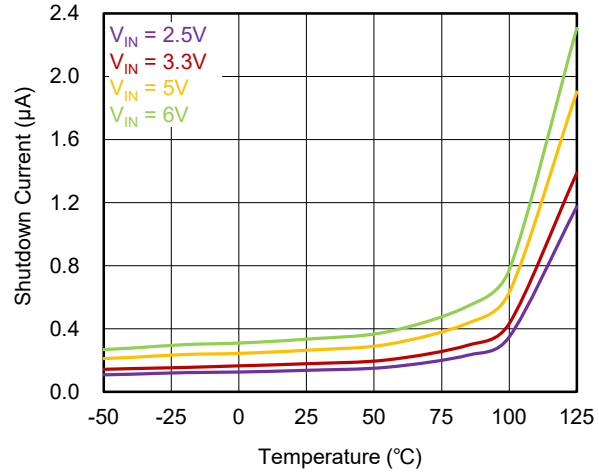

Output Leakage Current vs. Temperature



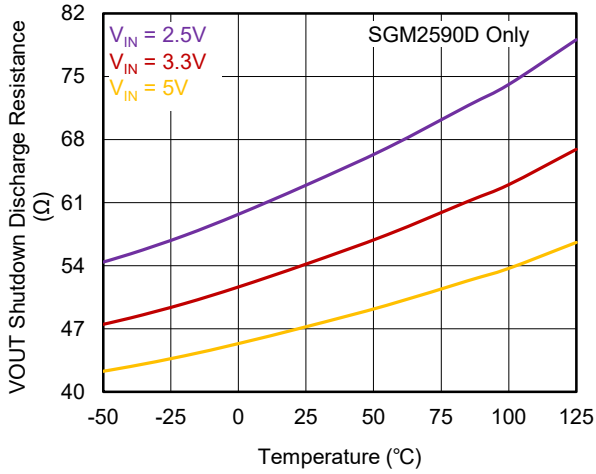

Quiescent Current vs. Temperature




Shutdown Current vs. Temperature

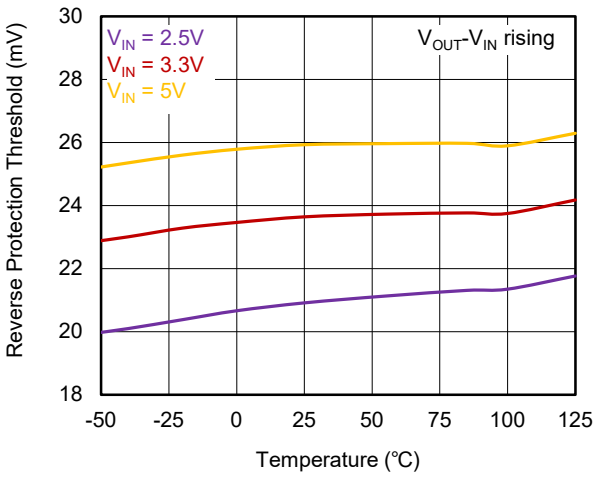



VOUT Shutdown Discharge Resistance vs. Temperature

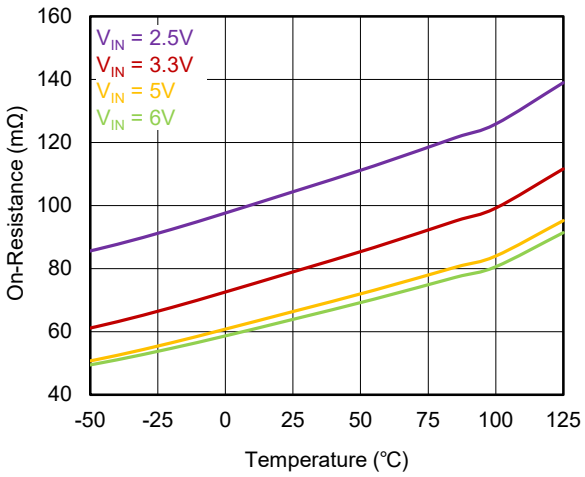


## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

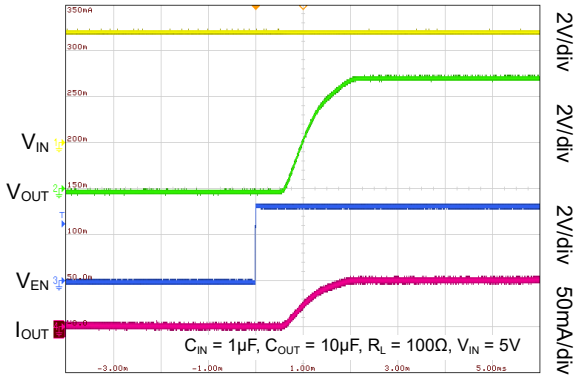
Reverse Protection Threshold vs. Temperature




On-Resistance vs. Temperature

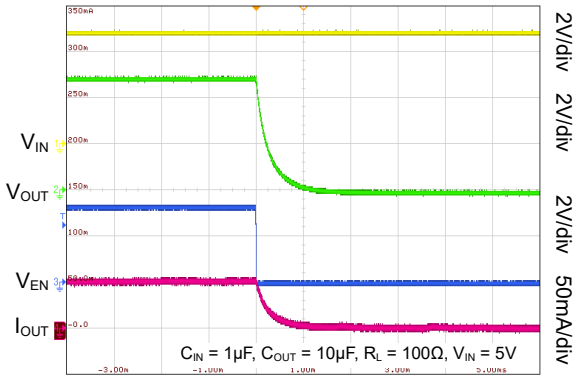



Turn-On Delay and Rise Time



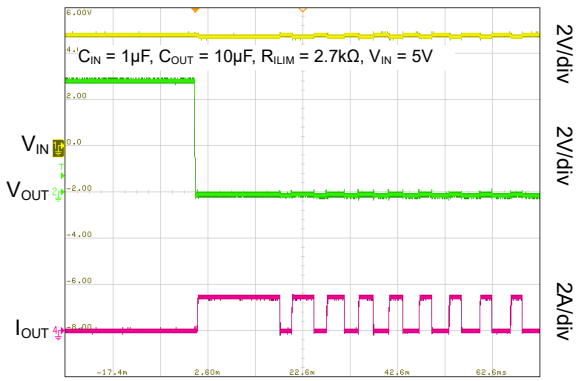

Time (1ms/div)

Turn-Off Delay and Fall Time



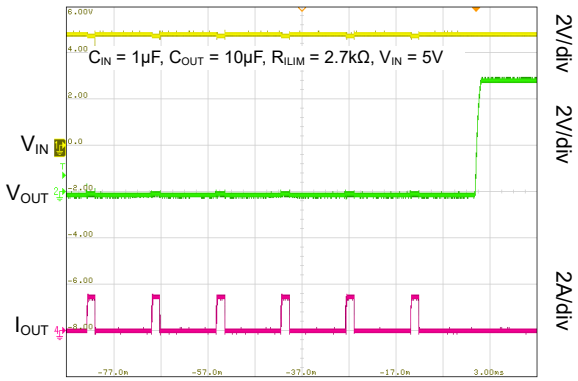

Time (1ms/div)

No Load to Output Short Transient Response




Time (10ms/div)

Output Short to No Load Recovery Response




Time (10ms/div)

## FUNCTIONAL BLOCK DIAGRAM

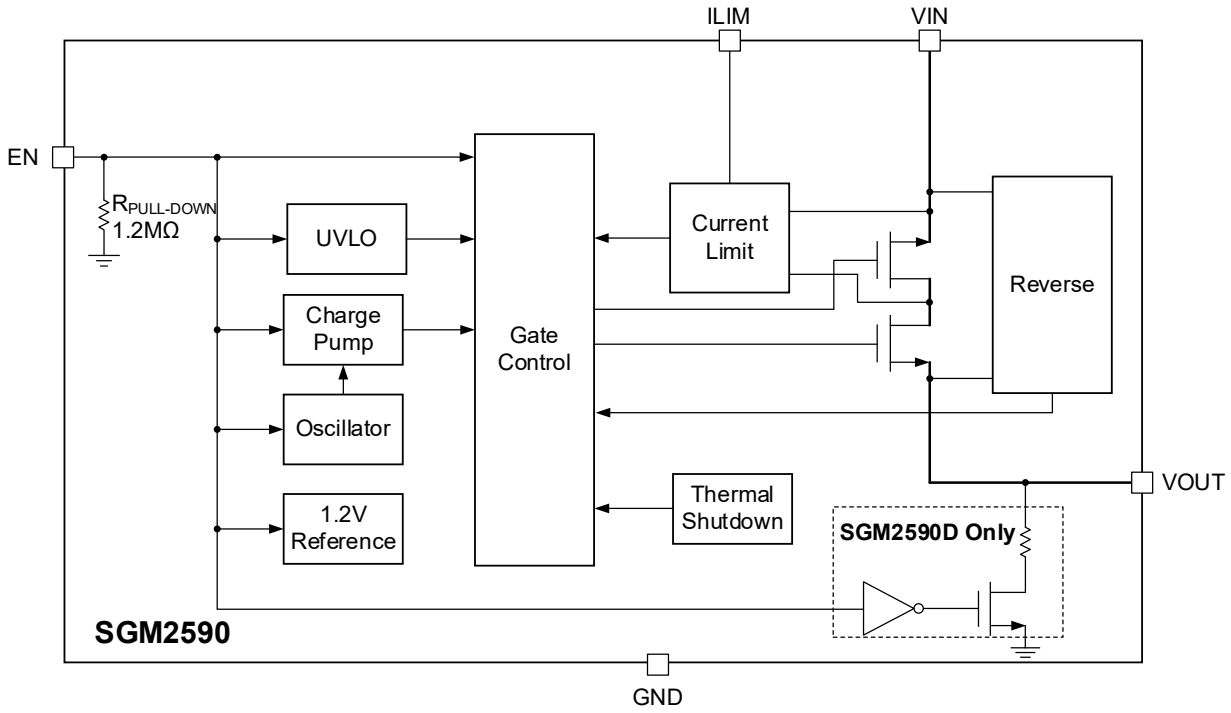



**Figure 2. SGM2590 Block Diagram**

## TIMING DIAGRAM

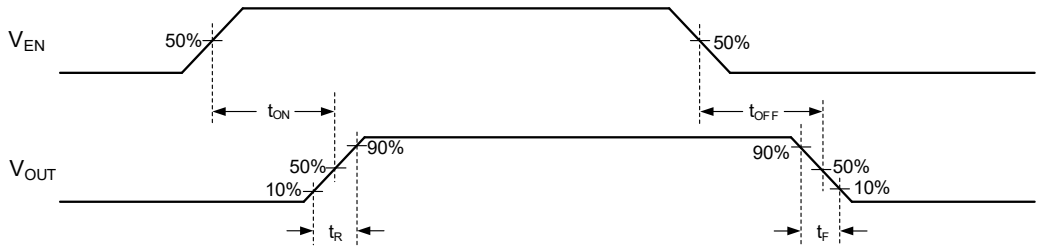



**Figure 3. Switch Turn-On and Turn-Off Times**

# DETAILED DESCRIPTION

## Input and Output

VIN should be connected to the power source that is the power supply of the internal logic circuitry and loads. Normally, load current flows from VIN to VOUT. The output MOSFET and driver circuit are designed to allow the voltage of VOUT is higher than VIN, when the device is turned off.

## Thermal Shutdown (TSD)

The thermal shutdown threshold is +156℃ with 55℃ hysteresis.

## Soft-Start

The soft-start feature is used to limit inrush current during start-up or hot-plug events so that the device can cope with inrush current when connected to large capacitive loads.

## Under-Voltage Lockout (UVLO)

If the voltage on the VIN pin falls below its under-voltage lockout threshold, the device will be disabled. The device resumes operation when the power supply goes back above the UVLO threshold.

## Current Limit and Short-Circuit Protection

The current limit protection circuit is designed to protect the upstream power supply by limiting the output current to the current limit threshold set by the $R_{ILIM}$ from ILIM to GND.

If the short-circuit state persists, the device will cycle on and off under thermal protection as a result of power dissipation.

## Reverse-Voltage Protection

When the output voltage exceeds the input voltage by 24mV (TYP), the device turns off the internal N-MOSFET to avoid the reverse current from the output to input. Its hysteresis voltage is 16mV (TYP).

## Output Discharge

The SGM2590D integrates the output discharge feature. When the EN pin is pulled low (below $V_{IL}$), a discharge resistance with a typical value of 47Ω is connected between the VOUT and GND. This resistance pulls down the output and prevents it from floating when the device is disabled.

# APPLICATION INFORMATION

## Current Limit Programming

An external resistor ($R_{ILIM}$) placed between the ILIM pin and GND sets the switch current limit threshold ($I_{LIM}$). The ILIM pin voltage is regulated by an internal control loop. The current limit threshold is proportional to the current pulled from the ILIM pin by the resistor. Use short trace routes for the $R_{ILIM}$ on the PCB to minimize the impact of parasitics and noise on the accuracy of the current limit setting.

$$I_{LIM} = \frac{6612}{R_{ILIM}^{0.982}} \quad (1)$$

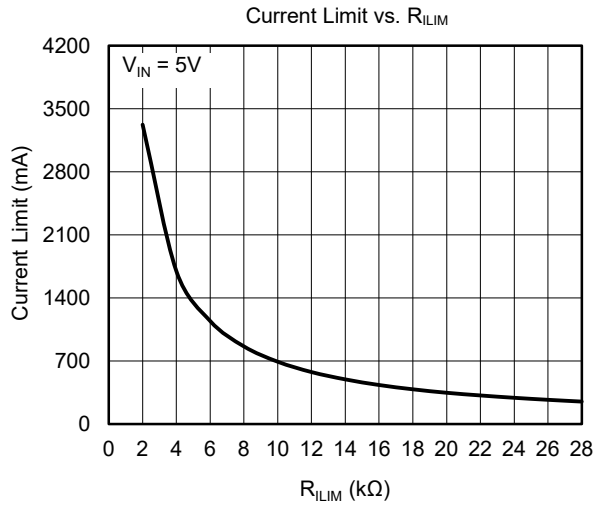



**Figure 4. Current Limit Threshold ($I_{LIM}$) vs. Current Limit Programming Resistor ($R_{ILIM}$)**

## Power Dissipation

Assuming a given ambient temperature and an output current, the maximum allowable power dissipation is calculated by:

$$P_{D(MAX)} = \frac{T_{J(MAX)} - T_A}{\theta_{JA}} \quad (2)$$

where:

- $P_{D(MAX)}$ is the maximum power dissipation.
- $T_{J(MAX)}$ is the maximum operating junction temperature.
- $T_A$ is the operating ambient temperature.
- $\theta_{JA}$ is junction to air thermal impedance.

Please note that the thermal vias are placed under the exposed pad of the device, thus allowing for thermal dissipation away from the device.

## Supply Filter Capacitor

It is recommended to use a 10μF capacitor between VIN and GND close to the device pins. It can limit the voltage drop of the input supply. Larger $C_{IN}$ can reduce voltage dip in high current applications. Without an input capacitor, short-circuit at the output will cause the input voltage to ring, which may destroy the chip's internal circuitry when the input transient voltage exceeds the absolute maximum supply voltage (6.5V).

## Output Filter Capacitor

To reduce EMI, improve the transient performance, and minimize negative effects of resistance and inductance between the bypass capacitor and the downstream connector, a low-ESR 10μF ceramic capacitor between VOUT and GND standard bypass methods are recommended. If the output port is connected to the load through a long cable, the parasitic inductance of the cable may cause voltage to ring, whose negative ringing may damage the chip, so an anti-parallel Schottky diode such as BAT54 is recommended to connect in parallel with the output.

## PCB Layout Guide

A reasonable PCB layout is critical to the stable performance of the device. For best results, follow the guidelines below.

- Keep the power traces as short and wide as possible, and use at least 2 ounces of copper.
- Placing a ground plane under all circuits to reduce resistance and inductance will improve DC and transient performances.
- Ensure that the input decoupling capacitors on VIN have a minimal trace length to VIN and GND.
- Place the output capacitors as close to the device as possible to minimize the effect of PCB parasitic inductance.

# REVISION HISTORY

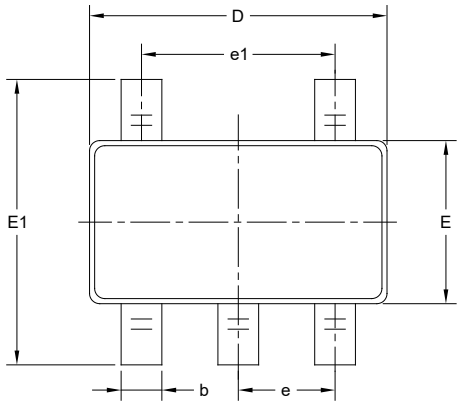
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

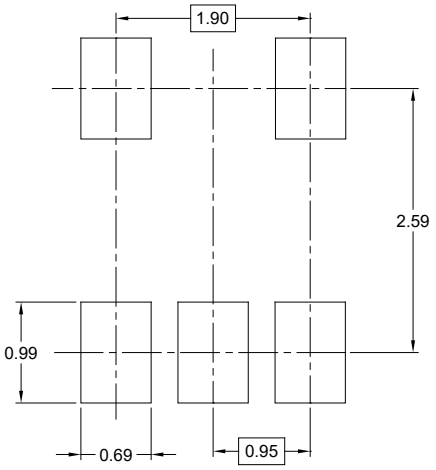
| NOVEMBER 2023 – REV.A to REV.A.1 | Page |
|---|---|
| Updated Electrical Characteristics section | 4 |

| Changes from Original (NOVEMBER 2023) to REV.A | Page |
|---|---|
| Changed from product preview to production data | All |

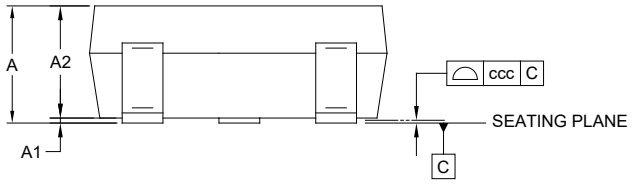
# PACKAGE OUTLINE DIMENSIONS

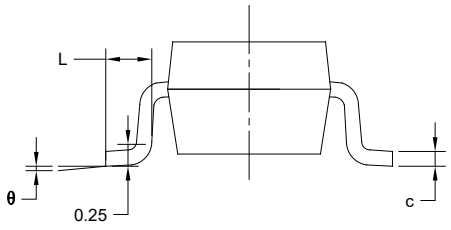
## SOT-23-5




**RECOMMENDED LAND PATTERN** (Unit: mm)



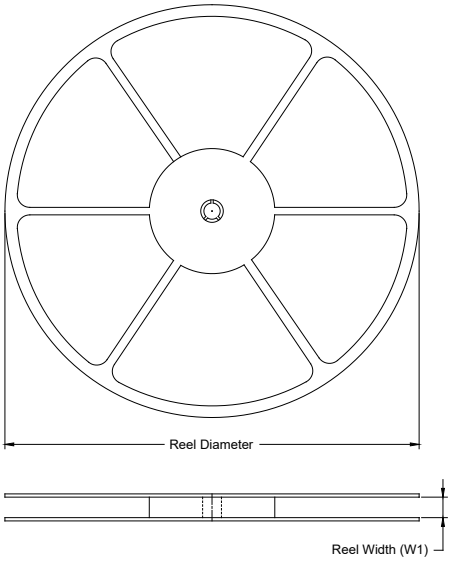




| Symbol | Dimensions In Millimeters | | |
|---|---|---|---|
| | MIN | MOD | MAX |
| A | - | - | 1.450 |
| A1 | 0.000 | - | 0.150 |
| A2 | 0.900 | - | 1.300 |
| b | 0.300 | - | 0.500 |
| c | 0.080 | - | 0.220 |
| D | 2.750 | - | 3.050 |
| E | 1.450 | - | 1.750 |
| E1 | 2.600 | - | 3.000 |
| e | 0.950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

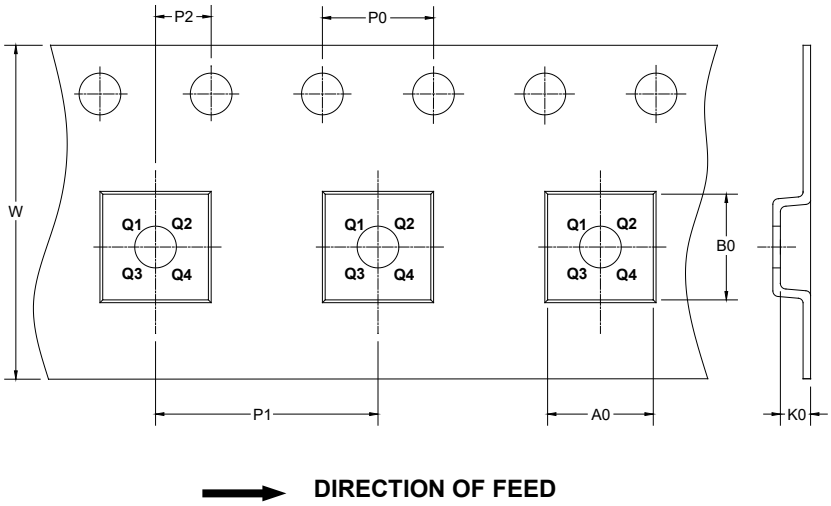
NOTES:
1. This drawing is subject to change without notice.
2. The dimensions do not include mold flashes, protrusions or gate burrs.
3. Reference JEDEC MO-178.

# TAPE AND REEL INFORMATION

## REEL DIMENSIONS




## TAPE DIMENSIONS




DIRECTION OF FEED

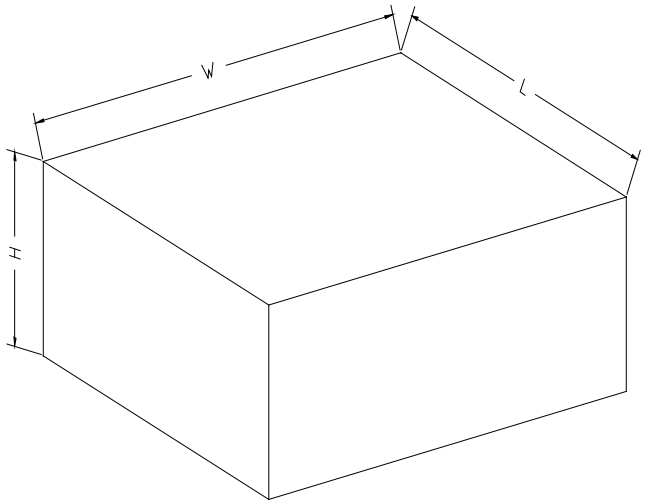
NOTE: The picture is only for reference. Please make the object as the standard.

## 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| SOT-23-5 | 7" | 9.5 | 3.20 | 3.20 | 1.40 | 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 |

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