

## GENERAL DESCRIPTION

The SGM2591 is a single channel power distribution switch. The switch controlled by the EN pin operates from 2.5V to 6V supply voltage. It can be used in USB power distribution applications.

The SGM2591 has integrated current limit function 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 nFAULT output will be asserted to low level during over-current, over-temperature or reverse voltage condition.

The SGM2591AD/BD/CD further reduces the total solution size by integrating a 50Ω pull-down resistor for output discharge when the switch is shut down by EN.

The SGM2591 is 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: 66mΩ (TYP)
- Three Current Limit Levels
  - SGM2591A/AD: 1300 ± 100mA
  - SGM2591B/BD: 2400 ± 160mA
  - SGM2591C/CD: 3000 ± 200mA
- Input Voltage Range: 2.5V to 6V
- Quiescent Current: 28μA (TYP)
- Shutdown Current: 0.27μA (TYP)
- Soft-Start Function
- Over-Temperature Protection
- Under-Voltage Lockout Protection for VIN
- No Reversed Leakage Current (Reverse Blocking)
- Fault Flag (nFAULT Pin)
- Quick Output Discharge (SGM2591AD/BD/CD)
- 1.2MΩ Pull-Down Resistor at EN Pin
- Available in a Green SOT-23-5 Package

## TYPICAL APPLICATION

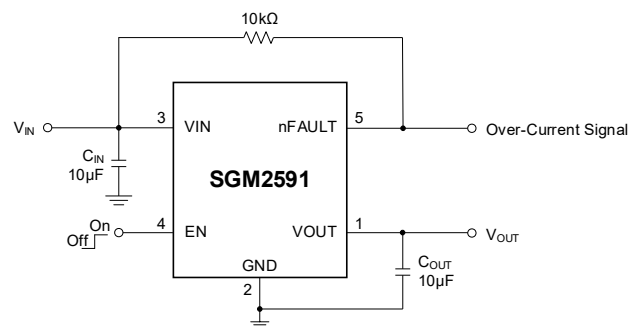


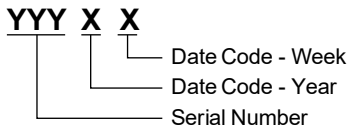
Figure 1. Typical Application Circuit

**PACKAGE/ORDERING INFORMATION**

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM2591A	SOT-23-5	-40°C to +125°C	SGM2591AXN5G/TR	0FEXX	Tape and Reel, 3000
SGM2591B	SOT-23-5	-40°C to +125°C	SGM2591BXN5G/TR	0FFXX	Tape and Reel, 3000
SGM2591C	SOT-23-5	-40°C to +125°C	SGM2591CXN5G/TR	0FGXX	Tape and Reel, 3000
SGM2591AD	SOT-23-5	-40°C to +125°C	SGM2591ADNX5G/TR	0EXXX	Tape and Reel, 3000
SGM2591BD	SOT-23-5	-40°C to +125°C	SGM2591BDNX5G/TR	0EYXX	Tape and Reel, 3000
SGM2591CD	SOT-23-5	-40°C to +125°C	SGM2591CDNX5G/TR	0EZXX	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,  $\theta_{JA}$ ..... 191°C/W
  - SOT-23-5,  $\theta_{JB}$ ..... 46.4°C/W
  - SOT-23-5,  $\theta_{JC}$ ..... 91°C/W
- Junction Temperature..... +150°C
- Storage Temperature Range..... -65°C to +150°C
- Lead Temperature (Soldering, 10s)..... +260°C
- 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
- Junction Temperature Range..... -40°C to +125°C

**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.

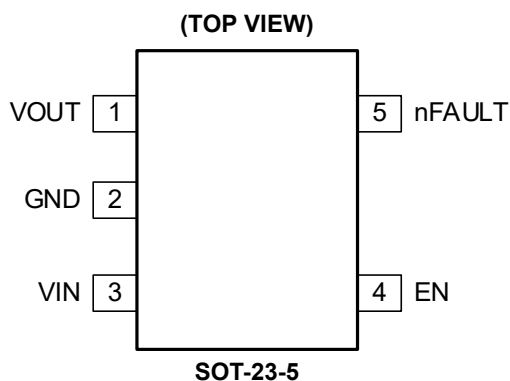
**ESD SENSITIVITY CAUTION**

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	VIN	Power Input Voltage.
4	EN	Chip Enable. Active-high for SGM2591. It has integrated a 1.2M $\Omega$ pull-down resistor at this pin.
5	nFAULT	Active-Low Open-Drain Output. It is asserted during over-current, over-temperature or reverse voltage condition.

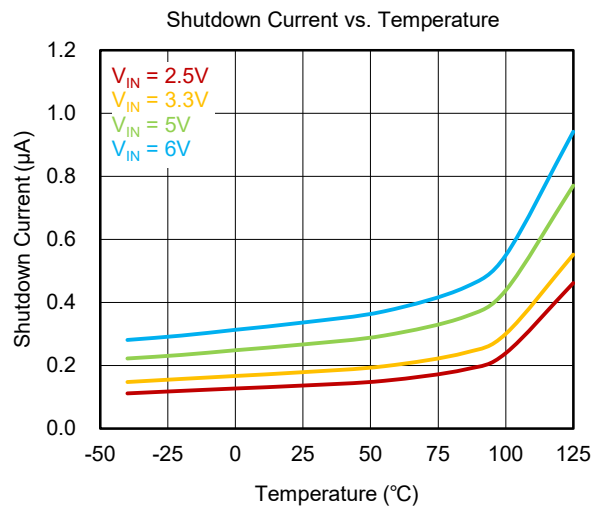
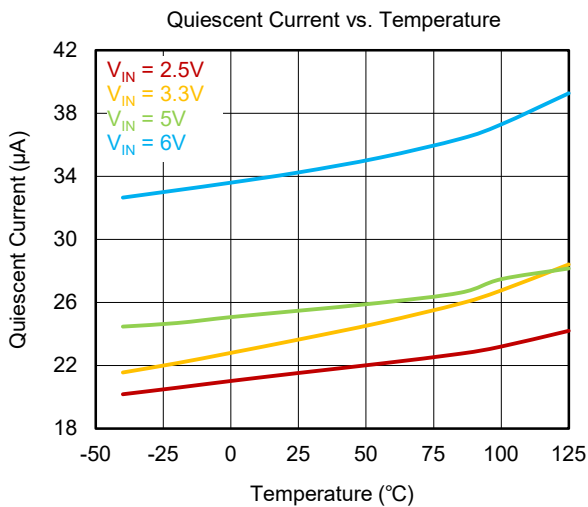
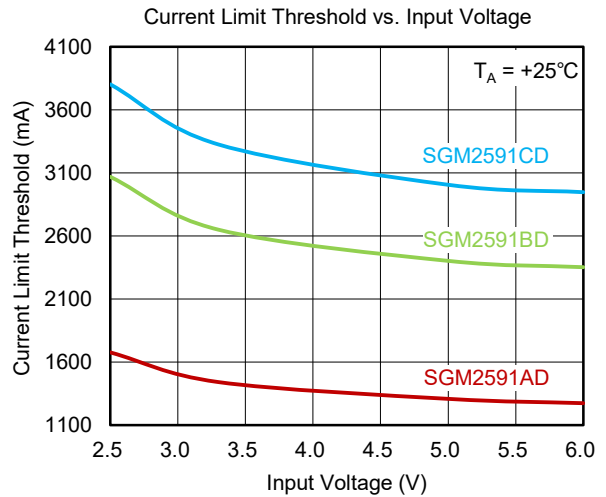
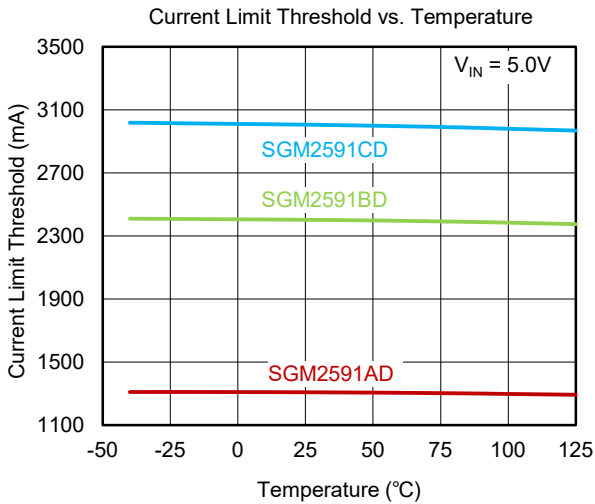
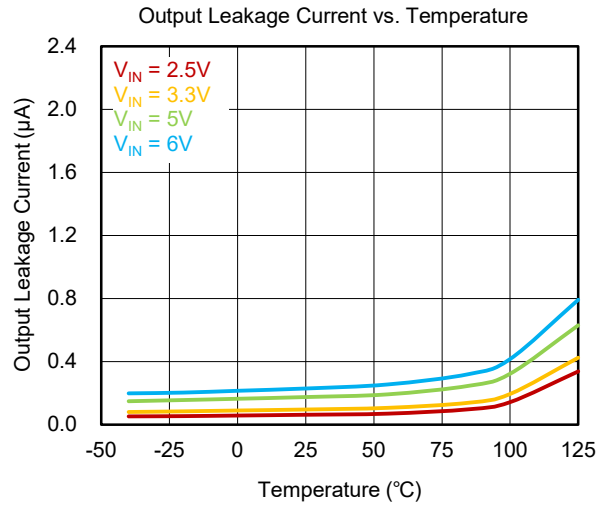
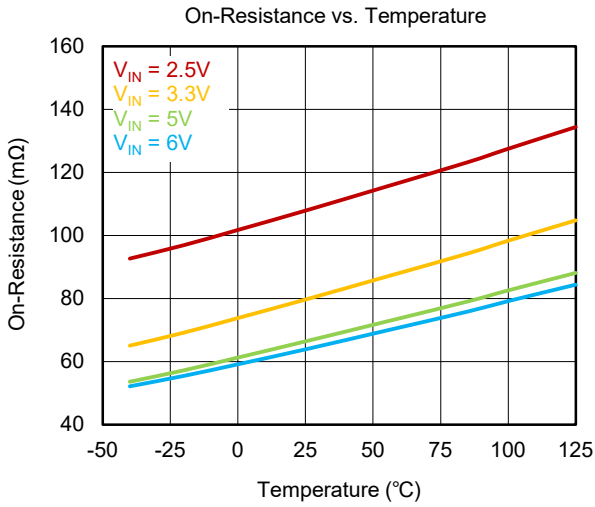
## ELECTRICAL CHARACTERISTICS

(T<sub>J</sub> = -40°C to +125°C, typical values are at T<sub>J</sub> = +25°C, V<sub>IN</sub> = 5V, unless otherwise noted.)

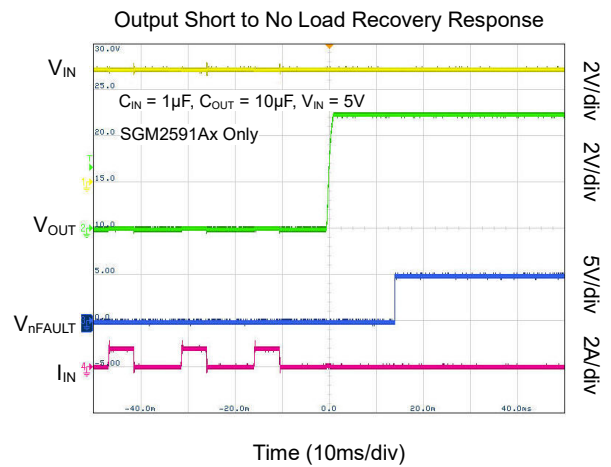
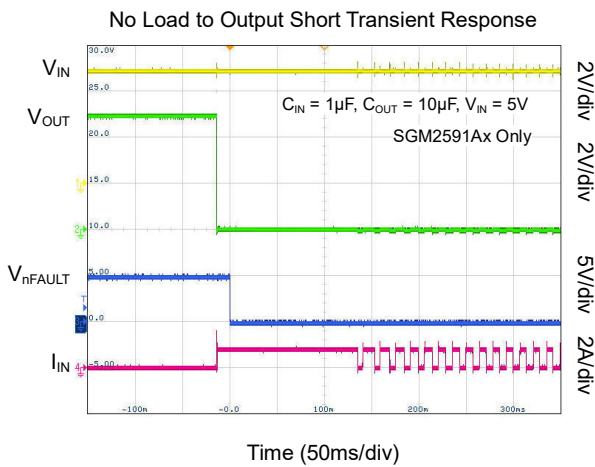
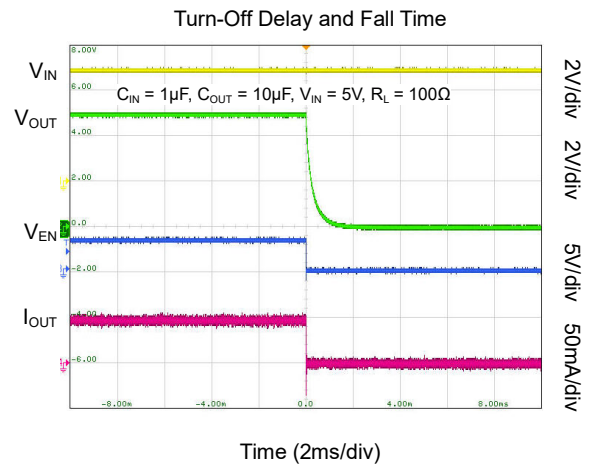
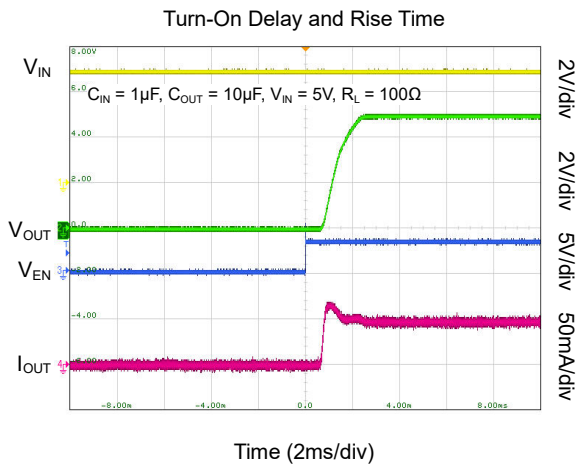
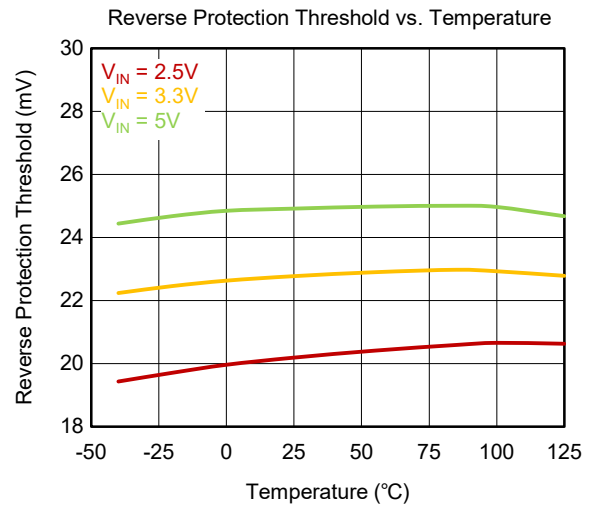
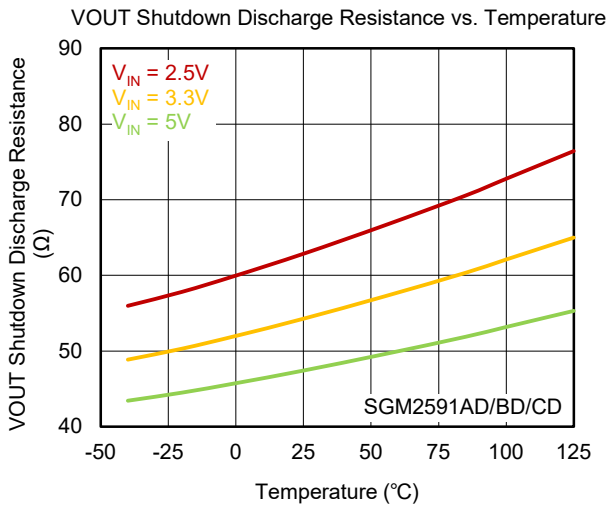
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	
Input Voltage Range	V <sub>IN</sub>		2.5		6	V	
Under-Voltage Lockout Threshold	V <sub>UVLO</sub>	V <sub>IN</sub> rising		2.23	2.35	V	
	V <sub>UVLO_HYS</sub>	V <sub>IN</sub> falling		100		mV	
Quiescent Current	I <sub>Q</sub>	Switch on, V <sub>OUT</sub> = open		28	60	μA	
Shutdown Current	I <sub>SD</sub>	Switch off, V <sub>OUT</sub> = open		0.27	3	μA	
Output Leakage Current	I <sub>LEAKAGE</sub>	Switch off, V <sub>OUT</sub> = 6V, V <sub>IN</sub> = 0V, T <sub>J</sub> = -40°C to +85°C		0.22	1.5	μA	
		Switch off, V <sub>OUT</sub> = 6V, V <sub>IN</sub> = 0V, T <sub>J</sub> = -40°C to +125°C		0.22	2.6		
Enable Input Threshold	V <sub>IH</sub>		1.2			V	
	V <sub>IL</sub>	T <sub>J</sub> = -40°C to +85°C			0.4		
		T <sub>J</sub> = -40°C to +125°C			0.3		
Pull-Down Resistor at EN Pin	R <sub>PULL-DOWN</sub>			1.2		MΩ	
On-Resistance	R <sub>DSON</sub>	I <sub>OUT</sub> = 200mA	T <sub>J</sub> = -40°C to +85°C	66	98	mΩ	
			T <sub>J</sub> = -40°C to +125°C	66	110		
Output Turn-On Delay Time	t <sub>ON</sub>	R <sub>L</sub> = 100Ω, C <sub>OUT</sub> = 0.1μF		1.1		ms	
Output Turn-Off Delay Time	SGM2591A/B/C	t <sub>OFF</sub>	R <sub>L</sub> = 100Ω, C <sub>OUT</sub> = 0.1μF	32		μs	
	SGM2591AD/BD/CD			27			
Output Turn-On Rise Time	t <sub>R</sub>	R <sub>L</sub> = 100Ω, C <sub>OUT</sub> = 0.1μF		2		ms	
Output Turn-Off Fall Time	t <sub>F</sub>	R <sub>L</sub> = 100Ω, C <sub>OUT</sub> = 0.1μF		20		μs	
Over-Current nFAULT Response Delay Time	t <sub>D</sub>	Force the chip into current limit mode		15		ms	
Current Limit Threshold	SGM2591A/AD	I <sub>LIM</sub>	T <sub>J</sub> = +25°C	1220	1300	1380	mA
			T <sub>J</sub> = -40°C to +125°C	1205	1300	1380	
	SGM2591B/BD		T <sub>J</sub> = +25°C	2280	2400	2530	
			T <sub>J</sub> = -40°C to +125°C	2245	2400	2540	
	SGM2591C/CD		T <sub>J</sub> = +25°C	2840	3000	3170	
			T <sub>J</sub> = -40°C to +125°C	2805	3000	3180	
Reverse Protection Threshold	V <sub>REV</sub>	V <sub>OUT</sub> rising	5	24	42	mV	
Reverse Protection Threshold Hysteresis	V <sub>REV_HYS</sub>	V <sub>OUT</sub> falling		16		mV	
nFAULT Output Resistance	R <sub>nFAULT</sub>	nFAULT is low and I <sub>SINK</sub> = 10mA		23		Ω	
nFAULT Leakage Current	I <sub>nFAULT</sub>	nFAULT is high		2		nA	
VO <sub>UT</sub> Shutdown Discharge Resistance (SGM2591AD/BD/CD)	R <sub>DIS</sub>	Switch off, sink 2mA into OUT		50		Ω	
Thermal Shutdown Temperature	T <sub>SD</sub>	T <sub>J</sub> increasing		156		°C	
Thermal Shutdown Hysteresis	T <sub>HYS</sub>			30		°C	

NOTE: The reverse nFAULT response delay time is 0.2ms.

TYPICAL PERFORMANCE CHARACTERISTICS



TYPICAL PERFORMANCE CHARACTERISTICS



FUNCTIONAL BLOCK DIAGRAM

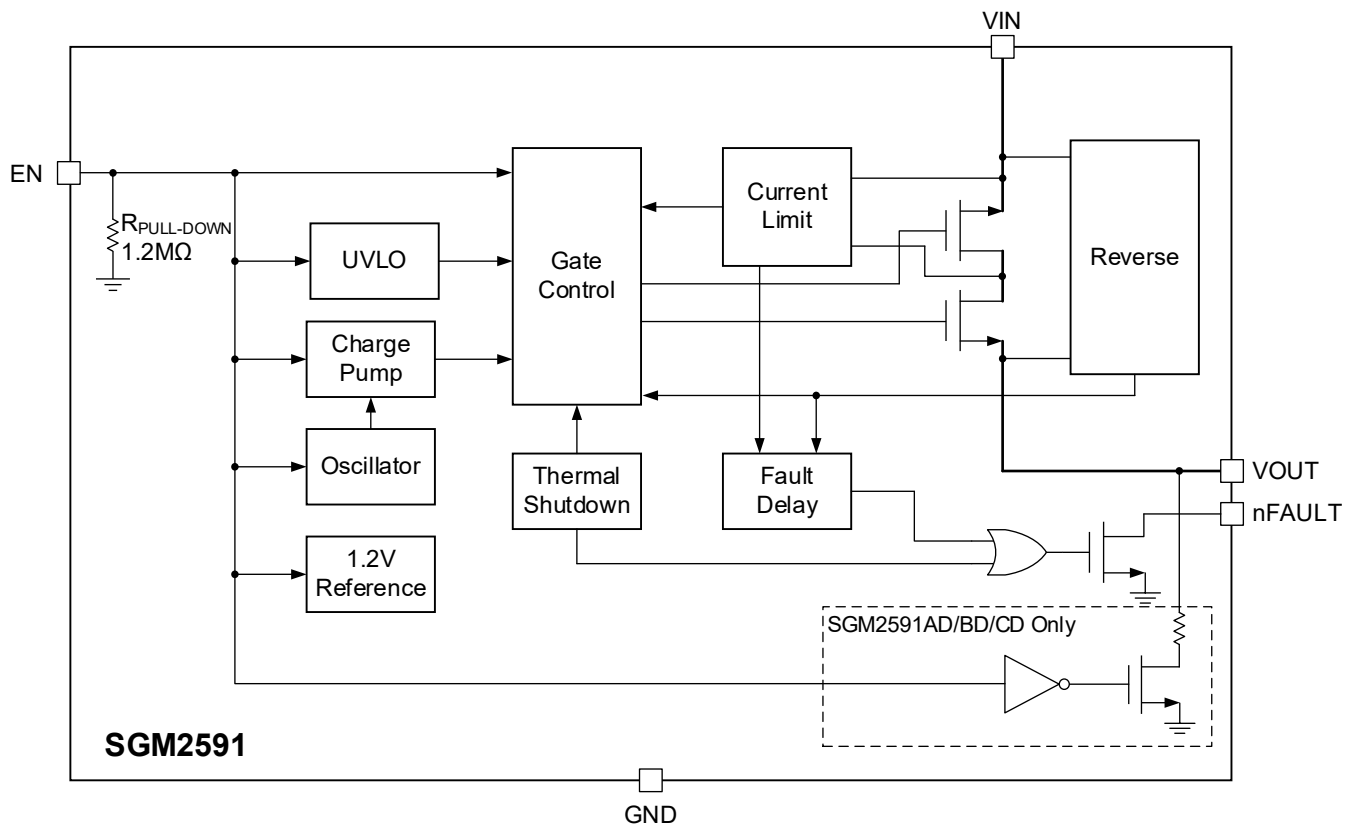


Figure 2. SGM2591 Block Diagram

TIMING DIAGRAMS

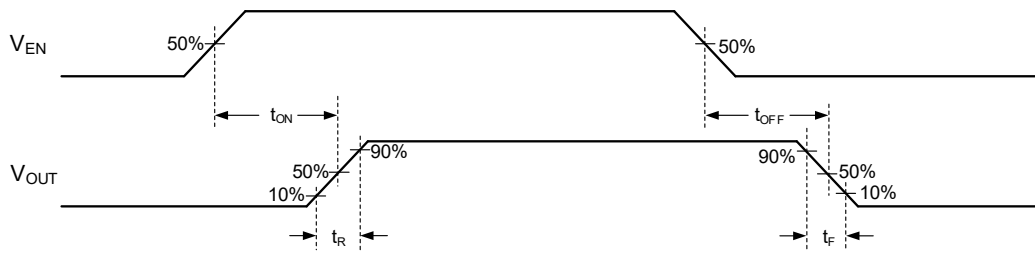


Figure 3. Switch Turn-On and Turn-Off Times

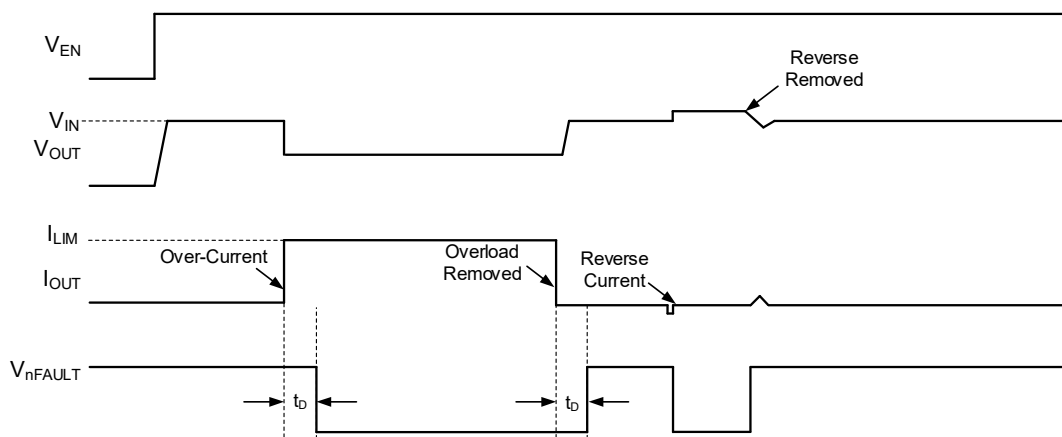


Figure 4. Fault Timing: Output Reset by Toggling EN



## 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°C with 30°C hysteresis.

### Soft-Start

The soft-start feature is used to limit inrush current during startup 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 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 UVLO threshold.

### Current Limit and Short-Circuit Protection

The current limit protection circuit is designed to limit the output current to protect the upstream power supply. The typical current limit threshold is set internally to approximately 1.3A (SGM2591A/AD), 2.4A (SGM2591B/BD), 3A (SGM2591C/CD).

The nFAULT pin will be asserted after the device enters short-circuit state for  $t_D$  (15ms).

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).

### Fault Flag (nFAULT)

The SGM2591 is designed to achieve delayed response via the internal delay "deglitch" circuit for over-current ( $t_D = 15ms$ , TYP) condition. The nFAULT pin indicates that the device enters and leaves over-current condition after the delay time ( $t_D$ ). But nFAULT will be asserted to low level as soon as the over-temperature condition occurs.

The nFAULT is the structure of N-MOSFET open-drain that outputs low level when an over-current, over-temperature or reverse voltage condition occurs. Figure 4 depicts the typical timing.

When an over-current occurs, nFAULT will not be asserted until the over-current persists for a delay time ( $t_D$ ). This ensures that nFAULT will not be asserted due to disturbances such as current jitter, thus avoids false fault reports.

### Output Discharge

The SGM2591AD/BD/CD integrate the output discharge feature. When the EN pin is pulled low (below  $V_{IL}$ ), a discharge resistance with a typical value of 50Ω 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**

**Power Dissipation**

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

$$P_{D(MAX)} = \frac{T_{J(MAX)} - T_A}{\theta_{JA}} \tag{1}$$

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**

It is recommended to use a low-ESR 10µF ceramic capacitor between VOUT and GND standard bypass methods to reduce EMI, improve the transient performance, and minimize negative effects of resistance and inductance between the bypass capacitor and the downstream connector. 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 Guidelines**

A reasonable PCB layout is critical to the stable performance of the SGM2591. 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 SGM2591 as possible to minimize the effect of PCB parasitic inductance.

**REVISION HISTORY**

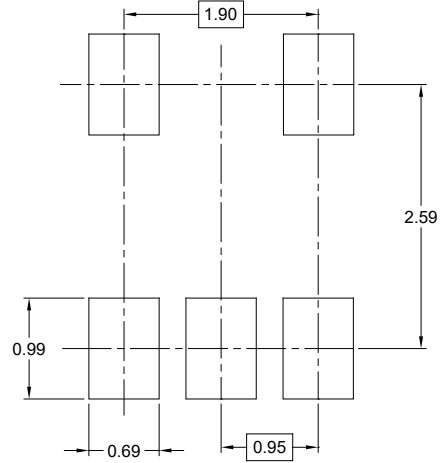
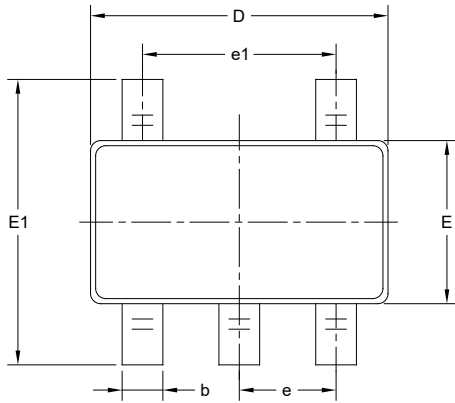
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

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

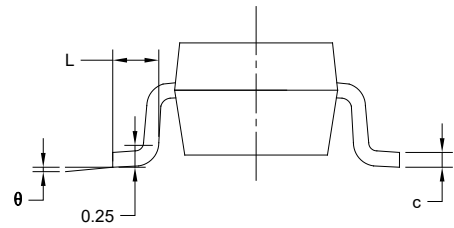
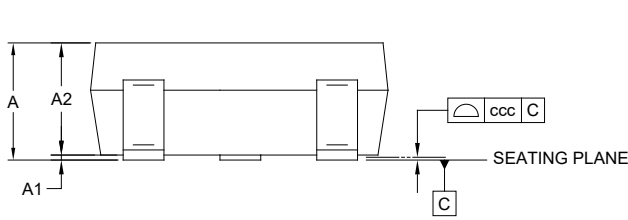
# PACKAGE INFORMATION

## 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
$\theta$	0°	-	8°
ccc	0.100		

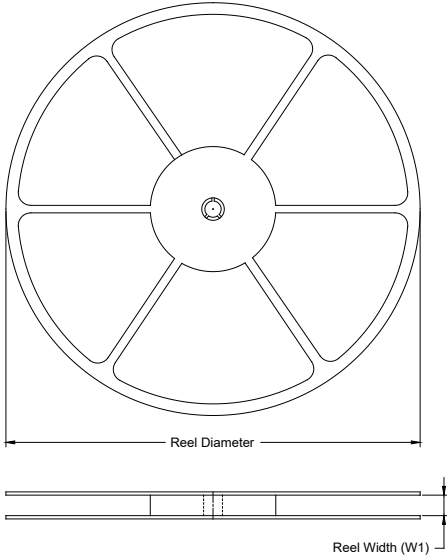
NOTES:

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.

# PACKAGE INFORMATION

## 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-23-5	7"	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3

DD0001

# PACKAGE INFORMATION

## 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