SGM2551A/SGM2551C Precision Adjustable Current Limited Power Distribution Switches

GENERAL DESCRIPTION

The SGM2551A and SGM2551C power distribution switches are intended for applications where precision current limiting is required or heavy capacitive loads and short circuits are encountered and provide up to 1.5A of continuous load current. These devices offer a programmable current limit threshold between 100mA and 1.7A via an external resistor. The power switch rise and fall times are controlled to minimize current surges during turn on/off. The SGM2551C has quick auto-discharge function in disable status.

SGM2551A and SGM2551C devices limit the output current to a safe level by using a constant-current mode when the output load exceeds the current limit threshold. An internal reverse-voltage comparator disables the power switch when the output voltage is driven higher than the input to protect devices on the input side of the switch.

SGM2551A and SGM2551C are available in the Green TDFN-2×2-6L and SOT-23-5 packages. They are rated over the -40℃ to +85℃ temperature range.

FEATURES

- **Up to 1.5A Maximum Load Current**
- **Meets USB Current Limiting Requirements**
- **Adjustable Current Limit: 100mA to 1.7A**
- **Fast Over-Current Response: 2μs**
- **90mΩ High-side MOSFET**
- **No Reverse Leakage Current of High-side MOSFET**
- **Reverse Input-Output Voltage Protection**
- **Operating Range: 2.5V to 5.5V**
- **Built-In Soft-Start Function**
- **Quick Auto-Discharge in Disable Status (SGM2551C)**
- **UL Recognized Component (UL File E481541)**
- **Evaluated to IEC 60950-1, Ed 2, Am1, Annex CC, Test Program 1 with CB Report**
- **Available in the Green TDFN-2×2-6L and SOT-23-5 Packages**

APPLICATIONS

USB Ports/Hubs
Digital TV
Set-Top Boxes
VOIP Phones

TYPICAL APPLICATION

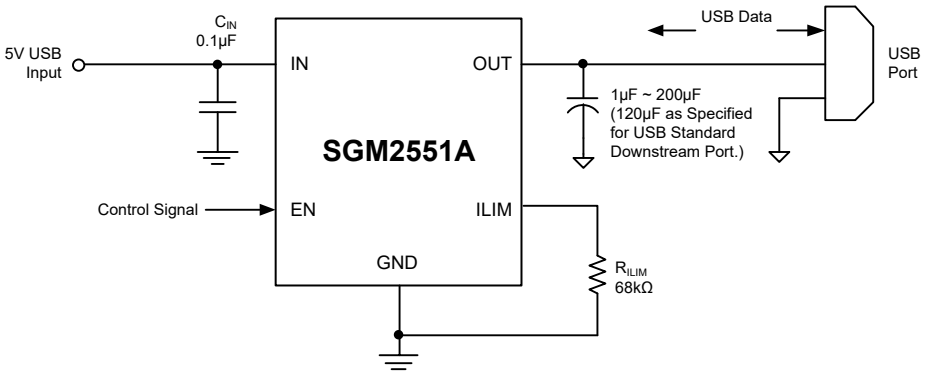


Figure 1. Typical Application as USB Power Switch

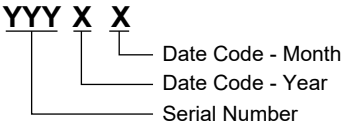
PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM2551A	SOT-23-5	-40℃ to +85℃	SGM2551AYN5G/TR	SKEXX	Tape and Reel, 3000
	TDFN-2×2-6L	-40℃ to +85℃	SGM2551AYTDI6G/TR	SK5 XXXX	Tape and Reel, 3000
SGM2551C	SOT-23-5	-40℃ to +85℃	SGM2551CYN5G/TR	SLEXX	Tape and Reel, 3000
	TDFN-2×2-6L	-40℃ to +85℃	SGM2551CYTDI6G/TR	SL2 XXXX	Tape and Reel, 3000

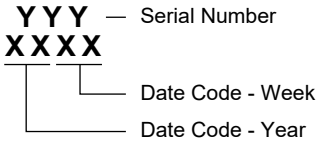
MARKING INFORMATION

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

SOT-23-5



TDFN-2×2-6L



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, VOUT, EN and ILIM to GND ..... -0.3V to 6V
Continuous Output Current..... Internally Limited
ILIM Source Current 1mA
Package Thermal Resistance
TDFN-2×2-6L, θ_{JA}..... 160℃/W
SOT-23-5, θ_{JA} ..... 250℃/W
Junction Temperature .....+150℃
Storage Temperature Range.....-65℃ to +150℃
Lead Temperature (Soldering, 10s) .....+260℃
ESD Susceptibility
HBM.....2000V
MM.....200V

RECOMMENDED OPERATING CONDITIONS

Input Voltage Range .....2.5V to 5.5V
Enable Voltage Range.....0V to 5.5V
Continuous Output Current Range .....0A to 1.5A
Current Limit Threshold Resistor Range..... 20kΩ to 387kΩ
Minimum Input Decoupling Capacitance 0.1μF
Operating Temperature Range .....-40℃ to +85℃

OVERSTRESS CAUTION

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

ESD SENSITIVITY CAUTION

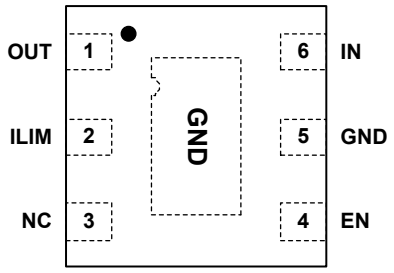
This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance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

DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

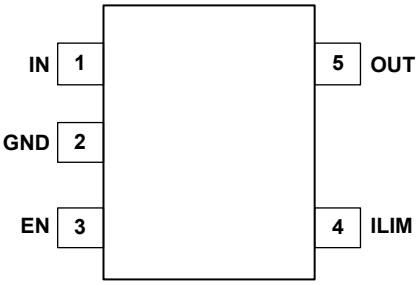
PIN CONFIGURATIONS

SGM2551A/SGM2551C (TOP VIEW)



TDFN-2×2-6L

SGM2551A/SGM2551C (TOP VIEW)



SOT-23-5

PIN DESCRIPTION

PIN		NAME	FUNCTION
TDFN-2×2-6L	SOT-23-5		
1	5	OUT	Power Switch Output.
2	4	ILIM	ILIM Pin. External resistor used to set current limit threshold; recommended 20kΩ ≤ R_{ILIM} ≤ 387kΩ. $I_{LIM} = \frac{39}{R_{ILIM} + 3}$ (A) where R_{ILIM} is in kΩ.
3	—	NC	No Internal Connection.
4	3	EN	Enable Input. Logic high turns on power switch.
5	2	GND	Ground. Connect externally to exposed pad.
6	1	IN	Input Voltage. Connect a 0.1μF or greater ceramic capacitor from IN to GND as close to the IC as possible.
Exposed Pad	—	GND	Internally connected to GND; used to heat-sink the part to the circuit board traces. Connect exposed pad to GND pin externally.

ELECTRICAL CHARACTERISTICS

(V_{IN} = 5V, T_A = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
POWER SWITCH							
High-side MOSFET On Resistance	$R_{DS(ON)}$				90	130	mΩ
Output Rise Time	t_R	V_{IN} = 5.5V	C_L = 1μF, R_L = 100Ω, Figure 2		1.8	3.5	ms
		V_{IN} = 2.5V			1.1	2.5	
Output Fall Time	t_F	V_{IN} = 5.5V			0.3	0.4	
		V_{IN} = 2.5V			0.3	0.4	
ENABLE INPUT							
Logic High of Enable Pin	V_{IH}			1.4			V
Logic Low of Enable Pin	V_{IL}					0.3	V
Input Current	I_{EN}	V_{EN} = 5.5V			0.01	1	μA
Turn-On Time	t_{ON}	C_L = 1μF, R_L = 100Ω, Figure 2			3	5	ms
Turn-Off Time	t_{OFF}				1.6	2.5	ms
CURRENT LIMIT							
Current Limit Threshold (Maximum DC output current I_{OUT} delivered to load), OUT connected to GND through 4Ω.	I_{LIM}	V_{IN} = 3V, R_{ILIM} = 68kΩ		460	545	610	mA
Response Time to Short Circuit	t_{IOS}	Figure 3			2		μs
REVERSE-VOLTAGE PROTECTION							
Reverse-Voltage Comparator Trip Point (V_{OUT} - V_{IN})				115	160	205	mV
Time from Reverse-Voltage Condition to MOSFET Turn-Off				3.5	5.5	7.5	ms
SUPPLY CURRENT							
Supply Current, Low-Level Output	$I_{IN(OFF)}$	V_{IN} = 5.5V, No load on OUT, V_{EN} = 0V			0.1	2.5	μA
Supply Current, High-Level Output	$I_{IN(ON)}$	R_{ILIM} = 36kΩ	V_{IN} = 5.5V, No load on OUT		71	105	μA
		R_{ILIM} = 68kΩ			62	95	
Reverse Leakage Current	I_{REV}	V_{OUT} = 5.5V, V_{IN} = 0V			0.01	1	μA
UNDER-VOLTAGE LOCKOUT							
Under-Voltage Lockout Threshold	V_{UVLO}	V_{IN} Rising			2.36	2.47	V
Under-Voltage Lockout Threshold Hysteresis					140		mV
QUICK DISCHARGE RESISTOR (SGM2551C ONLY)							
Discharge Resistor	$R_{Discharge}$				45		Ω
THERMAL SHUTDOWN							
Thermal Shutdown Threshold					140		℃
Thermal Shutdown Threshold in Current Limit					115		℃
Thermal Shutdown Hysteresis					10		℃

PARAMETER MEASUREMENT INFORMATION

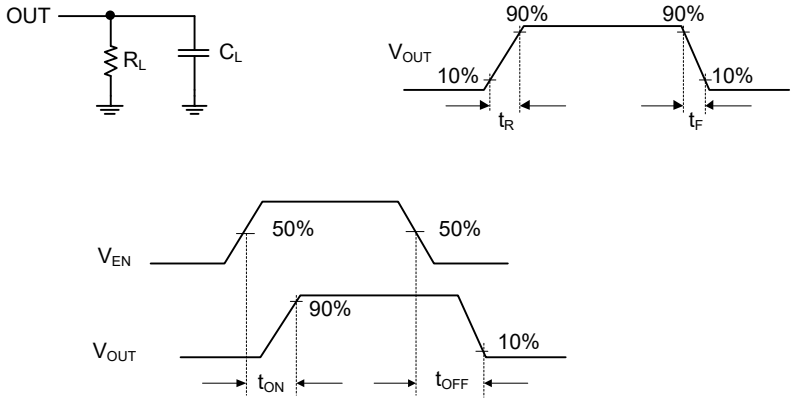


Figure 2. Test Circuit and Voltage Waveforms

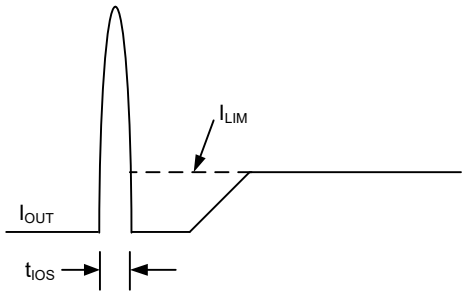


Figure 3. Response Time to Short Circuit Waveform

TYPICAL APPLICATION CIRCUIT

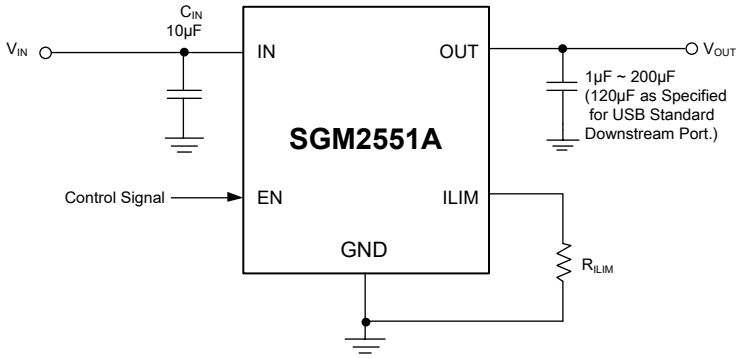
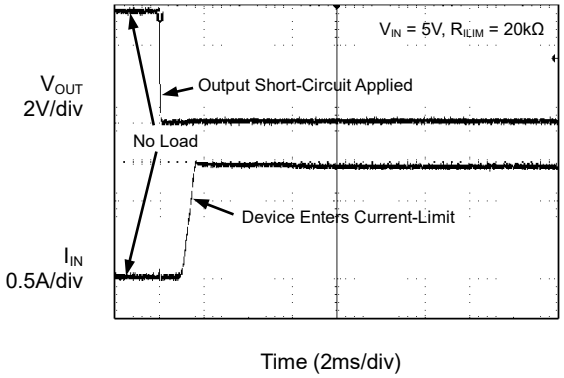


Figure 4. Typical Characteristics Reference Schematic

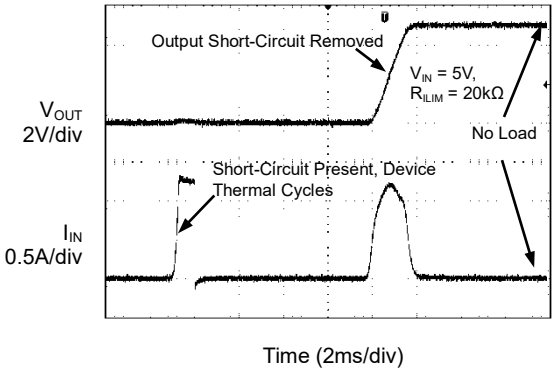
TYPICAL PERFORMANCE CHARACTERISTICS

No-Load to Short-Circuit Transient Response



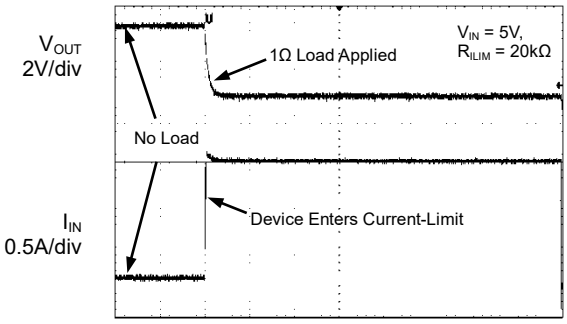
Time (2ms/div)

Short-Circuit to No-Load Recovery Response



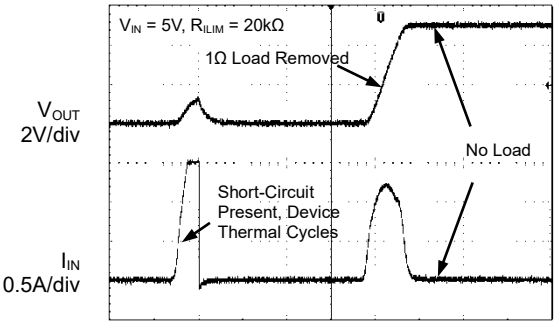
Time (2ms/div)

No-Load to 1Ω Transient Response



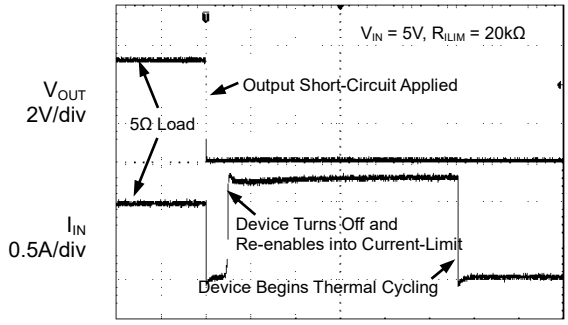
Time (2ms/div)

1Ω to No-Load Transient Response



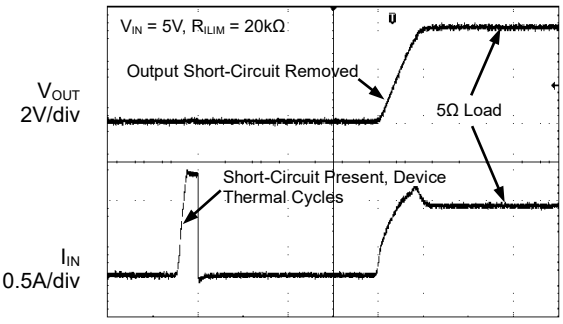
Time (2ms/div)

Full-Load to Short-Circuit Transient Response



Time (2ms/div)

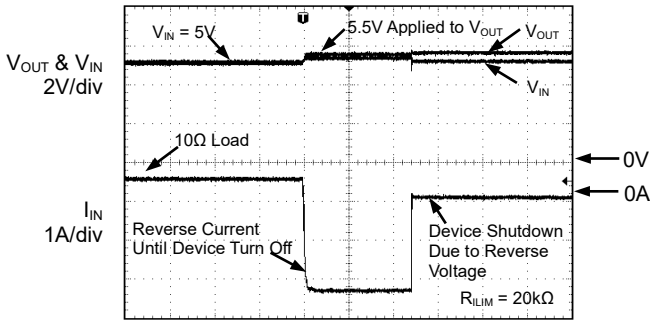
Short-Circuit to Full-Load Recovery Response



Time (2ms/div)

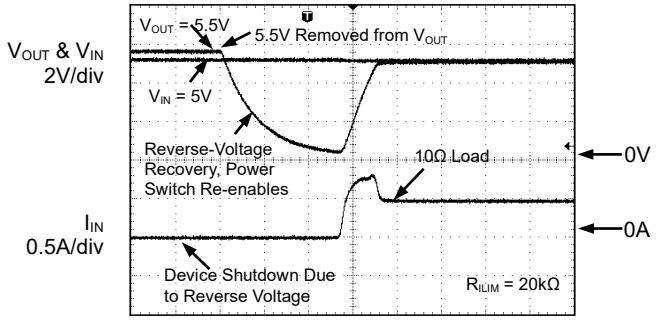
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Reverse-Voltage Protection Response



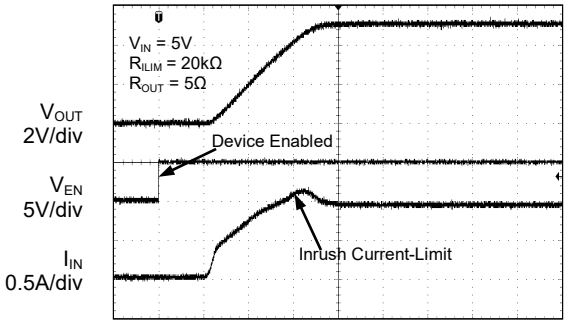
Time (2ms/div)

Reverse-Voltage Protection Recovery



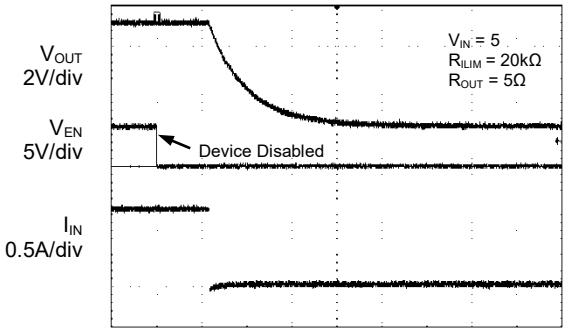
Time (2ms/div)

Turn-On Delay and Rise Time



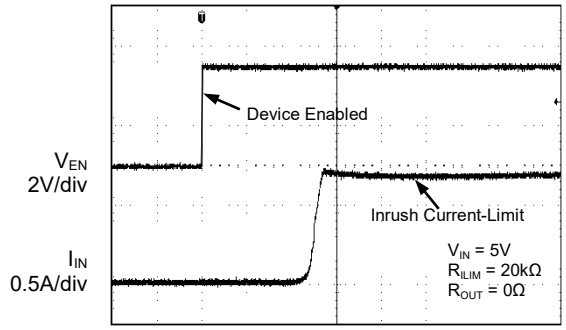
Time (1ms/div)

Turn-Off Delay and Rise Time



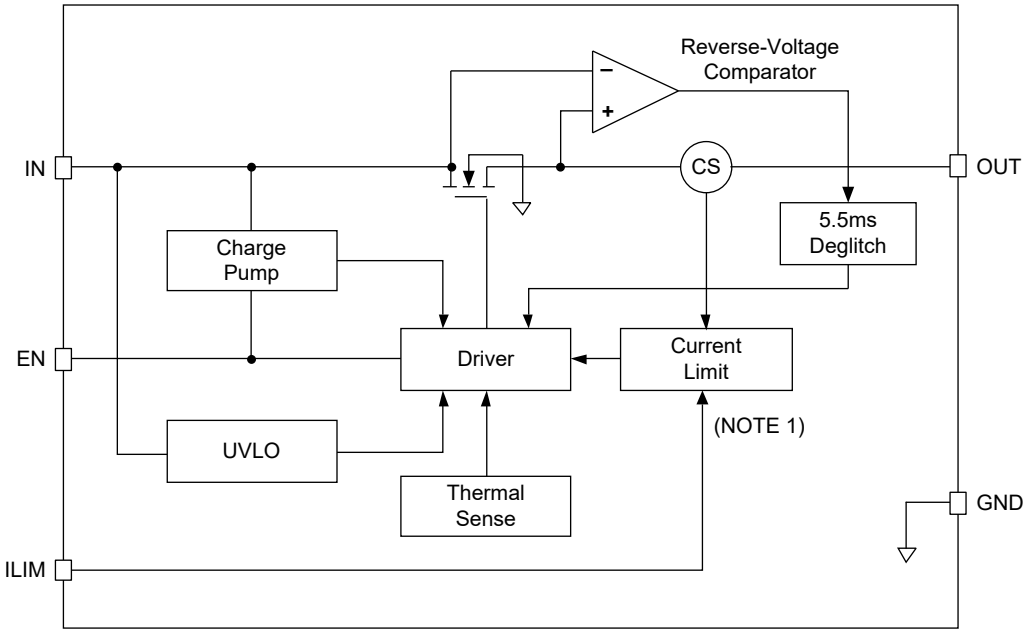
Time (1ms/div)

Device Enabled into Short-Circuit



Time (400μs/div)

FUNCTIONAL BLOCK DIAGRAM



NOTE 1: SGM2551A and SGM2551C parts enter constant-current mode during current limit condition.

DETAILED DESCRIPTION

Overview

The SGM2551A and SGM2551C are current limited, power distribution switches using N-Channel MOSFETs for applications where short circuits or heavy capacitive loads will be encountered and provide up to 1.5A of continuous load current. These devices allow the user to program the current limit threshold between 100mA and 1.7A via an external resistor. Additional device shutdown features include over-temperature protection and reverse-voltage protection. The device incorporates an internal charge pump and gate drive circuitry necessary to drive the N-Channel MOSFET. The charge pump supplies power to the driver circuit and provides the necessary voltage to pull the gate of the MOSFET above the source. The charge pump operates from input voltages as low as 2.5V and requires little supply current. The driver controls the gate voltage of the power switch. The driver incorporates circuitry that controls the rise and fall times of the output voltage to limit large current and voltage surges and provides built-in soft-start functionality. The SGM2551A and SGM2551C enter constant-current mode when the load exceeds the current limit threshold.

Over-Current Conditions

The SGM2551A and SGM2551C respond to over-current conditions by limiting output current to the I_{LIM} levels. When an over-current condition is detected, the device maintains a constant output current and reduces the output voltage accordingly. Two possible overload conditions can occur.

The first condition is when a short circuit or partial short circuit is present when the device is powered-up or enabled. The output voltage is held near zero potential with respect to ground and the SGM2551A/SGM2551C ramp the output current to I_{LIM}. The SGM2551A and SGM2551C devices will limit the current to I_{LIM} until the overload condition is removed or the device begins to thermal cycle.

The second condition is when a short circuit, partial short circuit, or transient overload occurs while the device is enabled and powered on. The device responds to the over-current condition within time t_{IOS} (see Figure 3). The current-sense amplifier is overdriven during this time and momentarily disables the internal current limit MOSFET. The current-sense amplifier recovers and limits the output current to I_{LIM}. Similar to the previous case, the SGM2551A and SGM2551C will limit the current to I_{LIM} until the overload condition is removed or the device begins to thermal cycle.

The SGM2551A and SGM2551C thermal cycles if an overload condition is present long enough to activate thermal limiting in any of the above cases. The device turns off when the junction temperature exceeds 115℃ while in current limit. The device remains off until the junction temperature cools 10℃ and then restarts. The SGM2551A and SGM2551C cycles on/off until the overload are removed.

Reverse-Voltage Protection

The reverse-voltage protection feature turns off the N-Channel MOSFET whenever the output voltage exceeds the input voltage by 160mV for 5.5ms. This prevents damage to devices on the input side of the SGM2551A/SGM2551C by preventing significant current from sinking into the input capacitance. The SGM2551A/SGM2551C devices allow the N-Channel MOSFET to turn on once the output voltage goes below the input voltage for the same 5.5ms deglitch time.

DETAILED DESCRIPTION (continued)

Under-Voltage Lockout (UVLO)

The under-voltage lockout (UVLO) circuit disables the power switch until the input voltage reaches the UVLO turn-on threshold. Built-in hysteresis prevents unwanted on/off cycling due to input voltage drop from large current surges.

Enable

The logic enable controls the power switch, bias for the charge pump, driver, and other circuits to reduce the supply current. The supply current is reduced to less than 1μA when a logic low is present on EN pin. A logic high input on EN enables the driver, control circuits, and power switch. The enable input is compatible with both TTL and CMOS logic levels.

Thermal Sense

The SGM2551A and SGM2551C have self-protection feature using two independent thermal sensing circuits that monitor the operating temperature of the power switch and disable operation if the temperature exceeds recommended operating conditions.

The SGM2551A and SGM2551C devices operate in constant-current mode during an over-current condition, which increases the voltage drop across power switch. The power dissipation in the package is proportional to the voltage drop across the power switch, which increases the junction temperature during an over-current condition. The first thermal sensor turns off the power switch when the die temperature exceeds 115℃ and the part is in current limit. Hysteresis is built into the thermal sensor, and the switch turns on after the device has cooled approximately 10℃.

The SGM2551A and SGM2551C also have a second ambient thermal sensor. The ambient thermal sensor turns off the power switch when the die temperature exceeds 140℃ regardless of whether the power switch is in current limit and will turn on the power switch after the device has cooled approximately 10℃.

REVISION HISTORY

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

JUNE 2018 – REV.A.2 to REV.A.3

Update Recommended Operating Conditions	2

DECEMBER 2017 – REV.A.1 to REV.A.2

Update Features section	1

APRIL 2015 – REV.A to REV.A.1

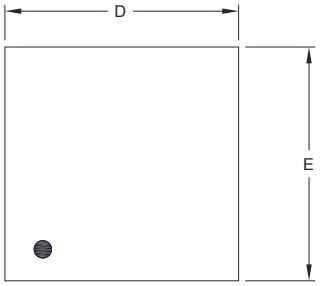
Change the C_{OUT} of Figure 1&4	1, 5

Changes from Original (JUNE 2014) to REV.A

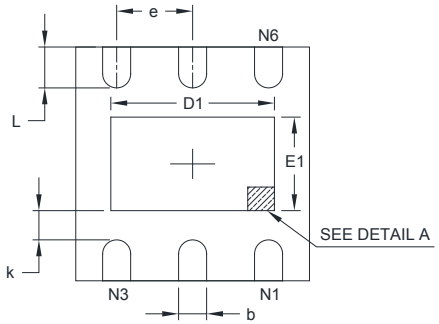
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

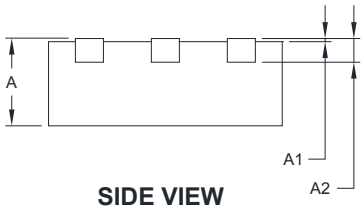
TDFN-2×2-6L



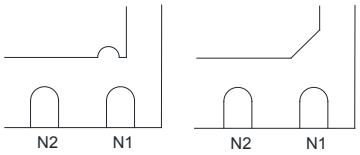
TOP VIEW



BOTTOM VIEW



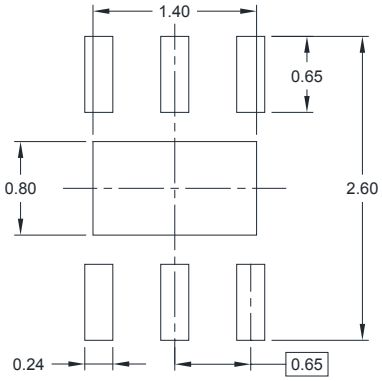
SIDE VIEW



DETAIL A

Pin #1 ID and Tie Bar Mark Options

NOTE: The configuration of the Pin #1 identifier is optional, but must be located within the zone indicated.

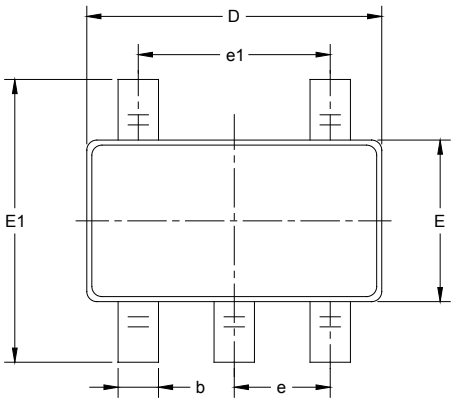


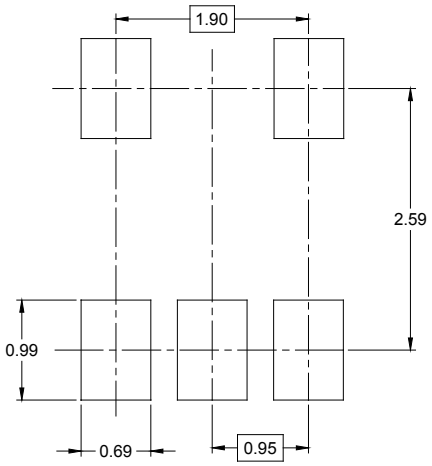
RECOMMENDED LAND PATTERN (Unit: mm)

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	1.100	1.450	0.043	0.057
E	1.900	2.100	0.075	0.083
E1	0.600	0.850	0.024	0.034
k	0.200 MIN		0.008 MIN	
b	0.180	0.300	0.007	0.012
e	0.650 TYP		0.026 TYP	
L	0.250	0.450	0.010	0.018

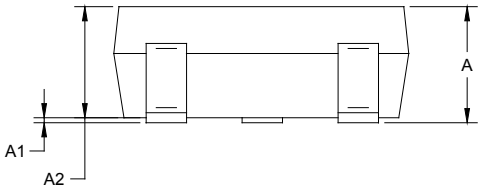
PACKAGE OUTLINE DIMENSIONS

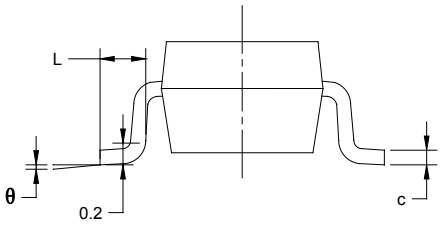
SOT-23-5





RECOMMENDED LAND PATTERN (Unit: mm)

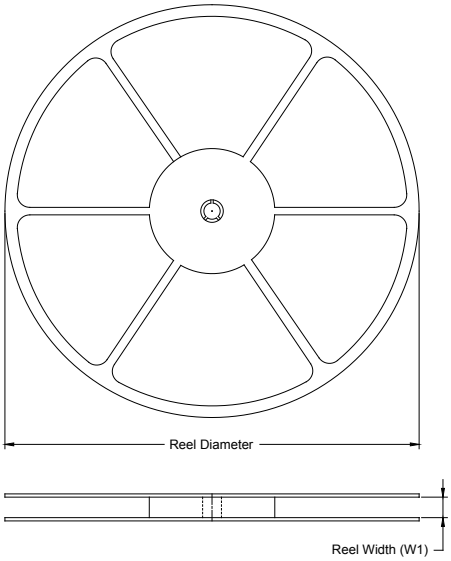




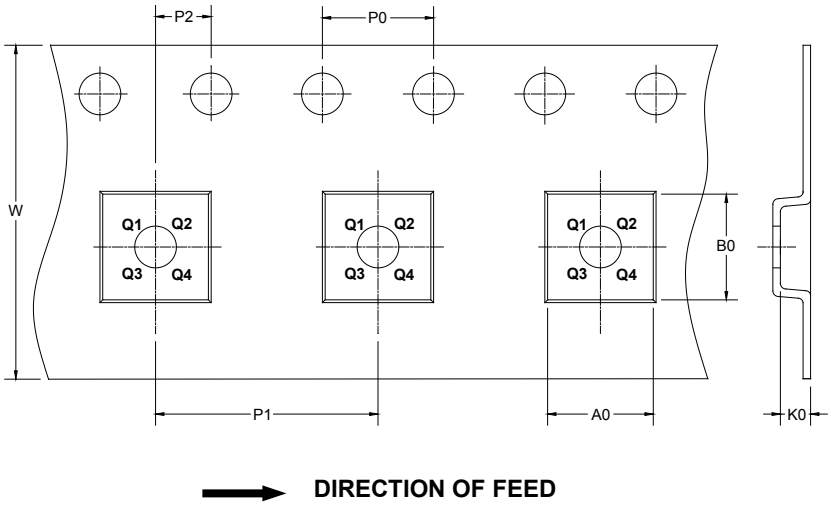
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC	
e1	1.900 BSC		0.075 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



DIRECTION OF FEED

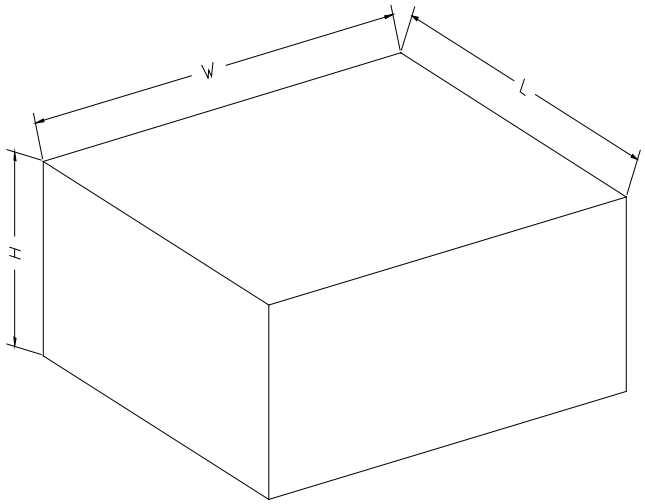
NOTE: The picture is only for reference. Please make the object as the standard.

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
TDFN-2×2-6L	7″	9.5	2.30	2.30	1.10	4.0	4.0	2.0	8.0	Q1

DD0001

CARTON BOX DIMENSIONS



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

KEY PARAMETER LIST OF CARTON BOX

Reel Type	Length (mm)	Width (mm)	Height (mm)	Pizza/Carton
7″ (Option)	368	227	224	8
7″	442	410	224	18

DD0002