SGM2059
300mA, Low V_{IN}, Ultra-Low Noise and High PSRR Linear Regulator

GENERAL DESCRIPTION

The SGM2059 is a low V_{IN}, ultra-low noise, high PSRR and low dropout voltage linear regulator. It is capable of supplying 300mA output current with typical dropout voltage of only 72mV. The operating input voltage range is from 1.1V to 5.5V. The fixed output voltage range is from 1.2V to 4.2V and adjustable output voltage range is from 0.793V to 5.0V.

Other features include logic-controlled shutdown mode, short-circuit current limit and thermal shutdown protection. The SGM2059 has automatic discharge function to quickly discharge V_{OUT} in the disabled status.

The SGM2059 is suitable for applications which need low noise and fast transient response power supply, such as power supply of camera module in smart phone, etc.

The SGM2059 is available in Green SOT-23-5 and SC70-5 packages. It operates over an operating temperature range of -40℃ to +125℃.

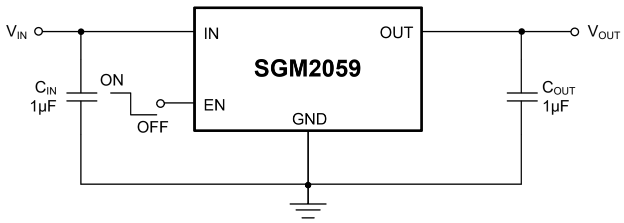
FEATURES

- **Operating Input Voltage Range: 1.1V to 5.5V**
- **Fixed Outputs of 1.2V, 1.5V, 1.8V, 2.5V, 2.8V, 2.9V, 3.0V, 3.3V and 4.2V**
- **Adjustable Output from 0.793V to 5.0V**
- **300mA Output Current**
- **Output Voltage Accuracy: ±1% at +25℃**
- **Low Quiescent Current: 13μA (TYP)**
- **Low Dropout Voltage: 72mV (TYP) at 300mA when V_{OUT} = 2.8V**
- **Ultra-Low Noise: 9.5μV_{RMS} (TYP)**
- **High PSRR: 92dB (TYP) at 1kHz**
- **Current Limiting and Thermal Protection**
- **Excellent Load and Line Transient Responses**
- **With Output Automatic Discharge**
- **Stable with Small Case Size Ceramic Capacitors**
- **Shutdown Supply Current: 0.03μA (TYP)**
- **-40℃ to +125℃ Operating Temperature Range**
- **Available in Green SOT-23-5 and SC70-5 Packages**

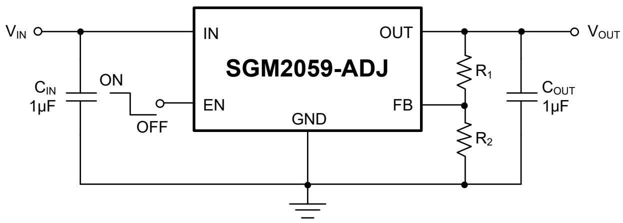
APPLICATIONS

Portable Electronic Devices
Smoke Detectors
IP Cameras
Wireless LAN Devices
Battery-Powered Equipment
Smartphones and Tablets
Digital Cameras and Audio Devices

TYPICAL APPLICATION



Fixed Output Voltage Version



Adjustable Output Voltage Version

Figure 1. Typical Application Circuits

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM2059-1.2	SOT-23-5	-40℃ to +125℃	SGM2059-1.2XN5G/TR	SZSXX	Tape and Reel, 3000
SGM2059-1.5	SOT-23-5	-40℃ to +125℃	SGM2059-1.5XN5G/TR	SZTXX	Tape and Reel, 3000
SGM2059-1.8	SOT-23-5	-40℃ to +125℃	SGM2059-1.8XN5G/TR	SZUXX	Tape and Reel, 3000
SGM2059-2.5	SOT-23-5	-40℃ to +125℃	SGM2059-2.5XN5G/TR	SZVXX	Tape and Reel, 3000
SGM2059-2.8	SOT-23-5	-40℃ to +125℃	SGM2059-2.8XN5G/TR	SYGXX	Tape and Reel, 3000
SGM2059-2.9	SOT-23-5	-40℃ to +125℃	SGM2059-2.9XN5G/TR	GAKXX	Tape and Reel, 3000
SGM2059-3.0	SOT-23-5	-40℃ to +125℃	SGM2059-3.0XN5G/TR	SZWXX	Tape and Reel, 3000
SGM2059-3.3	SOT-23-5	-40℃ to +125℃	SGM2059-3.3XN5G/TR	SZXXX	Tape and Reel, 3000
SGM2059-4.2	SOT-23-5	-40℃ to +125℃	SGM2059-4.2XN5G/TR	SZYXX	Tape and Reel, 3000
SGM2059-ADJ	SOT-23-5	-40℃ to +125℃	SGM2059-ADJXN5G/TR	SXZXX	Tape and Reel, 3000
SGM2059-ADJ	SC70-5	-40℃ to +125℃	SGM2059-ADJXC5G/TR	SYHXX	Tape and Reel, 3000

MARKING INFORMATION

NOTE: XX = Date Code.

YYY X X

- X — Date Code - Week
- X — Date Code - Year
- YYY — Serial Number

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

IN to GND .... -0.3V to 6V
OUT to GND .... -0.3V to (V_{IN} + 0.3V)
EN, FB to GND .... -0.3V to 6V
Package Thermal Resistance
SOT-23-5, θ_{JA} .... 206℃/W
SOT-23-5, θ_{JB} .... 64℃/W
SOT-23-5, $\theta_{JC(TOP)}$... 79℃/W
SC70-5, θ_{JA}.. 223℃/W
SC70-5, θ_{JB}.. 70℃/W
SC70-5, $\theta_{JC(TOP)}$ .... 83℃/W
Junction Temperature...+150℃
Storage Temperature Range ....-65℃ to +150℃
Lead Temperature (Soldering, 10s)............................+260℃
ESD Susceptibility
HBM...8000V
CDM 1000V

RECOMMENDED OPERATING CONDITIONS

Input Voltage Range...1.1V to 5.5V
Input Effective Capacitance, C_{IN} .... 0.5μF (MIN)
Output Effective Capacitance, C_{OUT}.................0.5μF to 10μF
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

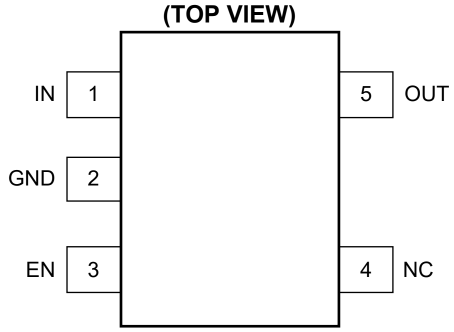
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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.

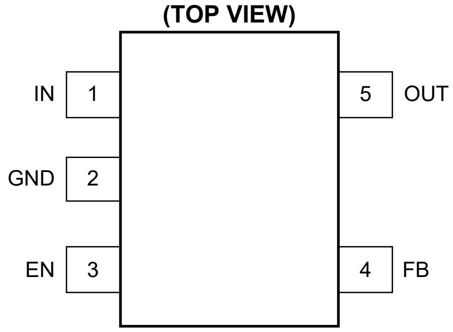
PIN CONFIGURATIONS

SGM2059-Fixed Output
(TOP VIEW)



SOT-23-5

SGM2059-ADJ
(TOP VIEW)



SOT-23-5/SC70-5

PIN DESCRIPTION

PIN	NAME	FUNCTION
1	IN	Input Supply Voltage Pin. It is recommended to use a 1μF or larger ceramic capacitor from IN pin to ground to get good power supply decoupling. This ceramic capacitor should be placed as close as possible to IN pin.
2	GND	Ground.
3	EN	Enable Pin. Drive EN high to turn on the regulator. Drive EN low to turn off the regulator. The EN pin has an internal 0.03μA pull-down current source which ensures that the device is turned off when the EN pin is floated. This pin must be connected to IN pin if enable functionality is not used.
4	NC	Not Connected (fixed voltage version).
	FB	Feedback Voltage Input Pin (adjustable voltage version only). Connect this pin to the midpoint of an external resistor divider to adjust the output voltage. Place the resistors as close as possible to this pin.
5	OUT	Regulator Output Pin. It is recommended to use an output capacitor with effective capacitance in the range of 0.5μF to 10μF to ensure stability. This ceramic capacitor should be placed as close as possible to OUT pin.

ELECTRICAL CHARACTERISTICS

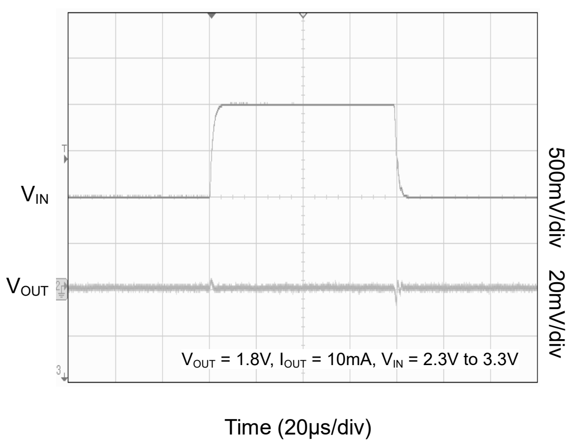
(V_{IN} = ($V_{OUT(NOM)}$ + 0.3V) or 1.1V (whichever is greater), V_{EN} = V_{IN}, C_{IN} = C_{OUT} = 1μF, T_J = -40℃ to +125℃, typical values are at T_J = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Input Voltage Range	V_{IN}	I_{OUT} = 60mA		1.1		5.5	V
		I_{OUT} = 100mA		1.2		5.5	
		I_{OUT} = 200mA		1.3		5.5	
		I_{OUT} = 300mA		1.4		5.5	
Output Voltage Accuracy	V_{OUT}	V_{IN} = 1.5V to 5.5V, I_{OUT} = 0.1mA, $V_{OUT(NOM)}$ ≥ 1.2V, T_J = +25℃		-1		1	%
		V_{IN} = 1.5V to 5.5V, I_{OUT} = 0.1mA to 300mA, $V_{OUT(NOM)}$ ≥ 1.2V, T_J = -40℃ to +125℃		-2		2	
Feedback Voltage (SGM2059-ADJ)	V_{FB}	V_{IN} = 1.5V to 5.5V, I_{OUT} = 0.1mA, T_J = +25℃		0.784	0.793	0.802	V
		V_{IN} = 1.5V to 5.5V, I_{OUT} = 0.1mA to 300mA, T_J = -40℃ to +125℃		0.773		0.813	
Line Regulation	ΔV_{LNR}	V_{IN} = ($V_{OUT(NOM)}$ + 0.3V) to 5.5V, I_{OUT} = 0.1mA			0.05	1	mV
Load Regulation	$\Delta V_{LDR}/V_{OUT}$	I_{OUT} = 0.1mA to 300mA, V_{OUT} ≥ 1.5V			1.2	5	mV/V
Dropout Voltage	V_{DROP}	V_{OUT} = $V_{OUT(NOM)}$ - 0.05V, I_{OUT} = 300mA	1.2V ≤ $V_{OUT(NOM)}$ < 1.5V		185	260	mV
			1.5V ≤ $V_{OUT(NOM)}$ < 1.8V		125	200	
			1.8V ≤ $V_{OUT(NOM)}$ < 2.8V		100	160	
			2.8V ≤ $V_{OUT(NOM)}$ ≤ 5.0V		72	120	
Output Current Limit	I_{LIMIT}	V_{OUT} = 90% × $V_{OUT(NOM)}$		300	600		mA
Short Circuit Current	I_{SHORT}	V_{OUT} = 0V			380		mA
Quiescent Current	I_Q	I_{OUT} = 0mA			13	40	μA
Shutdown Supply Current	I_{SHDN}	V_{EN} = 0V, V_{IN} = 5.5V			0.03	2	μA
EN Input Threshold	V_{IH}	V_{IN} = 1.1V to 5.5V		0.7			V
	V_{IL}					0.3	
EN Pull-Down Current	I_{EN}	V_{EN} = V_{IN}			0.03	1	μA
Output Discharge Resistance	R_{DIS}	V_{EN} = 0V, V_{IN} = 3.3V			50		Ω
Turn-On Time	t_{ON}	From EN rising from 0V to V_{IN} to 90% × $V_{OUT(NOM)}$, no load			100	240	μs
Power Supply Rejection Ratio	PSRR	I_{OUT} = 20mA, V_{IN} = $V_{OUT(NOM)}$ + 1V	f = 100Hz		90		dB
			f = 1kHz		92		
			f = 10kHz		80		
			f = 100kHz		53		
Output Voltage Noise	e_n	f = 10Hz to 100kHz, I_{OUT} = 20mA			9.5		$μV_{RMS}$
Thermal Shutdown Temperature	T_{SHDN}				160		℃
Thermal Shutdown Hysteresis	ΔT_{SHDN}				20		℃

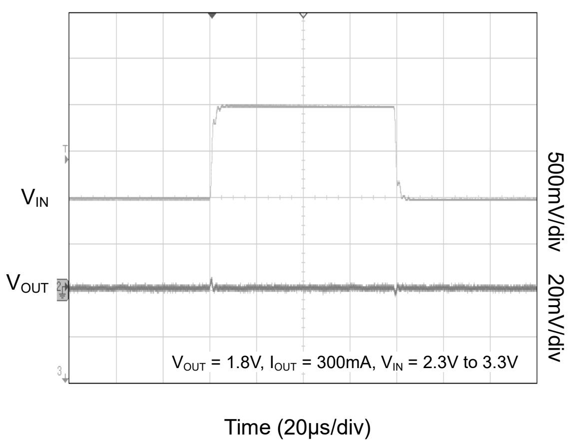
TYPICAL PERFORMANCE CHARACTERISTICS

T_J = +25℃, V_{IN} = ($V_{OUT(NOM)}$ + 0.3V) or 1.1V (whichever is greater), V_{EN} = 1V, C_{IN} = C_{OUT} = 1μF, unless otherwise noted.

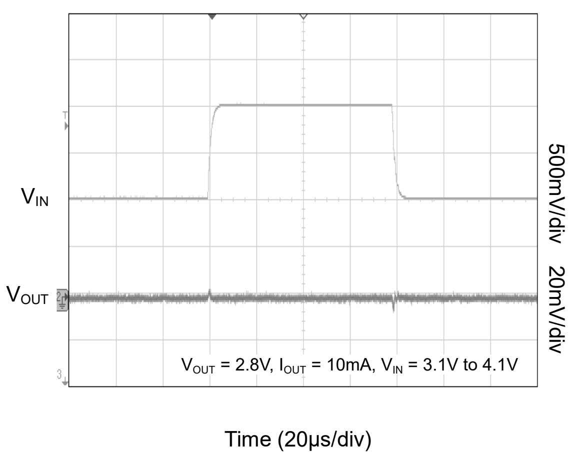
Line Transient Response



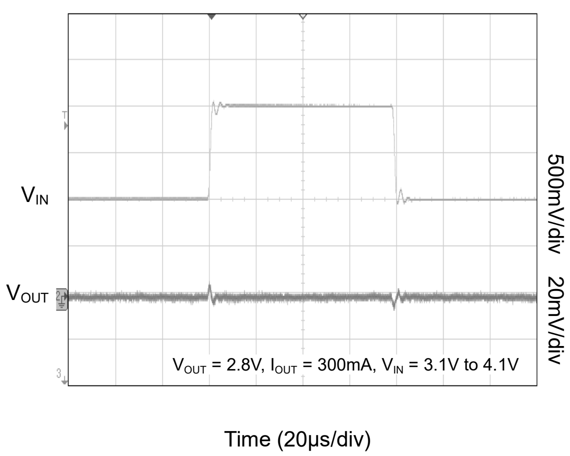
Line Transient Response



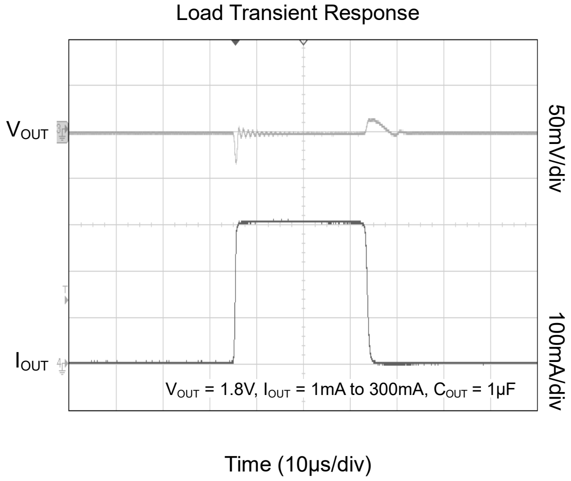
Line Transient Response



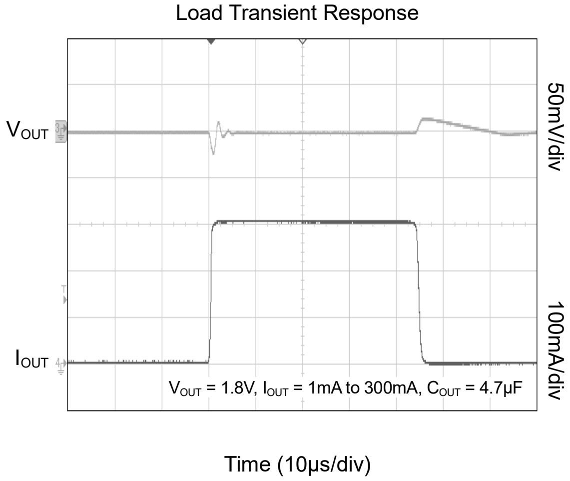
Line Transient Response



Load Transient Response



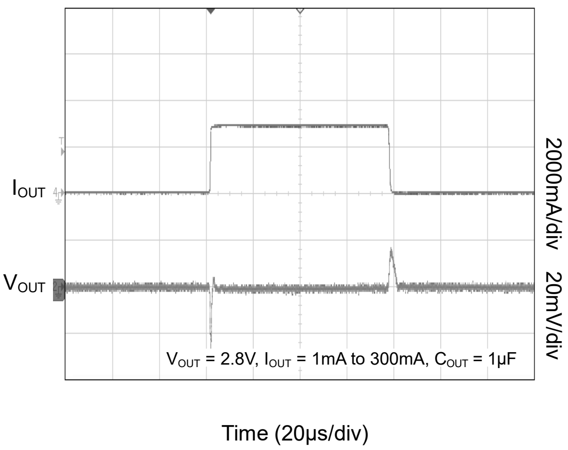
Load Transient Response



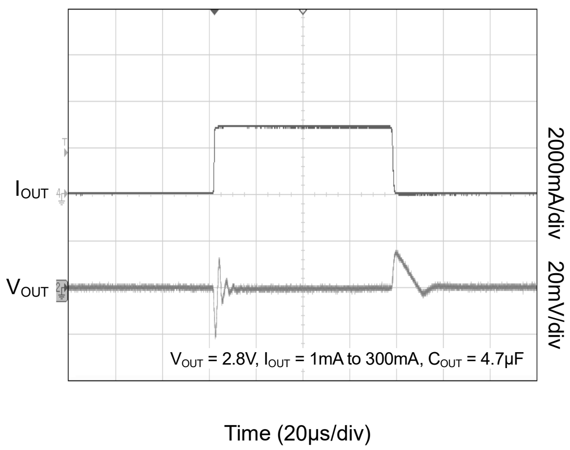
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_J = +25℃, V_{IN} = ($V_{OUT(NOM)}$ + 0.3V) or 1.1V (whichever is greater), V_{EN} = 1V, C_{IN} = C_{OUT} = 1μF, unless otherwise noted.

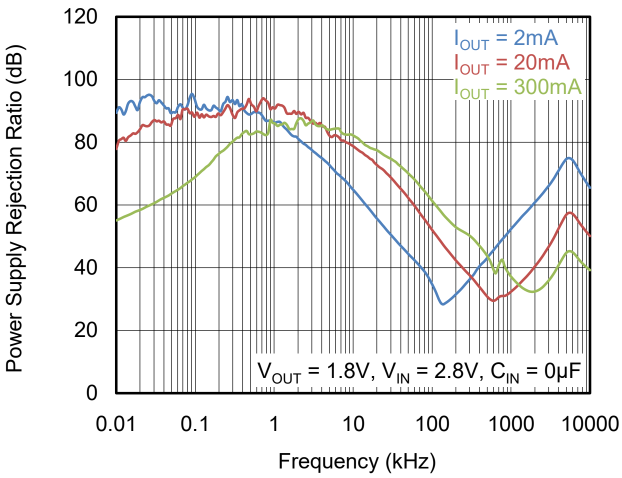
Load Transient Response



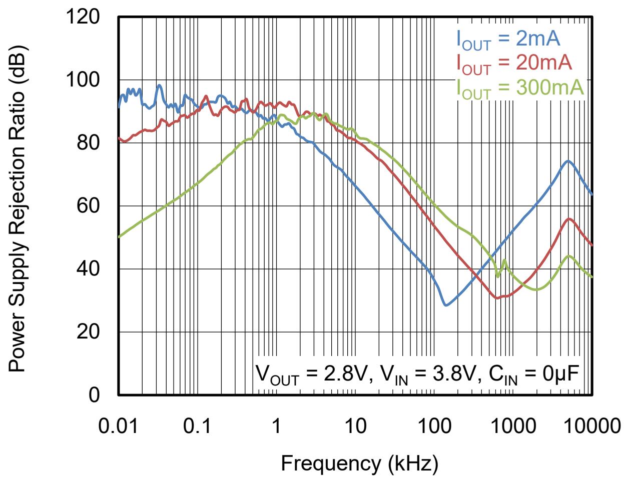
Load Transient Response



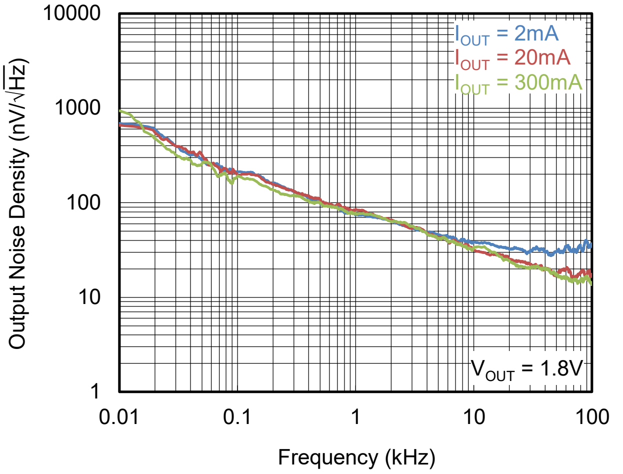
Power Supply Rejection Ratio vs. Frequency



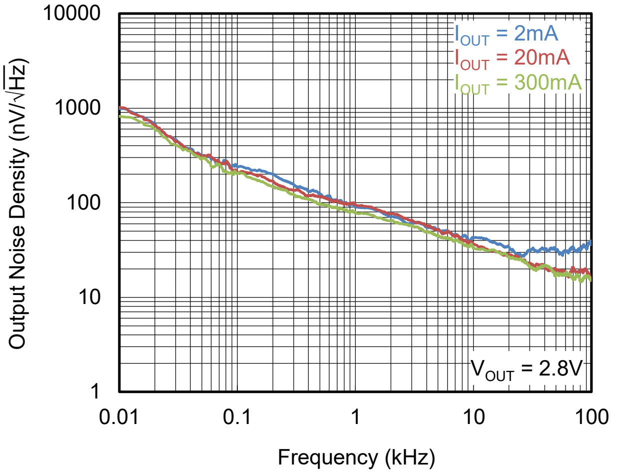
Power Supply Rejection Ratio vs. Frequency



Output Noise Density vs. Frequency

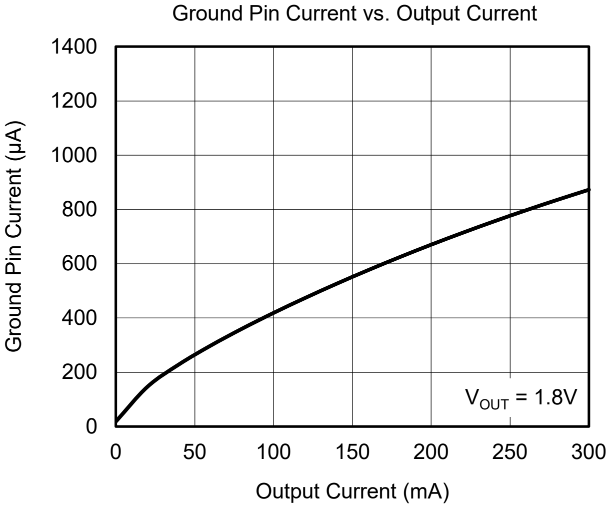


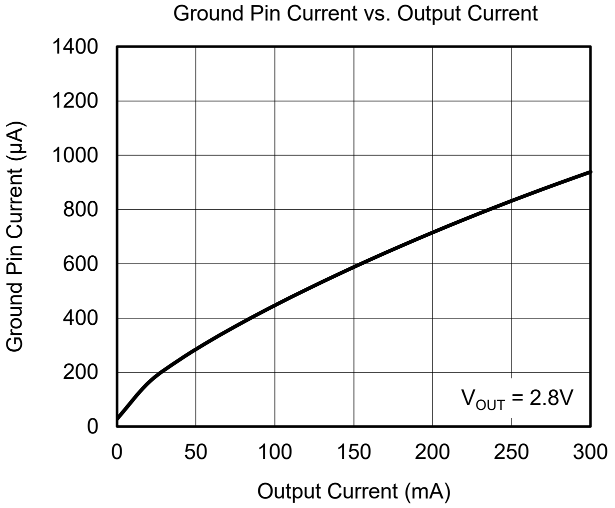
Output Noise Density vs. Frequency

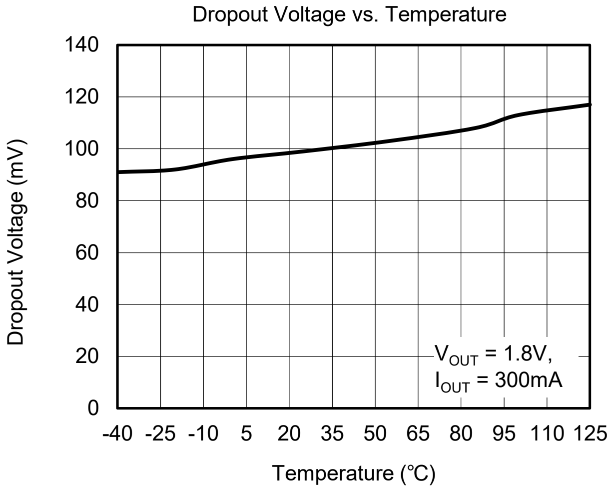


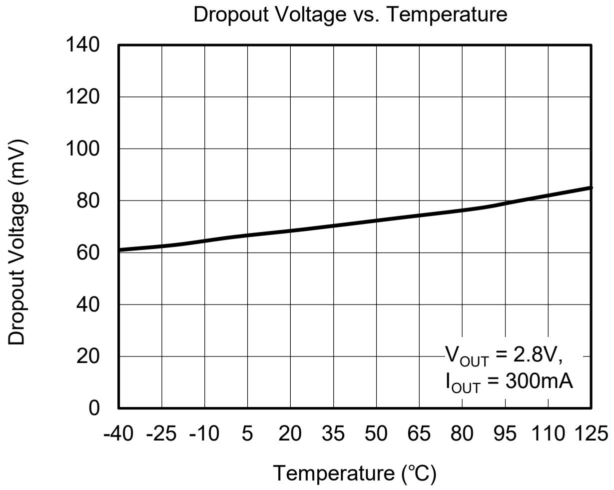
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

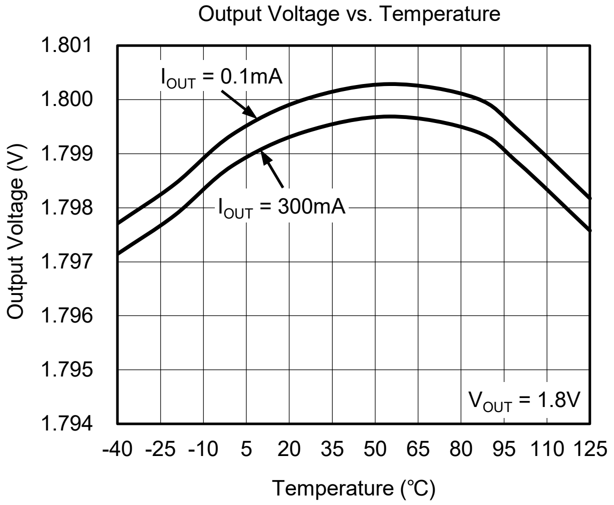
T_J = +25℃, V_{IN} = ($V_{OUT(NOM)}$ + 0.3V) or 1.1V (whichever is greater), V_{EN} = 1V, C_{IN} = C_{OUT} = 1μF, unless otherwise noted.

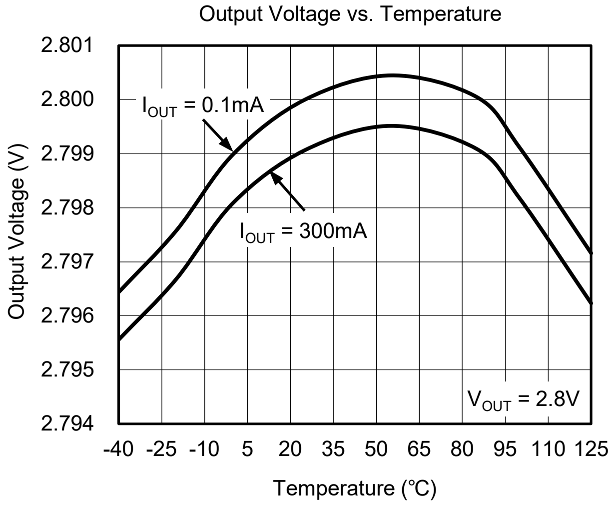








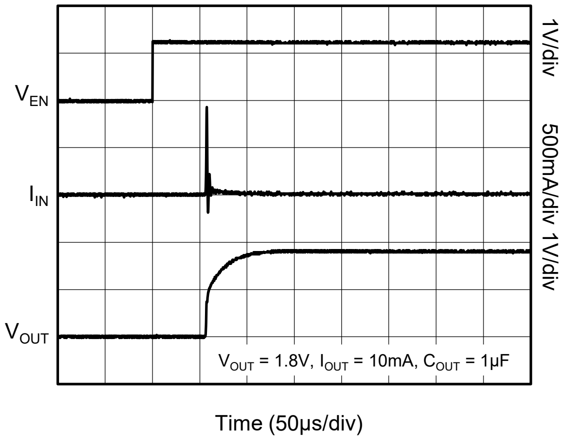




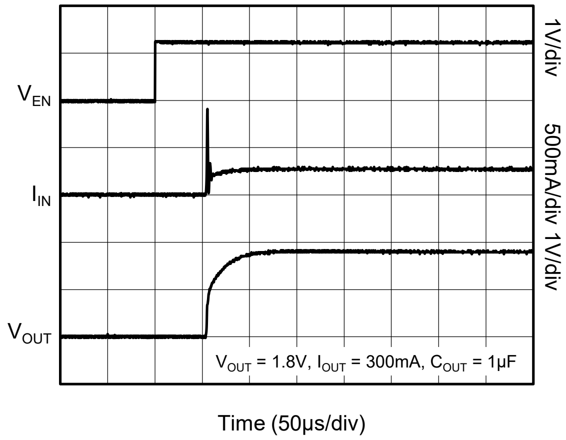
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_J = +25°C, V_{IN} = ($V_{OUT(NOM)}$ + 0.3V) or 1.1V (whichever is greater), V_{EN} = 1V, C_{IN} = C_{OUT} = 1μF, unless otherwise noted.

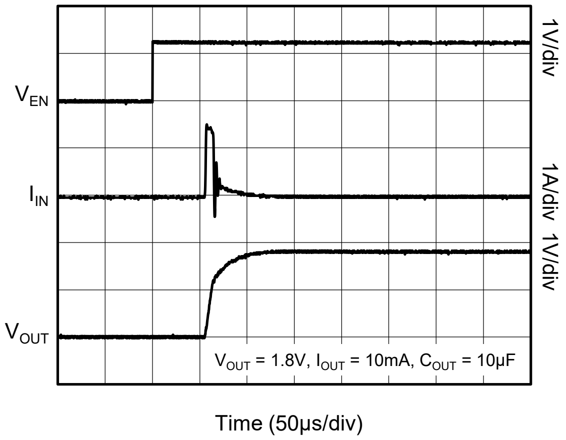
Enable Turn-On Response



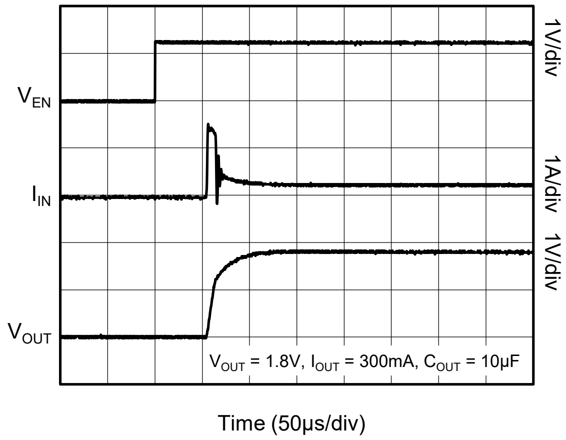
Enable Turn-On Response



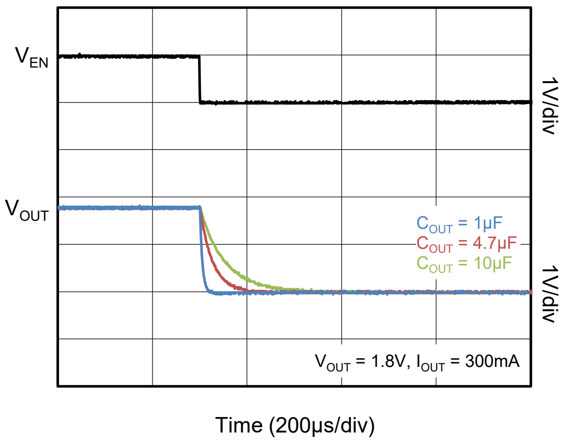
Enable Turn-On Response



Enable Turn-On Response



Enable Turn-Off Response



FUNCTIONAL BLOCK DIAGRAMS

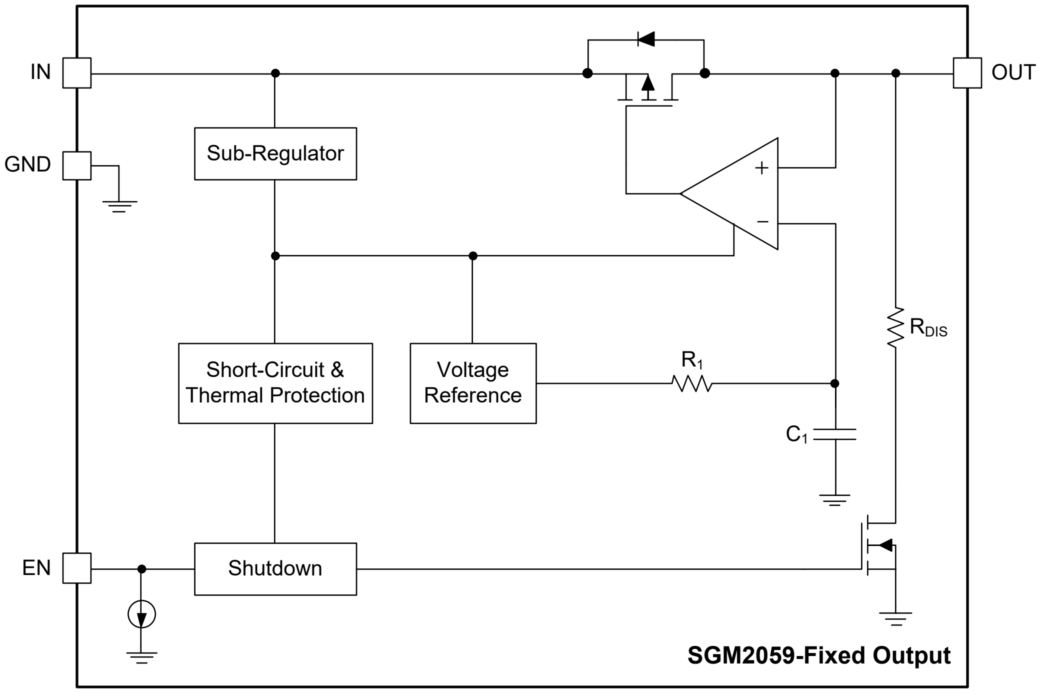


Figure 2. Fixed Output Regulator Block Diagram

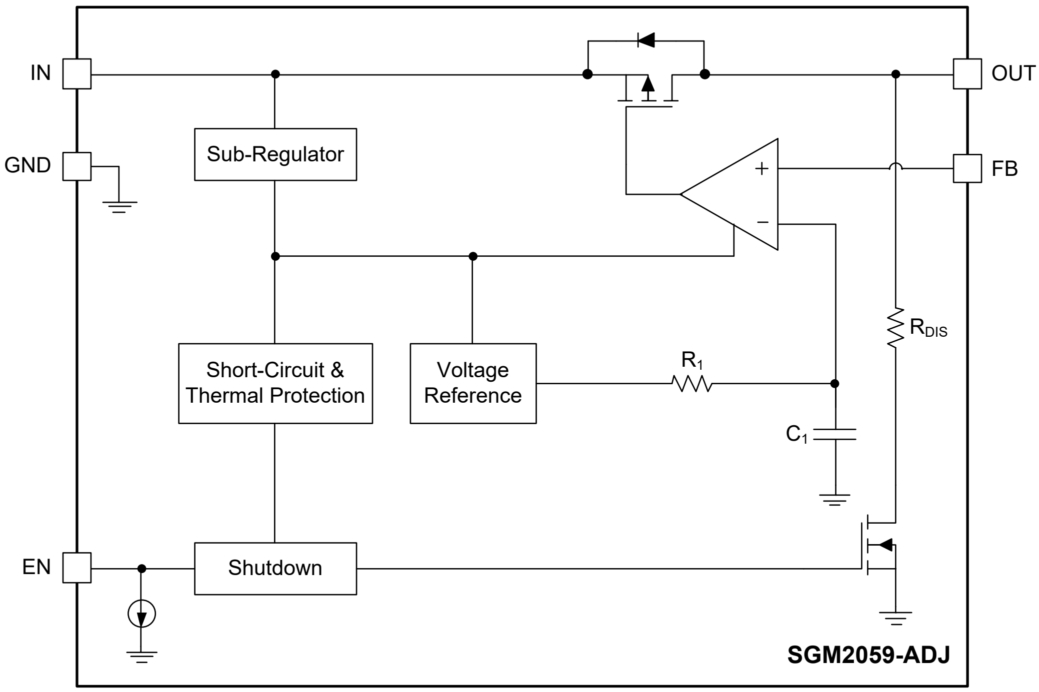


Figure 3. Adjustable Output Regulator Block Diagram

APPLICATION INFORMATION

The SGM2059 is a low V_{IN}, ultra-low noise, high PSRR and low dropout LDO and provides 300mA output current. These features make the device a reliable solution to solve many challenging problems in the generation of clean and accurate power supply. The high performance also makes the SGM2059 useful in a variety of applications. The SGM2059 provides the protection functions for output overload, output short -circuit condition and overheating.

The SGM2059 provides an EN pin as an external chip enable control to enable/disable the device. When the regulator is in shutdown state, the shutdown current consumes as low as 0.03μA (TYP).

Input Capacitor Selection (C_{IN})

The input decoupling capacitor should be placed as close as possible to the IN pin for ensuring the device stability. 1μF or larger X7R or X5R ceramic capacitor is selected to get good dynamic performance.

When V_{IN} is required to provide large current instantaneously, a large effective input capacitor is required. Multiple input capacitors can limit the input tracking inductance. Adding more input capacitors is available to restrict the ringing and to keep it below the device absolute maximum ratings.

Output Capacitor Selection (C_{OUT})

The output capacitor should be placed as close as possible to the OUT pin. 1μF or larger X7R or X5R ceramic capacitor is selected to get good dynamic performance. The minimum effective capacitance of C_{OUT} that SGM2059 can remain stable is 0.5μF. For ceramic capacitor, temperature, DC bias and package size will change the effective capacitance, so enough margin of C_{OUT} must be considered in design. Additionally, C_{OUT} with larger capacitance and lower ESR will help increase the high frequency PSRR and improve the load transient response.

Adjustable Regulator

The output voltage of the SGM2059-ADJ can be adjusted from 0.793V to 5.0V. The FB pin will be connected to two external resistors as shown in Figure 4. Capacitance C_{FF} = 10nF can be added to improve stability and reduce noise. Use R_2 = 40kΩ to maintain a 20μA minimum load. The output voltage is determined by the following equation:

$$V_{OUT} = V_{FB} \times \left(1 + \frac{R_1}{R_2}\right) \quad (1)$$

where:

V_{OUT} is output voltage and V_{FB} is the internal voltage reference, V_{FB} = 0.793V.

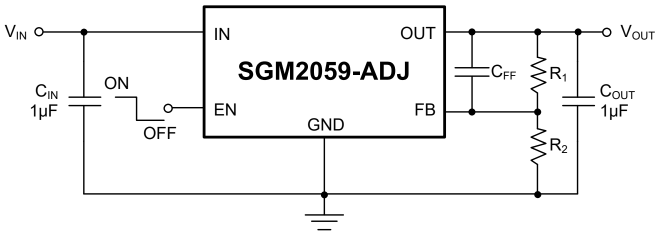


Figure 4. Adjustable Output Voltage Application

Enable Operation

The EN pin of the SGM2059 is used to enable/disable its device and to deactivate/activate the output automatic discharge function.

When the EN pin voltage is lower than 0.3V, the device is in shutdown state, there is no current flowing from IN to OUT pins. In this state, the automatic discharge transistor is active to discharge the output voltage through a 50Ω (TYP) resistor.

When the EN pin voltage is higher than 0.7V, the device is in active state, the input voltage is regulated to the output voltage and the automatic discharge transistor is turned off.

The EN pin is pulled down by internal 0.03μA (TYP) current source when the EN pin is floated. This current source will ensure the SGM2059 in shutdown state and reduce the power dissipation in system.

APPLICATION INFORMATION (continued)

Reverse Current Protection

The PMOS power transistor has an inherent body diode. This body diode will be forward biased when V_{OUT} > V_{IN}. When V_{OUT} > V_{IN}, the reverse current flowing from the OUT pin to the IN pin will damage the SGM2059. If V_{OUT} > V_{IN} event would happen in system, one external diode will be added between OUT pin and IN pin in circuit design to protect the SGM2059.

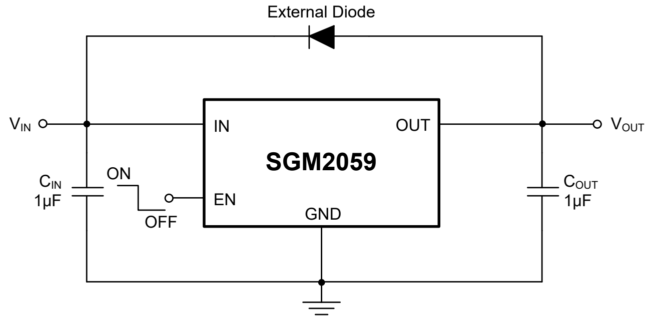


Figure 5. Reverse Protection Reference Design

Negatively Biased Output

When the output voltage is negative, the chip may not start up due to parasitic effects. Ensure that the output is greater than -0.3V under all conditions. If negatively biased output is excessive and expected in the application, a Schottky diode can be added between the OUT pin and GND pin.

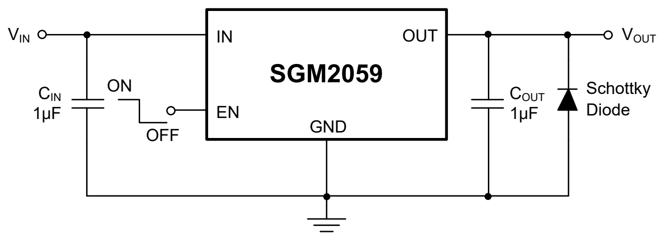


Figure 6. Negatively Biased Output Application

Output Current Limit and Short-Circuit Protection

When overload events happen, the output current is internally limited to 600mA (TYP). When the OUT pin is shorted to ground, the short-circuit protection will limit the output current to 380mA (TYP).

Thermal Shutdown

The SGM2059 can detect the temperature of die. When the die temperature exceeds the threshold value of thermal shutdown, the SGM2059 will be in shutdown state and it will remain in this state until the die temperature decreases to +140℃.

Power Dissipation (P_D)

Thermal protection limits power dissipation in the SGM2059. When power dissipation on pass element ($P_D = (V_{IN} - V_{OUT}) \times I_{OUT}$) is too much and the operating junction temperature exceeds +160℃, the OTP circuit starts the thermal shutdown function and turns the pass element off.

Therefore, thermal analysis for the chosen application is important to guarantee reliable performance over all conditions. To guarantee reliable operation, the junction temperature of the SGM2059 must not exceed +125℃.

The maximum allowable power dissipation depends on the thermal resistance of the IC package, the PCB layout, the rate of surrounding airflow, and the difference between the junction temperature and ambient temperature. The maximum power dissipation can be approximated using the following equation:

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

where $T_{J(MAX)}$ is the maximum junction temperature, T_A is the ambient temperature, and θ_{JA} is the junction -to-ambient thermal resistance.

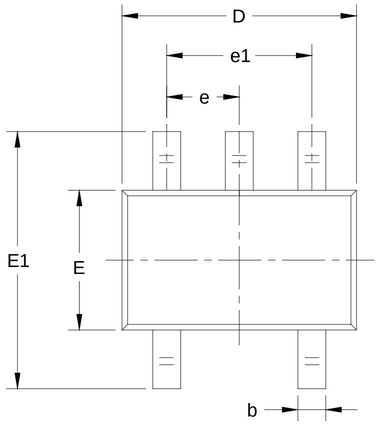
REVISION HISTORY

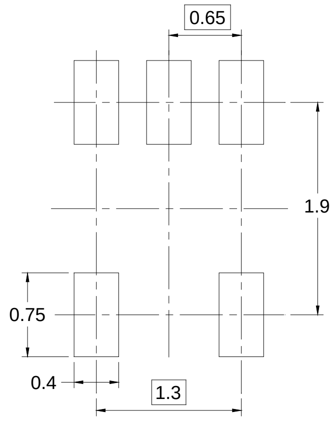
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (JUNE 2022) to REV.A	Page
Changed from product preview to production data	All

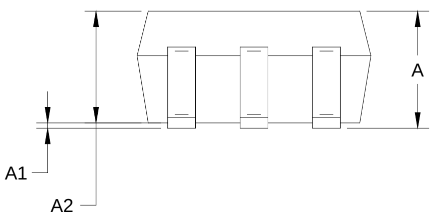
PACKAGE OUTLINE DIMENSIONS

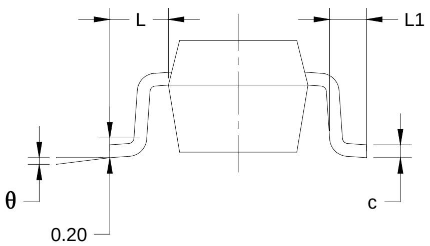
SC70-5





RECOMMENDED LAND PATTERN (Unit: mm)



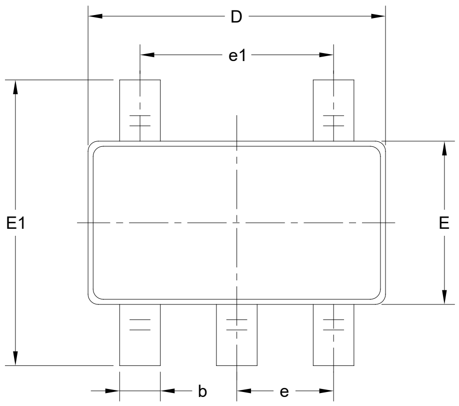


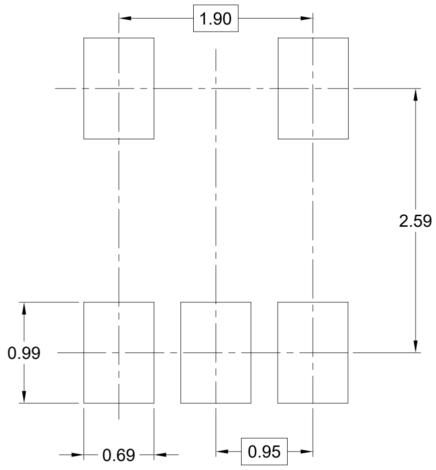
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.800	1.100	0.031	0.043
A1	0.000	0.100	0.000	0.004
A2	0.800	1.000	0.031	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.220	0.003	0.009
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.65 TYP		0.026 TYP	
e1	1.300 BSC		0.051 BSC	
L	0.525 REF		0.021 REF	
L1	0.260	0.460	0.010	0.018
θ	0°	8°	0°	8°

NOTES:
1. Body dimensions do not include mode flash or protrusion.
2. This drawing is subject to change without notice.

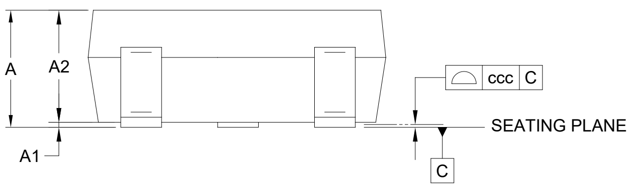
PACKAGE OUTLINE DIMENSIONS

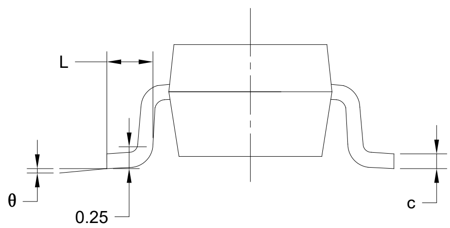
SOT-23-5





RECOMMENDED LAND PATTERN (Unit: mm)



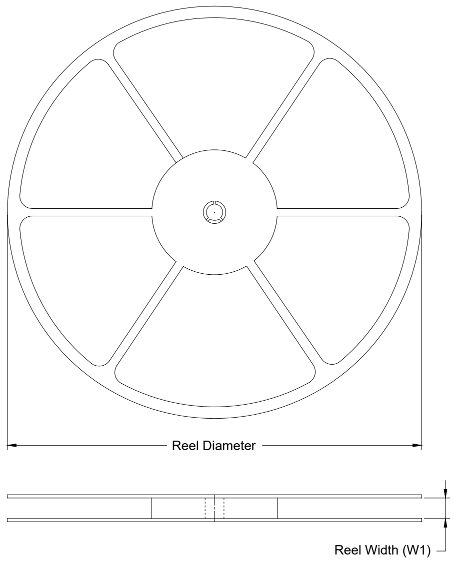


Symbol	Dimensions In Millimeters		
	MIN	MOD	MAX
A	-	-	1.450
A1	0.000	-	0.150
A2	0.900	-	1.300
b	0.300	-	0.500
c	0.080	-	0.220
D	2.750	-	3.050
E	1.450	-	1.750
E1	2.600	-	3.000
e	0.950 BSC		
e1	1.900 BSC		
L	0.300	-	0.600
θ	0°	-	8°
ccc	0.100		

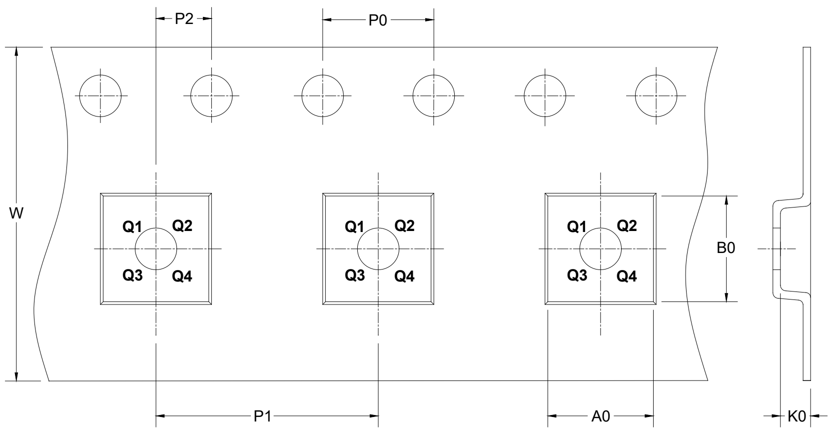
NOTES:
1. This drawing is subject to change without notice.
2. The dimensions do not include mold flashes, protrusions or gate burrs.
3. Reference JEDEC MO-178.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



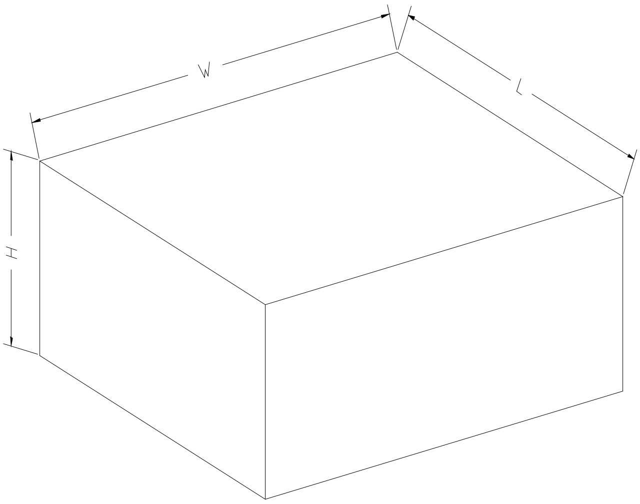
NOTE: The picture is only for reference. Please make the object as the standard.

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
SC70-5	7″	9.5	2.25	2.55	1.20	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