SGM2210P
200mA, Low Quiescent Current and Low Noise Linear Regulator

GENERAL DESCRIPTION

The SGM2210P is a low quiescent current, low noise and low dropout voltage linear regulator. It is capable of supplying 200mA output current with typical dropout voltage of 160mV. The operating input voltage range is from 2.5V to 20V. The fixed output voltage range is from 1.2V to 5.0V and adjustable output voltage range is from 1.185V to 12V.

Other features include logic-controlled shutdown mode, short-circuit current limit and thermal shutdown protection. The SGM2210P has automatic discharge function to quickly discharge V_{OUT} in the disabled status.

The SGM2210P is available in a Green SOT-23-5 package. It operates over an operating temperature range of -40℃ to +125℃.

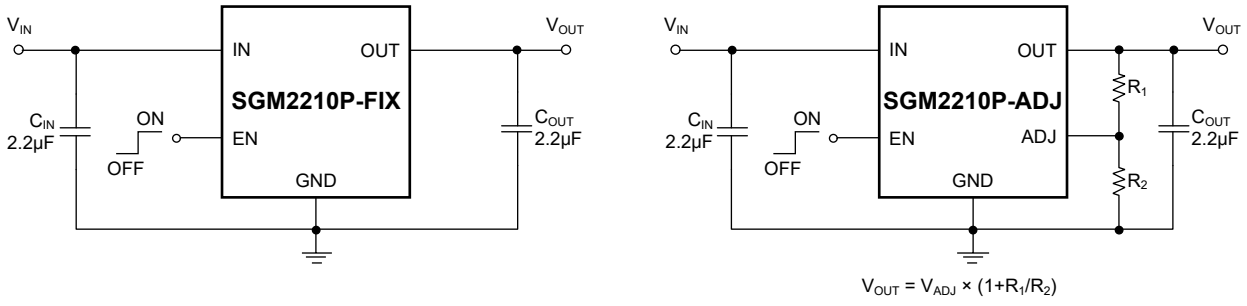
FEATURES

- **Operating Input Voltage Range: 2.5V to 20V**
- **Fixed Outputs of 1.2V, 3.3V, 4.1V and 5.0V**
- **Adjustable Output from 1.185V to 12V**
- **200mA Output Current**
- **Output Voltage Accuracy: ±1% at +25℃**
- **Quiescent Current: 36μA (TYP)**
- **Low Dropout: 80mV (TYP) at 100mA, V_{OUT} = 3.3V**
- **Low Noise: 48μV_{RMS} (TYP) at V_{OUT} = 3.3V**
- **High PSRR: 100dB (TYP) at 1kHz**
- **Reverse Current Protection when V_{OUT} > V_{IN}**
- **Shutdown Supply Current: 0.5μA (TYP)**
- **Current Limiting and Thermal Protection**
- **With Output Automatic Discharge**
- **Stable with Small Case Size Ceramic Capacitors**
- **-40℃ to +125℃ Operating Temperature Range**
- **Available in a Green SOT-23-5 Package**

APPLICATIONS

Palmtop Computers
Portable Electronics
Industrial and Medical Equipment
Battery-Powered Equipment

TYPICAL APPLICATION



Fixed Output Voltage Version

Adjustable Output Voltage Version

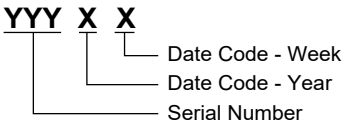
Figure 1. Typical Application Circuits

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM2210P-1.2B	SOT-23-5	-40℃ to +125℃	SGM2210P-1.2BXN5G/TR	15AXX	Tape and Reel, 3000
SGM2210P-3.3B	SOT-23-5	-40℃ to +125℃	SGM2210P-3.3BXN5G/TR	15BXX	Tape and Reel, 3000
SGM2210P-4.1B	SOT-23-5	-40℃ to +125℃	SGM2210P-4.1BXN5G/TR	15CXX	Tape and Reel, 3000
SGM2210P-5.0B	SOT-23-5	-40℃ to +125℃	SGM2210P-5.0BXN5G/TR	15DXX	Tape and Reel, 3000
SGM2210P-1.2	SOT-23-5	-40℃ to +125℃	SGM2210P-1.2XN5G/TR	CVEXX	Tape and Reel, 3000
SGM2210P-3.3	SOT-23-5	-40℃ to +125℃	SGM2210P-3.3XN5G/TR	CX3XX	Tape and Reel, 3000
SGM2210P-5.0	SOT-23-5	-40℃ to +125℃	SGM2210P-5.0XN5G/TR	CY4XX	Tape and Reel, 3000
SGM2210P-ADJ	SOT-23-5	-40℃ to +125℃	SGM2210P-ADJXN5G/TR	CY5XX	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

IN, EN to GND ..... -0.3V to 22V
OUT to GND ..... -0.3V to MIN(V_{IN} + 5.5V, 22V)
ADJ to GND ..... -0.3V to 2V
Output Current ..... Internally Limited
Package Thermal Resistance
SOT-23-5, θ_{JA} ..... 166.8℃/W
SOT-23-5, θ_{JB} ..... 32.3℃/W
SOT-23-5, θ_{JC} ..... 55.2℃/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 .....2.5V to 20V
Enable Input Voltage Range .....0V to 20V
Input Effective Capacitance, C_{IN} ..... 1μF (MIN)
Output Effective Capacitance, C_{OUT}.....1μF to 22μF
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.

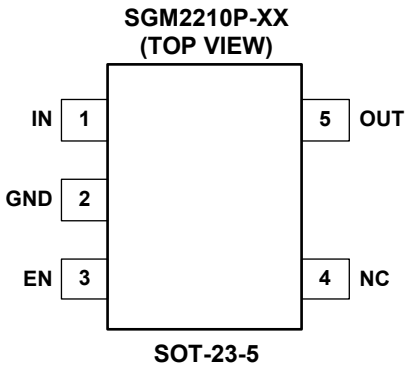
ESD SENSITIVITY CAUTION

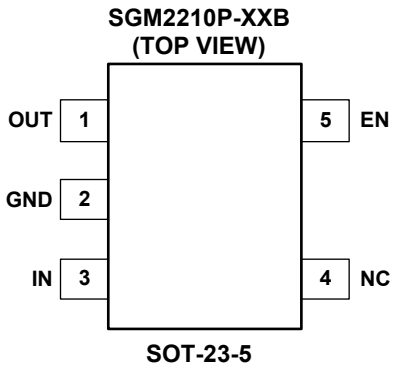
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance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

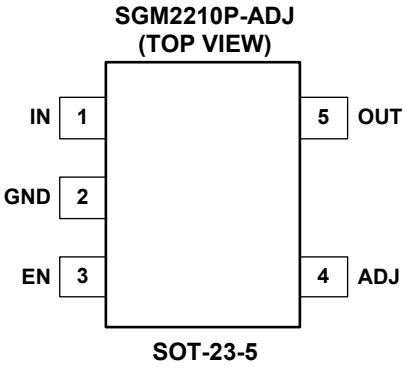
DISCLAIMER

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

PIN CONFIGURATIONS







PIN DESCRIPTION

PIN		NAME	FUNCTION
SGM2210P-XX	SGM2210P-XXB		
1	3	IN	Input Supply Voltage Pin. It is recommended to use a 2.2μF 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	2	GND	Ground.
3	5	EN	Enable Pin. Drive EN high to turn on the regulator. Drive EN low to turn off the regulator.
4	4	NC	No Connection (fixed voltage version only).
	–	ADJ	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	1	OUT	Regulator Output Pin. It is recommended to use a ceramic capacitor with effective capacitance in the range of 1μF to 22μF to ensure stability. This ceramic capacitor should be placed as close as possible to OUT pin.

FUNCTIONAL BLOCK DIAGRAMS

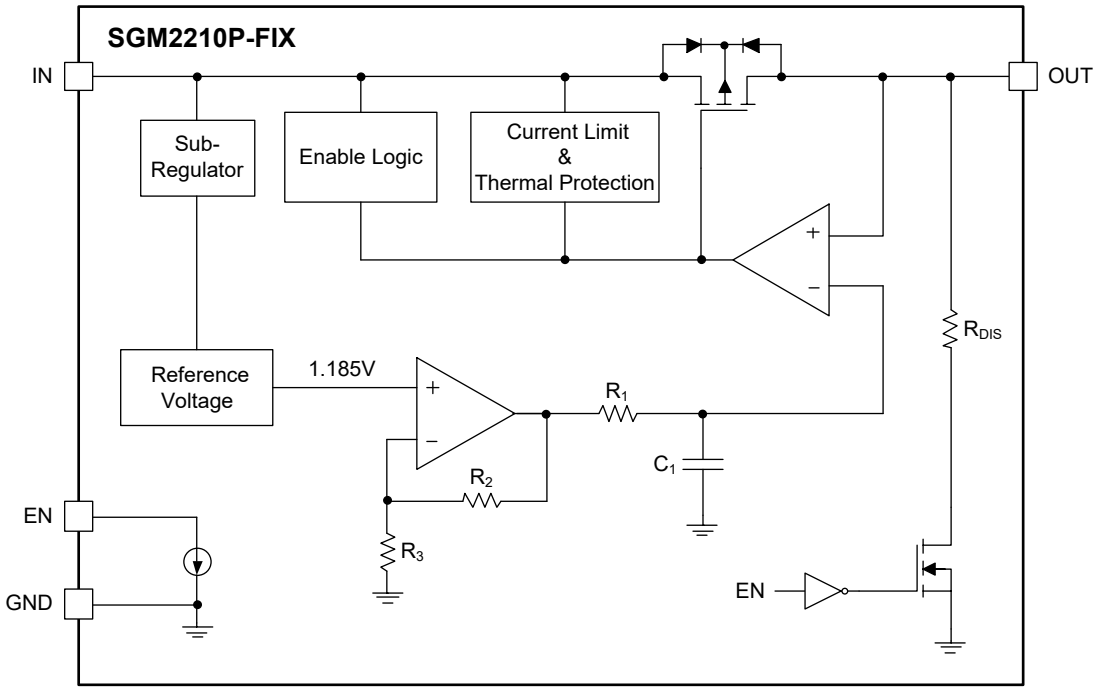


Figure 2. Fixed Version Block Diagram

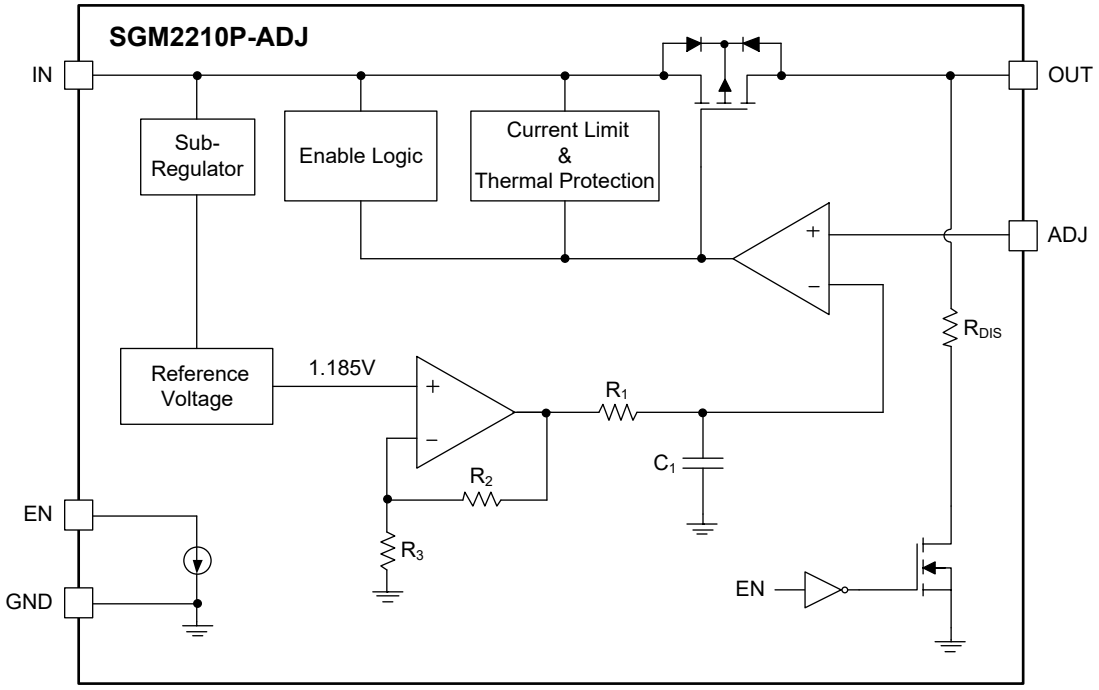


Figure 3. Adjustable Version Block Diagram

ELECTRICAL CHARACTERISTICS

(V_{IN} = $V_{OUT(NOM)}$ + 1V, V_{EN} = V_{IN}, I_{OUT} = 1mA, C_{IN} = 2.2μF, C_{OUT} = 2.2μF, 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}	T_J = +25℃		2.5		20	V
Output Voltage Accuracy	V_{OUT}	I_{OUT} = 1mA, T_J = +25℃		-1		1	%
		I_{OUT} = 1mA		-1.5		1.5	
Adjustable Voltage	V_{ADJ}	T_J = +25℃			1.185		V
ADJ Pin Current	I_{ADJ}	T_J = +25℃			1	3	nA
		T_J = -40℃ to +125℃				5	
Line Regulation	$\frac{\Delta V_{OUT}}{\Delta V_{IN} \times V_{OUT}}$	V_{IN} = ($V_{OUT(NOM)}$ + 1V) to 20V, I_{OUT} = 1mA	T_J = +25℃		0.001	0.005	%/V
			T_J = -40℃ to +125℃			0.01	
Load Regulation	$\frac{\Delta V_{OUT}}{V_{OUT} \times \Delta I_{OUT}}$	I_{OUT} = 1mA to 200mA	T_J = +25℃		0.0005	0.001	%/mA
			T_J = -40℃ to +125℃			0.003	
Dropout Voltage (1)	V_{DROP}	V_{OUT} = 3.3V, I_{OUT} = 100mA	T_J = +25℃		80	95	mV
			T_J = -40℃ to +125℃			135	
		V_{OUT} = 3.3V, I_{OUT} = 200mA	T_J = +25℃		160	190	
			T_J = -40℃ to +125℃			270	
Output Current Limit	I_{LIMIT}	V_{OUT} = 90% × $V_{OUT(NOM)}$, T_J = +25℃		240	380		mA
Quiescent Current	I_Q	V_{IN} = ($V_{OUT(NOM)}$ + 1V) to 20V, I_{OUT} = 0mA	T_J = +25℃		36	50	μA
			T_J = -40℃ to +125℃			65	
		V_{IN} = ($V_{OUT(NOM)}$ + 1V) to 20V, I_{OUT} = 200mA	T_J = +25℃		490	600	
			T_J = -40℃ to +125℃			650	
Shutdown Current	I_{SHDN}	V_{EN} = GND	T_J = +25℃		0.5	1	μA
			T_J = -40℃ to +125℃			1.6	
Enable Input Logic Low	V_{IL}	V_{IN} = 2.5V to 20V				0.4	V
Enable Input Logic High	V_{IH}	V_{IN} = 2.5V to 20V		1.2			
EN Pin Input Current	I_{EN}	V_{EN} = V_{IN}	T_J = +25℃		300	600	nA
			T_J = -40℃ to +125℃			1000	
Input Reverse Current	I_{REV-IN}	V_{EN} = 5.5V, V_{IN} = 15V, V_{OUT} = 20V			22		μA
Output Discharge Resistance	R_{DIS}	V_{IN} = 2.5V, V_{EN} = 0V			95		Ω
Power Supply Rejection Ratio	PSRR	V_{IN} = $V_{OUT(NOM)}$ + 1V, ΔV_{RIPPLE} = 0.2V_{P-P}, V_{OUT} = 3.3V, I_{OUT} = 10mA	f = 1kHz		100		dB
			f = 10kHz		82		
Output Voltage Noise	e_n	f = 10Hz to 100kHz, V_{OUT} = 3.3V, I_{OUT} = 10mA			48		μV_{RMS}
Thermal Shutdown Temperature	T_{SHDN}				155		℃
Thermal Shutdown Hysteresis	ΔT_{SHDN}				20		℃

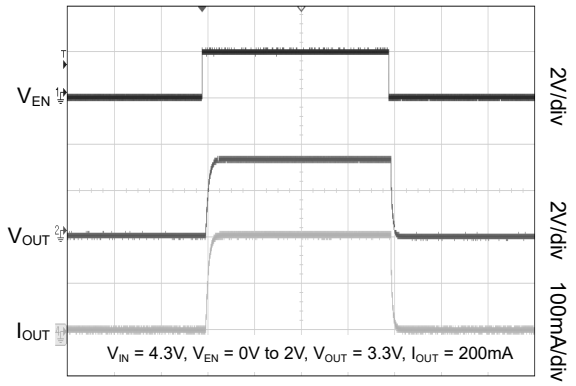
NOTE:

1. The dropout voltage is defined as the difference between V_{IN} and V_{OUT} when V_{OUT} falls to 95% × $V_{OUT(NOM)}$.

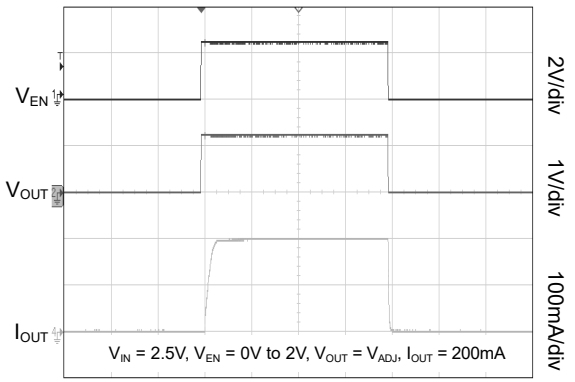
TYPICAL PERFORMANCE CHARACTERISTICS

T_J = +25℃, V_{IN} = $V_{OUT(NOM)}$ + 1V, V_{EN} = V_{IN}, C_{IN} = 2.2μF, C_{OUT} = 2.2μF, unless otherwise noted.

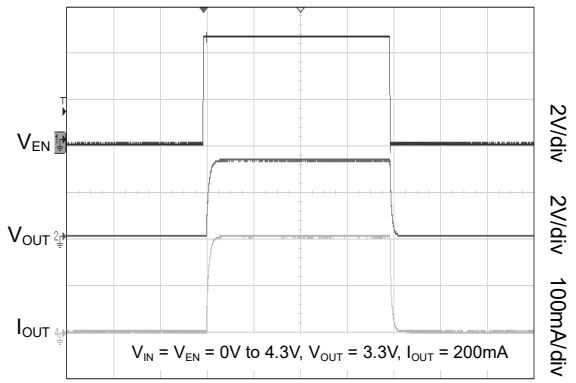
Start-Up with Enable



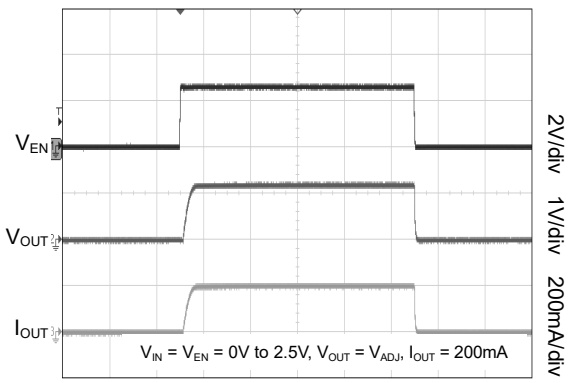
Start-Up with Enable



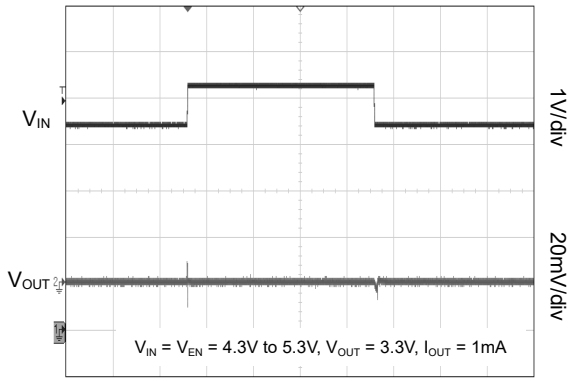
Turn-On Time



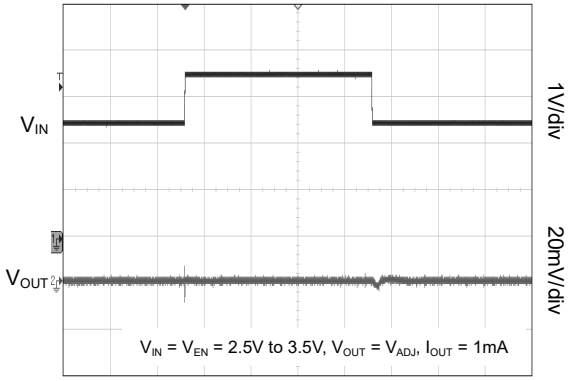
Turn-On Time



Line Transient Response



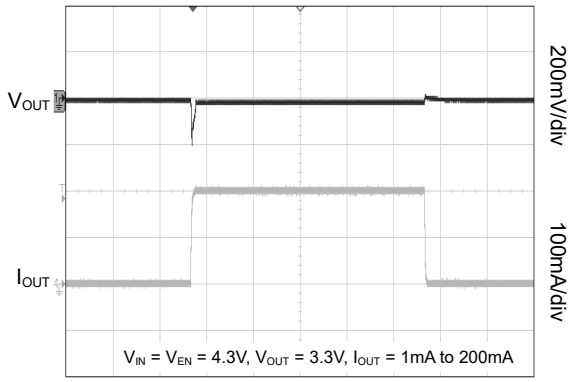
Line Transient Response



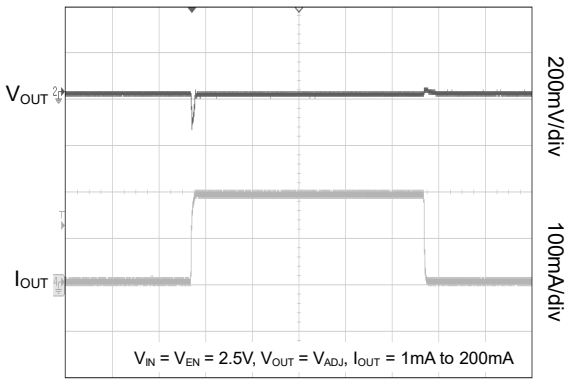
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_J = +25℃, V_{IN} = $V_{OUT(NOM)}$ + 1V, V_{EN} = V_{IN}, C_{IN} = 2.2μF, C_{OUT} = 2.2μF, unless otherwise noted.

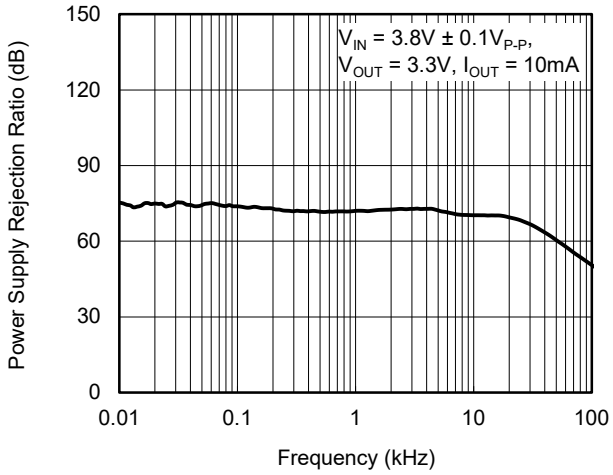
Load Transient Response



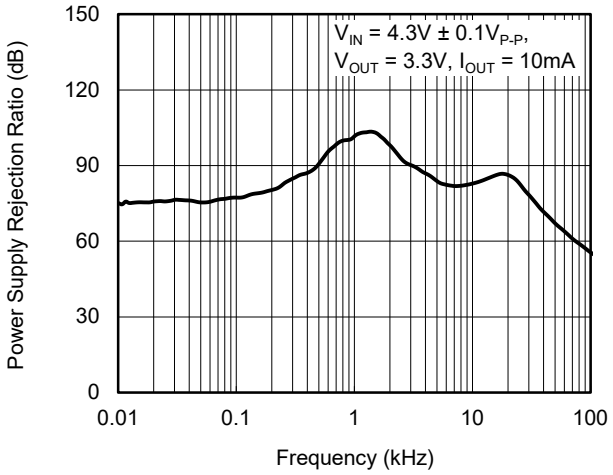
Load Transient Response



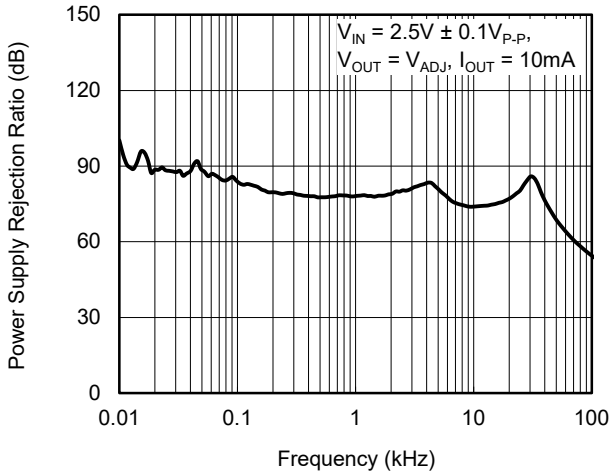
Power Supply Rejection Ratio vs. Frequency



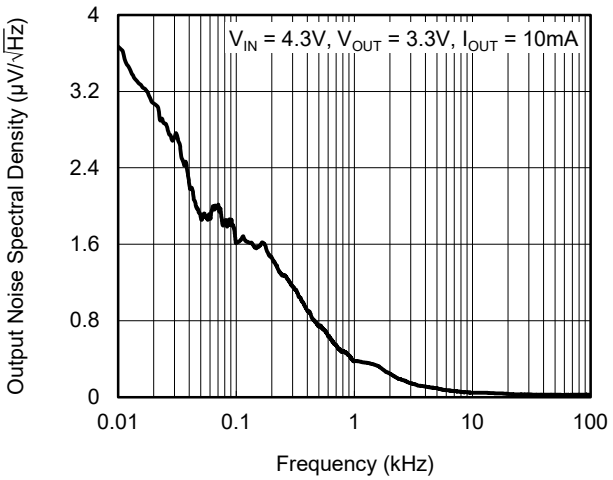
Power Supply Rejection Ratio vs. Frequency



Power Supply Rejection Ratio vs. Frequency



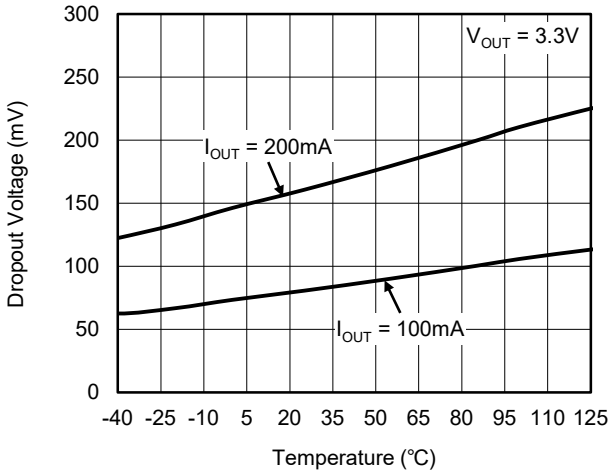
Output Noise Spectral Density vs. Frequency



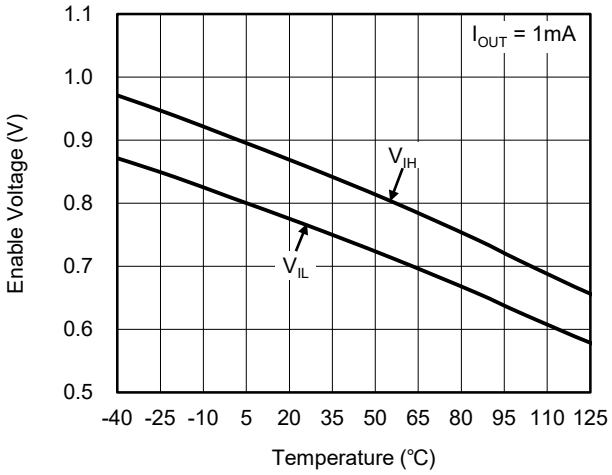
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_J = +25℃, V_{IN} = $V_{OUT(NOM)}$ + 1V, V_{EN} = V_{IN}, C_{IN} = 2.2μF, C_{OUT} = 2.2μF, unless otherwise noted.

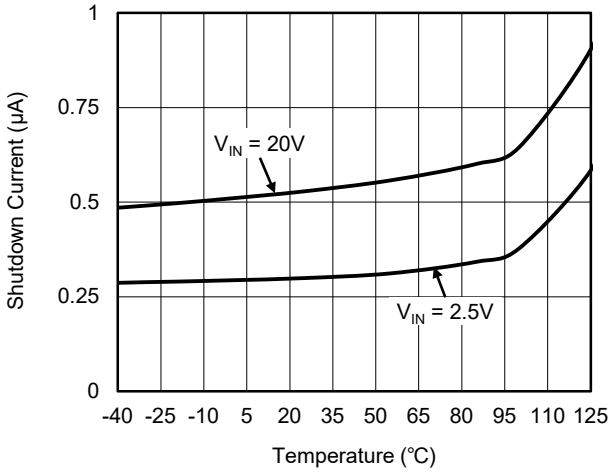
Dropout Voltage vs. Temperature



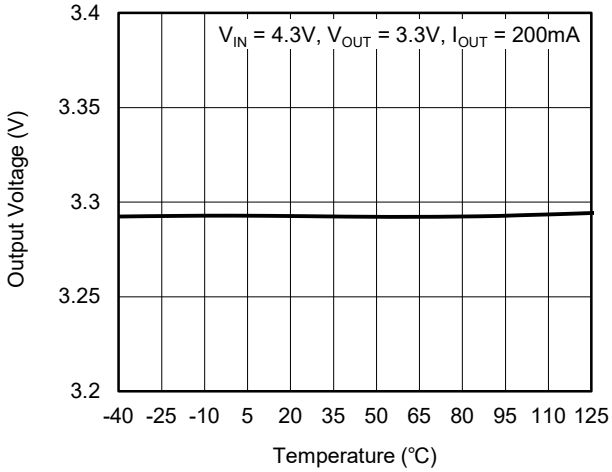
Enable Thresholds vs. Temperature



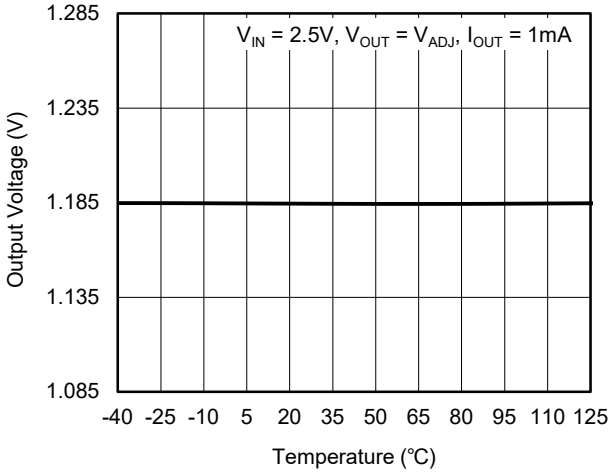
Shutdown Current vs. Temperature



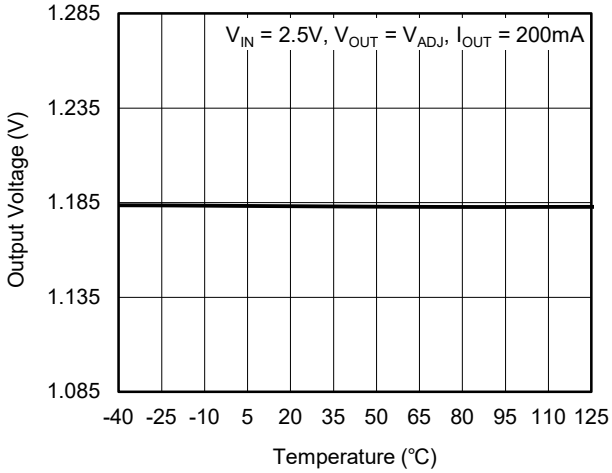
Output Voltage vs. Temperature



Output Voltage vs. Temperature



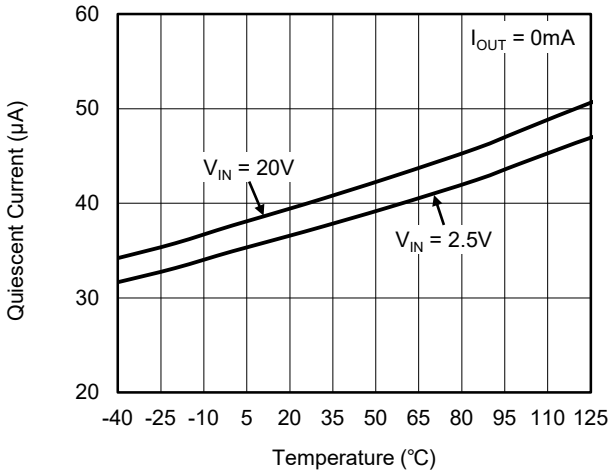
Output Voltage vs. Temperature



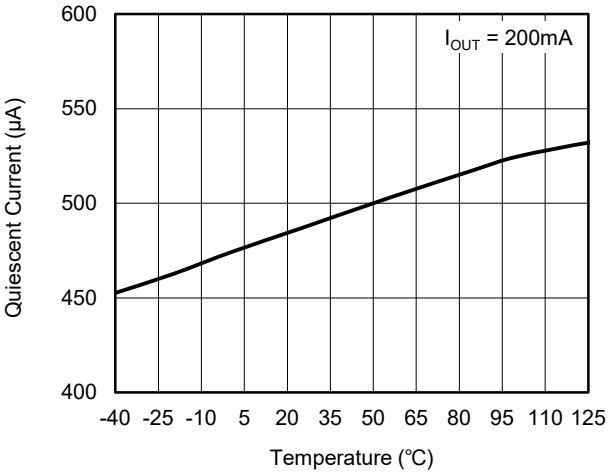
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_J = +25℃, V_{IN} = $V_{OUT(NOM)}$ + 1V, V_{EN} = V_{IN}, C_{IN} = 2.2μF, C_{OUT} = 2.2μF, unless otherwise noted.

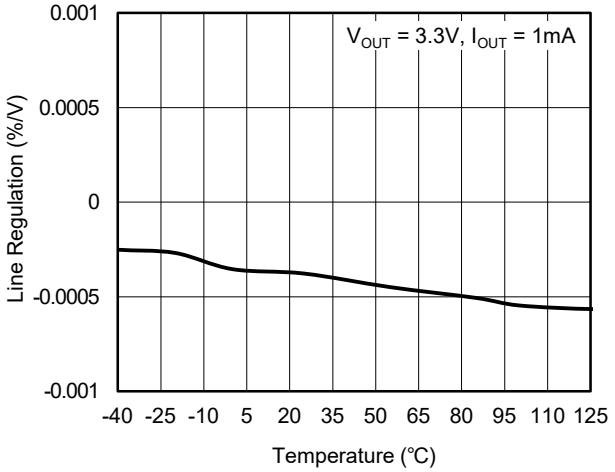
Quiescent Current vs. Temperature



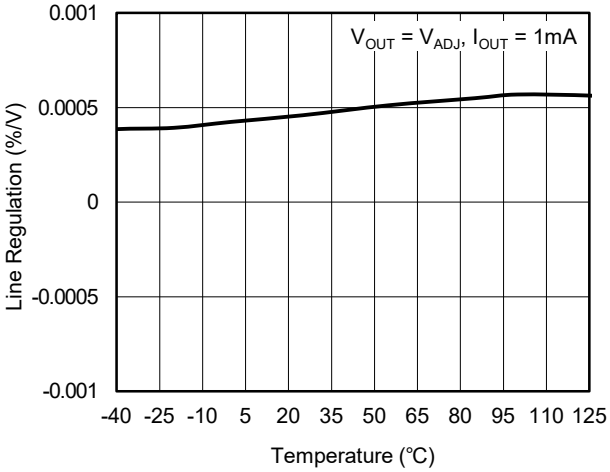
Quiescent Current vs. Temperature



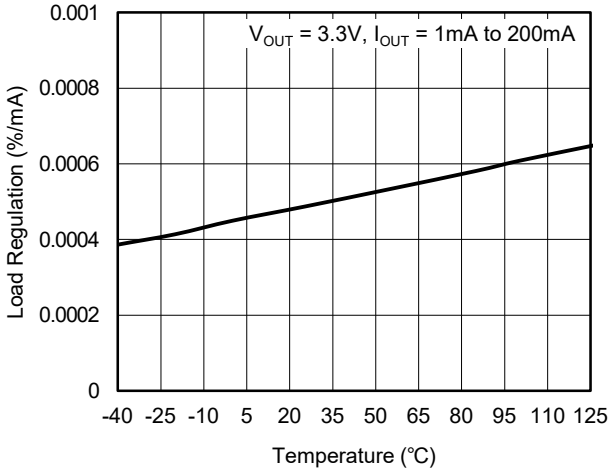
Line Regulation vs. Temperature



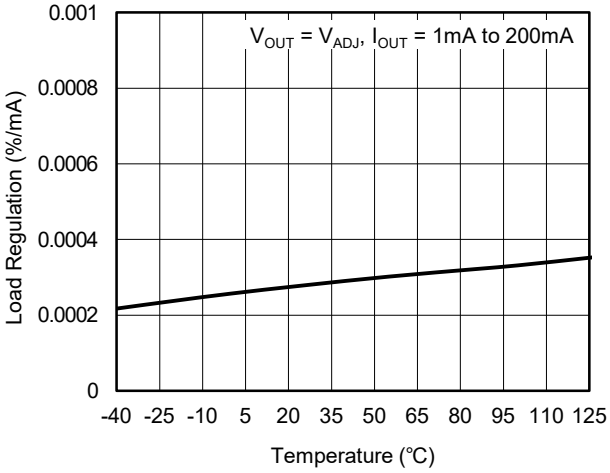
Line Regulation vs. Temperature



Load Regulation vs. Temperature



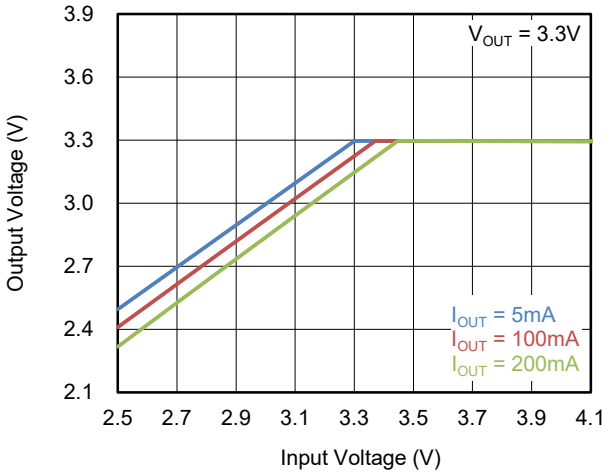
Load Regulation vs. Temperature



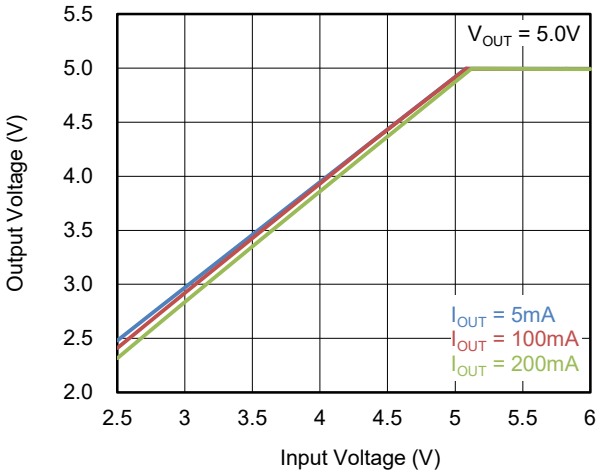
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_J = +25℃, V_{IN} = $V_{OUT(NOM)}$ + 1V, V_{EN} = V_{IN}, C_{IN} = 2.2μF, C_{OUT} = 2.2μF, unless otherwise noted.

Output Voltage vs. Input Voltage in Dropout



Output Voltage vs. Input Voltage in Dropout



APPLICATION INFORMATION

The SGM2210P is a low quiescent current, low noise and low dropout voltage linear regulator and provides 200mA 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 SGM2210P useful in a variety of applications. The SGM2210P provides protection functions for output overload, output short-circuit condition and overheating.

The SGM2210P 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 0.5μA (TYP).

Input Capacitor Selection (C_{IN})

The input decoupling capacitor should be placed as close as possible to the IN pin to ensure the device stability. 2.2μF 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. For C_{OUT} with larger capacitance, it is recommended to choose the larger capacitance C_{IN}.

Output Capacitor Selection (C_{OUT})

The output capacitor should be placed as close as possible to the OUT pin. 2.2μF or larger X7R or X5R ceramic capacitor is selected to get good dynamic performance. The minimum effective capacitance of C_{OUT} that SGM2210P can remain stable is 1μF. 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 SGM2210P-ADJ can be adjusted from 1.185V to 12V. The ADJ pin will be connected to two external resistors as shown in Figure 4. The output voltage is determined by the following equation:

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

where:

V_{OUT} is output voltage and V_{ADJ} is the internal voltage reference, V_{ADJ} = 1.185V.

One parallel capacitor (C_{FF}) with R_1 can be used to improve the feedback loop stability and PSRR, increase the transient response and reduce the output noise. Use R_2 = 150kΩ to maintain an 8μA minimum load.

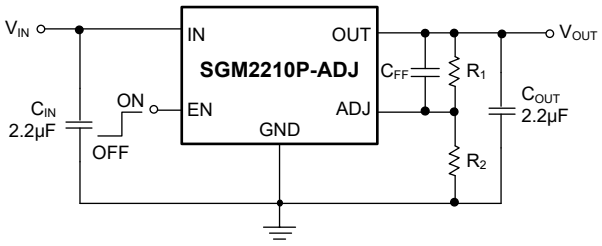


Figure 4. Adjustable Output Voltage Application

Enable Operation

The EN pin of the SGM2210P is used to enable/disable the device and to deactivate/activate the output automatic discharge function.

When the EN pin voltage is lower than 0.4V, 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 95Ω (TYP) resistor.

When the EN pin voltage is higher than 1.2V, the device is in active state. The output voltage is regulated to the expected value and the automatic discharge transistor is turned off.

Reverse Current Protection

The SGM2210P integrates reverse current protection between the OUT pin and the IN pin. When the monitoring circuit of the SGM2210P detects the output voltage is higher than the input voltage, it prevents the flowing of current from the OUT pin to the IN pin. In the case of V_{IN} is equal to 15V and V_{OUT} is equal to 20V, this feature reduces leakage current from the V_{OUT} to V_{IN} to 22μA (TYP). In addition, the reverse current protection circuit can work only when V_{OUT} - V_{IN} ≤ 5V. If the voltage between the OUT pin and the IN pin exceeds 5V, the SGM2210P will be damaged.

APPLICATION INFORMATION (continued)

Output Current Limit and Short-Circuit Protection

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

Thermal Shutdown

When the die temperature exceeds the threshold value of thermal shutdown, the SGM2210P will be in shutdown state and it will remain in this state until the die temperature decreases to +135℃.

Layout Guidelines

To get good PSRR, low output noise and high transient response performance, the input and output bypass capacitors must be placed as close as possible to the IN pin and OUT pin separately.

REVISION HISTORY

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

JUNE 2024 – REV.A.4 to REV.B	Page
Updated Absolute Maximum Ratings section	2
Added SGM2210P-1.2B/3.3B/4.1B/5.0B to Package/Ordering Information	All

DECEMBER 2023 – REV.A.3 to REV.A.4	Page
Updated Typical Performance Characteristics section	10

DECEMBER 2023 – REV.A.2 to REV.A.3	Page
Updated Absolute Maximum Ratings section	2

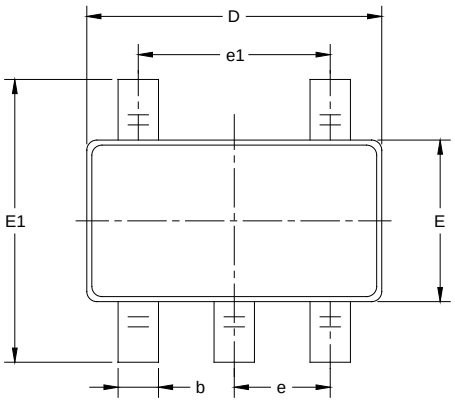
MARCH 2023 – REV.A.1 to REV.A.2	Page
Updated Electrical Characteristics section	5
Updated Application Information section	10

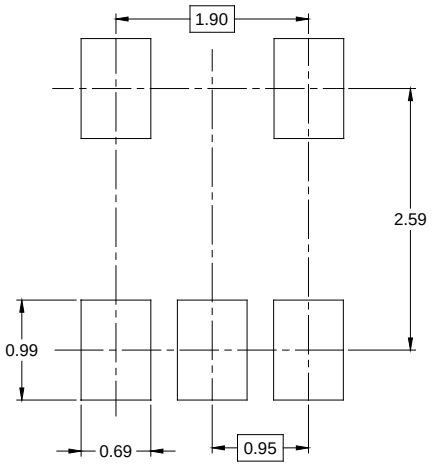
DECEMBER 2021 – REV.A to REV.A.1	Page
Updated Electrical Characteristics section	4, 5

Changes from Original (DECEMBER 2020) to REV.A	Page
Changed from product preview to production data	All

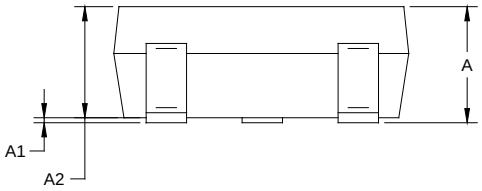
PACKAGE OUTLINE DIMENSIONS

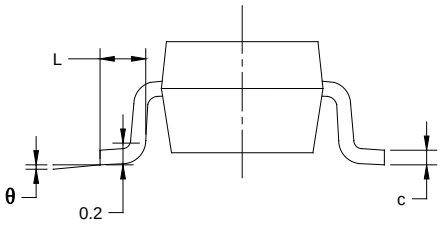
SOT-23-5





RECOMMENDED LAND PATTERN (Unit: mm)



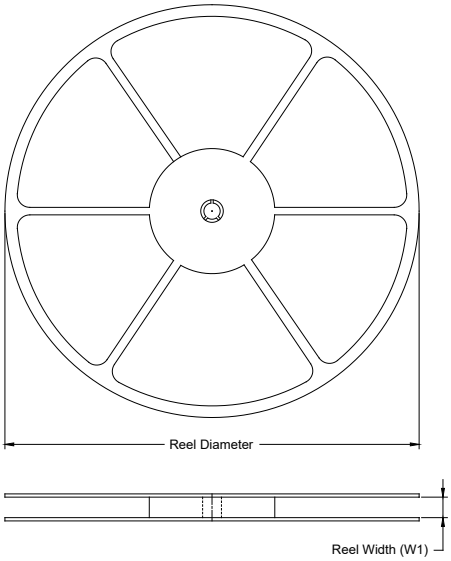


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037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

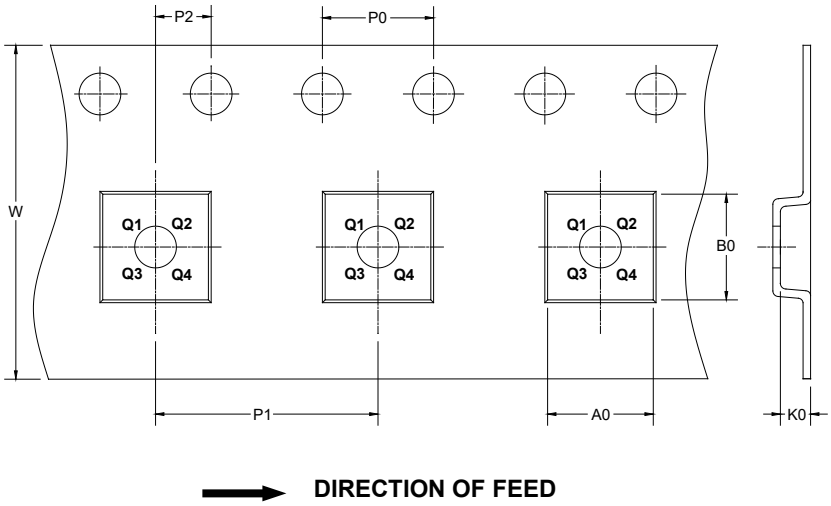
NOTES:
1. Body dimensions do not include mode flash or protrusion.
2. This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



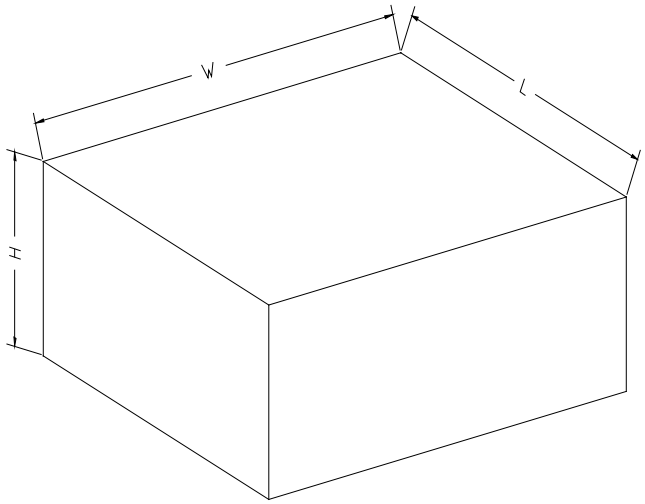
NOTE: The picture is only for reference. Please make the object as the standard.

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

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