SGM2239xQ
Automotive, 40V, 300mA, Low Quiescent Current and Low Dropout Voltage Linear Regulator

GENERAL DESCRIPTION

The SGM2239xQ is a high voltage, low quiescent current and low dropout voltage linear regulator. It is capable of supplying 300mA output current with typical dropout voltage of 750mV. The operating input voltage range is from 2.5V to 40V and output voltage range is from 1.215V to 35V.

Other features include current limit and thermal shutdown protection. The SGM2239xQ is suitable for various automotive applications.

This device is AEC-Q100 qualified (Automotive Electronics Council (AEC) standard Q100 Grade 1) and it is suitable for automotive applications.

The SGM2239xQ is available in Green TDFN-2×2-6AL and TDFN-3×3-8JL packages. It operates over an operating temperature range of -40℃ to +125℃.

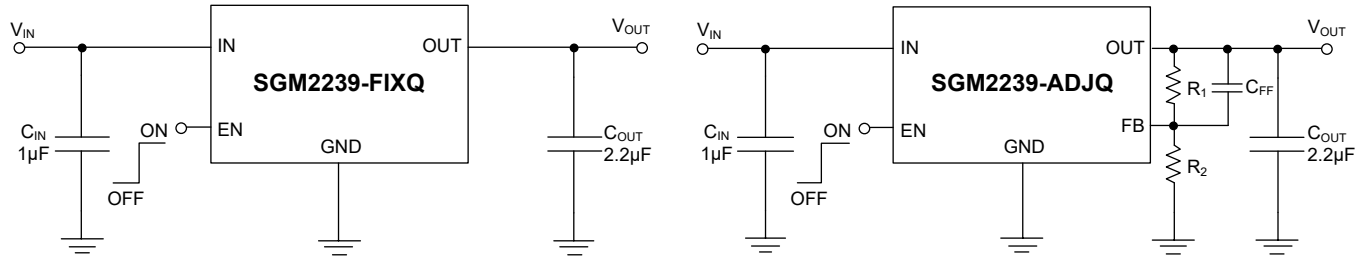
FEATURES

- **AEC-Q100 Qualified for Automotive Applications**
  Device Temperature Grade 1
  T_A = -40℃ to +125℃
- **Operating Input Voltage Range: 2.5V to 40V**
- **Enable Pin Accept Voltages Higher than the Supply Voltage and up to 40V**
- **Fixed Output from 1.8V to 12V**
- **Adjustable Output from 1.215V to 35V**
- **300mA Output Current**
- **Low Quiescent Current: 3.3μA (TYP)**
- **Low Dropout Voltage:**
  750mV (TYP) at 300mA, V_{OUT} = 5.0V
- **Current Limiting and Thermal Protection**
- **With Output Automatic Discharge**
- **Stable with Small Case Size Ceramic Capacitors**
- **-40℃ to +125℃ Operating Temperature Range**
- **Available in Green TDFN-2×2-6AL and TDFN-3×3-8JL Packages**

APPLICATIONS

Industrial Equipment
Automotive Applications
Battery-Powered Equipment
Medical 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
SGM2239-1.8Q	TDFN-2×2-6AL	-40℃ to +125℃ (T_A)	SGM2239-1.8QTDI6G/TR	1CI XXXX	Tape and Reel, 3000
SGM2239-2.5Q	TDFN-2×2-6AL	-40℃ to +125℃ (T_A)	SGM2239-2.5QTDI6G/TR	1CJ XXXX	Tape and Reel, 3000
SGM2239-3.0Q	TDFN-2×2-6AL	-40℃ to +125℃ (T_A)	SGM2239-3.0QTDI6G/TR	1CK XXXX	Tape and Reel, 3000
SGM2239-3.3Q	TDFN-2×2-6AL	-40℃ to +125℃ (T_A)	SGM2239-3.3QTDI6G/TR	1CL XXXX	Tape and Reel, 3000
SGM2239-3.6Q	TDFN-2×2-6AL	-40℃ to +125℃ (T_A)	SGM2239-3.6QTDI6G/TR	1CM XXXX	Tape and Reel, 3000
SGM2239-4.2Q	TDFN-2×2-6AL	-40℃ to +125℃ (T_A)	SGM2239-4.2QTDI6G/TR	1CN XXXX	Tape and Reel, 3000
SGM2239-5.0Q	TDFN-2×2-6AL	-40℃ to +125℃ (T_A)	SGM2239-5.0QTDI6G/TR	1CO XXXX	Tape and Reel, 3000
SGM2239-8.0Q	TDFN-2×2-6AL	-40℃ to +125℃ (T_A)	SGM2239-8.0QTDI6G/TR	1CP XXXX	Tape and Reel, 3000
SGM2239-9.0Q	TDFN-2×2-6AL	-40℃ to +125℃ (T_A)	SGM2239-9.0QTDI6G/TR	1CQ XXXX	Tape and Reel, 3000
SGM2239-12Q	TDFN-2×2-6AL	-40℃ to +125℃ (T_A)	SGM2239-12QTDI6G/TR	1CR XXXX	Tape and Reel, 3000
SGM2239-ADJQ	TDFN-2×2-6AL	-40℃ to +125℃ (T_A)	SGM2239-ADJQTDI6G/TR	1CS XXXX	Tape and Reel, 3000
SGM2239-1.8Q	TDFN-3×3-8JL	-40℃ to +125℃ (T_A)	SGM2239-1.8QTHI8G/TR	1CTTHI XXXXX YYYYYY	Tape and Reel, 4000
SGM2239-2.5Q	TDFN-3×3-8JL	-40℃ to +125℃ (T_A)	SGM2239-2.5QTHI8G/TR	1CUTHI XXXXX YYYYYY	Tape and Reel, 4000
SGM2239-3.0Q	TDFN-3×3-8JL	-40℃ to +125℃ (T_A)	SGM2239-3.0QTHI8G/TR	1CVTHI XXXXX YYYYYY	Tape and Reel, 4000
SGM2239-3.3Q	TDFN-3×3-8JL	-40℃ to +125℃ (T_A)	SGM2239-3.3QTHI8G/TR	1AZTHI XXXXX YYYYYY	Tape and Reel, 4000
SGM2239-3.6Q	TDFN-3×3-8JL	-40℃ to +125℃ (T_A)	SGM2239-3.6QTHI8G/TR	1CWTHI XXXXX YYYYYY	Tape and Reel, 4000
SGM2239-4.2Q	TDFN-3×3-8JL	-40℃ to +125℃ (T_A)	SGM2239-4.2QTHI8G/TR	1CXTHI XXXXX YYYYYY	Tape and Reel, 4000
SGM2239-5.0Q	TDFN-3×3-8JL	-40℃ to +125℃ (T_A)	SGM2239-5.0QTHI8G/TR	0X7THI XXXXX YYYYYY	Tape and Reel, 4000
SGM2239-8.0Q	TDFN-3×3-8JL	-40℃ to +125℃ (T_A)	SGM2239-8.0QTHI8G/TR	1CYTHI XXXXX YYYYYY	Tape and Reel, 4000

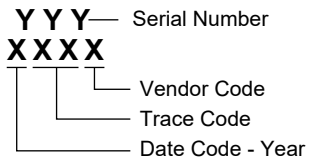
PACKAGE/ORDERING INFORMATION (continued)

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM2239-9.0Q	TDFN-3×3-8JL	-40℃ to +125℃ (T_A)	SGM2239-9.0QTHI8G/TR	1CZTHI XXXXX YYYYYY	Tape and Reel, 4000
SGM2239-12Q	TDFN-3×3-8JL	-40℃ to +125℃ (T_A)	SGM2239-12QTHI8G/TR	1D0THI XXXXX YYYYYY	Tape and Reel, 4000
SGM2239-ADJQ	TDFN-3×3-8JL	-40℃ to +125℃ (T_A)	SGM2239-ADJQTHI8G/TR	0X6THI XXXXX YYYYYY	Tape and Reel, 4000

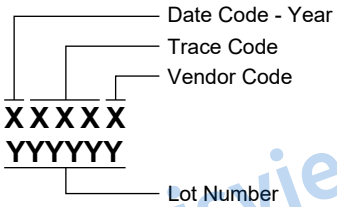
MARKING INFORMATION

NOTE: XXXX = Date Code, Trace Code and Vendor Code. XXXXX = Date Code, Trace Code and Vendor Code.

TDFN-2×2-6AL



TDFN-3×3-8JL



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 45V
OUT to GND ..... -0.3V to 45V
FB to GND ..... -0.3V to 45V
Package Thermal Resistance
TDFN-2×2-6AL, θ_{JA} ..... 62.9℃/W
TDFN-2×2-6AL, θ_{JB} ..... 28.9℃/W
TDFN-2×2-6AL, $\theta_{JC(TOP)}$ ..... 77.8℃/W
TDFN-2×2-6AL, $\theta_{JC(BOT)}$ ..... 11.6℃/W
TDFN-3×3-8JL, θ_{JA} ..... 50.2℃/W
TDFN-3×3-8JL, θ_{JB} ..... 22.5℃/W
TDFN-3×3-8JL, $\theta_{JC(TOP)}$ ..... 52.2℃/W
TDFN-3×3-8JL, $\theta_{JC(BOT)}$ ..... 11℃/W
Junction Temperature ..... +150℃
Storage Temperature Range ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃

RECOMMENDED OPERATING CONDITIONS

Supply Voltage Range, V_{IN} ..... 2.5V to 40V
Enable Input Voltage Range ..... 0V to 40V
Input Effective Capacitance, C_{IN} ..... 0.5μF (MIN)
Output Effective Capacitance, C_{OUT} ..... 1μF to 100μF
Operating Ambient Temperature Range ..... -40℃ to +125℃
Operating Junction Temperature Range ..... -40℃ to +150℃

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

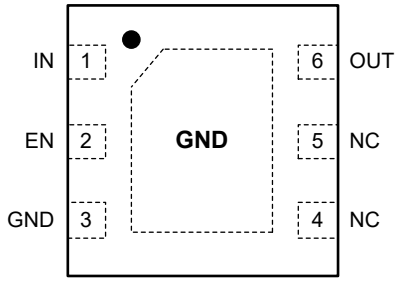
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance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

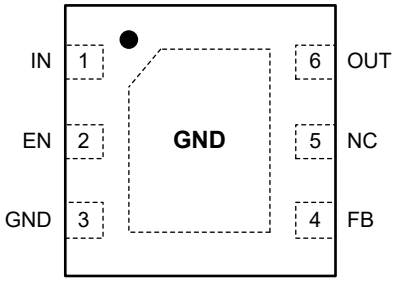
PIN CONFIGURATIONS

SGM2239-FIXQ (TOP VIEW)



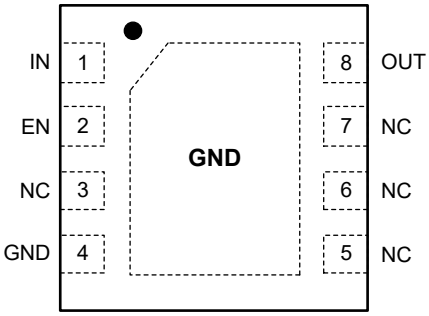
TDFN-2×2-6AL

SGM2239-ADJQ (TOP VIEW)



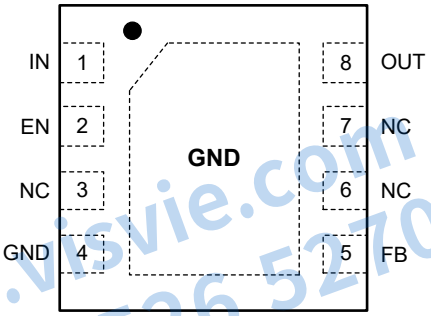
TDFN-2×2-6AL

SGM2239-FIXQ (TOP VIEW)



TDFN-3×3-8JL

SGM2239-ADJQ (TOP VIEW)



TDFN-3×3-8JL

PIN DESCRIPTION

PIN		NAME	FUNCTION
TDFN-2×2-6AL	TDFN-3×3-8JL		
1	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	2	EN	Enable Pin. Drive EN high to turn on the regulator. Drive EN low to turn off the regulator.
3	4	GND	Ground.
4	5	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.
		NC	No Connection (Fixed Version Only).
6	8	OUT	Regulator Output Pin. It is recommended to use a ceramic capacitor with effective capacitance in the range of 1μF to 100μF to ensure stability. This ceramic capacitor should be placed as close as possible to OUT pin.
5	3, 6, 7	NC	No Connection.
Exposed Pad	Exposed Pad	GND	Exposed Pad. Connect it to GND internally. Connect it to a large ground plane to maximize thermal performance. This pad is not an electrical connection point.

FUNCTIONAL BLOCK DIAGRAMS

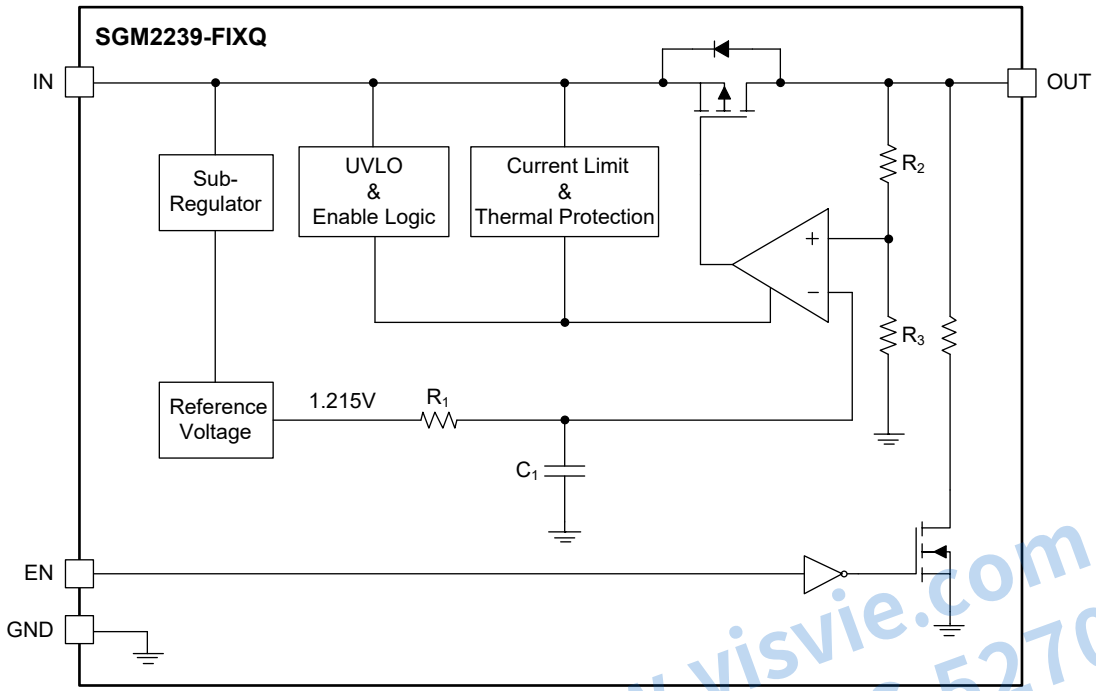


Figure 2. Block Diagram of Fixed Output Version

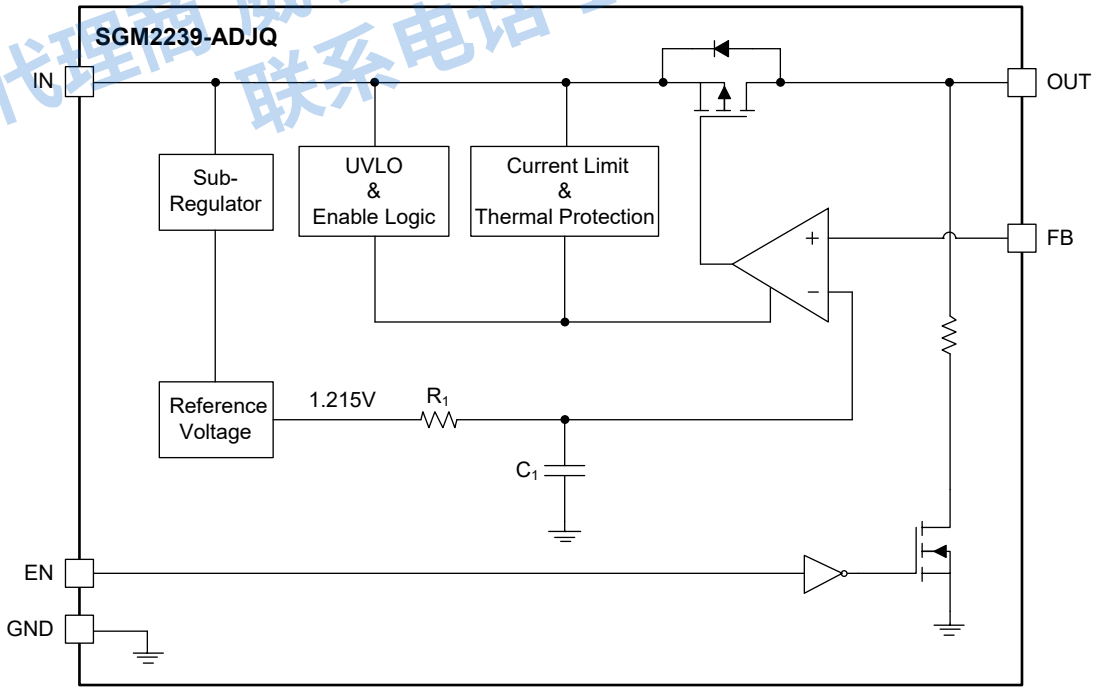


Figure 3. Block Diagram of Adjustable Output Version

ELECTRICAL CHARACTERISTICS

(V_{IN} = $V_{OUT(NOM)}$ + 2V, C_{IN} = 1μF, C_{OUT} = 2.2μF, T_A = T_J, 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}			2.5		40	V
Output Voltage Range	V_{OUT}			1.215		35	V
Output Voltage Accuracy	V_{OUT}	V_{IN} = ($V_{OUT(NOM)}$ + 2V) to 40V, I_{OUT} = 1mA	T_J = +25℃	TBD		TBD	%
			T_J = -40℃ to +125℃	TBD		TBD	
Feedback Voltage	V_{ADJ}	V_{IN} = ($V_{OUT(NOM)}$ + 2V) to 40V, I_{OUT} = 1mA	T_J = +25℃	TBD	1.215	TBD	V
			T_J = -40℃ to +125℃				
FB Pin Input Current	I_{ADJ}				0.1		nA
Under-Voltage Lockout	V_{UVLO}	V_{IN} rising			2.12		V
Line Regulation	$\frac{\Delta V_{OUT}}{\Delta V_{IN} \times V_{OUT}}$	V_{IN} = ($V_{OUT(NOM)}$ + 2V) to 40V, I_{OUT} = 0.1mA			0.01		%/V
Load Regulation	$\frac{\Delta V_{OUT}}{\Delta I_{OUT} \times V_{OUT}}$	I_{OUT} = 0.1mA to 300mA			0.001		%/mA
Dropout Voltage	V_{DROP}	V_{OUT} = 95% × $V_{OUT(NOM)}$, I_{OUT} = 300mA	$V_{OUT(NOM)}$ = 3.3V		795		mV
			$V_{OUT(NOM)}$ = 5.0V		750		
			$V_{OUT(NOM)}$ = 12V		750		
Output Current Limit	I_{LIMIT}	V_{IN} = $V_{OUT(NOM)}$ + 3V, V_{OUT} = 90% × $V_{OUT(NOM)}$			800		mA
Short-Circuit Current Limit	I_{SHORT}	V_{IN} = $V_{OUT(NOM)}$ + 3V, V_{OUT} =0V			440		mA
Ground Pin Current	I_{GND}	I_{OUT} = 0mA			3.3		μA
		I_{OUT} = 300mA			118		
Shutdown Supply Current	I_{SHDN}	V_{EN} = 0V, V_{IN} = 2.5 to 40V			0.35		μA
EN Pin High-Level Input Voltage	V_{IH}	V_{IN} = 2.5 to 40V			1.47		V
EN Pin Low-Level Input Voltage	V_{IL}	V_{IN} = 2.5 to 40V			1.37		V
EN Pin Input Current	I_{EN}	V_{EN} = 0V, V_{IN} = 40V			0.1		nA
		V_{EN} = 40V, V_{IN} = 40V			50		
Output Discharge Resistance	R_{DIS}	V_{EN} = 0V			225		Ω
Turn-On Time	t_{ON}	From assertion of V_{EN} to V_{OUT} = 90% × $V_{OUT(NOM)}$	$V_{OUT(NOM)}$ = 1.215V		0.9		ms
			$V_{OUT(NOM)}$ = 3.3V		1.1		
			$V_{OUT(NOM)}$ = 5.0V		1.4		
			$V_{OUT(NOM)}$ = 12V		3.0		
Power Supply Ripple Rejection	PSRR	V_{IN} = 2.5V, V_{OUT} = 1.215V, I_{OUT} = 10mA, C_{OUT} = 4.7μF	f = 100Hz		63		dB
			f = 1kHz		46		
			f = 100kHz		33		
		V_{IN} = 4.3V, V_{OUT} = 3.3V, I_{OUT} = 10mA, C_{OUT} = 4.7μF	f = 100Hz		61		
			f = 1kHz		45		
			f = 100kHz		34		
Output Voltage Noise	e_n	I_{OUT} = 10mA, C_{OUT} = 4.7μF, f = 10Hz to 100kHz	V_{OUT} = 1.215V		55		μV_{RMS}
			V_{OUT} = 3.3V		112		
Thermal Shutdown Temperature	T_{SHDN}				170		℃
Thermal Shutdown Hysteresis	ΔT_{SHDN}				25		℃

APPLICATION INFORMATION

The SGM2239xQ is a high voltage, low quiescent current 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 SGM2239xQ useful in a variety of applications. The SGM2239xQ provides protection functions for output overload and overheating.

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. 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. 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 makes SGM2239xQ 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 SGM2239-ADJQ can be adjusted from 1.215V to 35V. The FB 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} = 1.215V. R_1 and R_2 can be calculated for any output voltage range using equation 1. Choose R_2 = 1MΩ to maintain a 1.215μA minimum load.

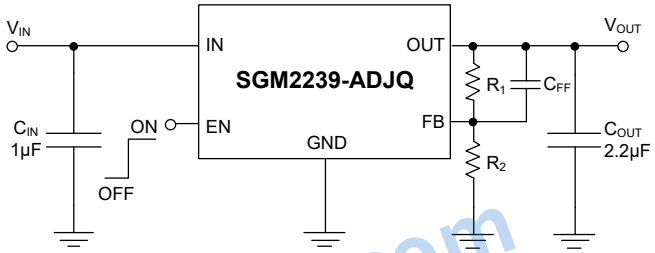


Figure 4. Adjustable Output Voltage Application

Enable Operation

The SGM2239xQ uses the EN pin to enable/disable the device and to deactivate/activate the output automatic discharge function.

When the EN pin voltage is lower than 1.37V, 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 225Ω (TYP) resistor.

When the EN pin voltage is higher than 1.47V, the device is in active state. The output voltage is regulated to the expected value and the automatic discharge transistor is turned off.

Under-Voltage Lockout (UVLO)

The UVLO circuit monitors the input voltage to prevent the device from turning on before V_{IN} rises above the V_{UVLO} threshold. The UVLO circuit responds quickly to glitches on the IN pin and attempts to disable the output of the device if any of these rails collapses. The local input capacitance prevents severe brownouts in most applications.

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 SGM2239xQ. If V_{OUT} > V_{IN} event would happen in system, one external Schottky diode will be added between OUT pin and IN pin in circuit design to protect the SGM2239xQ.

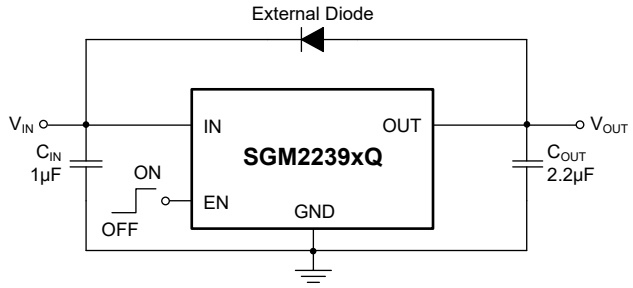


Figure 5. Reverse Protection Reference Design

Output Current Limit and Short-Circuit Protection

When overload events happen, the output current is internally limited to 800mA (TYP). When the OUT pin is shorted to ground, the short-circuit protection will limit the output current to 440mA (TYP).

Thermal Shutdown

When the die temperature exceeds the threshold value of thermal shutdown, the SGM2239xQ will be in shutdown state and it will remain in this state until the die temperature decreases to +145℃.

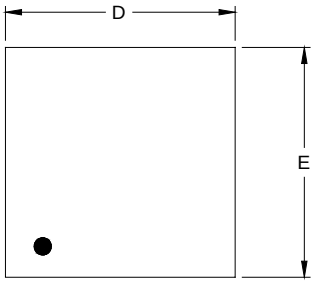
Power Dissipation (P_D)

Power dissipation (P_D) of the SGM2239xQ can be calculated by the equation $P_D = (V_{IN} - V_{OUT}) \times I_{OUT}$. The maximum allowable power dissipation ($P_{D(MAX)}$) of the SGM2239xQ is affected by many factors, including the difference between junction temperature and ambient temperature ($T_{J(MAX)} - T_A$), package thermal resistance from the junction to the ambient environment (θ_{JA}), the rate of ambient airflow and PCB layout. $P_{D(MAX)}$ can be approximated by the following equation:

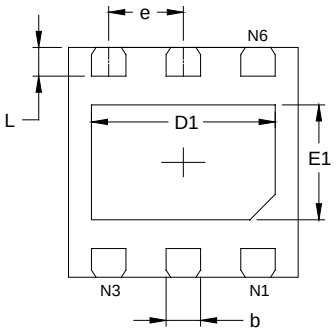
$$P_{D(MAX)} = (T_{J(MAX)} - T_A)/\theta_{JA} \quad (2)$$

PACKAGE OUTLINE DIMENSIONS

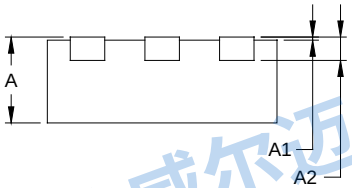
TDFN-2×2-6AL



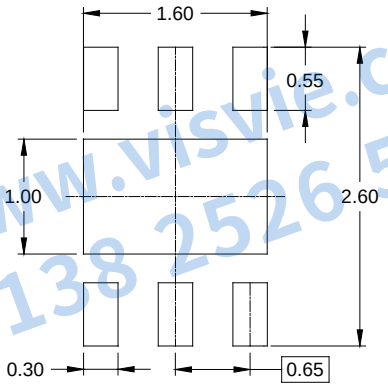
TOP VIEW



BOTTOM VIEW



SIDE VIEW



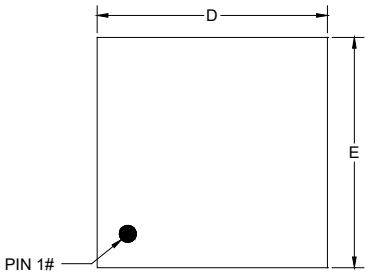
RECOMMENDED LAND PATTERN (Unit: mm)

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	1.500	1.700	0.059	0.067
E	1.900	2.100	0.075	0.083
E1	0.900	1.100	0.035	0.043
b	0.250	0.350	0.010	0.014
e	0.650 BSC		0.026 BSC	
L	0.174	0.326	0.007	0.013

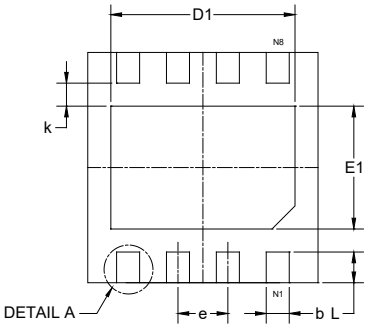
NOTE: This drawing is subject to change without notice.

PACKAGE OUTLINE DIMENSIONS

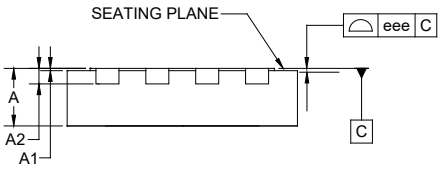
TDFN-3×3-8JL



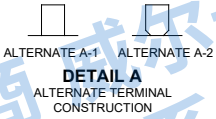
TOP VIEW



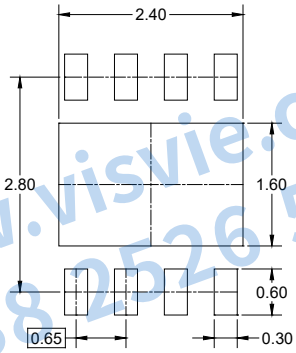
BOTTOM VIEW



SIDE VIEW



DETAIL A
ALTERNATE TERMINAL CONSTRUCTION



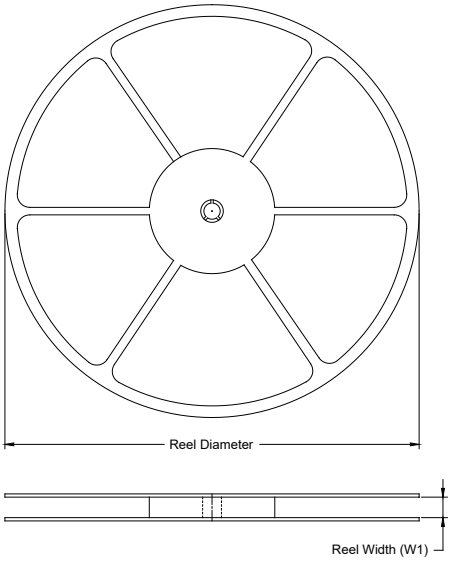
RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		
	MIN	MOD	MAX
A	0.700	-	0.800
A1	0.000	-	0.050
A2	0.203 REF		
b	0.250	-	0.350
D	2.900	-	3.100
D1	2.300	-	2.500
E	2.900	-	3.100
E1	1.500	-	1.700
e	0.650 BSC		
k	0.300 REF		
L	0.300	-	0.500
eee	0.080		

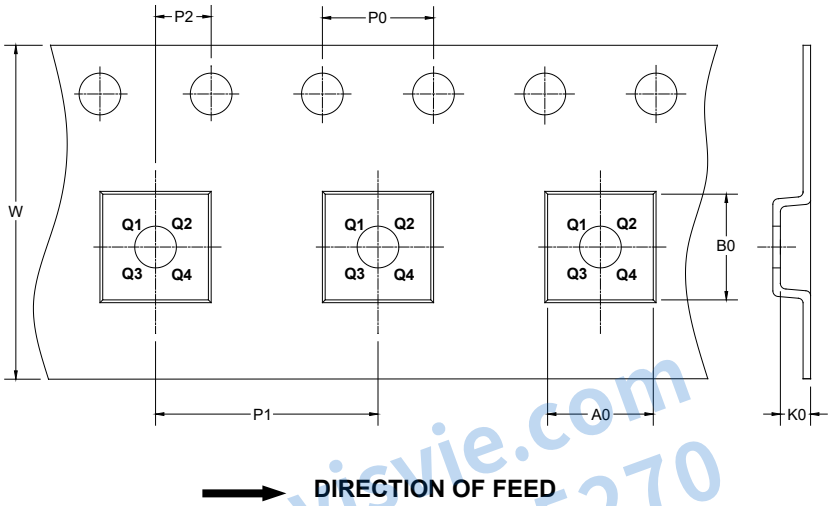
NOTE: This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



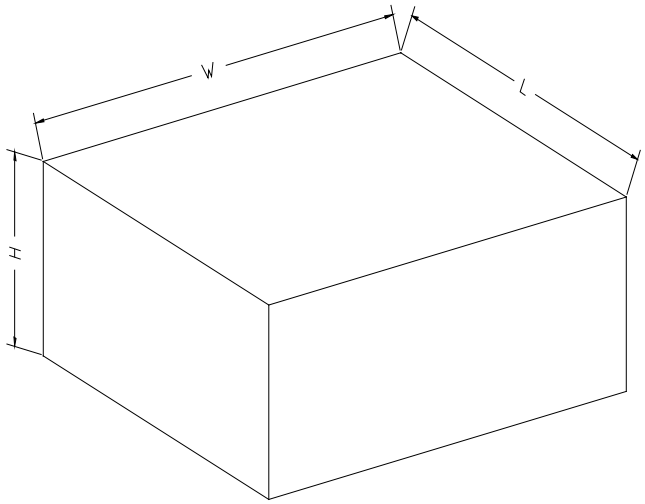
NOTE: The picture is only for reference. Please make the object as the standard.

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
TDFN-2×2-6AL	7"	9.5	2.30	2.30	1.10	4.0	4.0	2.0	8.0	Q1
TDFN-3×3-8JL	13"	12.4	3.35	3.35	1.13	4.0	8.0	2.0	12.0	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
13″	386	280	370	5

DD0002