SGM42401Q
Automotive Low-side Driver with Self-Protection Featuring Temperature and Current Limit

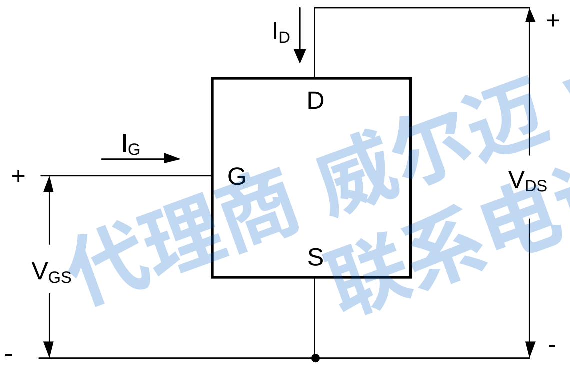
GENERAL DESCRIPTION

The SGM42401Q is a low-side smart discrete device with three terminals that provides protections against over-current, over-temperature and ESD. It also features integrated drain-to-gate clamping for over-voltage protection. This device is well-suited for harsh automotive environments and offers reliable protection.

The SGM42401Q is AEC-Q100 qualified (Automotive Electronics Council (AEC) standard Q100 Grade 1) and it is suitable for automotive applications.

The SGM42401Q is available in a Green SOT-223-3 package.

SIMPLIFIED SCHEMATIC



FEATURES

- **AEC-Q100 Qualified for Automotive Applications**
  Device Temperature Grade 1
  T_A = -40℃ to +125℃
- **Full Set of Protections**
  - **Short-Circuit Protection**
  - **Over-Voltage Protection**
  - **ESD Protection**
  - **Thermal Shutdown with Automatic Restart**
- **Clamp Integrated for Switching of Inductive Loads**
- **Support Gate Threshold Voltage: 1.75V (TYP)**
- **dV/dt Robustness**
- **Output Clamp Voltage: 42V**
- **Static Drain-to-Source On-Resistance:**
  90mΩ (TYP) at 10V
- **Continuous Drain Current: 3.5A (TYP)**
- **Output Peak Current (Thermal Limited): 8.5A**
- **Logic Level Input Capable of Analog Driving**
- **Available in a Green SOT-223-3 Package**

APPLICATIONS

Switch Resistance, Inductance and Capacitance Loads

Substitute Discrete Circuits and Electromechanical Relays

Automotive/Industrial

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM42401Q	SOT-223-3	-40℃ to +125℃	SGM42401QKC3G/TR	MF6 XXXXX	Tape and Reel, 2500

MARKING INFORMATION

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

X XXX X
- Vendor Code
- Trace Code
- Date Code - Year

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

Internally Clamped Drain-to-Source Voltage
- V_{DSS} 42V
- V_{DSS} (T_J = -40℃) 38V

Internally Clamped Drain-to-Gate Voltage
- V_{DGR} 42V
- V_{DGR} (T_J = -40℃) 38V

Gate-to-Source Voltage, V_{GS} .... ±14V
Continuous Drain Current, I_{DS} .... Internally Limited
Maximum Continuous Drain Current, I_{DS} (T_A = +25℃) 3.5A
Single Pulse Drain-to-Source Avalanche Energy (V_{DD} = 32V, V_G = 5.0V, I_{PK} = 1.0A, L = 300mH, R_{G_EXT} = 25Ω), E_{AS} (1) 430mJ
Load Dump Voltage (V_{GS} = 0V and 10V, R_I = 2.0Ω, R_L = 9.0Ω, t_d = 400ms), V_{LD} 40V

Package Thermal Resistance
- SOT-223-3, θ_{JA} .... 94.9℃/W
- SOT-223-3, θ_{JB} .... 47.3℃/W
- SOT-223-3, θ_{JC} .... 43.5℃/W

Package Thermal Characterization Parameter
- SOT-223-3, ψ_{JT} .... 6.5℃/W
- SOT-223-3, ψ_{JB} .... 43.6℃/W

Junction Temperature .... +150℃
Storage Temperature Range .... -65℃ to +150℃
Lead Temperature (Soldering, 10s) .... +260℃
ESD Susceptibility (2) (3)
HBM 8000V
CDM 2000V

NOTES:

1. $$E_{AS} = \frac{1}{2} \times L \times I_{PK}^2 \times \left(1 - \frac{V_{BAT}}{V_{BAT} - V_{CLAMP}}\right)$$

2. For human body model (HBM), all pins comply with AEC-Q100-002 specification.
3. For charged device model (CDM), all pins comply with AEC-Q100-011 specification.

RECOMMENDED OPERATING CONDITIONS

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

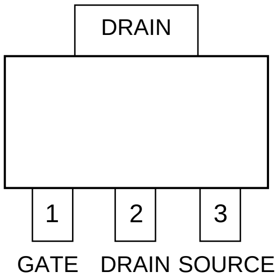
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance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

(TOP VIEW)



SOT-223-3

PIN DESCRIPTION

PIN	NAME	SYMBOL	FUNCTION
1	GATE	G	Gate Input.
2	DRAIN	D	Drain.
3	SOURCE	S	Source.

ELECTRICAL CHARACTERISTICS

(T_J = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Off Characteristics						
Drain-to-Source Breakdown Voltage [1]	V_{BR_DSS}	V_{GS} = 0V, I_{DS} = 10mA, T_J = +25℃ [2]	38 [3]	42	44	V
		V_{GS} = 0V, I_{DS} = 10mA, T_J = +125℃ [2]	40	42.5	45	
Drain Current at Zero Gate Voltage	I_{DSS}	V_{GS} = 0V, V_{DS} = 32V, T_J = +25℃		25	300	nA
		V_{GS} = 0V, V_{DS} = 32V, T_J = +125℃		200	500	nA
Gate Input Current	I_{GSSF}	V_{DS} = 0V, V_{GS} = 5V		220	290	μA
On Characteristics [1]						
Gate Threshold Voltage	V_{GS_TH}	V_{GS} = V_{DS}, I_{DS} = 150μA	1.35	1.75	2.25	V
Gate Threshold Temperature Coefficient	V_{GS_TH}/T_J			3.0		-mV/℃
Static Drain-to-Source On-Resistance	R_{DSON}	V_{GS} = 10V, I_{DS} = 1.7A, T_J = +25℃		90	140	mΩ
		V_{GS} = 10V, I_{DS} = 1.7A, T_J = +125℃		130	160	
		V_{GS} = 5.0V, I_{DS} = 1.7A, T_J = +25℃		90	140	
		V_{GS} = 5.0V, I_{DS} = 1.7A, T_J = +125℃		130	160	
		V_{GS} = 5.0V, I_{DS} = 0.5A, T_J = +25℃		90	140	
		V_{GS} = 5.0V, I_{DS} = 0.5A, T_J = +125℃		130	160	
Source-Drain Forward On Voltage	V_{SD}	V_{GS} = 0V, I_S = 7A		1.1		V
Switching Characteristics						
Turn-On Time	t_{ON}	V_{GS} = 10V, V_{DD} = 12V, I_{DS} = 2.5A, R_L = 4.7Ω; 10% V_{IN} to 90% I_{DS}		33	50	μs
Turn-Off Time	t_{OFF}	90% V_{IN} to 10% I_{DS}		87	110	μs
Turn-On Rise Time	t_{RISE}	10% I_{DS} to 90% I_{DS}		20	32	μs
Turn-Off Fall Time	t_{FALL}	90% I_{DS} to 10% I_{DS}		41	55	μs
Slew-Rate On	$-dV_{DS}/dt_{ON}$	70% to 50% V_{DD}		0.67	1.06	V/μs
Slew-Rate Off	dV_{DS}/dt_{OFF}	50% to 70% V_{DD}		0.28	0.45	V/μs
Self-Protection Characteristics [4]						
Current Limit	I_{LIM}	V_{DS} = 10V, V_{GS} = 5V, T_J = +25℃	6	8.5		A
		V_{DS} = 10V, V_{GS} = 5V, T_J = +125℃	4.2	5.2	6.2	
		V_{DS} = 10V, V_{GS} = 10V, T_J = +25℃	6	8.5		
		V_{DS} = 10V, V_{GS} = 10V, T_J = +125℃	4.7	5.7	6.7	
Temperature Limit (Turn-Off)	T_{LIM_OFF}	V_{GS} = 5V [5]	135	150	165	℃
Thermal Hysteresis	ΔT_{LIM_ON}	V_{GS} = 5V		15		
Temperature Limit (Turn-Off)	T_{LIM_OFF}	V_{GS} = 10V [5]	135	150	165	
Thermal Hysteresis	ΔT_{LIM_ON}	V_{GS} = 10V		15		
Gate Input Characteristics [5]						
Gate Input Current in Device On State	I_{GON}	V_{GS} = 5V, I_{DS} = 1A		220		μA
		V_{GS} = 10V, I_{DS} = 1A		220		
Gate Input Current in Current Limit State	I_{GCL}	V_{GS} = 5V, V_{DS} = 10V		220		μA
		V_{GS} = 10V, V_{DS} = 10V		220		
Gate Input Current in Thermal Limit Fault State	I_{GTL}	V_{GS} = 5V, V_{DS} = 10V		70		μA
		V_{GS} = 10V, V_{DS} = 10V		70		

NOTES:
1. Pulse test: pulse width ≤ 300μs, duty cycle ≤ 2%.
2. Caused by internal clamping voltage, not actual breakdown voltage, breakdown voltage is 44V.
3. MIN value including -40℃.
4. Fault conditions are considered to be outside the normal operating range of the component.
5. Not subject to production testing.

TEST CIRCUITS AND WAVEFORMS

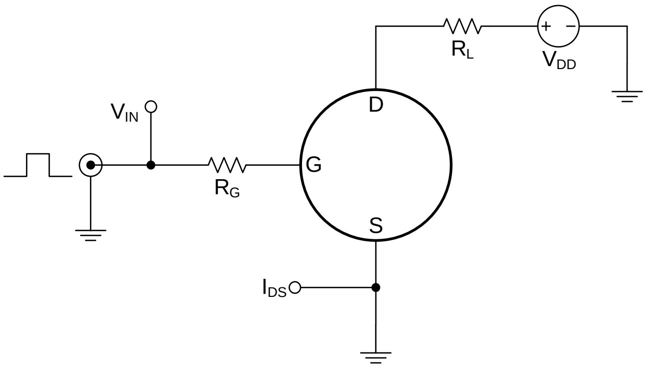


Figure 1. Test Circuit for Switching Resistive Loads

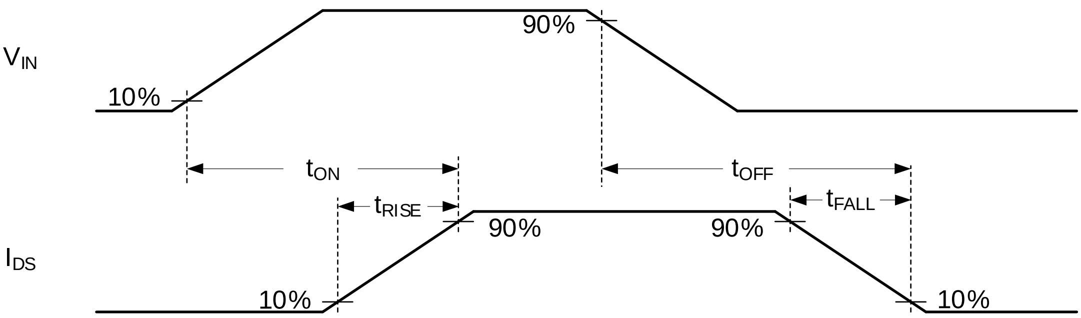


Figure 2. Waveforms for Switching Resistive Loads

TEST CIRCUITS AND WAVEFORMS (continued)

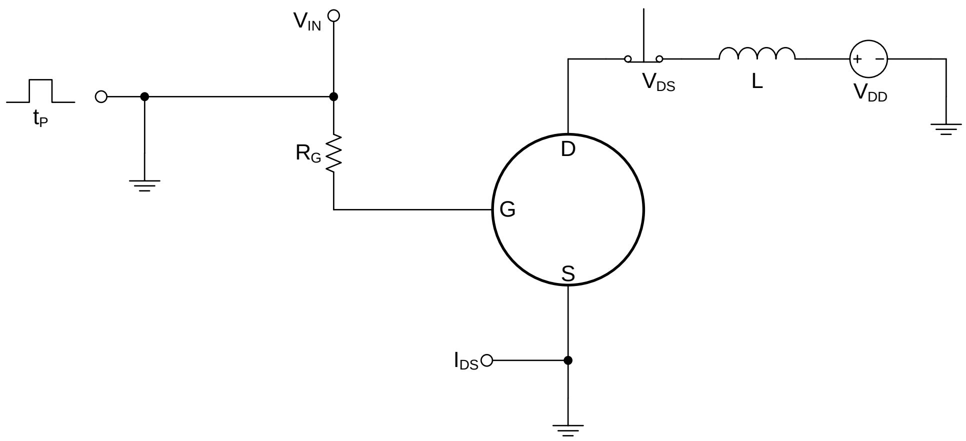


Figure 3. Test Circuit for Switching Inductive Loads

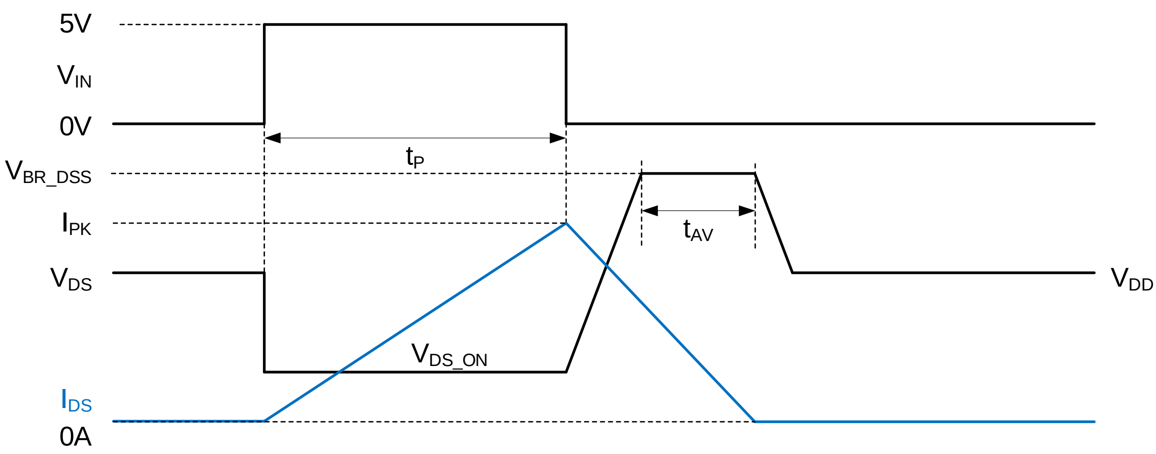
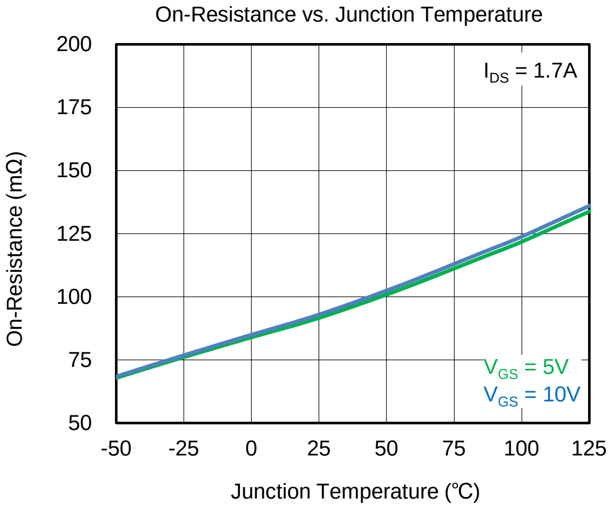
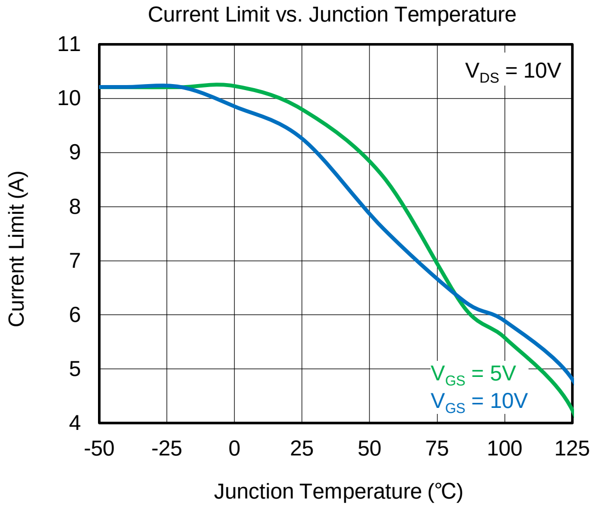
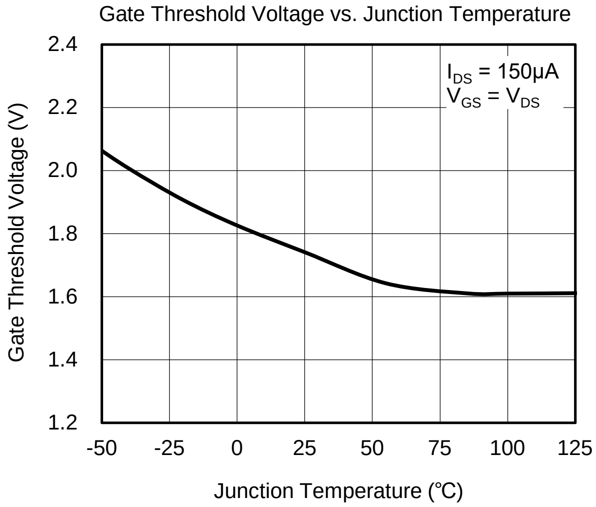


Figure 4. Waveforms for Switching Inductive Loads

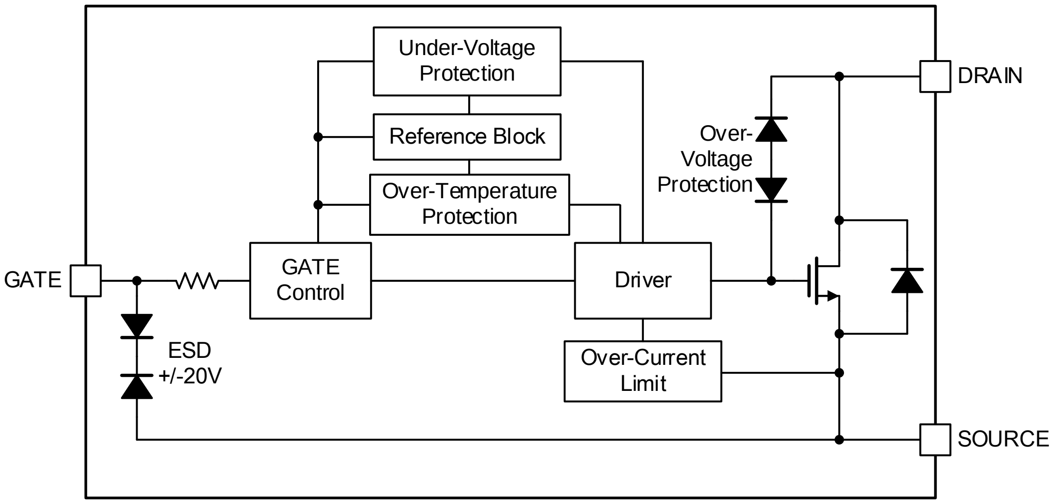
TYPICAL PERFORMANCE CHARACTERISTICS







FUNCTIONAL BLOCK DIAGRAM



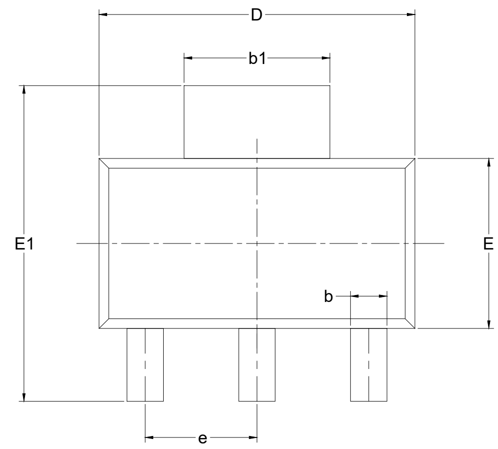
REVISION HISTORY

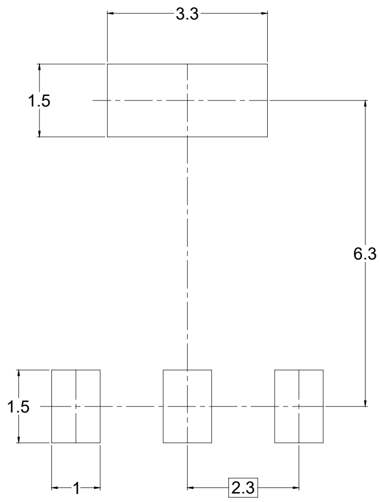
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

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

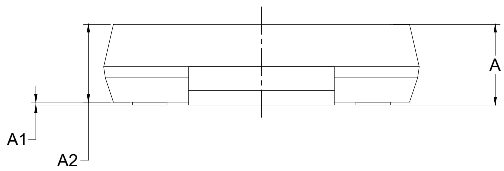
PACKAGE OUTLINE DIMENSIONS

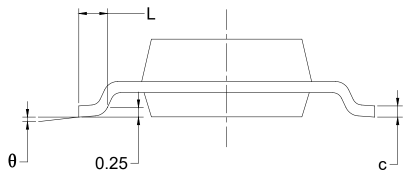
SOT-223-3





RECOMMENDED LAND PATTERN (Unit: mm)



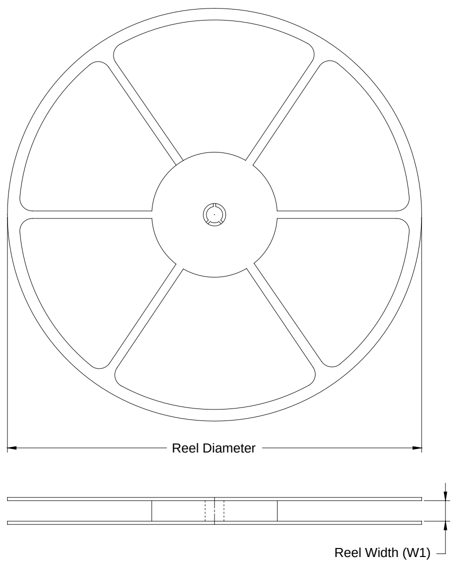


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	**MAX**	**MIN**	**MAX**
A		1.800		0.071
A1	0.020	0.100	0.001	0.004
A2	1.500	1.700	0.059	0.067
b	0.660	0.840	0.026	0.033
b1	2.900	3.100	0.114	0.122
c	0.230	0.350	0.009	0.014
D	6.300	6.700	0.248	0.264
E	3.300	3.700	0.130	0.146
E1	6.700	7.300	0.264	0.287
e	2.300 BSC		0.091 BSC	
L	0.750		0.030	
θ	0°	10°	0°	10°

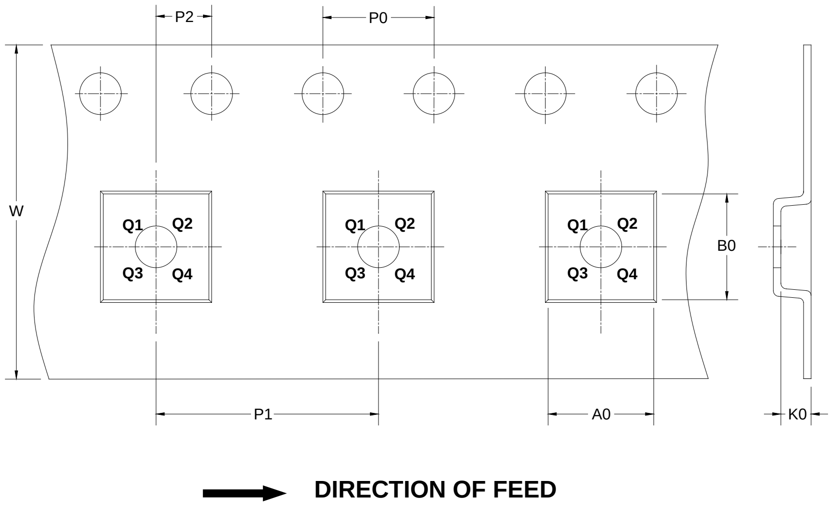
NOTES:
1. Body dimensions do not include mode flash or protrusion.
2. This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



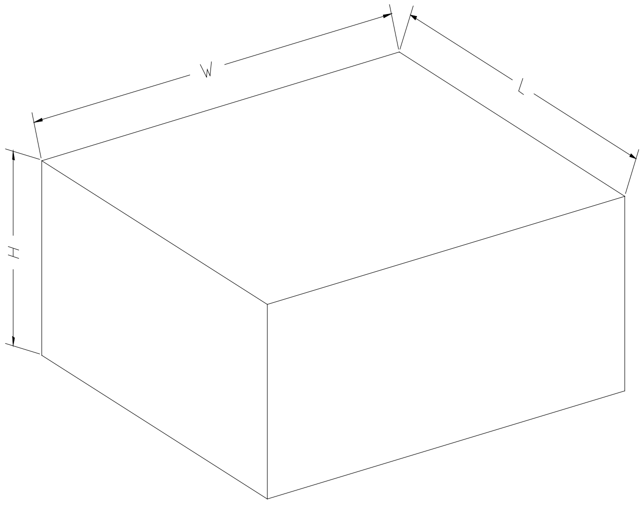
NOTE: The picture is only for reference. Please make the object as the standard.

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-223-3	13"	12.4	6.55	7.25	1.90	4.0	8.0	2.0	12.0	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
13″	386	280	370	5

DD0002