SGM431
Precision Programmable Reference

GENERAL DESCRIPTION

The SGM431x is a three-terminal adjustable shunt regulator, with specified thermal stability over applicable commercial, industrial and extended industrial temperature ranges. The output voltage can be set to any value between V_{REF} (approximately 2.5V) and 36V, with two external resistors. The SGM431x has a typical output impedance of 0.1Ω. Active output circuitry provides a very sharp turn-on characteristic, making it an excellent replacement for Zener diodes in many applications, such as onboard regulation, adjustable power supplies and switching power supplies.

In addition, low output drift versus temperature ensures good stability over the entire temperature range.

The SGM431 is available in Green SOIC-8, SOT-23, SOT-89-3, SOT-23-5 and SC70-6 packages. The SGM431B is available in Green SOIC-8, SOT-23, SOT-89-3 and SOT-23-5 packages.

FEATURES

- **Reference Voltage Tolerance at +25℃:**
  - **SGM431: 1% (Standard Grade)**
  - **SGM431B: 0.5% (B Grade)**
- **Adjustable Output Voltage: V_{REF} to 36V**
- **Typical Temperature Drift: 12mV**
- **Low Output Noise**
- **Typical Output Impedance: 0.1Ω**
- **Sink-Current Capability: 1mA to 100mA**
- **Operating Temperature Range: -40℃ to +125℃**
- **The SGM431 is available in Green SOIC-8, SOT-23, SOT-89-3, SOT-23-5 and SC70-6 Packages**
- **The SGM431B is available in Green SOIC-8, SOT-23, SOT-89-3 and SOT-23-5 Packages**

APPLICATIONS

Adjustable Voltage and Current Referencing
Secondary Side Regulation in Flyback SMPSs
Zener Replacement
Voltage Monitoring
Comparator with Integrated Reference

TYPICAL APPLICATION

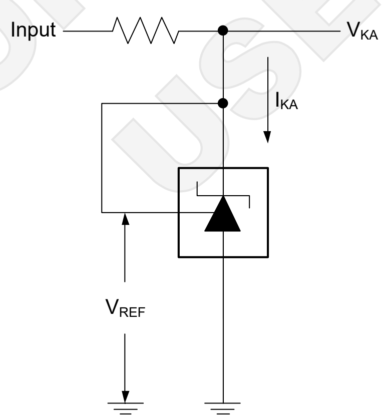


Figure 1. Typical Application Circuit

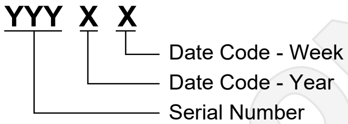
PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM431	SOIC-8	-40℃ to +125℃	SGM431XS8G/TR	SGM 431XS8 XXXXX	Tape and Reel, 4000
	SOT-23	-40℃ to +125℃	SGM431XN3LG/TR	MPCXX	Tape and Reel, 3000
	SOT-23-5	-40℃ to +125℃	SGM431XN5G/TR	MPBXX	Tape and Reel, 3000
	SOT-89-3	-40℃ to +125℃	SGM431XK3G/TR	SGM431X XXXXX	Tape and Reel, 1000
	SC70-6	-40℃ to +125℃	SGM431XC6G/TR	CJEXX	Tape and Reel, 3000
SGM431B	SOIC-8	-40℃ to +125℃	SGM431BXS8G/TR	SGM 431BXS8 XXXXX	Tape and Reel, 4000
	SOT-23	-40℃ to +125℃	SGM431BXN3LG/TR	CY6XX	Tape and Reel, 3000
	SOT-23-5	-40℃ to +125℃	SGM431BXN5G/TR	CY7XX	Tape and Reel, 3000
	SOT-89-3	-40℃ to +125℃	SGM431BXK3G/TR	SGM431BX XXXXX	Tape and Reel, 1000

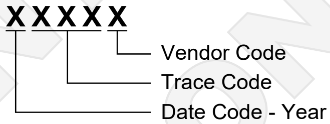
MARKING INFORMATION

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

SOT-23/SOT-23-5/SC70-6



SOIC-8/SOT-89-3



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

Cathode Voltage [1], V_{KA} 40V
Junction Temperature .... +150℃
Storage Temperature Range .... -65℃ to +150℃
Lead Temperature (Soldering, 10s) .... +260℃

RECOMMENDED OPERATING CONDITIONS

Cathode Voltage, V_{KA} .... V_{REF} to 36V
Cathode Current, I_{KA} .... 1mA to 100mA
Operating Temperature Range .... -40℃ to +125℃

NOTE:
1. All voltage values are with respect to ANODE, unless otherwise noted.

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

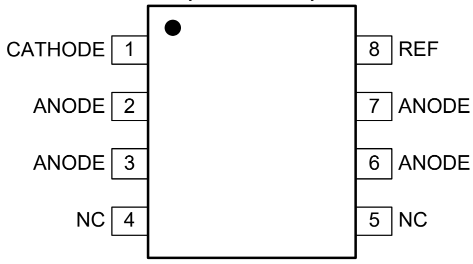
This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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.

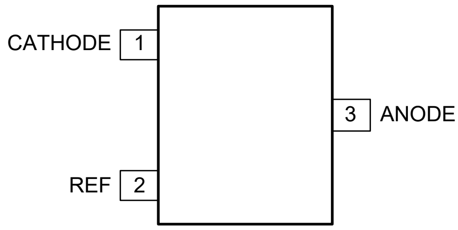
PIN CONFIGURATIONS

SGM431/SGM431B
(TOP VIEW)



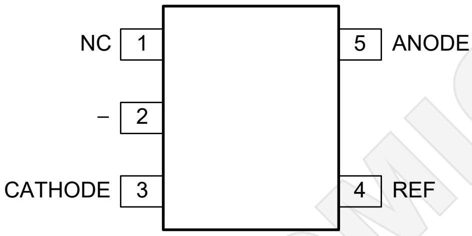
SOIC-8

SGM431/SGM431B
(TOP VIEW)



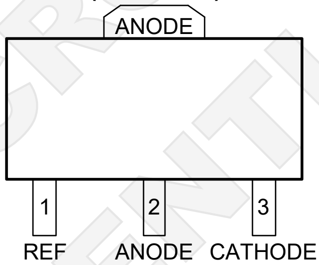
SOT-23

SGM431/SGM431B
(TOP VIEW)



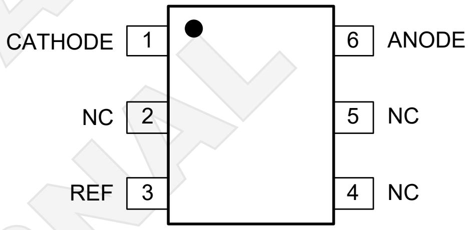
SOT-23-5

SGM431/SGM431B
(TOP VIEW)



SOT-89-3

SGM431
(TOP VIEW)



SC70-6

PIN DESCRIPTION

PIN					NAME	TYPE	DESCRIPTION
SOIC-8	SOT-23	SOT-23-5	SOT-89-3	SC70-6			
1	1	3	3	1	CATHODE	I/O	Shunt Current/Voltage Input.
2, 3, 6, 7	3	5	2	6	ANODE	O	Common Pin. Normally connected to ground.
4, 5	–	1	–	2, 4, 5	NC	–	Not Connected.
8	2	4	1	3	REF	I	Threshold Relative to Common Anode.
–	–	2	–	–	–	–	Pin 2 is attached to substrate and must be connected to anode or left open.

NOTE: I: input, O: output, I/O: input or output.

ELECTRICAL CHARACTERISTICS

(Over recommended operating conditions, T_J = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
SGM431							
Reference Voltage	V_{REF}	$V_{KA} = V_{REF}$, I_{KA} = 10mA			2.500		V
Deviation of Reference Input Voltage over Full Temperature Range (1)	$V_{I(DEV)}$	$V_{KA} = V_{REF}$, I_{KA} = 10mA			12		mV
Ratio of Change in Reference Voltage to the Change in Cathode Voltage	$\Delta V_{REF}/\Delta V_{KA}$	I_{KA} = 10mA	ΔV_{KA} = 10V - V_{REF}		0.8		mV/V
			ΔV_{KA} = 36V - 10V		0.4		
Reference Input Current	I_{REF}	I_{KA} = 10mA, R_1 = 10kΩ, $R_2 = \infty$			1		μA
Deviation of Reference Input Current over Full Temperature Range (1)	$I_{I(DEV)}$	I_{KA} = 10mA, R_1 = 10kΩ, $R_2 = \infty$			0.8		μA
Minimum Cathode Current for Regulation	I_{MIN}	$V_{KA} = V_{REF}$			0.4		mA
Off-State Cathode Current	I_{OFF}	V_{KA} = 36V, V_{REF} = 0			0.1		μA
Dynamic Impedance (2)	$\lvert Z_{KA}\rvert$	$V_{KA} = V_{REF}$, f ≤ 1kHz, I_{KA} = 1mA to 100mA			0.1		Ω
SGM431B							
Reference Voltage	V_{REF}	$V_{KA} = V_{REF}$, I_{KA} = 10mA			2.500		V
Deviation of Reference Input Voltage over Full Temperature Range (1)	$V_{I(DEV)}$	$V_{KA} = V_{REF}$, I_{KA} = 10mA			12		mV
Ratio of Change in Reference Voltage to the Change in Cathode Voltage	$\Delta V_{REF}/\Delta V_{KA}$	I_{KA} = 10mA	ΔV_{KA} = 10V - V_{REF}		0.8		mV/V
			ΔV_{KA} = 36V - 10V		0.4		
Reference Input Current	I_{REF}	I_{KA} = 10mA, R_1 = 10kΩ, $R_2 = \infty$			1		μA
Deviation of Reference Input Current over Full Temperature Range (1)	$I_{I(DEV)}$	I_{KA} = 10mA, R_1 = 10kΩ, $R_2 = \infty$			0.8		μA
Minimum Cathode Current for Regulation	I_{MIN}	$V_{KA} = V_{REF}$			0.4		mA
Off-State Cathode Current	I_{OFF}	V_{KA} = 36V, V_{REF} = 0			0.1		μA
Dynamic Impedance (2)	$\lvert Z_{KA}\rvert$	$V_{KA} = V_{REF}$, f ≤ 1kHz, I_{KA} = 1mA to 100mA			0.1		Ω

NOTES:

(1) The deviation parameters $V_{REF(DEV)}$ and $I_{REF(DEV)}$ are defined as the differences between the maximum and minimum values obtained over the rated temperature range. The average full-range temperature coefficient of the reference input voltage α_{VREF} is defined as:

$$\left|\alpha_{VREF}\right|\left(\frac{ppm}{℃}\right) = \frac{\left(\dfrac{V_{I(DEV)}}{V_{REF}\ \text{at}\ 25℃}\right)\times 10^6}{\Delta T_A}$$

where,

ΔT_A is the rated operating temperature range of the device.

α_{VREF} is positive or negative, depending on whether minimum V_{REF} or maximum V_{REF}, respectively, occurs at the lower temperature.

(2) The dynamic impedance is defined as:

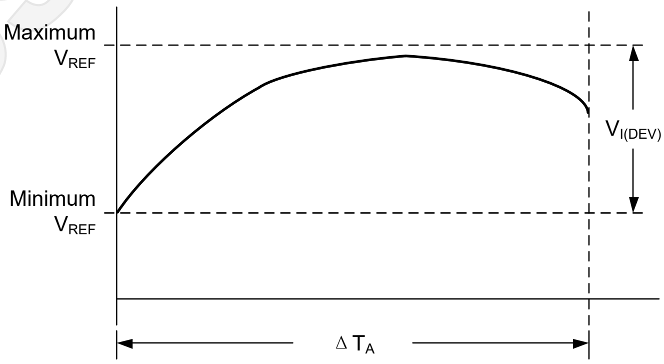
$$\left|Z_{KA}\right| = \frac{\Delta V_{KA}}{\Delta I_{KA}}$$

When the device is operating with two external resistors, the total dynamic impedance of the circuit is given by:

$$\left|z'\right| = \frac{\Delta V}{\Delta I}$$

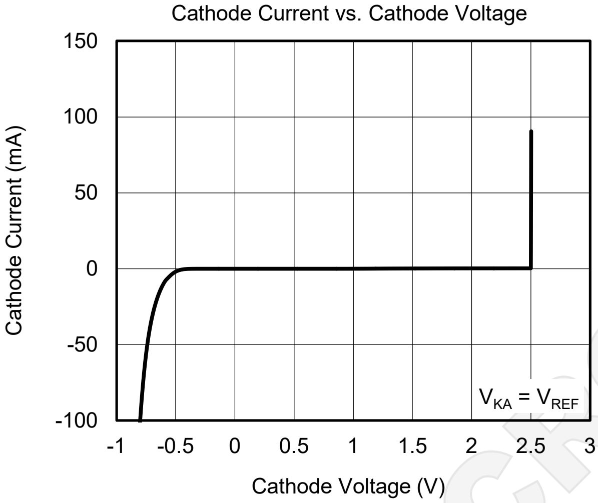
which is approximately equal to

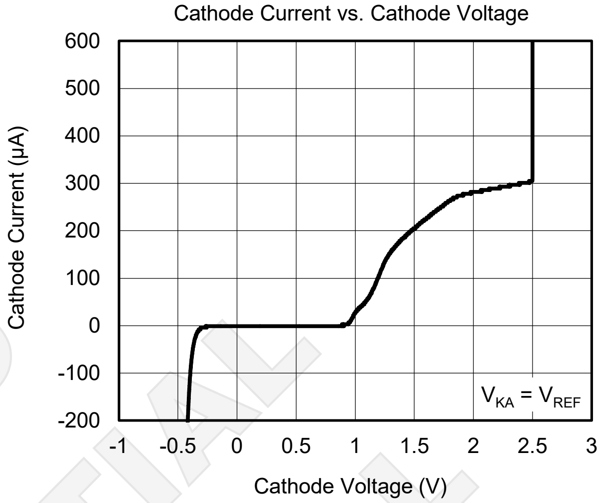
$$\left|Z_{KA}\right|\left(1+\frac{R_1}{R_2}\right).$$

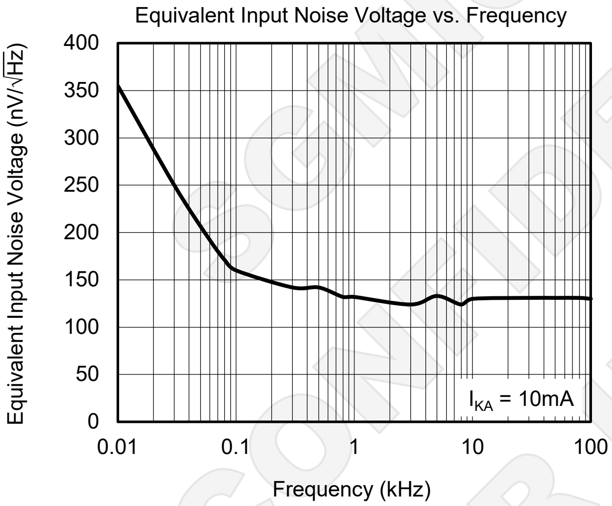


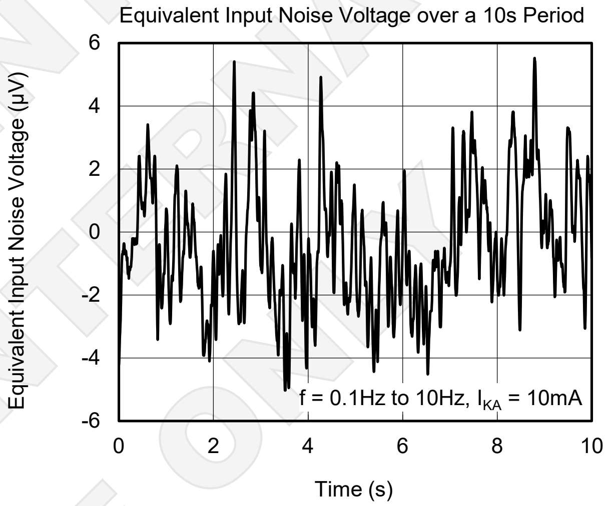
TYPICAL PERFORMANCE CHARACTERISTICS

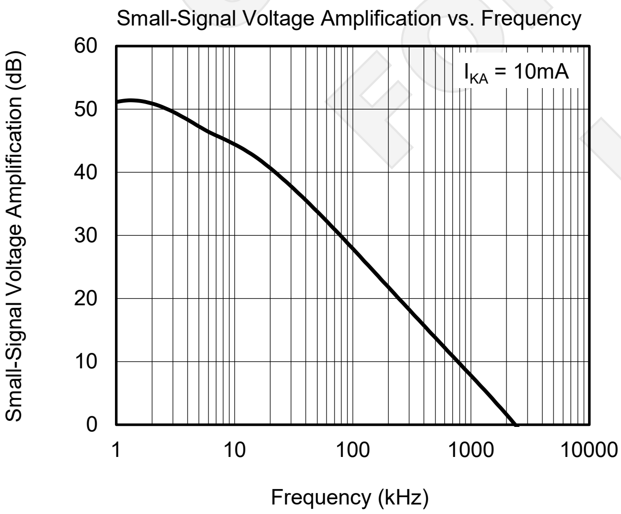
T_J = +25℃, unless otherwise noted.

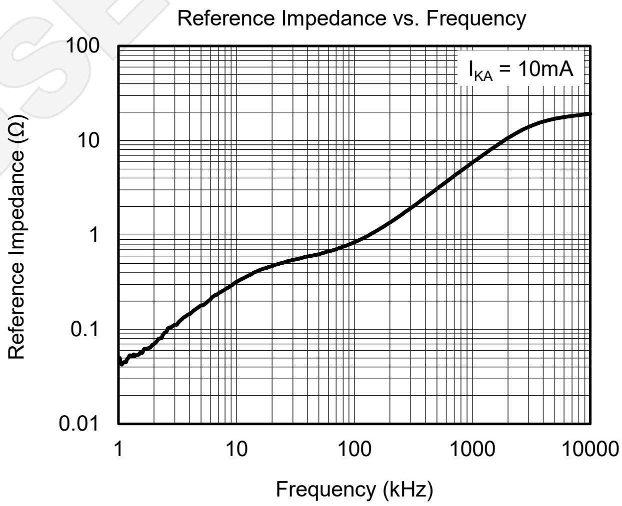






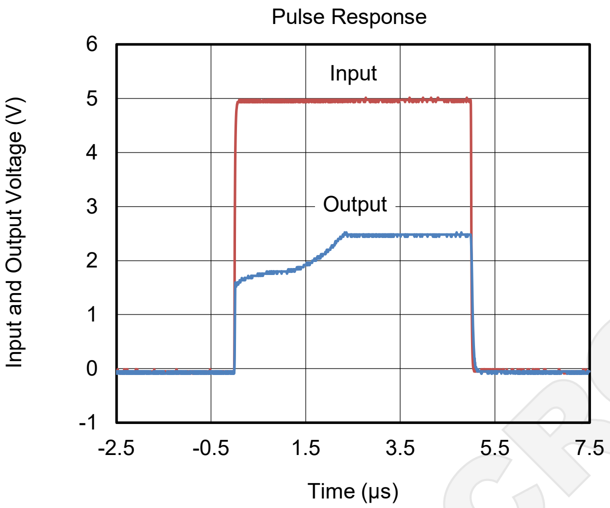






TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_J = +25℃, unless otherwise noted.



TEST CIRCUITS

Typical Characteristics Measurement Information

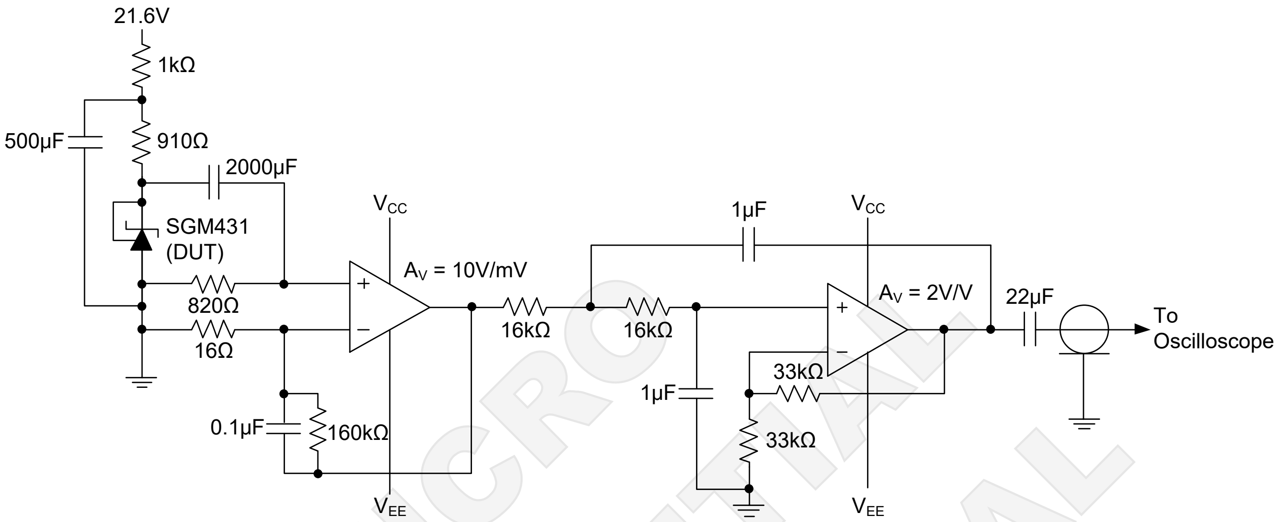


Figure 2. Test Circuit for Equivalent Input Noise Voltage over a 10s Period

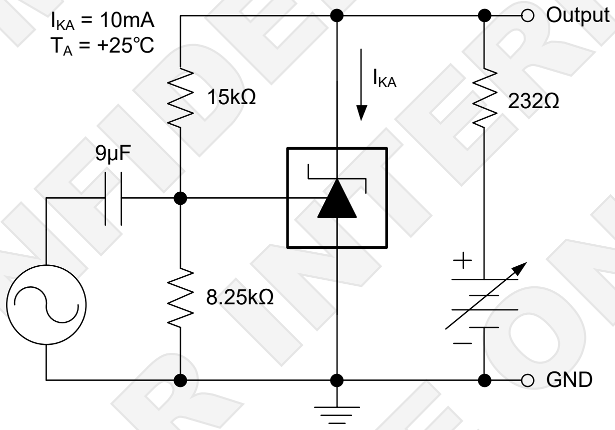


Figure 3. Test Circuit for Voltage Amplification

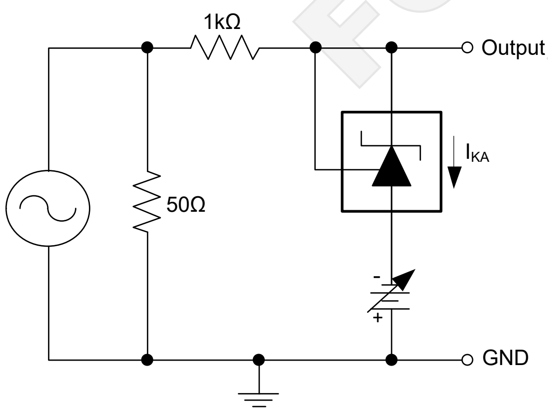


Figure 4. Test Circuit for Reference Impedance

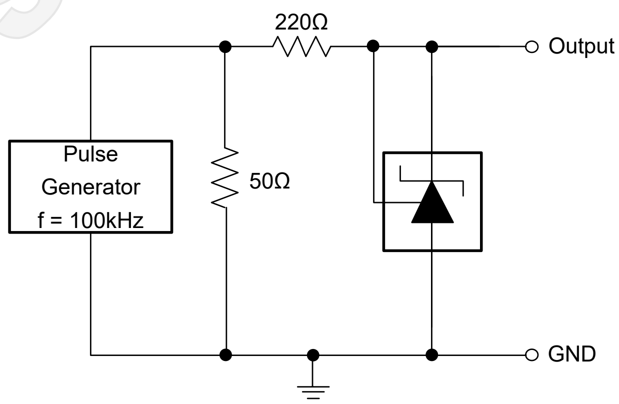


Figure 5. Test Circuit for Pulse Response

TEST CIRCUITS (continued)

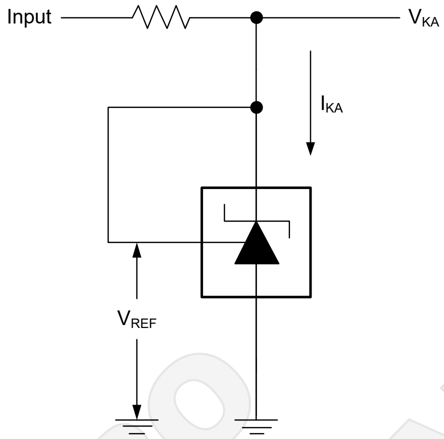
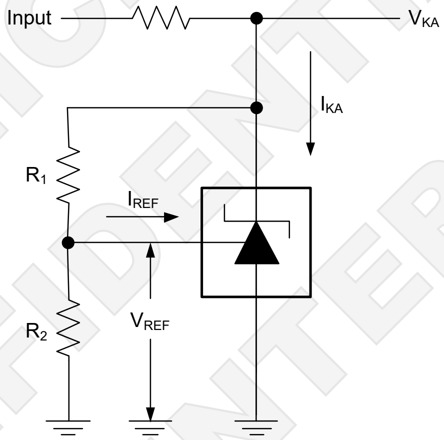


Figure 6. Test Circuit for $V_{KA} = V_{REF}$



$$V_{KA} = V_{REF}\left(1 + \frac{R_1}{R_2}\right) + I_{REF} \times R_1$$

Figure 7. Test Circuit for $V_{KA} > V_{REF}$

FUNCTIONAL BLOCK DIAGRAM

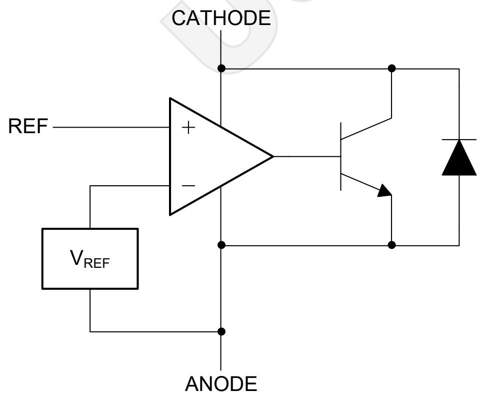


Figure 8. Equivalent Schematic

DETAILED DESCRIPTION

This device contains an accurate voltage reference and an operational amplifier, which are very fundamental analog building blocks. SGM431x is used in conjunction with its key components to behave as a single voltage reference, an error amplifier, a voltage clamp or a comparator with integrated reference.

The SGM431x can be operated and adjusted to cathode voltages from 2.5V to 36V, making this part optimum for a wide range of end equipment in industrial, auto, telecom and computing. In order for this device to behave as a shunt regulator or error amplifier, minimum current of 0.4mA (TYP) must be supplied into the CATHODE pin. Under this condition, feedback can be applied from the CATHODE and REF pins to create a replica of the internal reference voltage.

The SGM431x is characterized for operation from -40℃ to +125℃.

Feature Description

The SGM431x consists of an internal voltage reference and an amplifier that outputs a sink current based on the difference between the REF pin and the virtual internal pin. The sink current is produced by the internal transistor, shown in the above schematic (Figure 8). And it is used in order for this device to be able to sink a maximum current of 100mA. When operated with enough voltage headroom (≥ 2.5V) and cathode current (I_{KA}), The SGM431x forces the REF pin to 2.5V. However, the REF pin cannot be left floating, as it needs I_{REF} = 1μA (TYP). This is because the REF pin is driven into a NPN, which needs base current in order to operate properly.

When feedback is applied from the CATHODE and REF pins, The SGM431x behaves as a Zener diode, regulating to a constant voltage dependent on the current being supplied into the cathode. This is due to the internal amplifier and voltage reference entering the proper operating regions. The same amount of current needed in the above feedback situation must be applied to this device in open-loop, servo or error amplifying implementations in order to be in the proper linear region giving The SGM431x enough gain.

Unlike many linear regulators, The SGM431x is internally compensated to be stable without an output capacitor between the cathode and anode. However, if an output capacitor is desired, the SGM431x remains stable.

Device Functional Modes

Open-Loop (Comparator)

When the cathode/output voltage or current of the SGM431x is not being fed back to the REF pin in any form, this device is operating in open-loop. With proper cathode current (I_{KA}) applied to this device, the SGM431x will have the characteristics shown in Figure 8. With such high gain in this configuration, the SGM431x is typically used as a comparator. The voltage reference integrated makes the SGM431x a preferred choice when users are trying to monitor a certain level of a single signal.

Closed-Loop

When the cathode/output voltage or current of the SGM431x is being fed back to the REF pin in any form, this device is operating in closed-loop. The majority of applications involving the SGM431x use this manner to regulate a fixed voltage or current. The feedback enables this device to behave as an error amplifier, computing a portion of the output voltage and adjusting it to maintain the desired regulation. This is done by relating the output voltage back to the REF pin to make it equal to the internal reference voltage, which can be accomplished via resistive or direct feedback.

APPLICATION INFORMATION

Comparator with Integrated Reference

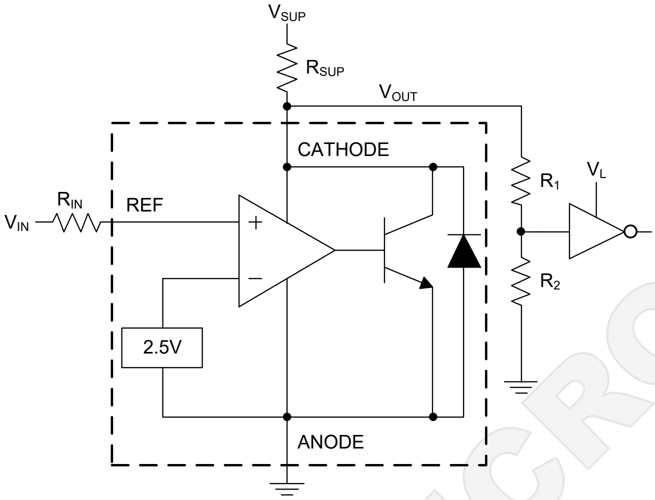


Figure 9. Comparator Application Schematic

Design Requirements

For this design example, use the parameters listed in Table 1 as the input parameters.

Table 1. Design Parameters

Design Parameter	Example Value
Input Voltage Range	0V to 5V
Input Resistance (R_{IN})	10kΩ
Supply Voltage	24V
Supply Resistance (R_{SUP})	1kΩ
Output Voltage Level	~ 2V to V_{SUP}

Detailed Design Procedure

When using the SGM431x as a comparator with reference, determine the following:

- Input Voltage Range
- Reference Voltage Accuracy
- Output Logic Input High and Low Level Thresholds
- Current Source Resistance

Basic Operation

In the configuration shown in Figure 9, the SGM431x will behave as a comparator, comparing the REF pin voltage to the internal virtual reference voltage. When provided a proper cathode current (I_{KA}), the SGM431x will have enough open-loop gain to provide a quick response. This can be seen in Figure 10, where the R_{SUP} = 10kΩ situation responds much slower than R_{SUP} = 1kΩ. With the SGM431x's maximum operating current (I_{MIN}) being 0.4mA (TYP), operation below that could result in low gain, leading to a slow response.

Overdrive

Slow or inaccurate responses can also occur when the REF pin is not provided enough overdrive voltage. This is the amount of voltage that is higher than the internal virtual reference. The internal virtual reference voltage will be within the range of 2.5V depending on which version is being used. The more overdrive voltage provided, the faster the SGM431x will respond.

For applications where the SGM431x is being used as a comparator, it is best to set the trip point to greater than the positive expected error (i.e.). For fast response, setting the trip point to > 10% of the internal V_{REF} should suffice.

For minimal voltage drop or difference from V_{IN} to the REF pin, it is recommended to use an input resistor < 10kΩ to provide I_{REF}.

Output Voltage and Logic Input Level

In order for the SGM431x to properly be used as a comparator, the logic output must be readable by the receiving logic device. This is accomplished by knowing the input high and low level threshold voltage levels, typically denoted by V_{IH} and V_{IL}.

As seen in Figure 10, the SGM431x's output low level voltage in open-loop/comparator mode is around 2V, which is typically sufficient for 5V supplied logic. However, it would not work for 3.3V or 1.8V supplied logic. In order to accommodate this, a resistive divider can be tied to the output to attenuate the output voltage to a voltage legible to the receiving low voltage logic device.

APPLICATION INFORMATION (continued)

The SGM431x's output high voltage is equal to V_{SUP} due to the SGM431x being open-collector. If V_{SUP} is much higher than the receiving logic's maximum input voltage tolerance, the output must be attenuated to accommodate the outgoing logic's reliability.

When using a resistive divider on the output, be sure to make the sum of the resistive divider (R_1 and R_2 in Figure 9) is much greater than R_{SUP} in order to not interfere with the SGM431x's ability to pull close to V_{SUP} when turning off.

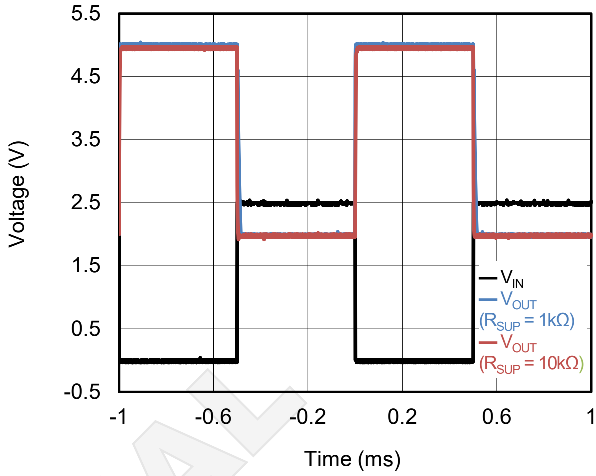


Figure 10. Output Response with Various Cathode Currents

Input Resistance

The SGM431x requires an input resistance in this application in order to source the reference current (I_{REF}) needed from this device to be in the proper operating regions while turning on. The actual voltage seen at the REF pin will be $V_{REF} = V_{IN} - I_{REF} \times R_{IN}$. Since I_{REF} can be as high as 1μA it is recommended to use a resistance small enough that will mitigate the error that I_{REF} creates from V_{IN}.

APPLICATION INFORMATION (continued)

Shunt Regulator/Reference

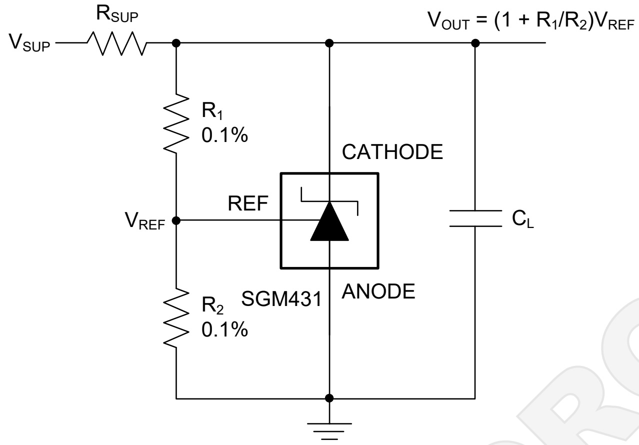


Figure 11. Shunt Regulator Schematic

Design Requirements

For this design example, use the parameters listed in Table 2 as the input parameters.

Table 2. Design Parameters

Design Parameter	Example Value
Supply Voltage	40V
Cathode Current (I_{KA})	5mA
Output Voltage Level	2.5V to 36V
Load Capacitance	100nF
Feedback Resistor Values and Accuracy (R_1 and R_2)	10kΩ (0.1%)

Detailed Design Procedure

When using the SGM431x as a shunt regulator, determine the following:

- Input Voltage Range
- Temperature Range
- Total Accuracy
- Cathode Current
- Reference Initial Accuracy
- Output Capacitance

Programming Output/Cathode Voltage

In order to program the cathode voltage to a regulated voltage a resistive divider must be shunted between the CATHODE and ANODE pins with the mid-point tied to the REF pin. This can be seen in Figure 11, with R_1 and R_2 being the resistive divider. The cathode/output voltage in the shunt regulator configuration can be approximated by the equation shown in Figure 11. The cathode voltage can be more accurately determined by taking into account the cathode current:

$$V_{OUT} = V_{REF}\left(1 + \frac{R_1}{R_2}\right) - I_{REF} \times R_1$$

In order for this equation to be valid, the SGM431x must be fully biased so that it has enough open-loop gain to mitigate any gain error. This can be done by meeting the I_{MIN} specification denoted in Electrical Characteristics.

Total Accuracy

When programming the output above unity gain ($V_{KA} = V_{REF}$), the SGM431x is susceptible to other errors that may effect the overall accuracy beyond V_{REF}. These errors include:

- R_1 and R_2 accuracies
- $V_{I(DEV)}$: change in reference voltage over temperature
- $\Delta V_{REF}/\Delta V_{KA}$: change in reference voltage to the change in cathode voltage
- $|Z_{KA}|$: dynamic impedance, causing a change in cathode voltage with cathode current

Worst case cathode voltage can be determined by taking all of the variables into account.

Stability

Though the SGM431x is stable with no capacitive load, the device that receives the shunt regulator's output voltage could present a capacitive load that is within the SGM431x region of stability. Also, designers may use capacitive loads to improve the transient response or for power supply decoupling.

APPLICATION INFORMATION (continued)

Start-Up Time

As shown in Figure 12, the SGM431x has a fast response up to around 2V and then slowly charges to its programmed value. Despite the secondary delay, SGM431x still has a fast response suitable for many clamp applications.

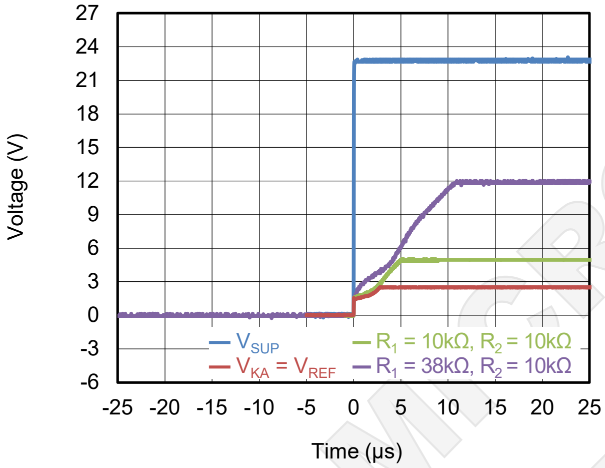


Figure 12. SGM431x Start-Up Response

Power Supply Recommendations

When using the SGM431x as a linear regulator to supply a load, designers will typically use a bypass capacitor on the CATHODE pin. When doing this, the SGM431x remains stable.

In order to not exceed the maximum cathode current, be sure that the supply voltage is current limited. Also, be sure to limit the current being driven into the REF pin, as not to exceed its absolute maximum rating.

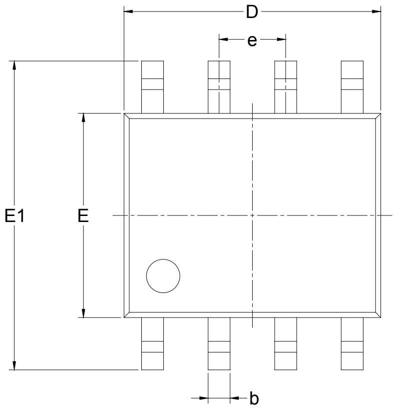
For applications shunting high currents, pay attention to the cathode and anode trace lengths, adjusting the width of the traces to have the proper current density.

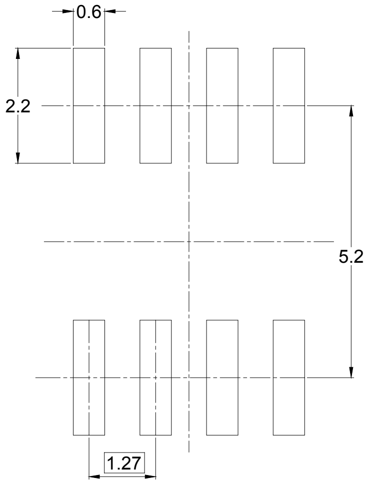
Layout

Bypass capacitors should be placed as close to the part as possible. Current-carrying traces need to have widths appropriate for the amount of current they are carrying; in the case of the SGM431x, these currents will be low.

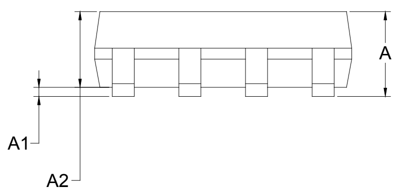
PACKAGE OUTLINE DIMENSIONS

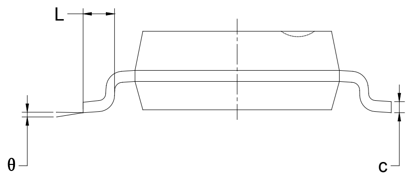
SOIC-8





RECOMMENDED LAND PATTERN (Unit: mm)

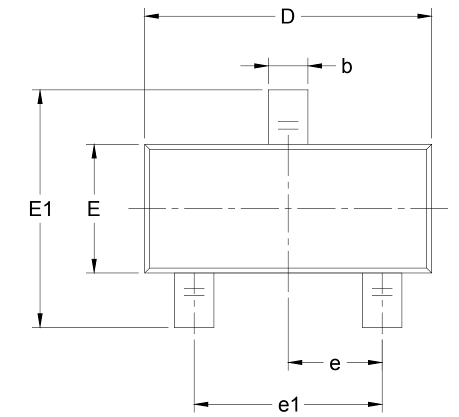


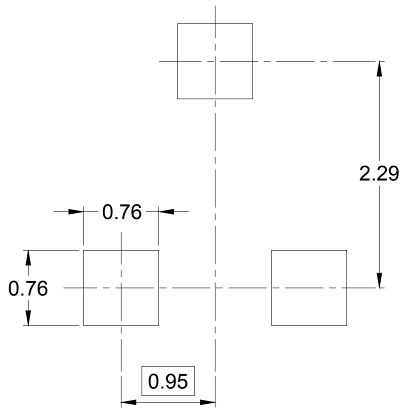


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

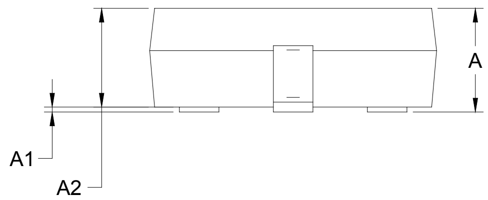
PACKAGE OUTLINE DIMENSIONS

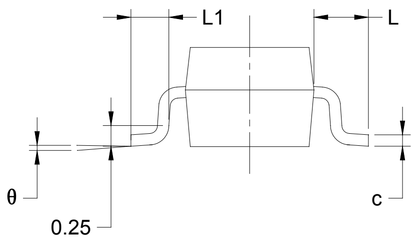
SOT-23





RECOMMENDED LAND PATTERN (Unit: mm)

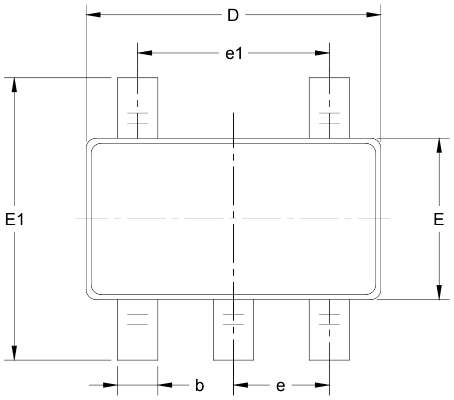


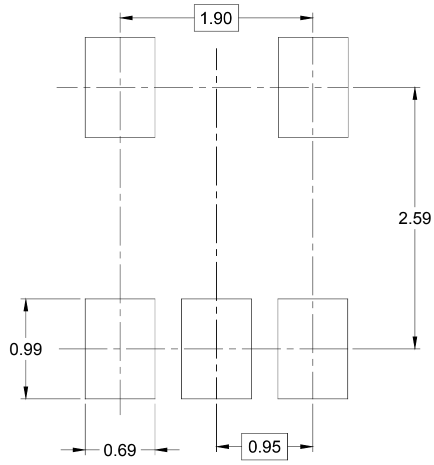


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.900	1.150	0.035	0.045
A1	0.000	0.100	0.000	0.004
A2	0.900	1.050	0.035	0.041
b	0.300	0.500	0.012	0.020
c	0.080	0.150	0.003	0.006
D	2.800	3.000	0.110	0.118
E	1.200	1.400	0.047	0.055
E1	2.250	2.550	0.089	0.100
e	0.950 BSC		0.037 BSC	
e1	1.900 BSC		0.075 BSC	
L	0.550 REF		0.022 REF	
L1	0.300	0.500	0.012	0.020
θ	0°	8°	0°	8°

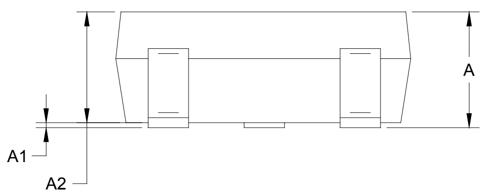
PACKAGE OUTLINE DIMENSIONS

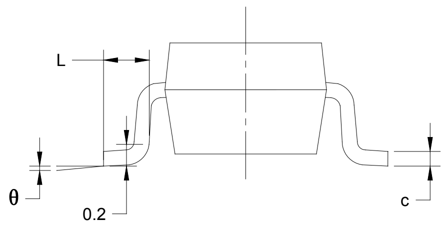
SOT-23-5





RECOMMENDED LAND PATTERN (Unit: mm)

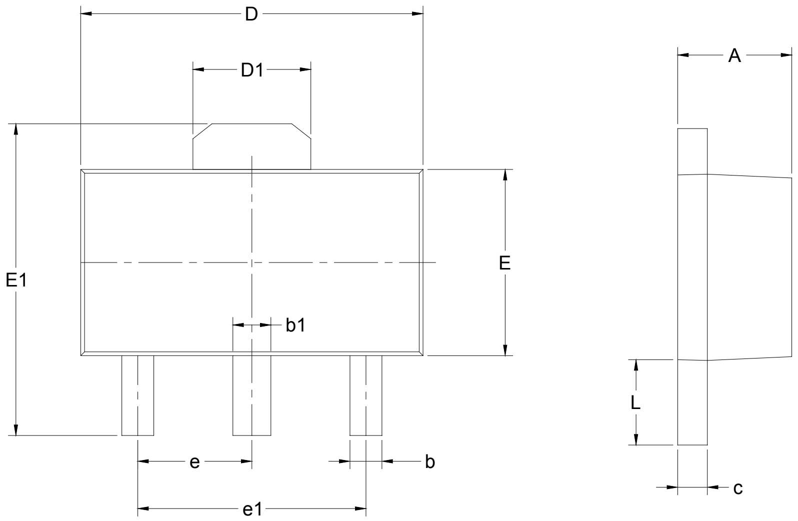


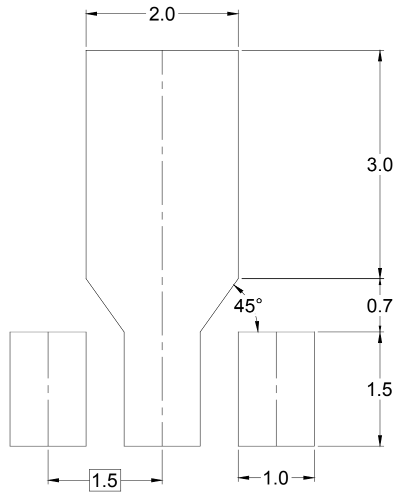


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	**MAX**	**MIN**	**MAX**
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 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°

PACKAGE OUTLINE DIMENSIONS

SOT-89-3



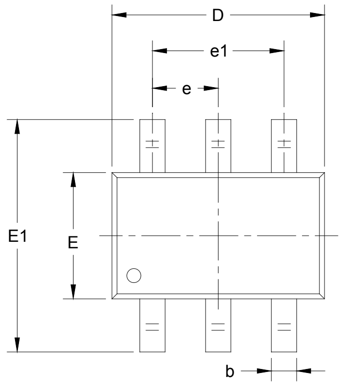


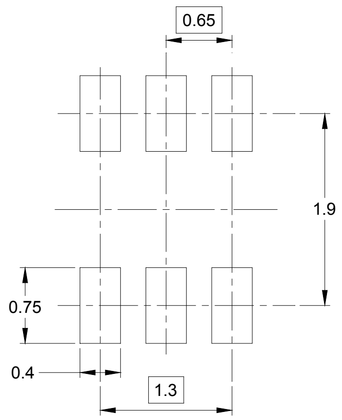
RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	**MAX**	**MIN**	**MAX**
A	1.400	1.600	0.055	0.063
b	0.320	0.520	0.013	0.020
b1	0.400	0.580	0.016	0.023
c	0.350	0.440	0.014	0.017
D	4.400	4.600	0.173	0.181
D1	1.550 REF		0.061 REF	
E	2.300	2.600	0.091	0.102
E1	3.940	4.250	0.155	0.167
e	1.500 TYP		0.060 TYP	
e1	3.000 TYP		0.118 TYP	
L	0.900	1.200	0.035	0.047

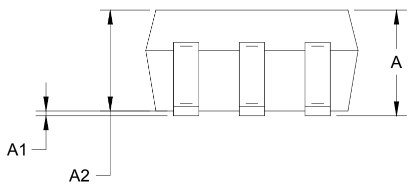
PACKAGE OUTLINE DIMENSIONS

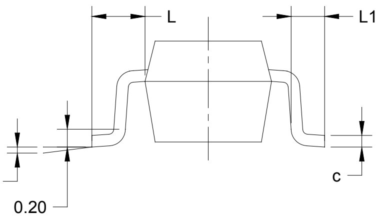
SC70-6





RECOMMENDED LAND PATTERN (Unit: mm)

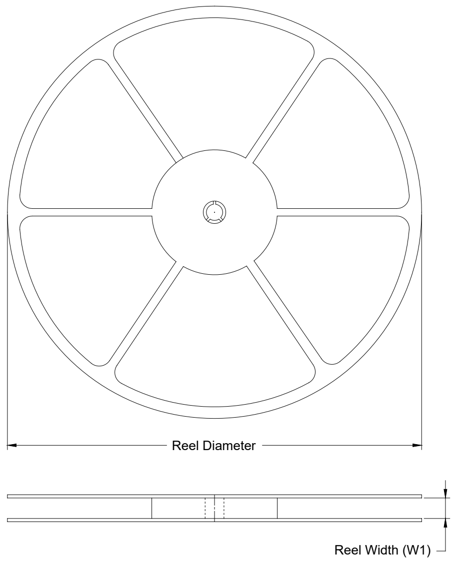




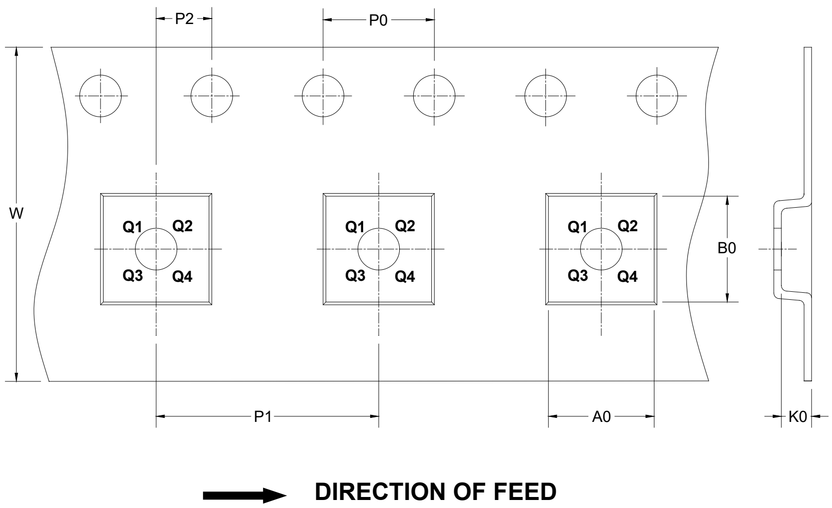
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.65 TYP		0.026 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°

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



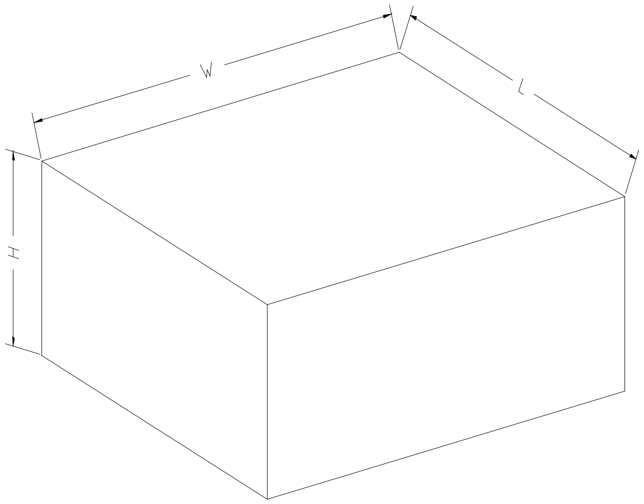
NOTE: The picture is only for reference. Please make the object as the standard.

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
SOIC-8	13″	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1
SOT-23	7″	9.5	3.15	2.77	1.22	4.0	4.0	2.0	8.0	Q3
SOT-23-5	7″	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3
SOT-89-3	7″	13.2	4.85	4.45	1.85	4.0	8.0	2.0	12.0	Q3
SC70-6	7″	9.5	2.40	2.50	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
13″	386	280	370	5

DD0002