

Description

The GM431 is a three terminal adjustable shunt regulator with thermal stability guaranteed over temperature. The output voltage can be adjusted to any value between 2.5V (V_{REF}) and 18V by using two external resistors. The GM431 has a typical dynamic output impedance of 0.2. Active output circuitry provides a very unique turn on characteristic, making the GM431 an excellent replacement for zener diodes in many applications such as on board regulation and adjustable power supplies. The GM431 is an ideal voltage reference for 3.0 to 3.3V switching power supplies.

The GM431 shunt regulator is available with 3 voltage tolerances 0.5%, 1.0% and 2.0% over full temperature range and four package options (SOT-23, TO-92, SOT-89 and SO-8).

Features

- ◆ Sink Current Capability 1mA to 100mA
- ◆ Low dynamic output impedance, 0.2 typ.
- ◆ Low output noise
- ◆ 0.5%, 1% or 2% reference voltage tolerance
- ◆ Alternate for TL431, LM431 & AS431
- ◆ Temperature range -40°C to + 125°C
- ◆ Available in SOT-23, TO-92, SOT-89 and Sop- 8 packages

Application

Switching power supplies

Linear regulator

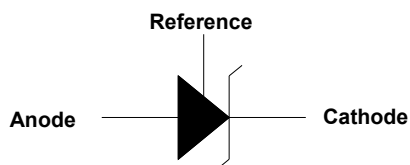
Adjustable supplies

Battery-operated computers

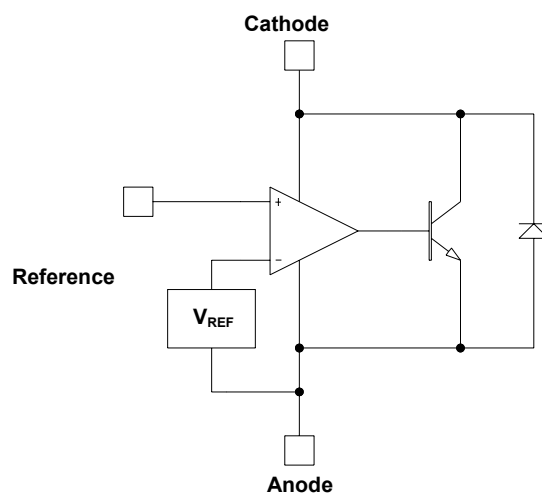
Computer disk drives

Instrumentation

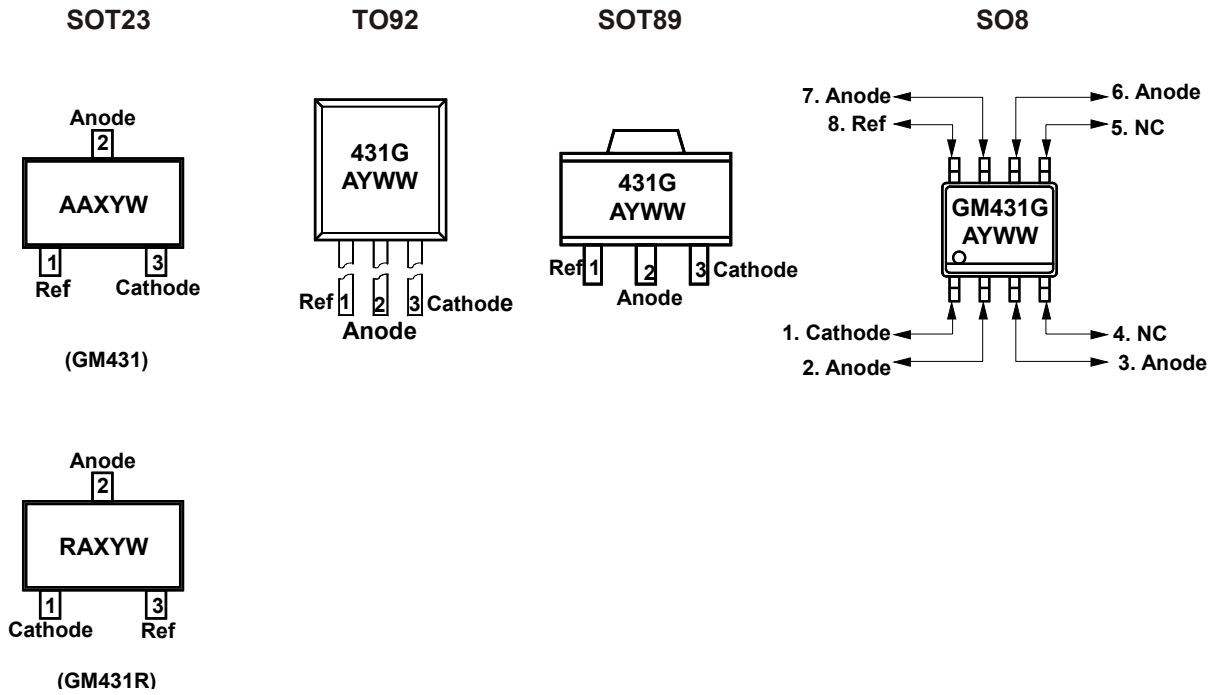
Logic Symbol



Block Diagram



Marking Information and Pin Configurations (Top View)



AAX: Marking Code (see table below)
 RAX: Marking Code (see table below)
 G: Grade Code (A: 0.5%, B: 1.0%, C: 2.0%)
 A: Assembly/Test Site Code
 Y: Year
 W: Week code
 WW: Week

Ordering Information

Ordering Number	Precision	Device Code	Grade	Package	Shipping
GM431AT92B	0.5%		A	TO-92	1,000 Units/ESD Bag
GM431AT92RL	0.5%		A	TO-92	2,000 Units/Ammo Pack (Tape)
GM431AST23R	0.5%	AAA		SOT-23	3,000 Units/Tape & Reel
GM431RAST23R	0.5%	RAA		SOT-23	3,000 Units/Tape & Reel
GM431AS8T	0.5%		A	SO-8	100 Units/Tube
GM431AS8R	0.5%		A	SO-8	2,500 Units/Tape & Reel
GM431AST89R	0.5%		A	SOT-89	1,000 Units/Tape & Reel
GM431BT92B	1.0%		B	TO-92	1,000 Units/ESD Bag
GM431BT92RL	1.0%		B	TO-92	2,000 Units/Ammo Pack (Tape)
GM431BST23R	1.0%	AAB		SOT-23	3,000 Units/Tape & Reel
GM431RBST23R	1.0%	RAB		SOT-23	3,000 Units/Tape & Reel
GM431BS8T	1.0%		B	SO-8	100 Units/Tube
GM431BS8R	1.0%		B	SO-8	2,500 Units/Tape & Reel
GM431BST89R	1.0%		B	SOT-89	1,000 Units/Tape & Reel
GM431CT92B	2.0%		A	TO-92	1,000 Units/ESD Bag
GM431CT92RL	2.0%		C	TO-92	2,000 Units/Ammo Pack (Tape)
GM431CST23R	2.0%	AAC		SOT-23	3,000 Units/Tape & Reel
GM431RCST23R	2.0%	RAC		SOT-23	3,000 Units/Tape & Reel
GM431CS8T	2.0%		C	SO-8	100 Units/Tube
GM431CS8R	2.0%		C	SO-8	2,500 Units/Tape & Reel
GM431AST89R	2.0%		C	SOT-89	1,000 Units/Tape & Reel

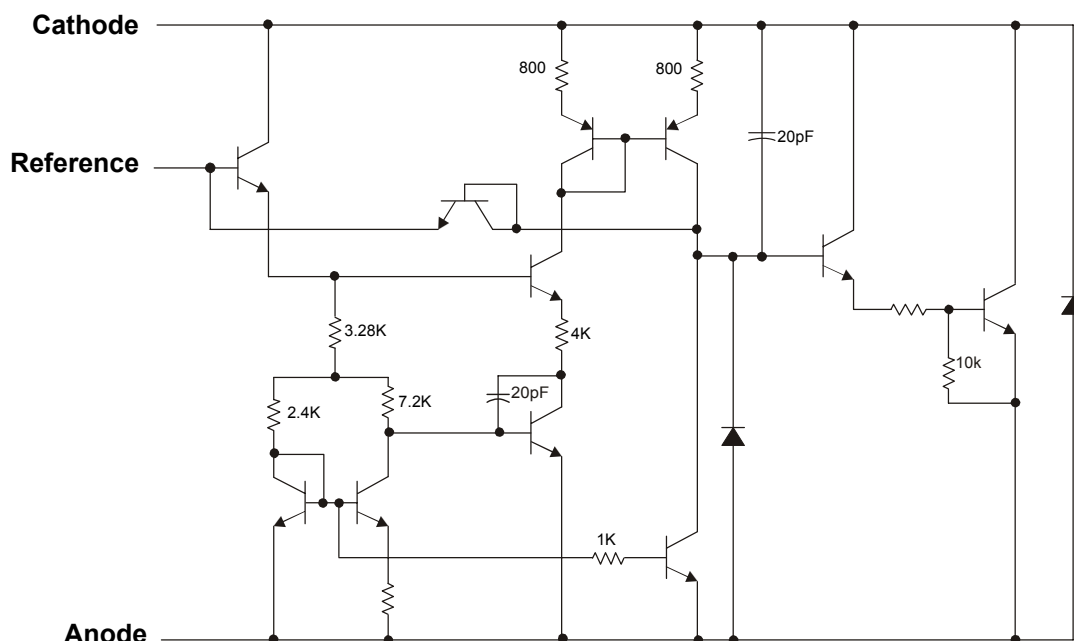
Absolute Maximum Ratings

PARAMETER	SYMBOL	RATINGS	UNITS
Cathode Voltage	V_{KA}	20	V
Continuous Cathode Current Range	I_K	-100 to 150	mA
Reference Input Current Range	I_{REF}	-50 μ A to 10mA	
Power Dissipation at $T_A = 25^\circ\text{C}$			
SOT-23	P_D	0.23	W
TO-92		0.78	
SOT-89		0.8	
SO-8		0.6	
Package Thermal Resistance			
SOT-23	θ_{JA}	336	$^\circ\text{C/W}$
TO-92		132	
SOT-89		132	
SO-8		163	
Operating Ambient Temperature Range	T_A	-40 - 125	$^\circ\text{C}$
Storage Temperature		- 65 to 150	$^\circ\text{C}$
Lead Temperature (soldering 10 sec.)		260	$^\circ\text{C}$

Recommended Operating Conditions

PARAMETER	SYMBOL	Min	Max	UNITS
Cathode Voltage	V_{KA}	V_{REF}	18	V
Cathode Current	I_K	10	100	mA

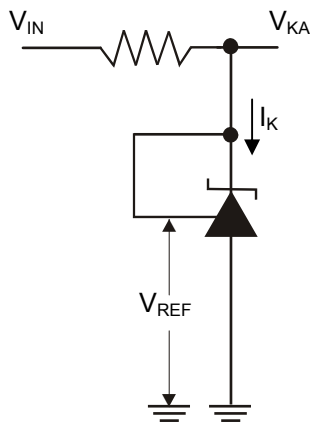
Equivalent Schematics



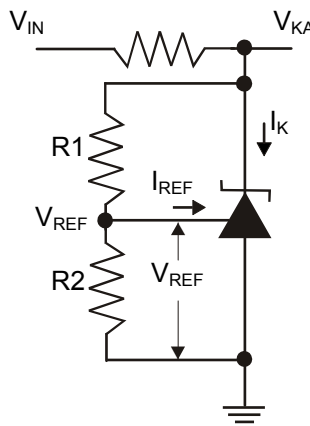
Electrical Characteristics (T_A = 25°C unless otherwise specified)

Parameter		Symbol	Condition	Min	Typ	Max	Unit
Reference Voltage	GM431A	V _{REF}	V _{KA} = V _{REF} , I _K = 10mA, Test circuit 1	2.488	2.500	2.513	mV
	GM431B			2.475	2.500	2.525	
	GM431C			2.450	2.500	2.550	
V _{REF} Deviation over Temperature		V _{REF(DEV)}	V _{KA} = V _{REF} , I _K = 10mA, Full Range Test circuit 1		4	17	mV
Ratio of change in V _{REF} to change in V _{KA}		ΔV _{REF} /ΔV _{KA}	I _K = 10mA				μA
			ΔV _{KA} = 10V to V _{REF}	-2.7	-1.0		
			ΔV _{KA} = 18V to 10V	-2	-0.4		
Reference Input Current		I _{REF}	I _K = 10mA, R1 = 10K, R2 = ∞ Test circuit 2		1.3	4	μA
I _{REF} Deviation over Temperature		V _{REF(DEV)}	I _K = 10mA, R1 = 10K, R2 = ∞ Full range, Test circuit 2		0.4	1.2	μA
Minimum Cathode Current		I _{K(MIN)}	V _{KA} = V _{REF} Test circuit 1		0.4	1.0	mA
Off-state cathode Current		I _{K(OFF)}	V _{KA} = 18V, V _{REF} = 0V Test circuit 3		0.1	1	μA
Dynamic Impedance		Z _{KA}	V _{KA} = V _{REF} , I _K = 1mA to 10mA, f ≤ 1kHz, Test circuit 1		0.2	0.5	Ω

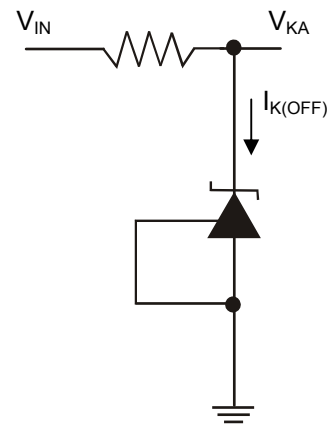
Test Circuits



Test Circuit 1
V_{KA} = V_{REF}



Test Circuit 2
V_{KA} > V_{REF}



Test Circuit 3
Off-State

Typical Characteristics

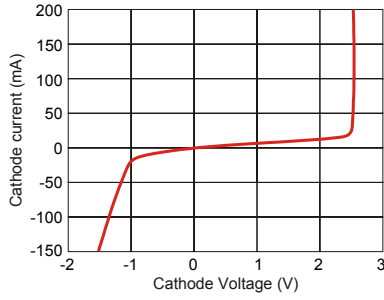


Figure 5. Cathode Current vs. Cathode Voltage

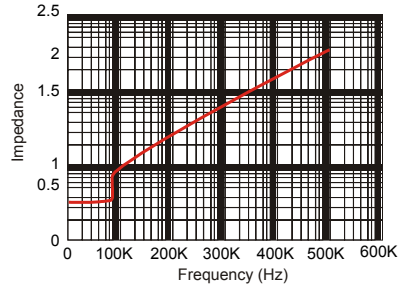


Figure 7. Dynamic Impedance

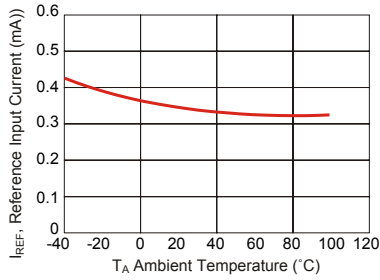


Figure 6. Reference Input Current vs. Ambient Temperature

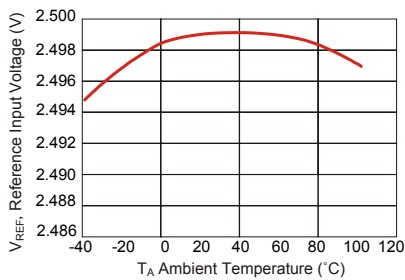


Figure 8. Reference Input Voltage vs. Ambient Temperature

AC Characteristic Determination:

This refers to the determination of the gain frequency characteristic of the Shunt regulator as an error amplifier. Taking the configuration in Figure 10, the error amplifier characteristic is as Shown in Figure 10.

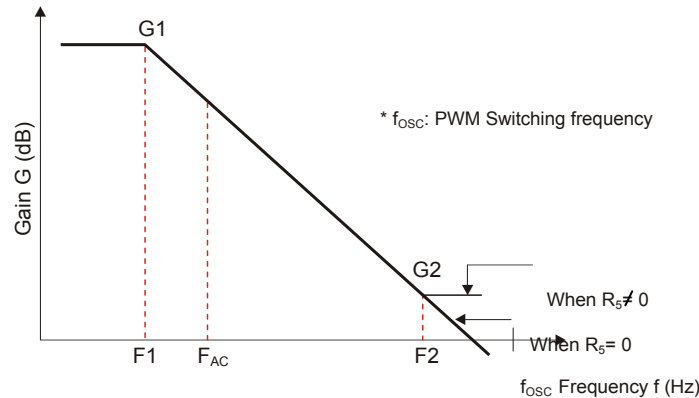


Figure 10. GM431 Error Amplification Characteristic

In Figure 17, the following formulas are obtained:

Gain

$$G1 = G0 \cong 50 \text{ dB to } 60 \text{ dB (determined by shunt regulator)}$$

$$G2 = \frac{R5}{R3}$$

Corner frequencies

$$f1 = 1/(2\pi C1 G0 R3)$$

$$f2 = 1/(2\pi C1 R5)$$

$G0$ is the Shunt regulator open-loop gain; this is given by the reciprocal of the reference voltage fluctuation:

$$\Delta V_{REF}/\Delta V_{KA}, \text{ and is approximately } 50 \text{ dB.}$$

Practical Example

Consider the example of a photocoupler, with an internal light emitting diode $V_F = 1.05 \text{ V}$ and $I_F = 2.5 \text{ mA}$, power supply output voltage $V2 = 5 \text{ V}$, and bias resistance $R2$ current of approximately $1/5 I_F$ at 0.5 mA . If the Shunt regulator $V_K = 3 \text{ V}$, the following values are found.

$$R1 = \frac{5 \text{ V} - 1.05 \text{ V} - 3 \text{ V}}{2.5 \text{ mA} + 0.5 \text{ mA}} = 316 \Omega$$

$$R2 = \frac{1.05 \text{ V}}{0.54 \text{ mA}} = 2.1 \text{ k}\Omega$$

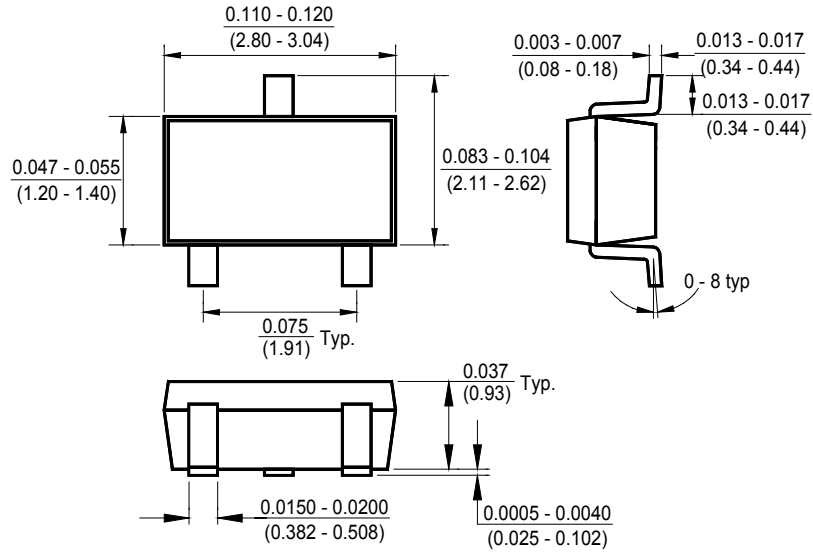
Next, assume that $R3 = R4 = 10 \text{ k}$. This gives a 5 V output. If $R5 = 3.3 \text{ k}$, and $C1 = 0.022 \text{ pF}$, the following values are found.

$$G2 = 3.3 \text{ k}\Omega / 10 \text{ k}\Omega = 0.33 \text{ times } (-10 \text{ dB})$$

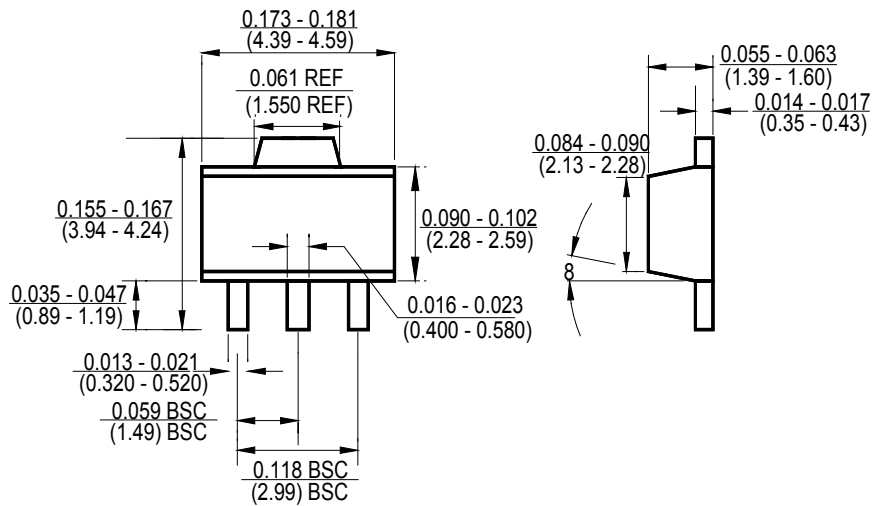
$$f1 = 1 / (2 \times \pi \times 0.022 \mu\text{F} \times 316 \times 10 \text{ k}) = 2.3 \text{ (Hz)}$$

$$f2 = 1 / (2 \times \pi \times 0.022 \mu\text{F} \times 3.3 \text{ k}) = 2.2 \text{ (kHz)}$$

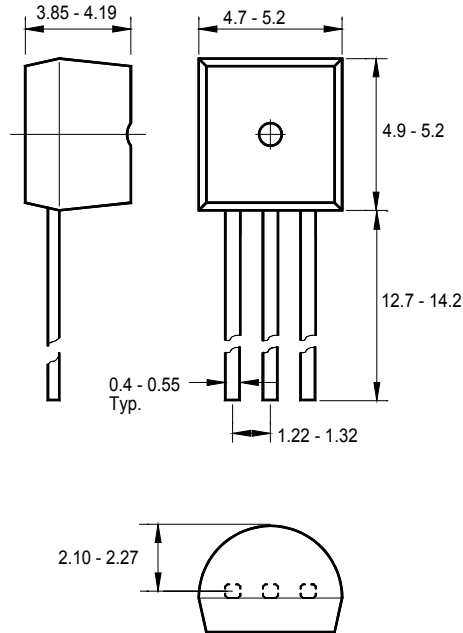
Package Outline Dimensions – SOT 23



Package Outline Dimensions – SOT 89

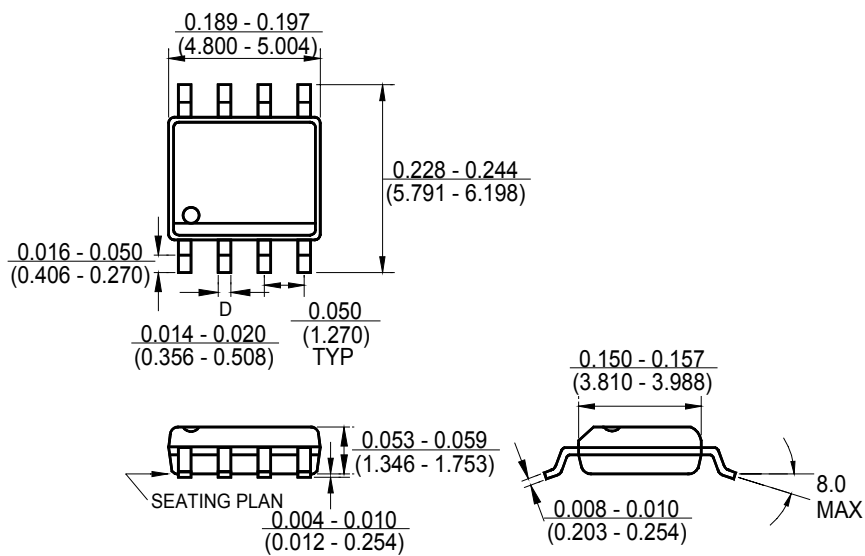


Package Outline Dimensions – TO 92



Dimensions are in millimeters

Package Outline Dimensions – SO 8



Ordering Number

<u>GM</u>	<u>431</u>	<u>A</u>	<u>T92</u>	<u>R</u>
APM Gamma Micro	Circuit Type	Output Accuracy	Package Type	Shipping Type
		A: 0.5% B: 1.0% C: 2.0%	T92: TO-92 ST23: SOT-23 ST89: SOT-89 S8: SO-8	B: Bag RL: Ammo Pack (Tape) T: Tube R: Tape & Reel

Ordering Number

<u>GM</u>	<u>431R</u>	<u>A</u>	<u>ST23</u>	<u>R</u>
APM Gamma Micro	Circuit Type	Output Accuracy	Package Type	Shipping Type
		A: 0.5% B: 1.0% C: 2.0%	ST23: SOT-23	R: Tape & Reel