TS431-Z

Adjustable Precision Shunt Regulator

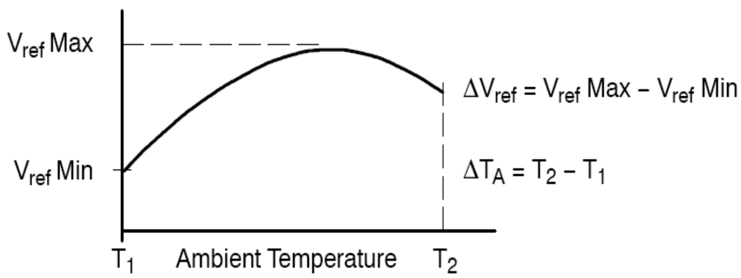
Electrical Characteristics (T_A=25°C, unless otherwise specified)

Parameter		Symbol	Test Conditions		Min	Typ	Max	Unit
Reference voltage	TS431A	V_{REF}	V_{KA} =V_{REF}, I_K =10mA (Figure 1)		2.470	2.495	2.520	V
	TS431B				2.483		2.507	
Deviation of reference input voltage		Δ V_{REF}	V_{KA} = V_{REF}, I_K =10mA (Figure 1) T_A=-20~85°C		--	6	20	mV
Radio of change in Vref to change in cathode Voltage		$\Delta V_{REF} / \Delta V_{KA}$	I_{KA} =10mA, (Figure 2)	V_{KA} = 10V to V_{REF}	--	-1.2	-2.0	mV/V
				V_{KA} = 36V to 10V	--	-1.0	-2.0	
Reference Input current		I_{REF}	R1=10KΩ, R2=∞ , I_{KA} =10mA (Figure 2)		--	1.5	3.5	µA
Deviation of reference input current, over temp.		ΔI_{REF}	R1=10KΩ, R2=∞ , I_{KA} =10mA T_A=-20~85°C (Figure 2)		--	0.4	1.2	µA
Off-state Cathode Current		I_{KA} (off)	V_{REF} =0V (Figure 3), V_{KA} =36V		--	0.1	1.0	µA
Dynamic Output Impedance		| Z_{KA} |	f<1KHz, V_{KA} = V_{REF} (Figure 1)		--	0.2	0.5	Ω
Minimum operating cathode current		I_{KA} (min)	V_{KA} = V_{REF} (Figure 1)		--	0.2	0.5	mA

* The deviation parameters ΔV_{REF} and ΔI_{REF} are defined as difference between the maximum value and minimum value obtained over the full operating ambient temperature range that applied.

* The average temperature coefficient of the reference input voltage, αV_{REF} is defined as:

$$\alpha V_{ref}\left(\frac{ppm}{°C}\right) = \frac{\left(\frac{(\Delta V_{ref})}{V_{ref}\ (T_A = 25°C)} \times 10^6\right)}{\Delta T_A}$$



Where: **T2-T1** = full temperature change.

αV_{REF} can be positive or negative depending on whether the slope is positive or negative.

Example: Maximum V_{REF}=2.496V at 30°C, minimum V_{REF} =2.492V at 0°C, V_{REF} =2.495V at 25°C, ΔT=70°C

αV_{REF} | = [4mV / 2495mV] * 10^6 / 70°C ≈ 23ppm/°C

Because minimum V_{REF} occurs at the lower temperature, the coefficient is positive.

* The dynamic impedance ZKA is defined as:

| Z_{KA} | = ΔV_{KA} / ΔI_{KA}

* When the device operating with two external resistors, R1 and R2, (refer to Figure 2) the total dynamic impedance of the circuit is given by:

| Z_{KA} | = Δv / Δi | ≈ Z_{KA} | * (1 + R1 / R2)

Test Circuits

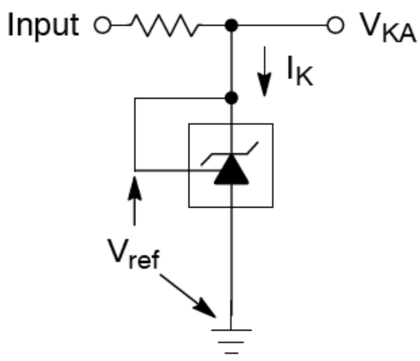
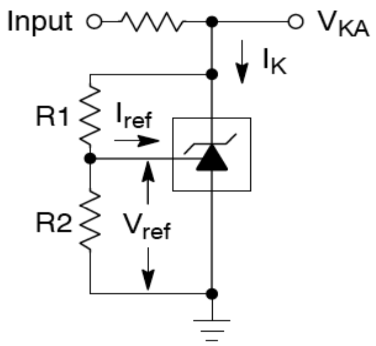


Figure 1: $V_{KA} = V_{REF}$



$$V_{KA} = V_{ref}\left(1 + \frac{R1}{R2}\right) + I_{ref} \bullet R1$$

Figure 2: $V_{KA} > V_{REF}$

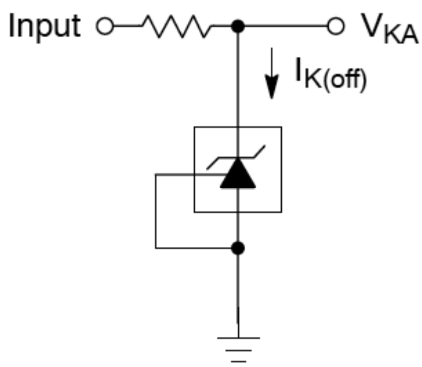


Figure 3: Off-State Current

Additional Information – Stability

When The TS431A/431B is used as a shunt regulator, there are two options for selection of C_L, are recommended for optional stability:

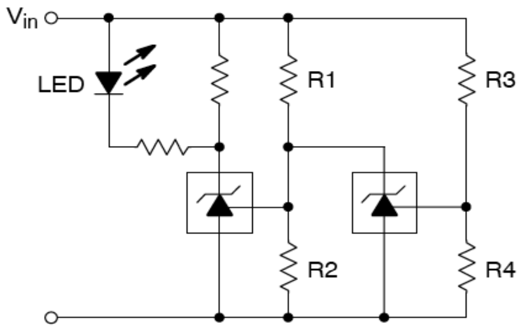
A) No load capacitance across the device, decouple at the load.

B) Large capacitance across the device, optional decoupling at the load.

The reason for this is that TS431A/431B exhibits instability with capacitances in the range of 10nF to 1uF (approx.) at light cathode current up to 3mA (typ). The device is less stable the lower the cathode voltage has been set for. Therefore while the device will be perfectly stable operating at a cathode current of 10mA (approx.) with a 0.1uF capacitor across it, it will oscillate transiently during start up as the cathode current passes through the instability region. Select a very low capacitance, or alternatively a high capacitance (10uF) will avoid this issue altogether. Since the user will probably wish to have local decoupling at the load anyway, the most cost effective method is to use no capacitance at all directly across the device. PCB trace/via resistance and inductance prevent the local load decoupling from causing the oscillation during the transient start up phase.

Note: if the TS431A/431B is located right at the load, so the load decoupling capacitor is directly across it, then this capacitor will have to be ≤1nF or ≥10uF.

Applications Examples (Continue)

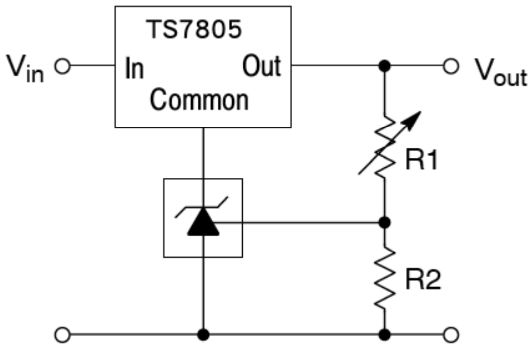


L.E.D. indicator is 'ON' when V_{in} is between the upper and lower limits,

$$\text{Lower limit} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

$$\text{Upper limit} = \left(1 + \frac{R3}{R4}\right) V_{ref}$$

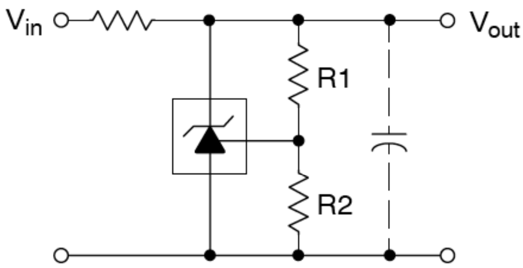
Figure 4: Voltage Monitor



$$V_{out} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

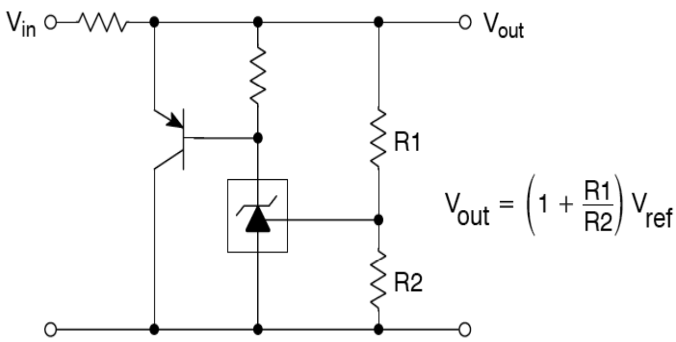
$$V_{out(min)} = V_{ref} + 5.0\text{ V}$$

Figure 5: Output Control for Three Terminal Fixed Regulator



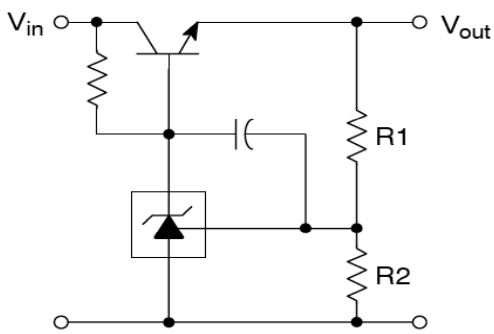
$$V_{out} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

Figure 6: Shunt Regulator



$$V_{out} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

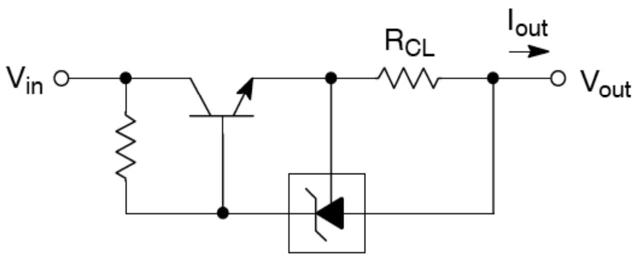
Figure 7: High Current Shunt Regulator



$$V_{out} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

$$V_{out(min)} = V_{ref} + V_{be} \approx 2.0\text{ V}$$

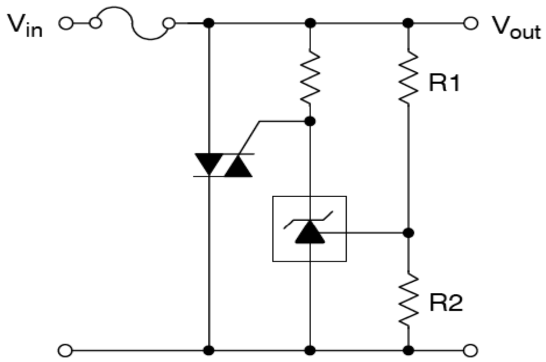
Figure 8: Series Pass Regulator



$$I_{out} = \frac{V_{ref}}{R_{CL}}$$

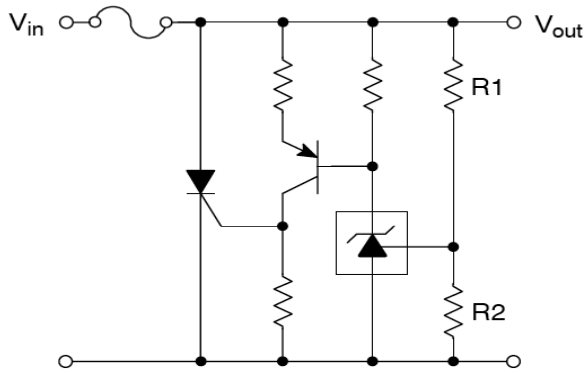
Figure 9: Constant Current Source

Applications Examples (Continue)



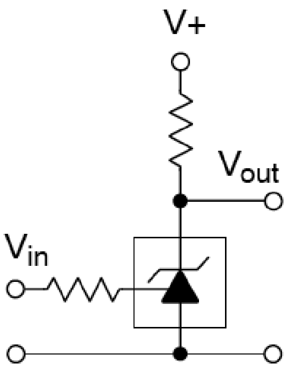
$$V_{out(trip)} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

Figure 10: TRIAC Crowbar



$$V_{out(trip)} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

Figure 11: SCR Crowbar



Vin	Vout
<Vref	V+
>Vref	≈0.74V

Figure 12: Single-Supply Comparator with Temperature-Compensated Threshold

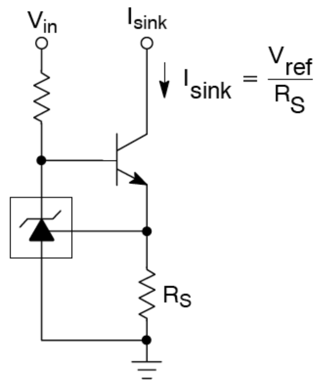
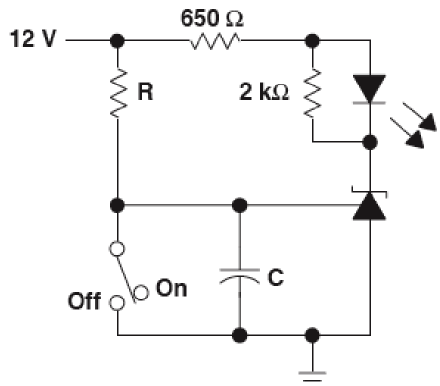


Figure 13: Constant Current Sink



$$Delay = R \times C \times l_n\left(\frac{12\ V}{12\ V - V_{ref}}\right)$$

Figure 14: Delay Timer

Typical Performance Characteristics

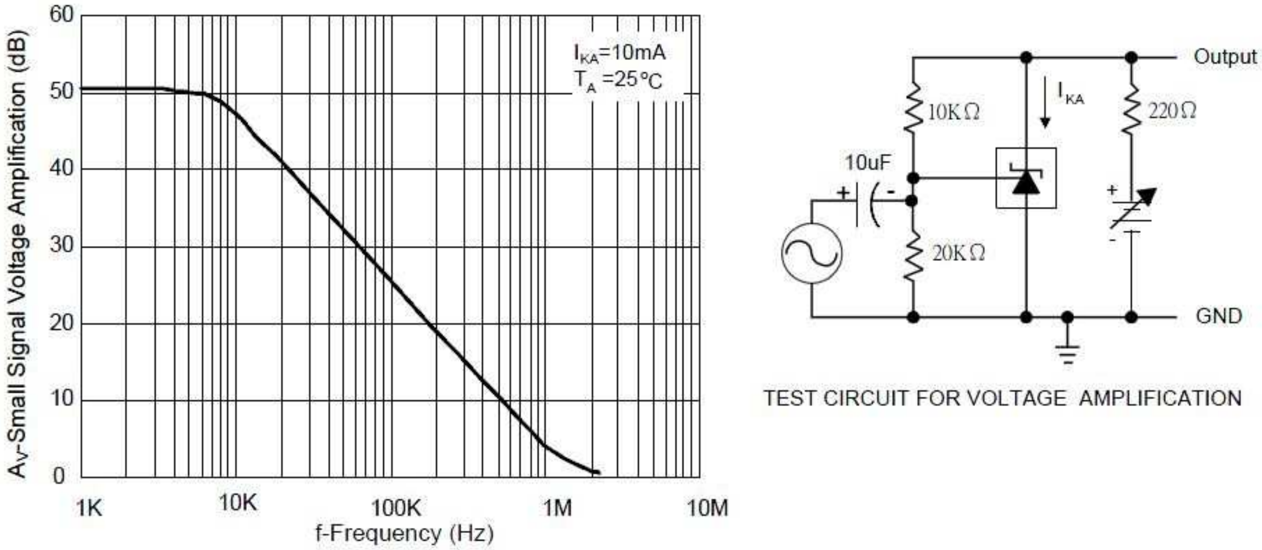


Figure 15: Small-Signal Voltage Gain and Phase Shirt vs. Frequency

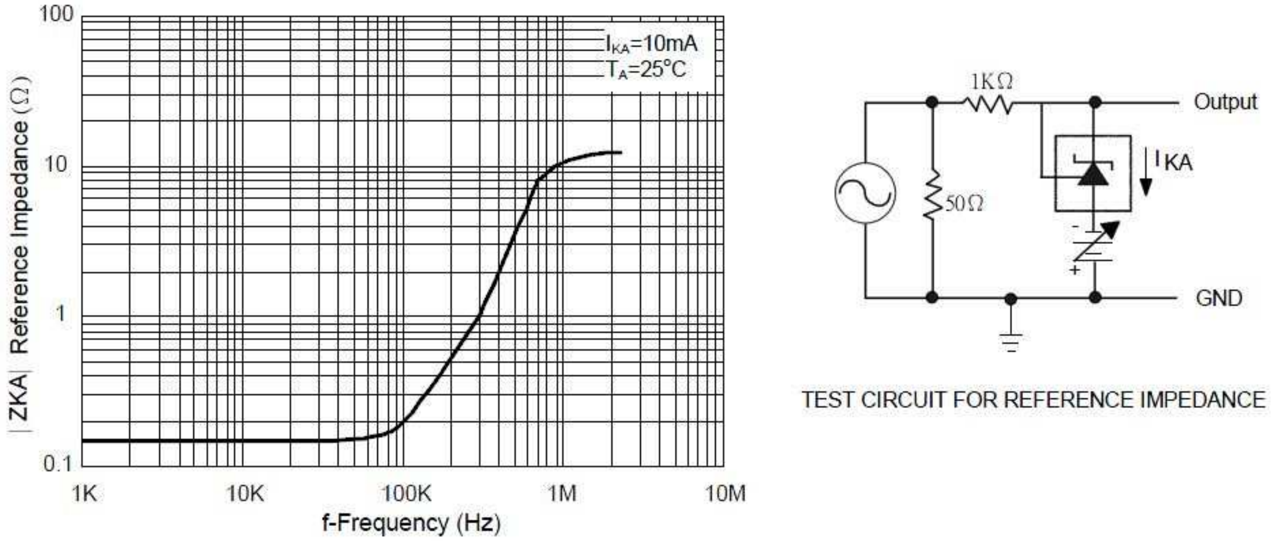
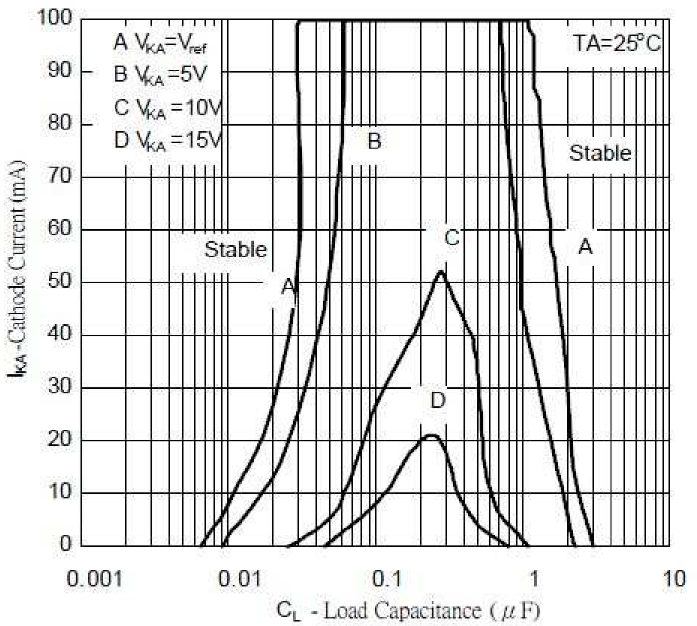
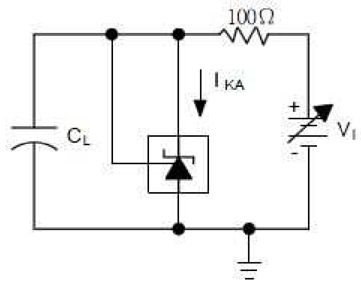


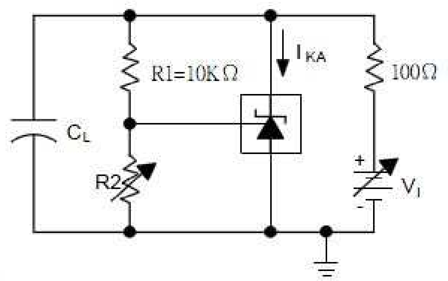
Figure 16: Reference Impedance vs. Frequency

Typical Performance Characteristics (Continue)





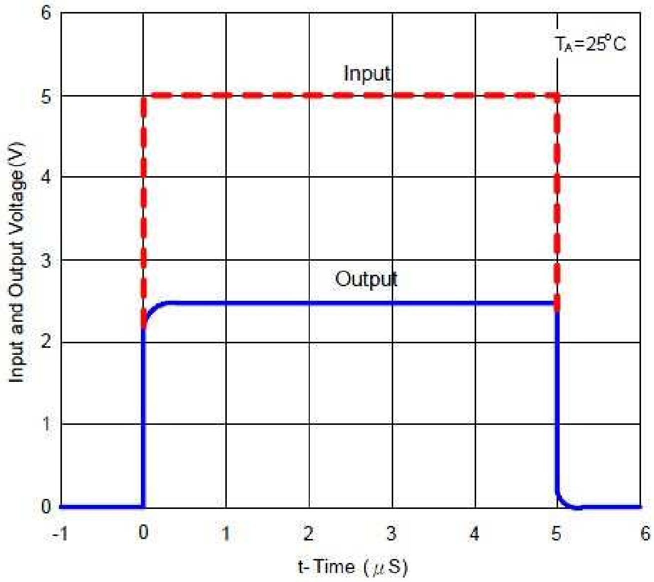
TEST CIRCUIT FOR CURVE A

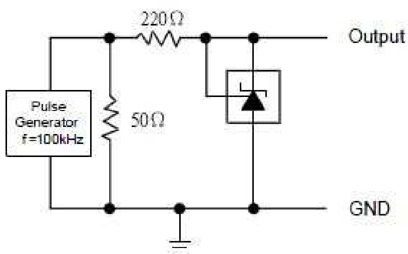


The areas under the curves represent conditions that may cause the device to oscillate For curves B,C, and D, R2 and V_I were adjusted to establish the initial V_{KA} and I_{KA} conditions with C_L=0 . V_{BATT} and C_L were then adjusted to determine the ranges of stability.

TEST CIRCUIT FOR CURVE B , C, AND D

Figure 17: Stability Boundary Condition





TEST CIRCUIT FOR PULSE RESPONSE

Figure 18: Pulse Response

Electrical Characteristics

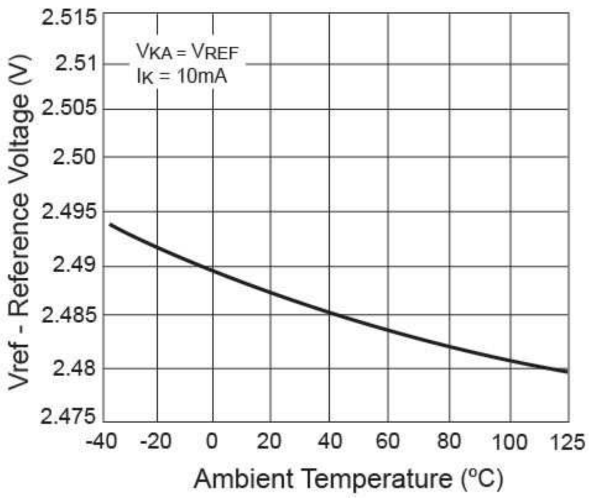


Figure 19: Reference Voltage vs. Temperature

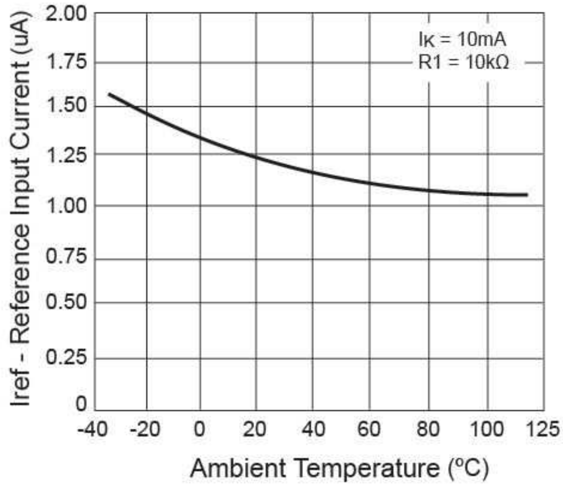


Figure 20: I_{REF} vs. Temperature

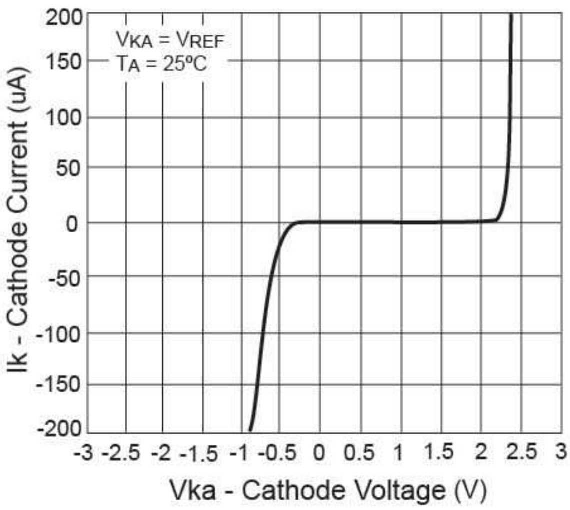


Figure 21: I_{KA} vs. V_{KA} (uA)

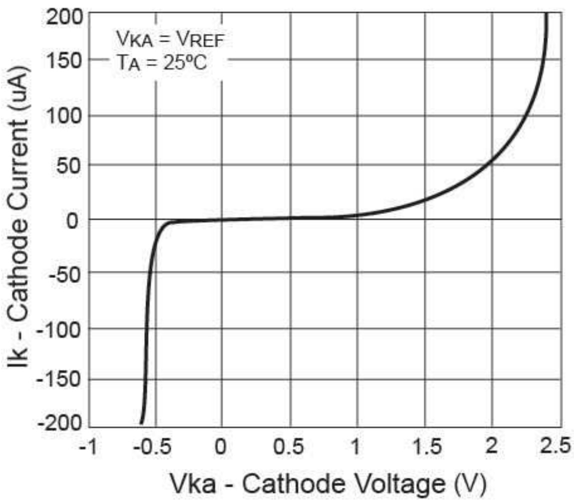
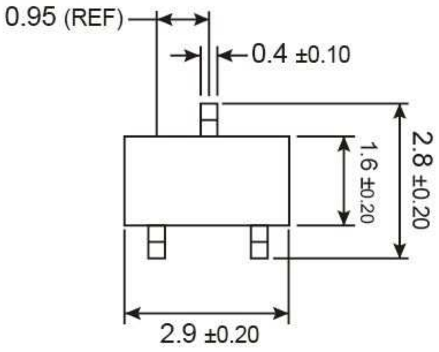
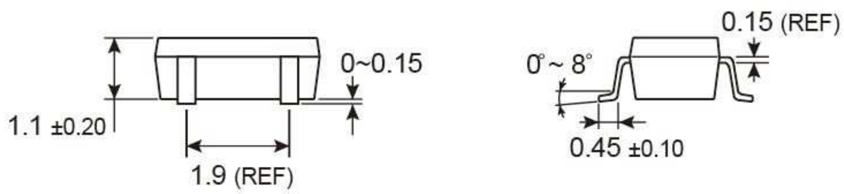


Figure 22: I_{KA} vs. V_{KA} (mA)

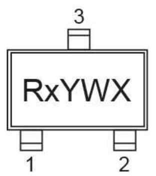
SOT-23 Mechanical Drawing





Unit: Millimeters

Marking Diagram



Rx = Device Code
R1 = TS431A (±1%)
RA = TS431AR (±1%)
R2 = TS431B (±0.5%)
Y = Year Code
2 = 2012, 3 = 2012, 4 = 2014 ………….
W = Week Code
01 ~ 26 (A~Z)
27 ~ 52 (a ~ z)
X = Internal ID Code

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