Recommended Operating Condition

Parameter	Symbol	Limit	Unit
Cathode Voltage (Note 1)	V_{KA}	16	V
Continuous Cathode Current Range	I_K	100	mA

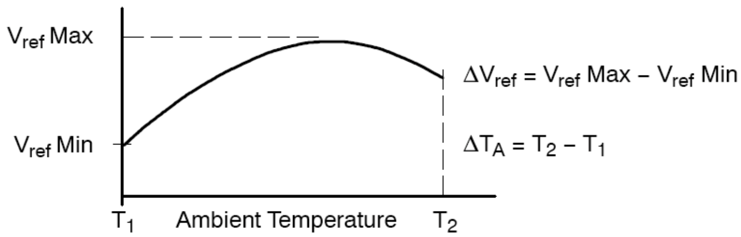
Electrical Characteristics (T_A=25°C unless otherwise noted)

Parameter		Symbol	Test Conditions	Min	Typ	Max	Unit
Reference voltage	TS432A	V_{REF}	V_{KA}=V_{REF}, I_K=10mA (Figure 1)	1.227	1.240	1.252	V
	TS432B			1.233		1.246	
Deviation of reference input voltage		ΔV_{REF}	V_{KA} =V_{REF}, I_K=10mA T_A= full range (Figure 1)	--	10	25	mV
Radio of change in Vref to change in cathode Voltage		$\Delta V_{REF}/\Delta V_{KA}$	I_{KA}=10mA, V_{KA} = 16V to V_{REF} (Figure 2)	--	-1.0	-2.7	mV/V
Reference Input current		I_{REF}	R1=10KΩ, R2=∞, I_{KA}=10mA T_A= full range (Figure 2)	--	0.25	0.5	µA
Deviation of reference input current, over temp.		ΔI_{REF}	R1=10KΩ, R2=∞, I_{KA}=10mA T_A= full range (Figure 2)	--	0.04	0.8	µA
Off-state Cathode Current		I_{KA} (off)	V_{REF}=0V (Figure 3), V_{KA}=16V	--	0.125	0.5	µA
Dynamic Output Impedance		$\lvert Z_{KA}\rvert$	f<1KHz, V_{KA}=V_{REF} I_{KA}=1mA to 100mA (Figure 1)	--	0.2	0.4	Ω
Minimum Operating Cathode Current		$I_{KA(MIN)}$	V_{KA}=V_{REF} (Figure 1)	--	20	80	µA

* 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:

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



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

αV_{REF} can be positive or negative depending on whether V_{REF} Min. or V_{REF} Max occurs at the lower ambient temperature. Example: ΔV_{REF}=7.2mV and the slope is positive, V_{REF}=1.241V at 25°C, ΔT=125°C

$$\alpha V_{ref}\left(\frac{ppm}{°C}\right) = \frac{\dfrac{0.0072}{1.241} \times 10^6}{125} = 46\ ppm/°C$$

* The dynamic impedance Z_{KA} is defined as:

$$\lvert Z_{KA}\rvert = \frac{\Delta V_{KA}}{\Delta I_K}$$

* 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:

$$\lvert Z_{KA}'\rvert = \lvert Z_{KA}\rvert \times \left(1 + \frac{R1}{R2}\right)$$

Test Circuits

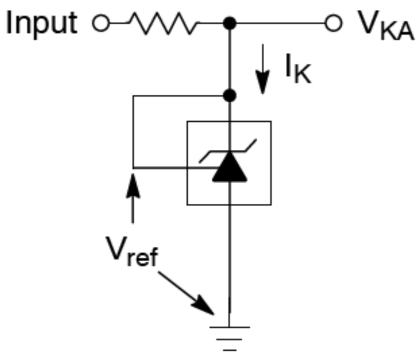
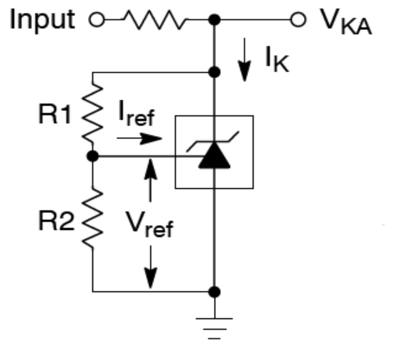


Figure 1: $V_{KA} = V_{REF}$



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

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

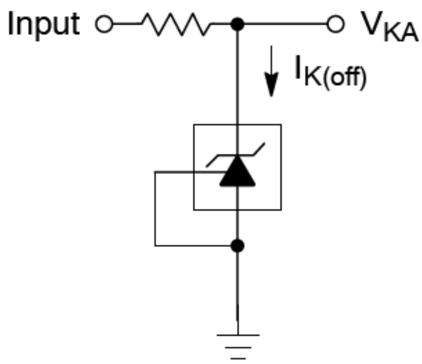


Figure 3: Off-State Current

Additional Information – Stability

When TS432 series is used as a shunt regulator, there are two options for selection of C_L, are recommended for optional stability:

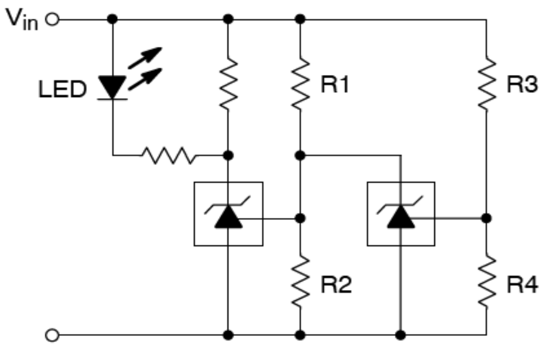
A) No load capacitance across the device, decouple at the load.

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

The reason for this is that TS432 series exhibits instability with capacitances in the range of 10nF to 1µF (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 0.1µF 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 (10µF) 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 TS432 series is located right at the load, so the load decoupling capacitor is directly across it, then this capacitor will have to be ≤1nF or ≥10µF.

Applications Examples

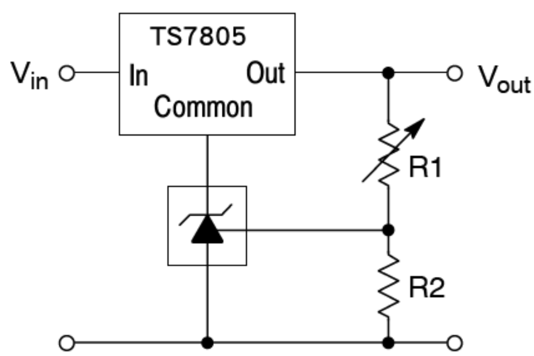


L.E.D. indicator is 'ON' when V_{in} is between the upper and lower limits,

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

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

Figure 4: Voltage Monitor

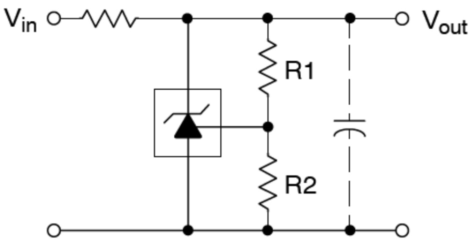


$$V_{out} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

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

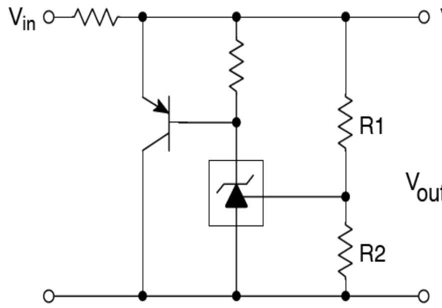
Figure 5: Output Control for Three Terminal Fixed Regulator

Applications Examples (Continue)



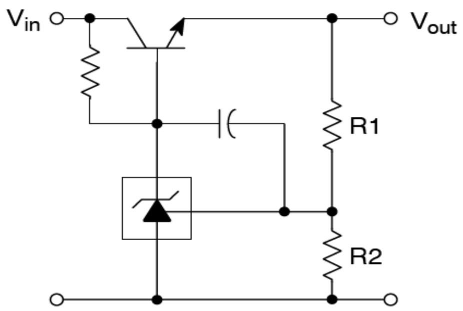
$$V_{out} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

Figure 6: Shunt Regulator



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

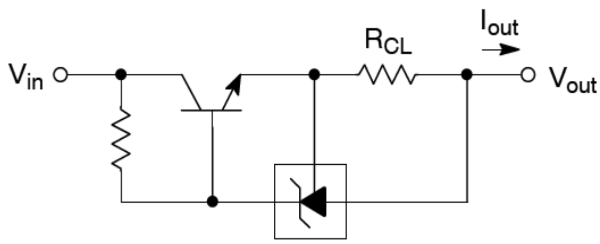
Figure 7: High Current Shunt Regulator



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

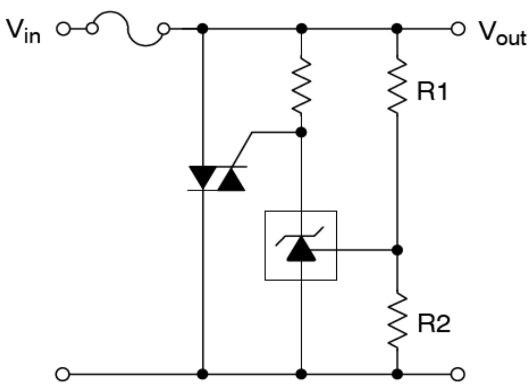
$$V_{out(min)} = V_{ref} + V_{be} \approx 2.0\ V$$

Figure 8: Series Pass Regulator



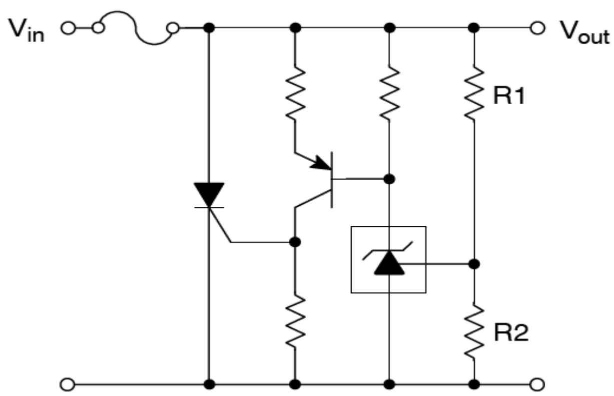
$$I_{out} = \frac{V_{ref}}{R_{CL}}$$

Figure 9: Constant Current Source



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

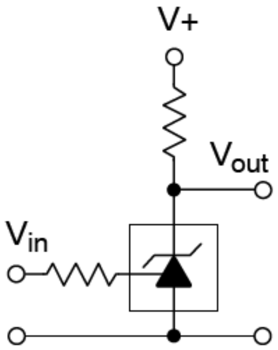
Figure 10: TRIAC Crowbar



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

Figure 11: SCR Crowbar

Applications Examples (Continue)



Vin	Vout
<Vref	V+
>Vref	≈0.74V

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

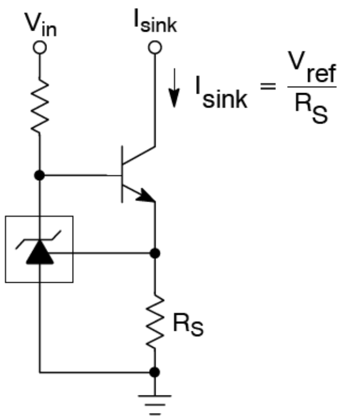
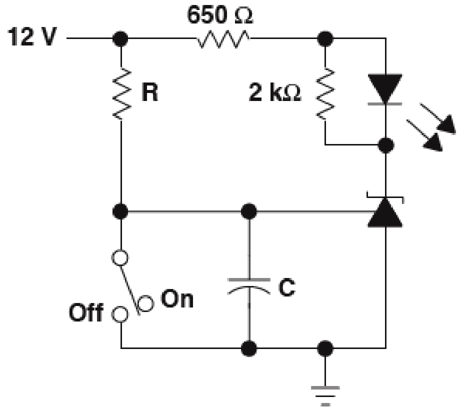


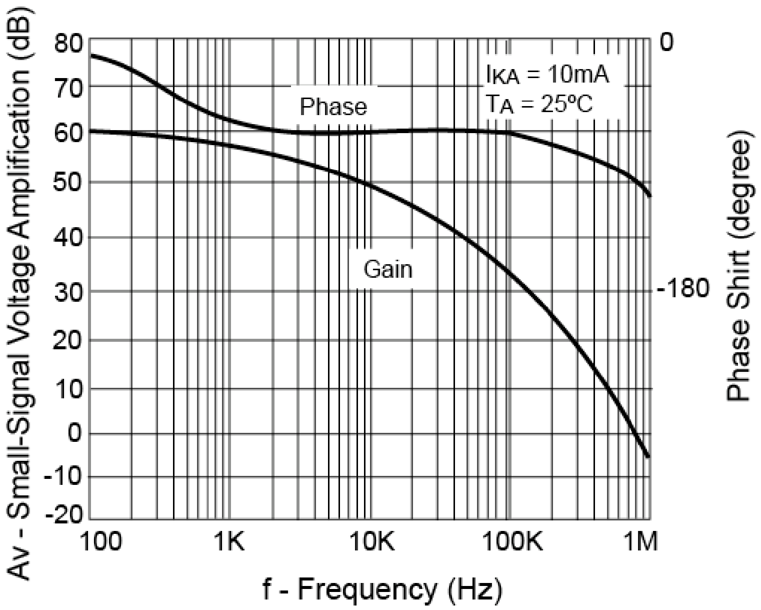
Figure 13: Constant Current Sink

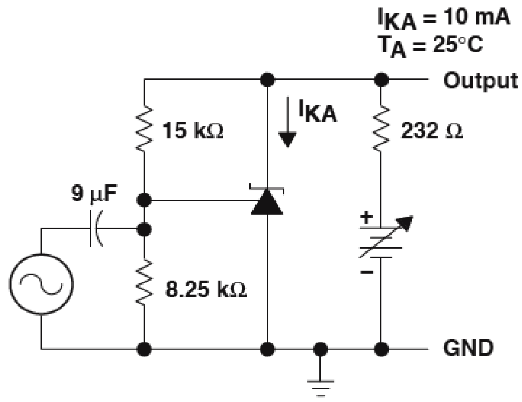


$$\text{Delay} = R \times C \times \ln\left(\frac{12\text{ V}}{12\text{ V} - V_{ref}}\right)$$

Figure 14: Delay Timer

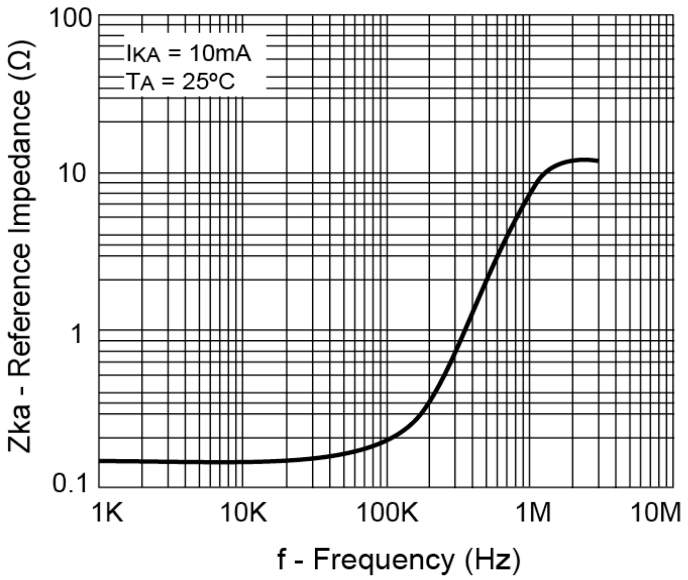
Typical Performance Characteristics

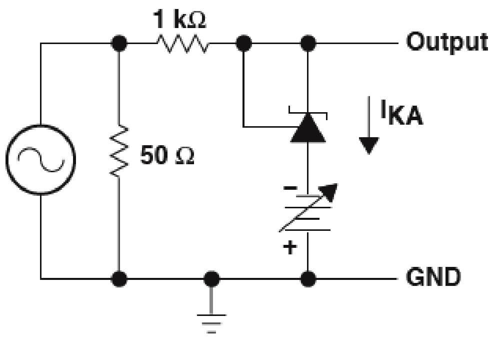




Test Circuit for Voltage Amplification

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

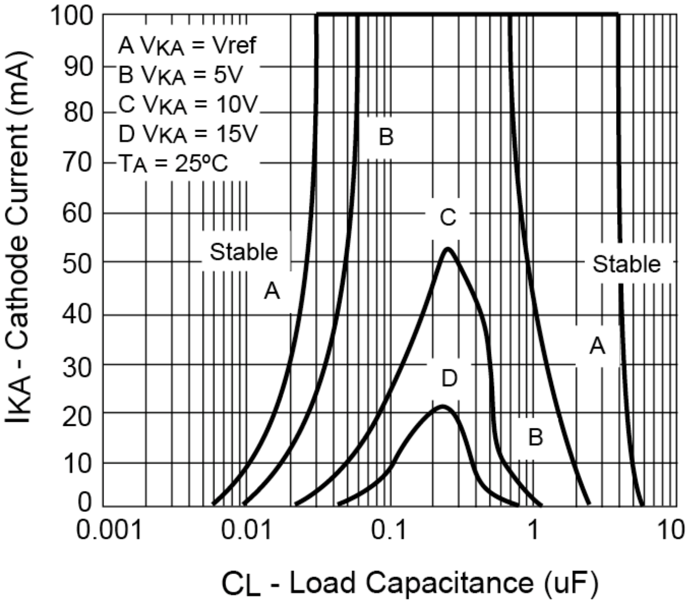


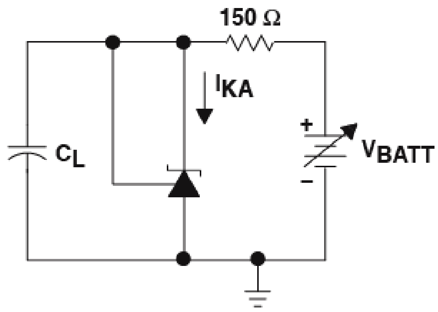


Test Circuit for Reference Impedance

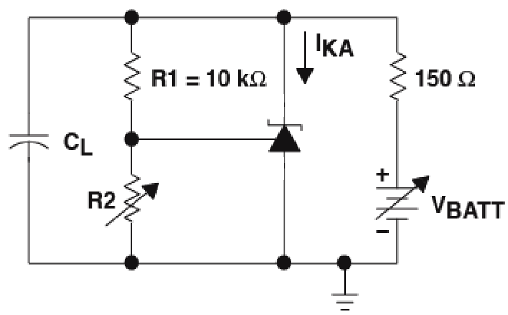
Figure 16: Reference Impedance vs. Frequency

Typical Performance Characteristics





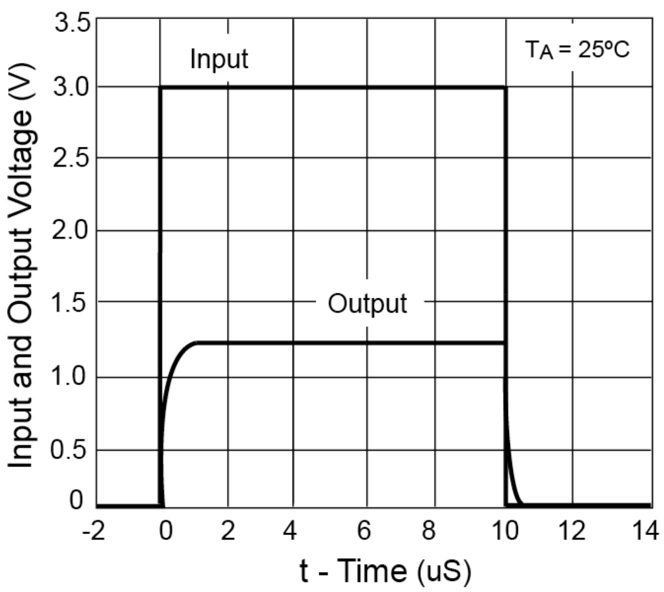
Test Circuit for Curve A

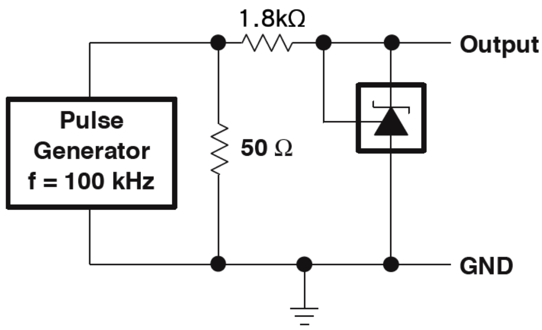


Test Circuit for Curve B, C and D

The areas under the curves represent conditions that may cause the device to oscillate. For curves B, C, and D, R2 and V+ were adjusted to establish the initial VKA and IKA conditions with CL=0. VBATT and CL then were adjusted to determine the ranges of stability.

Figure 17: Stability Boundary Condition





Test Circuit for Pulse Response, Ik=1mA

Figure 18: Pulse Response

Electrical Characteristics

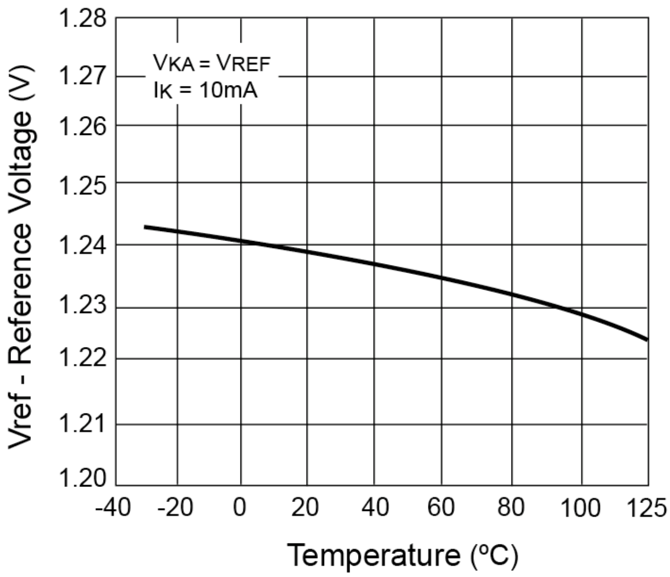


Figure 19: Reference Voltage vs. Temperature

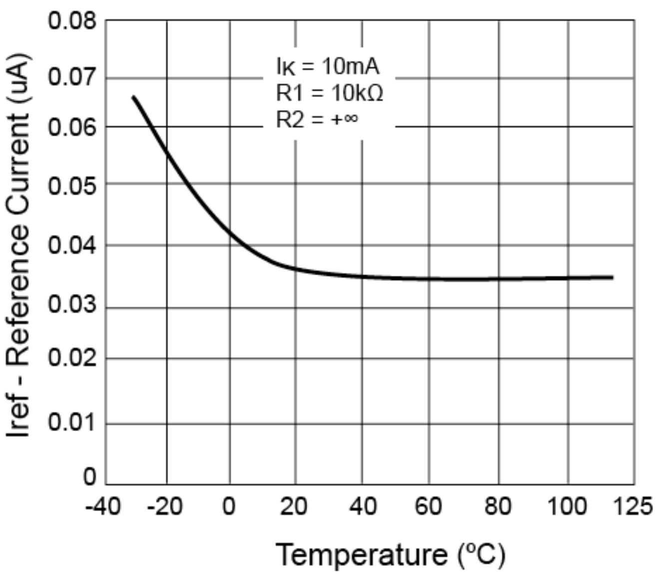


Figure 20: Reference Current vs. Temperature

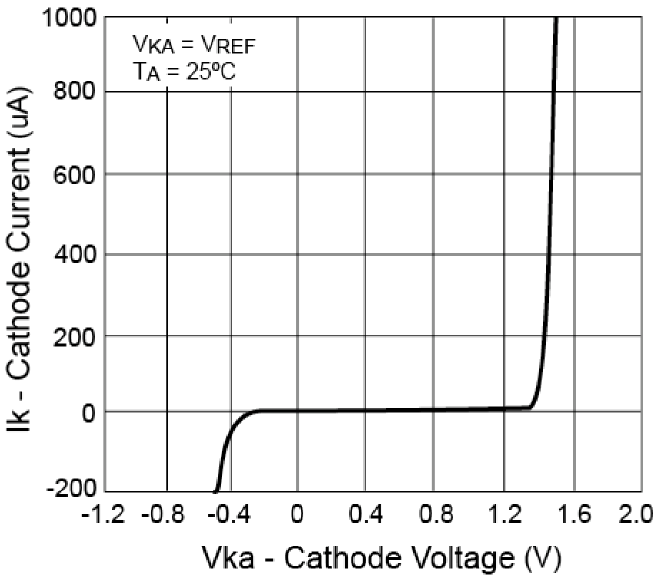
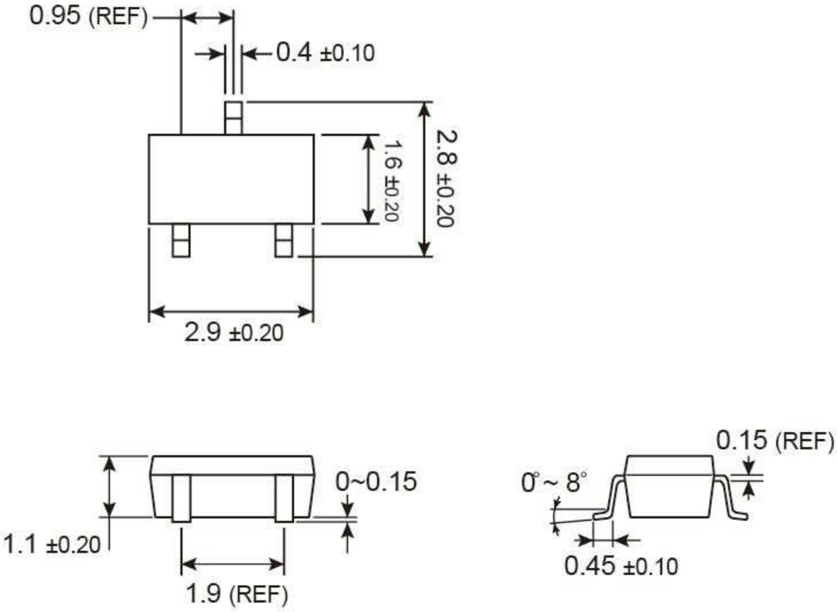


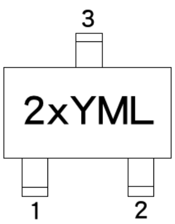
Figure 21: Cathode Current vs. Cathode Voltage

SOT-23 Mechanical Drawing



Unit: Millimeters

Marking Diagram

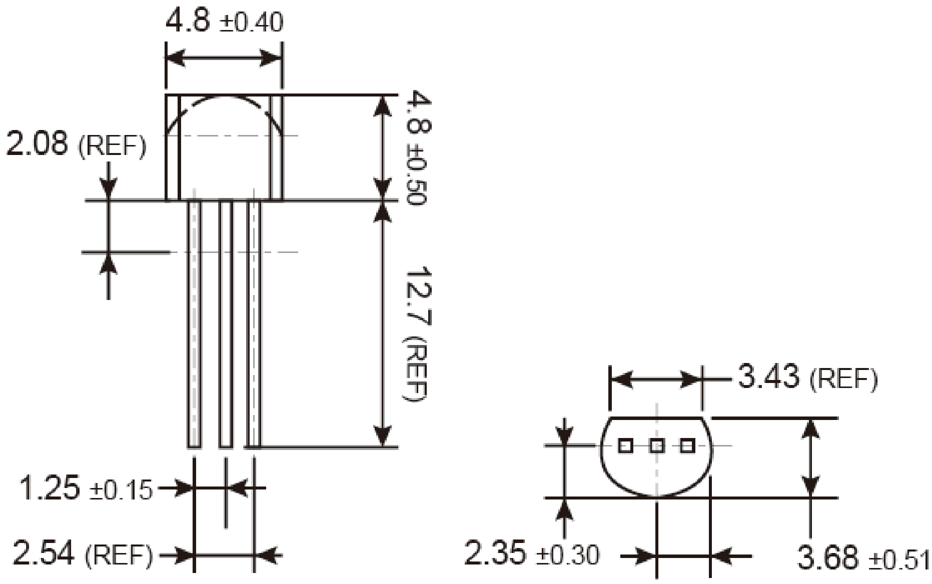


2 = Device Code
X = Tolerance Code
(**A** = ±1%, **B** = ±0.5%)
Y = Year Code
M = Month Code for Halogen Free Product

O =Jan	**P** =Feb	**Q** =Mar	**R** =Apr
S =May	**T** =Jun	**U** =Jul	**V** =Aug
W =Sep	**X** =Oct	**Y** =Nov	**Z** =Dec

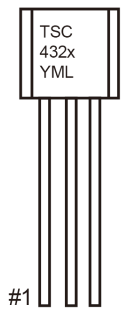
L = Lot Code

TO-92 Mechanical Drawing



Unit: Millimeters

Marking Diagram



X = Tolerance Code
(**A** = ±1%, **B** = ±0.5%)

Y = Year Code

M = Month Code for Halogen Free Product

O	=Jan	**P**	=Feb	**Q**	=Mar	**R**	=Apr
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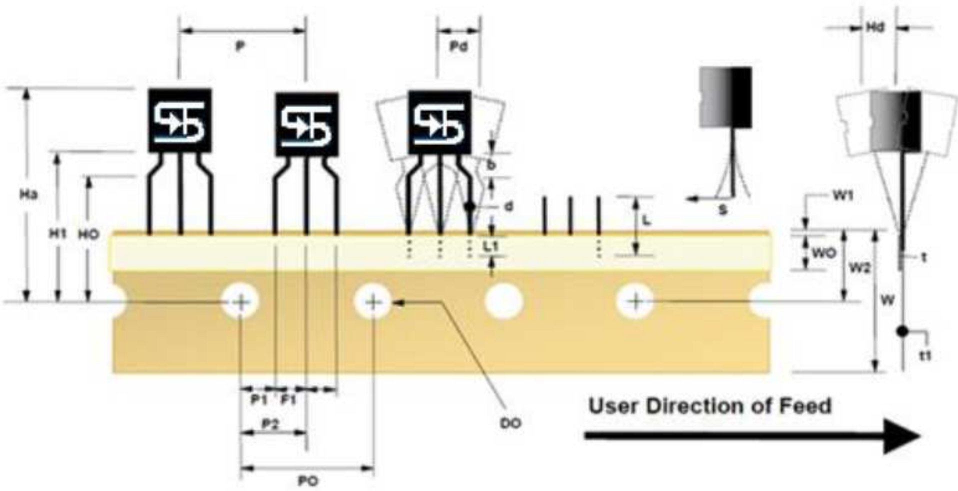
W	=Sep	**X**	=Oct	**Y**	=Nov	**Z**	=Dec

L = Lot Code

TO-92 Ammo Pack Mechanical Drawing



Tape Dimension

ITEM DESCRIPTION	SYMBOL	DIMENSION(mm)
Base of Package to Lead Bend	b	2.4892 (typ.)
Component Height	Ha	23.5712 (+/- 0.635)
Lead Clinch Height	HO	16.002 (+/- 0.508)
Component Base Height	H1	18.9992 (+/- 0.508)
Component Alignment (side / side)	Pd	1.016 (max)
Component Alignment (front / back)	Hd	0.7874 (max)
Component Pitch	P	12.7 (+/- 0.508)
Feed Hole Pitch	PO	12.7 (+/- 0.2032)
Hole Center to Component Center	P1	3.81 (+0.2286, -0.254)
Hole Center to Component Center	P2	6.2738 (+/- 0.1778)
Lead Spread	F1/F2	2.6416 (+/- 0.254)
Lead Thickness	d	0.4572 (+0.0508, -0.0762)
Cut Lead Length	L	10.8966 (max)
Taped Lead Length	L1	5.3086 (+1.2954, -1.3208)
Taped Lead Thickness	t	0.8218 (+/- 0.1524)
Carrier Tape Thickness	t1	0.5334 (+/- 0.1524)
Carrier Tape Width	W	17.9832 (+0.508, -0.4826)
Hold – down Tape Width	WO	5.9944 (+/- 0.3048)
Hold – down Tape position	W1	0.889 (max)
Feed Hole Position	W2	9.144 (+/- 0.635)
Sprocket Hole Diameter	DO	3.9878 (+0.2032, -0.1778)
Lead Spring Out	S	0.1016 (max)

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