

1.24V Programmable Shunt Voltage Reference

DESCRIPTION

The TS432A and TS432B is a three-terminal adjustable shunt regulator with specified thermal stability. The output voltage may be set to any value between V_{REF} (approximately 1.24V) and 18V with two external resistors. The TS432A and TS432B has a typical output impedance of 0.05Ω . Active output circuitry provides a very sharp turn-on characteristic, making the TS432A and TS432B excellent replacement for zener diode in many applications.

FEATURES

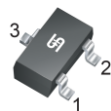
- Precision reference voltage
TS432A – $1.24V \pm 1\%$
TS432B – $1.24V \pm 0.5\%$
- Minimum cathode current: $20\mu A$ (typ.)
- Equivalent full range temp. coefficient $50ppm/^{\circ}C$
- Programmable output voltage up to 18V
- Fast turn-on response
- Sink current capability of $80\mu A$ to $100mA$
- Low dynamic output impedance 0.2Ω
- Low output noise
- RoHS compliant
- Halogen-free

APPLICATION

- SMPS
- Lighting
- Telecommunication
- Home appliance



SOT-23

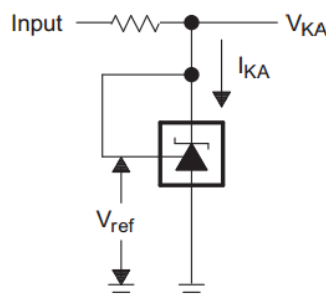


Pin Definition:

1. Reference
2. Cathode
3. Anode

Notes: SOT-23 MSL 3 (Moisture Sensitivity Level) per J-STD-020

SIMPLIFIED SCHEMATIC



ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

PARAMETER	SYMBOL	LIMIT	UNIT
Cathode Voltage	V_{KA}	18	V
Continuous Cathode Current	I_K	100	mA
Reference Input Current	I_{REF}	3	mA
Power Dissipation	P_D	0.35	W
Junction Temperature	T_J	+150	$^\circ\text{C}$
Operation Temperature Range	T_{OPER}	0 ~ +70	$^\circ\text{C}$
Storage Temperature Range	T_{STG}	-65 ~ +150	$^\circ\text{C}$

Note:

- 1: Voltage values are with respect to the anode terminal unless otherwise noted.
2: Rating apply to ambient temperature at 25°C

RECOMMEND OPERATING CONDITION

PARAMETER	SYMBOL	LIMIT	UNIT
Cathode Voltage (Note 1)	V_{KA}	16	V
Continuous Cathode Current Range	I_K	100	mA

ELECTRICAL SPECIFICATIONS ($T_A = +25^\circ\text{C}$, unless otherwise specified)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Reference voltage	V_{REF}	$V_{KA}=V_{REF}$, $I_K=10\text{mA}$ (Figure 1)	TS432A	1.227	1.252	V
			TS432B	1.233	1.246	
Deviation of reference input voltage	ΔV_{REF}	$V_{KA}=V_{REF}$, $I_K=10\text{mA}$ (Figure 1) $T_A=\text{full range}$	--	10	25	mV
Ratio of change in Vref to change in cathode Voltage	$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	$I_{KA}=10\text{mA}$, $V_{KA}=18\text{V}$ to V_{REF} (Figure 2)	--	-1.0	-2.7	mV/V
Reference Input current	I_{REF}	$R1=10\text{k}\Omega$, $R2=\infty$ $I_{KA}=10\text{mA}$ (Figure 2)	--	0.25	0.5	μA
Deviation of reference input current, over temp.	ΔI_{REF}	$R1=10\text{k}\Omega$, $R2=\infty$, $I_{KA}=10\text{mA}$ $T_A=\text{full range}$ (Figure 2)	--	0.04	0.08	μA
Off-state Cathode Current	$I_{KA(off)}$	$V_{REF}=0\text{V}$ (Figure 3), $V_{KA}=18\text{V}$	--	0.125	0.5	μA
Dynamic Output Impedance	$ Z_{KA} $	$f < 1\text{kHz}$, $V_{KA}=V_{REF}$ (Figure 1) $I_{KA}=1\text{mA}$ to 100mA	--	0.2	0.4	Ω
Minimum operating cathode current	$I_{KA}(\text{min})$	$V_{KA}=V_{REF}$ (Figure 1)	--	60	80	μA

Note: 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.

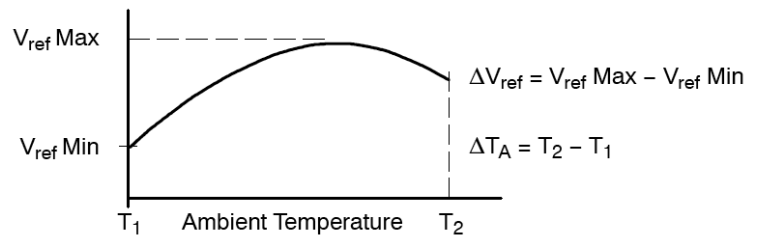
ORDERING INFORMATION

ORDERING CODE	PACKAGE	PACKING	DEVICE MARKING
TS432ACX RFG	SOT-23	3,000pcs / 7" Reel	2A
TS432BCX RFG	SOT-23	3,000pcs / 7" Reel	2B

DEVIATION PARAMETERS

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

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



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: $\Delta V_{REF}=7.2\text{mV}$ and the slope is positive, $V_{REF}=1.241\text{V}$ at 25°C , $\Delta T=125^{\circ}\text{C}$

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

Dynamic Impedance

The dynamic impedance Z_{KA} is defined as:

$$|Z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_K}$$

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:

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

Calculating Deviation Parameters and Dynamic Impedance

TEST CIRCUIT

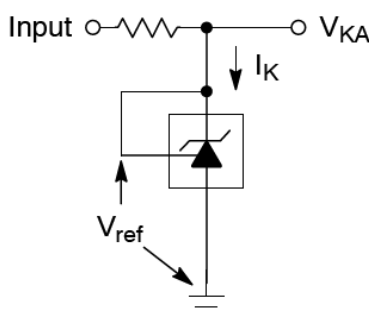


Figure 1: $V_{KA} = V_{REF}$

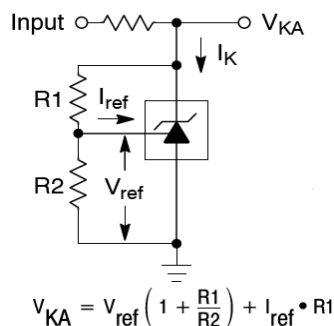


Figure 2: $V_{KA} > V_{REF}$

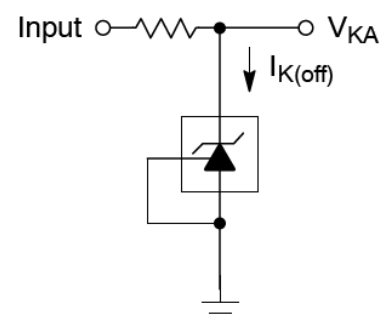


Figure 3: Off-State Current

APPLICATION INFORMATION

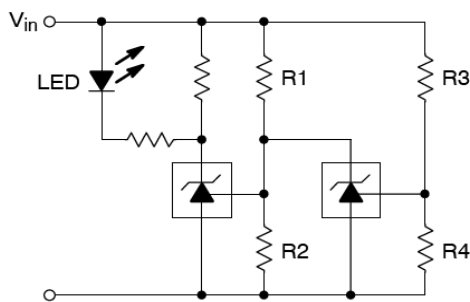
When The TS432A/432B is used as a shunt regulator, there are two options for selection of C_L , are recommended for optional stability:

- 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 TS432A/432B 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 TS432A/432B is located right at the load, so the load decoupling capacitor is directly across it, then this capacitor will have to be $\leq 1\text{nF}$ or $\geq 10\mu\text{F}$.

APPLICATION EXAMPLE

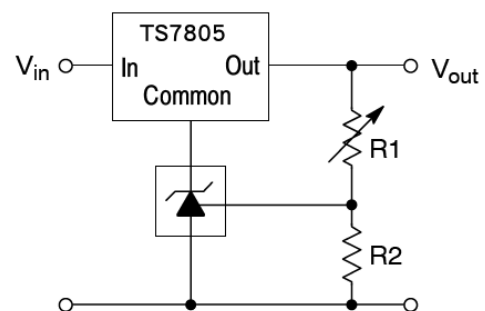


L.E.D. indicator is 'ON' when V_{in} is between the upper and lower limits,

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

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

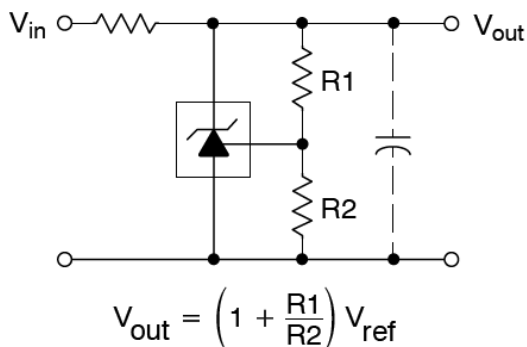
Figure 4: Voltage Monitor



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

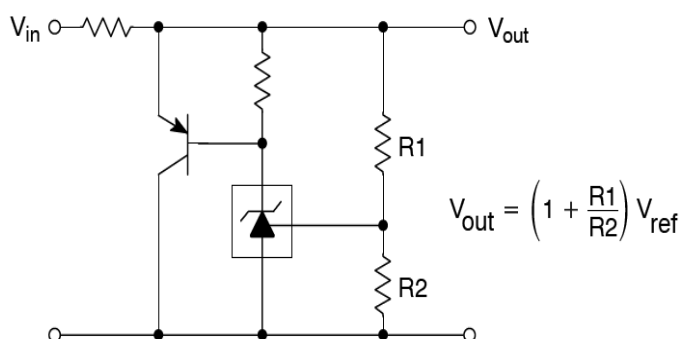
$$V_{out(min)} = V_{ref} + 5.0\text{ V}$$

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

APPLICATION EXAMPLE (CONTINUEO

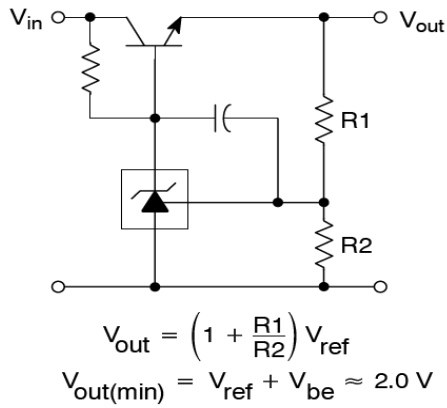


Figure 8: Series Pass Regulator

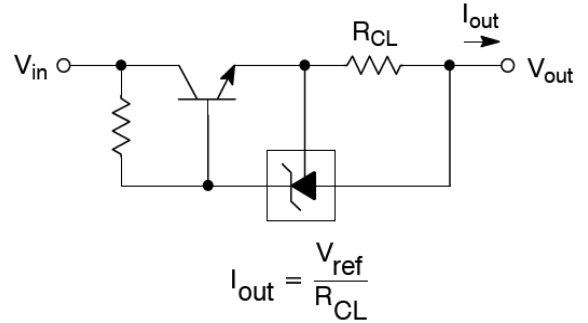


Figure 9: Constant Current Source

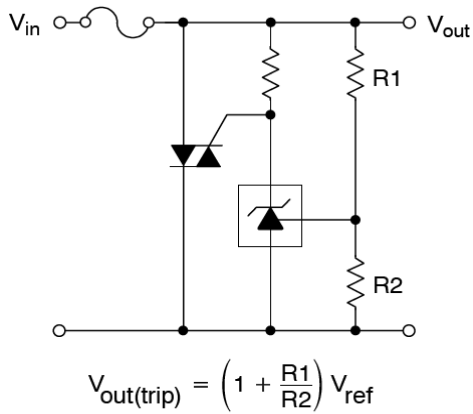


Figure 10: TRIAC Crowbar

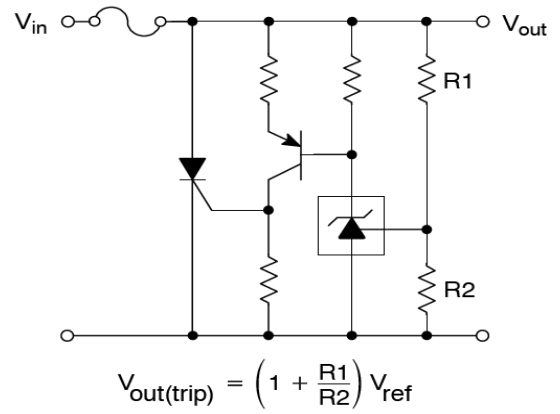


Figure 11: SCR Crowbar

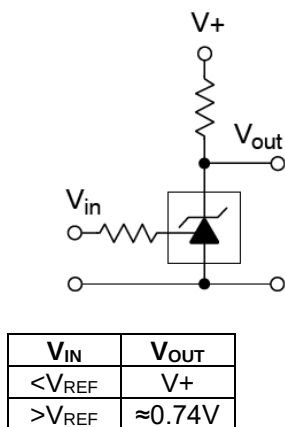


Figure 12: Single-Supply Comparator with Temperature-Compensated Threshold

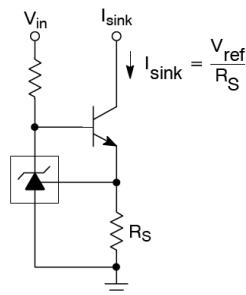


Figure 13: Constant Current Sink

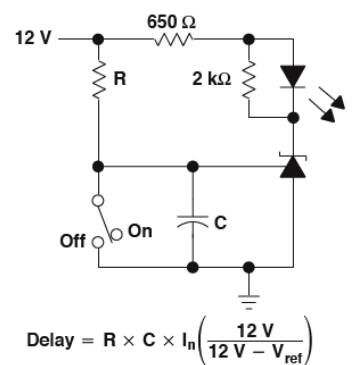
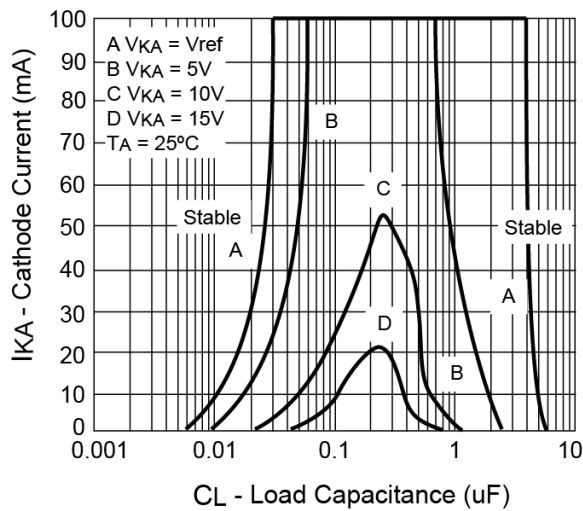
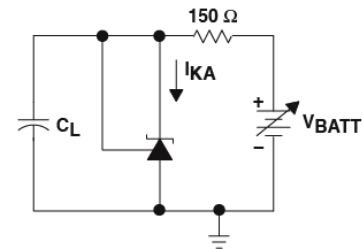


Figure 14: Delay Timer

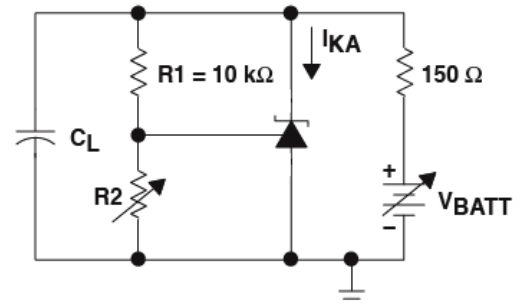
TYPICAL PERFORMANCE CHARACTERISTICS



The areas under the curves represent conditions that may cause the device to oscillate. For curves B, C, and D, R_2 and V_+ were adjusted to establish the initial V_{KA} and I_{KA} conditions with $C_L=0$. V_{BATT} and C_L then were adjusted to determine the ranges of stability.

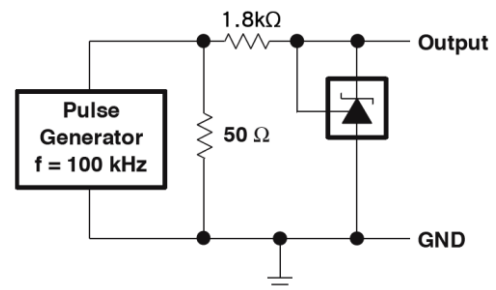
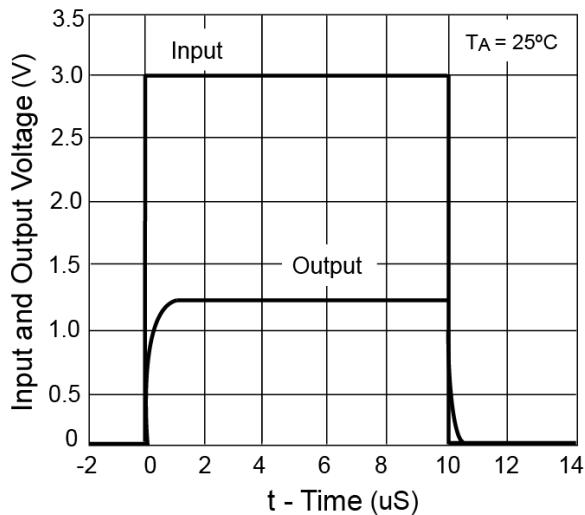


Test Circuit for Curve A



Test Circuit for Curve B, C and D

Figure 17: Stability Boundary Condition



Test Circuit for Pulse Response, $I_k=1mA$

Figure 18: Pulse Response

CHARACTERISTICS CURVES

($T_c = 25^\circ\text{C}$ unless otherwise noted)

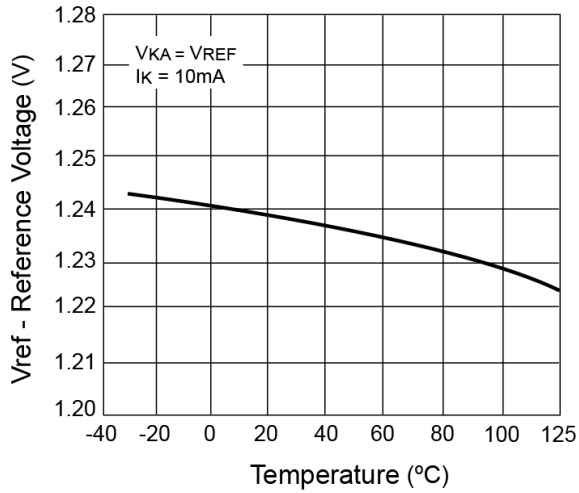


Figure 19: Reference Voltage vs. Temperature

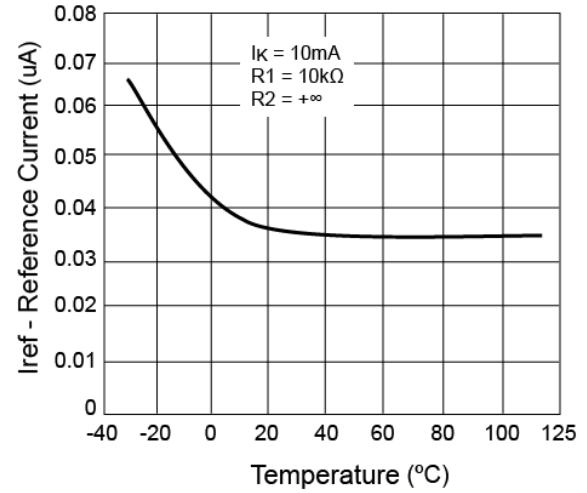


Figure 20: Reference Current vs. Temperature

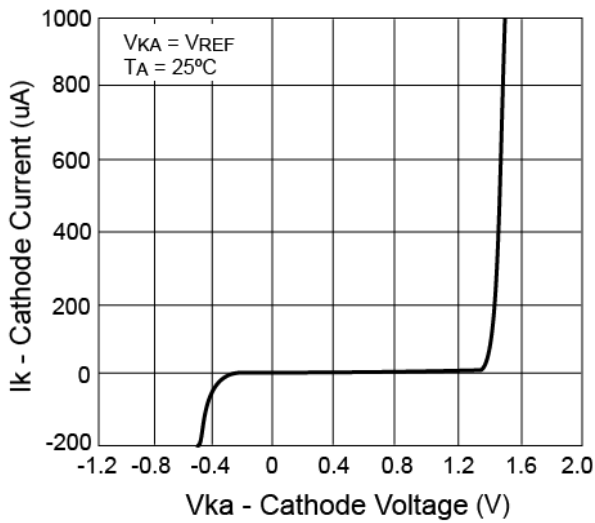
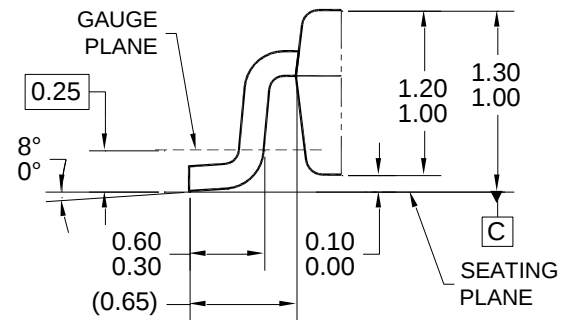
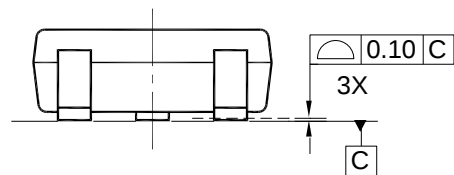
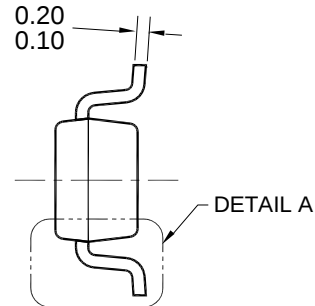
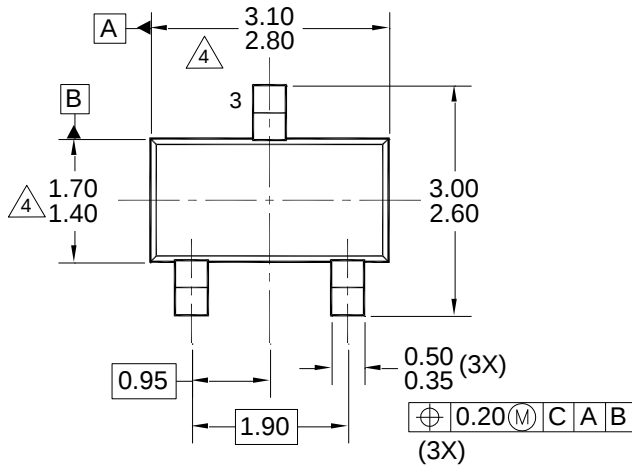


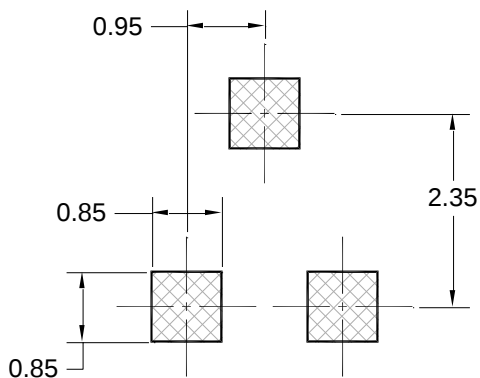
Figure 21: Cathode Current vs. Cathode Voltage

PACKAGE OUTLINE DIMENSIONS

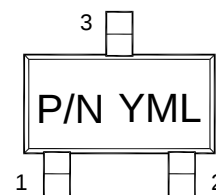
SOT-23



DETAIL A, ROTATED -90°
(SCALE 2:1)



SUGGESTED PAD LAYOUT



MARKING DIAGRAM

NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.
3. PACKAGE OUTLINE REFERENCE:
EIAJ ED-7500A, SC-59.
4. MOLDED PLASTIC BODY DIMENSIONS DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.
5. DWG NO. REF: HQ2SD07-SOT23IC-104 REV A.

P/N = PRODUCT DEVICE CODE

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

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