

Adjustable Precision Shunt Regulator

The TL431-E is a three-terminal adjustable regulator series with a guaranteed thermal stability over applicable temperature ranges. The output voltage may be set to any value between V_{ref} (approximately 2.5 volts) and 40 volts with two external resistors. These devices have a typical dynamic output impedance of 0.2Ω . Active output circuitry provides a very sharp turn-on characteristic, making these devices excellent replacement for zener diodes in many applications. The TL431-E is characterized for operation from -60°C to $+125^{\circ}\text{C}$



TO-92



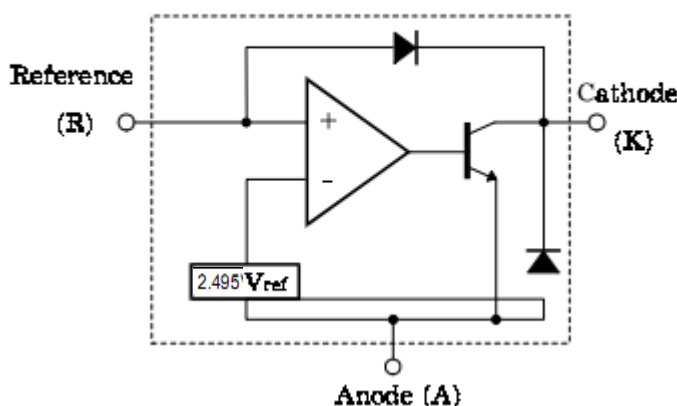
SOT-23

FEATURES

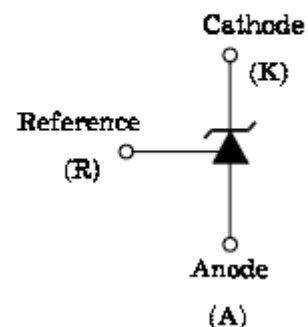
- ◆ Programmable Output Voltage to 36V
- ◆ Low Dynamic Output Impedance 0.2Ω .
- ◆ Sink Current Capability of 1 mA to 100 mA.
- ◆ Equivalent Full-Range Temperature Coefficient of $50 \text{ ppm}/^{\circ}\text{C}$
- ◆ Temperature Compensated for operation over Full Rated Operating Temperature Range
- ◆ Low Output Noise Voltage .
- ◆ Fast Turn on Respons
- ◆ Provided Pb-Free packages
- ◆ ESD tolerance (human body model) 2000V
- ◆ Package outline: TO-92, SOT-23

Internal Diagram

FUNCTIONAL BLOCK DIAGRAM



SYMBOL



ABSOLUTE MAXIMUM RATINGS

(Operating temperature range applies unless otherwise specified)

Characteristic	Symbol	Value	Unit
Cathode Voltage	V_{KA}	37	V
Cathode Current Range (Continuous)	I_K	100 ~ 150	mA
Reference Input Current Range	I_{REF}	0.05 ~ 10	mA
Power Dissipation at 25°C: TO – 92 Package ($R_{\theta JA} = 178^{\circ}\text{C/W}$)	P_D	0.7	W
SOT – 23 – 3 Package ($R_{\theta JA} = 625^{\circ}\text{C/W}$)		0.2	W
Junction Temperature Range	T_J	0 ~ 150	°C
Operating Temperature Range	T_g	-60~+85	°C
Storage Temperature Range	T_{stg}	-65 ~ +150	°C

RECOMMENDED OPERATING CONDITIONS

Characteristic	Symbol	Test Condition	Min	Typ	Max	Unit
Cathode Voltage	V_{KA}		REF		37	V
Cathode Current	I_K		0.5		100	mA

TL431-E-0.3% ELECTRICAL CHARACTERISTIC ($T_A=25^{\circ}\text{C}$, unless otherwise specified)

CHARACTERISTIC	SYMBOL	CIR- CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Reference Input Voltage	V_{REF}	1	$V_{KA}=V_{REF}, I_K=10\text{mA}$	2.487V	2.495V	2.502V	
Deviation of Reference Input Voltage Over Full Temperature Range	$\Delta V_{REF}/\Delta T$	1	$V_{KA}=V_{REF}, I_K=10\text{mA}$ $T_A=\text{Full Range}$		3	17	mV
Ratio of Change in Reference Input Voltage to the Change in Cathode Voltage	$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	2	$I_K=10\text{mA}$	$\Delta V_{KA}=10\text{V}-V_{REF}$	-1.4	-2.7	mv/V
				$\Delta V_{KA}=36\text{V}-10\text{V}$	-1	-2	
Reference Input Current	I_{REF}	2	$I_{KA}=10\text{mA}, R_1=10\text{K}\Omega, R_2=$		1.8	4	uA
Deviation of Reference Input Current Over Full Temperature Range	$\Delta I_{REF}/\Delta T$	2	$I_K=10\text{mA}, R_1=10\text{K}\Omega, R_2=$ $T_A=\text{Full Range}$		0.4	1.2	uA
Minimum Cathode Current for Regulation	$I_{KA\text{MIN}}$	1	$\Delta V_{KA}=V_{REF}$		0.5	1	mA
Off-State Cathode Current	$I_{KA\text{OFF}}$	3	$V_{KA}=36\text{V}, V_{REF}=0$		0.2	1	uA
Dynamic Impedance	Z_{KA}	1	$V_{KA}=V_{REF}, I_K=1\text{mA}\sim 100\text{mA},$ $F \leq 1\text{KHZ}$		0.2	0.5	Ω

TL431-E-0.5% ELECTRICAL CHARACTERISTIC (TA=250C,unless otherwise specified)

CHARACTERISTIC	SYMBOL	CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Reference Input Voltage	V_{REF}	1	$V_{KA}=V_{REF}, I_K=10mA$	2.482V	2.495V	2.507V	
Deviation of Reference Input Voltage Over Full Temperature Range	$\frac{\Delta V_{REF}}{\Delta T}$	1	$V_{KA}=V_{REF}, I_K=10mA$ $T_A=Full\ Range$		3	17	mV
Ratio of Change in Reference Input Voltage to the Change in Cathod Voltage	$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	2	$I_K=10mA$	$\Delta V_{KA}=10V-V_{REF}$	-1.4	-2.7	mv/V
				$\Delta V_{KA}=36V-10V$	-1	-2	
Reference Input Current	I_{REF}	2	$I_{KA}=10mA, R1=10K\Omega, R2=$		1.8	4	uA
Deviation of Reference Input Current Over Full Temperatur Range	$\frac{\Delta I_{REF}}{\Delta T}$	2	$I_K=10mA, R1=10K\Omega, R2=$ $T_A=Full\ Range$		0.4	1.2	uA
Minimum Cathode Current for Regulation	$I_{KA\ MIN}$	1	$\Delta V_{KA}=V_{REF}$		0.5	1	mA
Off-State Cathode Current	$I_{KA\ OFF}$	3	$V_{KA}=36V, V_{REF}=0$		0.2	1	uA
Dynamic Impedance	Z_{KA}	1	$V_{KA}=V_{REF}, I_K=1mA\sim 100mA$ $f \leq 1KHZ$		0.2	0.5	Ω

TL431-E-1% ELECTRICAL CHARACTERISTIC (TA=250C,unless otherwise specified)

CHARACTERISTIC	SYMBOL	CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Reference Input Voltage	V_{REF}	1	$V_{KA}=V_{REF}, I_K=10mA$	2.47	2.495V	2.52	
Deviation of Reference Input Voltage Over Full Temperature Range	$\frac{\Delta V_{REF}}{\Delta T}$	1	$V_{KA}=V_{REF}, I_K=10mA$ $T_A=Full\ Range$		3	17	mV
Ratio of Change in Reference Input Voltage to the Change in Cathod Voltage	$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	2	$I_K=10mA$	$\Delta V_{KA}=10V-V_{REF}$	-1.4	-2.7	mv/V
				$\Delta V_{KA}=36V-10V$	-1	-2	
Reference Input Current	I_{REF}	2	$I_{KA}=10mA, R1=10K\Omega, R2=$		1.8	4	uA
Deviation of Reference Input Current Over Full Temperatur Range	$\frac{\Delta I_{REF}}{\Delta T}$	2	$I_K=10mA, R1=10K\Omega, R2=$ $T_A=Full\ Range$		0.4	1.2	uA
Minimum Cathode Current for Regulation	$I_{KA\ MIN}$	1	$\Delta V_{KA}=V_{REF}$		0.5	1	mA
Off-State Cathode Current	$I_{KA\ OFF}$	3	$V_{KA}=36V, V_{REF}=0$		0.2	1	uA
Dynamic Impedance	Z_{KA}	1	$V_{KA}=V_{REF}, I_K=1mA\sim 100mA$ $f \leq 1KHZ$		0.2	0.5	Ω

TEST CIRCUITS

Fig. 1 Test Circuit for $V_{KA} = V_{REF}$

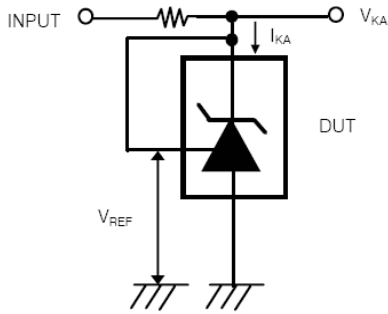


Fig. 2 Test Circuit for $V_{KA} \geq V_{REF}$

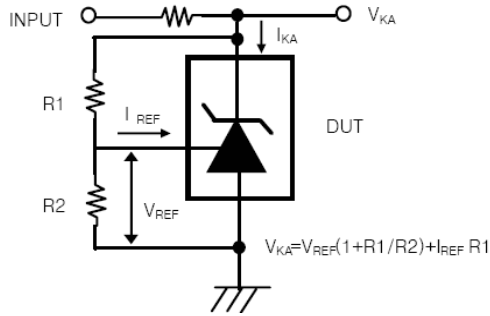
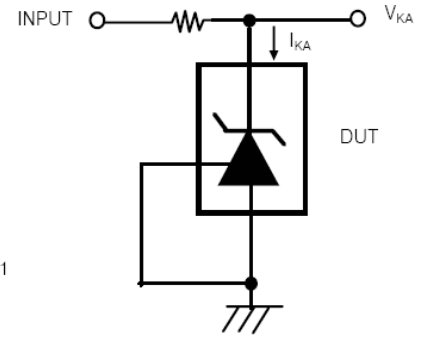
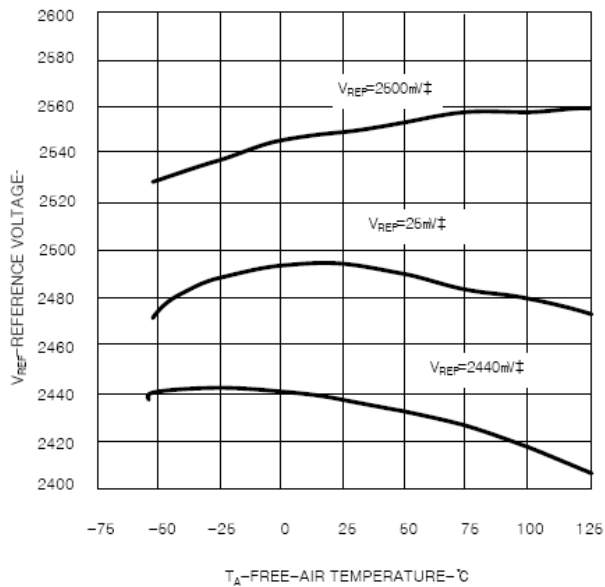


Fig. 3 Test Circuit for I_{KA} (off)



TYPICAL PERFORMANCE CHARACTERISTIC

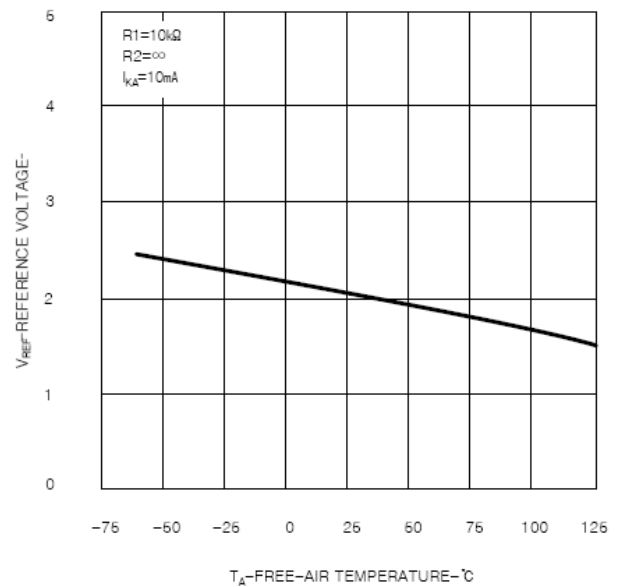
REFERENCE VOLTAGE vs
FREE-AIR TEMPERATURE †



† Data is applicable only within the recommended operating free-air temperature ranges of the various devices.
‡ Data is for devices having the indicated value of $\frac{V_{REF}}{I_{REF}}$ at $I_{KA}=10mV$, $T_A=25^\circ C$

Figure 4.

REFERENCE CURRENT vs
FREE-AIR TEMPERATURE †



† Data is applicable only within the recommended operating free-air temperature ranges of the various devices.

Figure 5.

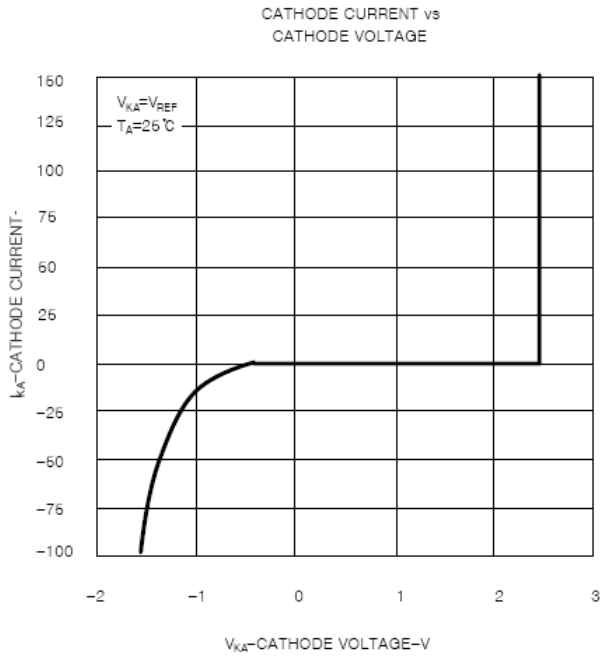


Figure 6.

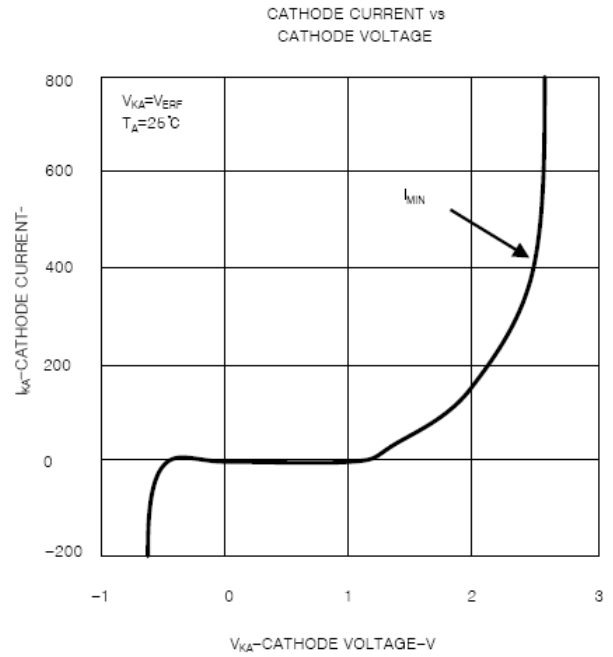


Figure 7.

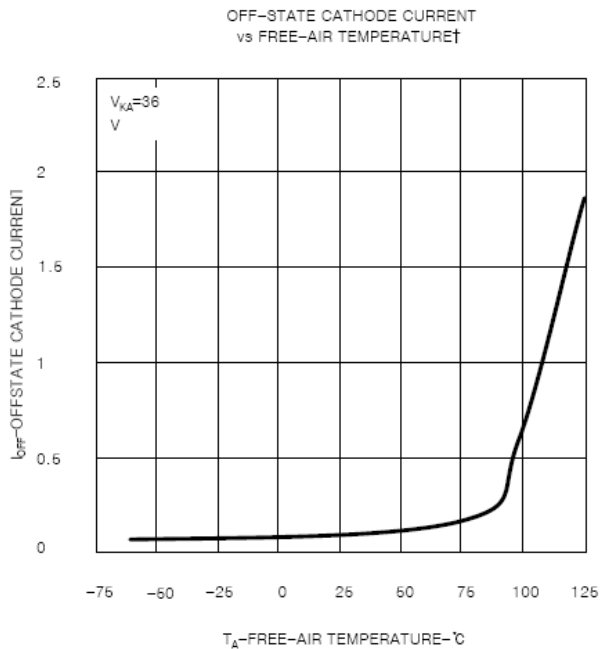


Figure 8.

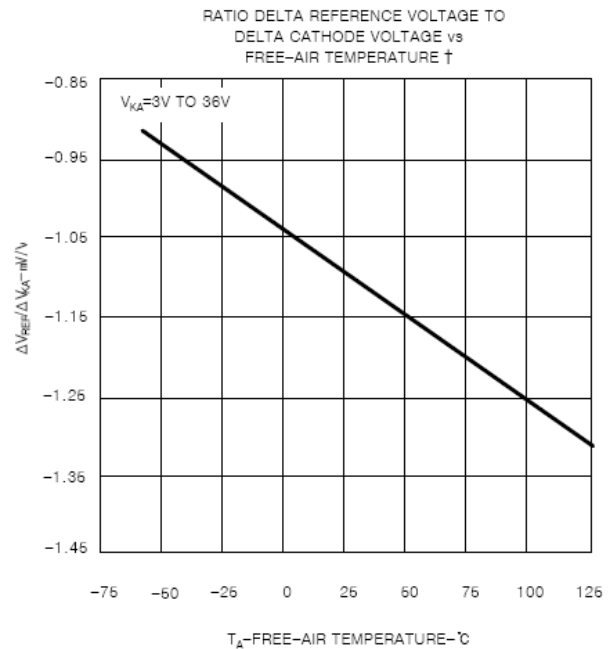


Figure 9.

† Data is applicable only within the recommended operating free-air temperature ranges of the various devices.

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EQUIVALENT INPUT NOISE VOLTAGE
VS FREQUENCY

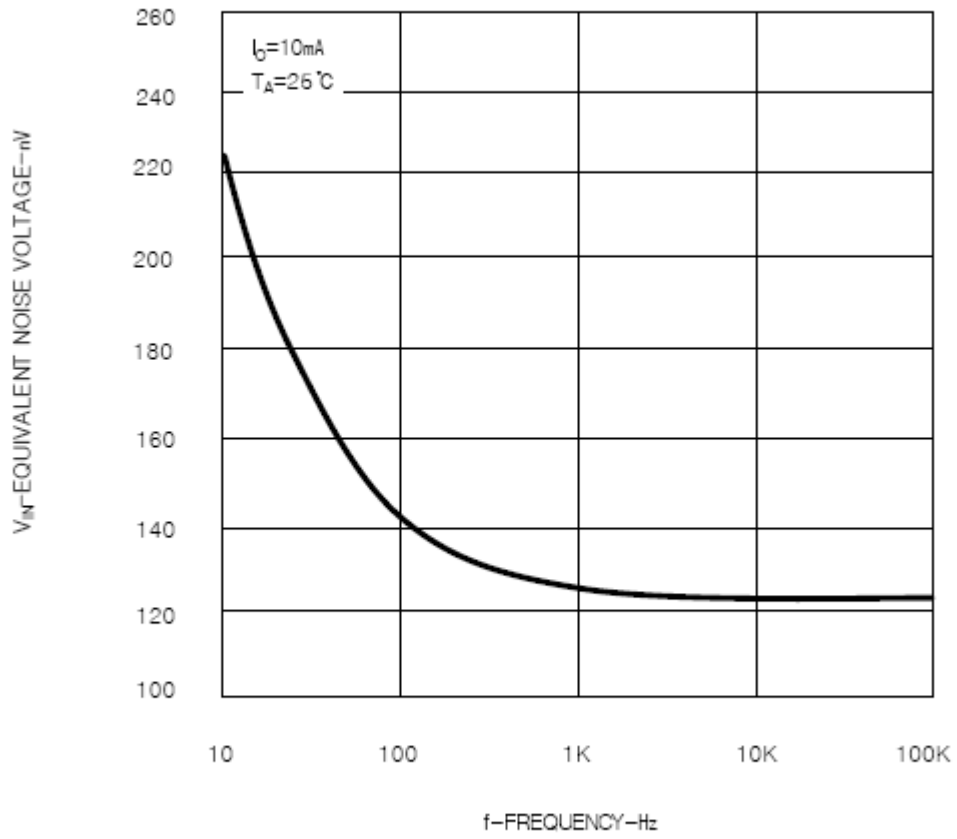
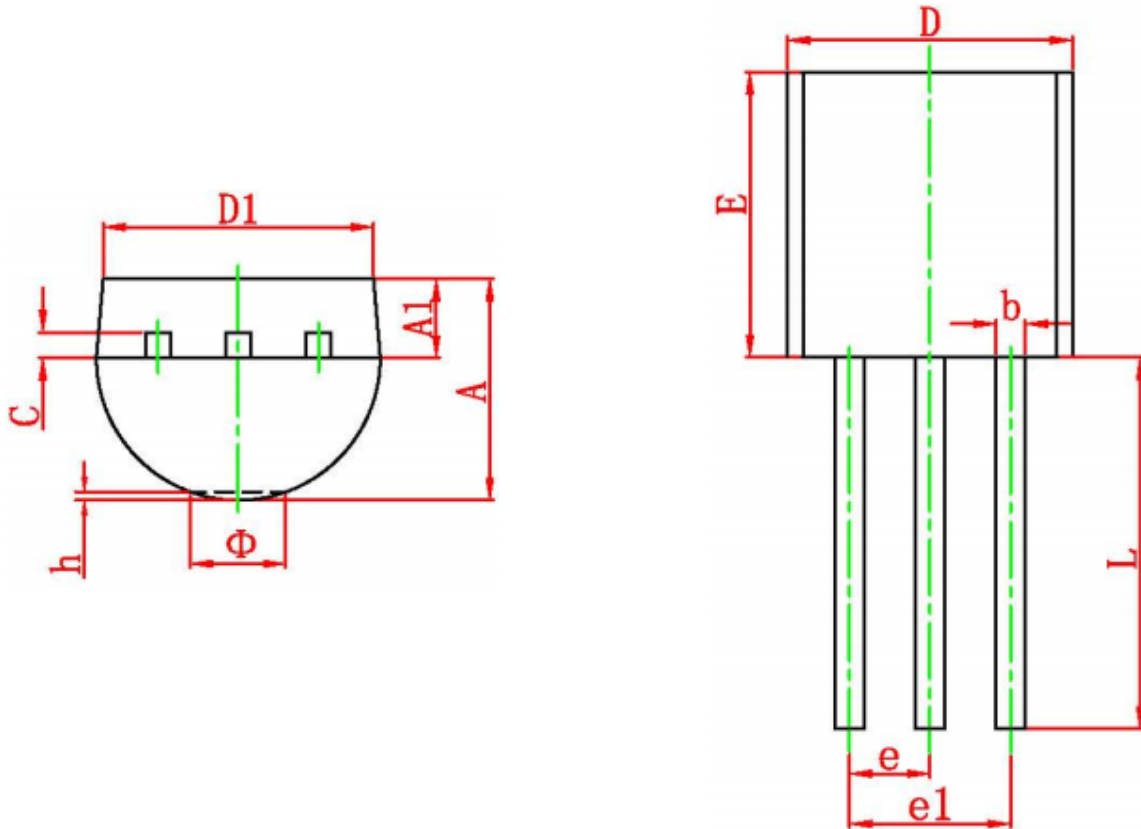


Figure 10.

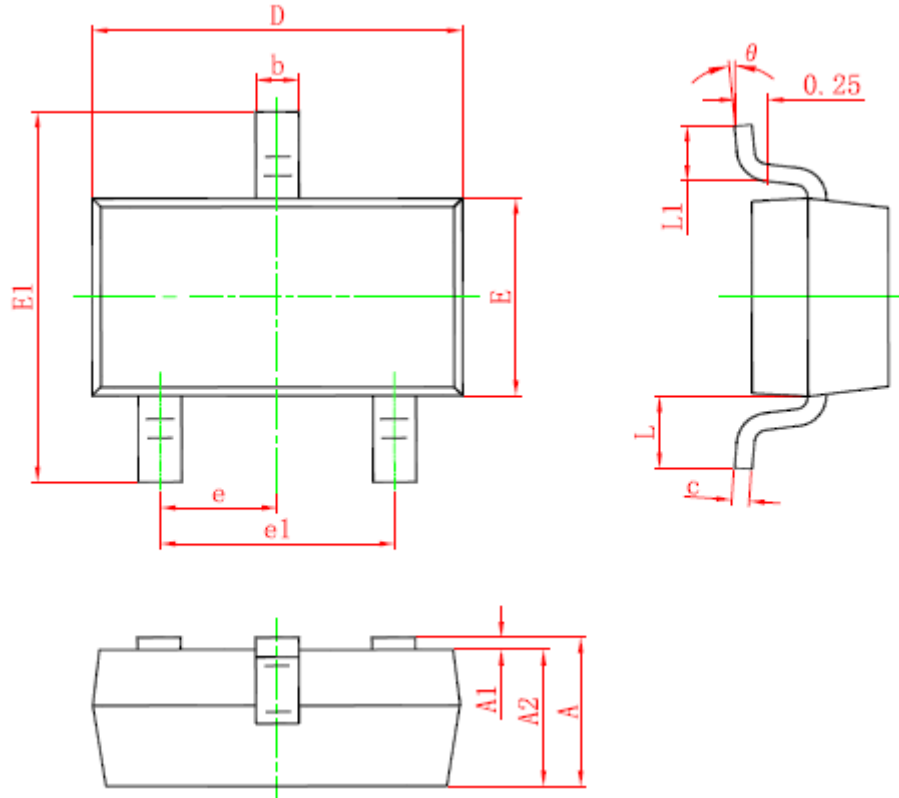
PACKAGE DESCRIPTION

TO-92 PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	3.300	3.700	0.130	0.148
A1	1.100	1.400	0.043	0.055
b	0.380	0.550	0.015	0.022
c	0.360	0.510	0.014	0.020
D	4.400	4.700	0.173	0.185
D1	3.430		0.135	
E	4.300	4.700	0.169	0.185
e	1.270TYP		0.050TYP	
e1	2.440	2.640	0.096	0.104
L	14.100	14.500	0.555	0.5721
		1.600		0.063
h	0.000	0.380	0.000	0.015

SOT-23 PACKAGE OUTLINE DIMENSIONS



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 TYP.		0.037 TYP.	
e1	1.800	2.000	0.071	0.079
L	0.550 REF.		0.022 REF.	
L1	0.300	0.500	0.012	0.020
θ	0°	8°	0°	8°