FSP431

■ FEATURES

- Equivalent Full-Range Temperature Coefficient ： 30 ppm/℃
- 0.2ΩTypical Output Impedance
- Sink-Current Capability ： 1 mA to 100 mA
- Low Output Noise
- Adjustable Output Voltage ： Vref to 36 V
- TO92-3L, SOT23-3L Package

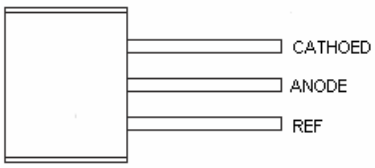
■ GENERAL DESCRIPTION

The FSP431 is three-terminal adjustable shunt regulators with specified thermal stability over applicable automotive, commercial, and military temperature ranges. The output voltage can be set to any value between Vref (approximately 2.5 V) and 36 V with two external resistors. These devices have a typical output impedance of 0.2Ω . Active output circuitry provides a very sharp turn-on characteristic, making these devices excellent replacements for Zener diodes in many applications, such as onboard regulation, adjustable power supplies, and switching power supplies.

■ PIN CONFIGURATION

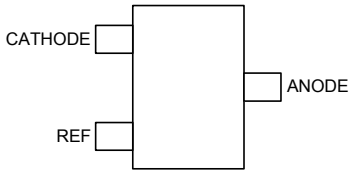
(1) TO92-3L

(Top View)

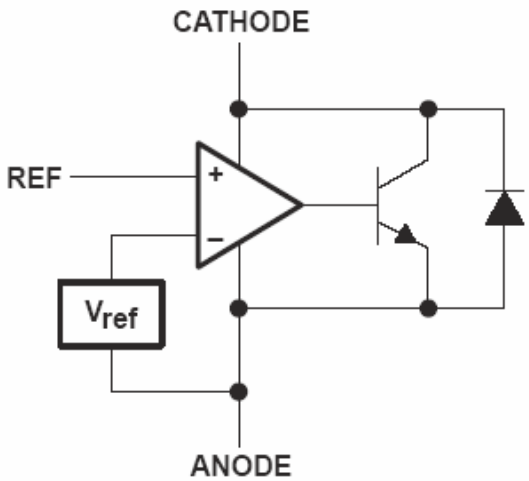


(2) SOT23-3L

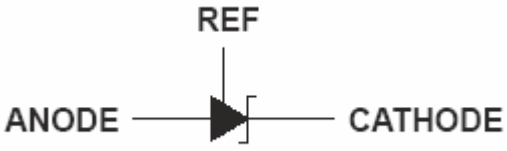
(Top View)



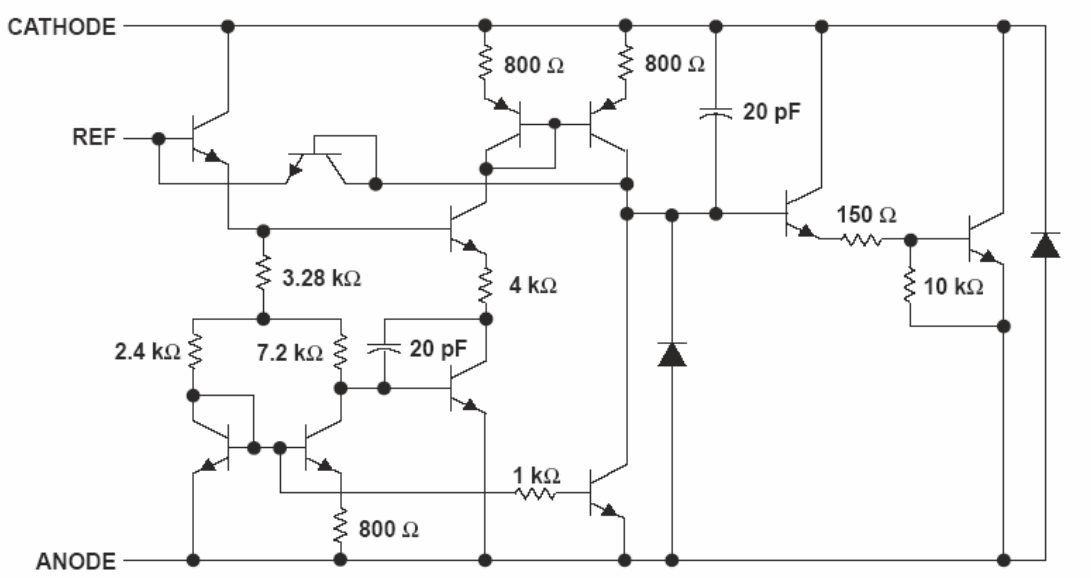
■ BLOCK DIAGRAM



■ SYMBOL



■ EQUIVALENT SCHEMATIC



Note: All component values are nominal.

■ ABSOLUTE MAXIMUM RATINGS (NOTE 1)

Parameter	Rating	Unit
Cathode Voltage, V_{KA} (Note 2)	37	V
Continuous Cathode Current Range, I_{KA}	-100 to 150	mA
Reference Input Current Range	-50μA to 10mA	
Operating Temperature	0 to 70	°C
Storage Temperature	-65 to 150	°C

Note 1: These are stress ratings only. Stresses exceeding the range specified under “Absolute Maximum Ratings’ may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in specifications is not implied and prolonged exposure to extreme conditions may affect device reliability.

Note 2: Voltage values are with respect to the anode terminal unless otherwise noted.

■ RECOMMENDED OPERATING CONDITIONS

Parameter	Rating	Unit
Cathode Voltage, V_{KA}	Vref to 36	V
Cathode Current, I_{KA}	1 to 100	mA
Operating Temperature, T_A	0 to 70	°C

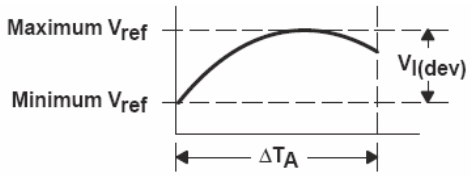
■ ELECTRICAL CHARACTERISTICS

(T_A=25°C, Unless otherwise noted)

PARAMETER	SYMBOL	TEST CONDITIONS		MIN	TYP	MAX	UNIT
Reference Voltage	V_{REF}	V_{KA} = V_{REF}, I_{KA} =10mA		2.47	2.495	2.52	V
Deviation of reference voltage over full temperature range (see Figure 1)	$V_{I(dev)}$	V_{KA} = V_{REF}, I_{KA} =10mA T_A= full range			4	25	mV
Ratio of change in reference voltage to the change in cathode voltage	$\Delta V_{REF}/\Delta V_{KA}$	I_{KA} =10mA	ΔV_{KA} =10V- V_{REF}		-4.7	-2.7	mV/V
			ΔV_{KA} =36V- 10V		-1	-2	
Reference Current	I_{REF}	I_{KA} =10mA, R1=10kΩ, R2=∞			2	4	μA
Deviation of reference current over full temperature range (see Figure 1)	$I_{I(dev)}$	I_{KA} =10mA, R1=10kΩ, R2=∞ T_A= full range			0.8	1.2	μA
Minimum Cathode Current for regulation	I_{MIN}	V_{KA} = V_{REF}			0.4	0.6	mA
Off-state Cathode Current	I_{OFF}	V_{KA} =36V, V_{REF} =0			0.1	0.5	mA
Dynamic Impedance (see Figure 1)	$\lvert Z_{KA} \rvert$	I_{KA} =1mA to 100Ma, V_{KA} = V_{REF} f≤1kHz			0.2	0.5	Ω

The deviation parameters $V_{ref(dev)}$ and $I_{ref(dev)}$ are defined as the differences between the maximum and minimum values obtained over the recommended temperature range. The average full-range temperature coefficient of the reference voltage, $V_{ref,}$ is defined as:

$$|\alpha_{Vref}| \left(\frac{ppm}{°C}\right) = \frac{\left(\frac{V_{I(dev)}}{V_{ref\ at\ 25°C}}\right) \times 10^6}{\Delta T_A}$$



Where :

ΔTA is the recommended operating free-air temperature range of the device.

α Vref can be positive or negative, depending on whether minimum Vref or maximum Vref, respectively , occurs at the lower temperature.

Example : maximum Vref=2.496V at 30°C, minimum Vref =2.492V at 0°C, Vref=2.495V at 25°C,

$$|\alpha_{Vref}| = \frac{\left(\frac{4\ mV}{2495\ mV}\right) \times 10^6}{70°C} \approx 23\ ppm/°C$$

Because minimum Vref occurs at the lower temperature, the coefficient is positive.

Calculating Dynamic Impedance

The dynamic impedance is defined as: $|z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_{KA}}$

When the device is operating with two external resistors, the total dynamic impedance of the circuit is given by:

$$|z'| = \frac{\Delta V}{\Delta I} \approx |z_{KA}| \left(1 + \frac{R1}{R2}\right)$$

Figure 1: Calculating Deviation Parameters and Dynamic Impedance

■ PARAMETER MEASUREMENT INFORMATION

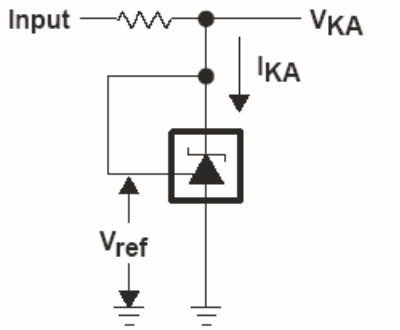


Figure 2: Test Circuit for $V_{KA}=V_{REF}$

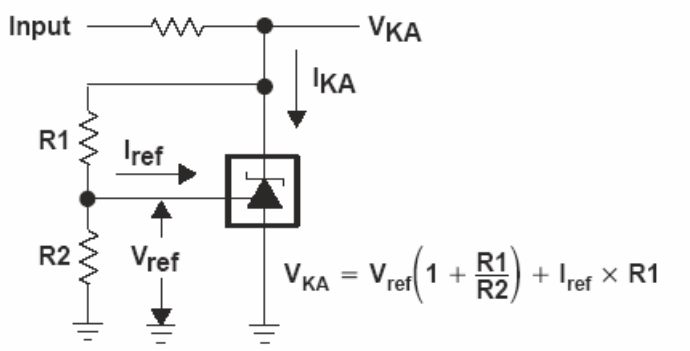


Figure 3: Test Circuit for $V_{KA}>V_{REF}$

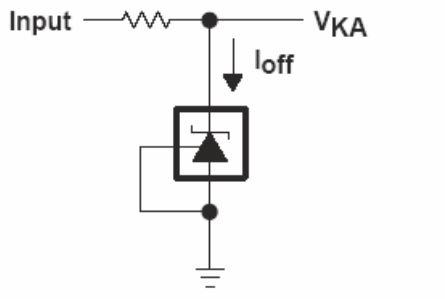
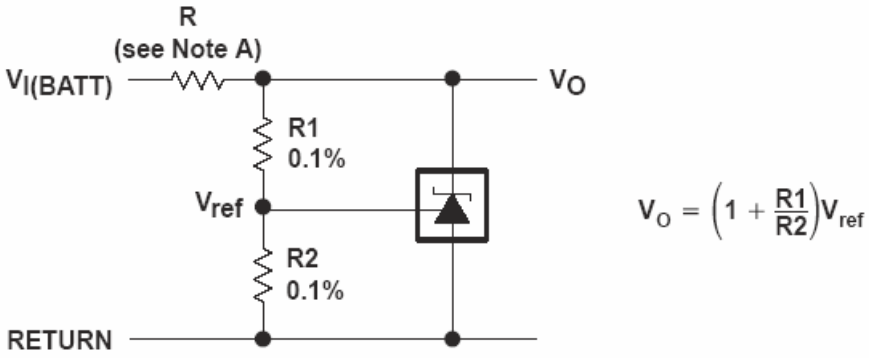


Figure 4: Test Circuit for Ioff

■ APPLICATION INFORMATION



Note A: R should provide cathode current ≥ 1mA to the FSP431 at minimum.($V_{I(BATT)}$)

Figure 5: shunt regulator

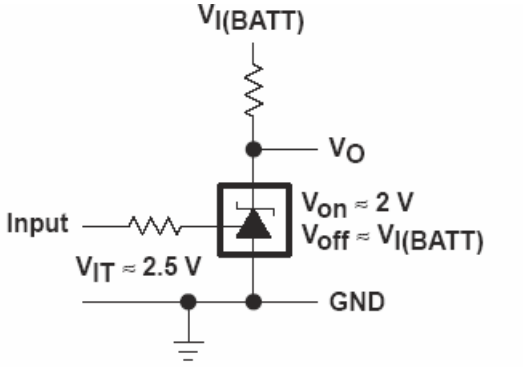
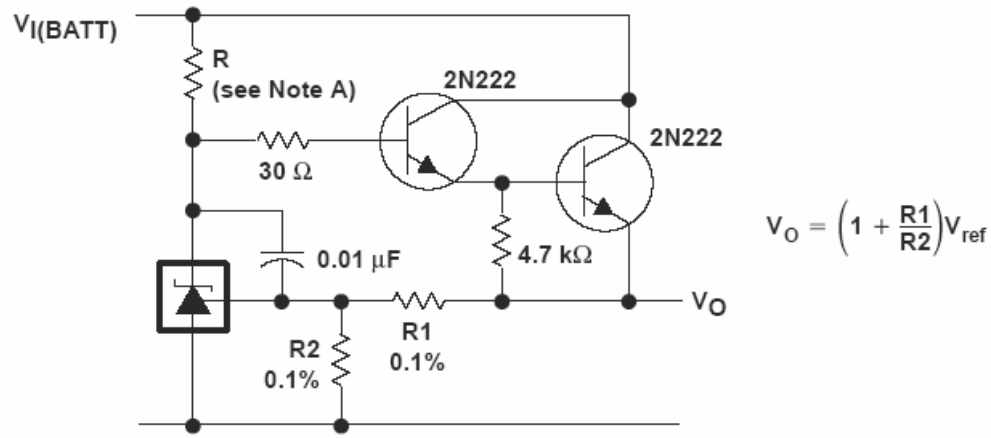


Figure 6: Single-Supply comparator with temperature-compensated threshold



Note A: R should provide cathode current ≥ 1mA to the FSP431 at minimum.($V_{I(BATT)}$)

Figure 7: Precision high-current series regulator

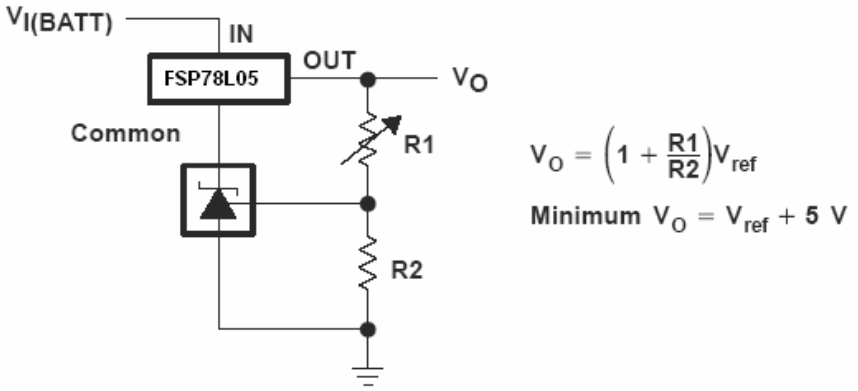


Figure 8: Output control of a three terminal fixed regulator

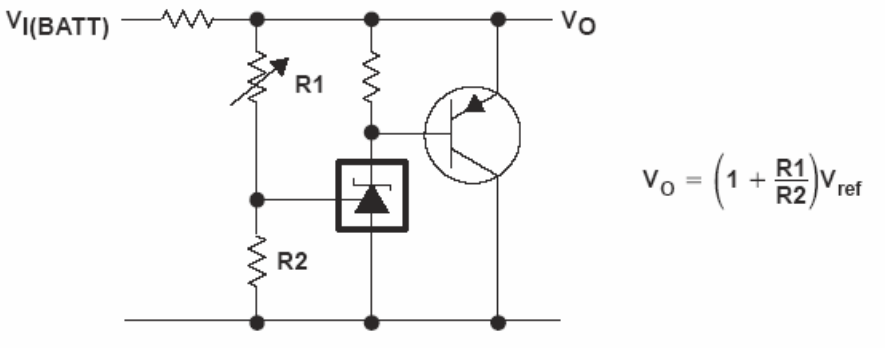
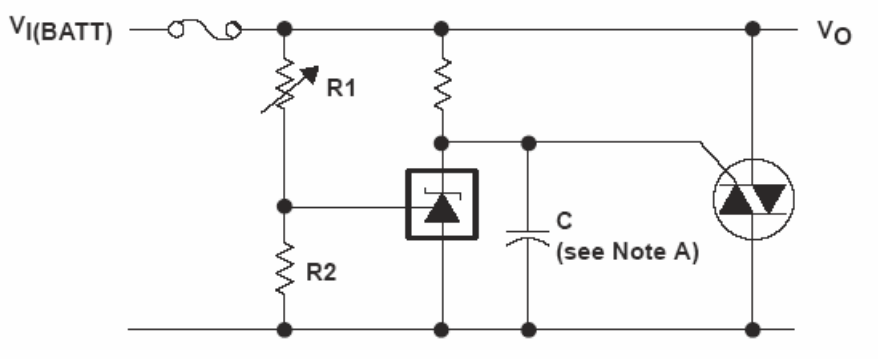


Figure 9: High current shunt regulator



Note A: Refer to the stability boundary condition to determine allowable values for C.

Figure 9: Crowbar Circuit

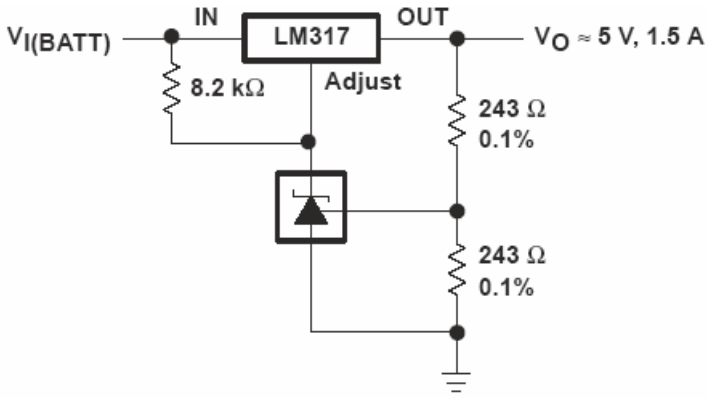
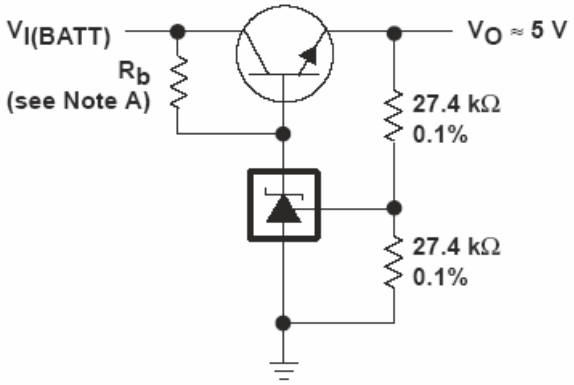


Figure 10: Precision 5V 1.5A regulator



Note A: Rb should provide cathode current ≥ 1mA to the FSP431.

Figure 11: Efficient 5V precision regulator

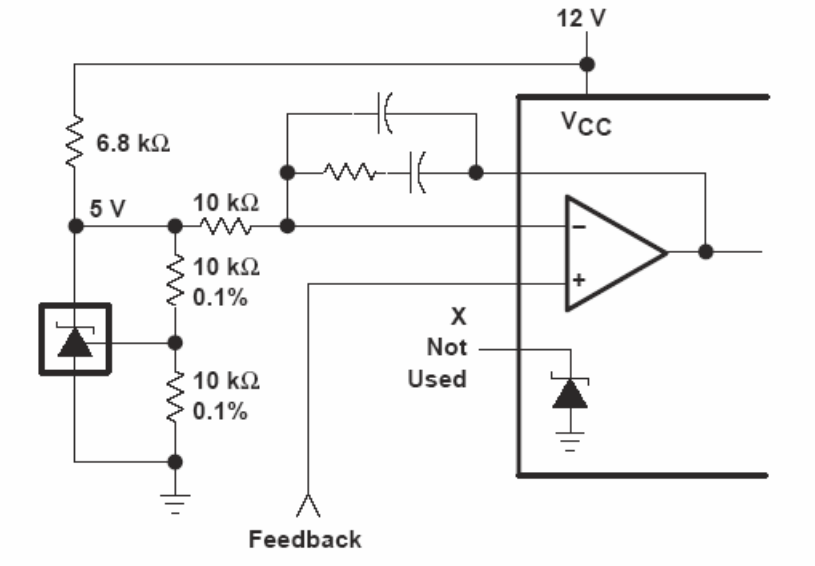
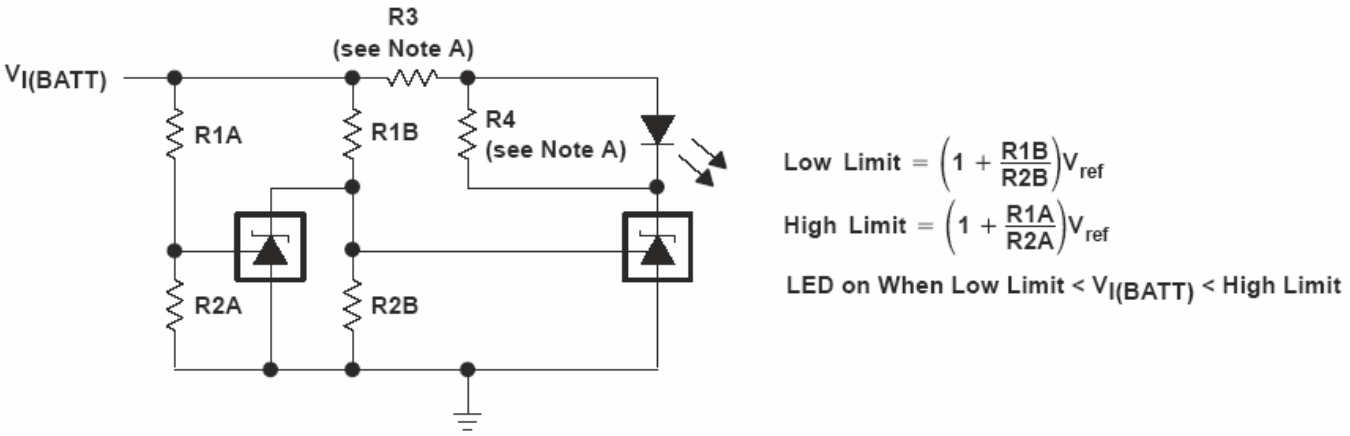


Figure 12: PWM converter with reference



Note A: R3 and R4 are selected to provide the desired LED intensity and cathode current ≥ 1mA to the FSP431 at the available.($V_{I(BATT)}$)

Figure 13: Voltage monitor

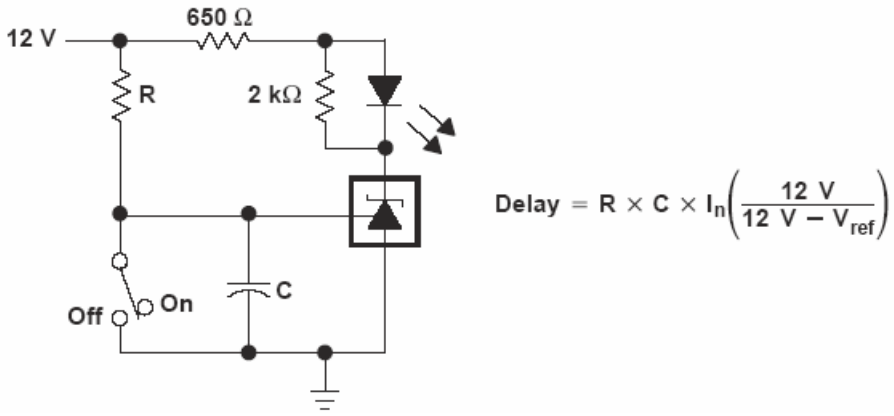


Figure 14: Delay Timer

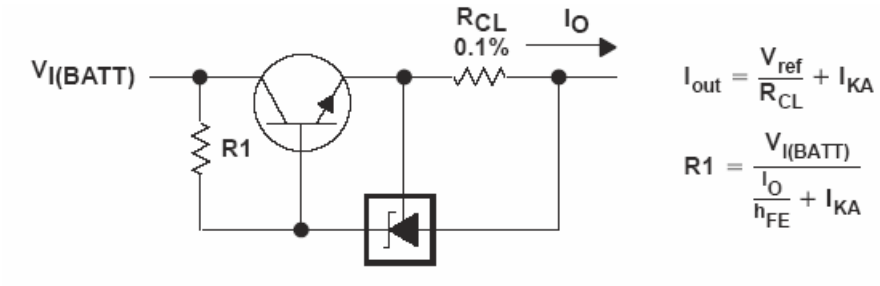


Figure 15: Precision current limiter

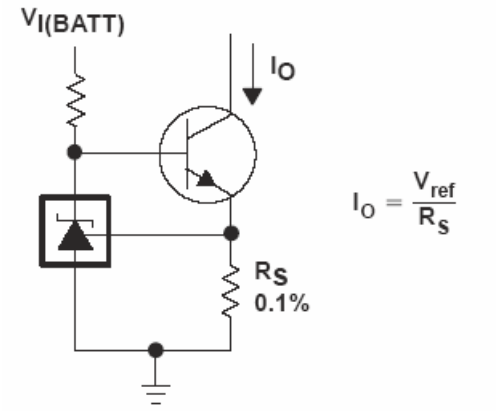
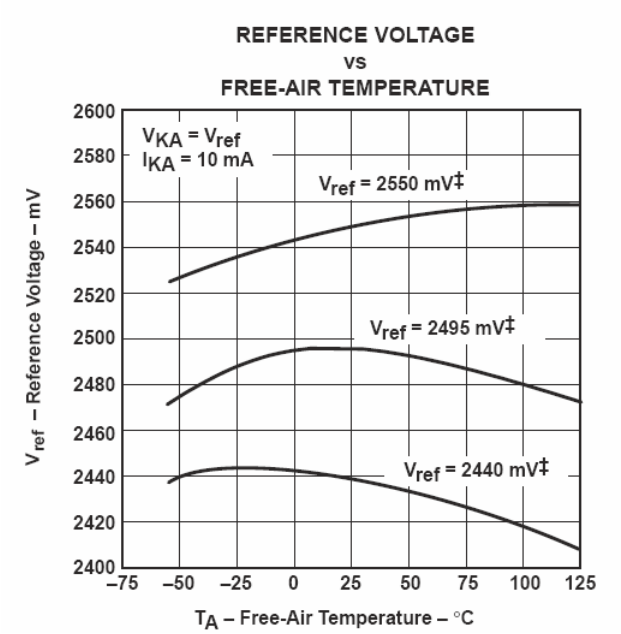
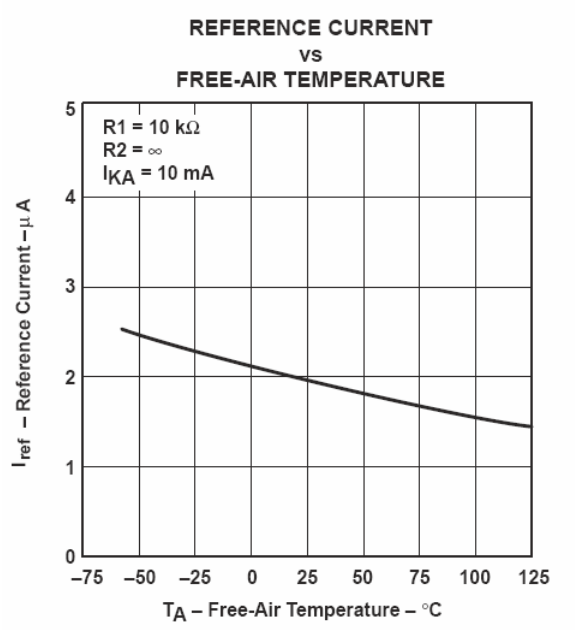
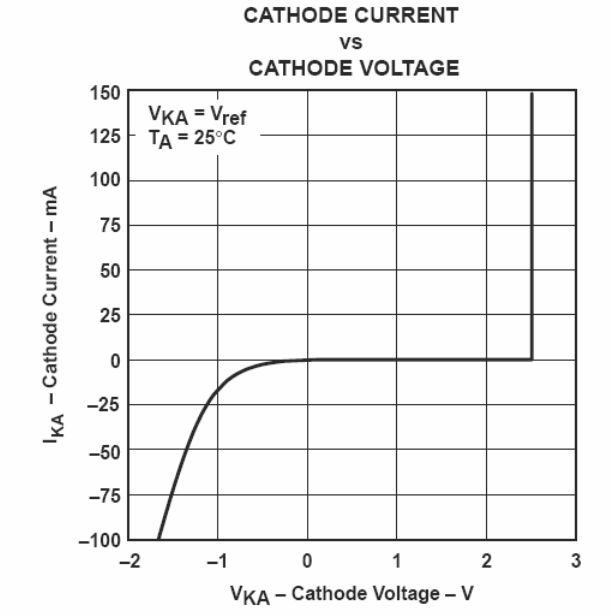


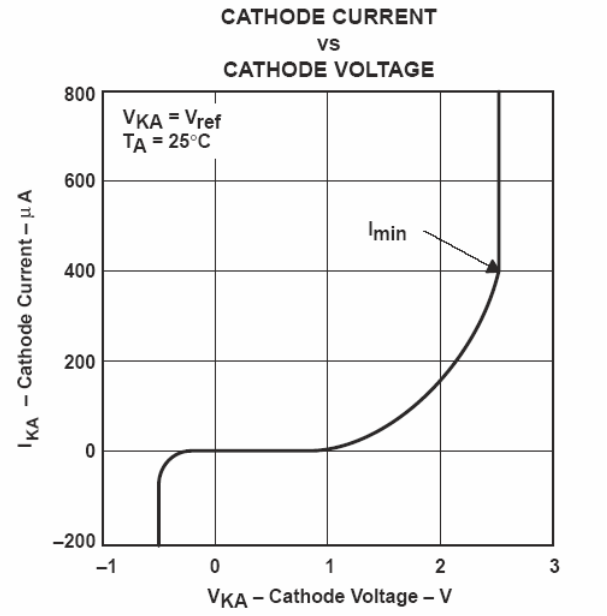
Figure 16: Precision constant-current sink

■ TYPICAL CHARACTERISTICS

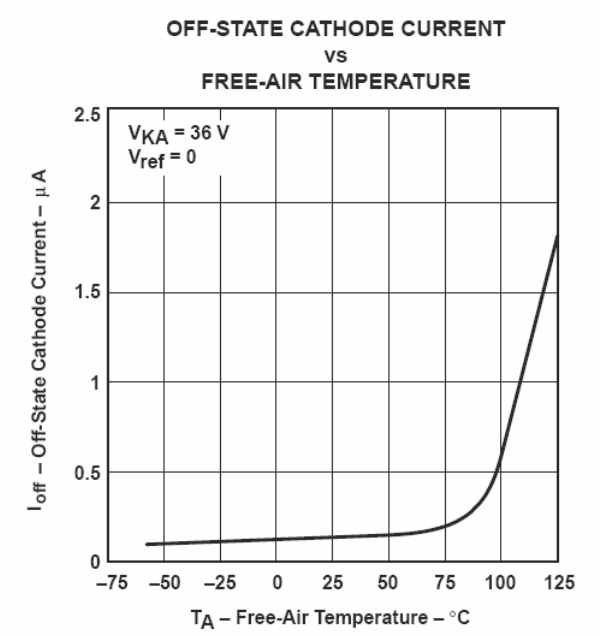


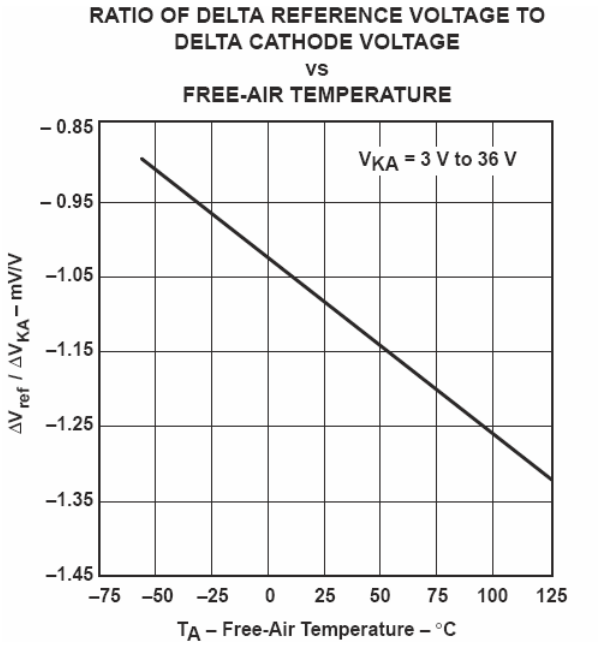


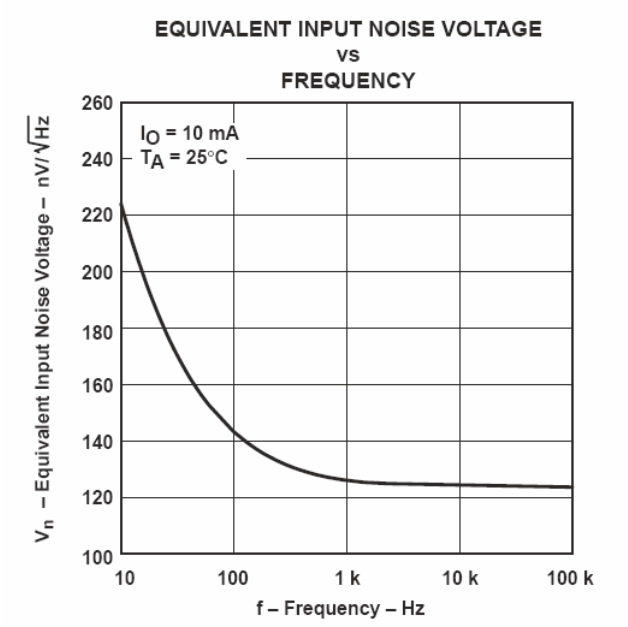


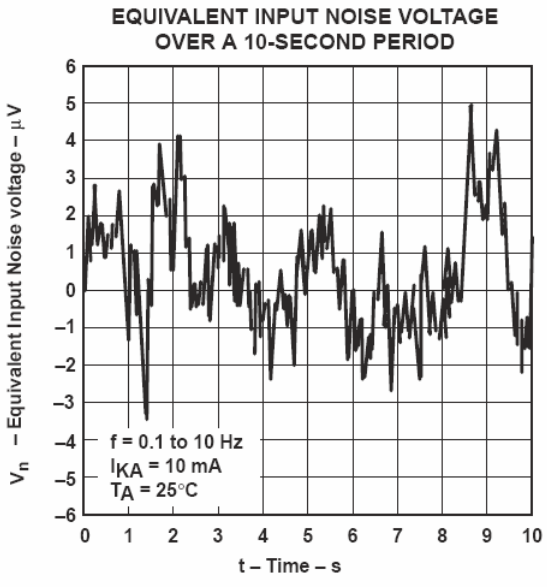


■ TYPICAL CHARACTERISTICS (CONTINUED)

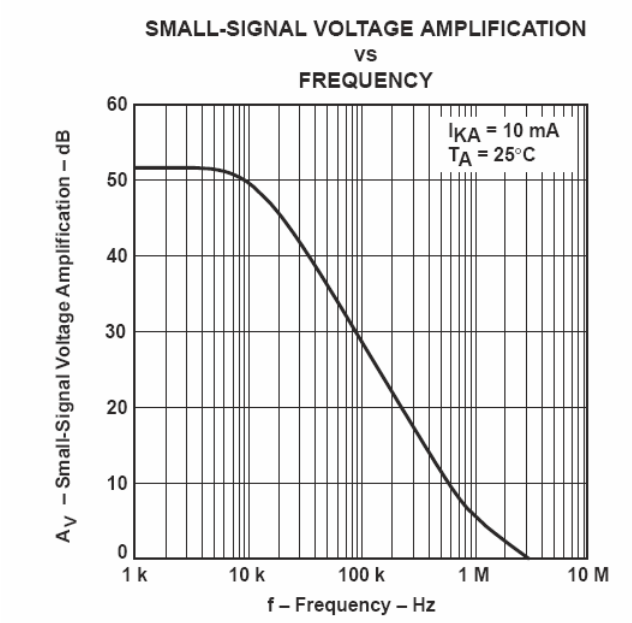


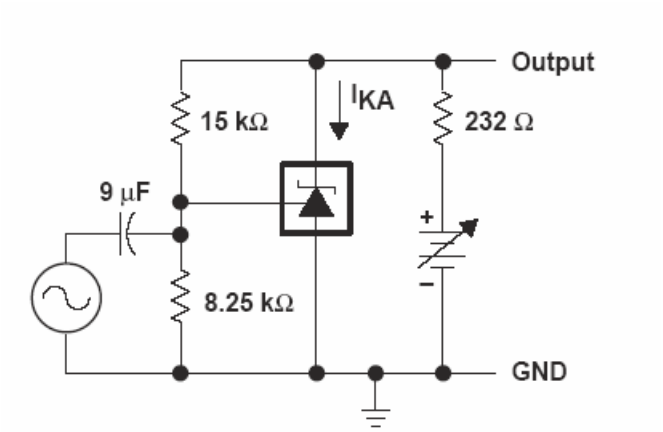


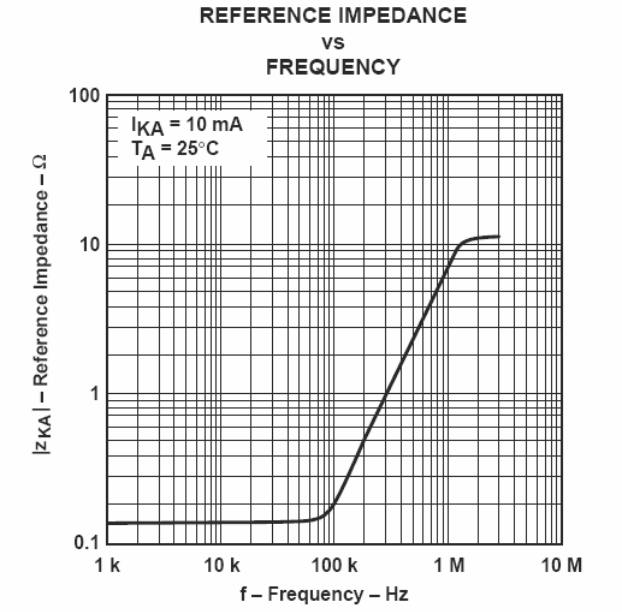


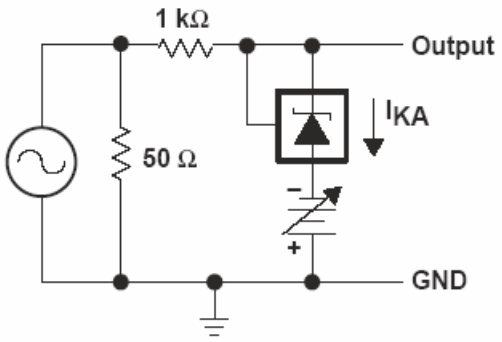


■ TYPICAL CHARACTERISTICS (CONTINUED)

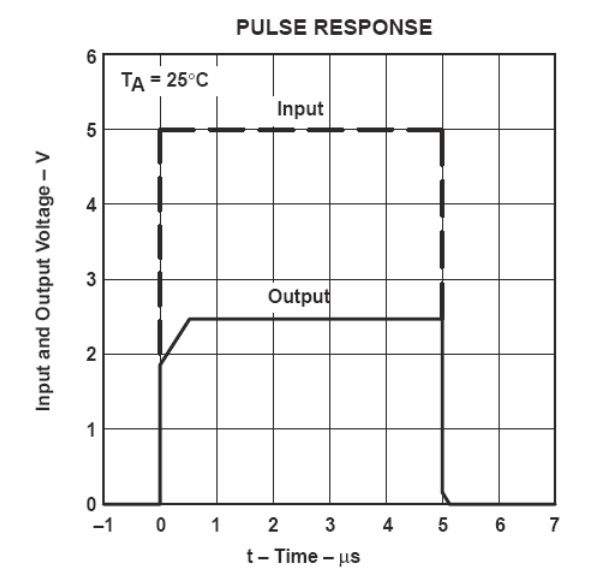


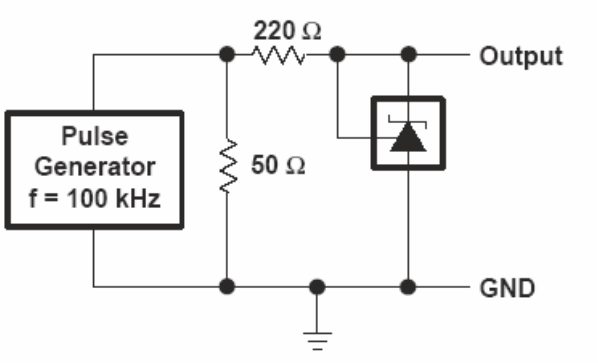


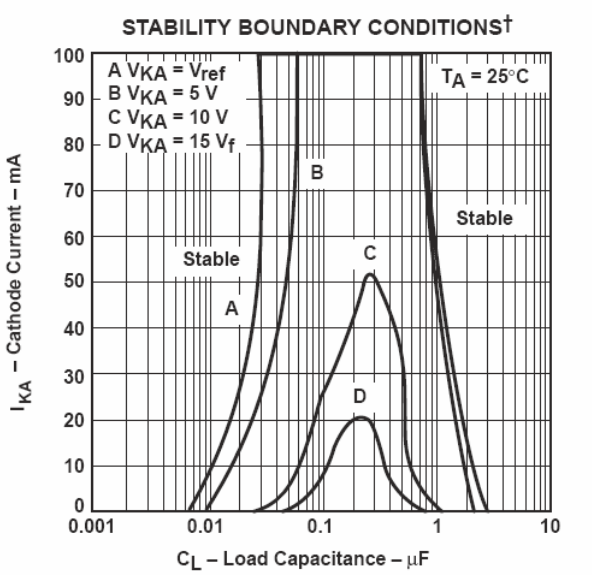


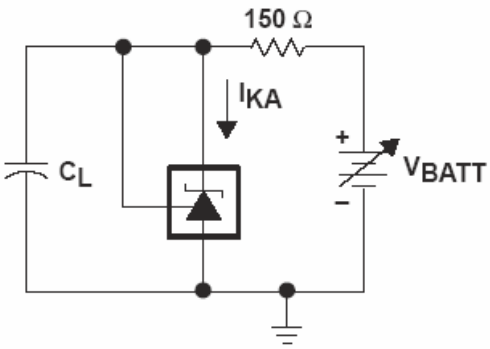


■ TYPICAL CHARACTERISTICS(CONTINUED)

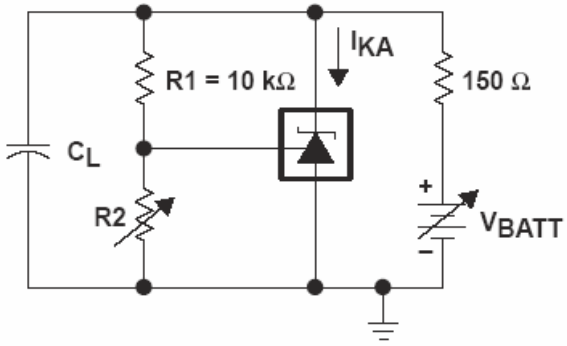






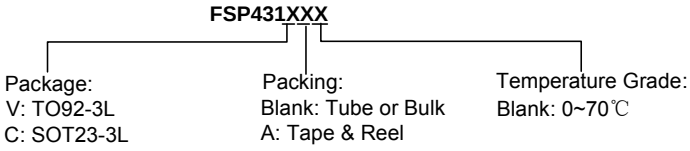


Test circuit for curve A



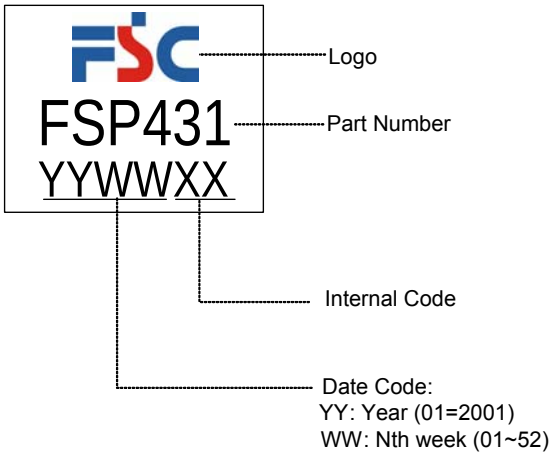
Test circuit for curve B, C and D

■ ORDERING INFORMATION



■ MARKING INFORMATION

(1) TO92-3L



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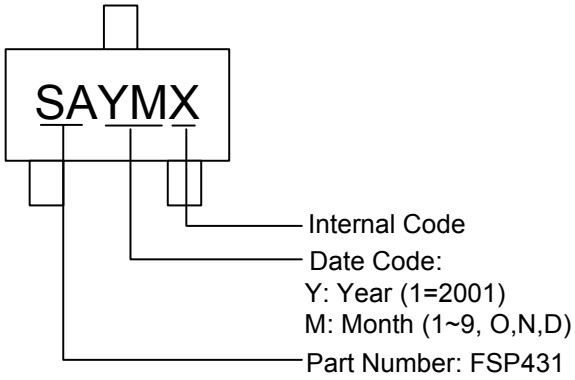
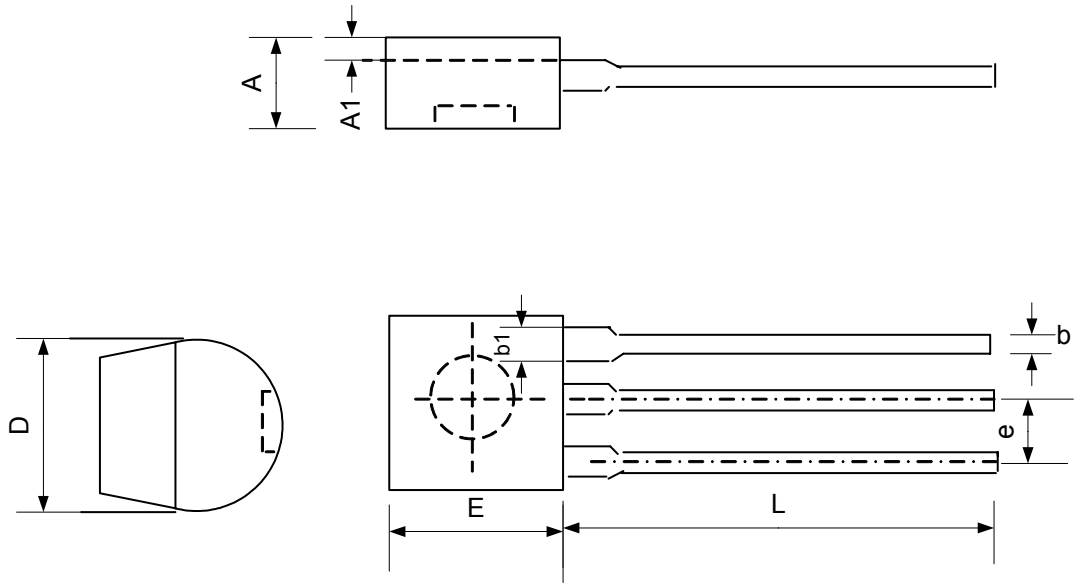


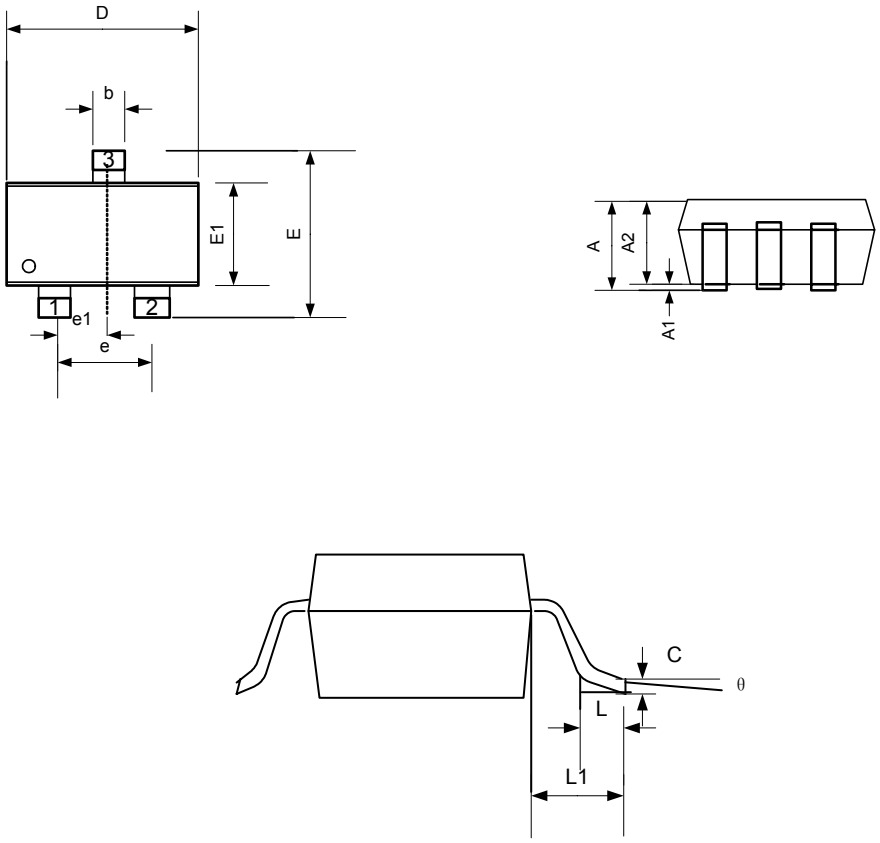
■ PACKAGE INFORMATION

(1) TO92-3L



Symbol	Dimensions In Millimeters			Dimensions In Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	3.302	3.556	3.810	0.130	0.140	0.150
A1	1.016			0.040		
b	0.330	0.381	0.432	0.013	0.015	0.017
b1	0.406	0.457	0.506	0.016	0.018	0.020
D	4.445	4.572	4.699	0.175	0.180	0.185
E	4.445	4.572	4.699	0.175	0.180	0.185
L	13.00		15.50	0.512		0.610
e	1.150	1.270	1.390	0.045	0.050	0.055

(2) SOT23-3L



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.400	0.012	0.016
C	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	2.650	2.950	0.104	0.116
E1	1.500	1.700	0.060	0.068
L	0.300	0.600	0.012	0.024
L1	0.700REF		0.028REF	
e1	0.95 Bsc.		0.038 Bsc.	
e	1.90 Bsc.		0.076 Bsc.	
θ	0°	8°	0°	8°