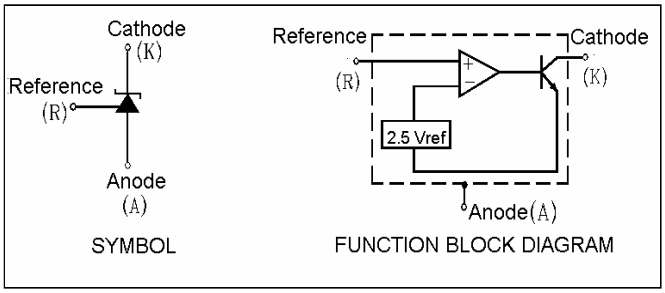
The PJ431, A, B integrated circuits are three-terminal programmable shunt regulator diodes. These monolithic IC voltage references operate as a low temperature coefficient zener which is programmable from Vref to 36 volts with two external resistors. These devices exhibit a wide operating current range of 1.0 to 100mA with a typical dynamic impedance of 0.22Ω. The characteristics of these references make them excellent replacements for zener diodes in many applications such as digital voltmeters, power supplies , and op amp circuitry. The 2.5 volt reference makes it convenient to obtain a stable reference from 5.0 volt logic supplies, and since The PJ431, A, B operates as a shunt regulator, it can be used as either a positive or negative tage reference.

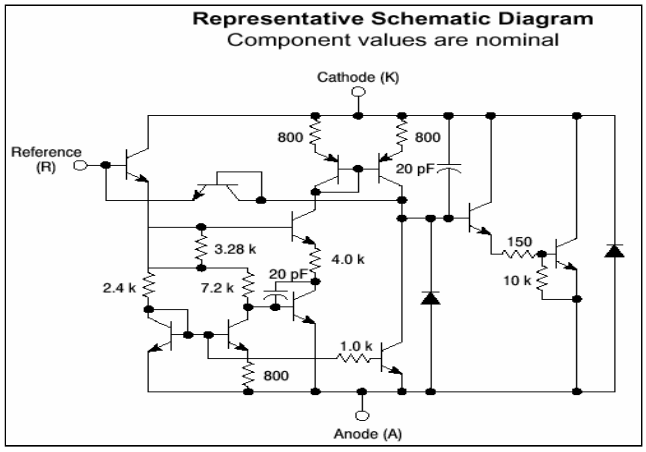
FEATURES

- Programmable Output Voltage to 36 Volts
- Voltage Reference Tolerance:
  - PJ431A : ±0.5%, Typ@25°C
  - PJ431 : ±1%, Typ@25°C
  - PJ431B : ±2%, Typ@25°C
- Low Dynamic Output Impedance, 0.22 Ω Typical
- Sink Current Capability of 1.0 to 100 mA
- Equivalent Full-Range Temperature Coefficient of 50 ppm/ ℃Typical
- Temperature Compensated for Operation over Full Rated Operating Temperature Range
- Low Output Noise Voltage

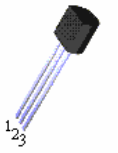
BLOCK DIAGRAM



CIRCUIT SCHEMATIC



TO-92



Pin: 1. Reference
2. Anode
3. Cathode

SOT-89

Pin: 1. Reference
2. Anode
3. Cathode

(Heatsink surface connected to Pin 2)

SOT-23

Pin: 1. Reference
2. Cathode
3. Anode

SOP-8

Pin: 1. Cathode
2. Anode
3. Anode
4. N.C.
5. N.C.
6. Anode
7. Anode
8. Reference

SOP-8 is an internally modified SOP-8 Package. Pins 2,3,6 and 7 are electrically common to the die attach flag. This internal lead frame modification decreases package thermal resistance and increases power dissipation capability when appropriately mounted on a printed on a printed circuit board. SOP-8 conforms to all external dimensions of the standard SOP-8 Package.

QRDERING INFORMATION

Device	Operating Temperature (Ambient)	Package
PJ431/ A/ B CT	- 20℃~ +85℃	TO-92
PJ431/ A/ B CS		SOP-8
PJ431/ A/ B CY		SOT-89
PJ431/ A/ B CX		SOT-23

MAXIMUM RATINGS (Full operating ambient temperature range applies unless otherwise noted.)

Rating	Symbol	Value	Unit
Cathode To Anode Voltage	V_{KA}	37	V
Cathode Current Range, Continuous	I_K	-100 to +150	mA
Reference Input Current Range, Continuous	I_{ref}	-0.05 to +10	mA
Operating Junction Temperature	T_J	150	℃
Operating Ambient Temperature Range	T_A	-20 to +85	℃
Storage Temperature Range	T_{stg}	-65 to +150	℃
Total Power Dissipation @ T_A = 25℃	P_D		W
Derate above 25℃ Ambient Temperature			
PJ431 / 431A / 431B CT		0.625	
PJ431 / 431A / 431B CS		0.70	
PJ431 / 431A /431 B CY		0.80	
PJ431 / 431A / 431B CX		0.30	
Total Power Dissipation @ T_C = 25℃	P_D		W
Derate above 25℃ Case Temperature			
PJ431 / 431A / 431B CT		1.5	
PJ431 / 431A / 431B CS		1.5	
PJ431 / 431A /431 B CY		1.5	
PJ431 / 431A / 431B CX		0.7	

THERMAL CHARACTERISTICS

Characteristics	Symbol	Min	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	178	114	℃ /W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83	41	℃/W

RECOMMENDED OPERATING CONDITIONS

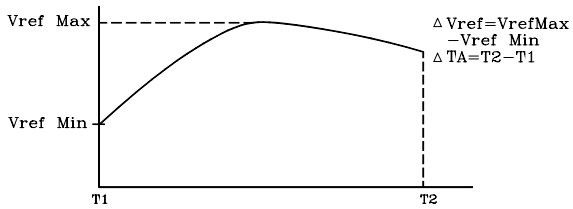
Condition/Value	Symbol	Min	Max	Unit
Cathode To Anode Voltage	V_{KA}	V_{ref}	36	V
Cathode Current	I_K	1.0	100	mA

1

T_{low} =-20 ℃, T_{high} = +85℃

2

The deviation parameter $\triangle V_{ref}$ is defined as the differences between the maximum and minimum values obtained over the full operating ambient temperature range the applies.



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

$$\alpha V_{ref} \frac{ppm}{℃} = \frac{(\triangle vref)}{\frac{Vref@25℃}{\triangle T_A}} x10^6 = \frac{\triangle Vref \times 10^6}{\triangle T_A (Vref@25℃)}$$

αV_{ref} can be positive of negative depending on whether V_{ref} Min of V_{ref} Max occurs at the lower ambient temperature. (Refer to Figure 6)

Example: $\triangle V_{ref}$ = 8.0 mV and slope is positive,
V_{ref} @ 25 ℃ = 2.5V, $\triangle T_A$ = 85℃

$$\alpha V_{ref} = \frac{0.008 \times 10^6}{70(2.5)} = 45.8 \text{ ppm/℃}$$

3

The dynamic impedance Z_{ka} is defined as:

$$|Z_{ka}| = \frac{\triangle V_{KA}}{\triangle I_K}$$

When the device is programmed with two external resistors, R1 and R2, (refer to Figure 2) the total dynamic impedance of the circuit is defined as:

$$|Z_{ka}| \approx |Z_{ka}| (1 + \frac{R1}{R2})$$

4

This test is not applicable to surface mount (D suffix) devices.

FIGURE 1 -- TEST CIRCUIT FOR $V_{KA} = V_{ref}$

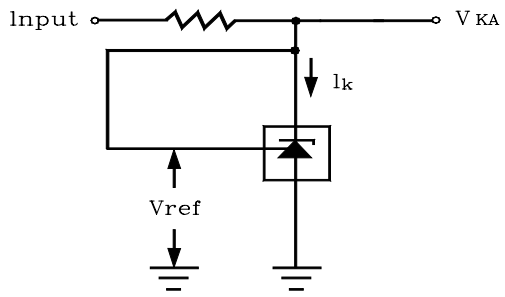
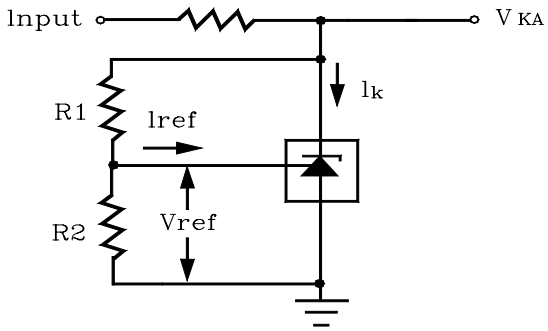
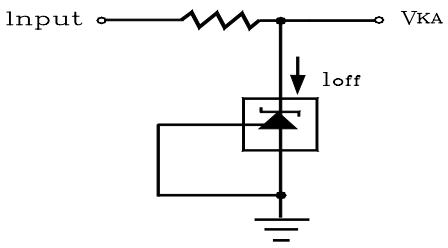


FIGURE 2 -- TEST CIRCUIT FOR $V_{KA} > V_{ref}$



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

FIGURE 3 -- TEST CIRCUIT FOR I_{off}



ELECTRICAL CHARACTERISTICS (Ambient temperature at 25℃ unless otherwise noted)

Characteristic	Symbol	PJ431			Unit
		Min	Typ	Max	
Reference Input Voltage (Figure 1) V_{KA} = V_{ref} , I_K = 10 mA, T_A = +25℃ T_A = T_{low} to T_{high} (Note 1) PJ431A PJ431 PJ431B	V_{ref}	 2.4875 2.475 2.45	 2.495 2.495 2.495	 2.5125 2.525 2.55	V
Reference Input Voltage Deviation Over Temperature Range (Figure 1, Note 1,2,4) V_{KA} = V_{ref} , I_K = 10 mA	△Vref	--	3.0	17	mV
Ratio of Change in Reference Input Voltage to Change in Cathode to Anode Voltage I_K = 10 mA (Figure 2), △V_{KA} = 10V to V_{ref} △V_{KA} = 36V to 10V	$\frac{\triangle Vref}{\triangle V_{KA}}$	 -- --	 - 1.4 - 1.0	 - 2.7 -.2.0	mV
Reference Input Current (Figure 2) I_K = 10 mA, R1 = 10 k, R2 = ∞ T_A = +25℃ T_A = T_{low} to T_{high} (Note 1)	I_{ref}	 -- --	 0.7 --	 4.0 5.2	μA
Reference Input Current Deviation Over Temperature Range (Figure 2, Note 1,4) I_K = 10 mA, R1 = 10 k, R2 = ∞	△I_{ref}	--	0.4	1.2	μA
Minimum Cathode Current for Regulation V_{KA} = V_{ref} (Figure 1)	I_{min}	--	0.5	1.0	mA
Off-State Cathode Current (Figure 3) V_{KA} = 36 V, V_{ref} = 0V	I_{off}	--	2.6	1000	nA
Dynamic Impedance (Figure 1, Note 3) V_{KA} = V_{ref}, △I_K = 1.0 mA to 100 mA, f ≤1.0 kHz	$\lvert Z_{ke} \rvert$	--	0.22	0.5	Ω

FIGURE 4-CATHODE CURRENT versus CATHODE VOLTAGE

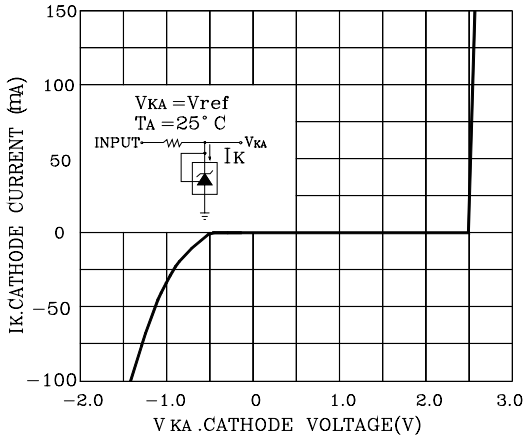


FIGURE 5-CATHODE CURRENT versus CATHODE VOLTAGE

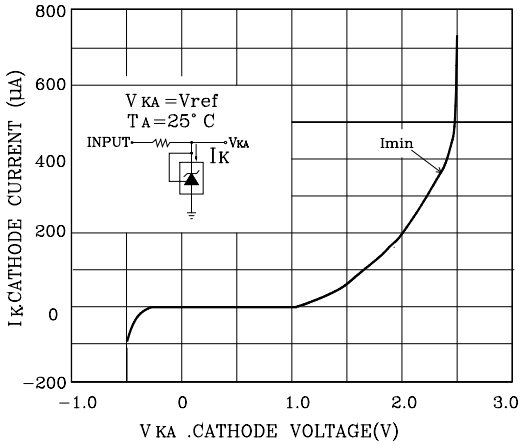


FIGURE 6-REFERENCE INPUT VOLTAGE versus AMBIENT TEMPERATURE

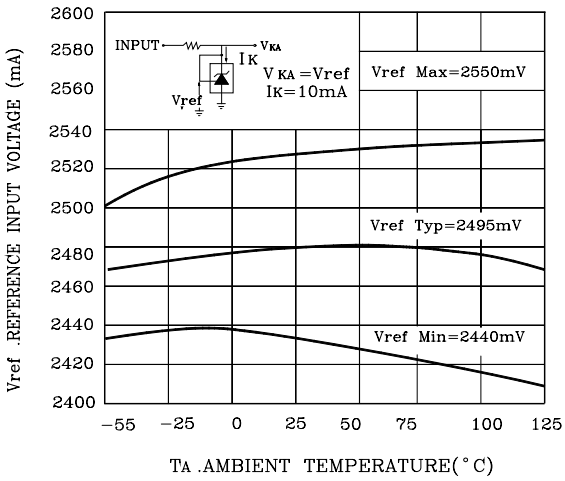


FIGURE 7-REFERENCE INPUT CURRENT versus AMBIENT TEMPERATURE

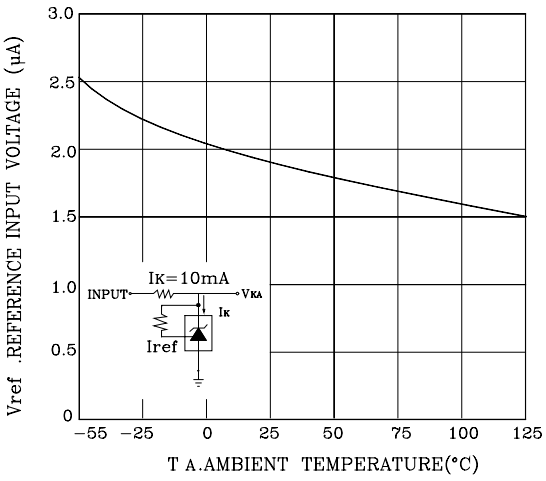


FIGURE 8-CHANGE IN REFERENCE INPUT VOLTAGE versus CATHODE VOLTAGE

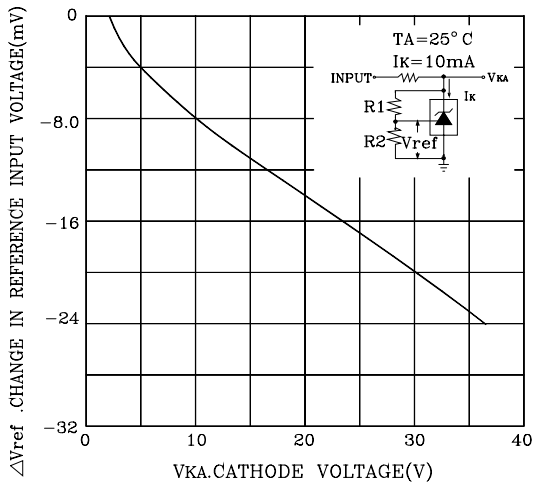


FIGURE 9 –OFF.STATE CATHODE CURRENT versus AMBIENT TEMPERATURE

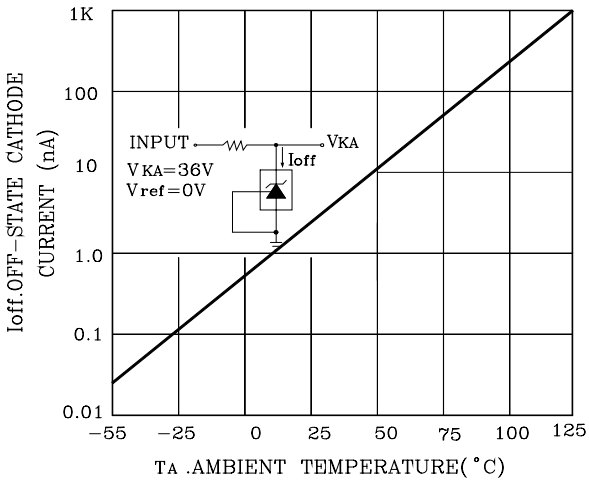


FIGURE 10 - DYNAMIC IMPEDANCE VERSUS FREQUENCY

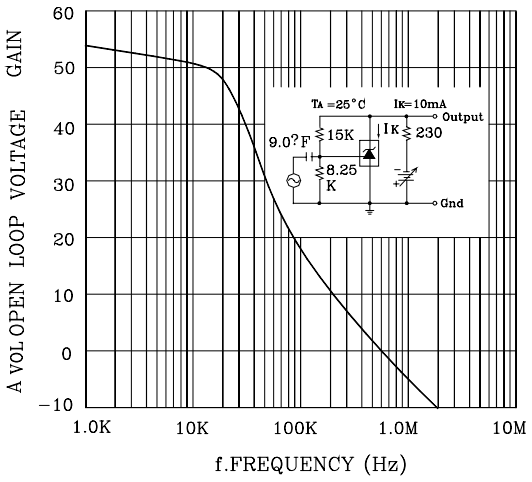


FIGURE 11 - DYNAMIC IMPEDANCE VERSUS AMBIENT TEMPERATURE

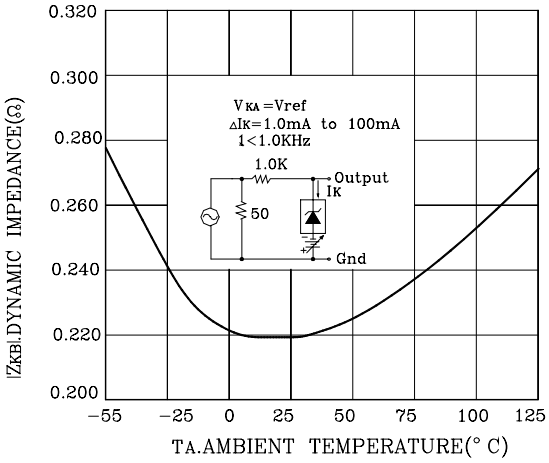


FIGURE 12 - OPEN LOOP VOLTAGE GAIN VERSUS FREQUENCY

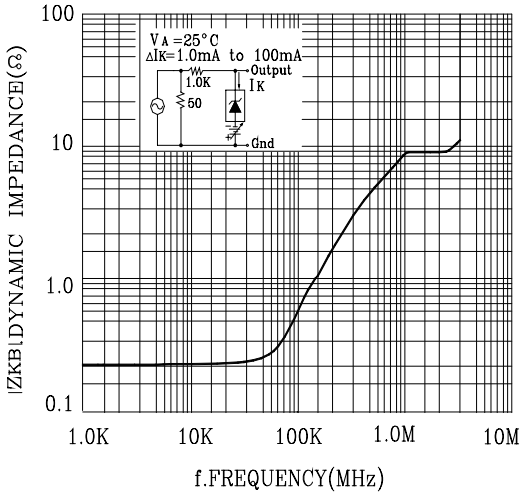


FIGURE 13 - SPECTRAL NOISE DENSITY

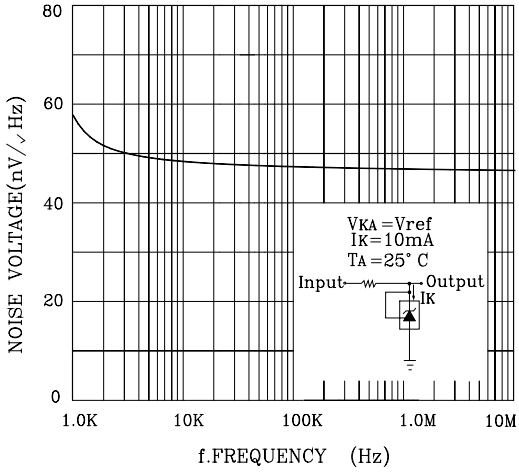


FIGURE 14 - PULSE RESPONSE

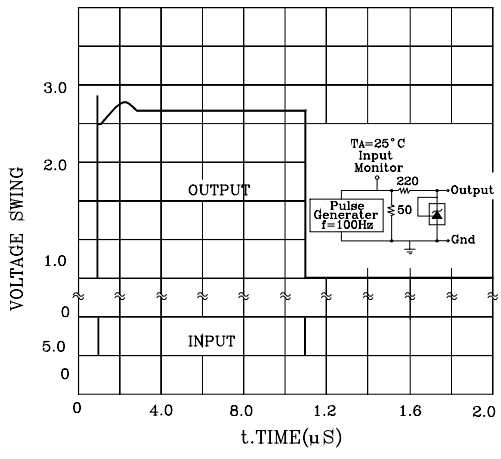


FIGURE 15 - STABILITY BOUNDARY CONDITIONS

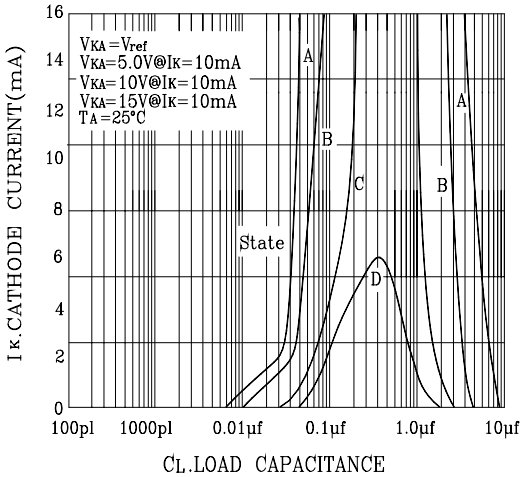


FIGURE 16-TEST CIRCUIT FOR CURVE A OF STABILITY BOUNDARY CONDITIONS

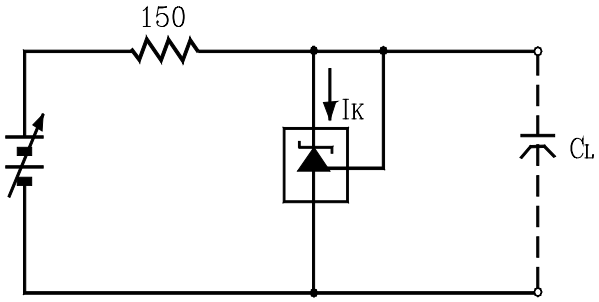


FIGURE 17-TEST CIRCUIT FOR CURVES B.C. AND D OF STABILITY BOUNDARY CONDITIONS

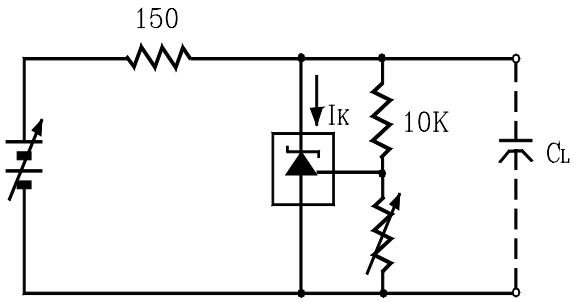
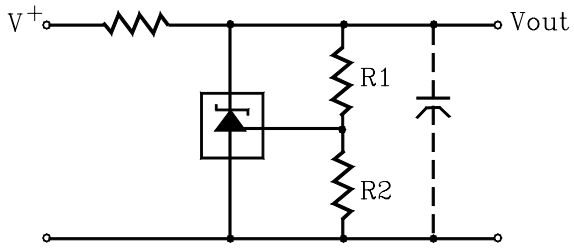
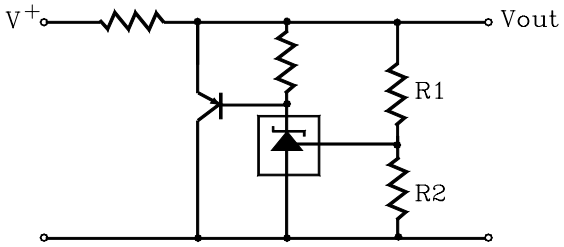


FIGURE 18-SHUNT REGULATOR



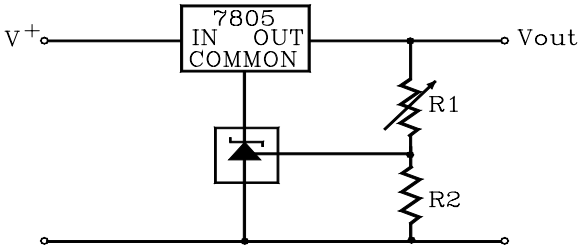
$$Vout=(1+\frac{R1}{R2})Vref$$

FIGURE 19-HIGH CURRENT SHUNT REGULATOR



$$Vout=(1+\frac{R1}{R2})Vref$$

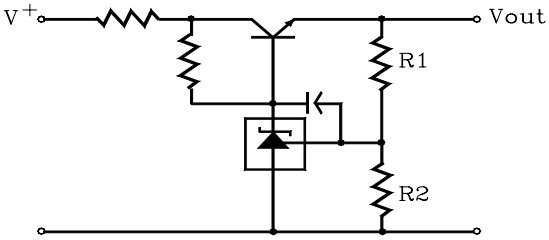
FIGURE 20-OUTPUT CONTROL OF A THREE-TERMINAL FIXED EGULATOR



$$Vout=(1+\frac{R1}{R2})Vref$$

$$Voutmin=Vref+5.0V$$

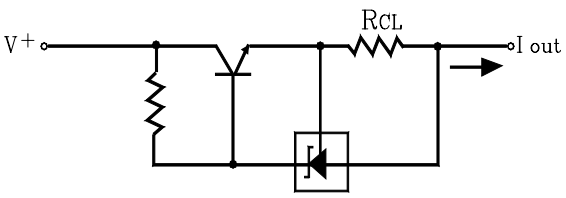
FIGURE 21-SERIES PASSEGULATOR



$$Vout=(1+\frac{R1}{R2})Vref$$

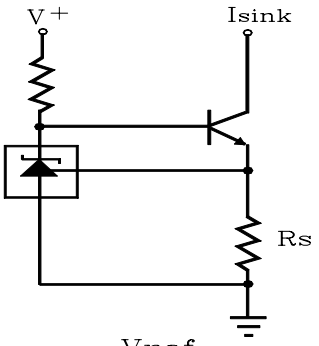
$$Voutmin=Vref+V_{BE}$$

FIGURE 22-CONSTANT CURRENT SOURCE



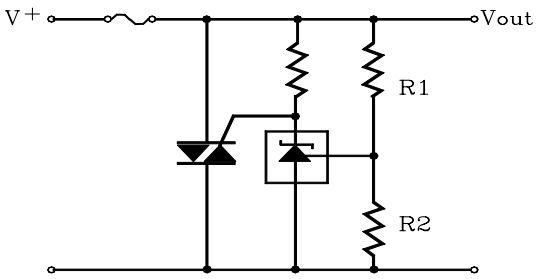
$$Iout = \frac{Vref}{RCL}$$

FIGURE 23-CONSTANT CURRENT SINK



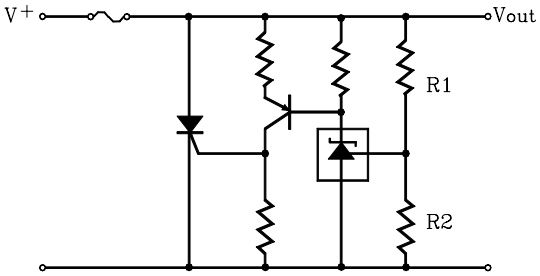
$$Isink = \frac{Vref}{Rs}$$

FIGURE 24-TRIAC CROWBAR



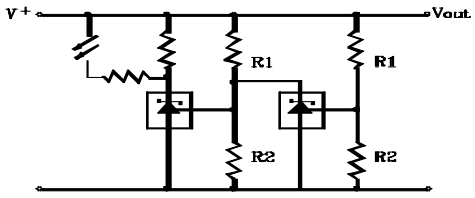
$$Vout(trip) = (1 + \frac{R1}{R2})Vref$$

FIGURE 25-SCR CROWBAR



$$Vout(trip) = (1 + \frac{R1}{R2})Vref$$

FIGURE 26-VOLTAGE MONITOR

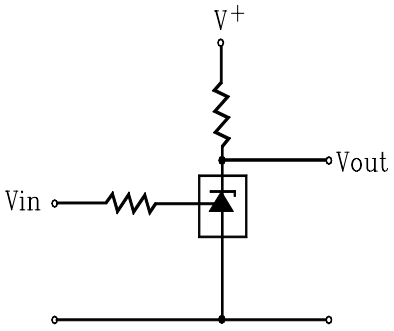


$$\text{Lower Limit} = (1 + \frac{R1}{R2})Vref$$

$$\text{Upper Limit} = (1 + \frac{R3}{R4})Vref$$

L.E.D. indicator is "on" when V+ is between the upper and lower limits.

FIGURE 27-SINGLE-SUPPLY COMPARATOR WITH TEMPERATURE-COMPENSATED THRESHOLD



Vin	Vout
<Vuref	V+
>Vuref	≈2.0V

FIGURE 28-LINER OHMMETER

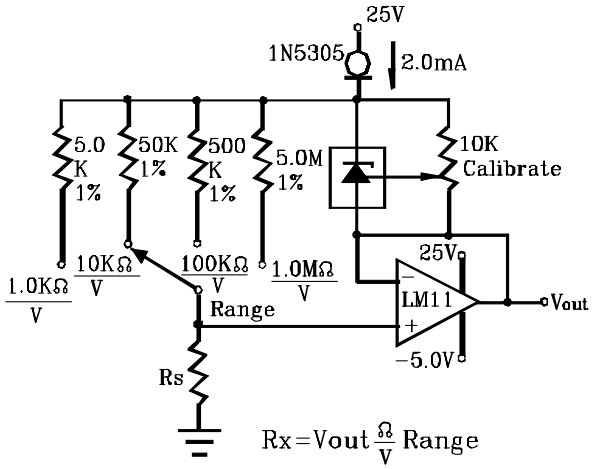


FIGURE 29-SIMPLE 400mW PHONO AMPLIFIER

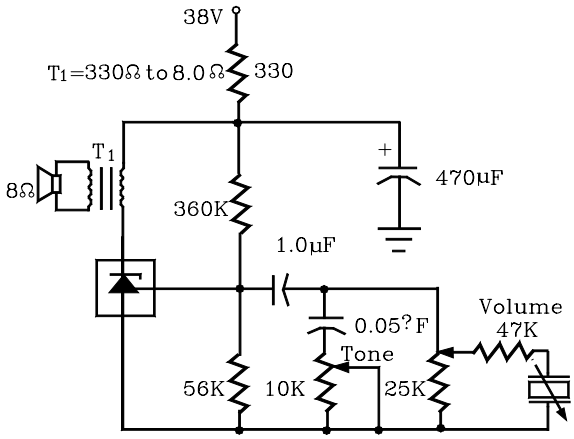
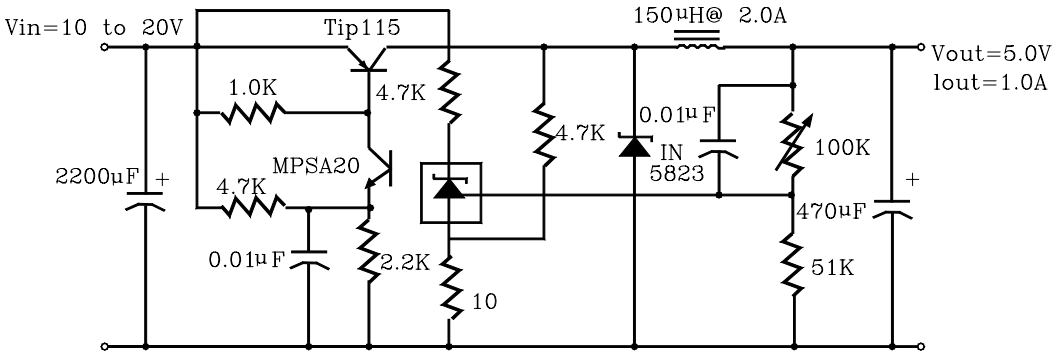


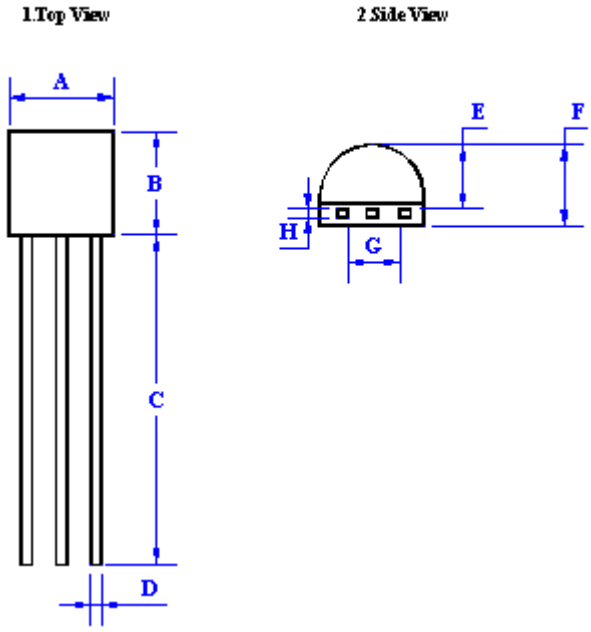
FIGURE 30-HIGH EFFICIENCY STEP-DOWN SWITCHING CONVERTER



TEST	CONDITIONS	RESULTS
Line Regulation	Vin=10V to 20V, Io=1.0A	53mV (1.1%)
Load Regulation	Vin=15V, Io=0A to 1.0A	25mV (0.5%)
Output Ripple	Vin=10V,Io=1.0A	50mVp-p P.A.R.D.
Output Ripple	Vin=20V, Io=1.0A	100mVp-p P.A.R.D.
Efficiency	Vin=15V, Io=1.0A	82%

TO-92 Mechanical drawing

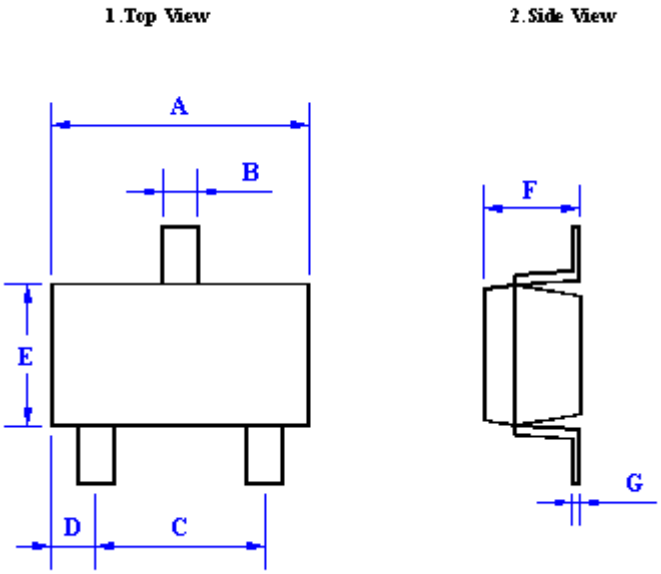
TO-92 Unit:mm



TO-92 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.3	4.7	0.169	0.185
B	4.3	4.7	0.169	0.185
C	14.3	14.3	0.563	0.563
D	0.435	0.485	0.017	0.019
E	2.19	2.81	0.086	0.111
F	3.3	3.7	0.130	0.146
G	2.42	2.66	0.095	0.105
H	0.375	0.425	0.015	0.107

SOT-23 Mechanical drawing

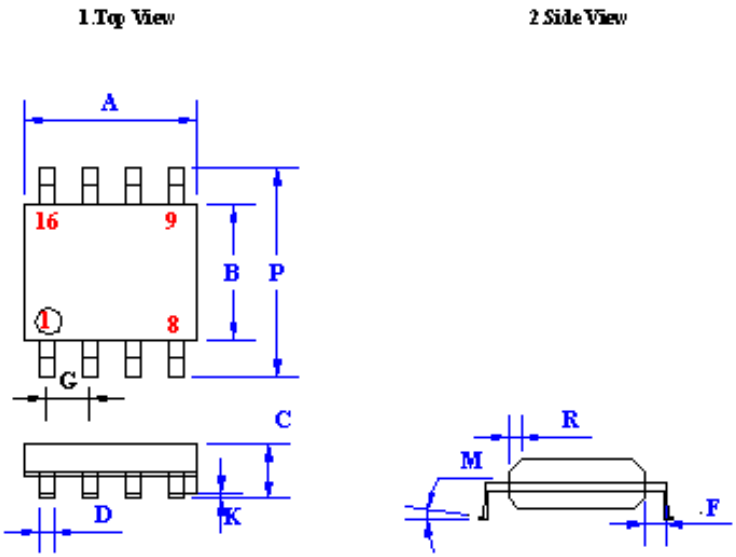
SOT-23 Unit:mm



SOT-23 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.88	2.91	0.110	0.120
B	0.39	0.42	0.014	0.018
C	1.78	2.03	0.070	0.080
D	0.51	0.61	0.020	0.024
E	1.59	1.66	0.061	0.065
F	1.04	1.08	0.038	0.049
G	0.07	0.09	0.003	0.005

SOP-8 Mechanical drawing

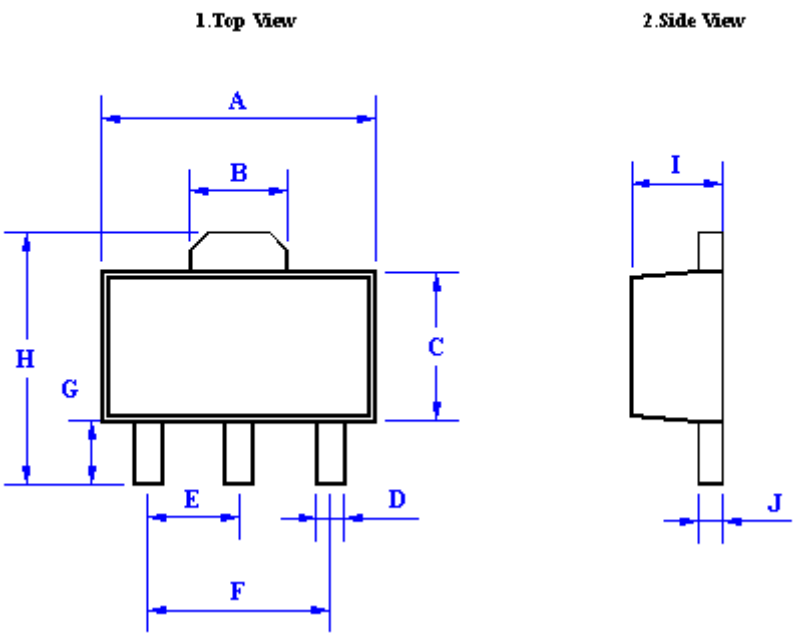
SOP-8 Unit:mm



SOP-8 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.196
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27BSC		0.05BSC	
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

SOT-89 Mechanical drawing

SOT-89 Unit:mm



SOT-89 Dimension				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.4	4.6	0.173	0.181
B	1.5	1.7	0.059	0.070
C	2.30	2.60	0.090	0.102
D	0.40	0.52	0.016	0.020
E	1.50	1.50	0.059	0.059
F	3.00	3.00	0.118	0.118
G	0.89	1.20	0.035	0.047
H	4.05	4.25	0.159	0.167
I	1.4	1.6	0.055	0.063
J	0.35	0.44	0.014	0.017