PJ1431

Programmable Precision References

The PJ1431 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 PJ1431 operates as a shunt regulator, it can be used as either a positive or negative tage reference.

FEATURES

- Programmable Output Voltage to 36 Volts
- Low Dynamic Output Impedance, 0.22 Ω Type
- 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

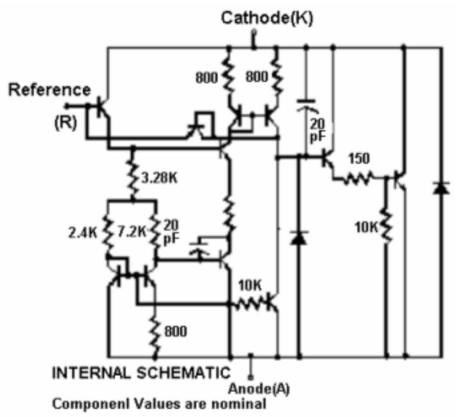
SOT-23

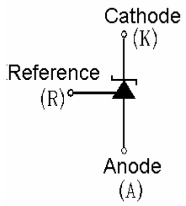
Pin: 1. Cathode
2. Reference
3. Anode

QRDERING INFORMATION

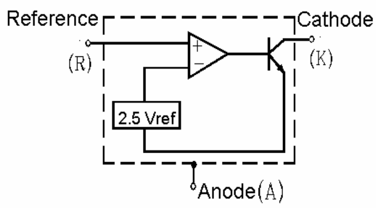
Device	Operating Temperature (Ambient)	Package
PJ1431CX	-20℃～+85℃	SOT-23

CIRCUIT SCHEMATIC





SYMBOL



FUNCTION BLOCK DIAGRAM

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℃ Derate above 25℃ Ambient Temperature PJ1431CX	P_D	0.30	W
Total Power Dissipation @ T_C = 25℃ Derate above 25℃ Case Temperature PJ1431CX	P_D	0.7	W

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

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

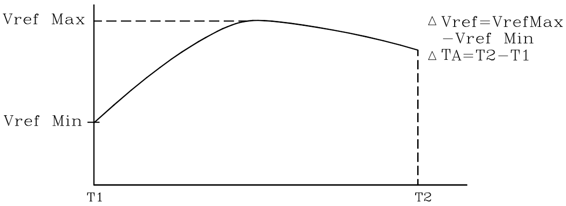
Characteristic	Symbol	PJ1431 Min	PJ1431 Typ	PJ1431 Max	Unit
Reference Input Voltage (Figure 1) $V_{KA} = V_{ref}$, I_K = 10 mA T_A = +25℃ $T_A = T_{low}$ to T_{high} (Note 1)	V_{ref}	 2.475 2.458	 2.500 --	 2.525 2.542	V
Reference Input Voltage Deviation Over Temperature Range (Figure 1, Note 1,2,4) $V_{KA} = V_{ref}$, I_K = 10 mA	$\triangle V_{ref}$	--	3.0	17	mV
Ratio of Change in Reference Input Voltage to Change in Cathode to Anode Voltage I_K = 10 mA (Figure 2), $\triangle V_{KA}$ = 10V to V_{ref} $\triangle V_{KA}$ = 36V to 10V	$\frac{\Delta V_{ref}}{\Delta V_{kA}}$	 -- --	 - 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 = ∞	$\triangle I_{ref}$	--	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) $V_{KA} = V_{ref}$, $\triangle I_K$ = 1.0 mA to 100 mA, f ≤1.0 kHz	$\lvert Z_{ke} \rvert$	--	0.22	0.5	Ω

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 :

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

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℃

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

3

The dynamic impedance Z_{ka} is defined as:

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

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:

$$|Z_{ka}| \approx |Z_{ka}|\left(1+\frac{R_1}{R_2}\right)$$

4

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

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

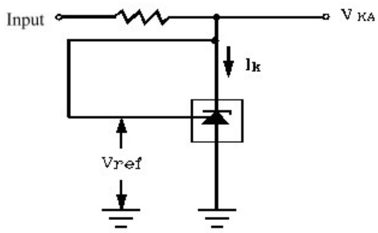
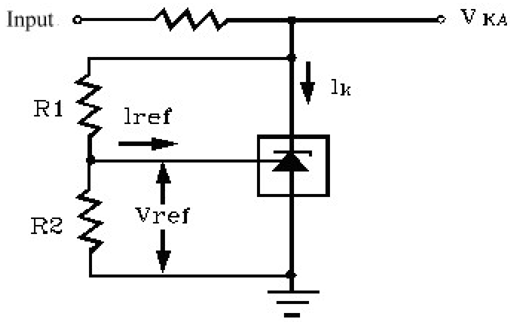


FIGURE 2 -- TEST CIRCUIT FOR V_{KA} > V_{ref}



$$V_{kA} = V_{ref}\left(1+\frac{R_1}{R_2}\right)+I_{ref}\bullet R_1$$

FIGURE 3 -- TEST CIRCUIT FOR I_{off}

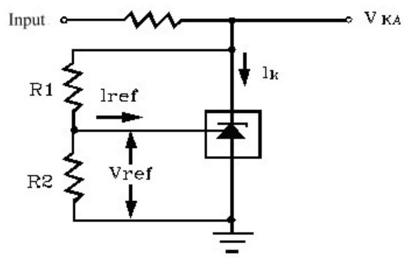


FIGURE 4-CATHODE CURRENT versus CATHODE VOLTAGE

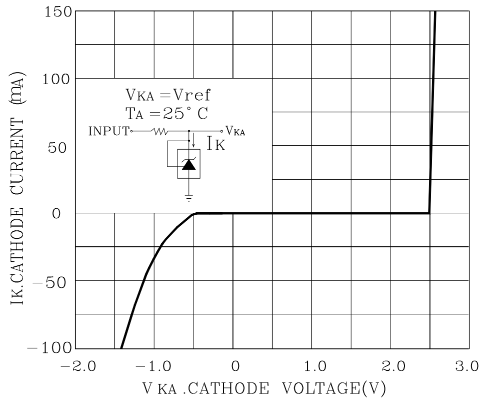


FIGURE 5-CATHODE CURRENT versus CATHODE VOLTAGE

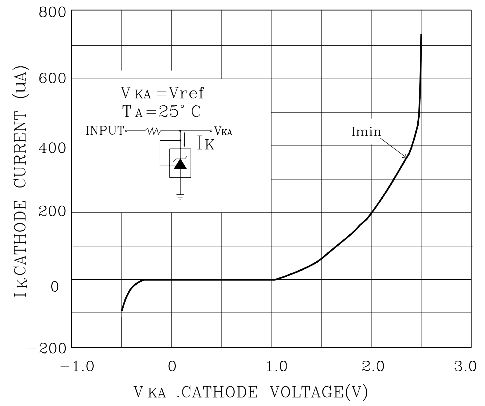


FIGURE 6-REFERENCE INPUT VOLTAGE versus AMBIENT TEMPERATURE

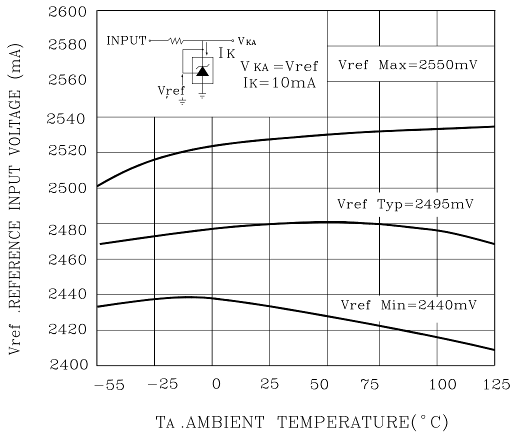


FIGURE 7-REFERENCE INPUT CURRENT versus AMBIENT TEMPERATURE

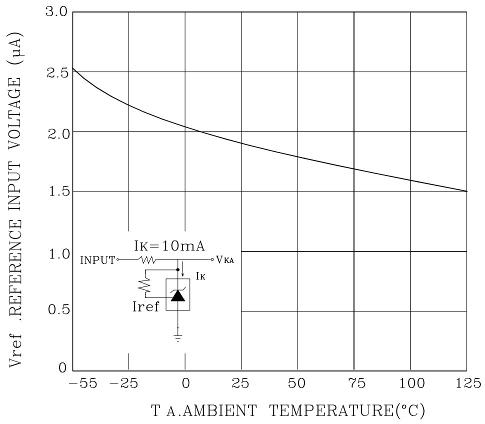


FIGURE 8-CHANGE IN REFERENCE INPUT VOLTAGE versus CATHODE VOLTAGE

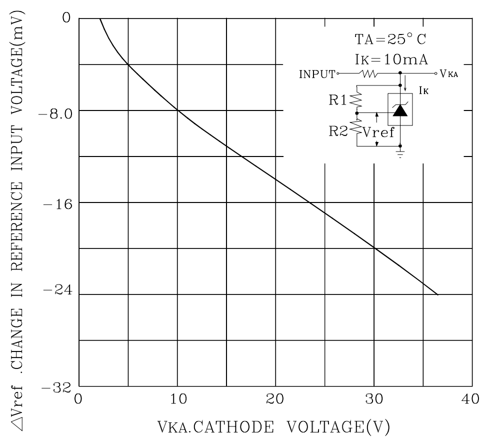


FIGURE 9 –OFF.STATE CATHODE CURRENT versus AMBIENT TEMPERATURE

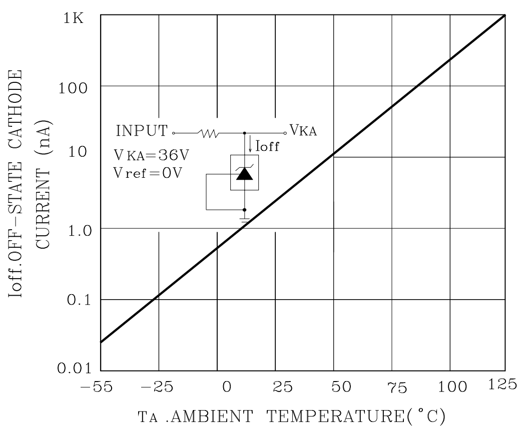


FIGURE 10 - DYNAMIC IMPEDANCE VERSUS FREQUENCY

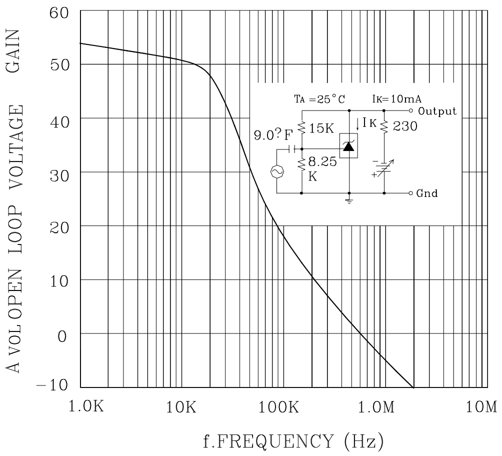


FIGURE 11 - DYNAMIC IMPEDANCE VERSUS AMBIENT TEMPERATURE

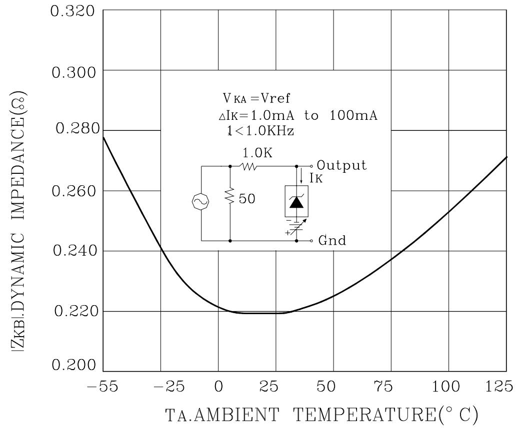


FIGURE 12 - OPEN LOOP VOLTAGE GAIN VERSUS FREQUENCY

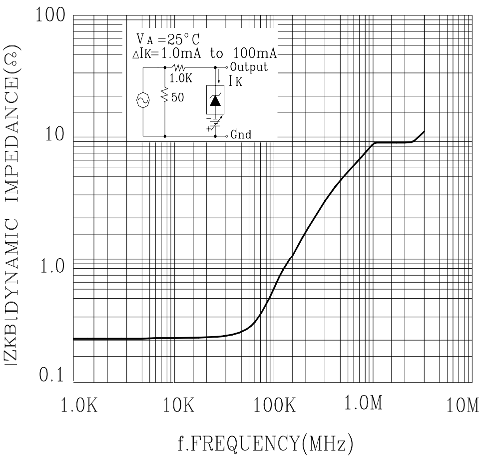


FIGURE 13 - SPECTRAL NOISE DENSITY

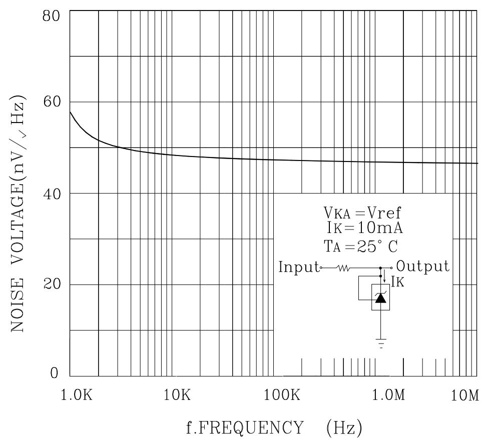


FIGURE 14 - PULSE RESPONSE

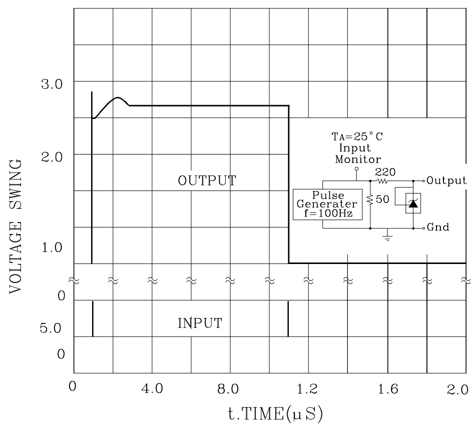


FIGURE 15 - STABILITY BOUNDARY CONDITIONS

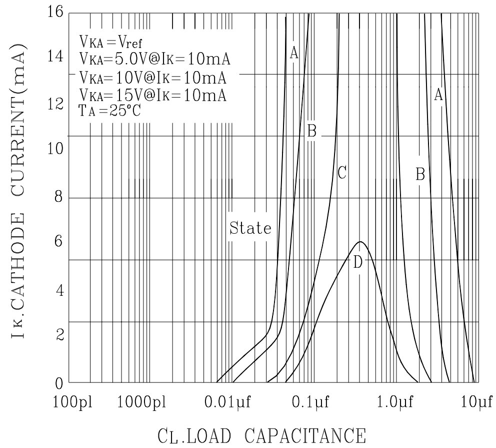


FIGURE 16-TEST CIRCUIT FOR CURVE A OF STABILITY BOUNDARY CONDITIONS

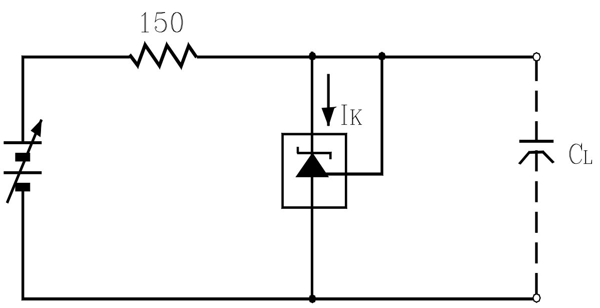


FIGURE 17-TEST CIRCUIT FOR CURVES B.C. AND D OF STABILITY BOUNDARY CONDITIONS

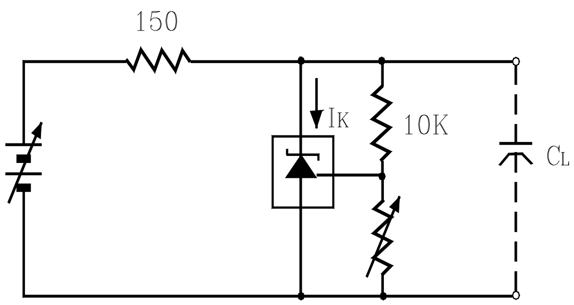
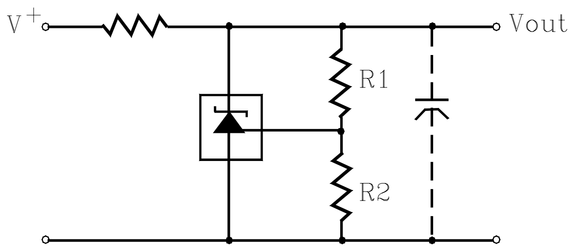
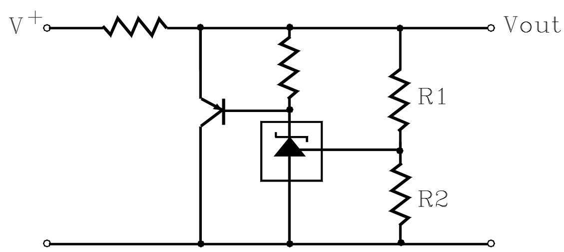


FIGURE 18-SHUNT REGULATOR



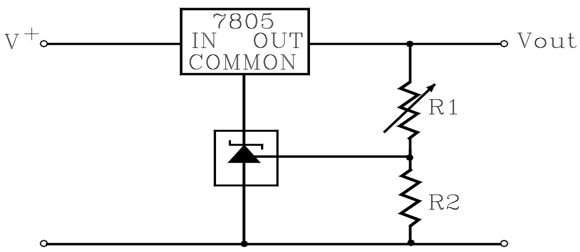
$$V_{out}=(1+\frac{R1}{R2})V_{ref}$$

FIGURE 19-HIGH CURRENT SHUNT REGULATOR



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

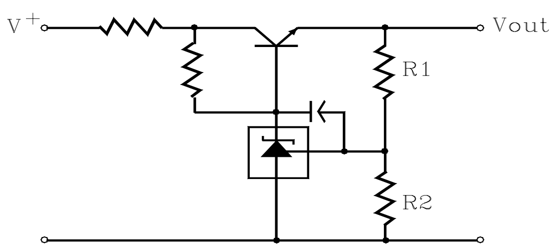
FIGURE 20-OUTPUT CONTROL OF A THREE-TERMINAL FIXED EGULATOR



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

$$V_{outmin}=V_{ref}+5.0V$$

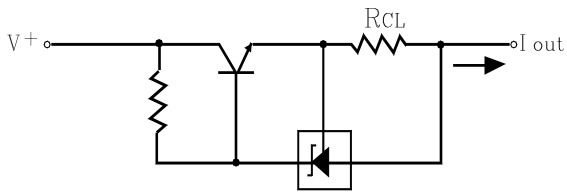
FIGURE 21-SERIES PASSEGULATOR



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

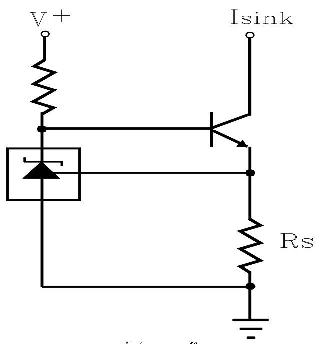
$$V_{outmin}=V_{ref}+V_{BE}$$

FIGURE 22-CONSTANT CURRENT SOURCE



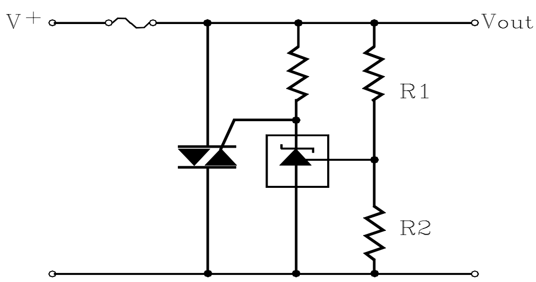
$$I_{out} = \frac{V_{ref}}{R_{CL}}$$

FIGURE 23-CONSTANT CURRENT SINK



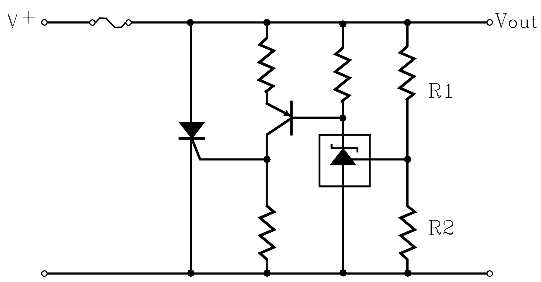
$$I_{sink} = \frac{V_{ref}}{R_s}$$

FIGURE 24-TRIAC CROWBAR



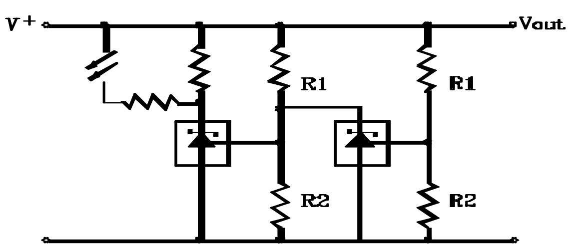
$$V_{out(trip)} = \left(1 + \frac{R1}{R2}\right)V_{ref}$$

FIGURE 25-SCR CROWBAR



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

FIGURE 26-VOLTAGE MONITOR

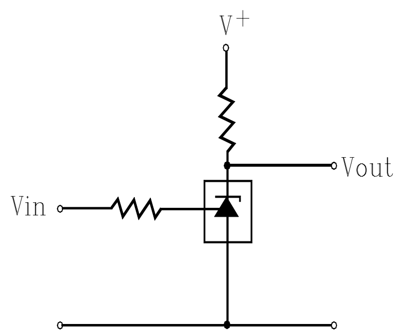


$$\text{Lower Limit} = \left(1 + \frac{R1}{R2}\right)V_{ref}$$

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

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

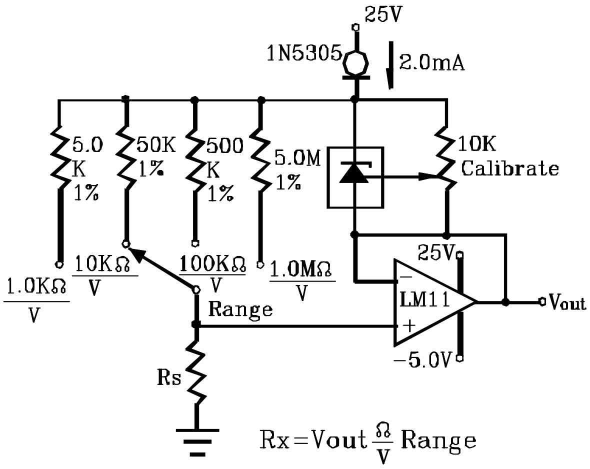


FIGURE 29-SIMPLE 400mW PHONO AMPLIFIER

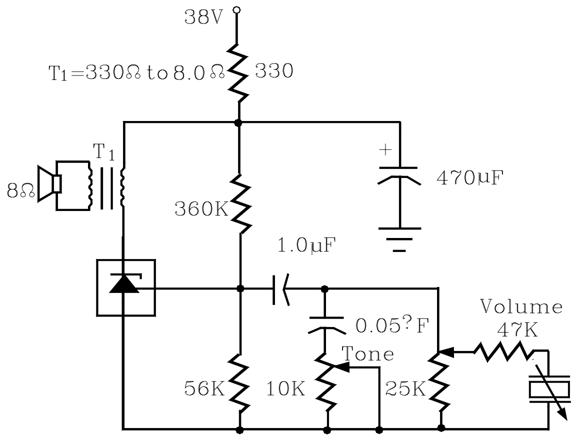
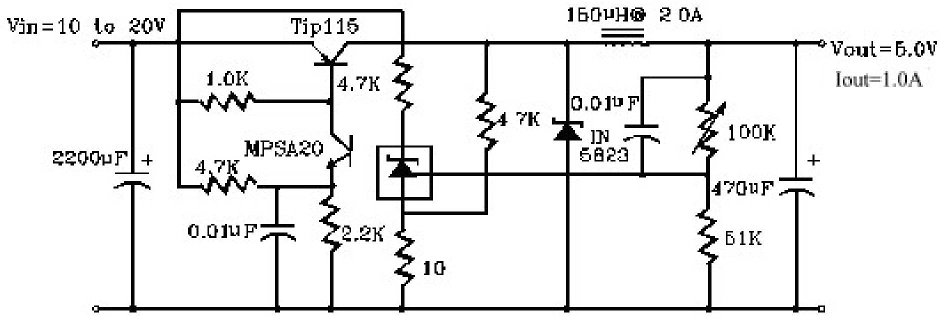
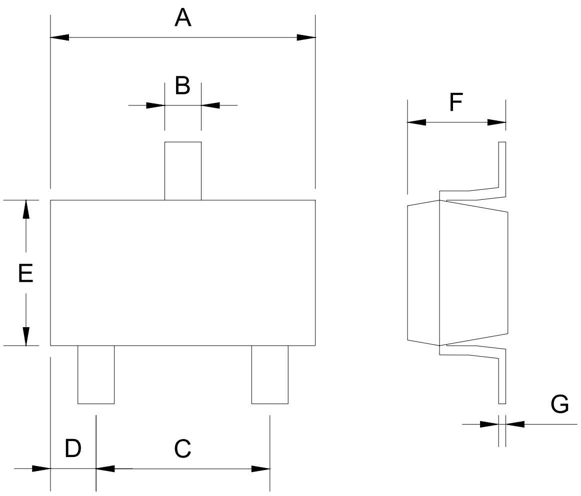


FIGURE 30-HIGH EFFICIENCY STEP-DOWN SWITCHING CONVERTER



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%



SOT-23 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.88	2.91	0.113	0.115
B	0.39	0.42	0.015	0.017
C	1.78	2.03	0.070	0.080
D	0.51	0.61	0.020	0.024
E	1.59	1.66	0.063	0.065
F	1.04	1.08	0.041	0.043
G	0.07	0.09	0.003	0.004