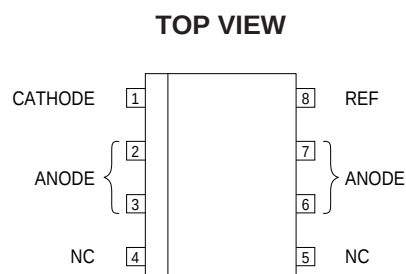


J Package – 8 Pin Ceramic DIP
N Package – 8 Pin Plastic DIP



D Package – 8 Pin Plastic (150) SOIC

* Note that the SOIC package used for the IP431A has a modified lead frame to increase power dissipation capability when appropriately mounted on a PCB.

PROGRAMMABLE PRECISION REFERENCE

FEATURES

- VOLTAGE REFERENCE TOLERANCE $\pm 1\%$
- PROGRAMMABLE OUTPUT VOLTAGE TO 36V
- EQUIVALENT FULL RANGE TEMPERATURE COEFFICIENT OF 30ppm/°C TYPICAL
- TEMPERATURE COMPENSATED FOR OPERATION OVER FULL RATED OPERATING TEMPERATURE RANGE
- SINK CURRENT CAPABILITY 1 TO 100 mA
- FAST TURN-ON RESPONSE
- LOW DYNAMIC OUTPUT IMPEDANCE (0.2Ω typical)
- LOW OUTPUT NOISE VOLTAGE
- ALSO AVAILABLE IN TO-92 PACKAGE

Part Number	J-Pack 8 Pin	N-Pack 8 Pin	D-Pack 8 Pin	Amb. Temp. Range	Note: To order, add the package identifier to the part number. eg. IP431AMJ IP431ACD
IP431AM	✓			-55 to +125°C	
IP431AI	✓	✓	✓	-40 to +85°C	
IP431AC	✓	✓	✓	0 to +70°C	

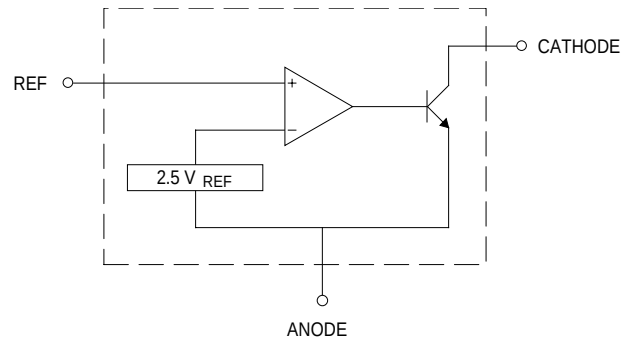
ABSOLUTE MAXIMUM RATINGS ($T_{case} = 25^{\circ}\text{C}$ unless otherwise stated)

V_{KA}	Cathode To Anode Voltage		37V
I_K	Cathode Current Range		-100 to +150mA
I_{REF}	Reference Input Current Range		-0.05 to +10mA
P_D	Power Dissipation @ $T_A = 25^{\circ}\text{C}$	D Package N Package J Package	0.70W 1.10W 1.25W
	Derate Above 25°C		6mW/°C
P_D	Power Dissipation @ $T_C = 25^{\circ}\text{C}$	D Package N Package J Package	1.5W 3W 3.3W
T_J	Maximum Operating Junction Temperature		150°C
T_A	Operating Ambient Temperature Range		See Table Above
T_{STG}	Storage Temperature Range		-65 to 150°C

DESCRIPTION

The IP431A circuit is a monolithic three terminal programmable shunt regulator diode. The voltage reference operates as a low temperature coefficient zener which is programmable between V_{REF} (2.5V) and 36 volts using two external resistors. The device has a wide operating current range of 1 mA to 100mA and a typical dynamic impedance of 0.2 Ω . Active output circuitry provides a very sharp turn-on characteristic making these devices excellent replacements for zener diodes in many applications. Being a shunt regulator it can be used as either a positive or negative voltage reference.

BLOCK DIAGRAM



RECOMMENDED OPERATING CONDITIONS

V_{KA}	Cathode To Anode Voltage	V_{REF} to 36V
I_K	Cathode Current Range	1.0 to 100mA

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise stated)

Parameter	Test Conditions	IP431AM			Units
		Min.	Typ.	Max.	
V_{REF} Reference Input Voltage (Figure 1)	$V_{KA} = V_{REF}$ $I_K = 10\text{mA}$ $T_A = -55 \text{ to } +125^\circ\text{C}^*$	2.47 2.426	2.495	2.52 2.564	V
ΔV_{REF} Reference Input Voltage Over Temperature Range ¹ (Figure 1)	$V_{KA} = V_{REF}$ $I_K = 10\text{mA}$ $T_A = -55 \text{ to } +125^\circ\text{C}^*$		15	44	mV
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$ Ratio of Reference Voltage Change to Change in Cathode to Anode Voltage (Figure 2)	$I_K = 10\text{mA}$ $\Delta V_{KA} = 10\text{V to } V_{REF}$ $\Delta V_{KA} = 36\text{V to } 10\text{V}$		-1.5 -0.7	-2.7 -2	mV/V
I_{REF} Reference Input Current (Figure 2)	$R1 = 10\text{k}\Omega$ $R2 = \infty$ $I_K = 10\text{mA}$ $T_A = -55 \text{ to } +125^\circ\text{C}^*$		1	4 7	μA
ΔI_{REF} Reference Input Current Deviation Over Temperature Range (Figure 2)	$R1 = 10\text{k}\Omega$ $R2 = \infty$ $I_K = 10\text{mA}$ $T_A = -55 \text{ to } +125^\circ\text{C}^*$		1	3	μA
I_{MIN} Minimum Cathode Current For Regulation (Figure 1)	$V_{KA} = V_{REF}$		0.5	1	mA
I_{OFF} Off-State Cathode Current (Figure 3)	$V_{KA} = 36\text{V}$ $V_{REF} = 0$		3	1000	nA
$ Z_{ka} $ Dynamic Impedance ² (Figure 1)	$V_{KA} = V_{REF}$ $f \leq 1\text{kHz}$ $\Delta I_K = 1\text{mA to } 100\text{mA}$		0.2	0.5	Ω

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

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise stated)

Parameter		Test Conditions		IP431AI			Units
				Min.	Typ.	Max.	
V _{REF}	Reference Input Voltage (Figure 1)	V _{KA} = V _{REF} I _K = 10mA	T _A = -40 to +85°C *	2.47 2.44	2.495	2.52 2.55	V
ΔV _{REF}	Reference Input Voltage Over Temperature Range ¹ (Figure 1)	V _{KA} = V _{REF} I _K = 10mA	T _A = -40 to +85°C *		7	30	mV
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	Ratio of Reference Voltage Change to Change in Cathode to Anode Voltage (Figure 2)	I _K = 10mA	ΔV _{KA} = 10V to V _{REF} ΔV _{KA} = 36V to 10V		-1.5 -0.7	-2.7 -2	mV/V
I _{REF}	Reference Input Current (Figure 2)	R1 = 10kΩ I _K = 10mA	R2 = ∞ T _A = -40 to +85°C *		1	4 6.5	μA
ΔI _{REF}	Reference Input Current Deviation Over Temperature Range (Figure 2)	R1 = 10kΩ I _K = 10mA	R2 = ∞ T _A = -40 to +85°C *		0.8	2.5	μA
I _{MIN}	Minimum Cathode Current For Regulation (Figure 1)	V _{KA} = V _{REF}			0.5	1	mA
I _{OFF}	Off-State Cathode Current (Figure 3)	V _{KA} = 36V	V _{REF} = 0		3	1000	nA
Z _{ka}	Dynamic Impedance ² (Figure 1)	V _{KA} = V _{REF} ΔI _K = 1mA to 100mA	f ≤ 1kHz		0.2	0.5	Ω

Parameter		Test Conditions		IP431AC			Units
				Min.	Typ.	Max.	
V _{REF}	Reference Input Voltage (Figure 1)	V _{KA} = V _{REF} I _K = 10mA	T _A = 0 to +70°C *	2.47 2.453	2.495	2.52 2.537	V
ΔV _{REF}	Reference Input Voltage Over Temperature Range ¹ (Figure 1)	V _{KA} = V _{REF} I _K = 10mA	T _A = 0 to +70°C *		3	17	mV
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	Ratio of Reference Voltage Change to Change in Cathode to Anode Voltage (Figure 2)	I _K = 10mA	ΔV _{KA} = 10V to V _{REF} ΔV _{KA} = 36V to 10V		-1.5 -0.7	-2.7 -2	mV/V
I _{REF}	Reference Input Current (Figure 2)	R1 = 10kΩ I _K = 10mA	R2 = ∞ T _A = 0 to +70°C *		1	4 5.2	μA
ΔI _{REF}	Reference Input Current Deviation Over Temperature Range (Figure 2)	R1 = 10kΩ I _K = 10mA	R2 = ∞ T _A = 0 to +70°C *		0.4	1.2	μA
I _{MIN}	Minimum Cathode Current For Regulation (Figure 1)	V _{KA} = V _{REF}			0.5	1	mA
I _{OFF}	Off-State Cathode Current (Figure 3)	V _{KA} = 36V	V _{REF} = 0		3	1000	nA
Z _{ka}	Dynamic Impedance ² (Figure 1)	V _{KA} = V _{REF} ΔI _K = 1mA to 100mA	f ≤ 1kHz		0.2	0.5	Ω

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

FIGURE 1

TEST CIRCUIT FOR $V_{KA} = V_{REF}$

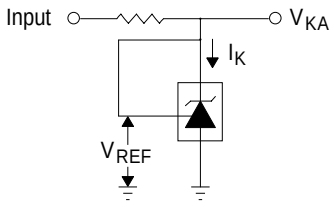
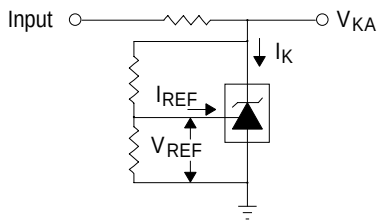


FIGURE 2

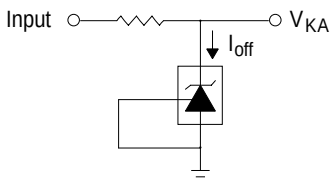
TEST CIRCUIT FOR $V_{KA} > V_{REF}$



$$V_{KA} = V_{REF} \left(1 + \frac{R1}{R2} \right) + I_{REF} \times R1$$

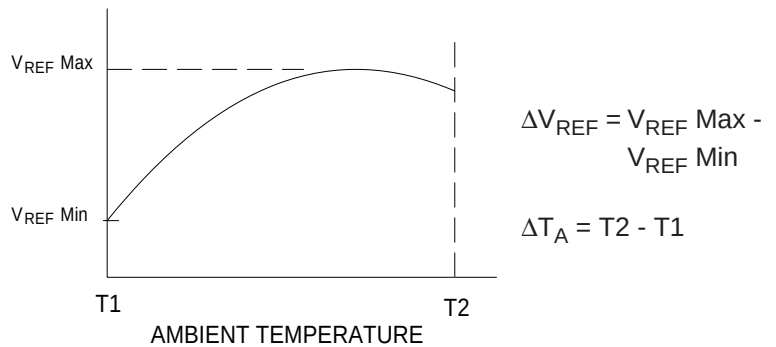
FIGURE 3

TEST CIRCUIT FOR I_{off}



NOTE 1

The deviation parameter ΔV_{REF} is defined as the differences between the maximum and minimum values obtained over the full operating ambient temperature range that applies.



The average temperature coefficient of the reference input voltage, $\propto V_{REF}$ is defined as:

$$\propto V_{REF} = \frac{\text{ppm}}{^{\circ}\text{C}} = \frac{\left(\frac{\Delta V_{REF}}{V_{REF} @ 25^{\circ}\text{C}} \right) \times 10^6}{\Delta T_A} = \frac{\Delta V_{REF} \times 10^6}{\Delta T_A (V_{REF} @ 25^{\circ}\text{C})}$$

$\propto V_{REF}$ can be positive or negative depending on whether $\propto V_{REF} \text{ Min}$ or $\propto V_{REF} \text{ Max}$ occurs at the lower ambient temperature.

Example: $\Delta V_{REF} = 8.0 \text{ mV}$ and slope is positive,
 $V_{REF} @ 25^{\circ}\text{C} = 2.495\text{V}$, $\Delta T_A = 70^{\circ}\text{C}$

$$\propto V_{REF} = \frac{0.008 \times 10^6}{70 (2.495)} = 45.8 \text{ ppm}/^{\circ}\text{C}$$

NOTE 2

The dynamic impedance Z_{ka} is defined as:

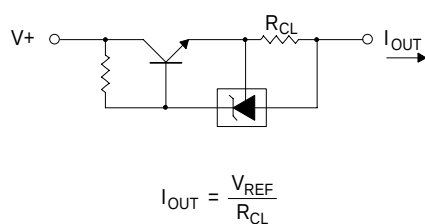
$$|Z_{ka}| = \frac{\Delta V_{KA}}{\Delta I_K}$$

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:

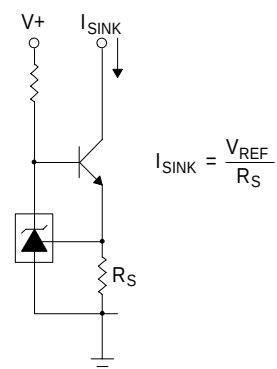
$$|Z_{ka}| \approx |Z_{ka}| \left(1 + \frac{R1}{R2} \right)$$

TYPICAL APPLICATIONS

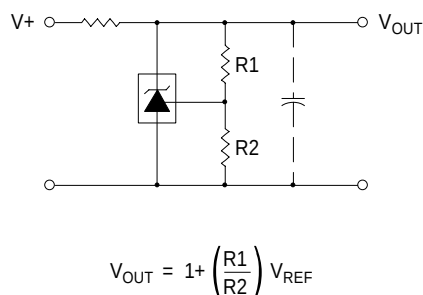
CONSTANT CURRENT SOURCE



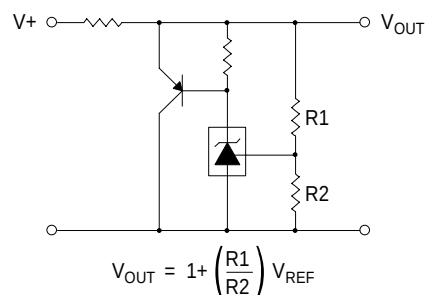
CONSTANT CURRENT SINK



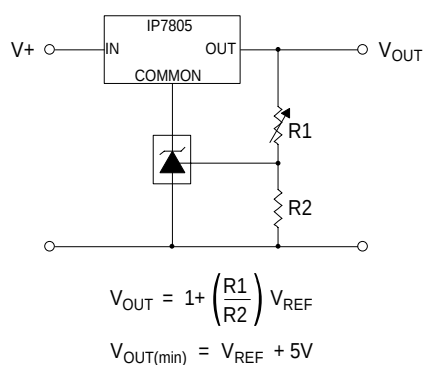
SHUNT REGULATOR



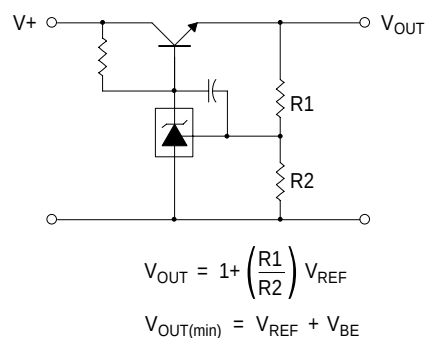
HIGH CURRENT SHUNT REGULATOR



OUTPUT CONTROL OF A THREE-TERMINAL FIXED REGULATOR

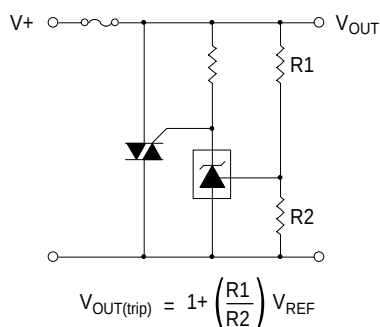


SERIES PASS REGULATOR

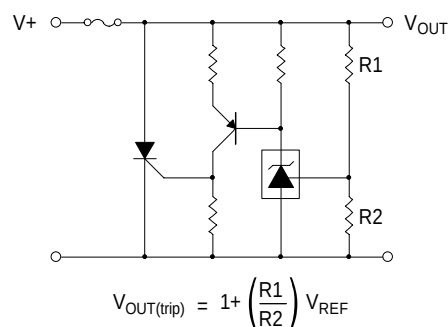


TYPICAL APPLICATIONS

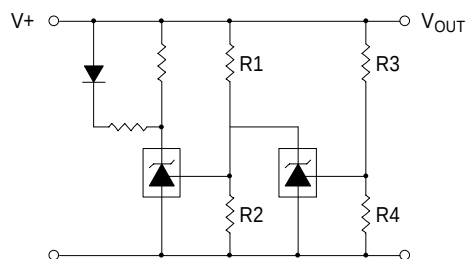
TRIAC CROWBAR



THYRISTOR CROWBAR



VOLTAGE MONITOR

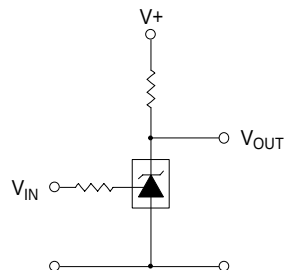


LED is 'on' when V+ is between the upper and lower limits.

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

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

SINGLE SUPPLY COMPARATOR WITH TEMPERATURE COMPENSATED THRESHOLD



$$V_{TH} = V_{REF}$$

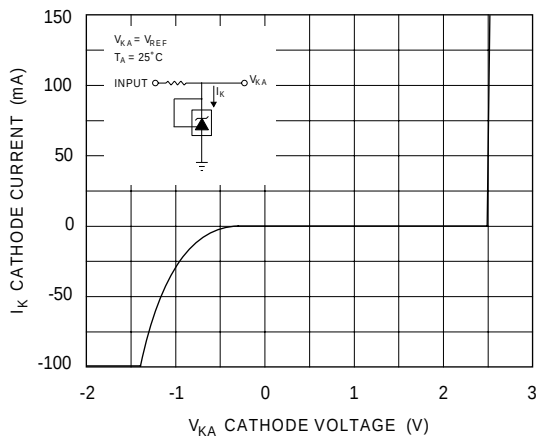
V _{IN}	V _{OUT}
< V _{REF}	V+
> V _{REF}	= 2.0 V

THERMAL CHARACTERISTICS

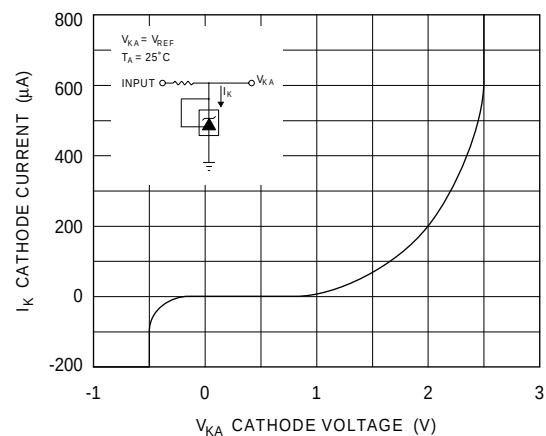
R _{θJA}	Thermal Resistance, Junction – Ambient	D Package	178°C/W
		N Package	114°C/W
		J Package	100°C/W
R _{θJC}	Thermal Resistance, Junction – Case	D Package	83°C/W
		N Package	41°C/W
		J Package	38°C/W

TYPICAL PERFORMANCE CHARACTERISTICS

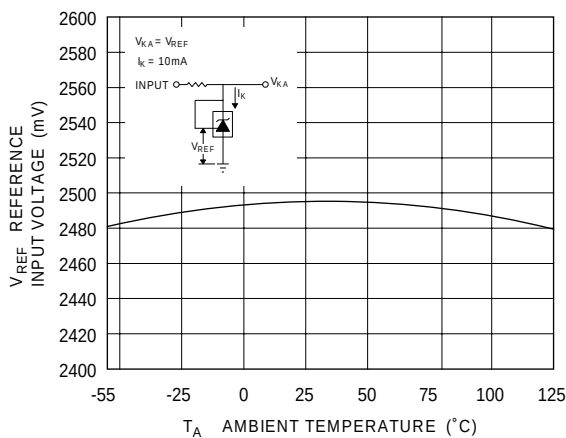
CATHODE CURRENT vs CATHODE VOLTAGE



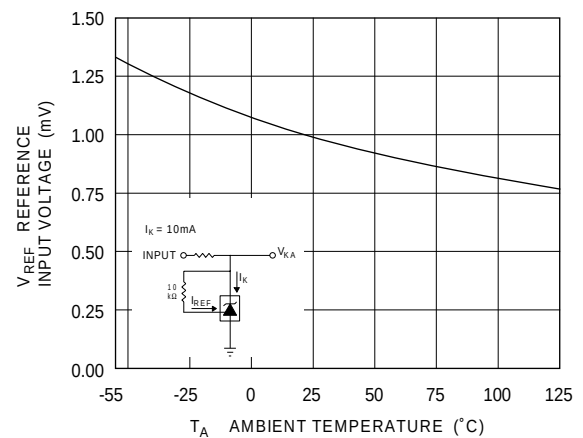
CATHODE CURRENT vs CATHODE VOLTAGE



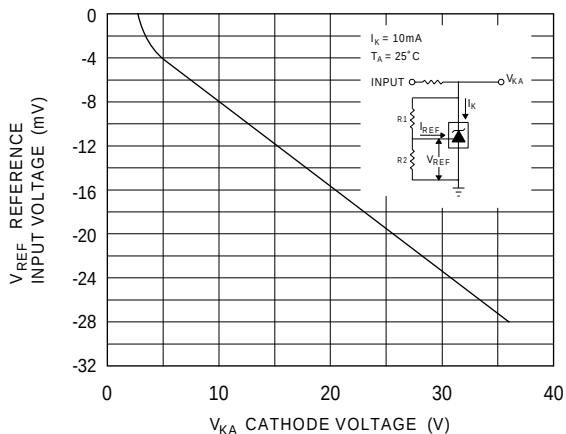
REFERENCE INPUT VOLTAGE vs AMBIENT TEMPERATURE



REFERENCE INPUT CURRENT vs AMBIENT TEMPERATURE



CHANGE IN REFERENCE INPUT VOLTAGE vs AMBIENT TEMPERATURE



OFF-STATE CATHODE CURRENT vs AMBIENT TEMPERATURE

