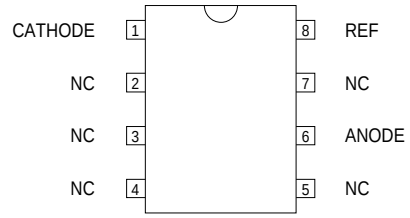
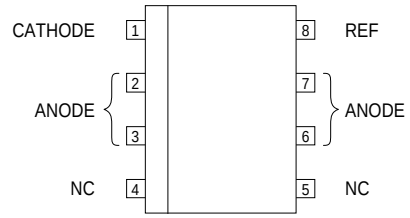
IP431A Series

TOP VIEW



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

TOP VIEW



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 ±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
IP431AM	✔			-55 to +125°C
IP431AI	✔	✔	✔	-40 to +85°C
IP431AC	✔	✔	✔	0 to +70°C

Note:
To order, add the package identifier to the part number.
eg. IP431AMJ
IP431ACD

ABSOLUTE MAXIMUM RATINGS (T_{case} = 25°C unless otherwise stated)

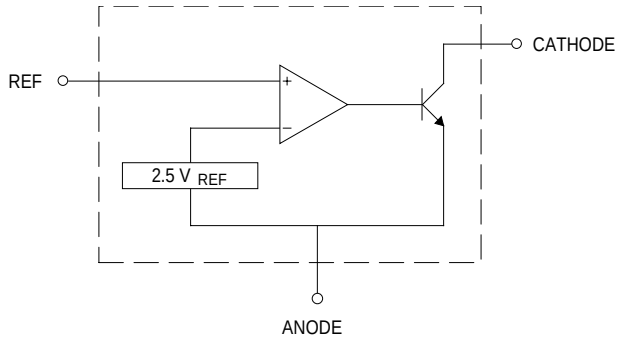
V_{KA}	Cathode To Anode Voltage		37V
I_K	Cathode Current Range		-100 to +150mA
I_{REF}	Reference Input Current Range		-0.05 to +10mA
P_D	Power Dissipation @ T_A = 25°C	D Package	0.70W
		N Package	1.10W
		J Package	1.25W
	Derate Above 25°C		6mW/°C
P_D	Power Dissipation @ T_C = 25°C	D Package	1.5W
		N Package	3W
		J Package	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

IP431A Series

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 0.2Ω. 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 °C unless otherwise stated)

	Parameter	Test Conditions		IP431AM Min.	IP431AM Typ.	IP431AM Max.	Units
V_{REF}	Reference Input Voltage (Figure 1)	$V_{KA} = V_{REF}$		2.47	2.495	2.52	V
		I_K = 10mA	T_A = -55 to +125°C *	2.426		2.564	
ΔV_{REF}	Reference Input Voltage Over Temperature Range [1] (Figure 1)	$V_{KA} = V_{REF}$					
		I_K = 10mA	T_A = -55 to +125°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 = 10mA	ΔV_{KA} = 10V to V_{REF}		-1.5	-2.7	mV/V
			ΔV_{KA} = 36V to 10V		-0.7	-2	
I_{REF}	Reference Input Current (Figure 2)	R1 = 10kΩ	R2 = ∞		1	4	µA
		I_K = 10mA	T_A = -55 to +125°C *			7	
ΔI_{REF}	Reference Input Current Deviation Over Temperature Range (Figure 2)	R1 = 10kΩ	R2 = ∞		1	3	µA
		I_K = 10mA	T_A = -55 to +125°C *				
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)	$V_{KA} = V_{REF}$	f ≤ 1kHz		0.2	0.5	Ω
		ΔI_K = 1mA to 100mA					

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

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

	Parameter	Test Conditions	IP431AI Min.	IP431AI Typ.	IP431AI Max.	Units
V_{REF}	Reference Input Voltage (Figure 1)	$V_{KA} = V_{REF}$	2.47	2.495	2.52	V
		I_K = 10mA, T_A = -40 to +85°C *	2.44		2.55	
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}		-1.5	-2.7	mV/V
		I_K = 10mA, ΔV_{KA} = 36V to 10V		-0.7	-2	
I_{REF}	Reference Input Current (Figure 2)	R1 = 10kΩ, R2 = ∞		1	4	µA
		I_K = 10mA, T_A = -40 to +85°C *			6.5	
ΔI_{REF}	Reference Input Current Deviation Over Temperature Range (Figure 2)	R1 = 10kΩ, R2 = ∞, I_K = 10mA, 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)	$V_{KA} = V_{REF}$, f ≤ 1kHz, ΔI_K = 1mA to 100mA		0.2	0.5	Ω

	Parameter	Test Conditions	IP431AC Min.	IP431AC Typ.	IP431AC Max.	Units
V_{REF}	Reference Input Voltage (Figure 1)	$V_{KA} = V_{REF}$	2.47	2.495	2.52	V
		I_K = 10mA, T_A = 0 to +70°C *	2.453		2.537	
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}		-1.5	-2.7	mV/V
		I_K = 10mA, ΔV_{KA} = 36V to 10V		-0.7	-2	
I_{REF}	Reference Input Current (Figure 2)	R1 = 10kΩ, R2 = ∞		1	4	µA
		I_K = 10mA, T_A = 0 to +70°C *			5.2	
ΔI_{REF}	Reference Input Current Deviation Over Temperature Range (Figure 2)	R1 = 10kΩ, R2 = ∞, I_K = 10mA, 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)	$V_{KA} = V_{REF}$, f ≤ 1kHz, ΔI_K = 1mA to 100mA		0.2	0.5	Ω

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

FIGURE 1

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

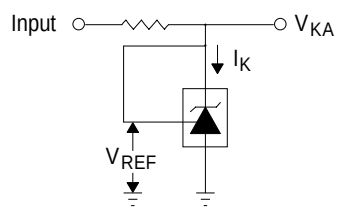
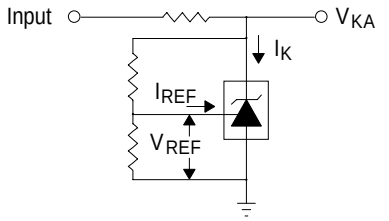


FIGURE 2

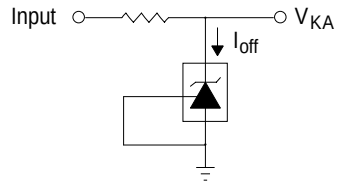
TEST CIRCUIT FOR $V_{KA} > V_{REF}$



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

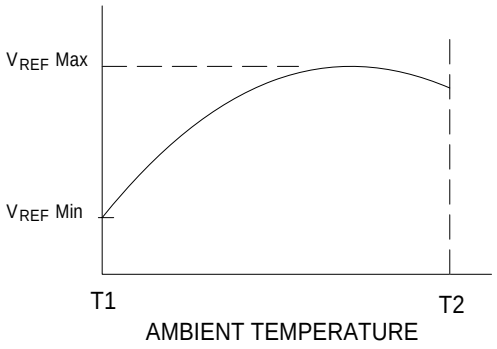
FIGURE 3

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.



$\Delta V_{REF} = V_{REF}$ Max - V_{REF} Min

$\Delta T_A = T2 - T1$

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

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

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

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

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

NOTE 2

The dynamic impedance Z_{ka} is defined as:

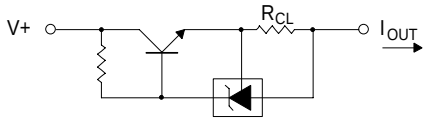
$$|Z_{ka}| = \frac{\Delta V_{KA}}{\Delta I_K}$$

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:

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

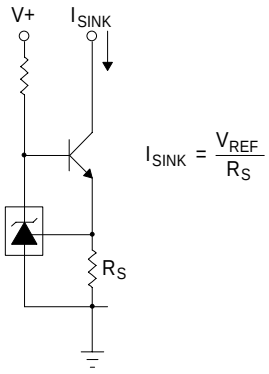
TYPICAL APPLICATIONS

CONSTANT CURRENT SOURCE

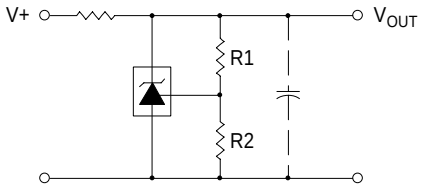


$$I_{OUT} = \frac{V_{REF}}{R_{CL}}$$

CONSTANT CURRENT SINK

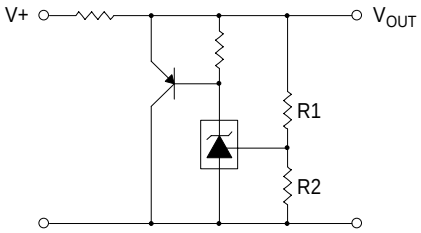


SHUNT REGULATOR



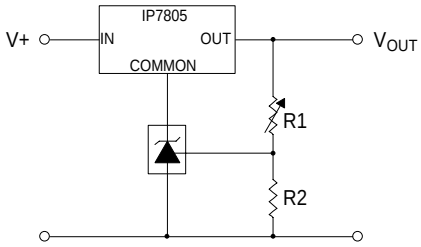
$$V_{OUT} = 1+ \left(\frac{R1}{R2}\right) V_{REF}$$

HIGH CURRENT SHUNT REGULATOR



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

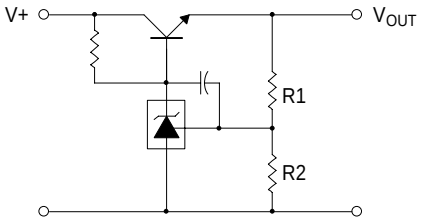
OUTPUT CONTROL OF A THREE-TERMINAL FIXED REGULATOR



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

$$V_{OUT(min)} = V_{REF} + 5V$$

SERIES PASS REGULATOR

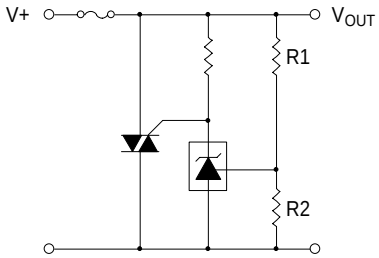


$$V_{OUT} = 1+ \left(\frac{R1}{R2}\right) V_{REF}$$

$$V_{OUT(min)} = V_{REF} + V_{BE}$$

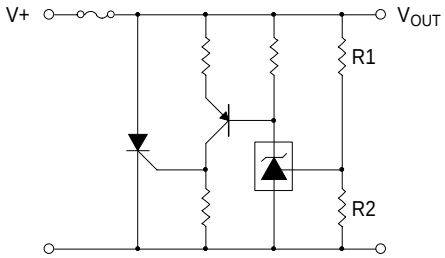
TYPICAL APPLICATIONS

TRIAC CROWBAR



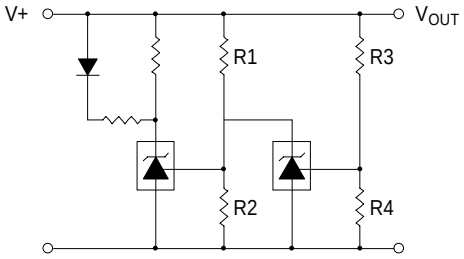
$$V_{OUT(trip)} = 1+\left(\frac{R1}{R2}\right) V_{REF}$$

THYRISTOR CROWBAR



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

VOLTAGE MONITOR

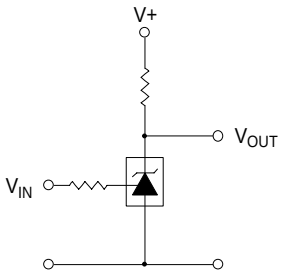


LED is 'on' when V+ is between the upper and lower limits.

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

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

SINGLE SUPPLY COMPARATOR WITH TEMPERATURE COMPENSATED THRESHOLD



$V_{TH} = V_{REF}$

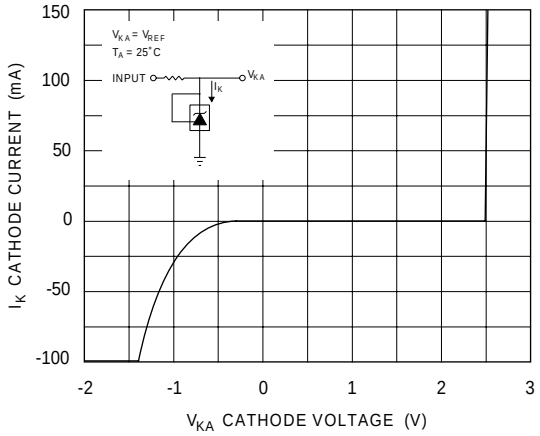
V_{IN}	V_{OUT}
$< V_{REF}$	V+
$> V_{REF}$	= 2.0 V

THERMAL CHARACTERISTICS

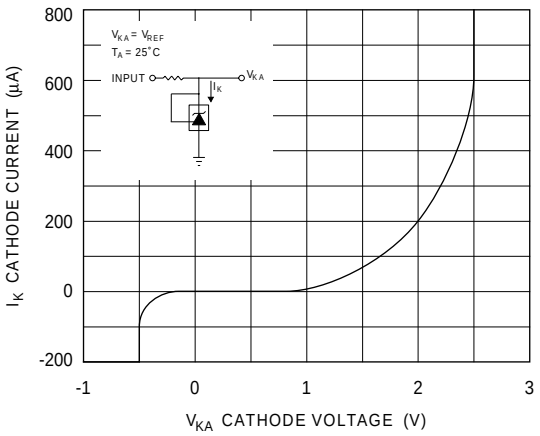
$R_{\theta JA}$	Thermal Resistance, Junction – Ambient	D Package	178°C/W
		N Package	114°C/W
		J Package	100°C/W
$R_{\theta JC}$	Thermal Resistance, Junction – Case	D Package	83°C/W
		N Package	41°C/W
		J Package	38°C/W

TYPICAL PERFORMANCE CHARACTERISTICS

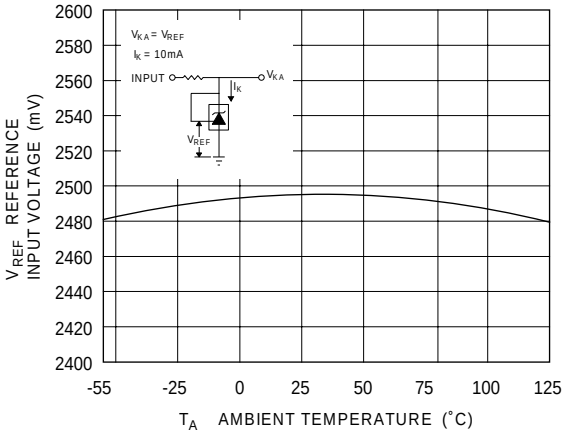
CATHODE CURRENT vs CATHODE VOLTAGE



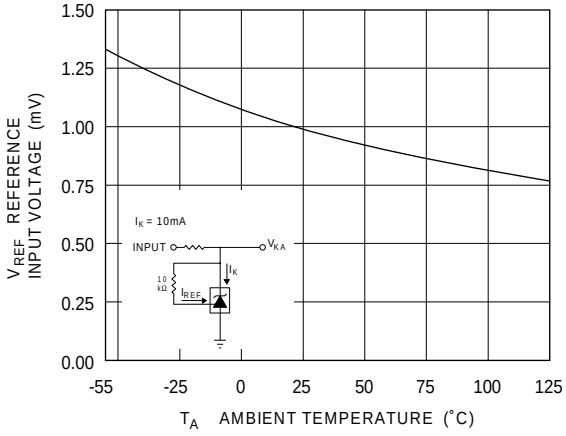
CATHODE CURRENT vs CATHODE VOLTAGE



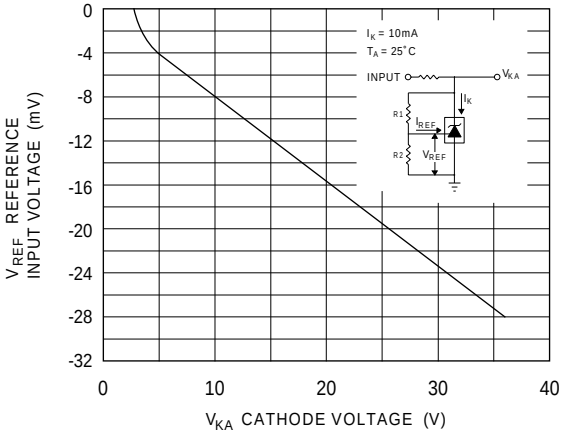
REFERENCE INPUT VOLTAGE vs AMBIENT TEMPERATURE



REFERENCE INPUT CURRENT vs AMBIENT TEMPERATURE



CHANGE IN REFERENCE INPUT VOLTAGE vs AMBIENT TEMPERATURE



OFF –STATE CATHODE CURRENT vs AMBIENT TEMPERATURE

