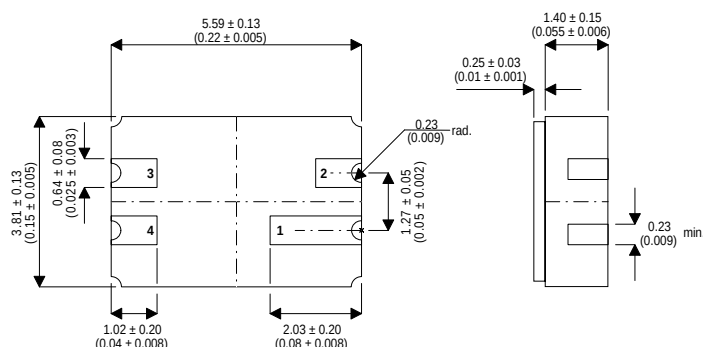




LCC3 HERMETICALLY SEALED CERAMIC SURFACE MOUNT PACKAGE

PIN 1 - NOT CONNECTED
PIN 2 - CATHODE

PIN 3 - REFERENCE
PIN 4 - ANODE

PART NUMBER	AMBIENT TEMP. RANGE
IP431CSM4	-55 TO +125°C

PROGRAMMABLE PRECISION REFERENCE

FEATURES

- **VOLTAGE REFERENCE TOLERANCE $\pm 1\%$**
- **PROGRAMMABLE OUTPUT VOLTAGE TO 36V**
- **EQUIVALENT FULL RANGE TEMPERATURE COEFFICIENT OF 30ppm/ $^{\circ}\text{C}$ 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 (0.2 Ω typical)**
- **LOW OUTPUT NOISE VOLTAGE**

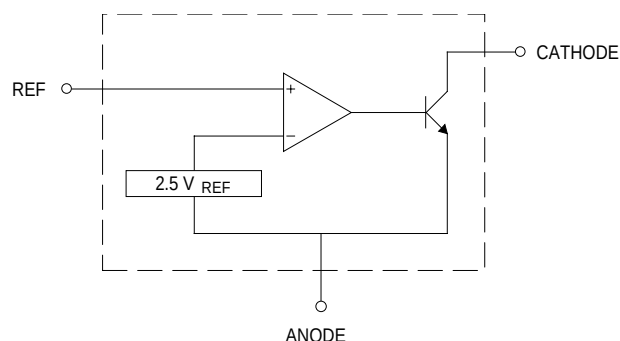
ABSOLUTE MAXIMUM RATINGS ($T_{case} = 25^{\circ}C$ unless otherwise stated)

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	0.80W
	Derate Above 25°C	6.4W/°C
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)	$V_{KA} = V_{REF}$ $I_K = 10\text{mA}$ $T_A = -55$ to $+125^\circ\text{C}^*$	2.47	2.495	2.52	V
ΔV_{REF} Reference Input Voltage Over Temperature Range ¹ (Figure 1)	$V_{KA} = V_{REF}$ $I_K = 10\text{mA}$ $T_A = -55$ to $+125^\circ\text{C}^*$	2.426		2.564	
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$ 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 10V		-1.5 -0.7	-2.7 -2	mV/V
I_{REF} Reference Input Current (Figure 2)	$R1 = 10\text{k}\Omega$ $I_K = 10\text{mA}$ $R2 = \infty$ $T_A = -55$ to $+125^\circ\text{C}^*$		1	4 7	
ΔI_{REF} Reference Input Current Deviation Over Temperature Range (Figure 2)	$R1 = 10\text{k}\Omega$ $I_K = 10\text{mA}$ $R2 = \infty$ $T_A = -55$ 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)	$V_{KA} = V_{REF}$ $\Delta I_K = 1\text{mA}$ to 100mA $f \leq 1\text{kHz}$		0.2	0.5	Ω

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

Parameter	Test Conditions	IP431AI			Units
		Min.	Typ.	Max.	
V_{REF} Reference Input Voltage (Figure 1)	$V_{KA} = V_{REF}$ $I_K = 10\text{mA}$ $T_A = -40$ to $+85^\circ\text{C}^*$	2.47	2.495	2.52	V
		2.44		2.55	
ΔV_{REF} Reference Input Voltage Over Temperature Range ¹ (Figure 1)	$V_{KA} = V_{REF}$ $I_K = 10\text{mA}$ $T_A = -40$ to $+85^\circ\text{C}^*$		7	30	mV
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$ Ratio of Reference Voltage Change to Change in Cathode to Anode Voltage (Figure 2)	$I_K = 10\text{mA}$ $\Delta V_{KA} = 10\text{V}$ to V_{REF}		-1.5	-2.7	mV/V
	$\Delta V_{KA} = 36\text{V}$ to 10V		-0.7	-2	
I_{REF} Reference Input Current (Figure 2)	$R1 = 10\text{k}\Omega$ $R2 = \infty$ $I_K = 10\text{mA}$ $T_A = -40$ to $+85^\circ\text{C}^*$		1	4	μA
				6.5	
ΔI_{REF} Reference Input Current Deviation Over Temperature Range (Figure 2)	$R1 = 10\text{k}\Omega$ $R2 = \infty$ $I_K = 10\text{mA}$ $T_A = -40$ to $+85^\circ\text{C}^*$		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)	$V_{KA} = 36\text{V}$ $V_{REF} = 0$		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 100mA		0.2	0.5	Ω

Parameter	Test Conditions	IP431AC			Units
		Min.	Typ.	Max.	
V_{REF} Reference Input Voltage (Figure 1)	$V_{KA} = V_{REF}$ $I_K = 10\text{mA}$ $T_A = 0$ to $+70^\circ\text{C}^*$	2.47	2.495	2.52	V
		2.453		2.537	
ΔV_{REF} Reference Input Voltage Over Temperature Range ¹ (Figure 1)	$V_{KA} = V_{REF}$ $I_K = 10\text{mA}$ $T_A = 0$ to $+70^\circ\text{C}^*$		3	17	mV
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$ Ratio of Reference Voltage Change to Change in Cathode to Anode Voltage (Figure 2)	$I_K = 10\text{mA}$ $\Delta V_{KA} = 10\text{V}$ to V_{REF}		-1.5	-2.7	mV/V
	$\Delta V_{KA} = 36\text{V}$ to 10V		-0.7	-2	
I_{REF} Reference Input Current (Figure 2)	$R1 = 10\text{k}\Omega$ $R2 = \infty$ $I_K = 10\text{mA}$ $T_A = 0$ to $+70^\circ\text{C}^*$		1	4	μA
				5.2	
ΔI_{REF} Reference Input Current Deviation Over Temperature Range (Figure 2)	$R1 = 10\text{k}\Omega$ $R2 = \infty$ $I_K = 10\text{mA}$ $T_A = 0$ to $+70^\circ\text{C}^*$		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)	$V_{KA} = 36\text{V}$ $V_{REF} = 0$		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 100mA		0.2	0.5	Ω

FIGURE 1

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

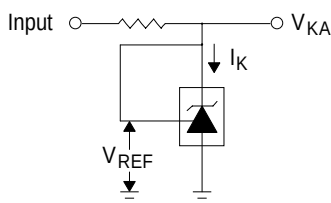
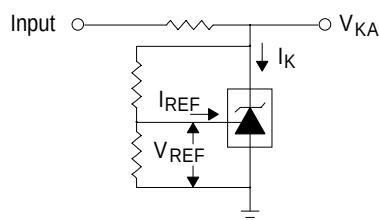


FIGURE 2

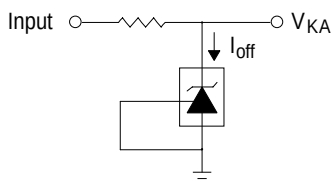
TEST CIRCUIT FOR $V_{KA} > V_{REF}$



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

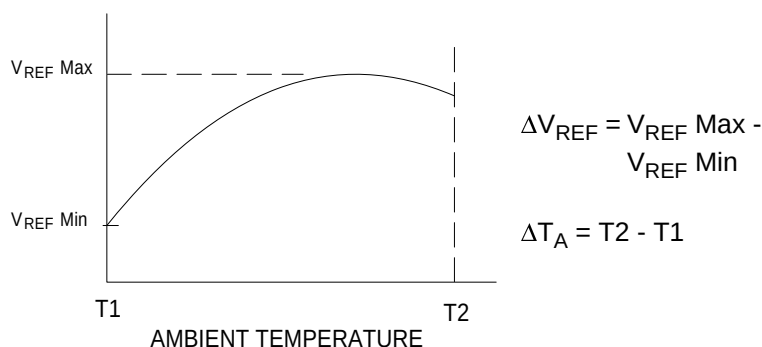
FIGURE 3

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:

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