Adjustable shunt regulator

PL432XA3/N3

Description

The PL432 is a three terminal adjustable shunt regulator with thermal stability guaranteed over temperature. The output voltage can be adjusted to any value from 1.24V(V_{REF}) to 20V with two external resistors. The PL432 has a typical dynamic output impedance of 0.05Ω. Active output circuitry provides a very sharp turn on characteristic, making the PL432 an excellent replacement for zener diodes. The PL432 shunt regulator is available with four Voltage tolerances(0.25%,0.5%,1% and 2%), and two package options(TO-92 and SOT-23). This allows the designer the opportunity to select the optimum combination of cost and performance for their application.

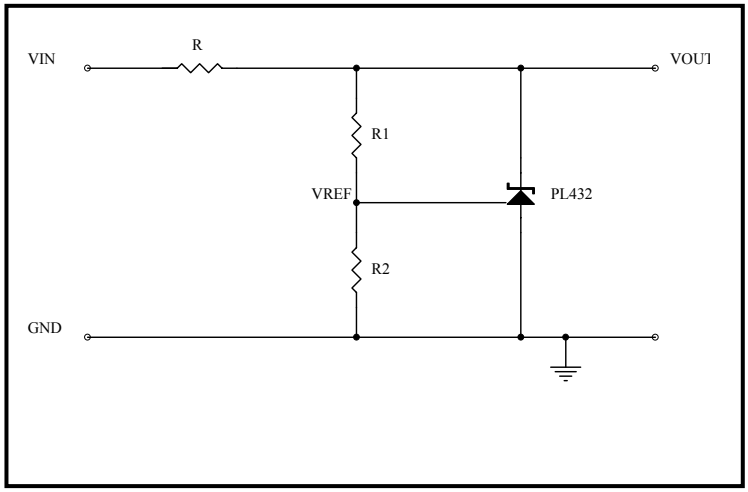
Features

- ◆Low voltage operation(down to 1.24V)
- ◆Wide operating current range 80μA to 100mA
- ◆Low dynamic output impedance 0.05Ω typ.
- ◆Trimmed bandgap design ±0.25%
- ◆Upgrade for PL431
- ◆Available in TO-92 and SOT-23 packages

Applications

- ◆Linear Regulators
- ◆Adjustable Supplies
- ◆Switching Power Supplies
- ◆Battery Operated Computers
- ◆Instrumentation
- ◆ Computer Disk Drives

Typical Application Circuit(Note 1,2)



Notes:

1) Set V_{OUT} according to the following equation:
$V_{OUT}=V_{REF}(1+R1/R2)+I_{REF}R1$

2) Choose the value for R as follows:
- The maximum limit for R should be such that the cathode current, Iz, is greater than the minimum operating current(80μA) at $V_{IN(MIN)}$.
- The minimum limit for R should be as such that Iz does not exceed 100mA under all load conditions, and the instantaneous turn-on value for Iz does not exceed 150mA. Both of the following conditions must be met:

  $R_{min}\geq V_{IN(max)}/150mA$(to limit instantaneous turn-on Iz)

  $R_{min}\geq \frac{V_{IN(max)}-V_{OUT}}{I_{OUT(min)}+100mA}$ (to limit Iz under normal operating conditions)

Absolute Maximum Ratings

Parameter	Symbol	Maximum	Units
Cathode Voltage	V_Z	20	V
Continuous Cathode Current	I_Z	100	mA
Reference Input Current	I_{REF}	3	mA
Power Dissipation at T_A=25℃ SOT-23 TO-92	P_D	0. 37 0.95	W
Thermal Resistance SOT-23 TO-92	Θ_{JA}	336 132	℃/W
Operating Ambient Temperature Range	T_A	0 to +70	℃
Operating Junction Temperature Range	T_J	0 to +150	℃
Storage Temperature Range	Tstg	-65 to +150	℃
Lead Temperature(Soldering) 10 seconds	T_{LEAD}	300	℃
ESD Rating(Human Body Model)	V_{ESD}	2	kV

Electrical Characteristics

Unless otherwise specified, TA=25℃. Values in bold apply over full operating ambient temperature range.

			PL432D			PL432C			
Parameter	Symbol	Condition	Min	Typ	Max	Min	Typ	Max	Unit
Reference Voltage	V_{REF}	V_Z=V_{REF},I_Z=10mA(Note 1)	1.237 **1.224**	1.240	1.243 **1.256**	1.234 **1.222**	1.240	1.246 **1.258**	V
V_{REF} Temperature Deviation	V_{DEV}	V_Z=V_{REF},I_Z=10mA(Note 1)	-	**10**	**25**	-	**10**	**25**	mV
Ratio of Change in V_{REF} to change in V_Z	$\frac{\Delta V_{REF}}{\Delta V_Z}$	I_Z=10mA, ΔV_Z=16V to V_{REF}	-	-1.0	-2.7	-	-1.0	-2.7	mV/V
Reference Input Current	I_{REF}	R1=10kΩ,R2=∞, I_Z=10mA(Note2)	-	0.15	0.5	-	0.15	0.5	μA
I_{REF} Temperature Deviation	$I_{REF(DEV)}$	R1=10kΩ,R2=∞, I_Z=10mA(Note 2)	-	**0.1**	**0.4**	-	**0.1**	**0.4**	μA
Off-state Cathode Current	$I_{Z(OFF)}$	V_{REF}=0V,V_Z=6V(Note 3)	-	0.125	0.150	-	0.125	0.150	μA
		V_{REF}=0V,V_Z=16V(Note 3)	-	0.135	0.150	-	0.135	0.150	
Dynamic Output Impedance	r_z	f <1kHz,V_Z=V_{REF} I_Z=100 μA to 100mA(Note 1)	-	0.05	0.15	-	0.05	0.15	Ω
Minimum Operating Current	$I_{Z(MIN)}$	V_Z=V_{REF}(Note 1)	-	20	**80**	-	20	**80**	μA

Electrical Characteristics(Cont.)

Unless otherwise specified, TA=25℃. Values in bold apply over full operating ambient temperature range.

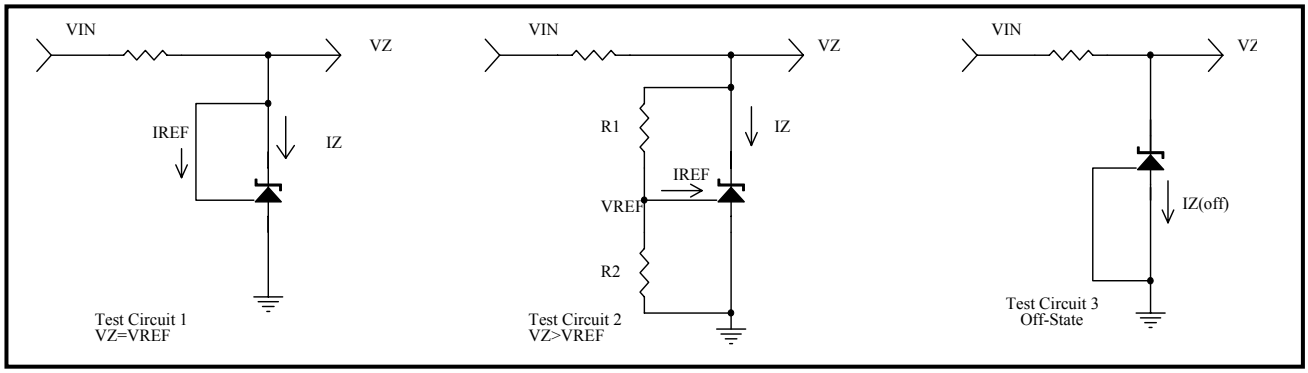
			PL432B			PL432A			
Parameter	Symbol	Condition	Min	Typ	Max	Min	Typ	Max	Unit
Reference Voltage	V_{REF}	V_Z=V_{REF},I_Z=10mA(Note 1)	1.228 **1.215**	1.240	1.252 **1.265**	1.215 **1.200**	1.240	1.265 **1.280**	V
V_{REF} Temperature Deviation	V_{DEV}	V_Z=V_{REF},I_Z=10mA(Note 1)	-	**10**	**25**	-	**10**	**35**	mV
Ratio of Change in V_{REF} to change in V_Z	$\frac{\Delta V_{REF}}{\Delta V_Z}$	I_Z=10mA, ΔV_Z=16V to V_{REF}	-	-1.0	-2.7	-	-1.0	-2.7	mV/V
Reference Input Current	I_{REF}	R1=10kΩ,R2=∞, I_Z=10mA(Note2)	-	0.15	0.5	-	0.15	0.5	μA
I_{REF} Temperature Deviation	$I_{REF(DEV)}$	R1=10kΩ,R2=∞, I_Z=10mA(Note 2)	-	**0.1**	**0.4**	-	**0.1**	**0.4**	μA
Off-state Cathode Current	$I_{Z(OFF)}$	V_{REF}=0V,V_Z=6V(Note 3)	-	0.125	0.150	-	0.125	0.150	μA
		V_{REF}=0V,V_Z=16V(Note 3)	-	0.135	0.150	-	0.135	0.150	
Dynamic Output Impedance	r_z	f<1kHz,V_Z=V_{REF} I_Z=100μA to 100mA(Note 1)	-	0.05	0.15	-	0.05	0.15	Ω
Minimum Operating Current	$I_{Z(MIN)}$	V_Z=V_{REF}(Note 1)	-	20	**80**	-	20	**80**	μA

Notes:
(1) See Test Circuit 1.
(2) See Test Circuit 2.
(3) See Test Circuit 3.

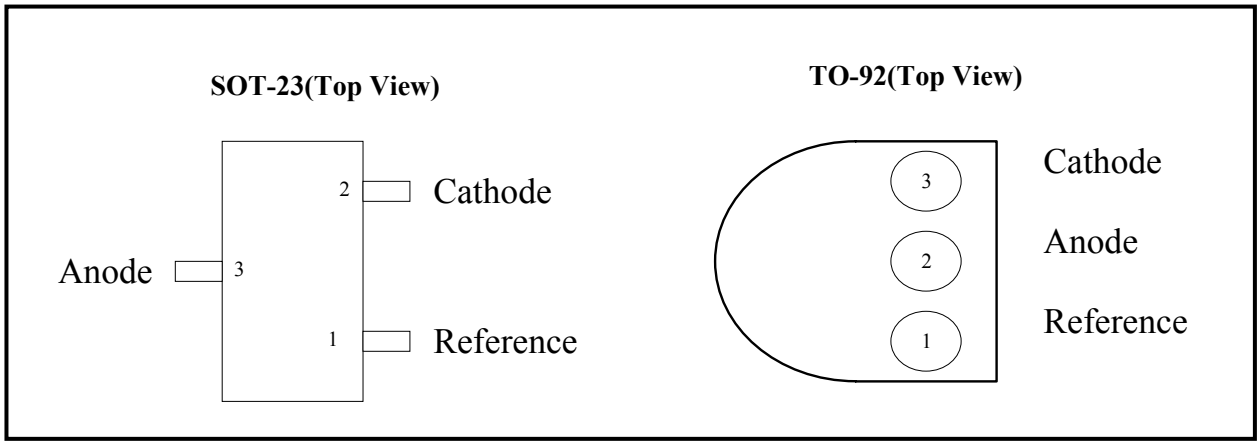
Recommended Operating Conditions

	Symbol	Min	Max	Unit
Cathode Voltage	V_Z	V_{REF}	16	V
Cathode Current	I_Z	0.08	100	mA

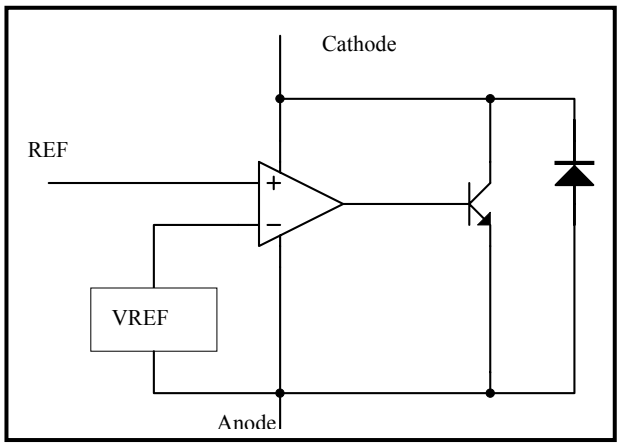
Test Circuits



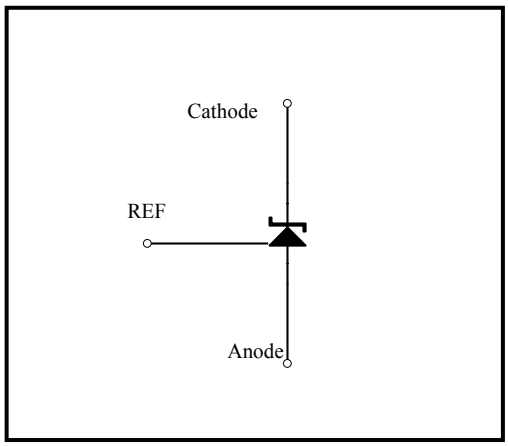
Pin Configurations



Block Diagram



Symbol

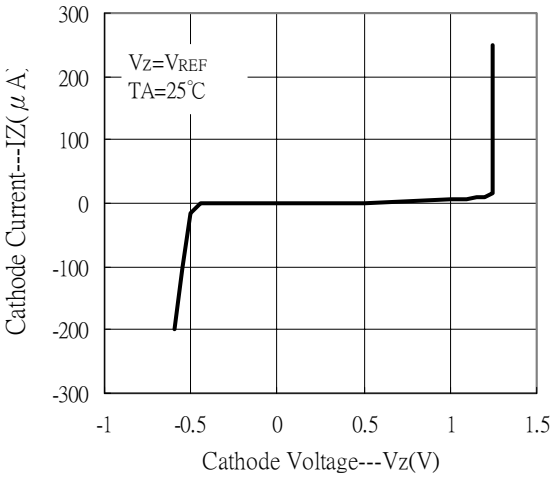


Ordering Information

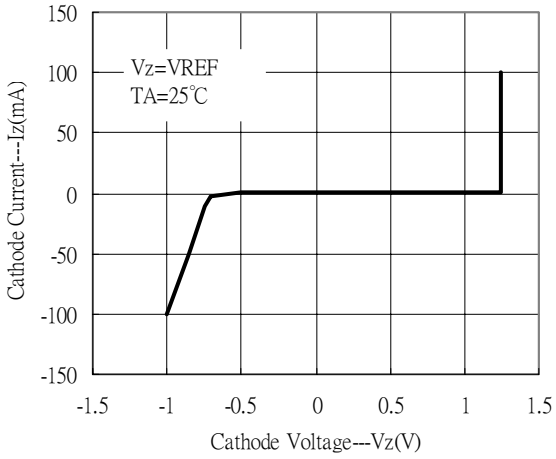
Package	Tolerance			
	0.25%	0.5%	1%	2%
TO-92	PL432DA3	PL432CA3	PL432BA3	PL432AA3
SOT-23	PL432DN3	PL432CN3	PL432BN3	PL432AN3

Characteristic Curves

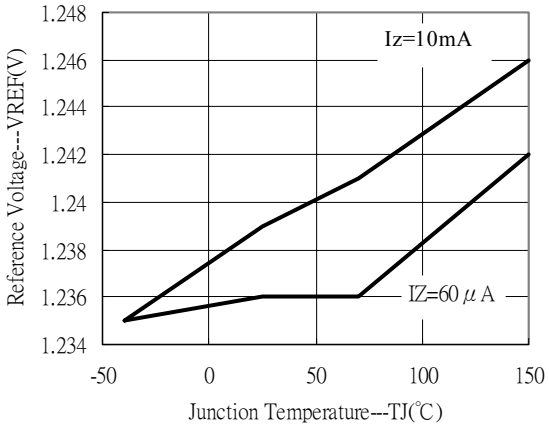
Cathode Current vs Cathode Voltage



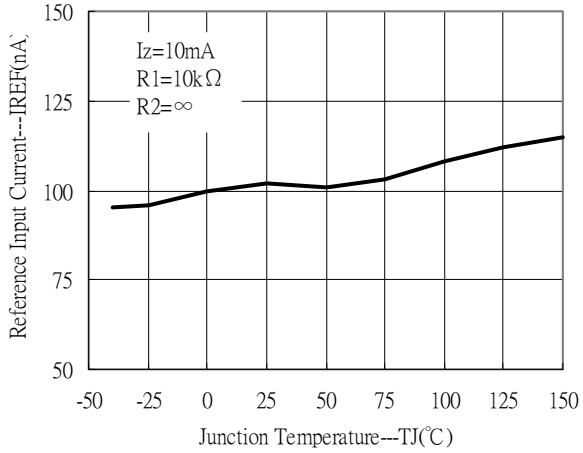
Cathode Current vs Cathode Voltage



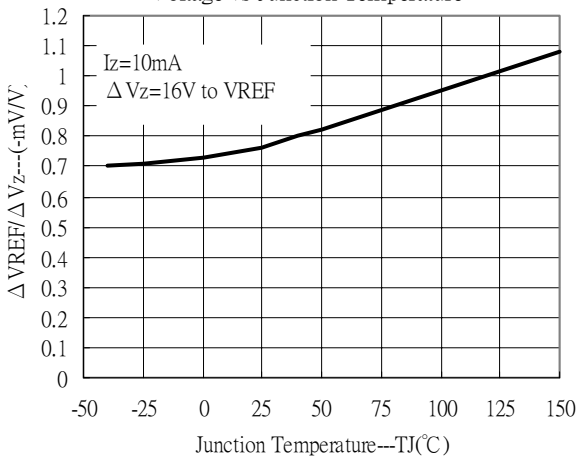
Reference Voltage vs Junction Temperature



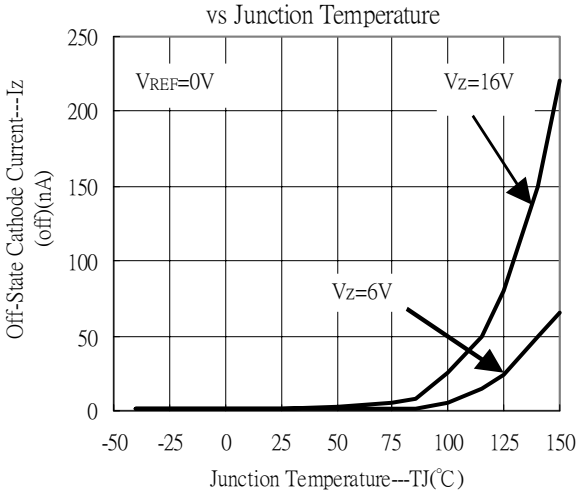
Reference Input Current vs Junction Temperature



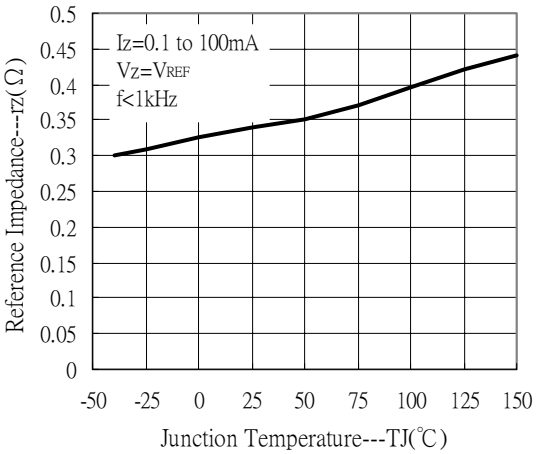
Ratio of Delta Reference Voltage to Delta Cathode Voltage vs Junction Temperature



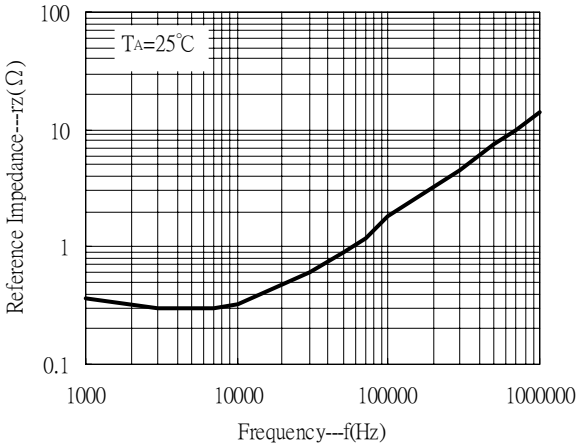
Off-State Cathode Current vs Junction Temperature



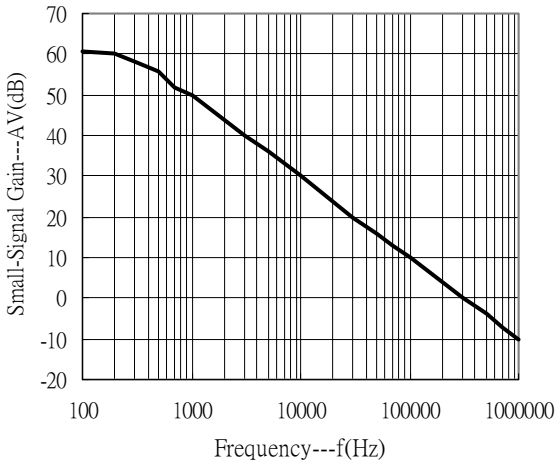
Reference Impedance vs Junction Temperature



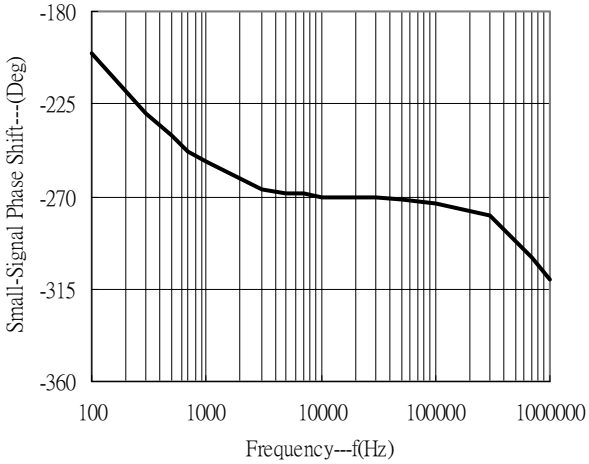
Reference Impedance vs Frequency



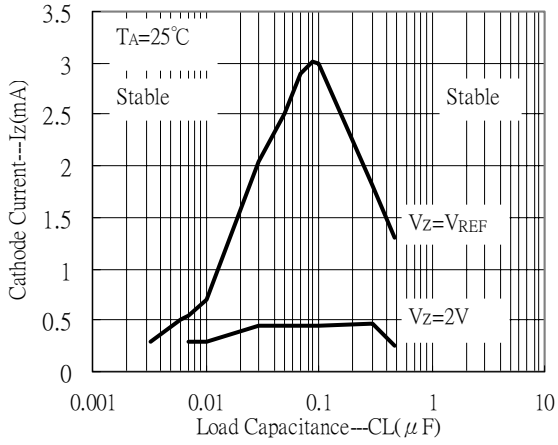
Small-Signal Gain vs Frequency



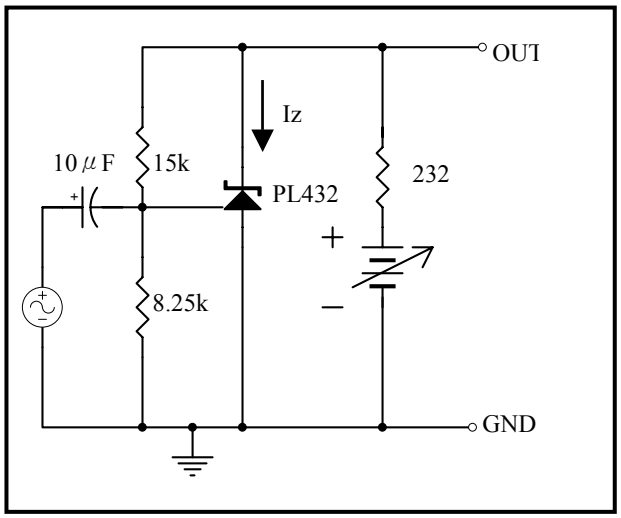
Small-Signal Phase Shift vs Frequency



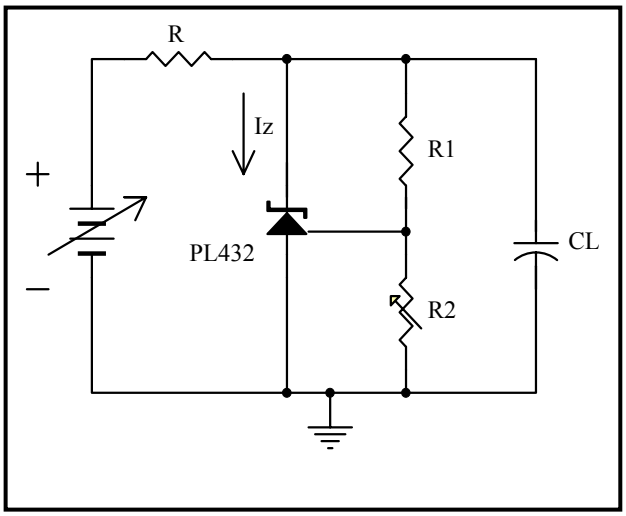
Stability Boundary Condition For Shunt Regulation
vs Cathode Current and Load Capacitance



Test Circuit-Small-Signal Gain and Phase



Test Circuit-Stability

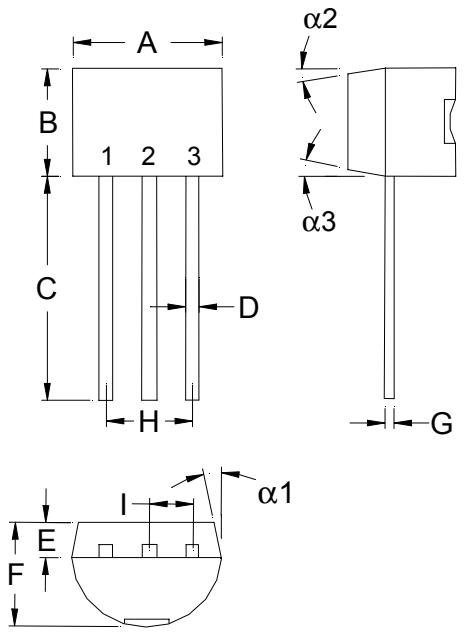


Applications Information - Stability

Selection of load capacitance when using PL432 as a shunt regulator

When the PL432 is used as a shunt regulator, two options for selection of C_L(see diagram on page 6) are recommended for optimal stability:
1) No load capacitance across the device, decouple at the load.
2) Large capacitance across the device, optimal decoupling at the load.
The reason for this is that PL432 exhibits instability with capacitances in the range of 10nF to 1 μ F (approx.) at light cathode currents(up to 3mA typical). The device is less stable the lower the cathode voltage has been set for. Therefore while the device will be perfectly stable operating at a cathode current of (say) 10mA with a 0.1 μ F capacitor across it, it will oscillate transiently during start-up as the cathode current passes through the instability region. Selecting a very low (or preferably, no) capacitance, or alternatively a high capacitance(such as 10 μ F) will avoid this issue altogether. Since the user will probably wish to have local decoupling at the load anyway, the most cost effective method is to use no capacitance at all directly across the device. PCB trace/via resistance and inductance prevent the local load decoupling from causing the oscillation during the transient start-up phase.
Note : if the PL432 is located right at the load, so the load decoupling capacitor is directly across it, then this capacitor will have to be $\leq$1nF or $\geq$10 μ F.

TO-92 Dimension



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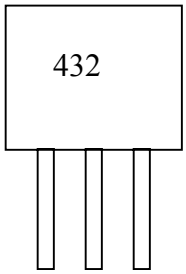


Style: Pin 1.Reference 2.Anode 3.Cathode

3-Lead TO-92 Plastic Package
CYStek Package Code: A3

*: Typical

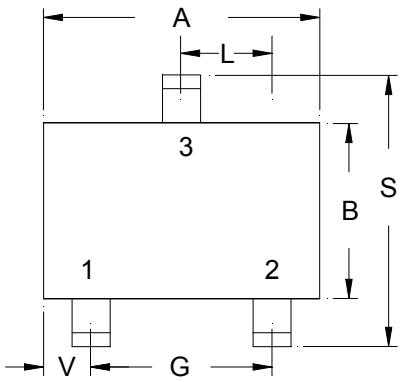
DIM	Inches		Millimeters		DIM	Inches		Millimeters	
	Min.	Max.	Min.	Max.		Min.	Max.	Min.	Max.
A	0.1704	0.1902	4.33	4.83	G	0.0142	0.0220	0.36	0.56
B	0.1704	0.1902	4.33	4.83	H	-	*0.1000	-	*2.54
C	0.5000	-	12.70	-	I	-	*0.0500	-	*1.27
D	0.0142	0.0220	0.36	0.56	α1	-	*5°	-	*5°
E	-	*0.0500	-	*1.27	α2	-	*2°	-	*2°
F	0.1323	0.1480	3.36	3.76	α3	-	*2°	-	*2°

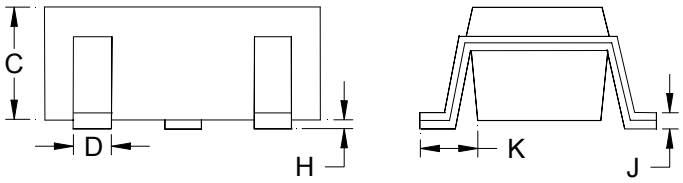
Notes: 1.Controlling dimension: millimeters.
2.Maximum lead thickness includes lead finish thickness, and minimum lead thickness is the minimum thickness of base material.
3.If there is any question with packing specification or packing method, please contact your local CYStek sales office.

Material:

- Lead: 42 Alloy ; solder plating
- Mold Compound: Epoxy resin family, flammability solid burning class: UL94V-0

SOT-23 Dimension





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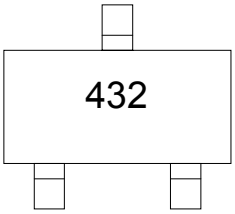

3-Lead SOT-23 Plastic
Surface Mounted Package
CYStek Package Code: N3

Style: Pin 1.Reference 2.Cathode
3.Anode

*: Typical

DIM	Inches		Millimeters		DIM	Inches		Millimeters	
	Min.	Max.	Min.	Max.		Min.	Max.	Min.	Max.
A	0.1102	0.1204	2.80	3.04	J	0.0034	0.0070	0.085	0.177
B	0.0472	0.0630	1.20	1.60	K	0.0128	0.0266	0.32	0.67
C	0.0335	0.0512	0.89	1.30	L	0.0335	0.0453	0.85	1.15
D	0.0118	0.0197	0.30	0.50	S	0.0830	0.1083	2.10	2.75
G	0.0669	0.0910	1.70	2.30	V	0.0098	0.0256	0.25	0.65
H	0.0005	0.0040	0.013	0.10					

Notes: 1.Controlling dimension: millimeters.
2.Maximum lead thickness includes lead finish thickness, and minimum lead thickness is the minimum thickness of base material.
3.If there is any question with packing specification or packing method, please contact your local CYCtek sales office.

Material:

- Lead: 42 Alloy; solder plating
- Mold Compound: Epoxy resin family, flammability solid burning class: UL94V-0

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