

Precision Adjustable Shunt Regulator

FEATURES

- Trimmed Bandgap to 0.5%, 1% and 2%
- Wide Operating Current 1mA to 150mA
- Extended Temperature Range: 0°C to 105°C
- Low Temperature Coefficient 30 ppm/°C
- Offered in TO-92, SOIC, SOT-89, SOT-23-5
- Improved Replacement in Performance for TL431
- Low Cost Solution

APPLICATIONS

- Battery Operating Equipment
- Adjustable Supplies
- Switching Power Supplies
- Error Amplifiers
- Single Supply Amplifier
- Monitors / VCRs / TVs
- Personal Computers

Now Available in Lead Free Packaging

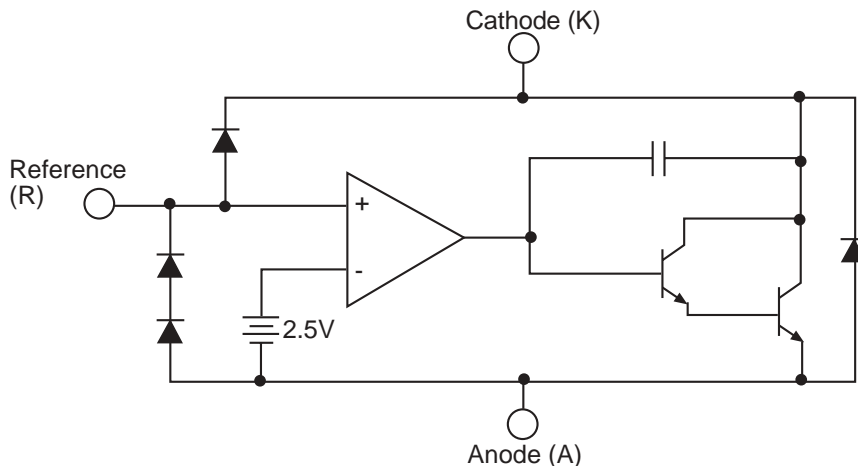
Refer to page 3 for pinouts.

DESCRIPTION

The SPX431 is a 3-terminal adjustable shunt voltage regulator providing a highly accurate bandgap reference. The SPX431 acts as an open-loop error amplifier with a 2.5V temperature compensation reference. The SPX431's thermal stability, wide operating current (150mA) and temperature range (0°C to 105°C) makes it suitable for a variety of applications that require a low cost, high performance solution. SPX431A tolerance of 0.5% is proven to be sufficient to overcome all of the other errors in the system to virtually eliminate the need for trimming in the power supply manufacturer's assembly line and contribute a significant cost savings.

The output voltage may be adjusted to any value between V_{REF} and 36 volts with two external resistors. The SPX431 is available in TO-92, SOIC-8, SOT-89, and SOT-23-5 packages.

TYPICAL APPLICATIONS CIRCUIT



ABSOLUTE MAXIMUM RATINGS

Cathode-Anode Reverse Breakdown V_{KA}	37V
Anode-Cathode Forward Current, (<10ms) I_{AK}	1A
Operating Cathode Current I_{KA}	150mA
Reference Input Current I_{REF}	10mA
Continuous Power Dissipation at 25°C P_D	
TO-92	775mW
SOT-23	200 mW
SOIC-8	750mW
SOT-89	1000mW

Junction Temperature T_J	150 °C
Storage Temperature T_{STG}	-65 to 150 °C

NOTE: Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

RECOMMENDED CONDITIONS

PARAMETER	SYMBOL	RATING	UNIT
Cathode Voltage	V_{KA}	V_{REF} to 36	V
Cathode Current	I_K	10	mA

TYPICAL THERMAL RESISTANCES

PACKAGE	θ_{JA}	θ_{JC}	TYPICAL DERATING
TO-92	160°C/W	80°C/W	6.3 mW/°C
SOT-23	575°C/W	150°C/W	1.7 mW/°C
SOIC-8	175°C/W	45°C/W	5.7 mW/°C
SOT-89	110°C/W	8°C/W	9.1 mW/°C

Typical deratings of the thermal resistances are given for ambient temperature >25°.

ELECTRICAL CHARACTERISTICS

Electrical characteristics at 25°C $I_K = 10\text{mA}$ $V_K = V_{REF}$, unless otherwise specified.

PARAMETER	SYMBOL	FIGURE	CONDITIONS	MIN	TYP	MAX	UNITS
SPX431A							
Reference Voltage	V_{REF}	2	$T_J = 0^\circ\text{C to } 105^\circ\text{C}$	2.490	2.503	2.515	V
		2		2.469		2.536	V
ΔV_{REF} withTemp.*	TC	2			0.07	0.20	mV/°C
Ratio of Change in V_{REF} to Cathode Voltage	$\frac{\Delta V_{REF}}{\Delta V_K}$	3	V_{REF} to 10V 10V to 36V	-2.7 -2.0	-1.0 -0.4	0.3	mV/V
Reference Input Current	I_{REF}	3			0.7	4.0	μA
I_{REF} Temp Deviation	ΔI_{REF}	3	$T_J = 0^\circ\text{C to } 105^\circ\text{C}$		0.4	1.2	μA
Min I_K for Regulation	$I_{K(MIN)}$	2			0.4	1.0	mA
Off State Leakage	$I_{K(OFF)}$	4	$V_{REF} = 0\text{V}, V_{KA} = 36\text{V}$		0.04	250	nA
Dynamic Output Impedance	Z_{KA}	2	$f_z = 1\text{kHz}$ $I_K = 1$ to 150mA		0.15	0.5	Ω
SPX431B							
Reference Voltage	V_{REF}	2	$T_J = 0^\circ\text{C to } 105^\circ\text{C}$	2.470	2.495	2.520	V
		2		2.449		2.541	V
ΔV_{REF} withTemp.*	TC	2			0.07	0.20	mV/°C
Ratio of Change in V_{REF} to Cathode Voltage	$\frac{\Delta V_{REF}}{\Delta V_K}$	3	V_{REF} to 10V 10V to 36V	-2.7 -2.0	-1.0 -0.4	0.3	mV/V
Reference Input Current	I_{REF}	3			0.7	4.0	μA
I_{REF} Temp Deviation	ΔI_{REF}	3	$T_J = 0^\circ\text{C to } 105^\circ\text{C}$		0.4	1.2	μA
Min I_K for Regulation	$I_{K(MIN)}$	2			0.4	1.0	mA
Off State Leakage	$I_{K(OFF)}$	4	$V_{REF} = 0\text{V}, V_{KA} = 36\text{V}$		0.04	500	nA
Dynamic Output Impedance	Z_{KA}	2	$f_z = 1\text{kHz}$ $I_K = 1$ to 150mA		0.15	0.5	Ω

PARAMETER	SYMBOL	FIGURE	CONDITIONS	MIN	TYP	MAX	UNITS
SPX431C							
Reference Voltage	V_{REF}	2	$T_J = 0^{\circ}\text{C to } 105^{\circ}\text{C}$	2.445	2.495	2.545	V
		2		V			
ΔV_{REF} withTemp.*	TC	2			0.07	0.20	mV/ $^{\circ}\text{C}$
Ratio of Change in V_{REF} to Cathode Voltage	$\frac{\Delta V_{REF}}{\Delta V_K}$	3	V_{REF} to 10V 10V to 36V	-2.7 -2.0	-1.0 -0.4	0.3	mV/V
Reference Input Current	I_{REF}	3			0.7	4.0	μA
I_{REF} Temp Deviation	ΔI_{REF}	3	$T_J = 0^{\circ}\text{C to } 105^{\circ}\text{C}$		0.4	1.2	μA
Min I_K for Regulation	$I_{K(MIN)}$	2			0.4	1.0	mA
Off State Leakage	$I_{K(OFF)}$	4	$V_{REF} = 0\text{V}, V_{KA} = 36\text{V}$		0.04	1000	nA
Dynamic Output Impedance	Z_{KA}	2	$f_z = 1\text{kHz}$ $I_K = 1$ to 150mA		0.15	0.5	Ω

Operating Range (T_J) = -40°C to 125°C .

*** See appropriate test circuit (Figure 2)**

CALCULATING AVERAGE TEMPERATURE COEFFICIENT (TC)

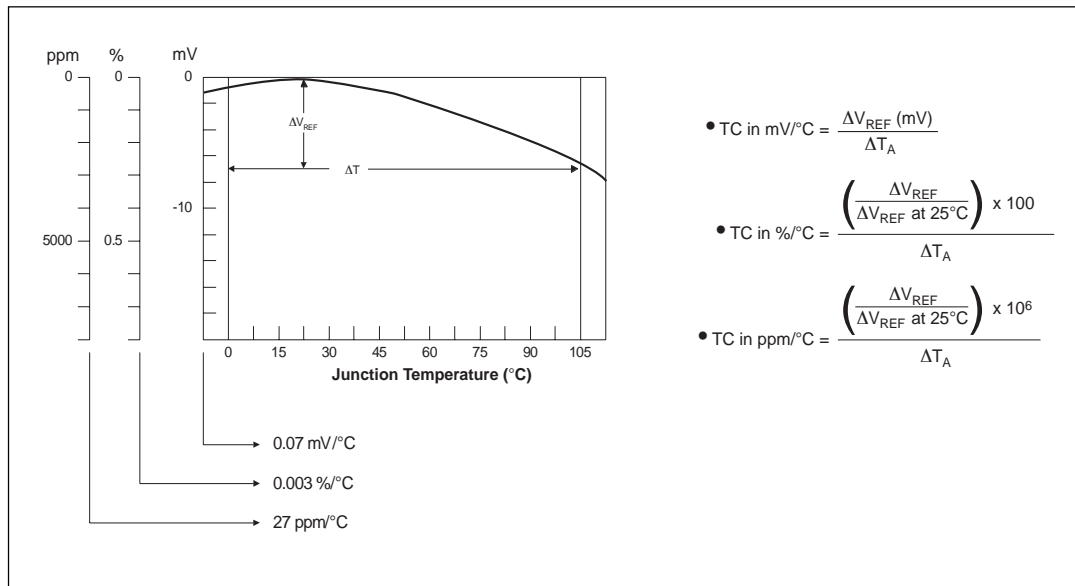
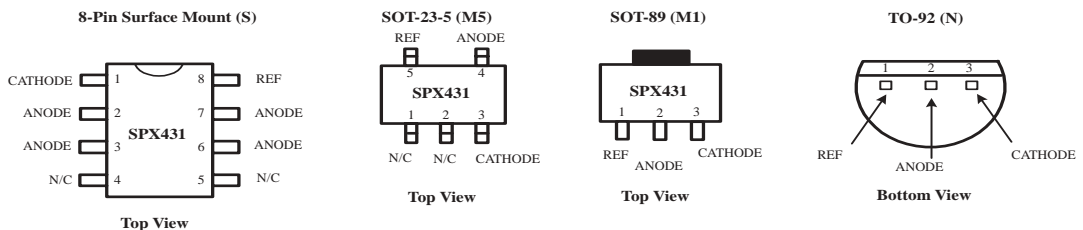


Figure 1. V_{REF} VS Temperature.

PACKAGE PINOUTS



TEST CIRCUITS

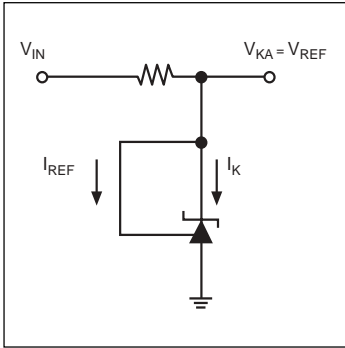


Figure 2. Test Circuit for $V_{KA} = V_{REF}$

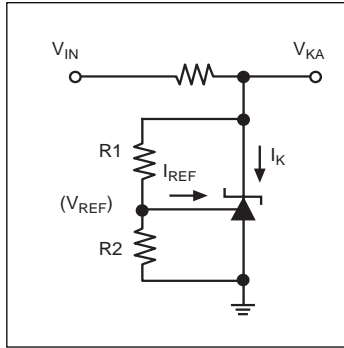


Figure 3. Test Circuit for $V_{KA} > V_{REF}$

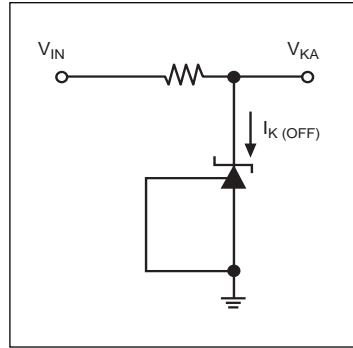


Figure 4. Test Circuit for $I_{K(OFF)}$

TYPICAL PERFORMANCE CHARACTERISTICS

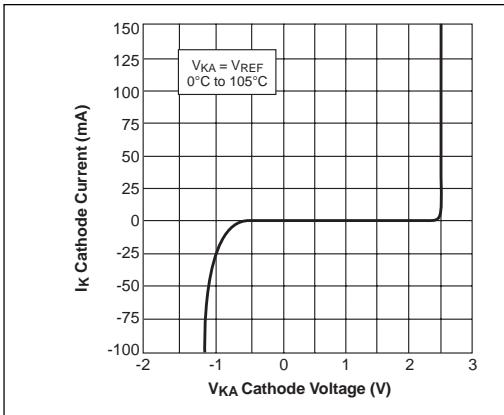


Figure 5. High Current Operating Characteristics

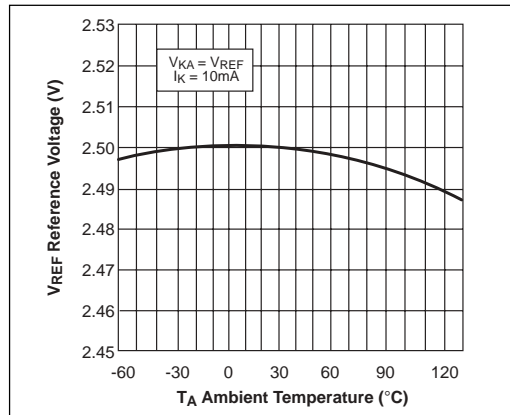


Figure 6. Reference Voltage VS Ambient Temperature

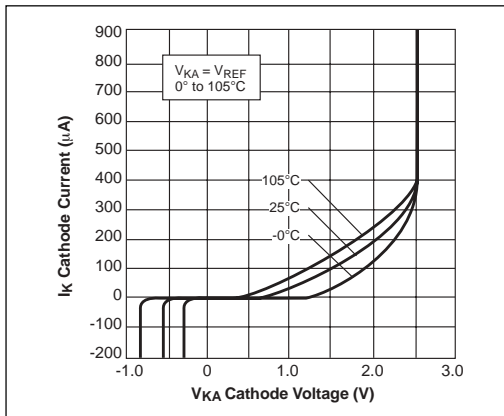


Figure 7. Low Current Operating Characteristics

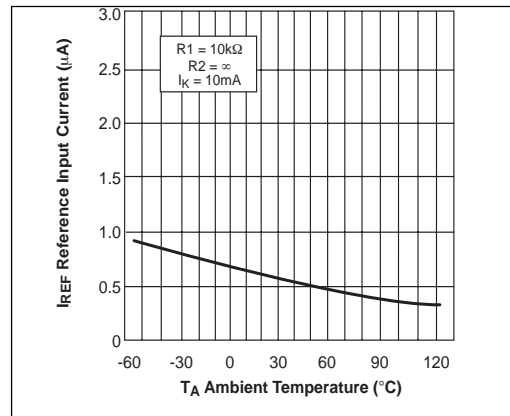


Figure 8. Reference Input Current VS Ambient Temperature

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

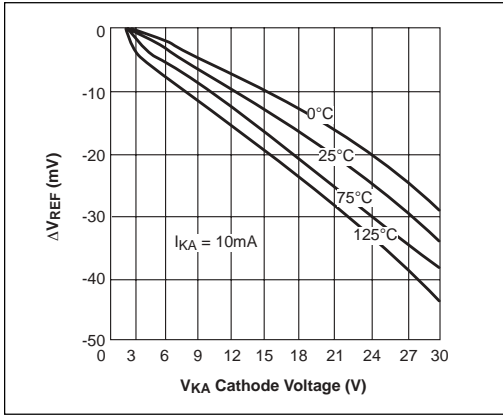


Figure 9. Reference Voltage Line Regulation VS Cathode Voltage and $T_{AMBIENT}$

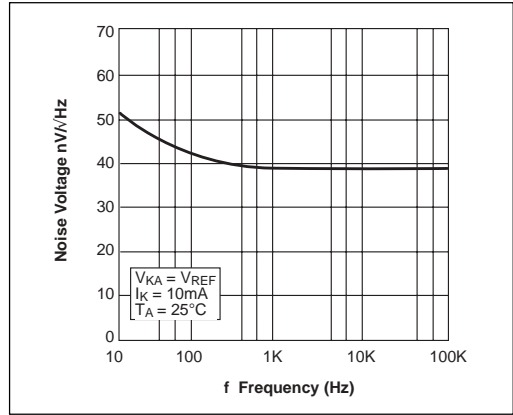


Figure 10. Noise Voltage VS Frequency

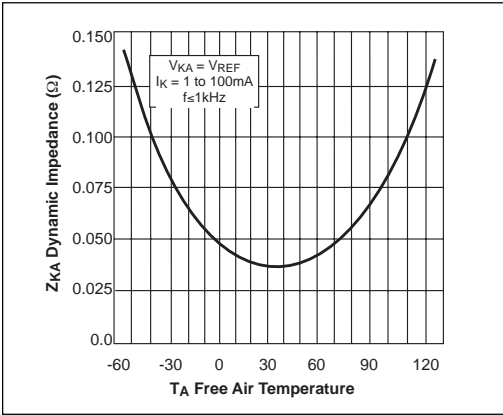


Figure 11. Low Frequency Dynamic Output Impedance VS $T_{AMBIENT}$

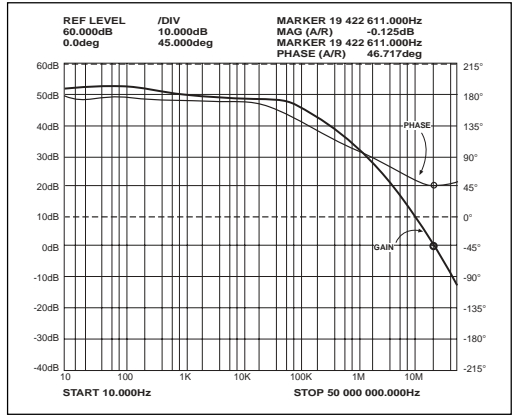


Figure 12. Small Signal Gain and Phase VS Frequency; $I_K = 10mA, T_A = 25^\circ C$

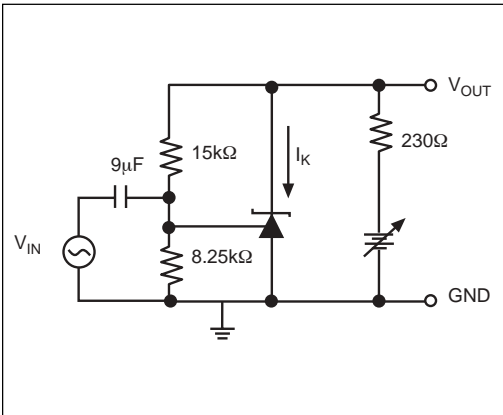


Figure 13. Test Circuit for Gain and Phase Frequency Response

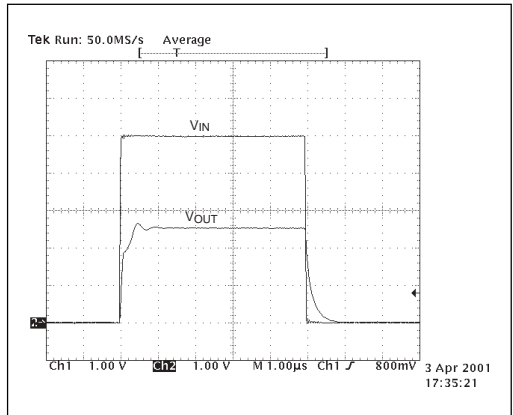


Figure 14. $F_z = 100kHz, I_K = 10mA, T_A = 25^\circ C$

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

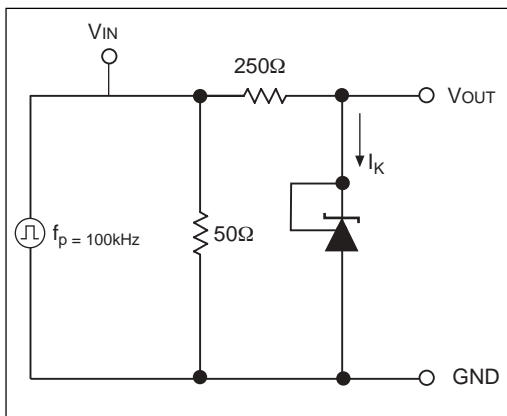


Figure 15. Test Circuit for Pulse Response

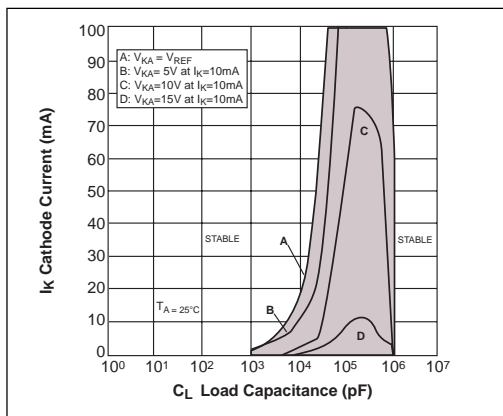


Figure 16. Stability Boundry Conditions

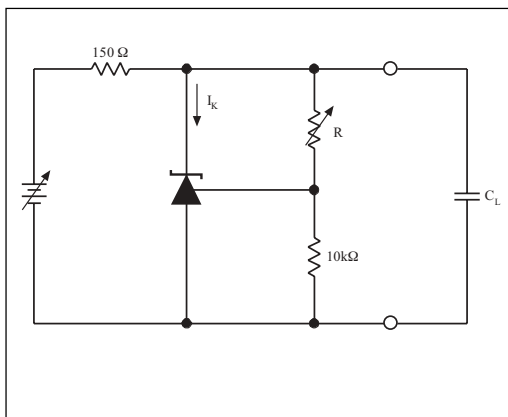


Figure 17. Test Circuit for Stability

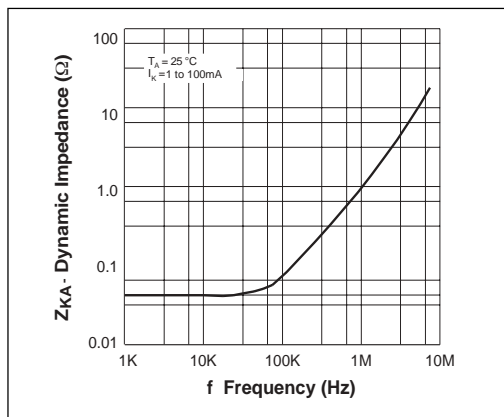


Figure 18. Dynamic Output Impedance $T_A = 25^\circ\text{C}$, $I_K = 1$ to 100mA

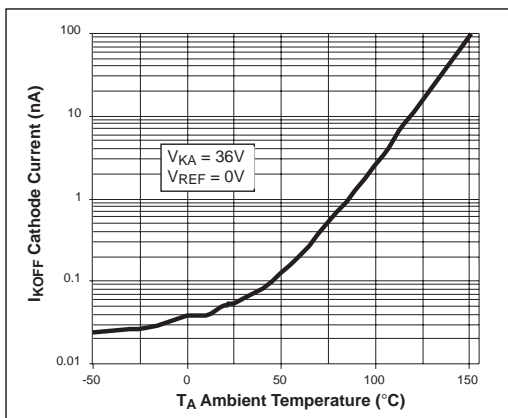


Figure 19. Off State Leakage

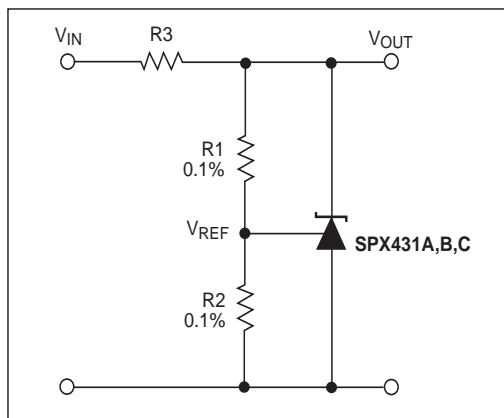


Figure 20. Shunt Regulator $V_{OUT} = (1 + R1/R2)V_{REF}$

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

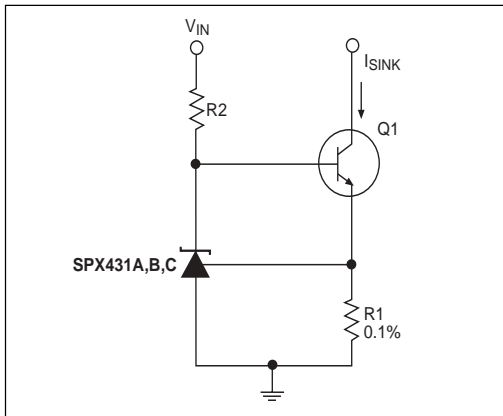


Figure 21. Constant Current, Sink, $I_{SINK} = V_{REF}/R1$

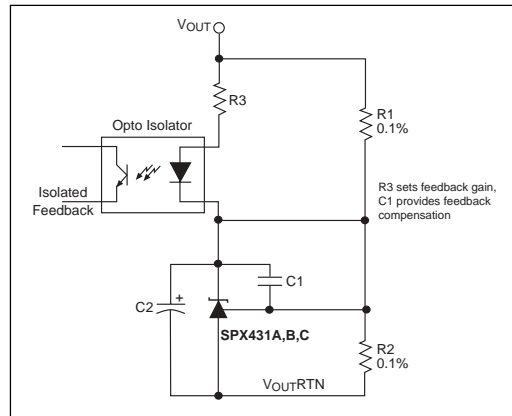


Figure 22. Reference Amplifier for Isolated Feedback in Off-Line DC-DC Converters

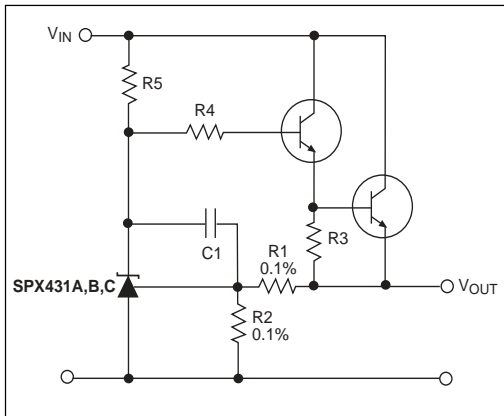


Figure 23. Precision High Current Series Regulator
 $V_{OUT} = (1+R1/R2)V_{REF}$

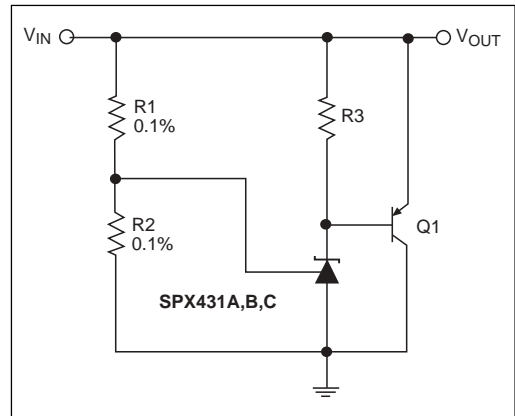


Figure 24. High Current Shunt Regulator
 $V_{OUT} = (1+R1/R2)V_{REF}$

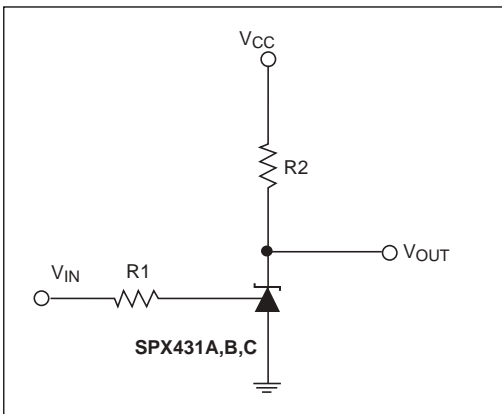
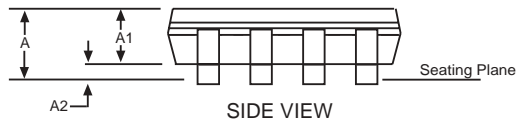
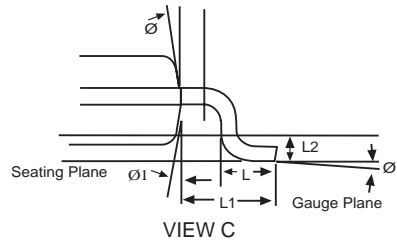
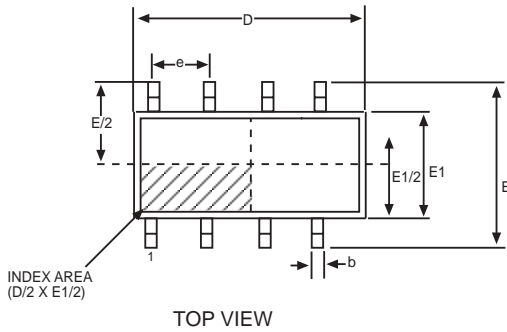


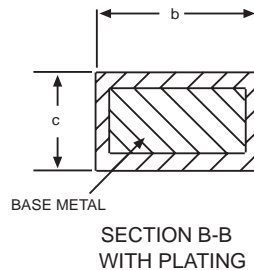
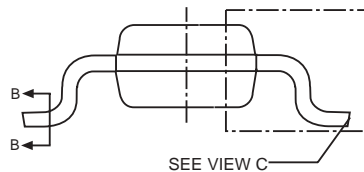
Figure 25. Single Supply Comparator with Temperature Compensated Threshold. V_{IN} threshold = 2.5V

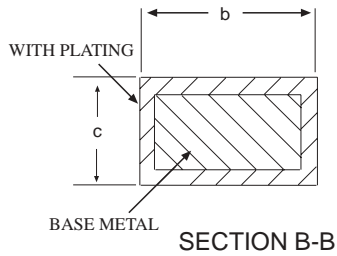
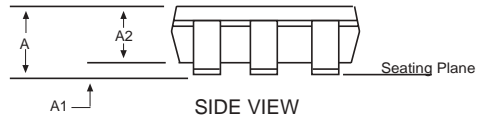
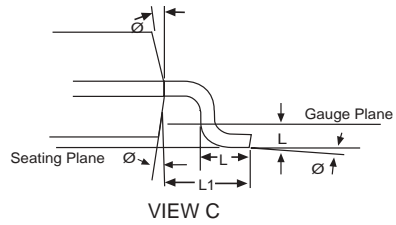
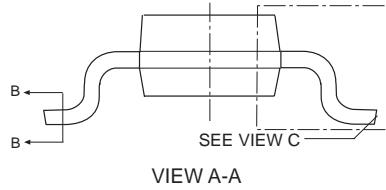
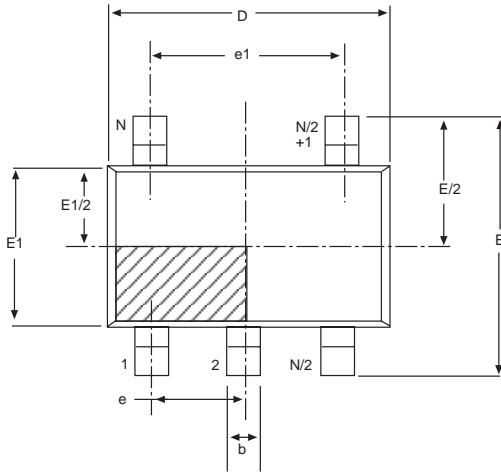
* Resistor values are chosen such that the effect to I_{REF} is negligible.



8 Pin NSOIC JEDEC MO-012 (AA) Variation			
SYMBOL	MIN	NOM	MAX
A	1.35	-	1.75
A1	0.1	-	0.25
A2	1.25	-	1.65
b	0.31	-	0.51
c	0.17	-	0.24
D	4.90 BSC		
E	6.00 BSC		
E1	3.90 BSC		
e	1.27 BSC		
L	0.4	-	1.27
L1	1.04 REF		
L2	0.25 BSC		
ø	0°	-	8°
ø1	5°	-	15°

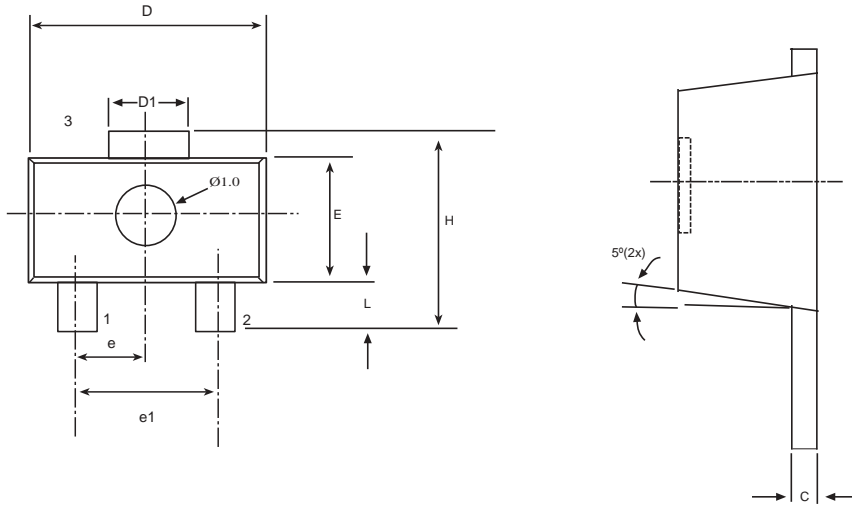
Note: Dimensions in (mm)





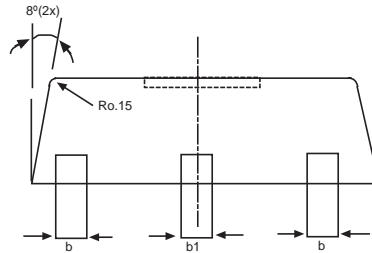
5 Pin SOT-23 JEDEC MO-178 (AA) Variation			
SYMBOL	MIN	NOM	MAX
A	-	-	1.45
A1	0	-	0.15
A2	0.9	1.15	1.3
b	0.3	-	0.5
c	0.08	-	0.22
D		2.90 BSC	
E		2.80 BSC	
E1		1.60 BSC	
e		0.95 BSC	
e1		1.90 BSC	
L	0.3	0.45	0.6
L1		0.60 REF	
L2		0.25 BSC	
Ø	0°	4°	8°
ø	5°	10°	15°

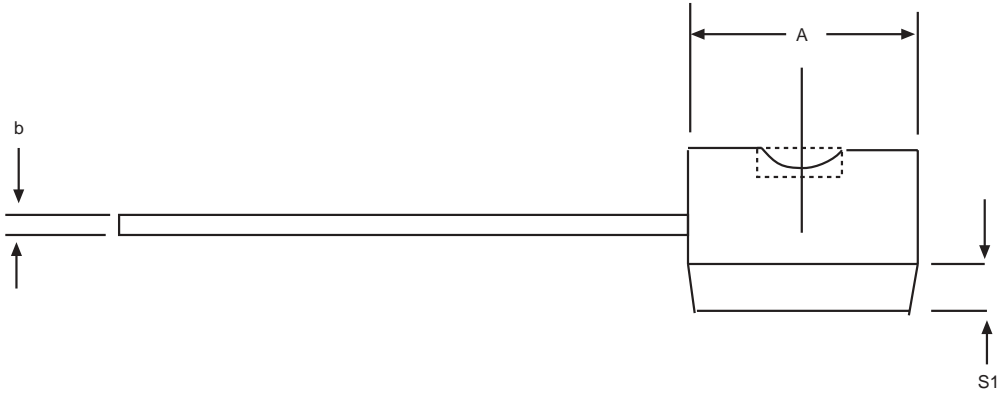
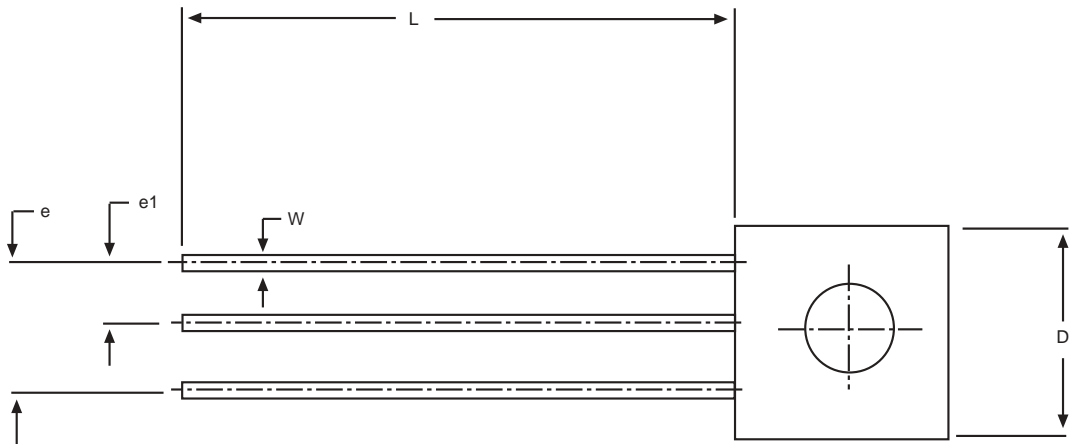
Note: Dimensions in (mm)



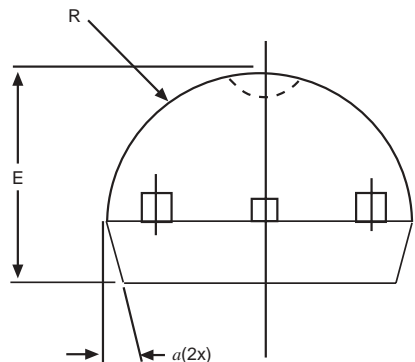
3 Pin SOT-89			
SYMBOL	MIN	NOM	MAX
b	0.36	0.42	0.48
L	0.8	-	1.2
b1	0.41	0.47	0.53
C	0.38	0.4	0.43
D	4.4	4.5	4.6
D1	1.4	1.6	1.75
H	3.94	-	4.25
E	2.4	2.5	2.6
e	1.45	1.5	1.55
e1	2.9	3	3.1

Note: Dimensions in (mm)





3 Pin TO-92			
SYMBOL	MIN	NOM	MAX
A	0.17	-	0.195
b	0.014	-	0.02
E	0.13	-	0.155
e	0.95	-	0.105
e1	0.045	-	0.055
L	0.5	-	0.61
R	0.085	-	0.095
S1	0.045	-	0.06
W	0.016	-	0.022
D	0.175	-	0.195
a	4°	-	6°



Note: Dimensions in (inches)

PART NUMBER	ACCURACY	OUTPUT VOLTAGE	PACKAGES
SPX431AM5	0.5%	2.503V	5-Pin SOT-23
SPX431AM5/TR	0.5%	2.503V	5-Pin SOT-23
SPX431AM1	0.5%	2.503V	3-Pin SOT-89
SPX431AM1/TR	0.5%	2.503V	3-Pin SOT-89
SPX431AS	0.5%	2.503V	8-Pin SOIC
SPX431AS/TR	0.5%	2.503V	8-Pin SOIC
SPX431AN	0.5%	2.503V	3-Pin TO-92
SPX431AN/TR	0.5%	2.503V	3-Pin TO-92
SPX431BM5	1.0%	2.495V	5-Pin SOT-23
SPX431BM5/TR	1.0%	2.495V	5-Pin SOT-23
SPX431BM1	1.0%	2.495V	3-Pin SOT-89
SPX431BM1/TR	1.0%	2.495V	3-Pin SOT-89
SPX431BS	1.0%	2.495V	8-Pin SOIC
SPX431BS/TR	1.0%	2.495V	8-Pin SOIC
SPX431BN	1.0%	2.495V	3-Pin TO-92
SPX431BN/TR	1.0%	2.495V	3-Pin TO-92
SPX431CM5	2.0%	2.495V	5-Pin SOT-23
SPX431CM5/TR	2.0%	2.495V	5-Pin SOT-23
SPX431CM1	2.0%	2.495V	3-Pin SOT-89
SPX431CM1/TR	2.0%	2.495V	3-Pin SOT-89
SPX431CS	2.0%	2.495V	8-Pin SOIC
SPX431CS/TR	2.0%	2.495V	8-Pin SOIC
SPX431CN	2.0%	2.495V	3-Pin TO-92
SPX431CN/TR	2.0%	2.495V	3-Pin TO-92

Available in lead free packaging. To order add "-L" suffix to part number.

Example: SPX431AM5/TR = standard; SPX431AM5-L/TR = lead free

/TR = Tape and Reel

Pack quantity is 2,000 for TO-92 and 2,500 for SOT-23, SOT-89 and NSOIC.

 [CLICK HERE TO ORDER SAMPLES](#) 



ANALOG EXCELLENCE

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