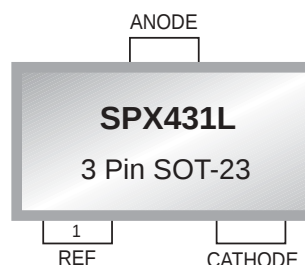


Precision Adjustable Shunt Regulator

FEATURES

- Tight Voltage Tolerance 0.5% at 10mA
- Wide Operating Current 1mA to 100mA
- Extended Temperature Range: 0°C to 105°C
- Low Temperature Coefficient 30 ppm/°C
- Improved Replacement in Performance for TL431 and AS431
- Low Cost Solution



Now Available in Lead Free Packaging

APPLICATIONS

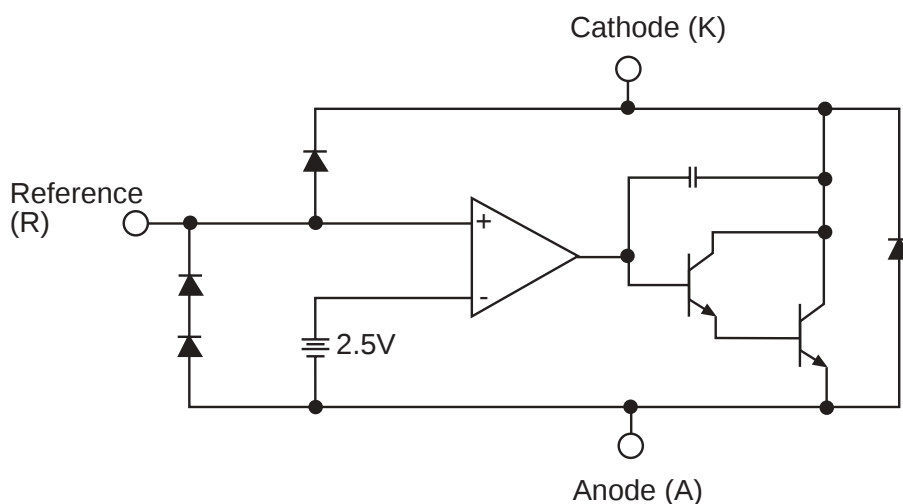
- Battery Operating Equipment
- Adjustable Supplies
- Switching Power Supplies
- Error Amplifiers
- Single Supply Amplifier
- Monitors / VCRs / TVs
- Personal Computers

DESCRIPTION

The SPX431L is a 3-terminal adjustable shunt voltage regulator providing a highly accurate bandgap reference. The SPX431L acts as an open-loop error amplifier with a 2.5V temperature compensation reference. The SPX431L's thermal stability, wide operating current (100mA) and temperature range (0°C to 105°C) makes it suitable for a variety of applications that require a low cost, high performance solution. SPX431L 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 20V with two external resistors. The SPX431L is available in TO-92, SOIC-8, SOT-89, and SOT-23-3 packages.

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Cathode-Anode Reverse Breakdown V_{KA}	20V
Anode-Cathode Forward Current, ($<10\text{ms}$) I_{AK}	1A
Operating Cathode Current I_{KA}	100mA
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
Lead Temperature (Soldering 10 sec.) T_L	300°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 20	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 $>25^\circ$.

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
SPX431LA							
Reference Voltage	V_{REF}	2		2.490	2.503	2.515	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 20V	-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°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	$V_{REF} = 0\text{V}$, $V_{KA} = 20\text{V}$		0.04	1.0	μA
Dynamic Output Impedance	Z_{KA}	2	$f_z \leq 1\text{kHz}$ $I_K = 1$ to 100mA		0.15	0.5	Ω
SPX431L							
Reference Voltage	V_{REF}	2		2.470	2.495	2.520	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 20V	-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°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	$V_{REF} = 0\text{V}$, $V_{KA} = 20\text{V}$		0.04	1.0	μA
Dynamic Output Impedance	Z_{KA}	2	$f_z \leq 1\text{kHz}$ $I_K = 1$ to 100mA		0.15	0.5	Ω

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
SPX431LC							
Reference Voltage	V_{REF}	2		2.445	2.495	2.545	V
ΔV_{REF} with Temp.*	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 20V	-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°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	$V_{REF} = 0\text{V}$, $V_{KA} = 16\text{V}$		0.04	1.0	μA
Dynamic Output Impedance	Z_{KA}	2	$f_z \leq 1\text{kHz}$ $I_K = 1$ to 100mA		0.15	0.5	Ω

Operating Range (T_J) = 0°C to 105°C .

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

CALCULATING AVERAGE TEMPERATURE COEFFICIENT (TC)

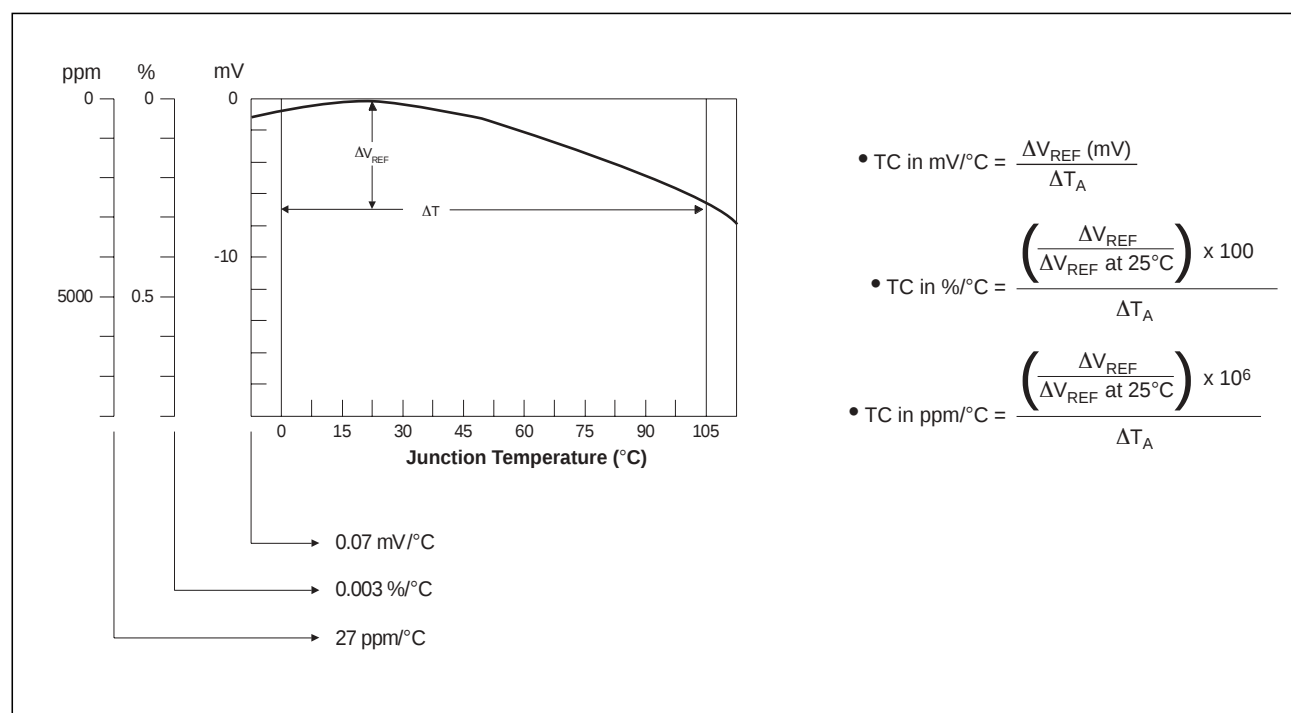


Figure 1. V_{REF} VS Temperature.

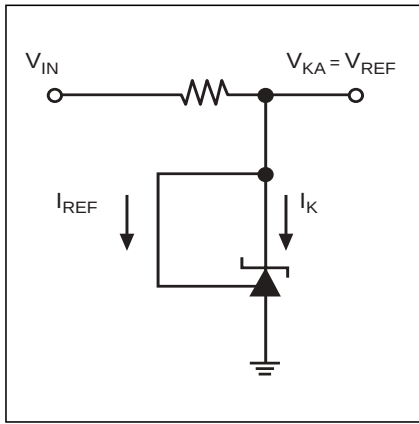


Figure 2. Test Circuit for $V_{KA} = V_{REF}$

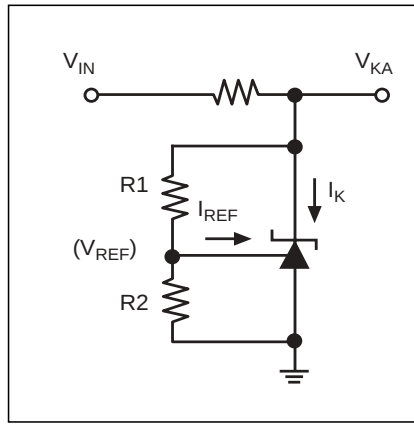


Figure 3. Test Circuit for $V_{KA} > V_{REF}$

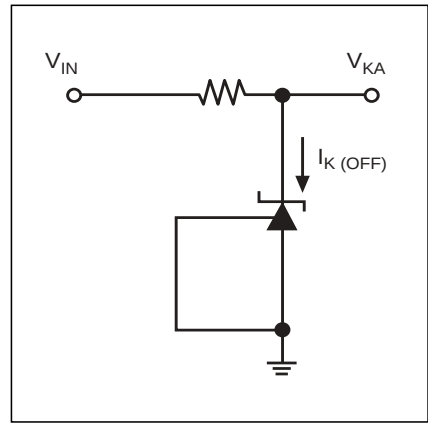


Figure 4. Test Circuit for I_{KOFF}

TYPICAL PERFORMANCE CHARACTERISTICS

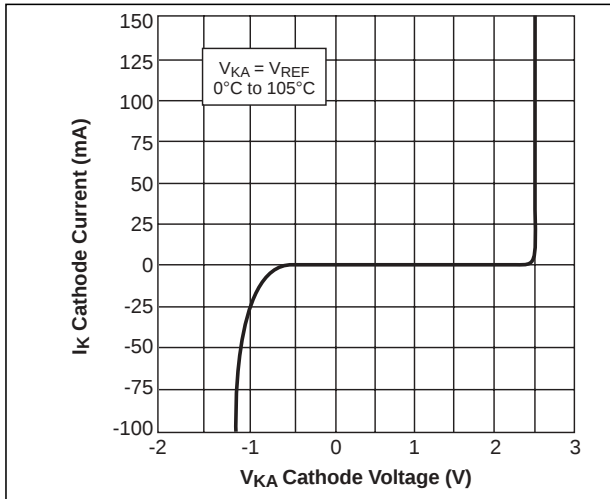


Figure 5. High Current Operating Characteristics

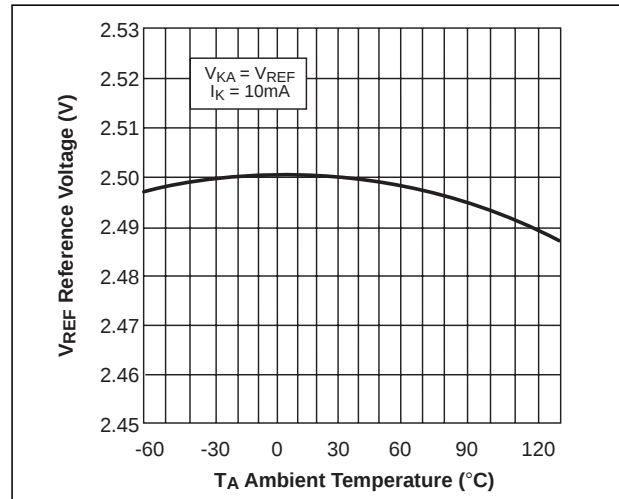


Figure 6. Reference Voltage VS Ambient Temperature

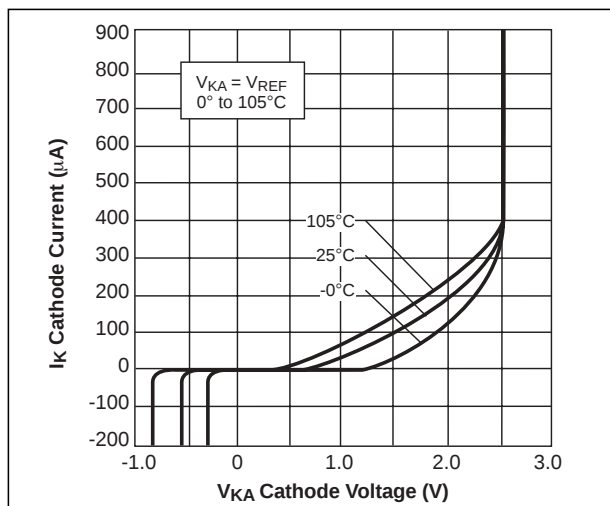


Figure 7. Low Current Operating Characteristics.

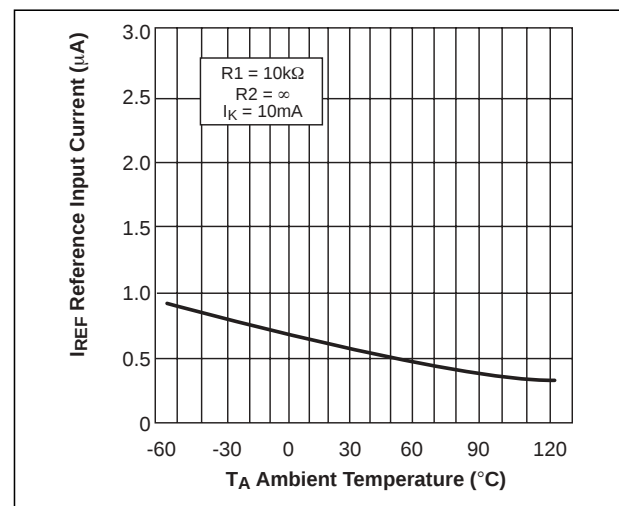


Figure 8. Reference Input Current VS Ambient Temperature.

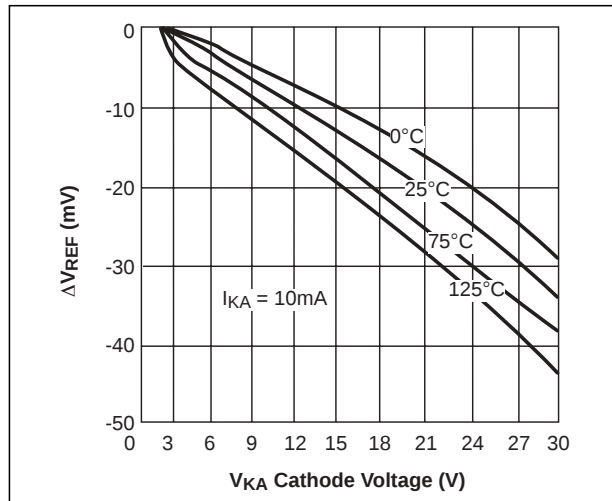


Figure 9. Reference Voltage Line Regulation VS Cathode Voltage and $T_{AMBIENT}$

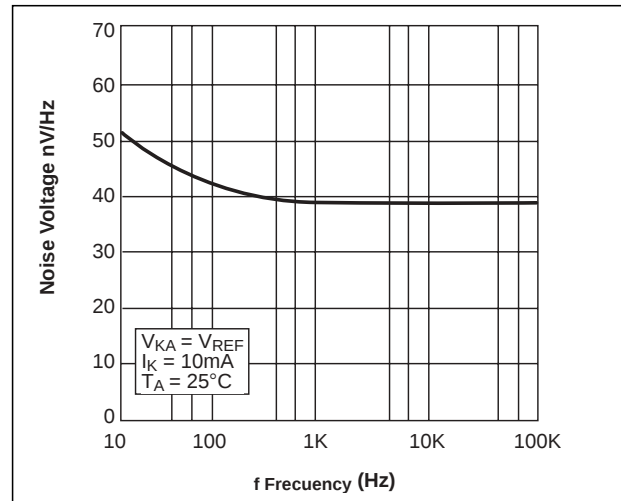


Figure 10. Noise Voltage VS Frequency

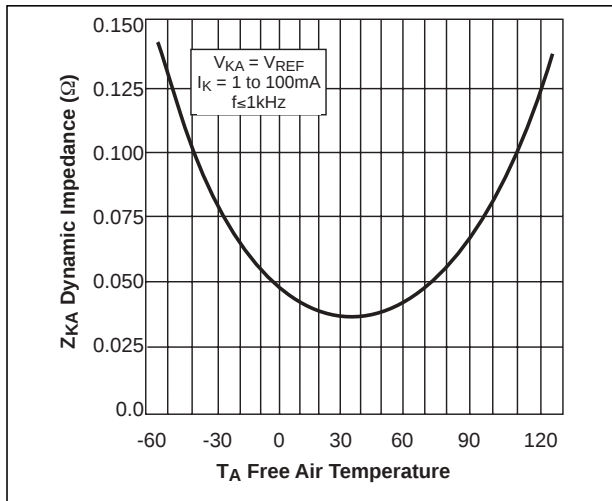


Figure 11. Low Frequency Dynamic Output Impedance VS $T_{AMBIENT}$

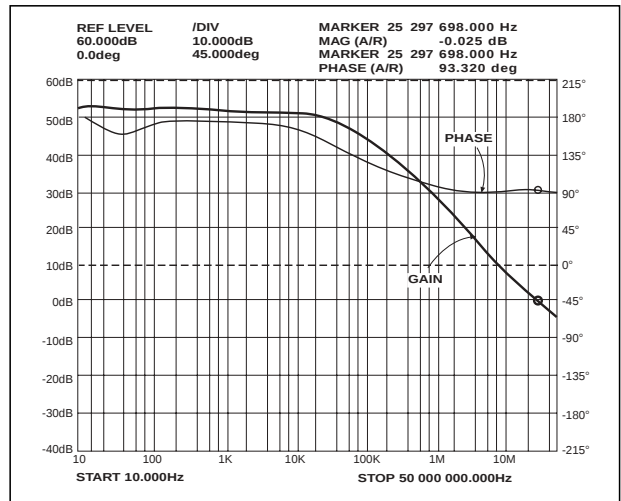


Figure 12. Small Signal Gain and Phase VS Frequency; $I_K = 10mA$, $T_A = 25^\circ C$

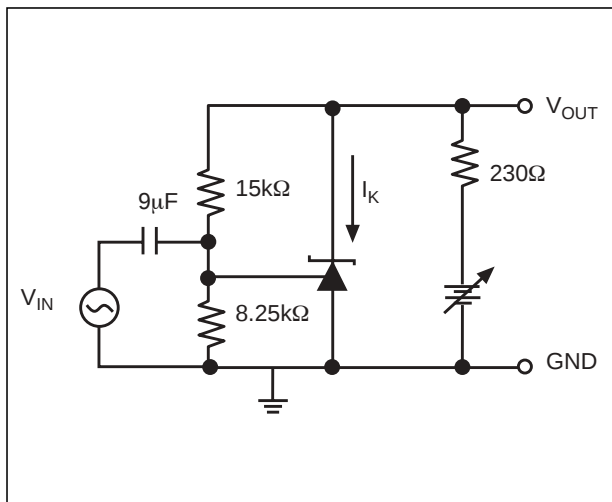


Figure 13. Test Circuit for Gain and Phase Frequency Response

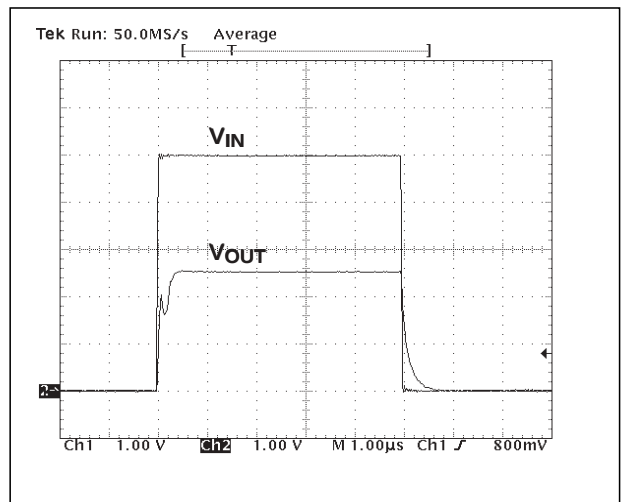


Figure 14. $F_z = 100kHz$, $I_K = 10mA$, $T_A = 25^\circ C$

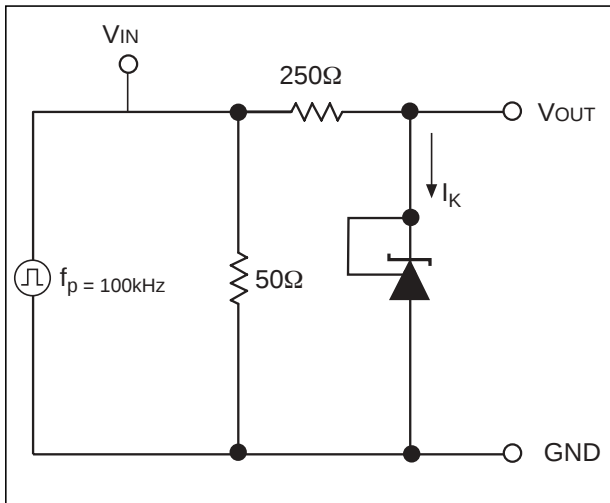


Figure 15. Test Circuit for Pulse Response

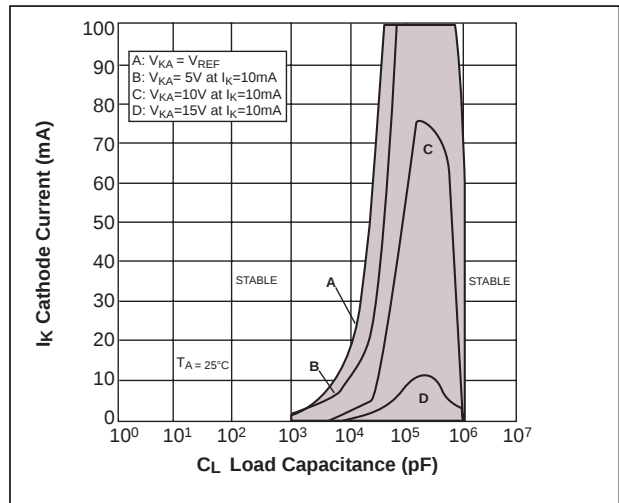


Figure 16. Stability Boundry Conditions

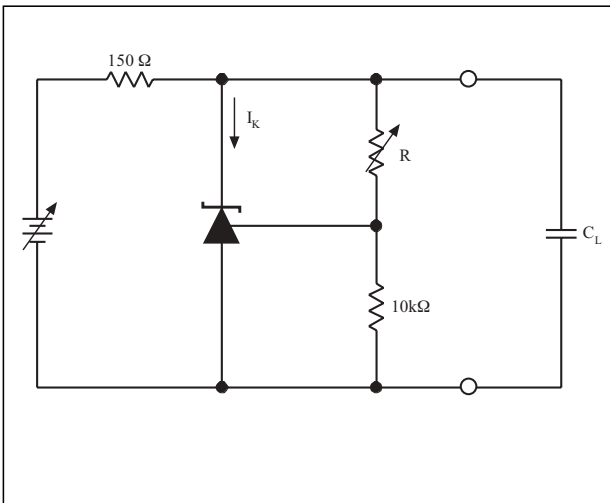


Figure 17. Test Circuit for Stability

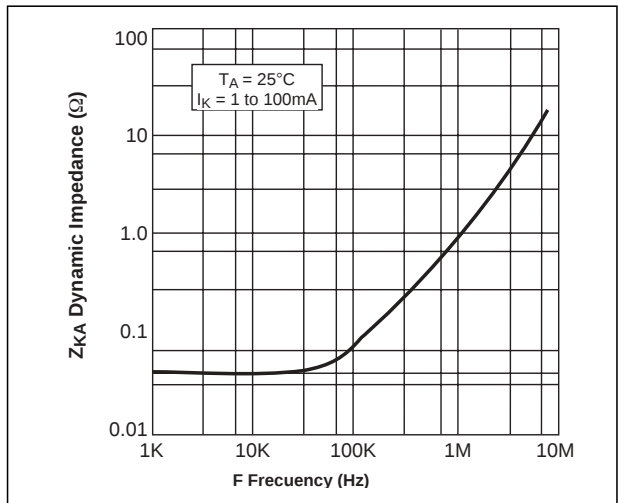


Figure 18. Dynamic Output Impedance $T_A = 25^\circ\text{C}$, $I_K = 1$ to 100mA

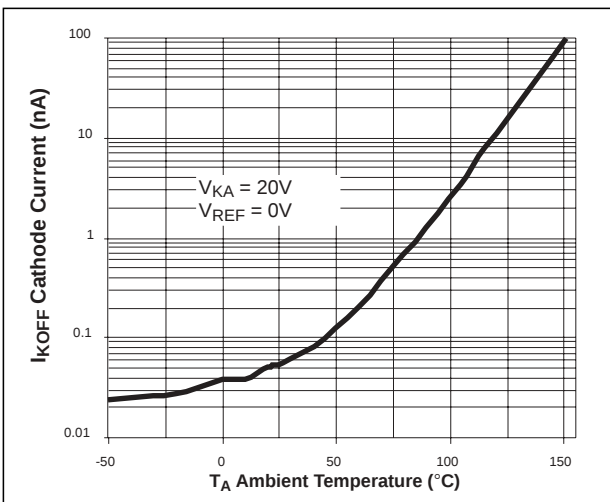


Figure 19. Off State Leakage

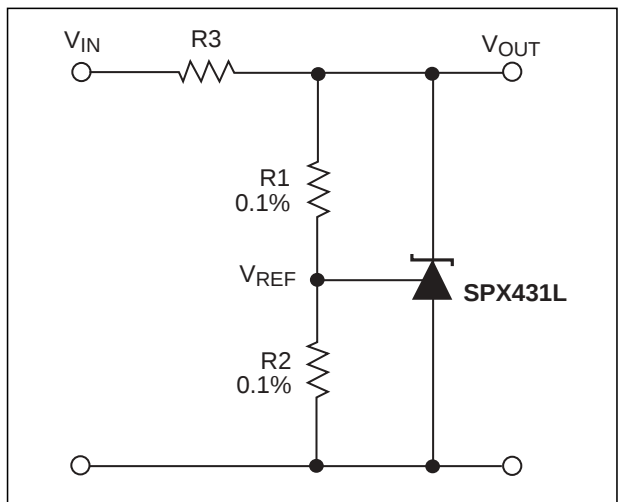


Figure 20. Shunt Regulator $V_{OUT} = (1 + R1/R2)V_{REF}$

TYPICAL PERFORMANCE CHARACTERISTICS

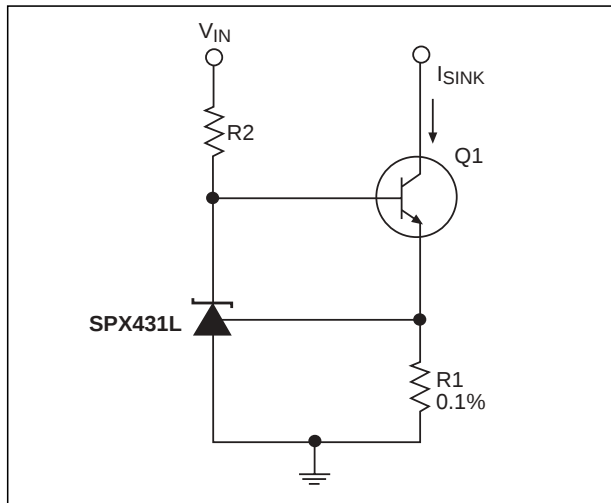


Figure 21. Constant Current Sink, $I_{SINK} = V_{REF}/R1$

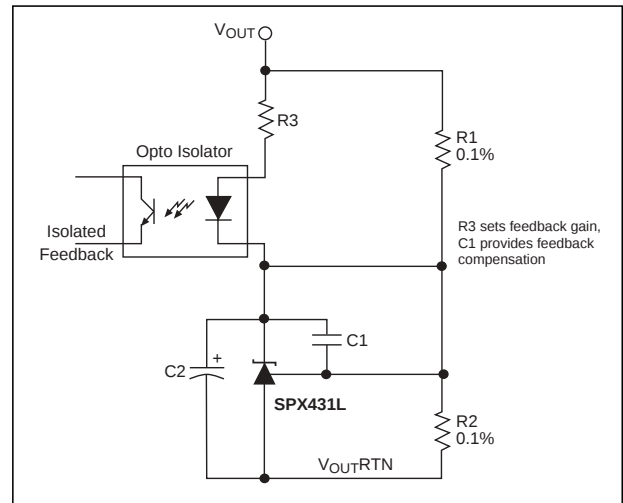


Figure 22. Reference Amplifier for Isolated Feedback in Off-Line DC-DC Converters

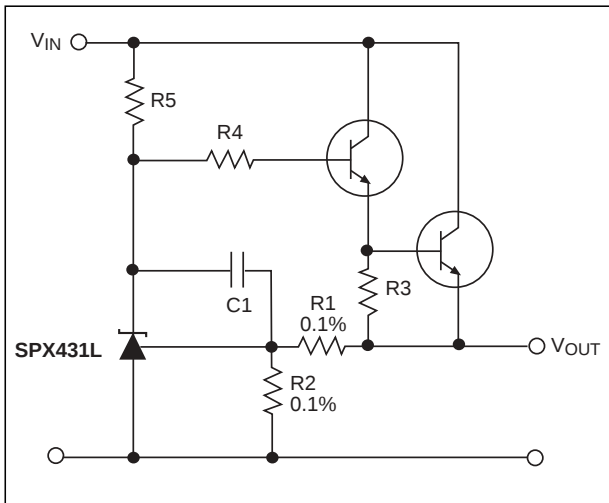


Figure 23. Precision High Current Series Regulator
 $V_{OUT} = (1+R1/R2)V_{REF}$

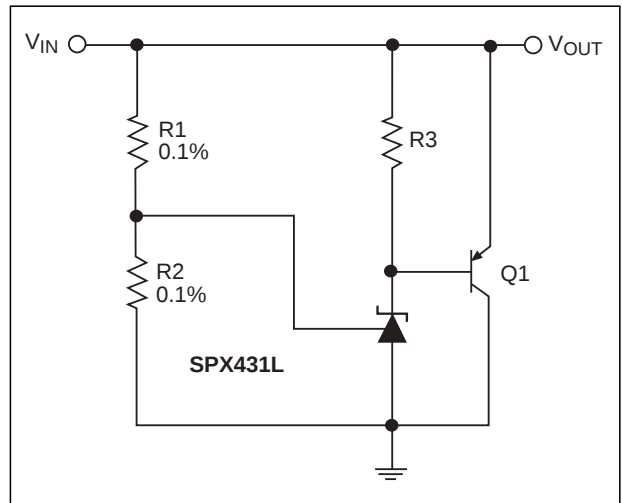


Figure 24. High Current Shunt regulator
 $V_{OUT} = (1+R1/R2)V_{REF}$

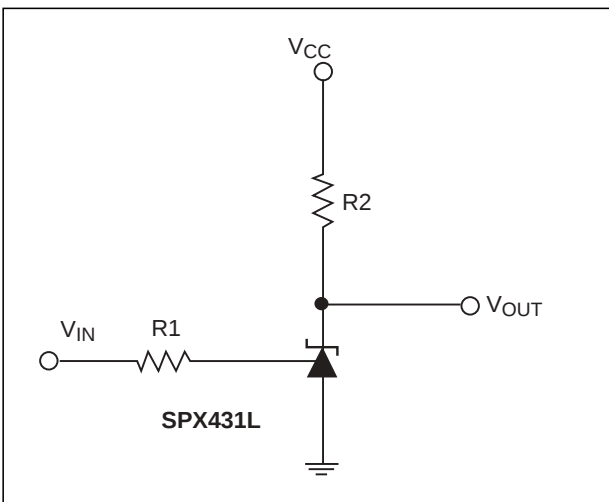
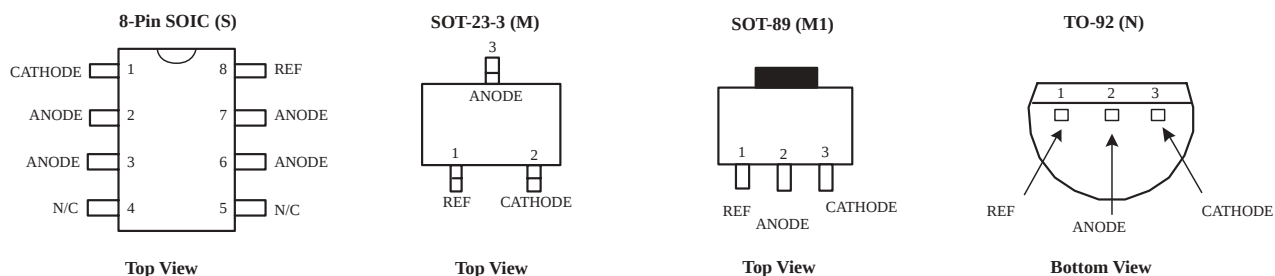
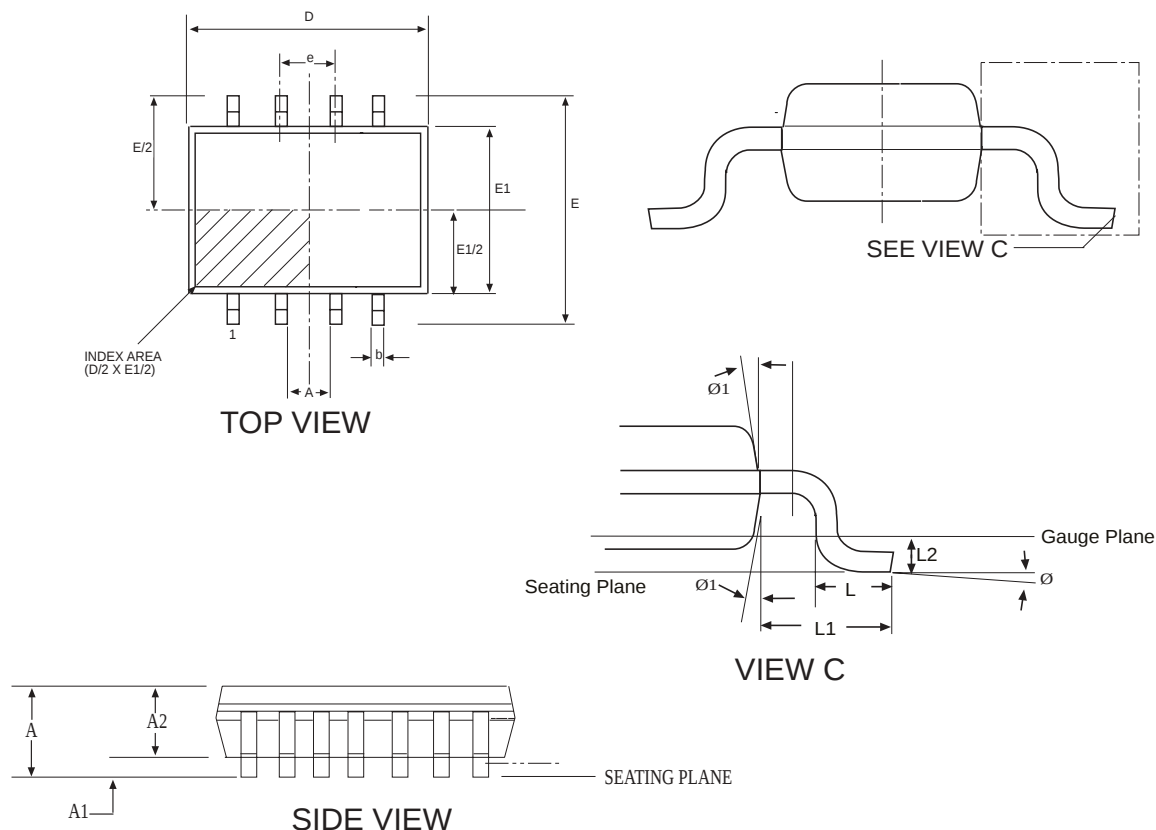


Figure 25. Single Supply Comparator with Temperature Compensated Threshold. V_{IN} threshold = 2.5V.

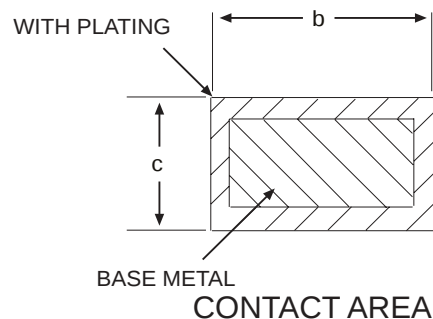
* Resistor values are chosen such that the effect to I_{REF} is negligible.



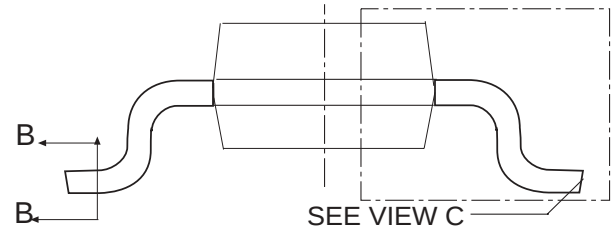
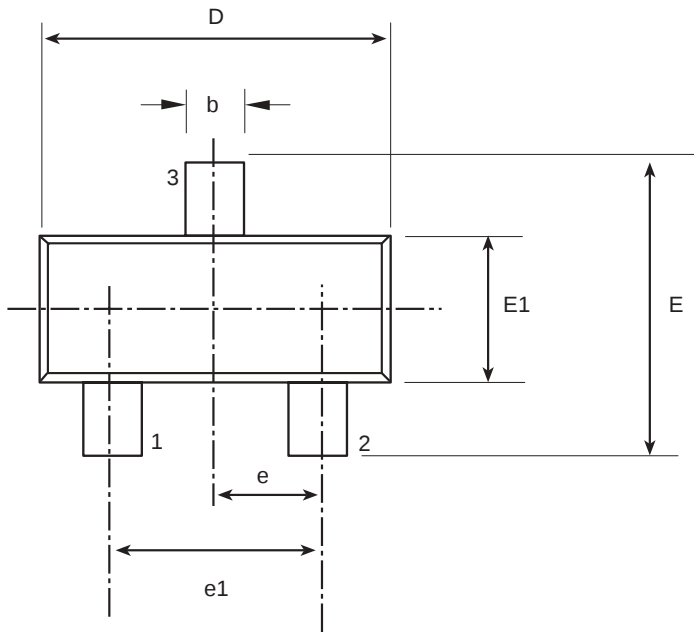
PACKAGE: 8 PIN NSOIC



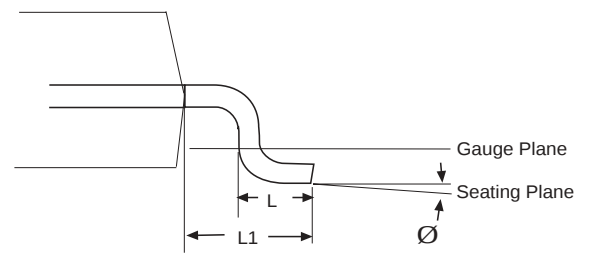
DIMENSIONS Minimum/Maximum (mm)	8 Pin NSOIC (JEDEC MS-012, AA - VARIATION)		
COMMON HEIGHT DIMENSION			
SYMBOL	MIN	NOM	MAX
A	1.35	-	1.75
A1	0.10	-	0.25
A2	1.25	-	1.65
b	0.31	-	0.51
c	0.17	-	0.25
D	4.90 BSC		
E	6.00 BSC		
E1	3.90 BSC		
e	1.27 BSC		
L	0.40	-	1.27
L1	1.04 REF		
L2	0.25 BSC		
Ø	0°	-	8°
Ø1	5°	-	15°



PACKAGE: 8 PIN NSOIC

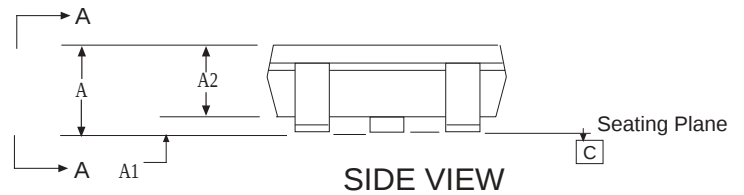


VIEW A-A

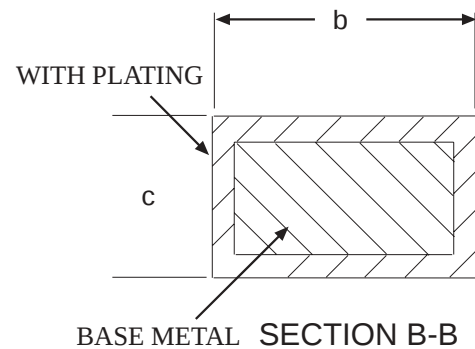


VIEW C

3 PIN SOT-23 JEDEC TO-236 (AB) Variation	Dimensions in (mm)		
	MIN	NOM	MAX
A	0.89	-	1.12
A1	0.01	-	0.10
A2	0.88	0.95	1.02
b	0.30	-	0.50
c	0.08	-	0.20
D	2.80	2.90	3.04
e	0.95 BSC		
e1	1.90 BSC		
E	2.10	-	2.64
E1	1.20	1.30	1.40
L	0.40	0.50	0.60
L1	0.54 REF		
Ø	0°	-	8°

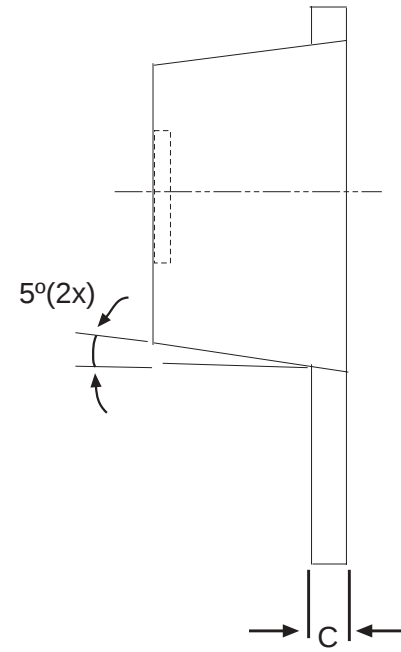
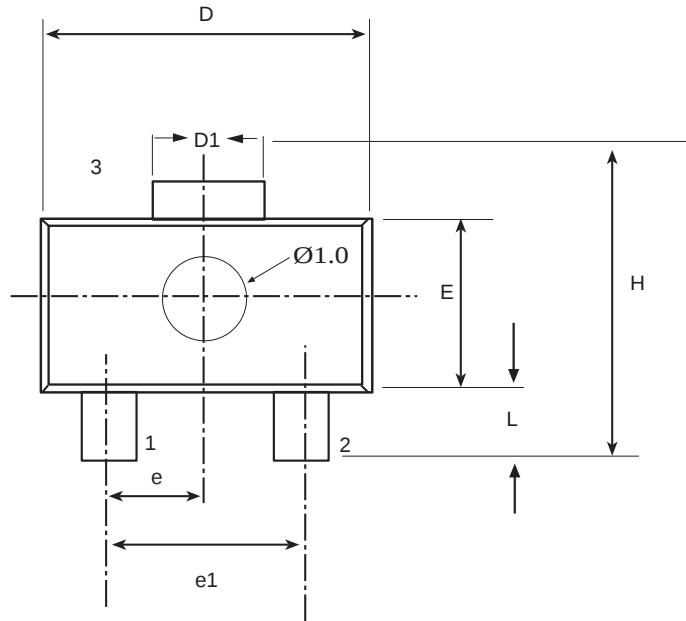


SIDE VIEW

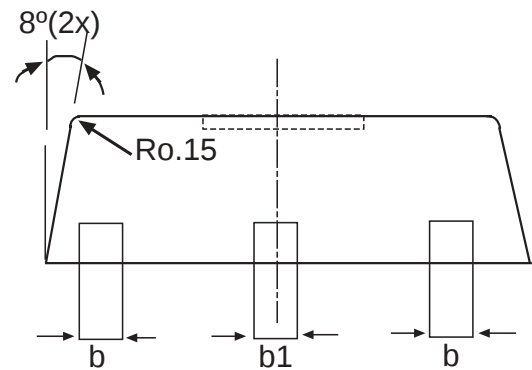


BASE METAL SECTION B-B

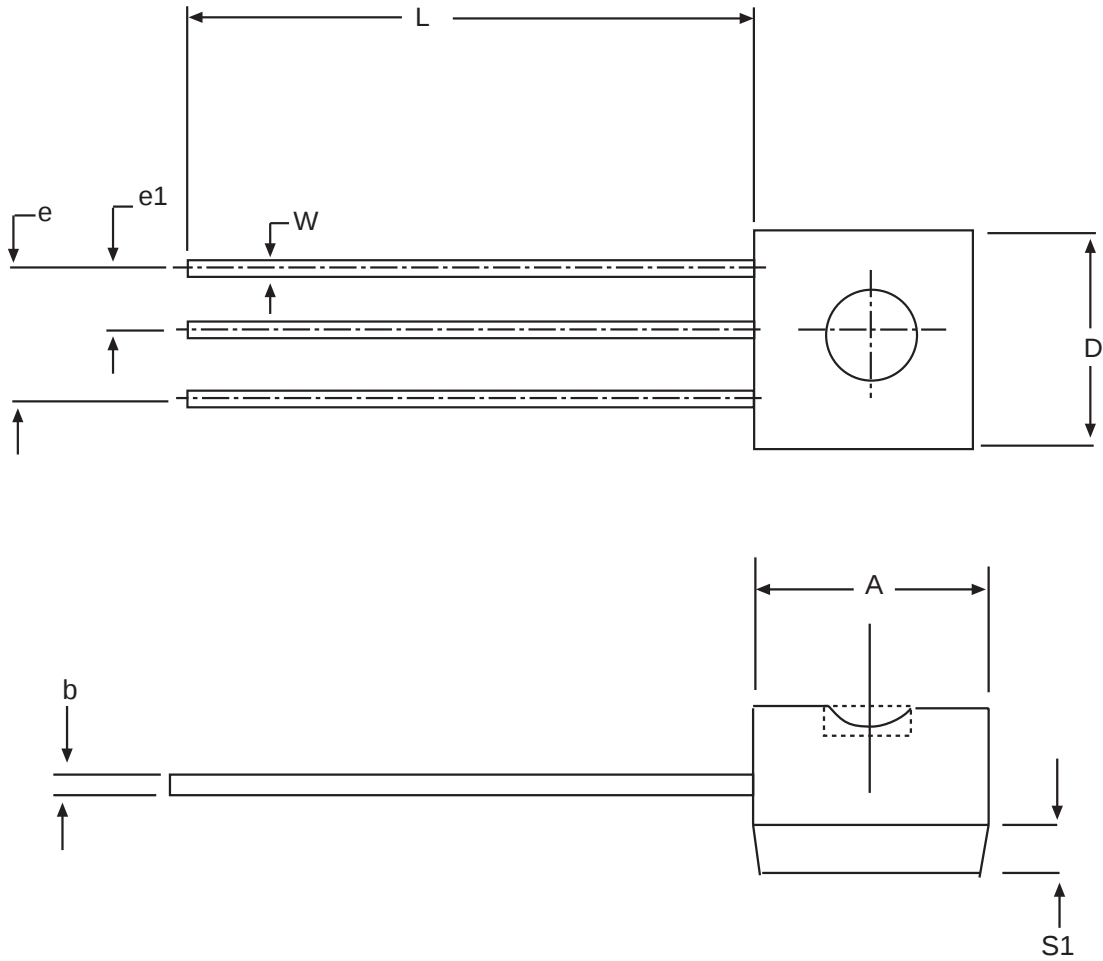
3 PIN SOT-23



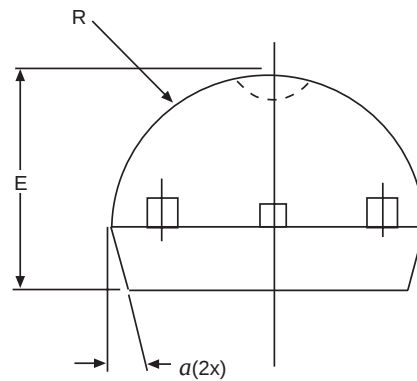
3 PIN SOT-89	Dimensions in (mm)		
	MIN	NOM	MAX
A	1.40	1.50	1.60
b	0.36	0.42	0.48
L	0.80	-	1.20
b1	0.41	0.47	0.53
C	0.38	0.40	0.43
D	4.40	4.50	4.60
D1	1.40	1.60	1.75
H	3.94	-	4.25
E	2.40	2.50	2.60
e	1.45	1.50	1.55
e1	2.90	3.00	3.10



3 PIN SOT-89



3 PIN TO-92	DIMENSIONS IN INCHES		
SYMBOL	MIN	NOM	MAX
A	.170	-	.195
b	.014	-	.020
E	.130	-	.155
e	.095	-	.105
e1	.045	-	.055
L	.500	-	.610
R	.085	-	.095
S1	.045	-	.060
W	.016	-	0.022
D	.175	-	.195
a	4°	-	6°



3 PIN TO-92

PART NUMBER	ACCURACY	OUTPUT VOLTAGE	PACKAGES
SPX431LAM	0.5%	2.503V	3-Pin SOT-23
SPX431LAM/TR	0.5%	2.503V	3-Pin SOT-23
SPX431LAM1	0.5%	2.503V	3-Pin SOT-89
SPX431LAM1/TR	0.5%	2.503V	3-Pin SOT-89
SPX431LAS	0.5%	2.503V	8-Pin nSOIC
SPX431LAS/TR	0.5%	2.503V	8-Pin nSOIC
SPX431LAN	0.5%	2.503V	3-Pin TO-92
SPX431LAN/TR	0.5%	2.503V	3-Pin TO-92
SPX431LM	1.0%	2.495V	3-Pin SOT-23
SPX431LM/TR	1.0%	2.495V	3-Pin SOT-23
SPX431LM1	1.0%	2.495V	3-Pin SOT-89
SPX431LM1/TR	1.0%	2.495V	3-Pin SOT-89
SPX431LS	1.0%	2.495V	8-Pin nSOIC
SPX431LS/TR	1.0%	2.495V	8-Pin nSOIC
SPX431LN	1.0%	2.495V	3-Pin TO-92
SPX431LN/TR	1.0%	2.495V	3-Pin TO-92
SPX431LCM	2.0%	2.495V	3-Pin SOT-23
SPX431LCM/TR	2.0%	2.495V	3-Pin SOT-23
SPX431LCM1	2.0%	2.495V	3-Pin SOT-89
SPX431LCM1/TR	2.0%	2.495V	3-Pin SOT-89
SPX431LCS	2.0%	2.495V	8-Pin nSOIC
SPX431LCS/TR	2.0%	2.495V	8-Pin nSOIC
SPX431LCN	2.0%	2.495V	3-Pin TO-92
SPX431LCN/TR	2.0%	2.495V	3-Pin TO-92

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

Example: SPX431LM/TR = standard; SPX431LM-L/TR = lead free

/TR = Tape and Reel

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



ANALOG EXCELLENCE

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