SPX431A,B,C

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 Equipments
- Adjustable Supplies
- Switching Power Supplies
- Error Amplifiers
- Single Supply Amplifier
- Monitors / VCR / TV
- Personal Computers

PRODUCT 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 manufactures 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.

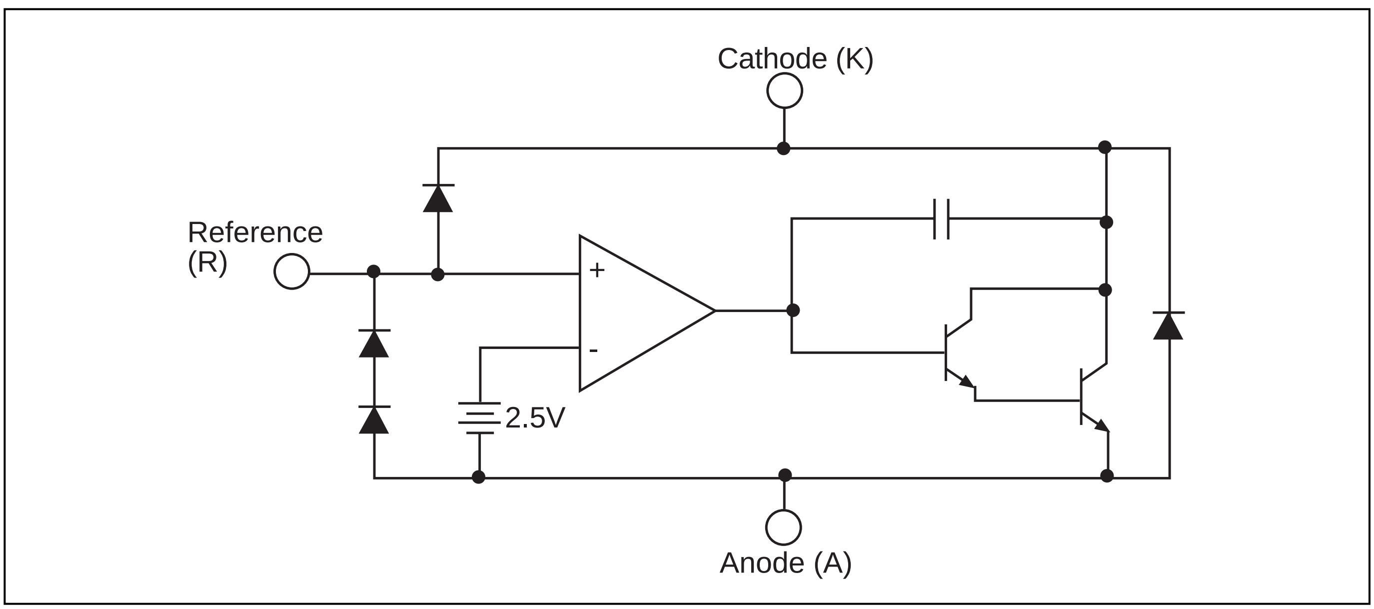


Figure 1. Block Diagram

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATING	UNITS
Cathode-Anode Reverse Breakdown	V_{KA}	37	V
Anode-Cathode Forward Current, (< 10ms)	I_{AK}	1	A
Operating Cathode Current	I_{KA}	150	mA
Reference Input Current	I_{REF}	10	mA
Continuous Power Dissipation at 25° C	P_D		
TO-92		775	mW
SOT-23		200	mW
SOIC-8		750	mW
SOT-89		1000	mW
Junction Temperature	T_J	150	°C
Storage Temperature	T_{STG}	- 65 to 150	°C
Lead Temperature (Soldering 10 sec.)	T_L	300	°C

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	0_{JA}	0_{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

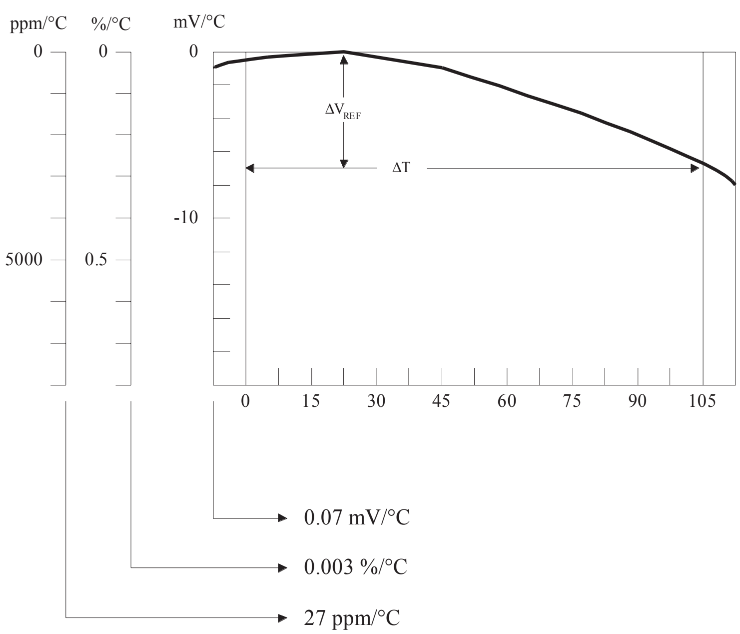
Typical deratings of the thermal resistances are given for ambient temperature >25°C.

ELECTRICAL CHARACTERISTICS at 25°C I_K @ 10mA $V_K = V_{REF}$, unless otherwise specified.

Parameter	Symbol	Test Conditions	Test Circuit	SPX431A			SPX431B			SPX431C			Unit
				Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Reference Voltage	V_{REF}	 T_J = 0°C to 105°C	1 1	2.490 2.469	2.503	2.515 2.536	2.470 2.449	2.495	2.520 2.541	2.445	2.495	2.545	V V
ΔV_{REF} with Temp.*	TC		1		0.07	0.20		0.07	0.20		0.07	0.20	mV/°C
Ratio of Change in V_{REF} to Cathode Voltage	$\frac{\Delta V_{REF}}{\Delta V_K}$	V_{REF} to 10V 10V to 36V	 2	-2.7 -2	-1.0 -0.4	 0.3	-2.7 -2.0	-1.0 -0.4	 0.3	-2.7 -2	-1.0 -0.4	 0.3	mV/V
Reference Input Current	I_{REF}		2		0.7	4		0.7	4		0.7	4	µA
I_{REF} Temp Deviation	ΔI_{REF}	T_J = 0°C to 105°C	2		0.4	1.2		0.4	1.2		0.4	1.2	µA
Min I_K for Regulation	$I_{K(MIN)}$		1		0.4	1		0.4	1		0.4	1	mA
Off State Leakage	$I_{K(OFF)}$	V_{REF} = 0V, V_{KA} = 36V	 3		0.04	250		0.04	500		0.04	1000	nA
Dynamic Output Impedance	Z_{KA}	f_Z = 1kHz I_K = 1 to 150mA	1		0.15	0.5		0.15	0.5		0.15	0.5	Ω

Operating Temperature Range (T_J) = -40°C to 125°C
see appropriate test circuit (Figure 3)

*CALCULATING AVERAGE TEMPERATURE COEFFICIENT (TC)



- TC in mV/°C $= \dfrac{\Delta V_{REF}\,(mV)}{\Delta T_A}$
- TC in %/°C $= \dfrac{\left(\dfrac{\Delta V_{REF}}{\Delta V_{REF} \text{ at } 25°C}\right) \times 100}{\Delta T_A}$
- TC in ppm/°C $= \dfrac{\left(\dfrac{\Delta V_{REF}}{\Delta V_{REF} \text{ at } 25°C}\right) \times 10^6}{\Delta T_A}$

Figure 2. V_{REF} vs. Temperature

TEST CIRCUITS

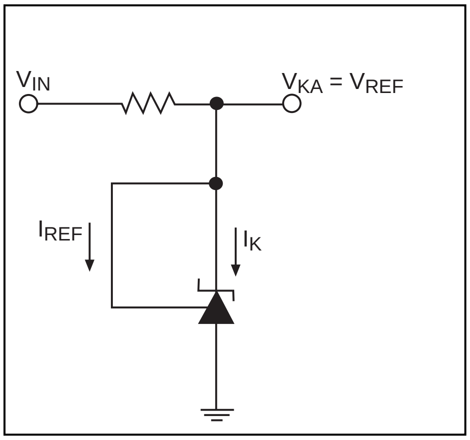


Figure 3a. Test Circuit for $V_{KA} = V_{REF}$

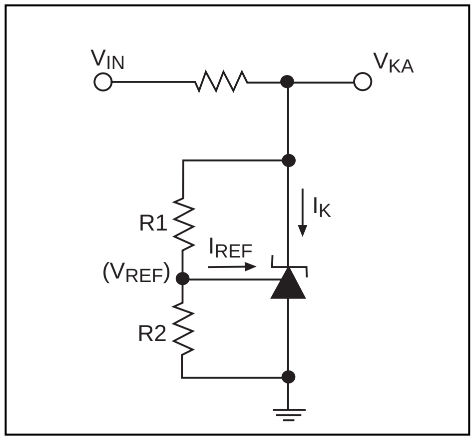


Figure 3b. Test Circuit for $V_{KA} > V_{REF}$

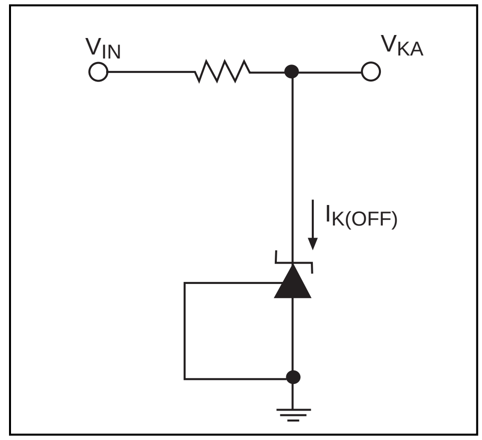


Figure 3c. Test Circuit for I_{KOFF}

TYPICAL PERFORMANCE CHARACTERISTICS

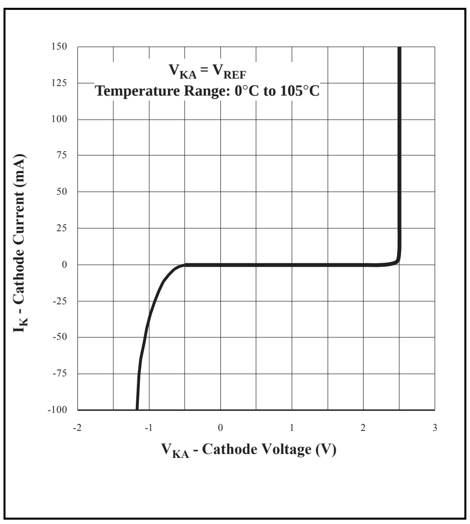


Figure 4. High Current Operating Characteristics

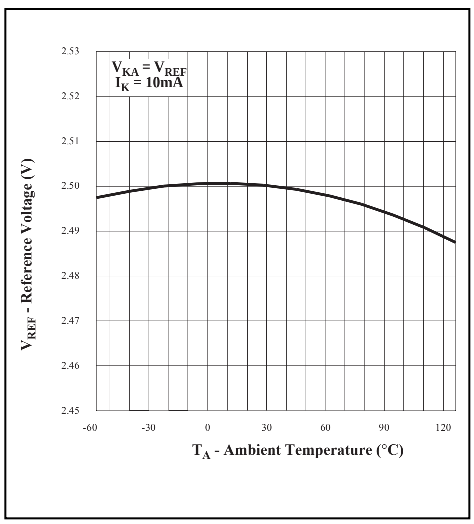


Figure 5. Reference Voltage vs. Ambient Temperature

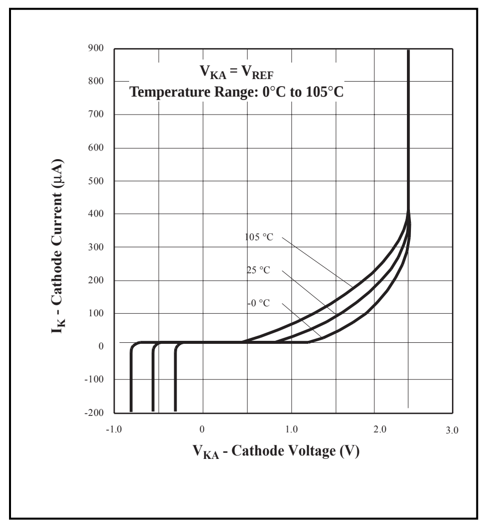


Figure 6. Low Current Operating Characteristics

TYPICAL PERFORMANCE CHARACTERISTICS

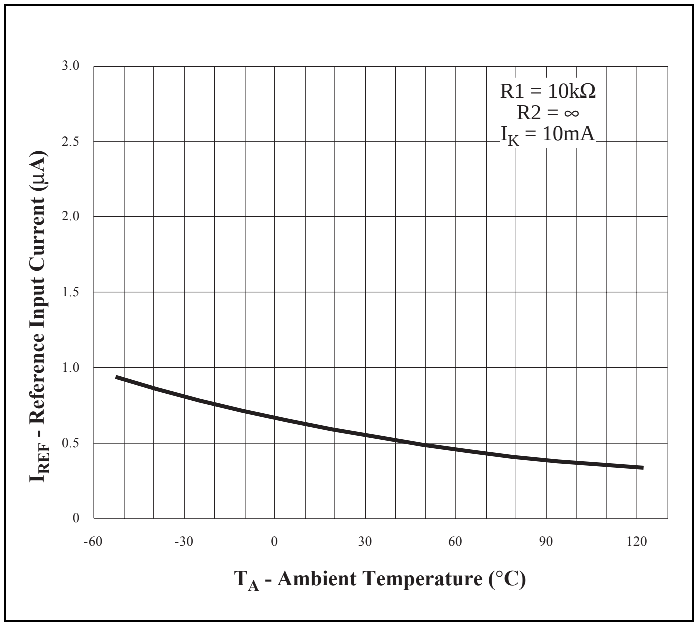


Figure 7. Reference Input Current vs. Ambient Temperature

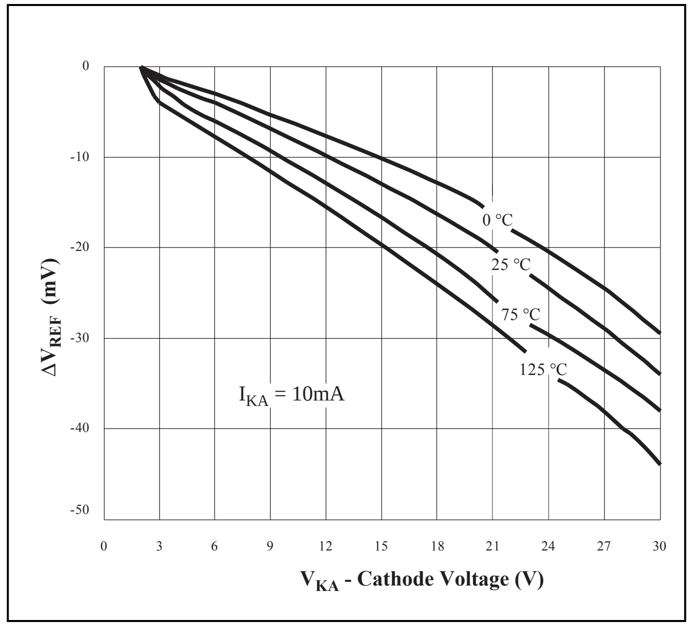


Figure 8. Reference Voltage Line Regulation vs. Cathode Voltage and $T_{AMBIENT}$

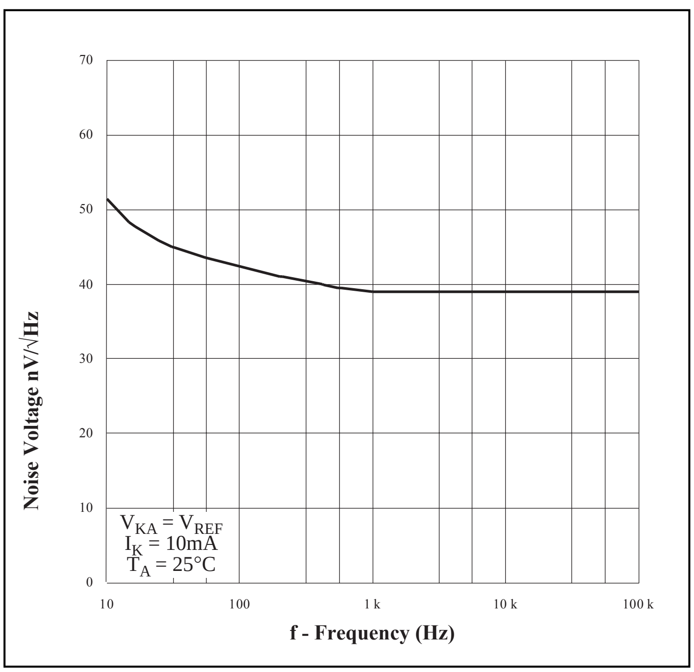


Figure 9. Noise Voltage vs. Frequency

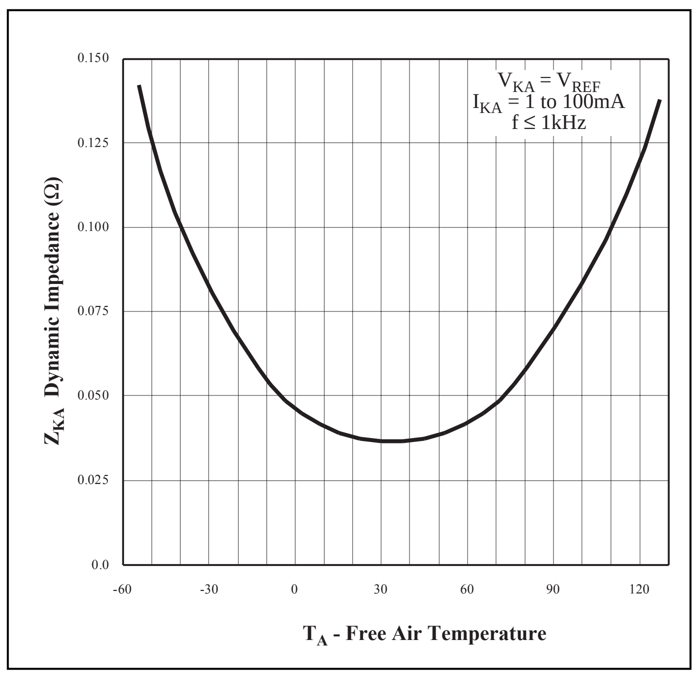


Figure 10. Low Frequency Dynamic Output Impedance vs. $T_{AMBIENT}$

TYPICAL PERFORMANCE CHARACTERISTICS

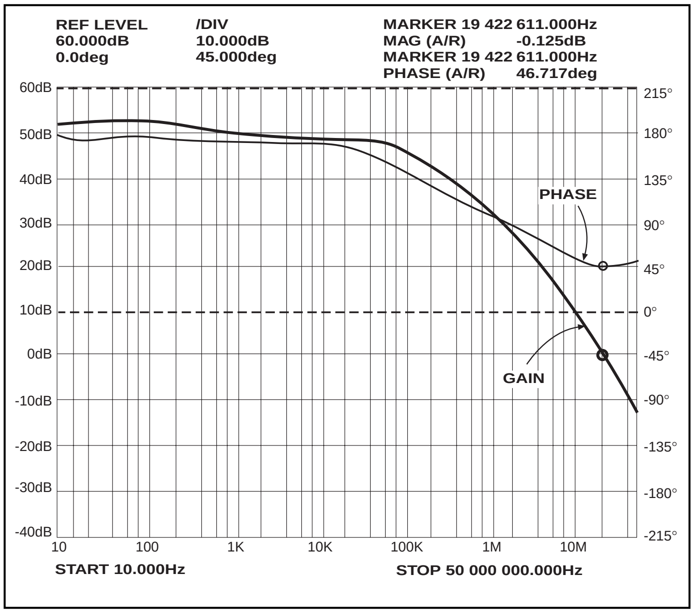


Figure 11a. Small Signal Gain and Phase vs. Frequency; T_A = 25°C

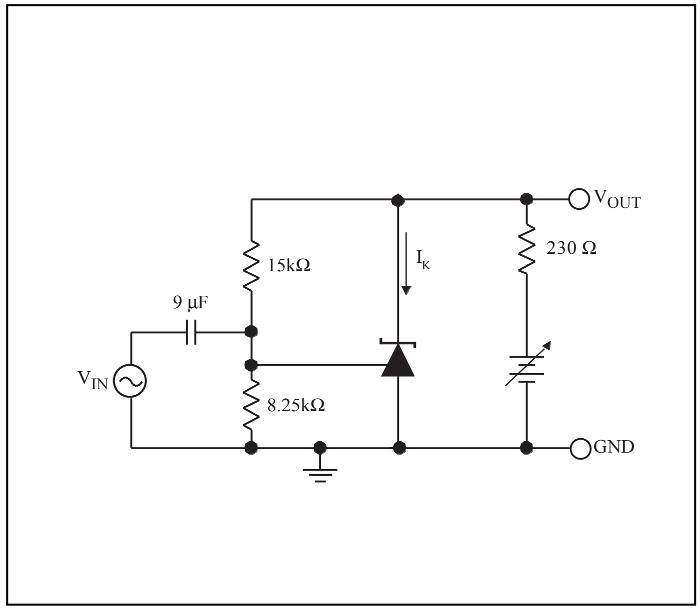


Figure 11b. Test Circuit for Gain and Phase Frequency Response

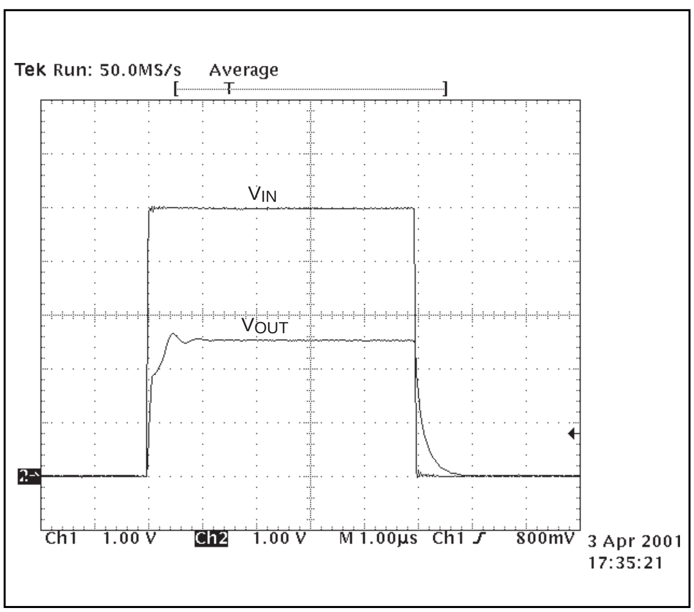


Figure 12a. Frequency = 100kHz, I_K = 10mA, T_A = 25°C

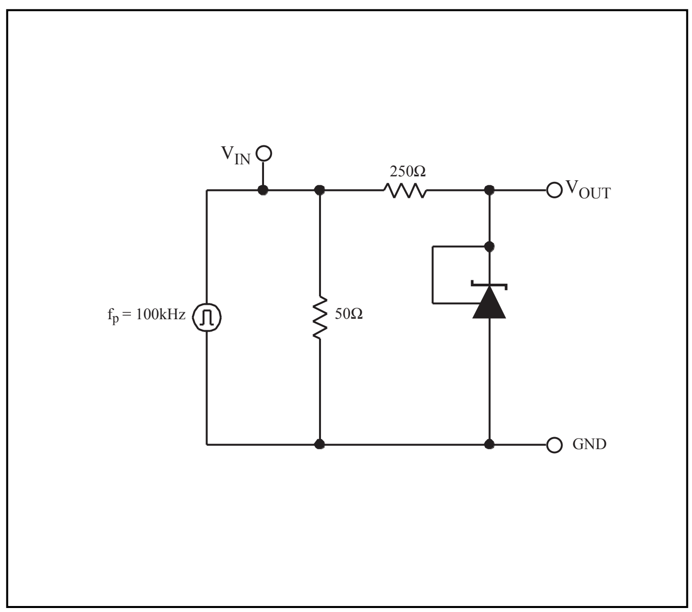


Figure 12b. Test Circuit for Pulse Response

TYPICAL PERFORMANCE CHARACTERISTICS

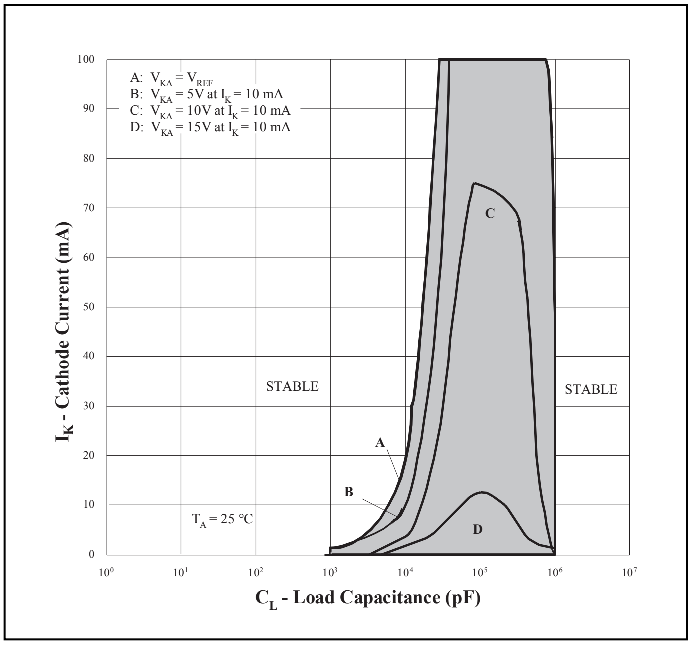


Figure 13a. Stability Boundary Conditions

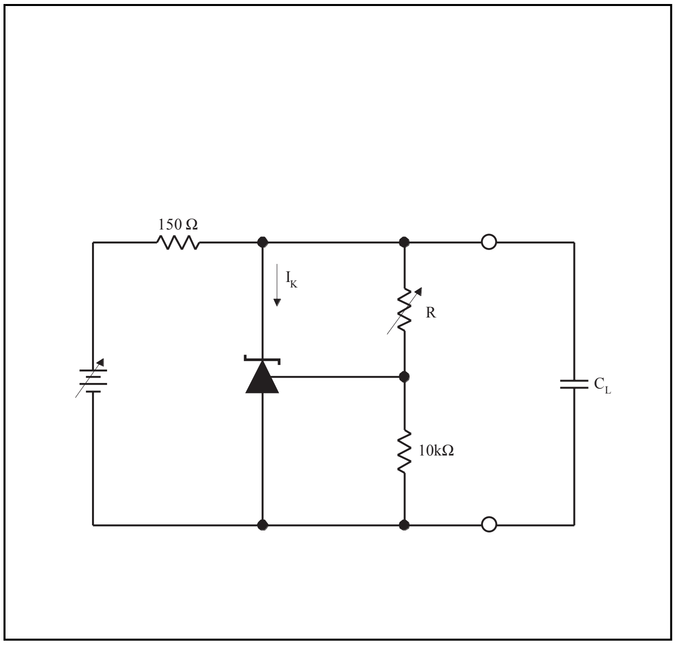


Figure 13b. Test Circuit for Stability

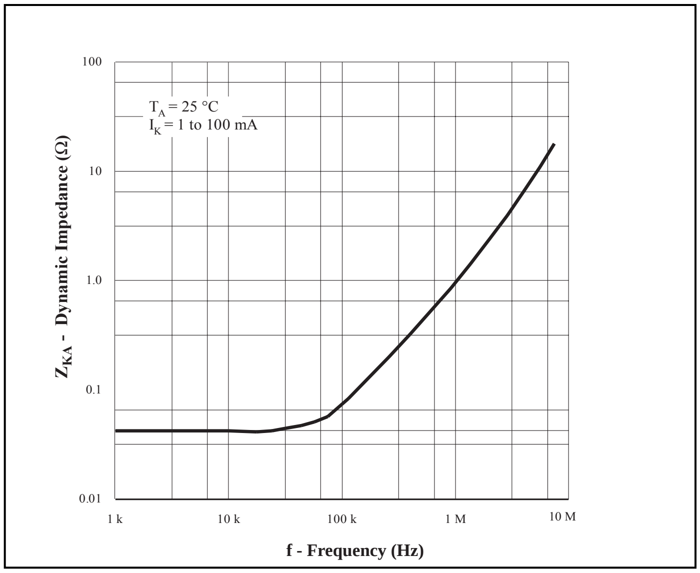


Figure 14. Dynamic Output Impedance T_A = 25°C, I_K = 1 to 100mA

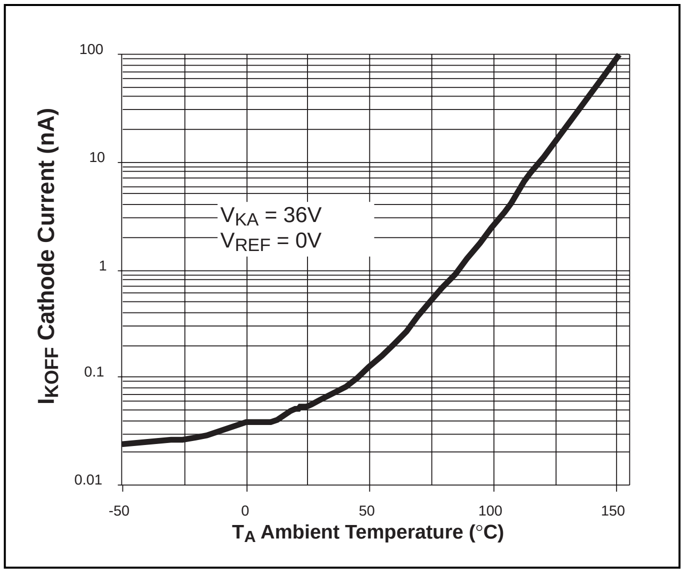


Figure 15. Off State Leakage

APPLICATION CIRCUITS

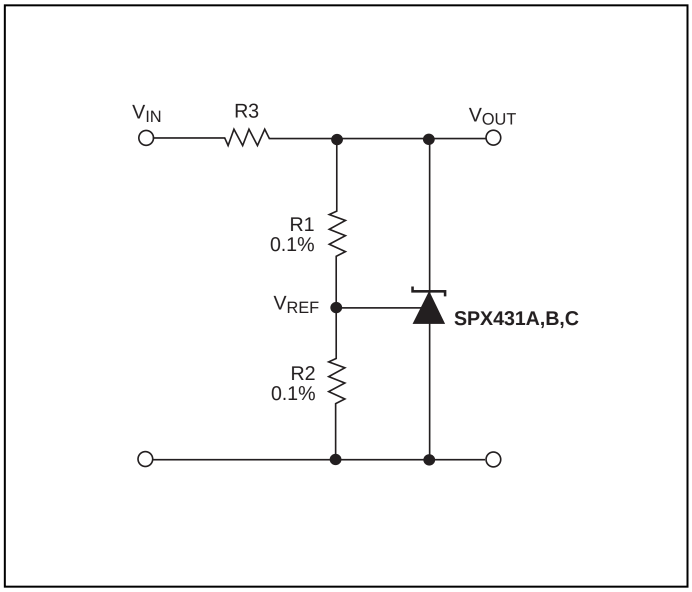


Figure 16. Shunt Regulator $V_{OUT} = (1 + R1/R2)V_{REF}$

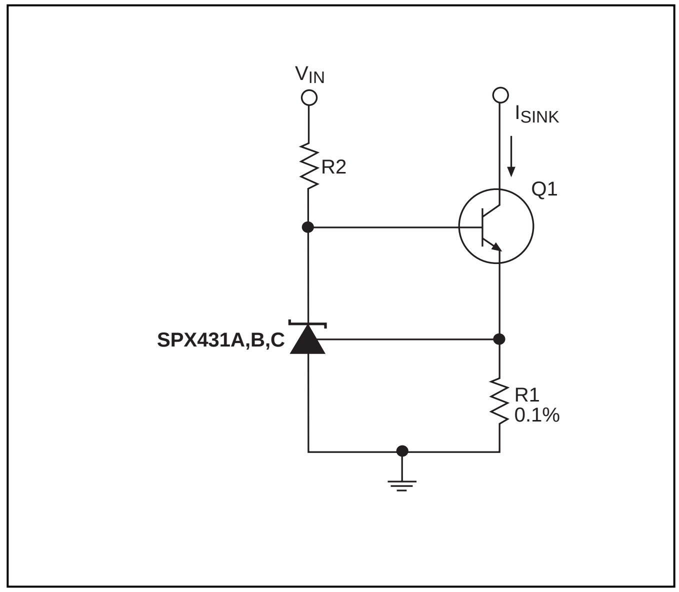


Figure 17. Constant Current, Sink, $I_{SINK} = V_{REF}/R1$

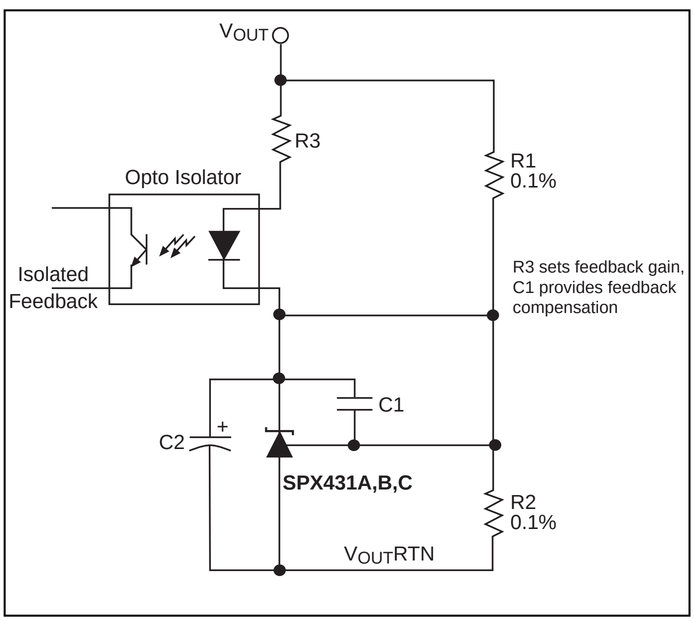


Figure 18. Reference Amplifier for Isolated Feedback in Off-Line DC-DC Converters

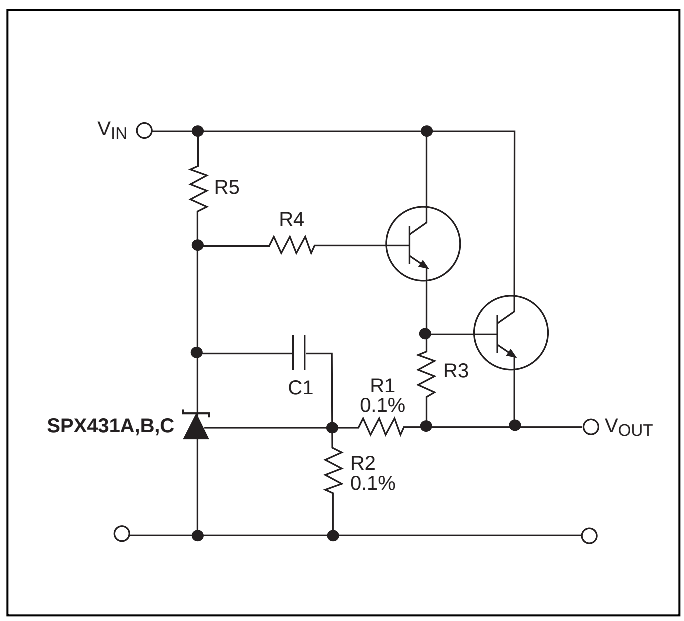


Figure 19. Precision High Current Series Regulator $V_{OUT} = (1 + R1/R2)V_{REF}$

APPLICATION CIRCUITS

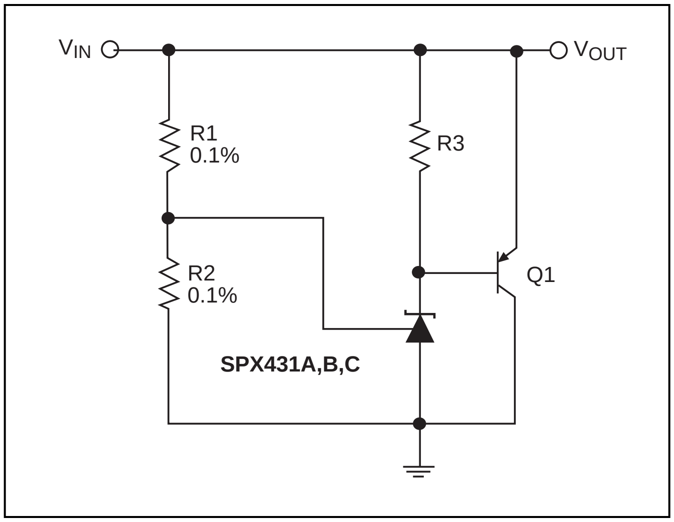


Figure 20. High Current Shunt Regulator
V_{OUT} = (1 + R1/R2)V_{REF}

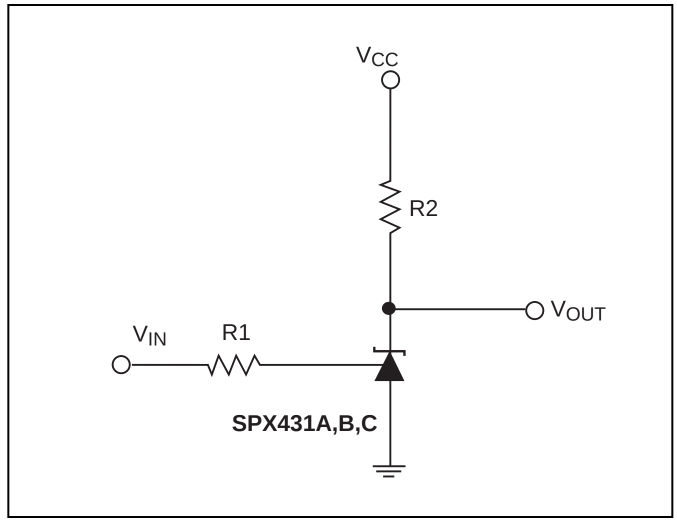
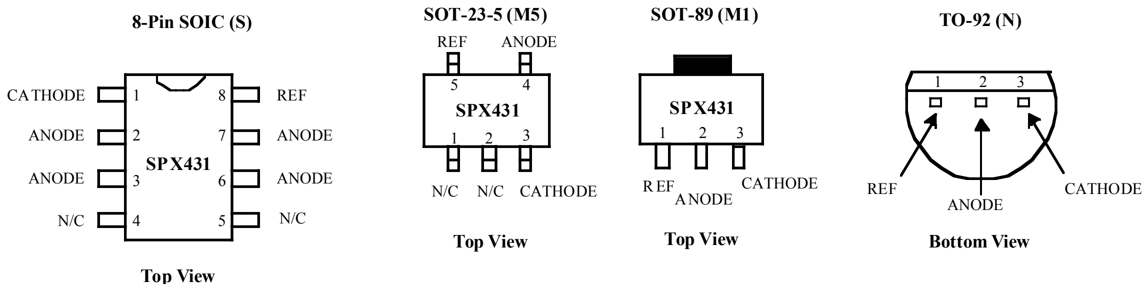


Figure 21. Single Supply Comparator with Temperature Compensated Threshold. V_{IN} threshold = 2.5V

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

PACKAGES



ORDERING INFORMATION

Ordering No.	Accuracy	Output Voltage	Packages
SPX431AM5	0.5%	2.503V	5-Pin SOT-23
SPX431AM1	0.5%	2.503V	3-Pin SOT-89
SPX431AS	0.5%	2.503V	8-Pin SOIC
SPX431AN	0.5%	2.503V	3-Pin TO-92
SPX431BM5	1.0%	2.495V	5-Pin SOT-23
SPX431BM1	1.0%	2.495V	3-Pin SOT-89
SPX431BS	1.0%	2.495V	8-Pin SOIC
SPX431BN	1.0%	2.495V	3-Pin TO-92
SPX431CM5	2.0%	2.495V	5-Pin SOT-23
SPX431CM1	2.0%	2.495V	3-Pin SOT-89
SPX431CS	2.0%	2.495V	8-Pin SOIC
SPX431CN	2.0%	2.495V	3-Pin TO-92

SIGNAL PROCESSING EXCELLENCE

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