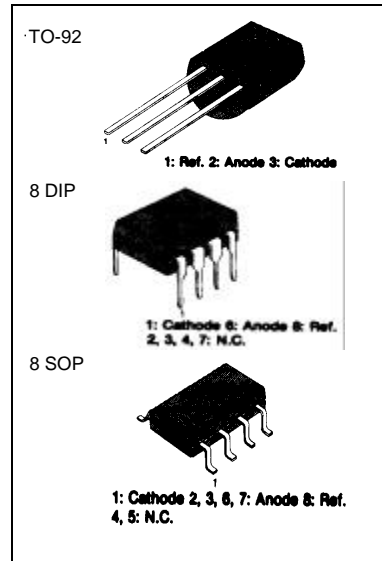


**PROGRAMMABLE SHUNT REGULATOR**

The LM431 Series are three-terminal adjustable regulator series with a guaranteed thermal stability over applicable temperature ranges. The output voltage may be set to any value between  $V_{REF}$  (approximately 2.5 volts) and 36 volts with two external resistors. These devices have a typical dynamic output impedance of  $0.2\Omega$ . Active output circuitry provides a very sharp turn-on characteristic, making these devices excellent replacement for zener diodes in many applications.

**FEATURES**

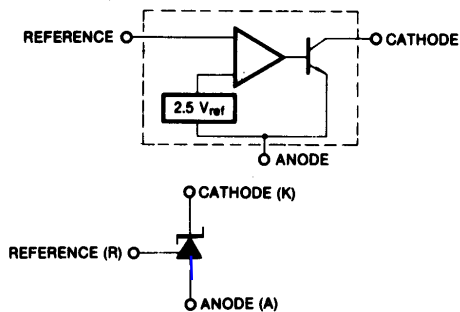
- Programmable output voltage to 36 volts
- Low dynamic output impedance 0.20 typical
- Sink current capability of 1.0 to 100mA
- Equivalent full-range temperature coefficient of 50ppm/°C typical
- Temperature compensated for operation over full rated operating temperature range
- Low output noise voltage
- Fast turn-on response



**ORDERING INFORMATION**

Device	Operating Temperature	Package
LM431ACZ (TL431CLP) (KA431Z)	-25 ~ + 85 °C	TO-92
TL431CP (KA431)	-25 ~ + 85 °C	8 DIP
LM431ACM (TL431CD) (KA431D)	-25 ~ + 85 °C	8 SOP
LM431BCZ (TL431ACL) (KA431AZ)	-25 ~ + 85 °C	TO-92
LM431BCM (TL431ACD) (KA431AD)	-25 ~ + 85 °C	8 SOP
LM431CCZ (KA431LZ)	-25 ~ + 85 °C	TO-92

**BLOCK DIAGRAM**



**ABSOLUTE MAXIMUM RATINGS**

(Operating temperature range applies unless otherwise specified.)

Characteristic	Symbol	Value	Unit
Cathode Voltage	$V_{KA}$	37	V
Cathode current Range (Continuous)	$I_{KA}$	-100 ~ + 150	mA
Reference Input Current Range	$I_{REF}$	0.05 ~ + 10	mA
Power Dissipation D, Z Suffix Package	$P_D$	770	mW
N Suffix Package		1000	mW
Operating Temperature Range	$T_{OPR}$	-25 ~ + 85	°C
Storage Temperature Range	$T_{STG}$	-65 ~ + 150	°C

**RECOMMENDED OPERATING CONDITIONS**

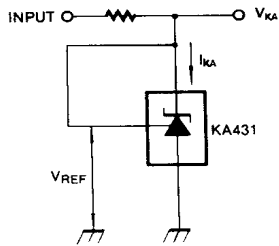
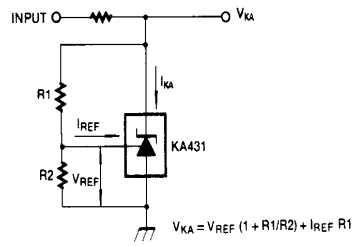
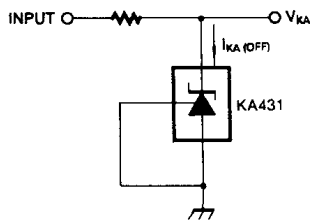
Characteristic	Symbol	Min	Typ	Max	Unit
Cathode Voltage	$V_{KA}$	$V_{REF}$		36	V
Cathode Current	$I_{KA}$	1.0		100	mA

**ELECTRICAL CHARACTERISTICS** ( $T_A = +25^\circ\text{C}$ , unless otherwise specified)

Characteristic	Symbol	Test Conditions	TL431			TL431A			TL431L			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Reference Input Voltage	$V_{REF}$	$V_{KA}=V_{REF}, I_{KA}=10\text{mA}$	2.440	2.495	2.550	2.470	2.495	2.520	2.482	2.495	2.508	V
Deviation of Reference Input Voltage Over-Temperature (Note 1)	$DV_{REF}/DT$	$V_{KA}=V_{REF}, I_{KA}=10\text{mA}$ $T_{MIN} \leq T_A \leq T_{MAX}$		4.5	17		4.5	17		4.5	17	mV
Ratio of Change in Reference Input Voltage to the Change in Cathode Voltage	$DV_{REF}/DI_{KA}$	$I_{KA}=10\text{mA}$										mV/W
		$DI_{KA}=10\text{V}-V_{REF}$		-10	-2.7		-1.0	-2.7		-1.0	-2.7	
		$DI_{KA}=36\text{V}-10\text{V}$		-0.5	-2.0		-0.5	-2.0		-0.5	-2.0	
Reference Input Current	$I_{REF}$	$I_{KA}=10\text{mA}, R_1=10\text{K}\Omega, R_2=\infty$	1.5	4		1.5	4		1.5	4		$\mu\text{A}$
Deviation of Reference Input Current Over Full Temperature Range	$DI_{REF}/DT$	$I_{KA}=10\text{mA}, R_1=10\text{K}\Omega, R_2=\infty$ $T_A = \text{Full Range}$		0.4	1.2		0.4	1.2		0.4	1.2	$\mu\text{A}$
Minimum Cathode Current for Regulation	$I_{KA(MIN)}$	$V_{KA}=V_{REF}$		0.45	1.0		0.45	1.0		0.45	1.0	mA
Off - Stage Cathode Current	$I_{KA(OFF)}$	$V_{KA}=36\text{V}, V_{REF}=0$		0.05	1.0		0.05	1.0		0.05	1.0	$\mu\text{A}$
Dynamic Impedance (Note 2)	$Z_{KA}$	$V_{KA}=V_{REF}, I_{KA}=1 \text{ to } 100\text{mA}$ f 1.0K $\Omega$		0.15	0.5		0.15	0.5		0.15	0.5	$\Omega$

 $T_{MIN} = -25^\circ\text{C}$ ,  $T_{MAX} = +85^\circ\text{C}$

## TEST CIRCUITS

Fig. 1 Test Circuit for  $V_{KA} = V_{REF}$ Fig. 2 Test Circuit for  $V_{KA} \geq V_{REF}$ Fig. 3 Test Circuit for  $I_{KA(OFF)}$ 

TYPICAL PERFORMANCE CHARACTERISTICS

Fig. 4 Cathode Current vs. Cathode Voltage

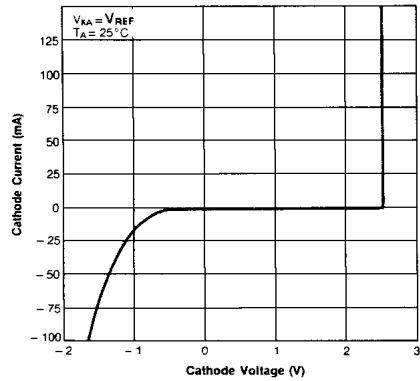


Fig. 5 Cathode Current vs. Cathode Voltage

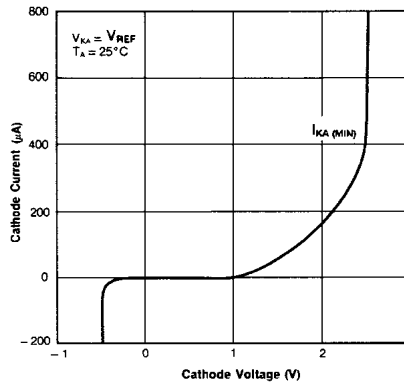


Fig. 6 Change In Reference Input Voltage vs. Cathode Voltage

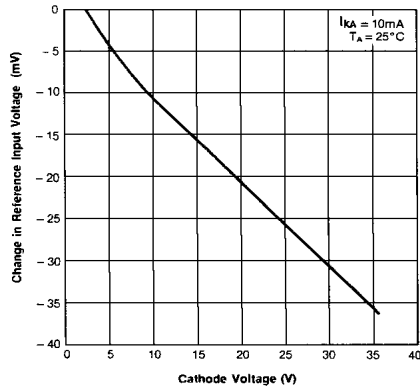


Fig. 7 Dynamic Impedance Frequency

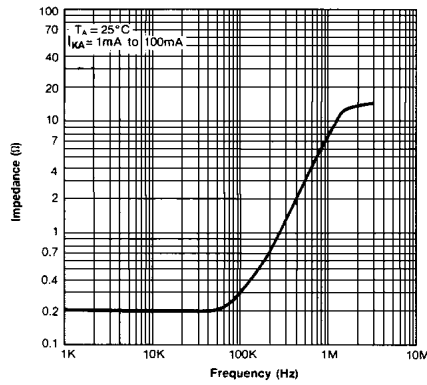


Fig. 8 Small Signal Voltage Amplification vs. Frequency

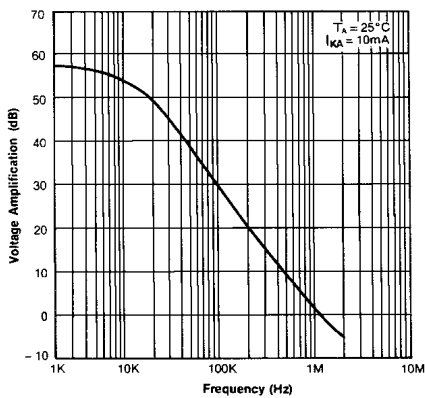
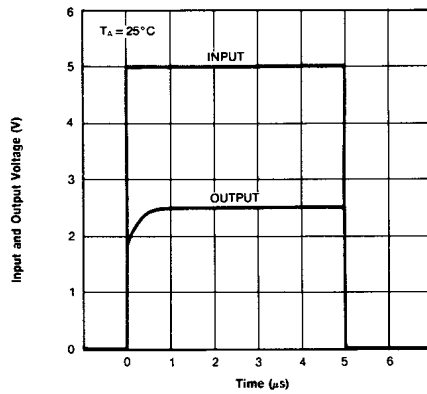


Fig. 9 Pulse Response



TYPICAL APPLICATIONS

Fig. 10 Shunt Regulator

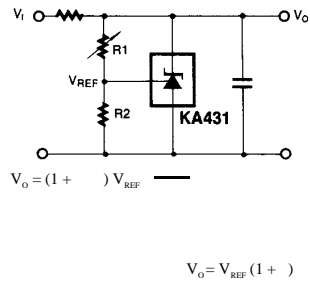


Fig.11 Output Control for a Three-Terminal Fixed Regulator

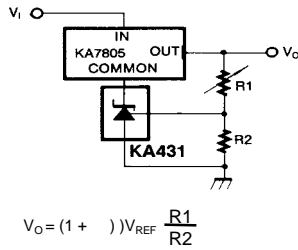


Fig.12 High Current Shunt Regulator

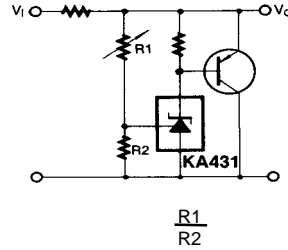


Fig. 13 Current Limit or Current Source

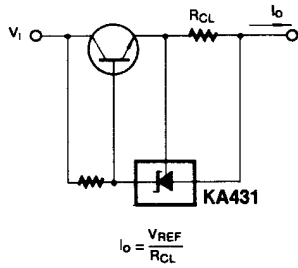
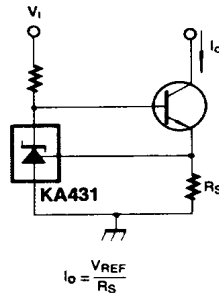


Fig. 14 Constant-Current Sink



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E <sup>2</sup> CMOS <sup>TM</sup>	PowerTrench <sup>®</sup>	
FACT <sup>TM</sup>	QFET <sup>TM</sup>	
FACT Quiet Series <sup>TM</sup>	QS <sup>TM</sup>	
FAST <sup>®</sup>	Quiet Series <sup>TM</sup>	
FAST <sub>r</sub> <sup>TM</sup>	SuperSOT <sup>TM</sup> -3	
GTO <sup>TM</sup>	SuperSOT <sup>TM</sup> -6	
HiSeC <sup>TM</sup>	SuperSOT <sup>TM</sup> -8	

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