

**GENERAL DESCRIPTION**

The L431 is a three-terminal adjustable shunt regulator utilizing an accurate 2.5V band-gap reference. The output voltage can be set to any value between 2.5V ( $V_{REF}$ ) to 29V with two external resistors as shown in the typical application circuit. The device exhibit a wide operating current range of 0.4 to 70 mA with a typical dynamic impedance of  $0.25\Omega$ . The characteristics of these reference make it excellent replacements for zener diodes in many applications such as digital voltmeters, power supplies, and op amp circuitry. The 2.5V volt reference makes it convenient to obtain a stable reference from 5.0V logic supplies. The L431 shunt regulator is available in three voltage tolerances (0.5%, 1.0% and 2%) and three package options (TO-92, SOT-23-3, SOT-23-5 and SOIC-8).

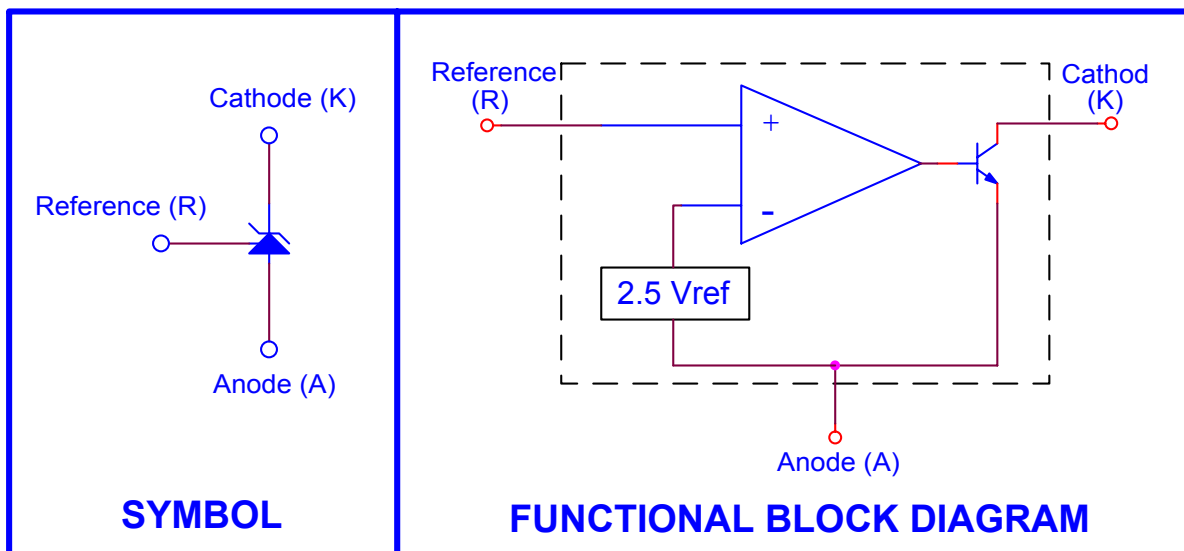
**FEATURES**

- Internal amplifier with 70 mA capability
- Programmable output voltage to 29V
- $0.25\Omega$  typical output impedance
- Pin to pin compatible with LM431
- Trimmed band-gap design 0.5%, 1.0% and 2% with three package options
- Low cost solution

**APPLICATIONS**

- Linear regulator controller
- Precision voltage reference
- Switching power supplies
- Battery operating equipment
- Instrumentation
- PCs, Computer disk drives

**SYMBOL & BLOCK DIAGRAM**



**ABSOLUTE MAXIMUM RATINGS**

PARAMETER	VALUE
Cathode-Anode Reverse Breakdown Voltage - $V_{KA}$	30V
Anode-Cathode Forward Current - $I_{AK}$	70 mA
Reference Input Current - $I_{REF}$	10 mA
Storage Temperature Range - $T_{STG}$	-65 to +150 °C
Junction Temperature - $T_J$	150 °C
Lead Temperature (Soldering, 10 Seconds) - $T_L$	300 °C
Continuous Power at 25 °C - $P_D$	
TO-92	700 mW
SOIC-8	650 mW
SOT-23	200 mW

**RECOMMENDED CONDITIONS**

Parameter	Rating
Cathode Voltage ( $V_{KA}$ )	$V_{REF}$ to 29V
Cathode Current ( $I_K$ )	10 mA

**TYPICAL THERMAL RESISTANCES**

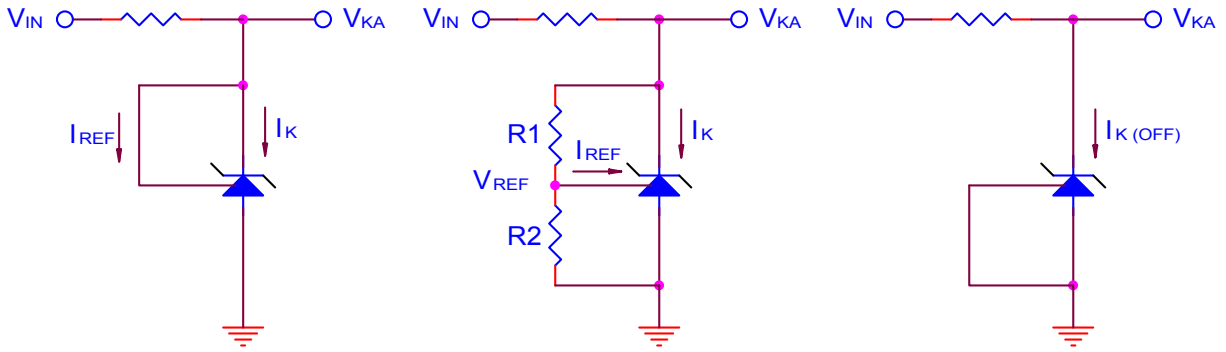
Package	$\theta_{JA}$	$\theta_{JC}$	Typ. Derating
TO-92	160 °C/W	80 °C/W	6.3 mW/°C
SOIC-8	175 °C/W	45 °C/W	5.7 mW/°C
SOT-23	575 °C/W	150 °C/W	1.7 mW/°C

**ELECTRICAL SPECIFICATIONS**

(Ambient temperature must be derated base on power dissipation and package thermal characteristics. The conditions are:  $V_{KA} = V_{REF}$  and  $I_K = 10$  mA unless otherwise stated)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS	TEST CIRCUIT
Reference Voltage	$T_A = 25$ °C, L431 (0.5%)	2.482	2.495	2.507	V	1
	$T_A = 25$ °C, L431 (1%)	2.470	2.495	2.520		
	$T_A = 25$ °C, L431 (2%)	2.445	2.495	2.550		
$\Delta V_{REF}$ with Temp.			0.07	0.2	mV/°C	1
Ration of Change in $V_{REF}$ to Cathode Voltage	$V_{REF}$ to 10V	-2.7	-1.0		mV/V	2
	10V to 30V	-2.0	-0.4	0.3		
Reference Input Current			0.7	4	$\mu$ A	2
$I_{REF}$ Temp. Deviation	Over Temp.		0.4	1.2	$\mu$ A	2
Min. $I_K$ for Regulation			0.4	1	mA	1
Off State Leakage	$V_{REF} = 0V, V_{KA} = 30V$		0.04	250	nA	3
Dynamic Output Impedance	$f \leq 1KHz, I_K = 1$ to 70 mA		0.25	0.5	$\Omega$	1

**TEST CIRCUITS**

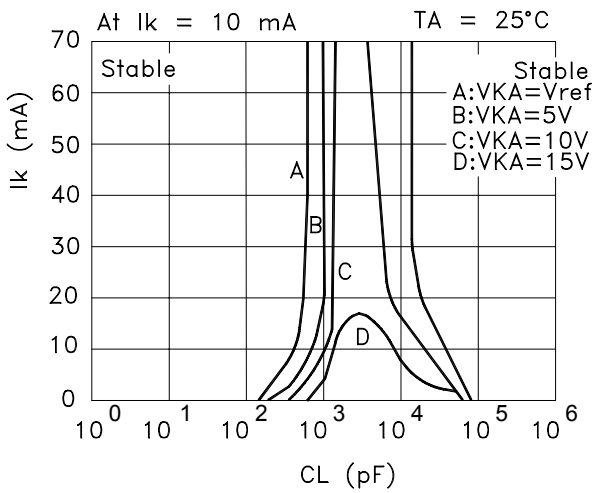


- TEST CIRCUIT 1 -  
( $V_{KA} = V_{REF}$ )

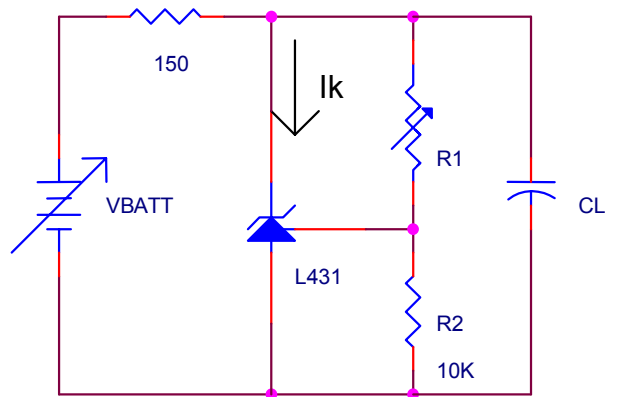
- TEST CIRCUIT 2 -  
( $V_{KA} > V_{REF}$ )

- TEST CIRCUIT 3 -  
(OFF STATE CURRENT)

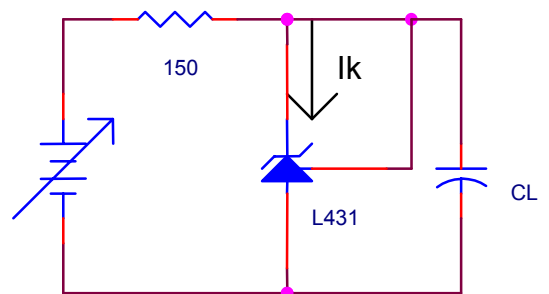
**Stability Boundary Condition For Shunt Regulation  
VS. Cathode Current and Load Capacitance**



**Test Circuit for  $V_{ka} > V_{ref}$**

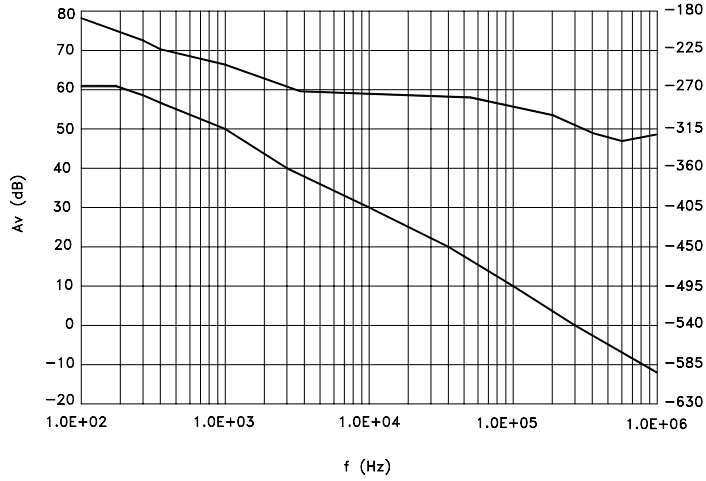


**Test Circuit for  $V_{ka} = V_{ref}$**

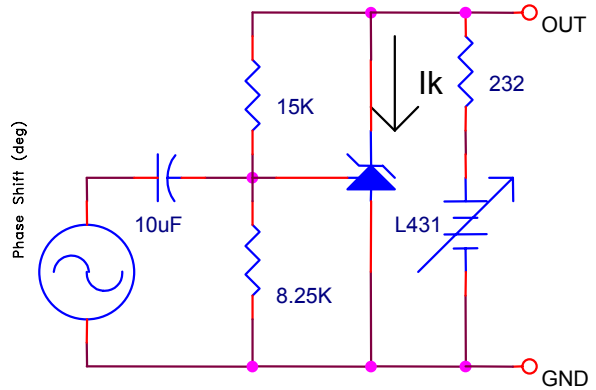


The areas under the curves represent conditions that may cause the device to oscillate. For curves B, C and D, R1 and VBATT were adjusted to establish the initial Vka and Ika conditions with CL = 0. VBATT and CL then were adjusted to determine the ranges of stability.

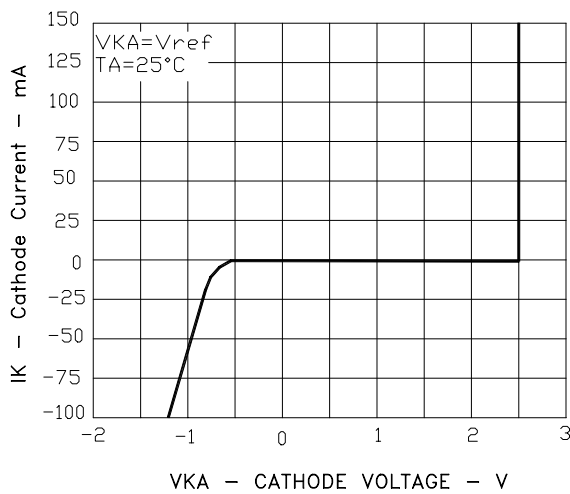
Small-Signal Gain and Phase Shift  
VS. Frequency



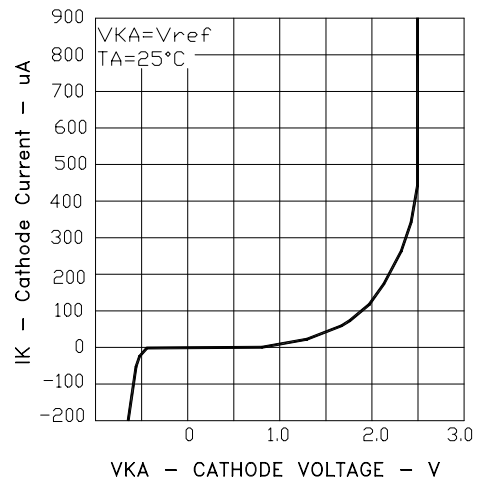
Test Circuit for Small Signal Gain and Phase



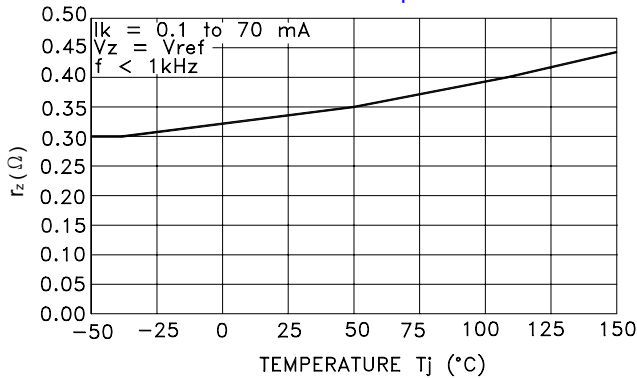
Cathode Current  
VS. Cathode Voltage



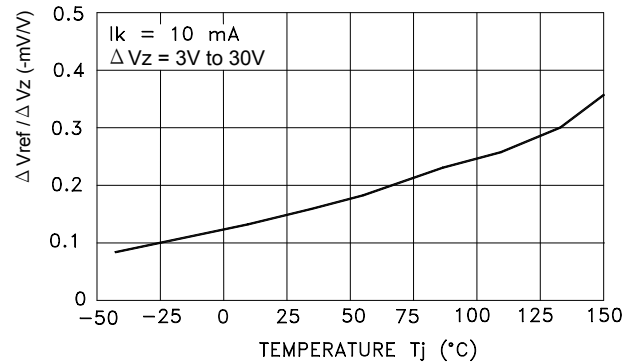
Cathode Current  
VS. Cathode Voltage



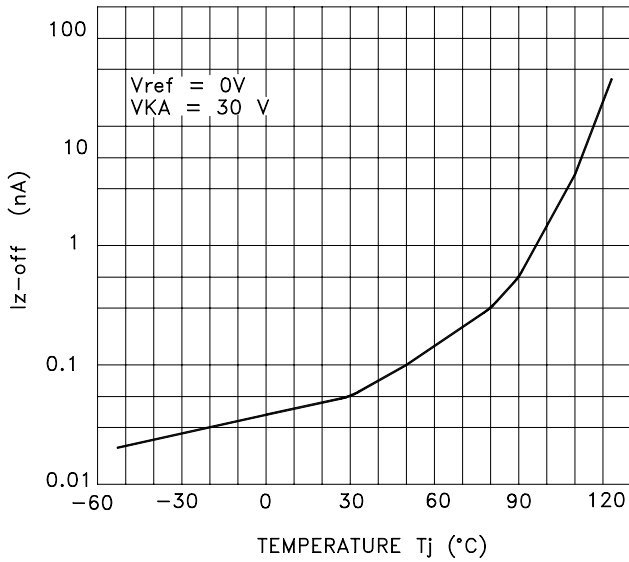
Reference Impedance  
VS. Junction Temperature



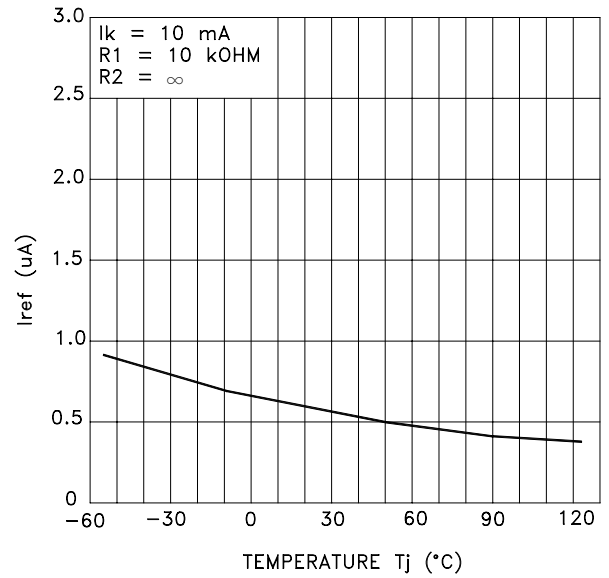
Ratio of Delta Reference Voltage to Delta Cathode Voltage  
VS. Junction Temperature



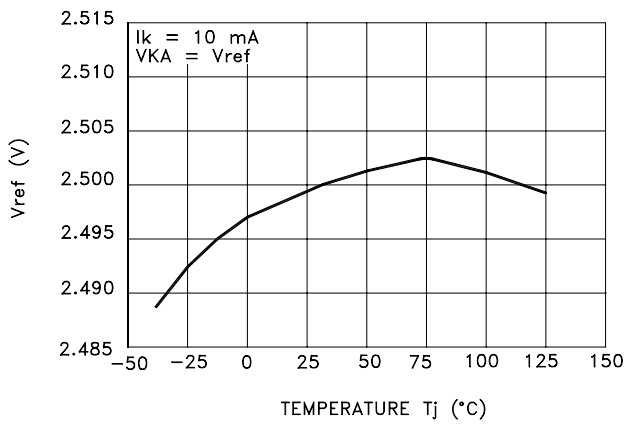
Off-State Cathode Current VS. Junction Temperature



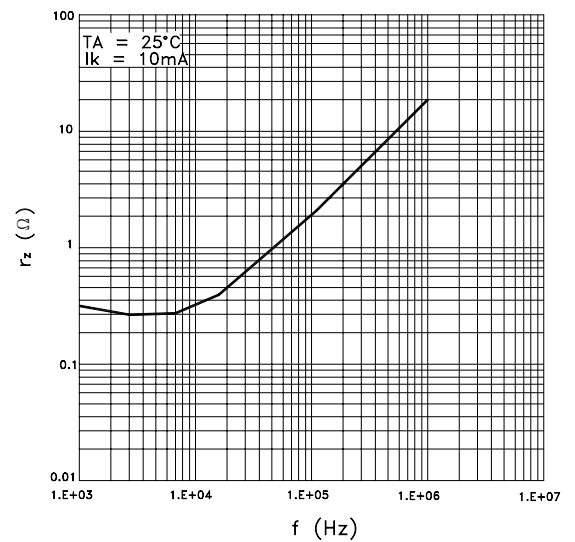
Reference Input Current VS. Junction Temperature



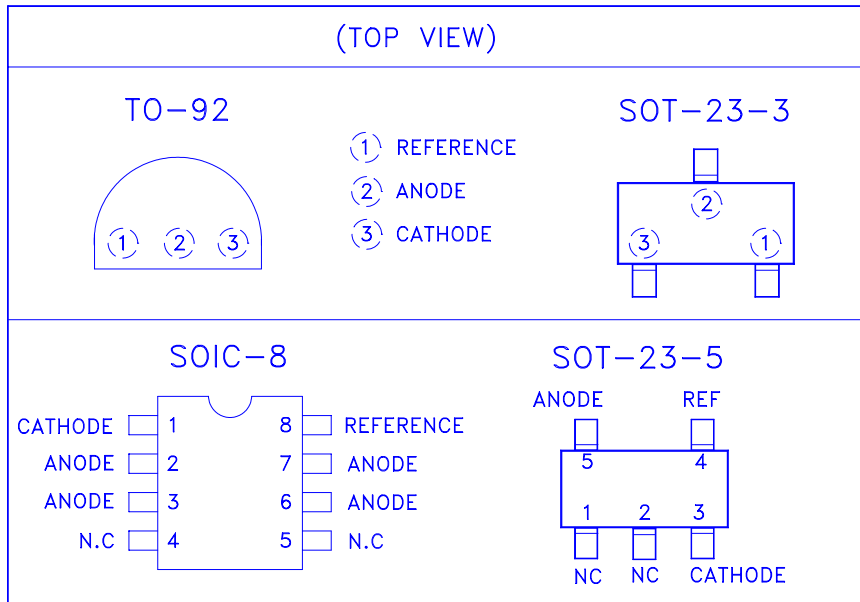
Reference Voltage VS. Junction Temperature



Reference Impedance VS. Frequency



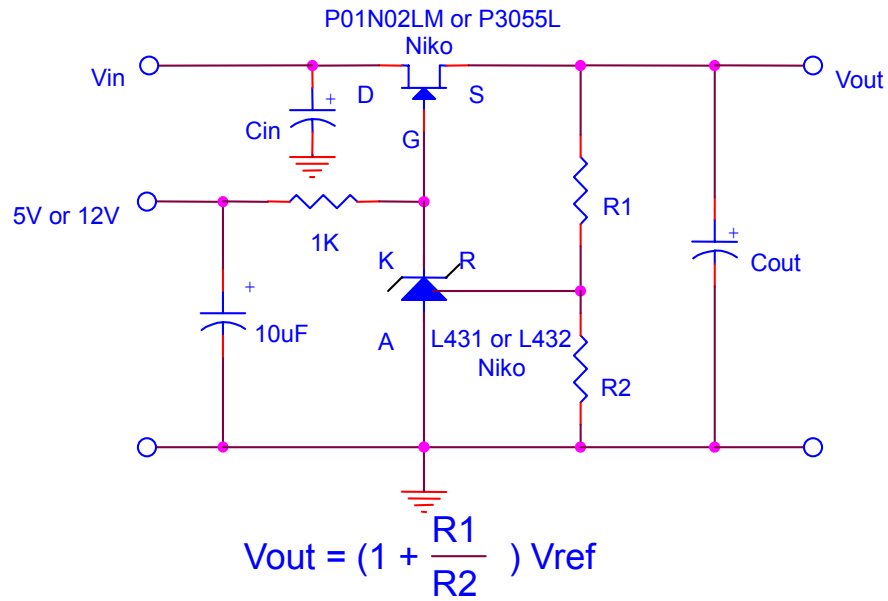
**PIN CONFIGURATION**



**DEVICE SELECTION GUIDE**

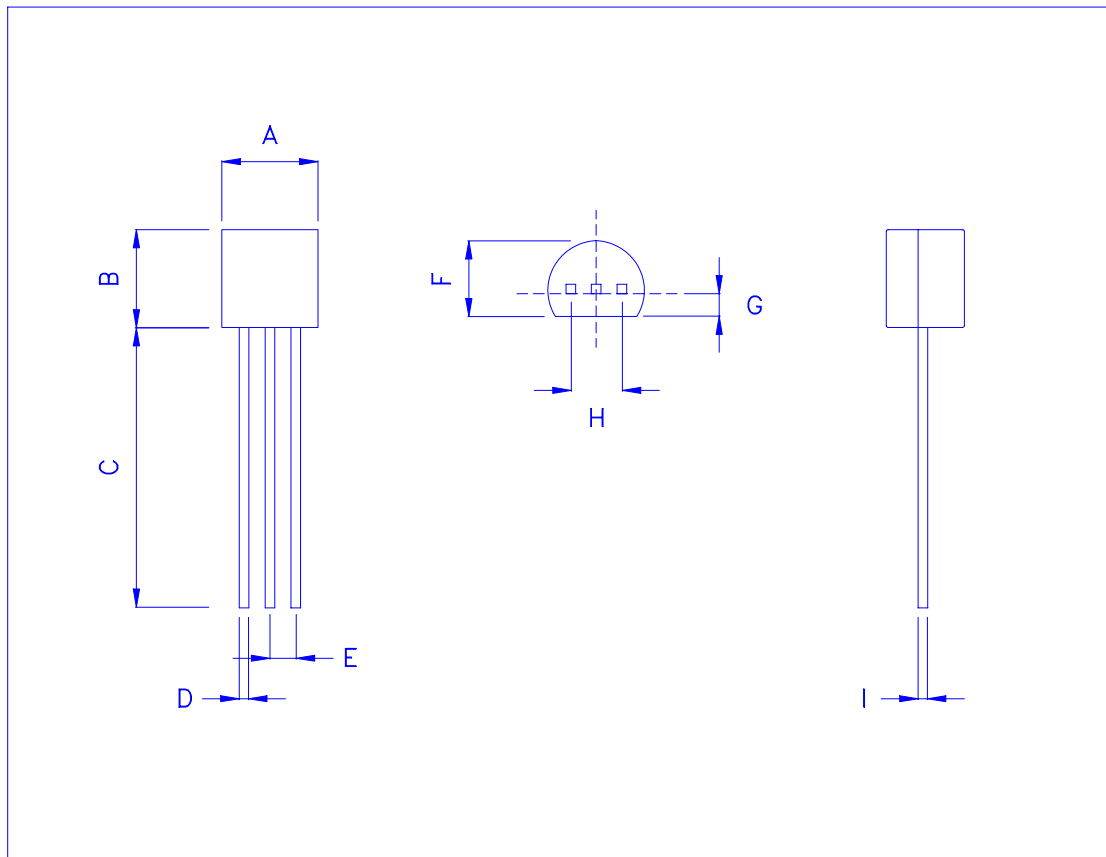
Device	L431NB	L431M3R	L431VB	L431M5B
Package	TO-92	SOT-23-3	SOIC-8	SOT-23-5
Marking	L431N	1M3R	L431V	1M5A
Tolerance	1%	1%	1%	1%

**APPLICATION CIRCUIT**



**TO-92 MECHANICAL DATA**

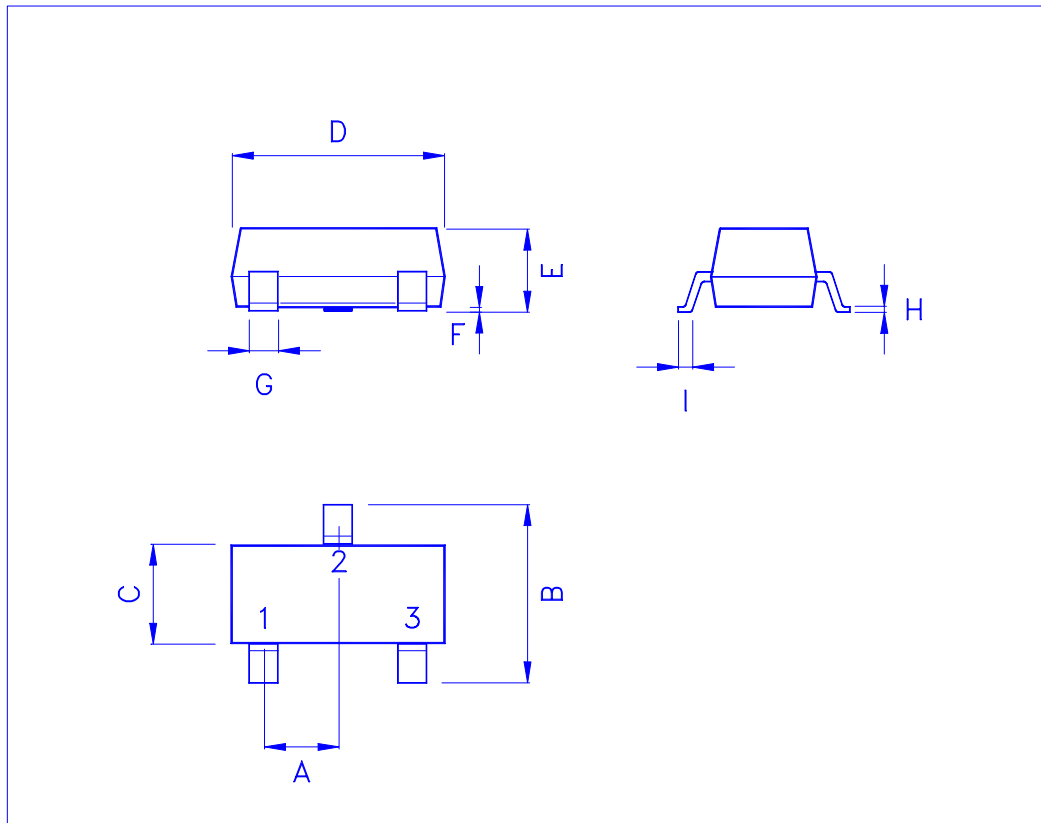
Dimension	mm			Dimension	mm		
	Min.	Typ.	Max.		Min.	Typ.	Max.
A	4.445		5.207	H	2.413	2.540	2.667
B	4.318		5.334	I	0.356		0.533
C	12.7		15.5	J			
D	0.356		0.533	K			
E	1.143	1.27	1.397	L			
F	3.175		4.191	M			
G	0.762		1.270	N			





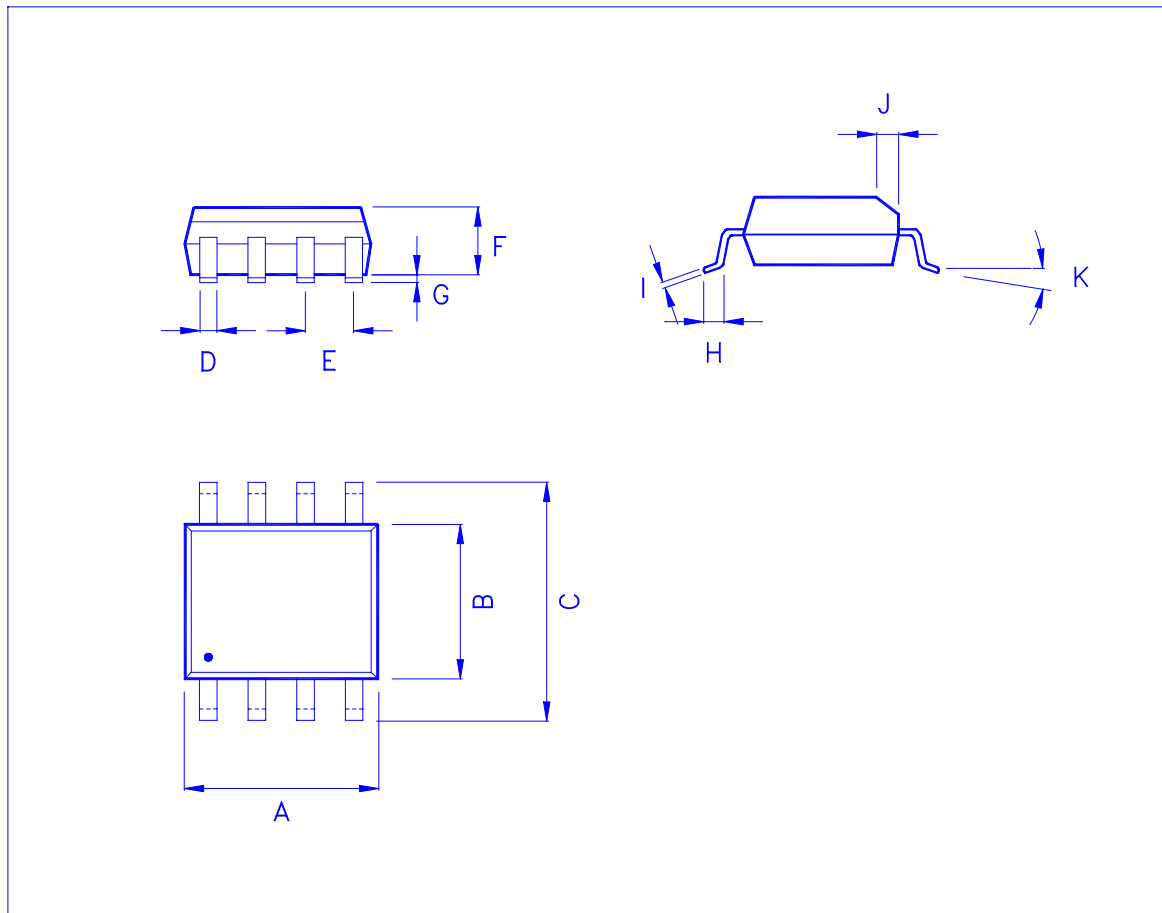
**SOT-23 (M3) MECHANICAL DATA**

Dimension	mm			Dimension	mm		
	Min.	Typ.	Max.		Min.	Typ.	Max.
A		0.95		H	0.10	0.15	0.25
B	2.60	2.80	3.00	I	0.37		
C	1.40	1.60	1.80	J			
D	2.70	2.90	3.10	K			
E	1.00	1.10	1.30	L			
F	0.00		0.10	M			
G	0.35	0.4	0.5	N			



**SOIC-8 (D) MECHANICAL DATA**

Dimension	mm			Dimension	mm		
	Min.	Typ.	Max.		Min.	Typ.	Max.
A	4.8		5.0	H	0.4		1.27
B	3.8		4.0	I	0.18		0.25
C	5.8		6.2	J		0.22	
D	0.35		0.48	K	0°		8°
E		1.27		L			
F			1.65	M			
G	0.1		0.25	N			



**SOT-23 (M5) MECHANICAL DATA**

Dimension	mm			Dimension	mm		
	Min.	Typ.	Max.		Min.	Typ.	Max.
A	1.0	1.10	1.30	e		1.90(TYP)	
A1	0.00		0.10	H	2.60	2.80	3.00
A2	0.70	0.80	0.90	L	0.37		
b	0.35	0.40	0.50				
C	0.10	0.15	0.25				
D	2.70	2.90	3.10				
E	1.40	1.60	1.80				

