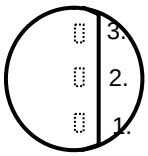
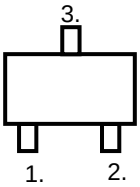
Adjustable Reference Source

TO-92 (TOP VIEW)



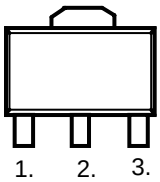
1. REF
2. ANODE
3. CATHODE

SOT-23



1. REF
2. CATHODE
3. ANODE

SOT-89



1. REF
2. ANODE
3. CATHODE

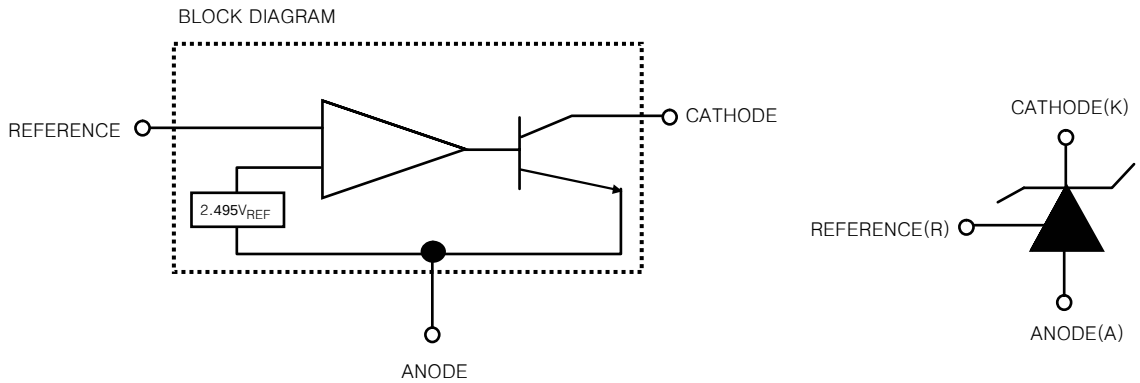
ADJUSTABLE ACCURATE REFERENCE SOURCE

The TL431 is three-terminal adjustable shunt regulator with specified termal stability.
The output voltage may be set to any value between V_{REF}(Approx. 2.5V) and 36V with two external resistors.
This device has a typical output inpedance of 0.2Ω.
Active output circuitry provides a very sharp turn-on characteristic, making this device excellent replacement for zener diodes in many application.

Features

- Equivalent Full Range Temperature Coefficient 50PPM/℃
- Temperature Compensated For Operation Over Full Rate Operating Temperature Range
- Adjustable Output Voltage
- Fast Turn-on Response
- Sink Current Capability 1㎃ to 100㎃
- Low (0.2Ω Typ.) Dynamic Output Impedance
- Low Output Noise

FUNCTION BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

(Full Operating Ambient Temperature Range Applies Unless Otherwise Noted)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Cathode Voltage	V_{KA}	37	V
Continuous Cathode Current Range	I_{KA}	−100~+150	mA
Reference Input Current Range	I_{REF}	0.05~10	mA
Junction Temperature	T_J	150	℃
Operating Temperature	T_{OPR}	−20 ~ 85	℃
Storage Temperature	T_{STG}	−65 ~ 150	℃
Total Power Dissipation	P_D	700	mW

ELECTRICAL CHARACTERISTIC (T_A=25℃, unless otherwise specified)

CHARACTERISTIC	SYMBOL	CIR-CUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Deviation of Reference Input Voltage Over Full Temperature Range	$\Delta V_{REF}/\Delta T$	1	$V_{KA}=V_{REF}$, I_K=10mA T_A=Full Range			3	17	mV
Ratio of Change in Reference Input Voltage to the Change in Cathod Voltage	$\Delta V_{REF}/\Delta V_{KA}$	2	I_K=10mA	ΔV_{KA}=10V−V_{REF}		−1.4	−2.7	mV/V
				ΔV_{KA}=36V−10V		−1	−2	
Reference Input Current	I_{REF}	2	I_{KA}=10mA, R1=10kΩ, R2=∞			1.8	4	μA
Deviation of Reference Input Current Over Full Temperature Range	$\Delta I_{REF}/\Delta T$	2	I_K=10mA, R1=10kΩ, R2=∞ T_A=Full Range			0.4	1.2	μA
Minimum Cathode Current for Regulation	I_{KA}MIN	1	$\Delta V_{KA}=V_{REF}$			0.5	1	mA
Off-State Cathode Current	I_{KA}OFF	3	V_{KA}=36V, V_{REF}=0			0.2	1	μA
Dynamic Impedance	Z_{KA}	1	$V_{KA}=V_{REF}$, I_K=1mA~100mA, f≤1kHz			0.2	0.5	Ω

CLASSIFICATION OF V_{REF}

Rank	TYP.	0.3%	0.5%	1%
Range	2.495	2.487-2.502	2.483-2.507	2.470-2.520

Fig. 1 Test Circuit for $V_{KA}=V_{REF}$

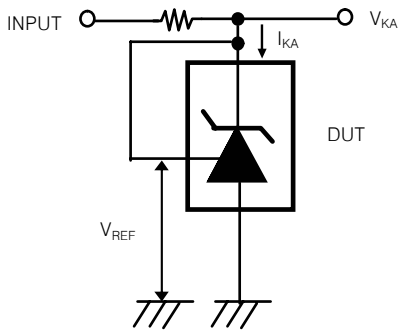


Fig. 2 Test Circuit for $V_{KA}\geq V_{REF}$

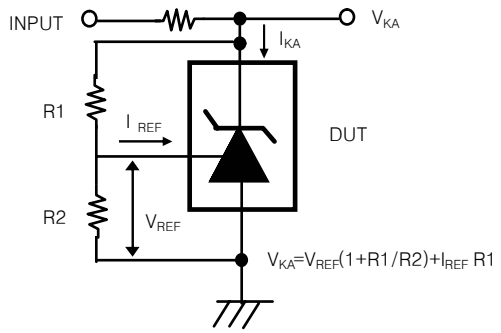
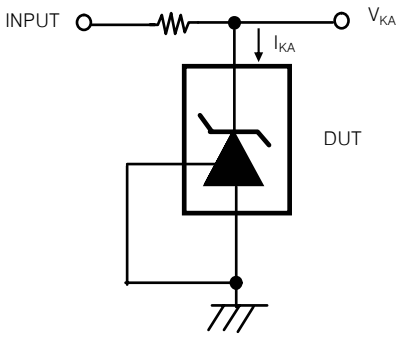
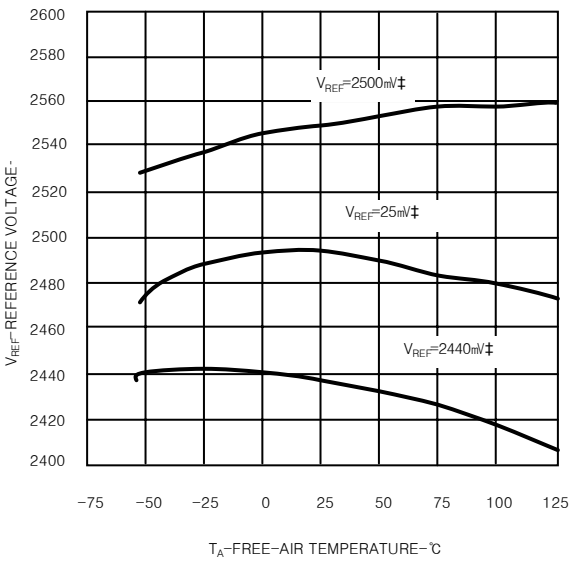


Fig. 3 Test Circuit for I_{KA} (off)



TYPICAL PERFORMANCE CHARACTERISTICS

REFERENCE VOLTAGE vs
FREE-AIR TEMPERATURE†

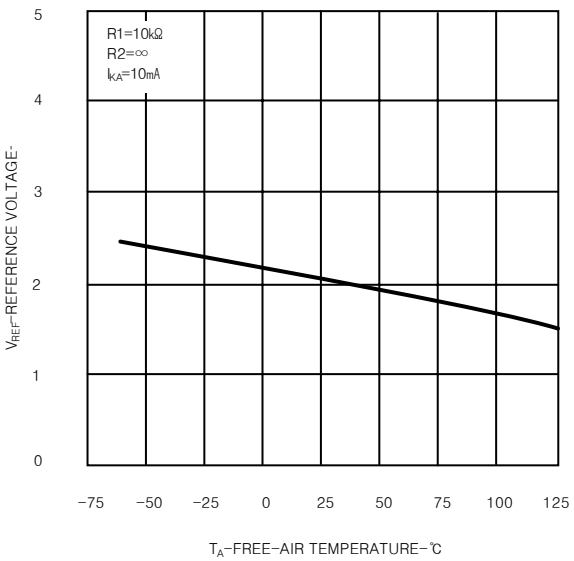


† Data is applicable only within the recommended operating free-air temperature ranges of the various devices.

‡ Data is for devices having the indicated value of V_{REF} at I_{KA}=10mV, T_A=25°C

Figure 4.

REFERENCE CURRENT vs
FREE-AIR TEMPERATURE †



† Data is applicable only within the recommended operating free-air temperature ranges of the various devices.

Figure 5.

CATHODE CURRENT vs
CATHODE VOLTAGE

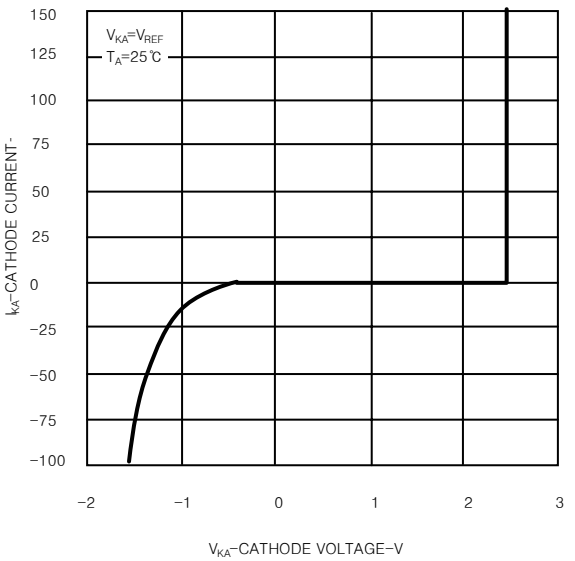


Figure 6.

CATHODE CURRENT vs
CATHODE VOLTAGE

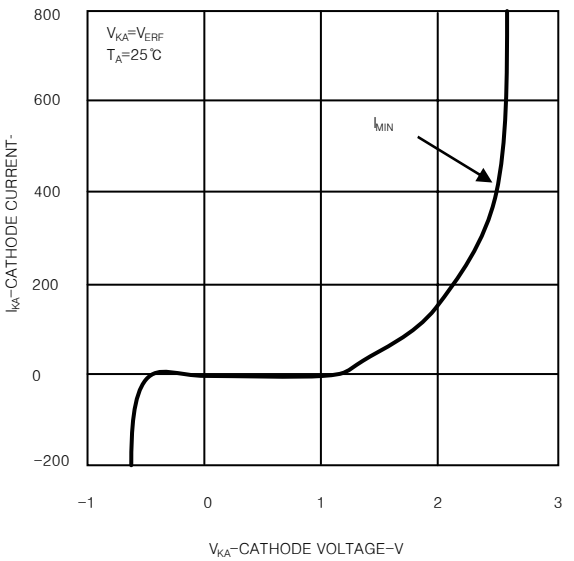
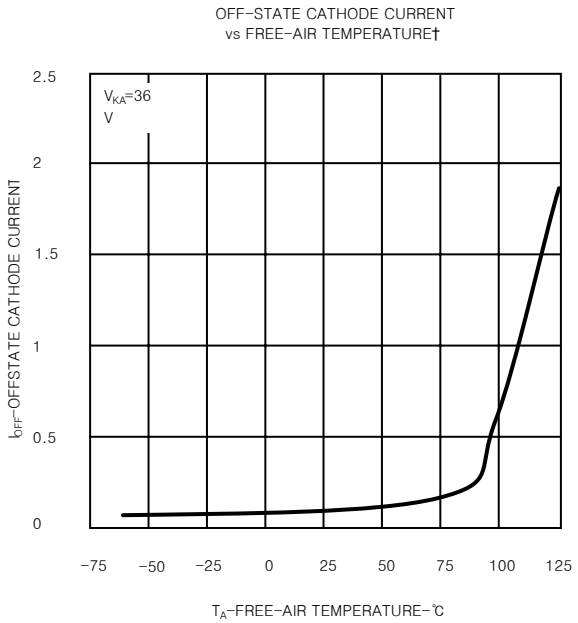


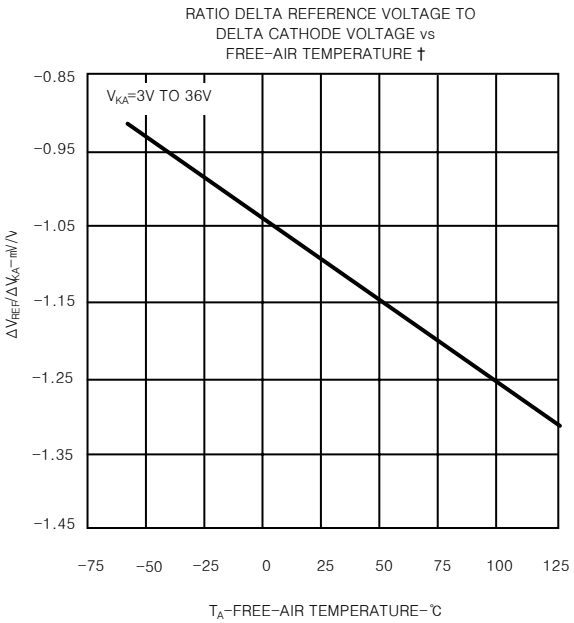
Figure 7.

TYPICAL PERFORMANCE CHARACTERISTICS



† Data is applicable only within the recommended operating free-air temperature ranges of the various devices.

Figure 8.



† Data is applicable only within the recommended operating free-air temperature ranges of the various devices.

Figure 9.

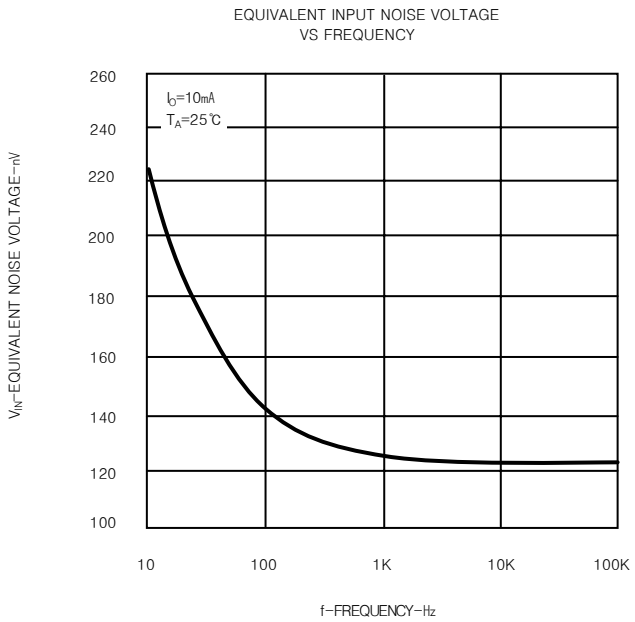


Figure 10.

TYPICAL PERFORMANCE CHARACTERISTICS

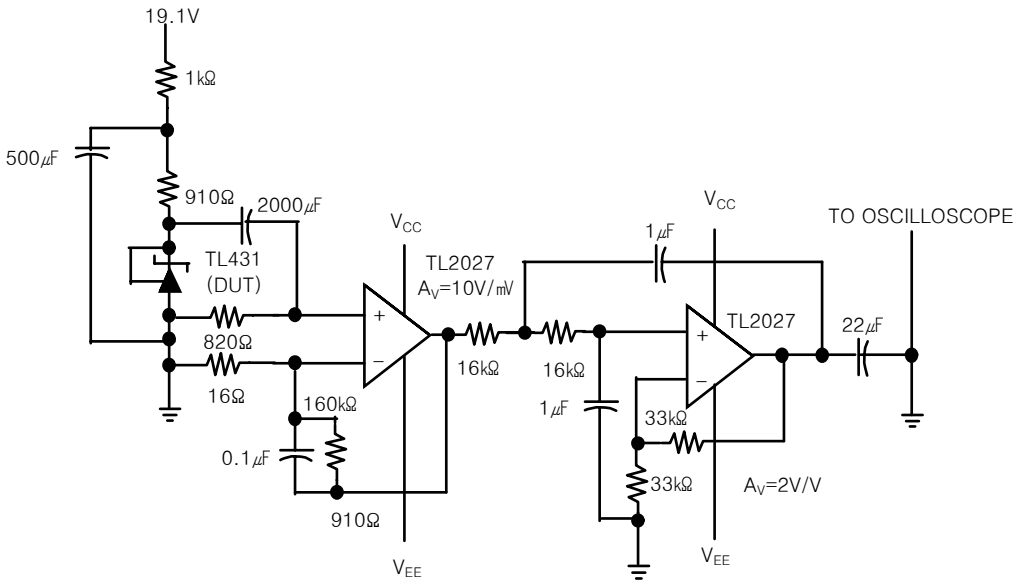
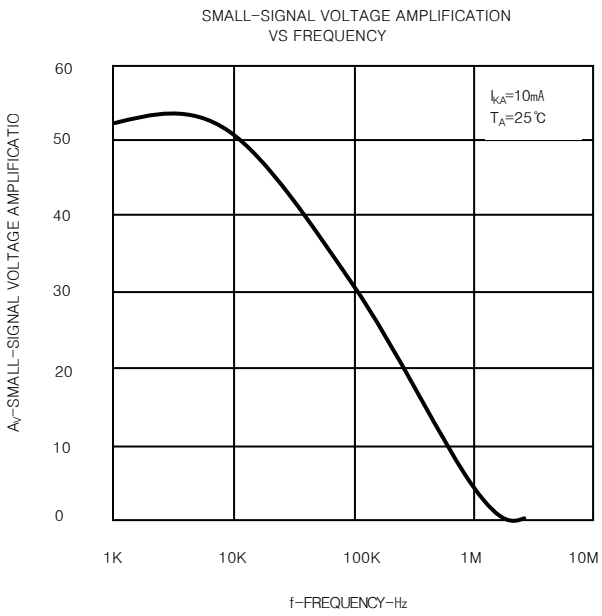
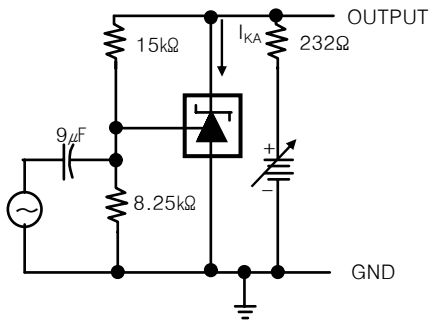


Figure 11. Test Circuit for Equivalent Input Noise Voltage

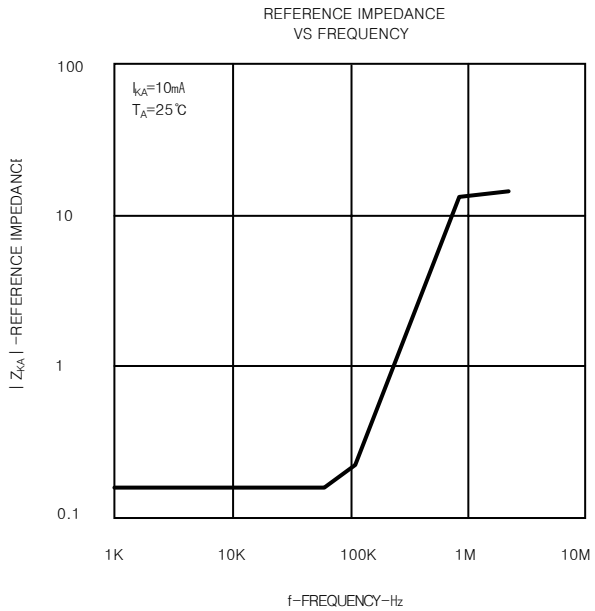


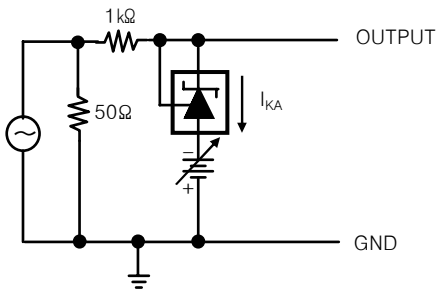


Test Circuit for Voltage Amplification

Figure 12.

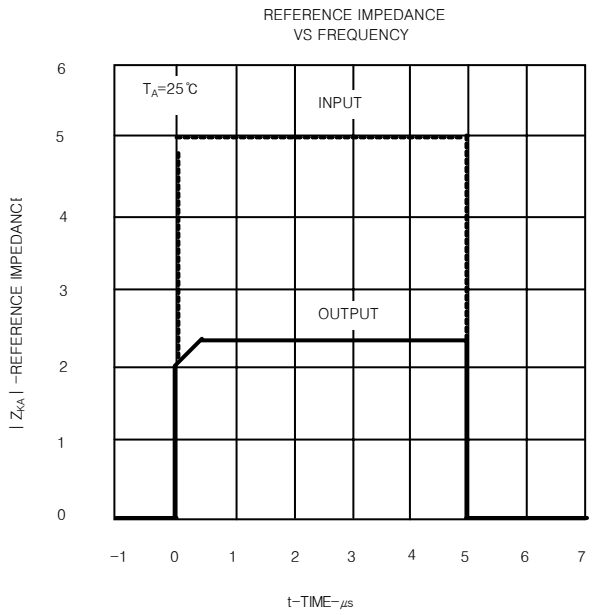
TYPICAL PERFORMANCE CHARACTERISTICS

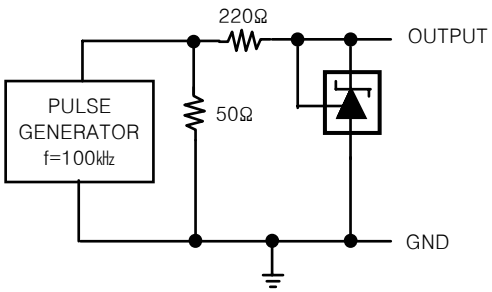




Test Circuit for Reference Impedance

Figure 13.

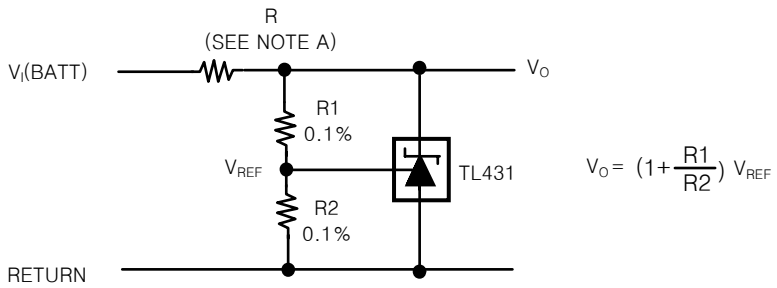




Test Circuit for Pulse Response

Figure 14.

APPLICATION INFORMATION



NOTE A : R Should provide cathode current≥1㎃ to the TL431 at minimum V_I(BATT)

Figure 15. Shunt Regulator

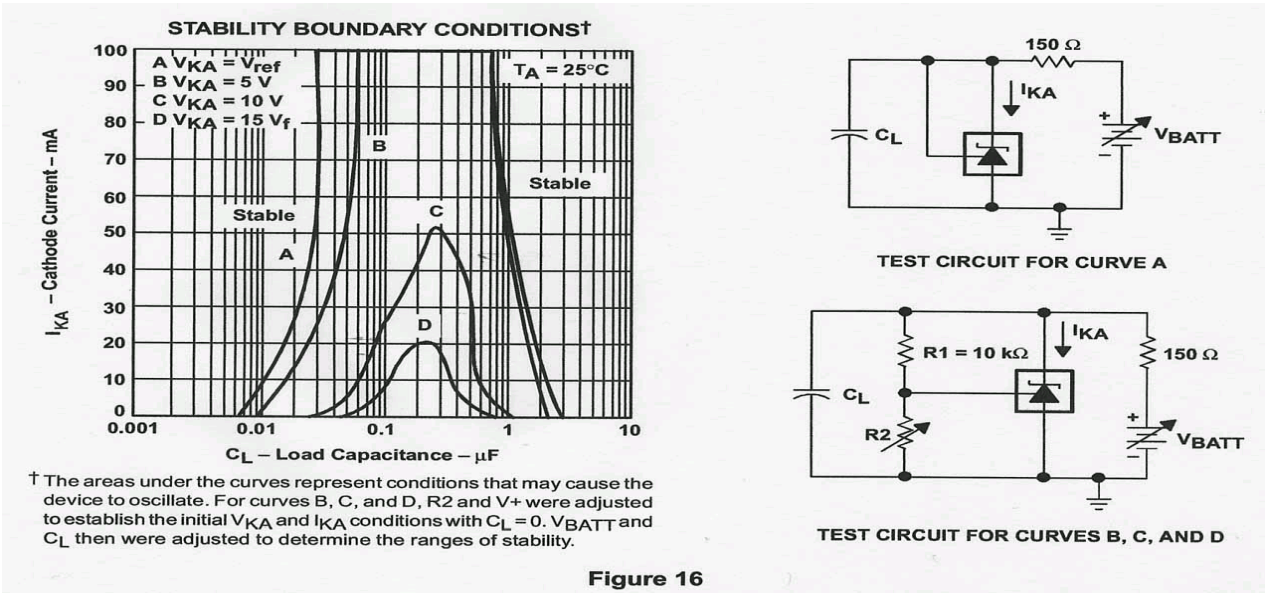
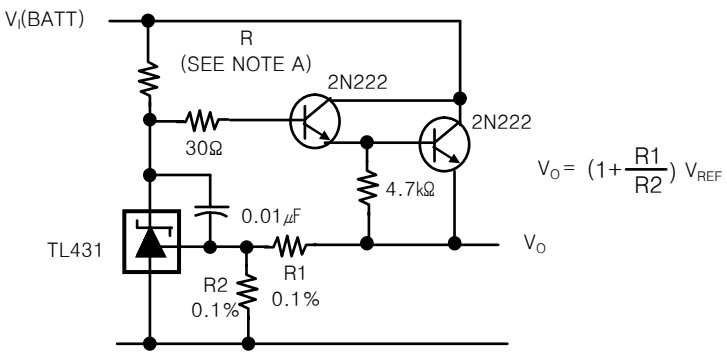


Figure 16



NOTE A : R Should provide cathode current≥1㎃ to the TL431 at minimum V_I(BATT)

Figure 17. Precision High-Current Series Regulator

APPLICATION INFORMATION

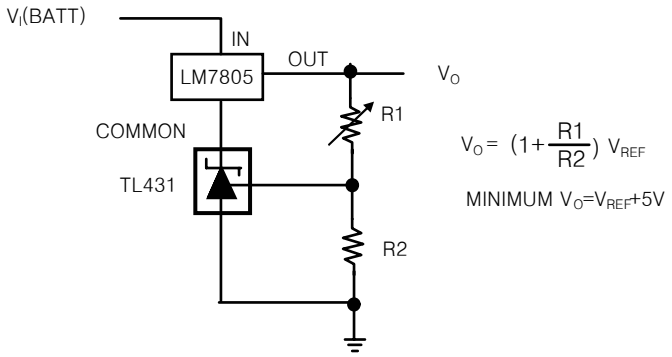


Figure 18. Output Control of a 3-Terminal Fixed Regulator

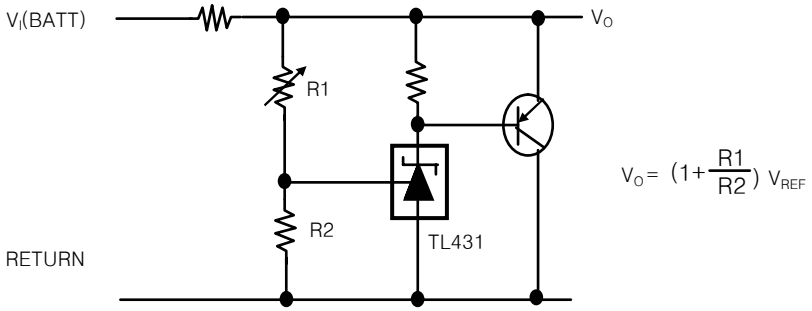
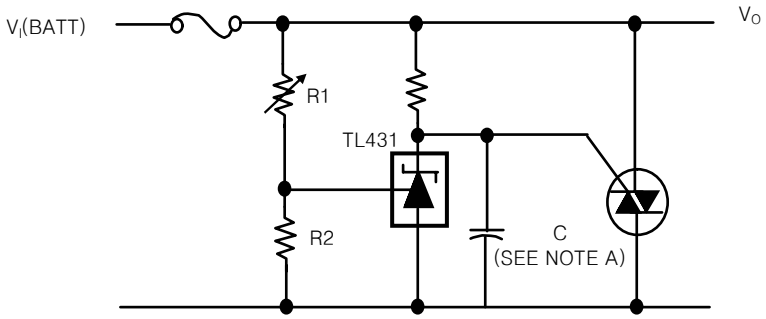


Figure 19. High-Current Shunt Regulator



NOTE A : Refer to the stability boundary conditions in Figure 16 to determine allowable values for C.

Figure 20. Crowbar Circuit

APPLICATION INFORMATION

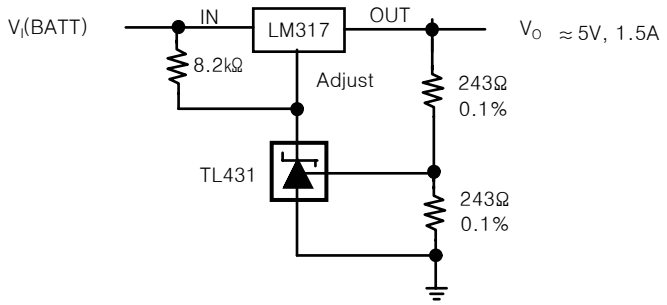
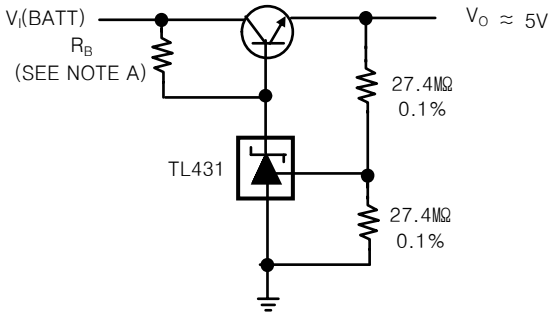


Figure 21. Precision 5-V 1.5A Regulator



NOTE A : R_B Should provide cathode current≥1㎃ to the TL431.

Figure 22. Efficient 5-V Precision Regulator

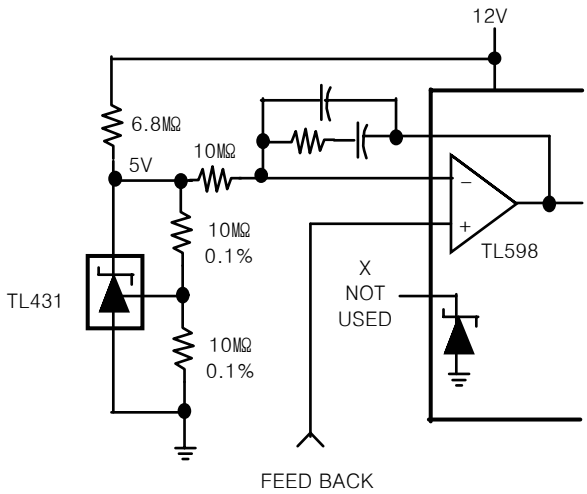
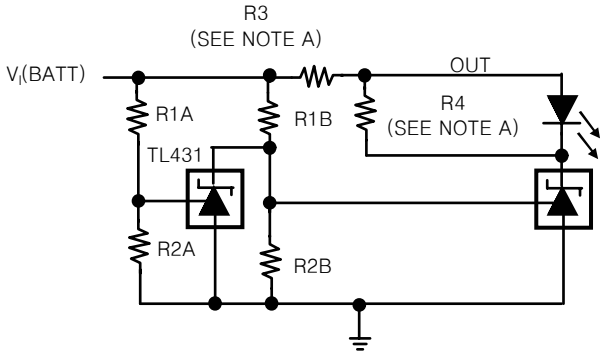


Figure 23. PWM Converter With Reference

APPLICATION INFORMATION



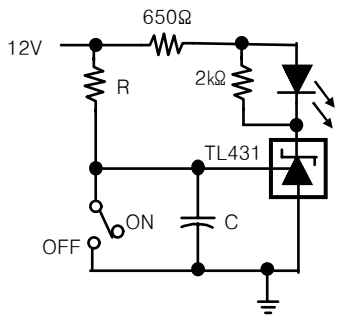
$$\text{LOW LIMIT} = \left(1+\frac{R1B}{R2B}\right) V_{REF}$$

$$\text{HIGH LIMIT} = \left(1+\frac{R1A}{R2A}\right) V_{REF}$$

LED ON WHEN LOW LIMIT < $V_{I(BATT)}$ < HIGH LIMIT

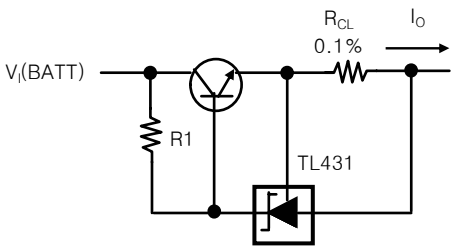
NOTE A : R3 and R4 are selected to provide the desired LED intensity and cathode current ≥1㎃ to the TL431 at the available $V_{I(BATT)}$.

Figure 24. Voltage Monitor



$$\text{DELAY} = RxCxI_N \left(\frac{12V}{12V-V_{REF}}\right)$$

Figure 25. Delay Timer



$$I_{OUT} = \frac{V_{REF}}{R_{CL}} + I_{KA}$$

$$R1 = \frac{V_{I(BATT)}}{\frac{I_O}{H_{FE}}} + I_{KA}$$

Figure 26. Precision Current Limiter

APPLICATION INFORMATION

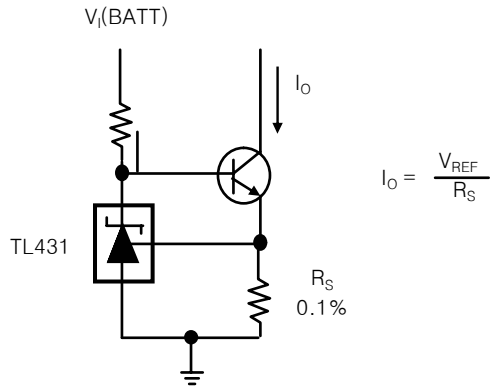
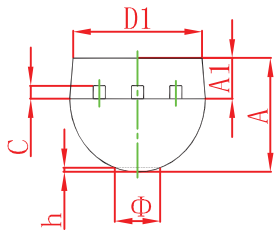
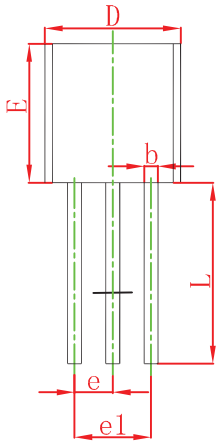


Figure 27. Precision Constant-Current Sink

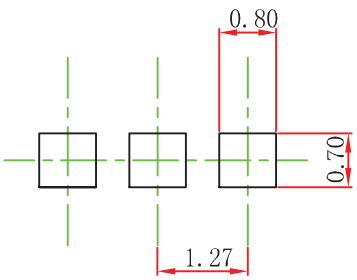
TO-92 Package Outline Dimensions





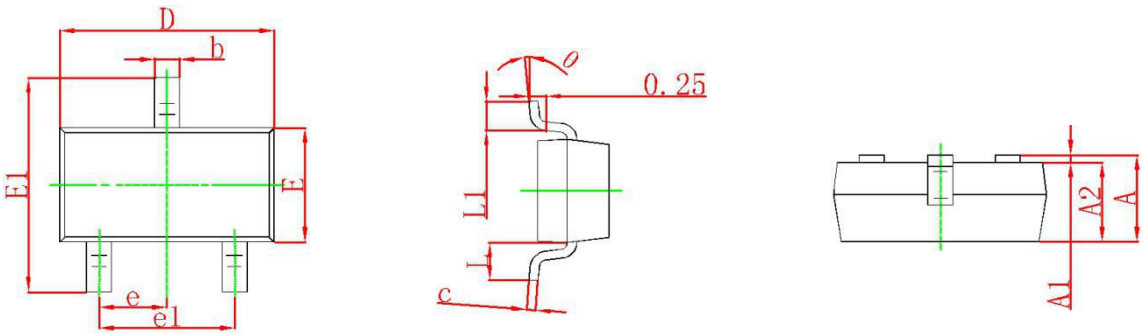
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	3.300	3.700	0.130	0.146
A1	1.100	1.400	0.043	0.055
b	0.380	0.550	0.015	0.022
c	0.360	0.510	0.014	0.020
D	4.300	4.700	0.169	0.185
D1	3.430		0.135	
E	4.300	4.700	0.169	0.185
e	1.270 TYP		0.050 TYP	
e1	2.440	2.640	0.096	0.104
L	14.100	14.500	0.555	0.571
Φ		1.600		0.063
h	0.000	0.380	0.000	0.015

TO-92 Suggested Pad Layout



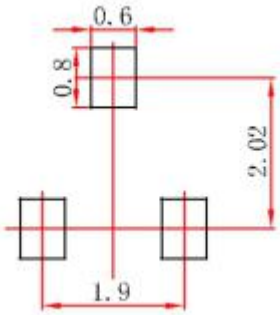
Note:
1.Controlling dimension:in millimeters.
2.General tolerance:± 0.05mm.
3.The pad layout is for reference purposes only.

SOT-23 Package Outline Dimensions



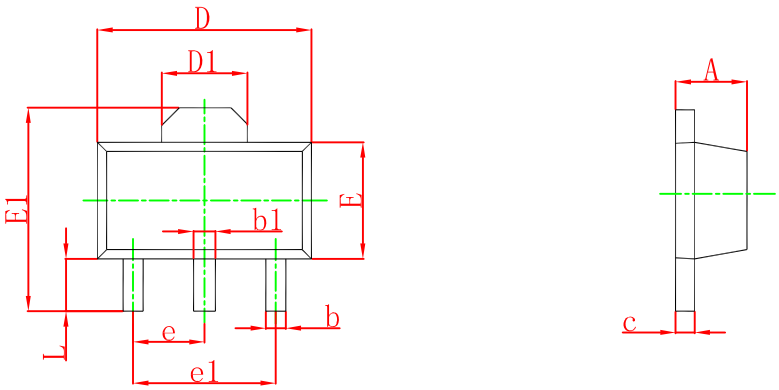
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.900	1.150	0.035	0.045
A1	0.000	0.100	0.000	0.004
A2	0.900	1.050	0.035	0.041
b	0.300	0.500	0.012	0.020
c	0.080	0.150	0.003	0.006
D	2.800	3.000	0.110	0.118
E	1.200	1.400	0.047	0.055
E1	2.250	2.550	0.089	0.100
e	0.950 TYP		0.037 TYP	
e1	1.800	2.000	0.071	0.079
L	0.550 REF		0.022 REF	
L1	0.300	0.500	0.012	0.020
θ	0°	8°	0°	8°

SOT-23 Suggested Pad Layout



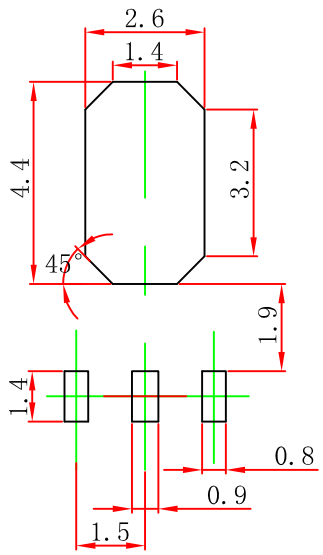
Note:
1.Controlling dimension:in millimeters.
2.General tolerance:±0.05mm.
3.The pad layout is for reference purposes only.

SOT-89-3L Package Outline Dimensions



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.400	1.600	0.055	0.063
b	0.320	0.520	0.013	0.020
b1	0.400	0.580	0.016	0.023
c	0.350	0.440	0.014	0.017
D	4.400	4.600	0.173	0.181
D1	1.550 REF.		0.061 REF.	
E	2.300	2.600	0.091	0.102
E1	3.940	4.250	0.155	0.167
e	1.500 TYP.		0.060 TYP.	
e1	3.000 TYP.		0.118 TYP.	
L	0.900	1.200	0.035	0.047

SOT-89-3L Suggested Pad Layout



Note:
1.Controlling dimension:in millimeters.
2.General tolerance:±0.05mm.
3.The pad layout is for reference purposes only.