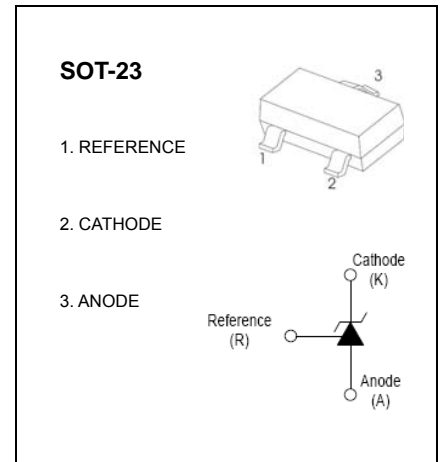


DEVICE DESCRIPTION

The TL431 is a three-terminal adjustable shunt regulator offering excellent temperature stability. This device has a typical dynamic output impedance of 0.2Ω. The device can be used as a replacement for zener diodes in many applications.

FEATURES

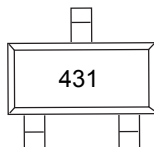
- The output voltage can be adjusted to 36V
- Low dynamic output impedance, its typical value is 0.2Ω
- Trapping current capability is 1 to 100mA
- Low output noise voltage
- Fast on-state response
- The effective temperature compensation in the working range of full temperature
- The typical value of the equivalent temperature factor in the whole temperature scope is 50 ppm/°C


APPLICATION

- Shunt Regulator
- High-Current Shunt Regulator
- Precision Current Limiter

ABSOLUTE MAXIMUM RATINGS (Operating temperature range applies unless otherwise specified)

Parameter	Symbol	Value	Units
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	P_D	350	mW
Operating temperature	T_{opr}	-40~+85	°C
Storage temperature Range	T_{stg}	-65~+150	°C

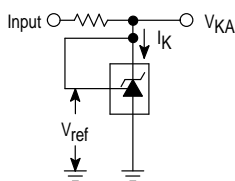
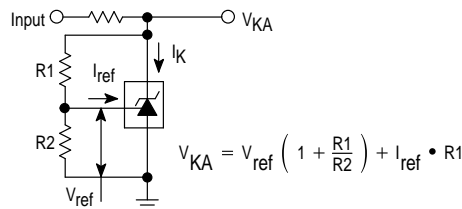
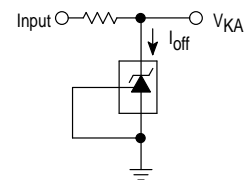
MARKING


ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}\text{C}$ unless otherwise specified)

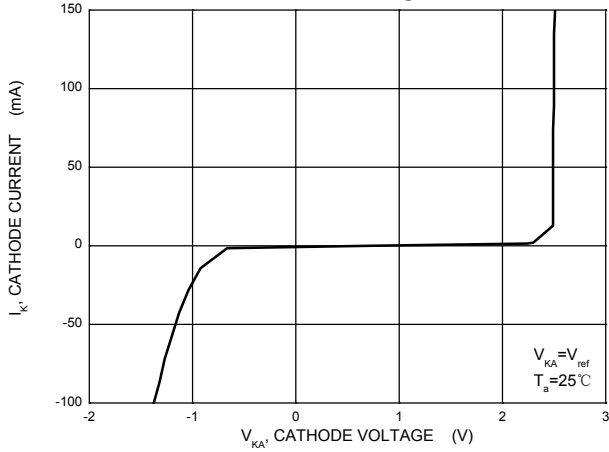
Parameter	Symbol	Test conditions	Min	Typ	Max	Unit
Reference Input Voltage (Fig.1)	V_{ref}	$V_{KA}=V_{REF}, I_{KA}=10\text{mA}$	2.487	2.5	2.513	V
Deviation of reference input Voltage Over temperature (note) (Fig.1)	$\Delta V_{ref}/\Delta T$	$V_{KA}=V_{REF}, I_{KA}=10\text{mA}$ $T_{min}\leq T_a\leq T_{max}$		3.0	17	mV
Ratio Of Change in Reference Input Voltage to the change in Cathode Voltage (Fig.2)	$\Delta V_{ref}/\Delta V_{KA}$	$I_{KA}=10\text{mA}$	$\Delta V_{KA}=10\text{V}\sim V_{REF}$	-1.0	-2.7	mV/V
			$\Delta V_{KA}=36\text{V}\sim 10\text{V}$	-0.5	-2.0	mV/V
Reference Input Current (Fig.2)	I_{ref}	$I_{KA}=10\text{mA}, R_1=10\text{K}\Omega$ $R_2=\infty$		1.5	4	μA
Deviation Of Reference Input Current Over Full Temperature Range (Fig.2)	$\Delta I_{ref}/\Delta T$	$I_{KA}=10\text{mA}, R_1=10\text{K}\Omega$ $R_2=\infty$ $T_a=\text{full Temperature}$		0.4	1.2	μA
Minimum cathode current for Regulation (Fig.1)	$I_{KA(\text{min})}$	$V_{KA}=V_{REF}$		0.45	1.0	mA
Off-state cathode Current (Fig.3)	$I_{KA(\text{OFF})}$	$V_{KA}=36\text{V}, V_{REF}=0$		0.05	1.0	μA
Dynamic Impedance	Z_{KA}	$V_{KA}=V_{REF}, I_{KA}=1\text{ to }100\text{mA}$ $f\leq 1.0\text{KHz}$		0.15	0.5	Ω

 note: $T_{MIN}=0^{\circ}\text{C}, T_{MAX}=+70^{\circ}\text{C}$
CLASSIFICATION OF V_{ref}

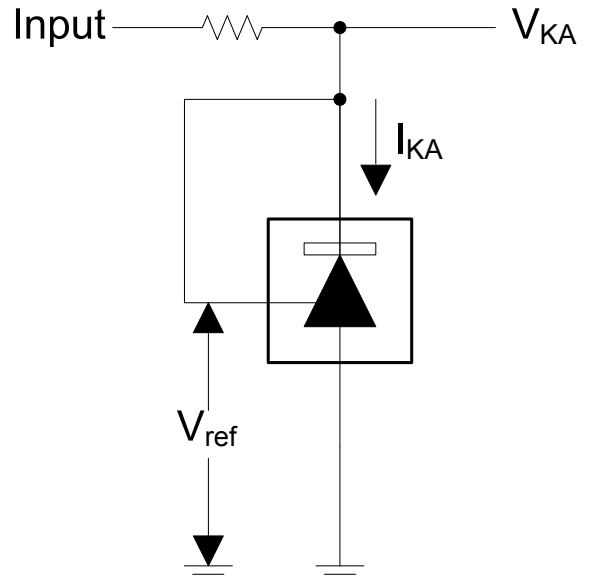
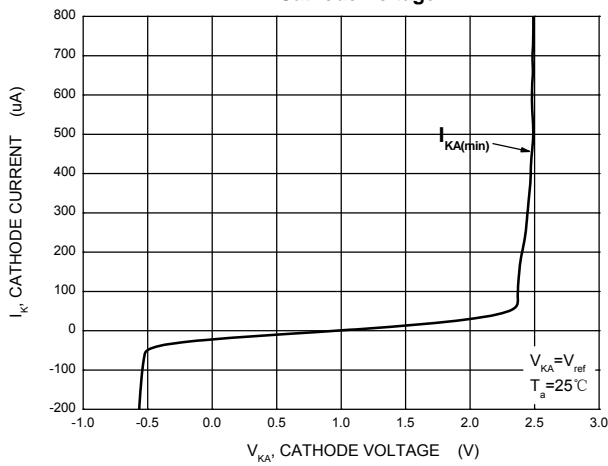
Rank	0.5%
Range	2.487-2.513

Figure 1. Test Circuit for $V_{KA} = V_{ref}$

Figure 2. Test Circuit for $V_{KA} > V_{ref}$

Figure 3. Test Circuit for I_{off}


Cathode Current versus Cathode Voltage

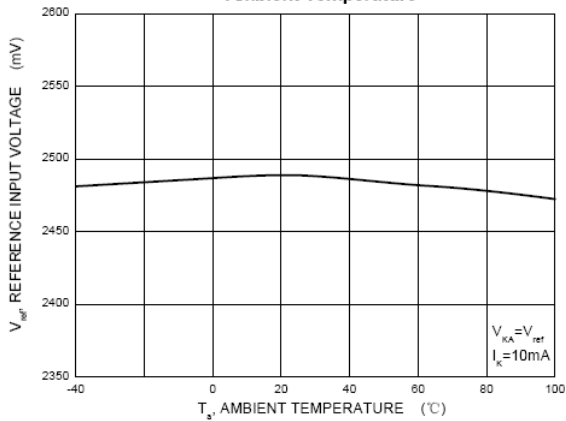


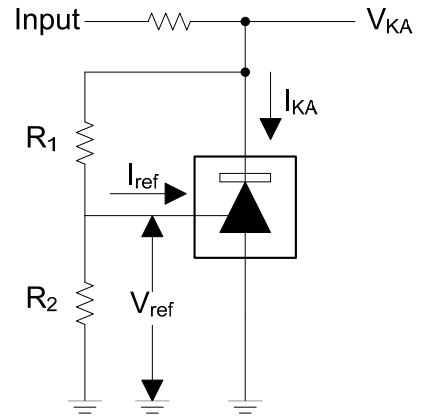
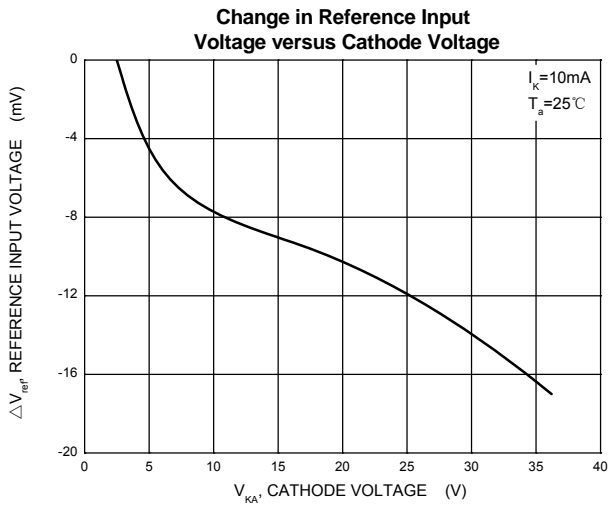
Cathode Current versus Cathode Voltage



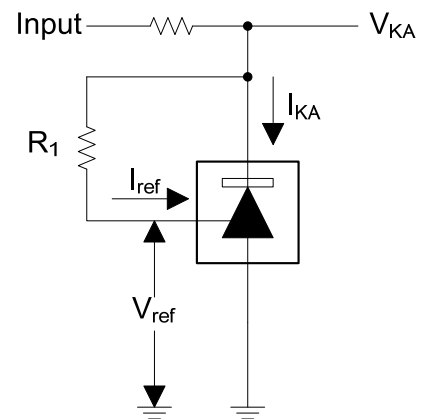
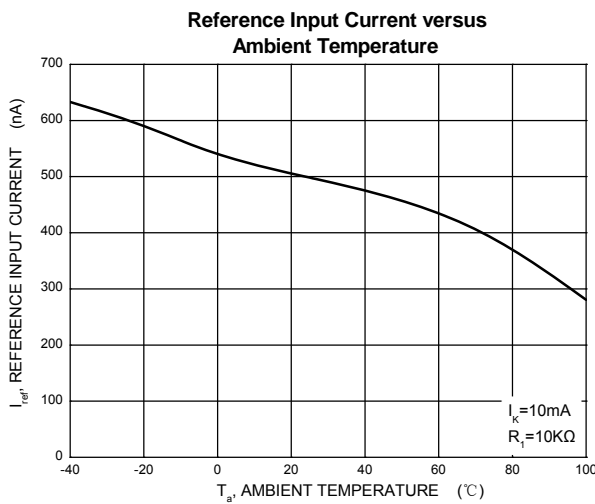
Test Circuit for $V_{KA} = V_{ref}$

Reference Input Voltage versus Ambient Temperature

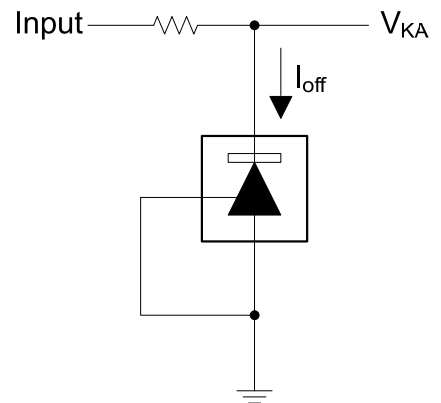
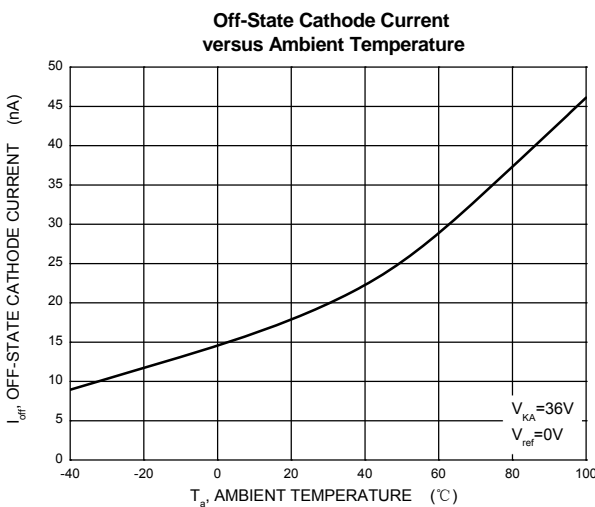




Test Circuit for $V_{KA} = V_{ref}(1 + R_1/R_2) + R_1 * I_{ref}$



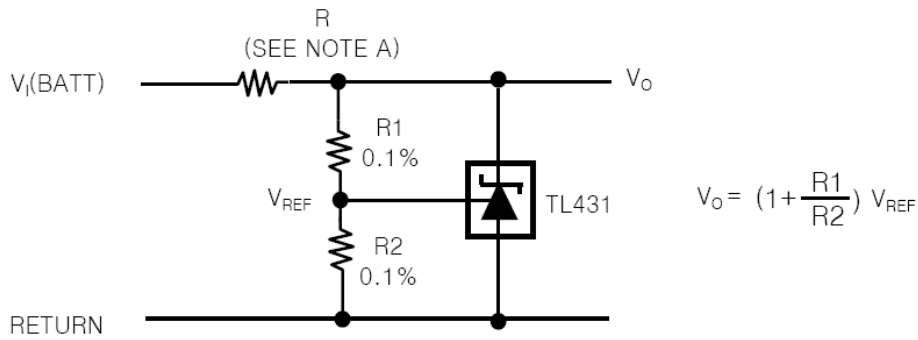
Test Circuit for I_{ref}



Test Circuit for I_{off}

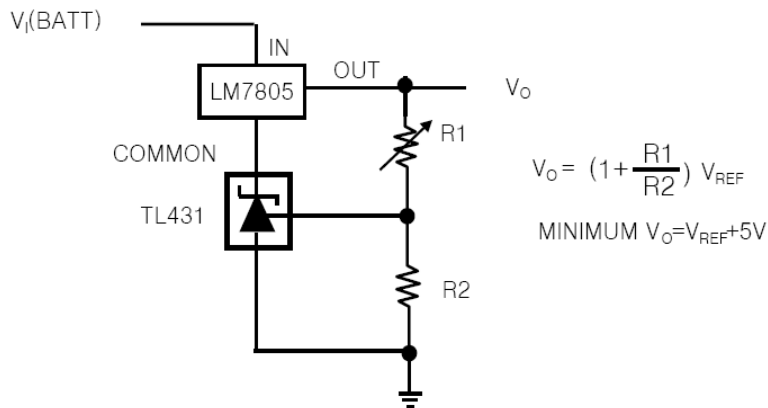
APPLICATION INFORMATION

1. Shunt Regulator

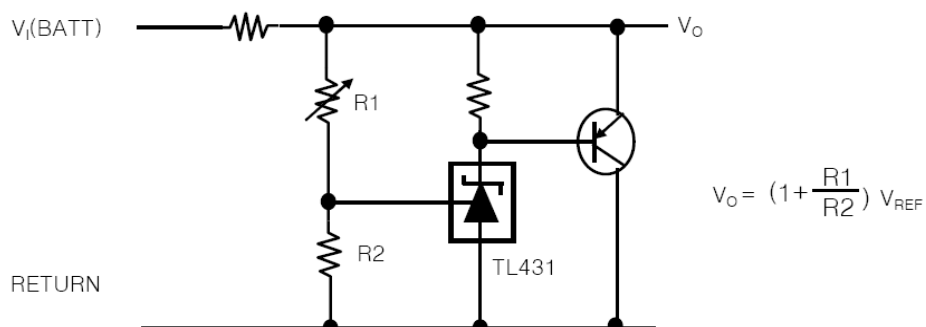


Note A : R Should provide cathode current 1mA to the TL431 at minimum $V_{I(BATT)}$

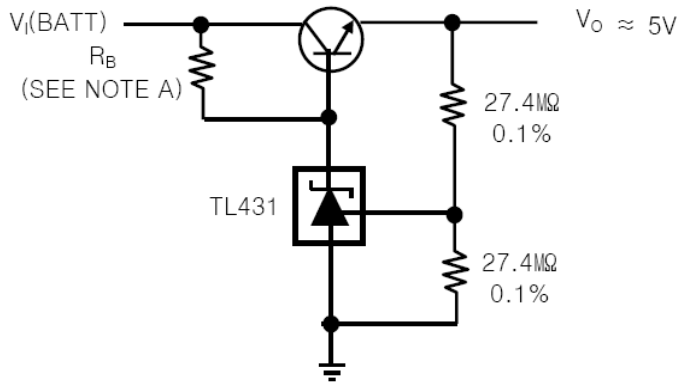
2. Output Control of a Three-Terminal Fixed Regulator



3. High-Current Shunt Regulator

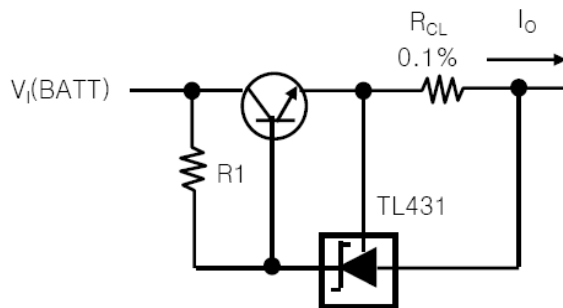


4. Efficient 5-V Precision Regulator



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

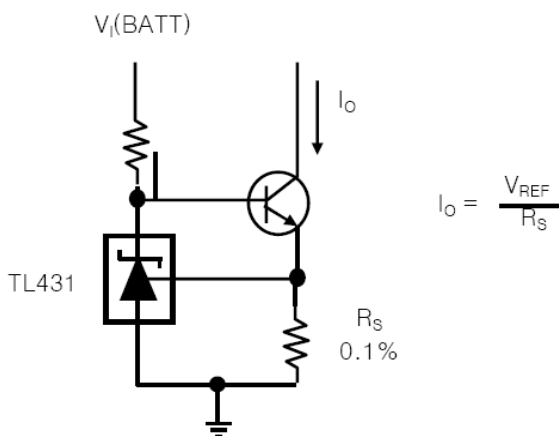
5. Precision Current Limiter



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

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

6. Precision Constant-Current Sink



$$I_o = \frac{V_{REF}}{R_S}$$

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[MC78M12CDTT5G](#) [L9468N](#)