1.24V Adjustable Shunt Regulator — B431L

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Description

The B431L is a three terminal adjustable shunt regulator with thermal stability of 50ppm/°C. The output voltage can be adjusted to any value from 1.24V (V_{REF}) to 16V with two external resistors. These devices have a typical output impedance of 0.05Ω. Active output circuitry provides a very sharp turn-on characteristics and making the device excellent replacement for zener diodes in many applications. The B431L is an ideal voltage reference in an isolated feedback circuit for 3.0V switch mode power supplies

The B431L shunt regulator is available with three voltage tolerances (0.5%, 1.0% and 2.0%) and three package options (SOT-23-3, TO-92, 8SOIC). This allows the designer the opportunity to select the optimum combination of cost and performance for their application.

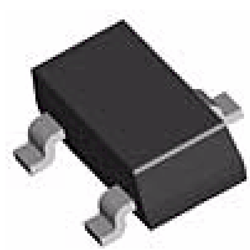
Features

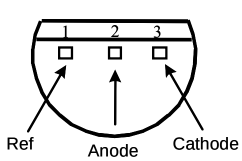
- **Low voltage operation (down to 1.24V)**
- **Wide operating current……80µA to 100mA**
- **Trimmed bandgap design………….. ± 0.5%**
- **Low Dynamic Output Impedance…....0.05Ω**
- **Wide temperature range…... -40°C to +85°C**
- **Available in ……..SOT-23-3, TO-92 , 8SOIC**
- **Pin-to-Pin Replacement …………….SC431L**

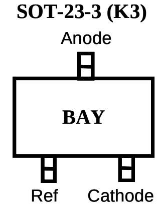
Applications

- **Switching Power Supplies**
- **Adjustable Power Supplies**
- **Linear Regulators**
- **Battery Powered Equipment**
- **Monitors, TV, VCR**
- **Instrumentation**

Pin Connection







Ordering Information

Package	Tolerance		
	0.5%	1%	2%
TO-92	B431LAZ	B431LBZ	B431LCZ
SO-8	B431LAM	B431LBM	B431LCM
SOT-23	B431LAK3	B431LBK3	B431LCK3

Absolute Maximum Rating

Parameter	Symbol	Maximum	Units
Cathode Voltage	V_z	20	V
Continuous Cathode Current	I_z	100	mA
Reference Input Current Range		3	mA
Power Dissipation at T_A - 25°C SOT-23-3 S0-8 TO-92	P_D	0.37 0.75 0.95	W
Thermal Resistance SOT-23-3 S0-8 TO-92	O_{JA}	336 175 132	°C/W
Operating Junction Temperature Range	T_J	-40 to +150	°C
Storage Temperature Range	T_{STG}	-65 to +150	°C
Lead Temperature (Soldering) 10 seconds	T_{LEAD}	300	°C
ESD Rating (Human Body Model)	T_{ESD}	2	kV

Recommended Operating Conditions

	Min	Max	Symbol
Cathode Voltage, Vz	V_{REF}	16	V
Cathode Current, Iz	80µA	100	mA

Electrical Characteristics

Unless specified: $T_{A = 25°C}$. Values in bold apply over full operating ambient temperature.

			B431LA 0.5%			
Parameter	**Symbol**	**Condition**	**Min**	**Typ**	**Max**	**Units**
Reference Voltage	V_{REF}	$V_Z = V_{REF1}$ $I_Z = 10mA^{(1)}$	1.234 **1.222**	1.240	1.246 **1.258**	V
V_{REF} Temp Deviation	V_{DEV}	$V_Z = V_{REF1,}$ $I_Z = 10mA^{(1)}$ I_A=full range		10	25	mV
Ratio of Change in V_{REF} To Change in V_Z	$\frac{\Delta V_{REF}}{\Delta V_Z}$	$I_Z = 10mA, \Delta V_Z = 16V$ to V_{Ref} (2)		-2.7	-1.0	mV/V
Reference Input Current	I_{REF}	R1 = 10kΩ, R2 = ∞, $I_Z = 10mA^{(2)}$		0.15	0.5	µA
I_{REF} Temperature Deviation	$I_{REF(DEV)}$	R1 = 10kΩ, R2 = ∞, $I_Z = 10mA^{(2)}$		0.1	0.4	µA
Off-State Cathode Current	$I_{Z\ (OFF)}$	V_{REF} = 0V, V_Z =16V(3)		0.125	0.150	µA
		V_{REF} = 0V, V_Z =16V(3)		0.135	0.150	
Min Operating Current	$I_{Z(MIN)}$	$V_Z = V_{REF}^{(1)}$		20	80	µA
Dynamic Impedance	Z_{KA}	$V_{KA}=V_{ref}$, I_K=100µA to 100mA, f≤1kHA		0.05	0.15	Ω

Electrical Characteristics

Unless specified: $T_A = 25°C$. Values in bold apply over full operating ambient temperature.

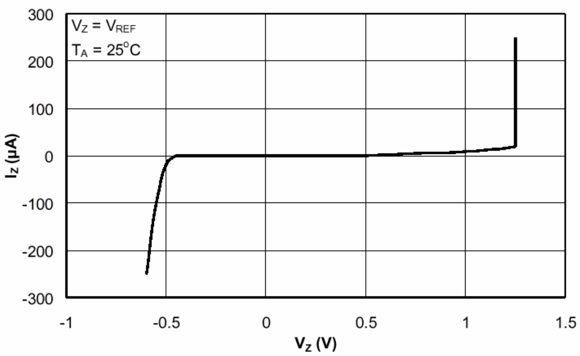
Parameter	Symbol	Condition	B431LB 1% Min	B431LB 1% Typ	B431LB 1% Max	Units
Reference Voltage	V_{REF}	$V_Z = V_{REF1}$ $I_Z = 10mA^{(1)}$	1.228 **1.215**	1.240	1.252 **1.265**	V
V_{REF} Temp Deviation	V_{DEV}	$V_Z = V_{REF1},$ $I_Z = 10mA^{(1)}$ I_A=full range		10	25	mV
Ratio of Change in V_{REF} To Change in V_Z	$\frac{\Delta V_{REF}}{\Delta V_Z}$	$I_Z = 10mA, \Delta V_Z = 16V$ to V_{Ref} (2)		-1.0	-2.7	mV/V
Reference Input Current	I_{REF}	R1 = 10kΩ, R2 = ∞, $I_Z = 10mA^{(2)}$		0.15	0.5	µA
I_{REF} Temperature Deviation	$I_{REF(DEV)}$	R1 = 10kΩ, R2 = ∞, $I_Z = 10mA^{(2)}$		0.1	0.4	µA
Off-State Cathode Current	$I_{Z\ (OFF)}$	$V_{REF} = 0V, V_Z = 16V^{(3)}$		0.125	0.150	µA
		$V_{REF} = 0V, V_Z = 16V^{(3)}$		0.135	0.150	
Min Operating Current	$I_{Z(MIN)}$	$V_Z = V_{REF}^{(1)}$		20	80	µA
Dynamic Impedance	Z_{KA}	$V_{KA}=V_{ref},$ I_K=100µA to 100mA, f≤1kHA		0.05	0.15	Ω

Electrical Characteristics

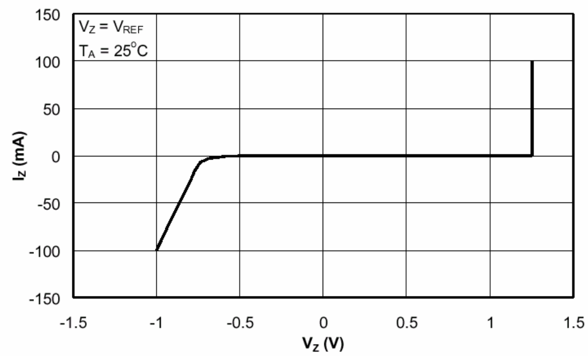
Unless specified: $T_A = 25°C$. Values in bold apply over full operating ambient temperature.

Parameter	Symbol	Condition	B431LC 2% Min	B431LC 2% Typ	B431LC 2% Max	Units
Reference Voltage	V_{REF}	$V_Z = V_{REF1}$ $I_Z = 10mA^{(1)}$	1.215 **1.200**	1.240	1.265 **1.280**	V
V_{REF} Temp Deviation	V_{DEV}	$V_Z = V_{REF1},$ $I_Z = 10mA^{(1)}$ I_A=full range		10	35	mV
Ratio of Change in V_{REF} To Change in V_Z	$\frac{\Delta V_{REF}}{\Delta V_Z}$	$I_Z = 10mA, \Delta V_Z = 16V$ to V_{Ref} (2)		-1.0	-2.7	mV/V
Reference Input Current	I_{REF}	R1 = 10kΩ, R2 = ∞, $I_Z = 10mA^{(2)}$		0.15	0.5	µA
I_{REF} Temperature Deviation	$I_{REF(DEV)}$	R1 = 10kΩ, R2 = ∞, $I_Z = 10mA^{(2)}$		0.1	0.4	µA
Off-State Cathode Current	$I_{Z\ (OFF)}$	$V_{REF} = 0V, V_Z = 16V^{(3)}$		0.125	0.150	µA
		$V_{REF} = 0V, V_Z = 16V^{(3)}$		0.135	0.150	
Min Operating Current	$I_{Z(MIN)}$	$V_Z = V_{REF}^{(1)}$		20	80	µA
Dynamic Impedance	Z_{KA}	$V_{KA}=V_{ref},$ I_K=100µA to 100mA, f≤1kHA		0.05	0.15	Ω

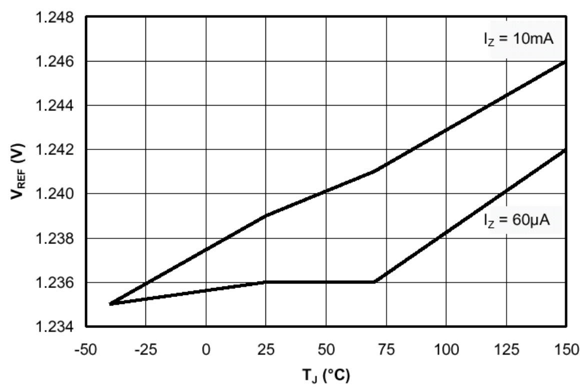
Cathode Current vs. Cathode Voltage



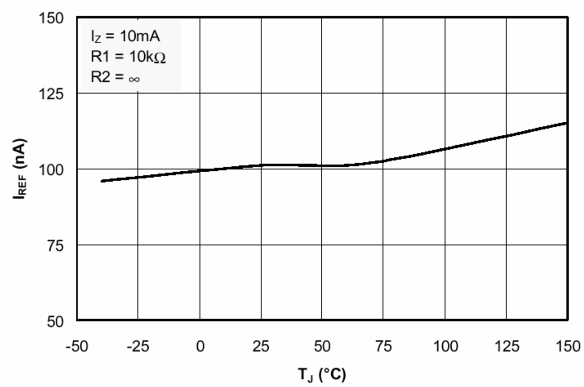
Cathode Current vs. Cathode Voltage



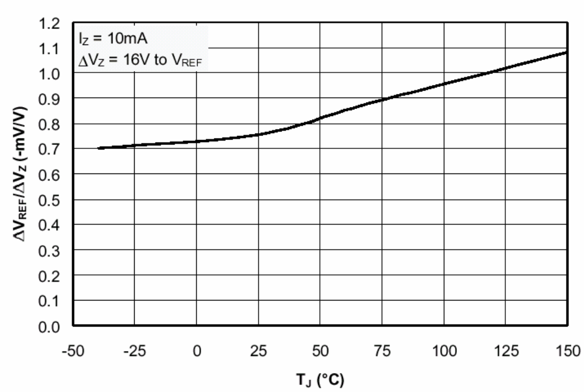
Reference Voltage vs. Junction Temperature



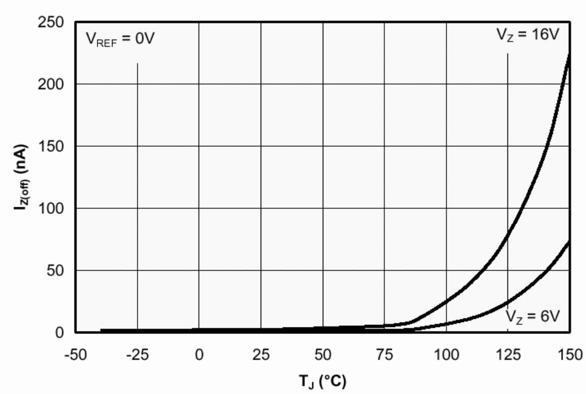
Reference Input Current vs. Junction Temperature



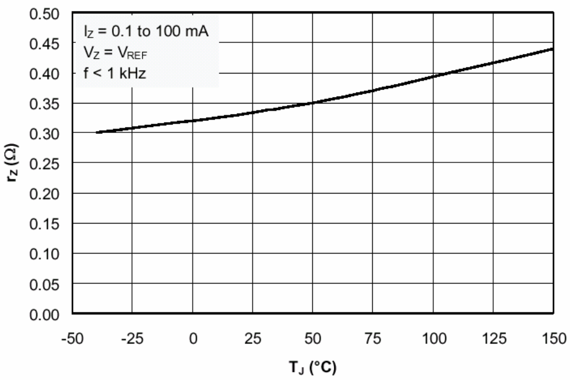
Ratio of Delta Reference Voltage to Delta Cathode Voltage vs. Junction Temperature



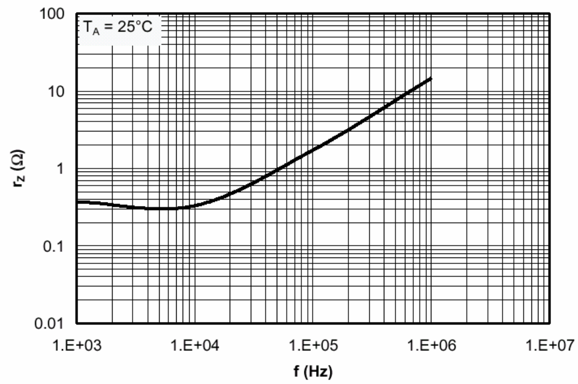
Off-State Cathode Current vs. Junction Temperature



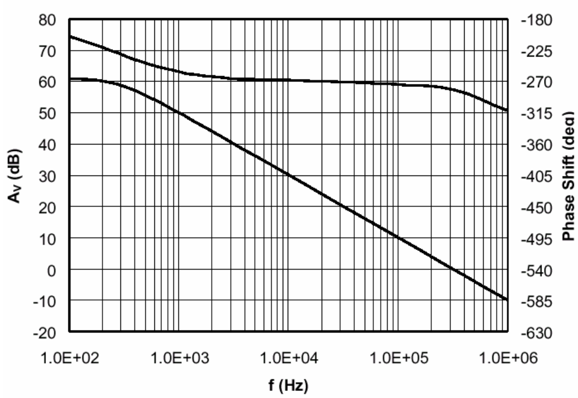
Reference Impedance vs. Junction Temperature



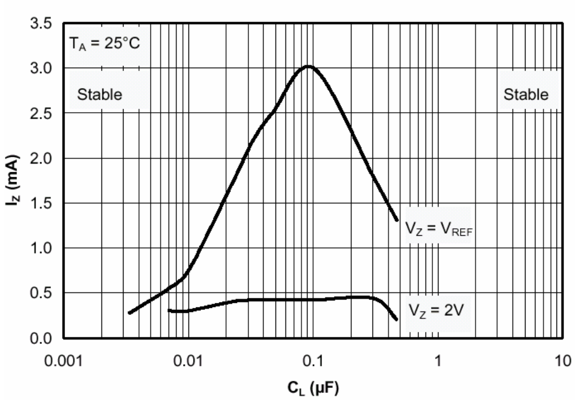
Reference Impedance vs. Frequency



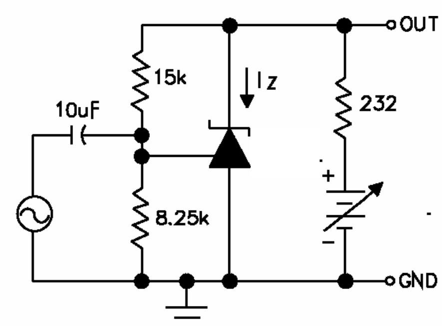
Small-Signal Gain and Phase Shift vs. Frequency



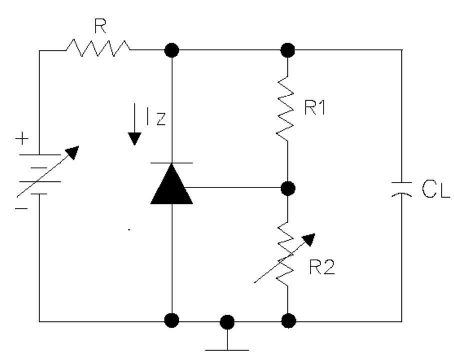
Stability Boundary Condition For Shunt Regulation vs. Cathode Current and Load Capacitance



Test Circuit: Small-Signal Gain & Phase



Test Circuit: Stability



Application Notes:

1) Set V_{OUT} according to the following equation:

$$V_{OUT} = V_{REF}\left(1 + \frac{R1}{R2}\right) + I_{REF}\,R1$$

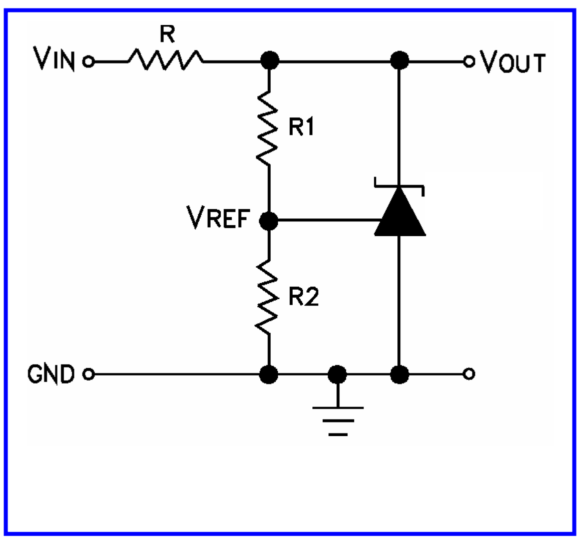
2) Choose the value for R as follows:

- The maximum limit for R should be such that the cathode current, I_Z, is greater than the minimum operating current (80µA) at $V_{IN(MIN)}$.

- The minimum limit for R should be such that I_Z does not exceed 100mA under all load conditions, and the instantaneous turn-on value for I_Z does not exceed 150mA. Both of the following conditions must be met:

$$R_{min} \geq \frac{V_{IN(max)}}{150\ \text{mA}} \quad \text{(to limit instantaneous turn-on } I_Z\text{)}$$

$$R_{min} \geq \frac{V_{IN(max)} - V_{OUT}}{I_{OUT\ (min)} + 100\ \text{mA}} \quad \text{(to limit } I_Z \text{ under normal}$$



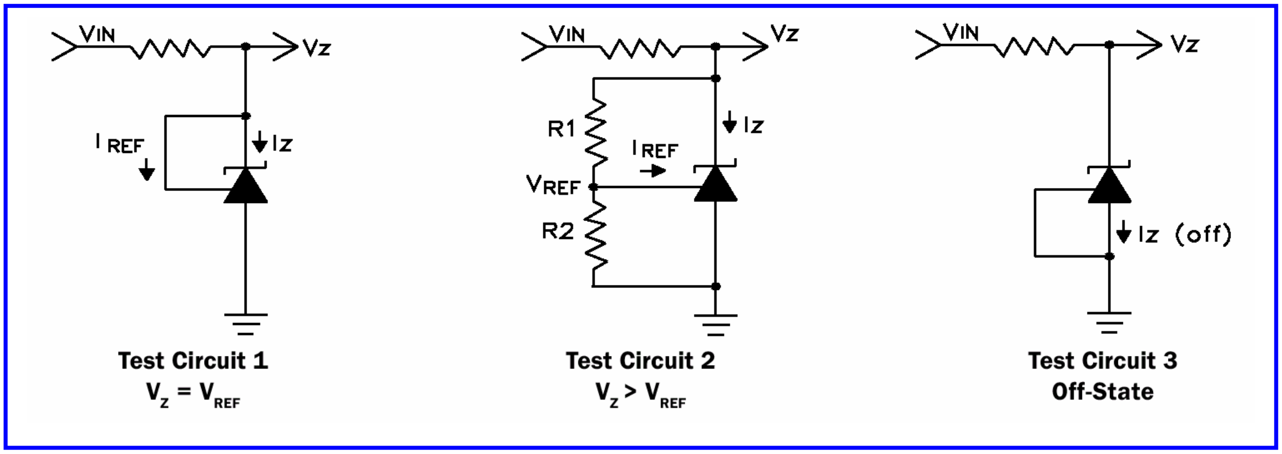
Stability: Selection of Load Capacitor

Selection of load capacitor for when B431L is used as a shunt regulator, two options for selection of C_L 1) No load capacitance across the device, decouple at the load 2) Large capacitance across the device, optional decoupling at the load.

The reason for this is that B431L exhibits instability with capacitances in the range of 10nF to 1µF (approx.) at light cathode currents (up to 3mA typical). The device is less stable the lower the cathode voltage has been set for. Therefore while the device will be perfectly stable operating at a cathode current of 10mA with a 0.1µF capacitor across it, it will oscillate transiently during start-up as the cathode current passes through the instability region. Selecting a very low (or preferably, no) capacitance, or alternatively a high capacitance such as 10µF will avoid this issue altogether. Since the user anyway, the most cost effective method is to use no capacitance at all directly across the device. PCB trace/via resistance and inductance prevent the local load decoupling from causing the oscillation during the transient start-up phase.

Note: if the B431L is located right at the load, so the load decoupling capacitor is directly across it, then this capacitor will have to be ≤1nF or ≥ 10µF

Test Circuits:

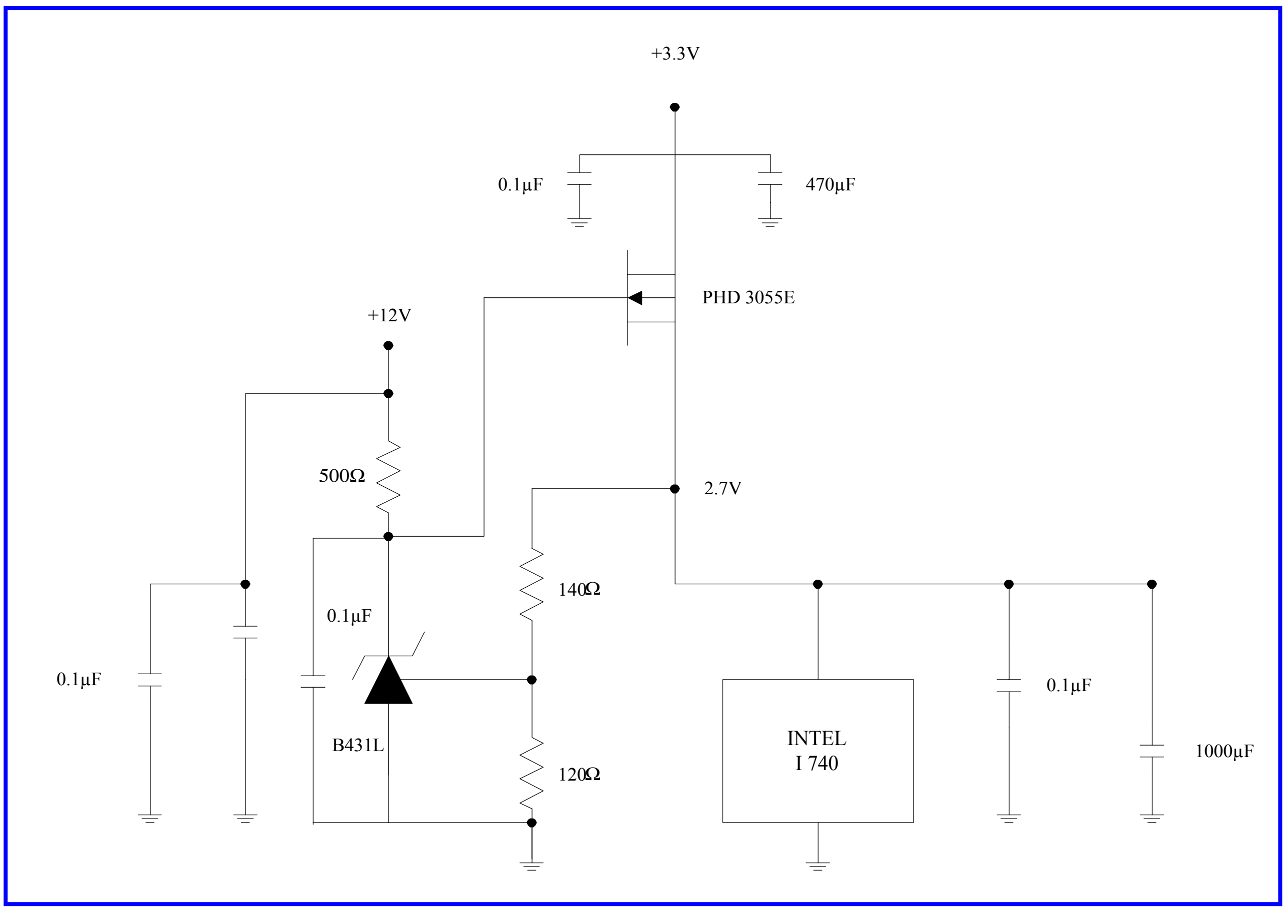


Test Circuit 1 $V_Z = V_{REF}$

Test Circuit 2 $V_Z > V_{REF}$

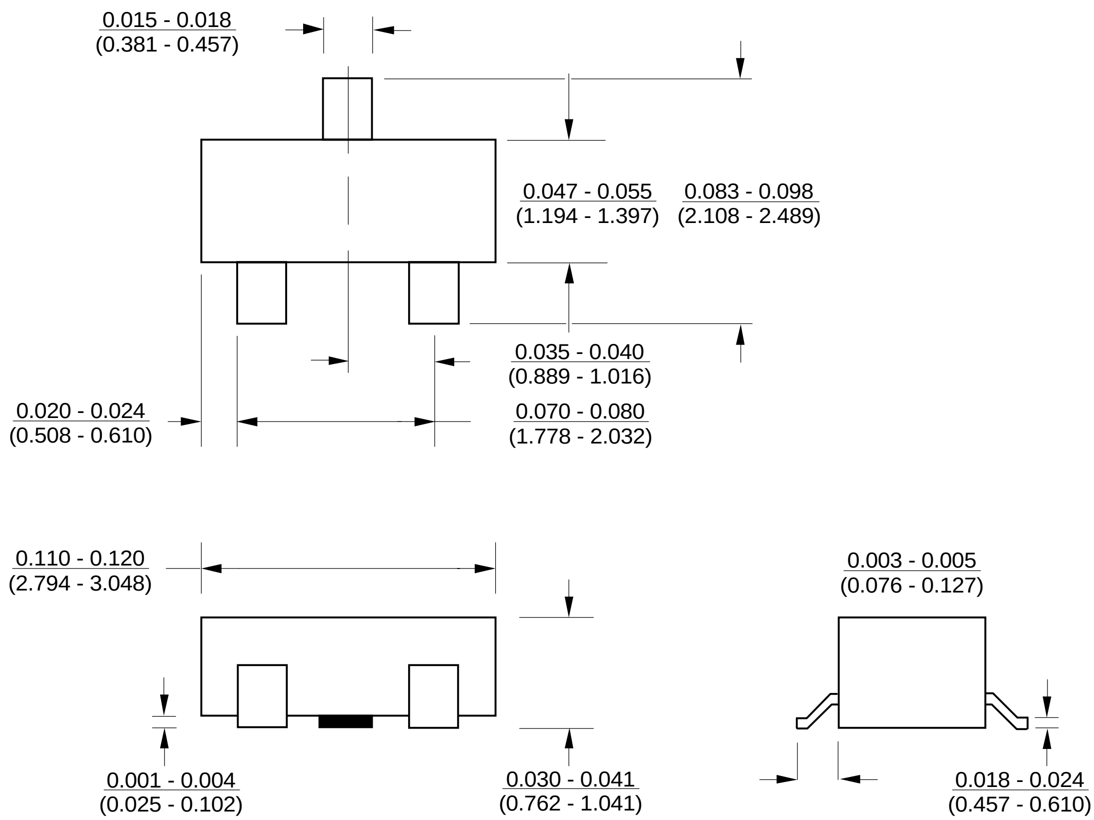
Test Circuit 3 Off-State

Application Circuit:



*If the output voltage has noise, then please add a 0.1µF in between drain and gate of power MOSFET to reduce the noise.

SOT-23



Advance Information- These data sheets contain descriptions of products that are in development. The specifications are based on the engineering calculations, computer simulations and/ or initial prototype evaluation.

Preliminary Information- These data sheets contain minimum and maximum specifications that are based on the initial device characterizations. These limits are subject to change upon the completion of the full characterization over the specified temperature and supply voltage ranges.

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