PROGRAMMABLE PRECISION SHUNT REGULATOR TL431/A/C

FEATURES

- Programmable Output Voltage to 40V
- Guaranteed 0.5% Reference Voltage Tolerance
- Low (0.2Ω Typ.) Dynamic Output Impedance
- Cathode Current Range(Continuous) – 100 ~ 150 mA
- Equivalent Full Range Temperature Coefficient of 50PPM/℃
- Temperature Compensated For Operation Over Full Rate Operating Temperature Range
- Low Output Noise Voltage
- Fast Turn-on Response
- TO-92, SOT-89 or SOT-23 3L Package

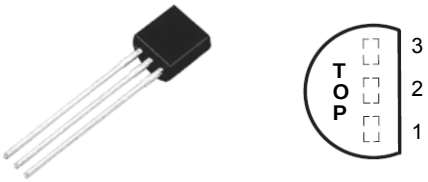
APPLICATION

- Shunt Regulator
- Precision High-Current Series Regulator
- High-Current Shunt Regulator
- Crowbar Circuit
- PWM Converter With Reference
- Voltage Monitor
- Precision Current Limiter

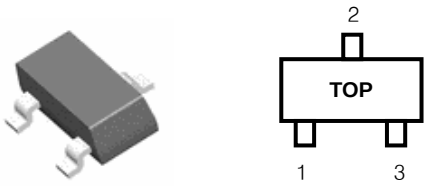
DESCRIPSION

The TL431 is a three-terminal adjustable shunt regulator with specified thermal stability over applicable temperature V_{REF} (Approx. 2.5V) and 40V with two external resistors. This device has a typical dynamic output impedance of 0.2Ω. Active output circuitry provides a very sharp turn-on characteristic, making this device excellent replacement for zener diodes in many applications. The TL431 is characterized for operation from -40℃ to +125℃.

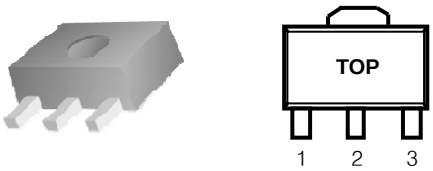
TO-92 PKG



SOT-23 PKG



SOT-89 PKG



PIN 1. Reference 2. Anode 3. Cathode

ORDERING INFORMATION

Device (Marking)	Package
TL431	TO-92
TL431-A	
TL431-C	
431	SOT-23 3L
431	SOT-89 3L

Absolute Maximum Ratings

(Operating temperature range applies unless otherwise specified)

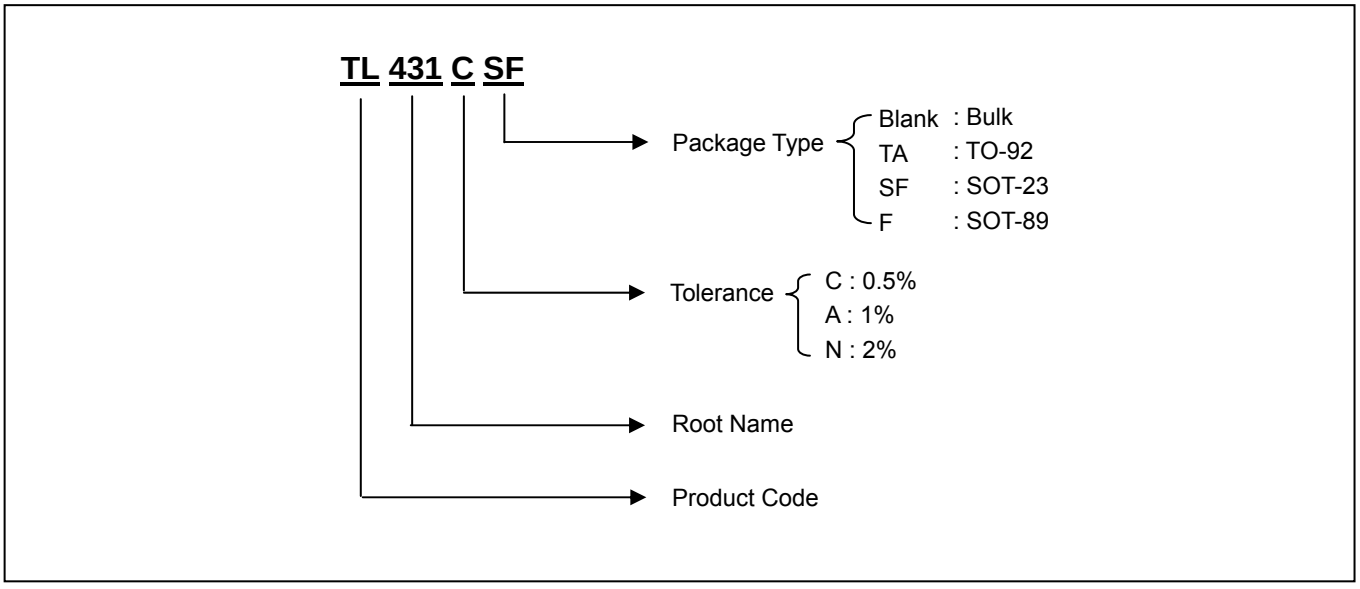
CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
Cathode Voltage	V_{KA}	-	42	V
Cathode Current Range(Continuous)	I_K	-100	150	mA
Reference Input Current Range	I_{REF}	0.05	10	mA
Junction Temperature Range	T_J	0	150	℃
Storage Temperature Range	T_{STG}	-60	150	℃
Operating Temperature Range	T_{OPR}	-40	125	℃

RECOMMENDED OPERATING CONDITIONS

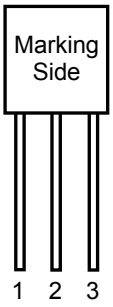
CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
Cathode Voltage	V_{KA}	V_{REF}	40	V
Cathode Current	I_K	0.5	100	mA

Ordering Information

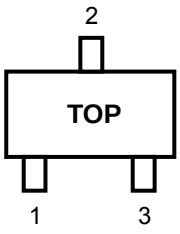
V_{REF}	Package	Tolerance	Order No.(Note 1)	Package Marking	Supplied As
2.495V	TO-92	0.5%	TL431C	TL431-C	Bulk
			TL431CTA		Tape
		1%	TL431A	TL431-A	Bulk
			TL431ATA		Tape
		2%	TL431	TL431	Bulk
			TL431TA		Tape
	SOT-23	0.5%	TL431CSF	431	Reel
		1%	TL431ASF		Reel
		2%	TL431SF		Reel
	SOT-89	0.5%	TL431CF	431	Reel
		1%	TL431AF		Reel
		2%	TL431F		Reel



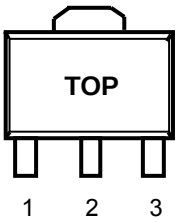
PIN CONFIGURATION



TO-92 PKG



SOT-23 PKG



SOT-89 PKG

PIN DESCRIPTION

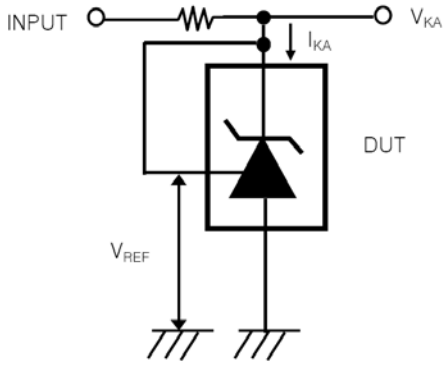
Pin No.	TO-92 / SOT-23 / SOT-89	
	Name	Function
1	Reference	Reference Voltage
2	Anode	Ground
3	Cathode	Input Supply Voltage

TL431 ELECTRICAL CHARACTERISTICS

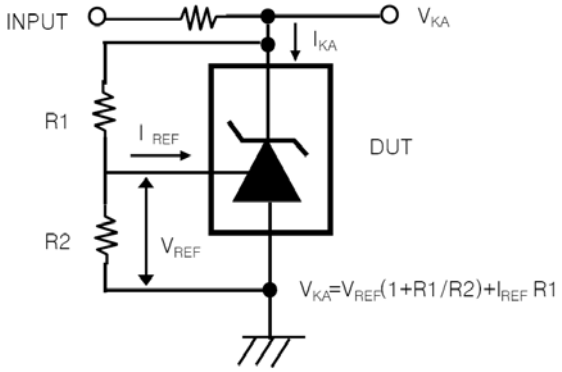
(T_A=25℃, unless otherwise specified)

CHARACTERISTIC	SYMBOL	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Reference Input Voltage	V_{REF}	$V_{KA}=V_{REF}$, I_K=10mA	TL431C	2.483	2.495	2.507	V
			TL431A	2.470	2.495	2.520	
			TL431	2.440	2.495	2.550	
Deviation of Reference Input Voltage	$\Delta V_{REF}/\Delta T$	$V_{KA}=V_{REF}$, I_K=10mA T_A=Full Range			3	17	mV
Ratio of Change in Reference Input Voltage to the Change in Cathode Voltage	$\Delta V_{REF}/\Delta V_{KA}$	I_K=10mA	ΔV_{KA}=10V -V_{REF}		-1.4	-2.7	mV/V
			ΔV_{KA}=36V-10V		-1.0	-2.0	
Reference Input Current	I_{REF}	I_{KA}=10mA, R_1=10kΩ, R_2=∞			1.8	4.0	uA
Deviation of Reference Input Current	$\Delta I_{REF}/\Delta T$	I_K=10mA, R_1=10kΩ, R_2=∞ T_A=Full Range			0.4	1.2	uA
Minimum Cathode Current for Regulation	$I_{K(MIN)}$	$V_{KA}=V_{REF}$				0.5	mA
Off-State Cathode Current	$I_{K(OFF)}$	V_{KA}=42V, V_{REF}=0			0.17	0.90	uA
Dynamic Impedance	Z_{KA}	$V_{KA}=V_{REF}$, I_K=1mA~100mA f ≤ 1kHz			0.27	0.50	Ω

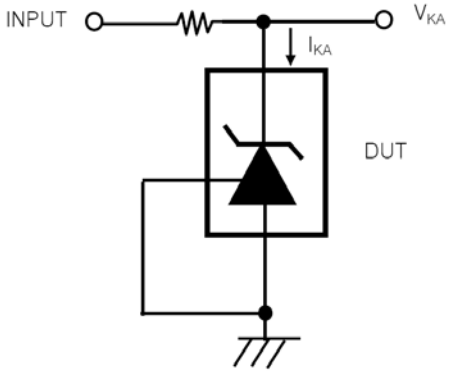
TEST CIRCUITS



[Fig 1. Test circuit for $V_{KA} = V_{REF}$]



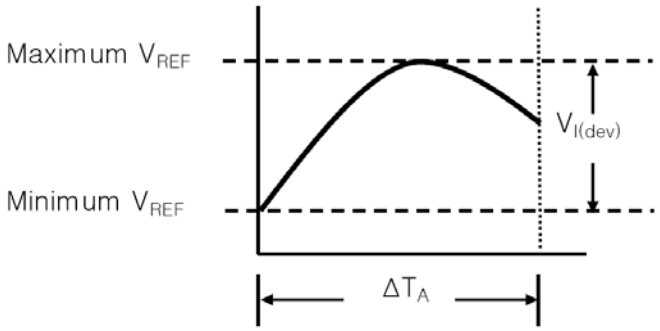
[Fig 2. Test circuit for $V_{KA} \geq V_{REF}$]



[Fig 3. Test circuit for $I_{KA(OFF)}$]

The deviation parameters $\Delta V_{REF}/\Delta T$ and $\Delta I_{REF}/\Delta T$ are defined as the differences between the maximum and minimum values obtained over the recommended temperature range. The average full-range temperature coefficient of the reference voltage, αV_{REF}, is defined as :

$$|\alpha V_{REF}|\ (\frac{ppm}{℃}) = \frac{(\frac{V_{I(dev)}}{V_{REF}\text{at } 25℃})\ x10^6}{\Delta T_A}$$



Where :

ΔT_A is the recommended operating free-air temperature range of the device.

αV_{REF} can be positive or negative, depending on whether minimum V_{REF} or maximum V_{REF}, respectively, occurs at the lower temperature.

Example : Maximum V_{REF}=2496mV at 30℃, maximum V_{REF}=2492mV at 0℃, V_{REF}=2495mV at 25℃, ΔT_A=70℃ for TL431C.

$$\left|a_{V_{REF}}\right| = \frac{\left(\frac{4mV}{2495mV}\right)\times 10^6}{70°C} \approx \frac{23ppm}{°C}$$

Because minimum V_{REF} occurs at the lower temperature, the coefficient is positive.

Calculating Dynamic Impedance

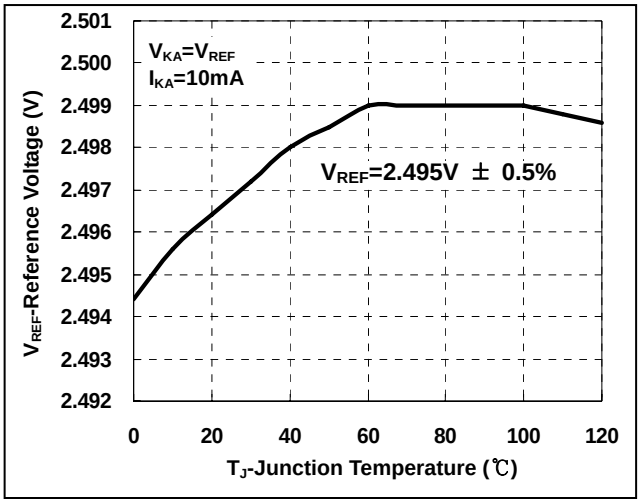
The dynamic impedance is defined as : $\left|Z_{KA}\right| = \frac{\Delta V_{KA}}{\Delta I_{KA}}$

When the device is operating with two external resistors, the total dynamic impedance of the circuit is given by :

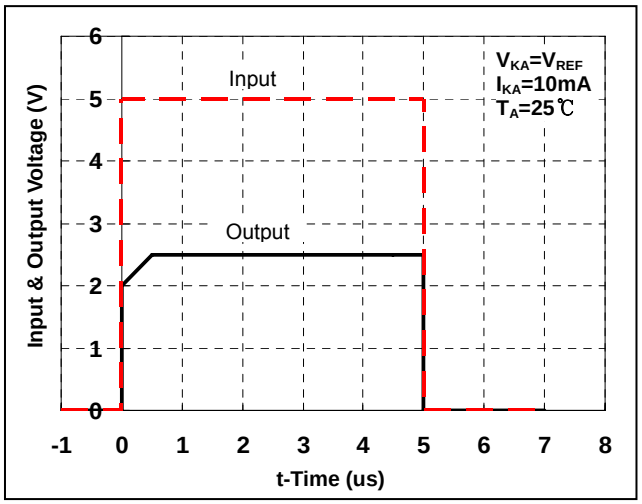
$$\left|Z'\right| = \frac{\Delta V}{\Delta I} \approx \left|Z_{KA}\right|\left(1+\frac{R1}{R2}\right)$$

TYPICAL OPERATING CHARACTERISTICS

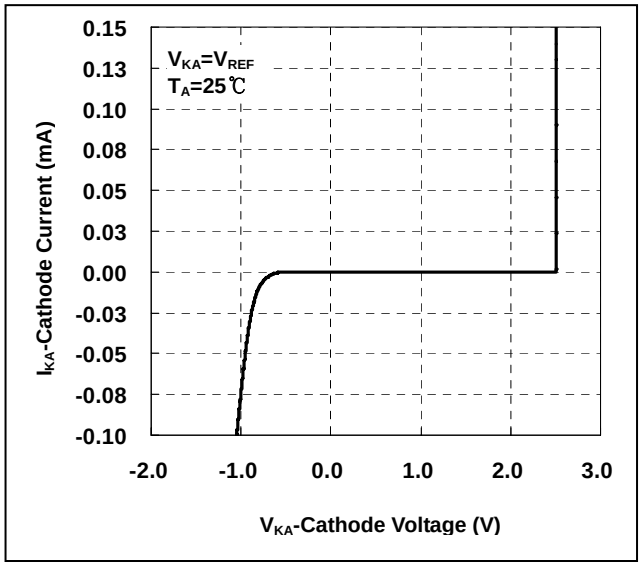
REFERENCE VOLTAGE vs
JUNCTION TEMPERATUR



PULSE RESPONS



CATHODE CURRENT vs
CATHODE VOLTAGE



CATHODE CURRENT vs
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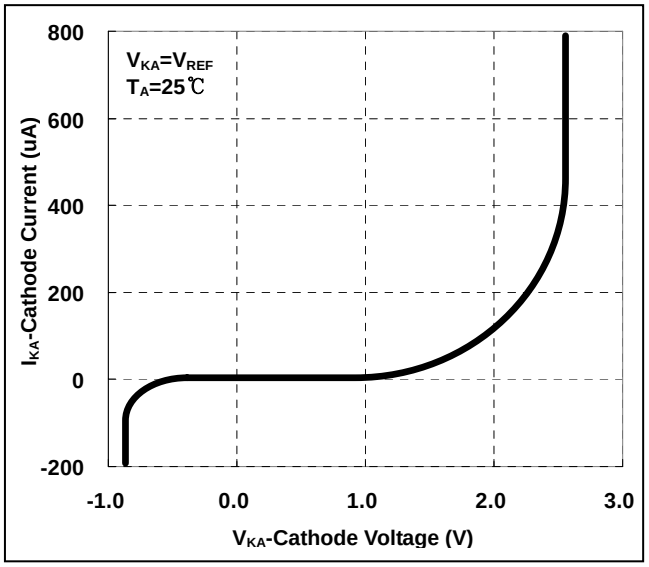
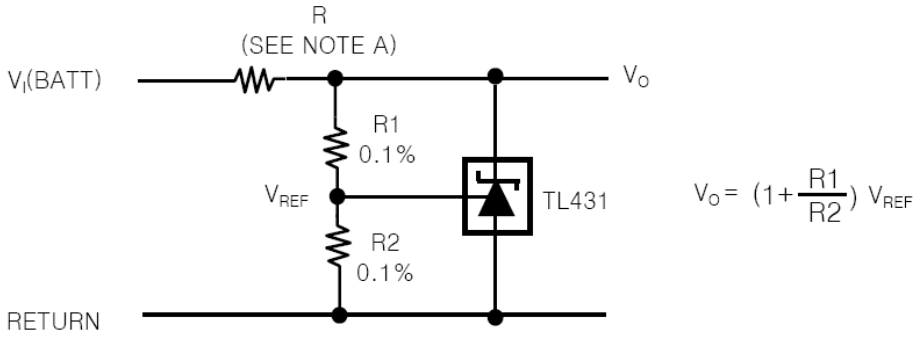


T.B.D

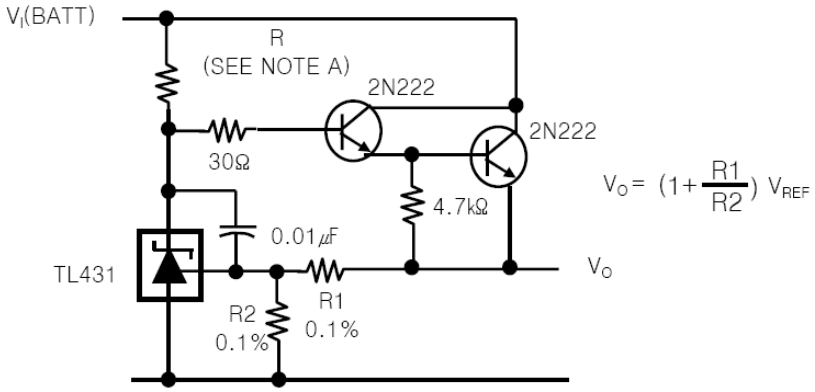
APPICATION INFORMATION

1. Shunt Regulator



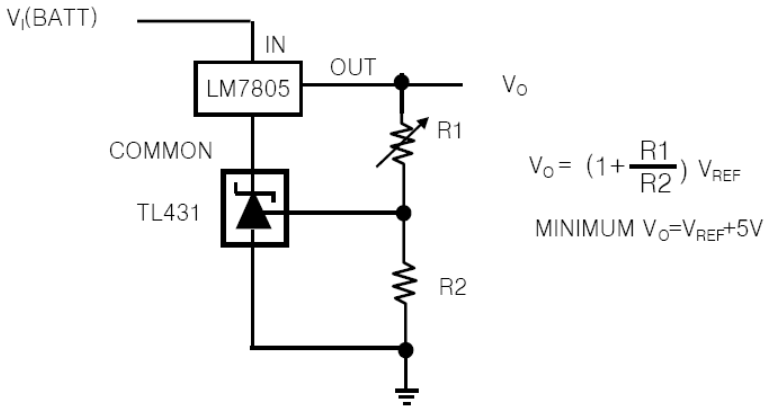
Note A : R Should provide cathode current 1mA to the TL431 at minimum $V_{I(BATT)}$

2. Precision High-Current Series Regulator

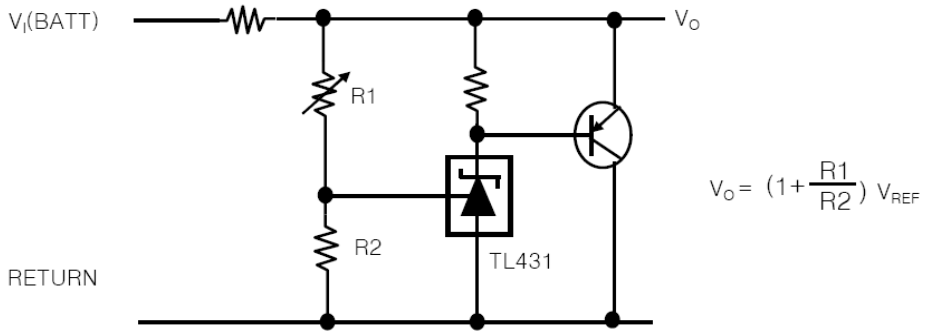


Note A : R Should provide cathode current≥1mA to the TL431 at minimum $V_{I(BATT)}$

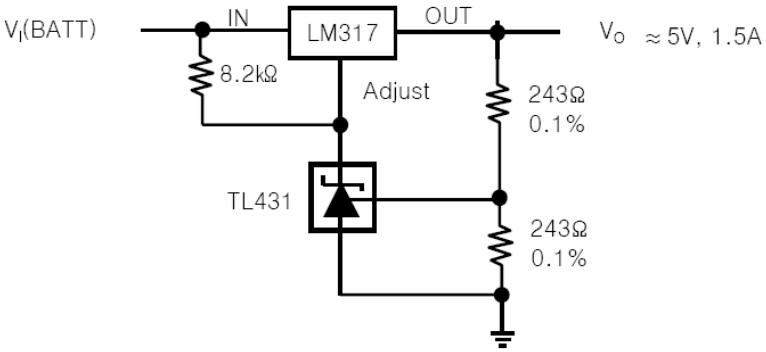
3. Output Control of a Three-Terminal Fixed Regulator



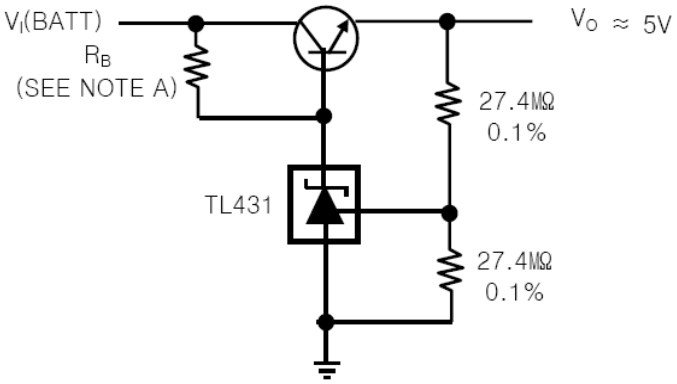
4. High-Current Shunt Regulator



5. Precision 5-V 1.5A Regulator

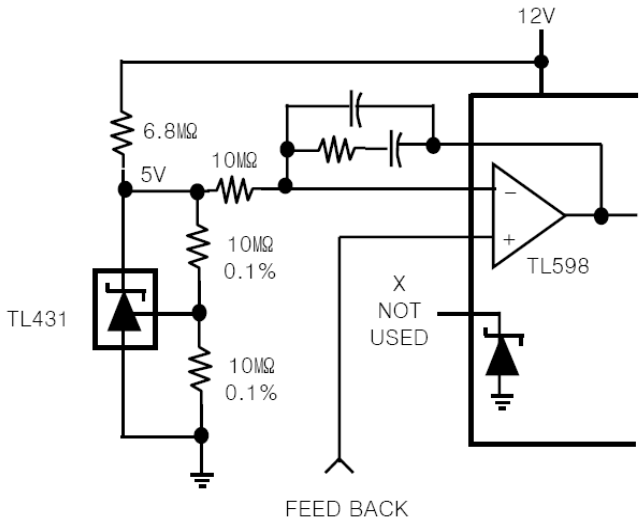


6. Efficient 5-V Precision Regulator

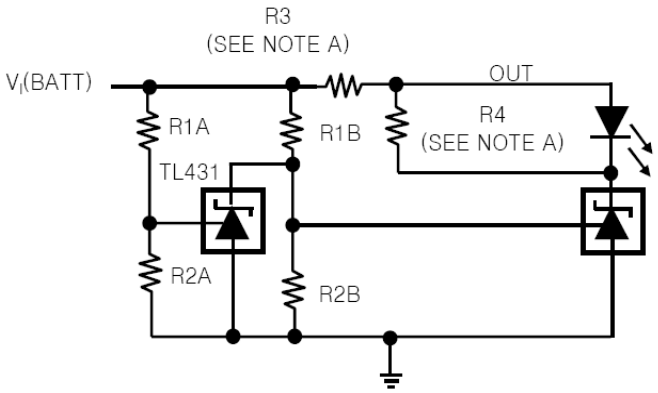


NOTE A : R_B Should provide cathode current≥1mA to the TL431.

7. PWM Converter With Reference



8. Voltage Monitor



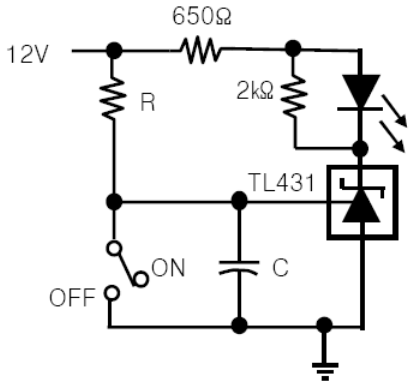
$$\text{LOW LIMIT} = \left(1+\frac{R1B}{R2B}\right) V_{REF}$$

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

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

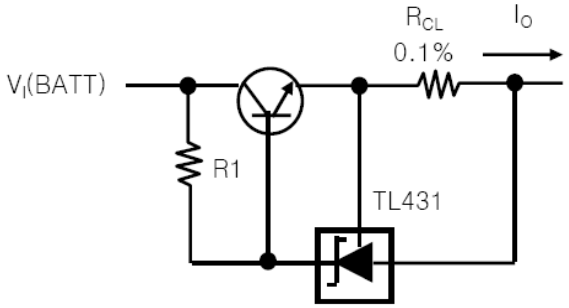
NOTE A : R3 and R4 are selected to provide the desired LED intensity and cathode current ≥1mA to the TL431 at the available $V_{I(BATT)}$.

9. Delay Timer



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

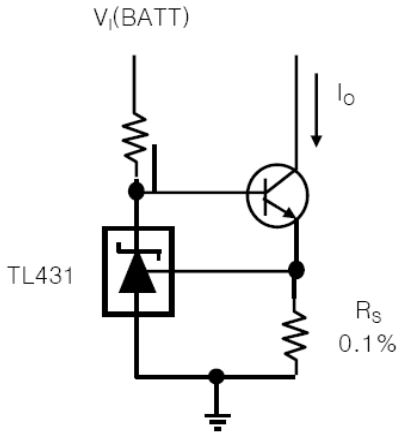
10. Precision Current Limiter



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

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

11. Precision Constant-Current Sink



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