



# TL431

## LINEAR INTEGRATED CIRCUIT

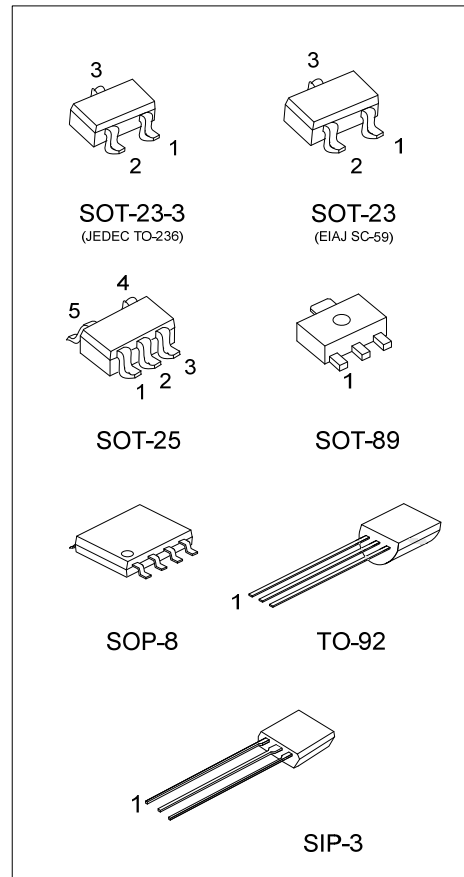
### PROGRAMMABLE PRECISION REFERENCE

#### DESCRIPTION

The UTC **TL431** is a three-terminal adjustable regulator with a guaranteed thermal stability over applicable temperature ranges. The output voltage may be set to any value between  $V_{REF}$  (approximately 2.5V) and 36V with two external resistors. It provides very wide applications, including shunt regulator, series regulator, switching regulator, voltage reference and others.

#### FEATURES

- \* Programmable output Voltage to 36V.
- \* Low dynamic output impedance 0.2Ω.
- \* Sink current capability of 1.0 to 100mA.
- \* Equivalent full-range temperature coefficient of 50ppm/°C typical for operation over full rated operating temperature range.



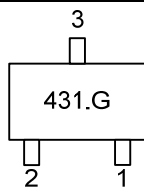
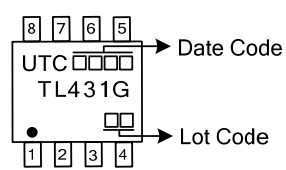
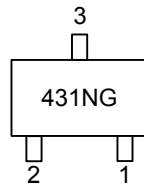
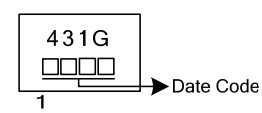
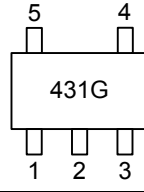
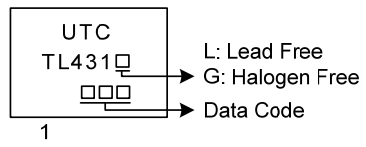
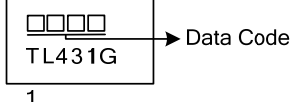
#### ORDERING INFORMATION

Ordering Number		Package	Pin Assignment								Packing
Lead Free	Halogen Free		1	2	3	4	5	6	7	8	
-	TL431G-AB3-R	SOT-89	R	A	K	-	-	-	-	-	Tape Reel
-	TL431G-AE2-R	SOT-23-3	K	R	A	-	-	-	-	-	Tape Reel
-	TL431G-AE3-R	SOT-23	K	R	A	-	-	-	-	-	Tape Reel
-	TL431NSG-AE3-R	SOT-23	R	K	A	-	-	-	-	-	Tape Reel
-	TL431NSG-AE2-R	SOT-23-3	R	K	A	-	-	-	-	-	Tape Reel
-	TL431G-AF5-R	SOT-25	X	X	K	R	A	-	-	-	Tape Reel
-	TL431NG-AF5-A-R	SOT-25	X	A	X	K	R	-	-	-	Tape Reel
-	TL431G-S08-R	SOP-8	K	A	A	X	X	A	A	R	Tape Reel
-	TL431G-G03-K	SIP-3	R	A	K	-	-	-	-	-	Bulk
TL431K-T92-B	TL431G-T92-B	TO-92	R	A	K	-	-	-	-	-	Tape Box
TL431K-T92-K	TL431G-T92-K	TO-92	R	A	K	-	-	-	-	-	Bulk

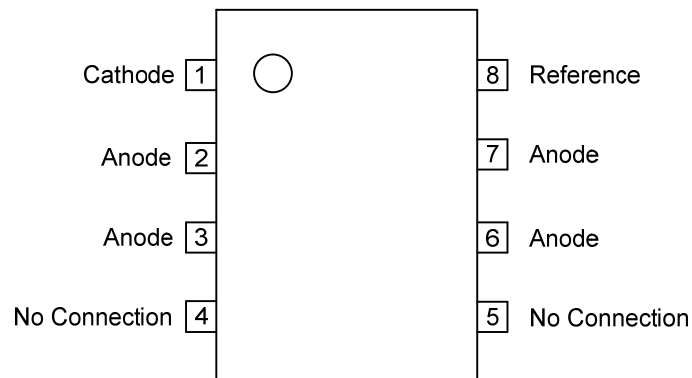
Note: Pin Code: K: Cathode A: Anode R: Reference X: No Connection

<p>TL431G-AF5-A-R</p>	<p>(1) B: Tape Box, K: Bulk, R: Tape Reel, T: Tube                  (2) refer to Pin Assignment                  (3) AB3: SOT-89, AE2: SOT-23-3, AE3: SOT-23,                  AF5: SOT-25, S08: SOP-8, G03: SIP-3, T92: TO-92                  (4) G: Halogen Free and Lead Free, K: Lead Free</p>
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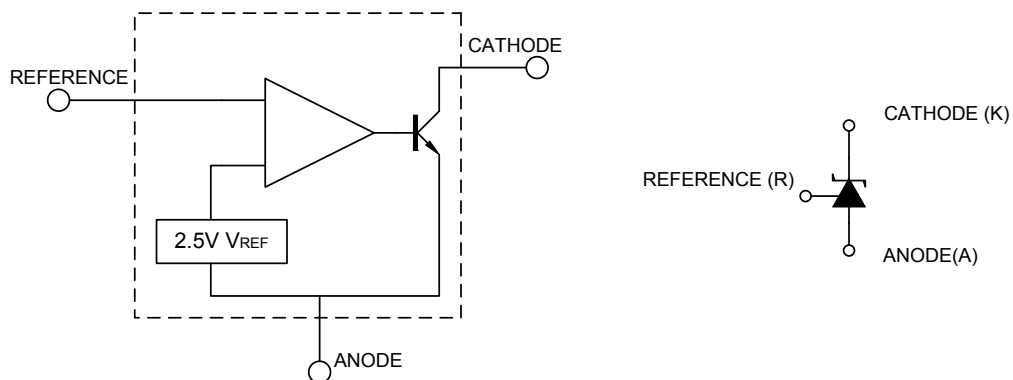
### MARKING

PACKAGE	MARKING	PACKAGE	MARKING
SOT-23-3 SOT-23 (TL431)		SOP-8	
SOT-23-3 SOT-23 (TL431NS)		SIP-3	
SOT-25		TO-92	
SOT-89			

### PIN CONFIGURATION(For SOP-8)



### BLOCK DIAGRAM



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

PARAMETER	SYMBOL	RATINGS	UNIT	
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	TO-92	$P_D$	770	mW
	SOT-89		800	mW
	SOT-23/SOT-23-3		300	mW
	SOT-25			
	SIP-3		400	mW
	SOP-8	600	mW	
Operating Junction	$T_J$	+150	°C	
Operating Ambient	$T_{OPR}$	-40 ~ +85	°C	
Storage Temperature	$T_{STG}$	-65 ~ +150	°C	

Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged  
 Absolute maximum ratings are stress ratings only and functional device operation is not implied.

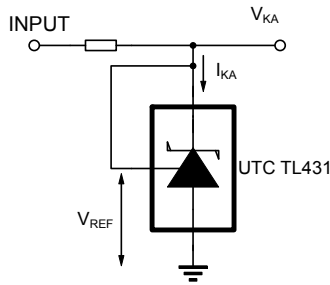
■ RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT
Cathode Voltage	$V_{KA}$	$V_{REF}$		36	V
Cathode Current	$I_{KA}$	1		100	mA

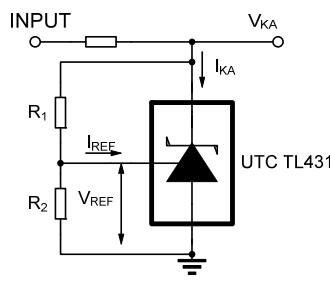
■ ELECTRICAL CHARACTERISTICS ( $T_C = 25^\circ\text{C}$ , unless otherwise specified.)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT	
Reference Input Voltage	$V_{REF}$	$V_{KA}=V_{REF}, I_{KA}=10\text{mA}$	TL431-A	2.483	2.495	2.507	V
			TL431-1	2.470	2.495	2.520	V
			TL431-2	2.520	-	2.545	V
			TL431-3	2.445	-	2.470	V
Deviation of reference Input Voltage Over temperature	$\frac{\Delta V_{REF}}{\Delta T}$	$V_{KA}=V_{REF}, I_{KA}=10\text{mA}, 0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$		4.5	17	mV	
Ratio of Change in Reference Input Voltage to the Change in Cathode Voltage	$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	$I_{KA}=10\text{mA}$	$\Delta V_{KA}=10\text{V} \sim V_{REF}$	-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	$I_{REF}$	$I_{KA}=10\text{mA}, R1=10\text{k}\Omega, R2=\infty$		1.5	4	$\mu\text{A}$	
Deviation of Reference Input Current Over Full Temperature Range	$\frac{\Delta I_{REF}}{\Delta T}$	$I_{KA}=10\text{mA}, R1=10\text{k}\Omega, R2=\infty, T_A = \text{full Temperature}$		0.4	1.2	$\mu\text{A}$	
Minimum Cathode Current for Regulation	$I_{KA(MIN)}$	$V_{KA}=V_{REF}$		0.3	0.5	mA	
Off-State Cathode Current	$I_{KA(OFF)}$	$V_{KA}=36\text{V}, V_{REF}=0$		0.05	1.0	$\mu\text{A}$	
Dynamic Impedance	$Z_{KA}$	$V_{KA}=V_{REF}, I_{KA}=1 \sim 100\text{mA}, f \leq 1.0\text{kHz}$		0.15	0.5	$\Omega$	

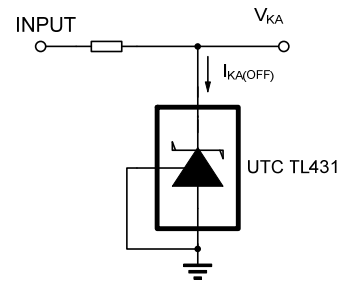
## ■ TEST CIRCUIT



For  $V_{KA} = V_{REF}$

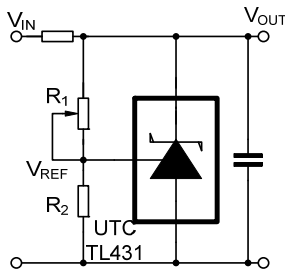


$V_{KA} = V_{REF} \times (1 + R_1/R_2) + I_{REF} \times R_1$   
For  $V_{KA} \geq V_{REF}$



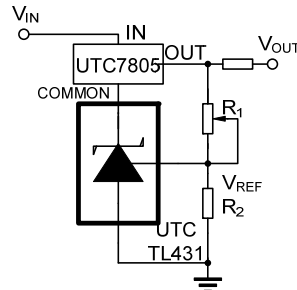
For  $I_{KA(OFF)}$

## ■ APPLICATION CIRCUIT



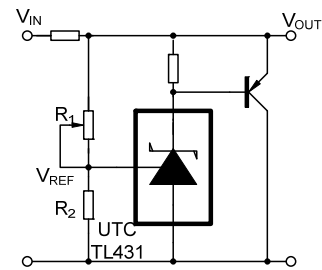
$$V_{OUT} = (1 + R_1/R_2) \times V_{REF}$$

Shutdown Regulator



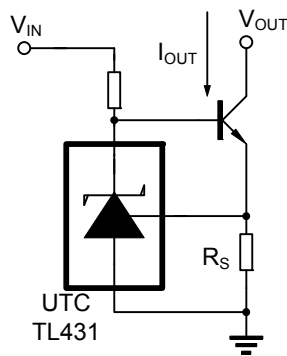
$$V_{OUT} = (1 + R_1/R_2) \times V_{REF}$$

Minimum  $V_{OUT} = V_{REF} + 5V$   
Output Control of a Three-Terminal Fixed Regulator



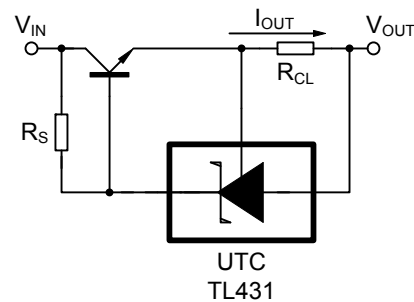
$$V_{OUT} = (1 + R_1/R_2) \times V_{REF}$$

Higher-current Shunt Regulator



$$I_{OUT} = V_{REF}/R_S$$

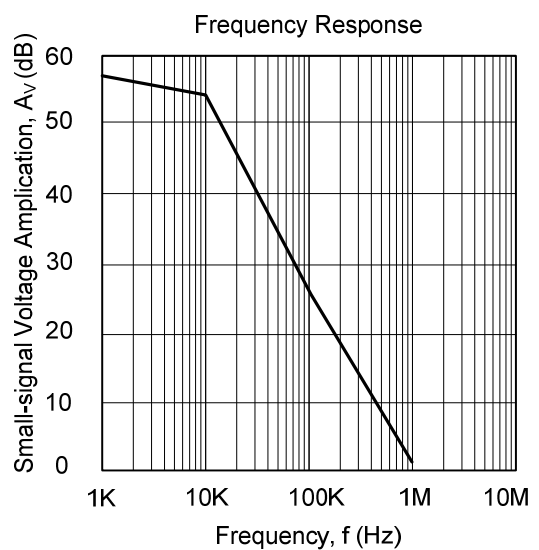
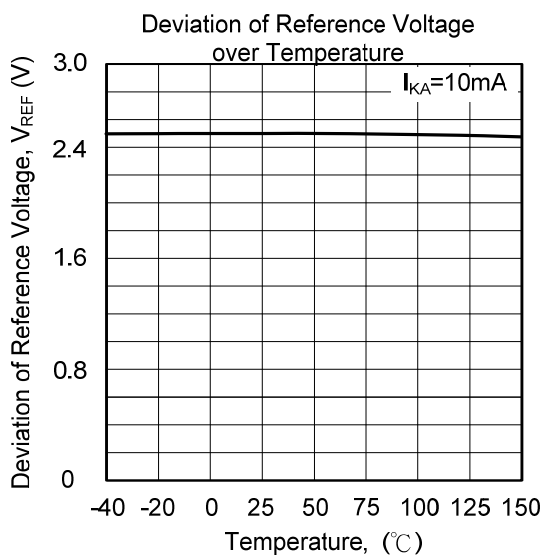
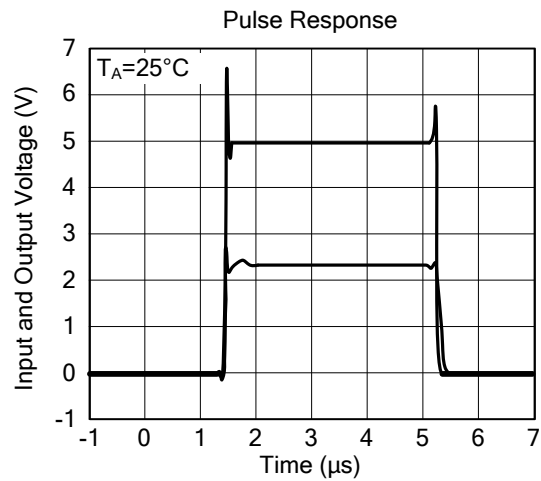
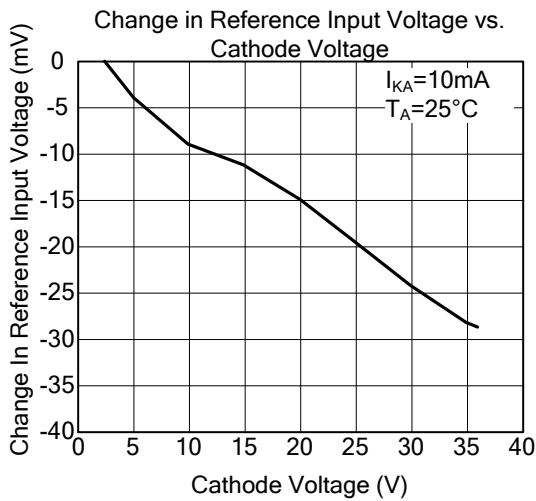
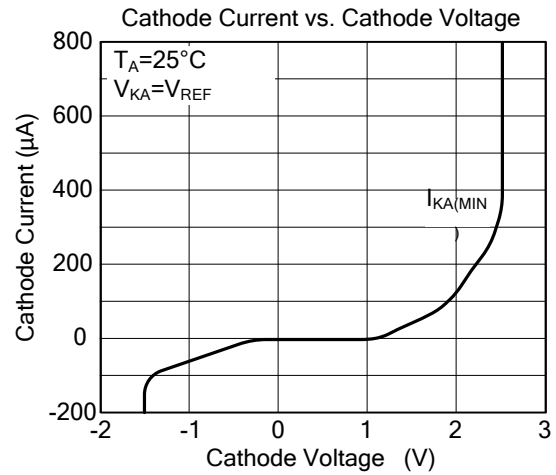
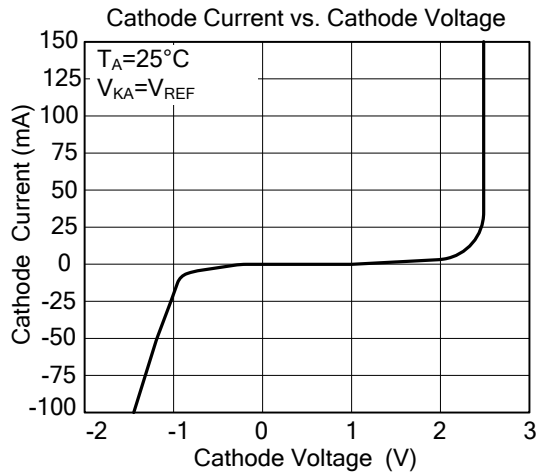
Constant-current Sink



$$I_{OUT} = V_{REF}/R_{CL}$$

Current Limiting or Current Source

### TYPICAL CHARACTERISTICS



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