



# TL431

## LINEAR INTEGRATED CIRCUIT

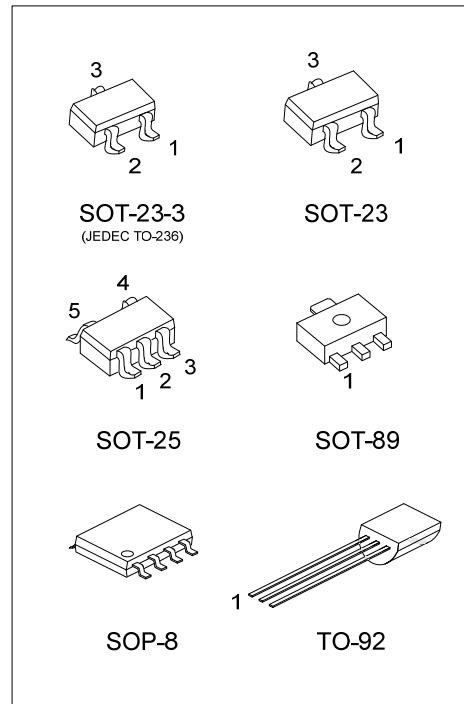
### PROGRAMMABLE PRECISION REFERENCE

■ **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.



Lead-free: TL431K  
 Halogen-free: TL431G  
 TL431NS for SOT-23  
 Lead-free: TL431NSL  
 Halogen-free: TL431NSG

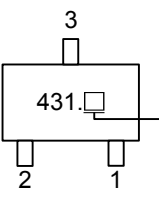
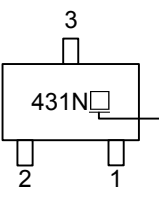
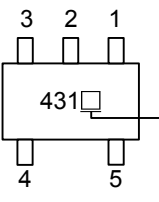
■ **ORDERING INFORMATION**

Ordering Number			Pin Assignment								Package	Packing
Normal	Lead Free	Halogen Free	1	2	3	4	5	6	7	8		
TL431-AB3-R	TL431K-AB3-R	TL431G-AB3-R	R	A	K	-	-	-	-	-	SOT-89	Tape Reel
TL431-AE2-R	TL431K-AE2-R	TL431G-AE2-R	K	R	A	-	-	-	-	-	SOT-23-3	Tape Reel
TL431-AE3-R	TL431K-AE3-R	TL431G-AE3-R	K	R	A	-	-	-	-	-	SOT-23	Tape Reel
TL431NS-AE3-R	TL431NSL-AE3-R	TL431NSG-AE3-R	R	K	A	-	-	-	-	-	SOT-23	Tape Reel
TL431-AF5-R	TL431K-AF5-R	TL431G-AF5-R	X	X	K	R	A	-	-	-	SOT-25	Tape Reel
TL431-S08-R	TL431K-S08-R	TL431G-S08-R	K	A	A	X	X	A	A	R	SOP-8	Tape Reel
TL431-T92-B	TL431K-T92-B	TL431G-T92-B	R	A	K	-	-	-	-	-	TO-92	Tape Box
TL431-T92-K	TL431K-T92-K	TL431G-T92-K	R	A	K	-	-	-	-	-	TO-92	Bulk

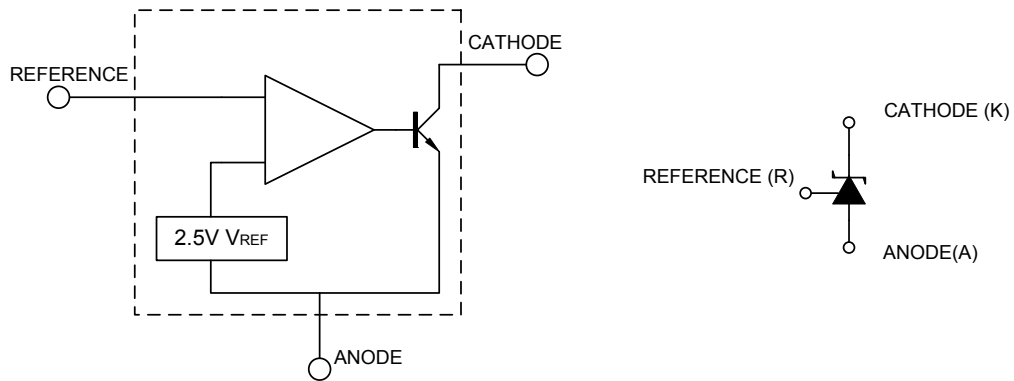
Note: Pin Code: K: Cathode A: Anode R: Reference X: No Connection

<p>TL431K-AB3-R</p> <p>(1)Packing Type</p> <p>(2)Package Type</p> <p>(3)Lead Plating</p>	<p>(1) B: Tape Box, K: Bulk, R: Tape Reel</p> <p>(2) AB3: SOT-89, AE2: SOT-23-3, AE3: SOT-23, AF5: SOT-25, S08:SOP-8, T92: TO-92</p> <p>(3) G: Halogen Free, K: Lead Free Plating, Blank: Pb/Sn</p> <p>G: Halogen Free, L: Lead Free Only for TL431NS Type</p>
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### MARKING

PACKAGE	MARKING
SOT-23-3 SOT-23	 <p>3 431 □ 2 1</p> <p>→ K: Lead Free G: Halogen Free</p>
SOT-23 (TL431NS)	 <p>3 431N □ 2 1</p> <p>→ L: Lead Free G: Halogen Free</p>
SOT-25	 <p>3 2 1 431 □ 4 5</p> <p>→ K: Lead Free G: Halogen Free</p>

### 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/SOT-25		300	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.

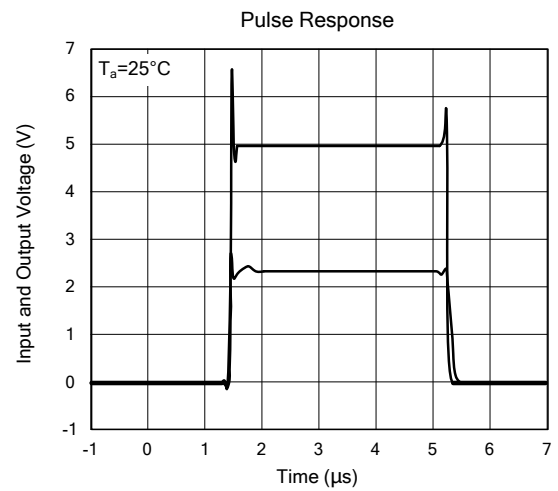
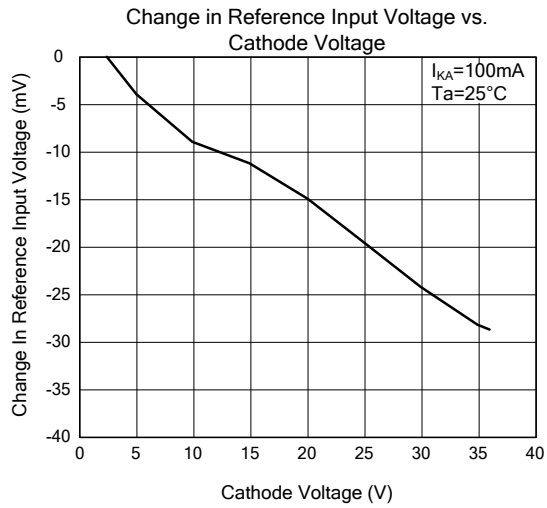
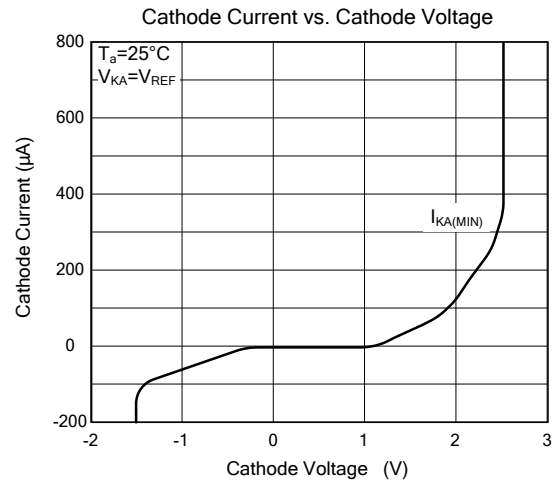
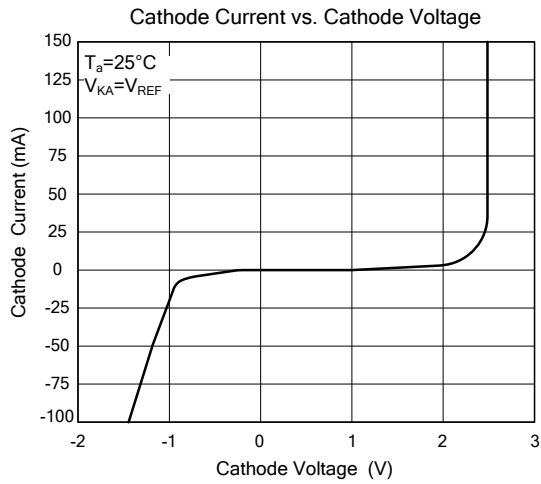
■ RECOMMENDED OPERATING CONDITIONS

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

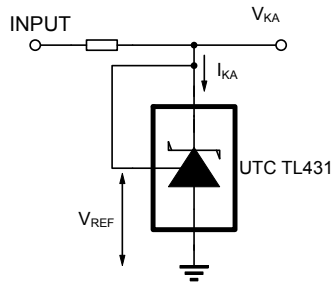
■ ELECTRICAL CHARACTERISTICS ( $T_C = 25^\circ\text{C}$ , unless otherwise specified.)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Reference Input Voltage	$V_{REF}$	$V_{KA}=V_{REF}, I_{KA}=10\text{mA}$	2.470	2.495	2.520	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	$I_{KA(MIN)}$	$V_{KA}=V_{REF}$		0.19	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	$Z_{KA}$	$V_{KA}=V_{REF}, I_{KA}=1 \text{ to } 100\text{mA}$ $f \leq 1.0\text{kHz}$		0.15	0.5	$\Omega$

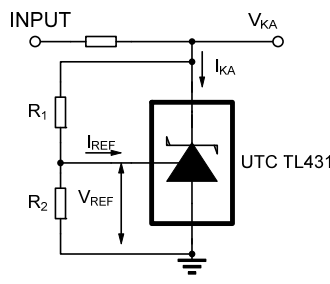
### TYPICAL CHARACTERISTICS



### TEST CIRCUIT

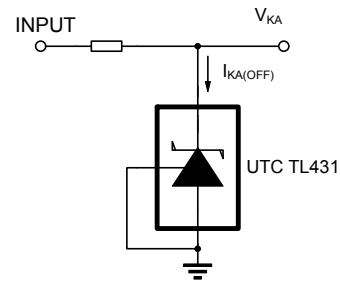


For  $V_{KA} = V_{REF}$



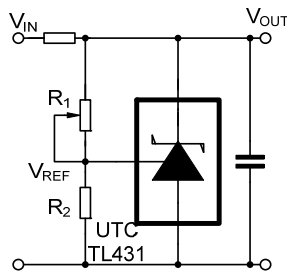
$$V_{KA} = V_{REF} \times (1 + R_1/R_2) + I_{REF} \times R_1$$

For  $V_{KA} \geq V_{REF}$



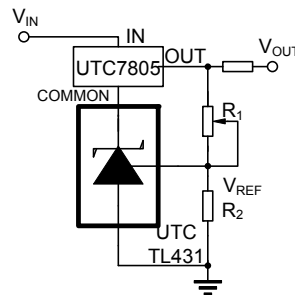
For  $I_{KA(OFF)}$

### APPLICATION CIRCUIT



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

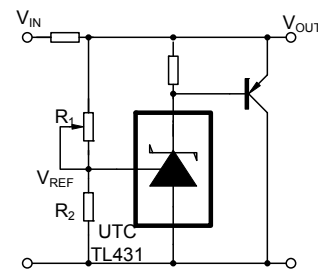
Shutdown Regulator



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

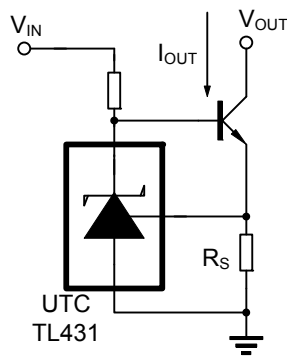
Minimum  $V_{OUT} = V_{REF} + 5V$

Output Control of a Three-Terminal Fixed Regulator



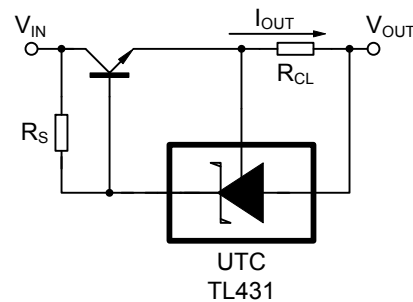
$$V_{OUT} = (1 + R_1/R_2) \times V_{REF}$$

Higher-current Shunt Regulator



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

Constant-current Sink



$$R_S = V_{REF}/R_{CL}$$

Current Limiting or Current Source

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