

## LL431

## LINEAR INTEGRATED CIRCUIT

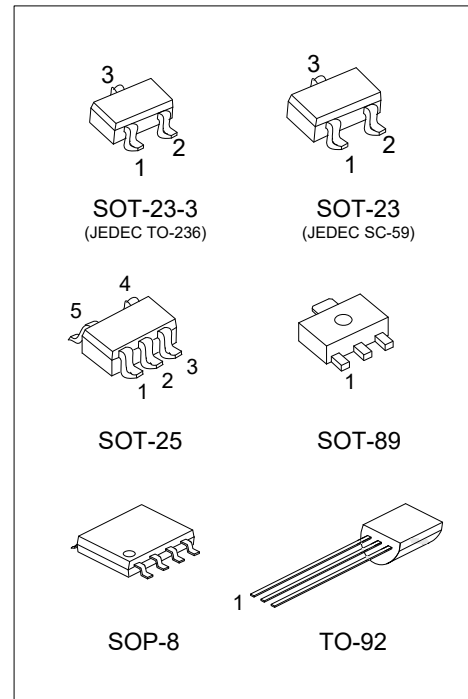
### PROGRAMMABLE PRECISION REFERENCE

#### DESCRIPTION

The UTC **LL431** 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 36 V with two external resistors. It can be used in provides very wide applications including shunt regulator, series regulator, switching regulator, voltage reference and others.

#### FEATURES

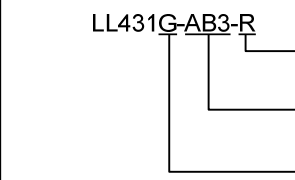
- \*Programmable output Voltage to 36V.
- \*Sink current capability of 1.0 to 100mA.
- \*Equivalent full-range temperature coefficient of 50ppm/ °C typical for operation over full rated operating temperature range.



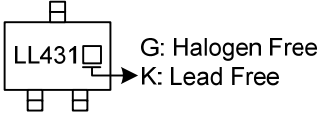
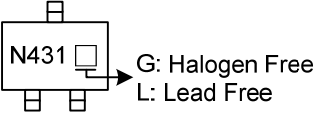
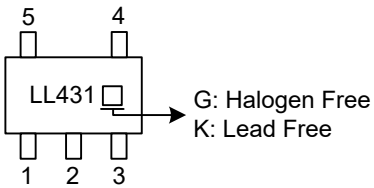
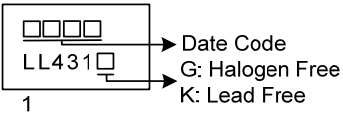
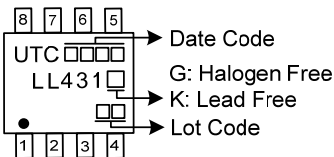
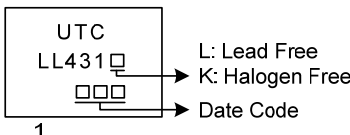
#### ORDERING INFORMATION

| Ordering Number |                | Package  | Pin Assignment |   |   |   |   |   |   |   | Packing   |
|-----------------|----------------|----------|----------------|---|---|---|---|---|---|---|-----------|
| Lead Free       | Halogen Free   |          | 1              | 2 | 3 | 4 | 5 | 6 | 7 | 8 |           |
| LL431K-AB3-R    | LL431G-AB3-R   | SOT-89   | R              | A | K | - | - | - | - | - | Tape Reel |
| LL431K-AE2-R    | LL431G-AE2-R   | SOT-23-3 | R              | K | A | - | - | - | - | - | Tape Reel |
| LL431NSL-AE2-R  | LL431NSG-AE2-R | SOT-23-3 | K              | R | A | - | - | - | - | - | Tape Reel |
| LL431K-AE3-R    | LL431G-AE3-R   | SOT-23   | R              | K | A | - | - | - | - | - | Tape Reel |
| LL431NSK-AE3-R  | LL431NSG-AE3-R | SOT-23   | K              | R | A | - | - | - | - | - | Tape Reel |
| LL431K-AF5-R    | LL431G-AF5-R   | SOT-25   | X              | X | K | R | A | - | - | - | Tape Reel |
| LL431K-S08-R    | LL431G-S08-R   | SOP-8    | K              | A | A | X | X | A | A | R | Tape Reel |
| LL431K-T92-B    | LL431G-T92-B   | TO-92    | R              | A | K | - | - | - | - | - | Tape Box  |
| LL431K-T92-K    | LL431G-T92-K   | TO-92    | R              | A | K | - | - | - | - | - | Bulk      |
| LL431K-T92-R    | LL431G-T92-R   | TO-92    | R              | A | K | - | - | - | - | - | Tape Reel |

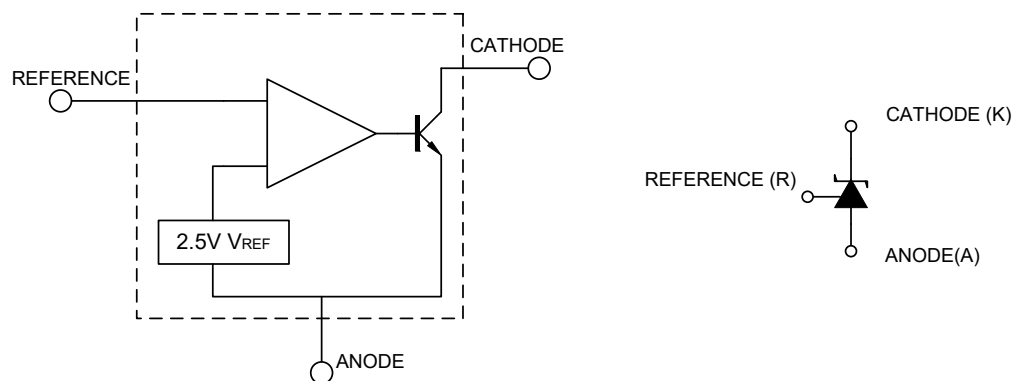
Note: Pin Code: R: Reference A: Anode K: Cathode X: No Connection

|   |                  |  |
|---|------------------|--|
|  | (1)Packing Type  | (1) B: Tape Box, K: Bulk, R: Tape Reel   |
|   | (2)Package Type  | (2) AB3: SOT-89, AE2: SOT-23-3, AE3: SOT-23, AF5: SOT-25, S08:SOP-8, T92: TO-92          |
|   | (3)Green Package | (3) G: Halogen Free, K: Lead Free<br>G: Halogen Free, L: Lead Free Only for TL431NS Type |

### MARKING

| SOT-23-3 / SOT-23<br>(LL431)  | SOT-23-3 / SOT-23<br>(LL431NS)  | SOT-25  |
|---|---|---|
|  |  |  |
| SOT-89  | SOP-8   | TO-92   |
|  |  |  |

### 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           |                 | $I_{REF}$ | -0.05 ~ +10 | mA   |
| Power Dissipation                 | SOT-89          | $P_D$     | 500         | mW   |
|                                   | SOT-23-3/SOT-23 |           | 300         | mW   |
|                                   | SOT-25          |           | 600         | mW   |
|                                   | SOP-8           |           | 770         | mW   |
|                                   | TO-92           |           | 770         | mW   |
| Junction Temperature              |                 | $T_J$     | +150        | °C   |
| Operating Temperature             |                 | $T_{OPR}$ | -40 ~ +125  | °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.

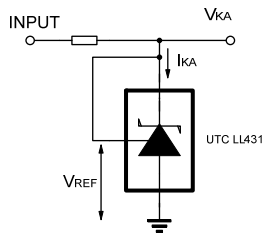
■ RECOMMENDED OPERATING CONDITIONS

| PARAMETER       | SYMBOL   | RATINGS           | UNIT |
|-----------------|----------|-------------------|------|
| Cathode Voltage | $V_{KA}$ | $V_{REF} \sim 36$ | V    |
| Cathode Current | $I_{KA}$ | 0.1 ~ 100         | mA   |

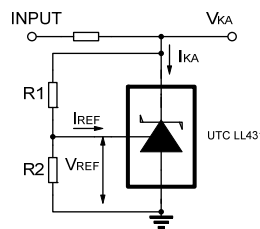
■ ELECTRICAL CHARACTERISTICS ( $T_C = 25^\circ\text{C}$ , unless otherwise specified.)

| PARAMETER   | SYMBOL                              | TEST CONDITIONS  |  | MIN   | TYP   | MAX   | UNIT |
|---|-------------------------------------|--|--|-------|-------|-------|------|
| Reference Input Voltage   | V <sub>REF</sub>                    | V <sub>KA</sub> =V <sub>REF</sub> , I <sub>KA</sub> =10mA                                | LL431-A                                | 2.483 | 2.495 | 2.507 | V    |
|   |                                     |  | LL431-1                                | 2.470 | 2.495 | 2.520 | V    |
|   |                                     |  | LL431-2                                | 2.520 | -     | 2.545 | V    |
|   |                                     |  | LL431-3                                | 2.445 | -     | 2.470 | V    |
| Deviation of reference Input Voltage Over temperature                       | ΔV <sub>REF</sub> /ΔT               | V <sub>KA</sub> =V <sub>REF</sub> , I <sub>KA</sub> =10mA<br>0°C ≤ T <sub>A</sub> ≤ 70°C |  |       | 4.5   | 17    | mV   |
| Ratio of Change in Reference Input Voltage to the Change in Cathode Voltage | ΔV <sub>REF</sub> /ΔV <sub>KA</sub> | I <sub>KA</sub> =10mA  | ΔV <sub>KA</sub> =10V~V <sub>REF</sub> |       | -1.0  | -2.7  | mV/V |
|   |                                     |  | ΔV <sub>KA</sub> =36V~10V              |       | -0.5  | -2.0  |      |
| Reference Input Current   | I <sub>REF</sub>                    | I <sub>KA</sub> =10mA, R1=10kΩ, R2=∞   |  |       | 0.2   | 0.4   | μA   |
| Deviation of Reference Input Current Over Full Temperature Range            | ΔI <sub>REF</sub> /ΔT               | I <sub>KA</sub> =10mA, R1=10kΩ, R2=∞<br>T <sub>A</sub> =full Temperature                 |  |       | 0.4   | 1.2   | μA   |
| Minimum Cathode Current for Regulation                                      | I <sub>KA(MIN)</sub>                | V <sub>KA</sub> =V <sub>REF</sub>  |  |       |       | 100   | μA   |
| Off-State Cathode Current   | I <sub>KA(OFF)</sub>                | V <sub>KA</sub> =36V, V <sub>REF</sub> =0  |  |       | 0.05  | 0.1   | μA   |
| Dynamic Impedance   | Z <sub>KA</sub>                     | V <sub>KA</sub> =V <sub>REF</sub> , I <sub>KA</sub> =1 to 100mA<br>f≤1.0kHz              |  |       | 0.5   |       | Ω    |

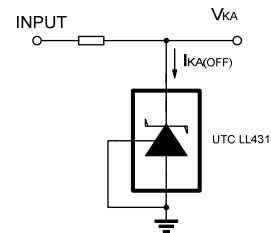
### ■ TEST CIRCUIT



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

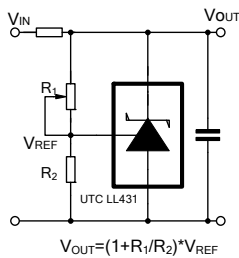


$V_{KA} = V_{REF}(1 + R_1/R_2) + I_{REF} \cdot R_1$   
For  $V_{KA} \cong V_{REF}$



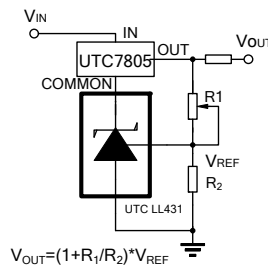
For  $I_{KA(OFF)}$

### ■ APPLICATION CIRCUIT



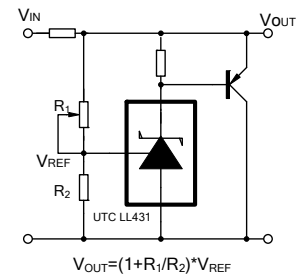
$$V_{OUT} = (1 + R_1/R_2) \cdot V_{REF}$$

Shutdown Regulator



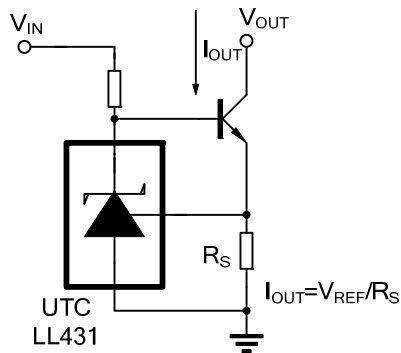
$$V_{OUT} = (1 + R_1/R_2) \cdot V_{REF}$$

Output Control of a Three-Terminal Fixed Regulator



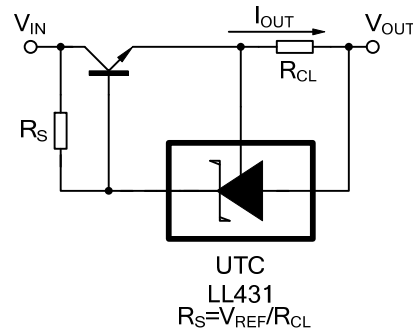
$$V_{OUT} = (1 + R_1/R_2) \cdot V_{REF}$$

Higher-current Shunt Regulator



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

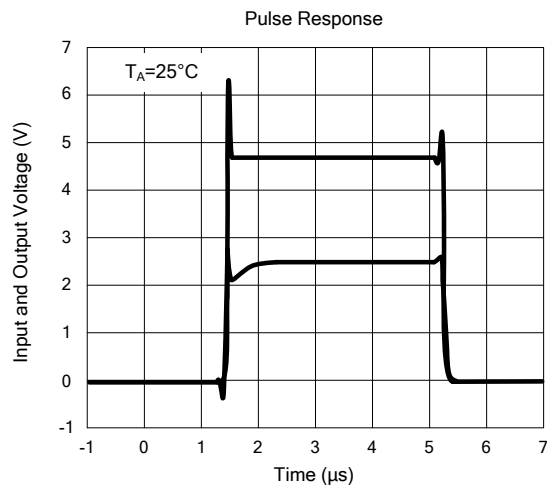
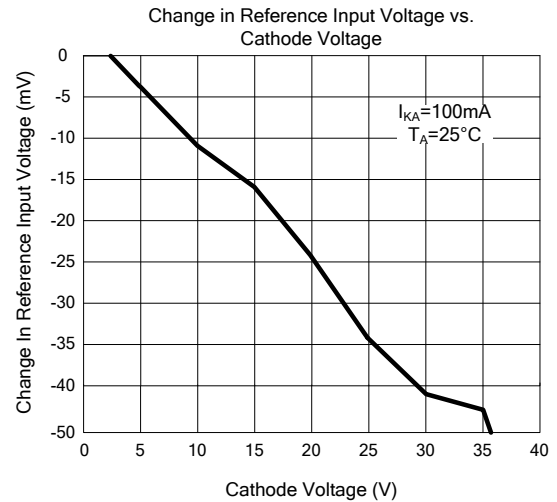
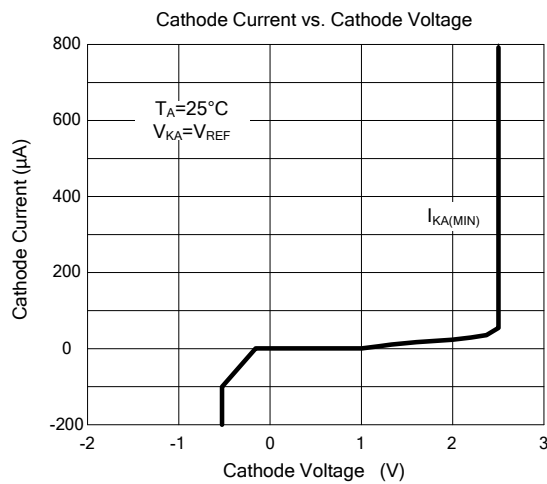
Constant-current Sink



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

Current Limiting or Current Source

## ■ TYPICAL CHARACTERISTICS



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