

## TL431

## LINEAR INTEGRATED CIRCUIT

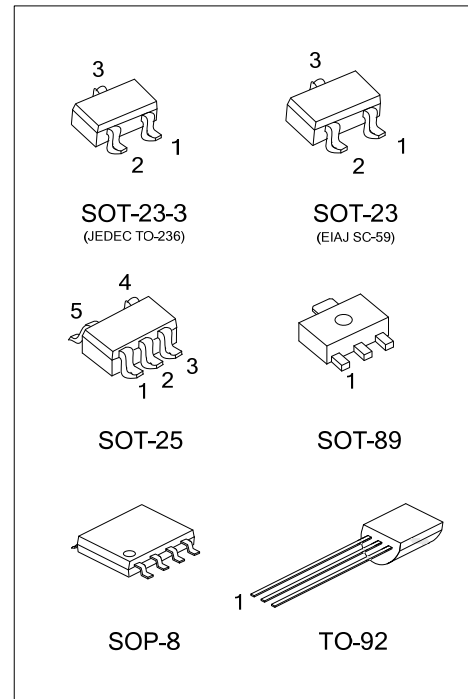
### 4PROGRAMMABLE PRECISION REFERENCE

#### 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

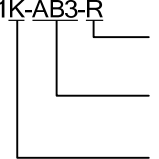
- \* Programmable output Voltage to 36V.
- \* Low dynamic output impedance 0.2Ω.
- \* Sink current capability of 1.0 to 100mA.
- \* Equivalent full-range temperature coefficient of 50ppm/ °C typical for operation over full rated operating temperature range.



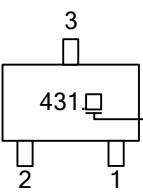
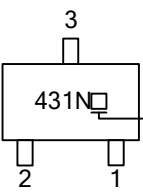
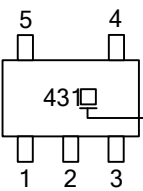
#### ORDERING INFORMATION

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

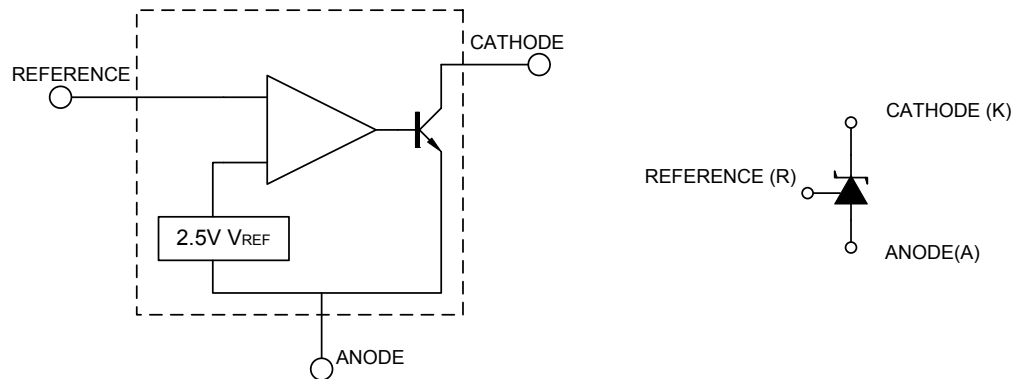
Note: Pin Code: K: Cathode A: Anode R: Reference X: No Connection

|                                                                                                                                                                           |  |                                                                                                                                                                                                                                                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>TL431K-AB3-R</p>  <p>(1)Packing Type</p> <p>(2)Package Type</p> <p>(3)Lead Free</p> |  | <p>(1) B: Tape Box, K: Bulk, R: Tape Reel, T: Tube</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</p> <p>G: Halogen Free, L: Lead Free Only for TL431NS Type</p> |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### ■ MARKING

| PACKAGE                         | MARKING                                                                                                                   |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| SOT-23-3<br>SOT-23              |  <p>K: Lead Free<br/>G: Halogen Free</p> |
| SOT-23-3<br>SOT-23<br>(TL431NS) |  <p>L: Lead Free<br/>G: Halogen Free</p> |
| SOT-25                          |  <p>K: Lead Free<br/>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                  | 770         | mW   |
|                                   | SOT-89                 | 800         | mW   |
|                                   | SOT-23/SOT-23-3/SOT-25 | 300         | 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.

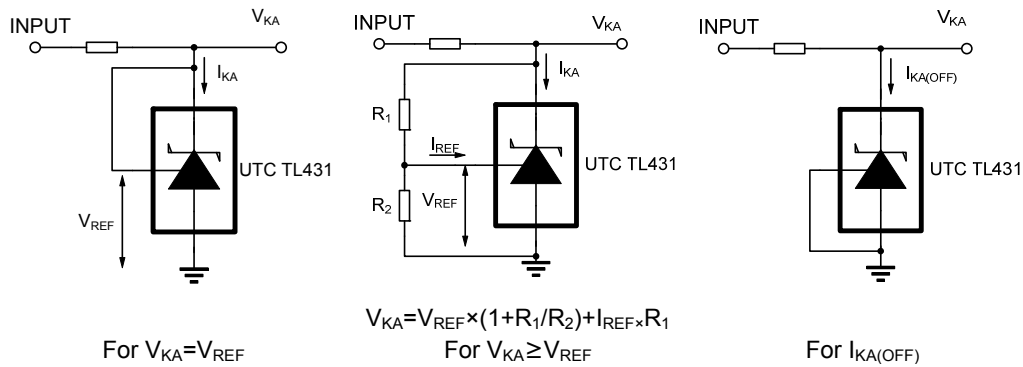
### ■ RECOMMENDED OPERATING CONDITIONS

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

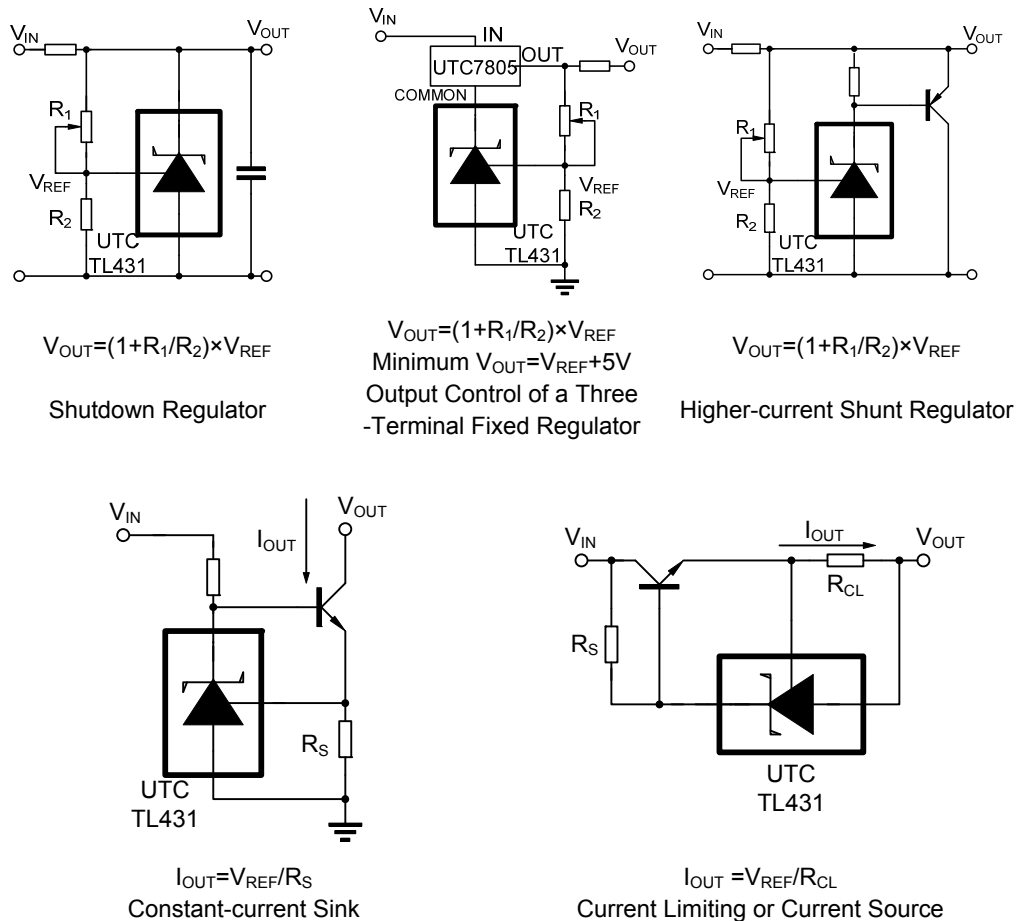
### ■ ELECTRICAL CHARACTERISTICS ( $T_C = 25^\circ\text{C}$ , unless otherwise specified.)

| PARAMETER                                                                   | SYMBOL                                 | TEST CONDITIONS                                                                           |                                        | MIN   | TYP   | MAX   | UNIT |
|-----------------------------------------------------------------------------|----------------------------------------|-------------------------------------------------------------------------------------------|----------------------------------------|-------|-------|-------|------|
| Reference Input Voltage                                                     | V <sub>REF</sub>                       | V <sub>KA</sub> =V <sub>REF</sub> , I <sub>KA</sub> =10mA                                 | 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 <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 | $\frac{\Delta V_{REF}}{\Delta V_{KA}}$ | 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  | mV/V |
| Reference Input Current                                                     | I <sub>REF</sub>                       | I <sub>KA</sub> =10mA, R1=10kΩ, R2=∞                                                      |                                        |       | 1.5   | 4     | μA   |
| Deviation of Reference Input Current Over Full Temperature Range            | $\frac{\Delta I_{REF}}{\Delta T}$      | 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>                                                         |                                        |       | 0.3   | 0.5   | mA   |
| Off-State Cathode Current                                                   | I <sub>KA(OFF)</sub>                   | V <sub>KA</sub> =36V, V <sub>REF</sub> =0                                                 |                                        |       | 0.05  | 1.0   | μA   |
| Dynamic Impedance                                                           | Z <sub>KA</sub>                        | V <sub>KA</sub> =V <sub>REF</sub> , I <sub>KA</sub> =1~ 100mA, f≤1.0kHz                   |                                        |       | 0.15  | 0.5   | Ω    |

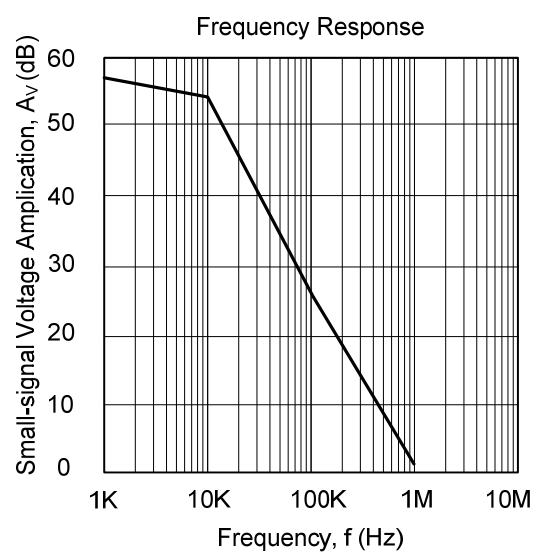
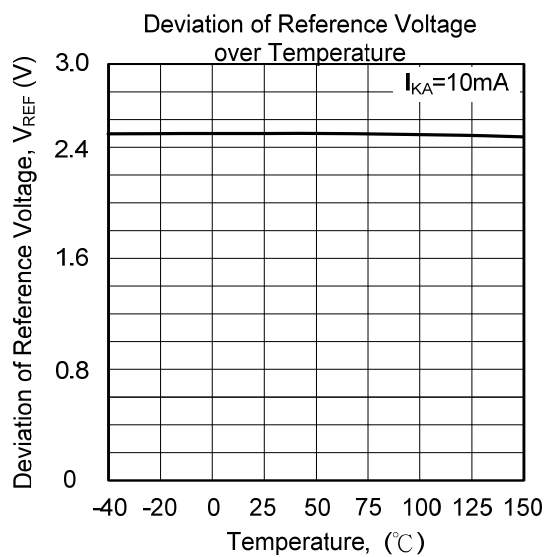
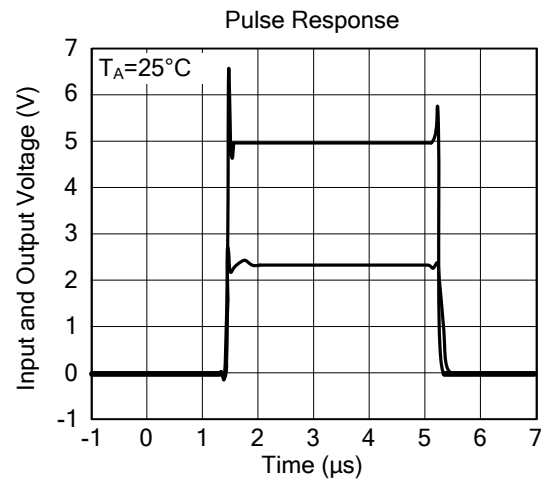
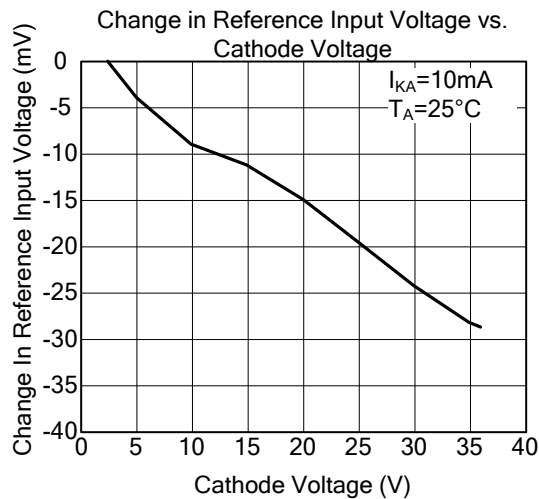
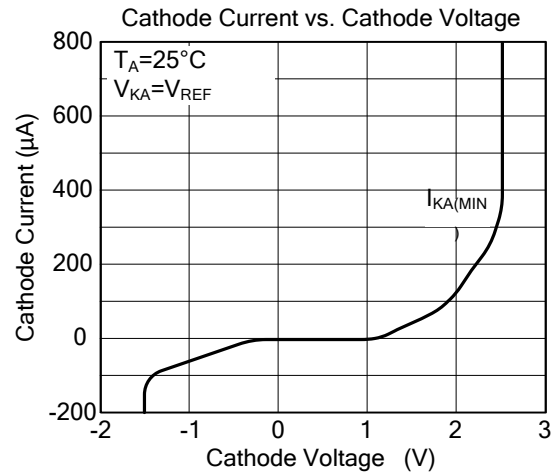
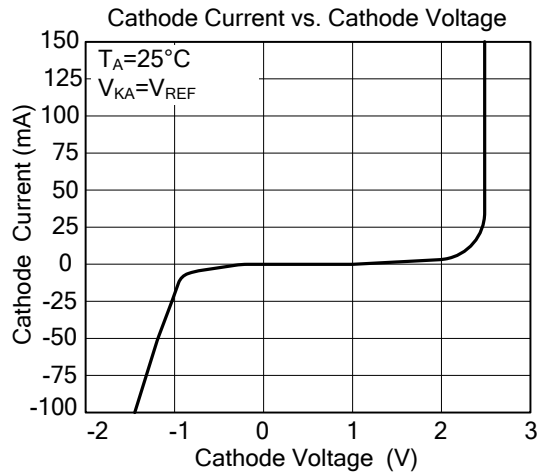
### ■ TEST CIRCUIT



### ■ APPLICATION CIRCUIT



### TYPICAL CHARACTERISTICS



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