

## ADJUSTABLE PRECISION SHUNT REGULATOR

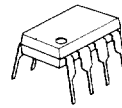
## ■ GENERAL DESCRIPTION

The NJM431 is a 3 terminal adjustable shunt regulator. The output voltage may be set to any value between  $V_{REF}$  (about 2.5V) and 36V by two resistors. Output circuitry shows a sharp turn-on characteristics. Applications include shunt regulators, series regulators for small power and isolation regulators with photo couplers.

## ■ FEATURES

- Operating Voltage ( $V_{KA} = V_{REF} \sim 36V$ )
- Fast Turn-On Respability
- Cathode Current (1mA  $\sim$  100mA)
- Low Dynamic Output Impedance (0.2 $\Omega$  typ.)
- Package Outline DIP8, DMP8, TO-92, SOT-89
- Bipolar Technology

## ■ PACKAGE OUTLINE



NJM431D

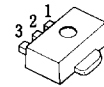


NJM431M



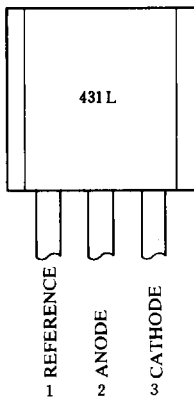
NJM431L (TO-92)

1. REF
2. ANODE
3. CATHODE

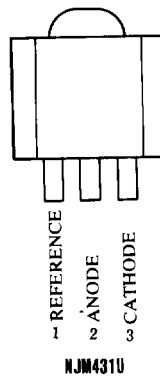


NJM431U (SOT-89)

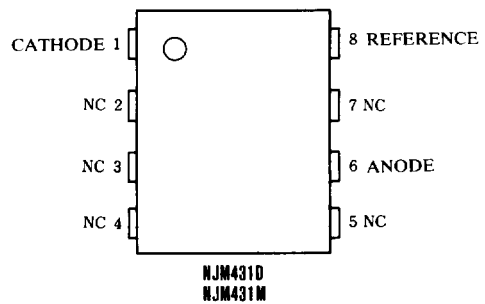
## ■ PIN CONFIGURATION



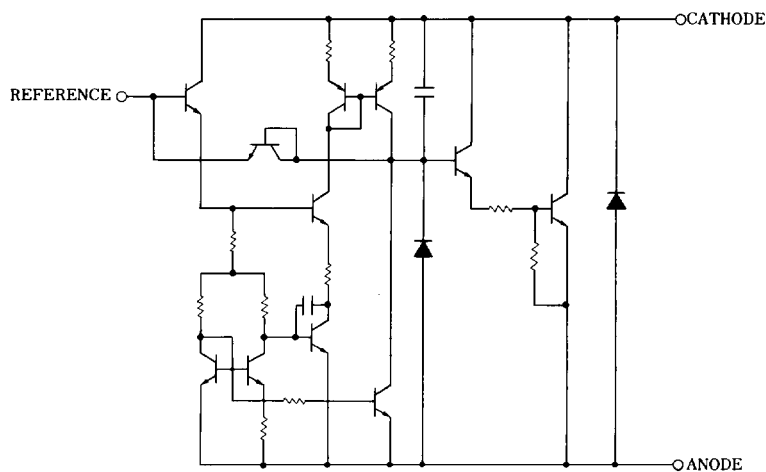
NJM431L



NJM431U

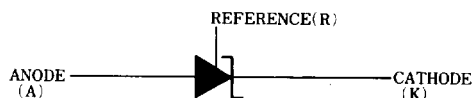
NJM431D  
NJM431M

## ■ EQUIVALENT CIRCUIT





## ■ BLOCK DIAGRAM



## ■ ABSOLUTE MAXIMUM RATINGS

(Ta=25°C)

| PARAMETER                  | SYMBOL    | RATINGS     | UNIT |
|----------------------------|-----------|-------------|------|
| Cathode Voltage (note)     | $V_{KA}$  | 37          | V    |
| Continuous Cathode Current | $I_{KA}$  | -100 ~ 150  | mA   |
| Reference Input Current    | $I_{REF}$ | -0.05 ~ 10  | mA   |
| Power Dissipation          | $P_D$     | (DIP8) 700  | mW   |
|                            |           | (DMP8) 300  | mW   |
|                            |           | (TO92) 500  | mW   |
|                            |           | (SOT89) 350 | mW   |
| Operating Temperature      | $T_{opr}$ | -20 ~ +85   | °C   |
| Storage Temperature        | $T_{sig}$ | -40 ~ +125  | °C   |

(note) Unless specified, all voltage values are with respect to the anode terminal.

## ■ RECOMMENDED OPERATING CONDITIONS

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

## ■ ELECTRICAL CHARACTERISTICS (Ta=25°C)

| PARAMETER                                                  | SYMBOL                                 | TEST CONDITION                                                                                  | MIN.                            | TYP. | MAX. | UNIT |      |
|------------------------------------------------------------|----------------------------------------|-------------------------------------------------------------------------------------------------|---------------------------------|------|------|------|------|
| Reference Voltage                                          | V <sub>REF</sub>                       | V <sub>KA</sub> = V <sub>REF</sub> , I <sub>K</sub> = 10mA (note 1)                             | 2440                            | 2495 | 2550 | mV   |      |
| Reference Voltage Change<br>(Full Oper. Temp. Range)       | V <sub>REF</sub><br>(dev)              | V <sub>KA</sub> = V <sub>REF</sub> , I <sub>K</sub> = 10mA (note 1)<br>Ta = -20°C ~ +85°C       | —                               | 8    | 17   | mV   |      |
| Reference Voltage Change<br>vs. Cathode Voltage Change     | $\frac{\Delta V_{REF}}{\Delta V_{KA}}$ | I <sub>K</sub> = 10mA (note 2)<br>$\Delta V_{KA} = 36V - 10V$                                   | $\Delta V_{KA} = 10V - V_{REF}$ | —    | -1.4 | -2.7 | mV/V |
|                                                            |                                        |                                                                                                 |                                 | —    | -1   | -2   | mV/V |
| Reference Input Current                                    | I <sub>REF</sub>                       | I <sub>K</sub> = 10mA, R <sub>1</sub> = 10kΩ, R <sub>2</sub> = ∞ (note 2)                       | —                               | 2    | 4    | μA   |      |
| Reference Input Current Change<br>(Full Oper. Temp. Range) | I <sub>REF</sub><br>(dev)              | I <sub>K</sub> = 10mA, R <sub>1</sub> = 10kΩ, R <sub>2</sub> = ∞ (note 2)<br>Ta = -20°C ~ +85°C | —                               | 0.4  | 1.2  | μA   |      |
| Minimum Input Current                                      | I <sub>MIN</sub>                       | V <sub>KA</sub> = V <sub>REF</sub> (note 1)                                                     | —                               | 0.4  | 1.0  | mA   |      |
| Cathode Current (Off Cond.)                                | I <sub>OFF</sub>                       | V <sub>KA</sub> = 36V, V <sub>REF</sub> = 0 (note 3)                                            | —                               | 0.1  | 1.0  | μA   |      |
| Dynamic Impedance                                          | Z <sub>KA</sub>                        | V <sub>KA</sub> = V <sub>REF</sub> , I <sub>K</sub> = 1mA ~ 100mA,<br>f ≤ 1kHz (note 1)         | —                               | 0.2  | 0.5  | Ω    |      |

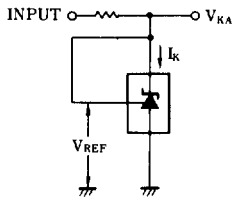
(note 1) TEST CIRCUIT (Fig. 1)

(note 2) TEST CIRCUIT (Fig. 2)

(note 3) TEST CIRCUIT (Fig. 3)



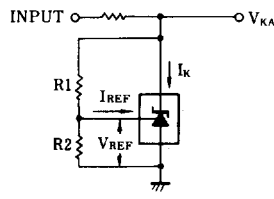
## ■ TEST CIRCUITS



1.  $V_{KA} = V_{REF}$

$$V_O = V_{KA} = V_{REF}$$

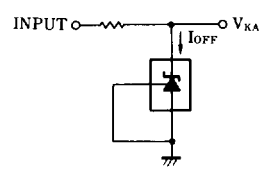
(Fig. 1)



2.  $V_{KA} > V_{REF}$

$$V_O = V_{KA} = V_{REF} \cdot \left(1 + \frac{R_1}{R_2}\right) + I_{REF} \cdot R_1$$

(Fig. 2)

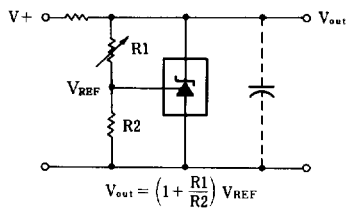


3.  $I_{OFF}$

(Fig. 3)

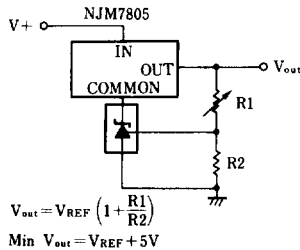
## ■ TYPICAL APPLICATION

(1) Shunt Regulator



$$V_{out} = \left(1 + \frac{R_1}{R_2}\right) V_{REF}$$

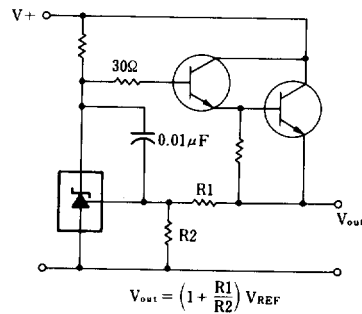
(3) Output Control of a Three-Terminal fixed Regulator



$$V_{out} = V_{REF} \left(1 + \frac{R_1}{R_2}\right)$$

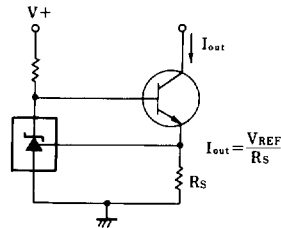
Min  $V_{out} = V_{REF} + 5V$

(2) Series Regulator



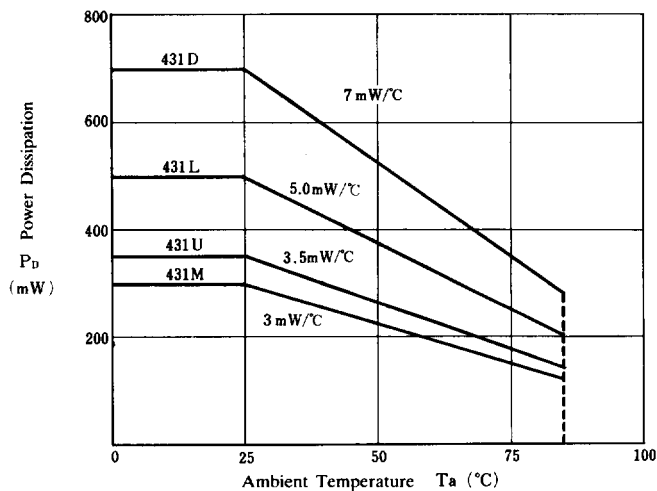
$$V_{out} = \left(1 + \frac{R_1}{R_2}\right) V_{REF}$$

(4) Constant Current Source



$$I_{out} = \frac{V_{REF}}{R_S}$$

## ■ POWER DISSIPATION VS. AMBIENT TEMPERATURE

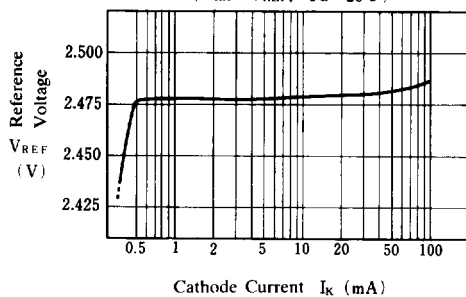




## ■ TYPICAL CHARACTERISTICS

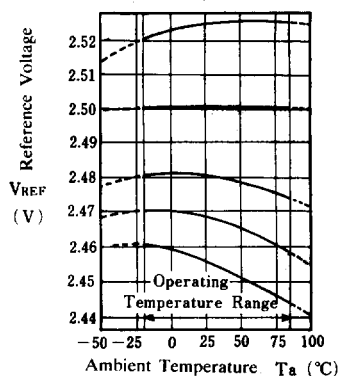
### Reference Voltage

( $V_{KA} = V_{REF}$ ,  $T_a = 25^\circ\text{C}$ )



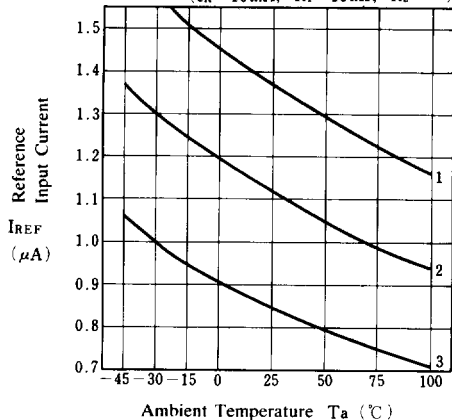
### Reference Voltage

( $V_{KA} = V_{REF}$ ,  $I_K = 10\text{mA}$ )



### Reference Input Current

( $I_K = 10\text{mA}$ ,  $R_1 = 10\text{k}\Omega$ ,  $R_2 = \infty$ )



$I_{REF}(\text{dev})$

No. 1 -  $0.38\mu\text{A}$

No. 2 -  $0.27\mu\text{A}$

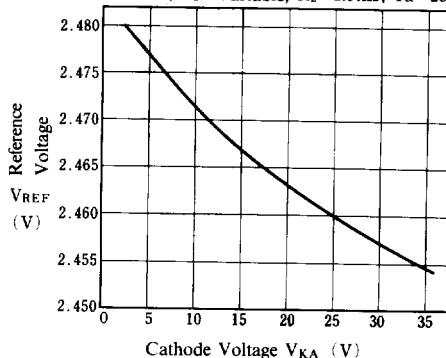
No. 3 -  $0.21\mu\text{A}$

$V_{REF}(\text{dev})$  ( $T_a = -20 \sim 25^\circ\text{C}$ ) ( $T_a = 25 \sim 85^\circ\text{C}$ ) ( $T_a = 25^\circ\text{C}$ )

|       |        |        |        |
|-------|--------|--------|--------|
| No. 1 | + 5 mV | + 1 mV | 2525mV |
| No. 2 | 0 mV   | 0 mV   | 2501mV |
| No. 3 | 0 mV   | - 6 mV | 2481mV |
| No. 4 | - 2 mV | - 9 mV | 2468mV |
| No. 5 | - 5 mV | -12mV  | 2456mV |

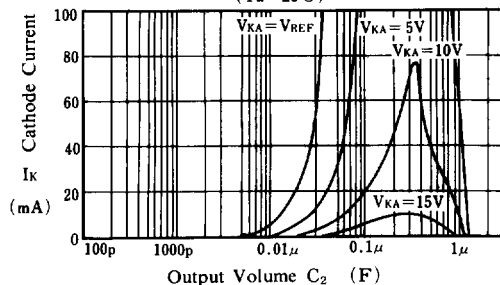
### Reference Voltage

( $I_K = 10\text{mA}$ ,  $R_1$ : Variable,  $R_2 = 2.5\text{k}\Omega$ ,  $T_a = 25^\circ\text{C}$ )



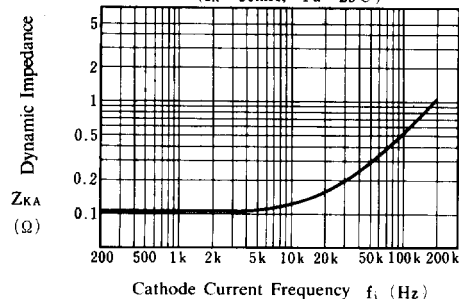
### Safety Operating Boundary Condition

( $T_a = 25^\circ\text{C}$ )



### Dynamic Impedance

( $I_K = 10\text{mA}$ ,  $T_a = 25^\circ\text{C}$ )



Note) Oscillation might occur while operating within the range of safety curve. So that, it is necessary to make ample margins by taking considerations of fluctuation of the device.