# ADJUSTABLE PRECISION SHUNT REGULATION

## General Description

The DIODES™ LA431 is a low voltage three terminal adjustable shunt regulator with a guaranteed thermal stability over applicable temperature ranges. The output voltage can be set to any value between 2.495V (VREF) to 36V with two external resistors (please refer application circuit). The high precise Reference voltage tolerance is available in two grades: ±0.4% and ±1.0%. This device has a typical minimum cathode current of 0.1 mA. Active output circuitry provides a very sharp turn on characteristic, making this device excellent replacement for Zener diodes in many applications.

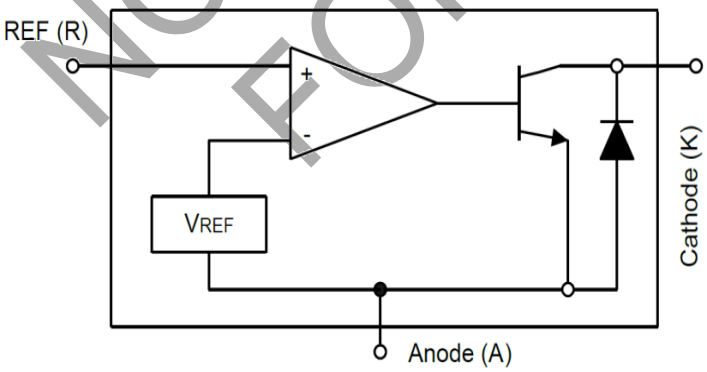
## Features

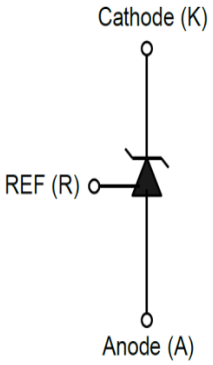
- Precision reference voltage :
  - LA431O : 2.495V±0.4%
  - LA431N : 2.495V±1.0%
- Adjustable output voltage is VREF to 36V
- Sink current capability is 120mA
- Low dynamic output impedance is 0.2Ω (typ.)
- Minimum Cathode current for regulation is 0.1mA (typ.)
- Plastic material has UL flammability classification 94V-0

## Applications

- Switching Mode Power Supply
- Voltage Reference Application

## Block Diagram & Symbol

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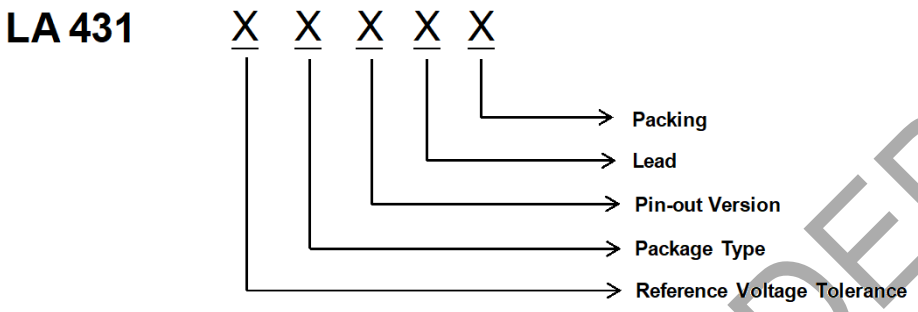
## Ordering Information




| Reference Voltage Tolerance | Package Type | Pin-out Version | Lead | Packing |
|---|---|---|---|---|
| O : ±0.4%<br>N : ±1.0% | H : TO92-3L<br>C : SOT23-3L | Blank (TO92-3L): 1. REF 2. ANODE 3. CATHODE<br>A (SOT23-3L): 1. CATHODE 2. REF 3. ANODE<br>R (SOT23-3L): 1. REF 2. CATHODE 3. ANODE | P : RoHS & Halogen Free (ref. IEC 61249-2-21) | A : Tape & Reel |

| Product Number | Output Voltage Tolerance | Package | Lead | Packing |
|---|---|---|---|---|
| LA431OHPA | 0.4 % | TO92-3L | RoHS& Halogen Free | Taping |
| LA431NHPA | 1.0 % | TO92-3L | RoHS& Halogen Free | Taping |
| LA431OCAPA | 0.4 % | SOT23-3L | RoHS& Halogen Free | Taping & Reel |
| LA431NCAPA | 1.0 % | SOT23-3L | RoHS& Halogen Free | Taping & Reel |
| LA431OCRPA | 0.4 % | SOT23-3L | RoHS& Halogen Free | Taping & Reel |
| LA431NCRPA | 1.0 % | SOT23-3L | RoHS& Halogen Free | Taping & Reel |

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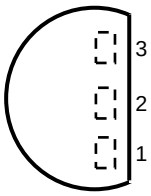
## Pin Assignment

**TO92-3L**

**(Top View)**

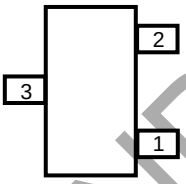



**LA431OHPA**
**LA431NHPA**

1.R
2.A
3.C

**SOT23-3L**

**(Top View)**

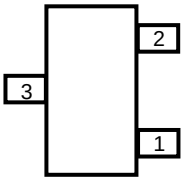



**LA431OCAPA**
**LA431NCAPA**

1.C
2.R
3.A

**SOT23-3L**

**(Top View)**




**LA431OCRPA**
**LA431NCRPA**

1.R
2.C
3.A

## Pin Descriptions

| Pin Name | Pin Description |
|---|---|
| R | Ref |
| A | Anode |
| C | Cathode |

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## Absolute Maximum Ratings(at $T_A$=25°C)

Note: Operate over the “Absolute Maximum Ratings” may cause permanent damage to the device. Exposure to such conditions for extended time may still affect the reliability of the device.

| Characteristics | | Symbol | Rating | Unit |
|---|---|---|---|---|
| Cathode Voltage | | $V_{KA}$ | 40 | V |
| Continuous Cathode Current | | $I_{KA}$ | 120 | mA |
| Reference Input Current | | $I_{REF}$ | 10 | mA |
| Junction Temperature | | $T_J$ | 150 | °C |
| Storage Temperature | | $T_{STG}$ | -40~150 | °C |
| ESD Withstand Voltage:<br>-Human Body Model (HBM), Model = 2<br>-Machine Model (MM) Model = B | | $V_{ESD}$ | 2000<br>200 | V<br>V |
| Thermal Resistance (Junction to Case) | SOT23-3L | θjc | 110 | °C/W |
| | TO92-3L | | 80 | |
| Thermal Resistance (Junction to Ambient) | SOT23-3L | θja | 350 | °C/W |
| | TO92-3L | | 150 | |
| Power dissipation | SOT23-3L | $P_D$ | 285 | mW |
| | TO92-3L | | 625 | |
| Moisture Sensitivity | | MSL | Please refer the MSL label on the IC package bag/carton for detail | |

Note1: Ratings apply to ambient temperature at 25°C

## Recommended Operating Conditions

| Characteristics | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| Cathode Voltage | $V_{KA}$ | $V_{REF}$ | 36 | V |
| Cathode Current | $I_{KA}$ | 0.3 | 100 | mA |
| Operating Temperature (Operating free-air temperature) | $T_A$ | -40 | 125 | °C |

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## Electrical Characteristics

($T_A$=25°C, unless otherwise specified)

| Characteristics | Symbol | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| Reference Voltage | $V_{REF}$ | $V_{KA}$ = $V_{REF}$, $I_{KA}$ = 1mA (Fig.1) | 0.4 % | 2.485 | 2.495 | 2.505 | V |
| | | | 1.0 % | 2.470 | | 2.520 | |
| Deviation of Reference Input Voltage over full temperature Range ( *Note 2) | $V_{REF(DEV)}$ | $V_{KA}$ = $V_{REF}$, $I_{KA}$ = 10mA, $T_A$ = -20~85°C (Fig.1) | | | 20 | 30 | mV |
| | | $V_{KA}$ = $V_{REF}$, $I_{KA}$ = 10mA, $T_A$ = -40~125°C (Fig.1) | | | 25 | 35 | |
| Reference Input Current | $I_{REF}$ | R1 = 10KΩ,R2 = ∞, $I_{KA}$= 10mA (Fig.2) | | | 1.5 | 3.5 | uA |
| Deviation of Reference Input Current over Temperature ( *Note 2) | $I_{REF(DEV)}$ | R1 = 10KΩ,R2 = ∞, $I_{KA}$ = 10mA $T_A$ = -40~125°C (Fig.2) | | | 0.4 | 1.2 | uA |
| Ratio of the Change in Reference Voltage to the Change in Cathode Voltage | $\Delta V_{REF}/\Delta V_{KA}$ | $I_{KA}$ = 10mA (Fig.2) | $V_{KA}$ = 10V ~$V_{REF}$ | | -1.2 | -2.0 | mV/V |
| | | | $V_{KA}$= 36V ~10V | | -1 | -2.0 | |
| Minimum Cathode Current for Regulation | $I_{KA(min)}$ | $V_{KA}$ = $V_{REF}$ (Fig.1) | | | 0.1 | 0.3 | mA |
| Off-state Cathode Current | $I_{KA(OFF)}$ | $V_{KA}$ = 36V, $V_{REF}$ = 0V (Fig.3) | | | 0.1 | 1 | uA |
| Dynamic Output Impedance | $Z_{KA}$ | $V_{KA}$ = $V_{REF}$ Frequency ≤ 1KHz (Fig.1) | | | 0.2 | 0.5 | Ω |

Note 2 : The speicifications are guaranteed by designed and are not tested when in mass-production.

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## Application Circuit

**Fig1: $V_{KA}=V_{REF}$**

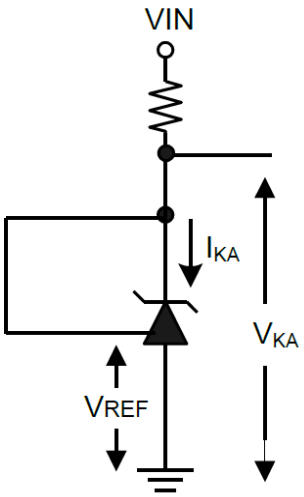



**Fig2: $V_{KA}>V_{REF}$**

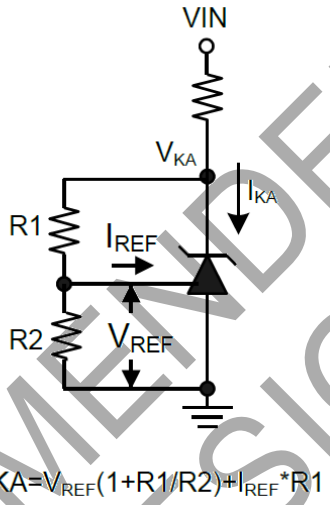
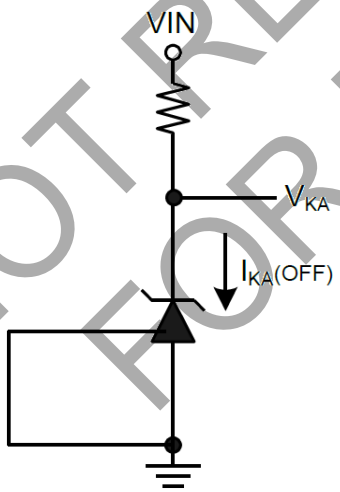



**Fig3: Off state current**

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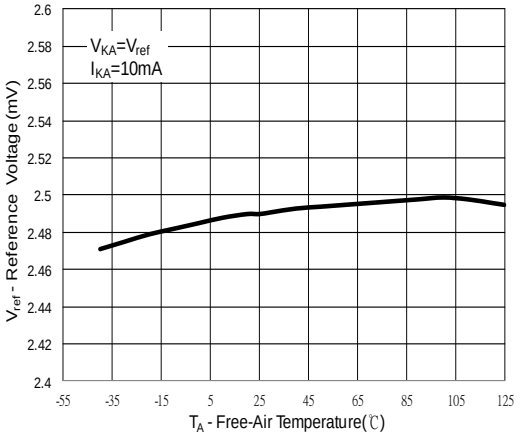
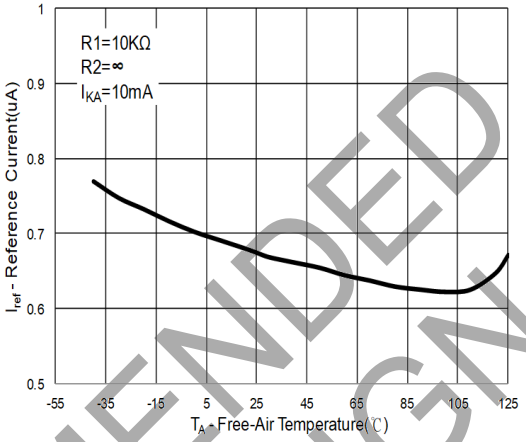
## Typical Characteristics

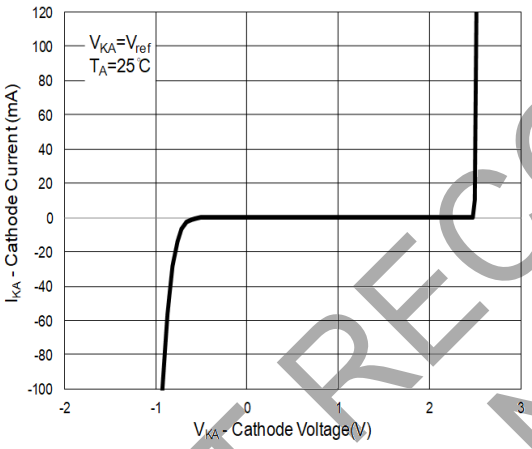
**REFERENCE VOLTAGE VS. FREE-AIR TEMPERATURE**



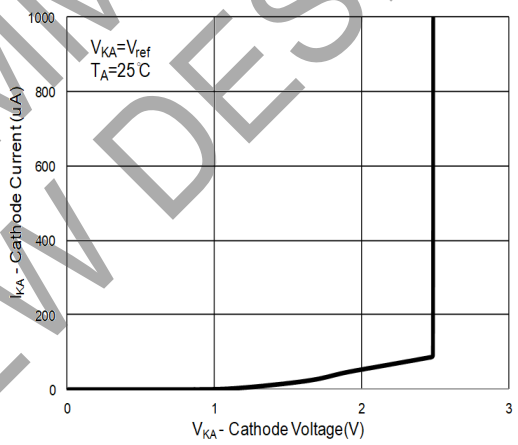

**REFERENCE CURRENT VS. FREE-AIR TEMPERATURE**



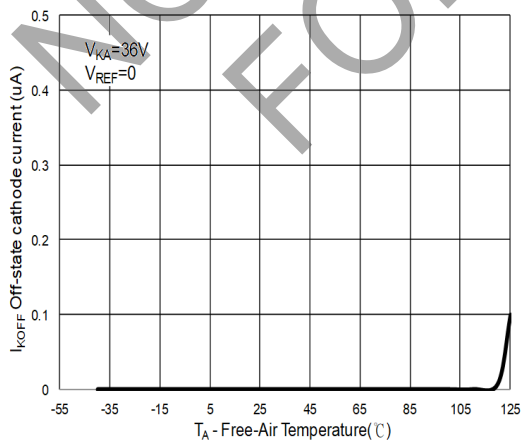

**CATHODE CURRENT VS. CATHODE VOLTAGE**



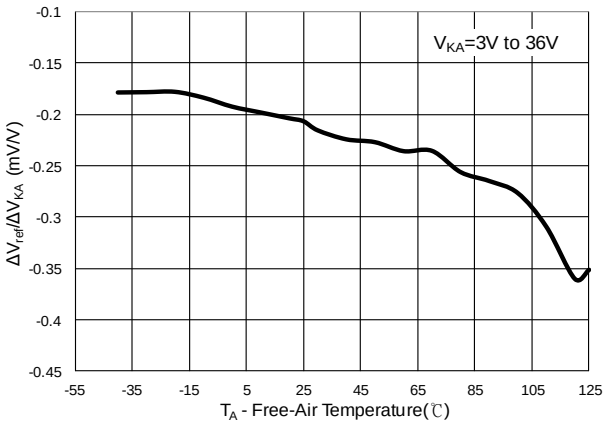

**CATHODE CURRENT VS. CATHODE VOLTAGE**




**OFF-STATE CATHODE CURRENT VS. FREE-AIR TEMPERATURE**




**RATIO OF DELTA REFERENCE VOLTAGE TO DELTA CATHODE VOLTAGE VS. FREE-AIR TEMPERATURE**

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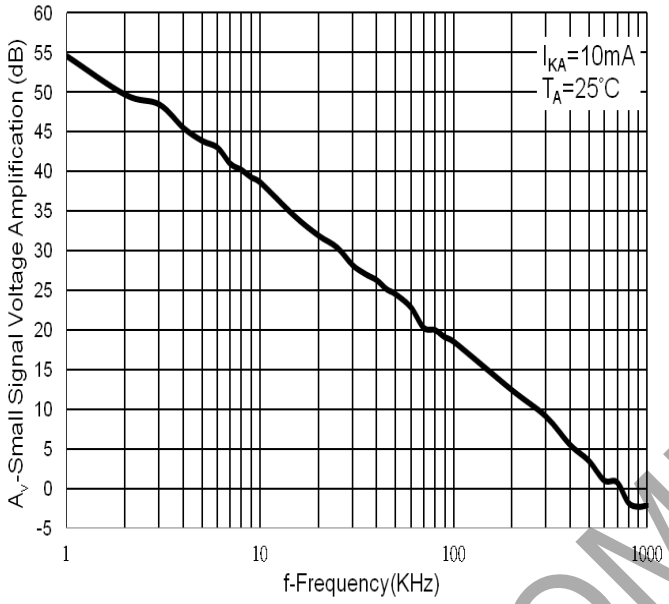
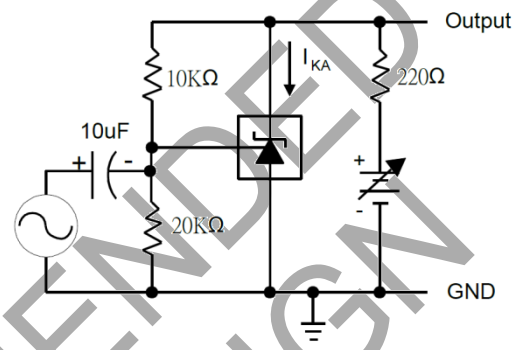
## Typical Characteristics(Continued)

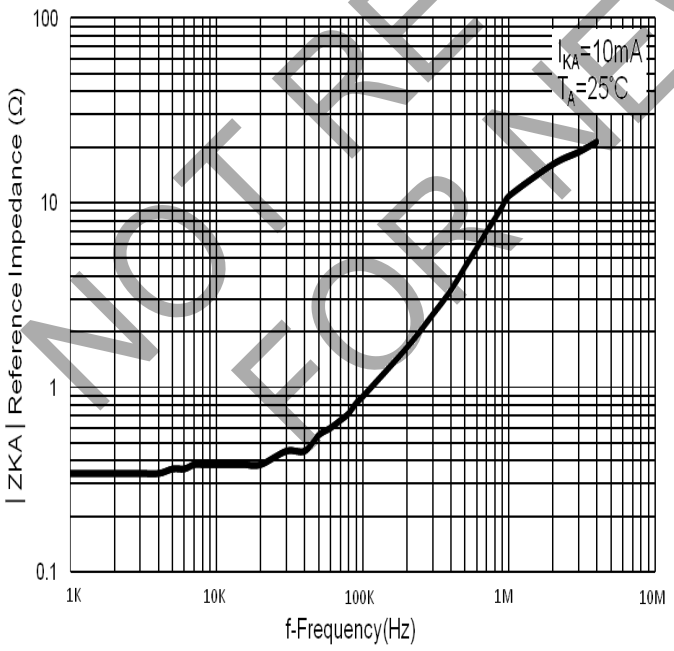
### (1) Small Signal Voltage Amplification Vs Frequency

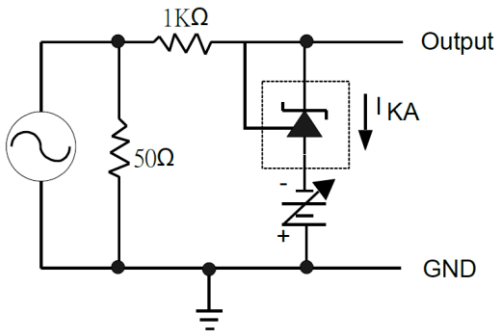



**Test Circuit For Voltage Amplification**

### (2) Reference Impedance VS Frequency




**Test Circuit For Reference Impedance**

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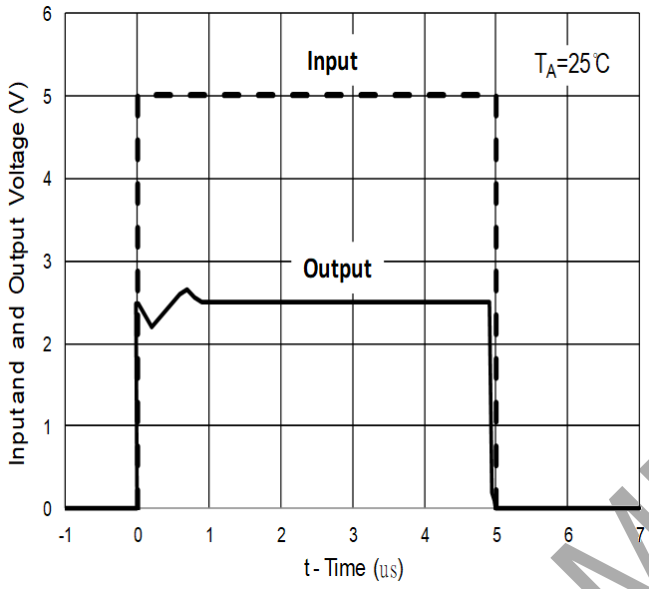
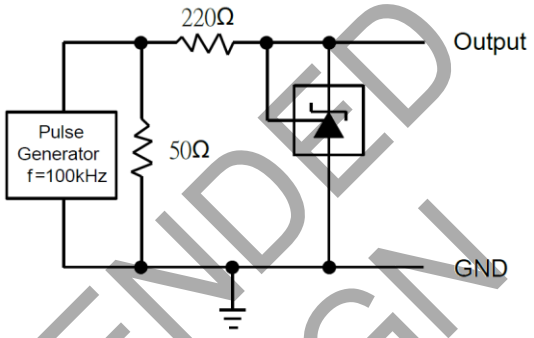
## Typical Characteristics (Continued)

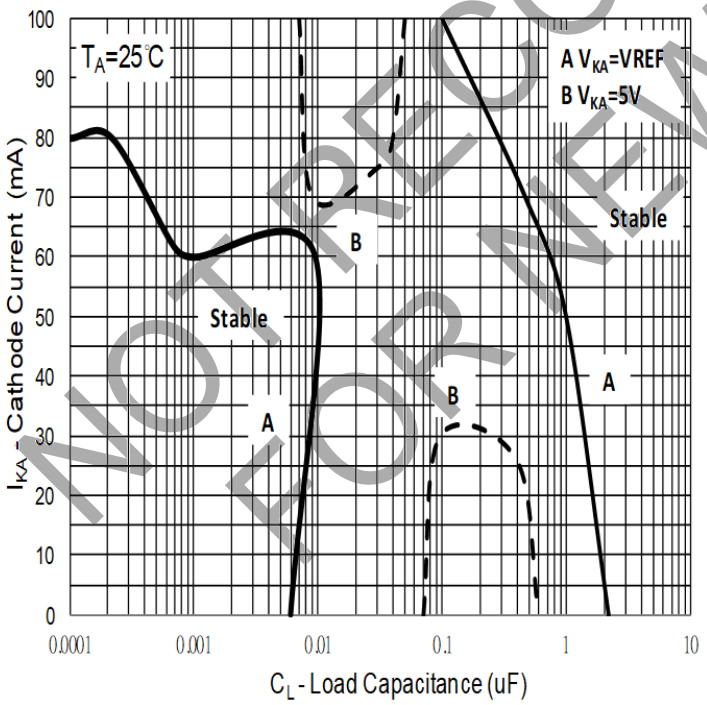
### (3) Pulse Response

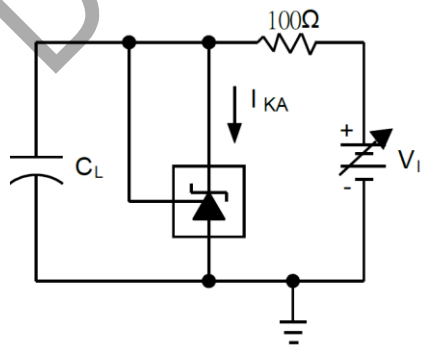


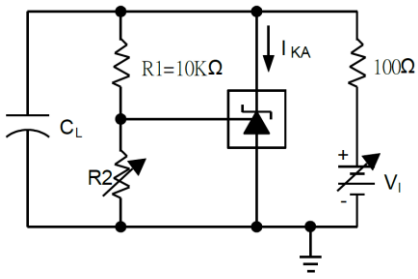

Test Circuit For Pulse Response

### (4) Stability boundary conditions




Test Circuit For Curve A




Test Circuit For Curve B

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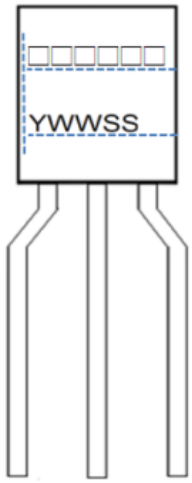
## Marking Information (NEW)

Effective Date: 2015/11/1

**(1) TO92-3L**




1) YWWSS = Date Code,

Y: Year

WW: Week

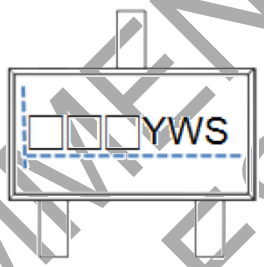
SS: Internal control code

2) □□□□□□ = Marking Number

LA431OHPA: 431OHP

LA431NHPA: 431NHP

**(2) SOT23-3L**




1) YWS = Date Code,

Y: Year

W: Week

S: Internal control code

2) □□□ = Marking Number

LA431OCAPA: OAA

LA431NCAPA: NAA

LA431OCRPA: OAR

LA431NCRPA: NAR

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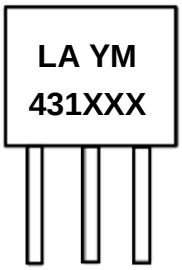
## Marking Information (OLD)

Before 2015/10/31 (included) production, the marking code of parts were used as below.

**(1) TO92-3L**




1) YM = Date Code,

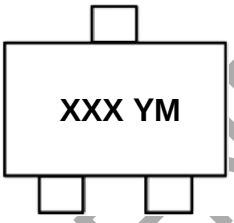
Y: Year, M: Month

2) 431xxx = Marking Number

LA431OHPA: 431OHP

LA431NHPA: 431NHP

**(2) SOT23-3L**




1) YM = Date Code,

Y: Year, M: Month

2) xxx = Marking Number

LA431OCAPA: OAA

LA431NCAPA: NAA

LA431OCRPA: OAR

LA431NCRPA: NAR

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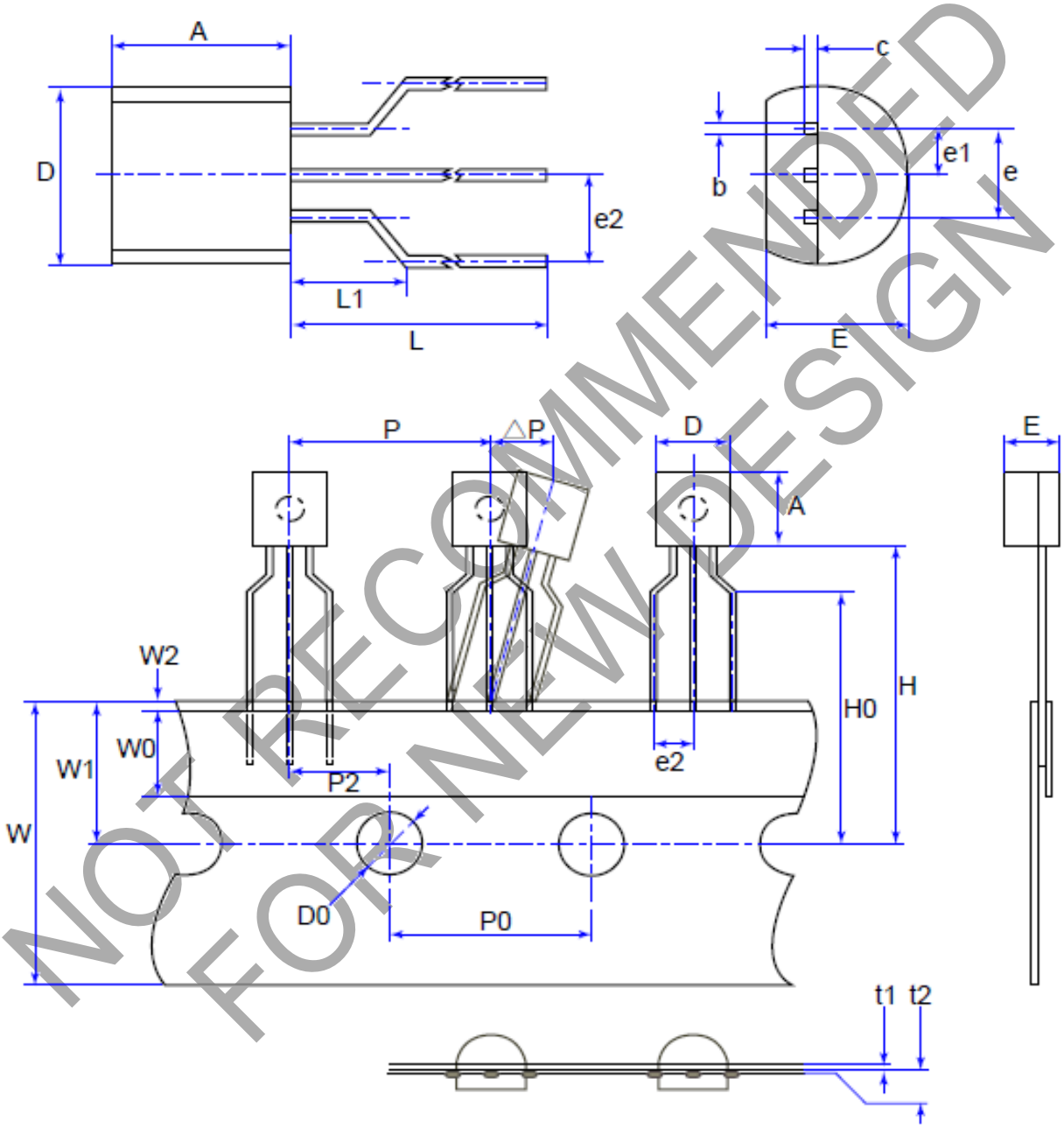
## Mechanical Information

**(1) Package type: TO92-3L**

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## Mechanical Information (Continued)

Unit: mm

| Symbol | Min | Max |
|---|---|---|
| A | 4.30 | 4.70 |
| b | 0.38 | 0.55 |
| c | 0.36 | 0.51 |
| D | 4.30 | 4.70 |
| D0 | 3.80 | 4.20 |
| E | 3.30 | 3.70 |
| e | 2.44 | 2.64 |
| e1 | 1.27 TYP | |
| e2 | 2.20 | 2.96 |
| H | 18.00 | 21.00 |
| H0 | 15.50 | 16.50 |
| L | 12.70 | - |
| L1 | 2.50 | 4.50 |
| P | 12.40 | 13.00 |
| P0 | 12.50 | 12.90 |
| P2 | 6.05 | 6.65 |
| t1 | 0.35 | 0.45 |
| t2 | 0.15 | 0.25 |
| W | 17.50 | 19.00 |
| W0 | 5.50 | 6.50 |
| W1 | 8.50 | 9.50 |
| W2 | - | 1.00 |
| $\Delta$P | - | 1.00 |

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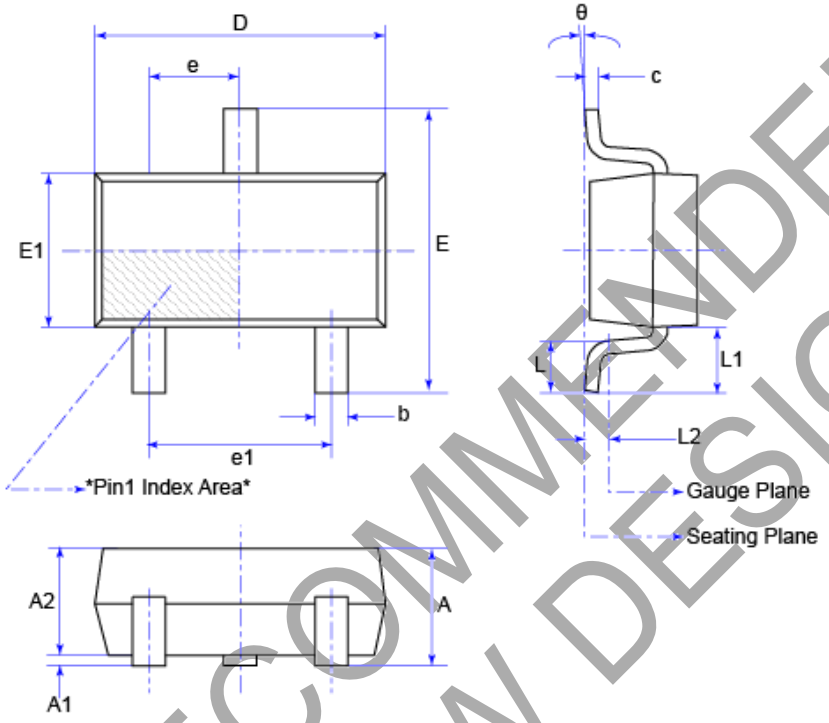
## Mechanical Information (Continued)

### (1) Package type: SOT23-3L




Unit: mm

| Variations / Symbol | SOT23 ( A ) | |
|---|---|---|
| | Min | Max |
| A | 0.900 | 1.150 |
| A1 | - | 0.100 |
| A2 | 0.890 | 1.100 |
| b | 0.300 | 0.500 |
| c | 0.070 | 0.202 |
| D | 2.800 | 3.040 |
| E | 2.100 | 2.640 |
| E1 | 1.200 | 1.400 |
| e | 0.950 REF | |
| e1 | 1.800 | 2.000 |
| L | 0.300 | 0.500 |
| L1 | 0.550 REF | |
| L2 | 0.250 BSC | |
| θ | 0° | 8° |

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## MSL (Moisture Sensitive Level) Information

### IPC/JEDEC J-STD-020D.1 Moisture Sensitivity Levels Table

| LEVEL | FLOOR LIFE | | SOAK REQUIREMENTS | | | | |
|---|---|---|---|---|---|---|---|
| | | | Standard | | Accelerated Equivalent [1] | | |
| | | | | | eV 0.40-0.48 | eV 0.30-0.39 | CONDITION |
| | TIME | CONDITION | TIME (hours) | CONDITION | TIME (hours) | TIME (hours) | |
| 1 | Unlimited | ≤30 °C /85% RH | 168 +5/-0 | 85 °C /85% RH | NA | NA | NA |
| 2 | 1 year | ≤30 °C /60% RH | 168 +5/-0 | 85 °C /60% RH | NA | NA | NA |
| 2a | 4 weeks | ≤30 °C /60% RH | 696[2] +5/-0 | 30 °C /60% RH | 120 -1/+0 | 168 -1/+0 | 60 °C/ 60% RH |
| 3 | 168 hours | ≤30 °C /60% RH | 192[2] +5/-0 | 30 °C /60% RH | 40 -1/+0 | 52 -1/+0 | 60 °C/ 60% RH |
| 4 | 72 hours | ≤30 °C /60% RH | 96[2] +2/-0 | 30 °C /60% RH | 20 +0.5/-0 | 24 +0.5/-0 | 60 °C/ 60% RH |
| 5 | 48 hours | ≤30 °C /60% RH | 72[2] +2/-0 | 30 °C /60% RH | 15 +0.5/-0 | 20 +0.5/-0 | 60 °C/ 60% RH |
| a | 24 hours | ≤30 °C /60% RH | 48[2] +2/-0 | 30 °C /60% RH | 10 +0.5/-0 | 13 +0.5/-0 | 60 °C/ 60% RH |
| 6 | Time on Label (TOL) | ≤30 °C /60% RH | TOL | 30 °C /60% RH | NA | NA | NA |

**Note 1:** CAUTION - To use the ‘‘accelerated equivalent’’ soak conditions, correlation of damage response (including electrical, after soak and reflow), should be established with the ‘‘standard’’ soak conditions. Alternatively, if the known activation energy for moisture diffusion of the package materials is in the range of 0.40 - 0.48 eV or 0.30 - 0.39 eV, the ‘‘accelerated equivalent’’ may be used. Accelerated soak times may vary due to material properties (e.g .mold compound, encapsulant, etc.). JEDEC document JESD22-A120 provides a method for determining the diffusion coefficient.

**Note 2:** The standard soak time includes a default value of 24 hours for semiconductor manufacturer’s exposure time (MET) between bake and bag and includes the maximum time allowed out of the bag at the distributor’s facility. If the actual MET is less than 24 hours the soak time may be reduced. For soak conditions of 30 °C/60% RH, the soak time is reduced by 1 hour for each hour the MET is less than 24 hours. For soak conditions of 60 °C/60% RH, the soak time is reduced by 1 hour for each 5 hours the MET is less than 24 hours. If the actual MET is greater than 24 hours the soak time must be increased. If soak conditions are 30 °C/60% RH, the soak time is increased 1 hour for each hour that the actual MET exceeds 24 hours. If soak conditions are 60 °C/60% RH, the soak time is increased 1 hour for each 5 hours that the actual MET exceeds 24 hours.

NOT RECOMMENDED FOR NEW DESIGN


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