# ADJUSTABLE PRECISION SHUNT REGULATION

## General Description

The DIODES™ LA432 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 1.24V ($V_{REF}$) to 18V with two external resistors (see application circuit). The high precise Reference voltage tolerance is available in two grades: ±0.5% and ±1.0%. This device has a typical output impedance of 0.05Ω. Active output circuitry provides a very sharp turn on characteristic, making this device excel lent replacement for Zener diodes in many applications.

The LA432 is characterized for operation from -40°C to 125°C. The LA432 is available in a low profile SOT23-3L & TO92-3L package.

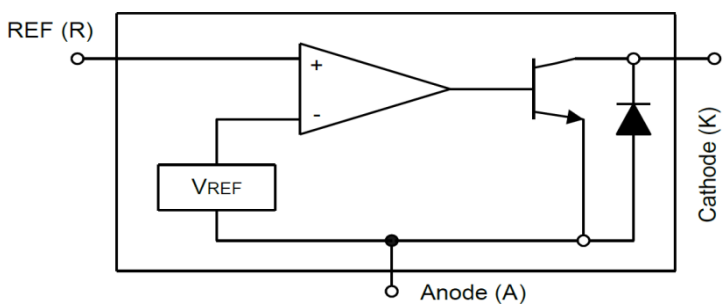
## Features

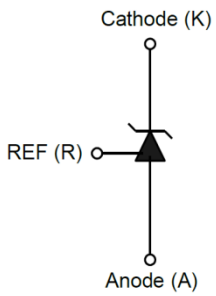
- Precision reference voltage :
  - LA432OCA/OCR : 1.24V±0.5%
  - LA432N : 1.24V±1.0%
- Adjustable output voltage is VREF to 18V
- Sink current capability : 100mA @ $V_{KA}$ = 2.5V
  40mA @ $V_{KA}$ = 1.24V
- Low dynamic output impedance is 0.05Ω (typ.)
- Minimum Cathode current for regulation is 55μA (typ.)
- Plastic material has UL flammability classification 94V-0
- Low Temperature Deviation: 3mV Typical
- Low Equivalent Full-Range Temperature Coefficient: 20PPM/°C (typ.)

## Applications

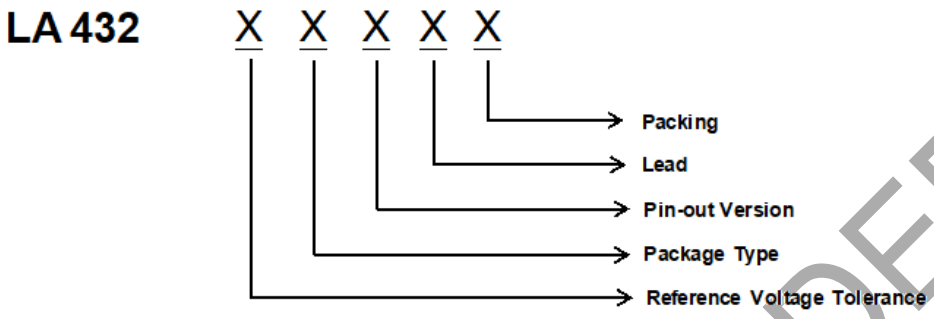
- Switching mode power supplies
- Voltage reference applications

## Block Diagram & Symbol



## Ordering Information




| Reference Voltage Tolerance | Package Type | Pin-out Version | | Lead | Packing |
|---|---|---|---|---|---|
| O : ±0.5%<br>N : ±1.0% | H : TO92-3L<br>C : SOT23-3L | Blank<br>(TO92-3L) | 1. REF<br>2. ANODE<br>3. CATHODE | P : RoHS & Halogen Free<br>(ref. IEC 61249-2-21) | A : Tape & Reel |
| | | A<br>(SOT23-3L) | 1. CATHODE<br>2. REF<br>3. ANODE | | |
| | | R<br>(SOT23-3L) | 1. REF<br>2. CATHODE<br>3. ANODE | | |

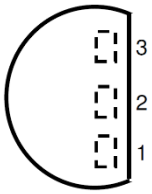
| Product Number | Output Voltage Tolerance | Package | Lead | Packing |
|---|---|---|---|---|
| LA432NHPA | 1.0 % | TO92-3L | RoHS & Halogen Free | Taping |
| LA432OCAPA | 0.5 % | SOT23-3L | RoHS & Halogen Free | Taping & Reel |
| LA432NCAPA | 1.0 % | SOT23-3L | RoHS & Halogen Free | Taping & Reel |
| LA432OCRPA | 0.5 % | SOT23-3L | RoHS & Halogen Free | Taping & Reel |
| LA432NCRPA | 1.0 % | SOT23-3L | RoHS & Halogen Free | Taping & Reel |

**Note:** TO92-3L package only to provide ±1.0% Output Voltage Tolerance.

## Pin Assignment

**TO92-3L**

**(Top View)**

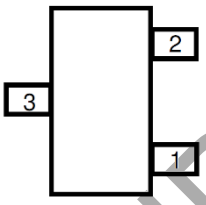



**LA432NHPA**

1. R
2. A
3. C

**SOT23-3L**

**(Top View)**

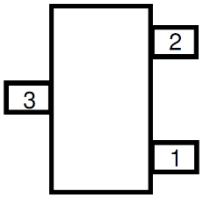



**LA432OCAPA**
**LA432NCAPA**

1. C
2. R
3. A

**SOT23-3L**

**(Top View)**




**LA432OCRPA**
**LA432NCRPA**

1. R
2. C
3. A



## Pin Descriptions

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

## 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 | | $V_{KA}$ | 20 | V |
| Continuous Cathode Current | | $I_{KA}$ | -100 to 100mA (@ VKA = 2.5V)<br>-100 to 40mA (@ VKA = 1.24V) | mA |
| Reference Input Current | | $I_{REF}$ | 10 | mA |
| Junction Temperature | | $T_J$ | 150 | °C |
| Storage Temperature | | $T_{STG}$ | -40~150 | °C |
| Thermal Resistance (Junction to Case) | SOT23-3L | θjc | 110 | °C/W |
| | TO92-3L | | 80 | W |
| Thermal Resistance (Junction to Ambient) | SOT23-3L | θja | 350 | °C/W |
| | TO92-3L | | 150 | °C/W |
| Power dissipation | SOT23-3L | $P_D$ | 285 | mW |
| | TO92-3L | | 625 | °C/W |
| 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 | $V_{KA}$ | $V_{REF}$ | 18 | V |
| Cathode Current | $I_{KA}$ | 0.1 | 100mA (@ VKA = 2.5V)<br>40mA (@ VKA = 1.24V) | mA |
| Operating Temperature (Operating free-air temperature) | $T_A$ | -40 | 125 | °C |

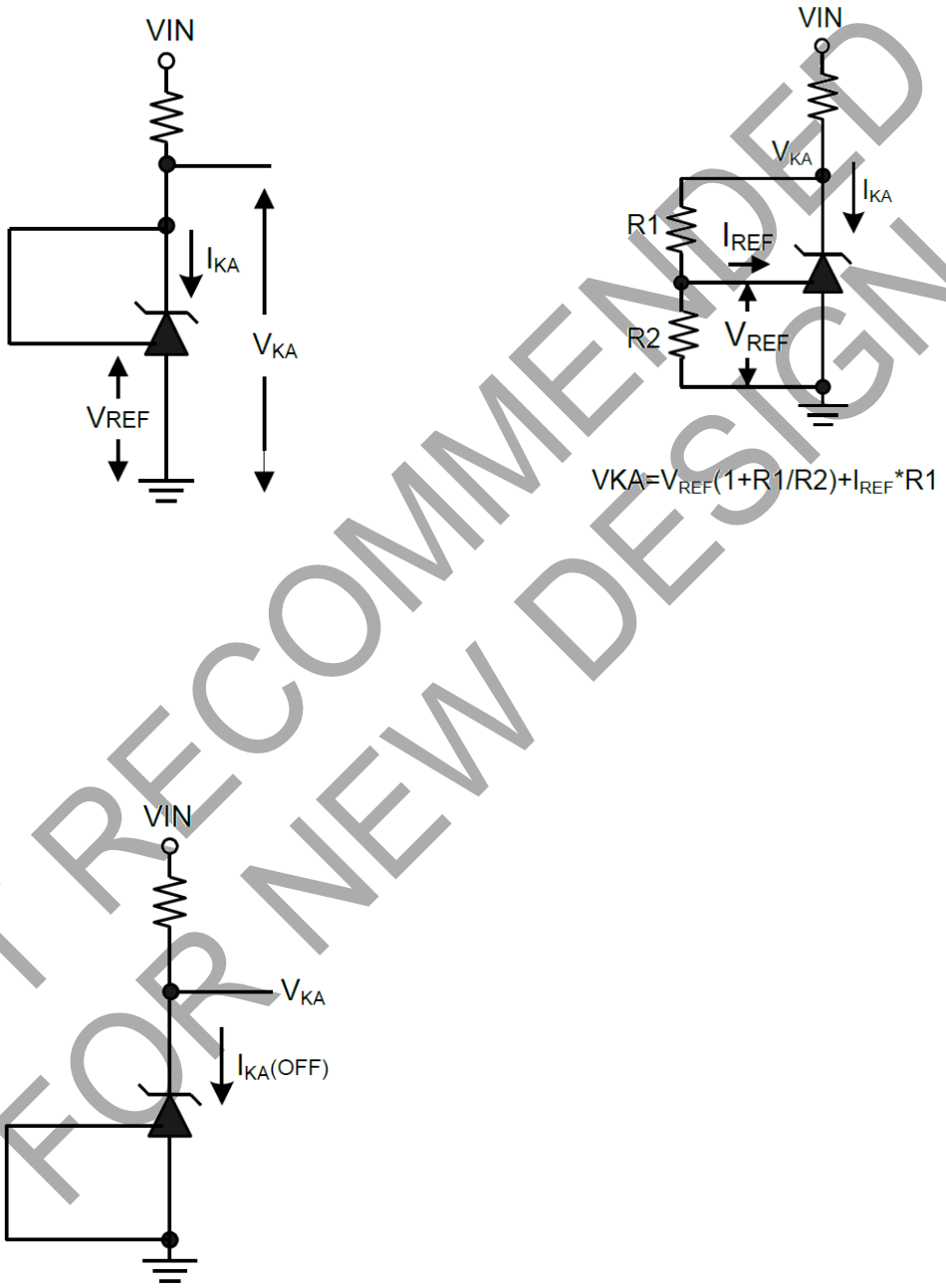
## Electrical Characteristics

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

| Characteristics | Symbol | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| Reference Voltage | $V_{REF}$ | $V_{KA}$ = $V_{REF}$, $I_{KA}$ = 10mA (Fig.1) | 0.5 % | 1.233 | 1.240 | 1.246 | V |
| | | | 1.0 % | 1.227 | | 1.252 | |
| Deviation of Reference Input Voltage over full temperature Range ( *Note 2) | $V_{REF(DEV)}$ | $V_{KA}$ = $V_{REF}$, $I_{KA}$ = 10mA, (Fig.1) | $T_A$ = 0~70°C | - | 2 | 10 | mV |
| | | | $T_A$ = -40~85°C | - | 3 | 10 | |
| | | | $T_A$ = -40~125°C | - | 4 | 15 | |
| Reference Input Current | $I_{REF}$ | R1 = 10kΩ,R2 = ∞, $I_{KA}$= 10mA (Fig.2) | | - | 0.25 | - | μA |
| 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) | | - | 0.1 | 0.4 | μA |
| Ratio of the Change in Reference Voltage to the Change in Cathode Voltage | $\Delta V_{REF}/\Delta V_{KA}$ | $I_{KA}$ = 10mA (Fig.2) | $\Delta V_{KA}$ : $V_{REF}$~16V | - | -0.5 | -1.5 | mV/V |
| Minimum Cathode Current for Regulation | $I_{KA(min)}$ | $V_{KA}$ = $V_{REF}$ (Fig.1) | | - | 55 | 80 | μA |
| Off-state Cathode Current | $I_{KA(OFF)}$ | $V_{KA}$ = 18V, $V_{REF}$ = 0V (Fig.3) | | - | 0.04 | 0.10 | μA |
| | | $V_{KA}$ = 6V, $V_{REF}$ = 0V (Fig.3) | | - | 0.01 | 0.05 | |
| Dynamic Output Impedance | $Z_{KA}$ | $V_{KA}$ = $V_{REF}$, $I_{KA}$ = 1 to 100mA Frequency ≤ 1kHz (Fig.1) | | - | 0.05 | 0.15 | Ω |

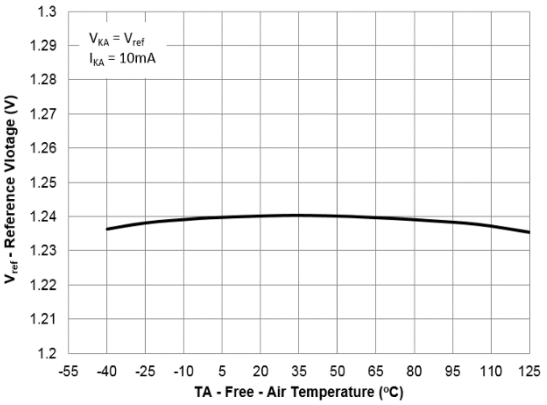
Note 2 : These speicifications are guaranteed by designed and are not tested when in mass-production.

## Application Circuit

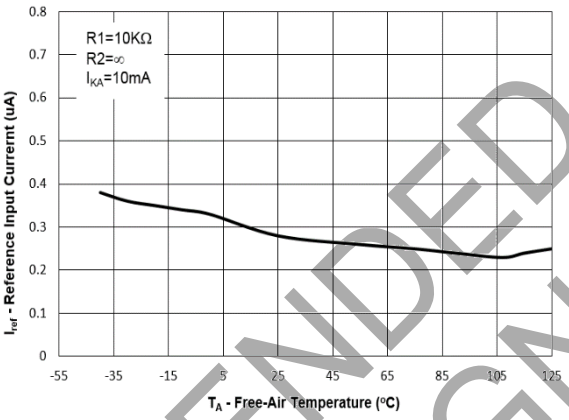


## Typical Characteristics

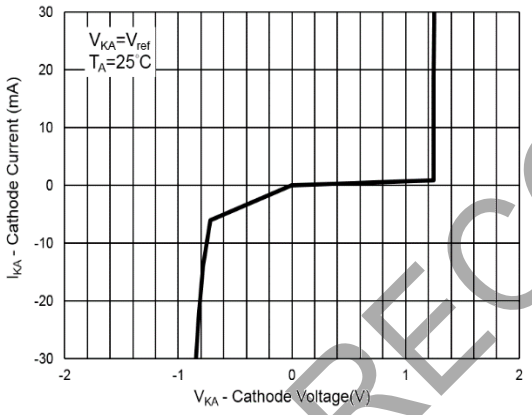
**REFERENCE VOLTAGE VS. FREE-AIR TEMPERTURE**



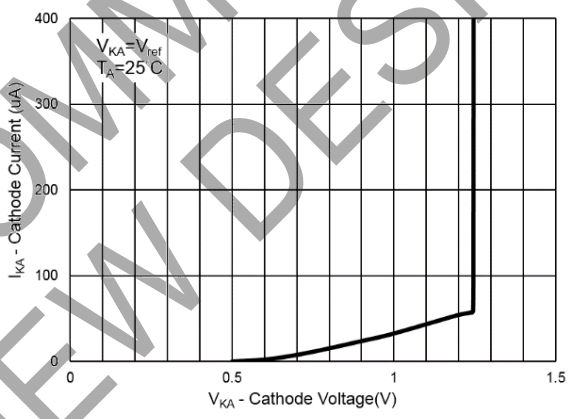

**REFERENCE CURRENT VS. FREE-AIR TEMPERATURE**



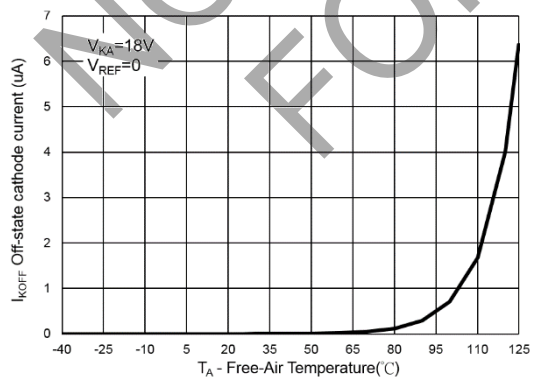

**CATHODE CURRENT VS. CATHODE VOLTAGE**



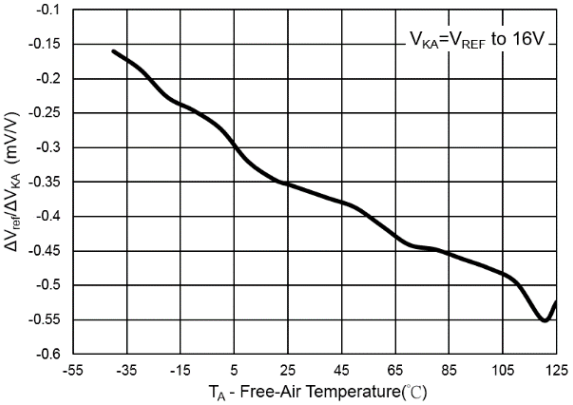

**CATHODE CURRENT VS. CATHODE VOLTAGE**




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

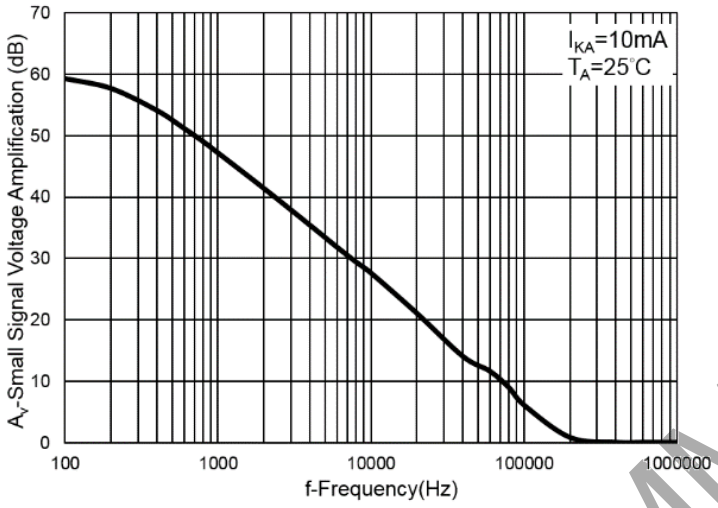


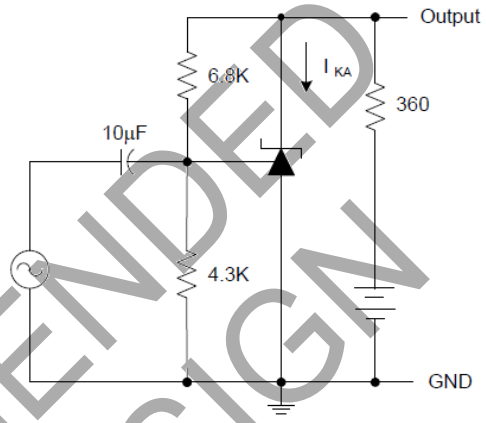

**RATIO OF DELTA REFERENCE VOLTAGE TO DELTA CATHODE VOLTAGE VS. FREE-AIR TEMPERATURE**



## Typical Characteristics (Continued)

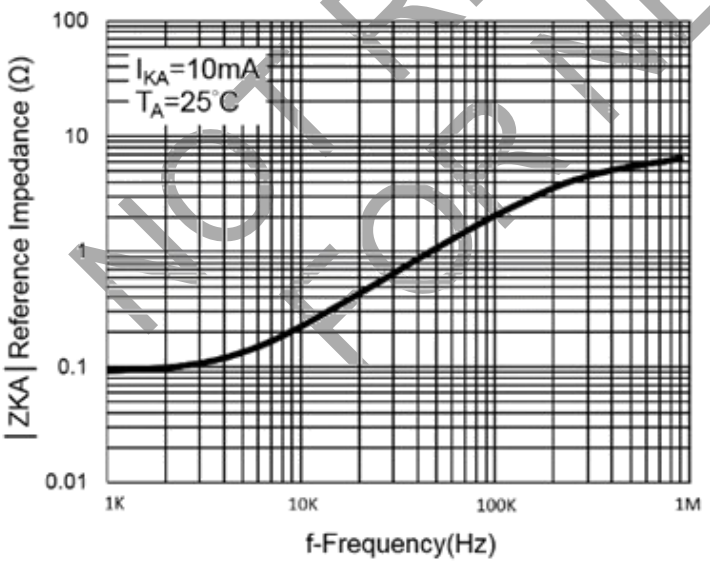
### (1) Small Signal Voltage Amplification Vs Frequency

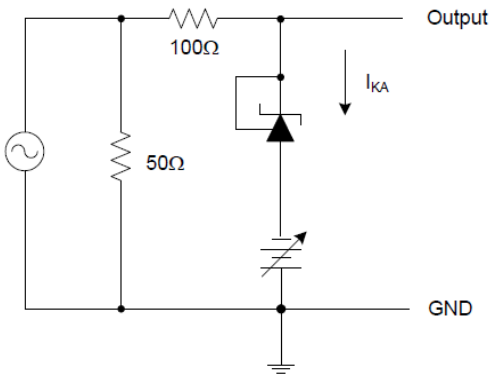



**Test Circuit for Voltage Amplification**

### (2) Reference Impedance VS Frequency

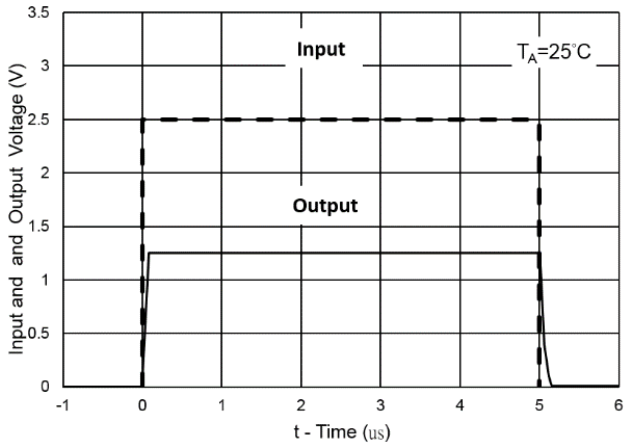


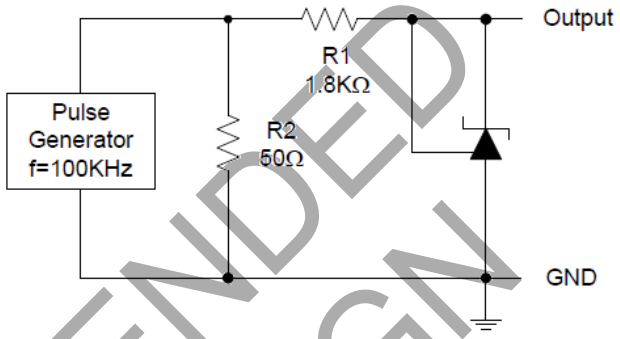




**Test Circuit for Reference Impedance**

## Typical Characteristics (Continued)

### (3) Pulse Response

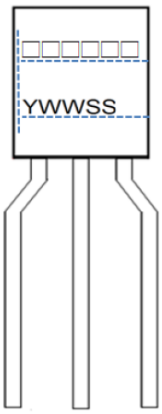



**Test Circuit for Pulse Response**

## Marking Information

**(1) TO92-3L**




1) □□□□□□ = Marking Name

A432NH = LA432NHPA

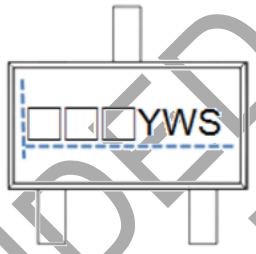
2) YWWSS = Date Code

Y = Years

WW = Weeks

SS =Internal control code

**(2) SOT23-3L**




1) □□□ = Marking Number

AB6 = LA432OCAPA
AB7 = LA432NCAPA
AB8 = LA432OCRPA
AB9 = LA432NCRPA

2) YWS = Date Code,

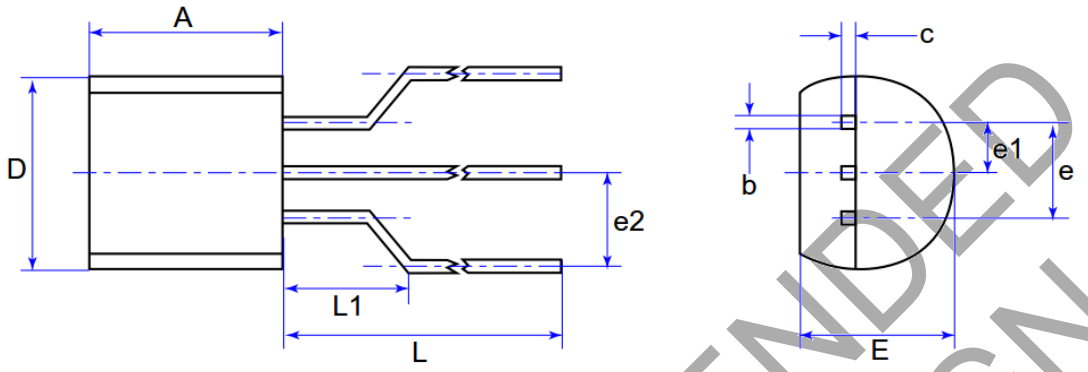
Y: Year

W: Week

S: Internal control code

## Mechanical Information

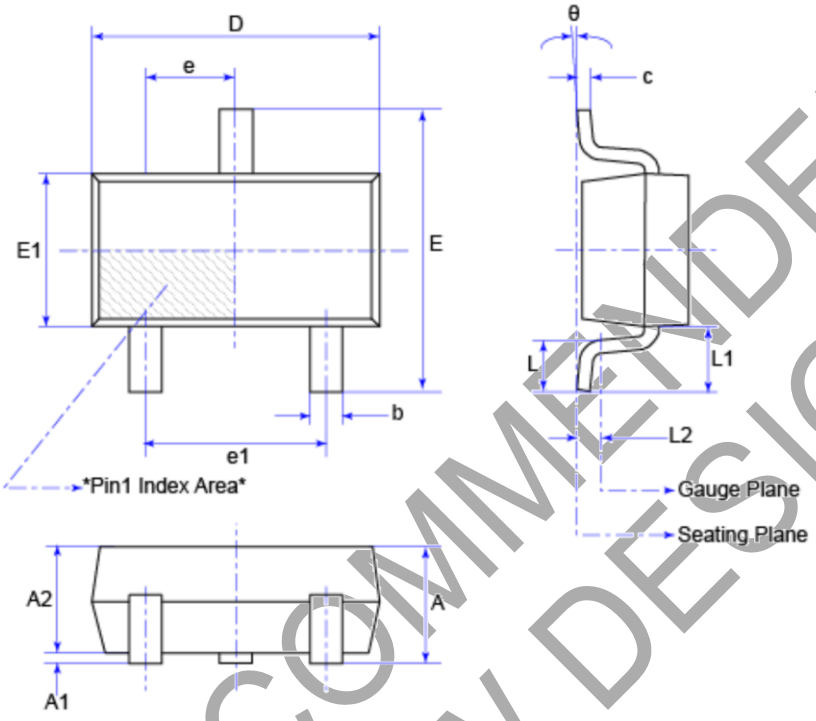
**(1) Package type: TO92-3L**




| Symbol | Min | Max |
|---|---|---|
| A | 4.30 | 4.70 |
| b | 0.38 | 0.55 |
| c | 0.36 | 0.51 |
| D | 4.30 | 4.70 |
| E | 3.30 | 3.70 |
| e | 2.44 | 2.64 |
| e1 | 1.27 TYP | |
| e2 | 2.20 | 2.80 |
| L | 13.00 | 14.00 |
| L1 | 2.50 | 4.50 |

## Mechanical Information (Continued)

**(2) 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° |

## 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.

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