



# AP432/AP432A

## Adjustable Precision Shunt Regulator

### ■ Features

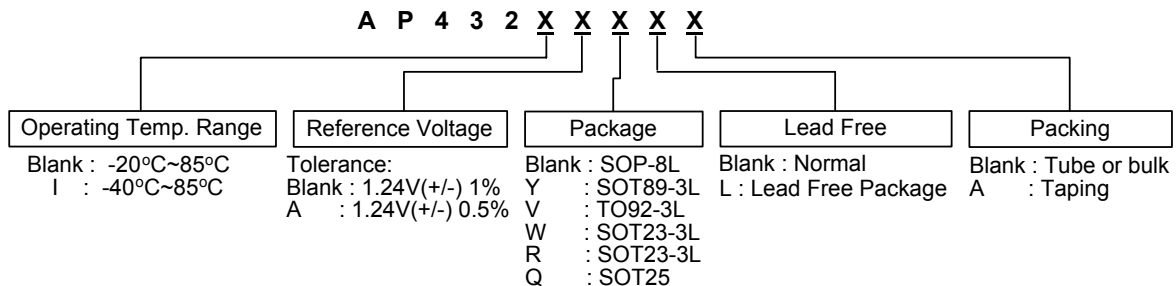
- Precision reference voltage  
AP432 : 1.24V ± 1%  
AP432A : 1.24V ± 0.5%
- Sink current capability: 200mA.
- Minimum cathode current for regulation: 150µA
- Equivalent full-range temp coefficient: 30 ppm/°C
- Fast turn-on Response.
- Low dynamic output impedance: 0.2Ω
- Programmable output voltage to 20v
- Low output noise
- Packages: SOT89, SOT23, SOT25, SOP8 and TO92

### ■ General Description

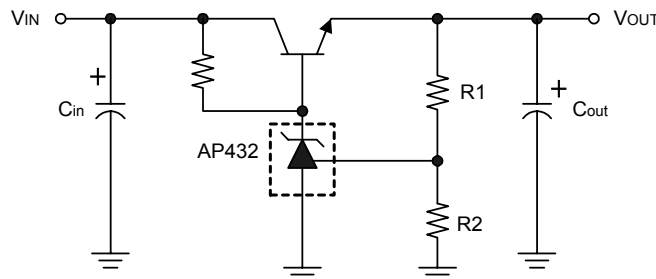
The AP432/432A are 3-terminal adjustable precision shunt regulators with guaranteed stable temperature over the applicable extended commercial temperature range. The output voltage may be set at any level greater than 1.24V ( $V_{REF}$ ) up to 20V merely by selecting two external resistors that act as a voltage divider network. These devices have a typical output impedance of 0.2Ω. Active output circuitry provides very sharp turn-on characteristics, making these devices excellent improved replacements for Zener diodes in many applications.

The precise +/- 1% reference voltage tolerance of the AP432/432A make it possible in many applications to avoid the use of a variable resistor, consequently saving cost and eliminating drift and reliability problems associated with it.

### ■ Ordering Information



### ■ Typical Application Circuit

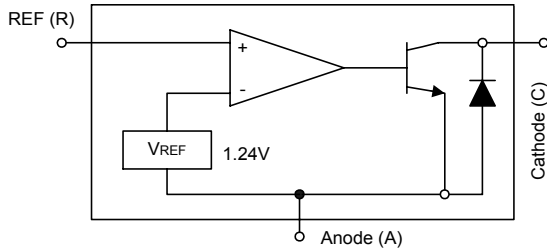


$$V_{OUT} = (1 + R1/R2)V_{REF}$$

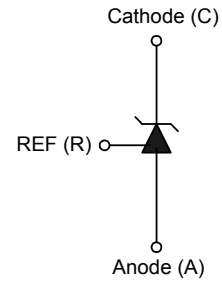
Precision Regulator

## Adjustable Precision Shunt Regulator

### ■ Block Diagram



### ■ Symbol



### ■ Pin Configuration

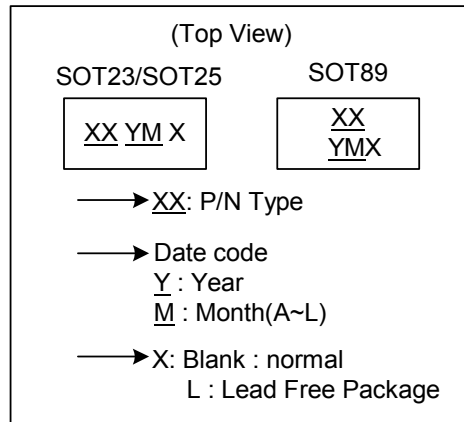
| Order Number  | Pin Configuration (Top View) | Order Number  | Pin Configuration (Top View) |
|---|------------------------------|---|------------------------------|
| AP432Y<br>AP432AY<br>AP432IY<br>AP432IAY<br>(SOT89) |                              | AP432R<br>AP432AR<br>AP432IR<br>AP432IAR<br>(SOT23) |                              |
| AP432V<br>AP432AV<br>AP432IV<br>AP432IAV<br>(TO92)  |                              | AP432W<br>AP432AW<br>AP432IW<br>AP432IAW<br>(SOT23) |                              |
| AP432<br>AP432A<br>AP432I<br>AP432IA<br>(SOP)       |                              | AP432Q<br>AP432AQ<br>AP432IQ<br>AP432IAQ<br>(SOT25) |                              |

## Adjustable Precision Shunt Regulator

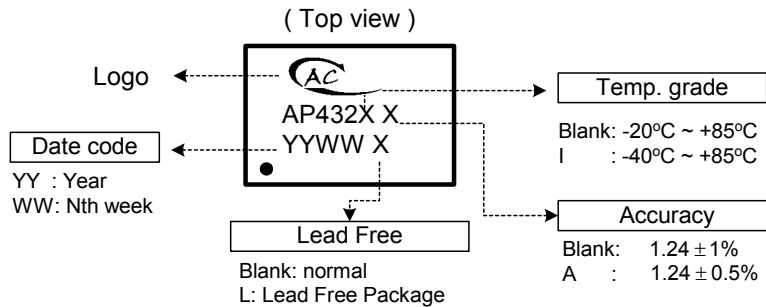
### ■ Marking Information

#### (1) SOT23 / SOT25 / SOT89

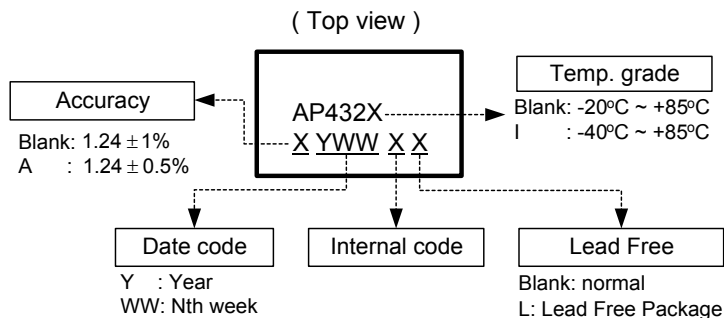
| P/N Type | X X |
|----------|-----|
| AP432Y   | B1  |
| AP432AY  | B2  |
| AP432IY  | BA  |
| AP432IAY | BB  |
| AP432W   | B3  |
| AP432AW  | B4  |
| AP432IW  | BC  |
| AP432IAW | BD  |
| AP432R   | B5  |
| AP432AR  | B6  |
| AP432IR  | BE  |
| AP432IAR | BF  |
| AP432Q   | B7  |
| AP432AQ  | B8  |
| AP432IQ  | BG  |
| AP432IAQ | BH  |



#### (2) SOP



#### (3) TO92





# AP432/AP432A

## Adjustable Precision Shunt Regulator

### ■ Absolute Maximum Ratings

|   |             |               |
|---|-------------|---------------|
| Cathode Voltage.....                      | .....       | 20V           |
| Continuous cathode current .....          | .....       | -10mA ~ 250mA |
| Reference input current range .....       | .....       | 10mA          |
| Operating temperature range (AP432) ..... | .....       | -20°C ~ 85°C  |
| (AP432A).....                             | .....       | -40°C~85°C    |
| Lead Temperature.....                     | .....       | 260°C         |
| Storage Temperature .....                 | .....       | -65°C ~ 150°C |
| Power Dissipation (Notes 1, 2)            | SOT89 ..... | 0.80W         |
|   | TO92 .....  | 0.78W         |
|   | SOT23 ..... | 0.25W         |
|   | SOT25.....  | 0.25W         |
|   | SOP.....    | 0.6W          |

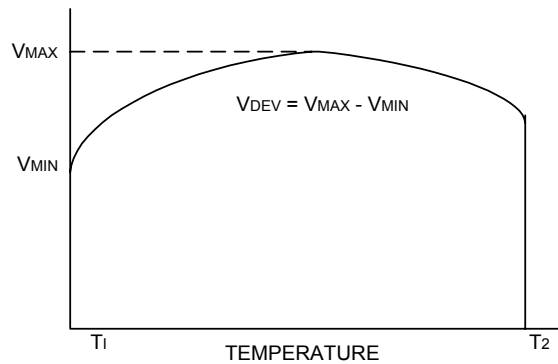
Note 1: T<sub>J</sub>, max =150°C. .

Note 2: Ratings apply to ambient temperature at 25°C.

### ■ Electrical Characteristics (T<sub>a</sub>=25°C, unless otherwise specified.)

| Parameter   | Test conditions   | Symbol                                 | Min.  | Typ. | Max.  | Unit |
|---|---|--|-------|------|-------|------|
| Reference Voltage   | V <sub>KA</sub> = V <sub>ref</sub> ,<br>I <sub>KA</sub> = 10mA<br>(Fig.1)                           | AP432                                  | 1.227 | 1.24 | 1.252 | V    |
|   |   | AP432A                                 | 1.233 |      | 1.246 |      |
| Deviation of Reference Input Voltage over Temperature (Note 3)            | V <sub>KA</sub> = V <sub>REF</sub> , I <sub>KA</sub> = 10mA,<br>T <sub>a</sub> = full range (Fig.1) | V <sub>REF</sub>                       |       | 3.0  | 20    | mV   |
| Ratio of the Change in Reference Voltage to the Change in Cathode Voltage | I <sub>KA</sub> = 10mA<br>(Fig.2)      V <sub>KA</sub> = 20 ~V <sub>REF</sub>                       | $\frac{\Delta V_{REF}}{\Delta V_{KA}}$ |       | -1.4 | -2.0  | mV/V |
| Reference Input Current   | R1 = 10KΩ, R2 = ∞<br>I <sub>KA</sub> = 10mA (Fig.2)   | I <sub>REF</sub>                       |       | 1.4  | 3.5   | μA   |
| Deviation of Reference Input Current over Temperature                     | R1 = 10KΩ, R2 = ∞<br>I <sub>KA</sub> = 10mA<br>T <sub>a</sub> = Full range (Fig.2)                  | α <sub>IREF</sub>                      |       | 0.4  | 1.2   | μA   |
| Minimum Cathode Current for Regulation                                    | V <sub>KA</sub> = V <sub>REF</sub> (Fig.1)  | I <sub>KA(min)</sub>                   |       | 0.15 | 0.3   | mA   |
| Off-state Current   | V <sub>KA</sub> = 20V, V <sub>REF</sub> = 0V (Fig.3)  | I <sub>KA(off)</sub>                   |       | 0.1  | 1.0   | μA   |
| Dynamic Output Impedance (Note 4)   | V <sub>KA</sub> = V <sub>REF</sub><br>Frequency ≤ 1KHz (Fig.1)                                      | Z <sub>KA</sub>                        |       | 0.2  | 0.5   | Ω    |

## Adjustable Precision Shunt Regulator



Note 3. Deviation of reference input voltage,  $V_{DEV}$ , is defined as the maximum variation of the reference over the full temperature range.

The average temperature coefficient of the reference input voltage  $\alpha V_{REF}$  is defined as:

$$|\alpha V_{REF}| = \frac{\left(\frac{V_{DEV}}{V_{REF}(25^\circ\text{C})}\right) \times 10^6}{T_2 - T_1} \dots\dots\dots (\text{ppm}/^\circ\text{C})$$

Where:

$T_2 - T_1$  = full temperature change.

$\alpha V_{REF}$  can be positive or negative depending on whether the slope is positive or negative.

Note 4. The dynamic output impedance,  $R_Z$ , is defined as:

$$|Z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_{KA}}$$

When the device is programmed with two external resistors R1 and R2 (see Figure 2.), the dynamic output impedance of the overall circuit, is defined as:

$$|Z_{KA}'| = \frac{\Delta V}{\Delta I} \approx |Z_{KA}| \left(1 + \frac{R1}{R2}\right)$$

### ■ Test Circuits

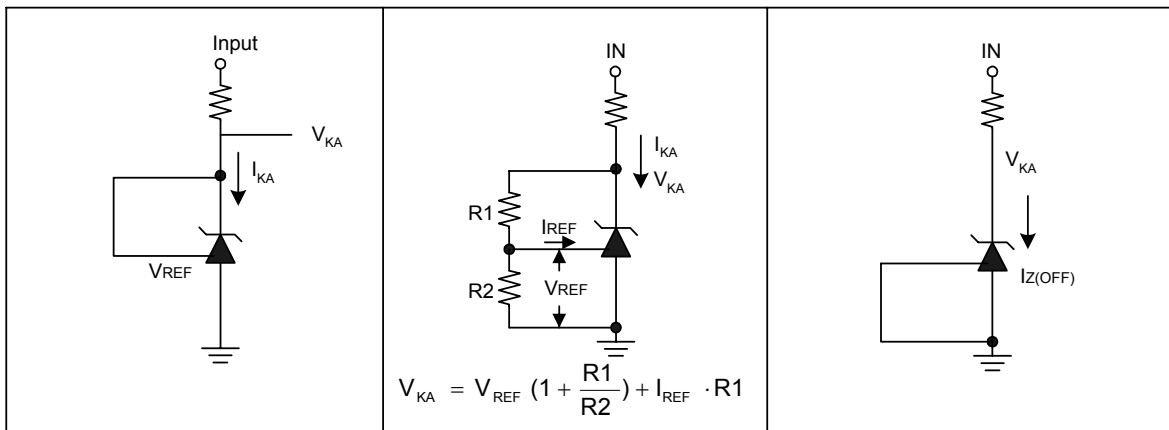


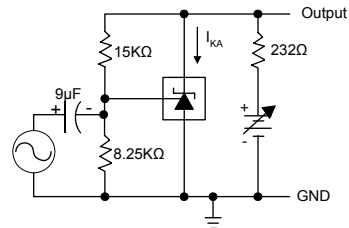
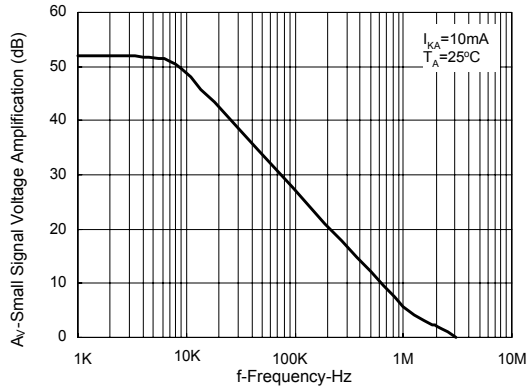
Fig1. Test Circuit for  $V_{KA} = V_{REF}$

Fig2. Test circuit for  $V_{KA} > V_{REF}$

Fig3. Test Circuit for off-state Current

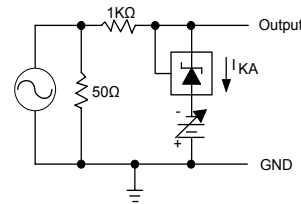
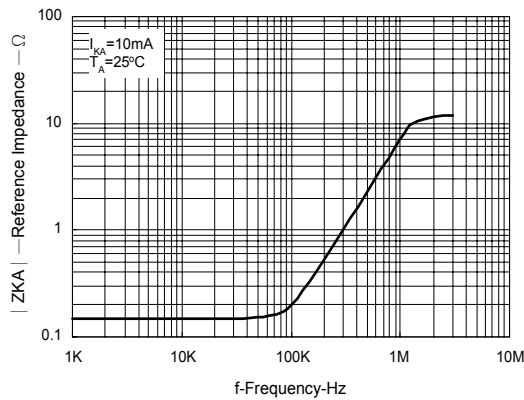
### Typical Performance Characteristics

SMALL-SIGNAL VOLTAGE AMPLIFICATION vs. FREQUENCY



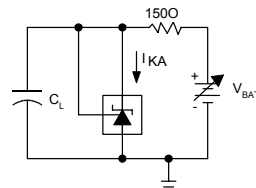
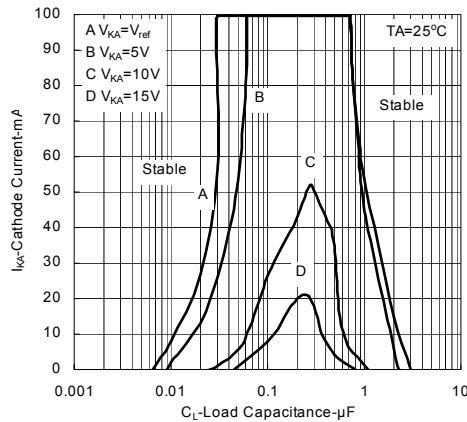
TEST CIRCUIT FOR VOLTAGE AMPLIFICATION

REFERENCE IMPEDANCE vs. FREQUENCY

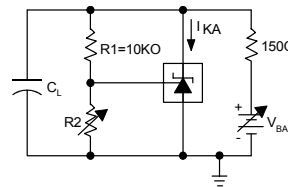


TEST CIRCUIT FOR REFERENCE IMPEDANCE

STABILITY BOUNDARY CONDITIONS†



TEST CIRCUIT FOR CURVE A

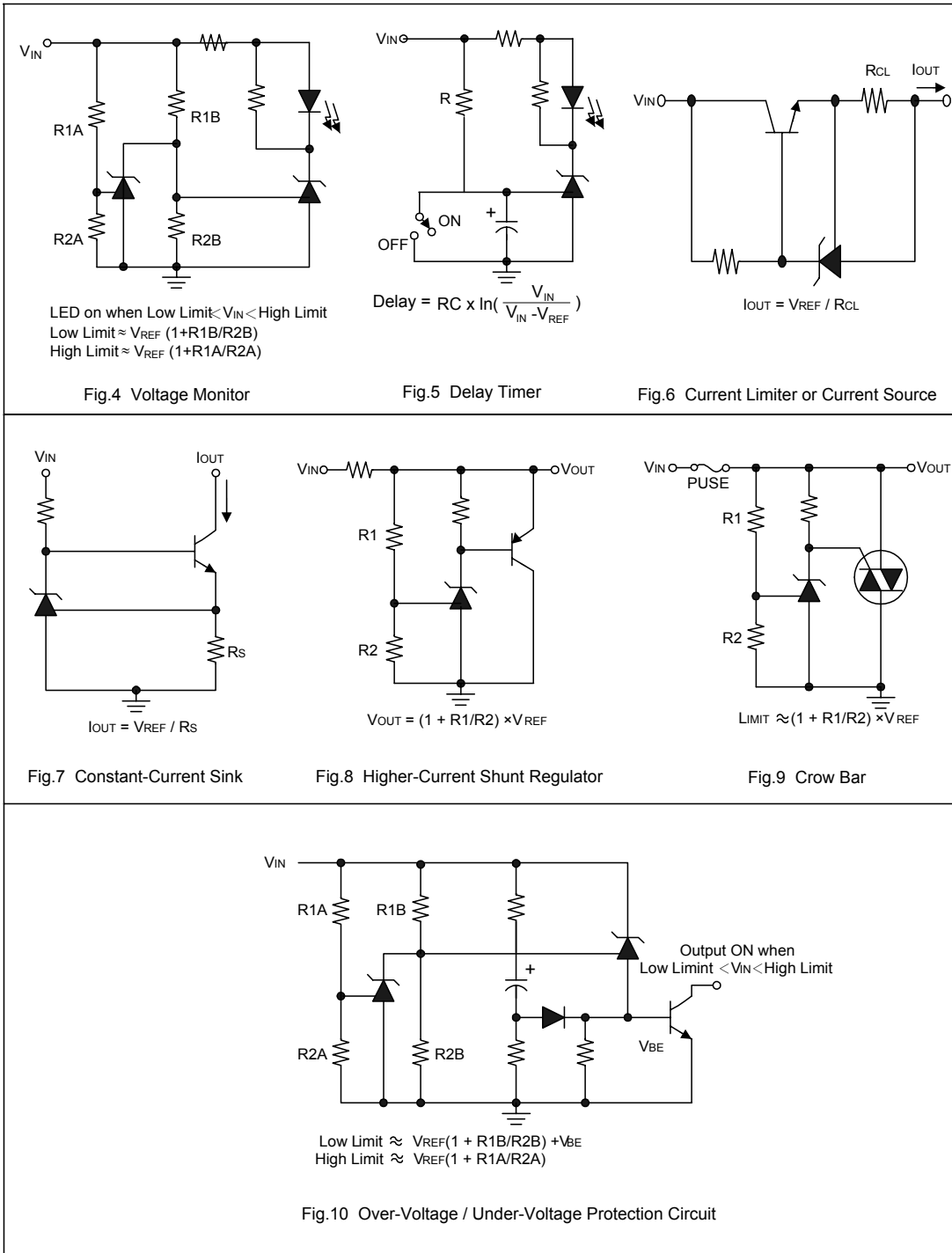


TEST CIRCUIT FOR CURVE B, C, AND D

†The areas under the curves represent conditions that may cause the device to oscillate. For curves B, C, and D, R2 and V+ were adjusted to establish the initial  $V_{KA}$  and  $I_{KA}$  conditions with  $C_L = 0.1 \mu F$  and  $V_{BATT}$  and  $C_L$  were then adjusted to determine the ranges of stability.

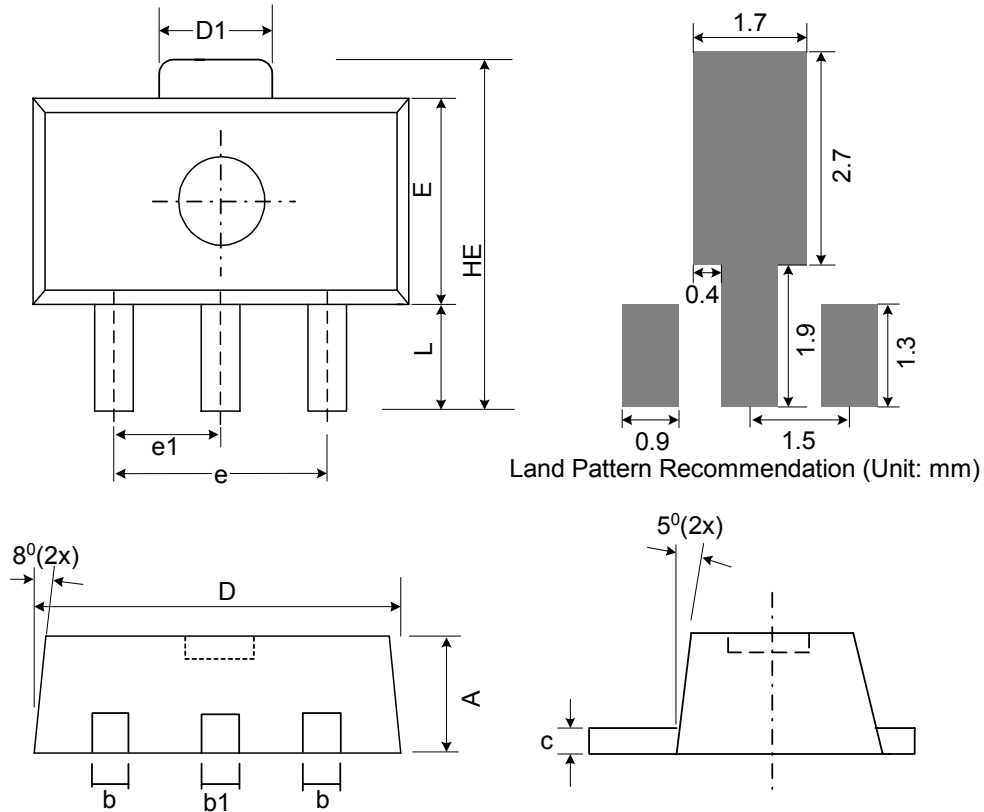
## Adjustable Precision Shunt Regulator

### Application Examples



### ■ Package Diagrams

#### (1) SOT89-3L Package Outline Dimension

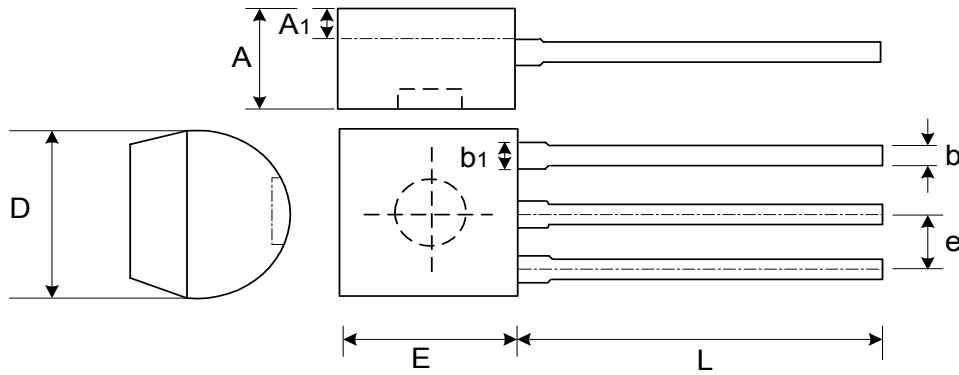


| Symbol | Dimensions In Millimeters |      |      | Dimensions In Inches |       |       |
|--------|---------------------------|------|------|----------------------|-------|-------|
|        | Min.                      | Nom. | Max. | Min.                 | Nom.  | Max.  |
| A      | 1.40                      | 1.50 | 1.60 | 0.055                | 0.059 | 0.063 |
| b      | 0.36                      | 0.42 | 0.48 | 0.014                | 0.016 | 0.018 |
| b1     | 0.41                      | 0.47 | 0.53 | 0.016                | 0.043 | 0.051 |
| C      | 0.35                      | 0.39 | 0.43 | 0.014                | 0.015 | 0.017 |
| D      | 4.40                      | 4.50 | 4.60 | 0.173                | 0.177 | 0.181 |
| D1     | 1.40                      | 1.60 | 1.75 | 0.055                | 0.062 | 0.069 |
| e      | 2.90                      | 3.00 | 3.10 | 0.114                | 0.118 | 0.122 |
| e1     | 1.45                      | 1.50 | 1.55 | 0.057                | 0.059 | 0.061 |
| E      | 2.35                      | 2.48 | 2.60 | 0.093                | 0.098 | 0.102 |
| HE     | 3.94                      | -    | 4.25 | 0.155                | -     | 0.167 |
| L      | 0.80                      | -    | 1.20 | 0.031                | -     | 0.047 |



## Adjustable Precision Shunt Regulator

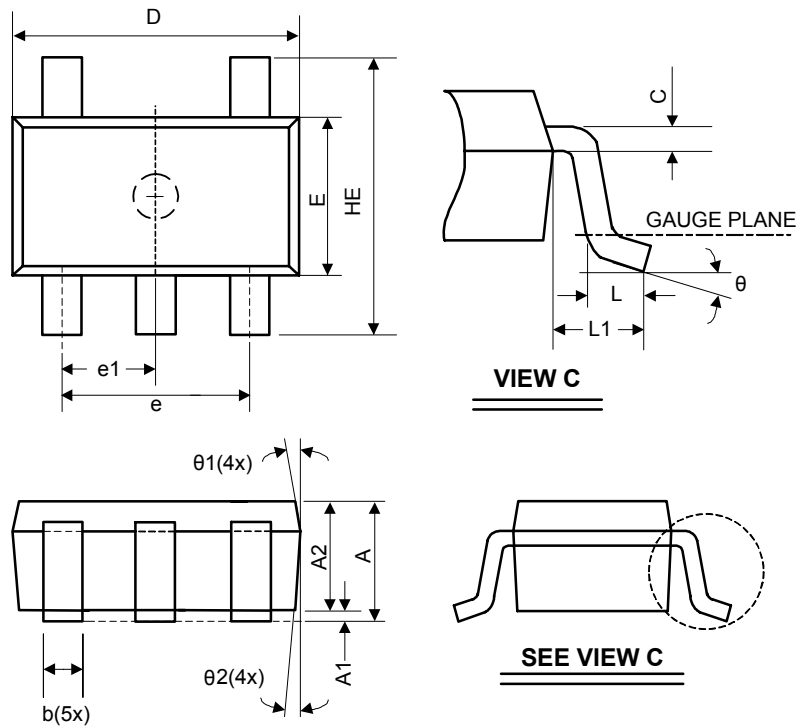
### (2) TO92-3L Package Outline Dimension



| Symbol | Dimensions In Millimeters |       |        | Dimensions In Inches |       |       |
|--------|---------------------------|-------|--------|----------------------|-------|-------|
|        | Min.                      | Nom.  | Max.   | Min.                 | Nom.  | Max.  |
| A      | 3.302                     | 3.556 | 3.810  | 0.130                | 0.140 | 0.150 |
| A1     | 1.016                     | -     | -      | 0.040                | -     | -     |
| b      | 0.330                     | 0.381 | 0.432  | 0.013                | 0.015 | 0.017 |
| b1     | 0.406                     | 0.457 | 0.506  | 0.016                | 0.018 | 0.020 |
| D      | 4.445                     | 4.572 | 4.699  | 0.175                | 0.180 | 0.185 |
| E      | 4.445                     | 4.572 | 4.699  | 0.175                | 0.180 | 0.185 |
| L      | 13.00                     | -     | 15.500 | 0.512                | -     | 0.610 |
| e      | 1.150                     | 1.270 | 1.390  | 0.045                | 0.050 | 0.055 |

## Adjustable Precision Shunt Regulator

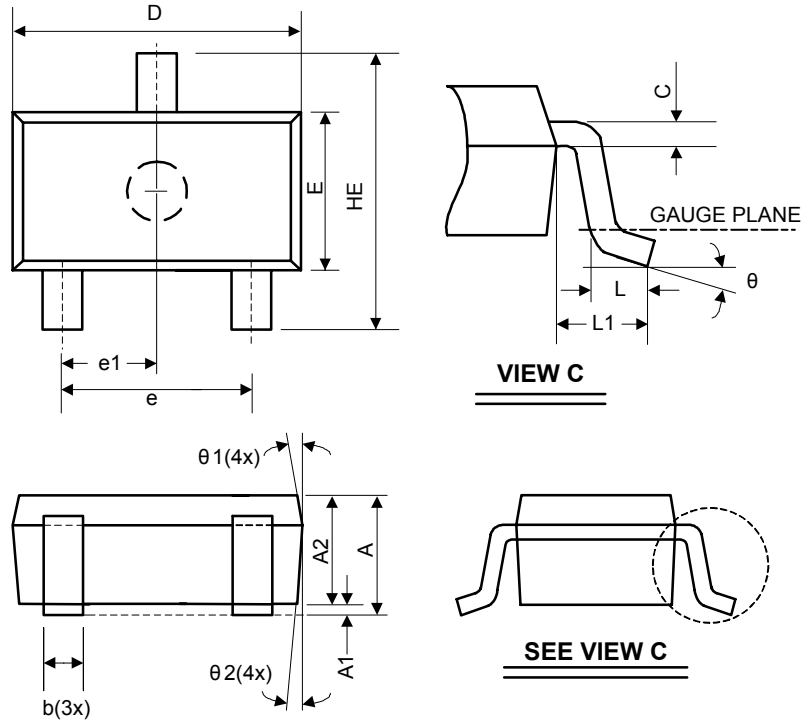
### (3) SOT23-5L Package Outline Dimension



| Symbol    | Dimensions In Millimeters |      |      | Dimensions In Inches |       |       |
|-----------|---------------------------|------|------|----------------------|-------|-------|
|           | Min.                      | Nom. | Max. | Min.                 | Nom.  | Max.  |
| A         | 1.05                      | -    | 1.35 | 0.041                | -     | 0.053 |
| A1        | 0.05                      | -    | 0.15 | 0.002                | -     | 0.006 |
| A2        | 1.00                      | 1.10 | 1.20 | 0.039                | 0.043 | 0.047 |
| b         | 0.25                      | -    | 0.50 | 0.010                | -     | 0.020 |
| C         | 0.08                      | -    | 0.20 | 0.003                | -     | 0.008 |
| D         | 2.70                      | 2.90 | 3.00 | 0.106                | 0.114 | 0.118 |
| E         | 1.50                      | 1.60 | 1.70 | 0.059                | 0.063 | 0.067 |
| HE        | 2.60                      | 2.80 | 3.00 | 0.102                | 0.110 | 0.118 |
| L         | 0.30                      | -    | 0.60 | 0.012                | -     | 0.024 |
| L1        | 0.50                      | 0.60 | 0.70 | 0.020                | 0.024 | 0.028 |
| e         | 1.80                      | 1.90 | 2.00 | 0.071                | 0.075 | 0.079 |
| e1        | 0.85                      | 0.95 | 1.05 | 0.033                | 0.037 | 0.041 |
| $\theta$  | 0°                        | 5°   | 10°  | 0°                   | 5°    | 10°   |
| $\theta1$ | 3°                        | 5°   | 7°   | 3°                   | 5°    | 7°    |
| $\theta2$ | 6°                        | 8°   | 10°  | 6°                   | 8°    | 10°   |

## Adjustable Precision Shunt Regulator

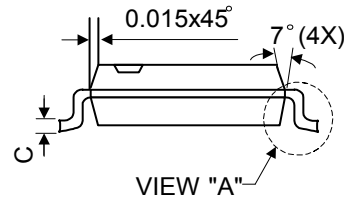
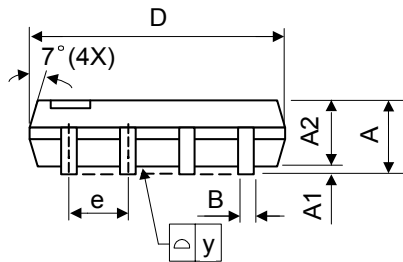
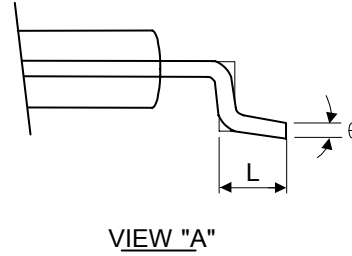
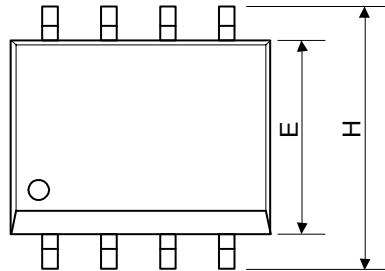
### (4) SOT23-3L Package Outline Dimension



| Symbol     | Dimensions In Millimeters |      |      | Dimensions In Inches |       |       |
|------------|---------------------------|------|------|----------------------|-------|-------|
|            | Min.                      | Nom. | Max. | Min.                 | Nom.  | Max.  |
| A          | 1.05                      | -    | 1.35 | 0.041                | -     | 0.053 |
| A1         | 0.05                      | -    | 0.15 | 0.002                | -     | 0.006 |
| A2         | 1.00                      | 1.10 | 1.20 | 0.039                | 0.043 | 0.047 |
| b          | 0.25                      | -    | 0.50 | 0.010                | -     | 0.020 |
| C          | 0.08                      | -    | 0.20 | 0.003                | -     | 0.008 |
| D          | 2.70                      | 2.90 | 3.00 | 0.106                | 0.114 | 0.118 |
| E          | 1.50                      | 1.60 | 1.70 | 0.059                | 0.063 | 0.067 |
| HE         | 2.60                      | 2.80 | 3.00 | 0.102                | 0.110 | 0.118 |
| L          | 0.30                      | -    | 0.60 | 0.012                | -     | 0.024 |
| L1         | 0.50                      | 0.60 | 0.70 | 0.020                | 0.024 | 0.028 |
| e          | 1.80                      | 1.90 | 2.00 | 0.071                | 0.075 | 0.079 |
| e1         | 0.85                      | 0.95 | 1.05 | 0.033                | 0.037 | 0.041 |
| $\theta$   | 0°                        | 5°   | 10°  | 0°                   | 5°    | 10°   |
| $\theta 1$ | 3°                        | 5°   | 7°   | 3°                   | 5°    | 7°    |
| $\theta 2$ | 6°                        | 8°   | 10°  | 6°                   | 8°    | 10°   |

## Adjustable Precision Shunt Regulator

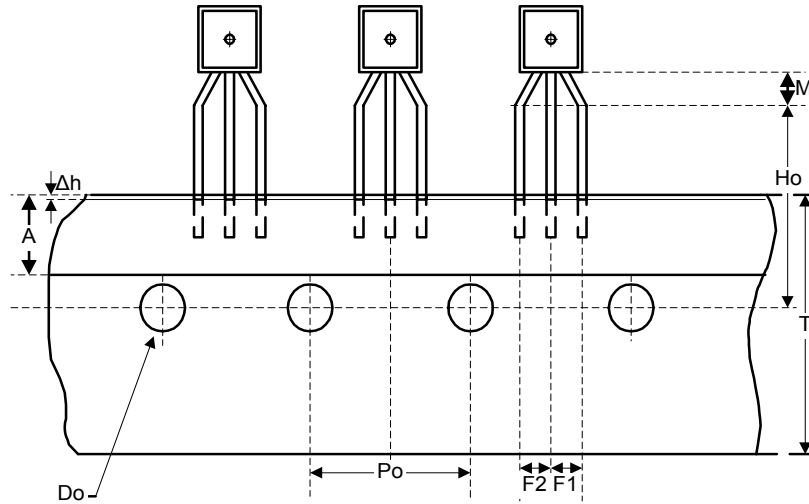
### (5) SOP-8L Package Outline Dimension



| Symbol   | Dimensions In Millimeters |      |           | Dimensions In Inches |       |           |
|----------|---------------------------|------|-----------|----------------------|-------|-----------|
|          | Min.                      | Nom. | Max.      | Min.                 | Nom.  | Max.      |
| A        | 1.40                      | 1.60 | 1.75      | 0.055                | 0.063 | 0.069     |
| A1       | 0.10                      | -    | 0.25      | 0.040                | -     | 0.100     |
| A2       | 1.30                      | 1.45 | 1.50      | 0.051                | 0.057 | 0.059     |
| B        | 0.33                      | 0.41 | 0.51      | 0.013                | 0.016 | 0.020     |
| C        | 0.19                      | 0.20 | 0.25      | 0.0075               | 0.008 | 0.010     |
| D        | 4.80                      | 5.05 | 5.30      | 0.189                | 0.199 | 0.209     |
| E        | 3.70                      | 3.90 | 4.10      | 0.146                | 0.154 | 0.161     |
| e        | -                         | 1.27 | -         | -                    | 0.050 | -         |
| H        | 5.79                      | 5.99 | 6.20      | 0.228                | 0.236 | 0.244     |
| L        | 0.38                      | 0.71 | 1.27      | 0.015                | 0.028 | 0.050     |
| y        | -                         | -    | 0.10      | -                    | -     | 0.004     |
| $\theta$ | $0^\circ$                 | -    | $8^\circ$ | $0^\circ$            | -     | $8^\circ$ |

### ■ Taping Information

(1)TO92 TAPING

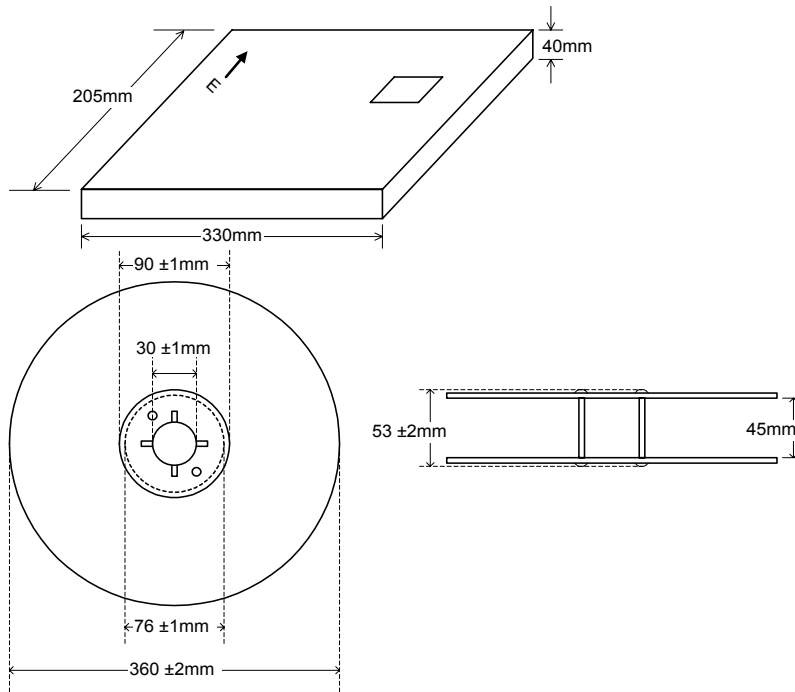


| Symbol     | Millimeters |      |      | Inches |       |       |
|------------|-------------|------|------|--------|-------|-------|
|            | Min.        | Typ. | Max. | Min.   | Typ.  | Max.  |
| $P_o$      | 12.4        | 12.7 | 13.0 | 0.488  | 0.500 | 0.512 |
| $M$        | 2.0         | 2.5  | 3.0  | 0.079  | 0.098 | 0.118 |
| $H_o$      | 15.5        | 16.0 | 16.5 | 0.610  | 0.630 | 0.650 |
| $D_o$      | -           | 4.0  | -    | -      | 0.157 | -     |
| $A$        | -           | 6.0  | -    | -      | 0.236 | -     |
| $\Delta h$ | 0.0         | -    | 1.0  | 0.000  | -     | 0.039 |
| $T$        | -           | 18.0 | -    | -      | 0.709 | -     |
| $F_1$      | 2.4         | 2.5  | 2.9  | 0.094  | 0.098 | 0.114 |
| $F_2$      | 2.4         | 2.5  | 2.9  | 0.094  | 0.098 | 0.114 |



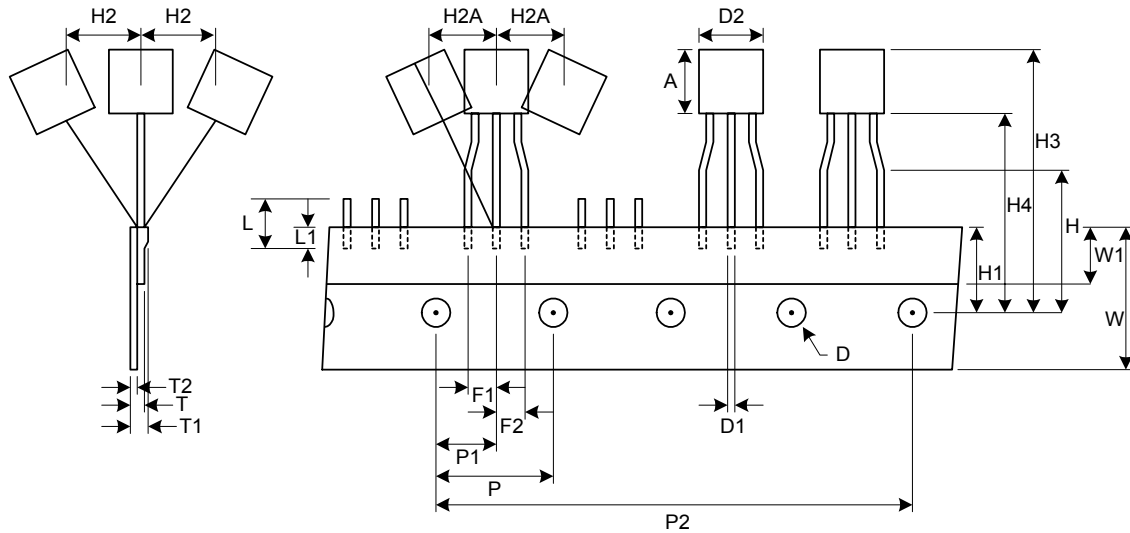
# AP432/AP432A

## Adjustable Precision Shunt Regulator



## Adjustable Precision Shunt Regulator

### (2) TO92 TAPING



| Symbol | Millimeters |       |      | Inches |        |        |
|--------|-------------|-------|------|--------|--------|--------|
|        | Min.        | Typ.  | Max. | Min.   | Typ.   | Max.   |
| A      | 3.18        | 7.59  | 12   | 0.125  | 0.299  | 0.472  |
| D      | 3.8         | 4     | 4.2  | 0.150  | 0.157  | 0.165  |
| D1     | 0.36        | 0.445 | 0.53 | 0.014  | 0.018  | 0.021  |
| D2     | -           | -     | 9.0  | -      | -      | 0.354  |
| F1,F2  | 2.4         | 2.5   | 2.7  | 0.094  | 0.098  | 0.106  |
| F1-F2  | -           | 0.30  | -    | -      | ±0.012 | -      |
| H      | 15.5        | 16    | 16.5 | 0.610  | 0.630  | 0.650  |
| H1     | 8.5         | 9     | 9.5  | 0.335  | 0.354  | 0.374  |
| H2     | -           | -     | 0.5  | -      | -      | 0.020  |
| H2A    | -           | -     | 0.5  | -      | -      | 0.020  |
| H3     | -           | -     | 27   | -      | -      | 1.063  |
| H4     | -           | -     | 20   | -      | -      | 0.787  |
| L      | -           | -     | 11   | -      | -      | 0.433  |
| L1     | 2.5         | -     | -    | 0.098  | -      | -      |
| P      | 12.5        | 12.7  | 12.9 | 0.492  | 0.500  | 0.508  |
| P1     | 5.95        | 6.35  | 6.75 | 0.234  | 0.250  | 0.266  |
| P2     | 50.3        | 50.8  | 51.3 | 1.980  | 2.000  | 2.020  |
| T      | -           | -     | 0.55 | -      | -      | 0.022  |
| T1     | -           | -     | 1.42 | -      | -      | 0.056  |
| T2     | 0.36        | 0.52  | 0.68 | 0.014  | 0.020  | 0.027  |
| W      | 17.5        | 18.25 | 19   | 0.689  | 0.719  | 0.748  |
| W1     | 5           | 6     | 7    | 0.197  | 0.236  | 0.276  |
| ----*  | 253         | 254   | 255  | 9.961  | 10.000 | 10.039 |

----\* = every 20 pcs distance.

### ■ BOX Dimension

