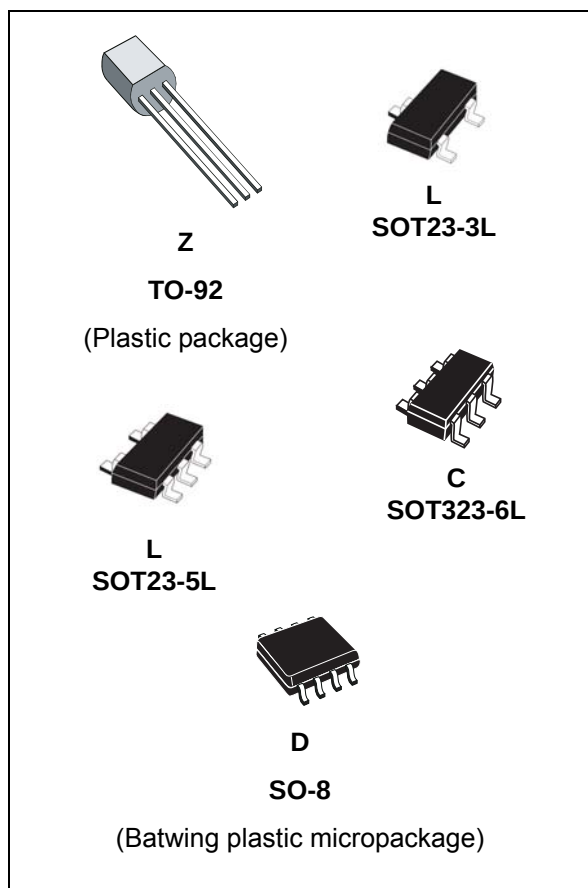


## Adjustable voltage reference

Datasheet - production data



### Features

- Adjustable output voltage:  $V_{REF}$  to 36 V
- Sink current capability: 1 to 100 mA
- Typical output impedance: 0.22  $\Omega$
- 0.4% and 0.25% voltage precision
- Automotive temp. range - 40 °C to +125 °C

### Description

The TL1431 is an adjustable shunt voltage reference with guaranteed temperature stability over the entire operating temperature range.

The output voltage may be set to any value between 2.5 V and 36 V with two external resistors.

The TL1431 operates with a wide current range from 1 to 100 mA with a typical dynamic impedance of 0.2  $\Omega$ .

# Contents

|          |                                                          |           |
|----------|----------------------------------------------------------|-----------|
| <b>1</b> | <b>Schematic diagrams</b>                                | <b>3</b>  |
| <b>2</b> | <b>Absolute maximum ratings and operating conditions</b> | <b>4</b>  |
| <b>3</b> | <b>Electrical characteristics</b>                        | <b>6</b>  |
| <b>4</b> | <b>Parameter definitions</b>                             | <b>12</b> |
| 4.1      | Reference input voltage deviation overtemperature range  | 12        |
| 4.2      | Temperature coefficient of reference input voltage       | 12        |
| 4.3      | Dynamic impedance                                        | 12        |
| <b>5</b> | <b>Package information</b>                               | <b>13</b> |
| 5.1      | SO-8 package information                                 | 14        |
| 5.2      | TO-92 Ammopack package information                       | 15        |
| 5.3      | TO-92 (bulk) package information                         | 17        |
| 5.4      | SOT23-3L package information                             | 18        |
| 5.5      | SOT23-5L package information                             | 19        |
| 5.6      | SOT323-6L package information                            | 20        |
| 5.7      | SO-8 packing information                                 | 21        |
| 5.8      | SOT23-3L packing information                             | 22        |
| 5.9      | SOT23-5L packing information                             | 23        |
| 5.10     | SOT323-6L packing information                            | 24        |
| <b>6</b> | <b>Ordering information</b>                              | <b>25</b> |
| <b>7</b> | <b>Revision history</b>                                  | <b>26</b> |

# 1 Schematic diagrams

Figure 1. TO-92 pin connections (top view)

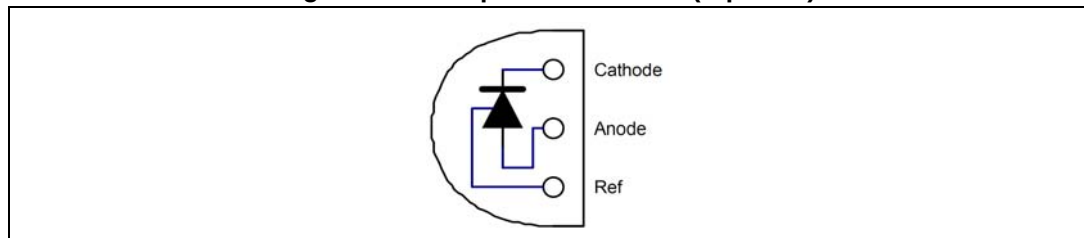


Figure 2. SO-8 batwing pin connections (top view)

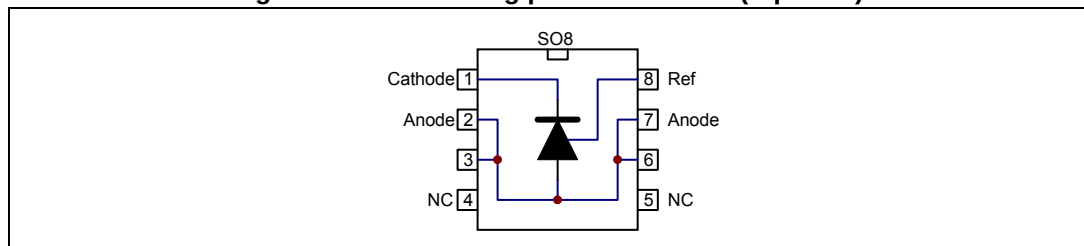


Figure 3. SOT23-5L and SOT23-3L pin connections (top view)

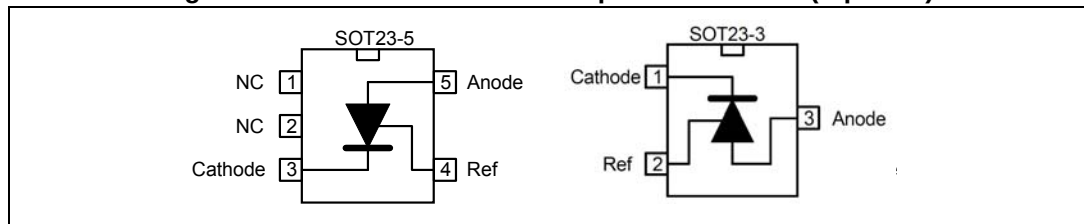


Figure 4. SOT323-6L pin connections (top view)

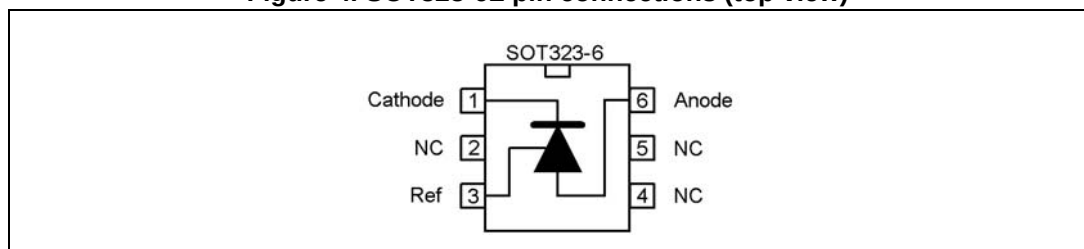
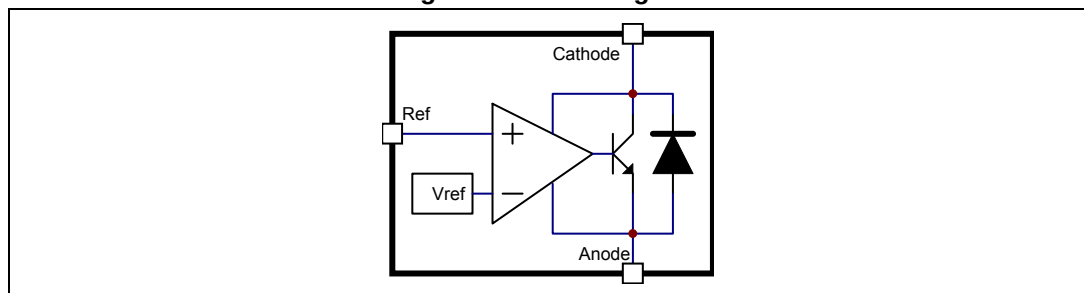


Figure 5. Block diagram



## 2 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings**

| Symbol    | Parameter                                | Value        | Unit |
|-----------|------------------------------------------|--------------|------|
| $V_{KA}$  | Cathode-to-anode voltage                 | 37           | V    |
| $I_k$     | Continuous cathode current range         | -100 to +150 | mA   |
| $I_{ref}$ | Reference input current range            | -0.05 to +10 | mA   |
| $T_j$     | Junction temperature                     | +150         | °C   |
| $P_d$     | Power dissipation <sup>(1)</sup>         |              | mW   |
|           | TO92                                     | 625          |      |
|           | SO-8 batwing                             | 960          |      |
|           | SOT23-3L                                 | 500          |      |
|           | SOT23-5L                                 | 790          |      |
|           | SOT323-6L                                | 565          |      |
| $T_{stg}$ | Storage temperature range                | -65 to +150  | °C   |
| ESD       | HBM: human body model <sup>(2)</sup>     | 2000         | V    |
|           | MM: machine model <sup>(3)</sup>         | 200          |      |
|           | CDM: charged device model <sup>(4)</sup> | 1500         |      |

1. Calculated with  $T_j = +150$  °C and  $T_{amb} = +25$  °C with relative  $R_{thja}$  depending on the package.
2. Human body model: A 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 kΩ resistor between two pins of the device. This happens for all couples of connected pin combinations while the other pins are left floating.
3. Machine model: A 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω). This happens for all couples of connected pin combinations while the other pins are left floating.
4. Charged device model: all pins and the package are charged together to the specified voltage and then discharged directly to the ground through only one pin. This happens for all pins

**Table 2. Operating conditions**

| Symbol     | Parameter                            | Value           | Unit |
|------------|--------------------------------------|-----------------|------|
| $V_{KA}$   | Cathode-to-anode voltage             | $V_{ref}$ to 36 | V    |
| $I_k$      | Cathode current                      | 1 to 100        | mA   |
| $T_{oper}$ | Operating free-air temperature range |                 | °C   |
|            | TL1431C/AC                           | -20 to +70      |      |
|            | TL1431I/AI                           | -40 to +105     |      |
|            | TL1431IY/AIY                         | -40 to +125     |      |

Table 3. Thermal data

| Symbol     | Parameter                                 | TO-92 | SO-8<br>batwing | SOT23-3L | SOT23-5L | SOT323-6L | Unit |
|------------|-------------------------------------------|-------|-----------------|----------|----------|-----------|------|
| $R_{thJC}$ | Thermal<br>resistance<br>junction-case    | 57    | 30              | 136      | 67       | 110       | °C/W |
| $R_{thJA}$ | Thermal<br>resistance<br>junction-ambient | 200   | 85              | 248      | 157      | 221       |      |

### 3 Electrical characteristics

$T_{amb} = 25\text{ }^{\circ}\text{C}$  (unless otherwise specified).

**Table 4. Electrical characteristics for TL1431C, TL1431AC**

| Symbol                                 | Parameter                                                                                                                                                                                 | TL1431C |          |          | TL1431AC |          |          | Unit                    |
|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|----------|----------|----------|----------|----------|-------------------------|
|                                        |                                                                                                                                                                                           | Min.    | Typ.     | Max.     | Min.     | Typ.     | Max.     |                         |
| $V_{ref}$                              | Reference input voltage - see <a href="#">Figure 6</a><br>$V_{KA} = V_{ref}$ , $I_k = 10\text{ mA}$                                                                                       | 2.490   | 2.500    | 2.510    | 2.493    | 2.500    | 2.507    | V                       |
| $\Delta V_{ref}$                       | Reference input voltage deviation over temperature range <sup>(1)</sup> - see <a href="#">Figure 6</a><br>$V_{KA} = V_{ref}$ , $I_k = 10\text{ mA}$ , $T_{min} \leq T_{amb} \leq T_{max}$ |         | 3        | 20       |          | 3        | 20       | mV                      |
| $\frac{\Delta V_{ref}}{\Delta T}$      | Temperature coefficient of reference input voltage <sup>(2)</sup><br>$V_{KA} = V_{ref}$ , $I_k = 10\text{ mA}$ , $T_{min} \leq T_{amb} \leq T_{max}$                                      |         | $\pm 13$ | $\pm 90$ |          | $\pm 13$ | $\pm 90$ | ppm/ $^{\circ}\text{C}$ |
| $\frac{\Delta V_{ref}}{\Delta V_{ka}}$ | Ratio of change in reference input voltage to change in cathode to anode voltage (see <a href="#">Figure 7</a> )<br>$I_k = 10\text{ mA}$ - $\Delta V_{KA} = 36\text{ V}$ to $3\text{ V}$  | -2      | -1.1     |          | -2       | -1.1     |          | mV/V                    |
| $I_{ref}$                              | Reference input current<br>$I_k = 10\text{ mA}$ , $R1 = 10\text{ k}\Omega$ , $R2 = \infty$<br>$T_{min} \leq T_{amb} \leq T_{max}$                                                         |         | 1.5      | 2.5<br>3 |          | 1.5      | 2.5<br>3 | $\mu\text{A}$           |
| $\Delta I_{ref}$                       | Reference input current deviation over temperature range<br>$I_k = 10\text{ mA}$ , $R1 = 10\text{ k}\Omega$ , $R2 = \infty$ , $T_{min} \leq T_{amb} \leq T_{max}$                         |         | 0.2      | 1.2      |          | 0.2      | 1.2      | $\mu\text{A}$           |
| $I_{min}$                              | Minimum cathode current for regulation<br><a href="#">Figure 6</a><br>$V_{KA} = V_{ref}$                                                                                                  |         | 0.5      | 1        |          | 0.5      | 0.6      | mA                      |
| $I_{off}$                              | Off-state cathode current (see <a href="#">Figure 8</a> )                                                                                                                                 |         | 180      | 500      |          | 180      | 500      | nA                      |
| $ Z_{KA} $                             | Dynamic impedance <sup>(3)</sup><br>$V_{KA} = V_{ref}$ , $\Delta I_k = 1\text{ to }100\text{ mA}$ , $f \leq 1\text{ kHz}$                                                                 |         | 0.2      | 0.5      |          | 0.2      | 0.5      | $\Omega$                |

1. See [Reference input voltage deviation overtemperature range](#) in [Section 4: Parameter definitions on page 12](#).

2. See [Temperature coefficient of reference input voltage](#) in [Section 4: Parameter definitions on page 12](#).

3. See [Dynamic impedance](#) in [Section 4: Parameter definitions on page 12](#).

$T_{amb} = 25\text{ }^{\circ}\text{C}$  (unless otherwise specified).

**Table 5. Electrical characteristics for TL1431I, TL1431AI**

| Symbol                                 | Parameter                                                                                                                                                                                 | TL1431I |          |           | TL1431AI |          |           | Unit                    |
|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|----------|-----------|----------|----------|-----------|-------------------------|
|                                        |                                                                                                                                                                                           | Min.    | Typ.     | Max.      | Min.     | Typ.     | Max.      |                         |
| $V_{ref}$                              | Reference input voltage - see <a href="#">Figure 6</a><br>$V_{KA} = V_{ref}$ , $I_k = 10\text{ mA}$                                                                                       | 2.490   | 2.500    | 2.510     | 2.493    | 2.500    | 2.507     | V                       |
| $\Delta V_{ref}$                       | Reference input voltage deviation over temperature range <sup>(1)</sup> - see <a href="#">Figure 6</a><br>$V_{KA} = V_{ref}$ , $I_k = 10\text{ mA}$ , $T_{min} \leq T_{amb} \leq T_{max}$ |         | 7        | 30        |          | 7        | 30        | mV                      |
| $\frac{\Delta V_{ref}}{\Delta T}$      | Temperature coefficient of reference input voltage <sup>(2)</sup><br>$V_{KA} = V_{ref}$ , $I_k = 10\text{ mA}$ , $T_{min} \leq T_{amb} \leq T_{max}$                                      |         | $\pm 22$ | $\pm 100$ |          | $\pm 22$ | $\pm 100$ | ppm/ $^{\circ}\text{C}$ |
| $\frac{\Delta V_{ref}}{\Delta V_{KA}}$ | Ratio of change in reference input voltage to change in cathode to anode voltage - see <a href="#">Figure 7</a><br>$I_k = 10\text{ mA}$ - $\Delta V_{KA} = 36\text{ V}$ to $3\text{ V}$   | -2      | -1.1     |           | -2       | -1.1     |           | mV/V                    |
| $I_{ref}$                              | Reference input current<br>$I_k = 10\text{ mA}$ , $R1 = 10\text{ k}\Omega$ , $R2 = \infty$<br>$T_{min} \leq T_{amb} \leq T_{max}$                                                         |         | 1.5      | 2.5<br>3  |          | 1.5      | 2.5<br>3  | $\mu\text{A}$           |
| $\Delta I_{ref}$                       | Reference input current deviation over temperature range<br>$I_k = 10\text{ mA}$ , $R1 = 10\text{ k}\Omega$ , $R2 = \infty$ , $T_{min} \leq T_{amb} \leq T_{max}$                         |         | 0.5      | 1         |          | 0.8      | 1.2       | $\mu\text{A}$           |
| $I_{min}$                              | Minimum cathode current for regulation - see <a href="#">Figure 6</a><br>$V_{KA} = V_{ref}$                                                                                               |         | 0.5      | 1         |          | 0.5      | 0.7       | mA                      |
| $I_{off}$                              | Off-state cathode current - see <a href="#">Figure 8</a>                                                                                                                                  |         | 180      | 500       |          | 180      | 500       | nA                      |
| $ Z_{KA} $                             | Dynamic impedance <sup>(3)</sup><br>$V_{KA} = V_{ref}$ , $\Delta I_k = 1\text{ to }100\text{ mA}$ , $f \leq 1\text{ kHz}$                                                                 |         | 0.2      | 0.5       |          | 0.2      | 0.5       | $\Omega$                |

1. See [Reference input voltage deviation over temperature range](#) in [Section 4: Parameter definitions on page 12](#).

2. See [Temperature coefficient of reference input voltage](#) in [Section 4: Parameter definitions on page 12](#).

3. See [Dynamic impedance](#) in [Section 4: Parameter definitions on page 12](#).

$T_{amb} = 25\text{ }^{\circ}\text{C}$  (unless otherwise specified).

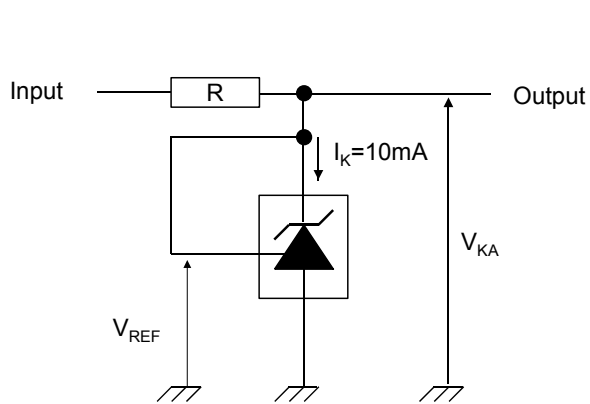
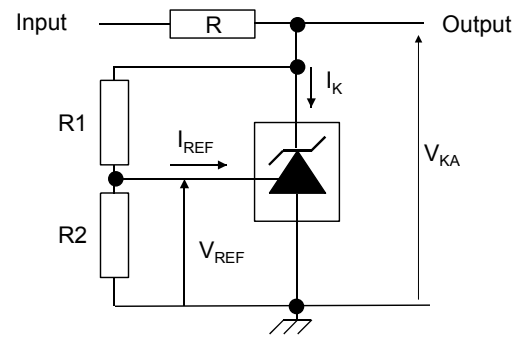
**Table 6. Electrical characteristics for TL1431IY, TL1431AIY**

| Symbol                                 | Parameter                                                                                                                                                                                 | TL1431IY |          |           | TL1431AIY |          |           | Unit                    |
|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|----------|-----------|-----------|----------|-----------|-------------------------|
|                                        |                                                                                                                                                                                           | Min.     | Typ.     | Max.      | Min.      | Typ.     | Max.      |                         |
| $V_{ref}$                              | Reference input voltage - see <a href="#">Figure 6</a><br>$V_{KA} = V_{ref}$ , $I_k = 10\text{ mA}$                                                                                       | 2.490    | 2.500    | 2.510     | 2.493     | 2.500    | 2.507     | V                       |
| $\Delta V_{ref}$                       | Reference input voltage deviation over temperature range <sup>(1)</sup> - see <a href="#">Figure 6</a><br>$V_{KA} = V_{ref}$ , $I_k = 10\text{ mA}$ , $T_{min} \leq T_{amb} \leq T_{max}$ |          | 7        | 30        |           | 7        | 30        | mV                      |
| $\frac{\Delta V_{ref}}{\Delta T}$      | Temperature coefficient of reference input voltage <sup>(2)</sup><br>$V_{KA} = V_{ref}$ , $I_k = 10\text{ mA}$ , $T_{min} \leq T_{amb} \leq T_{max}$                                      |          | $\pm 22$ | $\pm 100$ |           | $\pm 22$ | $\pm 100$ | ppm/ $^{\circ}\text{C}$ |
| $\frac{\Delta V_{ref}}{\Delta V_{KA}}$ | Ratio of change in reference input voltage to change in cathode to anode voltage - see <a href="#">Figure 7</a><br>$I_k = 10\text{ mA}$ - $\Delta V_{KA} = 36\text{ V}$ to $3\text{ V}$   | -2       | -1.1     |           | -2        | -1.1     |           | mV/V                    |
| $I_{ref}$                              | Reference input current<br>$I_k = 10\text{ mA}$ , $R1 = 10\text{ k}\Omega$ , $R2 = \infty$<br>$T_{min} \leq T_{amb} \leq T_{max}$                                                         |          | 1.5      | 2.5<br>3  |           | 1.5      | 2.5<br>3  | $\mu\text{A}$           |
| $\Delta I_{ref}$                       | Reference input current deviation over temperature range<br>$I_k = 10\text{ mA}$ , $R1 = 10\text{ k}\Omega$ , $R2 = \infty$ , $T_{min} \leq T_{amb} \leq T_{max}$                         |          | 0.5      | 1         |           | 0.8      | 1.2       | $\mu\text{A}$           |
| $I_{min}$                              | Minimum cathode current for regulation - see <a href="#">Figure 6</a><br>$V_{KA} = V_{ref}$                                                                                               |          | 0.5      | 1         |           | 0.5      | 0.7       | mA                      |
| $I_{off}$                              | Off-state cathode current - see <a href="#">Figure 8</a>                                                                                                                                  |          | 180      | 500       |           | 180      | 500       | nA                      |
| $ Z_{KA} $                             | Dynamic impedance <sup>(3)</sup><br>$V_{KA} = V_{ref}$ , $\Delta I_k = 1\text{ to }100\text{ mA}$ , $f \leq 1\text{ kHz}$                                                                 |          | 0.2      | 0.5       |           | 0.2      | 0.5       | $\Omega$                |

1. See [Reference input voltage deviation over temperature range](#) in [Section 4: Parameter definitions on page 12](#).

2. See [Temperature coefficient of reference input voltage](#) in [Section 4: Parameter definitions on page 12](#).

3. See [Dynamic impedance](#) in [Section 4: Parameter definitions on page 12](#).

Figure 6. Test circuit  $V_{KA} = V_{REF}$ Figure 7. Test circuit for  $V_{KA} > V_{REF}$ 

$$V_{KA} = V_{REF} \left(1 + \frac{R1}{R2}\right) + R1 \times I_{REF}$$

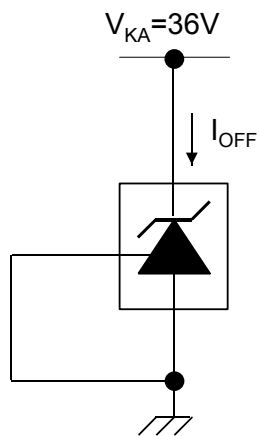
Figure 8. Test circuit for  $I_{OFF}$ 

Figure 9. Test circuit for phase margin and voltage gain

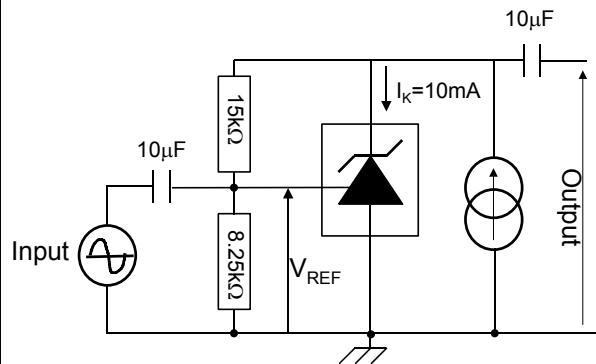


Figure 10. Test circuit for response time

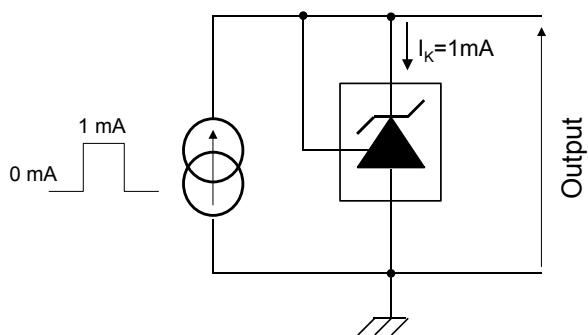


Figure 11. Reference voltage vs. temperature

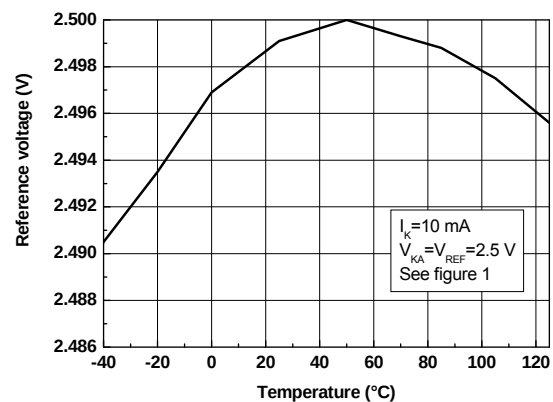


Figure 12. Reference voltage vs. cathode current

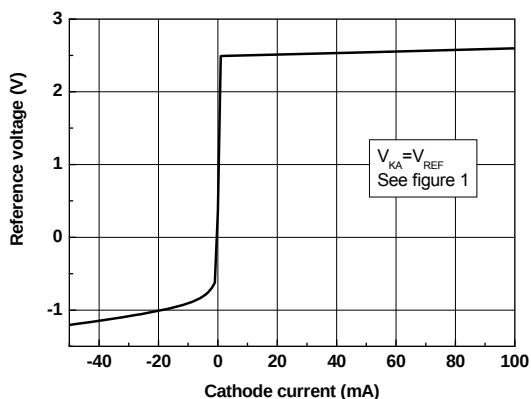
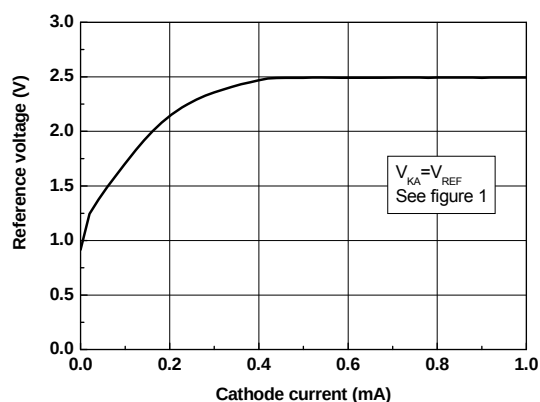
Figure 13. Reference voltage vs. cathode current ( $I_K = 0$  to 1 mA)

Figure 14. Reference current vs. temperature

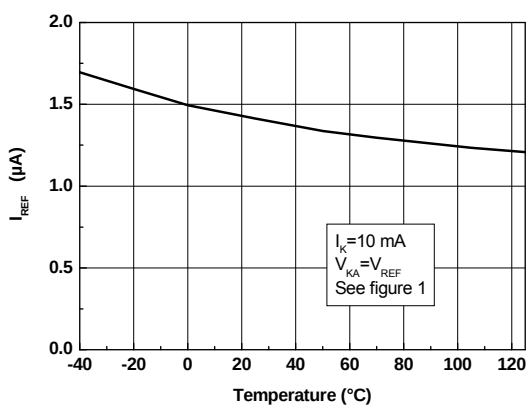


Figure 15. Off-state cathode current vs. temperature

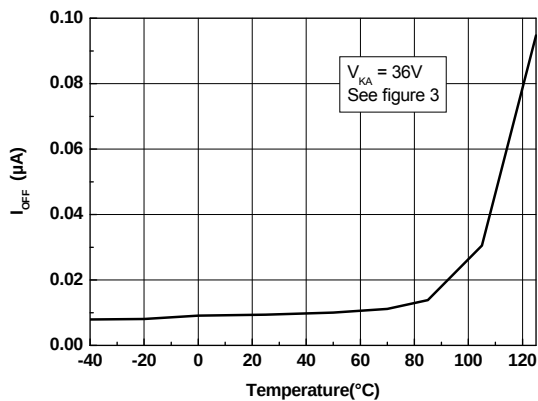
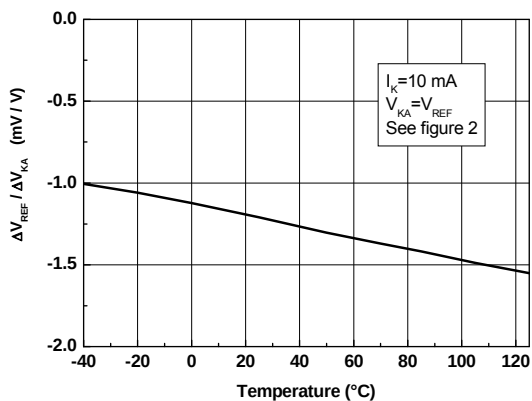
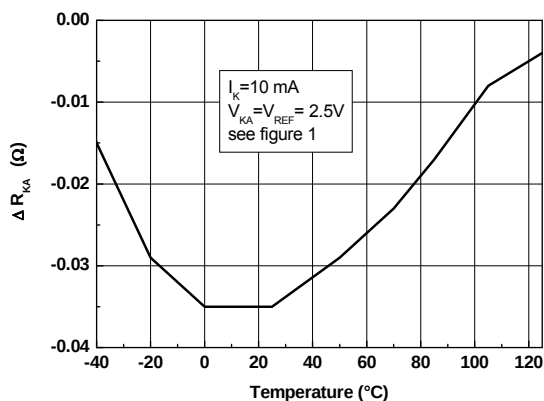
Figure 16. Ratio of change in  $V_{REF}$  to change in  $V_{KA}$  vs. temperatureFigure 17. Drift of  $R_{KA}$  vs. temperature

Figure 18. Maximum operating current vs. temperature

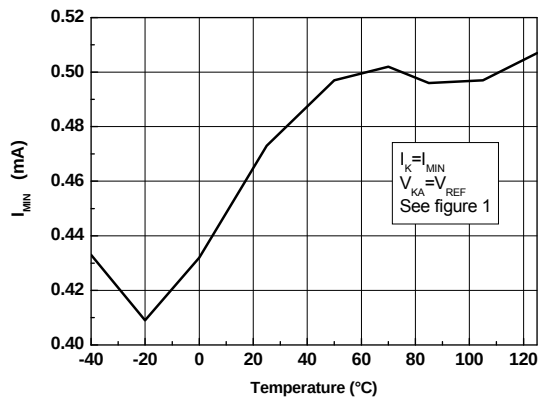


Figure 19. Gain and phase vs. frequency

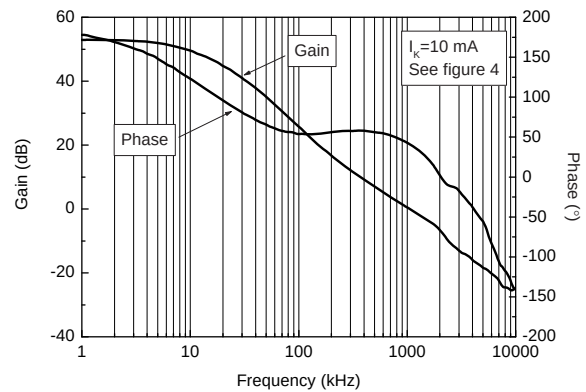


Figure 20. Stability behavior with capacitive loads

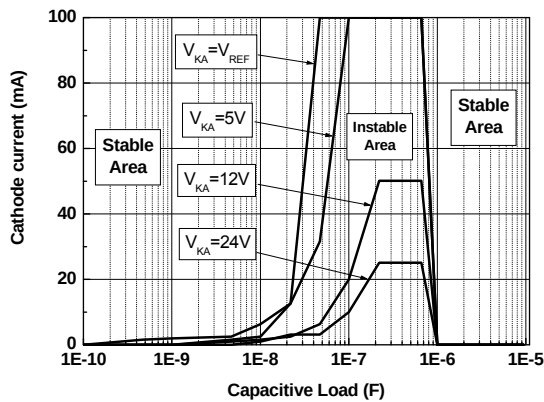
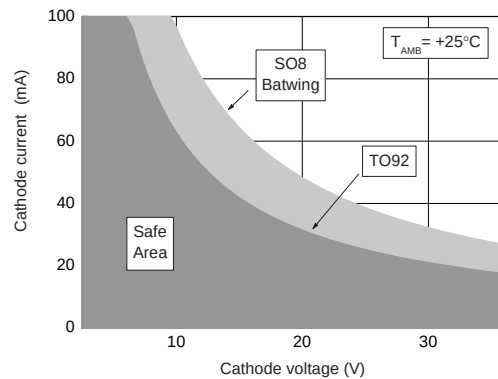
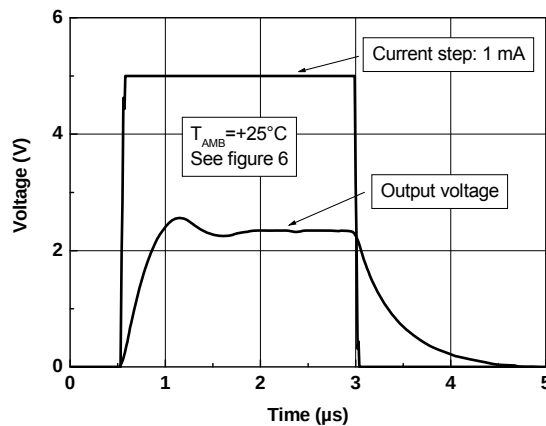


Figure 21. Maximum power dissipation

Figure 22. Pulse response for  $I_K = 1$  mA

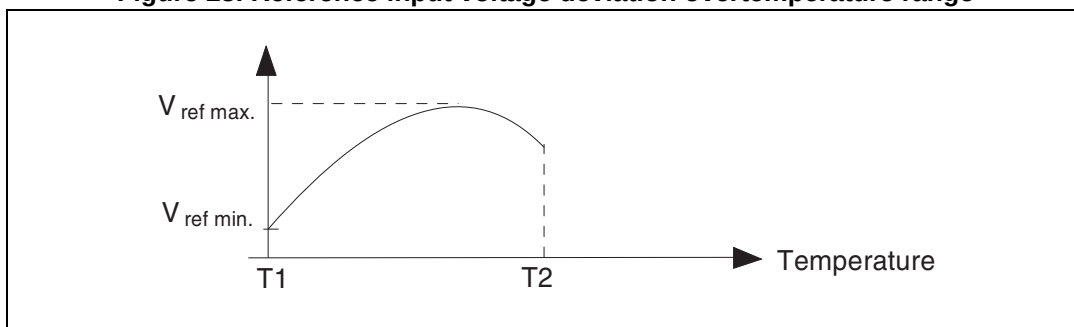
## 4 Parameter definitions

### 4.1 Reference input voltage deviation overtemperature range

$\Delta V_{ref}$  is defined as the difference between the maximum and minimum values obtained over the full temperature range.

$$\Delta V_{ref} = V_{ref\ max.} - V_{ref\ min.}$$

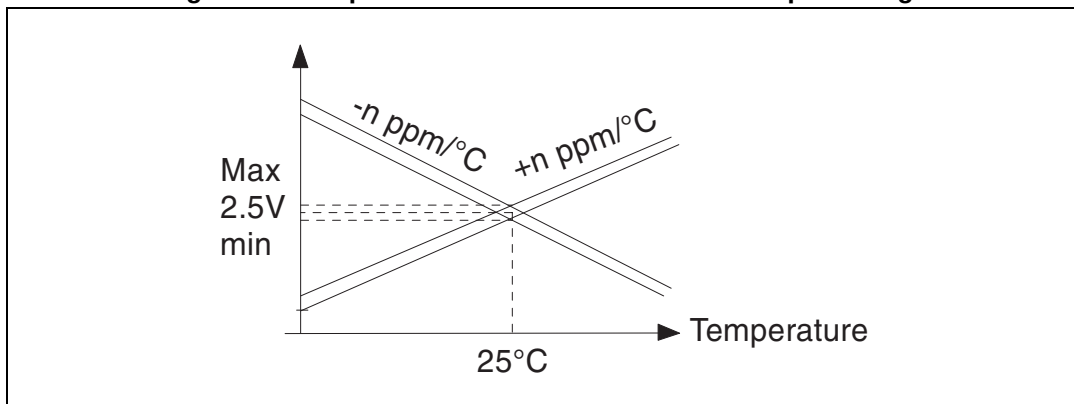
Figure 23. Reference input voltage deviation overtemperature range



### 4.2 Temperature coefficient of reference input voltage

The temperature coefficient is defined as the slopes (positive and negative) of the voltage versus temperature limits within which the reference is guaranteed.

Figure 24. Temperature coefficient of reference input voltage



### 4.3 Dynamic impedance

The dynamic impedance is defined as  $|Z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_K}$

## 5 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK® is an ST trademark.

5.1 SO-8 package information

Figure 25. SO-8 package outline

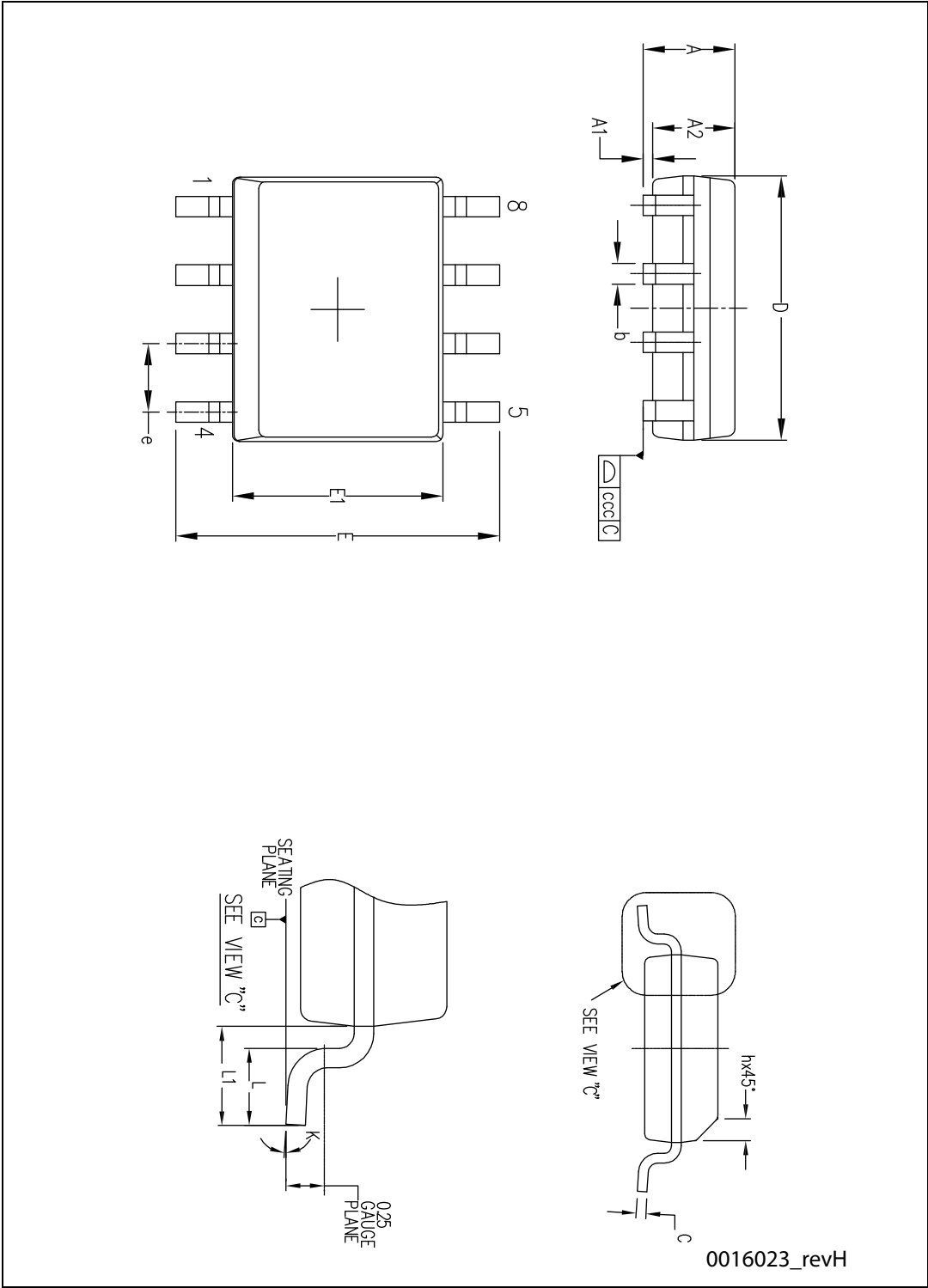


Table 7. SO-8 package mechanical data

| Dim. | mm   |      |      |
|------|------|------|------|
|      | Min. | Typ. | Max. |
| A    |      |      | 1.75 |
| A1   | 0.10 |      | 0.25 |
| A2   | 1.25 |      |      |
| b    | 0.28 |      | 0.48 |
| c    | 0.17 |      | 0.23 |
| D    | 4.80 | 4.90 | 5.00 |
| E    | 5.80 | 6.00 | 6.20 |
| E1   | 3.80 | 3.90 | 4.00 |
| e    |      | 1.27 |      |
| h    | 0.25 |      | 0.50 |
| L    | 0.40 |      | 1.27 |
| L1   |      | 1.04 |      |
| k    | 0    |      | 8    |
| ccc  |      |      | 0.10 |

## 5.2 TO-92 Ammopack package information

Figure 26. TO-92 Ammopack package outline

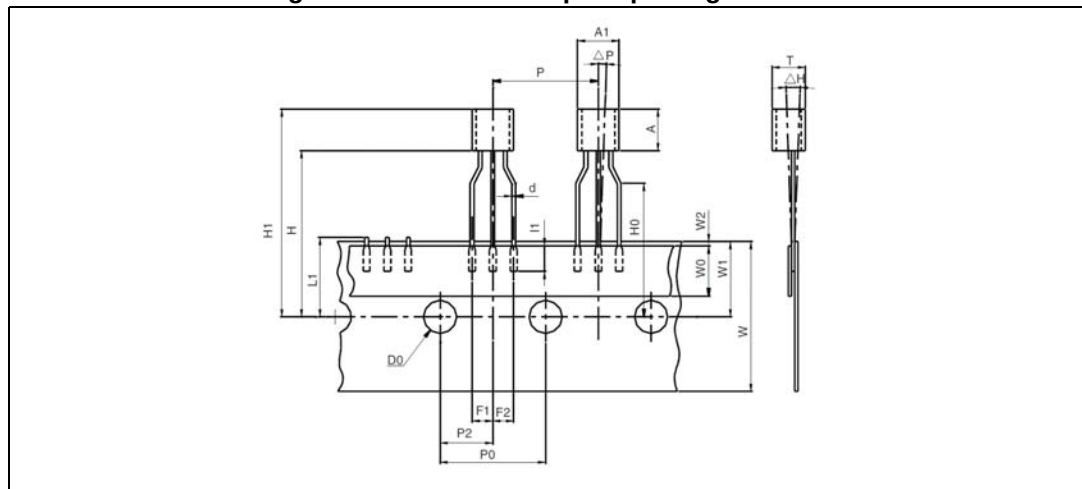


Table 8. TO-92 Ammopack package mechanical data

| Dim.       | Millimeters |      |      | Inches |       |       |
|------------|-------------|------|------|--------|-------|-------|
|            | Min.        | Typ. | Max. | Min.   | Typ.  | Max.  |
| A1         |             |      | 5.0  |        |       | 0.197 |
| A          |             |      | 5.0  |        |       | 0.197 |
| T          |             |      | 4.0  |        |       | 0.157 |
| d          |             | 0.45 |      |        | 0.018 |       |
| l1         | 2.5         |      |      | 0.098  |       |       |
| P          | 11.7        | 12.7 | 13.7 | 0.461  | 0.500 | 0.539 |
| PO         | 12.4        | 12.7 | 13   | 0.488  | 0.500 | 0.512 |
| P2         | 5.95        | 6.35 | 6.75 | 0.234  | 0.250 | 0.266 |
| F1/F2      | 2.4         | 2.5  | 2.8  | 0.094  | 0.098 | 0.110 |
| $\Delta h$ | -1          | 0    | 1    | -0.039 | 0     | 0.039 |
| $\Delta P$ | -1          | 0    | 1    | -0.039 | 0     | 0.039 |
| W          | 17.5        | 18.0 | 19.0 | 0.689  | 0.709 | 0.748 |
| W0         | 5.7         | 6    | 6.3  | 0.224  | 0.236 | 0.248 |
| W1         | 8.5         | 9    | 9.75 | 0.335  | 0.354 | 0.384 |
| W2         |             |      | 0.5  |        |       | 0.020 |
| H          |             |      | 20   |        |       | 0.787 |
| H0         | 15.5        | 16   | 16.5 | 0.610  | 0.630 | 0.650 |
| H1         |             |      | 25   |        |       | 0.984 |
| DO         | 3.8         | 4.0  | 4.2  | 0.150  | 0.157 | 0.165 |
| L1         |             |      | 11   |        |       | 0.433 |

5.3 TO-92 (bulk) package information

Figure 27. TO-92 bulk package outline

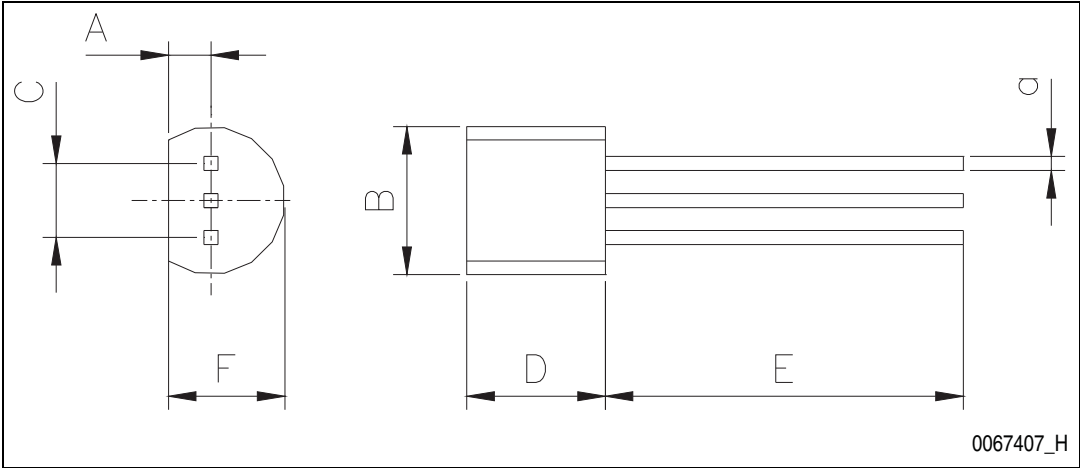


Table 9. TO-92 bulk package mechanical data

| Dim. | Millimeters |      |      | Inches |       |       |
|------|-------------|------|------|--------|-------|-------|
|      | Min.        | Typ. | Max. | Min.   | Typ.  | Max.  |
| A    |             | 1.35 |      |        | 0.053 |       |
| B    |             |      | 4.70 |        |       | 0.185 |
| C    |             | 2.54 |      |        | 0.100 |       |
| D    | 4.40        |      |      | 0.173  |       |       |
| E    | 12.70       |      |      | 0.500  |       |       |
| F    |             |      | 3.70 |        |       | 0.146 |
| a    |             |      | 0.5  |        |       | 0.019 |

## 5.4 SOT23-3L package information

Figure 28. SOT23-3L package outline

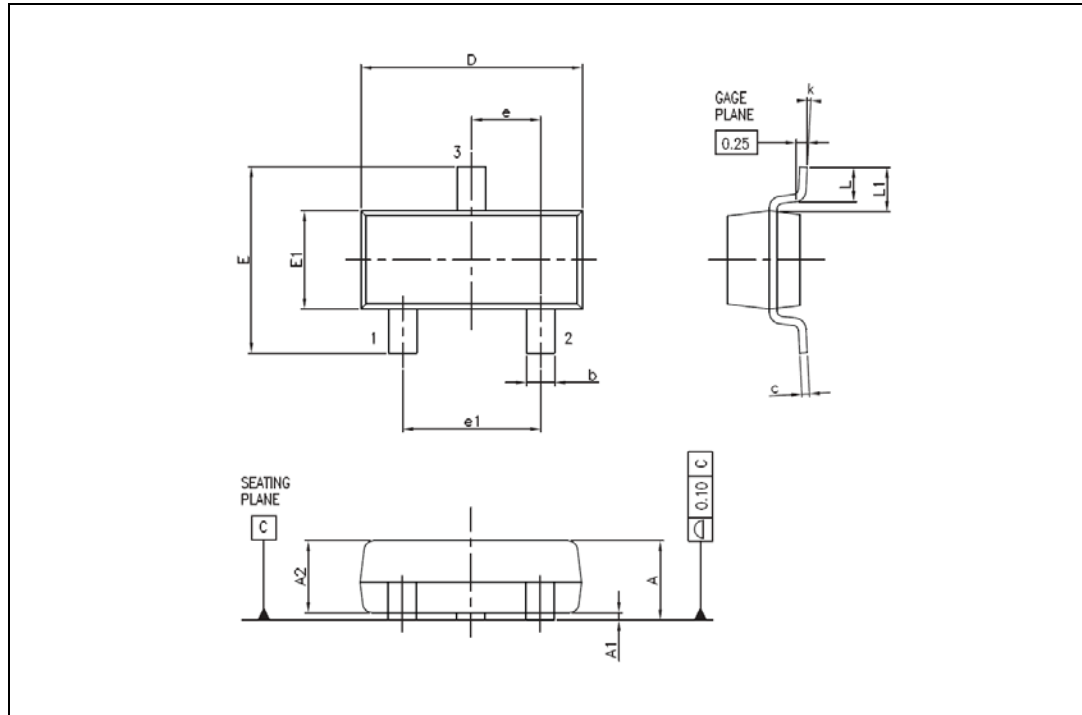


Table 10. SOT23-3L package mechanical data

| Dimensions |             |      |      |        |       |       |
|------------|-------------|------|------|--------|-------|-------|
| Ref.       | Millimeters |      |      | Inches |       |       |
|            | Min.        | Typ. | Max. | Min.   | Typ.  | Max.  |
| A          | 0.89        |      | 1.12 | 0.035  |       | 0.044 |
| A1         | 0.01        |      | 0.10 | 0.0004 |       | 0.004 |
| A2         | 0.88        | 0.95 | 1.02 | 0.035  | 0.037 | 0.040 |
| b          | 0.30        |      | 0.50 | 0.012  |       | 0.020 |
| c          | 0.08        |      | 0.20 | 0.003  |       | 0.008 |
| D          | 2.80        | 2.90 | 3.04 | 0.110  | 0.114 | 0.120 |
| E          | 2.10        |      | 2.64 | 0.083  |       | 0.104 |
| E1         | 1.20        | 1.30 | 1.40 | 0.047  | 0.051 | 0.055 |
| e          |             | 0.95 |      |        | 0.037 |       |
| e1         |             | 1.90 |      |        | 0.075 |       |
| L          | 0.40        | 0.50 | 0.60 | 0.016  | 0.020 | 0.024 |
| L1         |             | 0.54 |      |        | 0.021 |       |
| k          | 0d          |      | 8d   |        |       |       |

## 5.5 SOT23-5L package information

Figure 29. SOT23-5L package outline

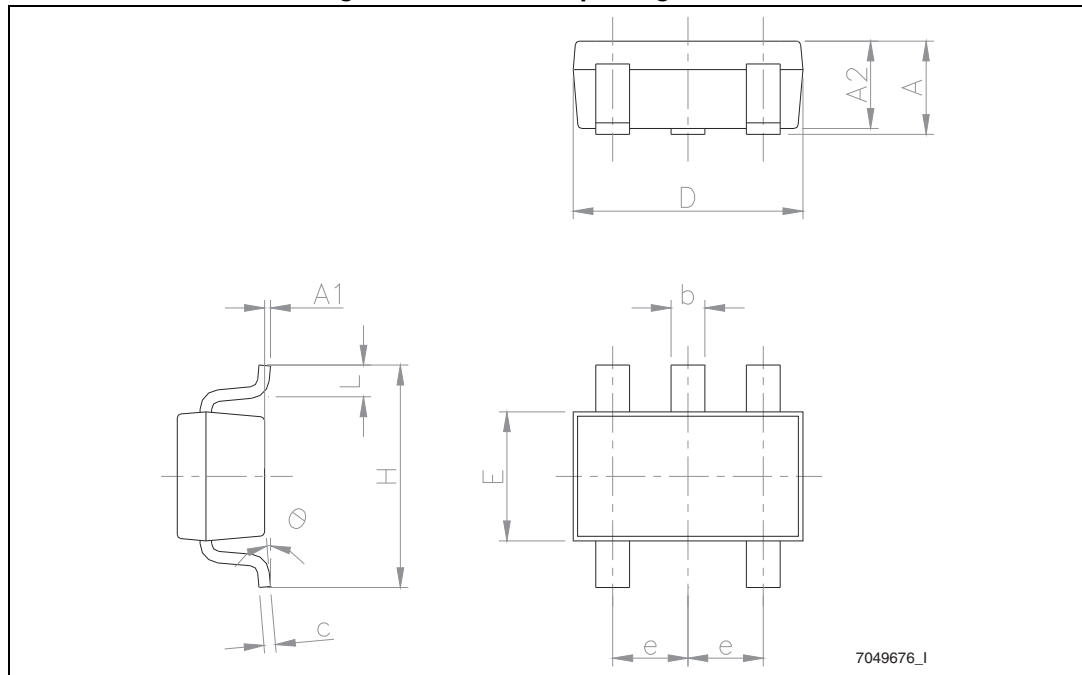


Table 11. SOT23-5L package mechanical data

| Ref. | Dimensions  |      |            |        |       |       |
|------|-------------|------|------------|--------|-------|-------|
|      | Millimeters |      |            | Inches |       |       |
|      | Min.        | Typ. | Max.       | Min.   | Typ.  | Max.  |
| A    | 0.90        |      | 1.45       | 0.035  |       | 0.057 |
| A1   |             |      | 0.15       |        |       | 0.006 |
| A2   | 0.90        |      | 1.30       | 0.035  |       | 0.051 |
| b    | 0.35        |      | 0.50       | 0.014  |       | 0.020 |
| c    | 0.09        |      | 0.20       | 0.004  |       | 0.008 |
| D    | 2.80        |      | 3.05       | 0.110  |       | 0.120 |
| E    | 1.50        |      | 1.75       | 0.059  |       | 0.069 |
| e    |             | 0.95 |            |        | 0.037 |       |
| H    | 2.60        |      | 3.00       | 0.102  |       | 0.118 |
| L    | 0.10        |      | 0.60       | 0.004  |       | 0.024 |
| θ    | 0 degrees   |      | 10 degrees |        |       |       |

5.6 SOT323-6L package information

Figure 30. SOT323-6L package outline

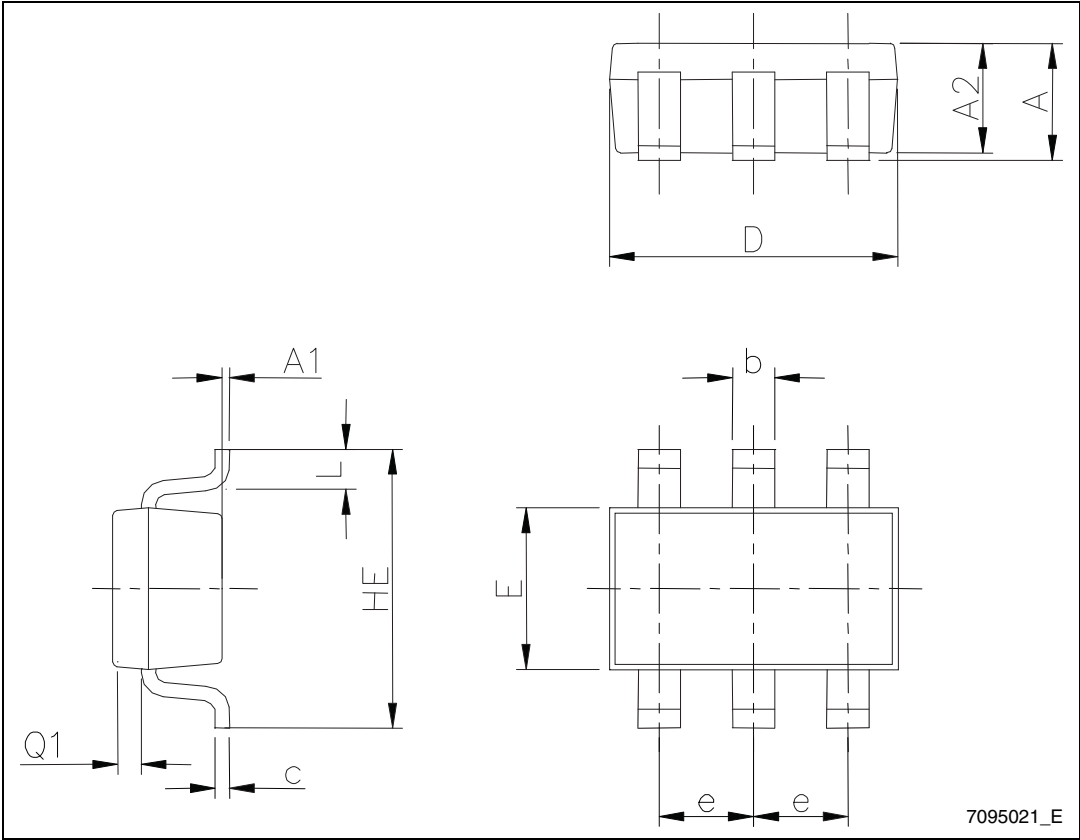


Table 12. SOT323-6L package mechanical data

| Ref. | Dimensions  |      |      |        |       |       |
|------|-------------|------|------|--------|-------|-------|
|      | Millimeters |      |      | Inches |       |       |
|      | Min.        | Typ. | Max. | Min.   | Typ.  | Max.  |
| A    | 0.80        |      | 1.10 | 0.031  |       | 0.043 |
| A1   | 0           |      | 0.10 |        |       | 0.004 |
| A2   | 0.80        |      | 1.00 | 0.031  |       | 0.039 |
| b    | 0.15        |      | 0.30 | 0.006  |       | 0.012 |
| c    | 0.10        |      | 0.18 | 0.004  |       | 0.007 |
| D    | 1.80        |      | 2.20 | 0.071  |       | 0.087 |
| E    | 1.15        |      | 1.35 | 0.045  |       | 0.053 |
| e    |             | 0.65 |      |        | 0.026 |       |
| HE   | 1.80        |      | 2.40 | 0.071  |       | 0.094 |
| L    | 0.10        |      | 0.40 | 0.004  |       | 0.016 |
| Q1   | 0.10        |      | 0.40 | 0.004  |       | 0.016 |

## 5.7 SO-8 packing information

Figure 31. SO-8 tape and reel outline

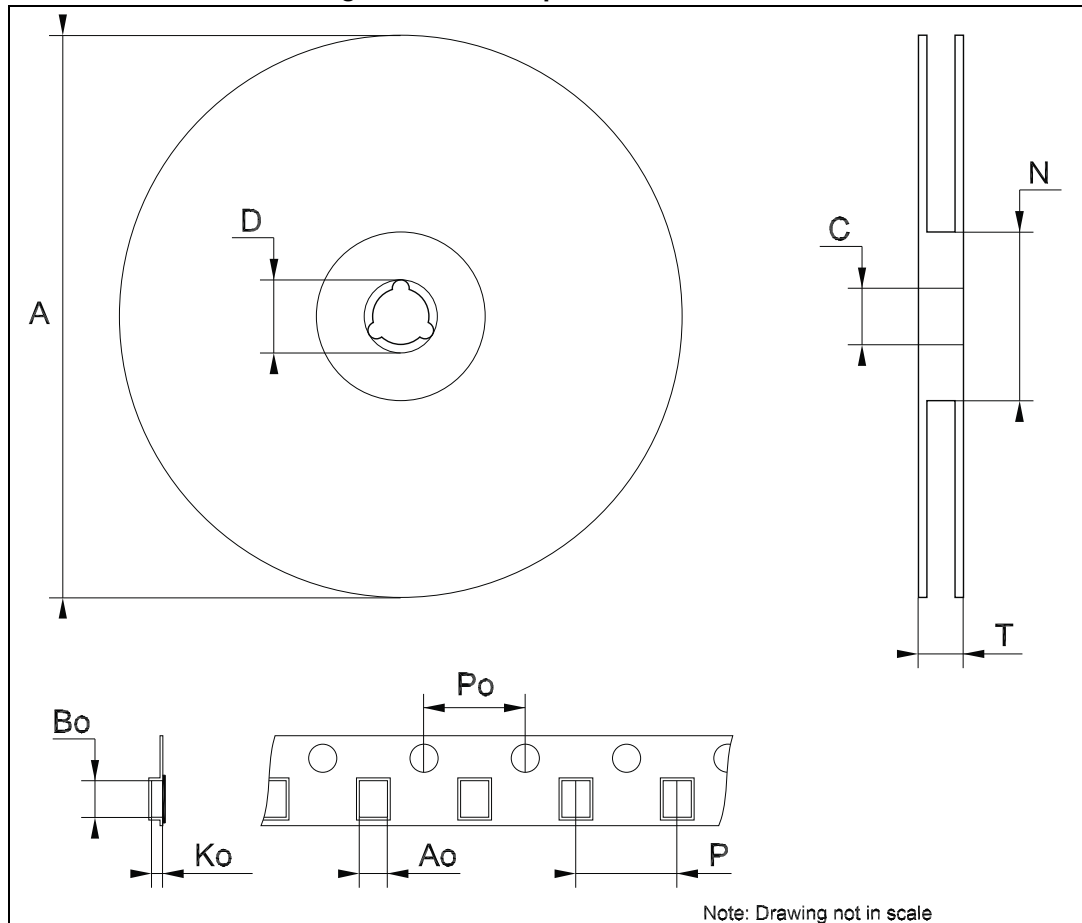
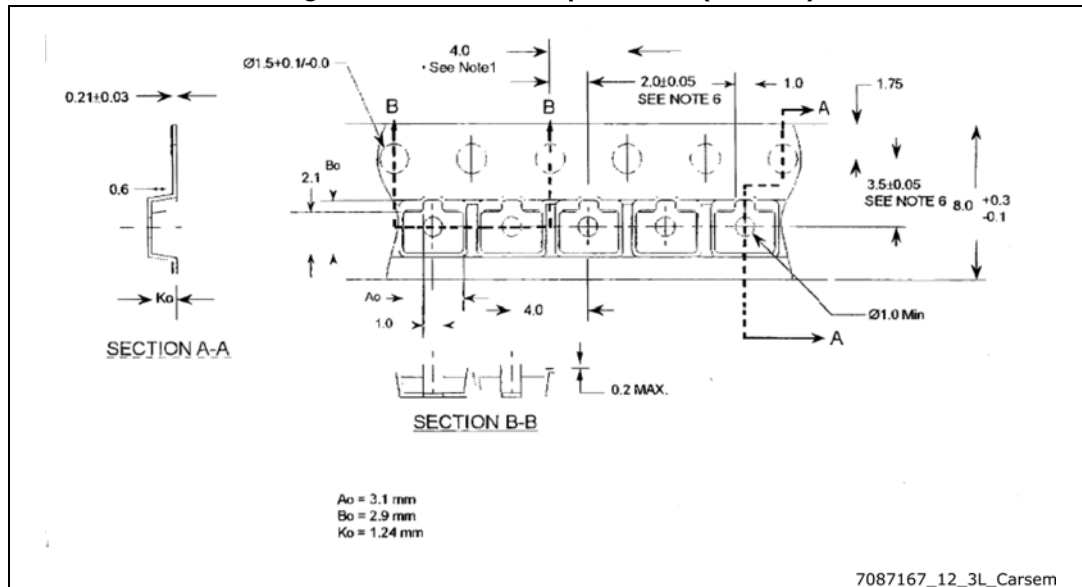


Table 13. SO-8 tape and reel mechanical data

| Dim. | mm   |      |      |
|------|------|------|------|
|      | Min. | Typ. | Max. |
| A    |      | -    | 330  |
| C    | 12.8 | -    | 13.2 |
| D    | 20.2 | -    |      |
| N    | 60   | -    |      |
| T    |      | -    | 22.4 |
| Ao   | 8.1  | -    | 8.5  |
| Bo   | 5.5  | -    | 5.9  |
| Ko   | 2.1  | -    | 2.3  |
| Po   | 3.9  | -    | 4.1  |
| P    | 7.9  | -    | 8.1  |

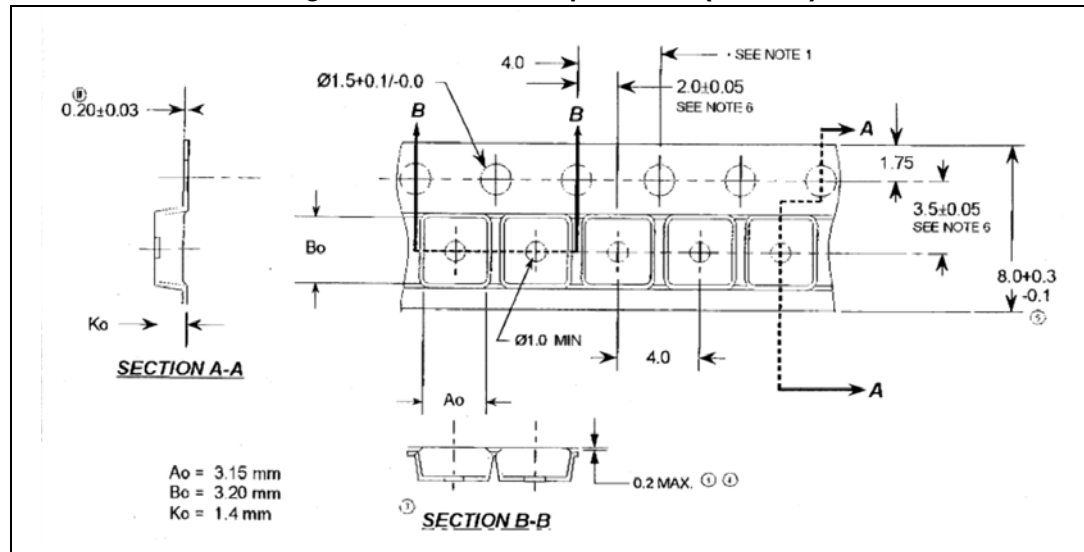
## 5.8 SOT23-3L packing information

Figure 32. SOT23-3L tape outline (Carsem)



## 5.9 SOT23-5L packing information

**Figure 33. SOT23-5L tape outline (Carsem)**



## 5.10 SOT323-6L packing information

Figure 34. SOT323-6L tape outline

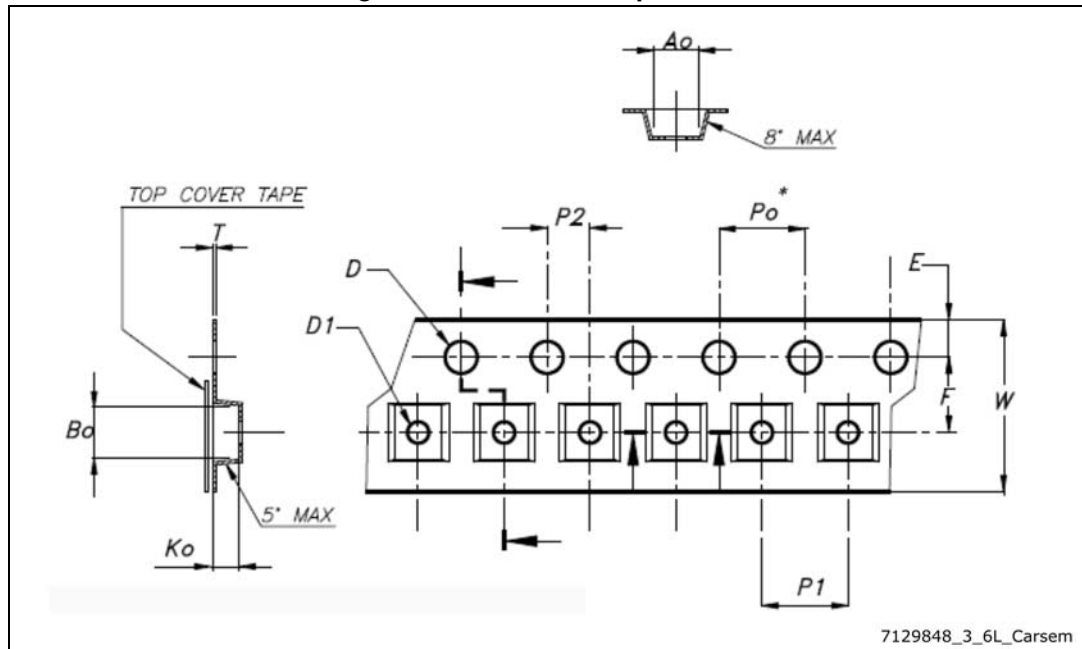


Table 14. SOT323-6L tape mechanical data

| Dim. | Value                |
|------|----------------------|
| Ao   | $2.25 \pm 0.1$       |
| Bo   | $2.4 \pm 0.1$        |
| Ko   | $1.22 \pm 0.1$       |
| F    | $3.5 \pm 0.05$       |
| E    | $1.75 \pm 0.1$       |
| W    | $8 + 0.3 / - 0.1$    |
| P2   | $2 \pm 0.05$         |
| Po   | $4 \pm 0.1$          |
| P1   | $4 \pm 0.1$          |
| T    | $0.30 \pm 0.05$      |
| D    | $\phi 1.5 + 0.1 / 0$ |
| D1   | $\phi 1 + 0.25 / 0$  |

## 6 Ordering information

Table 15. Order code

| Order code                              | Accuracy (%) | Temperature range | Package          | Packing                        | Marking       |         |
|-----------------------------------------|--------------|-------------------|------------------|--------------------------------|---------------|---------|
| TL1431CD<br>TL1431CDT                   | 0.4          | - 20 °C, +70 °C   | SO-8             | Tube or<br>tape and reel       | 1431C         |         |
| TL1431ACD<br>TL1431ACDT                 | 0.25         |                   |                  |                                | 1431AC        |         |
| TL1431CZ<br>TL1431CZT<br>TL1431CZ-AP    | 0.4          |                   | TO-92            | Bulk or<br>tape or<br>Ammopack | TL1431C       |         |
| TL1431ACZ<br>TL1431ACZT<br>TL1431ACZ-AP | 0.25         |                   |                  |                                | TL1431AC      |         |
| TL1431CL3T                              | 0.4          |                   | SOT23-3L         | Tape and reel                  | 1C            |         |
| TL1431ACL3T                             | 0.25         |                   |                  |                                | 1AC           |         |
| TL1431CL5T                              | 0.4          |                   | SOT23-5L         |                                | 1C            |         |
| TL1431ACL5T                             | 0.25         |                   |                  |                                | 1AC           |         |
| TL1431CCT                               | 0.4          |                   | SOT323-6L        |                                | 14C           |         |
| TL1431ACCT                              | 0.25         |                   |                  |                                |               |         |
| TL1431ID<br>TL1431IDT                   | 0.4          | -40 °C, + 105 °C  | SO-8             | Tube or<br>tape and reel       | 1431I         |         |
| TL1431AID<br>TL1431AIDT                 | 0.25         |                   |                  |                                | 1431AI        |         |
| TL1431IZ<br>TL1431IZT<br>TL1431IZ-AP    | 0.4          |                   | TO-92            | Bulk or<br>tape or<br>Ammopack | TL1431I       |         |
| TL1431AIZ<br>TL1431AIZT<br>TL1431AIZ-AP | 0.25         |                   |                  |                                | TL1431AI      |         |
| TL1431IYDT <sup>(1)</sup>               | 0.4          |                   | -40 °C, + 125 °C | SO-8<br>(automotive grade)     | Tape and reel | 1431IY  |
| TL1431AIYDT <sup>(1)</sup>              | 0.25         |                   |                  |                                |               | 1431AIY |

1. Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 and Q 002 or equivalent.

## 7 Revision history

**Table 16. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                 |
|-------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 01-Mar-2002 | 1        | Initial release.                                                                                                                                                                                                                                                                                                                                        |
| 01-Nov-2005 | 2        | PPAP references inserted in the datasheet see Table 13: Order code on page 25.                                                                                                                                                                                                                                                                          |
| 25-Apr-2007 | 3        | Minimum value for temperature range updated in Table 2: Operating conditions.<br>Minimum values added and maximum values deleted for $\frac{\Delta V_{ref}}{\Delta V_{ka}}$ parameter in Table 4 in Section 3: Electrical characteristics.<br>Package information for TO92 tape and reel updated, see Section 5: Package information.<br>Format update. |
| 11-Mar-2008 | 4        | Corrected SO-8 package mechanical data.<br>Corrected footnote for automotive grade order codes in order code table.<br>Corrected packing information for TO92 devices in order code table.                                                                                                                                                              |
| 11-Sep-2012 | 5        | Added: feature Automotive temp. range - 40 °C to +125 °C on page 1.<br>Updated: Table 14 on page 25.                                                                                                                                                                                                                                                    |
| 01-Oct-2014 | 6        | Updated Section 5: Package information.<br>Minor text changes.                                                                                                                                                                                                                                                                                          |
| 20-Nov-2015 | 7        | Added SOT23-3L, SOT23-5L and SOT323-6L packages.<br>Updated <i>Section 1: Schematic diagrams</i> , <i>Section 2: Absolute maximum ratings and operating conditions</i> , <i>Section 5: Package information</i> and <i>Section 6: Ordering information</i> .<br>Minor text changes.                                                                      |
| 30-Aug-2017 | 8        | Added Table 3: Thermal data.<br>Minor text changes.                                                                                                                                                                                                                                                                                                     |
| 06-Dec-2017 | 9        | Updated title on the cover page.                                                                                                                                                                                                                                                                                                                        |

**IMPORTANT NOTICE – PLEASE READ CAREFULLY**

STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST's terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers' products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2017 STMicroelectronics – All rights reserved

Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения «JONHON», а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов «FORSTAR».



## JONHON

«JONHON» (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели,  
кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



Телефон: 8 (812) 309-75-97 (многоканальный)

Факс: 8 (812) 320-03-32

Электронная почта: [ocean@oceanchips.ru](mailto:ocean@oceanchips.ru)

Web: <http://oceanchips.ru/>

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, д. 2, корп. 4, лит. А