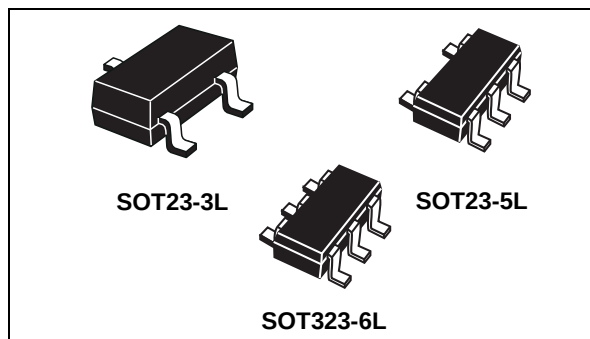


## Programmable shunt voltage reference

Datasheet - production data



### Features

- Adjustable output voltage: 1.24 V to 18 V
- Low operating current: 100  $\mu$ A at 25  $^{\circ}$ C
- 0.25%, 0.5%, 1% and 1.5% voltage precision
- Sink current capability up to 60 mA
- -40 to +125  $^{\circ}$ C temperature range
- 100 ppm/ $^{\circ}$ C maximum temperature coefficient
- Available in SOT23-3L, SOT23-5L and SOT323-6L packages

### Applications

- Computers

- Battery chargers
- Switch mode power supplies
- Battery operated equipment
- Data acquisition systems
- Energy management

### Description

The TLVH431 is a low power programmable shunt voltage reference, with guaranteed temperature stability over the entire operating temperature range.

The output voltage may be set to any value between 1.24 V and 18 V by means of an external resistor divider.

The TLVH431 operates with a wide current range from 100  $\mu$ A to 60 mA with a typical dynamic impedance of 0.22  $\Omega$ .

Available in SOT23-3L, SOT23-5L and SOT323-6L surface mounted packages, it can be designed in applications where space saving is a critical issue.

The low operating current is a key advantage for power restricted designs.

Table 1. Device summary

| Part number  | Precision | Package   | Temperature range |
|--------------|-----------|-----------|-------------------|
| TLVH431AIL3T | 0.5%      | SOT23-3L  | -40 to +125°C     |
| TLVH431BIL3T | 0.25%     |           |                   |
| TLVH431MIL3T | 1%        |           |                   |
| TLVH431LIL3T | 1.5%      |           |                   |
| TLVH431AIL5T | 0.5%      | SOT23-5L  |                   |
| TLVH431BIL5T | 0.25%     |           |                   |
| TLVH431LIL5T | 1.5%      |           |                   |
| TLVH431AICT  | 0.5%      | SOT323-6L |                   |
| TLVH431BICT  | 0.25%     |           |                   |
| TLVH431LICT  | 1.5%      |           |                   |

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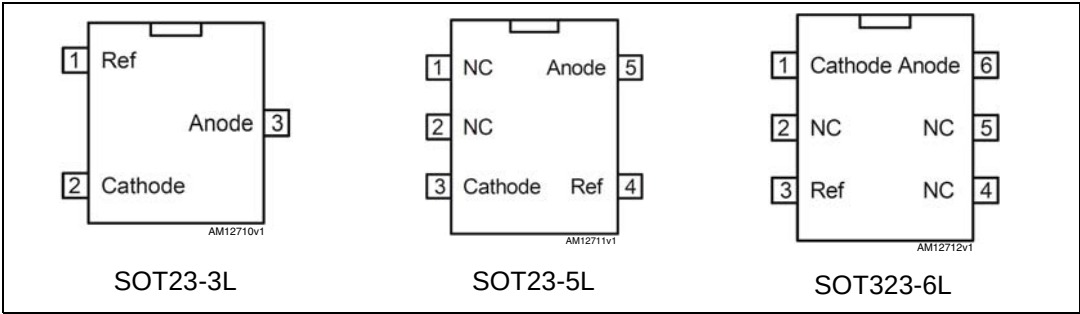
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1 Pin configuration

Figure 1. Pin configuration (top view)



## 2 Maximum ratings

**Table 2. Absolute maximum ratings**

| Symbol     | Parameter                           | Value         | Unit |
|------------|-------------------------------------|---------------|------|
| $V_{KA}$   | Cathode to anode voltage            | 22            | V    |
| $I_K$      | Continuous cathode current range    | - 100 to +100 | mA   |
| $I_{REF}$  | Reference input current range       | - 0.05 to +3  | mA   |
| $T_{STG}$  | Storage temperature                 | - 65 to +150  | °C   |
| ESD        | Human body model (HBM)              | 2             | kV   |
|            | Machine model (MM)                  | 200           | V    |
|            | Charged device model                | 1500          | V    |
| $T_{LEAD}$ | Lead temperature (soldering) 10 sec | 260           | °C   |
| $T_J$      | Max. junction temperature           | +150          | °C   |

*Note: Absolute maximum ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied.*

**Table 3. Thermal data**

| Symbol     | Parameter                           | SOT323-6L | SOT23-3L | SOT23-5L | Unit |
|------------|-------------------------------------|-----------|----------|----------|------|
| $R_{thJA}$ | Thermal resistance junction-ambient | 221       | 248      | 157      | °C/W |
| $R_{thJC}$ | Thermal resistance junction-case    | 110       | 136      | 67       | °C/W |

**Table 4. Operating conditions**

| Symbol     | Parameter                            | Value           | Unit |
|------------|--------------------------------------|-----------------|------|
| $V_{KA}$   | Cathode to anode voltage             | $V_{ref}$ to 18 | V    |
| $I_{kmin}$ | Minimum operating current            | 100             | μA   |
| $I_{kmax}$ | Maximum operating current            | 60              | mA   |
| $T_{oper}$ | Operating free air temperature range | -40 to +125     | °C   |

### 3 Electrical characteristics

$I_K = 10 \text{ mA}$ ,  $T_{\text{amb}} = 25 \text{ }^{\circ}\text{C}$  (unless otherwise specified).

**Table 5. Electrical characteristics for TLVH431**

| Symbol                                        | Parameter                                                                        | Test conditions                                                                                                                             | Min.                             | Typ.     | Max.                             | Unit                    |
|-----------------------------------------------|----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|----------|----------------------------------|-------------------------|
| $V_{\text{ref}}$                              | Reference voltage                                                                | $V_{KA} = V_{\text{ref}}$<br>TLVH431A 0.5%<br>TLVH431B 0.25%<br>TLVH431M 1%<br>TLVH431L 1.5%                                                | 1.234<br>1.237<br>1.227<br>1.222 | 1.24     | 1.246<br>1.243<br>1.253<br>1.258 | V                       |
| $\Delta V_{\text{ref}}$                       | Reference voltage variation over temperature range <sup>(1)</sup>                | - 40 $^{\circ}\text{C} < T_{\text{amb}} < +125 \text{ }^{\circ}\text{C}$<br>TLVH431A 0.5%<br>TLVH431B 0.25%<br>TLVH431M 1%<br>TLVH431L 1.5% | -26.7<br>-23.5<br>-32.8<br>-39   |          | +26.7<br>+23.5<br>+32.8<br>+39   | mV                      |
| $\Delta V_{KA}/\Delta T$                      | Average temperature coefficient                                                  | $V_{KA} = V_{\text{ref}}$ , - 40 $^{\circ}\text{C} < T_{\text{amb}} < +125 \text{ }^{\circ}\text{C}$                                        |                                  | $\pm 30$ | $\pm 100$                        | ppm/ $^{\circ}\text{C}$ |
| $I_{K\text{min}}$                             | Minimum cathode current for regulation                                           | $V_{KA} = V_{\text{ref}}$                                                                                                                   |                                  | 60       | 100                              | $\mu\text{A}$           |
|                                               |                                                                                  | $V_{KA} = V_{KA\text{max}}$                                                                                                                 |                                  | 160      | 200                              |                         |
| $\Delta I_{K\text{min}}$                      | Minimum cathode current variation over temperature range                         | $V_{KA} = V_{\text{ref}}$ , - 40 $^{\circ}\text{C} < T_{\text{amb}} < +125 \text{ }^{\circ}\text{C}$                                        |                                  | 70       | 100                              | $\mu\text{A}$           |
|                                               |                                                                                  | $V_{KA} = V_{KA\text{max}}$ , - 40 $^{\circ}\text{C} < T_{\text{amb}} < +125 \text{ }^{\circ}\text{C}$                                      |                                  | 100      | 200                              |                         |
| $I_{\text{ref}}$                              | Reference input current                                                          | $R_1 = 10 \text{ k}\Omega$ , $R_2 = \infty$                                                                                                 |                                  | 1.5      | 2.5                              | $\mu\text{A}$           |
| $\Delta I_{\text{ref}}$                       | Reference current variation over temperature range                               | $R_1 = 10 \text{ k}\Omega$ , $R_2 = \infty$<br>- 40 $^{\circ}\text{C} < T_{\text{amb}} < +125 \text{ }^{\circ}\text{C}$                     |                                  | 2.5      | 3.5                              | $\mu\text{A}$           |
| $\frac{\Delta V_{\text{ref}}}{\Delta V_{KA}}$ | Ratio of change in reference input voltage to change in cathode to anode voltage | $\Delta V_{KA} = 18 \text{ V to } V_{\text{ref}}$                                                                                           |                                  |          | -2                               | mV/V                    |
|                                               |                                                                                  | $\Delta V_{KA} = 18 \text{ V to } V_{\text{ref}}$ , - 40 $^{\circ}\text{C} < T_{\text{amb}} < +125 \text{ }^{\circ}\text{C}$                |                                  |          | -2.5                             |                         |
| $I_{\text{off}}$                              | Off-state cathode current                                                        | $V_{KA} = V_{KA\text{max}}$ , $V_{\text{ref}} = \text{GND}$                                                                                 |                                  | 10       | 80                               | nA                      |
| $\Delta I_{\text{off}}$                       | Off-state cathode current over temperature range                                 | $V_{KA} = V_{KA\text{max}}$ , $V_{\text{ref}} = \text{GND}$<br>- 40 $^{\circ}\text{C} < T_{\text{amb}} < +125 \text{ }^{\circ}\text{C}$     |                                  | 1000     | 2000                             | nA                      |
| $ R_{KA} $                                    | Static impedance                                                                 | $V_{KA} = V_{\text{ref}}$ , $\Delta I_K = 100 \text{ } \mu\text{A to } 60 \text{ mA}$                                                       |                                  | 0.14     | 0.62                             | W                       |
| $ Z_{KA} $                                    | Dynamic impedance <sup>(2)</sup>                                                 | $V_{KA} = V_{\text{ref}}$ , $\Delta I_K = 10 \text{ mA to } 60 \text{ mA}$ , $f \leq 1 \text{ kHz}$                                         |                                  | 0.22     | 0.85                             | W                       |
| $e_n$                                         | Wide band noise                                                                  | $I_K = 10 \text{ mA}$ ; $10 \text{ Hz} < f < 100 \text{ kHz}$                                                                               |                                  | 30       |                                  | mV <sub>RMS</sub>       |
| $T_{\text{ON}}$                               | Turn-on setting time                                                             | $V_{KA} = V_{\text{ref}}$ , $\Delta I_K = 10 \text{ mA}$                                                                                    |                                  | 40       | 70                               | $\mu\text{sec}$         |

1. The tolerance values, across the temperature range, are calculated as:  $\pm V_{K25^{\circ}\text{C}} \times \{\text{tolerance}_{25^{\circ}\text{C}} + [(\text{ppm}_{\text{max}}/^{\circ}\text{C}) \times (\Delta T)]\}$ .  
Example: TLVH431A  $\Delta V_K = \pm 1.24 \times (0.5\% + 100 \text{ ppm}/^{\circ}\text{C} \times 165^{\circ}\text{C}) = \pm 1.24 \times (0.5\% + 1.65\%) = \pm 1.24 \times 2.15\% = \pm 26.7 \text{ mV}$ .

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

**Note:** Limits are 100% production tested at 25  $^{\circ}\text{C}$ . Limits over the temperature range are guaranteed through correlation and by design.

# 4 Typical performance characteristics

The following plots are referred to the typical application circuit and, unless otherwise noted, at  $T_A = 25\text{ }^{\circ}\text{C}$ .

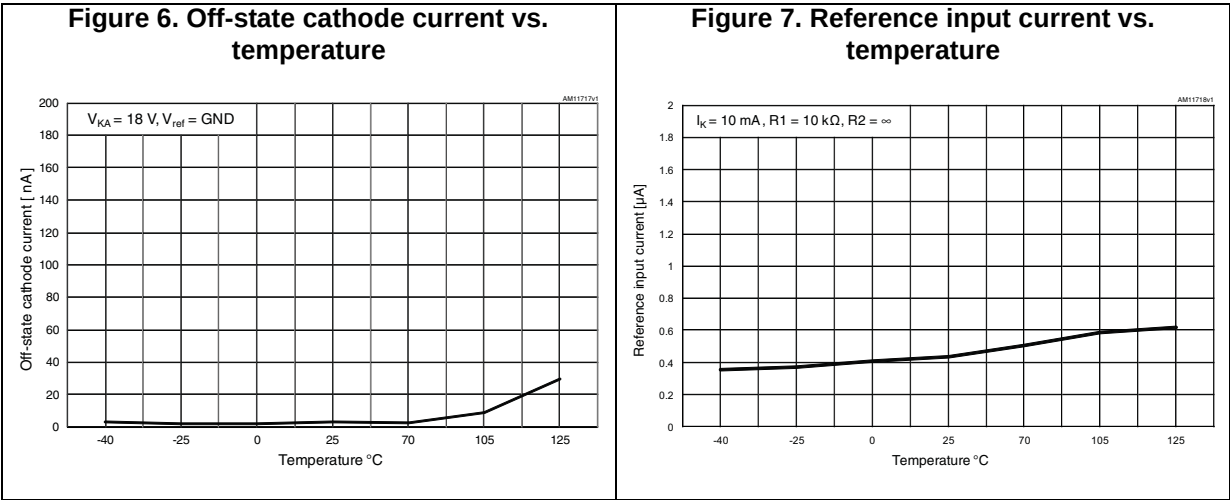
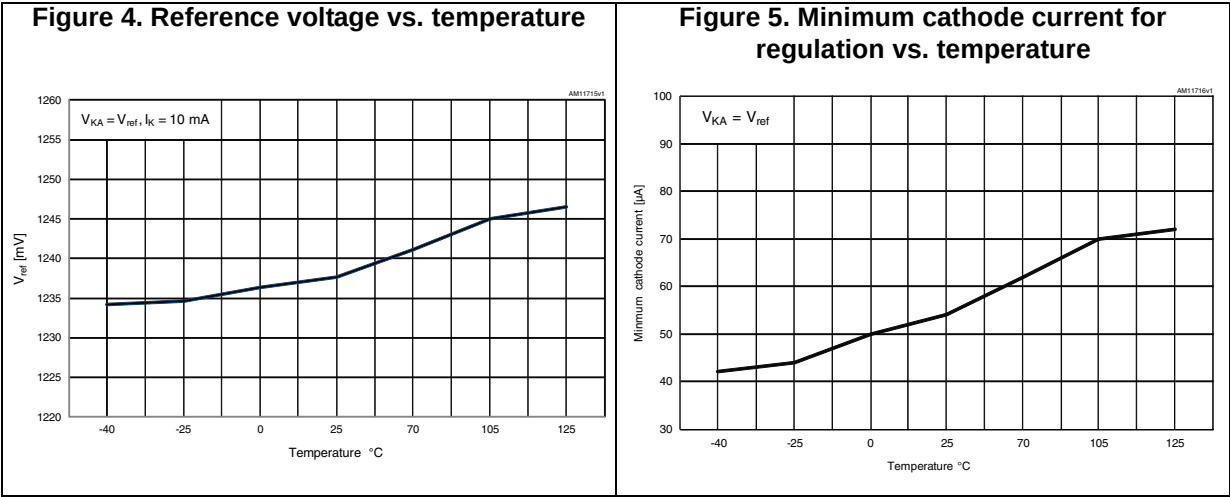
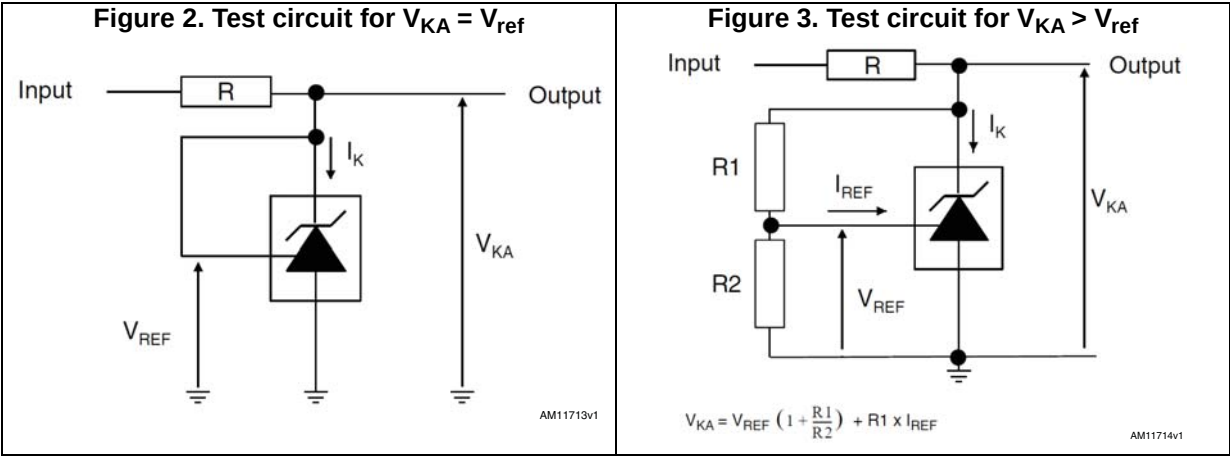


Figure 8. Cathode current vs. cathode voltage

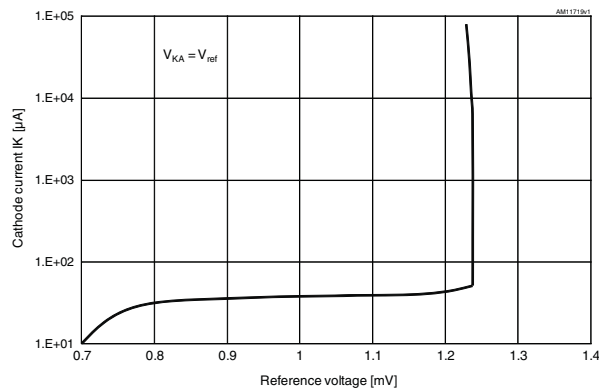
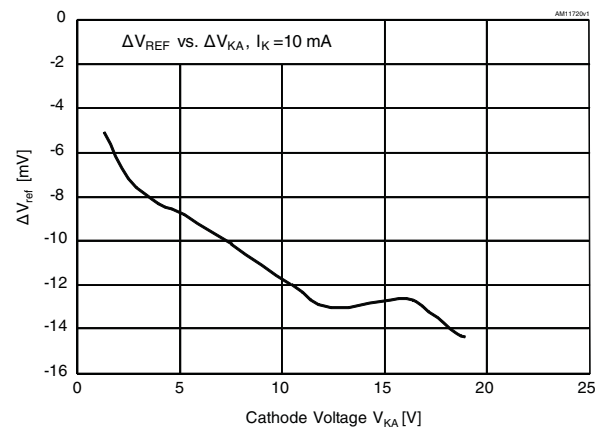
Figure 9.  $\Delta V_{ref}$  vs.  $\Delta V_{KA}$ 

Figure 10. Wideband noise

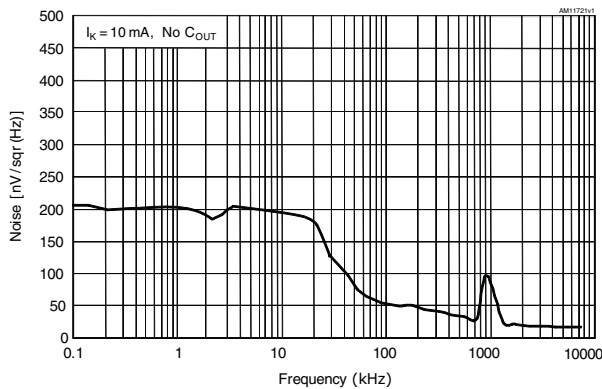
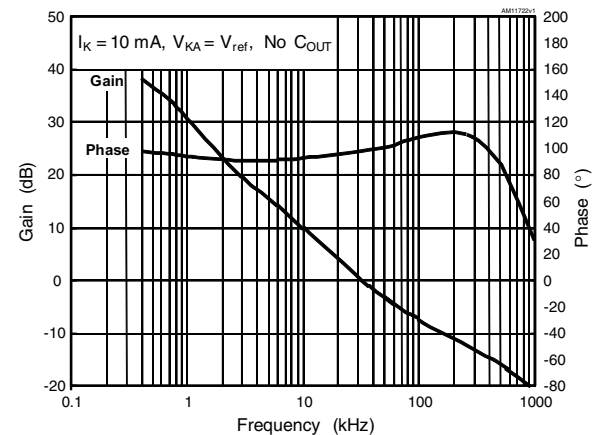
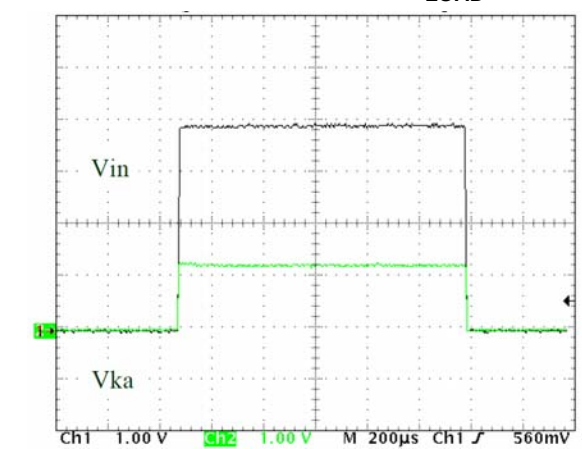
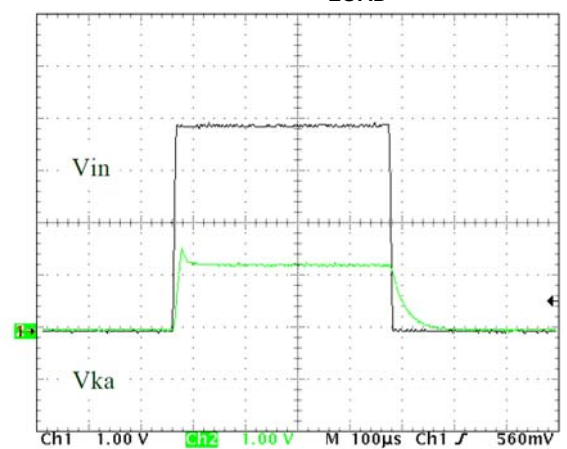


Figure 11. Gain and phase vs. frequency

Figure 12. Turn-on (no  $C_{LOAD}$ )

$V_{IN}$  from 0 to 4 V,  $I_K = 1 \text{ mA}$ , no  $C_{LOAD}$

Figure 13. Turn-on ( $C_{LOAD} = 10 \text{ nF}$ )

$V_{IN}$  from 0 to 4 V,  $I_K = 1 \text{ mA}$ ,  $C_{LOAD} = 10 \text{ nF}$

## 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 SOT23-3L package information

Figure 14. SOT23-3L package outline

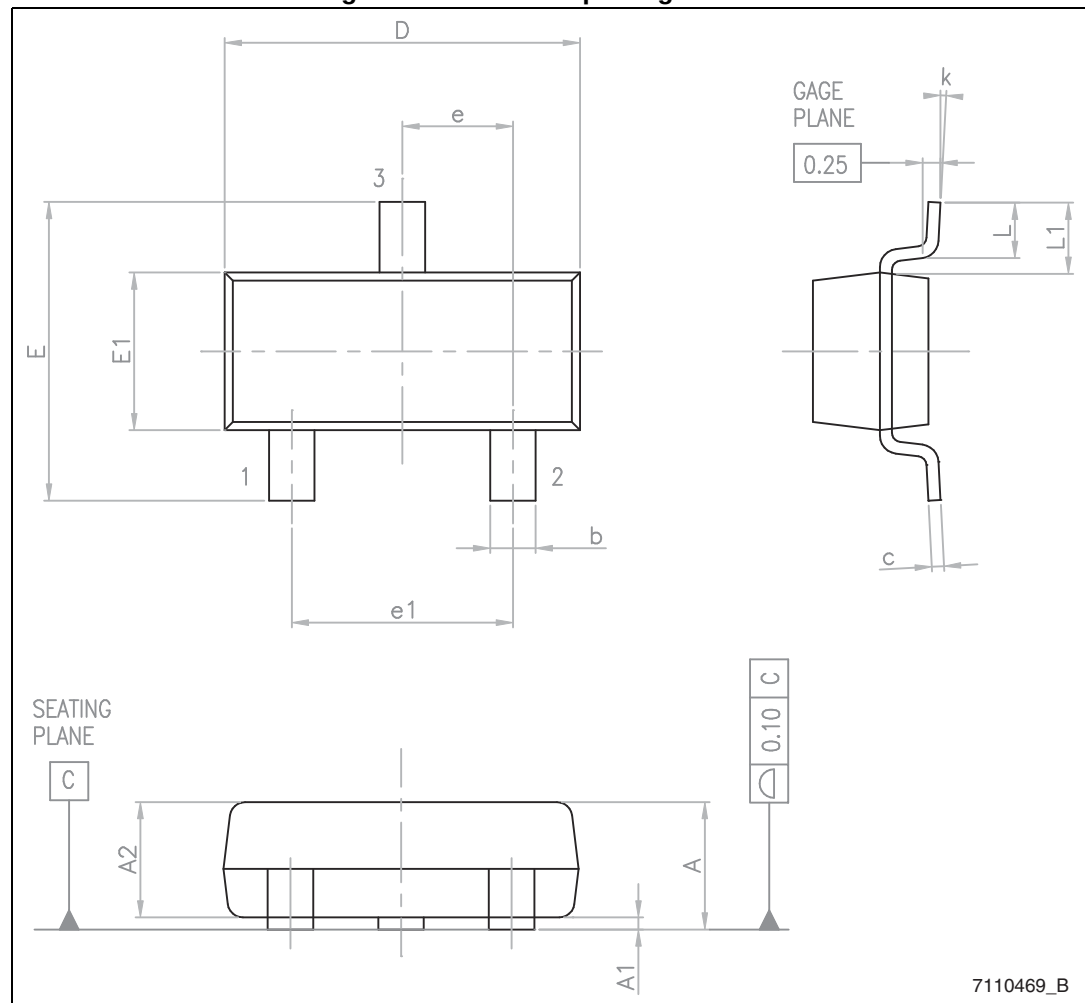


Table 6. SOT23-3L mechanical data

| Dim. | mm   |      |      |
|------|------|------|------|
|      | Min. | Typ. | Max. |
| A    | 0.89 |      | 1.12 |
| A1   | 0.01 |      | 0.10 |
| A2   | 0.88 | 0.95 | 1.02 |
| b    | 0.30 |      | 0.50 |
| c    | 0.08 |      | 0.20 |
| D    | 2.80 | 2.90 | 3.04 |
| E    | 2.10 |      | 2.64 |
| E1   | 1.20 | 1.30 | 1.40 |
| e    |      | 0.95 |      |
| e1   |      | 1.90 |      |
| L    | 0.40 | 0.50 | 0.60 |
| L1   |      | 0.54 |      |
| k    | 0°   |      | 8°   |

## 5.2 SOT23-5L package information

Figure 15. SOT23-5L package outline

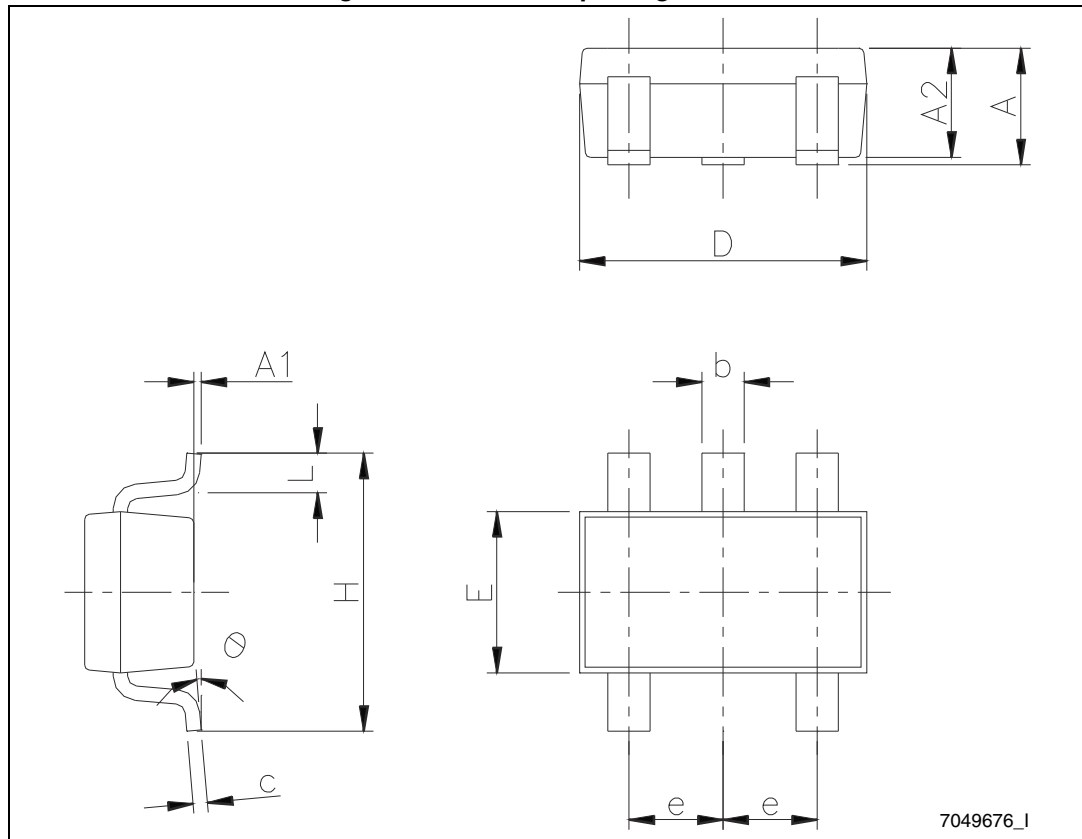
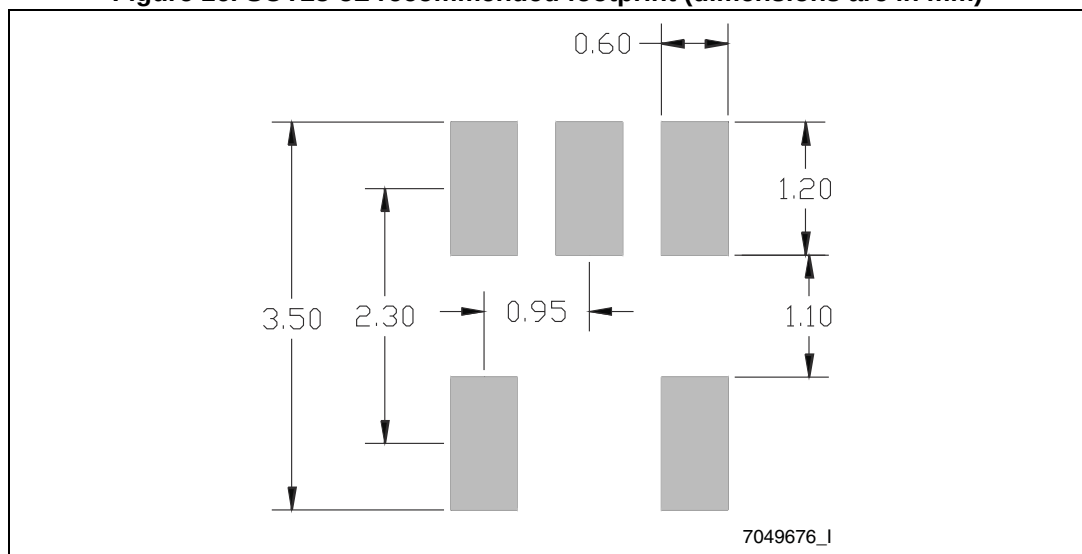


Table 7. SOT23-5L mechanical data

| Dim.     | mm   |      |      |
|----------|------|------|------|
|          | Min. | Typ. | Max. |
| A        | 0.90 | 1.20 | 1.45 |
| A1       |      |      | 0.15 |
| A2       | 0.90 | 1.05 | 1.30 |
| b        | 0.35 | 0.40 | 0.50 |
| c        | 0.09 | 0.15 | 0.20 |
| D        | 2.80 | 2.90 | 3.00 |
| e        |      | 0.95 |      |
| E        | 1.50 | 1.60 | 1.75 |
| H        | 2.60 | 2.80 | 3.00 |
| L        | 0.10 | 0.35 | 0.60 |
| $\theta$ | 0°   |      | 10°  |

Figure 16. SOT23-5L recommended footprint (dimensions are in mm)



### 5.3 SOT323-6L package information

Figure 17. SOT323-6L package outline

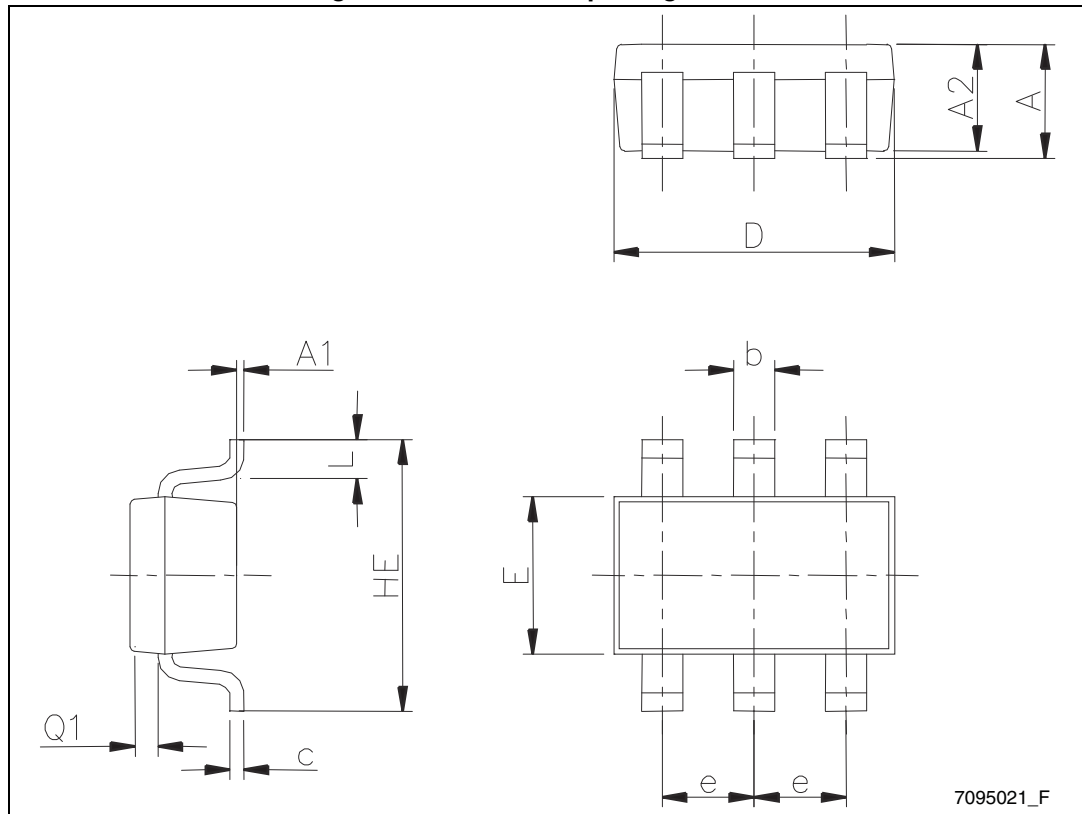
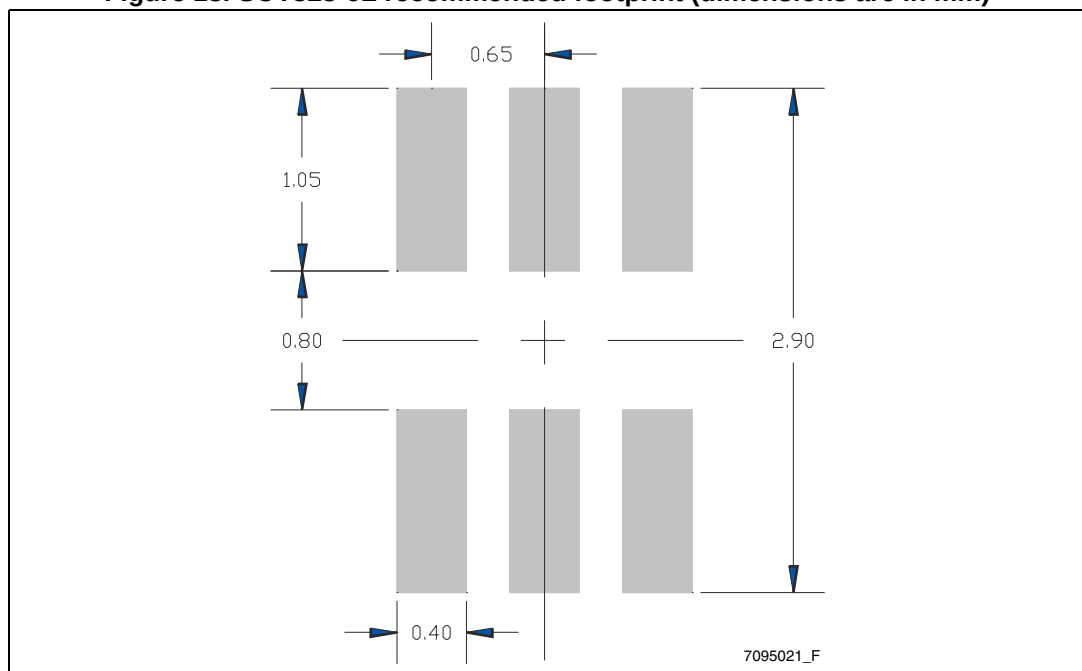


Table 8. SOT323-6L mechanical data

| Dim. | mm   |      |      |
|------|------|------|------|
|      | Min. | Typ. | Max. |
| A    | 0.80 |      | 1.10 |
| A1   | 0    |      | 0.10 |
| A2   | 0.80 |      | 1.00 |
| b    | 0.15 |      | 0.30 |
| c    | 0.10 |      | 0.18 |
| D    | 1.80 |      | 2.20 |
| E    | 1.15 |      | 1.35 |
| e    |      | 0.65 |      |
| HE   | 1.80 |      | 2.40 |
| L    | 0.10 |      | 0.40 |
| Q1   | 0.10 |      | 0.40 |

Figure 18. SOT323-6L recommended footprint (dimensions are in mm)



## 6 Revision History

**Table 9. Document revision history**

| Date        | Revision | Changes                                                                                                                                                              |
|-------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 13-Jun-2012 | 1        | Initial release.                                                                                                                                                     |
| 23-Jan-2014 | 2        | Updated the Features in cover page, Table 1: Device summary and Table 5: Electrical characteristics for TLVH431.<br>Minor text changes.                              |
| 28-Jan-2014 | 3        | Updated the min. value of Vref in Table 5: Electrical characteristics for TLVH431.                                                                                   |
| 24-Mar-2015 | 4        | Updated Table 7: SOT23-5L mechanical data.<br>Minor text changes.                                                                                                    |
| 23-Nov-2015 | 5        | Updated features in cover page, <a href="#">Table 1: Device summary</a> and <a href="#">Table 5: Electrical characteristics for TLVH431</a> .<br>Minor text changes. |

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