

## Programmable shunt voltage reference

Datasheet –production data

### Features

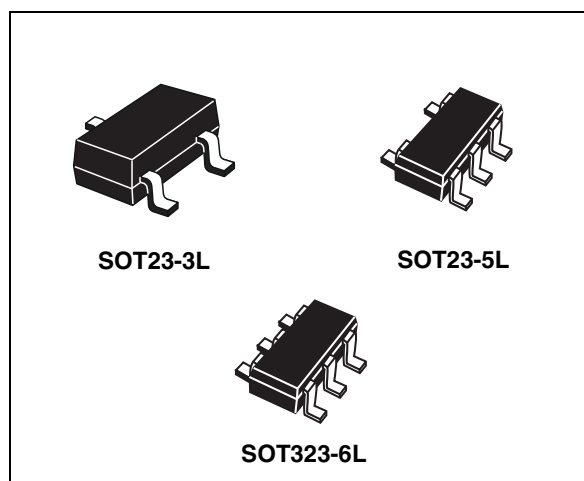
- Adjustable output voltage: 1.24 V to 18 V
- Low operating current: 100  $\mu$ A at 25 °C
- 0.25% and 0.5% voltage precision
- Sink current capability up to 60 mA
- -40 to +125 °C temperature range
- 100 ppm/°C maximum temperature coefficient
- Available in SOT23-3L, SOT23-5L and SOT323-6L packages

### 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%     |           |                   |
| TLVH431AIL5T | 0.5%      | SOT23-5L  |                   |
| TLVH431BIL5T | 0.25%     |           |                   |
| TLVH431AICT  | 0.5%      | SOT323-6L |                   |
| TLVH431BICT  | 0.25%     |           |                   |

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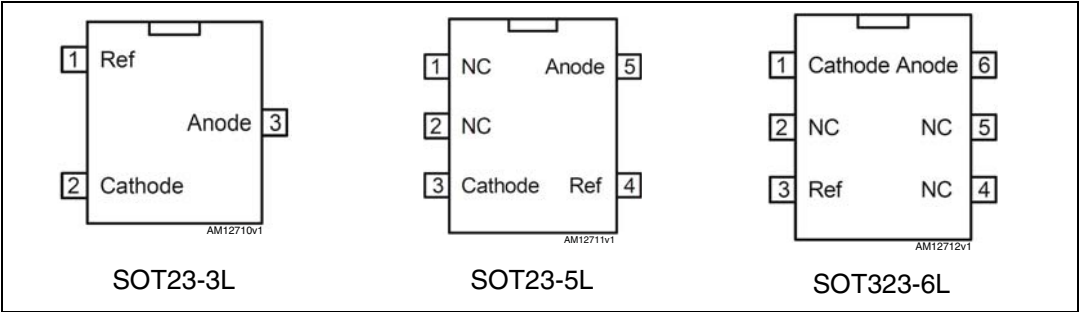
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# 1 Pin configuration

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%                                                                            | 1.234<br>1.237 | 1.24     | 1.246<br>1.243 | V                       |
| $\Delta V_{\text{ref}}$                       | Reference voltage variation overtemperature range <sup>(1)</sup>                 | - 40 $^{\circ}\text{C} < T_{\text{amb}} < +125 \text{ }^{\circ}\text{C}$<br>TLVH431A 0.5%<br>TLVH431B 0.25%                             | -26.7<br>-23.5 |          | +26.7<br>+23.5 | 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 overtemperature 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 overtemperature 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 $V_{\text{ref}}$<br>- 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 overtemperature 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 mA                                                            |                | 0.14     | 0.62           | $\Omega$                |
| $ Z_{KA} $                                    | Dynamic impedance <sup>(2)</sup>                                                 | $V_{KA} = V_{\text{ref}}$ , $\Delta I_K = 10 \text{ mA}$ to 60 mA,<br>$f \leq 1 \text{ kHz}$                                            |                | 0.22     | 0.85           | $\Omega$                |
| $e_n$                                         | Wide band noise                                                                  | $I_K = 10 \text{ mA}$ ; 10 Hz < $f$ < 100 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 overtemperature tolerance values 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 2. Test circuit for  $V_{KA} = V_{ref}$

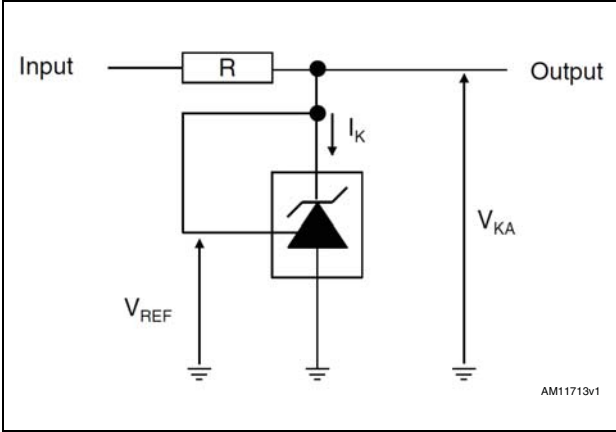


Figure 3. Test circuit for  $V_{KA} > V_{ref}$

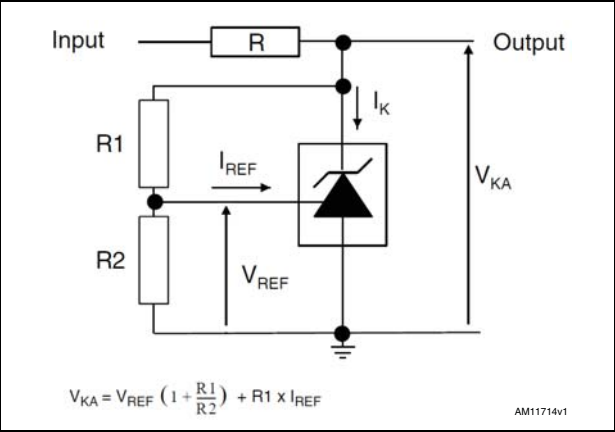


Figure 4. Reference voltage vs. temperature

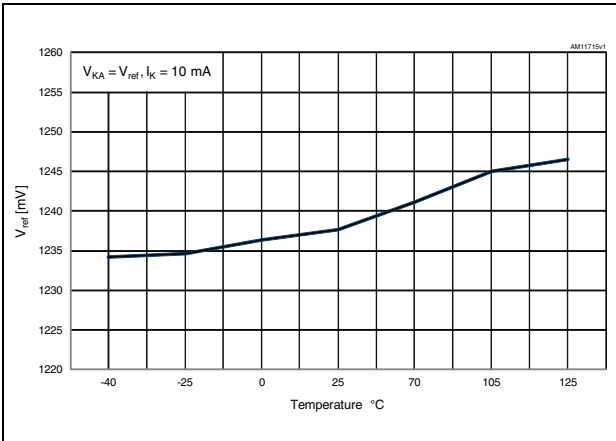


Figure 5. Minimum cathode current for regulation vs. temperature

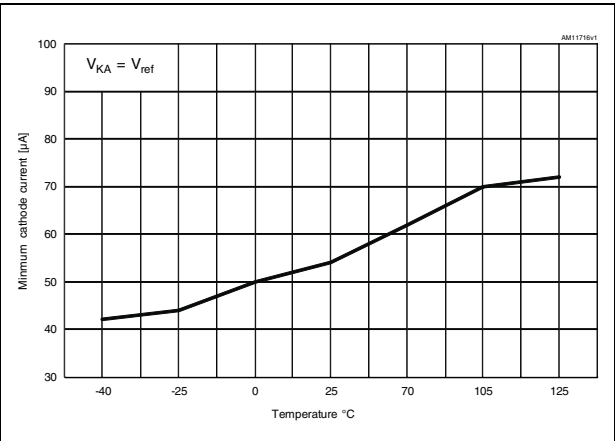


Figure 6. Off-state cathode current vs. temperature

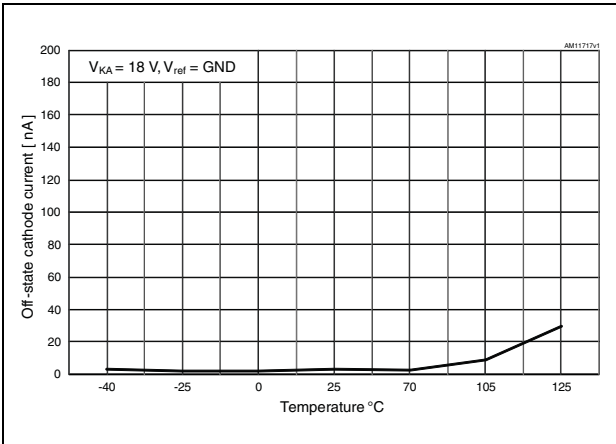
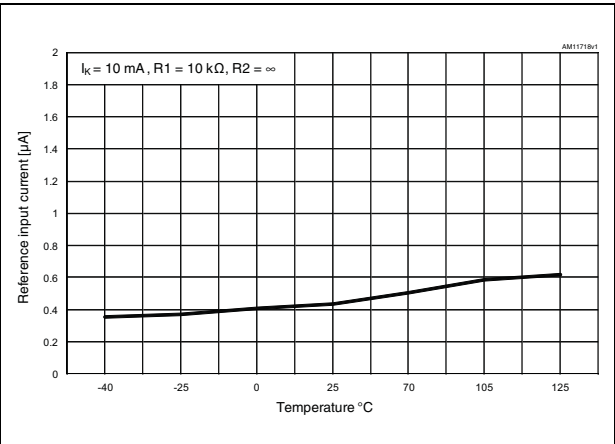
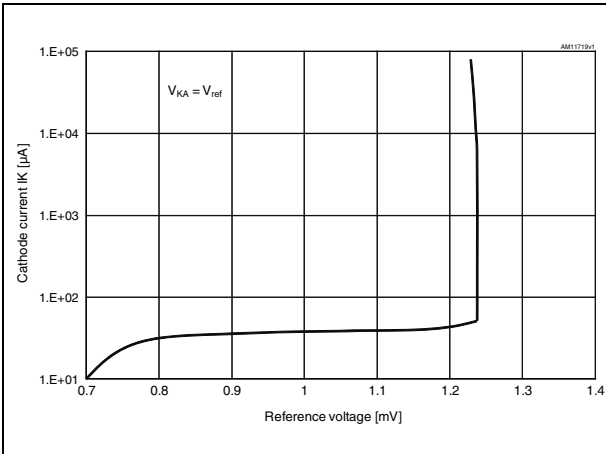


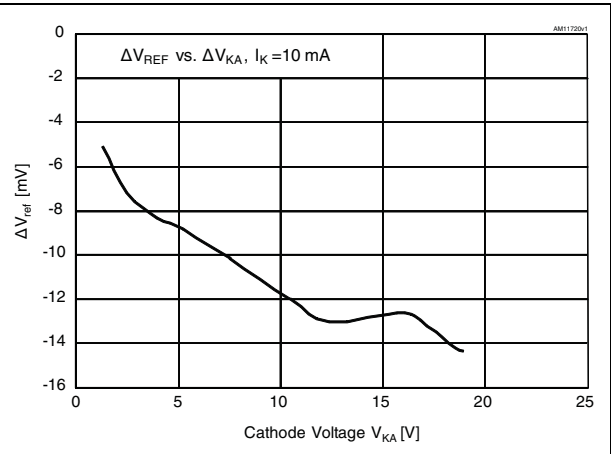
Figure 7. Reference input current vs. temperature



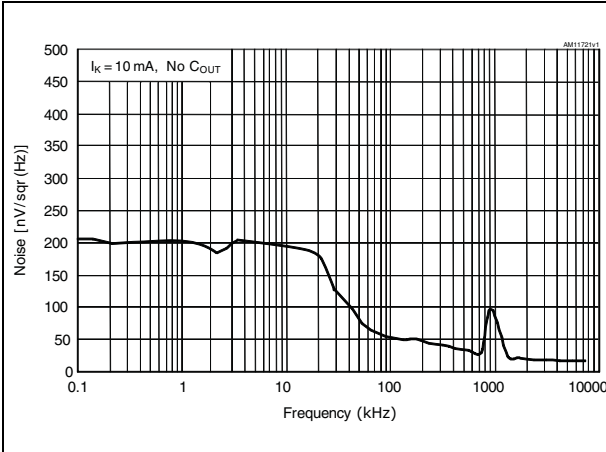
**Figure 8. Cathode current vs. cathode voltage**



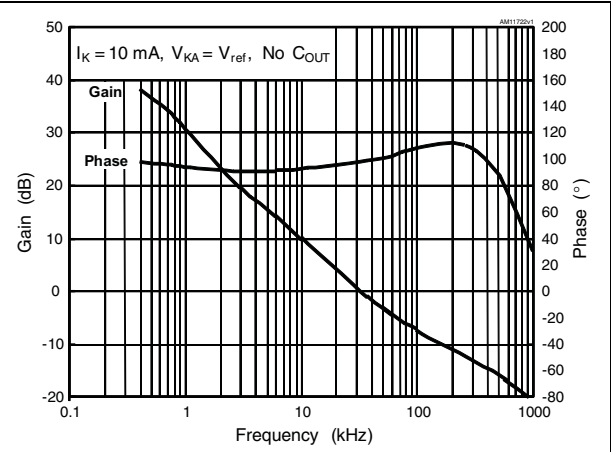
**Figure 9.  $\Delta V_{ref}$  vs.  $\Delta V_{KA}$**



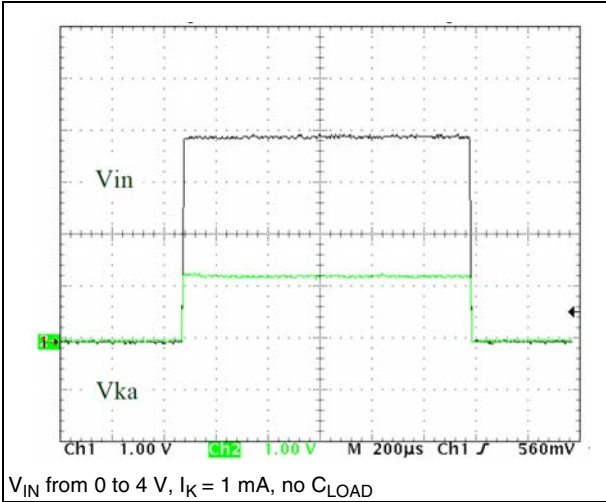
**Figure 10. Wideband noise**



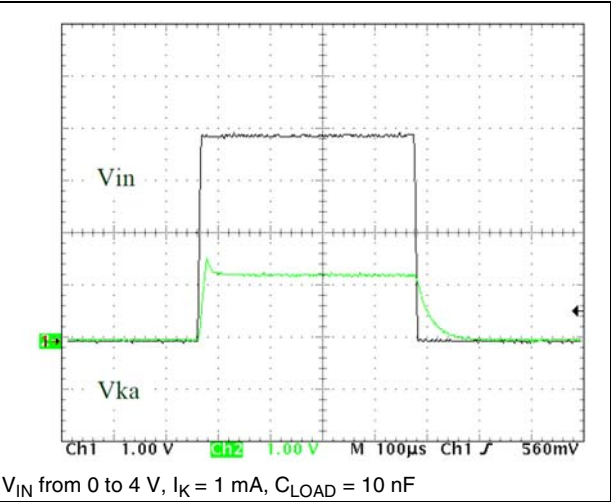
**Figure 11. Gain and phase vs. frequency**



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



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



## 5 Package mechanical data

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.

**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°   |

Figure 14. SOT23-3L drawing dimensions

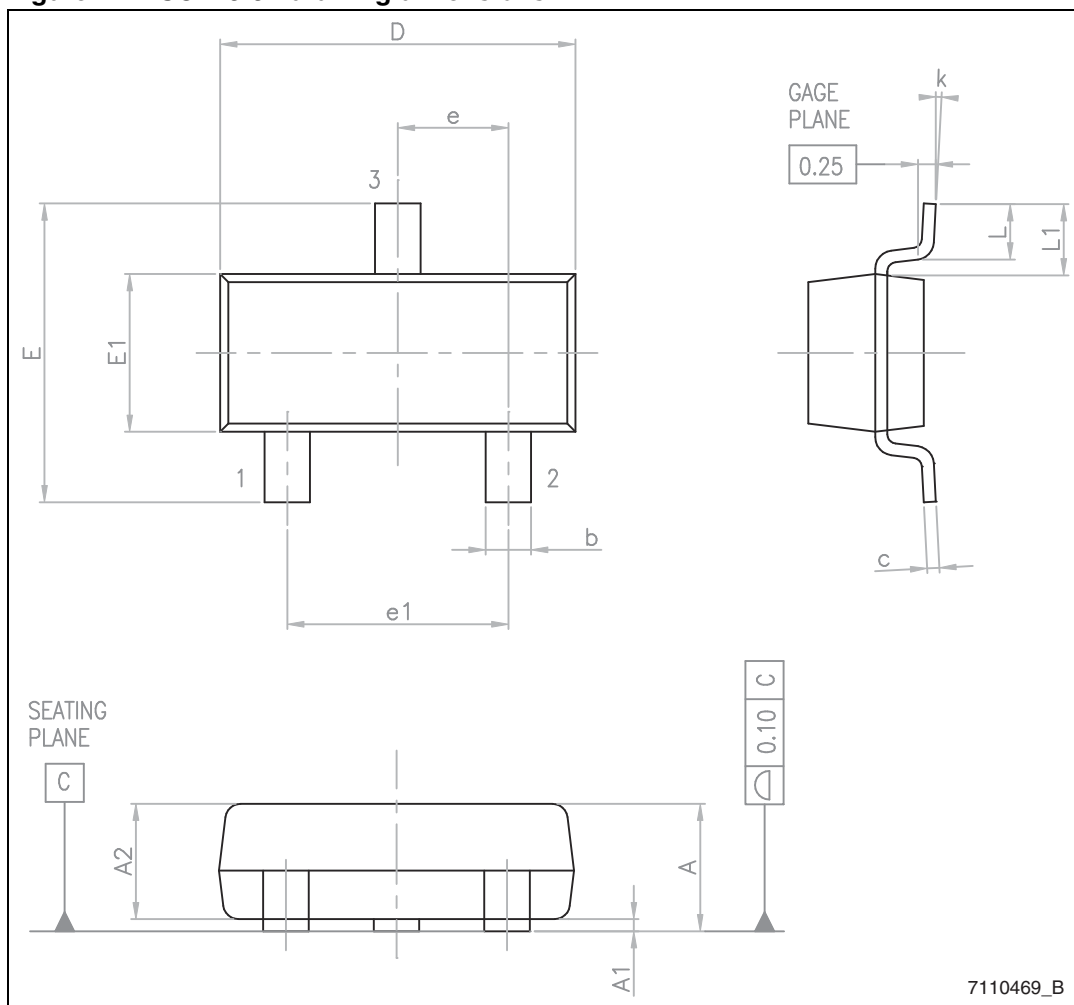


Table 7. SOT23-5L mechanical data

| 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 |
| D1   |      | 1.90 |      |
| e    |      | 0.95 |      |
| E    | 2.60 | 2.80 | 3.00 |
| F    | 1.50 | 1.60 | 1.75 |
| L    | 0.10 | 0.35 | 0.60 |
| K    | 0°   |      | 10°  |

Figure 15. SOT23-5L drawing dimensions

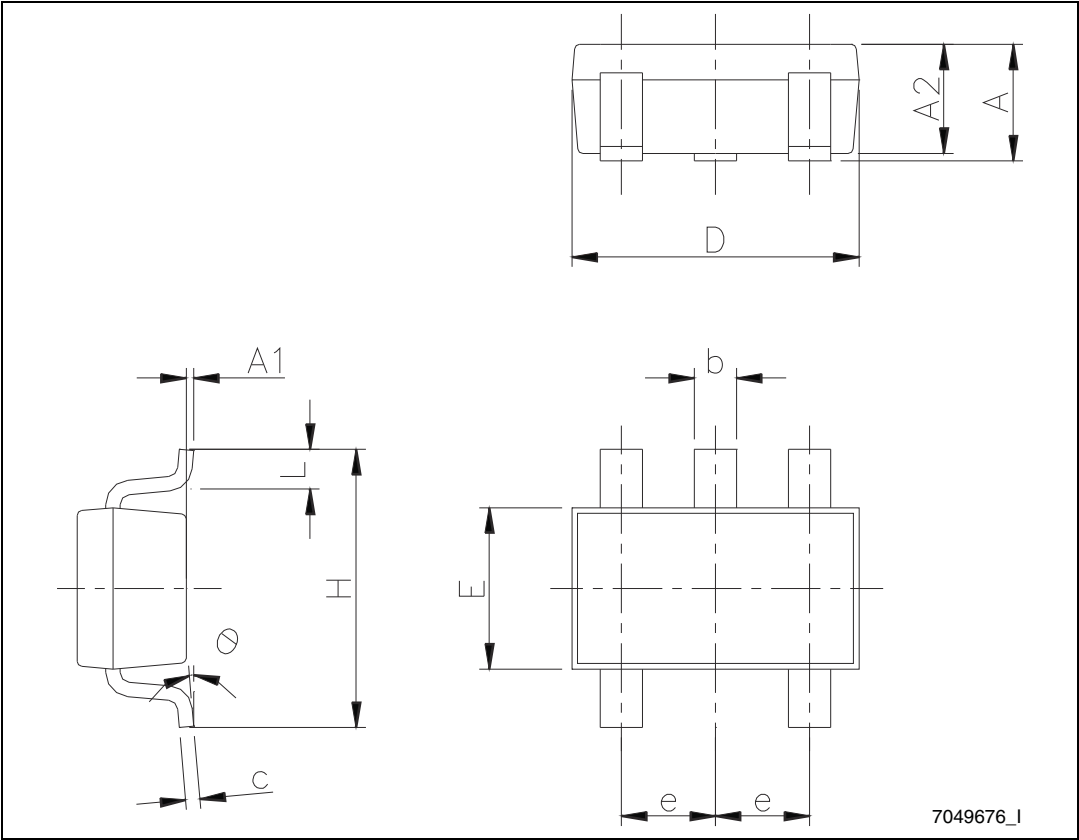
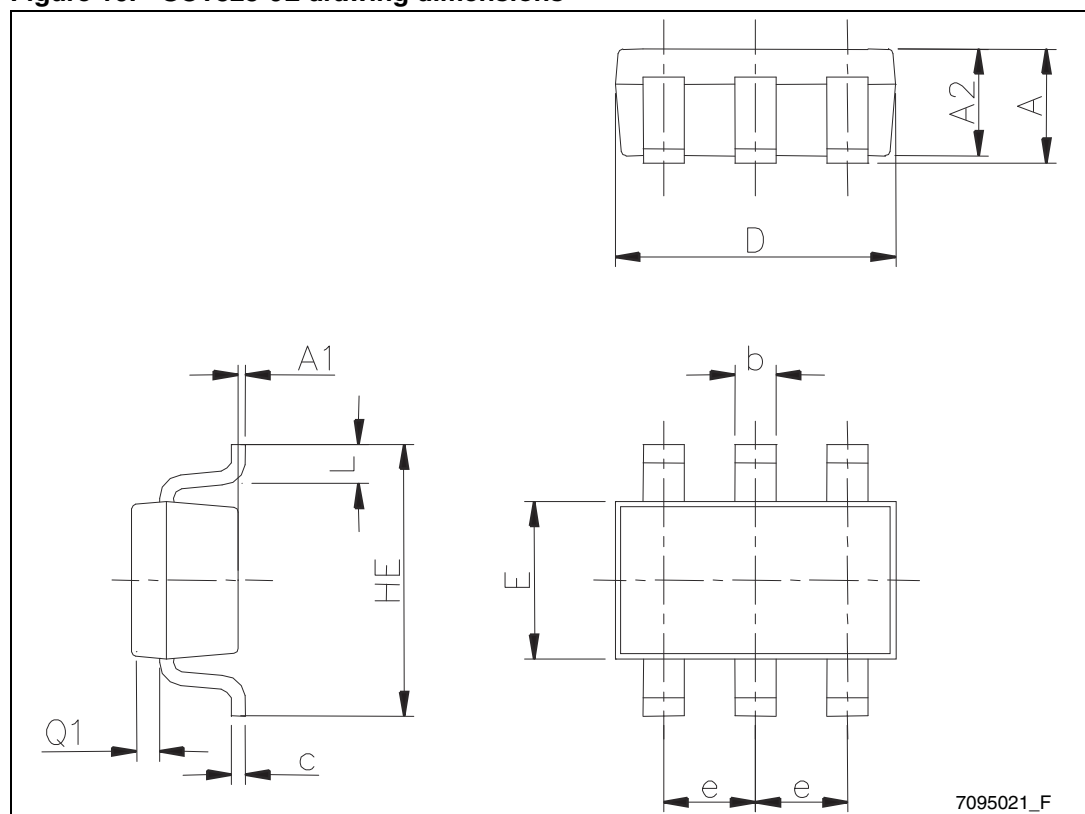
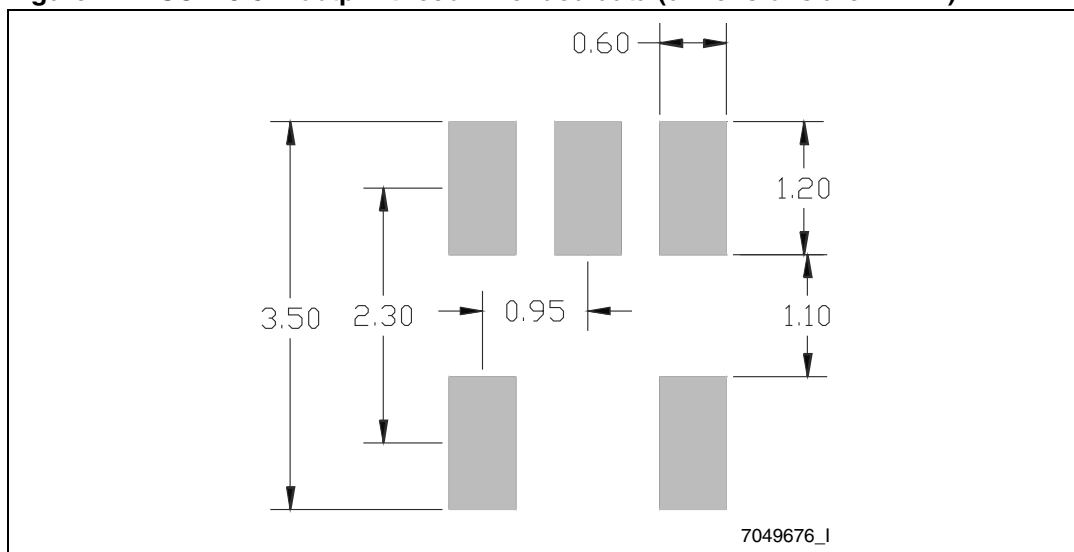
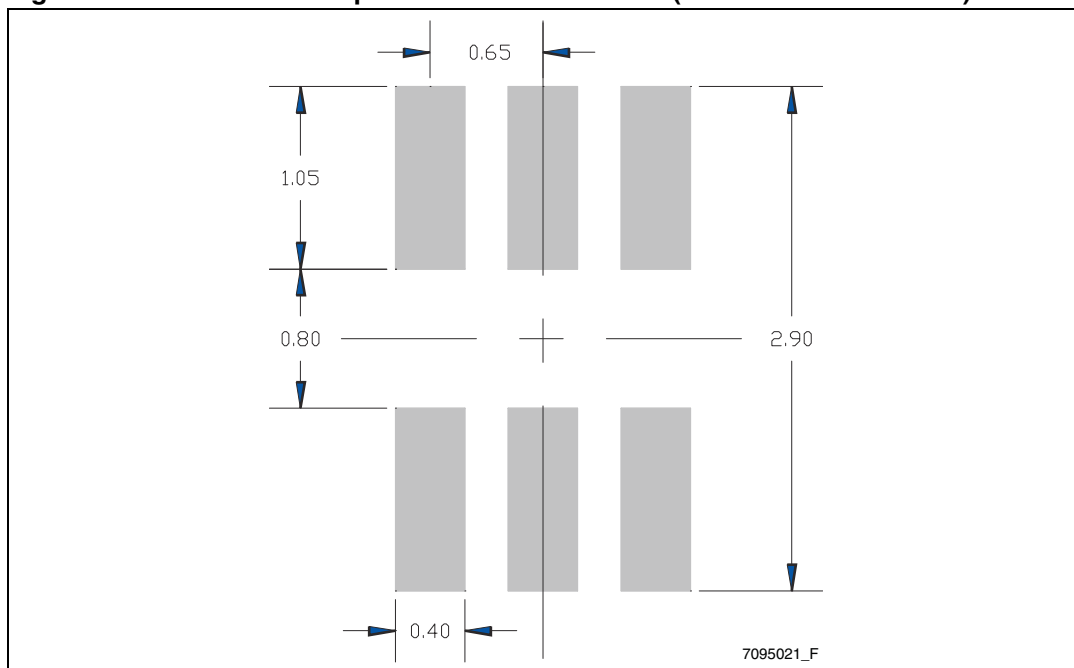


Table 8. SOT323-6L mechanical data

| 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 16. SOT323-6L drawing dimensions



**Figure 17. SOT23-5L footprint recommended data (dimensions are in mm)****Figure 18. SOT323-6L footprint recommended data (dimensions are in mm)**

## 6 Revision History

**Table 9. Document revision history**

| Date        | Revision | Changes          |
|-------------|----------|------------------|
| 13-Jun-2012 | 1        | Initial release. |

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