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# TS4061

## Precision micropower shunt voltage reference

**Datasheet - production data**


## Features

- Fixed 1.225 V,1.25 V output voltages
- Ultra low operating current: 10 µA at 25 °C
- High precision @ 25 °C: +/-0.1% (TS4061A), +/- 0.2% (TS4061B)
- Very low LF noise: typ.10 µ $V_{p-p}$
- Stable when used with capacitive loads
- Industrial (-40 to +85 °C) temperature range
- 35 ppm/°C max. temperature coefficient
- Available in SOT23-3L and SOT323-3L packages

## Applications

- Portable, battery-operated equipment
- Data acquisition systems
- Instrumentation

## Description

The TS4061 is a low power and high accuracy shunt voltage reference providing a stable output voltage over the industrial temperature range (-40 to +85 °C), with a maximum temperature coefficient of 35 ppm/°C. It is available in 0.1% and 0.2% initial accuracy versions. The SOT323-3L and SOT23-3L packages can be designed in applications where space saving is a critical issue. The very low operating current is a key advantage for power restricted designs. The TS4061 is very stable and can be used in a broad range of application conditions.

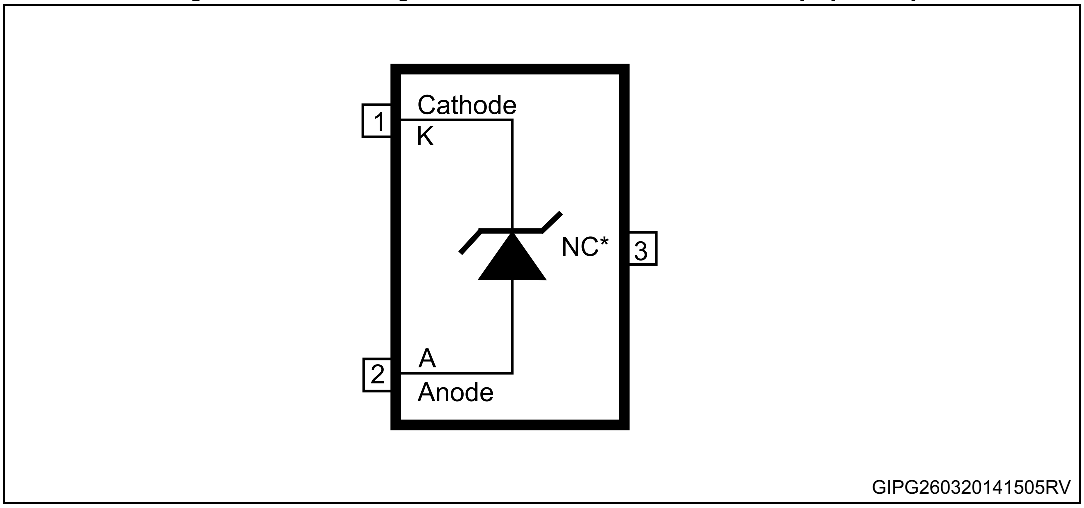


This is information on a product in full production. www.st.com

# Contents

# 1 Pin configuration

**Figure 1. Pin configuration SOT23-3L, SOT323-3L (top view)**




*Note: The NC pin must be left unconnected or connected to anode.*

# 2 Maximum ratings

**Table 1. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $I_k$ | Reverse breakdown current | 20 | mA |
| $I_f$ | Forward current | 15 | mA |
| $P_d$ | Power dissipation(1) | 500 | mW |
| $T_{std}$ | Storage temperature | -65 to +150 | °C |
| $E_{SD}$ | 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 |

1. $P_d$ has been calculated with $T_{amb}$ = 25 °C and $T_{jmax}$ = 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 2. Thermal data**

| Symbol | Parameter | SOT323-3L | SOT23-3L | Unit |
|---|---|---|---|---|
| $R_{thJA}$ | Thermal resistance junction-ambient | 246 | 242 | °C/W |
| $R_{thJC}$ | Thermal resistance junction-case | 171 | 103 | °C/W |

**Table 3. Operating conditions**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $I_{kmin}$ | Minimum operating current | 10 | µA |
| $I_{kmax}$ | Maximum operating current | 15 | mA |
| $T_{oper}$ | Operating free air temperature range | -40 to +85 | °C |

# 3 Electrical characteristics

Limits are 100% production tested at 25 °C. Limits over full temperature range are guaranteed through correlation and by design. $I_k$ = 10 µA, $T_{amb}$ = 25 °C (unless otherwise specified).

**Table 4. Electrical characteristics for TS4061**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_k$ | Reverse breakdown voltage ($V_k$ = 1.225 V) | $I_k$ = 10 µA, TS4061A | 1.2237 | 1.225 | 1.2262 | V |
| | | $I_k$ = 10 µA, TS4061B | 1.2225 | | 1.2275 | |
| | Reverse breakdown voltage ($V_k$ = 1.25 V) | $I_k$ = 10 µA, TS4061A | 1.2487 | 1.25 | 1.2512 | V |
| | | $I_k$ = 10 µA, TS4061B | 1.2475 | | 1.2525 | |
| $I_{kmin}$ | Minimum operating current | $T_{amb}$ = 25 °C | | 7.5 | 10 | µA |
| | | -40 °C < $T_{amb}$ < +85 °C | | | 12 | |
| $\Delta V_k/\Delta T$ | Average temperature coefficient | 10 µA < $I_k$ < 15 mA | | 20 | 35 | ppm/°C |
| $\Delta V_k/\Delta I_k$ | Reverse breakdown voltage change with operating current range | $I_{kmin}$ < $I_k$ < 1 mA<br>-40 °C < $T_{amb}$ < +85 °C | | 0.2 | 1 | mV |
| | | 1mA < $I_k$ < 15 mA<br>-40 °C < $T_{amb}$ < +85 °C | | 1.7 | 4 | |
| $R_{ka}$ | Static impedance | $\Delta I_k$ = 10 µA to 10 mA | | 0.15 | 0.3 | Ω |
| Hys | Thermal hysteresis(1) | $I_k$ = 10 µA | | 120 | | ppm |
| Noise | Wideband noise | $I_k$ = 10 µA 10 Hz < f< 10 kHz | | 95 | | µVRMS |
| | Low frequency noise | $I_k$ = 10 µA 0.1 Hz < f< 10 Hz | | 10 | | µVp-p |

1. Thermal hysteresis is defined as the difference in voltage measured at +25 °C after cycling to -40 °C and the measurement at +25 °C after cycling to temperature +85 °C.

# 4 Typical performance characteristics

(The following plots are referred to the typical application circuit and, unless otherwise noted, at $T_A$ = 25 °C)

**Figure 2. $V_K$ change vs temperature (1.225 V version)**

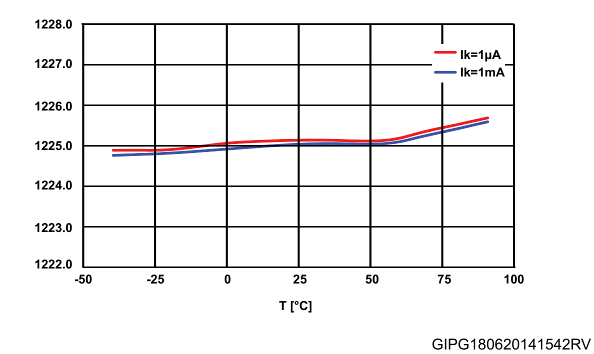



**Figure 3. $V_K$ change vs temperature (1.25 V version)**

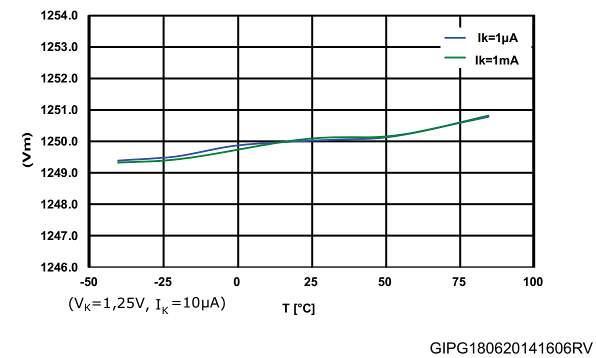



**Figure 4. $I_{Kmin}$ minimum current for regulation**

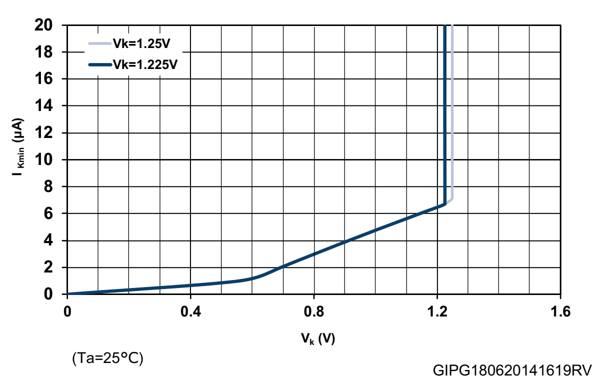



**Figure 5. $I_{Kmin}$ minimum current for regulation vs temperature**

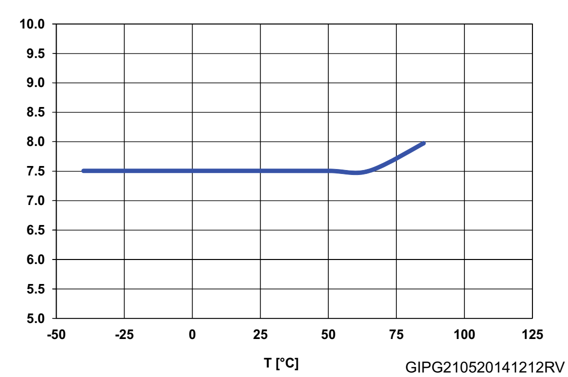



**Figure 6. Output impedance vs frequency**

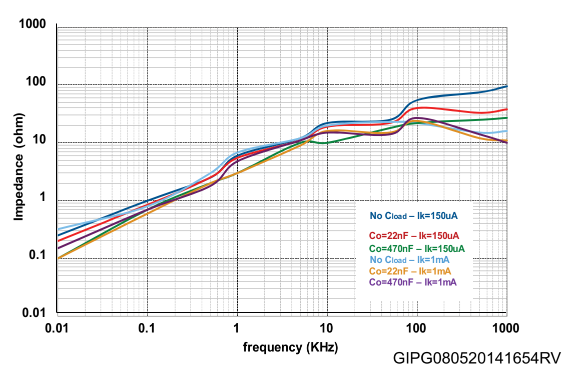



**Figure 7. Forward characteristics**

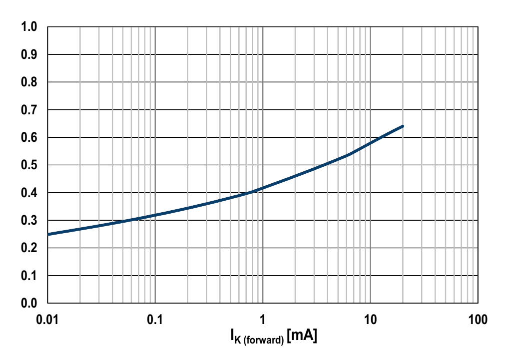


**Figure 8. Start-up waveform (no $C_{load}$)**

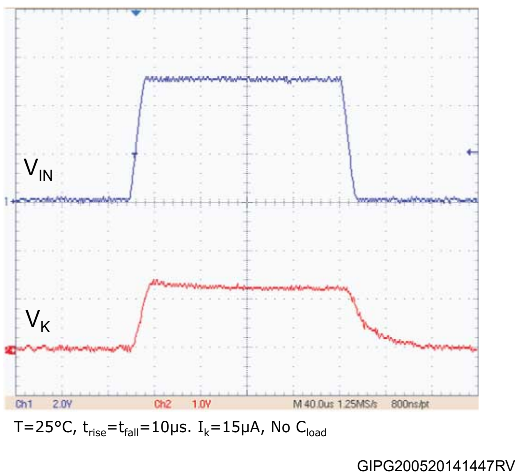



**Figure 9. Start-up waveform ($C_{load}$ = 100 nF)**

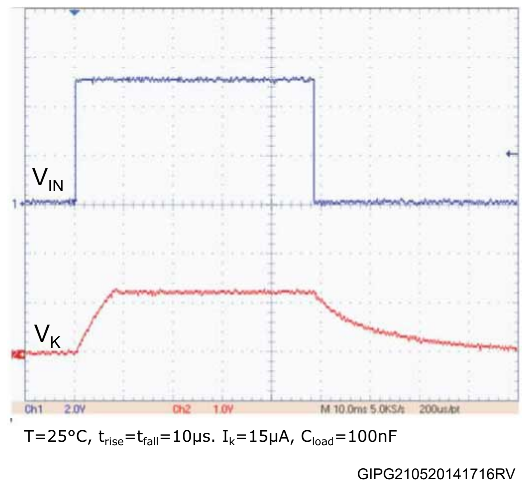
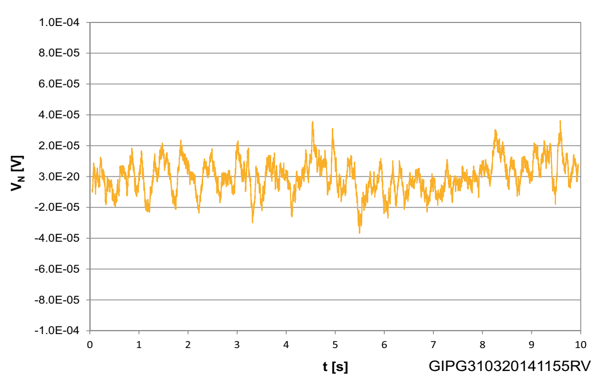



**Figure 10. Low frequency noise**



# 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*. ECOPACK® is an ST trademark.

## 5.1 SOT23-3L, TS4061

**Figure 11. SOT23-3L mechanical drawings**

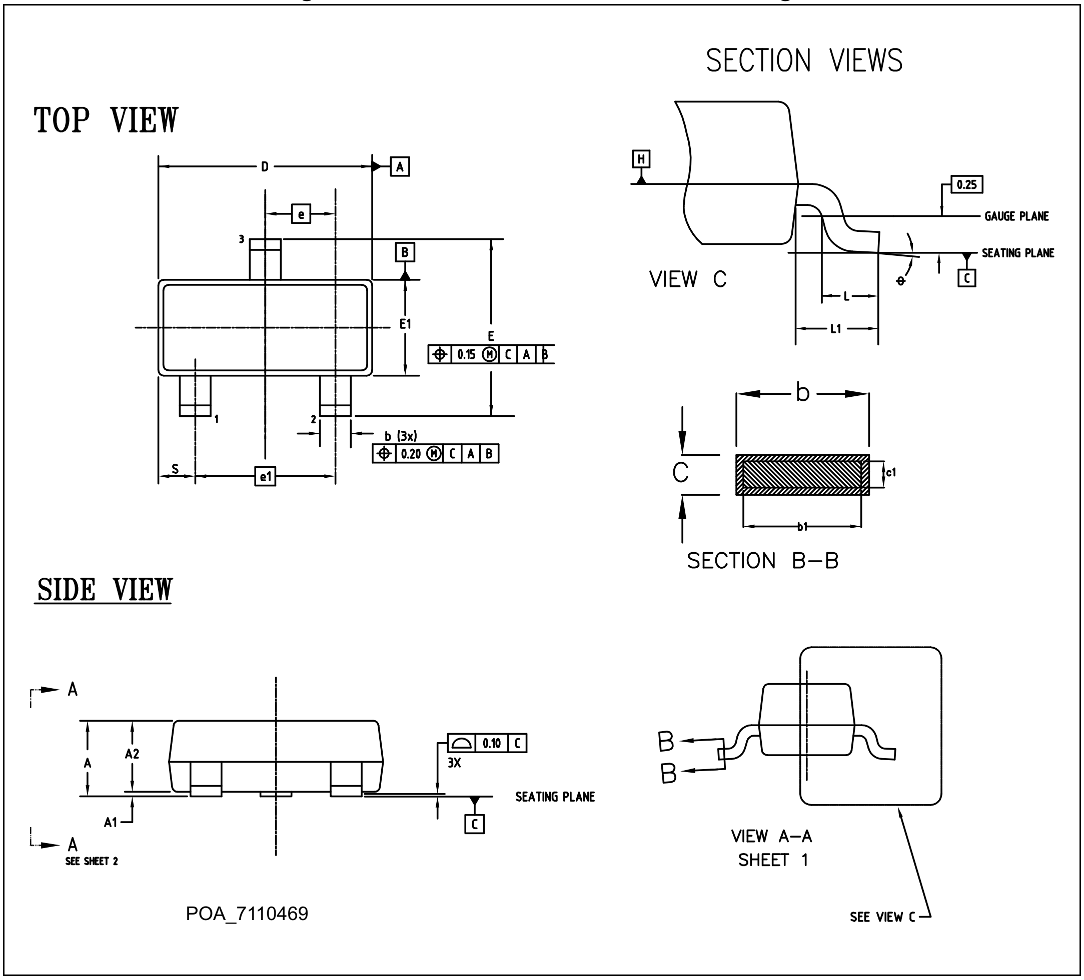
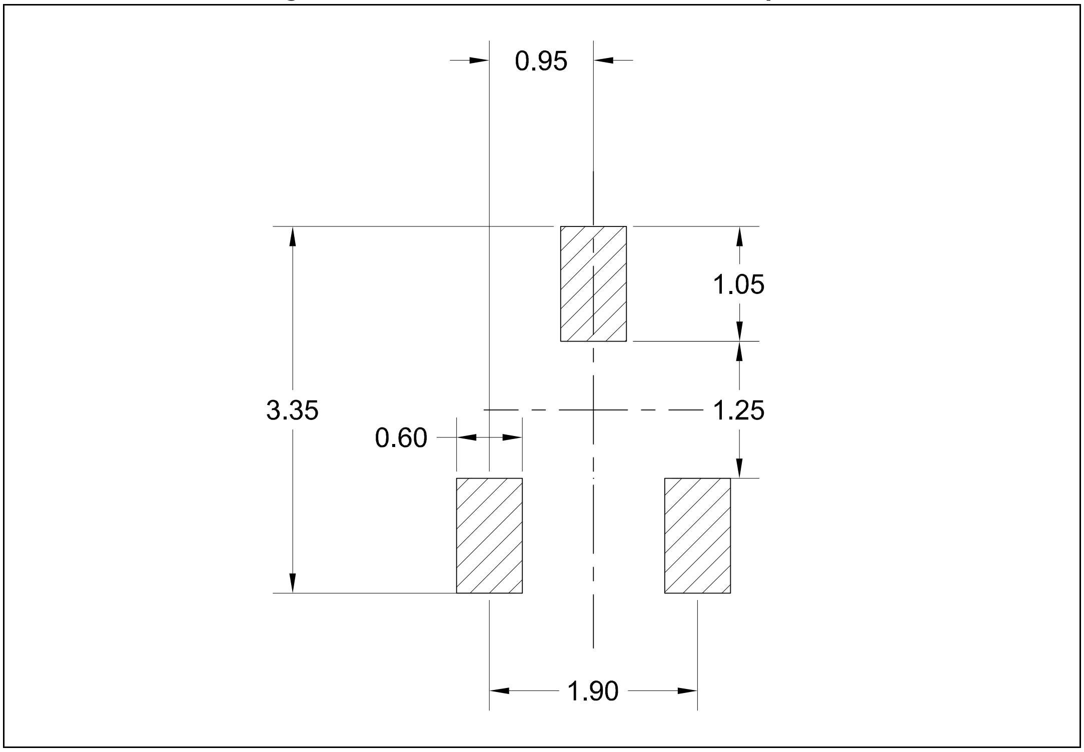


**Table 5. SOT23-3L mechanical data**

| Dim. | mm | | |
|---|---|---|---|
| | **Min.** | **Typ.** | **Max.** |
| A | 0.89 | | 1.12 |
| A1 | 0.013 | | 0.10 |
| A2 | 0.88 | 0.95 | 1.02 |
| b | 0.37 | | 0.50 |
| b1 | 0.37 | 0.40 | 0.45 |
| c | 0.085 | | 0.18 |
| c1 | 0.085 | | 0.16 |
| D | 2.80 | | 3.04 |
| E | 2.10 | | 2.64 |
| E1 | 1.20 | | 1.40 |
| e | 0.95 BSC | | |
| e1 | 1.90 BSC | | |
| *L | 0.28 | 0.38 | 0.48 |
| L1 | 0.55 | | |
| R | 0.05 | | |
| R1 | 0.05 | | |
| $\theta$ | 0° | | 8° |
| s | 0.45 | | 0.60 |

**Figure 12. SOT23-3L recommended footprint**



## 5.2 SOT323-3L, TS4061

Figure 13. SOT323-3L drawings

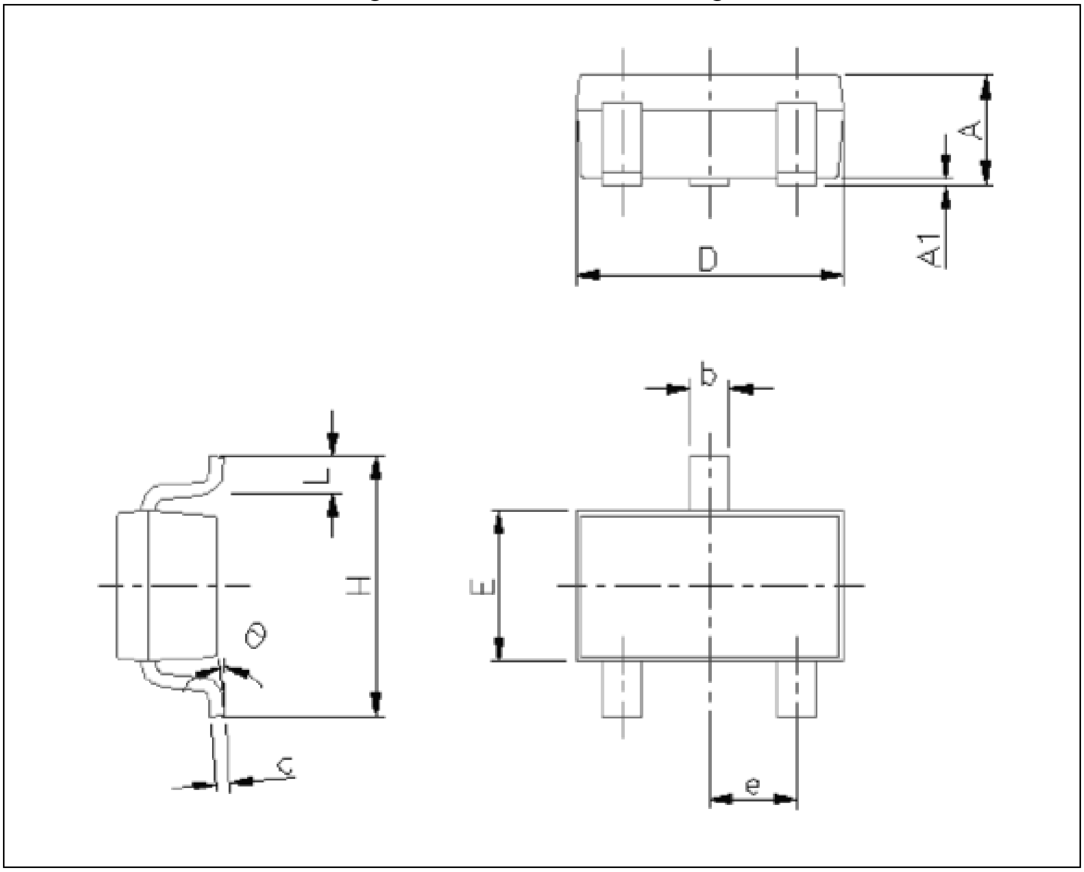
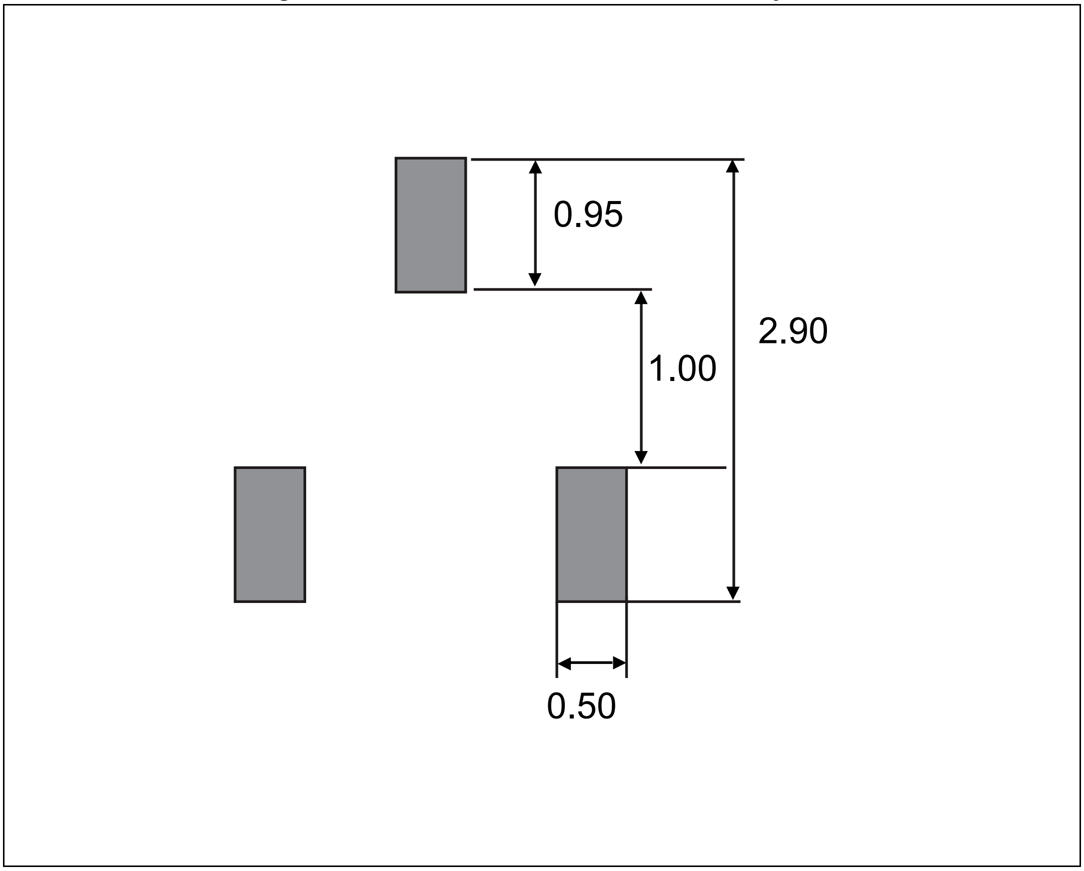



Table 6. SOT323-3L mechanical data

| Dim. | mm | | |
|---|---|---|---|
| | Typ. | Min. | Max. |
| A | | 0.80 | 1.10 |
| A1 | | 0.00 | 0.10 |
| b | | 0.25 | 0.40 |
| c | | 0.10 | 0.18 |
| D | | 1.80 | 2.20 |
| E | | 1.15 | 1.35 |
| e | 0.65 | 0.60 | 0.70 |
| H | | 1.80 | 2.40 |
| L | | 0.10 | 0.30 |

**Figure 14. SOT323-3L recommended footprint**



# 6 Ordering information

**Table 7. Order codes**

| Order codes | Output voltage (V) | Precision (%) | Package | Temperature range (°C) |
|---|---|---|---|---|
| TS4061AILT-1.25 | 1.25 | 0.1 | SOT23-3L | -40 to +85 |
| TS4061AILT-1.225 | 1.225 | | | |
| TS4061AICT-1.25 | 1.25 | 0.1 | SOT323-3L | -40 to +85 |
| TS4061AICT-1.225 | 1.225 | | | |
| TS4061BILT-1.25 | 1.25 | 0.2 | SOT23-3L | -40 to +85 |
| TS4061BILT-1.225 | 1.225 | | | |
| TS4061BICT-1.25 | 1.25 | 0.2 | SOT323-3L | -40 to +85 |
| TS4061BICT-1.225 | 1.225 | | | |

# 7 Revision history

**Table 8. Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 21-Jul-2014 | 1 | Initial release. |
| 01-Feb-2018 | 2 | Updated: *Table 5*, *Figure 11*, *Figure 12* and Note: *The NC pin must be left unconnected or connected to anode.* |