# Precision micropower shunt voltage reference
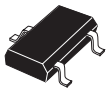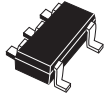
## Features

- Fixed 2.048 V, 2.5 V, 3.0 V, 4.096 V and 5.0 V output voltages
- Ultra low operating current: 10 µA at 25 °C
- High precision @ 25 °C: +/- 0.1% (LM4040A), +/- 0.2% (LM4040B), +/- 0.5 % (LM4040C), +/- 1% (LM4040D)
- Very low LF noise: typ.10 µ Vp-p
- Stable when used with capacitive loads
- Industrial (-40 to +125 °C) temperature range
- 70 ppm/°C max. temperature coefficient
- Available in SOT23-3L and SOT323-5L packages

**SOT23-3L**　　　**SOT323-5L**

| Maturity status link |
|---|
| LM4040 |

## Applications

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

## Description

The LM4040 is a low power and high accuracy shunt voltage reference providing a stable output voltage over the industrial temperature range (-40 to +125 °C), with a maximum temperature coefficient of 70 ppm/°C. It is available in 0.1%, 0.2%, 0.5% and 1% initial accuracy versions. The SOT323-5L 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 LM4040 is very stable and can be used in a broad range of application conditions.

# 1 Pin configuration

**Figure 1.** Pin configuration SOT23-3L, SOT323-5L (top view)



SOT23-3L                    SOT323-5L
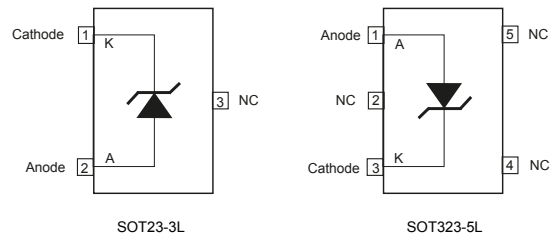
*Note:* *The NC pin must be left unconnected or connected to anode.*

# 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 |
| 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 |

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 | SOT323-5L | SOT23-3L | Unit |
|---|---|---|---|---|
| $R_{thJA}$ | Thermal resistance junction ambient | 245 | 210 | °C/W |
| $R_{thJC}$ | Thermal resistance junction-case | 105 | 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 +125 | °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).

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_k$ | Reverse breakdown voltage ($V_k$ = 2.048 V) | $I_k$ = 10 µA, LM4040A | 2.0460 | 2.048 | 2.0500 | V |
| | | $I_k$ = 10 µA, LM4040B | 2.0439 | | 2.0521 | |
| | | $I_k$ = 10 µA, LM4040C | 2.0378 | | 2.0582 | |
| | | $I_k$ = 10 µA, LM4040D | 2.0275 | | 2.0685 | |
| | Reverse breakdown voltage ($V_k$ = 2.5 V) | $I_k$ = 10 µA, LM4040A | 2.4975 | 2.50 | 2.5025 | V |
| | | $I_k$ = 10 µA, LM4040B | 2.4950 | | 2.5050 | |
| | | $I_k$ = 10 µA, LM4040C | 2.04875 | | 2.5125 | |
| | | $I_k$ = 10 µA, LM4040D | 2.4750 | | 2.5250 | |
| | Reverse breakdown voltage ($V_k$ = 3.0 V) | $I_k$ = 12 µA, LM4040A | 2.9970 | 3.0 | 3.0030 | V |
| | | $I_k$ = 12 µA, LM4040B | 2.9940 | | 3.0060 | |
| | | $I_k$ = 12 µA, LM4040c | 2.9850 | | 3.0150 | |
| | | $I_k$ = 12 µA, LM4040D | 2.9700 | | 3.0300 | |
| | Reverse breakdown voltage ($V_k$ = 4.096 V) | $I_k$ = 20 µA, LM4040A | 4.0919 | 4.096 | 4.1001 | V |
| | | $I_k$ = 20 µA, LM4040B | 4.0878 | | 4.1042 | |
| | | $I_k$ = 20 µA, LM4040C | 4.0755 | | 4.1165 | |
| | | $I_k$ = 20 µA, LM4040D | 4.0550 | | 4.1370 | |
| | Reverse breakdown voltage ($V_k$ = 4.096 V) | $I_k$ = 20 µA, LM4040A | 4.9950 | 5.0 | 5.0050 | V |
| | | $I_k$ = 20 µA, LM4040B | 4.9900 | | 5.0100 | |
| | | $I_k$ = 20 µA, LM4040C | 4.9750 | | 5.0250 | |
| | | $I_k$ = 20 µA, LM4040D | 4.9500 | | 5.0500 | |
| $I_{kmin}$ | Minimum operating current | Tamb = 25 °C, $V_k$ <2.5 V | | 7.5 | 10 | mA |
| | | -40 °C < Tamb < +125 °C | | | 12 | |
| | | Tamb = 25 °C, $V_k$ >3.0 V | | 15 | 20 | |
| | | -40 °C < Tamb < +125 °C | | | 25 | |
| $\Delta V_k/\Delta T$ | Average temperature coefficient | 10 µA <$I_k$ <20 mA | | 20 | 70 | ppm/° C |
| $\Delta V_k/\Delta I_k$ | Reverse breakdown voltage change with operating current range | $I_k$ min < $I_k$ < 1 mA -40 °C < Tamb < +125 °C | | 0.2 | 1 | mV |
| | | 1 mA < $I_k$ < 15 mA -40 °C < Tamb < +125 °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 | | mV$_{RMS}$ |
| | 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 +125 °C.*

# 4 Typical performance characteristics

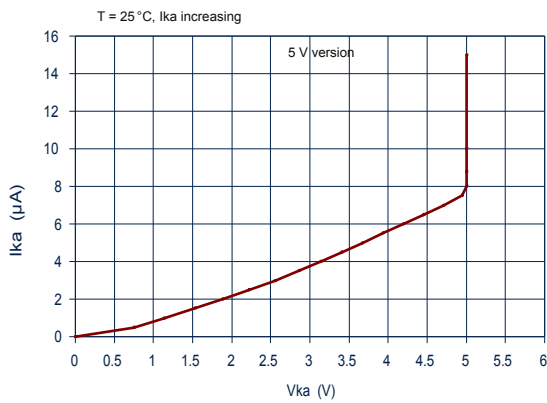(C$_{IN}$ = 1 µF; C$_{OUT}$ = 10 µF, T$_J$ = 25 °C unless otherwise specified.)
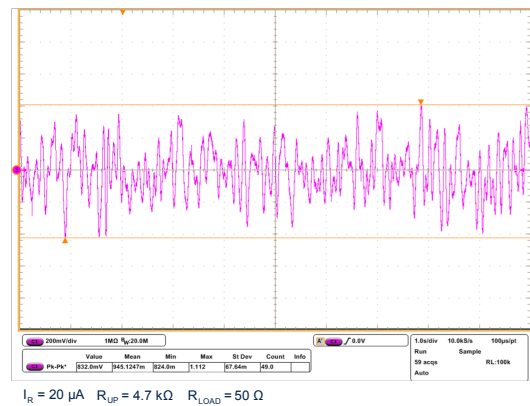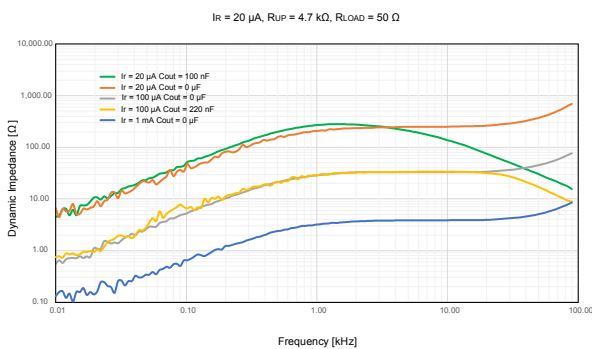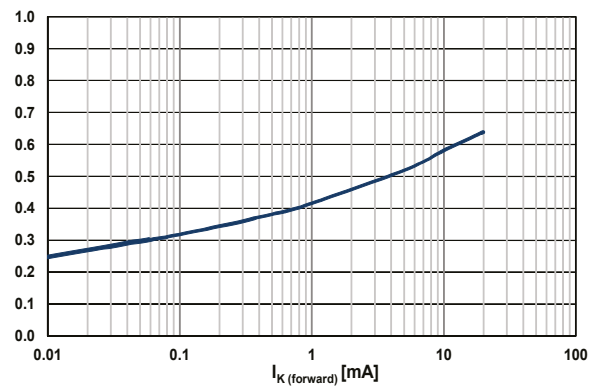
**Figure 2. V$_K$ change vs. temperature (5 V version)**
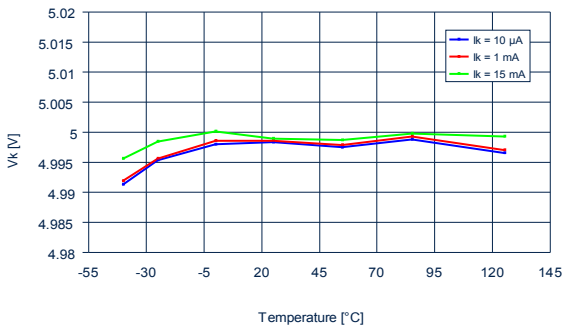


**Figure 3. V$_K$ change vs. temperature (5 V version)**
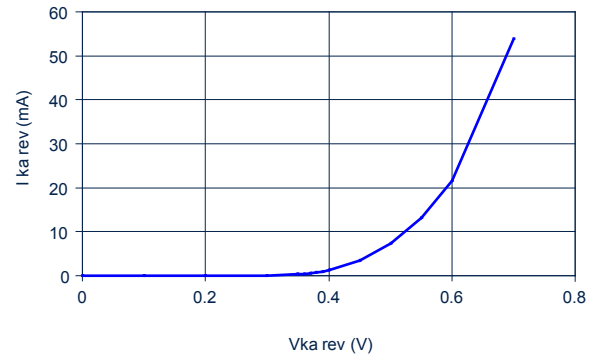


**Figure 4. I$_{Kmin}$ minimum current for regulation**



**Figure 5. Low frequency noise test**



I$_R$ = 20 µA    R$_{UP}$ = 4.7 kΩ    R$_{LOAD}$ = 50 Ω

**Figure 6. Measured dynamic impedance**
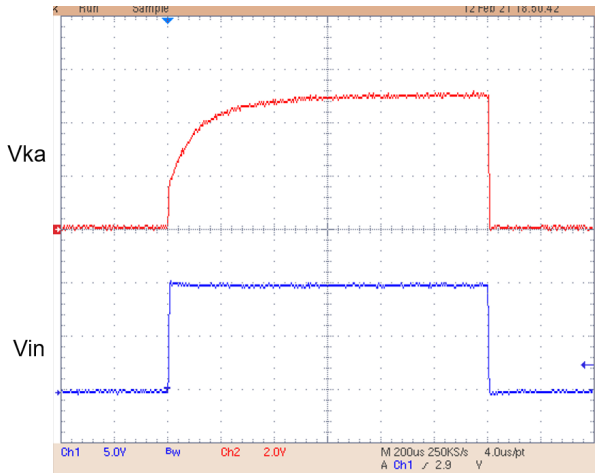


**Figure 7. Forward characteristics**

**Figure 8. Turn-on time setting (no Cload )**

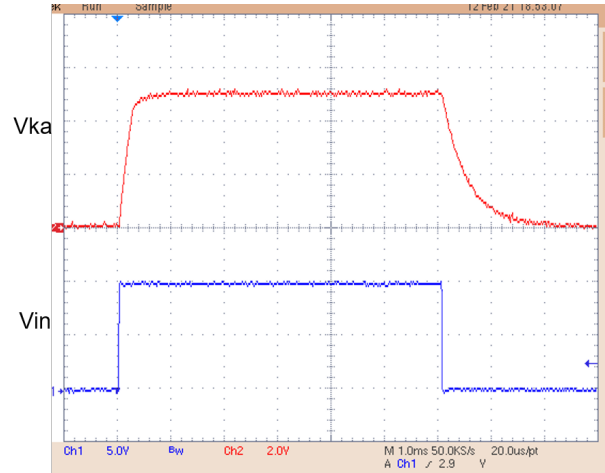

Vin: 10 V, trise: 5 μsec, Ika: 10 μA, No Cload

**Figure 9. Turn-on time setting (Cload = 100 nF)**



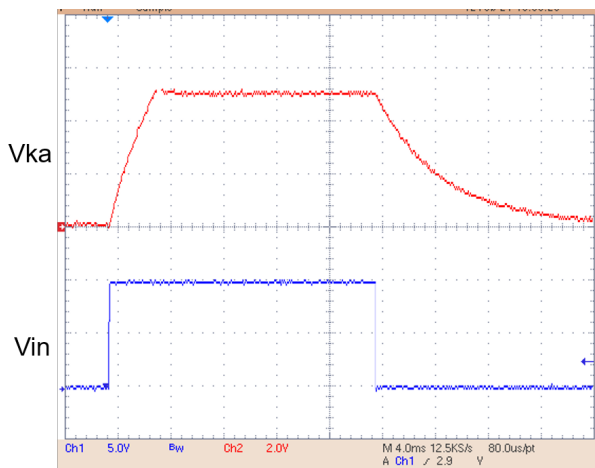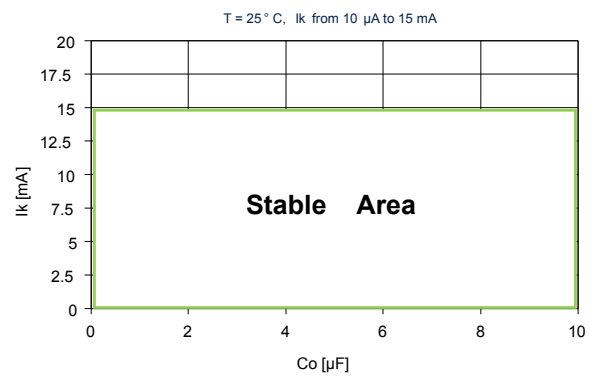Vin: 10 V, trise: 5 μsec, Ika: 10 μA, Cload: 100 nF

**Figure 10. Turn-on time setting (Cload = 1 μF)**



Vin: 10 V, trise: 5 μsec, Ika: 10 μA, Cload: 1 μF

**Figure 11. Stability plane vs. Cout**

# 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. ECOPACK is an ST trademark.

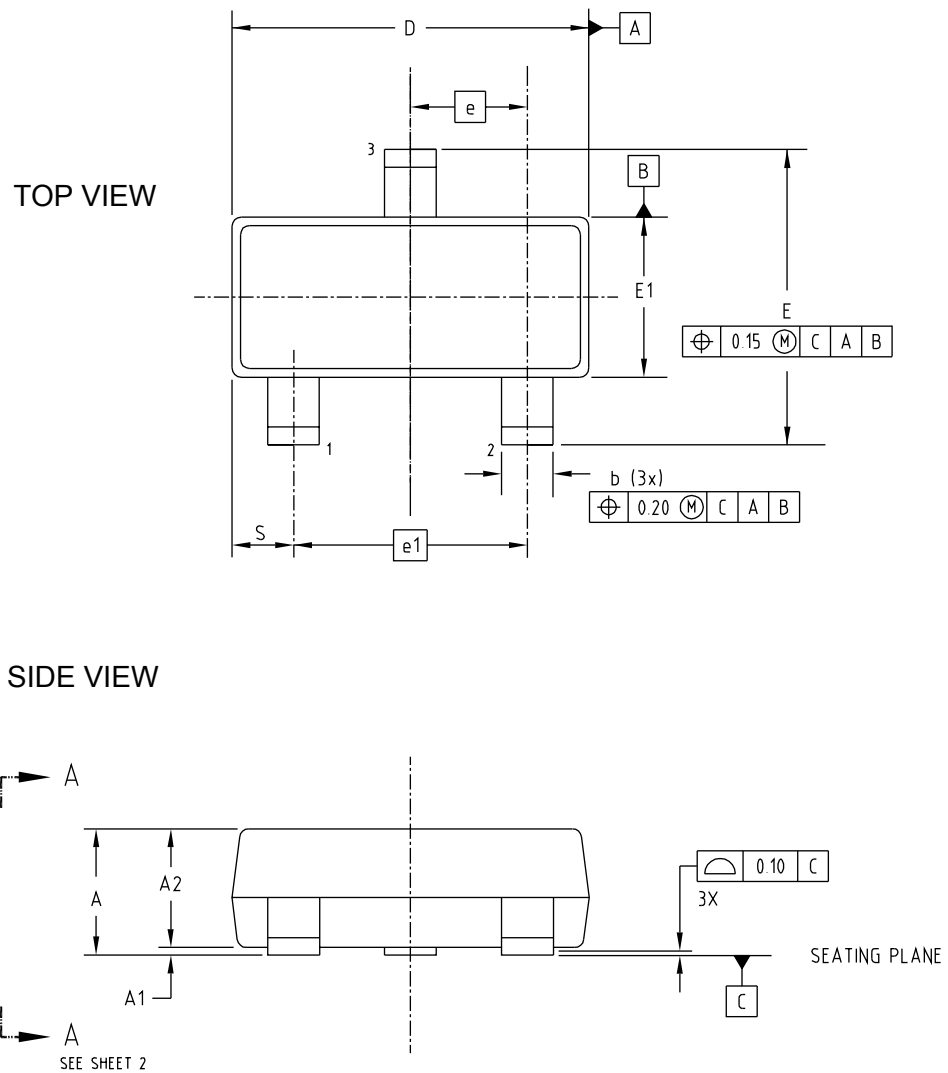## 5.1 SOT23-3L package information

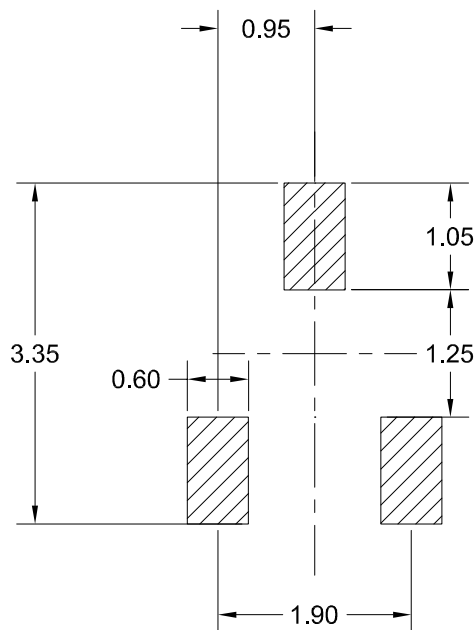### Figure 12. SOT23-3L package outline

**Table 4. SOT23-3L mechanical data**

| Dim. | mm | | |
|------|------|------|------|
| | Min. | Typ. | Max. |
| A | 0.80 | | 1.10 |
| A1 | 0 | | 0.10 |
| A2 | 0.80 | 0.90 | 1 |
| b | 0.15 | | 0.30 |
| c | 0.10 | | 0.22 |
| D | 1.80 | 2 | 2.20 |
| E | 1.80 | 2.10 | 2.40 |
| E1 | 1.15 | 1.25 | 1.35 |
| e | | 0.65 | |
| e1 | | 130 | |
| L | 0.26 | 0.36 | 0.46 |
| < | 0° | | 8° |

**Figure 13. SOT23-3L recommended footprint**

## 5.2 SOT323-5L package information

**Figure 14. SOT323-5L package outline**

SIDE VIEW

TOP VIEW
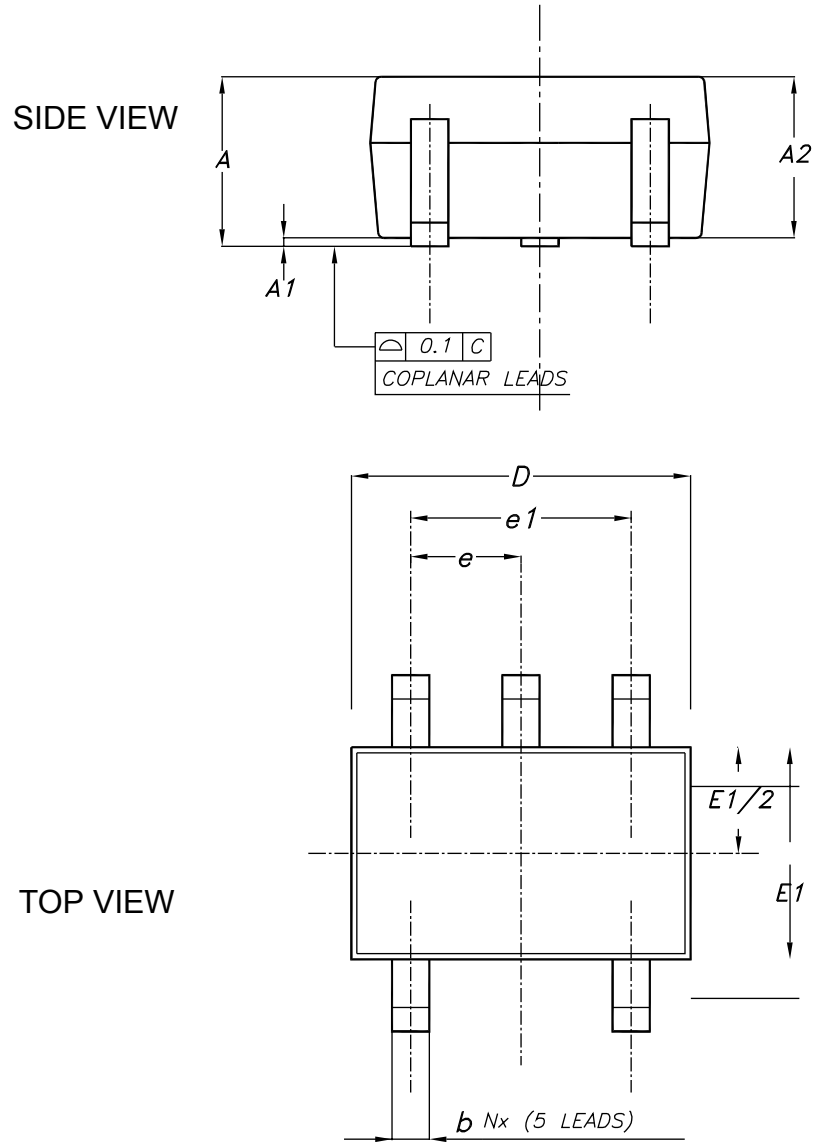
Table 5. **SOT323-5L mechanical data**

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 0.89 | | 1.12 |
| A1 | 0.013 | | 0.10 |
| A2 | 0.88 | 0.95 | 1.2 |
| 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 | 2.90 | 3.04 |
| E | 2.10 | | 2.64 |
| E1 | 1.20 | 1.30 | 1.40 |
| e | | 0.95 BSC | |
| e1 | | 1.90 BSC | |
| L | 0.28 | 0.38 | 0.48 |
| L1 | | 0.55 REF | |
| L2 | | | |
| R | 0.05 | | |
| R1 | 0.05 | | |
| Ɵ | 0° | | 8° |
| s | 0.45 | | 0.60 |

Figure 15. **SOT323-5L recommended footprint**
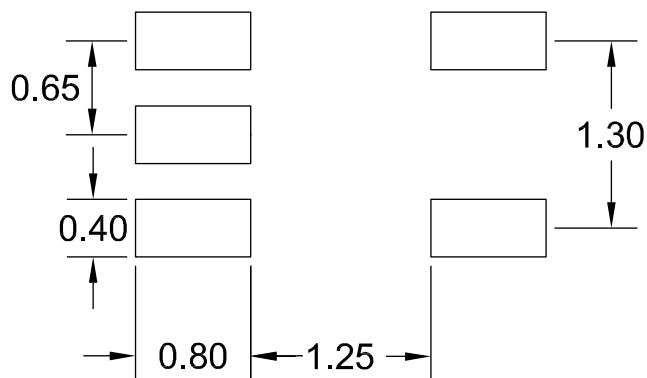
## 5.3 SOT23-3L packing information

**Figure 16. SOT23-3L tape outline**

**Figure 17. SOT23-3L reel drawing**
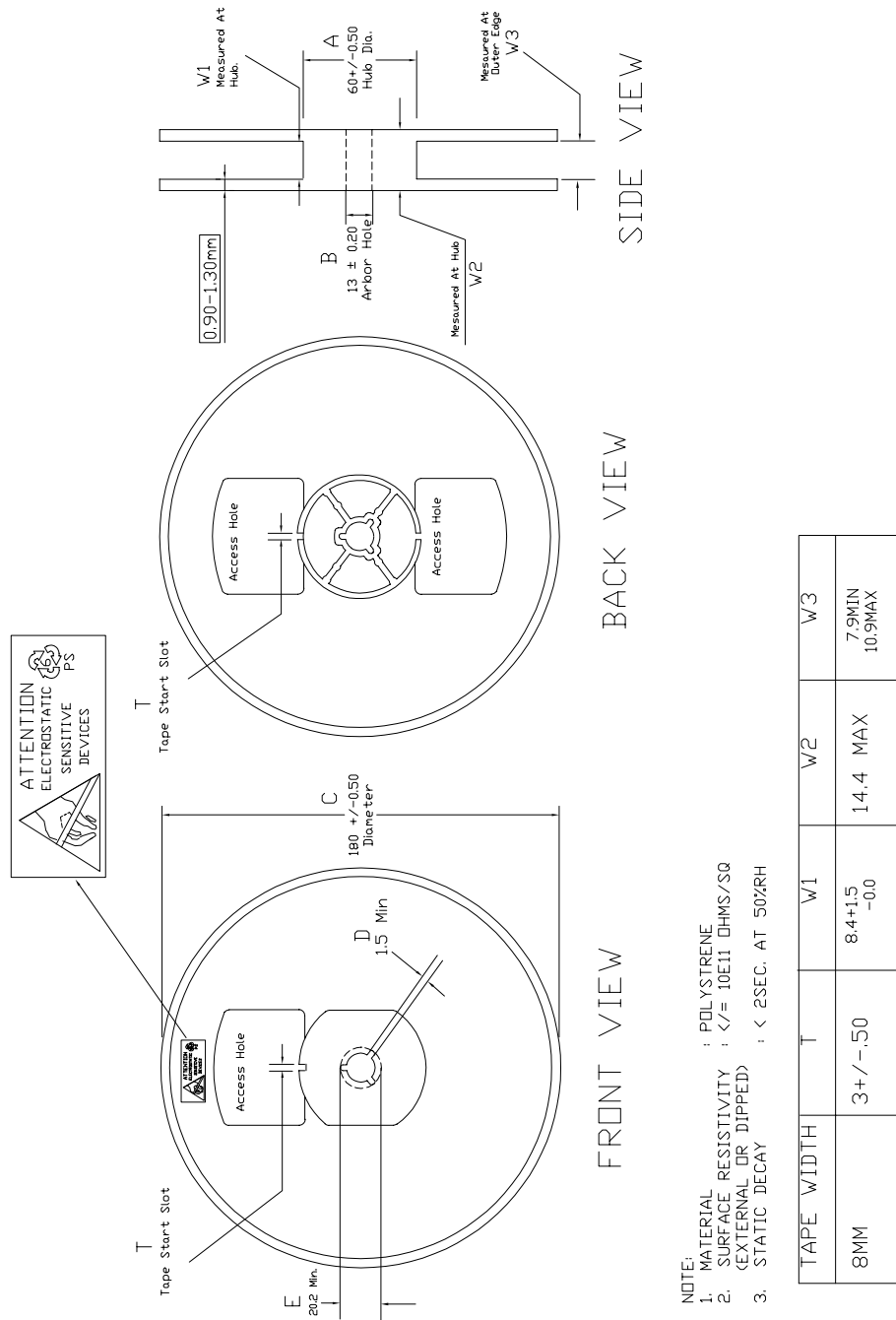
**Figure 18. SOT23-3L tape direction**



Direction of feed
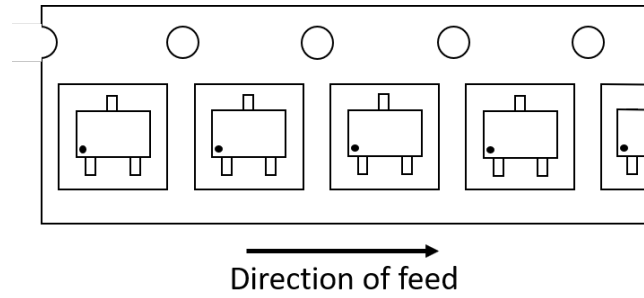
## 5.4 SOT323-5L packing information

**Figure 19. SOT323-5L tape outline**
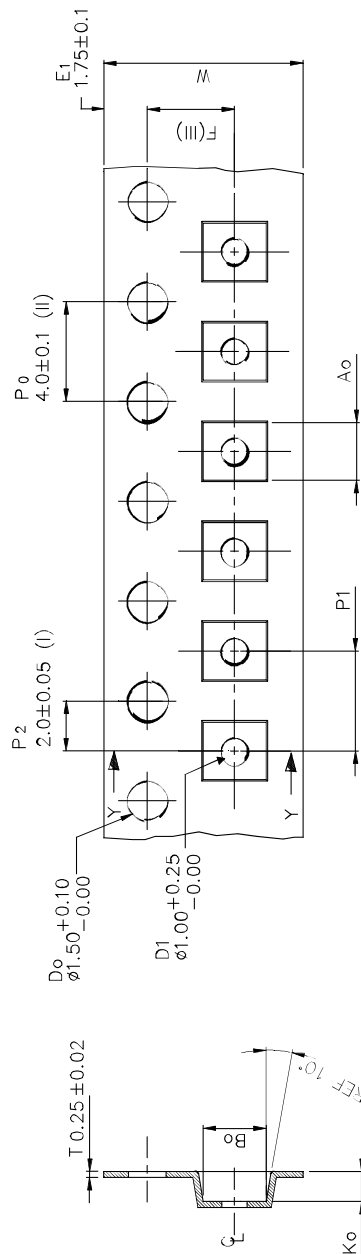


(I) Measured from centreline of sprocket hole to centreline of pocket.

(II) Cumulative tolerance of 10 sprocket holes is ± 0.20 .

(III) Measured from centreline of sprocket hole to centreline of pocket.

(IV) Other material available.

(V) Typical SR of form tape to be $10^4 \leq SR < 10^{11}$ OHMS.

ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.

| | |
|---|---|
| Ao | 2.25 +/−0.10 |
| Bo | 2.45 +/−0.10 |
| Ko | 1.20 +/−0.10 |
| F | 3.50 +/−0.05 |
| P1 | 4.00 +/−0.10 |
| W | 8.00 +0.3/−0.1 |

**Figure 20. SOT323-5L reel drawing**
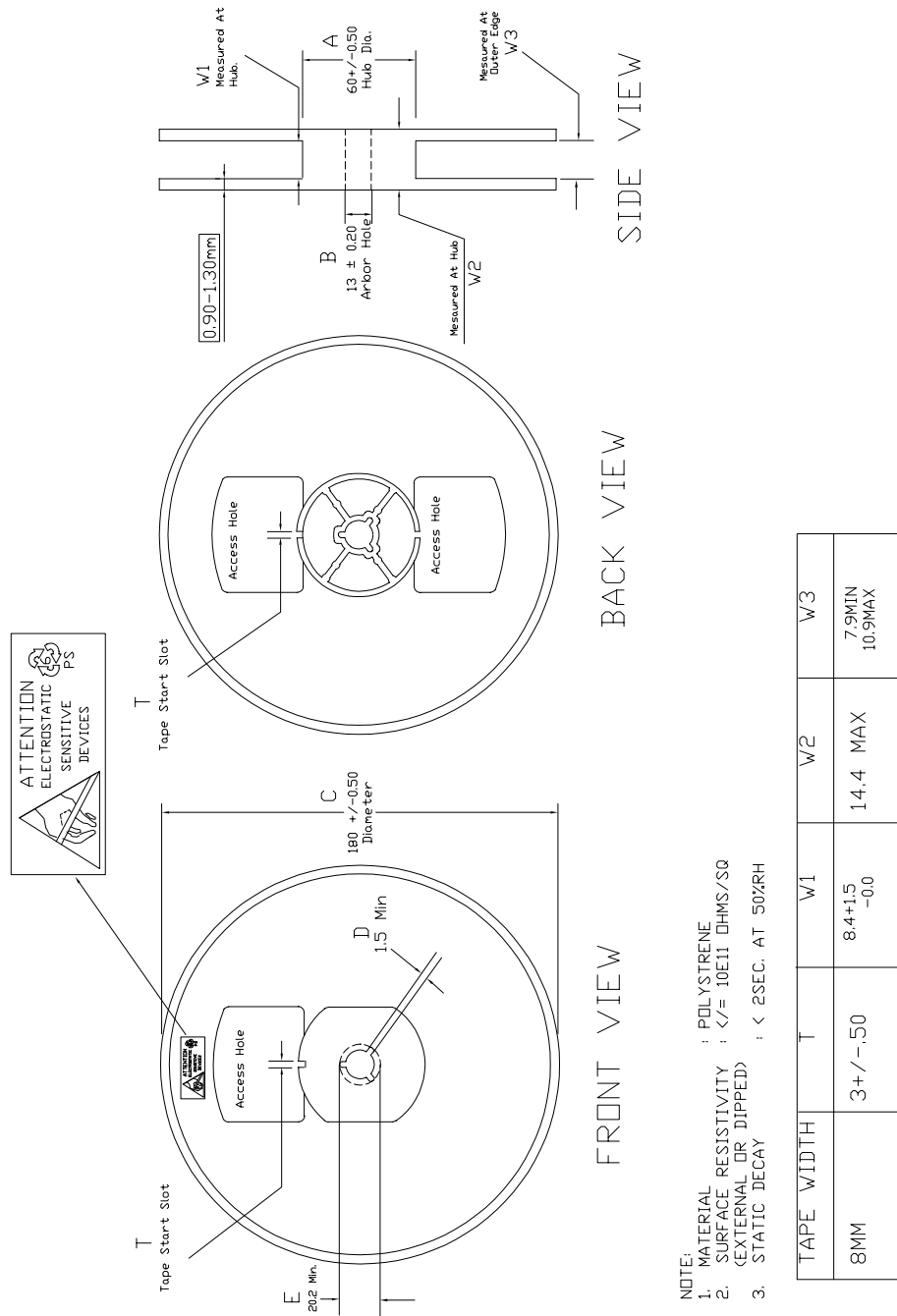
**Figure 21. SOT323-5L tape direction**



Direction of feed
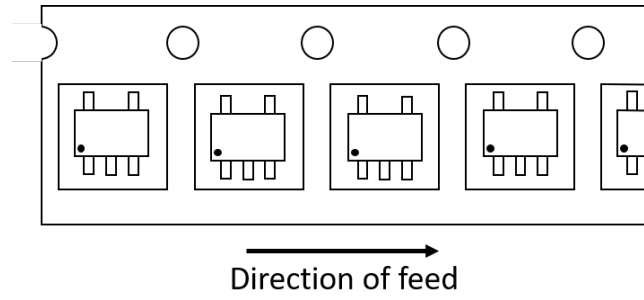
# 6 Ordering information

| Order codes | Precision (%) | Package | Output voltage (V) | Marking | Temperature range (°C) |
|---|---|---|---|---|---|
| LM4040AELT-2.0 | 0.1% | SOT23-3L | 2.048 | A20 | -40°C to +125°C |
| LM4040BELT-2.0 | 0.2% | SOT23-3L | 2.048 | B20 | -40°C to +125°C |
| LM4040CELT-2.0 | 0.5% | SOT23-3L | 2.048 | C20 | -40°C to +125°C |
| LM4040DELT-2.0 | 1.0% | SOT23-3L | 2.048 | D20 | -40°C to +125°C |
| LM4040AECT-2.0 | 0.1% | SOT323-5L | 2.048 | A20 | -40°C to +125°C |
| LM4040BECT-2.0 | 0.2% | SOT323-5L | 2.048 | A20 | -40°C to +125°C |
| LM4040CECT-2.0 | 0.5% | SOT323-5L | 2.048 | C20 | -40°C to +125°C |
| LM4040DECT-2.0 | 1.0% | SOT323-5L | 2.048 | D20 | -40°C to +125°C |
| LM4040AELT-2.5 | 0.1% | SOT23-3L | 2.5 | A25 | -40°C to +125°C |
| LM4040BELT-2.5 | 0.2% | SOT23-3L | 2.5 | B25 | -40°C to +125°C |
| LM4040CELT-2.5 | 0.5% | SOT23-3L | 2.5 | C25 | -40°C to +125°C |
| LM4040DELT-2.5 | 1.0% | SOT23-3L | 2.5 | D25 | -40°C to +125°C |
| LM4040AECT-2.5 | 0.1% | SOT323-5L | 2.5 | A25 | -40°C to +125°C |
| LM4040BECT-2.5 | 0.2% | SOT323-5L | 2.5 | A25 | -40°C to +125°C |
| LM4040CECT-2.5 | 0.5% | SOT323-5L | 2.5 | C25 | -40°C to +125°C |
| LM4040DECT-2.5 | 1.0% | SOT323-5L | 2.5 | D25 | -40°C to +125°C |
| LM4040AELT-3.0 | 0.1% | SOT23-3L | 3.0 | A30 | -40°C to +125°C |
| LM4040BELT-3.0 | 0.2% | SOT23-3L | 3.0 | B30 | -40°C to +125°C |
| LM4040CELT-3.0 | 0.5% | SOT23-3L | 3.0 | C30 | -40°C to +125°C |
| LM4040DELT-3.0 | 1.0% | SOT23-3L | 3.0 | D30 | -40°C to +125°C |
| LM4040AECT-3.0 | 0.1% | SOT323-5L | 3.0 | A30 | -40°C to +125°C |
| LM4040BECT-3.0 | 0.2% | SOT323-5L | 3.0 | A30 | -40°C to +125°C |
| LM4040CECT-3.0 | 0.5% | SOT323-5L | 3.0 | C30 | -40°C to +125°C |
| LM4040DECT-3.0 | 1.0% | SOT323-5L | 3.0 | D30 | -40°C to +125°C |
| LM4040AELT-4.1 | 0.1% | SOT23-3L | 4.096 | A40 | -40°C to +125°C |
| LM4040BELT-4.1 | 0.2% | SOT23-3L | 4.096 | B40 | -40°C to +125°C |
| LM4040CELT-4.1 | 0.5% | SOT23-3L | 4.096 | C40 | -40°C to +125°C |
| LM4040DELT-4.1 | 1.0% | SOT23-3L | 4.096 | D40 | -40°C to +125°C |
| LM4040AECT-4.1 | 0.1% | SOT323-5L | 4.096 | A40 | -40°C to +125°C |
| LM4040BECT-4.1 | 0.2% | SOT323-5L | 4.096 | A40 | -40°C to +125°C |
| LM4040CECT-4.1 | 0.5% | SOT323-5L | 4.096 | C40 | -40°C to +125°C |
| LM4040DECT-4.1 | 1.0% | SOT323-5L | 4.096 | D40 | -40°C to +125°C |
| LM4040AELT-5.0 | 0.1% | SOT23-3L | 5.0 | A50 | -40°C to +125°C |
| LM4040BELT-5.0 | 0.2% | SOT23-3L | 5.0 | B50 | -40°C to +125°C |
| LM4040CELT-5.0 | 0.5% | SOT23-3L | 5.0 | C50 | -40°C to +125°C |
| LM4040DELT-5.0 | 1.0% | SOT23-3L | 5.0 | D50 | -40°C to +125°C |
| LM4040AECT-5.0 | 0.1% | SOT323-5L | 5.0 | A50 | -40°C to +125°C |
| LM4040BECT-5.0 | 0.2% | SOT323-5L | 5.0 | A50 | -40°C to +125°C |

| Order codes | Precision (%) | Package | Output voltage (V) | Marking | Temperature range (°C) |
|---|---|---|---|---|---|
| LM4040CECT-5.0 | 0.5% | SOT323-5L | 5.0 | C50 | -40°C to +125°C |
| LM4040DECT-5.0 | 1.0% | SOT323-5L | 5.0 | D50 | -40°C to +125°C |

# Revision history

**Table 6.** Document revision history

| Date | Version | Changes |
|------|---------|---------|
| 26-Jan-2021 | 1 | First release. |

# Contents

# List of tables

# List of figures

**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. For additional information about ST trademarks, please refer to www.st.com/trademarks. 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.

# X-ON Electronics

Largest Supplier of Electrical and Electronic Components

*Click to view similar products for* Voltage References *category:*

*Click to view products by* STMicroelectronics *manufacturer:*

Other Similar products are found below :

REF01J/883  5962-8686103XC  NCV431BVDMR2G  LT6654AMPS6-2.048#TRMPBF  SCV431AIDMR2G  LT1019AIS8-2.5  SC431ILPRAG  AP432AQG-7  NJM2823F-TE1  TL431-A  MCP1502T-18E/CHY  MCP1502T-40E/CHY  TL431ACZ  KA431SLMF2TF  KA431SMF2TF  KA431SMFTF  LM4040QCEM3-3.0/NOPB  LM4041C12ILPR  LM4120AIM5-2.5/NOP  LM431SCCMFX  TS3330AQPR  REF5040MDREP  REF3012AIDBZR  LM285BXMX-1.2/NOPB  LM385BM-2.5/NOPB  LM4040AIM3-10.0  LM4040BIM3-4.1  LM4040CIM3-10.0  LM4040CIM3X-2.0/NOPB  LM4041BSD-122GT3  LM4041QDIM3-ADJ/NO  LM4050QAEM3X4.1/NOPB  LM4051BIM3-ADJ/NOPB  LM4051CIM3X-1.2/NOPB  LM4128CMF-1.8/NOPB  LM4132DMF-1.8/NOPB  LM4132EMF-1.8/NOPB  LM4132EMF-2.0/NOPB  LM4140CCMX-1.2/NOPB  LM431CIM  LM385BD-2.5R2G  LM385M-2.5/NOPB  LM4030AMF-4.096/NOPB  LM4040D30ILPR  LM4051CIM3X-ADJ/NOPB  AP432YG-13  AS431ANTR-G1  AS431BZTR-E1  AN431AN-ATRG1  AP431IBNTR-G1