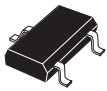
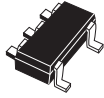


## Precision micropower shunt voltage reference



SOT23-3L



SOT323-5L

### 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  $\mu$ A at 25 °C
- High precision @ 25 °C: +/- 0.1% (LM4040A), +/- 0.2% (LM4040B), +/- 0.5 % (LM4040C), +/- 1% (LM4040D)
- Very low LF noise: typ.10  $\mu$  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

### Maturity status link

[LM4040](#)

### Applications

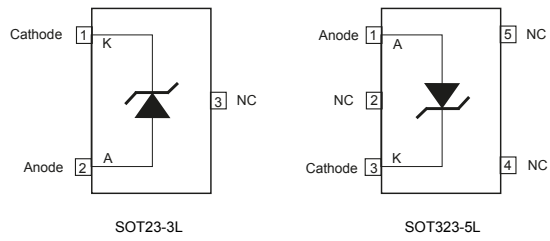
- Portable, battery-operated equipment
- Data acquisition systems
- Instrumentation

### 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)



*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 <sup>(1)</sup>     | 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  $T_{amb} = 25\text{ °C}$  and  $T_{jmax} = 150\text{ °C}$ .

**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

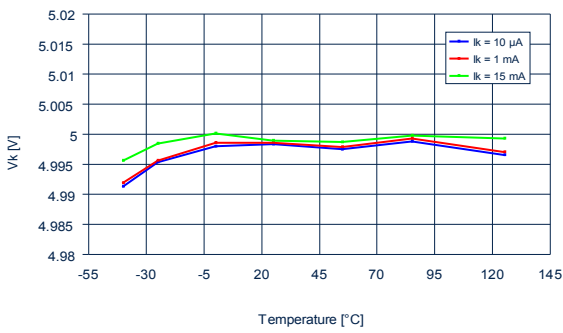
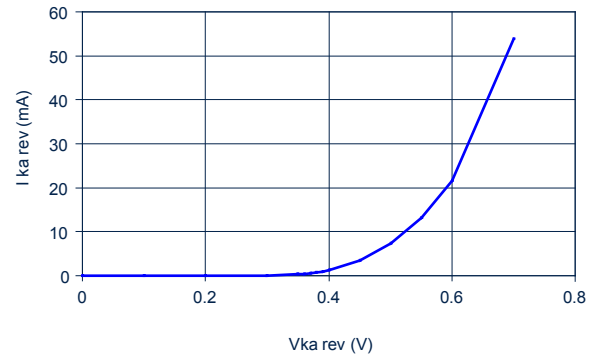
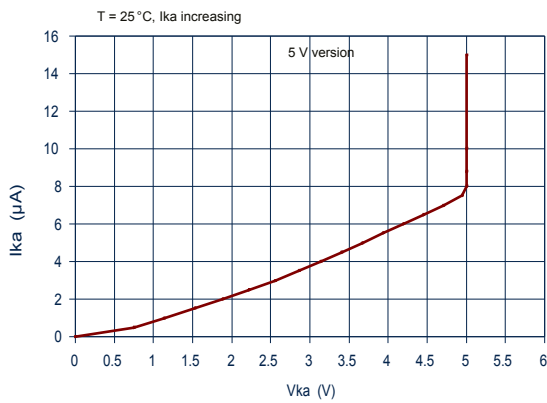
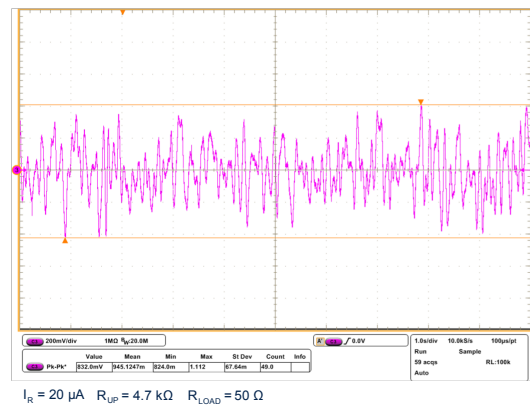
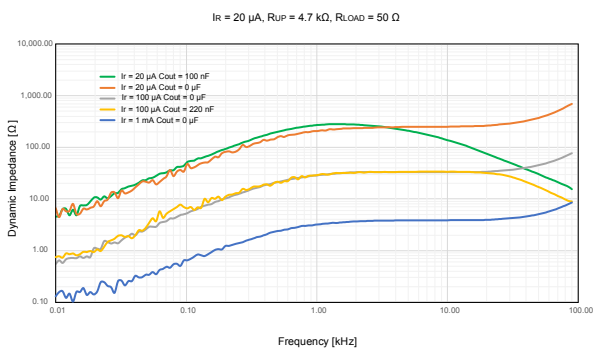
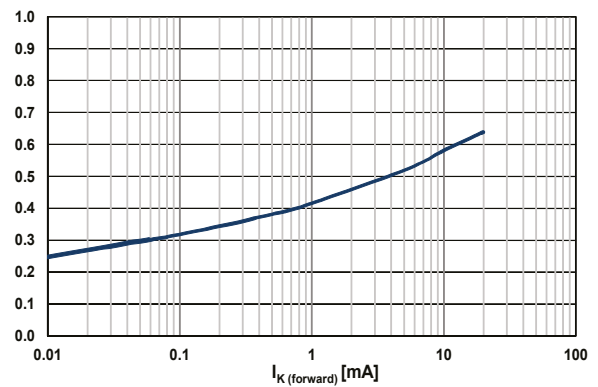
Limits are 100% production tested at 25 °C. Limits over full temperature range are guaranteed through correlation and by design.  $I_k = 10 \mu\text{A}$ ,  $T_{\text{amb}} = 25 \text{ °C}$  (unless otherwise specified).

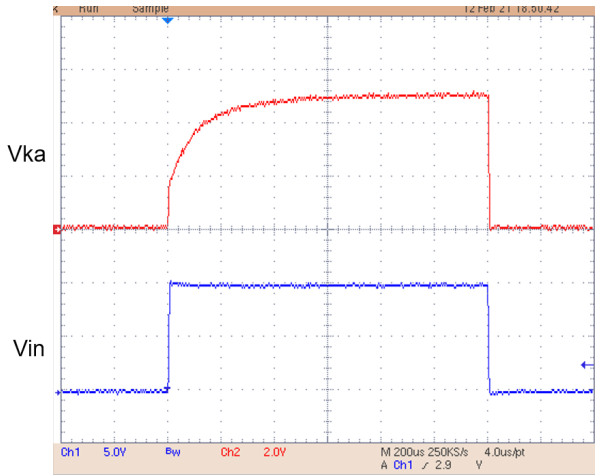
| Symbol   | Parameter   | Test conditions   | Min.    | Typ.   | Max.   | Unit              |
|--|---|---|---------|--------|--------|-------------------|
| $V_k$  | Reverse breakdown voltage<br>( $V_k = 2.048 \text{ V}$ )      | $I_k = 10 \mu\text{A}$ , LM4040A  | 2.0460  | 2.048  | 2.0500 | V                 |
|  |   | $I_k = 10 \mu\text{A}$ , LM4040B  | 2.0439  |        | 2.0521 |                   |
|  |   | $I_k = 10 \mu\text{A}$ , LM4040C  | 2.0378  |        | 2.0582 |                   |
|  |   | $I_k = 10 \mu\text{A}$ , LM4040D  | 2.0275  |        | 2.0685 |                   |
|  | Reverse breakdown voltage<br>( $V_k = 2.5 \text{ V}$ )        | $I_k = 10 \mu\text{A}$ , LM4040A  | 2.4975  | 2.50   | 2.5025 | V                 |
|  |   | $I_k = 10 \mu\text{A}$ , LM4040B  | 2.4950  |        | 2.5050 |                   |
|  |   | $I_k = 10 \mu\text{A}$ , LM4040C  | 2.04875 |        | 2.5125 |                   |
|  |   | $I_k = 10 \mu\text{A}$ , LM4040D  | 2.4750  |        | 2.5250 |                   |
|  | Reverse breakdown voltage<br>( $V_k = 3.0 \text{ V}$ )        | $I_k = 12 \mu\text{A}$ , LM4040A  | 2.9970  | 3.0    | 3.0030 | V                 |
|  |   | $I_k = 12 \mu\text{A}$ , LM4040B  | 2.9940  |        | 3.0060 |                   |
|  |   | $I_k = 12 \mu\text{A}$ , LM4040c  | 2.9850  |        | 3.0150 |                   |
|  |   | $I_k = 12 \mu\text{A}$ , LM4040D  | 2.9700  |        | 3.0300 |                   |
|  | Reverse breakdown voltage<br>( $V_k = 4.096 \text{ V}$ )      | $I_k = 20 \mu\text{A}$ , LM4040A  | 4.0919  | 4.096  | 4.1001 | V                 |
|  |   | $I_k = 20 \mu\text{A}$ , LM4040B  | 4.0878  |        | 4.1042 |                   |
|  |   | $I_k = 20 \mu\text{A}$ , LM4040C  | 4.0755  |        | 4.1165 |                   |
|  |   | $I_k = 20 \mu\text{A}$ , LM4040D  | 4.0550  |        | 4.1370 |                   |
| Reverse breakdown voltage<br>( $V_k = 4.096 \text{ V}$ ) | $I_k = 20 \mu\text{A}$ , LM4040A                              | 4.9950  | 5.0     | 5.0050 | V      |                   |
|  | $I_k = 20 \mu\text{A}$ , LM4040B                              | 4.9900  |         | 5.0100 |        |                   |
|  | $I_k = 20 \mu\text{A}$ , LM4040C                              | 4.9750  |         | 5.0250 |        |                   |
|  | $I_k = 20 \mu\text{A}$ , LM4040D                              | 4.9500  |         | 5.0500 |        |                   |
| $I_{k\text{min}}$  | Minimum operating current                                     | $T_{\text{amb}} = 25 \text{ °C}$ , $V_k < 2.5 \text{ V}$                                      |         | 7.5    | 10     | mA                |
|  |   | $-40 \text{ °C} < T_{\text{amb}} < +125 \text{ °C}$   |         |        | 12     |                   |
|  |   | $T_{\text{amb}} = 25 \text{ °C}$ , $V_k > 3.0 \text{ V}$                                      |         | 15     | 20     |                   |
|  |   | $-40 \text{ °C} < T_{\text{amb}} < +125 \text{ °C}$   |         |        | 25     |                   |
| $\Delta V_k / \Delta T$                                  | Average temperature coefficient                               | $10 \mu\text{A} < I_k < 20 \text{ mA}$  |         | 20     | 70     | ppm/°C            |
| $\Delta V_k / \Delta I_k$                                | Reverse breakdown voltage change with operating current range | $I_k \text{ min} < I_k < 1 \text{ mA}$<br>$-40 \text{ °C} < T_{\text{amb}} < +125 \text{ °C}$ |         | 0.2    | 1      | mV                |
|  |   | $1 \text{ mA} < I_k < 15 \text{ mA}$<br>$-40 \text{ °C} < T_{\text{amb}} < +125 \text{ °C}$   |         | 1.7    | 4      |                   |
| $R_{ka}$   | Static impedance  | $\Delta I_k = 10 \mu\text{A}$ to $10 \text{ mA}$  |         | 0.15   | 0.3    | $\Omega$          |
| Hys  | Thermal hysteresis <sup>(1)</sup>                             | $I_k = 10 \mu\text{A}$  |         | 120    |        | ppm               |
| Noise  | Wideband noise  | $I_k = 10 \mu\text{A}$ , $10 \text{ Hz} < f < 10 \text{ kHz}$                                 |         | 95     |        | mV <sub>RMS</sub> |
|  | Low frequency noise   | $I_k = 10 \mu\text{A}$ , $0.1 \text{ Hz} < f < 10 \text{ Hz}$                                 |         | 10     |        | $\mu\text{Vp-p}$  |

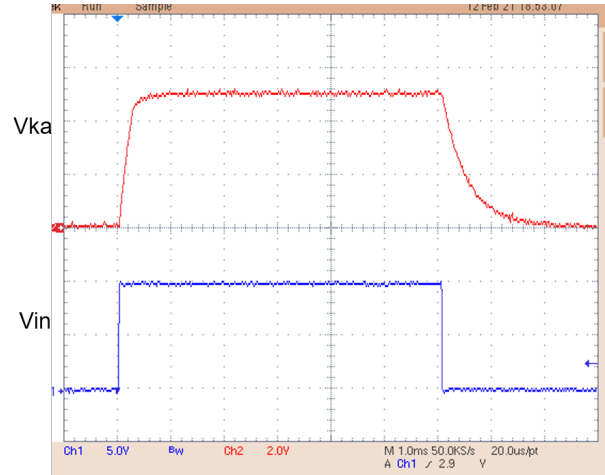
1. Thermal hysteresis is defined as the difference in voltage measured at +25 °C after cycling to -40 °C and the measurement at +25 °C after cycling to temperature +125 °C.

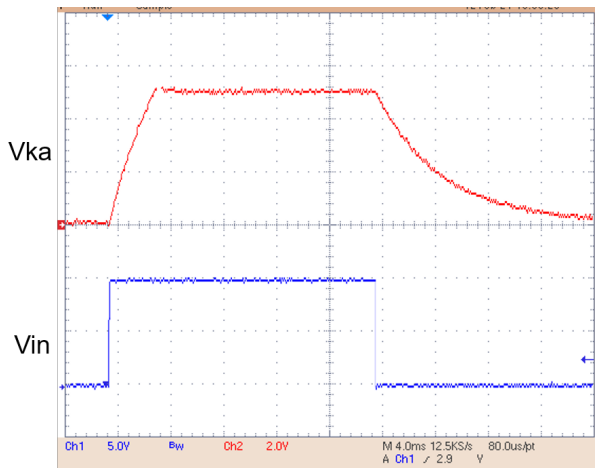
## 4 Typical performance characteristics

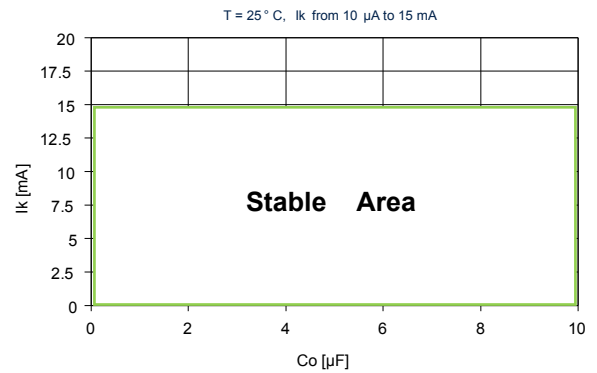
( $C_{IN} = 1 \mu\text{F}$ ;  $C_{OUT} = 10 \mu\text{F}$ ,  $T_J = 25^\circ\text{C}$  unless otherwise specified.)

**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**

**Figure 6. Measured dynamic impedance**

**Figure 7. Forward characteristics**


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

 Vin: 10 V, trise: 5  $\mu$ sec, Ika: 10  $\mu$ A, No Load

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

 Vin: 10 V, trise: 5  $\mu$ sec, Ika: 10  $\mu$ A, Load: 100 nF

**Figure 10. Turn-on time setting (Load = 1  $\mu$ F)**

 Vin: 10 V, trise: 5  $\mu$ sec, Ika: 10  $\mu$ A, Load: 1  $\mu$ F

**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](http://www.st.com). ECOPACK is an ST trademark.

### 5.1 SOT23-3L package information

Figure 12. SOT23-3L package outline

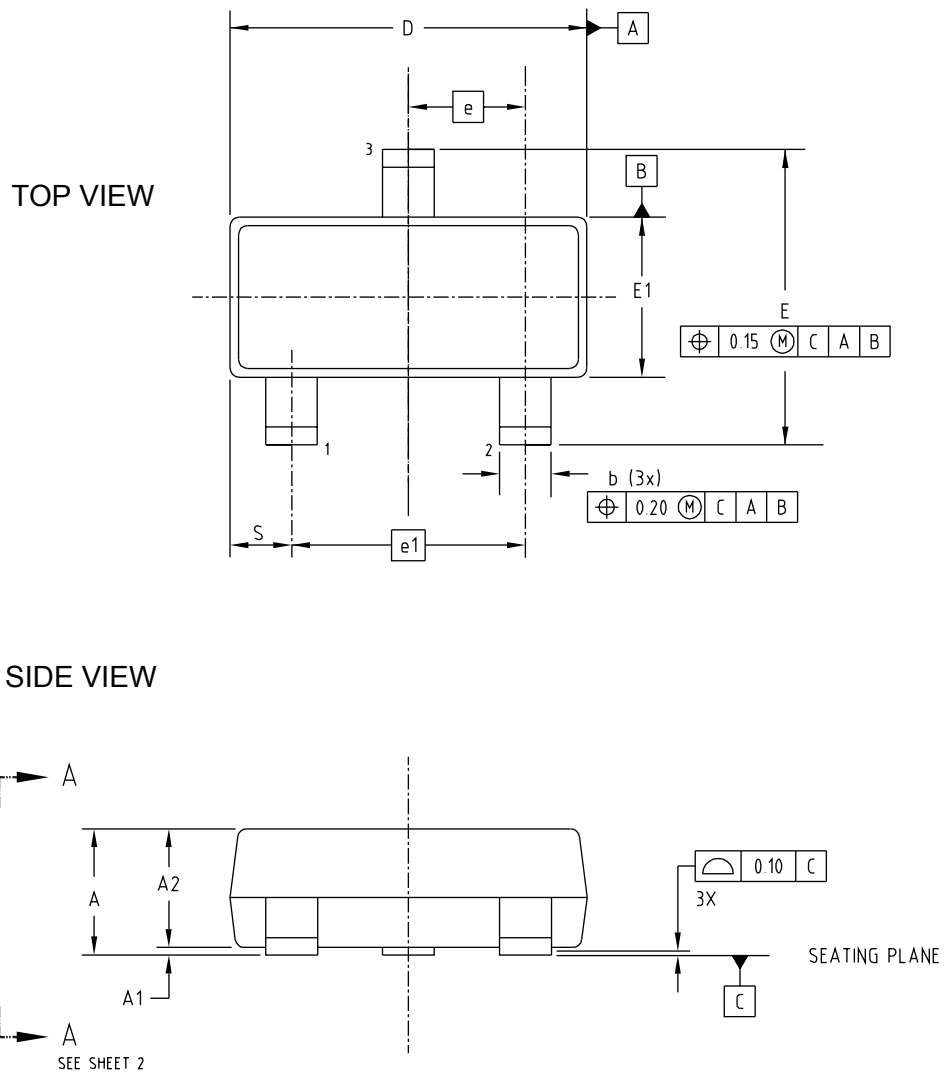
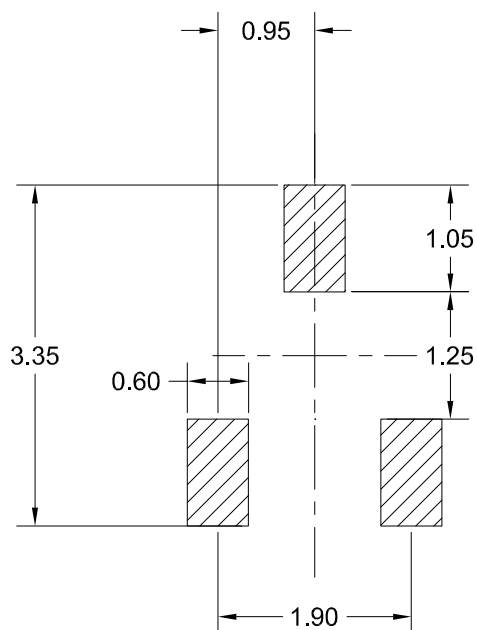


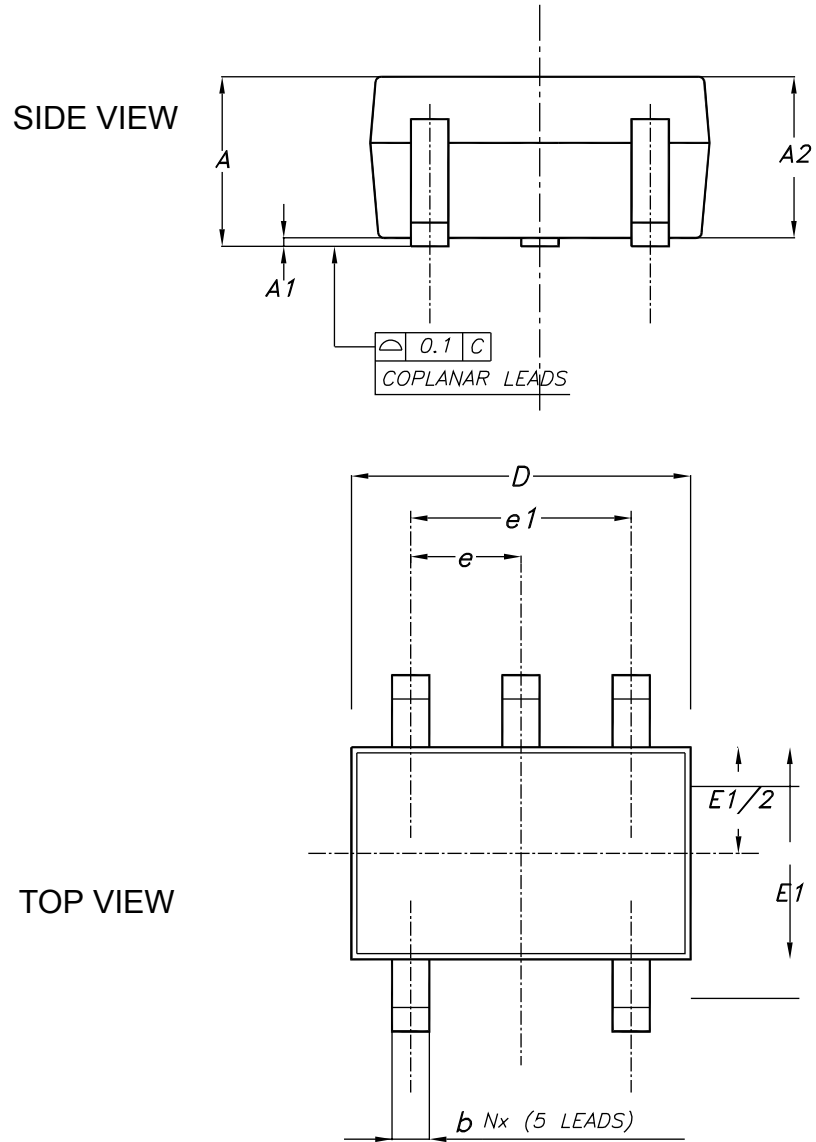
Table 4. SOT23-3L mechanical data

| 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

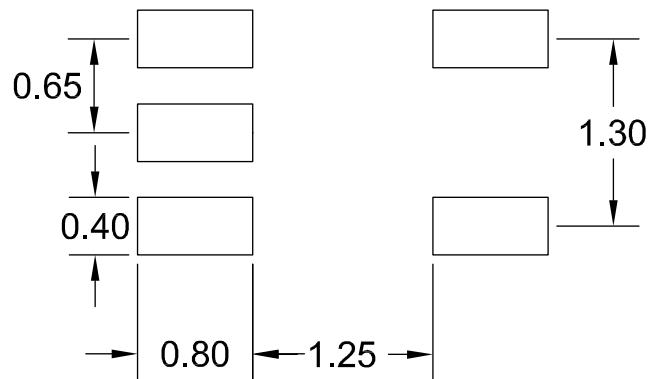




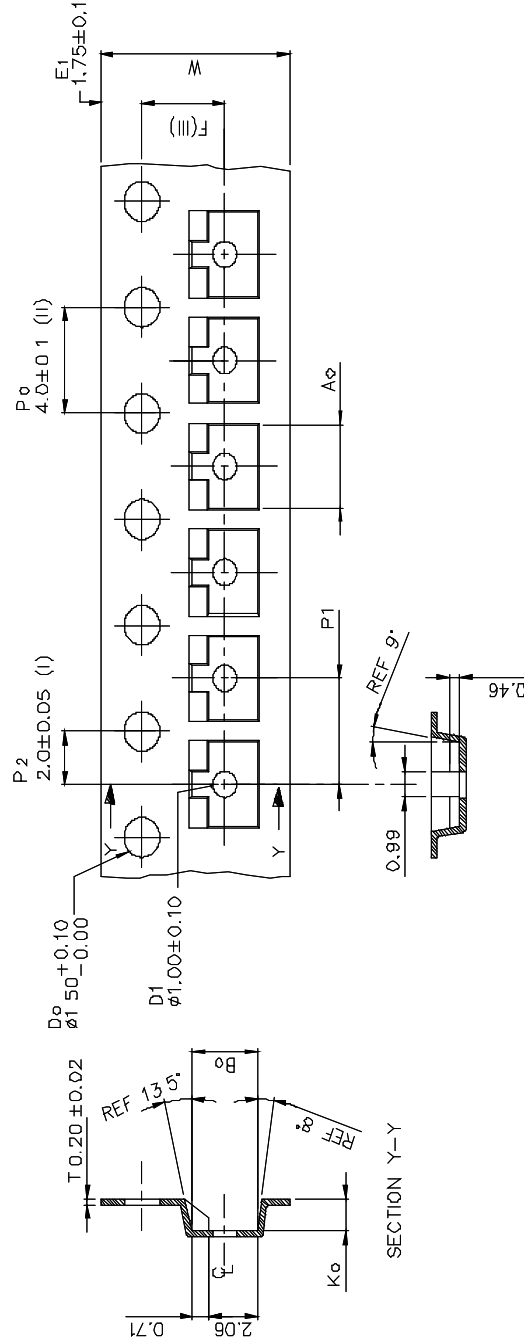
**5.2 SOT323-5L package information**
**Figure 14. SOT323-5L package outline**


**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     |          |      |
| θ    | 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**


- (I) Measured from centreline of sprocket hole to centreline of pocket.
- (II) Cumulative tolerance of 10 sprocket holes is  $\pm 0.20$ .
- (III) Measured from centreline of sprocket hole to centreline of pocket.
- (IV) Other material available.
- (V) Typical SR of form tape Max. 10° OHM/SR

ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.

|       |        |             |
|-------|--------|-------------|
| $A_0$ | $3.15$ | $+/-0.10$   |
| $B_0$ | $2.77$ | $+/-0.10$   |
| $K_0$ | $1.22$ | $+/-0.10$   |
| $F$   | $3.50$ | $+/-0.05$   |
| $P_1$ | $4.00$ | $+/-0.10$   |
| $W$   | $8.00$ | $+0.3/-0.1$ |

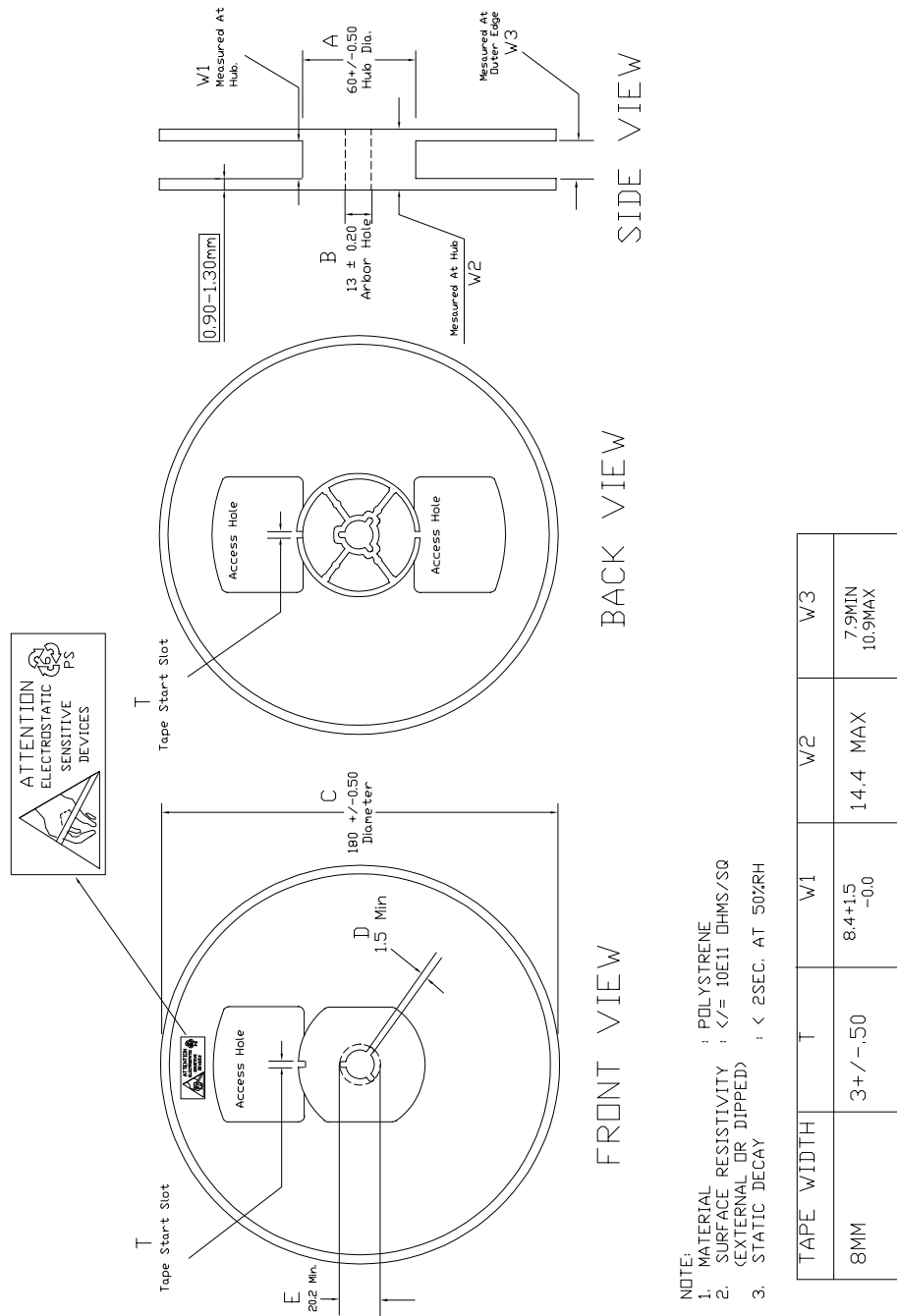
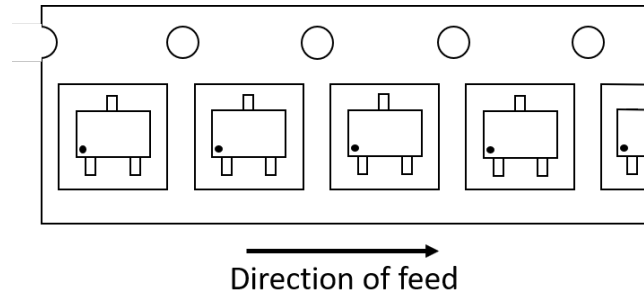
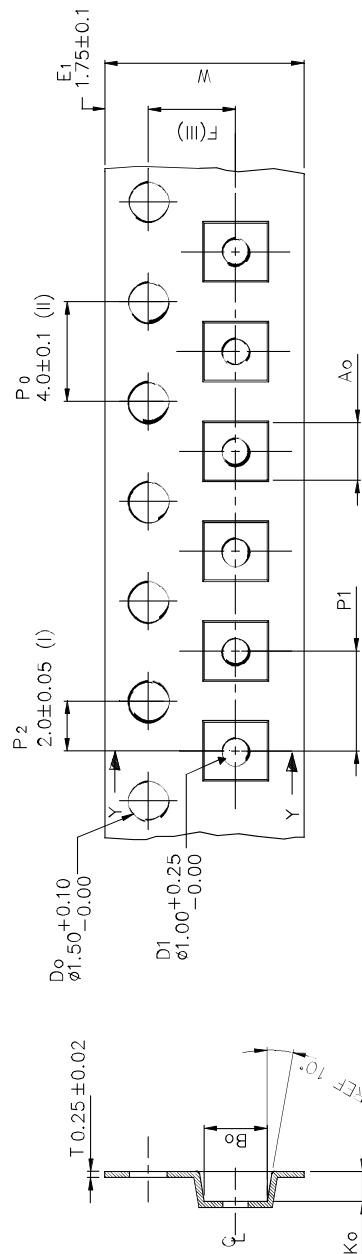
**Figure 17. SOT23-3L reel drawing**


Figure 18. SOT23-3L tape direction



## 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  $\pm 0.20$ .
  - (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

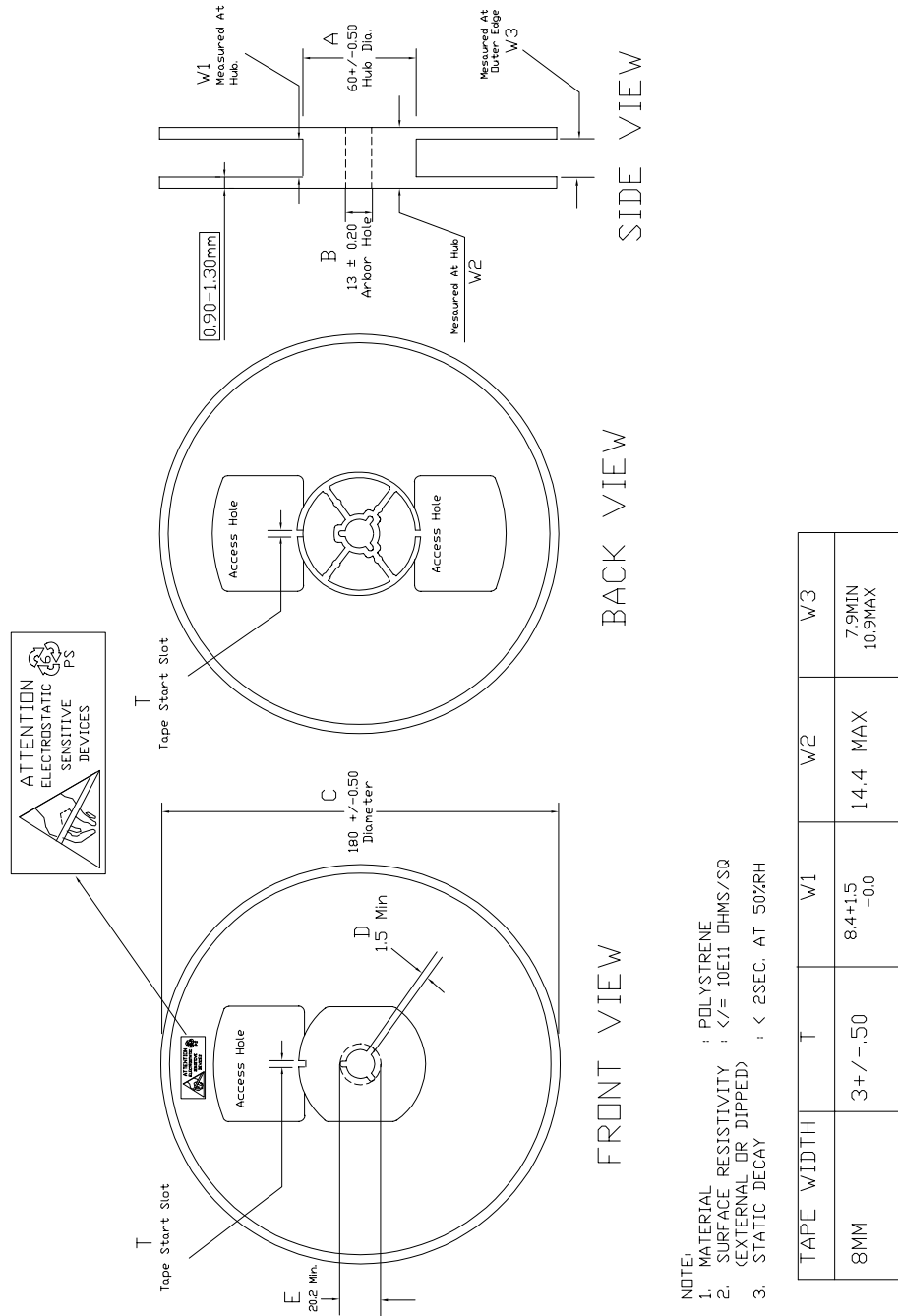
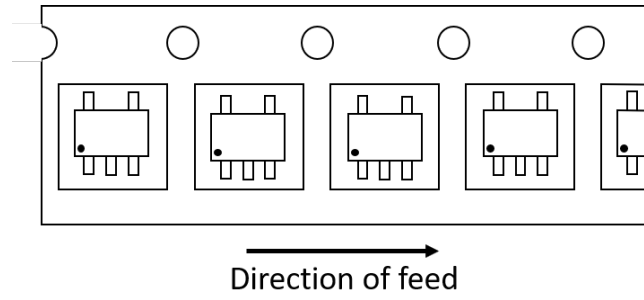


Figure 21. SOT323-5L tape direction



## 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        |

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## Revision history

**Table 6. Document revision history**

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

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