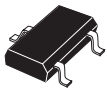
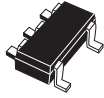


Precision micropower shunt voltage reference



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 μ 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 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

Maturity status link

[LM4040](#)

Applications

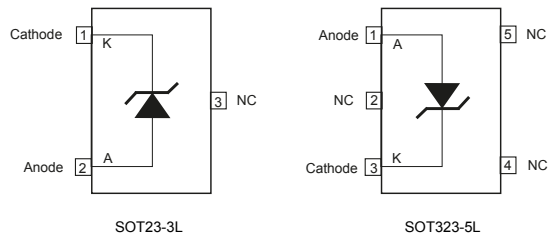
- Portable, battery-operated equipment
- Data acquisition systems
- Instrumentation

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 ⁽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 $T_{amb} = 25\text{ °C}$ 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 ($V_k = 2.048 \text{ V}$) | $I_k = 10 \mu\text{A}$, 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 ($V_k = 2.5 \text{ V}$) | $I_k = 10 \mu\text{A}$, 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 ($V_k = 3.0 \text{ V}$) | $I_k = 12 \mu\text{A}$, 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 ($V_k = 4.096 \text{ V}$) | $I_k = 20 \mu\text{A}$, 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 ($V_k = 4.096 \text{ V}$) | $I_k = 20 \mu\text{A}$, 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 | $I_k \text{ min} < I_k < 1 \text{ mA}$ $-40 \text{ °C} < T_{\text{amb}} < +125 \text{ °C}$ | | 0.2 | 1 | mV |
| | | $1 \text{ mA} < I_k < 15 \text{ mA}$ $-40 \text{ °C} < T_{\text{amb}} < +125 \text{ °C}$ | | 1.7 | 4 | |
| R_{ka} | Static impedance | $\Delta I_k = 10 \mu\text{A}$ to 10 mA | | 0.15 | 0.3 | Ω |
| Hys | Thermal hysteresis ⁽¹⁾ | $I_k = 10 \mu\text{A}$ | | 120 | | ppm |
| Noise | Wideband noise | $I_k = 10 \mu\text{A}$, $10 \text{ Hz} < f < 10 \text{ kHz}$ | | 95 | | mV _{RMS} |
| | 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.)

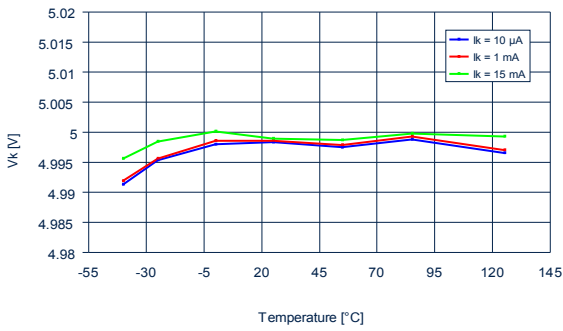
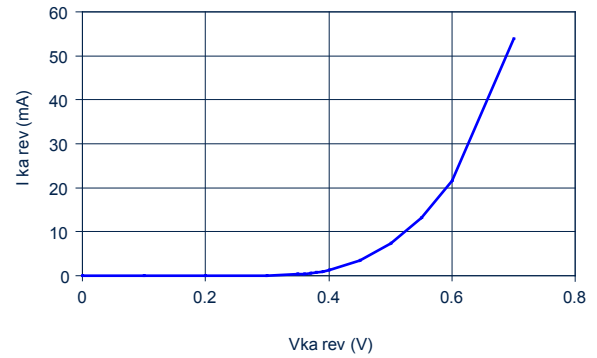
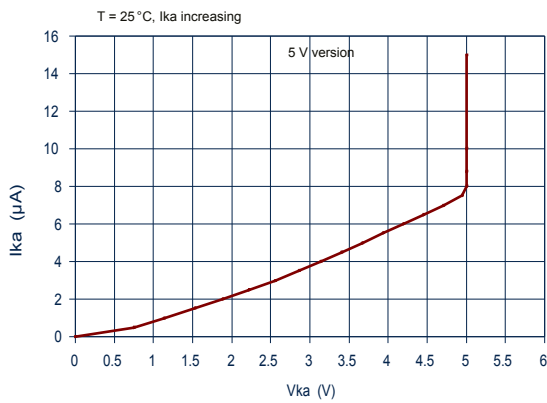
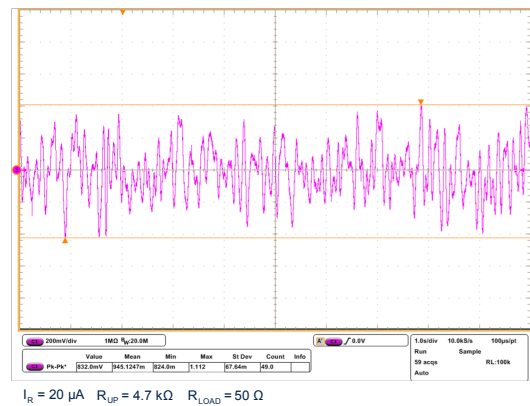
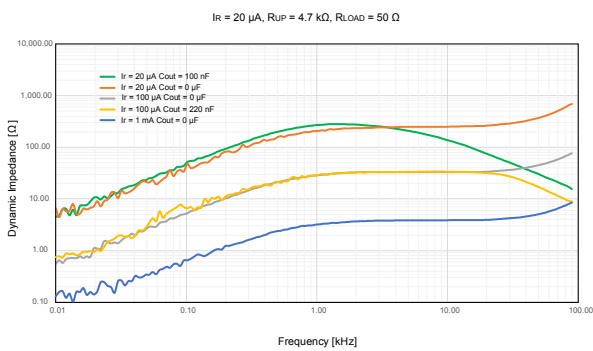
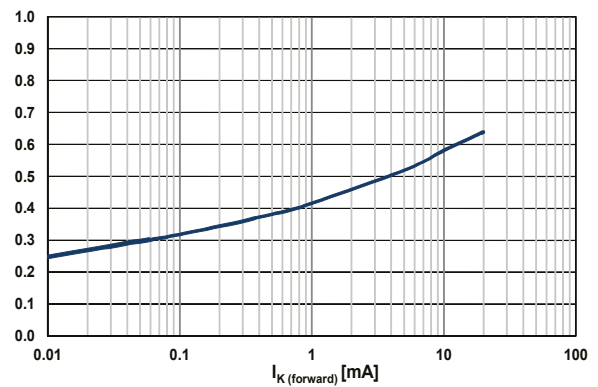
Figure 2. V_K change vs. temperature (5 V version)

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


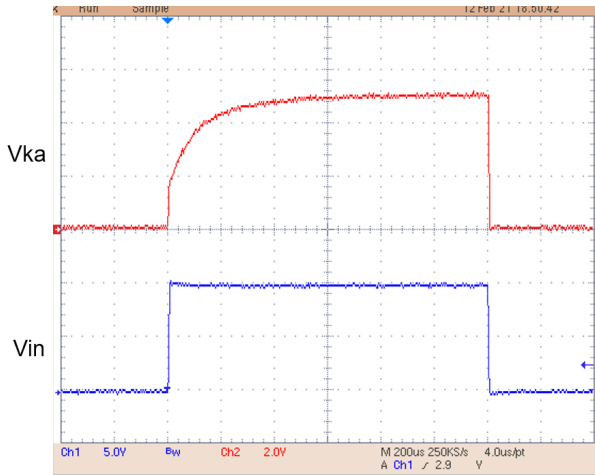
Figure 8. Turn-on time setting (no Load)

 Vin: 10 V, trise: 5 μ sec, Ika: 10 μ A, No Load

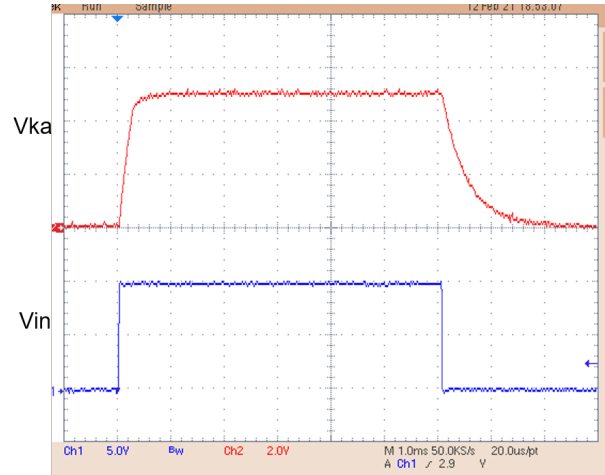
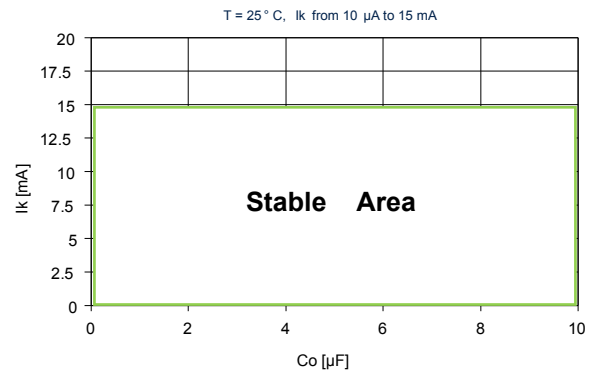
Figure 9. Turn-on time setting (Load = 100 nF)

 Vin: 10 V, trise: 5 μ sec, Ika: 10 μ A, Load: 100 nF

Figure 10. Turn-on time setting (Load = 1 μ F)

 Vin: 10 V, trise: 5 μ sec, Ika: 10 μ A, Load: 1 μ 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. ECOPACK is an ST trademark.

5.1 SOT23-3L package information

Figure 12. SOT23-3L package outline

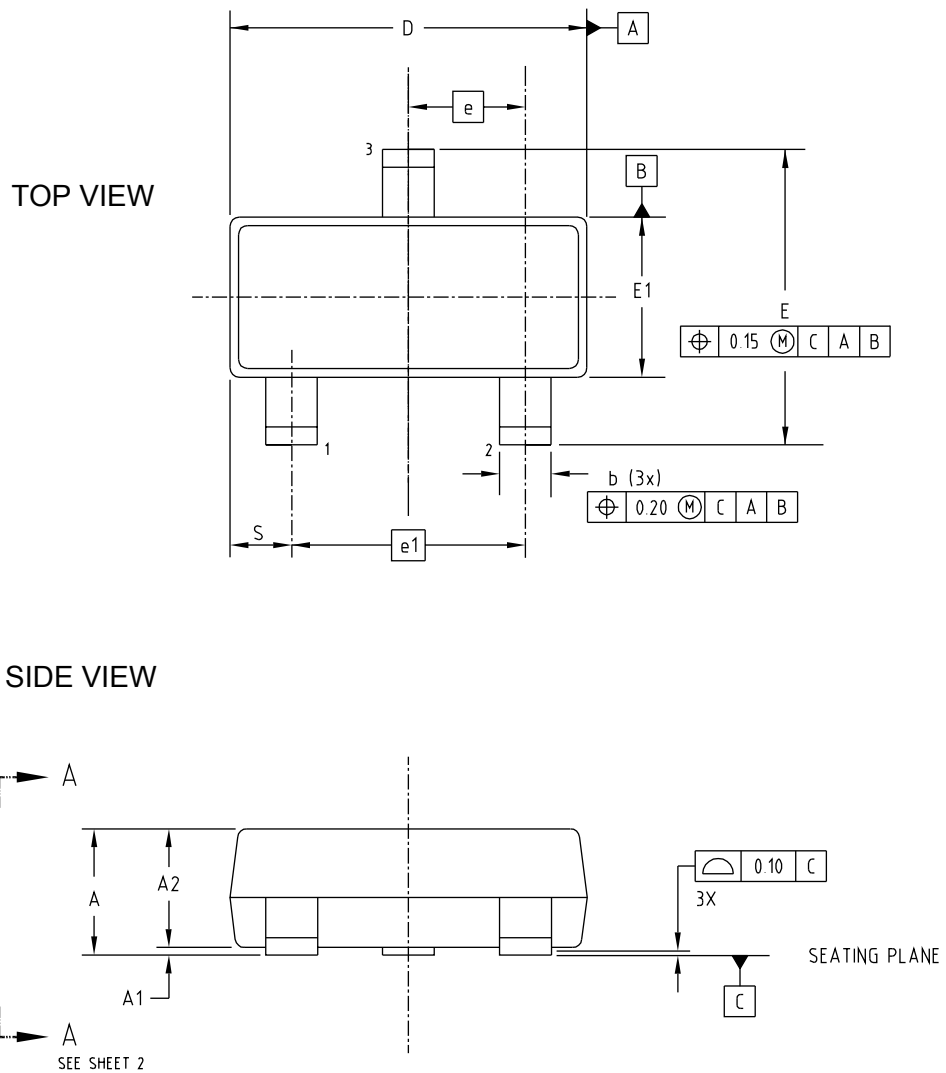
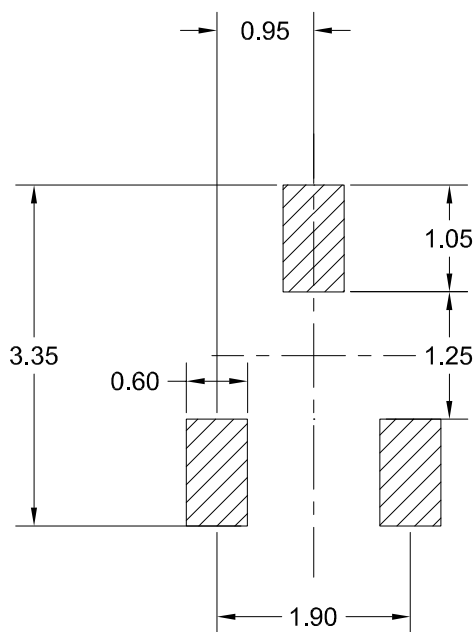


Table 4. SOT23-3L mechanical data

| 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



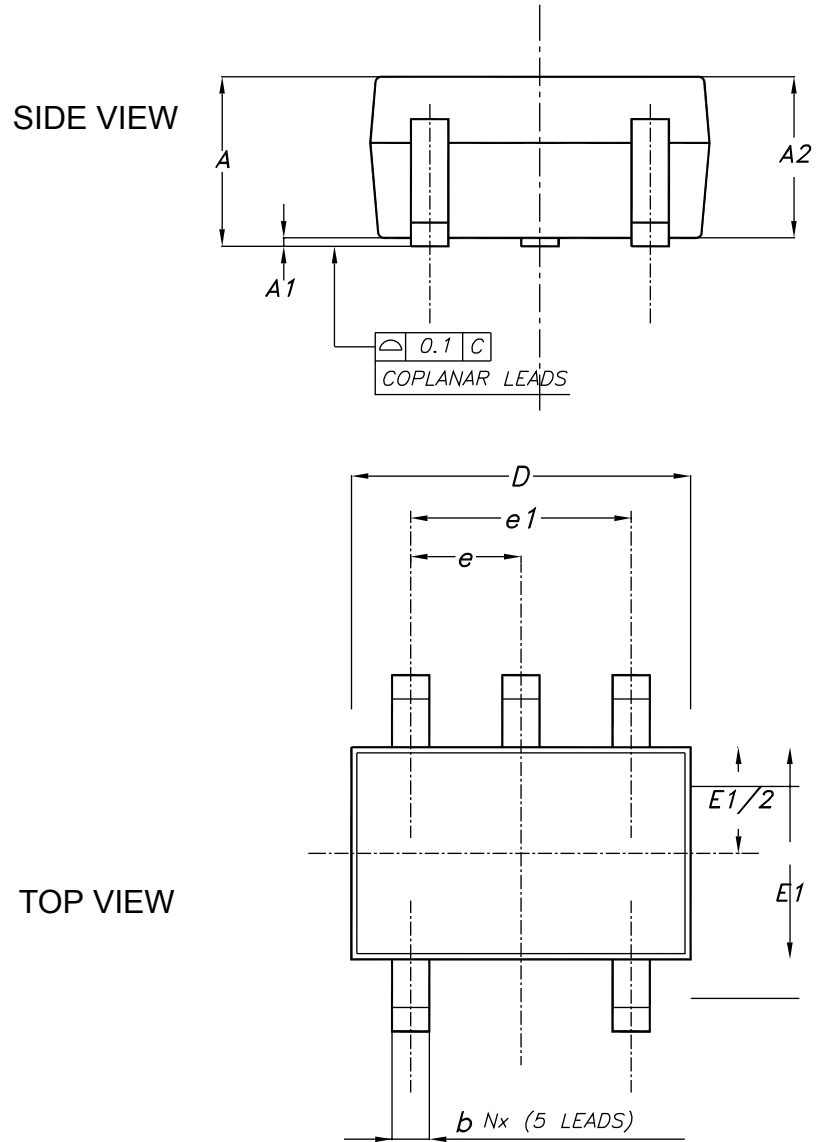
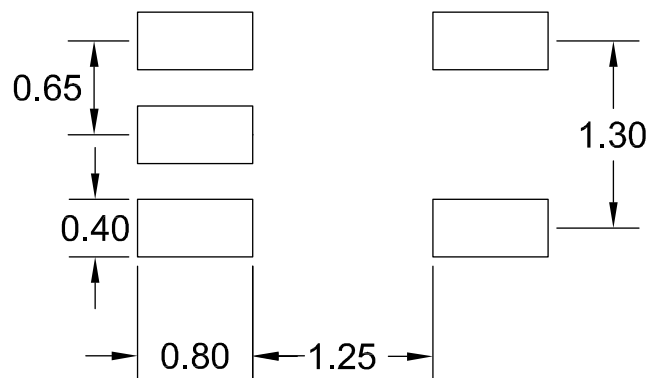
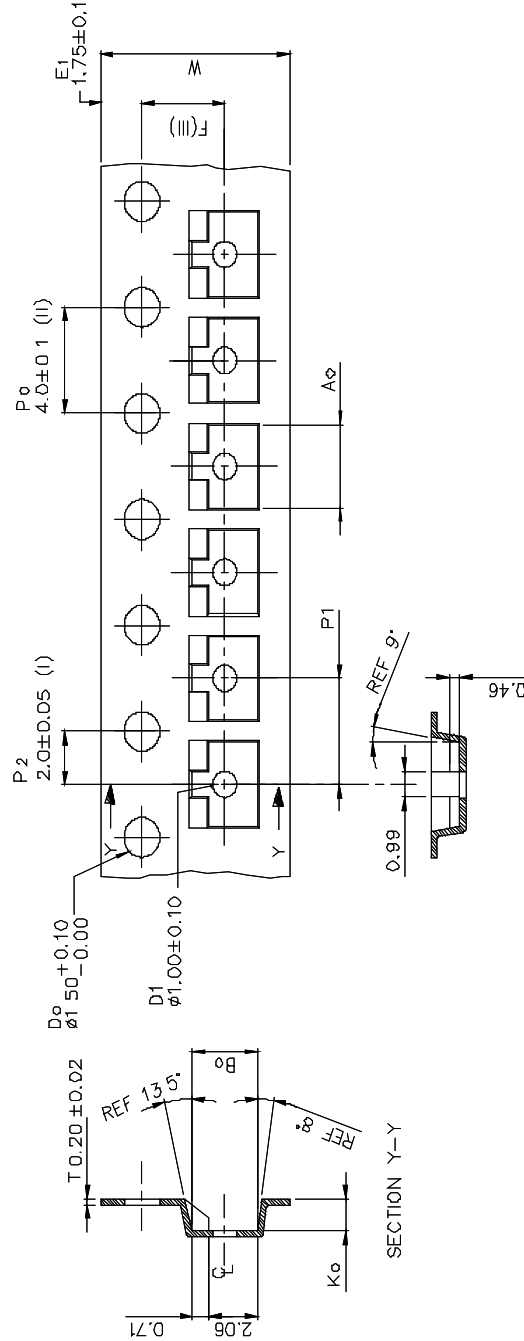
5.2 SOT323-5L package information
Figure 14. SOT323-5L package outline


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 ± 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 | $+0.3/-0.1$ |

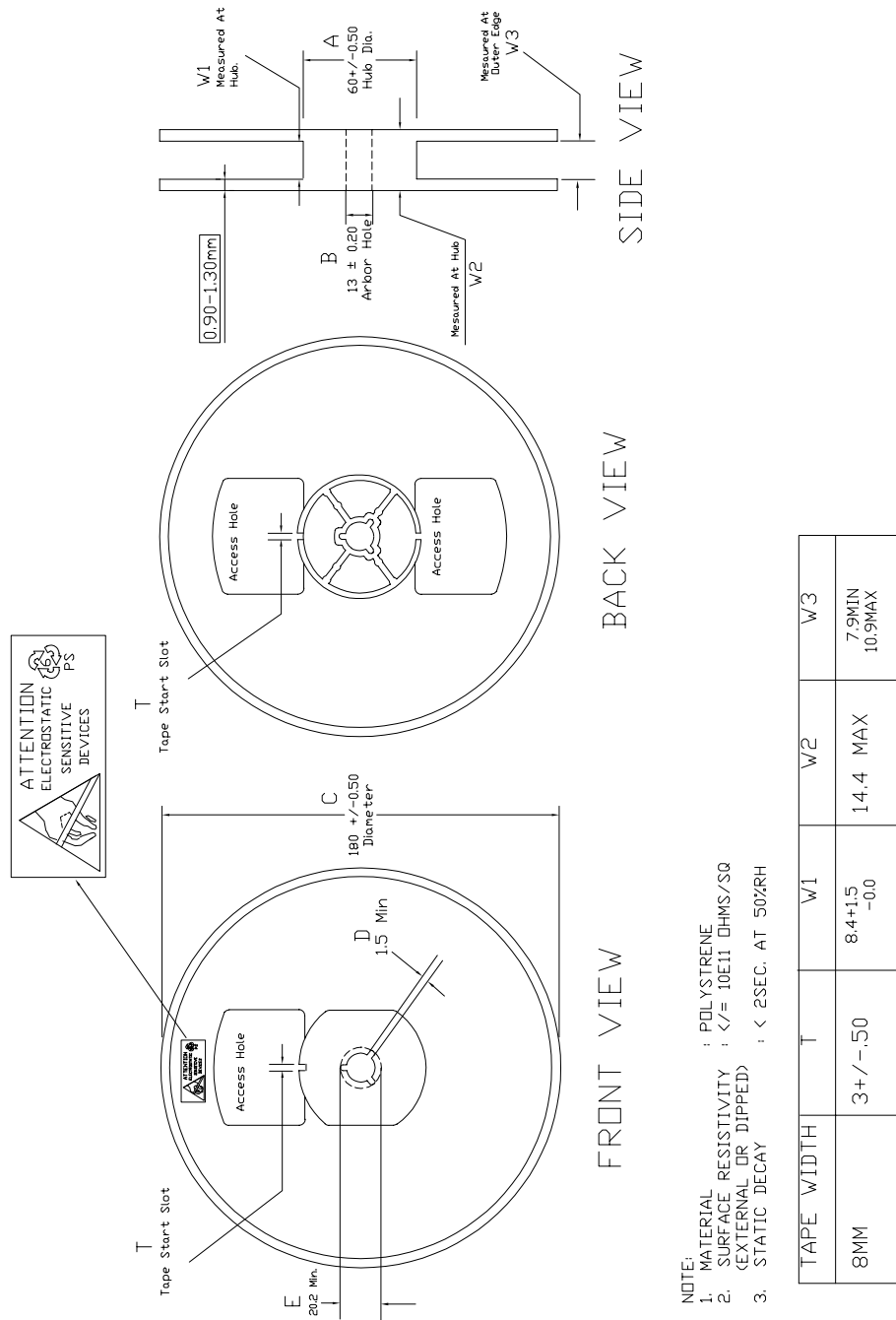
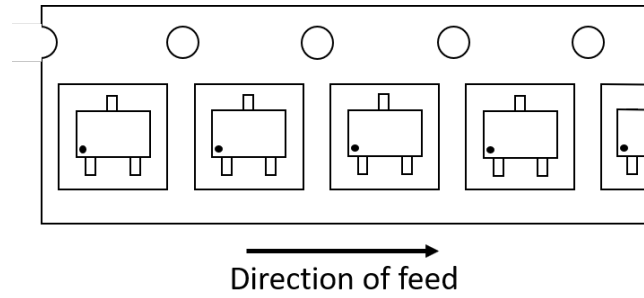
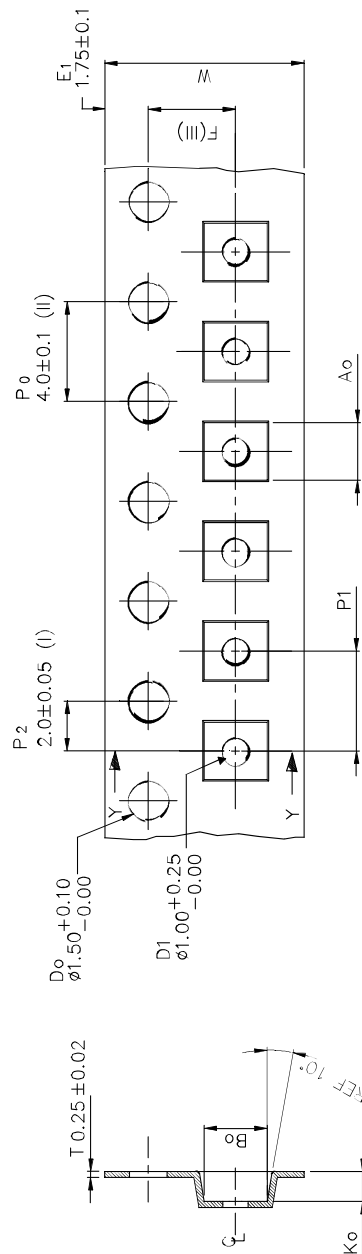
Figure 17. SOT23-3L reel drawing


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 ± 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 |
| B0 | 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

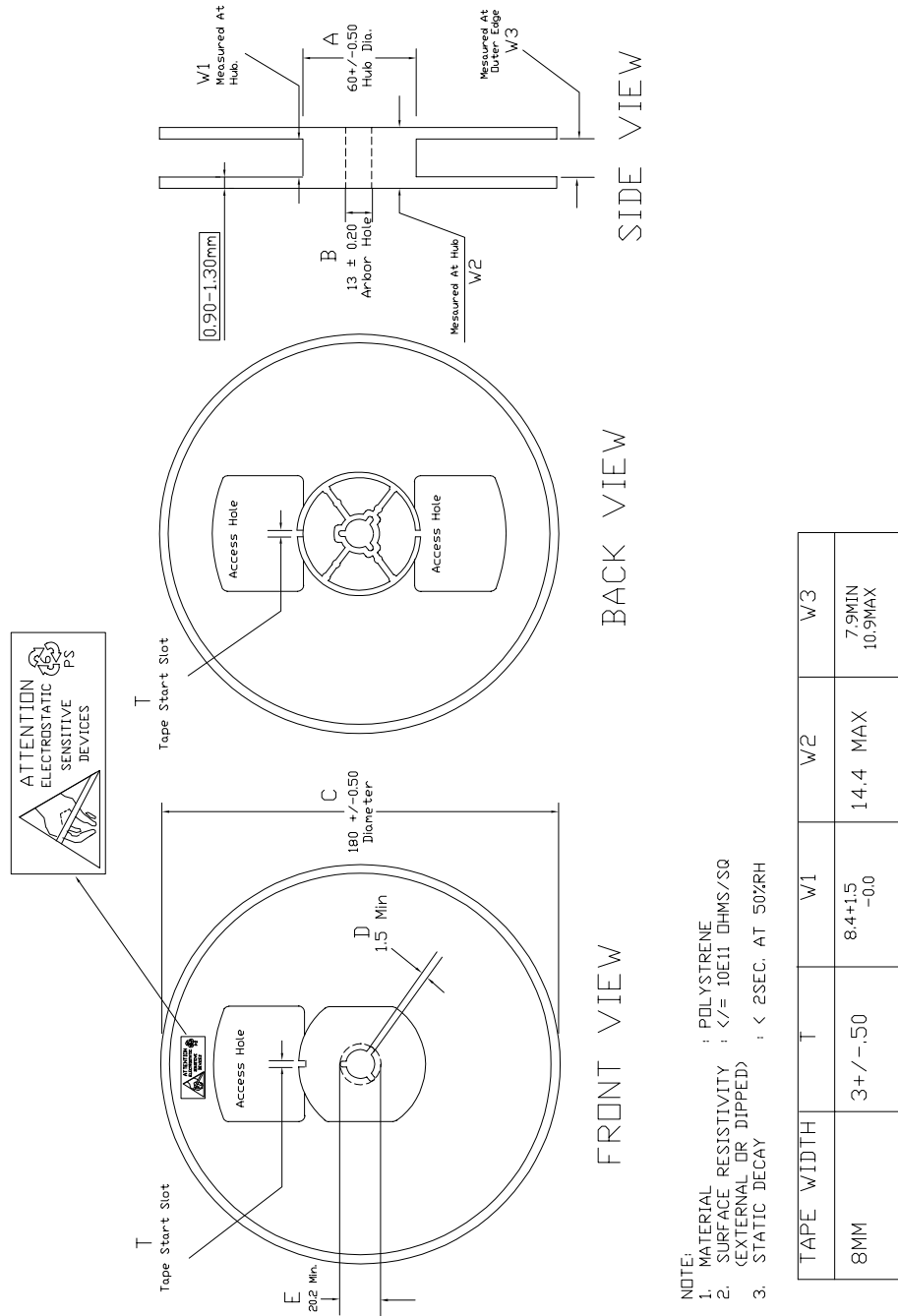
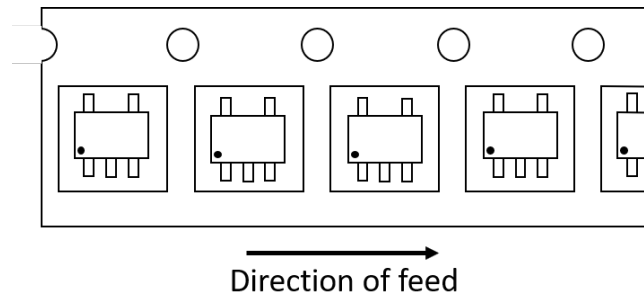


Figure 21. SOT323-5L tape direction



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 |

Revision history

Table 6. Document revision history

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

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