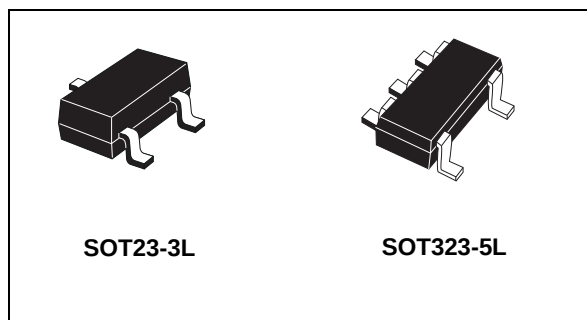


## Precision micropower shunt voltage reference

Datasheet - production data



### Description

The LM4041 is a micropower shunt voltage reference, providing a stable 1.225 V output voltage, with an initial accuracy of 0.1% @ 25 °C and a low temperature coefficient. Available in SOT323-5L and SOT23-3L surface mount 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. In addition, the LM4041 is very stable and can be used in a broad range of application conditions.

### Features

- Fixed 1.225 V typical output voltage
- Ultra low operating current: 40  $\mu$ A at 25 °C
- High precision:  $\pm$  0.1% @ 25 °C (0.2%, 0.5% and 1% versions are also available)
- Stable when used with capacitive loads
- Industrial (- 40 to+ 85 °C) and Extended (- 40 to +125 °C) temperature range versions available
- 100 ppm/°C maximum temperature coefficient
- Available in SOT23-3L and SOT323-5L packages

### Applications

- Computers
- Battery chargers
- Switch mode power supply
- Battery operated equipment
- Data acquisition systems
- Energy management
- Instrumentation

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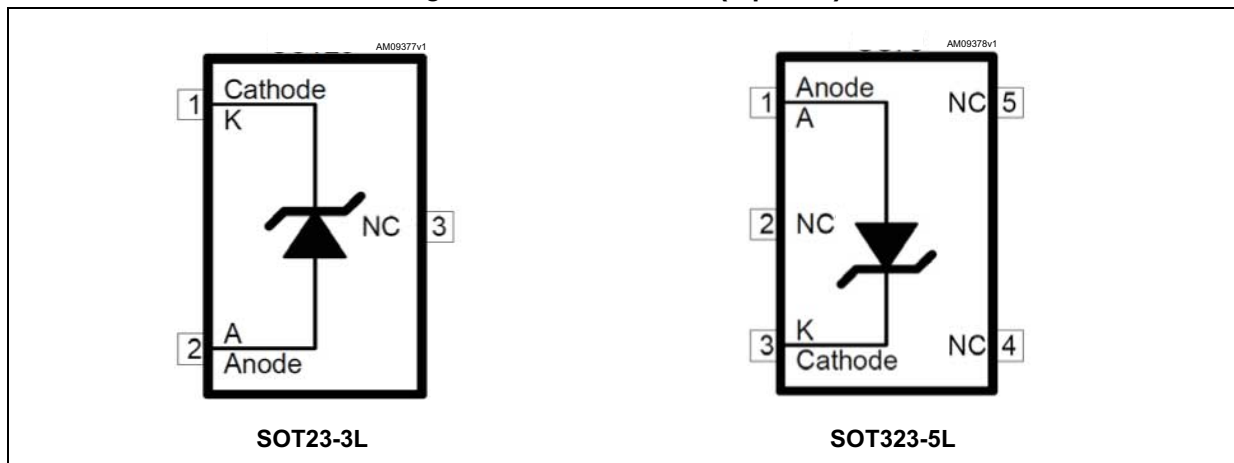
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# 1 Pin configuration

Figure 1. Pin connection (top view)



**Note:** Below pins must be left floating or connected to Anode pin to improve noise immunity due to PCB layout.

SOT23-3L: pin 3.

SOT323-5L: pin 2, pin 4 and pin 5.

## 2 Maximum ratings

**Table 1. Absolute maximum ratings**

| Symbol     | Parameter                                                 | Value        | Unit |
|------------|-----------------------------------------------------------|--------------|------|
| $I_K$      | Reverse breakdown current                                 | 20           | mA   |
| $V_K$      | Maximum cathode voltage                                   | 8            | V    |
| $I_F$      | Forward current                                           | 10           | mA   |
| $P_D$      | Power dissipation <sup>(1)</sup><br>SOT23-3L<br>SOT323-5L | 500<br>536   | mW   |
| $T_{STG}$  | 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   |

1.  $P_D$  has been calculated with  $T_{AMB} = 25^\circ\text{C}$  and  $T_{JMAX} = 150^\circ\text{C}$ .

**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 | 233       | 248      | °C/W |
| $R_{thJC}$ | Thermal resistance junction-case    | 90        | 136      | °C/W |

**Table 3. Operating conditions**

| Symbol     | Parameter                            |            | Value         | Unit |
|------------|--------------------------------------|------------|---------------|------|
| $I_{KMIN}$ | Minimum operating current            |            | 40            | μA   |
| $I_{KMAX}$ | Maximum operating current            |            | 12            | mA   |
| $T_{OPER}$ | Operating free air temperature range | Industrial | - 40 to + 85  | °C   |
|            |                                      | Extended   | - 40 to + 125 |      |

### 3 Electrical characteristics

$T_{AMB} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified.

**Table 4. Electrical characteristics**

| Symbol                    | Parameter                                                     | Test conditions                                                                                                                                                                            | Min.                               | Typ.     | Max.                               | Unit                    |
|---------------------------|---------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|----------|------------------------------------|-------------------------|
| $V_k$                     | Reverse breakdown voltage                                     | $I_k = 100\text{ }\mu\text{A}$<br>LM4041A, 0.1%<br>LM4041B, 0.2%<br>LM4041C, 0.5%<br>LM4041D, 1%                                                                                           | 1.2238<br>1.2225<br>1.219<br>1.213 | 1.225    | 1.2262<br>1.2275<br>1.231<br>1.237 | V                       |
| $I_{kmin}$                | Minimum operating current                                     | $T_{amb} = 25\text{ }^{\circ}\text{C}$<br>$-40\text{ }^{\circ}\text{C} < T_{amb} < T_{max}^{(1)}$                                                                                          |                                    | 25       | 40<br>50                           | $\mu\text{A}$           |
| $\Delta V_k / \Delta T$   | Average temperature coefficient <sup>(2)</sup>                | $I_k = 100\text{ }\mu\text{A}$                                                                                                                                                             |                                    | $\pm 36$ | $\pm 100$                          | ppm/ $^{\circ}\text{C}$ |
| $\Delta V_k / \Delta I_k$ | Reverse breakdown voltage change with operating current range | $I_{kmin} < I_k < 1\text{ mA}$<br>$-40\text{ }^{\circ}\text{C} < T_{amb} < T_{max}^{(1)}$<br>$1\text{ mA} < I_k < 12\text{ mA}$<br>$-40\text{ }^{\circ}\text{C} < T_{amb} < T_{max}^{(1)}$ |                                    | 0.4<br>4 | 1<br>8<br>10                       | mV                      |
| $R_{ka}$                  | Static impedance                                              | $\Delta I_k = 100\text{ }\mu\text{A}$ to $1\text{ mA}$                                                                                                                                     |                                    | 0.4      | 1                                  | W                       |
| $K_{vh}$                  | Long term stability                                           | $I_k = 100\text{ }\mu\text{A}$ , $t = 1000\text{ hrs}$                                                                                                                                     |                                    | 120      |                                    | ppm                     |
| $e_n$                     | Wide band noise                                               | $I_k = 100\text{ }\mu\text{A}$ , $10\text{ Hz} < f < 10\text{ kHz}$                                                                                                                        |                                    | 60       |                                    | $\mu\text{V}_{RMS}$     |

1.  $T_{max} = 85\text{ }^{\circ}\text{C}$  for LM4041xI (industrial version) and  $T_{max} = 125\text{ }^{\circ}\text{C}$  for LM4041xE (extended version).

2. The average temperature coefficient is defined as:  $10^6 \times \{\max(\Delta V_k) / [V_{k@25^{\circ}\text{C}} \times (T_{max} - T_{min})]\}$  [ppm/ $^{\circ}\text{C}$ ].

**Note:** Limits are 100% production tested at  $25\text{ }^{\circ}\text{C}$ . Limits over temperature 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  $T_A = 25^\circ\text{C}$ .

Figure 2.  $V_K$  change vs. temperature

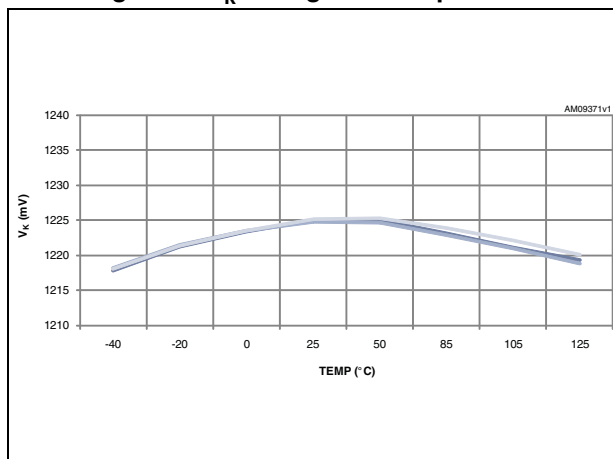


Figure 3. Minimum current for regulation

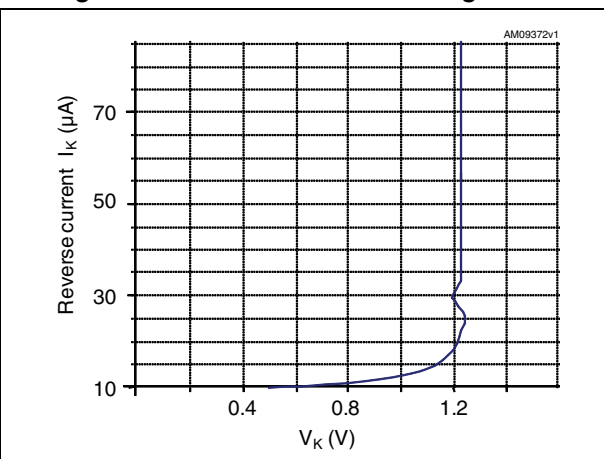


Figure 4. Output impedance vs. frequency

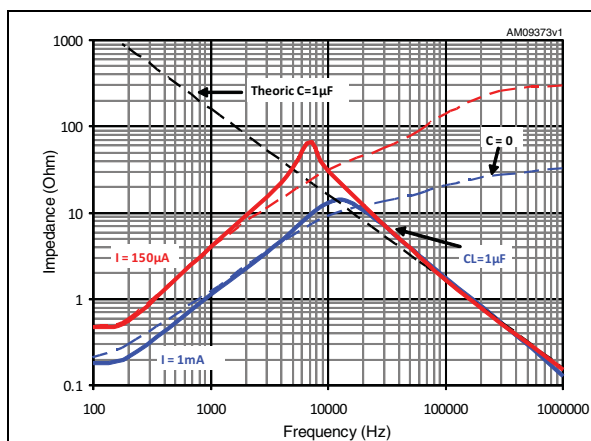


Figure 5. Minimum current for regulation vs. temperature

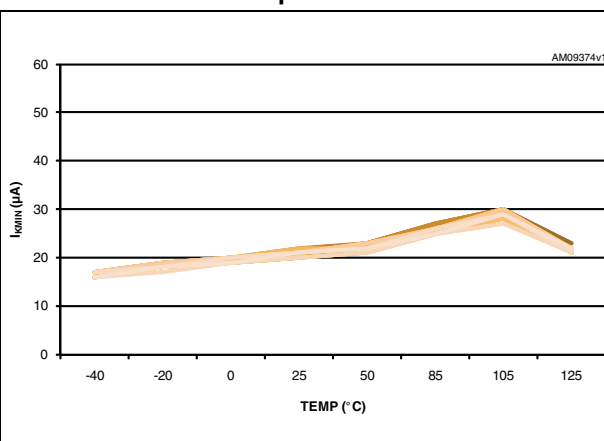


Figure 6. Startup characteristics

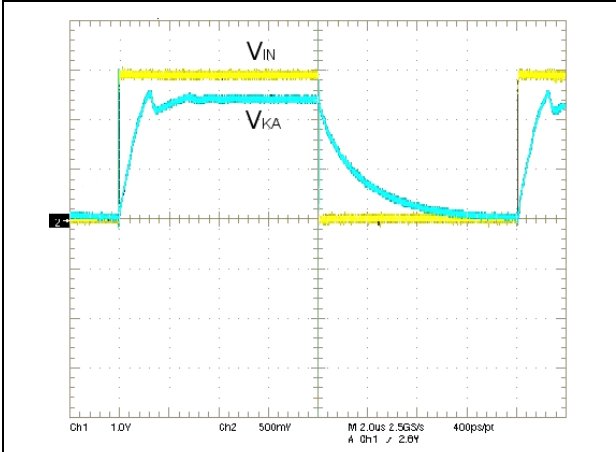


Figure 7. Startup measure circuit

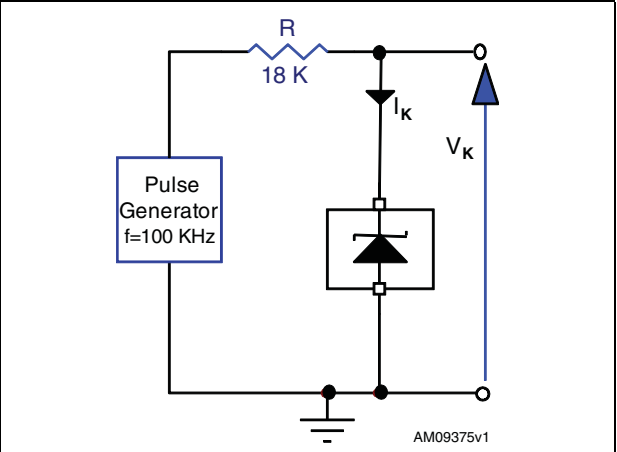
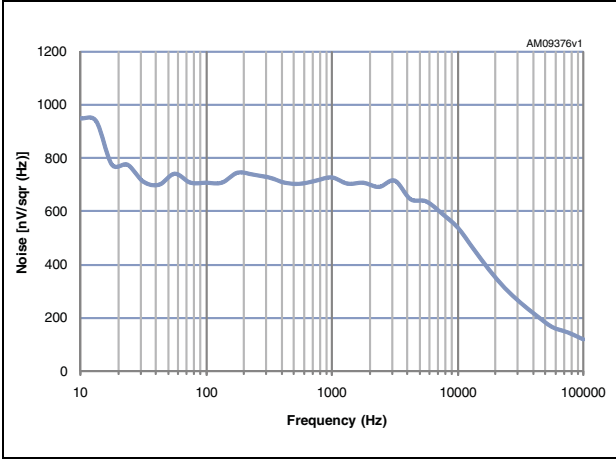


Figure 8. Wideband noise voltage



## 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.

Figure 9. SOT23-3L dimensions

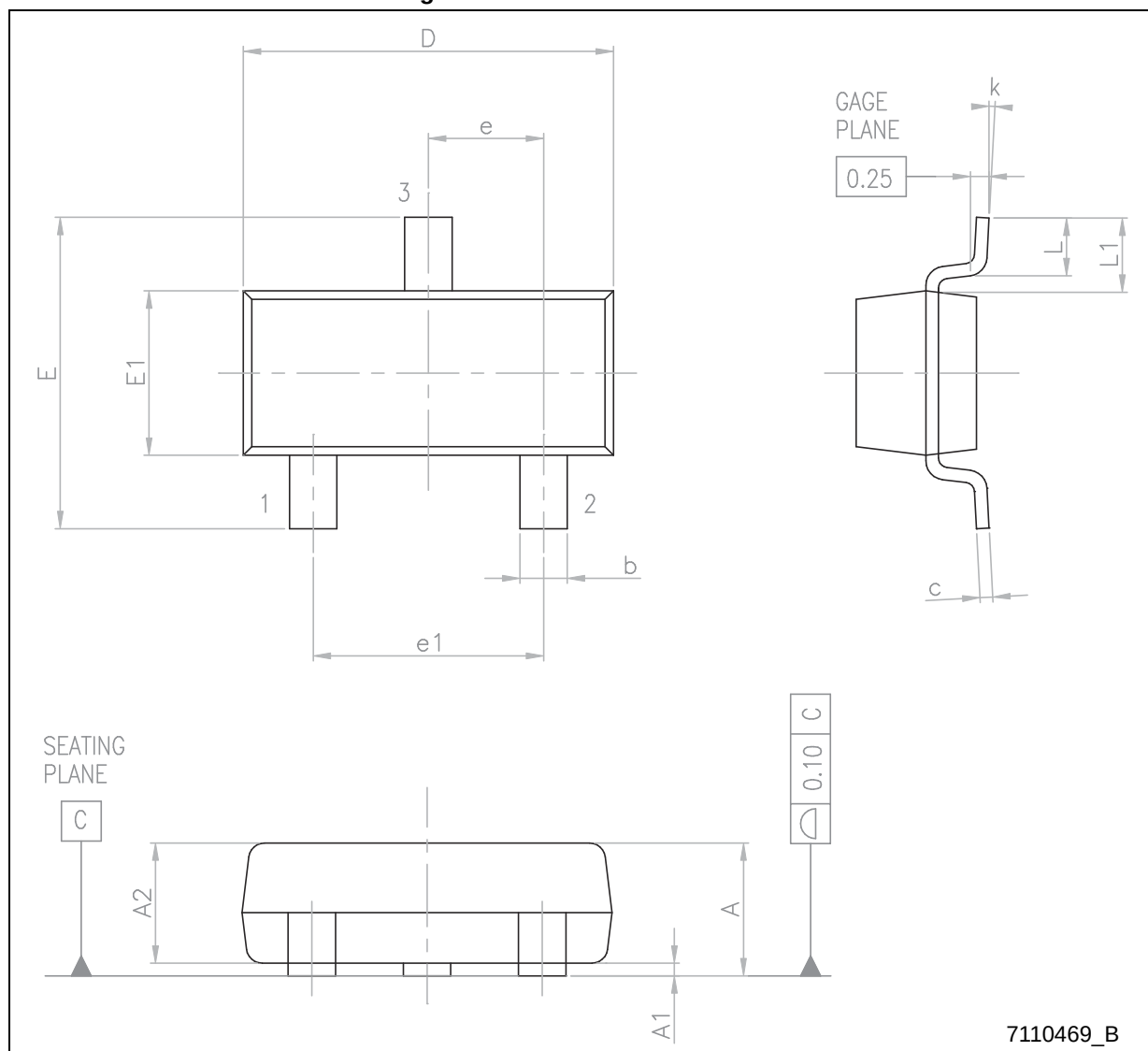


Table 5. SOT23-3L mechanical data

| 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 10. SOT323-5L dimensions

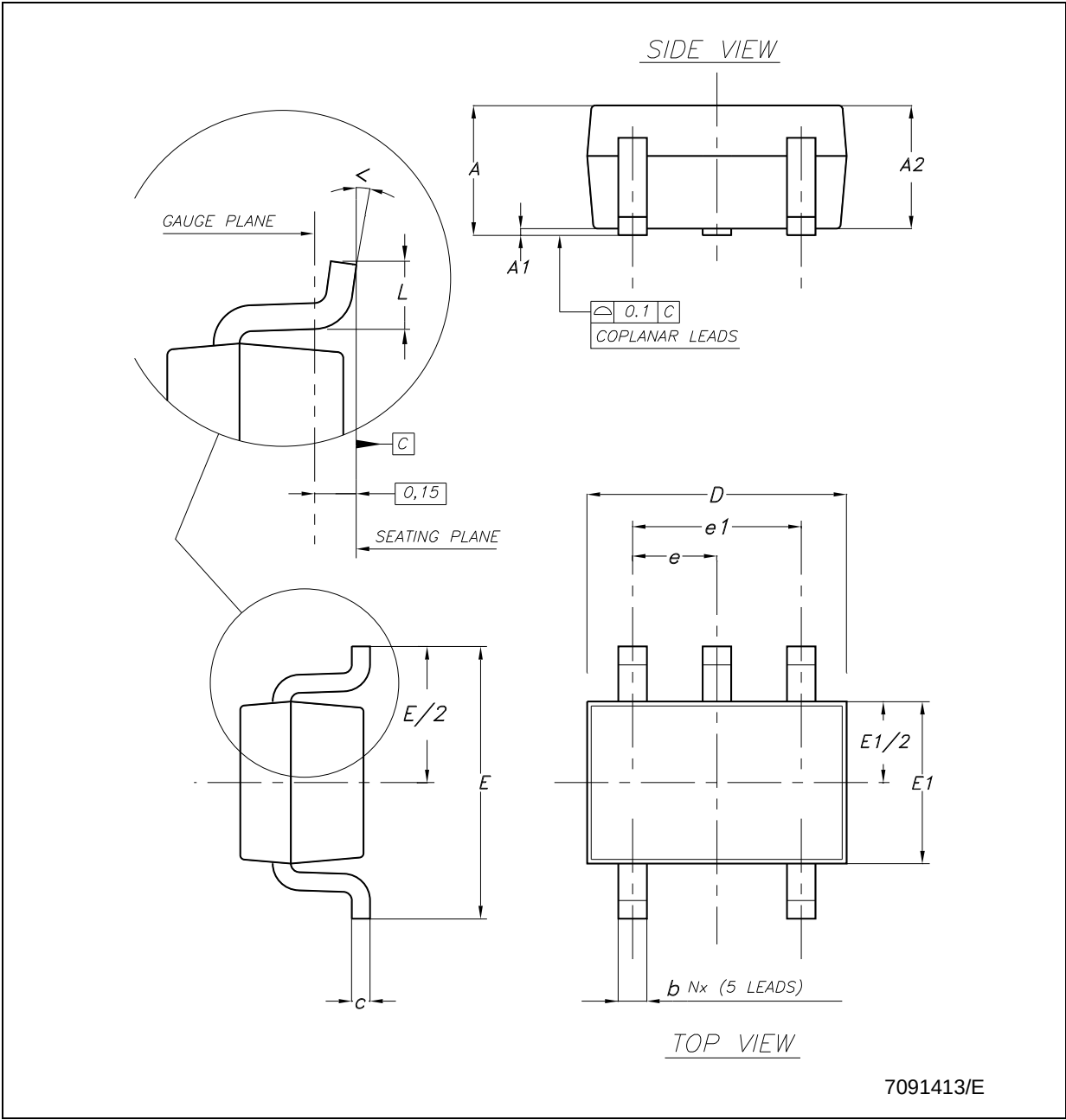


Table 6. SOT323-5L mechanical data

| 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   |      | 1.30 |      |
| L    | 0.26 | 0.36 | 0.46 |
| <    | 0°   |      | 8°   |

## 6 Packaging mechanical data

Figure 11. Tape and reel SOT23-3L and SOT323-5L mechanical drawing

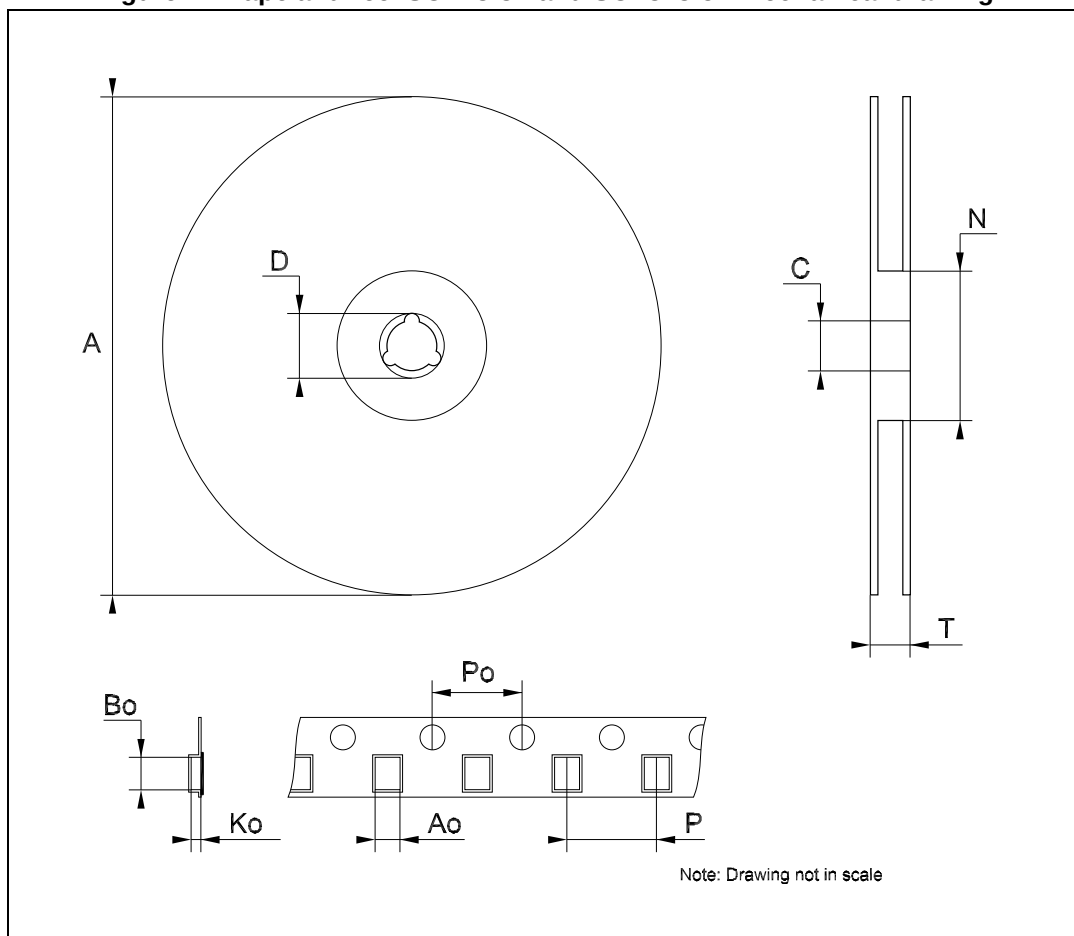


Table 7. Tape and reel SOT23-3L mechanical data

| Dim. | mm   |      |      |
|------|------|------|------|
|      | Min. | Typ. | Max. |
| A    |      |      | 180  |
| C    | 12.8 | 13.0 | 13.2 |
| D    | 20.2 |      |      |
| N    | 60   |      |      |
| T    |      |      | 14.4 |
| Ao   | 3.13 | 3.23 | 3.33 |
| Bo   | 3.07 | 3.17 | 3.27 |
| Ko   | 1.27 | 1.37 | 1.47 |
| Po   | 3.9  | 4.0  | 4.1  |
| P    | 3.9  | 4.0  | 4.1  |

Table 8. SOT323-5L mechanical data

| Dim. | mm.  |      |      |
|------|------|------|------|
|      | Min. | Typ. | Max. |
| A    | 175  | 180  | 185  |
| C    | 12.8 | 13   | 13.2 |
| D    | 20.2 |      |      |
| N    | 59.5 | 60   | 60.5 |
| T    |      |      | 14.4 |
| Ao   |      | 2.25 |      |
| Bo   |      | 2.7  |      |
| Ko   |      | 1.2  |      |
| Po   | 3.9  | 4    | 4.1  |
| P    | 3.8  | 4    | 4.2  |

## 7 Order codes

Table 9. Order codes

| Order codes    | Precision | Packages  | Operating temperature range   | Marking |
|----------------|-----------|-----------|-------------------------------|---------|
| LM4041AICT-1.2 | 0.1%      | SOT323-5L | Industrial<br>- 40 to + 85 °C | L2      |
| LM4041BICT-1.2 | 0.2%      |           |                               | L2      |
| LM4041CICT-1.2 | 0.5%      |           |                               | L25     |
| LM4041DICT-1.2 | 1%        |           |                               | L26     |
| LM4041AILT-1.2 | 0.1%      | SOT23-3L  | Industrial<br>- 40 to + 85 °C | L23     |
| LM4041BILT-1.2 | 0.2%      |           |                               | L24     |
| LM4041CILT-1.2 | 0.5%      |           |                               | L25     |
| LM4041DILT-1.2 | 1%        |           |                               | L26     |
| LM4041AECT-1.2 | 0.1%      | SOT323-5L | Extended<br>- 40 to + 125 °C  | E2      |
| LM4041BECT-1.2 | 0.2%      |           |                               | E2      |
| LM4041CECT-1.2 | 0.5%      |           |                               | E25     |
| LM4041DECT-1.2 | 1%        |           |                               | E26     |
| LM4041AELT-1.2 | 0.1%      | SOT23-3L  | Extended<br>- 40 to + 125 °C  | E23     |
| LM4041BELT-1.2 | 0.2%      |           |                               | E24     |
| LM4041CELT-1.2 | 0.5%      |           |                               | E25     |
| LM4041DELT-1.2 | 1%        |           |                               | E26     |

## 8 Revision history

**Table 10. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                             |
|-------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 09-May-2011 | 1        | Initial release.                                                                                                                                                                                                                                                                                    |
| 05-Dec-2011 | 2        | Changed maturity code and updated <a href="#">Table 9 on page 14</a> .                                                                                                                                                                                                                              |
| 25-Jul-2012 | 3        | Added: marking order codes <a href="#">Table 9 on page 14</a> .                                                                                                                                                                                                                                     |
| 18-Feb-2014 | 4        | Part number LM4041xx changed to LM4041.<br>Updated <a href="#">Table 1: Absolute maximum ratings</a> , <a href="#">Section 1: Pin configuration</a> and <a href="#">Section 5: Package mechanical data</a> .<br>Added <a href="#">Section 6: Packaging mechanical data</a> .<br>Minor text changes. |

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