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**Precision micropower shunt voltage reference**

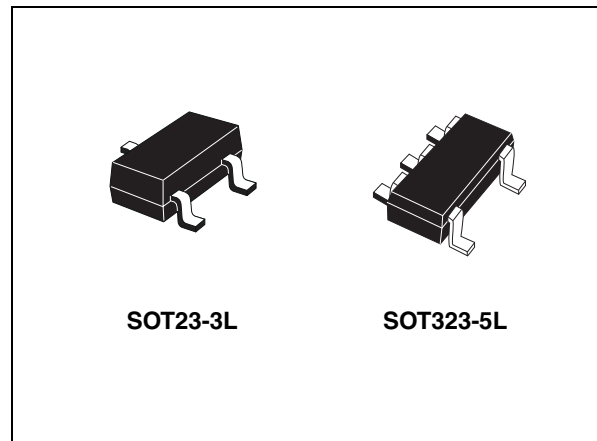
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**Features**

- Fixed 1.225 V typical output voltage
- Ultra low operating current: 40  $\mu$ A at 25 °C
- High precision: +/- 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

**Description**

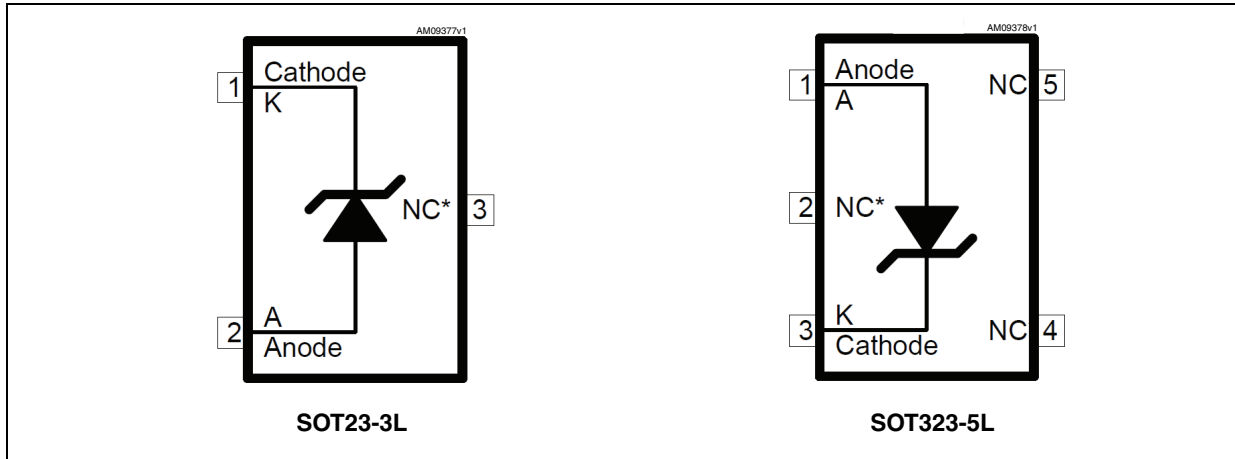
The LM4041 is a micropower shunt voltage reference, providing a stable 1.225 V output voltage, with an initial accuracy of 0.1% @ 25 °C and a low temperature coefficient. Available in SOT323-5L and SOT23-3L surface mount packages, it can be designed in applications where space saving is a critical issue. 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.

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# 1 Pin configuration

Figure 1. Pin connection (top view)



\* This pin must be left floating or connected to Anode pin.

## 2 Maximum ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$I_K$	Reverse breakdown current	20	mA
$I_F$	Forward current	10	mA
$P_D$	Power dissipation <sup>(1)</sup>		
	SOT23-3L	500	mW
	SOT323-5L	536	
$T_{STG}$	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
		Extended	- 40 to + 125

### 3 Electrical characteristics

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

**Table 4. Electrical characteristics**

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

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

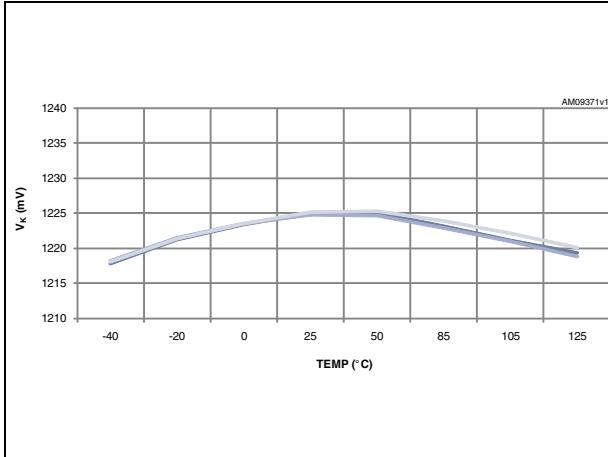
2. The average temperature coefficient is defined as:  $10^6 \times \{\max(\Delta V_k) / [V_{k@25\text{ °C}} \times (T_{max} - T_{min})]\}$  [ppm/°C].

**Note:** Limits are 100% production tested at 25 °C. Limits over temperature are guaranteed through correlation and by design.

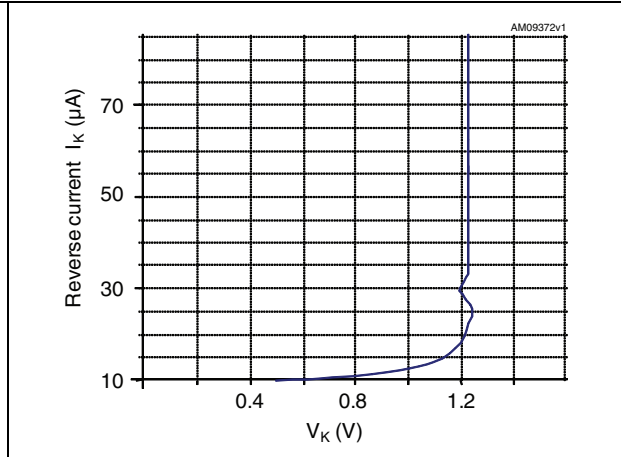
## 4 Typical performance characteristics

The following plots are referred to the typical application circuit and, unless otherwise noted, at  $T_A = 25\text{ }^\circ\text{C}$ .

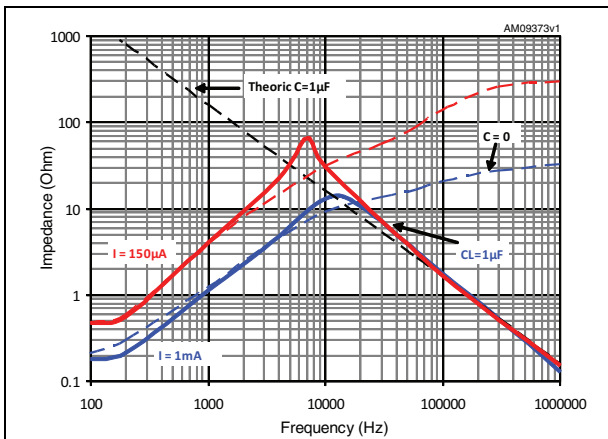
**Figure 2.  $V_k$  change vs. temperature**



**Figure 3. Minimum current for regulation**



**Figure 4. Output impedance vs. frequency**



**Figure 5. Minimum current for regulation vs. temperature**

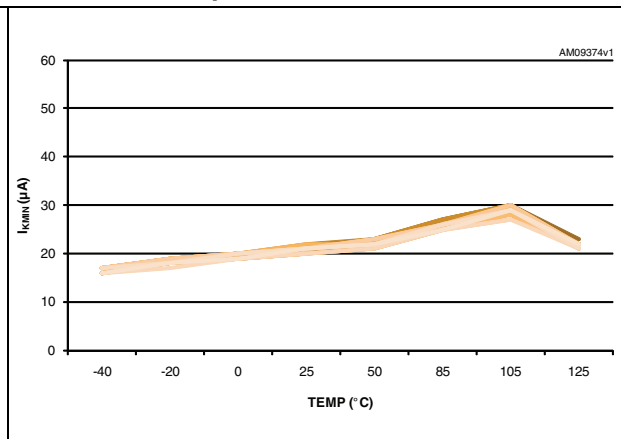


Figure 6. Startup characteristics

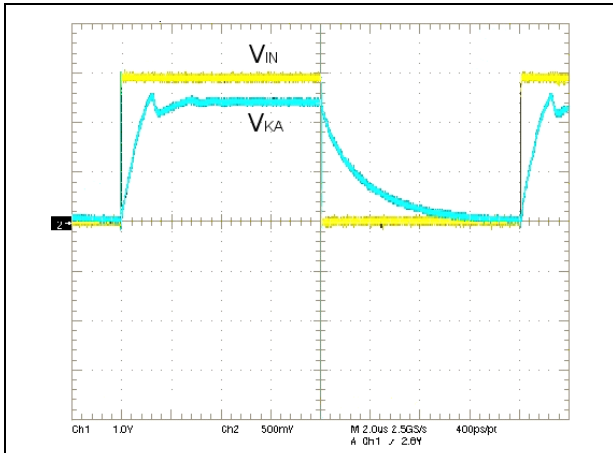


Figure 7. Startup measure circuit

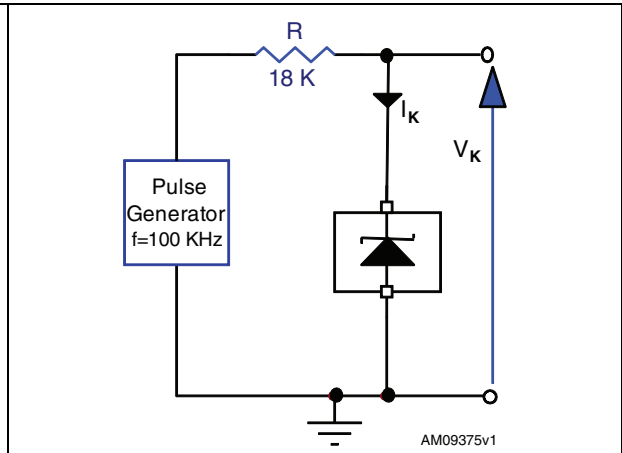
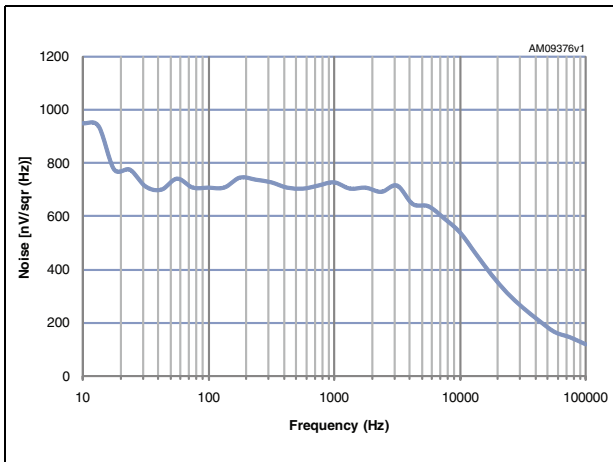


Figure 8. Wideband noise voltage



## 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

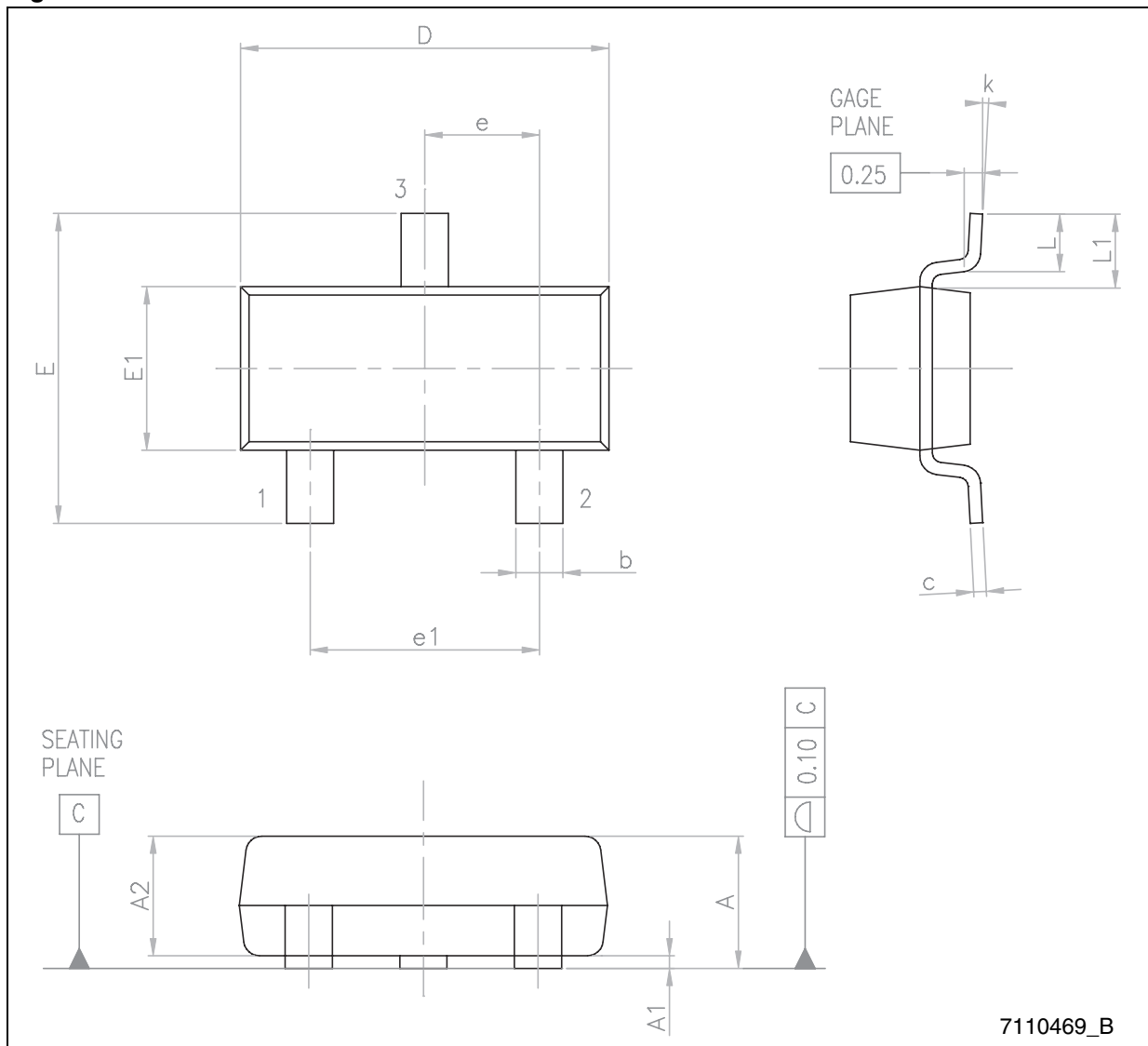




Table 5. SOT23-3L mechanical data

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

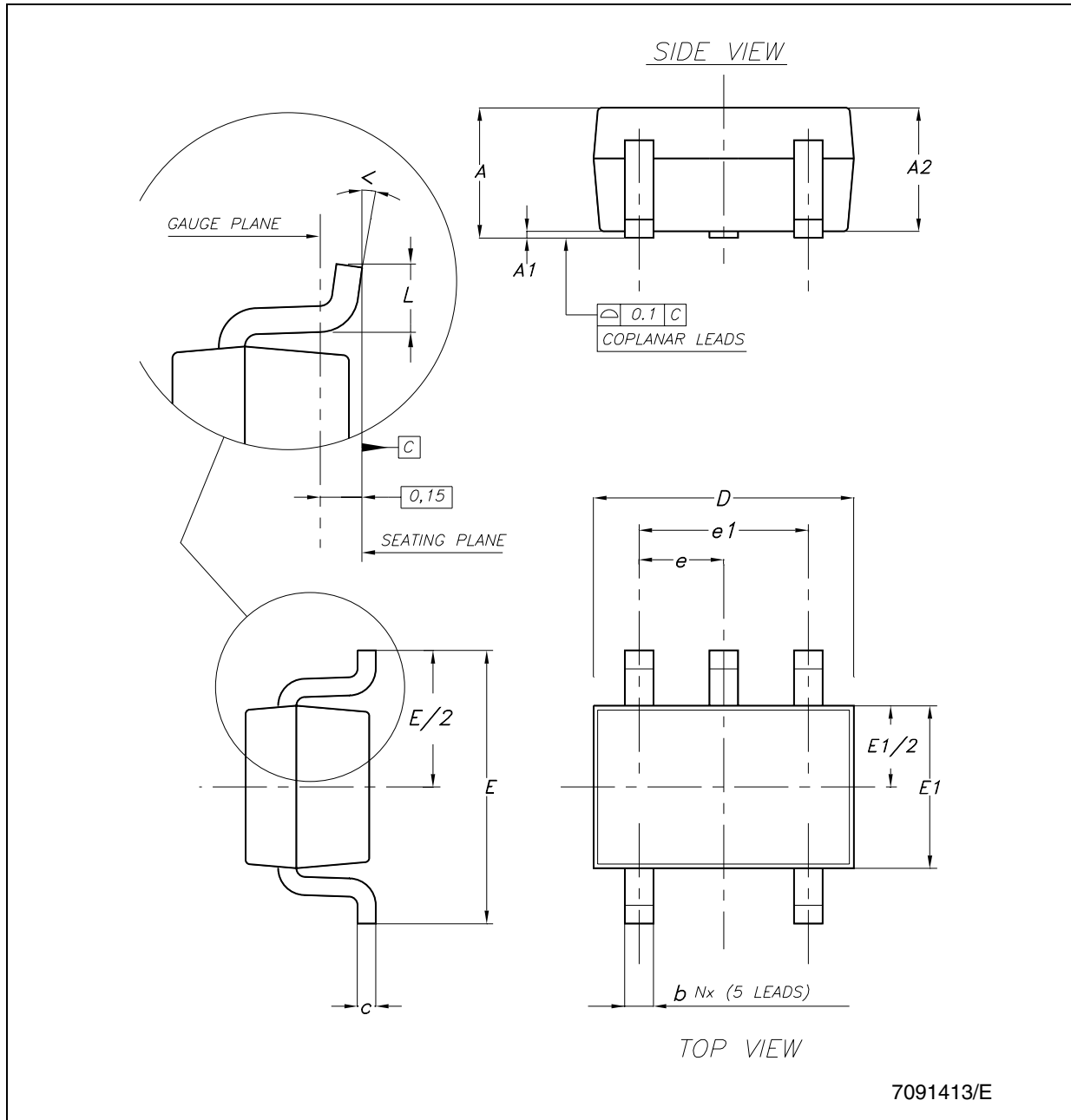
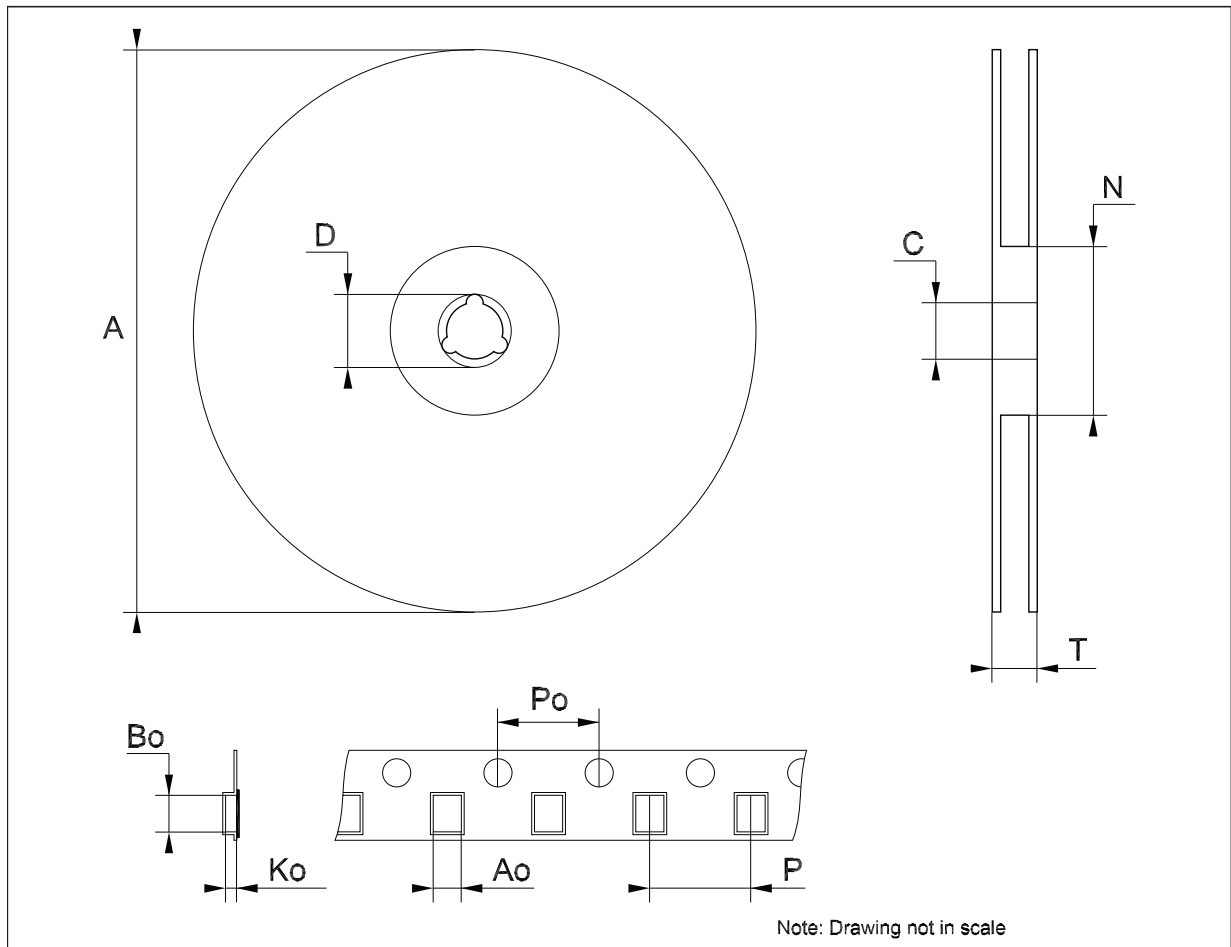


Table 6. SOT323-5L mechanical data

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°

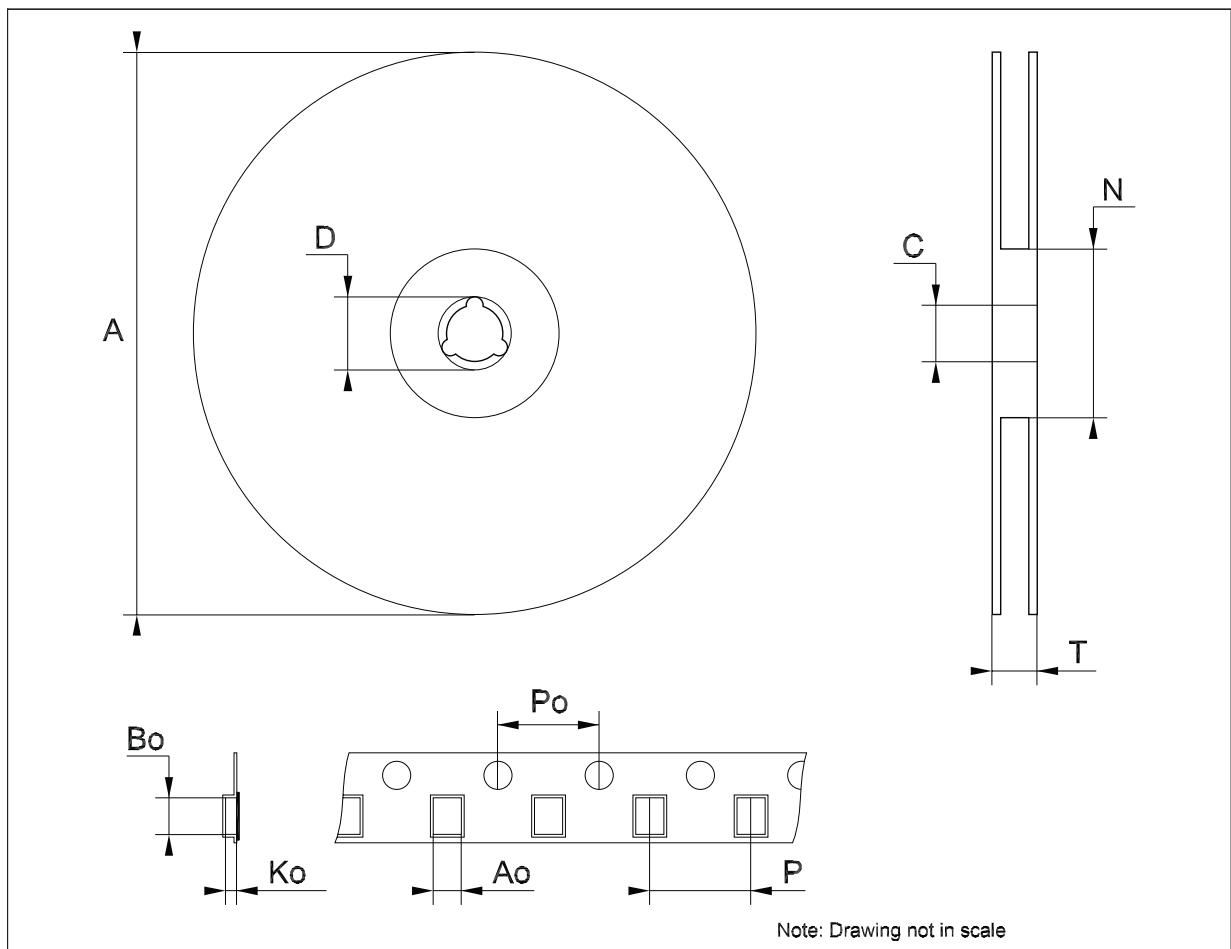
**Tape & reel SOT23-xL mechanical data**

Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			180			7.086
C	12.8	13.0	13.2	0.504	0.512	0.519
D	20.2			0.795		
N	60			2.362		
T			14.4			0.567
Ao	3.13	3.23	3.33	0.123	0.127	0.131
Bo	3.07	3.17	3.27	0.120	0.124	0.128
Ko	1.27	1.37	1.47	0.050	0.054	0.058
Po	3.9	4.0	4.1	0.153	0.157	0.161
P	3.9	4.0	4.1	0.153	0.157	0.161



**Tape & reel SOT323-xL mechanical data**

Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	175	180	185	6.889	7.086	7.283
C	12.8	13	13.2	0.504	0.512	0.519
D	20.2			0.795		
N	59.5	60	60.5		2.362	
T			14.4			0.567
Ao		2.25			0.088	
Bo		2.7			0.106	
Ko		1.2			0.047	
Po	3.9	4	4.1	0.153	0.157	0.161
P	3.8	4	4.2	0.149	0.157	0.165



## 6 Order codes

**Table 7. Order codes**

Order codes	Precision	Packages	Operating temperature range
LM4041AICT-1.2	0.1%	SOT323-5L	Industrial - 40 to + 85 °C
LM4041BICT-1.2	0.2%		
LM4041CICT-1.2	0.5%		
LM4041DICT-1.2	1%		
LM4041AILT-1.2	0.1%	SOT23-3L	Industrial - 40 to + 85 °C
LM4041BILT-1.2	0.2%		
LM4041CILT-1.2	0.5%		
LM4041DILT-1.2	1%		
LM4041AECT-1.2	0.1%	SOT323-5L	Extended - 40 to + 125 °C
LM4041BECT-1.2	0.2%		
LM4041CECT-1.2	0.5%		
LM4041DECT-1.2	1%		
LM4041AELT-1.2	0.1%	SOT23-3L	Extended - 40 to + 125 °C
LM4041BELT-1.2	0.2%		
LM4041CELT-1.2	0.5%		
LM4041DELT-1.2	1%		

## 7 Revision history

**Table 8. Document revision history**

Date	Revision	Changes
09-May-2011	1	Initial release.
05-Dec-2011	2	Changed maturity code and updated <a href="#">Table 7 on page 14</a> .

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