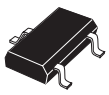
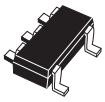
LM4040

Datasheet

Precision micropower shunt voltage reference



SOT23-3L



SOT323-5L

Maturity status link
LM4040

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

Applications

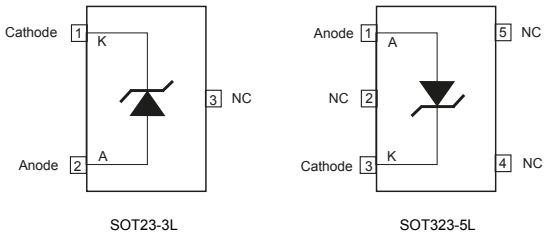
- Portable, battery-operated equipment
- Data acquisition systems
- Instrumentation

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 °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	µA
		-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	ΔI_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)

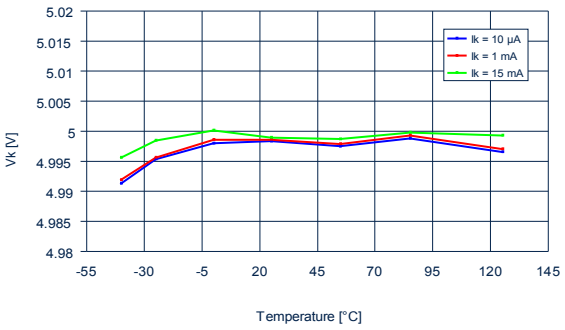


Figure 3. V_K change vs. temperature (5 V version)

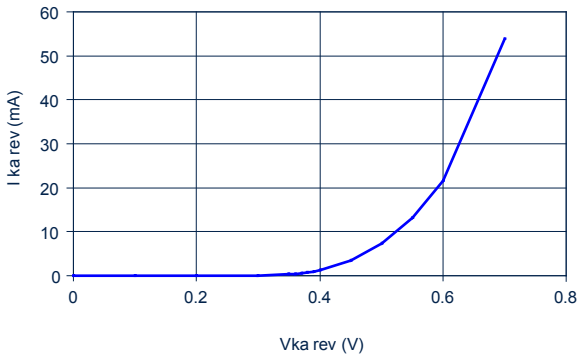


Figure 4. I_{Kmin} minimum current for regulation

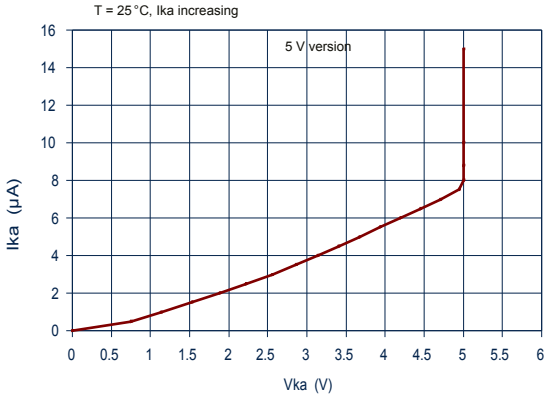
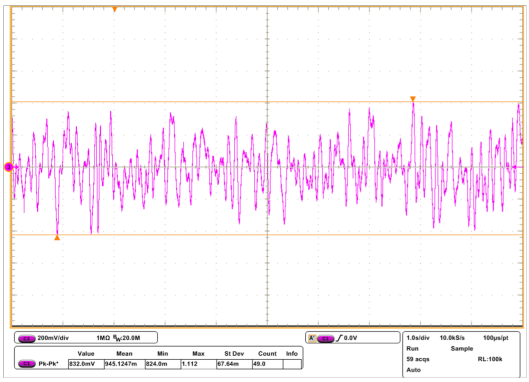


Figure 5. Low frequency noise test



I_R = 20 µA R_{UP} = 4.7 kΩ R_{LOAD} = 50 Ω

Figure 6. Measured dynamic impedance

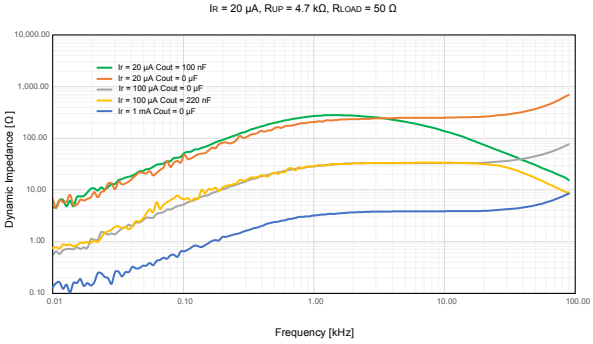


Figure 7. Forward characteristics

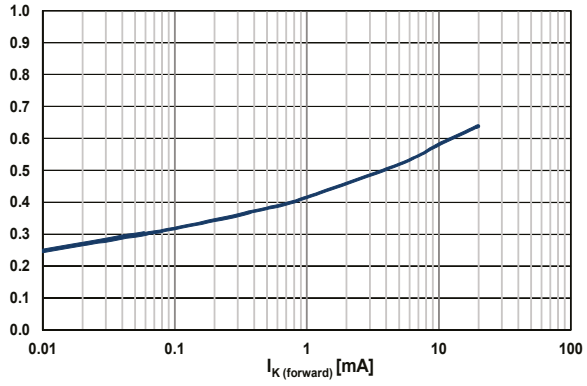
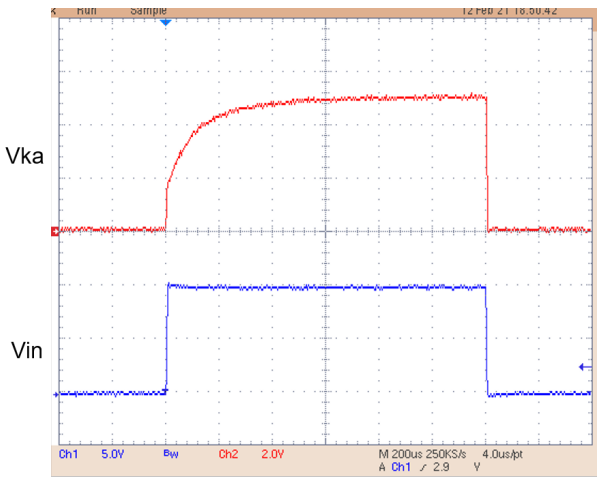
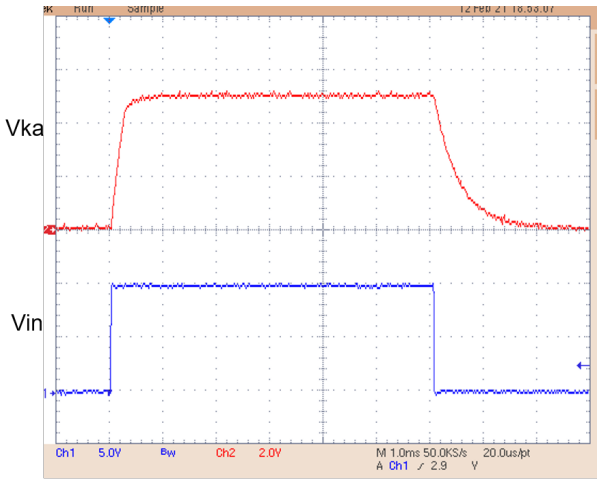


Figure 8. Turn-on time setting (no Cload)



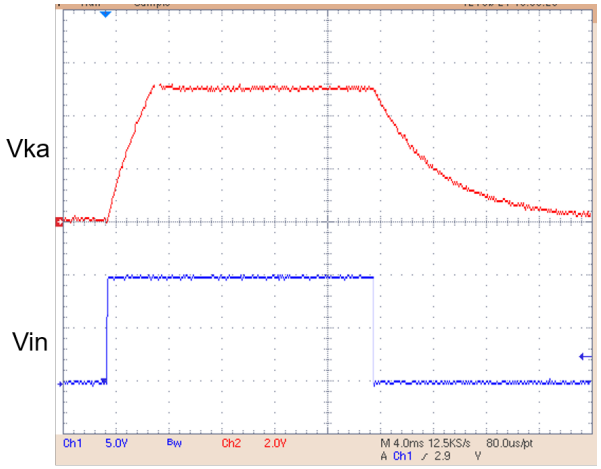
Vin: 10 V, trise: 5 µsec, Ika: 10 µA, No Cload

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



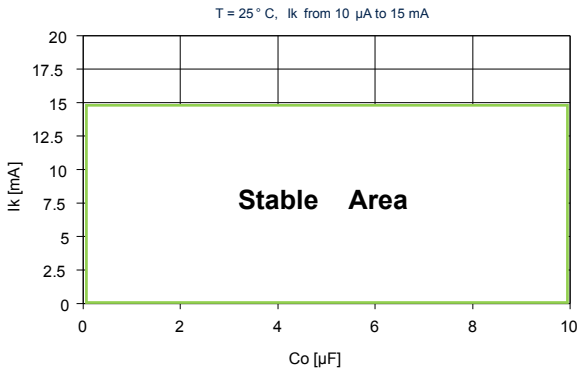
Vin: 10 V, trise: 5 µsec, Ika: 10 µA, Cload: 100 nF

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

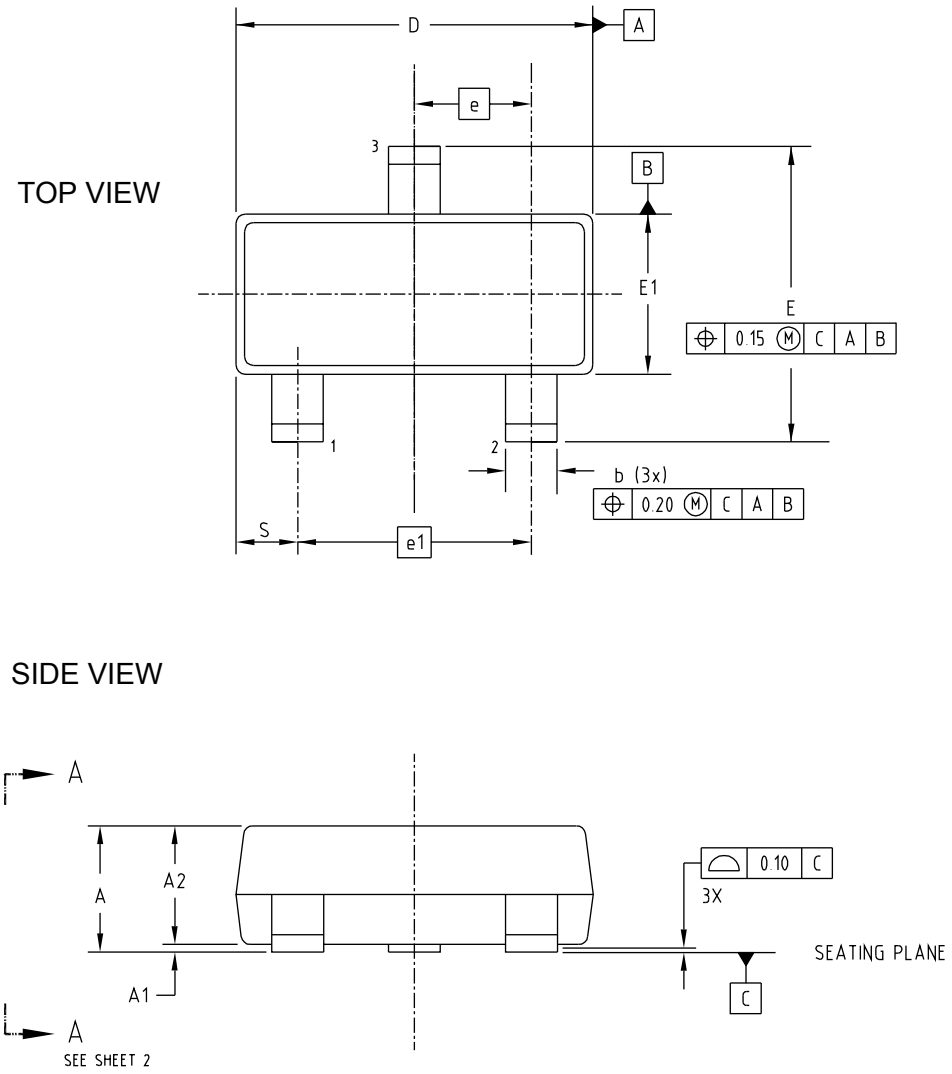
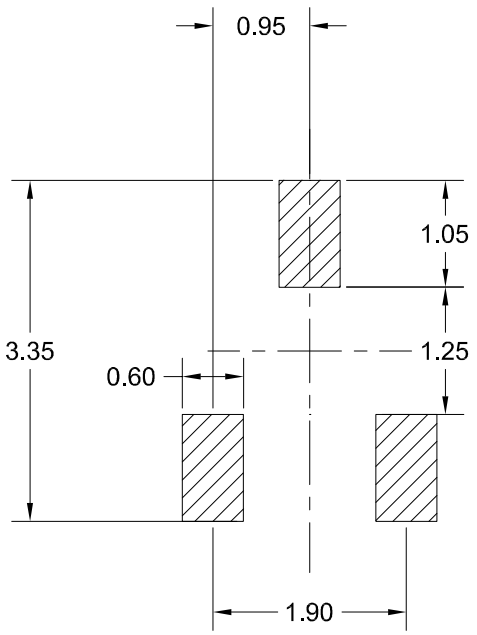


Table 4. **SOT23-3L mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	0.89		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 13. **SOT23-3L recommended footprint**



5.2 SOT323-5L package information

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

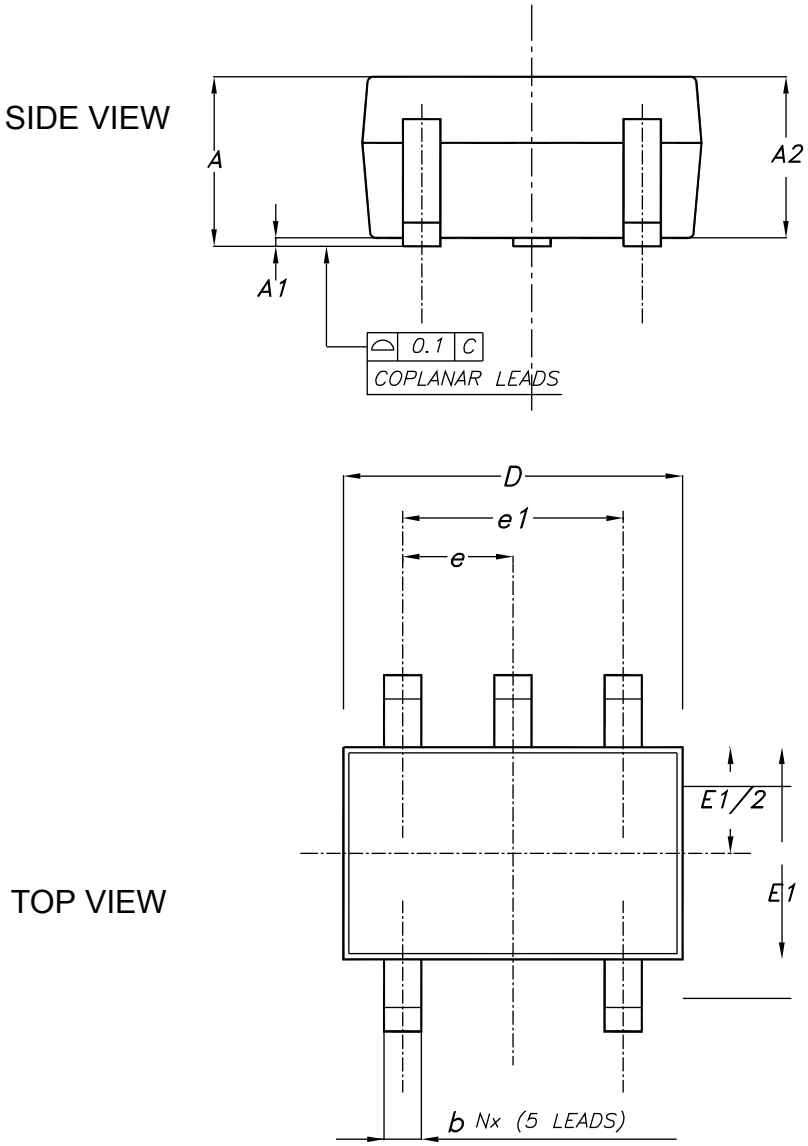
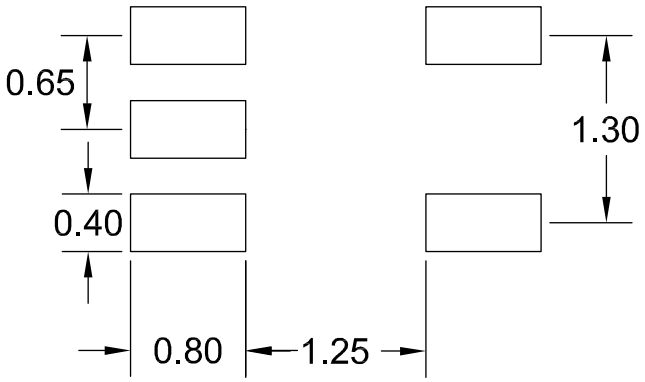


Table 5. **SOT323-5L mechanical data**

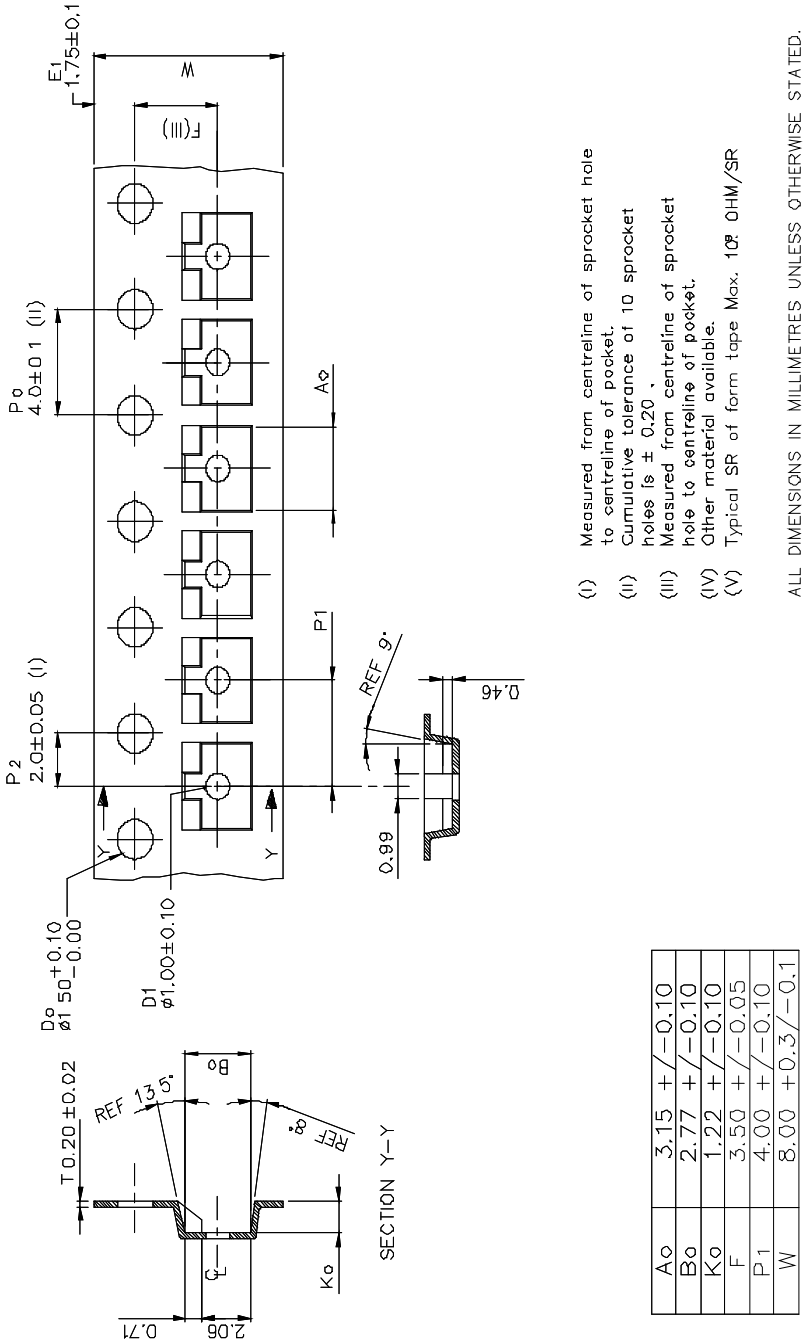
Dim.	mm		
	Min.	Typ.	Max.
A	0.80		1.10
A1	0		0.10
A2	0.80	0.90	1
b	0.15		0.30
c	0.10		0.22
D	1.80	2	2.20
E	1.80	2.10	2.40
E1	1.15	1.25	1.35
e		0.65	
e1		130	
L	0.26	0.36	0.46
<	0°		8°

Figure 15. **SOT323-5L recommended footprint**



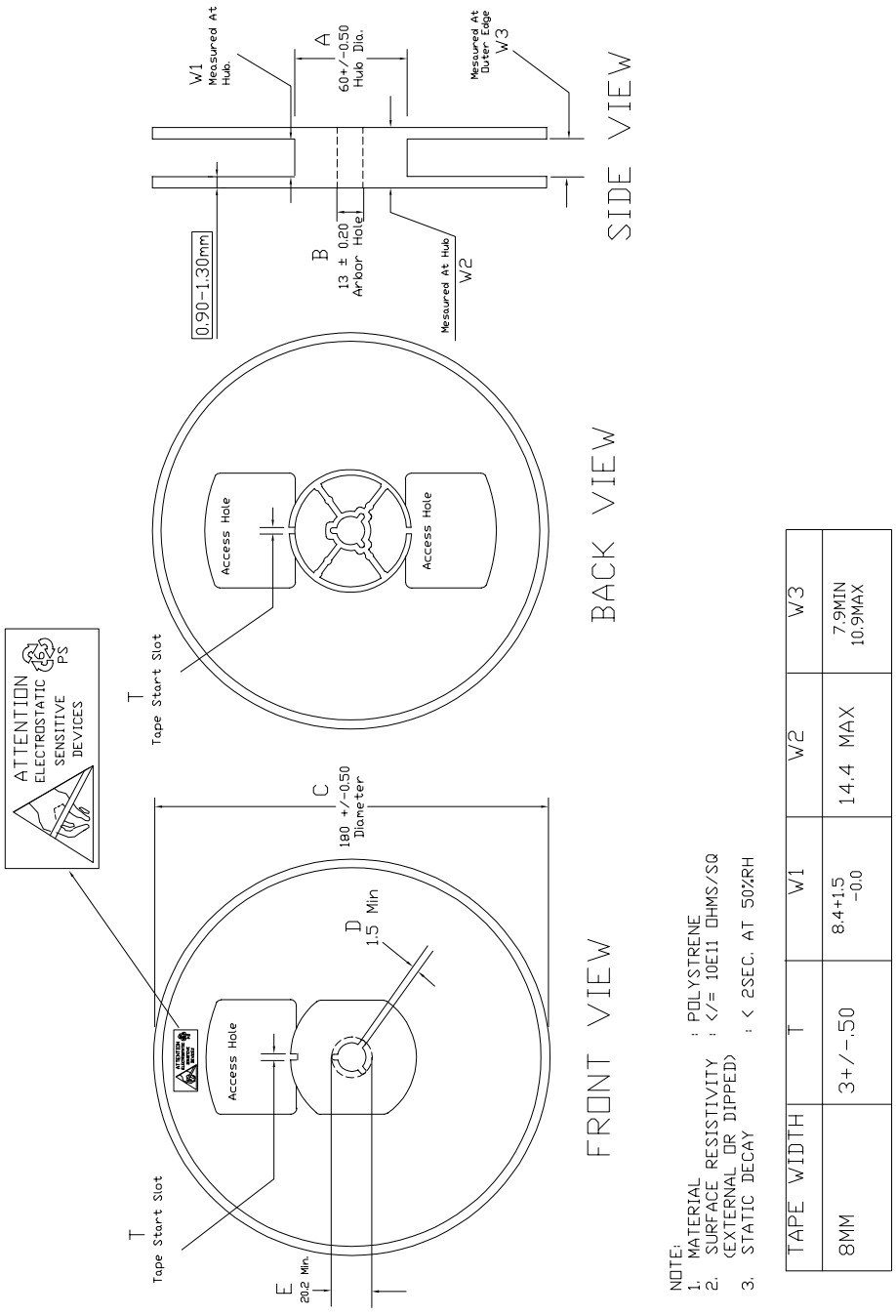
5.3 SOT23-3L packing information

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



A0	3.15 +/−0.10
B0	2.77 +/−0.10
K0	1.22 +/−0.10
F	3.50 +/−0.05
P1	4.00 +/−0.10
W	8.00 +0.3/−0.1

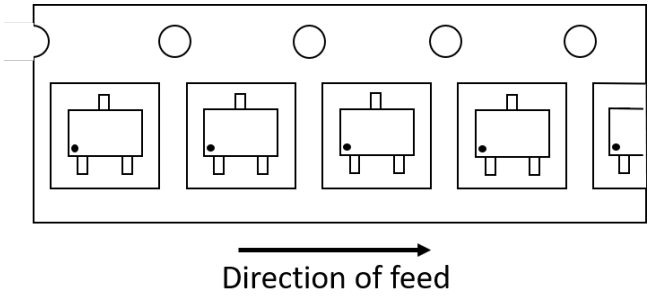
Figure 17. **SOT23-3L reel drawing**



NOTE:
1. MATERIAL : POLYSTRENE
2. SURFACE RESISTIVITY : <= 10E11 OHMS/SQ
(EXTERNAL OR DIPPED)
3. STATIC DECAY : < 2SEC. AT 50%RH

TAPE WIDTH	T	W1	W2	W3
8MM	3+/-.50	8.4+1.5 -0.0	14.4 MAX	7.9MIN 10.9MAX

Figure 18. **SOT23-3L tape direction**



5.4 SOT323-5L packing information

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

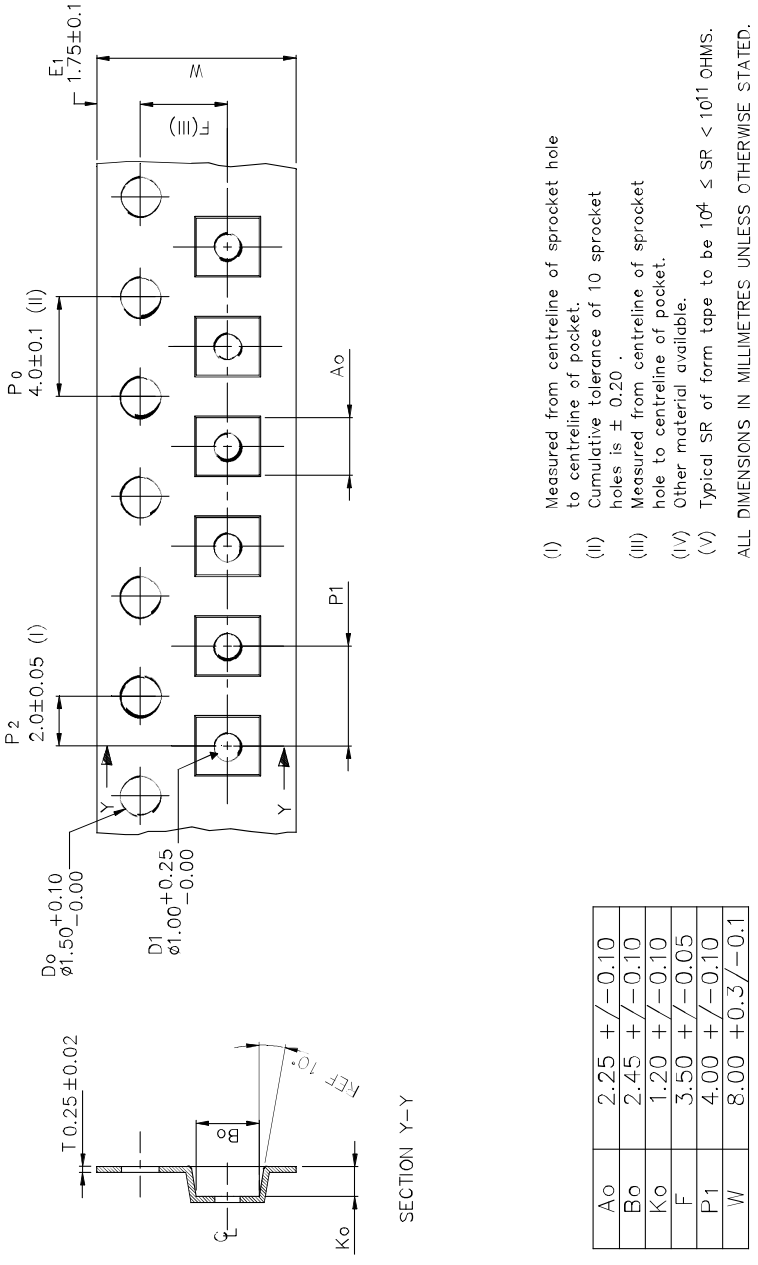
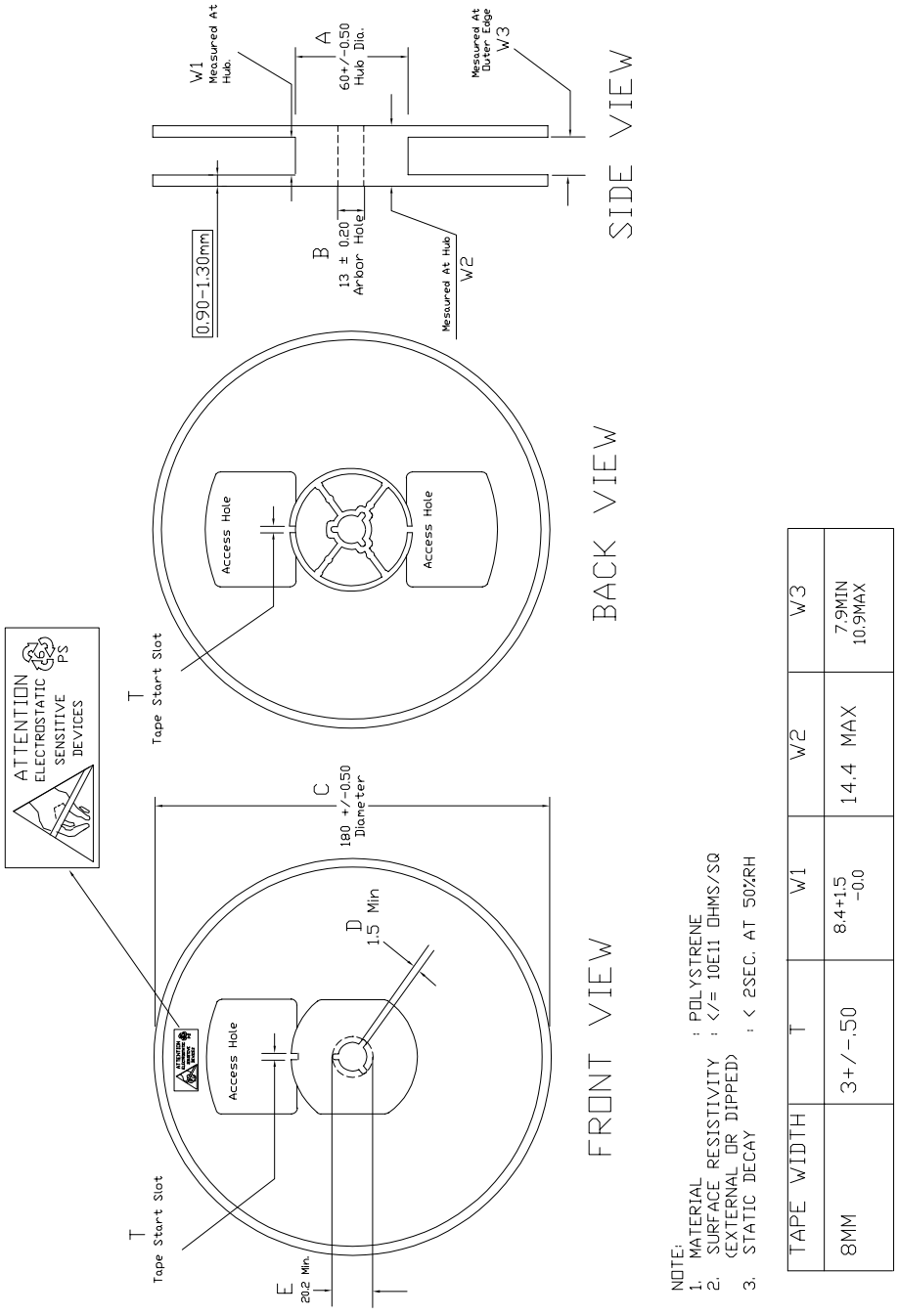


Figure 20. **SOT323-5L reel drawing**



NOTE:
1. MATERIAL : POLYSTRENE
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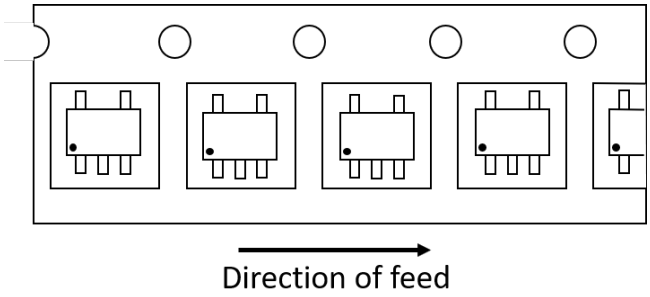
(EXTERNAL OR DIPPED)
3. STATIC DECAY : < 2SEC. AT 50%RH

TAPE WIDTH	T	W1	W2	W3
8MM	3+/-.50	8.4+1.5 -0.0	14.4 MAX	7.9MIN 10.9MAX

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	Revision	Changes
26-Jan-2021	1	Initial release.
24-May-2022	2	Updated I_{kmin} unit in table 3. Updated table 4 and 5.

Contents

List of tables

List of figures