PRECISION MICROPOWER SHUNT VOLTAGE REFERENCE

Check for Samples: LM4040-EP

FEATURES

- **Fixed Output Voltage of 2.5 V**
- **Tight Output Tolerances and Low Temperature Coefficient**
  - **Max 0.65%, 100 ppm/°C**
- **Low Output Noise: 35 μV_{RMS} Typ**
- **Wide Operating Current Range: 45 μA Typ to 15 mA**
- **Stable With All Capacitive Loads; No Output Capacitor Required**

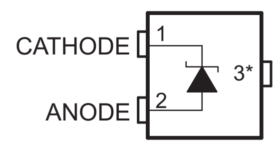
APPLICATIONS

- **Data-Acquisition Systems**
- **Power Supplies and Power-Supply Monitors**
- **Instrumentation and Test Equipment**
- **Process Controls**
- **Precision Audio**
- **Automotive Electronics**
- **Energy Management**
- **Battery-Powered Equipment**

SUPPORTS DEFENSE, AEROSPACE, AND MEDICAL APPLICATIONS

- **Controlled Baseline**
- **One Assembly/Test Site**
- **One Fabrication Site**
- **Available in Military (–55°C/125°C) Temperature Range**(1)
- **Extended Product Life Cycle**
- **Extended Product-Change Notification**
- **Product Traceability**

DBZ (SOT-23) PACKAGE
(TOP VIEW)



* Pin 3 is attached to substrate and must be connected to ANODE or left open.

(1) Custom temperature ranges available

DESCRIPTION/ORDERING INFORMATION

The LM4040 series of shunt voltage references are versatile, easy-to-use references that cater to a vast array of applications. The 2-pin fixed-output device requires no external capacitors for operation and is stable with all capacitive loads. Additionally, the reference offers low dynamic impedance, low noise, and low temperature coefficient to ensure a stable output voltage over a wide range of operating currents and temperatures. The LM4040 uses fuse and Zener-zap reverse breakdown voltage trim during wafer sort to offer an output voltage tolerance of 0.65%.

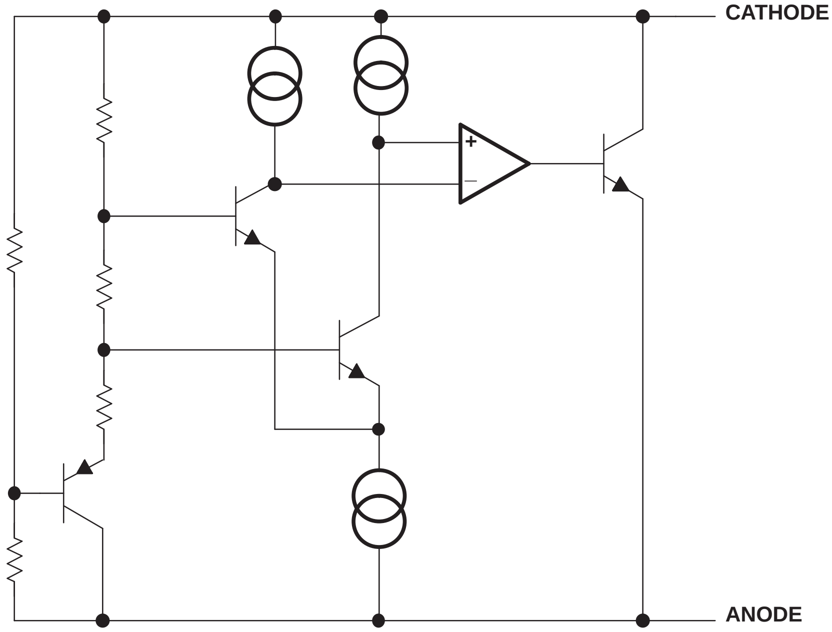
Packaged in a space-saving SOT-23-3 package and requiring a minimum current of 45 µA (typ), the LM4040 also is ideal for portable applications. The LM4040C25 is characterized for operation over an ambient temperature range of –55°C to 125°C.

ORDERING INFORMATION(1)

T_A	DEVICE GRADE	V_{KA}	PACKAGE		ORDERABLE PART NUMBER	TOP-SIDE MARKING(2)
–55°C to 125°C	0.65% initial accuracy and 100 ppm/°C temperature coefficient	2.5 V	SOT-23-3 (DBZ)	Reel of 250	LM4040C25MDBZTEP	SAGU

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
(2) The actual top-side marking has one additional character that designates the wafer fab/assembly site.

FUNCTIONAL BLOCK DIAGRAM



Absolute Maximum Ratings(1)

over free-air temperature range (unless otherwise noted)

		MIN	MAX	UNIT
I_Z	Continuous cathode current	–10	25	mA
T_J	Operating virtual junction temperature		150	°C
T_{stg}	Storage temperature range	–65	150	°C

(1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

THERMAL INFORMATION

THERMAL METRIC(1)		LM4040 DBZ 3 PINS	UNITS
θ_{JA}	Junction-to-ambient thermal resistance(2)	320.8	°C/W
θ_{JC}	Junction-to-case thermal resistance	98.2	
θ_{JB}	Junction-to-board thermal resistance(3)	53.3	
ψ_{JT}	Junction-to-top characterization parameter(4)	3.3	
ψ_{JB}	Junction-to-board characterization parameter(5)	51.8	

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, SPRA953.
(2) The junction-to-ambient thermal resistance under natural convection is obtained in a simulation on a JEDEC-standard, high-K board, as specified in JESD51-7, in an environment described in JESD51-2a.
(3) The junction-to-board thermal resistance is obtained by simulating in an environment with a ring cold plate fixture to control the PCB temperature, as described in JESD51-8.
(4) The junction-to-top characterization parameter, ψ_{JT}, estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining θ_{JA}, using a procedure described in JESD51-2a (sections 6 and 7).
(5) The junction-to-board characterization parameter, ψ_{JB}, estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining θ_{JA} , using a procedure described in JESD51-2a (sections 6 and 7).

Recommended Operating Conditions

		MIN	MAX	UNIT
I_Z	Cathode current	See (1)	15	mA
T_A	Free-air temperature	–55	125	°C

(1) See parametric tables

Electrical Characteristics

at extended temperature range, full-range T_A = –55°C to 125°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
V_Z	Reverse breakdown voltage	I_Z = 100 µA	25°C		2.5		V
ΔV_Z	Reverse breakdown voltage tolerance	I_Z = 100 µA	25°C	–16		16	mV
			Full range	–42		42	
$I_{Z,min}$	Minimum cathode current		25°C		45	75	µA
			Full range			82	
α_{VZ}	Average temperature coefficient of reverse breakdown voltage	I_Z = 10 mA	25°C		±20		ppm/°C
		I_Z = 1 mA	25°C		±15		
			Full range			±100	
		I_Z = 100 µA	25°C		±15		
$\frac{\Delta V_Z}{\Delta I_Z}$	Reverse breakdown voltage change with cathode current change	$I_{Z,min} < I_Z <$ 1 mA	25°C		0.3	0.8	mV
			Full range			1.1	
		1 mA < I_Z < 15 mA	25°C		2.5	6	
			Full range			9	
Z_Z	Reverse dynamic impedance	I_Z = 1 mA, f = 120 Hz, I_{AC} = 0.1 I_Z	25°C		0.3		Ω
e_N	Wideband noise	I_Z = 100 µA, 10 Hz ≤ f ≤ 10 kHz	25°C		35		μV_{RMS}
	Long-term stability of reverse breakdown voltage	t = 1000 h, T_A = 25°C ± 0.1°C, I_Z = 100 µA			120		ppm
V_{HYST}	Thermal hysteresis (1)	ΔT_A = –55°C to 125°C			0.08		%

(1) Thermal hysteresis is defined as $V_{Z,25°C}$ (after cycling to –55°C) – $V_{Z,25°C}$ (after cycling to 125°C).

TYPICAL CHARACTERISTICS

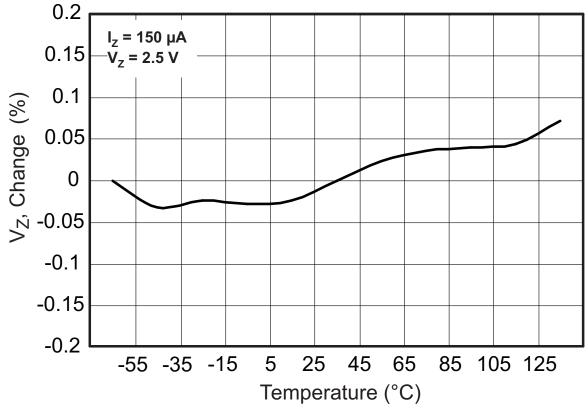


Figure 1. Change in V_Z vs Change in Temperature

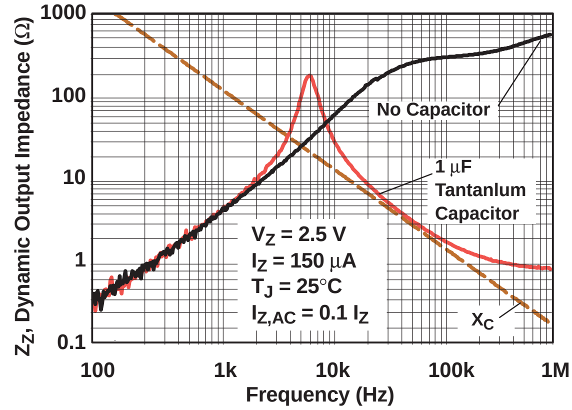


Figure 2. Output Impedance vs Frequency

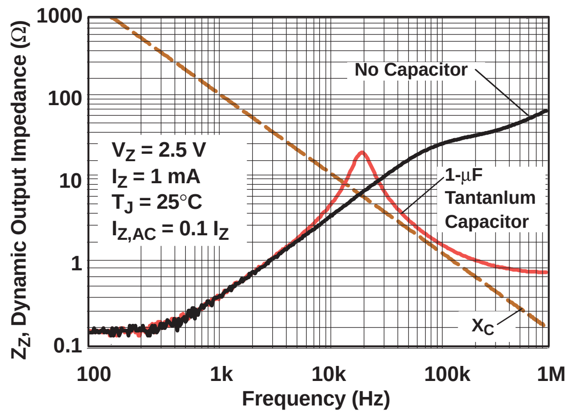


Figure 3. Output Impedance vs Frequency

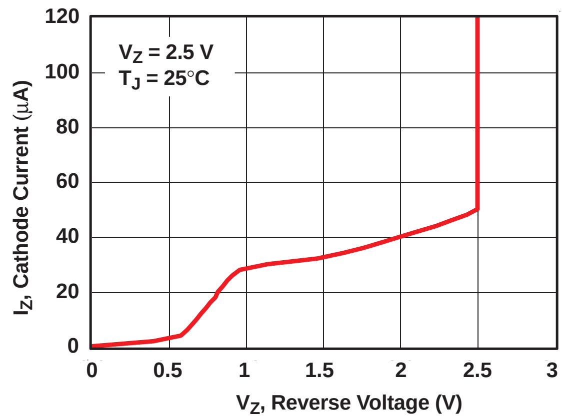


Figure 4. Cathode Current vs Reverse Voltage

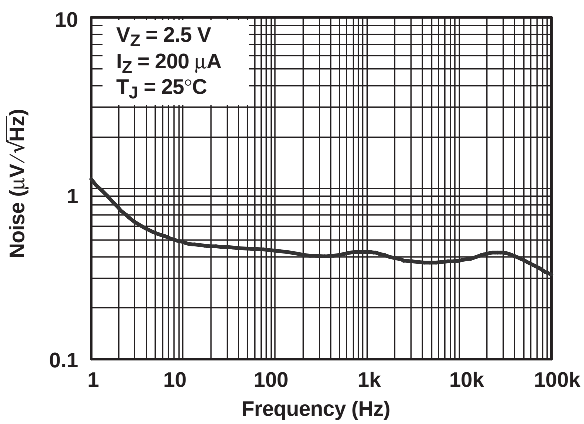


Figure 5. Noise Voltage vs Frequency

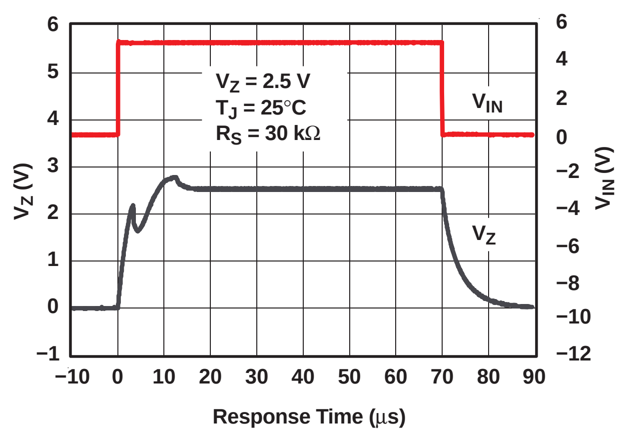


Figure 6. Start-Up Characteristics

APPLICATION INFORMATION

Start-Up Characteristics

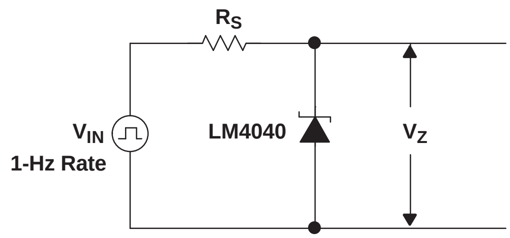


Figure 7. Test Circuit

Output Capacitor

The LM4040 does not require an output capacitor across cathode and anode for stability. However, if an output bypass capacitor is desired, the LM4040 is designed to be stable with all capacitive loads.

SOT-23 Connections

There is a parasitic Schottky diode connected between pins 2 and 3 of the SOT-23 packaged device. Thus, pin 3 of the SOT-23 package must be left floating or connected to pin 2.

Cathode and Load Currents

In a typical shunt-regulator configuration (see Figure 8), an external resistor, R_S, is connected between the supply and the cathode of the LM4040. R_S must be set properly, as it sets the total current available to supply the load (I_L) and bias the LM4040 (I_Z). In all cases, I_Z must stay within a specified range for proper operation of the reference. Taking into consideration one extreme in the variation of the load and supply voltage (maximum I_L and minimum V_S), R_S must be small enough to supply the minimum I_Z required for operation of the regulator, as given by data-sheet parameters. At the other extreme, maximum V_S and minimum I_L, R_S must be large enough to limit I_Z to less than its maximum-rated value of 15 mA.

R_S is calculated according to Equation 1:

$$R_S = \frac{(V_S - V_Z)}{(I_L + I_Z)} \quad (1)$$

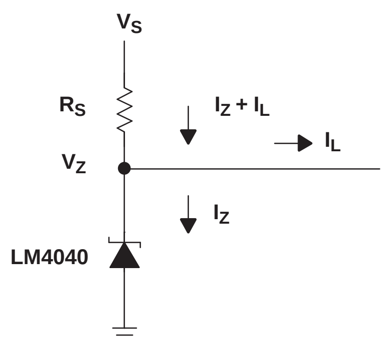


Figure 8. Shunt Regulator

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
LM4040C25MDBZTEP	NRND	Production	SOT-23 (DBZ) | 3	250 | SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-55 to 125	SAGU
LM4040C25MDBZTEP.A	NRND	Production	SOT-23 (DBZ) | 3	250 | SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-55 to 125	SAGU
V62/11615-01XE	NRND	Production	SOT-23 (DBZ) | 3	250 | SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-55 to 125	SAGU

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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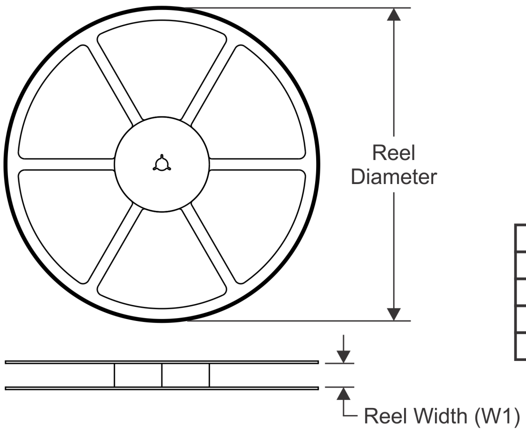
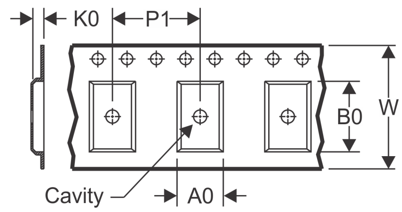
TAPE AND REEL INFORMATION

REEL DIMENSIONS

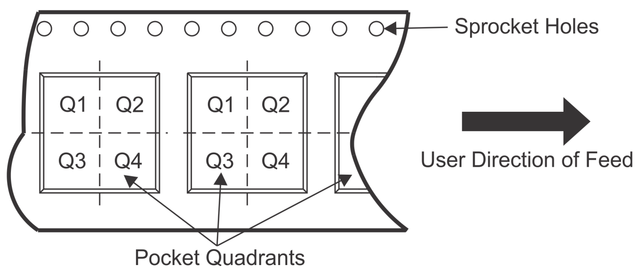


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

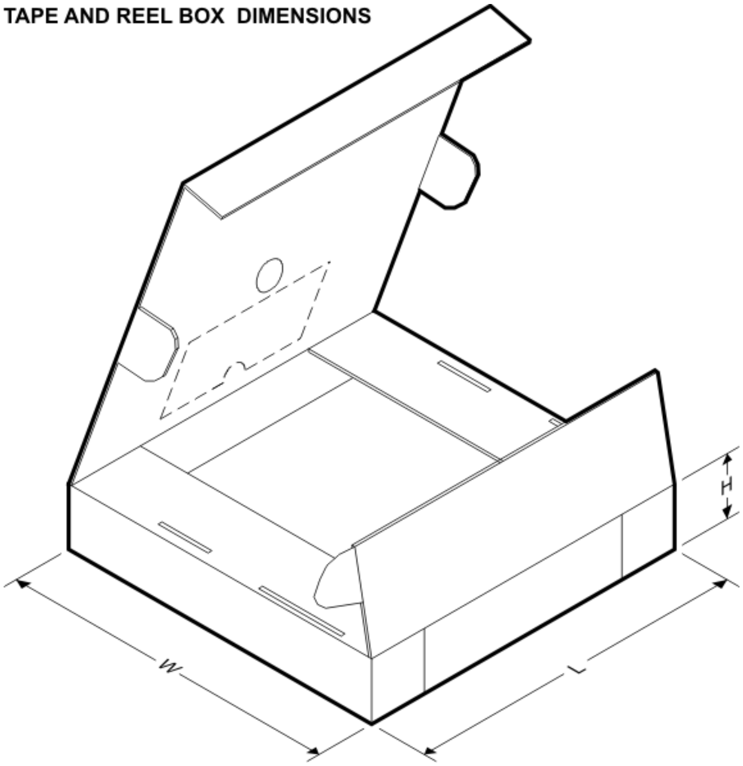
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

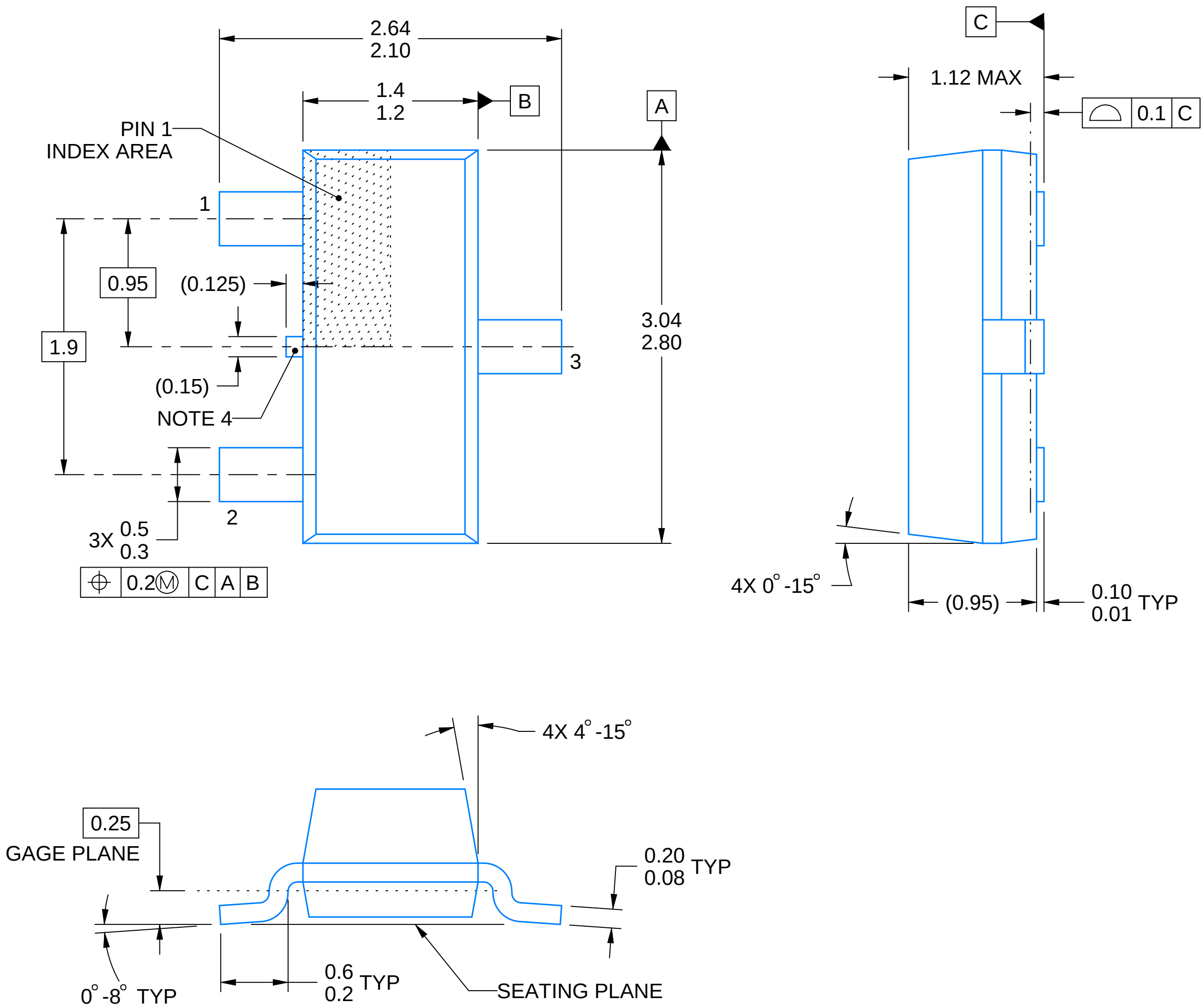
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM4040C25MDBZTEP	SOT-23	DBZ	3	250	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM4040C25MDBZTEP	SOT-23	DBZ	3	250	200.0	183.0	25.0



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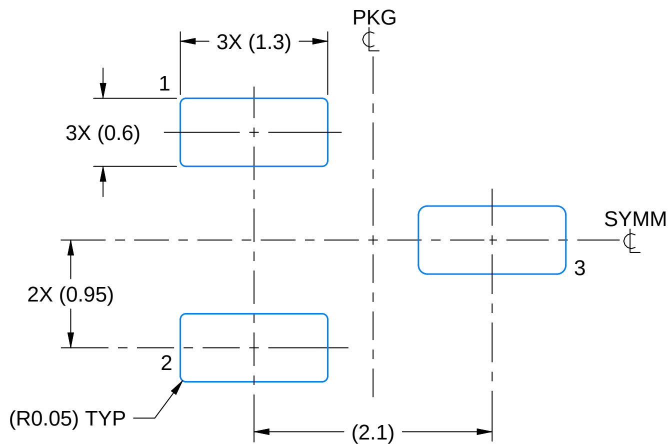
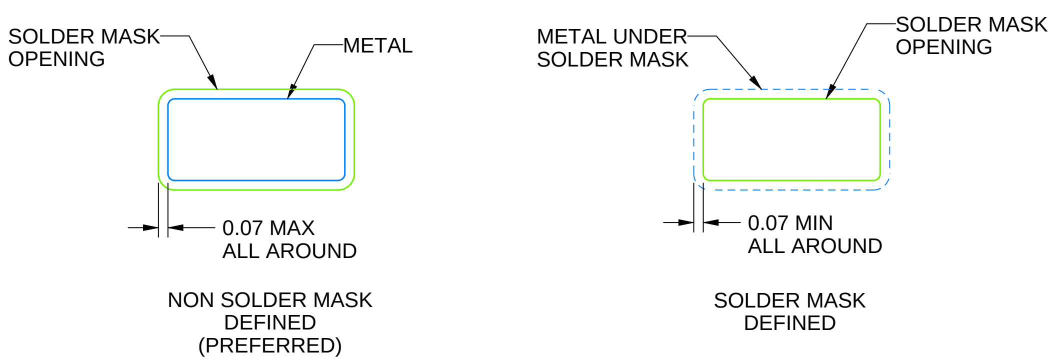
NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC registration TO-236, except minimum foot length.
4. Support pin may differ or may not be present.
5. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.25mm per side



LAND PATTERN EXAMPLE
SCALE:15X



SOLDER MASK DETAILS

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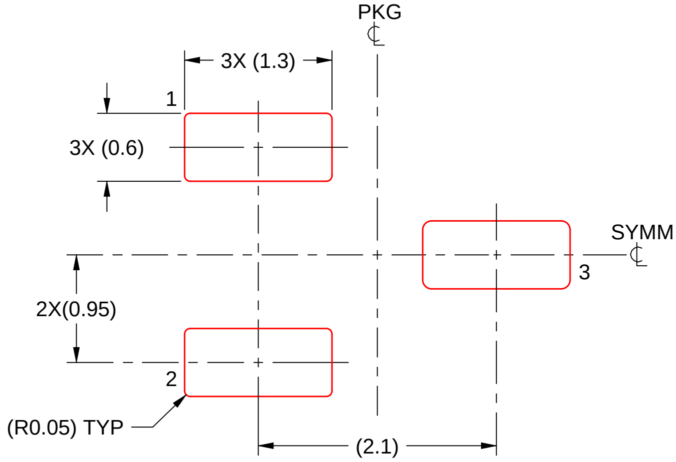
NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 THICK STENCIL
SCALE:15X

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NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

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