LM4050-N/-Q1 Precision Micropower Shunt Voltage Reference

1 Features

- Small Package: SOT-23
- No Output Capacitor Required
- Tolerates Capacitive Loads
- Fixed Reverse Breakdown Voltages of 2.048V, 2.5V, 4.096V, 5V, 8.192V, and 10V
- Key Specifications (LM4050-N)
  - Output Voltage Tolerance (A Grade, 25°C) ±0.1% (Maximum)
  - Low Output Noise (10Hz to 10kHz) 41µVrms (Typical)
  - Wide Operating Current Range 60µA to 15mA
  - Industrial Temperature Range −40°C to 85°C
  - Extended Temperature Range −40°C to 125°C
  - Low Temperature Coefficient 50ppm/°C (max)
  - LM4050-N-Q1 is AEC-Q100 Grade 1 Qualified and are Manufactured on an Automotive Grade Flow

2 Applications

- Battery-Powered Equipment
- Data-Acquisition Systems
- Instrumentation and Test Equipment
- Process Control
- Energy Management/Metering
- Automotive Electronics
- Precision Audio

3 Description

Designed for space-critical applications, the LM4050-N precision voltage reference is available in the sub-miniature (3mm × 1.3mm) SOT-23 surface-mount package. The LM4050-N design eliminates the need for an external stabilizing capacitor while maintaining stability with any capacitive load, thus making the LM4050-N easy to use. Further reducing design effort is the availability of several fixed reverse breakdown voltages: 2.048V, 2.5V, 4.096V, 5V, 8.192V, and 10V. The minimum operating current increases from 60µA for the LM4050-N-2.0 to 100µA for the LM4050-N-10.0. All versions have a maximum operating current of 15mA.

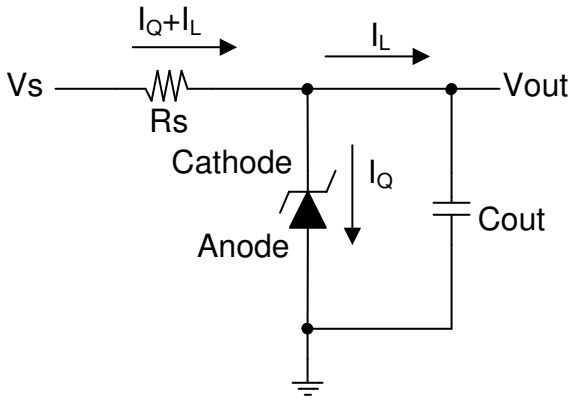
The LM4050-N utilizes fuse and Zener-zap reverse breakdown voltage trim during wafer sort to make sure that the prime parts have an accuracy of better than ±0.1% (A grade) at 25°C. Bandgap reference temperature drift curvature correction and low dynamic impedance verify stable reverse breakdown voltage accuracy over a wide range of operating temperatures and currents.

All grades and voltage options of the LM4050-N are available in both an industrial temperature range (−40°C and 85°C) and an extended temperature range (−40°C and 125°C).

Device Information

PART NUMBER	PACKAGE (1)	BODY SIZE (NOM) (2)
LM4050-N	SOT-23 (3)	2.92mm × 1.30mm
LM4050-N-Q1		

(1) For all available packages, see the orderable addendum at the end of the data sheet.
(2) The package size (length × width) is a nominal value and includes pins, where applicable.



Shunt Regulator Schematic

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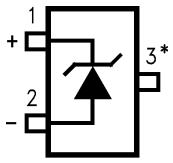
4 Pin Configuration and Functions



*This pin must be left floating or connected to pin 2.(1)

Figure 4-1. DBZ Package
3-Pin SOT-23
Top View

Table 4-1. Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
Cathode	1	I/O	Shunt current and input voltage
Anode	2	O	Common pin, normally connected to ground
NC	3	—	No internal connection (1)

(1) **In applications with high electromagnetic interference (for example, when placed near transformers or other electromagnetic sources) or significant high-frequency switching noise, TI recommends to connect this pin to the anode.**

5 Specifications

5.1 Absolute Maximum Ratings

See (1),(2)

	MIN	MAX	UNIT
Reverse Current		20	mA
Forward Current		10	mA
Power Dissipation (T_A = 25°C)(1)		280	mW
Maximum Junction Temperature (2)		150	°C
Storage Temperature	–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.

5.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±2000	V
		Charged device model (CDM), per JEDEC specification JESD22-C101(2)	±500	

(1) JEDEC document JEP155 states that 500V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250V CDM allows safe manufacturing with a standard ESD control process.

5.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted) (1) (1)

		MIN	MAX	UNIT
Industrial Temperature Range	Ambient Temperature Range	–40	85	°C
	Junction Temperature Range	–40	85	°C
Extended Temperature Range	Ambient Temperature Range	–40	125	°C
	Junction Temperature	–40	125	°C

(1) *Recommended Operating Conditions* are conditions under the device is intended to be functional. For specifications and conditions, see *Electrical Characteristics* section.

5.4 Thermal Information

THERMAL METRIC(1)		LM4050-N/-Q1 DBZ (SOT-23) 3 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	287	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	106.6	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	57.7	°C/W
ψ_{JT}	Junction-to-top characterization parameter	5.5	°C/W
ψ_{JB}	Junction-to-board characterization parameter	56.4	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	N/A	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, SPRA953.

5.5 Electrical Characteristics: 2V Option

All other limits $T_A = T_J = 25°C$. The grades A, B and C designate initial Reverse Breakdown Voltage tolerances of ±0.1%, ±0.2%, and 0.5% respectively.

PARAMETER		TEST CONDITIONS		MIN[4]	TYP[3]	MAX[4]	UNIT
V_R	Reverse Breakdown Voltage	I_R = 100µA			2.048		V
	Reverse breakdown voltage tolerance[5]	I_R = 100µA	LM4050AIM3, LM4050AEM3			±2.048	mV
			LM4050BIM3, LM4050BEM3			±4.096	
			LM4050CIM3, LM4050CEM3			±10.24	
		Industrial temperature range $T_A = T_J = T_{MIN}$ to T_{MAX}	LM4050AIM3			±9.0112	
			LM4050BIM3			±11.4688	
			LM4050CIM3			±14.7456	
		Extended temperature range $T_A = T_J = T_{MIN}$ to T_{MAX}	LM4050AEM3			±12.288	
			LM4050BEM3			±14.7456	
			LM4050CEM3			±17.2032	
I_{RMIN}	Minimum operating current	$T_A = T_J = 25°C$			41	60	µA
		$T_A = T_J = T_{MIN}$ to T_{MAX}				65	
$\Delta V_R/\Delta T$	Average reverse breakdown voltage temperature coefficient[5]	I_R = 10mA			±20		ppm/°C
		I_R = 1mA			±15		
		I_R = 100µA, $T_A = T_J = 25°C$			±15		
		I_R = 100µA, $T_A = T_J = T_{MIN}$ to T_{MAX}				±50	
$\Delta V_R/\Delta I_R$	Reverse breakdown voltage change with operating current change[6]	$I_{RMIN} \le I_R \le$ 1mA, $T_A = T_J = 25°C$			0.3	0.8	mV
		$I_{RMIN} \le I_R \le$ 1mA, $T_A = T_J = T_{MIN}$ to T_{MAX}				1.2	
		1mA ≤ I_R ≤ 15mA, $T_A = T_J = 25°C$			2.3	6	
		1mA ≤ I_R ≤ 15mA, $T_A = T_J = T_{MIN}$ to T_{MAX}				8	
Z_R	Reverse dynamic impedance	I_R = 1mA, f = 120Hz, I_{AC} = 0.1 I_R			0.3		Ω
e_N	Wideband noise	I_R = 100µA, 10Hz ≤ f ≤ 10kHz			34		μV_{rms}
ΔV_R	Reverse breakdown voltage long term stability	t = 1000 hrs, T = 25°C ±0.1°C, I_R = 100µA			120		ppm
V_{HYST}	Thermal hysteresis [7]	ΔT = −40°C to 125°C			0.7		mV

5.6 Electrical Characteristics: 2.5V Option

All other limits $T_A = T_J = 25°C$. The grades A, B and C designate initial Reverse Breakdown Voltage tolerances of ±0.1%, ±0.2%, and 0.5% respectively.

PARAMETER		TEST CONDITIONS		MIN[4]	TYP[3]	MAX[4]	UNIT
V_R	Reverse breakdown voltage	I_R = 100µA			2.500		V
		I_R = 100µA	LM4050AIM3, LM4050AEM3			±2.5	mV
			LM4050BIM3, LM4050BEM3			±5	
			LM4050CIM3, LM4050CEM3			±13	
	Reverse breakdown voltage tolerance[5]	Industrial temperature range, $T_A = T_J = T_{MIN}$ to T_{MAX}	LM4050AIM3			±11	mV
			LM4050BIM3			±24	
			LM4050CIM3			±21	
		Extended temperature range, $T_A = T_J = T_{MIN}$ to T_{MAX}	LM4050AEM3			±15	
			LM4050BEM3			±18	
			LM4050CEM3			±25	
I_{RMIN}	Minimum operating current	$T_A = T_J = 25°C$			41	60	µA
		$T_A = T_J = T_{MIN}$ to T_{MAX}				65	
$\Delta V_R/\Delta T$	Average reverse breakdown voltage temperature coefficient[5]	I_R = 10mA			±20		ppm/°C
		I_R = 1mA			±15		
		I_R = 100µA, $T_A = T_J = 25°C$			±15		
		I_R = 100µA, $T_A = T_J = T_{MIN}$ to T_{MAX}				±50	
$\Delta V_R/\Delta I_R$	Reverse breakdown voltage change with operating current change[6]	$I_{RMIN} \le I_R \le$ 1mA, $T_A = T_J = 25°C$			0.3	0.8	mV
		$I_{RMIN} \le I_R \le$ 1mA $T_A = T_J = T_{MIN}$ to T_{MAX}				1.2	
$\Delta V_R/\Delta I_R$	Reverse breakdown voltage change with operating current change[6]	1mA ≤ I_R ≤ 15mA, $T_A = T_J = 25°C$			2.3	6	mV
		1mA ≤ I_R ≤ 15mA, $T_A = T_J = T_{MIN}$ to T_{MAX}				8	
Z_R	Reverse dynamic impedance	I_R = 1mA, f = 120Hz, I_{AC} = 0.1 I_R			0.3		Ω
e_N	Wideband noise	I_R = 100µA, 10Hz ≤ f ≤ 10kHz			41		μV_{rms}
ΔV_R	Reverse breakdown voltage long term stability	t = 1000 hrs, T = 25°C ±0.1°C, I_R = 100µA			120		ppm
V_{HYST}	Thermal hysteresis [7]	ΔT = −40°C to 125°C			07		mV

5.7 Electrical Characteristics: 4.1V Option

All other limits $T_A = T_J = 25°C$. The grades A, B and C designate initial Reverse Breakdown Voltage tolerances of ±0.1%, ±0.2%, and 0.5% respectively.

PARAMETER		TEST CONDITIONS		MIN	TYP[3]	MAX	UNIT
V_R	Reverse Breakdown Voltage	I_R = 100µA			4.096		V
	Reverse Breakdown Voltage Tolerance[5]	I_R = 100µA	LM4050AIM3, LM4050AEM3			±4.1	mV
			LM4050BIM3,LM4050BEM3			±8.2	
			LM4050CIM3, LM4050CEM3			±21	
		Industrial temperature range, $T_A = T_J = T_{MIN}$ to T_{MAX}	LM4050AIM3			±18	
			LM4050BIM3			±22	
			LM4050CIM3			±34	
		Extended temperature range, $T_A = T_J = T_{MIN}$ to T_{MAX}	LM4050AEM3			±25	
			LM4050BEM3			±29	
			LM4050CEM3			±41	
I_{RMIN}	Minimum Operating Current	$T_A = T_J = 25°C$			52	68	µA
		Industrial temperature range, $T_A = T_J = T_{MIN}$ to T_{MAX}				73	
		Extended temperature range, $T_A = T_J = T_{MIN}$ to T_{MAX}				78	
$\Delta V_R/\Delta T$	Average reverse breakdown voltage temperature coefficient[5]	I_R = 10mA			±30		ppm/°C
		I_R = 1mA			±20		
		I_R = 100µA, $T_A = T_J = 25°C$			±20		
		I_R = 100µA, $T_A = T_J = T_{MIN}$ to T_{MAX}				±50	
$\Delta V_R/\Delta I_R$	Reverse breakdown voltage change with operating current change[6]	$I_{RMIN} \le I_R \le$ 1mA, $T_A = T_J = 25°C$			0.2	0.9	mV
		$I_{RMIN} \le I_R \le$ 1mA, $T_A = T_J = T_{MIN}$ to T_{MAX}				1.2	
		1mA ≤ I_R ≤ 15mA, $T_A = T_J = 25°C$			2	7	
		1mA ≤ I_R ≤ 15mA, $T_A = T_J = T_{MIN}$ to T_{MAX}				10	
Z_R	Reverse dynamic impedance	I_R = 1mA, f = 120Hz, I_{AC} = 0.1 I_R			0.5		Ω
e_N	Wideband noise	I_R = 100µA, 10Hz ≤ f ≤ 10kHz			93		μV_{rms}
ΔV_R	Reverse breakdown voltage long term stability	t = 1000 hrs, T = 25°C ±0.1°C, I_R = 100µA			120		ppm
V_{HYST}	Thermal hysteresis[7]	ΔT = −40°C to 125°C			1.148		mV

5.8 Electrical Characteristics: 5V Option

All other limits $T_A = T_J = 25°C$. The grades A, B and C designate initial Reverse Breakdown Voltage tolerances of ±0.1%, ±0.2% and 0.5% respectively.

PARAMETER		TEST CONDITIONS		MIN[4]	TYP[3]	MAX[4]	UNIT
V_R	Reverse Breakdown Voltage	I_R = 100µA			5		V
	Reverse Breakdown Voltage Tolerance[5]	I_R = 100µA	LM4050AIM3, LM4050AEM3			±5	mV
			LM4050BIM3. LM4050BEM3			±10	
			LM4050CIM3, LM4050CEM3			±25	
		Industrial Temp. Range $T_A = T_J = T_{MIN}$ to T_{MAX}	LM4050AIM3			±22	
			LM4050BIM3			±27	
			LM4050CIM3			±42	
		Extended Temp. Range $T_A = T_J = T_{MIN}$ to T_{MAX}	LM4050AEM3			±30	
			LM4050BEM3			±35	
			LM4050CEM3			±50	
I_{RMIN}	Minimum Operating Current	$T_A = T_J = 25°C$			56	74	µA
		Industrial Temp. Range $T_A = T_J = T_{MIN}$ to T_{MAX}				80	
		Extended Temp. Range $T_A = T_J = T_{MIN}$ to T_{MAX}				90	
$\Delta V_R/\Delta T$	Average Reverse Breakdown Voltage Temperature Coefficient[5]	I_R = 10mA			±30		ppm/°C
		I_R = 1mA			±20		
		I_R = 100µA, $T_A = T_J = 25°C$			±20		
		I_R = 100µA $T_A = T_J = T_{MIN}$ to T_{MAX}				±50	
$\Delta V_R/\Delta I_R$	Reverse Breakdown Voltage Change with Operating Current Change[6]	$I_{RMIN} \le I_R \le$ 1mA, $T_A = T_J = 25°C$			0.2	1	mV
		$I_{RMIN} \le I_R \le$ 1mA $T_A = T_J = T_{MIN}$ to T_{MAX}				1.4	
		1mA $\le I_R \le$ 15mA, $T_A = T_J = 25°C$			2	8	
		1mA $\le I_R \le$ 15mA $T_A = T_J = T_{MIN}$ to T_{MAX}				12	
Z_R	Reverse Dynamic Impedance	I_R = 1mA, f = 120Hz			0.5		Ω
		$I_{AC} = 0.1\ I_R$					
e_N	Wideband Noise	I_R = 100µA 10Hz ≤ f ≤ 10kHz			93		μV_{rms}
ΔV_R	Reverse Breakdown Voltage Long Term Stability	t = 1000 hrs T = 25°C ±0.1°C I_R = 100µA			120		ppm
V_{HYST}	Thermal Hysteresis[7]	ΔT = –40°C to 125°C			1.4		mV

5.9 Electrical Characteristics: 8.2V Option

All other limits $T_A = T_J = 25°C$. The grades A, B and C designate initial Reverse Breakdown Voltage tolerances of ±0.1% and ±0.2% and 0.5% respectively.

PARAMETER		TEST CONDITIONS		MIN[4]	TYP[3]	MAX[4]	UNIT
V_R	Reverse Breakdown Voltage	I_R = 150µA			8.192		V
	Reverse Breakdown Voltage Tolerance [5]	I_R = 150µA	LM4050AIM3, LM4050AEM3			±8.2	mV
			LM4050BIM3, LM4050BEM3			±16	
			LM4050CIM3, LM4050CEM3			±41	
		Industrial Temp. Range $T_A = T_J = T_{MIN}$ to T_{MAX}	LM4050AIM3			±35	
			LM4050BIM3			±43	
			LM4050CIM3			±68	
		Extended Temp. Range $T_A = T_J = T_{MIN}$ to T_{MAX}	LM4050AEM3			±49	
			LM4050BEM3			±57	
			LM4050CEM3			±82	
I_{RMIN}	Minimum Operating Current	$T_A = T_J = 25°C$			74	91	µA
		Industrial Temp. Range $T_A = T_J = T_{MIN}$ to T_{MAX}				95	
		Extended Temp. Range $T_A = T_J = T_{MIN}$ to T_{MAX}				100	
$\Delta V_R/\Delta T$	Average Reverse Breakdown Voltage Temperature Coefficient [5]	I_R = 10mA			±40		ppm/°C
		I_R = 1mA			±20		
		I_R = 150µA, $T_A = T_J = 25°C$			±20		
		I_R = 150µA $T_A = T_J = T_{MIN}$ to T_{MAX}				±50	
$\Delta V_R/\Delta I_R$	Reverse Breakdown Voltage Change with Operating Current Change [6]	$I_{RMIN} \le I_R \le$ 1mA, $T_A = T_J = 25°C$			0.9	3.1	mV
		$I_{RMIN} \le I_R \le$ 1mA $T_A = T_J = T_{MIN}$ to T_{MAX}				4.6	
		1mA ≤ I_R ≤ 15mA, $T_A = T_J = 25°C$			7	10	
		1mA ≤ I_R ≤ 15mA $T_A = T_J = T_{MIN}$ to T_{MAX}				18	
Z_R	Reverse Dynamic Impedance	I_R = 1mA, f = 120Hz, I_{AC} = 0.1 I_R			0.6		Ω
e_N	Wideband Noise	I_R = 150µA 10Hz ≤ f ≤ 10kHz			150		μV_{rms}
ΔV_R	Reverse Breakdown Voltage Long Term Stability	t = 1000 hrs T = 25°C ±0.1°C I_R = 150µA			120		ppm
V_{HYST}	Thermal Hysteresis [7]	ΔT = −40°C to 125°C			2.3		mV

5.10 Electrical Characteristics: 10V Option

All other limits $T_A = T_J = 25°C$. The grades A, B and C designate initial Reverse Breakdown Voltage tolerances of ±0.1% and ±0.2% and 0.5% respectively.

PARAMETER		TEST CONDITIONS		MIN(4)	TYP(3)	MAX(4)	UNIT
V_R	Reverse Breakdown Voltage	I_R = 150µA			10		V
V_R	Reverse Breakdown Voltage Tolerance (5)	I_R = 150µA	LM4050AIM3, LM4050AEM3			±10	mV (max)
			LM4050BIM3, LM4050BEM3			±20	
			LM4050CIM3, LM4050CEM3			±50	
		Industrial Temp. Range $T_A = T_J = T_{MIN}$ to T_{MAX}	LM4050AIM3			±43	
			LM4050BIM3			±53	
			LM4050CIM3			±83	
		Extended Temp. Range $T_A = T_J = T_{MIN}$ to T_{MAX}	LM4050AEM3			±60	
			LM4050BEM3			±70	
			LM4050CEM3			±100	
I_{RMIN}	Minimum Operating Current	$T_A = T_J = 25°C$			80	100	µA
		Industrial Temp. Range $T_A = T_J = T_{MIN}$ to T_{MAX}				103	
		Extended Temp. Range $T_A = T_J = T_{MIN}$ to T_{MAX}				110	
$\Delta V_R/\Delta T$	Average Reverse Breakdown Voltage Temperature Coefficient (5)	I_R = 10mA			±40		ppm/°C
		I_R = 1mA			±20		
		I_R = 150µA, $T_A = T_J = 25°C$			±20		
		I_R = 150µA $T_A = T_J = T_{MIN}$ to T_{MAX}				±50	
$\Delta V_R/\Delta I_R$	Reverse Breakdown Voltage Change with Operating Current Change (6)	$I_{RMIN} \le I_R \le$ 1mA, $T_A = T_J = 25°C$			2.5	3.8	mV
		$I_{RMIN} \le I_R \le$ 1mA $T_A = T_J = T_{MIN}$ to T_{MAX}				6	
		1mA ≤ I_R ≤ 15mA, $T_A = T_J = 25°C$			8	12	
		1mA ≤ I_R ≤ 15mA $T_A = T_J = T_{MIN}$ to T_{MAX}				23	
Z_R	Reverse Dynamic Impedance	I_R = 1mA, f = 120Hz, I_{AC} = 0.1 I_R			0.7		Ω
e_N	Wideband Noise	I_R = 150µA 10Hz ≤ f ≤ 10kHz			150		μV_{rms}
ΔV_R	Reverse Breakdown Voltage Long Term Stability	t = 1000 hrs T = 25°C ±0.1°C I_R = 150µA			120		ppm
V_{HYST}	Thermal Hysteresis(7)	ΔT = −40°C to 125°C			2.8		mV

(1) The maximum power dissipation must be derated at elevated temperatures and is dictated by T_{Jmax} (maximum junction temperature), $R_{\theta JA}$ (junction to ambient thermal resistance), and T_A (ambient temperature). The maximum allowable power dissipation at any temperature is $PD_{max} = (T_{Jmax} - T_A)/R_{\theta JA}$ or the number given in the *Absolute Maximum Ratings*, whichever is lower. For the LM4050-N, T_{Jmax} = 150°C, and the typical thermal resistance ($R_{\theta JA}$), when board mounted, is 326°C/W for the SOT-23 package.

(2) High junction temperatures degrade operating lifetimes. Operating lifetime is de-rated for junction temperatures greater than 125°C.

(3) Typicals are at $T_J = 25°C$ and represent most likely parametric norm.

(4) Limits are 100% production tested at 25°C. Limits over temperature are verified through correlation using Statistical Quality Control (SQC) methods. The limits are used to calculate National's AOQL.

(5) The overtemperature limit for Reverse Breakdown Voltage Tolerance is defined as the room temperature Reverse Breakdown Voltage Tolerance ±[($\Delta V_R/\Delta T$)(maxΔT)(V_R)]. Where, $\Delta V_R/\Delta T$ is the V_R temperature coefficient, maxΔT is the maximum difference in temperature from the reference point of 25°C to T_{MIN} or T_{MAX}, and V_R is the reverse breakdown voltage. The total overtemperature tolerance for the different grades in the industrial temperature range where maxΔT = 65°C is shown below: A-grade: ±0.425% = ±0.1% ±50ppm/°C × 65°C B-grade: ±0.525% = ±0.2% ±50ppm/°C × 65°C C-grade: ±0.825% = ±0.5% ±50ppm/°C × 65°C. Therefore, as an example, the A-grade LM4050-N-2.5 has an overtemperature Reverse Breakdown Voltage tolerance of ±2.5V × 0.425% = ±11 mV.

(6) Load regulation is measured on pulse basis from no load to the specified load current. Output changes due to die temperature change must be taken into account separately.

(7) Thermal hysteresis is defined as the difference in voltage measured at 25°C after cycling to temperature –40°C and the 25°C measurement after cycling to temperature 125°C.

5.11 Typical Characteristics

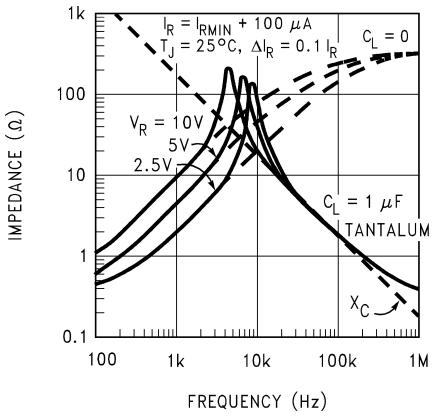


Figure 5-1. Output Impedance vs Frequency

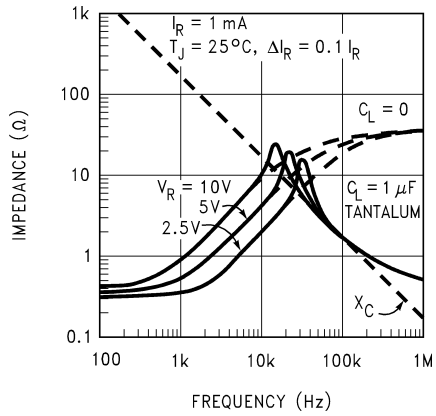


Figure 5-2. Output Impedance vs Frequency

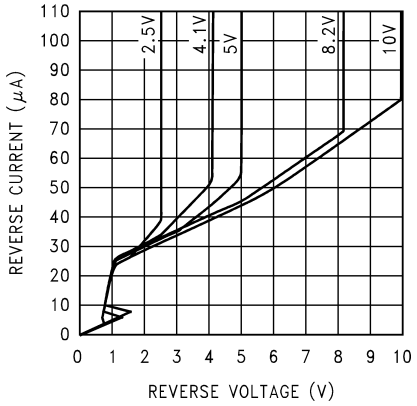


Figure 5-3. Reverse Characteristics and Minimum Operating Current

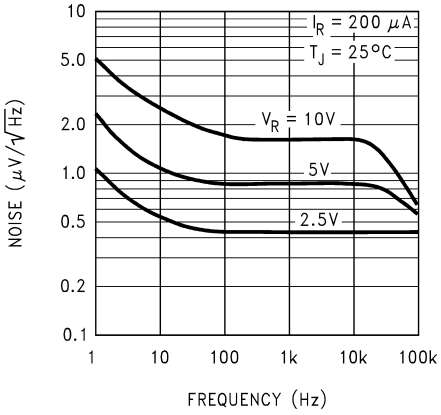


Figure 5-4. Noise Voltage vs Frequency

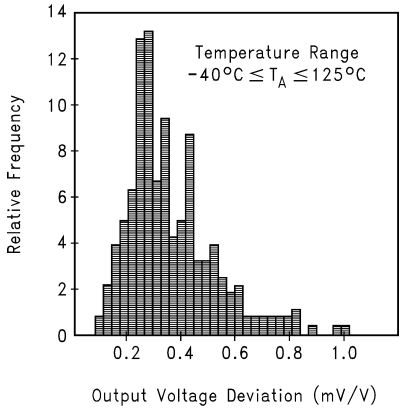


Figure 5-5. Thermal Hysteresis

5.11.1 Start-Up Characteristics

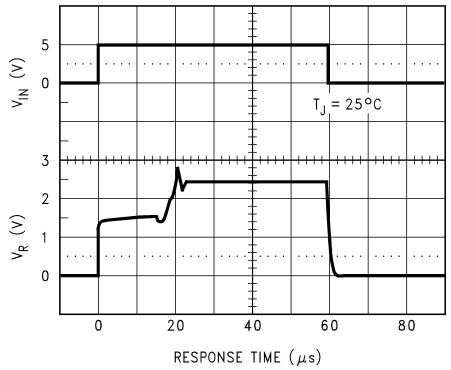


Figure 5-6. Input Voltage Step Response LM4050-N-2.5

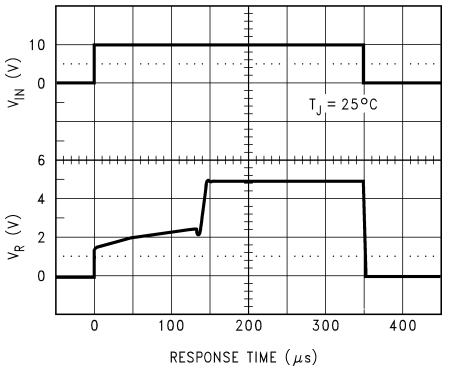


Figure 5-7. Input Voltage Step Response LM4050-N-5

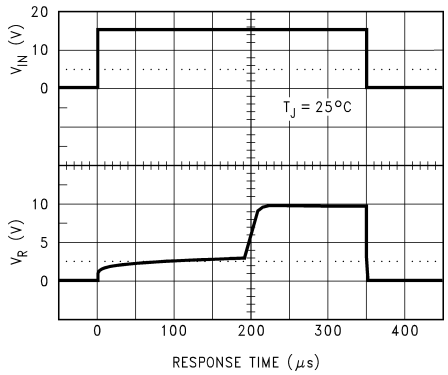


Figure 5-8. Input Voltage Step Response LM4050-N-10

6 Parameter Measurement Information

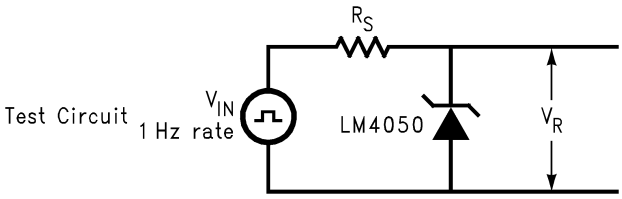


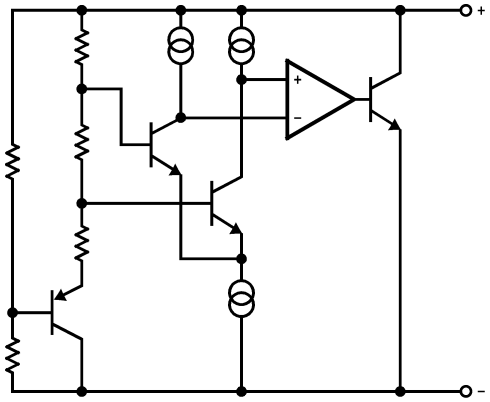
Figure 6-1. Test Circuit

7 Detailed Description

7.1 Overview

The LM4050-N device is a precision micropower shunt voltage reference. The part comes in 6 different fixed-output voltage options for space-constrained applications, removing the need for feedback resistors. The voltage tolerance accuracies are ±0.1%, ±0.2%, and ±0.5% for Versions A, B, and C, respectively. The LM4050-N comes in two application versions, Industrial and Extended temperature range, which are operational from –40°C to 85°C and –40°C to 125°C, respectively.

7.2 Functional Block Diagram



7.3 Feature Description

The LM4050-N behaves as a high-precision Zener diode. The voltage is regulated between the cathode and anode which is dependent on the current being supplied to the cathode. This current is needed for the LM4050-N to regulate within the specified limits. Refer to the minimum and maximum operating requirements for the specific voltage option used. The LM4050-N is internally compensated to be stable without the use of an output capacitor. However, if desired, a bypass capacitor can be used.

7.4 Device Functional Modes

The LM4050-N can only operate in closed loop due to the fact that the feedback resistors are internal to the device. Additionally, the output voltage cannot be adjusted for the same reason. The output voltage is regulated in a closed loop, provided the Rs (see *Section 7.2*) resistor is sized to deliver the current to the cathode within the limits specified for the fixed-voltage version being used.

8 Application and Implementation

Note

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation to confirm system functionality.

8.1 Application Information

The LM4050-N is a precision micropower curvature-corrected bandgap shunt voltage reference. For space critical applications, the LM4050-N is available in the sub-miniature SOT-23 surface-mount package. The LM4050-N has been designed for stable operation without the need of an external capacitor connected between the + pin and the − pin. If, however, a bypass capacitor is used, the LM4050-N remains stable. Reducing design effort is the availability of several fixed reverse breakdown voltages: 2.048V, 2.5V, 4.096V, 5V, 8.192V, and 10V. The minimum operating current increases from 60µA for the LM4050-N-2.0 to 100µA for the LM4050-N-10.0. All versions have a maximum operating current of 15mA.

LM4050-Ns in the SOT-23 packages have a parasitic Schottky diode between pin 2 (−) and pin 3 (Die attach interface contact). Therefore, pin 3 of the SOT-23 package must be left floating or connected to pin 2.

The 4.096V version allows single 5V 12-bit ADCs or DACs to operate with an LSB equal to 1mV. For 12-bit ADCs or DACs that operate on supplies of 10V or greater, the 8.192V version gives 2mV per LSB.

The typical thermal hysteresis specification is defined as the change in 25°C voltage measured after thermal cycling. The device is thermal cycled to temperature –40°C and then measured at 25°C. Next the device is thermal cycled to temperature 125°C and again measured at 25°C. The resulting V_{OUT} delta shift between the 25°C measurements is thermal hysteresis. Thermal hysteresis is common in precision references and is induced by thermal-mechanical package stress. Changes in environmental storage temperature, operating temperature and board mounting temperature are all factors that can contribute to thermal hysteresis.

In a conventional shunt regulator application (Figure 8-1) , an external series resistor (R_S) is connected between the supply voltage and the LM4050-N. R_S determines the current that flows through the load (I_L) and the LM4050-N (I_Q). Since load current and supply voltage can vary, R_S must be small enough to supply at least the maximum I_{RMIN} (spec. table) to the LM4050-N even when the supply voltage is at the minimum and the load current is at the maximum value. When the supply voltage is at the maximum and I_L is at the minimum, R_S must be large enough so that the current flowing through the LM4050-N is less than 15mA.

R_S is determined by the supply voltage, (V_S), the load and operating current, (I_L and I_Q), and the LM4050-N's reverse breakdown voltage, V_R.

$$R_S = \frac{V_S - V_R}{I_L + I_Q} \tag{1}$$

8.2 Typical Applications

8.2.1 Shunt Regulator

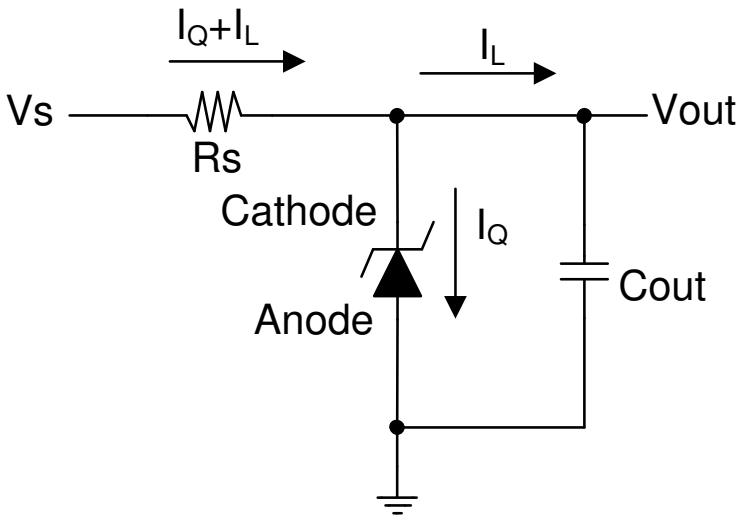


Figure 8-1. Shunt Regulator Schematic

8.2.1.1 Design Requirements

For this design example, use the parameters listed in Table 8-1 as the input parameters.

Table 8-1. Design Parameters

DESIGN PARAMETER	VALUE
Output Voltage	2V, 2.5V, 4.1V, 5V, 8.2V, 10V
Minimum Cathode Current	41µA, 41µA, 52µA, 56µA, 74µA, 80µA (typical) (Respective to Above field)

8.2.1.2 Detailed Design Procedure

R_S sets the cathode current of the shunt reference. Make sure that this current is greater than the minimum cathode current to maintain regulation and less that the maximum reverse current to prevent overheating of the shunt reference. A suggested good starting value for most designs is from approximately 0.5mA to 1mA.

$$I_{RMIN} < \frac{V_s - V_{out}}{R_s} < 0.015A \tag{2}$$

8.2.1.3 Application Curve

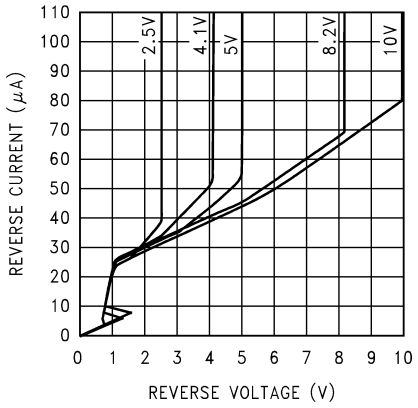
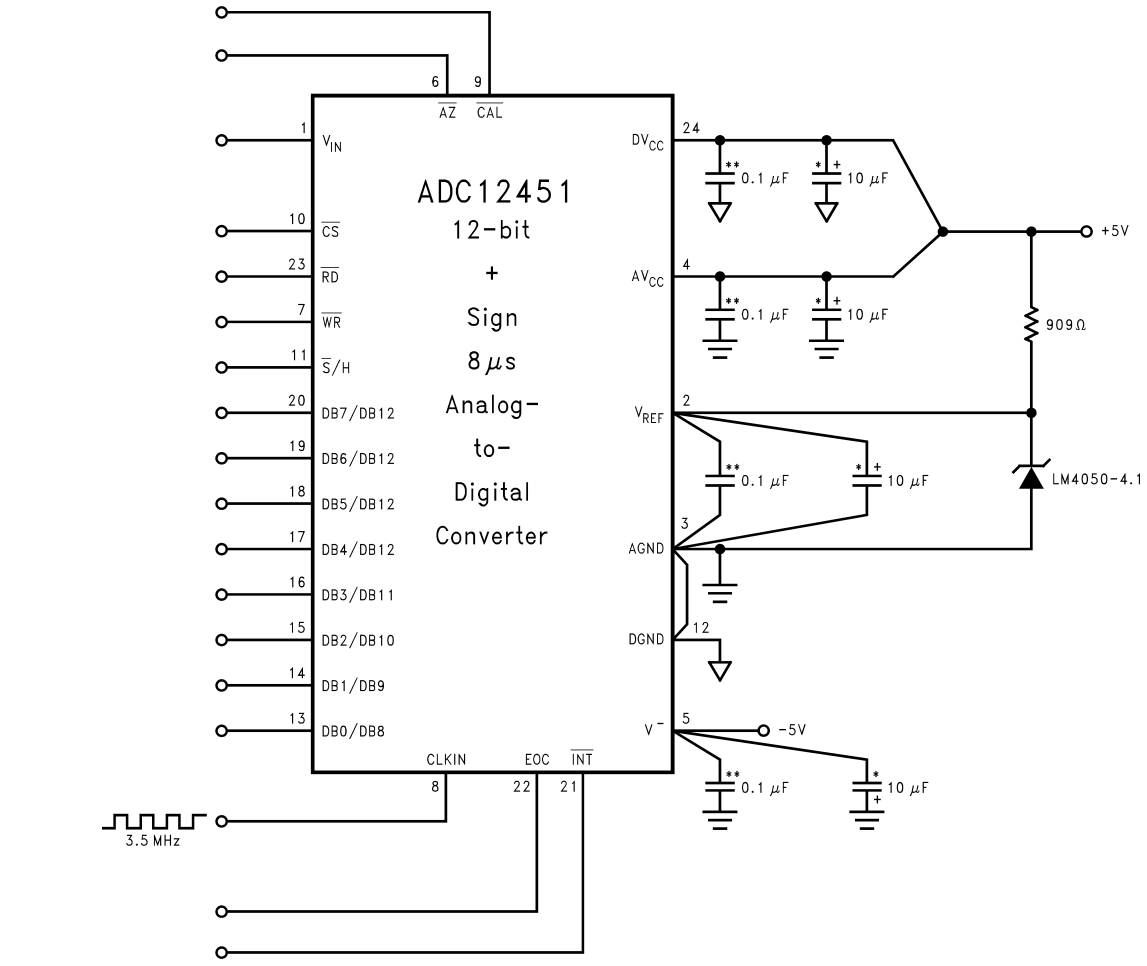


Figure 8-2. Reverse Characteristics and Minimum Operating Current

8.2.2 Precision Reference for an Analog-to-Digital Converter



**Ceramic monolithic *Tantalum

Figure 8-3. LM4050-N-4.1'S Nominal 4.096 Breakdown Voltage Gives ADC12451 1MV/LSB

8.2.2.1 Design Requirements

For this design example, use the parameters listed in Table 8-2 as the input parameters.

Table 8-2. Design Parameters

DESIGN PARAMETER	VALUE
Output Voltage	4.1V

8.2.2.2 Detailed Design Procedure

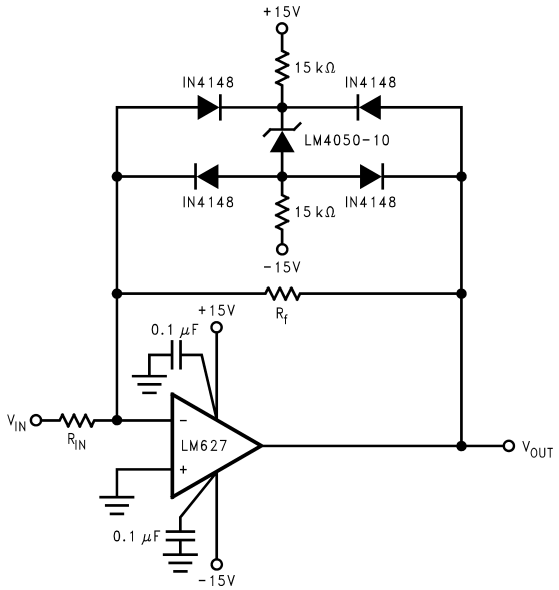
Set I_Q to approximately 1mA.

$$R_s = \frac{V_s - V_{out}}{I_Q} \quad (3)$$

where

- Rs = 900Ω, nearest preferred Value = 909Ω

8.2.3 V_{OUT} Bounded Amplifier



Bounded amplifier reduces saturation-induced delays and can prevent succeeding stage damage. Nominal clamping voltage is ±11.5V (LM4050-N's reverse breakdown voltage +2 diode V_F).

Figure 8-4. Bounded Amplifier

8.2.3.1 Design Requirements

The only design requirement is V_{OUT} bounded to ±11.5V.

8.2.3.2 Detailed Design Procedure

$$V_{bound} = 2 \times V_{wd} + V_{out} \tag{4}$$

$$V_{fwd} = 0.7\ V \tag{5}$$

$$V_{bound} = (2 \times 0.7\ V) + 10\ V \tag{6}$$

Set I_Q to approximately 0.6mA.

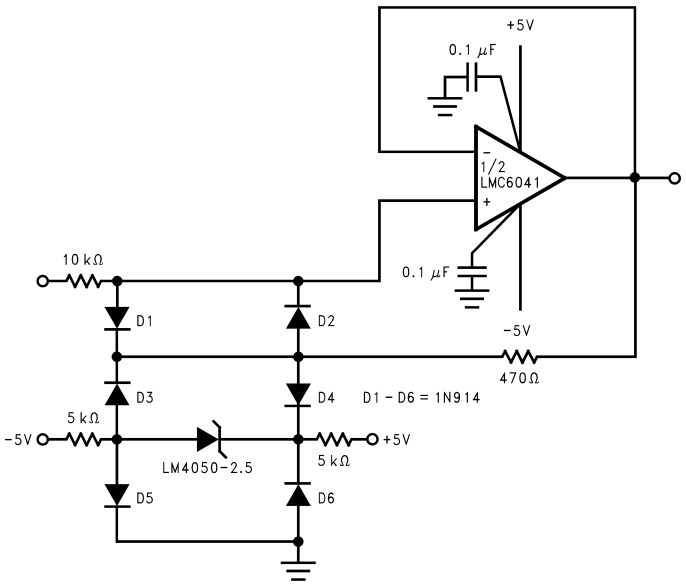
$$R_s = \frac{V_s + |-V_s| - V_{out}}{I_Q} \tag{7}$$

$$R_s = \frac{30\ V - 10\ V}{0.0006A} \tag{8}$$

where

- R_S (total) = 33kΩ (select 2 × 15kΩ)

8.2.4 V_{IN} Bounded Amplifier



The bounding voltage is ±4V with the LM4050-N-2.5 (LM4050-N's reverse breakdown voltage + 3 diode V_F).

Figure 8-5. Protecting Op Amp Input

8.2.4.1 Design Requirements

The only design requirement is V_{IN} bounded to ±4.6V.

8.2.4.2 Detailed Design Procedure

$$V_{bound} = 3 \times V_{wd} + V_{out} \tag{9}$$

$$V_{fwd} = 0.7\ V \tag{10}$$

$$V_{bound} = (3 \times 0.7\ V) + 2.5\ V \tag{11}$$

Set I_Q to approximately 0.6mA.

$$R_s = \frac{V_s + |-V_s| - V_{out}}{I_Q} \tag{12}$$

$$R_s = \frac{10\ V - 2.5\ V}{0.0006A} \tag{13}$$

where

- R_S (total) = 12.5kΩ (select 2 × 5kΩ)

8.2.5 ±4.096 Precision Reference

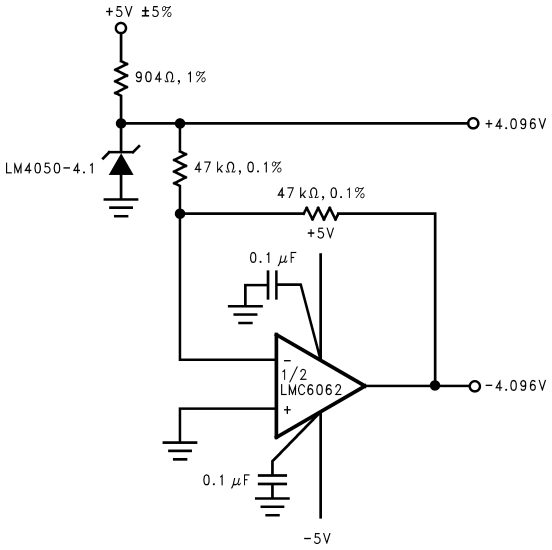


Figure 8-6. Precision ±4.096v Reference

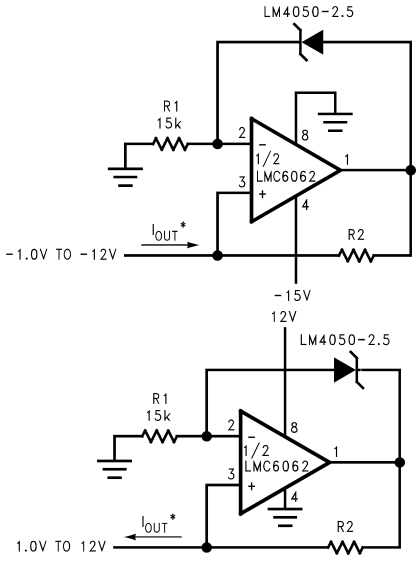
8.2.5.1 Design Requirements

The only design requirement is a positive and negative reference generated from a positive reference, ±4.096V.

8.2.5.2 Detailed Design Procedure

Follow the design procedure set in *Section 8.2.2*.

8.2.6 ±1mA Precision Current Sources



$$I_{out} = \frac{V_{out}}{R2}$$

Figure 8-7. Precision 1µA to 1mA Current Source (±)

8.2.6.1 Design Requirements

The only design requirement is a dual ±1mA current source.

8.2.6.2 Detailed Design Procedure

Set worse-case cathode current to 0.6mA.

$$V_{out_{opampmax}} = 12\ V \tag{14}$$

$$R1 = \frac{Vout_{Opampmax} - Vout}{I_Q} \tag{15}$$

$$R1 = \frac{12\ V - 2.5\ V}{0.0006A} \tag{16}$$

$$R1 = 1.583 \times 10^4\ \Omega \tag{17}$$

$$I_{out} = \frac{V_{out}}{R2} \tag{18}$$

8.3 Power Supply Recommendations

Noise on the power supply input to R_S can affect output noise performance. Noise performance can be reduced by using an optional bypass capacitor at the input side of R_S and Ground. TI recommends a 0.1µF ceramic capacitor or higher.

8.4 Layout

8.4.1 Layout Guidelines

Place R_S as close to the cathode as possible. If an input and output capacitor is used, place this as close to the reference as possible.

8.4.2 Layout Example

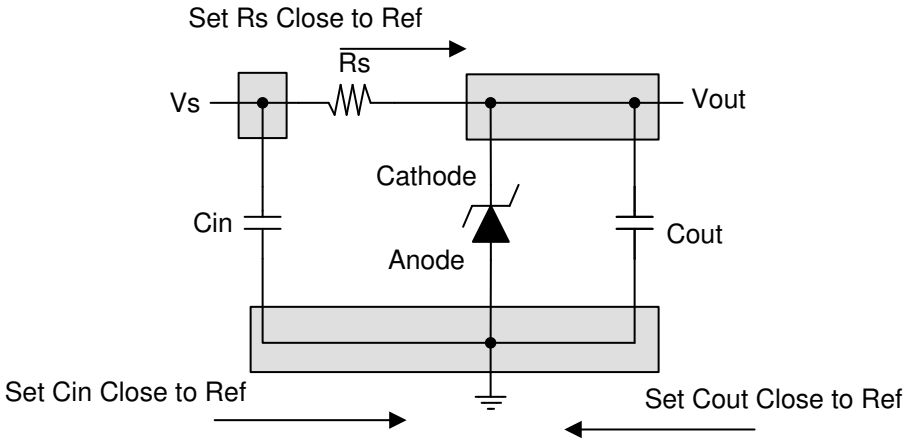


Figure 8-8. Layout Recommendation

9 Device and Documentation Support

9.1 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

9.2 Trademarks

TI E2E™ is a trademark of Texas Instruments.
All trademarks are the property of their respective owners.

9.3 Electrostatic Discharge Caution

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

9.4 Glossary

TI Glossary	This glossary lists and explains terms, acronyms, and definitions.

10 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision G (September 2015) to Revision H (March 2025) — **Page**

- Updated the numbering format for tables, figures, and cross-references throughout the document ... 1
- Updated *Applications* links ... 1
- Added information about high EMI applications ... 3
- Removed machine model (MM) ESD specification and revised the CDM ESD specification ... 4
- Removed industrial temperature range part numbers from extended temperature range row and corrected typos ... 6
- Updated reverse breakdown voltage change with operating current change ... 11
- Clarified orderable part number information. ... 24

Changes from Revision F (June 2015) to Revision G (September 2015) — **Page**

- Added *ESD Ratings* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section ... 1
- Removed Vapor Phase and Infrared Lead Temperatures from Abs Max Ratings table. ... 4

Changes from Revision E (April 2013) to Revision F (April 2015) — **Page**

- Deleted "-25" from (LM4050-N) in Key Specifications title and "A/-Q1B/-Q1C" from Key Specification re: auto grade ... 1
- Added Maximum Junction Temperature to Abs Max Ratings table ... 4
- Added table notes to Operating Ratings table to clarify operating and high junction temperature ranges ... 5
- Deleted "-N" from part numbers in EC table "Limits" column headers ... 6

Changes from Revision D (April 2013) to Revision E (April 2013)	Page
• Changed layout of National Data Sheet to TI format	21

11 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation. Part numbers containing an "X" contain the same electrical properties as those which do not contain an "X".

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM4050AEM3-10/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RGA	Samples
LM4050AEM3-2.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RNA	Samples
LM4050AEM3-2.5/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RCA	Samples
LM4050AEM3-5.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	REA	Samples
LM4050AEM3-8.2/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RFA	Samples
LM4050AEM3X-10/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RGA	Samples
LM4050AEM3X-2.5/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RCA	Samples
LM4050AEM3X-5.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	REA	Samples
LM4050AIM3-10/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RGA	Samples
LM4050AIM3-2.5/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RCA	Samples
LM4050AIM3-4.1/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RDA	Samples
LM4050AIM3-5.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	REA	Samples
LM4050AIM3X-2.5/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RCA	Samples
LM4050AIM3X-4.1/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RDA	Samples
LM4050AIM3X-5.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	REA	Samples
LM4050BEM3-10/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RGB	Samples
LM4050BEM3-2.5/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RCB	Samples
LM4050BEM3-4.1/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RDB	Samples
LM4050BEM3-5.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	REB	Samples
LM4050BEM3-8.2/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RFB	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM4050BEM3X-10/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RGB	Samples
LM4050BEM3X-2.5/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RCB	Samples
LM4050BEM3X-5.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	REB	Samples
LM4050BIM3-10/NOPB	ACTIVE	SOT-23	DBZ	3	1000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RGB	Samples
LM4050BIM3-2.5/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RCB	Samples
LM4050BIM3-4.1/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RDB	Samples
LM4050BIM3-5.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	REB	Samples
LM4050BIM3X-2.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RNB	Samples
LM4050BIM3X-2.5/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RCB	Samples
LM4050BIM3X-4.1/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RDB	Samples
LM4050BIM3X-5.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	REB	Samples
LM4050CEM3-10/NOPB	ACTIVE	SOT-23	DBZ	3	1000	RoHS & Green	SN	Level-1-260C-UNLIM		RGC	Samples
LM4050CEM3-2.5/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RCC	Samples
LM4050CEM3-5.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM		REC	Samples
LM4050CEM3X-2.5/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RCC	Samples
LM4050CEM3X-5.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM		REC	Samples
LM4050CIM3-10/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RGC	Samples
LM4050CIM3-2.5/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RCC	Samples
LM4050CIM3-4.1/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RDC	Samples
LM4050CIM3-5.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	REC	Samples
LM4050CIM3X-2.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RNC	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM4050CIM3X-2.5/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RCC	Samples
LM4050CIM3X-4.1/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RDC	Samples
LM4050CIM3X-5.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	REC	Samples
LM4050QAEM3-10/NOPB	OBSOLETE	SOT-23	DBZ	3		TBD	Call TI	Call TI	-40 to 125	RYA	
LM4050QAEM3-2.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RSA	Samples
LM4050QAEM3-2.5/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RTA	Samples
LM4050QAEM3-4.1/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RUA	Samples
LM4050QAEM3-5.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RVA	Samples
LM4050QAEM3X10/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RYA	Samples
LM4050QAEM3X2.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RSA	Samples
LM4050QAEM3X2.5/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RTA	Samples
LM4050QAEM3X4.1/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RUA	Samples
LM4050QAEM3X5.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RVA	Samples
LM4050QAEM3X8.2/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RXA	Samples
LM4050QAIM3-10/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RYA	Samples
LM4050QAIM3-2.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RSA	Samples
LM4050QAIM3-2.5/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RTA	Samples
LM4050QAIM3-4.1/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RUA	Samples
LM4050QAIM3-8.2/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RXA	Samples
LM4050QAIM3X4.1/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RUA	Samples
LM4050QBEM3-10/NOPB	OBSOLETE	SOT-23	DBZ	3		TBD	Call TI	Call TI	-40 to 125	RYB	
LM4050QBEM3-2.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RSB	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM4050QBEM3-2.5/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RTB	Samples
LM4050QBEM3-4.1/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RUB	Samples
LM4050QBEM3-5.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RVB	Samples
LM4050QBEM3-8.2/NOPB	OBSOLETE	SOT-23	DBZ	3		TBD	Call TI	Call TI	-40 to 125	RXB	
LM4050QBEM3X10/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RYB	Samples
LM4050QBEM3X2.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RSB	Samples
LM4050QBEM3X2.5/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RTB	Samples
LM4050QBEM3X4.1/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RUB	Samples
LM4050QBEM3X5.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RVB	Samples
LM4050QBEM3X8.2/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RXB	Samples
LM4050QBIM3-10/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RYB	Samples
LM4050QBIM3-2.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RSB	Samples
LM4050QBIM3-2.5/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RTB	Samples
LM4050QBIM3-4.1/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RUB	Samples
LM4050QBIM3-5.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RVB	Samples
LM4050QBIM3-8.2/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RXB	Samples
LM4050QCEM3-10/NOPB	OBSOLETE	SOT-23	DBZ	3		TBD	Call TI	Call TI	-40 to 125	RYC	
LM4050QCEM3-2.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RSC	Samples
LM4050QCEM3-2.5/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RTC	Samples
LM4050QCEM3-4.1/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RUC	Samples
LM4050QCEM3-5.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RVC	Samples
LM4050QCEM3-8.2/NOPB	OBSOLETE	SOT-23	DBZ	3		TBD	Call TI	Call TI	-40 to 125	RXC	

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM4050QCEM3X10/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RYC	Samples
LM4050QCEM3X2.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RSC	Samples
LM4050QCEM3X2.5/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RTC	Samples
LM4050QCEM3X4.1/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RUC	Samples
LM4050QCEM3X5.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RVC	Samples
LM4050QCEM3X8.2/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	RXC	Samples
LM4050QCIM3-2.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RSC	Samples
LM4050QCIM3-4.1/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RUC	Samples
LM4050QCIM3-5.0/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	RVC	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices 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.

OTHER QUALIFIED VERSIONS OF LM4050-N, LM4050-N-Q1 :

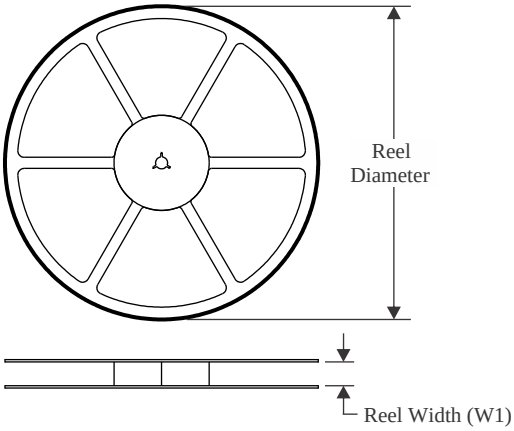
- Catalog : LM4050-N
- Automotive : LM4050-N-Q1

NOTE: Qualified Version Definitions:

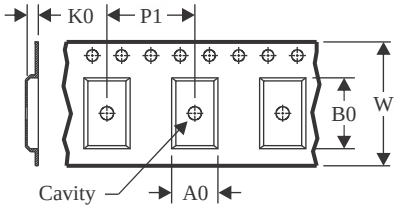
- Catalog - TI's standard catalog product
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

TAPE AND REEL INFORMATION

REEL DIMENSIONS

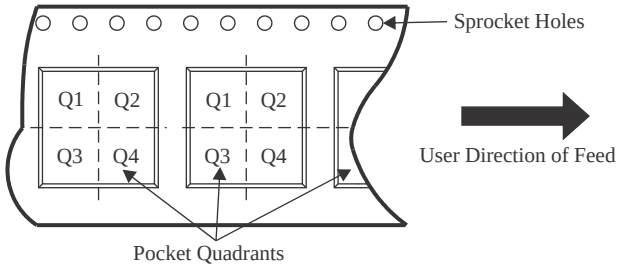


TAPE DIMENSIONS



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
LM4050AEM3-10/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050AEM3-2.0/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050AEM3-2.0/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050AEM3-2.5/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050AEM3-2.5/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050AEM3-5.0/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050AEM3-5.0/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050AEM3-8.2/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050AEM3X-10/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050AEM3X-2.5/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050AEM3X-2.5/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050AEM3X-5.0/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050AEM3X-5.0/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050AIM3-10/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050AIM3-2.5/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050AIM3-2.5/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3

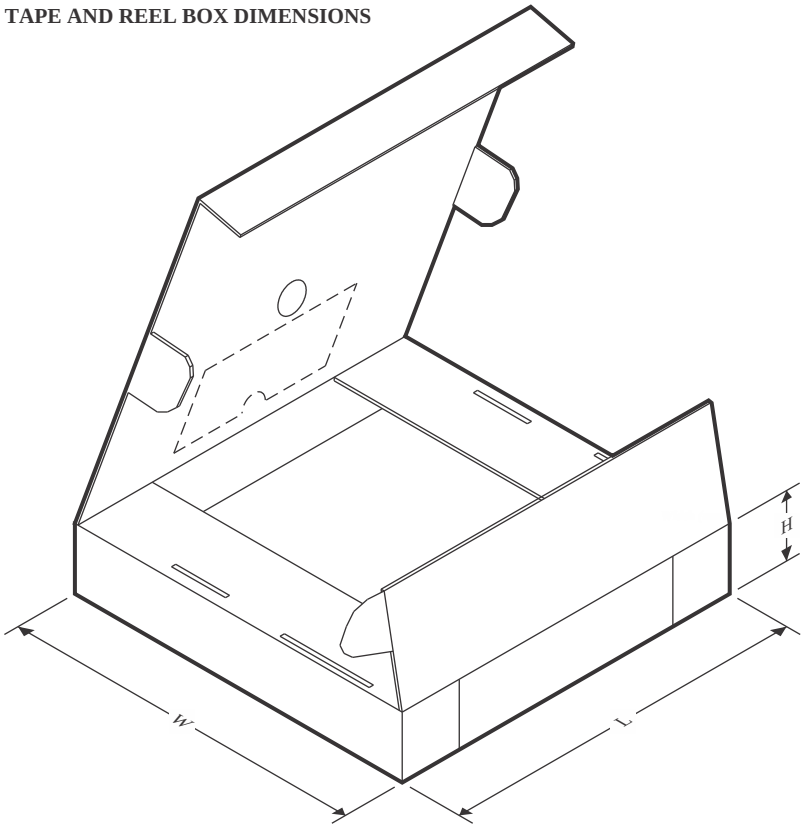
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM4050AIM3-4.1/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050AIM3-4.1/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050AIM3-5.0/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050AIM3-5.0/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050AIM3X-2.5/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050AIM3X-2.5/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050AIM3X-4.1/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050AIM3X-4.1/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050AIM3X-5.0/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050AIM3X-5.0/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050BEM3-10/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050BEM3-2.5/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050BEM3-2.5/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050BEM3-4.1/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050BEM3-4.1/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050BEM3-5.0/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050BEM3-5.0/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050BEM3-8.2/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050BEM3X-10/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050BEM3X-2.5/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050BEM3X-2.5/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050BEM3X-5.0/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050BEM3X-5.0/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050BIM3-10/NOPB	SOT-23	DBZ	3	1000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050BIM3-2.5/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050BIM3-2.5/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050BIM3-4.1/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050BIM3-4.1/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050BIM3-5.0/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050BIM3-5.0/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050BIM3X-2.0/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050BIM3X-2.0/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050BIM3X-2.5/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050BIM3X-2.5/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050BIM3X-4.1/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050BIM3X-4.1/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050BIM3X-5.0/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050BIM3X-5.0/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050CEM3-10/NOPB	SOT-23	DBZ	3	1000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050CEM3-2.5/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050CEM3-2.5/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3

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
LM4050CEM3-5.0/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050CEM3-5.0/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050CEM3X-2.5/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050CEM3X-2.5/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050CEM3X-5.0/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050CEM3X-5.0/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050CIM3-10/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050CIM3-2.5/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050CIM3-2.5/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050CIM3-4.1/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050CIM3-4.1/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050CIM3-5.0/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050CIM3-5.0/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050CIM3X-2.0/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050CIM3X-2.0/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050CIM3X-2.5/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050CIM3X-2.5/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050CIM3X-4.1/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050CIM3X-4.1/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050CIM3X-5.0/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050CIM3X-5.0/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050QAEM3-2.0/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QAEM3-2.5/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QAEM3-4.1/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QAEM3-4.1/ NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050QAEM3-5.0/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QAEM3X10/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QAEM3X2.0/ NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050QAEM3X2.0/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QAEM3X2.5/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QAEM3X4.1/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QAEM3X5.0/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QAEM3X8.2/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3

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
LM4050QAIM3-10/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QAIM3-2.0/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QAIM3-2.5/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QAIM3-4.1/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QAIM3-4.1/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050QAIM3-8.2/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QAIM3X4.1/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QAIM3X4.1/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050QBEM3-2.0/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QBEM3-2.5/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QBEM3-4.1/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QBEM3-5.0/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QBEM3X10/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QBEM3X2.0/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QBEM3X2.5/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QBEM3X4.1/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QBEM3X5.0/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QBEM3X8.2/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QBIM3-10/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QBIM3-2.0/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QBIM3-2.5/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QBIM3-4.1/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050QBIM3-4.1/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QBIM3-5.0/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QBIM3-8.2/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QCEM3-2.0/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QCEM3-2.5/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QCEM3-4.1/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QCEM3-4.1/ NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050QCEM3-5.0/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3

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
LM4050QCEM3X10/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QCEM3X2.0/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QCEM3X2.5/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QCEM3X4.1/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QCEM3X5.0/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QCEM3X8.2/ NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QCIM3-2.0/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QCIM3-4.1/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM4050QCIM3-4.1/NOPB	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
LM4050QCIM3-5.0/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	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)
LM4050AEM3-10/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050AEM3-2.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050AEM3-2.0/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050AEM3-2.5/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050AEM3-2.5/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050AEM3-5.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050AEM3-5.0/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050AEM3-8.2/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050AEM3X-10/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050AEM3X-2.5/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050AEM3X-2.5/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050AEM3X-5.0/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050AEM3X-5.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050AIM3-10/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050AIM3-2.5/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050AIM3-2.5/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050AIM3-4.1/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050AIM3-4.1/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM4050AIM3-5.0/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050AIM3-5.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050AIM3X-2.5/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050AIM3X-2.5/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050AIM3X-4.1/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050AIM3X-4.1/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050AIM3X-5.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050AIM3X-5.0/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050BEM3-10/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050BEM3-2.5/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050BEM3-2.5/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050BEM3-4.1/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050BEM3-4.1/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050BEM3-5.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050BEM3-5.0/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050BEM3-8.2/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050BEM3X-10/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050BEM3X-2.5/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050BEM3X-2.5/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050BEM3X-5.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050BEM3X-5.0/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050BIM3-10/NOPB	SOT-23	DBZ	3	1000	208.0	191.0	35.0
LM4050BIM3-2.5/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050BIM3-2.5/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050BIM3-4.1/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050BIM3-4.1/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050BIM3-5.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050BIM3-5.0/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050BIM3X-2.0/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050BIM3X-2.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050BIM3X-2.5/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050BIM3X-2.5/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050BIM3X-4.1/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050BIM3X-4.1/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050BIM3X-5.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050BIM3X-5.0/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050CEM3-10/NOPB	SOT-23	DBZ	3	1000	208.0	191.0	35.0
LM4050CEM3-2.5/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050CEM3-2.5/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050CEM3-5.0/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050CEM3-5.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050CEM3X-2.5/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050CEM3X-2.5/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM4050CEM3X-5.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050CEM3X-5.0/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050CIM3-10/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050CIM3-2.5/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050CIM3-2.5/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050CIM3-4.1/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050CIM3-4.1/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050CIM3-5.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050CIM3-5.0/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050CIM3X-2.0/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050CIM3X-2.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050CIM3X-2.5/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050CIM3X-2.5/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050CIM3X-4.1/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050CIM3X-4.1/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050CIM3X-5.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050CIM3X-5.0/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050QAEM3-2.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QAEM3-2.5/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QAEM3-4.1/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QAEM3-4.1/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050QAEM3-5.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QAEM3X10/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QAEM3X2.0/ NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050QAEM3X2.0/ NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QAEM3X2.5/ NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QAEM3X4.1/ NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QAEM3X5.0/ NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QAEM3X8.2/ NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QAIM3-10/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QAIM3-2.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QAIM3-2.5/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QAIM3-4.1/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QAIM3-4.1/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050QAIM3-8.2/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QAIM3X4.1/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QAIM3X4.1/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050QBEM3-2.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0

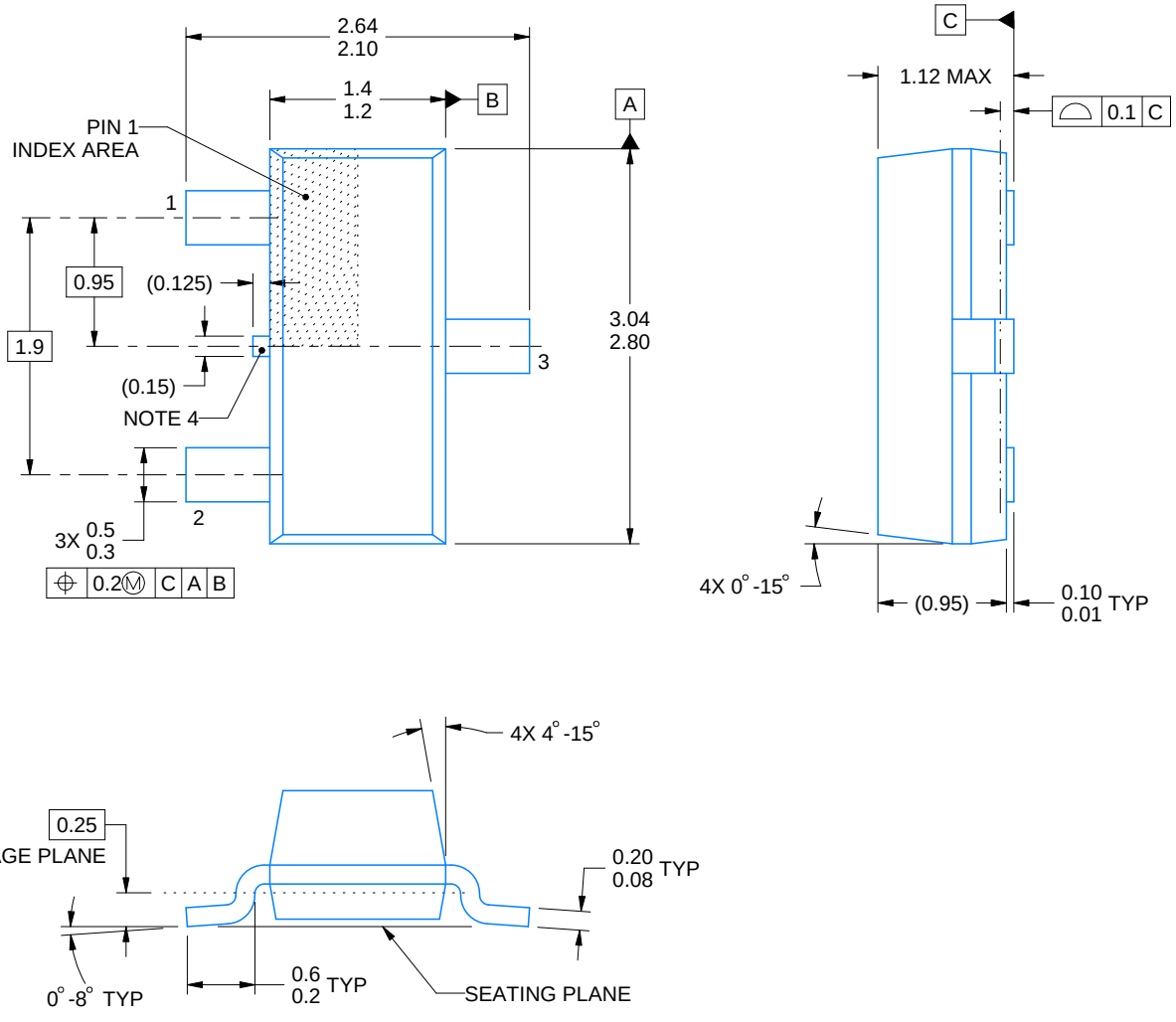
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM4050QBEM3-2.5/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QBEM3-4.1/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QBEM3-5.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QBEM3X10/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QBEM3X2.0/ NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QBEM3X2.5/ NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QBEM3X4.1/ NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QBEM3X5.0/ NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QBEM3X8.2/ NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QBIM3-10/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QBIM3-2.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QBIM3-2.5/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QBIM3-4.1/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050QBIM3-4.1/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QBIM3-5.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QBIM3-8.2/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QCEM3-2.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QCEM3-2.5/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QCEM3-4.1/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QCEM3-4.1/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050QCEM3-5.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QCEM3X10/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QCEM3X2.0/ NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QCEM3X2.5/ NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QCEM3X4.1/ NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QCEM3X5.0/ NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QCEM3X8.2/ NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QCIM3-2.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QCIM3-4.1/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM4050QCIM3-4.1/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4050QCIM3-5.0/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0

PACKAGE OUTLINE

DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



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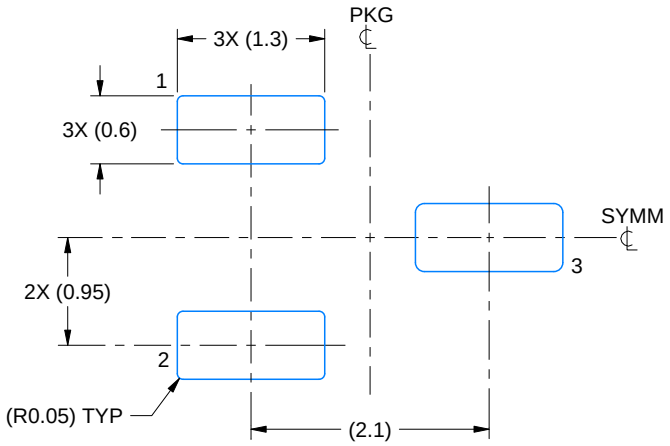
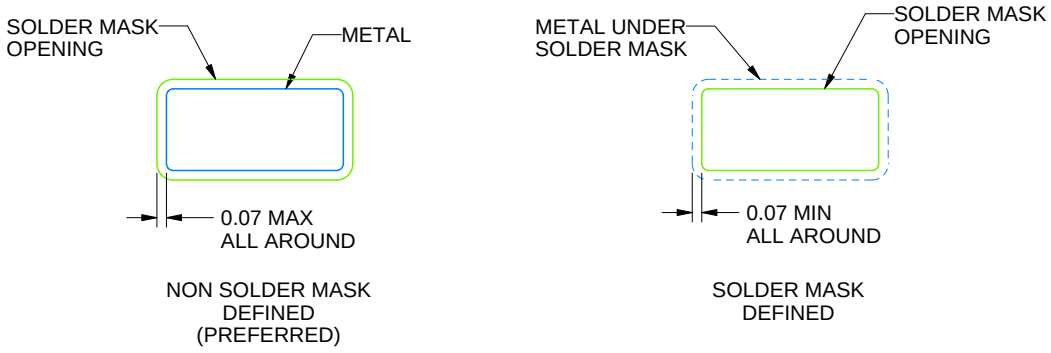
NOTES:

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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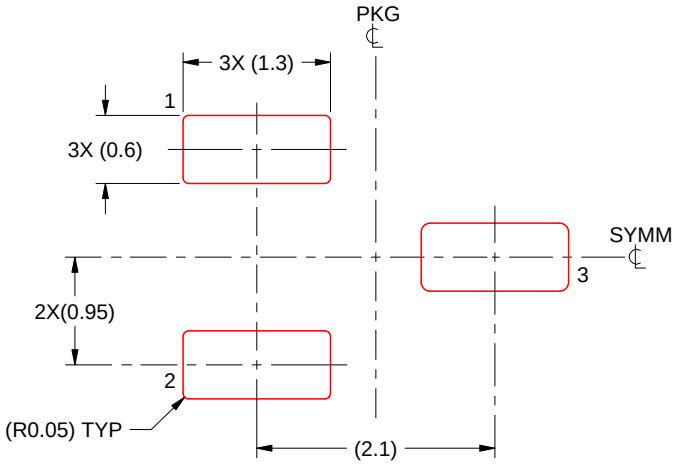
NOTES: (continued)

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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