

LM4041 Precision Micropower Shunt Voltage Reference

1 Features

- 1.225-V Fixed and Adjustable Outputs (1.225 V to 10 V)
- Tight Output Tolerances and Low Temperature Coefficient
 - Max 0.1%, 100 ppm/°C – A Grade
 - Max 0.2%, 100 ppm/°C – B Grade
 - Max 0.5%, 100 ppm/°C – C Grade
 - Max 1.0%, 150 ppm/°C – D Grade
- Low Output Noise . . . 20 μV_{RMS} (Typ)
- Wide Operating Current Range . . . 45 μA (Typ) to 12 mA
- Stable With All Capacitive Loads; No Output Capacitor Required
- Available in
 - Industrial Temperature: –40°C to 85°C
 - Extended Temperature: –40°C to 125°C

2 Applications

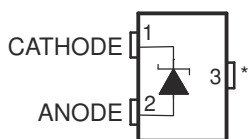
- Data-Acquisition Systems
- Power Supplies and Power-Supply Monitors
- Instrumentation and Test Equipment
- Process Control
- Precision Audio
- Automotive Electronics
- Energy Management/Metering
- Battery-Powered Equipment

3 Description

The LM4041 series of shunt voltage references are versatile, easy-to-use references suitable for a wide array of applications. They require no external capacitors for operation and are stable with all capacitive loads. Additionally, the reference offers low dynamic impedance, low noise, and a low temperature coefficient to ensure a stable output voltage over a wide range of operating currents and temperatures. The LM4041 uses fuse and Zener-zap reverse breakdown voltage trim during wafer sort to offer four output voltage tolerances, ranging from 0.1% (max) for the A grade to 1% (max) for the D grade. Thus, a great deal of flexibility is offered to designers in choosing the best cost-to-performance ratio for their applications. The LM4041 is available in a fixed (1.225 V nominal) or an adjustable version (which requires an external resistor divider to set the output to a value between 1.225 V and 10 V).

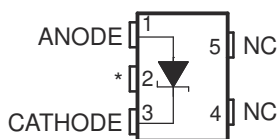
Packaged in space-saving SC-70 and SOT-23-3 and requiring a minimum current of 45 μA (typ), the LM4041 also is ideal for portable applications. The TO-92 package also is available for through-hole packaging needs. The LM4041xl is characterized for operation over an ambient temperature range of –40°C to 85°C. The LM4041xQ is characterized for operation over an ambient temperature range of –40°C to 125°C.

1.2 V . . . DBZ (SOT-23) PACKAGE
(TOP VIEW)



* Pin 3 must be connected to ANODE or left open.

1.2 V . . . DCK (SC-70) PACKAGE
(TOP VIEW)



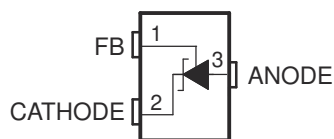
NC – No internal connection
* Pin 2 must be connected to ANODE or left open.

1.2 V . . . LP (TO-92/TO-226) PACKAGE
(TOP VIEW)

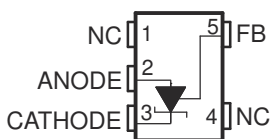


NC – No internal connection

Adjustable . . . DBZ (SOT-23) PACKAGE
(TOP VIEW)

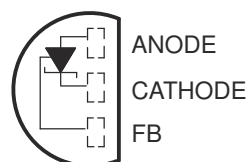


Adjustable . . . DCK (SC-70) PACKAGE
(TOP VIEW)



NC – No internal connection

Adjustable . . . LP (TO-92/TO-226) PACKAGE
(TOP VIEW)



4 Functional Block Diagram

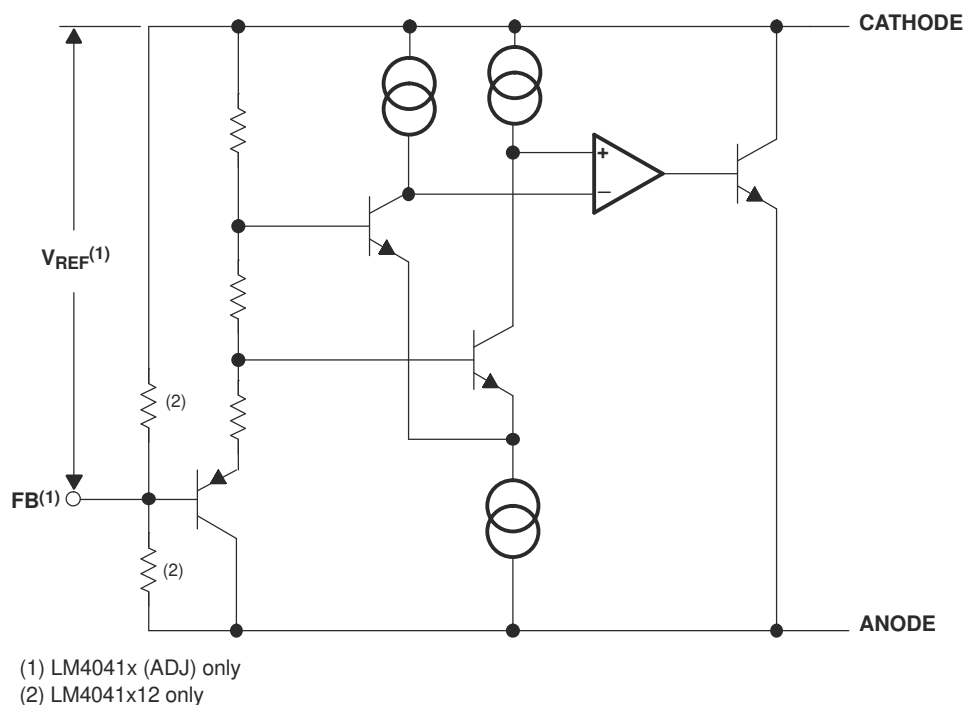


Figure 4-1. Functional Block Diagram

5 Absolute Maximum Ratings

over free-air temperature range (unless otherwise noted)

		MIN	MAX ⁽¹⁾	UNIT
V_Z	Continuous cathode voltage		15	V
I_Z	Continuous cathode current	-10	25	mA
θ_{JA}	Package thermal impedance ^{(2) (3)}		206	°C/W
			252	
			156	
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.
- (2) Maximum power dissipation is a function of $T_J(\text{max})$, θ_{JA} , and T_A . The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
- (3) The package thermal impedance is calculated in accordance with JESD 51-7.

6 Recommended Operating Conditions

			MIN	MAX	UNIT
I _Z	Cathode current		(1)	12	mA
V _Z	Reverse breakdown voltage (adjustable version)			10	V
T _A	Free-air temperature	LM4041 (I temperature)	−40	85	°C
		LM4041 (Q temperature)	−40	125	

(1) See parametric tables

7 LM4041x12I Electrical Characteristics

full-range $T_A = -40^{\circ}\text{C}$ to 85°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T _A	LM4041A12I			LM4041B12I			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V _Z	Reverse breakdown voltage	I _Z = 100 μA	25°C	1.225			1.225			V
	Reverse breakdown voltage tolerance	I _Z = 100 μA	25°C	−1.2		1.2	−2.4		2.4	mV
			Full range	−9.2		9.2	−10.4		10.4	
I _{Z,min}	Minimum cathode current		25°C	45		75	45		75	μA
			Full range			80			80	
α _{VZ}	Average temperature coefficient of reverse breakdown voltage	I _Z = 10 mA	25°C	±20			±20			ppm/°C
		I _Z = 1 mA	25°C	±15			±15			
			Full range			±100			±100	
		I _Z = 100 μA	25°C	±15			±15			
ΔV _Z /ΔI _Z	Reverse breakdown voltage change with cathode current change	I _{Z,min} < I _Z < 1 mA	25°C	0.7		1.5	0.7		1.5	mV
			Full range			2			2	
		1 mA < I _Z < 12 mA	25°C	4		6	4		6	
			Full range			8			8	
Z _Z	Reverse dynamic impedance	I _Z = 1 mA, f = 120 Hz, I _{AC} = 0.1 I _Z	25°C	0.5		1.5	0.5		1.5	Ω
e _N	Wideband noise	I _Z = 100 μA, 10 Hz ≤ f ≤ 10 kHz	25°C	20			20			μV _{RMS}
	Long-term stability of reverse breakdown voltage	t = 1000 h, T _A = 25°C ± 0.1°C, I _Z = 100 μA	25°C	120			120			ppm

8 LM4041x12I Electrical Characteristics

full-range $T_A = -40^{\circ}\text{C}$ to 85°C (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A	LM4041C12I			LM4041D12I			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_Z	Reverse breakdown voltage	$I_Z = 100\ \mu\text{A}$		1.225			1.225		V
	Reverse breakdown voltage tolerance	$I_Z = 100\ \mu\text{A}$							mV
$I_{Z,\text{min}}$	Minimum cathode current	25°C		45	75		45	75	μA
		Full range			80			80	
α_{VZ}	Average temperature coefficient of reverse breakdown voltage	$I_Z = 10\ \text{mA}$		± 20			± 20		ppm/°C
		$I_Z = 1\ \text{mA}$		± 15			± 15		
					± 100			± 150	
		$I_Z = 100\ \mu\text{A}$		± 15			± 15		
$\Delta V_Z / \Delta I_Z$	Reverse breakdown voltage change with cathode current change	$I_{Z,\text{min}} < I_Z < 1\ \text{mA}$		0.7	1.5		0.7	2	mV
					2			2.5	
		$1\ \text{mA} < I_Z < 12\ \text{mA}$		2.5	6		2.5	8	
					8			10	
Z_Z	Reverse dynamic impedance	$I_Z = 1\ \text{mA}$, $f = 120\ \text{Hz}$, $I_{AC} = 0.1\ I_Z$		0.5	1.5		0.5	2	Ω
e_N	Wideband noise	$I_Z = 100\ \mu\text{A}$, $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$		20			20		μV_{RMS}
	Long-term stability of reverse breakdown voltage	$t = 1000\ \text{h}$, $T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$, $I_Z = 100\ \mu\text{A}$		120			120		ppm

9 LM4041x12Q Electrical Characteristics

full-range $T_A = -40^{\circ}\text{C}$ to 125°C (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A	LM4041C12Q			LM4041D12Q			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_Z	Reverse breakdown voltage	$I_Z = 100\ \mu\text{A}$		1.225			1.225		V
	Reverse breakdown voltage tolerance	$I_Z = 100\ \mu\text{A}$		25°C			25°C		mV
		Full range	–6		6	–12		12	
$I_{Z,\text{min}}$	Minimum cathode current			25°C			25°C		μA
		Full range	–18.4		18.4	–31		31	
α_{VZ}	Average temperature coefficient of reverse breakdown voltage	$I_Z = 10\ \text{mA}$		25°C			25°C		ppm/°C
					45			45	
		$I_Z = 1\ \text{mA}$		25°C			25°C		
					75			75	
$\Delta V_Z / \Delta I_Z$	Reverse breakdown voltage change with cathode current change	$I_{Z,\text{min}} < I_Z < 1\ \text{mA}$		25°C			25°C		mV
					80			80	
		$1\ \text{mA} < I_Z < 12\ \text{mA}$		25°C			25°C		
					80			80	
Z_Z	Reverse dynamic impedance	$I_Z = 1\ \text{mA}, f = 120\ \text{Hz}, I_{AC} = 0.1\ I_Z$		25°C			25°C		Ω
		Full range			±20			±20	
e_N	Wideband noise	$I_Z = 100\ \mu\text{A}, 10\ \text{Hz} \leq f \leq 10\ \text{kHz}$		25°C			25°C		μV_{RMS}
					±15			±15	
	Long-term stability of reverse breakdown voltage	$t = 1000\ \text{h}, T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}, I_Z = 100\ \mu\text{A}$		25°C			25°C		ppm
					±100			±150	

10 LM4041xl (Adjustable Version) Electrical Characteristics

full-range $T_A = -40^\circ\text{C}$ to 85°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T _A	LM4041BI			LM4041CI			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V _{REF}	Reference voltage	I _Z = 100 μA, V _Z = 5 V	25°C	1.233			1.233			V
	Reference voltage tolerance ⁽¹⁾	I _Z = 100 μA, V _Z = 5 V	25°C	−2.5		2.5	−6.2		6.2	mV
			Full range	−10.5		10.5	−14		14	
I _{Z,min}	Minimum cathode current		25°C	45		75	45		75	μA
			Full range			80	80			
ΔV _{REF} /ΔI _Z	Reference voltage change with cathode current change	I _{Z,min} < I _Z < 1 mA	25°C	0.7		1.5	0.7		1.5	mV
			Full range			2	2			
		1 mA < I _Z < 12 mA	25°C	2		4	2		4	
			Full range			6	6			
ΔV _{REF} /ΔV _{KA}	Reference voltage change with output voltage change	I _Z = 1 mA	25°C	−1.55		−2	−1.55		−2	mV/V
			Full range			−2.5	−2.5			
I _{FB}	Feedback current		25°C	60		100	60		100	nA
			Full range			120	120			
αV _{REF}	Average temperature coefficient of reference voltage ⁽¹⁾	I _Z = 10 mA, V _Z = 5 V	25°C	±20			±20			ppm/°C
		I _Z = 1 mA, V _Z = 5 V	25°C	±15			±15			
			Full range			±100	±100			
		I _Z = 100 μA, V _Z = 5 V	25°C	±15			±15			
Z _Z	Reverse dynamic impedance	I _Z = 1 mA, f = 120 Hz, I _{AC} = 0.1 I _Z , V _Z = V _{REF}	25°C	0.3			0.3			Ω
		I _Z = 1 mA, f = 120 Hz, I _{AC} = 0.1 I _Z , V _Z = 10 V	25°C	2			2			
e _N	Wideband noise	I _Z = 100 μA, V _Z = V _{REF} , 10 Hz ≤ f ≤ 10 kHz	25°C	20			20			μV _{RMS}
	Long-term stability of reverse breakdown voltage	t = 1000 h, T _A = 25°C ± 0.1°C, I _Z = 100 μA	25°C	120			120			ppm

(1) Reference voltage tolerance and average temperature coefficient change with output voltage (V_Z). See *Typical Characteristics*.

11 LM4041xl (Adjustable Version) Electrical Characteristics

full-range $T_A = -40^{\circ}\text{C}$ to 85°C (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A	LM4041DI			UNIT
			MIN	TYP	MAX	
V_{REF}	Reference voltage	$I_Z = 100\ \mu\text{A}$, $V_Z = 5\ \text{V}$		1.233		V
	Reference voltage tolerance ⁽¹⁾	25°C	-12		12	mV
		Full range	-24		24	
$I_{Z,min}$	Minimum cathode current	25°C		45	75	μA
		Full range			80	
$\Delta V_{REF}/\Delta I_Z$	Reference voltage change with cathode current change	$I_{Z,min} < I_Z < 1\ \text{mA}$	25°C	0.7	2	mV
			Full range		2.5	
		$1\ \text{mA} < I_Z < 12\ \text{mA}$	25°C	2	6	
			Full range		8	
$\Delta V_{REF}/\Delta V_{KA}$	Reference voltage change with output voltage change	$I_Z = 1\ \text{mA}$	25°C	-1.55	-2	mV/V
			Full range		-3	
I_{FB}	Feedback current	25°C		60	150	nA
		Full range			200	
αV_{REF}	Average temperature coefficient of reference voltage ⁽¹⁾	$I_Z = 10\ \text{mA}$, $V_Z = 5\ \text{V}$	25°C	± 20		ppm/ $^{\circ}\text{C}$
		$I_Z = 1\ \text{mA}$, $V_Z = 5\ \text{V}$	25°C	± 15		
			Full range		± 150	
		$I_Z = 100\ \mu\text{A}$, $V_Z = 5\ \text{V}$	25°C	± 15		
Z_Z	Reverse dynamic impedance	$I_Z = 1\ \text{mA}$, $f = 120\ \text{Hz}$, $I_{AC} = 0.1\ I_Z$, $V_Z = V_{REF}$	25°C	0.3		Ω
		$I_Z = 1\ \text{mA}$, $f = 120\ \text{Hz}$, $I_{AC} = 0.1\ I_Z$, $V_Z = 10\ \text{V}$	25°C	2		
e_N	Wideband noise	$I_Z = 100\ \mu\text{A}$, $V_Z = V_{REF}$, $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$	25°C	20		μV_{RMS}
	Long-term stability of reverse breakdown voltage	$t = 1000\ \text{h}$, $T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$, $I_Z = 100\ \mu\text{A}$	25°C	120		ppm

(1) Reference voltage tolerance and average temperature coefficient change with output voltage (V_Z). See *Typical Characteristics*.

12 LM4041xQ (Adjustable Version) Electrical Characteristics

full-range $T_A = -40^\circ\text{C}$ to 125°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T _A	LM4041CQ			LM4041DQ			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V _{REF}	Reference voltage	I _Z = 100 μA, V _Z = 5 V	25°C	1.233			1.233			V
	Reference voltage tolerance ⁽¹⁾	I _Z = 100 μA, V _Z = 5 V	25°C	−6.2		6.2	−12		12	mV
			Full range	−18		18	−30		30	
I _{Z,min}	Minimum cathode current		25°C	45		75	45		75	μA
			Full range			80			80	
ΔV _{REF} /ΔI _Z	Reference voltage change with cathode current change	I _{Z,min} < I _Z < 1 mA	25°C	0.7		1.5	0.7		2	mV
			Full range			2			2.5	
		1 mA < I _Z < 12 mA	25°C	2		4	2		6	
			Full range			8			10	
ΔV _{REF} /ΔV _{KA}	Reference voltage change with output voltage change	I _Z = 1 mA	25°C	−1.55		−2	−1.55		−2.5	mV/V
			Full range			−3			−4	
I _{FB}	Feedback current		25°C	60		100	60		150	nA
			Full range			120			200	
αV _{REF}	Average temperature coefficient of reference voltage ⁽¹⁾	I _Z = 10 mA, V _Z = 5 V	25°C	±20			±20			ppm/°C
		I _Z = 1 mA, V _Z = 5 V	25°C	±15			±15			
			Full range			±100			±150	
		I _Z = 100 μA, V _Z = 5 V	25°C	±15			±15			
Z _Z	Reverse dynamic impedance	I _Z = 1 mA, f = 120 Hz, I _{AC} = 0.1 I _Z , V _Z = V _{REF}	25°C	0.3			0.3			Ω
		I _Z = 1 mA, f = 120 Hz, I _{AC} = 0.1 I _Z , V _Z = 10 V	25°C	2			2			
e _N	Wideband noise	I _Z = 100 μA, V _Z = V _{REF} , 10 Hz ≤ f ≤ 10 kHz	25°C	20			20			μV _{RMS}
	Long-term stability of reverse breakdown voltage	t = 1000 h, T _A = 25°C ± 0.1°C, I _Z = 100 μA	25°C	120			120			ppm

(1) Reference voltage tolerance and average temperature coefficient change with output voltage (V_Z). See *Typical Characteristics*.

13 Typical Characteristics

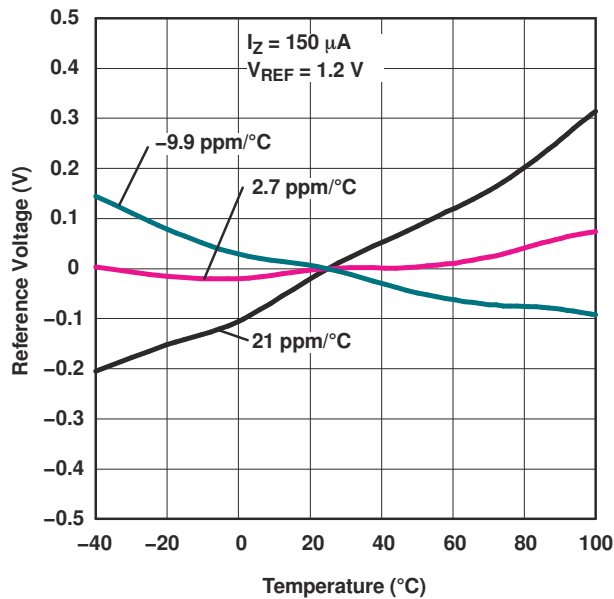


Figure 13-1. Temperature Drift for Different Average Temperature Coefficients

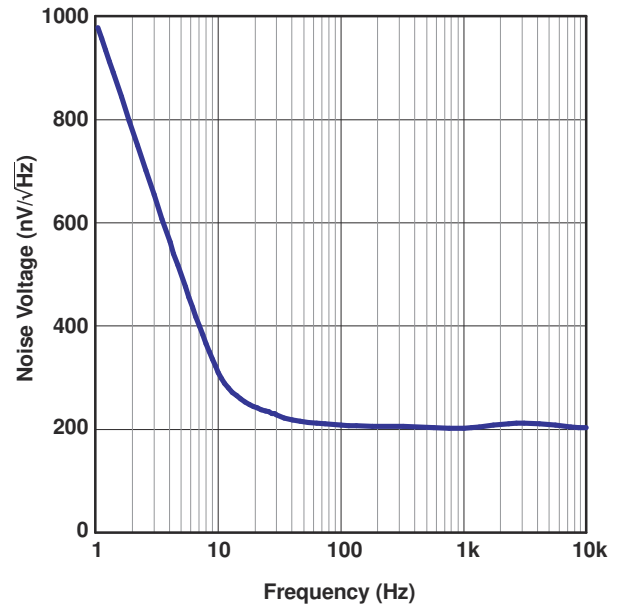


Figure 13-2. Noise Voltage vs Frequency

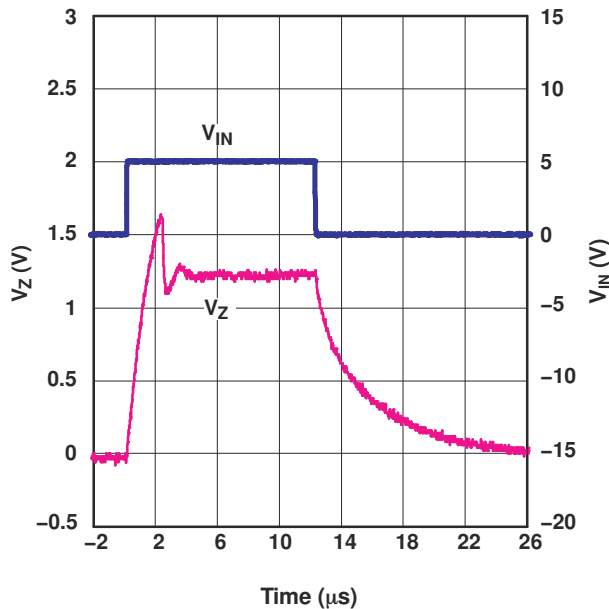


Figure 13-3. Start-Up Characteristics

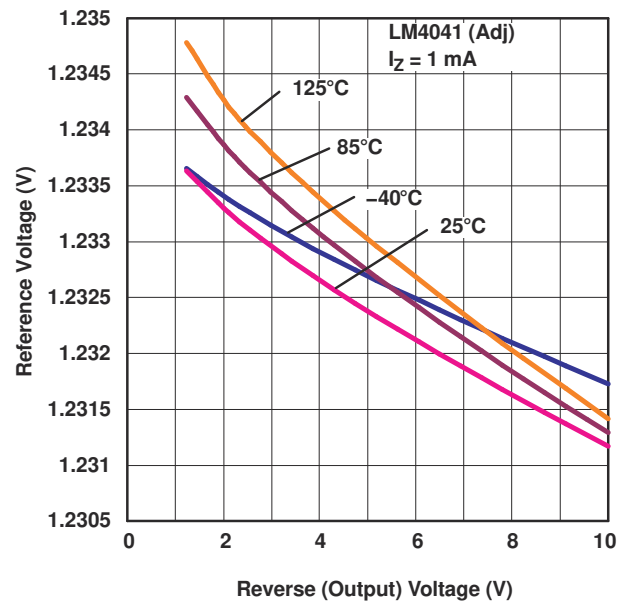


Figure 13-4. Reference Voltage vs Reverse (Output) Voltage (for Different Temperatures)

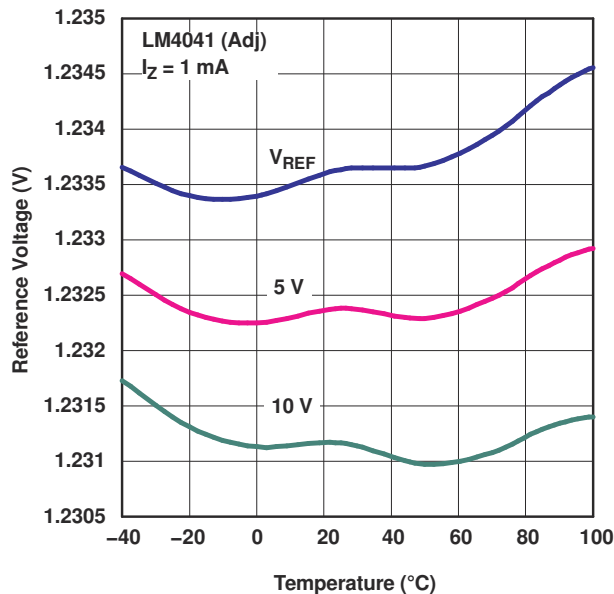


Figure 13-5. Reference Voltage vs Temperature (for Different Reverse Voltages)

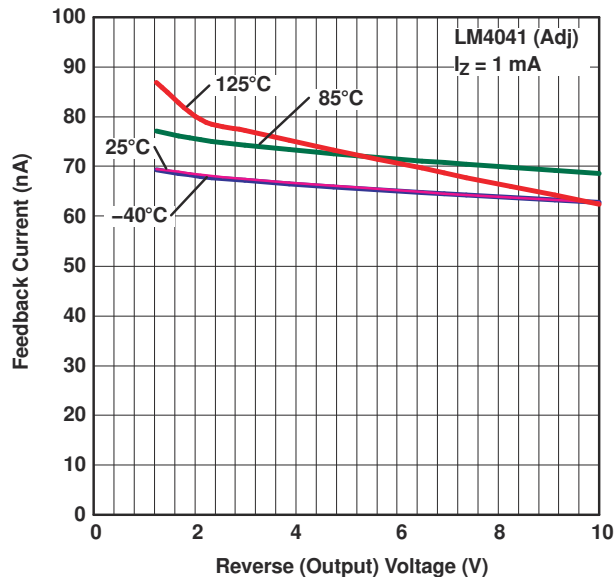


Figure 13-6. Feedback Current vs Reverse (Output) Voltage (for Different Temperatures)

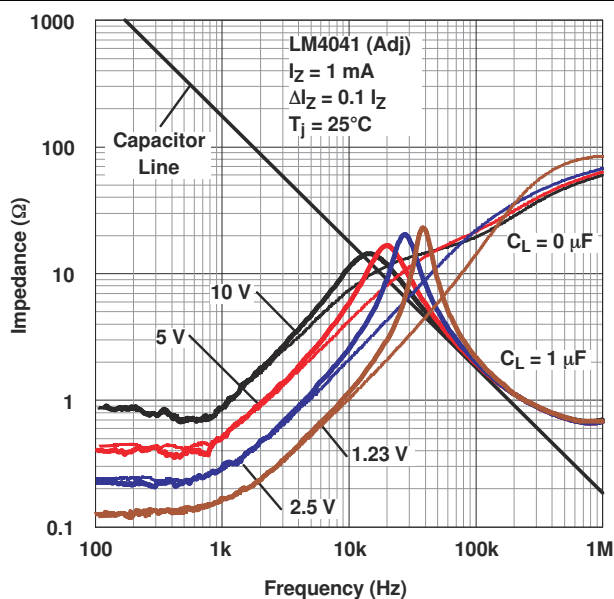


Figure 13-7. Output Impedance vs Frequency

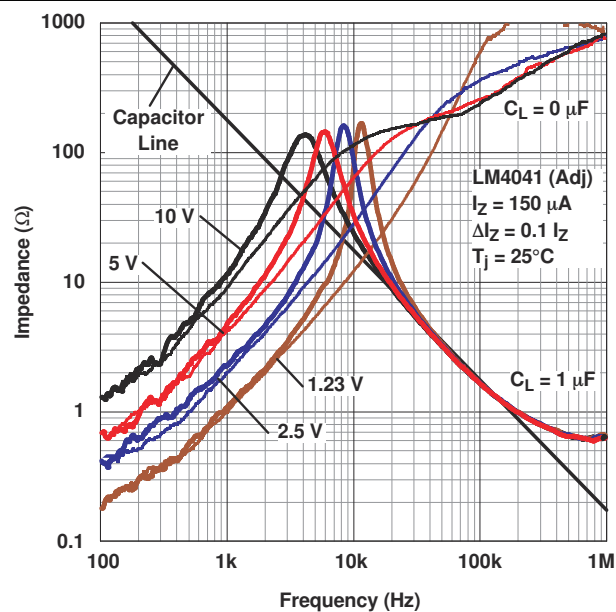


Figure 13-8. Output Impedance vs Frequency

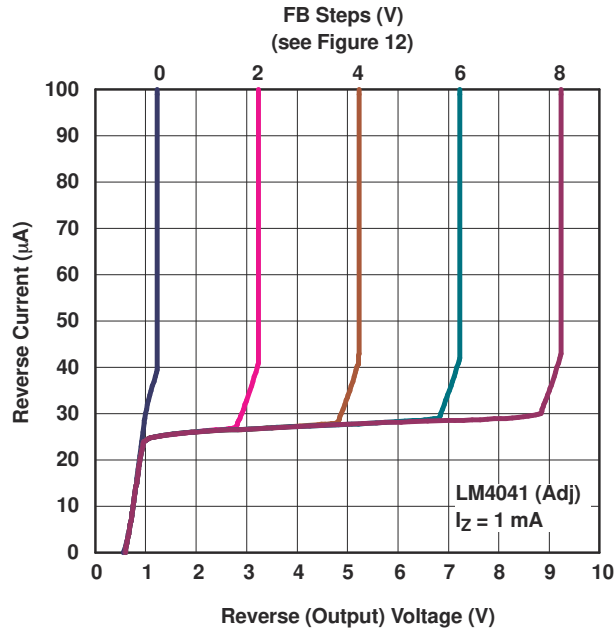


Figure 13-9. Reverse Characteristics

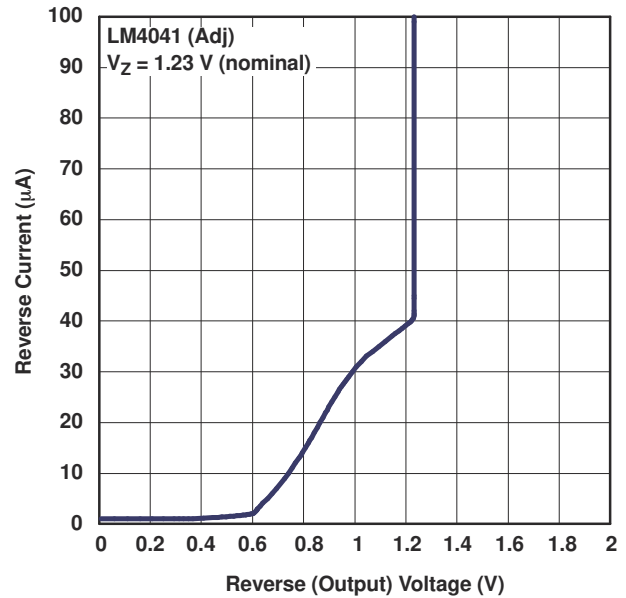


Figure 13-10. Reverse Characteristics and Minimum Operating Current

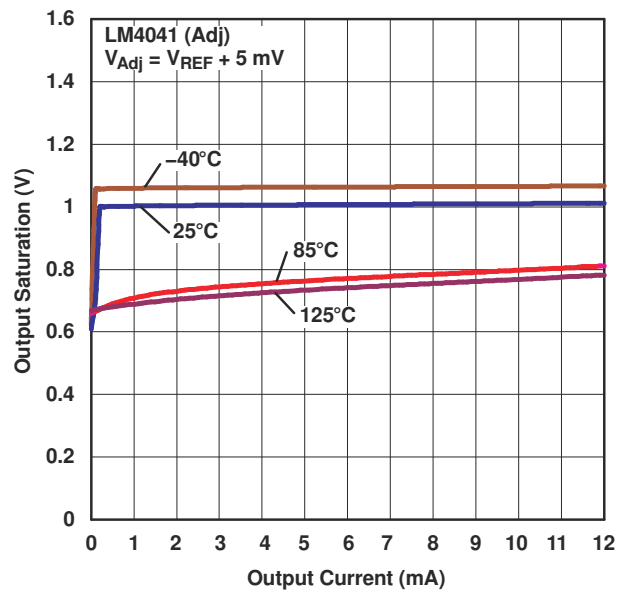


Figure 13-11. Output Saturation vs Output Current

14 Application Information

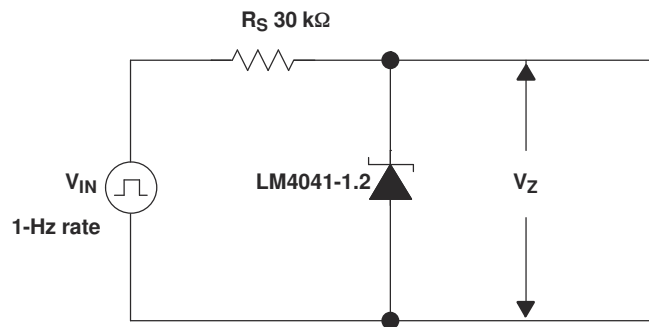


Figure 14-1. Startup Characteristics Test Circuit

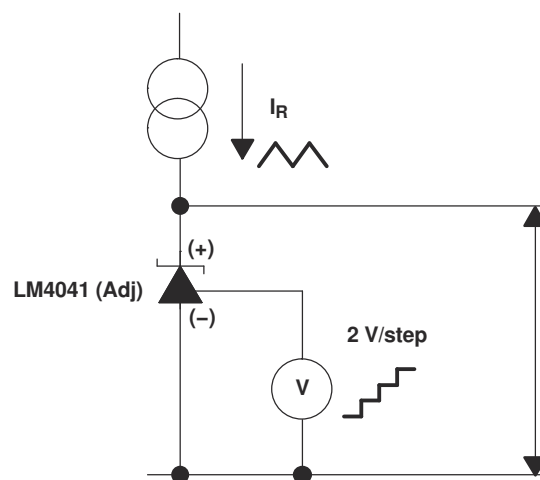


Figure 14-2. Reverse Characteristics Test Circuit

14.1 Output Capacitor

The LM4041 does not require an output capacitor across CATHODE and ANODE for stability. However, if an output bypass capacitor is desired, the LM4041 is designed to be stable with all capacitive loads.

14.2 SOT-23 and SC-70 Pin 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. Similarly, pin 2 of the SC-70 package also must be left floating or connected to pin 1.

14.3 Adjustable Version

The adjustable version allows V_Z to be set by a user-defined resistor divider. The output voltage, V_Z , is set according to the equation shown in Figure 14-3.

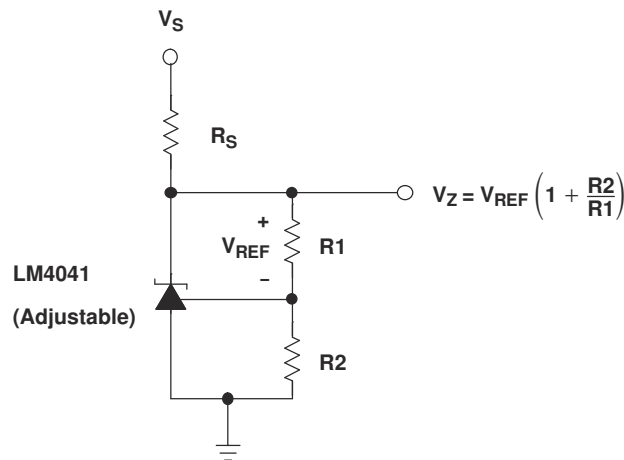


Figure 14-3. Adjustable Shunt Regulator

14.4 Cathode and Load Currents

In a typical shunt regulator configuration (see Figure 14-4), an external resistor, R_S , is connected between the supply and the cathode of the LM4041. R_S must be set properly, as it sets the total current available to supply the load (I_L) and bias the LM4041 (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 recommended rating of 12 mA.

R_S is calculated as shown in Equation 1.

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

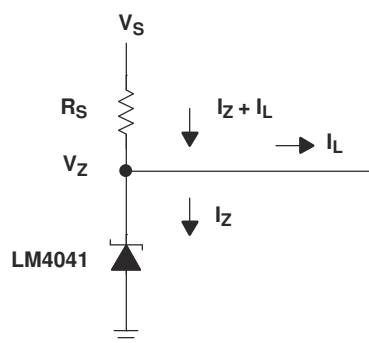


Figure 14-4. Shunt Regulator

15 Revision History

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

Changes from Revision E (February 2006) to Revision F (September 2020)	Page
• Updated the numbering format for tables, figures and cross-references throughout the document.....	1
• Deleted <i>Ordering Information</i> table. See Mechanical, Packaging, and Orderable Information at the end of the data sheet.....	2

16 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.

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
LM4041A12IDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU SN	Level-1-260C-UNLIM	-40 to 85	(4MK3, 4MKU)	Samples
LM4041A12IDBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4MK3, 4MKU)	Samples
LM4041A12IDCKR	ACTIVE	SC70	DCK	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MKU	Samples
LM4041B12IDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4ML3, 4MLU)	Samples
LM4041B12IDBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4ML3, 4MLU)	Samples
LM4041B12IDCKR	ACTIVE	SC70	DCK	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MLU	Samples
LM4041BIDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4MG3, 4MGU)	Samples
LM4041BIDBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4MG3, 4MGU)	Samples
LM4041BIDCKR	ACTIVE	SC70	DCK	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MGU	Samples
LM4041BIDCKT	ACTIVE	SC70	DCK	5	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MGU	Samples
LM4041C12IDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4MM3, 4MMU)	Samples
LM4041C12IDBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4MM3, 4MMU)	Samples
LM4041C12IDCKR	ACTIVE	SC70	DCK	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MMU	Samples
LM4041C12IDCKRE4	ACTIVE	SC70	DCK	5	3000	TBD	Call TI	Call TI	-40 to 85		Samples
LM4041C12IDCKRG4	ACTIVE	SC70	DCK	5	3000	TBD	Call TI	Call TI	-40 to 85		Samples
LM4041C12ILP	ACTIVE	TO-92	LP	3	1000	RoHS & Green	SN	N / A for Pkg Type	-40 to 85	NPC12I	Samples
LM4041C12ILPR	ACTIVE	TO-92	LP	3	2000	RoHS & Green	SN	N / A for Pkg Type	-40 to 85	NPC12I	Samples
LM4041C12QDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	(4MS3, 4MSU)	Samples
LM4041C12QDBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	(4MS3, 4MSU)	Samples
LM4041CIDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4MH3, 4MHU)	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
LM4041CIDBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4MH3, 4MHU)	Samples
LM4041CIDCKR	ACTIVE	SC70	DCK	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MHU	Samples
LM4041CIDCKT	ACTIVE	SC70	DCK	5	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MHU	Samples
LM4041CILP	LIFEBUY	TO-92	LP	3	1000	RoHS & Green	SN	N / A for Pkg Type	-40 to 85	NPCI	
LM4041CILPE3	NRND	TO-92	LP	3	1000	TBD	Call TI	Call TI	-40 to 85		
LM4041CILPR	ACTIVE	TO-92	LP	3	2000	RoHS & Green	SN	N / A for Pkg Type	-40 to 85	NPCI	Samples
LM4041CQDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	(4MP3, 4MPU)	Samples
LM4041CQDBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	(4MP3, 4MPU)	Samples
LM4041D12IDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4MN3, 4MNU)	Samples
LM4041D12IDBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4MN3, 4MNU)	Samples
LM4041D12IDCKR	ACTIVE	SC70	DCK	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MNU	Samples
LM4041D12ILP	ACTIVE	TO-92	LP	3	1000	RoHS & Green	SN	N / A for Pkg Type	-40 to 85	NPD12I	Samples
LM4041D12ILPE3	ACTIVE	TO-92	LP	3	1000	TBD	Call TI	Call TI	-40 to 85		Samples
LM4041D12ILPR	ACTIVE	TO-92	LP	3	2000	RoHS & Green	SN	N / A for Pkg Type	-40 to 85	NPD12I	Samples
LM4041D12QDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	(4MT3, 4MTU)	Samples
LM4041DIDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4MJ3, 4MJU)	Samples
LM4041DIDBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4MJ3, 4MJU)	Samples
LM4041DIDCKR	ACTIVE	SC70	DCK	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MJU	Samples
LM4041DILP	LIFEBUY	TO-92	LP	3	1000	RoHS & Green	SN	N / A for Pkg Type	-40 to 85	NPDI	
LM4041DILPR	ACTIVE	TO-92	LP	3	2000	RoHS & Green	SN	N / A for Pkg Type	-40 to 85	NPDI	Samples
LM4041DQDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	(4MR3, 4MRU)	Samples
LM4041DQDBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	(4MR3, 4MRU)	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 ≤ 1000 ppm threshold. Antimony trioxide based flame retardants must also meet the ≤ 1000 ppm 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.

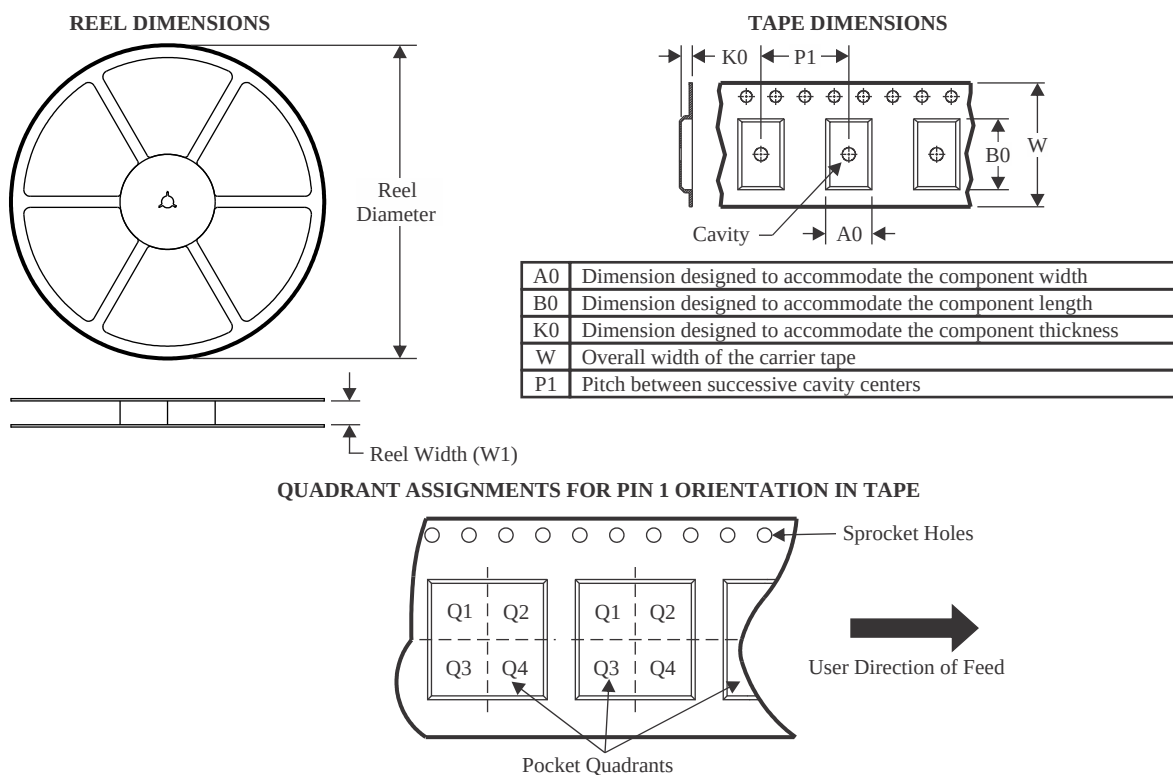
⁽⁵⁾ Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

⁽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.

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In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

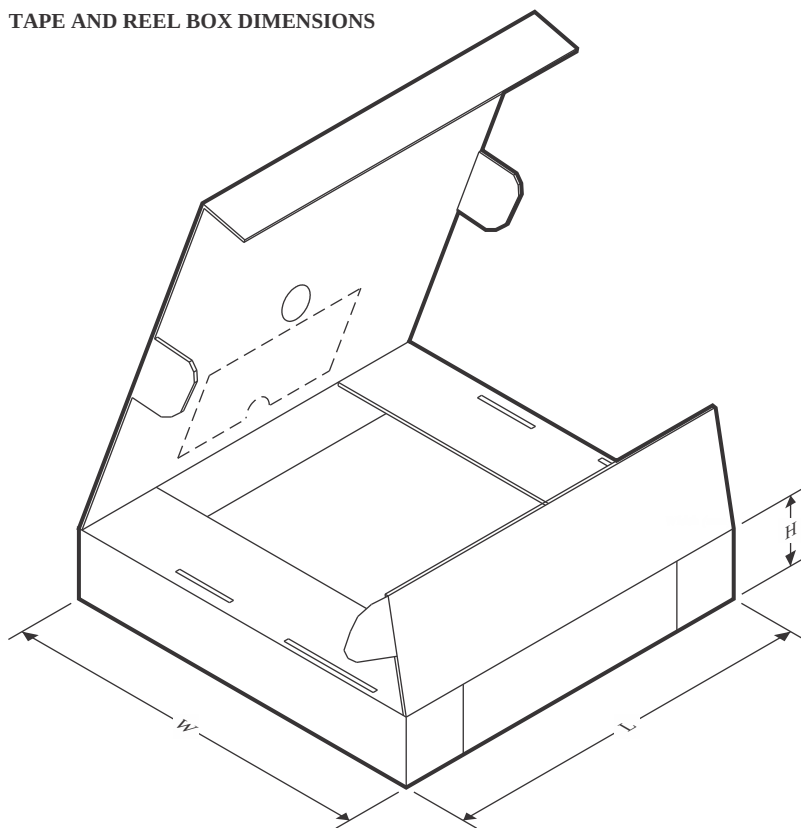


*All dimensions are nominal

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
LM4041A12IDBZR	SOT-23	DBZ	3	3000	180.0	8.4	2.9	3.35	1.35	4.0	8.0	Q3
LM4041A12IDBZT	SOT-23	DBZ	3	250	180.0	8.4	2.9	3.35	1.35	4.0	8.0	Q3
LM4041A12IDCKR	SC70	DCK	5	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
LM4041B12IDBZR	SOT-23	DBZ	3	3000	180.0	8.4	2.9	3.35	1.35	4.0	8.0	Q3
LM4041B12IDBZT	SOT-23	DBZ	3	250	180.0	8.4	2.9	3.35	1.35	4.0	8.0	Q3
LM4041B12IDCKR	SC70	DCK	5	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
LM4041BIDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
LM4041BIDBZT	SOT-23	DBZ	3	250	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
LM4041BIDBZT	SOT-23	DBZ	3	250	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
LM4041BIDCKR	SC70	DCK	5	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
LM4041BIDCKT	SC70	DCK	5	250	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
LM4041C12IDBZR	SOT-23	DBZ	3	3000	180.0	8.4	2.9	3.35	1.35	4.0	8.0	Q3
LM4041C12IDBZT	SOT-23	DBZ	3	250	180.0	8.4	2.9	3.35	1.35	4.0	8.0	Q3
LM4041C12IDCKR	SC70	DCK	5	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
LM4041C12QDBZR	SOT-23	DBZ	3	3000	180.0	8.4	2.9	3.35	1.35	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
LM4041C12QDBZT	SOT-23	DBZ	3	250	180.0	8.4	2.9	3.35	1.35	4.0	8.0	Q3
LM4041C1DBZR	SOT-23	DBZ	3	3000	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
LM4041C1DBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
LM4041C1DBZT	SOT-23	DBZ	3	250	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
LM4041C1DBZT	SOT-23	DBZ	3	250	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
LM4041C1DCKR	SC70	DCK	5	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
LM4041C1DCKT	SC70	DCK	5	250	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
LM4041CQDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
LM4041CQDBZR	SOT-23	DBZ	3	3000	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
LM4041CQDBZT	SOT-23	DBZ	3	250	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
LM4041CQDBZT	SOT-23	DBZ	3	250	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
LM4041D121DBZR	SOT-23	DBZ	3	3000	180.0	8.4	2.9	3.35	1.35	4.0	8.0	Q3
LM4041D121DBZT	SOT-23	DBZ	3	250	180.0	8.4	2.9	3.35	1.35	4.0	8.0	Q3
LM4041D121DCKR	SC70	DCK	5	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
LM4041D1DBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
LM4041D1DBZR	SOT-23	DBZ	3	3000	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
LM4041D1DBZT	SOT-23	DBZ	3	250	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
LM4041D1DCKR	SC70	DCK	5	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
LM4041DQDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
LM4041DQDBZR	SOT-23	DBZ	3	3000	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
LM4041DQDBZT	SOT-23	DBZ	3	250	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
LM4041DQDBZT	SOT-23	DBZ	3	250	178.0	9.2	3.15	2.77	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)
LM4041A12IDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4041A12IDBZT	SOT-23	DBZ	3	250	210.0	185.0	35.0
LM4041A12IDCKR	SC70	DCK	5	3000	200.0	183.0	25.0
LM4041B12IDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4041B12IDBZT	SOT-23	DBZ	3	250	210.0	185.0	35.0
LM4041B12IDCKR	SC70	DCK	5	3000	200.0	183.0	25.0
LM4041BIDBZR	SOT-23	DBZ	3	3000	200.0	183.0	25.0
LM4041BIDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
LM4041BIDBZT	SOT-23	DBZ	3	250	180.0	180.0	18.0
LM4041BIDBZT	SOT-23	DBZ	3	250	200.0	183.0	25.0
LM4041BIDCKR	SC70	DCK	5	3000	200.0	183.0	25.0
LM4041BIDCKT	SC70	DCK	5	250	203.0	203.0	35.0
LM4041C12IDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4041C12IDBZT	SOT-23	DBZ	3	250	210.0	185.0	35.0
LM4041C12IDCKR	SC70	DCK	5	3000	200.0	183.0	25.0
LM4041C12QDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4041C12QDBZT	SOT-23	DBZ	3	250	210.0	185.0	35.0
LM4041CIDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0

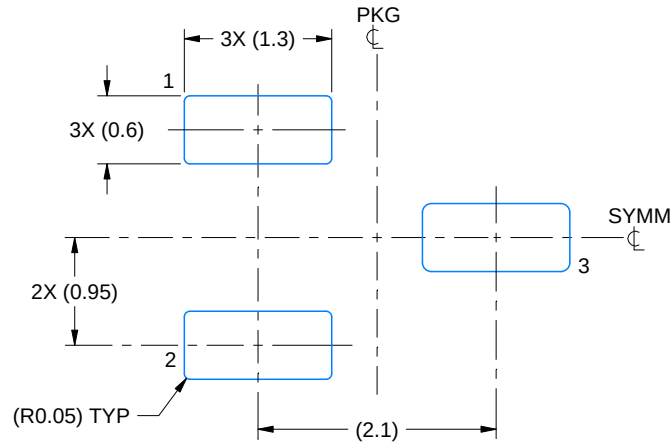
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM4041CIDBZR	SOT-23	DBZ	3	3000	200.0	183.0	25.0
LM4041CIDBZT	SOT-23	DBZ	3	250	203.0	203.0	35.0
LM4041CIDBZT	SOT-23	DBZ	3	250	180.0	180.0	18.0
LM4041CIDCKR	SC70	DCK	5	3000	200.0	183.0	25.0
LM4041CIDCKT	SC70	DCK	5	250	200.0	183.0	25.0
LM4041CQDBZR	SOT-23	DBZ	3	3000	200.0	183.0	25.0
LM4041CQDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
LM4041CQDBZT	SOT-23	DBZ	3	250	180.0	180.0	18.0
LM4041CQDBZT	SOT-23	DBZ	3	250	200.0	183.0	25.0
LM4041D12IDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM4041D12IDBZT	SOT-23	DBZ	3	250	210.0	185.0	35.0
LM4041D12IDCKR	SC70	DCK	5	3000	200.0	183.0	25.0
LM4041DIDBZR	SOT-23	DBZ	3	3000	200.0	183.0	25.0
LM4041DIDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
LM4041DIDBZT	SOT-23	DBZ	3	250	180.0	180.0	18.0
LM4041DIDCKR	SC70	DCK	5	3000	200.0	183.0	25.0
LM4041DQDBZR	SOT-23	DBZ	3	3000	200.0	183.0	25.0
LM4041DQDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
LM4041DQDBZT	SOT-23	DBZ	3	250	203.0	203.0	35.0
LM4041DQDBZT	SOT-23	DBZ	3	250	180.0	180.0	18.0

EXAMPLE BOARD LAYOUT

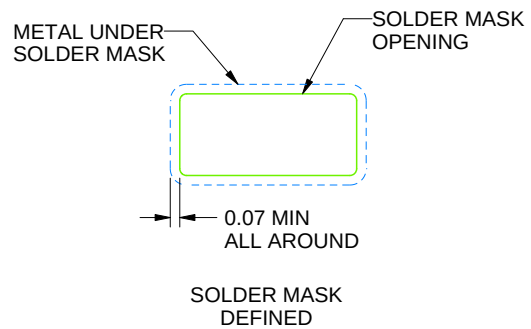
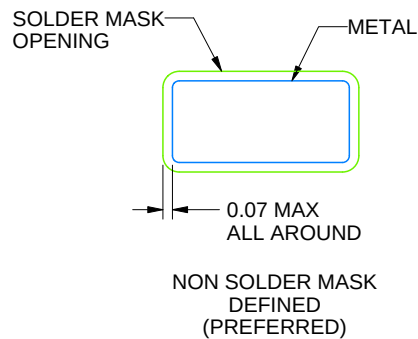
DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
SCALE:15X



SOLDER MASK DETAILS

4214838/D 03/2023

NOTES: (continued)

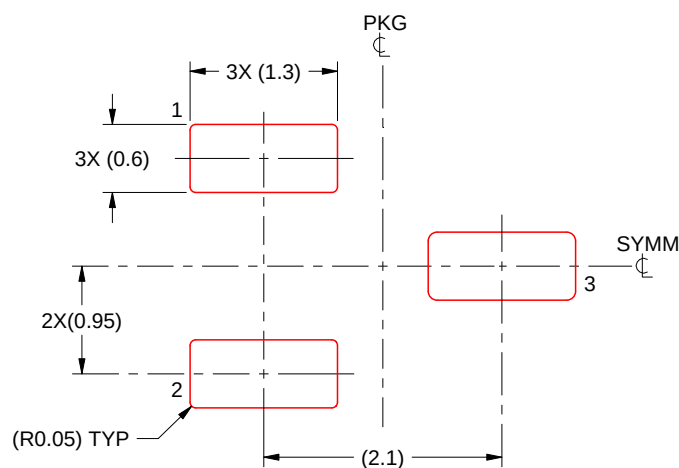
4. Publication IPC-7351 may have alternate designs.
5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR

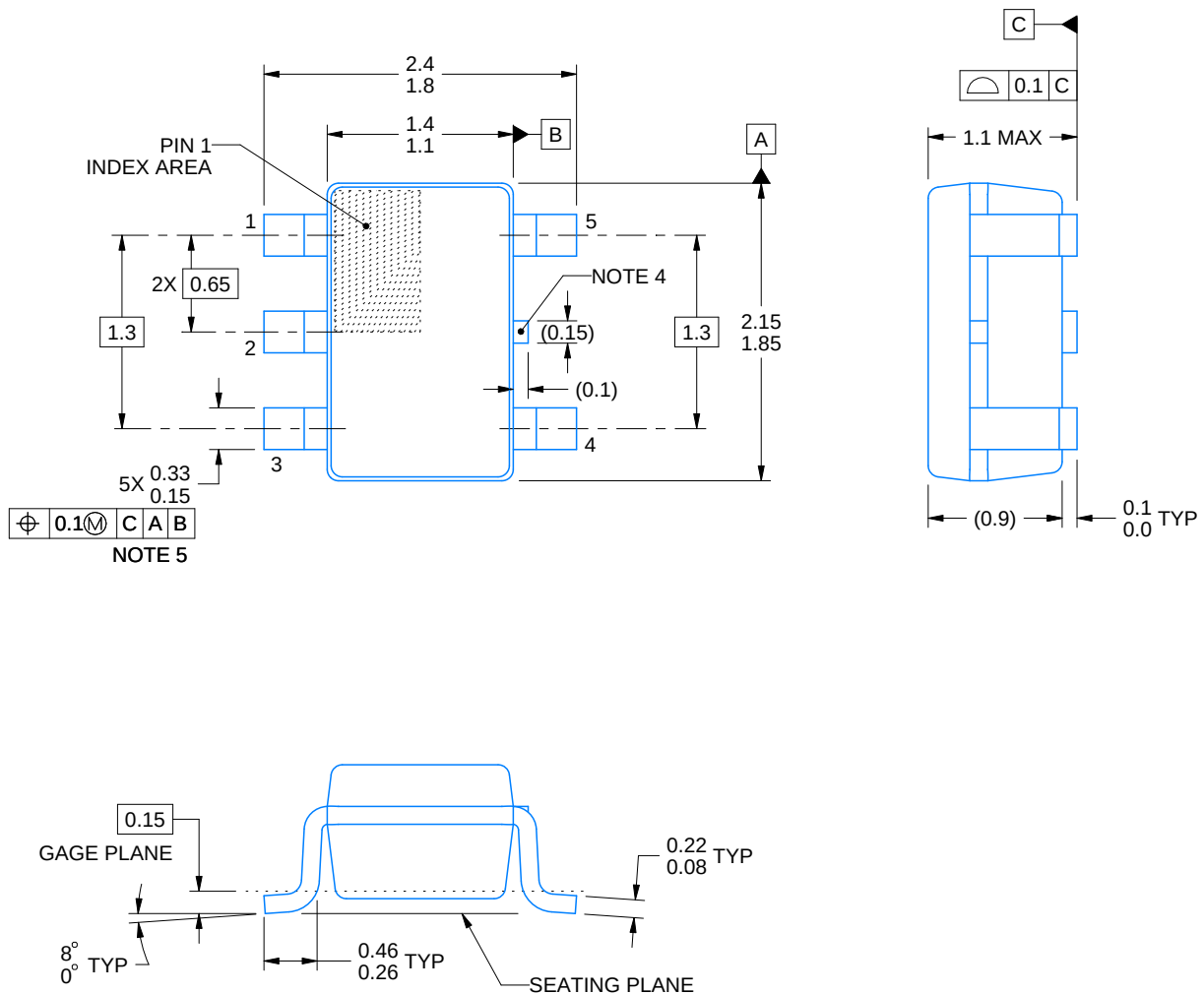


SOLDER PASTE EXAMPLE
BASED ON 0.125 THICK STENCIL
SCALE:15X

4214838/D 03/2023

NOTES: (continued)

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



4214834/D 07/2023

NOTES:

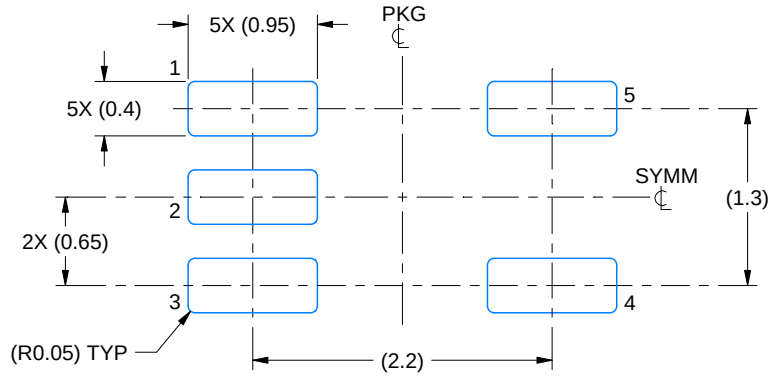
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC MO-203.
4. Support pin may differ or may not be present.
5. Lead width does not comply with JEDEC.

EXAMPLE BOARD LAYOUT

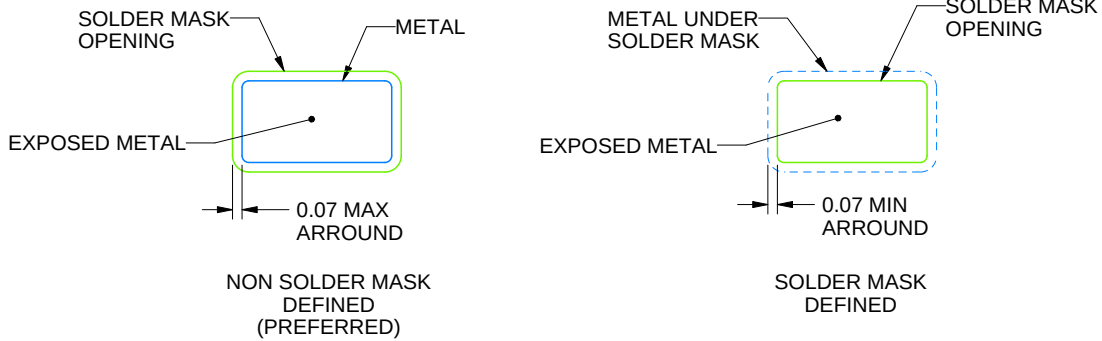
DCK0005A

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:18X

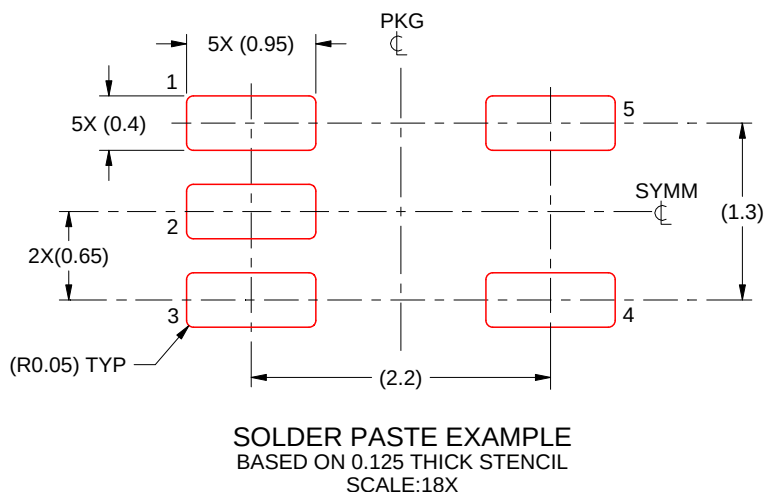


SOLDER MASK DETAILS

4214834/D 07/2023

NOTES: (continued)

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



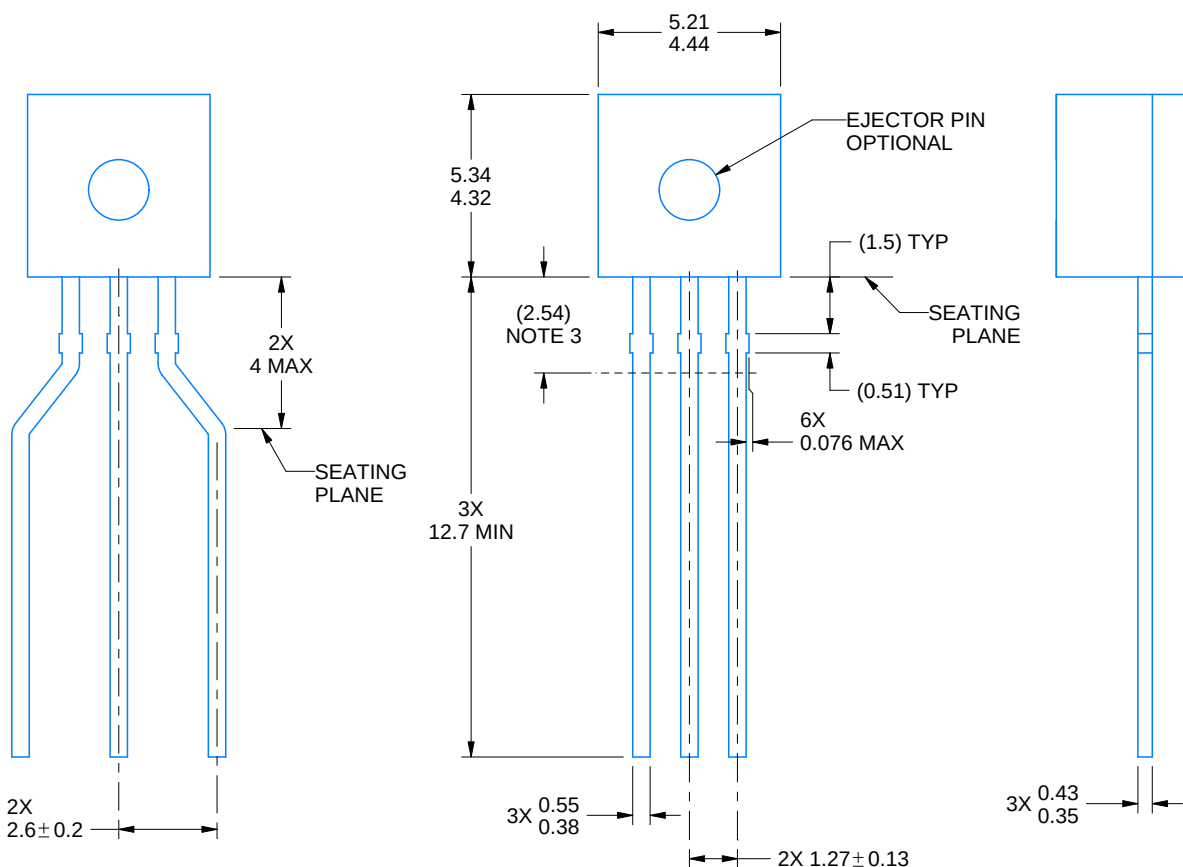
4214834/D 07/2023

NOTES: (continued)

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



Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.



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NOTES:

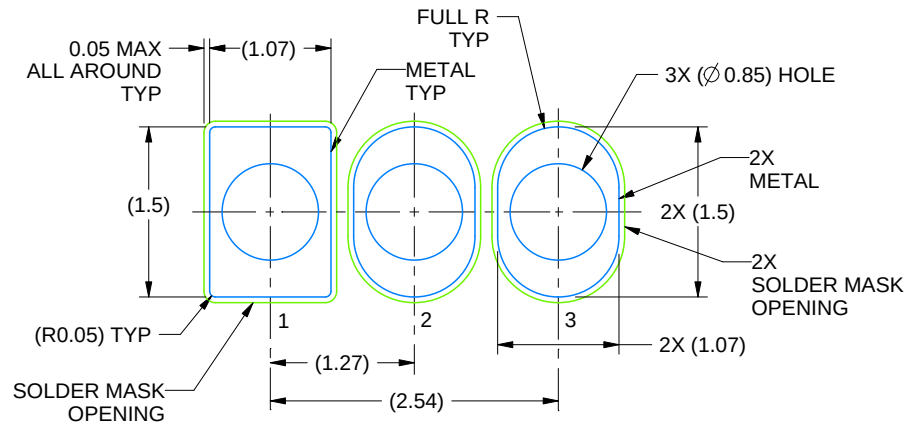
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Lead dimensions are not controlled within this area.
4. Reference JEDEC TO-226, variation AA.
5. Shipping method:
 - a. Straight lead option available in bulk pack only.
 - b. Formed lead option available in tape and reel or ammo pack.
 - c. Specific products can be offered in limited combinations of shipping medium and lead options.
 - d. Consult product folder for more information on available options.

EXAMPLE BOARD LAYOUT

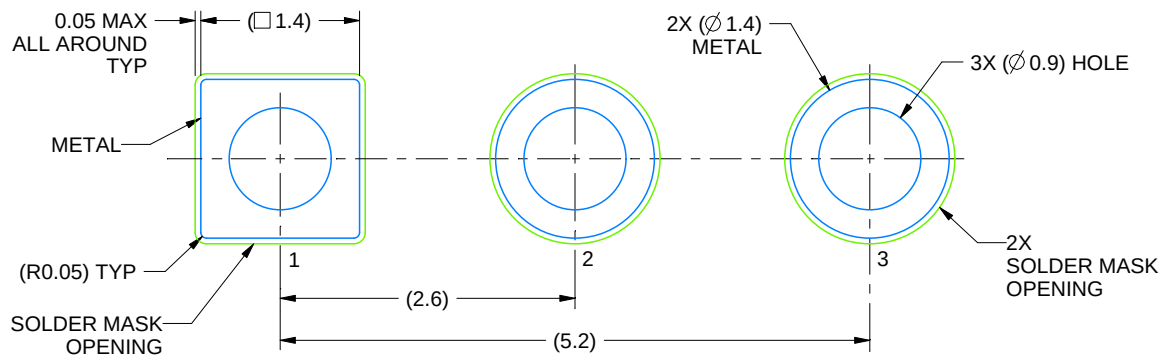
LP0003A

TO-92 - 5.34 mm max height

TO-92



LAND PATTERN EXAMPLE
STRAIGHT LEAD OPTION
NON-SOLDER MASK DEFINED
SCALE:15X



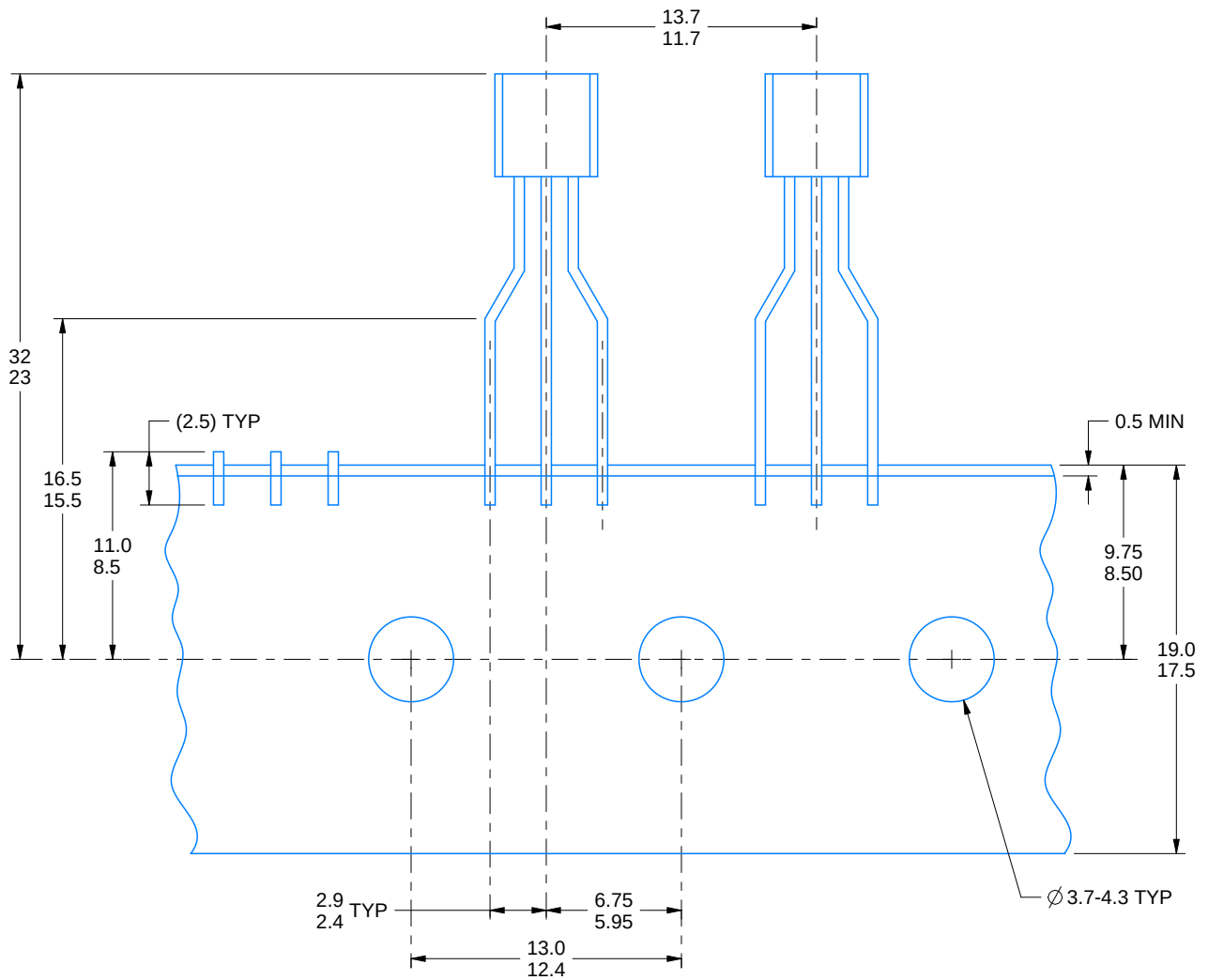
LAND PATTERN EXAMPLE
FORMED LEAD OPTION
NON-SOLDER MASK DEFINED
SCALE:15X

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LP0003A

TO-92 - 5.34 mm max height

TO-92



FOR FORMED LEAD OPTION PACKAGE

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