

LM4041 高精度マイクロパワー・シャント電圧リファレンス

1 特長

- 固定出力 (1.225V)、
可変出力 (1.225V ~ 10V)
- 厳しい出力許容誤差と小さい温度係数
 - 0.1% 以下、100ppm/°C – A グレード
 - 0.2% 以下、100ppm/°C – B グレード
 - 0.5% 以下、100ppm/°C – C グレード
 - 1.0% 以下、150ppm/°C – D グレード
- 低い出力ノイズ。20µV_{RMS} (標準値)
- 広い動作電流範囲。45µA (標準値) ~ 12mA
- 容量性負荷の大小にかかわらず安定して動作するため、出力コンデンサは不要
- 利用可能なバージョン：
 - 産業用温度範囲：-40°C ~ 85°C
 - 拡張動作温度範囲：-40°C ~ 125°C

2 アプリケーション

- データ収集システム
- 電源と電源モニタ
- 計装およびテスト機器
- プロセス制御
- 高精度オーディオ
- 車載用電子機器
- エネルギー管理 / 測定

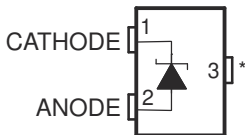
- バッテリー駆動の機器

3 概要

LM4041 シリーズのシャント電圧リファレンスは、多様なアプリケーションに適した汎用性が高く使いやすい基準電圧です。外付けコンデンサを必要とせず、容量性負荷の大小にかかわらず安定して動作します。また、この基準電圧はダイナミック・インピーダンス、ノイズ、温度係数が小さく、広範囲の動作電流および温度にわたって安定した電圧を確実に出力します。LM4041 では、ウェハー・ソート時のヒューズとツェナー・ザップ逆方向ブレイクダウンによる電圧調整を使用して、最大 0.1% (A グレード) から最大 1% (D グレード) までの 4 種類の出力電圧許容誤差の製品を提供しています。このため、アプリケーションに適した最良のコスト / 性能比を非常に柔軟に選択できます。LM4041 は、固定バージョン (公称 1.225V) または可変バージョン (出力を 1.225V ~ 10V の値に設定するための外付け抵抗分割器が必要) で提供しています。

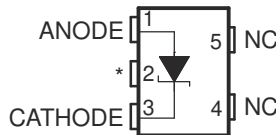
省スペースの SC-70 と SOT-23-3 にパッケージ化され、45µA (標準値) の電流で動作する LM4041 は、ポータブル・アプリケーションにも理想的です。スルーホール・パッケージの要求に対しては、TO-92 パッケージも提供しています。LM4041xI は -40°C ~ 85°C の周囲温度範囲で動作します。LM4041xQ は -40°C ~ 125°C の周囲温度範囲で動作します。

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)



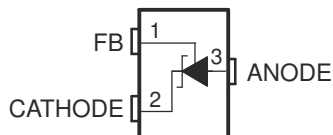
NC – No internal connection
* Pin 2 must be connected to ANODE or left open.

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

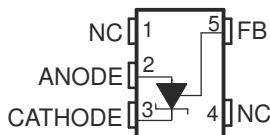


NC – No internal connection

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

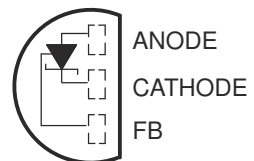


Adjustable ... DCK (SC-70) PACKAGE
(TOP VIEW)

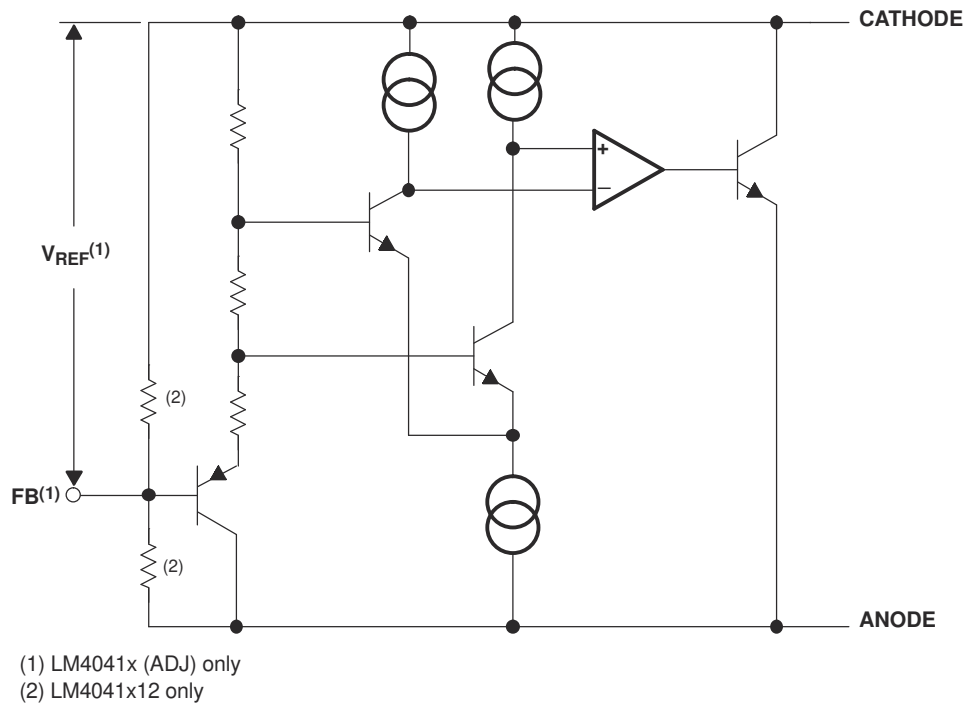


NC – No internal connection

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



4 Functional Block Diagram



✎ 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)}	DBZ package	206	°C/W
		DCK package	252	
		LP package	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	$I_Z = 100\ \mu\text{A}$	25°C			1.225			V	
	Reverse breakdown voltage tolerance	$I_Z = 100\ \mu\text{A}$	25°C			-1.2	1.2	-2.4	2.4	mV
			Full range			-9.2	9.2	-10.4	10.4	
$I_{Z,\text{min}}$	Minimum cathode current		25°C			45	75	45	75	μA
			Full range			80				
α_{VZ}	Average temperature coefficient of reverse breakdown voltage	$I_Z = 10\ \text{mA}$	25°C			± 20			ppm/°C	
		$I_Z = 1\ \text{mA}$	25°C			± 15				
		Full range			± 100					
		$I_Z = 100\ \mu\text{A}$	25°C			± 15				
$\Delta V_Z/\Delta I_Z$	Reverse breakdown voltage change with cathode current change	$I_{Z,\text{min}} < I_Z < 1\ \text{mA}$	25°C			0.7	1.5	0.7	1.5	mV
			Full range			2				
		$1\ \text{mA} < I_Z < 12\ \text{mA}$	25°C			4	6	4	6	
			Full range			8				
Z_Z	Reverse dynamic impedance	$I_Z = 1\ \text{mA}$, $f = 120\ \text{Hz}$, $I_{AC} = 0.1\ I_Z$	25°C			0.5	1.5	0.5	1.5	Ω
e_N	Wideband noise	$I_Z = 100\ \mu\text{A}$, $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$	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	

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	$I_Z = 100\ \mu\text{A}$	25°C			1.225			V
	Reverse breakdown voltage tolerance	$I_Z = 100\ \mu\text{A}$	25°C			-6			mV
			Full range			-14			
$I_{Z,\text{min}}$	Minimum cathode current		25°C			45			μA
			Full range			80			
α_{VZ}	Average temperature coefficient of reverse breakdown voltage	$I_Z = 10\ \text{mA}$	25°C			± 20			ppm/°C
			25°C			± 15			
			Full range			± 100			
			25°C			± 15			
$\Delta V_Z / \Delta I_Z$	Reverse breakdown voltage change with cathode current change	$I_{Z,\text{min}} < I_Z < 1\ \text{mA}$	25°C			0.7			mV
			Full range			2			
		$1\ \text{mA} < I_Z < 12\ \text{mA}$	25°C			2.5			
			Full range			8			
Z_Z	Reverse dynamic impedance	$I_Z = 1\ \text{mA}$, $f = 120\ \text{Hz}$, $I_{AC} = 0.1\ I_Z$	25°C			0.5			Ω
e_N	Wideband noise	$I_Z = 100\ \mu\text{A}$, $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$	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

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	$I_Z = 100\ \mu\text{A}$	25°C			1.225			V	
	Reverse breakdown voltage tolerance	$I_Z = 100\ \mu\text{A}$	25°C			-6			6	mV
			Full range			-18.4			18.4	
$I_{Z,\text{min}}$	Minimum cathode current		25°C			45			75	μA
			Full range						80	
α_{VZ}	Average temperature coefficient of reverse breakdown voltage	$I_Z = 10\ \text{mA}$	25°C			± 20			ppm/°C	
			25°C			± 15				
			Full range			± 100				
			25°C			± 15				
$\Delta V_Z / \Delta I_Z$	Reverse breakdown voltage change with cathode current change	$I_{Z,\text{min}} < I_Z < 1\ \text{mA}$	25°C			0.7			1.5	mV
			Full range						2	
		$1\ \text{mA} < I_Z < 12\ \text{mA}$	25°C			2.5			6	
			Full range						8	
Z_Z	Reverse dynamic impedance	$I_Z = 1\ \text{mA}$, $f = 120\ \text{Hz}$, $I_{AC} = 0.1\ I_Z$	25°C			0.5			Ω	
			Full range							1.5
e_N	Wideband noise	$I_Z = 100\ \mu\text{A}$, $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$	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	

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	$I_Z = 100\ \mu\text{A}$, $V_Z = 5\ \text{V}$	25°C			1.233			V	
	Reference voltage tolerance ⁽¹⁾	$I_Z = 100\ \mu\text{A}$, $V_Z = 5\ \text{V}$	25°C			-2.5	2.5		mV	
			Full range			-10.5	10.5			
$I_{Z,min}$	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		1.5		mV
			Full range					2		
		$1\ \text{mA} < I_Z < 12\ \text{mA}$	25°C			2		4		
			Full range					6		
$\Delta V_{REF}/\Delta V_{KA}$	Reference voltage change with output voltage change	$I_Z = 1\ \text{mA}$	25°C			-1.55		-2		mV/V
			Full range					-2.5		
I_{FB}	Feedback current		25°C			60		100		nA
			Full range					120		
αV_{REF}	Average temperature coefficient of reference voltage ⁽¹⁾	$I_Z = 10\ \text{mA}$, $V_Z = 5\ \text{V}$	25°C			± 20		± 20		ppm/°C
		$I_Z = 1\ \text{mA}$, $V_Z = 5\ \text{V}$	25°C			± 15		± 15		
			Full range					± 100		
		$I_Z = 100\ \mu\text{A}$, $V_Z = 5\ \text{V}$	25°C			± 15		± 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		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		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		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		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	$I_Z = 100\ \mu\text{A}$, $V_Z = 5\ \text{V}$	25°C	1.233		V	
	Reference voltage tolerance ⁽¹⁾	$I_Z = 100\ \mu\text{A}$, $V_Z = 5\ \text{V}$	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/°C	
			25°C	$I_Z = 1\ \text{mA}$, $V_Z = 5\ \text{V}$	± 15		
				Full range			± 150
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	
			25°C	$I_Z = 1\ \text{mA}$, $f = 120\ \text{Hz}$, $I_{AC} = 0.1\ I_Z$, $V_Z = 10\ \text{V}$	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*.

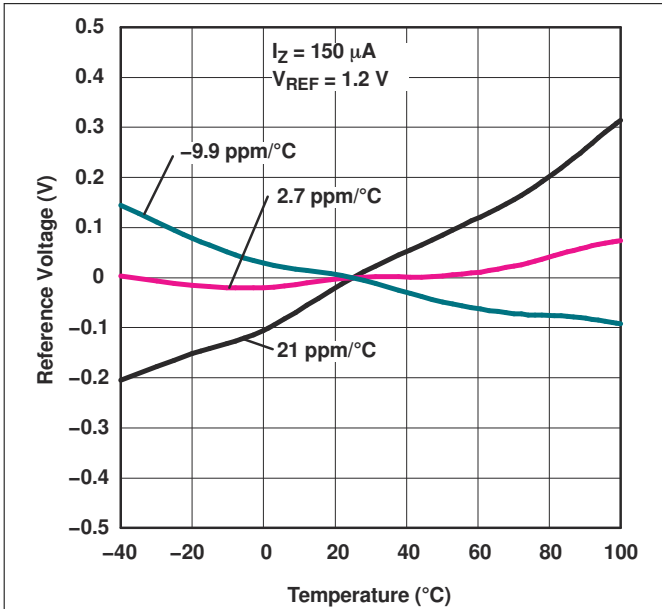
12 LM4041xQ (Adjustable Version) Electrical Characteristics

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

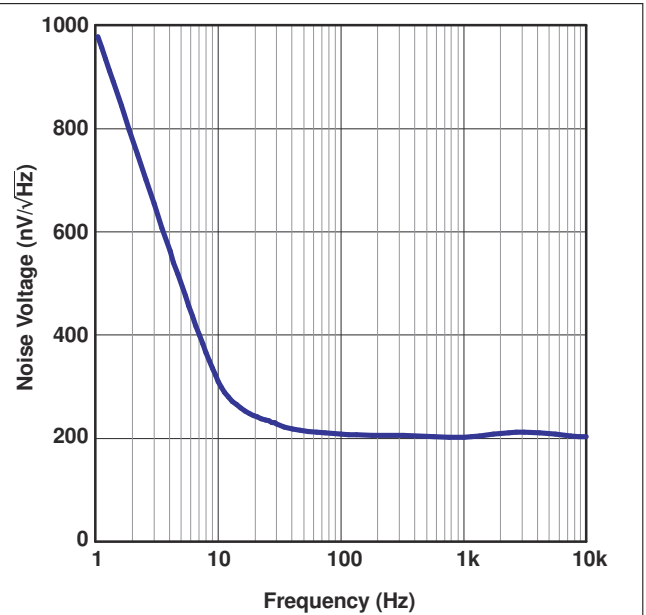
PARAMETER	TEST CONDITIONS	T_A	LM4041CQ			LM4041DQ			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{REF}	Reference voltage	$I_Z = 100\ \mu\text{A}$, $V_Z = 5\ \text{V}$	25°C			1.233			V
	Reference voltage tolerance ⁽¹⁾	$I_Z = 100\ \mu\text{A}$, $V_Z = 5\ \text{V}$	25°C			-6.2	6.2		mV
			Full range			-18	18		
$I_{Z,min}$	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	1.5		mV
			Full range			2			
		$1\ \text{mA} < I_Z < 12\ \text{mA}$	25°C			2	4		
			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	100		nA
			Full range			120			
αV_{REF}	Average temperature coefficient of reference voltage ⁽¹⁾	$I_Z = 10\ \text{mA}$, $V_Z = 5\ \text{V}$	25°C			± 20			ppm/°C
		$I_Z = 1\ \text{mA}$, $V_Z = 5\ \text{V}$	25°C			± 15			
			Full range			± 100			
		$I_Z = 100\ \mu\text{A}$, $V_Z = 5\ \text{V}$	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*.

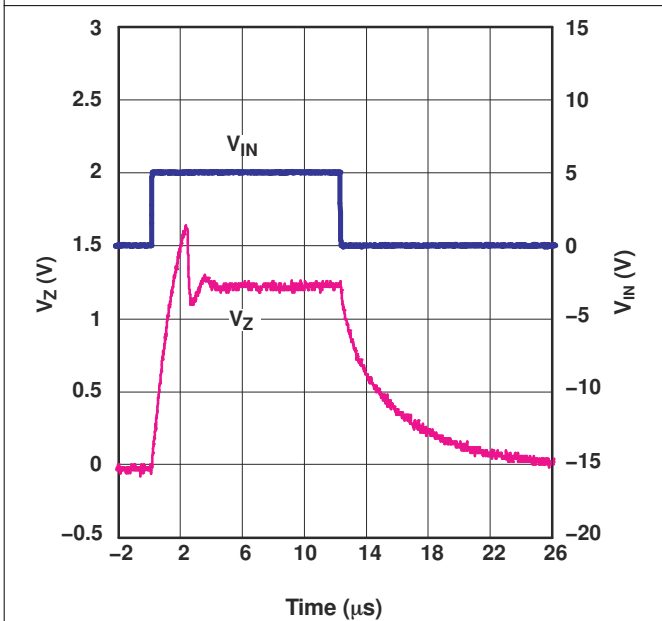
13 Typical Characteristics



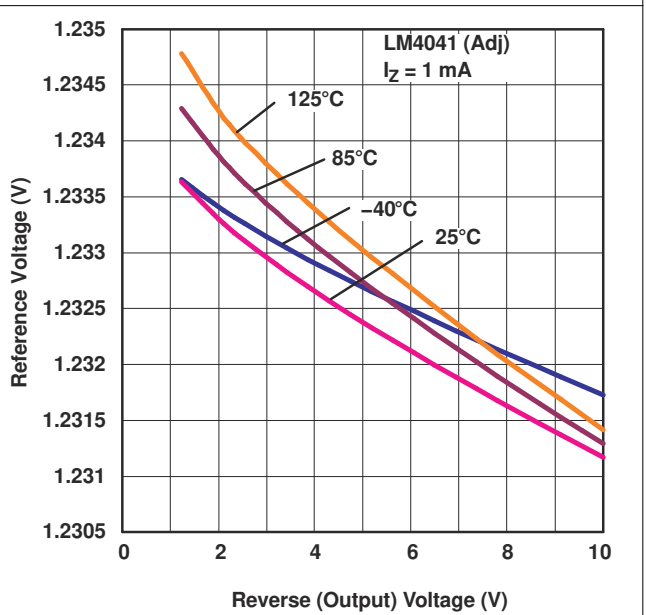
13-1. Temperature Drift for Different Average Temperature Coefficients



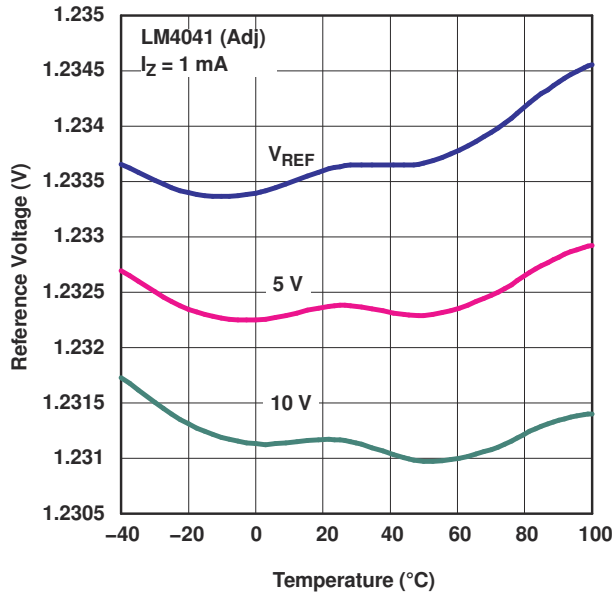
13-2. Noise Voltage vs Frequency



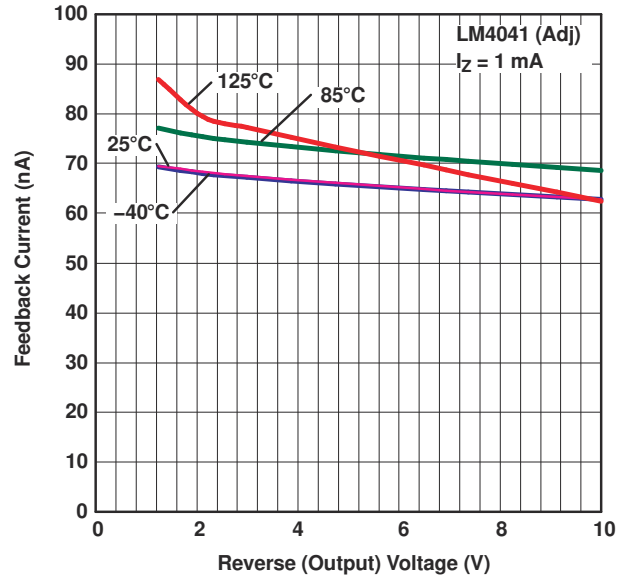
13-3. Start-Up Characteristics



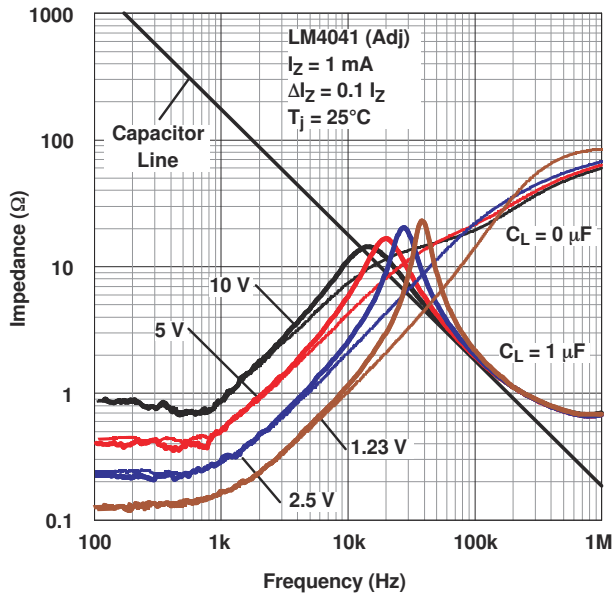
13-4. Reference Voltage vs Reverse (Output) Voltage (for Different Temperatures)



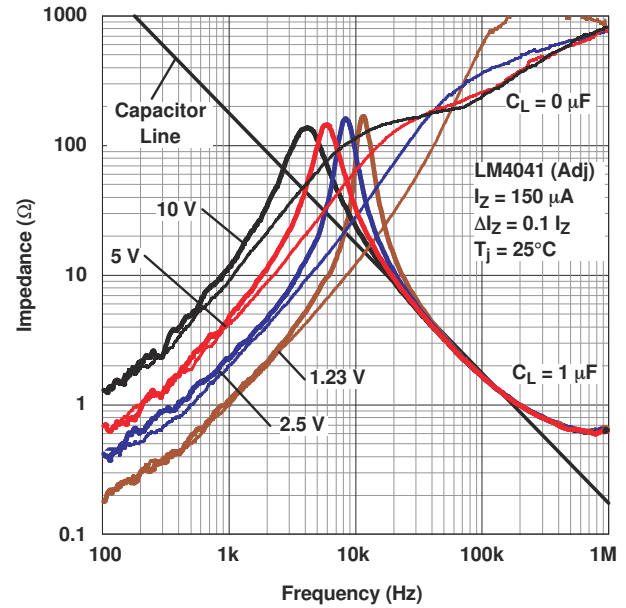
13-5. Reference Voltage vs Temperature (for Different Reverse Voltages)



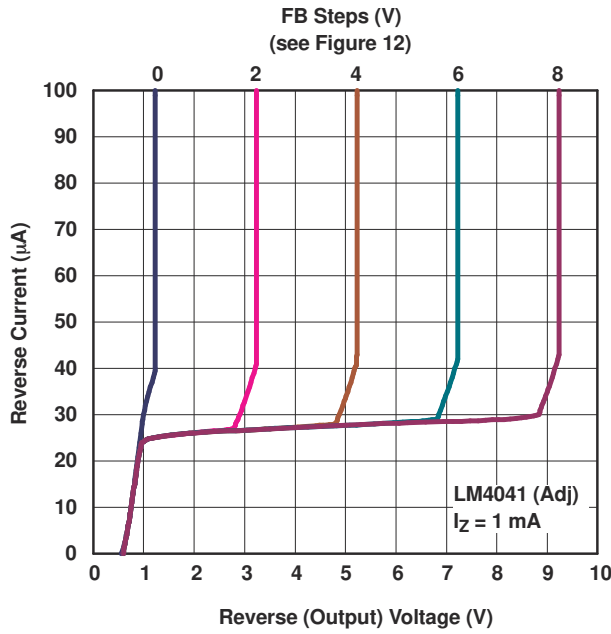
13-6. Feedback Current vs Reverse (Output) Voltage (for Different Temperatures)



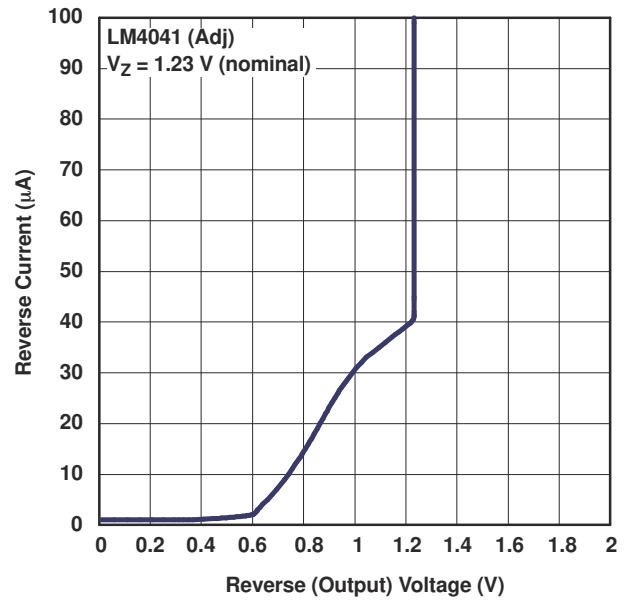
13-7. Output Impedance vs Frequency



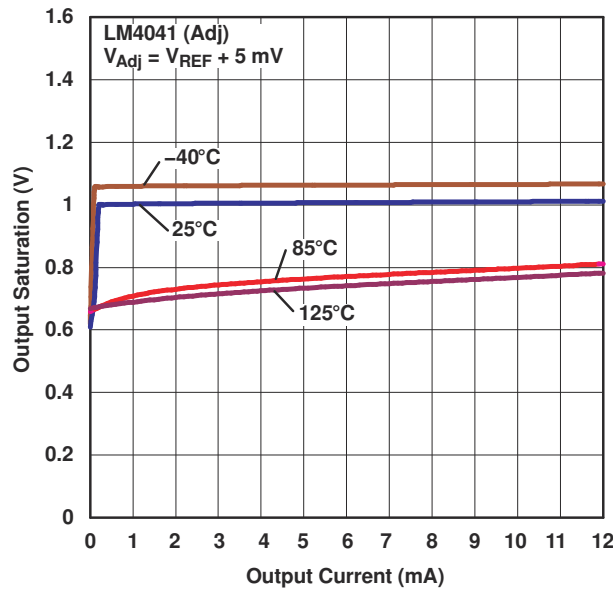
13-8. Output Impedance vs Frequency




13-9. Reverse Characteristics




13-10. Reverse Characteristics and Minimum Operating Current




13-11. Output Saturation vs Output Current

14 Application Information

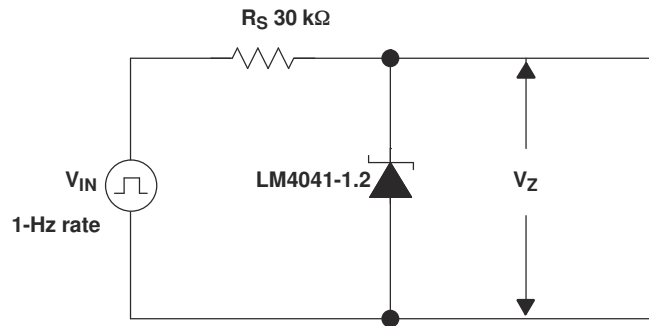


Figure 14-1. Startup Characteristics Test Circuit

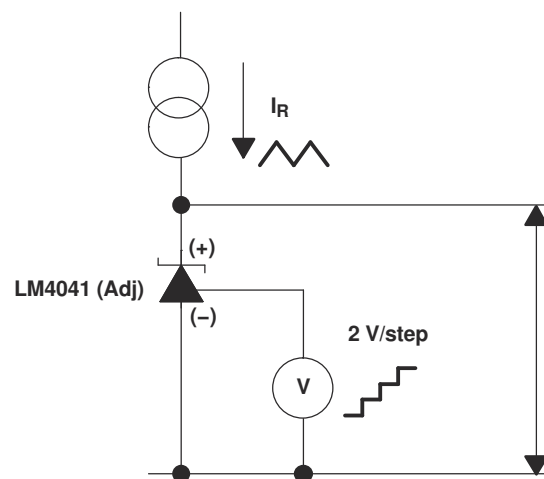


Figure 14-2. Reverse Characteristics Test Circuit

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](#).

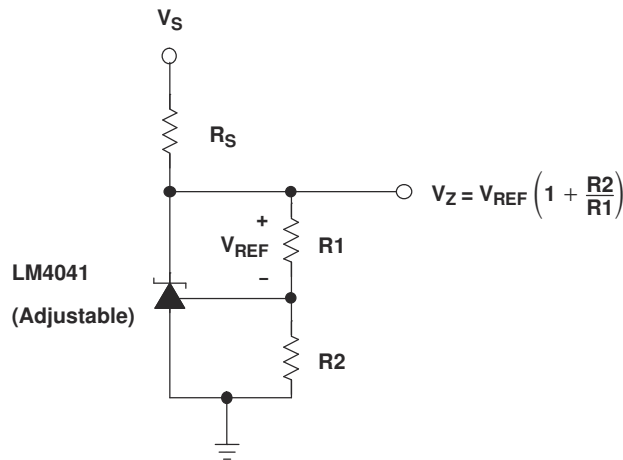


Figure 14-3. Adjustable Shunt Regulator

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](#).

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

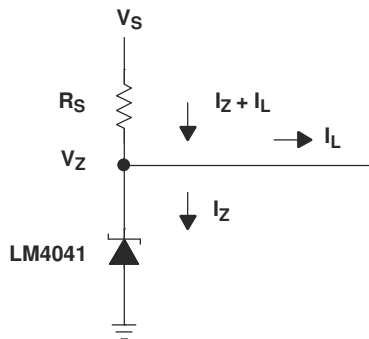


Figure 14-4. Shunt Regulator

15 Revision History

資料番号末尾の英字は改訂を表しています。その改訂履歴は英語版に準じています。

Changes from Revision E (February 2006) to Revision F (September 2020)	Page
• 文書全体にわたって表、図、相互参照の採番方法を更新.....	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	OBSOLETE	TO-92	LP	3		TBD	Call TI	Call TI	-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	OBSOLETE	TO-92	LP	3		TBD	Call TI	Call TI	-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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TAPE AND REEL INFORMATION

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
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	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
LM4041BIDBZT	SOT-23	DBZ	3	250	179.0	8.4	3.15	2.95	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
LM4041CIDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
LM4041CIDBZR	SOT-23	DBZ	3	3000	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
LM4041CIDBZT	SOT-23	DBZ	3	250	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
LM4041CIDBZT	SOT-23	DBZ	3	250	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
LM4041CIDCKR	SC70	DCK	5	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
LM4041CIDCKT	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	178.0	9.2	3.15	2.77	1.22	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
LM4041CQDBZT	SOT-23	DBZ	3	250	179.0	8.4	3.15	2.95	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
LM4041D12IDBZR	SOT-23	DBZ	3	3000	180.0	8.4	2.9	3.35	1.35	4.0	8.0	Q3
LM4041D12IDBZT	SOT-23	DBZ	3	250	180.0	8.4	2.9	3.35	1.35	4.0	8.0	Q3
LM4041D12IDCKR	SC70	DCK	5	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
LM4041D12QDBZR	SOT-23	DBZ	3	3000	180.0	8.4	2.9	3.35	1.35	4.0	8.0	Q3
LM4041DIDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
LM4041DIDBZR	SOT-23	DBZ	3	3000	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
LM4041DIDBZT	SOT-23	DBZ	3	250	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
LM4041DIDCKR	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	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

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	180.0	180.0	18.0
LM4041BIDBZR	SOT-23	DBZ	3	3000	200.0	183.0	25.0
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	200.0	183.0	25.0

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM4041CIDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
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	180.0	180.0	18.0
LM4041CQDBZR	SOT-23	DBZ	3	3000	200.0	183.0	25.0
LM4041CQDBZT	SOT-23	DBZ	3	250	200.0	183.0	25.0
LM4041CQDBZT	SOT-23	DBZ	3	250	180.0	180.0	18.0
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
LM4041D12QDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
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	180.0	180.0	18.0
LM4041DQDBZT	SOT-23	DBZ	3	250	203.0	203.0	35.0

GENERIC PACKAGE VIEW

LP 3

TO-92 - 5.34 mm max height

TRANSISTOR OUTLINE



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

4040001-2/F

LP0003A



PACKAGE OUTLINE

TO-92 - 5.34 mm max height

TO-92



4215214/B 04/2017

NOTES:

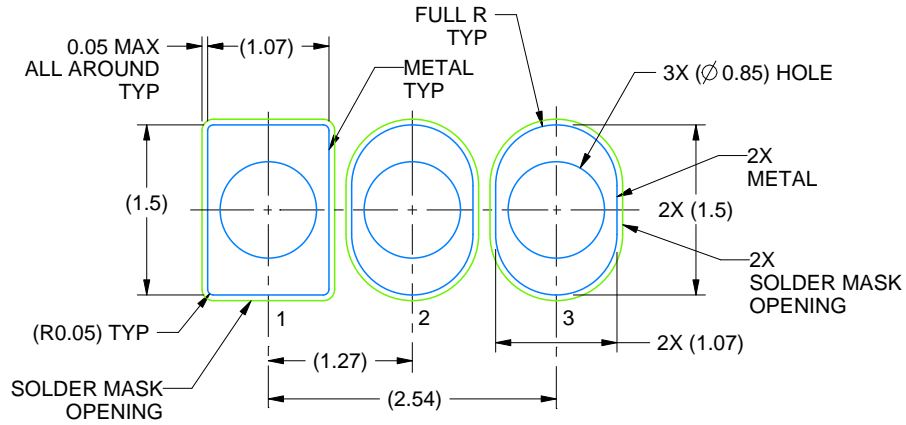
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Lead dimensions are not controlled within this area.
4. Reference JEDEC TO-226, variation AA.
5. Shipping 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

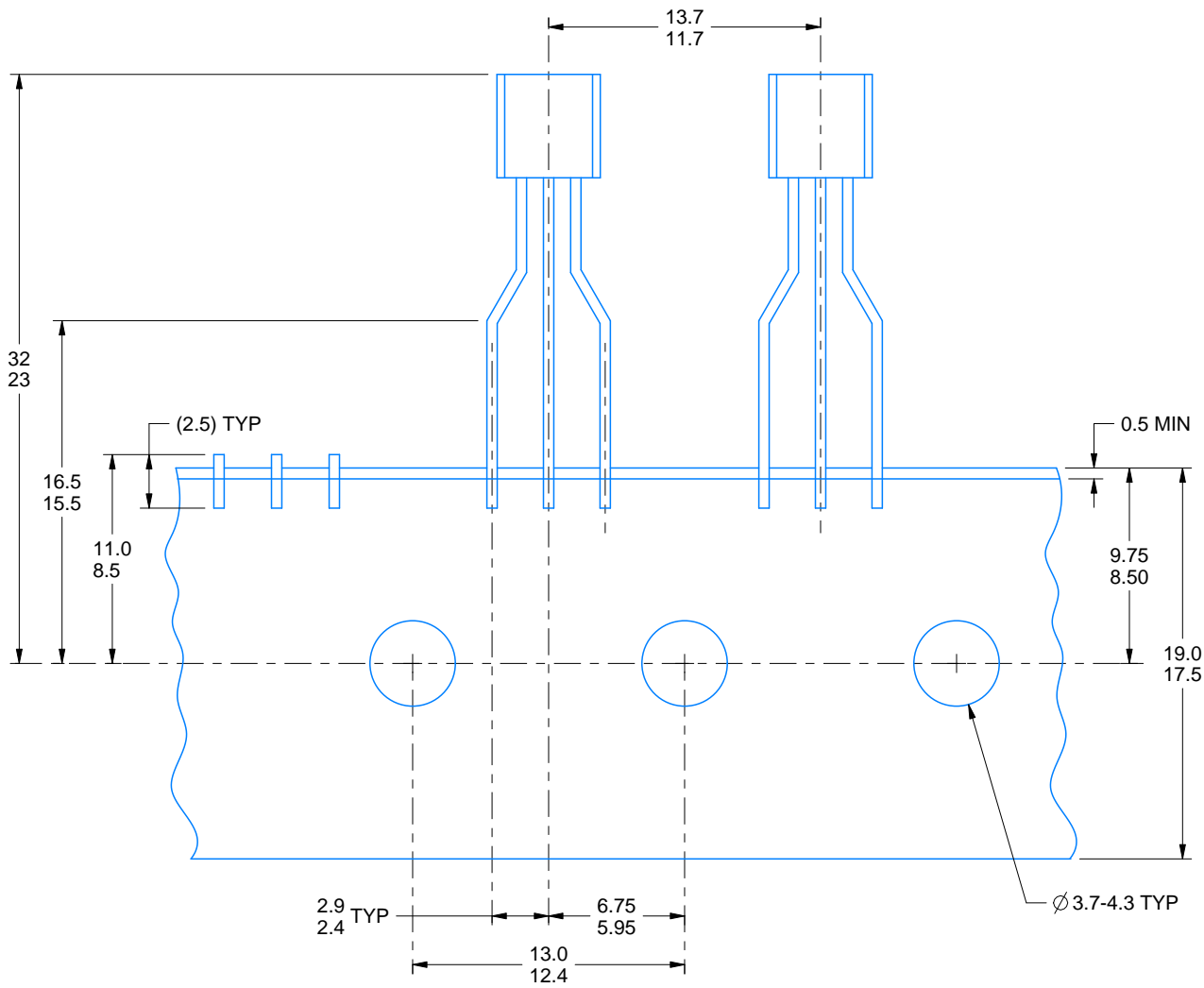
4215214/B 04/2017

TAPE SPECIFICATIONS

LP0003A

TO-92 - 5.34 mm max height

TO-92



FOR FORMED LEAD OPTION PACKAGE

4215214/B 04/2017

DCK0005A



PACKAGE OUTLINE

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



4214834/E 06/2024

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.
6. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.25mm per side

EXAMPLE BOARD LAYOUT

DCK0005A

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:18X



SOLDER MASK DETAILS

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NOTES: (continued)

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

EXAMPLE STENCIL DESIGN

DCK0005A

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



SOLDER PASTE EXAMPLE
BASED ON 0.125 THICK STENCIL
SCALE: 18X

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NOTES: (continued)

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

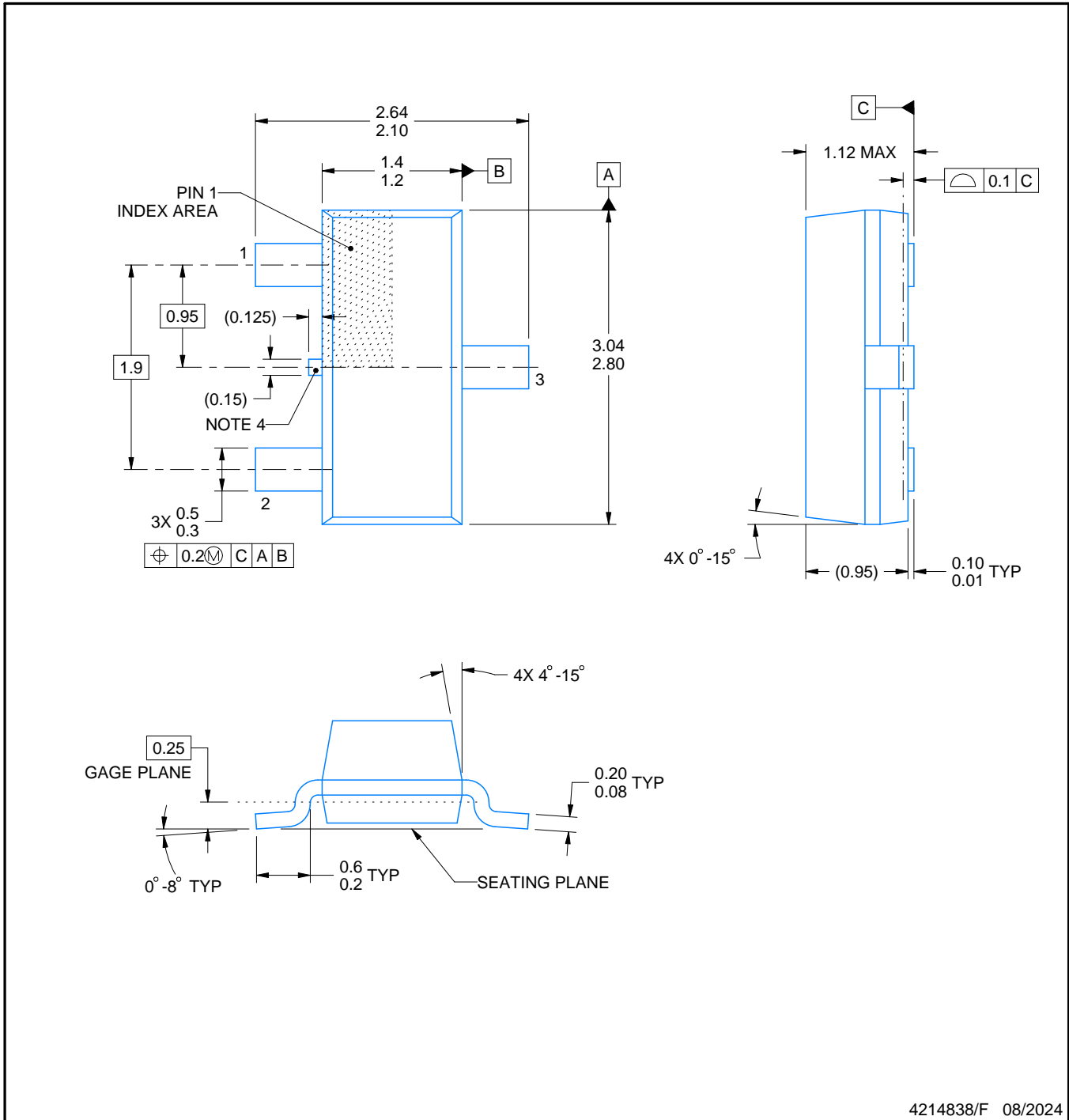
DBZ0003A



PACKAGE OUTLINE

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



4214838/F 08/2024

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

EXAMPLE BOARD LAYOUT

DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
SCALE:15X



SOLDER MASK DETAILS

4214838/F 08/2024

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.

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

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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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