

## LM4041 精密低功耗并联电压基准

### 1 信息

- 具有 1.225V 固定输出电压和可调输出电压 (1.225V 至 10V)
- 严格输出容差和低温度系数
  - 0.1% (最大值), 100ppm/°C - A 级
  - 0.2% (最大值), 100ppm/°C - B 级
  - 0.5% (最大值), 100ppm/°C - C 级
  - 1.0% (最大值), 150ppm/°C - D 级
- 低输出噪声。。。20  $\mu$ V<sub>RMS</sub> (典型值)
- 宽工作电流范围。。。45  $\mu$ A (典型值) 至 12mA
- 与所有容性负载一起工作时保持稳定；无需输出电容器
- 可提供
  - 工业温度：-40°C 至 85°C
  - 工作温度范围：-40°C 至 125°C

### 2 应用

- 数据采集系统
- 电源和电源监控器
- 仪表和测试设备
- 过程控制

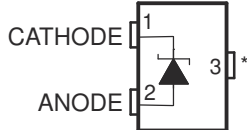
- 精密音频
- 汽车电子产品
- 能源管理/计量
- 电池供电类设备

### 3 说明

LM4041 系列并联电压基准功能多样、易于使用，适合各种应用。它们无需外部电容器即可运行，与所有容性负载一起工作时保持稳定。此外，该基准具备低动态阻抗、低噪声和低温度系数，可确保在广泛的运行电流和温度范围内实现稳定的输出电压。LM4041 在晶圆筛选期间使用保险丝和齐纳击穿反向击穿电压修整，以提供四种输出电压容差 - 从最高 0.1% (A 级) 到最高 1% (D 级)。这样设计人员可以非常灵活地为应用选择具有高性价比的产品。LM4041 可提供固定电压 (1.225V 标称值) 或可调电压版本 (需要外部电阻分压器将输出设为 1.225V 至 10V 间的任意值)。

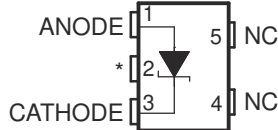
LM4041 采用节省空间的 SC-70 和 SOT-23-3 封装，最低电流为 45  $\mu$ A (典型值)，因此是便携式应用的理想之选。如需穿孔封装，我们还提供 TO-92 封装。LM4041xI 的额定工作环境温度范围是 -40°C 至 85°C。LM4041xQ 的额定工作环境温度范围是 -40°C 至 125°C。

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)



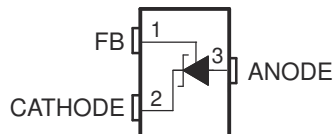
NC - No internal connection  
\* Pin 2 must be connected to ANODE or left open.

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

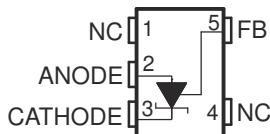


NC - No internal connection

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

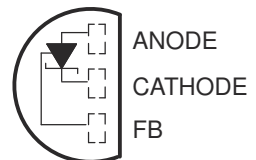


Adjustable ... DCK (SC-70) PACKAGE  
(TOP VIEW)



NC - No internal connection

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



## 4 Functional Block Diagram

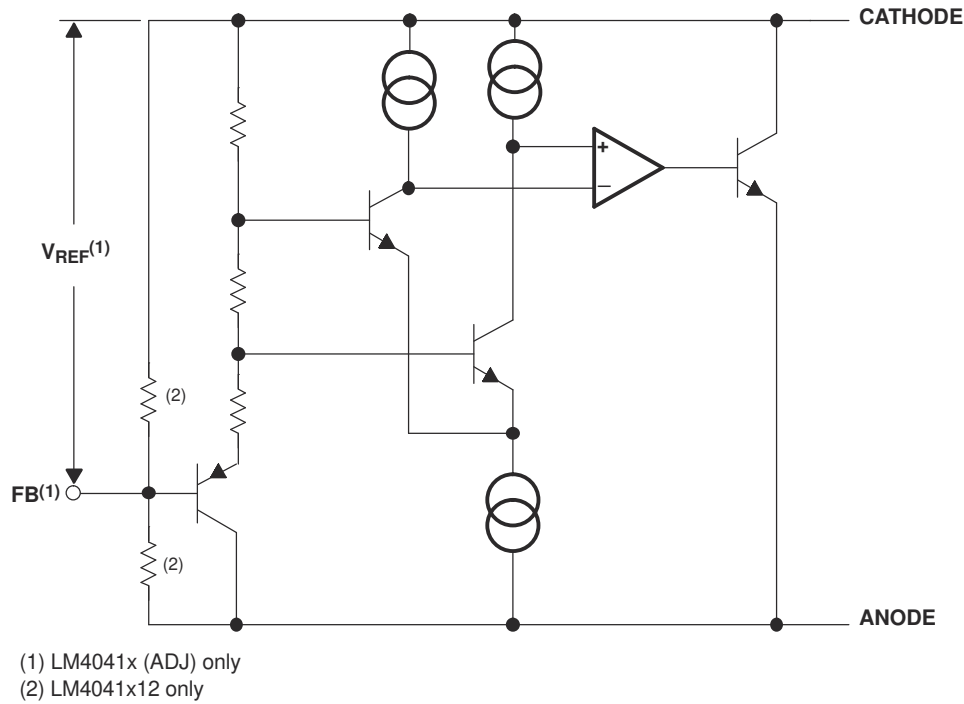


图 4-1. Functional Block Diagram

## 5 Absolute Maximum Ratings

over free-air temperature range (unless otherwise noted)

		MIN	MAX <sup>(1)</sup>	UNIT
$V_Z$	Continuous cathode voltage		15	V
$I_Z$	Continuous cathode current	- 10	25	mA
$\theta_{JA}$	Package thermal impedance <sup>(2) (3)</sup>	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  $T_J(\max)$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\max) - T_A) / \theta_{JA}$ . 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  $85^\circ\text{C}$  (unless otherwise noted)

PARAMETER	TEST CONDITIONS	$T_A$	LM4041A12I			LM4041B12I			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_Z$	Reverse breakdown voltage	$I_Z = 100 \mu\text{A}$	1.225			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	$\mu\text{A}$		
		Full range	80						
$\alpha_{V_Z}$	Average temperature coefficient of reverse breakdown voltage	$I_Z = 10 \text{ mA}$	25°C			$\pm 20$			ppm/°C
		$I_Z = 1 \text{ mA}$	25°C			$\pm 15$			
		$I_Z = 100 \mu\text{A}$	25°C			$\pm 15$			
$\Delta V_Z / \Delta I_Z$	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	$\Omega$	
$e_N$	Wideband noise	$I_Z = 100 \mu\text{A}$ , $10 \text{ Hz} \leq f \leq 10 \text{ kHz}$	25°C	20			20	$\mu\text{V}_{\text{RMS}}$	
	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	

## 8 LM4041x12I Electrical Characteristics

full-range  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$  (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	$I_Z = 100\ \mu\text{A}$	- 6                      6			- 12                      12			mV
		Full range	- 14                      14			- 24                      24			
$I_{Z,\text{min}}$	Minimum cathode current	$25^\circ\text{C}$	45    75			45    75			$\mu\text{A}$
		Full range	80			80			
$\alpha_{V_Z}$	Average temperature coefficient of reverse breakdown voltage	$I_Z = 10\ \text{mA}$	$\pm 20$			$\pm 20$			ppm/ $^\circ\text{C}$
		$I_Z = 1\ \text{mA}$	$\pm 15$			$\pm 15$			
			Full range	$\pm 100$			$\pm 150$		
		$I_Z = 100\ \mu\text{A}$	$\pm 15$			$\pm 15$			
$\frac{\Delta V_Z}{V_Z} / \frac{\Delta I_Z}{I_Z}$	Reverse breakdown voltage change with cathode current change	$I_{Z,\text{min}} < I_Z < 1\ \text{mA}$	$25^\circ\text{C}$	0.7    1.5		0.7    2		mV	
			Full range	2		2.5			
		$1\ \text{mA} < I_Z < 12\ \text{mA}$	$25^\circ\text{C}$	2.5    6		2.5    8			
			Full range	8		10			
$Z_Z$	Reverse dynamic impedance	$I_Z = 1\ \text{mA}$ , $f = 120\ \text{Hz}$ , $I_{\text{AC}} = 0.1 I_Z$	$25^\circ\text{C}$	0.5    1.5		0.5    2		$\Omega$	
$e_N$	Wideband noise	$I_Z = 100\ \mu\text{A}$ , $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$	$25^\circ\text{C}$	20		20		$\mu\text{V}_{\text{RMS}}$	
	Long-term stability of reverse breakdown voltage	$t = 1000\ \text{h}$ , $T_A = 25^\circ\text{C} \pm 0.1^\circ\text{C}$ , $I_Z = 100\ \mu\text{A}$	$25^\circ\text{C}$	120		120		ppm	

## 9 LM4041x12Q Electrical Characteristics

 full-range  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$  (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			-31	31
$I_{Z,\text{min}}$	Minimum cathode current		25°C			45	75		$\mu\text{A}$		
			Full range			80					
$\alpha_{V_Z}$	Average temperature coefficient of reverse breakdown voltage	$I_Z = 10\ \text{mA}$	25°C			$\pm 20$			ppm/°C		
		$I_Z = 1\ \text{mA}$	25°C			$\pm 15$					
			Full range			$\pm 100$					
		$I_Z = 100\ \mu\text{A}$	25°C			$\pm 15$					
$\frac{\Delta V_Z}{V_Z} / \frac{\Delta I_Z}{I_Z}$	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				2.5	
		$1\ \text{mA} < I_Z < 12\ \text{mA}$	25°C			2.5	6			2.5	8
			Full range			8					
$Z_Z$	Reverse dynamic impedance	$I_Z = 1\ \text{mA}$ , $f = 120\ \text{Hz}$ , $I_{\text{AC}} = 0.1 I_Z$	25°C			0.5			$\Omega$		
			Full range			1.5				2	
$e_N$	Wideband noise	$I_Z = 100\ \mu\text{A}$ , $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$	25°C			20			$\mu\text{V}_{\text{RMS}}$		
	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  $85^\circ\text{C}$  (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 <sup>(1)</sup>	$I_Z = 100\ \mu\text{A}$ , $V_Z = 5\ \text{V}$	25°C			- 2.5	2.5		mV	
			Full range			- 10.5	10.5			
$I_{Z,min}$	Minimum cathode current		25°C			45		75		$\mu\text{A}$
			Full range			80		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		2		
		$1\ \text{mA} < I_Z < 12\ \text{mA}$	25°C			2		4		
			Full range			6		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		- 2.5		
$I_{FB}$	Feedback current		25°C			60		100		nA
			Full range			120		120		
$\alpha V_{REF}$	Average temperature coefficient of reference voltage <sup>(1)</sup>	$I_Z = 10\ \text{mA}$ , $V_Z = 5\ \text{V}$	25°C			$\pm 20$		$\pm 20$		ppm/°C
		$I_Z = 1\ \text{mA}$ , $V_Z = 5\ \text{V}$	25°C			$\pm 15$		$\pm 15$		
			Full range			$\pm 100$		$\pm 100$		
		$I_Z = 100\ \mu\text{A}$ , $V_Z = 5\ \text{V}$	25°C			$\pm 15$		$\pm 15$		
$Z_Z$	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		$\Omega$
		$I_Z = 1\ \text{mA}$ , $f = 120\ \text{Hz}$ , $I_{AC} = 0.1\ I_Z$ , $V_Z = 10\ \text{V}$	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		$\mu\text{V}_{RMS}$
	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  $85^\circ\text{C}$  (unless otherwise noted)

PARAMETER	TEST CONDITIONS	$T_A$	LM4041DI			UNIT
			MIN	TYP	MAX	
$V_{REF}$ Reference voltage	$I_Z = 100\ \mu\text{A}$ , $V_Z = 5\ \text{V}$	$25^\circ\text{C}$	1.233			V
Reference voltage tolerance <sup>(1)</sup>	$I_Z = 100\ \mu\text{A}$ , $V_Z = 5\ \text{V}$	$25^\circ\text{C}$	- 12	12		mV
		Full range	- 24	24		
$I_{Z,\text{min}}$ Minimum cathode current		$25^\circ\text{C}$	45 75		$\mu\text{A}$	
		Full range	80			
$\Delta V_{REF}/\Delta I_Z$ Reference voltage change with cathode current change	$I_{Z,\text{min}} < I_Z < 1\ \text{mA}$	$25^\circ\text{C}$	0.7 2		mV	
		Full range	2.5			
	$1\ \text{mA} < I_Z < 12\ \text{mA}$	$25^\circ\text{C}$	2 6			
		Full range	8			
$\Delta V_{REF}/\Delta V_{KA}$ Reference voltage change with output voltage change	$I_Z = 1\ \text{mA}$	$25^\circ\text{C}$	- 1.55	- 2		mV/V
		Full range	- 3			
$I_{FB}$ Feedback current		$25^\circ\text{C}$	60	150		nA
		Full range	200			
$\alpha V_{REF}$ Average temperature coefficient of reference voltage <sup>(1)</sup>	$I_Z = 10\ \text{mA}$ , $V_Z = 5\ \text{V}$	$25^\circ\text{C}$	$\pm 20$			ppm/ $^\circ\text{C}$
	$I_Z = 1\ \text{mA}$ , $V_Z = 5\ \text{V}$	$25^\circ\text{C}$	$\pm 15$			
		Full range	$\pm 150$			
	$I_Z = 100\ \mu\text{A}$ , $V_Z = 5\ \text{V}$	$25^\circ\text{C}$	$\pm 15$			
$Z_Z$ Reverse dynamic impedance	$I_Z = 1\ \text{mA}$ , $f = 120\ \text{Hz}$ , $I_{AC} = 0.1\ I_Z$ , $V_Z = V_{REF}$	$25^\circ\text{C}$	0.3			$\Omega$
	$I_Z = 1\ \text{mA}$ , $f = 120\ \text{Hz}$ , $I_{AC} = 0.1\ I_Z$ , $V_Z = 10\ \text{V}$	$25^\circ\text{C}$	2			
$e_N$ Wideband noise	$I_Z = 100\ \mu\text{A}$ , $V_Z = V_{REF}$ , $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$	$25^\circ\text{C}$	20			$\mu\text{V}_{\text{RMS}}$
Long-term stability of reverse breakdown voltage	$t = 1000\ \text{h}$ , $T_A = 25^\circ\text{C} \pm 0.1^\circ\text{C}$ , $I_Z = 100\ \mu\text{A}$	$25^\circ\text{C}$	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  $125^\circ\text{C}$  (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 <sup>(1)</sup>	$I_Z = 100\ \mu\text{A}$ , $V_Z = 5\ \text{V}$	25°C			-6.2	6.2		mV
			Full range			-18	18		
$I_{Z,min}$	Minimum cathode current		25°C			45	75		$\mu\text{A}$
			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			
$\alpha V_{REF}$	Average temperature coefficient of reference voltage <sup>(1)</sup>	$I_Z = 10\ \text{mA}$ , $V_Z = 5\ \text{V}$	25°C			$\pm 20$			ppm/°C
		$I_Z = 1\ \text{mA}$ , $V_Z = 5\ \text{V}$	25°C			$\pm 15$			
			Full range			$\pm 100$			
		$I_Z = 100\ \mu\text{A}$ , $V_Z = 5\ \text{V}$	25°C			$\pm 15$			
$Z_Z$	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			$\Omega$
		$I_Z = 1\ \text{mA}$ , $f = 120\ \text{Hz}$ , $I_{AC} = 0.1\ I_Z$ , $V_Z = 10\ \text{V}$	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			$\mu\text{V}_{RMS}$
	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

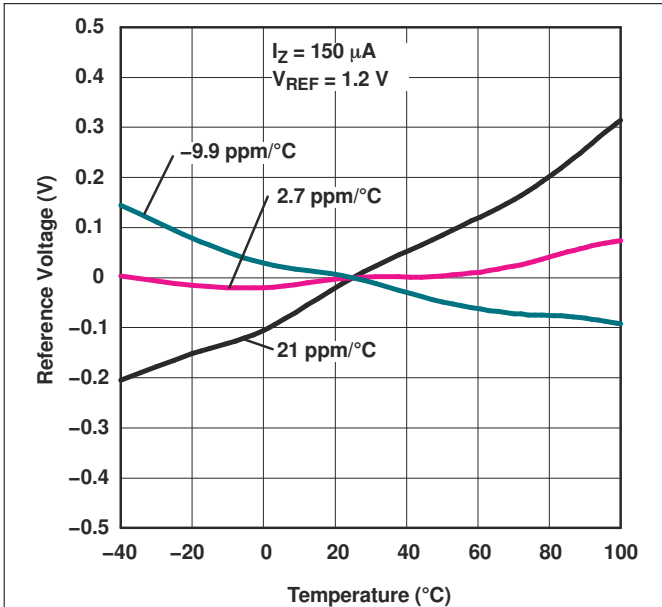


图 13-1. Temperature Drift for Different Average Temperature Coefficients

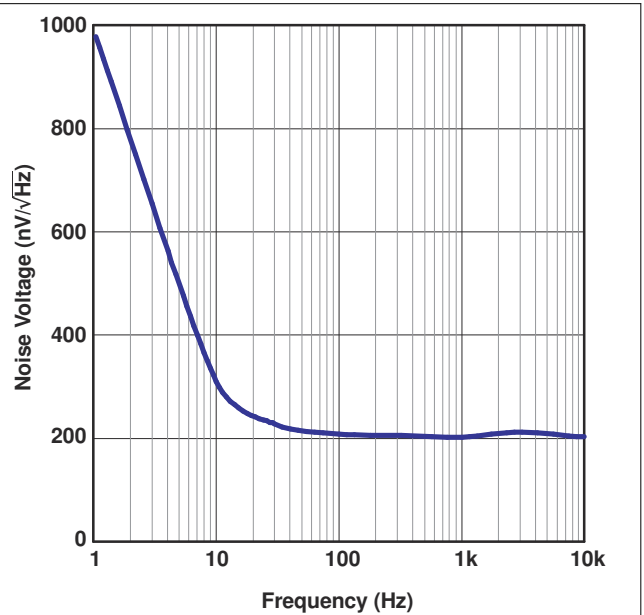


图 13-2. Noise Voltage vs Frequency

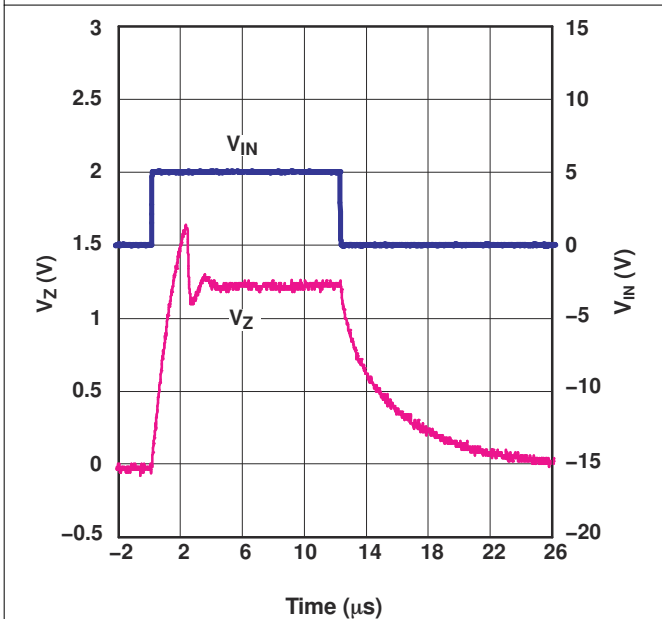


图 13-3. Start-Up Characteristics

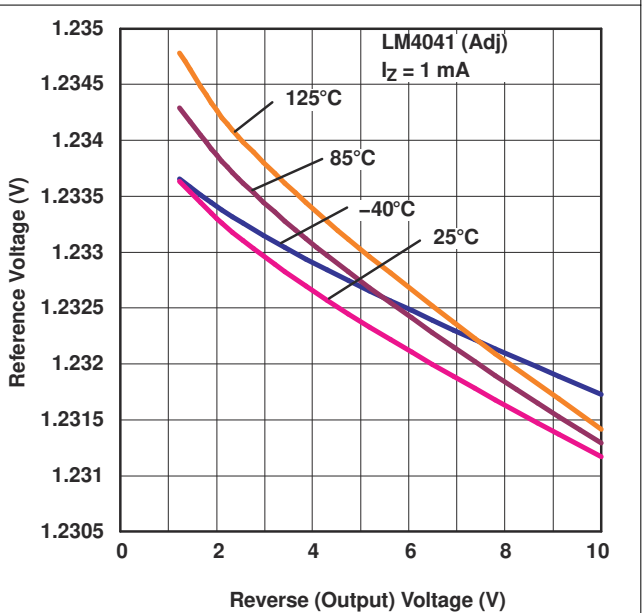


图 13-4. Reference Voltage vs Reverse (Output) Voltage (for Different Temperatures)

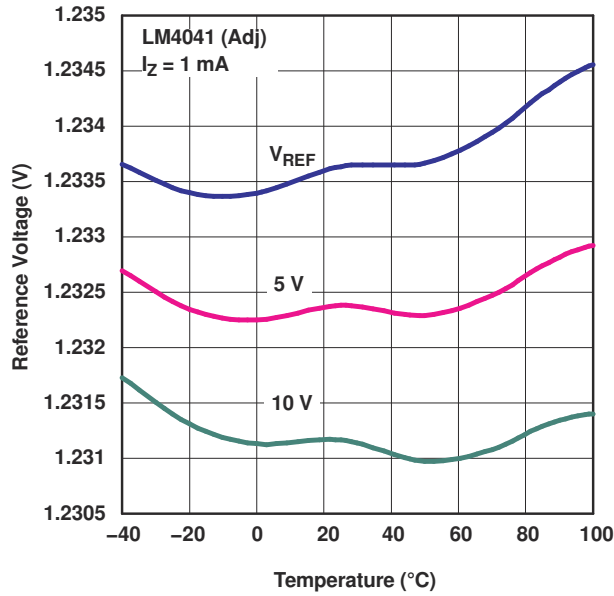


图 13-5. Reference Voltage vs Temperature (for Different Reverse Voltages)

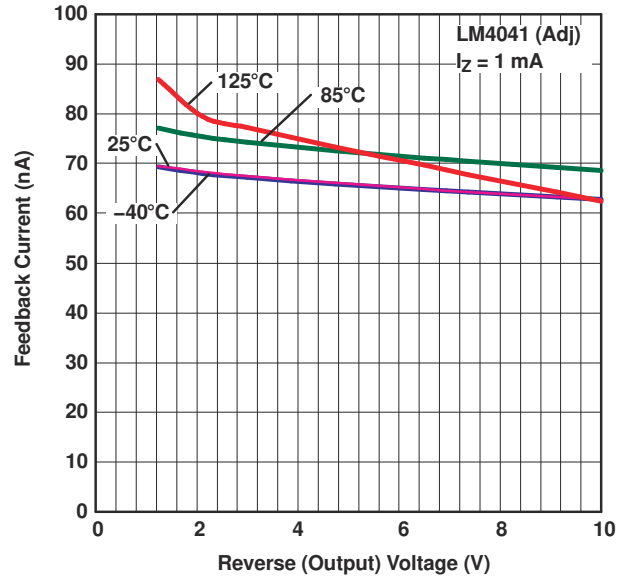


图 13-6. Feedback Current vs Reverse (Output) Voltage (for Different Temperatures)

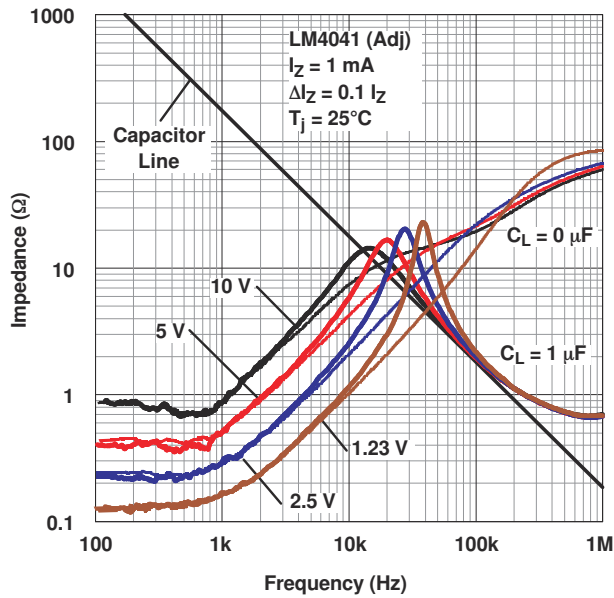


图 13-7. Output Impedance vs Frequency

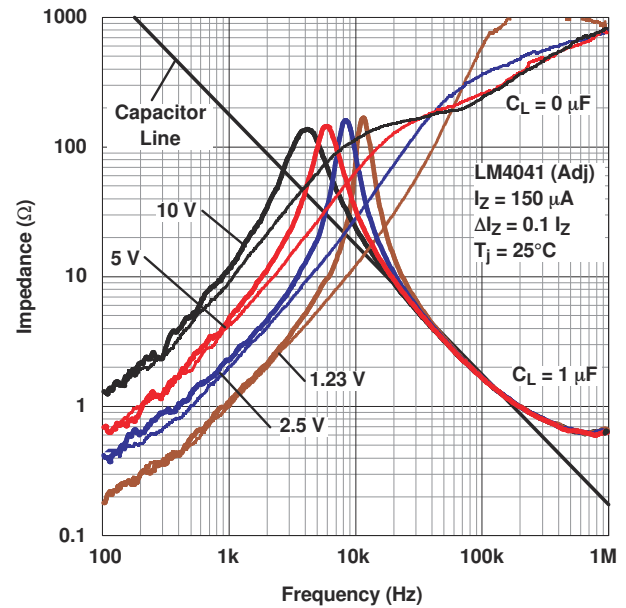


图 13-8. Output Impedance vs Frequency

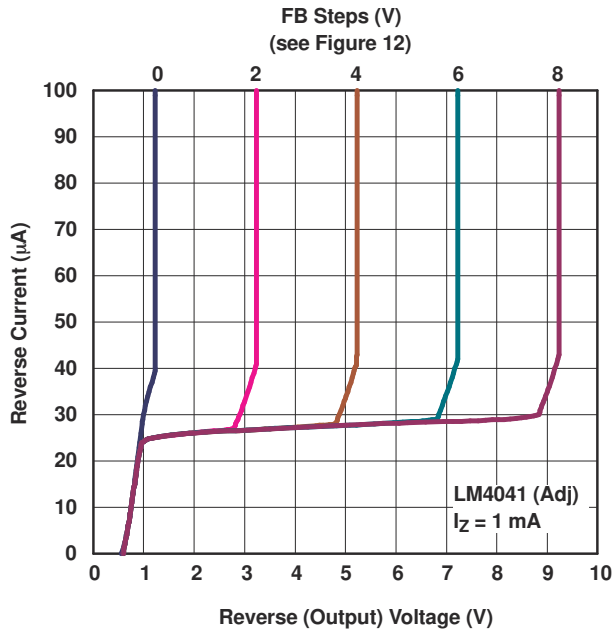


图 13-9. Reverse Characteristics

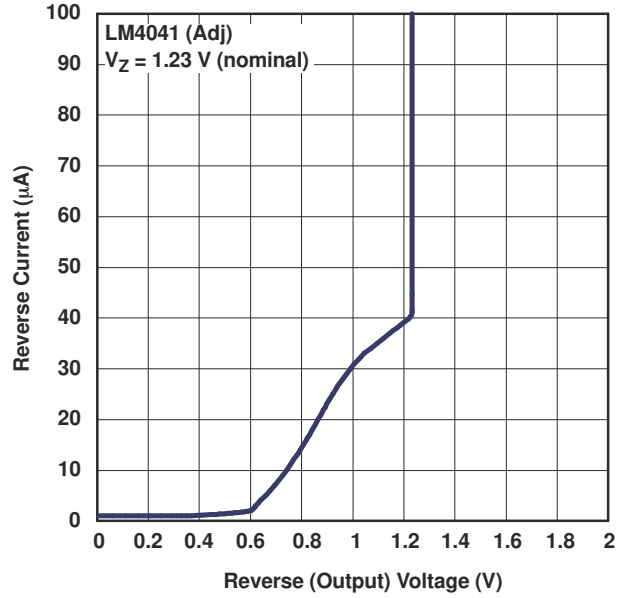


图 13-10. Reverse Characteristics and Minimum Operating Current

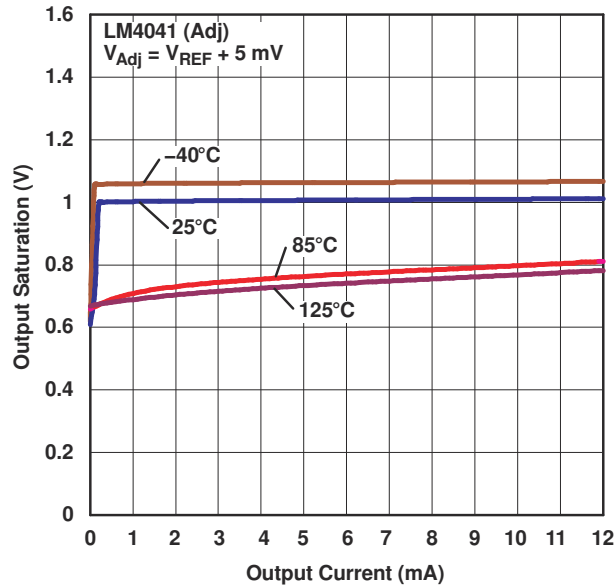


图 13-11. Output Saturation vs Output Current

## 14 Application Information

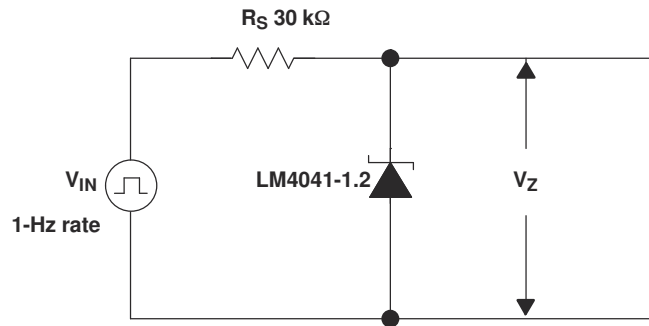


图 14-1. Startup Characteristics Test Circuit

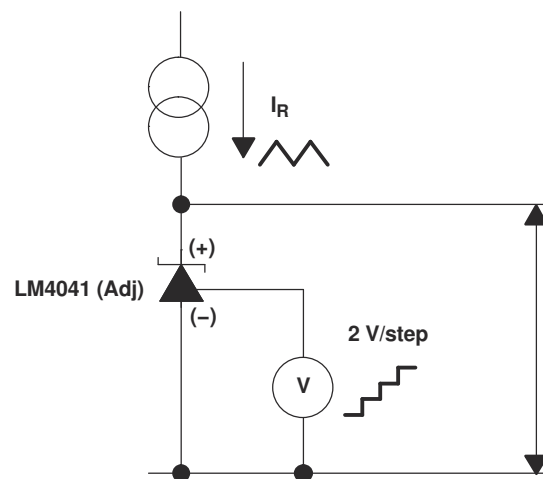


图 14-2. Reverse Characteristics Test Circuit

### 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 图 14-3.

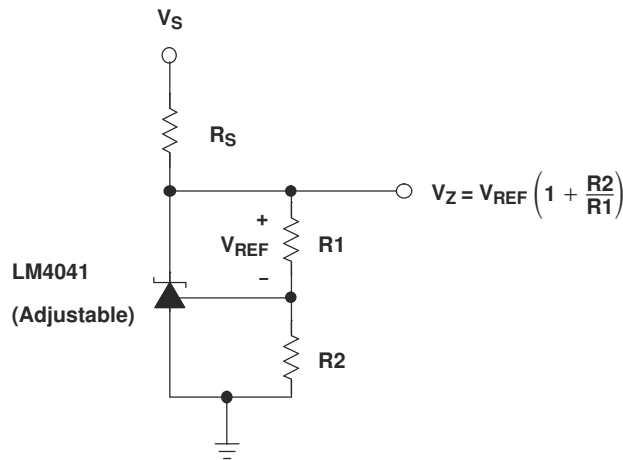


图 14-3. Adjustable Shunt Regulator

### 14.4 Cathode and Load Currents

In a typical shunt regulator configuration (see 图 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 方程式 1.

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

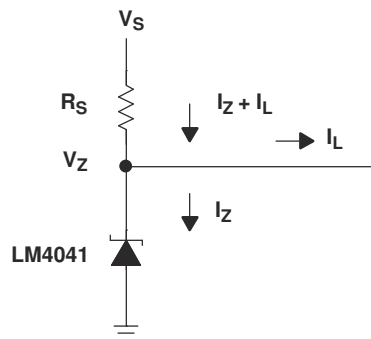


图 14-4. Shunt Regulator

## 15 Revision History

注：以前版本的页码可能与当前版本的页码不同

<b>Changes from Revision E (February 2006) to Revision F (September 2020)</b>	<b>Page</b>
• 更新了整个文档的表、图和交叉参考的编号格式。.....	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)	<a href="#">Samples</a>
LM4041A12IDBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4MK3, 4MKU)	<a href="#">Samples</a>
LM4041A12IDCKR	ACTIVE	SC70	DCK	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MKU	<a href="#">Samples</a>
LM4041B12IDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4ML3, 4MLU)	<a href="#">Samples</a>
LM4041B12IDBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4ML3, 4MLU)	<a href="#">Samples</a>
LM4041B12IDCKR	ACTIVE	SC70	DCK	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MLU	<a href="#">Samples</a>
LM4041BIDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4MG3, 4MGU)	<a href="#">Samples</a>
LM4041BIDBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4MG3, 4MGU)	<a href="#">Samples</a>
LM4041BIDCKR	ACTIVE	SC70	DCK	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MGU	<a href="#">Samples</a>
LM4041BIDCKT	ACTIVE	SC70	DCK	5	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MGU	<a href="#">Samples</a>
LM4041C12IDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4MM3, 4MMU)	<a href="#">Samples</a>
LM4041C12IDBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4MM3, 4MMU)	<a href="#">Samples</a>
LM4041C12IDCKR	ACTIVE	SC70	DCK	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MMU	<a href="#">Samples</a>
LM4041C12IDCKRE4	ACTIVE	SC70	DCK	5	3000	TBD	Call TI	Call TI	-40 to 85		<a href="#">Samples</a>
LM4041C12IDCKRG4	ACTIVE	SC70	DCK	5	3000	TBD	Call TI	Call TI	-40 to 85		<a href="#">Samples</a>
LM4041C12ILP	ACTIVE	TO-92	LP	3	1000	RoHS & Green	SN	N / A for Pkg Type	-40 to 85	NPC12I	<a href="#">Samples</a>
LM4041C12ILPR	ACTIVE	TO-92	LP	3	2000	RoHS & Green	SN	N / A for Pkg Type	-40 to 85	NPC12I	<a href="#">Samples</a>
LM4041C12QDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	(4MS3, 4MSU)	<a href="#">Samples</a>
LM4041C12QDBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	(4MS3, 4MSU)	<a href="#">Samples</a>
LM4041CIDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4MH3, 4MHU)	<a href="#">Samples</a>



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)	<a href="#">Samples</a>
LM4041CIDCKR	ACTIVE	SC70	DCK	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MHU	<a href="#">Samples</a>
LM4041CIDCKT	ACTIVE	SC70	DCK	5	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MHU	<a href="#">Samples</a>
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	<a href="#">Samples</a>
LM4041CQDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	(4MP3, 4MPU)	<a href="#">Samples</a>
LM4041CQDBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	(4MP3, 4MPU)	<a href="#">Samples</a>
LM4041D12IDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4MN3, 4MNU)	<a href="#">Samples</a>
LM4041D12IDBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4MN3, 4MNU)	<a href="#">Samples</a>
LM4041D12IDCKR	ACTIVE	SC70	DCK	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MNU	<a href="#">Samples</a>
LM4041D12ILP	ACTIVE	TO-92	LP	3	1000	RoHS & Green	SN	N / A for Pkg Type	-40 to 85	NPD12I	<a href="#">Samples</a>
LM4041D12ILPE3	ACTIVE	TO-92	LP	3	1000	TBD	Call TI	Call TI	-40 to 85		<a href="#">Samples</a>
LM4041D12ILPR	ACTIVE	TO-92	LP	3	2000	RoHS & Green	SN	N / A for Pkg Type	-40 to 85	NPD12I	<a href="#">Samples</a>
LM4041D12QDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	(4MT3, 4MTU)	<a href="#">Samples</a>
LM4041DIDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4MJ3, 4MJU)	<a href="#">Samples</a>
LM4041DIDBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(4MJ3, 4MJU)	<a href="#">Samples</a>
LM4041DIDCKR	ACTIVE	SC70	DCK	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MJU	<a href="#">Samples</a>
LM4041DILPR	ACTIVE	TO-92	LP	3	2000	RoHS & Green	SN	N / A for Pkg Type	-40 to 85	NPDI	<a href="#">Samples</a>
LM4041DQDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	(4MR3, 4MRU)	<a href="#">Samples</a>
LM4041DQDBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	(4MR3, 4MRU)	<a href="#">Samples</a>

(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.

<sup>(2)</sup> **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  $\leq 1000$ ppm threshold. Antimony trioxide based flame retardants must also meet the  $\leq 1000$ ppm threshold requirement.

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

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

<sup>(5)</sup> 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.

<sup>(6)</sup> 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	3000	179.0	8.4	3.15	2.95	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
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
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	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
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	178.0	9.2	3.15	2.77	1.22	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
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	178.0	9.2	3.15	2.77	1.22	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
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	200.0	183.0	25.0
LM4041BIDBZT	SOT-23	DBZ	3	250	180.0	180.0	18.0
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	180.0	180.0	18.0
LM4041CIDBZT	SOT-23	DBZ	3	250	203.0	203.0	35.0
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	180.0	180.0	18.0
LM4041DIDBZR	SOT-23	DBZ	3	3000	200.0	183.0	25.0
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	180.0	180.0	18.0
LM4041DQDBZR	SOT-23	DBZ	3	3000	200.0	183.0	25.0
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

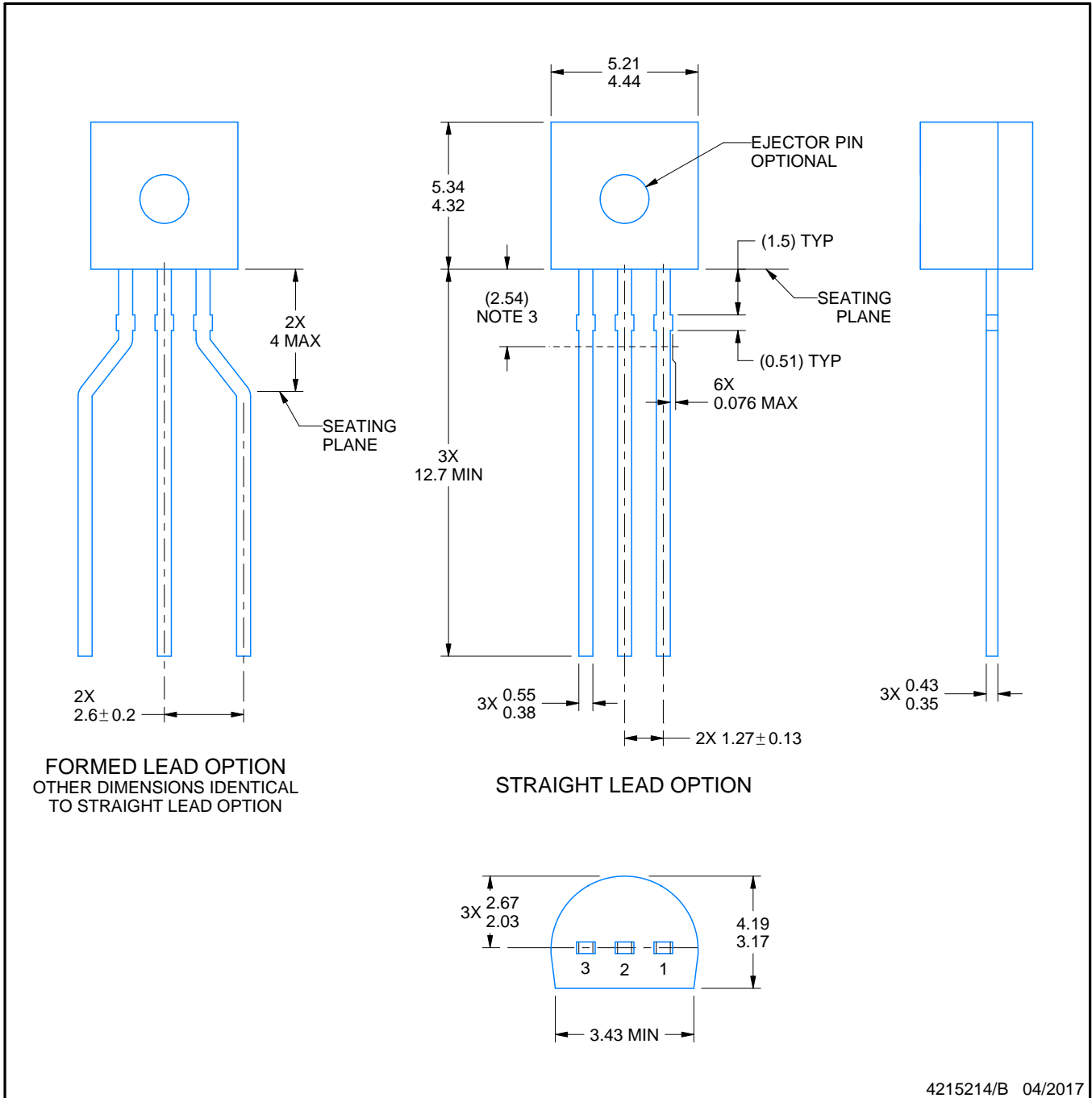
LP0003A



PACKAGE OUTLINE

TO-92 - 5.34 mm max height

TO-92

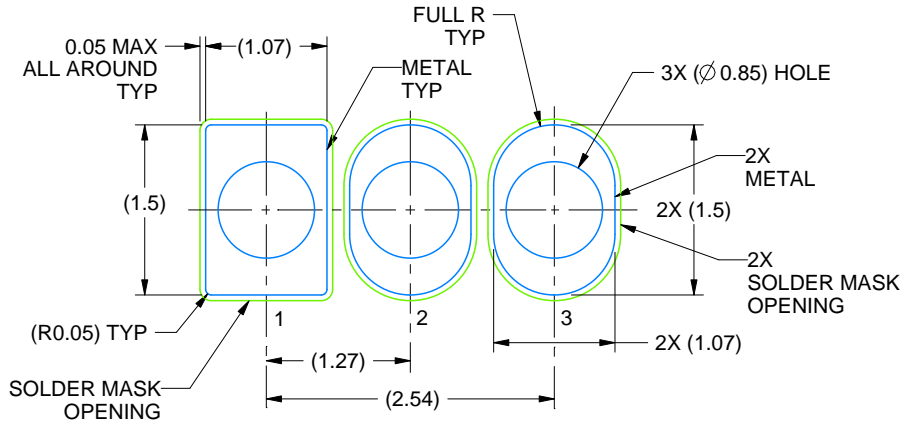


4215214/B 04/2017

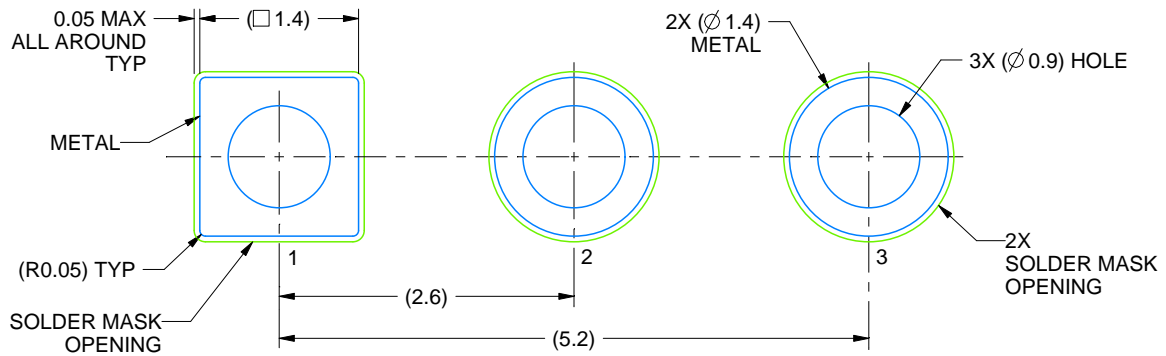
NOTES:

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.





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



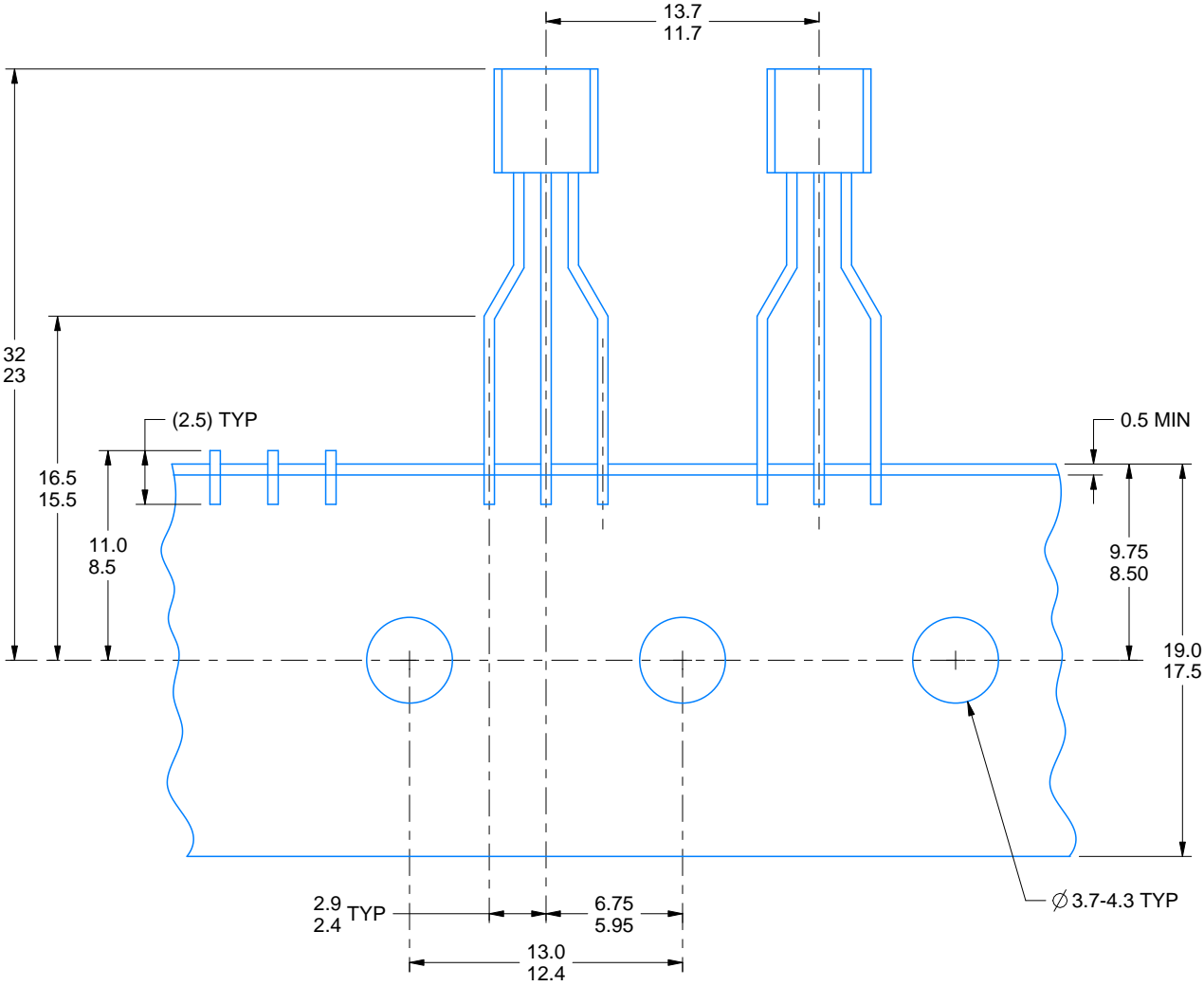
LAND PATTERN EXAMPLE  
FORMED LEAD OPTION  
NON-SOLDER MASK DEFINED  
SCALE:15X

**TAPE SPECIFICATIONS**

**LP0003A**

**TO-92 - 5.34 mm max height**

TO-92



FOR FORMED LEAD OPTION PACKAGE

4215214/B 04/2017

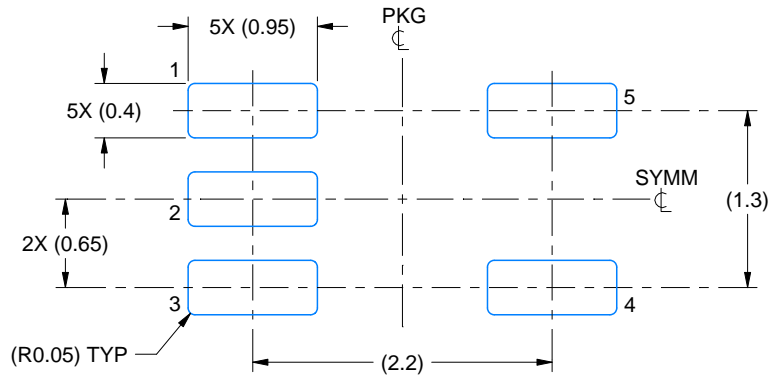


# EXAMPLE BOARD LAYOUT

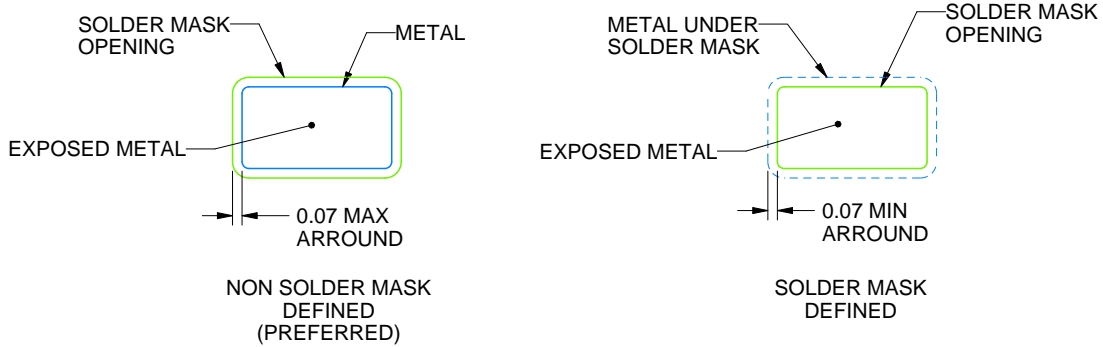
DCK0005A

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:18X



SOLDER MASK DETAILS

4214834/E 06/2024

NOTES: (continued)

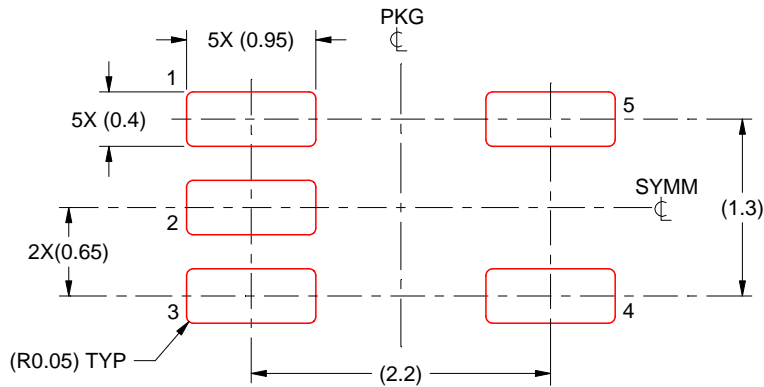
7. Publication IPC-7351 may have alternate designs.
8. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

DCK0005A

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



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

4214834/E 06/2024

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.

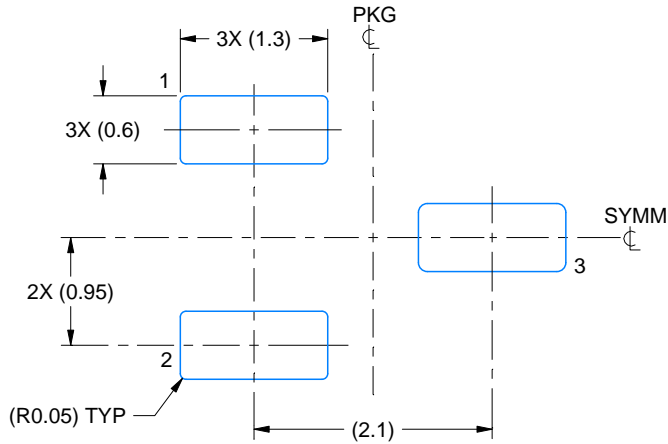


# EXAMPLE BOARD LAYOUT

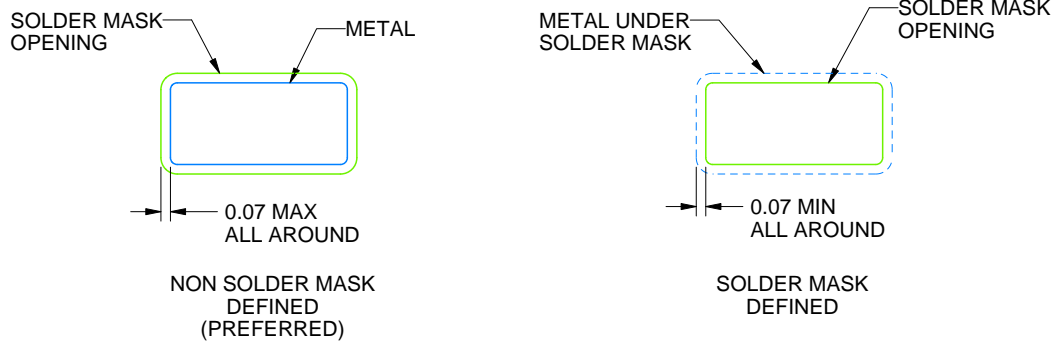
DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE  
SCALE:15X



SOLDER MASK DETAILS

4214838/E 06/2024

NOTES: (continued)

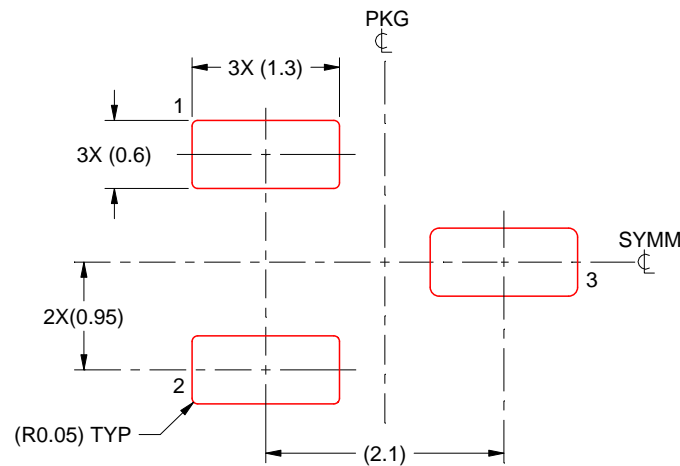
- 5. Publication IPC-7351 may have alternate designs.
- 6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# 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

4214838/E 06/2024

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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