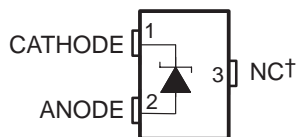


# LM4041 PRECISION MICROPOWER SHUNT VOLTAGE REFERENCE

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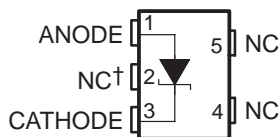
- **1.225-V Fixed and Adjustable Outputs (1.225 V to 10 V)**
- **Tight Output Tolerances and Low Temperature Coefficient**
  - Max 0.1%, 100 ppm/°C – A Grade
  - Max 0.2%, 100 ppm/°C – B Grade
  - Max 0.5%, 100 ppm/°C – C Grade
  - Max 1.0%, 150 ppm/°C – D Grade
- **Low Output Noise . . . 20  $\mu$ V<sub>RMS</sub> (Typ)**
- **Wide Operating Current Range . . . 60  $\mu$ A 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
- **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

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



NC – No internal connection  
† This pin is connected internally to ANODE via die substrate; leave open or connect to ANODE.

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



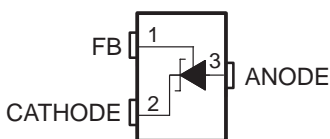
NC – No internal connection  
† This pin is connected internally to ANODE via die substrate; leave open or connect to ANODE.

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

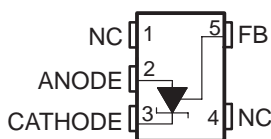


NC – No internal connection

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

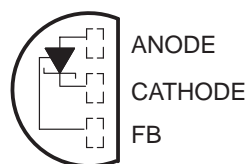


Adjustable . . . DCK (SC-70) PACKAGE  
(TOP VIEW)



NC – No internal connection

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



## description/ordering information

The LM4041 series of shunt voltage references are versatile, easy-to-use references with a vast array of applications. They require no external resistors or 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 operating from a minimum current of 60 to 100  $\mu$ A, the LM4041 also is ideal for portable applications. The TO-92 package also is available for through-hole packaging needs. The LM4041xI 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.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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# LM4041

## PRECISION MICROPOWER SHUNT VOLTAGE REFERENCE

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### ORDERING INFORMATION

T <sub>A</sub>	DEVICE GRADE	V <sub>Z</sub>	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	<u>A grade:</u> 0.1% initial accuracy and 100 ppm/°C temperature coefficient	1.2 V	SC-70 (DCK)	Reel of 3000	LM4041A12IDCKR	
				Reel of 3000	LM4041A12IDBZR	
			SOT-23-3 (DBZ)	Reel of 250	LM4041A12IDBZT	
				Bulk of 1000	LM4041A12ILP	
			TO-92/TO-226 (LP)	Reel of 2000	LM4041A12ILPR	
	<u>B grade:</u> 0.2% initial accuracy and 100 ppm/°C temperature coefficient	ADJ	SC-70 (DCK)	Reel of 3000	LM4041BIDCKR	
				Reel of 3000	LM4041BIDBZR	
			SOT-23-3 (DBZ)	Reel of 250	LM4041BIDBZT	
				Bulk of 1000	LM4041BILP	
			TO-92/TO-226 (LP)	Reel of 2000	LM4041BILPR	
		1.2 V	SC-70 (DCK)	Reel of 3000	LM4041B12IDCKR	
				Reel of 3000	LM4041B12IDBZR	
			SOT-23-3 (DBZ)	Reel of 250	LM4041B12IDBZT	
				Bulk of 1000	LM4041B12ILP	
			TO-92/TO-226 (LP)	Reel of 2000	LM4041B12ILPR	
	<u>C grade:</u> 0.5% initial accuracy and 100 ppm/°C temperature coefficient	ADJ	SC-70 (DCK)	Reel of 3000	LM4041CIDCKR	
				Reel of 3000	LM4041CIDBZR	
			SOT-23-3 (DBZ)	Reel of 250	LM4041CIDBZT	
				Bulk of 1000	LM4041CILP	
			TO-92/TO-226 (LP)	Reel of 2000	LM4041CILPR	
		1.2 V	SC-70 (DCK)	Reel of 3000	LM4041C12IDCKR	
				Reel of 3000	LM4041C12IDBZR	
			SOT-23-3 (DBZ)	Reel of 250	LM4041C12IDBZT	
				Bulk of 1000	LM4041C12ILP	
			TO-92/TO-226 (LP)	Reel of 2000	LM4041C12ILPR	

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).

# LM4041

## PRECISION MICROPOWER SHUNT VOLTAGE REFERENCE

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### ORDERING INFORMATION

T <sub>A</sub>	DEVICE GRADE	V <sub>Z</sub>	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	<u>D grade:</u> 1.0% initial accuracy and 150 ppm/°C temperature coefficient	ADJ	SC-70 (DCK)	Reel of 3000	LM4041DIDCKR	
			SOT-23-3 (DBZ)	Reel of 3000	LM4041DIDBZR	
				Reel of 250	LM4041DIDBZT	
			TO-92/TO-226 (LP)	Bulk of 1000	LM4041DILP	
				Reel of 2000	LM4041DILPR	
		1.2 V	SC-70 (DCK)	Reel of 3000	LM4041D12IDCKR	
			SOT-23-3 (DBZ)	Reel of 3000	LM4041D12IDBZR	
				Reel of 250	LM4041D12IDBZT	
			TO-92/TO-226 (LP)	Bulk of 1000	LM4041D12ILP	
				Reel of 2000	LM4041D12ILPR	
–40°C to 125°C	<u>C grade:</u> 0.5% initial accuracy and 100 ppm/°C temperature coefficient	ADJ	SOT-23-3 (DBZ)	Reel of 3000	LM4041CQDBZR	
				Reel of 250	LM4041CQDBZT	
		1.2 V	SOT-23-3 (DBZ)	Reel of 3000	LM4041C12QDBZR	
				Reel of 250	LM4041C12QDBZT	
	<u>D grade:</u> 1.0% initial accuracy and 150 ppm/°C temperature coefficient	ADJ	SOT-23-3 (DBZ)	Reel of 3000	LM4041DQDBZR	
				Reel of 250	LM4041DQDBZT	
		1.2 V	SOT-23-3 (DBZ)	Reel of 3000	LM4041D12QDBZR	
				Reel of 250	LM4041D12QDBZT	

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).

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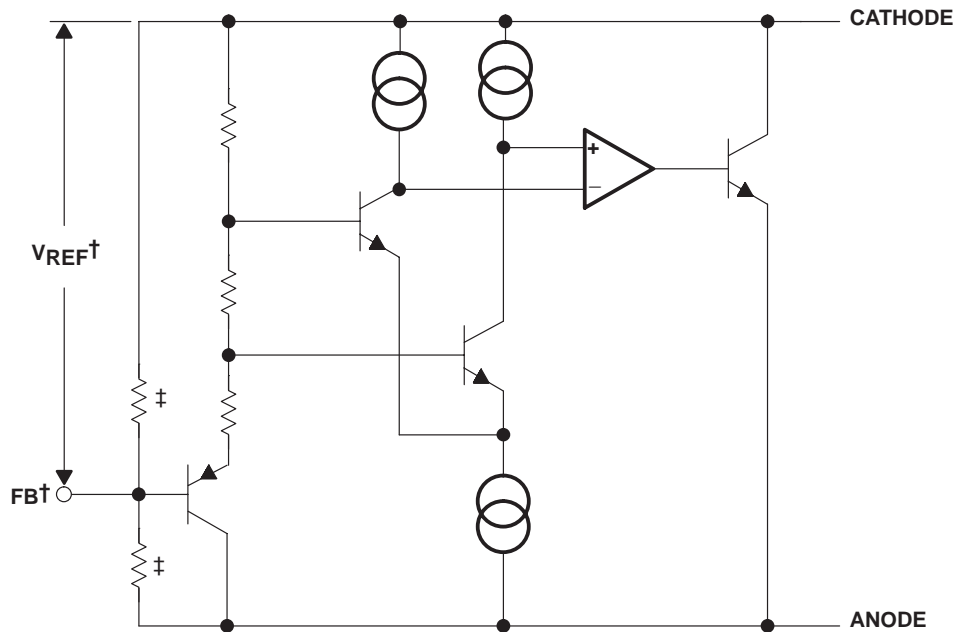


# LM4041

## PRECISION MICROPOWER SHUNT VOLTAGE REFERENCE

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### functional block diagram



† LM4041x (ADJ) only  
‡ LM4041x12 only

### absolute maximum ratings over the free-air temperature range (unless otherwise noted)†

Continuous cathode voltage, $V_Z$	15 V
Continuous cathode current, $I_Z$	–10 mA to 25 mA
Package thermal impedance, $\theta_{JA}$ (see Notes 1 and 2): DBZ package	206°C/W
DCK package	252°C/W
LP package	156°C/W
Operating virtual junction temperature, $T_J$	150°C
Storage temperature range, $T_{stg}$	–65°C to 110°C

† 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.

NOTES: 1. Maximum power dissipation is a function of  $T_J(\text{max})$ ,  $\theta_{JA}$ , 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.  
2. The package thermal impedance is calculated in accordance with JESD 51-7.

### recommended operating conditions

			MIN	MAX	UNIT
I <sub>Z</sub>	Cathode current		‡	12	mA
V <sub>Z</sub>	Reverse breakdown voltage (adjustable version)			10	V
T <sub>A</sub>	Free-air temperature range	LM4041 (I temperature)	−40	85	°C
		LM4041 (Q temperature)	−40	125	

‡ See parametric tables

# LM4041

## PRECISION MICROPOWER SHUNT VOLTAGE REFERENCE

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**LM4041x12I electrical characteristics, full-range  $T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$  (unless otherwise noted)**

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

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# LM4041

## PRECISION MICROPPOWER SHUNT VOLTAGE REFERENCE

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LM4041x12I electrical characteristics, full-range  $T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T <sub>A</sub>	LM4041C12I			LM4041D12I			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V <sub>Z</sub>	Reverse breakdown voltage	I <sub>Z</sub> = 100 μA	25°C	1.225			1.225			V
	Reverse breakdown voltage tolerance	I <sub>Z</sub> = 100 μA	25°C	−6		6	−12		12	mV
			Full range	−14		14	−24		24	
I <sub>Z,min</sub>	Minimum cathode current		25°C	45		75	45		75	μA
			Full range			80			80	
α <sub>VZ</sub>	Average temperature coefficient of reverse breakdown voltage	I <sub>Z</sub> = 10 mA	25°C	±20			±20			ppm/°C
		I <sub>Z</sub> = 1 mA	25°C	±15			±15			
			Full range			±100			±150	
		I <sub>L</sub> = 100 μA	25°C	±15			±15			
ΔV <sub>Z</sub> /ΔI <sub>Z</sub>	Reverse breakdown voltage change with cathode current change	I <sub>Z,min</sub> < I <sub>Z</sub> < 1 mA	25°C	0.7		1.5	0.7		2	mV
			Full range			2			2.5	
		1 mA < I <sub>Z</sub> < 12 mA	25°C	2.5		6	2.5		8	
			Full range			8			10	
Z <sub>Z</sub>	Reverse dynamic impedance	I <sub>Z</sub> = 1 mA, f = 120 Hz, I <sub>AC</sub> = 0.1 I <sub>Z</sub>	25°C	0.5		1.5	0.5		2	Ω
e <sub>N</sub>	Wideband noise	I <sub>Z</sub> = 100 μA, 10 Hz ≤ f ≤ 10 kHz	25°C	20			20			μV <sub>RMS</sub>
	Long-term stability of reverse breakdown voltage	t = 1000 h, T <sub>A</sub> = 25°C ± 0.1°C, I <sub>Z</sub> = 100 μA	25°C	120			120			ppm

# LM4041

## PRECISION MICROPOWER SHUNT VOLTAGE REFERENCE

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**LM4041x12Q electrical characteristics full-range  $T_A = -40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$  (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	T <sub>A</sub>	LM4041C12Q			LM4041D12Q			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V <sub>Z</sub>	Reverse breakdown voltage	I <sub>Z</sub> = 100 μA	25°C	1.225			1.225			V
	Reverse breakdown voltage tolerance	I <sub>Z</sub> = 100 μA	25°C	−6		6	−12		12	mV
			Full range	−18.4		18.4	−31		31	
I <sub>Z,min</sub>	Minimum cathode current		25°C	45		75	45		75	μA
			Full range			80			80	
α <sub>VZ</sub>	Average temperature coefficient of reverse breakdown voltage	I <sub>Z</sub> = 10 mA	25°C	±20			±20			ppm/°C
		I <sub>Z</sub> = 1 mA	25°C	±15			±15			
				Full range			±100			
			I <sub>L</sub> = 100 μA	25°C	±15			±15		
ΔV <sub>Z</sub> /ΔI <sub>Z</sub>	Reverse breakdown voltage change with cathode current change	I <sub>Z,min</sub> < I <sub>Z</sub> < 1 mA	25°C	0.7		1.5	0.7		2	mV
			Full range			2			2.5	
		1 mA < I <sub>Z</sub> < 12 mA	25°C	2.5		6	2.5		8	
			Full range			8			10	
Z <sub>Z</sub>	Reverse dynamic impedance	I <sub>Z</sub> = 1 mA, f = 120 Hz, I <sub>AC</sub> = 0.1 I <sub>Z</sub>	25°C	0.5			0.5			Ω
			Full range			1.5			2	
e <sub>N</sub>	Wideband noise	I <sub>Z</sub> = 100 μA, 10 Hz ≤ f ≤ 10 kHz	25°C	20			20			μVRMS
	Long-term stability of reverse breakdown voltage	t = 1000 h, T <sub>A</sub> = 25°C ± 0.1°C, I <sub>Z</sub> = 100 μA	25°C	120			120			ppm

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# LM4041

## PRECISION MICROPOWER SHUNT VOLTAGE REFERENCE

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**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 <sub>A</sub>	LM4041B			LM4041C			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V <sub>REF</sub>	Reference voltage	I <sub>Z</sub> = 100 μA, V <sub>Z</sub> = 5 V	25°C	1.233			1.233			V
	Reference voltage tolerance (see Note 3)	I <sub>Z</sub> = 100 μA, V <sub>Z</sub> = 5 V	25°C	−2.5      2.5			−6.2      6.2			mV
			Full range	−10.5      10.5			−14      14			
I <sub>Z,min</sub>	Minimum cathode current		25°C	45      75			45      75			μA
			Full range	80			80			
ΔV <sub>REF</sub> /ΔI <sub>Z</sub>	Reference voltage change with cathode current change	I <sub>Z,min</sub> < I <sub>Z</sub> < 1 mA (see Note 4) SOT-23-3: V <sub>Z</sub> ≥ 1.6 V	25°C	0.7      1.5			0.7      1.5			mV
			Full range	2			2			
		1 mA < I <sub>Z</sub> < 12 mA (see Note 4) SOT-23-3: V <sub>Z</sub> = V <sub>REF</sub>	25°C	2      4			2      4			
			Full range	6			6			
ΔV <sub>REF</sub> /ΔV <sub>KA</sub>	Reference voltage change with output voltage change	I <sub>Z</sub> = 1 mA	25°C	−1.55      −2			−1.55      −2			mV/V
			Full range	−2.5			−2.5			
I <sub>FB</sub>	Feedback current		25°C	60      100			60      100			nA
			Full range	120			120			
αV <sub>REF</sub>	Average temperature coefficient of reference voltage (see Note 3)	I <sub>Z</sub> = 10 mA, V <sub>Z</sub> = 5 V	25°C	±20			±20			ppm/°C
		I <sub>Z</sub> = 1 mA, V <sub>Z</sub> = 5 V	25°C	±15			±15			
			Full range	±100			±100			
		I <sub>L</sub> = 100 μA, V <sub>Z</sub> = 5 V	25°C	±15			±15			
Z <sub>Z</sub>	Reverse dynamic impedance	I <sub>Z</sub> = 1 mA, f = 120 Hz, I <sub>AC</sub> = 0.1 I <sub>Z</sub> , V <sub>Z</sub> = V <sub>REF</sub>	25°C	0.3			0.3			Ω
		I <sub>Z</sub> = 1 mA, f = 120 Hz, I <sub>AC</sub> = 0.1 I <sub>Z</sub> , V <sub>Z</sub> = 10 V	25°C	2			2			
e <sub>N</sub>	Wideband noise	I <sub>Z</sub> = 100 μA, V <sub>Z</sub> = V <sub>REF</sub> , 10 Hz ≤ f ≤ 10 kHz	25°C	20			20			μV <sub>RMS</sub>
	Long-term stability of reverse breakdown voltage	t = 1000 h, T <sub>A</sub> = 25°C ± 0.1°C, I <sub>Z</sub> = 100 μA	25°C	120			120			ppm

NOTES: 3. Reference Voltage Tolerance and Average Temperature Coefficient will change with output voltage ( $V_Z$ ). See Performance Curves.  
4. For  $V_Z \leq 1.6\ \text{V}$ , the LM4041 (adjustable) must operate with reduced  $I_Z$  in the SOT-23-3 package due to the series resistance of the die attach between the die anode output and the package anode pin (Pin 3). See Figure 9, Output Saturation (SOT-23-3 Only) in typical performance characteristics.



# LM4041

## PRECISION MICROPOWER SHUNT VOLTAGE REFERENCE

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**LM4041xl (adjustable version) electrical characteristics, full-range  $T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$  (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	$T_A$	LM4041D			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 (see Note 3)	$I_Z = 100\ \mu\text{A}$ , $V_Z = 5\ \text{V}$	$25^{\circ}\text{C}$	-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	$I_{Z,\text{min}} < I_Z < 1\ \text{mA}$ (see Note 4) SOT-23-3: $V_Z \geq 1.6\ \text{V}$	$25^{\circ}\text{C}$		0.7	2	mV
		Full range			2.5	
	$1\ \text{mA} < I_Z < 12\ \text{mA}$ (see Note 4) SOT-23-3: $V_Z = V_{REF}$	$25^{\circ}\text{C}$		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		-2.5	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 (see Note 3)	$I_Z = 10\ \text{mA}$ , $V_Z = 5\ \text{V}$	$25^{\circ}\text{C}$		$\pm 20$		ppm/ $^{\circ}\text{C}$
	$I_Z = 1\ \text{mA}$ , $V_Z = 5\ \text{V}$	$25^{\circ}\text{C}$		$\pm 15$		
		Full range			$\pm 150$	
	$I_L = 100\ \mu\text{A}$ , $V_Z = 5\ \text{V}$	$25^{\circ}\text{C}$		$\pm 15$		
$Z_Z$ 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		$\mu\text{VRMS}$
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

- NOTES: 3. Reference Voltage Tolerance and Average Temperature Coefficient will change with output voltage ( $V_Z$ ). See Performance Curves.  
4. For  $V_Z \leq 1.6\ \text{V}$ , the LM4041 (adjustable) must operate with reduced  $I_Z$  in the SOT-23-3 package due to the series resistance of the die attach between the die anode output and the package anode pin (Pin 3). See Figure 9, Output Saturation (SOT-23-3 Only) in *typical performance characteristics*.

PRODUCT PREVIEW



# LM4041

## PRECISION MICROPOWER SHUNT VOLTAGE REFERENCE

SLCS146A – FEBRUARY 2005 – REVISED FEBRUARY 2005

**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 <sub>A</sub>	LM4041C			LM4041D			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V <sub>REF</sub>	Reference voltage	I <sub>Z</sub> = 100 μA, V <sub>Z</sub> = 5 V	25°C	1.233			1.233			V
	Reference voltage tolerance (see Note 3)	I <sub>Z</sub> = 100 μA, V <sub>Z</sub> = 5 V	25°C	−6.2		6.2	−12		12	mV
			Full range	−18		18	−30		30	
I <sub>Z,min</sub>	Minimum cathode current		25°C	45		60	45		65	μA
			Full range			68			73	
ΔV <sub>REF</sub> /ΔI <sub>Z</sub>	Reference voltage change with cathode current change	I <sub>Z,min</sub> < I <sub>Z</sub> < 1 mA (see Note 4) SOT-23-3: V <sub>Z</sub> ≥ 1.6 V  1 mA < I <sub>Z</sub> < 12 mA (see Note 4) SOT-23-3: V <sub>Z</sub> = V <sub>REF</sub>	25°C	0.7		1.5	0.7		2	mV
			Full range			2			2.5	
			25°C	2		8	2		10	
			Full range			6			8	
ΔV <sub>REF</sub> /ΔV <sub>KA</sub>	Reference voltage change with output voltage change	I <sub>Z</sub> = 1 mA	25°C	−1.55		−2	−1.55		−2.5	mV/V
			Full range			−3			−4	
I <sub>FB</sub>	Feedback current		25°C	60		100	60		150	nA
			Full range			120			200	
αV <sub>REF</sub>	Average temperature coefficient of reference voltage (see Note 3)	I <sub>Z</sub> = 10 mA, V <sub>Z</sub> = 5 V	25°C	±20			±20			ppm/°C
		I <sub>Z</sub> = 1 mA, V <sub>Z</sub> = 5 V	25°C	±15			±15			
			Full range			±100			±150	
		I <sub>L</sub> = 100 μA, V <sub>Z</sub> = 5 V	25°C	±15			±15			
Z <sub>Z</sub>	Reverse dynamic impedance	I <sub>Z</sub> = 1 mA, f = 120 Hz, I <sub>AC</sub> = 0.1 I <sub>Z</sub> , V <sub>Z</sub> = V <sub>REF</sub>	25°C	0.3			0.3			Ω
		I <sub>Z</sub> = 1 mA, f = 120 Hz, I <sub>AC</sub> = 0.1 I <sub>Z</sub> , V <sub>Z</sub> = 10 V	25°C	2			2			
e <sub>N</sub>	Wideband noise	I <sub>Z</sub> = 100 μA, V <sub>Z</sub> = V <sub>REF</sub> , 10 Hz ≤ f ≤ 10 kHz	25°C	20			20			μV <sub>RMS</sub>
	Long-term stability of reverse breakdown voltage	t = 1000 h, T <sub>A</sub> = 25°C ± 0.1°C, I <sub>Z</sub> = 100 μA	25°C	120			120			ppm

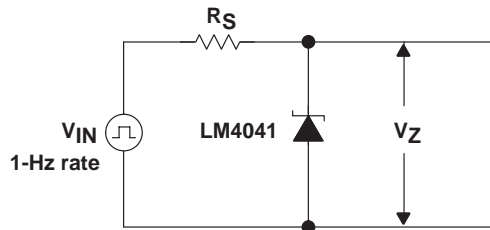
NOTES: 3. Reference Voltage Tolerance and Average Temperature Coefficient will change with output voltage ( $V_Z$ ). See Performance Curves.  
 4. For  $V_Z \leq 1.6\ \text{V}$ , the LM4041 (adjustable) must operate with reduced  $I_Z$  in the SOT-23-3 package due to the series resistance of the die attach between the die anode output and the package anode pin (Pin 3). See Figure 9, Output Saturation (SOT-23-3 Only) in typical performance characteristics.

PRODUCT PREVIEW



## APPLICATION INFORMATION

### start-up characteristics



**Figure 1. Test Circuit**

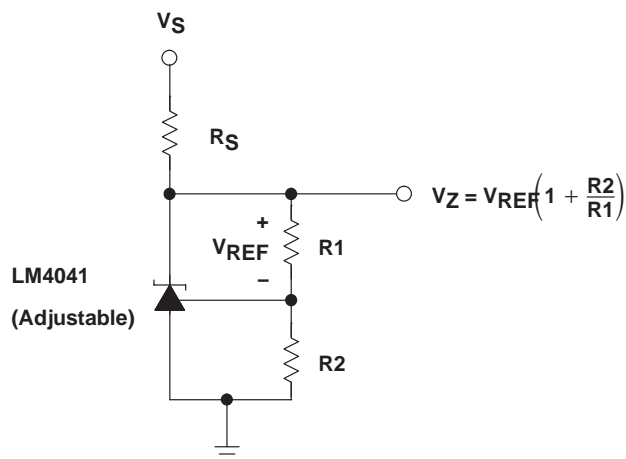
### output capacitor

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.

### 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.

**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 2.



**Figure 2. Adjustable Shunt Regulator**

# LM4041

## PRECISION MICROPOWER SHUNT VOLTAGE REFERENCE

SLCS146A – FEBRUARY 2005 – REVISED FEBRUARY 2005

### APPLICATION INFORMATION

#### cathode and load currents

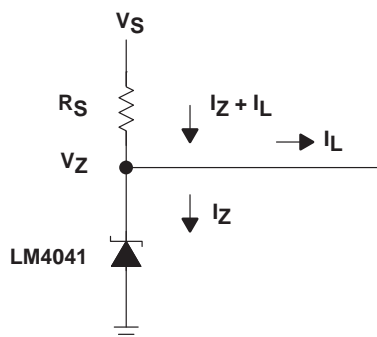


Figure 3. Shunt Regulator

In a typical shunt regulator configuration (see Figure 3), 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 rated value of 20 mA.

$R_S$  is calculated according to the following equation:

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

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
LM4041A12IDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
LM4041A12IDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
LM4041A12IDCKR	PREVIEW	SC70	DCK	5	3000	None	Call TI	Call TI
LM4041A12ILP	PREVIEW	TO-92	LP	3	1000	None	Call TI	Call TI
LM4041AIDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
LM4041AIDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
LM4041AIDCKR	PREVIEW	SC70	DCK	5	3000	None	Call TI	Call TI
LM4041AILP	PREVIEW	TO-92	LP	3	1000	None	Call TI	Call TI
LM4041AILPR	PREVIEW	TO-92	LP	3	2000	None	Call TI	Call TI
LM4041B12IDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
LM4041B12IDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
LM4041B12IDCKR	PREVIEW	SC70	DCK	5	3000	None	Call TI	Call TI
LM4041B12ILP	PREVIEW	TO-92	LP	3	1000	None	Call TI	Call TI
LM4041BIDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
LM4041BIDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
LM4041BIDCKR	PREVIEW	SC70	DCK	5	3000	None	Call TI	Call TI
LM4041BILP	PREVIEW	TO-92	LP	3	1000	None	Call TI	Call TI
LM4041BILPR	PREVIEW	TO-92	LP	3	2000	None	Call TI	Call TI
LM4041C12IDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
LM4041C12IDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
LM4041C12IDCKR	PREVIEW	SC70	DCK	5	3000	None	Call TI	Call TI
LM4041C12ILP	PREVIEW	TO-92	LP	3	1000	None	Call TI	Call TI
LM4041C12QDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
LM4041C12QDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
LM4041CIDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
LM4041CIDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
LM4041CIDCKR	PREVIEW	SC70	DCK	5	3000	None	Call TI	Call TI
LM4041CILP	PREVIEW	TO-92	LP	3	1000	None	Call TI	Call TI
LM4041CILPR	PREVIEW	TO-92	LP	3	2000	None	Call TI	Call TI
LM4041CQDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
LM4041CQDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
LM4041D12IDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
LM4041D12IDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
LM4041D12IDCKR	PREVIEW	SC70	DCK	5	3000	None	Call TI	Call TI
LM4041D12QDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
LM4041D12QDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
LM4041DIDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
LM4041DIDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
LM4041DIDCKR	PREVIEW	SC70	DCK	5	3000	None	Call TI	Call TI
LM4041DILP	PREVIEW	TO-92	LP	3	1000	None	Call TI	Call TI
LM4041DILPR	PREVIEW	TO-92	LP	3	2000	None	Call TI	Call TI
LM4041DQDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
LM4041DQDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

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**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> Eco Plan - May not be currently available - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

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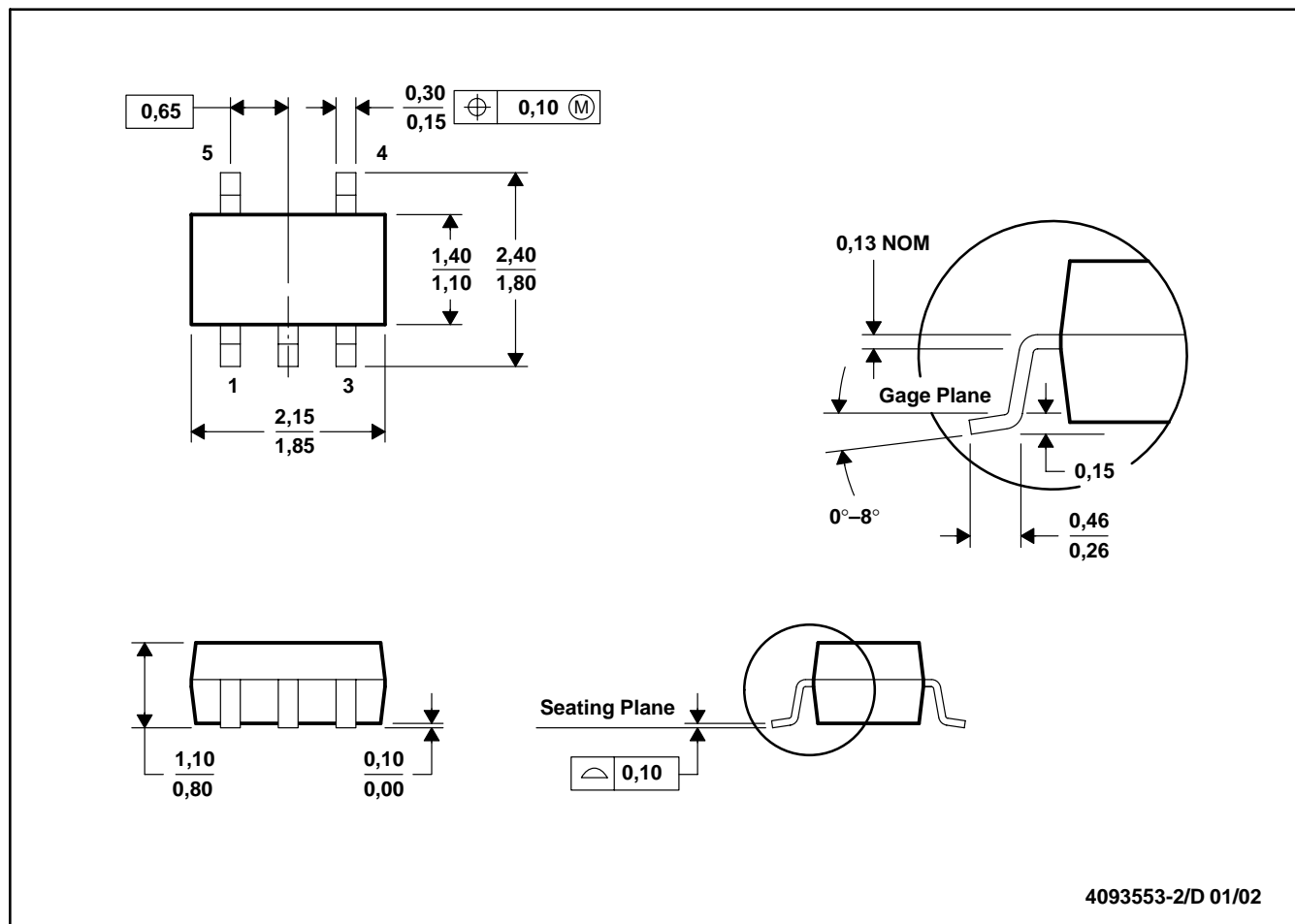
<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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## DCK (R-PDSO-G5)

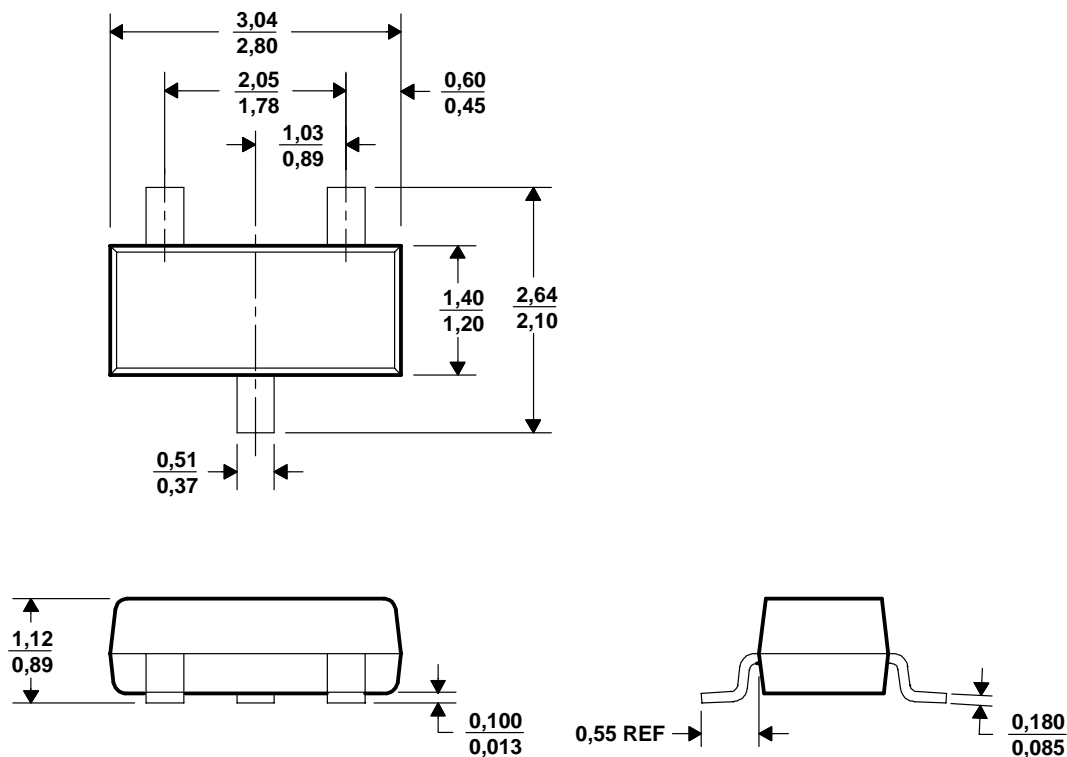
## PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion.
  - Falls within JEDEC MO-203

DBZ (R-PDSO-G3)

PLASTIC SMALL-OUTLINE



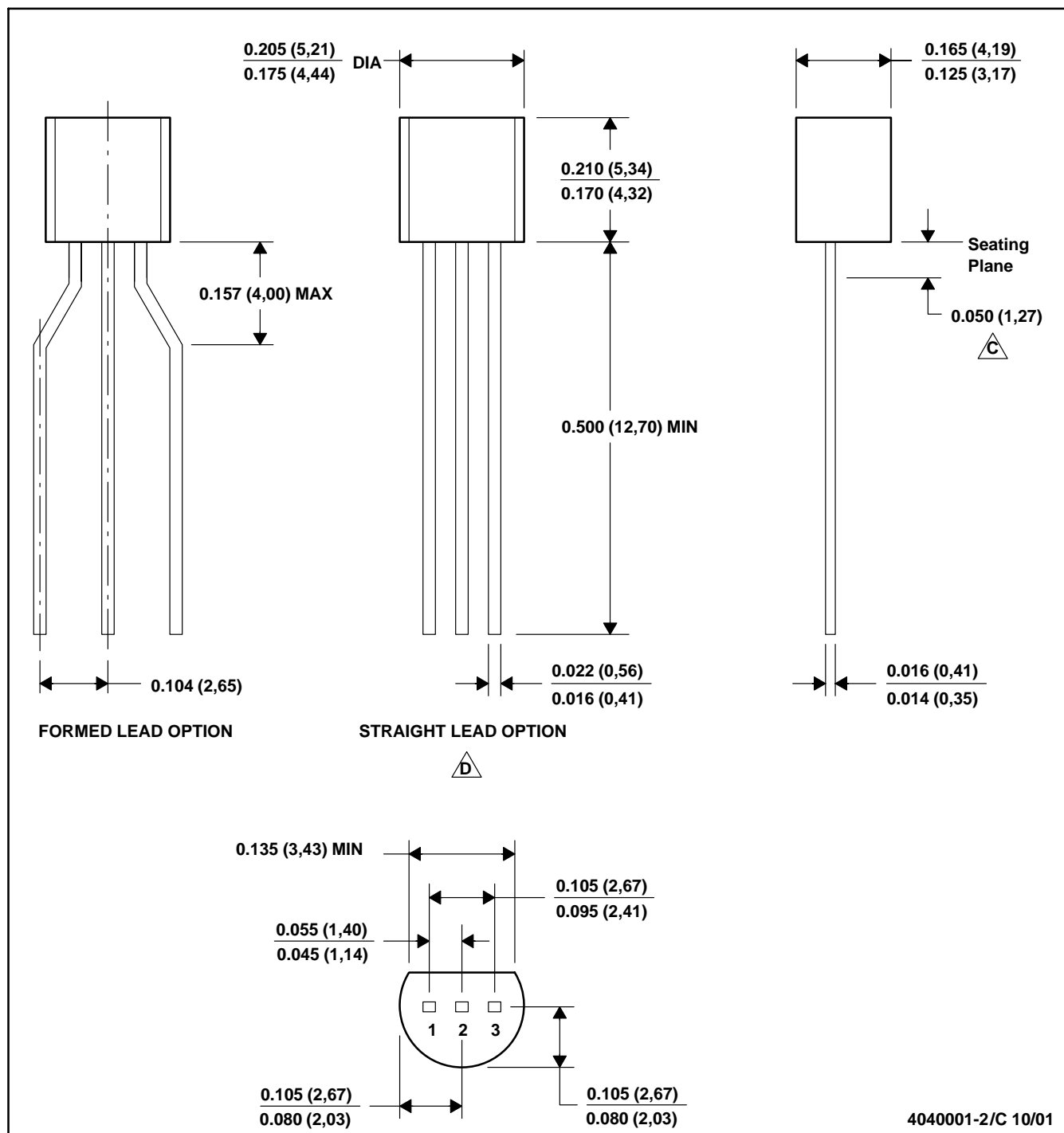
4203227/A 08/01

- NOTES:
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  - B. This drawing is subject to change without notice.
  - C. Dimensions are inclusive of plating.
  - D. Dimensions are exclusive of mold flash and metal burr.



## LP (O-PBCY-W3)

## PLASTIC CYLINDRICAL PACKAGE



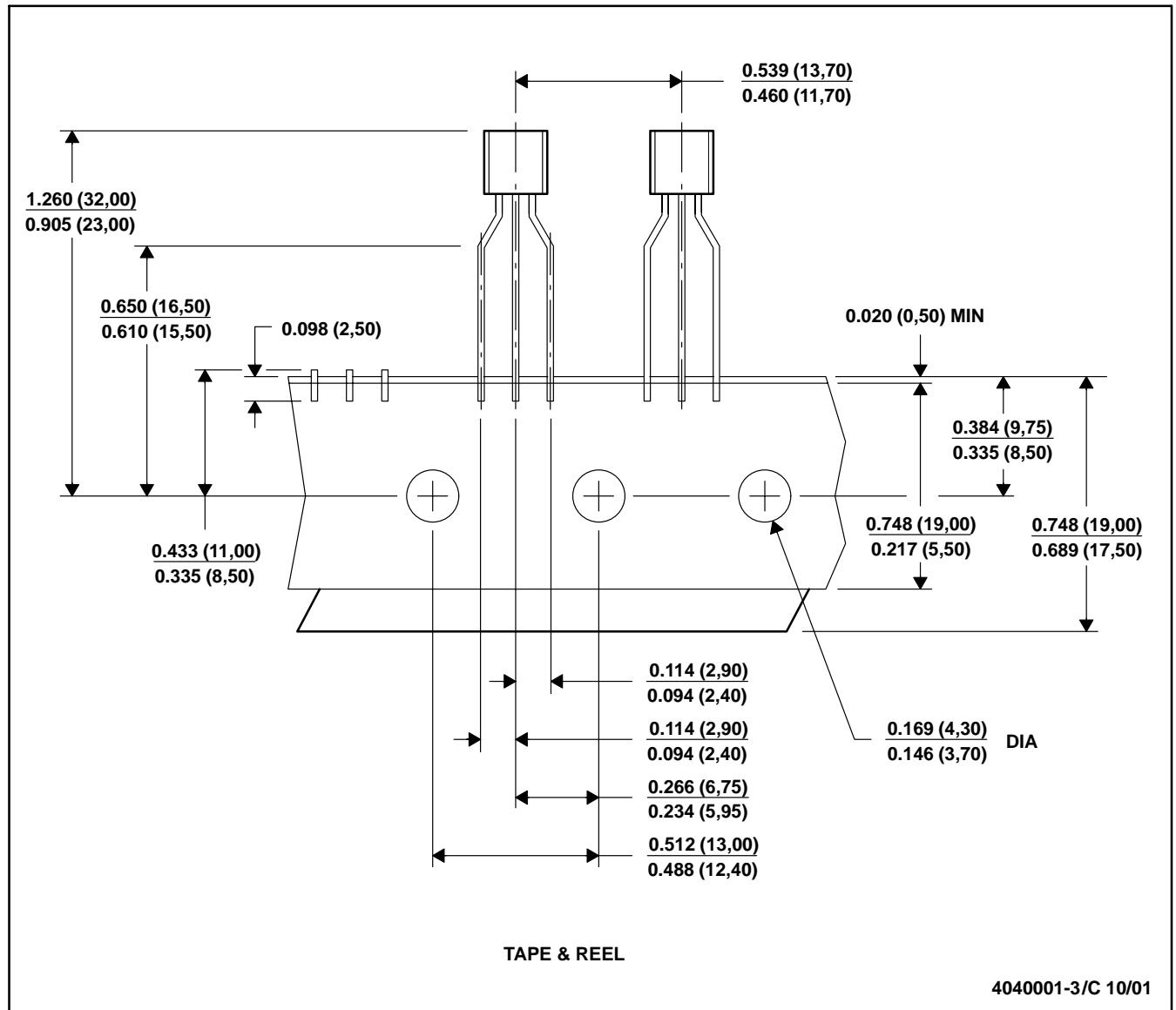
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 B. This drawing is subject to change without notice.  
 $\triangle C$  Lead dimensions are not controlled within this area  
 $\triangle D$  Falls within JEDEC TO -226 Variation AA (TO-226 replaces TO-92)  
 E. Shipping Method:  
     Straight lead option available in bulk pack only.  
     Formed lead option available in tape & reel or ammo pack.

# MECHANICAL DATA

MSOT002A – OCTOBER 1994 – REVISED NOVEMBER 2001

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE



- NOTES: A. All linear dimensions are in inches (millimeters).  
B. This drawing is subject to change without notice.  
C. Tape and Reel information for the Format Lead Option package.

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