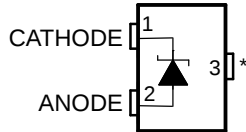


## FEATURES

- 1.225-V Fixed and Adjustable Outputs (1.225 V to 10 V)
- Tight Output Tolerances and Low Temperature Coefficient
  - Max 0.1%, 100 ppm/°C – A Grade
  - Max 0.2%, 100 ppm/°C – B Grade
  - Max 0.5%, 100 ppm/°C – C Grade
  - Max 1.0%, 150 ppm/°C – D Grade
- Low Output Noise . . . 20  $\mu\text{V}_{\text{RMS}}$  (Typ)
- Wide Operating Current Range . . . 45  $\mu\text{A}$  (Typ) to 12 mA
- Stable With All Capacitive Loads; No Output Capacitor Required

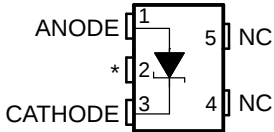
- Available in
  - Industrial Temperature:  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$
  - Extended Temperature:  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$
- Applications
  - Data-Acquisition Systems
  - Power Supplies and Power-Supply Monitors
  - Instrumentation and Test Equipment
  - Process Control
  - Precision Audio
  - Automotive Electronics
  - Energy Management/Metering
  - Battery-Powered Equipment

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



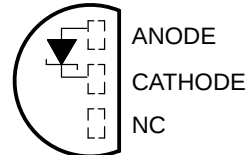
\* Pin 3 must be connected to ANODE or left open.

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



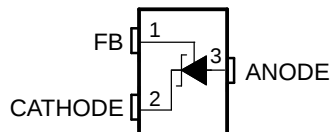
NC – No internal connection  
\* Pin 2 must be connected to ANODE or left open.

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

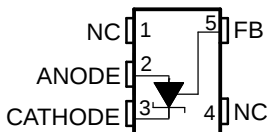


NC – No internal connection

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

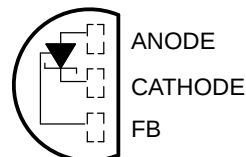


Adjustable . . . DCK (SC-70) PACKAGE  
(TOP VIEW)



NC – No internal connection

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



## 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 requiring a minimum current of 45  $\mu\text{A}$  (typ), the LM4041 also is ideal for portable applications. The TO-92 package also is available for through-hole packaging needs. The LM4041xl is characterized for operation over an ambient temperature range of  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ . The LM4041xQ is characterized for operation over an ambient temperature range of  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ .



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.

# LM4041

## PRECISION MICROPOWER SHUNT VOLTAGE REFERENCE

SLCS146C–FEBRUARY 2005–REVISED MAY 2005

### ORDERING INFORMATION

| T <sub>A</sub> | DEVICE GRADE                                                                   | V <sub>Z</sub> | PACKAGE <sup>(1)</sup> |              | ORDERABLE PART NUMBER | TOP-SIDE MARKING <sup>(2)</sup> |
|----------------|--------------------------------------------------------------------------------|----------------|------------------------|--------------|-----------------------|---------------------------------|
| –40°C to 85°C  | A grade:<br>0.1% initial accuracy<br>and<br>100 ppm/°C temperature coefficient | 1.2 V          | SC-70 (DCK)            | Reel of 3000 | LM4041A12IDCKR        | PREVIEW                         |
|                |                                                                                |                | SOT-23-3 (DBZ)         | Reel of 3000 | LM4041A12IDBZR        | PREVIEW                         |
|                |                                                                                |                |                        | Reel of 250  | LM4041A12IDBZT        | PREVIEW                         |
|                |                                                                                |                | TO-92/TO-226 (LP)      | Bulk of 1000 | LM4041A12ILP          | PREVIEW                         |
|                |                                                                                |                |                        | Reel of 2000 | LM4041A12ILPR         | PREVIEW                         |
|                |                                                                                |                |                        |              |                       |                                 |
|                | B grade:<br>0.2% initial accuracy<br>and<br>100 ppm/°C temperature coefficient | ADJ            | SC-70 (DCK)            | Reel of 3000 | LM4041BIDCKR          | PREVIEW                         |
|                |                                                                                |                | SOT-23-3 (DBZ)         | Reel of 3000 | LM4041BIDBZR          | PREVIEW                         |
|                |                                                                                |                |                        | Reel of 250  | LM4041BIDBZT          | PREVIEW                         |
|                |                                                                                |                | TO-92/TO-226 (LP)      | Bulk of 1000 | LM4041BILP            | PREVIEW                         |
|                |                                                                                |                |                        | Reel of 2000 | LM4041BILPR           | PREVIEW                         |
|                |                                                                                |                |                        |              |                       |                                 |
|                |                                                                                | 1.2 V          | SC-70 (DCK)            | Reel of 3000 | LM4041B12IDCKR        | PREVIEW                         |
|                |                                                                                |                | SOT-23-3 (DBZ)         | Reel of 3000 | LM4041B12IDBZR        | PREVIEW                         |
|                |                                                                                |                |                        | Reel of 250  | LM4041B12IDBZT        | PREVIEW                         |
|                |                                                                                |                | TO-92/TO-226 (LP)      | Bulk of 1000 | LM4041B12ILP          | PREVIEW                         |
|                |                                                                                |                |                        | Reel of 2000 | LM4041B12ILPR         | PREVIEW                         |
|                |                                                                                |                |                        |              |                       |                                 |
|                | C grade:<br>0.5% initial accuracy<br>and<br>100 ppm/°C temperature coefficient | ADJ            | SC-70 (DCK)            | Reel of 3000 | LM4041CIDCKR          | MH_                             |
|                |                                                                                |                |                        | Reel of 250  | LM4041CIDCKT          | MH_                             |
|                |                                                                                |                | SOT-23-3 (DBZ)         | Reel of 3000 | LM4041CIDBZR          | 4MH_                            |
|                |                                                                                |                |                        | Reel of 250  | LM4041CIDBZT          | 4MH_                            |
|                |                                                                                |                | TO-92/TO-226 (LP)      | Bulk of 1000 | LM4041CILP            | PREVIEW                         |
|                |                                                                                |                |                        | Reel of 2000 | LM4041CILPR           | PREVIEW                         |
|                |                                                                                | 1.2 V          | SC-70 (DCK)            | Reel of 3000 | LM4041C12IDCKR        | MM_                             |
|                |                                                                                |                | SOT-23-3 (DBZ)         | Reel of 3000 | LM4041C12IDBZR        | 4MM_                            |
|                |                                                                                |                |                        | Reel of 250  | LM4041C12IDBZT        | 4MM_                            |
|                |                                                                                |                | TO-92/TO-226 (LP)      | Bulk of 1000 | LM4041C12ILP          | PREVIEW                         |
|                |                                                                                |                |                        | Reel of 2000 | LM4041C12ILPR         | PREVIEW                         |
|                |                                                                                |                |                        |              |                       |                                 |
|                | D grade:<br>1.0% initial accuracy<br>and<br>150 ppm/°C temperature coefficient | ADJ            | SC-70 (DCK)            | Reel of 3000 | LM4041DIDCKR          | MJ_                             |
|                |                                                                                |                |                        | Reel of 250  | LM4041DIDCKT          | MJ_                             |
|                |                                                                                |                | SOT-23-3 (DBZ)         | Reel of 3000 | LM4041DIDBZR          | 4MJ_                            |
|                |                                                                                |                |                        | Reel of 250  | LM4041DIDBZT          | 4MJ_                            |
|                |                                                                                |                | TO-92/TO-226 (LP)      | Bulk of 1000 | LM4041DILP            | PREVIEW                         |
|                |                                                                                |                |                        | Reel of 2000 | LM4041DILPR           | PREVIEW                         |
|                |                                                                                | 1.2 V          | SC-70 (DCK)            | Reel of 3000 | LM4041D12IDCKR        | MN_                             |
|                |                                                                                |                | SOT-23-3 (DBZ)         | Reel of 3000 | LM4041D12IDBZR        | 4MN_                            |
|                |                                                                                |                |                        | Reel of 250  | LM4041D12IDBZT        | 4MN_                            |
|                |                                                                                |                | TO-92/TO-226 (LP)      | Bulk of 1000 | LM4041D12ILP          | PREVIEW                         |
|                |                                                                                |                |                        | Reel of 2000 | LM4041D12ILPR         | PREVIEW                         |
|                |                                                                                |                |                        |              |                       |                                 |

(1) 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).

(2) DBZ/DCK: The actual top-side marking has one additional character that designates the assembly/test site.

### ORDERING INFORMATION

| T <sub>A</sub> | DEVICE GRADE                                                                | V <sub>Z</sub> | PACKAGE <sup>(1)</sup> |              | ORDERABLE PART NUMBER | TOP-SIDE MARKING <sup>(2)</sup> |
|----------------|-----------------------------------------------------------------------------|----------------|------------------------|--------------|-----------------------|---------------------------------|
| –40°C to 125°C | C grade:<br>0.5% initial accuracy and<br>100 ppm/°C temperature coefficient | ADJ            | SOT-23-3 (DBZ)         | Reel of 3000 | LM4041CQDBZR          | 4MP_                            |
|                |                                                                             |                |                        | Reel of 250  | LM4041CQDBZT          |                                 |
|                |                                                                             | 1.2 V          | SOT-23-3 (DBZ)         | Reel of 3000 | LM4041C12QDBZR        | 4MS_                            |
|                |                                                                             |                |                        | Reel of 250  | LM4041C12QDBZT        |                                 |
|                | D grade:<br>1.0% initial accuracy and<br>150 ppm/°C temperature coefficient | ADJ            | SOT-23-3 (DBZ)         | Reel of 3000 | LM4041DQDBZR          | 4MR_                            |
|                |                                                                             |                |                        | Reel of 250  | LM4041DQDBZT          |                                 |
|                |                                                                             | 1.2 V          | SOT-23-3 (DBZ)         | Reel of 3000 | LM4041D12QDBZR        | 4MT_                            |
|                |                                                                             |                |                        | Reel of 250  | LM4041D12QDBZT        |                                 |

(1) 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).

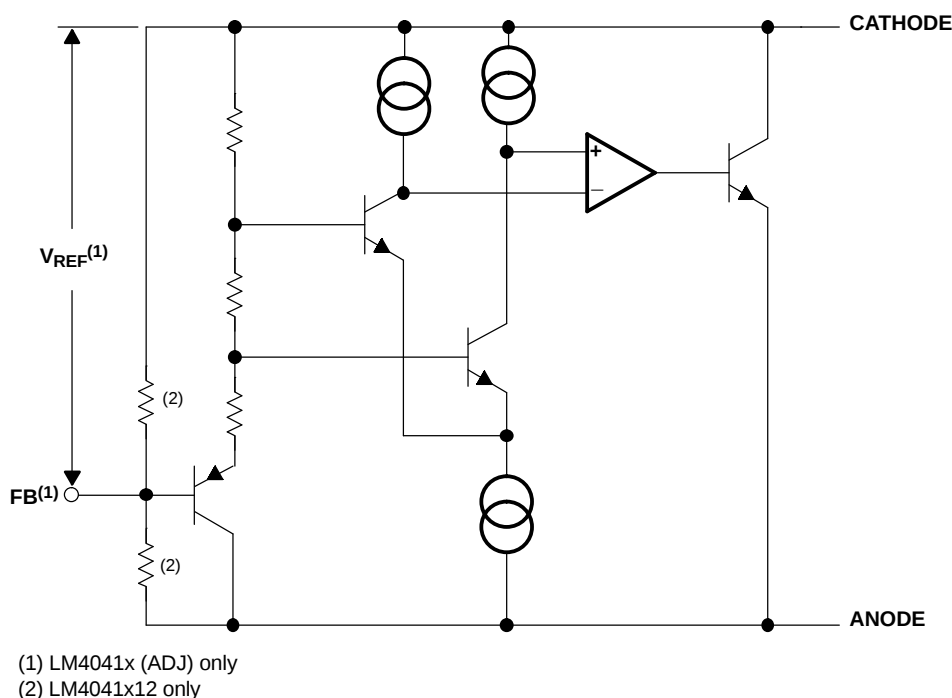
(2) DBZ/DCK: The actual top-side marking has one additional character that designates the assembly/test site.

# LM4041

## PRECISION MICROPOWER SHUNT VOLTAGE REFERENCE

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### FUNCTIONAL BLOCK DIAGRAM



### Absolute Maximum Ratings<sup>(1)</sup>

over free-air temperature range (unless otherwise noted)

|               |                                             | MIN         | MAX | 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  $T_J(\text{max})$ ,  $\theta_{JA}$ , 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.
- (3) The package thermal impedance is calculated in accordance with JESD 51-7.

### Recommended Operating Conditions

|       |                                                | MIN                    | MAX | UNIT |
|-------|------------------------------------------------|------------------------|-----|------|
| $I_Z$ | Cathode current                                | <sup>(1)</sup>         | 12  | mA   |
| $V_Z$ | Reverse breakdown voltage (adjustable version) |                        | 10  | V    |
| $T_A$ | Free-air temperature                           | LM4041 (I temperature) | –40 | °C   |
|       |                                                | LM4041 (Q temperature) | –40 |      |

- (1) See parametric tables

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

## 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                                    | $I_Z = 100\ \mu\text{A}$                                                                                   |            | 1.225      |     |            | 1.225 |     | V                          |
|                           | Reverse breakdown voltage tolerance                          | $I_Z = 100\ \mu\text{A}$                                                                                   |            | 25°C       |     |            |       |     | mV                         |
|                           |                                                              |                                                                                                            |            | Full range |     |            |       |     |                            |
| $I_{Z,\text{min}}$        | Minimum cathode current                                      |                                                                                                            |            | 25°C       |     |            |       |     | $\mu\text{A}$              |
|                           |                                                              |                                                                                                            |            | Full range |     |            |       |     |                            |
| $\alpha_{VZ}$             | Average temperature coefficient of reverse breakdown voltage | $I_Z = 10\ \text{mA}$                                                                                      |            | 25°C       |     |            |       |     | ppm/°C                     |
|                           |                                                              | $I_Z = 1\ \text{mA}$                                                                                       |            | 25°C       |     |            |       |     |                            |
|                           |                                                              |                                                                                                            |            | Full range |     |            |       |     |                            |
|                           |                                                              | $I_Z = 100\ \mu\text{A}$                                                                                   |            | 25°C       |     |            |       |     |                            |
| $\Delta V_Z / \Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,\text{min}} < I_Z < 1\ \text{mA}$                                                                    |            | 25°C       |     |            |       |     | mV                         |
|                           |                                                              |                                                                                                            |            | Full range |     |            |       |     |                            |
|                           |                                                              | $1\ \text{mA} < I_Z < 12\ \text{mA}$                                                                       |            | 25°C       |     |            |       |     |                            |
|                           |                                                              |                                                                                                            |            | Full range |     |            |       |     |                            |
| $Z_Z$                     | Reverse dynamic impedance                                    | $I_Z = 1\ \text{mA}$ , $f = 120\ \text{Hz}$ ,<br>$I_{AC} = 0.1\ I_Z$                                       |            | 25°C       |     |            |       |     | $\Omega$                   |
|                           |                                                              |                                                                                                            |            | Full range |     |            |       |     |                            |
| $e_N$                     | Wideband noise                                               | $I_Z = 100\ \mu\text{A}$ ,<br>$10\ \text{Hz} \leq f \leq 10\ \text{kHz}$                                   |            | 25°C       |     |            |       |     | $\mu\text{V}_{\text{RMS}}$ |
|                           | Long-term stability of reverse breakdown voltage             | $t = 1000\ \text{h}$ ,<br>$T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$ ,<br>$I_Z = 100\ \mu\text{A}$ |            | 25°C       |     |            |       |     | ppm                        |

# 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                                                     | $T_A$                                                                                                | LM4041BI |            |          | LM4041CI  |          |           | UNIT                    |
|--------------------------------|---------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|----------|------------|----------|-----------|----------|-----------|-------------------------|
|                                |                                                                     |                                                                                                      | MIN      | TYP        | MAX      | MIN       | TYP      | MAX       |                         |
| $V_{REF}$                      | Reference voltage                                                   | $I_Z = 100\ \mu\text{A}$ , $V_Z = 5\ \text{V}$                                                       |          | 1.233      |          |           | 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       | –6.2     | 6.2       | mV                      |
|                                |                                                                     |                                                                                                      |          | Full range | –10.5    | 10.5      | –14      | 14        |                         |
| $I_{Z,min}$                    | Minimum cathode current                                             |                                                                                                      |          | 25°C       | 45       | 75        | 45       | 75        | $\mu\text{A}$           |
|                                |                                                                     |                                                                                                      |          | 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       | 0.7      | 1.5       | mV                      |
|                                |                                                                     |                                                                                                      |          | Full range |          | 2         |          | 2         |                         |
|                                |                                                                     | $1\ \text{mA} < I_Z < 12\ \text{mA}$                                                                 |          | 25°C       | 2        | 4         | 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        | –1.55    | –2        | mV/V                    |
|                                |                                                                     |                                                                                                      |          | Full range |          | –2.5      |          | –2.5      |                         |
| $I_{FB}$                       | Feedback current                                                    |                                                                                                      |          | 25°C       | 60       | 100       | 60       | 100       | nA                      |
|                                |                                                                     |                                                                                                      |          | Full range |          | 120       |          | 120       |                         |
| $\alpha V_{REF}$               | 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/ $^{\circ}\text{C}$ |
|                                |                                                                     | $I_Z = 1\ \text{mA}$ , $V_Z = 5\ \text{V}$                                                           |          | 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*.

### 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        |                         |
| $I_{Z,min}$                    | 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                | $I_{Z,min} < I_Z < 1\ \text{mA}$                                                                     | $25^{\circ}\text{C}$ |          | 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       |           | $\mu\text{V}_{RMS}$     |
|                                | 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*.

# LM4041

## PRECISION MICROPOWER SHUNT VOLTAGE REFERENCE

SLCS146C—FEBRUARY 2005—REVISED MAY 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                                                     | $T_A$                                                                                                | LM4041CQ |       |     | LM4041DQ |       |     | UNIT                    |
|--------------------------------|---------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|----------|-------|-----|----------|-------|-----|-------------------------|
|                                |                                                                     |                                                                                                      | MIN      | TYP   | MAX | MIN      | TYP   | MAX |                         |
| $V_{REF}$                      | Reference voltage                                                   | $I_Z = 100\ \mu\text{A}$ , $V_Z = 5\ \text{V}$                                                       |          | 1.233 |     |          | 1.233 |     | V                       |
|                                | Reference voltage tolerance <sup>(1)</sup>                          | $I_Z = 100\ \mu\text{A}$ , $V_Z = 5\ \text{V}$                                                       |          |       |     |          |       |     | mV                      |
|                                |                                                                     |                                                                                                      |          |       |     |          |       |     |                         |
| $I_{Z,min}$                    | Minimum cathode current                                             |                                                                                                      |          |       |     |          |       |     | $\mu\text{A}$           |
|                                |                                                                     |                                                                                                      |          |       |     |          |       |     |                         |
| $\Delta V_{REF}/\Delta I_Z$    | Reference voltage change with cathode current change                | $I_{Z,min} < I_Z < 1\ \text{mA}$                                                                     |          |       |     |          |       |     | mV                      |
|                                |                                                                     |                                                                                                      |          |       |     |          |       |     |                         |
|                                |                                                                     |                                                                                                      |          |       |     |          |       |     |                         |
|                                |                                                                     |                                                                                                      |          |       |     |          |       |     |                         |
| $\Delta V_{REF}/\Delta V_{KA}$ | Reference voltage change with output voltage change                 | $I_Z = 1\ \text{mA}$                                                                                 |          |       |     |          |       |     | mV/V                    |
|                                |                                                                     |                                                                                                      |          |       |     |          |       |     |                         |
| $I_{FB}$                       | Feedback current                                                    |                                                                                                      |          |       |     |          |       |     | nA                      |
|                                |                                                                     |                                                                                                      |          |       |     |          |       |     |                         |
| $\alpha V_{REF}$               | Average temperature coefficient of reference voltage <sup>(1)</sup> | $I_Z = 10\ \text{mA}$ , $V_Z = 5\ \text{V}$                                                          |          |       |     |          |       |     | ppm/ $^{\circ}\text{C}$ |
|                                |                                                                     |                                                                                                      |          |       |     |          |       |     |                         |
|                                |                                                                     |                                                                                                      |          |       |     |          |       |     |                         |
|                                |                                                                     |                                                                                                      |          |       |     |          |       |     |                         |
| $Z_Z$                          | Reverse dynamic impedance                                           | $I_Z = 1\ \text{mA}$ , $f = 120\ \text{Hz}$ , $I_{AC} = 0.1\ I_Z$ , $V_Z = V_{REF}$                  |          |       |     |          |       |     | $\Omega$                |
|                                |                                                                     | $I_Z = 1\ \text{mA}$ , $f = 120\ \text{Hz}$ , $I_{AC} = 0.1\ I_Z$ , $V_Z = 10\ \text{V}$             |          |       |     |          |       |     |                         |
| $e_N$                          | Wideband noise                                                      | $I_Z = 100\ \mu\text{A}$ , $V_Z = V_{REF}$ , $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$              |          |       |     |          |       |     | $\mu\text{V}_{RMS}$     |
|                                | Long-term stability of reverse breakdown voltage                    | $t = 1000\ \text{h}$ , $T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$ , $I_Z = 100\ \mu\text{A}$ |          |       |     |          |       |     | ppm                     |

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

## TYPICAL CHARACTERISTICS

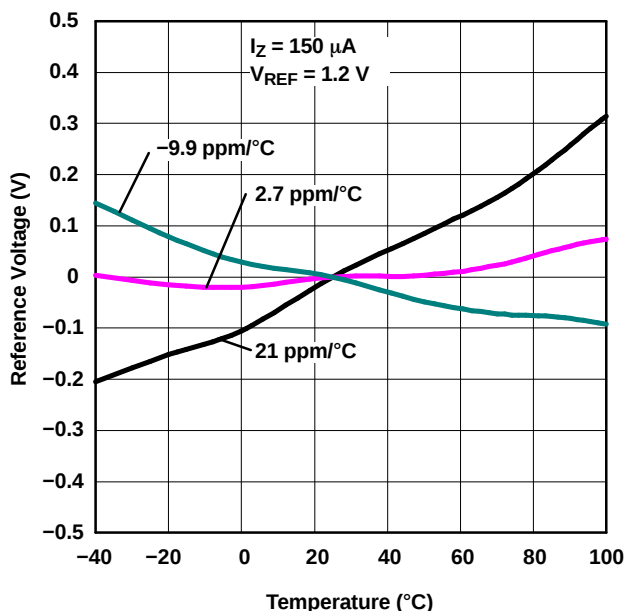


Figure 1. Temperature Drift for Different Average Temperature Coefficients

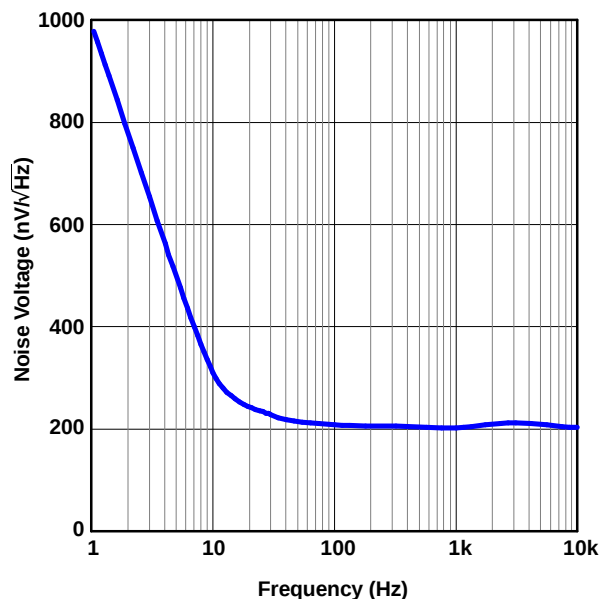


Figure 2. Noise Voltage vs Frequency

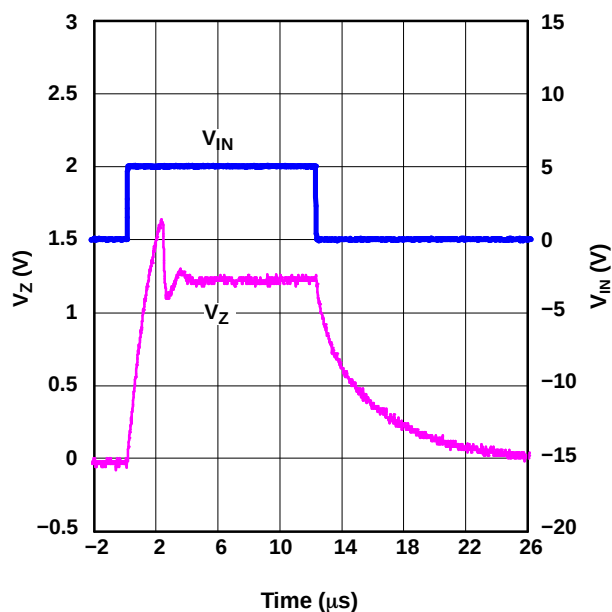


Figure 3. Start-Up Characteristics

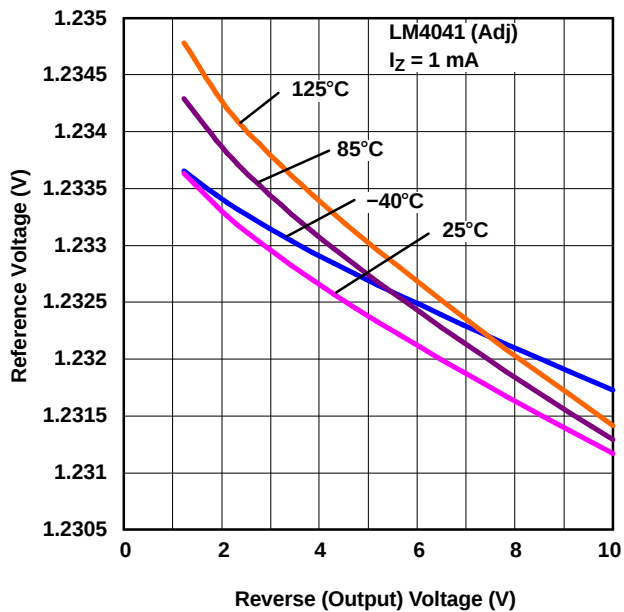


Figure 4. Reference Voltage vs Reverse (Output) Voltage (for Different Temperatures)

## TYPICAL CHARACTERISTICS

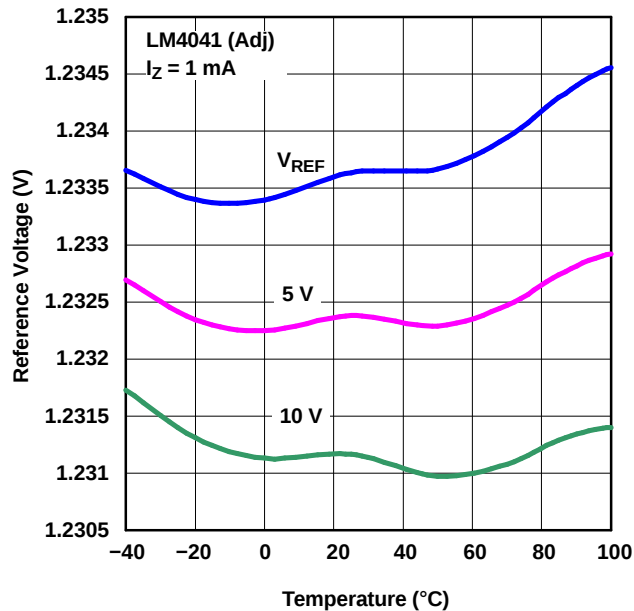


Figure 5. Reference Voltage vs Temperature (for Different Reverse Voltages)

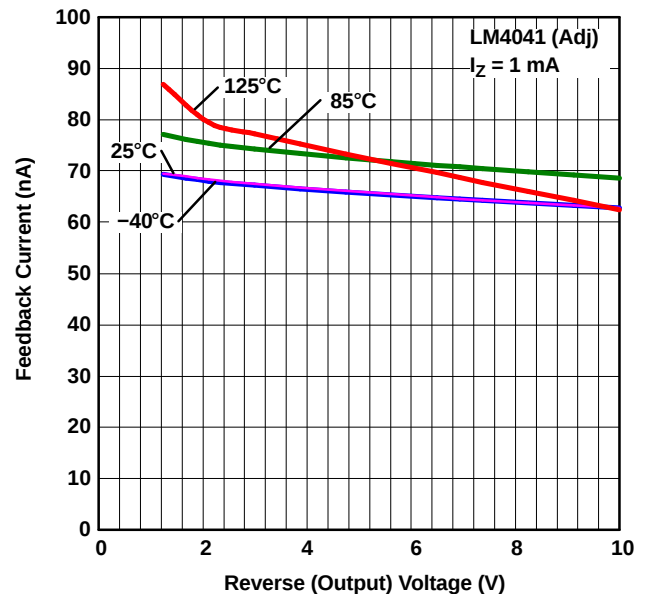


Figure 6. Feedback Current vs Reverse (Output) Voltage (for Different Temperatures)

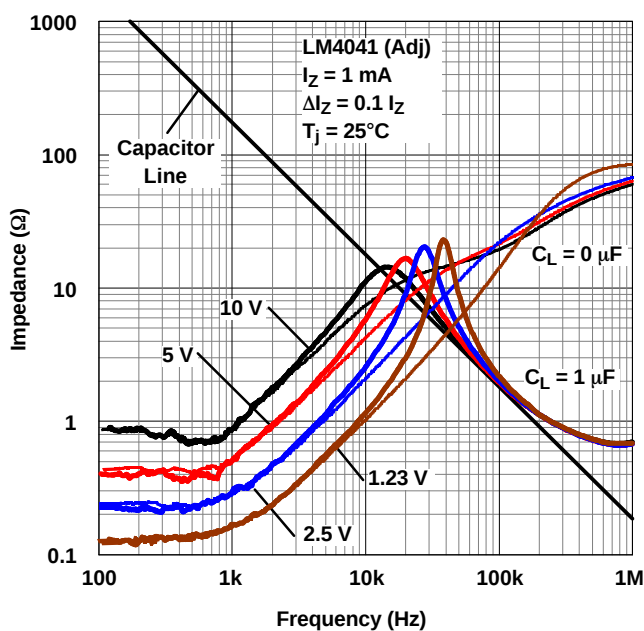


Figure 7. Output Impedance vs Frequency

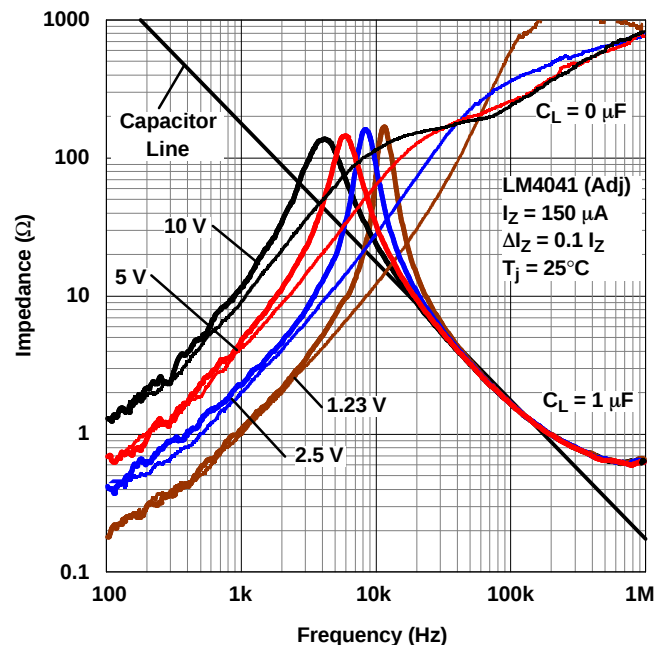


Figure 8. Output Impedance vs Frequency

## TYPICAL CHARACTERISTICS

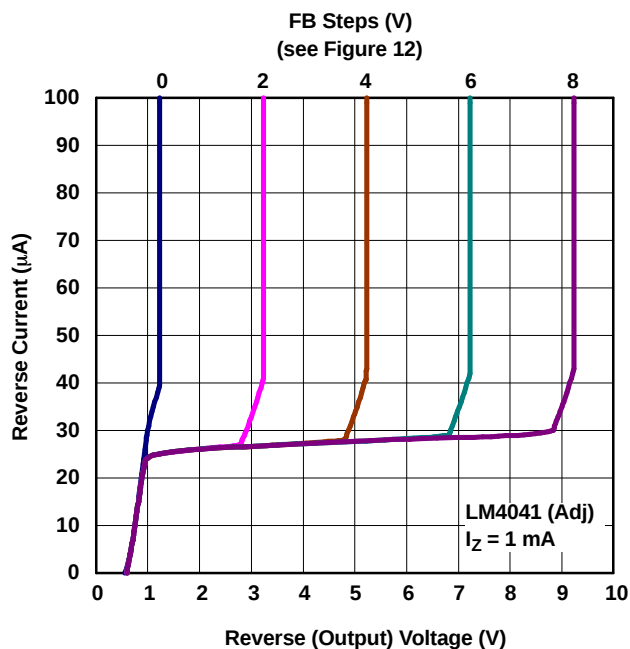


Figure 9. Reverse Characteristics

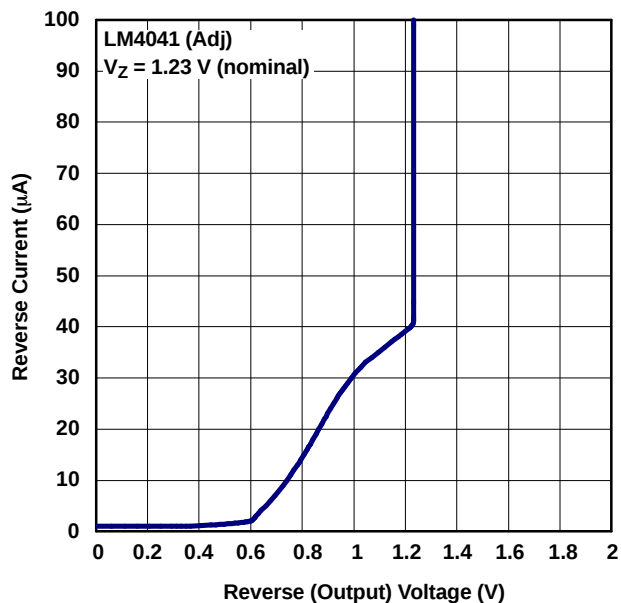


Figure 10. Reverse Characteristics and Minimum Operating Current

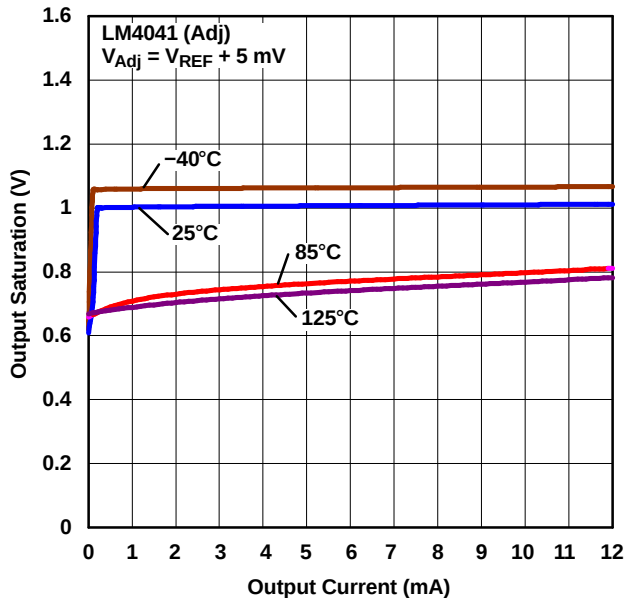
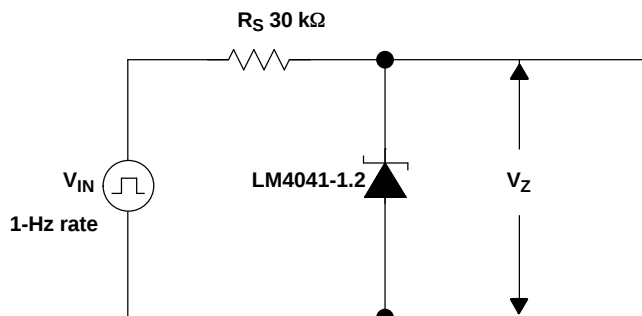
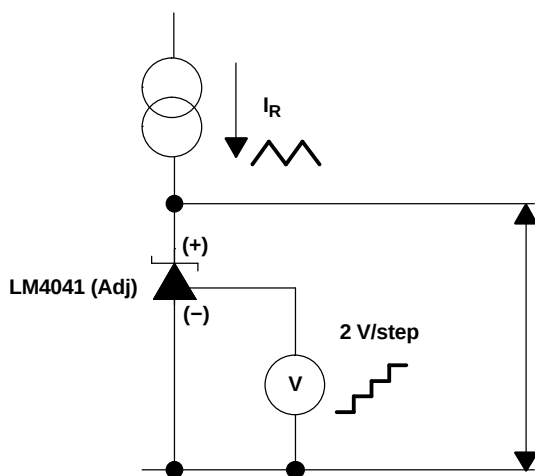


Figure 11. Output Saturation vs Output Current

## APPLICATION INFORMATION



**Figure 12. Startup Characteristics Test Circuit**



**Figure 13. Reverse Characteristics 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.

## APPLICATION INFORMATION

### 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](#).

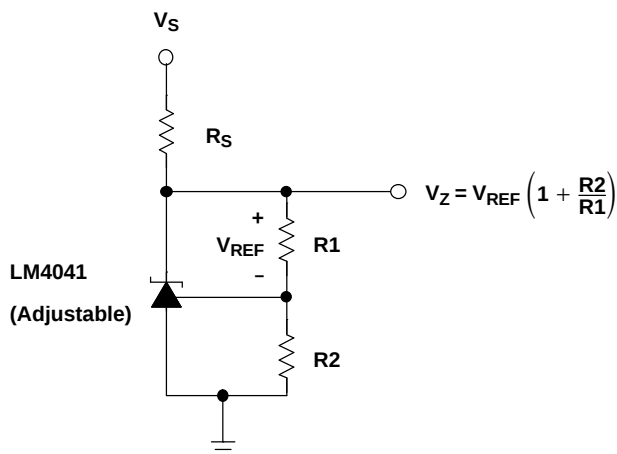


Figure 14. Adjustable Shunt Regulator

### Cathode and Load Currents

In a typical shunt regulator configuration (see [Figure 15](#)), 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](#).

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

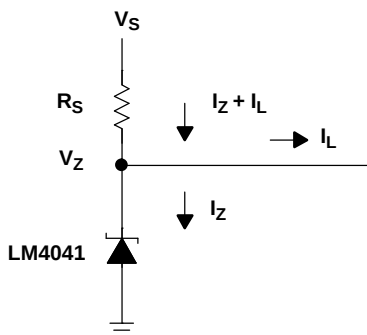


Figure 15. Shunt Regulator

**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   | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041A12IDBZRG4 | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041A12IDBZT   | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041A12IDBZTG4 | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041A12IDCKR   | ACTIVE                | SC70         | DCK             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041A12IDCKRE4 | ACTIVE                | SC70         | DCK             | 5    | 3000        | TBD                     | Call TI          | Call TI                      |
| LM4041A12ILP     | PREVIEW               | TO-92        | LP              | 3    | 1000        | TBD                     | Call TI          | Call TI                      |
| LM4041B12IDBZR   | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041B12IDBZRG4 | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041B12IDBZT   | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041B12IDBZTG4 | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041B12IDCKR   | ACTIVE                | SC70         | DCK             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041B12IDCKRE4 | ACTIVE                | SC70         | DCK             | 5    | 3000        | TBD                     | Call TI          | Call TI                      |
| LM4041B12ILP     | PREVIEW               | TO-92        | LP              | 3    | 1000        | TBD                     | Call TI          | Call TI                      |
| LM4041BIDBZR     | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041BIDBZRG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041BIDBZT     | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041BIDBZTG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041BIDCKR     | ACTIVE                | SC70         | DCK             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041BIDCKRE4   | ACTIVE                | SC70         | DCK             | 5    | 3000        | TBD                     | Call TI          | Call TI                      |
| LM4041BIDCKT     | ACTIVE                | SC70         | DCK             | 5    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041BIDCKTE4   | ACTIVE                | SC70         | DCK             | 5    | 250         | TBD                     | Call TI          | Call TI                      |
| LM4041BILP       | PREVIEW               | TO-92        | LP              | 3    | 1000        | TBD                     | Call TI          | Call TI                      |
| LM4041BILPR      | PREVIEW               | TO-92        | LP              | 3    | 2000        | TBD                     | Call TI          | Call TI                      |
| LM4041C12IDBZR   | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041C12IDBZRG4 | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041C12IDBZT   | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041C12IDBZTG4 | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |

| 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> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| LM4041C12IDCKR   | ACTIVE                | SC70         | DCK             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041C12IDCKRE4 | ACTIVE                | SC70         | DCK             | 5    | 3000        | TBD                     | Call TI          | Call TI                      |
| LM4041C12ILP     | PREVIEW               | TO-92        | LP              | 3    | 1000        | TBD                     | Call TI          | Call TI                      |
| LM4041C12QDBZR   | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041C12QDBZRG4 | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041C12QDBZT   | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041C12QDBZTG4 | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041CIDBZR     | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041CIDBZRG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041CIDBZT     | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041CIDBZTG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041CIDCKR     | ACTIVE                | SC70         | DCK             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041CIDCKRE4   | ACTIVE                | SC70         | DCK             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041CIDCKT     | ACTIVE                | SC70         | DCK             | 5    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041CIDCKTE4   | ACTIVE                | SC70         | DCK             | 5    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041CILP       | PREVIEW               | TO-92        | LP              | 3    | 1000        | TBD                     | Call TI          | Call TI                      |
| LM4041CILPR      | PREVIEW               | TO-92        | LP              | 3    | 2000        | TBD                     | Call TI          | Call TI                      |
| LM4041CQDBZR     | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041CQDBZRG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041CQDBZT     | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041CQDBZTG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041D12IDBZR   | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041D12IDBZRG4 | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041D12IDBZT   | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041D12IDBZTG4 | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041D12IDCKR   | ACTIVE                | SC70         | DCK             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041D12IDCKRE4 | ACTIVE                | SC70         | DCK             | 5    | 3000        | TBD                     | Call TI          | Call TI                      |
| LM4041D12QDBZR   | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |

| 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> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| LM4041D12QDBZRG4 | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041D12QDBZT   | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041D12QDBZTG4 | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041DIDBZR     | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041DIDBZRG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041DIDBZT     | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041DIDBZTG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041DIDCKR     | ACTIVE                | SC70         | DCK             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041DIDCKRE4   | ACTIVE                | SC70         | DCK             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041DIDCKT     | ACTIVE                | SC70         | DCK             | 5    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041DIDCKTE4   | ACTIVE                | SC70         | DCK             | 5    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041DILP       | PREVIEW               | TO-92        | LP              | 3    | 1000        | TBD                     | Call TI          | Call TI                      |
| LM4041DILPR      | PREVIEW               | TO-92        | LP              | 3    | 2000        | TBD                     | Call TI          | Call TI                      |
| LM4041DQDBZR     | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041DQDBZRG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041DQDBZT     | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM4041DQDBZTG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |

<sup>(1)</sup> 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> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

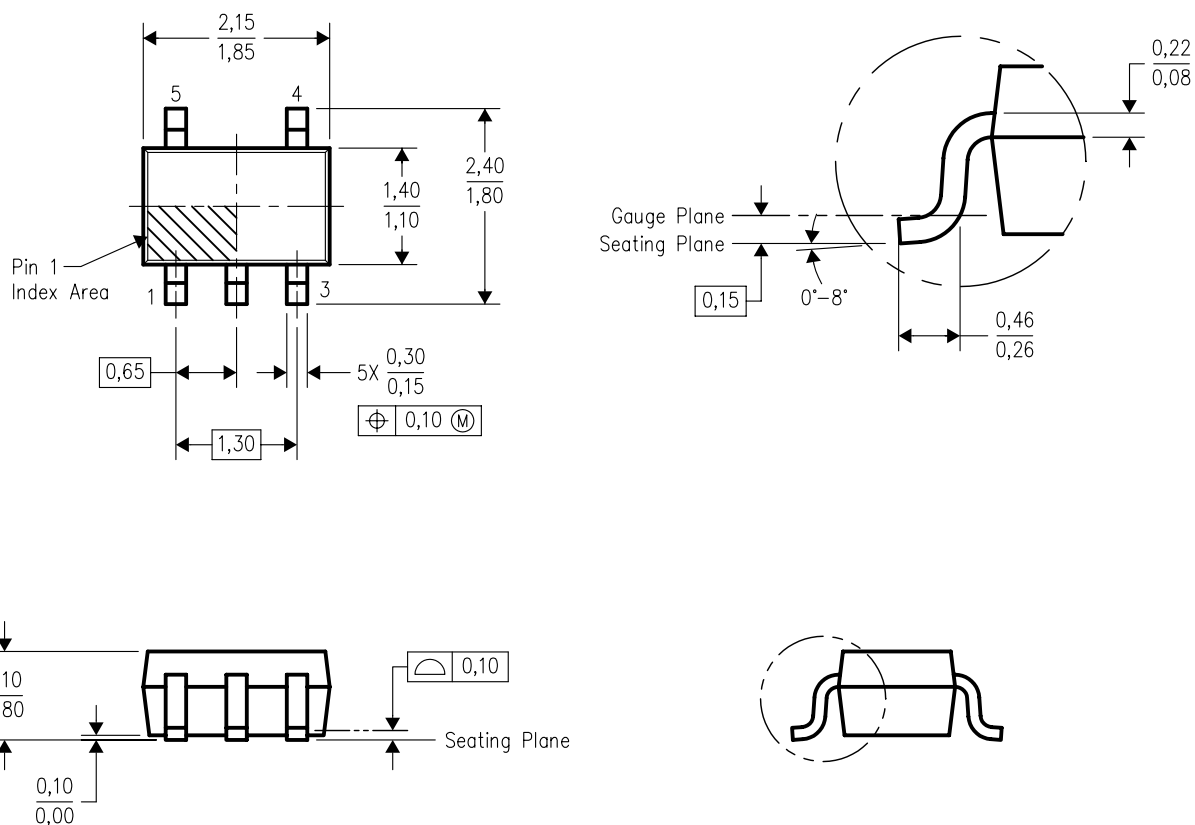
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## DCK (R-PDSO-G5)

## PLASTIC SMALL-OUTLINE PACKAGE

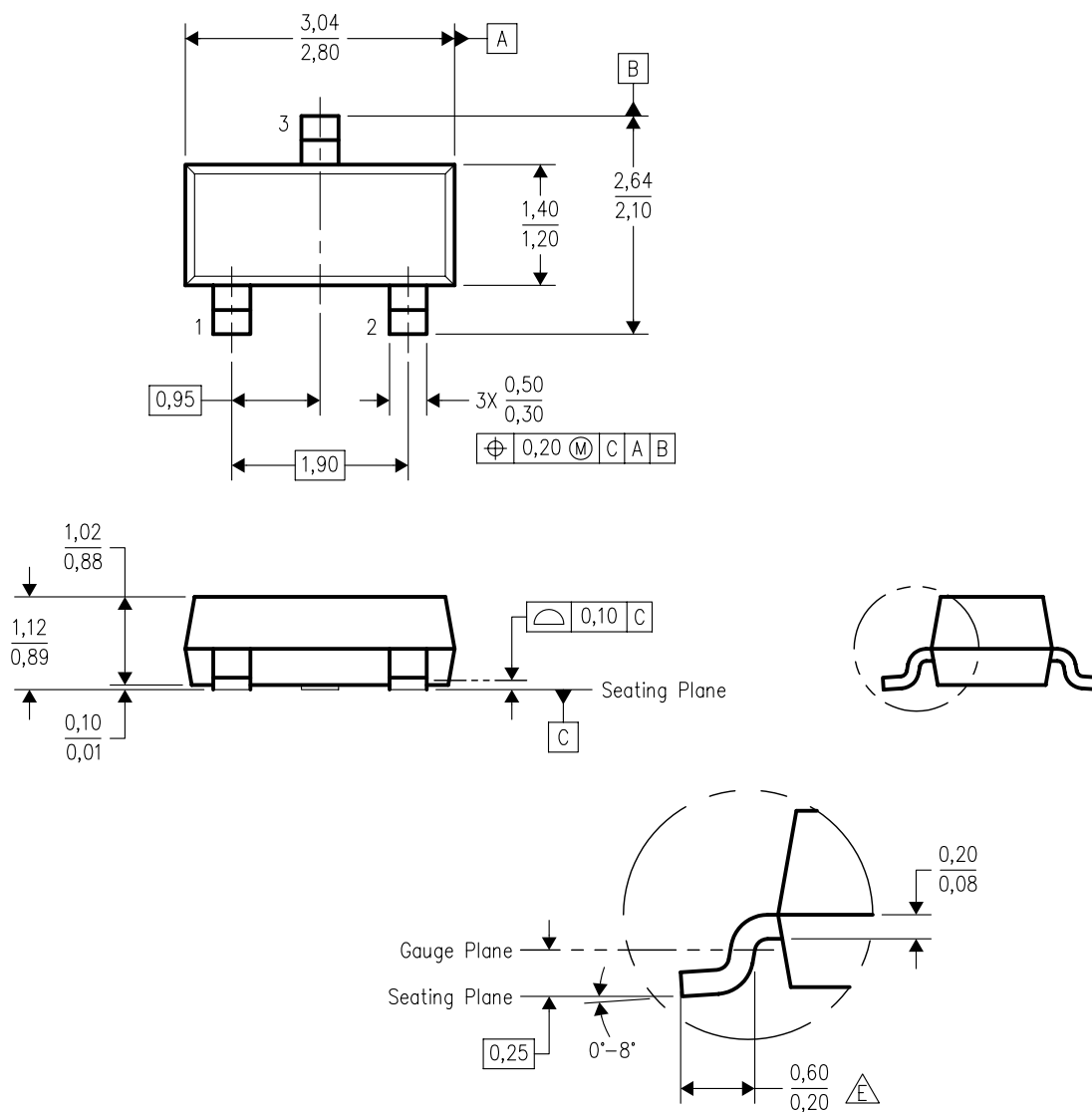


4093553-2/E 10/2005

- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
  - Falls within JEDEC MO-203 variation AA.

DBZ (R-PDSO-G3)

PLASTIC SMALL-OUTLINE

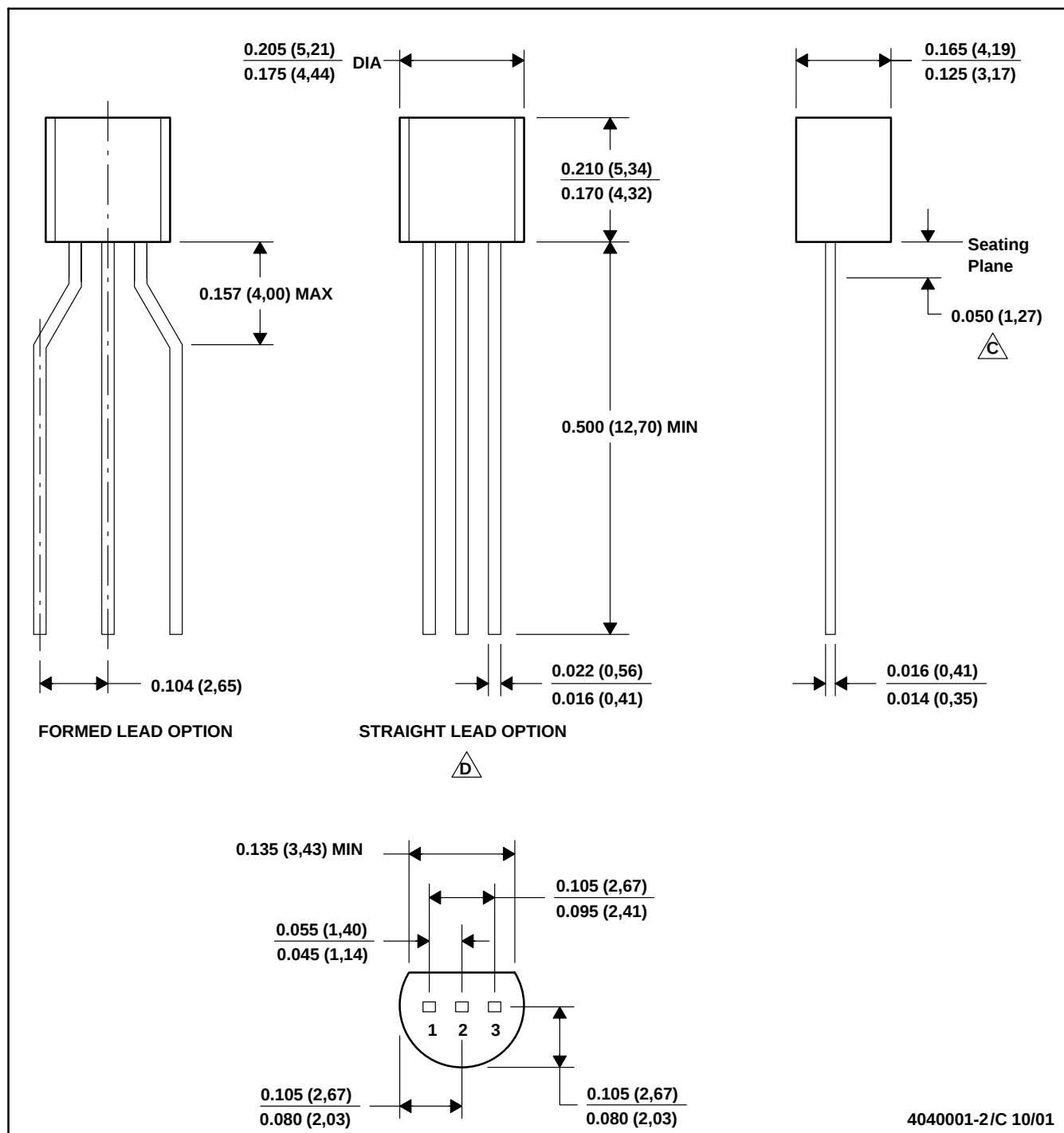


4203227/B 04/2005

- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. Lead dimensions are inclusive of plating.
  - D. Body dimensions are exclusive of mold flash and protrusion. Mold flash and protrusion not to exceed 0.25 per side.
  - E. Falls within JEDEC TO-236 variation AB, except minimum foot length.

## LP (O-PBCY-W3)

## PLASTIC CYLINDRICAL PACKAGE



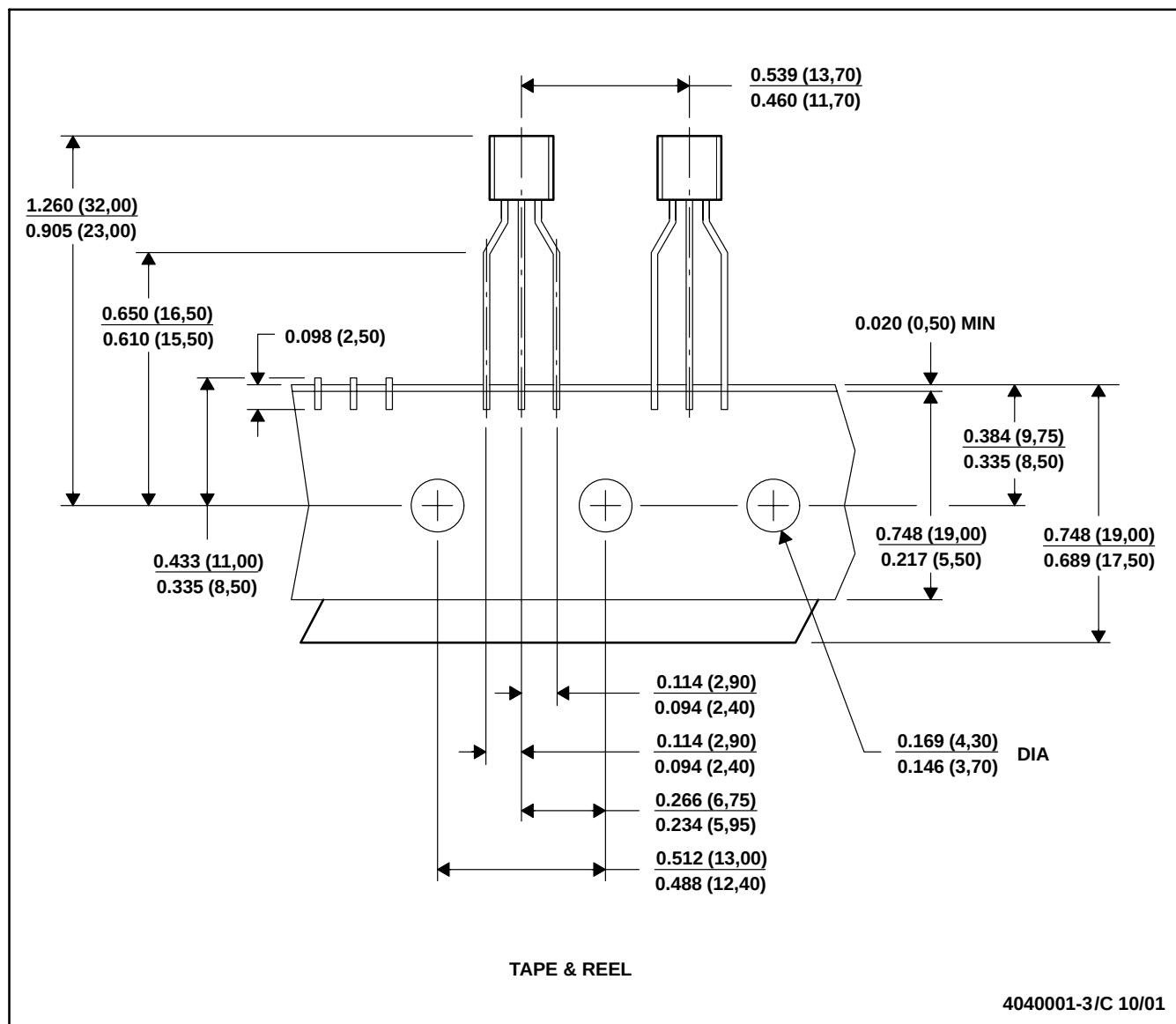
- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Lead dimensions are not controlled within this area.  
 D. Falls within JEDEC TO -226 Variation AA (TO-226 replaces TO-92).  
 E. Shipping Method:  
 Straight lead option available 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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| Data Converters  | <a href="http://dataconverter.ti.com">dataconverter.ti.com</a>     | Automotive          | <a href="http://www.ti.com/automotive">www.ti.com/automotive</a>         |
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