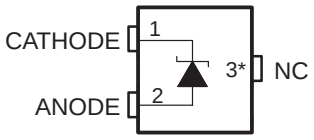
SLOS456A − JANUARY 2005 − REVISED FEBRUARY 2005

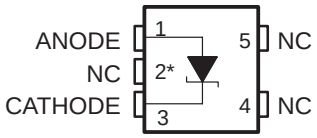
- **Fixed Output Voltages of 2.048 V, 2.5 V, 3 V, 4.096 V, 5 V, 8.192 V, and 10 V**
- **Tight Output Tolerances and Low Temperature Coefficient**
  - **Max 0.1%, 100 ppm/°C − A Grade**
  - **Max 0.2%, 100 ppm/°C − B Grade**
  - **Max 0.5%, 100 ppm/°C − C Grade**
  - **Max 1.0%, 150 ppm/°C − D Grade**
- **Low Output Noise . . . 35 $\mu V_{RMS}$ (Typ)**
- **Wide Operating Current Range . . . 60 μA to 20 mA**
- **Stable With All Capacitive Loads; No Output Capacitor Required**
- **Available in Extended Temperature Range . . . −40°C to 125°C**
- **Applications**
  - **Data-Acquisition Systems**
  - **Power Supplies and Power-Supply Monitors**
  - **Instrumentation and Test Equipment**
  - **Process Controls**
  - **Precision Audio**
  - **Automotive Electronics**
  - **Energy Management**
  - **Battery-Powered Equipment**

**DBZ (SOT-23) PACKAGE**
**(TOP VIEW)**




* This pin must be left open or connected to Pin 2, due to an internal connection to ANODE (die substrate).

**DCK (SC-70) PACKAGE**
**(TOP VIEW)**




* This pin must be left open or connected to Pin 1, due to an internal connection to ANODE (die substrate).

**LP (TO-92/TO-226) PACKAGE**
**(TOP VIEW)**


NC – No internal connection

## description/ordering information

The LM4040 series of shunt voltage references are versatile, easy-to-use references that cater to a vast array of applications. The 2-pin fixed-output device requires no external resistors or capacitors for operation and is stable with all capacitive loads. Additionally, the reference offers low dynamic impedance, low noise, and low temperature coefficient to ensure a stable output voltage over a wide range of operating currents and temperatures. The LM4040 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.

Packaged in space-saving SC-70 and SOT-23-3 packages and operating from a minimum current of 60 μA to 100 μA, the LM4040 is also ideal for portable applications. The LM4040xI is characterized for operation over an ambient temperature range of −40°C to 85°C. The LM4040xQ is characterized for operation over an ambient temperature range of −40°C to 125°C.

## ORDERING INFORMATION

| $T_A$ | DEVICE GRADE | $V_{KA}$ | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING‡ |
|---|---|---|---|---|---|---|
| −40°C to 85°C | A grade: 0.1% initial accuracy and 100 ppm/°C temperature coefficient | 2.048 V | SC-70 (DCK) | Reel of 3000 | LM4040A20IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040A20IDBZR | PREVIEW |
| | | | | Reel of 250 | LM4040A20IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040A20ILP | |
| | | | | Reel of 2000 | LM4040A20ILPR | |
| | | 2.5 V | SC-70 (DCK) | Reel of 3000 | LM4040A25IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040A25IDBZR | |
| | | | | Reel of 250 | LM4040A25IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040A25ILP | |
| | | | | Reel of 2000 | LM4040A25ILPR | |
| | | 3 V | SC-70 (DCK) | Reel of 3000 | LM4040A30IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040A30IDBZR | |
| | | | | Reel of 250 | LM4040A30IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040A30ILP | |
| | | | | Reel of 2000 | LM4040A30ILPR | |
| | | 4.096 V | SC-70 (DCK) | Reel of 3000 | LM4040A41IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040A41IDBZR | |
| | | | | Reel of 250 | LM4040A41IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040A41ILP | |
| | | | | Reel of 2000 | LM4040A41ILPR | |
| | | 5 V | SC-70 (DCK) | Reel of 3000 | LM4040A50IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040A50IDBZR | |
| | | | | Reel of 250 | LM4040A50IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040A50ILP | |
| | | | | Reel of 2000 | LM4040A50ILPR | |
| | | 8.192 V | SC-70 (DCK) | Reel of 3000 | LM4040A82IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040A82IDBZR | |
| | | | | Reel of 250 | LM4040A82IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040A82ILP | |
| | | | | Reel of 2000 | LM4040A82ILPR | |
| | | 10 V | SC-70 (DCK) | Reel of 3000 | LM4040A10IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040A10IDBZR | |
| | | | | Reel of 250 | LM4040A10IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040A10ILP | |
| | | | | Reel of 2000 | LM4040A10ILPR | |

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

‡ DBV/DCK: The actual top-side marking has one additional character that designates the assembly/test site.

## ORDERING INFORMATION (continued)

| $T_A$ | DEVICE GRADE | $V_{KA}$ | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING‡ |
|---|---|---|---|---|---|---|
| −40°C to 85°C | B grade: 0.2% initial accuracy and 100 ppm/°C temperature coefficient | 2.048 V | SC-70 (DCK) | Reel of 3000 | LM4040B20IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040B20IDBZR | |
| | | | | Reel of 250 | LM4040B20IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040B20ILP | |
| | | | | Reel of 2000 | LM4040B20ILPR | |
| | | 2.5 V | SC-70 (DCK) | Reel of 3000 | LM4040B25IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040B25IDBZR | |
| | | | | Reel of 250 | LM4040B25IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040B25ILP | |
| | | | | Reel of 2000 | LM4040B25ILPR | |
| | | 3 V | SC-70 (DCK) | Reel of 3000 | LM4040B30IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040B30IDBZR | |
| | | | | Reel of 250 | LM4040B30IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040B30ILP | |
| | | | | Reel of 2000 | LM4040B30ILPR | |
| | | 4.096 V | SC-70 (DCK) | Reel of 3000 | LM4040B41IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040B41IDBZR | |
| | | | | Reel of 250 | LM4040B41IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040B41ILP | |
| | | | | Reel of 2000 | LM4040B41ILPR | |
| | | 5 V | SC-70 (DCK) | Reel of 3000 | LM4040B50IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040B50IDBZR | |
| | | | | Reel of 250 | LM4040B50IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040B50ILP | |
| | | | | Reel of 2000 | LM4040B50ILPR | |
| | | 8.192 V | SC-70 (DCK) | Reel of 3000 | LM4040B82IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040B82IDBZR | |
| | | | | Reel of 250 | LM4040B82IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040B82ILP | |
| | | | | Reel of 2000 | LM4040B82ILPR | |
| | | 10 V | SC-70 (DCK) | Reel of 3000 | LM4040B10IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040B10IDBZR | |
| | | | | Reel of 250 | LM4040B10IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040B10ILP | |
| | | | | Reel of 2000 | LM4040B10ILPR | |

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

‡ DBV/DCK: The actual top-side marking has one additional character that designates the assembly/test site.

**ORDERING INFORMATION (continued)**

| $T_A$ | DEVICE GRADE | $V_{KA}$ | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING‡ |
|---|---|---|---|---|---|---|
| −40°C to 85°C | C grade: 0.5% initial accuracy and 100 ppm/°C temperature coefficient | 2.048 V | SC-70 (DCK) | Reel of 3000 | LM4040C20IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040C20IDBZR | |
| | | | | Reel of 250 | LM4040C20IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040C20ILP | |
| | | | | Reel of 2000 | LM4040C20ILPR | |
| | | 2.5 V | SC-70 (DCK) | Reel of 3000 | LM4040C25IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040C25IDBZR | 4MU_ |
| | | | | Reel of 250 | LM4040C25IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040C25ILP | PREVIEW |
| | | | | Reel of 2000 | LM4040C25ILPR | |
| | | 3 V | SC-70 (DCK) | Reel of 3000 | LM4040C30IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040C30IDBZR | |
| | | | | Reel of 250 | LM4040C30IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040C30ILP | |
| | | | | Reel of 2000 | LM4040C30ILPR | |
| | | 4.096 V | SC-70 (DCK) | Reel of 3000 | LM4040C41IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040C41IDBZR | |
| | | | | Reel of 250 | LM4040C41IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040C41ILP | |
| | | | | Reel of 2000 | LM4040C41ILPR | |
| | | 5 V | SC-70 (DCK) | Reel of 3000 | LM4040C50IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040C50IDBZR | |
| | | | | Reel of 250 | LM4040C50IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040C50ILP | |
| | | | | Reel of 2000 | LM4040C50ILPR | |
| | | 8.192 V | SC-70 (DCK) | Reel of 3000 | LM4040C82IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040C82IDBZR | |
| | | | | Reel of 250 | LM4040C82IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040C82ILP | |
| | | | | Reel of 2000 | LM4040C82ILPR | |
| | | 10 V | SC-70 (DCK) | Reel of 3000 | LM4040C10IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040C10IDBZR | |
| | | | | Reel of 250 | LM4040C10IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040C10ILP | |
| | | | | Reel of 2000 | LM4040C10ILPR | |

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

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## ORDERING INFORMATION (continued)

| $T_A$ | DEVICE GRADE | $V_{KA}$ | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING‡ |
|---|---|---|---|---|---|---|
| −40°C to 85°C | D grade: 1.0% initial accuracy and 150 ppm/°C temperature coefficient | 2.048 V | SC-70 (DCK) | Reel of 3000 | LM4040D20IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040D20IDBZR | |
| | | | | Reel of 250 | LM4040D20IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040D20ILP | |
| | | | | Reel of 2000 | LM4040D20ILPR | |
| | | 2.5 V | SC-70 (DCK) | Reel of 3000 | LM4040D25IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040D25IDBZR | 4ME_ |
| | | | | Reel of 250 | LM4040D25IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040D25ILP | PREVIEW |
| | | | | Reel of 2000 | LM4040D25ILPR | |
| | | 3 V | SC-70 (DCK) | Reel of 3000 | LM4040D30IDCKR | |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040D30IDBZR | |
| | | | | Reel of 250 | LM4040D30IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040D30ILP | |
| | | | | Reel of 2000 | LM4040D30ILPR | |
| | | 4.096 V | SC-70 (DCK) | Reel of 3000 | LM4040D41IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040D41IDBZR | |
| | | | | Reel of 250 | LM4040D41IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040D41ILP | |
| | | | | Reel of 2000 | LM4040D41ILPR | |
| | | 5 V | SC-70 (DCK) | Reel of 3000 | LM4040D50IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040D50IDBZR | |
| | | | | Reel of 250 | LM4040D50IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040D50ILP | |
| | | | | Reel of 2000 | LM4040D50ILPR | |
| | | 8.192 V | SC-70 (DCK) | Reel of 3000 | LM4040D82IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040D82IDBZR | |
| | | | | Reel of 250 | LM4040D82IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040D82ILP | |
| | | | | Reel of 2000 | LM4040D82ILPR | |
| | | 10 V | SC-70 (DCK) | Reel of 3000 | LM4040D10IDCKR | PREVIEW |
| | | | SOT-23-3 (DBZ) | Reel of 3000 | LM4040D10IDBZR | |
| | | | | Reel of 250 | LM4040D10IDBZT | |
| | | | TO-92/TO-226 (LP) | Bulk of 1000 | LM4040D10ILP | |
| | | | | Reel of 2000 | LM4040D10ILPR | |

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

‡ DBV/DCK: The actual top-side marking has one additional character that designates the assembly/test site.

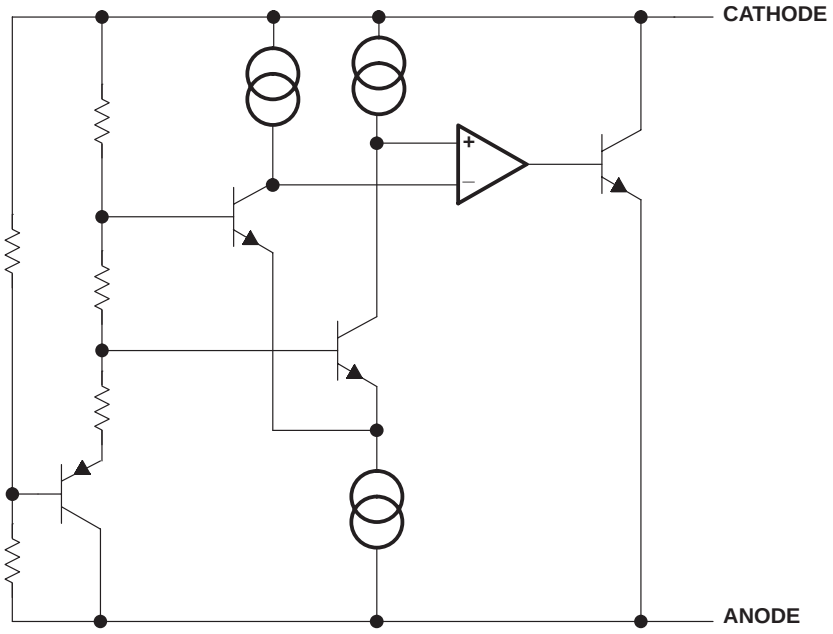
**ORDERING INFORMATION (continued)**

| $T_A$ | DEVICE GRADE | $V_{KA}$ | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING‡ |
|---|---|---|---|---|---|---|
| −40°C to 125°C | C grade: 0.5% initial accuracy and 100 ppm/°C temperature coefficient | 2.048 V | SOT-23-3 (DBZ) | Reel of 3000 | LM4040C20QDBZR | PREVIEW |
| | | | | Reel of 250 | LM4040C20QDBZT | |
| | | 2.5 V | | Reel of 3000 | LM4040C25QDBZR | 4MA_ |
| | | | | Reel of 250 | LM4040C25QDBZT | |
| | | 3 V | | Reel of 3000 | LM4040C30QDBZR | PREVIEW |
| | | | | Reel of 250 | LM4040C30QDBZT | |
| | | 5 V | | Reel of 3000 | LM4040C50QDBZR | |
| | | | | Reel of 250 | LM4040C50QDBZT | |
| | D grade: 1.0% initial accuracy and 150 ppm/°C temperature coefficient | 2.048 V | SOT-23-3 (DBZ) | Reel of 3000 | LM4040D20QDBZR | |
| | | | | Reel of 250 | LM4040D20QDBZT | |
| | | 2.5 V | | Reel of 3000 | LM4040D25QDBZR | 4MB_ |
| | | | | Reel of 250 | LM4040D25QDBZT | |
| | | 3 V | | Reel of 3000 | LM4040D30QDBZR | PREVIEW |
| | | | | Reel of 250 | LM4040D30QDBZT | |
| | | 5 V | | Reel of 3000 | LM4040D50QDBZR | |
| | | | | Reel of 250 | LM4040D50QDBZT | |

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

‡ DBV/DCK: The actual top-side marking has one additional character that designates the assembly/test site.

## functional block diagram




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

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 $T_J(max)$, $\theta_{JA}$, and $T_A$. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) - T_A)/\theta_{JA}$. Operating at the absolute maximum $T_J$ of 150°C can affect reliability.
2. The package thermal impedance is calculated in accordance with JESD 51-7.

## recommended operating conditions

| | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $I_Z$ | Cathode current | | ‡ | 20 | mA |
| $T_A$ | Free-air temperature range | LM4040xxxI | −40 | 85 | °C |
| | | LM4040xxxQ | −40 | 125 | |

‡ See parametric tables

**LM4040x20I electrical characteristics at industrial temperature range (unless otherwise noted) (full-range $T_A$ = −40°C to 85°C)**

| PARAMETER | | TEST CONDITIONS | $T_A$ | LM4040A20I | | | LM4040B20I | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_Z$ | Reverse breakdown voltage | $I_Z$ = 100 µA | 25°C | | 2.048 | | | 2.048 | | V |
| $\Delta V_Z$ | Reverse breakdown voltage tolerance | $I_Z$ = 100 µA | 25°C | −2 | | 2 | −4.1 | | 4.1 | mV |
| | | | Full range | −15 | | 15 | −17 | | 17 | |
| $I_{Z,min}$ | Minimum cathode current | | 25°C | | 45 | 60 | | 45 | 60 | µA |
| | | | Full range | | | 65 | | | 65 | |
| $\alpha_{VZ}$ | Average temperature coefficient of reverse breakdown voltage | $I_Z$ = 10 mA | 25°C | | ±20 | | | ±20 | | ppm/°C |
| | | $I_Z$ = 1 mA | 25°C | | ±15 | | | ±15 | | |
| | | | Full range | | | ±100 | | | ±100 | |
| | | $I_L$ = 100 µA | 25°C | | ±15 | | | ±15 | | |
| $\Delta V_Z/\Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,min} < I_Z < 1$ mA | 25°C | | 0.3 | 0.8 | | 0.3 | 0.8 | mV |
| | | | Full range | | | 1 | | | 1 | |
| | | 1 mA < $I_Z$ < 15 mA | 25°C | | 2.5 | 6 | | 2.5 | 6 | |
| | | | Full range | | | 8 | | | 8 | |
| $z_Z$ | Reverse dynamic impedance | $I_Z$ = 1 mA, f = 120 Hz, $I_{AC}$ = 0.1 $I_Z$ | 25°C | | 0.3 | 0.8 | | 0.3 | 0.8 | Ω |
| $e_N$ | Wideband noise | $I_Z$ = 100 µA, 10 Hz ≤ f ≤ 10 kHz | 25°C | | 35 | | | 35 | | $\mu V_{RMS}$ |
| | Long-term stability of reverse breakdown voltage | t = 1000 h, $T_A$ = 25°C ± 0.1°C, $I_Z$ = 100 µA | | | 120 | | | 120 | | ppm |
| $V_{HYST}$ | Thermal hysteresis (see Note 3) | $\Delta T_A$ = −40°C to 125°C | | | 0.08 | | | 0.08 | | % |

NOTE 3: Thermal hysteresis is defined as $V_{Z,25°C}$ (after cycling to −40°C) − $V_{Z,25°C}$ (after cycling to 125°C).

**LM4040x20I electrical characteristics at industrial temperature range (unless otherwise noted) (full-range $T_A$ = −40°C to 85°C)**

| PARAMETER | | TEST CONDITIONS | $T_A$ | LM4040C20I | | | LM4040D20I | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_Z$ | Reverse breakdown voltage | $I_Z$ = 100 µA | 25°C | | 2.048 | | | 2.048 | | V |
| $\Delta V_Z$ | Reverse breakdown voltage tolerance | $I_Z$ = 100 µA | 25°C | −10 | | 10 | −20 | | 20 | mV |
| | | | Full range | −23 | | 23 | −40 | | 40 | |
| $I_{Z,min}$ | Minimum cathode current | | 25°C | | 45 | 60 | | 45 | 65 | µA |
| | | | Full range | | | 65 | | | 70 | |
| $\alpha_{VZ}$ | Average temperature coefficient of reverse breakdown voltage | $I_Z$ = 10 mA | 25°C | | ±20 | | | ±20 | | ppm/°C |
| | | $I_Z$ = 1 mA | 25°C | | ±15 | | | ±15 | | |
| | | | Full range | | | ±100 | | | ±150 | |
| | | $I_L$ = 100 µA | 25°C | | ±15 | | | ±15 | | |
| $\Delta V_Z/\Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,min} < I_Z < 1$ mA | 25°C | | 0.3 | 0.8 | | 0.3 | 1 | mV |
| | | | Full range | | | 1 | | | 1.2 | |
| | | 1 mA < $I_Z$ < 15 mA | 25°C | | 2.5 | 6 | | 2.5 | 8 | |
| | | | Full range | | | 8 | | | 10 | |
| $Z_Z$ | Reverse dynamic impedance | $I_Z$ = 1 mA, f = 120 Hz, $I_{AC}$ = 0.1 $I_Z$ | 25°C | | 0.3 | 0.9 | | 0.3 | 1.1 | Ω |
| $e_N$ | Wideband noise | $I_Z$ = 100 µA, 10 Hz ≤ f ≤ 10 kHz | 25°C | | 35 | | | 35 | | $\mu V_{RMS}$ |
| | Long-term stability of reverse breakdown voltage | t = 1000 h, $T_A$ = 25°C ± 0.1°C, $I_Z$ = 100 µA | | | 120 | | | 120 | | ppm |
| $V_{HYST}$ | Thermal hysteresis (see Note 3) | $\Delta T_A$ = −40°C to 125°C | | | 0.08 | | | 0.08 | | % |

NOTE 3: Thermal hysteresis is defined as $V_{Z,25°C}$ (after cycling to −40°C) − $V_{Z,25°C}$ (after cycling to 125°C).

## LM4040x20Q electrical characteristics at extended temperature range (unless otherwise noted) (full-range $T_A$ = −40°C to 125°C)

| PARAMETER | | TEST CONDITIONS | $T_A$ | LM4040C20Q | | | LM4040D20Q | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_Z$ | Reverse breakdown voltage | $I_Z$ = 100 µA | 25°C | | 2.048 | | | 2.048 | | V |
| $\Delta V_Z$ | Reverse breakdown voltage tolerance | $I_Z$ = 100 µA | 25°C | −10 | | 10 | −20 | | 20 | mV |
| | | | Full range | −30 | | 30 | −50 | | 50 | |
| $I_{Z,min}$ | Minimum cathode current | | 25°C | | 45 | 60 | | 45 | 65 | µA |
| | | | Full range | | | 68 | | | 73 | |
| $\alpha_{VZ}$ | Average temperature coefficient of reverse breakdown voltage | $I_Z$ = 10 mA | 25°C | | ±20 | | | ±20 | | ppm/°C |
| | | $I_Z$ = 1 mA | 25°C | | ±15 | | | ±15 | | |
| | | | Full range | | | ±100 | | | ±150 | |
| | | $I_L$ = 100 µA | 25°C | | ±15 | | | ±15 | | |
| $\Delta V_Z/\Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,min} < I_Z < 1$ mA | 25°C | | 0.3 | 0.8 | | 0.3 | 1 | mV |
| | | | Full range | | | 1 | | | 1.2 | |
| | | 1 mA < $I_Z$ < 15 mA | 25°C | | 2.5 | 6 | | 2.5 | 8 | |
| | | | Full range | | | 8 | | | 10 | |
| $z_Z$ | Reverse dynamic impedance | $I_Z$ = 1 mA, f = 120 Hz, $I_{AC}$ = 0.1 $I_Z$ | 25°C | | 0.3 | 0.9 | | 0.3 | 1.1 | Ω |
| $e_N$ | Wideband noise | $I_Z$ = 100 µA, 10 Hz ≤ f ≤ 10 kHz | 25°C | | 35 | | | 35 | | $\mu V_{RMS}$ |
| | Long-term stability of reverse breakdown voltage | t = 1000 h, $T_A$ = 25°C ± 0.1°C, $I_Z$ = 100 µA | | | 120 | | | 120 | | ppm |
| $V_{HYST}$ | Thermal hysteresis (see Note 3) | $\Delta T_A$ = −40°C to 125°C | | | 0.08 | | | 0.08 | | % |

NOTE 3: Thermal hysteresis is defined as $V_{Z,25°C}$ (after cycling to −40°C) − $V_{Z,25°C}$ (after cycling to 125°C).

**LM4040x25I electrical characteristics at industrial temperature range (unless otherwise noted) (full-range $T_A$ = −40°C to 85°C)**

| PARAMETER | | TEST CONDITIONS | $T_A$ | LM4040A25I | | | LM4040B25I | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_Z$ | Reverse breakdown voltage | $I_Z$ = 100 µA | 25°C | | 2.5 | | | 2.5 | | V |
| $\Delta V_Z$ | Reverse breakdown voltage tolerance | $I_Z$ = 100 µA | 25°C | −2.5 | | 2.5 | −5 | | 5 | mV |
| | | | Full range | −19 | | 19 | −21 | | 21 | |
| $I_{Z,min}$ | Minimum cathode current | | 25°C | | 45 | 75 | | 45 | 75 | µA |
| | | | Full range | | | 80 | | | 80 | |
| $\alpha_{VZ}$ | Average temperature coefficient of reverse breakdown voltage | $I_Z$ = 10 mA | 25°C | | ±20 | | | ±20 | | ppm/°C |
| | | $I_Z$ = 1 mA | 25°C | | ±15 | | | ±15 | | |
| | | | Full range | | | ±100 | | | ±100 | |
| | | $I_L$ = 100 µA | 25°C | | ±15 | | | ±15 | | |
| $\Delta V_Z/\Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,min} < I_Z < 1$ mA | 25°C | | 0.3 | 0.8 | | 0.3 | 0.8 | mV |
| | | | Full range | | | 1 | | | 1 | |
| | | 1 mA < $I_Z$ < 15 mA | 25°C | | 2.5 | 6 | | 2.5 | 6 | |
| | | | Full range | | | 8 | | | 8 | |
| $Z_Z$ | Reverse dynamic impedance | $I_Z$ = 1 mA, f = 120 Hz, $I_{AC}$ = 0.1 $I_Z$ | 25°C | | 0.3 | 0.8 | | 0.3 | 0.8 | Ω |
| $e_N$ | Wideband noise | $I_Z$ = 100 µA, 10 Hz ≤ f ≤ 10 kHz | 25°C | | 35 | | | 35 | | $\mu V_{RMS}$ |
| | Long-term stability of reverse breakdown voltage | t = 1000 h, $T_A$ = 25°C ± 0.1°C, $I_Z$ = 100 µA | | | 120 | | | 120 | | ppm |
| $V_{HYST}$ | Thermal hysteresis (see Note 3) | $\Delta T_A$ = −40°C to 125°C | | | 0.08 | | | 0.08 | | % |

NOTE 3: Thermal hysteresis is defined as $V_{Z,25°C}$ (after cycling to −40°C) − $V_{Z,25°C}$ (after cycling to 125°C).

**LM4040x25I electrical characteristics at industrial temperature range (unless otherwise noted) (full-range $T_A$ = −40°C to 85°C)**

| PARAMETER | | TEST CONDITIONS | $T_A$ | LM4040C25I | | | LM4040D25I | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_Z$ | Reverse breakdown voltage | $I_Z$ = 100 µA | 25°C | | 2.5 | | | 2.5 | | V |
| $\Delta V_Z$ | Reverse breakdown voltage tolerance | $I_Z$ = 100 µA | 25°C | −12 | | 12 | −25 | | 25 | mV |
| | | | Full range | −29 | | 29 | −49 | | 49 | |
| $I_{Z,min}$ | Minimum cathode current | | 25°C | | 45 | 75 | | 45 | 75 | µA |
| | | | Full range | | | 80 | | | 80 | |
| $\alpha_{VZ}$ | Average temperature coefficient of reverse breakdown voltage | $I_Z$ = 10 mA | 25°C | | ±20 | | | ±20 | | ppm/°C |
| | | $I_Z$ = 1 mA | 25°C | | ±15 | | | ±15 | | |
| | | | Full range | | | ±100 | | | ±150 | |
| | | $I_L$ = 100 µA | 25°C | | ±15 | | | ±15 | | |
| $\Delta V_Z/\Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,min} < I_Z < 1$ mA | 25°C | | 0.3 | 0.8 | | 0.3 | 1 | mV |
| | | | Full range | | | 1 | | | 1.2 | |
| | | 1 mA < $I_Z$ < 15 mA | 25°C | | 2.5 | 6 | | 2.5 | 8 | |
| | | | Full range | | | 8 | | | 10 | |
| $Z_Z$ | Reverse dynamic impedance | $I_Z$ = 1 mA, f = 120 Hz, $I_{AC}$ = 0.1 $I_Z$ | 25°C | | 0.3 | 0.9 | | 0.3 | 1.1 | Ω |
| $e_N$ | Wideband noise | $I_Z$ = 100 µA, 10 Hz ≤ f ≤ 10 kHz | 25°C | | 35 | | | 35 | | $\mu V_{RMS}$ |
| | Long-term stability of reverse breakdown voltage | t = 1000 h, $T_A$ = 25°C ± 0.1°C, $I_Z$ = 100 µA | | | 120 | | | 120 | | ppm |
| $V_{HYST}$ | Thermal hysteresis (see Note 3) | $\Delta T_A$ = −40°C to 125°C | | | 0.08 | | | 0.08 | | % |

NOTE 3: Thermal hysteresis is defined as $V_{Z,25°C}$ (after cycling to −40°C) − $V_{Z,25°C}$ (after cycling to 125°C).

## LM4040x25Q electrical characteristics at extended temperature range (unless otherwise noted) (full-range $T_A$ = −40°C to 125°C)

| PARAMETER | | TEST CONDITIONS | $T_A$ | LM4040C25Q | | | LM4040D25Q | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_Z$ | Reverse breakdown voltage | $I_Z$ = 100 µA | 25°C | | 2.5 | | | 2.5 | | V |
| $\Delta V_Z$ | Reverse breakdown voltage tolerance | $I_Z$ = 100 µA | 25°C | −12 | | 12 | −25 | | 25 | mV |
| | | | Full range | −38 | | 38 | −63 | | 63 | |
| $I_{Z,min}$ | Minimum cathode current | | 25°C | | 45 | 75 | | 45 | 75 | µA |
| | | | Full range | | | 80 | | | 80 | |
| $\alpha_{VZ}$ | Average temperature coefficient of reverse breakdown voltage | $I_Z$ = 10 mA | 25°C | | ±20 | | | ±20 | | ppm/°C |
| | | $I_Z$ = 1 mA | 25°C | | ±15 | | | ±15 | | |
| | | | Full range | | | ±100 | | | ±150 | |
| | | $I_L$ = 100 µA | 25°C | | ±15 | | | ±15 | | |
| $\Delta V_Z/\Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,min} < I_Z < 1$ mA | 25°C | | 0.3 | 0.8 | | 0.3 | 1 | mV |
| | | | Full range | | | 1 | | | 1.2 | |
| | | 1 mA < $I_Z$ < 15 mA | 25°C | | 2.5 | 6 | | 2.5 | 8 | |
| | | | Full range | | | 8 | | | 10 | |
| $Z_Z$ | Reverse dynamic impedance | $I_Z$ = 1 mA, f = 120 Hz, $I_{AC}$ = 0.1 $I_Z$ | 25°C | | 0.3 | 0.9 | | 0.3 | 1.1 | Ω |
| $e_N$ | Wideband noise | $I_Z$ = 100 µA, 10 Hz ≤ f ≤ 10 kHz | 25°C | | 35 | | | 35 | | $\mu V_{RMS}$ |
| | Long-term stability of reverse breakdown voltage | t = 1000 h, $T_A$ = 25°C ± 0.1°C, $I_Z$ = 100 µA | | | 120 | | | 120 | | ppm |
| $V_{HYST}$ | Thermal hysteresis (see Note 3) | $\Delta T_A$ = −40°C to 125°C | | | 0.08 | | | 0.08 | | % |

NOTE 3: Thermal hysteresis is defined as $V_{Z,25°C}$ (after cycling to −40°C) − $V_{Z,25°C}$ (after cycling to 125°C).

**LM4040x30I electrical characteristics at industrial temperature range (unless otherwise noted) (full-range $T_A$ = −40°C to 85°C)**

| PARAMETER | | TEST CONDITIONS | $T_A$ | LM4040A30I | | | LM4040B30I | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_Z$ | Reverse breakdown voltage | $I_Z$ = 100 µA | 25°C | | 3 | | | 3 | | V |
| $\Delta V_Z$ | Reverse breakdown voltage tolerance | $I_Z$ = 100 µA | 25°C | −3 | | 3 | −6 | | 6 | mV |
| | | | Full range | −22 | | 22 | −26 | | 26 | |
| $I_{Z,min}$ | Minimum cathode current | | 25°C | | 47 | 62 | | 47 | 62 | µA |
| | | | Full range | | | 67 | | | 67 | |
| $\alpha_{VZ}$ | Average temperature coefficient of reverse breakdown voltage | $I_Z$ = 10 mA | 25°C | | ±20 | | | ±20 | | ppm/°C |
| | | $I_Z$ = 1 mA | 25°C | | ±15 | | | ±15 | | |
| | | | Full range | | | ±100 | | | ±100 | |
| | | $I_L$ = 100 µA | 25°C | | ±15 | | | ±15 | | |
| $\Delta V_Z/\Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,min} < I_Z < 1$ mA | 25°C | | 0.6 | 0.8 | | 0.6 | 0.8 | mV |
| | | | Full range | | | 1.1 | | | 1.1 | |
| | | 1 mA < $I_Z$ < 15 mA | 25°C | | 2.7 | 6 | | 2.7 | 6 | |
| | | | Full range | | | 9 | | | 9 | |
| $Z_Z$ | Reverse dynamic impedance | $I_Z$ = 1 mA, f = 120 Hz, $I_{AC}$ = 0.1 $I_Z$ | 25°C | | 0.4 | 0.9 | | 0.4 | 0.9 | Ω |
| $e_N$ | Wideband noise | $I_Z$ = 100 µA, 10 Hz ≤ f ≤ 10 kHz | 25°C | | 35 | | | 35 | | $\mu V_{RMS}$ |
| | Long-term stability of reverse breakdown voltage | t = 1000 h, $T_A$ = 25°C ± 0.1°C, $I_Z$ = 100 µA | | | 120 | | | 120 | | ppm |
| $V_{HYST}$ | Thermal hysteresis (see Note 3) | $\Delta T_A$ = −40°C to 125°C | | | 0.08 | | | 0.08 | | % |

NOTE 3: Thermal hysteresis is defined as $V_{Z,25°C}$ (after cycling to −40°C) − $V_{Z,25°C}$ (after cycling to 125°C).

**LM4040x30I electrical characteristics at industrial temperature range (unless otherwise noted) (full-range $T_A$ = −40°C to 85°C)**

| PARAMETER | | TEST CONDITIONS | $T_A$ | LM4040C30I | | | LM4040D30I | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_Z$ | Reverse breakdown voltage | $I_Z$ = 100 µA | 25°C | | 3 | | | 3 | | V |
| $\Delta V_Z$ | Reverse breakdown voltage tolerance | $I_Z$ = 100 µA | 25°C | −15 | | 15 | −30 | | 30 | mV |
| | | | Full range | −34 | | 34 | −59 | | 59 | |
| $I_{Z,min}$ | Minimum cathode current | | 25°C | | 45 | 60 | | 45 | 65 | µA |
| | | | Full range | | | 65 | | | 70 | |
| $\alpha_{VZ}$ | Average temperature coefficient of reverse breakdown voltage | $I_Z$ = 10 mA | 25°C | | ±20 | | | ±20 | | ppm/°C |
| | | $I_Z$ = 1 mA | 25°C | | ±15 | | | ±15 | | |
| | | | Full range | | | ±100 | | | ±150 | |
| | | $I_L$ = 100 µA | 25°C | | ±15 | | | ±15 | | |
| $\Delta V_Z/\Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,min} < I_Z < 1$ mA | 25°C | | 0.4 | 0.8 | | 0.4 | 1.1 | mV |
| | | | Full range | | | 1.1 | | | 1.3 | |
| | | 1 mA < $I_Z$ < 15 mA | 25°C | | 2.7 | 6 | | 2.7 | 8 | |
| | | | Full range | | | 9 | | | 11 | |
| $z_Z$ | Reverse dynamic impedance | $I_Z$ = 1 mA, f = 120 Hz, $I_{AC}$ = 0.1 $I_Z$ | 25°C | | 0.4 | 0.9 | | 0.4 | 1.2 | Ω |
| $e_N$ | Wideband noise | $I_Z$ = 100 µA, 10 Hz ≤ f ≤ 10 kHz | 25°C | | 35 | | | 35 | | $\mu V_{RMS}$ |
| | Long-term stability of reverse breakdown voltage | t = 1000 h, $T_A$ = 25°C ± 0.1°C, $I_Z$ = 100 µA | | | 120 | | | 120 | | ppm |
| $V_{HYST}$ | Thermal hysteresis (see Note 3) | $\Delta T_A$ = −40°C to 125°C | | | 0.08 | | | 0.08 | | % |

NOTE 3: Thermal hysteresis is defined as $V_{Z,25°C}$ (after cycling to −40°C) − $V_{Z,25°C}$ (after cycling to 125°C).

## LM4040x30Q electrical characteristics at extended temperature range (unless otherwise noted) (full-range $T_A$ = −40°C to 125°C)

| PARAMETER | | TEST CONDITIONS | $T_A$ | LM4040C30Q | | | LM4040D30Q | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_Z$ | Reverse breakdown voltage | $I_Z$ = 100 µA | 25°C | | 3 | | | 3 | | V |
| $\Delta V_Z$ | Reverse breakdown voltage tolerance | $I_Z$ = 100 µA | 25°C | −15 | | 15 | −30 | | 30 | mV |
| | | | Full range | −15 | | 45 | −75 | | 75 | |
| $I_{Z,min}$ | Minimum cathode current | | 25°C | | 47 | 62 | | 47 | 67 | µA |
| | | | Full range | | | 70 | | | 75 | |
| $\alpha_{VZ}$ | Average temperature coefficient of reverse breakdown voltage | $I_Z$ = 10 mA | 25°C | | ±20 | | | ±20 | | ppm/°C |
| | | $I_Z$ = 1 mA | 25°C | | ±15 | | | ±15 | | |
| | | | Full range | | | ±100 | | | ±150 | |
| | | $I_L$ = 100 µA | 25°C | | ±15 | | | ±15 | | |
| $\Delta V_Z/\Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,min} < I_Z < 1$ mA | 25°C | | 0.4 | 0.8 | | 0.4 | 1.1 | mV |
| | | | Full range | | | 1.1 | | | 1.3 | |
| | | 1 mA < $I_Z$ < 15 mA | 25°C | | 2.7 | 6 | | 2.7 | 8 | |
| | | | Full range | | | 9 | | | 11 | |
| $Z_Z$ | Reverse dynamic impedance | $I_Z$ = 1 mA, f = 120 Hz, $I_{AC}$ = 0.1 $I_Z$ | 25°C | | 0.4 | 0.9 | | 0.4 | 1.2 | Ω |
| $e_N$ | Wideband noise | $I_Z$ = 100 µA, 10 Hz ≤ f ≤ 10 kHz | 25°C | | 35 | | | 35 | | $\mu V_{RMS}$ |
| | Long-term stability of reverse breakdown voltage | t = 1000 h, $T_A$ = 25°C ± 0.1°C, $I_Z$ = 100 µA | | | 120 | | | 120 | | ppm |
| $V_{HYST}$ | Thermal hysteresis (see Note 3) | $\Delta T_A$ = −40°C to 125°C | | | 0.08 | | | 0.08 | | % |

NOTE 3: Thermal hysteresis is defined as $V_{Z,25°C}$ (after cycling to −40°C) − $V_{Z,25°C}$ (after cycling to 125°C).

**LM4040x41I electrical characteristics at industrial temperature range (unless otherwise noted) (full-range $T_A$ = −40°C to 85°C)**

| PARAMETER | | TEST CONDITIONS | $T_A$ | LM4040A41I | | | LM4040B41I | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_Z$ | Reverse breakdown voltage | $I_Z$ = 100 µA | 25°C | | 4.096 | | | 4.096 | | V |
| $\Delta V_Z$ | Reverse breakdown voltage tolerance | $I_Z$ = 100 µA | 25°C | −4.1 | | 4.1 | −8.2 | | 8.2 | mV |
| | | | Full range | −31 | | 31 | −35 | | 35 | |
| $I_{Z,min}$ | Minimum cathode current | | 25°C | | 50 | 68 | | 50 | 68 | µA |
| | | | Full range | | | 73 | | | 73 | |
| $\alpha_{VZ}$ | Average temperature coefficient of reverse breakdown voltage | $I_Z$ = 10 mA | 25°C | | ±30 | | | ±30 | | ppm/°C |
| | | $I_Z$ = 1 mA | 25°C | | ±20 | | | ±20 | | |
| | | | Full range | | | ±100 | | | ±100 | |
| | | $I_L$ = 100 µA | 25°C | | ±20 | | | ±20 | | |
| $\Delta V_Z/\Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,min} < I_Z < 1$ mA | 25°C | | 0.5 | 0.9 | | 0.5 | 0.9 | mV |
| | | | Full range | | | 1.2 | | | 1.2 | |
| | | 1 mA < $I_Z$ < 15 mA | 25°C | | 3 | 7 | | 3 | 7 | |
| | | | Full range | | | 10 | | | 10 | |
| $Z_Z$ | Reverse dynamic impedance | $I_Z$ = 1 mA, f = 120 Hz, $I_{AC}$ = 0.1 $I_Z$ | 25°C | | 0.5 | 1 | | 0.5 | 1 | Ω |
| $e_N$ | Wideband noise | $I_Z$ = 100 µA, 10 Hz ≤ f ≤ 10 kHz | 25°C | | 80 | | | 80 | | $\mu V_{RMS}$ |
| | Long-term stability of reverse breakdown voltage | t = 1000 h, $T_A$ = 25°C ± 0.1°C, $I_Z$ = 100 µA | | | 120 | | | 120 | | ppm |
| $V_{HYST}$ | Thermal hysteresis (see Note 3) | $\Delta T_A$ = −40°C to 125°C | | | 0.08 | | | 0.08 | | % |

NOTE 3: Thermal hysteresis is defined as $V_{Z,25°C}$ (after cycling to −40°C) − $V_{Z,25°C}$ (after cycling to 125°C).

## LM4040x41I electrical characteristics at industrial temperature range (unless otherwise noted) (full-range $T_A$ = −40°C to 85°C)

| PARAMETER | | TEST CONDITIONS | $T_A$ | LM4040C41I | | | LM4040D41I | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_Z$ | Reverse breakdown voltage | $I_Z$ = 100 µA | 25°C | | 4.096 | | | 4.096 | | V |
| $\Delta V_Z$ | Reverse breakdown voltage tolerance | $I_Z$ = 100 µA | 25°C | −20 | | 20 | −41 | | 41 | mV |
| | | | Full range | −47 | | 47 | −81 | | 81 | |
| $I_{Z,min}$ | Minimum cathode current | | 25°C | | 50 | 68 | | 50 | 73 | µA |
| | | | Full range | | | 73 | | | 78 | |
| $\alpha_{VZ}$ | Average temperature coefficient of reverse breakdown voltage | $I_Z$ = 10 mA | 25°C | | ±30 | | | ±30 | | ppm/°C |
| | | $I_Z$ = 1 mA | 25°C | | ±20 | | | ±20 | | |
| | | | Full range | | | ±100 | | | ±150 | |
| | | $I_L$ = 100 µA | 25°C | | ±20 | | | ±20 | | |
| $\Delta V_Z/\Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,min} < I_Z < 1$ mA | 25°C | | 0.5 | 0.9 | | 0.5 | 1.2 | mV |
| | | | Full range | | | 1.2 | | | 1.5 | |
| | | 1 mA < $I_Z$ < 15 mA | 25°C | | 3 | 7 | | 3 | 9 | |
| | | | Full range | | | 10 | | | 13 | |
| $Z_Z$ | Reverse dynamic impedance | $I_Z$ = 1 mA, f = 120 Hz, $I_{AC}$ = 0.1 $I_Z$ | 25°C | | 0.5 | 1 | | 0.5 | 1.3 | Ω |
| $e_N$ | Wideband noise | $I_Z$ = 100 µA, 10 Hz ≤ f ≤ 10 kHz | 25°C | | 80 | | | 80 | | $\mu V_{RMS}$ |
| | Long-term stability of reverse breakdown voltage | t = 1000 h, $T_A$ = 25°C ± 0.1°C, $I_Z$ = 100 µA | | | 120 | | | 120 | | ppm |
| $V_{HYST}$ | Thermal hysteresis (see Note 3) | $\Delta T_A$ = −40°C to 125°C | | | 0.08 | | | 0.08 | | % |

NOTE 3: Thermal hysteresis is defined as $V_{Z,25°C}$ (after cycling to −40°C) − $V_{Z,25°C}$ (after cycling to 125°C).

**LM4040x50I electrical characteristics at industrial temperature range (unless otherwise noted) (full-range $T_A$ = −40°C to 85°C)**

| PARAMETER | | TEST CONDITIONS | $T_A$ | LM4040A50I | | | LM4040B50I | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_Z$ | Reverse breakdown voltage | $I_Z$ = 100 µA | 25°C | | 5 | | | 5 | | V |
| $\Delta V_Z$ | Reverse breakdown voltage tolerance | $I_Z$ = 100 µA | 25°C | −5 | | 5 | −10 | | 10 | mV |
| | | | Full range | −38 | | 38 | −43 | | 43 | |
| $I_{Z,min}$ | Minimum cathode current | | 25°C | | 54 | 74 | | 54 | 74 | µA |
| | | | Full range | | | 80 | | | 80 | |
| $\alpha_{VZ}$ | Average temperature coefficient of reverse breakdown voltage | $I_Z$ = 10 mA | 25°C | | ±30 | | | ±30 | | ppm/°C |
| | | $I_Z$ = 1 mA | 25°C | | ±20 | | | ±20 | | |
| | | | Full range | | | ±100 | | | ±100 | |
| | | $I_L$ = 100 µA | 25°C | | ±20 | | | ±20 | | |
| $\Delta V_Z/\Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,min} < I_Z < 1$ mA | 25°C | | 0.5 | 1 | | 0.5 | 1 | mV |
| | | | Full range | | | 1.4 | | | 1.4 | |
| | | 1 mA < $I_Z$ < 15 mA | 25°C | | 3.5 | 8 | | 3.5 | 8 | |
| | | | Full range | | | 12 | | | 12 | |
| $Z_Z$ | Reverse dynamic impedance | $I_Z$ = 1 mA, f = 120 Hz, $I_{AC}$ = 0.1 $I_Z$ | 25°C | | 0.5 | 1.1 | | 0.5 | 1.1 | Ω |
| $e_N$ | Wideband noise | $I_Z$ = 100 µA, 10 Hz ≤ f ≤ 10 kHz | 25°C | | 80 | | | 80 | | $\mu V_{RMS}$ |
| | Long-term stability of reverse breakdown voltage | t = 1000 h, $T_A$ = 25°C ± 0.1°C, $I_Z$ = 100 µA | | | 120 | | | 120 | | ppm |
| $V_{HYST}$ | Thermal hysteresis (see Note 3) | $\Delta T_A$ = −40°C to 125°C | | | 0.08 | | | 0.08 | | % |

NOTE 3: Thermal hysteresis is defined as $V_{Z,25°C}$ (after cycling to −40°C) − $V_{Z,25°C}$ (after cycling to 125°C).

**LM4040x50I electrical characteristics at industrial temperature range (unless otherwise noted) (full-range $T_A$ = −40°C to 85°C)**

| PARAMETER | | TEST CONDITIONS | $T_A$ | LM4040C50I | | | LM4040D50I | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_Z$ | Reverse breakdown voltage | $I_Z$ = 100 µA | 25°C | | 5 | | | 5 | | V |
| $\Delta V_Z$ | Reverse breakdown voltage tolerance | $I_Z$ = 100 µA | 25°C | −25 | | 25 | −50 | | 50 | mV |
| | | | Full range | −58 | | 58 | −99 | | 99 | |
| $I_{Z,min}$ | Minimum cathode current | | 25°C | | 54 | 74 | | 54 | 79 | µA |
| | | | Full range | | | 80 | | | 85 | |
| $\alpha_{VZ}$ | Average temperature coefficient of reverse breakdown voltage | $I_Z$ = 10 mA | 25°C | | ±30 | | | ±30 | | ppm/°C |
| | | $I_Z$ = 1 mA | 25°C | | ±20 | | | ±20 | | |
| | | | Full range | | | ±100 | | | ±150 | |
| | | $I_L$ = 100 µA | 25°C | | ±20 | | | ±20 | | |
| $\Delta V_Z/\Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,min} < I_Z < 1$ mA | 25°C | | 0.5 | 1 | | 0.5 | 1.3 | mV |
| | | | Full range | | | 1.4 | | | 1.8 | |
| | | 1 mA < $I_Z$ < 15 mA | 25°C | | 3.5 | 8 | | 3.5 | 10 | |
| | | | Full range | | | 12 | | | 15 | |
| $Z_Z$ | Reverse dynamic impedance | $I_Z$ = 1 mA, f = 120 Hz, $I_{AC}$ = 0.1 $I_Z$ | 25°C | | 0.5 | 1.1 | | 0.5 | 1.5 | Ω |
| $e_N$ | Wideband noise | $I_Z$ = 100 µA, 10 Hz ≤ f ≤ 10 kHz | 25°C | | 80 | | | 80 | | $\mu V_{RMS}$ |
| | Long-term stability of reverse breakdown voltage | t = 1000 h, $T_A$ = 25°C ± 0.1°C, $I_Z$ = 100 µA | | | 120 | | | 120 | | ppm |
| $V_{HYST}$ | Thermal hysteresis (see Note 3) | $\Delta T_A$ = −40°C to 125°C | | | 0.08 | | | 0.08 | | % |

NOTE 3: Thermal hysteresis is defined as $V_{Z,25°C}$ (after cycling to −40°C) − $V_{Z,25°C}$ (after cycling to 125°C).

## LM4040x50Q electrical characteristics at extended temperature range (unless otherwise noted) (full-range $T_A$ = −40°C to 125°C)

| PARAMETER | | TEST CONDITIONS | $T_A$ | LM4040C50Q | | | LM4040D50Q | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_Z$ | Reverse breakdown voltage | $I_Z$ = 100 µA | 25°C | | 5 | | | 5 | | V |
| $\Delta V_Z$ | Reverse breakdown voltage tolerance | $I_Z$ = 100 µA | 25°C | −25 | | 25 | −50 | | 50 | mV |
| | | | Full range | −75 | | 75 | −125 | | 125 | |
| $I_{Z,min}$ | Minimum cathode current | | 25°C | | 54 | 74 | | 54 | 79 | µA |
| | | | Full range | | | 83 | | | 88 | |
| $\alpha_{VZ}$ | Average temperature coefficient of reverse breakdown voltage | $I_Z$ = 10 mA | 25°C | | ±30 | | | ±30 | | ppm/°C |
| | | $I_Z$ = 1 mA | 25°C | | ±20 | | | ±20 | | |
| | | | Full range | | | ±100 | | | ±150 | |
| | | $I_L$ = 100 µA | 25°C | | ±20 | | | ±20 | | |
| $\Delta V_Z/\Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,min} < I_Z < 1$ mA | 25°C | | 0.5 | 1 | | 0.5 | 1 | mV |
| | | | Full range | | | 1.4 | | | 1.8 | |
| | | 1 mA < $I_Z$ < 15 mA | 25°C | | 3.5 | 8 | | 3.5 | 8 | |
| | | | Full range | | | 12 | | | 15 | |
| $Z_Z$ | Reverse dynamic impedance | $I_Z$ = 1 mA, f = 120 Hz, $I_{AC}$ = 0.1 $I_Z$ | 25°C | | 0.5 | 1.1 | | 0.5 | 1.1 | Ω |
| $e_N$ | Wideband noise | $I_Z$ = 100 µA, 10 Hz ≤ f ≤ 10 kHz | 25°C | | 80 | | | 80 | | $\mu V_{RMS}$ |
| | Long-term stability of reverse breakdown voltage | t = 1000 h, $T_A$ = 25°C ± 0.1°C, $I_Z$ = 100 µA | | | 120 | | | 120 | | ppm |
| $V_{HYST}$ | Thermal hysteresis (see Note 3) | $\Delta T_A$ = −40°C to 125°C | | | 0.08 | | | 0.08 | | % |

NOTE 3: Thermal hysteresis is defined as $V_{Z,25°C}$ (after cycling to −40°C) − $V_{Z,25°C}$ (after cycling to 125°C).

## LM4040x82I electrical characteristics at industrial temperature range (unless otherwise noted) (full-range $T_A$ = −40°C to 85°C)

| PARAMETER | | TEST CONDITIONS | $T_A$ | LM4040A82I | | | LM4040B82I | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_Z$ | Reverse breakdown voltage | $I_Z$ = 150 µA | 25°C | | 8.192 | | | 8.192 | | V |
| $\Delta V_Z$ | Reverse breakdown voltage tolerance | $I_Z$ = 150 µA | 25°C | −8.2 | | 8.2 | −16 | | 16 | mV |
| | | | Full range | −61 | | 61 | −70 | | 70 | |
| $I_{Z,min}$ | Minimum cathode current | | 25°C | | 67 | 91 | | 67 | 91 | µA |
| | | | Full range | | | 95 | | | 95 | |
| $\alpha_{VZ}$ | Average temperature coefficient of reverse breakdown voltage | $I_Z$ = 10 mA | 25°C | | ±40 | | | ±40 | | ppm/°C |
| | | $I_Z$ = 1 mA | 25°C | | ±20 | | | ±20 | | |
| | | | Full range | | | ±100 | | | ±100 | |
| | | $I_L$ = 150 µA | 25°C | | ±20 | | | ±20 | | |
| $\Delta V_Z/\Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,min} < I_Z < 1$ mA | 25°C | | 0.6 | 1.3 | | 0.6 | 1.3 | mV |
| | | | Full range | | | 2.5 | | | 2.5 | |
| | | 1 mA < $I_Z$ < 15 mA | 25°C | | 7 | 10 | | 7 | 10 | |
| | | | Full range | | | 18 | | | 18 | |
| $Z_Z$ | Reverse dynamic impedance | $I_Z$ = 1 mA, f = 120 Hz, $I_{AC}$ = 0.1 $I_Z$ | 25°C | | 0.6 | 1.5 | | 0.6 | 1.5 | Ω |
| $e_N$ | Wideband noise | $I_Z$ = 150 µA, 10 Hz ≤ f ≤ 10 kHz | 25°C | | 130 | | | 130 | | $\mu V_{RMS}$ |
| | Long-term stability of reverse breakdown voltage | t = 1000 h, $T_A$ = 25°C ± 0.1°C, $I_Z$ = 150 µA | | | 120 | | | 120 | | ppm |
| $V_{HYST}$ | Thermal hysteresis (see Note 3) | $\Delta T_A$ = −40°C to 125°C | | | 0.08 | | | 0.08 | | % |

NOTE 3: Thermal hysteresis is defined as $V_{Z,25°C}$ (after cycling to −40°C) − $V_{Z,25°C}$ (after cycling to 125°C).

**LM4040x82I electrical characteristics at industrial temperature range (unless otherwise noted) (full-range $T_A$ = −40°C to 85°C)**

| PARAMETER | | TEST CONDITIONS | $T_A$ | LM4040C82I | | | LM4040D82I | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_Z$ | Reverse breakdown voltage | $I_Z$ = 150 µA | 25°C | | 8.192 | | | 8.192 | | V |
| $\Delta V_Z$ | Reverse breakdown voltage tolerance | $I_Z$ = 150 µA | 25°C | −41 | | 41 | −82 | | 82 | mV |
| | | | Full range | −94 | | 94 | −162 | | 162 | |
| $I_{Z,min}$ | Minimum cathode current | | 25°C | | 67 | 91 | | 67 | 96 | µA |
| | | | Full range | | | 95 | | | 100 | |
| $\alpha_{VZ}$ | Average temperature coefficient of reverse breakdown voltage | $I_Z$ = 10 mA | 25°C | | ±40 | | | ±40 | | ppm/°C |
| | | $I_Z$ = 1 mA | 25°C | | ±20 | | | ±20 | | |
| | | | Full range | | | ±100 | | | ±150 | |
| | | $I_L$ = 150 µA | 25°C | | ±20 | | | ±20 | | |
| $\Delta V_Z/\Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,min} < I_Z < 1$ mA | 25°C | | 0.6 | 1.3 | | 0.6 | 1.7 | mV |
| | | | Full range | | | 2.5 | | | 3 | |
| | | 1 mA < $I_Z$ < 15 mA | 25°C | | 7 | 10 | | 7 | 15 | |
| | | | Full range | | | 18 | | | 24 | |
| $Z_Z$ | Reverse dynamic impedance | $I_Z$ = 1 mA, f = 120 Hz, $I_{AC}$ = 0.1 $I_Z$ | 25°C | | 0.6 | 1.5 | | 0.6 | 1.9 | Ω |
| $e_N$ | Wideband noise | $I_Z$ = 150 µA, 10 Hz ≤ f ≤ 10 kHz | 25°C | | 130 | | | 130 | | $\mu V_{RMS}$ |
| | Long-term stability of reverse breakdown voltage | t = 1000 h, $T_A$ = 25°C ± 0.1°C, $I_Z$ = 150 µA | | | 120 | | | 120 | | ppm |
| $V_{HYST}$ | Thermal hysteresis (see Note 3) | $\Delta T_A$ = −40°C to 125°C | | | 0.08 | | | 0.08 | | % |

NOTE 3: Thermal hysteresis is defined as $V_{Z,25°C}$ (after cycling to −40°C) − $V_{Z,25°C}$ (after cycling to 125°C).

## LM4040x10I electrical characteristics at industrial temperature range (unless otherwise noted) (full-range $T_A$ = −40°C to 85°C)

| PARAMETER | | TEST CONDITIONS | $T_A$ | LM4040A10I | | | LM4040B10I | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_Z$ | Reverse breakdown voltage | $I_Z$ = 150 µA | 25°C | | 10 | | | 10 | | V |
| $\Delta V_Z$ | Reverse breakdown voltage tolerance | $I_Z$ = 150 µA | 25°C | −10 | | 10 | −20 | | 20 | mV |
| | | | Full range | −75 | | 75 | −85 | | 85 | |
| $I_{Z,min}$ | Minimum cathode current | | 25°C | | 75 | 100 | | 75 | 100 | µA |
| | | | Full range | | | 103 | | | 103 | |
| $\alpha_{VZ}$ | Average temperature coefficient of reverse breakdown voltage | $I_Z$ = 10 mA | 25°C | | ±40 | | | ±40 | | ppm/°C |
| | | $I_Z$ = 1 mA | 25°C | | ±20 | | | ±20 | | |
| | | | Full range | | | ±100 | | | ±100 | |
| | | $I_L$ = 150 µA | 25°C | | ±20 | | | ±20 | | |
| $\Delta V_Z/\Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,min} < I_Z < 1$ mA | 25°C | | 0.8 | 1.5 | | 0.8 | 1.5 | mV |
| | | | Full range | | | 3.5 | | | 3.5 | |
| | | 1 mA < $I_Z$ < 15 mA | 25°C | | 8 | 12 | | 8 | 12 | |
| | | | Full range | | | 23 | | | 23 | |
| $Z_Z$ | Reverse dynamic impedance | $I_Z$ = 1 mA, f = 120 Hz, $I_{AC}$ = 0.1 $I_Z$ | 25°C | | 0.7 | 1.7 | | 0.7 | 1.7 | Ω |
| $e_N$ | Wideband noise | $I_Z$ = 150 µA, 10 Hz ≤ f ≤ 10 kHz | 25°C | | 180 | | | 180 | | $\mu V_{RMS}$ |
| | Long-term stability of reverse breakdown voltage | t = 1000 h, $T_A$ = 25°C ± 0.1°C, $I_Z$ = 150 µA | | | 120 | | | 120 | | ppm |
| $V_{HYST}$ | Thermal hysteresis (see Note 3) | $\Delta T_A$ = −40°C to 125°C | | | 0.08 | | | 0.08 | | % |

NOTE 3: Thermal hysteresis is defined as $V_{Z,25°C}$ (after cycling to −40°C) − $V_{Z,25°C}$ (after cycling to 125°C).

## LM4040x10I electrical characteristics at industrial temperature range (unless otherwise noted) (full-range $T_A$ = −40°C to 85°C)

| PARAMETER | | TEST CONDITIONS | $T_A$ | LM4040C10I | | | LM4040D10I | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_Z$ | Reverse breakdown voltage | $I_Z$ = 150 µA | 25°C | | 10 | | | 10 | | V |
| $\Delta V_Z$ | Reverse breakdown voltage tolerance | $I_Z$ = 150 µA | 25°C | −50 | | 50 | −100 | | 100 | mV |
| | | | Full range | −115 | | 115 | −198 | | 198 | |
| $I_{Z,min}$ | Minimum cathode current | | 25°C | | 75 | 100 | | 75 | 110 | µA |
| | | | Full range | | | 103 | | | 113 | |
| $\alpha_{VZ}$ | Average temperature coefficient of reverse breakdown voltage | $I_Z$ = 10 mA | 25°C | | ±40 | | | ±40 | | ppm/°C |
| | | $I_Z$ = 1 mA | 25°C | | ±20 | | | ±20 | | |
| | | | Full range | | | ±100 | | | ±150 | |
| | | $I_L$ = 150 µA | 25°C | | ±20 | | | ±20 | | |
| $\Delta V_Z/\Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,min} < I_Z < 1$ mA | 25°C | | 0.8 | 1.5 | | 0.8 | 2 | mV |
| | | | Full range | | | 3.5 | | | 4 | |
| | | 1 mA < $I_Z$ < 15 mA | 25°C | | 8 | 12 | | 8 | 18 | |
| | | | Full range | | | 23 | | | 29 | |
| $z_Z$ | Reverse dynamic impedance | $I_Z$ = 1 mA, f = 120 Hz, $I_{AC}$ = 0.1 $I_Z$ | 25°C | | 0.7 | 1.7 | | 0.7 | 2.3 | Ω |
| $e_N$ | Wideband noise | $I_Z$ = 150 µA, 10 Hz ≤ f ≤ 10 kHz | 25°C | | 180 | | | 180 | | $\mu V_{RMS}$ |
| | Long-term stability of reverse breakdown voltage | t = 1000 h, $T_A$ = 25°C ± 0.1°C, $I_Z$ = 150 µA | | | 120 | | | 120 | | ppm |
| $V_{HYST}$ | Thermal hysteresis (see Note 3) | $\Delta T_A$ = −40°C to 125°C | | | 0.08 | | | 0.08 | | % |

NOTE 3: Thermal hysteresis is defined as $V_{Z,25°C}$ (after cycling to −40°C) − $V_{Z,25°C}$ (after cycling to 125°C).

## start-up characteristics

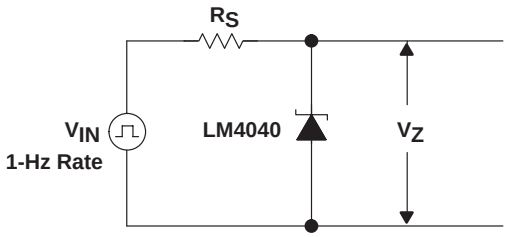



**Figure 1. Test Circuit**

### output capacitor

The LM4040 does not require an output capacitor across cathode and anode for stability. However, if an output bypass capacitor is desired, the LM4040 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.

## TYPICAL CHARACTERISTICS

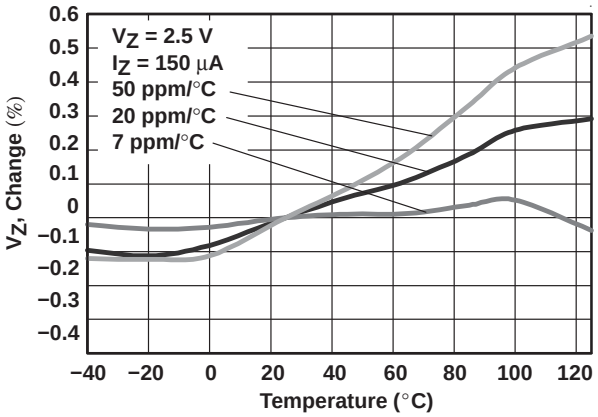



Figure 2. Temperature Drift for Different Average Temperature Coefficients

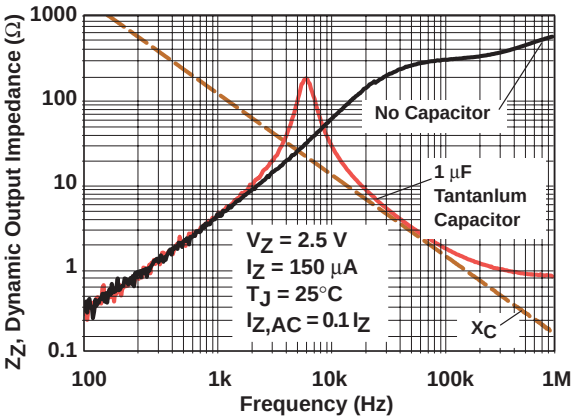



Figure 3. Output Impedance vs Frequency

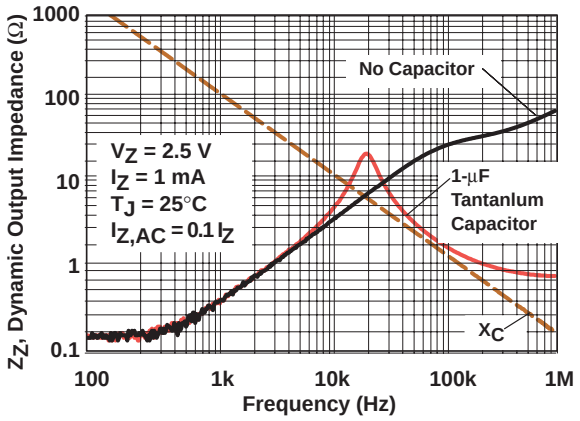



Figure 4. Output Impedance vs Frequency

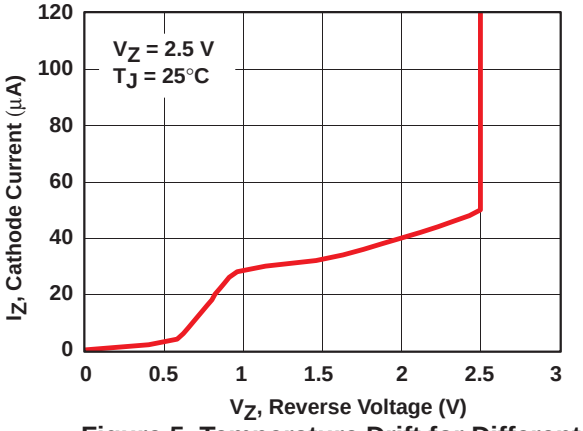



Figure 5. Temperature Drift for Different Average Temperature Coefficient

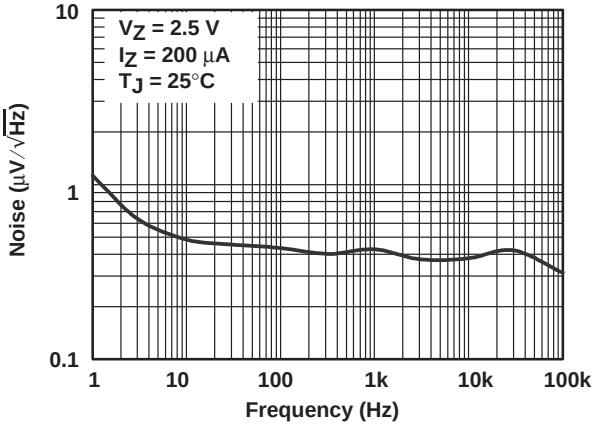



Figure 6. Noise Voltage vs Frequency

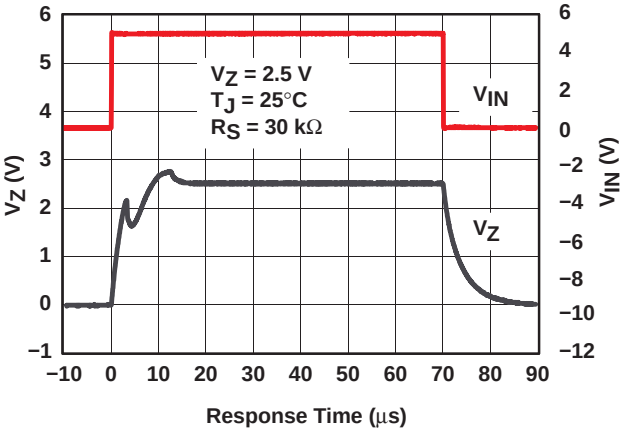



Figure 7. Start-Up Characteristics

## APPLICATION INFORMATION

### use with ADCs or DACs

The LM4040x-41 and LM4040x-82 are designed to be cost-effective voltage reference as required in 12-bit data acquisition systems. For 12-bit systems operating from 5-V supplies such as the ADS7842 (see Figure 2), the LM4040x-41 (4.096 V) permits operation with a LSB of 1 mV. For 12-bit ADCs or DACs operating from supplies of 10 V (or higher), the LM4040x-82 (8.192 V) allows a LSB of 2 mV.

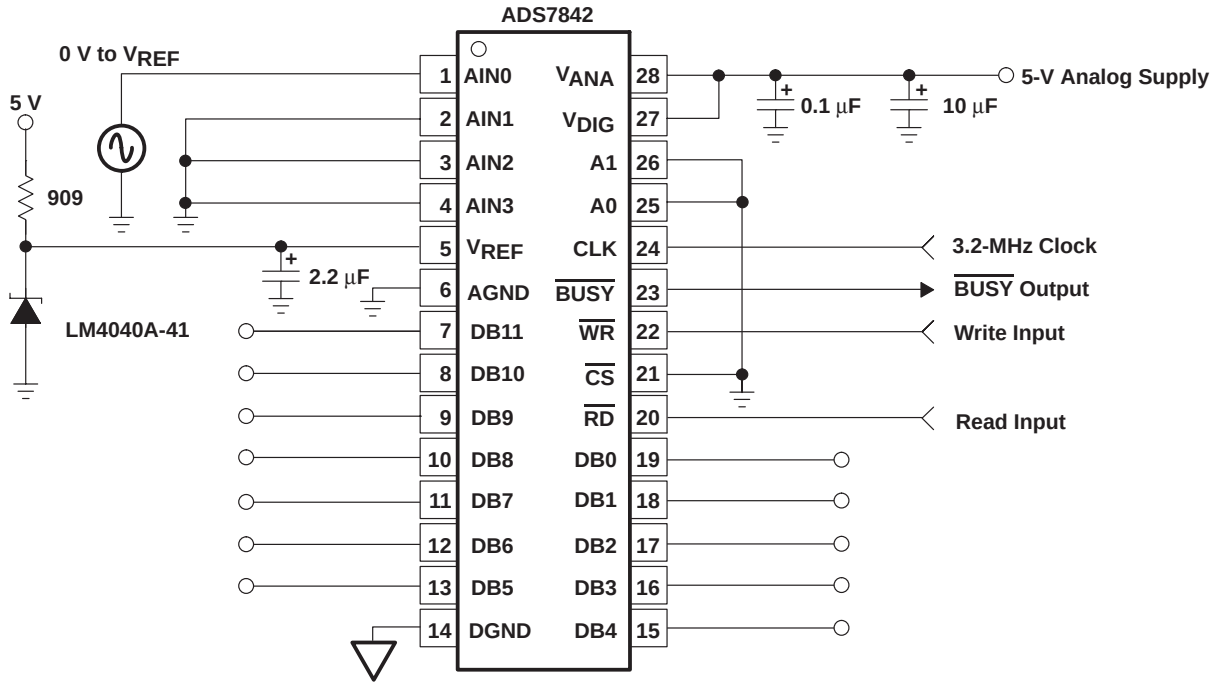



**Figure 8. Data-Acquisition Circuit With LM4040x-41**

## APPLICATION INFORMATION

### cathode and load currents

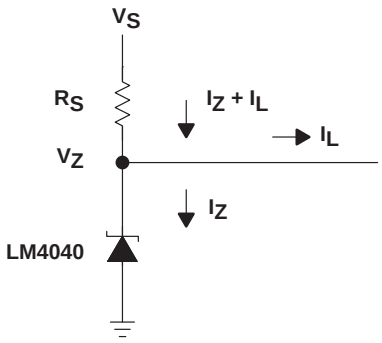



**Figure 9. Shunt Regulator**

In a typical shunt-regulator configuration (see Figure 3), an external resistor, $R_S$, is connected between the supply and the cathode of the LM4040. $R_S$ needs to be set properly, as it sets the total current available to supply the load ($I_L$) and bias the LM4040 ($I_Z$). 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 $V_S$), $R_S$ needs to 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 $I_L$, $R_S$ needs to be large enough to limit $I_Z$ to less than its maximum rated value of 20 mA.

$R_S$ is calculated according to the equation:

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

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) |
|---|---|---|---|---|---|---|---|---|
| LM4040A10IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040A10IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040A10IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040A10ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040A10ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040A25IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040A25IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040A25IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040A25ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040A25ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040A30IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040A30IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040A30IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040A30ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040A30ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040A41IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040A41IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040A41IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040A41ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040A41ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040A50IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040A50IDCKR | PREVIEW | SC70 | DCK | 6 | 3000 | None | Call TI | Call TI |
| LM4040A50ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040A82IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040A82IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040A82IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040A82ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040A82ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040B10IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040B10IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040B10IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040B10ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040B10ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040B25IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040B25IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040B25IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040B25ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040B25ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040B30IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040B30IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040B30IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040B30ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) |
|---|---|---|---|---|---|---|---|---|
| LM4040B30ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040B41IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040B41IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040B41IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040B41ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040B41ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040B50IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040B50IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040B50IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040B50ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040B50ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040B82IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040B82IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040B82IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040B82ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040B82ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040C10IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040C10IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040C10IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040C10ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040C10ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040C20QDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040C20QDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040C25IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040C25IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040C25IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040C25ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040C25ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040C25QDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040C25QDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040C30IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040C30IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040C30ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040C30ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040C30QDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040C30QDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040C41IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040C41IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040C41IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040C41ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040C41ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040C50IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040C50IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) |
|---|---|---|---|---|---|---|---|---|
| LM4040C50IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040C50ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040C50ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040C50QDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040C50QDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040C82IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040C82IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040C82IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040C82ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040C82ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040D10IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040D10IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040D10IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040D10ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040D10ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040D20QDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040D20QDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040D25IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040D25IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040D25IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040D25ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040D25ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040D25QDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040D25QDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040D30IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040D30IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040D30IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040D30ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040D30ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040D30QDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040D30QDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040D41IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040D41IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040D41IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040D41ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040D41ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040D50IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040D50IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040D50IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040D50ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040D50ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |
| LM4040D50QDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040D50QDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |

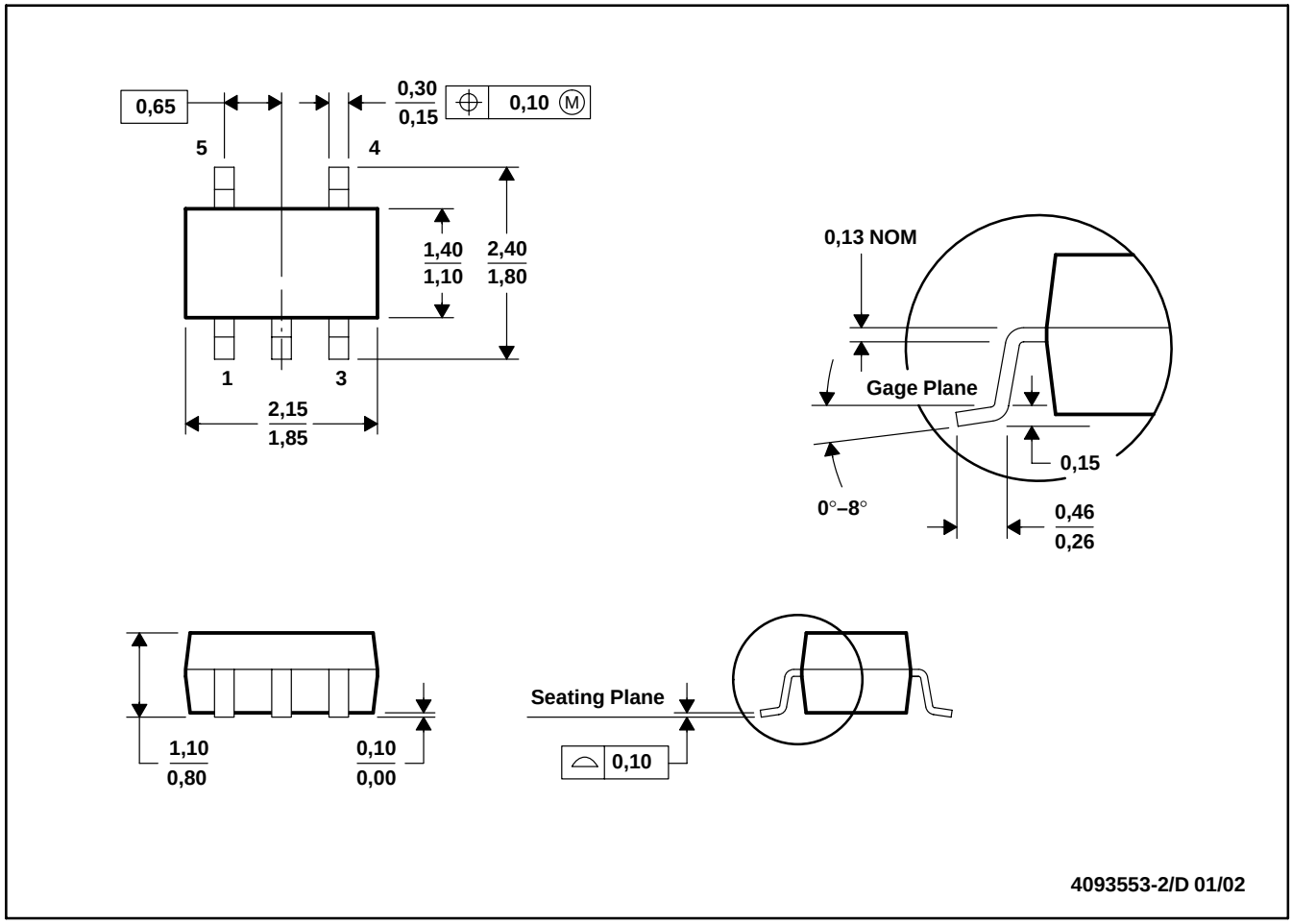
| Orderable Device | Status [1] | Package Type | Package Drawing | Pins | Package Qty | Eco Plan [2] | Lead/Ball Finish | MSL Peak Temp [3] |
|---|---|---|---|---|---|---|---|---|
| LM4040D82IDBZR | PREVIEW | SOT-23 | DBZ | 3 | 3000 | None | Call TI | Call TI |
| LM4040D82IDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | None | Call TI | Call TI |
| LM4040D82IDCKR | PREVIEW | SC70 | DCK | 5 | 3000 | None | Call TI | Call TI |
| LM4040D82ILP | PREVIEW | TO-92 | LP | 3 | 1000 | None | Call TI | Call TI |
| LM4040D82ILPR | PREVIEW | TO-92 | LP | 3 | 2000 | None | Call TI | Call TI |

[1] The marketing status values are defined as follows:
**ACTIVE:** Product device recommended for new designs.
**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.
**OBSOLETE:** TI has discontinued the production of the device.

[2] Eco Plan - May not be currently available - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
**None:** Not yet available Lead (Pb-Free).
**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" and in addition, uses package materials that do not contain halogens, including bromine (Br) or antimony (Sb) above 0.1% of total product weight.

[3] MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDECindustry standard classifications, and peak solder temperature.

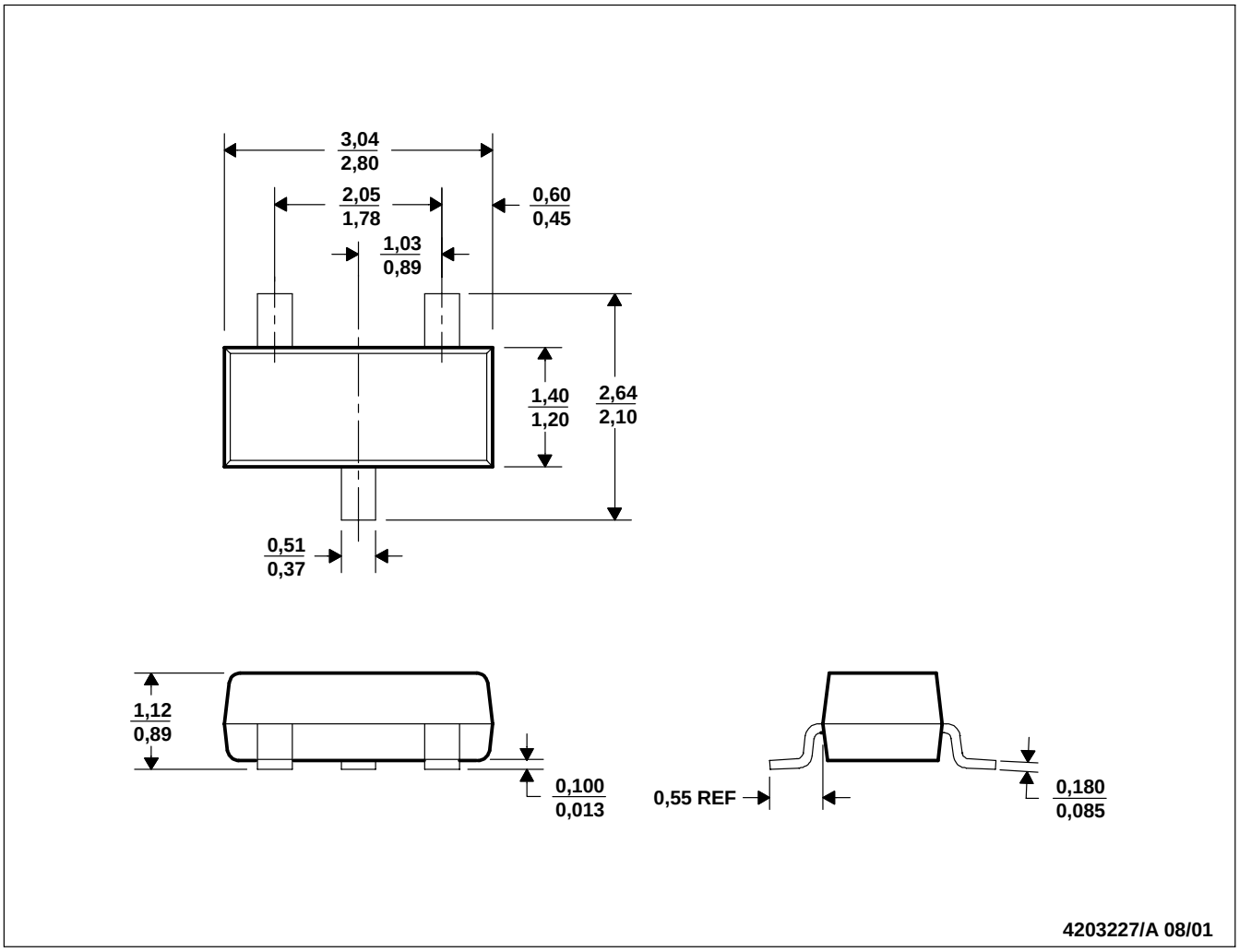
**DCK (R-PDSO-G5)** **PLASTIC SMALL-OUTLINE PACKAGE**




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

MPDS108 – AUGUST 2001

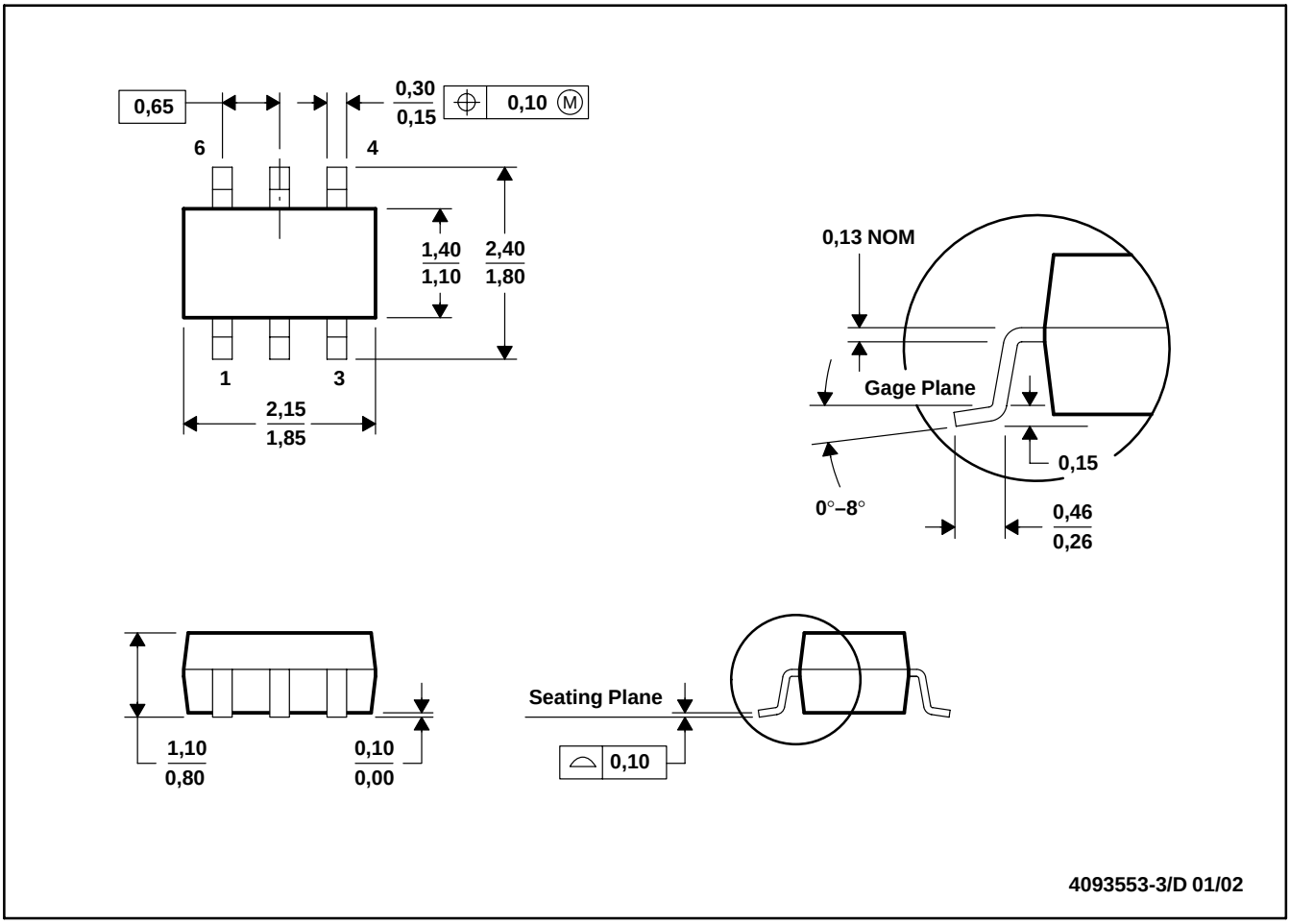
**DBZ (R-PDSO-G3)** **PLASTIC SMALL-OUTLINE**




NOTES: A. All linear dimensions are in millimeters.
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.

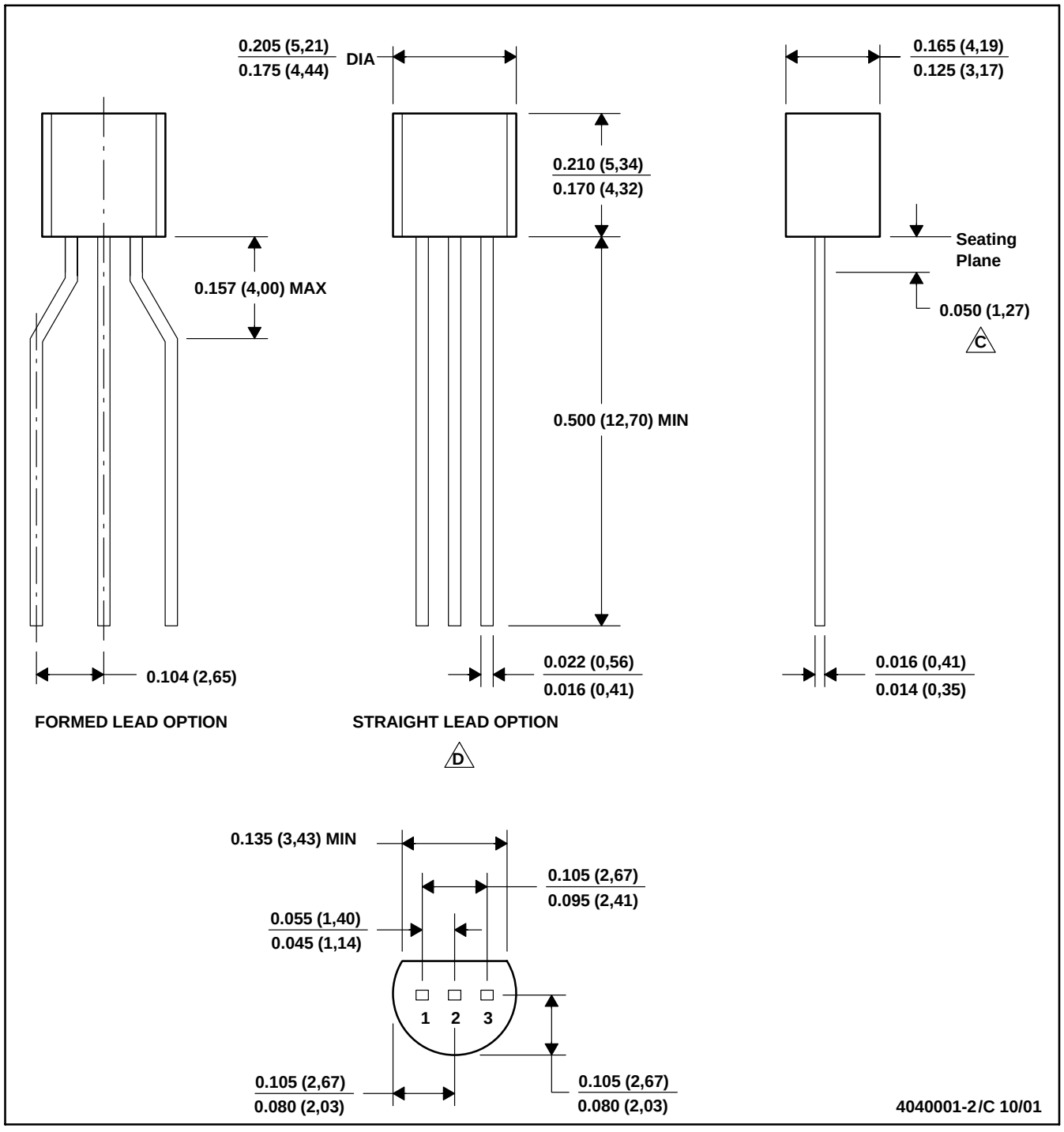
MPDS114 – FEBRUARY 2002

**DCK (R-PDSO-G6)** **PLASTIC SMALL-OUTLINE PACKAGE**



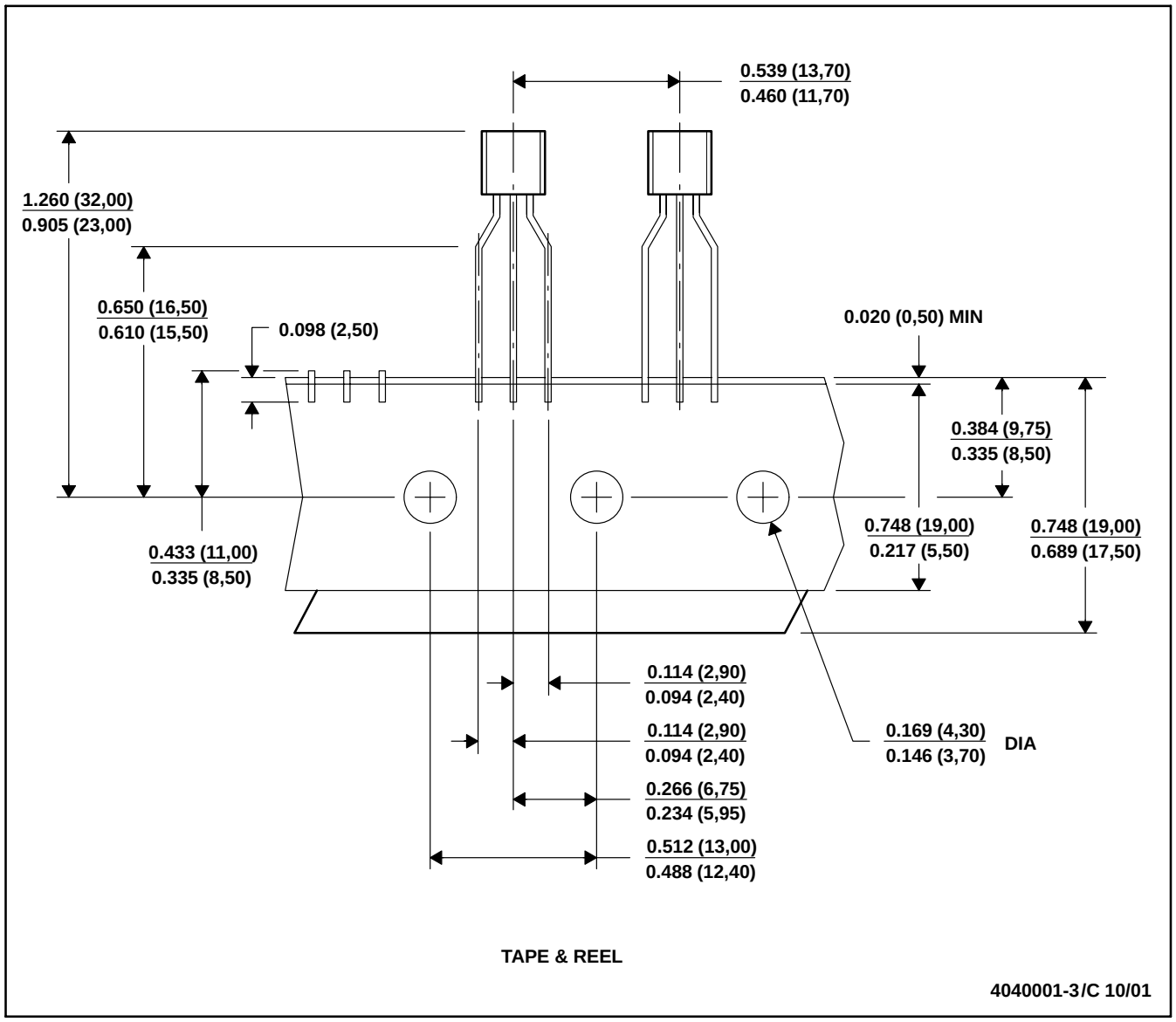

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion.
D. Falls within JEDEC MO-203

**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.

**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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