

PRECISION MICROPOWER SHUNT VOLTAGE REFERENCE

 Check for Samples: [TL4050-Q1](#)

FEATURES

- Qualified for Automotive Applications
- Fixed Output Voltages of 2.048 V, 2.5 V, 4.096 V, 5 V
- Tight Output Tolerances and Low Temperature Coefficient
 - Max 0.1%, 50 ppm/°C – A Grade
 - Max 0.2%, 50 ppm/°C – B Grade
 - Max 0.5%, 50 ppm/°C – C Grade
- Low Output Noise: 41 μV_{RMS} Typ
- Wide Operating Current Range: 60 μA Typ to 15 mA
- Stable With All Capacitive Loads; No Output

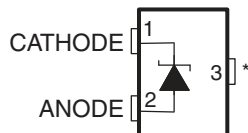
Capacitor Required

- Available in Extended Temperature Range: –40°C to 125°C

APPLICATIONS

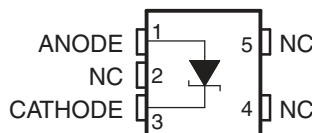
- Data-Acquisition Systems
- Power Supplies and Power-Supply Monitors
- Instrumentation and Test Equipment
- Process Controls
- Precision Audio
- Automotive Electronics
- Energy Management
- Battery-Powered Equipment

DBZ (SOT-23-3) PACKAGE
(TOP VIEW)



*Pin 3 is attached to Substrate and must be connected to ANODE or left open.

DCK (SC-70) PACKAGE
(TOP VIEW)



NC – No internal connection

DESCRIPTION

The TL4050-Q1 family of shunt voltage references are versatile easy-to-use references suitable for a wide array of applications. The two-terminal fixed-output device requires no external 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 TL4050-Q1 is available in three initial tolerances, ranging from 0.1% (maximum) for the A grade to 0.5% (maximum) for the C grade. Thus, a great deal of flexibility is available to designers in choosing the best cost-to-performance ratio for their applications. Packaged in the space-saving SOT-23-3 and SC-70 packages and requiring a minimum current of 45 μA (typical), the TL4050-Q1 also is ideal for portable applications.

The TL4050x-Q1 characterization is for operation over an ambient temperature range of –40°C to 125°C.

PACKAGE AND ORDERING INFORMATION

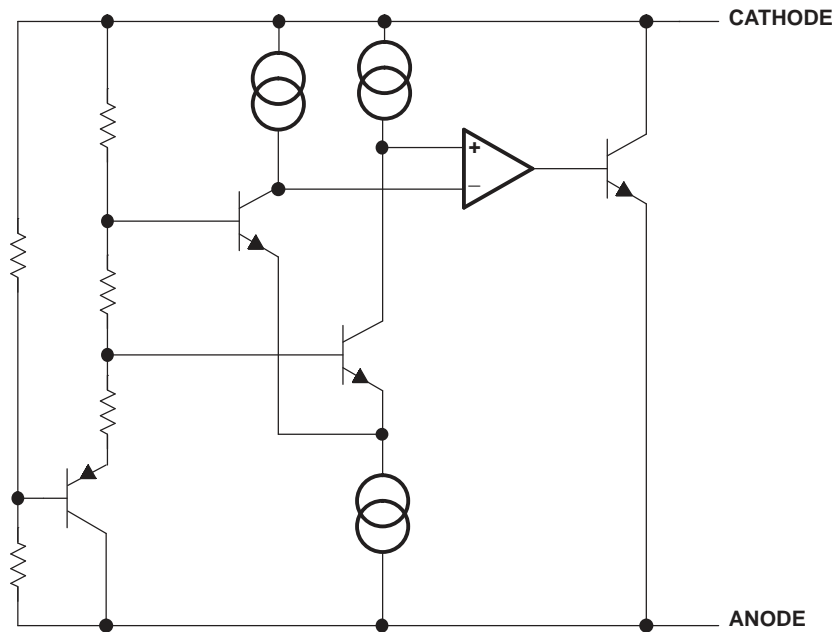
For the most-current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI Web site at www.ti.com.

Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.



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.

FUNCTIONAL BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS⁽¹⁾

over free-air temperature range (unless otherwise noted)

| | | MIN | MAX | UNIT |
|-----------|--|-----|-----|------|
| I_Z | Continuous cathode current | -10 | 20 | mA |
| 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.

THERMAL INFORMATION

| THERMAL METRIC ⁽¹⁾ | TL4050-Q1 | | UNIT |
|--|-----------|--------|------|
| | DBZ | DCK | |
| | 3 PINS | 5 PINS | |
| θ_{JA} Junction-to-ambient thermal resistance ⁽²⁾ | 331.1 | 289.9 | °C/W |
| θ_{JcTop} Junction-to-case (top) thermal resistance ⁽³⁾ | 107.5 | 56.4 | °C/W |
| θ_{JB} Junction-to-board thermal resistance ⁽⁴⁾ | 63.4 | 93 | °C/W |
| ψ_{JT} Junction-to-top characterization parameter ⁽⁵⁾ | 4.9 | 0.7 | °C/W |
| ψ_{JB} Junction-to-board characterization parameter ⁽⁶⁾ | 61.7 | 91.4 | °C/W |
| θ_{JcBot} Junction-to-case (bottom) thermal resistance ⁽⁷⁾ | N/A | N/A | °C/W |

- (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](#).
- (2) The junction-to-ambient thermal resistance under natural convection is obtained in a simulation on a JEDEC-standard, high-K board, as specified in JESD51-7, in an environment described in JESD51-2a.
- (3) The junction-to-case (top) thermal resistance is obtained by simulating a cold plate test on the package top. No specific JEDEC-standard test exists, but a close description can be found in the ANSI SEMI standard G30-88.
- (4) The junction-to-board thermal resistance is obtained by simulating in an environment with a ring cold plate fixture to control the PCB temperature, as described in JESD51-8.
- (5) The junction-to-top characterization parameter, ψ_{JT} , estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining θ_{JA} , using a procedure described in JESD51-2a (sections 6 and 7).
- (6) The junction-to-board characterization parameter, ψ_{JB} , estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining θ_{JA} , using a procedure described in JESD51-2a (sections 6 and 7).
- (7) The junction-to-case (bottom) thermal resistance is obtained by simulating a cold plate test on the exposed (power) pad. No specific JEDEC standard test exists, but a close description can be found in the ANSI SEMI standard G30-88.

RECOMMENDED OPERATING CONDITIONS

| | | MIN | MAX | UNIT | |
|-------|----------------------|---------------|-----|------|----|
| I_Z | Cathode current | (1) | 15 | mA | |
| T_A | Free-air temperature | I temperature | -40 | 85 | °C |
| | | Q temperature | -40 | 125 | |

- (1) See parametric tables

TL4050x20-Q1 ELECTRICAL CHARACTERISTICS

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

| PARAMETER | TEST CONDITIONS | T_A | TL4050A20-Q1 | | | TL4050B20-Q1 | | | TL4050C20-Q1 | | | UNIT |
|---------------------------------|---|----------------------|--------------|--------|-----|--------------|---------|-----|--------------|---------|---------------|----------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_Z | Reverse breakdown voltage $I_Z = 100 \mu\text{A}$ | 25°C | 2.048 | | | 2.048 | | | 2.048 | | | V |
| ΔV_Z | Reverse breakdown voltage tolerance $I_Z = 100 \mu\text{A}$ | 25°C | -2.048 | 2.048 | | -4.096 | 4.096 | | -10.24 | 10.24 | | mV |
| | | Full range | -12.288 | 12.288 | | -14.7456 | 14.7456 | | -17.2032 | 17.2032 | | |
| $I_{Z,\text{min}}$ | Minimum cathode current | 25°C | 41 | | 60 | | 41 | | 60 | | μA | |
| | | Full range | | | 65 | | | | 65 | | | |
| α_{VZ} | Average temperature coefficient of reverse breakdown voltage $I_Z = 10 \text{ mA}$ | 25°C | ± 20 | | | ± 20 | | | ± 20 | | | ppm/ $^{\circ}\text{C}$ |
| | | 25°C | ± 15 | | | ± 15 | | | ± 15 | | | |
| | | 25°C | ± 15 | | | ± 15 | | | ± 15 | | | |
| | | Full range | ± 50 | | | ± 50 | | | ± 50 | | | |
| $\frac{\Delta V_Z}{\Delta I_Z}$ | Reverse breakdown voltage change with cathode current change $I_{Z,\text{min}} < I_Z < 1 \text{ mA}$ | 25°C | 0.3 | 0.8 | | 0.3 | 0.8 | | 0.3 | 0.8 | | mV |
| | | Full range | | | 1.2 | | | | 1.2 | | | |
| | $1 \text{ mA} < I_Z < 15 \text{ mA}$ | 25°C | 2.3 | 6 | | 2.3 | 6 | | 2.3 | 6 | | |
| | | Full range | | | 8 | | | | 8 | | | |
| Z_Z | Reverse dynamic impedance $I_Z = 1 \text{ mA}$, $f = 120 \text{ Hz}$, $I_{AC} = 0.1 I_Z$ | 25°C | 0.3 | | | 0.3 | | | 0.3 | | | Ω |
| e_N | Wideband noise $I_Z = 100 \mu\text{A}$, $10 \text{ Hz} \leq f \leq 10 \text{ kHz}$ | 25°C | 34 | | | 34 | | | 34 | | | μV_{RMS} |
| | Long-term stability of reverse breakdown voltage $t = 1000 \text{ h}$, $T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$, $I_Z = 100 \mu\text{A}$ | | 120 | | | 120 | | | 120 | | | ppm |
| V_{HYST} | Thermal hysteresis ⁽¹⁾ $\Delta T_A = -40^{\circ}\text{C}$ to 125°C | | 0.7 | | | 0.7 | | | 0.7 | | | mV |

(1) Thermal hysteresis is defined as $V_{Z,25^{\circ}\text{C}}$ (after cycling to -40°C) – $V_{Z,25^{\circ}\text{C}}$ (after cycling to 125°C).

TL4050x25-Q1 ELECTRICAL CHARACTERISTICS

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

| PARAMETER | TEST CONDITIONS | T_A | TL4050B25-Q1 | | | UNIT |
|---------------------------------|--|--|--------------------|----------|----------|----------------------------|
| | | | MIN | TYP | MAX | |
| V_Z | Reverse breakdown voltage | $I_Z = 100\ \mu\text{A}$ | | 2.5 | | V |
| ΔV_Z | Reverse breakdown voltage tolerance | $I_Z = 100\ \mu\text{A}$ | | | 5 | mV |
| | | Full range | -5 | | 18 | |
| $I_{Z,\text{min}}$ | Minimum cathode current | $I_Z = 100\ \mu\text{A}$ | | 41 | 60 | μA |
| | | Full range | -18 | | 65 | |
| α_{VZ} | Average temperature coefficient of reverse breakdown voltage | $I_Z = 10\ \text{mA}$ | 25°C | ± 20 | | ppm/ $^\circ\text{C}$ |
| | | $I_Z = 1\ \text{mA}$ | 25°C | ± 15 | | |
| | | $I_Z = 100\ \mu\text{A}$ | 25°C | ± 15 | | |
| | | Full range | | | ± 50 | |
| $\frac{\Delta V_Z}{\Delta I_Z}$ | Reverse breakdown voltage change with cathode current change | $I_{Z,\text{min}} < I_Z < 1\ \text{mA}$ | 25°C | 0.3 | 0.8 | mV |
| | | | Full range | | | |
| | | $1\ \text{mA} < I_Z < 15\ \text{mA}$ | 25°C | 2.3 | 6 | |
| | | | Full range | | | |
| Z_Z | Reverse dynamic impedance | $I_Z = 1\ \text{mA}$, $f = 120\ \text{Hz}$, $I_{AC} = 0.1\ I_Z$ | 25°C | 0.3 | | Ω |
| e_N | Wideband noise | $I_Z = 100\ \mu\text{A}$, $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$ | 25°C | 41 | | μV_{RMS} |
| | Long-term stability of reverse breakdown voltage | $t = 1000\ \text{h}$, $T_A = 25^\circ\text{C} \pm 0.1^\circ\text{C}$, $I_Z = 100\ \mu\text{A}$ | | 120 | | ppm |
| V_{HYST} | Thermal hysteresis ⁽¹⁾ | $\Delta T_A = -40^\circ\text{C}$ to 125°C | | 0.7 | | mV |

 (1) Thermal hysteresis is defined as $V_{Z,25^\circ\text{C}}$ (after cycling to -40°C) – $V_{Z,25^\circ\text{C}}$ (after cycling to 125°C).

TL4050x41-Q1 ELECTRICAL CHARACTERISTICS

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

| PARAMETER | TEST CONDITIONS | T_A | TL4050B41-Q1 | | | UNIT |
|---------------------------------|--|--|--------------|----------|----------|----------------------------|
| | | | MIN | TYP | MAX | |
| V_Z | Reverse breakdown voltage | $I_Z = 100\ \mu\text{A}$ | | 4.096 | | V |
| ΔV_Z | Reverse breakdown voltage tolerance | $I_Z = 100\ \mu\text{A}$ | 25°C | -8.2 | 8.2 | mV |
| | | | Full range | -29 | 29 | |
| $I_{Z,\text{min}}$ | Minimum cathode current | | 25°C | 52 | 68 | μA |
| | | | Full range | | 78 | |
| α_{VZ} | Average temperature coefficient of reverse breakdown voltage | $I_Z = 10\ \text{mA}$ | 25°C | ± 30 | | ppm/°C |
| | | $I_Z = 1\ \text{mA}$ | 25°C | ± 20 | | |
| | | $I_Z = 100\ \mu\text{A}$ | 25°C | ± 20 | | |
| | | | Full range | | ± 50 | |
| $\frac{\Delta V_Z}{\Delta I_Z}$ | Reverse breakdown voltage change with cathode current change | $I_{Z,\text{min}} < I_Z < 1\ \text{mA}$ | 25°C | 0.2 | 0.9 | mV |
| | | | Full range | | | |
| | | $1\ \text{mA} < I_Z < 15\ \text{mA}$ | 25°C | 2 | 7 | |
| | | | Full range | | | |
| Z_Z | Reverse dynamic impedance | $I_Z = 1\ \text{mA}$, $f = 120\ \text{Hz}$, $I_{AC} = 0.1\ I_Z$ | 25°C | 0.5 | | Ω |
| e_N | Wideband noise | $I_Z = 100\ \mu\text{A}$, $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$ | 25°C | 93 | | μV_{RMS} |
| | Long-term stability of reverse breakdown voltage | $t = 1000\ \text{h}$, $T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$, $I_Z = 100\ \mu\text{A}$ | | 120 | | ppm |
| V_{HYST} | Thermal hysteresis ⁽¹⁾ | $\Delta T_A = -40^{\circ}\text{C}$ to 125°C | | 1.148 | | mV |

(1) Thermal hysteresis is defined as $V_{Z,25^{\circ}\text{C}}$ (after cycling to -40°C) – $V_{Z,25^{\circ}\text{C}}$ (after cycling to 125°C).

TL4050x50-Q1 ELECTRICAL CHARACTERISTICS

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

| PARAMETER | TEST CONDITIONS | T_A | TL4050A50-Q1 | | | TL4050B50-Q1 | | | TL4050C50-Q1 | | | UNIT | | | | |
|---------------------------------|--|--|--------------|----------|-----|--------------|----------|-----|--------------|----------|-----|------|----------------------------|-----|--|---------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | | | | | |
| V_Z | Reverse breakdown voltage | $I_Z = 100\ \mu\text{A}$ | 5 | | | 5 | | | 5 | | | V | | | | |
| ΔV_Z | Reverse breakdown voltage tolerance | $I_Z = 100\ \mu\text{A}$ | 25°C | -5 | | 5 | | -10 | | 10 | | -25 | | 25 | | mV |
| | | | Full range | -30 | | 30 | | -35 | | 35 | | -50 | | 50 | | |
| $I_{Z,\text{min}}$ | Minimum cathode current | | 25°C | 56 | | 74 | | 56 | | 74 | | 56 | | 74 | | μA |
| | | | Full range | | | 90 | | | | 90 | | | | 90 | | |
| α_{V_Z} | Average temperature coefficient of reverse breakdown voltage | $I_Z = 10\ \text{mA}$ | 25°C | ± 30 | | | ± 30 | | | ± 30 | | | ppm/°C | | | |
| | | $I_Z = 1\ \text{mA}$ | 25°C | ± 20 | | | ± 20 | | | ± 20 | | | | | | |
| | | $I_Z = 100\ \mu\text{A}$ | 25°C | ± 20 | | | ± 20 | | | ± 20 | | | | | | |
| | | | Full range | ± 50 | | | ± 50 | | | ± 50 | | | | | | |
| $\frac{\Delta V_Z}{\Delta I_Z}$ | Reverse breakdown voltage change with cathode current change | $I_{Z,\text{min}} < I_Z < 1\ \text{mA}$ | 25°C | 0.2 | | 1 | | 0.2 | | 1 | | 0.2 | | 1 | | mV |
| | | | Full range | | | 1.4 | | | | 1.4 | | | | 1.4 | | |
| | | $1\ \text{mA} < I_Z < 15\ \text{mA}$ | 25°C | 2 | | 8 | | 2 | | 8 | | 2 | | 8 | | |
| | | | Full range | | | 12 | | | | 12 | | | | 12 | | |
| Z_Z | Reverse dynamic impedance | $I_Z = 1\ \text{mA}$, $f = 120\ \text{Hz}$, $I_{AC} = 0.1 I_Z$ | 25°C | 0.5 | | | 0.5 | | | 0.5 | | | Ω | | | |
| e_N | Wideband noise | $I_Z = 100\ \mu\text{A}$, $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$ | 25°C | 93 | | | 93 | | | 93 | | | μV_{RMS} | | | |
| | Long-term stability of reverse breakdown voltage | $t = 1000\ \text{h}$, $T_A = 25^\circ\text{C} \pm 0.1^\circ\text{C}$, $I_Z = 100\ \mu\text{A}$ | | 120 | | | 120 | | | 120 | | | ppm | | | |
| V_{HYST} | Thermal hysteresis ⁽¹⁾ | $\Delta T_A = -40^\circ\text{C}$ to 125°C | | 1.4 | | | 1.4 | | | 1.4 | | | mV | | | |

 (1) Thermal hysteresis is defined as $V_{Z,25^\circ\text{C}}$ (after cycling to -40°C) – $V_{Z,25^\circ\text{C}}$ (after cycling to 125°C).

TYPICAL CHARACTERISTICS

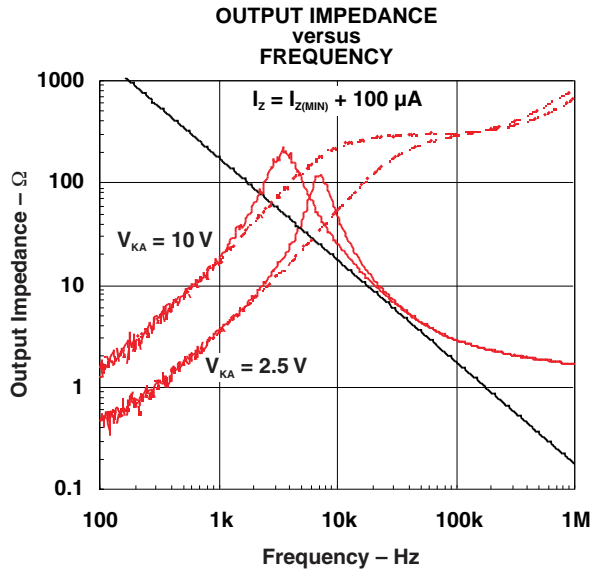


Figure 1.

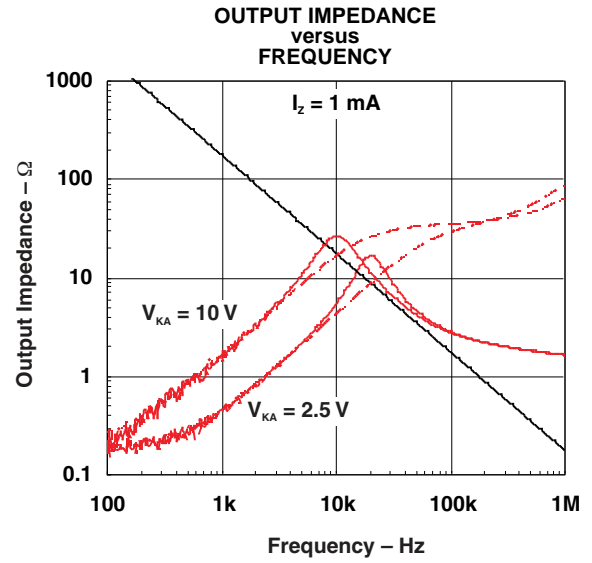


Figure 2.

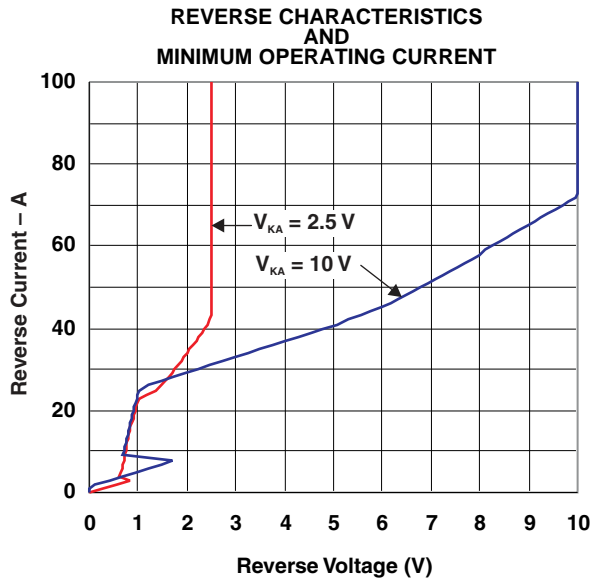


Figure 3.

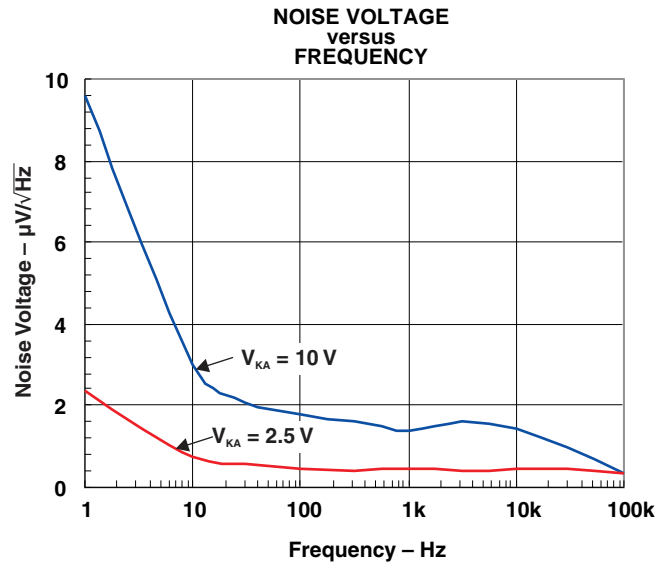


Figure 4.

TYPICAL CHARACTERISTICS (continued)

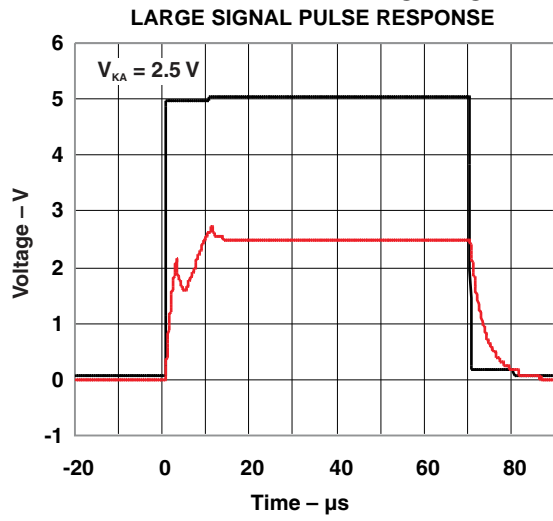


Figure 5.

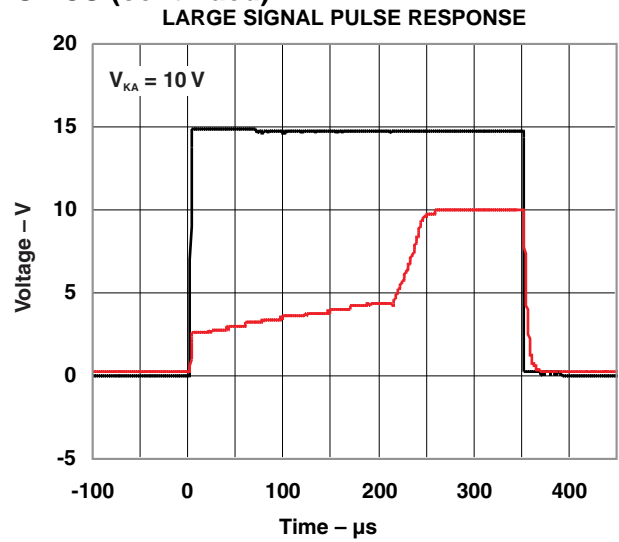


Figure 6.

APPLICATION INFORMATION

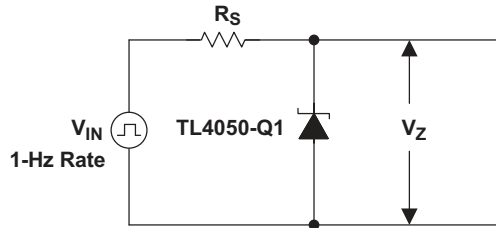


Figure 7. Start-Up Test Circuit

Output Capacitor

The TL4050-Q1 does not require an output capacitor across cathode and anode for stability. However, in an application using an output bypass capacitor, the TL4050-Q1 is stable with all capacitive loads.

SOT-23-3 Pin Connections

There is a parasitic Schottky diode connected between pins 2 and 3 of the SOT-23-3 packaged device. Thus, pin 3 of the SOT-23-3 package must be left floating or connected to pin 2.

Use With ADCs or DACs

The design of the TL4050x41-Q1 is as a 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 8), the TL4050x41-Q1 (4.096 V) permits operation with an LSB of 1 mV.

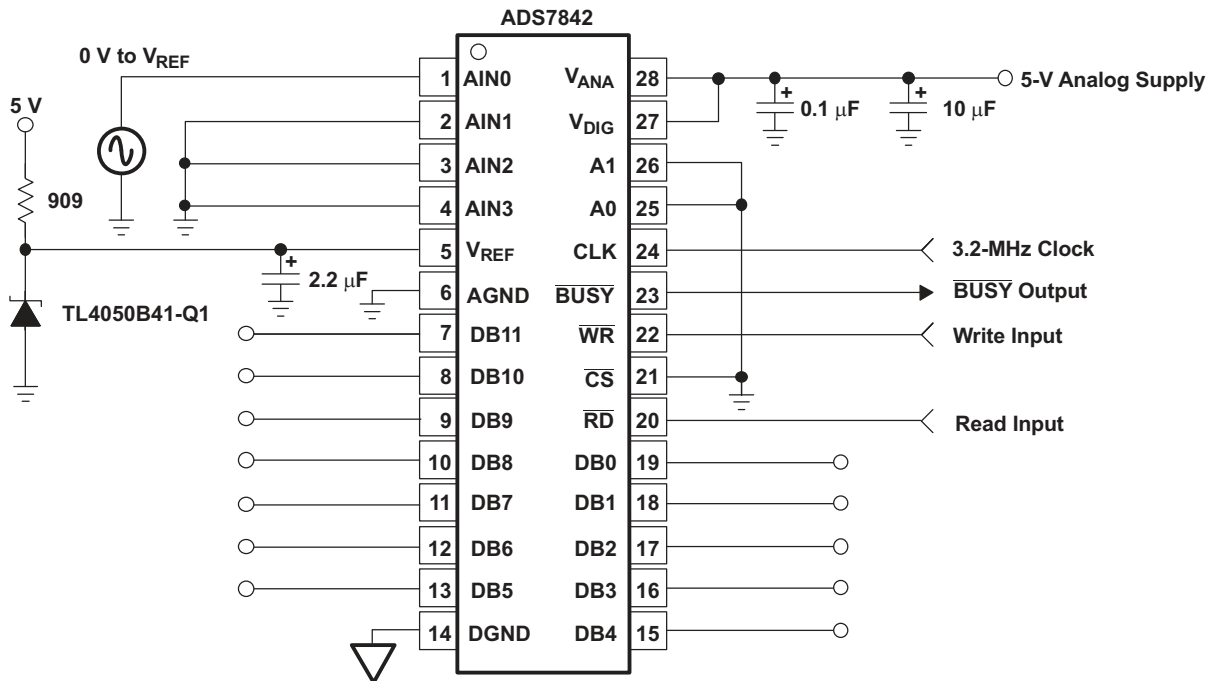


Figure 8. Data-Acquisition Circuit With TL4050x41-Q1

Cathode and Load Currents

In a typical shunt-regulator configuration (see [Figure 9](#)), an external resistor, R_S , connects between the supply and the cathode of the TL4050-Q1. Proper choice of R_S is essential, as R_S sets the total current available to supply the load (I_L) and bias the TL4050-Q1 (I_Z). In all cases, I_Z must stay within a specified range for proper operation of the reference. Taking into consideration one extreme in the variation of the load and supply voltage (maximum I_L and minimum V_S), R_S must be small enough to supply the minimum I_Z required for operation of the regulator, as given by data-sheet parameters. At the other extreme, maximum V_S and minimum I_L , R_S must be large enough to limit I_Z to less than its maximum-rated value of 15 mA.

[Equation 1](#) calculates R_S :

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

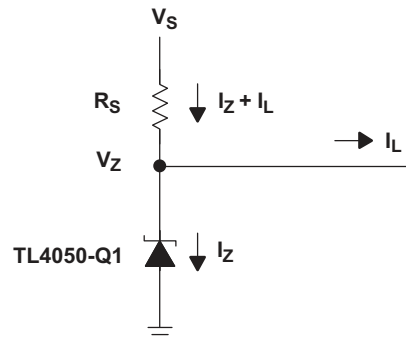


Figure 9. Shunt Regulator

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| TL4050A50QDBZRQ1 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | TLGU | Samples |
| TL4050A50QDCKRQ1 | ACTIVE | SC70 | DCK | 5 | 3000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 7GU | Samples |
| TL4050B25QDBZRQ1 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | TLHU | Samples |
| TL4050B25QDCKRQ1 | ACTIVE | SC70 | DCK | 5 | 3000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 7HU | Samples |
| TL4050B41QDBZRQ1 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | TMXU | Samples |
| TL4050B50QDBZRQ1 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | TLJU | Samples |
| TL4050B50QDCKRQ1 | ACTIVE | SC70 | DCK | 5 | 3000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 7JU | Samples |
| TL4050C20QDBZRQ1 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | TMYU | Samples |
| TL4050C50QDBZRQ1 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | TKZU | Samples |

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

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

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

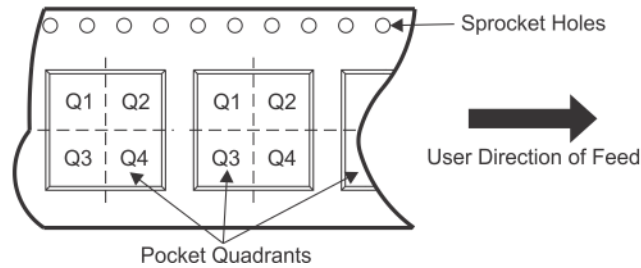
Important Information and Disclaimer:The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION



QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TL4050A50QDBZRQ1 | SOT-23 | DBZ | 3 | 3000 | 179.0 | 8.4 | 3.15 | 2.95 | 1.22 | 4.0 | 8.0 | Q3 |
| TL4050A50QDCKRQ1 | SC70 | DCK | 5 | 3000 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| TL4050B25QDBZRQ1 | SOT-23 | DBZ | 3 | 3000 | 179.0 | 8.4 | 3.15 | 2.95 | 1.22 | 4.0 | 8.0 | Q3 |
| TL4050B25QDCKRQ1 | SC70 | DCK | 5 | 3000 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| TL4050B41QDBZRQ1 | SOT-23 | DBZ | 3 | 3000 | 179.0 | 8.4 | 3.15 | 2.95 | 1.22 | 4.0 | 8.0 | Q3 |
| TL4050B50QDBZRQ1 | SOT-23 | DBZ | 3 | 3000 | 179.0 | 8.4 | 3.15 | 2.95 | 1.22 | 4.0 | 8.0 | Q3 |
| TL4050B50QDCKRQ1 | SC70 | DCK | 5 | 3000 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| TL4050C20QDBZRQ1 | SOT-23 | DBZ | 3 | 3000 | 179.0 | 8.4 | 3.15 | 2.95 | 1.22 | 4.0 | 8.0 | Q3 |
| TL4050C50QDBZRQ1 | SOT-23 | DBZ | 3 | 3000 | 179.0 | 8.4 | 3.15 | 2.95 | 1.22 | 4.0 | 8.0 | Q3 |

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TL4050A50QDBZRQ1 | SOT-23 | DBZ | 3 | 3000 | 200.0 | 183.0 | 25.0 |
| TL4050A50QDCKRQ1 | SC70 | DCK | 5 | 3000 | 200.0 | 183.0 | 25.0 |
| TL4050B25QDBZRQ1 | SOT-23 | DBZ | 3 | 3000 | 200.0 | 183.0 | 25.0 |
| TL4050B25QDCKRQ1 | SC70 | DCK | 5 | 3000 | 200.0 | 183.0 | 25.0 |
| TL4050B41QDBZRQ1 | SOT-23 | DBZ | 3 | 3000 | 200.0 | 183.0 | 25.0 |
| TL4050B50QDBZRQ1 | SOT-23 | DBZ | 3 | 3000 | 200.0 | 183.0 | 25.0 |
| TL4050B50QDCKRQ1 | SC70 | DCK | 5 | 3000 | 200.0 | 183.0 | 25.0 |
| TL4050C20QDBZRQ1 | SOT-23 | DBZ | 3 | 3000 | 200.0 | 183.0 | 25.0 |
| TL4050C50QDBZRQ1 | SOT-23 | DBZ | 3 | 3000 | 200.0 | 183.0 | 25.0 |

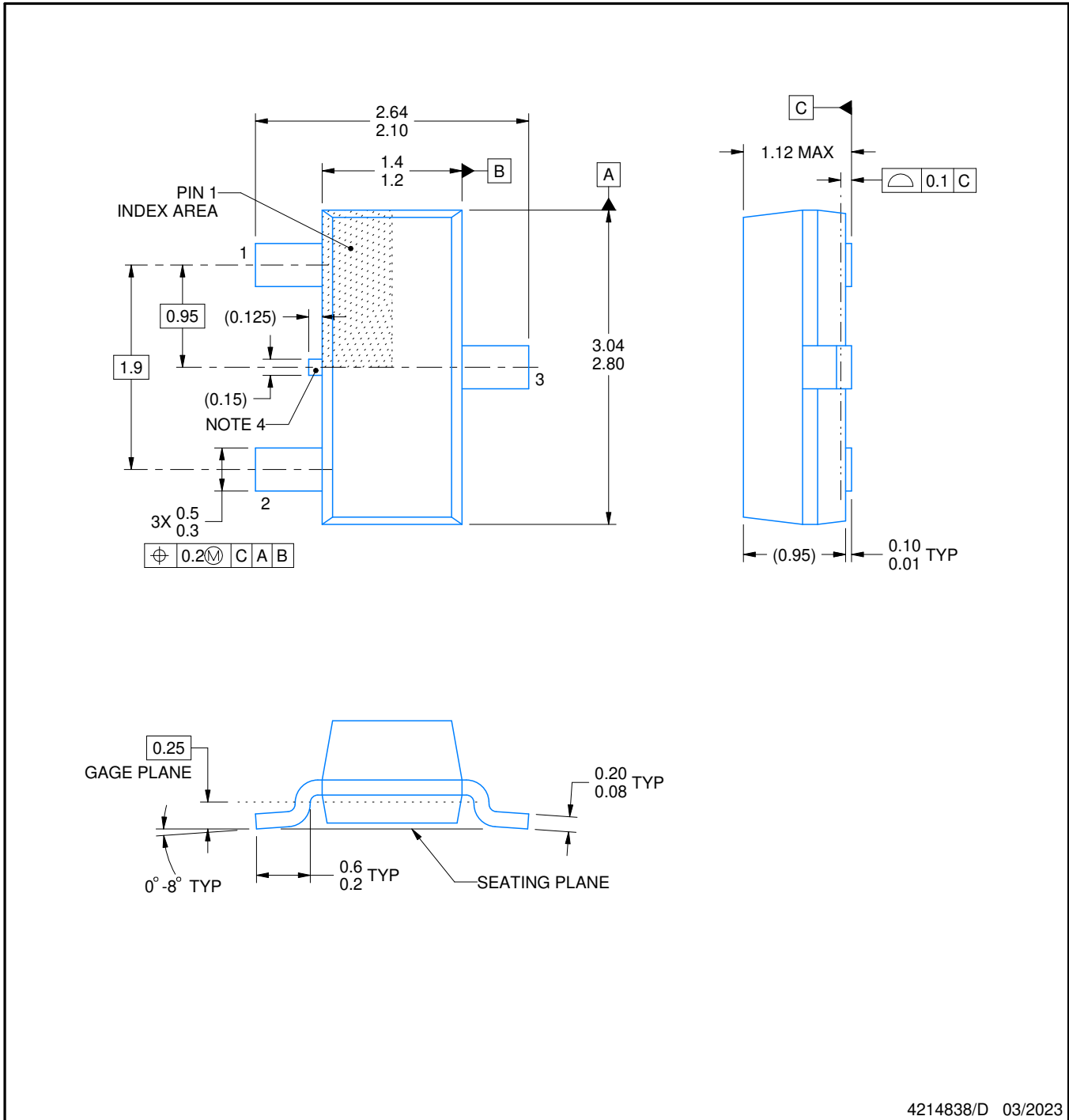
DBZ0003A



PACKAGE OUTLINE

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



4214838/D 03/2023

NOTES:

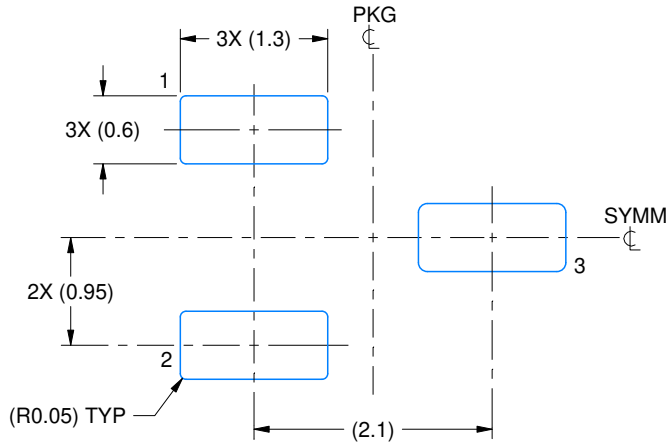
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC registration TO-236, except minimum foot length.
4. Support pin may differ or may not be present.

EXAMPLE BOARD LAYOUT

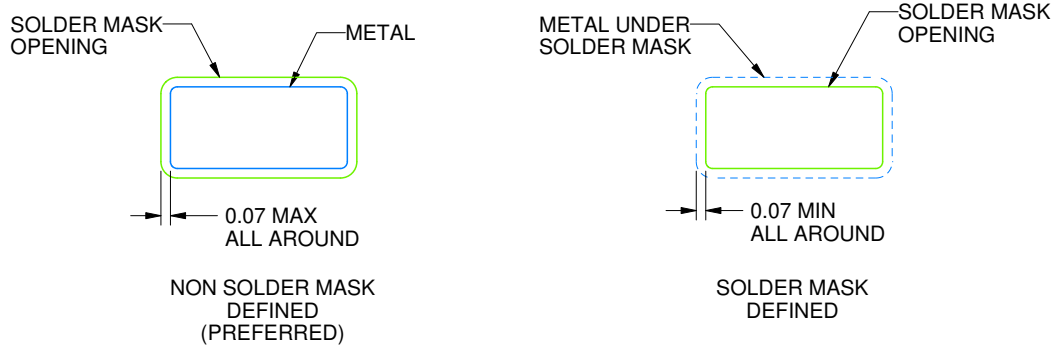
DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
SCALE:15X



SOLDER MASK DETAILS

4214838/D 03/2023

NOTES: (continued)

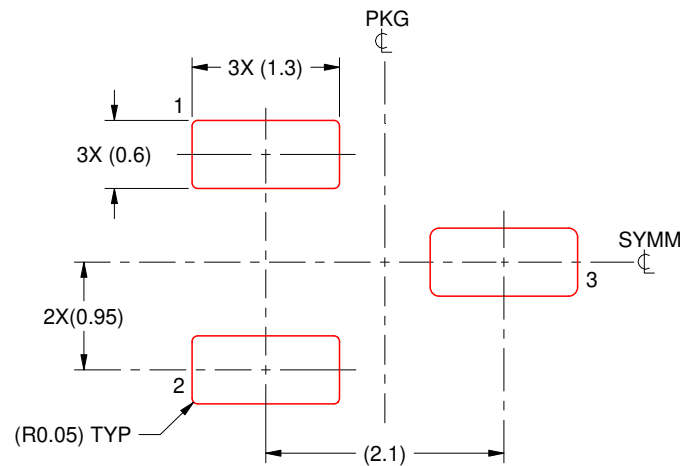
4. Publication IPC-7351 may have alternate designs.
5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



SOLDER PASTE EXAMPLE
BASED ON 0.125 THICK STENCIL
SCALE:15X

4214838/D 03/2023

NOTES: (continued)

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

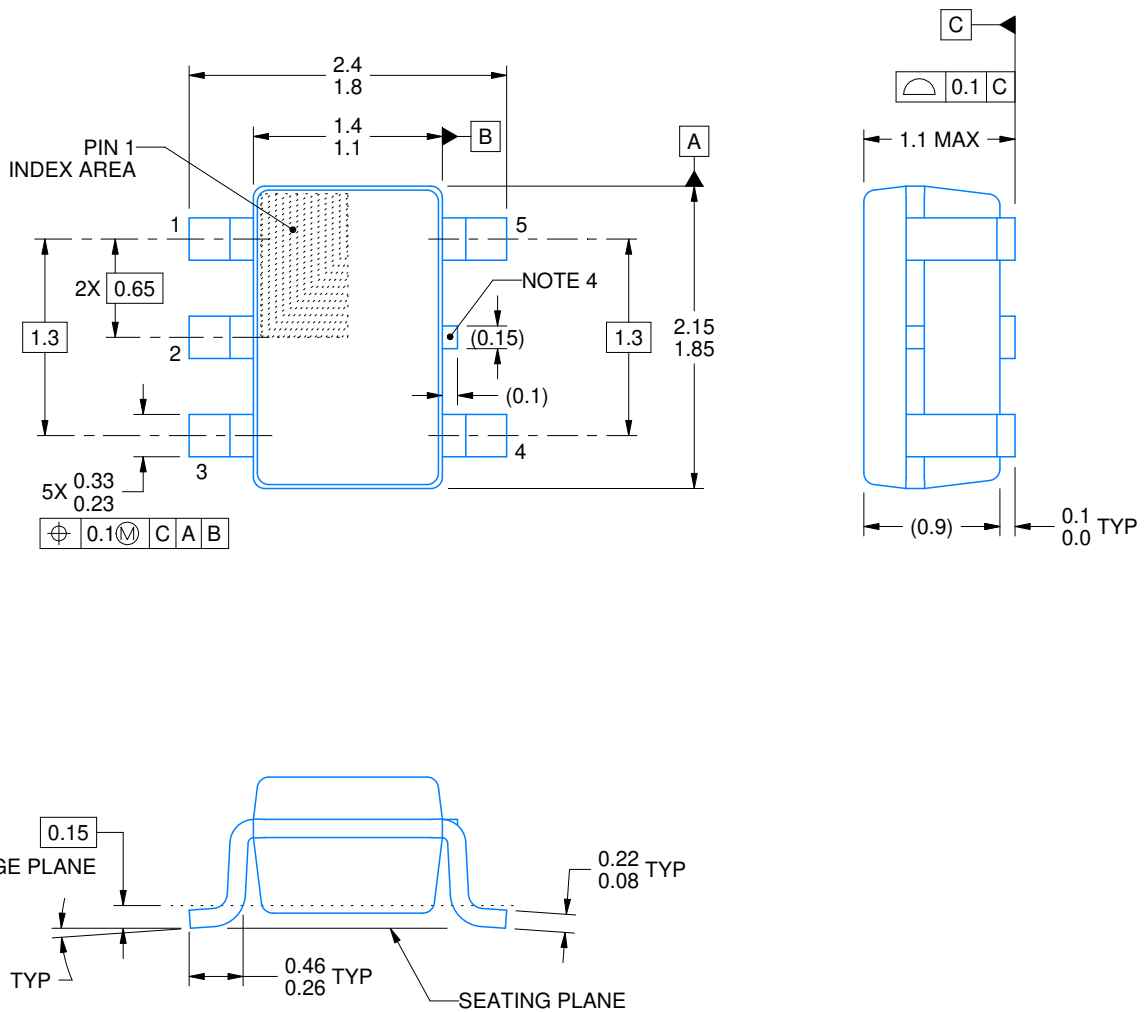
DCK0005A



PACKAGE OUTLINE

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



4214834/C 03/2023

NOTES:

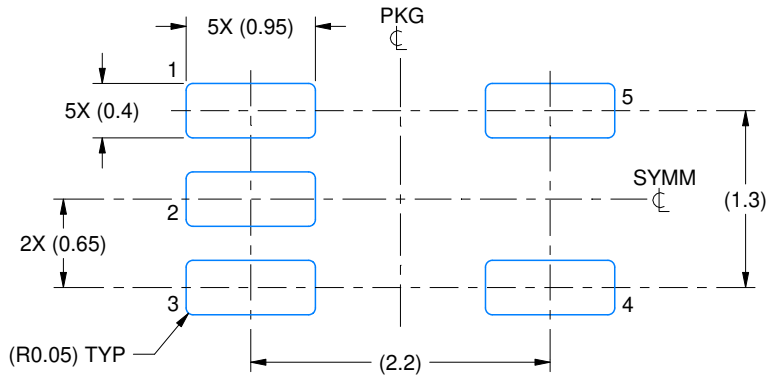
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC MO-203.
4. Support pin may differ or may not be present.

EXAMPLE BOARD LAYOUT

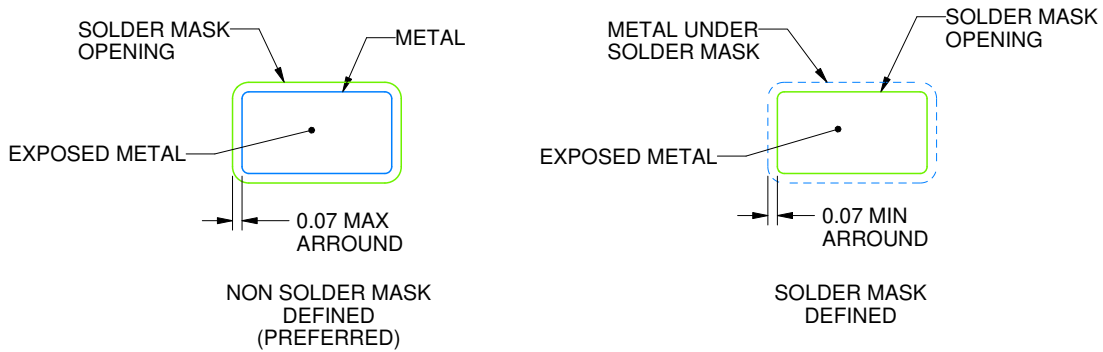
DCK0005A

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:18X



SOLDER MASK DETAILS

4214834/C 03/2023

NOTES: (continued)

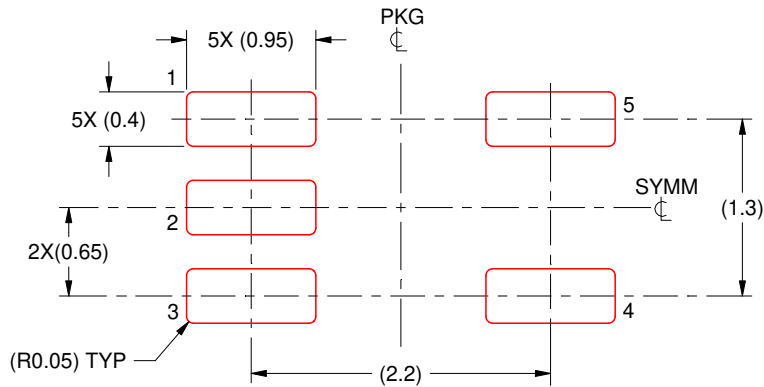
- 4. Publication IPC-7351 may have alternate designs.
- 5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DCK0005A

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



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

4214834/C 03/2023

NOTES: (continued)

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

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#) or other applicable terms available either on [ti.com](https://www.ti.com) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2023, Texas Instruments Incorporated