
LM4041 Precision Micropower Shunt Voltage Reference

1 Features

- 1.225V Fixed and adjustable outputs (1.225V to 10V)
- Tight output tolerances and low temperature coefficient
 - Maximum 0.1%, 100ppm/°C – A grade
 - Maximum 0.2%, 100ppm/°C – B grade
 - Maximum 0.5%, 100ppm/°C – C grade
 - Maximum 1.0%, 150ppm/°C – D grade
- Low output noise . . . 20 μ V_{RMS} (typical)
- Wide operating current range . . . 45 μ A (typical) to 12mA
- Stable with all capacitive loads; no output capacitor required
- Available in
 - Industrial temperature: –40°C to 85°C
 - Extended temperature: –40°C to 125°C

2 Applications

- [Data-Acquisition Systems](#)
- [Power Supplies and Power-Supply Monitors](#)
- [Instrumentation and Test Equipment](#)
- [Process Control](#)
- [Precision Audio](#)
- [Automotive Electronics](#)
- [Energy Management/Metering](#)
- [Battery-Powered Equipment](#)

3 Description

The LM4041 series of shunt voltage references are versatile, easy-to-use references designed for a wide array of applications. These parts do not require external capacitors for operation and are stable with all capacitive loads. Additionally, the reference offers low dynamic impedance, low noise, and a low temperature coefficient to maintain a stable output voltage over a wide range of operating currents and temperatures. The LM4041 uses fuse and Zener-zap reverse breakdown voltage trim during wafer sort to offer four output voltage tolerances, ranging from 0.1% (maximum) for the A grade to 1% (maximum) for the D grade. Thus, a great deal of flexibility is offered to designers in choosing the best cost-to-performance ratio for applications. The LM4041 is available in a fixed (1.225V nominal) or an adjustable version (which requires an external resistor divider to set the output to a value between 1.225V and 10V).

Packaged in space-saving SC-70 and SOT-23-3 and requiring a minimum current of 45 μ A (typical), the LM4041 also designed for portable applications. The TO-92 package also is available for through-hole packaging needs. The LM4041xl is characterized for operation over an ambient temperature range of –40°C to 85°C. The LM4041xQ is characterized for operation over an ambient temperature range of –40°C to 125°C.

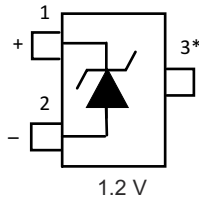


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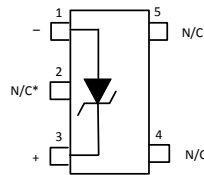
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4 Pin Configuration and Functions

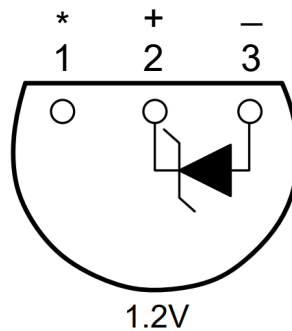
Pin Functions



**Figure 4-1. DBZ Package
3-Pin SOT-23
Top View**



**Figure 4-2. DCK Package
5-Pin SC70
Top View**



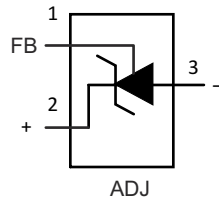
**Figure 4-3. LP Package
3-Pin TO-92
Bottom View**

Pin Functions

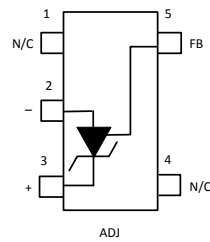
| NAME | PIN | | | I/O | DESCRIPTION |
|---------|--------|------|-------|-----|---|
| | SOT-23 | SC70 | TO-92 | | |
| Anode | 2 | 1 | 3 | O | Anode pin, normally grounded |
| Cathode | 1 | 3 | 2 | I/O | Shunt current and output voltage |
| FB | — | — | — | I | Feedback pin for adjustable output voltage |
| NC* | 3 | 2 | 1 | — | **Must float or connect to anode ⁽¹⁾ |
| NC | — | 4, 5 | — | — | No connect |

(1) In applications with high electromagnetic interference (for example, when placed near transformers or other electromagnetic sources) or significant high-frequency switching noise, TI recommends to connect this pin to the anode.

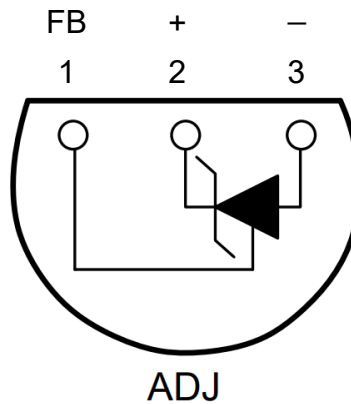
Pin Functions: ADJ Pinouts



**Figure 4-4. DBZ Package
3-Pin SOT-23
Top View**



**Figure 4-5. DCK Package
5-Pin SC70
Top View**



**Figure 4-6. LP Package
3-Pin TO-92
Bottom View**

| NAME | PIN | | | I/O | DESCRIPTION |
|---------|--------|------|-------|-----|--|
| | SOT-23 | SC70 | TO-92 | | |
| Anode | 3 | 2 | 3 | O | Anode pin, normally grounded |
| Cathode | 2 | 3 | 2 | I/O | Shunt current and output voltage |
| FB | 1 | 5 | 1 | I | Feedback pin for adjustable output voltage |
| NC** | — | — | — | — | **Must float or connect to anode |
| NC | — | 1, 4 | — | — | No connect |

5 Specifications

5.1 Absolute Maximum Ratings

over free-air temperature range (unless otherwise noted)

| | | MIN | MAX ⁽¹⁾ | UNIT |
|------------------|--|-------------|--------------------|------|
| V _Z | Continuous cathode voltage | | 15 | V |
| I _Z | Continuous cathode current | -10 | 25 | mA |
| θ _{JA} | Package thermal impedance ^{(2) (3)} | DBZ package | 206 | °C/W |
| | | DCK package | 252 | |
| | | LP package | 156 | |
| T _J | Operating virtual junction temperature | | 150 | °C |
| T _{stg} | Storage temperature range | -65 | 150 | °C |

- (1) Stresses beyond those listed under "absolute maximum ratings" can 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 can affect device reliability.
- (2) Maximum power dissipation is a function of T_{J(max)}, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is P_D = (T_{J(max)} - T_A)/θ_{JA}. Operating at the absolute maximum T_J of 150°C can affect reliability.
- (3) The package thermal impedance is calculated in accordance with JESD 51-7.

5.2 ESD Ratings

| | | | VALUE | UNIT |
|--------------------|-------------------------|--|-------|------|
| V _(ESD) | Electrostatic Discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ^{(1) (2)} | ±2000 | V |
| | | Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽³⁾ | ±500 | |

- (1) JEDEC document JEP155 states that 500V HBM allows safe manufacturing with a standard ESD control process.
- (2) The human-body model is a 100pF capacitor discharged through a 1.5kΩ resistor into each pin. The machine model is a 200pF capacitor discharged directly into each pin. All pins are rated at 2kV for human-body model, but the feedback pin which is rated at 1kV.
- (3) JEDEC document JEP157 states that 250V CDM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 250V CDM is possible with the necessary precautions.

5.3 Recommended Operating Conditions

| | | MIN | MAX | UNIT | |
|-------|--|------------------------|-----|------|----|
| I_Z | Cathode current | (1) | 12 | mA | |
| V_Z | Reverse breakdown voltage (adjustable version) | | 10 | V | |
| T_A | Free-air temperature | LM4041 (I temperature) | –40 | 85 | °C |
| | | LM4041 (Q temperature) | –40 | 125 | |

(1) See parametric tables

5.4 LM4041x12I Electrical Characteristics

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

| PARAMETER | TEST CONDITIONS | T_A | LM4041A12I | | | LM4041B12I | | | UNIT |
|-------------------------|--|---|------------|-----------|-----|------------|------|----------------------------|------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_Z | Reverse breakdown voltage | $I_Z = 100\mu\text{A}$ | 1.225 | | | 1.225 | | | V |
| | Reverse breakdown voltage tolerance | $I_Z = 100\mu\text{A}$ | 25°C | –1.2 | 1.2 | –2.4 | 2.4 | mV | |
| | | | Full range | –9.2 | 9.2 | –10.4 | 10.4 | | |
| $I_{Z,\text{min}}$ | Minimum cathode current | | 25°C | 45 | 75 | 45 | 75 | μA | |
| | | | Full range | | 80 | | 80 | | |
| α_{VZ} | Average temperature coefficient of reverse breakdown voltage | $I_Z = 10\text{mA}$ | 25°C | ± 20 | | ± 20 | | ppm/°C | |
| | | $I_Z = 1\text{mA}$ | 25°C | ± 15 | | ± 15 | | | |
| | | | Full range | ± 100 | | ± 100 | | | |
| $\Delta V_Z/\Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,\text{min}} < I_Z < 1\text{mA}$ | 25°C | 0.7 | 1.5 | 0.7 | 1.5 | mV | |
| | | | Full range | | 2 | | 2 | | |
| | | $1\text{mA} < I_Z < 12\text{mA}$ | 25°C | 4 | 6 | 4 | 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 | 0.5 | 1.5 | 0.5 | 1.5 | Ω | |
| e_N | Wideband noise | $I_Z = 100\mu\text{A}$, $10\text{Hz} \leq f \leq 10\text{kHz}$ | 25°C | 20 | | 20 | | μV_{RMS} | |
| | Long-term stability of reverse breakdown voltage | $t = 1000\text{ h}$, $T_A = 25^\circ\text{C} \pm 0.1^\circ\text{C}$, $I_Z = 100\mu\text{A}$ | 25°C | 120 | | 120 | | ppm | |

5.5 LM4041x12I Electrical Characteristics

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

| PARAMETER | TEST CONDITIONS | T_A | LM4041C12I | | | LM4041D12I | | | UNIT |
|-------------------------|--|---|------------|-----|-----|------------|-----|-----|----------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_Z | Reverse breakdown voltage | $I_Z = 100\mu\text{A}$ | 1.225 | | | 1.225 | | | V |
| | Reverse breakdown voltage tolerance | $I_Z = 100\mu\text{A}$ | 25°C | | | 25°C | | | mV |
| | | | Full range | -6 | 6 | -12 | 12 | | |
| $I_{Z,\text{min}}$ | Minimum cathode current | | 25°C | | | 25°C | | | μA |
| | | | Full range | -14 | 14 | -24 | 24 | | |
| α_{VZ} | Average temperature coefficient of reverse breakdown voltage | $I_Z = 10\text{mA}$ | 25°C | | | 25°C | | | ppm/°C |
| | | $I_Z = 1\text{mA}$ | ±20 | | | ±20 | | | |
| | | | ±15 | | | ±15 | | | |
| | | Full range | ±100 | | | ±150 | | | |
| $\Delta V_Z/\Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,\text{min}} < I_Z < 1\text{mA}$ | 25°C | | | 25°C | | | mV |
| | | | Full range | 0.7 | 1.5 | 0.7 | 2 | | |
| | | $1\text{mA} < I_Z < 12\text{mA}$ | 25°C | | | 25°C | | | |
| | | | Full range | 2.5 | 6 | 2.5 | 8 | | |
| Z_Z | Reverse dynamic impedance | $I_Z = 1\text{mA}, f = 120\text{Hz}, I_{\text{AC}} = 0.1 I_Z$ | 25°C | | | 25°C | | | Ω |
| | | | Full range | 0.5 | 1.5 | 0.5 | 2 | | |
| e_N | Wideband noise | $I_Z = 100\mu\text{A}, 10\text{Hz} \leq f \leq 10\text{kHz}$ | 25°C | | | 25°C | | | μV_{RMS} |
| | Long-term stability of reverse breakdown voltage | $t = 1000\text{ h}, T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}, I_Z = 100\mu\text{A}$ | 25°C | | | 25°C | | | ppm |

5.6 LM4041x12Q Electrical Characteristics

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

| PARAMETER | TEST CONDITIONS | T_A | LM4041C12Q | | | LM4041D12Q | | | UNIT |
|-------------------------|--|---|------------|-----|-----|---------------------------------|-----|-----|----------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_Z | Reverse breakdown voltage | $I_Z = 100\mu\text{A}$ | 25°C | | | 1.225 | | | V |
| | Reverse breakdown voltage tolerance | $I_Z = 100\mu\text{A}$ | 25°C | | | -6 6 | | | mV |
| | | | Full range | | | -18.4 18.4 | | | |
| $I_{Z,\text{min}}$ | Minimum cathode current | | 25°C | | | 45 75 | | | μA |
| | | | Full range | | | 80 80 | | | |
| α_{VZ} | Average temperature coefficient of reverse breakdown voltage | $I_Z = 10\text{mA}$ | 25°C | | | ± 20 | | | ppm/°C |
| | | $I_Z = 1\text{mA}$ | 25°C | | | ± 15 | | | |
| | | | Full range | | | ± 100 | | | |
| | | $I_Z = 100\mu\text{A}$ | 25°C | | | ± 15 | | | |
| $\Delta V_Z/\Delta I_Z$ | Reverse breakdown voltage change with cathode current change | $I_{Z,\text{min}} < I_Z < 1\text{mA}$ | 25°C | | | 0.7 1.5 | | | mV |
| | | | Full range | | | 2 2.5 | | | |
| | | $1\text{mA} < I_Z < 12\text{mA}$ | 25°C | | | 2.5 6 | | | |
| | | | Full range | | | 8 10 | | | |
| 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 |
| | | | Full range | | | 1.5 2 | | | |
| e_N | Wideband noise | $I_Z = 100\mu\text{A}$, $10\text{Hz} \leq f \leq 10\text{kHz}$ | 25°C | | | 20 | | | μV_{RMS} |
| | Long-term stability of reverse breakdown voltage | $t = 1000\text{ h}$, $T_A = 25^\circ\text{C} \pm 0.1^\circ\text{C}$, $I_Z = 100\mu\text{A}$ | 25°C | | | 120 | | | ppm |

5.7 LM4041xl (Adjustable Version) Electrical Characteristics

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

| PARAMETER | TEST CONDITIONS | T_A | LM4041BI | | | LM4041CI | | | UNIT | |
|--------------------------------|---|--|------------|-----|-----|----------|------|-----------|------|---------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | | |
| V_{REF} | Reference voltage | $I_Z = 100\mu\text{A}$, $V_Z = 5\text{V}$ | 25°C | | | 1.233 | | | V | |
| | Reference voltage tolerance ⁽¹⁾ | $I_Z = 100\mu\text{A}$, $V_Z = 5\text{V}$ | 25°C | | | -2.5 | 2.5 | | mV | |
| | | | Full range | | | -10.5 | 10.5 | | | |
| $I_{Z,min}$ | Minimum cathode current | | 25°C | | | 45 | | 75 | | μA |
| | | | Full range | | | | | 80 | | |
| $\Delta V_{REF}/\Delta I_Z$ | Reference voltage change with cathode current change | $I_{Z,min} < I_Z < 1\text{mA}$ | 25°C | | | 0.7 | | 1.5 | | mV |
| | | | Full range | | | | | 2 | | |
| | | $1\text{mA} < I_Z < 12\text{mA}$ | 25°C | | | 2 | | 4 | | |
| | | | Full range | | | | | 6 | | |
| $\Delta V_{REF}/\Delta V_{KA}$ | Reference voltage change with output voltage change | $I_Z = 1\text{mA}$ | 25°C | | | -1.55 | | -2 | | mV/V |
| | | | Full range | | | | | -2.5 | | |
| I_{FB} | Feedback current | | 25°C | | | 60 | | 100 | | nA |
| | | | Full range | | | | | 120 | | |
| αV_{REF} | Average temperature coefficient of reference voltage ⁽¹⁾ | $I_Z = 10\text{mA}$, $V_Z = 5\text{V}$ | 25°C | | | ± 20 | | ± 20 | | ppm/°C |
| | | $I_Z = 1\text{mA}$, $V_Z = 5\text{V}$ | 25°C | | | ± 15 | | ± 15 | | |
| | | | Full range | | | | | ± 100 | | |
| | | $I_Z = 100\mu\text{A}$, $V_Z = 5\text{V}$ | 25°C | | | ± 15 | | ± 15 | | |
| Z_Z | Reverse dynamic impedance | $I_Z = 1\text{mA}$, $f = 120\text{Hz}$, $I_{AC} = 0.1 I_Z$, $V_Z = V_{REF}$ | 25°C | | | 0.3 | | 0.3 | | Ω |
| | | $I_Z = 1\text{mA}$, $f = 120\text{Hz}$, $I_{AC} = 0.1 I_Z$, $V_Z = 10\text{V}$ | 25°C | | | 2 | | 2 | | |
| e_N | Wideband noise | $I_Z = 100\mu\text{A}$, $V_Z = V_{REF}$, $10\text{Hz} \leq f \leq 10\text{kHz}$ | 25°C | | | 20 | | 20 | | μV_{RMS} |
| | Long-term stability of reverse breakdown voltage | $t = 1000\text{h}$, $T_A = 25^\circ\text{C} \pm 0.1^\circ\text{C}$, $I_Z = 100\mu\text{A}$ | 25°C | | | 120 | | 120 | | ppm |

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

5.8 LM4041xl (Adjustable Version) Electrical Characteristics

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

| PARAMETER | TEST CONDITIONS | T_A | LM4041DI | | | UNIT |
|--------------------------------|---|---|------------|-----|-----|---------------------|
| | | | MIN | TYP | MAX | |
| V_{REF} | Reference voltage | $I_Z = 100\mu\text{A}$, $V_Z = 5\text{V}$ | 25°C | | | V |
| | Reference voltage tolerance ⁽¹⁾ | $I_Z = 100\mu\text{A}$, $V_Z = 5\text{V}$ | 25°C | | | mV |
| | | | Full range | | | |
| $I_{Z,min}$ | Minimum cathode current | | 25°C | | | μA |
| | | | Full range | | | |
| $\Delta V_{REF}/\Delta I_Z$ | Reference voltage change with cathode current change | $I_{Z,min} < I_Z < 1\text{mA}$ | 25°C | | | mV |
| | | | Full range | | | |
| | | $1\text{mA} < I_Z < 12\text{mA}$ | 25°C | | | |
| | | | Full range | | | |
| $\Delta V_{REF}/\Delta V_{KA}$ | Reference voltage change with output voltage change | $I_Z = 1\text{mA}$ | 25°C | | | mV/V |
| | | | Full range | | | |
| I_{FB} | Feedback current | | 25°C | | | nA |
| | | | Full range | | | |
| αV_{REF} | Average temperature coefficient of reference voltage ⁽¹⁾ | $I_Z = 10\text{mA}$, $V_Z = 5\text{V}$ | 25°C | | | ppm/°C |
| | | | Full range | | | |
| | | $I_Z = 1\text{mA}$, $V_Z = 5\text{V}$ | 25°C | | | |
| | | | Full range | | | |
| Z_Z | Reverse dynamic impedance | $I_Z = 1\text{mA}$, $f = 120\text{Hz}$, $I_{AC} = 0.1 I_Z$, $V_Z = V_{REF}$ | 25°C | | | Ω |
| | | | Full range | | | |
| e_N | Wideband noise | $I_Z = 100\mu\text{A}$, $V_Z = V_{REF}$, $10\text{Hz} \leq f \leq 10\text{kHz}$ | 25°C | | | μV_{RMS} |
| | | | Full range | | | |
| | Long-term stability of reverse breakdown voltage | $t = 1000\text{ h}$, $T_A = 25^\circ\text{C} \pm 0.1^\circ\text{C}$, $I_Z = 100\mu\text{A}$ | 25°C | | | ppm |

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

5.9 LM4041xQ (Adjustable Version) Electrical Characteristics

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

| PARAMETER | TEST CONDITIONS | T_A | LM4041CQ | | | LM4041DQ | | | UNIT |
|--------------------------------|---|--|------------|-----|-----|----------|-----|---------------------|---------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_{REF} | Reference voltage | $I_Z = 100\mu\text{A}$, $V_Z = 5\text{V}$ | 25°C | | | 1.233 | | | V |
| | Reference voltage tolerance ⁽¹⁾ | $I_Z = 100\mu\text{A}$, $V_Z = 5\text{V}$ | 25°C | | | -6.2 | 6.2 | | mV |
| | | | Full range | | | -18 | 18 | | |
| $I_{Z,min}$ | Minimum cathode current | | 25°C | | | 45 | | 75 | μA |
| | | | Full range | | | | | 80 | |
| $\Delta V_{REF}/\Delta I_Z$ | Reference voltage change with cathode current change | $I_{Z,min} < I_Z < 1\text{mA}$ | 25°C | | | 0.7 | | 1.5 | mV |
| | | | Full range | | | | | 2 | |
| | | $1\text{mA} < I_Z < 12\text{mA}$ | 25°C | | | 2 | | 4 | |
| | | | Full range | | | | | 8 | |
| $\Delta V_{REF}/\Delta V_{KA}$ | Reference voltage change with output voltage change | $I_Z = 1\text{mA}$ | 25°C | | | -1.55 | | -2 | mV/V |
| | | | Full range | | | | | -3 | |
| I_{FB} | Feedback current | | 25°C | | | 60 | | 100 | nA |
| | | | Full range | | | | | 120 | |
| αV_{REF} | Average temperature coefficient of reference voltage ⁽¹⁾ | $I_Z = 10\text{mA}$, $V_Z = 5\text{V}$ | 25°C | | | ± 20 | | ppm/°C | |
| | | $I_Z = 1\text{mA}$, $V_Z = 5\text{V}$ | 25°C | | | ± 15 | | | |
| | | | Full range | | | | | | ± 100 |
| | | $I_Z = 100\mu\text{A}$, $V_Z = 5\text{V}$ | 25°C | | | ± 15 | | | |
| Z_Z | Reverse dynamic impedance | $I_Z = 1\text{mA}$, $f = 120\text{Hz}$, $I_{AC} = 0.1 I_Z$, $V_Z = V_{REF}$ | 25°C | | | 0.3 | | Ω | |
| | | $I_Z = 1\text{mA}$, $f = 120\text{Hz}$, $I_{AC} = 0.1 I_Z$, $V_Z = 10\text{V}$ | 25°C | | | 2 | | | |
| e_N | Wideband noise | $I_Z = 100\mu\text{A}$, $V_Z = V_{REF}$, $10\text{Hz} \leq f \leq 10\text{kHz}$ | 25°C | | | 20 | | μV_{RMS} | |
| | Long-term stability of reverse breakdown voltage | $t = 1000\text{h}$, $T_A = 25^\circ\text{C} \pm 0.1^\circ\text{C}$, $I_Z = 100\mu\text{A}$ | 25°C | | | 120 | | ppm | |

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

5.10 Typical Characteristics

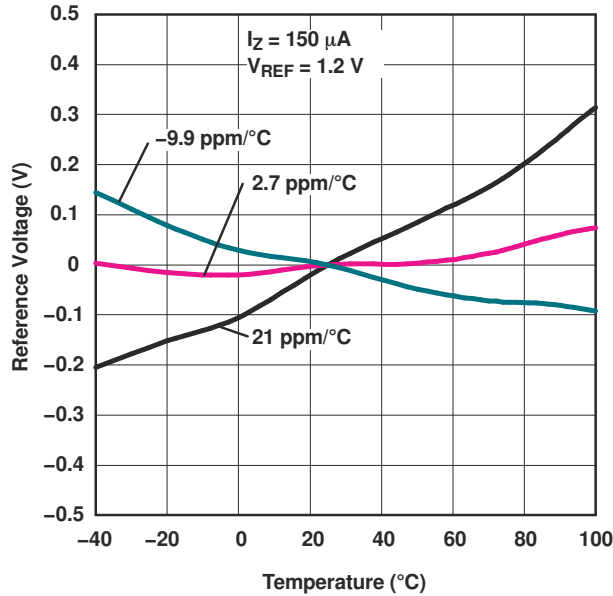


Figure 5-1. Temperature Drift for Different Average Temperature Coefficients

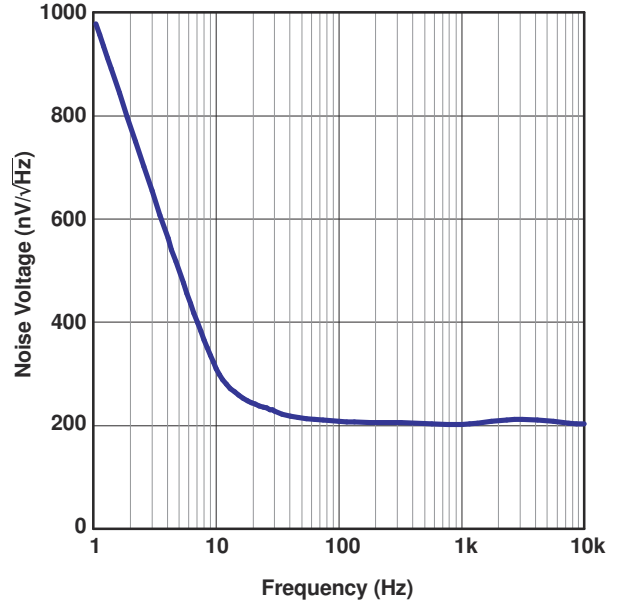


Figure 5-2. Noise Voltage vs Frequency

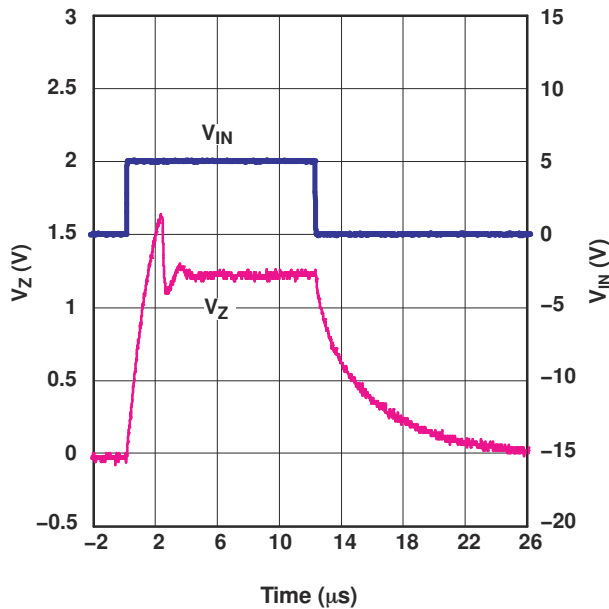


Figure 5-3. Start-Up Characteristics

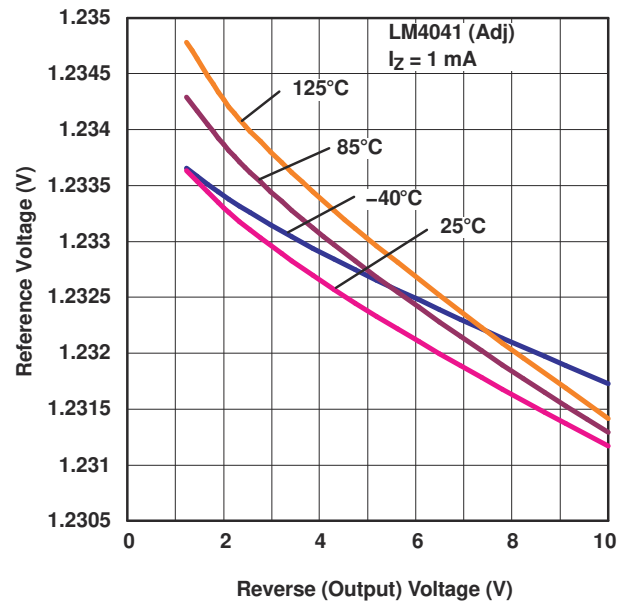


Figure 5-4. Reference Voltage vs Reverse (Output) Voltage (for Different Temperatures)

5.10 Typical Characteristics (continued)

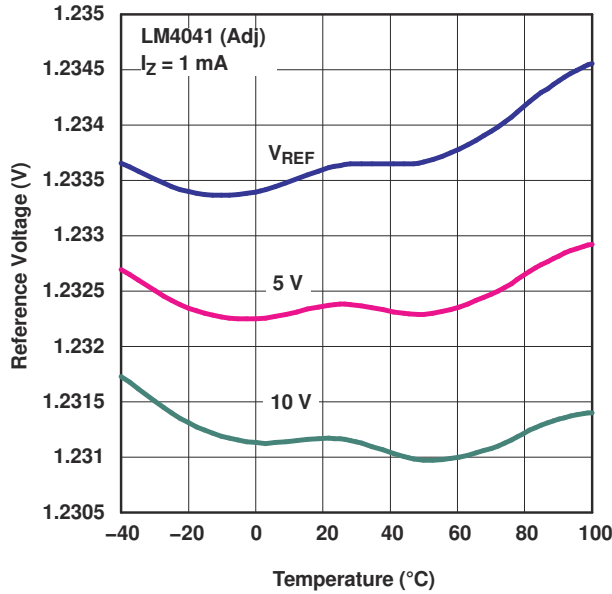


Figure 5-5. Reference Voltage vs Temperature (for Different Reverse Voltages)

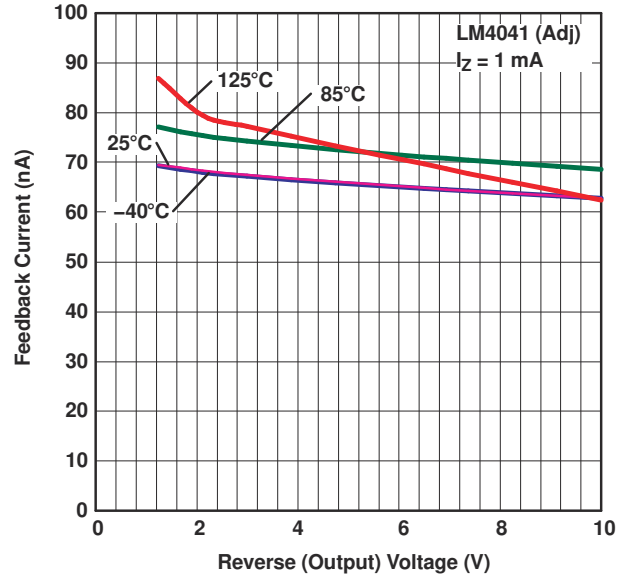


Figure 5-6. Feedback Current vs Reverse (Output) Voltage (for Different Temperatures)

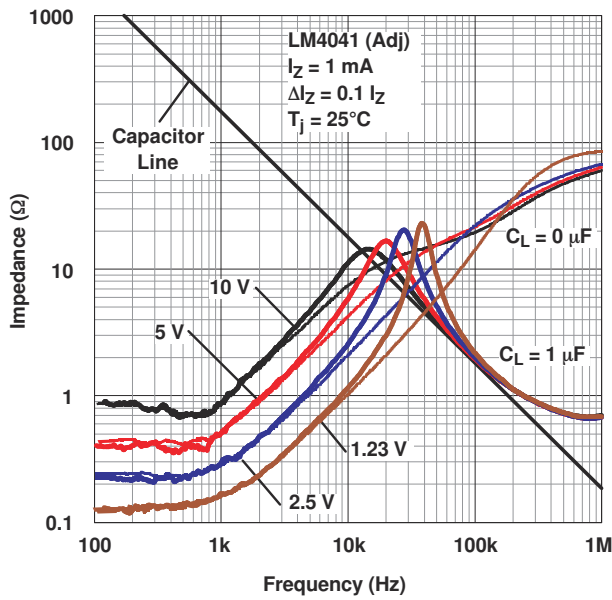


Figure 5-7. Output Impedance vs Frequency

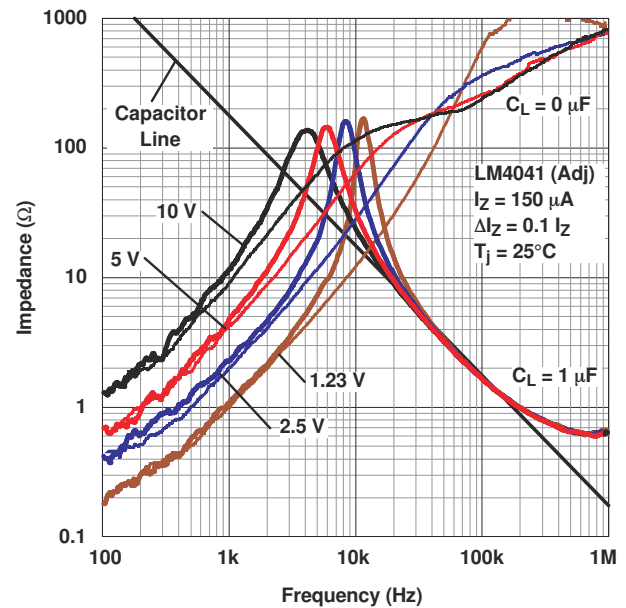
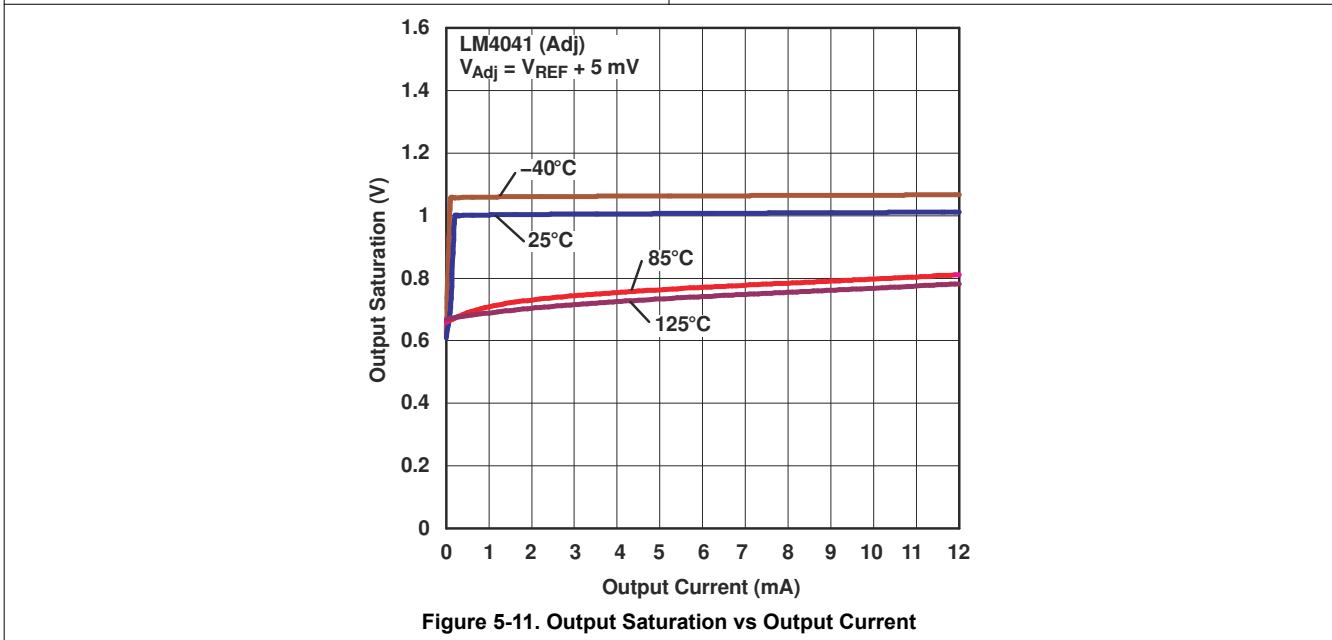
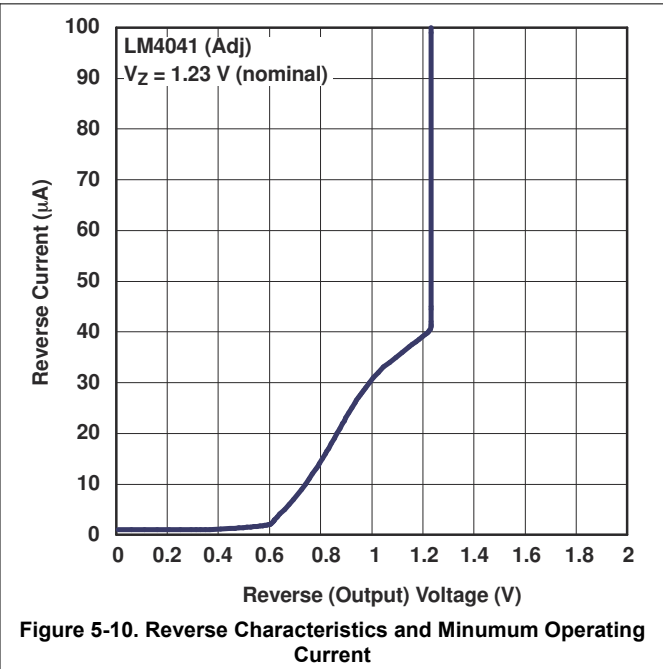
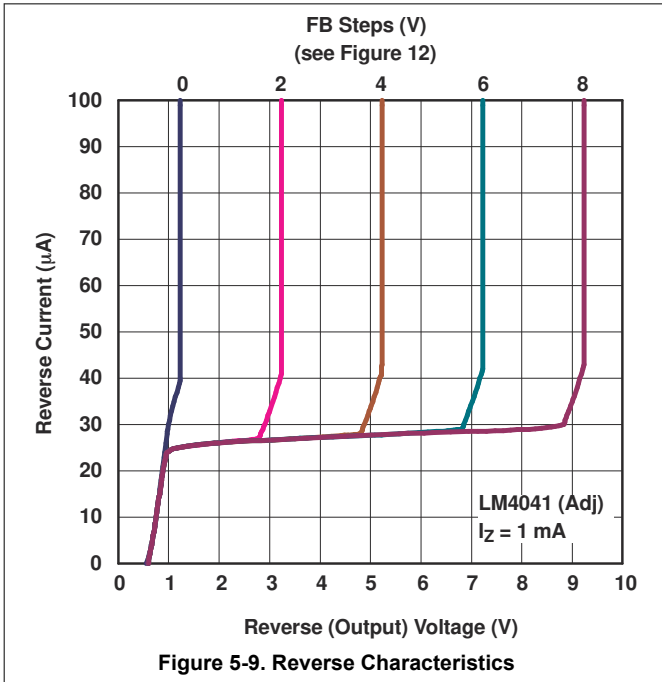


Figure 5-8. Output Impedance vs Frequency

5.10 Typical Characteristics (continued)



6 Functional Block Diagram

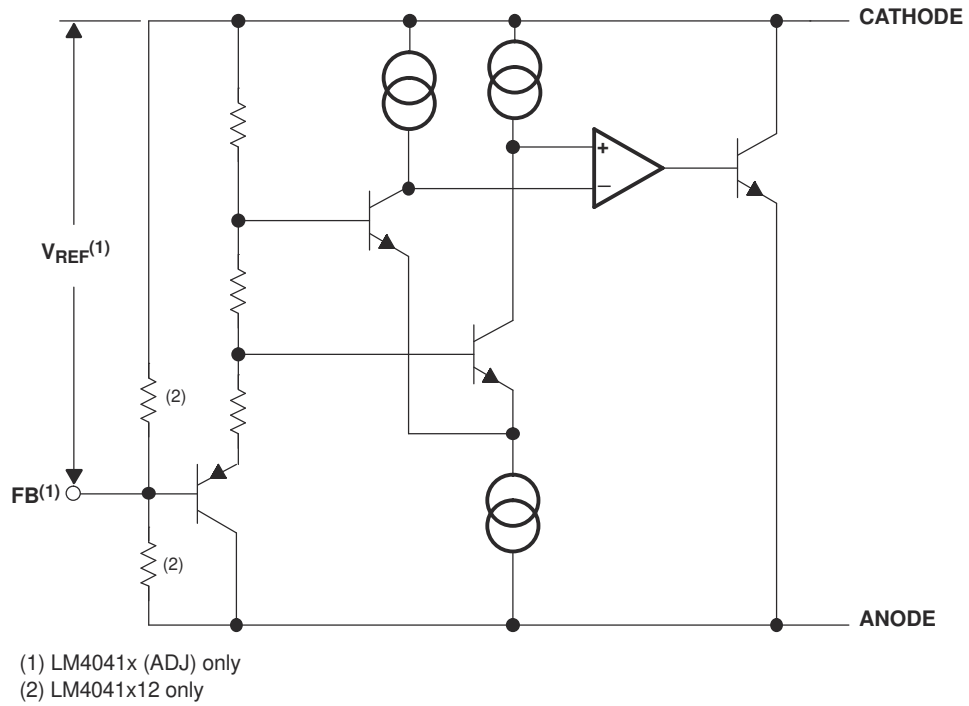


Figure 6-1. Functional Block Diagram

7 Application Information

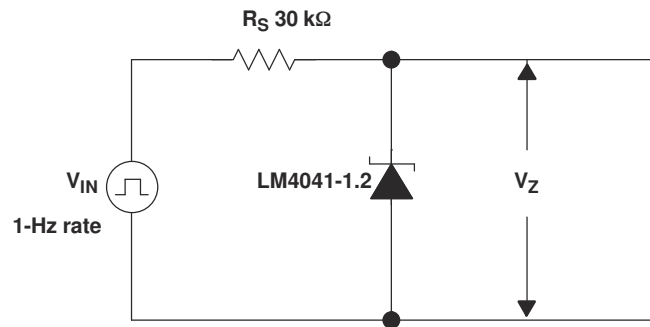


Figure 7-1. Startup Characteristics Test Circuit

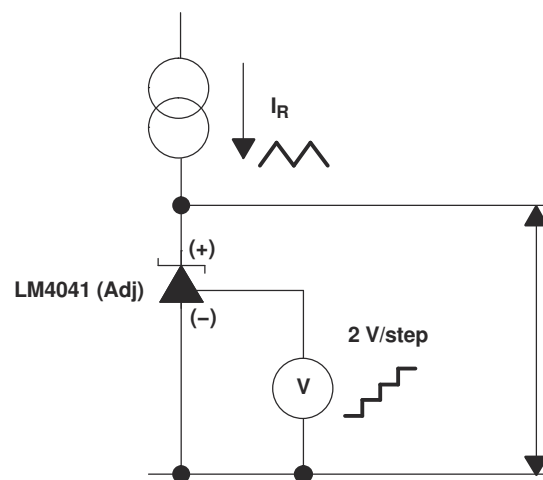


Figure 7-2. Reverse Characteristics Test Circuit

7.1 Output Capacitor

The LM4041 does not require an output capacitor across CATHODE and ANODE for stability. However, if an output bypass capacitor is desired, the LM4041 is designed to be stable with all capacitive loads.

7.2 SOT-23 and SC-70 Pin Connections

There is a parasitic Schottky diode connected between pins 2 and 3 of the SOT-23 packaged device. Thus, pin 3 of the SOT-23 package must be left floating or connected to pin 2. Similarly, pin 2 of the SC-70 package also must be left floating or connected to pin 1.

7.3 Adjustable Version

The adjustable version allows V_Z to be set by a user-defined resistor divider. The output voltage, V_Z , is set according to the equation shown in Figure 7-3.

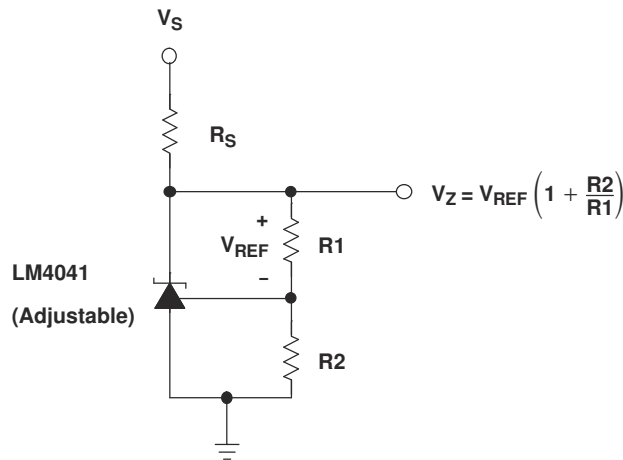


Figure 7-3. Adjustable Shunt Regulator

When the output voltage, V_Z , is set below 2.5V on adjustable versions of LM4041, the device can experience increased reference voltage change with output voltage change ($\Delta V_{REF}/\Delta V_{KA}$) when compared to output voltages set equal to or above 2.5V.

7.4 Cathode and Load Currents

In a typical shunt regulator configuration (see Figure 7-4), an external resistor, R_S , is connected between the supply and the cathode of the LM4041. R_S must be set properly, this sets the total current available to supply the load (I_L) and bias the LM4041 (I_Z). In all cases, I_Z must stay within a specified range for proper operation of the reference. Taking into consideration one extreme in the variation of the load and supply voltage (maximum I_L and minimum V_S), R_S must be small enough to supply the minimum I_Z required for operation of the regulator, as given by data sheet parameters. At the other extreme, maximum V_S and minimum I_L , R_S must be large enough to limit I_Z to less than the maximum recommended rating of 12mA.

R_S is calculated as shown in Equation 1.

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

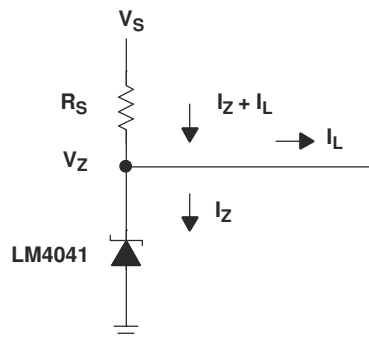


Figure 7-4. Shunt Regulator

8 Device and Documentation Support

8.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Notifications* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

8.2 Trademarks

TI E2E™ is a trademark of Texas Instruments.

All trademarks are the property of their respective owners.

8.3 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

8.4 Support Resources

[TI E2E™ support forums](#) are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

8.5 Glossary

[TI Glossary](#) This glossary lists and explains terms, acronyms, and definitions.

9 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from Revision G (July 2024) to Revision H (March 2025) | Page |
|--|--------------------|
| • Updated LP pin numbering..... | 3 |
| • Added electromagnetic interference note and updated LP pinout numbering..... | 3 |
| • Added ESD ratings..... | 5 |
| • Added reference voltage change with output voltage change details..... | 17 |

| Changes from Revision F (September 2020) to Revision G (July 2024) | Page |
|---|-------------------|
| • Updated <i>Applications</i> links..... | 1 |
| • Updated pinout diagrams | 3 |

Changes from Revision E (February 2006) to Revision F (September 2020)**Page**

- Updated the numbering format for tables, figures and cross-references throughout the document..... 1
 - Deleted *Ordering Information* table. See Mechanical, Packaging, and Orderable Information at the end of the data sheet..... 15
-

10 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

| Orderable part number | Status (1) | Material type (2) | Package Pins | Package qty Carrier | RoHS (3) | Lead finish/ Ball material (4) | MSL rating/ Peak reflow (5) | Op temp (°C) | Part marking (6) |
|---------------------------------|---------------|----------------------|------------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| LM4041A12IDBZR | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU SN | Level-1-260C-UNLIM | -40 to 85 | (4MK3, 4MKU) |
| LM4041A12IDBZR.A | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (4MK3, 4MKU) |
| LM4041A12IDBZT | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (4MK3, 4MKU) |
| LM4041A12IDBZT.A | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (4MK3, 4MKU) |
| LM4041A12IDBZT1G4 | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | 4MK3 |
| LM4041A12IDBZT1G4.A | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | 4MK3 |
| LM4041A12IDCKR | Active | Production | SC70 (DCK) 5 | 3000 LARGE T&R | Yes | NIPDAU SN | Level-1-260C-UNLIM | -40 to 85 | MKU |
| LM4041A12IDCKR.A | Active | Production | SC70 (DCK) 5 | 3000 LARGE T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 85 | MKU |
| LM4041B12IDBZR | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (4ML3, 4MLU) |
| LM4041B12IDBZR.A | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (4ML3, 4MLU) |
| LM4041B12IDBZT | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (4ML3, 4MLU) |
| LM4041B12IDBZT.A | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (4ML3, 4MLU) |
| LM4041B12IDCKR | Active | Production | SC70 (DCK) 5 | 3000 LARGE T&R | Yes | NIPDAU SN | Level-1-260C-UNLIM | -40 to 85 | MLU |
| LM4041B12IDCKR.A | Active | Production | SC70 (DCK) 5 | 3000 LARGE T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 85 | MLU |
| LM4041BIDBZR | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU SN | Level-1-260C-UNLIM | -40 to 85 | (4MG3, 4MGU) |
| LM4041BIDBZR.A | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 85 | (4MG3, 4MGU) |
| LM4041BIDBZR1G4 | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (4MG3, 4MGU) |
| LM4041BIDBZR1G4.A | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (4MG3, 4MGU) |
| LM4041BIDBZT | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | NIPDAU SN | Level-1-260C-UNLIM | -40 to 85 | (4MG3, 4MGU) |
| LM4041BIDBZT.A | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 85 | (4MG3, 4MGU) |
| LM4041BIDCKR | Active | Production | SC70 (DCK) 5 | 3000 LARGE T&R | Yes | NIPDAU SN | Level-1-260C-UNLIM | -40 to 85 | MGU |
| LM4041BIDCKR.A | Active | Production | SC70 (DCK) 5 | 3000 LARGE T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 85 | MGU |
| LM4041BIDCKT | Active | Production | SC70 (DCK) 5 | 250 SMALL T&R | Yes | NIPDAU SN | Level-1-260C-UNLIM | -40 to 85 | MGU |
| LM4041BIDCKT.A | Active | Production | SC70 (DCK) 5 | 250 SMALL T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 85 | MGU |
| LM4041C12IDBZR | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (4MM3, 4MMU) |
| LM4041C12IDBZR.A | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (4MM3, 4MMU) |
| LM4041C12IDBZR1G4 | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 4MM3 |
| LM4041C12IDBZR1G4.A | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 4MM3 |
| LM4041C12IDBZT | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (4MM3, 4MMU) |

| Orderable part number | Status (1) | Material type (2) | Package Pins | Package qty Carrier | RoHS (3) | Lead finish/ Ball material (4) | MSL rating/ Peak reflow (5) | Op temp (°C) | Part marking (6) |
|--------------------------------|---------------|----------------------|------------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| LM4041C12IDBZT.A | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (4MM3, 4MMU) |
| LM4041C12IDCKR | Active | Production | SC70 (DCK) 5 | 3000 LARGE T&R | Yes | NIPDAU SN | Level-1-260C-UNLIM | -40 to 85 | MMU |
| LM4041C12IDCKR.A | Active | Production | SC70 (DCK) 5 | 3000 LARGE T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 85 | MMU |
| LM4041C12IDCKRE4 | Active | Production | SC70 (DCK) 5 | 3000 LARGE T&R | - | Call TI | Call TI | -40 to 85 | |
| LM4041C12IDCKRG4 | Active | Production | SC70 (DCK) 5 | 3000 LARGE T&R | - | Call TI | Call TI | -40 to 85 | |
| LM4041C12ILP | Active | Production | TO-92 (LP) 3 | 1000 BULK | Yes | SN | N/A for Pkg Type | -40 to 85 | NPC12I |
| LM4041C12ILP.A | Active | Production | TO-92 (LP) 3 | 1000 BULK | Yes | SN | N/A for Pkg Type | -40 to 85 | NPC12I |
| LM4041C12ILPR | Active | Production | TO-92 (LP) 3 | 2000 LARGE T&R | Yes | SN | N/A for Pkg Type | -40 to 85 | NPC12I |
| LM4041C12ILPR.A | Active | Production | TO-92 (LP) 3 | 2000 LARGE T&R | Yes | SN | N/A for Pkg Type | -40 to 85 | NPC12I |
| LM4041C12QDBZR | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (4MS3, 4MSU) |
| LM4041C12QDBZR.A | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (4MS3, 4MSU) |
| LM4041C12QDBZT | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (4MS3, 4MSU) |
| LM4041C12QDBZT.A | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (4MS3, 4MSU) |
| LM4041CIDBZR | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (4MH3, 4MHU) |
| LM4041CIDBZR.A | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (4MH3, 4MHU) |
| LM4041CIDBZT | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | NIPDAU SN | Level-1-260C-UNLIM | -40 to 85 | (4MH3, 4MHU) |
| LM4041CIDBZT.A | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 85 | (4MH3, 4MHU) |
| LM4041CIDCKR | Active | Production | SC70 (DCK) 5 | 3000 LARGE T&R | Yes | NIPDAU SN | Level-1-260C-UNLIM | -40 to 85 | MHU |
| LM4041CIDCKR.A | Active | Production | SC70 (DCK) 5 | 3000 LARGE T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 85 | MHU |
| LM4041CIDCKT | Active | Production | SC70 (DCK) 5 | 250 SMALL T&R | Yes | NIPDAU SN | Level-1-260C-UNLIM | -40 to 85 | MHU |
| LM4041CIDCKT.A | Active | Production | SC70 (DCK) 5 | 250 SMALL T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 85 | MHU |
| LM4041CILP | Obsolete | Production | TO-92 (LP) 3 | - | - | Call TI | Call TI | -40 to 85 | NPCI |
| LM4041CILPE3 | NRND | Production | TO-92 (LP) 3 | 1000 BULK | - | Call TI | Call TI | -40 to 85 | |
| LM4041CILPR | Active | Production | TO-92 (LP) 3 | 2000 LARGE T&R | Yes | SN | N/A for Pkg Type | -40 to 85 | NPCI |
| LM4041CILPR.A | Active | Production | TO-92 (LP) 3 | 2000 LARGE T&R | Yes | SN | N/A for Pkg Type | -40 to 85 | NPCI |
| LM4041CQDBZR | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (4MP3, 4MPU) |
| LM4041CQDBZR.A | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (4MP3, 4MPU) |
| LM4041CQDBZT | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (4MP3, 4MPU) |
| LM4041CQDBZT.A | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (4MP3, 4MPU) |
| LM4041D12IDBZR | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (4MN3, 4MNU) |
| LM4041D12IDBZR.A | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (4MN3, 4MNU) |

| Orderable part number | Status (1) | Material type (2) | Package Pins | Package qty Carrier | RoHS (3) | Lead finish/ Ball material (4) | MSL rating/ Peak reflow (5) | Op temp (°C) | Part marking (6) |
|---------------------------------|---------------|----------------------|------------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| LM4041D12IDBZR1G4 | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 4MN3 |
| LM4041D12IDBZR1G4.A | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 4MN3 |
| LM4041D12IDBZT | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (4MN3, 4MNU) |
| LM4041D12IDBZT.A | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (4MN3, 4MNU) |
| LM4041D12IDCKR | Active | Production | SC70 (DCK) 5 | 3000 LARGE T&R | Yes | NIPDAU SN | Level-1-260C-UNLIM | -40 to 85 | MNU |
| LM4041D12IDCKR.A | Active | Production | SC70 (DCK) 5 | 3000 LARGE T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 85 | MNU |
| LM4041D12ILP | Active | Production | TO-92 (LP) 3 | 1000 BULK | Yes | SN | N/A for Pkg Type | -40 to 85 | NPD12I |
| LM4041D12ILP.A | Active | Production | TO-92 (LP) 3 | 1000 BULK | Yes | SN | N/A for Pkg Type | -40 to 85 | NPD12I |
| LM4041D12ILPE3 | Active | Production | TO-92 (LP) 3 | 1000 BULK | - | Call TI | Call TI | -40 to 85 | |
| LM4041D12ILPR | Active | Production | TO-92 (LP) 3 | 2000 LARGE T&R | Yes | SN | N/A for Pkg Type | -40 to 85 | NPD12I |
| LM4041D12ILPR.A | Active | Production | TO-92 (LP) 3 | 2000 LARGE T&R | Yes | SN | N/A for Pkg Type | -40 to 85 | NPD12I |
| LM4041D12IQDBZR | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (4MT3, 4MTU) |
| LM4041D12IQDBZR.A | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (4MT3, 4MTU) |
| LM4041DIDBZR | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU SN | Level-1-260C-UNLIM | -40 to 85 | (4MJ3, 4MJU) |
| LM4041DIDBZR.A | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 85 | (4MJ3, 4MJU) |
| LM4041DIDBZT | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | NIPDAU SN | Level-1-260C-UNLIM | -40 to 85 | (4MJ3, 4MJU) |
| LM4041DIDBZT.A | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 85 | (4MJ3, 4MJU) |
| LM4041DIDCKR | Active | Production | SC70 (DCK) 5 | 3000 LARGE T&R | Yes | NIPDAU SN | Level-1-260C-UNLIM | -40 to 85 | MJU |
| LM4041DIDCKR.A | Active | Production | SC70 (DCK) 5 | 3000 LARGE T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 85 | MJU |
| LM4041DIDCKRG4 | Active | Production | SC70 (DCK) 5 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | MJU |
| LM4041DIDCKRG4.A | Active | Production | SC70 (DCK) 5 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | MJU |
| LM4041DILP | Obsolete | Production | TO-92 (LP) 3 | - | - | Call TI | Call TI | -40 to 85 | NPDI |
| LM4041DILPR | Active | Production | TO-92 (LP) 3 | 2000 LARGE T&R | Yes | SN | N/A for Pkg Type | -40 to 85 | NPDI |
| LM4041DILPR.A | Active | Production | TO-92 (LP) 3 | 2000 LARGE T&R | Yes | SN | N/A for Pkg Type | -40 to 85 | NPDI |
| LM4041DQDBZR | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | NIPDAU SN | Level-1-260C-UNLIM | -40 to 125 | (4MR3, 4MRU) |
| LM4041DQDBZR.A | Active | Production | SOT-23 (DBZ) 3 | 3000 LARGE T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 125 | (4MR3, 4MRU) |
| LM4041DQDBZT | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | NIPDAU SN | Level-1-260C-UNLIM | -40 to 125 | (4MR3, 4MRU) |
| LM4041DQDBZT.A | Active | Production | SOT-23 (DBZ) 3 | 250 SMALL T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 125 | (4MR3, 4MRU) |

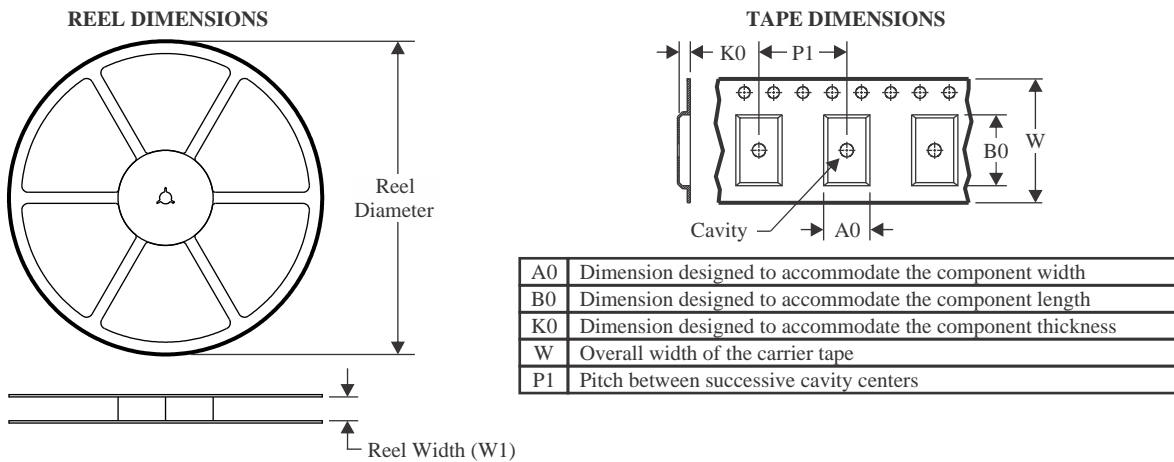
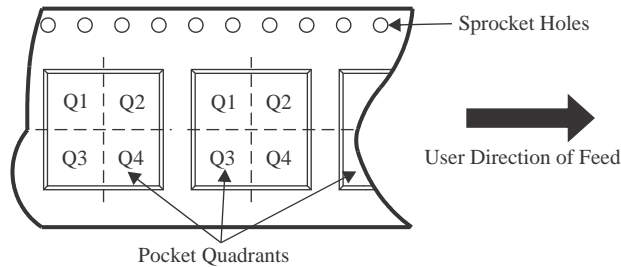
(1) Status: For more details on status, see our [product life cycle](#).

- (2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.
- (3) **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.
- (4) **Lead finish/Ball material:** Parts 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.
- (5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.
- (6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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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 |
|-------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| LM4041A12IDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 2.9 | 3.35 | 1.35 | 4.0 | 8.0 | Q3 |
| LM4041A12IDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 2.9 | 3.35 | 1.35 | 4.0 | 8.0 | Q3 |
| LM4041A12IDBZT1G4 | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 2.9 | 3.35 | 1.35 | 4.0 | 8.0 | Q3 |
| LM4041A12IDCKR | SC70 | DCK | 5 | 3000 | 180.0 | 8.4 | 2.3 | 2.55 | 1.2 | 4.0 | 8.0 | Q3 |
| LM4041A12IDCKR | SC70 | DCK | 5 | 3000 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| LM4041B12IDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 2.9 | 3.35 | 1.35 | 4.0 | 8.0 | Q3 |
| LM4041B12IDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 2.9 | 3.35 | 1.35 | 4.0 | 8.0 | Q3 |
| LM4041B12IDCKR | SC70 | DCK | 5 | 3000 | 180.0 | 8.4 | 2.3 | 2.55 | 1.2 | 4.0 | 8.0 | Q3 |
| LM4041B12IDCKR | SC70 | DCK | 5 | 3000 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| LM4041BIDBZR | SOT-23 | DBZ | 3 | 3000 | 178.0 | 9.2 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| LM4041BIDBZR1G4 | SOT-23 | DBZ | 3 | 3000 | 178.0 | 9.2 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| LM4041BIDBZR1G4 | SOT-23 | DBZ | 3 | 3000 | 179.0 | 8.4 | 3.15 | 2.95 | 1.22 | 4.0 | 8.0 | Q3 |
| LM4041BIDBZT | SOT-23 | DBZ | 3 | 250 | 179.0 | 8.4 | 3.15 | 2.95 | 1.22 | 4.0 | 8.0 | Q3 |
| LM4041BIDBZT | SOT-23 | DBZ | 3 | 250 | 178.0 | 9.2 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| LM4041BIDCKR | SC70 | DCK | 5 | 3000 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| LM4041BIDCKT | SC70 | DCK | 5 | 250 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |

| 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 |
|-------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| LM4041C12IDBZR | SOT-23 | DBZ | 3 | 3000 | 179.0 | 8.4 | 3.15 | 2.95 | 1.22 | 4.0 | 8.0 | Q3 |
| LM4041C12IDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 2.9 | 3.35 | 1.35 | 4.0 | 8.0 | Q3 |
| LM4041C12IDBZR1G4 | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 2.9 | 3.35 | 1.35 | 4.0 | 8.0 | Q3 |
| LM4041C12IDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 2.9 | 3.35 | 1.35 | 4.0 | 8.0 | Q3 |
| LM4041C12IDCKR | SC70 | DCK | 5 | 3000 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| LM4041C12IDCKR | SC70 | DCK | 5 | 3000 | 180.0 | 8.4 | 2.3 | 2.55 | 1.2 | 4.0 | 8.0 | Q3 |
| LM4041C12QDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 2.9 | 3.35 | 1.35 | 4.0 | 8.0 | Q3 |
| LM4041C12QDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 2.9 | 3.35 | 1.35 | 4.0 | 8.0 | Q3 |
| LM4041CIDBZR | SOT-23 | DBZ | 3 | 3000 | 178.0 | 9.2 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| LM4041CIDBZT | SOT-23 | DBZ | 3 | 250 | 178.0 | 9.2 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| LM4041CIDBZT | SOT-23 | DBZ | 3 | 250 | 179.0 | 8.4 | 3.15 | 2.95 | 1.22 | 4.0 | 8.0 | Q3 |
| LM4041CIDCKR | SC70 | DCK | 5 | 3000 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| LM4041CIDCKT | SC70 | DCK | 5 | 250 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| LM4041CQDBZR | SOT-23 | DBZ | 3 | 3000 | 178.0 | 9.2 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| LM4041CQDBZR | SOT-23 | DBZ | 3 | 3000 | 179.0 | 8.4 | 3.15 | 2.95 | 1.22 | 4.0 | 8.0 | Q3 |
| LM4041CQDBZT | SOT-23 | DBZ | 3 | 250 | 179.0 | 8.4 | 3.15 | 2.95 | 1.22 | 4.0 | 8.0 | Q3 |
| LM4041CQDBZT | SOT-23 | DBZ | 3 | 250 | 178.0 | 9.2 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| LM4041D12IDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 2.9 | 3.35 | 1.35 | 4.0 | 8.0 | Q3 |
| LM4041D12IDBZR1G4 | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 2.9 | 3.35 | 1.35 | 4.0 | 8.0 | Q3 |
| LM4041D12IDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 2.9 | 3.35 | 1.35 | 4.0 | 8.0 | Q3 |
| LM4041D12IDCKR | SC70 | DCK | 5 | 3000 | 180.0 | 8.4 | 2.3 | 2.55 | 1.2 | 4.0 | 8.0 | Q3 |
| LM4041D12IDCKR | SC70 | DCK | 5 | 3000 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| LM4041D12QDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 2.9 | 3.35 | 1.35 | 4.0 | 8.0 | Q3 |
| LM4041DIDBZR | SOT-23 | DBZ | 3 | 3000 | 179.0 | 8.4 | 3.15 | 2.95 | 1.22 | 4.0 | 8.0 | Q3 |
| LM4041DIDBZR | SOT-23 | DBZ | 3 | 3000 | 178.0 | 9.2 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| LM4041DIDBZT | SOT-23 | DBZ | 3 | 250 | 178.0 | 9.2 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| LM4041DIDCKR | SC70 | DCK | 5 | 3000 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| LM4041DIDCKRG4 | SC70 | DCK | 5 | 3000 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| LM4041DQDBZR | SOT-23 | DBZ | 3 | 3000 | 178.0 | 9.2 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| LM4041DQDBZR | SOT-23 | DBZ | 3 | 3000 | 179.0 | 8.4 | 3.15 | 2.95 | 1.22 | 4.0 | 8.0 | Q3 |
| LM4041DQDBZT | SOT-23 | DBZ | 3 | 250 | 179.0 | 8.4 | 3.15 | 2.95 | 1.22 | 4.0 | 8.0 | Q3 |
| LM4041DQDBZT | SOT-23 | DBZ | 3 | 250 | 178.0 | 9.2 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|-------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| LM4041A12IDBZR | SOT-23 | DBZ | 3 | 3000 | 210.0 | 185.0 | 35.0 |
| LM4041A12IDBZT | SOT-23 | DBZ | 3 | 250 | 210.0 | 185.0 | 35.0 |
| LM4041A12IDBZT1G4 | SOT-23 | DBZ | 3 | 250 | 210.0 | 185.0 | 35.0 |
| LM4041A12IDCKR | SC70 | DCK | 5 | 3000 | 210.0 | 185.0 | 35.0 |
| LM4041A12IDCKR | SC70 | DCK | 5 | 3000 | 200.0 | 183.0 | 25.0 |
| LM4041B12IDBZR | SOT-23 | DBZ | 3 | 3000 | 210.0 | 185.0 | 35.0 |
| LM4041B12IDBZT | SOT-23 | DBZ | 3 | 250 | 210.0 | 185.0 | 35.0 |
| LM4041B12IDCKR | SC70 | DCK | 5 | 3000 | 210.0 | 185.0 | 35.0 |
| LM4041B12IDCKR | SC70 | DCK | 5 | 3000 | 200.0 | 183.0 | 25.0 |
| LM4041BIDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 180.0 | 18.0 |
| LM4041BIDBZR1G4 | SOT-23 | DBZ | 3 | 3000 | 180.0 | 180.0 | 18.0 |
| LM4041BIDBZR1G4 | SOT-23 | DBZ | 3 | 3000 | 200.0 | 183.0 | 25.0 |
| LM4041BIDBZT | SOT-23 | DBZ | 3 | 250 | 200.0 | 183.0 | 25.0 |
| LM4041BIDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 180.0 | 18.0 |
| LM4041BIDCKR | SC70 | DCK | 5 | 3000 | 200.0 | 183.0 | 25.0 |
| LM4041BIDCKT | SC70 | DCK | 5 | 250 | 203.0 | 203.0 | 35.0 |
| LM4041C12IDBZR | SOT-23 | DBZ | 3 | 3000 | 200.0 | 183.0 | 25.0 |
| LM4041C12IDBZR | SOT-23 | DBZ | 3 | 3000 | 210.0 | 185.0 | 35.0 |

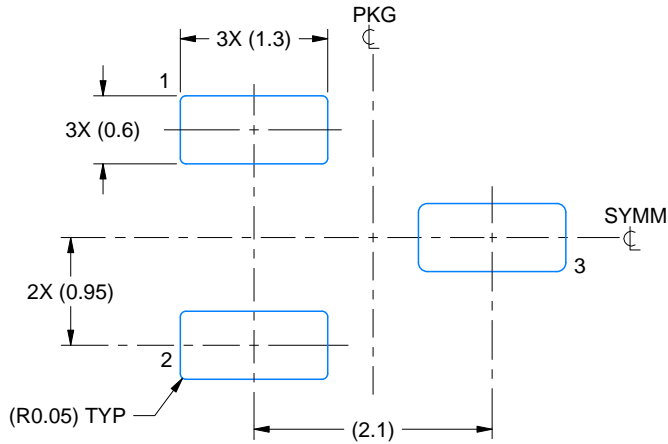
| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|-------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| LM4041C12IDBZR1G4 | SOT-23 | DBZ | 3 | 3000 | 210.0 | 185.0 | 35.0 |
| LM4041C12IDBZT | SOT-23 | DBZ | 3 | 250 | 210.0 | 185.0 | 35.0 |
| LM4041C12IDCKR | SC70 | DCK | 5 | 3000 | 200.0 | 183.0 | 25.0 |
| LM4041C12IDCKR | SC70 | DCK | 5 | 3000 | 210.0 | 185.0 | 35.0 |
| LM4041C12QDBZR | SOT-23 | DBZ | 3 | 3000 | 210.0 | 185.0 | 35.0 |
| LM4041C12QDBZT | SOT-23 | DBZ | 3 | 250 | 210.0 | 185.0 | 35.0 |
| LM4041CIDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 180.0 | 18.0 |
| LM4041CIDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 180.0 | 18.0 |
| LM4041CIDBZT | SOT-23 | DBZ | 3 | 250 | 203.0 | 203.0 | 35.0 |
| LM4041CIDCKR | SC70 | DCK | 5 | 3000 | 200.0 | 183.0 | 25.0 |
| LM4041CIDCKT | SC70 | DCK | 5 | 250 | 200.0 | 183.0 | 25.0 |
| LM4041CQDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 180.0 | 18.0 |
| LM4041CQDBZR | SOT-23 | DBZ | 3 | 3000 | 200.0 | 183.0 | 25.0 |
| LM4041CQDBZT | SOT-23 | DBZ | 3 | 250 | 200.0 | 183.0 | 25.0 |
| LM4041CQDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 180.0 | 18.0 |
| LM4041D12IDBZR | SOT-23 | DBZ | 3 | 3000 | 210.0 | 185.0 | 35.0 |
| LM4041D12IDBZR1G4 | SOT-23 | DBZ | 3 | 3000 | 210.0 | 185.0 | 35.0 |
| LM4041D12IDBZT | SOT-23 | DBZ | 3 | 250 | 210.0 | 185.0 | 35.0 |
| LM4041D12IDCKR | SC70 | DCK | 5 | 3000 | 210.0 | 185.0 | 35.0 |
| LM4041D12IDCKR | SC70 | DCK | 5 | 3000 | 200.0 | 183.0 | 25.0 |
| LM4041D12QDBZR | SOT-23 | DBZ | 3 | 3000 | 210.0 | 185.0 | 35.0 |
| LM4041DIDBZR | SOT-23 | DBZ | 3 | 3000 | 200.0 | 183.0 | 25.0 |
| LM4041DIDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 180.0 | 18.0 |
| LM4041DIDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 180.0 | 18.0 |
| LM4041DIDCKR | SC70 | DCK | 5 | 3000 | 200.0 | 183.0 | 25.0 |
| LM4041DIDCKRG4 | SC70 | DCK | 5 | 3000 | 200.0 | 183.0 | 25.0 |
| LM4041DQDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 180.0 | 18.0 |
| LM4041DQDBZR | SOT-23 | DBZ | 3 | 3000 | 200.0 | 183.0 | 25.0 |
| LM4041DQDBZT | SOT-23 | DBZ | 3 | 250 | 203.0 | 203.0 | 35.0 |
| LM4041DQDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 180.0 | 18.0 |

EXAMPLE BOARD LAYOUT

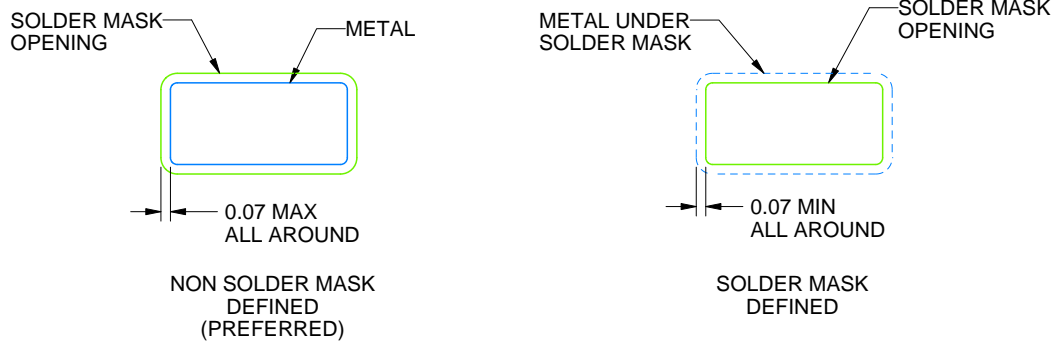
DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
SCALE:15X



SOLDER MASK DETAILS

4214838/F 08/2024

NOTES: (continued)

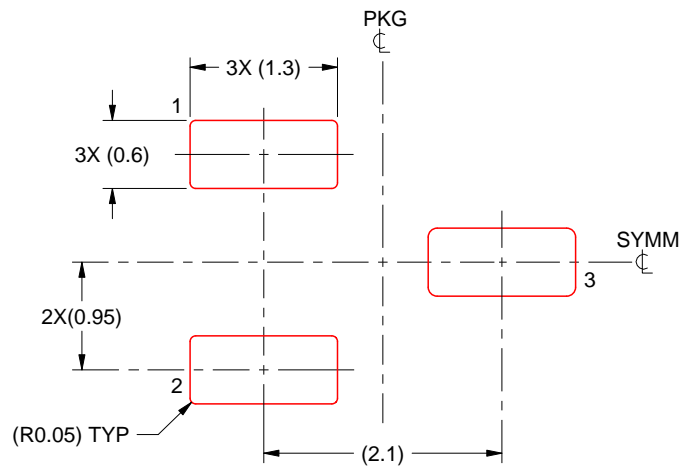
- 5. Publication IPC-7351 may have alternate designs.
- 6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



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

4214838/F 08/2024

NOTES: (continued)

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

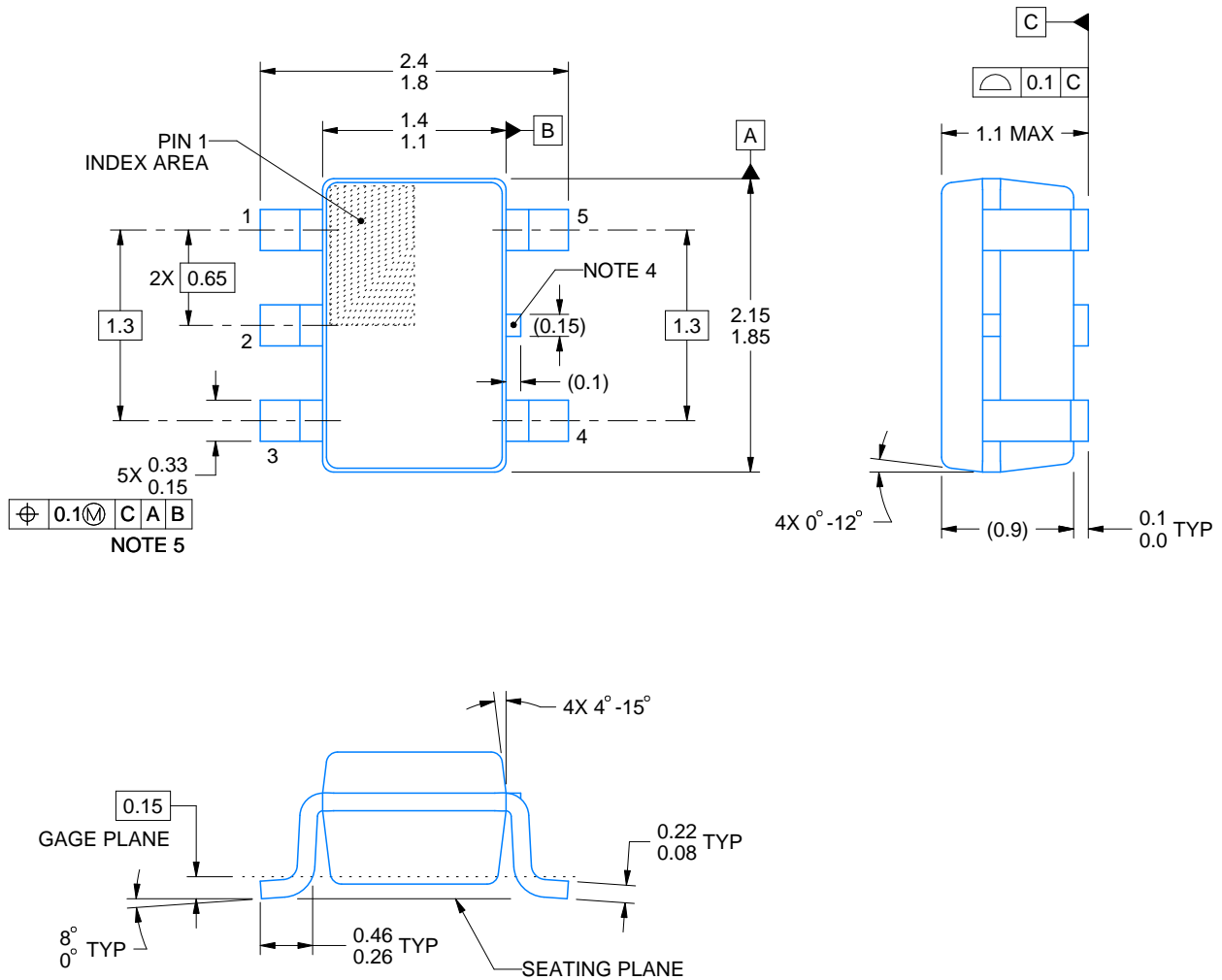
DCK0005A



PACKAGE OUTLINE

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



4214834/G 11/2024

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.
5. Lead width does not comply with JEDEC.
6. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.25mm per side

EXAMPLE BOARD LAYOUT

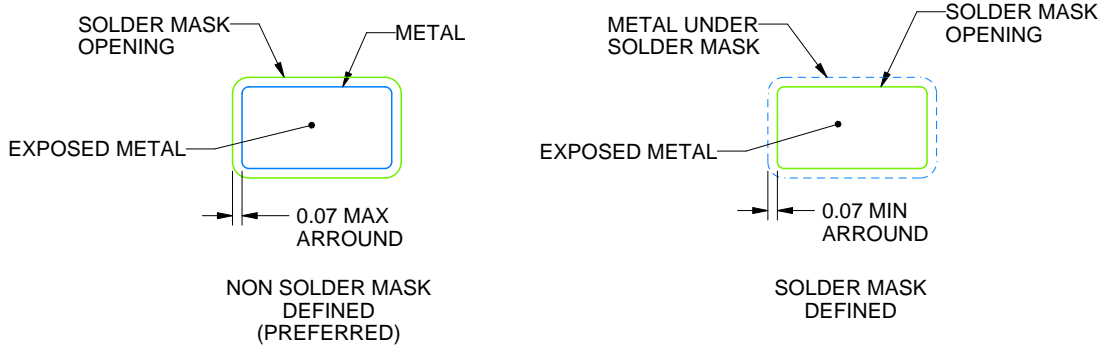
DCK0005A

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:18X



SOLDER MASK DETAILS

4214834/G 11/2024

NOTES: (continued)

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

EXAMPLE STENCIL DESIGN

DCK0005A

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



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

4214834/G 11/2024

NOTES: (continued)

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

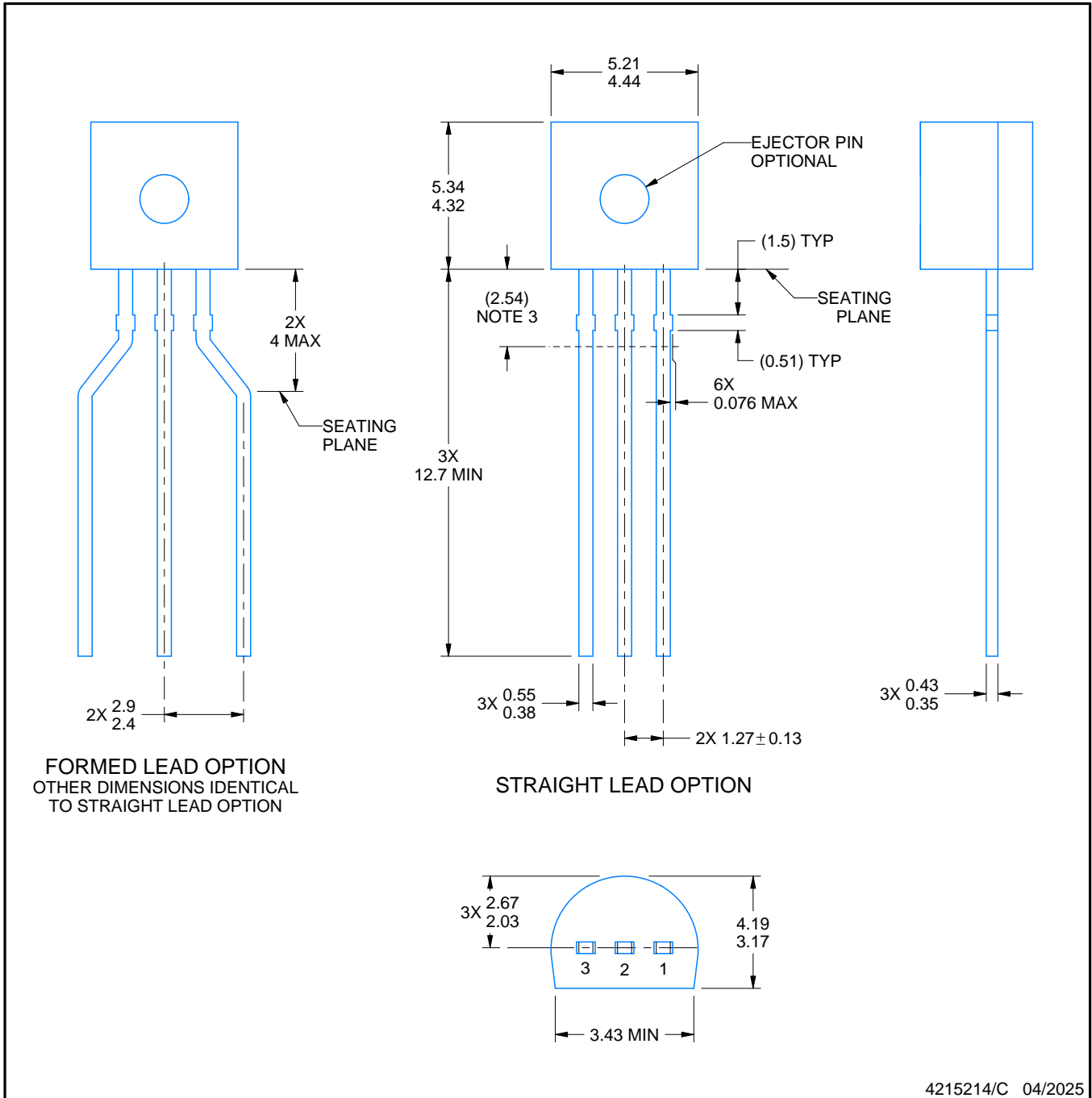
LP0003A



PACKAGE OUTLINE

TO-92 - 5.34 mm max height

TO-92



4215214/C 04/2025

NOTES:

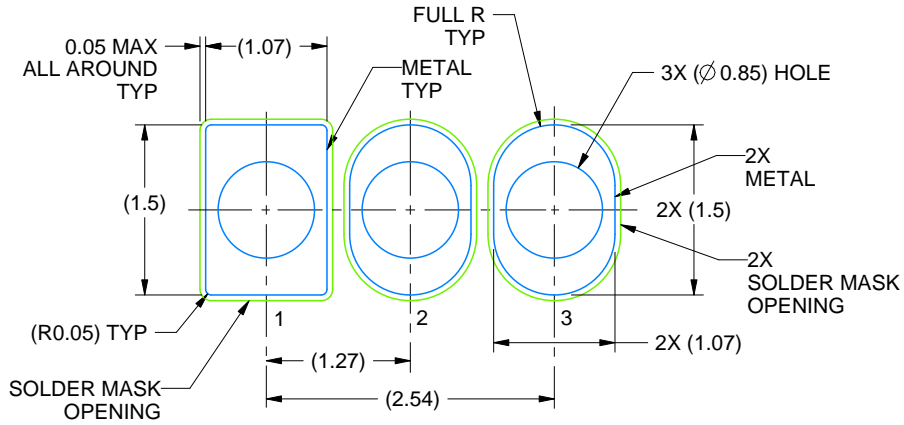
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Lead dimensions are not controlled within this area.
4. Reference JEDEC TO-226, variation AA.
5. Shipping method:
 - a. Straight lead option available in bulk pack only.
 - b. Formed lead option available in tape and reel or ammo pack.
 - c. Specific products can be offered in limited combinations of shipping medium and lead options.
 - d. Consult product folder for more information on available options.

EXAMPLE BOARD LAYOUT

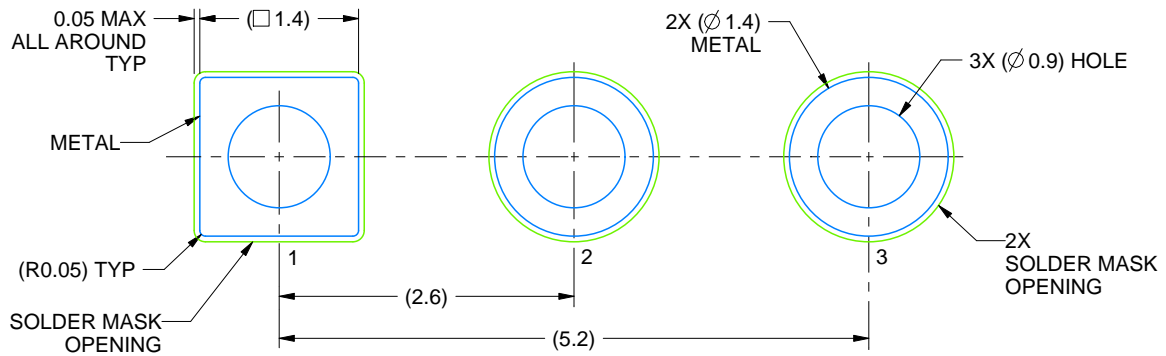
LP0003A

TO-92 - 5.34 mm max height

TO-92



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



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

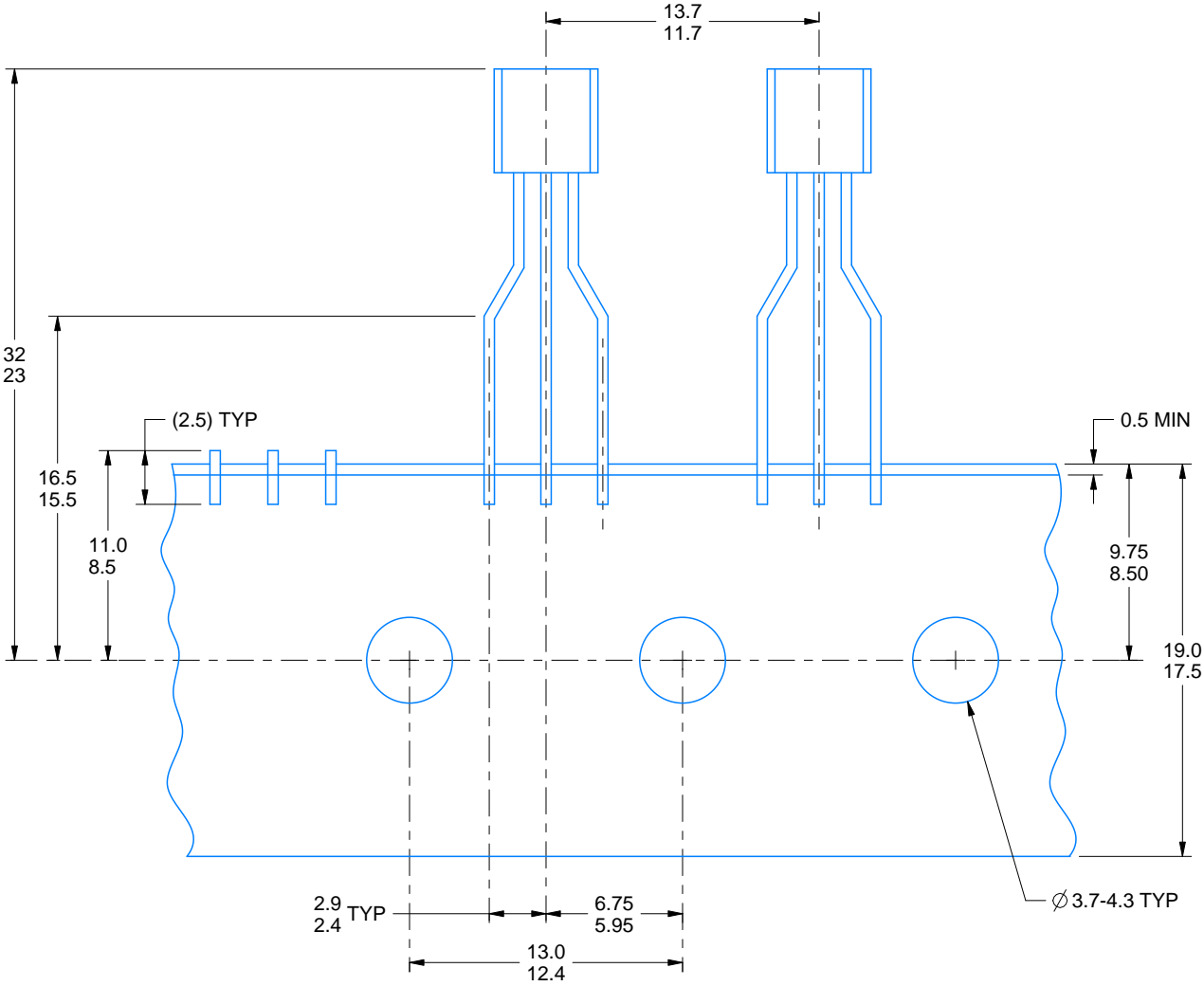
4215214/C 04/2025

TAPE SPECIFICATIONS

LP0003A

TO-92 - 5.34 mm max height

TO-92



FOR FORMED LEAD OPTION PACKAGE

4215214/C 04/2025

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