# TLV703 300-mA, Low-$I_Q$, Low-Dropout Regulator

## 1 Features

- Very Low Dropout:
  - 37 mV at $I_{OUT}$ = 50 mA, $V_{OUT}$ = 2.8 V
  - 75 mV at $I_{OUT}$ = 100 mA, $V_{OUT}$ = 2.8 V
  - 220 mV at $I_{OUT}$ = 300 mA, $V_{OUT}$ = 2.8 V
- 2% Accuracy
- Low $I_Q$: 35 µA
- Fixed-Output Voltage Combinations Possible From 1.2 V to 4.8 V
- High PSRR: 68 dB at 1 kHz
- Stable With Effective Capacitance of 0.1 µF
- Thermal Shutdown and Overcurrent Protection
- Packages: 5-Pin SOT-23

## 2 Applications

- Wireless Handsets
- Smart Phones
- ZigBee® Networks
- *Bluetooth*® Devices
- Li-Ion Battery-Operated Handheld Products
- WLAN and Other PC Add-on Cards

## 3 Description

The TLV703 series of low-dropout (LDO) linear regulators are low quiescent current devices with excellent line and load transient performance. These LDOs are designed for power-sensitive applications. A precision band-gap and error amplifier provides overall 2% accuracy. Low output noise, very high power-supply rejection ratio (PSRR), and low-dropout voltage make this series of devices ideal for a wide selection of battery-operated handheld equipment. All device versions have thermal shutdown and current limit for safety.

Furthermore, these devices are stable with an effective output capacitance of only 0.1 µF. This feature enables the use of cost-effective capacitors that have higher bias voltages and temperature derating. The devices regulate to specified accuracy with no output load.

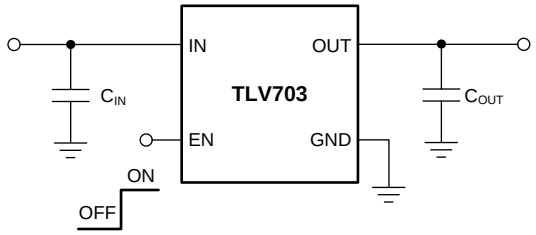
The TLV703 series of LDO linear regulators are available in a 5-pin SOT-23 package.

**Device Information**[1]

| PART NUMBER | PACKAGE | BODY SIZE (NOM) |
|---|---|---|
| TLV703 | SOT-23 (5) | 2.90 mm × 1.60 mm |

(1) For all available packages, see the orderable addendum at the end of the data sheet.

**Typical Application Circuit**




An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

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## 4 Revision History

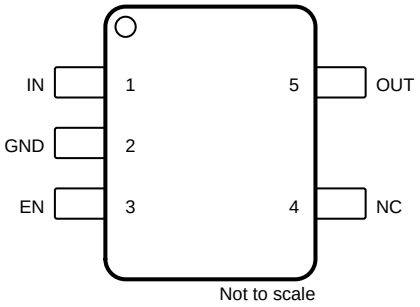
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| DATE | REVISION | NOTES |
|---|---|---|
| March 2017 | * | Initial release. |


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# 5 Pin Configuration and Functions

**DBV Package**
**5-Pin SOT-23**
**Top View**




Not to scale

**Pin Functions**

| PIN | | I/O | DESCRIPTION |
|---|---|---|---|
| NO. | NAME | | |
| 1 | IN | I | Input pin. A small, 1-µF ceramic capacitor is recommended from this pin to ground to assure stability and good transient performance. See the *Input and Output Capacitor Requirements* in the *Application Information* section for more details. |
| 2 | GND | — | Ground pin |
| 3 | EN | I | Enable pin. Driving EN over 0.9 V turns on the regulator. Driving EN below 0.4 V puts the regulator into shutdown mode and reduces operating current to 1 µA, nominal. |
| 4 | NC | — | No connection. This pin can be tied to ground to improve thermal dissipation. |
| 5 | OUT | O | Regulated output voltage pin. A small, 1-µF ceramic capacitor is needed from this pin to ground to assure stability. See the *Input and Output Capacitor Requirements* in the *Application Information* section for more details. |

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# 6 Specifications

## 6.1 Absolute Maximum Ratings

over operating junction temperature range (unless otherwise noted)(1)

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| Voltage(2) | IN, EN, OUT | –0.3 | 6 | V |
| Current (source) | OUT | Internally limited | | |
| Output short-circuit duration | | Indefinite | | |
| Total continuous power dissipation | | See *Thermal Information* | | |
| Temperature | Operating virtual junction, $T_J$ | –55 | 150 | °C |
| | Storage, $T_{stg}$ | –55 | 150 | |

(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 my affect device reliability.
(2) All voltages are with respect to the network ground terminal.

## 6.2 ESD Ratings

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

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

## 6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

| | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{IN}$ | Input voltage range | 2 | | 5.5 | V |
| $V_{OUT}$ | Output voltage range | 1.2 | | 4.8 | V |
| $I_{OUT}$ | Output current | 0 | | 300 | mA |

## 6.4 Thermal Information

| THERMAL METRIC(1) | | TLV703 DBV (SOT-23) 5 PINS | UNIT |
|---|---|---|---|
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 254.1 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 143.9 | °C/W |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 58.0 | °C/W |
| $\psi_{JT}$ | Junction-to-top characterization parameter | 25.3 | °C/W |
| $\psi_{JB}$ | Junction-to-board characterization parameter | 56.6 | °C/W |
| $R_{\theta JC(bot)}$ | Junction-to-case (bottom) thermal resistance | N/A | °C/W |

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report.


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## 6.5 Electrical Characteristics

at $V_{IN}$ = $V_{OUT(nom)}$ + 0.5 V or 2 V (whichever is greater), $I_{OUT}$ = 10 mA, $V_{EN}$ = 0.9 V, $C_{OUT}$ = 1 µF, and $T_J$ = –40°C to +125°C (unless otherwise noted); typical values are at $T_J$ = 25°C

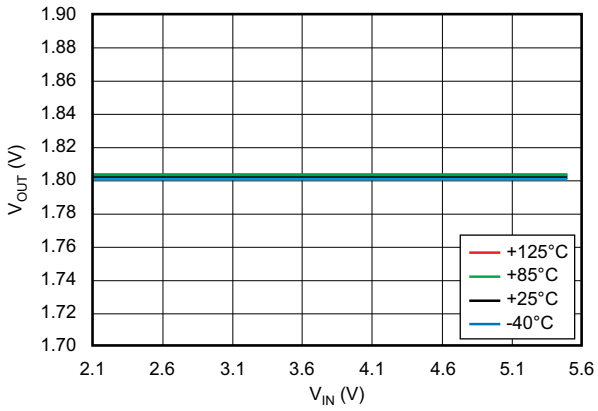
| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{IN}$ | Input voltage range | | 2 | | 5.5 | V |
| $V_{OUT}$ | DC output accuracy | –40°C ≤ $T_J$ ≤ 125°C | –2% | 0.5% | 2% | |
| $\Delta V_{OUT(\Delta VIN)}$ | Line regulation | $V_{OUT(nom)}$ + 0.5 V ≤ $V_{IN}$ ≤ 5.5 V, $I_{OUT}$ = 10 mA | | 1 | 5 | mV |
| $\Delta V_{OUT(\Delta IOUT)}$ | Load regulation | 0 mA ≤ $I_{OUT}$ ≤ 300 mA | | 1 | 15 | mV |
| $V_{DO}$ | Dropout voltage(1) | $V_{IN}$ = 0.98 × $V_{OUT(nom)}$, $I_{OUT}$ = 300 mA | | 260 | 375 | mV |
| $I_{CL}$ | Output current limit | $V_{OUT}$ = 0.9 × $V_{OUT(nom)}$ | 320 | 500 | 860 | mA |
| $I_{GND}$ | Ground pin current | $I_{OUT}$ = 0 mA | | 35 | 55 | µA |
| | | $I_{OUT}$ = 300 mA, $V_{IN}$ = $V_{OUT}$ + 0.5 V | | 370 | | |
| $I_{SHDN}$ | Ground pin current (shutdown) | $V_{EN}$ ≤ 0.4 V, $V_{IN}$ = 2 V | | 400 | | nA |
| | | $V_{EN}$ ≤ 0.4 V, 2 V ≤ $V_{IN}$ ≤ 4.5 V, $T_J$ = –40°C to +85°C | | 1 | 2 | µA |
| PSRR | Power-supply rejection ratio | $V_{IN}$ = 2.3 V, $V_{OUT}$ = 1.8 V, $I_{OUT}$ = 10 mA, f = 1 kHz | | 68 | | dB |
| $V_n$ | Output noise voltage | BW = 100 Hz to 100 kHz, $V_{IN}$ = 2.3 V, $V_{OUT}$ = 1.8 V, $I_{OUT}$ = 10 mA | | 48 | | $\mu V_{RMS}$ |
| $t_{STR}$ | Start-up time(2) | $C_{OUT}$ = 1 µF, $I_{OUT}$ = 300 mA | | 100 | | µs |
| $V_{EN(high)}$ | Enable pin high (enabled) | | 0.9 | | $V_{IN}$ | V |
| $V_{EN(low)}$ | Enable pin low (disabled) | | 0 | | 0.4 | V |
| $I_{EN}$ | Enable pin current | $V_{IN}$ = $V_{EN}$ = 5.5 V | | 0.04 | | µA |
| UVLO | Undervoltage lockout | $V_{IN}$ rising | | 1.9 | | V |
| $T_{sd}$ | Thermal shutdown temperature | Shutdown, temperature increasing | | 165 | | °C |
| | | Reset, temperature decreasing | | 145 | | |
| $T_J$ | Operating junction temperature | | –40 | | 125 | °C |

(1) $V_{DO}$ is measured for devices with $V_{OUT(nom)}$ ≥ 2.35 V.
(2) Start-up time = time from EN assertion to 0.98 × $V_{OUT(nom)}$.

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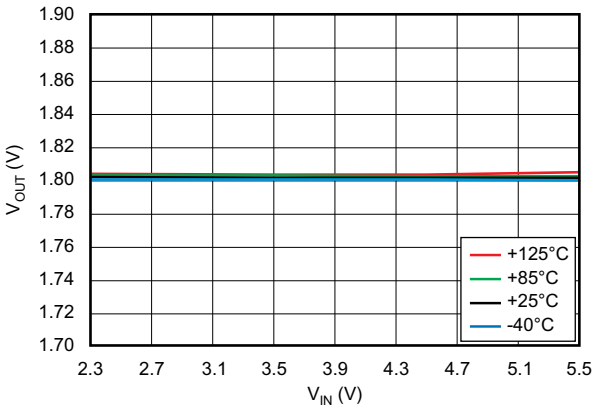
## 6.6 Typical Characteristics

over operating temperature range ($T_J$ = –40°C to +125°C), $V_{IN}$ = $V_{OUT(nom)}$ + 0.5 V or 2 V, whichever is greater, $I_{OUT}$ = 10 mA, $V_{EN}$ = $V_{IN}$, $C_{OUT}$ = 1 µF (unless otherwise noted); typical values are at $T_J$ = 25°C



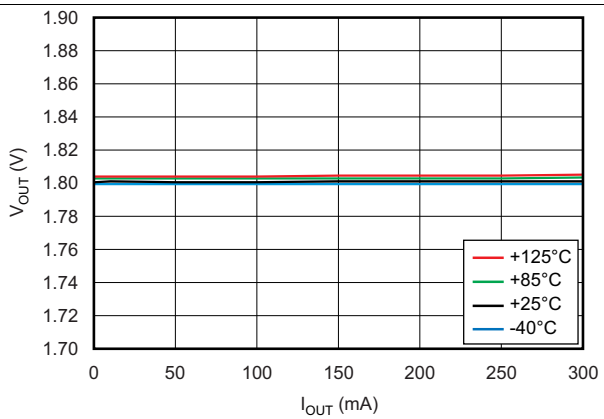

$V_{OUT}$ = 1.8 V, $I_{OUT}$ = 10 mA

**Figure 1. Line Regulation**



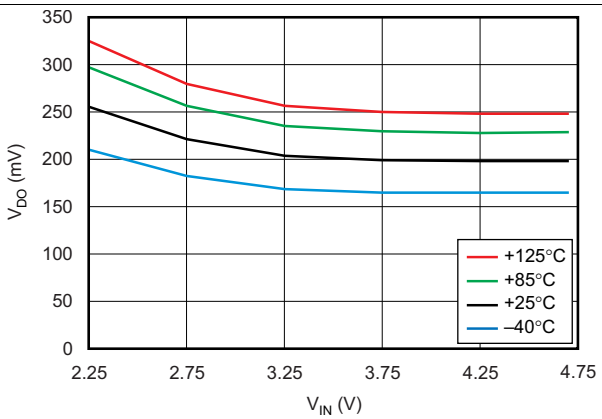

$V_{OUT}$ = 1.8 V, $I_{OUT}$ = 300 mA

**Figure 2. Line Regulation**



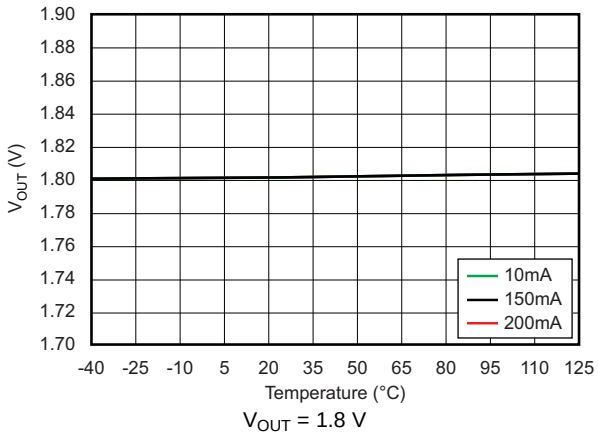

$V_{OUT}$ = 1.8 V

**Figure 3. Load Regulation**



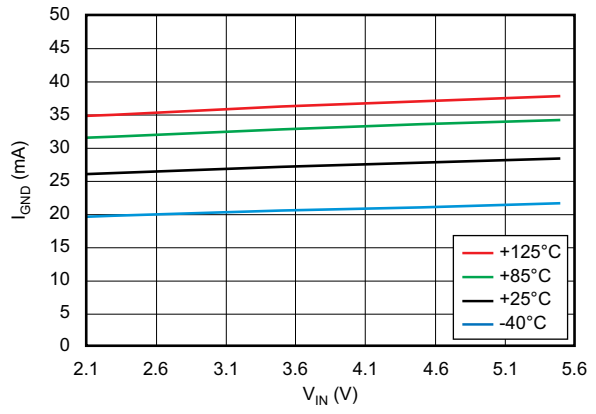

$I_{OUT}$ = 300 mA

**Figure 4. Dropout Voltage vs Input Voltage**




$V_{OUT}$ = 1.8 V

**Figure 5. Output Voltage vs Temperature**



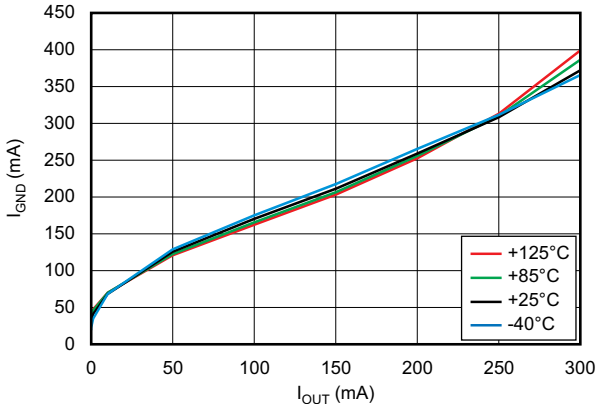

$V_{OUT}$ = 1.8 V

**Figure 6. Ground Pin Current vs Input Voltage**


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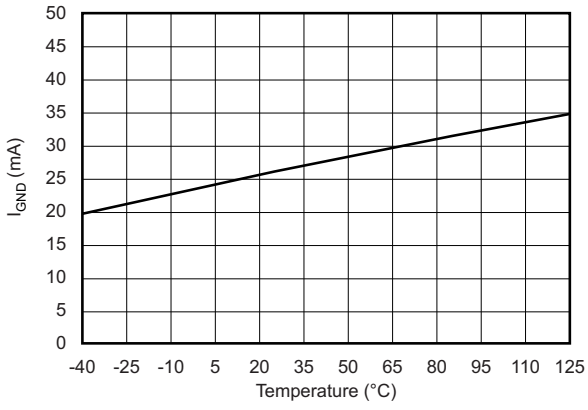
## Typical Characteristics (continued)

over operating temperature range ($T_J$ = –40°C to +125°C), $V_{IN}$ = $V_{OUT(nom)}$ + 0.5 V or 2 V, whichever is greater, $I_{OUT}$ = 10 mA, $V_{EN}$ = $V_{IN}$, $C_{OUT}$ = 1 µF (unless otherwise noted); typical values are at $T_J$ = 25°C



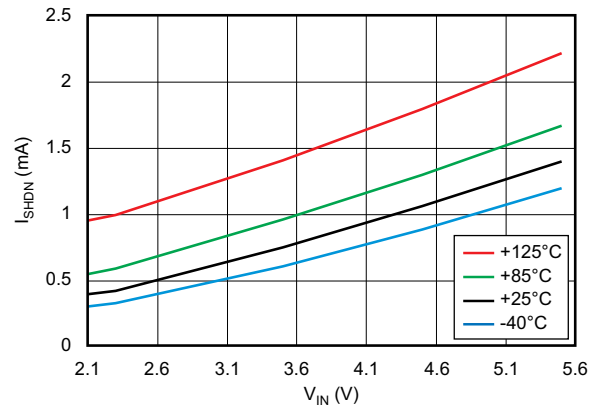

$V_{OUT}$ = 1.8 V

**Figure 7. Ground Pin Current vs Load**



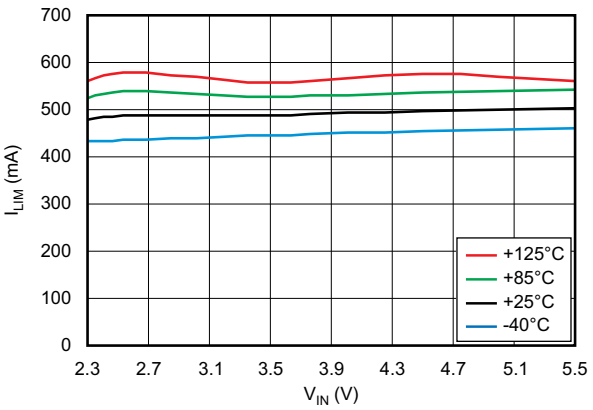

$V_{OUT}$ = 1.8 V

**Figure 8. Ground Pin Current vs Temperature**



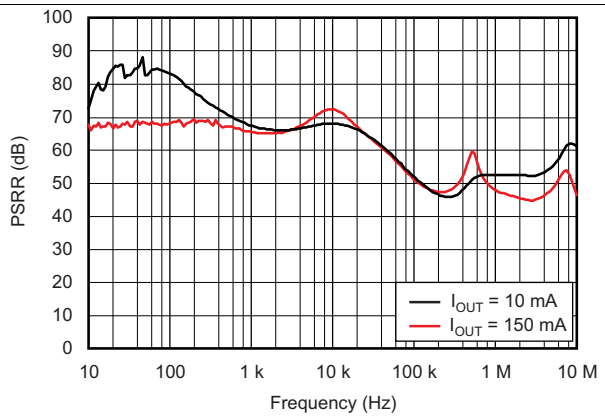

$V_{OUT}$ = 1.8 V

**Figure 9. Shutdown Current vs Input Voltage**



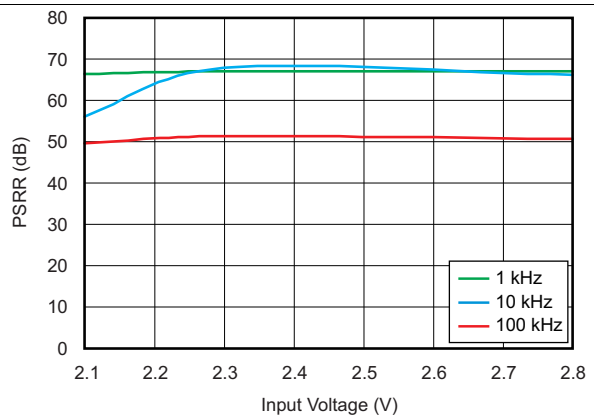

$V_{OUT}$ = 1.8 V

**Figure 10. Current Limit vs Input Voltage**




$V_{IN}$ – $V_{OUT}$ = 0.5 V

**Figure 11. Power-Supply Ripple Rejection vs Frequency**



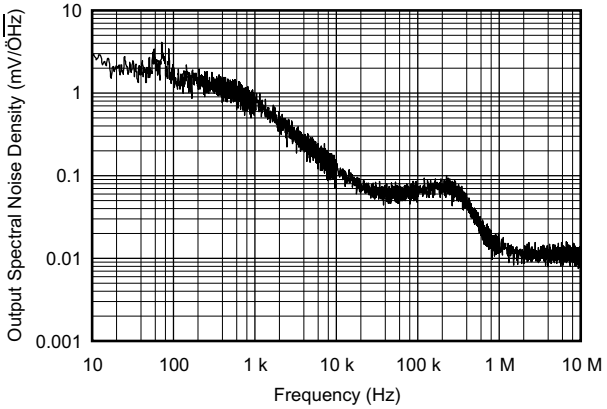

$V_{OUT}$ = 1.8 V

**Figure 12. Power-Supply Ripple Rejection vs Input Voltage**

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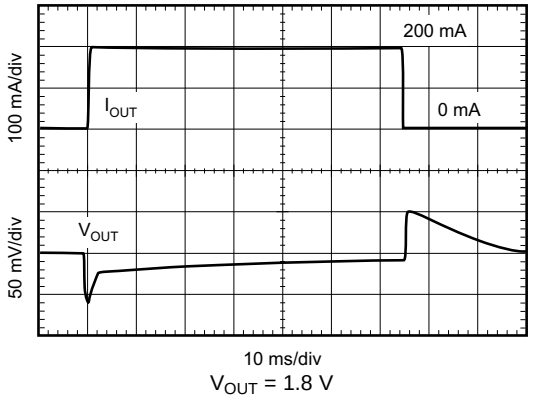
## Typical Characteristics (continued)

over operating temperature range ($T_J$ = –40°C to +125°C), $V_{IN}$ = $V_{OUT(nom)}$ + 0.5 V or 2 V, whichever is greater, $I_{OUT}$ = 10 mA, $V_{EN}$ = $V_{IN}$, $C_{OUT}$ = 1 µF (unless otherwise noted); typical values are at $T_J$ = 25°C



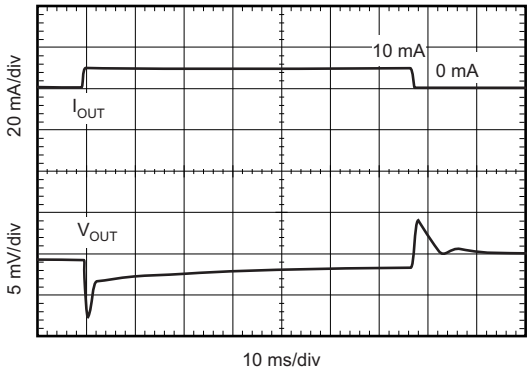

$V_{OUT}$ = 1.8 V, $I_{OUT}$ = 10 mA, $C_{IN}$ = $C_{OUT}$ = 1 µF

**Figure 13. Output Spectral Noise Density vs Frequency**



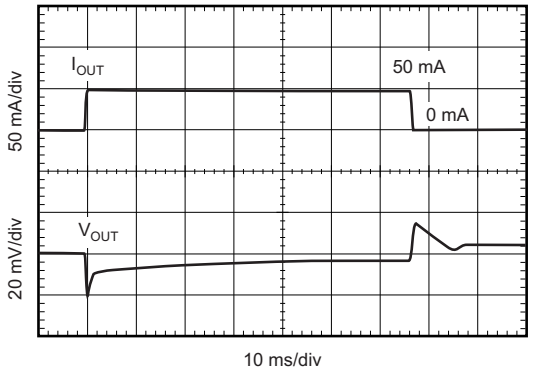

$V_{OUT}$ = 1.8 V

**Figure 14. Load Transient Response**



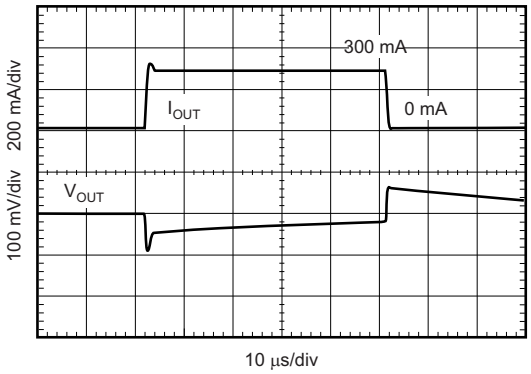

$V_{OUT}$ = 1.8 V, $t_R$ = $t_F$ = 1 µs

**Figure 15. Load Transient Response**



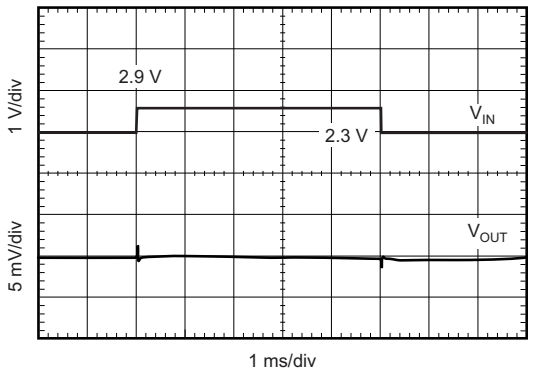

$V_{OUT}$ = 1.8 V, $t_R$ = $t_F$ = 1 µs

**Figure 16. Load Transient Response**




$V_{OUT}$ = 1.8 V, $t_R$ = $t_F$ = 1 µs

**Figure 17. Load Transient Response**



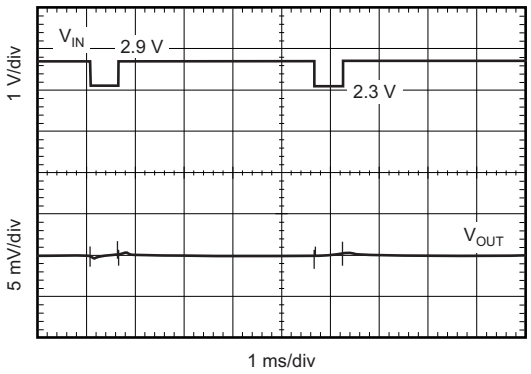

$V_{OUT}$ = 1.8 V, $I_{OUT}$ = 300 mA, slew rate = 1 V/µs

**Figure 18. Line Transient Response**


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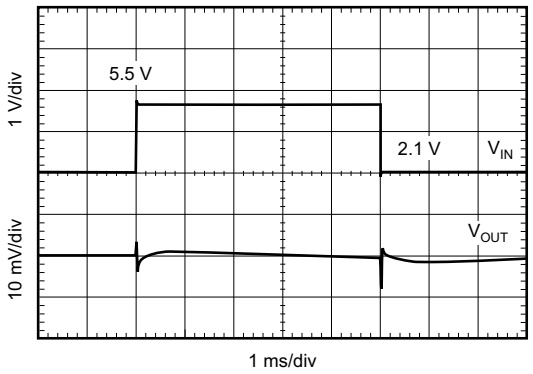
## Typical Characteristics (continued)

over operating temperature range ($T_J$ = –40°C to +125°C), $V_{IN}$ = $V_{OUT(nom)}$ + 0.5 V or 2 V, whichever is greater, $I_{OUT}$ = 10 mA, $V_{EN}$ = $V_{IN}$, $C_{OUT}$ = 1 µF (unless otherwise noted); typical values are at $T_J$ = 25°C



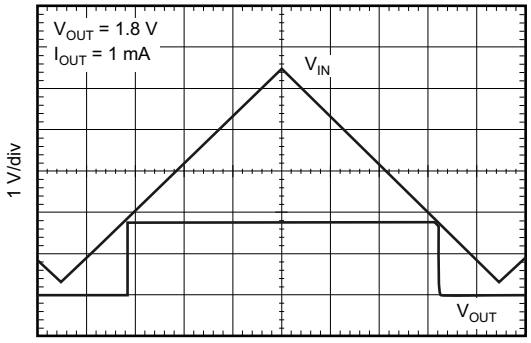

$V_{OUT}$ = 1.8 V, $I_{OUT}$ = 1 mA, slew rate = 1 V/µs

**Figure 19. Line Transient Response**




$V_{OUT}$ = 1.8 V, $I_{OUT}$ = 300 mA, slew rate = 1 V/µs

**Figure 20. Line Transient Response**




$V_{OUT}$ = 1.8 V, $I_{OUT}$ = 1 mA

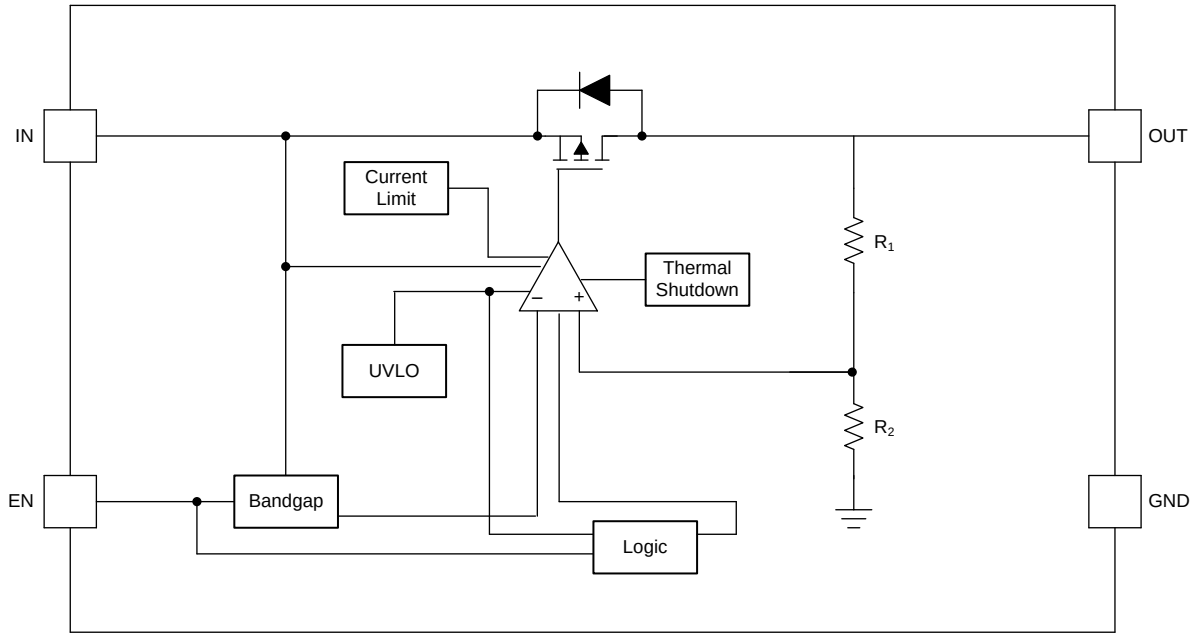
**Figure 21. $V_{IN}$ Ramp Up, Ramp Down Response**

# 7 Detailed Description

## 7.1 Overview

The TLV703 series of low-dropout (LDO) linear regulators are low quiescent current devices with excellent line and load transient performance. These LDOs are designed for power-sensitive applications. A precision band-gap and error amplifier provides overall 2% accuracy. Low output noise, very high power-supply rejection ratio (PSRR), and low dropout voltage make this series of devices ideal for most battery-operated handheld equipment. All device versions have integrated thermal shutdown, current limit, and undervoltage lockout (UVLO).

## 7.2 Functional Block Diagram




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## 7.3 Feature Description

### 7.3.1 Internal Current Limit

The TLV703 internal current limit helps protect the regulator during fault conditions. During current limit, the output sources a fixed amount of current that is largely independent of the output voltage. In such a case, the output voltage is not regulated, and is $V_{OUT} = I_{CL} \times R_{LOAD}$. The PMOS pass transistor dissipates $(V_{IN} – V_{OUT}) \times I_{CL}$ until thermal shutdown is triggered and the device turns off. As the device cools, the internal thermal shutdown circuit turns the device back on. If the fault condition continues, the device cycles between current limit and thermal shutdown; see the *Thermal Consideration* section for more details.

The PMOS pass element in the TLV703 has a built-in body diode that conducts current when the voltage at OUT exceeds the voltage at IN. This current is not limited, so if extended reverse voltage operation is anticipated, external limiting to 5% of the rated output current is recommended.

### 7.3.2 Shutdown

The enable pin (EN) is active high. The device is enabled when voltage at the EN pin goes above 0.9 V. The device is turned off when the EN pin is held at less than 0.4 V. When shutdown capability is not required, EN can be connected to the IN pin.


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## Feature Description (continued)

### 7.3.3 Dropout Voltage

The TLV703 uses a PMOS pass transistor to achieve low dropout. When ($V_{IN}$ – $V_{OUT}$) is less than the dropout voltage ($V_{DO}$), the PMOS pass device is in the linear (triode) region of operation and the input-to-output resistance is the $R_{DS(on)}$ of the PMOS pass element. $V_{DO}$ scales approximately with output current because the PMOS device functions as a resistor in dropout.

As with any linear regulator, PSRR and transient response are degraded when ($V_{IN}$ – $V_{OUT}$) approaches dropout. Figure 12 illustrates this effect.

### 7.3.4 Undervoltage Lockout (UVLO)

The TLV703 uses a UVLO circuit to keep the output shut off until internal circuitry is operating properly.

## 7.4 Device Functional Modes

### 7.4.1 Normal Operation

The device regulates to the nominal output voltage under the following conditions:

- The input voltage is greater than the nominal output voltage added to the dropout voltage
- The output current is less than the current limit
- The input voltage is greater than the UVLO voltage

### 7.4.2 Dropout Operation

If the input voltage is lower than the nominal output voltage plus the specified dropout voltage, but all other conditions are met for normal operation, the device operates in dropout mode. In this condition, the output voltage is the same as the input voltage minus the dropout voltage. The transient performance of the device is significantly degraded because the pass device is in a triode state and no longer regulates the output voltage of the LDO. Line or load transients in dropout can result in large output voltage deviations.

Table 1 lists the conditions that lead to the different modes of operation.

**Table 1. Device Functional Mode Comparison**

| OPERATING MODE | PARAMETER | |
|---|---|---|
| | $V_{IN}$ | $I_{OUT}$ |
| Normal mode | $V_{IN} > V_{OUT\ (nom)} + V_{DO}$ | $I_{OUT} < I_{CL}$ |
| Dropout mode | $V_{IN} < V_{OUT\ (nom)} + V_{DO}$ | $I_{OUT} < I_{CL}$ |
| Current limit | $V_{IN}$ > UVLO | $I_{OUT} > I_{CL}$ |

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# 8 Application and Implementation

**NOTE**

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

## 8.1 Application Information

The TLV703 belongs to a family of next-generation value LDO regulators. These devices consume low quiescent current and deliver excellent line and load transient performance. These characteristics, combined with low noise and very good PSRR with little ($V_{IN}$ – $V_{OUT}$) headroom, make this family of devices ideal for portable RF applications. This family of regulators offers current limit and thermal protection, and is specified from –40°C to +125°C.

## 8.2 Typical Application

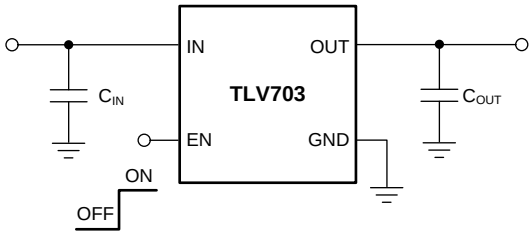



**Figure 22. Typical Application Circuit**

### 8.2.1 Design Requirements

Table 2 lists the design parameters.

**Table 2. Design Parameters**

| PARAMETER | DESIGN REQUIREMENT |
|---|---|
| Input voltage | 2.5 V to 3.3 V |
| Output voltage | 1.8 V |
| Output current | 100 mA |

### 8.2.2 Detailed Design Procedure

#### *8.2.2.1 Input and Output Capacitor Requirements*

1-μF X5R- and X7R-type ceramic capacitors are recommended because these capacitors have minimal variation in value and equivalent series resistance (ESR) over temperature.

However, the TLV703 is designed to be stable with an *effective capacitance* of 0.1 μF or larger at the output. Thus, the device is stable with capacitors of other dielectric types as well, as long as the effective capacitance under operating bias voltage and temperature is greater than 0.1 μF. In addition to allowing the use of lower-cost dielectrics, this capability of being stable with 0.1-μF effective capacitance also enables the use of smaller footprint capacitors that have higher derating in size- and space-constrained applications.

Using a 0.1-μF rated capacitor at the output of the LDO does not ensure stability because the effective capacitance under the specified operating conditions must not be less than 0.1 μF. Maximum ESR must be less than 200 mΩ.

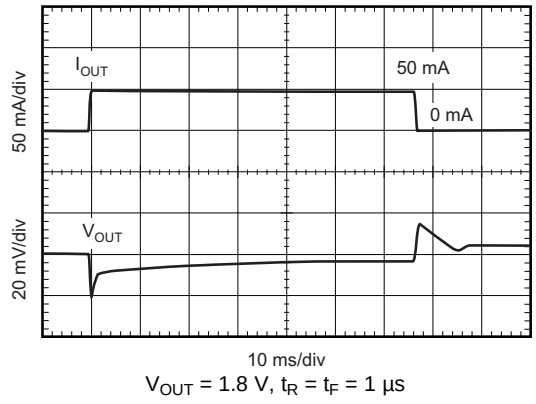

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Although an input capacitor is not required for stability, good analog design practice is to connect a 0.1-µF to 1-µF, low ESR capacitor across the IN pin and GND pin of the regulator. This capacitor counteracts reactive input sources and improves transient response, noise rejection, and ripple rejection. A higher-value capacitor may be necessary if large, fast rise-time load transients are anticipated, or if the device is not located close to the power source. If source impedance is more than 2 Ω, a 0.1-µF input capacitor may be necessary to ensure stability.

#### *8.2.2.2 Transient Response*

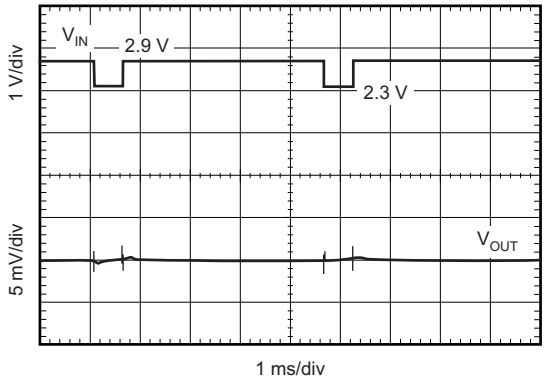
As with any regulator, increasing the size of the output capacitor reduces overshoot and undershoot magnitude but increases the duration of the transient response.

### 8.2.3 Application Curves




$V_{OUT}$ = 1.8 V, $t_R$ = $t_F$ = 1 µs

**Figure 23. Load Transient Response**




$V_{OUT}$ = 1.8 V, $I_{OUT}$ = 1 mA, slew rate = 1 V/µs

**Figure 24. Line Transient Response**

## 9 Power Supply Recommendations

Connect a low output impedance power supply directly to the IN pin of the TLV703. Inductive impedances between the input supply and the IN pin can create significant voltage excursions at the IN pin during start-up or load transient events.

### 9.1 Power Dissipation

The ability to remove heat from the die is different for each package type, presenting different considerations in the printed-circuit-board (PCB) layout. The PCB area around the device that is free of other components moves the heat from the device to the ambient air; see the *Thermal Information* section for thermal performance on the TLV703 evaluation module (EVM). The EVM is a two-layer board with two ounces of copper per side.

Power dissipation depends on input voltage and load conditions. Equation 1 shows that power dissipation ($P_D$) is equal to the product of the output current and the voltage drop across the output pass element.

$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} \quad (1)$$

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# 10 Layout

## 10.1 Layout Guidelines

Place input and output capacitors as close to the device pins as possible. To improve ac performance (such as PSRR, output noise, and transient response), TI recommends designing the board with separate ground planes for $V_{IN}$ and $V_{OUT}$ with the ground plane connected only at the GND pin of the device. In addition, connect the ground connection for the output capacitor directly to the GND pin of the device. High ESR capacitors can degrade PSRR performance.

## 10.2 Layout Example

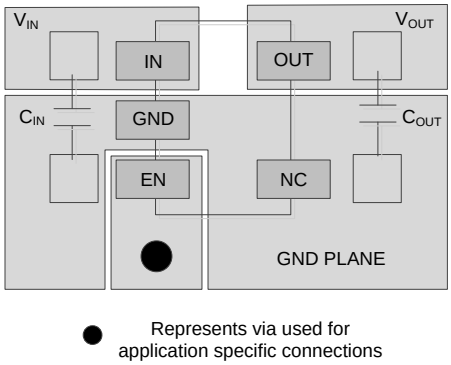



**Figure 25. Example Layout**

## 10.3 Thermal Consideration

Thermal protection disables the output when the junction temperature rises to approximately 165°C, allowing the device to cool. When the junction temperature cools to approximately 145°C, the output circuitry is again enabled. Depending on power dissipation, thermal resistance, and ambient temperature, the thermal protection circuit can cycle on and off. This cycling limits the dissipation of the regulator, thus protecting the regulator from damage resulting from overheating.

Any tendency to activate the thermal protection circuit indicates excessive power dissipation or an inadequate heatsink. For reliable operation, limit junction temperature to 125°C maximum.

To estimate the margin of safety in a complete design (including heatsink), increase the ambient temperature until the thermal protection is triggered; use worst-case loads and signal conditions.

The internal protection circuitry of the TLV703 is designed to protect against overload conditions. This circuitry is not intended to replace proper heatsinking. Continuously running the TLV703 into thermal shutdown degrades device reliability.


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# 11 Device and Documentation Support

## 11.1 Device Support

### 11.1.1 Development Support

### 11.1.2 Device Nomenclature

**Table 3. Ordering Information(1)**

| PRODUCT | $V_{OUT}$ (2) |
|---|---|
| TLV703**xx** ***yyyz*** | **XX** is nominal output voltage (for example, 28 = 2.8 V).<br>**YYY** is the package designator.<br>**Z** is tape and reel quantity (R = 3000). |

(1) For the most current package and ordering information see the Package Option Addendum at the end of this document, or visit the device product folder at www.ti.com.
(2) Output voltages from 1.2 V to 4.8 V in 50-mV increments are available. Contact factory for details and availability.

## 11.2 Documentation Support

### 11.2.1 Related Documentation

For related documentation see the following:

*Using the TLV700xxEVM-503 Evaluation Module*

## 11.3 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* 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.

## 11.4 Community Resources

The following links connect to TI community resources. Linked contents are 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.

**TI E2E™ Online Community** ***TI's Engineer-to-Engineer (E2E) Community.*** Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

**Design Support** ***TI's Design Support*** Quickly find helpful E2E forums along with design support tools and contact information for technical support.

## 11.5 Trademarks

E2E is a trademark of Texas Instruments.
*Bluetooth* is a registered trademark of Bluetooth SIG.
ZigBee is a registered trademark of the ZigBee Alliance.
All other trademarks are the property of their respective owners.

## 11.6 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.

## 11.7 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

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## 12 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.


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## 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) |
|---|---|---|---|---|---|---|---|---|---|
| TLV70310DBVR | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU \| SN | Level-1-260C-UNLIM | -40 to 125 | 1F4Q |
| TLV70310DBVR.A | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1F4Q |
| TLV70310DBVR.B | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1F4Q |
| TLV70311DBVR | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU \| SN | Level-1-260C-UNLIM | -40 to 125 | 1F1Q |
| TLV70311DBVR.A | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1F1Q |
| TLV70311DBVR.B | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1F1Q |
| TLV70312DBVR | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU \| SN | Level-1-260C-UNLIM | -40 to 125 | 1ECQ |
| TLV70312DBVR.A | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1ECQ |
| TLV70312DBVR.B | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1ECQ |
| TLV70313DBVR | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU \| SN | Level-1-260C-UNLIM | -40 to 125 | 1G5Q |
| TLV70313DBVR.A | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1G5Q |
| TLV70313DBVR.B | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1G5Q |
| TLV70315DBVR | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU \| SN | Level-1-260C-UNLIM | -40 to 125 | 1EDQ |
| TLV70315DBVR.A | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1EDQ |
| TLV70315DBVR.B | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1EDQ |
| TLV70318DBVR | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU \| SN | Level-1-260C-UNLIM | -40 to 125 | 1AZE |
| TLV70318DBVR.A | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1AZE |
| TLV70318DBVR.B | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1AZE |
| TLV70325DBVR | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU \| SN | Level-1-260C-UNLIM | -40 to 125 | 1EEQ |
| TLV70325DBVR.A | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1EEQ |
| TLV70325DBVR.B | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1EEQ |
| TLV70327DBVR | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU \| SN | Level-1-260C-UNLIM | -40 to 125 | 1EXQ |
| TLV70327DBVR.A | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1EXQ |
| TLV70327DBVR.B | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1EXQ |
| TLV70328DBVR | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU \| SN | Level-1-260C-UNLIM | -40 to 125 | 1B3E |
| TLV70328DBVR.A | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1B3E |
| TLV70328DBVR.B | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1B3E |
| TLV70329DBVR | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU \| SN | Level-1-260C-UNLIM | -40 to 125 | 1EZQ |
| TLV70329DBVR.A | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1EZQ |

| 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) |
|---|---|---|---|---|---|---|---|---|---|
| TLV70329DBVR.B | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1EZQ |
| TLV70330DBVR | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU \| SN | Level-1-260C-UNLIM | -40 to 125 | 1I9Q |
| TLV70330DBVR.A | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1I9Q |
| TLV70330DBVR.B | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1I9Q |
| TLV70333DBVR | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU \| SN | Level-1-260C-UNLIM | -40 to 125 | 1AHQ |
| TLV70333DBVR.A | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1AHQ |
| TLV70333DBVR.B | Active | Production | SOT-23 (DBV) \| 5 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 1AHQ |

(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.

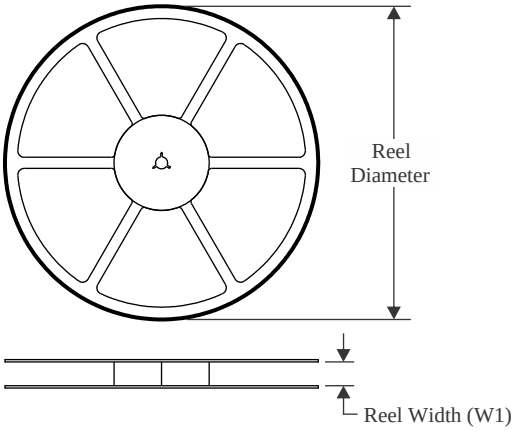
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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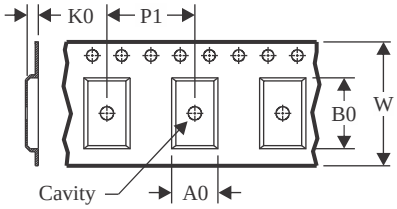
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## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

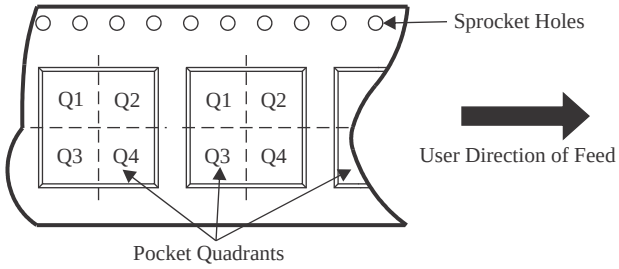



**TAPE DIMENSIONS**




| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

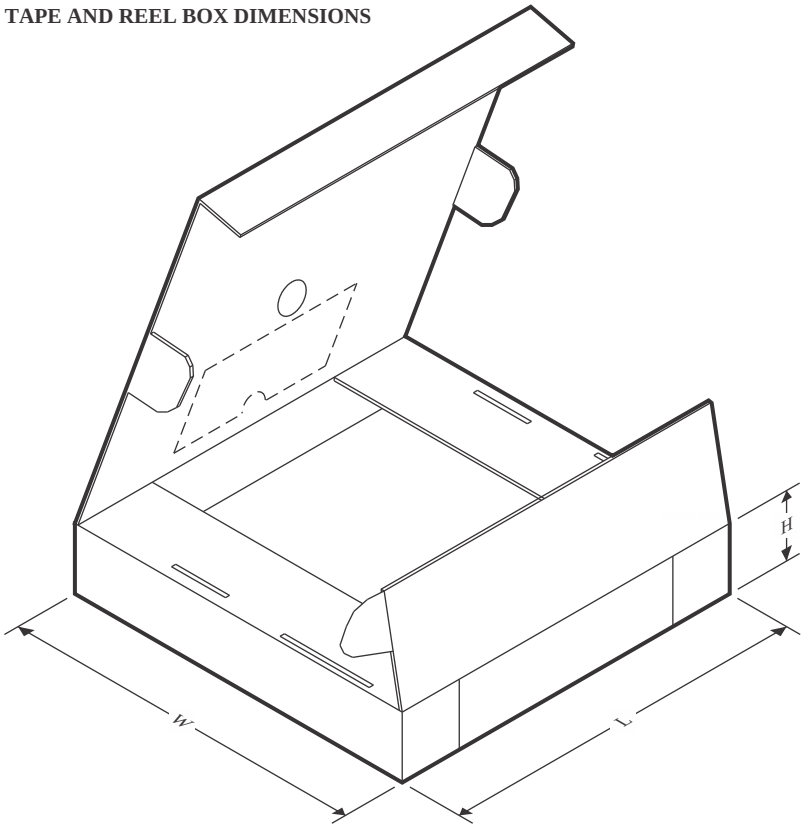
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TLV70310DBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TLV70311DBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TLV70312DBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TLV70313DBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TLV70315DBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TLV70318DBVR | SOT-23 | DBV | 5 | 3000 | 178.0 | 9.0 | 3.3 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TLV70318DBVR | SOT-23 | DBV | 5 | 3000 | 178.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TLV70318DBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TLV70325DBVR | SOT-23 | DBV | 5 | 3000 | 178.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TLV70327DBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TLV70328DBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TLV70329DBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TLV70330DBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TLV70333DBVR | SOT-23 | DBV | 5 | 3000 | 178.0 | 9.0 | 3.3 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TLV70333DBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TLV70333DBVR | SOT-23 | DBV | 5 | 3000 | 178.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |

TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

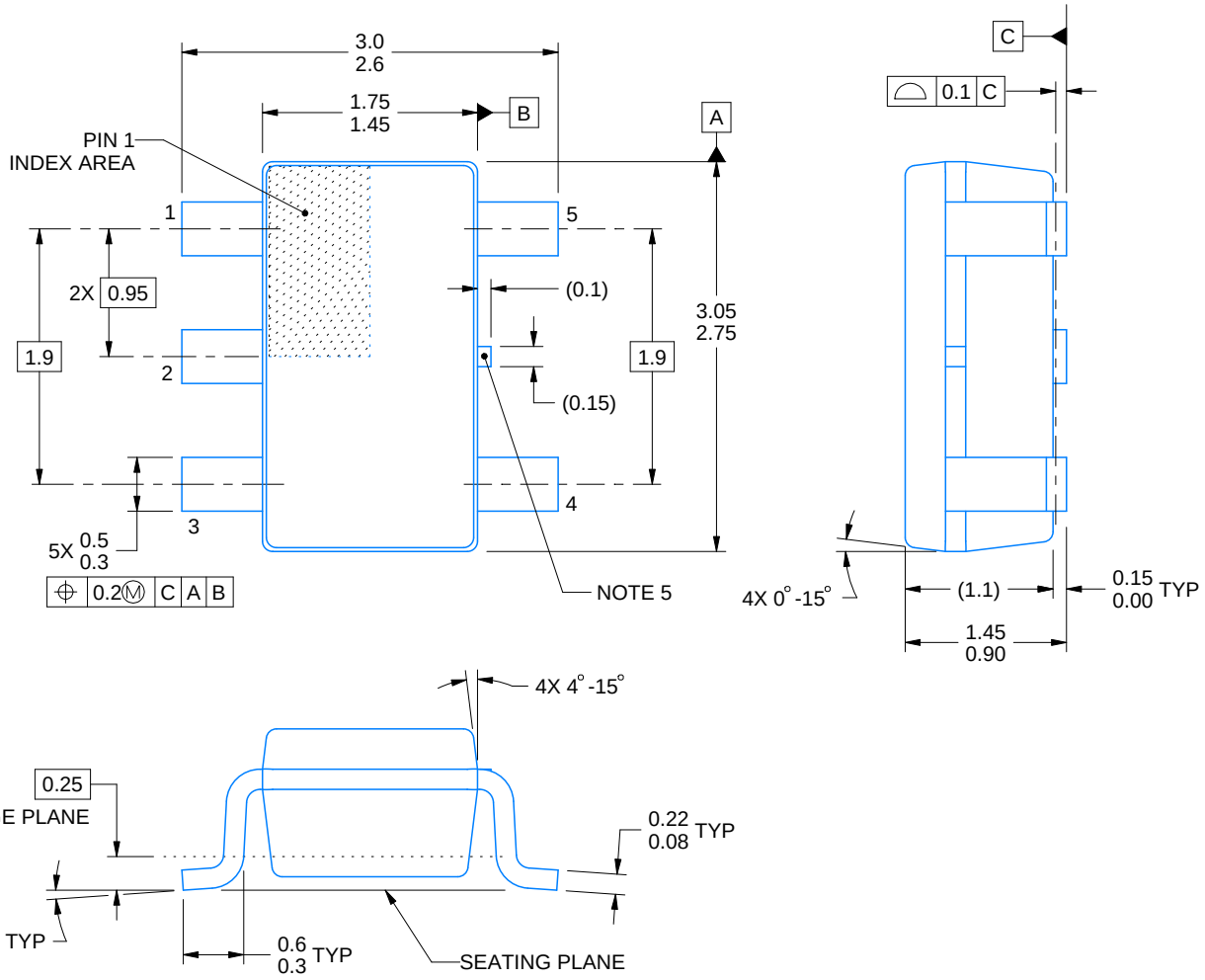
| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| TLV70310DBVR | SOT-23 | DBV | 5 | 3000 | 210.0 | 185.0 | 35.0 |
| TLV70311DBVR | SOT-23 | DBV | 5 | 3000 | 210.0 | 185.0 | 35.0 |
| TLV70312DBVR | SOT-23 | DBV | 5 | 3000 | 210.0 | 185.0 | 35.0 |
| TLV70313DBVR | SOT-23 | DBV | 5 | 3000 | 210.0 | 185.0 | 35.0 |
| TLV70315DBVR | SOT-23 | DBV | 5 | 3000 | 210.0 | 185.0 | 35.0 |
| TLV70318DBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| TLV70318DBVR | SOT-23 | DBV | 5 | 3000 | 208.0 | 191.0 | 35.0 |
| TLV70318DBVR | SOT-23 | DBV | 5 | 3000 | 210.0 | 185.0 | 35.0 |
| TLV70325DBVR | SOT-23 | DBV | 5 | 3000 | 208.0 | 191.0 | 35.0 |
| TLV70327DBVR | SOT-23 | DBV | 5 | 3000 | 210.0 | 185.0 | 35.0 |
| TLV70328DBVR | SOT-23 | DBV | 5 | 3000 | 210.0 | 185.0 | 35.0 |
| TLV70329DBVR | SOT-23 | DBV | 5 | 3000 | 210.0 | 185.0 | 35.0 |
| TLV70330DBVR | SOT-23 | DBV | 5 | 3000 | 210.0 | 185.0 | 35.0 |
| TLV70333DBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| TLV70333DBVR | SOT-23 | DBV | 5 | 3000 | 210.0 | 185.0 | 35.0 |
| TLV70333DBVR | SOT-23 | DBV | 5 | 3000 | 208.0 | 191.0 | 35.0 |

# PACKAGE OUTLINE

## DBV0005A

## SOT-23 - 1.45 mm max height

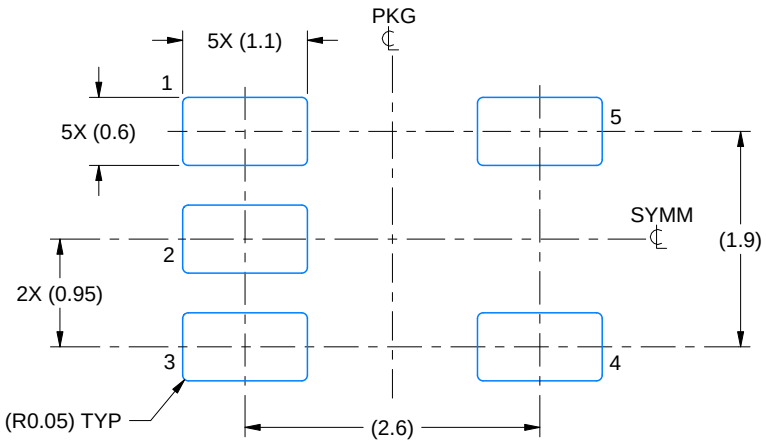
SMALL OUTLINE TRANSISTOR



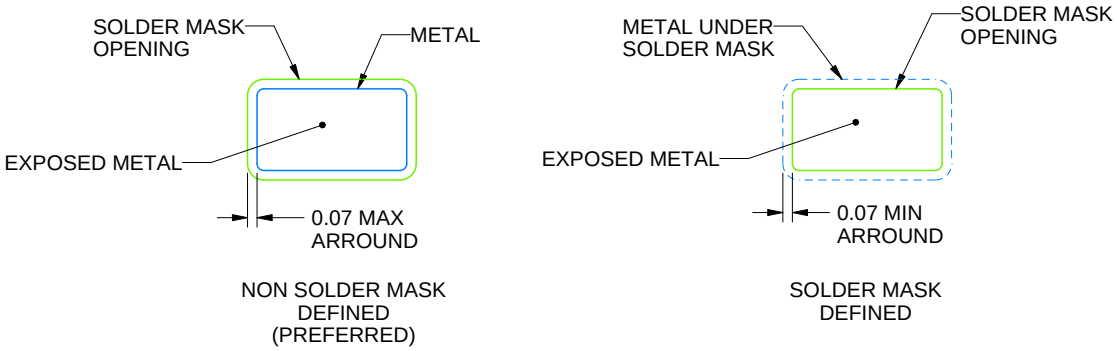

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NOTES:

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. Refernce JEDEC MO-178.
4. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.25 mm per side.
5. Support pin may differ or may not be present.




LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X

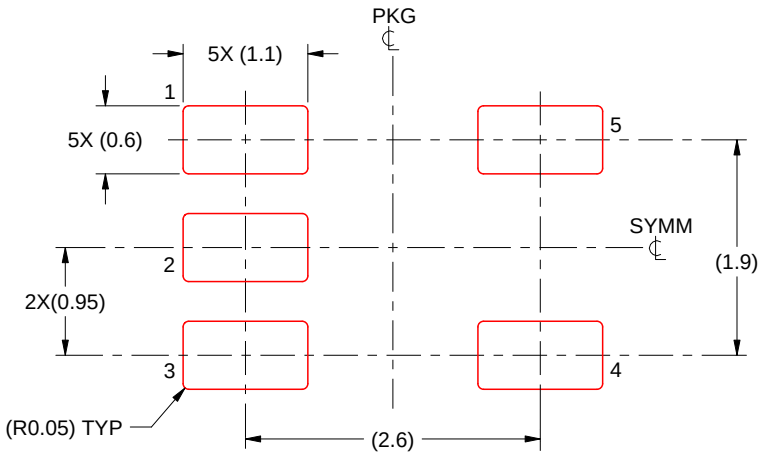



SOLDER MASK DETAILS

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NOTES: (continued)

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




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

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NOTES: (continued)

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

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Last updated 10/2025