1 Features

- Wide Input Voltage Range: 2.5 V to 24 V
- Low 3.2-μA Quiescent Current
- Ground Pin Current: 3.4 μA at 100-mA \( I_{\text{OUT}} \)
- Stable With a Low-ESR, 1-μF Typical Output Capacitor
- Operating Junction Temperature: –40°C to 125°C
- Available in SOT23-5 Package

   - See Package Option Addendum at end of this document for complete list of available voltage options

2 Applications

- Ultralow Power Microcontrollers
- E-Meters
- Fire Alarms and Smoke Detector Systems
- Handset Peripherals
- Industrial and Automotive Applications
- Remote Controllers
- Zigbee® Networks
- Portable, Battery-Powered Equipment

3 Description

The TLV704 series of low-dropout (LDO) regulators are ultralow quiescent current devices designed for extremely power-sensitive applications. Quiescent current is virtually constant over the complete load current and ambient temperature range. These devices are an ideal power-management attachment to low-power microcontrollers, such as the MSP430.

The TLV704 operates over a wide operating input voltage of 2.5 V to 24 V. Thus, the device is an excellent choice for both battery-powered systems as well as industrial applications that undergo large line transients.

The TLV704 is available in a 3-mm × 3-mm SOT23-5 package, which is ideal for cost-effective board manufacturing.

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>PACKAGE</th>
<th>BODY SIZE (nom)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLV704</td>
<td>SOT-23 (5)</td>
<td>2.90 mm x 1.60 mm</td>
</tr>
</tbody>
</table>

(1) For all available packages, see the orderable addendum at the end of the data sheet.
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4 Revision History
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision C (August, 2011) to Revision D  Page

- Added ESD Ratings table, Feature Description section, Device Functional Modes, Application and Implementation section, Power Supply Recommendations section, Layout section, Device and Documentation Support section, and Mechanical, Packaging, and Orderable Information section ........................................... 1
- Changed fourth bullet in Features list .......................................................... 1
- Changed Applications list .............................................................................. 1
- Changed front-page figure; removed pinout ................................................... 1
- Changed Pin Configuration and Functions section; updated table format, renamed pin package to meet new standards ........................................... 4
- Changed "free-air" to "junction" temperature in condition statement for Absolute Maximum Ratings ........................................... 5
- Changed "free-air" to "junction" temperature in condition statement for Recommended Operating Conditions ................................. 5
- Deleted Power Dissipation Rating table ........................................................ 5
- Changed "T_A" to "T_J" in condition statement for Electrical Characteristics .............. 6
- Changed parametric symbol for line regulation ............................................ 6
- Changed parametric symbol for load regulation .......................................... 6

Changes from Revision B (November, 2010) to Revision C  Page

- Revised document to reflect PK package option removal ................................ 1
- Removed SOT89 (PK) package from front-page figure .................................... 1
- Deleted PK package information from Pin Functions table ............................ 4
- Revised Thermal Information table and Power Dissipation Rating table ........ 5
- Added load regulation specifications for V_OUT ≥ 3.3 V .................................... 6
- Removed Figure 15 and Figure 16 ................................................................. 14
Changes from Revision A (October, 2010) to Revision B

- Updated document to reflect availability of PK package option........................................................................................................ 1
- Corrected typo in front-page figure......................................................................................................................................................... 1
- Changed Pin Functions table to correct pin numbering for PK package option.................................................................................. 4
- Revised Typical Characteristics section; added and removed graphs.................................................................................................. 7
- Updated format of Application Information section......................................................................................................................... 10
5 Pin Configuration and Functions

DBV Package
SOT-23 (5)
(Top View)

Pin Functions

<table>
<thead>
<tr>
<th>PIN</th>
<th>I/O</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>GND</td>
<td>1</td>
<td>Ground</td>
</tr>
<tr>
<td>IN</td>
<td>2</td>
<td>Unregulated input voltage.</td>
</tr>
<tr>
<td>OUT</td>
<td>3</td>
<td>Regulated output voltage. Any capacitor greater than 1 µF between this pin and ground is needed for stability.</td>
</tr>
<tr>
<td>NC</td>
<td>4, 5</td>
<td>Not internally connected. This pin can be left open or tied to ground for improved thermal performance.</td>
</tr>
</tbody>
</table>
6 Specifications

6.1 Absolute Maximum Ratings
Over operating junction temperature range, unless otherwise noted(1).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MIN</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage(2)</td>
<td>–0.3</td>
<td>24</td>
<td>V</td>
</tr>
<tr>
<td>Current source</td>
<td>Internally limited</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>–40</td>
<td>150</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td>–65</td>
<td>150</td>
<td>°C</td>
</tr>
</tbody>
</table>

(1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) All voltages are with respect to network ground terminal.

6.2 ESD Ratings

<table>
<thead>
<tr>
<th>Electrostatic discharge</th>
<th>VALUE</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins(1)</td>
<td>±2000</td>
<td>V</td>
</tr>
<tr>
<td>Charged device model (CDM), per JEDEC specification JESD22-C101, all pins(2)</td>
<td>±500</td>
<td>V</td>
</tr>
</tbody>
</table>

(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 junction temperature range (unless otherwise noted)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MIN</th>
<th>NOM</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>VN</td>
<td>2.5</td>
<td>24</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>IOUT</td>
<td>0</td>
<td>150</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>TJ</td>
<td>–40</td>
<td>125</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

6.4 Thermal Information

<table>
<thead>
<tr>
<th>THERMAL METRIC(1)</th>
<th>TLV704</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>RθJA</td>
<td>213.1</td>
<td>°C/W</td>
</tr>
<tr>
<td>RθJC(top)</td>
<td>110.9</td>
<td>°C/W</td>
</tr>
<tr>
<td>RθJB</td>
<td>97.4</td>
<td>°C/W</td>
</tr>
<tr>
<td>ψJT</td>
<td>22.0</td>
<td>°C/W</td>
</tr>
<tr>
<td>ψJB</td>
<td>78.4</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

(1) For more information about traditional and new thermal metrics, see the IC Package Thermal Metrics application report, SPRA953.
### 6.5 Electrical Characteristics

All values are at $T_J = 25^\circ C$, $V_{IN} = V_{OUT(nom)} + 1 \, V$, $I_{OUT} = 1 \, mA$, and $C_{OUT} = 1 \, \mu F$, unless otherwise noted.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IN}$</td>
<td>Input voltage range</td>
<td>24</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{OUT}$</td>
<td>Output voltage range</td>
<td>1.2</td>
<td>5</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{OUT}$ DC output accuracy</td>
<td>$V_{(nom)} + 1 , V &lt; V_{IN} &lt; 24 , V$</td>
<td>$-2%$</td>
<td>$2%$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta V_{O(V)}$</td>
<td>Line regulation</td>
<td>$V_{OUT} \leq 3.3 , V$</td>
<td>0 mA $&lt; I_{OUT} &lt; 10 , mA$</td>
<td>10</td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 mA $&lt; I_{OUT} &lt; 50 , mA$</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 mA $&lt; I_{OUT} &lt; 100 , mA$</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_{OUT} \geq 3.3 , V$</td>
<td></td>
<td>0 mA $&lt; I_{OUT} &lt; 10 , mA$</td>
<td>7</td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 mA $&lt; I_{OUT} &lt; 50 , mA$</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 mA $&lt; I_{OUT} &lt; 100 , mA$</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>$V_{DO}$</td>
<td>Dropout voltage (1)</td>
<td></td>
<td>75</td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td>$I_{OUT} = 10 , mA$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{OUT} = 50 , mA$</td>
<td></td>
<td></td>
<td>400</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{OUT} = 100 , mA$</td>
<td></td>
<td></td>
<td>850</td>
<td>1000</td>
<td>mA</td>
</tr>
<tr>
<td>$I_{CL}$</td>
<td>Output current limit</td>
<td>$V_{OUT} = 0 , V$</td>
<td>160</td>
<td>1000</td>
<td>mA</td>
</tr>
<tr>
<td>$I_{GND}$</td>
<td>Ground pin current</td>
<td>$I_{OUT} = 0 , mA$</td>
<td>3.2</td>
<td>4.5</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{OUT} = 100 , mA$</td>
<td>3.4</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>$PSRR$</td>
<td>Power-supply rejection ratio</td>
<td>$f = 100 , kHz$, $C_{OUT} = 10 , \mu F$</td>
<td>60</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>$T_J$</td>
<td>Operating junction temperature</td>
<td></td>
<td>$-40$</td>
<td>125</td>
<td>°C</td>
</tr>
</tbody>
</table>

(1) $V_{IN} = V_{OUT(nom)} - 0.1 \, V$. 
6.6 Typical Characteristics

Figure 1. Line Regulation

Figure 2. Load Regulation ($V_{OUT} = 3.3$ V)

Figure 3. Output Voltage vs Junction Temperature

Figure 4. Dropout Voltage vs Input Voltage (TLV70433)

Figure 5. Dropout Voltage vs Output Current

Figure 6. Ground Current vs Junction Temperature
Typical Characteristics (continued)

Figure 7. Ground Pin Current vs Input Voltage

Figure 8. Ground Pin Current vs Load Current

Figure 9. Current Limit vs Junction Temperature

Figure 10. Output Spectral Noise Density vs Frequency

Figure 11. Power-Supply Ripple Rejection vs Frequency

Figure 12. Power Up/Power Down
Typical Characteristics (continued)

Figure 13. Line Transient Response

Figure 14. Load Transient Response
7 Detailed Description

7.1 Overview
The TLV704 series belong to a family of ultralow I\textsubscript{Q} LDO regulators. I\textsubscript{Q} remains fairly constant over the complete output load current and temperature range. The devices are ensured to operate over a temperature range of –40°C to 125°C.

7.2 Functional Block Diagram

7.3 Feature Description

7.3.1 Regulator Protection
The TLV704 series of LDO regulators use a PMOS-pass transistor that has a built-in back diode that conducts reverse current when the input voltage drops below the output voltage (for example, during power down). Current is conducted from the output to the input and is not internally limited. If extended reverse voltage operation is anticipated, external limiting is appropriate.

The TLV704 features internal current limiting. During normal operation, the TLV704 limits output current to approximately 250 mA. When current limiting engages, the output voltage scales back linearly until the overcurrent condition ends. Do not exceed the rated maximum operating junction temperature of 125°C. Continuously running the device under conditions where the junction temperature exceeds 125°C degrades device reliability.

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. Performance data for JEDEC high-K boards are given in the Thermal Information table. Using heavier copper increases the effectiveness in removing heat from the device. The addition of plated through-holes to heat-dissipating layers also improves heatsink effectiveness. Power dissipation depends on input voltage and load conditions. Power dissipation (P\textsubscript{D}) is equal to the product of the output current and the voltage drop across the output pass element, as shown in Equation 2.
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.

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 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 controls the current through the LDO. Line or load transients in dropout may result in large output voltage deviations.

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

<table>
<thead>
<tr>
<th>OPERATING MODE</th>
<th>PARAMETER</th>
<th>IOUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal mode</td>
<td>$V_{IN} &gt; V_{OUT ,(nom)} + V_{DO}$</td>
<td>$I_{OUT} &lt; I_{CL}$</td>
</tr>
<tr>
<td>Dropout mode</td>
<td>$V_{IN} &lt; V_{OUT ,(nom)} + V_{DO}$</td>
<td>$I_{OUT} &lt; I_{CL}$</td>
</tr>
</tbody>
</table>
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 TLV704 family of LDOs are designed for power-sensitive applications and feature low quiescent current. These devices pair well with low-power microcontrollers, such as the MSP430.

8.2 Typical Application

8.2.1 Design Requirements
Select the desired device based on the output voltage.

Provide an input supply with adequate headroom to account for dropout and output current to account for the GND terminal current, and power the load.

8.2.2 Detailed Design Procedure
8.2.2.1 Input and Output Capacitor Requirements
The TLV704 requires a 1-µF or larger capacitor connected between OUT and GND for stability. Ceramic or tantalum capacitors can be used. Larger value capacitors result in better transient and noise performance.

Although an input capacitor is not required for stability, when a 0.1-µF or larger capacitor is placed between IN and GND, it counteracts reactive input sources and improves transient and noise performance. Higher value capacitors are necessary if large, fast rise time load transients are anticipated.
9 Power Supply Recommendations

Connect a low output impedance power supply directly to the IN pin of the TLV704. 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. If inductive impedances are unavoidable, use an input capacitor.

10 Layout

10.1 Layout Guidelines

Input and output capacitors should be placed as close to the device pins as possible. To avoid interference of noise and ripple on the board, TI recommends designing the board with separate ground planes for \( V_{\text{IN}} \) and \( V_{\text{OUT}} \), with the ground plane connected only at the device GND pin. In addition, the ground connection for the output capacitor should be connected directly to the device GND pin.

10.2 Layout Example

![Layout Example for the DBV Package](image-url)
10.3 Power Dissipation and Junction Temperature

To ensure reliable operation, worst-case junction temperature should not exceed 125°C. This restriction limits the power dissipation the regulator can handle in any given application. To ensure the junction temperature is within acceptable limits, calculate the maximum allowable dissipation, \( P_{D(\text{max})} \), and the actual dissipation, \( P_D \), which must be less than or equal to \( P_{D(\text{max})} \).

The maximum power dissipation limit is determined using Equation 1:

\[
P_{D(\text{max})} = \frac{T_{J\text{max}} - T_A}{R_{\theta JA}}
\]

where:
- \( T_{J\text{max}} \) is the maximum allowable junction temperature.
- \( R_{\theta JA} \) is the thermal resistance junction-to-ambient for the package (see the Thermal Information table).
- \( T_A \) is the ambient temperature.

The regulator dissipation is calculated using Equation 2:

\[
P_D = (V_{IN} - V_{OUT}) \times I_{OUT}
\]

Power dissipation resulting from quiescent current is negligible.

10.4 Estimating Junction Temperature

The JEDEC standard now recommends the use of psi (\( \Psi \)) thermal metrics to estimate the junction temperatures of the LDO while in-circuit on a typical PCB board application. These metrics are not strictly speaking thermal resistances, but rather offer practical and relative means of estimating junction temperatures. These psi metrics are determined to be significantly independent of the copper-spreading area. The key thermal metrics (\( \Psi_{JT} \) and \( \Psi_{JB} \)) are given in the Thermal Information table and are used in accordance with Equation 3.

\[
\Psi_{JT}: T_J = T_T + \Psi_{JT} \times P_D
\]
\[
\Psi_{JB}: T_J = T_B + \Psi_{JB} \times P_D
\]

where:
- \( P_D \) is the power dissipated as explained in Thermal Information
- \( T_T \) is the temperature at the center-top of the device package
- \( T_B \) is the PCB surface temperature measured 1 mm from the device package and centered on the package edge.

10.5 Package Mounting

Solder pad footprint recommendations for the TLV704 are available from the TI’s website at www.ti.com through the TLV704 series product folders. The recommended land pattern for the DBV package is appended to this data sheet.
11 Device and Documentation Support

11.1 Device Support

11.1.1 Development Support

11.1.1.1 Evaluation Module

An evaluation module (EVM) is available to assist in the initial circuit performance evaluation using the TLV704. The TLV70433DBVEVM-712 evaluation module (and related user guide) can be requested at the Texas Instruments website through the product folders or purchased directly from the TI eStore.

11.1.2 Device Nomenclature

Table 2. Available Options

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>VOUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLV704xxyyyy</td>
<td>xx is nominal output voltage (for example 33 = 3.3 V)</td>
</tr>
<tr>
<td></td>
<td>yyy is Package Designator</td>
</tr>
<tr>
<td></td>
<td>z is Package Quantity</td>
</tr>
</tbody>
</table>

(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.

11.2 Documentation Support

11.2.1 Related Documentation

• TLV70433DBVEVM-712, TLV70433PKEVM-712 Evaluation Modules, SBVU017

11.3 Trademarks

Zigbee is a registered trademark of ZigBee Alliance. All other trademarks are the property of their respective owners.

11.4 Electrostatic Discharge Caution

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

11.5 Glossary

SLYZ022 — Ti Glossary.

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

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.
## PACKAGING INFORMATION

<table>
<thead>
<tr>
<th>Orderable Device</th>
<th>Status (1)</th>
<th>Package Type</th>
<th>Package Drawing</th>
<th>Pins</th>
<th>Package Qty</th>
<th>Eco Plan (2)</th>
<th>Lead/Ball Finish</th>
<th>MSL Peak Temp (3)</th>
<th>Op Temp (°C)</th>
<th>Device Marking (4/5)</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLV70430DBVR</td>
<td>ACTIVE</td>
<td>SOT-23</td>
<td>DBV</td>
<td>5</td>
<td>3000</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
<td>-40 to 125</td>
<td>QUQ</td>
<td>Samples</td>
</tr>
<tr>
<td>TLV70430DBVT</td>
<td>ACTIVE</td>
<td>SOT-23</td>
<td>DBV</td>
<td>5</td>
<td>250</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
<td>-40 to 125</td>
<td>QUQ</td>
<td>Samples</td>
</tr>
<tr>
<td>TLV70433DBVR</td>
<td>ACTIVE</td>
<td>SOT-23</td>
<td>DBV</td>
<td>5</td>
<td>3000</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
<td>-40 to 125</td>
<td>PAO</td>
<td>Samples</td>
</tr>
<tr>
<td>TLV70433DBVT</td>
<td>ACTIVE</td>
<td>SOT-23</td>
<td>DBV</td>
<td>5</td>
<td>250</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
<td>-40 to 125</td>
<td>PAO</td>
<td>Samples</td>
</tr>
<tr>
<td>TLV704345DBVR</td>
<td>ACTIVE</td>
<td>SOT-23</td>
<td>DBV</td>
<td>5</td>
<td>3000</td>
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(1) The marketing status values are defined as follows:
- **ACTIVE**: Product device recommended for new designs.
- **LIFEBUY**: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
- **NRND**: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
- **PREVIEW**: Device has been announced but is not in production. Samples may or may not be available.
- **OBSOLETE**: TI has discontinued the production of the device.

(2) **RoHS**: TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
- **RoHS Exempt**: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
- **Green**: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) **MSL, Peak Temp.**: The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

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

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

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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

### 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

### REEL DIMENSIONS

- **K0 - P1**
- **A0**

### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE

- **Sprocket Holes**
- **User Direction of Feed**
- **Pocket Quadrants**

*All dimensions are nominal*

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<th>Pins</th>
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*All dimensions are nominal*
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.
4. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
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.
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