

## DS90LV011AQ Automotive LVDS Differential Driver

Check for Samples: [DS90LV011AQ](#)

### FEATURES

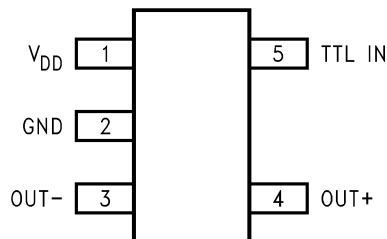
- AECQ-100 Grade 1
- Conforms to TIA/EIA-644-A Standard
- >400Mbps (200MHz) Switching Rates
- 700 ps (100 ps typical) Maximum Differential Skew
- 1.5 ns Maximum Propagation Delay
- Single 3.3V Power Supply
- $\pm 350$  mV Differential Signaling
- Power Off Protection (Outputs in TRI-STATE)
- Pinout Simplifies PCB Layout
- Low Power Dissipation (23 mW @ 3.3V Typical)
- SOT-23 5-Lead Package
- Pin Compatible with SN65LVDS1

### DESCRIPTION

The DS90LV011AQ is an LVDS driver optimized for high data rate and low power applications. The DS90LV011AQ is a current mode driver allowing power dissipation to remain low even at high frequency. In addition, the short circuit fault current is also minimized. The device is designed to support data rates in excess of 400Mbps (200MHz) utilizing Low Voltage Differential Signaling (LVDS) technology.

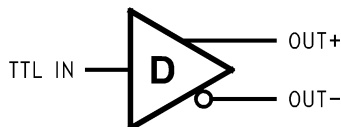
The device is offered in a 5-lead SOT-23 package. The LVDS outputs have been arranged for easy PCB layout. The differential driver outputs provide low EMI with its typical low output swing of 350 mV. The DS90LV011AQ can be paired with its companion single line receiver, the DS90LT012AQ, or with any of TI's LVDS receivers, to provide a high-speed LVDS interface.

### Connection Diagram



**Figure 1. Top View**  
See Package Number MF05A

### Functional Diagram



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

All trademarks are the property of their respective owners.



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.

### Absolute Maximum Ratings <sup>(1)(2)</sup>

|   |                                 |
|---|---------------------------------|
| Supply Voltage ( $V_{DD}$ )                           | -0.3V to 4.0V                   |
| LVCMOS input voltage (TTL IN)                         | -0.3V to to ( $V_{DD} + 0.3V$ ) |
| LVDS output voltage ( $OUT_{\pm}$ )                   | -0.3V to +3.9V                  |
| LVDS output short circuit current                     | 24mA                            |
| Maximum Package Power Dissipation @ +25°C             |                                 |
| DBV Package   | 794 mW                          |
| Derate DBV Package                                    | 7.22 mW/°C above +25°C          |
| Package Thermal Resistance (4-Layer, 2 oz. Cu, JEDEC) |                                 |
| $\theta_{JA}$   | 138.5°C/Watt                    |
| $\theta_{JC}$   | 107.0°C/Watt                    |
| Storage Temperature                                   | -65°C to +150°C                 |
| Lead Temperature Range Soldering                      |                                 |
| (4 sec.)  | +260°C                          |
| Maximum Junction Temperature                          | +135°C                          |
| ESD Ratings   |                                 |
| HBM <sup>(3)</sup>                                    | ≥ 8kV                           |
| MM <sup>(4)</sup>                                     | ≥ 250V                          |
| CDM <sup>(5)</sup>                                    | ≥ 1250V                         |

- (1) Absolute Maximum Ratings are those values beyond which the safety of the device cannot be ensured. They are not meant to imply that the devices should be operated at these limits. Electrical Characteristics specifies conditions of device operation.
- (2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/Distributors for availability and specifications.
- (3) Human Body Model, applicable std. JESD22-A114C
- (4) Machine Model, applicable std. JESD22-A115-A
- (5) Field Induced Charge Device Model, applicable std. JESD22-C101-C

### Recommended Operating Conditions

|                             | Min | Typ | Max  | Units |
|-----------------------------|-----|-----|------|-------|
| Supply Voltage ( $V_{DD}$ ) | 3.0 | 3.3 | 3.6  | V     |
| Temperature ( $T_A$ )       | -40 | +25 | +125 | °C    |

### Electrical Characteristics

Over Supply Voltage and Operating Temperature ranges, unless otherwise specified. <sup>(1)(2)(3)</sup>

| Symbol          | Parameter  | Conditions                                   | Pin           | Min   | Typ  | Max   | Units |
|-----------------|--|--|---------------|-------|------|-------|-------|
| $ V_{OD} $      | Output Differential Voltage                              | $R_L = 100\Omega$<br>(Figure 2 and Figure 3) | OUT+,<br>OUT- | 250   | 350  | 450   | mV    |
| $\Delta V_{OD}$ | $V_{OD}$ Magnitude Change                                |  |               |       | 3    | 35    | mV    |
| $V_{OS}$        | Offset Voltage   | $R_L = 100\Omega$<br>(Figure 2)              |               | 1.125 | 1.22 | 1.375 | V     |
| $\Delta V_{OS}$ | Offset Magnitude Change                                  |  |               | 0     | 1    | 25    | mV    |
| $I_{OFF}$       | Power-off Leakage  | $V_{OUT} = 3.6V$ or GND, $V_{DD} = 0V$       |               |       | ±1   | ±10   | µA    |
| $I_{OS}$        | Output Short Circuit Current <sup>(4)</sup>              | $V_{OUT+}$ and $V_{OUT-} = 0V$               |               |       | -6   | -24   | mA    |
| $I_{OSD}$       | Differential Output Short Circuit Current <sup>(4)</sup> | $V_{OD} = 0V$                                |               |       | -5   | -12   | mA    |
| $C_{OUT}$       | Output Capacitance                                       |  |               |       | 3    |       | pF    |

- (1) Current into device pins is defined as positive. Current out of device pins is defined as negative. All voltages are referenced to ground except  $V_{OD}$ .
- (2) All typicals are given for:  $V_{DD} = +3.3V$  and  $T_A = +25^\circ C$ .
- (3) The DS90LV011AQ is a current mode device and only function with datasheet specification when a resistive load is applied to the drivers outputs.
- (4) Output short circuit current ( $I_{OS}$ ) is specified as magnitude only, minus sign indicates direction only.

## Electrical Characteristics (continued)

Over Supply Voltage and Operating Temperature ranges, unless otherwise specified. <sup>(1)(2)(3)</sup>

| Symbol          | Parameter            | Conditions                     |  | Pin             | Min | Typ  | Max             | Units |    |
|-----------------|----------------------|--------------------------------|--|-----------------|-----|------|-----------------|-------|----|
| V <sub>IH</sub> | Input High Voltage   |                                |  | TTL IN          | 2.0 |      | V <sub>DD</sub> | V     |    |
| V <sub>IL</sub> | Input Low Voltage    |                                |  |                 | GND |      | 0.8             | V     |    |
| I <sub>IH</sub> | Input High Current   | V <sub>IN</sub> = 3.3V or 2.4V |  |                 |     |      | ±2              | ±10   | µA |
| I <sub>IL</sub> | Input Low Current    | V <sub>IN</sub> = GND or 0.5V  |  |                 |     |      | ±1              | ±10   | µA |
| V <sub>CL</sub> | Input Clamp Voltage  | I <sub>CL</sub> = -18 mA       |  |                 |     | -1.5 | -0.6            |       | V  |
| C <sub>IN</sub> | Input Capacitance    |                                |  |                 |     |      | 3               |       | pF |
| I <sub>DD</sub> | Power Supply Current | No Load                        | V <sub>IN</sub> = V <sub>DD</sub> or GND | V <sub>DD</sub> |     | 5    | 8               | mA    |    |
|                 |                      | R <sub>L</sub> = 100Ω          |  |                 |     | 7    | 10              | mA    |    |

## Switching Characteristics

Over Supply Voltage and Operating Temperature Ranges, unless otherwise specified. <sup>(1)(2)(3)(4)</sup>

| Symbol            | Parameter   | Conditions   | Min | Typ | Max | Units |
|-------------------|---|--|-----|-----|-----|-------|
| t <sub>PHLD</sub> | Differential Propagation Delay High to Low                                      | R <sub>L</sub> = 100Ω, C <sub>L</sub> = 15 pF<br>(Figure 4 and Figure 5) | 0.3 | 1.0 | 1.5 | ns    |
| t <sub>PLHD</sub> | Differential Propagation Delay Low to High                                      |  | 0.3 | 1.1 | 1.5 | ns    |
| t <sub>SKD1</sub> | Differential Pulse Skew  t <sub>PHLD</sub> - t <sub>PLHD</sub>   <sup>(5)</sup> |  | 0   | 0.1 | 0.7 | ns    |
| t <sub>SKD3</sub> | Differential Part to Part Skew <sup>(6)</sup>                                   |  | 0   | 0.2 | 1.0 | ns    |
| t <sub>SKD4</sub> | Differential Part to Part Skew <sup>(7)</sup>                                   |  | 0   | 0.4 | 1.2 | ns    |
| t <sub>TLH</sub>  | Transition Low to High Time   |  | 0.2 | 0.5 | 1.0 | ns    |
| t <sub>THL</sub>  | Transition High to Low Time   |  | 0.2 | 0.5 | 1.0 | ns    |
| f <sub>MAX</sub>  | Maximum Operating Frequency <sup>(8)</sup>                                      |  |     |     | 250 |       |

- (1) All typicals are given for: V<sub>DD</sub> = +3.3V and T<sub>A</sub> = +25°C.
- (2) These parameters are ensured by design. The limits are based on statistical analysis of the device performance over PVT (process, voltage, temperature) ranges.
- (3) C<sub>L</sub> includes probe and fixture capacitance.
- (4) Generator waveform for all tests unless otherwise specified: f = 1 MHz, Z<sub>O</sub> = 50Ω, t<sub>r</sub> ≤ 1 ns, t<sub>f</sub> ≤ 1 ns (10%-90%).
- (5) t<sub>SKD1</sub>, |t<sub>PHLD</sub> - t<sub>PLHD</sub>|, is the magnitude difference in differential propagation delay time between the positive going edge and the negative going edge of the same channel.
- (6) t<sub>SKD3</sub>, Differential Part to Part Skew, is defined as the difference between the minimum and maximum specified differential propagation delays. This specification applies to devices at the same V<sub>DD</sub> and within 5°C of each other within the operating temperature range.
- (7) t<sub>SKD4</sub>, part to part skew, is the differential channel to channel skew of any event between devices. This specification applies to devices over recommended operating temperature and voltage ranges, and across process distribution. t<sub>SKD4</sub> is defined as |Max - Min| differential propagation delay.
- (8) f<sub>MAX</sub> generator input conditions: t<sub>r</sub> = t<sub>f</sub> < 1 ns (0% to 100%), 50% duty cycle, 0V to 3V. Output criteria: duty cycle = 45%/55%, V<sub>OD</sub> > 250mV.

### Parameter Measurement Information

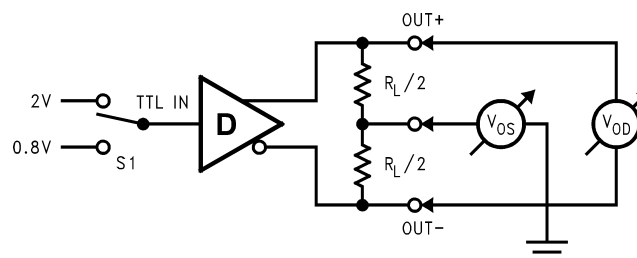
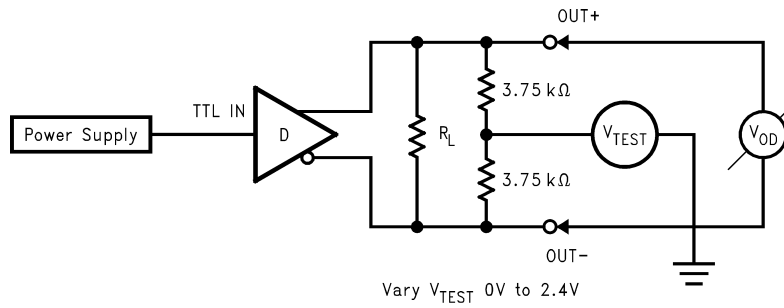
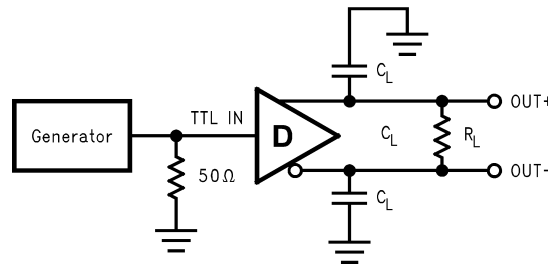


Figure 2. Differential Driver DC Test Circuit

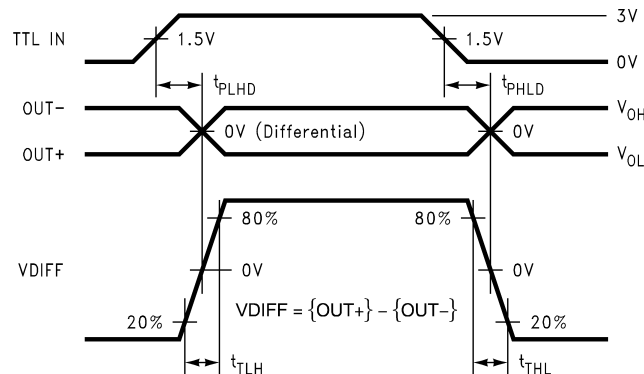
**Parameter Measurement Information (continued)**



**Figure 3. Differential Driver Full Load DC Test Circuit**



**Figure 4. Differential Driver Propagation Delay and Transition Time Test Circuit**



**Figure 5. Differential Driver Propagation Delay and Transition Time Waveforms**

**APPLICATION INFORMATION**

**DEVICE PIN DESCRIPTIONS**

| Package Pin Number | Pin Name        | Description                     |
|--------------------|-----------------|---------------------------------|
| <b>SOT-23</b>      |                 |                                 |
| 5                  | TTL IN          | LVTTTL/LVCMOS driver input pins |
| 4                  | OUT+            | Non-inverting driver output pin |
| 3                  | OUT-            | Inverting driver output pin     |
| 2                  | GND             | Ground pin                      |
| 1                  | V <sub>DD</sub> | Power supply pin, +3.3V ± 0.3V  |

---

**REVISION HISTORY**

| <b>Changes from Revision C (April 2013) to Revision D</b>  | <b>Page</b>          |
|--|----------------------|
| <hr/> <ul style="list-style-type: none"><li>• Changed layout of National Data Sheet to TI format .....</li></ul> <hr/> | <hr/> <b>4</b> <hr/> |

**PACKAGING INFORMATION**

| Orderable Device    | Status<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2)         | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Top-Side Markings<br>(4) | Samples                 |
|---------------------|---------------|--------------|-----------------|------|-------------|-------------------------|------------------|----------------------|--------------|--------------------------|-------------------------|
| DS90LV011AQMFB/NOPB | ACTIVE        | SOT-23       | DBV             | 5    | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | N01Q                     | <a href="#">Samples</a> |
| DS90LV011AQMFE/NOPB | ACTIVE        | SOT-23       | DBV             | 5    | 250         | Green (RoHS & no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | N01Q                     | <a href="#">Samples</a> |
| DS90LV011AQMFX/NOPB | ACTIVE        | SOT-23       | DBV             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | N01Q                     | <a href="#">Samples</a> |

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

**ACTIVE:** Product device recommended for new designs.

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

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

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

**OBsolete:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side 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 Top-Side Marking for that device.

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

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

**TAPE AND REEL INFORMATION**

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


\*All dimensions are nominal

| Device              | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| DS90LV011AQM/NOPB   | SOT-23       | DBV             | 5    | 1000 | 178.0              | 8.4                | 3.2     | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| DS90LV011AQMFE/NOPB | SOT-23       | DBV             | 5    | 250  | 178.0              | 8.4                | 3.2     | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| DS90LV011AQMFX/NOPB | 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**

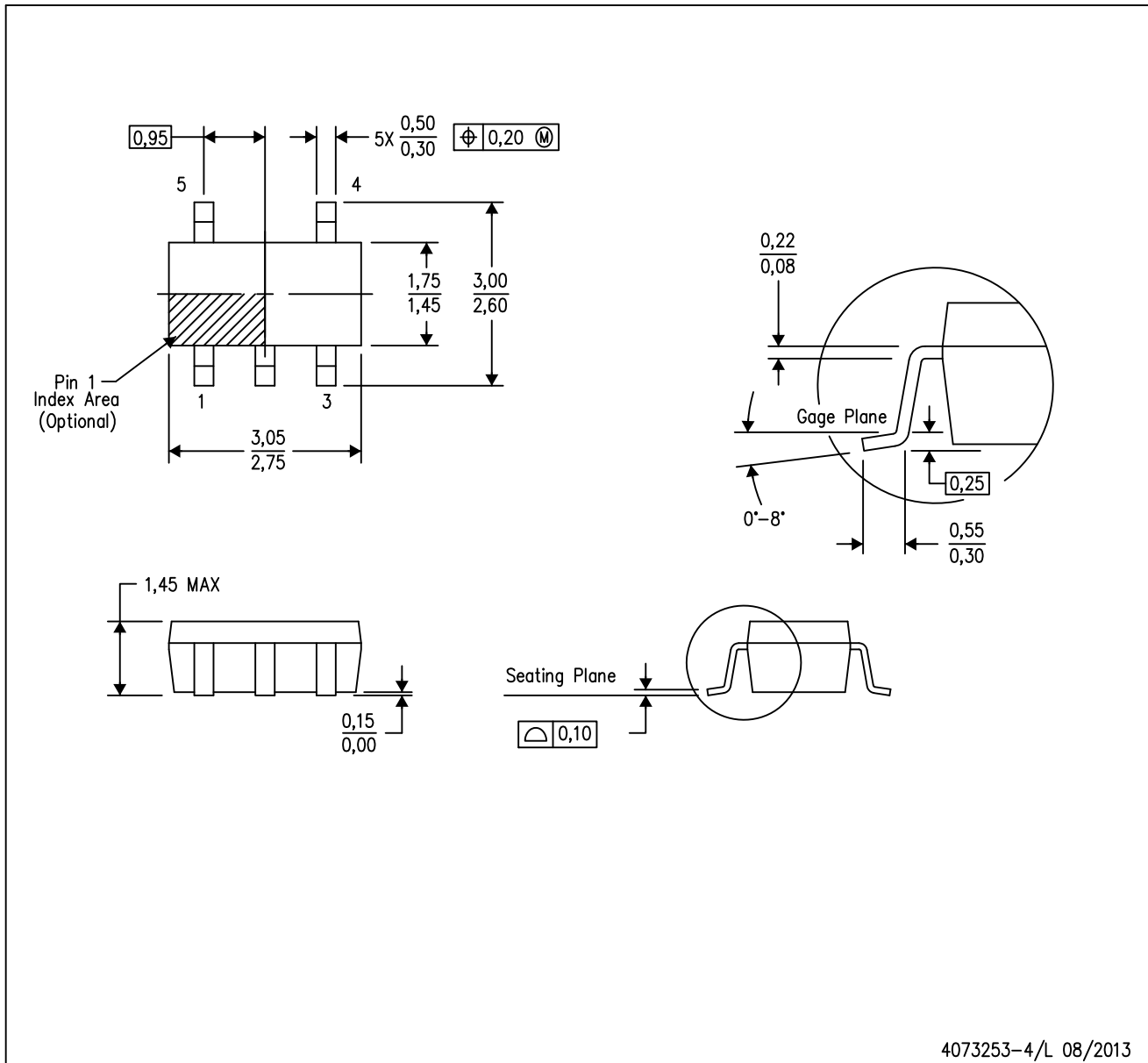

\*All dimensions are nominal

| Device              | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|---------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| DS90LV011AQMF/NOPB  | SOT-23       | DBV             | 5    | 1000 | 210.0       | 185.0      | 35.0        |
| DS90LV011AQMFE/NOPB | SOT-23       | DBV             | 5    | 250  | 210.0       | 185.0      | 35.0        |
| DS90LV011AQMFX/NOPB | SOT-23       | DBV             | 5    | 3000 | 210.0       | 185.0      | 35.0        |

# MECHANICAL DATA

DBV (R-PDSO-G5)

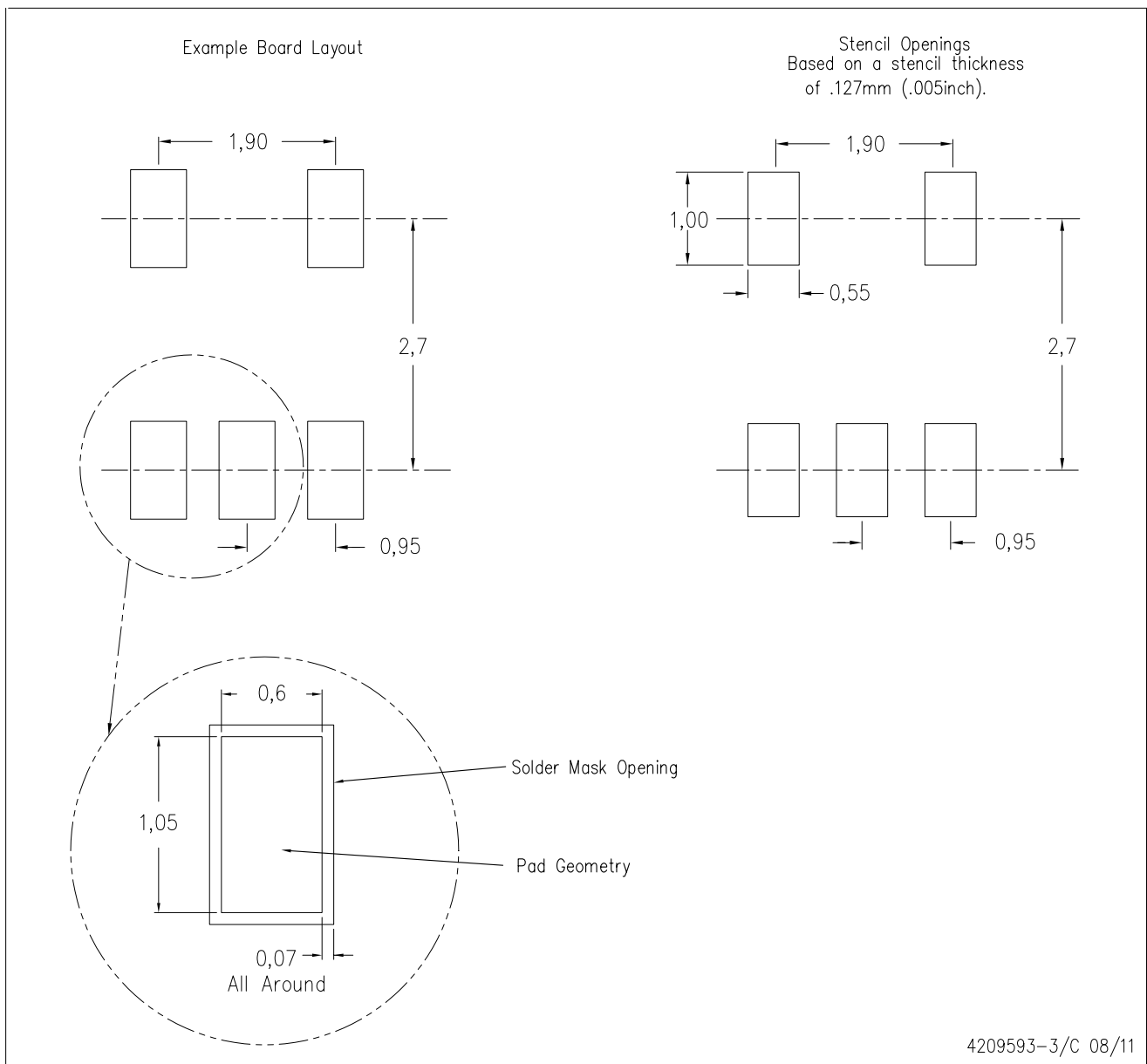
PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
  - D. Falls within JEDEC MO-178 Variation AA.

DBV (R-PDSO-G5)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
  - D. Publication IPC-7351 is recommended for alternate designs.
  - E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

|                              |  |
|------------------------------|--|
| Audio                        | <a href="http://www.ti.com/audio">www.ti.com/audio</a>                               |
| Amplifiers                   | <a href="http://amplifier.ti.com">amplifier.ti.com</a>                               |
| Data Converters              | <a href="http://dataconverter.ti.com">dataconverter.ti.com</a>                       |
| DLP® Products                | <a href="http://www.dlp.com">www.dlp.com</a>   |
| DSP                          | <a href="http://dsp.ti.com">dsp.ti.com</a>   |
| Clocks and Timers            | <a href="http://www.ti.com/clocks">www.ti.com/clocks</a>                             |
| Interface                    | <a href="http://interface.ti.com">interface.ti.com</a>                               |
| Logic                        | <a href="http://logic.ti.com">logic.ti.com</a>                                       |
| Power Mgmt                   | <a href="http://power.ti.com">power.ti.com</a>                                       |
| Microcontrollers             | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a>                   |
| RFID                         | <a href="http://www.ti-rfid.com">www.ti-rfid.com</a>                                 |
| OMAP Applications Processors | <a href="http://www.ti.com/omap">www.ti.com/omap</a>                                 |
| Wireless Connectivity        | <a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a> |

### Applications

|                               |  |
|-------------------------------|--|
| Automotive and Transportation | <a href="http://www.ti.com/automotive">www.ti.com/automotive</a>                         |
| Communications and Telecom    | <a href="http://www.ti.com/communications">www.ti.com/communications</a>                 |
| Computers and Peripherals     | <a href="http://www.ti.com/computers">www.ti.com/computers</a>                           |
| Consumer Electronics          | <a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>                   |
| Energy and Lighting           | <a href="http://www.ti.com/energy">www.ti.com/energy</a>                                 |
| Industrial                    | <a href="http://www.ti.com/industrial">www.ti.com/industrial</a>                         |
| Medical                       | <a href="http://www.ti.com/medical">www.ti.com/medical</a>                               |
| Security                      | <a href="http://www.ti.com/security">www.ti.com/security</a>                             |
| Space, Avionics and Defense   | <a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a> |
| Video and Imaging             | <a href="http://www.ti.com/video">www.ti.com/video</a>                                   |

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)