

## DS25CP152Q Automotive 3.125 Gbps LVDS 2x2 Crosspoint Switch

Check for Samples: [DS25CP152Q](#)

### FEATURES

- AECQ-100 Grade 3
- DC - 3.125 Gbps Low Jitter, Low Skew, Low Power Operation
- Pin Configurable, Fully Differential, Non-Blocking Architecture
- On-chip 100Ω Input and Output Terminations Minimize Return Losses, Reduce Component Count and Minimize Board Space
- 8 kV ESD on LVDS I/O Pins Protects Adjoining Components
- Small 4 mm x 4 mm WQFN-16 space saving package

### APPLICATIONS

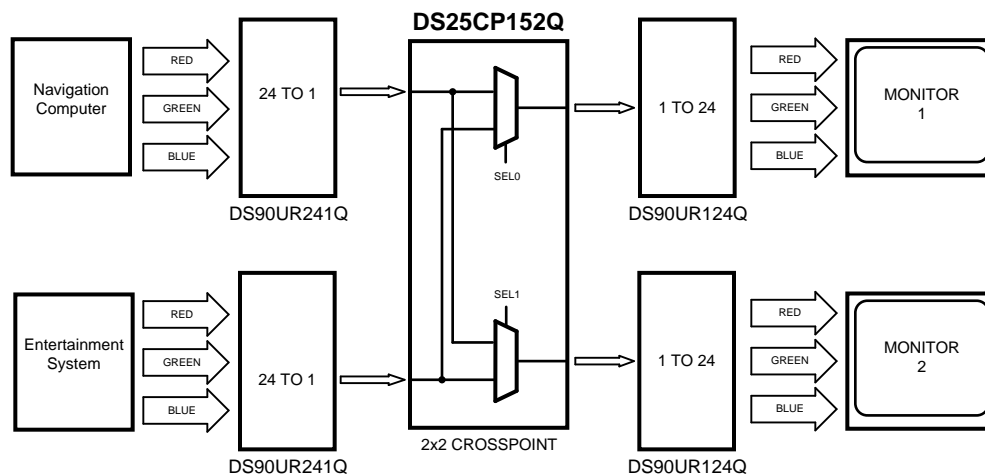
- Automotive Display Applications
- Clock and Data Buffering and Muxing
- OC-48 / STM-16
- SD/HD/3G HD SDI Routers

### DESCRIPTION

The DS25CP152Q is a 3.125 Gbps 2x2 LVDS crosspoint switch optimized for high-speed signal routing and switching over lossy FR-4 printed circuit board backplanes and balanced cables. Fully differential signal paths ensure exceptional signal integrity and noise immunity. The non-blocking architecture allows connections of any input to any output or outputs.

Wide input common mode range allows the switch to accept signals with LVDS, CML and LVPECL levels; the output levels are LVDS. A very small package footprint requires a minimal space on the board while the flow-through pinout allows easy board layout. Each differential input and output is internally terminated with a 100Ω resistor to lower device return losses, reduce component count and further minimize board space.

### Typical Application



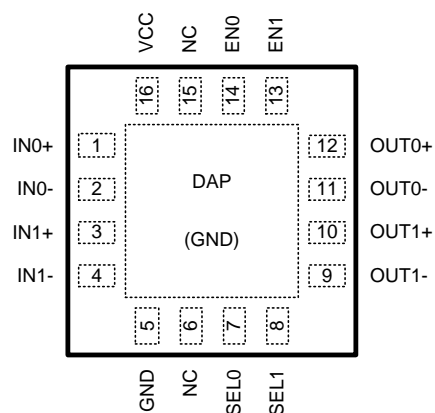
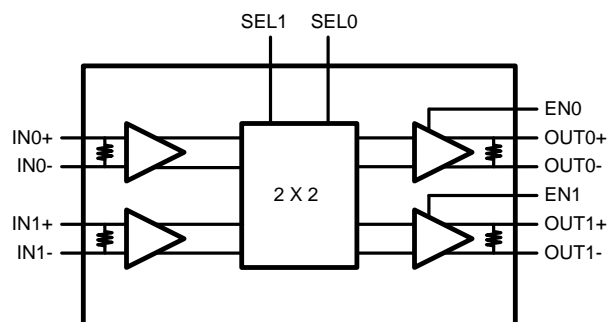
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### Block Diagram



### DS25CP152Q Pin Diagram

### Pin Descriptions

| Pin Name                       | Pin Number       | I/O, Type | Pin Description  |
|--------------------------------|------------------|-----------|--|
| IN0+, IN0- ,<br>IN1+, IN1-     | 1, 2,<br>3, 4    | I, LVDS   | Inverting and non-inverting high speed LVDS input pins.                    |
| OUT0+, OUT0- ,<br>OUT1+, OUT1- | 12, 11,<br>10, 9 | O, LVDS   | Inverting and non-inverting high speed LVDS output pins.                   |
| SEL0, SEL1                     | 7, 8             | I, LVCMOS | Switch configuration pins. There is a 20 kΩ pulldown resistor on each pin. |
| EN0, EN1                       | 14, 13           | I, LVCMOS | Output enable pins. There is a 20 kΩ pulldown resistor on each pin.        |
| NC                             | 6, 15            | I, LVCMOS | "NO CONNECT" pins.   |
| VDD                            | 16               | Power     | Power supply pin.  |
| GND                            | 5, DAP           | Power     | Ground pin and Device Attach Pad (DAP) ground.                             |



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                             | –0.3V to +4V                 |
| LVCMOS Input Voltage                       | –0.3V to ( $V_{CC} + 0.3V$ ) |
| LVDS Input Voltage                         | –0.3V to +4V                 |
| Differential Input Voltage  VID            | 1.0V                         |
| LVDS Output Voltage                        | –0.3V to ( $V_{CC} + 0.3V$ ) |
| LVDS Differential Output Voltage           | 0V to 1.0V                   |
| LVDS Output Short Circuit Current Duration | 5 ms                         |
| Junction Temperature                       | +105°C                       |
| Storage Temperature Range                  | –65°C to +150°C              |
| Lead Temperature Range                     |                              |
| Soldering (4 sec.)                         | +260°C                       |
| Maximum Package Power Dissipation at 25°C  |                              |
| RGH0016A Package                           | 1.91W                        |
| Derate RGH0016A Package                    | 23.9 mW/°C above +25°C       |
| Package Thermal Resistance                 |                              |
| $\theta_{JA}$                              | +41.8°C/W                    |
| $\theta_{JC}$                              | +6.9°C/W                     |
| ESD Susceptibility                         |                              |
| HBM <sup>(3)</sup>                         | ≥8 kV                        |
| MM <sup>(4)</sup>                          | ≥250V                        |
| CDM <sup>(5)</sup>                         | ≥1250V                       |

- (1) “Absolute Maximum Ratings” indicate limits beyond which damage to the device may occur, including inoperability and degradation of device reliability and/or performance. Functional operation of the device and/or non-degradation at the Absolute Maximum Ratings or other conditions beyond those indicated in the Recommended Operating Conditions is not implied. The Recommended Operating Conditions indicate conditions at which the device is functional and the device should not be operated beyond such conditions.
- (2) If Military/Aerospace specified devices are required, please contact the TI 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 ( $V_{CC}$ )                      | 3.0 | 3.3 | 3.6 | V     |
| Receiver Differential Input Voltage ( $V_{ID}$ ) | 0   |     | 1   | V     |
| Operating Free Air Temperature ( $T_A$ )         | –40 | +25 | +85 | °C    |

## DC Electrical Characteristics

Over recommended operating supply and temperature ranges unless otherwise specified. <sup>(1)</sup> <sup>(2)</sup> <sup>(3)</sup>

| Symbol                          | Parameter                | Conditions                         | Min | Typ | Max      | Units |
|---------------------------------|--------------------------|------------------------------------|-----|-----|----------|-------|
| <b>LVCMOS DC SPECIFICATIONS</b> |                          |                                    |     |     |          |       |
| $V_{IH}$                        | High Level Input Voltage |                                    | 2.0 |     | $V_{CC}$ | V     |
| $V_{IL}$                        | Low Level Input Voltage  |                                    | GND |     | 0.8      | V     |
| $I_{IH}$                        | High Level Input Current | $V_{IN} = 3.6V$<br>$V_{CC} = 3.6V$ | 40  | 175 | 250      | μA    |
| $I_{IL}$                        | Low Level Input Current  | $V_{IN} = GND$<br>$V_{CC} = 3.6V$  |     | 0   | ±10      | μA    |

- (1) The Electrical Characteristics tables list guaranteed specifications under the listed Recommended Operating Conditions except as otherwise modified or specified by the Electrical Characteristics Conditions and/or Notes. Typical specifications are estimations only and are not guaranteed.
- (2) Current into device pins is defined as positive. Current out of device pins is defined as negative. All voltages are referenced to ground except  $V_{OD}$  and  $\Delta V_{OD}$ .
- (3) Typical values represent most likely parametric norms for  $V_{CC} = +3.3V$  and  $T_A = +25^\circ C$ , and at the [Recommended Operating Conditions](#) at the time of product characterization and are not guaranteed.

## DC Electrical Characteristics (continued)

Over recommended operating supply and temperature ranges unless otherwise specified. <sup>(1)</sup> <sup>(2)</sup> <sup>(3)</sup>

| Symbol                               | Parameter   | Conditions  | Min  | Typ     | Max             | Units         |
|--------------------------------------|---|---|------|---------|-----------------|---------------|
| $V_{CL}$                             | Input Clamp Voltage   | $I_{CL} = -18 \text{ mA}$ , $V_{CC} = 0\text{V}$                                |      | -0.9    | -1.5            | V             |
| <b>LVDS INPUT DC SPECIFICATIONS</b>  |   |   |      |         |                 |               |
| $V_{ID}$                             | Input Differential Voltage                                      |   | 0    |         | 1               | V             |
| $V_{TH}$                             | Differential Input High Threshold                               | $V_{CM} = +0.05\text{V}$ or $V_{CC}-0.05\text{V}$                               |      | 0       | +100            | mV            |
| $V_{TL}$                             | Differential Input Low Threshold                                |   | -100 | 0       |                 | mV            |
| $V_{CMR}$                            | Common Mode Voltage Range                                       | $V_{ID} = 100 \text{ mV}$   | 0.05 |         | $V_{CC} - 0.05$ | V             |
| $I_{IN}$                             | Input Current   | $V_{IN} = +3.6\text{V}$ or $0\text{V}$<br>$V_{CC} = 3.6\text{V}$ or $0\text{V}$ |      | $\pm 1$ | $\pm 10$        | $\mu\text{A}$ |
| $C_{IN}$                             | Input Capacitance   | Any LVDS Input Pin to GND   |      | 1.7     |                 | pF            |
| $R_{IN}$                             | Input Termination Resistor                                      | Between IN+ and IN-   |      | 100     |                 | $\Omega$      |
| <b>LVDS OUTPUT DC SPECIFICATIONS</b> |   |   |      |         |                 |               |
| $V_{OD}$                             | Differential Output Voltage                                     | $R_L = 100\Omega$   | 250  | 350     | 450             | mV            |
| $\Delta V_{OD}$                      | Change in Magnitude of $V_{OD}$ for Complimentary Output States |   | -35  |         | 35              | mV            |
| $V_{OS}$                             | Offset Voltage  | $R_L = 100\Omega$   | 1.05 | 1.2     | 1.375           | V             |
| $\Delta V_{OS}$                      | Change in Magnitude of $V_{OS}$ for Complimentary Output States |   | -35  |         | 35              | mV            |
| $I_{OS}$                             | Output Short Circuit Current <sup>(4)</sup>                     | OUT to GND  |      | -35     | -55             | mA            |
|                                      |   | OUT to $V_{CC}$   |      | 7       | 55              | mA            |
| $C_{OUT}$                            | Output Capacitance  | Any LVDS Output Pin to GND  |      | 1.2     |                 | pF            |
| $R_{OUT}$                            | Output Termination Resistor                                     | Between OUT+ and OUT-   |      | 100     |                 | $\Omega$      |
| <b>SUPPLY CURRENT</b>                |   |   |      |         |                 |               |
| $I_{CC}$                             | Supply Current  | EN0 = EN1 = High  |      | 64      | 77              | mA            |
| $I_{CCZ}$                            | Supply Current with Outputs Disabled                            | EN0 = EN1 = Low   |      | 23      | 29              | mA            |

(4) Output short circuit current ( $I_{OS}$ ) is specified as magnitude only, minus sign indicates direction only.

## AC Electrical Characteristics

Over recommended operating supply and temperature ranges unless otherwise specified. <sup>(1)</sup> <sup>(2)</sup> <sup>(3)</sup>

| Symbol                               | Parameter   | Conditions        | Min | Typ | Max | Units |
|--------------------------------------|---|-------------------|-----|-----|-----|-------|
| <b>LVDS OUTPUT AC SPECIFICATIONS</b> |   |                   |     |     |     |       |
| $t_{PLHD}$                           | Differential Propagation Delay Low to High        | $R_L = 100\Omega$ |     | 340 | 500 | ps    |
| $t_{PHLD}$                           | Differential Propagation Delay High to Low        |                   |     | 344 | 500 | ps    |
| $t_{SKD1}$                           | Pulse Skew $ t_{PLHD} - t_{PHLD} $ <sup>(4)</sup> |                   |     | 4   | 35  | ps    |
| $t_{SKD2}$                           | Channel to Channel Skew <sup>(5)</sup>            |                   |     | 12  | 40  | ps    |
| $t_{SKD3}$                           | Part to Part Skew <sup>(6)</sup>                  |                   |     | 50  | 150 | ps    |

- (1) The Electrical Characteristics tables list guaranteed specifications under the listed [Recommended Operating Conditions](#) except as otherwise modified or specified by the Electrical Characteristics Conditions and/or Notes. Typical specifications are estimations only and are not guaranteed.
- (2) Typical values represent most likely parametric norms for  $V_{CC} = +3.3\text{V}$  and  $T_A = +25^\circ\text{C}$ , and at the Recommended Operation Conditions at the time of product characterization and are not guaranteed.
- (3) Specification is guaranteed by characterization and is not tested in production.
- (4)  $t_{SKD1}$ ,  $|t_{PLHD} - t_{PHLD}|$ , Pulse Skew, is the magnitude difference in differential propagation delay time between the positive going edge and the negative going edge of the same channel.
- (5)  $t_{SKD2}$ , Channel to Channel Skew, is the difference in propagation delay ( $t_{PLHD}$  or  $t_{PHLD}$ ) among all output channels in Broadcast mode (any one input to all outputs).
- (6)  $t_{SKD3}$ , Part to Part Skew, is defined as the difference between the minimum and maximum differential propagation delays. This specification applies to devices at the same  $V_{CC}$  and within  $5^\circ\text{C}$  of each other within the operating temperature range.

## AC Electrical Characteristics (continued)

Over recommended operating supply and temperature ranges unless otherwise specified <sup>(1)</sup> <sup>(2)</sup> <sup>(3)</sup>

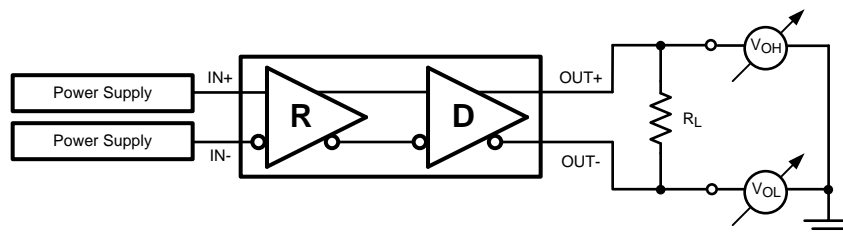
| Symbol                            | Parameter   | Conditions  | Min        | Typ | Max  | Units |                   |
|-----------------------------------|---|---|------------|-----|------|-------|-------------------|
| t <sub>LHT</sub>                  | Rise Time   | R <sub>L</sub> = 100Ω   |            | 65  | 120  | ps    |                   |
| t <sub>HLT</sub>                  | Fall Time   |   |            | 65  | 120  | ps    |                   |
| t <sub>ON</sub>                   | Output Enable Time                                    | ENn = LH to output active   |            | 7   | 20   | μs    |                   |
| t <sub>OFF</sub>                  | Output Disable Time                                   | ENn = HL to output inactive   |            | 5   | 12   | ns    |                   |
| t <sub>SEL</sub>                  | Select Time   | SELn LH or HL to output   |            | 3.5 | 12   | ns    |                   |
| JITTER PERFORMANCE <sup>(3)</sup> |   |   |            |     |      |       |                   |
| t <sub>RJ1</sub>                  | Random Jitter (RMS Value)<br><sup>(7)</sup>           | V <sub>ID</sub> = 350 mV<br>V <sub>CM</sub> = 1.2V<br>Clock (RZ)    | 2.5 Gbps   |     | 0.5  | 1     | ps                |
| t <sub>RJ2</sub>                  |   |   | 3.125 Gbps |     | 0.5  | 1     | ps                |
| t <sub>DJ1</sub>                  | Deterministic Jitter (Peak to Peak)<br><sup>(8)</sup> | V <sub>ID</sub> = 350 mV<br>V <sub>CM</sub> = 1.2V<br>K28.5 (NRZ)   | 2.5 Gbps   |     | 8    | 25    | ps                |
| t <sub>DJ2</sub>                  |   |   | 3.125 Gbps |     | 3    | 19    | ps                |
| t <sub>TJ1</sub>                  | Total Jitter (Peak to Peak)<br><sup>(9)</sup>         | V <sub>ID</sub> = 350 mV<br>V <sub>CM</sub> = 1.2V<br>PRBS-23 (NRZ) | 2.5 Gbps   |     | 0.04 | 0.08  | UI <sub>P-P</sub> |
| t <sub>TJ2</sub>                  |   |   | 3.125 Gbps |     | 0.03 | 0.09  | UI <sub>P-P</sub> |

(7) Measured on a clock edge with a histogram and an accumulation of 1500 histogram hits. Input stimulus jitter is subtracted geometrically.

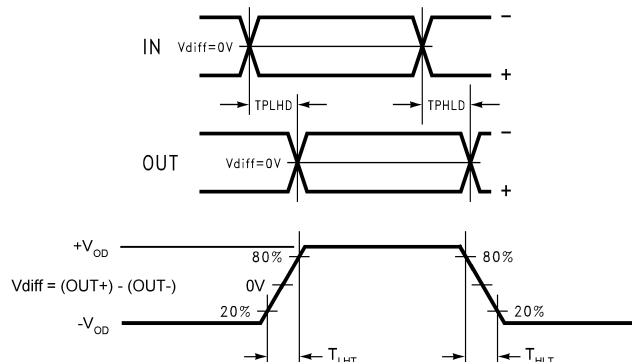
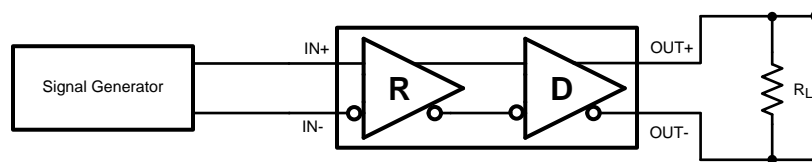
(8) Tested with a combination of the 1100000101 (K28.5+ character) and 0011111010 (K28.5- character) patterns. Input stimulus jitter is subtracted algebraically.

(9) Measured on an eye diagram with a histogram and an accumulation of 3500 histogram hits. Input stimulus jitter is subtracted.

## DC TEST CIRCUITS



## AC Test Circuits and Timing Diagrams



## Functional Description

The DS25CP152Q is a 3.125 Gbps 2x2 LVDS digital crosspoint switch optimized for high-speed signal routing and switching over lossy FR-4 printed circuit board backplanes and balanced cables.

## Switch Configuration Truth Table

| S1 | S0 | OUT1 | OUT0 |
|----|----|------|------|
| 0  | 0  | IN0  | IN0  |
| 0  | 1  | IN0  | IN1  |
| 1  | 0  | IN1  | IN0  |
| 1  | 1  | IN1  | IN1  |

## Output Enable Truth Table

| EN1 | EN0 | OUT1     | OUT0     |
|-----|-----|----------|----------|
| 0   | 0   | Disabled | Disabled |
| 0   | 1   | Disabled | Enabled  |
| 1   | 0   | Enabled  | Disabled |
| 1   | 1   | Enabled  | Enabled  |

## Input Interfacing

The DS25CP152Q accepts differential signals and allows simple AC or DC coupling. With a wide common mode range, the DS25CP152Q can be DC-coupled with all common differential drivers (i.e. LVPECL, LVDS, CML). The following three figures illustrate typical DC-coupled interface to common differential drivers. Note that the DS25CP152Q inputs are internally terminated with a 100Ω resistor.

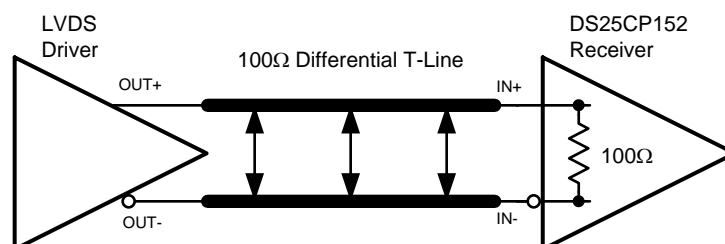


Figure 1. Typical LVDS Driver DC-Coupled Interface to DS25CP152Q Input

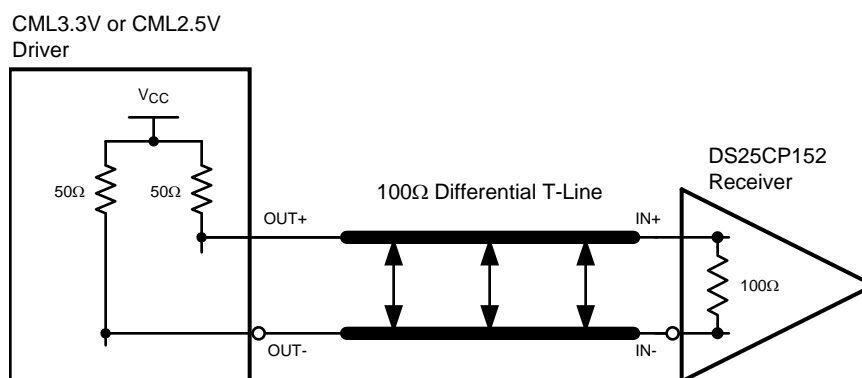


Figure 2. Typical CML Driver DC-Coupled Interface to DS25CP152Q Input

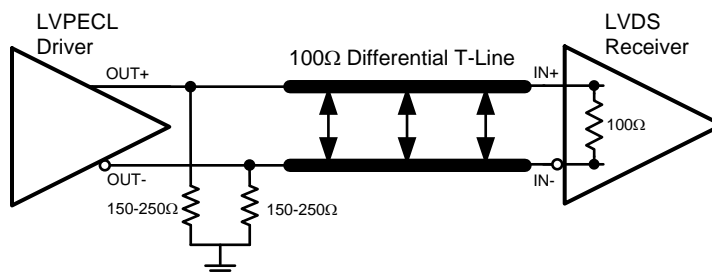


Figure 3. Typical LVPECL Driver DC-Coupled Interface to DS25CP152Q Input

## Output Interfacing

The DS25CP152Q outputs signals that are compliant to the LVDS standard. Its outputs can be DC-coupled to most common differential receivers. The following figure illustrates typical DC-coupled interface to common differential receivers and assumes that the receivers have high impedance inputs. While most differential receivers have a common mode input range that can accommodate LVDS compliant signals, it is recommended to check the respective receiver's data sheet prior to implementing the suggested interface implementation.

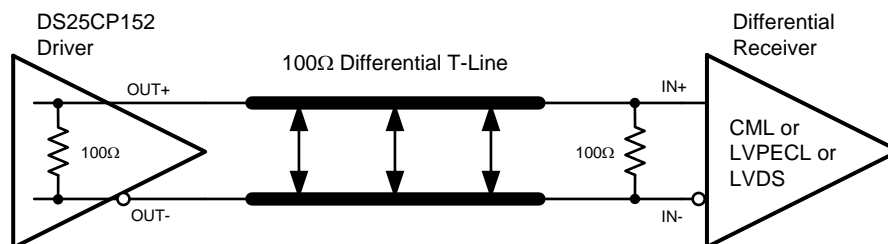
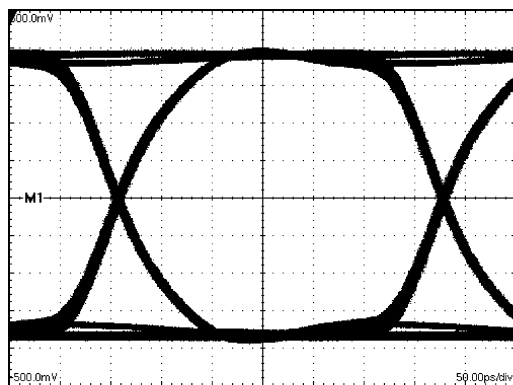
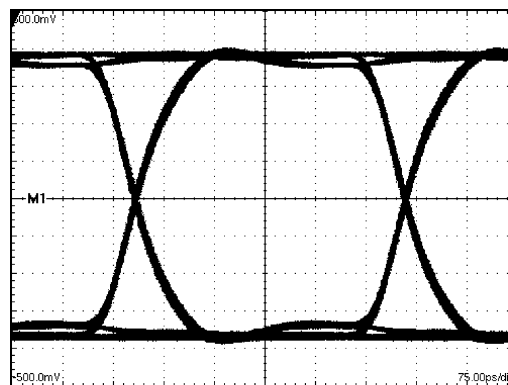


Figure 4. Typical DS25CP152Q Output DC-Coupled Interface to an LVDS, CML or LVPECL Receiver

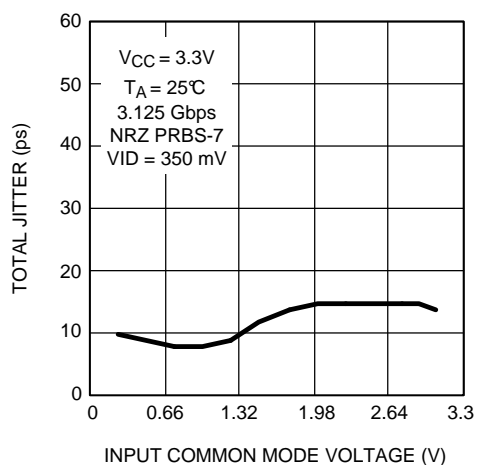
## Typical Performance Characteristics



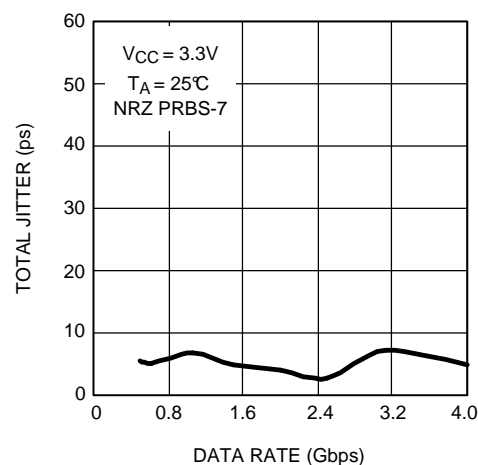
**Figure 5. A 3.125 Gbps NRZ PRBS-7 After 2"  
Differential FR-4 Stripline**  
V:100 mV / DIV, H:50 ps / DIV



**Figure 6. A 2.5 Gbps NRZ PRBS-7 After 2"  
Differential FR-4 Stripline**  
V:100 mV / DIV, H:75 ps / DIV



**Figure 7. Total Jitter as a Function of Input Common Mode Voltage**



**Figure 8. Total Jitter as a Function of Data Rate**

**PACKAGING INFORMATION**

| Orderable Device   | Status<br>(1) | Package Type | Package<br>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                 |
|--------------------|---------------|--------------|--------------------|------|-------------|----------------------------|------------------|----------------------|--------------|--------------------------|-------------------------|
| DS25CP152QSQ/NOPB  | ACTIVE        | WQFN         | RGH                | 16   | 1000        | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | 2C152QS                  | <a href="#">Samples</a> |
| DS25CP152QSQX/NOPB | ACTIVE        | WQFN         | RGH                | 16   | 4500        | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | 2C152QS                  | <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.

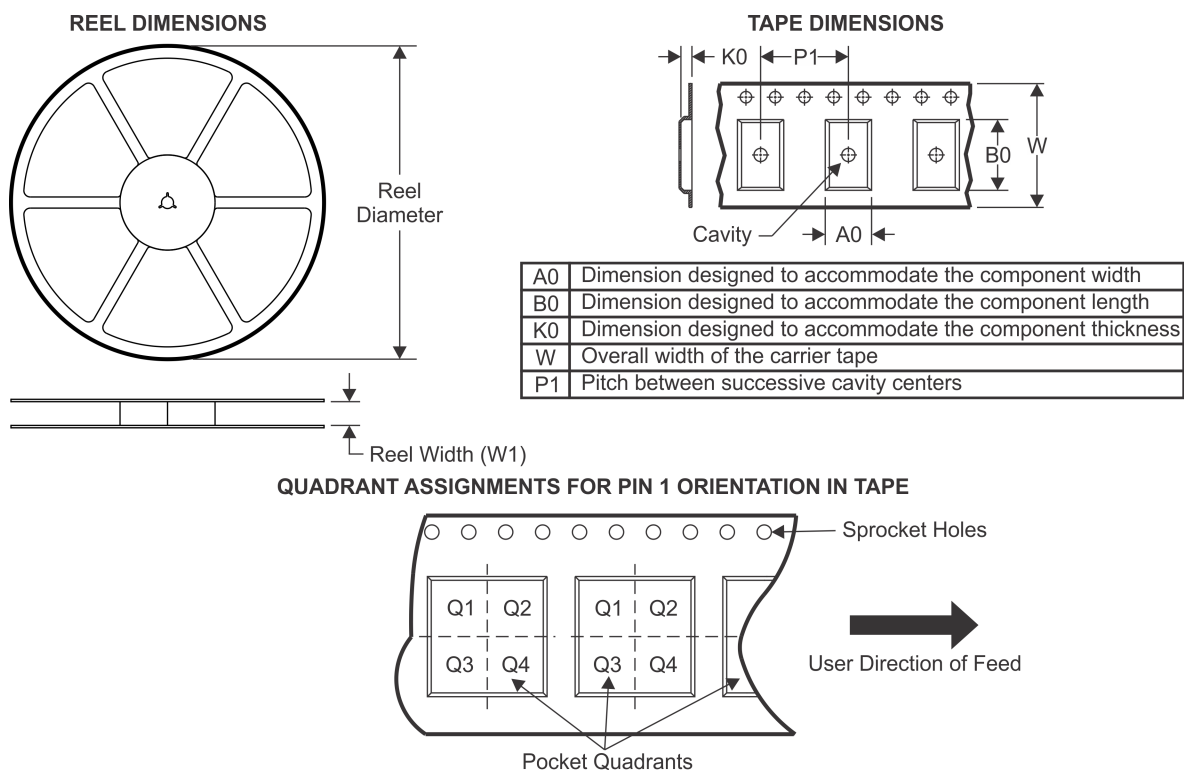
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

(4) Only one of markings shown within the brackets will appear on the physical device.

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**TAPE AND REEL INFORMATION**


\*All dimensions are nominal

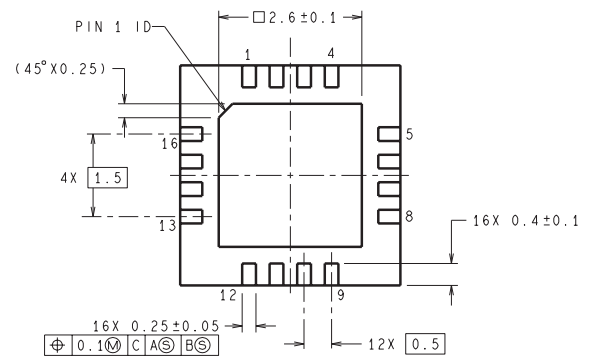
| Device             | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|--------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| DS25CP152QSQ/NOPB  | WQFN         | RGH             | 16   | 1000 | 178.0              | 12.4               | 4.3     | 4.3     | 1.3     | 8.0     | 12.0   | Q1            |
| DS25CP152QSQX/NOPB | WQFN         | RGH             | 16   | 4500 | 330.0              | 12.4               | 4.3     | 4.3     | 1.3     | 8.0     | 12.0   | Q1            |

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device             | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|--------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| DS25CP152QSQ/NOPB  | WQFN         | RGH             | 16   | 1000 | 210.0       | 185.0      | 35.0        |
| DS25CP152QSQX/NOPB | WQFN         | RGH             | 16   | 4500 | 349.0       | 337.0      | 45.0        |



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