

# DS25MB100

## 2.5 Gbps 2:1/1:2 CML Mux/Buffer with Transmit Pre-Emphasis and Receive Equalization

### General Description

The DS25MB100 is a signal conditioning 2:1 multiplexer and 1:2 fan-out buffer designed for use in backplane redundancy or cable driving applications. Signal conditioning features include input equalization and programmable output Pre-emphasis that enable data communication in FR4 backplane up to 2.5 Gbps. Each input stage has a fixed equalizer to reduce ISI distortion from board traces. All output drivers have four selectable levels of Pre-emphasis to compensate for transmission losses from long FR4 backplane or cable attenuation reducing deterministic jitter. The Pre-emphasis levels can be independently controlled for the line-side and switch-side drivers. The internal loopback paths from switch-side input to switch-side output enable at-speed system testing. All receiver inputs are internally terminated with 100Ω differential terminating resistors. All driver outputs are internally terminated with 50Ω to V<sub>CC</sub>.

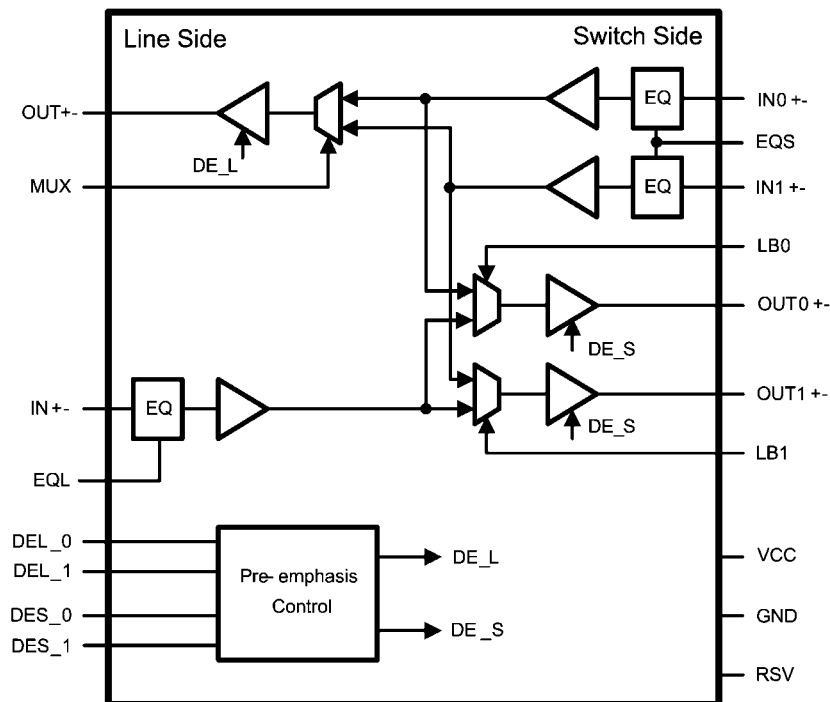
### Features

- 2:1 multiplexer and 1:2 buffer
- 0.25–2.5 Gbps fully differential data paths
- Fixed input equalization
- Programmable output Pre-emphasis
- Independent Pre-emphasis controls
- Programmable loopback modes
- On-chip terminations
- HBM ESD rating 6 kV on all pins
- +3.3V supply
- Low power, 0.45 W typical
- Lead-less LLP-36 package
- –40°C to +85°C operating temperature range

### Applications

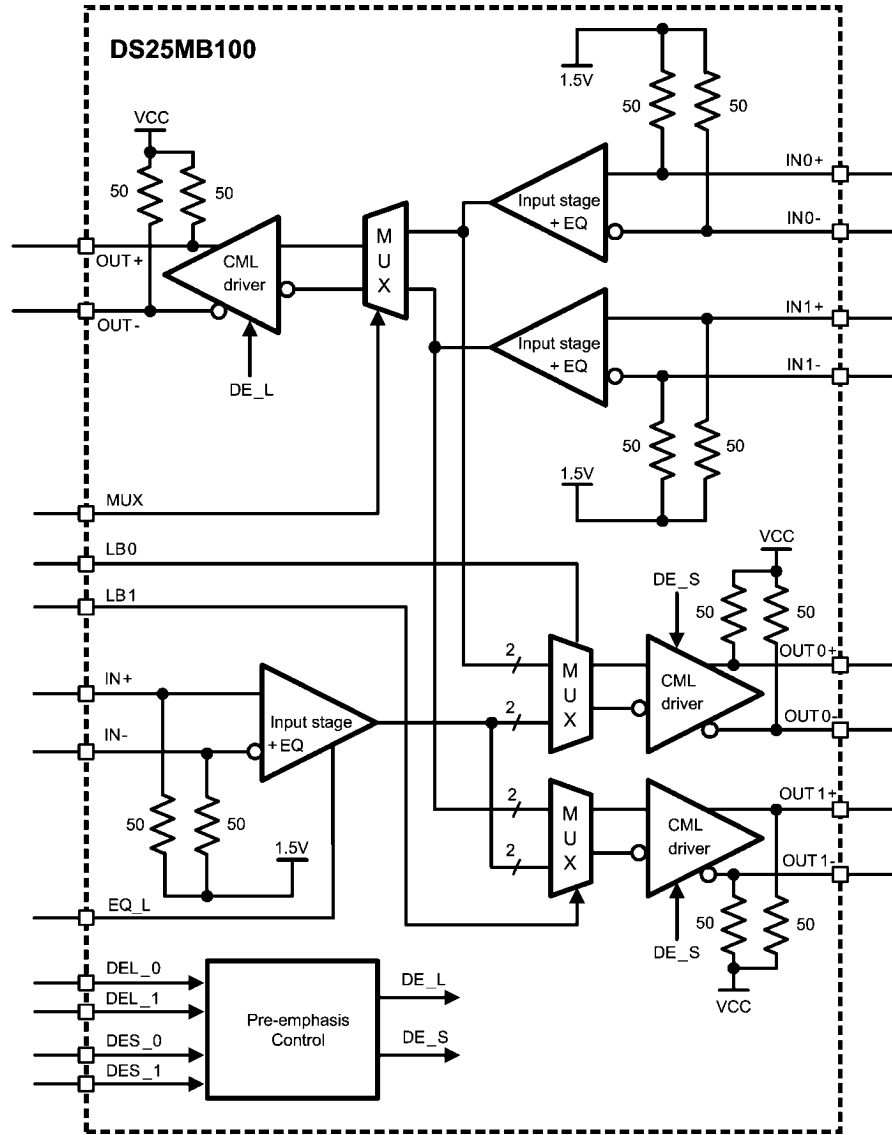
- Backplane or cable driver
- Redundancy and signal conditioning applications
- CPRI/OBSAI

### Functional Block Diagram



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# Simplified Block Diagram



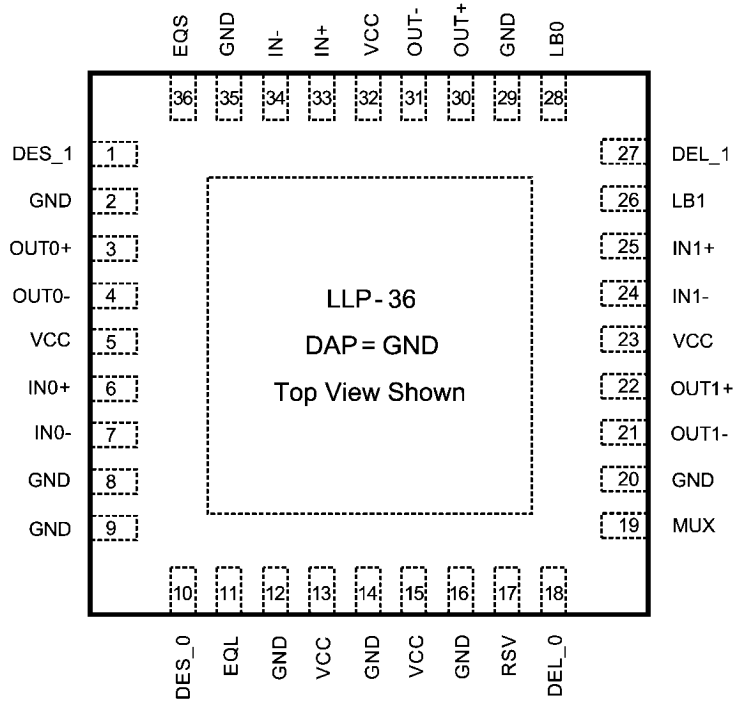
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## Pin Descriptions

| Pin Name  | Pin Number                      | I/O | Description   |
|---|---------------------------------|-----|---|
| <b>LINE SIDE HIGH SPEED DIFFERENTIAL IO's</b>   |                                 |     |   |
| IN+   | 33                              | I   | Inverting and non-inverting differential inputs at the line side. IN+ and IN- have an internal 50Ω connected to an internal reference voltage. See <i>Figure 6</i> .  |
| IN-   | 34                              |     |   |
| OUT+  | 30                              | O   | Inverting and non-inverting differential outputs at the line side. OUT+ and OUT- have an internal 50Ω connected to V <sub>CC</sub> .  |
| OUT-  | 31                              |     |   |
| <b>SWITCH SIDE HIGH SPEED DIFFERENTIAL IO's</b> |                                 |     |   |
| OUT0+   | 3                               | O   | Inverting and non-inverting differential outputs at the switch side. OUT0+ and OUT0- have an internal 50Ω connected to V <sub>CC</sub> .  |
| OUT0-   | 4                               |     |   |
| OUT1+   | 22                              | O   | Inverting and non-inverting differential outputs at the switch side. OUT1+ and OUT1- have an internal 50Ω connected to V <sub>CC</sub> .  |
| OUT1-   | 21                              |     |   |
| IN0+  | 6                               | I   | Inverting and non-inverting differential inputs to the mux at the switch side. IN0+ and IN0- have an internal 50Ω connected to an internal reference voltage. See <i>Figure 6</i> .   |
| IN0-  | 7                               |     |   |
| IN1+  | 25                              | I   | Inverting and non-inverting differential inputs to the mux at the switch side. IN1+ and IN1- have an internal 50Ω connected to an internal reference voltage. See <i>Figure 6</i> .   |
| IN1-  | 24                              |     |   |
| <b>CONTROL (3.3V LVCMOS)</b>                    |                                 |     |   |
| MUX   | 19                              | I   | A logic low at MUX selects IN1±. MUX is internally pulled high. Default state for MUX is IN0±.  |
| EQL   | 11                              | I   | A logic low enables the input equalizer on the line side. EQL is internally pulled high. Default is with EQ disabled.   |
| EQS   | 36                              | I   | A logic low enables the input equalizer on the switch side. EQS is internally pulled high. Default is with EQ disabled.   |
| DEL_0   | 18                              | I   | DEL_0 and DEL_1 select the output Pre-emphasis of the line side drivers (OUT±). DEL_0 and DEL_1 are internally pulled high.   |
| DEL_1   | 27                              |     |   |
| DES_0   | 10                              | I   | DES_0 and DES_1 select the output Pre-emphasis of the switch side drivers (OUT0±, OUT1±). DES_0 and DES_1 are internally pulled high.   |
| DES_1   | 1                               |     |   |
| LB0   | 28                              |     | A logic low at LB0 enables the internal loopback path from IN0± to OUT0±. LB0 is internally pulled high.  |
| LB1   | 26                              | I   | A logic low at LB1 enables the internal loopback path from IN1± to OUT1±. LB1 is internally pulled high.  |
| RSV   | 17                              | I   | Reserve pin to support factory testing. This pin can be left open, or tied to GND, or tied to GND through an external pull-down resistor.   |
| <b>POWER</b>                                    |                                 |     |   |
| V <sub>CC</sub>                                 | 5, 13, 15, 23, 32               | P   | V <sub>CC</sub> = 3.3V ± 5%.<br>Each V <sub>CC</sub> pin should be connected to the V <sub>CC</sub> plane through a low inductance path, typically with a via located as close as possible to the landing pad of the V <sub>CC</sub> pin. It is recommended to have a 0.01 μF or 0.1 μF, X7R, size-0402 bypass capacitor from each V <sub>CC</sub> pin to ground plane. |
| GND   | 2, 8, 9, 12, 14, 16, 20, 29, 35 | P   | Ground reference. Each ground pin should be connected to the ground plane through a low inductance path, typically with a via located as close as possible to the landing pad of the GND pin.   |
| GND   | DAP                             | P   | DAP is the metal contact at the bottom side, located at the center of the LLP package. It should be connected to the GND plane with at least 16 via to lower the ground impedance and improve the thermal performance of the package.   |

**Note:** I=Input, O=Output, P=Power

# Connection Diagram



Order Number DS25MB100TSQ  
See NS Package Number SQA36A

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## Functional Description

The DS25MB100 is a signal conditioning 2:1 multiplexer and a 1:2 buffer designed to support port redundancy up to 2.5 Gbps. Each input stage has a fixed equalizer that provides equalization to compensate about 5 dB of transmission loss from a short backplane trace (about 10 inches backplane). The output driver has Pre-emphasis (driver-side equalization) to compensate the transmission loss of the backplane that it is driving. The driver conditions the output signal such that the lower frequency and higher frequency pulses reach approximately the same amplitude at the end of the backplane, and minimize the deterministic jitter caused by the amplitude disparity. The DS25MB100 provides four steps of user-selectable Pre-emphasis ranging from 0, -3, -6 and -9 dB to handle different lengths of backplane. *Figure 1* shows a driver Pre-emphasis waveform. The Pre-emphasis duration is 188ps nominal, corresponds to 0.47 bit-width at 2.5 Gbps. The Pre-emphasis levels of switch-side and line-side can be individually programmed.

The high speed inputs are self-biased to about 1.3V and are designed for AC coupling. The inputs are compatible to most

AC coupling differential signals such as LVDS, LVPECL and CML.

**TABLE 1. Logic Table For Multiplex Controls**

| MUX            | Mux Function                   |
|----------------|--------------------------------|
| 0              | MUX select switch input, IN1±. |
| 1<br>(default) | MUX select switch input, IN0±. |

**TABLE 2. Logic Table For Loopback Controls**

| LB0            | Loopback Function                   |
|----------------|-------------------------------------|
| 0              | Enable loopback from IN0± to OUT0±. |
| 1<br>(default) | Normal mode. Loopback disabled.     |
| LB1            | Loopback Function                   |
| 0              | Enable loopback from IN1± to OUT1±. |
| 1<br>(default) | Normal mode. Loopback disabled.     |

**TABLE 3. Line-Side Pre-Emphasis Controls**

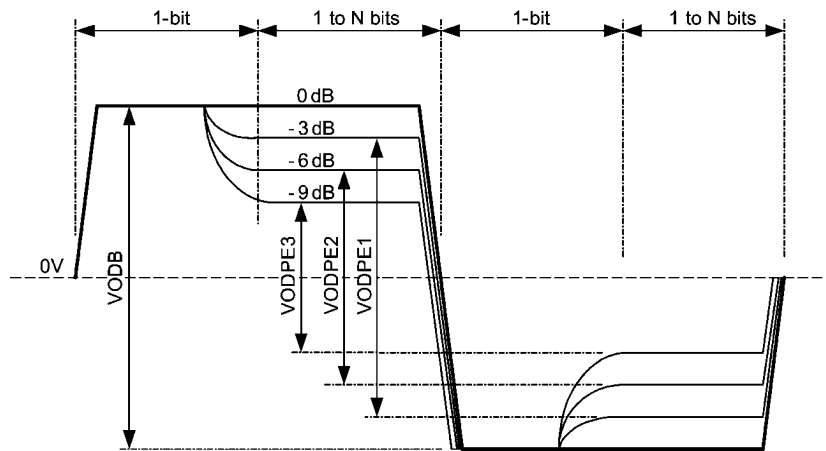
| DEL_[1:0]        | Pre-Emphasis Level in mV <sub>PP</sub> (VODB) | Pre-Emphasis Level in mV <sub>PP</sub> (VODPE) | Pre-Emphasis in dB (VODPE/VODB) | Typical FR4 Board Trace |
|------------------|---|--|---------------------------------|-------------------------|
| 0 0              | 1300  | 1300   | 0                               | 10 inches               |
| 0 1              | 1300  | 920  | -3                              | 20 inches               |
| 1 0              | 1300  | 650  | -6                              | 30 inches               |
| 1 1<br>(default) | 1300  | 461  | -9                              | 40 inches               |

**TABLE 4. Switch-Side Pre-Emphasis Controls**

| DES_[1:0]        | Pre-Emphasis Level in mV <sub>PP</sub> (VODB) | Pre-Emphasis Level in mV <sub>PP</sub> (VODPE) | Pre-Emphasis in dB (VODPE/VODB) | Typical FR4 Board Trace |
|------------------|---|--|---------------------------------|-------------------------|
| 0 0              | 1300  | 1300   | 0                               | 10 inches               |
| 0 1              | 1300  | 920  | -3                              | 20 inches               |
| 1 0              | 1300  | 650  | -6                              | 30 inches               |
| 1 1<br>(default) | 1300  | 461  | -9                              | 40 inches               |

**TABLE 5. EQ Controls For Line And Switch Sides**

| EQL or EQS  | Equalizer Function                  |
|-------------|-------------------------------------|
| 0           | Enable equalization.                |
| 1 (default) | Normal mode. Equalization disabled. |



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**FIGURE 1. Driver Pre-Emphasis Differential Waveform (Showing All 4 Pre-Emphasis Steps)**

**Absolute Maximum Ratings** (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

|  |                              |
|--|------------------------------|
| Supply Voltage ( $V_{CC}$ )                | -0.3V to 4V                  |
| CMOS/TTL Input Voltage                     | -0.3V to ( $V_{CC} + 0.3V$ ) |
| CML Input/Output Voltage                   | -0.3V to ( $V_{CC} + 0.3V$ ) |
| Junction Temperature                       | +150°C                       |
| Storage Temperature                        | -65°C to +150°C              |
| Lead Temperature                           |                              |
| Soldering, 4 seconds                       | +260°C                       |
| Thermal Resistance, $\theta_{JA}$ (Note 8) | 26.2°C/W                     |
| Thermal Resistance, $\theta_{JC}$          | 3.3°C/W                      |

Thermal Resistance,  $\Phi_{JB}$ 

11.1°C/W

ESD Rating (Note 10)

HBM, 1.5 k $\Omega$ , 100 pF

CDM

MM

6 kV

1.25 kV

350V

**Recommended Operating Ratings**

|  | Min   | Typ | Max   | Units            |
|--|-------|-----|-------|------------------|
| Supply Voltage ( $V_{CC}$ -GND)          | 3.135 | 3.3 | 3.465 | V                |
| Supply Noise Amplitude<br>10 Hz to 2 GHz |       |     | 100   | mV <sub>PP</sub> |
| Ambient Temperature                      | -40   |     | 85    | °C               |
| Case Temperature                         |       |     | 100   | °C               |

**Electrical Characteristics**

Over recommended operating supply and temperature ranges unless otherwise specified.

| Symbol                           | Parameter  | Conditions  | Min        | Typ<br>(Note 2)     | Max            | Units                                  |
|----------------------------------|--|---|------------|---------------------|----------------|--|
| <b>LVC MOS DC SPECIFICATIONS</b> |  |   |            |                     |                |  |
| $V_{IH}$                         | High Level Input Voltage   |   | 2.0        |                     | $V_{CC} + 0.3$ | V                                      |
| $V_{IL}$                         | Low Level Input Voltage  |   | -0.3       |                     | 0.8            | V                                      |
| $I_{IH}$                         | High Level Input Current   | $V_{IN} = V_{CC}$   | -10        |                     | 10             | $\mu$ A                                |
| $I_{IL}$                         | Low Level Input Current  | $V_{IN} = GND$  | 75         | 94                  | 124            | $\mu$ A                                |
| $R_{PU}$                         | Pull-High Resistance   |   |            | 35                  |                | k $\Omega$                             |
| <b>RECEIVER SPECIFICATIONS</b>   |  |   |            |                     |                |  |
| $V_{ID}$                         | Differential Input Voltage Range (Note 9)                        | AC Coupled Differential Signal<br>Below 1.25 Gbps<br>Above 1.25 Gbps<br>This parameter is not tested at production  | 100<br>100 |                     | 1750<br>1560   | mV <sub>P-P</sub><br>mV <sub>P-P</sub> |
| $V_{ICM}$                        | Common Mode Voltage at Receiver Inputs                           | Measured at receiver inputs reference to ground   |            | 1.3                 |                | V                                      |
| $R_{ITD}$                        | Input Differential Termination (Note 3)                          | On-chip differential termination between IN+ or IN-   | 84         | 100                 | 116            | $\Omega$                               |
| <b>DRIVER SPECIFICATIONS</b>     |  |   |            |                     |                |  |
| $V_{ODB}$                        | Output Differential Voltage Swing without Pre-Emphasis (Note 4)  | $R_L = 100\Omega \pm 1\%$<br>DES_1=DES_0=0<br>DEL_1=DEL_0=0<br>Driver Pre-emphasis disabled<br>Running K28.7 pattern at 2.5 Gbps<br>See Figure 5 for test circuit.  | 1100       | 1300                | 1500           | mV <sub>P-P</sub>                      |
| $V_{PE}$                         | Output Pre-Emphasis Voltage Ratio<br>$20 \cdot \log(VODPE/VODB)$ | $R_L = 100\Omega \pm 1\%$<br>Running K28.7 pattern at 2.5 Gbps<br>DEx_[1:0]=00<br>DEx_[1:0]=01<br>DEx_[1:0]=10<br>DEx_[1:0]=11<br>x=S for switch side Pre-emphasis control<br>x=L for line side Pre-emphasis control<br>See Figure 1 on waveform.<br>See Figure 5 for test circuit. |            | 0<br>-3<br>-6<br>-9 |                | dB<br>dB<br>dB<br>dB                   |

| Symbol                    | Parameter                                  | Conditions   | Min  | Typ<br>(Note 2) | Max         | Units                   |
|---------------------------|--|--|------|-----------------|-------------|-------------------------|
| T <sub>PE</sub>           | Pre-Emphasis Width                         | Tested at -9 dB Pre-emphasis level, DEx[1:0]=11<br>x=S for switch side Pre-emphasis control<br>x=L for line side Pre-emphasis control<br>See <i>Figure 4</i> on measurement condition.   | 125  | 188             | 250         | ps                      |
| R <sub>OTSE</sub>         | Output Termination (Note 3)                | On-chip termination from OUT+ or OUT- to V <sub>CC</sub>   | 42   | 50              | 58          | Ω                       |
| R <sub>OTD</sub>          | Output Differential Termination            | On-chip differential termination between OUT+ and OUT-   |      | 100             |             | Ω                       |
| ΔR <sub>OTSE</sub>        | Mis-Match in Output Termination Resistors  | Mis-match in output terminations at OUT+ and OUT-  |      |                 | 5           | %                       |
| V <sub>OCM</sub>          | Output Common Mode Voltage                 |  |      | 2.7             |             | V                       |
| <b>POWER DISSIPATION</b>  |  |  |      |                 |             |                         |
| P <sub>D</sub>            | Power Dissipation                          | V <sub>DD</sub> = 3.3V @ 25°C<br>All outputs terminated by 100Ω ±1%.<br>DEL_[1:0]=0, DES_[1:0]=0<br>Running PRBS 27-1 pattern at 2.5 Gbps  |      | 0.45            |             | W                       |
| <b>AC CHARACTERISTICS</b> |  |  |      |                 |             |                         |
| t <sub>R</sub>            | Differential Low to High Transition Time   | Measured with a clock-like pattern at 2.5 Gbps, between 20% and 80% of the differential output voltage. Pre-emphasis disabled<br>Transition time is measured with fixture as shown in <i>Figure 5</i> , adjusted to reflect the transition time at the output pins |      | 100             |             | ps                      |
| t <sub>F</sub>            | Differential High to Low Transition Time   |  |      | 100             |             | ps                      |
| t <sub>PLH</sub>          | Differential Low to High Propagation Delay | Measured at 50% differential voltage from input to output  |      |                 | 1           | ns                      |
| t <sub>PHL</sub>          | Differential High to Low Propagation Delay |  |      |                 | 1           | ns                      |
| t <sub>SKP</sub>          | Pulse Skew                                 | t <sub>PHL</sub> - t <sub>PLH</sub>  |      |                 | 20          | ps                      |
| t <sub>SKO</sub>          | Output Skew (Note 7)                       | Difference in propagation delay between two outputs in the same device   |      |                 | 100         | ps                      |
| t <sub>SKPP</sub>         | Part-to-Part Skew                          | Difference in propagation delay between the same output from devices operating under identical conditions  |      |                 | 100         | ps                      |
| t <sub>SM</sub>           | Mux Switch Time                            | Measured from V <sub>IH</sub> or V <sub>IL</sub> of the mux-control or loopback control to 50% of the valid differential output  |      | 1.8             | 6           | ns                      |
| RJ                        | Device Random Jitter (Note 5)              | See <i>Figure 5</i> for test circuit.<br>Alternating-1-0 pattern<br>EQ and Pre-emphasis disabled.<br>At 0.25 Gbps<br>At 1.25 Gbps<br>At 2.5 Gbps   |      |                 | 2<br>2<br>2 | psrms<br>psrms<br>psrms |
| DJ                        | Device Deterministic Jitter (Note 6)       | See <i>Figure 5</i> for test circuit.<br>EQ and Pre-emphasis disabled<br>Between 0.25 and 2.5 Gbps with PRBS7 pattern for DS25MB100 @ -40°C to 85°C  |      |                 | 35          | Psp                     |
| DR                        | Data Rate (Note 9)                         | Tested with alternating-1-0 pattern  | 0.25 |                 | 2.5         | Gbps                    |

**Note 1:** "Absolute Maximum Ratings" are the ratings beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits.

**Note 2:** Typical parameters measured at V<sub>CC</sub> = 3.3V, T<sub>A</sub> = 25°C, and represent most likely parametric norms at the time of product characterization. The typical specifications are not guaranteed.

**Note 3:** IN+ and IN- are generic names refer to one of the many pairs of complimentary inputs of the DS25MB100. OUT+ and OUT- are generic names refer to one of the many pairs of the complimentary outputs of the DS25MB100. Differential input voltage V<sub>ID</sub> is defined as IIN+ - IN-. Differential output voltage V<sub>OD</sub> is defined as IOUT+ - OUT-.

**Note 4:** K28.7 pattern is a 10-bit repeating pattern of K28.7 code group {001111 1000}

K28.5 pattern is a 20-bit repeating pattern of +K28.5 and -K28.5 code groups {110000 0101 001111 1010}

**Note 5:** Device output random jitter is a measurement of the random jitter contribution from the device. It is derived by the equation  $\sqrt{RJ_{OUT}^2 - RJ_{IN}^2}$ , where  $RJ_{OUT}$  is the total random jitter measured at the output of the device in psrms,  $RJ_{IN}$  is the random jitter of the pattern generator driving the device.

**Note 6:** Device output deterministic jitter is a measurement of the deterministic jitter contribution from the device. It is derived by the equation  $(DJ_{OUT} - DJ_{IN})$ , where  $DJ_{OUT}$  is the total peak-to-peak deterministic jitter measured at the output of the device in pspp,  $DJ_{IN}$  is the peak-to-peak deterministic jitter of the pattern generator driving the device.

**Note 7:**  $t_{SKO}$  is the magnitude difference in the propagation delays among data paths. An example is the output skew among data paths from  $IN0_{\pm}$  to  $OUT_{\pm}$  and  $IN1_{\pm}$  to  $OUT_{\pm}$ . Another example is the output skew among data paths from  $IN_{\pm}$  to  $OUT0_{\pm}$  and  $IN_{\pm}$  to  $OUT1_{\pm}$ .  $t_{SKO}$  also refers to the delay skew of the loopback paths of the same port and between similar data paths. An example is the output skew among data paths  $IN0_{\pm}$  to  $OUT0_{\pm}$  and  $IN1_{\pm}$  to  $OUT1_{\pm}$ .

**Note 8:** Thermal resistances are based on having 16 thermal relief vias on the DAP pad under the 0 airflow condition.

**Note 9:** This parameter is guaranteed by design and/or characterization. It is not tested in production.

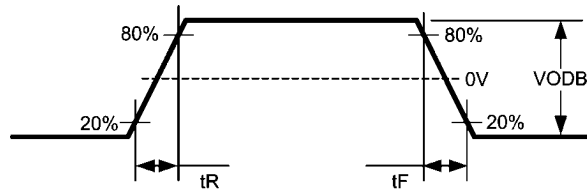
**Note 10:** ESD tests conform to the following standards:

Human Body Model applicable standard: MIL-STD-883, Method 3015.7

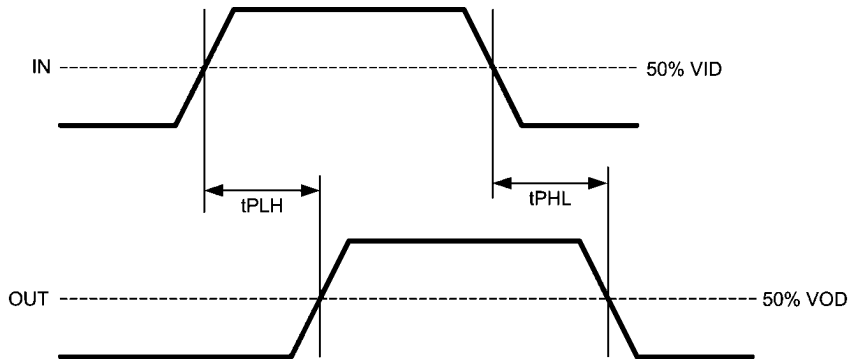
Machine Model applicable standard: JESD22-A115-A (ESD MM standard of JEDEC)

Field-induced Charge Device Model: Applicable standard JESD22-C101-C (ESD FICDM standard of JEDEC)

## Timing Diagrams

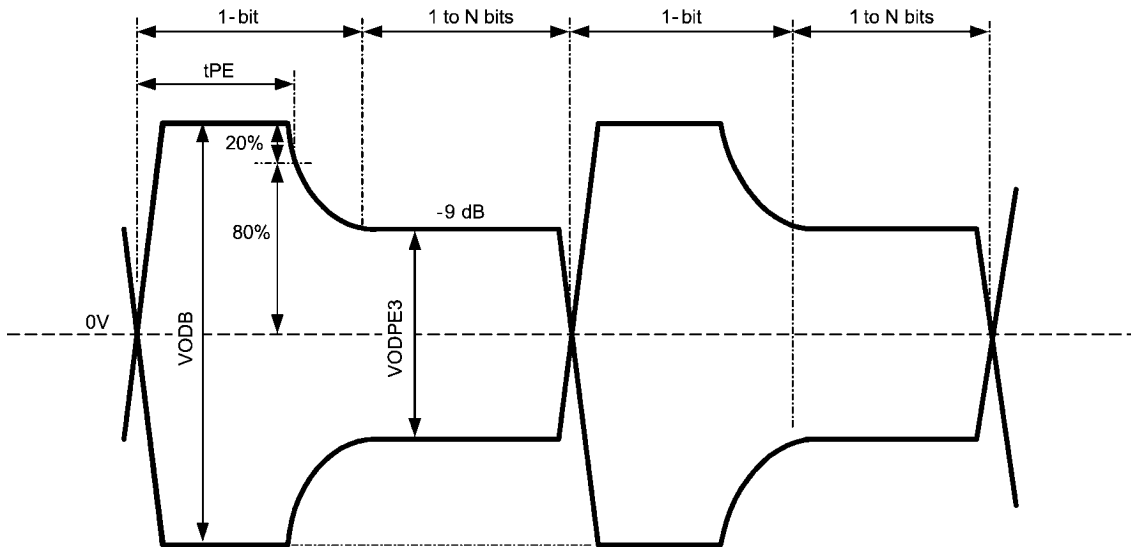


**FIGURE 2. Driver Output Transition Time**



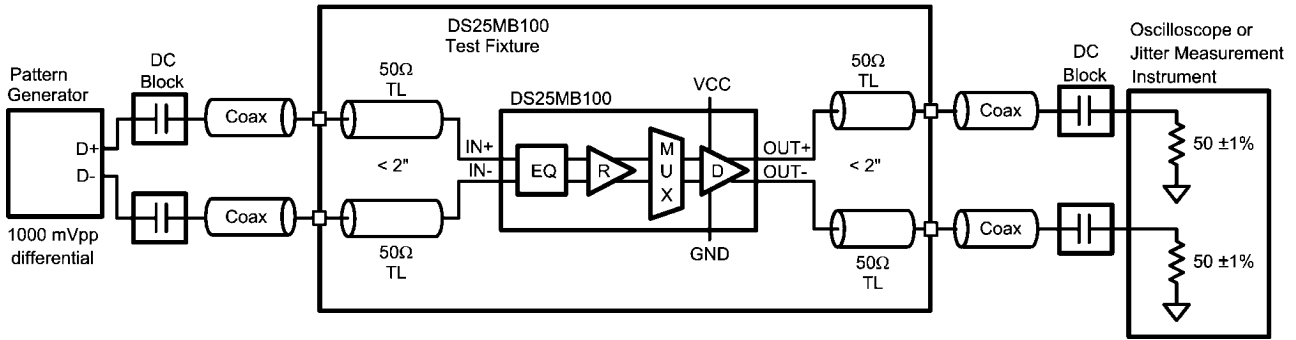
**FIGURE 3. Propagation Delay from Input to Output**





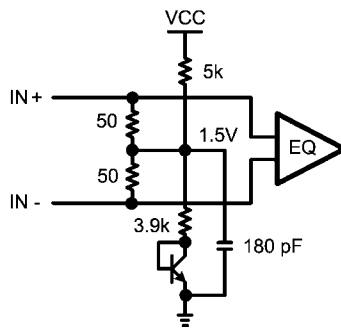
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FIGURE 4. Test Condition for Output Pre-Emphasis Duration



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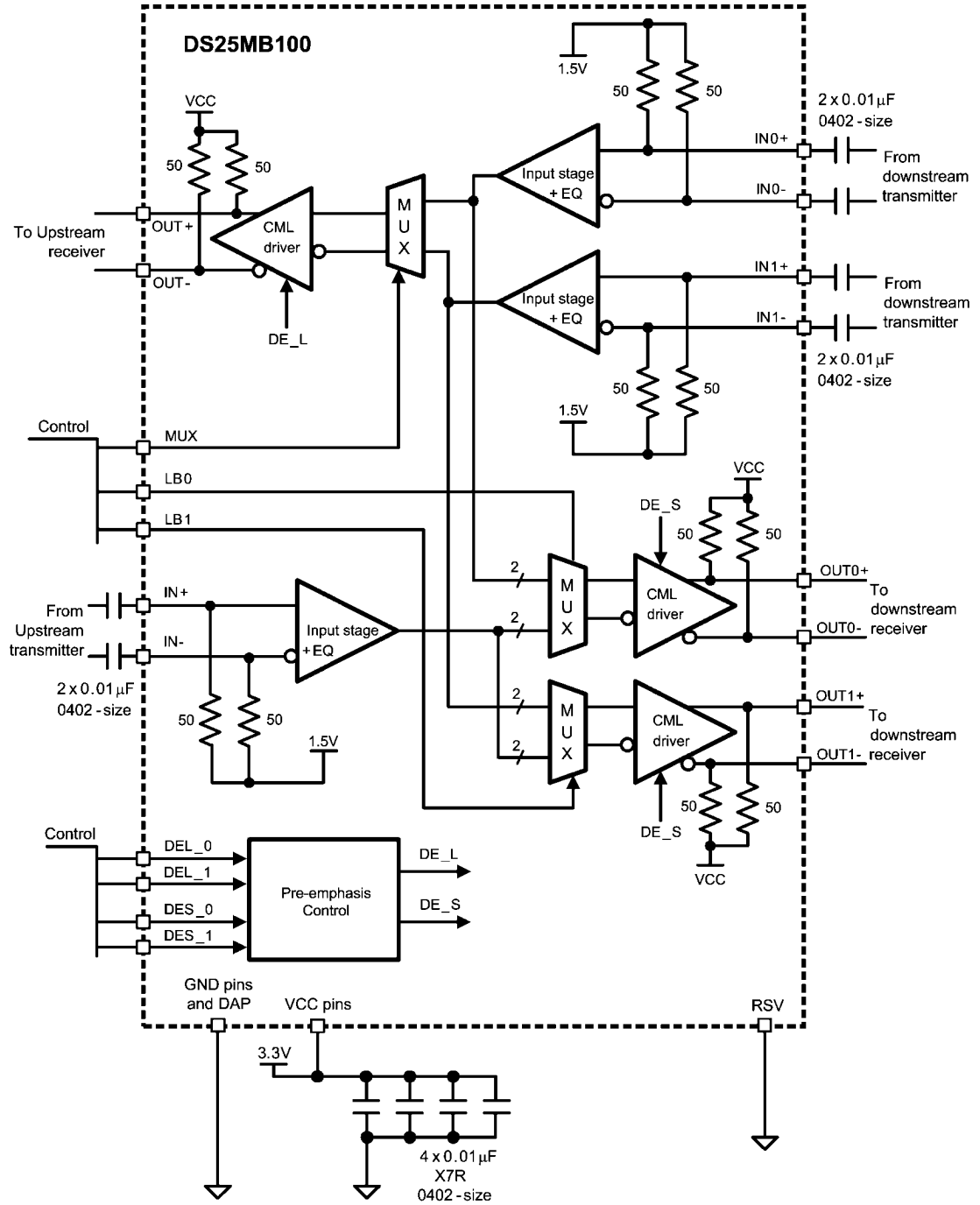
FIGURE 5. AC Test Circuit



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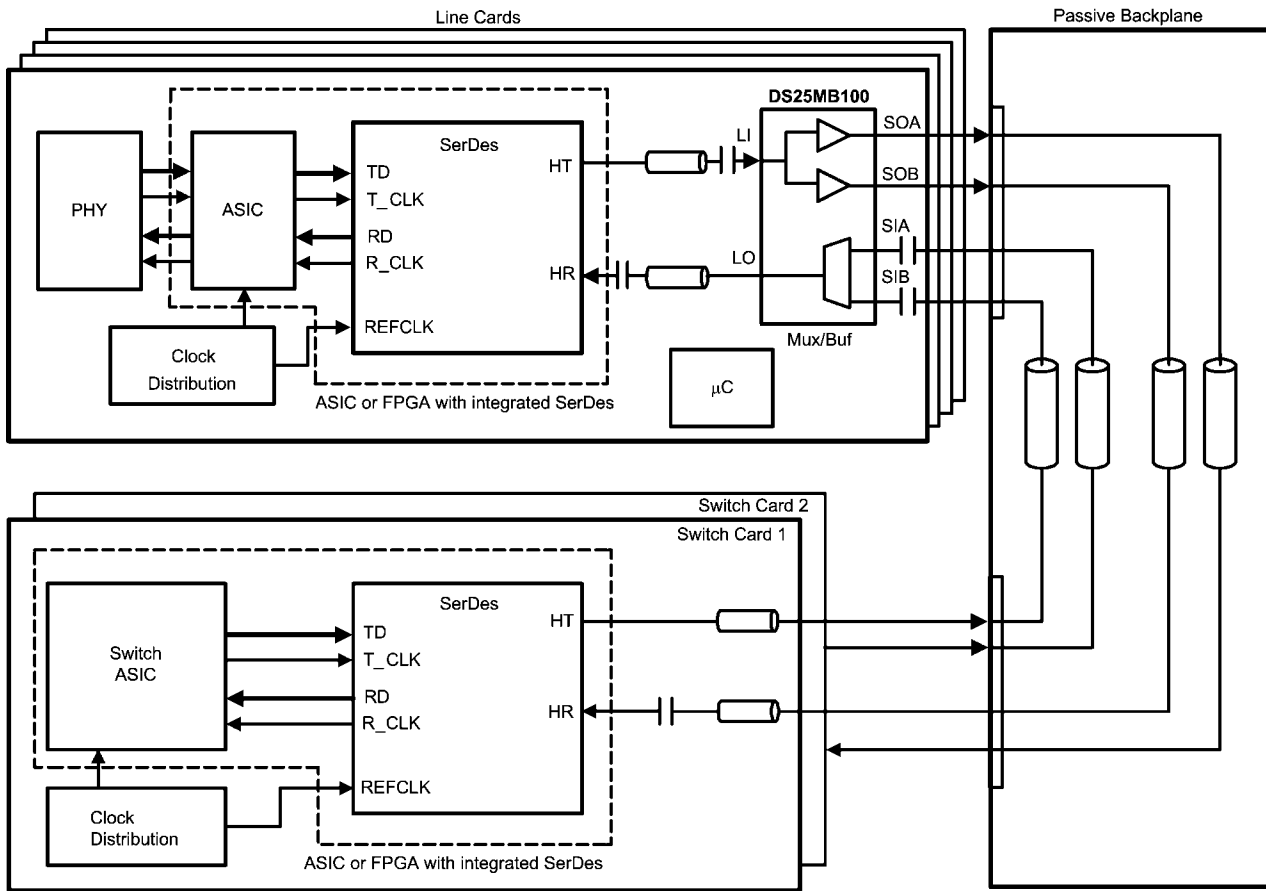
FIGURE 6. Receiver Input Termination and Bias Circuit

# Application Information



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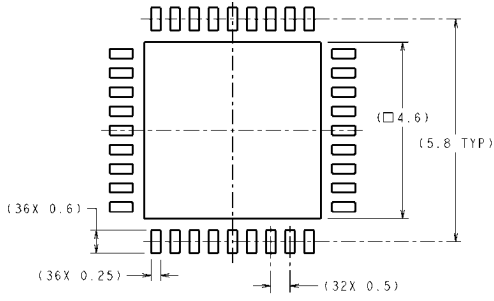
FIGURE 7. Application Diagram



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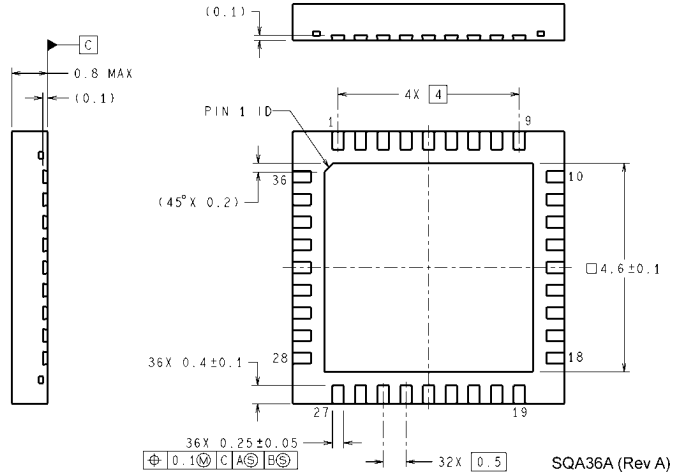
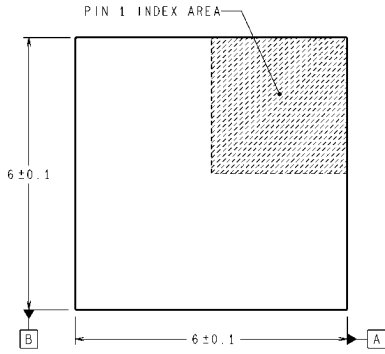
FIGURE 8. Network Switch System With Redundancy

**Physical Dimensions** inches (millimeters) unless otherwise noted



**DIMENSIONS ARE IN MILLIMETERS**  
DIMENSIONS IN ( ) FOR REFERENCE ONLY

**RECOMMENDED LAND PATTERN**



**LLP-36 Package**  
**Order Number DS25MB100TSQ**  
**NS Package Number SQA36A**

SQA36A (Rev A)

# Notes

## Notes

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| Data Converters                | <a href="http://www.national.com/adc">www.national.com/adc</a>                 | Distributors            | <a href="http://www.national.com/contacts">www.national.com/contacts</a>           |
| Displays                       | <a href="http://www.national.com/displays">www.national.com/displays</a>       | Green Compliance        | <a href="http://www.national.com/quality/green">www.national.com/quality/green</a> |
| Ethernet                       | <a href="http://www.national.com/ethernet">www.national.com/ethernet</a>       | Packaging               | <a href="http://www.national.com/packaging">www.national.com/packaging</a>         |
| Interface                      | <a href="http://www.national.com/interface">www.national.com/interface</a>     | Quality and Reliability | <a href="http://www.national.com/quality">www.national.com/quality</a>             |
| LVDS                           | <a href="http://www.national.com/lvds">www.national.com/lvds</a>               | Reference Designs       | <a href="http://www.national.com/refdesigns">www.national.com/refdesigns</a>       |
| Power Management               | <a href="http://www.national.com/power">www.national.com/power</a>             | Feedback                | <a href="http://www.national.com/feedback">www.national.com/feedback</a>           |
| Switching Regulators           | <a href="http://www.national.com/switchers">www.national.com/switchers</a>     |                         |  |
| LDOs                           | <a href="http://www.national.com/ldo">www.national.com/ldo</a>                 |                         |  |
| LED Lighting                   | <a href="http://www.national.com/led">www.national.com/led</a>                 |                         |  |
| PowerWise                      | <a href="http://www.national.com/powerwise">www.national.com/powerwise</a>     |                         |  |
| Serial Digital Interface (SDI) | <a href="http://www.national.com/sdi">www.national.com/sdi</a>                 |                         |  |
| Temperature Sensors            | <a href="http://www.national.com/tempsensors">www.national.com/tempsensors</a> |                         |  |
| Wireless (PLL/VCO)             | <a href="http://www.national.com/wireless">www.national.com/wireless</a>       |                         |  |

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