



# THE DATASHEET OF MAX9325EQI+



## 2:8 Differential LVPECL/LVECL/HSTL Clock and Data Driver

MAX9325

### General Description

The MAX9325 low-skew, 2:8 differential driver features extremely low output-to-output skew (50ps max) and part-to-part skew (225ps max). These features make the device ideal for clock and data distribution across a backplane or board. The device selects one of the two differential HSTL or LVECL/LVPECL inputs and repeats them at eight differential outputs. Outputs are compatible with LVECL and LVPECL, and can directly drive 50Ω terminated transmission lines.

The differential inputs can be configured to accept a single-ended signal when the unused complementary input is connected to the on-chip reference output voltage  $V_{BB}$ . All inputs have internal pulldown resistors to  $V_{EE}$ . The internal pulldowns and a fail-safe circuit ensure differential low default outputs when the inputs are left open or at  $V_{EE}$ .

The MAX9325 operates over a 2.375V to 3.8V supply range for interfacing to differential HSTL and LVPECL signals. This allows high-performance clock or data distribution in systems with a nominal +2.5V or +3.3V supply. For LVECL operation, the device operates with a -2.375V to -3.8V supply.

The MAX9325 is offered in 28-lead PLCC and space-saving 28-lead QFN packages. The MAX9325 is specified for operation from -40°C to +85°C.

### Applications

Precision Clock Distribution  
Low-Jitter Data Repeaters

### Features

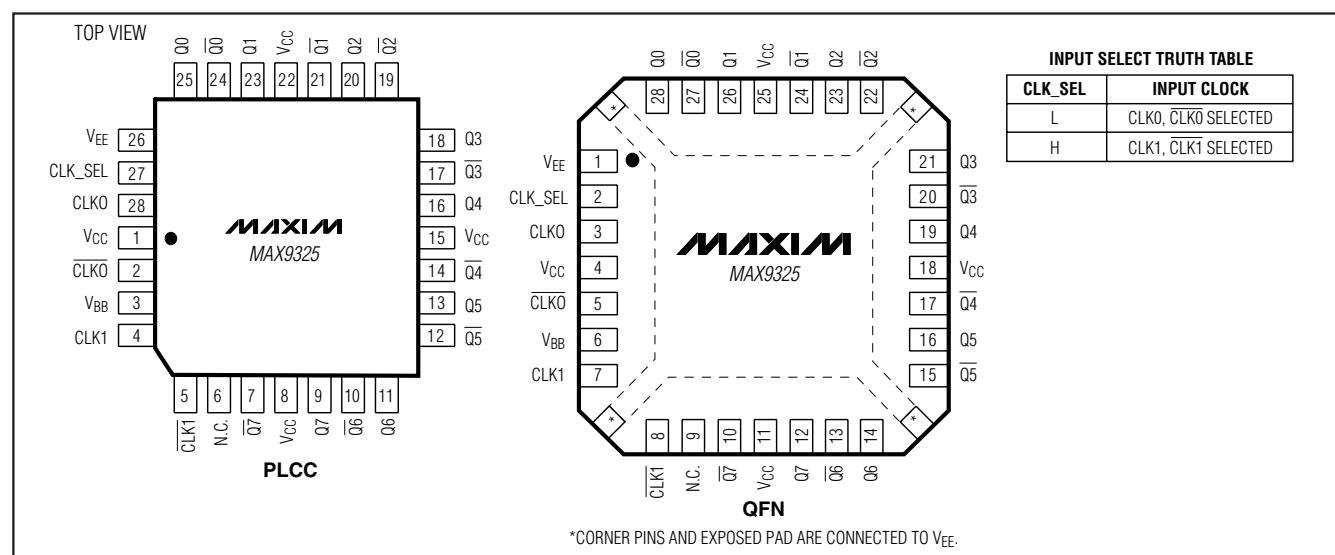
- ◆ 50ps (max) Output-to-Output Skew
- ◆ 1.5ps<sub>RMS</sub> (max) Random Jitter
- ◆ Guaranteed 300mV Differential Output at 700MHz
- ◆ +2.375V to +3.8V Supplies for Differential HSTL/LVPECL
- ◆ -2.375V to -3.8V Supplies for Differential LVECL
- ◆ Two Selectable Differential Inputs
- ◆ On-Chip Reference for Single-Ended Inputs
- ◆ Outputs Low for Inputs Open or at  $V_{EE}$
- ◆ Pin Compatible with MC100LVE310

### Ordering Information

| PART       | TEMP RANGE     | PIN-PACKAGE      |
|------------|----------------|------------------|
| MAX9325EQI | -40°C to +85°C | 28 PLCC          |
| MAX9325EGI | -40°C to +85°C | 28 QFN 5mm x 5mm |

Functional Diagram appears at end of data sheet.

### Pin Configurations



## 2:8 Differential LVPECL/LVECL/HSTL Clock and Data Driver

### ABSOLUTE MAXIMUM RATINGS

$V_{CC} - V_{EE}$  ..... -0.3V to +4.1V  
 Inputs (CLK<sub>+</sub>, CLK<sub>-</sub>, CLK\_SEL) to  $V_{EE}$  ..... -0.3V to ( $V_{CC} + 0.3V$ )  
 CLK<sub>+</sub> to CLK<sub>-</sub> .....  $\pm 3.0V$   
 Continuous Output Current ..... 50mA  
 Surge Output Current ..... 100mA  
 $V_{BB}$  Sink/Source Current .....  $\pm 0.65mA$   
 Continuous Power Dissipation ( $T_A = +70^\circ C$ )  
     28-Lead PLCC (derate 10.5mW/ $^\circ C$  above  $+70^\circ C$ ) ..... 842mW  
      $\theta_{JA}$  in Still Air .....  $+95^\circ C/W$   
      $\theta_{JC}$  .....  $+25^\circ C/W$

28-Lead QFN (derate 20.8mW/ $^\circ C$  above  $+70^\circ C$ ) ..... 1667mW  
      $\theta_{JA}$  in Still Air .....  $+48^\circ C/W$   
      $\theta_{JC}$  .....  $+2^\circ C/W$   
 Operating Temperature Range .....  $-40^\circ C$  to  $+85^\circ C$   
 Junction Temperature .....  $+150^\circ C$   
 Storage Temperature Range .....  $-65^\circ C$  to  $+150^\circ C$   
 ESD Protection  
     Human Body Model (CLK<sub>+</sub>, CLK<sub>-</sub>, Q<sub>+</sub>, Q<sub>-</sub>) .....  $\geq 2kV$   
     Soldering Temperature (10s) .....  $+300^\circ C$

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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

### DC ELECTRICAL CHARACTERISTICS

( $V_{CC} - V_{EE}$ ) = 2.375V to 3.8V,  $R_L = 50\Omega \pm 1\%$  to  $V_{CC} - 2V$ . Typical values are at ( $V_{CC} - V_{EE}$ ) = 3.3V,  $V_{IH} = (V_{CC} - 1V)$ ,  $V_{IL} = (V_{CC} - 1.5V)$ .)  
 (Notes 1–4)

| PARAMETER                                                 | SYMBOL           | CONDITIONS                        | -40°C                   |     |                         | +25°C                   |     |                         | +85°C                   |     |                         | UNITS |
|-----------------------------------------------------------|------------------|-----------------------------------|-------------------------|-----|-------------------------|-------------------------|-----|-------------------------|-------------------------|-----|-------------------------|-------|
|                                                           |                  |                                   | MIN                     | TYP | MAX                     | MIN                     | TYP | MAX                     | MIN                     | TYP | MAX                     |       |
| SINGLE-ENDED INPUT (CLK_SEL)                              |                  |                                   |                         |     |                         |                         |     |                         |                         |     |                         |       |
| Single-Ended Input High Voltage                           | V <sub>IH</sub>  | Figure 1                          | V <sub>CC</sub> - 1.165 |     | V <sub>CC</sub>         | V <sub>CC</sub> - 1.165 |     | V <sub>CC</sub>         | V <sub>CC</sub> - 1.165 |     | V <sub>CC</sub>         | V     |
| Single-Ended Input Low Voltage                            | V <sub>IL</sub>  | Figure 1                          | V <sub>EE</sub>         |     | V <sub>CC</sub> - 1.475 | V <sub>EE</sub>         |     | V <sub>CC</sub> - 1.475 | V <sub>EE</sub>         |     | V <sub>CC</sub> - 1.475 | V     |
| Input Current                                             | I <sub>IN</sub>  | V <sub>IH</sub> , V <sub>IL</sub> | -10.0                   |     | +150                    | -10.0                   |     | +150                    | -10.0                   |     | +150                    | μA    |
| DIFFERENTIAL INPUT (CLK <sub>+</sub> , CLK <sub>-</sub> ) |                  |                                   |                         |     |                         |                         |     |                         |                         |     |                         |       |
| Single-Ended Input High Voltage                           | V <sub>IH</sub>  | Figure 1                          | V <sub>CC</sub> - 1.165 |     | V <sub>CC</sub>         | V <sub>CC</sub> - 1.165 |     | V <sub>CC</sub>         | V <sub>CC</sub> - 1.165 |     | V <sub>CC</sub>         | V     |
| Single-Ended Input Low Voltage                            | V <sub>IL</sub>  | Figure 1                          | V <sub>EE</sub>         |     | V <sub>CC</sub> - 1.475 | V <sub>EE</sub>         |     | V <sub>CC</sub> - 1.475 | V <sub>EE</sub>         |     | V <sub>CC</sub> - 1.475 | V     |
| Differential Input High Voltage                           | V <sub>IHD</sub> | Figure 1                          | V <sub>EE</sub> + 1.2   |     | V <sub>CC</sub>         | V <sub>EE</sub> + 1.2   |     | V <sub>CC</sub>         | V <sub>EE</sub> + 1.2   |     | V <sub>CC</sub>         | V     |

## 2:8 Differential LVPECL/LVECL/HSTL Clock and Data Driver

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### DC ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} - V_{EE}$ ) = 2.375V to 3.8V,  $R_L = 50\Omega \pm 1\%$  to  $V_{CC} - 2V$ . Typical values are at ( $V_{CC} - V_{EE}$ ) = 3.3V,  $V_{IH} = (V_{CC} - 1V)$ ,  $V_{IL} = (V_{CC} - 1.5V)$ .) (Notes 1–4)

| PARAMETER                                                     | SYMBOL              | CONDITIONS                                  | -40°C            |                  |                   | +25°C            |                  |                   | +85°C            |                  |                   | UNITS   |
|---------------------------------------------------------------|---------------------|---------------------------------------------|------------------|------------------|-------------------|------------------|------------------|-------------------|------------------|------------------|-------------------|---------|
|                                                               |                     |                                             | MIN              | TYP              | MAX               | MIN              | TYP              | MAX               | MIN              | TYP              | MAX               |         |
| Differential Input Low Voltage                                | $V_{ILD}$           | Figure 1                                    | $V_{EE}$         |                  | $V_{CC} - 0.095$  | $V_{EE}$         |                  | $V_{CC} - 0.095$  | $V_{EE}$         |                  | $V_{CC} - 0.095$  | V       |
| Differential Input Voltage                                    | $V_{IHD} - V_{ILD}$ | $(V_{CC} - V_{EE}) < 3.0V$ , Figure 1       | 0.095            |                  | $V_{CC} - V_{EE}$ | 0.095            |                  | $V_{CC} - V_{EE}$ | 0.095            |                  | $V_{CC} - V_{EE}$ | V       |
|                                                               |                     | $(V_{CC} - V_{EE}) \geq 3.0V$ , Figure 1    | 0.095            |                  | 3.0               | 0.095            |                  | 3.0               | 0.095            |                  | 3.0               |         |
| Input Current                                                 | $I_{IN}$            | $V_{IH}$ , $V_{IL}$ , $V_{IHD}$ , $V_{ILD}$ | -10.0            |                  | +150.0            | -10.0            |                  | +150.0            | -10.0            |                  | +150.0            | $\mu A$ |
| <b>OUTPUT (<math>Q_+</math>, <math>\overline{Q}_+</math>)</b> |                     |                                             |                  |                  |                   |                  |                  |                   |                  |                  |                   |         |
| Single-Ended Output High Voltage                              | $V_{OH}$            | Figure 2                                    | $V_{CC} - 1.085$ | $V_{CC} - 0.977$ | $V_{CC} - 0.880$  | $V_{CC} - 1.025$ | $V_{CC} - 0.949$ | $V_{CC} - 0.88$   | $V_{CC} - 1.025$ | $V_{CC} - 0.929$ | $V_{CC} - 0.88$   | V       |
| Single-Ended Output Low Voltage                               | $V_{OL}$            | Figure 2                                    | $V_{CC} - 1.810$ | $V_{CC} - 1.695$ | $V_{CC} - 1.620$  | $V_{CC} - 1.810$ | $V_{CC} - 1.697$ | $V_{CC} - 1.62$   | $V_{CC} - 1.810$ | $V_{CC} - 1.698$ | $V_{CC} - 1.62$   | V       |
| Differential Output Voltage                                   | $V_{OH} - V_{OL}$   | Figure 2                                    | 535              | 718              |                   | 595              | 749              |                   | 595              | 769              |                   | mV      |
| <b>REFERENCE VOLTAGE OUTPUT (<math>V_{BB}</math>)</b>         |                     |                                             |                  |                  |                   |                  |                  |                   |                  |                  |                   |         |
| Reference Voltage Output                                      | $V_{BB}$            | $I_{BB} = \pm 0.5mA$ (Note 5)               | $V_{CC} - 1.38$  | $V_{CC} - 1.318$ | $V_{CC} - 1.26$   | $V_{CC} - 1.38$  | $V_{CC} - 1.325$ | $V_{CC} - 1.26$   | $V_{CC} - 1.38$  | $V_{CC} - 1.328$ | $V_{CC} - 1.26$   | V       |
| <b>SUPPLY</b>                                                 |                     |                                             |                  |                  |                   |                  |                  |                   |                  |                  |                   |         |
| Supply Current                                                | $I_{EE}$            | (Note 6)                                    |                  | 35               | 50                |                  | 39               | 55                |                  | 42               | 65                | mA      |

## 2:8 Differential LVPECL/LVECL/HSTL Clock and Data Driver

### AC ELECTRICAL CHARACTERISTICS—PLCC Package

((V<sub>CC</sub> - V<sub>EE</sub>) = 2.375V to 3.8V, R<sub>L</sub> = 50Ω ±1% to V<sub>CC</sub> - 2V, f<sub>IN</sub> ≤ 500MHz, input transition time = 125ps (20% to 80%). Typical values are at (V<sub>CC</sub> - V<sub>EE</sub>) = 3.3V, V<sub>IH</sub> = (V<sub>CC</sub> - 1V), V<sub>IL</sub> = (V<sub>CC</sub> - 1.5V).) (Note 7)

| PARAMETER                          | SYMBOL                                 | CONDITIONS                                                             | -40°C |     |     | +25°C |     |     | +85°C |     |     | UNITS |
|------------------------------------|----------------------------------------|------------------------------------------------------------------------|-------|-----|-----|-------|-----|-----|-------|-----|-----|-------|
|                                    |                                        |                                                                        | MIN   | TYP | MAX | MIN   | TYP | MAX | MIN   | TYP | MAX |       |
| Differential Input-to-Output Delay | t <sub>PLHD</sub><br>t <sub>PHLD</sub> | Figure 2                                                               | 525   |     | 725 | 550   |     | 750 | 575   |     | 775 | ps    |
| Single-Ended Input-to-Output Delay | t <sub>PLH</sub><br>t <sub>PHL</sub>   | Figure 3 (Note 8)                                                      | 500   |     | 750 | 550   |     | 800 | 600   |     | 850 | ps    |
| Output-to-Output Skew              | t <sub>SKOO</sub>                      | (Note 9)                                                               |       |     | 50  |       |     | 50  |       |     | 50  | ps    |
| Part-to-Part Skew                  | t <sub>SKPP</sub>                      | Differential input (Note 10)                                           |       |     | 160 |       |     | 190 |       |     | 225 | ps    |
| Added Random Jitter                | t <sub>RJ</sub>                        | f <sub>IN</sub> = 0.5GHz clock pattern (Note 11)                       |       |     | 1.5 |       |     | 1.5 |       |     | 1.5 | psRMS |
| Added Deterministic Jitter         | t <sub>DJ</sub>                        | f <sub>IN</sub> = 1.0Gbps, 2E <sup>23</sup> - 1 PRBS pattern (Note 11) |       |     | 100 |       |     | 100 |       |     | 100 | psp-p |
| Switching Frequency                | f <sub>MAX</sub>                       | V <sub>OH</sub> - V <sub>OL</sub> ≥ 300mV clock pattern                | 1.5   |     |     | 1.5   |     |     | 1.5   |     |     | GHz   |
| Output Rise/Fall Time (20% to 80%) | t <sub>R</sub> , t <sub>F</sub>        | Figure 2                                                               | 140   |     | 440 | 140   |     | 440 | 140   |     | 440 | ps    |

## 2:8 Differential LVPECL/LVECL/HSTL Clock and Data Driver

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### AC ELECTRICAL CHARACTERISTICS—QFN Package

(( $V_{CC} - V_{EE}$ ) = 2.375V to 3.8V,  $R_L = 50\Omega \pm 1\%$  to  $V_{CC} - 2V$ ,  $f_{IN} \leq 500\text{MHz}$ , input transition time = 125ps (20% to 80%). Typical values are at ( $V_{CC} - V_{EE}$ ) = 3.3V,  $V_{IH} = (V_{CC} - 1V)$ ,  $V_{IL} = (V_{CC} - 1.5V)$ .) (Note 7)

| PARAMETER                          | SYMBOL                   | CONDITIONS                                                       | -40°C |     |     | +25°C |     |     | +85°C |     |     | UNITS |
|------------------------------------|--------------------------|------------------------------------------------------------------|-------|-----|-----|-------|-----|-----|-------|-----|-----|-------|
|                                    |                          |                                                                  | MIN   | TYP | MAX | MIN   | TYP | MAX | MIN   | TYP | MAX |       |
| Differential Input-to-Output Delay | $t_{PLHD}$<br>$t_{PHLD}$ | Figure 2                                                         | 250   |     | 575 | 298   |     | 553 | 309   |     | 576 | ps    |
| Single-Ended Input-to-Output Delay | $t_{PLH}$<br>$t_{PHL}$   | Figure 3 (Note 8)                                                | 253   |     | 581 | 310   |     | 586 | 324   |     | 606 | ps    |
| Output-to-Output Skew              | $t_{SKOO}$               | (Note 9)                                                         |       |     | 50  |       |     | 50  |       |     | 50  | ps    |
| Part-to-Part Skew                  | $t_{SKPP}$               | Differential input (Note 10)                                     |       |     | 192 |       |     | 215 |       |     | 218 | ps    |
| Added Random Jitter                | $t_{RJ}$                 | $f_{IN} = 0.5\text{GHz}$ clock pattern (Note 11)                 |       |     | 1.5 |       |     | 1.5 |       |     | 1.5 | psRMS |
| Added Deterministic Jitter         | $t_{DJ}$                 | $f_{IN} = 1.0\text{Gbps}$ , $2E^{23} - 1$ PRBS pattern (Note 11) |       |     | 95  |       |     | 95  |       |     | 95  | pSP-P |
| Switching Frequency                | $f_{MAX}$                | $V_{OH} - V_{OL} \geq 300\text{mV}$ clock pattern                | 1.5   |     |     | 1.5   |     |     | 1.5   |     |     | GHz   |
| Output Rise/Fall Time (20% to 80%) | $t_R$ , $t_F$            | Figure 2                                                         | 97    |     | 411 | 104   |     | 210 | 111   |     | 232 | ps    |

**Note 1:** Measurements are made with the device in thermal equilibrium.

**Note 2:** Current into a pin is defined as positive. Current out of a pin is defined as negative.

**Note 3:** DC parameters production tested at  $T_A = +25^\circ\text{C}$  and guaranteed by design over the full operating temperature range.

**Note 4:** Single-ended input operation using  $V_{BB}$  is limited to ( $V_{CC} - V_{EE}$ ) = 3.0V to 3.8V.

**Note 5:** Use  $V_{BB}$  only for inputs that are on the same device as the  $V_{BB}$  reference.

**Note 6:** All pins open except  $V_{CC}$  and  $V_{EE}$ .

**Note 7:** Guaranteed by design and characterization. Limits are set at  $\pm 6$  sigma.

**Note 8:** Measured from the 50% point of the input signal with the 50% point equal to  $V_{BB}$ , to the 50% point of the output signal.

**Note 9:** Measured between outputs of the same part at the signal crossing points for a same-edge transition. Differential input signal.

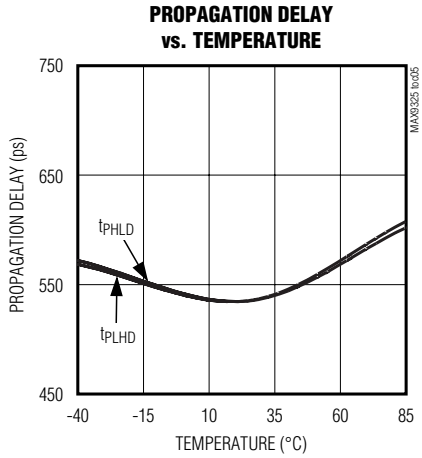
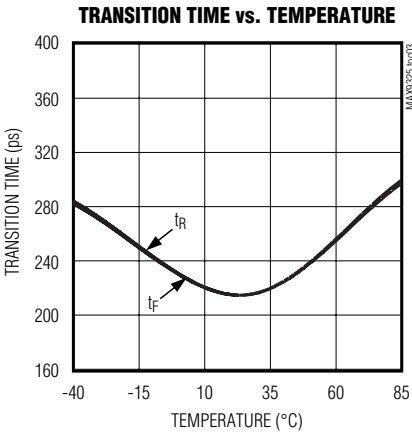
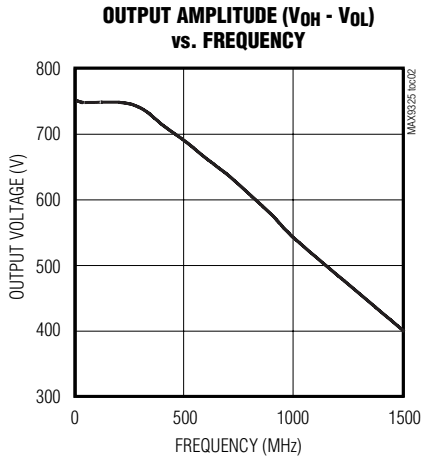
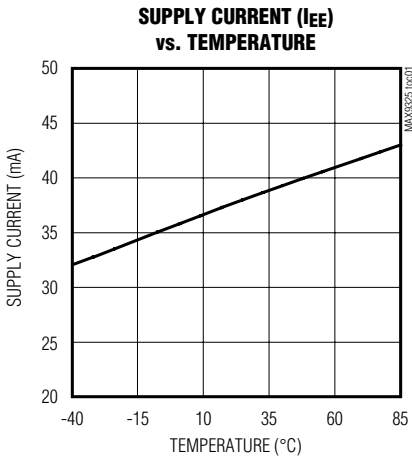
**Note 10:** Measured between outputs of different parts under identical condition for same-edge transition.

**Note 11:** Device jitter added to the input signal. Differential input signal.

# 2:8 Differential LVPECL/LVECL/HSTL Clock and Data Driver

## Typical Operating Characteristics

(PLCC package, typical values are at  $(V_{CC} - V_{EE}) = 3.3V$ ,  $V_{IH} = (V_{CC} - 1V)$ ,  $V_{IL} = (V_{CC} - 1.5V)$ ,  $R_L = 50\Omega \pm 1\%$  to  $V_{CC} - 2V$ ,  $f_{IN} = 500MHz$ , input transition time = 125ps (20% to 80%).)



## 2:8 Differential LVPECL/LVECL/HSTL Clock and Data Driver

### Pin Description

| PIN          |               | NAME             | FUNCTION                                                                                                                                                                                                                                      |
|--------------|---------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PLCC         | QFN           |                  |                                                                                                                                                                                                                                               |
| 1, 8, 15, 22 | 4, 11, 18, 25 | V <sub>CC</sub>  | Positive Supply Voltage. Bypass each V <sub>CC</sub> to V <sub>EE</sub> with 0.1μF and 0.01μF ceramic capacitors. Place the capacitors as close to the device as possible, with the smaller value capacitor closest to the device.            |
| 2            | 5             | CLK <sub>0</sub> | Inverting Differential Clock Input 0. Internal 105kΩ pulldown to V <sub>EE</sub> .                                                                                                                                                            |
| 3            | 6             | V <sub>BB</sub>  | Reference Output Voltage. Connect to the inverting or noninverting clock input to provide a reference for single-ended operation. When used, bypass V <sub>BB</sub> to V <sub>CC</sub> with a 0.01μF ceramic capacitor. Otherwise leave open. |
| 4            | 7             | CLK <sub>1</sub> | Noninverting Differential Clock Input 1. Internal 105kΩ pulldown to V <sub>EE</sub> .                                                                                                                                                         |
| 5            | 8             | CLK <sub>1</sub> | Inverting Differential Clock Input 1. Internal 105kΩ pulldown to V <sub>EE</sub> .                                                                                                                                                            |
| 6            | 9             | N.C.             | Not Connected                                                                                                                                                                                                                                 |
| 7            | 10            | Q <sub>7</sub>   | Inverting Q7 Output. Typically terminate with 50Ω resistor to V <sub>CC</sub> - 2V.                                                                                                                                                           |
| 9            | 12            | Q <sub>7</sub>   | Noninverting Q7 Output. Typically terminate with 50Ω resistor to V <sub>CC</sub> - 2V.                                                                                                                                                        |
| 10           | 13            | Q <sub>6</sub>   | Inverting Q6 Output. Typically terminate with 50Ω resistor to V <sub>CC</sub> - 2V.                                                                                                                                                           |
| 11           | 14            | Q <sub>6</sub>   | Noninverting Q6 Output. Typically terminate with 50Ω resistor to V <sub>CC</sub> - 2V.                                                                                                                                                        |
| 12           | 15            | Q <sub>5</sub>   | Inverting Q5 Output. Typically terminate with 50Ω resistor to V <sub>CC</sub> - 2V.                                                                                                                                                           |
| 13           | 16            | Q <sub>5</sub>   | Noninverting Q5 Output. Typically terminate with 50Ω resistor to V <sub>CC</sub> - 2V.                                                                                                                                                        |
| 14           | 17            | Q <sub>4</sub>   | Inverting Q4 Output. Typically terminate with 50Ω resistor to V <sub>CC</sub> - 2V.                                                                                                                                                           |
| 16           | 19            | Q <sub>4</sub>   | Noninverting Q4 Output. Typically terminate with 50Ω resistor to V <sub>CC</sub> - 2V.                                                                                                                                                        |
| 17           | 20            | Q <sub>3</sub>   | Inverting Q3 Output. Typically terminate with 50Ω resistor to V <sub>CC</sub> - 2V.                                                                                                                                                           |
| 18           | 21            | Q <sub>3</sub>   | Noninverting Q3 Output. Typically terminate with 50Ω resistor to V <sub>CC</sub> - 2V.                                                                                                                                                        |
| 19           | 22            | Q <sub>2</sub>   | Inverting Q2 Output. Typically terminate with 50Ω resistor to V <sub>CC</sub> - 2V.                                                                                                                                                           |
| 20           | 23            | Q <sub>2</sub>   | Noninverting Q2 Output. Typically terminate with 50Ω resistor to V <sub>CC</sub> - 2V.                                                                                                                                                        |
| 21           | 24            | Q <sub>1</sub>   | Inverting Q1 Output. Typically terminate with 50Ω resistor to V <sub>CC</sub> - 2V.                                                                                                                                                           |
| 23           | 26            | Q <sub>1</sub>   | Noninverting Q1 Output. Typically terminate with 50Ω resistor to V <sub>CC</sub> - 2V.                                                                                                                                                        |
| 24           | 27            | Q <sub>0</sub>   | Inverting Q0 Output. Typically terminate with 50Ω resistor to V <sub>CC</sub> - 2V.                                                                                                                                                           |
| 25           | 28            | Q <sub>0</sub>   | Noninverting Q0 Output. Typically terminate with 50Ω resistor to V <sub>CC</sub> - 2V.                                                                                                                                                        |
| 26           | 1             | V <sub>EE</sub>  | Negative Supply Voltage                                                                                                                                                                                                                       |
| 27           | 2             | CLK_SEL          | Clock Select Input. When driven low, the CLK <sub>0</sub> input is selected. Drive high to select the CLK <sub>1</sub> Input. The CLK_SEL threshold is equal to V <sub>BB</sub> . Internal 75kΩ pulldown to V <sub>EE</sub> .                 |
| 28           | 3             | CLK <sub>0</sub> | Noninverting Differential Clock Input 0. Internal 105kΩ pulldown to V <sub>EE</sub> .                                                                                                                                                         |
| Exposed      | Exposed Pad   | —                | Internally Connected to V <sub>EE</sub>                                                                                                                                                                                                       |

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# 2:8 Differential LVPECL/LVECL/HSTL Clock and Data Driver

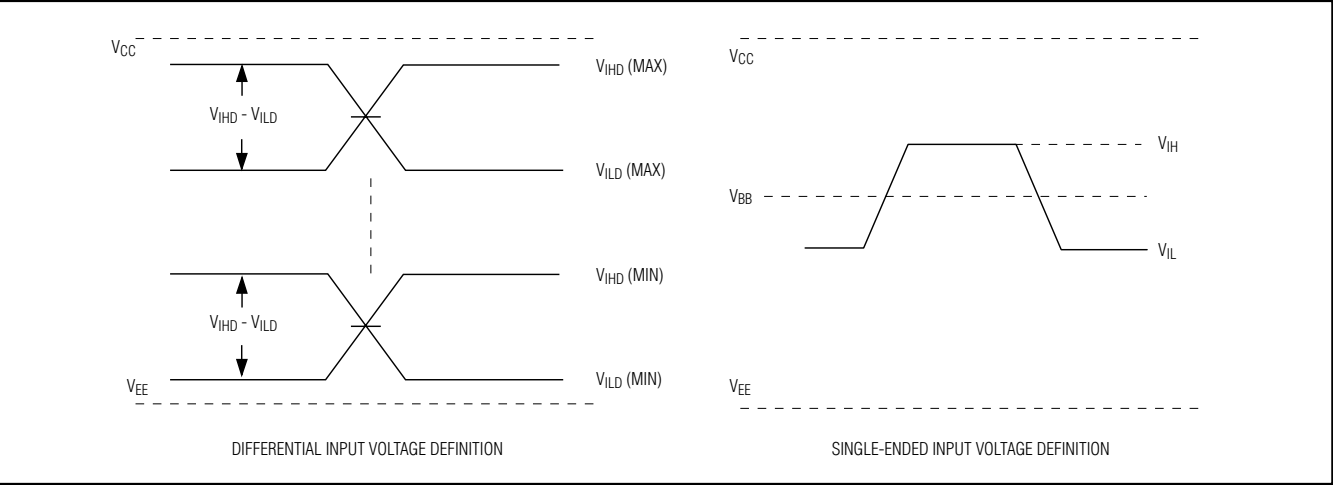


Figure 1. Input Voltage Definitions

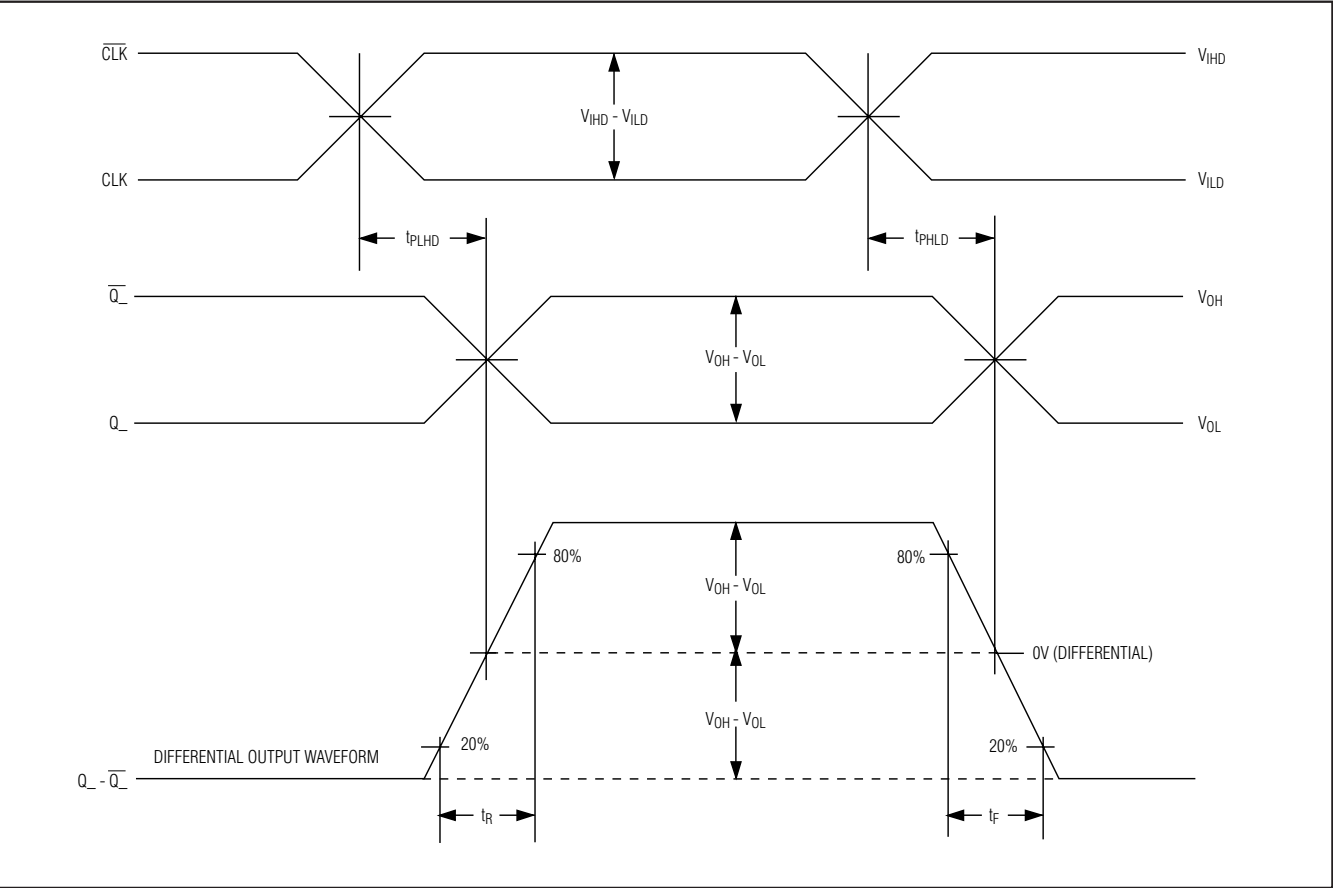


Figure 2. Differential Input ( $CLK_$ ,  $\overline{CLK}_$ ) to Output ( $Q_$ ,  $\overline{Q}_$ ) Delay Timing Diagram

## 2:8 Differential LVPECL/LVECL/HSTL Clock and Data Driver

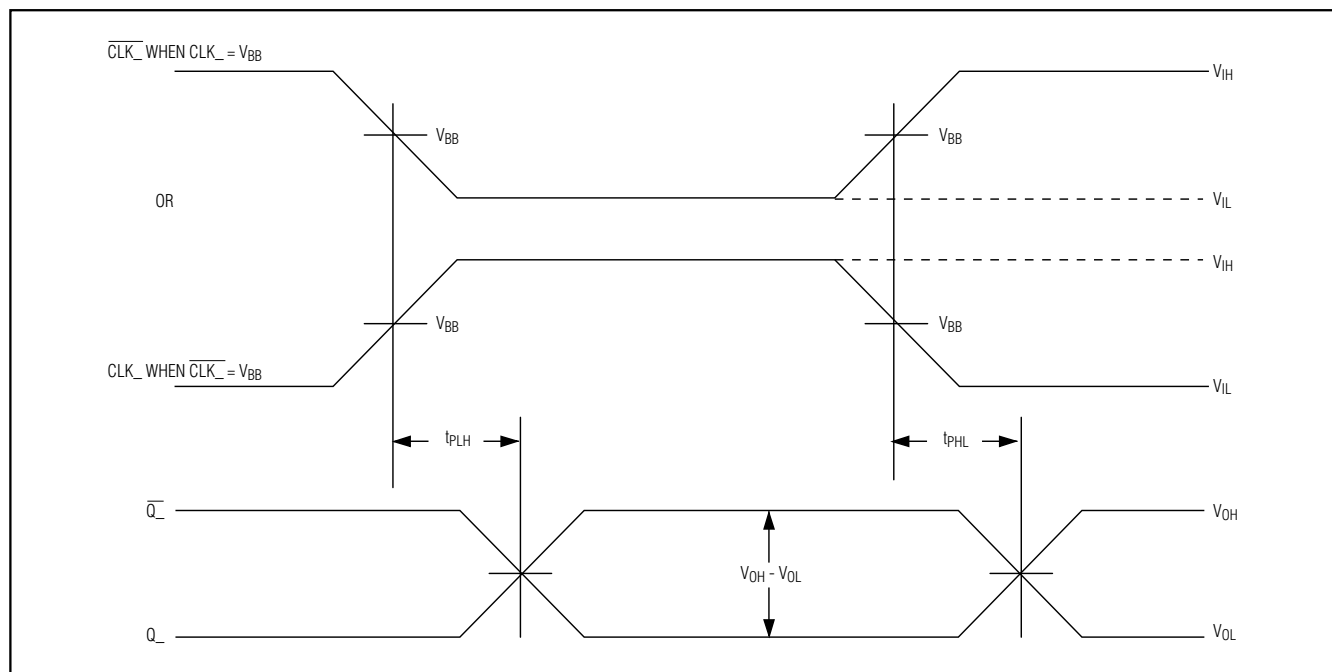


Figure 3. Single-Ended Input (CLK\_, CLK\_) to Output (Q\_, Q\_) Delay Timing Diagram

### Detailed Description

The MAX9325 low-skew, 2:8 differential driver features extremely low output-to-output skew (50ps max) and part-to-part skew (225ps max). These features make the device ideal for clock and data distribution across a backplane or board. The device selects one of the two differential HSTL or LVECL/LVPECL inputs, and repeats them at eight differential outputs. Outputs are compatible with LVECL and LVPECL, and can directly drive 50Ω terminated transmission lines.

A 2:1 mux selects between the two differential inputs, CLK0, CLK0 and CLK1, CLK1. The 2:1 mux is switched by the single-ended CLK\_SEL input. A logic low selects the CLK0, CLK0 input. A logic high selects the CLK1, CLK1 input. The logic threshold for CLK\_SEL is set by an internal V\_BB voltage reference. The selected input is reproduced at eight differential outputs at speeds up to 700MHz.

The differential inputs can be configured to accept a single-ended signal when the unused complementary input is connected to the on-chip reference output voltage (V\_BB). A single-ended input of at least V\_BB ±95mV or a differential input of at least 95mV switches the outputs to the V\_OH and V\_OL levels specified in the *DC Electrical Characteristics*. The maximum magnitude of the differential input from CLK\_ to CLK\_ is ±3.0V or

±(V\_CC - V\_EE), whichever is less. This limit also applies to the difference between a single-ended input and any reference voltage input.

The single-ended CLK\_SEL input has a 75kΩ pulldown to V\_EE that selects the default input, CLK0, CLK0, when CLK\_SEL is left open or at V\_EE. All the differential inputs have 105kΩ pulldowns to V\_EE. Internal pulldowns and a fail-safe circuit ensure differential low default outputs when the inputs are left open or at V\_EE.

Specifications for the high and low voltages of a differential input (V\_IHD and V\_ILD) and the differential input voltage (V\_IHD - V\_ILD) apply simultaneously.

For interfacing to differential HSTL and LVPECL signals, these devices operate over a +2.375V to +3.8V supply range, allowing high-performance clock or data distribution in systems with a nominal +2.5V or +3.3V supply. For differential LVECL operation, these devices operate from a -2.375V to -3.8V supply.

### Single-Ended Operation

CLK\_SEL is a single-ended input with the input threshold internally set to V\_BB, and can be driven to V\_CC or V\_EE or by a single-ended LVPECL/LVECL signal. The CLK\_, CLK\_ are differential inputs but can be configured to accept single-ended inputs when operating at supply voltages greater than 2.58V. The recommended supply voltage for single-ended operation is 3.0V to 3.8V. A dif-

## 2:8 Differential LVPECL/LVECL/HSTL Clock and Data Driver

ferential input is configured for single-ended operation by connecting the on-chip reference voltage,  $V_{BB}$ , to an unused complementary input as a reference. For example, the differential  $CLK0$ ,  $CLK0$  input is converted to a noninverting, single-ended input by connecting  $V_{BB}$  to  $CLK0$  and connecting the single-ended input to  $CLK0$ . Similarly, an inverting input is obtained by connecting  $V_{BB}$  to  $CLK0$  and connecting the single-ended input to  $CLK0$ . With a differential input configured as single-ended (using  $V_{BB}$ ), the single-ended input can be driven to  $V_{CC}$  or  $V_{EE}$  or with a single-ended LVPECL/LVECL signal.

When configuring a differential input as a single-ended input, a user must ensure that the supply voltage ( $V_{CC} - V_{EE}$ ) is greater than 2.58V. This is because the input high minimum level must be at ( $V_{EE} + 1.2V$ ) or higher for proper operation. The reference voltage  $V_{BB}$  must be at least ( $V_{EE} + 1.2V$ ) or higher for the same reason because it becomes the high-level input when the other single-ended input swings below it. The minimum  $V_{BB}$  output for the MAX9325 is ( $V_{CC} - 1.38V$ ). Substituting the minimum  $V_{BB}$  output for ( $V_{BB} = V_{EE} + 1.2V$ ) results in a minimum supply ( $V_{CC} - V_{EE}$ ) of 2.58V. Rounding up to standard supplies gives the single-ended operating supply ranges ( $V_{CC} - V_{EE}$ ) of 3.0V to 3.8V for the MAX9325.

When using the  $V_{BB}$  reference output, bypass it with a  $0.01\mu F$  ceramic capacitor to  $V_{CC}$ . If not used, leave it open. The  $V_{BB}$  reference can source or sink 0.5mA, which is sufficient to drive two inputs.

### Applications Information

#### Output Termination

Terminate the outputs through  $50\Omega$  to ( $V_{CC} - 2V$ ) or use equivalent Thevenin terminations. Terminate each Q and  $\bar{Q}$  output with identical termination on each for low output distortion. When a single-ended signal is taken from the differential output, terminate both  $Q_{-}$  and  $\bar{Q}_{-}$ .

Ensure that output currents do not exceed the current limits as specified in the *Absolute Maximum Ratings* table. Under all operating conditions, the device's total thermal limits should be observed.

#### Supply Bypassing

Bypass each  $V_{CC}$  to  $V_{EE}$  with high-frequency surface-mount ceramic  $0.1\mu F$  and  $0.01\mu F$  capacitors. Place the capacitors as close to the device as possible with the  $0.01\mu F$  capacitor closest to the device pins.

Use multiple vias when connecting the bypass capacitors to ground. When using the  $V_{BB}$  reference output, bypass it with a  $0.01\mu F$  ceramic capacitor to  $V_{CC}$ . If the  $V_{BB}$  reference is not used, it can be left open.

### Traces

Circuit board trace layout is very important to maintain the signal integrity of high-speed differential signals. Maintaining integrity is accomplished in part by reducing signal reflections and skew, and increasing common-mode noise immunity.

Signal reflections are caused by discontinuities in the  $50\Omega$  characteristic impedance of the traces. Avoid discontinuities by maintaining the distance between differential traces, not using sharp corners or using vias. Maintaining distance between the traces also increases common-mode noise immunity. Reducing signal skew is accomplished by matching the electrical length of the differential traces.

### Exposed-Pad Package

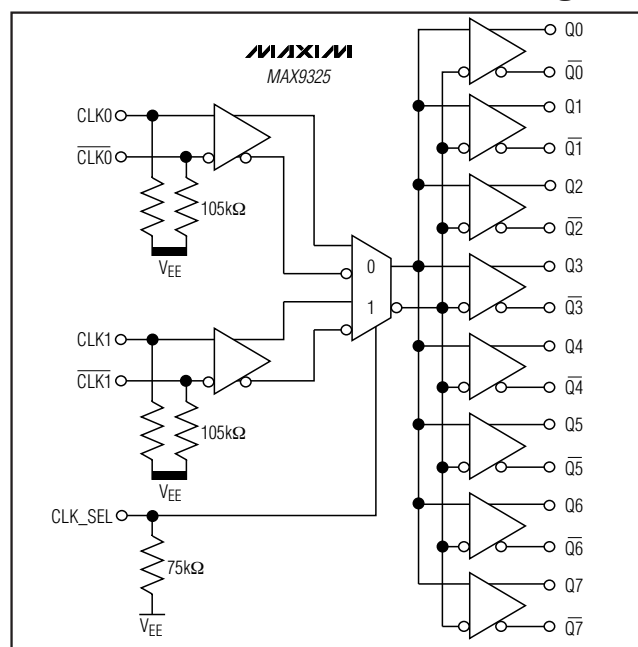
The 28-lead QFN package (MAX9325EG1) has the exposed paddle on the bottom of the package that provides the primary heat removal path from the IC to the PC board, as well as excellent electrical grounding to the PC board. **The MAX9325EG1's exposed pad is internally connected to  $V_{EE}$ . Do not connect the exposed pad to a separate circuit ground plane unless  $V_{EE}$  and the circuit ground are the same.**

### Chip Information

TRANSISTOR COUNT: 1030

PROCESS: Bipolar

### Functional Diagram

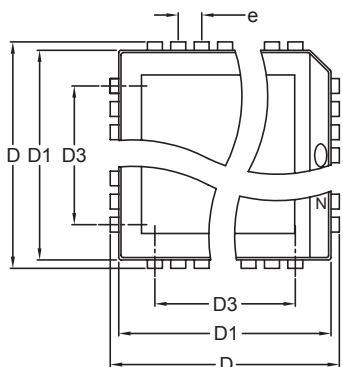


# 2:8 Differential LVPECL/LVECL/HSTL Clock and Data Driver

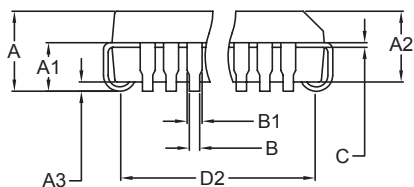
## Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)

MAX9325



|    | INCHES |       | MILLIMETERS |      |
|----|--------|-------|-------------|------|
|    | MIN    | MAX   | MIN         | MAX  |
| A  | 0.165  | 0.180 | 4.20        | 4.57 |
| A1 | 0.090  | 0.120 | 2.29        | 3.04 |
| A2 | 0.145  | 0.156 | 3.69        | 3.96 |
| A3 | 0.020  | ---   | 0.51        | ---  |
| B  | 0.013  | 0.021 | 0.33        | 0.53 |
| B1 | 0.026  | 0.032 | 0.66        | 0.81 |
| C  | 0.009  | 0.011 | 0.23        | 0.28 |
| e  | 0.050  |       | 1.27        |      |



|    | INCHES |       | MILLIMETERS |       | N  | MO047 |
|----|--------|-------|-------------|-------|----|-------|
|    | MIN    | MAX   | MIN         | MAX   |    |       |
| D  | 0.385  | 0.395 | 9.78        | 10.03 | 20 | AA    |
| D1 | 0.350  | 0.356 | 8.89        | 9.04  |    |       |
| D2 | 0.290  | 0.330 | 7.37        | 8.38  |    |       |
| D3 | 0.200  | REF   | 5.08        | REF   |    |       |

|    |       |       |       |       |    |    |
|----|-------|-------|-------|-------|----|----|
| D  | 0.485 | 0.495 | 12.32 | 12.57 | 28 | AB |
| D1 | 0.450 | 0.456 | 11.43 | 11.58 |    |    |
| D2 | 0.390 | 0.430 | 9.91  | 10.92 |    |    |
| D3 | 0.300 | REF   | 7.62  | REF   |    |    |

|    |       |       |       |       |    |    |
|----|-------|-------|-------|-------|----|----|
| D  | 0.685 | 0.695 | 17.40 | 17.65 | 44 | AC |
| D1 | 0.650 | 0.656 | 16.51 | 16.66 |    |    |
| D2 | 0.590 | 0.630 | 14.99 | 16.00 |    |    |
| D3 | 0.500 | REF   | 12.70 | REF   |    |    |

|    |       |       |       |       |    |    |
|----|-------|-------|-------|-------|----|----|
| D  | 0.785 | 0.795 | 19.94 | 20.19 | 52 | AD |
| D1 | 0.750 | 0.756 | 19.05 | 19.20 |    |    |
| D2 | 0.690 | 0.730 | 17.53 | 18.54 |    |    |
| D3 | 0.600 | REF   | 15.24 | REF   |    |    |

|    |       |       |       |       |    |    |
|----|-------|-------|-------|-------|----|----|
| D  | 0.985 | 0.995 | 25.02 | 25.27 | 68 | AE |
| D1 | 0.950 | 0.958 | 24.13 | 24.33 |    |    |
| D2 | 0.890 | 0.930 | 22.61 | 23.62 |    |    |
| D3 | 0.800 | REF   | 20.32 | REF   |    |    |

### NOTES:

1. D1 DOES NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .20mm (.008") PER SIDE.
3. LEADS TO BE COPLANAR WITHIN .10mm.
4. CONTROLLING DIMENSION: MILLIMETER
5. MEETS JEDEC MO047-XX AS SHOWN IN TABLE.
6. N = NUMBER OF PINS.

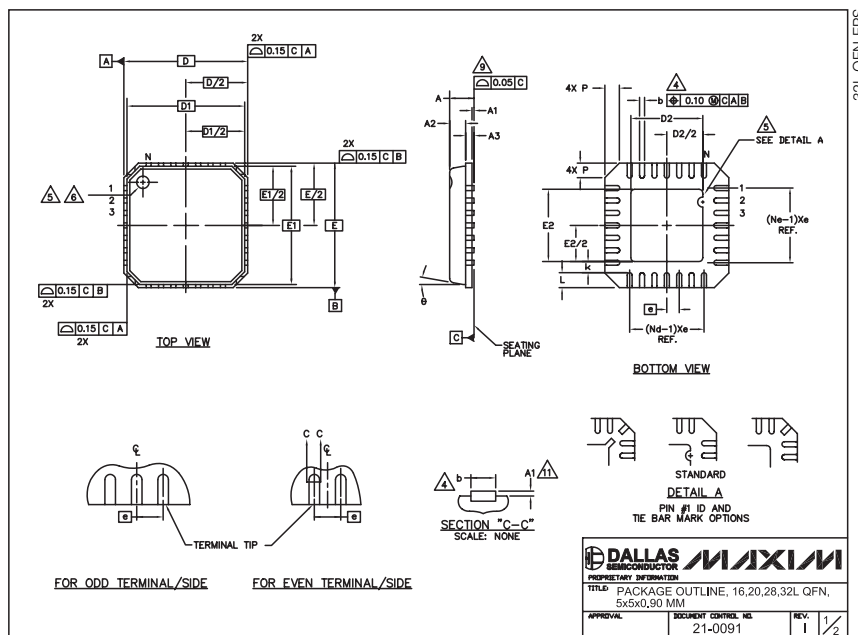
|                                                                                |                                                |
|--------------------------------------------------------------------------------|------------------------------------------------|
|                                                                                |                                                |
| <small>PROPRIETARY INFORMATION</small>                                         |                                                |
| <small>TITLE: FAMILY PACKAGE OUTLINE:<br/>20L, 28L, 44L, 52L, 68L PLCC</small> |                                                |
| <small>APPROVAL</small>                                                        | <small>DOCUMENT CONTROL NO.</small><br>21-0049 |
| <small>REV.</small><br>D                                                       | <small>1</small><br>1                          |

PLCC:EPS

# 2:8 Differential LVPECL/LVECL/HSTL Clock and Data Driver

## Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)



| COMMON DIMENSIONS |          |      |      |          |      |      |          |      |      |          |      |      |
|-------------------|----------|------|------|----------|------|------|----------|------|------|----------|------|------|
| PKG               | 16L 5x5  |      |      | 20L 5x5  |      |      | 28L 5x5  |      |      | 32L 5x5  |      |      |
| SYMBOL            | MIN.     | NOM. | MAX. | MIN.     | NOM. | MAX. | MIN.     | NOM. | MAX. | MIN.     | NOM. | MAX. |
| A                 | 0.80     | 0.90 | 1.00 | 0.80     | 0.90 | 1.00 | 0.80     | 0.90 | 1.00 | 0.80     | 0.90 | 1.00 |
| A1                | 0.00     | 0.01 | 0.05 | 0.00     | 0.01 | 0.05 | 0.00     | 0.01 | 0.05 | 0.00     | 0.01 | 0.05 |
| A2                | 0.00     | 0.65 | 1.00 | 0.00     | 0.65 | 1.00 | 0.00     | 0.65 | 1.00 | 0.00     | 0.65 | 1.00 |
| A3                | 0.20 REF |      |      | 0.20 REF |      |      | 0.20 REF |      |      | 0.20 REF |      |      |
| b                 | 0.28     | 0.33 | 0.40 | 0.23     | 0.28 | 0.35 | 0.18     | 0.23 | 0.30 | 0.18     | 0.23 | 0.30 |
| D                 | 4.90     | 5.00 | 5.10 | 4.90     | 5.00 | 5.10 | 4.90     | 5.00 | 5.10 | 4.90     | 5.00 | 5.10 |
| D1                | 4.75 BSC |      |      | 4.75 BSC |      |      | 4.75 BSC |      |      | 4.75 BSC |      |      |
| E                 | 4.90     | 5.00 | 5.10 | 4.90     | 5.00 | 5.10 | 4.90     | 5.00 | 5.10 | 4.90     | 5.00 | 5.10 |
| E1                | 4.75 BSC |      |      | 4.75 BSC |      |      | 4.75 BSC |      |      | 4.75 BSC |      |      |
| e                 | 0.80 BSC |      |      | 0.65 BSC |      |      | 0.50 BSC |      |      | 0.50 BSC |      |      |
| k                 | 0.25     | —    | —    | 0.25     | —    | —    | 0.25     | —    | —    | 0.25     | —    | —    |
| L                 | 0.35     | 0.55 | 0.75 | 0.35     | 0.55 | 0.75 | 0.35     | 0.55 | 0.75 | 0.30     | 0.40 | 0.50 |
| N                 | 16       |      |      | 20       |      |      | 28       |      |      | 32       |      |      |
| ND                | 4        |      |      | 5        |      |      | 7        |      |      | 8        |      |      |
| NE                | 4        |      |      | 5        |      |      | 7        |      |      | 8        |      |      |
| P                 | 0.00     | 0.42 | 0.60 | 0.00     | 0.42 | 0.60 | 0.00     | 0.42 | 0.60 | 0.00     | 0.42 | 0.60 |
| θ                 | 0°       |      | 12°  | 0°       |      | 12°  | 0°       |      | 12°  | 0°       |      | 12°  |

| EXPOSED PAD VARIATIONS |      |      |      |      |      |      |  |  |
|------------------------|------|------|------|------|------|------|--|--|
| PKG CODES              | B2   |      |      | E2   |      |      |  |  |
| G1655-3                | 2.95 | 3.10 | 3.25 | 2.95 | 3.10 | 3.25 |  |  |
| G2855-1                | 2.95 | 2.70 | 2.85 | 2.95 | 2.70 | 2.85 |  |  |
| G2855-2                | 2.95 | 3.10 | 3.25 | 2.95 | 3.10 | 3.25 |  |  |
| G2855-1                | 2.95 | 2.70 | 2.85 | 2.95 | 2.70 | 2.85 |  |  |
| G2855-2                | 2.95 | 3.10 | 3.25 | 2.95 | 3.10 | 3.25 |  |  |
| G3255-1                | 2.95 | 3.10 | 3.25 | 2.95 | 3.10 | 3.25 |  |  |

NOTES:

- DIE THICKNESS ALLOWABLE IS 0.305mm MAXIMUM (.012 INCHES MAXIMUM)
- DIMENSIONING & TOLERANCES CONFORM TO ASME Y14.5M, — 1994.
- N IS THE NUMBER OF TERMINALS.
- ND IS THE NUMBER OF TERMINALS IN X-DIRECTION & Ne IS THE NUMBER OF TERMINALS IN Y-DIRECTION.
- DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.20 AND 0.25mm FROM TERMINAL TIP.
- THE PIN #1 IDENTIFIER MUST BE EXISTED ON THE TOP SURFACE OF THE PACKAGE BY USING INDENTATION MARK OR INK/LASER MARKED. DETAILS OF PIN #1 IDENTIFIER IS OPTIONAL, BUT MUST BE LOCATED WITHIN ZONE INDICATED.
- EXACT SHAPE AND SIZE OF THIS FEATURE IS OPTIONAL.
- ALL DIMENSIONS ARE IN MILLIMETERS.
- PACKAGE WARPAGE MAX 0.05mm.
- APPLIED FOR EXPOSED PAD AND TERMINALS. EXCLUDE EMBEDDED PART OF EXPOSED PAD FROM MEASURING.
- MEETS JEDEC MO220; EXCEPT DIMENSION "b".
- APPLIED FOR EXPOSED PAD AND TERMINALS. EXCLUDE EMBEDDING PART OF EXPOSED PAD FROM MEASURING.
- THIS PACKAGE OUTLINE APPLIES TO ANVIL SINGULATION (STEPPED SIDES).

DALLAS MAXIM SEMICONDUCTOR

PROPRIETARY INFORMATION

TITLE: PACKAGE OUTLINE, 16,20,28,32L QFN, 5x5x0,90 MM

APPROVAL: 21-0091

DOCUMENT CONTROL: 21-0091

REV: 1

1/2

Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

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