

## Description

The 8P791208 is a low additive jitter 2:8 buffer with CMOS/differential outputs. The device takes one or two reference clocks, selects between them using a pin selection, and generates up to eight outputs that are the same as the reference frequency.

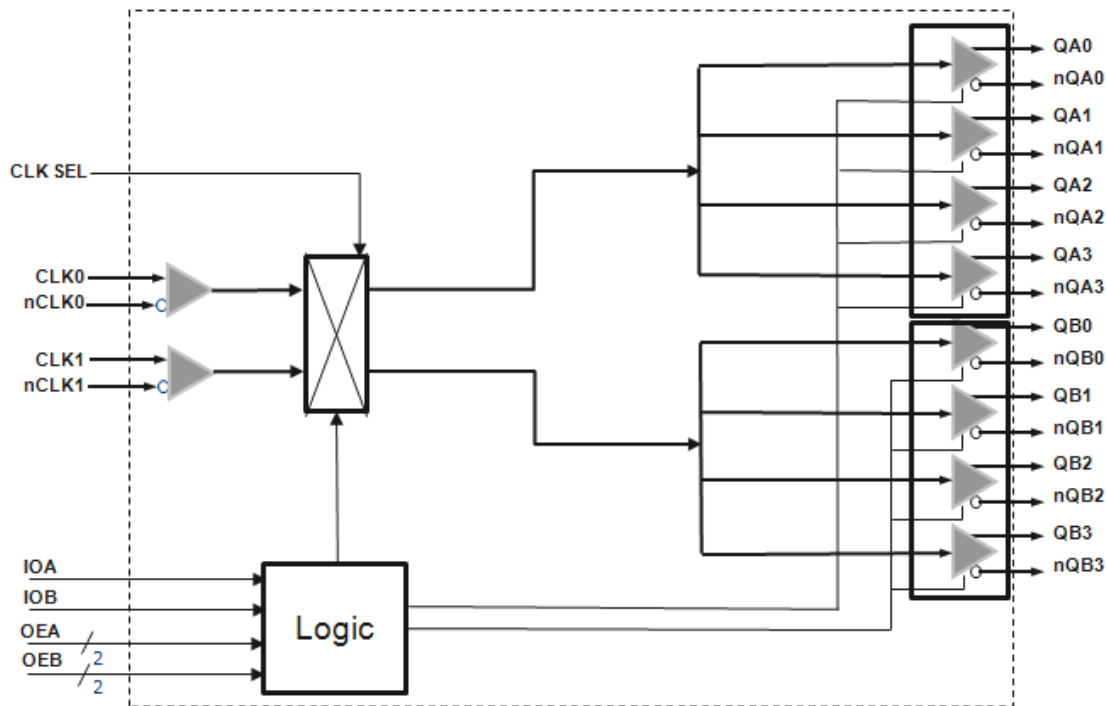
The 8P791208 supports two output banks, each with its own power supply. All outputs in one bank would generate the same output frequency, but each output can be individually controlled for output type or output enable.

The device can operate over the -40°C to 85°C temperature range.

## Features

- Accepts input frequencies ranging from 1PPS (1Hz) to 700MHz
- Two differential inputs support LVPECL, LVDS, LVHSTL, HCSL, or LVCMOS reference clocks
- Generates 8 differential or 16 LVCMOS outputs
- Outputs arranged in two banks of four outputs each
- Select pins control which input drives which of two output banks
- Controlled by 3-level input pins that are 3.3V tolerant for all core voltages
- Output type may be selected from LVPEC, LVDS or 2xLVCMOS
- Each bank supports a separate power supply of 3.3V, 2.5V, or 1.8V
- LVCMOS outputs are limited to 125MHz maximum and support swings of 3.3V, 2.5V, 1.8V, and 1.5V
- Individual output enables and output type selection supported
- Output noise floor of -158dBc/Hz at 156.25MHz
- Core voltage supply of 3.3V, 2.5V, or 1.8V
- -40°C to 85°C ambient operating temperature
- Lead-free (RoHS 6) QFN-32 (5 × 5mm) packaging

## Block Diagram



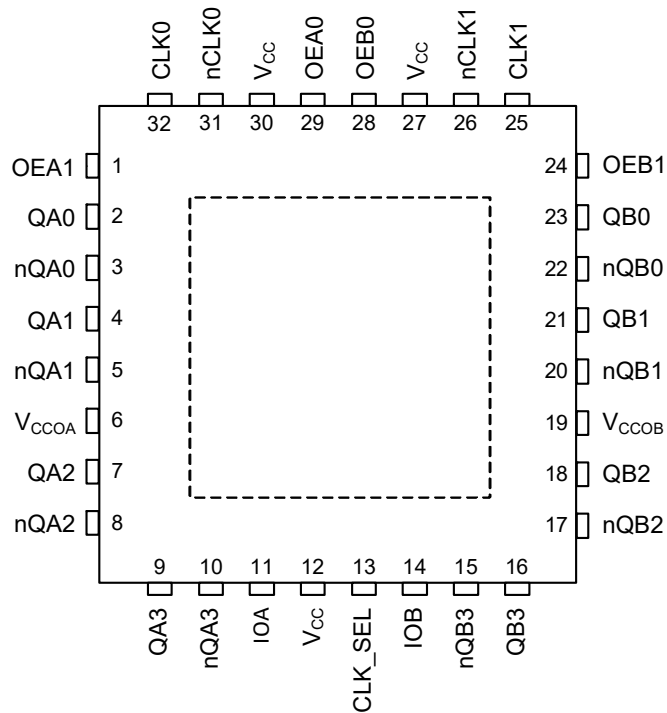
8P791208 transistor count: 9,703

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## Pin Assignments

**Figure 1. Pin Assignment for 5mm × 5mm VFQFN Package – Top View**



## Pin Descriptions

**Table 1. Pin Description**

| Number | Name              | Type <sup>[a]</sup> | Description   |
|--------|-------------------|---------------------|---|
| 1      | OEA1              | Input (PU)          | Controls output enable functions for Bank A. LVCMOS/LVTTL input levels.   |
| 2      | QA0               | Output              | Positive differential clock output. Included in Bank A. Refer to <a href="#">Output Drivers</a> for additional details. |
| 3      | nQA0              | Output              | Negative differential clock output. Included in Bank A. Refer to <a href="#">Output Drivers</a> for additional details. |
| 4      | QA1               | Output              | Positive differential clock output. Included in Bank A. Refer to <a href="#">Output Drivers</a> for additional details. |
| 5      | nQA1              | Output              | Negative differential clock output. Included in Bank A. Refer to <a href="#">Output Drivers</a> for additional details. |
| 6      | V <sub>CCOA</sub> | Power               | Output voltage supply for output Bank A.  |
| 7      | QA2               | Output              | Positive differential clock output. Included in Bank A. Refer to <a href="#">Output Drivers</a> for additional details. |
| 8      | nQA2              | Output              | Negative differential clock output. Included in Bank A. Refer to <a href="#">Output Drivers</a> for additional details. |
| 9      | QA3               | Output              | Positive differential clock output. Included in Bank A. Refer to <a href="#">Output Drivers</a> for additional details. |
| 10     | nQA3              | Output              | Negative differential clock output. Included in Bank A. Refer to <a href="#">Output Drivers</a> for additional details. |

**Table 1. Pin Description (Cont.)**

| Number | Name              | Type <sup>[a]</sup> | Description  |
|--------|-------------------|---------------------|--|
| 11     | IOA               | Input (PU/PD)       | Controls output mode functions for Bank A. 3-level input.  |
| 12     | V <sub>CC</sub>   | Power               | Core Logic voltage supply.   |
| 13     | CLK_SEL           | Input (PU/PD)       | Input Clock Selection Control pin. 3-level input. This pin's function is described in the Input Selection section.               |
| 14     | IOB               | Input (PU/PD)       | Controls output mode functions for Bank B. 3-level input.  |
| 15     | nQB3              | Output              | Negative differential clock output. Included in Bank B. Refer to <a href="#">Output Drivers</a> for additional details.          |
| 16     | QB3               | Output              | Positive differential clock output. Included in Bank B. Refer to <a href="#">Output Drivers</a> for additional details.          |
| 17     | nQB2              | Output              | Negative differential clock output. Included in Bank B. Refer to <a href="#">Output Drivers</a> for additional details.          |
| 18     | QB2               | Output              | Positive differential clock output. Included in Bank B. Refer to <a href="#">Output Drivers</a> for additional details.          |
| 19     | V <sub>CCOB</sub> | Power               | Output voltage supply for Output Bank B.   |
| 20     | nQB1              | Output              | Negative differential clock output. Included in Bank B. Refer to <a href="#">Output Drivers</a> for additional details.          |
| 21     | QB1               | Output              | Positive differential clock output. Included in Bank B. Refer to <a href="#">Output Drivers</a> for additional details.          |
| 22     | nQB0              | Output              | Negative differential clock output. Included in Bank B. Refer to <a href="#">Output Drivers</a> for additional details.          |
| 23     | QB0               | Output              | Positive differential clock output. Included in Bank B. Refer to <a href="#">Output Drivers</a> for additional details.          |
| 24     | OEB1              | Input (PU)          | Controls output enable functions for Bank B. LVCMOS/LVTTL input levels.  |
| 25     | CLK1              | Input (PD)          | Non-inverting differential clock input.  |
| 26     | nCLK1             | Input (PU/PD)       | Inverting differential clock input. V <sub>CC</sub> /2 when left floating (set by the internal pull-up and pulldown resistors).  |
| 27     | V <sub>CC</sub>   | Power               | Core Logic voltage supply.   |
| 28     | OEB0              | Input (PU)          | Controls output enable functions for Bank B. LVCMOS/LVTTL input levels.  |
| 29     | OEA0              | Input (PU)          | Controls output enable functions for Bank A. LVCMOS/LVTTL input levels.  |
| 30     | V <sub>CC</sub>   | Power               | Core Logic voltage supply.   |
| 31     | nCLK0             | Input (PU/PD)       | Inverting differential clock input. V <sub>CC</sub> /2 when left floating (set by the internal pull-up and pull-down resistors). |
| 32     | CLK0              | Input (PD)          | Non-inverting differential clock input.  |
| EP     | Exposed Pad       | Ground              | Must be connected to GND.  |

[a] Pull-up (PU) and pull-down (PD) resistors are indicated in parentheses. *Pull-up* and *pull-down* refers to internal input resistors. See [Table 10, DC Input Characteristics](#), for typical values.

## Principles of Operation

### Input Selection

The 8P791208 supports two input references: CLK0 and CLK1 that may be driven with differential or single-ended clock signals. Either may be used as the source frequency for either or both output banks under control of the CLK\_SEL input pin.

**Table 2. Input Selection Control**

| CLK_SEL               | Description                                       |
|-----------------------|---|
| High                  | Banks A and B both driven from CLK1               |
| Middle <sup>[a]</sup> | Bank A driven from CLK0 & Bank B driven from CLK1 |
| Low                   | Banks A and B both driven from CLK0               |

[a] A 'middle' voltage level is defined in [Table 11](#). Leaving the input pin open will also generate this level via a weak internal resistor network.

### Output Drivers

The QA[0:3] and QB[0:3] clock outputs are provided with pin-controlled output drivers. The following table shows how each bank can be controlled. Each bank is separately controlled and all outputs within a single bank will behave the same way.

**Table 3. Output Mode Control**

| IOx    | Output Bank Mode Function          |
|--------|------------------------------------|
| High   | All outputs in the bank are LVDS   |
| Middle | All outputs in the bank are LVPECL |
| Low    | All outputs in the bank are LVCMOS |

The operating voltage ranges of each output is determined by its independent output power pin ( $V_{CCOA}$  or  $V_{CCOB}$ ) and thus each can have different output voltage levels. Output voltage levels of 1.8V, 2.5V or 3.3V are supported for differential operation and LVCMOS operation. In addition, LVCMOS output operation supports 1.5V  $V_{CCO}$ .

### LVCMOS Operation

When a given output is configured to provide LVCMOS levels, then both the Q and nQ outputs will toggle at the selected output frequency. All the previously described configuration and control apply equally to both outputs. Frequency, voltage levels and enable / disable status apply to both the Q and nQ pins. When configured as LVCMOS, the Q & nQ outputs are in-phase relative to one another.

## Output Enable Control

The 8P791208 has separate pins that control the output enable behavior for each bank as shown in the following table.

**Table 4. Output Enable Control**

| OEx1 | OEx0 | Output Enable Function |      |      |      |
|------|------|------------------------|------|------|------|
|      |      | Qx3                    | Qx2  | Qx1  | Qx0  |
| High | High | On                     | On   | On   | On   |
| High | Low  | Hi-Z                   | Hi-Z | On   | On   |
| Low  | High | On                     | On   | Hi-Z | Hi-Z |
| Low  | Low  | Hi-Z                   | Hi-Z | Hi-Z | Hi-Z |

## Absolute Maximum Ratings

NOTE: The absolute maximum ratings are stress ratings only. Stresses greater than those listed below can cause permanent damage to the device. Functional operation of the 8P79208 at absolute maximum ratings is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

**Table 5. Absolute Maximum Ratings**

| Item   | Rating                                    |
|--|---|
| Supply Voltage, $V_{CCX}$ <sup>[a]</sup> to GND  | 3.63V                                     |
| Inputs OEA[1:0], OEB[1:0], IOA, IOB, CLK_SEL, CLK0, nCLK0, CLK1, nCLK1                     | -0.5V to $V_{CC} + 0.5V$                  |
| Outputs, $I_O$ QA[0:3], nQA[0:3]; QB[0:3], nQB[0:3]<br>Continuous Current<br>Surge Current | 40mA<br>60mA                              |
| Outputs, $V_O$ QA[0:3], nQA[0:3]; QB[0:3], nQB[0:3]  | -0.5V to $V_{CCOX}$ <sup>[b]</sup> + 0.5V |
| Maximum Junction Temperature   | 125°C                                     |
| Storage Temperature, $T_{STG}$   | -65°C to 150°C                            |
| Lead Temperature (Soldering, 10s)  | +260°C                                    |

[a]  $V_{CCX}$  denotes  $V_{CC}$ ,  $V_{CCOA}$ , or  $V_{CCOB}$ .

[b]  $V_{CCOX}$  denotes  $V_{CCOA}$  or  $V_{CCOB}$ .

## Supply Voltage Characteristics

**Table 6. Power Supply Characteristics,  $V_{CC} = V_{CCOA} = V_{CCOB} = 3.3V \pm 5\%$ ,  $V_{EE} = 0V$ ,  $T_A = -40^{\circ}C$  to  $85^{\circ}C$**

| Symbol                     | Parameter                            | Test Conditions   | Minimum | Typical | Maximum  | Units |
|----------------------------|--------------------------------------|---|---------|---------|----------|-------|
| $V_{CC}$                   | Core supply voltage                  |   | 3.135   | 3.3     | 3.465    | V     |
| $V_{CCOA}$ ,<br>$V_{CCOB}$ | Output supply voltage                |   | 3.135   | 3.3     | $V_{CC}$ | V     |
| $I_{CC}$                   | Core supply current                  | Device configured for LVDS logic levels                           |         | 22      | 25       | mA    |
| $I_{CCOX}$                 | Output supply current <sup>[a]</sup> | All outputs configured for LVDS logic levels;<br>outputs unloaded |         | 136     | 153      | mA    |

[a] Internal dynamic switching current at maximum  $f_{OUT}$  is included.

**Table 7. Power Supply Characteristics,  $V_{CC} = V_{CCOA} = V_{CCOB} = 2.5V \pm 5\%$ ,  $V_{EE} = 0V$ ,  $T_A = -40^{\circ}C$  to  $85^{\circ}C$**

| Symbol                     | Parameter                            | Test Conditions   | Minimum | Typical | Maximum  | Units |
|----------------------------|--------------------------------------|---|---------|---------|----------|-------|
| $V_{CC}$                   | Core supply voltage                  |   | 2.375   | 2.5     | 2.625    | V     |
| $V_{CCOA}$ ,<br>$V_{CCOB}$ | Output supply voltage                |   | 2.375   | 2.5     | $V_{CC}$ | V     |
| $I_{CC}$                   | Core supply current                  | Device configured for LVDS logic levels                           |         | 21      | 24       | mA    |
| $I_{CCOX}$                 | Output supply current <sup>[a]</sup> | All outputs configured for LVDS logic levels;<br>outputs unloaded |         | 135     | 151      | mA    |

[a] Internal dynamic switching current at maximum  $f_{OUT}$  is included.

**Table 8. Power Supply Characteristics,  $V_{CC} = V_{CCOA} = V_{CCOB} = 1.8V \pm 5\%$ ,  $V_{EE} = 0V$ ,  $T_A = -40^{\circ}C$  to  $85^{\circ}C$**

| Symbol                     | Parameter                            | Test Conditions   | Minimum | Typical | Maximum  | Units |
|----------------------------|--------------------------------------|---|---------|---------|----------|-------|
| $V_{CC}$                   | Core supply voltage                  |   | 1.71    | 1.8     | 1.89     | V     |
| $V_{CCOA}$ ,<br>$V_{CCOB}$ | Output supply voltage                |   | 1.71    | 1.8     | $V_{CC}$ | V     |
| $I_{CC}$                   | Core supply current                  | Device configured for LVDS logic levels                           |         | 18      | 20       | mA    |
| $I_{CCOX}$                 | Output supply current <sup>[a]</sup> | All outputs configured for LVDS logic levels;<br>outputs unloaded |         | 122     | 137      | mA    |

[a] Internal dynamic switching current at maximum  $f_{OUT}$  is included.

**Table 9. Typical Output Supply Current,  $V_{CCOA} = V_{CCOB} = 3.3V \pm 5\%$ ,  $2.5V \pm 5\%$  or  $1.8V \pm 5\%$ ,  $V_{EE} = 0V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$**

| Symbol     | Parameter <sup>[a]</sup>     | Test Conditions <sup>[b]</sup> | $V_{CCOx}^{[c]} = 3.3V \pm 5\%$ |        |         | $V_{CCOx}^{[c]} = 2.5V \pm 5\%$ |        |         | $V_{CCOx}^{[c]} = 1.8V \pm 5\%$ |        |         | $V_{CCOx}^{[c]} = 1.5V \pm 5\%$ | Units |
|------------|------------------------------|--------------------------------|---------------------------------|--------|---------|---------------------------------|--------|---------|---------------------------------|--------|---------|---------------------------------|-------|
|            |                              |                                | LVDS                            | LVPECL | LVC MOS | LVDS                            | LVPECL | LVC MOS | LVDS                            | LVPECL | LVC MOS | LVC MOS                         |       |
| $I_{CCOB}$ | Bank B output supply current | All outputs enabled            | 77                              | 52     | 46      | 76                              | 51     | 27      | 69                              | 46     | 25      | 21                              | mA    |
|            |                              | 2 outputs enabled              | 49                              | 37     | 41      | 49                              | 34     | 25      | 49                              | 32     | 20      | 17                              | mA    |
|            |                              | No outputs enabled             | 42                              | 23     | 40      | 36                              | 19     | 21      | 28                              | 32     | 20      | 17                              | mA    |
| $I_{CCOA}$ | Bank A output supply current | All outputs enabled            | 77                              | 52     | 46      | 76                              | 51     | 27      | 69                              | 46     | 25      | 21                              | mA    |
|            |                              | 2 outputs enabled              | 49                              | 37     | 41      | 49                              | 34     | 25      | 49                              | 32     | 20      | 17                              | mA    |
|            |                              | No outputs enabled             | 42                              | 23     | 40      | 36                              | 19     | 21      | 28                              | 32     | 20      | 17                              | mA    |

[a] Internal dynamic switching current at maximum  $f_{OUT}$  is included.

[b] Tested with outputs unloaded.

[c]  $V_{CCOx}$  denotes  $V_{CCOA}$ ,  $V_{CCOB}$ .



## DC Electrical Characteristics

**Table 10. Pin Characteristics**

| Symbol                | Parameter   |                                      | Test Conditions <sup>[a]</sup>                               | Minimum                             | Typical | Maximum | Units |
|-----------------------|---|--------------------------------------|--|-------------------------------------|---------|---------|-------|
| C <sub>IN</sub>       | Input capacitance   |                                      |  |                                     | 2       |         | pF    |
| R <sub>PULLUP</sub>   | Input pull-up resistor  |                                      |  |                                     | 51      |         | kΩ    |
| R <sub>PULLDOWN</sub> | Input pull-down resistor  |                                      |  |                                     | 51      |         | kΩ    |
| R <sub>OUT</sub>      | Output impedance  | QA[3:0], nQA[3:0], QB[3:0], nQB[3:0] | LVC MOS output type selected<br>V <sub>CCOx</sub> = 3.3V ±5% |                                     | 24      |         | Ω     |
|                       |   |                                      | LVC MOS output type selected<br>V <sub>CCOx</sub> = 2.5V ±5% |                                     | 15      |         | Ω     |
|                       |   |                                      | LVC MOS output type selected<br>V <sub>CCOx</sub> = 1.8V ±5% |                                     | 25      |         | Ω     |
|                       |   |                                      | LVC MOS output type selected<br>V <sub>CCOx</sub> = 1.5V ±5% |                                     | 48      |         | Ω     |
| C <sub>PD</sub>       | Power dissipation capacitance (per output pair)<br>QA[3:0], nQA[3:0], QB[3:0], nQB[3:0] | LVPECL                               | V <sub>CCOx</sub> = 3.465V or 2.625V                         |                                     | 4.2     |         | pF    |
|                       |   | LVDS                                 |  |                                     |         |         |       |
|                       |   | LVC MOS                              |  |                                     | 5.8     |         | pF    |
|                       |   | LVPECL                               | V <sub>CCOx</sub> = 1.89V                                    |                                     | 4.7     |         | pF    |
|                       |   | LVDS                                 |  |                                     |         |         |       |
|                       |   | LVC MOS                              |  | V <sub>CCOx</sub> = 1.89V or 1.545V |         | 5.2     |       |

[a] V<sub>CCOx</sub> refers to V<sub>CCOA</sub> for QA[3:0], nQA[3:0], or V<sub>CCOB</sub> for QB[3:0], nQB[3:0].

**Table 11. LVC MOS/LVTTL Control / Status Signals DC Characteristics for 3-level Pins, V<sub>EE</sub> = 0V, T<sub>A</sub> = -40°C to 85°C**

| Symbol          | Parameter                           | Signals                                 | Test Conditions        | Minimum                | Typical | Maximum                | Units |
|-----------------|-------------------------------------|---|------------------------|------------------------|---------|------------------------|-------|
| V <sub>IH</sub> | Input high voltage                  | IOA, IOB, CLK_SEL                       | V <sub>CC</sub> = 3.3V | 0.85 * V <sub>CC</sub> |         | 3.63                   | V     |
|                 |                                     |   | V <sub>CC</sub> = 2.5V | 0.85 * V <sub>CC</sub> |         | 2.625                  | V     |
|                 |                                     |   | V <sub>CC</sub> = 1.8V | 0.85 * V <sub>CC</sub> |         | 1.89                   | V     |
| V <sub>IM</sub> | Input middle voltage <sup>[a]</sup> | IOA, IOB, CLK_SEL                       | V <sub>CC</sub> = 3.3V | 0.45 * V <sub>CC</sub> |         | 0.55 * V <sub>CC</sub> | V     |
|                 |                                     |   | V <sub>CC</sub> = 2.5V | 0.45 * V <sub>CC</sub> |         | 0.55 * V <sub>CC</sub> | V     |
|                 |                                     |   | V <sub>CC</sub> = 1.8V | 0.45 * V <sub>CC</sub> |         | 0.55 * V <sub>CC</sub> | V     |
| V <sub>IL</sub> | Input low voltage                   | OEA[1:0], OEB[1:0]<br>IOA, IOB, CLK_SEL | V <sub>CC</sub> = 3.3V | -0.3                   |         | 0.15 * V <sub>CC</sub> | V     |
|                 |                                     |   | V <sub>CC</sub> = 2.5V | -0.3                   |         | 0.15 * V <sub>CC</sub> | V     |
|                 |                                     |   | V <sub>CC</sub> = 1.8V | -0.3                   |         | 0.15 * V <sub>CC</sub> | V     |

**Table 11. LVCMOS/LVTTL Control / Status Signals DC Characteristics for 3-level Pins,  $V_{EE} = 0V$ ,  $T_A = -40^{\circ}C$  to  $85^{\circ}C$**

| Symbol   | Parameter            | Signals                                 | Test Conditions   | Minimum | Typical | Maximum | Units   |
|----------|----------------------|---|---|---------|---------|---------|---------|
| $I_{IH}$ | Input high current   | IOA, IOB, CLK_SEL                       | $V_{CC} = V_{IN} = 3.465V$ or $2.625V$ or $1.89V$                   |         |         | 150     | $\mu A$ |
| $I_{IM}$ | Input middle current | IOA, IOB, CLK_SEL                       | $V_{CC} = 3.465V$ or $2.625V$ or $1.89V$ ,<br>$V_{IN} = V_{CC} / 2$ |         |         |         | $\mu A$ |
| $I_{IL}$ | Input low current    | OEA[1:0], OEB[1:0]<br>IOA, IOB, CLK_SEL | $V_{CC} = 3.465V$ or $2.625V$ or $1.89V$ ,<br>$V_{IN} = 0V$         | -150    |         |         | $\mu A$ |

[a] For 3-level input pins, a mid-level voltage is used to select the 3<sup>rd</sup> state. This voltage will be maintained by a weak internal pull-up / pull-down network for each pin to select this state if the pin is left open. It is recommended that any external resistor networks used to select a middle-level input voltage be terminated to the device's core  $V_{CC}$  voltage level.

**Table 12. LVCMOS/LVTTL Control / Status Signals DC Characteristics for 2-Level Pins,  $V_{EE} = 0V$ ,  $T_A = -40^{\circ}C$  to  $85^{\circ}C$**

| Symbol   | Parameter          | Signals            | Test Conditions                                   | Minimum         | Typical | Maximum         | Units   |
|----------|--------------------|--------------------|---|-----------------|---------|-----------------|---------|
| $V_{IH}$ | Input high voltage | OEA[1:0], OEB[1:0] | $V_{CC} = 3.3V$                                   | 2               |         | 3.63            | V       |
|          |                    |                    | $V_{CC} = 2.5V$                                   | 1.7             |         | 2.625           | V       |
|          |                    |                    | $V_{CC} = 1.8V$                                   | $0.65 * V_{CC}$ |         | 1.89            | V       |
| $V_{IL}$ | Input low voltage  | OEA[1:0], OEB[1:0] | $V_{CC} = 3.3V$                                   | -0.3            |         | 0.8             | V       |
|          |                    |                    | $V_{CC} = 2.5V$                                   | -0.3            |         | 0.7             | V       |
|          |                    |                    | $V_{CC} = 1.8V$                                   | -0.3            |         | $0.35 * V_{CC}$ | V       |
| $I_{IH}$ | Input high current | OEA[1:0], OEB[1:0] | $V_{CC} = V_{IN} = 3.465V$ or $2.625V$ or $1.89V$ |                 |         | 150             | $\mu A$ |
| $I_{IL}$ | Input low current  | OEA[1:0], OEB[1:0] | $V_{CC} = V_{IN} = 3.465V$ or $2.625V$ or $1.89V$ | -150            |         |                 | $\mu A$ |

**Table 13. Differential Input DC Characteristics,  $V_{CC} = 3.3V \pm 5\%$ ,  $2.5V \pm 5\%$  or  $1.8V \pm 5\%$ ,  $V_{EE} = 0V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$**

| Symbol    | Parameter                                     | Test Conditions  | Minimum                                       | Typical | Maximum        | Units   |
|-----------|---|--|---|---------|----------------|---------|
| $I_{IH}$  | Input high current                            | CLKx, nCLKx <sup>[a]</sup><br>$V_{CC} = V_{IN} = 3.465V$ or $2.625V$ |   |         | 150            | $\mu A$ |
| $I_{IL}$  | Input low current                             | CLKx <sup>[a]</sup>  | $V_{CC} = 3.465V$ or $2.625V$ , $V_{IN} = 0V$ | -5      |                | $\mu A$ |
|           |   | nCLKx <sup>[a]</sup>   | $V_{CC} = 3.465V$ or $2.625V$ , $V_{IN} = 0V$ | -150    |                | $\mu A$ |
| $V_{PP}$  | Peak-to-peak voltage <sup>[b]</sup>           |  | 0.15  |         | 1.3            | V       |
| $V_{CMR}$ | Common mode input voltage <sup>[b], [c]</sup> |  | $V_{EE}$                                      |         | $V_{CC} - 1.2$ | V       |

[a] CLKx denotes CLK0, CLK1. nCLKx denotes nCLK0, nCLK1.

[b]  $V_{IL}$  should not be less than  $-0.3V$ .  $V_{IH}$  should not be higher than  $V_{CC}$ .

[c] Common mode voltage is defined as the cross-point.

**Table 14. LVPECL DC Characteristics,  $V_{CC} = 3.3V \pm 5\%$ ,  $2.5V \pm 5\%$  or  $1.8V \pm 5\%$ ,  $V_{EE} = 0V$ ,  $T_A = -40^\circ C$  to  $+85^\circ C$**

| Symbol   | Parameter           | Test Conditions | Min               | Typ | Max               | Unit |
|----------|---------------------|-----------------|-------------------|-----|-------------------|------|
| $V_{OH}$ | Output High Voltage | Qx, nQx         | $V_{CCOX} - 1.3$  |     | $V_{CCOX} - 0.8$  | mV   |
| $V_{OL}$ | Output Low Voltage  | Qx, nQx         | $V_{CCOX} - 2.05$ |     | $V_{CCOX} - 1.75$ | mV   |

**Table 15. LVDS DC Characteristics,  $V_{CC} = 3.3V \pm 5\%$ ,  $2.5V \pm 5\%$  or  $1.8V \pm 5\%$ ,  $V_{CCOX}^{[a]} = 3.3V \pm 5\%$ ,  $V_{EE} = 0V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$**

| Symbol          | Parameter                   | Test Conditions                          | Minimum | Typical | Maximum | Units |
|-----------------|-----------------------------|--|---------|---------|---------|-------|
| $V_{OD}$        | Differential output voltage | Terminated $100\Omega$ across Qx and nQx | 247     |         | 465     | mV    |
| $\Delta V_{OD}$ | $V_{OD}$ magnitude change   |  |         |         | 50      | mV    |
| $V_{OS}$        | Offset voltage              |  | 1.1     |         | 1.375   | V     |
| $\Delta V_{OS}$ | $V_{OS}$ magnitude change   |  |         |         | 50      | mV    |

[a]  $V_{CCOX}$  denotes  $V_{CCOA}$ ,  $V_{CCOB}$ .

[b] Qx denotes QA0, QA1, QA2, QA3, QB0, QB1, QB2, QB3.

nQx denotes nQA0, nQA1, nQA2, nQA3, nQB0, nQB1, nQB2, nQB3.

**Table 16. LVDS DC Characteristics,  $V_{CC} = 3.3V \pm 5\%$ ,  $2.5V \pm 5\%$  or  $1.8V \pm 5\%$ ,  $V_{CCOX}^{[a]} = 2.5V \pm 5\%$ ,  $V_{EE} = 0V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$**

| Symbol          | Parameter                   | Test Conditions                          | Minimum | Typical | Maximum | Units |
|-----------------|-----------------------------|--|---------|---------|---------|-------|
| $V_{OD}$        | Differential output voltage | Terminated $100\Omega$ across Qx and nQx | 247     |         | 465     | mV    |
| $\Delta V_{OD}$ | $V_{OD}$ magnitude change   |  |         |         | 50      | mV    |
| $V_{OS}$        | Offset voltage              |  | 1.1     |         | 1.375   | V     |
| $\Delta V_{OS}$ | $V_{OS}$ magnitude change   |  |         |         | 50      | mV    |

[a]  $V_{CCOX}$  denotes  $V_{CCOA}$ ,  $V_{CCOB}$ .

[b] Qx denotes QA0, QA1, QA2, QA3, QB0, QB1, QB2, QB3.

nQx denotes nQA0, nQA1, nQA2, nQA3, nQB0, nQB1, nQB2, nQB3.

**Table 17. LVDS DC Characteristics,  $V_{CC} = 3.3V \pm 5\%$ ,  $2.5V \pm 5\%$  or  $1.8V \pm 5\%$ ,  $V_{CCOx}^{[a]} = 1.8V \pm 5\%$ ,  $V_{EE} = 0V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$**

| Symbol          | Parameter                   |                 | Test Conditions                                    | Minimum | Typical | Maximum | Units |
|-----------------|-----------------------------|-----------------|--|---------|---------|---------|-------|
| $V_{OD}$        | Differential output voltage | $Qx, nQx^{[b]}$ | Terminated $100\Omega$<br>across<br>$Qx$ and $nQx$ | 247     |         | 454     | mV    |
| $\Delta V_{OD}$ | $V_{OD}$ magnitude change   | $Qx, nQx^{[b]}$ |  |         |         | 50      | mV    |
| $V_{OS}$        | Offset voltage              | $Qx, nQx^{[b]}$ |  | 1.1     |         | 1.375   | V     |
| $\Delta V_{OS}$ | $V_{OS}$ magnitude change   | $Qx, nQx^{[b]}$ |  |         |         | 50      | mV    |

[a]  $V_{CCOx}$  denotes  $V_{CCOA}$ ,  $V_{CCOB}$ .

[b]  $Qx$  denotes  $QA0, QA1, QA2, QA3, QB0, QB1, QB2, QB3$ .

$nQx$  denotes  $nQA0, nQA1, nQA2, nQA3, nQB0, nQB1, nQB2, nQB3$ .

**Table 18. LVC MOS Clock Outputs DC Characteristics,  $V_{CCOx}^{[a]} = 3.3V \pm 5\%$ ,  $2.5V \pm 5\%$  or  $1.8V \pm 5\%$ ,  $V_{EE} = 0V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$**

| Symbol   | Parameter                              | Test Conditions | $V_{CCOx}^{[a]} = 3.3V \pm 5\%$ |     |     | $V_{CCOx}^{[a]} = 2.5V \pm 5\%$ |     |     | $V_{CCOx}^{[a]} = 1.8V \pm 5\%$ |     |      | $V_{CCOx}^{[a]} = 1.5V \pm 5\%$ |     |      | Units |
|----------|--|-----------------|---------------------------------|-----|-----|---------------------------------|-----|-----|---------------------------------|-----|------|---------------------------------|-----|------|-------|
|          |  |                 | Min                             | Typ | Max | Min                             | Typ | Max | Min                             | Typ | Max  | Min                             | Typ | Max  |       |
| $V_{OH}$ | Output high voltage<br>$Qx, nQx^{[b]}$ | $I_{OH} = -8mA$ | 2.4                             |     |     | 1.8                             |     |     | $V_{CC} - 0.45$                 |     |      | $V_{CC} - 0.38$                 |     |      | V     |
| $V_{OL}$ | Output low voltage<br>$Qx, nQx^{[b]}$  | $I_{OL} = 8mA$  |                                 |     | 0.8 |                                 |     | 0.6 |                                 |     | 0.45 |                                 |     | 0.38 | V     |

[a]  $V_{CCOx}$  denotes  $V_{CCOA}$ ,  $V_{CCOB}$ .

[b]  $Qx$  denotes  $QA0, QA1, QA2, QA3, QB0, QB1, QB2, QB3$ .  $nQx$  denotes  $nQA0, nQA1, nQA2, nQA3, nQB0, nQB1, nQB2, nQB3$ .

**Table 19. Input Frequency Characteristics,  $V_{CC} = 3.3V \pm 5\%$ ,  $2.5V \pm 5\%$  or  $1.8V \pm 5\%$ ,  $V_{EE} = 0V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$**

| Symbol   | Parameter                       |                     | Test Conditions | Minimum | Typical | Maximum | Units |
|----------|---------------------------------|---------------------|-----------------|---------|---------|---------|-------|
| $f_{IN}$ | Input Frequency                 | $CLKx, nCLKx^{[a]}$ |                 | 1Hz     |         | 700MHz  |       |
| idc      | Input duty cycle <sup>[b]</sup> |                     |                 |         | 50      |         | %     |

[a]  $CLKx$  denotes  $CLK0, CLK1$ .  $nCLKx$  denotes  $nCLK0, nCLK1$ .

[b] Any deviation from a 50% / 50% duty cycle on the input may be reflected in the output duty cycle.

## AC Electrical Characteristics

**Table 20. AC Characteristics,  $V_{CC} = 3.3V \pm 5\%$ ,  $2.5V \pm 5\%$  or  $1.8V \pm 5\%$ ,  $V_{CCOx}^{[a]} = 3.3V \pm 5\%$ ,  $2.5V \pm 5\%$  or  $1.8V \pm 5\%$ ,  $V_{EE} = 0V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$**

| Symbol        | Parameter <sup>[b]</sup>             |                             | Test Conditions               | Minimum | Typical | Maximum | Units |
|---------------|--------------------------------------|-----------------------------|-------------------------------|---------|---------|---------|-------|
| $f_{OUT}$     | Output frequency                     | LVDS, LVPECL                |                               | 1PPS    |         | 700MHz  |       |
| $f_{OUT}$     | Output frequency                     | LVCMOS                      |                               | 1PPS    |         | 125MHz  |       |
| $t_{PD}$      | Propagation delay                    | LVCMOS                      | $V_{DDOx} = 3.3V \pm 5\%$     | 1.25    |         | 2.25    | ns    |
|               |                                      | LVDS                        |                               | 0.85    |         | 2.0     | ns    |
|               |                                      | LVPECL                      |                               | 0.85    |         | 2.0     | ns    |
| $t_R / t_F$   | Output rise and fall times           | LVPECL                      | 20% to 80%                    | 125     |         | 700     | ps    |
|               |                                      | LVDS                        | 20% to 80%, $V_{CCOx} = 3.3V$ | 150     |         | 550     | ps    |
|               |                                      |                             | 20% to 80%, $V_{CCOx} = 2.5V$ | 175     |         | 575     | ps    |
|               |                                      |                             | 20% to 80%, $V_{CCOx} = 1.8V$ | 200     |         | 600     | ps    |
|               |                                      | LVCMOS                      | 20% to 80%, $V_{CCOx} = 3.3V$ | 250     |         | 775     | ps    |
|               |                                      |                             | 20% to 80%, $V_{CCOx} = 2.5V$ | 200     |         | 915     | ps    |
|               |                                      |                             | 20% to 80%, $V_{CCOx} = 1.8V$ | 300     |         | 950     | ps    |
|               |                                      |                             | 20% to 80%, $V_{CCOx} = 1.5V$ | 200     |         | 1400    | ps    |
| $t_{sk(b)}$   | Bank skew <sup>[c], [d], [e]</sup>   | LVPECL, LVDS <sup>[f]</sup> |                               |         |         | 60      | ps    |
|               |                                      | LVCMOS <sup>[g]</sup>       |                               |         |         | 100     | ps    |
| $t_{sk(out)}$ | Output Skew <sup>[c], [d], [j]</sup> | LVPECL <sup>[f]</sup>       | $V_{CCOx} = 3.3V \pm 5\%$     |         |         | 65      | ps    |
|               |                                      |                             | $V_{CCOx} = 2.5V \pm 5\%$     |         |         | 62      | ps    |
|               |                                      |                             | $V_{CCOx} = 1.8V \pm 5\%$     |         |         | 62      | ps    |
|               |                                      | LVDS <sup>[f]</sup>         | $V_{CCOx} = 3.3V \pm 5\%$     |         |         | 45      | ps    |
|               |                                      |                             | $V_{CCOx} = 2.5V \pm 5\%$     |         |         | 45      | ps    |
|               |                                      |                             | $V_{CCOx} = 1.8V \pm 5\%$     |         |         | 35      | ps    |
|               |                                      | LVCMOS <sup>[g]</sup>       | $V_{CCOx} = 3.3V \pm 5\%$     |         |         | 90      | ps    |
|               |                                      |                             | $V_{CCOx} = 2.5V \pm 5\%$     |         |         | 100     | ps    |
|               |                                      |                             | $V_{CCOx} = 1.8V \pm 5\%$     |         |         | 95      | ps    |
| $t_{sk(pp)}$  | Part-to-Part Skew <sup>[c]</sup>     | LVPECL <sup>[k]</sup>       | $V_{CCOx} = 3.3V \pm 5\%$     |         |         | 380     | ps    |
|               |                                      |                             | $V_{CCOx} = 2.5V \pm 5\%$     |         |         |         |       |
|               |                                      |                             | $V_{CCOx} = 1.8V \pm 5\%$     |         |         |         |       |
|               |                                      | LVDS <sup>[k]</sup>         | $V_{CCOx} = 3.3V \pm 5\%$     |         |         | 325     | ps    |
|               |                                      |                             | $V_{CCOx} = 2.5V \pm 5\%$     |         |         |         |       |
|               |                                      |                             | $V_{CCOx} = 1.8V \pm 5\%$     |         |         |         |       |
|               |                                      | LVCMOS <sup>[l]</sup>       | $V_{CCOx} = 3.3V \pm 5\%$     |         |         | 590     | ps    |
|               |                                      |                             | $V_{CCOx} = 2.5V \pm 5\%$     |         |         |         |       |
|               |                                      |                             | $V_{CCOx} = 1.8V \pm 5\%$     |         |         |         |       |

**Table 20. AC Characteristics,  $V_{CC} = 3.3V \pm 5\%$ ,  $2.5V \pm 5\%$  or  $1.8V \pm 5\%$ ,  $V_{CCOx}^{[a]} = 3.3V \pm 5\%$ ,  $2.5V \pm 5\%$  or  $1.8V \pm 5\%$ ,  $V_{EE} = 0V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$**

| Symbol              | Parameter <sup>[b]</sup>              |              | Test Conditions                      | Minimum | Typical | Maximum | Units  |
|---------------------|---------------------------------------|--------------|--------------------------------------|---------|---------|---------|--------|
| odc                 | Output duty cycle <sup>[h], [i]</sup> | LVPECL, LVDS | $V_{CCOx} = 3.3V$ or $2.5V$          | 45      |         | 55      | %      |
|                     |                                       | LVPECL, LVDS | $V_{CCOx} = 1.8V$                    | 43      |         | 57      | %      |
|                     |                                       | LVCMOS       | $V_{CCOx} = 3.3V$ or $2.5V$          | 45      |         | 55      |        |
|                     |                                       |              | $V_{CCOx} = 1.8V$                    | 43      |         | 57      | %      |
|                     |                                       |              | $V_{CCOx} = 1.5V$                    | 40      |         | 60      |        |
| MUX <sub>ISOL</sub> | Mux Isolation                         |              |                                      |         | 70      | dB      |        |
|                     | Noise Floor                           | LVPECL, LVDS | Offset >10MHz from 156.25MHz carrier |         | 157     |         | dBc/Hz |

[a]  $V_{CCOx}$  denotes  $V_{CCOxA}$ ,  $V_{CCOxB}$ .

[b] Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500lfpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.

[c] This parameter is guaranteed by characterization. Not tested in production.

[d] This parameter is defined in accordance with JEDEC Standard 65.

[e] Defined as skew within a bank of outputs at the same supply voltage and with equal load conditions.

[f] Measured at the output differential crosspoint.

[g] Measured at  $V_{CCOx}/2$  of the rising edge.

[h] Measured using 50% /50% duty cycle on input reference.

[i] Measurements taken for the following output frequencies:

LVDS and LVPECL: 50MHz, 100MHz, 156.25MHz, 250MHz, 312.5MHz, 491.52MHz, 700MHz

LVCMOS: 25MHz, 50MHz, 100MHz, 125MHz.

[j] Defined as skew between outputs at the same supply voltage and with equal load conditions.

[k] Defined as skew between outputs on different devices operating at the same supply voltage and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at the differential crosspoints.

[l] Defined as skew between outputs on different devices operating at the same supply voltage and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at  $V_{CCOx}/2$ .

**Table 21. Typical Additive Jitter,  $V_{CC} = 3.3V \pm 5\%$ ,  $2.5V \pm 5\%$  or  $1.8V \pm 5\%$ ,  $V_{CCOx}^{[a]} = 3.3V \pm 5\%$ ,  $2.5V \pm 5\%$ ,  $1.8V \pm 5\%$  or  $1.5V \pm 5\%$  (1.5V only supported for LVCMOS outputs),  $V_{EE} = 0V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$**

| Symbol            | Parameter                    |        | Test Conditions <sup>[b]</sup>                                  |                             | Minimum | Typical | Maximum | Units |
|-------------------|------------------------------|--------|---|-----------------------------|---------|---------|---------|-------|
| $t_{jit(f)}$      | RMS Additive Jitter (Random) | LVPECL | $f_{OUT} = 156.25MHz$ ,<br>Integration Range:<br>12kHz to 20MHz | $V_{CCOx} = 3.3V$ or $2.5V$ |         | 64      |         | fs    |
|                   |                              |        |   | $V_{CCOx} = 1.8V$           |         | 81      |         | fs    |
|                   |                              | LVDS   | $f_{OUT} = 156.25MHz$ ,<br>Integration Range:<br>12kHz to 20MHz | $V_{CCOx} = 3.3V$ or $2.5V$ |         | 70      |         | fs    |
|                   |                              |        |   | $V_{CCOx} = 1.8V$           |         | 114     |         | fs    |
|                   |                              | LVCMOS | $f_{OUT} = 125MHz$ ,<br>Integration Range:<br>12kHz to 20MHz    | $V_{CCOx} = 3.3V$ or $2.5V$ |         | 105     |         | fs    |
|                   |                              |        |   | $V_{CCOx} = 1.8V$           |         | 140     |         | fs    |
| $V_{CCOx} = 1.5V$ |                              |        |   | 192                         |         | fs      |         |       |

[a]  $V_{CCOx}$  denotes  $V_{CCOxA}$ ,  $V_{CCOxB}$ .

[b] All outputs configured for the specific output type, as shown in the table.

## Applications Information

### Recommendations for Unused Input and Output Pins

#### Inputs

##### *CLK/nCLK Inputs*

For applications not requiring the use of the differential input, both CLK and nCLK can be left floating. Though not required, but for additional protection, a 1k $\Omega$  resistor can be tied from CLK to ground.

##### *LVC MOS LV TTL Level Control Pins*

All control pins have internal pull-ups or pull-downs; additional resistance is not required but can be added for additional protection. A 1k $\Omega$  resistor can be used.

##### *LVC MOS 3-level I/O Control Pins*

These pins are 3-level pins and if left unconnected this is interpreted as a valid input selection option (Middle).

#### Outputs

##### *LVC MOS Outputs*

All unused LVC MOS outputs can be left floating. It is recommended that there is no trace attached.

##### *LVPECL Outputs*

All unused LVPECL outputs can be left floating. We recommend that there is no trace attached. Both sides of the differential output pair should either be left floating or terminated.

##### *LVDS Outputs*

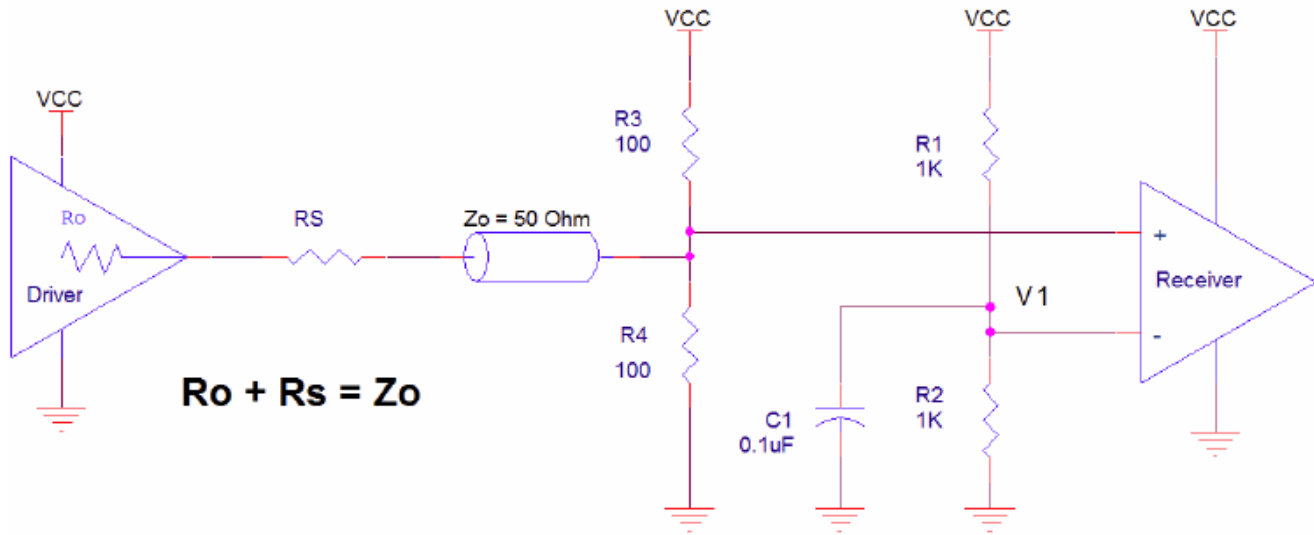
All unused LVDS output pairs can be either left floating or terminated with 100 $\Omega$  across. If they are left floating, there should be no trace attached.

### Wiring the Differential Input to Accept Single-ended Levels

Figure 2 shows how a differential input can be wired to accept single ended levels. The reference voltage  $V_1 = V_{CC}/2$  is generated by the bias resistors R1 and R2. The bypass capacitor (C1) is used to help filter noise on the DC bias. This bias circuit should be located as close to the input pin as possible. The ratio of R1 and R2 might need to be adjusted to position the  $V_1$  in the center of the input voltage swing. For example, if the input clock swing is 2.5V and  $V_{CC} = 3.3V$ , R1 and R2 value should be adjusted to set  $V_1$  at 1.25V. The values below are for when both the single ended swing and  $V_{CC}$  are at the same voltage. This configuration requires that the sum of the output impedance of the driver ( $R_o$ ) and the series resistance ( $R_s$ ) equals the transmission line impedance. In addition, matched termination at the input will attenuate the signal in half.

This can be done in one of two ways. First, R3 and R4 in parallel should equal the transmission line impedance. For most 50 $\Omega$  applications, R3 and R4 can be 100 $\Omega$ . The values of the resistors can be increased to reduce the loading for slower and weaker LVC MOS driver. When using single-ended signaling, the noise rejection benefits of differential signaling are reduced. Even though the differential input can handle full rail LVC MOS signaling, it is recommended that the amplitude be reduced while maintaining an edge rate faster than 1V/ns. The datasheet specifies a lower differential amplitude, however this only applies to differential signals. For single-ended applications, the swing can be larger, however  $V_{IL}$  cannot be less than  $-0.3V$  and  $V_{IH}$  cannot be more than  $V_{CC} + 0.3V$ . Though some of the recommended components might not be used, the pads should be placed in the layout. They can be utilized for debugging purposes. The datasheet specifications are characterized and guaranteed by using a differential signal.

**Figure 2. Recommended Schematic for Wiring a Differential Input to Accept Single-ended Levels**

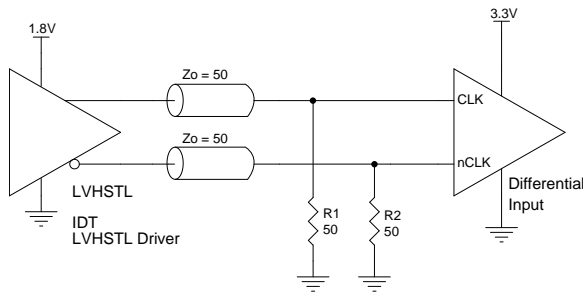




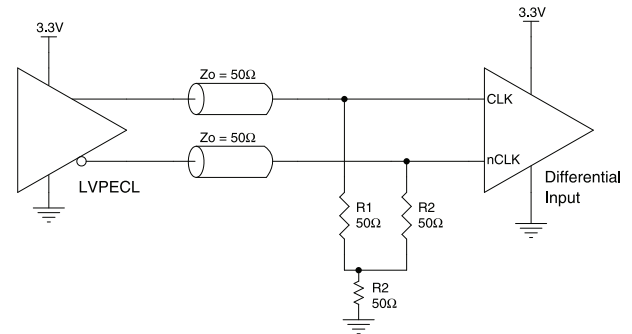
### 3.3V Differential Clock Input Interface

The CLK /nCLK accepts LVDS, LVPECL, LVHSTL, HCSL and other differential signals. Both  $V_{SWING}$  and  $V_{OH}$  must meet the  $V_{PP}$  and  $V_{CMR}$  input requirements. Figure 3 to Figure 7 show interface examples for the CLK/nCLK input driven by the most common driver types. The input interfaces suggested here are examples only. Please consult with the vendor of the driver component to confirm the driver termination requirements. For example, in Figure 3, the input termination applies for Renesas open emitter LVHSTL drivers. If you are using an LVHSTL driver from another vendor, use their termination recommendation.

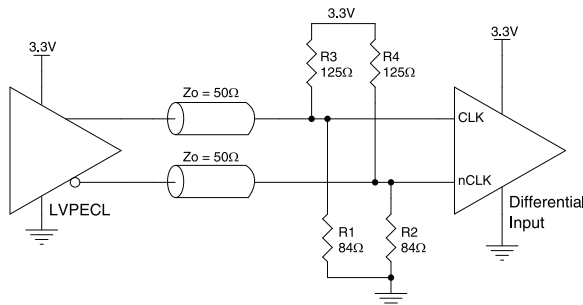
**Figure 3. CLKx/nCLKx Input Driven by a Renesas Open Emitter LVHSTL Driver**



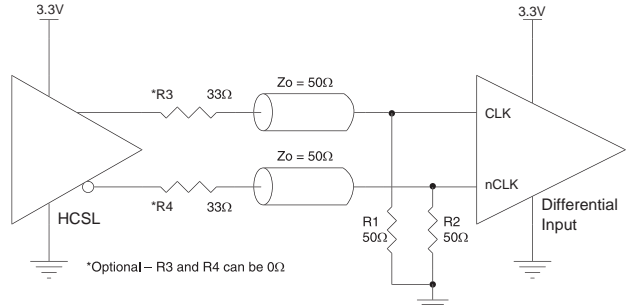
**Figure 4. CLKx/nCLKx Input Driven by a 3.3V LVPECL Driver**



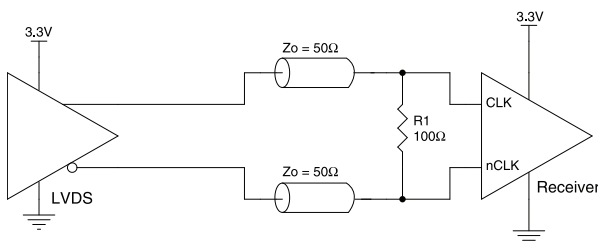
**Figure 5. CLK/nCLK Input Driven by a 3.3V LVPECL Driver**



**Figure 6. CLK/nCLK Input Driven by a 3.3V HCSL Driver**



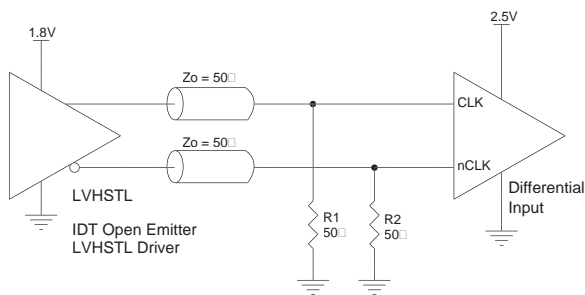
**Figure 7. CLK/nCLK Input Driven by a 3.3V LVDS Driver**



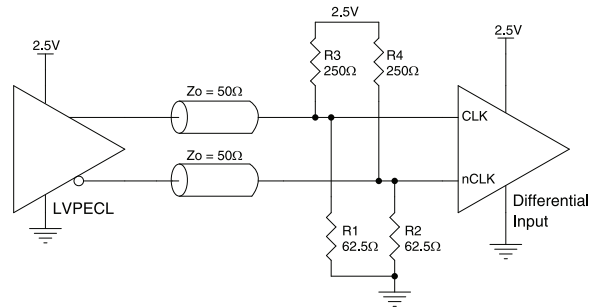
## 2.5V Differential Clock Input Interface

CLKx/nCLKx accepts LVDS, LVPECL, LVHSTL, HCSL and other differential signals. Both  $V_{SWING}$  and  $V_{OH}$  must meet the  $V_{PP}$  and  $V_{CMR}$  input requirements. Figure 8 to Figure 12 show interface examples for the CLKx/nCLKx input driven by the most common driver types. The input interfaces suggested here are examples only. Please consult with the vendor of the driver component to confirm the driver termination requirements. For example, in Figure 8, the input termination applies for Renesas open emitter LVHSTL drivers. If you are using an LVHSTL driver from another vendor, use their termination recommendation.

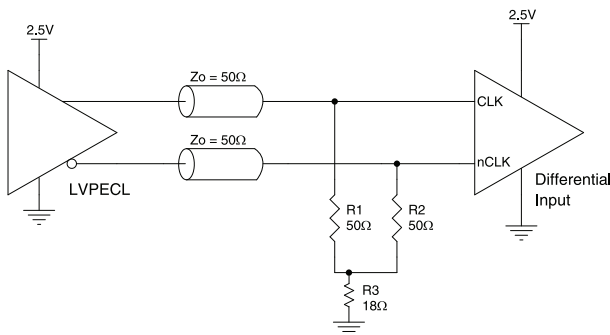
**Figure 8. CLKx/nCLKx Input Driven by a Renesas Open Emitter LVHSTL Driver**



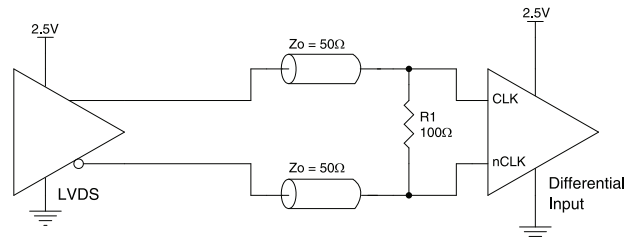
**Figure 9. CLKx/nCLKx Input Driven by a 2.5V LVPECL Driver**



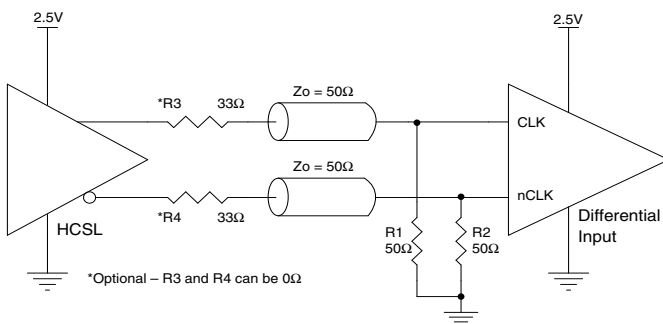
**Figure 10. CLK/nCLK Input Driven by a 2.5V LVPECL Driver**



**Figure 11. CLK/nCLK Input Driven by a 2.5V LVDS Driver**



**Figure 12. CLK/nCLK Input Driven by a 2.5V HCSL Driver**

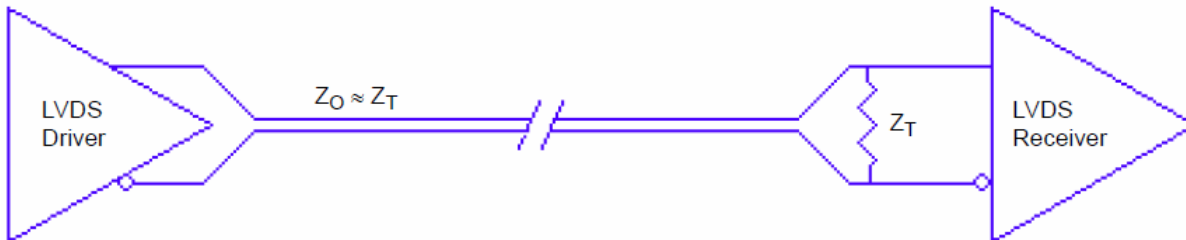


## LVDS Driver Termination

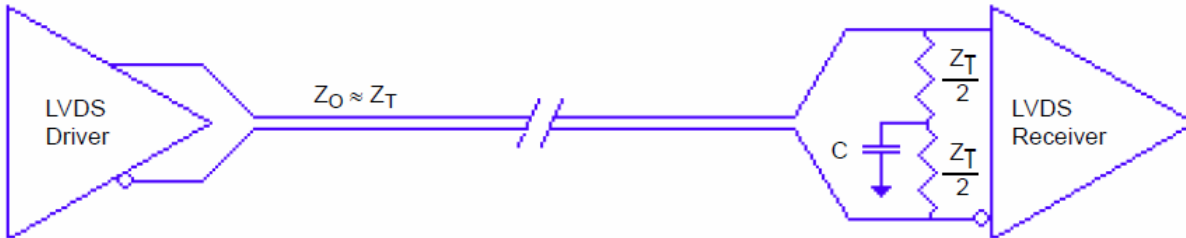
For a general LVDS interface, the recommended value for the termination impedance ( $Z_T$ ) is between  $90\Omega$  and  $132\Omega$ . The actual value should be selected to match the differential impedance ( $Z_0$ ) of your transmission line. A typical point-to-point LVDS design uses a  $100\Omega$  parallel resistor at the receiver and a  $100\Omega$  differential transmission-line environment. In order to avoid any transmission-line reflection issues, the components should be surface mounted and must be placed as close to the receiver as possible. Renesas offers a full line of LVDS compliant devices with two types of output structures: current source and voltage source.

The standard termination schematic as shown in Figure 13 can be used with either type of output structure. Figure 14, which can also be used with both output types, is an optional termination with center tap capacitance to help filter common mode noise. The capacitor value should be approximately  $50\text{pF}$ . If using a non-standard termination, it is recommended to contact Renesas and confirm if the output structure is current source or voltage source type. In addition, since these outputs are LVDS compatible, the input receiver's amplitude and common-mode input range should be verified for compatibility with the output.

**Figure 13. Standard LVDS Termination**



**Figure 14. Optional LVDS Termination**

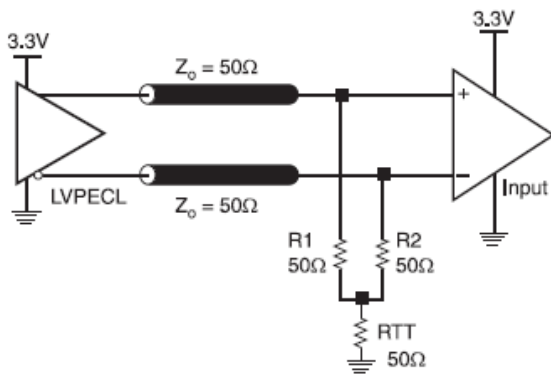


## Termination for 3.3V LVPECL Outputs

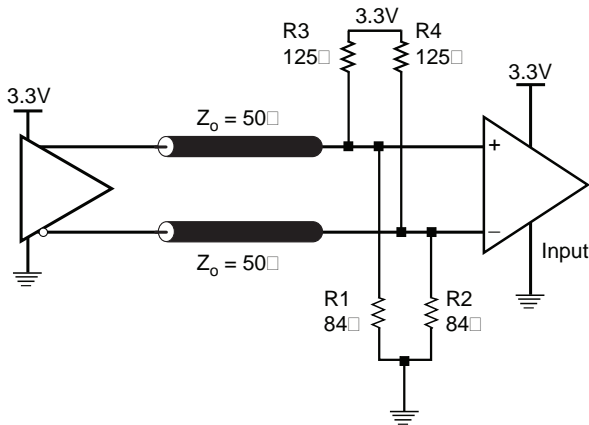
The clock layout topology shown below is a typical termination for LVPECL outputs. The two different layouts mentioned are recommended only as guidelines.

The differential output is a low impedance follower output that generate ECL/LVPECL compatible outputs. Therefore, terminating resistors (DC current path to ground) or current sources must be used for functionality. These outputs are designed to drive 50Ω transmission lines. Matched impedance techniques should be used to maximize operating frequency and minimize signal distortion. [Figure 15](#) and [Figure 16](#) show two different layouts which are recommended only as guidelines. Other suitable clock layouts may exist and it would be recommended that the board designers simulate to guarantee compatibility across all printed circuit and clock component process variations.

**Figure 15. 3.3V LVPECL Output Termination**



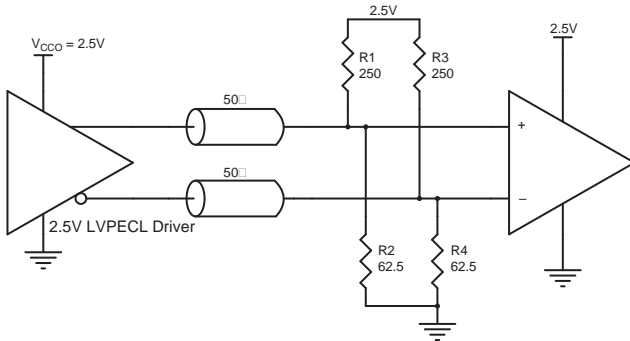
**Figure 16. 3.3V LVPECL Output Termination**



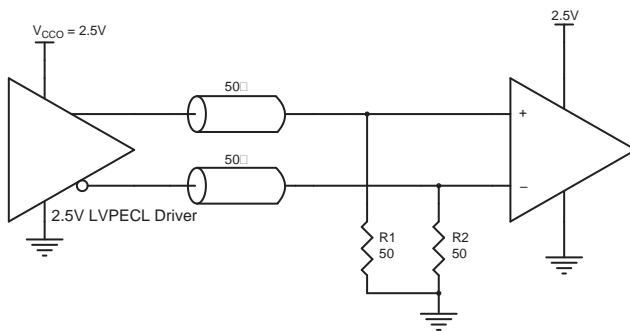
## Termination for 2.5V LVPECL Outputs

Figure 17 and Figure 18 show examples of termination for 2.5V LVPECL driver. These terminations are equivalent to terminating  $50\Omega$  to  $V_{CC0} - 2V$ . For  $V_{CC0} = 2.5V$ , the  $V_{CC0} - 2V$  is very close to ground level. The R3 in Figure 18 can be eliminated and the termination is shown in Figure 19.

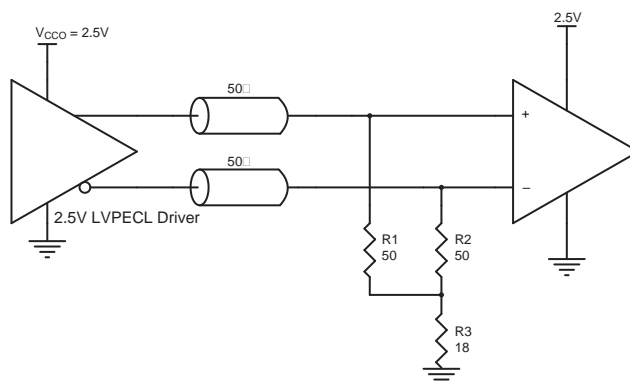
**Figure 17. 2.5V LVPECL Driver Termination Example**



**Figure 18. 2.5V LVPECL Driver Termination Example**



**Figure 19. 2.5V LVPECL Driver Termination Example**



## Power Dissipation and Thermal Considerations

The 8P791208 is a multi-functional, high speed device that targets a wide variety of clock frequencies and applications. Since this device is highly programmable with a broad range of features and functionality, the power consumption will vary as each of these features and functions is enabled.

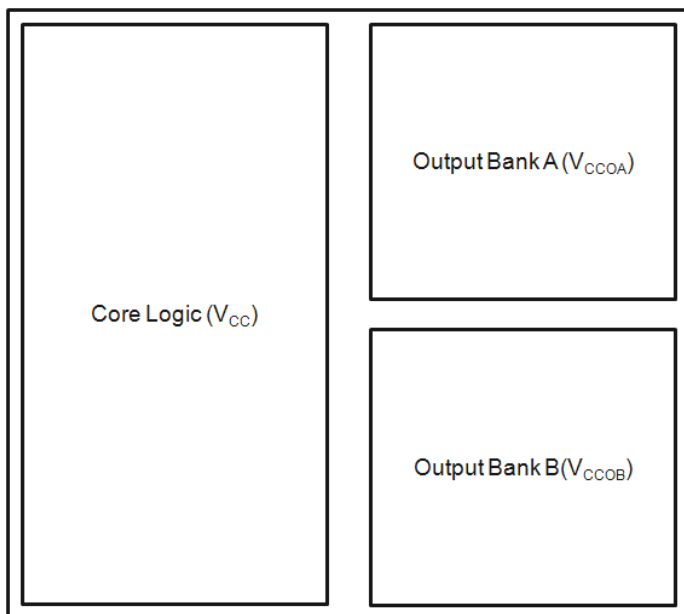
The 8P791208 device was designed and characterized to operate within the ambient industrial temperature range of  $T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ . The ambient temperature represents the temperature around the device, not the junction temperature. When using the device in extreme cases, such as maximum operating frequency and high ambient temperature, external air flow may be required in order to ensure a safe and reliable junction temperature. Extreme care must be taken to avoid exceeding  $125^{\circ}\text{C}$  junction temperature.

The power calculation examples below were generated using a maximum ambient temperature and supply voltage. For many applications, the power consumption will be much lower. Please contact Renesas technical support for any concerns on calculating the power dissipation for your own specific configuration.

### Power Domains

The 8P791208 device has a number of separate power domains that can be independently enabled and disabled via register accesses (all power supply pins must still be connected to a valid supply voltage). [Figure 20](#) indicates the individual domains and the associated power pins.

**Figure 20. 8P791208 Power Domains**



### Power Consumption Calculation

Determining total power consumption involves several steps:

1. Determine the power consumption using maximum current values for core voltage from [Table 6](#) to [Table 9](#) for the appropriate case of how many banks or outputs are enabled.
2. Determine the nominal power consumption of each enabled output path.
  - a. This consists of a base amount of power that is independent of operating frequency, as shown in [Table 22](#) to [Table 28](#) (depending on the chosen output protocol).
  - b. Then there is a variable amount of power that is related to the output frequency. This can be determined by multiplying the output frequency by the FQ\_Factor shown in [Table 22](#) to [Table 28](#).
3. All of the above totals are then summed.

## Thermal Considerations

Once the total power consumption has been determined, it is necessary to calculate the maximum operating junction temperature for the device under the environmental conditions it will operate in. Thermal conduction paths, air flow rate and ambient air temperature are factors that can affect this. The thermal conduction path refers to whether heat is to be conducted away via a heat-sink, via airflow or via conduction into the PCB through the device pads (including the ePAD). Thermal conduction data is provided for typical scenarios in [Table 30](#). Please contact Renesas for assistance in calculating results under other scenarios.

## Current Consumption Data and Equations

**Table 22. 3.3V LVDS Output Calculation Table**

| LVDS   | FQ_Factor (mA/MHz) | Base_Current (mA) |
|--------|--------------------|-------------------|
| Bank A | 0.08               | 25.309            |
| Bank B | 0.08               | 25.309            |

**Table 23. 2.5V LVDS Output Calculation Table**

| LVDS   | FQ_Factor (mA/MHz) | Base_Current (mA) |
|--------|--------------------|-------------------|
| Bank A | 0.05               | 35.476            |
| Bank B | 0.05               | 35.476            |

**Table 24. 1.8V LVDS Output Calculation Table**

| LVDS   | FQ_Factor (mA/MHz) | Base_Current (mA) |
|--------|--------------------|-------------------|
| Bank A | 0.05               | 35.330            |
| Bank B | 0.05               | 35.330            |

**Table 25. 3.3V LVCMOS Output Calculation Table**

| LVCMOS | Base_Current (mA) |
|--------|-------------------|
| Bank A | 31.522            |
| Bank B | 31.522            |

**Table 26. 2.5V LVCMOS Output Calculation Table**

| LVCMOS | Base_Current (mA) |
|--------|-------------------|
| Bank A | 18.665            |
| Bank B | 18.665            |

**Table 27. 1.8V LVCMOS Output Calculation Table**

| LVCMOS | Base_Current (mA) |
|--------|-------------------|
| Bank A | 14.704            |
| Bank B | 14.704            |

**Table 28. 1.5V LVCMOS Output Calculation Table**

| LVCMOS | Base_Current (mA) |
|--------|-------------------|
| Bank A | 12.522            |
| Bank B | 12.522            |

Applying the values to the following equation will yield output current by frequency:

$$Q_x \text{ Current (mA)} = FQ\_Factor * \text{Frequency (MHz)} + \text{Base\_Current}$$

where:

Q<sub>x</sub> Current is the specific output current according to output type and frequency

FQ\_Factor is used for calculating current increase due to output frequency

Base\_Current is the base current for each output path independent of output frequency

The second step is to multiply the power dissipated by the thermal impedance to determine the maximum power gradient, using the following equation:

$$T_J = T_A + (\theta_{JA} * P_{d_{total}})$$

where:

T<sub>J</sub> is the junction temperature (°C)

T<sub>A</sub> is the ambient temperature (°C)

θ<sub>JA</sub> is the thermal resistance value from [Table 30](#), dependent on ambient airflow (°C/W).

P<sub>d<sub>total</sub></sub> is the total power dissipation of the 8P791208 under usage conditions, including power dissipated due to loading (W).

Note: For LVPECL outputs the power dissipation through the load is assumed to be 27.95mW. When selecting LVCMOS outputs, power dissipation through the load will vary based on a variety of factors including termination type and trace length. For these examples, power dissipation through loading will be calculated using C<sub>PD</sub> (located in [Table 10](#)) and output frequency:

$$P_{d_{OUT}} = C_{PD} * f_{OUT} * V_{CCO}^2$$

where:

P<sub>d<sub>out</sub></sub> is the power dissipation of the output (W)

C<sub>PD</sub> is the power dissipation capacitance (pF)

f<sub>OUT</sub> is the output frequency of the selected output (MHz)

V<sub>CCO</sub> is the voltage supplied to the appropriate output (V)



## Example Calculations

**Table 29. Example 1 – Common Customer Configuration (3.3V Core Voltage)**

| Circuit | Configuration | Frequency (MHz) | V <sub>CC0</sub> |
|---------|---------------|-----------------|------------------|
| Bank A  | LVDS          | 125             | 3.3V             |
| Bank B  | LVDS          |                 | 3.3V             |

Core supply current, I<sub>CC</sub> = 25mA (maximum)

- Output supply current, Bank A current = 0.08mA x 125MHz + 30mA = 40mA
- Output supply current, Bank B current = 0.08mA x 125MHz + 30mA = 40mA

Total device current = 25mA + 40mA + 40mA = 105mA

Total device power = 3.465V \* 105mA = 363.825mW or 0.364W

With an ambient temperature of 85°C and no airflow, the junction temperature is:

- T<sub>J</sub> = 85°C + 35.23°C/W \* 0.364W = 97.82°C

## LVPECL Power Considerations (700MHz)

This section provides information on power dissipation and junction temperature for the 8P791208.

Equations and example calculations are also provided.

### 4. Power Dissipation.

The total power dissipation for the 8P791208 is the sum of the core power plus the power dissipated in the load(s).

The following is the power dissipation for V<sub>CC</sub> = 3.465V, which gives worst case results.

Note: I<sub>EE\_MAX</sub> @ 85°C is 124mA

For information on calculating power dissipated in the load, see [Calculations and Equations](#).

- Power (core)<sub>MAX</sub> = V<sub>CC\_MAX</sub> \* I<sub>EE\_MAX</sub> = 3.465V \* 124mA = **429.66mW**
- Power (outputs)<sub>MAX</sub> = **27.95mW/Loaded Output pair**  
If all outputs are loaded, the total power is 8 \* 27.95mW = **223.6mW**
- Total Power**<sub>-MAX</sub> = 429.66mW + 223.6mW = **653.26mW**

### 5. Junction Temperature.

Junction temperature, T<sub>J</sub>, is the temperature at the junction of the bond wire and bond pad directly affects the reliability of the device. The maximum recommended junction temperature is 125°C. Limiting the internal transistor junction temperature, T<sub>J</sub>, to 125°C ensures that the bond wire and bond pad temperature remains below 125°C.

The equation for T<sub>J</sub> is as follows: T<sub>J</sub> = θ<sub>JA</sub> \* Pd<sub>total</sub> + T<sub>A</sub>

T<sub>J</sub> = Junction Temperature

θ<sub>JA</sub> = Junction-to-Ambient Thermal Resistance

Pd<sub>total</sub> = Total Device Power Dissipation (example calculation is in section 1 above)

T<sub>A</sub> = Ambient Temperature

In order to calculate junction temperature, the appropriate junction-to-ambient thermal resistance θ<sub>JA</sub> must be used. Assuming no air flow and a multi-layer board, the appropriate value is 35.23°C/W per [Table 30](#).

Therefore, Tj for an ambient temperature of 85°C with all outputs switching is:

$$85^{\circ}\text{C} + 0.653\text{W} * 35.23^{\circ}\text{C/W} = 108^{\circ}\text{C}.$$

This is below the limit of 125°C.

This calculation is only an example. Tj will obviously vary depending on the number of loaded outputs, supply voltage, air flow and the type of board (multi-layer).

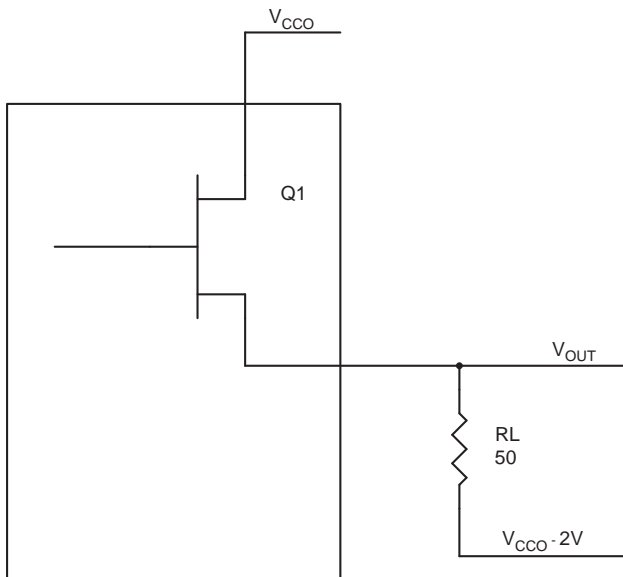
**Table 30. Thermal Resistance  $\theta_{JA}$  for 32-Lead VFQFN, Forced Convection**

| Meters per Second                           | $\theta_{JA}$ by Velocity |          |          |
|---|---------------------------|----------|----------|
|   | 0                         | 1        | 2.5      |
| Multi-Layer PCB, JEDEC Standard Test Boards | 35.23°C/W                 | 31.6°C/W | 30.0°C/W |

6. Calculations and Equations.

The purpose of this section is to calculate the power dissipation for the LVPECL output pair. LVPECL output driver circuit and termination are shown in Figure 21.

**Figure 21. LVPECL Driver Circuit and Termination**



To calculate worst case power dissipation into the load, use the following equations which assume a 50Ω load, and a termination voltage of  $V_{CCO} - 2V$ .

- For logic high,  $V_{OUT} = V_{OH\_MAX} = V_{CCO\_MAX} - 0.8V$   
 $(V_{CCO\_MAX} - V_{OH\_MAX}) = 0.8V$
- For logic low,  $V_{OUT} = V_{OL\_MAX} = V_{CCO\_MAX} - 1.75V$   
 $(V_{CCO\_MAX} - V_{OL\_MAX}) = 1.75V$

Pd\_H is power dissipation when the output drives high.

Pd\_L is the power dissipation when the output drives low.

$$Pd\_H = [(V_{OH\_MAX} - (V_{CCO\_MAX} - 2V))/R_L] * (V_{CCO\_MAX} - V_{OH\_MAX}) = [(2V - (V_{CCO\_MAX} - V_{OH\_MAX}))/R_L] * (V_{CCO\_MAX} - V_{OH\_MAX}) = [(2V - 0.8V)/50\Omega] * 0.8V = \mathbf{19.2mW}$$

$$Pd\_L = [(V_{OL\_MAX} - (V_{CCO\_MAX} - 2V))/R_L] * (V_{CCO\_MAX} - V_{OL\_MAX}) = [(2V - (V_{CCO\_MAX} - V_{OL\_MAX}))/R_L] * (V_{CCO\_MAX} - V_{OL\_MAX}) = [(2V - 1.75V)/50\Omega] * 1.75V = \mathbf{8.75mW}$$

Total Power Dissipation per output pair = Pd\_H + Pd\_L = **27.95mW**

## LVDS Power Considerations (700MHz)

This section provides information on power dissipation and junction temperature for the 8P791208. Equations and example calculations are also provided.

### 7. Power Dissipation.

The total power dissipation for the 8P791208 is the sum of the core power plus the power dissipated in the load(s). The following is the power dissipation for  $V_{CC} = 3.465V$ , which gives worst case results.

- Power (core)<sub>MAX</sub> =  $V_{CC\_MAX} * I_{CC\_MAX} = 3.465V * 25mA = \mathbf{86.625mW}$
- Power (outputs)<sub>MAX</sub> =  $V_{CCOx\_MAX} * I_{CCO\_MAX} = 3.465V * 153mA = \mathbf{530.145mW}$
- **Total Power**<sub>MAX</sub> =  $86.625W + 530.145mW = \mathbf{616.77mW}$

### 8. Junction Temperature.

Junction temperature, T<sub>j</sub>, is the temperature at the junction of the bond wire and bond pad directly affects the reliability of the device. The maximum recommended junction temperature is 125°C. Limiting the internal transistor junction temperature, T<sub>j</sub>, to 125°C ensures that the bond wire and bond pad temperature remains below 125°C.

The equation for T<sub>j</sub> is as follows:  $T_j = \theta_{JA} * Pd\_total + T_A$

T<sub>j</sub> = Junction Temperature

$\theta_{JA}$  = Junction-to-Ambient Thermal Resistance

Pd<sub>total</sub> = Total Device Power Dissipation (example calculation is in section 1 above)

T<sub>A</sub> = Ambient Temperature

In order to calculate junction temperature, the appropriate junction-to-ambient thermal resistance  $\theta_{JA}$  must be used. Assuming no air flow and a multi-layer board, the appropriate value is 35.23°C/W per [Table 30](#).

Therefore, T<sub>j</sub> for an ambient temperature of 85°C with all outputs switching is:

$$85^\circ\text{C} + 0.617W * 35.23^\circ\text{C}/W = 107^\circ\text{C}. \text{ This is below the limit of } 125^\circ\text{C}.$$

This calculation is only an example. T<sub>j</sub> will obviously vary depending on the number of loaded outputs, supply voltage, air flow and the type of board (multi-layer).

## LVCMOS Power Considerations (125MHz)

This section provides information on power dissipation and junction temperature for the 8P791208. Equations and example calculations are also provided.

### 9. Power Dissipation.

The total power dissipation for the 8P791208 is the sum of the core power plus the power dissipated in the load(s).

The following is the power dissipation for  $V_{CC} = 3.465V$ , which gives worst case results.

- $\text{Power (core)}_{MAX} = V_{CC\_MAX} * I_{CC\_MAX} = 3.465V * 63mA = 217.81mW$

### Dynamic Power Dissipation at $f_{OUT(max)}$

#### Total Power:

$$\text{Total Power (F}_{OUT\_MAX}) = [(C_{PD} * N) * \text{Frequency} * (V_{CCO})^2] = [(0.58pF * 2) * 125MHz * (3.456V)^2] = 13.92722mW \text{ per output}$$

N = number of outputs

Dynamic Power Dissipation:

$$\begin{aligned} &= \text{Static Power} + \text{Dynamic Power Dissipation} \\ &= 217.81mW + 13.927mW \\ &= 231.737mW \end{aligned}$$

### 10. Junction Temperature.

Junction temperature,  $T_j$ , is the temperature at the junction of the bond wire and bond pad directly affects the reliability of the device. The maximum recommended junction temperature is 125°C. Limiting the internal transistor junction temperature,  $T_j$ , to 125°C ensures that the bond wire and bond pad temperature remains below 125°C.

The equation for  $T_j$  is as follows:  $T_j = \theta_{JA} * Pd\_total + T_A$

$T_j$  = Junction Temperature

$\theta_{JA}$  = Junction-to-Ambient Thermal Resistance

$Pd\_total$  = Total Device Power Dissipation (example calculation is in section 1 above)

$T_A$  = Ambient Temperature

In order to calculate junction temperature, the appropriate junction-to-ambient thermal resistance  $\theta_{JA}$  must be used. Assuming no air flow and a multi-layer board, the appropriate value is 35.23°C/W per [Table 30](#).

Therefore,  $T_j$  for an ambient temperature of 85°C with all outputs switching is:

$$85^\circ C + 0.232W * 35.23^\circ C/W = 93.27^\circ C. \text{ This is below the limit of } 125^\circ C.$$

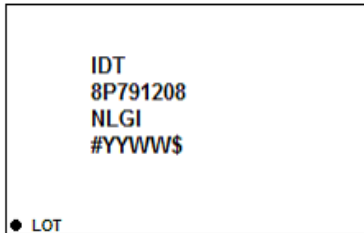
This calculation is only an example.  $T_j$  will obviously vary depending on the number of loaded outputs, supply voltage, air flow and the type of board (multi-layer).

## Package Outline Drawings

The package outline drawings are appended at the end of this document and are accessible from the link below. The package information is the most current data available.

[www.idt.com/document/psc/32-vfqfn-package-outline-drawing-50-x-50-x-090-mm-body-epad-315-x-315-mm-nlg32p1](http://www.idt.com/document/psc/32-vfqfn-package-outline-drawing-50-x-50-x-090-mm-body-epad-315-x-315-mm-nlg32p1)

## Marking Diagram



1. IDT
2. Line 2 and line 3 indicates the part number.
3. Line 3:
  - “#” indicates stepping.
  - “YYWW” indicates the date code (YY are the last two digits of the year, and “WW” is a work week number that the part was assembled).
  - “\$” indicates the mark code.

## Ordering Information

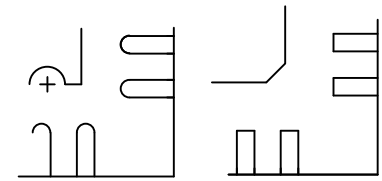
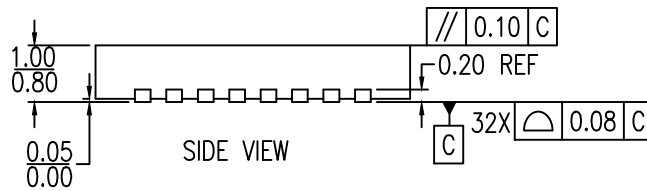
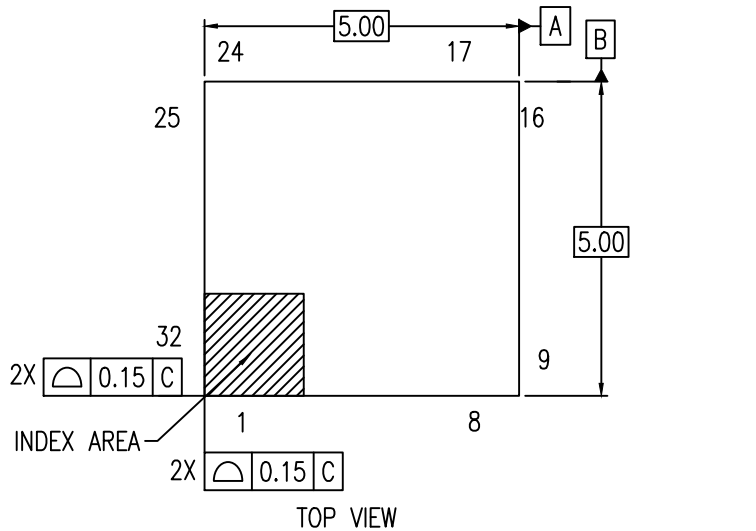
| Orderable Part Number | Marking         | Package                  | Carrier Type                                | Temperature   |
|-----------------------|-----------------|--------------------------|---|---------------|
| 8P791208NLGI          | IDT8P791208NLGI | 32-lead VFQFN, Lead Free | Tray  | -40°C to 85°C |
| 8P791208NLGI8         | IDT8P791208NLGI | 32-lead VFQFN, Lead Free | Tape and Reel, Pin 1 Orientation: EIA-481-C | -40°C to 85°C |
| 8P791208NLGI/W        | IDT8P791208NLGI | 32-lead VFQFN, Lead Free | Tape and Reel, Pin 1 Orientation: EIA-481-D | -40°C to 85°C |

**Table 31. Pin 1 Orientation in Tape and Reel Packaging**

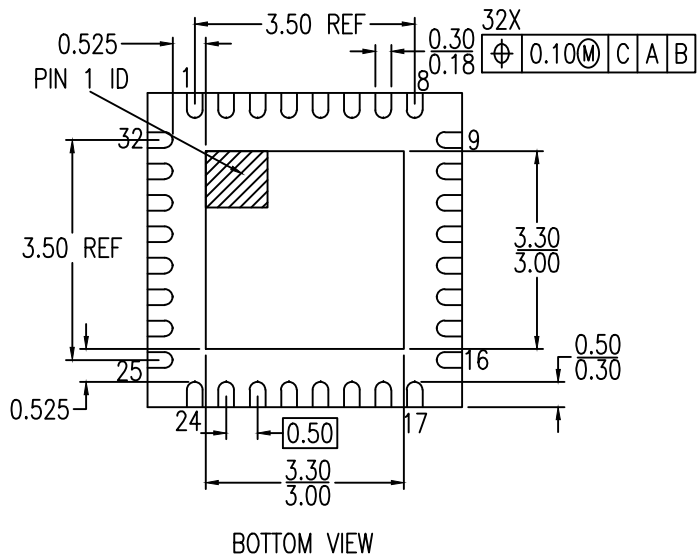
| Part Number Suffix | Pin 1 Orientation      | Illustration |
|--------------------|------------------------|--------------|
| NLGI8              | Quadrant 1 (EIA-481-C) |              |
| NLGI/W             | Quadrant 2 (EIA-481-D) |              |

## Revision History

| Date               | Description of Change   |
|--------------------|---|
| September 21, 2020 | ▪ Corrected description typos in Figure 6 and Figure 7 titles.  |
| June 2, 2020       | ▪ Reformatted document headers and footers.<br>▪ Updated AC Electrical Characteristics table with Output Skew and Part-to-Part Skew parameters.   |
| May 8, 2018        | ▪ Updated the propagation delay minimum and maximum numbers for LVC MOS in <a href="#">Table 20</a><br>▪ Updated the <a href="#">Package Outline Drawings</a> ; however, no technical changes |
| November 5, 2017   | ▪ Added $t_{PD}$ symbol to <a href="#">Table 20</a>   |
| August 23, 2017    | ▪ Added <a href="#">Table 14</a><br>▪ Updated the package outline drawings. No mechanical changes.  |
| November 28, 2016  | Initial release.  |

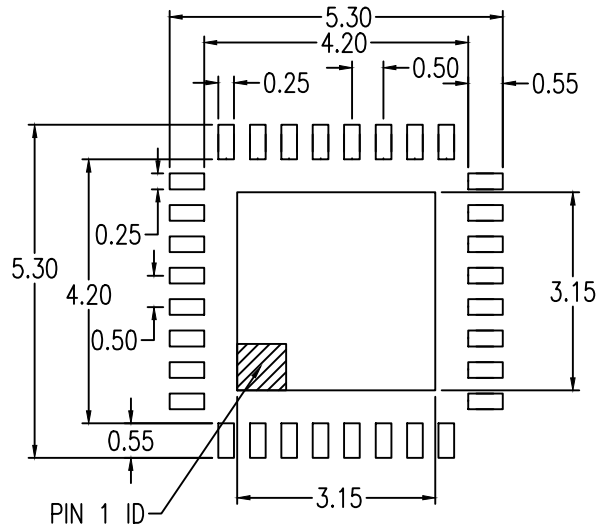


PIN #1 ID OPTION



NOTE:

1. ALL DIMENSION ARE IN MM. ANGLES IN DEGREES.
2. COPLANARITY APPLIE TO THE EXPOSED PAD AS WELL AS THE TERMINALS.  
COPLANARITY SHALL NOT EXCEED 0.08 MM.
3. WARPAGE SHALL NOT EXCEED 0.10 MM.
4. PIN LOCATION IS UNIDENTIFIED BY EITHER CHAMFER OR NOTCH.



### RECOMMENDED LAND PATTERN DIMENSION

1. ALL DIMENSIONS ARE IN MM. ANGLES IN DEGREES.
2. TOP DOWN VIEW, AS VIEWED ON PCB.
3. LAND PATTERN RECOMMENDATION PER IPC-7351B GENERIC REQUIREMENT FOR SURFACE MOUNT DESIGN AND LAND PATTERN.

| Package Revision History |         |                 |
|--------------------------|---------|-----------------|
| Date Created             | Rev No. | Description     |
| April 12, 2018           | Rev 02  | New Format      |
| Feb 8, 2016              | Rev 01  | Added "k: Value |