

## General Description

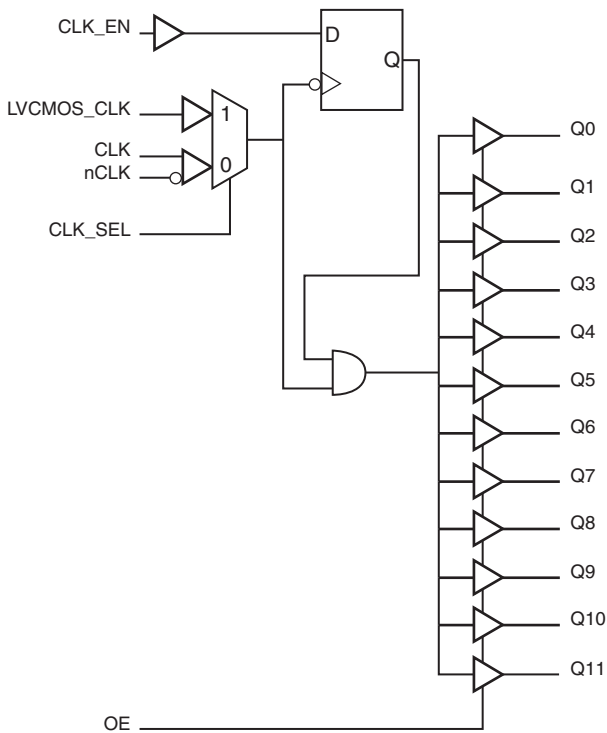
The 83948I-147 is a low skew, 1-to-12 Differential-to-LVCMOS/LVTTL Fanout Buffer. The 83948I-147 has two selectable clock inputs. The CLK, nCLK pair can accept most standard differential input levels. The LVCMOS\_CLK can accept LVCMOS or LVTTTL input levels. The low impedance LVCMOS/LVTTL outputs are designed to drive 50Ω series or parallel terminated transmission lines. The effective fanout can be increased from 12 to 24 by utilizing the ability of the outputs to drive two series terminated lines.

The 83948I-147 is characterized at full 3.3V, full 2.5V or mixed 3.3V core/2.5V output operating supply modes. Guaranteed output and part-to-part skew characteristics make the 83948I-147 ideal for those clock distribution applications demanding well defined performance and repeatability.

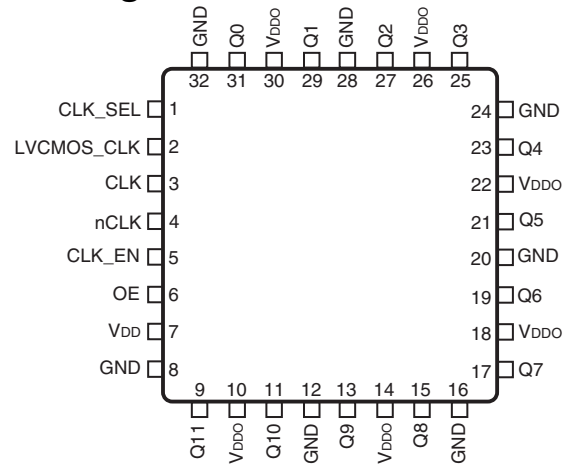
## Features

- Twelve LVCMOS/LVTTL outputs
- Selectable differential CLK/nCLK or LVCMOS/LVTTL clock input
- CLK/nCLK pair can accept the following differential input levels: LVPECL, LVDS, LVHSTL, SSTL, HCSL
- LVCMOS\_CLK supports the following input types: LVCMOS, LVTTTL
- Output frequency: 350MHz
- Additive phase jitter, RMS: 0.14ps (typical)
- Output skew: 100ps (maximum), 3.3V±5%
- Part-to-part skew: 1ns (maximum), 3.3V±5%
- Operating supply modes:
  - Core/Output 3.3V/3.3V
  - 3.3V/2.5V
  - 2.5V/2.5V
- -40°C to 85°C ambient operating temperature
- Lead-free (RoHS 6) packaging

## Block Diagram



## Pin Assignment



**83948I-147**  
**32-Lead LQFP**  
**7mm x 7mm x 1.4mm package body**  
**Y Package**  
**Top View**

## Pin Descriptions and Characteristics

**Table 1. Pin Descriptions**

| Number  | Name   | Type   |          | Description   |
|---|--|--------|----------|---|
| 1   | CLK_SEL  | Input  | Pullup   | Clock select input. When HIGH, selects LVCMOS_CLK input. When LOW, selects CLK/nCLK inputs. LVCMOS / LVTTTL interface levels.       |
| 2   | LVCMOS_CLK                                       | Input  | Pullup   | Single-ended clock input. LVCMOS/LVTTTL interface levels.   |
| 3   | CLK  | Input  | Pullup   | Non-inverting differential clock input.   |
| 4   | nCLK   | Input  | Pulldown | Inverting differential clock input.   |
| 5   | CLK_EN   | Input  | Pullup   | Clock enable pin. LVCMOS/LVTTTL interface levels.   |
| 6   | OE   | Input  | Pullup   | Output enable pin. When LOW, outputs are in an High-impedance state. when HIGH, outputs are active. LVCMOS/LVTTTL interface levels. |
| 7   | V <sub>DD</sub>                                  | Power  |          | Power supply pin.   |
| 8, 12, 16, 20, 24, 28, 32                     | GND  | Power  |          | Power supply ground.  |
| 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31 | Q11, Q10, Q9, Q8, Q7, Q6, Q5, Q4, Q3, Q2, Q1, Q0 | Output |          | Single-ended clock outputs. LVCMOS/LVTTTL interface levels.   |
| 10, 14, 18, 22, 26, 30                        | V <sub>DDO</sub>                                 | Power  |          | Output supply pins.   |

NOTE: *Pullup* and *Pulldown* refer to internal input resistors. See Table 2, *Pin Characteristics*, for typical values.

**Table 2. Pin Characteristics**

| Symbol                | Parameter                                  | Test Conditions | Minimum | Typical | Maximum | Units |
|-----------------------|--|-----------------|---------|---------|---------|-------|
| C <sub>IN</sub>       | Input Capacitance                          |                 |         | 4       |         | pF    |
| R <sub>PULLUP</sub>   | Input Pullup Resistor                      |                 |         | 51      |         | kΩ    |
| R <sub>PULLDOWN</sub> | Input Pulldown Resistor                    |                 |         | 51      |         | kΩ    |
| C <sub>PD</sub>       | Power Dissipation Capacitance (per output) |                 |         | 12      |         | pF    |
| R <sub>OUT</sub>      | Output Impedance                           |                 | 5       | 7       | 12      | Ω     |

## Function Tables

**Table 3A. Clock Select Function Table**

| Control Input | Clock                     |
|---------------|---------------------------|
| 0             | CLK/nCLK inputs selected  |
| 1             | LVCMOS_CLK input selected |

**Table 3B. Clock Input Function Table**

| Inputs  |             |                |                | Outputs | Input to Output Mode         | Polarity      |
|---------|-------------|----------------|----------------|---------|------------------------------|---------------|
| CLK_SEL | LVC MOS_CLK | CLK            | nCLK           | Q[0:11] |                              |               |
| 0       | –           | 0              | 1              | LOW     | Differential to Single-Ended | Non-Inverting |
| 0       | –           | 1              | 0              | HIGH    | Differential to Single-Ended | Non-Inverting |
| 0       | –           | 0              | Biased; NOTE 1 | LOW     | Single-Ended to Single-Ended | Non-Inverting |
| 0       | –           | 1              | Biased; NOTE 1 | HIGH    | Single-Ended to Single-Ended | Non-Inverting |
| 0       | –           | Biased; NOTE 1 | 0              | HIGH    | Single-Ended to Single-Ended | Inverting     |
| 0       | –           | Biased; NOTE 1 | 1              | LOW     | Single-Ended to Single-Ended | Inverting     |
| 1       | 0           | –              | –              | LOW     | Single-Ended to Single-Ended | Non-Inverting |
| 1       | 1           | –              | –              | HIGH    | Single-Ended to Single-Ended | Non-Inverting |

NOTE 1: Please refer to the Application Information Section, *Wiring the Differential Input to Accept Single-ended Levels*.

## Absolute Maximum Ratings

NOTE: Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These ratings are stress specifications only. Functional operation of product at these conditions or any conditions beyond those listed in the *DC Characteristics* or *AC Characteristics* is not implied. Exposure to absolute maximum rating conditions for extended periods may affect product reliability.

| Item                                     | Rating                    |
|--|---------------------------|
| Supply Voltage, $V_{DD}$                 | 4.6V                      |
| Inputs, $V_I$                            | -0.5V to $V_{DD} + 0.5V$  |
| Outputs, $V_O$                           | -0.5V to $V_{DDO} + 0.5V$ |
| Package Thermal Impedance, $\theta_{JA}$ | 73.6°C/W (0 mps)          |
| Storage Temperature, $T_{STG}$           | -65°C to 150°C            |

## DC Electrical Characteristics

**Table 4A. Power Supply DC Characteristics,  $V_{DD} = V_{DDO} = 3.3V \pm 5\%$ ,  $T_A = -40^\circ C$  to  $85^\circ C$** 

| Symbol    | Parameter             | Test Conditions | Minimum | Typical | Maximum | Units |
|-----------|-----------------------|-----------------|---------|---------|---------|-------|
| $V_{DD}$  | Power Supply Voltage  |                 | 3.135   | 3.3     | 3.465   | V     |
| $V_{DDO}$ | Output Supply Voltage |                 | 3.135   | 3.3     | 3.465   | V     |
| $I_{DD}$  | Power Supply Current  |                 |         |         | 55      | mA    |

**Table 4B. Power Supply DC Characteristics,  $V_{DD} = V_{DDO} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ C$  to  $85^\circ C$** 

| Symbol    | Parameter               | Test Conditions | Minimum | Typical | Maximum | Units |
|-----------|-------------------------|-----------------|---------|---------|---------|-------|
| $V_{DD}$  | Positive Supply Voltage |                 | 2.375   | 2.5     | 2.625   | V     |
| $V_{DDO}$ | Output Supply Voltage   |                 | 2.375   | 2.5     | 2.625   | V     |
| $I_{DD}$  | Power Supply Current    |                 |         |         | 52      | mA    |

**Table 4C. Power Supply DC Characteristics,  $V_{DD} = 3.3V \pm 5\%$ ,  $V_{DDO} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$** 

| Symbol    | Parameter             | Test Conditions | Minimum | Typical | Maximum | Units |
|-----------|-----------------------|-----------------|---------|---------|---------|-------|
| $V_{DD}$  | Power Supply Voltage  |                 | 3.135   | 3.3     | 3.465   | V     |
| $V_{DDO}$ | Output Supply Voltage |                 | 2.375   | 2.5     | 2.625   | V     |
| $I_{DD}$  | Power Supply Current  |                 |         |         | 55      | mA    |

**Table 4D. DC Characteristics,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$** 

| Symbol    | Parameter                            |          | Test Conditions                                     | Minimum   | Typical | Maximum         | Units         |
|-----------|--------------------------------------|----------|---|-----------|---------|-----------------|---------------|
| $V_{IH}$  | Input High Voltage                   | LVC MOS  | $V_{DD} = 3.465V$                                   | 2         |         | $V_{DD} + 0.3$  | V             |
|           |                                      | LVC MOS  | $V_{DD} = 2.625V$                                   | 1.7       |         | $V_{DD} + 0.3$  | V             |
| $V_{IL}$  | Input Low Voltage                    | LVC MOS  | $V_{DD} = 3.465V$                                   | -0.3      |         | 0.8             | V             |
|           |                                      | LVC MOS  | $V_{DD} = 2.625V$                                   | -0.3      |         | 0.7             | V             |
| $I_{IN}$  | Input Current                        |          | $V_{IN} = V_{DD}$ or $V_{IN} = 3.465V$ or $2.625V$  |           |         | 300             | $\mu\text{A}$ |
| $V_{OH}$  | Output High Voltage; NOTE 1          |          | $V_{DDO} = 3.3V \pm 5\%$<br>$I_{OH} = -24\text{mA}$ | 2.4       |         |                 | V             |
|           |                                      |          | $V_{DDO} = 2.5V \pm 5\%$<br>$I_{OH} = -15\text{mA}$ | 1.8       |         |                 | V             |
| $V_{OL}$  | Output Low Voltage; NOTE 1           |          | $V_{DDO} = 3.3V \pm 5\%$<br>$I_{OL} = 24\text{mA}$  |           |         | 0.55            | V             |
|           |                                      |          | $V_{DDO} = 3.3V \pm 5\%$<br>$I_{OL} = 12\text{mA}$  |           |         | 0.30            | V             |
|           |                                      |          | $V_{DDO} = 2.5V \pm 5\%$<br>$I_{OL} = 15\text{mA}$  |           |         | 0.6             | V             |
| $V_{PP}$  | Peak-to-Peak Input Voltage; NOTE 2   | CLK/nCLK | $V_{DD} = 3.465V$ or $2.625V$                       | 0.15      |         | 1.3             | V             |
| $V_{CMR}$ | Common Mode Input Voltage; NOTE 2, 3 | CLK/nCLK | $V_{DD} = 3.465V$ or $2.625V$                       | GND + 0.5 |         | $V_{DD} - 0.85$ | V             |

NOTE 1: Outputs capable of driving  $50\Omega$  transmission lines terminated with  $50\Omega$  to  $V_{DDO}/2$ . See Parameter Measurement section, *Output Load AC Test Circuit diagrams*.

NOTE 2:  $V_{IL}$  should not be less than  $-0.3V$ .

NOTE 3: Common mode voltage is defined as  $V_{IH}$ .

## AC Electrical Characteristics

**Table 5A. AC Characteristics,  $V_{DD} = V_{DDO} = 3.3V \pm 5\%$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$** 

| Parameter          | Symbol  | Test Conditions                             | Minimum                | Typical | Maximum | Units |
|--------------------|---|---|------------------------|---------|---------|-------|
| $f_{MAX}$          | Output Frequency  |   |                        |         | 350     | MHz   |
| $t_{PD}$           | Propagation Delay   | CLK/nCLK; NOTE 1                            | $f \leq 350\text{MHz}$ | 2       | 4       | ns    |
|                    |   | LVC MOS_CLK; NOTE 2                         | $f \leq 350\text{MHz}$ | 2       | 4       | ns    |
| $f_{jit}$          | Buffer Additive Phase Jitter, RMS; refer to Additive Phase Jitter Section | 155.52MHz, Integration Range: 12kHz – 20MHz |                        | 0.14    | 1       | ps    |
| $t_{sk(o)}$        | Output Skew; NOTE 3, 7  | Measured on the Rising Edge @ $V_{DDO}/2$   |                        |         | 100     | ps    |
| $t_{sk(pp)}$       | Part-to-Part Skew; NOTE 4, 7  | Measured on the Rising Edge @ $V_{DDO}/2$   |                        |         | 1       | ns    |
| $t_R / t_F$        | Output Rise/Fall Time   | 0.8V to 2V                                  | 0.2                    |         | 1.0     | ns    |
| odc                | Output Duty Cycle   | $f \leq 150\text{MHz}$ , Ref = CLK/nCLK     | 45                     | 50      | 55      | %     |
| $t_{PZL}, t_{PZH}$ | Output Enable Time; NOTE 5  |   |                        |         | 5       | ns    |
| $t_{PLZ}, t_{PHZ}$ | Output Disable Time; NOTE 5   |   |                        |         | 5       | ns    |
| $t_S$              | Clock Enable Setup Time; NOTE 6   | CLK_EN to CLK/nCLK                          |                        | 1       |         | ns    |
|                    |   | CLK_EN to LVC MOS_CLK                       |                        | 0       |         | ns    |
| $t_H$              | Clock Enable Hold Time; NOTE 6  | CLK/nCLK to CLK_EN                          |                        | 0       |         | ns    |
|                    |   | LVC MOS_CLK to CLK_EN                       |                        | 1       |         | ns    |

NOTE: 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 500 lpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.

NOTE 1: Measured from the differential input crossing point to  $V_{DDO}/2$  of the output.

NOTE 2: Measured from  $V_{DD}/2$  of the input to  $V_{DDO}/2$  of the output.

NOTE 3: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at  $V_{DDO}/2$ .

NOTE 4: Defined as skew between outputs on different devices operating at the same supply voltage and with equal load conditions. Using the same type of input on each device, the output is measured at  $V_{DDO}/2$ .

NOTE 5: These parameters are guaranteed by characterization. Not tested in production.

NOTE 6: Setup and Hold times are relative to the rising edge of the input clock.

NOTE 7: This parameter is defined in accordance with JEDEC Standard 65.

**Table 5B. AC Characteristics,  $V_{DD} = V_{DDO} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$** 

| Parameter          | Symbol  | Test Conditions                             | Minimum                | Typical | Maximum | Units |
|--------------------|---|---|------------------------|---------|---------|-------|
| $f_{MAX}$          | Output Frequency  |   |                        |         | 350     | MHz   |
| $t_{PD}$           | Propagation Delay   | CLK/nCLK; NOTE 1                            | $f \leq 350\text{MHz}$ | 1.5     | 4.2     | ns    |
|                    |   | LVC MOS_CLK; NOTE 2                         | $f \leq 350\text{MHz}$ | 1.7     | 4.4     | ns    |
| $f_{jit}$          | Buffer Additive Phase Jitter, RMS; refer to Additive Phase Jitter Section | 155.52MHz, Integration Range: 12kHz – 20MHz |                        | 0.14    | 1       | ps    |
| $t_{sk(o)}$        | Output Skew; NOTE 3, 7  | Measured on the Rising Edge @ $V_{DDO}/2$   |                        |         | 160     | ps    |
| $t_{sk(pp)}$       | Part-to-Part Skew; NOTE 4, 7  | Measured on the Rising Edge @ $V_{DDO}/2$   |                        |         | 2       | ns    |
| $t_R / t_F$        | Output Rise/Fall Time   | 0.6V to 1.8V                                | 0.1                    |         | 1.0     | ns    |
| odc                | Output Duty Cycle   | $f \leq 150\text{MHz}$ , Ref = CLK/nCLK     | 40                     |         | 60      | %     |
| $t_{PZL}, t_{PZH}$ | Output Enable Time; NOTE 5  |   |                        |         | 5       | ns    |
| $t_{PLZ}, t_{PHZ}$ | Output Disable Time; NOTE 5   |   |                        |         | 5       | ns    |
| $t_S$              | Clock Enable Setup Time; NOTE 6   | CLK_EN to CLK/nCLK                          |                        | 1       |         | ns    |
|                    |   | CLK_EN to LVC MOS_CLK                       |                        | 0       |         | ns    |
| $t_H$              | Clock Enable Hold Time; NOTE 6  | CLK/nCLK to CLK_EN                          |                        | 0       |         | ns    |
|                    |   | LVC MOS_CLK to CLK_EN                       |                        | 1       |         | ns    |

NOTE: 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 500 lpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.

NOTE 1: Measured from the differential input crossing point to  $V_{DDO}/2$  of the output.

NOTE 2: Measured from  $V_{DD}/2$  of the input to  $V_{DDO}/2$  of the output.

NOTE 3: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at  $V_{DDO}/2$ .

NOTE 4: Defined as skew between outputs on different devices operating at the same supply voltage and with equal load conditions. Using the same type of input on each device, the output is measured at  $V_{DDO}/2$ .

NOTE 5: These parameters are guaranteed by characterization. Not tested in production.

NOTE 6: Setup and Hold times are relative to the rising edge of the input clock.

NOTE 7: This parameter is defined in accordance with JEDEC Standard 65.

**Table 5C. AC Characteristics,  $V_{DD} = 3.3V \pm 5\%$ ,  $V_{DDO} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$** 

| Parameter          | Symbol  | Test Conditions                             | Minimum                | Typical | Maximum | Units |
|--------------------|---|---|------------------------|---------|---------|-------|
| $f_{MAX}$          | Output Frequency  |   |                        |         | 350     | MHz   |
| $t_{PD}$           | Propagation Delay   | CLK/nCLK; NOTE 1                            | $f \leq 350\text{MHz}$ | 2       | 4       | ns    |
|                    |   | LVC MOS_CLK; NOTE 2                         | $f \leq 350\text{MHz}$ | 2       | 4       | ns    |
| $f_{jit}$          | Buffer Additive Phase Jitter, RMS; refer to Additive Phase Jitter Section | 155.52MHz, Integration Range: 12kHz – 20MHz |                        | 0.14    | 1       | ps    |
| $t_{sk(o)}$        | Output Skew; NOTE 3, 7  | Measured on the Rising Edge @ $V_{DDO}/2$   |                        |         | 100     | ps    |
| $t_{sk(pp)}$       | Part-to-Part Skew; NOTE 4, 7  | Measured on the Rising Edge @ $V_{DDO}/2$   |                        |         | 1       | ns    |
| $t_R / t_F$        | Output Rise/Fall Time   | 0.8V to 2V                                  | 0.1                    |         | 1.0     | ns    |
| odc                | Output Duty Cycle   | $f \leq 200\text{MHz}$ , Ref = CLK/nCLK     | 45                     |         | 55      | %     |
| $t_{PZL}, t_{PZH}$ | Output Enable Time; NOTE 5  |   |                        |         | 5       | ns    |
| $t_{PLZ}, t_{PHZ}$ | Output Disable Time; NOTE 5   |   |                        |         | 5       | ns    |
| $t_S$              | Clock Enable Setup Time; NOTE 6   | CLK_EN to CLK/nCLK                          |                        | 1       |         | ns    |
|                    |   | CLK_EN to LVC MOS_CLK                       |                        | 0       |         | ns    |
| $t_H$              | Clock Enable Hold Time; NOTE 6  | CLK/nCLK to CLK_EN                          |                        | 0       |         | ns    |
|                    |   | LVC MOS_CLK to CLK_EN                       |                        | 1       |         | ns    |

NOTE: 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 500 lpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.

NOTE 1: Measured from the differential input crossing point to  $V_{DDO}/2$  of the output.

NOTE 2: Measured from  $V_{DD}/2$  of the input to  $V_{DDO}/2$  of the output.

NOTE 3: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at  $V_{DDO}/2$ .

NOTE 4: Defined as skew between outputs on different devices operating at the same supply voltage and with equal load conditions. Using the same type of input on each device, the output is measured at  $V_{DDO}/2$ .

NOTE 5: These parameters are guaranteed by characterization. Not tested in production.

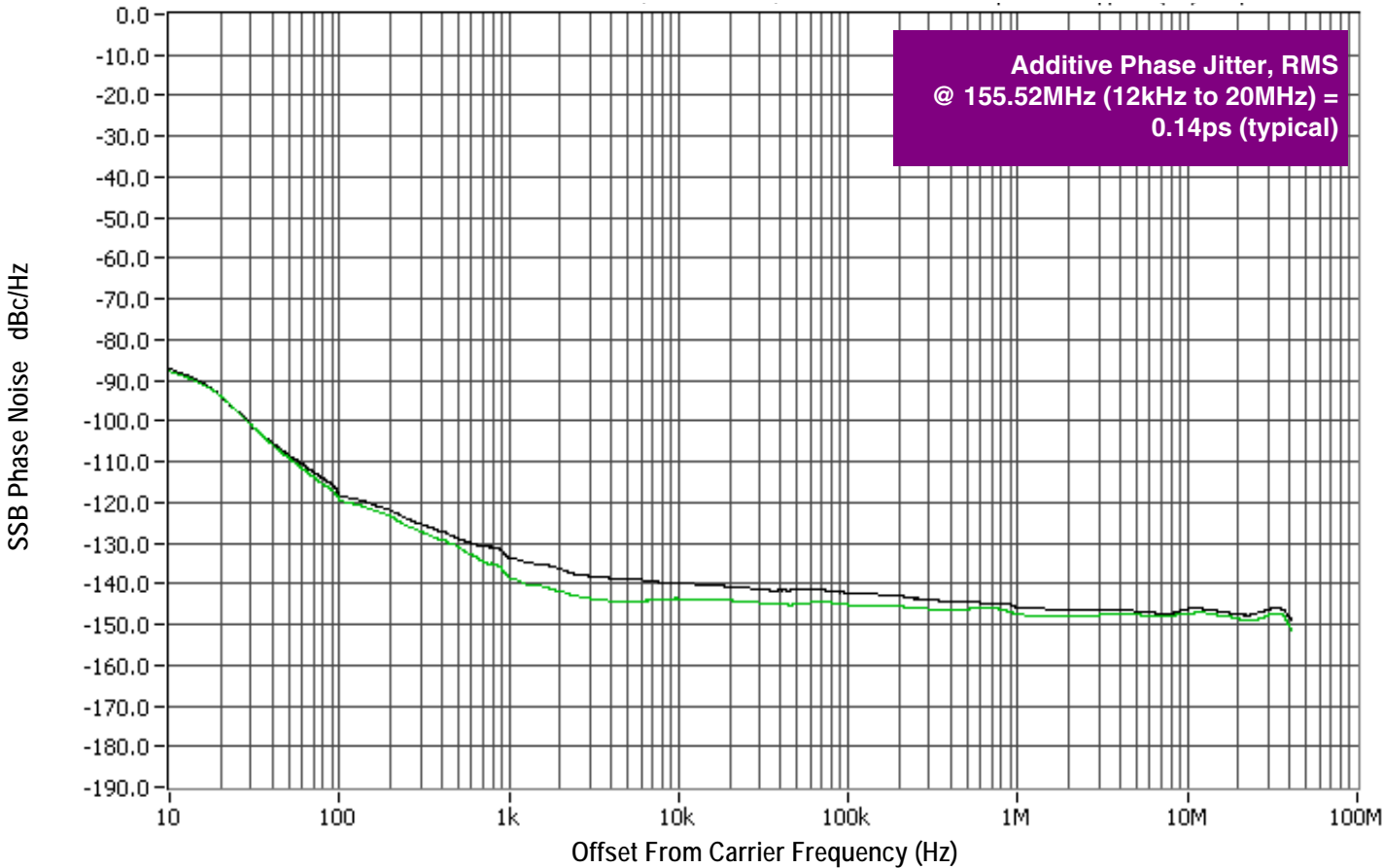
NOTE 6: Setup and Hold times are relative to the rising edge of the input clock.

NOTE 7: This parameter is defined in accordance with JEDEC Standard 65.

## Additive Phase Jitter

The spectral purity in a band at a specific offset from the fundamental compared to the power of the fundamental is called the ***dBc Phase Noise***. This value is normally expressed using a Phase noise plot and is most often the specified plot in many applications. Phase noise is defined as the ratio of the noise power present in a 1Hz band at a specified offset from the fundamental frequency to the power value of the fundamental. This ratio is expressed in decibels (dBm) or a ratio of the power in the 1Hz band to the power in the

fundamental. When the required offset is specified, the phase noise is called a ***dBc*** value, which simply means dBm at a specified offset from the fundamental. By investigating jitter in the frequency domain, we get a better understanding of its effects on the desired application over the entire time record of the signal. It is mathematically possible to calculate an expected bit error rate given a phase noise plot.

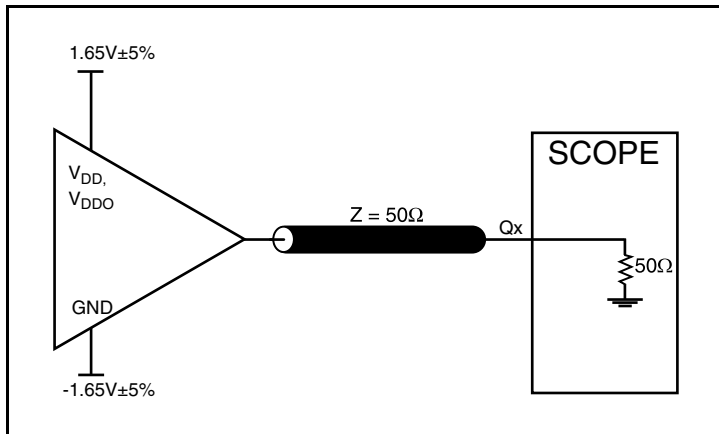


As with most timing specifications, phase noise measurements has issues relating to the limitations of the equipment. Often the noise floor of the equipment is higher than the noise floor of the device.

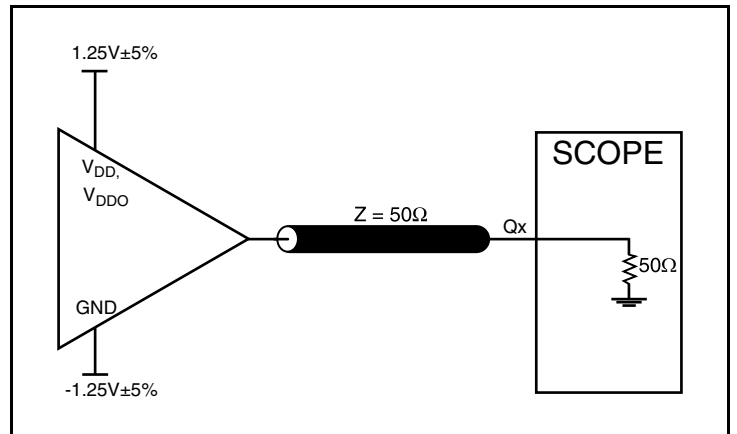
This is illustrated above. The device meets the noise floor of what is shown, but can actually be lower. The phase noise is dependent on the input source and measurement equipment.



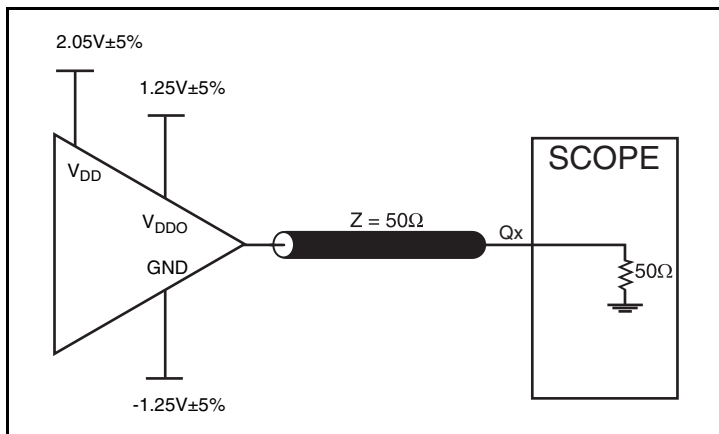
### Parameter Measurement Information



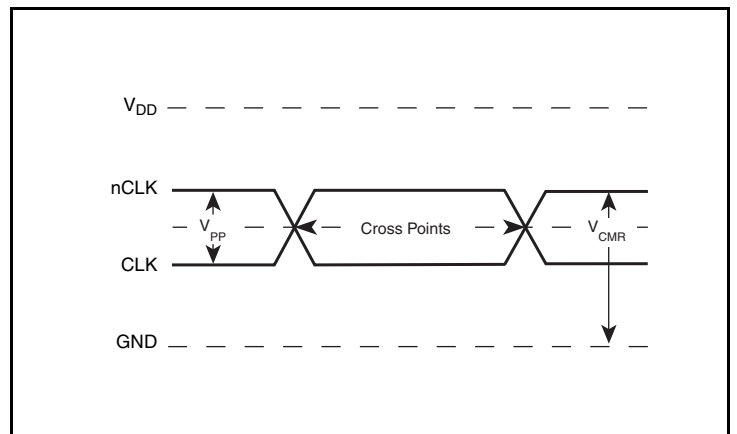
3.3V Core/3.3V LVCMOS Output Load AC Test Circuit



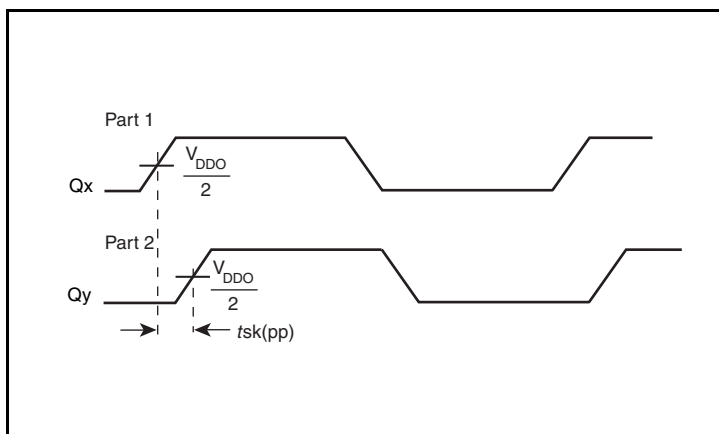
2.5V Core/2.5V LVCMOS Output Load AC Test Circuit



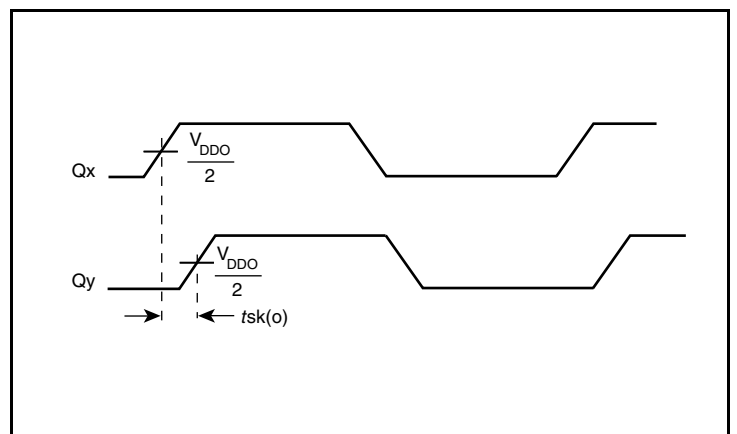
3.3V Core/2.5V LVCMOS Output Load AC Test Circuit



Differential Input Level

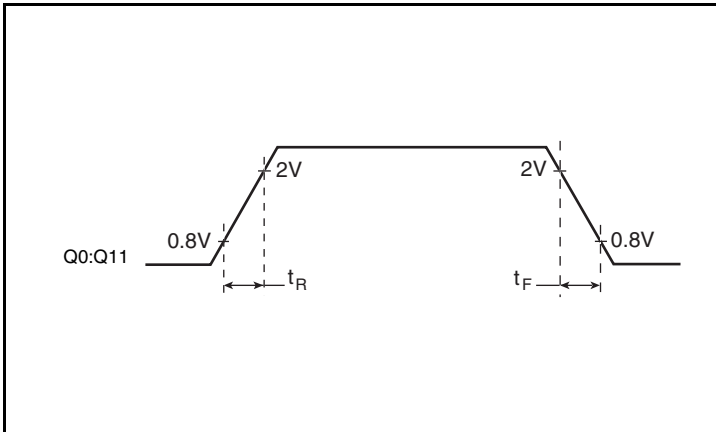


Part-to-Part Skew

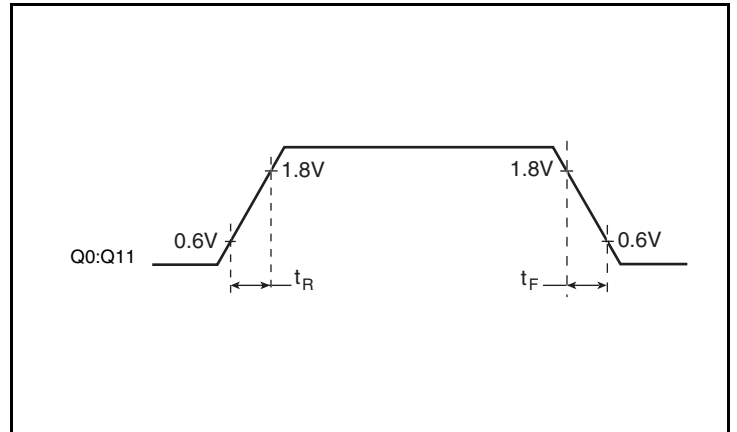


Output Skew

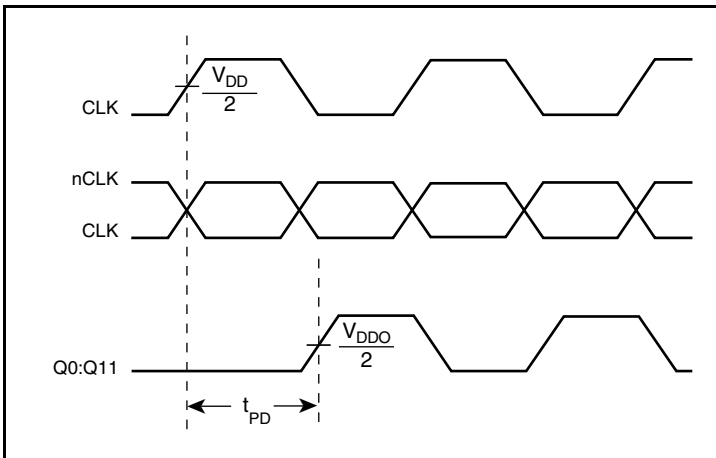
## Parameter Measurement Information, continued



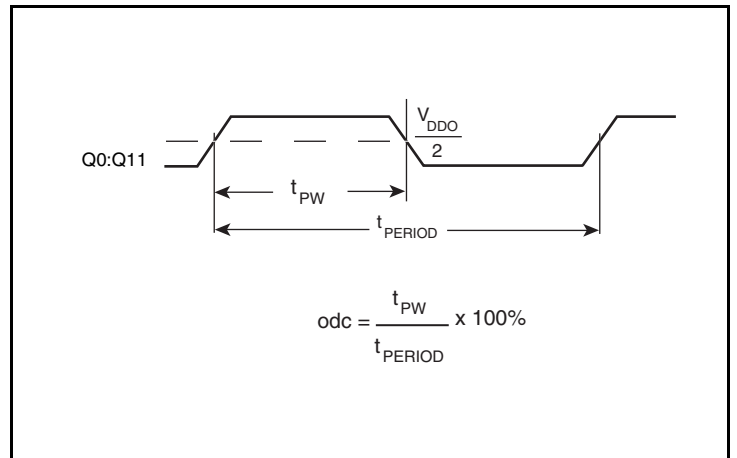
**3.3V Output Rise/Fall Time**



**2.5V Output Rise/Fall Time**



**Propagation Delay**



**Output Duty Cycle/Pulse Width/Period**

## Application Information

### Wiring the Differential Input to Accept Single Ended Levels

Figure 1 shows how the differential input can be wired to accept single ended levels. The reference voltage  $V_{REF} = V_{DD}/2$  is generated by the bias resistors R1, R2 and C1. This bias circuit should be located as close as possible to the input pin. The ratio of R1 and R2 might need to be adjusted to position the  $V_{REF}$  in the center of the input voltage swing. For example, if the input clock swing is only 2.5V and  $V_{DD} = 3.3V$ ,  $V_{REF}$  should be 1.25V and  $R2/R1 = 0.609$ .

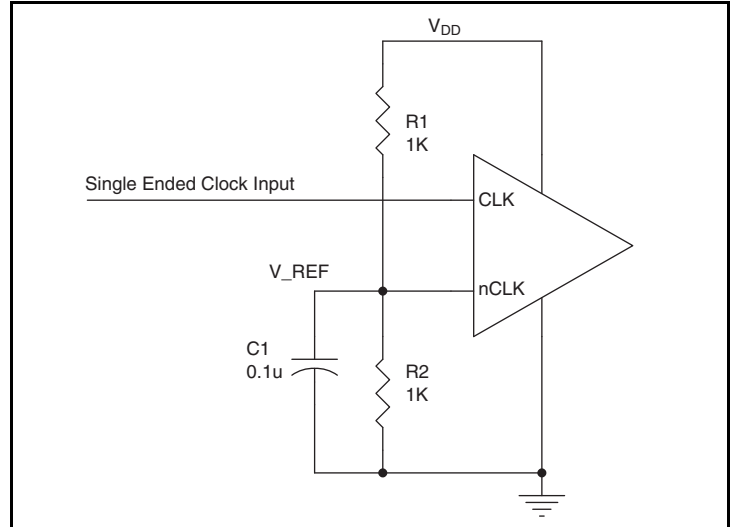


Figure 1. Single-Ended Signal Driving Differential Input

### 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.

##### CLK Input

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

##### LVC MOS 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.

#### Outputs:

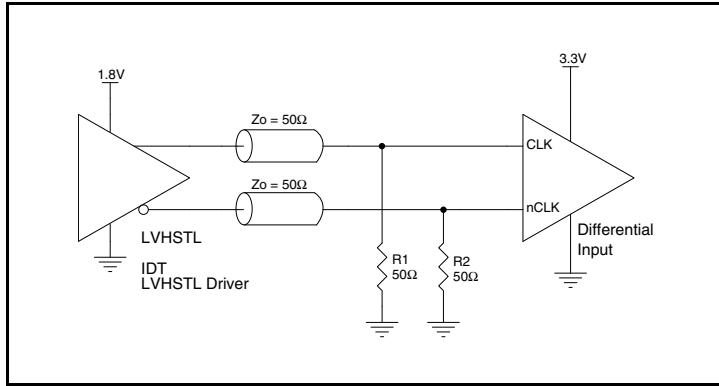
##### LVC MOS Outputs

All unused LVC MOS output can be left floating. There should be no trace attached.

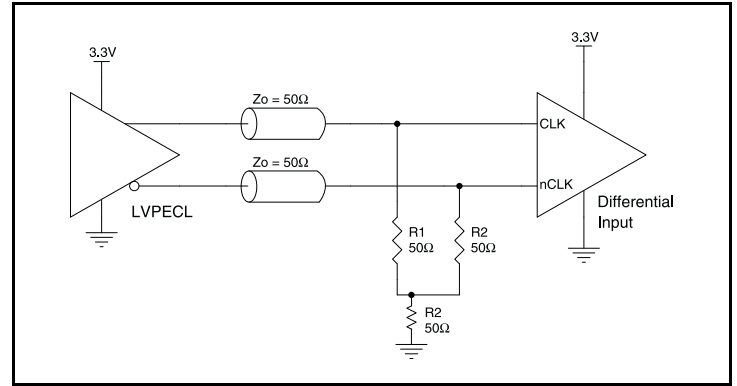
## Differential Clock Input Interface

The CLK /nCLK accepts LVDS, LVPECL, LVHSTL, SSTL, HCSL and other differential signals. Both signals must meet the  $V_{PP}$  and  $V_{CMR}$  input requirements. *Figures 2A to 2F* 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

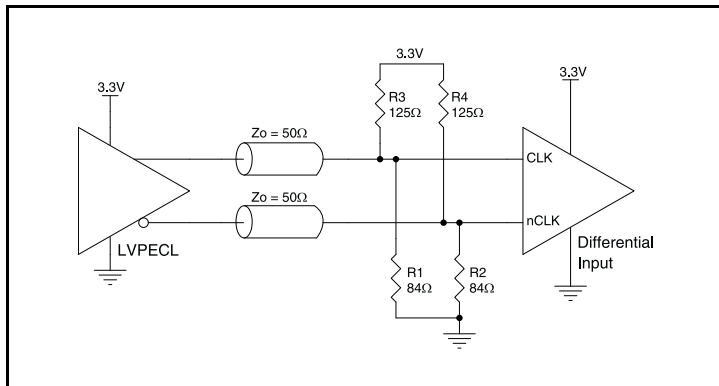
vendor of the driver component to confirm the driver termination requirements. For example, in Figure 2A, the input termination applies for IDT open emitter LVHSTL drivers. If you are using an LVHSTL driver from another vendor, use their termination recommendation.



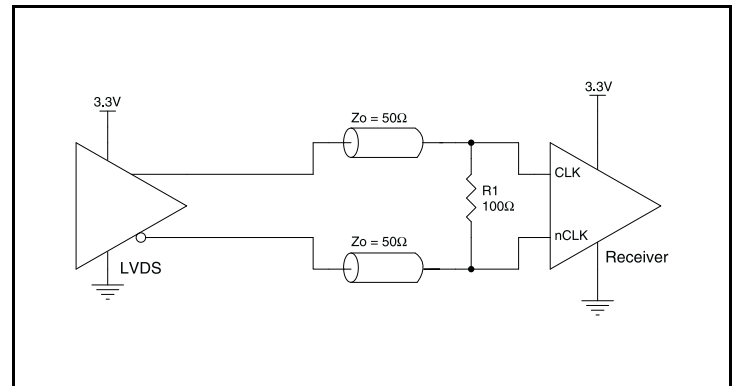
**Figure 2A.** CLK/nCLK Input Driven by an IDT Open Emitter LVHSTL Driver



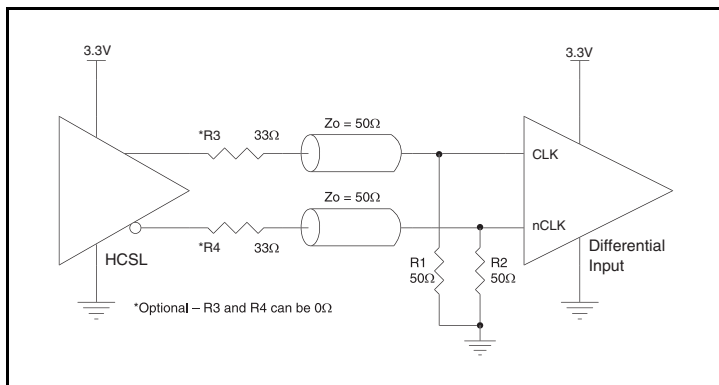
**Figure 2B.** CLK/nCLK Input Driven by a 3.3V LVPECL Driver



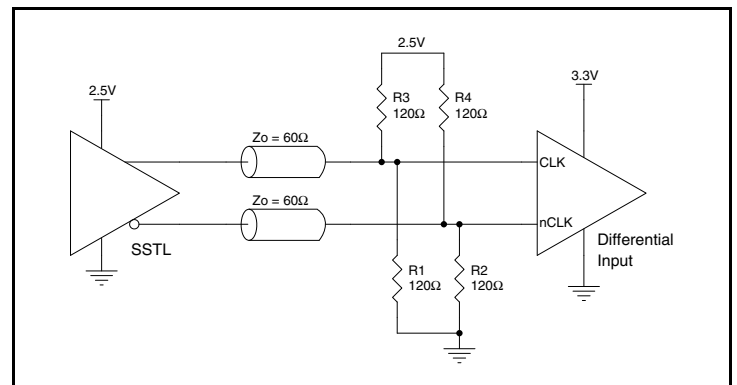
**Figure 2C.** CLK/nCLK Input Driven by a 3.3V LVPECL Driver



**Figure 2D.** CLK/nCLK Input Driven by a 3.3V LVDS Driver



**Figure 2E.** CLK/nCLK Input Driven by a 3.3V HCSL Driver



**Figure 2F.** CLK/nCLK Input Driven by a 2.5V SSTL Driver

## Reliability Information

**Table 6.  $\theta_{JA}$  vs. Air Flow Table for a 32-Lead LQFP**

| $\theta_{JA}$ vs. Air Flow                  |          |          |          |
|---|----------|----------|----------|
| Meters per Second                           | 0        | 1        | 2.5      |
| Multi-Layer PCB, JEDEC Standard Test Boards | 73.6°C/W | 63.9°C/W | 60.3°C/W |

## Transistor Count

The transistor count for 839481-147 is: 1040  
 Pin compatible with the MPC9448

## Package Outline and Package Dimension

### Package Outline - Y Suffix for 32-Lead LQFP

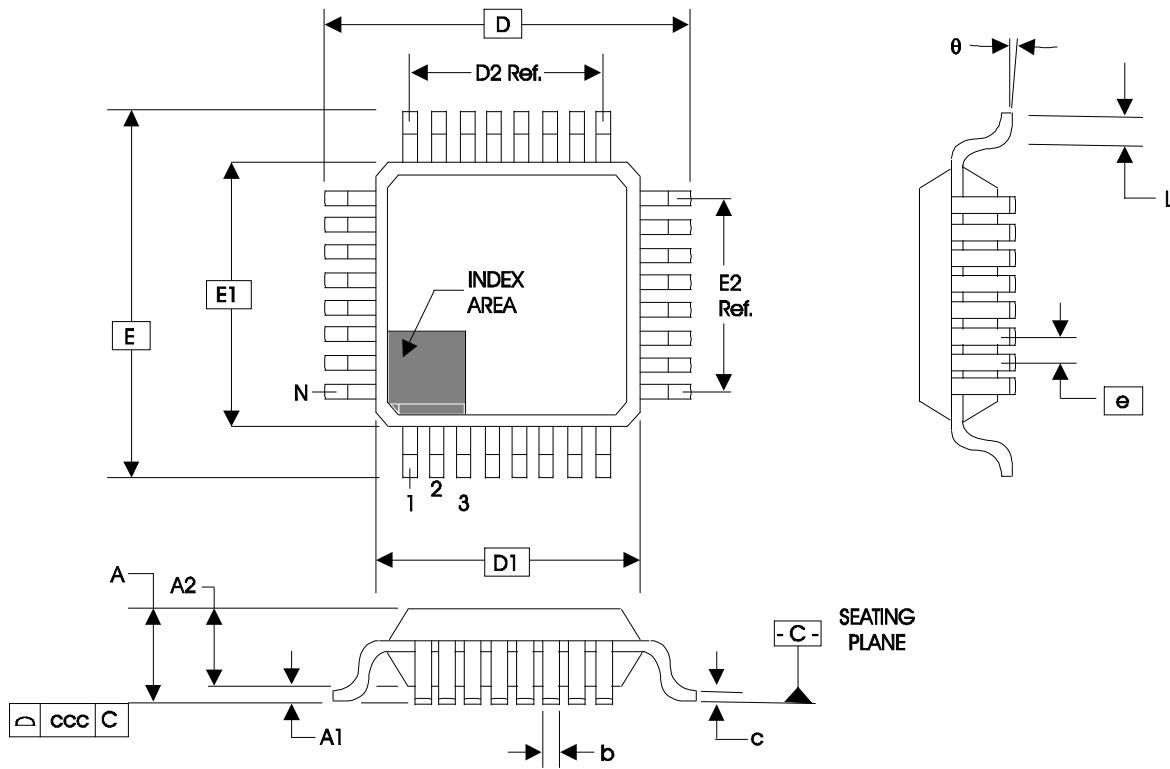


Table 7. Package Dimensions for 32-Lead LQFP

| JEDEC Variation: ABC - HD<br>All Dimensions in Millimeters |            |         |         |
|--|------------|---------|---------|
| Symbol   | Minimum    | Nominal | Maximum |
| <b>N</b>   | 32         |         |         |
| <b>A</b>   |            |         | 1.60    |
| <b>A1</b>  | 0.05       | 0.10    | 0.15    |
| <b>A2</b>  | 1.35       | 1.40    | 1.45    |
| <b>b</b>   | 0.30       | 0.37    | 0.45    |
| <b>c</b>   | 0.09       |         | 0.20    |
| <b>D &amp; E</b>   | 9.00 Basic |         |         |
| <b>D1 &amp; E1</b>   | 7.00 Basic |         |         |
| <b>D2 &amp; E2</b>   | 5.60 Ref.  |         |         |
| <b>e</b>   | 0.80 Basic |         |         |
| <b>L</b>   | 0.45       | 0.60    | 0.75    |
| <b>θ</b>   | 0°         |         | 7°      |
| <b>ccc</b>   |            |         | 0.10    |

Reference Document: JEDEC Publication 95, MS-026

## Ordering Information

**Table 8. Ordering Information**

| <b>Part/Order Number</b> | <b>Marking</b> | <b>Package</b>           | <b>Shipping Packaging</b> | <b>Temperature</b> |
|--------------------------|----------------|--------------------------|---------------------------|--------------------|
| 83948AYI-147LF           | ICS948AI147L   | "Lead-Free" 32-Lead LQFP | Tray                      | -40°C to 85°C      |
| 83948AYI-147LFT          | ICS948AI147L   | "Lead-Free" 32-Lead LQFP | Tape & Reel               | -40°C to 85°C      |

## Revision History Sheet

| Rev | Table      | Page   | Description of Change   | Date     |
|-----|------------|--|---|----------|
| B   | T2         | 1  | Features Section - added Lead-Free bullet.  | 11/21/05 |
|     |            | 2  | Pin Characteristics Table - changed $C_{IN}$ from 4pF max. to 4pF typical; and added 5 $\Omega$ min. and 12 $\Omega$ max to $R_{OUT}$ . |          |
|     | 7          | Updated <i>Single Ended Signal Driving Differential Input diagram</i> .<br>Added <i>Recommendations for Unused Input and Output Pins</i> . |   |          |
|     | T8         | 10   | Ordering Information Table - added lead-free part number, marking, and note.  |          |
| C   | T5A<br>T5B | 1  | Features Section - added <i>Additive Phase Jitter</i> bullet.   | 1/15/08  |
|     |            | 5  | 3.3V AC Characteristics Table - added <i>Additive Phase Jitter</i> .  |          |
|     | 6          | 3.3V AC Characteristics Table - added <i>Additive Phase Jitter</i> .   |   |          |
|     | 7          | Added <i>Additive Phase Jitter</i> section.  |   |          |
|     | T6         | 11   | Updated <i>Differential Input Clock Interface</i> section.  |          |
| 12  |            | Updated <i>Reliability Information</i> .<br>Updated format throughout the datasheet.   |   |          |
| D   | T4C<br>T5C | 1  | Features Section - added mix voltage to supply voltage bullet.  | 4/1/09   |
|     |            | 4  | Added Mix DC Characteristics Power Supply Table.  |          |
|     | 7          | Added Mix AC Characteristics Table.  |   |          |
|     | 9          | Parameter Measurement Information Section - added 3.3V/2.5V LVCMOS<br><i>Output Load AC Test Circuit</i> diagram.                          |   |          |
|     | T8         | 15   | Ordering Information Table - deleted ICS prefix from Part/Order Number column.  |          |
| D   | T1         | 2  | Output supply pins, Changed $V_{DD}$ to $V_{DDO}$   | 11/1/12  |
| D   | T8         | 15   | Removed leaded orderable parts from Ordering Information table  | 11/14/12 |
| D   | T8         | 15   | Fixed typo: removed extra "l" from orderable part number.   | 7/17/14  |
|     |            | 17   | Updated Headers and Footers.<br>Updated Contact information.  |          |
| D   |            |  | Removed ICS from part number where needed.<br>Updated data sheet header and footer.   | 3/30/16  |





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