

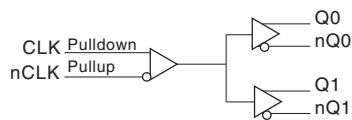
General Description

The 85311 is a low skew, high performance 1-to-2 Differential-to-2.5V/3.3V ECL/LVPECL Fanout Buffer and a member of the high performance clock solutions from IDT. The CLK, nCLK pair can accept most standard differential input levels. The 85311 is characterized to operate from either a 2.5V or a 3.3V power supply. Guaranteed output and part-to-part skew characteristics make the 85311 ideal for those clock distribution applications demanding well defined performance and repeatability.

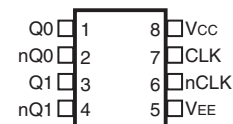
Features

- Two differential 2.5V/3.3V LVPECL / ECL outputs
- One CLK, nCLK input pair
- CLK, nCLK pair can accept the following differential input levels: LVDS, LVPECL, LVHSTL, SSTL, HCSL
- Maximum output frequency: 1GHz
- Translates any single ended input signal to 3.3V LVPECL levels with resistor bias on nCLK input
- Output skew: 15ps (maximum)
- Part-to-part skew: 100ps (maximum)
- Propagation delay: 1.4ns (maximum)
- Additive phase jitter, RMS: 0.14ps (typical), 3.3V
- LVPECL mode operating voltage supply range: $V_{CC} = 2.375V$ to $3.465V$, $V_{EE} = 0V$
- ECL mode operating voltage supply range: $V_{CC} = 0V$, $V_{EE} = -2.375V$ to $-3.465V$
- 0°C to 70°C ambient operating temperature
- Available in lead-free (RoHS 6) package

Block Diagram



Pin Assignment



85311

8-Lead SOIC

3.90mm x 4.903mm x 1.37mm package body

M Package

Top View

Pin Descriptions and Pin Characteristic Tables

Table 1. Pin Descriptions

| Number | Name | Type | | Description |
|--------|-----------------|--------|----------|--|
| 1, 2 | Q0, nQ0 | Output | | Differential output pair. LVPECL interface levels. |
| 3, 4 | Q1, nQ1 | Output | | Differential output pair. LVPECL interface levels. |
| 5 | V _{EE} | Power | | Negative supply pin. |
| 6 | nCLK | Input | Pullup | Inverting differential clock input. |
| 7 | CLK | Input | Pulldown | Non-inverting differential clock input. |
| 8 | V _{CC} | Power | | Positive supply pin. |

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 _{IN} | Input Capacitance | | | 4 | | pF |
| R _{PULLUP} | Input Pullup Resistor | | | 51 | | kΩ |
| R _{PULLDOWN} | Input Pulldown Resistor | | | 51 | | kΩ |

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_{CC} | 4.6V |
| Inputs, V_I | -0.5V to $V_{CC} + 0.5V$ |
| Outputs, I_O Continuous Current Surge Current | 50mA 100mA |
| Storage Temperature, T_{STG} | -65°C to 150°C |
| Package Thermal Impedance, θ_{JA} | 103°C/W (0 lfpm) |

DC Electrical Characteristics

Table 3A. Power Supply DC Characteristics, $V_{CC} = 3.3V \pm 5\%$ or $2.5V \pm 5\%$, $V_{EE} = 0V$, $T_A = 0^\circ C$ to $70^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|----------|-------------------------|-----------------|---------|---------|---------|-------|
| V_{CC} | Positive Supply Voltage | | 3.135 | 3.3 | 3.465 | V |
| | | | 2.375 | 2.5 | 2.625 | V |
| I_{EE} | Power Supply Current | | | | 25 | mA |

Table 3B. Differential DC Characteristics, $V_{CC} = 3.3V \pm 5\%$ or $2.5V \pm 5\%$, $V_{EE} = 0V$, $T_A = 0^\circ C$ to $70^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-----------|---|-----------------|---|---------|-----------------|---------|
| I_{IH} | Input High Current | nCLK | $V_{CC} = V_{IN} = 3.465V$ or $2.625V$ | | 5 | μA |
| | | CLK | $V_{CC} = V_{IN} = 3.465V$ or $2.625V$ | | 150 | μA |
| I_{IL} | Input Low Current | nCLK | $V_{CC} = 3.465V$ or $2.625V$, $V_{IN} = 0V$ | -150 | | μA |
| | | CLK | $V_{CC} = 3.465V$ or $2.625V$, $V_{IN} = 0V$ | -5 | | μA |
| V_{PP} | Peak-to-Peak Input Voltage; NOTE 1 | | 0.15 | | 1.3 | V |
| V_{CMR} | Common Mode Input Voltage; NOTE 1, 2 | | $V_{EE} + 0.5$ | | $V_{CC} - 0.85$ | V |

NOTE 1: V_{IL} should not be less than -0.3V.

NOTE 2: Common mode voltage is defined as V_{IH} .

Table 3C. LVPECL DC Characteristics, $V_{CC} = 3.3V \pm 5\%$ or $2.5V \pm 5\%$, $V_{EE} = 0V$, $T_A = 0^\circ C$ to $70^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-------------|-----------------------------------|-----------------|----------------|---------|----------------|-------|
| V_{OH} | Output High Current; NOTE 1 | | $V_{CC} - 1.4$ | | $V_{CC} - 0.9$ | V |
| V_{OL} | Output Low Current; NOTE 1 | | $V_{CC} - 2.0$ | | $V_{CC} - 1.7$ | V |
| V_{SWING} | Peak-to-Peak Output Voltage Swing | | 0.65 | | 1.0 | V |

NOTE1: Outputs terminated with 50Ω to $V_{CC} - 2V$.

AC Electrical Characteristics

Table 4A. AC Characteristics, $V_{CC} = 3.3V \pm 5\%$, $V_{EE} = 0V$, $T_A = 0^\circ C$ to $70^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|--------------|---|--|---------|---------|---------|-------|
| f_{MAX} | Maximum Output Frequency | | | | 1 | GHz |
| t_{PD} | Propagation Delay; NOTE 1 | $f \leq 1GHz$ | 0.9 | | 1.4 | ns |
| f_{jit} | Buffer Additive Phase Jitter, RMS; refer to Additive Phase Jitter Section | 156.25MHz, Integration Range (12kHz – 20MHz) | | 0.14 | | ps |
| $t_{sk(o)}$ | Output Skew; NOTE 2, 4 | | | | 15 | ps |
| $t_{sk(pp)}$ | Part-to-Part Skew; NOTE 3, 4 | | | | 100 | ps |
| t_R / t_F | Output Rise/Fall Time | 20% to 80% @ 50MHz | 300 | | 700 | ps |
| odc | Output Duty Cycle | | 48 | | 52 | % |

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

All parameters are measured 500MHz unless otherwise noted.

NOTE 1: Measured from the differential input crossing point to the differential output crossing point.

NOTE 2: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at the differential cross points.

NOTE 3: Defined as skew between outputs on different devices operating at the same supply voltages and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at the differential cross points.

NOTE 4: This parameter is defined in accordance with JEDEC Standard 65.

Table 4B. AC Characteristics, $V_{CC} = 2.5V \pm 5\%$, $V_{EE} = 0V$, $T_A = 0^\circ C$ to $70^\circ C$

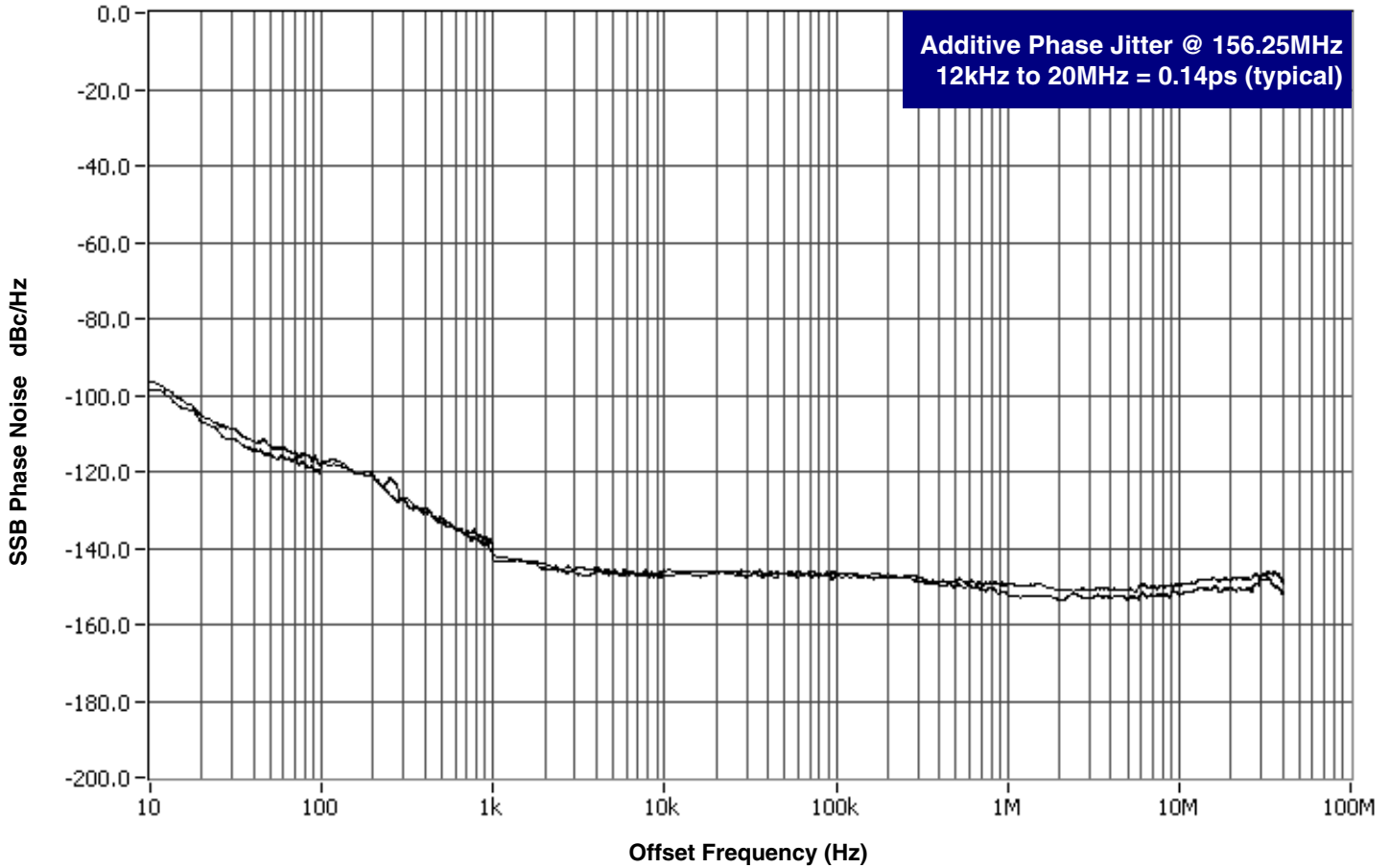
| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|--------------|---|--|---------|---------|---------|-------|
| f_{MAX} | Maximum Output Frequency | | | | 1 | GHz |
| t_{PD} | Propagation Delay; NOTE 1 | $f \leq 1GHz$ | 0.9 | | 1.4 | ns |
| f_{jit} | Buffer Additive Phase Jitter, RMS; refer to Additive Phase Jitter Section | 156.25MHz, Integration Range (12kHz – 20MHz) | | 0.135 | | ps |
| $t_{sk(o)}$ | Output Skew; NOTE 2, 4 | | | | 15 | ps |
| $t_{sk(pp)}$ | Part-to-Part Skew; NOTE 3, 4 | | | | 100 | ps |
| t_R / t_F | Output Rise/Fall Time | 20% to 80% @ 50MHz | 300 | | 700 | ps |
| odc | Output Duty Cycle | | 48 | | 52 | % |

See Table 5A for NOTES.

Additive Phase Jitter (3.3V)

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

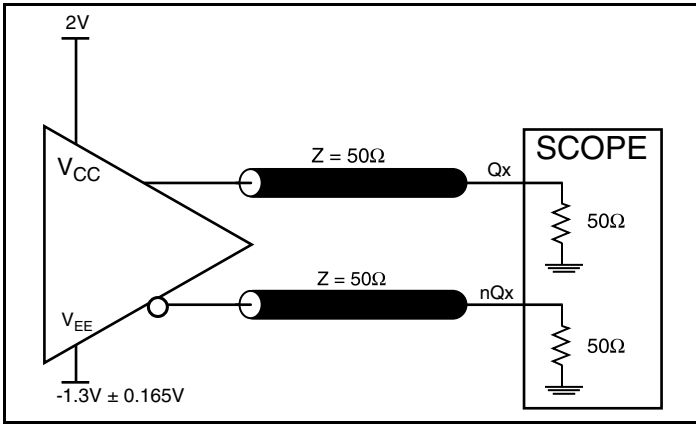
of the power in the 1Hz band to the power in the fundamental. When the required offset is specified, the phase noise is called a ***dBc*** value, which simply means dBm at a specified offset from the fundamental. By investigating jitter in the frequency domain, we get a better understanding of its effects 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.



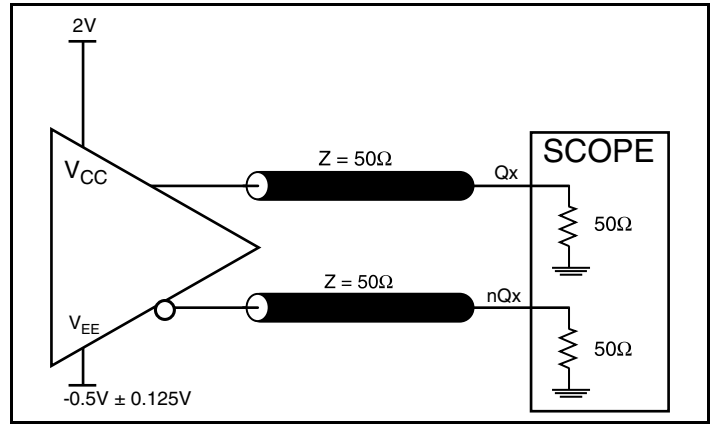
As with most timing specifications, phase noise measurements has issues relating to the limitations of the equipment. Often the noise floor of the equipment is higher than the noise floor of the device. This

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.

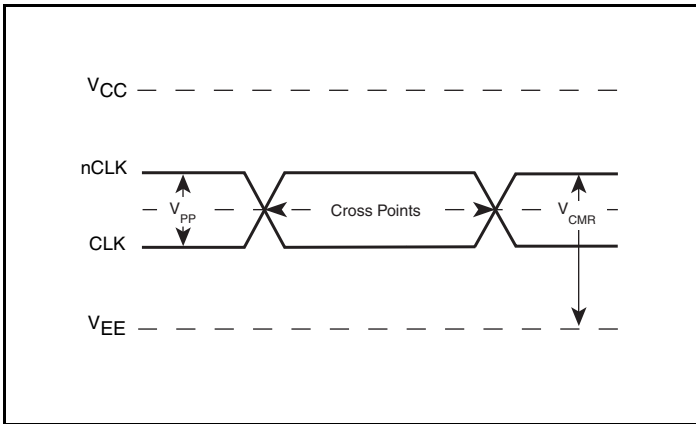
Parameter Measurement Information



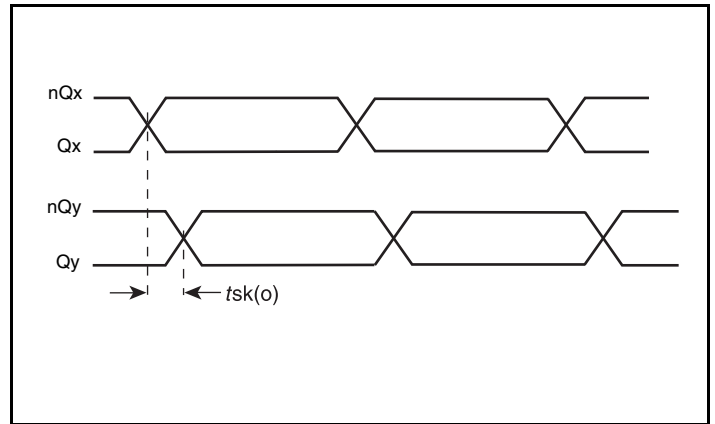
3.3V Core/ 3.3V LVPECL Output Load AC Test Circuit



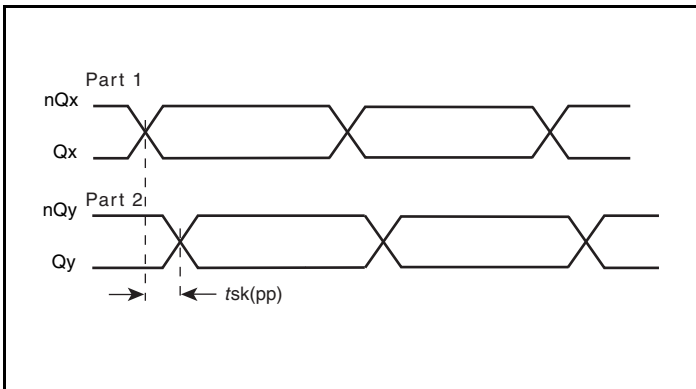
2.5V Core/ 2.5V LVPECL Output Load AC Test Circuit



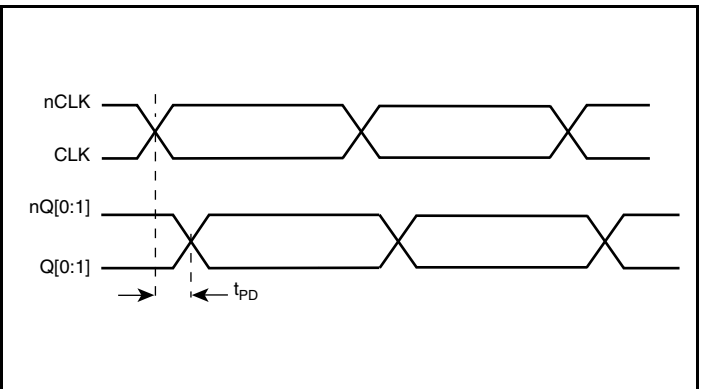
Differential Input Level



Output Skew

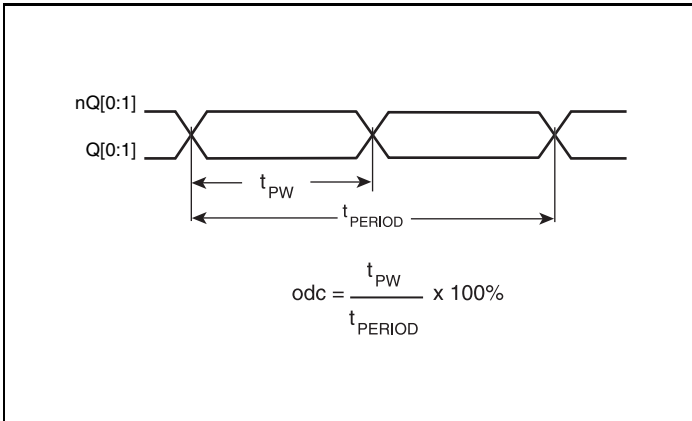


Part-to-Part Skew

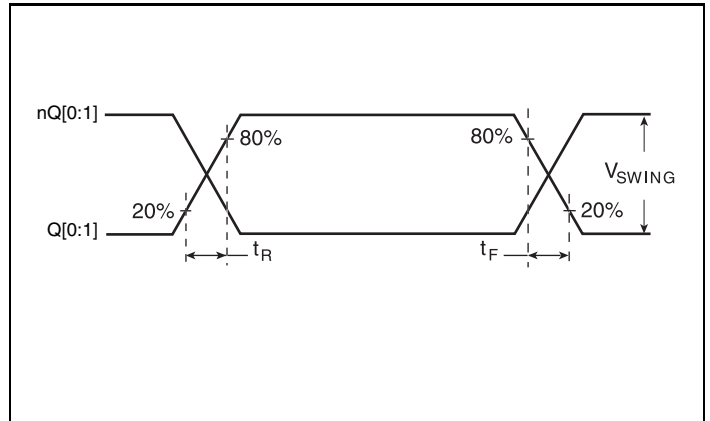


Propagation Delay

Parameter Measurement Information, continued



Output Duty Cycle/Pulse Width/Period



Output Rise/Fall Time

Applications 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 $V_{REF} = V_{CC}/2$ 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 $V_{CC} = 3.3V$, V_{REF} should be 1.25V and $R2/R1 = 0.609$.

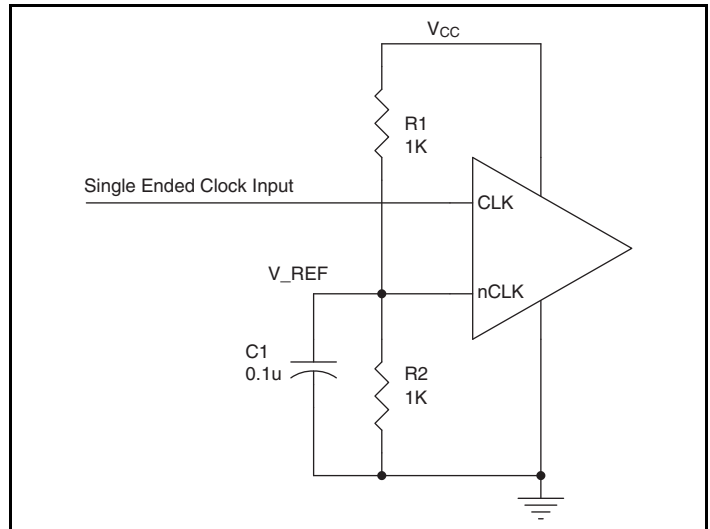


Figure 1. Single-Ended Signal Driving Differential Input

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's open emitter LVHSTL drivers. If you are using an LVHSTL driver from another vendor, use their termination recommendation.

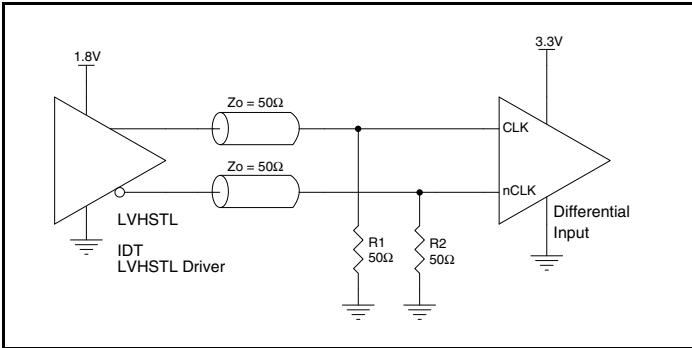


Figure 2A. CLK/nCLK Input Driven by an IDT Open Emitter LVHSTL Driver

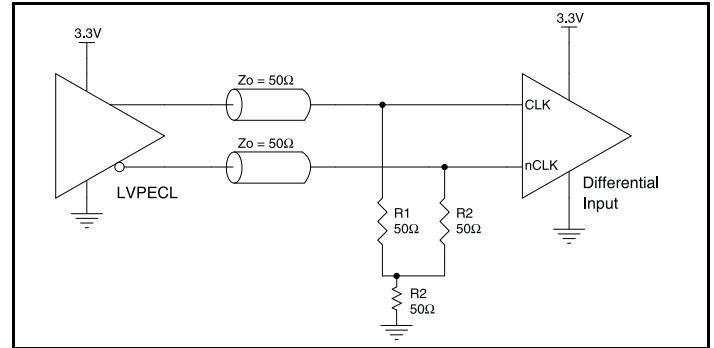


Figure 2B. CLK/nCLK Input Driven by a 3.3V LVPECL Driver

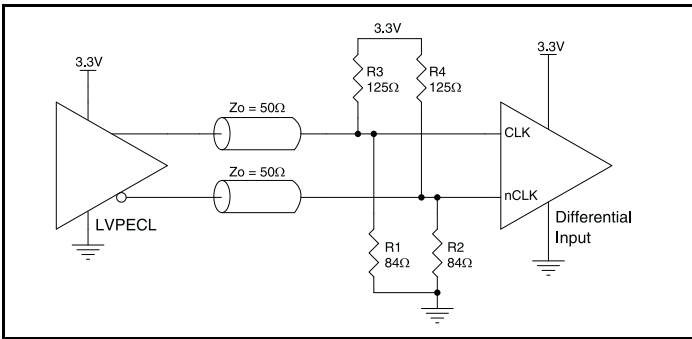


Figure 2C. CLK/nCLK Input Driven by a 3.3V LVPECL Driver

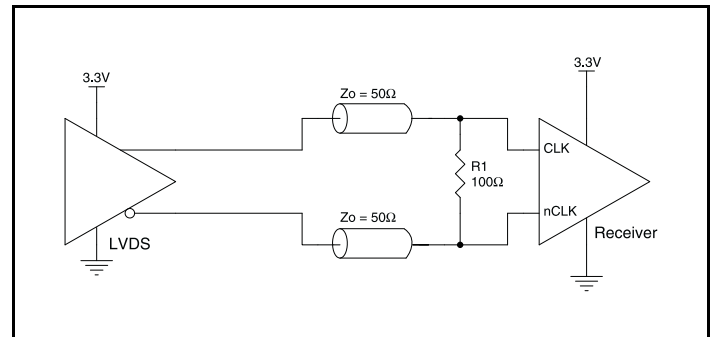


Figure 2D. CLK/nCLK Input Driven by a 3.3V LVDS Driver

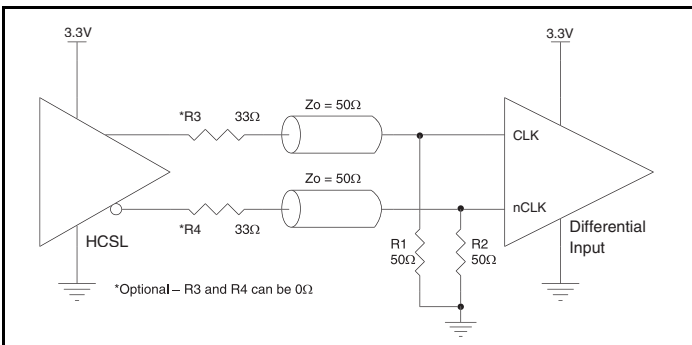


Figure 2E. CLK/nCLK Input Driven by a 3.3V HCSL Driver

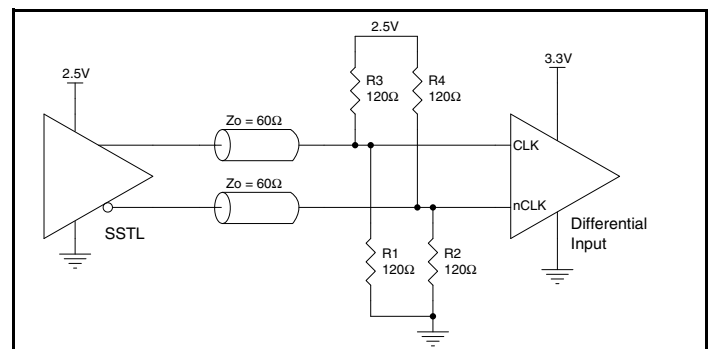


Figure 2F. CLK/nCLK Input Driven by a 2.5V SSTL Driver

Recommendations for Unused Output Pins

Outputs:

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.

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.

FOUT and nFOUT are low impedance follower outputs 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. *Figures 3A and 3B* 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.

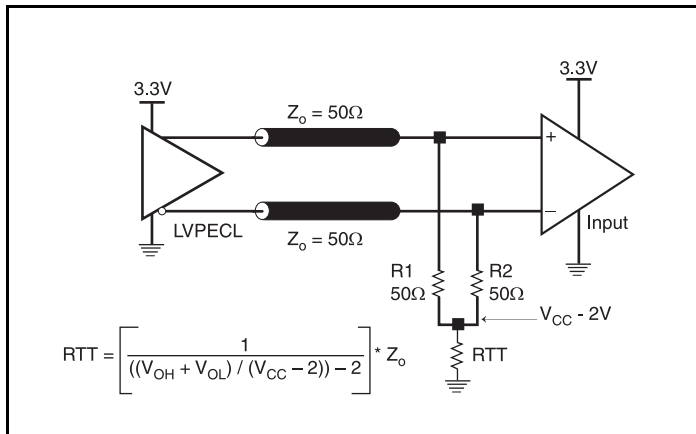


Figure 3A. 3.3V LVPECL Output Termination

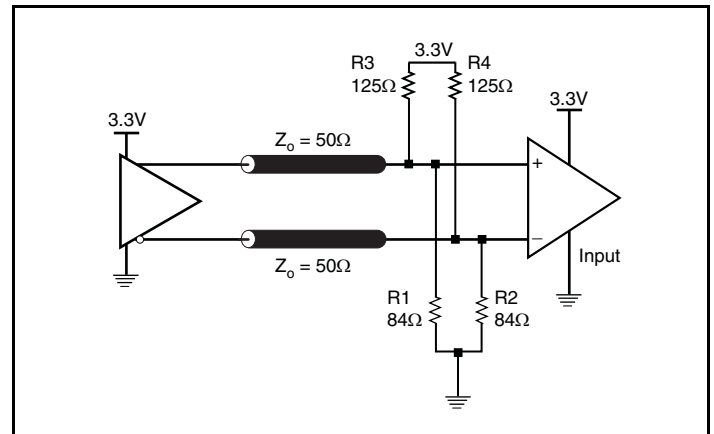


Figure 3B. 3.3V LVPECL Output Termination

Termination for 2.5V LVPECL Outputs

Figure 4A and Figure 4B show examples of termination for 2.5V LVPECL driver. These terminations are equivalent to terminating 50Ω to $V_{CC} - 2V$. For $V_{CC} = 2.5V$, the $V_{CC} - 2V$ is very close to ground

level. The R3 in Figure 4B can be eliminated and the termination is shown in Figure 4C.

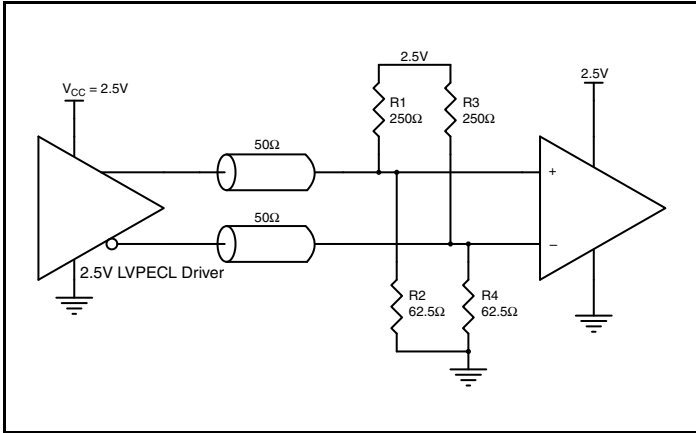


Figure 4A. 2.5V LVPECL Driver Termination Example

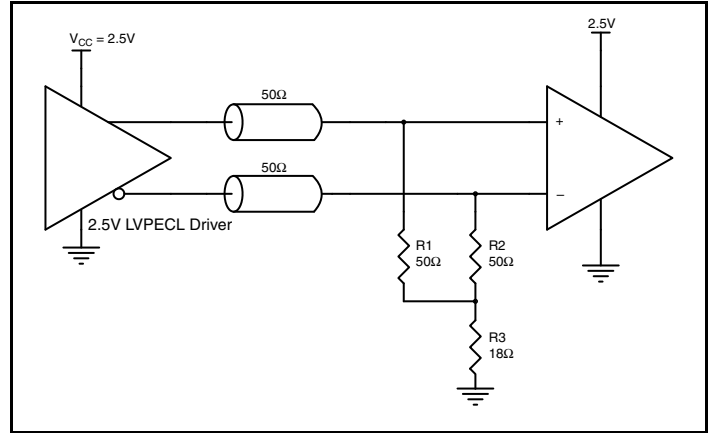


Figure 4B. 2.5V LVPECL Driver Termination Example

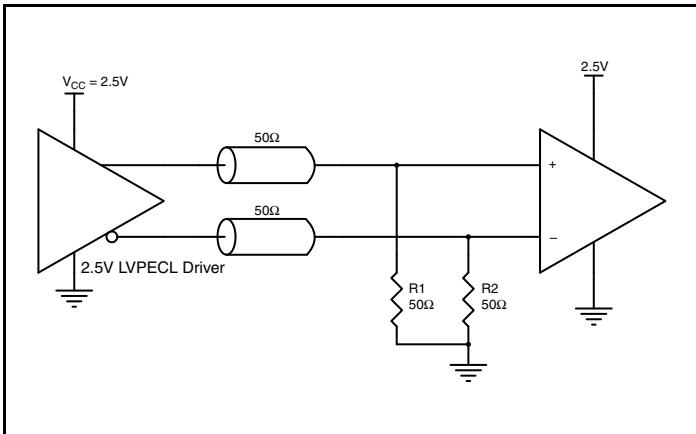


Figure 4C. 2.5V LVPECL Driver Termination Example

Power Considerations

This section provides information on power dissipation and junction temperature for the 85311. Equations and example calculations are also provided.

1. Power Dissipation.

The total power dissipation for the 85311 is the sum of the core power plus the power dissipated in the load(s). The following is the power dissipation for $V_{CC} = 3.3V + 5\% = 3.465V$, which gives worst case results.

NOTE: Please refer to Section 3 for details on calculating power dissipated in the load.

- Power (core)_{MAX} = $V_{CC_MAX} * I_{EE_MAX} = 3.465V * 25mA = \mathbf{86.6mW}$
- Power (outputs)_{MAX} = **30mW/Loaded Output pair**
If all outputs are loaded, the total power is $2 * 30mW = \mathbf{60mW}$

Total Power_{MAX} (3.3V, with all outputs switching) = $86.6mW + 60mW = \mathbf{146.6mW}$

2. Junction Temperature.

Junction temperature, T_j , is the temperature at the junction of the bond wire and bond pad and directly affects the reliability of the device. The maximum recommended junction temperature for devices is 125°C.

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

T_j = Junction Temperature

θ_{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 θ_{JA} must be used. Assuming no air flow and a multi-layer board, the appropriate value is 103°C/W per Table 5 below.

Therefore, T_j for an ambient temperature of 70°C with all outputs switching is:

$$70^\circ\text{C} + 0.147\text{W} * 103^\circ\text{C/W} = 85.14^\circ\text{C}. \text{ This is well below the limit of } 125^\circ\text{C}.$$

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 (single layer or multi-layer).

Table 5. Thermal Resistance θ_{JA} for 8 Lead SOIC, Forced Convection

| θ_{JA} vs. Air Flow | | | |
|---|---------|--------|--------|
| Linear Feet per Minute | 0 | 200 | 500 |
| Multi-Layer PCB, JEDEC Standard Test Boards | 103°C/W | 94°C/W | 89°C/W |

3. Calculations and Equations.

The purpose of this section is to derive the power dissipated into the load.

LVPECL output driver circuit and termination are shown in *Figure 5*.

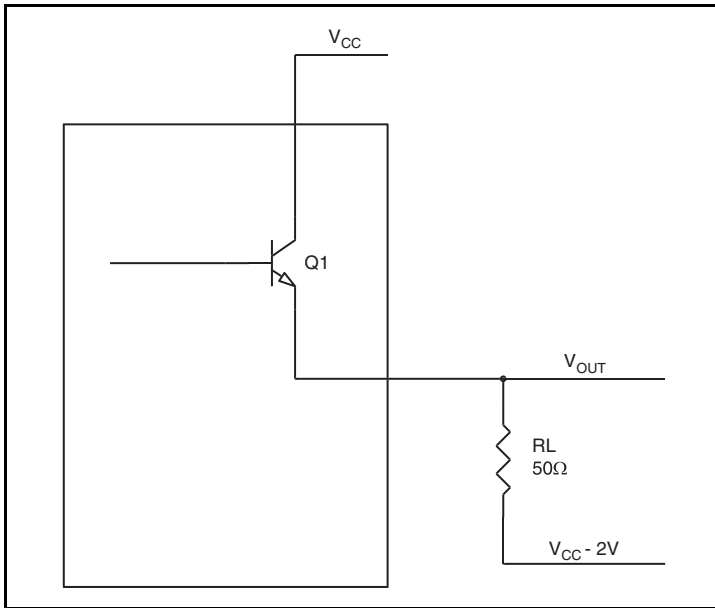


Figure 5. LVPECL Driver Circuit and Termination

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

- For logic high, $V_{OUT} = V_{OH_MAX} = V_{CC_MAX} - 0.9V$
 $(V_{CC_MAX} - V_{OH_MAX}) = 0.9V$
- For logic low, $V_{OUT} = V_{OL_MAX} = V_{CC_MAX} - 1.7V$
 $(V_{CC_MAX} - V_{OL_MAX}) = 1.7V$

Pd_H is power dissipation when the output drives high.

Pd_L is the power dissipation when the output drives low.

$$Pd_H = [(V_{OH_MAX} - (V_{CC_MAX} - 2V))/R_L] * (V_{CC_MAX} - V_{OH_MAX}) = [(2V - (V_{CC_MAX} - V_{OH_MAX}))/R_L] * (V_{CC_MAX} - V_{OH_MAX}) = [(2V - 0.9V)/50\Omega] * 0.9V = \mathbf{19.8mW}$$

$$Pd_L = [(V_{OL_MAX} - (V_{CC_MAX} - 2V))/R_L] * (V_{CC_MAX} - V_{OL_MAX}) = [(2V - (V_{CC_MAX} - V_{OL_MAX}))/R_L] * (V_{CC_MAX} - V_{OL_MAX}) = [(2V - 1.7V)/50\Omega] * 1.7V = \mathbf{10.2mW}$$

$$\text{Total Power Dissipation per output pair} = Pd_H + Pd_L = \mathbf{30mW}$$

Reliability Information

Table 6. θ_{JA} vs. Air Flow Table for a 8 Lead SOIC

| θ_{JA} by Velocity | | | |
|---|---------|--------|--------|
| Linear Feet per Minute | 0 | 200 | 500 |
| Multi-Layer PCB, JEDEC Standard Test Boards | 103°C/W | 94°C/W | 89°C/W |

Transistor Count

The transistor count for 85311 is: 225

Package Outline and Package Dimensions

Package Outline - M Suffix for 8 Lead SOIC

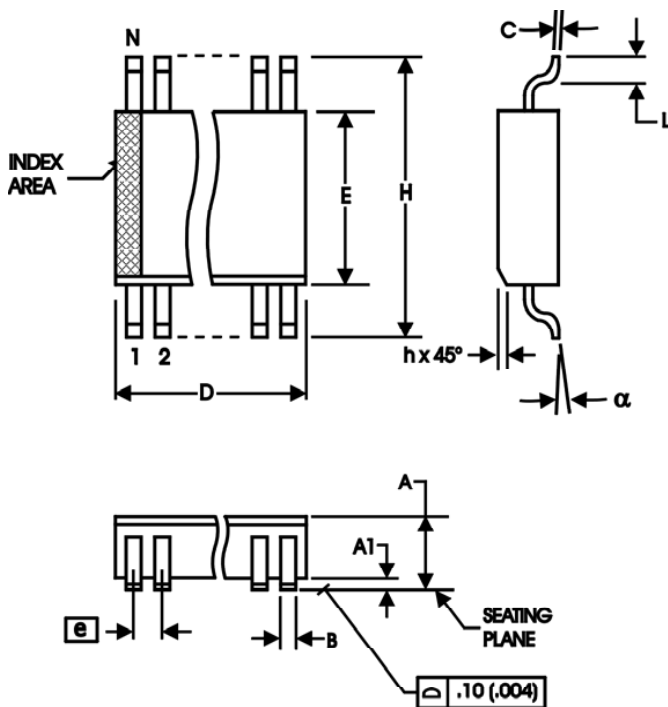


Table 7. Package Dimensions

| All Dimensions in Millimeters | | |
|-------------------------------|------------|---------|
| Symbol | Minimum | Maximum |
| N | 8 | |
| A | 1.35 | 1.75 |
| A1 | 0.10 | 0.25 |
| B | 0.33 | 0.51 |
| C | 0.19 | 0.25 |
| D | 4.80 | 5.00 |
| E | 3.80 | 4.00 |
| e | 1.27 Basic | |
| H | 5.80 | 6.20 |
| h | 0.25 | 0.50 |
| L | 0.40 | 1.27 |
| α | 0° | 8° |

Reference Document: JEDEC Publication 95, MS-012

Ordering Information

Table 8. Ordering Information

| Part/Order Number | Marking | Package | Shipping Packaging | Temperature |
|-------------------|----------|-------------------------|--------------------|-------------|
| 85311AMLF | 85311ALF | "Lead-Free" 8 Lead SOIC | Tube | 0°C to 70°C |
| 85311AMLFT | 85311ALF | "Lead-Free" 8 Lead SOIC | Tape & Reel | 0°C to 70°C |

Revision History Sheet

| Rev | Table | Page | Description of Change | Date |
|-----|--------------|--|--|----------|
| A | | 8 | Added Termination for LVPECL Outputs section. | 5/30/02 |
| A | | 5 7 | 3.3V Output Load Test Circuit Diagram - corrected VEE equation to read $-1.3V \pm 0.165V$ from $\pm 0.135V$. Updated Output Rise/Fall Time Diagram. | 9/23/02 |
| B | T2 T8 | 1 2 3 3 5 6 7 8 13 | Add Lead-Free bullet in Features section. Pin Characteristics table - changed C_{IN} 4pF max. to 4pF typical. Absolute Maximum Ratings, updated Outputs rating. Combined 3.3V & 2.5V Power tables and Differential DC Characteristics tables. Updated Parameter Measurement Information. Updated Single Ended Signal Driving Differential Input diagram. Added Termination for 2.5V LVPECL Output section. Added Differential Clock Input Interface section. Ordering Information table - added Lead Free part number. | 6/17/04 |
| B | T8 | 7 13 | Added Recommendations for Unused Input and Output Pins. Ordering Information Table - corrected Lead-Free marking and added Lead-Free Note. | 7/28/05 |
| C | T3 | 3 9 - 10 | LVPECL DC Characteristics Table -corrected V_{OH} max. from $V_{CC} - 1.0V$ to $V_{CCO} - 0.9V$; and V_{SWING} max. from 0.9V to 1.0V. Power Considerations - corrected power dissipation to reflect VOH max in Table 3C. | 4/11/07 |
| D | T4A - T4B | 4 5 8 | Added 2.5V AC Characteristics Table. Added Additive Phase Jitter spec to both AC Tables. Added Additive Phase Jitter plot. Updated <i>Differential Input Clock Interface</i> section. | 10/22/08 |
| D | T8 | 14 | Ordering Information - removed leaded devices. Updated data sheet format. | 7/8/15 |
| E | T6 T8 | 11 13 14 | Power Considerations - updated Junction Temperature section and corrected Table 5, Thermal Resistance Table. Corrected table. Ordering Information Table - deleted table note. Deleted HiperClockS reference throughout the datasheet. Updated datasheet header/footer. | 2/16/16 |

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(Rev.1.0 Mar 2020)

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