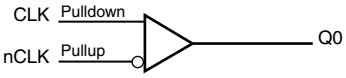
## General Description

The 83021I is a 1-to-1 Differential-to-LVCMOS/ LVTTL Translator and a member of the family of High Performance Clock Solutions from IDT. The differential input is highly flexible and can accept the following input types: LVPECL, LVDS, LVHSTL, SSTL, and HCSL. The small 8-lead SOIC footprint makes this device ideal for use in applications with limited board space.

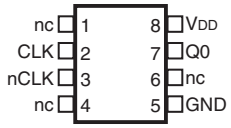
## Features

- One LVCMOS/LVTTL output
- Differential CLK/nCLK input pair
- CLK/nCLK pair can accept the following differential input levels: LVPECL, LVDS, LVHSTL, SSTL, HCSL
- Output frequency: 350MHz (typical)
- Part-to-part skew: 500ps (maximum)
- Additive phase jitter, RMS: 0.21ps (typical), 3.3V output
- Full 3.3V and 2.5V operating supply
- -40°C to 85°C ambient operating temperature

## Block Diagram




## Pin Assignment




**83021I**

**8-Lead SOIC, 150Mil**
**3.9mm x 4.9mm x 1.375mm package body**
**M Package**
**Top View**

## Table 1. Pin Descriptions

| Number | Name | Type | | Description |
|---|---|---|---|---|
| 1, 4, 6 | nc | Unused | | No connect. |
| 2 | CLK | Input | Pulldown | Non-inverting differential clock input. |
| 3 | nCLK | Input | Pullup | Inverting differential clock input. |
| 5 | GND | Power | | Power supply ground. |
| 7 | Q0 | Output | | Single-ended clock output. LVCMOS/LVTTL interface levels. |
| 8 | $V_{DD}$ | 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 |
| $C_{PD}$ | Power Dissipation Capacitance | $V_{DD}$ = 3.6V | | 23 | | pF |
| $R_{OUT}$ | Output Impedance | | 5 | 7 | 12 | Ω |

## 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 $V_{DD}$ + 0.5V |
| Package Thermal Impedance, $\theta_{JA}$ | 103°C/W (0 lfpm) |
| Storage Temperature, $T_{STG}$ | -65°C to 150°C |

## DC Electrical Characteristics

**Table 3A. Power Supply DC Characteristics,** $V_{DD}$ = 3.3V ± 0.3V or 2.5V ± 5%, $T_A$ = -40°C to 85°C

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|---|
| $V_{DD}$ | Positive Supply Voltage | | 3.0 | 3.3 | 3.6 | V |
| | | | 2.375 | 2.5 | 2.625 | V |
| $I_{DD}$ | Power Supply Current | | | | 20 | mA |

**Table 3B. LVCMOS/LVTTL DC Characteristics,** $V_{DD}$ = 3.3V ± 0.3V or 2.5V ± 5%, $T_A$ = -40°C to 85°C

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|---|
| $V_{OH}$ | Output High Voltage; NOTE 1 | $V_{DD}$ = 3.6V | 2.6 | | | V |
| | | $V_{DD}$ = 2.625V | 1.8 | | | V |
| $V_{OL}$ | Output Low Voltage; NOTE 1 | $V_{DD}$ = 3.6V or 2.625V | | | 0.5 | V |

NOTE 1: Outputs terminated with 50Ω to $V_{DD}$/2. See Parameter Measurement Information, *Output Load Test Circuit Diagrams.*

**Table 3C. Differential DC Characteristics,** $V_{DD}$ = 3.3V ± 0.3V or 2.5V ± 5%, $T_A$ = -40°C to 85°C

| Symbol | Parameter | | Test Conditions | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|---|---|
| $I_{IH}$ | Input High Current | nCLK | $V_{IN}$ = $V_{DD}$ = 3.6V or 2.625V | | | 5 | µA |
| | | CLK | $V_{IN}$ = $V_{DD}$ = 3.6V or 2.625V | | | 150 | µA |
| $I_{IL}$ | Input Low Cureent | nCLK | $V_{IN}$ = 0V, $V_{DD}$ = 3.6V or 2.625V | -150 | | | µA |
| | | CLK | $V_{IN}$ = 0V, $V_{DD}$ = 3.6V or 2.625V | -5 | | | µA |
| $V_{PP}$ | Peak-to-Peak Input Voltage | | | 0.15 | | 1.3 | V |
| $V_{CMR}$ | Common Mode Input Voltage; NOTE 1, 2 | | | GND + 0.5 | | $V_{DD}$ – 0.85 | V |

NOTE 1: For single ended applications, the maximum input voltage for CLK, nCLK is $V_{DD}$ + 0.3V.
NOTE 2: Common mode voltage is defined as $V_{IH}$.

# AC Electrical Characteristics

**Table 4A. AC Characteristics,** $V_{DD}$ = 3.3V ± 0.3V, $T_A$ = -40°C to 85°C

| Parameter | Symbol | Test Conditions | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|---|
| $f_{MAX}$ | Output Frequency | | | 350 | | MHz |
| $t_{PD}$ | Propagation Delay, NOTE 1 | $f \leq$ 350MHz | 1.7 | 2.0 | 2.3 | ns |
| *t*sk(pp) | Part-to-Part Skew; NOTE 2, 3 | | | | 500 | ps |
| *t*jit | Buffer Additive Phase Jitter, RMS; refer to Additive Phase Jitter Section | 100MHz, Integration Range (637kHz – 10MHz) | | 0.21 | | ps |
| $t_R$ / $t_F$ | Output Rise/Fall Time | 0.8V to 2V | 100 | 250 | 400 | ps |
| odc | Output Duty Cycle | $f \leq$ 166MHz | 45 | 50 | 55 | % |
| | | 166MHz < $f \leq$ 350MHz | 40 | 50 | 60 | % |

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 lfpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.
All parameters measured at $f_{MAX}$ unless noted otherwise.
NOTE 1: Measured from the differential input crossing point to the output at $V_{DD}/2$.
NOTE 2: 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 $V_{DD}/2$.
NOTE 3: This parameter is defined in accordance with JEDEC Standard 65.

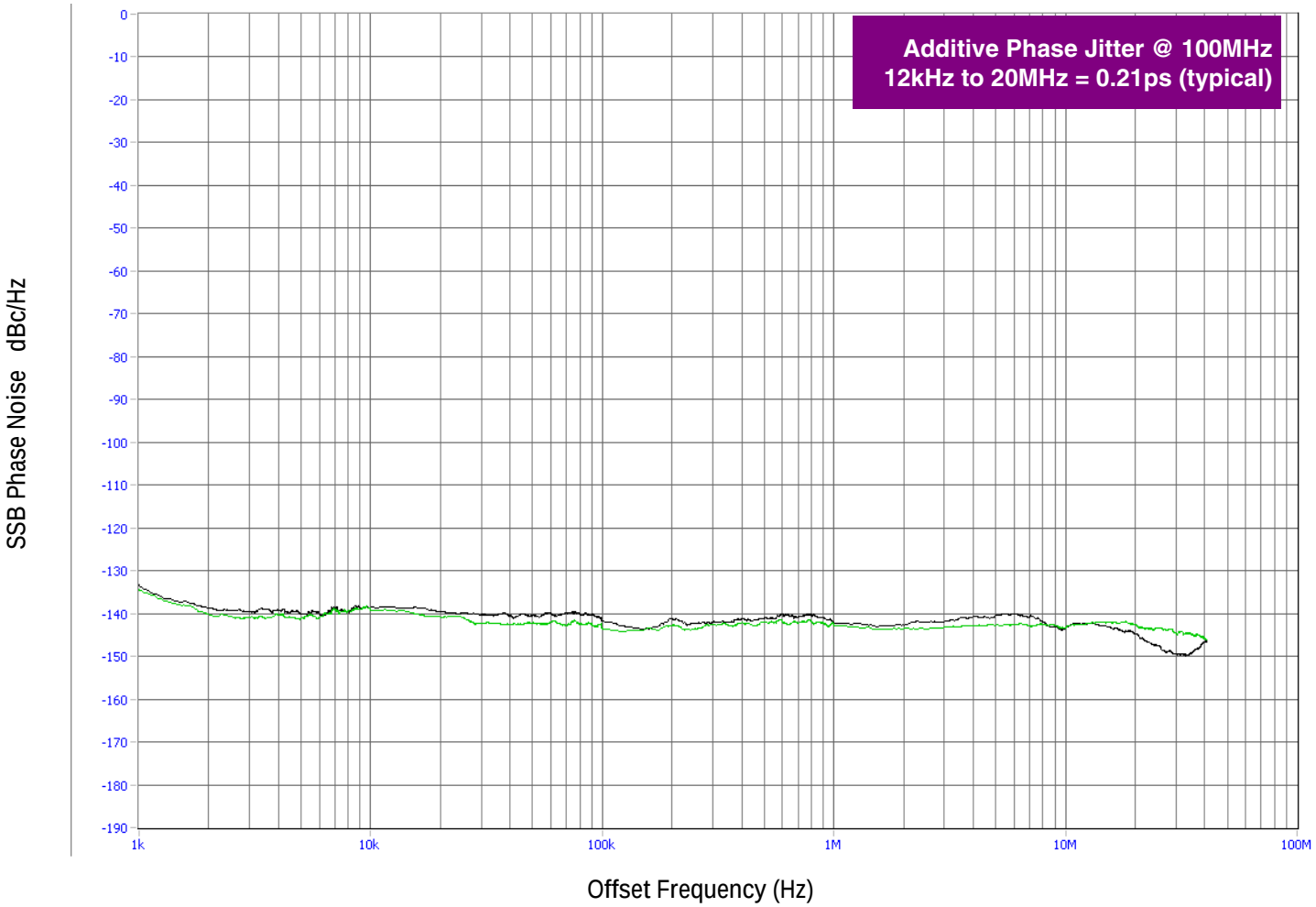
**Table 4B. AC Characteristics,** $V_{DD}$ = 2.5V ± 5%, $T_A$ = -40°C to 85°C

| Parameter | Symbol | Test Conditions | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|---|
| $f_{MAX}$ | Output Frequency | | | 350 | | MHz |
| $t_{PD}$ | Propagation Delay, NOTE 1 | $f \leq$ 350MHz | 1.9 | 2.2 | 2.5 | ns |
| *t*sk(pp) | Part-to-Part Skew; NOTE 2, 3 | | | | 500 | ps |
| *t*jit | Buffer Additive Phase Jitter, RMS; refer to Additive Phase Jitter Section | 100MHz, Integration Range (637kHz – 10MHz) | | 0.21 | | ps |
| $t_R$ / $t_F$ | Output Rise/Fall Time | 20% to 80% | 250 | | 550 | ps |
| odc | Output Duty Cycle | $f \leq$ 250MHz | 45 | 50 | 55 | % |
| | | 250MHz < $f \leq$ 350MHz | 40 | 50 | 60 | % |

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 lfpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.
All parameters measured at $f_{MAX}$ unless noted otherwise.
NOTE 1: Measured from the differential input crossing point to the output at $V_{DD}/2$.
NOTE 2: 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 $V_{DD}/2$.
NOTE 3: This parameter is defined in accordance with JEDEC Standard 65.

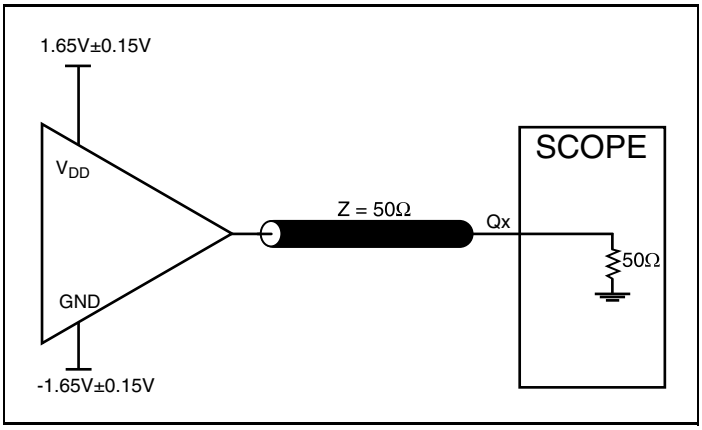
## Additive Phase Jitter

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.

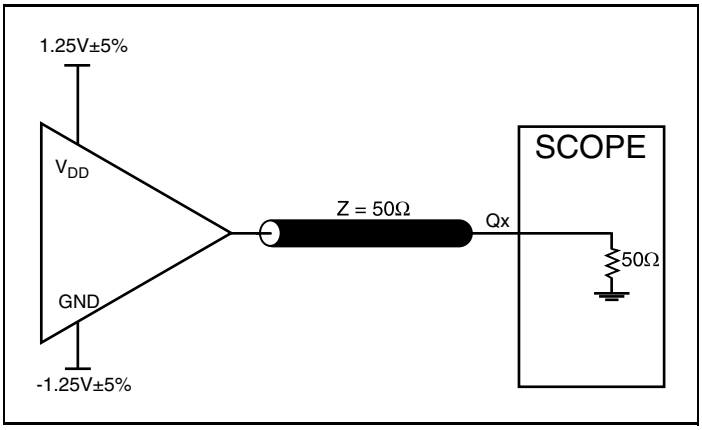



As with most timing specifications, phase noise measurements has issues relating to the limitations of the equipment. Often the noise floor of the equipment is higher than the noise floor of the device. This is illustrated above. The device meets the noise floor of what is shown, but can actually be lower. The phase noise is dependent on the input source and measurement equipment.

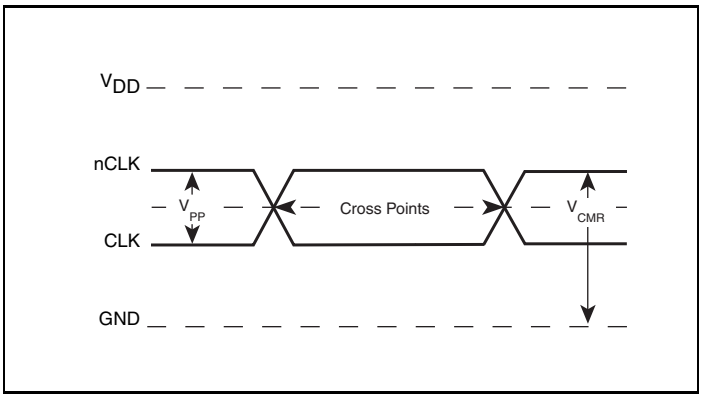
## Parameter Measurement Information



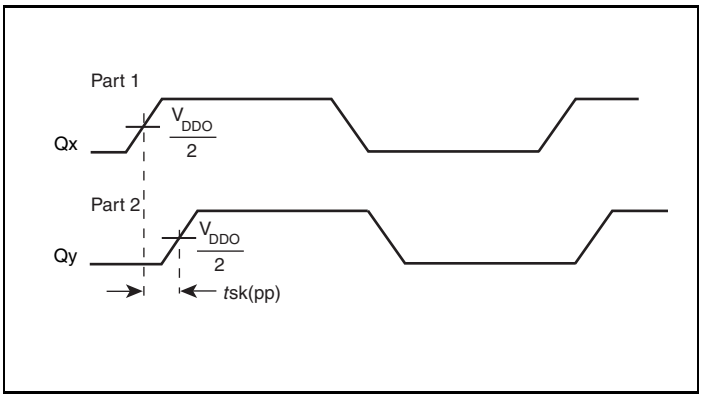

**3.3V Core/3.3V LVCMOS Output Load AC Test Circuit**



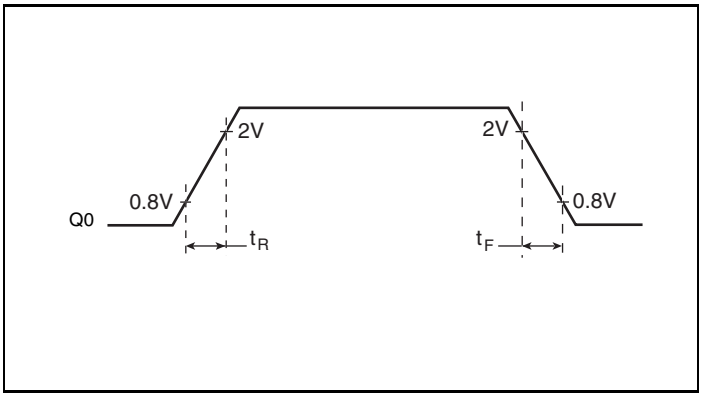

**2.5V Core/2.5V LVCMOS Output Load AC Test Circuit**



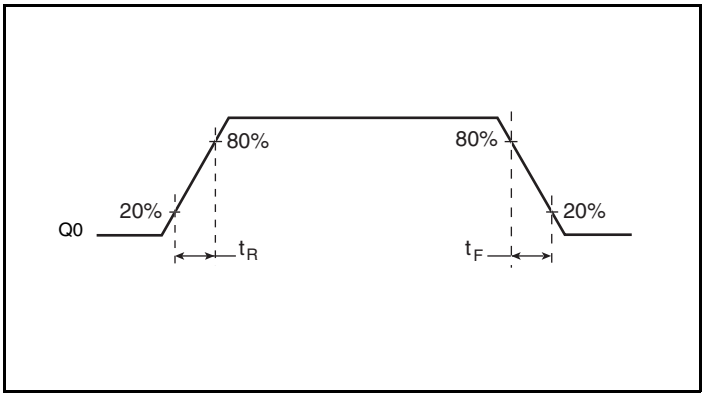

**Differential Input Level**




**Part-to-Part Skew**

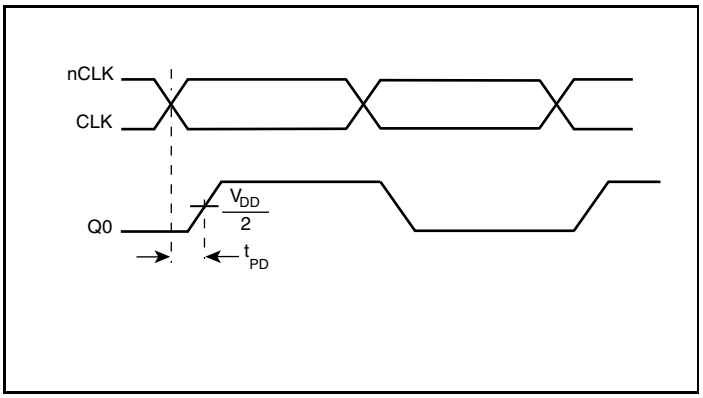



**3.3V Output Rise/Fall Time**

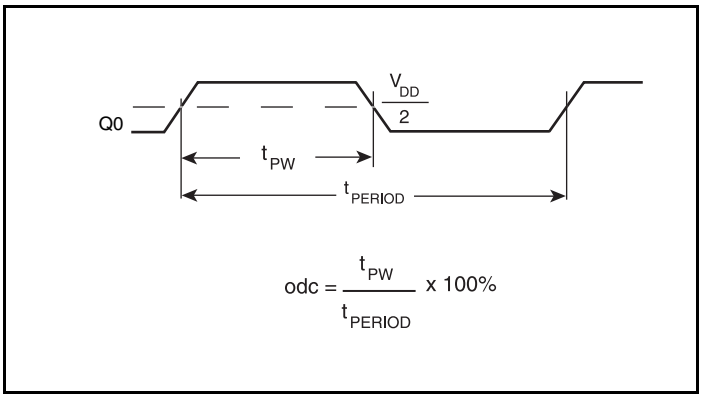



**2.5V Output Rise/Fall Time**

## Parameter Measurement Information, continued




**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.

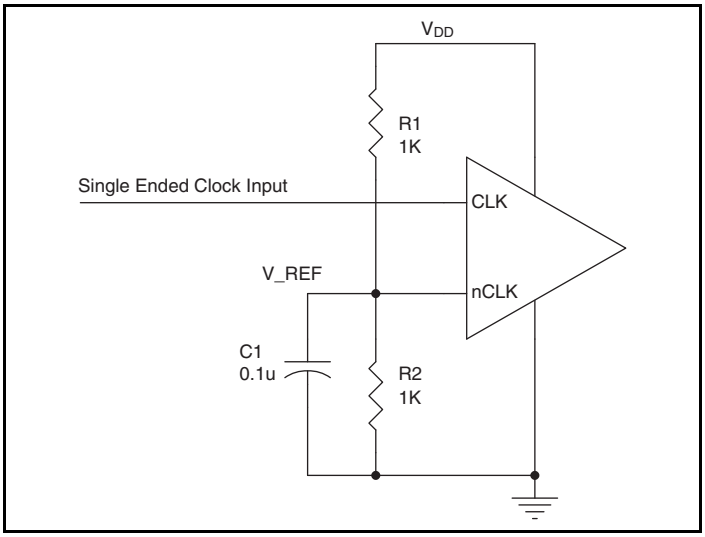



**Figure 1. Single-Ended Signal Driving Differential Input**

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

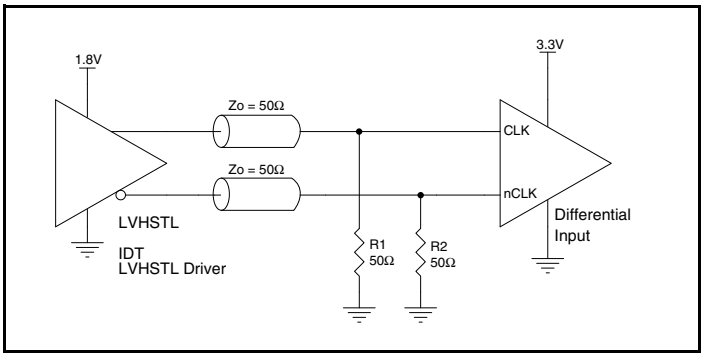



**Figure 2A. HiPerClockS CLK/nCLK Input Driven by an IDT Open Emitter HiPerClockS LVHSTL Driver**

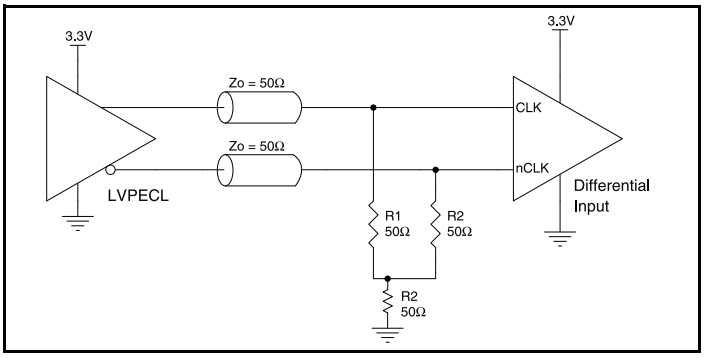



**Figure 2B. HiPerClockS CLK/nCLK Input Driven by a 3.3V LVPECL Driver**

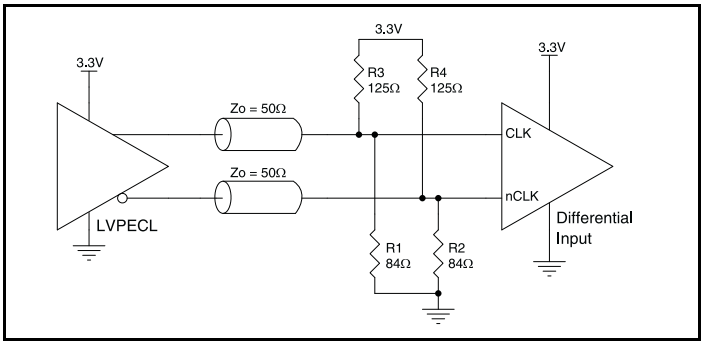



**Figure 2C. HiPerClockS CLK/nCLK Input Driven by a 3.3V LVPECL Driver**

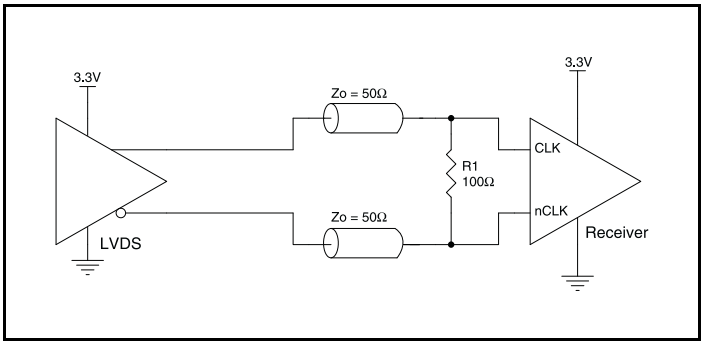



**Figure 2D. HiPerClockS CLK/nCLK Input Driven by a 3.3V LVDS Driver**

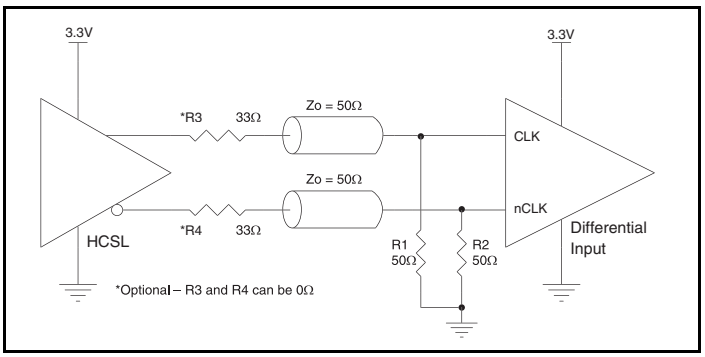



**Figure 2E. HiPerClockS CLK/nCLK Input Driven by a 3.3V HCSL Driver**

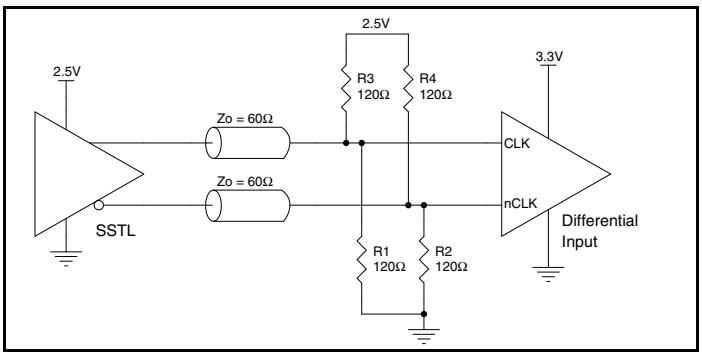



**Figure 2F. HiPerClockS CLK/nCLK Input Driven by a 2.5V SSTL Driver**

## Reliability Information

**Table 5. $\theta_{JA}$ vs. Air Flow Table for an 8 Lead SOIC**

| $\theta_{JA}$ by Velocity | | | |
|---|---|---|---|
| Linear Feet per Minute | **0** | **200** | **500** |
| Single-Layer PCB, JEDEC Standard Test Boards | 123°C/W | 110°C/W | 99°C/W |
| Multi-Layer PCB, JEDEC Standard Test Boards | 103°C/W | 94°C/W | 89°C/W |

## Transistor Count

The transistor count for 83021I is: 416
Pin-to-pin compatible with the MC100EPT21

# Package Outline and Package Dimensions

**Package Outline - M Suffix for 8 Lead SOIC**

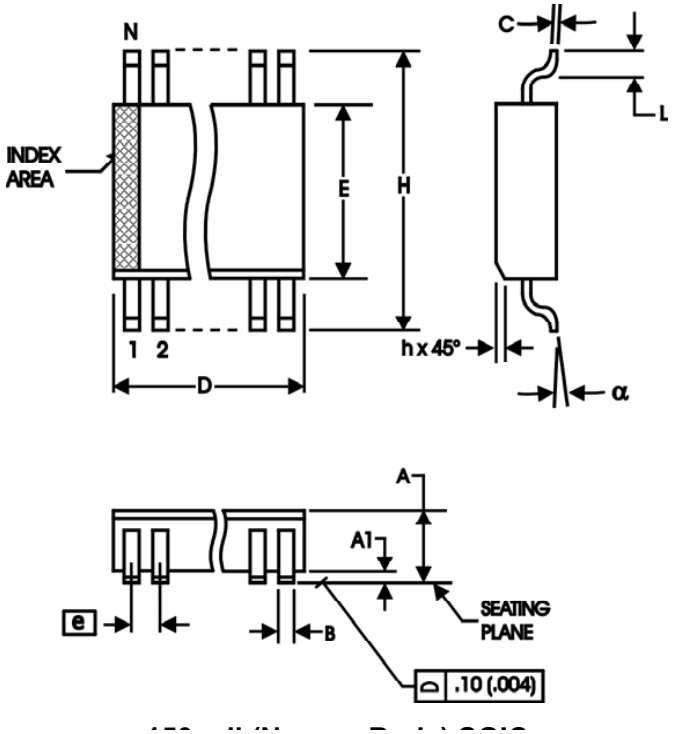



**Table 6. Package Dimensions**

| 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 7. Ordering Information**

| Part/Order Number | Marking | Package | Shipping Packaging | Temperature |
|---|---|---|---|---|
| 83021AMILF | 83021AIL | “Lead-Free” 8 Lead SOIC | Tube | -40°C to 85°C |
| 83021AMILFT | 83021AIL | “Lead-Free” 8 Lead SOIC | Tape & Reel | -40°C to 85°C |

## Revision History Sheet

| Rev | Table | Page | Description of Change | Date |
|---|---|---|---|---|
| B | T2<br>T3B<br>T3C<br>T3D<br>T4B | 2<br>3<br>3<br>3<br>4<br>5<br><br>6<br>7 | Pin Characteristics table - added 2.5V $C_{PD}$.<br>Added 2.5V Power Supply table.<br>LVCMOS table - added 2.5V $V_{OH}$.<br>Differential table - added 2.5V.<br>Added 2.5V AC Characteristics table.<br>Added 2.5V Output Load AC Test Circuit Diagram, and 2.5V Output Rise/Fall Time Diagrams.<br>Updated Figure 1.<br>Added Differential Clock Input Interface section. | 6/3/04 |
| B | <br>T4A | 2<br>4 | Pin Characteristics Table - changed $C_{IN}$ 4pF max. to 4pF typical.<br>3.3V AC Characteristics Table - changed odc Test Conditions. | 6/30/04 |
| B | T7 | 1<br>10 | Features Section - added Lead-Free bullet.<br>Ordering Information Table - Added Lead-Free part number. | 3/21/05 |
| C | T4A, T4B<br><br>T7 | 1<br>4<br>5<br>11 | Features Section - added Additive Phase Jitter bullet.<br>AC Characteristics Tables - added Additive Phase Jitter row.<br>Added Additive Phase Jitter Plot.<br>Added Lead-Free Note. | 12/12/05 |
| C | | 1<br>8<br>9 | Pin Assignment - corrected package body measurements.<br>Updated *Differential Clock Input Interface.*<br>Updated *Reliability Information*.<br>Updated datasheet format . | 6/18/08 |
| C | <br>T4A, T4B | 1<br>4 | Corrected typo in Header from 1-to-2... to 1-to-1....<br>AC Tables - added Temperature NOTE. | 10/31/08 |
| D | T7 | 10 | Remove leaded orderable parts from Ordering Information table | 11/14/12 |
| D | | 1 | Features section - removed leaded part note.<br>Description - removed chip | 4/23/14 |
| D | T7 | 1<br>10 | Removed HiPerClockS from General Description.<br>Ordering Information - removed 2500 from Tape and Reel.<br>Updated Datasheet header and footer. | 12/14/15 |

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