

### General Description

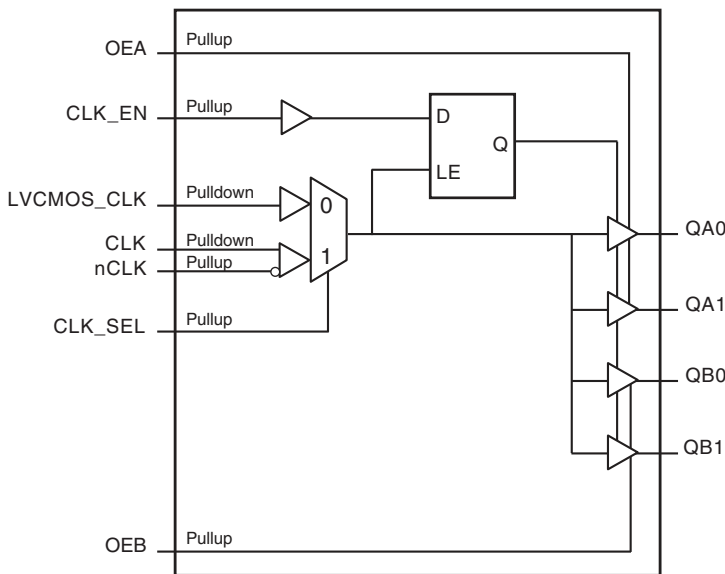
The ICS8305I-02 is a low skew, 1-to-4, Differential/LVCMOS-to-LVCMOS/LVTTL Fanout Buffer. The ICS8305I-02 has selectable clock inputs that accept either differential or single-ended input levels. The clock enable is internally synchronized to eliminate runt pulses on the outputs during asynchronous assertion/deassertion of the clock enable pin. Outputs are forced LOW when the clock is disabled. A separate output enable pin controls whether the outputs are in the active or high impedance state.

Guaranteed output and part-to-part skew characteristics make the ICS8305I-02 ideal for those applications demanding well defined performance and repeatability.

### Features

- Four LVCMOS/LVTTL outputs, (two banks of two LVCMOS outputs)
- Selectable differential CLK, nCLK pair or LVCMOS\_CLK input
- CLK, nCLK pair can accept the following differential input levels: LVPECL, LVDS, LVHSTL, HCSL
- LVCMOS\_CLK supports the following input types: LVCMOS, LVTTL
- Maximum output frequency: 250MHz
- Output skew: 100ps (maximum)
- Power supply modes:  
Core/Output  
3.3V/3.3V  
3.3V/2.5V  
3.3V/1.8V  
3.3V/1.5V
- -40°C to 85°C ambient operating temperature
- Lead-free (RoHS 6) packaging

### Block Diagram



### Pin Assignment

OEA	1	16	QA0
OEB	2	15	VDDO_A
VDD	3	14	QA1
CLK_EN	4	13	GND
CLK	5	12	QB0
nCLK	6	11	VDDO_B
CLK_SEL	7	10	QB1
LVCMOS_CLK	8	9	GND

#### ICS8305I-02

#### 16-Lead TSSOP

4.4mm x 5.0mm x 0.92mm package body

#### G Package

#### Top View

**Table 1. Pin Descriptions**

Number	Name	Type		Description
1	OEA	Input	Pullup	Output enable for Bank A outputs. When LOW, QAx outputs are in HIGH impedance state. When HIGH, QAx outputs are active. LVCMOS / LVTTTL interface levels.
2	OEB	Input	Pullup	Output enable for Bank B outputs. When LOW, QBx outputs are in HIGH impedance state. When HIGH, QBx outputs are active. LVCMOS / LVTTTL interface levels.
3	V <sub>DD</sub>	Power		Positive supply pins.
4	CLK_EN	Input	Pullup	Synchronizing clock enable. When LOW, the output clocks are disabled. When HIGH, output clocks are enabled. LVCMOS / LVTTTL interface levels.
5	CLK	Input	Pulldown	Non-inverting differential clock input.
6	nCLK	Input	Pullup	Inverting differential clock input.
7	CLK_SEL	Input	Pullup	Clock select input. When HIGH, selects CLK, nCLK inputs. When LOW, selects LVCMOS_CLK input. LVCMOS / LVTTTL interface levels.
8	LVCMOS_CLK	Input	Pulldown	Single-ended clock input. LVCMOS/LVTTTL interface levels.
9, 13	GND	Power		Power supply ground.
10, 12	QB1, QB0	Output		Single-ended Bank B clock outputs. LVCMOS/LVTTTL interface levels.
11	V <sub>DDO_B</sub>	Power		Output supply pin for Bank B outputs.
14, 16	QA1, QA0	Output		Single-ended Bank A clock outputs. LVCMOS/LVTTTL interface levels.
15	V <sub>DDO_A</sub>	Power		Output supply pin for Bank A outputs.

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

**Table 2. Pin Characteristics**

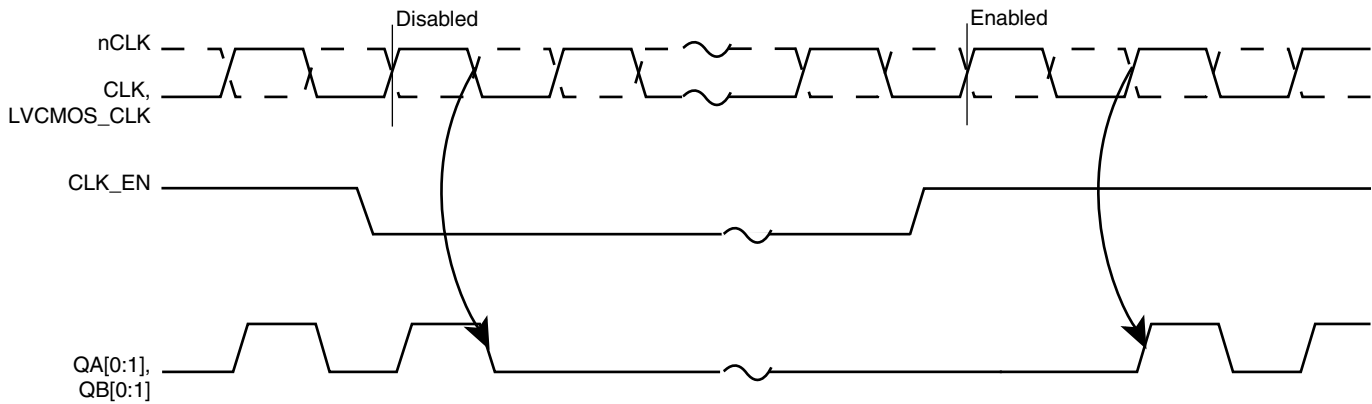
Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
C <sub>IN</sub>	Input Capacitance			4		pF
R <sub>PULLUP</sub>	Input Pullup Resistor			51		kΩ
R <sub>PULLDOWN</sub>	Input Pulldown Resistor			51		kΩ
C <sub>PD</sub>	Power Dissipation Capacitance (per output)			13		pF
R <sub>OUT</sub>	Output Impedance	V <sub>DDO_A</sub> = V <sub>DDO_B</sub> = 3.3V		9		Ω
		V <sub>DDO_A</sub> = V <sub>DDO_B</sub> = 2.5V		11		Ω
		V <sub>DDO_A</sub> = V <sub>DDO_B</sub> = 1.8V		15		Ω
		V <sub>DDO_A</sub> = V <sub>DDO_B</sub> = 1.5V		20		Ω

## Function Tables

**Table 3. Clock Input Function Table**

Inputs				Outputs
OEA, OEB	CLK_EN	CLK_SEL	Selected Source	QAx, QBx
1	0	0	LVC MOS_CLK	Disabled; LOW
1	0	1	CLK, nCLK	Disabled; LOW
1	1	0	LVC MOS_CLK	Enabled
1 (default)	1 (default)	1 (default)	CLK, nCLK	Enabled
0	X	X		High-Impedance

NOTE: After CLK\_EN switches, the clock outputs are disabled or enabled following a rising and falling input clock edge as shown in Figure 1.



**Figure 1. CLK\_EN Timing Diagram**

## 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, $\theta_{JA}$	100.3°C/W (0 mps)
Storage Temperature, $T_{STG}$	-65°C to 150°C

## DC Electrical Characteristics

**Table 4A. Power Supply DC Characteristics,  $V_{DD} = 3.3V \pm 5\%$ ,  $V_{DDO\_A} = V_{DDO\_B} = 3.3V \pm 5\%$  or  $2.5V \pm 5\%$  or  $1.8V \pm 0.15V$  or  $1.5V \pm 5\%$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{DD}$	Positive Supply Voltage		3.135	3.3	3.465	V
$V_{DDO\_A}$ , $V_{DDO\_B}$	Output Supply Voltage		3.135	3.3	3.465	V
			2.375	2.5	2.625	V
			1.65	1.8	1.95	V
			1.425	1.5	1.575	V
$I_{DD}$	Power Supply Current				21	mA
$I_{DDO\_A} +$ $I_{DDO\_B}$	Output Supply Current	No Load			5	mA

**Table 4B. LVCMOS DC Characteristics**,  $V_{DD} = 3.3V \pm 5\%$ ,  $V_{DDO\_A} = V_{DDO\_B} = 3.3V \pm 5\%$  or  $2.5V \pm 5\%$  or  $1.8V \pm 0.15V$  or  $1.5V \pm 5\%$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$ 

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
$V_{IH}$	Input High Voltage			2		$V_{DD} + 0.3$	V
$V_{IL}$	Input Low Voltage			-0.3		0.8	V
$I_{IH}$	Input High Current	OEA, OEB, CLK_SEL, CLK_EN	$V_{DD} = V_{IN} = 3.465V$			5	$\mu\text{A}$
		LVCMOS_CLK	$V_{DD} = V_{IN} = 3.465V$			150	$\mu\text{A}$
$I_{IL}$	Input Low Current	OEA, OEB, CLK_SEL, CLK_EN	$V_{DD} = 3.465V, V_{IN} = 0V$	-150			$\mu\text{A}$
		LVCMOS_CLK	$V_{DD} = 3.465V, V_{IN} = 0V$	-5			$\mu\text{A}$
$V_{OH}$	Output High Voltage; NOTE 1		$V_{DDO\_X} = 3.3V \pm 5\%$	2.6			V
			$V_{DDO\_X} = 2.5V \pm 5\%$	1.8			V
			$V_{DDO\_X} = 1.8V \pm 0.15V$	1.5			V
			$V_{DDO\_X} = 1.5V \pm 5\%$	$V_{DDO\_X} - 0.3$			V
$V_{OL}$	Output Low Voltage; NOTE 1		$V_{DDO\_X} = 3.3V \pm 5\%$			0.5	V
			$V_{DDO\_X} = 2.5V \pm 5\%$			0.4	V
			$V_{DDO\_X} = 1.8V \pm 0.15V$			0.35	V
			$V_{DDO\_X} = 1.5V \pm 5\%$			0.30	V
$I_{OZL}$	Output High-Impedance Low			-5			$\mu\text{A}$
$I_{OZH}$	Output High-Impedance High					5	$\mu\text{A}$

NOTE:  $V_{DDO\_X}$  denotes  $V_{DDO\_A}$  and  $V_{DDO\_B}$ .NOTE 1: Outputs terminated with  $50\Omega$  to  $V_{DDO\_X}/2$ . See Parameter Measurement Information section, *Output Load Test Circuit diagrams*.**Table 4C. DC Characteristics**,  $V_{DD} = 3.3V \pm 5\%$ ,  $V_{DDO\_A} = V_{DDO\_B} = 3.3V \pm 5\%$  or  $2.5V \pm 5\%$  or  $1.8V \pm 0.15V$  or  $1.5V \pm 5\%$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$ 

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
$I_{IH}$	Input High Current	CLK,	$V_{DD} = V_{IN} = 3.465V$			150	$\mu\text{A}$
		nCLK	$V_{DD} = V_{IN} = 3.465V$			5	$\mu\text{A}$
$I_{IL}$	Input Low Current	CLK	$V_{DD} = 3.465V, V_{IN} = 0V$	-5			$\mu\text{A}$
		nCLK	$V_{DD} = 3.465V, V_{IN} = 0V$	-150			$\mu\text{A}$
$V_{PP}$	Peak-to-Peak Input Voltage; NOTE 1			0.15		1.3	V
$V_{CMR}$	Input Common Mode Voltage; NOTE 1, 2			GND + 0.5		$V_{DD} - 0.85$	V

NOTE 1:  $V_{IL}$  should not be less than -0.3V.NOTE 2: Common mode voltage is defined as  $V_{IH}$ .

## AC Electrical Characteristics

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

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{OUT}$	Output Frequency				250	MHz
$t_{PD}$	Propagation Delay; NOTE 1		1.9		3.2	ns
$t_{sk(o)}$	Output Skew; NOTE 2, 4	Measured on the Rising Edge			100	ps
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 3, 4				900	ps
$t_{sk(b)}$	Bank Skew; NOTE 4, 5				35	ps
$f_{jit}$	Buffer Additive Phase Jitter, RMS; refer to Additive Phase Jitter Section, NOTE 6	CLK, nCLK 156.25MHz, Integration Range: 12kHz - 20MHz		0.25		ps
$t_R / t_F$	Output Rise/Fall Time; NOTE 7	20% to 80%	100		700	ps
odc	Output Duty Cycle; NOTE 8	CLK, nCLK	$f_{OUT} \leq 156.25\text{MHz}$	45	55	%
		LVC MOS_CLK	$f_{OUT} \leq 156.25\text{MHz}$	40	60	%
$t_{EN}$	Output Enable Time; NOTE 7				5	ns
$t_{DIS}$	Output Disable Time; NOTE 7				5	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: All parameters measured at  $f \leq 250\text{MHz}$  unless noted otherwise.

NOTE 1: Measured from the  $V_{DD}/2$  of the input clock (LVC MOS\_CLK) or from the differential input crossing point (CLK, nCLK) to  $V_{DDO\_X}/2$  of the output.

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

NOTE 3: Defined as skew between outputs on different devices operating at the same supply voltages, with equal load conditions. Using the same type of inputs on each device, the outputs are measured at  $V_{DDO\_X}/2$ .

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

NOTE 5: Defined as skew within a bank of outputs at the same voltages and with equal load conditions.

NOTE 6: Driving only one input clock.

NOTE 7: These parameters are guaranteed by characterization. Not tested in production.

NOTE 8: Input duty cycle must be 50%.

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

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{OUT}$	Output Frequency				250	MHz
$t_{PD}$	Propagation Delay; NOTE 1		1.9		3.2	ns
$t_{sk(o)}$	Output Skew; NOTE 2, 4	Measured on the Rising Edge			100	ps
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 3, 4				900	ps
$t_{sk(b)}$	Bank Skew; NOTE 4, 5				35	ps
$f_{jit}$	Buffer Additive Phase Jitter, RMS; refer to Additive Phase Jitter Section, NOTE 6	CLK, nCLK 156.25MHz, Integration Range: 12kHz - 20MHz		0.25		ps
$t_R / t_F$	Output Rise/Fall Time; NOTE 7	20% to 80%	100		700	ps
odc	Output Duty Cycle; NOTE 8	CLK, nCLK	$f_{OUT} \leq 156.25\text{MHz}$	45	55	%
		LVC MOS_CLK	$f_{OUT} \leq 156.25\text{MHz}$	40	60	%
$t_{EN}$	Output Enable Time; NOTE 7				5	ns
$t_{DIS}$	Output Disable Time; NOTE 7				5	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: All parameters measured at  $f \leq 250\text{MHz}$  unless noted otherwise.

NOTE 1: Measured from the  $V_{DD}/2$  of the input clock (LVC MOS\_CLK) or from the differential input crossing point (CLK, nCLK) to  $V_{DDO\_X}/2$  of the output.

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

NOTE 3: Defined as skew between outputs on different devices operating at the same supply voltages, with equal load conditions. Using the same type of inputs on each device, the outputs are measured at  $V_{DDO\_X}/2$ .

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

NOTE 5: Defined as skew within a bank of outputs at the same voltages and with equal load conditions.

NOTE 6: Driving only one input clock.

NOTE 7: These parameters are guaranteed by characterization. Not tested in production.

NOTE 8: Input duty cycle must be 50%.

**Table 5C. AC Characteristics,  $V_{DD} = 3.3V \pm 5\%$ ,  $V_{DDO\_A} = V_{DDO\_B} = 1.8V \pm 0.15V$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$** 

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{OUT}$	Output Frequency				250	MHz
$t_{PD}$	Propagation Delay; NOTE 1		2.2		3.9	ns
$t_{sk(o)}$	Output Skew; NOTE 2, 4	Measured on the Rising Edge			100	ps
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 3, 4				1.2	ns
$t_{sk(b)}$	Bank Skew; NOTE 4, 5				50	ps
$f_{jit}$	Buffer Additive Phase Jitter, RMS; refer to Additive Phase Jitter Section, NOTE 6	CLK, nCLK 156.25MHz, Integration Range: 12kHz - 20MHz		0.28		ps
$t_R / t_F$	Output Rise/Fall Time; NOTE 7	20% to 80%	100		800	ps
odc	Output Duty Cycle; NOTE 8	CLK, nCLK	$f_{OUT} \leq 156.25\text{MHz}$	45	55	%
		LVC MOS_CLK	$f_{OUT} \leq 156.25\text{MHz}$	40	60	%
$t_{EN}$	Output Enable Time: NOTE 7				5	ns
$t_{DIS}$	Output Disable Time: NOTE 7				5	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: All parameters measured at  $f \leq 250\text{MHz}$  unless noted otherwise.

NOTE 1: Measured from the  $V_{DD}/2$  of the input clock (LVC MOS\_CLK) or from the differential input crossing point (CLK, nCLK) to  $V_{DDO\_X}/2$  of the output.

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

NOTE 3: Defined as skew between outputs on different devices operating at the same supply voltages, with equal load conditions. Using the same type of inputs on each device, the outputs are measured at  $V_{DDO\_X}/2$ .

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

NOTE 5: Defined as skew within a bank of outputs at the same voltages and with equal load conditions.

NOTE 6: Driving only one input clock.

NOTE 7: These parameters are guaranteed by characterization. Not tested in production.

NOTE 8: Input duty cycle must be 50%.



**Table 5D. AC Characteristics,  $V_{DD} = 3.3V \pm 5\%$ ,  $V_{DDO\_A} = V_{DDO\_B} = 1.5V \pm 5\%$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$** 

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{OUT}$	Output Frequency				250	MHz
$t_{PD}$	Propagation Delay; NOTE 1		2.5		4.3	ns
$t_{sk(o)}$	Output Skew; NOTE 2, 4	Measured on the Rising Edge			100	ps
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 3, 4				1.6	ns
$t_{sk(b)}$	Bank Skew; NOTE 4, 5				50	ps
$f_{jit}$	Buffer Additive Phase Jitter, RMS; refer to Additive Phase Jitter Section, NOTE 6	CLK, nCLK 156.25MHz, Integration Range: 12kHz - 20MHz		0.35		ps
$t_R / t_F$	Output Rise/Fall Time; NOTE 7	20% to 80%	100		800	ps
odc	Output Duty Cycle; NOTE 8	CLK, nCLK	$f_{OUT} \leq 156.25\text{MHz}$	45	55	%
		LVC MOS_CLK	$f_{OUT} \leq 156.25\text{MHz}$	40	60	%
$t_{EN}$	Output Enable Time: NOTE 7				5	ns
$t_{DIS}$	Output Disable Time: NOTE 7				5	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: All parameters measured at  $f \leq 250\text{MHz}$  unless noted otherwise.

NOTE 1: Measured from the  $V_{DD}/2$  of the input clock (LVC MOS\_CLK) or from the differential input crossing point (CLK, nCLK) to  $V_{DDO\_X}/2$  of the output.

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

NOTE 3: Defined as skew between outputs on different devices operating at the same supply voltages, with equal load conditions. Using the same type of inputs on each device, the outputs are measured at  $V_{DDO\_X}/2$ .

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

NOTE 5: Defined as skew within a bank of outputs at the same voltages and with equal load conditions.

NOTE 6: Driving only one input clock.

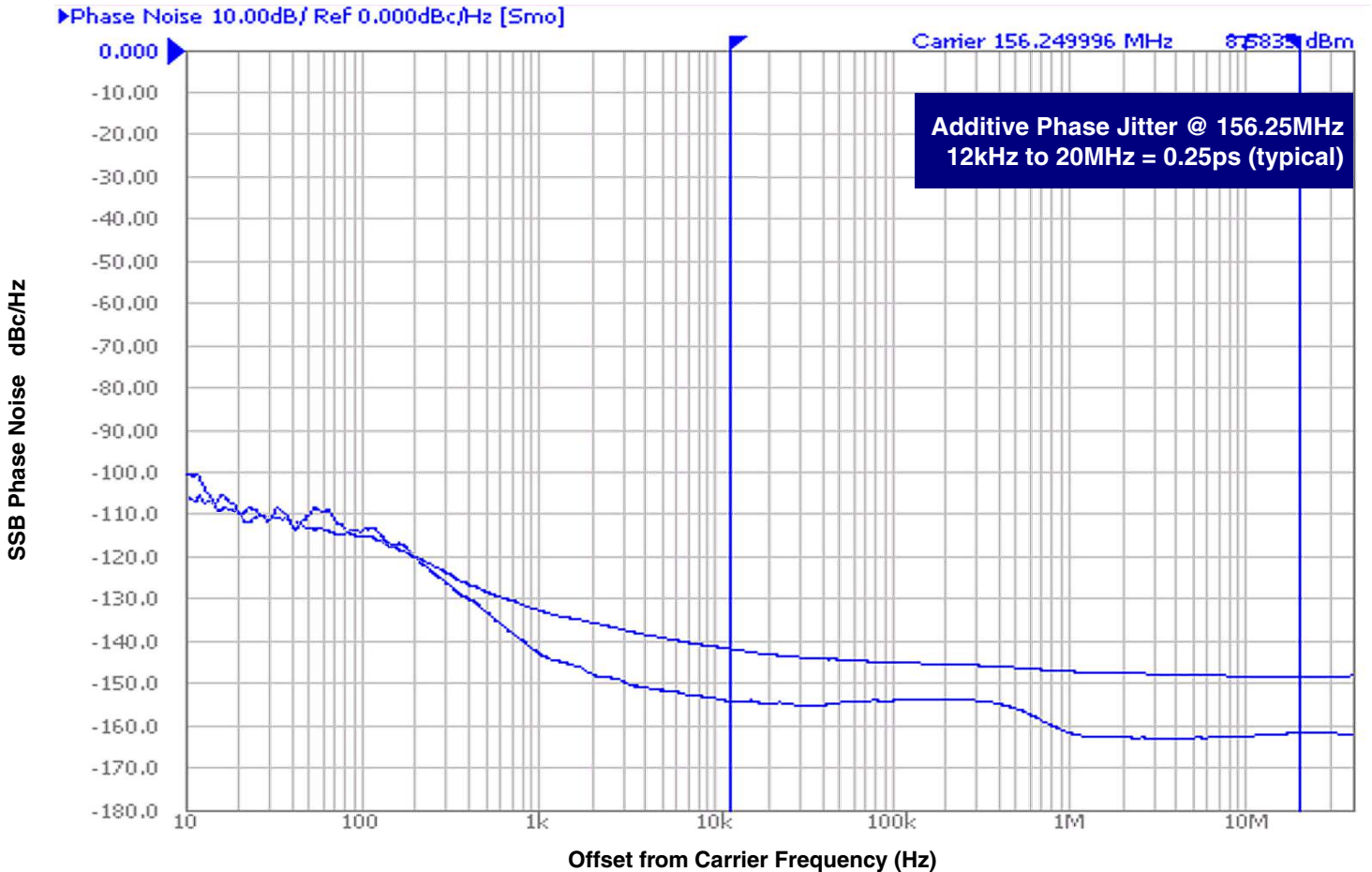
NOTE 7: These parameters are guaranteed by characterization. Not tested in production.

NOTE 8: Input duty cycle must be 50%.

## 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.

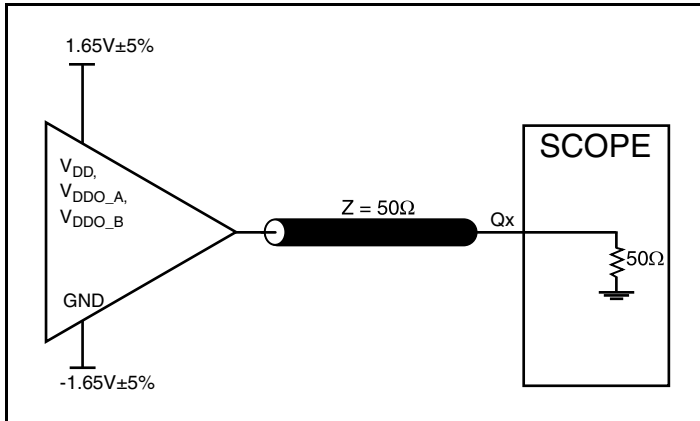


As with most timing specifications, phase noise measurements have issues relating to the limitations of the equipment. Often the noise floor of the equipment is higher than the noise floor of the device. This is illustrated above. The device meets the noise floor of what is

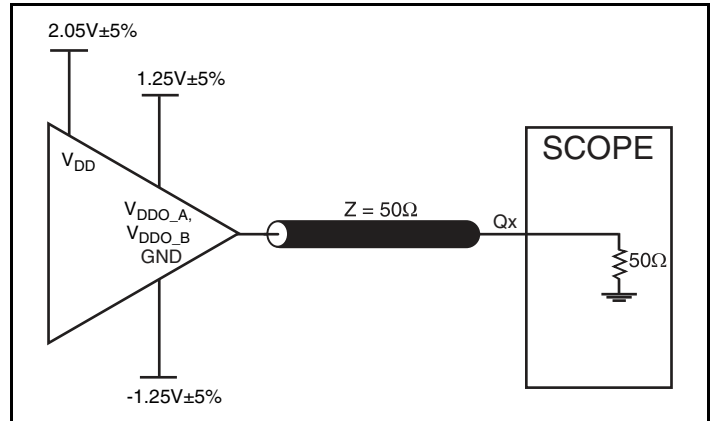
shown, but can actually be lower. The phase noise is dependent on the input source and measurement equipment.

Measured using a Rohde & Schwarz SMA100 as the input source.

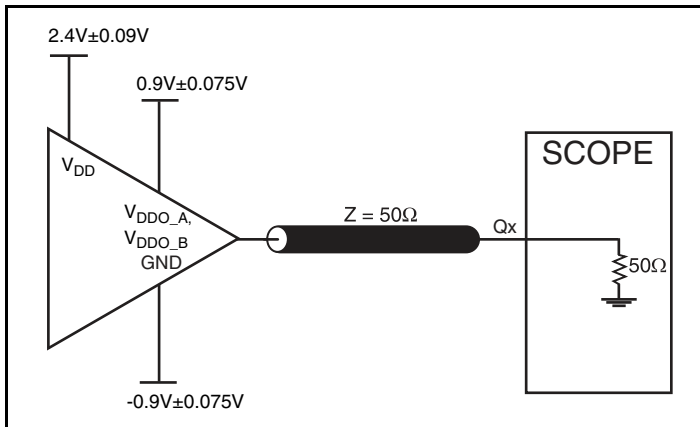
### Parameter Measurement Information



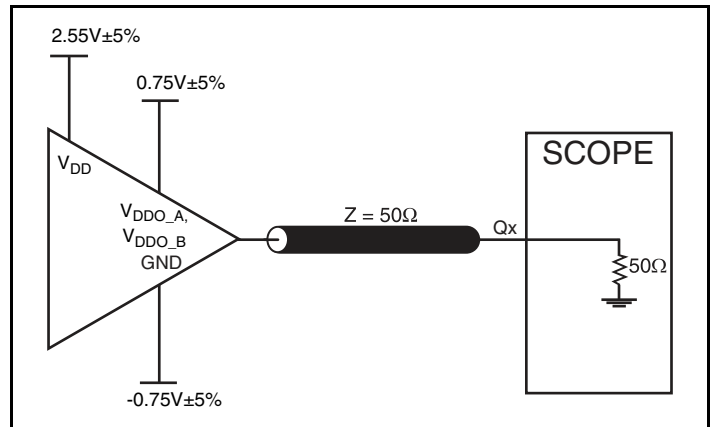
3.3V Core/3.3V LVCMOS Output Load Test Circuit



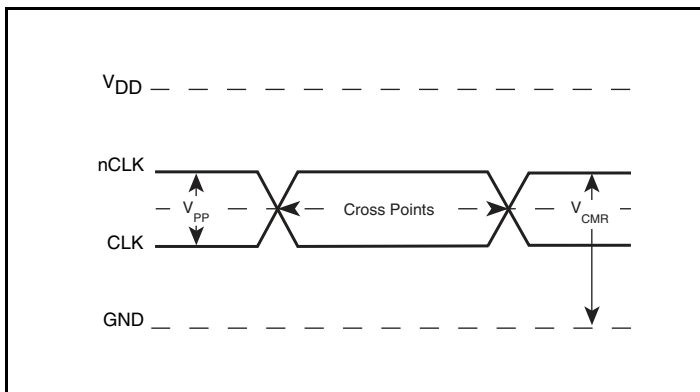
3.3V Core/2.5V LVCMOS Output Load Test Circuit



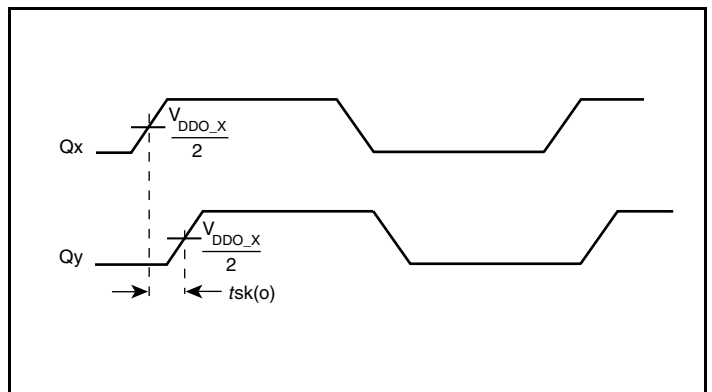
3.3V Core/1.8V LVCMOS Output Load Test Circuit



3.3V Core/1.5V LVCMOS Output Load Test Circuit

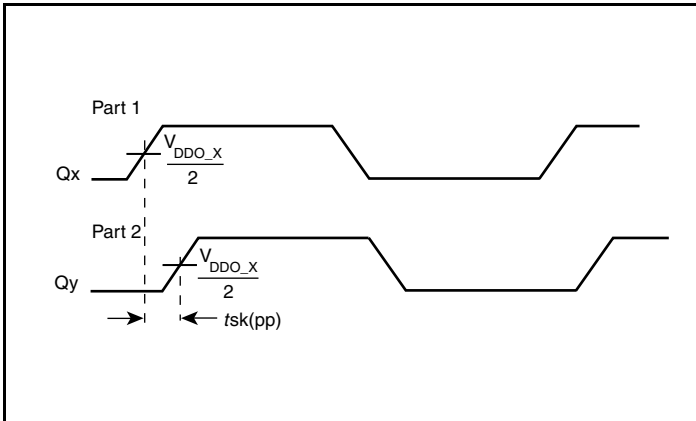


Differential Input Level

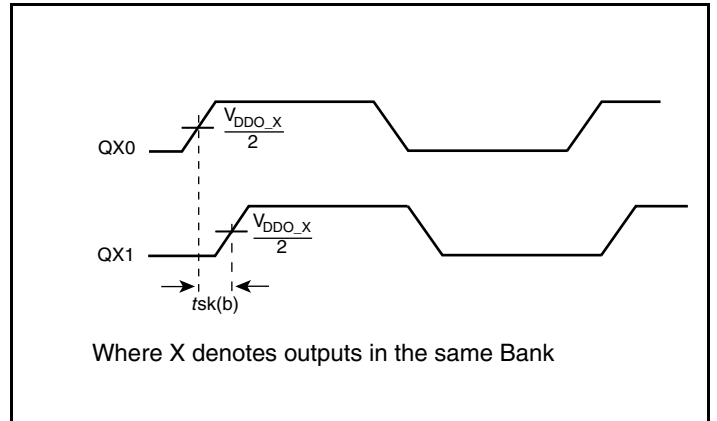


Output Skew

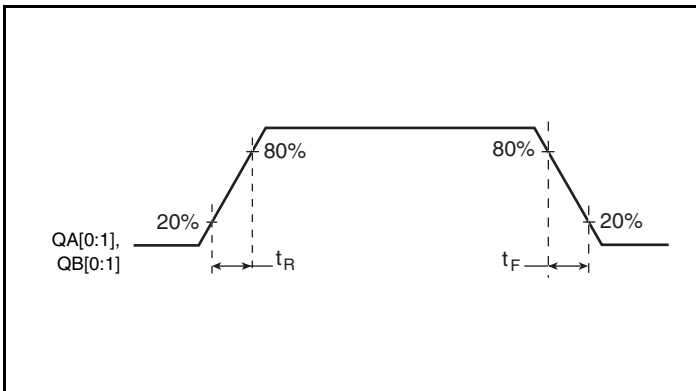
Parameter Measurement Information, continued



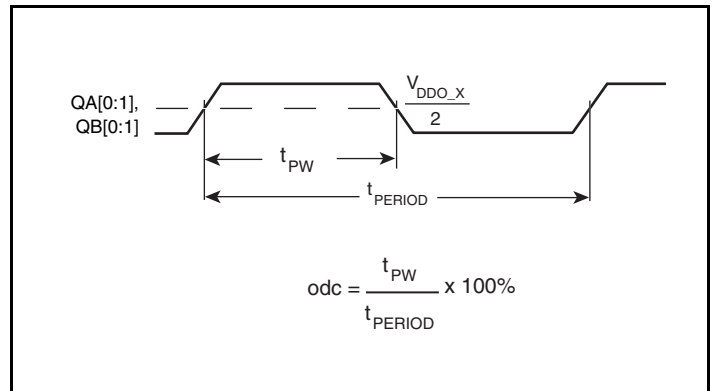
Part-to-Part Skew



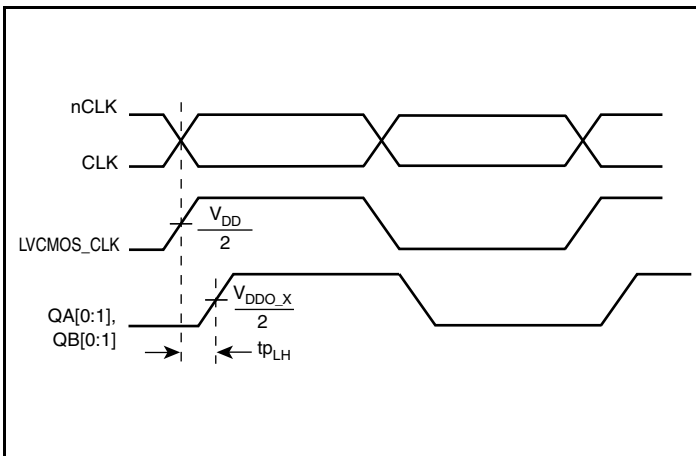
Bank Skew



Output Rise/Fall Time



Output Duty Cycle/Pulse Width/Period



Propagation Delay

## Applications Information

### 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  $V_1 = V_{DD}/2$  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  $V_{DD} = 3.3V$ , 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  $V_{DD}$  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 LVCMOS driver. When using single-ended signaling, the noise rejection benefits of differential signaling are reduced. Even though the differential input can handle full rail LVCMOS signaling, it is recommended that the amplitude be reduced. 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  $V_{DD} + 0.3V$ . 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.

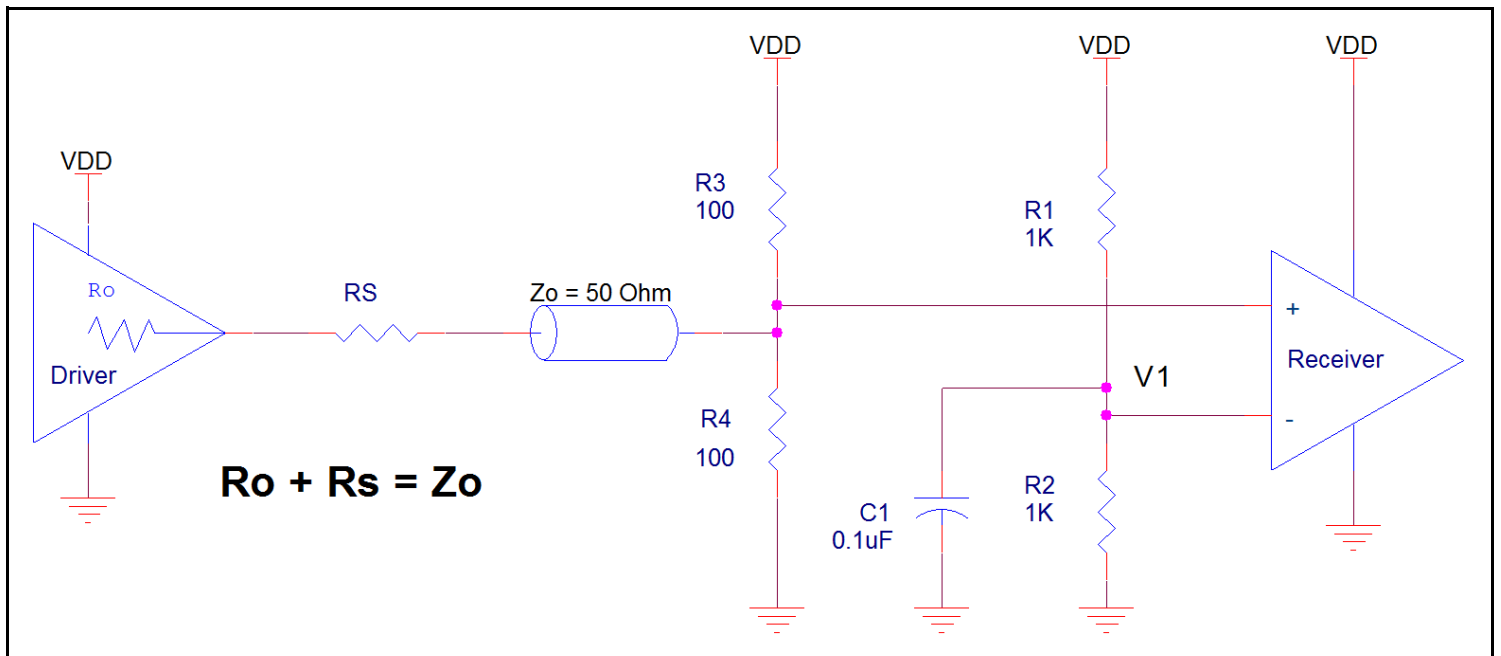


Figure 2. Recommended Schematic for Wiring a Differential Input to Accept Single-ended Levels

## 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.

#### LVCMOS\_CLK Input

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

#### LVCMOS Control Pins

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

### Outputs:

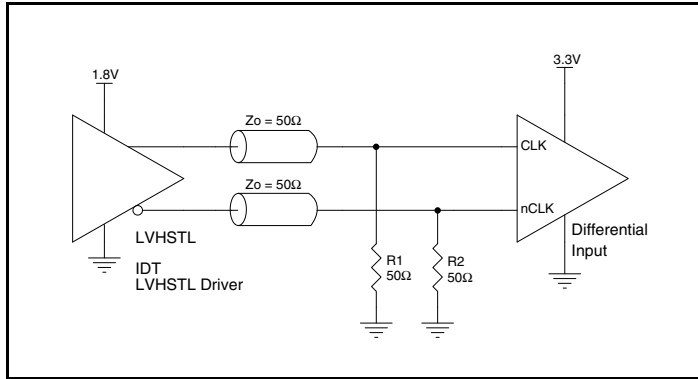
#### LVCMOS Outputs

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

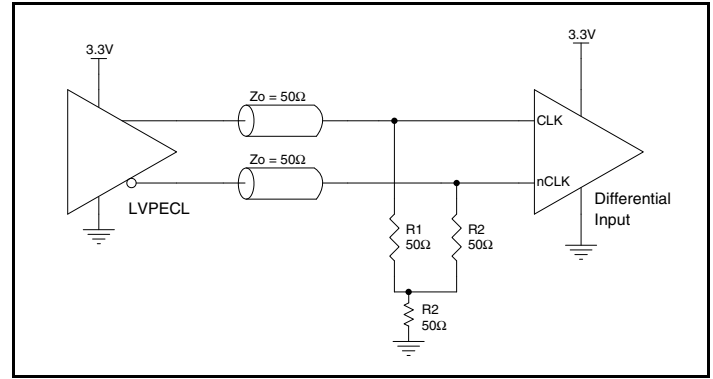
## Differential Clock Input Interface

The CLK /nCLK accepts LVDS, LVPECL, LVHSTL, HCSL and other differential signals. The differential signals must meet the  $V_{PP}$  and  $V_{CMR}$  input requirements. *Figures 3A to 3E* 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

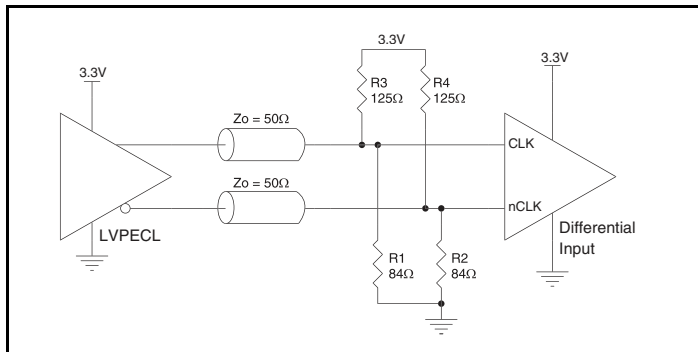
with the vendor of the driver component to confirm the driver termination requirements. For example, in Figure 3A, the input termination applies for IDT open emitter LVHSTL drivers. If you are using an LVHSTL driver from another vendor, use their termination recommendation.



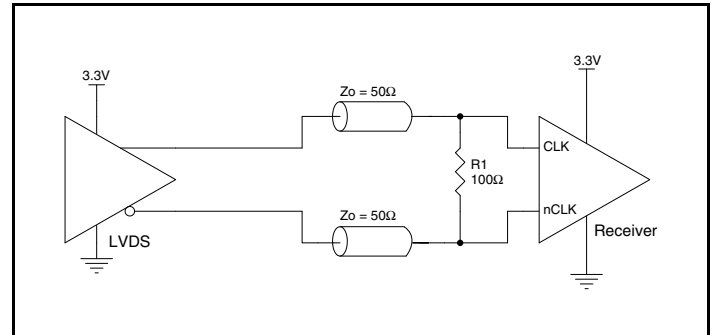
**Figure 3A.** CLK/nCLK Input Driven by an IDT Open Emitter LVHSTL Driver



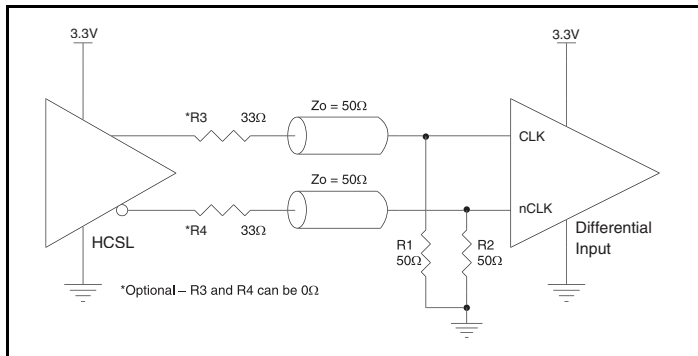
**Figure 3B.** CLK/nCLK Input Driven by a 3.3V LVPECL Driver



**Figure 3C.** CLK/nCLK Input Driven by a 3.3V LVPECL Driver



**Figure 3D.** CLK/nCLK Input Driven by a 3.3V LVDS Driver



**Figure 3E.** CLK/nCLK Input Driven by a 3.3V HCSL Driver

## Power Considerations

This section provides information on power dissipation and junction temperature for the ICS8305I-02. Equations and example calculations are also provided.

### 1. Power Dissipation.

The total power dissipation for the ICS8305I-02 is the sum of the core power plus the power dissipation due to loading. The following is the power dissipation for  $V_{DD} = 3.3V + 5\% = 3.465V$ , which gives worst case results.

- Power (core)<sub>MAX</sub> =  $V_{DD\_MAX} * I_{DD\_MAX} = 3.465V * 21mA = 72.765mW$

### LVCMOS Driver Power Dissipation

- Output Impedance  $R_{OUT}$  Power Dissipation due to Loading  $50\Omega$  to  $V_{DD}/2$   
Output Current  $I_{OUT} = V_{DD\_MAX} / [2 * (50\Omega + R_{OUT})] = 3.465V / [2 * (50\Omega + 9\Omega)] = 35.36mA$
- Power Dissipation on the  $R_{OUT}$  per LVCMOS output  
Power (LVCMOS) =  $R_{OUT} * (I_{OUT})^2 = 9\Omega * (35.36mA)^2 = 11.25mW$  per output

Total Power Dissipation on the  $R_{OUT}$

$$\text{Total Power (R}_{OUT}\text{)} = 11.25mW * 4 = 45mW$$

### Dynamic Power Dissipation at 250MHz

$$\text{Power (250MHz)} = C_{PD} * \text{Frequency} * (V_{DD})^2 * \text{Number of outputs} = 13pF * 250MHz * (3.465V)^2 * 4 = 156.53mW$$

### Total Power

$$\begin{aligned} &= \text{Power (core)}_{MAX} + \text{Total Power (R}_{OUT}\text{)} + \text{Power (250MHz)} \\ &= 72.765mW + 45mW + 156.53mW \\ &= 274.3mW \end{aligned}$$

### 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 is  $125^\circ C$ . Limiting the internal transistor junction temperature,  $T_j$ , to  $125^\circ C$  ensures that the bond wire and bond pad temperature remains below  $125^\circ C$ .

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  $100.3^\circ C/W$  per Table 6 below.

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

$$85^\circ C + 0.274W * 100.3^\circ C/W = 112.5^\circ C. \text{ This is below the limit of } 125^\circ C.$$

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).

**Table 6. Thermal Resistance  $\theta_{JA}$  for 16 Lead TSSOP, Forced Convection**

$\theta_{JA}$ by Velocity			
Meters per Second	0	1	2.5
Multi-Layer PCB, JEDEC Standard Test Boards	$100.3^\circ C/W$	$96.0^\circ C/W$	$93.9^\circ C/W$



## Reliability Information

Table 7.  $\theta_{JA}$  vs. Air Flow Table for a 16 Lead TSSOP

$\theta_{JA}$ vs. Air Flow			
Meters per Second	0	1	2.5
Multi-Layer PCB, JEDEC Standard Test Boards	100.3°C/W	96.0°C/W	93.9°C/W

## Transistor Count

The transistor count for ICS8305I-02: 538

## Package Outline and Package Dimensions

Package Outline - G Suffix for 16 Lead TSSOP

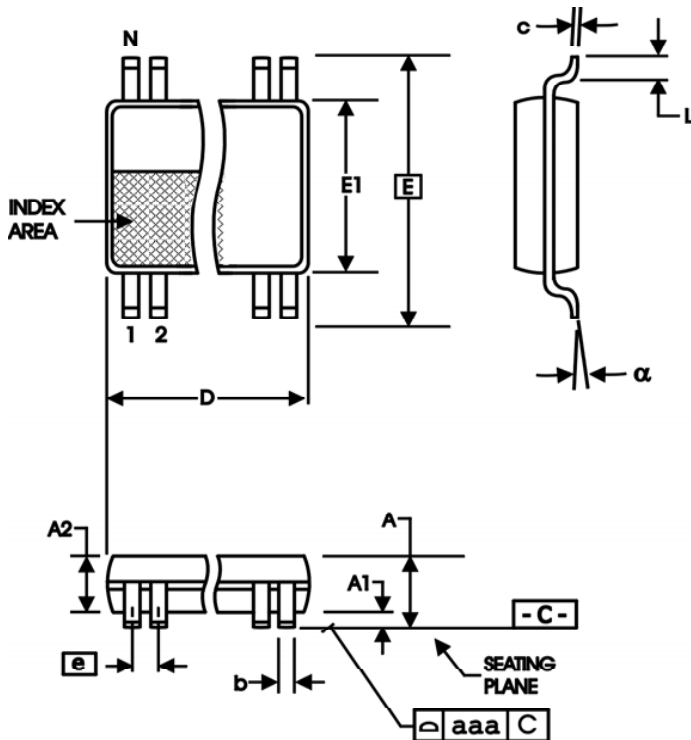


Table 8. Package Dimensions for 16 Lead TSSOP

All Dimensions in Millimeters		
Symbol	Minimum	Maximum
N	16	
A		1.20
A1	0.05	0.15
A2	0.80	1.05
b	0.19	0.30
c	0.09	0.20
D	4.90	5.10
E	6.40 Basic	
E1	4.30	4.50
e	0.65 Basic	
L	0.45	0.75
$\alpha$	0°	8°
aaa		0.10

Reference Document: JEDEC Publication 95, MO-153

## Ordering Information

**Table 9. Ordering Information**

<b>Part/Order Number</b>	<b>Marking</b>	<b>Package</b>	<b>Shipping Packaging</b>	<b>Temperature</b>
8305AGI-02LF	305AI02L	"Lead-Free" 16 Lead TSSOP	Tube	-40°C to 85°C
8305AGI-02LFT	305AI02L	"Lead-Free" 16 Lead TSSOP	Tape & Reel	-40°C to 85°C

## We've Got Your Timing Solution



6024 Silver Creek Valley Road  
San Jose, California 95138

**Sales**  
800-345-7015 (inside USA)  
+408-284-8200 (outside USA)  
Fax: 408-284-2775  
[www.IDT.com/go/contactIDT](http://www.IDT.com/go/contactIDT)

**Technical Support**  
[netcom@idt.com](mailto:netcom@idt.com)  
+480-763-2056

DISCLAIMER Integrated Device Technology, Inc. (IDT) and its subsidiaries reserve the right to modify the products and/or specifications described herein at any time and at IDT's sole discretion. All information in this document, including descriptions of product features and performance, is subject to change without notice. Performance specifications and the operating parameters of the described products are determined in the independent state and are not guaranteed to perform the same way when installed in customer products. The information contained herein is provided without representation or warranty of any kind, whether express or implied, including, but not limited to, the suitability of IDT's products for any particular purpose, an implied warranty of merchantability, or non-infringement of the intellectual property rights of others. This document is presented only as a guide and does not convey any license under intellectual property rights of IDT or any third parties.

IDT's products are not intended for use in applications involving extreme environmental conditions or in life support systems or similar devices where the failure or malfunction of an IDT product can be reasonably expected to significantly affect the health or safety of users. Anyone using an IDT product in such a manner does so at their own risk, absent an express, written agreement by IDT.

Integrated Device Technology, IDT and the IDT logo are registered trademarks of IDT. Other trademarks and service marks used herein, including protected names, logos and designs, are the property of IDT or their respective third party owners.

Copyright 2013. All rights reserved.