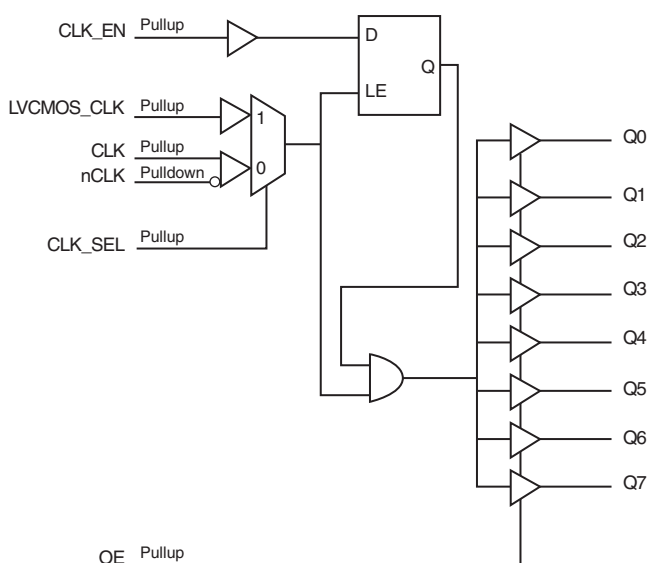


LOW SKEW, 1-TO-8

DIFFERENTIAL/LVCMOS-TO-LVCMOS FANOUT BUFFER

The ICS8308I is characterized for 3.3V core/3.3V output, 3.3V core/2.5V output or 2.5V core/2.5V output operation. Guaranteed output and part-part skew characteristics make the 8308I ideal for those clock distribution applications requiring well defined performance and repeatability.

- 8 LVCMOS/LVTTL outputs (7Ω typical output impedance)
- Selectable LVCMOS_CLK or differential CLK, nCLK inputs
- CLK, nCLK pair can accept the following differential input levels: LVPECL, LVDS, LVHSTL, SSTL, HCSL
- Maximum Output Frequency: 350MHz
- Output Skew: $(3.3V \pm 5\%)$: 100ps (maximum)
- Part to Part Skew: $(3.3V \pm 5\%)$: 1ns (maximum)
- Supply Voltage Modes:
(Core/Output)
3.3V/3.3V
3.3V/2.5V
2.5V/2.5V
- -40°C to 85°C ambient operating temperature
- Available in both, Standard and RoHS/Lead-Free compliant packages



Q0	1	24	VDDO
GND	2	23	Q2
CLK_SEL	3	22	GND
LVCNMOS_CLK	4	21	Q3
CLK	5	20	VDDO
nCLK	6	19	Q4
CLK_EN	7	18	GND
OE	8	17	Q5
VDD	9	16	VDDO
GND	10	15	Q6
Q1	11	14	GND
VDDO	12	13	Q7

Top View



TABLE 1. PIN DESCRIPTIONS

Number	Name	Type		Description
1, 11, 13, 15, 17, 19, 21, 23	Q0, Q1, Q7, Q6, Q5, Q4, Q3, Q2	Output		Clock outputs. LVCMOS / LVTTTL interface levels.
2, 10, 14, 18, 22	GND	Power		Power supply ground.
3	CLK_SEL	Input	Pullup	Clock select input. Selects LVCMOS clock input when HIGH. Selects CLK, nCLK inputs when LOW. LVCMOS / LVTTTL interface levels.
4	LVCMOS_CLK	Input	Pullup	Clock input. LVCMOS / LVTTTL interface levels.
5	CLK	Input	Pullup	Non-inverting differential clock input.
6	nCLK	Input	Pulldown	Inverting differential clock input.
7	CLK_EN	Input	Pullup	Clock enable. LVCMOS / LVTTTL interface levels.
8	OE	Input	Pullup	Output enable. LVCMOS / LVTTTL interface levels.
9	V _{DD}	Power		Core supply pin.
12, 16, 20, 24	V _{DDO}	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 _{IN}	Input Capacitance			4		pF
C _{PD}	Power Dissipation Capacitance (per output)			12		pF
R _{PULLUP}	Input Pullup Resistor			51		kΩ
R _{PULLDOWN}	Input Pulldown Resistor			51		kΩ
R _{OUT}	Output Impedance		5	7	12	Ω

TABLE 3A. CLOCK SELECT FUNCTION TABLE

Control Input	Clock Input
CLK_SEL	
0	CLK, nCLK is selected
1	LVCMOS_CLK is selected

TABLE 3B. CLOCK INPUT FUNCTION TABLE

Inputs				Outputs	Input to Output Mode	Polarity
CLK_SEL	LVCMOS_CLK	CLK	nCLK	Q0:Q7		
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

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, θ_{JA}	70°C/W (0 lfpm)
Storage Temperature, T_{STG}	-65°C to 150°C

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.

TABLE 4A. POWER SUPPLY DC CHARACTERISTICS, $V_{DD} = V_{DDO} = 3.3V \pm 5\%$, $T_A = -40^\circ$ TO 85°

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Core 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				46	mA
I_{DDO}	Output Supply Current				11	mA

TABLE 4B. POWER SUPPLY DC CHARACTERISTICS, $V_{DD} = 3.3V \pm 5\%$, $V_{DDO} = 2.5V \pm 5\%$, $T_A = -40^\circ$ TO 85°

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Core 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				46	mA
I_{DDO}	Output Supply Current				10	mA

TABLE 4C. POWER SUPPLY DC CHARACTERISTICS, $V_{DD}, V_{DDO} = 2.5V \pm 5\%$, $T_A = -40^\circ$ TO 85°

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Core 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				43	mA
I_{DDO}	Output Supply Current				10	mA



TABLE 4D. DC CHARACTERISTICS, $V_{DD} = V_{DDO} = 3.3V \pm 5\%$, $T_A = -40^\circ$ TO 85°

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
V_{IH}	Input High Voltage	LVC MOS		2		$V_{DD} + 0.3$	V
V_{IL}	Input Low Voltage	LVC MOS_CLK		-0.3		1.3	V
		CLK_EN, OE				0.8	0.8
I_{IN}	Input Current		$V_{IN} = V_{DD}$ or $V_{IN} = GND$			300	μA
V_{OH}	Output High Voltage; NOTE 1		$I_{OH} = -24mA$	2.4			V
V_{OL}	Output Low Voltage; NOTE 1		$I_{OL} = 24mA$			0.55	V
			$I_{OL} = 12mA$			0.30	V
V_{PP}	Peak-to-Peak Input Voltage	CLK, nCLK		0.15		1.3	V
V_{CMR}	Input Common Mode Voltage; NOTE 2, 3	CLK, nCLK		GND + 0.5		$V_{DD} - 0.85$	V

NOTE 1: Outputs capable of driving 50 Ω transmission lines terminated with 50 Ω to $V_{DDO}/2$.

See Parameter Measurement section, "3.3V Output Load AC Test Circuit".

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

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

TABLE 4E. DC CHARACTERISTICS, $V_{DD} = 3.3V \pm 5\%$, $V_{DDO} = 2.5V \pm 5\%$, $T_A = -40^\circ$ TO 85°

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
V_{IH}	Input High Voltage	LVC MOS		2		$V_{DD} + 0.3$	V
V_{IL}	Input Low Voltage	LVC MOS_CLK		-0.3		1.3	V
		CLK_EN, OE				0.8	V
I_{IN}	Input Current		$V_{IN} = V_{DD}$ or $V_{IN} = GND$			300	μA
V_{OH}	Output High Voltage; NOTE 1		$I_{OH} = -15mA$	1.8			V
V_{OL}	Output Low Voltage; NOTE 1		$I_{OL} = 15mA$			0.6	V
V_{PP}	Peak-to-Peak Input Voltage	CLK, nCLK		0.15		1.3	V
V_{CMR}	Input Common Mode Voltage; NOTE 2, 3	CLK, nCLK		GND + 0.5		$V_{DD} - 0.85$	V

NOTE 1: Outputs capable of driving 50 Ω transmission lines terminated with 50 Ω to $V_{DDO}/2$.

See Parameter Measurement section, "3.3V Output Load AC Test Circuit".

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

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



TABLE 4F. DC CHARACTERISTICS, $V_{DD}, V_{DDO} = 2.5V \pm 5\%$, $T_A = -40^\circ$ TO 85°

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{IH}	Input High Voltage	LVC MOS	2		$V_{DD} + 0.3$	V
V_{IL}	Input Low Voltage	LVC MOS_CLK	-0.3		1.3	V
		CLK_EN, OE			0.7	V
I_{IN}	Input Current	$V_{IN} = V_{DD}$ or $V_{IN} = GND$			300	μA
V_{OH}	Output High Voltage; NOTE 1	$I_{OH} = -15mA$	1.8			V
V_{OL}	Output Low Voltage; NOTE 1	$I_{OL} = 15mA$			0.6	V
V_{PP}	Peak-to-Peak Input Voltage	CLK, nCLK	0.15		1.3	V
V_{CMR}	Input Common Mode Voltage; NOTE 2, 3	CLK, nCLK	$GND + 0.5$		$V_{DD} - 0.85$	V

NOTE 1: Outputs capable of driving 50 Ω transmission lines terminated with 50 Ω to $V_{DDO}/2$.

See Parameter Measurement section, "3.3V Output Load AC Test Circuit".

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

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

TABLE 5A. AC CHARACTERISTICS, $V_{DD} = V_{DDO} = 3.3V \pm 5\%$, $T_A = -40^\circ$ TO 85°

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
f_{MAX}	Output Frequency				350	MHz
t_{PD}	Propagation Delay;	CLK, nCLK; NOTE 1	$f \leq 350MHz$	2	4	ns
		LVC MOS_CLK; NOTE 2	$f \leq 350MHz$	2	4	ns
$t_{sk(o)}$	Output Skew; NOTE 3, 7	Measured on rising edge @ $V_{DDO}/2$			100	ps
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 4, 7	Measured on rising edge @ $V_{DDO}/2$			1	ns
t_R / t_F	Output Rise/Fall Time	0.8V to 2V	0.2		1	ns
odc	Output Duty Cycle	$f \leq 150MHz$, 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 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 voltages and with equal load conditions. Using the same type of inputs on each device, the outputs are 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, $V_{DD} = 3.3V \pm 5\%$, $V_{DDO} = 2.5V \pm 5\%$, $T_A = -40^\circ$ TO 85°

Symbol	Parameter		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
		LVCMOS_CLK; NOTE 2	$f \leq 350\text{MHz}$	2		4	ns
$t_{sk(o)}$	Output Skew; NOTE 3, 7		Measured on rising edge @ $V_{DDO}/2$			100	ps
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 4, 7		Measured on rising edge @ $V_{DDO}/2$			1	ns
t_R / t_F	Output Rise/Fall Time		0.6V to 1.8V	0.2		1.0	ns
odc	Output Duty Cycle		$f \leq 150\text{MHz}$, 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 LVCMOS_CLK		0			ns
t_H	Clock Enable Hold Time; NOTE 6	CLK, nCLK to CLK_EN		0			ns
		LVCMOS_CLK to CLK_EN		1			ns

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 voltages and with equal load conditions. Using the same type of inputs on each device, the outputs are 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, $V_{DD} = V_{DDO} = 2.5V \pm 5\%$, $T_A = -40^\circ$ TO 85°

Symbol	Parameter		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
		LVCMOS_CLK; NOTE 2	$f \leq 350\text{MHz}$	1.7		4.4	ns
$t_{sk(o)}$	Output Skew; NOTE 3, 7		Measured on rising edge @ $V_{DDO}/2$			160	ps
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 4, 7		Measured on rising edge @ $V_{DDO}/2$			2	ns
t_R / t_F	Output Rise/Fall Time		0.6V to 1.8V	0.2		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 LVCMOS_CLK		0			ns
t_H	Clock Enable Hold Time; NOTE 6	CLK, nCLK to CLK_EN		0			ns
		LVCMOS_CLK to CLK_EN		1			ns

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 voltages and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at $V_{DDO}/2$.

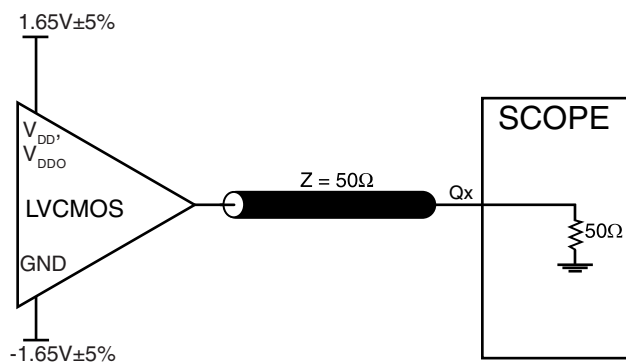
NOTE 5: These parameters are guaranteed by characterization. Not tested in production.

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

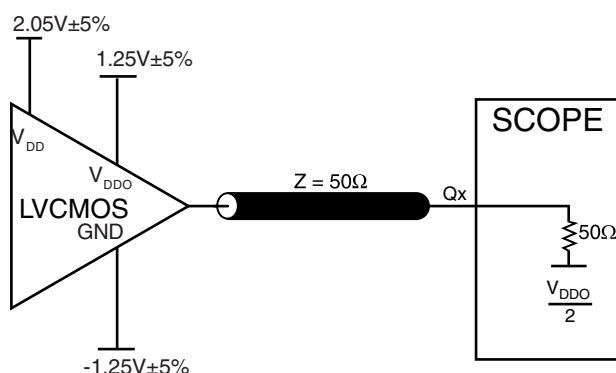
NOTE 7: This parameter is defined in accordance with JEDEC Standard 65.



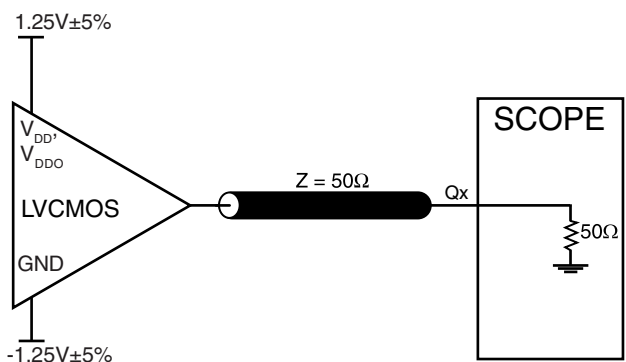
PARAMETER MEASUREMENT INFORMATION



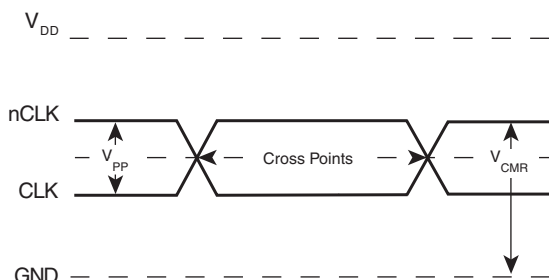
3.3V CORE/3.3V OUTPUT LOAD AC TEST CIRCUIT



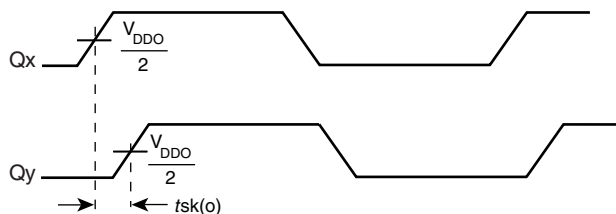
3.3V CORE/2.5V OUTPUT LOAD AC TEST CIRCUIT



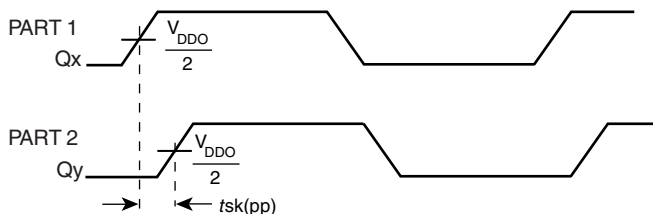
2.5V CORE/2.5V OUTPUT LOAD AC TEST CIRCUIT



DIFFERENTIAL INPUT LEVEL



OUTPUT SKEW



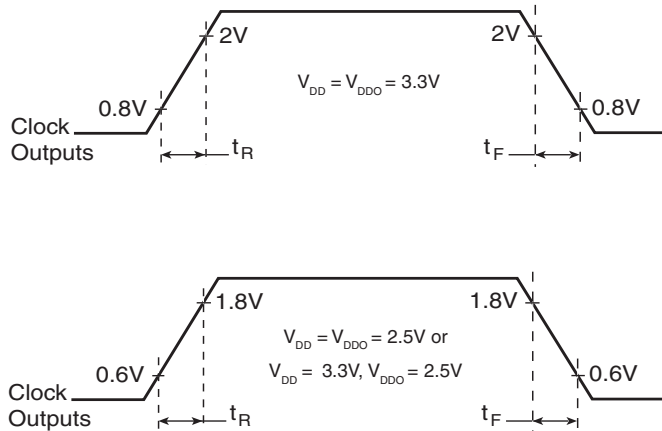
PART-TO-PART SKEW



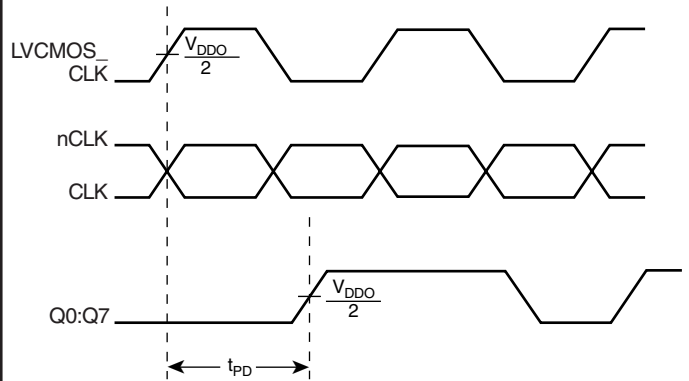
Integrated
Circuit
Systems, Inc.

ICS8308I

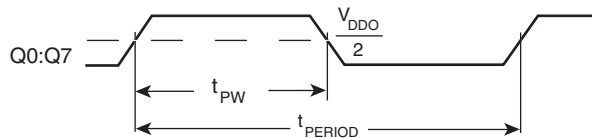
LOW SKEW, 1-TO-8 DIFFERENTIAL/LVCMOS-TO-LVCMOS FANOUT BUFFER



OUTPUT RISE/FALL TIME



PROPAGATION DELAY



OUTPUT DUTY CYCLE/PULSE WIDTH/PERIOD

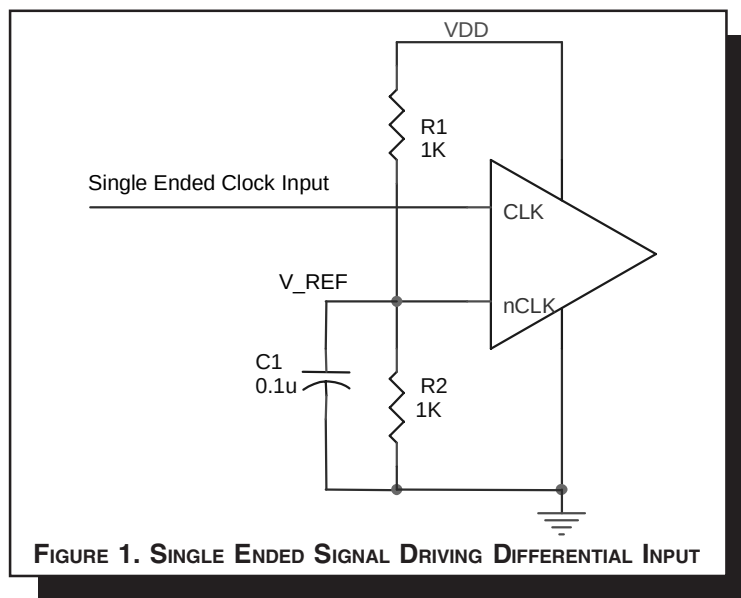


APPLICATION INFORMATION

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 $R2/R1 = 0.609$.



RECOMMENDATIONS FOR UNUSED INPUT AND OUTPUT PINS

INPUTS:

CLK INPUT:

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

CLK/nCLK INPUT:

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 Ω resistor can be tied from CLK to ground.

SELECT PINS:

All select pins have internal pull-ups and pull-downs; additional resistance is not required but can be added for additional protection. A 1k Ω resistor can be used.

OUTPUTS:

LVCMOS OUTPUT:

All unused LVCMOS output can be left floating. We recommend that there is no trace attached.



DIFFERENTIAL CLOCK INPUT INTERFACE

The CLK/nCLK accepts LVDS, LVPECL, LVHSTL, SSTL, HCSL and other differential signals. Both V_{SWING} and V_{OH} must meet the V_{PP} and V_{CMR} input requirements. Figures 3A to 3D 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 3A*, the input termination applies for ICS HiPerClockS LVHSTL drivers. If you are using an LVHSTL driver from another vendor, use their termination recommendation.

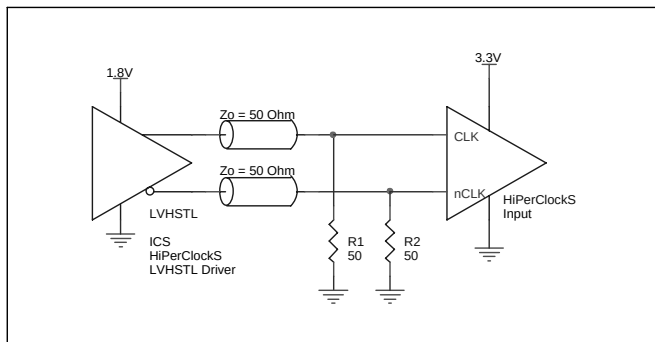


FIGURE 3A. HiPerClockS CLK/nCLK INPUT DRIVEN BY ICS HiPerClockS LVHSTL DRIVER

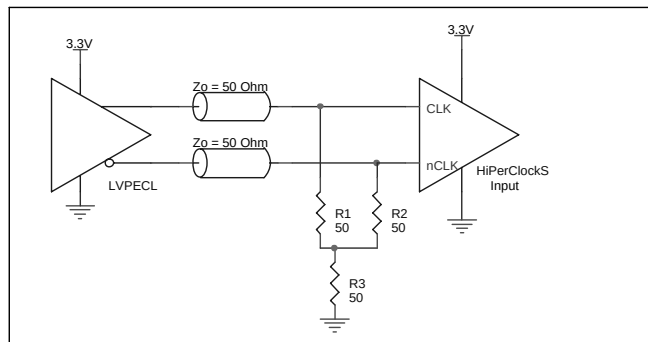


FIGURE 3B. HiPerClockS CLK/nCLK INPUT DRIVEN BY 3.3V LVPECL DRIVER

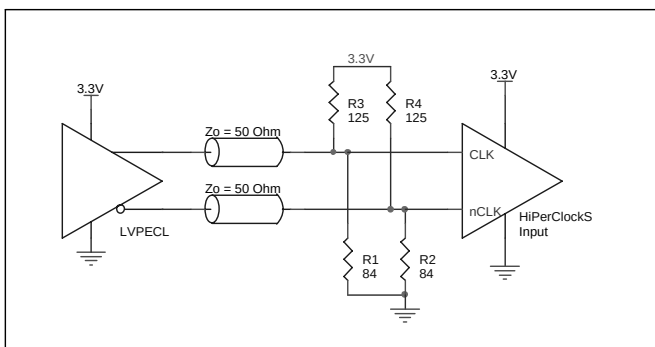


FIGURE 3C. HiPerClockS CLK/nCLK INPUT DRIVEN BY 3.3V LVPECL DRIVER

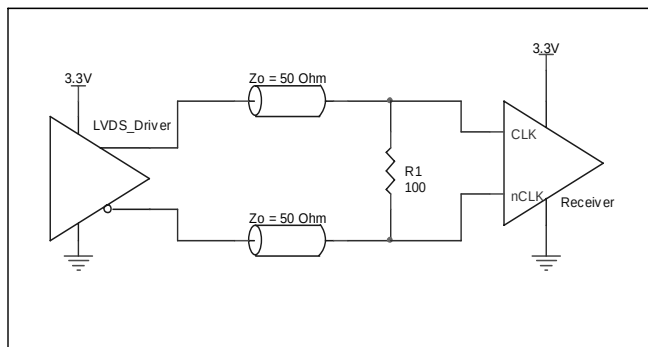


FIGURE 3D. HiPerClockS CLK/nCLK INPUT DRIVEN BY 3.3V LVDS DRIVER



SCHEMATIC EXAMPLE

Figure 3 shows a schematic example of the ICS8308I. In this example, the LVCMOS_CLK input is selected. The decoupling capacitors should be physically located near the power pin.

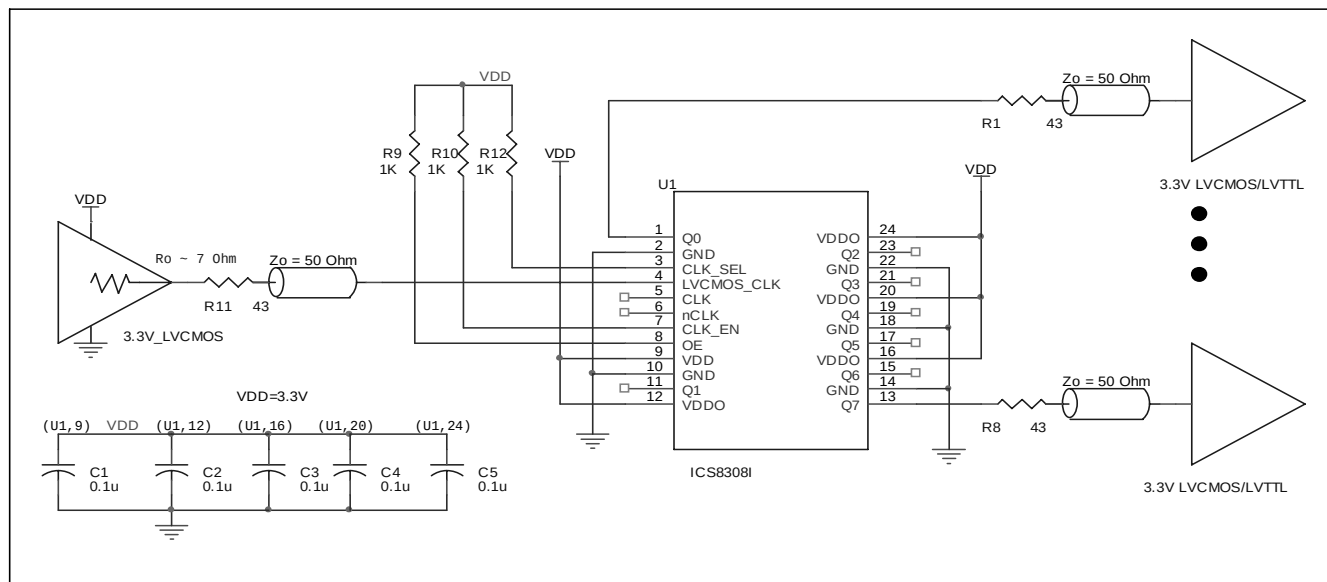


FIGURE 3. ICS8308I LVPECL BUFFER SCHEMATIC EXAMPLE

RELIABILITY INFORMATION

TABLE 6. θ_{JA} VS. AIR FLOW TABLE FOR 24 LEAD TSSOP

θ_{JA} by Velocity (Linear Feet per Minute)			
	0	200	500
Multi-Layer PCB, JEDEC Standard Test Boards	70°C/W	63°C/W	60°C/W

TRANSISTOR COUNT

The transistor count for ICS8308I is: 1040



PACKAGE OUTLINE - G SUFFIX FOR 24 LEAD TSSOP

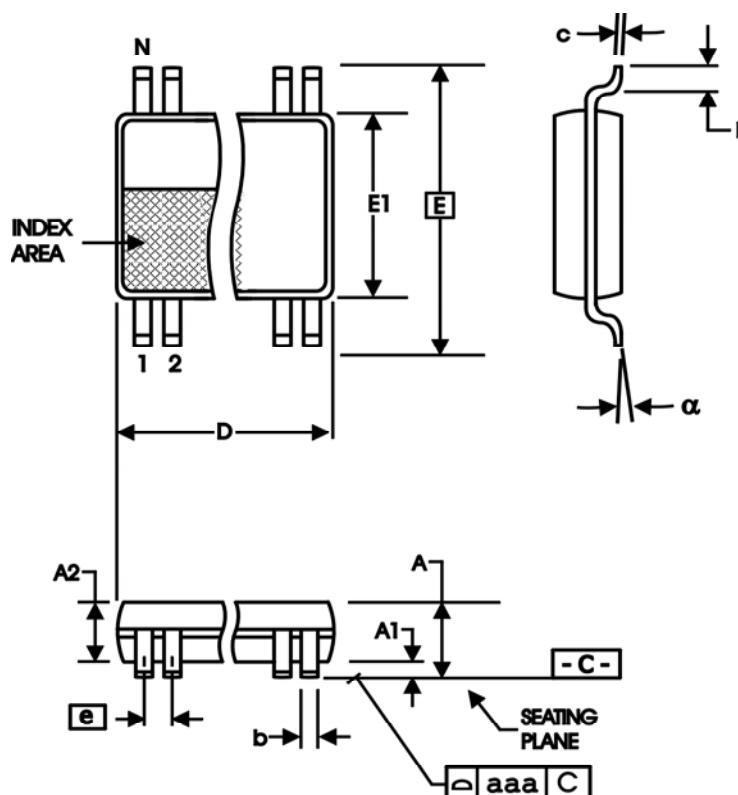


TABLE 7. PACKAGE DIMENSIONS

SYMBOL	Millimeters	
	Minimum	Maximum
N	24	
A	--	1.20
A1	0.05	0.15
A2	0.80	1.05
b	0.19	0.30
c	0.09	0.20
D	7.70	7.90
E	6.40 BASIC	
E1	4.30	4.50
e	0.65 BASIC	
L	0.45	0.75
α	0°	8°
aaa	--	0.10

REFERENCE DOCUMENT: JEDEC PUBLICATION 95, MO-153



Integrated
Circuit
Systems, Inc.

ICS8308I

LOW SKEW, 1-TO-8 DIFFERENTIAL/LVCMOS-TO-LVCMOS FANOUT BUFFER

TABLE 8. ORDERING INFORMATION

Part/Order Number	Marking	Package	Shipping Packaging	Temperature
ICS8308AGI	ICS8308AGI	24 Lead TSSOP	tube	-40°C to 85°C
ICS8308AGIT	ICS8308AGI	24 Lead TSSOP	tape & reel	-40°C to 85°C
ICS8308AGILF	ICS8308AGILF	24 Lead "Lead-Free" TSSOP	tube	-40°C to 85°C
ICS8308AGILFT	ICS8308AGILF	24 Lead "Lead-Free" TSSOP	tape & reel	-40°C to 85°C

NOTE: Parts that are ordered with an "LF" suffix to the part number are the Pb-Free configuration and are RoHS compliant.

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ICS8308I

LOW SKEW, 1-TO-8

DIFFERENTIAL/LVCMOS-TO-LVCMOS FANOUT BUFFER

REVISION HISTORY SHEET				
Rev	Table	Page	Description of Change	Date
A		11	Added Schematic Layout	4/16/04
B	T4B T4E T5B	1	Features section - added mix supply voltage bullet.	10/20/04
		3	Added Mix Power Supply Table.	
		4	Added Mix DC Characteristics Table.	
		6	Added Mix AC Characteristics Table.	
		8	Added Mix Output Load AC Test Circuit Diagram.	
B	T8	14	Ordering Information Table - added "Lead-Free" part number.	1/12/05
B	T8	1	Corrected Block Diagram, added CLK_SEL.	7/25/05
		10	Added "Recommendations for Unused Input and Output Pins".	
		14	Ordering Information Table - added Lead-Free note.	