DUAL LVCMOS / LVTTL-TODIFFERENTIAL LVHSTL TRANSLATOR

ICS85222

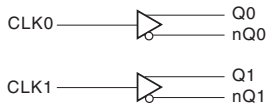
General Description

The ICS85222 is a Dual LVCMOS / LVTTL-to-Differential LVHSTL Translator and a member of the HiPerClocks™ family of High Performance Clock Solutions from ICS. The ICS85222 has two single ended clock inputs. The single ended clock input accepts LVCMOS or LVTTL input levels and translates them to LVHSTL levels. The small outline 8-pin SOIC package makes this device ideal for applications where space, high performance and low power are important. For optimum performance, both output pairs need to be terminated, even if one output pair is unused.

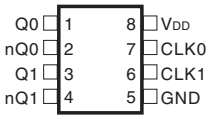
Features

- 2 differential LVHSTL outputs
- Selectable CLK0, CLK1 LVCMOS clock inputs
- CLK0 and CLK1 can accept the following input levels: LVCMOS or LVTTL
- Maximum output frequency: 350MHz
- Part-to-part skew: 350ps (maximum)
- Propagation delay: 1.3ns (maximum)
- V_{OH}: 1.2V (maximum)
- 3.3V and 2.5V operating supply
- 0°C to 70°C ambient operating temperature
- Industrial temperature information available upon request
- Lead-Free package fully RoHS compliant

Block Diagram



Pin Assignment



ICS85222
8-Lead SOIC
3.90mm x 4.92mm x 1.37mm body package
M Package
Top View

TABLE 1. PIN DESCRIPTIONS

Number	Name	Type		Description
1, 2	Q0, nQ0	Output		Differential output pair. LVHSTL interface levels.
3, 4	Q1, nQ1	Output		Differential output pair. LVHSTL interface levels.
5	GND	Power		Power supply ground.
6	CLK1	Input	Pulldown	LVCMOS / LVTTL clock input.
7	CLK0	Input	Pulldown	LVCMOS / LVTTL clock input.
8	V_{DD}	Power		Positive supply pin.

NOTE: *Pulldown* refers to internal input resistors. See Table 2, Pin Characteristics, for typical values.
NOTE: Unused output pairs must be terminated. Refer to Application Information section for a schematic layout.

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

Supply Voltage, V_{DD}	4.6V
Inputs, V_I	-0.5V to V_{DD} + 0.5V
Outputs, I_O	
Continuous Current	50mA
Surge Current	100mA
Package Thermal Impedance, θ_{JA}	112.7°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 3A. Power Supply DC Characteristics, V_{DD} = 3.3V±5%, V_{DD} = 2.5V±5%, T_A = 0°C to 70°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Positive Supply Voltage		3.135	3.3	3.465	V
V_{DD}	Positive Supply Voltage		2.375	2.5	2.625	V
I_{DD}	Power Supply Current				45	mA

Table 3B. LVCMOS / LVTTL DC Characteristics, V_{DD} = 3.3V±5%, V_{DD} = 2.5V±5%, T_A = 0°C to 70°C

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
V_{IH}	Input High Voltage	CLK0, CLK1		2		V_{DD} + 0.3	V
V_{IL}	Input Low Voltage	CLK0, CLK1		-0.3		1.3	V
I_{IH}	Input High Current	CLK0, CLK1	$V_{DD} = V_{IN}$ = 3.465V, $V_{DD} = V_{IN}$ = 2.625V			150	µA
I_{IL}	Input Low Current	CLK0, CLK1	$V_{DD} = V_{IN}$ = 3.465V, $V_{DD} = V_{IN}$ = 2.625V	-5			µA

Table 3C. LVHSTL DC Characteristics, V_{DD} = 3.3V±5%, V_{DD} = 2.5V±5%, T_A = 0°C to 70°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{OH}	Output High Voltage; NOTE 1		1		1.2	V
V_{OL}	Output Low Voltage; NOTE 1	V_{DD} = 3.3V ± 5%	0		0.4	V
		V_{DD} = 2.5V ± 5%	0		0.55	V
V_{SWING}	Peak-to-Peak Output Voltage Swing	V_{DD} = 3.3V ± 5%	0.6		1.2	V
		V_{DD} = 2.5V ± 5%	0.45		1.2	V

NOTE 1: Outputs terminated with 50Ω to GND.

TABLE 4A. AC CHARACTERISTICS, V_{DD} = 3.3V±5%, TA = 0°C TO 70°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
f_{MAX}	Output Frequency				350	MHz
t_{PD}	Propagation Delay; NOTE 1	$f \leq$ 350MHz	750	950	1150	ps
*t*sk(pp)	Part-to-Part Skew; NOTE 2, 3				350	ps
t_R	Output Rise Time	20% to 80%	150		800	ps
t_F	Output Fall Time	20% to 80%	150		800	ps
odc	Output Duty Cycle	$f \leq$ 150MHz	48		52	%
		150 < $f \leq$ 250MHz	47		53	%
		250 < $f \leq$ 350MHz	45		55	%

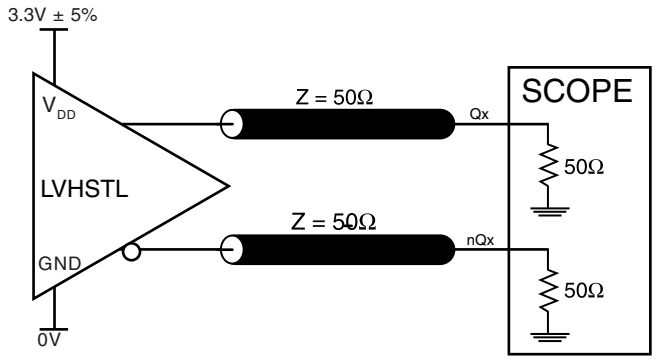
NOTE 1: Measured from V_{DD}/2 of the input to the differential output crossing point.
NOTE 2: Defined as skew between outputs on different devices operating at the same supply voltages and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at the differential cross points.
NOTE 3: This parameter is defined in accordance with JEDEC Standard 65.

TABLE 4B. AC CHARACTERISTICS, V_{DD} = 2.5V±5%, TA = 0°C TO 70°C

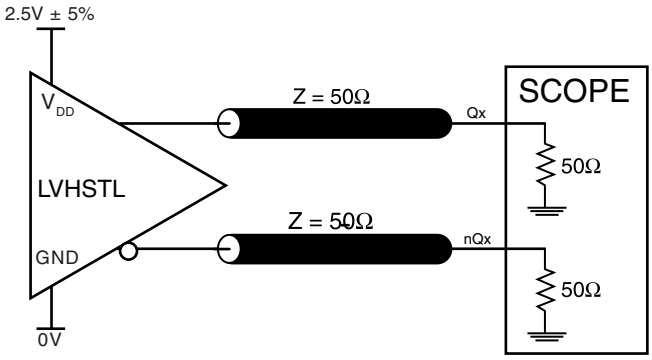
Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
f_{MAX}	Output Frequency				350	MHz
t_{PD}	Propagation Delay; NOTE 1	$f \leq$ 350MHz	850	1075	1300	ps
*t*sk(pp)	Part-to-Part Skew; NOTE 2, 3				450	ps
t_R	Output Rise Time	20% to 80%	150		800	ps
t_F	Output Fall Time	20% to 80%	150		800	ps
odc	Output Duty Cycle	$f \leq$ 150MHz	45		55	%
		150 < $f \leq$ 350MHz	40		60	%

NOTE 1: Measured from V_{DD}/2 of the input to the differential output crossing point.
NOTE 2: 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 3: This parameter is defined in accordance with JEDEC Standard 65.

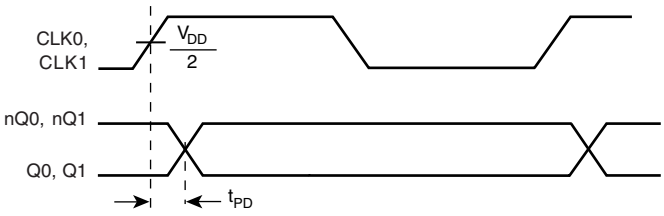
PARAMETER MEASUREMENT INFORMATION



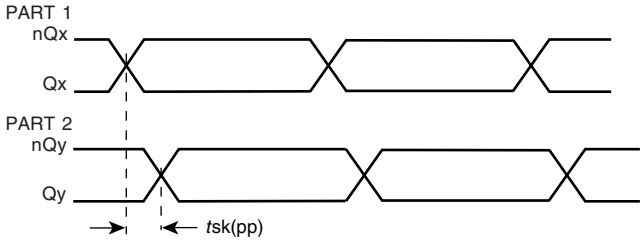
3.3V CORE/3.3V OUTPUT LOAD AC TEST CIRCUIT



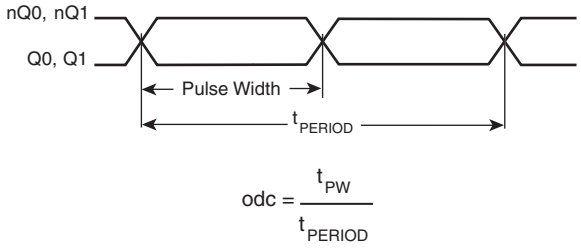
2.5V CORE/2.5V OUTPUT LOAD AC TEST CIRCUIT



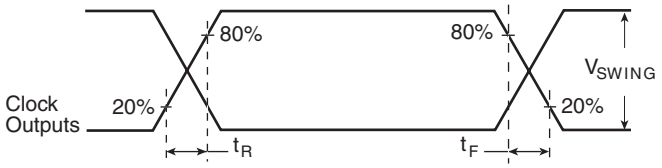
PROPAGATION DELAY



PART-TO-PART SKEW



OUTPUT DUTY CYCLE/PULSE WIDTH/PERIOD



OUTPUT RISE/FALL TIME

APPLICATION INFORMATION

SCHEMATIC EXAMPLE

Figure 1 shows a schematic example of ICS85222. In this example, the inputs are driven by 7Ω output LVCMOS drivers with series terminations. The decoupling capacitors should be physically located near the power pin. For ICS85222, the unused output need to be terminated.

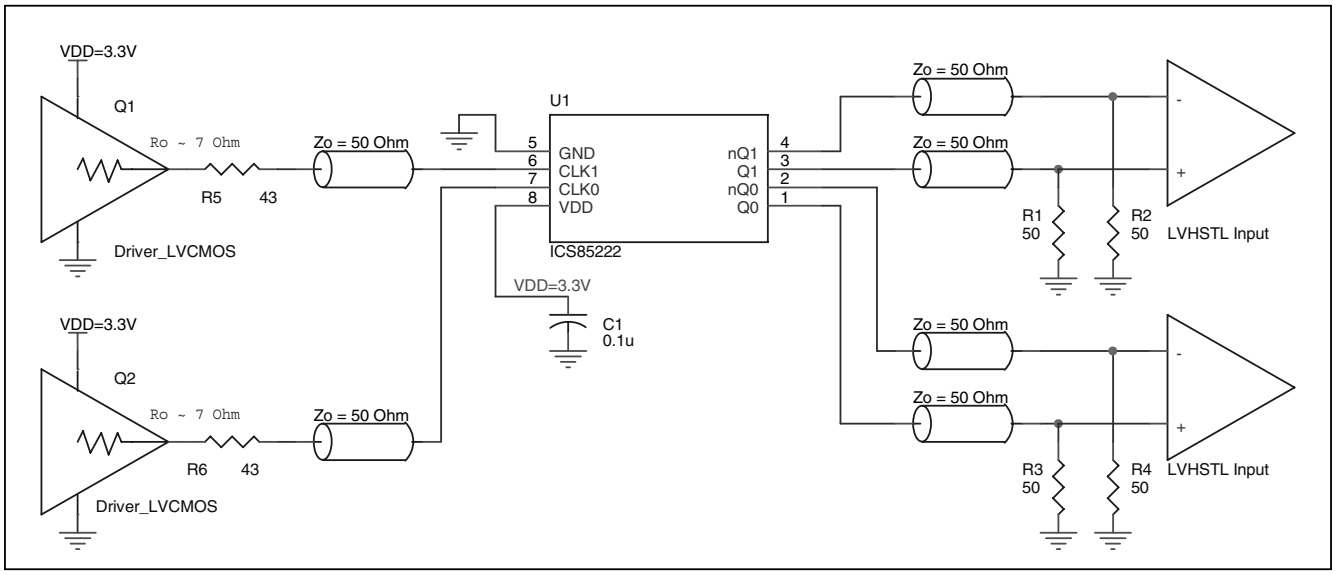


FIGURE 1. ICS85222 LVHSTL BUFFER SCHEMATIC EXAMPLE

POWER CONSIDERATIONS

This section provides information on power dissipation and junction temperature for the ICS85222.
Equations and example calculations are also provided.

1. Power Dissipation.
The total power dissipation for the ICS85222 is the sum of the core power plus the power dissipated in the load(s).
The following is the power dissipation for V_{DD} = 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 $(core)_{MAX} = V_{DD\_MAX} * I_{DD\_MAX}$ = 3.465V * 45mA = **155.9mW**
- Power $(outputs)_{MAX}$ = **78.9mW/Loaded Output pair**
  If all outputs are loaded, the total power is 2 * 78.9mW = **157.8mW**

Total Power$_{_MAX}$ (3.465V, with all outputs switching) = 155.9mW + 157.8mW = **313.7mW**

2. Junction Temperature.
Junction temperature, Tj, 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 HiPerClockS™ devices is 125°C.

The equation for Tj is as follows: $Tj = \theta_{JA} * Pd\_total + T_A$

Tj = 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 a moderate air flow of 200 linear feet per minute and a multi-layer board, the appropriate value is 103.3°C/W per Table 5 below. Therefore, Tj for an ambient temperature of 70°C with all outputs switching is:

70°C + 0.314W * 103.3°C/W = 102.4°C. This is well below the limit of 125°C

This calculation is only an example. Tj 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-PIN SOIC, FORCED CONVECTION

θ_{JA} by Velocity (Linear Feet per Minute)			
	0	**200**	**500**
Single-Layer PCB, JEDEC Standard Test Boards	153.3°C/W	128.5°C/W	115.5°C/W
Multi-Layer PCB, JEDEC Standard Test Boards	112.7°C/W	103.3°C/W	97.1°C/W

NOTE: Most modern PCB designs use multi-layered boards. The data in the second row pertains to most designs.

3. Calculations and Equations.

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

LVHSTL output driver circuit and termination are shown in *Figure 2.*

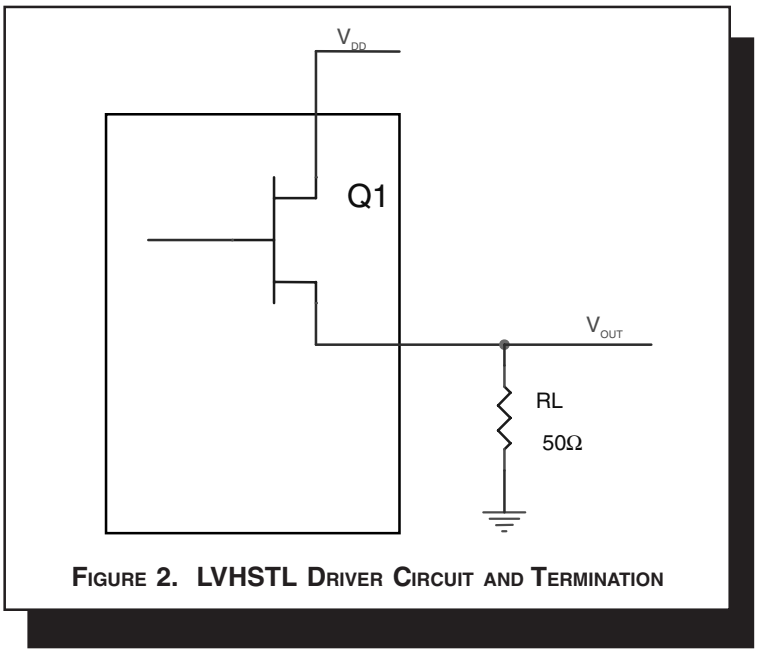


FIGURE 2. LVHSTL DRIVER CIRCUIT AND TERMINATION

To calculate worst case power dissipation into the load, use the following equations which assume a 50Ω load.

Pd_H is power dissipation when the output drives high.
Pd_L is the power dissipation when the output drives low.

$$Pd\_H = (V_{OH\_MAX}/R_L) * (V_{DD\_MAX} - V_{OH\_MAX})$$

$$Pd\_L = (V_{OL\_MAX}/R_L) * (V_{DD\_MAX} - V_{OL\_MAX})$$

Pd_H = (1.2V/50Ω) * (3.465V - 1.2V) = **54.4mW**
Pd_L = (0.4V/50Ω) * (3.465V - 0.4V) = **24.52mW**

Total Power Dissipation per output pair = Pd_H + Pd_L = **78.9mW**

RELIABILITY INFORMATION

TABLE 6. θ_{JA} VS. AIR FLOW TABLE FOR 8 LEAD SOIC

θ_{JA} by Velocity (Linear Feet per Minute)			
	0	**200**	**500**
Single-Layer PCB, JEDEC Standard Test Boards	153.3°C/W	128.5°C/W	115.5°C/W
Multi-Layer PCB, JEDEC Standard Test Boards	112.7°C/W	103.3°C/W	97.1°C/W

NOTE: Most modern PCB designs use multi-layered boards. The data in the second row pertains to most designs.

TRANSISTOR COUNT

The transistor count for ICS85222 is: 443

Package Outline - M Suffix for 8 Lead SOIC

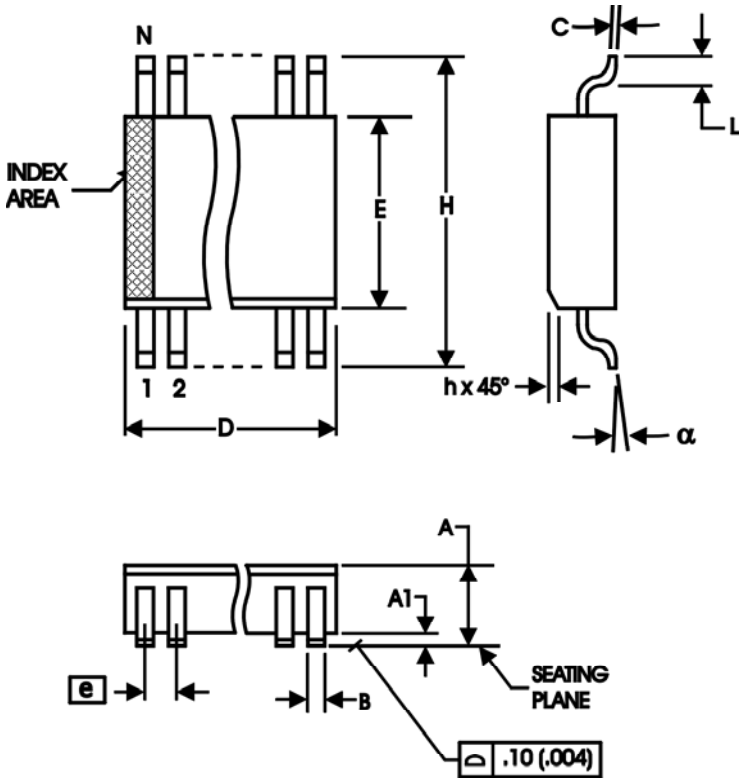


Table 7. Package Dimensions

SYMBOL	Millimeters	
	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

TABLE 8. ORDERING INFORMATION

Part/Order Number	Marking	Package	Shipping Package	Temperature
ICS85222AM	85222AM	8 Lead SOIC	tube	0°C to 70°C
ICS85222AMT	85222AM	8 Lead SOIC	2500 tape & reel	0°C to 70°C
ICS85222AMLF	85222AML	8 Lead "Lead-Free" SOIC	tube	0°C to 70°C
ICS85222AMLFT	85222AML	8 Lead "Lead-Free" SOIC	2500 tape & reel	0°C to 70°C

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

REVISION HISTORY SHEET				
Rev	**Table**	**Page**	**Description of Change**	**Date**
B	T2 T8	1 2 12	Features section - add Lead-Free bullet. Pin Characteristics table - changed C_{IN} 4pF max. to 4pF typical. Ordering Information Table - added Lead-Free part number. Updated data sheet format.	3/31/05

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