


### General Description

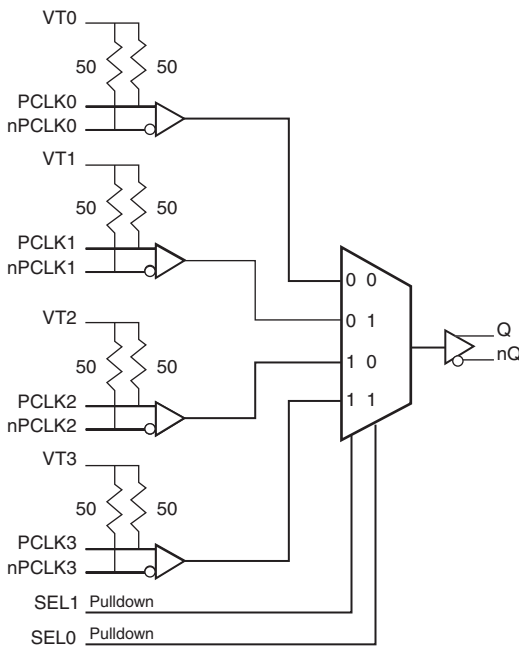


The ICS854S057BI is a 4:1 or 2:1 LVDS Clock Multiplexer which can operate up to 2GHz. The PCLK, nPCLK pairs can accept most standard differential input levels. Internal termination is provided on each differential input pair. The ICS854S057BI operates using a 2.5V supply voltage. The fully differential architecture and low propagation delay make it ideal for use in high speed multiplexing applications. The select pins have internal pull-down resistors. Leaving one input unconnected (pulled to logic low by the internal resistor) will transform the device into a 2:1 multiplexer. The SEL1 pin is the most significant bit and the binary number applied to the select pins will select the same numbered data input (i.e., 00 selects PCLK0, nPCLK0).

### Features

- High speed differential multiplexer. The device can be configured as either a 4:1 or 2:1 multiplexer
- One LVDS output pair
- Four selectable PCLK, nPCLK inputs with internal termination
- PCLKx, nPCLKx pairs can accept the following differential input levels: LVPECL, LVDS, CML, SSTL
- Maximum output frequency: >2GHz
- Part-to-part skew: 200ps (maximum)
- Propagation delay: 800ps (maximum)
- Additive phase jitter, RMS: 0.065ps (typical)
- Full 2.5V power supply
- -40°C to 85°C ambient operating temperature
- Available in lead-free (RoHS 6) package

### Block Diagram



### Pin Assignment

VDD	1	20	VDD
PCLK0	2	19	PCLK3
VT0	3	18	VT3
nPCLK0	4	17	nPCLK3
SEL1	5	16	Q
SEL0	6	15	nQ
PCLK1	7	14	PCLK2
VT1	8	13	VT2
nPCLK1	9	12	nPCLK2
GND	10	11	GND

### ICS854S057BI

**20-Lead TSSOP**  
**4.4mm x 6.5mm x 0.925mm package body**  
**G Package**  
**Top View**

**Table 1. Pin Descriptions**

Number	Name	Type		Description
1, 20	V <sub>DD</sub>	Power		Power supply pins.
2	PCLK0	Input		Non-inverting LVPECL differential clock input. R <sub>T</sub> = 50Ω termination to VT0.
3	VT0	Input		Termination input. For LVDS input, leave floating. R <sub>T</sub> = 50Ω termination to VT0.
4	nPCLK0	Input		Inverting LVPECL differential clock input. R <sub>T</sub> = 50Ω termination to VT0.
5, 6	SEL1, SEL0	Input	Pulldown	Clock select inputs. LVCMOS/LVTTL interface levels.
7	PCLK1	Input		Non-inverting LVPECL differential clock input. R <sub>T</sub> = 50Ω termination to VT1.
8	VT1	Input		Termination input. For LVDS input, leave floating. R <sub>T</sub> = 50Ω termination to VT1.
9	nPCLK1	Input		Inverting LVPECL differential clock input. R <sub>T</sub> = 50Ω termination to VT1.
10, 11	GND	Power		Power supply ground.
12	nPCLK2	Input		Inverting LVPECL differential clock input. R <sub>T</sub> = 50Ω termination to VT2.
13	VT2	Input		Termination input. For LVDS input, leave floating. R <sub>T</sub> = 50Ω termination to VT2.
14	PCLK2	Input		Non-inverting LVPECL differential clock input. R <sub>T</sub> = 50Ω termination to VT2.
15, 16	nQ, Q	Output		Differential output pair. LVDS interface levels.
17	nPCLK3	Input		Inverting LVPECL differential clock input. R <sub>T</sub> = 50Ω termination to VT3.
18	VT3	Input		Termination input. For LVDS input, leave floating. R <sub>T</sub> = 50Ω termination to VT3.
19	PCLK3	Input		Non-inverting LVPECL differential clock input. R <sub>T</sub> = 50Ω termination to VT3.

NOTE: *Pulldown* refers 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			2		pF
R <sub>PULLDOWN</sub>	Input Pulldown Resistor			50		kΩ
R <sub>T</sub>	Input Termination Resistor		40	50	60	Ω

**Table 3. Control Input Function Table**

Inputs		Outputs
SEL1	SEL0	PCLKx, nPCLKx
0	0	PCLK0, nPCLK0
0	1	PCLK1, nPCLK1
1	0	PCLK2, nPCLK2
1	1	PCLK3, nPCLK3

## 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, $I_O$ Continuous Current Surge Current	10mA 15mA
Input Current, PCLK, nPCLK	$\pm 50mA$
$V_T$ Current, $I_{VT}$	$\pm 100mA$
Package Thermal Impedance, $\theta_{JA}$	92.1°C/W (0 mps)
Storage Temperature, $T_{STG}$	-65°C to 150°C

## DC Electrical Characteristics

**Table 4A. LVDS Power Supply DC Characteristics,  $V_{DD} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ C$  to  $85^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{DD}$	Power Supply Voltage		2.375	2.5	2.625	V
$I_{DD}$	Power Supply Current				50	mA

**Table 4B. LVCMOS/LVTTL DC Characteristics,  $V_{DD} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ C$  to  $85^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{IH}$	Input High Voltage	$V_{DD} = 2.5V$	1.7		$V_{DD} + 0.3$	V
$V_{IL}$	Input Low Voltage	$V_{DD} = 2.5V$	-0.3		0.7	V
$I_{IH}$	Input High Current	SEL0, SEL1 $V_{DD} = V_{IN} = 2.625V$			150	$\mu A$
$I_{IL}$	Input Low Current	SEL0, SEL1 $V_{DD} = 2.625V, V_{IN} = 0V$	-10			$\mu A$

**Table 4C. LVPECL Differential DC Characteristics,  $V_{DD} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ C$  to  $85^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$I_{IN}$	Absolute Input Current; NOTE 1	$V_{DD} = V_{IN} = 2.625V$			35	mA
$V_{PP}$	Peak-to-Peak Voltage; NOTE 2		0.15		1.2	V
$V_{CMR}$	Common Mode Input Voltage; NOTE 2, 3		GND + 1.2		$V_{DD}$	V

NOTE 1: Guaranteed by design.

NOTE 2:  $V_{IL}$  should not be less than -0.3V.

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

**Table 4D. LVDS DC Characteristics,  $V_{DD} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$** 

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{OD}$	Differential Output Voltage		225	325	425	mV
$\Delta V_{OD}$	$V_{OD}$ Magnitude Change			4	35	mV
$V_{OS}$	Offset Voltage		1.125	1.25	1.375	V
$\Delta V_{OS}$	$V_{OS}$ Magnitude Change			5	25	mV

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

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{MAX}$	Output Frequency			>2		GHz
$t_{PD}$	Propagation Delay; NOTE 1		300		800	ps
$tsk(pp)$	Part-to-Part Skew; NOTE 2, 3				200	ps
$tsk(i)$	Input Skew				40	ps
$\sigma_{jit}$	Buffer Additive Phase Jitter, RMS; refer to Additive Phase Jitter Section	622.08MHz, Integration Range: 12kHz – 20MHz		0.065		ps
$t_R / t_F$	Output Rise/Fall Time	20% to 80%	50		250	ps
odc	Output Duty Cycle	$\leq 700\text{MHz}$	49		51	%
		$f \leq 1.1\text{GHz}$	47		53	%
		$f \leq 2\text{GHz}$	43		57	%
$MUX_{ISOLATION}$	MUX Isolation	$f = 500\text{MHz}$		-65		dBm

NOTE: All parameters measured at  $f \leq 1.9\text{GHz}$  unless noted otherwise.

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

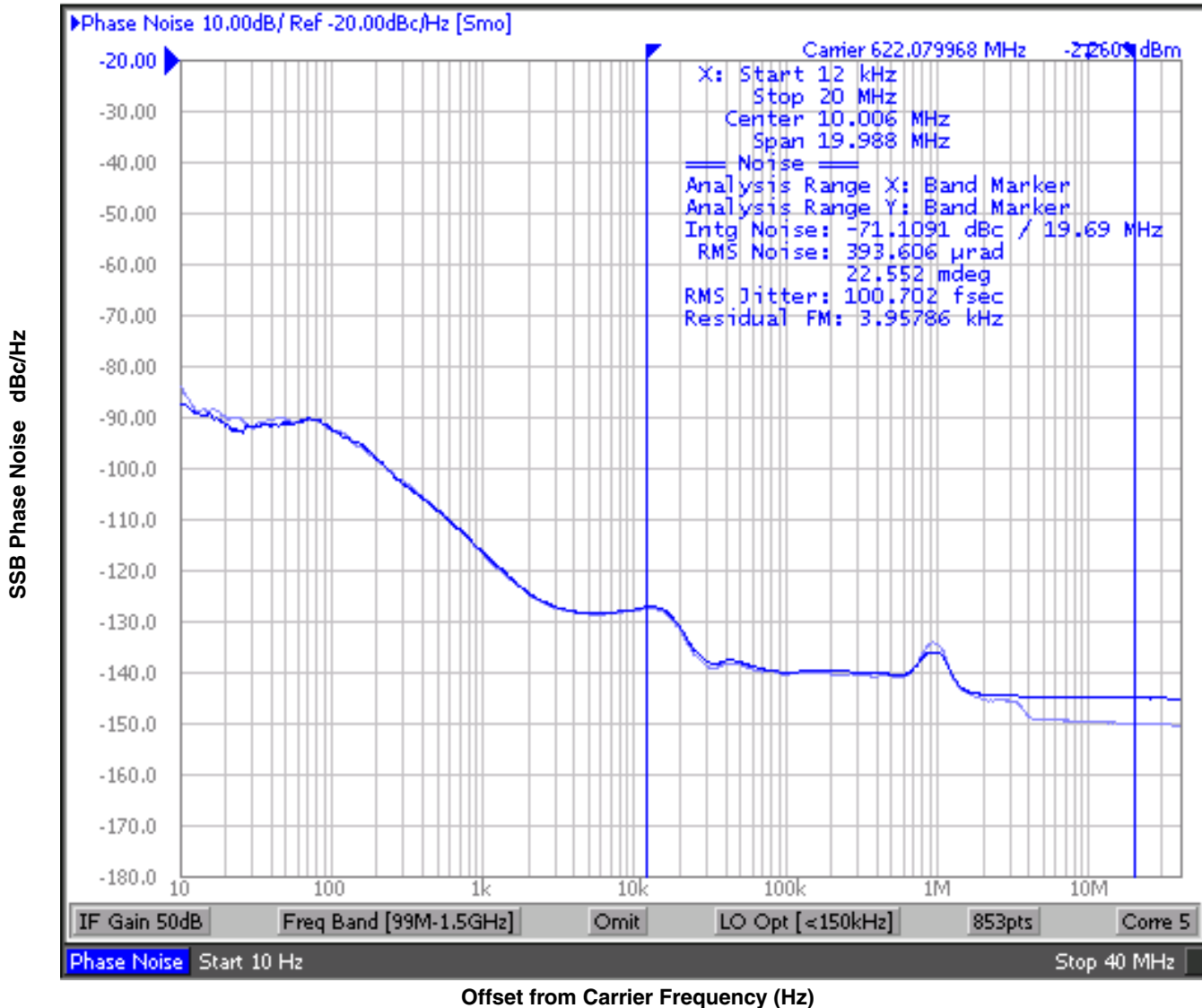
NOTE 2: Defined as skew between different devices operating at the same supply voltage, same frequency and with equal load conditions. Using the same type of inputs on each device, the output is measured at the differential cross point.

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

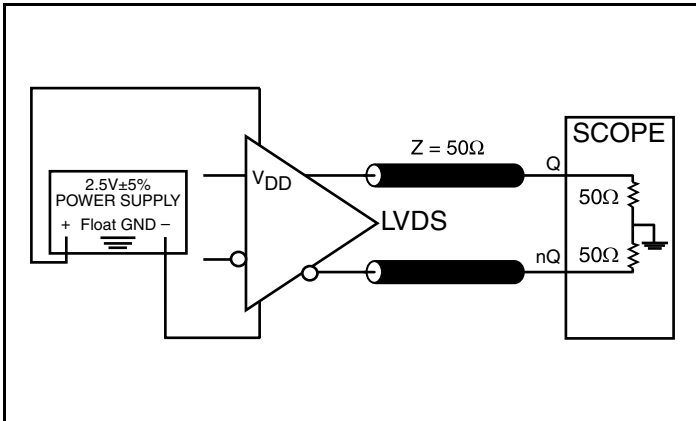
of the power in the 1Hz band to the power in the fundamental. When the required offset is specified, the phase noise is called a ***dBc*** value, which simply means dBm at a specified offset from the fundamental. By investigating jitter in the frequency domain, we get a better understanding of its effects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



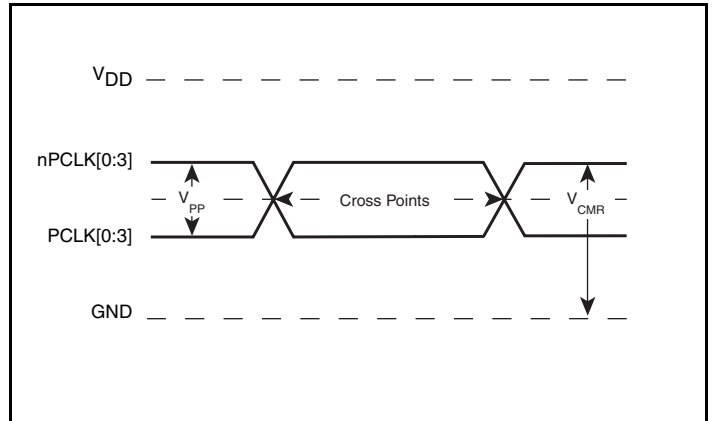
As with most timing specifications, phase noise measurements has issues relating to the limitations of the equipment. Often the noise floor of the equipment is higher than the noise floor of the device. This is illustrated above. The device meets the noise floor of what is shown, but can actually be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

The source generator "Rohde & Schwarz SMA100A Low Noise Signal Generator as external input to an Agilent 8133A 3GHz Pulse Generator".

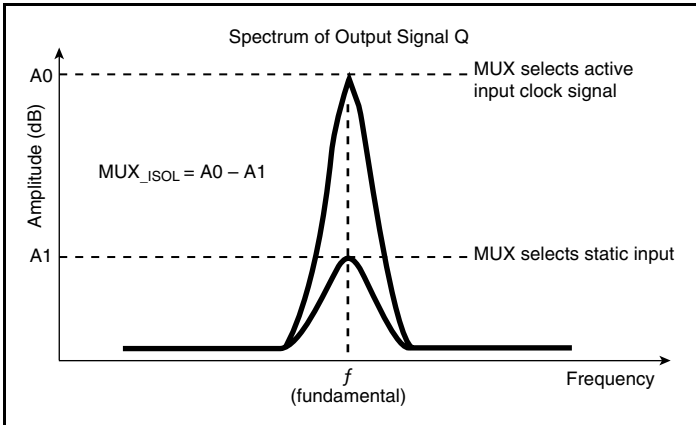
### Parameter Measurement Information



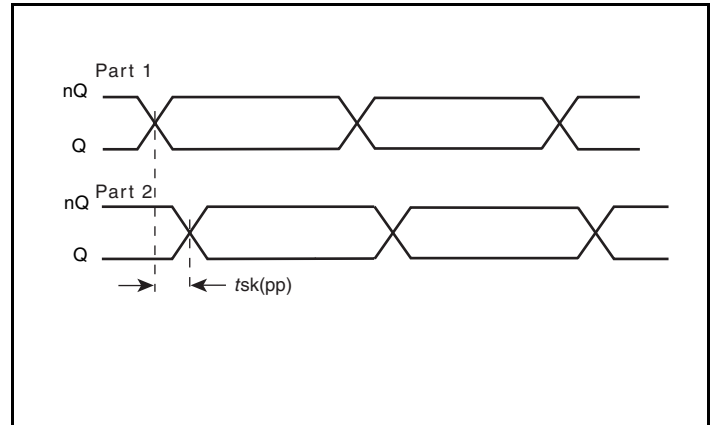
LVDS Output Load AC Test Circuit



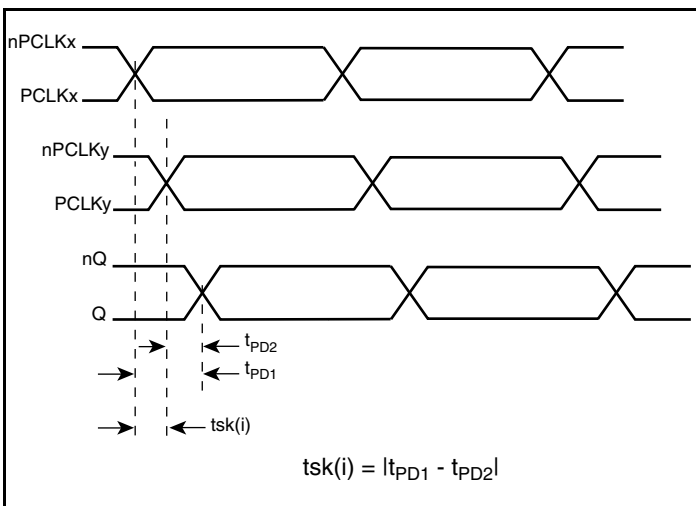
Differential Input Level



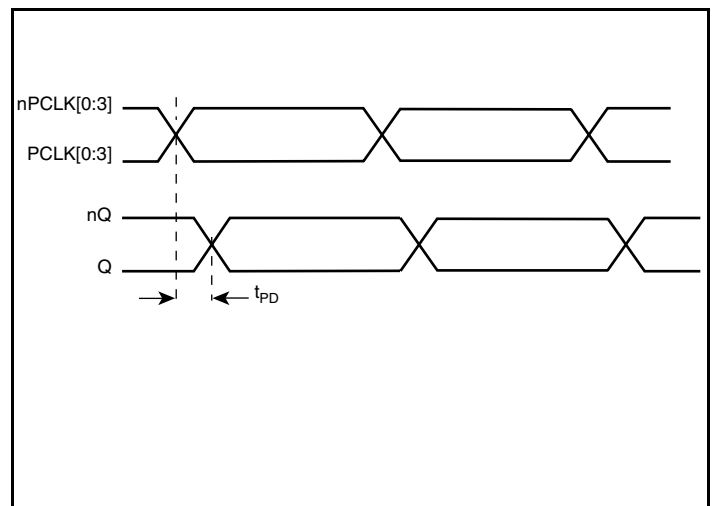
MUX Isolation



Part-to-Part Skew

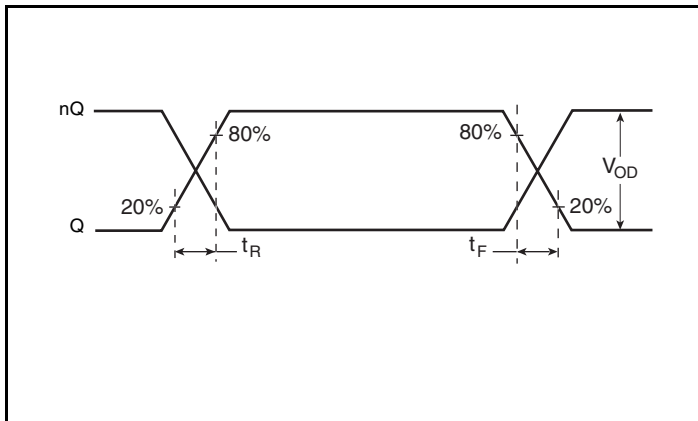


Input Skew

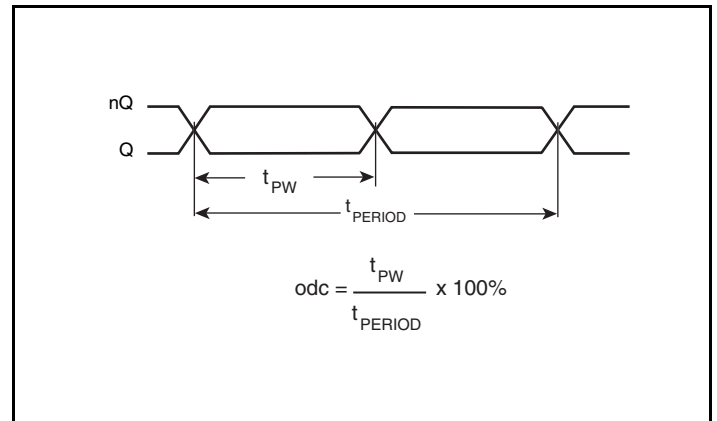


Propagation Delay

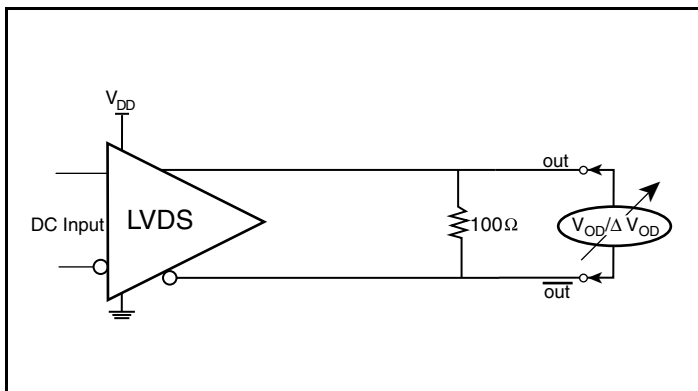
## Parameter Measurement Information, continued



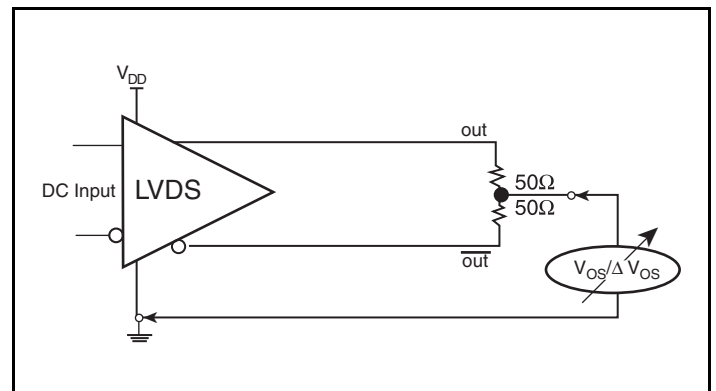
Output Rise/Fall Time



Output Duty Cycle/Pulse Width/Period



Differential Output Voltage Setup



Offset Voltage Setup

## Application Information

### Recommendations for Unused Input Pins

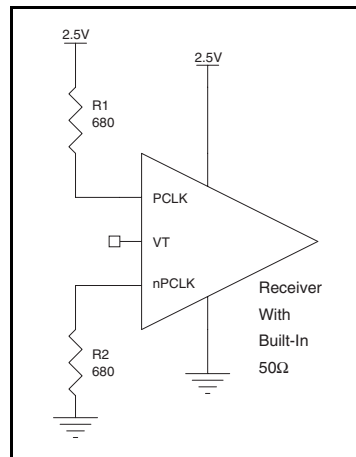
#### Inputs:

##### LVC MOS Control Pins

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

### 2.5V Differential Input with Built-In 50 $\Omega$ Termination Unused Input Handling

To prevent oscillation and to reduce noise, it is recommended to have pullup and pulldown connect to true and compliment of the unused input as shown in *Figure 1*.



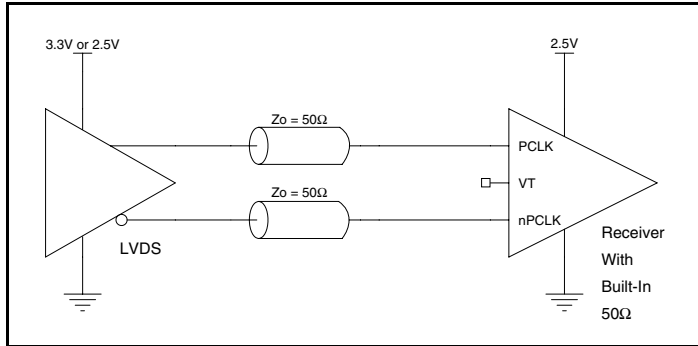
**Figure 1. Unused Input Handling**



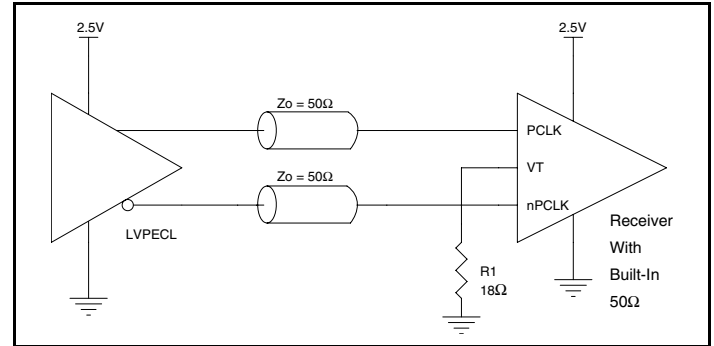
## 2.5V LVPECL Input with Built-In 50Ω Termination Interface

The PCLK /nPCLK with built-in 50Ω terminations accept LVDS, LVPECL, CML, SSTL and other differential signals. Both differential signals must meet the  $V_{PP}$  and  $V_{CMR}$  input requirements. *Figures 2A to 2E* show interface examples for the PCLK /nPCLK with built-in 50Ω termination input driven by the most common driver types. The input

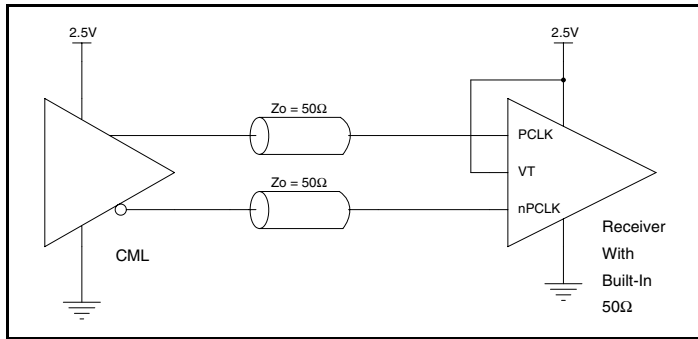
interfaces suggested here are examples only. If the driver is from another vendor, use their termination recommendation. Please consult with the vendor of the driver component to confirm the driver termination requirements.



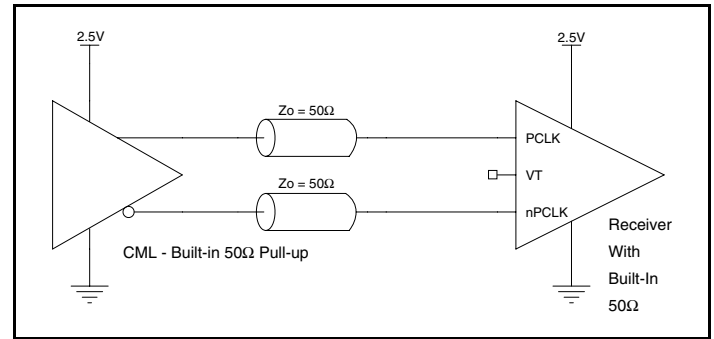
**Figure 2A. PCLK/nPCLK Input with Built-In 50Ω Driven by an LVDS Driver**



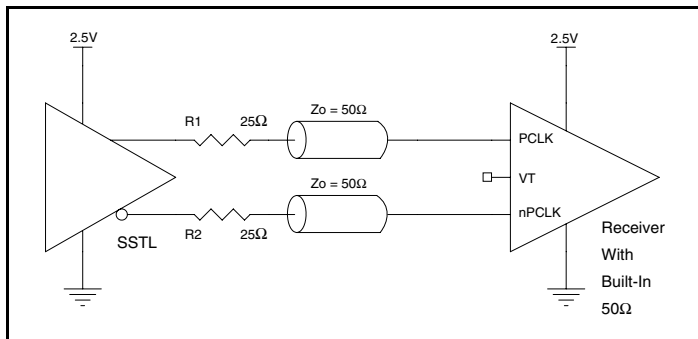
**Figure 2B. PCLK/nPCLK Input with Built-In 50Ω Driven by an LVPECL Driver**



**Figure 2C. PCLK/nPCLK Input with Built-In 50Ω Driven by a CML Driver**



**Figure 2D. PCLK/nPCLK Input with Built-In 50Ω Driven by a CML Driver with Built-In 50Ω Pullup**

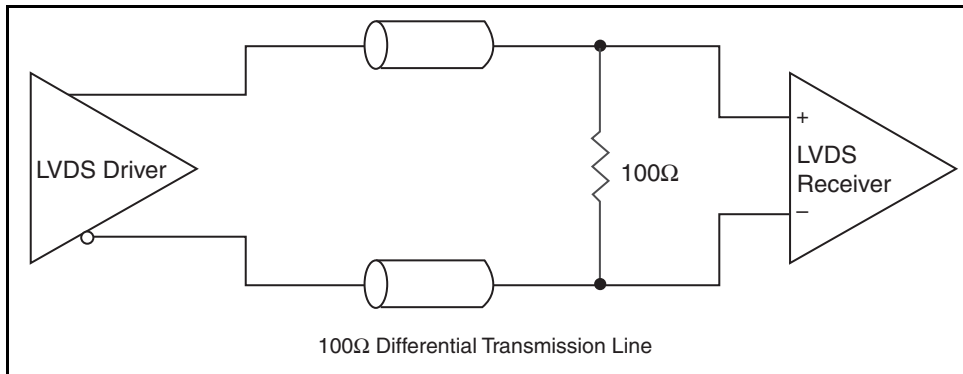


**Figure 2E. PCLK/nPCLK Input with Built-In 50Ω Driven by an SSTL Driver**

### LVDS Driver Termination

A general LVDS interface is shown in *Figure 3*. Standard termination for LVDS type output structure requires both a 100Ω parallel resistor at the receiver and a 100Ω differential transmission line environment. In order to avoid any transmission line reflection issues, the 100Ω resistor must be placed as close to the receiver as possible. IDT offers a full line of LVDS compliant devices with two types of output structures: current source and voltage source. The standard

termination schematic as shown in *Figure 3* can be used with either type of output structure. If using a non-standard termination, it is recommended to contact IDT and confirm if the output is a current source or a voltage source type structure. In addition, since these outputs are LVDS compatible, the input receivers amplitude and common mode input range should be verified for compatibility with the output.

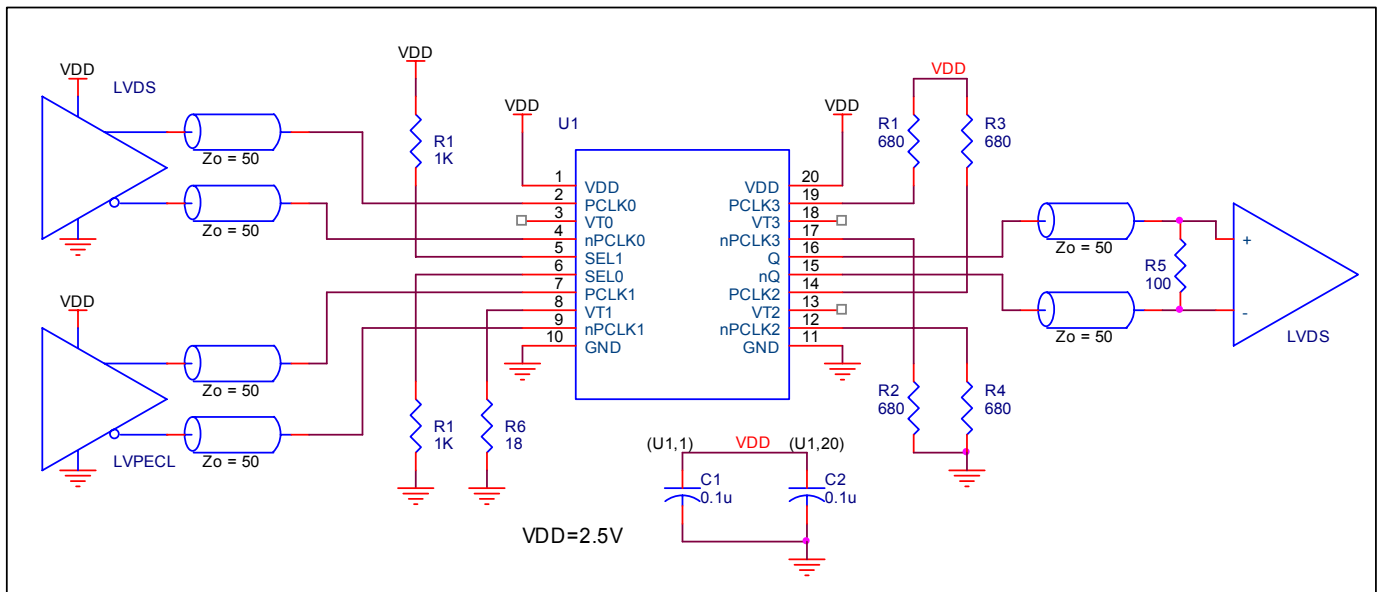


**Figure 3. Typical LVDS Driver Termination**

### Schematic Example

*Figure 4* shows a schematic example of the ICS854S057BI. In this example, the PCLK0/nPCLK0 and PCLK1/nPCLK1 inputs are used.

The decoupling capacitors should be physically located near the power pin.



**Figure 4. ICS854S057BI LVDS Schematic Example**

## Power Considerations

This section provides information on power dissipation and junction temperature for the ICS854S057BI. Equations and example calculations are also provided.

### 1. Power Dissipation.

The total power dissipation for the ICS854S057BI is the sum of the core power plus the power dissipation in the load(s). The following is the power dissipation for  $V_{DD} = 2.5V + 5\% = 2.625V$ , which gives worst case results.

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

- Power (core)<sub>MAX</sub> =  $V_{DD\_MAX} * I_{DD\_MAX} = 2.625V * 50mA = 131.25mW$
- Power Dissipation for internal termination  $R_T$   
Power ( $R_T$ )<sub>MAX</sub> =  $4 * (V_{PP\_MAX})^2 / R_{T\_MIN} = (1.2V)^2 / 80\Omega = 72mW$

**Total Power**<sub>MAX</sub> = 131.25mW + 72mW = **203.25mW**

### 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°C. Limiting the internal transistor junction temperature,  $T_j$ , to 125°C ensures that the bond wire and bond pad temperature remains below 125°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 92.1°C/W per Table 6 below.

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

$$85^\circ C + 0.203W * 92.1^\circ C/W = 103.7^\circ C. \text{ This is below the limit of } 125^\circ C.$$

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 20 Lead TSSOP, Forced Convection**

$\theta_{JA}$ by Velocity			
Meters per Second	0	1	2.5
Multi-Layer PCB, JEDEC Standard Test Boards	92.1°C/W	86.5°C/W	83.0°C/W

## Reliability Information

Table 7.  $\theta_{JA}$  vs. Air Flow Table for a 20 Lead TSSOP

$\theta_{JA}$ by Velocity			
Meters per Second	0	1	2.5
Multi-Layer PCB, JEDEC Standard Test Boards	92.1°C/W	86.5°C/W	83.0°C/W

## Transistor Count

The transistor count for ICS854S057BI is: 375

This device is pin and function compatible and a suggested replacement for ICS854057.

## Package Outline and Package Dimensions

Package Outline - G Suffix for 20 Lead TSSOP

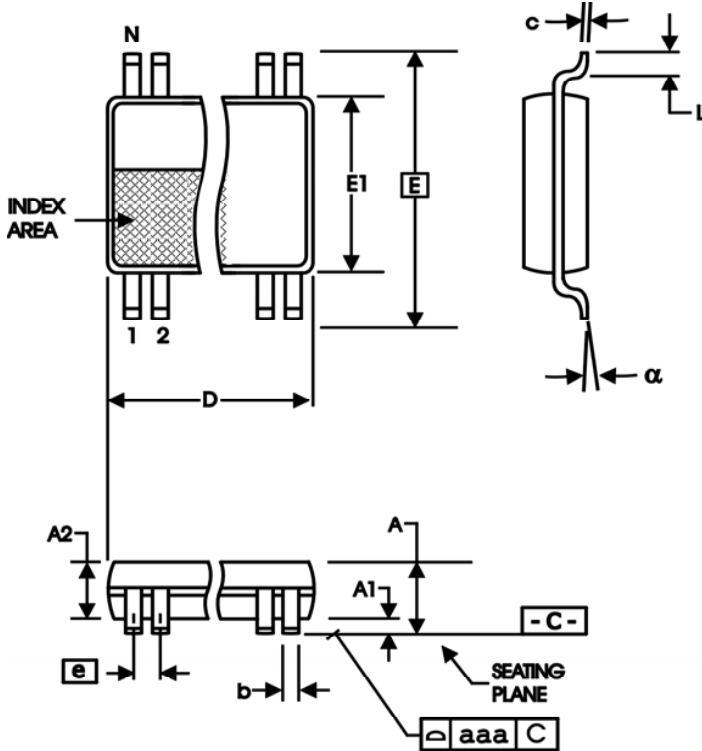


Table 8. Package Dimensions

All Dimensions in Millimeters		
Symbol	Minimum	Maximum
N	20	
A		1.20
A1	0.05	0.15
A2	0.80	1.05
b	0.19	0.30
c	0.09	0.20
D	6.40	6.60
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**

Part/Order Number	Marking	Package	Shipping Packaging	Temperature
854S057BGILF	ICS54S057BIL	"Lead-Free" 20 Lead TSSOP	Tube	-40°C to 85°C
854S057BGILFT	ICS54S057BIL	"Lead-Free" 20 Lead TSSOP	2500 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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## Revision History Sheet

Rev	Table	Page	Description of Change	Date
A		10 11	Updated LVDS Output Termination application note. Updated Power Dissipation calculation in Power Considerations Application Note.	3/26/10
A		11	Corrected Power Dissipation calculation in the Power Considerations Application Note.	3/29/10



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