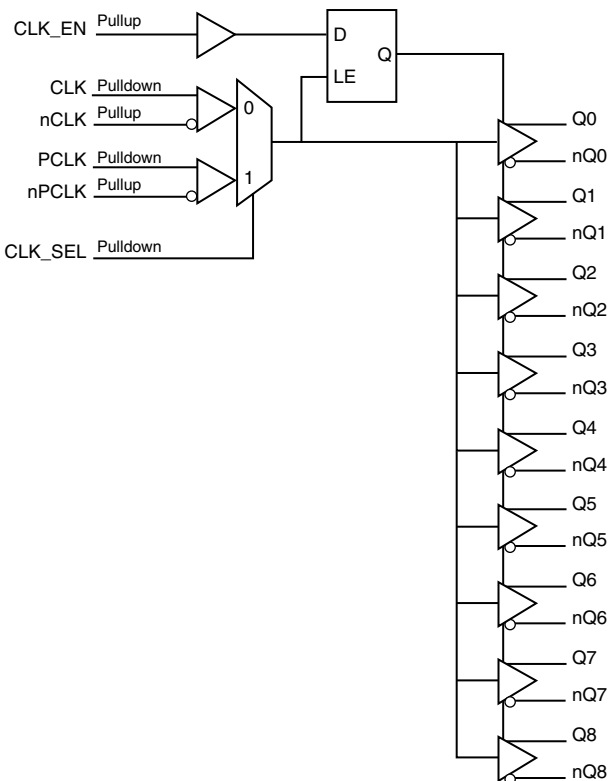


## General Description

The ICS853S031I is a low skew, high performance 1-to-9 Differential-to-2.5V/3.3V LVPECL/ECL Fanout Buffer. The ICS853S031I has two selectable clock inputs. The CLK, nCLK pair can accept most standard differential input levels. The PCLK, nPCLK pair can accept LVPECL, LVDS, CML or SSTL input levels. The clock enable is internally synchronized to eliminate runt pulses on the outputs during asynchronous assertion/deassertion of the clock enable pin.

Guaranteed output and part-to-part skew characteristics make the ICS853S0311 ideal for high performance workstation and server applications.

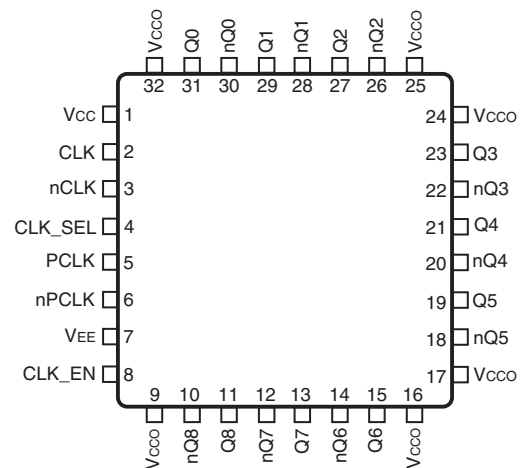
## Block Diagram



## Features

- Nine differential 2.5V, 3.3V LVPECL/ECL outputs
- Selectable differential CLK, nCLK or LVPECL clock inputs
- CLK, nCLK pair can accept the following differential input levels: LVPECL, LVDS, LVHSTL, HCSL, SSTL
- PCLK, nPCLK supports the following input types: LVPECL, LVDS, CML, SSTL
- Output frequency: 1.6GHz (maximum)
- Translates any single-ended input signal (LVCMOS, LVTTL, GTL) to 3.3V LVPECL levels with resistor bias on nCLK or nPCLK inputs
- Output skew: 20ps (typical)
- Part-to-part skew: 90ps (typical)
- Propagation delay: 885ps (typical), PCLK
- LVPECL mode operating voltage supply range:  
 $V_{CC} = 2.375V$  to  $3.465V$ ,  $V_{EE} = 0V$
- ECL mode operating voltage supply range:  
 $V_{CC} = 0V$ ,  $V_{EE} = -3.465V$  to  $-2.375V$
- $-40^{\circ}C$  to  $85^{\circ}C$  ambient operating temperature
- Available lead-free (RoHS 6) package

## Pin Assignment



**ICS853S031I**  
**32-Lead LQFP**  
**7mm x 7mm x 1.4mm package body**  
**Y Package**  
**Top View**

**Table 1. Pin Descriptions**

| Number                   | Name             | Type   |          | Description                                                                                                                                                                |
|--------------------------|------------------|--------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                        | V <sub>CC</sub>  | Power  |          | Positive supply pin.                                                                                                                                                       |
| 2                        | CLK              | Input  | Pulldown | Non-inverting differential clock input.                                                                                                                                    |
| 3                        | nCLK             | Input  | Pullup   | Inverting differential clock input.                                                                                                                                        |
| 4                        | CLK_SEL          | Input  | Pulldown | Clock select input. When HIGH, selects PCLK/nPCLK inputs. When LOW, selects CLK/nCLK inputs. LVTTTL / LVCMOS interface levels.                                             |
| 5                        | PCLK             | Input  | Pulldown | Non-inverting differential LVPECL clock input.                                                                                                                             |
| 6                        | nPCLK            | Input  | Pullup   | Inverting differential LVPECL clock input.                                                                                                                                 |
| 7                        | V <sub>EE</sub>  | Power  |          | Negative supply pin.                                                                                                                                                       |
| 8                        | CLK_EN           | Input  | Pullup   | Synchronizing clock enable. When HIGH, clock outputs follow clock input. When LOW, Qx outputs are forced low, nQx outputs are forced high. LVTTTL/LVCMOS interface levels. |
| 9, 16, 17,<br>24, 25, 32 | V <sub>CCO</sub> | Power  |          | Output supply pins.                                                                                                                                                        |
| 10, 11                   | nQ8, Q8          | Output |          | Differential output pair. LVPECL/ECL interface levels.                                                                                                                     |
| 12, 13                   | nQ7, Q7          | Output |          | Differential output pair. LVPECL/ECL interface levels.                                                                                                                     |
| 14, 15                   | nQ6, Q6          | Output |          | Differential output pair. LVPECL/ECL interface levels.                                                                                                                     |
| 18, 19                   | nQ5, Q5          | Output |          | Differential output pair. LVPECL/ECL interface levels.                                                                                                                     |
| 20, 21                   | nQ4, Q4          | Output |          | Differential output pair. LVPECL/ECL interface levels.                                                                                                                     |
| 22, 23                   | nQ3, Q3          | Output |          | Differential output pair. LVPECL/ECL interface levels.                                                                                                                     |
| 26, 27                   | nQ2, Q2          | Output |          | Differential output pair. LVPECL/ECL interface levels.                                                                                                                     |
| 28, 29                   | nQ1, Q1          | Output |          | Differential output pair. LVPECL/ECL interface levels.                                                                                                                     |
| 30, 31                   | nQ0, Q0          | Output |          | Differential output pair. LVPECL/ECL interface levels.                                                                                                                     |

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

**Table 2. Pin Characteristics**

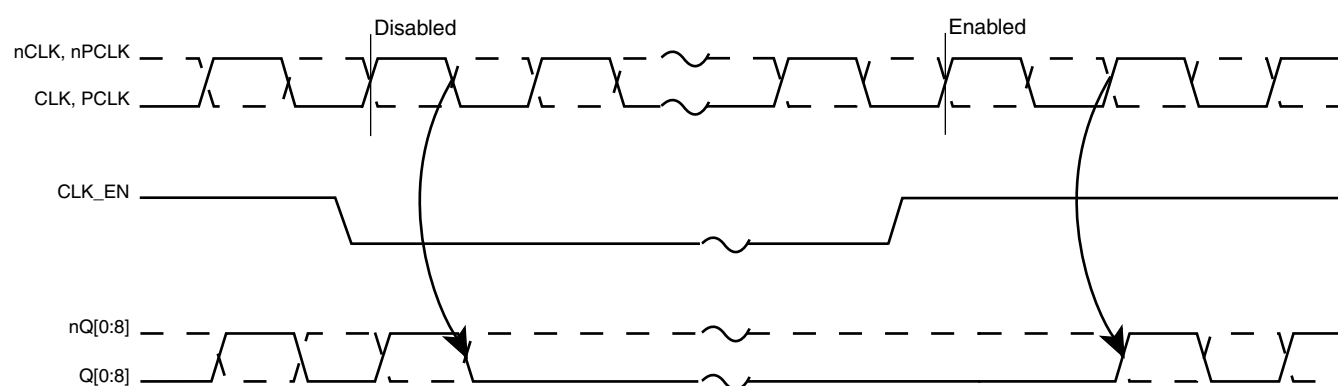
| Symbol                | Parameter               | Test Conditions | Minimum | Typical | Maximum | Units      |
|-----------------------|-------------------------|-----------------|---------|---------|---------|------------|
| R <sub>PULLDOWN</sub> | Input Pulldown Resistor |                 |         | 50      |         | k $\Omega$ |
| R <sub>PULLUP</sub>   | Input Pullup Resistor   |                 |         | 50      |         | k $\Omega$ |

# Function Tables

**Table 3A. Control Input Function Table**

| Inputs |         |                  | Outputs      |                |
|--------|---------|------------------|--------------|----------------|
| CLK_EN | CLK_SEL | Selected Sources | Q0:Q8        | nQ0:nQ8        |
| 0      | 0       | CLK, nCLK        | Disabled:LOW | Disabled: HIGH |
| 0      | 1       | PCLK, nPCLK      | Disabled:LOW | Disabled: HIGH |
| 1      | 0       | CLK, nCLK        | Enabled      | Enabled        |
| 1      | 1       | PCLK, nPCLK      | Enabled      | Enabled        |

After CLK\_EN switches, the clock outputs are disabled or enabled following a rising and falling input clock edge as shown in Figure 1. In the active mode, the state of the outputs are a function of the CLK, nCLK and PCLK, nPCLK inputs as described in Table 3B.



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

**Table 3B. Clock Input Function Table**

| Inputs         |                | Outputs |         | Input to Output Mode         | Polarity      |
|----------------|----------------|---------|---------|------------------------------|---------------|
| CLK or PCLK    | nCLK or nPCLK  | Q0:Q8   | nQ0:nQ8 |                              |               |
| 0              | 1              | LOW     | HIGH    | Differential to Differential | Non-Inverting |
| 1              | 0              | HIGH    | LOW     | Differential to Differential | Non-Inverting |
| 0              | Biased; NOTE 1 | LOW     | HIGH    | Single-Ended to Differential | Non-Inverting |
| 1              | Biased; NOTE 1 | HIGH    | LOW     | Single-Ended to Differential | Non-Inverting |
| Biased; NOTE 1 | 0              | HIGH    | LOW     | Single-Ended to Differential | Inverting     |
| Biased; NOTE 1 | 1              | LOW     | HIGH    | Single-Ended to Differential | Inverting     |

Note 1: Please refer to the Applications Information, "Wiring the Differential Input to Accept Single Ended Levels".

## 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, $V_{CC}$                              | 4.6V (LVPECL mode, $V_{EE} = 0V$ ) |
| Negative Supply Voltage, $V_{EE}$                     | -4.6V (ECL mode, $V_{CC} = 0V$ )   |
| Inputs, $V_I$ (LVPECL mode)                           | -0.5V to $V_{CC} + 0.5V$           |
| Inputs, $V_I$ (ECL mode)                              | 0.5V to $V_{EE} - 0.5V$            |
| Outputs, $I_O$<br>Continuous Current<br>Surge Current | 50mA<br>100mA                      |
| Operating Temperature Range, $T_A$                    | -40°C to +85°C                     |
| Package Thermal Impedance, $\theta_{JA}$              | 71.4°C/W (1 mps)                   |
| Storage Temperature, $T_{STG}$                        | -65°C to 150°C                     |

## DC Electrical Characteristics

**Table 4A. Power Supply DC Characteristics,  $V_{CC} = V_{CCO} = 2.375V$  to  $3.465V$ ;  $V_{EE} = 0V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$**

| Symbol    | Parameter               | Test Conditions | Minimum | Typical | Maximum | Units |
|-----------|-------------------------|-----------------|---------|---------|---------|-------|
| $V_{CC}$  | Positive Supply Voltage |                 | 2.375   | 3.3     | 3.465   | V     |
| $V_{CCO}$ | Output Supply Voltage   |                 | 2.375   | 3.3     | 3.465   | V     |
| $I_{EE}$  | Power Supply Current    |                 |         |         | 70      | mA    |

**Table 4B. LVCMOS/LVTTL DC Characteristics,  $V_{CC} = V_{CCO} = 2.375V$  to  $3.465V$ ;  $V_{EE} = 0V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$**

| Symbol   | Parameter          | Test Conditions                               | Minimum | Typical | Maximum | Units   |
|----------|--------------------|-----------------------------------------------|---------|---------|---------|---------|
| $V_{IH}$ | Input High Voltage | $V_{CC} = 3.3V$                               | 2.2     |         | 3.465   | V       |
|          |                    | $V_{CC} = 2.5V$                               | 1.7     |         | 3.465   | V       |
| $V_{IL}$ | Input Low Voltage  | $V_{CC} = 3.3V$                               | -0.3    |         | 0.8     | V       |
|          |                    | $V_{CC} = 2.5V$                               | -0.3    |         | 0.7     | V       |
| $I_{IH}$ | Input High Current | $V_{CC} = V_{IN} = 3.465V$ or $2.625V$        |         |         | 10      | $\mu A$ |
|          |                    | $V_{CC} = V_{IN} = 3.465V$ or $2.625V$        |         |         | 150     | $\mu A$ |
| $I_{IL}$ | Input Low Current  | $V_{CC} = 3.465V$ or $2.625V$ , $V_{IN} = 0V$ | -150    |         |         | $\mu A$ |
|          |                    | $V_{CC} = 3.465V$ or $2.625V$ , $V_{IN} = 0V$ | -10     |         |         | $\mu A$ |

**Table 4C. Differential DC Characteristics,  $V_{CC} = V_{CCO} = 2.375V$  to  $3.465V$ ;  $V_{EE} = 0V$ ,  $T_A = -40^{\circ}C$  to  $85^{\circ}C$** 

| Symbol    | Parameter                            |      | -40°C          |     |                 | 25°C           |     |                 | 85°C           |     |                 | Units   |
|-----------|--------------------------------------|------|----------------|-----|-----------------|----------------|-----|-----------------|----------------|-----|-----------------|---------|
|           |                                      |      | Min            | Typ | Max             | Min            | Typ | Max             | Min            | Typ | Max             |         |
| $I_{IH}$  | Input High Current                   | CLK  |                |     | 150             |                |     | 150             |                |     | 150             | $\mu A$ |
|           |                                      | nCLK |                |     | 10              |                |     | 10              |                |     | 10              | $\mu A$ |
| $I_{IL}$  | Input Low Current                    | CLK  | -10            |     |                 | -10            |     |                 | -10            |     |                 | $\mu A$ |
|           |                                      | nCLK | -150           |     |                 | -150           |     |                 | -150           |     |                 | $\mu A$ |
| $V_{PP}$  | Peak-to-Peak Voltage; NOTE 1         |      | 0.15           |     | 1.3             | 0.15           |     | 1.3             | 0.15           |     | 1.3             | V       |
| $V_{CMR}$ | Common Mode Input Voltage; NOTE 1, 2 |      | $V_{EE} + 0.7$ |     | $V_{CC} - 0.85$ | $V_{EE} + 0.7$ |     | $V_{CC} - 0.85$ | $V_{EE} + 0.7$ |     | $V_{CC} - 0.85$ | V       |

NOTE 1:  $V_{IL}$  should not be less than  $-0.3V$ .

NOTE 2: Common mode input voltage is defined as  $V_{IH}$ .

**Table 4D. LVPECL DC Characteristics,  $V_{CC} = V_{CCO} = 3.3V \pm 5\%$ ;  $V_{EE} = 0V$ ,  $T_A = -40^{\circ}C$  to  $85^{\circ}C$** 

| Symbol      | Parameter                                    |       | -40°C |      |          | 25°C |      |          | 85°C |      |          | Units   |
|-------------|----------------------------------------------|-------|-------|------|----------|------|------|----------|------|------|----------|---------|
|             |                                              |       | Min   | Typ  | Max      | Min  | Typ  | Max      | Min  | Typ  | Max      |         |
| $V_{OH}$    | Output High Voltage; NOTE 1                  |       | 2.14  | 2.38 | 2.56     | 2.14 | 2.38 | 2.57     | 2.14 | 2.36 | 2.59     | V       |
| $V_{OL}$    | Output Low Voltage; NOTE 1                   |       | 1.45  | 1.61 | 1.79     | 1.45 | 1.58 | 1.80     | 1.45 | 1.57 | 1.82     | V       |
| $V_{PP}$    | Peak-to-Peak Input Voltage                   |       | 0.15  | 0.8  | 1.3      | 0.15 | 0.8  | 1.3      | 0.15 | 0.8  | 1.3      | V       |
| $V_{CMR}$   | Input High Voltage Common Mode Range; NOTE 2 |       | 1.2   |      | $V_{CC}$ | 1.2  |      | $V_{CC}$ | 1.2  |      | $V_{CC}$ | V       |
| $V_{SWING}$ | Output Voltage Swing                         |       | 0.6   |      | 1.0      | 0.6  |      | 1.0      | 0.6  |      | 1.0      | V       |
| $I_{IH}$    | Input High Current                           | PCLK  |       |      | 150      |      |      | 150      |      |      | 150      | $\mu A$ |
|             |                                              | nPCLK |       |      | 10       |      |      | 10       |      |      | 10       | $\mu A$ |
| $I_{IL}$    | Input Low Current                            | PCLK  | -10   |      |          | -10  |      |          | -10  |      |          | $\mu A$ |
|             |                                              | nPCLK | -150  |      |          | -150 |      |          | -150 |      |          | $\mu A$ |

NOTE: Input and output parameters vary 1:1 with  $V_{CC}$ . This variation has been taken into account in the table above.

NOTE 1: Outputs terminated with  $50\Omega$  to  $V_{CCO} - 2V$ .

NOTE 2: Common mode voltage is defined as  $V_{IH}$ .

**Table 4E. LVPECL DC Characteristics,  $V_{CC} = V_{CCO} = 2.5V \pm 5\%$ ;  $V_{EE} = 0V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$** 

| Symbol      | Parameter                                    | -40°C |      |          | 25°C |      |          | 85°C |      |          | Units   |
|-------------|----------------------------------------------|-------|------|----------|------|------|----------|------|------|----------|---------|
|             |                                              | Min   | Typ  | Max      | Min  | Typ  | Max      | Min  | Typ  | Max      |         |
| $V_{OH}$    | Output High Voltage; NOTE 1                  | 1.34  | 1.58 | 1.76     | 1.34 | 1.58 | 1.77     | 1.34 | 1.56 | 1.79     | V       |
| $V_{OL}$    | Output Low Voltage; NOTE 1                   | 0.65  | 0.81 | 0.99     | 0.65 | 0.78 | 1.00     | 0.65 | 0.77 | 1.02     | V       |
| $V_{PP}$    | Peak-to-Peak Input Voltage                   | 0.15  | 0.8  | 1.3      | 0.15 | 0.8  | 1.3      | 0.15 | 0.8  | 1.3      | V       |
| $V_{CMR}$   | Input High Voltage Common Mode Range; NOTE 2 | 1.2   |      | $V_{CC}$ | 1.2  |      | $V_{CC}$ | 1.2  |      | $V_{CC}$ | V       |
| $V_{SWING}$ | Output Voltage Swing                         | 0.6   |      | 1.0      | 0.6  |      | 1.0      | 0.6  |      | 1.0      | V       |
| $I_{IH}$    | Input High Current                           | PCLK  |      | 150      |      |      | 150      |      |      | 150      | $\mu A$ |
|             |                                              | nPCLK |      | 10       |      |      | 10       |      |      | 10       | $\mu A$ |
| $I_{IL}$    | Input Low Current                            | PCLK  | -10  |          | -10  |      |          | -10  |      |          | $\mu A$ |
|             |                                              | nPCLK | -150 |          | -150 |      |          | -150 |      |          | $\mu A$ |

NOTE: Input and output parameters vary 1:1 with  $V_{CC}$ . This variation has been taken into account in the table above.

NOTE 1: Outputs terminated with  $50\Omega$  to  $V_{CCO} - 2V$ .

NOTE 2: Common mode voltage is defined as  $V_{IH}$ .

**Table 4F. ECL DC Characteristics,  $V_{CC} = 0V$ ;  $V_{EE} = -3.465V$  to  $-2.375V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$** 

| Symbol      | Parameter                                    | -40°C        |       |       | 25°C         |       |       | 85°C         |       |       | Units   |
|-------------|----------------------------------------------|--------------|-------|-------|--------------|-------|-------|--------------|-------|-------|---------|
|             |                                              | Min          | Typ   | Max   | Min          | Typ   | Max   | Min          | Typ   | Max   |         |
| $V_{OH}$    | Output High Voltage; NOTE 1                  | -1.16        | -0.92 | -0.74 | -1.16        | -0.92 | -0.73 | -1.16        | -0.94 | -0.71 | V       |
| $V_{OL}$    | Output Low Voltage; NOTE 1                   | -1.85        | -1.69 | -1.51 | -1.85        | -1.72 | -1.5  | -1.85        | -1.73 | -1.48 | V       |
| $V_{PP}$    | Peak-to-Peak Input Voltage                   | 0.15         | 0.8   | 1.3   | 0.15         | 0.8   | 1.3   | 0.15         | 0.8   | 1.3   | V       |
| $V_{CMR}$   | Input High Voltage Common Mode Range; NOTE 2 | $V_{EE}+1.2$ |       | 0     | $V_{EE}+1.2$ |       | 0     | $V_{EE}+1.2$ |       | 0     | V       |
| $V_{SWING}$ | Output Voltage Swing                         | 0.6          |       | 1.0   | 0.6          |       | 1.0   | 0.6          |       | 1.0   | V       |
| $I_{IH}$    | Input High Current                           | PCLK         |       | 150   |              |       | 150   |              |       | 150   | $\mu A$ |
|             |                                              | nPCLK        |       | 10    |              |       | 10    |              |       | 10    | $\mu A$ |
| $I_{IL}$    | Input Low Current                            | PCLK         | -10   |       | -10          |       |       | -10          |       |       | $\mu A$ |
|             |                                              | nPCLK        | -150  |       | -150         |       |       | -150         |       |       | $\mu A$ |

NOTE 1: Outputs terminated with  $50\Omega$  to  $V_{CCO} - 2V$ .

NOTE 2: Common mode voltage is defined as  $V_{IH}$ .

## AC Electrical Characteristics

**Table 5. AC Characteristics**,  $V_{CC} = V_{CCO} = -3.465V$  to  $-2.375V$  or ,  $V_{CC} = V_{CCO} = 2.375V$  to  $3.465V$ ;  $V_{EE} = 0V$ ,  $T_A = -40^{\circ}C$  to  $85^{\circ}C$

| Symbol       | Parameter                    |                          | -40°C |     |     | 25°C |     |      | 85°C |      |      | Units |
|--------------|------------------------------|--------------------------|-------|-----|-----|------|-----|------|------|------|------|-------|
|              |                              |                          | Min   | Typ | Max | Min  | Typ | Max  | Min  | Typ  | Max  |       |
| $f_{OUT}$    | Output Frequency             |                          |       |     | 1.6 |      |     | 1.6  |      |      | 1.6  | GHz   |
| $t_{PD}$     | Propagation Delay; NOTE 1    | PCLK, nPCLK              | 705   | 825 | 945 | 760  | 885 | 1005 | 835  | 960  | 1085 | ps    |
|              |                              | CLK, nCLK                | 770   | 885 | 995 | 825  | 945 | 1070 | 895  | 1025 | 1150 | ps    |
| $t_{sk(o)}$  | Output Skew; NOTE 2, 4       |                          |       | 20  | 55  |      | 20  | 55   |      | 20   | 55   | ps    |
| $t_{sk(pp)}$ | Part-to-Part Skew; NOTE 3, 4 |                          |       | 85  | 225 |      | 90  | 245  |      | 95   | 250  | ps    |
| $t_R / t_F$  | Output Rise/Fall Time        | 20% to 80%               | 100   | 215 | 400 | 100  | 225 | 400  | 100  | 215  | 350  | ps    |
| odc          | Output Duty Cycle            | $f \leq 266MHz$          | 48    |     | 52  | 48   |     | 52   | 48   |      | 52   | %     |
|              |                              | $266MHz < f \leq 500MHz$ | 46    |     | 54  | 46   |     | 54   | 46   |      | 54   | %     |

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 lfm. The device will meet specifications after thermal equilibrium has been reached under these conditions.

NOTE: All parameters are measured at  $f_{OUT} \leq 500$  MHz, unless otherwise noted.

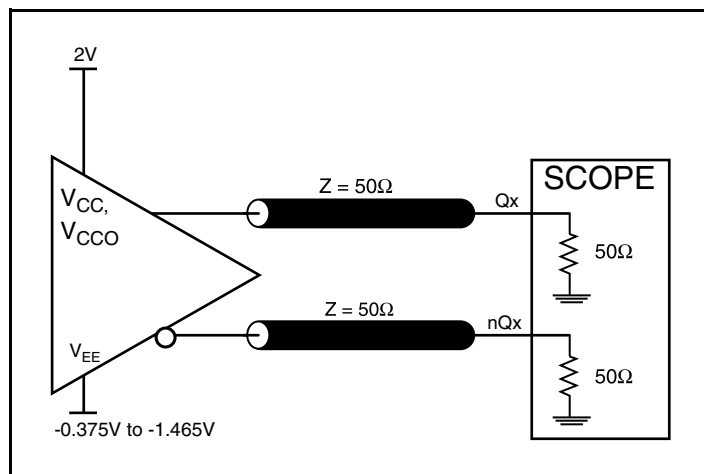
NOTE 1: Measured from the differential input crossing point to the differential output crossing point.

NOTE 2: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at the output differential cross points.

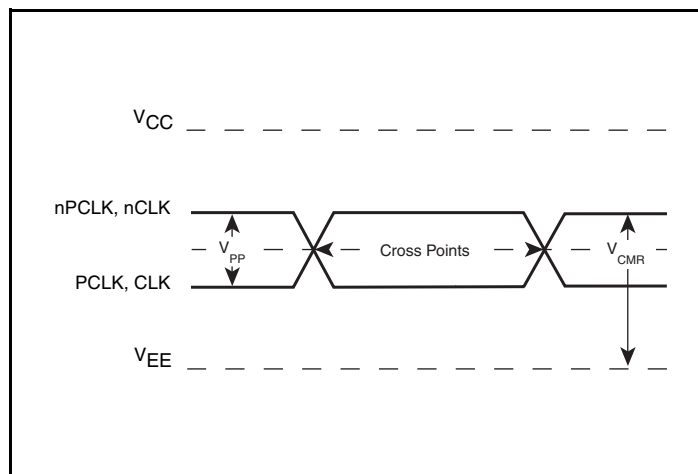
NOTE 3: Defined as skew between outputs on different devices operating at the same supply voltage, same temperature and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at the differential cross points.

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

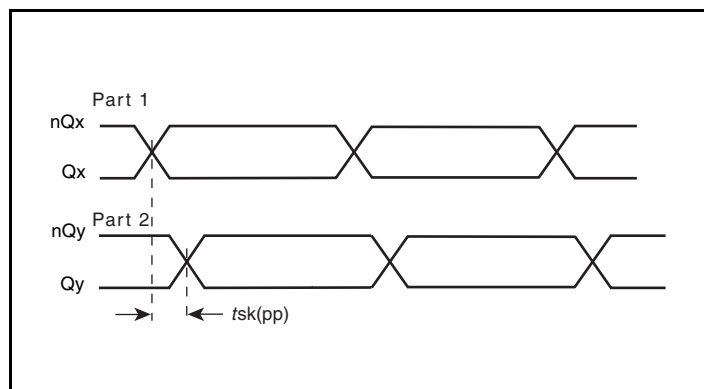
## Parameter Measurement Information



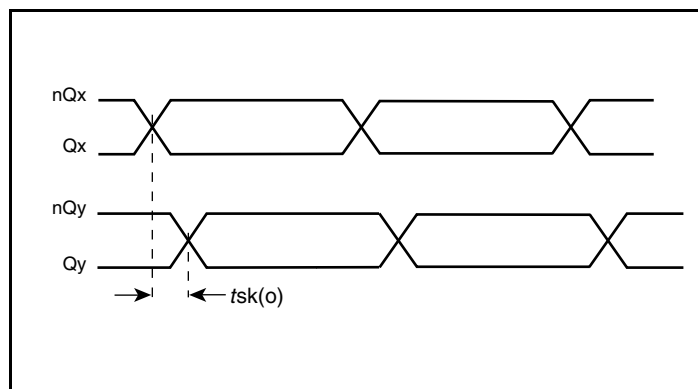
LVPECL Output Load AC Test Circuit



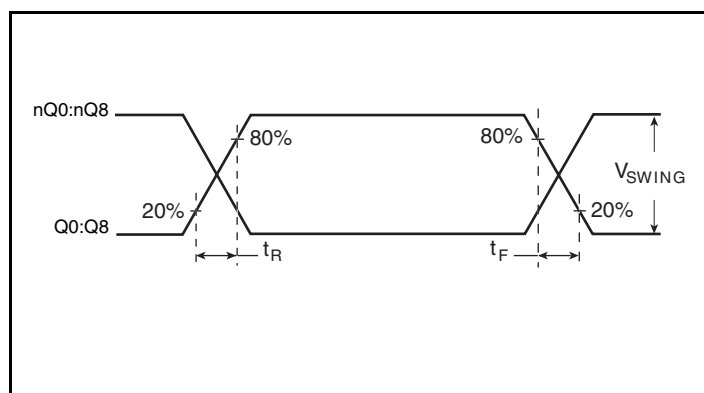
Differential Input Level



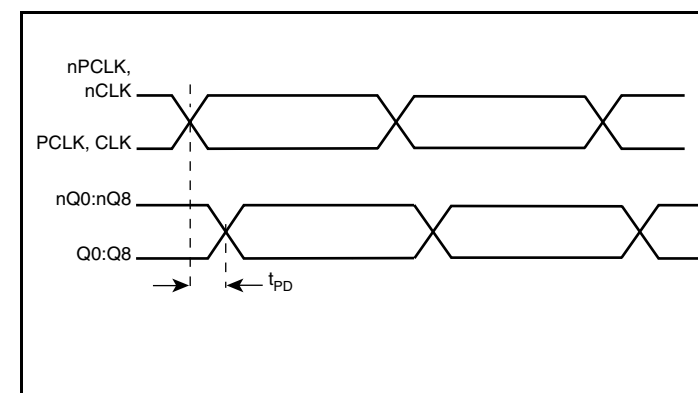
Part-to-Part Skew



Output Skew



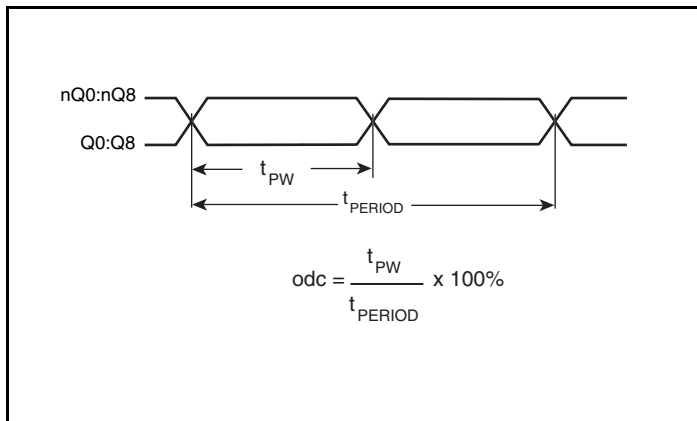
Output Rise/Fall Time



Propagation Delay



## Parameter Measurement Information, continued



Output Duty Cycle/Pulse Width/Period

## 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  $V_{REF} = V_{DD}/2$  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  $V_{REF}$  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  $V_{REF}$  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 50Ω applications, R3 and R4 can be 100Ω. 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.

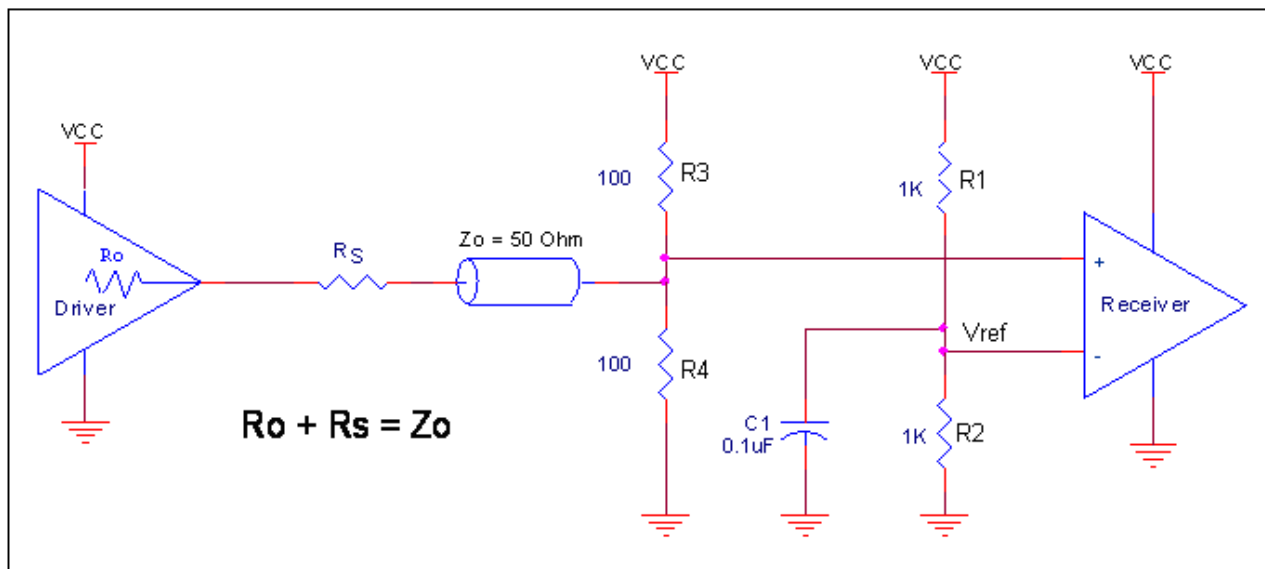
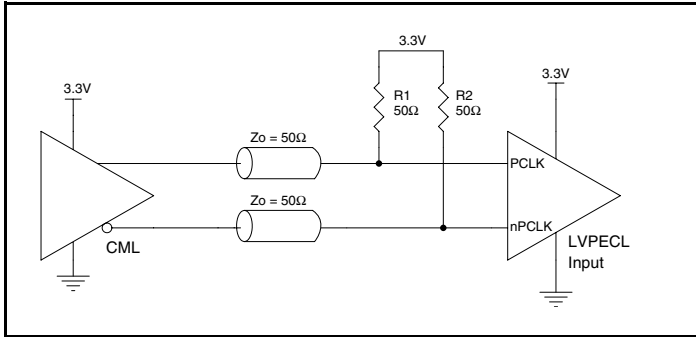


Figure 2. Recommended Schematic for Wiring a Differential Input to Accept Single-ended Levels

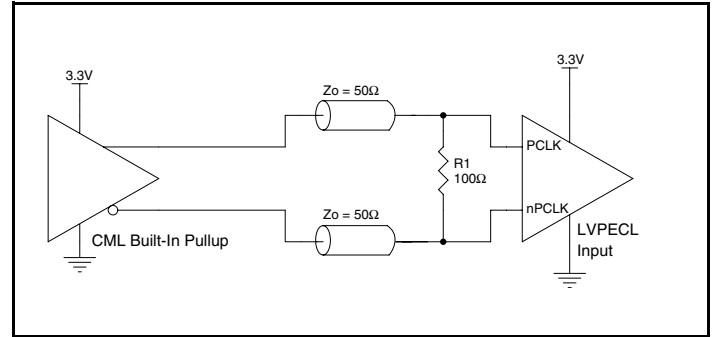
## LVPECL Clock Input Interface

The PCLK /nPCLK accepts LVPECL, LVDS, CML, SSTL and other differential signals. Both  $V_{SWING}$  and  $V_{OH}$  must meet the  $V_{PP}$  and  $V_{CMR}$  input requirements. *Figures 3A to 3F* show interface examples for the PCLK/nPCLK input driven by the most common driver types.

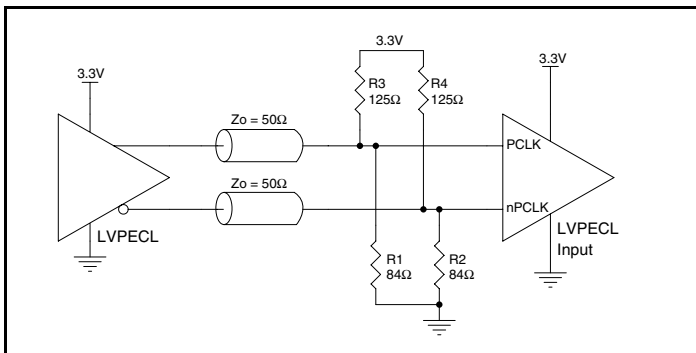
The input interfaces suggested here are examples only. If the driver is from another vendor, use their termination recommendation. Please consult with the vendor of the driver component to confirm the driver termination requirements.



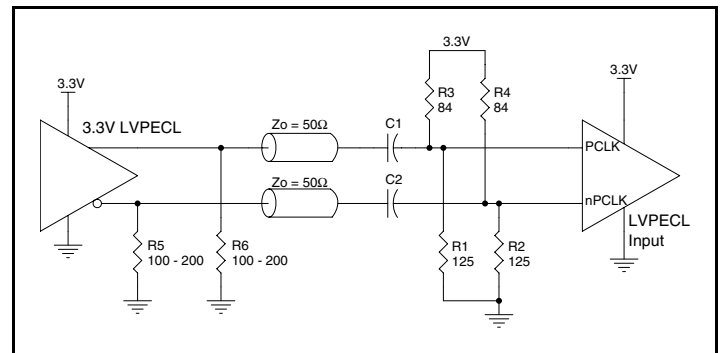
**Figure 3A. PCLK/nPCLK Input Driven by a CML Driver**



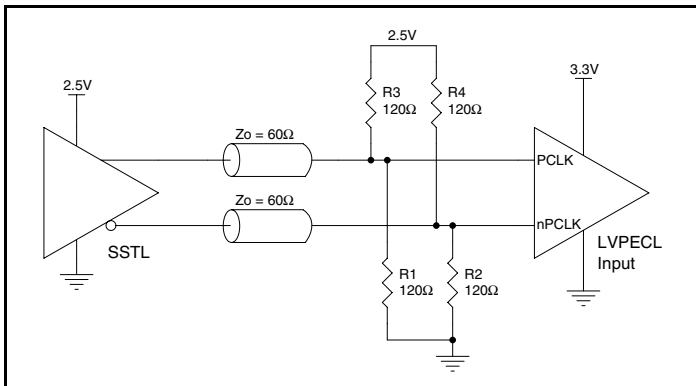
**Figure 3B. PCLK/nPCLK Input Driven by a Built-In Pullup CML Driver**



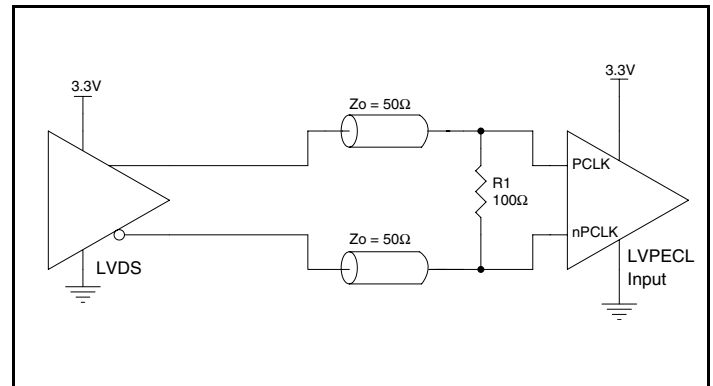
**Figure 3C. PCLK/nPCLK Input Driven by a 3.3V LVPECL Driver**



**Figure 3D. PCLK/nPCLK Input Driven by a 3.3V LVPECL Driver with AC Couple**



**Figure 3E. PCLK/nPCLK Input Driven by an SSTL Driver**

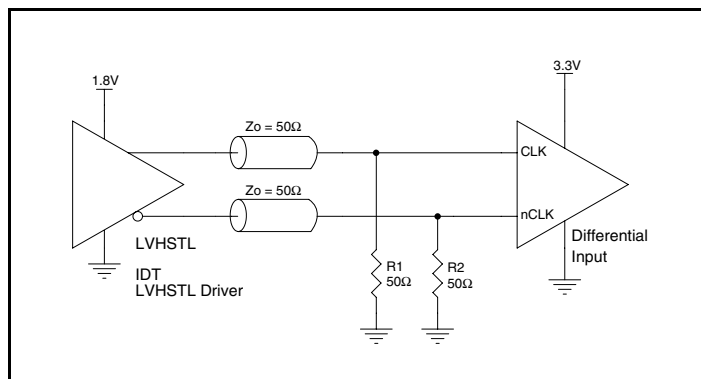


**Figure 3F. PCLK/nPCLK Input Driven by a 3.3V LVDS Driver**

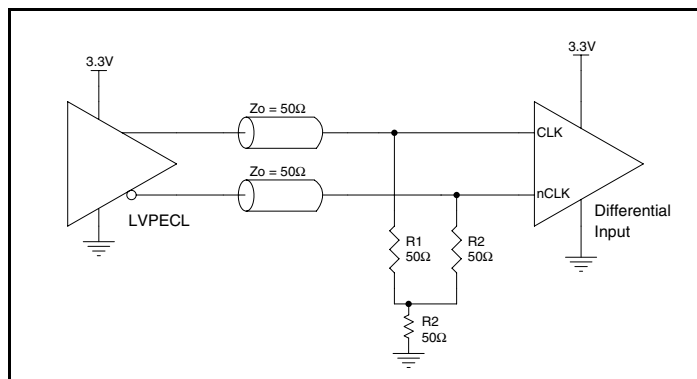
## Differential Clock Input Interface

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 4A to 4F* show interface examples for the CLK/nCLK input driven by the most common driver types. The input interfaces suggested here are examples only.

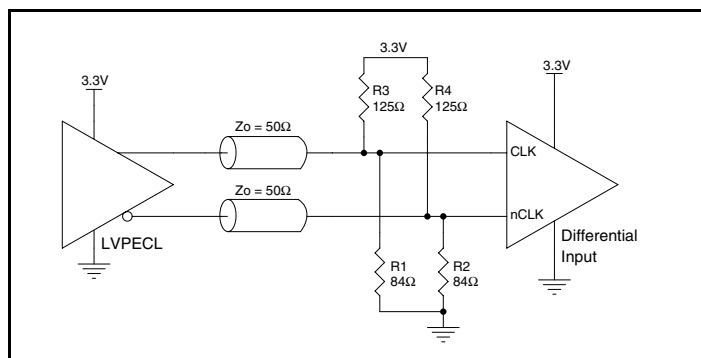
Please consult with the vendor of the driver component to confirm the driver termination requirements. For example, in Figure 4A, the input termination applies for IDT open emitter LVHSTL drivers. If you are using an LVHSTL driver from another vendor, use their termination recommendation.



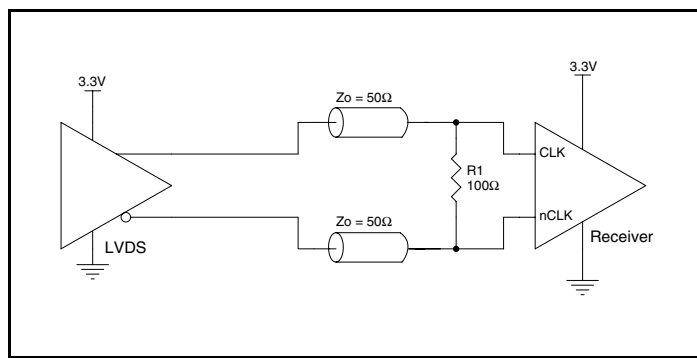
**Figure 4A. CLK/nCLK Input Driven by an IDT Open Emitter LVHSTL Driver**



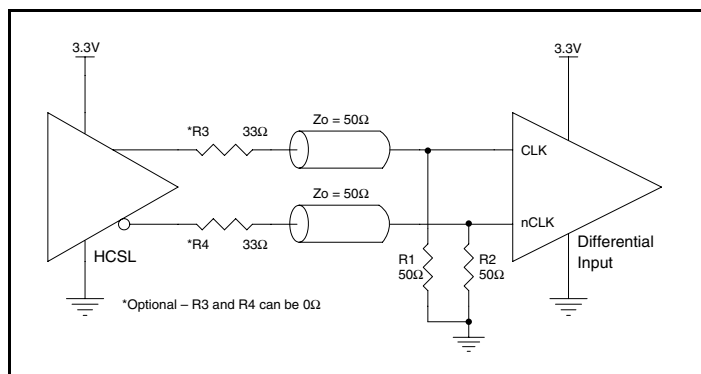
**Figure 4B. CLK/nCLK Input Driven by a 3.3V LVPECL Driver**



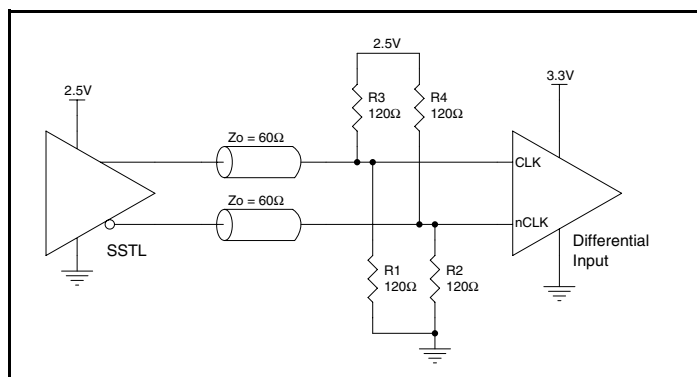
**Figure 4C. CLK/nCLK Input Driven by a 3.3V LVPECL Driver**



**Figure 4D. CLK/nCLK Input Driven by a 3.3V LVDS Driver**



**Figure 4E. CLK/nCLK Input Driven by a 3.3V HCSL Driver**



**Figure 4F. CLK/nCLK Input Driven by a 2.5V SSTL Driver**

## Recommendations for Unused Output Pins

### Inputs:

#### PCLK/nPCLK Inputs

For applications not requiring the use of a differential input, both the PCLK and nPCLK pins can be left floating. Though not required, but for additional protection, a 1k $\Omega$  resistor can be tied from PCLK to ground. For applications

#### 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.

#### LVC MOS Control Pins

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

### Outputs:

#### LVPECL Outputs

All unused LVPECL outputs can be left floating. We recommend that there is no trace attached. Both sides of the differential output pair should either be left floating or terminated.

## Termination for 3.3V LVPECL Outputs

The clock layout topology shown below is a typical termination for LVPECL outputs. The two different layouts mentioned are recommended only as guidelines.

The differential outputs are low impedance follower outputs that generate ECL/LVPECL compatible outputs. Therefore, terminating resistors (DC current path to ground) or current sources must be used for functionality. These outputs are designed to drive 50 $\Omega$

transmission lines. Matched impedance techniques should be used to maximize operating frequency and minimize signal distortion.

*Figures 5A and 5B* show two different layouts which are recommended only as guidelines. Other suitable clock layouts may exist and it would be recommended that the board designers simulate to guarantee compatibility across all printed circuit and clock component process variations.

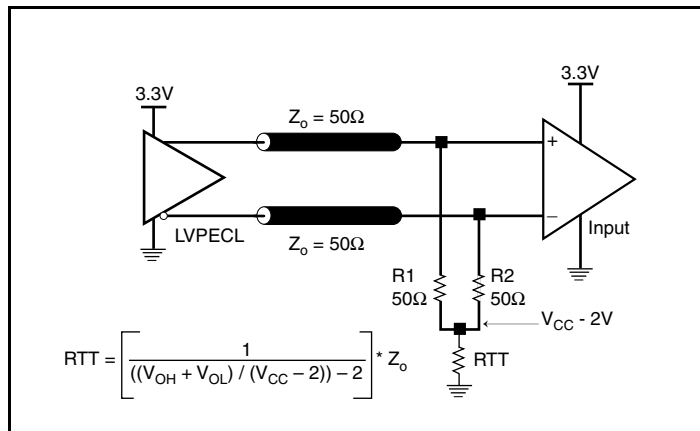


Figure 5A. 3.3V LVPECL Output Termination

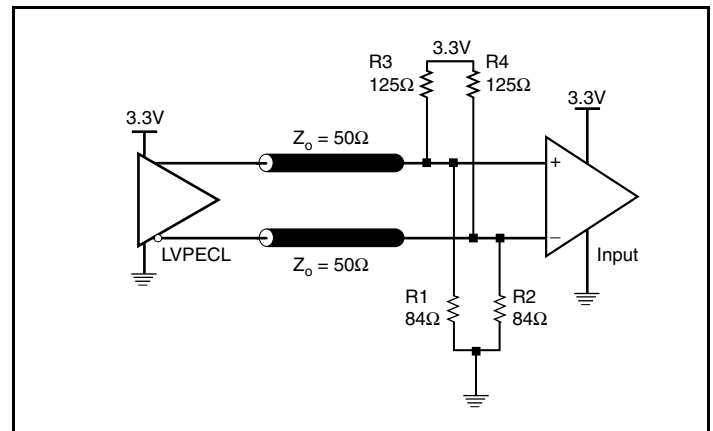


Figure 5B. 3.3V LVPECL Output Termination

## Termination for 2.5V LVPECL Outputs

Figure 6A and Figure 6B show examples of termination for 2.5V LVPECL driver. These terminations are equivalent to terminating  $50\Omega$  to  $V_{CCO} - 2V$ . For  $V_{CCO} = 2.5V$ , the  $V_{CCO} - 2V$  is very close to ground

level. The  $R3$  in Figure 6B can be eliminated and the termination is shown in Figure 6C.

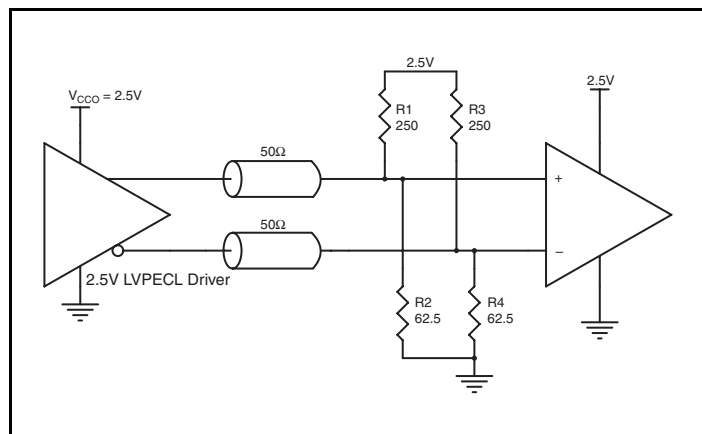


Figure 6A. 2.5V LVPECL Driver Termination Example

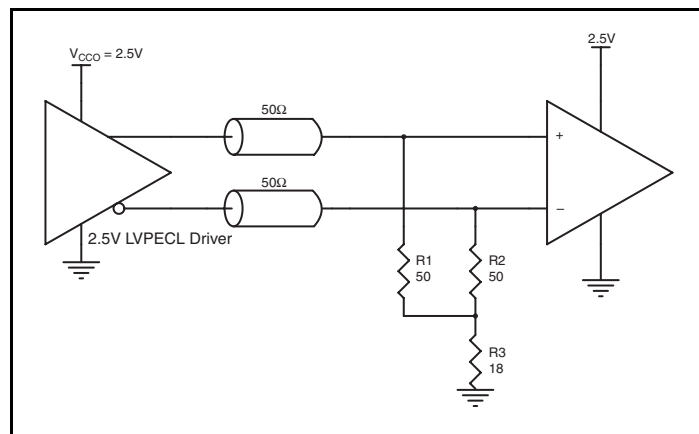


Figure 6B. 2.5V LVPECL Driver Termination Example

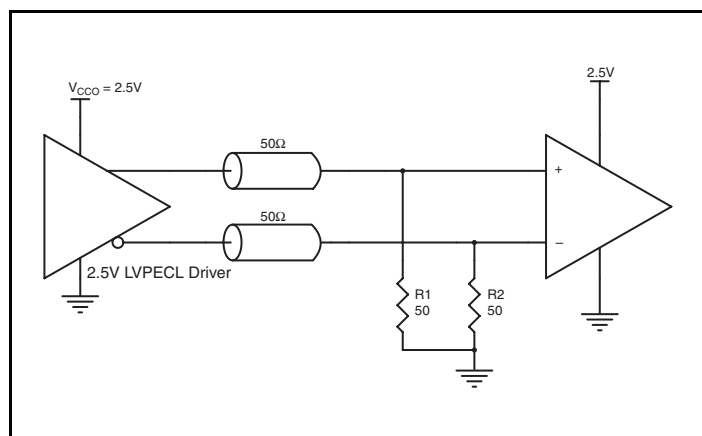


Figure 6C. 2.5V LVPECL Driver Termination Example

## Schematic Example

Figure 7 shows an example of ICS853S031I application schematic. In this example, the device is operated at  $V_{CC} = 3.3V$ . The decoupling capacitor should be located as close as possible to the power pin. The input is driven by a 3.3V LVPECL driver. Only two terminations

examples are shown in this schematic. For more termination approaches, please refer to the LVPECL Termination Application Note.

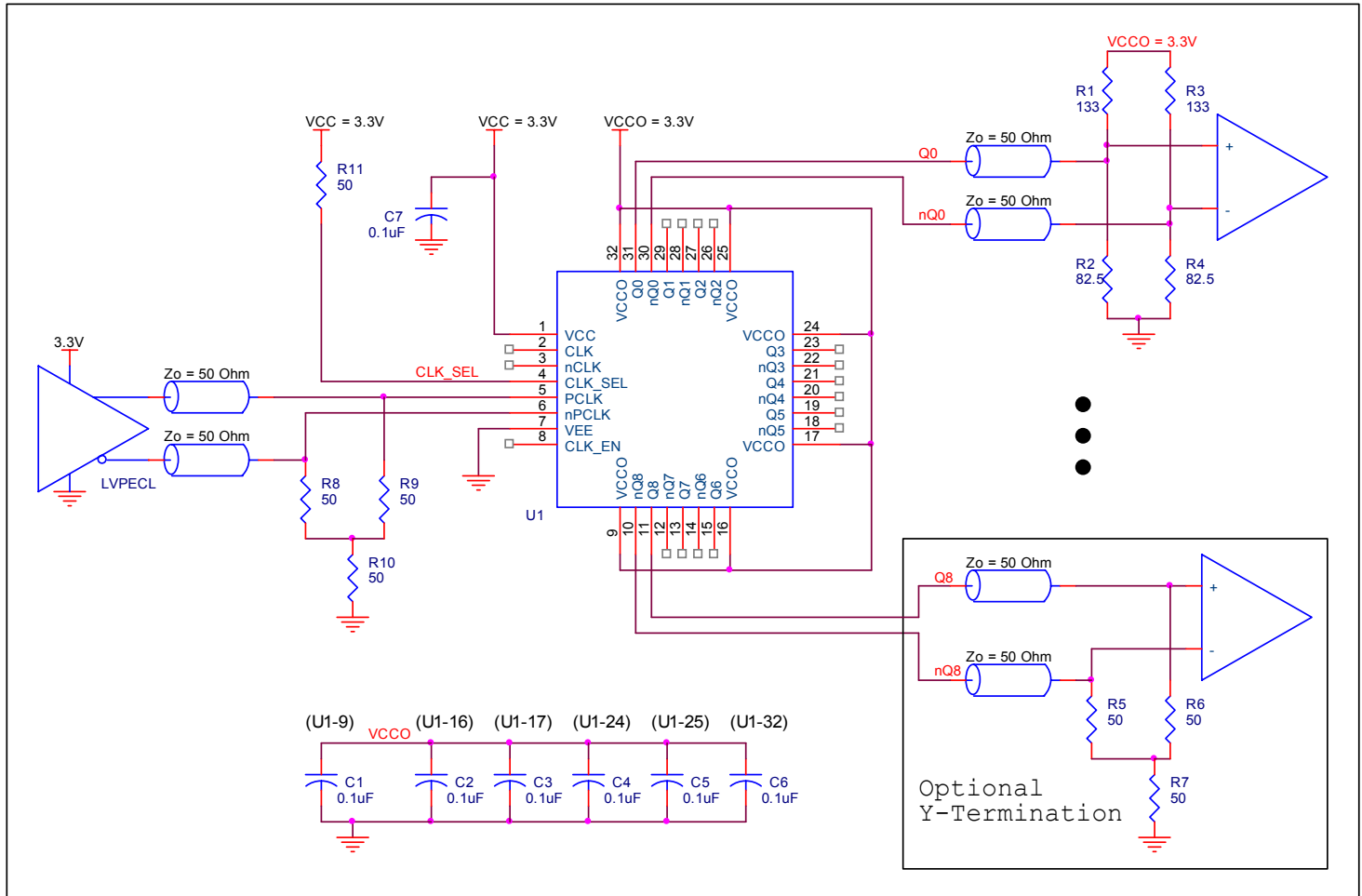


Figure 7. ICS853S031I Example LVPECL Clock Output Buffer Schematic

## Power Considerations

This section provides information on power dissipation and junction temperature for the ICS853S031I. Equations and example calculations are also provided.

### 1. Power Dissipation.

The total power dissipation for the ICS853S031I is the sum of the core power plus the power dissipated in the load(s). The following is the power dissipation for  $V_{CC} = 3.465V$ , which gives worst case results.

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

- Power (core)<sub>MAX</sub> =  $V_{CC\_MAX} * I_{EE\_MAX} = 3.465V * 70mA = \mathbf{242.55mW}$
- Power (outputs)<sub>MAX</sub> = **33.71mW/Loaded Output pair**  
If all outputs are loaded, the total power is  $9 * 33.71mW = \mathbf{303.39mW}$

**Total Power<sub>MAX</sub>** (3.465V, with all outputs switching) =  $303.39mW + 242.55mW = \mathbf{545.94mW}$

### 2. Junction Temperature.

Junction temperature,  $T_j$ , is the temperature at the junction of the bond wire and bond pad 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 a moderate air flow of 1 meter per second and a multi-layer board, the appropriate value is 71.4°C/W per Table 6 below.

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

$$85^{\circ}C + 0.546W * 71.4^{\circ}C/W = 124^{\circ}C. \text{ This is below the limit of } 125^{\circ}C.$$

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).

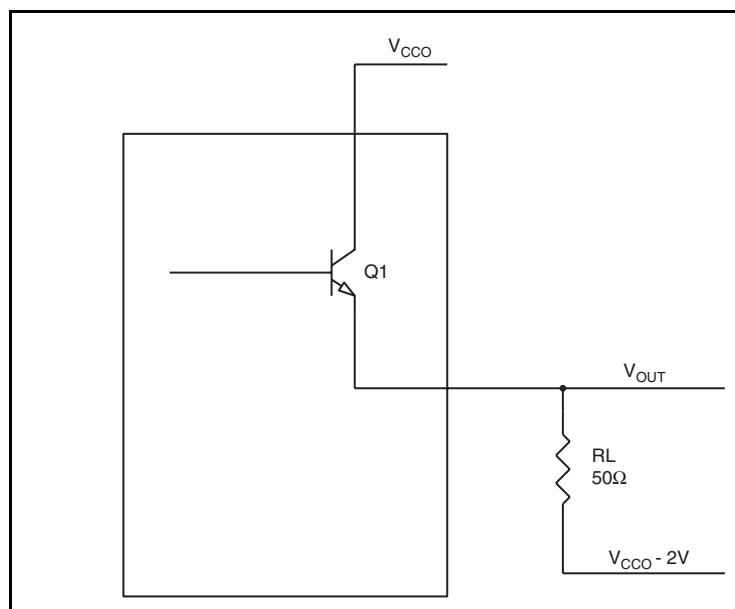
**Table 6. Thermal Resistance  $\theta_{JA}$  for 32 Lead LQFP, Forced Convection**

| $\theta_{JA}$ by Velocity                   |          |          |          |
|---------------------------------------------|----------|----------|----------|
| Meters per Second                           | 0        | 1        | 2.5      |
| Multi-Layer PCB, JEDEC Standard Test Boards | 80.9°C/W | 71.4°C/W | 67.7°C/W |

### 3. Calculations and Equations.

The purpose of this section is to calculate power dissipation on the LVPECL output pairs.

LVPECL output driver circuit and termination are shown in *Figure 8*.



**Figure 8. LVPECL Driver Circuit and Termination**

To calculate typical case power dissipation into the load, use the following equations which assume a 50Ω load, and a termination voltage of  $V_{CCO} - 2V$ .

- For logic high,  $V_{OUT} = V_{OH\_MAX} = V_{CCO\_MAX} - 0.71V$   
( $V_{CCO\_MAX} - V_{OH\_MAX}$ ) = **0.71V**
- For logic low,  $V_{OUT} = V_{OL\_MAX} = V_{CCO\_MAX} - 1.48V$   
( $V_{CCO\_MAX} - V_{OL\_MAX}$ ) = **1.48V**

$Pd\_H$  is power dissipation when the output drives high.

$Pd\_L$  is the power dissipation when the output drives low.

$$Pd\_H = [(V_{OH\_MAX} - (V_{CCO\_MAX} - 2V))/R_L] * (V_{CCO\_MAX} - V_{OH\_MAX}) = [(2V - (V_{CCO\_MAX} - V_{OH\_MAX}))/R_L] * (V_{CCO\_MAX} - V_{OH\_MAX}) = [(2V - 0.71V)/50\Omega] * 0.71V = \mathbf{18.32mW}$$

$$Pd\_L = [(V_{OL\_MAX} - (V_{CCO\_MAX} - 2V))/R_L] * (V_{CCO\_MAX} - V_{OL\_MAX}) = [(2V - (V_{CCO\_MAX} - V_{OL\_MAX}))/R_L] * (V_{CCO\_MAX} - V_{OL\_MAX}) = [(2V - 1.48V)/50\Omega] * 1.48V = \mathbf{15.39mW}$$

$$\text{Total Power Dissipation per output pair} = Pd\_H + Pd\_L = \mathbf{33.71mW}$$



## Reliability Information

**Table 7.  $\theta_{JA}$  vs. Air Flow Table for a 32 Lead LQFP**

| $\theta_{JA}$ vs. Air Flow                  |          |          |          |
|---------------------------------------------|----------|----------|----------|
| Meters per Second                           | 0        | 1        | 2.5      |
| Multi-Layer PCB, JEDEC Standard Test Boards | 80.9°C/W | 71.4°C/W | 67.7°C/W |

## Transistor Count

The transistor count for ICS853S031I is: 383

Pin compatible with ICS8531-01

This device is pin and functional compatible, and is the suggested replacement for the ICS853031.



# Package Outline and Package Dimensions, continued

## Package Outline - Y Suffix for 32 Lead LQFP

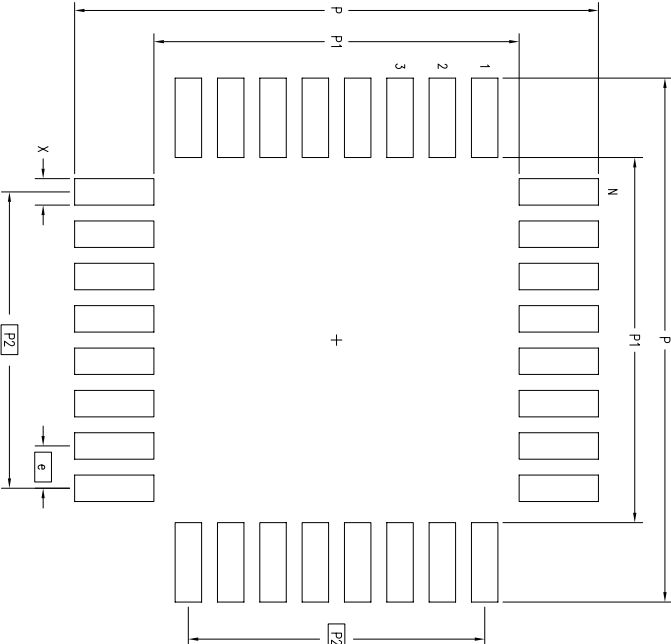
| SYMBOL | JEDEC VARIATION |      |      | NOMINAL | TYPICAL | MAXIMUM |
|--------|-----------------|------|------|---------|---------|---------|
|        | MIN             | NOM  | MAX  |         |         |         |
| A      | —               | —    | 1.60 |         |         |         |
| A1     | .05             | .10  | .15  |         |         |         |
| A2     | 1.35            | 1.40 | 1.45 |         |         |         |
| D      | 9.00            | BSC  | 4    |         |         |         |
| D1     | 7.00            | BSC  | 5.2  |         |         |         |
| E      | 9.00            | BSC  | 4    |         |         |         |
| E1     | 7.00            | BSC  | 5.2  |         |         |         |
| N      | 32              |      |      |         |         |         |
| e      | .80             | BSC  |      |         |         |         |
| b      | .30             | .37  | .45  | 7       |         |         |
| b1     | .30             | .35  | .40  |         |         |         |
| ccc    | —               | —    | .10  |         |         |         |
| ddd    | —               | —    | .20  |         |         |         |

| SYMBOL | JEDEC VARIATION |      |      | NOMINAL | TYPICAL | MAXIMUM |
|--------|-----------------|------|------|---------|---------|---------|
|        | MIN             | NOM  | MAX  |         |         |         |
| A      | —               | —    | 1.60 |         |         |         |
| A1     | .05             | .10  | .15  |         |         |         |
| A2     | 1.35            | 1.40 | 1.45 |         |         |         |
| D      | 9.00            | BSC  | 4    |         |         |         |
| D1     | 7.00            | BSC  | 5.2  |         |         |         |
| E      | 9.00            | BSC  | 4    |         |         |         |
| E1     | 7.00            | BSC  | 5.2  |         |         |         |
| N      | 48              |      |      |         |         |         |
| e      | .50             | BSC  |      |         |         |         |
| b      | .17             | .22  | .27  | 7       |         |         |
| b1     | .17             | .20  | .23  |         |         |         |
| ccc    | —               | —    | .08  |         |         |         |
| ddd    | —               | —    | .08  |         |         |         |

### NOTES:

- ALL DIMENSIONING AND TOLERANCING CONFORM TO ANSI Y14.5M-1982
- TOP PACKAGE MAY BE SMALLER THAN BOTTOM PACKAGE BY .15 mm
- DATUMS [A-B] AND [D-E] TO BE DETERMINED AT DATUM PLANE [H-I]
- DIMENSIONS D AND E ARE TO BE DETERMINED AT SEATING PLANE [C-]
- DIMENSIONS D1 AND E1 DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE MOLD PROTRUSION IS .25 mm PER SIDE. D1 AND E1 ARE MAXIMUM BODY SIZE DIMENSIONS INCLUDING MOLD MISMATCH
- DETAILS OF PIN 1 IDENTIFIER IS OPTIONAL, BUT MUST BE LOCATED WITHIN THE ZONE INDICATED
- DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION IS .08 mm IN EXCESS OF THE b DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT.
- EXACT SHAPE OF EACH CORNER IS OPTIONAL
- THESE DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN .10 AND .25 mm FROM THE LEAD TIP
- ALL DIMENSIONS ARE IN MILLIMETERS
- THIS OUTLINE CONFORMS TO JEDEC PUBLICATION 95 REGISTRATION MS-026, VARIATIONS BBA & BBC.

### LAND PATTERN DIMENSIONS



|    | MIN  | MAX   |    | MIN  | MAX   |
|----|------|-------|----|------|-------|
| P  | 9.80 | 10.00 | P  | 9.80 | 10.00 |
| P1 | 6.80 | 7.00  | P1 | 6.80 | 7.00  |
| P2 | 5.60 | BSC   | P2 | 5.50 | BSC   |
| X  | .40  | .60   | X  | .25  | .35   |
| e  | .80  | BSC   | e  | .50  | BSC   |
| N  | 32   |       | N  | 48   |       |

TOLERANCES  
UNLESS SPECIFIED  
DECIMAL  
ANGULAR  
±

XXXX  
XXXX

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10/15/95

CHECKED  
DATE  
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1.00/.10 FORM

REV  
02

## Ordering Information

Table 8. Ordering Information

| Part/Order Number | Marking      | Package                 | Shipping Packaging | Temperature   |
|-------------------|--------------|-------------------------|--------------------|---------------|
| 853S031BYILF      | ICS53S031BIL | Lead-Free, 32 Lead LQFP | Tray               | -40°C to 85°C |
| 853S031BYILFT     | ICS53S031BIL | Lead-Free, 32 Lead LQFP | 1000 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.

## Revision History Sheet

| Rev | Table | Page | Description of Change          | Date    |
|-----|-------|------|--------------------------------|---------|
| A   |       | 18   | Corrected package information. | 8/17/11 |
|     |       |      |                                |         |



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(Rev.1.0 Mar 2020)

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