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## GENERAL DESCRIPTION

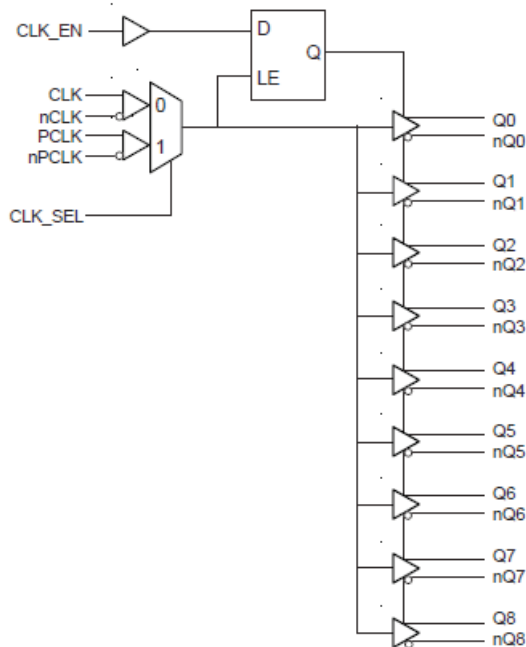
The 8531-01 is a low skew, high performance 1-to-9 Differential-to-3.3V LVPECL Fanout Buffer and a member of the family of High Performance Clock Solutions from IDT. The 8531-01 has two selectable clock inputs. The CLK, nCLK pair can accept most standard differential input levels. The PCLK, nPCLK pair can accept LVPECL, 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 skew and part-to-part skew characteristics make the 8531-01 ideal for high performance workstation and server applications.

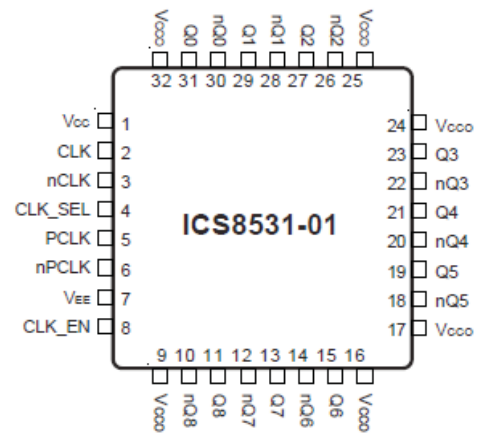
## FEATURES

- Nine differential 3.3V LVPECL outputs
- Selectable differential CLK, nCLK or LVPECL clock inputs
- CLK, nCLK pair can accept the following differential input levels: LVPECL, LVDS, LVHSTL, SSTL, HCSL
- PCLK, nPCLK supports the following input types: LVPECL, CML, SSTL
- Maximum output frequency: 500MHz
- Translates any single ended input signal (LVCMOS, LVTTTL, GTL) to 3.3V LVPECL levels with resistor bias on nCLK input
- Additive phase jitter, RMS: 0.17ps (typical)
- Output skew: 50ps (maximum)
- Part-to-part skew: 250ps (maximum)
- Propagation delay: 2ns (maximum)
- 3.3V operating supply
- 0°C to 70°C ambient operating temperature
- Available in lead-free (RoHS 6) package
- Industrial Temperature information available upon request

## BLOCK DIAGRAM



## PIN ASSIGNMENT



**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  |          | Power 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. 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, Q outputs are forced low, nQ outputs are forced high. LVTTTL / LVCMOS interface levels. |
| 9, 16, 17, 24, 25, 32 | V <sub>CCO</sub> | Power  |          | Output supply pins.  |
| 10, 11                | nQ8, Q8          | Output |          | Differential output pair. LVPECL interface level.  |
| 12, 13                | nQ7, Q7          | Output |          | Differential output pair. LVPECL interface level.  |
| 14, 15                | nQ6, Q6          | Output |          | Differential output pair. LVPECL interface level.  |
| 18, 19                | nQ5, Q5          | Output |          | Differential output pair. LVPECL interface level.  |
| 20, 21                | nQ4, Q4          | Output |          | Differential output pair. LVPECL interface level.  |
| 22, 23                | nQ3, Q3          | Output |          | Differential output pair. LVPECL interface level.  |
| 26, 27                | nQ2, Q2          | Output |          | Differential output pair. LVPECL interface level.  |
| 28, 29                | nQ1, Q1          | Output |          | Differential output pair. LVPECL interface level.  |
| 30, 31                | nQ0, Q0          | Output |          | Differential output pair. LVPECL interface level.  |

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

**TABLE 2. PIN CHARACTERISTICS**

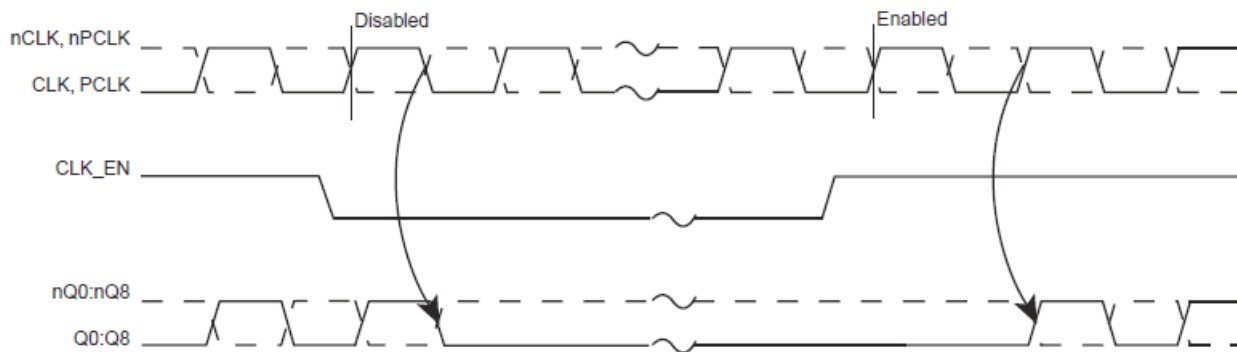
| Symbol                | Parameter               | Test Conditions | Minimum | Typical | Maximum | Units |
|-----------------------|-------------------------|-----------------|---------|---------|---------|-------|
| C <sub>IN</sub>       | Input Capacitance       |                 |         | 4       |         | pF    |
| R <sub>PULLUP</sub>   | Input Pullup Resistor   |                 |         | 51      |         | kΩ    |
| R <sub>PULLDOWN</sub> | Input Pulldown Resistor |                 |         | 51      |         | kΩ    |

**TABLE 3A. CONTROL INPUT FUNCTION TABLE**

| Inputs |         |                  | Outputs       |                |
|--------|---------|------------------|---------------|----------------|
| CLK_EN | CLK_SEL | Selected Sourced | 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 Application Information section, "Wiring the Differential Input to Accept Single Ended Levels".

**ABSOLUTE MAXIMUM RATINGS**

|  |                          |
|--|--------------------------|
| Supply Voltage, $V_{CC}$                 | 4.6V                     |
| Inputs, $V_I$                            | -0.5V to $V_{CC} + 0.5V$ |
| Outputs, $I_O$                           |                          |
| Continuous Current                       | 50mA                     |
| Surge Current                            | 100mA                    |
| Package Thermal Impedance, $\theta_{JA}$ | 47.9°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,  $V_{CC} = V_{CCO} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$** 

| Symbol    | Parameter             | Test Conditions | Minimum | Typical | Maximum | Units |
|-----------|-----------------------|-----------------|---------|---------|---------|-------|
| $V_{CC}$  | Power Supply Voltage  |                 | 3.135   | 3.3     | 3.465   | V     |
| $V_{CCO}$ | Output Supply Voltage |                 | 3.135   | 3.3     | 3.465   | V     |
| $I_{EE}$  | Power Supply Current  |                 |         |         | 80      | mA    |

**TABLE 4B. LVCMOS / LVTTTL DC CHARACTERISTICS,  $V_{CC} = V_{CCO} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$** 

| Symbol   | Parameter          | Test Conditions | Minimum                        | Typical | Maximum | Units   |
|----------|--------------------|-----------------|--------------------------------|---------|---------|---------|
| $V_{IH}$ | CLK_EN, CLK_SEL    |                 | 2                              |         | 3.765   | V       |
| $V_{IL}$ | CLK_EN, CLK_SEL    |                 | -0.3                           |         | 0.8     | V       |
| $I_{IH}$ | Input High Current | CLK_EN          | $V_{CC} = V_{IN} = 3.465V$     |         | 5       | $\mu A$ |
|          |                    | CLK_SEL         | $V_{CC} = V_{IN} = 3.465V$     |         | 150     | $\mu A$ |
| $I_{IL}$ | Input Low Current  | CLK_EN          | $V_{IN} = 0V, V_{CC} = 3.465V$ | -150    |         | $\mu A$ |
|          |                    | CLK_SEL         | $V_{IN} = 0V, V_{CC} = 3.465V$ | -5      |         | $\mu A$ |

**TABLE 4C. DIFFERENTIAL DC CHARACTERISTICS,  $V_{CC} = V_{CCO} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$** 

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

NOTE 1: For single ended applications, the maximum input voltage for CLK and nCLK is  $V_{CC} + 0.3V$ .

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

**TABLE 4D. LVPECL DC CHARACTERISTICS,  $V_{CC} = V_{CCO} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$** 

| Symbol      | Parameter                               | Test Conditions | Minimum                        | Typical | Maximum         | Units   |
|-------------|---|-----------------|--------------------------------|---------|-----------------|---------|
| $I_{IH}$    | Input High Current                      | PCLK            | $V_{CC} = V_{IN} = 3.465V$     |         | 150             | $\mu A$ |
|             |   | nPCLK           | $V_{CC} = V_{IN} = 3.465V$     |         | 5               | $\mu A$ |
| $I_{IL}$    | Input Low Current                       | PCLK            | $V_{IN} = 0V, V_{CC} = 3.465V$ | -5      |                 | $\mu A$ |
|             |   | nPCLK           | $V_{IN} = 0V, V_{CC} = 3.465V$ | -150    |                 | $\mu A$ |
| $V_{PP}$    | Peak-to-Peak Input Voltage              |                 | 0.3                            |         | 1               | V       |
| $V_{CMR}$   | Common Mode Input Voltage;<br>NOTE 1, 2 |                 | $V_{EE} + 1.5$                 |         | $V_{CC}$        | V       |
| $V_{OH}$    | Output High Voltage; NOTE 3             |                 | $V_{CCO} - 1.4$                |         | $V_{CCO} - 0.9$ | V       |
| $V_{OL}$    | Output Low Voltage; NOTE 3              |                 | $V_{CCO} - 2.0$                |         | $V_{CCO} - 1.7$ | V       |
| $V_{SWING}$ | Peak-to-Peak Output Voltage Swing       |                 | 0.6                            |         | 1.0             | V       |

NOTE 1: Common mode input voltage is defined as  $V_{IH}$ .

NOTE 2: For single ended applications, the maximum input voltage for PCLK and nPCLK is  $V_{CC} + 0.3V$ .

NOTE 3: Outputs terminated with  $50\Omega$  to  $V_{CCO} - 2V$ .

**TABLE 5. AC CHARACTERISTICS,  $V_{CC} = V_{CCO} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$** 

| Symbol       | Parameter   | Test Conditions                | Minimum | Typical | Maximum | Units |
|--------------|---|--------------------------------|---------|---------|---------|-------|
| $f_{MAX}$    | Output Frequency  |                                |         |         | 500     | MHz   |
| $t_{PD}$     | Propagation Delay; NOTE 1   | $f \leq 250MHz$                | 1       |         | 2       | ns    |
| $t_{jit}$    | Buffer Additive Phase Jitter, RMS;<br>refer to Additive Phase Jitter Section;<br>NOTE 2 | 155.52MHz,<br>(12kHz to 20MHz) |         | 0.17    |         | ps    |
| $t_{sk(o)}$  | Output Skew; NOTE 3, 5  |                                |         |         | 50      | ps    |
| $t_{sk(pp)}$ | Part-to-Part Skew; NOTE 4, 5  |                                |         |         | 250     | ps    |
| $t_R / t_F$  | Output Rise/Fall Time   | 20% to 80% @ 50MHz             | 300     |         | 700     | ps    |
| odc          | Output Duty Cycle   |                                | 48      | 50      | 52      | %     |

All parameters measured at 250MHz unless noted otherwise.

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

NOTE 2: Driving only one input clock.

NOTE 3: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at the output differential cross points.

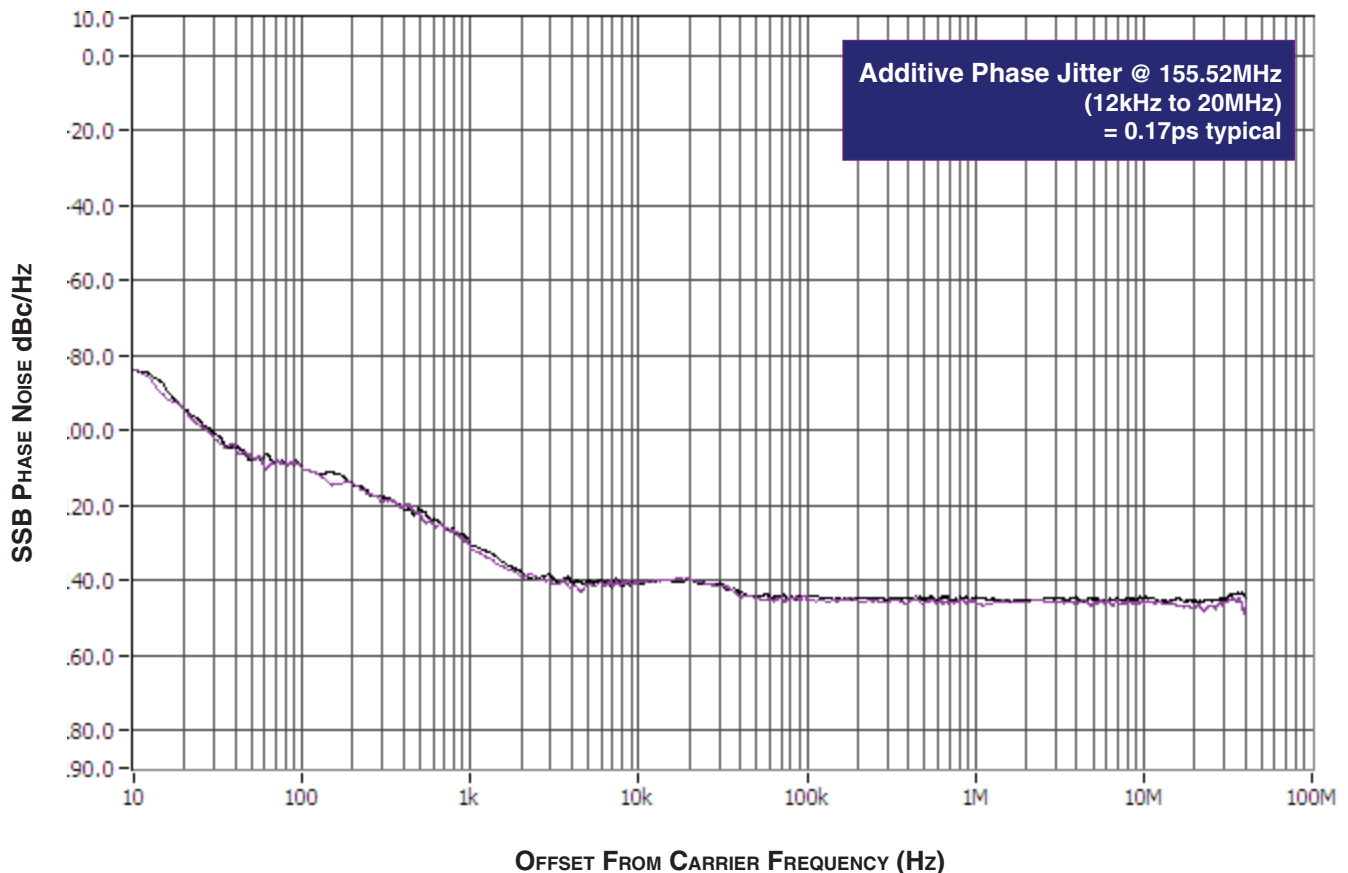
NOTE 4: Defined as skew between outputs on different devices operating at the same supply voltages and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at the differential cross points.

NOTE 5: 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

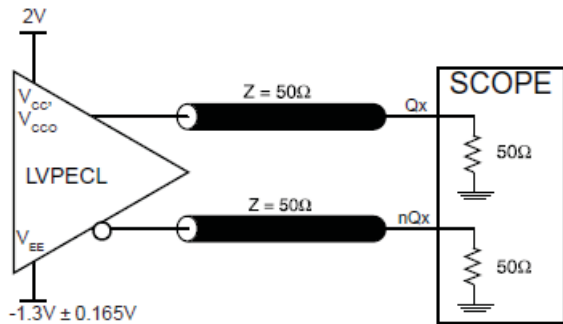
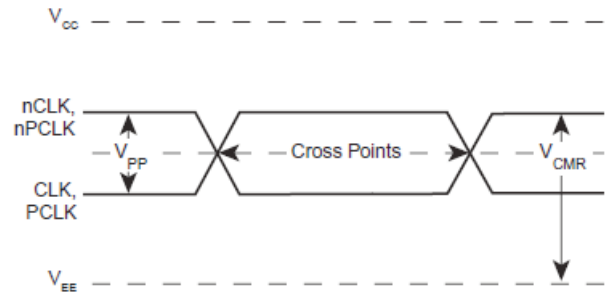
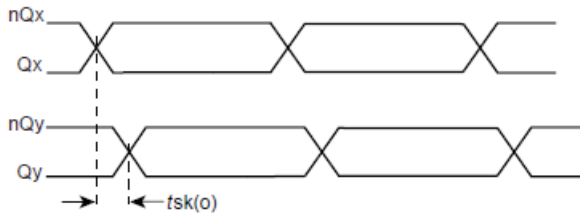
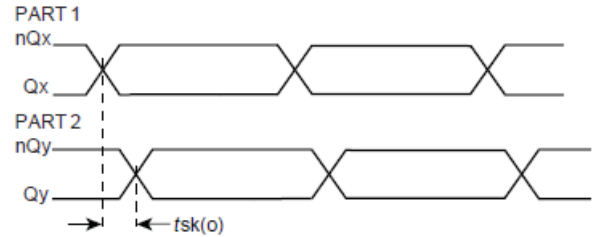
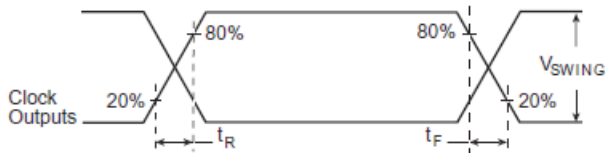
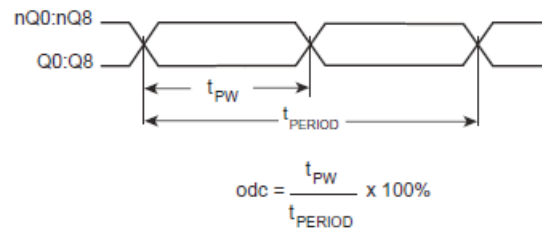
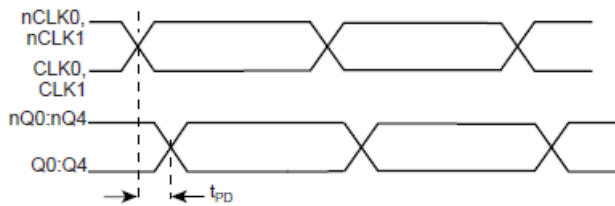
(dBm) or a ratio of the power in the 1Hz band to the power in the fundamental. When the required offset is specified, the phase noise is called a **dBc** value, which simply means dBm at a specified offset from the fundamental. By investigating jitter in the frequency domain, we get a better understanding 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 have issues. The primary issue relates 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 dependant on the input source and measurement equipment.

# PARAMETER MEASUREMENT INFORMATION


**3.3V OUTPUT LOAD AC TEST CIRCUIT**

**DIFFERENTIAL INPUT LEVEL**

**OUTPUT SKEW**

**PART-TO-PART SKEW**

**OUTPUT RISE/FALL TIME**

**OUTPUT DUTY CYCLE/PULSE WIDTH/PERIOD**

**PROPAGATION DELAY**



## APPLICATION INFORMATION

### WIRING THE DIFFERENTIAL INPUT TO ACCEPT SINGLE ENDED LEVELS

Figure 2 shows how the differential input can be wired to accept single ended levels. The reference voltage  $V_{REF} \approx V_{CC}/2$  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  $V_{CC} = 3.3V$ ,  $V_{REF}$  should be 1.25V and  $R2/R1 = 0.609$ .

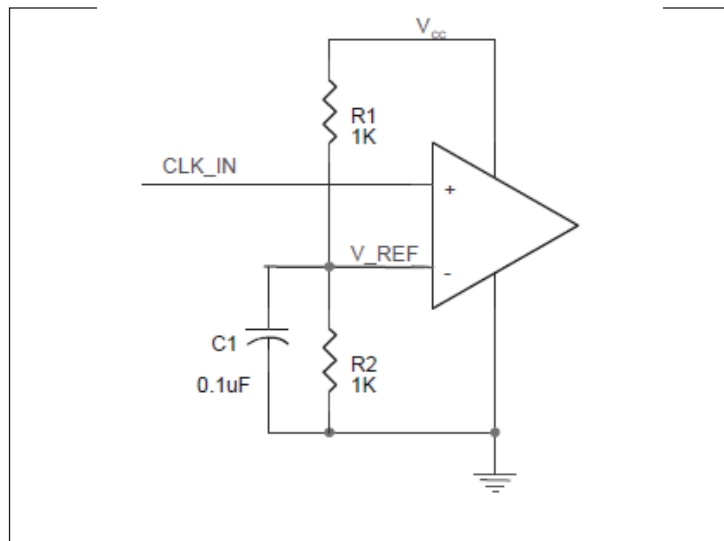


FIGURE 2. SINGLE ENDED SIGNAL DRIVING DIFFERENTIAL INPUT

### RECOMMENDATIONS FOR UNUSED INPUT AND OUTPUT PINS

#### INPUTS:

##### 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 $\Omega$  resistor can be tied from CLK to ground.

##### PCLK/nPCLK INPUT:

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.

##### 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:

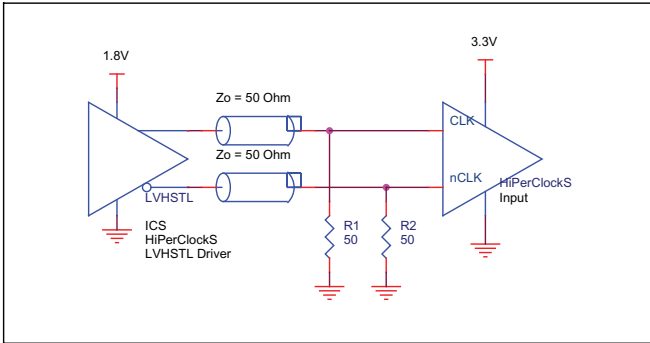
##### LVPECL OUTPUTS:

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.

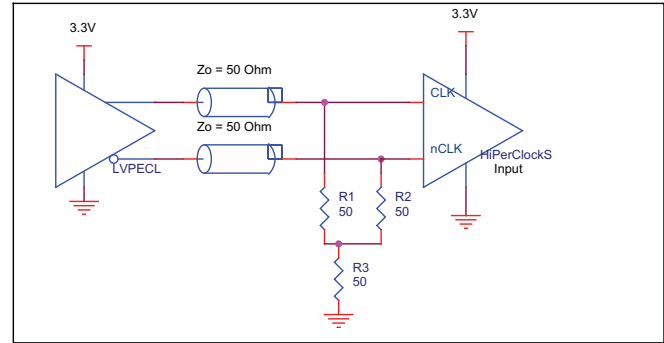
## DIFFERENTIAL CLOCK INPUT INTERFACE

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 3E show interface examples for the HiPerClockS CLK/nCLK input driven by the most common driver types. The input interfaces suggested here are examples only.

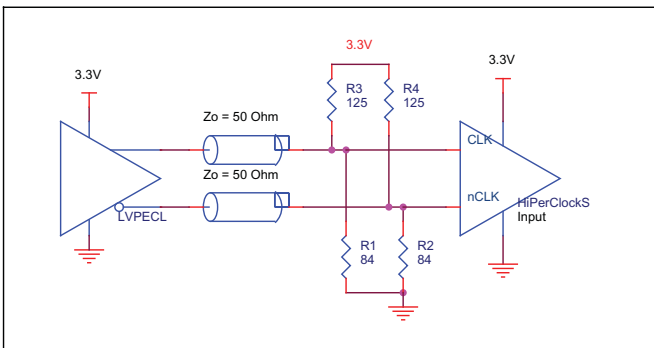
Please consult with the vendor of the driver component to confirm the driver termination requirements. For example in *Figure 3A*, the input termination applies for IDT HiPerClockS LVHSTL drivers. If you are using an LVHSTL driver from another vendor, use their termination recommendation.



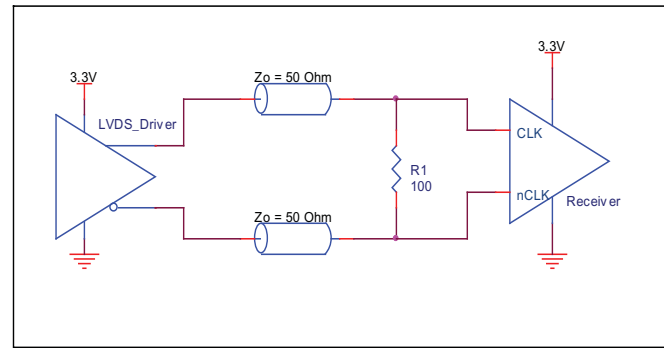
**FIGURE 3A. HiPerClockS CLK/nCLK INPUT DRIVEN BY IDT HiPerClockS LVHSTL DRIVER**



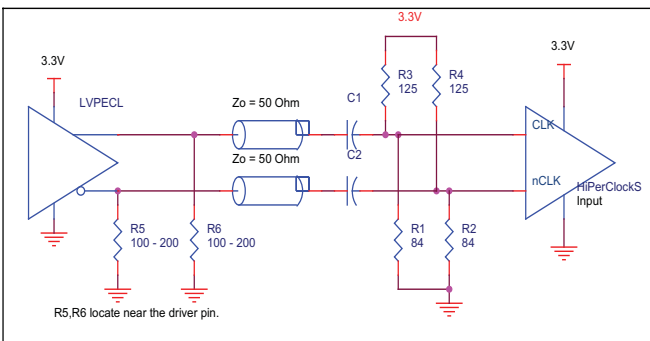
**FIGURE 3B. HiPerClockS CLK/nCLK INPUT DRIVEN BY 3.3V LVPECL DRIVER**



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



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

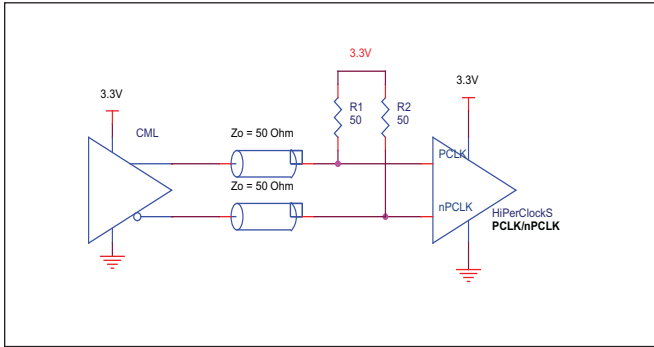


**FIGURE 3E. HiPerClockS CLK/nCLK INPUT DRIVEN BY 3.3V LVPECL DRIVER WITH AC COUPLE**

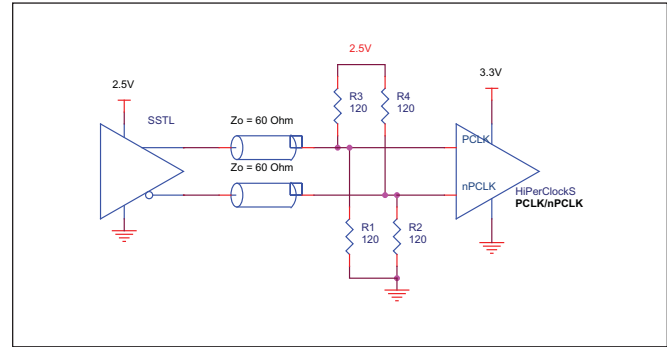
## LVPECL CLOCK INPUT INTERFACE

The PCLK /nPCLK accepts LVPECL, CML, SSTL and other differential signals. Both  $V_{SWING}$  and  $V_{OH}$  must meet the  $V_{PP}$  and  $V_{CMR}$  input requirements. Figures 4A to 4E show interface examples for the HiPerClockS PCLK/nPCLK input driven by the most common driver

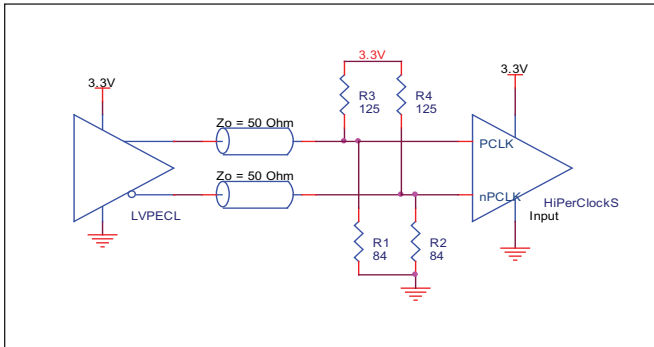
types. The input interfaces suggested here are examples only. If the driver is from another vendor, use their termination recommendation. Please consult with the vendor of the driver component to confirm the driver termination requirements.



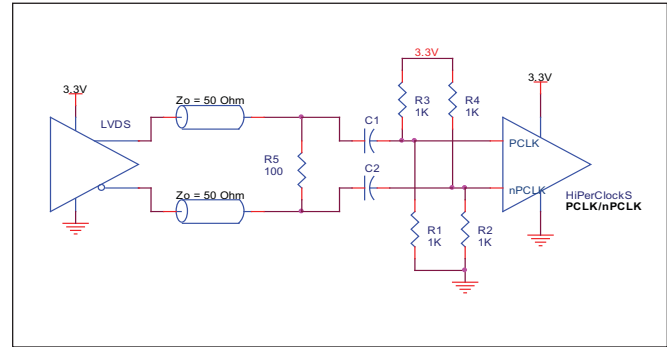
**FIGURE 4A. HiPerClockS PCLK/nPCLK INPUT DRIVEN BY A CML DRIVER**



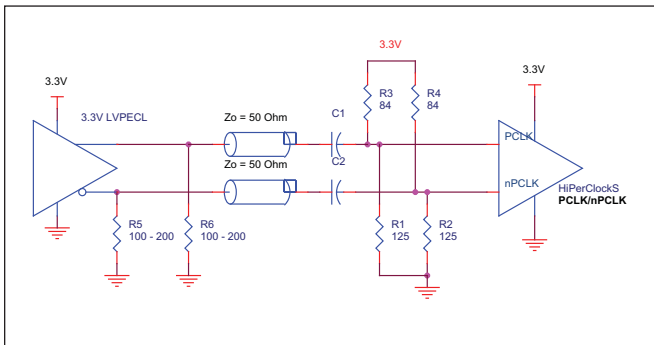
**FIGURE 4B. HiPerClockS PCLK/nPCLK INPUT DRIVEN BY AN SSTL DRIVER**



**FIGURE 4C. HiPerClockS PCLK/nPCLK INPUT DRIVEN BY A 3.3V LVPECL DRIVER**



**FIGURE 4D. HiPerClockS PCLK/nPCLK INPUT DRIVEN BY A 3.3V LVDS DRIVER**



**FIGURE 4E. HiPerClockS PCLK/nPCLK INPUT DRIVEN BY A 3.3V LVPECL DRIVER WITH AC COUPLE**

## TERMINATION FOR 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.

FOUT and nFOUT 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.

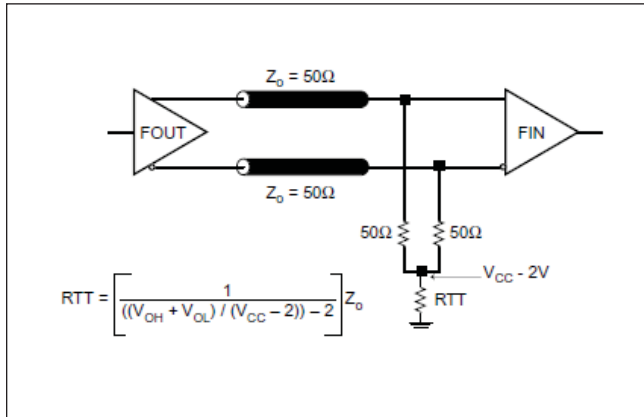


FIGURE 5A. LVPECL OUTPUT TERMINATION

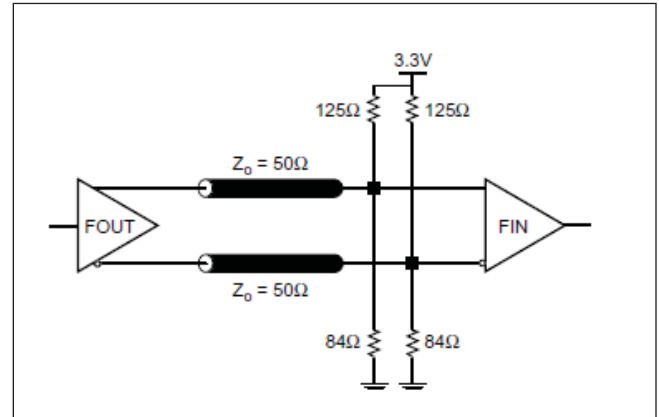


FIGURE 5B. LVPECL OUTPUT TERMINATION

## POWER CONSIDERATIONS

This section provides information on power dissipation and junction temperature for the 8531-01. Equations and example calculations are also provided.

### 1. Power Dissipation.

The total power dissipation for the 8531-01 is the sum of the core power plus the power dissipated in the load(s). The following is the power dissipation for  $V_{CC} = 3.3V + 5\% = 3.465V$ , which gives worst case results.

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

- Power (core)<sub>MAX</sub> =  $V_{CC,MAX} * I_{EE,MAX} = 3.465V * 80mA = 277.2mW$
- Power (outputs)<sub>MAX</sub> = **30mW/Loaded Output pair**  
If all outputs are loaded, the total power is  $9 * 30mW = 270mW$

$$\text{Total Power}_{MAX} \text{ (3.465V, with all outputs switching)} = 277.2mW + 270mW = 547.2mW$$

### 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 for HiPerClockS™ devices is 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 200 linear feet per minute and a multi-layer board, the appropriate value is 42.1°C/W per Table 6 below.

Therefore,  $T_j$  for an ambient temperature of 70°C with all outputs switching is:

$$70^\circ\text{C} + 0.547\text{W} * 42.1^\circ\text{C/W} = 93^\circ\text{C}. \text{ This is well below the limit of } 125^\circ\text{C}.$$

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 (single layer or multi-layer).

**TABLE 6. THERMAL RESISTANCE  $\theta_{JA}$  FOR 32-PIN LQFP FORCED CONVECTION**

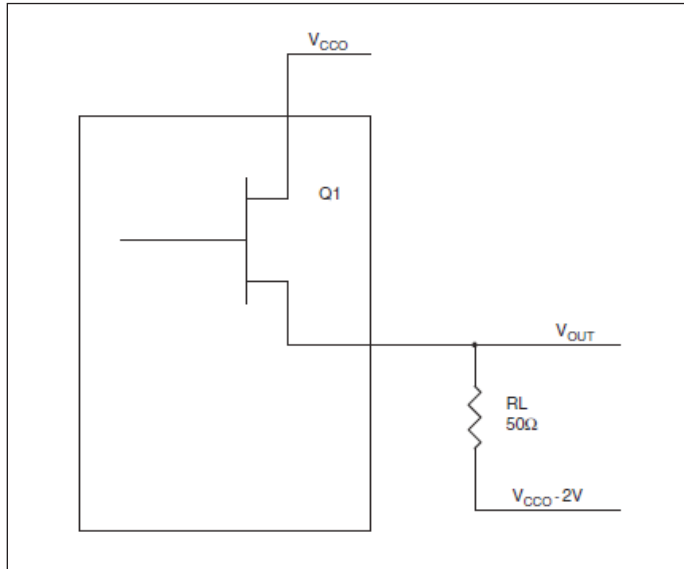
| $\theta_{JA}$ by Velocity (Linear Feet per Minute) |          |          |          |
|--|----------|----------|----------|
|  | 0        | 200      | 500      |
| Single-Layer PCB, JEDEC Standard Test Boards       | 67.8°C/W | 55.9°C/W | 50.1°C/W |
| Multi-Layer PCB, JEDEC Standard Test Boards        | 47.9°C/W | 42.1°C/W | 39.4°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.

LVPECL output driver circuit and termination are shown in *Figure 6*.



**FIGURE 6. LVPECL DRIVER CIRCUIT AND TERMINATION**

To calculate worst 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,  $V_{OUT} = V_{OH\_MAX} = V_{CCO\_MAX} - 0.9V$

$$(V_{CCO\_MAX} - V_{OH\_MAX}) = 0.9V$$

- For logic low,  $V_{OUT} = V_{OL\_MAX} = V_{CCO\_MAX} - 1.7V$

$$(V_{CCO\_MAX} - V_{OL\_MAX}) = 1.7V$$

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

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

$$Pd\_H = [(V_{OH\_MAX} - (V_{CCO\_MAX} - 2V))/R_L] * (V_{CCO\_MAX} - V_{OH\_MAX}) = [(2V - (V_{CCO\_MAX} - V_{OH\_MAX}))/R_L] * (V_{CCO\_MAX} - V_{OH\_MAX}) = [(2V - 0.9V)/50\Omega] * 0.9V = 19.8mW$$

$$Pd\_L = [(V_{OL\_MAX} - (V_{CCO\_MAX} - 2V))/R_L] * (V_{CCO\_MAX} - V_{OL\_MAX}) = [(2V - (V_{CCO\_MAX} - V_{OL\_MAX}))/R_L] * (V_{CCO\_MAX} - V_{OL\_MAX}) = [(2V - 1.7V)/50\Omega] * 1.7V = 10.2mW$$

$$\text{Total Power Dissipation per output pair} = Pd\_H + Pd\_L = 30mW$$

## RELIABILITY INFORMATION

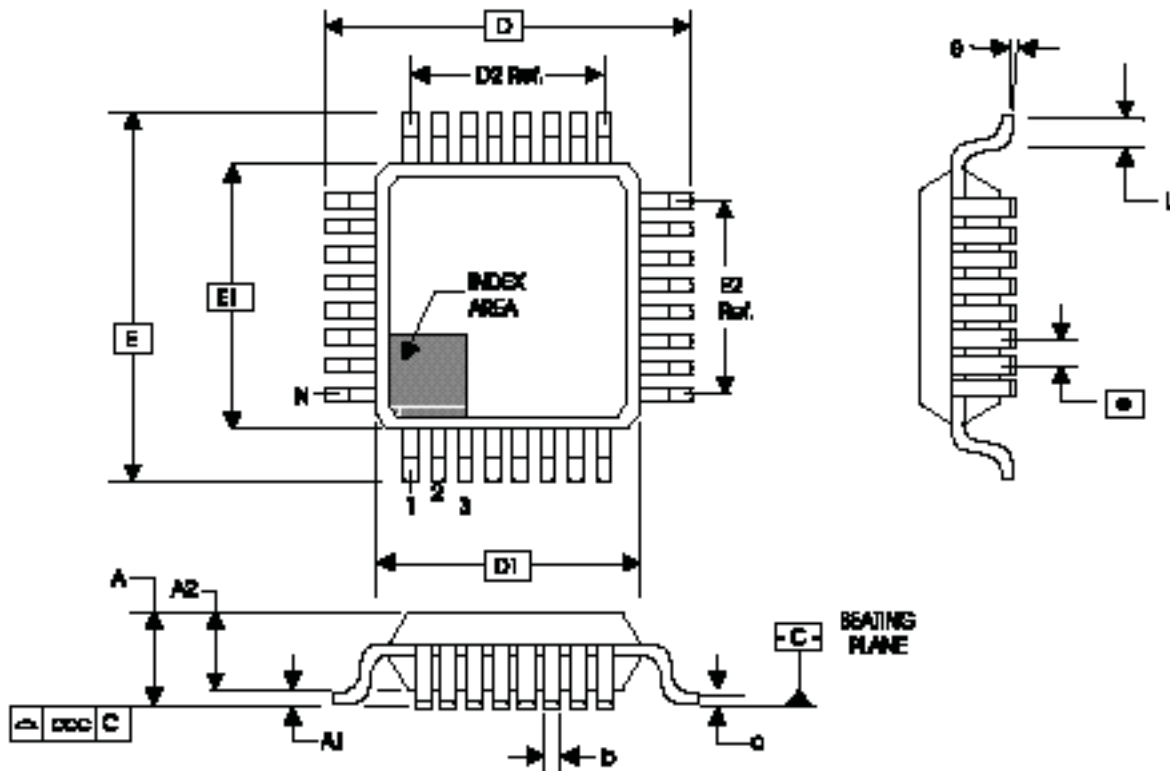
**TABLE 7.  $\theta_{JA}$  VS. AIR FLOW TABLE FOR 32 LEAD LQFP**

| $\theta_{JA}$ by Velocity (Linear Feet per Minute) |          |            |            |
|--|----------|------------|------------|
|  | <b>0</b> | <b>200</b> | <b>500</b> |
| Single-Layer PCB, JEDEC Standard Test Boards       | 67.8°C/W | 55.9°C/W   | 50.1°C/W   |
| Multi-Layer PCB, JEDEC Standard Test Boards        | 47.9°C/W | 42.1°C/W   | 39.4°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 8531-01 is: 632

**PACKAGE OUTLINE AND DIMENSIONS - Y SUFFIX FOR 32 LEAD LQFP**

**TABLE 8. PACKAGE DIMENSIONS**

| JEDEC VARIATION<br>ALL DIMENSIONS IN MILLIMETERS |            |         |         |
|--|------------|---------|---------|
| SYMBOL   | BBA        |         |         |
|  | MINIMUM    | NOMINAL | MAXIMUM |
| N  | 32         |         |         |
| A  | --         | --      | 1.60    |
| A1   | 0.05       | --      | 0.15    |
| A2   | 1.35       | 1.40    | 1.45    |
| b  | 0.30       | 0.37    | 0.45    |
| c  | 0.09       | --      | 0.20    |
| D  | 9.00 BASIC |         |         |
| D1   | 7.00 BASIC |         |         |
| D2   | 5.60 Ref.  |         |         |
| E  | 9.00 BASIC |         |         |
| E1   | 7.00 BASIC |         |         |
| E2   | 5.60 Ref.  |         |         |
| e  | 0.80 BASIC |         |         |
| L  | 0.45       | 0.60    | 0.75    |
| $\theta$   | 0°         | --      | 7°      |
| ccc  | --         | --      | 0.10    |

Reference Document: JEDEC Publication 95, MS-026



**TABLE 9. ORDERING INFORMATION**

| <b>Part/Order Number</b> | <b>Marking</b> | <b>Package</b>           | <b>Shipping Packaging</b> | <b>Temperature</b> |
|--------------------------|----------------|--------------------------|---------------------------|--------------------|
| 8531AY-01LF              | ICS8531AY01L   | 32 lead "Lead Free" LQFP | Tray                      | 0°C to +70°C       |
| 8531AY-01LFT             | ICS8531AY01L   | 32 lead "Lead Free" LQFP | Tape and Reel             | 0°C to +70°C       |

| REVISION HISTORY SHEET |       |   |   |          |
|------------------------|-------|---|---|----------|
| Rev                    | Table | Page  | Description of Change   | Date     |
| B                      | 4A    | 4   | Separated LVCMOS rows into own table.   | 6/15/01  |
|                        | 4C    | 4   | Changed HSTL table to Differential table.   |          |
|                        | 4D    | 5   | Changed $V_{PP}$ value from 0.1 Min. to 0.15 Min. Changed $V_{CMR}$ values from 0.13 Min, 1.3 Max. to 0.5 Min, $V_{CC} - 0.85$ .  |          |
|                        | 5     | 5   | In LVPECL table, changed $V_{CMR}$ values from 0.7 Min, 2.5 Max. to 0.5 Min, $V_{CC} - 0.85$ .<br>Changed $V_{OH}$ values from 1.9 Min., 2.3 Max. to $V_{CC} - 1.4$ Min., $V_{CC} - 1.0$ Max.<br>Changed $V_{OL}$ values from 1.2 Min, 1.6 Max. to $V_{CC} - 2.0$ Min, $V_{CC} - 1.7$ Max.<br>Changed $V_{SWING}$ values from 0.55 Min. to 0.6 Min.<br>Changed $t_{LH}$ & $t_{HL}$ rows to $t_{PD}$ . Values stayed same.<br>$t_R$ and $t_F$ values changed from 100 Min, 600 Max. to 300 Min., 700 Max.<br>Changed $t_{DC}$ row to odc. Values stayed same.<br>Deleted $t_S$ and $t_H$ rows. |          |
| B                      |       | 1   | Changed all $V_{DDX}$ to $V_{CCX}$ .<br>Changed $V_{CCO}$ to equal $3.3V \pm 5\%$ from $1.8V \pm 0.2V$ .<br>Updated Block Diagram.  | 6/18/01  |
| B                      | 4C    | 4   | Changed $V_{CMR}$ value from 0.5 Min. to $V_{EE} + 0.5$ Min.  | 8/9/01   |
|                        | 4D    | 5   | Changed $V_{CMR}$ values from 0.15 Min, 1.3 Max, to 0.3 Min, 1 Max.<br>Changed $V_{PP}$ values from 0.5 Min., $V_{CC} - 0.85$ Max. to $V_{EE} + 1.5$ Min., $V_{CC}$ Max.  |          |
| B                      |       | 3   | Updated Figure 1, CLK_EN Timing Diagram.  | 11/1/01  |
|                        |       | 6, 7  | Updated Figure 2, Output Load Test Circuit.<br>Revised labels on figures.   |          |
| B                      |       | 8   | Added Termination for LVPECL Outputs section.   | 5/28/02  |
| B                      |       | 2   | Pin Description table - $V_{CC}$ description changed to "Core supply pin" from "Positive supply pin".   | 10/02/02 |
|                        |       | 4   | Power Supply Characteristics table - $V_{CC}$ description changed to "Core Supply Voltage" from "Positive Supply Voltage".  |          |
|                        |       | 5   | Output Load Test Circuit diagram - corrected $V_{EE}$ equation to read, $V_{EE} = -1.3V \pm 0.165V$ from $V_{EE} = -1.3V \pm 0.135V$ .  |          |
| C                      | T2    | 2   | Pin Characteristics table - changed $C_{IN}$ 4pF max. to 4pF typical.   | 2/2/04   |
|                        |       | 4   | Updated Absolute Maximum Ratings.   |          |
|                        | T4A   | 4   | Power Supply DC Characteristics table - changed $I_{EE}$ 70mA max. to 80mA max and deleted 50mA typical.  |          |
|                        |       | 7   | Updated LVPECL Output Termination drawings.   |          |
|                        |       | 8   | Added Differential Clock Input Interface section.   |          |
|                        | 9     | Added LVPECL Clock Input Interface section.   |   |          |
|                        | 10    | Power Considerations - corrected Power Dissipation from 70mA to 80mA to correspond with $I_{EE}$ .<br>Updated format throughout the data sheet. |   |          |
| C                      | T9    | 14  | Ordering Information Table - added Lead-Free part number.   | 10/15/04 |
| D                      | T4D   | 5   | LVPECL DC Characteristics - changed VSWING max. limit from 850mV to 1.0V.   | 6/23/06  |
|                        | T9    | 15  | Added Recommendations for Unused Input and Output Pins.<br>Ordering Information Table - added lead-free note.   |          |
| E                      | 1     |   | Features Section - added RMS Phase Jitter bullet.   | 12/4/06  |
|                        | T5    | 5   | AC Characteristics Table - add RMS Phase Jitter spec.   |          |
|                        |       | 6   | Added Additive Phase Jitter Plot.   |          |
| F                      | T4D   | 5   | LVPECL DC Characteristics Table - corrected $V_{OH}$ max. from $V_{CCO} - 1.0V$ to $V_{CCO} - 0.9V$ .   | 4/11/07  |
|                        |       | 12 - 13   | Power Considerations - corrected power dissipation to reflect $V_{OH}$ max in Table 4D.   |          |
| F                      |       | 1   | Removed ICS from the part number where needed.  | 1/19/16  |
|                        |       | 1   | General Description - Removed ICS Chip and Hiperlocks.  |          |
|                        |       | 1   | Features section - removed reference to leaded part.  |          |
|                        | T9    | 16  | Ordering Information - removed quantity from tape and reel. Deleted LF note below the table.<br>Updated header and footer.  |          |



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