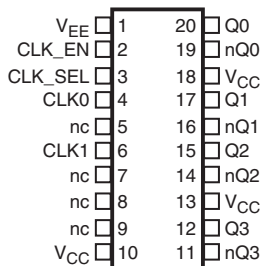


## General Description

The ICS8535-01 is a low skew, high performance 1-to-4 LVCMOS/LVTTL-to-3.3V LVPECL fanout buffer. The ICS8535-01 has two single ended clock inputs. the single ended clock input accepts LVCMOS or LVTTL input levels and translate them to 3.3V LVPECL levels. The clock enable is internally synchronized to eliminate runt clock pulses on the output during asynchronous assertion/deassertion of the clock enable pin.

Guaranteed output and part-to-part skew characteristics make the ICS8535-01 ideal for those applications demanding well defined performance and repeatability.

## Pin Assignment



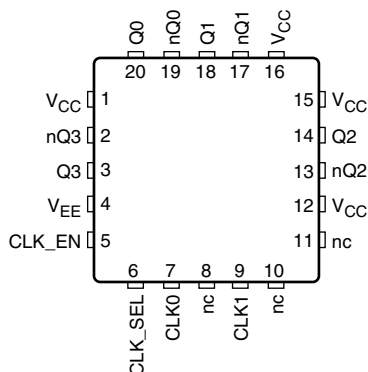
ICS8535-01

20-Lead TSSOP

4.4mm x 6.5mm x 0.92 body package

G Package

Top View



ICS8535-01

20-Lead VFQFN

4mm x 4mm x 0.9 body package

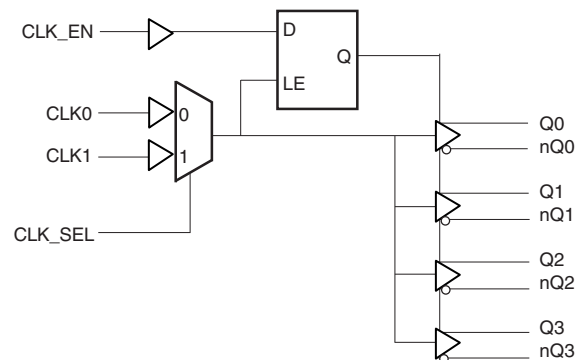
K Package

Top View

## Features

- Four differential 3.3V LVPECL outputs
- Selectable CLK0 or CLK1 inputs for redundant and multiple frequency fanout applications
- CLK0 or CLK1 can accept the following input levels: LVCMOS or LVTTL
- Maximum output frequency: 266MHz
- Translates LVCMOS and LVTTL levels to 3.3V LVPECL levels
- Output skew: 30ps (maximum)
- Part-to-part skew: 250ps (maximum)
- Propagation delay: 1.9ns (maximum)
- Additive phase jitter, RMS: < 0.09ps (typical)
- 3.3V operating supply
- 0°C to 70°C ambient operating temperature
- Lead-free (RoHS 6) packaging

## Block Diagram



## Pin Descriptions and Characteristics

**Table 1. Pin Descriptions<sup>1</sup>**

| Name            | Type   |          | Description  |
|-----------------|--------|----------|--|
| V <sub>EE</sub> | Power  |          | Negative supply pin.   |
| 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. LVCMOS / LVTTTL interface levels. |
| CLK_SEL         | Input  | Pulldown | Clock select input. When HIGH, selects CLK1 input. When LOW, selects CLK0 input. LVCMOS / LVTTTL interface levels.   |
| CLK0            | Input  | Pulldown | LVCMOS / LVTTTL clock input.   |
| CLK1            | Input  | Pulldown | LVCMOS / LVTTTL clock input.   |
| nc              | Unused |          | No connect   |
| V <sub>CC</sub> | Power  |          | Positive supply pins   |
| nQ3, Q3         | Output |          | Differential output pair. LVPECL interface levels.   |
| nQ2, Q2         | Output |          | Differential output pair. LVPECL interface levels.   |
| nQ1, Q1         | Output |          | Differential output pair. LVPECL interface levels.   |
| nQ0, Q0         | Output |          | Differential output pair. LVPECL interface levels.   |

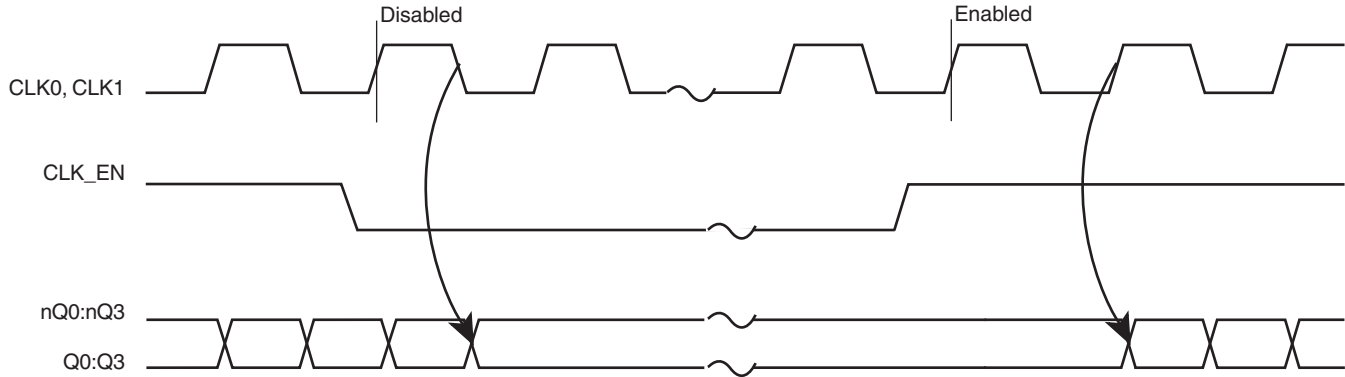
NOTE 1: *Pullup* and *Pulldown* refers to internal input resistors. See [Table 2, Pin Characteristics](#), for typical values.

**Table 2. Pin Characteristics**

| Symbol                | Parameter               | Test Conditions | Minimum | Typical | Maximum | Units |
|-----------------------|-------------------------|-----------------|---------|---------|---------|-------|
| C <sub>IN</sub>       | Input Capacitance       |                 |         | 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 Source | Q0:Q3         | nQ0:nQ3        |
| 0      | 0       | CLK0            | Disabled; LOW | Disabled; HIGH |
| 0      | 1       | CLK1            | Disabled; LOW | Disabled; HIGH |
| 1      | 0       | CLK0            | Enabled       | Enabled        |
| 1      | 1       | CLK1            | Enabled       | Enabled        |



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

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

| Inputs       | Outputs |         |
|--------------|---------|---------|
| CLK0 or CLK1 | Q0:Q3   | nQ0:nQ3 |
| 0            | LOW     | HIGH    |
| 1            | HIGH    | LOW     |

## 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 Electrical 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                                 |
| Inputs, $V_I$  | -0.5V to $V_{CC} + 0.5V$             |
| Outputs, $I_O$<br>Continuous Current<br>Surge Current                      | 50mA<br>100mA                        |
| Package Thermal Impedance, $\theta_{JA}$<br>20-Lead TSSOP<br>20-Lead VFQFN | 73.2°C/W (0 lfps)<br>60.4°C/W (0mps) |
| Storage Temperature, $T_{STG}$   | -65°C to 150°C                       |

## DC Electrical Characteristics

**Table 4A. Power Supply DC Characteristics,  $V_{CC} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  to  $70^\circ C$**

| Symbol   | Parameter               | Test Conditions | Minimum | Typical | Maximum | Units |
|----------|-------------------------|-----------------|---------|---------|---------|-------|
| $V_{CC}$ | Positive Supply Voltage |                 | 3.135   | 3.3     | 3.465   | V     |
| $I_{EE}$ | Power Supply Current    |                 |         |         | 50      | mA    |

**Table 4B. LVCMOS/LVTTL DC Characteristics,  $V_{CC} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  to  $70^\circ C$**

| Symbol   | Parameter          | Test Conditions     | Minimum                        | Typical | Maximum        | Units   |
|----------|--------------------|---------------------|--------------------------------|---------|----------------|---------|
| $V_{IH}$ | Input High Voltage | CLK0, CLK1          | 2                              |         | $V_{CC} + 0.3$ | V       |
|          |                    | CLK_EN, CLK_SEL     | 2                              |         | $V_{CC} + 0.3$ | v       |
| $V_{IL}$ | Input Low Voltage  | CLK0, CLK1          | -0.3                           |         | 1.3            | V       |
|          |                    | CLK_EN, CLK_SEL     | -0.3                           |         | 0.8            | V       |
| $I_{IH}$ | Input High Current | CLK0, CLK1, CLK_SEL | $V_{IN} = V_{CC} = 3.465V$     |         | 150            | $\mu A$ |
|          |                    | CLK_EN              | $V_{IN} = V_{CC} = 3.465V$     |         | 5              | $\mu A$ |
| $I_{IL}$ | Input Low Current  | CLK0, CLK1, CLK_SEL | $V_{IN} = 0V, V_{CC} = 3.465V$ | -5      |                | $\mu A$ |
|          |                    | CLK_EN              | $V_{IN} = 0V, V_{CC} = 3.465V$ | -150    |                | $\mu A$ |

**Table 4C. LVPECL DC Characteristics,  $V_{CC} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  to  $70^\circ C$**

| Symbol      | Parameter                        | Test Conditions | Minimum        | Typical | Maximum        | Units |
|-------------|----------------------------------|-----------------|----------------|---------|----------------|-------|
| $V_{OH}$    | Output High Voltage <sup>1</sup> |                 | $V_{CC} - 1.4$ |         | $V_{CC} - 0.9$ | V     |
| $V_{OL}$    | Output Low Voltage <sup>1</sup>  |                 | $V_{CC} - 2.0$ |         | $V_{CC} - 1.7$ | V     |
| $V_{SWING}$ | Output Voltage Swing             |                 | 0.6            |         | 1.0            | V     |

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

## AC Characteristics

**Table 5. AC Characteristics,  $V_{CC} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  to  $70^\circ C$ <sup>1</sup>**

| Symbol      | Parameter  | Test Conditions    | Minimum | Typical | Maximum | Units |
|-------------|--|--------------------|---------|---------|---------|-------|
| $f_{MAX}$   | Output Frequency   |                    |         |         | 266     | MHz   |
| $t_{PD}$    | Propagation Delay <sup>2</sup>   | $f \leq 266MHz$    | 1.0     |         | 1.9     | ns    |
| $tsk(o)$    | Output Skew <sup>3, 4</sup>  |                    |         | 11      | 30      | ps    |
| $tsk(pp)$   | Part-to-Part Skew <sup>4, 5</sup>  |                    |         |         | 250     | ps    |
| $f_{jit}$   | Buffer Additive Phase Jitter, RMS; refer to Additive Phase Jitter section <sup>6</sup> |                    |         | 0.09    |         | ps    |
| $t_R / t_F$ | Output Rise/Fall Time  | 20% to 80% @ 50MHz | 300     |         | 700     | ps    |
| odc         | Output Duty Cycle  |                    | 48      | 50      | 52      | %     |

NOTE 1: All parameters measured at 266MHz unless noted otherwise. The cycle-to-cycle jitter on the input will equal the jitter on the output. The part does not add jitter.

NOTE 2: Measured from the  $V_{CC} / 2$  of the input to the differential output crosspoint.

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

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

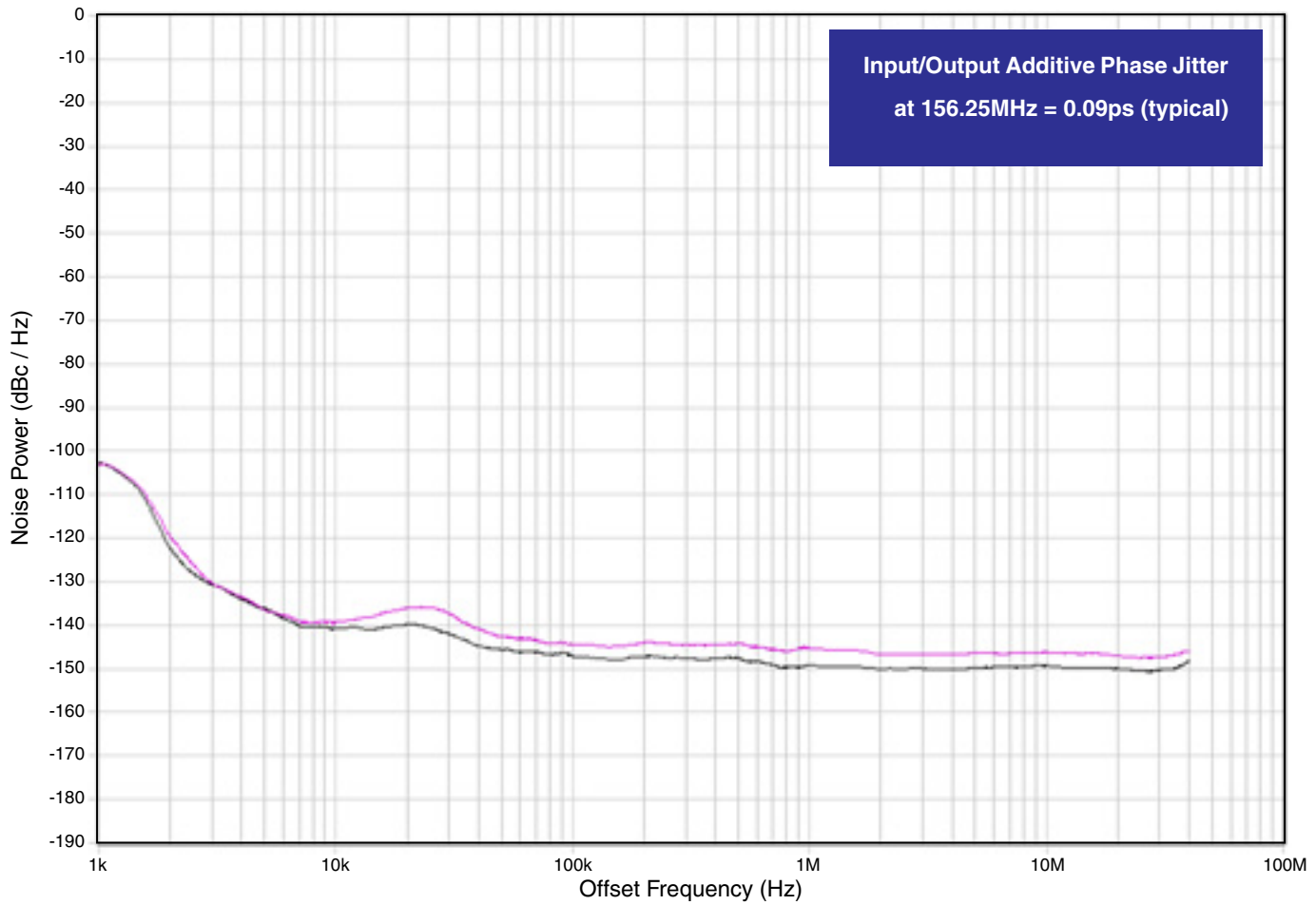
NOTE 5: Defined as skew between outputs on different devices operating at the same supply voltages and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at the differential crosspoints.

NOTE 6: Driving only one input clock.

## 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

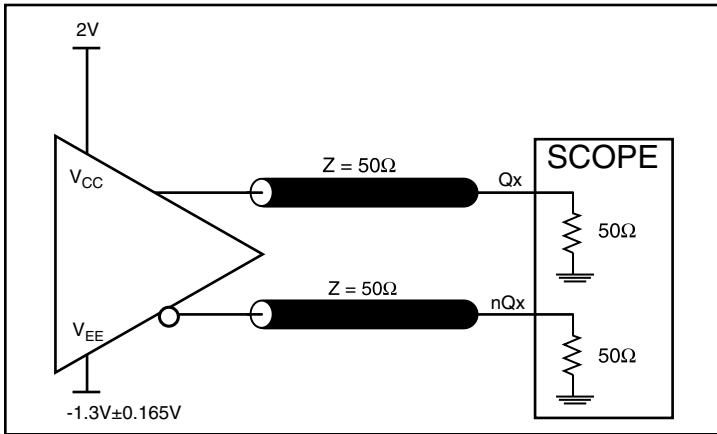
of the power in the 1Hz band to the power in the fundamental. When the required offset is specified, the phase noise is called a **dBc** value, which simply means dBm at a specified offset from the fundamental. By investigating jitter in the frequency domain, we get a better understanding of its effects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



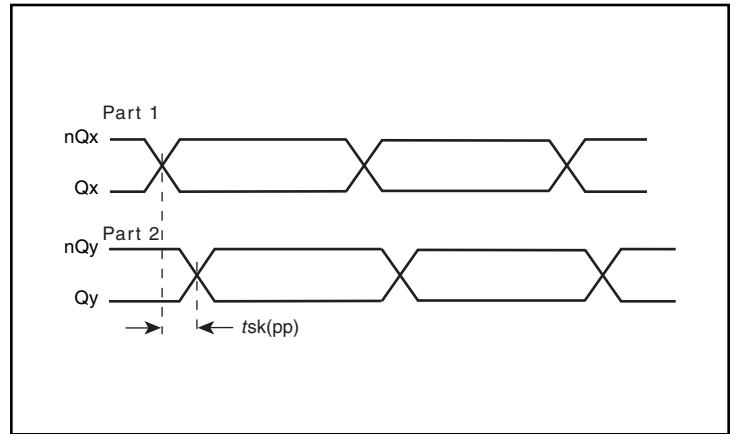
As with most timing specifications, phase noise measurements have issues. The primary issue relates to the limitations of the equipment. Often the noise floor of the equipment is higher than the noise floor

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 dependent on the input source and measurement equipment.

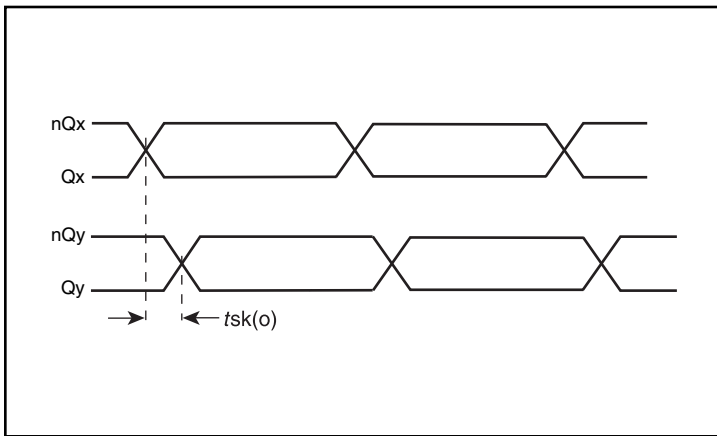
## Parameter Measurement Information



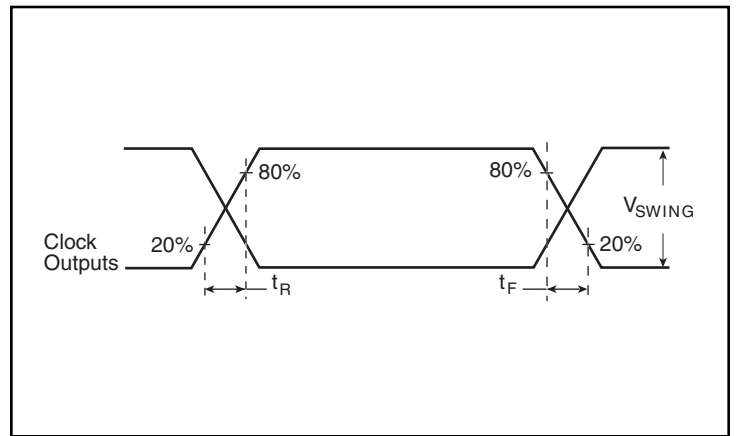
3.3V Output Load Test Circuit



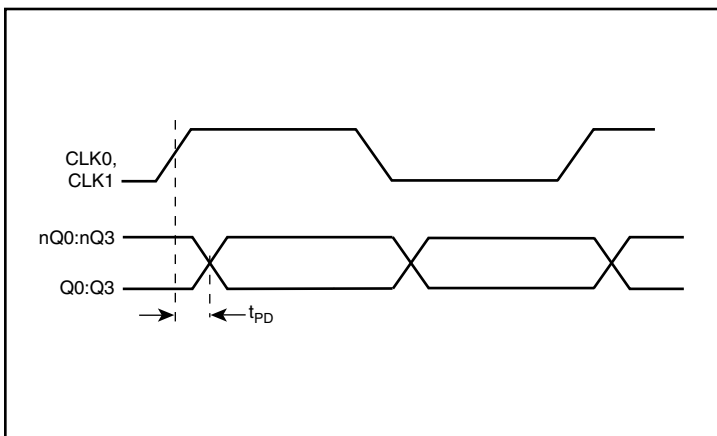
Part-to-Part Skew



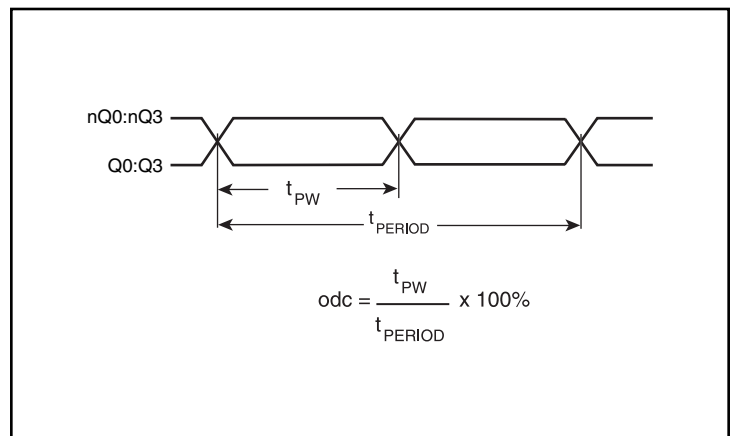
Output Skew



Output Rise/Fall Time



Propagation Delay



Output Duty Cycle/Pulse Width/Period

## Applications Information

### Recommendations for Unused Input Pins

#### Inputs:

##### CLK Input

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

##### LVC MOS Control Pins

All control pins have internal pullups; additional resistance is not required but can be added for additional protection. A 1kΩ 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 output is a low impedance follower output 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 50Ω

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

Figure 2A and Figure 2B 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.

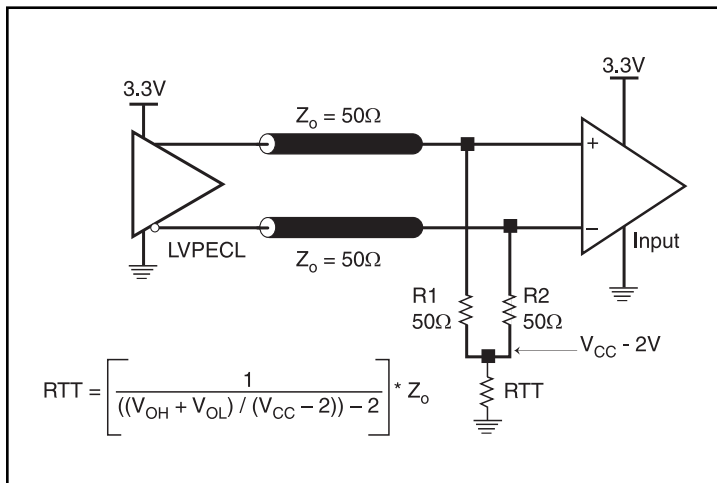


Figure 2A. 3.3V LVPECL Output Termination

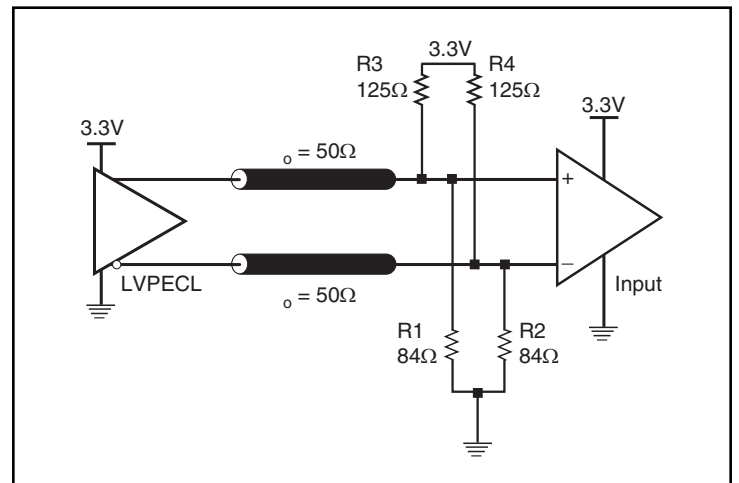


Figure 2B. 3.3V LVPECL Output Termination



## Schematic Example

Figure 3 shows a schematic example of the ICS8535-01. In this example, the CLK0 input is selected. The decoupling capacitors

should be physically located near the power pin. For ICS8535-01, the unused clock outputs can be left floating

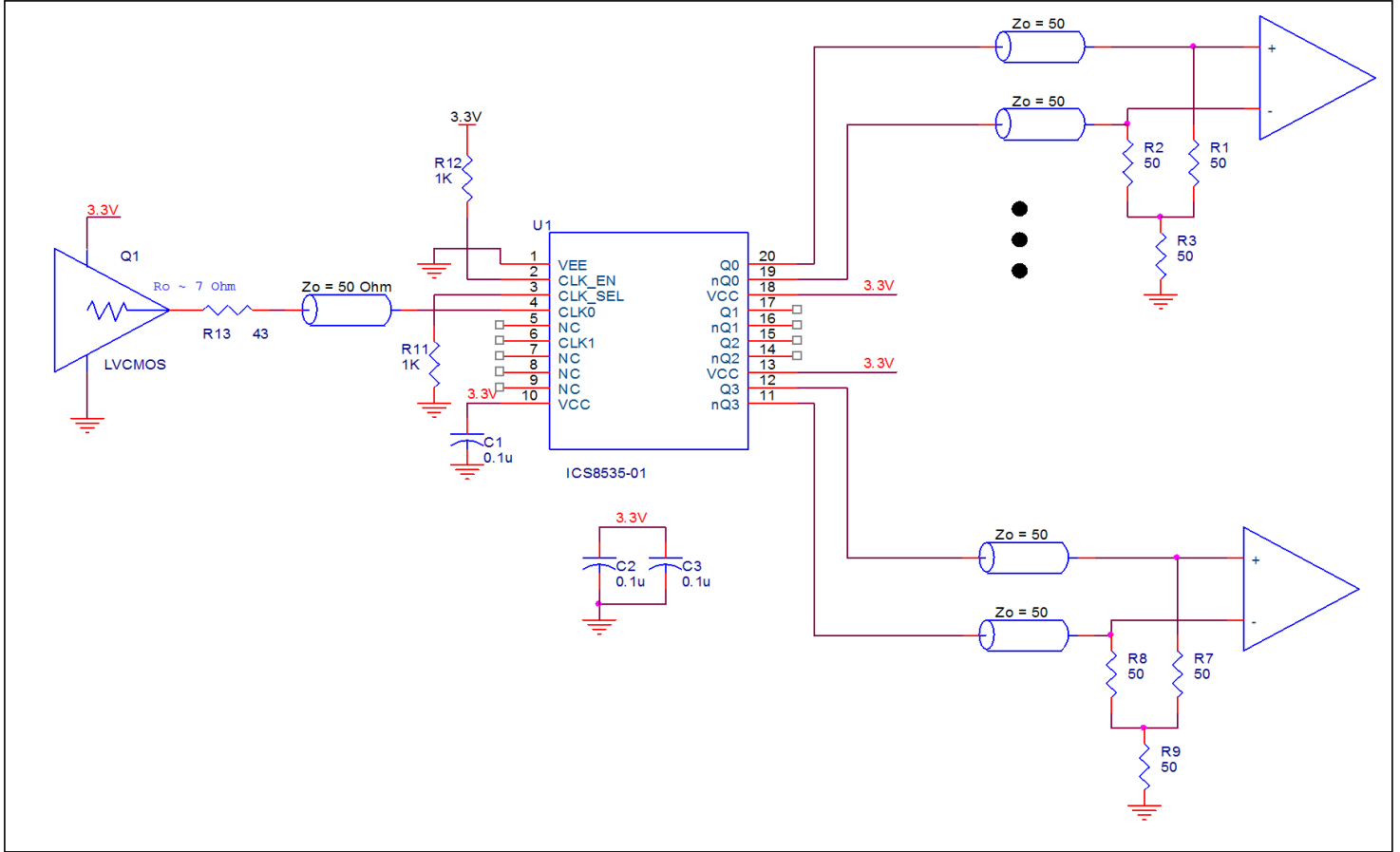


Figure 3. ICS8535-01 Schematic Example

## Power Considerations

This section provides information on power dissipation and junction temperature for the ICS8535-01. Equations and example calculations are also provided.

### 1. Power Dissipation.

The total power dissipation for the ICS8535-01 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> =  $V_{CC\_MAX} * I_{EE\_MAX} = 3.465V * 50mA = 173.25mW$
- Power (outputs)<sub>MAX</sub> = **30mW/Loaded Output pair**  
If all outputs are loaded, the total power is  $4 * 30mW = 120mW$

**Total Power**<sub>MAX</sub> (3.465V, with all outputs switching) =  $173.25mW + 120mW = 293.25mW$

### 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.

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 66.6°C/W per [Table 6A](#) below.

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

$$70^\circ C + 0.293W * 66.6^\circ C/W = 89.5^\circ C. \text{ This is below the limit of } 125^\circ C.$$

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 (single layer or multi-layer).

**Table 6A. Thermal Resistance  $\theta_{JA}$  for 20-Lead TSSOP, Forced Convection**

| $\theta_{JA}$ by Velocity                    |           |          |          |
|--|-----------|----------|----------|
| Linear Feet per Minute                       | 0         | 200      | 500      |
| Single-Layer PCB, JEDEC Standard Test Boards | 114.5°C/W | 98.0°C/W | 88.0°C/W |
| Multi-Layer PCB, JEDEC Standard Test Boards  | 73.2°C/W  | 66.6°C/W | 63.5°C/W |

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

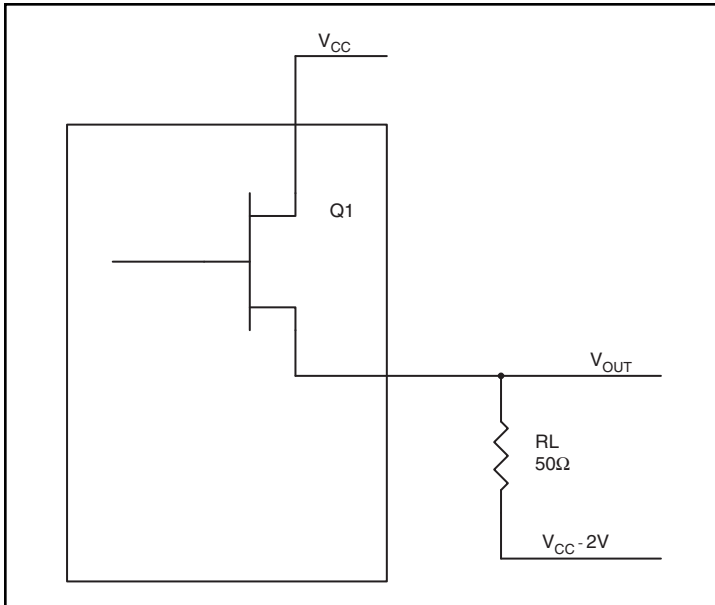
**Table 6B.  $\theta_{JA}$  vs. Air Flow Table for 20-Lead VFQFN**

| $\theta_{JA}$ by Velocity                   |          |          |          |
|---|----------|----------|----------|
| Meters per Second                           | 0        | 1        | 3        |
| Multi-Layer PCB, JEDEC Standard Test Boards | 60.4°C/W | 52.8°C/W | 46.0°C/W |

### 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 4*.



**Figure 4. 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  $V_{CC} - 2V$ .

- For logic high,  $V_{OUT} = V_{OH\_MAX} = V_{CC\_MAX} - 0.9V$   
 $(V_{CC\_MAX} - V_{OH\_MAX}) = 0.9V$
- For logic low,  $V_{OUT} = V_{OL\_MAX} = V_{CC\_MAX} - 1.7V$   
 $(V_{CC\_MAX} - V_{OL\_MAX}) = 1.7V$

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

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

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

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

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

## Reliability Information

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

| $\theta_{JA}$ by Velocity                    |           |          |          |
|--|-----------|----------|----------|
| Linear Feet per Minute                       | 0         | 200      | 500      |
| Single-Layer PCB, JEDEC Standard Test Boards | 114.5°C/W | 98.0°C/W | 88.0°C/W |
| Multi-Layer PCB, JEDEC Standard Test Boards  | 73.2°C/W  | 66.6°C/W | 63.5°C/W |

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

**Table 7B.  $\theta_{JA}$  vs. Air Flow Table for 20-Lead VFQFN**

| $\theta_{JA}$ by Velocity                   |          |          |          |
|---|----------|----------|----------|
| Meters per Second                           | 0        | 1        | 3        |
| Multi-Layer PCB, JEDEC Standard Test Boards | 60.4°C/W | 52.8°C/W | 46.0°C/W |

## Transistor Count

The transistor count for the IS8535-01 is 412.

# Package Outline and Package Dimensions

## Package Outline - G Suffix for 20-Lead TSSOP

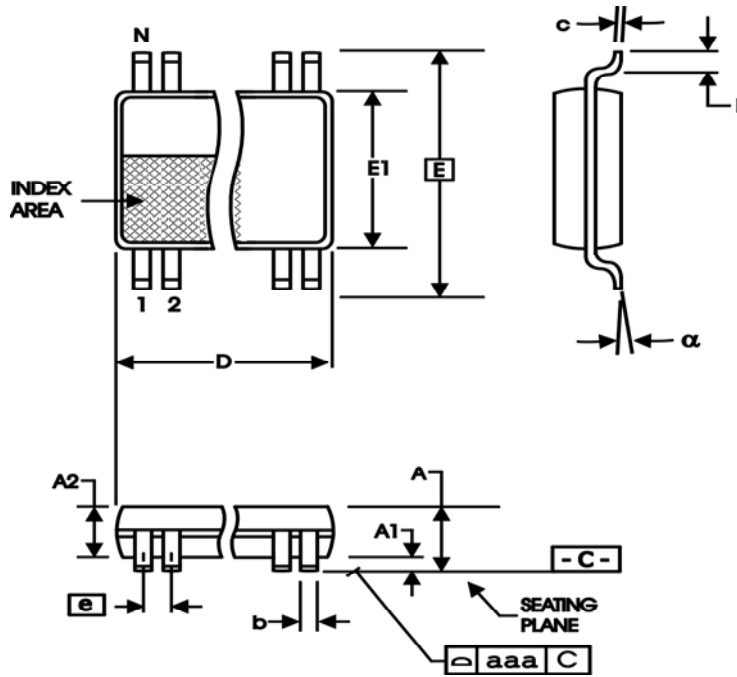


Table 8A. Package Dimensions for TSSOP

| Symbol   | Millimeters |         |
|----------|-------------|---------|
|          | 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

Package Outline and Package Dimensions (continued)

Package Outline - K Suffix for 20-Lead VFQFN

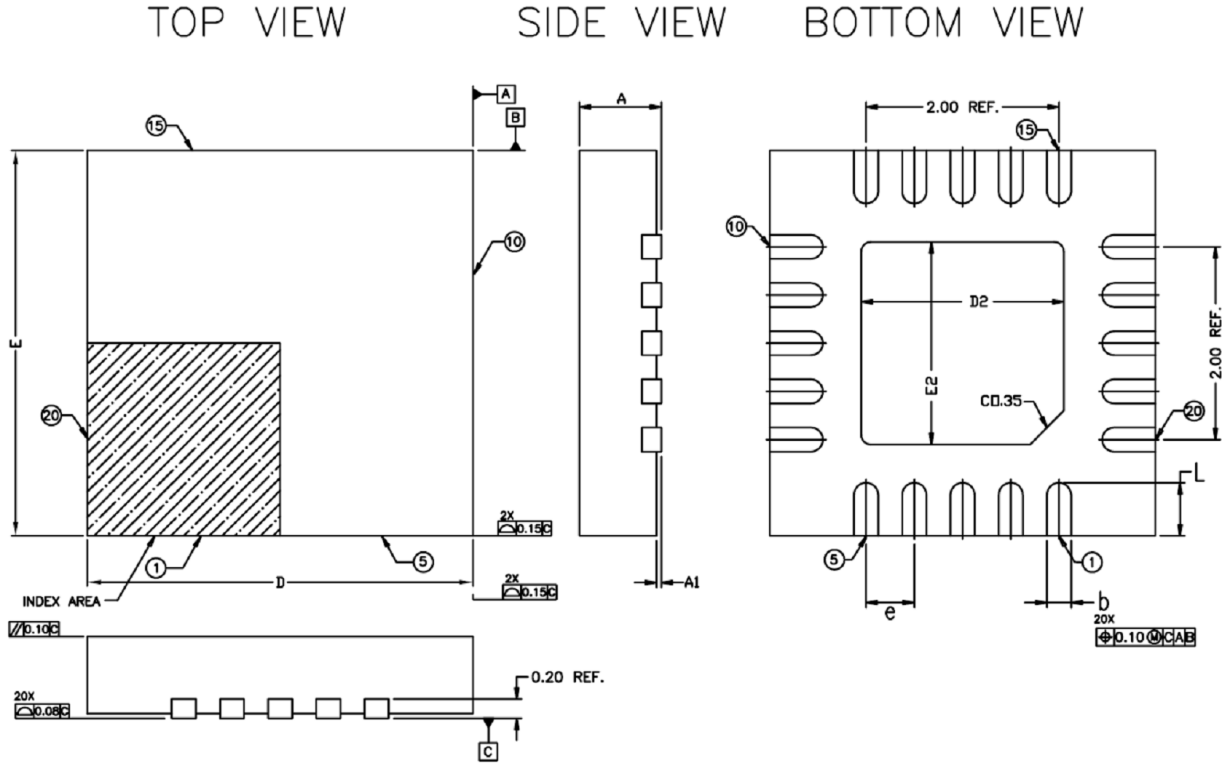


Table 9. Package Dimensions for 20-Lead VFQFN

| JEDEC Variation:<br>All Dimensions in Millimeters |          |      |         |
|---|----------|------|---------|
| Symbol  | Minimum  | Nom  | Maximum |
| b   | 0.20     | 0.25 | 0.30    |
| D   | 3.90     | 4.00 | 4.10    |
| E   | 3.90     | 4.00 | 4.10    |
| D2  | 1.95     | 2.10 | 2.25    |
| E2  | 1.95     | 2.10 | 2.25    |
| L   | 0.45     | 0.55 | 0.65    |
| e   | 0.50 BSC |      |         |
| N   | 20       |      |         |
| A   | 0.80     | 0.90 | 1.00    |
| A1  | 0.00     | 0.02 | 0.05    |
| A3  | 0.2 REF  |      |         |

Reference Document: JEDEC Publication 95, MO-220

NOTE:

The drawing and dimension data originate from IDT package outline drawing PSC-4170, rev03.

1. Dimensions and tolerances conform to ASME Y14.5M-1994
2. All dimensions are in millimeters. All angles are in degrees.
3. N is the total number of terminals.
4. All specifications comply with JEDEC MO-220.

## Ordering Information

Table 10. Ordering Information

| Part/Order Number | Marking      | Package                   | Shipping Packaging | Temperature |
|-------------------|--------------|---------------------------|--------------------|-------------|
| 8535AG-01LF       | ICS8535A01LF | "Lead-Free" 20-Lead TSSOP | Tube               | 0°C to 70°C |
| 8535AG-01LFT      | ICS8535A01LF | "Lead-Free" 20-Lead TSSOP | Tape & Reel        | 0°C to 70°C |
| 8535AK-01LF       | 35A01L       | "Lead-Free" 20-Lead VFQFN | Tube               | 0°C to 70°C |
| 8535AK-01LFT      | 35A01L       | "Lead-Free" 20-Lead VFQFN | Tape & Reel        | 0°C to 70°C |

## Revision History Sheet

| Rev | Table            | Page                       | Description of Change  | Date     |
|-----|------------------|----------------------------|--|----------|
| B   |                  | 3                          | Updated Figure 1 - CLK_EN Timing Diagram.  | 10/16/01 |
| B   |                  | 3                          | Updated Figure 1 - CLK_EN Timing Diagram.  | 10/29/01 |
| B   |                  | 8                          | Added Termination for LVPECL Outputs section.  | 5/29/02  |
| B   |                  | 6                          | Output Load Test Circuit - corrected $V_{EE}$ equation to read " $V_{EE} = -0.5V \pm 0.165V$ " from " $V_{EE} = -0.5V \pm 0.135V$ ".   | 10/4/02  |
| C   | T5               | 5                          | AC Characteristics table - changed tsk(pp) from 150ps max. to 250ps. max. Update format.   | 12/13/02 |
| D   |                  | 8<br>4<br>4                | Added Schematic layout in the Application Section.<br>LVCMOS Table - changed $V_{IH}$ 3.765V Max. to $V_{CC} + 0.3V$ Max.<br>LVPECL Table - changed $V_{SWING}$ 0.85V Max. to 1.0V Max.  | 1/20/03  |
| D   |                  | 8                          | Schematic Example, changed sentence to read "In this example, the XTAL input is selected." to "..., The CLK1 input is selected."<br>Corrected schematic example.   | 4/1/03   |
| E   | T2<br>T5         | 1<br>2<br>4<br>5<br>6<br>8 | Added RMS Jitter to Features section.<br>Pin Characteristics Table - changed $C_{IN}$ from 4pF max. to 4pF typical.<br>Revised Absolute Maximum Ratings Output.<br>AC Characteristics Table - added RMS Jitter.<br>Added Additive Phase Jitter Section.<br>Revised LVPECL Output Termination diagrams. | 9/19/03  |
| E   |                  | 14                         | Added "Lead-Free" Part/Order Number rows.  | 11/13/03 |
| E   |                  | 14                         | Corrected "Lead-Free" marking and order/part numbers.  | 12/4/03  |
| E   | T5               | 1<br>5                     | Added Lead-Free bullet in the Features section.<br>AC Characteristics table - added Note 5.  | 6/17/04  |
| E   | T9               | 14                         | Corrected Lead-Free marking in Ordering Information Table.   | 9/17/04  |
| E   | T7B<br>T8B<br>T9 | 1<br>12<br>14<br>15        | Pin Assignment - added 20-Lead VFQFN package information.<br>Added 20-Lead VFQFN Reliability Information.<br>Added 20-Lead VFQFN Package Outline and Dimensions.<br>Ordering Information Table - added 20-Lead VFQFN ordering information.   | 10/7/04  |
| E   | T9               | 15                         | Ordering Information Table - added "Lead-Free/Annealed" part number.   | 10/11/04 |
| E   |                  | 1                          | Pin Assignment - corrected letter package for 20-Lead VFQFN from "G Package" to "K Package".   | 12/8/04  |
| E   | T9               | 15                         | Ordering Information Table - corrected marking on TSSOP Lead-Free package and added Lead-Free note.  | 5/24/05  |
| E   | T9               | 8<br>15                    | Added Recommendations for Unused Input and Output Pins.<br>Ordering Information Table - corrected 20-Lead VFQFN marking and added Lead-Free 20-Lead VFQFN part number.   | 9/16/05  |
| E   | T9               | 15                         | Ordering Information Table - corrected 20-Lead VFQFN Shipping Packaging.   | 3/21/06  |
| E   | T6B<br>T7B       | 4<br>10<br>12              | Absolute Maximum Ratings - corrected 20-Lead VFQFN Package Thermal Impedance.<br>Corrected 20-Lead VFQFN Theta JA.<br>Corrected 20-Lead VFQFN Theta JA.  | 10/02/06 |



| Rev | Table | Page         | Description of Change   | Date    |
|-----|-------|--------------|---|---------|
| F   | T4C   | 4<br>10 - 11 | LVPECL DC Characteristics Table -corrected $V_{OH}$ max. from $V_{CC} - 1.0V$ to $V_{CC} - 0.9V$ .<br>Power Considerations - corrected power dissipation to reflect $V_{OH}$ max in Table 4C. | 4/12/07 |
| F   |       | 1            | NRND - Not Recommended For New Designs  | 5/20/13 |
| F   |       | 1            | Removed NRND marking from datasheet   | 5/28/13 |
| F   | T8B   | 14<br>14     | Updated datasheet format.<br>Updated Package Outline<br>Updated package dimensions to reflect tighter tolerances.   | 8/7/14  |



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