

GENERAL DESCRIPTION

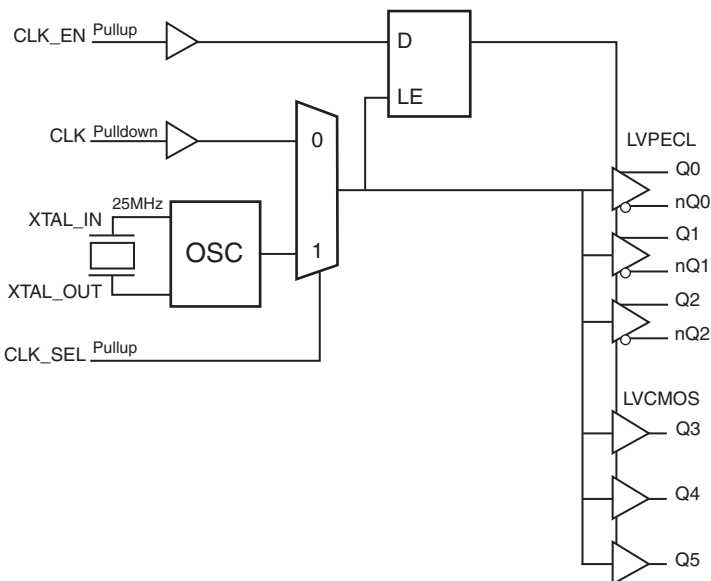
The 8536I-33 is a low skew, high performance 1-to-6 Crystal Oscillator/LVCMOS-to-3.3V, 2.5V LVPECL/LVCMOS fanout buffer. The 8536I-33 has selectable single ended clock or crystal inputs. The single-ended clock input accepts LVCMOS or LVTTTL input levels and translate them to 3.3V LVPECL levels. The output 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 8536I-33 ideal for those applications demanding well defined performance and repeatability.

FEATURES

- Three differential LVPECL outputs, and three single ended LVCMOS outputs
- Selectable LVCMOS/LVTTTL CLK or crystal inputs
- CLK can accept the following input levels: LVCMOS, LVTTTL
- Crystal frequency: 25MHz
- Maximum output frequency: 266MHz
- Output skew: 80ps (maximum)
- Part-to-part skew: 800ps (maximum)
- Propagation delay: 1.95ns (maximum)
- Additive phase jitter, RMS: 0.32ps (typical), LVPECL output
- Full 3.3V or 2.5V operating supply
- -40°C to 85°C ambient operating temperature
- Available in lead-free (RoHS 6) package

BLOCK DIAGRAM



PIN ASSIGNMENT

| | | | |
|-------------|----|----|-------------|
| CLK_EN | 1 | 20 | VEE |
| XTAL_IN | 2 | 19 | Q5 |
| XTAL_OUT | 3 | 18 | Q4 |
| Vcc | 4 | 17 | VCCO_LVCMOS |
| CLK | 5 | 16 | Q3 |
| CLK_SEL | 6 | 15 | VEE |
| VEE | 7 | 14 | Q2 |
| Q0 | 8 | 13 | nQ2 |
| nQ0 | 9 | 12 | nQ1 |
| VCCO_LVPECL | 10 | 11 | Q1 |

8536I-33
20-Lead TSSOP
 6.5mm x 4.4mm x 0.925mm package body
G Package
 Top View

TABLE 1. PIN DESCRIPTIONS

| Number | Name | Type | | Description |
|------------|-------------------------|--------|----------|--|
| 1 | CLK_EN | Input | Pullup | Synchronizing clock enable. When HIGH, clock outputs follows clock input. When LOW, Q outputs are forced low, nQ0 output is forced high. LVCMOS / LVTTTL interface levels. |
| 2, 3 | XTAL_IN, XTAL_OUT | Input | | Crystal oscillator interface. XTAL_IN is the input. XTAL_OUT is the output. |
| 4 | V _{CC} | Power | | Positive supply pins. |
| 5 | CLK | Input | Pulldown | Single-ended clock input. LVCMOS / LVTTTL interface levels. |
| 6 | CLK_SEL | Input | Pullup | Clock select input. When HIGH, selects XTAL inputs. When LOW, selects CLK input. LVCMOS / LVTTTL interface levels. |
| 7, 15, 20 | V _{EE} | Power | | Negative supply pin. |
| 8, 9 | Q0, nQ0 | Output | | Differential clock outputs. LVPECL interface levels. |
| 10 | V _{CCO_LVPECL} | Power | | Output power supply mode for LVPECL clock outputs. |
| 11, 12 | Q1, nQ1 | Output | | Differential clock outputs. LVPECL interface levels. |
| 13, 14 | nQ2, Q2 | Output | | Differential clock outputs. LVPECL interface levels. |
| 16, 18, 19 | Q3, Q4, Q5 | Output | | Single ended clock outputs. LVCMOS / LVTTTL interface levels. |
| 17 | V _{CCO_LVCMOS} | Power | | Output power supply mode for LVCMOS / LVTTTL clock outputs. |

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 _{IN} | Input Capacitance | | | 4 | | pF |
| C _{PD} | Power Dissipation Capacitance (per output) | Q3:Q5 | V _{CC} , V _{CCO_LVCMOS} = 3.465V | 8 | | pF |
| | | | V _{CC} , V _{CCO_LVCMOS} = 2.625V | 5 | | pF |
| R _{PULLUP} | Input Pullup Resistor | | | 51 | | kΩ |
| R _{PULLDOWN} | Input Pulldown Resistor | | | 51 | | kΩ |
| R _{OUT} | Output Impedance | Q3:Q5 | V _{CC} , V _{CCO_LVCMOS} = 3.465V | 15 | | Ω |
| | | Q3:Q5 | V _{CC} , V _{CCO_LVCMOS} = 2.625V | 20 | | Ω |

TABLE 3A. CONTROL INPUT FUNCTION TABLE

| Inputs | | | Outputs | | |
|--------|---------|-------------------|---------------|----------------|---------------|
| CLK_EN | CLK_SEL | Selected Source | Q0:Q2 | nQ0:nQ2 | Q3:Q5 |
| 0 | 0 | CLK | Disabled; LOW | Disabled; HIGH | Disabled; LOW |
| 0 | 1 | XTAL_IN, XTAL_OUT | Disabled; LOW | Disabled; HIGH | Disabled; LOW |
| 1 | 0 | CLK | Enabled | Enabled | Enabled |
| 1 | 1 | XTAL_IN, XTAL_OUT | Enabled | Enabled | Enabled |

After CLK_EN switches, the clock outputs are disabled or enabled following a rising and falling input clock or crystal oscillator edge as shown in Figure 1.

In the active mode, the state of the outputs are a function of the CLK input as described in Table 3B.

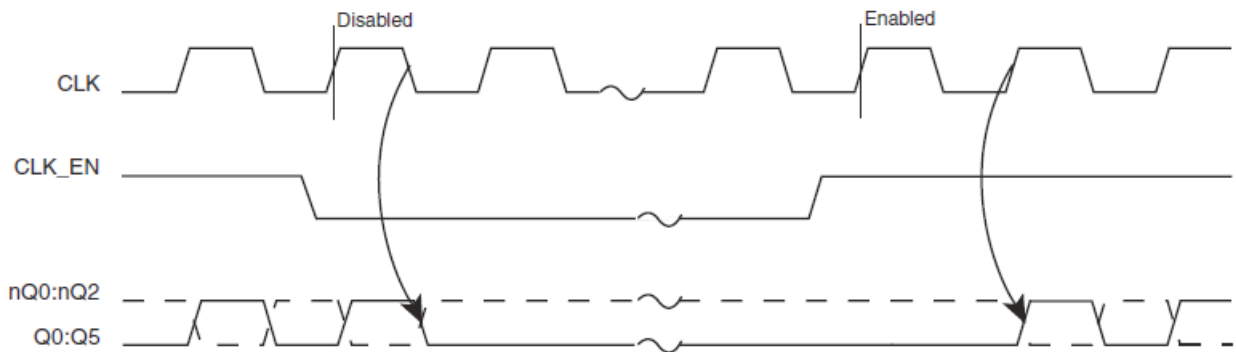


FIGURE 1. CLK_EN TIMING DIAGRAM

TABLE 3B. CLOCK INPUT FUNCTION TABLE

| Inputs | Outputs | | |
|--------|---------|---------|-------|
| | Q0:Q2 | nQ0:nQ2 | Q3:Q5 |
| 0 | LOW | HIGH | LOW |
| 1 | HIGH | LOW | HIGH |

ABSOLUTE MAXIMUM RATINGS

| | |
|--|----------------------------------|
| Supply Voltage, V_{CC} | 4.6V |
| Inputs, V_i (LVCMOS) | -0.5V to $V_{CC} + 0.5V$ |
| Outputs, V_o (LVCMOS) | -0.5V to $V_{CC_LVCMOS} + 0.5V$ |
| Inputs, V_i (LVPECL) | -0.5V to $V_{CC} + 0.5V$ |
| Outputs, I_o (LVPECL) | |
| Continuous Current | 50mA |
| Surge Current | 100mA |
| Package Thermal Impedance, θ_{JA} | 91.1°C/W (0 mps) |
| 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, $V_{CC} = V_{CC_LVPECL} = V_{CC_LVCMOS} = 3.3V \pm 5\%$, $V_{EE} = 0V$, $T_A = -40^\circ C$ TO $85^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|--------------------------------------|----------------------|-----------------|---------|---------|---------|-------|
| V_{CC} | Power Supply Voltage | | 3.135 | 3.3 | 3.465 | V |
| V_{CC_LVPECL} V_{CC_LVCMOS} | Power Supply Voltage | | 3.135 | 3.3 | 3.465 | V |
| I_{EE} | Power Supply Current | | | | 80 | mA |
| I_{CC_LVPECL} | Power Supply Current | | | | 25 | mA |
| I_{CC_LVCMOS} | Power Supply Current | | | | 45 | mA |

TABLE 4B. POWER SUPPLY DC CHARACTERISTICS, $V_{CC} = V_{CC_LVPECL} = V_{CC_LVCMOS} = 2.5V \pm 5\%$, $V_{EE} = 0V$, $T_A = -40^\circ C$ TO $85^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|--------------------------------------|----------------------|-----------------|---------|---------|---------|-------|
| V_{CC} | Power Supply Voltage | | 2.375 | 2.5 | 2.625 | V |
| V_{CC_LVPECL} V_{CC_LVCMOS} | Power Supply Voltage | | 2.375 | 2.5 | 2.625 | V |
| I_{EE} | Power Supply Current | | | | 80 | mA |
| I_{CC_LVPECL} | Power Supply Current | | | | 30 | mA |
| I_{CC_LVCMOS} | Power Supply Current | | | | 45 | mA |

TABLE 4C. LVCMOS / LVTTTL DC CHARACTERISTICS, T_A = -40°C TO 85°C

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|------------------|-----------------------------|---|--|---------|-----------------------|-------|
| V _{IH} | Input High Voltage | V _{CC} = 3.3V | 2 | | V _{CC} + 0.3 | V |
| | | V _{CC} = 2.5V | 1.7 | | V _{CC} + 0.3 | V |
| V _{IL} | Input Low Voltage | V _{CC} = 3.3V | -0.3 | | 0.8 | V |
| | | V _{CC} = 2.5V | -0.3 | | 0.7 | V |
| V _{HYS} | Input Hysteresis | CLK_EN, CLK_SEL | 100 | | | mV |
| I _{IH} | Input High Current | CLK | V _{CC} = V _{IN} = 3.465V or 2.625V | | 150 | μA |
| | | CLK_EN, CLK_SEL | V _{CC} = V _{IN} = 3.465V or 2.625V | | 5 | μA |
| I _{IL} | Input Low Current | CLK | V _{CC} = 3.465V or 2.625V, V _{IN} = 0V | -5 | | μA |
| | | CLK_EN, CLK_SEL | V _{CC} = 3.465V or 2.625V, V _{IN} = 0V | -150 | | μA |
| V _{OH} | Output High Voltage; NOTE 1 | V _{CCO_LVCMOS} = 3.465V | 2.6 | | | V |
| | | V _{CCO_LVCMOS} = 2.625V | 1.8 | | | V |
| V _{OL} | Output Low Voltage; NOTE 1 | V _{CCO_LVCMOS} = 3.465 or 2.625V | | | 0.5 | V |

NOTE 1: Outputs terminated with 50Ω to V_{CCO_LVCMOS}/2. See Parameter Measurement Information Section. "LVCMOS Output Load Test circuit" diagrams.

TABLE 4D. LVPECL DC CHARACTERISTICS, V_{CC} = V_{CCO_LVPECL} = 3.3V±5%, V_{EE} = 0V, T_A = -40°C TO 85°C

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|--------------------|-----------------------------------|-----------------|-------------------------------|---------|-------------------------------|-------|
| V _{OH} | Output High Voltage; NOTE 1 | | V _{CCO_LVPECL} - 1.4 | | V _{CCO_LVPECL} - 0.9 | V |
| V _{OL} | Output Low Voltage; NOTE 1 | | V _{CCO_LVPECL} - 2.0 | | V _{CCO_LVPECL} - 1.7 | V |
| V _{SWING} | Peak-to-Peak Output Voltage Swing | | 0.6 | | 1.0 | V |

NOTE 1: Outputs terminated with 50Ω to V_{CCO_LVPECL} - 2V.

TABLE 4E. LVPECL DC CHARACTERISTICS, V_{CC} = V_{CCO_LVPECL} = 2.5V±5%, V_{EE} = 0V, T_A = -40°C TO 85°C

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|--------------------|-----------------------------------|-----------------|-------------------------------|---------|-------------------------------|-------|
| V _{OH} | Output High Voltage; NOTE 1 | | V _{CCO_LVPECL} - 1.4 | | V _{CCO_LVPECL} - 0.9 | V |
| V _{OL} | Output Low Voltage; NOTE 1 | | V _{CCO_LVPECL} - 2.0 | | V _{CCO_LVPECL} - 1.5 | V |
| V _{SWING} | Peak-to-Peak Output Voltage Swing | | 0.4 | | 1.0 | V |

NOTE 1: Outputs terminated with 50Ω to V_{CCO_LVPECL} - 2V.

TABLE 5. CRYSTAL CHARACTERISTICS

| Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|------------------------------------|-----------------|-------------|---------|---------|-------|
| Mode of Oscillation | | Fundamental | | | |
| Frequency | | 12 | | 40 | MHz |
| Equivalent Series Resistance (ESR) | | | | 50 | Ω |
| Shunt Capacitance | | | | 7 | pF |
| Drive Level | | | | 1 | mW |

TABLE 6A. LVPECL AC CHARACTERISTICS, $V_{CC} = V_{CCO_LVPECL} = 3.3V \pm 5\%$, $V_{EE} = 0V$, $T_A = -40^\circ C$ TO $85^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-------------|---|---|---------|---------|---------|-------|
| f_{MAX} | Output Frequency | | | | 266 | MHz |
| t_{PD} | Propagation Delay; NOTE 1 | | 1.2 | | 1.95 | ns |
| tjit | Buffer Additive Phase Jitter, RMS; refer to Additive Phase Jitter Section | 155.52MHz, (Integration Range: 12kHz - 20MHz) | | 0.35 | | ps |
| tsk(b) | Bank Skew; NOTE 2, 5 | | | | 55 | ps |
| tsk(o) | Output Skew; NOTE 3, 5 | | | | 80 | ps |
| tsk(pp) | Part-to-Part Skew; NOTE 4, 5 | | | | 800 | ps |
| t_R / t_F | Output Rise/Fall Time | 20% to 80% | 250 | | 600 | ps |
| odc | Output Duty Cycle | | 46 | | 54 | % |

All parameters measured at $f \leq 266MHz$ unless noted otherwise.

NOTE 1: Measured from the $V_{CC}/2$ of the input to the differential output crossing point.

NOTE 2: Defined as skew within a bank of outputs at the same voltage and with equal load conditions.

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

Measured at the LVPECL output differential cross points.

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

NOTE 5: This parameter is defined in accordance with JEDEC Standard 65.

TABLE 6B. LVPECL AC CHARACTERISTICS, $V_{CC} = V_{CCO_LVPECL} = 2.5V \pm 5\%$, $V_{EE} = 0V$, $T_A = -40^\circ C$ TO $85^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-------------|---|---|---------|---------|---------|-------|
| f_{MAX} | Output Frequency | | | | 266 | MHz |
| t_{PD} | Propagation Delay; NOTE 1 | | 1.3 | | 2 | ns |
| tjit | Buffer Additive Phase Jitter, RMS; refer to Additive Phase Jitter Section | 155.52MHz, (Integration Range: 12kHz - 20MHz) | | 0.32 | | ps |
| tsk(b) | Bank Skew; NOTE 2, 5 | | | | 65 | ps |
| tsk(o) | Output Skew; NOTE 3, 5 | | | | 80 | ps |
| tsk(pp) | Part-to-Part Skew; NOTE 4, 5 | | | | 425 | ps |
| t_R / t_F | Output Rise/Fall Time | 20% to 80% | 250 | | 800 | ps |
| odc | Output Duty Cycle | | 46 | | 54 | % |

All parameters measured at $f \leq 266MHz$ unless noted otherwise.

NOTE 1: Measured from the $V_{CC}/2$ of the input to the differential output crossing point.

NOTE 2: Defined as skew within a bank of outputs at the same voltage and with equal load conditions.

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

Measured at the LVPECL output differential cross points.

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

NOTE 5: This parameter is defined in accordance with JEDEC Standard 65.

TABLE 6C. LVCMOS AC CHARACTERISTICS, $V_{CC} = V_{CCO_LVCMOS} = 3.3V \pm 5\%$, $T_A = -40^\circ\text{C}$ TO 85°C

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-------------|---|---|---------|---------|---------|-------|
| f_{MAX} | Output Frequency | | | | 266 | MHz |
| t_{PD} | Propagation Delay; NOTE 1 | | 2.4 | | 3.5 | ns |
| tjit | Buffer Additive Phase Jitter, RMS; refer to Additive Phase Jitter Section | 155.52MHz, (Integration Range: 12kHz - 20MHz) | | 0.35 | | ps |
| tsk(b) | Bank Skew; NOTE 2, 5 | | | | 65 | ps |
| tsk(o) | Output Skew; NOTE 3, 5 | | | | 80 | ps |
| tsk(pp) | Part-to-Part Skew; NOTE 4, 5 | | 0.730 | | 800 | ps |
| t_R / t_F | Output Rise/Fall Time | 20% to 80% | 0.3 | | 1.15 | ns |
| odc | Output Duty Cycle | | 46 | | 54 | % |

All parameters measured at $f \leq 266\text{MHz}$ unless noted otherwise.

NOTE 1: Measured from the $V_{CC}/2$ of the input to $V_{CCO_LVCMOS}/2$ of the output.

NOTE 2: Defined as skew within a bank of outputs at the same voltage and with equal load conditions.

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

Measured at $V_{CCO_LVCMOS}/2$.

NOTE 4: Defined as skew between outputs on different devices operating at the same supply voltage and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at $V_{CCO_LVCMOS}/2$.

NOTE 5: This parameter is defined in accordance with JEDEC Standard 65.

TABLE 6D. LVCMOS AC CHARACTERISTICS, $V_{CC} = V_{CCO_LVCMOS} = 2.5V \pm 5\%$, $T_A = -40^\circ\text{C}$ TO 85°C

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-------------|---|---|---------|---------|---------|-------|
| f_{MAX} | Output Frequency | | | | 266 | MHz |
| t_{PD} | Propagation Delay; NOTE 1 | | 2.5 | | 3.75 | ns |
| tjit | Buffer Additive Phase Jitter, RMS; refer to Additive Phase Jitter Section | 155.52MHz, (Integration Range: 12kHz - 20MHz) | | 0.32 | | ps |
| tsk(b) | Bank Skew; NOTE 2, 5 | | | | 75 | ps |
| tsk(o) | Output Skew; NOTE 3, 5 | | | | 80 | ps |
| tsk(pp) | Part-to-Part Skew; NOTE 4, 5 | | | | 800 | ps |
| t_R / t_F | Output Rise/Fall Time | 20% to 80% | 0.425 | | 1.85 | ns |
| odc | Output Duty Cycle | | 46 | | 54 | % |

All parameters measured at $f \leq 266\text{MHz}$ unless noted otherwise.

NOTE 1: Measured from the $V_{CC}/2$ of the input to $V_{CCO_LVCMOS}/2$ of the output.

NOTE 2: Defined as skew within a bank of outputs at the same voltage and with equal load conditions.

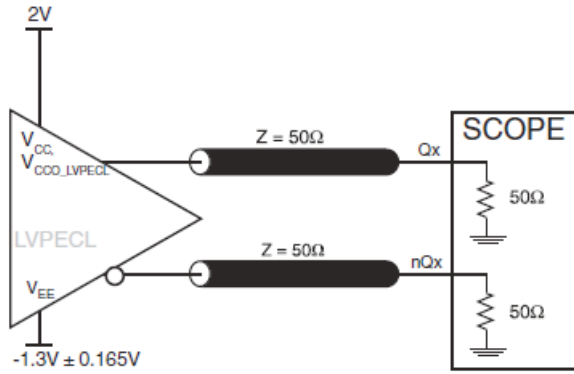
NOTE 3: Defined as skew between outputs at the same supply voltage and with equal load conditions.

Measured at $V_{CCO_LVCMOS}/2$.

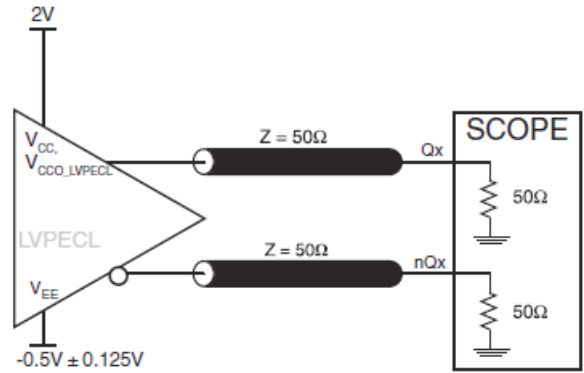
NOTE 4: Defined as skew between outputs on different devices operating at the same supply voltage and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at $V_{CCO_LVCMOS}/2$.

NOTE 5: This parameter is defined in accordance with JEDEC Standard 65.

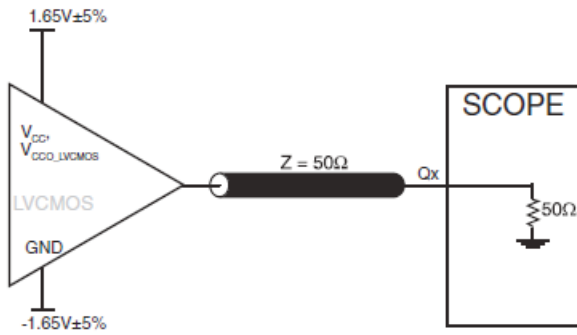
PARAMETER MEASUREMENT INFORMATION



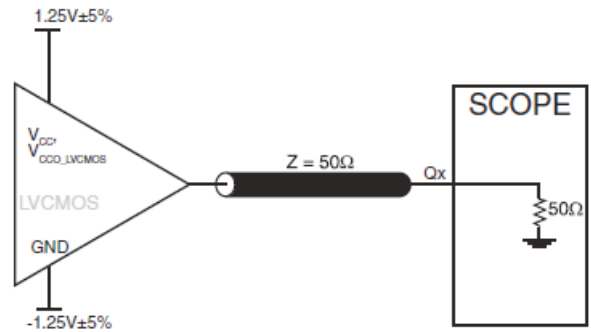
3.3V LVPECL OUTPUT LOAD AC TEST CIRCUIT



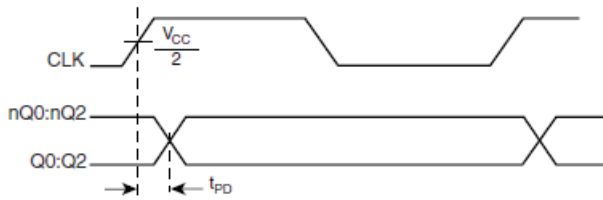
2.5V LVPECL OUTPUT LOAD AC TEST CIRCUIT



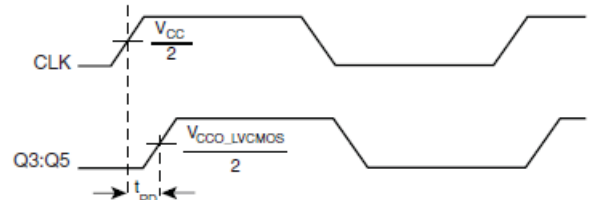
3.3V LVCMOS OUTPUT LOAD AC TEST CIRCUIT



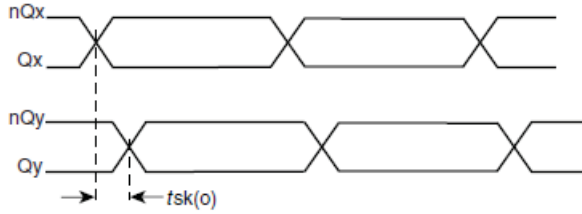
2.5V LVCMOS OUTPUT LOAD AC TEST CIRCUIT



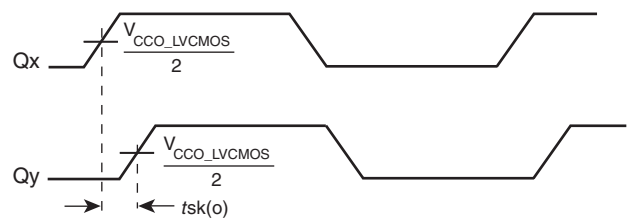
LVPECL PROPAGATION DELAY



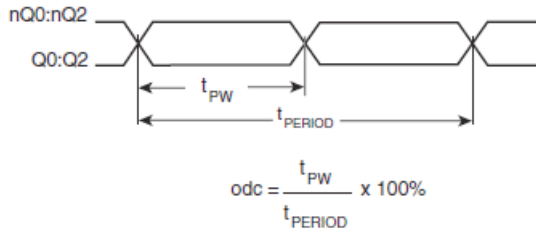
LVCMOS PROPAGATION DELAY



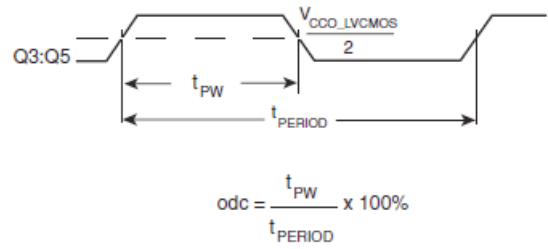
LVPECL OUTPUT SKEW



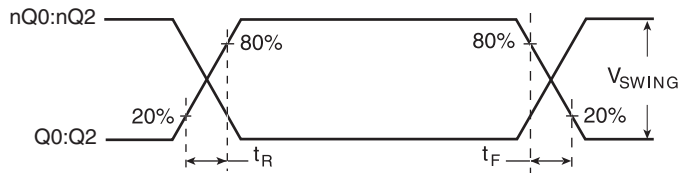
LVCMOS OUTPUT SKEW



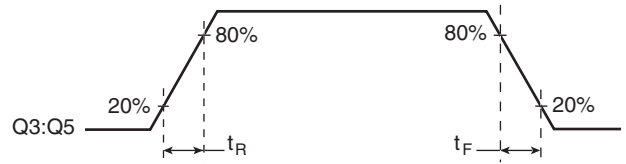
LVPECL OUTPUT DUTY CYCLE/PULSE WIDTH/PERIOD



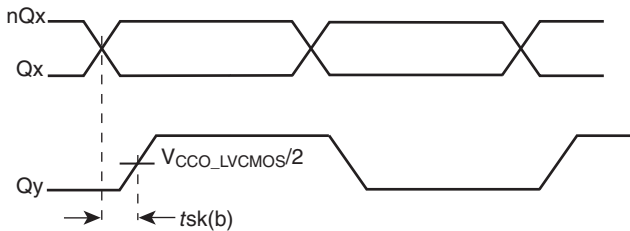
LVCMOS OUTPUT DUTY CYCLE/PULSE WIDTH/PERIOD



LVPECL OUTPUT RISE/FALL TIME



LVCMOS OUTPUT RISE/FALL TIME



BANK SKEW

APPLICATION INFORMATION

RECOMMENDATIONS FOR UNUSED INPUT AND OUTPUT PINS

INPUTS:

CRYSTAL INPUTS

For applications not requiring the use of the crystal oscillator input, both XTAL_IN and XTAL_OUT can be left floating. Though not required, but for additional protection, a 1kΩ resistor can be tied from XTAL_IN to ground.

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 pull-ups or pull-downs; additional resistance is not required but can be added for additional protection. A 1kΩ resistor can be used.

OUTPUTS:

LVC MOS OUTPUTS

All unused LVC MOS output can be left floating. There should be no trace attached.

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.

CRYSTAL INPUT INTERFACE

The 8536I-33 has been characterized with 18pF parallel resonant crystals. The capacitor values, C1 and C2, shown in *Figure 2* below were determined using an 18pF parallel resonant crystal and were chosen to minimize the ppm error. These same capacitor values will

tune any 18pF parallel resonant crystal over the frequency range and other parameters specified in this data sheet. The optimum C1 and C2 values can be slightly adjusted for different board layouts.

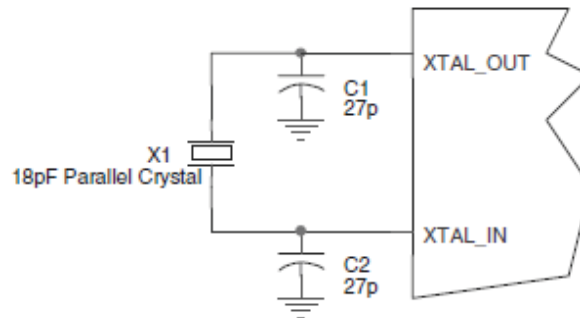


FIGURE 2. CRYSTAL INPUT INTERFACE

LVC MOS TO XTAL INTERFACE

The XTAL_IN input can accept a single-ended LVC MOS signal through an AC coupling capacitor. A general interface diagram is shown in *Figure 3*. The XTAL_OUT pin can be left floating. The input edge rate can be as slow as 10ns. For LVC MOS inputs, it is recommended that the amplitude be reduced from full swing to half swing in order to prevent signal interference with the power rail and to reduce noise. This configuration requires that the output

impedance of the driver (R_o) plus the series resistance (R_s) equals the transmission line impedance. In addition, matched termination at the crystal input will attenuate the signal in half. This can be done in one of two ways. First, R_1 and R_2 in parallel should equal the transmission line impedance. For most 50Ω applications, R_1 and R_2 can be 100Ω. This can also be accomplished by removing R_1 and making R_2 50Ω.

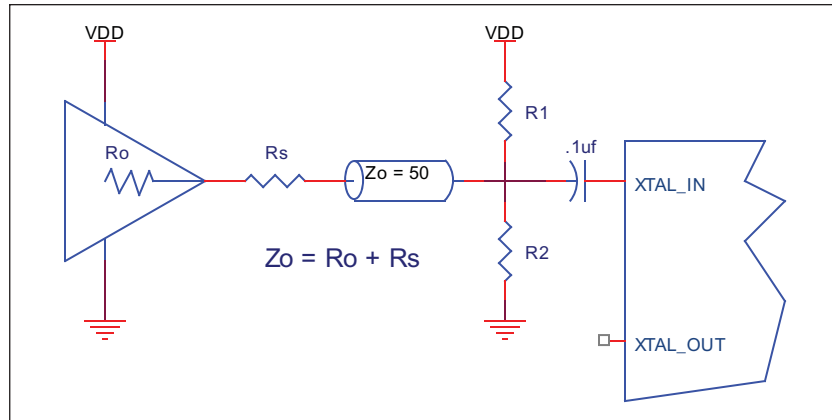


FIGURE 3. GENERAL DIAGRAM FOR LVC MOS DRIVER TO XTAL INPUT INTERFACE

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.

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 50Ω transmission lines. Matched impedance techniques should be used to maximize operating frequency and minimize signal distortion. *Figures 4A and 4B* 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.

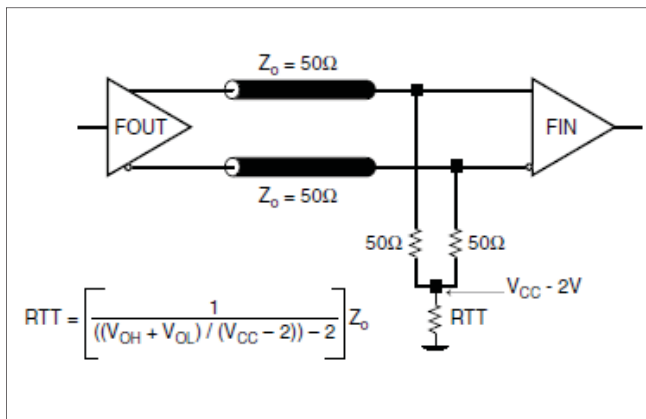


FIGURE 4A. LVPECL OUTPUT TERMINATION

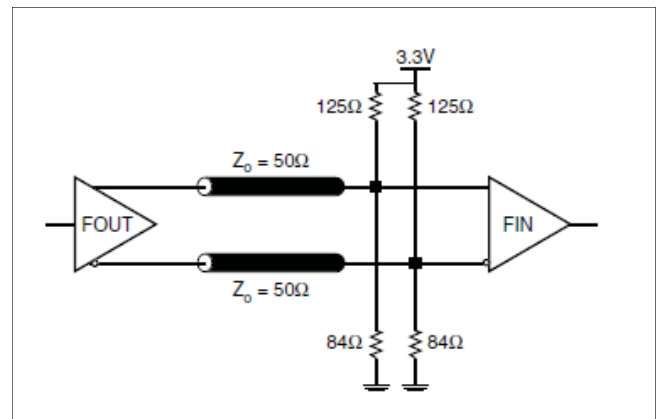


FIGURE 4B. LVPECL OUTPUT TERMINATION

TERMINATION FOR 2.5V LVPECL OUTPUTS

Figure 5A and Figure 5B show examples of termination for 2.5V LVPECL driver. These terminations are equivalent to terminating 50Ω to $V_{CC} - 2V$. For $V_{CC} = 2.5V$, the $V_{CC} - 2V$ is

very close to $_LVCMOS$ ground level. The R3 in Figure 5B can be eliminated and the termination is shown in Figure 5C.

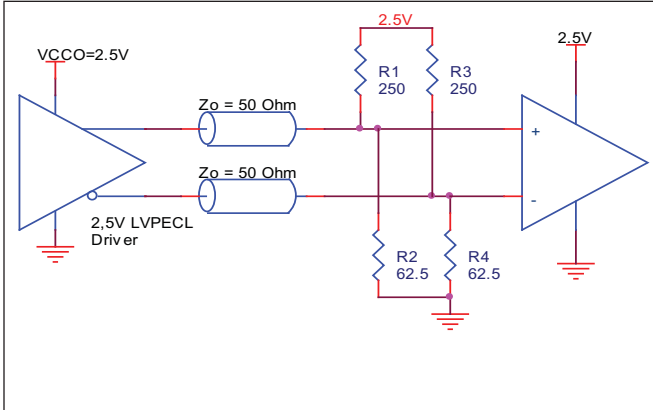


FIGURE 5A. 2.5V LVPECL DRIVER TERMINATION EXAMPLE

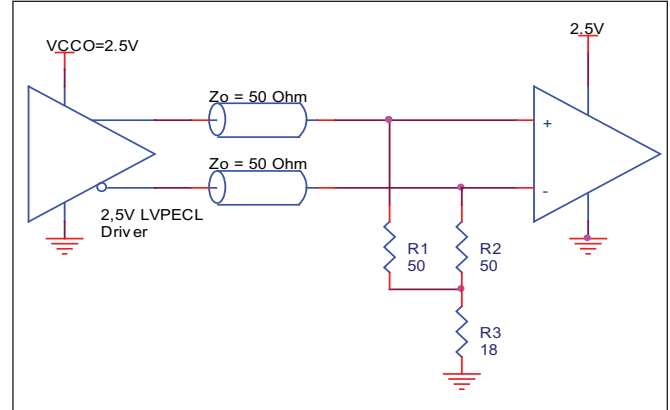


FIGURE 5B. 2.5V LVPECL DRIVER TERMINATION EXAMPLE

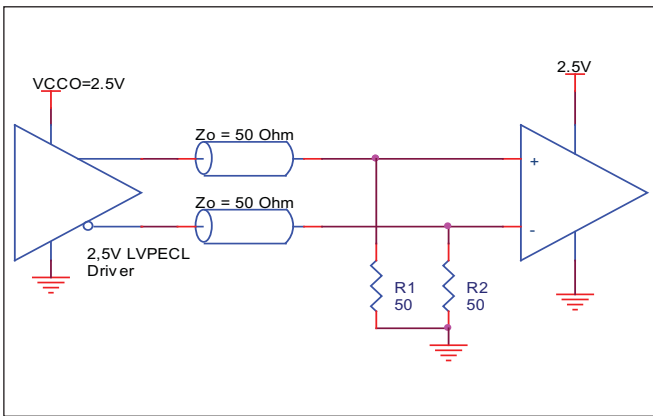


FIGURE 5C. 2.5V LVPECL TERMINATION EXAMPLE

POWER CONSIDERATIONS

This section provides information on power dissipation and junction temperature for the 8536I-33. Equations and example calculations are also provided.

1. Power Dissipation.

The total power dissipation for the 8536I-33 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.

Core and LVPECL Output Power Dissipation

- Power (core)_{MAX} = $V_{CC_MAX} * I_{EE_MAX} = 3.465V * 80mA = 277.2mW$
- Power (outputs)_{MAX} = **30mW/Loaded Output pair**
If all outputs are loaded, the total power is $3 * 30mW = 90mW$

LVC MOS Output Power Dissipation

- Output Impedance R_{OUT} Power Dissipation due to Loading 50Ω to $V_{CCO_LVC MOS}/2$
Output Current $I_{OUT} = V_{CCO_MAX} / [2 * (50\Omega + R_{OUT})] = 3.465V / [2 * (50\Omega + 15\Omega)] = 26.7mA$
- Power Dissipation on the R_{OUT} per LVC MOS output
Power (R_{OUT}) = $R_{OUT} * (I_{OUT})^2 = 15\Omega * (26.7mA)^2 = 10.7mW$ per output
- Total Power Dissipation on the R_{OUT}
Total Power (R_{OUT}) = $10.7mW * 3 = 32.1mW$

Total Power Dissipation

- **Total Power**
= Power (LVPECL) + Total Power (R_{OUT})
= $277.2mW + 90mW + 32.1mW$
= **399.3mW**

2. Junction Temperature.

Junction temperature, Tj, is the temperature at the junction of the bond wire and bond pad and directly affects the reliability of the device. The maximum recommended junction temperature for HiPerClockS™ devices is 125°C.

The equation for Tj is as follows: $T_j = \theta_{JA} * P_{d_total} + T_A$

Tj = Junction Temperature

θ_{JA} = Junction-to-Ambient Thermal Resistance

Pd_total = Total Device Power Dissipation (example calculation is in section 1 above)

T_A = Ambient Temperature

In order to calculate junction temperature, the appropriate junction-to-ambient thermal resistance θ_{JA} must be used. Assuming no air flow and a multi-layer board, the appropriate value is 91.1°C/W per Table 7 below.

Therefore, Tj for an ambient temperature of 85°C with all outputs switching is:
 $85^\circ\text{C} + 0.3993\text{W} * 91.1^\circ\text{C}/\text{W} = 121.4^\circ\text{C}$. This is below the limit of 125°C.

This calculation is only an example. Tj will obviously vary depending on the number of loaded outputs, supply voltage, air flow, and the type of board (single layer or multi-layer).

TABLE 7. THERMAL RESISTANCE θ_{JA} FOR 20-PIN TSSOP, FORCED CONVECTION

| θ_{JA} by Velocity (Linear Feet per Minute) | | | |
|--|----------|----------|----------|
| | 0 | 200 | 500 |
| Multi-Layer PCB, JEDEC Standard Test Boards | 91.1°C/W | 86.7°C/W | 84.6°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 6.

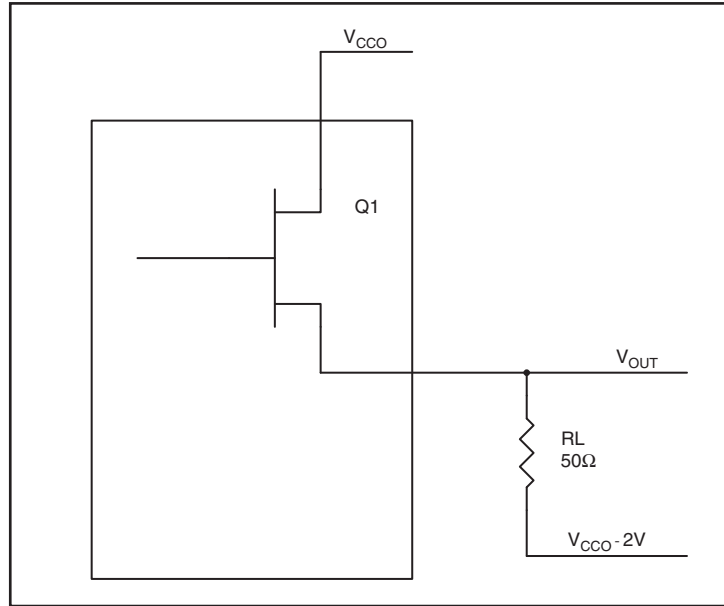


FIGURE 6. LVPECL DRIVER CIRCUIT AND TERMINATION

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.

$$Pd_H = [(V_{OH_MAX} - (V_{CCO_MAX} - 2V))/R_L] * (V_{CCO_MAX} - V_{OH_MAX}) = [(2V - (V_{CCO_MAX} - V_{OH_MAX}))/R_L] * (V_{CCO_MAX} - V_{OH_MAX}) = [(2V - 0.9V)/50\Omega] * 0.9V = \mathbf{19.8mW}$$

$$Pd_L = [(V_{OL_MAX} - (V_{CCO_MAX} - 2V))/R_L] * (V_{CCO_MAX} - V_{OL_MAX}) = [(2V - (V_{CCO_MAX} - V_{OL_MAX}))/R_L] * (V_{CCO_MAX} - V_{OL_MAX}) = [(2V - 1.7V)/50\Omega] * 1.7V = \mathbf{10.2mW}$$

$$\text{Total Power Dissipation per output pair} = Pd_H + Pd_L = \mathbf{30mW}$$

RELIABILITY INFORMATION

TABLE 8. θ_{JA} VS. AIR FLOW TABLE FOR 20 LEAD TSSOP

| θ_{JA} by Velocity (Meters per Second) | | | |
|---|----------|----------|----------|
| | 0 | 1 | 2.5 |
| Multi-Layer PCB, JEDEC Standard Test Boards | 91.1°C/W | 86.7°C/W | 84.6°C/W |

TRANSISTOR COUNT

The transistor count for 8536I-33 is: 550

PACKAGE OUTLINE & PACKAGE DIMENSIONS

PACKAGE OUTLINE - G SUFFIX FOR 20 LEAD TSSOP

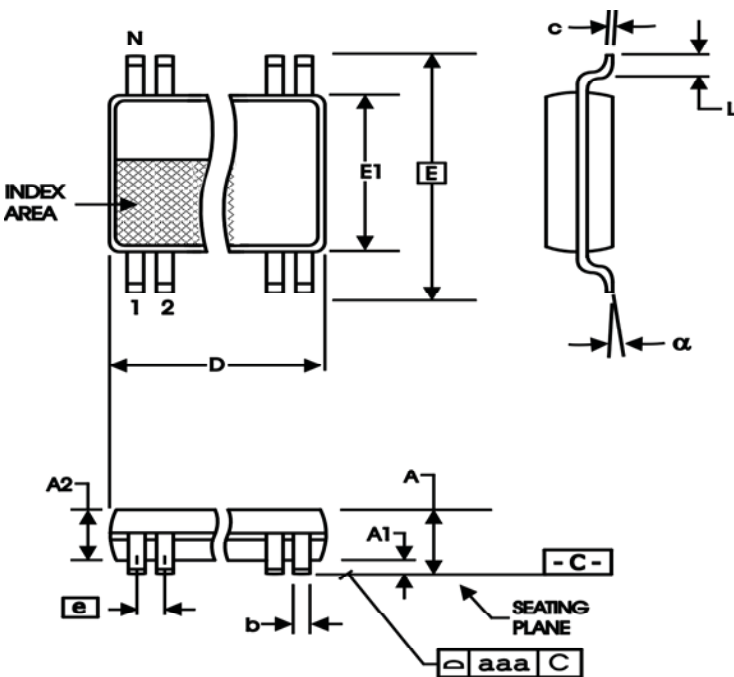


TABLE 9. PACKAGE DIMENSIONS

| SYMBOL | Millimeters | |
|----------|-------------|------|
| | MIN | MAX |
| 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 |
| α | 0° | 8° |
| aaa | -- | 0.10 |

Reference Document: JEDEC Publication 95, MO-153

TABLE 10. ORDERING INFORMATION

| Part/Order Number | Marking | Package | Shipping Packaging | Temperature |
|-------------------|--------------|---------------------------|--------------------|---------------|
| 8536CGI-33LF | ICS8536CI33L | 20 lead "Lead-Free" TSSOP | tube | -40°C to 85°C |
| 8536CGI-33LFT | ICS8536CI33L | 20 lead "Lead-Free" TSSOP | 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 |
|------------|--------------|-------------|--|-------------|
| B | T1 | 1 2 | Pin Assignment - corrected pins 13 & 14. Pin Description Table - corrected pin 13 & 14. | 6/25/08 |
| B | T10 | 17 | Ordering Information - removed leaded devices. Update data sheet format. | 7/10/15 |
| | | | | |

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Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Contact Information

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