



GENERAL DESCRIPTION

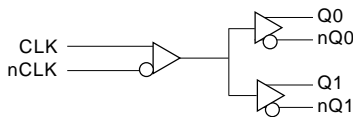


The ICS85311 is a low skew, high performance 1-to-2 Differential-to-2.5V/3.3V ECL/LVPECL Fanout Buffer and a member of the HiPerClockS™ family of High Performance Clock Solutions from ICS. The CLK, nCLK pair can accept most standard differential input levels. The ICS85311 is characterized to operate from either a 2.5V or a 3.3V power supply. Guaranteed output and part-to-part skew characteristics make the ICS85311 ideal for those clock distribution applications demanding well defined performance and repeatability.

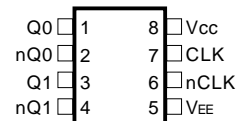
FEATURES

- 2 differential 2.5V/3.3V LVPECL/ECL outputs
- 1 CLK, nCLK input pair
- CLK, nCLK pair can accept the following differential input levels: LVDS, LVPECL, LVHSTL, SSTL, HCSL
- Maximum output frequency up to 1GHz
- Translates any single ended input signal to 3.3V LVPECL levels with resistor bias on nCLK input
- Output skew: 15ps (maximum)
- Part-to-part skew: 100ps (maximum)
- Propagation delay: 1.4ns (maximum)
- LVPECL mode operating voltage supply range:
 $V_{CC} = 2.375V$ to $3.465V$, $V_{EE} = 0V$
- ECL mode operating voltage supply range:
 $V_{CC} = 0V$, $V_{EE} = -2.375V$ to $-3.465V$
- 0°C to 70°C ambient operating temperature
- Industrial temperature information available upon request

BLOCK DIAGRAM



PIN ASSIGNMENT



ICS85311

8-Lead SOIC
3.90mm x 4.90mm x 1.37mm package body
M Package
Top View



TABLE 1. PIN DESCRIPTIONS

| Number | Name | Type | | Description |
|--------|-----------------|--------|----------|--|
| 1, 2 | Q0, nQ0 | Output | | Differential output pair. LVPECL interface levels. |
| 3, 4 | Q1, nQ1 | Output | | Differential output pair. LVPECL interface levels. |
| 5 | V _{EE} | Power | | Negative supply pin. Connect to ground. |
| 6 | nCLK | Input | Pullup | Inverting differential clock input. |
| 7 | CLK | Input | Pulldown | Non-inverting differential clock input. |
| 8 | V _{CC} | Power | | Positive supply pin. Connect to 2.5v or 3.3V. |

NOTE: *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 _{IN} | Input Capacitance | CLK, nCLK | | | | 4 | pF |
| R _{PULLUP} | Input Pullup Resistor | | | | 51 | | KΩ |
| R _{PULLDOWN} | Input Pulldown Resistor | | | | 51 | | KΩ |



ABSOLUTE MAXIMUM RATINGS

| | |
|--|--------------------------|
| Supply Voltage, V_{CC} | 4.6V |
| Inputs, V_I | -0.5V to $V_{CC} + 0.5V$ |
| Outputs, V_O | -0.5V to $V_{CC} + 0.5V$ |
| Package Thermal Impedance, θ_{JA} | 112°C/W |
| Storage Temperature, T_{STG} | -65°C to 150°C |

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 3A. 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 | | | | 25 | mA |

TABLE 3B. DIFFERENTIAL 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 |
|-----------|---|-----------------|--------------------------------|---------|-----------------|---------|
| I_{IH} | Input High Current | CLK | $V_{CC} = V_{IN} = 3.465V$ | | 150 | μA |
| | | nCLK | $V_{CC} = V_{IN} = 3.465V$ | | 5 | μA |
| I_{IL} | Input Low Current | CLK | $V_{CC} = 3.465V, V_{IN} = 0V$ | -5 | | μA |
| | | nCLK | $V_{CC} = 3.465V, V_{IN} = 0V$ | -150 | | μA |
| V_{PP} | Peak-to-Peak Input Voltage | | 0.15 | | 1.3 | V |
| V_{CMR} | Common Mode Input Voltage; NOTE 1, 2 | | $V_{EE} + 0.5$ | | $V_{CC} - 0.85$ | V |

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

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

TABLE 3C. POWER SUPPLY DC CHARACTERISTICS, $V_{CC} = 2.5V \pm 5\%$, $T_A = 0^\circ C$ TO $70^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|----------|-------------------------|-----------------|---------|---------|---------|-------|
| V_{CC} | Positive Supply Voltage | | 2.375 | 2.5 | 2.625 | V |
| I_{EE} | Power Supply Current | | | | 25 | mA |



TABLE 3D. DIFFERENTIAL DC CHARACTERISTICS, $V_{CC} = 2.5V \pm 5\%$, $T_A = 0^\circ C$ TO $70^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-----------|---|-----------------|--------------------------------|---------|-----------------|---------|
| I_{IH} | Input High Current | CLK | $V_{CC} = V_{IN} = 2.625V$ | | 150 | μA |
| | | nCLK | $V_{CC} = V_{IN} = 2.625V$ | | 5 | μA |
| I_{IL} | Input Low Current | CLK | $V_{CC} = 2.625V, V_{IN} = 0V$ | -5 | | μA |
| | | nCLK | $V_{CC} = 2.625V, V_{IN} = 0V$ | -150 | | μA |
| V_{PP} | Peak-to-Peak Input Voltage | | 0.15 | | 1.3 | V |
| V_{CMR} | Common Mode Input Voltage; NOTE 1, 2 | | $V_{EE} + 0.5$ | | $V_{CC} - 0.85$ | V |

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

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

TABLE 3E. LVPECL DC CHARACTERISTICS, $V_{CC} = 3.3V \pm 5\%$, $V_{CC} = 2.5V \pm 5\%$, $T_A = 0^\circ C$ TO $70^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-------------|-----------------------------------|-----------------|----------------|---------|----------------|-------|
| V_{OH} | Output High Voltage; NOTE 1 | | $V_{CC} - 1.4$ | | $V_{CC} - 1.0$ | V |
| V_{OL} | Output Low Voltage; NOTE 1 | | $V_{CC} - 2.0$ | | $V_{CC} - 1.7$ | V |
| V_{SWING} | Peak-to-Peak Output Voltage Swing | | 0.65 | | 0.9 | V |

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

TABLE 4F. AC CHARACTERISTICS, $V_{CC} = 3.3V \pm 5\%$, $V_{CC} = 2.5V \pm 5\%$, $T_A = 0^\circ C$ TO $70^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|--------------|------------------------------|--------------------|---------|---------|---------|-------|
| f_{MAX} | Maximum Output Frequency | | | | 1 | GHz |
| t_{PD} | Propagation Delay; NOTE 1 | $f \leq 1GHz$ | 0.9 | | 1.4 | ns |
| $t_{sk(o)}$ | Output Skew; NOTE 2, 4 | | | | 15 | ps |
| $t_{sk(pp)}$ | Part-to-Part Skew; NOTE 3, 4 | | | | 100 | ps |
| t_R | Output Rise Time | 20% to 80% @ 50MHz | 300 | | 700 | ps |
| t_F | Output Fall Time | 20% to 80% @ 50MHz | 300 | | 700 | ps |
| odc | Output Duty Cycle | | 48 | | 52 | % |

All parameters measured at 500MHz unless noted otherwise.

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

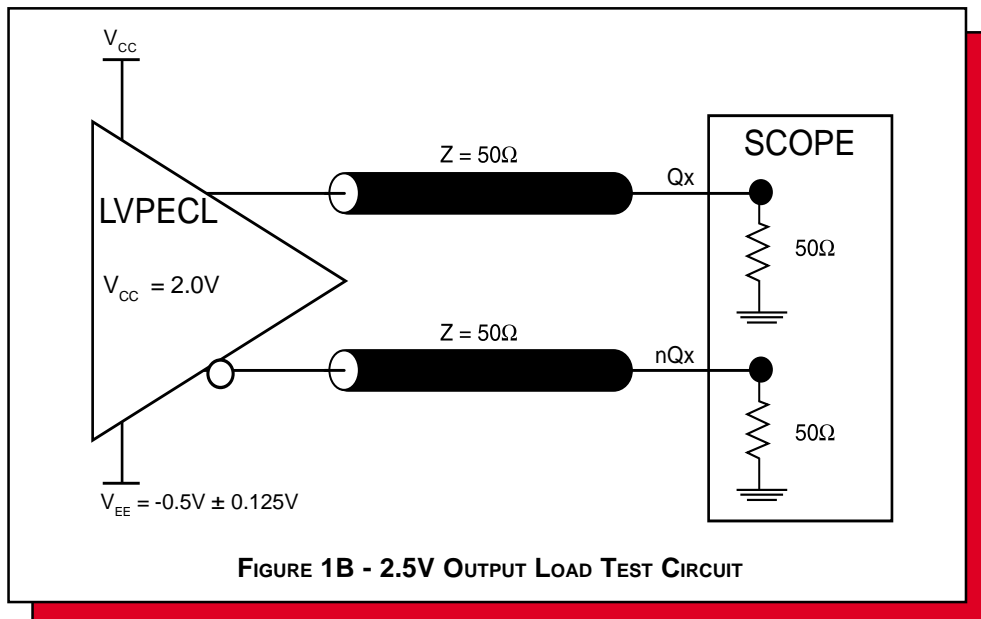
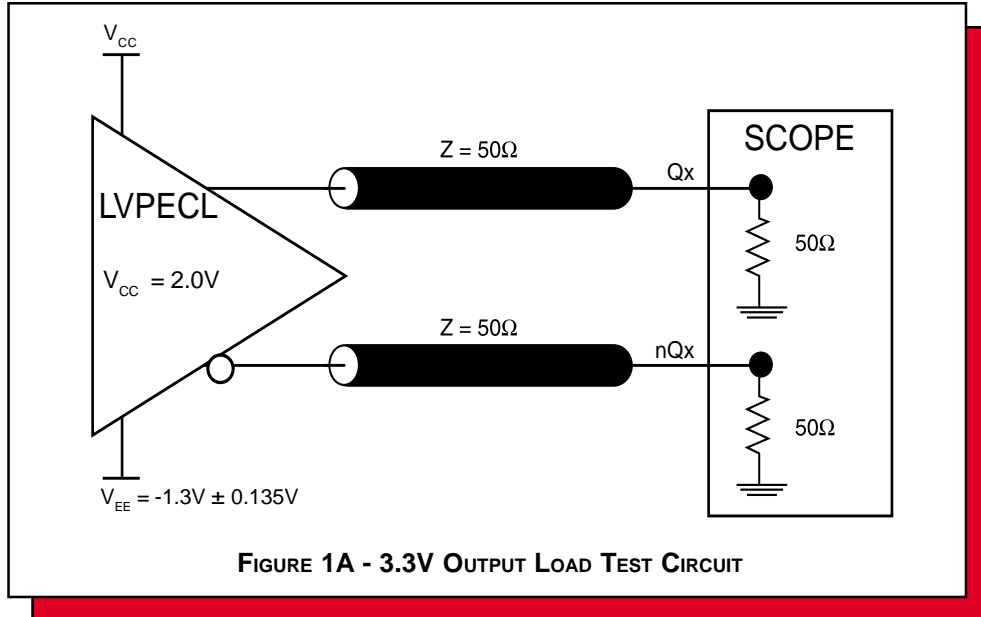
NOTE 2: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at the output differential cross points.

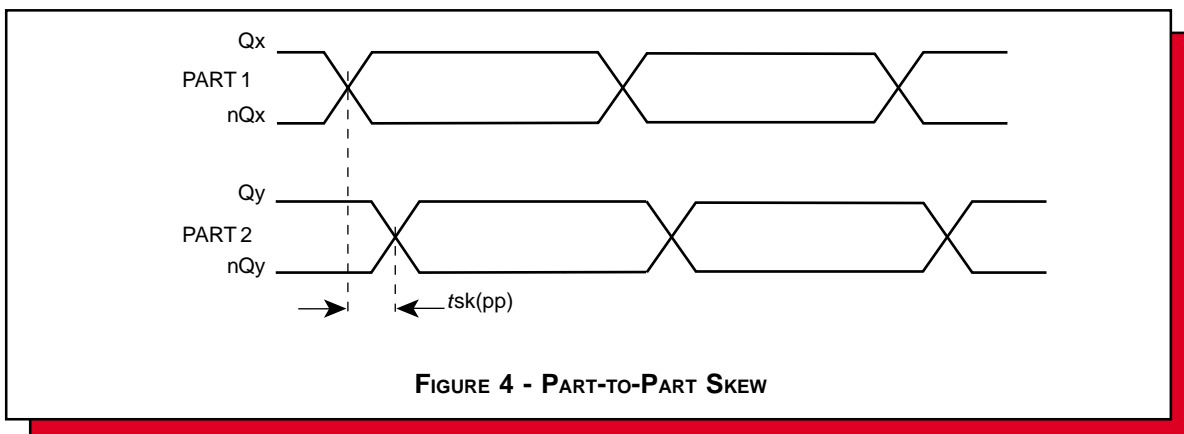
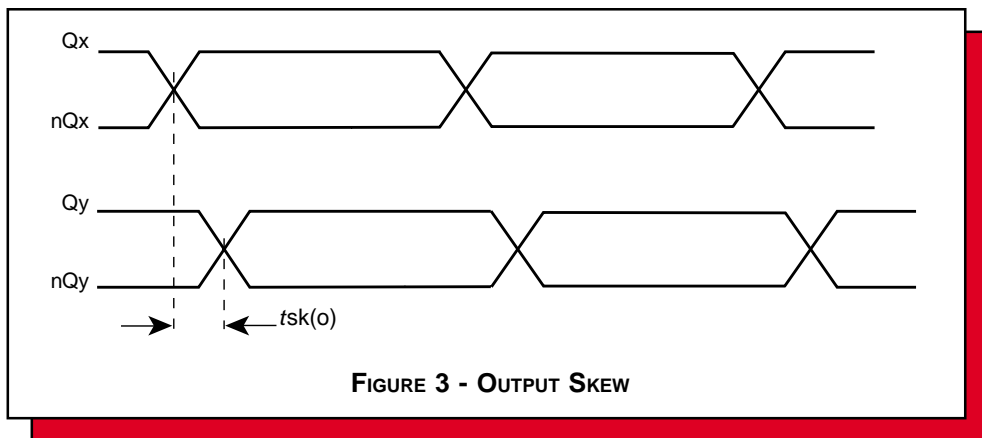
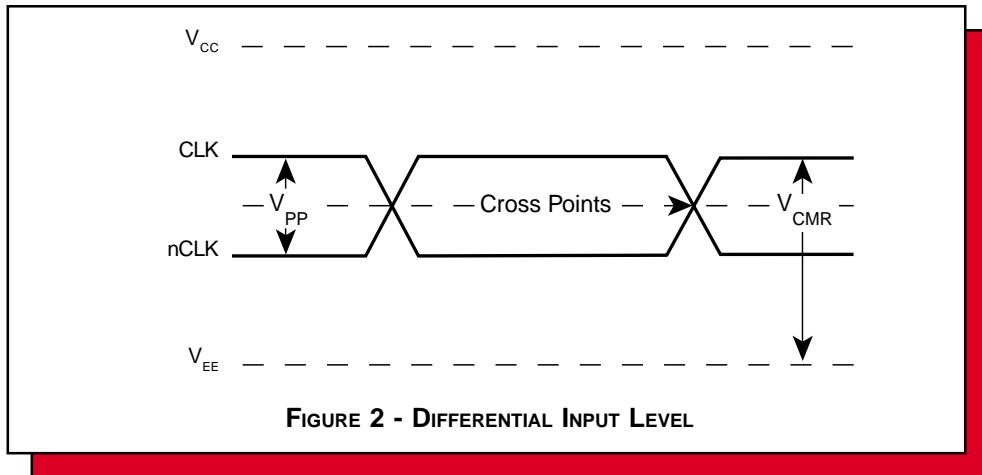
NOTE 3: Defined as skew between outputs on different devices operating at the same supply voltages and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at the differential cross points.

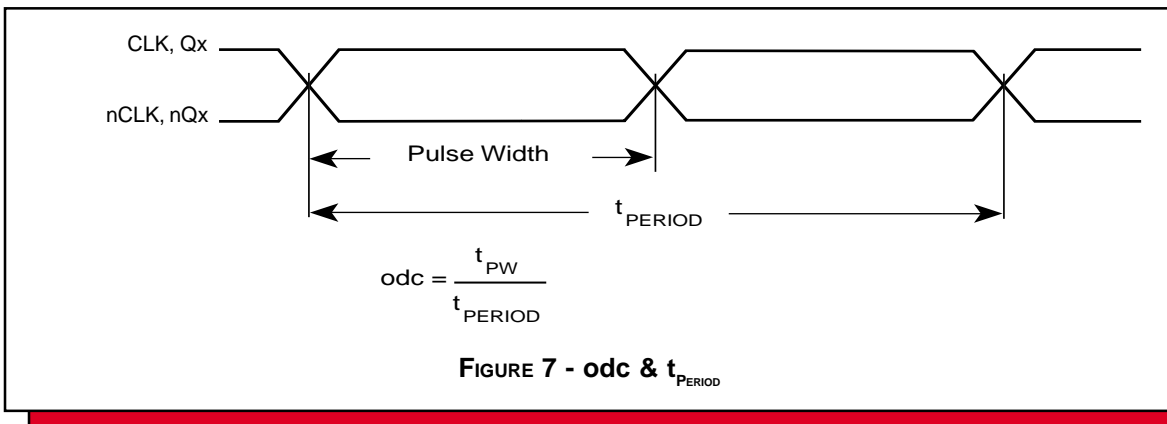
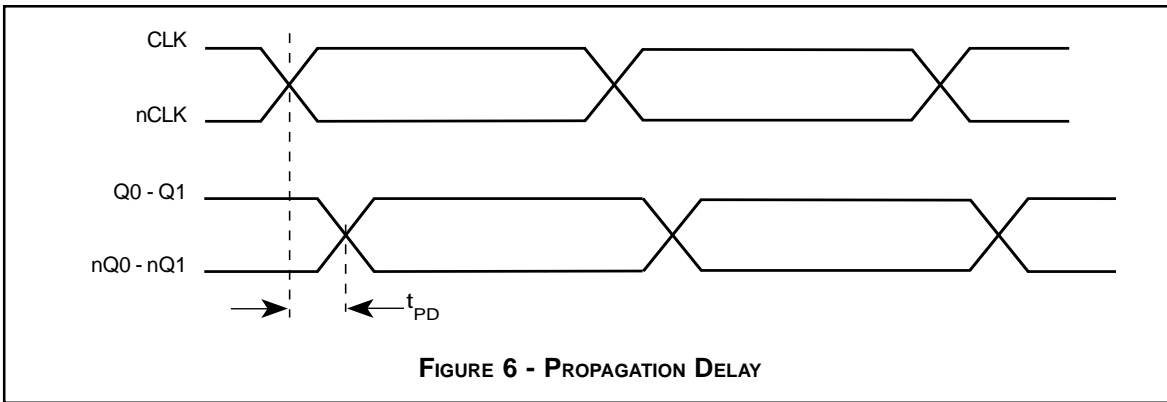
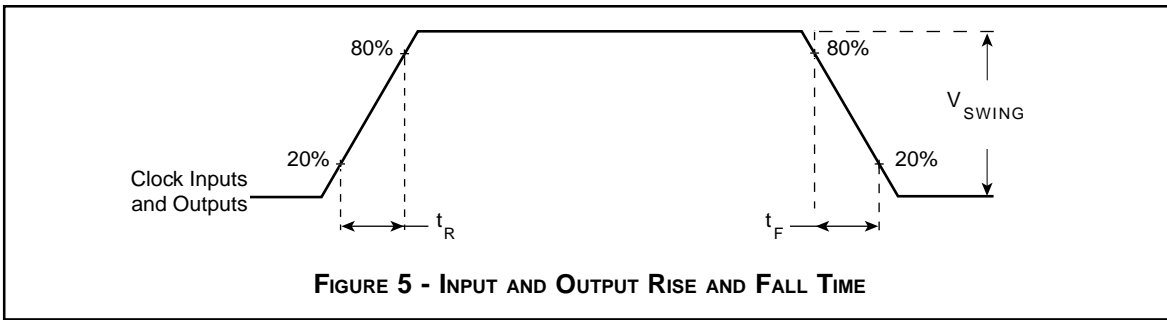
NOTE 4: This parameter is defined in accordance with JEDEC Standard 65.



PARAMETER MEASUREMENT INFORMATION





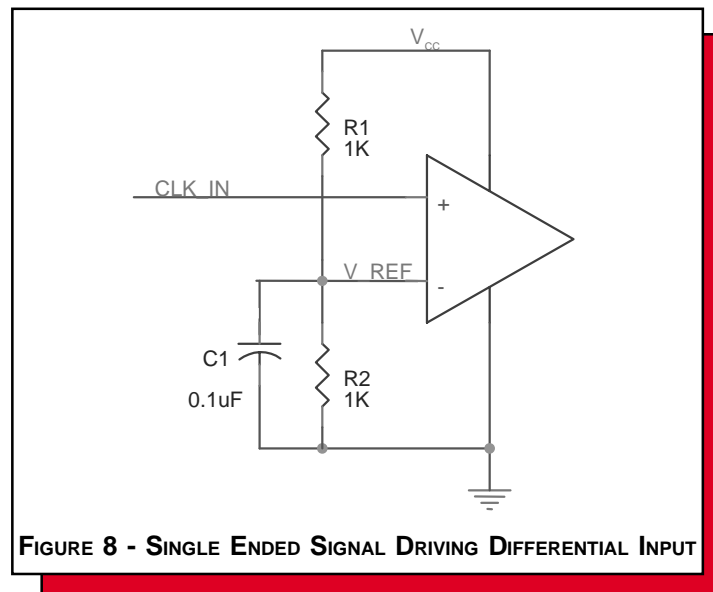




APPLICATION INFORMATION

WIRING THE DIFFERENTIAL INPUT TO ACCEPT SINGLE ENDED LEVELS

Figure 8 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 $R2/R1 = 0.609$.





POWER CONSIDERATIONS

This section provides information on power dissipation and junction temperature for the ICS85311. Equations and example calculations are also provided.

1. Power Dissipation.

The total power dissipation of the ICS85311 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) = $V_{CC} * I_{EE} = 3.465V * 25mA = 86.6mW$
- Power (outputs) = **30.2mW/Loaded Output pair**
If all outputs are loaded, the total power is $2 * 30.2mW = 60.4mW$

Total Power (3.465V, with all outputs switching) = $86.6mW + 60.4mW = 147mW$

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.

In order to determine if the junction temperature is below 125°C, the appropriate junction-to-ambient thermal resistance θ_{JA} must be used in conjunction with the total power dissipation. Assuming a moderate air flow of 200 linear feet per minute and a multi-layer board, the appropriate value is 103.3°C/W per the table below:

$T_j = \theta_{JA} * Pd_{total} + T_A$ where Pd_{total} is the total power dissipation of the device and T_A is the ambient temperature. Therefore, T_j for an ambient temperature of 70°C with all outputs switching is:
 $70°C + 0.147W * 103.3°C/W = 85.2°C$. This is well below the limit of 125°C.

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

Thermal Resistance θ_{JA} for 8-pin SOIC, Forced Convection

| θ_{JA} by Velocity (Linear Feet per Minute) | | | |
|--|-----------|-----------|-----------|
| | 0 | 200 | 500 |
| Single-Layer PCB, JEDEC Standard Test Boards | 153.3°C/W | 128.5°C/W | 115.5°C/W |
| Multi-Layer PCB, JEDEC Standard Test Boards | 112.7°C/W | 103.3°C/W | 97.1°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.

LVPECL output driver circuit and termination are shown in Figure 9.

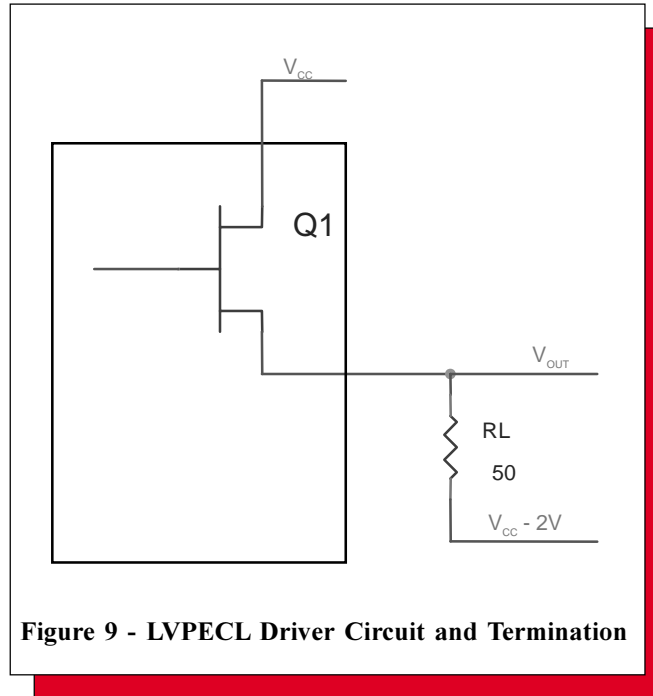


Figure 9 - LVPECL Driver Circuit and Termination

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

Pd_H is power dissipation when the output drives high.

Pd_L is the power dissipation when the output drives low.

$$Pd_H = [(V_{OH_MAX} - (V_{CC} - 2V))/R_L] * (V_{CC} - V_{OH_MAX})$$

$$Pd_L = [(V_{OL_MAX} - (V_{CC} - 2V))/R_L] * (V_{CC} - V_{OL_MAX})$$

- For logic high , $V_{OUT} = V_{OH_MAX} = V_{CC} - 1.0V$
Using $V_{CC} = 3.465$, this results in $V_{OH_MAX} = 2.465V$
- For logic low , $V_{OUT} = V_{OL_MAX} = V_{CC} - 1.7V$
Using $V_{CC} = 3.465$, this results in $V_{OL_MAX} = 1.765V$

$$Pd_H = [(2.465V - (3.465V - 2V))/50 \Omega] * (3.465V - 2.465V) = 20.0mW$$

$$Pd_L = [(1.765V - (3.465V - 2V))/50 \Omega] * (3.465V - 1.765V) = 10.2mW$$

$$\text{Total Power Dissipation per output pair} = Pd_H + Pd_L = 30.2mW$$



RELIABILITY INFORMATION

TABLE 5. θ_{JA} VS. AIR FLOW TABLE

| θ_{JA} by Velocity (Linear Feet per Minute) | | | |
|--|-----------|-----------|-----------|
| | 0 | 200 | 500 |
| Single-Layer PCB, JEDEC Standard Test Boards | 153.3°C/W | 128.5°C/W | 115.5°C/W |
| Multi-Layer PCB, JEDEC Standard Test Boards | 112.7°C/W | 103.3°C/W | 97.1°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 ICS85311 is: 225



PACKAGE OUTLINE - M SUFFIX

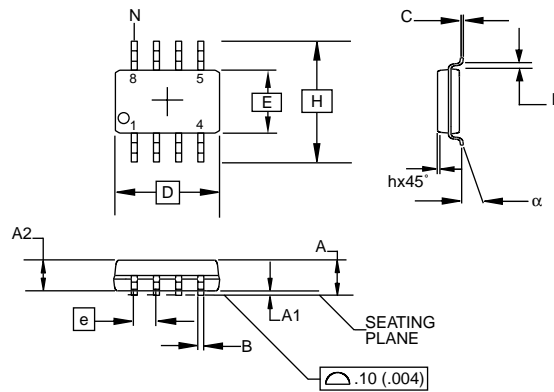


TABLE 6. PACKAGE DIMENSIONS

| SYMBOL | Millimeters | | Inches | |
|----------|-------------|---------|-------------|---------|
| | MINIMUM | MAXIMUM | MINIMUM | MAXIMUM |
| N | 8 | | | |
| A | 1.35 | 1.75 | 0.532 | 0.0688 |
| A1 | 0.10 | 0.25 | 0.0040 | 0.0098 |
| A2 | 1.25 | 1.50 | 0.0492 | 0.0590 |
| B | 0.33 | 0.51 | 0.013 | 0.020 |
| C | 0.19 | 0.25 | 0.0075 | 0.0098 |
| D | 4.80 | 5.00 | 0.1890 | 0.1968 |
| E | 3.80 | 4.00 | 0.1497 | 0.1574 |
| e | 1.27 BASIC | | 0.050 BASIC | |
| H | 5.80 | 6.20 | 0.2284 | 0.2440 |
| h | 0.25 | 0.50 | 0.010 | 0.020 |
| L | 0.40 | 1.27 | 0.016 | 0.050 |
| α | 0° | 8° | 0° | 8° |

Reference Document: JEDEC Publication 95, MS-012



Integrated
Circuit
Systems, Inc.

ICS85311

Low Skew, 1-to-2 Differential-to-2.5V/3.3V ECL/LVPECL Fanout Buffer

TABLE 7. ORDERING INFORMATION

| Part/Order Number | Marking | Package | Count | Temperature |
|-------------------|------------|------------------------------|-------------|-------------|
| ICS85311AM | ICS85311AM | 8 lead SOIC | 96 per tube | 0°C to 70°C |
| ICS85311AMT | ICS85311AM | 8 lead SOIC on Tape and Reel | 2500 | 0°C to 70°C |

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