

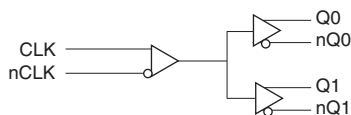
GENERAL DESCRIPTION

The 85211I-01 is a low skew, high performance 1-to-2 Differential-to-HSTL Fanout Buffer. The CLK, nCLK pair can accept most standard differential input levels. The 85211I-01 is characterized to operate from a 3.3V power supply. Guaranteed output and part-to-part skew characteristics make the 85211I-01 ideal for those clock distribution applications demanding well defined performance and repeatability. For optimal performance, terminate all outputs.

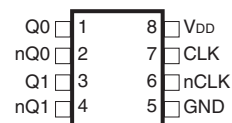
FEATURES

- Two differential HSTL compatible outputs
- One differential CLK, nCLK input pair
- CLK, nCLK pair can accept the following differential input levels: LVDS, LVPECL, HSTL, SSTL, HCSL
- Maximum output frequency: 700MHz
- Translates any single-ended input signal to HSTL levels with resistor bias on nCLK input
- Output skew: 30ps (maximum)
- Part-to-part skew: 250ps (maximum)
- Propagation delay: 1ns (maximum)
- Output crossover Voltage: 0.68V to 0.9V
- Output duty cycle: 49% - 51% up to 266.6MHz
- $V_{OH} = 1.4V$ (maximum)
- 3.3V operating supply
- -40°C to 85°C ambient operating temperature
- Available in lead-free RoHS-compliant package
- For functional replacement use 8523

BLOCK DIAGRAM



PIN ASSIGNMENT



85211I-01
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. HSTL interface levels. |
| 3, 4 | Q1, nQ1 | Output | | Differential output pair. HSTL interface levels. |
| 5 | GND | Power | | Power supply ground. |
| 6 | nCLK | Input | Pullup/ Pulldown | Inverting differential clock input. $V_{DD}/2$ default when left floating. |
| 7 | CLK | Input | Pulldown | Non-inverting differential clock input. |
| 8 | V_{DD} | Power | | Positive supply pin. |

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 |
| R_{PULLUP} | Input Pullup Resistor | | | 51 | | k Ω |
| $R_{PULLDOWN}$ | Input Pulldown Resistor | | | 51 | | k Ω |

TABLE 3. CLOCK INPUT FUNCTION TABLE

| Inputs | | Outputs | | Input to Output Mode | Polarity |
|----------------|----------------|---------|----------|------------------------------|---------------|
| CLK | nCLK | Q0, Q1 | nQ0, nQ1 | | |
| 0 | 0 | LOW | HIGH | Differential to Differential | Non Inverting |
| 1 | 1 | 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_{DD} | 4.6V |
| Inputs, V_{DD} | -0.5V to $V_{DD} + 0.5V$ |
| Outputs, V_{DD} | -0.5V to $V_{DD} + 0.5V$ |
| Package Thermal Impedance, θ_{JA} | 112.7°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, $V_{DD} = 3.3V \pm 5\%$, $T_A = -40^\circ C$ to $85^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|----------|----------------------|-----------------|---------|---------|---------|-------|
| V_{DD} | Power Supply Voltage | | 3.135 | 3.3 | 3.465 | V |
| I_{DD} | Power Supply Current | | | | 22 | mA |

TABLE 4B. DIFFERENTIAL DC CHARACTERISTICS, $V_{DD} = 3.3V \pm 5\%$, $T_A = -40^\circ C$ to $85^\circ C$

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

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

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

TABLE 4C. HSTL DC CHARACTERISTICS, $V_{DD} = 3.3V \pm 5\%$, $T_A = -40^\circ C$ to $85^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-------------|-----------------------------------|-----------------|---------|---------|---------|-------|
| V_{OH} | Output High Voltage; NOTE 1 | | 1.0 | | 1.4 | V |
| V_{OL} | Output Low Voltage; NOTE 1 | | 0 | | 0.4 | V |
| V_{OX} | Output Crossover Voltage | | 0.68 | | 0.9 | V |
| V_{SWING} | Peak-to-Peak Output Voltage Swing | | 0.6 | 1.0 | 1.4 | V |

NOTE 1: All outputs must be terminated with 50 Ω to ground.

TABLE 5. AC CHARACTERISTICS, $V_{DD} = 3.3V \pm 5\%$, $T_A = -40^{\circ}C$ TO $85^{\circ}C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-------------|------------------------------|-------------------|---------|---------|---------|-------|
| f_{MAX} | Output Frequency | | | | 700 | MHz |
| t_{PD} | Propagation Delay; NOTE 1 | $f \leq 600MHz$ | 0.7 | | 1.0 | ns |
| tsk(o) | Output Skew; NOTE 2, 4 | | | | 30 | ps |
| tsk(pp) | Part-to-Part Skew; NOTE 3, 4 | | | | 250 | ps |
| t_R / t_F | Output Rise/Fall Time | 20% to 80% | 200 | | 500 | ps |
| odc | Output Duty Cycle | | 48 | | 52 | % |
| | | $f \leq 266.6MHz$ | 49 | | 51 | % |

All parameters measured at 600MHz 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 1: Measured from the differential input crossing point to the differential output crossing point.

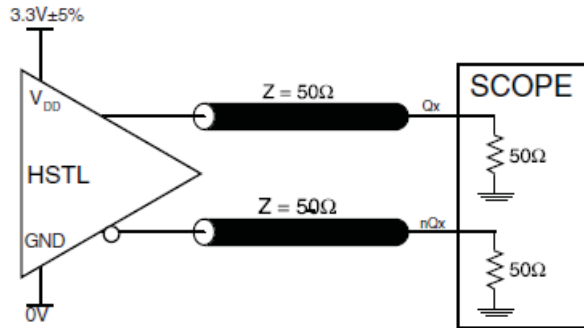
NOTE 2: Defined as skew between outputs at the same supply voltage and with equal load conditions.

Measured at output differential cross points.

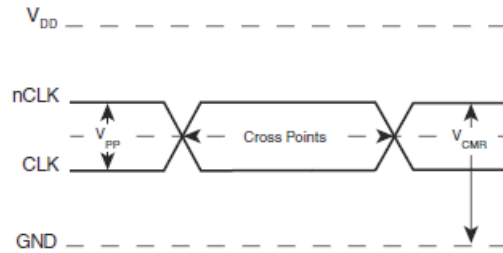
NOTE 3: Defined as skew between outputs on different devices operating at the same supply voltages and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at the differential cross points.

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

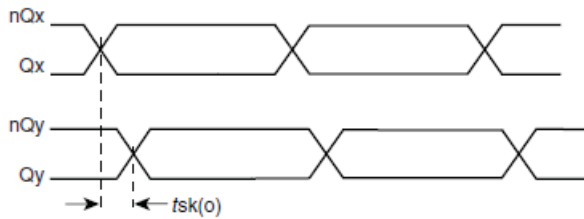
PARAMETER MEASUREMENT INFORMATION



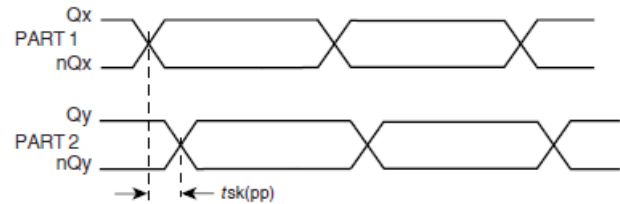
3.3V OUTPUT LOAD AC TEST CIRCUIT



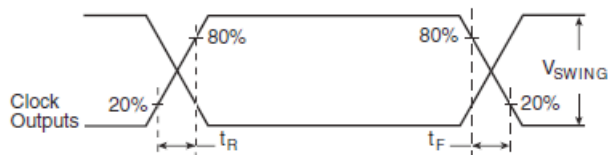
DIFFERENTIAL INPUT LEVEL



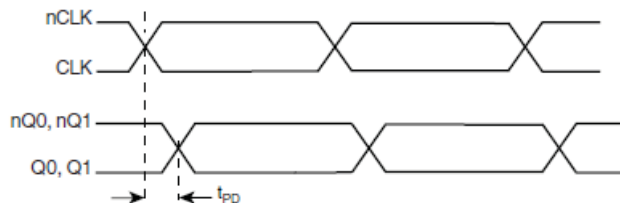
OUTPUT SKEW



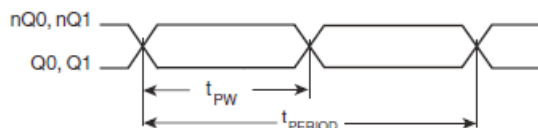
PART-TO-PART SKEW



OUTPUT RISE/FALL TIME



PROPAGATION DELAY



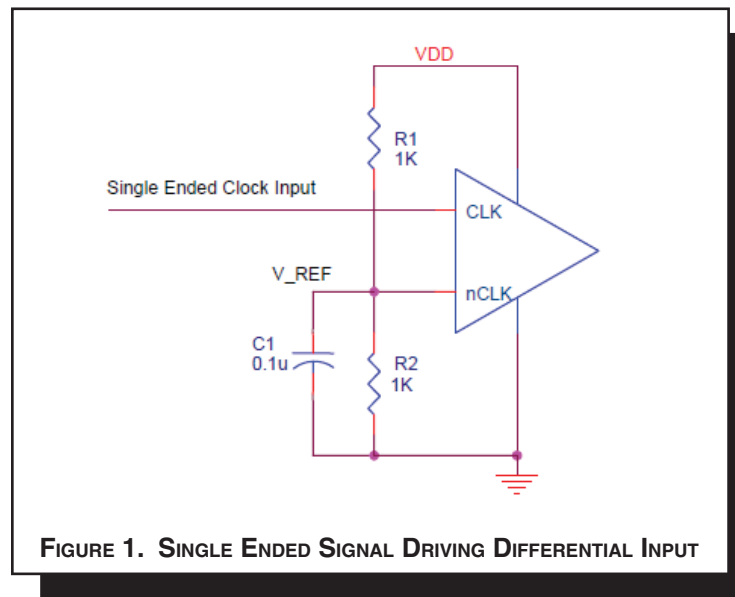
OUTPUT DUTY CYCLE/PULSE WIDTH/PERIOD

APPLICATION INFORMATION

WIRING THE DIFFERENTIAL INPUT TO ACCEPT SINGLE ENDED LEVELS

Figure 1 shows how the differential input can be wired to accept single ended levels. The reference voltage $V_{REF} = V_{DD}/2$ is generated by the bias resistors R1, R2 and C1. This bias circuit should be located as close as possible to the input pin. The ratio

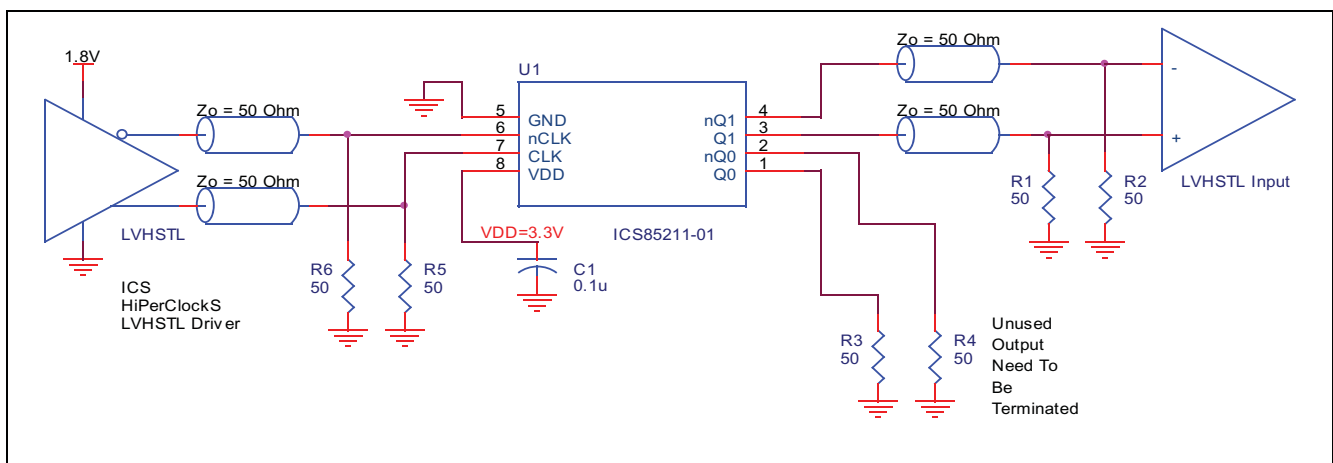
of R1 and R2 might need to be adjusted to position the V_{REF} in the center of the input voltage swing. For example, if the input clock swing is only 2.5V and $V_{DD} = 3.3V$, V_{REF} should be 1.25V and $R2/R1 = 0.609$.



SCHEMATIC EXAMPLE

Figure 2 shows a schematic example of 85211I-01. In this example, the input is driven by an ICS HiPerClockS HSTL driver. The decoupling capacitors should be physically located near

the power pin. For 85211I-01, the unused outputs need to be terminated.



RECOMMENDATIONS FOR UNUSED OUTPUT PINS

OUTPUTS:

HSTL OUTPUT

All unused HSTL 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.

CLOCK INPUT INTERFACE

The CLK /nCLK accepts differential input signals of both V_{SWING} and V_{OH} to meet the V_{PP} and V_{CMR} input requirements. *Figures 3A to 3D* show interface examples for the 85211I-01 clock input driven by most common driver types. The input interfaces suggested here are examples only. Please consult with

the vendor of the driver components to confirm the driver termination requirement. For example in *Figure 3*, the input termination applies for HSTL drivers. If you are using an HSTL driver from another vendor, use their termination recommendation.

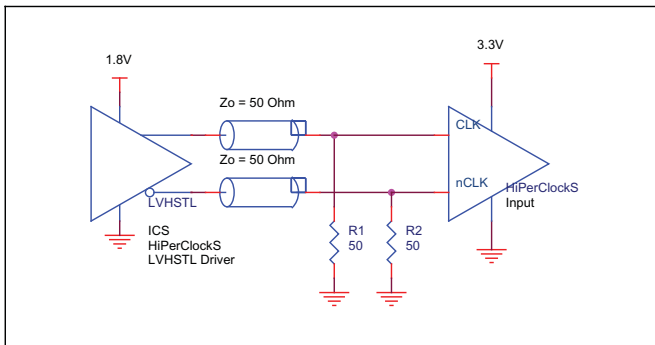


FIGURE 3A. 85211I-01 CLK/nCLK INPUT DRIVEN BY HSTL DRIVER

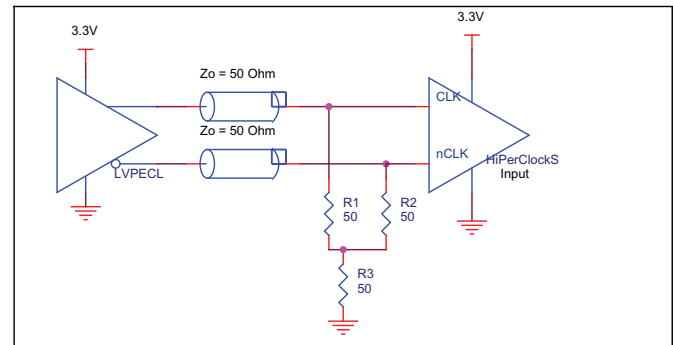


FIGURE 3B. 85211I-01 CLK/nCLK INPUT DRIVEN BY 3.3V LVPECL DRIVER (INTERFACE 1)

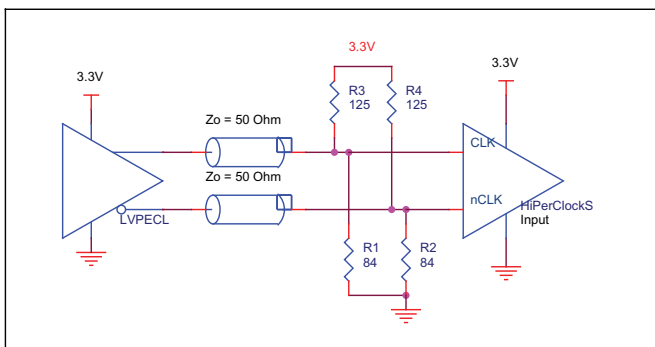


FIGURE 3C. 85211I-01 CLK/nCLK INPUT DRIVEN BY 3.3V LVPECL DRIVER (INTERFACE 2)

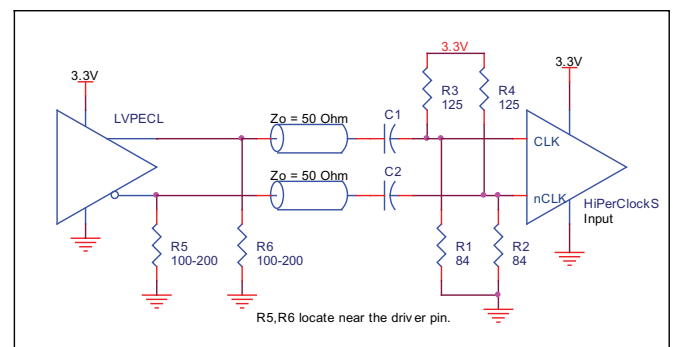


FIGURE 3D. 85211I-01 CLK/nCLK INPUT DRIVEN BY 3.3V LVPECL DRIVER WITH AC COUPLE

POWER CONSIDERATIONS

This section provides information on power dissipation and junction temperature for the 85211I-01. Equations and example calculations are also provided.

1. Power Dissipation.

The total power dissipation for the 85211I-01 is the sum of the core power plus the power dissipated in the load(s). The following is the power dissipation for $V_{DD} = 3.3V + 5\% = 3.465V$, which gives worst case results.

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

- Power (core)_{MAX} = $V_{DD_MAX} * I_{DD_MAX} = 3.465V * 22mA = 76.2mW$
- Power (outputs)_{MAX} = **82.34mW/Loaded Output pair**
If all outputs are loaded, the total power is $2 * 82.34mW = 164.7mW$

$$\text{Total Power}_{MAX} (3.465V, \text{ with all outputs switching}) = 76.2mW + 164.7mW = 240.9mW$$

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 the devices is 125°C.

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

T_j = 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 a moderate air flow of 200 linear feet per minute and a multi-layer board, the appropriate value is 103.3°C/W per Table 6 below. Therefore, T_j for an ambient temperature of 85°C with all outputs switching is:

$$85^\circ C + 0.241W * 103.3^\circ C/W = 110^\circ C. \text{ This is well below the limit of } 125^\circ C.$$

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).

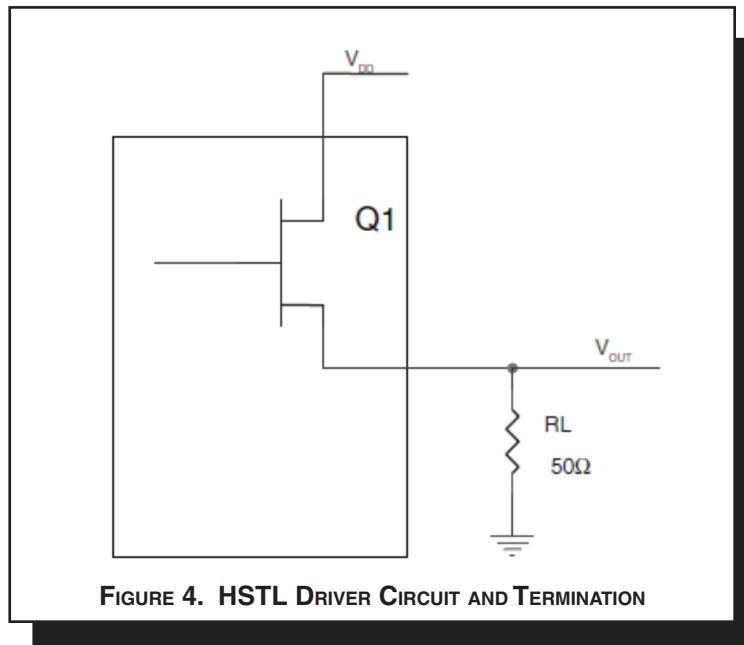
TABLE 6. THERMAL RESISTANCE θ_{JA} FOR 8-PIN SOIC, FORCED CONVECTION

| 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.

The purpose of this section is to derive the power dissipated into the load.

HSTL output driver circuit and termination are shown in *Figure 4*.



To calculate worst case power dissipation into the load, use the following equations which assume a 50Ω load.

Pd_H is power dissipation when the output drives high.

Pd_L is the power dissipation when the output drives low.

$$Pd_H = (V_{OH_MAX} / R_L) * (V_{DD_MAX} - V_{OH_MAX})$$

$$Pd_L = (V_{OL_MAX} / R_L) * (V_{DD_MAX} - V_{OL_MAX})$$

$$Pd_H = (1.4V / 50\Omega) * (3.465V - 1.4V) = 57.82mW$$

$$Pd_L = (0.4V / 50\Omega) * (3.465V - 0.4V) = 24.52mW$$

$$\text{Total Power Dissipation per output pair} = Pd_H + Pd_L = \mathbf{82.34mW}$$

RELIABILITY INFORMATION

TABLE 7. θ_{JA} VS. AIR FLOW TABLE FOR 8 LEAD SOIC

| 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 85211I-01 is: 411

PACKAGE OUTLINE - M SUFFIX FOR 8 LEAD SOIC

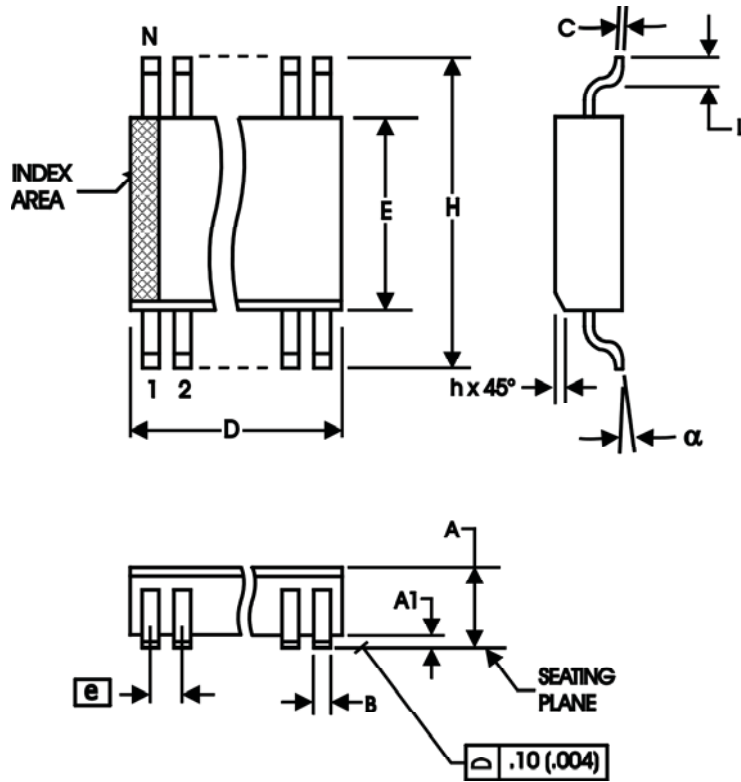


TABLE 8. PACKAGE DIMENSIONS

| SYMBOL | Millimeters | |
|----------|-------------|---------|
| | MINIMUM | MAXIMUM |
| N | 8 | |
| A | 1.35 | 1.75 |
| A1 | 0.10 | 0.25 |
| B | 0.33 | 0.51 |
| C | 0.19 | 0.25 |
| D | 4.80 | 5.00 |
| E | 3.80 | 4.00 |
| e | 1.27 BASIC | |
| H | 5.80 | 6.20 |
| h | 0.25 | 0.50 |
| L | 0.40 | 1.27 |
| α | 0° | 8° |

Reference Document: JEDEC Publication 95, MS-012

TABLE 9. ORDERING INFORMATION

| Part/Order Number | Marking | Package | Shipping Packaging | Temperature |
|--------------------------|----------------|-------------------------|---------------------------|--------------------|
| 85211AMI-01LF | 211AI01L | 8 lead "Lead-Free" SOIC | tube | -40°C to 85°C |
| 85211AMI-01LFT | 211AI01L | 8 lead "Lead-Free" SOIC | tape & reel | -40°C to 85°C |

| REVISION HISTORY SHEET | | | | |
|------------------------|-------|---------|--|----------|
| Rev | Table | Page | Description of Change | Date |
| A | 1 | 2 | Throughout data sheet changed LVHSTL to HSTL. | 7/16/03 |
| | 2 | 2 | Changed nCLK Type from $V_{DD}/2$ to Pullup/Pulldown. Pin Characteristics Table - changed C_{IN} 4pF max. to 4pF typical. Changed R_{PULLUP} to $R_{PULLUP}/R_{PULLDOWN}$, Pullup/Pulldown Resistors. | |
| A | T9 | 1 | Features section - added Lead Free/RoHS bullet. | 11/01/05 |
| | | 7 12 | Added <i>Recommendations for Unused Output Pins</i> . Ordering Information Table - added Lead-Free part number and marking. | |
| B | T9 | 12 | Updated datasheet's header/footer with IDT from ICS. | 8/4/10 |
| | | 14 | Removed ICS prefix from Part/Order Number column. Added Contact Page. | |
| B | T9 | 1 | Features Section - removed reference to leaded devices. | 6/12/15 |
| | | 12 | Ordering Information - removed leaded devices. Updated data sheet format. | |
| B | T9 | 12 | Product Discontinuation Notice - Last time buy expires September 7, 2016. PDN N-16-02. | 3/10/16 |
| | | | Ordering Information - Deleted LF note below table. | |

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