

GENERAL DESCRIPTION

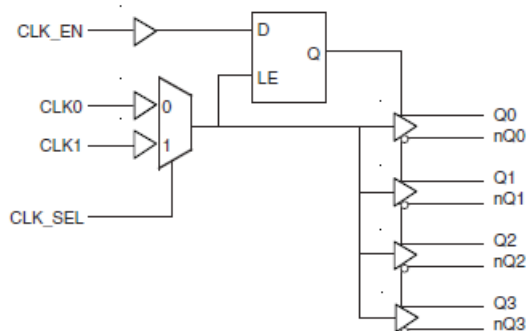
The 8525 is a low skew, high performance 1-to-4 LVCMOS-to-LVHSTL fanout buffer. The 8525 has two selectable clock inputs that accept LVCMOS or LVTTTL input levels and translate them to LVHSTL levels. The clock enable is internally synchronized to eliminate runt pulses on the outputs during asynchronous assertion/deassertion of the clock enable pin.

Guaranteed output and part-to-part skew characteristics make the 8525 ideal for those applications demanding well defined performance and repeatability.

FEATURES

- Four differential LVHSTL compatible outputs
- Selectable LVCMOS / LVTTTL clock inputs for redundant and multiple frequency fanout applications
- Maximum output frequency: 266MHz
- Translates LVCMOS and LVTTTL levels to LVHSTL levels
- Output skew: 35ps (maximum)
- Part-to-part skew: 150ps (maximum)
- Propagation delay: 1.9ns (maximum)
- 3.3V core, 1.8V operating supply
- 0°C to 70°C ambient operating temperature
- Industrial temperature information available upon request
- Available in lead-free RoHS compliant packages

BLOCK DIAGRAM



PIN ASSIGNMENT

| | | | |
|---------|----|----|------|
| GND | 1 | 20 | Q0 |
| CLK_EN | 2 | 19 | nQ0 |
| CLK_SEL | 3 | 18 | VDDO |
| CLK0 | 4 | 17 | Q1 |
| nc | 5 | 16 | nQ1 |
| CLK1 | 6 | 15 | Q2 |
| nc | 7 | 14 | nQ2 |
| nc | 8 | 13 | VDDO |
| nc | 9 | 12 | Q3 |
| VDD | 10 | 11 | nQ3 |

8525

20-Lead TSSOP

6.5mm x 4.4mm x 0.92mm Package Body

G Package

Top View

TABLE 1. PIN DESCRIPTIONS

| Number | Name | Type | | Description |
|------------|------------------|--------|----------|--|
| 1 | GND | Power | | Power supply ground. |
| 2 | 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. |
| 3 | CLK_SEL | Input | Pulldown | Clock select input. When HIGH, selects CLK1 input. When LOW, selects CLK0 input. LVCMOS / LVTTTL interface levels. |
| 4 | CLK0 | Input | Pulldown | LVCMOS / LVTTTL clock input. |
| 6 | CLK1 | Input | Pulldown | LVCMOS / LVTTTL clock input. |
| 5, 7, 8, 9 | nc | Unused | | No connect. |
| 10 | V _{DD} | Power | | Positive supply pin. |
| 13, 18 | V _{DDO} | Power | | Output supply pins. |
| 11, 12 | nQ3, Q3 | Output | | Differential output pair. LVHSTL interface levels. |
| 14, 15 | nQ2, Q2 | Output | | Differential output pair. LVHSTL interface levels. |
| 16, 17 | nQ1, Q1 | Output | | Differential output pair. LVHSTL interface levels. |
| 19, 20 | nQ0, Q0 | Output | | Differential output pair. LVHSTL interface levels. |

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 | | kΩ |
| R _{PULLDOWN} | 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 |

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

In the active mode, the state of the outputs are a function of the CLK0 and CLK1 inputs as described in Table 3B.


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

| | |
|--|--------------------------|
| Supply Voltage, V_{DD} | 4.6V |
| Inputs, V_I | -0.5V to $V_{DD} + 0.5V$ |
| Outputs, I_O | |
| Continuous Current | 50mA |
| Surge Current | 100mA |
| Package Thermal Impedance, θ_{JA} | 73.2°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, $V_{DD} = 3.3V \pm 5\%$, $V_{DDO} = 1.8V \pm 0.2V$, $T_A = 0^\circ C$ TO $70^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-----------|-------------------------|-----------------|---------|---------|---------|-------|
| V_{DD} | Positive Supply Voltage | | 3.135 | 3.3 | 3.465 | V |
| V_{DDO} | Output Supply Voltage | | 1.6 | 1.8 | 2.0 | V |
| I_{DD} | Power Supply Current | | | | 50 | mA |

TABLE 4B. LVCMOS / LVTTTL DC CHARACTERISTICS, $V_{DD} = 3.3V \pm 5\%$, $V_{DDO} = 1.8V \pm 0.2V$, $T_A = 0^\circ C$ TO $70^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|----------|--------------------|---|---------|---------|---------|---------|
| V_{IH} | Input High Voltage | CLK0, CLK1 | 2 | | 3.765 | V |
| | | CLK_EN, CLK_SEL | 2 | | 3.765 | 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 $V_{DD} = V_{IN} = 3.465V$ | | | 150 | μA |
| | | CLK_EN $V_{DD} = V_{IN} = 3.465V$ | | | 5 | μA |
| I_{IL} | Input Low Current | CLK0, CLK1, CLK_SEL $V_{DD} = 3.465V, V_{IN} = 0V$ | -5 | | | μA |
| | | CLK_EN $V_{DD} = 3.465V, V_{IN} = 0V$ | -150 | | | μA |

TABLE 4C. LVHSTL DC CHARACTERISTICS, $V_{DD} = 3.3V \pm 5\%$, $V_{DDO} = 1.8V \pm 0.2V$, $T_A = 0^\circ C$ TO $70^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-------------|--------------------------------------|-----------------|--|---------|--|-------|
| V_{OH} | Output High Voltage; NOTE 1 | | 1 | | 1.2 | V |
| V_{OL} | Output Low Voltage; NOTE 1 | | 0 | | 0.4 | V |
| V_{OX} | Output Crossover Voltage | | $40\% \times (V_{OH} - V_{OL}) + V_{OL}$ | | $60\% \times (V_{OH} - V_{OL}) + V_{OL}$ | V |
| V_{SWING} | Peak-to-Peak Output Voltage Swing | | 0.75 | | 1.25 | V |

NOTE 1: Outputs terminated with 50 Ω to GND.

TABLE 5. AC CHARACTERISTICS, $V_{DD} = 3.3V \pm 5\%$, $V_{DDO} = 1.8V \pm 0.2V$, $T_A = 0^\circ C$ TO $70^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-------------|------------------------------|--------------------|---------|---------|---------|-------|
| f_{MAX} | Maximum Output Frequency | | | | 266 | MHz |
| t_{PD} | Propagation Delay; NOTE 1 | $f \leq 266MHz$ | 1.0 | | 1.9 | ns |
| $tsk(o)$ | Output Skew; NOTE 2, 4 | | | | 35 | ps |
| $tsk(pp)$ | Part-to-Part Skew; NOTE 3, 4 | | | | 150 | ps |
| t_R / t_F | Output Rise/Fall Time | 20% to 80% @ 50MHz | 300 | | 700 | ps |
| odc | Output Duty Cycle | | 45 | 50 | 55 | % |

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.

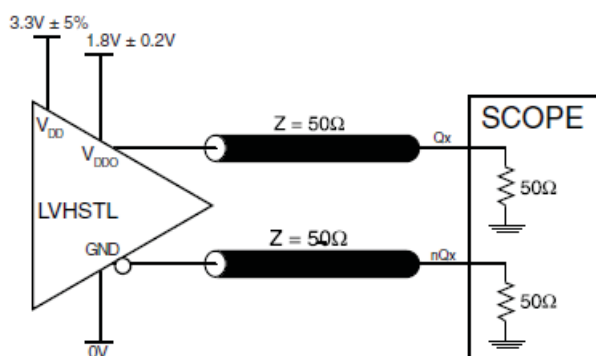
NOTE 1: Measured from the $V_{DD}/2$ of the input to the differential output crossing point.

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

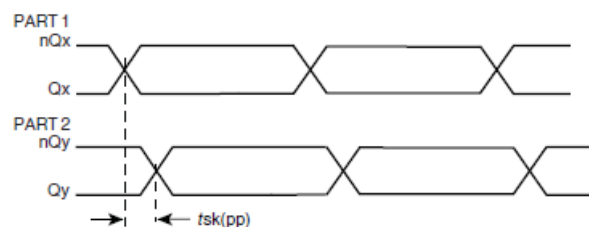
NOTE 3: Defined as skew between outputs on different devices operating at the same supply voltages and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at the differential cross points.

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

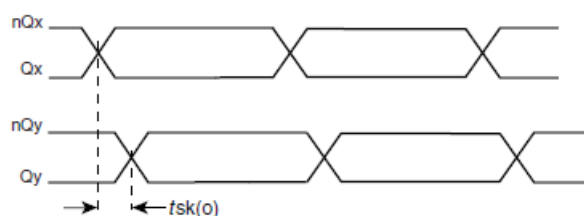
PARAMETER MEASUREMENT INFORMATION



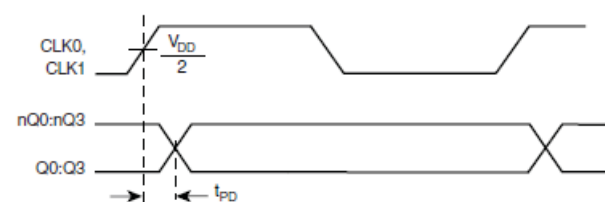
3.3V CORE/1.8V OUTPUT LOAD AC TEST CIRCUIT



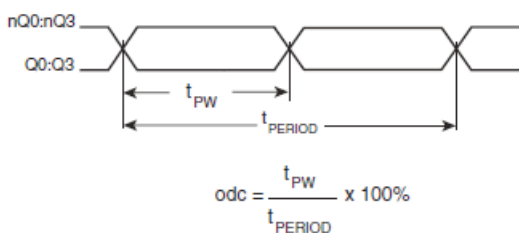
PART-TO-PART SKEW



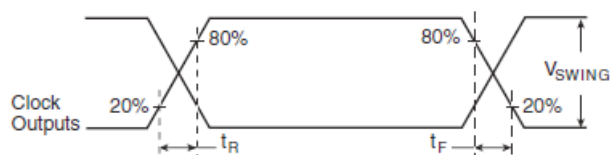
OUTPUT SKEW



PROPAGATION DELAY



OUTPUT DUTY CYCLE/PULSE WIDTH/PERIOD



OUTPUT RISE/FALL TIME

APPLICATION INFORMATION

RECOMMENDATIONS FOR UNUSED INPUT AND OUTPUT 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 1k Ω 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 1k Ω resistor can be used.

OUTPUTS:

LVHSTL OUTPUT

All unused LVHSTL 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.

POWER CONSIDERATIONS

This section provides information on power dissipation and junction temperature for the 8525. Equations and example calculations are also provided.

1. Power Dissipation.

The total power dissipation for the 8525 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} = $V_{DD_MAX} * I_{DD_MAX} = 3.465V * 50mA = 173.25mW$
- Power (outputs)_{MAX} = **32.8mW/Loaded Output pair**
If all outputs are loaded, the total power is $4 \times 32.8mW = 131.2mW$

Total Power_{MAX} (3.465V, with all outputs switching) = $173.25mW + 131.2mW = 304.45mW$

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 66.6°C/W per Table 6 below. Therefore, T_j for an ambient temperature of 70°C with all outputs switching is:

$70^\circ C + 0.305W * 66.6^\circ C/W = 90.3^\circ C$. This is well below the limit of 125°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).

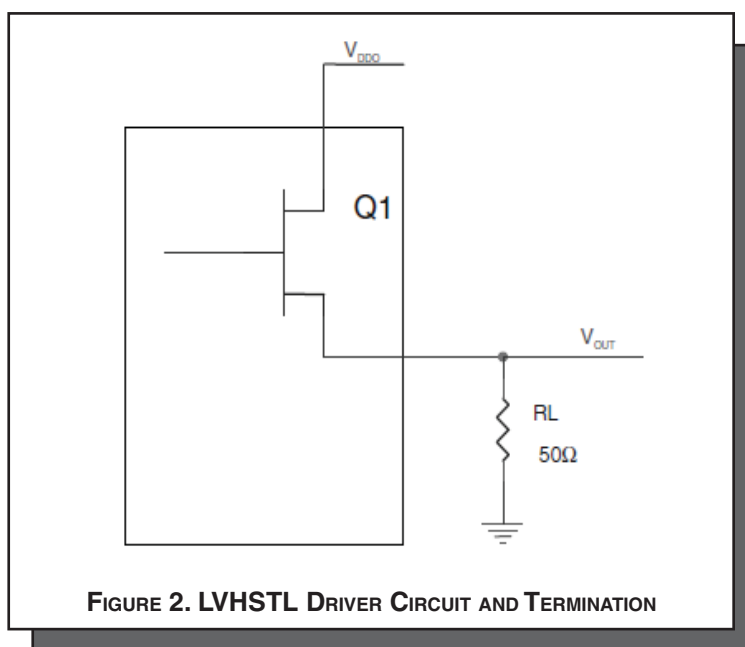
TABLE 6. THERMAL RESISTANCE θ_{JA} FOR 20-PIN TSSOP, FORCED CONVECTION

| θ_{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. | | | |

3. Calculations and Equations.

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

LVHSTL output driver circuit and termination are shown in *Figure 2*.



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.

$$Pd_H = (V_{OH_MIN} / R_L) * (V_{DDO_MAX} - V_{OH_MIN})$$

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

$$Pd_H = (1V / 50\Omega) * (2V - 1V) = \mathbf{20mW}$$

$$Pd_L = (0.4V / 50\Omega) * (2V - 0.4V) = \mathbf{12.8mW}$$

$$\text{Total Power Dissipation per output pair} = Pd_H + Pd_L = \mathbf{32.8mW}$$

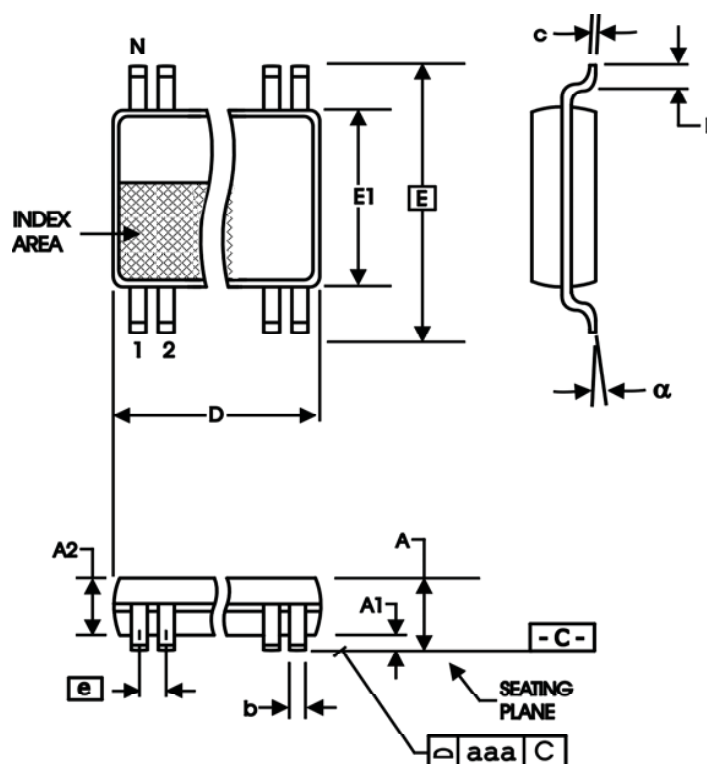
RELIABILITY INFORMATION

TABLE 7. θ_{JA} VS. AIR FLOW TABLE FOR 20 LEAD TSSOP

| θ_{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. | | | |

TRANSISTOR COUNT

The transistor count for 8525 is: 484

PACKAGE OUTLINE - G SUFFIX FOR 20 LEAD TSSOP

TABLE 8. PACKAGE DIMENSIONS

| 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 |
| α | 0° | 8° |
| aaa | -- | 0.10 |

REFERENCE DOCUMENT: JEDEC PUBLICATION 95, MO-153

TABLE 9. ORDERING INFORMATION

| Part/Order Number | Marking | Package | Shipping Packaging | Temperature |
|-------------------|-------------|---------------------------|--------------------|-------------|
| 8525BGLF | ICS8525BGLF | 20 lead "Lead-Free" TSSOP | tube | 0°C to 70°C |
| 8525BGLFT | ICS8525BGLF | 20 lead "Lead-Free" TSSOP | tape & reel | 0°C to 70°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 | | 3 | Updated Figure 1, CLK_EN Timing Diagram. | 10/17/01 |
| B | | 3 | Updated Figure 1, CLK_EN Timing Diagram. | 11/2/01 |
| B | | 1 | Features section, deleted 1.8V in Bullet 1 and 4. | 5/6/02 |
| C | T2 T9 | 1 | Added lead-free bullet. | 11/16/05 |
| | | 2 | Pin Characteristics Table - changed C_{IN} 4pF max. to 4pF typical. | |
| | | 7 | Added <i>Recommendations for Unused Input and Output Pins</i> . | |
| | | 8-9 | Corrected Power Considerations, Power Dissipation calculation. | |
| | | 12 | Ordering Information Table - added lead-free part number note. | |
| | | | Updated layout of datasheet. | |
| C | T9 | 12 | Ordering Information Table - added Lead Free marking | 8/1/07 |
| D | T9 | 12 | Updated datasheet's header/footer with IDT from ICS. | 8/1/10 |
| | | | Removed ICS prefix from Part/Order Number column. | |
| | | 14 | Added Contact Page. | |
| D | T9 | 12 | Ordering Information - removed leaded devices. | 7/8/15 |
| | | | Updated data sheet format. | |

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