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## FIN1049

# LVDS Dual-Line Driver with Dual-Line Receiver

### Features

- Greater than 400 Mbps Data Rate
- 3.3 V Power Supply Operation
- Low Power Dissipation
- Fail-Safe Protection for Open-Circuit Conditions
- Meets or Exceeds TIA/EIA-644-A LVDS Standard
- 16-pin TSSOP Package Saves Space
- Flow-Through Pinout Simplifies PCB Layout
- Enable/Disable for all Outputs
- Industrial Operating Temperature Range:  
-40°C to +85°C

### Description

This dual driver-receiver is designed for high-speed interconnects utilizing Low Voltage Differential Signaling (LVDS) technology. The driver accepts LVTTTL inputs and translates them to LVDS outputs. The receiver accepts LVDS inputs and translates them to LVTTTL outputs. The LVDS levels have a typical differential output swing of 350 mV, which provides for low EMI at ultra-low power dissipation even at high frequencies. The FIN1049 can accept LVPECL inputs for translating from LVPECL to LVDS. The En and Enb inputs are AND-ed together to enable / disable the outputs. The enables are common to all four outputs. A single-line driver and single-line receiver function is also available in the FIN1019.

### Ordering Information

| Part Number | Operating Temperature Range | Package                                                                     | Packing Method |
|-------------|-----------------------------|-----------------------------------------------------------------------------|----------------|
| FIN1049MTCX | -40 to +85°C                | 16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide | Tape and Reel  |

### Pin Configuration

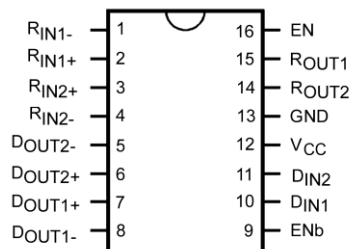


Figure 1. Pin Configuration

### Functional Diagram

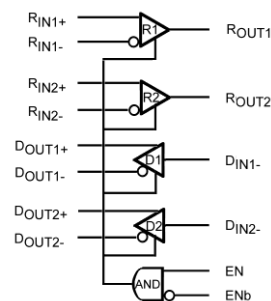


Figure 2. Functional Diagram

### Pin Definitions

| Pin #  | Name                                    | Description                                                   |
|--------|-----------------------------------------|---------------------------------------------------------------|
| 2, 3   | R <sub>IN1+</sub> , R <sub>IN2+</sub>   | Non-Inverting LVDS Inputs                                     |
| 1, 4   | R <sub>IN1-</sub> , R <sub>IN2-</sub>   | Inverting LVDS Inputs                                         |
| 7, 6   | D <sub>OUT1+</sub> , D <sub>OUT2+</sub> | Non-Inverting Driver Outputs                                  |
| 8, 5   | D <sub>OUT1-</sub> , D <sub>OUT2-</sub> | Inverting Driver Outputs                                      |
| 16, 9  | EN, ENb                                 | Driver Enable Pins for All Outputs                            |
| 15, 14 | R <sub>OUT1</sub> , R <sub>OUT2</sub>   | LVTTL Output Pins for R <sub>OUT1</sub> and R <sub>OUT2</sub> |
| 10, 11 | D <sub>IN1</sub> , D <sub>IN2</sub>     | LVTTL Input Pins for D <sub>IN1</sub> and D <sub>IN2</sub>    |
| 12     | V <sub>CC</sub>                         | Power Supply (3.3 V)                                          |
| 13     | GND                                     | Ground                                                        |

### Function Table

| Inputs |     | Outputs (LVTTL)   |                   | Inputs (LVDS) <sup>(1)</sup>     |                   | Outputs (LVDS)     |                    |
|--------|-----|-------------------|-------------------|----------------------------------|-------------------|--------------------|--------------------|
| EN     | ENb | R <sub>OUT1</sub> | R <sub>OUT2</sub> | R <sub>INn+</sub>                | R <sub>INn-</sub> | D <sub>OUTn+</sub> | D <sub>OUTn-</sub> |
| H      | L   | ON                | ON                |                                  |                   | ON                 | ON                 |
| H      | H   | Z                 | Z                 |                                  |                   | Z                  | Z                  |
| L      | H   | Z                 | Z                 |                                  |                   | Z                  | Z                  |
| L      | L   | Z                 | Z                 |                                  |                   | Z                  | Z                  |
| H      | L   | H                 | H                 | Open Current Fail-Safe Condition |                   |                    |                    |

**Legend:**

H=HIGH Logic Level  
 L=LOW Logic Level or OPEN  
 X=Don't Care  
 Z=High Impedance

**Note:**

1. Any unused receiver Inputs should be left open.

## Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

| Symbol           | Parameter                                 | Min. | Max.   | Unit |
|------------------|-------------------------------------------|------|--------|------|
| V <sub>CC</sub>  | Supply Voltage                            | -0.5 | +4.6   | V    |
| V <sub>IN</sub>  | LVDS DC Input Voltage                     | -0.5 | +4.6   | V    |
| V <sub>OUT</sub> | LVDS DC Output Voltage                    | -0.5 | +4.6   | V    |
| I <sub>OSD</sub> | Driver Short-Circuit Current (Continuous) | 10   |        | mA   |
| T <sub>STG</sub> | Storage Temperature Range                 | -65  | +150   | °C   |
| T <sub>J</sub>   | Max Junction Temperature                  |      | +150   | °C   |
| T <sub>L</sub>   | Lead Temperature (Soldering, 10 Seconds)  |      | +260   | °C   |
| ESD              | Human Body Model, JESD22-A114             |      | ≥ 7000 | V    |
|                  | Machine Model, JESD22-A115                |      | ≥ 250  |      |

## Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to Absolute Maximum Ratings.

| Symbol          | Parameter                         | Min. | Max.            | Unit |
|-----------------|-----------------------------------|------|-----------------|------|
| V <sub>CC</sub> | Supply Voltage                    | 3.0  | 3.6             | V    |
| V <sub>ID</sub> | Magnitude of Differential Voltage | 100  | V <sub>CC</sub> | mV   |
| T <sub>A</sub>  | Operating Temperature             | -40  | +85             | °C   |

## DC Electrical Characteristics

Over-supply voltage and operating temperature ranges, unless otherwise specified. All typical values are at  $T_A=25^\circ\text{C}$  and with  $V_{CC}=3.3\text{ V}$ .

| Symbol                                                                                                             | Parameter                                                                        | Conditions                                                                                    | Min.       | Typ.  | Max.                  | Units         |
|--------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|------------|-------|-----------------------|---------------|
| <b>LVDS Input DC Specifications</b> ( $R_{IN1+}$ , $R_{IN1-}$ , $R_{IN2+}$ , $R_{IN2-}$ ) See Figure 3 and Table 1 |                                                                                  |                                                                                               |            |       |                       |               |
| $V_{TH}$                                                                                                           | Differential Input Threshold HIGH                                                | $V_{CM}=1.2\text{ V}$ , $0.05\text{ V}$ , $2.35\text{ V}$                                     |            | 0     | 35                    | mV            |
| $V_{TL}$                                                                                                           | Differential Input Threshold LOW                                                 |                                                                                               | -100       | 0     |                       | mV            |
| $V_{IC}$                                                                                                           | Common Mode Voltage Range                                                        | $V_{ID}=100\text{ mV}$ , $V_{CC}=3.3\text{ V}$                                                | $V_{ID}/2$ |       | $V_{CC} - (V_{ID}/2)$ | V             |
| $I_{IN}$                                                                                                           | Input Current                                                                    | $V_{CC}=0\text{ V}$ or $3.6\text{ V}$ ,<br>$V_{IN}=0\text{ V}$ or $2.8\text{ V}$              |            |       | $\pm 20$              | mA            |
| <b>CMOS/ LVTTTL Input DC Specifications</b> ( $EN$ , $ENb$ , $D_{IN1}$ , $D_{IN2}$ )                               |                                                                                  |                                                                                               |            |       |                       |               |
| $V_{IH}$                                                                                                           | Input High Voltage (LVTTTL)                                                      |                                                                                               | 2.0        |       | $V_{CC}$              | V             |
| $V_{IL}$                                                                                                           | Input Low Voltage (LVTTTL)                                                       |                                                                                               | GND        |       | 0.8                   | V             |
| $I_{IN}$                                                                                                           | Input Current ( $EN$ , $ENb$ , $D_{IN1}$ , $D_{IN2}$ , $R_{INx+}$ , $R_{INx-}$ ) | $V_{IN}=0\text{ V}$ or $V_{CC}$                                                               |            |       | $\pm 20$              | $\mu\text{A}$ |
| $V_{IK}$                                                                                                           | Input Clamp Voltage                                                              | $V_{IK}=-18\text{ mA}$                                                                        | -1.5       | -0.7  |                       | V             |
| <b>LVDS Output DC Specifications</b> ( $D_{OUT1+}$ , $D_{OUT1-}$ , $D_{OUT2+}$ , $D_{OUT2-}$ )                     |                                                                                  |                                                                                               |            |       |                       |               |
| $V_{OD}$                                                                                                           | Output Differential Voltage                                                      | See Figure 4                                                                                  | 250        | 350   | 450                   | mV            |
| $\Delta V_{OD}$                                                                                                    | $V_{OD}$ Magnitude Change from                                                   | $R_L=100\ \Omega$                                                                             |            |       | 35                    | mV            |
|                                                                                                                    | Differential LOW-to-HIGH                                                         | Driver Enabled                                                                                |            |       |                       |               |
| $V_{OS}$                                                                                                           | Offset Voltage                                                                   | See Figure 4                                                                                  | 1.125      | 1.250 | 1.375                 | V             |
| $\Delta V_{OS}$                                                                                                    | Offset Magnitude Change from Differential LOW-to-HIGH                            |                                                                                               |            |       | 25                    | mV            |
| $I_{OS}$                                                                                                           | Short-Circuit Output Current                                                     | $D_{OUT+}=0\text{ V}$ & $D_{OUT-}=0\text{ V}$ ,<br>Driver Enabled                             |            |       | -9                    | mA            |
| $I_{OSD}$                                                                                                          |                                                                                  | $V_{OD}=0\text{ V}$ , Driver Enabled                                                          |            |       | -9                    | mA            |
| $I_{OFF}$                                                                                                          | Power-Off Input or Output Current                                                | $V_{CC}=0\text{ V}$ , $V_{OUT}=0\text{ V}$ or $V_{CC}$                                        |            |       | $\pm 20$              | mA            |
| $I_{OZD}$                                                                                                          | Disabled Output Leakage Current                                                  | Driver Disabled,<br>$D_{OUT+}=0\text{ V}$ or $V_{CC}$ or<br>$D_{OUT-}=0\text{ V}$ or $V_{CC}$ |            |       | $\pm 10$              | mA            |
| <b>CMOS/LVTTTL Output DC Specifications</b> ( $R_{OUT1}$ , $R_{OUT2}$ )                                            |                                                                                  |                                                                                               |            |       |                       |               |
| $V_{OH}$                                                                                                           | Output High Voltage                                                              | $I_{OH}=-2\text{ mA}$ , $V_{ID}=200\text{ mV}$                                                | 2.7        |       |                       | V             |
| $V_{OL}$                                                                                                           | Output Low Voltage                                                               | $I_{OL}=2\text{ mA}$ , $V_{ID}=200\text{ mV}$                                                 |            |       | 0.25                  | V             |
| $I_{OZ}$                                                                                                           | Disabled Output Leakage Current                                                  | Driver Disabled,<br>$R_{OUTn}=0\text{ V}$ or $V_{CC}$                                         |            |       | $\pm 10$              | mA            |
| $I_{CC}$                                                                                                           | Power Supply Current <sup>(2)</sup>                                              | Drivers Enabled, Any Valid Input Condition                                                    |            |       | 25                    | mA            |
| $I_{CCZ}$                                                                                                          | Power Supply Current                                                             | Drivers Disabled                                                                              |            |       | 10                    | mA            |
| $C_{IND}$                                                                                                          | Input Capacitance                                                                | LVDS Input                                                                                    |            | 3.0   |                       | pF            |
| $C_{OUT}$                                                                                                          | Output Capacitance                                                               | LVDS Output                                                                                   |            | 4.0   |                       | pF            |
| $C_{INT}$                                                                                                          | Input Capacitance                                                                | LVTTTL Input                                                                                  |            | 3.5   |                       | pF            |

### Note:

- Both driver and receiver inputs are static. All LVDS outputs have  $100\ \Omega$  load. None of the outputs have any lumped capacitive load.

## AC Electrical Characteristics

Over-supply voltage and operating temperature ranges, unless otherwise specified. All typical values are at  $T_A=25^\circ\text{C}$  and with  $V_{CC}=3.3\text{ V}$ .

| Symbol                                           | Parameter                                   | Conditions                          | Min. | Typ. | Max. | Units |
|--------------------------------------------------|---------------------------------------------|-------------------------------------|------|------|------|-------|
| <b>Switching Characteristics - LVDS Outputs</b>  |                                             |                                     |      |      |      |       |
| $t_{PLHD}$                                       | Differential Propagation Delay LOW-to-HIGH  | See Figure 5, Figure 6              |      |      | 2    | ns    |
| $t_{PHLD}$                                       | Differential Propagation Delay HIGH-to-LOW  |                                     |      |      | 2    | ns    |
| $t_{TLHD}$                                       | Differential Output Rise Time (20% to 80%)  |                                     | 0.2  |      | 1.0  | ns    |
| $t_{THLD}$                                       | Differential Output Fall Time (80% to 20%)  |                                     | 0.2  |      | 1.0  | ns    |
| $t_{SK(P)}$                                      | Pulse Skew $ t_{PLH} - t_{PHL} $            |                                     |      |      | 0.35 | ns    |
| $t_{SK(LH)}$ ,<br>$t_{SK(HL)}$                   | Channel-to-Channel Skew <sup>(3)</sup>      |                                     |      |      | 0.35 | ns    |
| $t_{SK(PP)}$                                     | Part-to-Part Skew <sup>(4)</sup>            |                                     |      |      | 1    | ns    |
| $t_{PZH}$                                        | Differential Output Enable Time, Z-to-HIGH  | See Figure 7, Figure 8              |      |      | 6    | ns    |
| $t_{PZL}$                                        | Differential Output Enable Time, A-to-LOW   |                                     |      |      | 6    | ns    |
| $t_{PHZ}$                                        | Differential Output Disable Time, HIGH-to-Z |                                     |      |      | 3    | ns    |
| $t_{PLZ}$                                        | Differential Output Disable Time, LOW-to-Z  |                                     |      |      | 3    | ns    |
| $f_{MAXD}$                                       | Maximum Frequency <sup>(5)</sup>            | See Figure 5                        | 200  |      |      | MHz   |
| <b>Switching Characteristics - LVTTL Outputs</b> |                                             |                                     |      |      |      |       |
| $t_{PHL}$                                        | Propagation Delay HIGH-to-LOW               | Measured from 20% to 80% Signal     | 0.5  | 1.0  | 3.5  | ns    |
| $t_{PLH}$                                        | Propagation Delay LOW-to-HIGH               | $V_{ID}=200\text{ mV}$              | 0.5  | 1.0  | 3.5  | ns    |
| $t_{SK1}$                                        | Pulse Skew                                  | Distributed Load                    | 0    | 35   | 400  | ps    |
| $t_{SK2}$                                        | Channel-to-Channel Skew                     | $C_L=15\text{ pF}$ and $50\ \Omega$ | 0    | 50   | 500  | ps    |
| $t_{SK3}$                                        | Part-to-Part Skew                           | $R_L=1\text{ k}\Omega$              | 0    |      | 1    | ns    |
| $t_{LHR}$                                        | Transition Time LOW-to-HIGH                 | $V_{OS}=1.2\text{ V}$               | 0.10 | 0.25 | 1.40 | ns    |
| $t_{HLR}$                                        | Transition Time HIGH-to-LOW                 | See Figure 9, Figure 10             | 0.10 | 0.18 | 1.40 | ns    |
| $t_{PHZ}$                                        | Disable Time HIGH-to-Z                      | See Figure 11, Figure 12            | 2.2  | 4.5  | 8.0  | ns    |
| $t_{PLZ}$                                        | Disable Time LOW-to-Z                       |                                     | 1.3  | 3.5  | 8.0  | ns    |
| $t_{PZH}$                                        | Enable Time Z-to-HIGH                       |                                     | 1.8  | 3.0  | 7.0  | ns    |
| $t_{PZL}$                                        | Enable Time Z-to-LOW                        |                                     | 0.9  | 1.4  | 7.0  | ns    |
| $f_{MAXT}$                                       | Maximum Frequency <sup>(6)</sup>            | See Figure 9                        | 200  |      |      | MHz   |

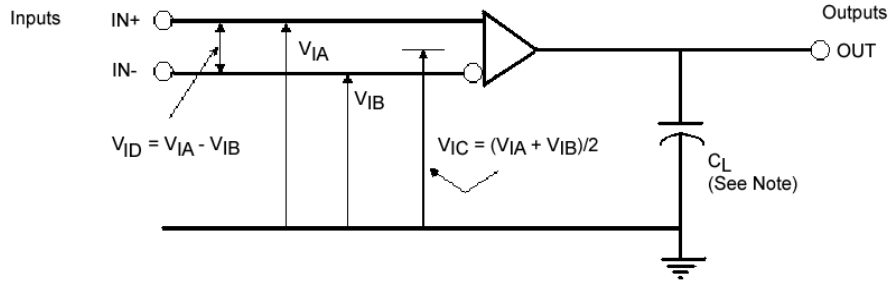
### Notes:

- $t_{SK(LH)}$ ,  $t_{SK(HL)}$  is the skew between specified outputs of a single device when the outputs have identical loads and are switching in the same direction.
- $t_{SK(PP)}$  is the magnitude of the difference in propagation delay times between any specified terminals of two devices switching in the same direction (either LOW-to-HIGH or HIGH-to-LOW) when both devices operate with the same supply voltage, same temperature, and have identical test circuits.
- $f_{MAXD}$  generator input conditions:  $t_r=t_f < 1\text{ ns}$  (10% to 90%), 50% duty cycle, 0 V to 3 V. Output criteria: duty cycle=45% / 55%,  $V_{OD} > 250\text{ mV}$ , all channels switch.
- $f_{MAXT}$  generator input conditions:  $t_r=t_f < 1\text{ ns}$  (10% to 90%), 50% duty cycle,  $V_{ID}=200\text{ mV}$ ,  $V_{CM}=1.2\text{ V}$ . Output criteria: duty cycle=45% / 55%,  $V_{OH} > 2.7\text{ V}$ .  $V_{OL} < 0.25\text{ V}$ , all channels switching.

## Required Specifications and Test Diagrams

**Notes:**

7. Electrostatic Discharge Capability: Human Body Model and Machine Model ESD should be measured using MIL-STD-883C method 3015.7 standard.
8. Latch-up immunity should be tested to the EIA/JEDEC Standard Number 78 (EIA/JESD78).



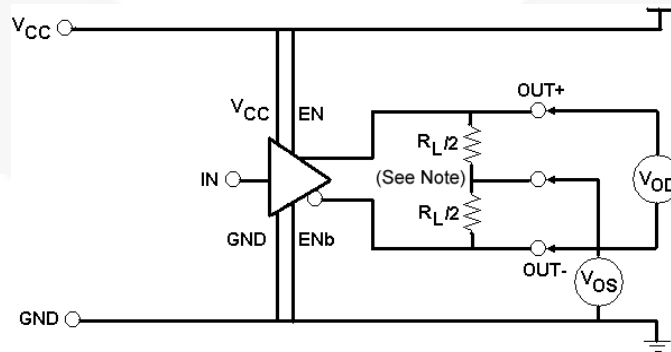
**Figure 3. Differential Receiver Voltage Definitions Test Circuit**

**Note:**

9.  $C_L=15$  pF, includes all probe and jig capacitances.

**Table 1. Receiver Minimum and Maximum Input Threshold Test Voltages**

| Applied Voltages (V) |                | Resulting Differential Input Voltage (mV) | Resulting Common Mode Input Voltage (V) |
|----------------------|----------------|-------------------------------------------|-----------------------------------------|
| $V_{IA}$             | $V_{IB}$       | $V_{ID}$                                  | $V_{IC}$                                |
| 1.25                 | 1.15           | 100                                       | 1.2                                     |
| 1.15                 | 1.25           | -100                                      | 1.2                                     |
| $V_{CC}$             | $V_{CC} - 0.1$ | 100                                       | $V_{CC} - 0.05$                         |
| $V_{CC} - 0.1$       | $V_{CC}$       | -100                                      | $V_{CC} - 0.05$                         |
| 0.1                  | 0.0            | 100                                       | 0.05                                    |
| 0.0                  | 0.1            | -100                                      | 0.05                                    |
| 1.75                 | 0.65           | 1100                                      | 1.2                                     |
| 0.65                 | 1.75           | -1100                                     | 1.2                                     |
| $V_{CC}$             | $V_{CC} - 1.1$ | 1100                                      | $V_{CC} - 0.55$                         |
| $V_{CC} - 1.1$       | $V_{CC}$       | -1100                                     | $V_{CC} - 0.55$                         |
| 1.1                  | 0.0            | 1100                                      | 0.55                                    |
| 0.0                  | 1.1            | -1100                                     | 0.55                                    |



**Figure 4. LVDS Output Circuit for DC Test**

**Note:**

10.  $R_L=100 \Omega$ .

Required Specifications and Test Diagrams (Continued)

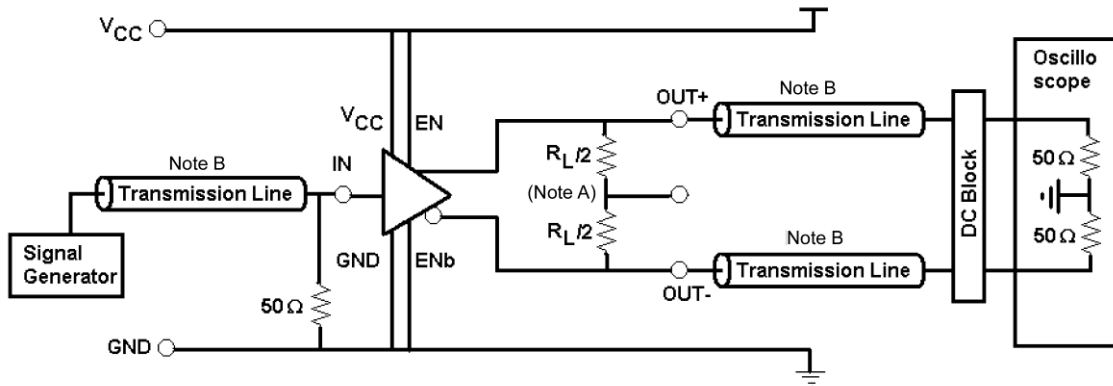


Figure 5. LVDS Output Propagation Delay and Transition Time Test Circuit

Notes:

- 11. A:  $R_L=100\ \Omega$ .
- 12. B:  $Z_0=50\ \Omega$  and  $C_T=15\ \text{pF}$  distributed.

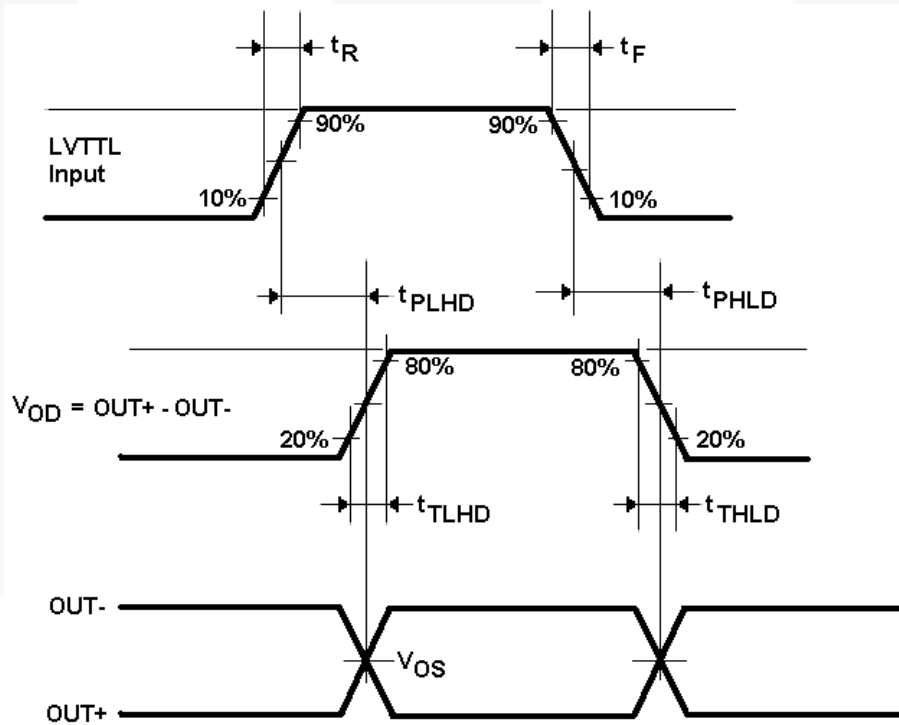


Figure 6. LVTTTL Input to LVDS Output AC Waveform



Required Specifications and Test Diagrams (Continued)

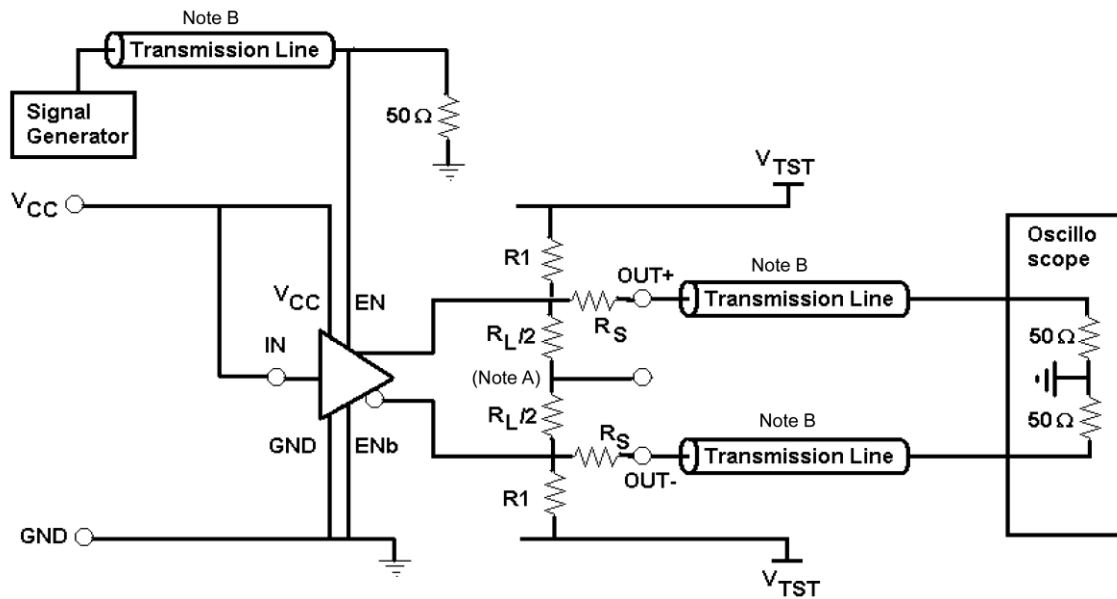


Figure 7. LVDS Output Enable / Disable Delay Test Circuit

Notes:

- 13. A:  $R_L=100 \Omega$ .
- 14. B:  $Z_O=50 \Omega$  and  $C_T=15 \text{ pF}$  distributed.
- 15.  $R_1=1000 \Omega$ ,  $R_S=950 \Omega$ .
- 16.  $V_{TST}=2.4 \text{ V}$ .

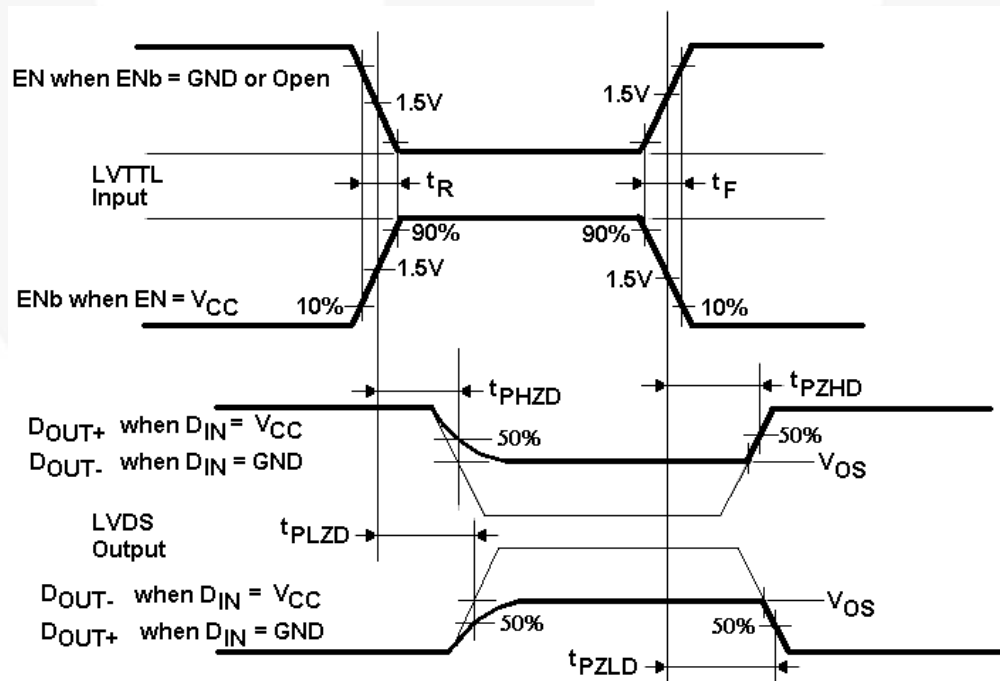
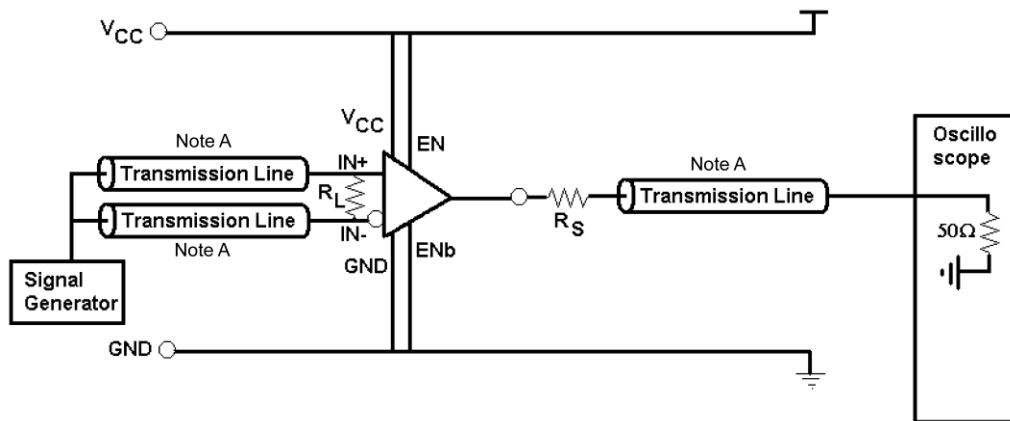


Figure 8. LVDS Output Enable / Disable Timing Waveforms

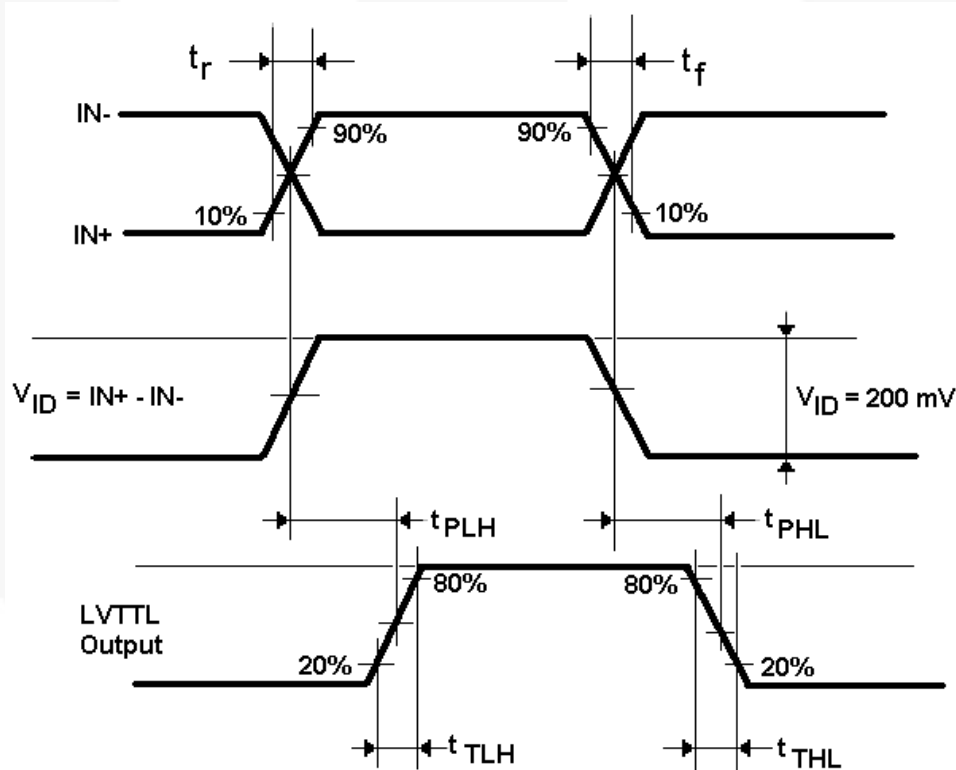
**Required Specifications and Test Diagrams (Continued)**



**Figure 9. LVTTTL Output Propagation Delay and Transition Time Test Circuit**

**Notes:**

- 17. A:  $Z_0=50\ \Omega$  and  $C_T=15\ \text{pF}$  distributed.
- 18.  $R_L=100\ \Omega$  and  $R_S=950\ \Omega$ .



**Figure 10. LVDS Input to LVTTTL Output Propagation Delay and Transition Time Waveforms**

Required Specifications and Test Diagrams (Continued)

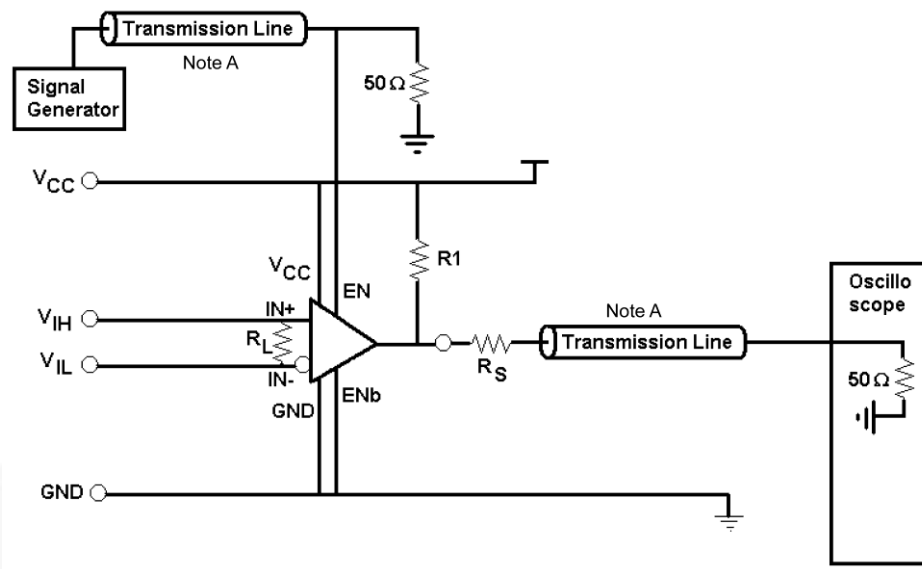


Figure 11. LVTTTL Output Enable / Disable Test Circuit

Notes:

- 19. A:  $Z_0=50\ \Omega$  and  $C_T=15\ \text{pF}$  distributed.
- 20.  $R_L=100\ \Omega$ ,  $R_1=1000\ \Omega$ , and  $R_S=950\ \Omega$ .

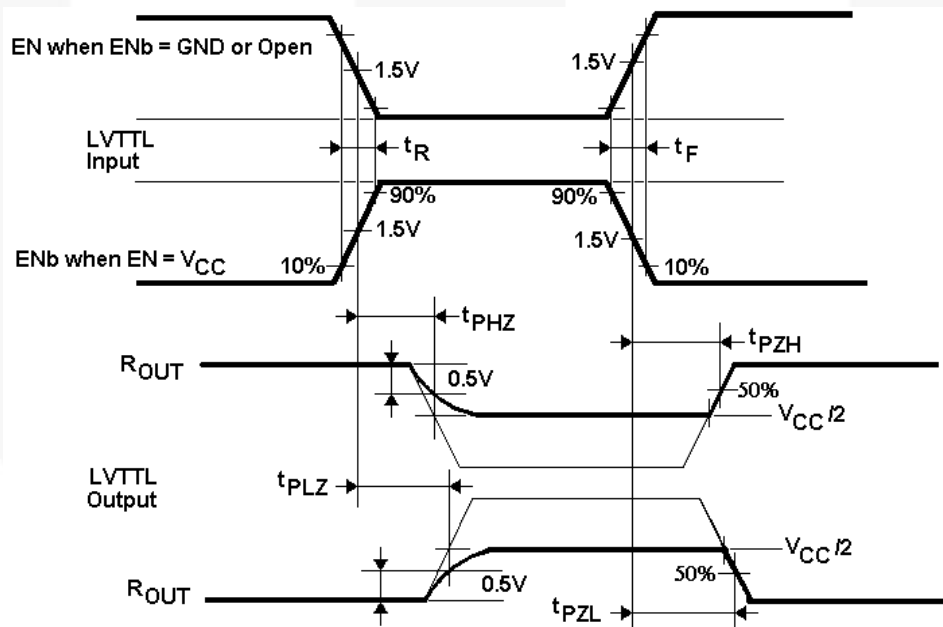
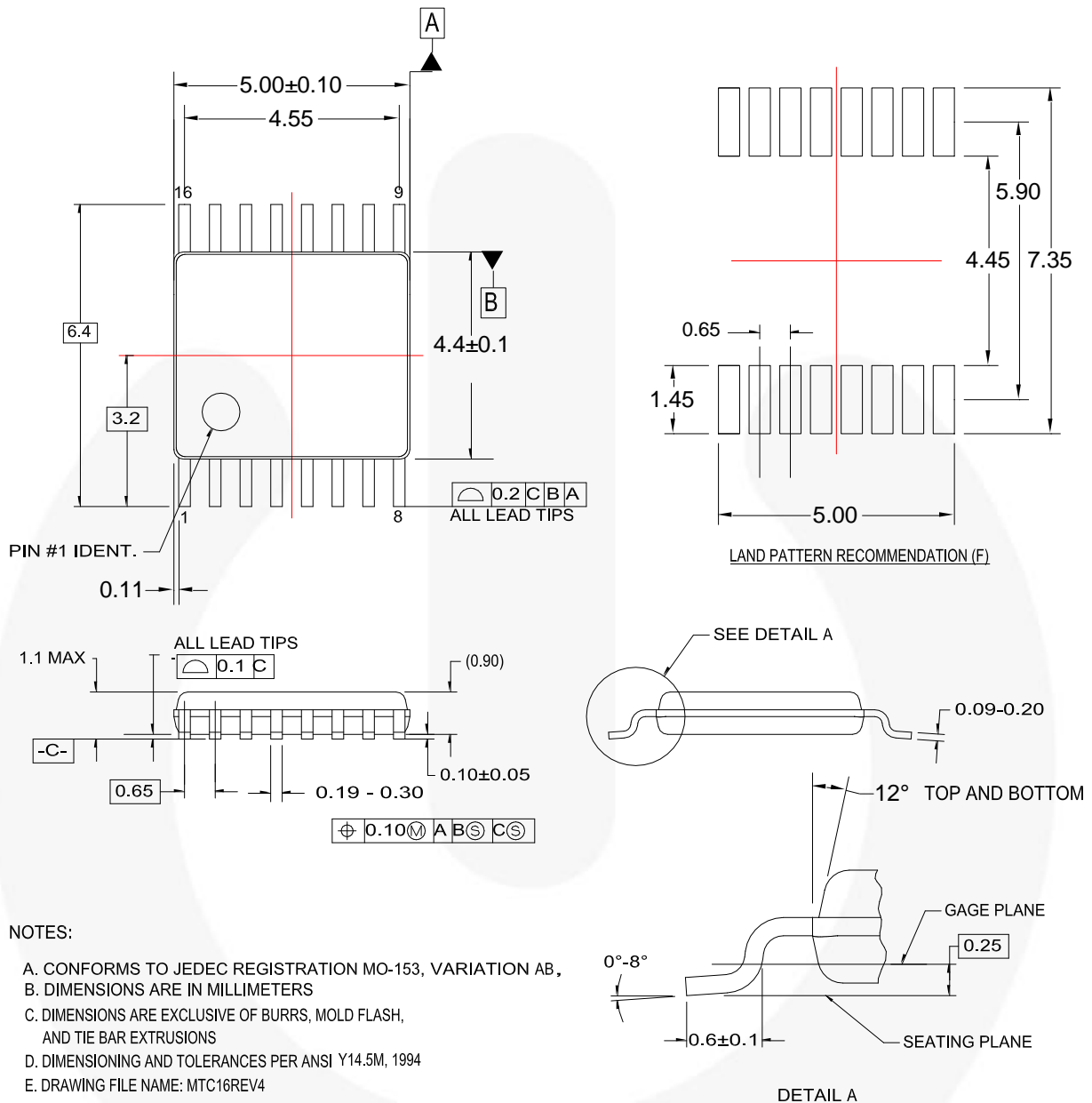


Figure 12. LVTTTL Output Enable / Disable Timing Waveforms

Physical Dimensions



NOTES:

- A. CONFORMS TO JEDEC REGISTRATION MO-153, VARIATION AB,
- B. DIMENSIONS ARE IN MILLIMETERS
- C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS
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- E. DRAWING FILE NAME: MTC16REV4
- F. LAND PATTERN RECOMMENDATION PER IPC7351 - ID# TSOP65P640X110-16N

MTC16rev4

Figure 13.16-Lead, Thin-Shrink Small-Outline Package (TSSOP), JEDEC MO-153, 4.4 mm Wide

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