

## GTLP16T1655

### 16-Bit LVTTTL/GTLP Universal Bus Transceiver with High Drive GTLP and Individual Byte Controls

#### General Description

The GTLP16T1655 is a 16-bit universal bus transceiver that provides LVTTTL to GTLP signal level translation. It allows for transparent, latched and clocked modes of data transfer. The device provides a high speed interface between cards operating at LVTTTL logic levels and a backplane operating at GTLP logic levels. High speed backplane operation is a direct result of GTLP's reduced output swing (<1V), reduced input threshold levels and output edge rate control. The edge rate control minimizes bus settling time. GTLP is a Fairchild Semiconductor derivative of the Gunning Transceiver Logic (GTL) JEDEC standard JESD8-3.

Fairchild's GTLP has internal edge-rate control and is process, voltage, and temperature (PVT) compensated. Its function is similar to BTL and GTL but with different output levels and receiver threshold. GTLP output LOW level is typically less than 0.5V, the output level HIGH is 1.5V and the receiver threshold is 1.0V.

#### Features

- Bidirectional interface between GTLP and LVTTTL logic levels
- Variable edge rate control pin to select desired edge rate on the GTLP backplane ( $V_{ERC}$ )
- $V_{REF}$  pin provides external supply reference voltage for receiver threshold adjustability
- Special PVT compensation circuitry to provide consistent performance over variations of process, supply voltage and temperature
- TTL compatible driver and control inputs
- Designed using Fairchild advanced BiCMOS technology
- Bushold data inputs on A port to eliminate the need for external pull-up resistors for unused inputs
- Power up/down and power off high impedance for live insertion
- Open drain on GTLP to support wired-or connection
- Flow through pinout optimizes PCB layout
- D-type flip-flop, latch and transparent data paths
- A Port source/sink  $-24\text{mA}/+24\text{mA}$
- B Port sink  $+100\text{mA}$
- Partitioned as two 8-bit transceivers with individual latch timing and output control but with a common clock
- External pin to pre-condition I/O capacitance to high state ( $V_{CCBIAS}$ )

#### Ordering Code:

| Order Number   | Package Number | Package Description   |
|----------------|----------------|---|
| GTLP16T1655MTD | MTD64          | 64-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide |

Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

GTLP16T1655 16-Bit LVTTTL/GTLP Universal Bus Transceiver with High Drive GTLP and Individual Byte Controls

### Connection Diagram

|                 |    |    |                     |
|-----------------|----|----|---------------------|
| 1OEAB           | 1  | 64 | CLK                 |
| 1OEBA           | 2  | 63 | 1LEAB               |
| V <sub>CC</sub> | 3  | 62 | 1LEBA               |
| 1A1             | 4  | 61 | VERC                |
| GND             | 5  | 60 | GND                 |
| 1A2             | 6  | 59 | 1B1                 |
| 1A3             | 7  | 58 | 1B2                 |
| GND             | 8  | 57 | GND                 |
| 1A4             | 9  | 56 | 1B3                 |
| GND             | 10 | 55 | 1B4                 |
| 1A5             | 11 | 54 | 1B5                 |
| GND             | 12 | 53 | GND                 |
| 1A6             | 13 | 52 | 1B6                 |
| 1A7             | 14 | 51 | 1B7                 |
| V <sub>CC</sub> | 15 | 50 | V <sub>CC</sub>     |
| 1A8             | 16 | 49 | 1B8                 |
| 2A1             | 17 | 48 | 2B1                 |
| GND             | 18 | 47 | GND                 |
| 2A2             | 19 | 46 | 2B2                 |
| 2A3             | 20 | 45 | 2B3                 |
| GND             | 21 | 44 | GND                 |
| 2A4             | 22 | 43 | 2B4                 |
| 2A5             | 23 | 42 | 2B5                 |
| GND             | 24 | 41 | V <sub>REF</sub>    |
| 2A6             | 25 | 40 | 2B6                 |
| GND             | 26 | 39 | GND                 |
| 2A7             | 27 | 38 | 2B7                 |
| V <sub>CC</sub> | 28 | 37 | 2B8                 |
| 2A8             | 29 | 36 | V <sub>CCBIAS</sub> |
| GND             | 30 | 35 | 2LEAB               |
| 2OEAB           | 31 | 34 | 2LEBA               |
| 2OEBA           | 32 | 33 | OE                  |

### Pin Descriptions

| Pin Names        | Description                            |
|------------------|--|
| 1OEAB            | A-to-B Output Enable (Active LOW)      |
| 2OEAB            | Byte 1 and Byte 2                      |
| 1OEBA            | B-to-A Output Enable (Active LOW)      |
| 2OEBA            | Byte 1 and Byte 2                      |
| OE               | Disables all I/O ports simultaneously  |
| 1LEAB            | A-to-B Latch Enable (Transparent HIGH) |
| 2LEAB            | Byte 1 and Byte 2                      |
| 1LEBA            | B-to-A Latch Enable (Transparent HIGH) |
| 2LEBA            | Byte 1 and Byte 2                      |
| V <sub>REF</sub> | GTL16 Reference Voltage                |
| CLK              | A-to-B and B-to-A Clock                |
| 1A1-1A8          | A Port I/O Byte 1 and Byte 2           |
| 2A1-2A8          |  |
| 1B1-1B8          | B Port I/O Byte 1 and Byte 2           |
| 2B1-2B8          |  |

### Truth Tables

(Note 1)

| Inputs |      |     |   | Output<br>B             | Mode           |
|--------|------|-----|---|-------------------------|----------------|
| OEAB   | LEAB | CLK | A |                         |                |
| H      | X    | X   | X | Z                       | High Impedance |
| L      | H    | X   | L | L                       | Transparent    |
| L      | H    | X   | H | H                       | Transparent    |
| L      | L    | ↑   | L | L                       | Registered     |
| L      | L    | ↑   | H | H                       | Registered     |
| L      | L    | H   | X | B <sub>0</sub> (Note 2) | Previous State |
| L      | L    | L   | X | B <sub>0</sub> (Note 3) | Previous State |

| Inputs |                  |                  | Outputs |        |
|--------|------------------|------------------|---------|--------|
| OE     | OEAB<br>(Note 4) | OEBA<br>(Note 4) | A Port  | B Port |
| L      | L                | L                | Active  | Active |
| L      | L                | H                | Z       | Active |
| L      | H                | L                | Active  | Z      |
| L      | H                | H                | Z       | Z      |
| H      | X                | X                | Z       | Z      |

| Inputs           | Output Edge |
|------------------|-------------|
| V <sub>ERC</sub> | B Port      |
| V <sub>CC</sub>  | Slow        |
| GND              | Fast        |

**Note 1:** A-to-B data flow is shown. B-to-A data flow is similar but uses OEBA, LEBA, CLK.

**Note 2:** Output level before the indicated steady state input conditions were established, provided CLK was HIGH prior to LEAB going LOW.

**Note 3:** Output level before the indicated steady state input conditions were established.

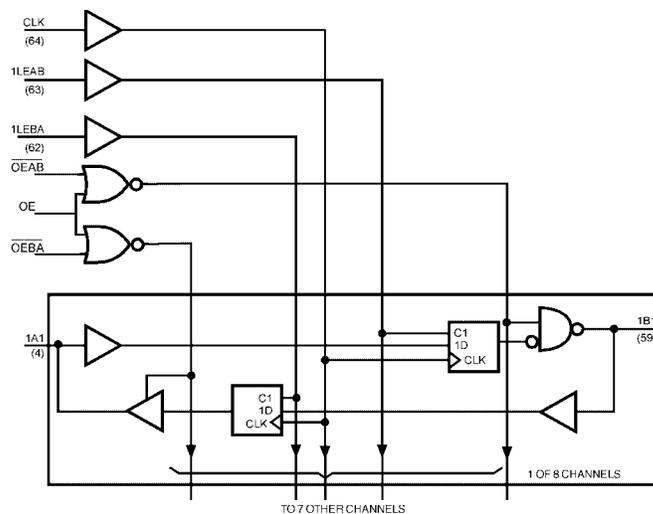
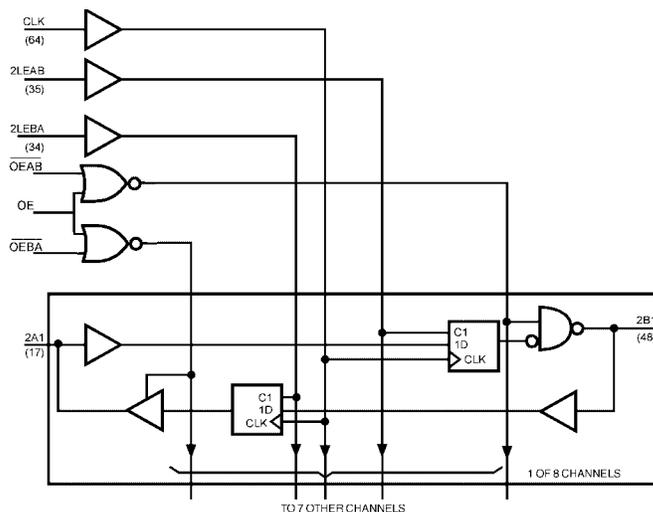
**Note 4:** OEAB and OEBA are byte-wide enables. Each is preceded by a number indicating the byte controlled.

## Functional Description

The GTLP16T1655 is a high drive (100 mA) 16-bit universal bus transceiver containing D-type flip-flop, latch and transparent modes of operation for the data path. The device is uniquely partitioned as two 8-bit transceivers with individual latch timing and output control signals but with a common clock pin (CLK) for both transceiver words. Data flow for each word is determined by the respective latch enables (xLEAB and xLEBA), output enables (xOEAB and xOEBA) and clock (CLK). The output enables (1OEAB, 1OEBA, 2OEAB and 2OEBA) control Byte1 and Byte2 data for the A to B and B to A directions respectively.

For A-to-B data flow, the devices operate in the transparent mode when LEAB is HIGH. When LEAB transitions LOW, the A data is latched independent of CLK HIGH or LOW. If LEAB is LOW the A data is registered on the CLK LOW-to-HIGH transition. When OEAB is LOW the outputs are active. With OEAB HIGH the outputs are HIGH impedance. Data flow for the B-to-A direction is identical but uses OEBA, LEBA and CLK. Note that CLK is common to both directions and both 8-bit words. OE is also common and is used to disable all I/O ports simultaneously.

## Logic Diagrams



### Absolute Maximum Ratings (Note 5)

|  |                 |
|--|-----------------|
| Supply Voltage ( $V_{CC}$ )  | -0.5V to +4.6V  |
| DC Input Voltage ( $V_I$ )   | -0.5V to +4.6V  |
| DC Output Voltage ( $V_O$ )  |                 |
| Outputs 3-STATE  | -0.5V to +4.6V  |
| Outputs Active (Note 6)  | -0.5V to + 4.6V |
| DC Output Sink Current into  |                 |
| A Port $I_{OL}$  | 48 mA           |
| DC Output Source Current from  |                 |
| A Port $I_{OH}$  | -48 mA          |
| DC Output Sink Current into B Port in the LOW State, $I_{OL}$ (Note 7) | 200 mA          |
| DC Input Diode Current ( $I_{IK}$ )                                    |                 |
| $V_I < 0V$   | -50 mA          |
| DC Output Diode Current ( $I_{OK}$ )                                   |                 |
| $V_O < 0V$   | -50 mA          |
| $V_O > V_{CC}$   | +50 mA          |
| ESD Rating   | >2000V          |
| Storage Temperature ( $T_{STG}$ )                                      | -65°C to +150°C |

### Recommended Operating Conditions

|  |                  |
|--|------------------|
| Supply Voltage $V_{CC}$                | 3.0V to 3.6V     |
| Bus Termination Voltage ( $V_{TT}$ )   |                  |
| GTLP                                   | 1.35V to 1.65V   |
| GTL                                    | 1.14V to 1.26V   |
| $V_{REF}$                              |                  |
| GTLP                                   | 0.87V to 1.1V    |
| GTL                                    | 0.74V to 0.87V   |
| Input Voltage ( $V_I$ )                |                  |
| on A Port and Control Pins             | 0.0V to $V_{CC}$ |
| on B Port                              | 0.0V to $V_{tt}$ |
| HIGH Level Output Current ( $I_{OH}$ ) |                  |
| A Port                                 | -24 mA           |
| LOW Level Output Current ( $I_{OL}$ )  |                  |
| A Port                                 | +24mA            |
| B Port                                 | +100 mA          |
| Operating Temperature ( $T_A$ )        | -40°C to +85°C   |

**Note 5:** The Absolute Maximum Ratings are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the absolute maximum rating. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

**Note 6:**  $I_O$  Absolute Maximum Rating must be observed.

**Note 7:**  $V_{TT}$  and  $R_{term}$  can be adjusted to accommodate backplane impedances other than 50Ω, within the boundaries of not exceeding the DC Absolute  $I_{OL}$  ratings (200 mA). Similarly  $V_{REF}$  can be adjusted to compensate for changes in  $V_{TT}$ .

### DC Electrical Characteristics

Over Recommended Operating Free-Air Temperature Range,  $V_{REF} = 1.0V$  (unless otherwise noted).

| Symbol        |                  | Test Conditions                       |                                | Min              | Typ (Note 8) | Max              | Units |
|---------------|------------------|---------------------------------------|--------------------------------|------------------|--------------|------------------|-------|
| $V_{IH}$      | B Port           |                                       |                                | $V_{REF} + 0.05$ |              | $V_{TT}$         | V     |
|               | Others           |                                       |                                | 2.0              |              |                  | V     |
| $V_{IL}$      | B Port           |                                       |                                | 0.0              |              | $V_{REF} - 0.05$ | V     |
|               | Others           |                                       |                                |                  |              | 0.8              | V     |
| $V_{REF}$     | GTLP             |                                       |                                | 0.74             | 1.0          | 1.1              | V     |
| $V_{IK}$      |                  | $V_{CC} = 3.0V$                       | $I_I = -18 mA$                 |                  |              | -1.2             | V     |
| $V_{OH}$      | A Port           | $V_{CC} = \text{Min to Max (Note 9)}$ | $I_{OH} = -100 \mu A$          | $V_{CC} - 0.2$   |              |                  | V     |
|               |                  | $V_{CC} = 3.0V$                       | $I_{OH} = -12 mA$              | 2.4              |              |                  |       |
|               |                  |                                       | $I_{OH} = -24 mA$              | 2.2              |              |                  |       |
| $V_{OL}$      | A Port           | $V_{CC} = \text{Min to Max (Note 9)}$ | $I_{OL} = 100 \mu A$           |                  |              | 0.20             | V     |
|               |                  | $V_{CC} = 3.0V$                       | $I_{OL} = 12 mA$               |                  |              | 0.40             |       |
|               |                  | $I_{OL} = 24 mA$                      |                                |                  | 0.50         |                  |       |
|               | B Port           | $V_{CC} = 3.0V$                       | $I_{OL} = 40 mA$               |                  |              | 0.20             |       |
|               |                  |                                       | $I_{OL} = 80 mA$               |                  |              | 0.40             |       |
|               |                  | $I_{OL} = 100 mA$                     |                                |                  | 0.50         |                  |       |
| $I_I$         | A Port           | $V_{CC} = 3.6V$                       | $V_I = V_{CC}$ or 0V           |                  |              | ±10              | μA    |
|               | Control Pins     | $V_{CC} = 3.6V$                       | $V_I = V_{CC}$ or 0V           |                  |              | ±10              | μA    |
|               | B Port           | $V_{CC} = 3.6V$                       | $V_I = V_{TT}$ or GND          |                  |              | ±10              | μA    |
| $I_{OFF}$     | Except $V_{ERC}$ | $V_{CC} = 0$                          | $V_I$ or $V_O = 0$ to $V_{CC}$ |                  |              | 100              | μA    |
| $I_{I(hold)}$ | A Port           | $V_{CC} = 3.0V$                       | $V_I = 0.8V$                   | 75               |              |                  | μA    |
|               |                  |                                       | $V_I = 2.0V$                   | -75              |              |                  |       |
|               |                  | $V_{CC} = 3.6V$                       | $V_I = 0$ to $V_{CC}$          |                  |              | ±500             |       |

| DC Electrical Characteristics (Continued)  |                         |  |   |     |              |      |       |
|--|-------------------------|--|---|-----|--------------|------|-------|
| Symbol   |                         | Test Conditions  |   | Min | Typ (Note 8) | Max  | Units |
| I <sub>OZH</sub>   | A Port                  | V <sub>CC</sub> = 3.6V   | V <sub>O</sub> = V <sub>CC</sub>                  |     |              | 10   | μA    |
|  | B Port                  |  | V <sub>O</sub> = 1.5V                             |     |              | 10   |       |
| I <sub>OZL</sub>   | A Port                  | V <sub>CC</sub> = 3.6V   | V <sub>O</sub> = 0V                               |     |              | -10  | μA    |
|  | B Port                  |  | V <sub>O</sub> = 0.4V                             |     |              | -10  |       |
| I <sub>OZPU</sub><br>(Note 10)   | A Port                  | V <sub>CC</sub> = 0 to 1.5V<br>$\overline{OE} = 0$ or V <sub>CC</sub>                            | V <sub>O</sub> = 0.5 to 3V                        |     |              | ±50  | μA    |
| I <sub>OZPD</sub><br>(Note 10)   | A Port                  | V <sub>CC</sub> = 1.5 to 0V<br>$\overline{OE} = 0$ or V <sub>CC</sub>                            | V <sub>O</sub> = 0.5 to 3V                        |     |              | ±50  | μA    |
| I <sub>CC</sub><br>(V <sub>CC</sub> )  | A or B Ports            | V <sub>CC</sub> = 3.6<br>I <sub>O</sub> = 0<br>V <sub>I</sub> = V <sub>CC</sub> or GND           | Outputs HIGH                                      |     |              | 55   | mA    |
|  |                         |  | Outputs LOW                                       |     |              | 55   |       |
|  |                         |  | Outputs Disabled                                  |     |              | 55   |       |
| ΔI <sub>CC</sub><br>(Note 11)  | A Port and Control Pins | V <sub>CC</sub> = 3.6V<br>A or Control<br>Inputs at V <sub>CC</sub> or GND                       | One Input at V <sub>CC</sub> -0.6                 |     | 0            | 1    | mA    |
| C <sub>i</sub>   | Control Pins            |  | V <sub>I</sub> = V <sub>CC</sub> or 0             |     | 5.8          | 7.0  | pF    |
|  | A Port                  |  | V <sub>I</sub> = V <sub>CC</sub> or 0             |     | 8.0          | 9.5  |       |
|  | B Port                  |  | V <sub>I</sub> = V <sub>CC</sub> or 0             |     | 8.3          | 9.9  |       |
| <p><b>Note 8:</b> All typical values are at V<sub>CC</sub> = 3.3V, and T<sub>A</sub> = 25°C.</p> <p><b>Note 9:</b> For conditions shown as Min or Max, use the appropriate value specified under recommended operating conditions.</p> <p><b>Note 10:</b> This is specified by characterization but not tested.</p> <p><b>Note 11:</b> This is the increase in supply current for each input that is at the specified TTL voltage level rather than V<sub>CC</sub> or GND.</p> |                         |  |   |     |              |      |       |
| <h3>Live Insertion Characteristics</h3> <p>Over Recommended Operating Free-Air Temperature Range, V<sub>REF</sub> = 1.0V (unless otherwise noted).</p>   |                         |  |   |     |              |      |       |
| Parameter  |                         | Test Conditions  |   | Min | Typ          | Max  | Units |
| I <sub>CC</sub><br>(V <sub>CC</sub> BIAS)  | B Port                  | V <sub>CC</sub> = 0 to 3V  | V <sub>O</sub> = 0 to 1.2V                        |     |              | 5    | mA    |
|  |                         | V <sub>CC</sub> = 3.0 to 3.6V  | V <sub>I</sub> (V <sub>CC</sub> BIAS) = 3 to 3.6V |     |              | 10   |       |
| V <sub>O</sub>   | B Port                  | V <sub>CC</sub> = 0    V <sub>I</sub> (V <sub>CC</sub> BIAS) = 3.3v                              |   |     | 1.1          |      | V     |
| I <sub>O</sub>   | B Port                  | V <sub>CC</sub> = 0    V <sub>I</sub> (V <sub>CC</sub> BIAS) = 3 to 3.6V    V <sub>O</sub> = 0.4 |   | -1  |              |      | μA    |
|  |                         | V <sub>CC</sub> = 0 to 3.6V $\overline{OE} = 3.3V$   |   |     |              | 100  |       |
|  |                         | V <sub>CC</sub> = 0 to 1.5V $\overline{OE} = 0$ to 3.3V  |   |     |              | 100  |       |
| <h3>AC Operating Requirements (GTL16T1655)</h3> <p>Over recommended ranges of supply voltage and operating free-air temperature, V<sub>TT</sub> = 1.5V and V<sub>ref</sub> = 1.0V (unless otherwise noted).</p>  |                         |  |   |     |              |      |       |
| Parameter  |                         |  |   | Min | Max          | Unit |       |
| f <sub>MAX</sub>   | Maximum Clock Frequency |  |   | 160 |              | MHz  |       |
| t <sub>WIDTH</sub>   | Pulse Duration          |  | LE HIGH   | 3.0 |              | ns   |       |
|  |                         |  | CLK HIGH or LOW                                   | 3.0 |              |      |       |
| t <sub>SU</sub>  | Setup Time              |  | Data before CLK↑                                  | 2.5 |              | ns   |       |
|  |                         |  | Data before LE↓ (CLK = X)                         | 2.5 |              |      |       |
| t <sub>HOLD</sub>  | Hold Time               |  | Data after CLK↑                                   | 0.5 |              | ns   |       |
|  |                         |  | Data after LE↓ (CLK = X)                          | 0.5 |              |      |       |

### B to A AC Electrical Characteristics (GTLP)

Over recommended range of supply voltage and operating free-air temperature,  $V_{REF} = 1.0V$ ,  $V_{TT} = 1.5V$ ,  $V_{ERC} = V_{CC}$  or GND (unless otherwise noted).  $C_L = 30$  pF for B Port and  $C_L = 50$  pF for A Port.

| Parameter    | From<br>(Input)   | To<br>(Output) | Min | Typ<br>(Note 12) | Max | Unit |
|--------------|-------------------|----------------|-----|------------------|-----|------|
| $f_{MAX}$    |                   |                | 160 |                  |     | MHz  |
| $t_{PLH}$    | B                 | A              | 1.0 |                  | 4.7 | ns   |
| $t_{PHL}$    |                   |                | 1.5 |                  | 4.8 |      |
| $t_{PLH}$    | LEAB              | A              | 1.2 |                  | 4.0 | ns   |
| $t_{PHL}$    |                   |                | 1.2 |                  | 3.8 |      |
| $t_{PLH}$    | CLK               | A              | 1.2 |                  | 4.0 | ns   |
| $t_{PHL}$    |                   |                | 1.2 |                  | 4.0 |      |
| $t_{PLZ/HZ}$ | $\overline{OE}$   | A              | 1.4 |                  | 4.5 | ns   |
| $t_{PZH/ZL}$ |                   |                | 1.0 |                  | 4.0 |      |
| $t_{PLZ/HZ}$ | $\overline{OEBA}$ | A              | 1.2 |                  | 4.9 | ns   |
| $t_{PZH/ZL}$ |                   |                | 1.0 |                  | 4.0 |      |

**Note 12:** All typical values are at  $V_{CC} = 3.3V$ , and  $T_A = 25^\circ C$ .

| <b>A to B AC Electrical Characteristics (GTL16T1655)</b>  |   |             |         |                |     |       |
|---|---|-------------|---------|----------------|-----|-------|
| Over recommended range of supply voltage and operating free air temperature, $V = 1.0V$ , $V_{TT} = 1.5V$ (unless otherwise noted).<br>$C_L = 30$ pF for B Port and $C_L = 50$ pF for A Port. |   |             |         |                |     |       |
| Symbol  | From (Input)                              | To (Output) | Min     | Type (Note 13) | Max | Units |
| $f_{MAX}$   |   |             | 160     |                |     | MHz   |
| $t_{PLH}$   | A   | B           | 2.6     |                | 5.7 | ns    |
| $t_{PHL}$   | $V_{ERC} = V_{CC}$                        |             | 0.8     |                | 4.5 |       |
| $t_{PLH}$   | A   | B           | 2.0     |                | 4.9 | ns    |
| $t_{PHL}$   | $V_{ERC} = GND$                           |             | 0.7     |                | 4.0 |       |
| $t_{PLH}$   | LEAB                                      | B           | 2.6     |                | 5.7 | ns    |
| $t_{PHL}$   | $V_{ERC} = V_{CC}$                        |             | 0.8     |                | 4.0 |       |
| $t_{PLH}$   | LEAB                                      | B           | 2.2     |                | 4.9 | ns    |
| $t_{PHL}$   | $V_{ERC} = GND$                           |             | 0.7     |                | 4.0 |       |
| $t_{PLH}$   | CLK                                       | B           | 2.8     |                | 5.7 | ns    |
| $t_{PHL}$   | $V_{ERC} = V_{CC}$                        |             | 1.0     |                | 4.0 |       |
| $t_{PLH}$   | CLK                                       | B           | 2.3     |                | 5.0 | ns    |
| $t_{PHL}$   | $V_{ERC} = GND$                           |             | 0.8     |                | 4.0 |       |
| $t_{PLH}$   | $\overline{OE}$                           | B           | 2.7     |                | 5.8 | ns    |
| $t_{PHL}$   | $V_{ERC} = V_{CC}$                        |             | 0.6     |                | 4.0 |       |
| $t_{PLH}$   | $\overline{OE}$                           | B           | 2.1     |                | 4.9 | ns    |
| $t_{PHL}$   | $V_{ERC} = GND$                           |             | 1.0     |                | 4.0 |       |
| $t_{PLH}$   | $\overline{OEAB}$                         | B           | 2.6     |                | 5.8 | ns    |
| $t_{PHL}$   | $V_{ERC} = V_{CC}$                        |             | 0.6     |                | 4.0 |       |
| $t_{PLH}$   | $\overline{OEAB}$                         | B           | 2.0     |                | 4.9 | ns    |
| $t_{PHL}$   | $V_{ERC} = GND$                           |             | 0.6     |                | 3.5 |       |
| $t_{FALL/RISE}$<br>$V_{ERC} = V_{CC}$   | Transition Time, B outputs (0.6V to 1.3V) |             | 0.7/0.7 | 2.0/2.5        |     | ns    |
| $t_{FALL/RISE}$<br>$V_{ERC} = GND$  | Transition Time, B outputs (0.6V to 1.3V) |             | 0.7/0.7 | 1.5/2.0        |     | ns    |
| <b>Note 13:</b> All Typical values are at $V_{CC} = 3.3V$ and $T_A = 25^\circ C$  |   |             |         |                |     |       |

### Extended Electrical Characteristics (GTLP)

Over recommended ranges of supply voltage and operating free-air temperature  $V_{REF} = 1.0V$  (unless otherwise noted).  
 $C_L = 30$  pF for B Port and  $C_L = 50$  pF for A Port.

| Symbol                           | From (Input) | To (Output) | Min | Typ (Note 14) | Max | Unit |
|----------------------------------|--------------|-------------|-----|---------------|-----|------|
| $t_{OSLH}$ (Note 15)             | A            | B           |     | 0.4           | 1.0 | ns   |
| $t_{OSHL}$ (Note 15)             |              |             |     | 0.4           | 1.0 | ns   |
| $t_{PV(HL)}$ (Note 16) (Note 17) | A            | B           |     |               | 1.5 | ns   |
| $t_{OSLH}$ (Note 15)             | CLKAB        | B           |     | 0.3           | 0.9 | ns   |
| $t_{OSHL}$ (Note 15)             |              |             |     | 0.3           | 0.6 | ns   |
| $t_{PV(HL)}$ (Note 16)(Note 17)  | CLKAB        | B           |     |               | 1.2 | ns   |
| $t_{OSLH}$ (Note 15)             | B            | A           |     | 0.3           | 1.0 | ns   |
| $t_{OSHL}$ (Note 15)             |              |             |     | 0.3           | 1.0 | ns   |
| $t_{OST}$ (Note 15)              | B            | A           |     | 0.6           | 1.5 | ns   |
| $t_{PV}$ (Note 16)               | B            | A           |     |               | 1.6 | ns   |
| $t_{OSLH}$ (Note 15)             | CLKAB        | A           |     | 0.3           | 0.6 | ns   |
| $t_{OSHL}$ (Note 15)             |              |             |     | 0.3           | 0.6 | ns   |
| $t_{OST}$ (Note 15)              | CLKAB        | A           |     | 0.5           | 1.0 | ns   |
| $t_{PV}$ (Note 16)               | CLKAB        | A           |     |               | 1.1 | ns   |

**Note 14:** All typical values are at  $V_{CC} = 3.3V$ , and  $T_A = 25^\circ C$ .

**Note 15:**  $t_{OSHL}/t_{OSLH}$  and  $t_{OST}$ —Output to output skew is defined as the absolute value of the difference between the actual propagation delay for all outputs within the same packaged device. The specifications are given for specific worst case  $V_{CC}$  and temperature and apply to any outputs switching in the same direction either HIGH-to-LOW ( $t_{OSHL}$ ) or LOW-to-HIGH ( $t_{OSLH}$ ) or in opposite directions both HL and LH ( $t_{OST}$ ). This parameter is guaranteed by design and statistical process distribution. Actual skew values between the GTLP outputs could vary on the backplane due to the loading and impedance seen by the device.

**Note 16:**  $t_{PV}$ —Part to part skew is defined as the absolute value of the difference between the actual propagation delay for all outputs from device to device. The parameter is specified for a specific worst case  $V_{CC}$  and temperature. This parameter is guaranteed by design and statistical process distribution. Actual skew values between the GTLP outputs could vary on the backplane due to the loading and impedance seen by the device.

**Note 17:** Due to the open drain structure on GTLP outputs,  $t_{OST}$  and  $t_{PV(LH)}$  in the A-to-B direction are not specified. Skew on these paths is dependent on the  $V_{TT}$  and  $R_T$  values on the backplane.

| <b>AC Operating Requirements (GTL)</b>  |                         |                                       |     |               |       |       |
|---|-------------------------|---------------------------------------|-----|---------------|-------|-------|
| Over recommended ranges of supply voltage and operating free-air temperature, $V_{TT} = 1.2V$ and $V_{ref} = 0.8V$ (unless otherwise noted).  |                         |                                       |     |               |       |       |
| Parameter   |                         |                                       | Min | Max           | Units |       |
| $f_{MAX}$   | Maximum Clock Frequency |                                       | 160 |               | MHz   |       |
| $t_{WIDTH}$   | Pulse Duration          | LE HIGH                               | 3.0 |               | ns    |       |
|   |                         | CLK HIGH or LOW                       | 3.0 |               | ns    |       |
| $t_{SU}$  | Setup Time              | Data before CLK $\uparrow$            | 2.5 |               | ns    |       |
|   |                         | Data before LE $\downarrow$ (CLK = X) | 2.5 |               |       |       |
| $t_{HOLD}$  | Hold Time               | Data after CLK $\uparrow$             | 0.5 |               | ns    |       |
|   |                         | Data after LE $\downarrow$ (CLK = X)  | 0.5 |               |       |       |
| <b>B to A AC Electrical Characteristics (GTL)</b>   |                         |                                       |     |               |       |       |
| Over recommended range of supply voltage and operating free air temperature, $V_{ref} = 0.8V$ , $V_{TT} = 1.2V$ , $V_{ERC} = V_{CC}$ or GND (unless otherwise noted). $C_L = 30pF$ for B Port and $C_L = 50 pF$ for A Port. |                         |                                       |     |               |       |       |
| Parameter   | From (Input)            | To (Output)                           | Min | Typ (Note 18) | Max   | Units |
| $f_{MAX}$   |                         |                                       | 160 |               |       | MHz   |
| $t_{PLH}$   | B                       | A                                     | 1.0 |               | 4.7   | ns    |
| $t_{PHL}$   |                         |                                       | 1.2 |               | 4.8   |       |
| $t_{PLH}$   | LEBA                    | A                                     | 1.0 |               | 4.4   | ns    |
| $t_{PHL}$   |                         |                                       | 1.1 |               | 4.0   |       |
| $t_{PLH}$   | CLK                     | A                                     | 1.0 |               | 4.2   | ns    |
| $t_{PHL}$   |                         |                                       | 1.1 |               | 4.1   |       |
| $t_{PLZ/HZ}$  | $\overline{OE}$         | A                                     | 1.5 |               | 4.6   | ns    |
| $t_{PZH/ZL}$  |                         |                                       | 1.2 |               | 4.2   |       |
| $t_{PLZ/HZ}$  | $\overline{OEBA}$       | A                                     | 1.2 |               | 4.9   | ns    |
| $t_{PZH/ZL}$  |                         |                                       | 1.0 |               | 4.0   |       |
| <b>Note 18:</b> All Typical values are at $V_{CC} = 3.3V$ and $T_A = 25^\circ C$ .  |                         |                                       |     |               |       |       |

### A to B AC Electrical Characteristics (GTL)

Over recommended range of supply voltage and operating free air temperature,  $V_{REF} = 0.8V$ ,  $V_{TT} = 1.2V$  (unless otherwise noted).  
 $C_L = 30$  pF for B Port and  $C_L = 50$  pF for A Port.

| Symbol                                | From (Input)                              | To (Output) | Min     | Typ (Note 19) | Max | Units |
|---------------------------------------|---|-------------|---------|---------------|-----|-------|
| $f_{MAX}$                             |   |             | 160     |               |     | MHz   |
| $t_{PLH}$                             | A   | B           | 2.2     |               | 5.7 | ns    |
| $t_{PHL}$                             | $V_{ERC} = V_{CC}$                        |             | 1.0     |               | 4.7 |       |
| $t_{PLH}$                             | A   | B           | 1.5     |               | 4.8 | ns    |
| $t_{PHL}$                             | $V_{ERC} = GND$                           |             | 0.9     |               | 4.0 |       |
| $t_{PLH}$                             | LEAB                                      | B           | 2.2     |               | 5.7 | ns    |
| $t_{PHL}$                             | $V_{ERC} = V_{CC}$                        |             | 1.0     |               | 4.1 |       |
| $t_{PLH}$                             | LEAB                                      | B           | 1.7     |               | 5.0 | ns    |
| $t_{PHL}$                             | $V_{ERC} = GND$                           |             | 0.9     |               | 4.4 |       |
| $t_{PLH}$                             | CLK                                       | B           | 2.8     |               | 5.8 | ns    |
| $t_{PHL}$                             | $V_{ERC} = V_{CC}$                        |             | 1.0     |               | 4.3 |       |
| $t_{PLH}$                             | CLK                                       | B           | 2.3     |               | 5.0 | ns    |
| $t_{PHL}$                             | $V_{ERC} = GND$                           |             | 1.0     |               | 4.3 |       |
| $t_{PLH}$                             | $\overline{OE}$                           | B           | 2.5     |               | 5.8 | ns    |
| $t_{PHL}$                             | $V_{ERC} = V_{CC}$                        |             | 0.8     |               | 4.3 |       |
| $t_{PLH}$                             | $\overline{OE}$                           | B           | 1.7     |               | 4.9 | ns    |
| $t_{PHL}$                             | $V_{ERC} = GND$                           |             | 0.9     |               | 4.3 |       |
| $t_{PLH}$                             | $\overline{OEAB}$                         | B           | 2.2     |               | 5.8 | ns    |
| $t_{PHL}$                             | $V_{ERC} = V_{CC}$                        |             | 0.8     |               | 4.3 |       |
| $t_{PLH}$                             | $\overline{OEAB}$                         | B           | 1.7     |               | 4.9 | ns    |
| $t_{PHL}$                             | $V_{ERC} = GND$                           |             | 0.9     |               | 3.8 |       |
| $t_{FALL/RISE}$<br>$V_{ERC} = V_{CC}$ | Transition Time, B outputs (0.6V to 1.3V) |             | 0.7/0.7 | 2.0/2.5       |     | ns    |
| $t_{FALL/RISE}$<br>$V_{ERC} = V_{CC}$ | Transition Time, B outputs (0.6V to 1.3V) |             | 0.7/0.7 | 1.5/2.0       |     | ns    |

**Note 19:** All Typical values are at  $V_{CC} = 3.3V$  and  $T_A = 25^\circ C$ .

### Extended Electrical Characteristics (GTL)

Over recommended ranges of supply voltage and operating free-air temperature  $V_{REF} = 0.8V$  (unless otherwise noted).  
 $C_L = 30$  pF for B Port and  $C_L = 50$  pF for A Port.

| Symbol                           | From (Input) | To (Output) | Min | Typ (Note 20) | Max | Unit |
|----------------------------------|--------------|-------------|-----|---------------|-----|------|
| $t_{OSLH}$ (Note 21)             | A            | B           |     | 0.4           | 1.0 | ns   |
| $t_{OSHL}$ (Note 21)             |              |             |     | 0.4           | 1.0 | ns   |
| $t_{PV(HL)}$ (Note 22) (Note 23) | A            | B           |     |               | 1.5 | ns   |
| $t_{OSLH}$ (Note 21)             | CLKAB        | B           |     | 0.3           | 0.9 | ns   |
| $t_{OSHL}$ (Note 21)             |              |             |     | 0.3           | 0.6 | ns   |
| $t_{PV(HL)}$ (Note 22)(Note 23)  | CLKAB        | B           |     |               | 1.2 | ns   |
| $t_{OSLH}$ (Note 21)             | B            | A           |     | 0.3           | 1.0 | ns   |
| $t_{OSHL}$ (Note 21)             |              |             |     | 0.3           | 1.0 | ns   |
| $t_{OST}$ (Note 21)              | B            | A           |     | 0.6           | 1.5 | ns   |
| $t_{PV}$ (Note 22)               | B            | A           |     |               | 1.6 | ns   |
| $t_{OSLH}$ (Note 21)             | CLKAB        | A           |     | 0.3           | 0.6 | ns   |
| $t_{OSHL}$ (Note 21)             |              |             |     | 0.3           | 0.6 | ns   |
| $t_{OST}$ (Note 21)              | CLKAB        | A           |     | 0.5           | 1.0 | ns   |
| $t_{PV}$ (Note 22)               | CLKAB        | A           |     |               | 1.1 | ns   |

**Note 20:** All typical values are at  $V_{CC} = 3.3V$ , and  $T_A = 25^\circ C$ .

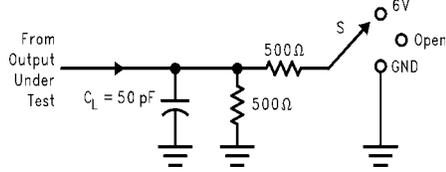
**Note 21:**  $t_{OSHL}/t_{OSLH}$  and  $t_{OST}$ —Output to output skew is defined as the absolute value of the difference between the actual propagation delay for all outputs within the same packaged device. The specifications are given for specific worst case  $V_{CC}$  and temperature and apply to any outputs switching in the same direction either HIGH-to-LOW ( $t_{OSHL}$ ) or LOW-to-HIGH ( $t_{OSLH}$ ) or in opposite directions both HL and LH ( $t_{OST}$ ). This parameter is guaranteed by design and statistical process distribution. Actual skew values between the GTL outputs could vary on the backplane due to the loading and impedance seen by the device.

**Note 22:**  $t_{PV}$ —Part to part skew is defined as the absolute value of the difference between the actual propagation delay for all outputs from device to device. The parameter is specified for a specific worst case  $V_{CC}$  and temperature. This parameter is guaranteed by design and statistical process distribution. Actual skew values between the GTL outputs could vary on the backplane due to the loading and impedance seen by the device.

**Note 23:** Due to the open drain structure on GTL outputs,  $t_{OST}$  and  $t_{PV(LH)}$  in the A-to-B direction are not specified. Skew on these paths is dependent on the  $V_{TT}$  and  $R_T$  values on the backplane.

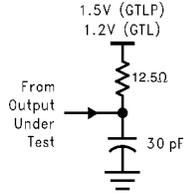
## Test Circuits and Timing Waveforms

**Test Circuit for A Outputs**



| Test              | S    |
|-------------------|------|
| $t_{PLH}/t_{PHL}$ | Open |
| $t_{PLZ}/t_{PZL}$ | 6V   |
| $t_{PHZ}/t_{PZH}$ | GND  |

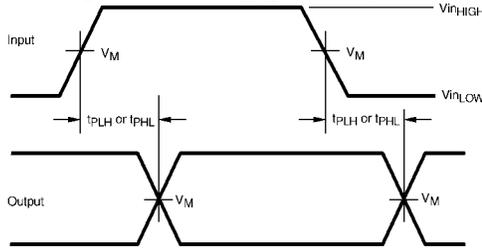
**Test Circuit for B Outputs**



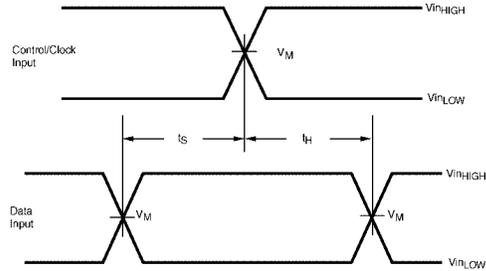
**Note A:**  $C_L$  includes probes and Jig capacitance.

**Note B:** For B Port,  $C_L = 30 \text{ pF}$  is used for worst case.

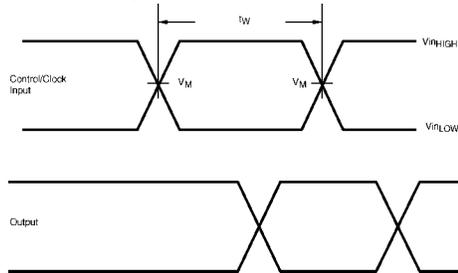
**Voltage Waveform - Propagation Delay Times**



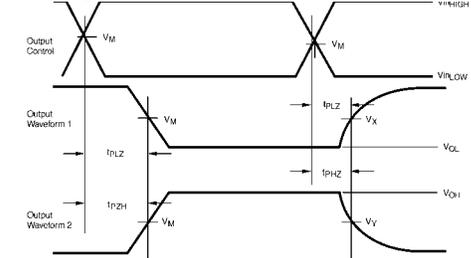
**Voltage Waveform - Setup and Hold Times**



**Voltage Waveform - Pulse Width**



**Voltage Waveform - Enable and Disable Times**



Output Waveform 1 is for an output with internal conditions such that the output is LOW except when disabled by the control output

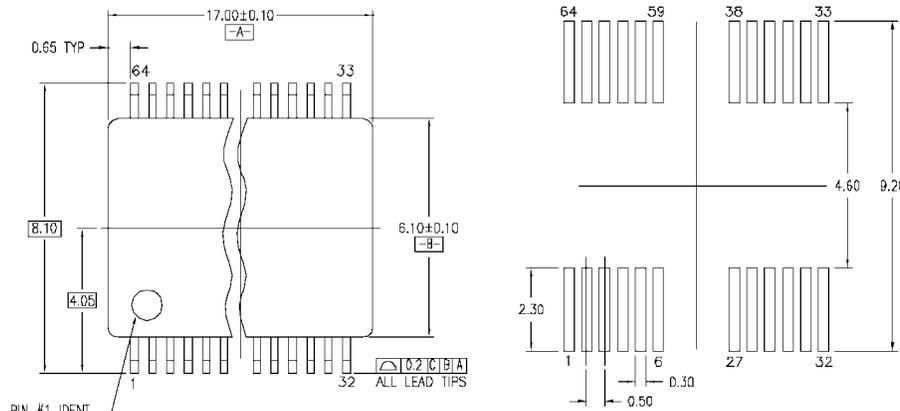
Output Waveform 2 is for an output with internal conditions such that the output is HIGH except when disabled by the control output

**Input and Measure Conditions**

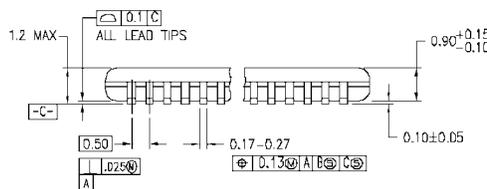
|              | A or LVTTTL Pins | B or GTLP Pins |
|--------------|------------------|----------------|
| $V_{inHIGH}$ | 3.0              | 1.5            |
| $V_{inLOW}$  | 0.0              | 0.0            |
| $V_M$        | 1.5              | 1.0            |
| $V_X$        | $V_{OL} + 0.3V$  | N/A            |
| $V_Y$        | $V_{OH} - 0.3V$  | N/A            |

All input pulses have the following characteristics: Frequency = 10MHz,  $t_{RISE} = t_{FALL} = 2 \text{ ns}$ ,  $Z_O = 50 \Omega$   
 The outputs are measured one at a time with one transition per measurement

**Physical Dimensions** inches (millimeters) unless otherwise noted



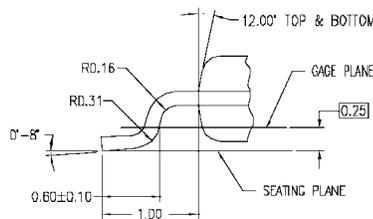
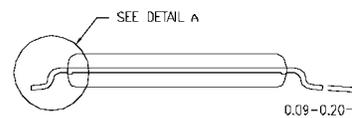
LAND PATTERN RECOMMENDATION



DIMENSIONS ARE IN MILLIMETERS

NOTES:

- A. CONFORMS TO JEDEC REGISTRATION MO-153, VARIATION EF, REF NOTE B, DATE 7/93.
- B. DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
- D. DIMENSIONS AND TOLERANCES PER ANSI Y14.5M, 1982.



DETAIL A

MTD64REV B

**64-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide Package Number MTD64**

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2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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