

**FAIRCHILD**  
SEMICONDUCTOR™

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## GTL36T612 36-Bit LVTTTL/GTLP Universal Bus Transceiver

### General Description

The GTLP36T612 is an 36-bit universal bus transceiver which 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 for 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 Transistor 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 or GTL but with different output levels and receiver thresholds. GTLP output LOW level is less than 0.5V, the output HIGH is 1.5V and the receiver threshold is 1.0V.

### Features

- Bidirectional interface between GTLP and LVTTTL logic levels
- Designed with edge rate control circuitry to reduce output noise on the GTLP port
- Partitioned as two 18-Bit transceivers with individual latch timing and output control
- V<sub>REF</sub> 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 -24mA/+24mA
- B Port sink +50mA
- For more information see AN-5026, Using BGA Packages

### Ordering Code:

Order Number	Package Number	Package Description
GTL36T612G (Note 1)(Note 2)	BGA114A	114-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide

**Note 1:** Ordering code "G" indicates Trays.

**Note 2:** Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

GTL36T612 36-Bit LVTTTL/GTLP Universal Bus Transceiver



### Truth Table

(Note 3)

Inputs					Output	Mode
CEAB	OEAB	LEAB	CLKAB	A	B	
X	H	X	X	X	Z	Latched
L	L	L	H	X	B <sub>0</sub> (Note 4)	storage of A data
L	L	L	L	X	B <sub>0</sub> (Note 5)	
X	L	H	X	L	L	Transparent
X	L	H	X	H	H	
L	L	L	↑	L	L	Clocked storage of A data
L	L	L	↑	H	H	
H	L	L	X	X	B <sub>0</sub> (Note 5)	Clock inhibit

**Note 3:** A-to-B data flow is shown. B-to-A data flow is similar but uses OEBA, LEBA, CLKBA, and CEBA.

**Note 4:** Output level before the indicated steady state input conditions were established, provided that CLKAB was HIGH before LEAB went LOW.

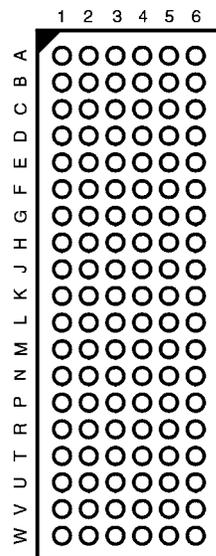
**Note 5:** Output level before the indicated steady-state input conditions were established.

### Pin Descriptions

Pin Names	Description
$\overline{OEAB}$	A-to-B Output Enable (Active LOW) (LVTTTL Level)
$\overline{OEBA}$	B-to-A Output Enable (Active LOW) (LVTTTL Level)
$\overline{CEAB}$	A-to-B Clock/LE Enable (Active LOW) (LVTTTL Level)
$\overline{CEBA}$	B-to-A Clock/LE Enable (Active LOW) (LVTTTL Level)
LEAB	A-to-B Latch Enable (Transparent HIGH) (LVTTTL Level)
LEBA	B-to-A Latch Enable (Transparent HIGH) (LVTTTL Level)
V <sub>REF</sub>	GTLP Input Threshold Reference Voltage
CLKAB	A-to-B Clock (LVTTTL Level)
CLKBA	B-to-A Clock (LVTTTL Level)
A <sub>1</sub> -A <sub>18</sub>	A-to-B Data Inputs or B-to-A 3-STATE Outputs
B <sub>1</sub> -B <sub>18</sub>	B-to-A Data Inputs or A-to-B Open Drain Outputs

### Connection Diagram

Pin Assignment for FBGA



(Top Thru View)

### FBGA Pin Assignments

Number in front of each pin indicates word.

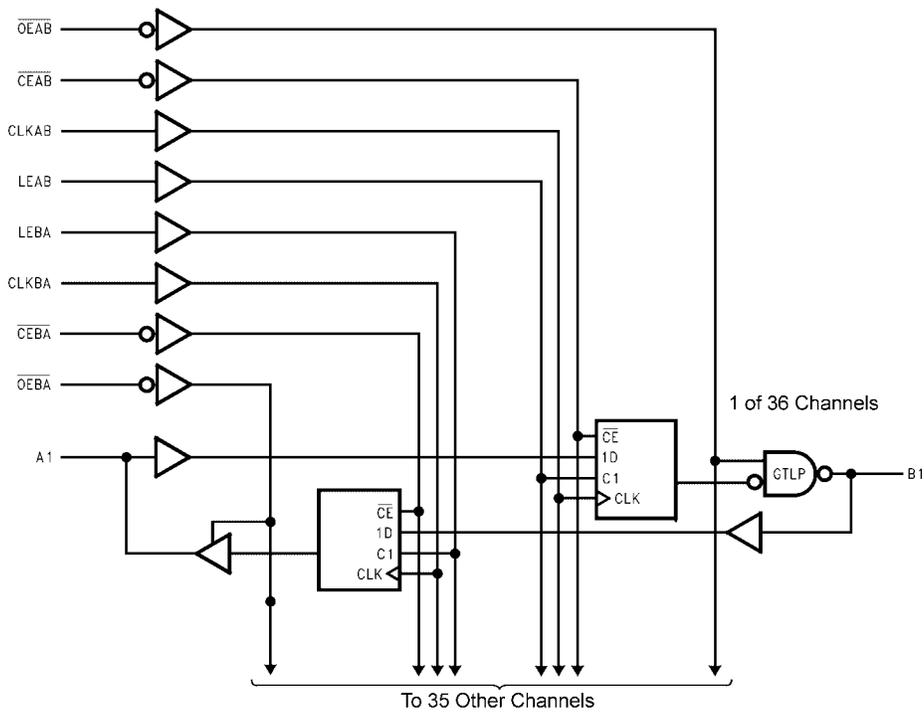
	1	2	3	4	5	6
<b>A</b>	1A <sub>2</sub>	1A <sub>1</sub>	1OEAB	1CLKAB	1B <sub>2</sub>	1B <sub>1</sub>
<b>B</b>	1A <sub>4</sub>	1A <sub>3</sub>	1LEAB	1CEAB	1B <sub>4</sub>	1B <sub>3</sub>
<b>C</b>	1A <sub>6</sub>	1A <sub>5</sub>	V <sub>CC</sub>	V <sub>CC</sub>	1B <sub>6</sub>	1B <sub>5</sub>
<b>D</b>	1A <sub>8</sub>	1A <sub>7</sub>	GND	GND	1B <sub>8</sub>	1B <sub>7</sub>
<b>E</b>	1A <sub>10</sub>	1A <sub>9</sub>	GND	GND	1B <sub>10</sub>	1B <sub>9</sub>
<b>F</b>	1A <sub>12</sub>	1A <sub>11</sub>	GND	GND	1B <sub>12</sub>	1B <sub>11</sub>
<b>G</b>	1A <sub>14</sub>	1A <sub>13</sub>	V <sub>CC</sub>	V <sub>REF</sub>	1B <sub>14</sub>	1B <sub>13</sub>
<b>H</b>	1A <sub>16</sub>	1A <sub>15</sub>	1OEBA	1CEBA	1B <sub>16</sub>	1B <sub>15</sub>
<b>J</b>	1A <sub>18</sub>	1A <sub>17</sub>	1LEBA	1CLKBA	1B <sub>18</sub>	1B <sub>17</sub>
<b>K</b>						
<b>L</b>	2A <sub>2</sub>	2A <sub>1</sub>	2OEAB	2CLKAB	2B <sub>2</sub>	2B <sub>1</sub>
<b>M</b>	2A <sub>4</sub>	2A <sub>3</sub>	2LEAB	2CEAB	2B <sub>4</sub>	2B <sub>3</sub>
<b>N</b>	2A <sub>6</sub>	2A <sub>5</sub>	V <sub>CC</sub>	V <sub>CC</sub>	2B <sub>6</sub>	2B <sub>5</sub>
<b>P</b>	2A <sub>8</sub>	2A <sub>7</sub>	GND	GND	2B <sub>8</sub>	2B <sub>7</sub>
<b>R</b>	2A <sub>10</sub>	2A <sub>9</sub>	GND	GND	2B <sub>10</sub>	2B <sub>9</sub>
<b>T</b>	2A <sub>12</sub>	2A <sub>11</sub>	GND	GND	2B <sub>12</sub>	2B <sub>11</sub>
<b>U</b>	2A <sub>14</sub>	2A <sub>13</sub>	V <sub>CC</sub>	V <sub>REF</sub>	2B <sub>14</sub>	2B <sub>13</sub>
<b>V</b>	2A <sub>16</sub>	2A <sub>15</sub>	2OEBA	2CEBA	2B <sub>16</sub>	2B <sub>15</sub>
<b>W</b>	2A <sub>18</sub>	2A <sub>17</sub>	2LEBA	2CLKBA	2B <sub>18</sub>	2B <sub>17</sub>

## Functional Description

The GTLP36T612 is an 36-bit registered transceiver containing D-type flip-flop, latch and transparent modes of operation for the data path. Data flow in each direction is controlled by the clock enables ( $\overline{CEAB}$  and  $\overline{CEBA}$ ), latch enables ( $\overline{LEAB}$  and  $\overline{LEBA}$ ), clock ( $\overline{CLKAB}$  and  $\overline{CLKBA}$ ) and output enables ( $\overline{OEAB}$  and  $\overline{OEBA}$ ). The clock enables ( $\overline{CEAB}$  and  $\overline{CEBA}$ ) and the output enables ( $\overline{OEAB}$  and  $\overline{OEBA}$ ) control the 18 bits of data for the A-to-B and B-to-A directions respectively.

For A-to-B data flow, when  $\overline{CEAB}$  is LOW, the device operates on the LOW-to-HIGH transition of  $\overline{CLKAB}$  for the flip-flop and on the HIGH-to-LOW transition of  $\overline{LEAB}$  for the latch path. That is, if  $\overline{CEAB}$  is LOW and  $\overline{LEAB}$  is LOW the A data is latched regardless as to the state of  $\overline{CLKAB}$  (HIGH or LOW) and if  $\overline{LEAB}$  is HIGH the device is in transparent mode. When  $\overline{OEAB}$  is LOW the outputs are active. When  $\overline{OEAB}$  is HIGH the outputs are HIGH impedance. The data flow of B-to-A is similar except that  $\overline{CEBA}$ ,  $\overline{OEBA}$ ,  $\overline{LEBA}$ , and  $\overline{CLKBA}$  are used.

## Logic Diagram



### Absolute Maximum Ratings (Note 6)

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 7)	-0.5V to $V_{CC} + 0.5V$
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, $I_{OL}$	100 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 Performance	>2000V
Storage Temperature ( $T_{STG}$ )	-65°C to +150°C

### Recommended Operating Conditions (Note 8)

Supply Voltage $V_{CC}/V_{CCQ}$	3.15V to 3.45V
Bus Termination Voltage ( $V_{TT}$ )	
GTLP	1.47V to 1.53V
$V_{REF}$	0.98V to 1.02V
Input Voltage ( $V_I$ )	
on A Port and Control Pins	0.0V to 3.45V
on B Port	0.0V to 3.45V
HIGH Level Output Current ( $I_{OH}$ )	
A Port	-24 mA
LOW Level Output Current ( $I_{OL}$ )	
A Port	+24 mA
B Port	+50 mA
Operating Temperature ( $T_A$ )	-40°C to +85°C

**Note 6:** Absolute Maximum continuous ratings are those values beyond which damage to the device may occur. Exposure to these conditions or conditions beyond those indicated may adversely affect device reliability. Functional operation under absolute maximum rated conditions is not implied.

**Note 7:**  $I_O$  Absolute Maximum Rating must be observed.

**Note 8:** Unused inputs must be held HIGH or LOW.

### DC Electrical Characteristics

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

Symbol		Test Conditions		Min	Typ (Note 9)	Max	Units
$V_{IH}$	B Port			$V_{REF} + 0.05$		$V_{TT}$	V
	Others			2.0			
$V_{IL}$	B Port			0.0		$V_{REF} - 0.05$	V
	Others					0.8	
$V_{REF}$	GTLP (Note 10)				1.0		V
$V_{IK}$		$V_{CC} = 3.15V$	$I_I = -18 mA$			-1.2	V
$V_{OH}$	A Port	$V_{CC}, V_{CCQ} = \text{Min to Max (Note 11)}$	$I_{OH} = -100 \mu A$	$V_{CC} - 0.2$			V
		$V_{CC} = 3.15V$	$I_{OH} = -8 mA$	2.4			
			$I_{OH} = -24 mA$	2.0			
$V_{OL}$	A Port	$V_{CC}, V_{CCQ} = \text{Min to Max (Note 11)}$	$I_{OL} = 100 \mu A$			0.2	V
		$V_{CC} = 3.15V$	$I_{OL} = 24 mA$			0.5	
	B Port	$V_{CC} = 3.15V$	$I_{OL} = 40 mA$			0.40	V
			$I_{OL} = 50 mA$			0.55	
$I_I$	Control Pins	$V_{CC} = \text{Min to Max (Note 11)}$	$V_I = 3.45V \text{ or } 0V$			$\pm 5$	$\mu A$
	A Port	$V_{CC} = 3.45V$	$V_I = 0V$			-10	$\mu A$
			$V_I = 3.45$			10	
B Port	$V_{CC} = 3.45V$	$V_I = V_{CC}$			5	$\mu A$	
			$V_I = 0$			-5	$\mu A$
$I_{OFF}$	A Port and Control Pins	$V_{CC} = 0$	$V_I \text{ or } V_O = 0 \text{ to } 3.45V$			30	$\mu A$
$I_{I(\text{hold})}$	A Port	$V_{CC} = 3.15V$	$V_I = 0.8V$	75			$\mu A$
			$V_I = 2.0V$			-75	
$I_{OZH}$	A Port	$V_{CC} = 3.45V$	$V_O = 3.45$			10	$\mu A$
	B Port		$V_O = 3.45V$			5	
$I_{OZL}$	A Port	$V_{CC} = 3.45V$	$V_O = 0V$			-10	$\mu A$
	B Port		$V_O = 0V$			-5	
$I_{CC}$ ( $V_{CC}/V_{CCQ}$ )	A or B Ports	$V_{CC} = 3.45V$ $I_O = 0$ $V_I = V_{CC} \text{ or } GND$	Outputs HIGH		60	80	mA
			Outputs LOW		60	80	
			Outputs Disabled		60	90	

DC Electrical Characteristics (Continued)						
Symbol	Test Conditions		Min	Typ (Note 9)	Max	Units
$\Delta I_{CC}$ (Note 12)	A Port and Control Pins	$V_{CC} = 3.45V$ , A or Control Inputs at $V_{CC}$ or GND	One Input at 2.7V		2	mA
$C_i$	Control Pins		$V_i = V_{CC}$ or 0	6		pF
	A Port		$V_i = V_{CC}$ or 0	7.5		
	B Port		$V_i = V_{CC}$ or 0	9.0		
<p><b>Note 9:</b> All typical values are at <math>V_{CC} = 3.3V</math>, <math>V_{CCQ} = 3.3V</math>, and <math>T_A = 25^\circ C</math>.</p> <p><b>Note 10:</b> GTLP <math>V_{REF}</math> and <math>V_{TT}</math> are specified to 2% tolerance since signal integrity and noise margin can be significantly degraded if these supplies are noisy. In addition, <math>V_{TT}</math> and <math>R_{term}</math> can be adjusted beyond the recommended operating conditions to accommodate backplane impedances other than 50Ω, but must remain within the boundaries of the DC Absolute Maximum ratings. Similarly <math>V_{REF}</math> can be adjusted to optimize noise margin.</p> <p><b>Note 11:</b> For conditions shown as Min or Max, use the appropriate value specified under recommended operating conditions.</p> <p><b>Note 12:</b> This is the increase in supply current for each input that is at the specified TTL voltage level rather than <math>V_{CC}</math> or GND.</p>						
AC Operating Requirements						
Over recommended ranges of supply voltage and operating free-air temperature, $V_{REF} = 1.0V$ (unless otherwise noted).						
Symbol	Test Conditions		Min	Max	Unit	
$f_{MAX}$	Maximum Clock Frequency		175		MHz	
$t_{WIDTH}$	Pulse Duration	LEAB or LEBA HIGH	3.0		ns	
		CLKAB or CLKBA HIGH or LOW	3.0			
$t_{SU}$	Setup Time	A before CLKBA $\uparrow$	1.1		ns	
		B before CLKBA $\uparrow$	3.0			
		A before LEAB	1.1			
		B before LEBA	2.7			
		$\overline{CEAB}$ before CLKAB $\uparrow$	1.2			
		$\overline{CEBA}$ before CLKBA $\uparrow$	1.4			
$t_{HOLD}$	Hold Time	A after CLKBA $\uparrow$	0.0		ns	
		B after CLKBA $\uparrow$	0.0			
		A after LEAB	0.8			
		B after LEBA	0.0			
		$\overline{CEAB}$ after CLKAB $\uparrow$	1.0			
		$\overline{CEBA}$ after CLKBA $\uparrow$	1.9			

### AC Electrical Characteristics

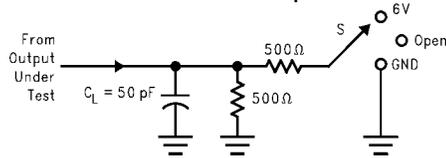
Over recommended range of supply voltage and operating free-air temperature,  $V_{REF} = 1.0V$  (unless otherwise noted).  
 $C_L = 30\text{ pF}$  for B Port and  $C_L = 50\text{ pF}$  for A Port.

Symbol	From (Input)	To (Output)	Min	Typ (Note 13)	Max	Unit
$t_{PLH}$ $t_{PHL}$	A	B	2.1 1.0	4.1 2.7	6.3 4.4	ns
$t_{PLH}$ $t_{PHL}$	LEAB	B	2.2 1.0	4.2 2.4	6.3 4.2	ns
$t_{PLH}$ $t_{PHL}$	CLKAB	B	2.2 1.0	4.4 2.5	6.5 4.4	ns
$t_{PLH}$ $t_{PHL}$	$\overline{OEAB}$	B	2.0 1.0	3.8 2.6	5.6 4.3	ns
$t_{RISE}$	Transition Time, B Outputs (20% to 80%)			3.1		ns
$t_{FALL}$	Transition Time, B Outputs (20% to 80%)			2.1		
$t_{PLH}$ $t_{PHL}$	B	A	1.8 1.8	3.8 3.8	5.8 5.8	ns
$t_{PLH}$ $t_{PHL}$	LEBA	A	0.3 0.4	2.2 2.4	4.6 4.6	ns
$t_{PLH}$ $t_{PHL}$	CLKBA	A	0.5 0.6	2.4 2.6	4.6 4.6	ns
$t_{PZH}$ , $t_{PZL}$ $t_{PHZ}$ , $t_{PLZ}$	$\overline{OEBA}$	A	0.3 0.3	2.7 2.5	5.2 5.2	ns

**Note 13:** All typical values are at  $V_{CC} = 3.3V$ , and  $T_A = 25^\circ C$ .

## Test Circuits and Timing Waveforms

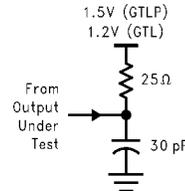
**Test Circuit for A Outputs**



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

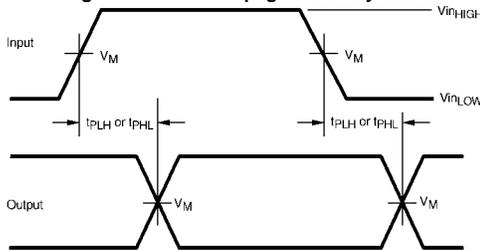
**Note A:**  $C_L$  includes probes and Jig capacitance.

**Test Circuit for B Outputs**

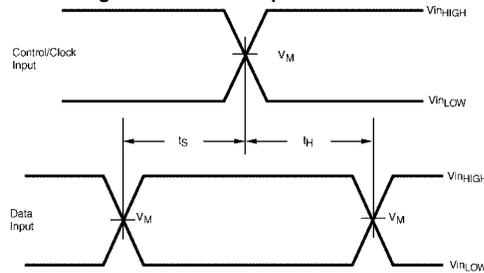


**Note B:** For B Port,  $C_L = 30$  pF is used for worst case.

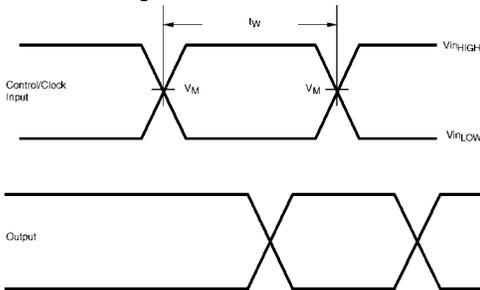
**Voltage Waveform - Propagation Delay Times**



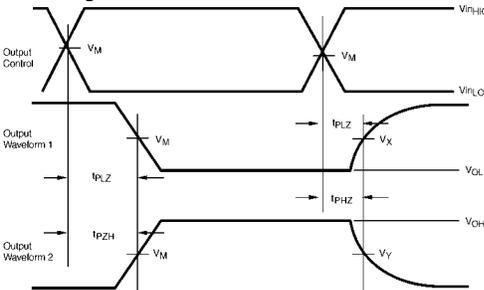
**Voltage Waveform - Setup and Hold Times**



**Voltage Waveform - Pulse Width**



**Voltage Waveform - Enable and Disable times**



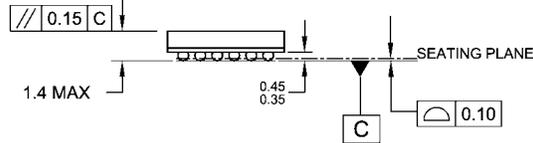
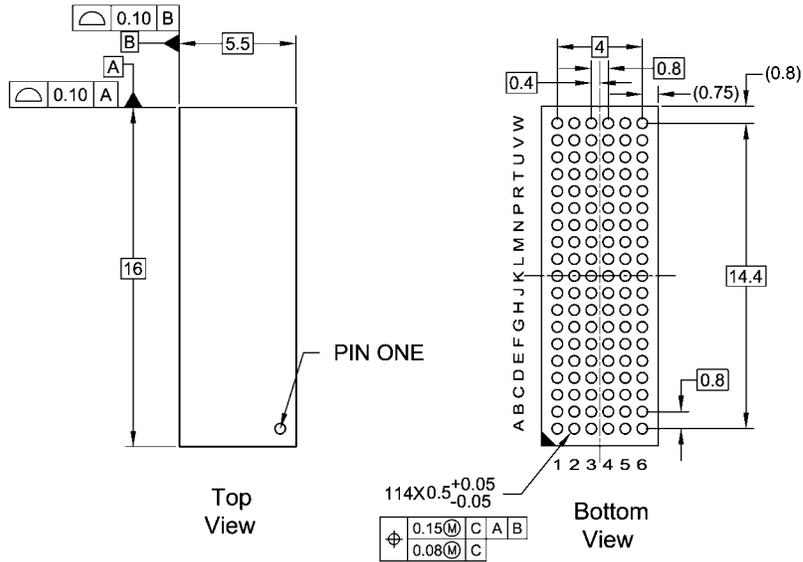
Output Waveform 1 is for an output with internal conditions such that the output is LOW except when disabled by the control output.  
Output Waveform 2 is for an output with internal conditions such that the output is HIGH except when disabled by the control output.

### Input and Measure Conditions

	A or LVTTL 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,  $t_{RISE} = t_{FALL} = 2$  ns (10% to 90%),  $Z_O = 50\Omega$ .  
The outputs are measured one at a time with one transition per measurement.

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



**NOTES:**

- A. THIS PACKAGE CONFORMS TO JEDEC MO-205
- B. ALL DIMENSIONS IN MILLIMETERS
- C. LAND PATTERN RECOMMENDATION: NSMD (Non Solder Mask Defined)  
.35MM DIA PADS WITH A SOLDERMASK OPENING OF .45MM CONCENTRIC TO PADS
- D. DRAWING CONFORMS TO ASME Y14.5M-1994

BGA114ArevE

**114-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide  
Package Number BGA114A**

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