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November 2016

# FXGL2014 — 4-Channel LVTTTL to GTL Transceiver

## Features

- Operates as a 4-bit GTL-/GTL/GTL+ Sampling receiver or as a LVTTTL to GTL-/GTL/GTL+ Driver
- 3.0 V to 3.6 V Operation with 5 V Tolerant LVTTTL Input
- GTL Input and Output 3.6 V Tolerant
- Vref Adjustable from 0.5 V to VCC/2
- Partial Power-down Permitted
- Under-Voltage Lockout (UVLO)
- ESD Protection exceeds 2000 V HBM per JESD22-A114 and 1000 V CDM per JESD22-CC101
- Latch-up Protection Exceeds 500 mA per JESD78
- Package Offered: TSSOP14
- -40°C to 85°C Operating Temperature Range

## Description

The FXGL2014 is a 4-channel translator to interface between 3.3-V LVTTTL chip set I/O and Xeon processor GTL-/GTL/GTL+ I/O.

The FXGL2014 integrates ESD protection cells on all terminals and is available in a TSSOP package (5.0 mm x 4.4 mm). The device is characterized over free air temperature range of -40°C to 85°C.

## Applications

- Server
- Base Station
- Wire-line Communication

## Ordering Information

Part Number	Operating Temperature Range	Package	Packing Method
FXGL2014MTC	-40 to +85°C	5.0 mm x 4.4 mm, 0.65 mm Pitch, 14 Lead TSSOP Package	Tape & Reel

FXGL2014 — 4-Channel LVTTTL to GTL Transceiver

## Analog Symbols

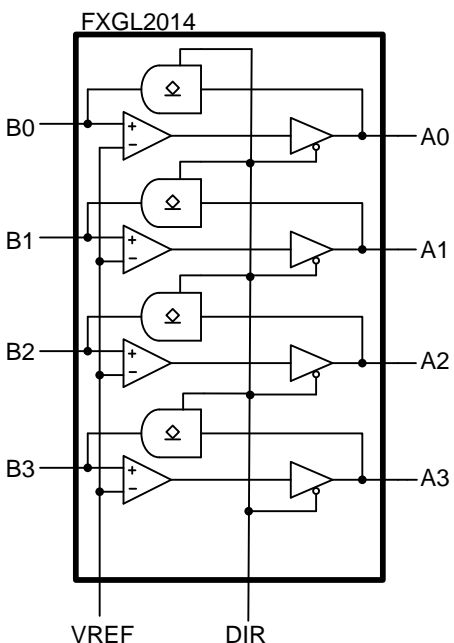


Figure 1. Analog Symbols

## Functional Description

INPUT	INPUT/OUTPUT	
	A (LVTTTL)	B (GTL)
High Voltage	Input	$B_n = A_n$
Low Voltage	$A_n = B_n$	Input

## Pin Configuration

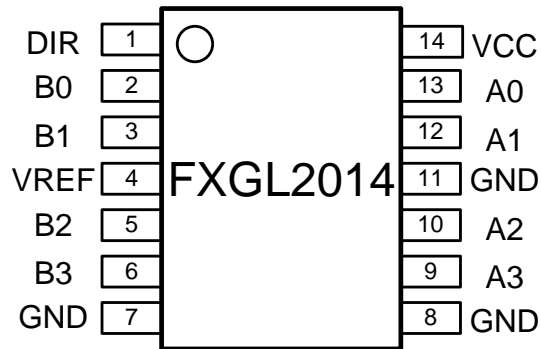


Figure 1. Pin Assignment (Top Through View)

## Pin Descriptions

Pin Name	Pin #	Description
A0	13	LVTTTL Data Input / Output
A1	12	
A2	10	
A3	9	
B0	2	GTL Data Input / Output
B1	3	
B2	5	
B3	6	
DIR	1	Direction Control Input (LVTTTL)
GND	7	Ground
	8	
	11	
VCC	14	Supply Voltage
VREF	4	GTL Reference Voltage

## 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
$V_{CC}$	Supply Voltage		-0.5	4.6	V
$I_{IK}$	Input Clamping Current, $V_I < 0$ V			-50	mA
$V_{DIR}$	Input Control Voltages DIR		-0.5	6	V
$V_I$	Input Voltage	A Port	-0.5	6.5	V
		B Port	-0.5	4.6	
$I_{CK}$	Control Input Clamp Current, $V_O < 0$ V			-50	mA
$V_O$	Output Voltage in Off-State	A Port	-0.5	6.5	V
		B Port	-0.5	4.6	
$I_{OL}$	Current into any output in the Low State	A Port		40	mA
		B Port		80	
$I_{OH}$	Current into any output in the High State			-40	mA
$T_{stg}$	Storage Temperature Range		-55	150	°C
$V_{ESD}$	Human Body Model (HBM), JEDEC: JESD22-A114	All Pins	2		kV
	Charged Device Model, JEDEC: JESD22-C101	All Pins	1		

## Recommended Operating Conditions

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

Symbol	Parameter		Min.	Typ.	Max.	Unit
$V_{CC}$	Supply Voltage		3.0	3.3	3.6	V
$V_{TT}$	Termination Voltage	GTL-	0.85	0.90	0.95	V
		GTL	1.14	1.20	1.26	
		GTL+	1.35	1.50	1.65	
$V_{REF}$	Reference Voltage	Overall	0.5	$2/3V_{TT}$	$V_{CC}/2$	V
		GTL-	0.50	0.60	0.63	
		GTL	0.76	0.80	0.84	
		GTL+	0.87	1.00	1.10	
$V_I$	Input Voltage	A Port	0	3.3	$5.5^{(3)}$	V
		B Port	0	$V_{TT}$	3.6	
$V_{IH}$	High-level Input Voltage	A Port and DIR	2			V
		B Port	$V_{REF} + 50 \text{ mV}$			
$V_{IL}$	Low-level Input Voltage	A Port and DIR			0.8	V
		B Port			$V_{REF} - 50 \text{ mV}$	
$I_{OL}$	Low-level Output Current	A Port			20	mA
		B Port			50	
$I_{OH}$	High-level Output current	A Port			-20	mA

### Notes:

1. Over operating free-air temperature range (unless otherwise noted).
2. All unused control inputs of the device must be held at  $V_{CC}$  or GND to ensure proper device operation.
3. The  $V_I$  (max) of LVTTTL port is 3.6 V if configured as output (DIR=L).

## Thermal Information

Thermal Metric		Value	Unit
$R_{\theta JA}$	Junction-to-Ambient Thermal Resistance	116	°C/W
$R_{\theta JC(top)}$	Junction-to-Case (top) Thermal Resistance	17	

## DC Electrical Characteristics

Specified at  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$  (unless otherwise noted).

Symbol	Parameter	Conditions	-40°C to 85°C			Unit
			Min.	Typ.	Max.	
$V_{OH}$	A Port	$V_{CC} = 3$ to $3.6$ V, $I_{OH} = -100$ $\mu\text{A}$	$V_{CC} - 0.2$			V
		$V_{CC} = 3$ V, $I_{OH} = -16$ mA	2.0			
$V_{OL}$	A Port	$V_{CC} = 3$ V, $I_{OL} = 8$ mA		0.28	0.40	V
	A Port	$V_{CC} = 3$ V, $I_{OL} = 12$ mA		0.42	0.60	
	A Port	$V_{CC} = 3$ V, $I_{OL} = 16$ mA		0.55	0.80	
	B Port	$V_{CC} = 3$ V, $I_{OL} = 40$ mA		0.23	0.40	
$I_I$	A Port	$V_{CC} = 3.6$ V, $V_I = V_{CC}$			$\pm 1$	$\mu\text{A}$
		$V_{CC} = 3.6$ V, $V_I = 0$ V			$\pm 1$	
		$V_{CC} = 3.6$ V, $V_I = 5.5$ V			5	
	B Port	$V_{CC} = 3.6$ V, $V_I = V_{TT}$ or GND			$\pm 1$	$\mu\text{A}$
Control Pin	$V_{CC} = 3.6$ V, $V_I = V_{CC}$ or 0 V			$\pm 1$	$\mu\text{A}$	
$I_{off}$	OFF-State Output Current on A Port	$V_{CC} = 0$ V, $V_{IO} = 0$ to $3.6$ V			$\pm 10$	$\mu\text{A}$
	OFF-State Output Current on A Port	$V_{CC} = 0$ V, $V_{IO} = 3.6$ to $5.5$ V			$\pm 100$	
	OFF-State Output Current on B Port	$V_{CC} = 0$ V, $V_{IO} = 0$ to $3.6$ V			$\pm 10$	
$I_{CC}$	A Port	$V_{CC} = 3.6$ V, $V_I = V_{CC}$ or GND, $I_O = 0$		3	10	mA
	B Port	$V_{CC} = 3.6$ V, $V_I = V_{TT}$ or GND, $I_O = 0$		3	10	mA
$\Delta I_{CC}$	A Port or Control Input	$V_{CC} = 3.6$ V, $V_I = V_{CC} - 0.6$ V			500	$\mu\text{A}$
$V_{UVLO}^{(4)}$	Under-Voltage Lockout Threshold	$V_{CC} = 0$ to $3$ V	1.5			V
$C_I^{(4)}$	Input Capacitance of Control Pin	$V_{CC} = 3$ to $3.6$ V, $V_I = 3.0$ V or 0 V		2.0		pF
$C_{IO}^{(4)}$	A Port	$V_{CC} = 3$ to $3.6$ V, $V_O = 3.0$ V or 0 V		4.0		pF
	B Port	$V_{CC} = 3$ to $3.6$ V, $V_O = V_{TT}$ or 0 V		5.46		

**Note:**

4. Guaranteed by characterization and / or design. Not production tested.

## AC Electrical Characteristics

Over-operating range,  $T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ ,  $V_{CC} = 3.0$  to  $3.6$  V,  $\text{GND} = 0$  V for GTL.

Symbol	Parameter		GTL-			GTL			GTL+			Unit
			$V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$			$V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$			$V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$			
			$V_{REF} = 0.6 \text{ V}$			$V_{REF} = 0.8 \text{ V}$			$V_{REF} = 1 \text{ V}$			
			$V_{TT} = 0.9 \text{ V}$			$V_{TT} = 1.2 \text{ V}$			$V_{TT} = 1.5 \text{ V}$			
			Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
$t_{PLH}$	Low to High Propagation Delay <sup>(5)</sup>	An to Bn		2.8	5.0		2.8	5.0		2.8	5.0	ns
$t_{PHL}$	High to Low Propagation Delay <sup>(5)</sup>			3.3	7.0		3.4	7.0		3.4	7.0	
$t_{PLH}$	Low to High Propagation Delay <sup>(5)</sup>	Bn to An		5.3	8.0		5.2	8.0		5.1	8.0	ns
$t_{PHL}$	High to Low Propagation Delay <sup>(5)</sup>			5.2	8.0		4.9	7.0		4.7	7.0	

**Note:**

- Guaranteed by characterization and / or design. Not production tested.



### Typical characteristics

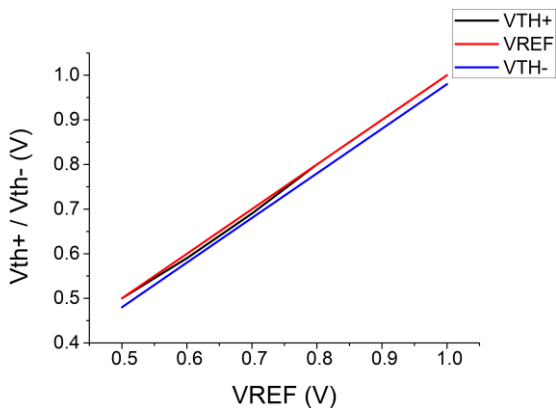


Figure 2. GTL Vth+ and Vth- vs. VREF (-40°C)

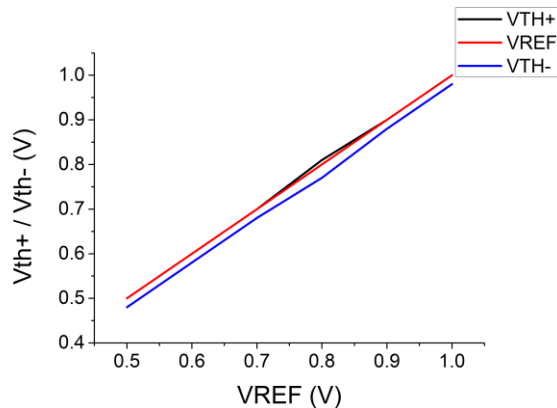


Figure 3. GTL Vth+ and Vth- vs. VREF (25°C)

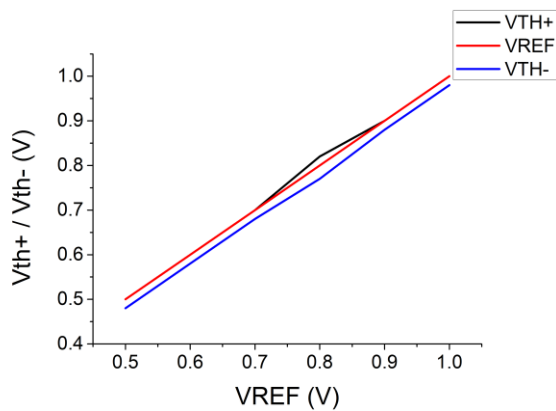
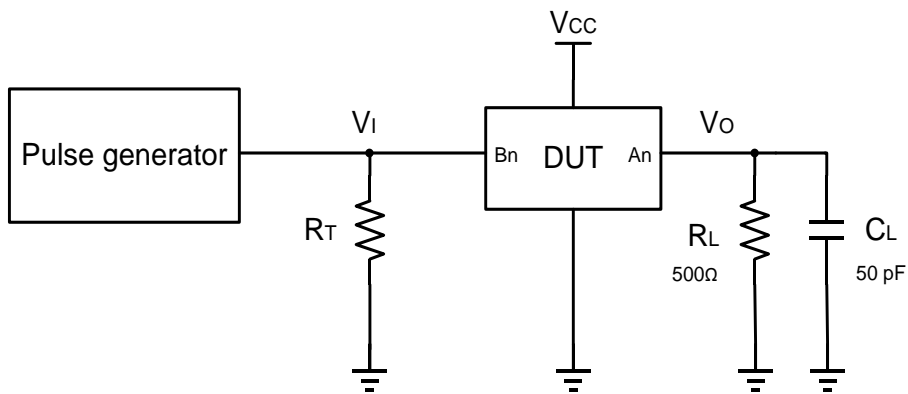
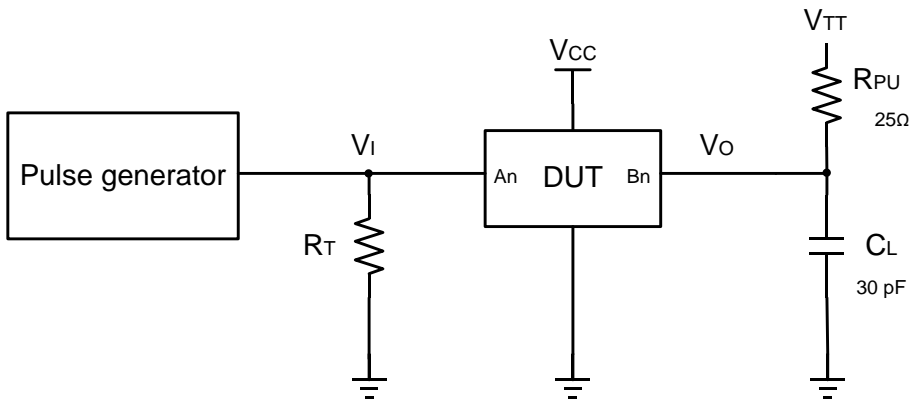


Figure 4. GTL Vth+ and Vth- vs. VREF (85°C)

**Test Information**



**Figure 5. Load Circuit for A Port**



**Figure 6. Load Circuit for B Port**

$R_T$  - Termination resistance; should be equal to output impedance of pulse generators.

$R_L$  - Load resistor.

$C_L$  - Load capacitance; includes jig and probe capacitance.

### Waveforms

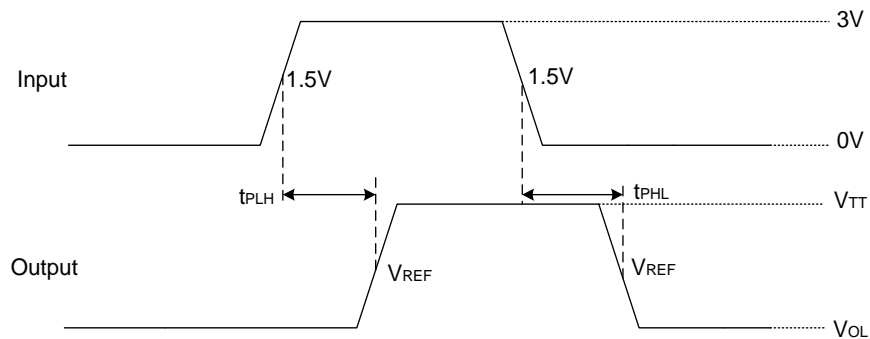
$V_M = 1.5\text{ V}$  at  $V_{CC} \geq 3.0\text{ V}$ ;  $V_M = V_{CC}$  at  $V_{CC} \leq 2.7\text{ V}$  for A ports and control pins.

$V_M = V_{REF}$  for B ports.



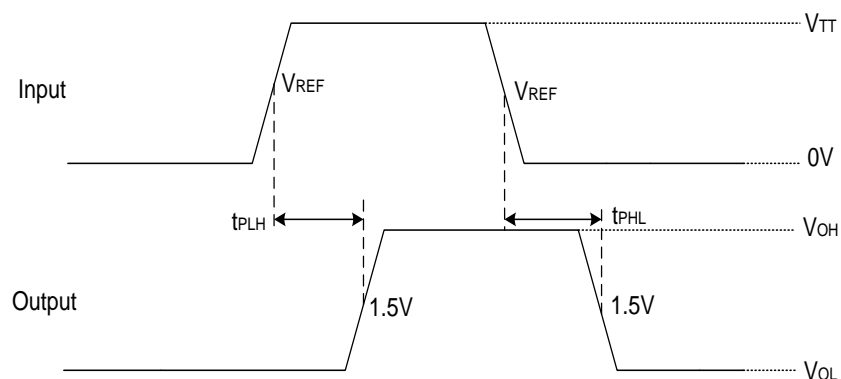
$V_M = 1.5\text{V}$  for A port and  $V_{REF}$  for B port

#### Pulse duration



A port to B port

#### Propagation delay times



B port to A port

#### Propagation delay times

**Figure 7. Voltage Waveforms**

- A. All control inputs are LVTTTL levels.
- B.  $C_L$  includes probe and jig capacitance.
- C. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 10\text{ MHz}$ ,  $Z_O = 50\ \Omega$ ,  $t_r \leq 2.5\text{ ns}$ ,  $t_f \leq 2.5\text{ ns}$ .
- D. The outputs are measured one at a time, with one transition per measurement.

## Application Information

### Application Overview

The FXGL2014 is a 4-channel translating transceiver designed for 3.3-V LVTTTL system interface with a GTL–/GTL/GTL+ bus, where GTL–/GTL/GTL+ refers to the reference voltage of the GTL bus and the input/output voltage thresholds associated with it.

The direction pin allows the part to function as either a GTL-to-LVTTTL sampling receiver or as a LVTTTL-to-GTL interface.

The FXGL2014 performs translation in two directions. One direction is GTL–/GTL/GTL+ to LVTTTL when DIR is tied to GND. With appropriate  $V_{REF}$  set up, the GTL input can be compliant with GTL–/GTL/GTL+. Another direction is LVTTTL to GTL–/GTL/GTL+ when DIR is tied to VCC. 3.6 V tolerance on the GTL output allows the GTL outputs to pull up to any voltage level under 3.6 V.

### Feature Description

#### 5 V Tolerance on LVTTTL Input

The FXGL2014 LVTTTL inputs (only) are tolerant up to 5.5 V and allow direct access to TTL or 5 V CMOS inputs. The LVTTTL outputs are not 5.5 V tolerant.

#### 3.6 V Tolerance on GTL Input / Output

The FXGL2014 GTL inputs and outputs operate up to 3.6 V, allowing the device to be used in higher voltage open-drain output applications.

#### Ultra-Low $V_{REF}$ and High Bandwidth

FXGL2014's  $V_{REF}$  tracks down to 0.5 V for low voltage CPUs with excellent propagation delay performance. This feature allows the FXGL2014 to support high data rates with the GTL– bus.

#### Under-Voltage Lockout (UVLO)

Under-voltage lockout circuit is integrated internal. This feature makes sure the data transferred effectively when power unstable.

### Typical Application

#### GTL–/GTL/GTL+ to LVTTTL

Select appropriate  $V_{TT}/V_{REF}$  based upon GTL–/GTL/GTL+. The parameters in Recommended Operating Conditions are compliant to the GTL specification.

The FXGL2014 requires industrial standard LVTTTL and GTL inputs. The design example in the Application Information shows standard voltage level and typical resistor values.

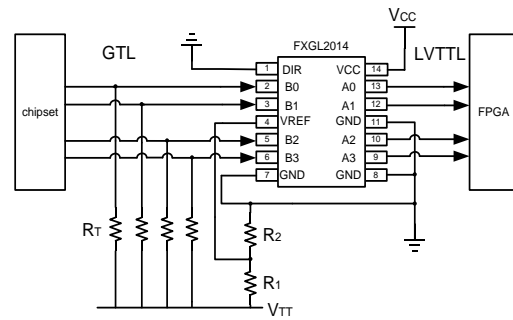


Figure 8. Application Diagram for GTL to LVTTTL

Table 1. Application Table for GTL to LVTTTL

	Port B to Port A
	GTL to LVTTTL
VCC	3.3 V
VREF	$2 \cdot V_{TT} / 3$
VTT	1.0 V
DIR	GND
RT	75 $\Omega$
R1	49.9 $\Omega$
R2	100 $\Omega$

#### LVTTTL to GTL–/GTL/GTL+

Because GTL is an open-drain interface, the selection of the pull-up resistor depends on the application requirement (for example, data rate) and PCB trace capacitance.

The FXGL2014 requires industrial standard LVTTTL and GTL inputs. The design example in the Application Information section show standard voltage level and typical resistor values.

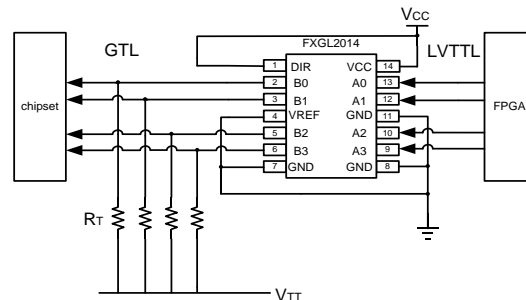
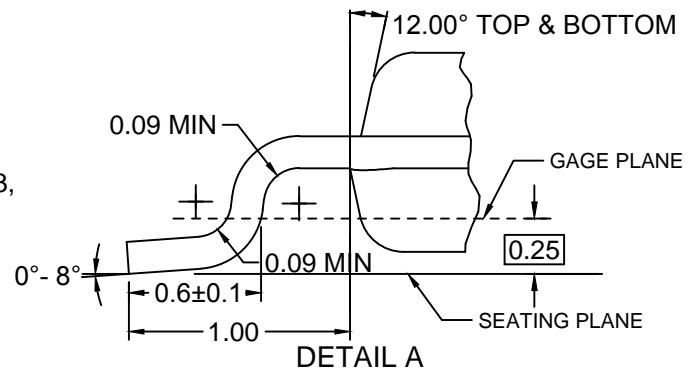
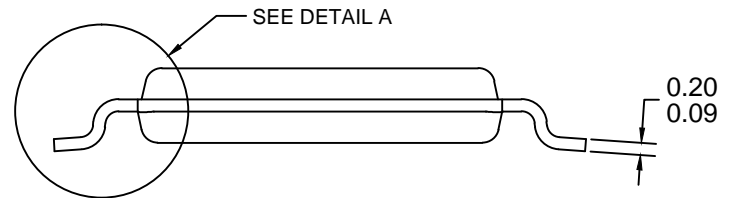
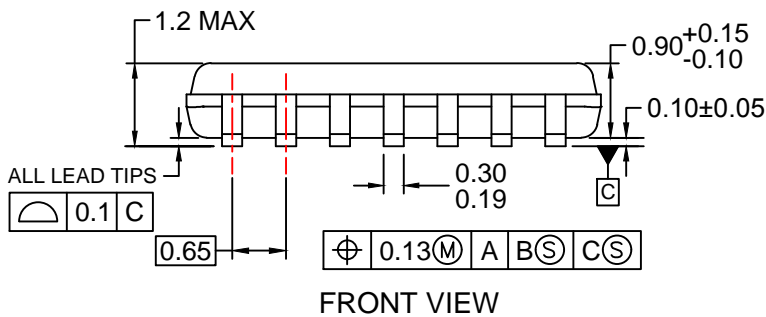
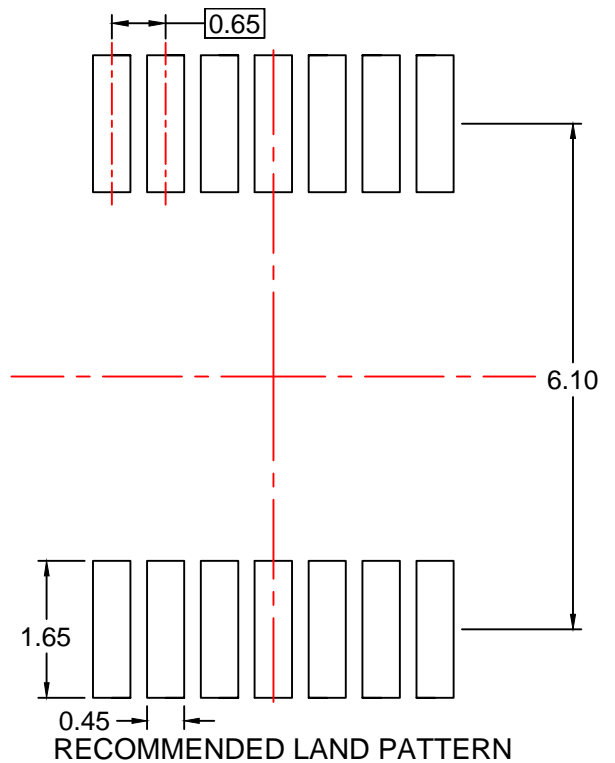
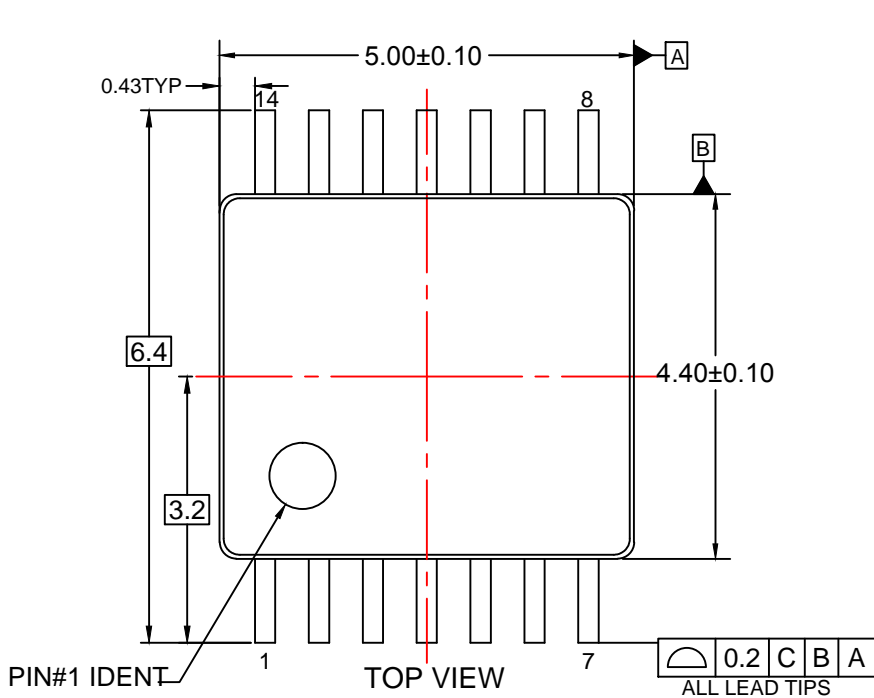


Figure 9. Application Diagram for LVTTTL to GTL

Table 2. Application Table for LVTTTL to GTL

	Port A to Port B
	LVTTTL to GTL
VCC	3.3 V
VREF	GND
VTT	1.0 V
DIR	GND
RT	75 $\Omega$
R1	Not Available
R2	Not Available



**NOTES:**

- A. CONFORMS TO JEDEC REGISTRATION MO-153, VARIATION AB, REF NOTE 6
- B. DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS
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