32-BIT LVTTL-TO-GTL+ BUS TRANSCEIVER

SCES293 – OCTOBER 1999

- **Bidirectional Interface Between GTL+ Signal Levels and LVTTL Logic Levels**
- **LVTTL Interfaces Are 5-V Tolerant**
- **Identical to ’32245 Function**
- **Medium-Drive GTL+ Outputs (50 mA)**
- **LVTTL Outputs (–24 mA/24 mA)**
- **GTL+ Rise and Fall Times Designed for Optimal Data-Transfer Rate and Signal Integrity**
- **I_{off}, Power-Up 3-State, and BIAS V_{CC} Support Live Insertion**
- **Bus Hold on A-Port Data Inputs**
- **Distributed V_{CC} and GND-Pin Configuration Minimizes High-Speed Switching Noise**
- **Packaged in Plastic Fine-Pitch Ball Grid Array Package**

NOTE: For tape and reel order entry:
The GKER package is abbreviated to KR.

description

The SN74GTLPH32945 is a medium-drive 32-bit bus transceiver that provides LVTTL-to-GTL+ and GTL+-to-LVTTL signal-level translation. It is partitioned as four 8-bit transceivers and is identical to the ’16245 function. The device provides a high-speed interface between cards operating at LVTTL logic levels and a backplane operating at GTL+ signal levels. High-speed (about two times faster than standard TTL or LVTTL) backplane operation is a direct result of GTLP’s reduced output swing (<1 V), reduced input threshold levels, improved differential input, and output edge control (OEC™). Improved GTLP OEC circuits minimize bus settling time and have been designed and tested using several backplane models. The medium drive is suitable for driving double-terminated backplanes.

GTL+ is the Texas Instruments derivative of the Gunning transceiver logic (GTL) JEDEC standard JESD 8-3. The AC specification of the SN74GTLPH32945 is given only at the preferred higher noise margin GTL+, but the user has the flexibility of using this device at either GTL (V_{TT} = 1.2 V and V_{REF} = 0.8 V) or GTL+ (V_{TT} = 1.5 V and V_{REF} = 1 V) signal levels.

Normally, the B port operates at GTL or GTL+ levels, while the A-port and control inputs are compatible with LVTTL logic levels and are 5-V tolerant. V_{REF} is the reference input voltage for the B port.

This device is fully specified for live-insertion applications using I_{off}, power-up 3-state, and BIAS V_{CC}. The I_{off} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down. The power-up 3-state circuitry places the outputs in the high-impedance state during power up and power down, which prevents driver conflict. The BIAS V_{CC} circuitry precharges and preconditions the B-port input/output connections, preventing disturbance of active data on the backplane during card insertion or removal, and permits true live-insertion capability.

Active bus-hold circuitry holds unused or undriven LVTTL inputs at a valid logic state. Use of pullup or pulldown resistors with the bus-hold circuitry is not recommended.

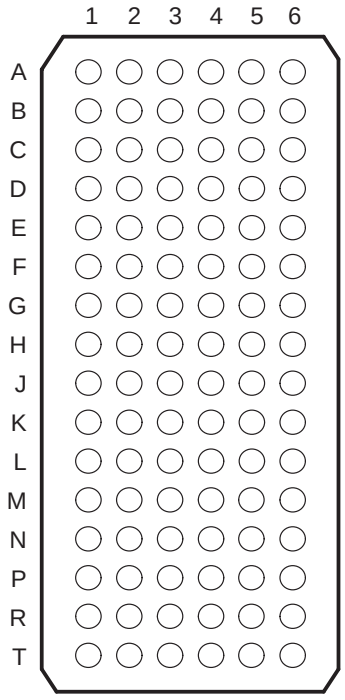
When V_{CC} is between 0 and 1.5 V, the device is in the high-impedance state during power up or power down. However, to ensure the high-impedance state above 1.5 V, the output-enable ($\overline{OE}$) input should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

The SN74GTLPH32945 is characterized for operation from –40°C to 85°C.

PRODUCT PREVIEW

OEC is a trademark of Texas Instruments Incorporated.

GKE PACKAGE
(TOP VIEW)



terminal assignments

	1	2	3	4	5	6
A	1A2	1A1	1DIR	$1\overline{OE}$	1B1	1B2
B	1A3	1A4	GND	GND	1B4	1B3
C	1A5	1A6	$1V_{CC}$	1BIAS V_{CC}	1B6	1B5
D	1A7	1A8	GND	GND	1B8	1B7
E	2A1	2A2	GND	GND	2B3	2B1
F	2A3	2A4	$1V_{CC}$	$1V_{REF}$	2B4	2B3
G	2A5	2A6	GND	GND	2B6	2B5
H	2A7	2A8	2DIR	$2\overline{OE}$	2B8	2B7
J	3A2	3A1	3DIR	$3\overline{OE}$	3B1	3B2
K	3A3	3A4	GND	GND	3B4	3B3
L	3A5	3A6	$2V_{CC}$	2BIAS V_{CC}	3B6	3B5
M	3A7	3A8	GND	GND	3B8	3B7
N	4A1	4A2	GND	GND	4B2	4B1
P	4A3	4A4	$2V_{CC}$	$2V_{REF}$	4B4	4B3
R	4A5	4A6	GND	GND	4B6	4B5
T	4A7	4A8	4DIR	$4\overline{OE}$	4B8	4B7

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functional description

The SN74GTLPH32945 is a medium-drive (50 mA) 32-bit bus transceiver partitioned as four 8-bit segments, providing standard ’245 functionality, and is designed for asynchronous communication between data buses. The device transmits data from the A port to the B port or from the B port to the A port, depending on the logic level at the direction-control (DIR) input. $\overline{OE}$ can be used to disable the device so the buses are effectively isolated. Data polarity is noninverting.

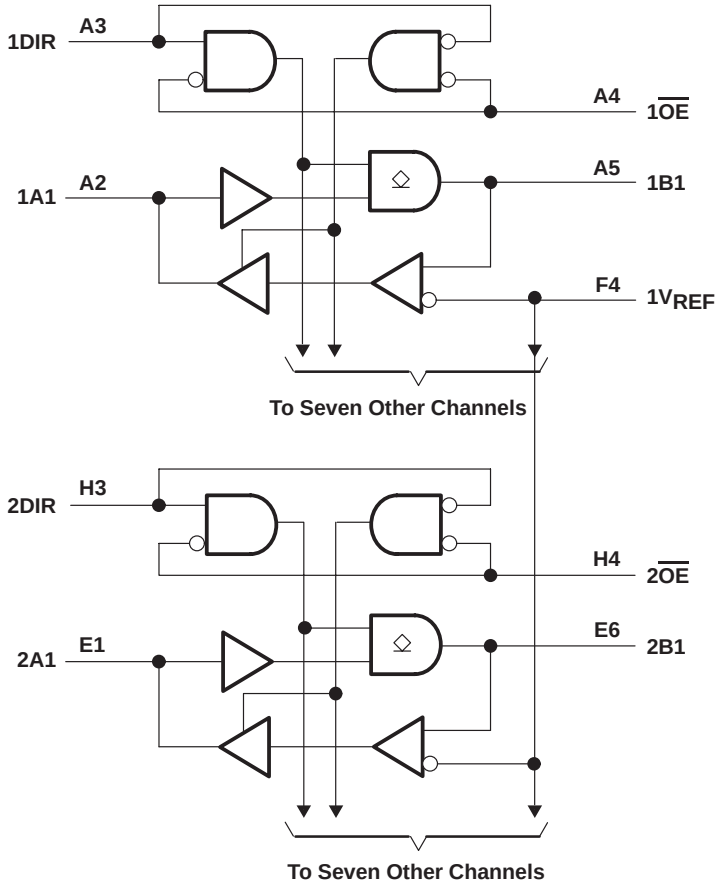
For A-to-B data flow, when $\overline{OE}$ is low and DIR is high, the B outputs take on the logic value of the A inputs. When $\overline{OE}$ is high, the outputs are in the high-impedance state.

Data flow for B to A is similar to that for A to B, but $\overline{OE}$ is low and DIR is low.

FUNCTION TABLE

INPUTS		OUTPUT	MODE
$\overline{OE}$	DIR		
L	L	B data to A port	Transparent
L	H	A data to B port	Transparent
H	X	Z	Isolation

logic diagram (positive logic)†



† $1V_{CC}$ and 1BIAS V_{CC} are associated with these channels.

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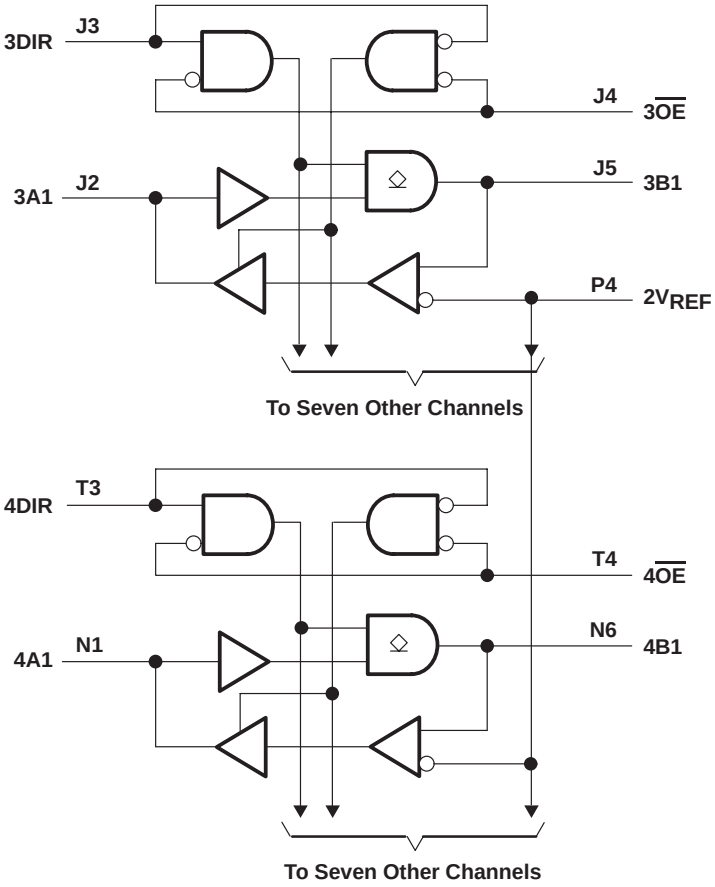
logic diagram (positive logic) (continued)†



† $2V_{CC}$ and 2BIAS V_{CC} are associated with these channels.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage range, V_{CC} and BIAS V_{CC} . . . . . –0.5 V to 4.6 V
Input voltage range, V_I (see Note 1): A-port and control inputs . . . . . –0.5 V to 7 V
B port and V_{REF} . . . . . –0.5 V to 4.6 V
Voltage range applied to any output in the high-impedance or power-off state, V_O
(see Note 1): A port . . . . . –0.5 V to 7 V
B port . . . . . –0.5 V to 4.6 V
Current into any output in the low state, I_O: A port . . . . . 48 mA
B port . . . . . 100 mA
Current into any A-port output in the high state, I_O (see Note 2) . . . . . 48 mA
Continuous current through each V_{CC} or GND . . . . . ±100 mA
Input clamp current, I_{IK} ($V_I < 0$) . . . . . –50 mA
Output clamp current, I_{OK} ($V_O < 0$) . . . . . –50 mA
Package thermal impedance, θ_{JA} (see Note 3) . . . . . 40°C/W
Storage temperature range, T_{stg} . . . . . –65°C to 150°C

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
2. This current flows only when the output is in the high state and $V_O > V_{CC}$.
3. The package thermal impedance is calculated in accordance with JESD 51.

recommended operating conditions (see Notes 4 through 6)

			MIN	NOM	MAX	UNIT
V_{CC}, BIAS V_{CC}	Supply voltage		3.15	3.3	3.45	V
V_{TT}	Termination voltage	GTL	1.14	1.2	1.26	V
		GTL+	1.35	1.5	1.65	
V_{REF}	Supply voltage	GTL	0.74	0.8	0.87	V
		GTL+	0.87	1	1.1	
V_I	Input voltage	B port			V_{TT}	V
		Except B port			V_{CC}	
V_{IH}	High-level input voltage	B port	V_{REF}+0.05			V
		Except B port	2			
V_{IL}	Low-level input voltage	B port			V_{REF}–0.05	V
		Except B port			0.8	
I_{IK}	Input clamp current				–18	mA
I_{OH}	High-level output current	A port			–24	mA
I_{OL}	Low-level output current	A port			24	mA
		B port			50	
T_A	Operating free-air temperature		–40		85	°C

NOTES: 4. All unused control inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.
5. Normal connection sequence is GND first, BIAS V_{CC} = 3.3 V second, and V_{CC} = 3.3 V, I/O, control inputs, V_{TT} and V_{REF} (any order) last. However, if the B-port I/O precharge is not required, the acceptable connection sequence is GND first and V_{CC} = 3.3 V, BIAS V_{CC} = 3.3 V, I/O, control inputs, V_{TT} and V_{REF} (any order) last. When V_{CC} is connected, the BIAS V_{CC} circuitry is disabled.
6. V_{TT} and R_{TT} can be adjusted to accommodate backplane impedances as long as they do not exceed the DC absolute I_{OL} ratings. Similarly, V_{REF} can be adjusted to optimize noise margins, but normally is 2/3 V_{TT}.

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electrical characteristics over recommended operating free-air temperature range for GTL+ (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
V_{IK}		V_{CC} = 3.15 V,	I_I = –18 mA			–1.2	V
V_{OH}	A port	V_{CC} = 3.15 V to 3.45 V,	I_{OH} = –100 µA	V_{CC}–0.2			V
		V_{CC} = 3.15 V	I_{OH} = –12 mA	2.4			
			I_{OH} = –24 mA	2			
V_{OL}	A port	V_{CC} = 3.15 V to 3.45 V,	I_{OL} = 100 µA			0.2	V
		V_{CC} = 3.15 V	I_{OL} = 12 mA			0.4	
			I_{OL} = 24 mA			0.5	
	B port	V_{CC} = 3.15 V to 3.45 V,	I_{OL} = 100 µA			0.2	
		V_{CC} = 3.15 V	I_{OL} = 10 mA			0.2	
			I_{OL} = 40 mA			0.4	
			I_{OL} = 50 mA			0.55	
I_I‡	B port	V_{CC} = 3.45 V,	V_I = 0 to 1.5 V			±10	µA
	A-port and control inputs	V_{CC} = 3.45 V	V_I = 0 or V_{CC}			±10	
			V_I = 5.5 V			±20	
I_{BHL}§	A port	V_{CC} = 3.15 V,	V_I = 0.8 V	75			µA
I_{BHH}¶	A port	V_{CC} = 3.15 V,	V_I = 2 V	–75			µA
I_{BHLO}#	A port	V_{CC} = 3.45 V,	V_I = 0 to V_{CC}			500	µA
I_{BHHO}‖	A port	V_{CC} = 3.45 V,	V_I = 0 to V_{CC}			–500	µA
I_{CC}	A or B port	V_{CC} = 3.45 V, I_O = 0, V_I (A-port or control input) = V_{CC} or GND, V_I (B port) = V_{TT} or GND	Outputs high			50	mA
			Outputs low			50	
			Outputs disabled			50	
ΔI_{CC}☆		V_{CC} = 3.45 V, One A-port or control input at V_{CC} – 0.6 V, Other A-port or control inputs at V_{CC} or GND				1	mA
C_i	Control inputs	V_I = 3.15 V or 0					pF
C_{io}	A port	V_O = 3.15 V or 0					pF
	B port	V_O = 1.5 V or 0					

† All typical values are at V_{CC} = 3.3 V, T_A = 25°C.
‡ For I/O ports, the parameter I_I includes the off-state output leakage current.
§ The bus-hold circuit can sink at least the minimum low sustaining current at V_{IL}max. I_{BHL} should be measured after lowering V_{IN} to GND and then raising it to V_{IL}max.
¶ The bus-hold circuit can source at least the minimum high sustaining current at V_{IH}min. I_{BHH} should be measured after raising V_{IN} to V_{CC} and then lowering it to V_{IH}min.
# An external driver must source at least I_{BHLO} to switch this node from low to high.
‖ An external driver must sink at least I_{BHHO} to switch this node from high to low.
☆ This is the increase in supply current for each input that is at the specified TTL voltage level rather than V_{CC} or GND.

live-insertion specifications for A port over recommended operating free-air temperature range

PARAMETER	TEST CONDITIONS			MIN	MAX	UNIT
I_{off}	V_{CC} = 0,	BIAS V_{CC} = 0,	V_I or V_O = 0 to 5.5 V		100	µA
I_{OZPU}	V_{CC} = 0 to 1.5 V,	V_O = 0.5 V to 3 V,	$\overline{OE}$ = 0		±100	µA
I_{OZPD}	V_{CC} = 1.5 V to 0,	V_O = 0.5 V to 3 V,	$\overline{OE}$ = 0		±100	µA

live-insertion specifications for B port over recommended operating free-air temperature range

PARAMETER	TEST CONDITIONS			MIN	MAX	UNIT
I_{off}	V_{CC} = 0,	BIAS V_{CC} = 0,	V_I or V_O = 0 to 1.5 V		100	μA
I_{OZPU}	V_{CC} = 0 to 1.5 V,	V_O = 0.5 V to 1.5 V,	$\overline{OE}$ = 0		±100	μA
I_{OZPD}	V_{CC} = 1.5 V to 0,	V_O = 0.5 V to 1.5 V,	$\overline{OE}$ = 0		±100	μA
I_{CC} (BIAS V_{CC})	V_{CC} = 0 to 3.15 V	BIAS V_{CC} = 3.15 V to 3.45 V,	V_O (B port) = 0 to 1.5 V		5	mA
	V_{CC} = 3.15 V to 3.45 V				10	μA
V_O	V_{CC} = 0,	BIAS V_{CC} = 3.3 V		0.95	1.05	V
I_O	V_{CC} = 0,	BIAS V_{CC} = 3.15 V to 3.45 V,	V_O (B port) = 0.6 V	–1		μA

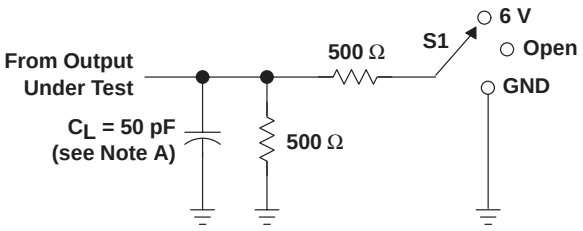
switching characteristics over recommended ranges of supply voltage and operating free-air temperature, V_{TT} = 1.5 V and V_{REF} = 1 V for GTL+ (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	MIN	TYP†	MAX	UNIT
f_{max}						MHz
t_{pd}	A	B				ns
t_{en}	$\overline{OE}$	B				ns
t_{dis}	$\overline{OE}$	B				ns
t_r	Rise time, B outputs (0.6 V to 1.3 V)					ns
t_f	Fall time, B outputs (1.3 V to 0.6 V)					ns
t_{pd}	B	A				ns
t_{en}	$\overline{OE}$	A				ns
t_{dis}						

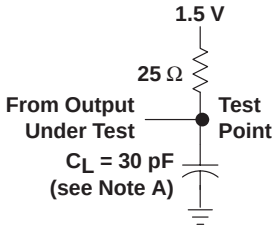
† All typical values are at V_{CC} = 3.3 V, T_A = 25°C.

PRODUCT PREVIEW

PARAMETER MEASUREMENT INFORMATION

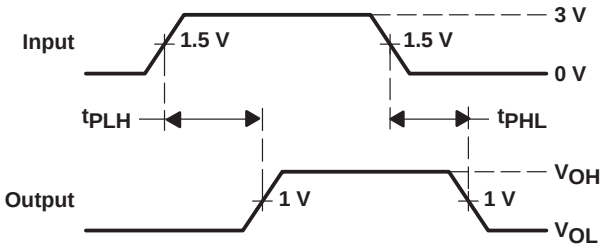


TEST	S1
t_{PLH}/t_{PHL} t_{PLZ}/t_{PZL} t_{PHZ}/t_{PZH}	Open 6 V GND

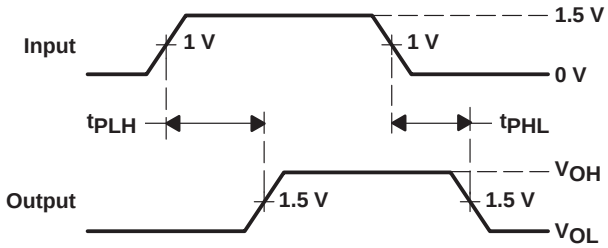


LOAD CIRCUIT FOR A OUTPUTS

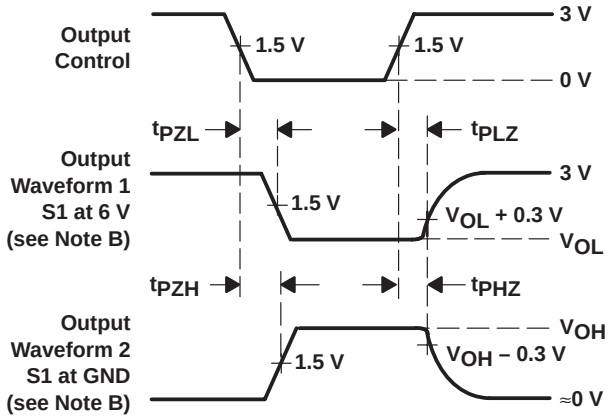
LOAD CIRCUIT FOR B OUTPUTS



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
(A port to B port)



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
(B port to A port)



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
(A port)

NOTES: A. C_L includes probe and jig capacitance.
B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
C. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50 Ω, t_r ≤ 2.5 ns, t_f ≤ 2.5 ns.
D. The outputs are measured one at a time with one transition per measurement.

Figure 1. Load Circuits and Voltage Waveforms

DISTRIBUTED-LOAD BACKPLANE SWITCHING CHARACTERISTICS

This data sheet is specified for and tested to the lump load shown in Figure 1. However, the designer probably uses this GTLP device in a distributed load like that shown in Figure 2, in which actual B-port backplane switching characteristics are different. Therefore, the device is modeled as shown in Figure 3, which very closely matches the results obtained using Figure 2. Switching characteristics based on Figure 3 more closely match actual backplane design requirements.

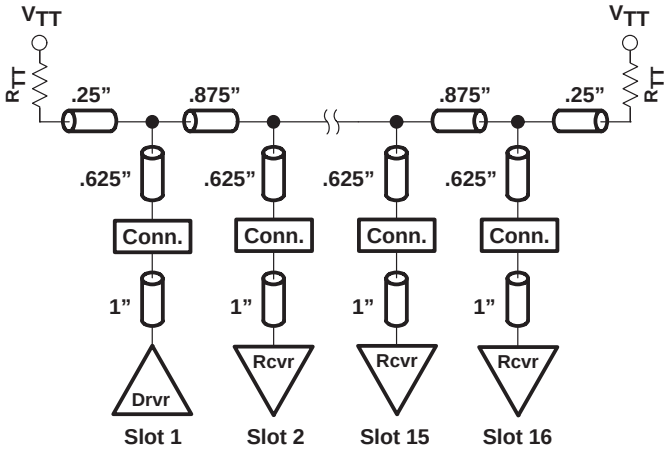


Figure 2. Test Backplane Model

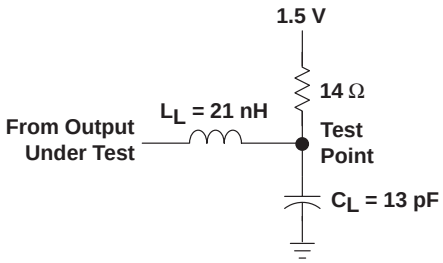


Figure 3. Distributed-Load Circuit for B Outputs

switching characteristics over recommended ranges of supply voltage and operating free-air temperature, V_{TT} = 1.5 V and V_{REF} = 1 V for GTL+ (see Figure 3)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	MIN	TYP†	MAX	UNIT
t_{pd}	A	B				ns
t_{en}	$\overline{OE}$	B				ns
t_{dis}						
t_r	Rise time, B outputs (0.6 V to 1.3 V)					ns
t_f	Fall time, B outputs (1.3 V to 0.6 V)					ns

† All typical values are at V_{CC} = 3.3 V, T_A = 25°C.

PRODUCT PREVIEW

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