

- Members of the Texas Instruments *Widebus™* Family
- D-Type Flip-Flops With Qualified Storage Enable
- Translate Between GTL/GTL+ Signal Levels and LVTTTL Logic Levels
- Support Mixed-Mode Signal Operation on All Ports (5-V Input/Output Voltages With 3.3-V  $V_{CC}$ )
- $I_{off}$  Supports Partial-Power-Down-Mode Operation
- Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors on A Port
- Distributed  $V_{CC}$  and GND-Pin Configuration Minimizes High-Speed Switching Noise
- ESD Protection Exceeds JESD 22
  - 2000-V Human-Body Model (A114-A)
  - 200-V Machine Model (A115-A)
  - 1000-V Charged-Device Model (C101)
- Latch-Up Performance Exceeds 250 mA Per JESD 17
- Package Options Include Plastic Thin Shrink Small-Outline (DGG) and Ceramic Quad Flat (HV) Packages

## description

The 'GTL16923 devices are 18-bit registered bus transceivers that provide LVTTTL-to-GTL/GTL+ and GTL/GTL+-to-LVTTTL signal-level translation. They are partitioned as two 9-bit transceivers with individual output-enable controls and contain D-type flip-flops for temporary storage of data flowing in either direction. The devices provide an interface between cards operating at LVTTTL logic levels and a backplane operating at GTL/GTL+ signal levels. Higher-speed operation is a direct result of the reduced output swing ( $<1$  V), reduced input threshold levels, and output edge control (OEC™).

The user has the flexibility of using these devices at either GTL ( $V_{TT} = 1.2$  V and  $V_{REF} = 0.8$  V) or the preferred higher noise margin GTL+ ( $V_{TT} = 1.5$  V and  $V_{REF} = 1$  V) signal levels. GTL+ is the Texas Instruments derivative of the Gunning transceiver logic (GTL) JEDEC standard JESD 8-3. The B port normally operates at GTL or GTL+ signal levels, while the A-port and control inputs are compatible with LVTTTL logic levels. All inputs can be driven from either 3.3-V or 5-V devices which allows use in a mixed 3.3-V/5-V system environment.  $V_{REF}$  is the reference input voltage for the B port.

Data flow in each direction is controlled by the output-enable ( $\overline{OEAB}$  and  $\overline{OEBA}$ ) and clock (CLKAB and CLKBA) inputs. The clock-enable ( $\overline{CEAB}$  and  $\overline{CEBA}$ ) inputs are used to enable or disable the clock for all 18 bits at a time. However,  $\overline{OEAB}$  and  $\overline{OEBA}$  are designed to control each 9-bit transceiver independently, which makes the device more versatile.

For A-to-B data flow, the device operates on the low-to-high transition of CLKAB if  $\overline{CEAB}$  is low. When  $\overline{OEAB}$  is low, the outputs are active. When  $\overline{OEAB}$  is high, the outputs are in the high-impedance state. Data flow for B to A is similar to that of A to B but uses  $\overline{OEBA}$ , CLKBA, and  $\overline{CEBA}$ .

These devices are fully specified for partial-power-down applications using  $I_{off}$ . The  $I_{off}$  circuitry disables the outputs, preventing damaging current backflow through the devices when they are powered down.

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

To ensure the high-impedance state during power up or power down,  $\overline{OE}$  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 SN54GTL16923 is characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN74GTL16923 is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .



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 **TEXAS  
INSTRUMENTS**

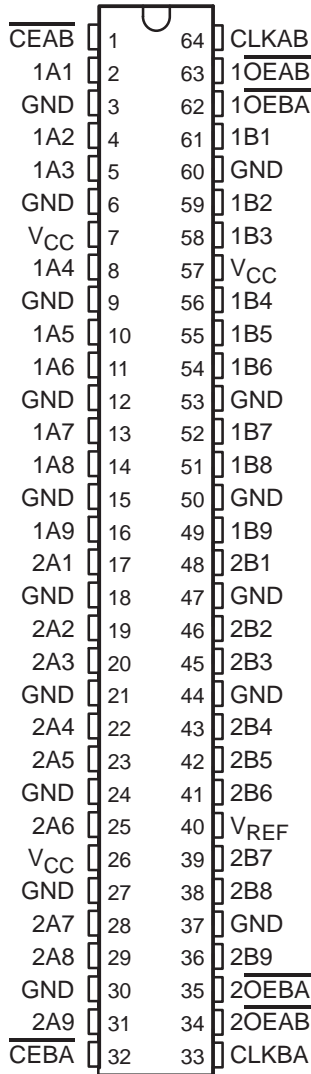
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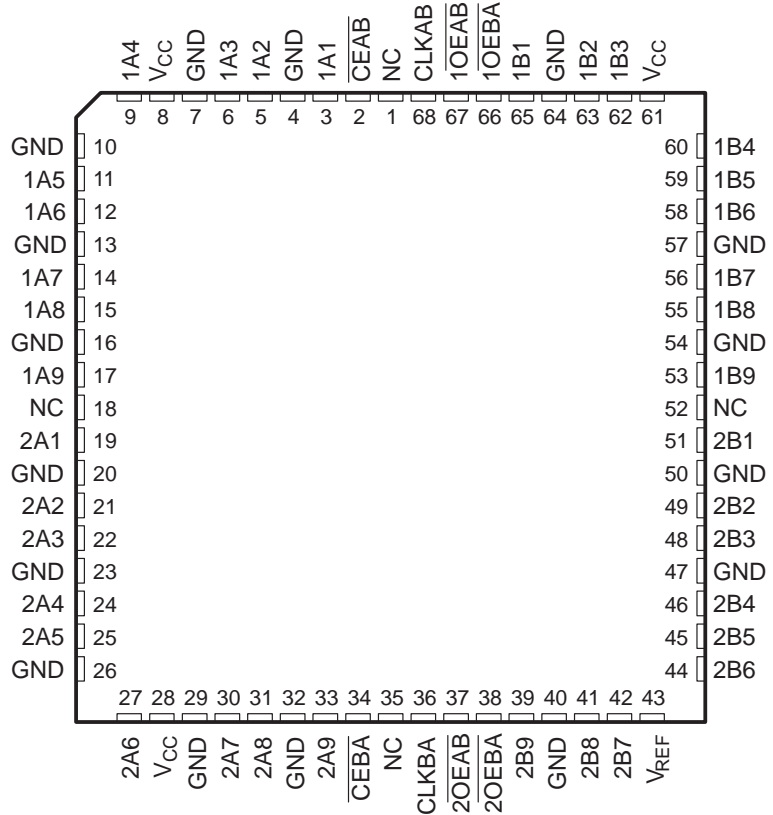
# SN54GTL16923, SN74GTL16923 18-BIT LVTTL-TO-GTL/GTL+ BUS TRANSCEIVERS

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**SN74GTL16923 . . . DGG PACKAGE  
(TOP VIEW)**



**SN54GTL16923 . . . HV PACKAGE  
(TOP VIEW)**



NC – No internal connection

**FUNCTION TABLE†**

INPUTS				OUTPUT B	MODE
CEAB	OEAB	CLKAB	A		
X	H	X	X	Z	Isolation
H	L	X	X	B <sub>0</sub> ‡	Latched storage of A data
X	L	H or L	X	B <sub>0</sub> ‡	
L	L	↑	L	L	Clocked storage of A data
L	L	↑	H	H	

† A-to-B data flow is shown. B-to-A data flow is similar, but uses OEBA, CLKBA, and CEBA.

‡ Output level before the indicated steady-state input conditions were established

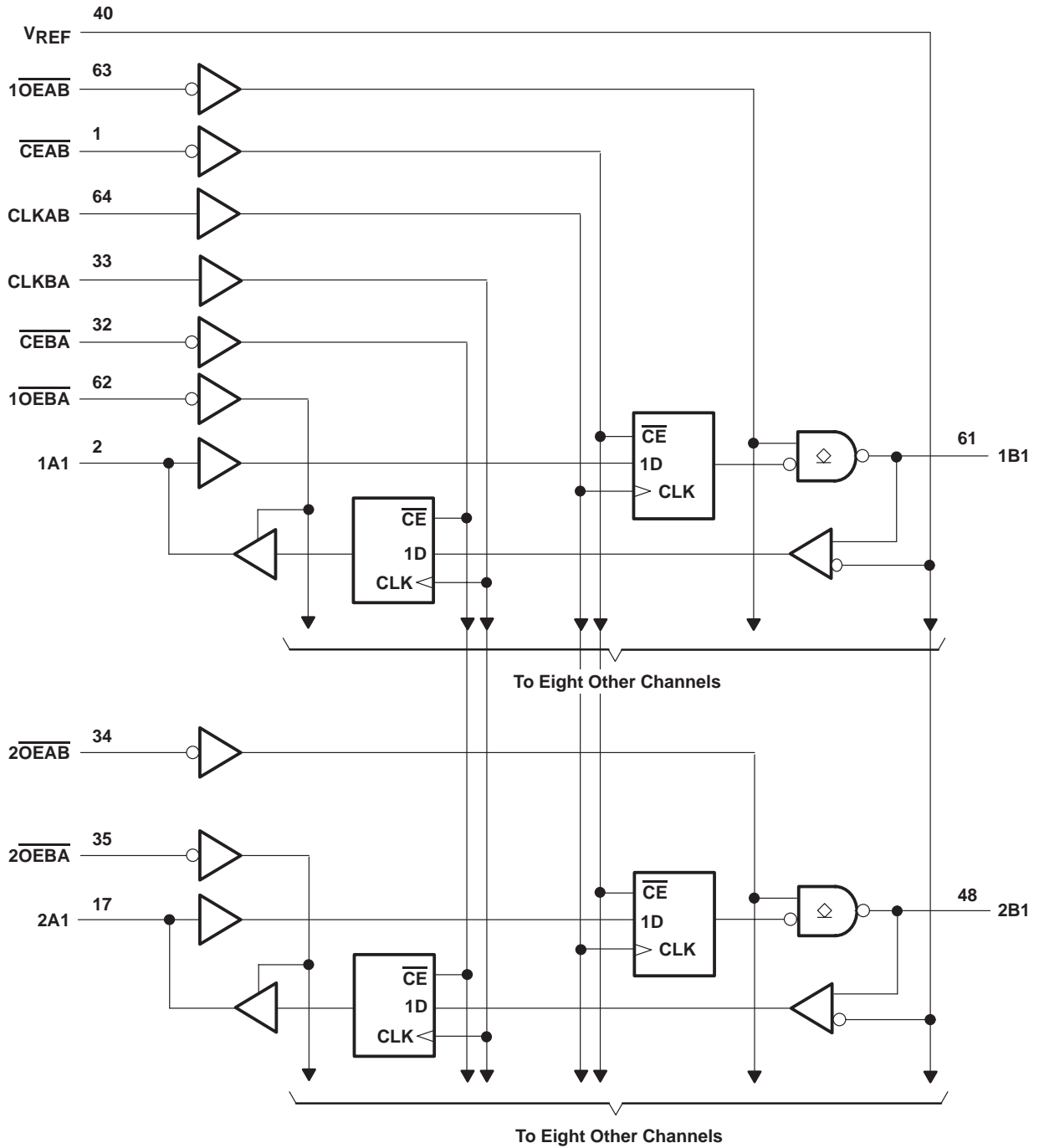


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## logic diagram (positive logic)



Pin numbers shown are for the DGG package.

# SN54GTL16923, SN74GTL16923 18-BIT LVTTL-TO-GTL/GTL+ BUS TRANSCEIVERS

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

Supply voltage range, $V_{CC}$	–0.5 V to 4.6 V
Input voltage range, $V_I$ (see Note 1)	–0.5 V to 7 V
Voltage range applied to any output in the high or power-off state, $V_O$ (see Note 1)	–0.5 V to 7 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, $\theta_{JA}$ (see Note 3)	55°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)

		SN54GTL16923			SN74GTL16923			UNIT	
		MIN	NOM	MAX	MIN	NOM	MAX		
$V_{CC}$	Supply voltage	3.15	3.3	3.45	3.15	3.3	3.45	V	
$V_{TT}$	Termination voltage	GTL	1.14	1.2	1.26	1.14	1.2	1.26	V
		GTL+	1.35	1.5	1.65	1.35	1.5	1.65	
$V_{REF}$	Supply voltage	GTL	0.74	0.8	0.87	0.74	0.8	0.87	V
		GTL+	0.87	1	1.1	0.87	1	1.1	
$V_I$	Input voltage	B port	0		$V_{TT}$	0		$V_{TT}$	V
		Except B port	0		5.5	0		5.5	
$V_{IH}$	High-level input voltage	B port	$V_{REF}+50$ mV			$V_{REF}+50$ mV			V
		Except B port	2			2			
$V_{IL}$	Low-level input voltage	B port	$V_{REF}-50$ mV			$V_{REF}-50$ mV			V
		Except B port	0.8			0.8			
$I_{IK}$	Input clamp current			–18			–18	mA	
$I_{OH}$	High-level output current	A port			–24		–24	mA	
$I_{OL}$	Low-level output current	A port			24		24	mA	
		B port			50		50		
$T_A$	Operating free-air temperature	–55		125	–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,  $V_{CC} = 3.3$  V, I/O, control inputs,  $V_{TT}$ ,  $V_{REF}$  (any order) last.  
 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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# SN54GTL16923, SN74GTL16923 18-BIT LVTTTL-TO-GTL/GTL+ BUS TRANSCEIVERS

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

PARAMETER		TEST CONDITIONS		SN54GTL16923		SN74GTL16923		UNIT
				MIN	TYP†	MAX	MIN	
V <sub>IK</sub>		V <sub>CC</sub> = 3.15 V, I <sub>I</sub> = -18 mA		-1.2		-1.2		V
V <sub>OH</sub>	A port	V <sub>CC</sub> = 3.15 V to 3.45 V, I <sub>OH</sub> = -100 μA		V <sub>CC</sub> -0.2		V <sub>CC</sub> -0.2		V
		V <sub>CC</sub> = 3.15 V, I <sub>OH</sub> = -12 mA		2.4		2.4		
		V <sub>CC</sub> = 3.15 V, I <sub>OH</sub> = -24 mA		2		2		
V <sub>OL</sub>	A port	V <sub>CC</sub> = 3.15 V to 3.45 V, I <sub>OL</sub> = 100 μA		0.2		0.2		V
		V <sub>CC</sub> = 3.15 V, I <sub>OL</sub> = 12 mA		0.4		0.4		
		V <sub>CC</sub> = 3.15 V, I <sub>OL</sub> = 24 mA		0.5		0.5		
	B port	V <sub>CC</sub> = 3.15 V to 3.45 V, I <sub>OL</sub> = 100 μA		0.2		0.2		
		V <sub>CC</sub> = 3.15 V, I <sub>OL</sub> = 10 mA		0.2		0.2		
		V <sub>CC</sub> = 3.15 V, I <sub>OL</sub> = 40 mA		0.4		0.4		
I <sub>I</sub>	B port	V <sub>CC</sub> = 3.45 V, V <sub>I</sub> = 5.5 V or GND		±5		±5		μA
	A-port and control inputs	V <sub>CC</sub> = 3.45 V, V <sub>I</sub> = V <sub>CC</sub> or GND		±5		±5		
		V <sub>CC</sub> = 3.45 V, V <sub>I</sub> = 5.5 V or GND		±20		±20		
I <sub>off</sub>		V <sub>CC</sub> = 0, V <sub>I</sub> or V <sub>O</sub> = 0 to 5.5 V				±100		μA
I <sub>I</sub> (hold)	A port	V <sub>CC</sub> = 3.15 V, V <sub>I</sub> = 0.8 V		75		75		μA
		V <sub>CC</sub> = 3.15 V, V <sub>I</sub> = 2 V		-75		-75		
		V <sub>CC</sub> = 3.45 V‡, V <sub>I</sub> = 0.8 V to 2 V		±500		±500		
I <sub>OZ</sub> §	A port	V <sub>CC</sub> = 3.45 V, V <sub>O</sub> = V <sub>CC</sub> or GND		±10		±10		μA
I <sub>OZH</sub>	B port	V <sub>CC</sub> = 3.45 V, V <sub>O</sub> = 1.5 V		10		10		μA
I <sub>CC</sub>	A or B port	V <sub>CC</sub> = 3.45 V, I <sub>O</sub> = 0, V <sub>I</sub> = V <sub>CC</sub> or GND		Outputs high		60		mA
				Outputs low		60		
				Outputs disabled		60		
ΔI <sub>CC</sub> ¶		V <sub>CC</sub> = 3.45 V, A-port or control inputs at V <sub>CC</sub> or GND, One input at V <sub>CC</sub> - 0.6 V		500		500		μA
C <sub>i</sub>	Control inputs	V <sub>I</sub> = 3.15 V or 0		2.5 3		2.5 3		pF
C <sub>io</sub>	A port	V <sub>O</sub> = 3.15 V or 0		6 8.5		6 8.5		pF
	B port	V <sub>O</sub> = 3.15 V or 0		7 9.5		7 9.5		

† All typical values are at V<sub>CC</sub> = 3.3 V, T<sub>A</sub> = 25°C.

‡ This is the bus-hold maximum dynamic current. It is the minimum overdrive current required to switch the input from one state to another.

§ For I/O ports, the parameter I<sub>OZ</sub> includes the input leakage current.

¶ 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.

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timing requirements over recommended ranges of supply voltage and operating free-air temperature for GTL (unless otherwise noted)

		SN54GTL16923		SN74GTL16923		UNIT
		MIN	MAX	MIN	MAX	
$f_{\text{clock}}$	Clock frequency		200		200	MHz
$t_w$	Pulse duration, CLK high or low	2.5		2.5		ns
$t_{\text{su}}$	Setup time	Data before CLK $\uparrow$	2.7		2.6	ns
		$\overline{\text{CE}}$ before CLK $\uparrow$	3.5		3.3	
$t_h$	Hold time	Data after CLK $\uparrow$	0.2		0.1	ns
		$\overline{\text{CE}}$ after CLK $\uparrow$	0		0	

switching characteristics over recommended ranges of supply voltage and operating free-air temperature for GTL (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54GTL16923			SN74GTL16923			UNIT
			MIN	TYP $\dagger$	MAX	MIN	TYP $\dagger$	MAX	
$f_{\text{max}}$			200			200			MHz
$t_{\text{PLH}}$	CLKAB	B	2.1		6	2.2		5.8	ns
$t_{\text{PHL}}$			2		6.5	2.1		6.3	
$t_{\text{dis}}$	$\overline{\text{OEAB}}$	B	1.6		5.6	1.7		5.3	ns
$t_{\text{en}}$			1.9		5.2	2		5	
Slew rate	Both transitions		0.5			0.5			V/ns
$t_r$	Transition time, B outputs (0.6 V to 1 V)		0.2		3	0.3		2.9	ns
$t_f$	Transition time, B outputs (1 V to 0.6 V)		0		4.3	0.1		3.9	ns
$t_{\text{PLH}}$	CLKBA	A	1.7		5.3	1.8		5	ns
$t_{\text{PHL}}$			1.6		5.1	1.7		4.8	
$t_{\text{en}}$	$\overline{\text{OEBA}}$	A	1.2		5.1	1.3		4.8	ns
$t_{\text{dis}}$			1.9		5.1	2		4.8	

$\dagger$  All typical values are at  $V_{\text{CC}} = 3.3 \text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

# SN54GTL16923, SN74GTL16923 18-BIT LVTTL-TO-GTL/GTL+ BUS TRANSCEIVERS

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**timing requirements over recommended ranges of supply voltage and operating free-air temperature for GTL+ (unless otherwise noted)**

		SN54GTL16923		SN74GTL16923		UNIT
		MIN	MAX	MIN	MAX	
$f_{\text{clock}}$	Clock frequency		200		200	MHz
$t_w$	Pulse duration, CLK high or low	2.5		2.5		ns
$t_{\text{su}}$	Setup time	Data before CLK $\uparrow$	2.4		2.3	ns
		$\overline{\text{CE}}$ before CLK $\uparrow$	3.5		3.3	
$t_h$	Hold time	Data after CLK $\uparrow$	0.2		0.1	ns
		$\overline{\text{CE}}$ after CLK $\uparrow$	0		0	

**switching characteristics over recommended ranges of supply voltage and operating free-air temperature for GTL+ (see Figure 1)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54GTL16923			SN74GTL16923			UNIT
			MIN	TYP $\dagger$	MAX	MIN	TYP $\dagger$	MAX	
$f_{\text{max}}$			200			200			MHz
$t_{\text{PLH}}$	CLKAB	B	2.1		6.1	2.2	4	5.9	ns
$t_{\text{PHL}}$			2		6.3	2.1	4	6.1	
$t_{\text{PLH}}$	$\overline{\text{OEAB}}$	B	1.8		5.4	1.9	3.4	5.2	ns
$t_{\text{PHL}}$			1.6		5.4	1.7	3.1	5.1	
Slew rate	Both transitions		0.5			0.5			V/ns
$t_r$	Transition time, B outputs (0.6 V to 1.3 V)		0.5		2.7	0.6	1.3	2.6	ns
$t_f$	Transition time, B outputs (1.3 V to 0.6 V)		0.3		3.4	0.4	1.3	3	ns
$t_{\text{PLH}}$	CLKBA	A	1.7		5.4	1.8	3.5	5.1	ns
$t_{\text{PHL}}$			1.6		5.2	1.7	3.3	4.9	
$t_{\text{en}}$	$\overline{\text{OEBA}}$	A	1.2		5.1	1.3	2.9	4.8	ns
$t_{\text{dis}}$			1.9		5.3	2	3.2	5	

$\dagger$  All typical values are at  $V_{\text{CC}} = 3.3 \text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

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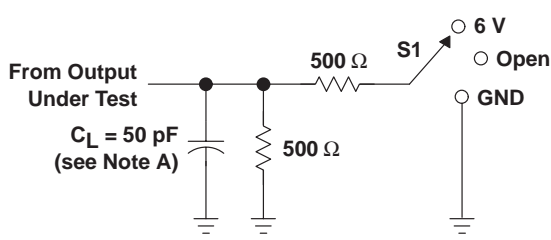
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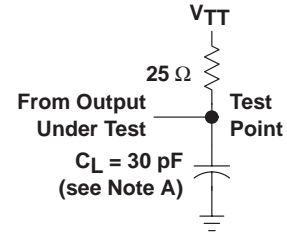
## PARAMETER MEASUREMENT INFORMATION

$$V_{TT} = 1.5 \text{ V}, V_{REF} = 1 \text{ V}$$

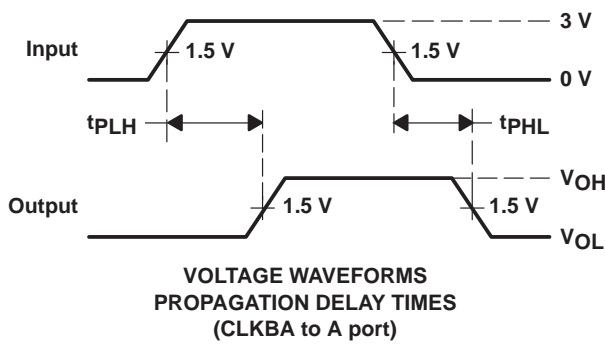
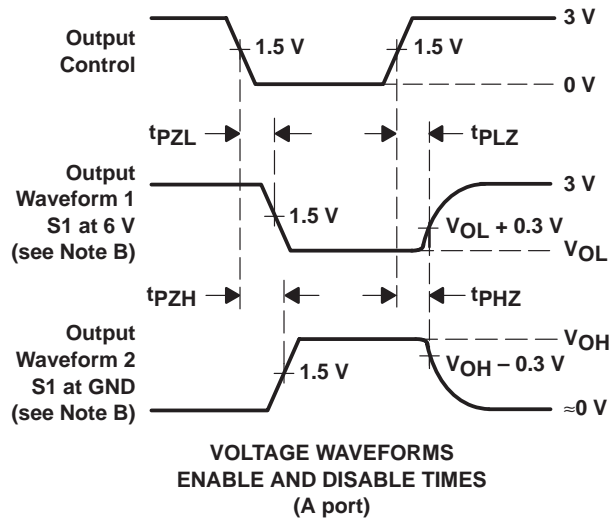
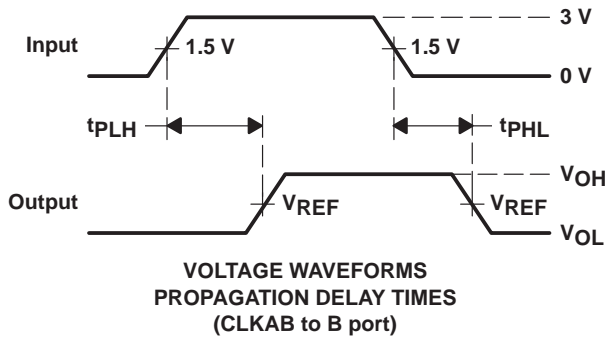
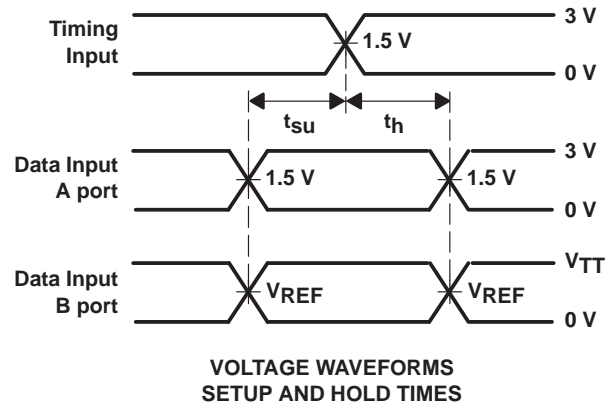
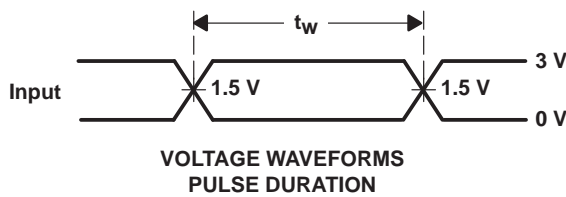


LOAD CIRCUIT FOR A OUTPUTS

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



LOAD CIRCUIT FOR B OUTPUTS



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

Figure 1. Load Circuits and Voltage Waveforms



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