CY74FCT652T
8-BIT REGISTERED TRANSCEIVER
WITH 3-STATE OUTPUTS

SCCS032B – SEPTEMBER 1994 – REVISED OCTOBER 2001

- **Function, Pinout, and Drive Compatible With FCT and F Logic**
- **Reduced V_{OH} (Typically = 3.3 V) Version of Equivalent FCT Functions**
- **Edge-Rate Control Circuitry for Significantly Improved Noise Characteristics**
- **I_{off} Supports Partial-Power-Down Mode Operation**
- **Matched Rise and Fall Times**
- **Fully Compatible With TTL Input and Output Logic Levels**
- **64-mA Output Sink Current 32-mA Output Source Current**
- **Independent Register for A and B Buses**
- **Multiplexed Real-Time and Stored Data Transfer**
- **3-State Outputs**

Q OR SO PACKAGE
(TOP VIEW)

CPAB	1	24	V_{CC}
SAB	2	23	CPBA
GAB	3	22	$\overline{SBA}$
A_1	4	21	$\overline{GBA}$
A_2	5	20	B_1
A_3	6	19	B_2
A_4	7	18	B_3
A_5	8	17	B_4
A_6	9	16	B_5
A_7	10	15	B_6
A_8	11	14	B_7
GND	12	13	B_8
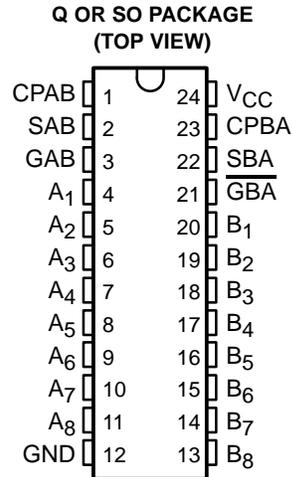
description

The CY74FCT652T consists of bus transceiver circuits, D-type flip-flops, and control circuitry arranged for multiplexed transmission of data directly from the input bus or from the internal storage registers. GAB and $\overline{GBA}$ inputs control the transceiver functions. Select-control (SAB and $\overline{SBA}$) inputs select either real-time or stored-data transfer. The circuitry used for select control eliminates the typical decoding glitch that occurs in a multiplexer during the transition between stored and real-time data. A low input level selects real-time data, and a high input level selects stored data.

Data on the A or B data bus, or both, can be stored in the internal D-type flip-flops by low-to-high transitions of the appropriate clock (CPAB or CPBA) inputs, regardless of the select or enable levels of the control pins. When SAB and $\overline{SBA}$ are in the real-time transfer mode, it also is possible to store data without using the internal D-type flip-flops by simultaneously enabling GAB and $\overline{GBA}$. In this configuration, each output reinforces its input. Thus, when all other data sources to the two sets of bus lines are at high impedance, each set of bus lines remains at its last state.

This device is fully specified for partial-power-down applications using I_{off}. The I_{off} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.

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ORDERING INFORMATION

T_A	PACKAGE†		SPEED (ns)	ORDERABLE PART NUMBER	TOP-SIDE MARKING
−40°C to 85°C	QSOP – Q	Tape and reel	5.4	CY74FCT652CTQCT	FCT652C
	SOIC – SO	Tube	5.4	CY74FCT652CTSOC	FCT652C
		Tape and reel	5.4	CY74FCT652CTSOCT	
	QSOP – Q	Tape and reel	6.3	CY74FCT652ATQCT	FCT652A
	SOIC – SO	Tube	6.3	CY74FCT652ATSOC	FCT652A
		Tape and reel	6.3	CY74FCT652ATSOCT	
	QSOP – Q	Tape and reel	9	CY74FCT652TQCT	FCT652

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

FUNCTION TABLE

INPUTS						DATA I/O		OPERATION OR FUNCTION
GAB	$\overline{GBA}$	CPAB	CPBA	SAB	SBA	$A_1–A_8$	$B_1–B_8$	
L	H	H or L	H or L	X	X	Input	Input	Isolation
L	H	↑	↑	X	X	Input	Input	Store A and B data
X	H	↑	H or L	X	X	Input	Unspecified§	Store A, hold B
H	H	↑	↑	X‡	X	Input	Output	Store A in both registers
L	X	H or L	↑	X	X	Unspecified§	Input	Hold A, store B
L	L	↑	↑	X	X‡	Output	Input	Store B in both registers
L	L	X	X	X	L	Output	Input	Real-time B data to A bus
L	L	X	H or L	X	H	Output	Input	Stored B data to A bus
H	H	X	X	L	X	Input	Output	Real-time A data to B bus
H	H	H or L	X	H	X	Input	Output	Stored A data to B bus
H	L	H or L	H or L	H	H	Output	Output	Stored A data to B bus and Stored B data to A bus

H = High logic level, L = Low logic level, X = Don't care, ↑ = Low-to-high transition

‡ Select control = L: clocks can occur simultaneously. Select control = H: clocks must be staggered in order to load both registers.

§ The data output functions can be enabled or disabled by various signals at the GAB and $\overline{GBA}$ inputs. Data input functions always are enabled, i.e., data at the bus pins are stored on every low-to-high transition of the clock inputs.

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3	21	1	23	2	22
GAB	$\overline{\text{GBA}}$	CPAB	CPBA	SAB	SBA
L	L	X	X	X	L

REAL-TIME TRANSFER
BUS B TO BUS A

3	21	1	23	2	22
GAB	$\overline{\text{GBA}}$	CPAB	CPBA	SAB	SBA
H	H	X	X	L	X

REAL-TIME TRANSFER
BUS A TO BUS B

3	21	1	23	2	22
GAB	$\overline{\text{GBA}}$	CPAB	CPBA	SAB	SBA
X	H	↑	X	X	X
L	X	X	↑	X	X
L	H	↑	↑	X	X

STORE DATA
FROM A AND/OR B

3	21	1	23	2	22
GAB	$\overline{\text{GBA}}$	CPAB	CPBA	SAB	SBA
H	L	H or L	H or L	H	H

TRANSFER STORED DATA
TO A AND/OR B
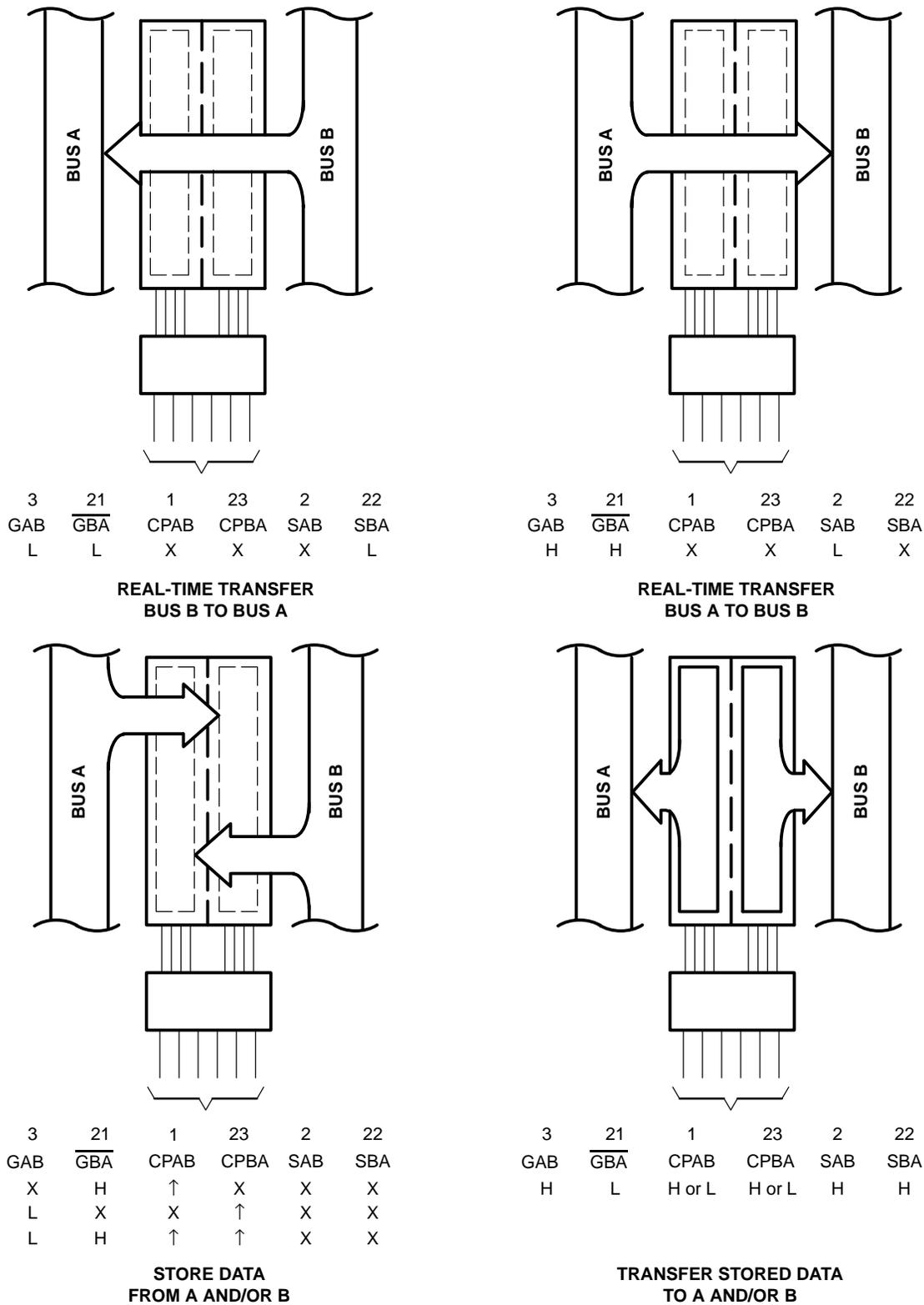
Figure 1. Bus-Management Functions

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logic diagram (positive logic)
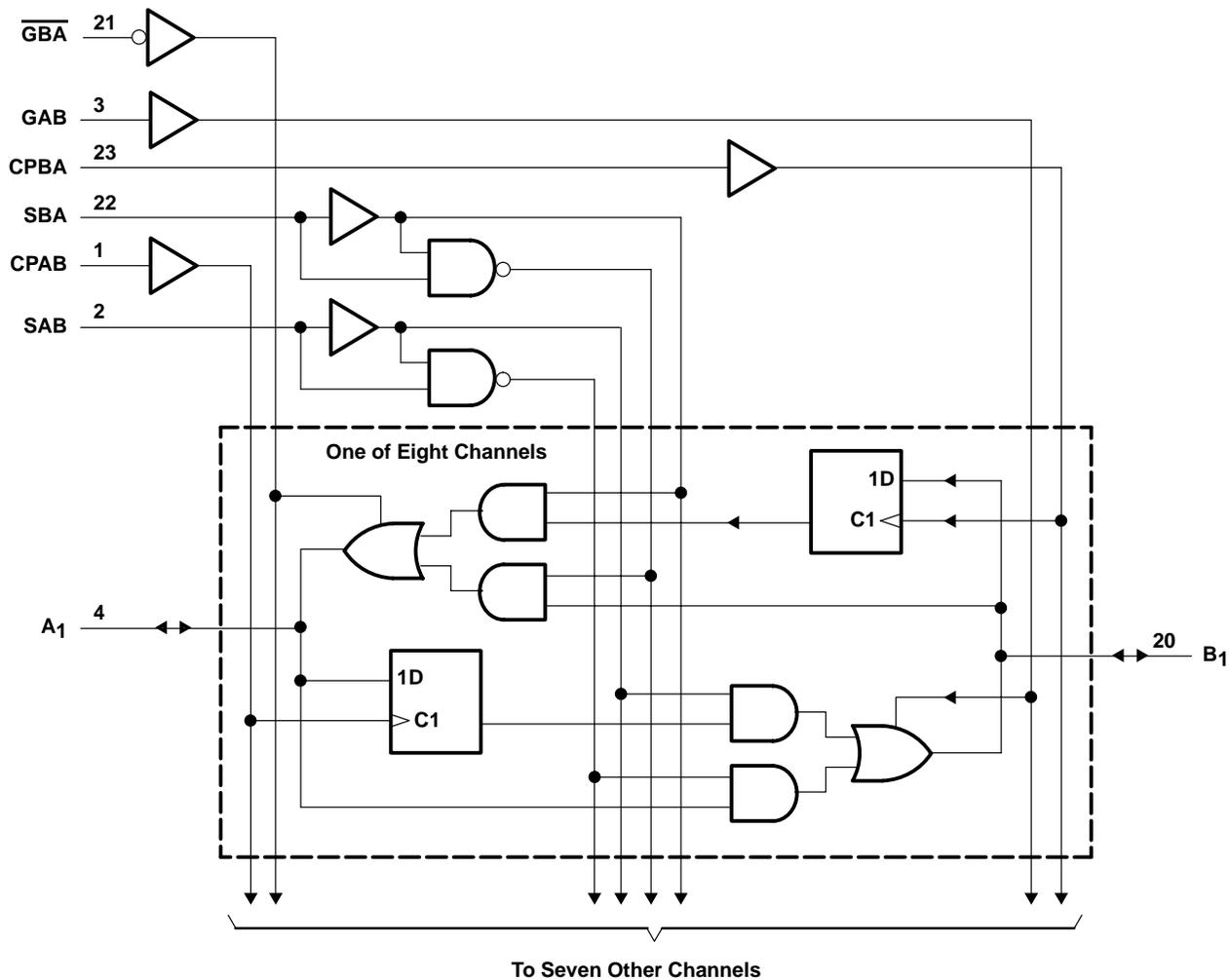
One of Eight Channels

To Seven Other Channels

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

Supply voltage range to ground potential . . . . −0.5 V to 7 V
DC input voltage range . . . . −0.5 V to 7 V
DC output voltage range . . . . −0.5 V to 7 V
DC output current (maximum sink current/pin) . . . . 120 mA
Package thermal impedance, θ_{JA} (see Note 1): Q package . . . . 61°C/W
SO package . . . . 46°C/W
Ambient temperature range with power applied, T_A . . . . −65°C to 135°C
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 package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions (see Note 2)

		MIN	NOM	MAX	UNIT
V_{CC}	Supply voltage	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			V
V_{IL}	Low-level input voltage			0.8	V
I_{OH}	High-level output current			−32	mA
I_{OL}	Low-level output current			64	mA
T_A	Operating free-air temperature	−40		85	°C

NOTE 2: All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation.

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8-BIT REGISTERED TRANSCEIVER
WITH 3-STATE OUTPUTS

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

PARAMETER	TEST CONDITIONS			MIN	TYP†	MAX	UNIT
V_{IK}	$V_{CC} = 4.75$ V,	$I_{IN} = -18$ mA			−0.7	−1.2	V
V_{OH}	$V_{CC} = 4.75$ V	$I_{OH} = -32$ mA		2			V
		$I_{OH} = -15$ mA		2.4	3.3		
V_{OL}	$V_{CC} = 4.75$ V,	$I_{OL} = 64$ mA			0.3	0.55	V
V_{hys}	All inputs				0.2		V
I_I	$V_{CC} = 5.25$ V,	$V_{IN} = V_{CC}$				5	µA
I_{IH}	$V_{CC} = 5.25$ V,	$V_{IN} = 2.7$ V				±1	µA
I_{IL}	$V_{CC} = 5.25$ V,	$V_{IN} = 0.5$ V				±1	µA
I_{OZH}	$V_{CC} = 5.25$ V,	$V_{OUT} = 2.7$ V				10	µA
I_{OZL}	$V_{CC} = 5.25$ V,	$V_{OUT} = 0.5$ V				−10	µA
I_{OS}‡	$V_{CC} = 5.25$ V,	$V_{OUT} = 0$ V		−60	−120	−225	mA
I_{off}	$V_{CC} = 0$ V,	$V_{OUT} = 4.5$ V				±1	µA
I_{CC}	$V_{CC} = 5.25$ V,	$V_{IN} \leq 0.2$ V,	$V_{IN} \geq V_{CC} - 0.2$ V		0.1	0.2	mA
ΔI_{CC}	$V_{CC} = 5.25$ V, $V_{IN} = 3.4$ V§, $f_1 = 0$, Outputs open				0.5	2	mA
I_{CCD}¶	$V_{CC} = 5.25$ V, One input switching at 50% duty cycle, Outputs open, GAB or $\overline{GBA}$ = GND, $V_{IN} \leq 0.2$ V or $V_{IN} \geq V_{CC} - 0.2$ V				0.06	0.12	mA/ MHz
I_C#	$V_{CC} = 5.25$ V, $f_0 = 10$ MHz, Outputs open, GAB = $\overline{GBA}$ = GND, SAB = CPAB = GND, SBA = V_{CC}	One bit switching at $f_1 = 5$ MHz at 50% duty cycle	$V_{IN} \leq 0.2$ V or $V_{IN} \geq V_{CC} - 0.2$ V		0.7	1.4	mA
			$V_{IN} = 3.4$ V or GND		1.2	3.4	
		Eight bits switching at $f_1 = 5$ MHz at 50% duty cycle	$V_{IN} \leq 0.2$ V or $V_{IN} \geq V_{CC} - 0.2$ V		2.8	5.6‖	
			$V_{IN} = 3.4$ V or GND		5.1	14.6‖	
C_i					5	10	pF
C_o					9	12	pF

† Typical values are at $V_{CC} = 5$ V, $T_A = 25°C$.

‡ Not more than one output should be shorted at a time. Duration of short should not exceed one second. The use of high-speed test apparatus and/or sample-and-hold techniques are preferable to minimize internal chip heating and more accurately reflect operational values. Otherwise, prolonged shorting of a high output can raise the chip temperature well above normal and cause invalid readings in other parametric tests. In any sequence of parameter tests, I_{OS} tests should be performed last.

§ Per TTL-driven input ($V_{IN} = 3.4$ V); all other inputs at V_{CC} or GND

¶ This parameter is derived for use in total power-supply calculations.

I_C $= I_{CC} + \Delta I_{CC} \times D_H \times N_T + I_{CCD} (f_0/2 + f_1 \times N_1)$
Where:
I_C = Total supply current
I_{CC} = Power-supply current with CMOS input levels
ΔI_{CC} = Power-supply current for a TTL high input ($V_{IN} = 3.4$ V)
D_H = Duty cycle for TTL inputs high
N_T = Number of TTL inputs at D_H
I_{CCD} = Dynamic current caused by an input transition pair (HLH or LHL)
f_0 = Clock frequency for registered devices, otherwise zero
f_1 = Input signal frequency
N_1 = Number of inputs changing at f_1
All currents are in milliamperes and all frequencies are in megahertz.

‖ Values for these conditions are examples of the I_{CC} formula.

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timing requirements over recommended operating free-air temperature range (unless otherwise noted) (see Figure 2)

			CY74FCT652T		CY74FCT652AT		CY74FCT652CT		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
t_w	Pulse duration, clock high or low		6		5		5		ns
t_{su}	Setup time, before CPAB↑ or CPBA↑	A or B	4		2		2		ns
t_h	Hold time, after CPAB↑ or CPBA↑	A or B	2		1.5		1.5		ns

switching characteristics over operating free-air temperature range (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	CY74FCT652T		CY74FCT652AT		CY74FCT652CT		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	A or B	B or A	1.5	9	1.5	6.3	1.5	5.4	ns
t_{PHL}			1.5	9	1.5	6.3	1.5	5.4	
t_{PZH}	GAB or $\overline{GBA}$	A or B	1.5	14	1.5	9.8	1.5	7.8	ns
t_{PZL}			1.5	14	1.5	9.8	1.5	7.8	
t_{PHZ}	GAB or $\overline{GBA}$	A or B	1.5	9	1.5	6.3	1.5	6.3	ns
t_{PLZ}			1.5	9	1.5	6.3	1.5	6.3	
t_{PLH}	CPAB or CPBA	A or B	1.5	9	1.5	6.3	1.5	5.7	ns
t_{PHL}			1.5	9	1.5	6.3	1.5	5.7	
t_{PLH}	SBA or SAB	A or B	1.5	11	1.5	7.7	1.5	6.2	ns
t_{PHL}			1.5	11	1.5	7.7	1.5	6.2	

PARAMETER MEASUREMENT INFORMATION

From Output Under Test

Test Point

C_L = 50 pF (see Note A)

500 Ω
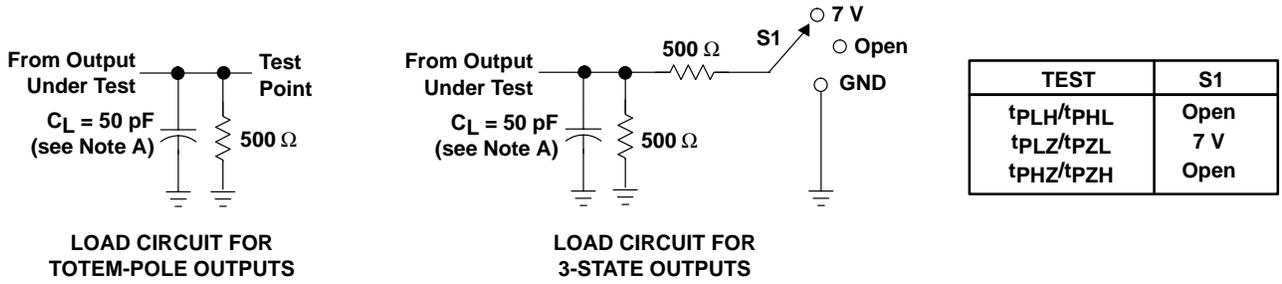
LOAD CIRCUIT FOR TOTEM-POLE OUTPUTS

From Output Under Test

C_L = 50 pF (see Note A)

500 Ω

500 Ω

S1

7 V

Open

GND

LOAD CIRCUIT FOR 3-STATE OUTPUTS

TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	7 V
t_{PHZ}/t_{PZH}	Open

Input

t_w

1.5 V

1.5 V

3 V

0 V
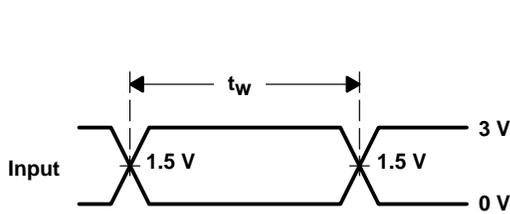
**VOLTAGE WAVEFORMS
PULSE DURATION**

Timing Input

1.5 V

3 V

0 V

t_h

t_{su}

Data Input

1.5 V

1.5 V

3 V

0 V
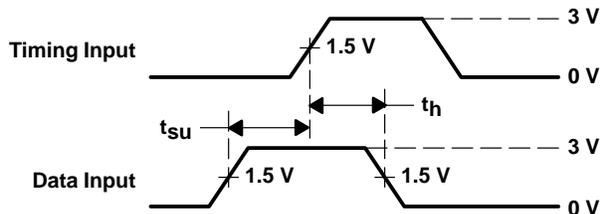
**VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES**

Input

1.5 V

1.5 V

3 V

0 V

t_{PLH}

t_{PHL}

In-Phase Output

1.5 V

1.5 V

V_{OH}

V_{OL}

t_{PHL}

t_{PLH}

Out-of-Phase Output

1.5 V

1.5 V

V_{OH}

V_{OL}
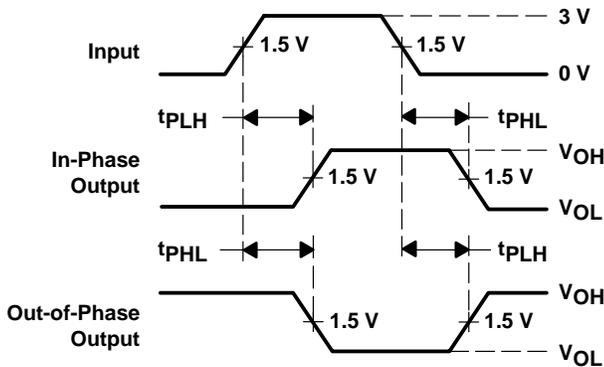
**VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS**

Output Control

1.5 V

1.5 V

3 V

0 V

t_{PZL}

t_{PLZ}

Output Waveform 1 (see Note B)

1.5 V

≈3.5 V

V_{OL} + 0.3 V

V_{OL}

t_{PZH}

t_{PHZ}

Output Waveform 2 (see Note B)

1.5 V

V_{OH} – 0.3 V

V_{OH}

≈0 V
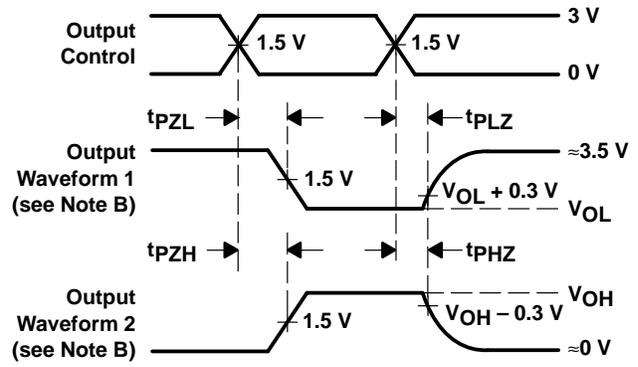
**VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
LOW- AND HIGH-LEVEL ENABLING**

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. The outputs are measured one at a time with one input transition per measurement.

Figure 2. Load Circuit and Voltage Waveforms

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