

SN54ABTH162460, SN74ABTH162460 4-TO-1 MULTIPLEXED/DEMULPLEXED REGISTERED TRANSCEIVERS WITH 3-STATE OUTPUTS

SCBS241E – FEBRUARY 1993 – REVISED MAY 1997

- **Members of the Texas Instruments Widebus™ Family**
- **B-Port Outputs Have Equivalent 25-Ω Series Resistors, So No External Resistors Are Required**
- **State-of-the-Art EPIC-II B™ BiCMOS Design Significantly Reduces Power Dissipation**
- **Latch-Up Performance Exceeds 500 mA Per JEDEC Standard JESD-17**
- **Typical V_{OLP} (Output Ground Bounce) < 1 V at V_{CC} = 5 V, T_A = 25°C**
- **High-Impedance State During Power Up and Power Down**
- **Distributed V_{CC} and GND Pin Configuration Minimizes High-Speed Switching Noise**
- **Flow-Through Architecture Optimizes PCB Layout**
- **Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors**
- **Package Options Include Plastic 300-mil Shrink Small-Outline (DL) Package and 380-mil Fine-Pitch Ceramic Flat (WD) Package Using 25-mil Center-to-Center Spacings**

description

The 'ABTH162460 are 4-bit to 1-bit multiplexed registered transceivers used in applications where four separate data paths must be multiplexed onto or demultiplexed from a single data path. Typical applications include multiplexing and/or demultiplexing of address and data information in microprocessor or bus-interface applications. This device also is useful in memory-interleaving applications.

Five 4-bit I/O ports (1A–4A, 1B1–4, 2B1–4, 3B1–4, and 4B1–4) are available for address and/or data transfer. The output-enable ($\overline{\text{OEB}}$, $\overline{\text{OEB1}}\text{--}\overline{\text{OEB4}}$, and $\overline{\text{OEA}}$) inputs control the bus-transceiver functions. These control signals also allow 4-bit or 16-bit control, depending on the $\overline{\text{OEB}}$ level.

SN54ABTH162460 . . . WD PACKAGE
SN74ABTH162460 . . . DL PACKAGE
(TOP VIEW)

LEAB1	1	56	$\overline{\text{OEB1}}$
LEAB2	2	55	$\overline{\text{OEB2}}$
LEBA	3	54	SEL0
GND	4	53	GND
LEB1	5	52	1B1
LEB2	6	51	1B2
V _{CC}	7	50	V _{CC}
CLKBA	8	49	1B3
$\overline{\text{OEB}}$	9	48	1B4
CLKAB	10	47	2B1
GND	11	46	GND
1A	12	45	2B2
2A	13	44	2B3
CE_SEL0	14	43	2B4
CE_SEL1	15	42	3B1
3A	16	41	3B2
4A	17	40	3B3
GND	18	39	GND
CLKENAB	19	38	3B4
CLKENB	20	37	4B1
CLKENBA	21	36	4B2
V _{CC}	22	35	V _{CC}
LEB3	23	34	4B3
LEB4	24	33	4B4
GND	25	32	GND
$\overline{\text{OEA}}$	26	31	SEL1
LEAB3	27	30	$\overline{\text{OEB3}}$
LEAB4	28	29	$\overline{\text{OEB4}}$



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SN54ABTH162460, SN74ABTH162460

4-TO-1 MULTIPLEXED/DEMULTIPLEXED REGISTERED TRANSCEIVERS

WITH 3-STATE OUTPUTS

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description (continued)

Address and/or data information can be stored using the internal storage latches/flip-flops. The latch-enable (LEB1–LEB4, LEBA, and LEAB1–LEAB4) and clock/clock-enable (CLK/CLKEN) inputs are used to control data storage. When either one of the latch-enable inputs is high, the latch is transparent (clock is a don't care as long as the latch enable is high). When the latch-enable input goes low (providing that the clock does not transit from low to high), the data present at the inputs is latched and remains latched until the latch-enable input is returned high. When the clock enable is low and the corresponding latch enable is low, data can be clocked on the low-to-high transition of the clock. When either the clock enable or the corresponding latch enable is high, the clock is a don't care.

Four select (SEL0, SEL1, CE_SEL0, and CE_SEL1) pins are provided to multiplex data (A port), or to select one of four clock enables (B port). This allows the user the flexibility of controlling one bit at a time.

The B-port outputs, which are designed to sink up to 12 mA, include equivalent 25-Ω series resistors to reduce overshoot and undershoot.

Active bus-hold circuitry is provided to hold unused or floating data inputs at a valid logic level.

When V_{CC} is between 0 and 2.1 V, the device is in the high-impedance state during power up or power down. However, to ensure the high-impedance state above 2.1 V, \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 SN54ABTH162460 is characterized for operation over the full military temperature range of –55°C to 125°C. The SN74ABTH162460 is characterized for operation from –40°C to 85°C.

Function Tables

A-TO-B OUTPUT ENABLE†

INPUTS		OUTPUT
\overline{OEB}	\overline{OEBn}	Bn
H	H	Z
H	L	Z
L	H	Z
L	L	Active

† n = 1, 2, 3, 4

A-TO-B STORAGE
(assuming $\overline{OEB} = L$, $\overline{OEBn} = L$)‡

INPUTS								OUTPUTS			
CLKENAB	CE_SEL1	CE_SEL0	CLKAB	LEAB1	LEAB2	LEAB3	LEAB4	B1	B2	B3	B4
X	X	X	H or L	H	L	L	L	A	A ₀	A ₀	A ₀
X	X	X	H or L	H	H	H	L	A	A	A	A ₀
L	X	X	L	L	L	L	L	A ₀	A ₀	A ₀	A ₀
L	L	L	↑	L	L	L	L	A	A ₀	A ₀	A ₀
L	L	H	↑	L	L	L	L	A ₀	A	A ₀	A ₀
L	H	L	↑	L	L	L	L	A ₀	A ₀	A	A ₀
L	H	H	↑	L	L	L	L	A ₀	A ₀	A ₀	A
H	X	X	↑	L	L	L	L	A ₀	A ₀	A ₀	A ₀

‡ This table does not cover all the latch-enable cases since they have similar results.



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Function Tables (Continued)

**B-TO-A STORAGE
 (before point P)**

INPUTS								P
$\overline{\text{CLKENB}}$	CLKBA	LEB1	LEB2	LEB3	LEB4	SEL1	SEL0	
X	X	H	L	L	L	L	L	B1
X	X	L	H	L	L	L	H	B2
X	X	L	L	H	L	H	L	B3
X	X	L	L	L	H	H	H	B4
L ↑ L L L L						L	L	B1
						L	H	B2
						H	L	B3
						H	H	B4
L L L L L L						L	L	B1 [†]
						L	H	B2 [†]
						H	L	B3 [†]
						H	H	B4 [†]

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

**B-TO-A STORAGE
 (after point P)**

INPUTS					OUTPUT A
$\overline{\text{CLKENBA}}$	CLKBA	LEBA	$\overline{\text{OE\overline{A}}}$	B	
X	X	X	H	X	Z
X	X	H	L	L	L
X	X	H	L	H	H
H	X	L	L	X	A ₀ [†]
L	↑	L	L	L	L
L	↑	L	L	H	H
L	L	L	L	X	A ₀ [†]

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

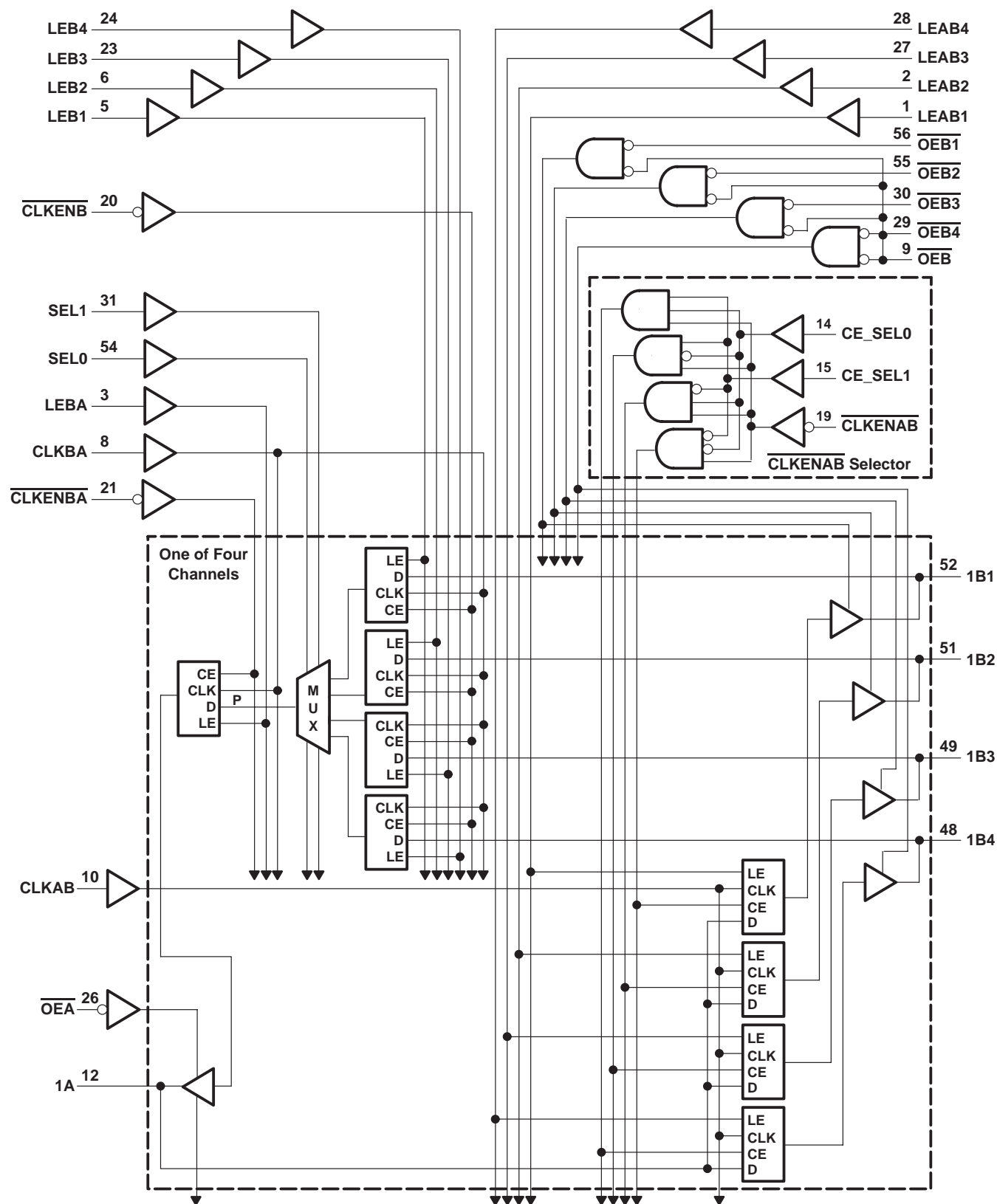
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4-TO-1 MULTIPLEXED/DEMULTIPLEXED REGISTERED TRANSCEIVERS

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logic diagram (positive logic)



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4-TO-1 MULTIPLEXED/DEMULTIPLEXED REGISTERED TRANSCEIVERS WITH 3-STATE OUTPUTS

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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 7 V
Input voltage range, V_I (except I/O ports) (see Note 1)	–0.5 V to 7 V
Voltage range applied to any output in the high or power-off state, V_O	–0.5 V to 5.5 V
Current into any output in the low state, I_O : SN54ABTH162460 (A port)	96 mA
SN74ABTH162460 (A port)	128 mA
B port	30 mA
Input clamp current, I_{IK} ($V_I < 0$)	–18 mA
Output clamp current, I_{OK} ($V_O < 0$)	–50 mA
Package thermal impedance, θ_{JA} (see Note 2): DL package	74 °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. The package thermal impedance is calculated in accordance with EIA/JEDEC Std JESD51.

recommended operating conditions (see Note 3)

			SN54ABTH162460			SN74ABTH162460			UNIT
			MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage		4.5	5	5.5	4.5	5	5.5	V
V_{IH}	High-level input voltage		2			2			V
V_{IL}	Low-level input voltage				0.8			0.8	V
V_I	Input voltage		0		V_{CC}	0		V_{CC}	V
I_{OH}	High-level output current	A port			–24			–32	mA
		B port			–12			–12	
I_{OL}	Low-level output current	A port			48			64	mA
		B port			12			12	
$\Delta t/\Delta v$	Input transition rise or fall rate	Outputs enabled			10			10	ns/V
$\Delta t/\Delta V_{CC}$	Power-up ramp rate		200			200			μs/V
T_A	Operating free-air temperature		–55		125	–40		85	°C

NOTE 3: Unused control pins must be held high or low to prevent them from floating.

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4-TO-1 MULTIPLEXED/DEMULTIPLEXED REGISTERED TRANSCEIVERS

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

PARAMETER		TEST CONDITIONS		SN54ABTH162460			SN74ABTH162460			UNIT
				MIN	TYP†	MAX	MIN	TYP†	MAX	
V _{IK}		V _{CC} = 4.5 V, I _I = −18 mA		−1.2			−1.2			V
V _{OH}	A port	V _{CC} = 5 V,	I _{OH} = −3 mA	3	3.4		3	3.4		V
		V _{CC} = 4.5 V	I _{OH} = −3 mA	2.5	3					
			I _{OH} = −32 mA				2	2.7		
	B port	V _{CC} = 5 V,	I _{OH} = −1 mA	3.8	4.2		3.85			
		V _{CC} = 4.5 V	I _{OH} = −1 mA	3.3	3.7		3.35			
			I _{OH} = −3 mA	3	3.6		3.1			
			I _{OH} = −12 mA				2.6			
V _{OL}	A port	V _{CC} = 4.5 V	I _{OL} = 24 mA		0.25	0.55			V	
			I _{OL} = 64 mA				0.3	0.55		
	B port	V _{CC} = 4.5 V	I _{OL} = 8 mA		0.4	0.8		0.4		0.65
			I _{OL} = 12 mA				0.5	0.8		
V _{hys}				100			100			mV
I _I	Control inputs	V _{CC} = 0 to 5.5 V, V _I = V _{CC} or GND		±1			±1			μA
	A or B ports	V _{CC} = 2.1 V to 5.5 V, V _I = V _{CC} or GND		±20			±20			
I _I (hold)	A or B ports	V _{CC} = 5.5 V, V _I = 0.8 V		75		500	75		500	μA
		V _{CC} = 4.5 V, V _I = 2 V		−75		−500	−75		−500	
I _O ‡	A port	V _{CC} = 5.5 V, V _O = 2.5 V		−50	−110	−180	−50		−180	mA
	B port	V _{CC} = 5.5 V	V _O = 2.5 V	−25	−55	−90	−25		−90	
			V _O = 0	−50	−110	−180	−50		−180	
I _{CEX}	Outputs high	V _{CC} = 5.5 V, V _O = 5.5 V		50			50			μA
I _{off}		V _{CC} = 0, V _I or V _O ≤ 4.5 V		±100			±100			μA
I _{OZPU} §		V _{CC} = 0 to 2.1 V, V _O = 0.5 V to 2.7 V, \overline{OE} = X		±50			±50			μA
I _{OZPD} §		V _{CC} = 2.1 V to 0, V _O = 0.5 V to 2.7 V, \overline{OE} = X		±50			±50			μA
I _{CC}	Outputs high	V _{CC} = 5.5 V, Outputs open		1.5			0.7			mA
	A port low			10			6			
	B port low			32			18			
	Outputs disabled			1.5			0.7			
ΔI _{CC} ¶		V _{CC} = 5.5 V, One input at 3.4 V, Other inputs at V _{CC} or GND		1			1			mA
C _i	Control inputs	V _I = 2.5 V or 0.5 V		3.5			3.5			pF
C _{io}	A or B ports	V _O = 2.5 V or 0.5 V		8			8			pF

† All typical values are at $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$.

‡ Not more than one output should be tested at a time, and the duration of the test should not exceed one second.

§ This parameter is characterized but not production tested.

¶ This is the increase in supply current for each input that is at the specified TTL voltage level rather than $V_{CC}\text{ or GND}$.

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4-TO-1 MULTIPLEXED/DEMULTIPLEXED REGISTERED TRANSCEIVERS
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timing requirements over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)(see Figure 1)

			$V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$		SN54ABTH162460		SN74ABTH162460		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
f_{clock}	Clock frequency		0	160	0	160	0	160	MHz
t_w	Pulse duration	CLKAB high or low	3.8		3.8		3.8		ns
		CLKBA high or low	4.5		4.5		4.5		
		LEAB1, 2, 3, or 4 high	2.8		2.8		2.8		
		LEBA high	2.8		2.8		2.8		
		LEB1, 2, 3, or 4 high	3		3		3		
t_{su}	Before CLKAB \uparrow	A bus	2.5		2.5		2.5		ns
		CE_SEL0/1	3.2		3.2		3.2		
		CLKENAB	3.2		3.2		3.2		
	Before LEAB1, 2, 3, or 4 \downarrow	A bus	3.6		3.6		3.6		
		B bus	3.8		3.8		3.8		
		CLKENB	2.3		2.3		2.3		
	Before CLKBA \uparrow	CLKENBA	2.5		2.5		2.5		
		LEB1, 2, 3, or 4	4.3		4.3		4.3		
		SEL0/1	4.5		4.5		4.5		
		Before LEB1, 2, 3, or 4 \downarrow	B bus		3.2		3.2		
	Before LEBA \downarrow	B bus	4		4		4		
		LEB1, 2, 3, or 4	4.4		4.4		4.4		
		SEL0/1	4.3		4.3		4.3		
t_h	After CLKAB \uparrow	A bus	0.5		0.5		0.5		ns
		CE_SEL0/1	1.1		1.1		1.1		
		CLKENAB	0.5		0.5		0.5		
	After LEAB1, 2, 3, or 4 \downarrow	A bus	1.2		1.2		1.2		
		B bus	1.3		1.3		1.3		
		CLKENB	1		1		1		
	After CLKBA \uparrow	CLKENBA	1		1		1		
		SEL0/1	0		0		0		
	After LEB1, 2, 3, or 4 \downarrow	B bus	1.5		1.5		1.5		
		After LEBA \downarrow	B bus	0.4	0.4		0.4		
		SEL0/1	0.1		0.1		0.1		

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4-TO-1 MULTIPLEXED/DEMULTIPLEXED REGISTERED TRANSCEIVERS

WITH 3-STATE OUTPUTS

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switching characteristics over recommended ranges of supply voltage and operating free-air temperature, $C_L = 50$ pF (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CC} = 5$ V, $T_A = 25^\circ\text{C}$			SN54ABTH162460		SN74ABTH162460		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
f_{\max}			160			160		160		MHz
t_{PLH}	B	A	2	3.6	5.9	2	7.1	2	6.5	ns
t_{PHL}			2	3.5	5.8	2	6.8	2	6.5	
t_{PZH}	$\overline{\text{OEA}}$	A	1.5	2.8	4.8	1.5	5.9	1.5	5.6	ns
t_{PZL}			1.5	2.6	4.8	1.5	5.7	1.5	5.5	
t_{PHZ}	$\overline{\text{OEA}}$	A	2	3.8	5.3	2	6	2	5.9	ns
t_{PLZ}			1.5	4	6.1	1.5	7	1.5	6.5	
t_{PLH}	A	B	2	3.3	5.5	2	6.5	2	6.2	ns
t_{PHL}			2	3.7	5.8	2	6.8	2	6.5	
t_{PZH}	$\overline{\text{OEB}}$	B	2	3.9	5.8	2	7.1	2	6.8	ns
t_{PZL}			2	3.7	5.6	2	6.6	1.5	6.3	
t_{PHZ}	$\overline{\text{OEB}}$	B	2	4	5.6	2	6.4	2	6.2	ns
t_{PLZ}			2	3.7	5.2	2	6.1	2	5.8	
t_{PZH}	$\overline{\text{OEB1}}, \bar{2}, \bar{3}, \bar{4}$	B	2	3.7	5.8	2	6.8	2	6.6	ns
t_{PZL}			2	3.5	5.4	2	6.4	2	6.2	
t_{PHZ}	$\overline{\text{OEB1}}, \bar{2}, \bar{3}, \bar{4}$	B	1.5	3.3	4.8	1.5	5.4	1.5	5.3	ns
t_{PLZ}			1.5	3.1	4.4	1.5	5.1	1.5	4.9	
t_{PLH}	CLKBA	A	1.5	4.2	6.7	1.5	8.1	1.5	7.4	ns
t_{PHL}			1.5	4.4	6.9	1.5	8.4	1.5	7.7	
t_{PLH}	CLKAB	B	2	3.5	5.8	2	6.9	2	6.5	ns
t_{PHL}			2	3.7	6	2	7	2	6.5	
t_{PLH}	LEBA	A	1.5	3	5.2	1.5	6.3	1.5	5.8	ns
t_{PHL}			1.5	3	5	1.5	6.3	1.5	5.8	
t_{PLH}	LEAB1, 2, 3, 4	B	2	3.4	5.4	2	6.5	2	6.2	ns
t_{PHL}			2	3.6	5.7	2	6.3	2	6.2	
t_{PLH}	LEBA1, 2, 3, 4	A	2	4	6.5	2	7.8	2	7.2	ns
t_{PHL}			2	4	6.1	2	7.5	2	6.8	
t_{PLH}	SEL	A	2	4.1	6.7	2	8.1	2	7.5	ns
t_{PHL}			2	3.8	6.2	2	7.3	2	6.9	

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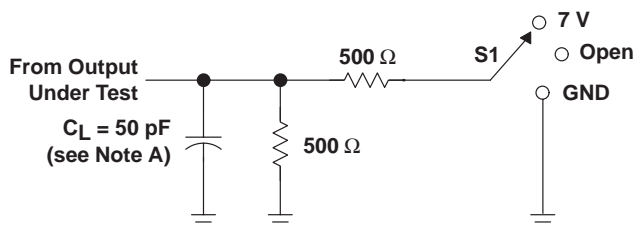
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4-TO-1 MULTIPLEXED/DEMULTIPLEXED REGISTERED TRANSCEIVERS

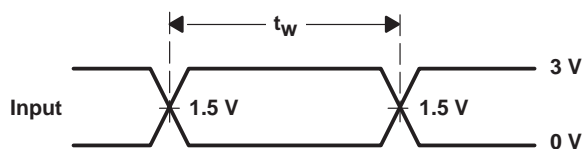
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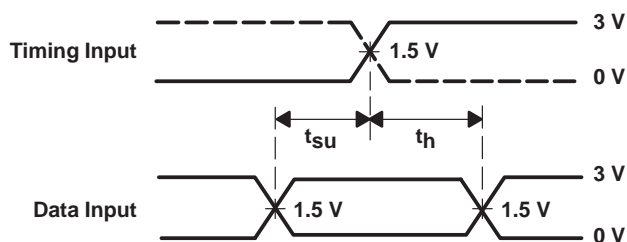
PARAMETER MEASUREMENT INFORMATION



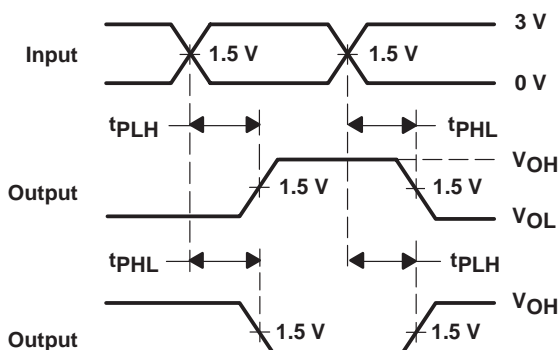
LOAD CIRCUIT



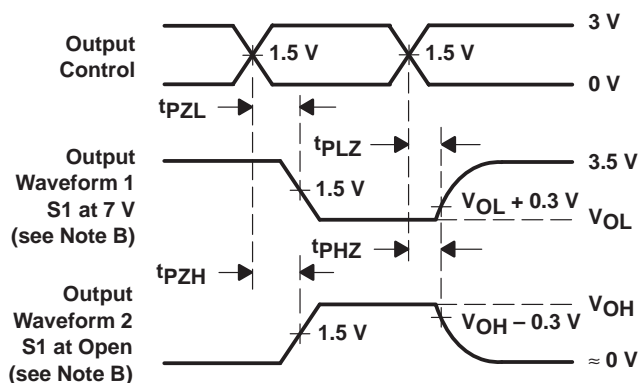
VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS



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. 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.

Figure 1. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
74ABTH162460DGGRE4	ACTIVE	TSSOP	DGG	56		TBD	Call TI	Call TI
74ABTH162460DGGRG4	ACTIVE	TSSOP	DGG	56		TBD	Call TI	Call TI
74ABTH162460DLG4	ACTIVE	SSOP	DL	56		TBD	Call TI	Call TI
74ABTH162460DLRG4	ACTIVE	SSOP	DL	56		TBD	Call TI	Call TI

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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DGG (R-PDSO-G)****PLASTIC SMALL-OUTLINE PACKAGE****48 PINS SHOWN**

- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold protrusion not to exceed 0,15.
 D. Falls within JEDEC MO-153

DL (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 D. Falls within JEDEC MO-118

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