

16-Bit Registered Transceivers

Features

- Low power, pin-compatible replacement for LCX and LPT families
- 5V tolerant inputs and outputs
- 24 mA balanced drive outputs
- Power-off disable outputs permits live insertion
- Edge-rate control circuitry for reduced noise
- FCT-C speed at 4.4 ns
- Latch-up performance exceeds JEDEC standard no. 17
- Typical output skew < 250 ps
- Industrial temperature range of -40°C to $+85^{\circ}\text{C}$
- TSSOP (19.6-mil pitch) or SSOP (25-mil pitch)
- Typical V_{olp} (ground bounce) performance exceeds Mil Std 883D
- $V_{\text{CC}} = 2.7\text{V}$ to 3.6V
- ESD (HBM) > 2000V

CY74FCT163H952

- Bus hold on data inputs
- Eliminates the need for external pull-up or pull-down resistors
- Devices with bus hold are not recommended for translating rail-to-rail CMOS signals to 3.3V logic levels

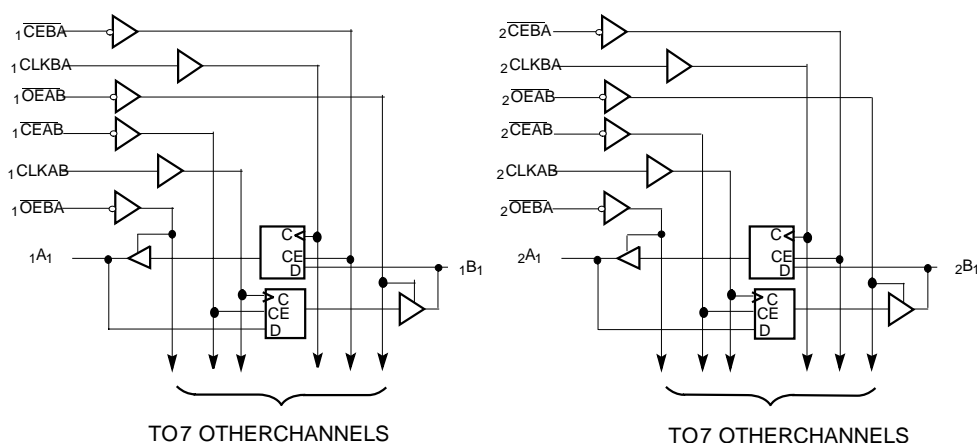
Functional Description

These 16-bit registered transceivers are high-speed, low-power devices. 16-bit operation is achieved by connecting the control lines of the two 8-bit registered transceivers together. For data flow from bus A-to-B, $\overline{\text{CEAB}}$ must be LOW to allow data to be stored when CLKAB transitions from LOW-to-HIGH. The stored data will be present on the output when $\overline{\text{OEAB}}$ is LOW. Control of data from B-to-A is similar and is controlled by using the $\overline{\text{CEBA}}$, CLKBA , and $\overline{\text{OEBA}}$ inputs. The outputs are 24-mA balanced output drivers with current limiting resistors to reduce the need for external terminating resistors and provide for minimal undershoot and reduced ground bounce.

The CY74FCT163H952 has "bus hold" on the data inputs, which retains the input's last state whenever the source driving the input goes to high impedance. This eliminates the need for pull-up/down resistors and prevents floating inputs.

The CY74FCT163952 is designed with inputs and outputs capable of being driven by 5.0V buses, allowing its use in mixed voltage systems as a translator. The outputs are also designed with a power off disable feature enabling its use in applications requiring live insertion.

Logic Block Diagrams; CY74FCT163952, CY74FCT163H952



Pin Configuration SSOP/TSSOP Top View



1 $\overline{\text{OEAB}}$	1	56	1 $\overline{\text{OEBA}}$
1 CLKBA	2	55	1 CLKBA
1 $\overline{\text{CEAB}}$	3	54	1 $\overline{\text{CEBA}}$
GND	4	53	GND
1 A_1	5	52	1 B_1
1 A_2	6	51	1 B_2
V_{CC}	7	50	V_{CC}
1 A_3	8	49	1 B_3
1 A_4	9	48	1 B_4
1 A_5	10	47	1 B_5
GND	11	46	GND
1 A_6	12	45	1 B_6
1 A_7	13	44	1 B_7
1 A_8	14	43	1 B_8
2 A_1	15	42	2 B_1
2 A_2	16	41	2 B_2
2 A_3	17	40	2 B_3
GND	18	39	GND
2 A_4	19	38	2 B_4
2 A_5	20	37	2 B_5
2 A_6	21	36	2 B_6
V_{CC}	22	35	V_{CC}
2 A_7	23	34	2 B_7
2 A_8	24	33	2 B_8
GND	25	32	GND
2 $\overline{\text{CEAB}}$	26	31	2 $\overline{\text{CEBA}}$
2 CLKAB	27	30	2 CLKBA
2 $\overline{\text{OEAB}}$	28	29	2 $\overline{\text{OEBA}}$

Pin Description

Name	Description
OEAB	A-to-B Output Enable Input (Active LOW)
OEBA	B-to-A Output Enable Input (Active LOW)
CEAB	A-to-B Clock Enable Input (Active LOW)
CEBA	B-to-A Clock Enable Input (Active LOW)
CLKAB	A-to-B Clock Input
CLKBA	B-to-A Clock Input
A	A-to-B Data Inputs or B-to-A Three-State Outputs ^[1]
B	B-to-A Data Inputs or A-to-B Three-State Outputs ^[1]

Function Table^[2, 3]

For A-to-B (Symmetric with B-to-A)

Inputs				Outputs
CEAB	CLKAB	OEAB	A	B
H	X	L	X	B ^[4]
X	L	L	X	B ^[4]
L		L	L	L
L		L	H	H
X	X	H	X	Z

Maximum Ratings^[5, 6]

(Above which the useful life may be impaired. For user guidelines, not tested.)

Storage Temperature	–55°C to +125°C
Ambient Temperature with Power Applied	–55°C to +125°C
Supply Voltage Range	0.5V to +4.6V
DC Input Voltage	–0.5V to +7.0V
DC Output Voltage	–0.5V to +7.0V
DC Output Current (Maximum Sink Current/Pin)	–60 to +120 mA
Power Dissipation	1.0W


Operating Range

Range	Ambient Temperature	V _{CC}
Industrial	–40°C to +85°C	2.7V to 3.6V

Electrical Characteristics for Non Bus Hold Devices Over the Operating Range V_{CC}=2.7V to 3.6V

Parameter	Description	Test Conditions	Min.	Typ. ^[7]	Max.	Unit
V _{IH}	Input HIGH Voltage	All Inputs	2.0		5.5	V
V _{IL}	Input LOW Voltage				0.8	V
V _H	Input Hysteresis ^[8]			100		mV
V _{IK}	Input Clamp Diode Voltage	V _{CC} =Min., I _{IN} =–18 mA		–0.7	–1.2	V
I _{IH}	Input HIGH Current	V _{CC} =Max., V _I =5.5			±1	μA
I _{IL}	Input LOW Current	V _{CC} =Max., V _I =GND			±1	μA
I _{OZH}	High Impedance Output Current (Three-State Output pins)	V _{CC} =Max., V _{OUT} =5.5V			±1	μA
I _{OZL}	High Impedance Output Current (Three-State Output pins)	V _{CC} =Max., V _{OUT} =GND			±1	μA
I _{OS}	Short Circuit Current ^[9]	V _{CC} =Max., V _{OUT} =GND	–60	–135	–240	mA
I _{OFF}	Power-Off Disable	V _{CC} =0V, V _{OUT} ≤4.5V			±100	μA
I _{CC}	Quiescent Power Supply Current	V _{IN} ≤0.2V, V _{IN} ≥V _{CC} –0.2V, V _{CC} =Max.		0.1	10	μA
ΔI _{CC}	Quiescent Power Supply Current (TTL inputs HIGH)	V _{IN} =V _{CC} –0.6V ^[10] , V _{CC} =Max.		2.0	30	μA

Notes:

- On the CY74FCT163H952, these pins have bus hold.
- A-to-B data flow is shown: B-to-A data flow is similar but uses, CEBA, CLKBA, and OEBA.
- H = HIGH Voltage Level. L = LOW Voltage Level. X = Don't Care.  = LOW-to-HIGH Transition. Z = HIGH Impedance.
- Level of B before the indicated steady-state input conditions were established.
- Operation beyond the limits set forth may impair the useful life of the device. Unless otherwise noted, these limits are over the operating free-air temperature.
- With the exception of inputs with bus hold, unused inputs must always be connected to an appropriate logic voltage level, preferably either V_{CC} or ground.
- Typical values are at V_{CC}=3.3V, T_A = +25°C ambient.
- This parameter is specified but not tested.
- 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 in order to minimize internal chip heating and more accurately reflect operational values. Otherwise prolonged shorting of a high output may raise the chip temperature well above normal and thereby cause invalid readings in other parametric tests. In any sequence of parameter tests, I_{OS} tests should be performed last.
- Per TTL driven input; all other inputs at V_{CC} or GND.

Electrical Characteristics For Bus Hold Devices Over the Operating Range $V_{CC}=2.7V$ to $3.6V$

Parameter	Description	Test Conditions	Min.	Typ. ^[7]	Max.	Unit
V_{IH}	Input HIGH Voltage	All Inputs	2.0		V_{CC}	V
V_{IL}	Input LOW Voltage				0.8	V
V_H	Input Hysteresis ^[8]			100		mV
V_{IK}	Input Clamp Diode Voltage	$V_{CC}=\text{Min.}, I_{IN}=-18\text{ mA}$		-0.7	-1.2	V
I_{IH}	Input HIGH Current	$V_{CC}=\text{Max.}, V_I=V_{CC}$			± 100	μA
I_{IL}	Input LOW Current				± 100	μA
I_{BBH} I_{BBL}	Bus Hold Sustain Current on Bus Hold Input ^[11]	$V_{CC}=\text{Min.}$ $V_I=2.0V$ $V_I=0.8V$	-50 +50			μA
I_{BHHO} I_{BHLO}	Bus Hold Overdrive Current on Bus Hold Input ^[11]	$V_{CC}=\text{Max.}, V_I=1.5V$			± 500	μA
I_{OZH}	High Impedance Output Current (Three-State Output pins)	$V_{CC}=\text{Max.}, V_{OUT}=V_{CC}$			± 1	μA
I_{OZL}	High Impedance Output Current (Three-State Output pins)	$V_{CC}=\text{Max.}, V_{OUT}=\text{GND}$			± 1	μA
I_{OS}	Short Circuit Current ^[9]	$V_{CC}=\text{Max.}, V_{OUT}=\text{GND}$	-60	-135	-240	mA
I_{OFF}	Power-Off Disable	$V_{CC}=0V, V_{OUT}\leq 4.5V$			± 100	μA
I_{CC}	Quiescent Power Supply Current	$V_{IN}\leq 0.2V, V_{CC}$ $V_{IN}\geq V_{CC}-0.2V$ $V_{CC}=\text{Max.}$			+40	μA
ΔI_{CC}	Quiescent Power supply Current (TTL inputs HIGH)	$V_{IN}=V_{CC}-0.6V^{[10]}$ $V_{CC}=\text{Max.}$			+350	μA

Electrical Characteristics For Balanced Drive Devices Over the Operating Range $V_{CC}=2.7V$ to $3.6V$

Parameter	Description	Test Conditions	Min.	Typ. ^[7]	Max.	Unit
I_{ODL}	Output LOW Dynamic Current ^[9]	$V_{CC}=3.3V, V_{IN}=V_{IH}$ or $V_{IL}, V_{OUT}=1.5V$	50	90	200	mA
I_{ODH}	Output HIGH Dynamic Current ^[9]	$V_{CC}=3.3V, V_{IN}=V_{IH}$ or $V_{IL}, V_{OUT}=1.5V$	-36	-60	-110	mA
V_{OH}	Output HIGH Voltage	$V_{CC}=\text{Min.}, I_{OH}=-0.1\text{ mA}$ $V_{CC}=\text{Min.}, I_{OH}=-8\text{ mA}$ $V_{CC}=3.0V, I_{OH}=-24\text{ mA}$	$V_{CC}-0.2$ 2.4 ^[12] 2.0			V
V_{OL}	Output LOW Voltage	$V_{CC}=\text{Min.}, I_{OL}=0.1\text{ mA}$ $V_{CC}=\text{Min.}, I_{OL}=24\text{ mA}$		0.3	0.55	V

Notes:

11. Pins with bus hold are described in Pin Description.
12. $V_{OH}=V_{CC}-0.6\text{ V}$ at rated current

Capacitance^[8] ($T_A = +25^\circ\text{C}, f = 1.0\text{ MHz}$)

Parameter	Description	Test Conditions	Typ. ^[7]	Max.	Unit
C_{IN}	Input Capacitance	$V_{IN} = 0V$	4.5	6.0	pF
C_{OUT}	Output Capacitance	$V_{OUT} = 0V$	5.5	8.0	pF

Power Supply Characteristics

Parameter	Description	Test Conditions		Typ. ^[7]	Max.	Unit
I _{CCD}	Dynamic Power Supply Current ^[13]	V _{CC} =Max., One Input Toggling, 50% Duty Cycle, Outputs Open, OE=GND	V _{IN} =V _{CC} or V _{IN} =GND	50	75	μA/MHz
I _C	Total Power Supply Current ^[14]	V _{CC} =Max., f ₁ =10 MHz, 50% Duty Cycle, Outputs Open, One Bit Toggling, OE=GND	V _{IN} =V _{CC} or V _{IN} =GND	0.5	0.8	mA
			V _{IN} =V _{CC} –0.6V or V _{IN} =GND	0.5	0.8	mA
		V _{CC} =Max., f ₁ =2.5 MHz, 50% Duty Cycle, Outputs Open, Sixteen Bits Toggling, OE=GND	V _{IN} =V _{CC} or V _{IN} =GND	2.0	3.0 ^[15]	mA
			V _{IN} =V _{CC} –0.6V or V _{IN} =GND	2.0	3.3 ^[15]	mA

Switching Characteristics Over the Operating Range $V_{CC} = 3.0\text{V}$ to 3.6V ^[16,17]

Parameter	Description	CY74FCT163952A		CY74FCT163952C CY74FCT163H952C		Unit	Fig. No. ^[18]
		Min.	Max.	Min.	Max.		
t_{PLH} t_{PHL}	Propagation Delay Data to Output	1.5	4.8	1.5	4.4	ns	1, 3
t_{PZH} t_{PZL}	Output Enable Time	1.5	6.2	1.5	5.8	ns	1, 7, 8
t_{PHZ} t_{PLZ}	Output Disable Time	1.5	5.6	1.5	5.2	ns	1, 7, 8
$t_{SK(O)}$	Output Skew ^[19]		0.5		0.5	ns	—

Notes:

13. This parameter is not directly testable, but is derived for use in Total Power Supply calculations.
14. $I_C = I_{QUIESCENT} + I_{INPUTS} + I_{DYNAMIC}$
 $I_C = I_{CC} + \Delta I_{CC} D_H N_T + I_{CCD} (f_0/2 + f_1 N_1)$
 I_{CC} = Quiescent Current with CMOS input levels
 ΔI_{CC} = Power Supply Current for a TTL HIGH input ($V_{IN} = 3.4\text{V}$)
 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 milliamps and all frequencies are in megahertz.
15. Values for these conditions are examples of the I_{CC} formula. These limits are specified but not tested.
16. Minimum limits are specified but not tested on Propagation Delays.
17. For $V_{CC} = 2.7$, propagation delay, output enable and output disable times should be degraded by 20%.
18. See "Parameter Measurement Information" in the General Information section.
19. Skew between any two outputs of the same package switching in the same direction. This parameter is ensured by design.

Ordering Information CY74FCT163952

Speed (ns)	Ordering Code	Package Name	Package Type	Operating Range
4.1	CY74FCT163952CPACT	Z48	48-Lead (240-Mil) TSSOP	Industrial
	CY74FCT163952CPVC/PVCT	O48	48-Lead (300-Mil) SSOP	
4.8	CY74FCT163952APVC/PVCT	O48	48-Lead (300-Mil) SSOP	Industrial

Ordering Information CY74FCT163H952

Speed (ns)	Ordering Code	Package Name	Package Type	Operating Range
4.1	74FCT163H952CPACT	Z48	48-Lead (240-Mil) TSSOP	Industrial
	CY74FCT163H952CPVC	O48	48-Lead (300-Mil) SSOP	
	74FCT163H952CPVCT	O48	48-Lead (300-Mil) SSOP	

IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF TI PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.