

## PRELIMINARY

December 1996

## Fast CMOS 16-Bit Bidirectional Transceiver

### Features

- Advanced 0.6 micron CMOS Technology
- Balanced Output Drivers:  $\pm 12\text{mA}$
- Output Impedance  $35\Omega$  (Typical)
- Typical  $V_{OLP}$  (Output Ground Bounce)  $< 0.5\text{V}$  at  $V_{CC} = 5\text{V}$ ,  $T_A = 25^\circ\text{C}$
- Bus Hold Retains Last Active Bus State During Three-State
- Hysteresis on All Inputs

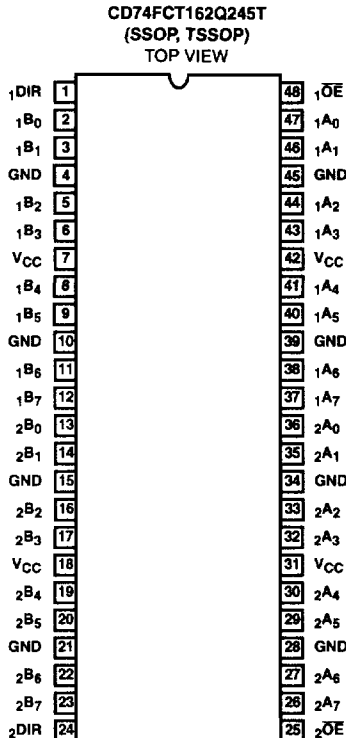
### Description

The CD74FCT162Q245T is a 16-bit bidirectional transceiver designed for asynchronous two-way communication between data buses. The direction control input pin ( $\chi\text{DIR}$ ) determines the direction of data flow through the bidirectional transceiver. The Direction and Output Enable controls are designed to operate these devices as either two independent 8-bit transceivers or one 16-bit transceiver. The output enable ( $\text{OE}$ ) input, when HIGH, disables both A and B ports by placing them in HIGH Z condition.

The CD74FCT162Q245T is designed with current limiting resistors at its outputs to control the output edge rate resulting in lower ground bounce and undershoot. This device features a typical output impedance of  $35\Omega$ , eliminating the need for external terminating resistors for most bus interface applications. This noise suppression benefit is designated by the letter "Q" (for quiet) in the part number.

The CD74FCT162Q245T also features "Bus Hold" which retains the input's last state whenever the input goes to high-impedance preventing "floating" inputs and eliminating the need for pullup/down resistors.

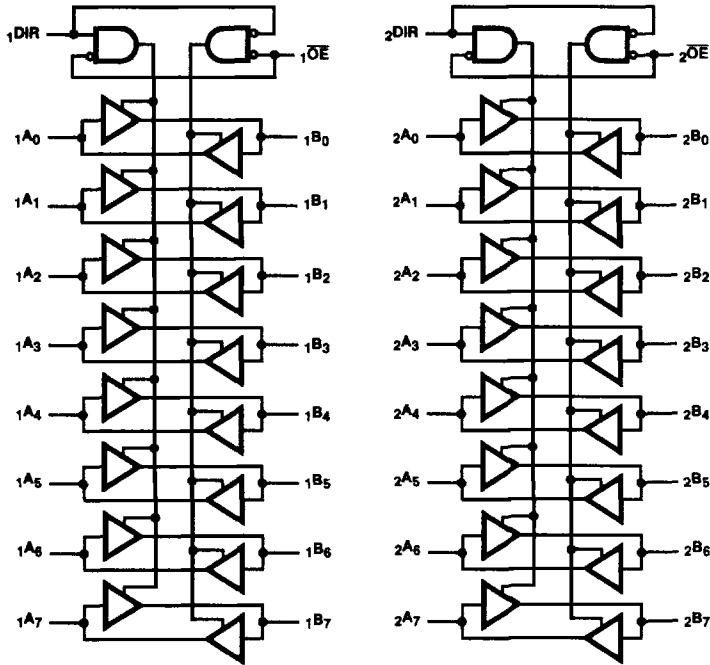
### Pinout



### Ordering Information

PART NUMBER	TEMP. RANGE (°C)	PACKAGE	PKG. NO.
CD74FCT162Q245TMT	-40 to 85	48 Ld TSSOP	M48.240-P
CD74FCT162Q245ATMT	-40 to 85	48 Ld TSSOP	M48.240-P
CD74FCT162Q245CTMT	-40 to 85	48 Ld TSSOP	M48.240-P
CD74FCT162Q245DTMT	-40 to 85	48 Ld TSSOP	M48.240-P
CD74FCT162Q245ETMT	-40 to 85	48 Ld TSSOP	M48.240-P
CD74FCT162Q245TSM	-40 to 85	48 Ld SSOP	M48.300-P
CD74FCT162Q245ATSM	-40 to 85	48 Ld SSOP	M48.300-P
CD74FCT162Q245CTSM	-40 to 85	48 Ld SSOP	M48.300-P
CD74FCT162Q245DTSM	-40 to 85	48 Ld SSOP	M48.300-P
CD74FCT162Q245ETSM	-40 to 85	48 Ld SSOP	M48.300-P

**Functional Block Diagram**



TRUTH TABLE (NOTE 1)

INPUTS		OUTPUTS
$x\overline{OE}$	$xDIR$	
L	L	Bus B Data to Bus A
L	H	Bus A Data to Bus B
H	X	High Z State

NOTE:

- 1. H = High Voltage Level
- L = Low Voltage Level
- X = Don't Care
- Z = High Impedance

**Pin Descriptions**

PIN NAME	DESCRIPTION
$x\overline{OE}$	Three-State Output Enable Inputs (Active LOW)
$xDIR$	Direction Control Input
$xAx$	Side A Inputs or Three-State Outputs (Note 2)
$xBx$	Side B Inputs or Three-State Outputs (Note 2)
GND	Ground
VCC	Power

NOTE:

- 2. For the CD74FCT162Q245T, these pins have "Bus Hold". All other pins are standard, outputs, or I/Os.

## CD74FCT162Q245T

### Absolute Maximum Ratings

DC Input Voltage ..... -0.5V to 7.0V  
 DC Output Current ..... 120mA

### Operating Conditions

Operating Temperature Range ..... -40°C to 85°C  
 Supply Voltage to Ground Potential  
   Inputs and V<sub>CC</sub> Only ..... -0.5V to 7.0V  
   Supply Voltage to Ground Potential  
   Outputs and D/O Only ..... -0.5V to 7.0V

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

### NOTE:

3.  $\theta_{JA}$  is measured with the component mounted on an evaluation PC board in free air.

### Thermal Information

Thermal Resistance (Typical, Note 3)  $\theta_{JA}$  (°C/W)  
   TSSOP Package ..... 94  
   SSOP Package ..... 76  
 Maximum Junction Temperature ..... 150°C  
 Maximum Storage Temperature Range ..... -65°C to 150°C  
 Maximum Lead Temperature (Soldering 10s) ..... 300°C  
   (Load Tips Only)

### Electrical Specifications

PARAMETER	SYMBOL	(NOTE 4) TEST CONDITIONS		MIN	(NOTE 5) TYP	MAX	UNITS
<b>DC ELECTRICAL SPECIFICATIONS</b> Over the Operating Range, T <sub>A</sub> = -40°C to 85°C, V <sub>CC</sub> = 5.0V ±10%							
Input HIGH Voltage	V <sub>IH</sub>	Guaranteed Logic HIGH Level		2.0	-	-	V
Input LOW Voltage	V <sub>IL</sub>	Guaranteed Logic LOW Level		-	-	0.8	V
Input HIGH Current	I <sub>IH</sub>	Standard Input V <sub>CC</sub> = Max	V <sub>IN</sub> = V <sub>CC</sub>	-	-	1	µA
Input HIGH Current	I <sub>IH</sub>	Bus Hold Input (Note 7) V <sub>CC</sub> = Max	V <sub>IN</sub> = V <sub>CC</sub>	-	-	±100	µA
Input LOW Current	I <sub>IL</sub>	Standard Input V <sub>CC</sub> = Min	V <sub>IN</sub> = GND	-	-	-1	µA
Input LOW Current	I <sub>IL</sub>	Bus Hold Input (Note 7) V <sub>CC</sub> = Min	V <sub>IN</sub> = GND	-	-	±100	µA
Bus Hold Sustain Current	I <sub>BHH</sub> I <sub>BHL</sub>	Bus Hold Input (Note 7) V <sub>CC</sub> = Min	V <sub>IN</sub> = 2.0V	-50	-	-	µA
			V <sub>IN</sub> = 0.8V	50	-	-	µA
High Impedance Output Current (Three-State) (Note 9)	I <sub>OZH</sub>	V <sub>CC</sub> = Max	V <sub>OUT</sub> = V <sub>CC</sub>	-	-	1	µA
	I <sub>OZL</sub>	V <sub>CC</sub> = Max	V <sub>OUT</sub> = GND	-	-	-1	µA
Clamp Diode Voltage	V <sub>IK</sub>	V <sub>CC</sub> = Min, I <sub>IN</sub> = -18mA		-	-0.7	-1.2	V
Output Drive Current	I <sub>O</sub>	V <sub>CC</sub> = Max (Note 6), V <sub>OUT</sub> = 2.5V		-50	-	-180	mA
Input Hysteresis	V <sub>H</sub>			-	100	-	mV
<b>OUTPUT DRIVE SPECIFICATIONS</b> Over the Operating Range							
Output LOW Current	I <sub>ODL</sub>	V <sub>CC</sub> = 5V, V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> , V <sub>OUT</sub> = 1.5V (Note 6)		36	-	-	mA
Output HIGH Current	I <sub>ODH</sub>	V <sub>CC</sub> = 5V, V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> , V <sub>OUT</sub> = 1.5V (Note 6)		-100	-166	-200	mA
Output HIGH Voltage	V <sub>OH</sub>	V <sub>CC</sub> = Min, V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -12.0mA	2.4	3.3	-	V
Output LOW Voltage	V <sub>OL</sub>	V <sub>CC</sub> = Min, V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OL</sub> = 12mA	-	0.4	0.55	V

# CD74FCT162Q245T

## Electrical Specifications (Continued)

PARAMETER	SYMBOL	(NOTE 4) TEST CONDITIONS	MIN	(NOTE 5) TYP	MAX	UNITS	
<b>CAPACITANCE</b> $T_A = 25^\circ\text{C}$ , $f = 1\text{MHz}$							
Input Capacitance (Note 9)	$C_{IN}$	$V_{IN} = 0\text{V}$	-	4.5	6	pF	
Output Capacitance (Note 9)	$C_{OUT}$	$V_{OUT} = 0\text{V}$	-	5.5	8	pF	
<b>POWER SUPPLY SPECIFICATIONS</b>							
Quiescent Power Supply Current	$I_{CC}$	$V_{CC} = \text{Max}$	$V_{IN} = \text{GND}$ or $V_{CC}$	-	0.1	500	$\mu\text{A}$
Supply Current per Input at TTL HIGH	$\Delta I_{CC}$	$V_{CC} = \text{Max}$	$V_{IN} = 3.4\text{V}$ (Note 10)	-	0.5	1.5	mA
Supply Current per Input per MHz (Note 11)	$I_{CCD}$	$V_{CC} = \text{Max}$ , Outputs Open $\overline{xOE} = \overline{xDIR} = \text{GND}$ One Bit Toggling 50% Duty Cycle	$V_{IN} = V_{CC}$ $V_{IN} = \text{GND}$	-	60	100	$\mu\text{A}/\text{MHz}$
Total Power Supply Current (Note 13)	$I_C$	$V_{CC} = \text{Max}$ , Outputs Open $f_i = 10\text{MHz}$ , 50% Duty Cycle $\overline{xOE} = \overline{xDIR} = \text{GND}$ One Bit Toggling	$V_{IN} = V_{CC}$ $V_{IN} = \text{GND}$	-	0.6	1.5 (Note 12)	mA
			$V_{IN} = 3.4\text{V}$ $V_{IN} = \text{GND}$	-	0.9	2.3 (Note 12)	mA
		$V_{CC} = \text{Max}$ , Outputs Open $f_i = 2.5\text{MHz}$ 50% Duty Cycle $\overline{xOE} = \overline{xDIR} = \text{GND}$ 16 Bits Toggling	$V_{IN} = V_{CC}$ $V_{IN} = \text{GND}$	-	2.4	4.5 (Note 12)	mA
			$V_{IN} = 3.4\text{V}$ $V_{IN} = \text{GND}$	-	6.4	16.5 (Note 12)	mA

**6**  
 D.D. 5V FCT  
 QUIET SERIES

## CD74FCT162Q245T

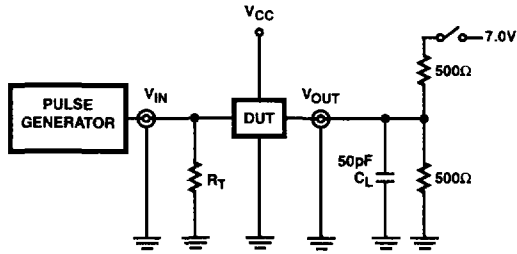
### Switching Specifications Over Operating Range

PARAMETER	SYMBOL	(NOTE 14) TEST CONDITIONS	T		AT		CT		DT		ET		UNITS
			(NOTE 15) MIN	MAX	(NOTE 15) MIN	MAX	(NOTE 15) MIN	MAX	(NOTE 16) MIN	MAX	(NOTE 15) MIN	MAX	
Propagation Delay A to B, B to A	$t_{PLH}$ , $t_{PHL}$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	1.5	7.0	1.5	4.6	1.5	4.1	1.5	3.8	1.5	3.2	ns
Output Enable Time $\chi\overline{OE}$ to A or B	$t_{PZH}$ , $t_{PZL}$		1.5	9.5	1.5	6.2	1.5	5.8	1.5	5.0	1.5	4.4	ns
Output Disable Time (Note 17) $\chi\overline{OE}$ to A or B	$t_{PHZ}$ , $t_{PLZ}$		1.5	7.5	1.5	5.0	1.5	4.8	1.5	4.3	1.5	4.0	ns
Output Enable Time $\chi\text{DIR}$ to A or B (Note 16)	$t_{PZH}$ , $t_{PZL}$		1.5	9.5	1.5	6.2	1.5	5.8	1.5	5.0	1.5	4.8	ns
Output Disable Time $\chi\text{DIR}$ to A or B (Note 16)	$t_{PHZ}$ , $t_{PLZ}$		1.5	7.5	1.5	5.0	1.5	4.8	1.5	4.3	1.5	4.0	ns
Output Skew(17)	$t_{SK(O)}$		-	0.5	-	0.5	-	0.5	-	0.5	-	0.5	ns

**NOTES:**

4. For conditions shown as Max or Min, use appropriate value specified under Electrical Specifications for the applicable device type.
5. Typical values are at  $V_{CC} = 5.0\text{V}$ ,  $25^\circ\text{C}$  ambient and maximum loading.
6. Not more than one output should be shorted at one time. Duration of the test should not exceed one second.
7. Pins with Bus Hold are identified in the pin description.
8. This specification does not apply to bi-directional functionalities with Bus Hold.
9. This parameter is determined by device characterization but is not production tested.
10. Per TTL driven input ( $V_{IN} = 3.4\text{V}$ ); all other inputs at  $V_{CC}$  or GND.
11. This parameter is not directly testable, but is derived for use in Total Power Supply Calculations.
12. Values for these conditions are examples of the  $I_{CC}$  formula. These limits are guaranteed but not tested.
13.  $I_C = I_{\text{QUIESCENT}} + I_{\text{INPUTS}} + I_{\text{DYNAMIC}}$   
 $I_C = I_{CC} + \Delta I_{CC} D_H N_T + I_{CCD} (f_{CP}/2 + f_I N_I)$   
 $I_{CC}$  = Quiescent Current  
 $\Delta I_{CC}$  = 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)  
 $f_{CP}$  = Clock Frequency for Register Devices (Zero for Non-Register Devices)  
 $f_I$  = Input Frequency  
 $N_I$  = Number of Inputs at  $f_I$   
 All currents are in milliamps and all frequencies are in megahertz.
14. See test circuit and wave forms.
15. Minimum limits are guaranteed but not tested on Propagation Delays.
16. This parameter is guaranteed but not production tested.
17. Skew between any two outputs, of the same package, switching in the same direction. This parameter is guaranteed by design..

**Test Circuits and Waveforms**



SWITCH POSITION	
TEST	SWITCH
$t_{PLZ}, t_{PZL}$	Closed
$t_{PHZ}, t_{PZH}, t_{PLH}, t_{PHL}$	Open

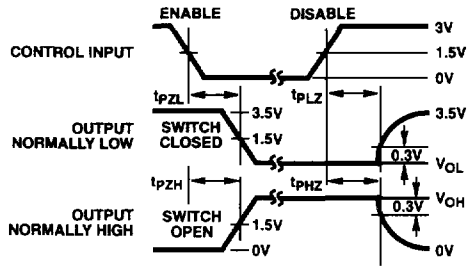
**DEFINITIONS:**

$C_L$  = Load capacitance, includes jig and probe capacitance.  
 $R_T$  = Termination resistance, should be equal to  $Z_{OUT}$  of the Pulse Generator.

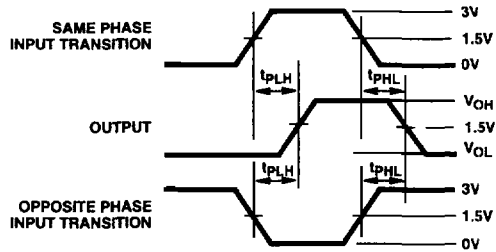
**NOTE:**

18. Pulse Generator for All Pulses: Rate  $\leq 1.0\text{MHz}$ ;  $Z_{OUT} \leq 50\Omega$ ;  
 $t_r, t_f \leq 2.5\text{ns}$ .

**FIGURE 1. TEST CIRCUIT**



**FIGURE 2. ENABLE AND DISABLE TIMING**



**FIGURE 3. PROPAGATION DELAY**