

January 1998

## Fast CMOS 16-Bit Registered Transceivers

### Features

- **Advanced 0.6 micron CMOS Technology**
- **These Devices Are High-speed, Low Power Devices with High Current Drive**
- **$V_{CC} = 5V \pm 10\%$**
- **Hysteresis on All Inputs**
- **CD74FCT16646T**
  - **High Output Drive:  $I_{OH} = -32mA$ ;  $I_{OL} = 64mA$**
  - **Power Off Disable Outputs Permit "Live Insertion"**
  - **Typical  $V_{OLP}$  (Output Ground Bounce)  $< 1.0V$  at  $V_{CC} = 5V$ ,  $T_A = 25^\circ C$**
- **CD74FCT162646T**
  - **Balanced Output Drivers:  $\pm 24mA$**
  - **Reduced System Switching Noise**
  - **Typical  $V_{OLP}$  (Output Ground Bounce)  $< 0.6V$  at  $V_{CC} = 5V$ ,  $T_A = 25^\circ C$**
- **CD74FCT162H646T**
  - **Bus Hold Retains Last Active Bus State During Three-State**
  - **Eliminates the Need for External Pull-Up Resistors**

### Description

These devices are 16-bit registered transceivers organized as two independent 8-bit bus transceivers designed with three-state D-type flip-flops and control circuitry arranged for multiplexed transmission of data directly from the data bus or from the internal storage registers. Each 8-bit transceiver utilizes the enable control ( $\chi\overline{OE}$ ) and direction pins ( $\chi DIR$ ) to control the transceiver functions. The Select ( $\chi SAB$  and  $\chi SBA$ ) control pins are used to select either real-time or stored data transfer. The circuitry used for select control will eliminate the typical decoding glitch that occurs in a multiplexer during the transition between real-time and stored data. A low input level selects real-time data and a high selects stored data.

The CD74FCT16646T output buffers are designed with a Power-Off disable allowing "live insertion" of boards when used as backplane drivers.

The CD74FCT162646T has  $\pm 24mA$  balanced output drivers. It is designed with current limiting resistors at its outputs to control the output edge rate resulting in lower ground bounce and undershoot. This eliminates the need for external terminating resistors for most interface applications.

The CD74FCT162H646T has "Bus Hold" which retains the input's last state whenever the input goes to high impedance preventing "floating" inputs and eliminating the need for pull-up/down resistors.

### Ordering Information

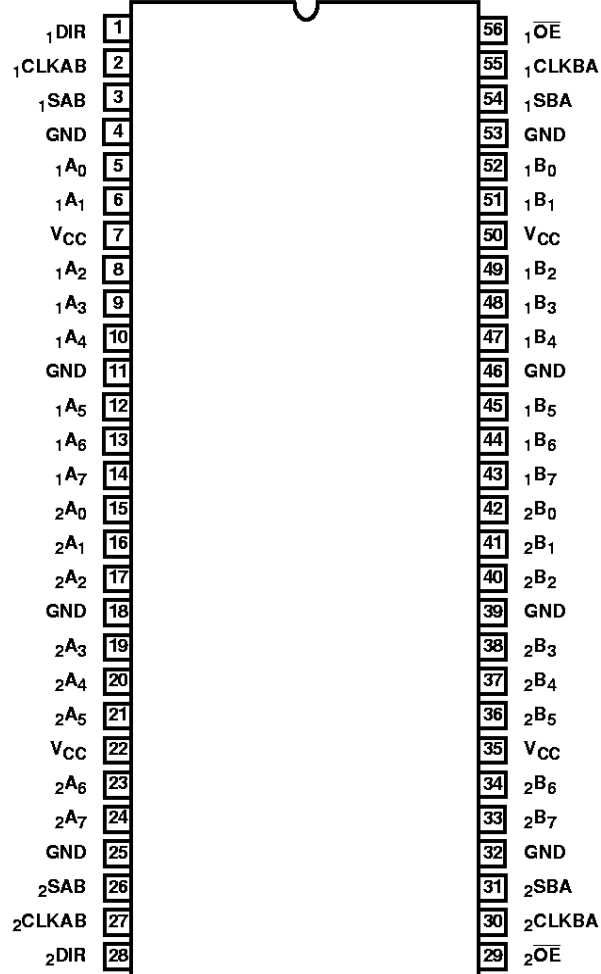
PART NUMBER	TEMP. RANGE (°C)	PACKAGE	PKG. NO.
CD74FCT16646ATMT	-40 to 85	56 Ld TSSOP	M56.240-P
CD74FCT16646ATSM	-40 to 85	56 Ld SSOP	M56.300-P
CD74FCT16646CTMT	-40 to 85	56 Ld TSSOP	M56.240-P
CD74FCT16646CTSM	-40 to 85	56 Ld SSOP	M56.300-P
CD74FCT16646DTMT	-40 to 85	56 Ld TSSOP	M56.240-P
CD74FCT16646DTSM	-40 to 85	56 Ld SSOP	M56.300-P
CD74FCT16646ETMT	-40 to 85	56 Ld TSSOP	M56.240-P
CD74FCT16646ETSM	-40 to 85	56 Ld SSOP	M56.300-P
CD74FCT16646TMT	-40 to 85	56 Ld TSSOP	M56.240-P
CD74FCT16646TSM	-40 to 85	56 Ld SSOP	M56.300-P
CD74FCT162646ATMT	-40 to 85	56 Ld TSSOP	M56.240-P
CD74FCT162646ATSM	-40 to 85	56 Ld SSOP	M56.300-P
CD74FCT162646CTMT	-40 to 85	56 Ld TSSOP	M56.240-P
CD74FCT162646CTSM	-40 to 85	56 Ld SSOP	M56.300-P
CD74FCT162646DTMT	-40 to 85	56 Ld TSSOP	M56.240-P
CD74FCT162646DTSM	-40 to 85	56 Ld SSOP	M56.300-P
CD74FCT162646ETMT	-40 to 85	56 Ld TSSOP	M56.240-P
CD74FCT162646ETSM	-40 to 85	56 Ld SSOP	M56.300-P
CD74FCT162646TMT	-40 to 85	56 Ld TSSOP	M56.240-P
CD74FCT162646TSM	-40 to 85	56 Ld SSOP	M56.300-P
CD74FCT162H646ATMT	-40 to 85	56 Ld TSSOP	M56.300-P
CD74FCT162H646ATSM	-40 to 85	56 Ld SSOP	M56.240-P
CD74FCT162H646CTMT	-40 to 85	56 Ld TSSOP	M56.240-P
CD74FCT162H646CTSM	-40 to 85	56 Ld SSOP	M56.300-P
CD74FCT162H646ETSM	-40 to 85	56 Ld SSOP	M56.300-P
CD74FCT162H646DTMT	-40 to 85	56 Ld TSSOP	M56.300-P
CD74FCT162H646ETMT	-40 to 85	56 Ld TSSOP	M56.240-P
CD74FCT162H646DTSM	-40 to 85	56 Ld SSOP	M56.240-P
CD74FCT162H646TMT	-40 to 85	56 Ld TSSOP	M56.240-P
CD74FCT162H646TSM	-40 to 85	56 Ld SSOP	M56.300-P

NOTE: When ordering, use the entire part number. Add the suffix 96 to obtain the variant in the tape and reel.

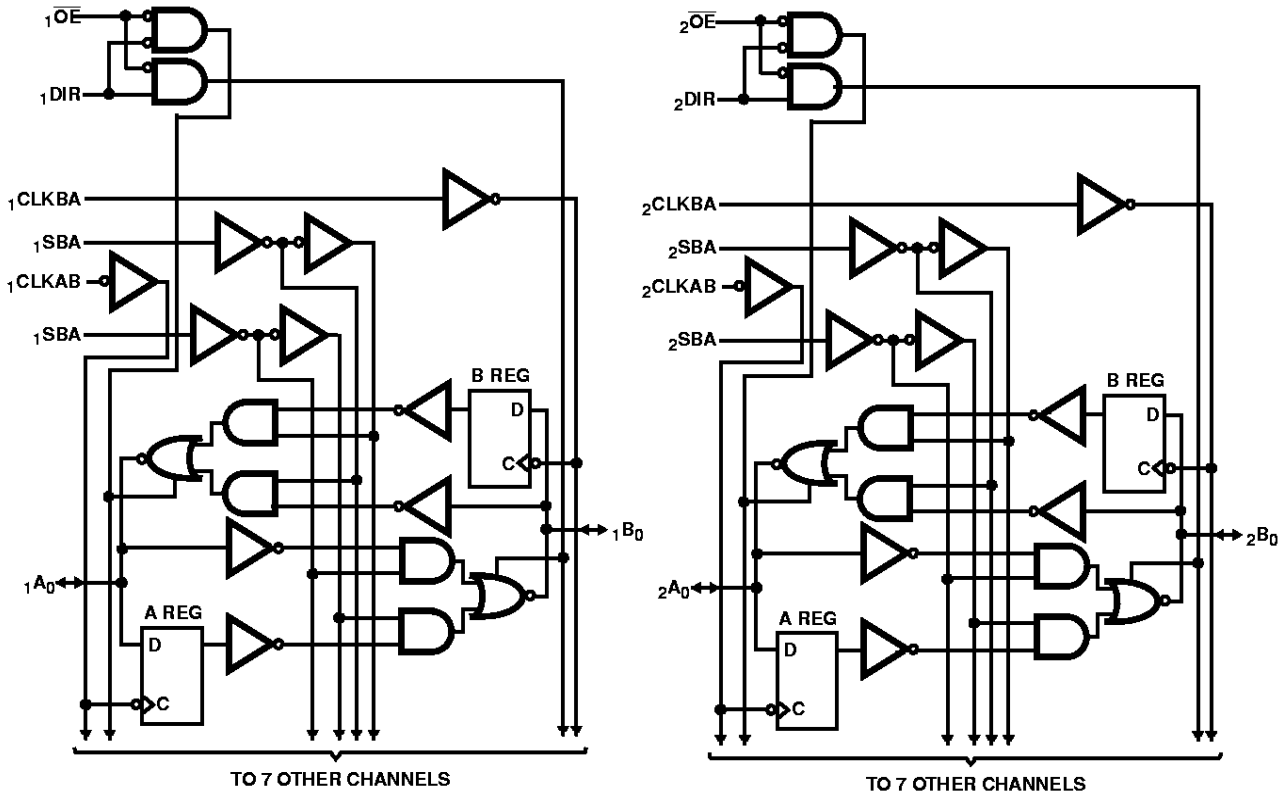
CD74FCT16646T, CD74FCT162646T, CD74FCT162H646T

Pinout

CD74FCT16646T, CD74FCT162646T, CD74FCT162H646T  
(SSOP, TSSOP)  
TOP VIEW



**Functional Block Diagram**



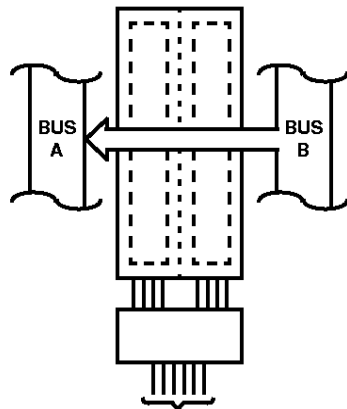
TRUTH TABLE (NOTE 1)

FUNCTION/OPERATION	INPUTS						(NOTE 2) DATA I/O	
	$\bar{x}OE$	$\bar{x}DIR$	$\bar{x}CLKAB$	$\bar{x}CLKBA$	$\bar{x}SAB$	$\bar{x}SBA$	$\bar{x}A_x$	$\bar{x}B_x$
Isolation	H	X	H or L	H or L	X	X	Input	Input
Store A and B Data	H	X	↑	↑	X	X		
Real Time B Data to A Bus	L	L	X	X	X	L	Output	Input
Stored B Data to A Bus	L	L	X	H or L	X	H		
Real Time A Data to B Bus	L	H	X	X	L	X	Input	Output
Stored A Data to B Bus	L	H	H or L	X	H	X		

NOTES:

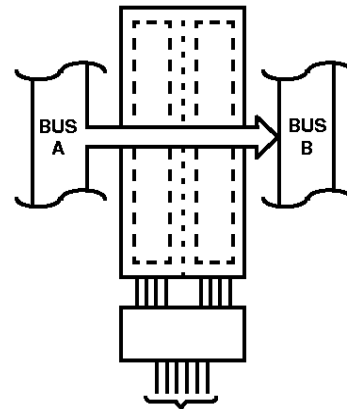
- The data output functions may be enabled or disabled by various signals at the  $\bar{x}OE$  or  $\bar{x}DIR$  inputs. Data input functions are always enabled, i.e., data at the bus pins will be stored on every low-to-high transition on the clock inputs.
- Select control = L: clocks can occur simultaneously.  
Select control = H: clocks must be staggered in order to load both registers.  
H = High Voltage Level  
L = Low Voltage Level  
X = Don't Care  
↑ = LOW-to-HIGH transition

CD74FCT16646T, CD74FCT162646T, CD74FCT162H646T



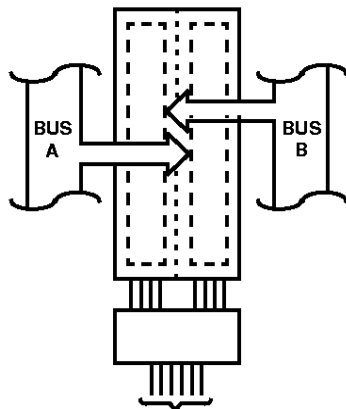
$\chi$ DIR  $\chi\overline{\text{OE}}$   $\chi$ CLKAB  $\chi$ CLKBA  $\chi$ SAB  $\chi$ SBA  
L L X X X L

FIGURE 1. REAL-TIME TRANSFER BUS B TO A



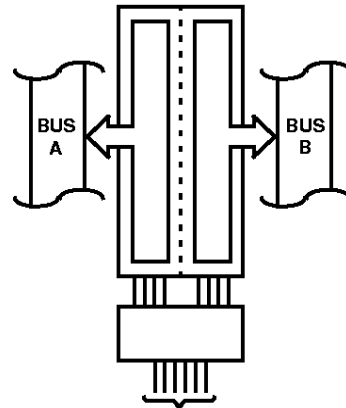
$\chi$ DIR  $\chi\overline{\text{OE}}$   $\chi$ CLKAB  $\chi$ CLKBA  $\chi$ SAB  $\chi$ SBA  
H L X X L X

FIGURE 2. REAL-TIME TRANSFER BUS A TO B



$\chi$ DIR  $\chi\overline{\text{OE}}$   $\chi$ CLKAB  $\chi$ CLKBA  $\chi$ SAB  $\chi$ SBA  
H L  $\uparrow$  X X X  
L L X  $\uparrow$  X X  
X H  $\uparrow$   $\uparrow$  X X

FIGURE 3. STORAGE FROM A AND/OR B



$\chi$ DIR  $\chi\overline{\text{OE}}$   $\chi$ CLKAB  $\chi$ CLKBA  $\chi$ SAB  $\chi$ SBA  
L L X H or L X H  
H L H or L X H X

FIGURE 4. TRANSFER STORES DATA TO A AND/OR B

**Pin Descriptions**

PIN NAME	DESCRIPTION
$\chi$ A $\chi$ (Note 3)	Data Register A Inputs Data Register B Outputs
$\chi$ B $\chi$ (Note 3)	Data Register B Inputs Data Register A Outputs
$\chi$ CLKAB, $\chi$ CLKBA	Clock Pulse Inputs
SAB, SBA	Output Data Source Select Inputs
$\chi$ DIR, $\chi\overline{\text{OE}}$	Output Enable Inputs
GND	Ground
V <sub>CC</sub>	Power

NOTE:

- For the CD74FCT162H646T, these pins have "Bus Hold". All other pins are standard, outputs, or I/Os.

## CD74FCT16646T, CD74FCT162646T, CD74FCT162H646T

### 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

### Thermal Information

Thermal Resistance (Typical, Note 4) θ<sub>JA</sub> (°C/W)  
 TSSOP SOIC Package ..... 85  
 SSOP Package ..... 70  
 Maximum Junction Temperature ..... 150°C  
 Maximum Storage Temperature Range ..... -65°C to 150°C  
 Maximum Lead Temperature (Soldering 10s) ..... 300°C  
 (Lead Tips Only)

*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:

4. θ<sub>JA</sub> is measured with the component mounted on an evaluation PC board in free air.

### Electrical Specifications

PARAMETER	SYMBOL	(NOTE 5) TEST CONDITIONS	MIN	(NOTE 6) 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>	Standard I/O, 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 8) V <sub>CC</sub> = Max				
		V <sub>IN</sub> = V <sub>CC</sub>	-	-	±100	μA
Input HIGH Current	I <sub>IH</sub>	Bus Hold I/O (Note 8) 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>	Standard I/O, V <sub>CC</sub> = Min				
		V <sub>IN</sub> = GND	-	-	-1	μA
Input LOW Current	I <sub>IL</sub>	Bus Hold Input (Note 8) V <sub>CC</sub> = Min				
		V <sub>IN</sub> = GND	-	-	±100	μA
Input LOW Current	I <sub>IL</sub>	Bus Hold I/O (Note 8) 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 8) 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> I <sub>OZL</sub>	V <sub>CC</sub> = Max	V <sub>OUT</sub> = 2.7V	-	-	1
			V <sub>OUT</sub> = 0.5V	-	-	-1
Clamp Diode Voltage	V <sub>IK</sub>	V <sub>CC</sub> = Min, I <sub>IN</sub> = -18mA	-	-0.7	-1.2	V
Short Circuit Current	I <sub>OS</sub>	V <sub>CC</sub> = Max (Note 7), V <sub>OUT</sub> = GND	-80	-140	-200	mA
Output Drive Current	I <sub>O</sub>	V <sub>CC</sub> = Max (Note 7), V <sub>OUT</sub> = 2.5V	-50	-	-180	mA
Input Hysteresis	V <sub>H</sub>		-	100	-	mV

**CD74FCT16646T, CD74FCT162646T, CD74FCT162H646T**

**Electrical Specifications (Continued)**

PARAMETER	SYMBOL	(NOTE 5) TEST CONDITIONS	MIN	(NOTE 6) TYP	MAX	UNITS	
<b>CD74FCT16646T OUTPUT DRIVE SPECIFICATIONS</b> Over the Operating Range							
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> = -3.0mA	2.5	3.5	-	V
			I <sub>OH</sub> = -15.0mA	2.4	3.5	-	V
			I <sub>OH</sub> = -32.0mA	2.0	3.0	-	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> = 64mA	-	0.2	0.55	V
Power Down Disable	I <sub>OFF</sub>	V <sub>CC</sub> = 0V, V <sub>IN</sub> or V <sub>OUT</sub> ≤ 4.5V	-	-	100	μA	
<b>CD74FCT162646T, CD74FCT162H646T OUTPUT DRIVE SPECIFICATIONS</b> Over the Operating Range							
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> = -24.0mA	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> = 24mA	-	0.3	0.55	V
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 7)	-	60	115	150	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 7)	-60	-115	-150	mA	
<b>CAPACITANCE</b> T <sub>A</sub> = 25°C, f = 1MHz							
Input Capacitance (Note 10)	C <sub>IN</sub>	V <sub>IN</sub> = 0V	-	4.5	6	pF	
Output Capacitance (Note 10)	C <sub>OUT</sub>	V <sub>OUT</sub> = 0V	-	5.5	8	pF	
<b>POWER SUPPLY SPECIFICATIONS</b>							
Quiescent Power Supply Current	I <sub>CC</sub>	V <sub>CC</sub> = Max	V <sub>IN</sub> = GND or V <sub>CC</sub>	-	0.12	500	μA
Supply Current per Input at TTL HIGH	ΔI <sub>CC</sub>	V <sub>CC</sub> = Max	V <sub>IN</sub> = 3.4V (Note 11)	-	0.5	1.5	mA
Supply Current per Input per MHz (Note 12)	I <sub>CCD</sub>	V <sub>CC</sub> = Max, Outputs Open x <sub>DIR</sub> = x <sub>OE</sub> = GND One Bit Toggling 50% Duty Cycle	V <sub>IN</sub> = V <sub>CC</sub> V <sub>IN</sub> = GND	-	75	120	μA/MHz
Total Power Supply Current (Note 14)	I <sub>C</sub>	V <sub>CC</sub> = Max, Outputs Open f <sub>CP</sub> = 10MHz (xCLKBA) 50% Duty Cycle x <sub>DIR</sub> = x <sub>OE</sub> = GND One Bit Toggling f <sub>i</sub> = 5MHz, 50% Duty Cycle	V <sub>IN</sub> = V <sub>CC</sub> V <sub>IN</sub> = GND	-	0.8	1.7 (Note 13)	mA
			V <sub>IN</sub> = 3.4V V <sub>IN</sub> = GND	-	1.3	3.2 (Note 13)	mA
		V <sub>CC</sub> = Max, Outputs Open f <sub>CP</sub> = 10MHz (xCLKBA) 50% Duty Cycle x <sub>DIR</sub> = x <sub>OE</sub> = GND 16 Bit Toggling f <sub>i</sub> = 2.5MHz, 50% Duty Cycle	V <sub>IN</sub> = V <sub>CC</sub> V <sub>IN</sub> = GND	-	3.8	6.5 (Note 13)	mA
			V <sub>IN</sub> = 3.4V V <sub>IN</sub> = GND	-	8.3	20.0 (Note 13)	mA

**CD74FCT16646T, CD74FCT162646T, CD74FCT162H646T**

**Switching Specifications Over Operating Range**

PARAMETER	SYM-BOL	(NOTE 15) TEST CONDITIONS	T		AT		CT		DT		ET		UNITS
			(NOTE 16) MIN	MAX	(NOTE 16) MIN	MAX	(NOTE 16) MIN	MAX	(NOTE 16) MIN	MAX	(NOTE 16) MIN	MAX	
Propagation Delay Bus to Bus	$t_{PLH}$ , $t_{PHL}$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	2.0	9.0	2.0	6.3	1.5	5.4	1.5	4.4	1.5	3.8	ns
Output Enable Time $\chi_{DIR}$ or $\chi_{OE}$ to Bus	$t_{PZH}$ , $t_{PZL}$		2.0	14.0	2.0	9.8	1.5	7.8	1.5	5.0	1.5	4.8	ns
Output Disable Time (Note 17) $\chi_{DIR}$ or $\chi_{OE}$ to Bus	$t_{PHZ}$ , $t_{PLZ}$		2.0	9.0	2.0	6.3	1.5	6.3	1.5	4.3	1.5	4.0	ns
Propagation Delay Clock to Bus	$t_{PLH}$ , $t_{PHL}$		2.0	9.0	2.0	6.3	1.5	5.7	1.5	4.4	1.5	3.8	ns
Propagation Delay $\chi_{SBA}$ or $\chi_{SAB}$ to Bus	$t_{PLH}$ , $t_{PHL}$		2.0	11.0	2.0	7.7	1.5	6.2	1.5	5.0	1.5	4.2	ns
Setup Time HIGH or LOW, Bus to Clock	$t_{SU}$		4.0	-	2.0	-	2.0	-	2.0	-	2.0	-	ns
Hold Time HIGH or LOW, Bus to Clock	$t_H$		2.0	-	1.5	-	1.5	-	1.0	-	0.0	-	ns
Clock Pulse Width HIGH or LOW (Note 17)	$t_W$		6.0	-	5.0	-	5.0	-	3.0	-	3.0	-	ns
Output Skew (Note 18)	$t_{SK(O)}$		-	0.5	-	0.5	-	0.5	-	0.5	-	0.5	ns

**NOTES:**

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