TEXAS INSTRUMENTS

CY74FCT16646T
CY74FCT162646T

SCCS060 - August 1994 - Revised March 2000

16-Bit Registered Transceivers

Features

- **FCT-E speed at 3.8 ns**
- **Power-off disable outputs permits live insertion**
- **Edge-rate control circuitry for significantly improved noise characteristics**
- **Typical output skew < 250 ps**
- **ESD > 2000V**
- **TSSOP (19.6-mil pitch) and SSOP (25-mil pitch) packages**
- **Industrial temperature range of −40˚C to +85˚C**
- **V_{CC} = 5V ± 10%**

CY74FCT16646T Features:

- **64 mA sink current, 32 mA source current**
- **Typical V_{OLP} (ground bounce) <1.0V at V_{CC} = 5V, T_A = 25˚C**

CY74FCT162646T Features:

- **Balanced 24 mA output drivers**
- **Reduced system switching noise**
- **Typical V_{OLP} (ground bounce) <0.6V at V_{CC} = 5V, T_A= 25˚C**

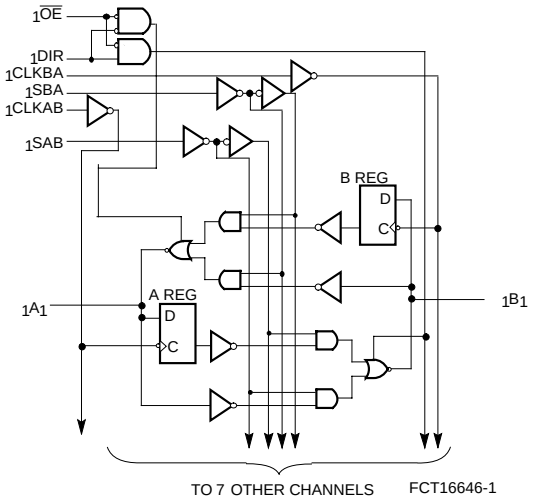
Functional Description

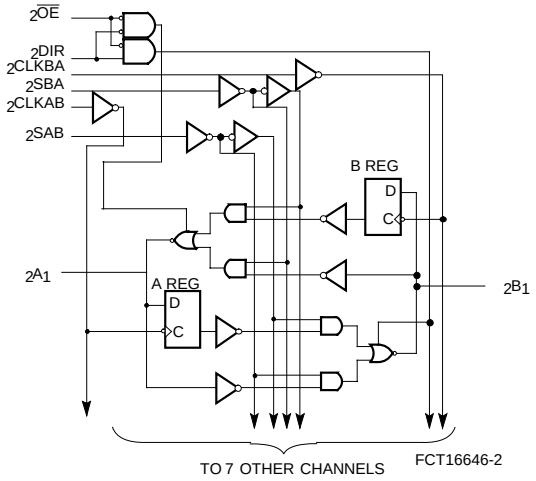
The CY74FCT16646T and CY74FCT162646T 16-bit transceivers are three-state, D-type registers, and control circuitry arranged for multiplexed transmission of data directly from the input bus or from the internal registers. Data on the A or B bus will be clocked into the registers as the appropriate clock pin goes to a HIGH logic level. Output Enable ($\overline{OE}$) and direction pins (DIR) are provided to control the transceiver function. In the transceiver mode, data present at the high impedance port may be stored in either the A or B register, or in both. The select controls can multiplex stored and real-time (transparent mode) data. The direction control determines which bus will receive data when the Output Enable ($\overline{OE}$) is Active LOW. In the isolation mode (Output Enable ($\overline{OE}$) HIGH), A data may be stored in the B register and/or B data may be stored in the A register. The output buffers are designed with a power-off disable feature that allows live insertion of boards.

The CY74FCT16646T is ideally suited for driving high-capacitance loads and low-impedance backplanes.

The CY74FCT162646T has 24-mA balanced output drivers with current limiting resistors in the outputs. This reduces the need for external terminating resistors and provides for minimal undershoot and reduced ground bounce. The CY74FCT162646T is ideal for driving transmission lines.

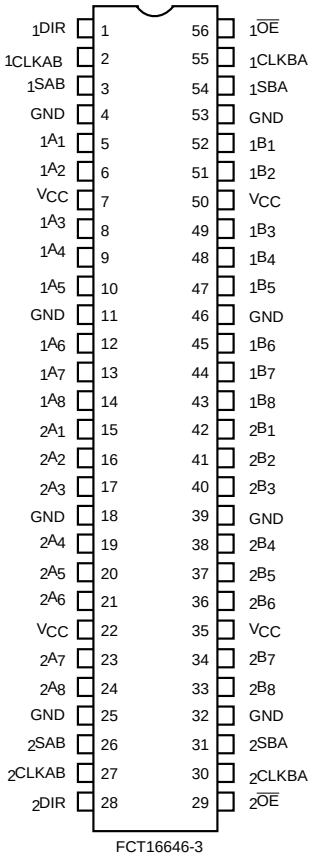
Logic Block Diagrams





Pin Configuration

SSOP/TSSOP
Top View



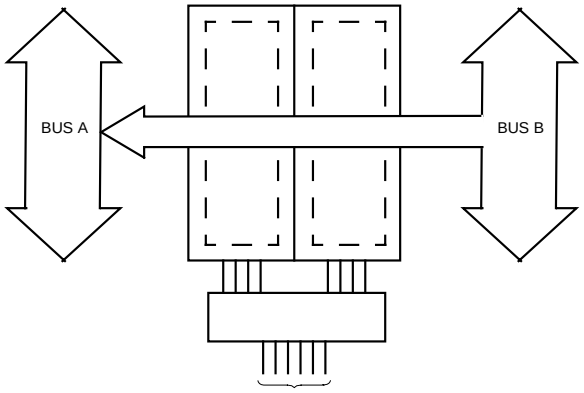
FCT16646-3

Pin Description

Pin Names	Description
A	Data Register A Inputs Data Register B Outputs
B	Data Register B Inputs Data Register A Outputs
CLKAB, CLKBA	Clock Pulse Inputs
SAB, SBA	Output Data Source Select Inputs
DIR	Direction
$\overline{OE}$	Output Enable (Active LOW)

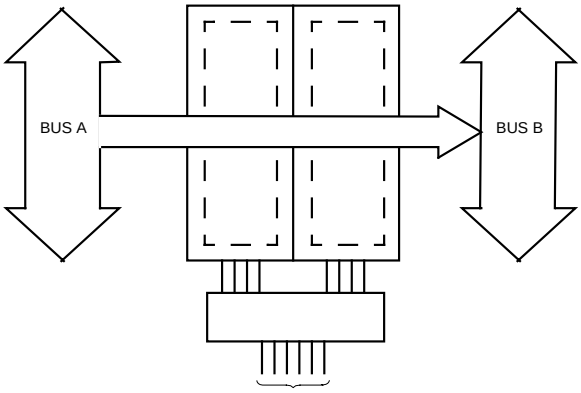
Function Table[1]

Inputs						Data I/O[2]		Function
$\overline{OE}$	DIR	CLKAB	CLKBA	SAB	SBA	A	B	
H H	X X	H or L ↓	H or L ↓	X X	X X	Input	Input	Isolation Store A and B Data
L L	L L	X X	X H or L	X X	L H	Output	Input	Real Time B Data to A Bus Stored B Data to A Bus
L L	H H	X H or L	X X	L H	X X	Input	Output	Real Time A Data to Bus Stored A Data to B Bus



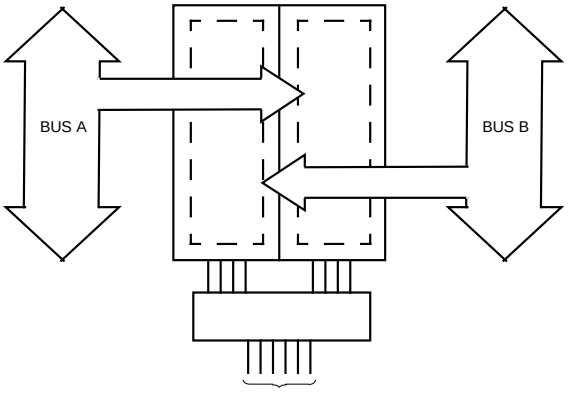
DIR	$\overline{OE}$	CLKAB	CLKBA	SAB	SBA
L	L	X	X	X	L

Real-Time Transfer
Bus B to Bus A



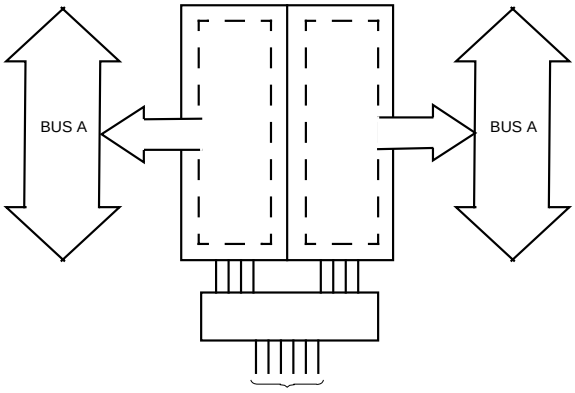
DIR	$\overline{OE}$	CLKAB	CLKBA	SAB	SBA
H	L	X	X	L	X

Real-Time Transfer
Bus A to Bus B



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

Storage from
A and/or B



DIR[3]	$\overline{OE}$	CLKAB	CLKBA	SAB	SBA
L	L	X	H or L	X	H
H	L	H or L	X	H	X

Transfer Stored Data
to A and/or B

Notes:

1. H = HIGH Voltage Level. L = LOW Voltage Level. X = Don't Care ↓ = LOW-to-HIGH Transition
2. The data output functions may be enabled or disabled by various signals at the $\overline{OE}$ or 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.
3. Cannot transfer data to A-bus and B-bus simultaneously.

Maximum Ratings[4]

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

Storage Temperature .....Com'l –55°C to +125°C

Ambient Temperature with Power Applied.....Com'l –55°C to +125°C

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

Static Discharge Voltage.....>2001V (per MIL-STD-883, Method 3015)

Operating Range

Range	Ambient Temperature	V_{CC}
Industrial	–40°C to +85°C	5V ± 10%

Electrical Characteristics Over the Operating Range

Parameter	Description	Test Conditions	Min.	Typ.[5]	Max.	Unit
V_{IH}	Input HIGH Voltage		2.0			V
V_{IL}	Input LOW Voltage				0.8	V
V_H	Input Hysteresis[6]			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=V_{CC}			±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}=2.7V			±1	µA
I_{OZL}	High Impedance Output Current (Three-State Output pins)	V_{CC}=Max., V_{OUT}=0.5V			±1	µA
I_{OS}	Short Circuit Current[7]	V_{CC}=Max., V_{OUT}=GND	–80	–140	–200	mA
I_O	Output Drive Current[7]	V_{CC}=Max., V_{OUT}=2.5V	–50		–180	mA
I_{OFF}	Power-Off Disable	V_{CC}=0V, V_{OUT}≤4.5V[9]			±1	µA

Output Drive Characteristics for CY74FCT16646T

Parameter	Description	Test Conditions	Min.	Typ.[5]	Max.	Unit
V_{OH}	Output HIGH Voltage	V_{CC}=Min., I_{OH}=–3 mA	2.5	3.5		V
		V_{CC}=Min., I_{OH}=–15 mA	2.4	3.5		V
		V_{CC}=Min., I_{OH}=–32 mA	2.0	3.0		V
V_{OL}	Output LOW Voltage	V_{CC}=Min., I_{OL}=64 mA		0.2	0.55	V

Output Drive Characteristics for CY74FCT162646T

Parameter	Description	Test Conditions	Min.	Typ.[5]	Max.	Unit
I_{ODL}	Output LOW Current[7]	V_{CC}=5V, V_{IN}=V_{IH} or V_{IL}, V_{OUT}=1.5V	60	115	150	mA
I_{ODH}	Output HIGH Current[7]	V_{CC}=5V, V_{IN}=V_{IH} or V_{IL}, V_{OUT}=1.5V	–60	–115	–150	mA
V_{OH}	Output HIGH Voltage	V_{CC}=Min., I_{OH}=–24 mA	2.4	3.3		V
V_{OL}	Output LOW Voltage	V_{CC}=Min., I_{OL}=24 mA		0.3	0.55	V

Notes:

4. Stresses greater than those listed under Maximum Ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.
5. Typical values are at V_{CC}= 5.0V, T_A= +25°C ambient.
6. This parameter is specified but not tested.
7. 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 parametrics tests. In any sequence of parameter tests, I_{OS} tests should be performed last.
8. This parameter is measured at characterization but not tested.
9. Tested at +25°C.

Capacitance (T_A = +25°C, f = 1.0 MHz)

Symbol	Description[8]	Conditions	Typ.	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[10]		Min.	Typ.[5]	Max.	Unit
I_{CC}	Quiescent Power Supply Current	V_{CC}=Max.	$V_{IN}\leq$0.2V $V_{IN}\geq V_{CC}$–0.2V	—	5	500	µA
ΔI_{CC}	Quiescent Power Supply Current TTL Inputs HIGH	V_{CC} = Max. V_{IN}=3.4V[11]		—	0.5	1.5	mA
I_{CCD}	Dynamic Power Supply Current[12]	V_{CC}=Max. Outputs Open DIR=OE=GND One-Bit Toggling 50% Duty Cycle	$V_{IN}=V_{CC}$ or V_{IN}=GND	—	75	120	µA/MHz
I_C	Total Power Supply Current[13]	V_{CC}=Max. Outputs Open f_0=10 MHz (CLKBA) 50% Duty Cycle DIR=$\overline{OE}$=GND One-Bit Toggling f_1=5 MHz 50% Duty Cycle	$V_{IN}=V_{CC}$ or V_{IN}=GND	—	0.8	1.7	mA
			V_{IN}=3.4V or V_{IN}=GND	—	1.3	3.2	
		V_{CC}=Max. Outputs Open f_0=10 MHz (CLKBA) 50% Duty Cycle DIR=$\overline{OE}$=GND Sixteen-Bits Toggling f_1=2.5 MHz 50% Duty Cycle	$V_{IN}=V_{CC}$ or V_{IN}=GND	—	3.8	6.5[14]	
			V_{IN}=3.4V or V_{IN}=GND	—	8.3	20.0[14]	

Notes:

10. For conditions shown as Max. or Min., use appropriate value specified under Electrical Characteristics for the applicable device type.
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. $I_C = I_{QUIESCENT} + I_{INPUTS} + I_{DYNAMIC}$
    $I_C = I_{CC}+\Delta I_{CC}D_HN_T+I_{CCD}(f_0/2 + f_1N_1)$
    I_{CC} = Quiescent Current with CMOS input levels
    ΔI_{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_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.
14. Values for these conditions are examples of the ICC formula. These limits are specified but not tested.

Switching Characteristics Over the Operating Range[15]

Parameter	Description	CY74FCT16646T		CY74FCT16646AT CY74FCT162646AT		Unit	Fig. No.[16]
		Min.	Max.	Min.	Max.		
t_{PLH} t_{PHL}	Propagation Delay Bus to Bus	1.5	9.0	1.5	6.3	ns	1, 2
t_{PZH} t_{PZL}	Output Enable Time DIR or $\overline{OE}$ to Bus	1.5	14.0	1.5	9.8	ns	1, 7, 8
t_{PHZ} t_{PLZ}	Output Disable Time DIR or $\overline{OE}$ to Bus	1.5	9.0	1.5	6.3	ns	1, 7, 8
t_{PLH} t_{PHL}	Propagation Delay Clock to Bus	1.5	9.0	1.5	6.3	ns	1, 5
t_{PLH} t_{PHL}	Propagation Delay SBA or SAB to Bus	1.5	11.0	1.5	7.7	ns	1,5
t_{SU}	Set-Up Time HIGH or LOW Bus to Clock	2.0	—	2.0	—	ns	4
t_H	Hold Time HIGH or LOW Bus to Clock	1.5	—	1.5	—	ns	4
t_W	Clock Pulse Width HIGH or LOW	5.0	—	5.0	—	ns	6
$t_{SK(O)}$	Output Skew[17]	—	0.5	—	0.5	ns	—

Parameter	Description	CY74FCT16646CT CY74FCT162646CT		CY74FCT16646ET CY74FCT162646ET		Unit	Fig. No.[16]
		Min.	Max.	Min.	Max.		
t_{PLH} t_{PHL}	Propagation Delay Bus to Bus	1.5	5.4	1.5	3.8	ns	1, 2
t_{PZH} t_{PZL}	Output Enable Time DIR or $\overline{OE}$ to Bus	1.5	7.8	1.5	4.8	ns	1, 7, 8
t_{PHZ} t_{PLZ}	Output Disable Time DIR or $\overline{OE}$ to Bus	1.5	6.3	1.5	4.0	ns	1, 7, 8
t_{PLH} t_{PHL}	Propagation Delay Clock to Bus	1.5	5.7	1.5	3.8	ns	1, 5
t_{PLH} t_{PHL}	Propagation Delay SBA or SAB to Bus	1.5	6.2	1.5	4.2	ns	1,5
t_{SU}	Set-Up Time HIGH or LOW Bus to Clock	2.0	—	2.0	—	ns	4
t_H	Hold Time HIGH or LOW Bus to Clock	1.5	—	0.0	—	ns	4
t_W	Clock Pulse Width HIGH or LOW	5.0	—	3.0	—	ns	6
$t_{SK(O)}$	Output Skew[17]	—	0.5	—	0.5	ns	—

Notes:

15. Minimum limits are specified but not tested on Propagation Delays.
16. See “Parameter Measurement Information” in the General Information section.
17. Skew any two outputs of the same package switching in the same direction. This parameter is ensured by design.

Ordering Information CY74FCT16646

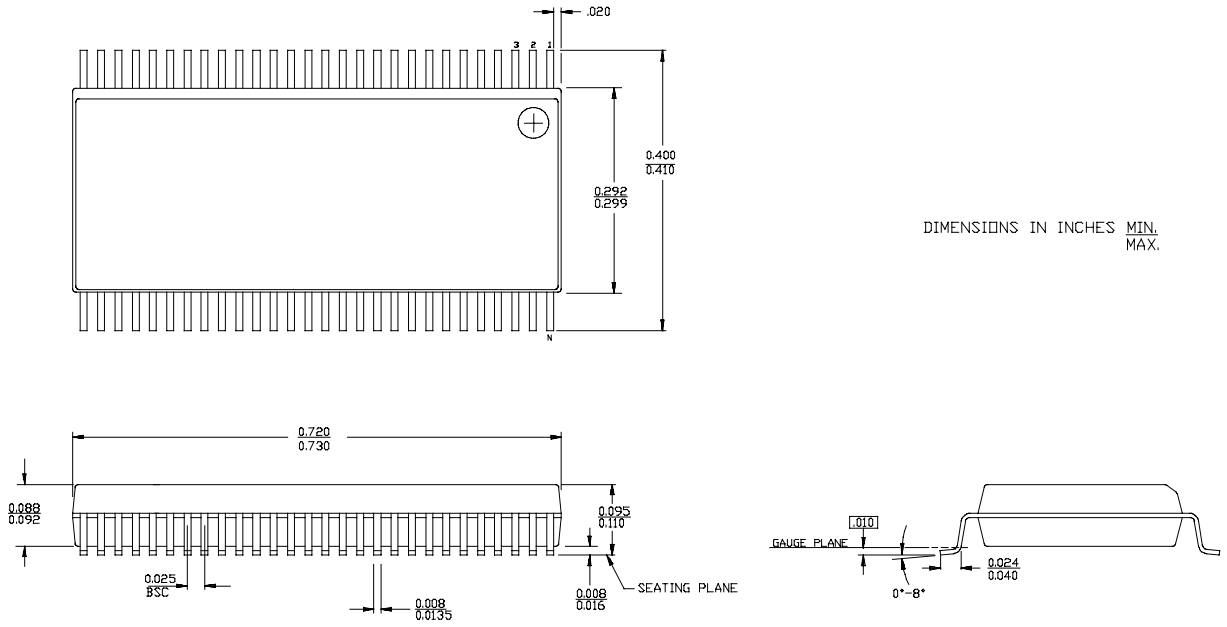
Speed (ns)	Ordering Code	Package Name	Package Type	Operating Range
3.8	CY74FCT16646ETPVC/PVCT	O56	56-Lead (300-Mil) SSOP	Industrial
5.4	CY74FCT16646CTPVC/PVCT	O56	56-Lead (300-Mil) SSOP	Industrial
6.3	CY74FCT16646ATPVC/PVCT	O56	56-Lead (300-Mil) SSOP	Industrial
9.0	CY74FCT16646TPVC/PVCT	O56	56-Lead (300-Mil) SSOP	Industrial

Ordering Information CY74FCT162646

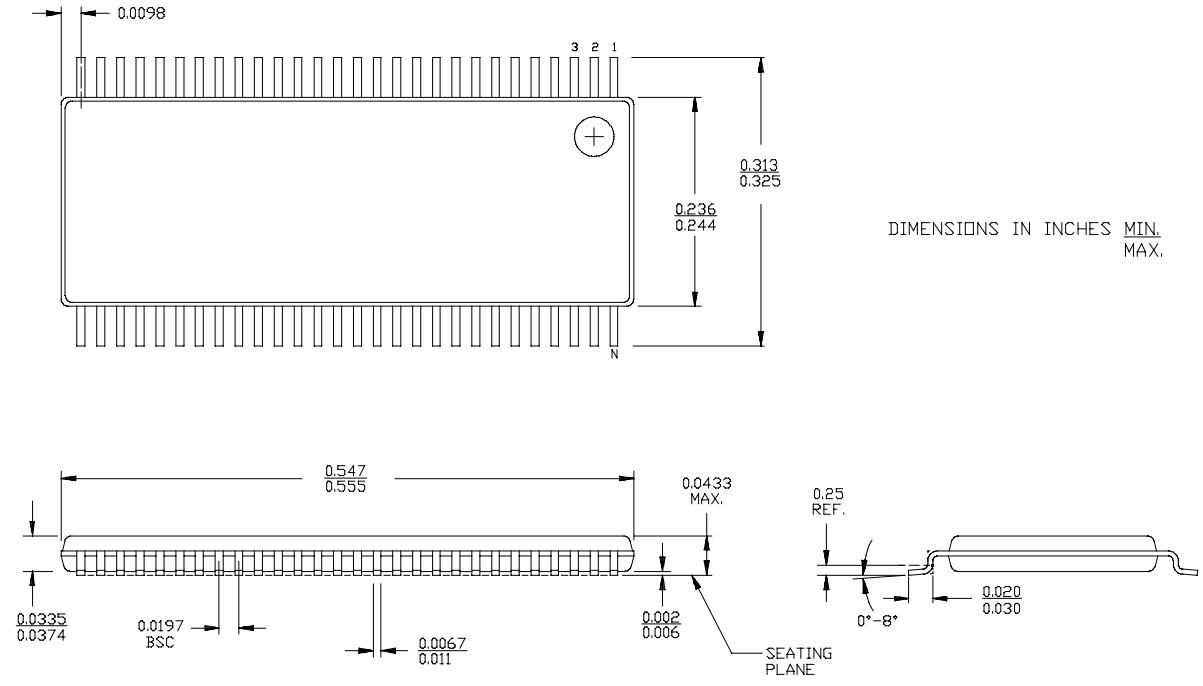
Speed (ns)	Ordering Code	Package Name	Package Type	Operating Range
3.8	74FCT162646ETPACT	Z56	56-Lead (240-Mil) TSSOP	Industrial
	CY74FCT162646ETPVC	O56	56-Lead (300-Mil) SSOP	
	74FCT162646ETPVCT	O56	56-Lead (300-Mil) SSOP	
5.4	74FCT162646CTPACT	Z56	56-Lead (240-Mil) TSSOP	Industrial
	CY74FCT162646CTPVC	O56	56-Lead (300-Mil) SSOP	
	74FCT162646CTPVCT	O56	56-Lead (300-Mil) SSOP	
6.3	74FCT162646ATPACT	Z56	56-Lead (240-Mil) TSSOP	Industrial
	CY74FCT162646ATPVC	O56	56-Lead (300-Mil) SSOP	
	74FCT162646ATPVCT	O56	56-Lead (300-Mil) SSOP	

Package Diagrams

56-Lead Shrunk Small Outline Package O56



56-Lead Thin Shrunk Small Outline Package Z56



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.