TEXAS INSTRUMENTS

CY54/74FCT646T

SCCS031 - July 1994 - Revised March 2000

8-Bit Registered Transceiver

Features

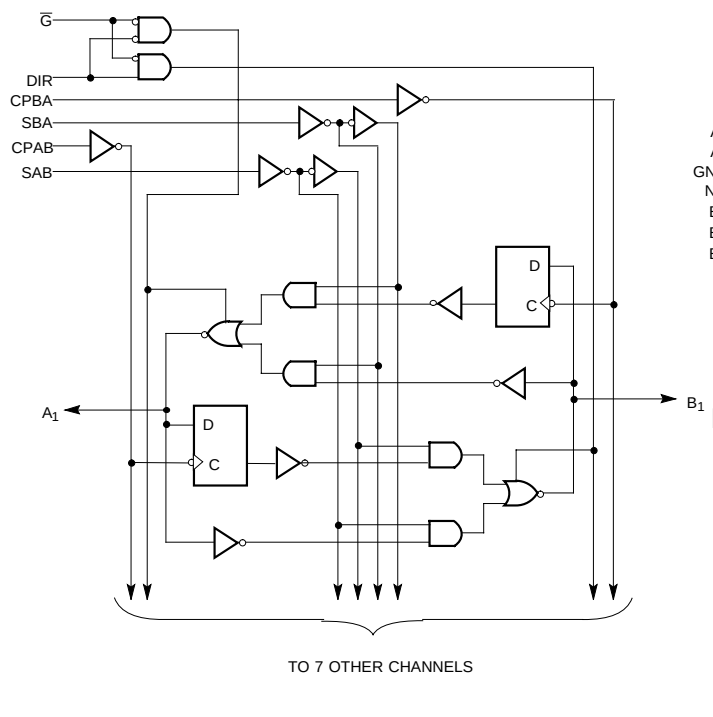
- **Function, pinout, and drive compatible with FCT and F logic**
- **FCT-C speed at 5.4 ns max. (Com'l)**
  FCT-A speed at 6.3 ns max. (Com'l)
- **Reduced V_{OH} (typically = 3.3V) versions of equivalent FCT functions**
- **Edge-rate control circuitry for significantly improved noise characteristics**
- **Power-off disable feature permits live insertion**
- **Matched rise and fall times**
- **Fully compatible with TTL input and output logic levels**
- **ESD > 2000V**
- **Sink current 64 mA (Com'l), 48 mA (Mil)**
  Source current 32 mA (Com'l), 12 mA (Mil)
- **Independent register for A and B buses**
- **Extended commercial range of –40˚C to +85˚C**

Functional Description

The FCT646T consists of a bus transceiver circuit with three-state, D-type flip-flops, 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. Enable Control $\overline{G}$ and direction pins 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 enable control $\overline{G}$ is Active LOW. In the isolation mode (enable Control $\overline{G}$ HIGH), A data may be stored in the B register and/or B data may be stored in the A register.

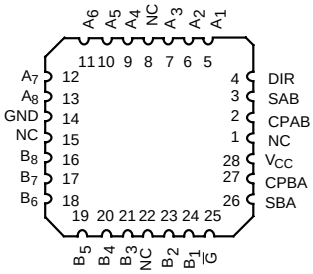
The outputs of the FCT646T are designed with a power-off disable feature to allow for live insertion of boards.

Function Block Diagrams

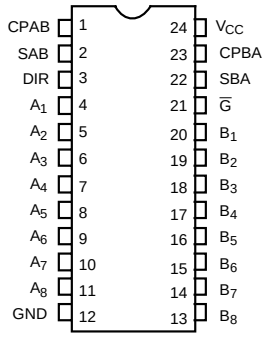


Pin Configurations

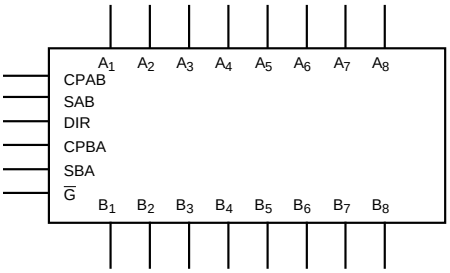
LCC
Top View



QSOP, SOIC
Top View

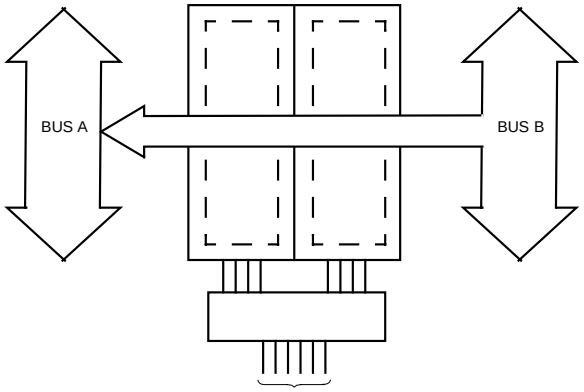


Logic Block Diagram

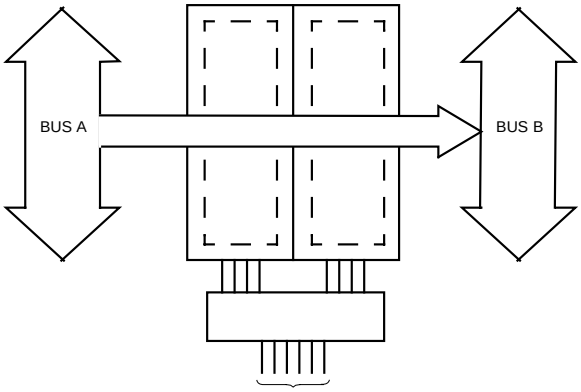


Pin Description

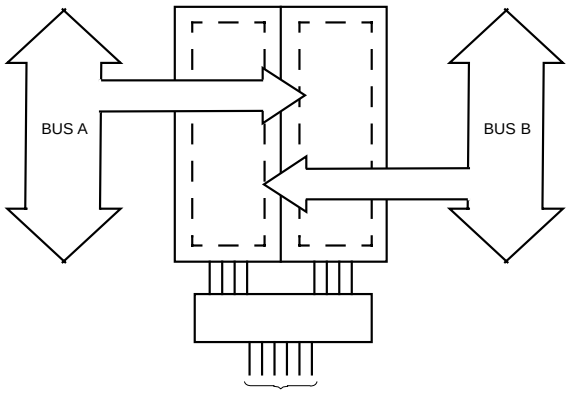
Name	Description
A	Data Register A Inputs, Data Register B Outputs
B	Data Register B Inputs, Data Register A Outputs
CPAB, CPBA	Clock Pulse Inputs
SAB, SBA	Output Data Source Select Inputs
DIR, $\overline{G}$	Output Enable Inputs



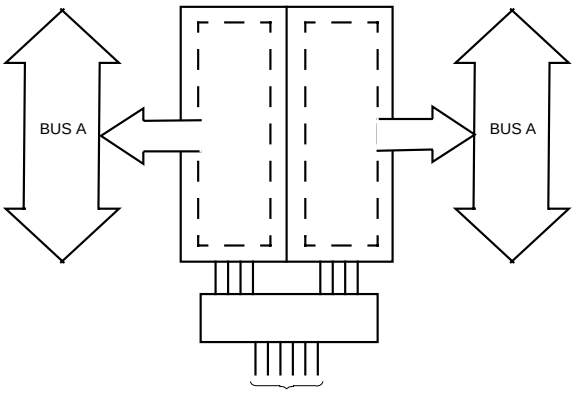
Real-Time Transfer
Bus B to Bus A



Real-Time Transfer
Bus A to Bus B



Storage from
A and/or B



Transfer Stored Data
to A and/or B

Function Table[2]

Inputs						Data I/O[3]		Operation or Function
$\overline{G}$	DIR	CPAB	CPBA	SAB	SBA	A_1 thru A_8	B_1 thru B_8	FCT646T
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 B Bus Stored A Data to B Bus

Notes:

1. Cannot transfer data to A bus and B bus simultaneously.
2. H = HIGH Voltage Level, L = LOW Voltage Level, ⌜ = LOW-to-HIGH Transition, X = Don't Care.
3. The data output functions may be enabled or disabled by various signals at the G 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 of the clock inputs.

Maximum Ratings[4, 5]

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

Storage Temperature .....–65°C to +150°C

Ambient Temperature with Power Applied.....–65°C to +135°C

Supply Voltage to Ground Potential .....–0.5V to +7.0V

DC Input Voltage.....–0.5V to +7.0V

DC Output Voltage.....–0.5V to +7.0V

DC Output Current (Maximum Sink Current/Pin).....120 mA

Power Dissipation 0.5W

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

Operating Range

Range	Range	Ambient Temperature	V_{CC}
Commercial	All	–40°C to +85°C	5V ± 5%
Military[6]	All	–55°C to +125°C	5V ± 10%

Electrical Characteristics Over the Operating Range

Parameter	Description	Test Conditions		Min.	Typ.[7]	Max.	Unit
V_{OH}	Output HIGH Voltage	V_{CC}=Min., I_{OH}=–32 mA	Com'l	2.0			V
		V_{CC}=Min., I_{OH}=–15 mA	Com'l	2.4	3.3		V
		V_{CC}=Min., I_{OH}=–12 mA	Mil	2.4	3.3		V
V_{OL}	Output LOW Voltage	V_{CC}=Min., I_{OL}=64 mA	Com'l		0.3	0.55	V
		V_{CC}=Min., I_{OL}=48 mA	Mil		0.3	0.55	V
V_{IH}	Input HIGH Voltage			2.0			V
V_{IL}	Input LOW Voltage					0.8	V
V_H	Hysteresis[8]	All inputs			0.2		V
V_{IK}	Input Clamp Diode Voltage	V_{CC}=Min., I_{IN}=–18 mA			–0.7	–1.2	V
I_I	Input HIGH Current	V_{CC}=Max., V_{IN}=V_{CC}				5	µA
I_{IH}	Input HIGH Current[8]	V_{CC}=Max., V_{IN}=2.7V				±1	µA
I_{IL}	Input LOW Current[8]	V_{CC}=Max., V_{IN}=0.5V				±1	µA
I_{OS}	Output Short Circuit Current[9]	V_{CC}=Max., V_{OUT}=0.0V		–60	–120	–225	mA
I_{OFF}	Power-Off Disable	V_{CC}=0V, V_{OUT}=4.5V				±1	µA

Capacitance[8]

Parameter	Description	Typ.[7]	Max.	Unit
C_{IN}	Input Capacitance	6	10	pF
C_{OUT}	Output Capacitance	8	12	pF

Notes:

4. Unless otherwise noted, these limits are over the operating free-air temperature range.
5. Unused inputs must always be connected to an appropriate logic voltage level, preferably either V_{CC} or ground.
6. T_A is the "instant on" case temperature.
7. Typical values are at V_{CC}=5.0V, T_A=+25˚C ambient.
8. This parameter is specified but not tested.
9. 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.

Power Supply Characteristics

Parameter	Description	Test Conditions	Typ.[7]	Max.	Unit
I_{CC}	Quiescent Power Supply Current	V_{CC}=Max., $V_{IN}\leq$0.2V, $V_{IN}\geq V_{CC}$–0.2V	0.1	0.2	mA
ΔI_{CC}	Quiescent Power Supply Current (TTL inputs HIGH)	V_{CC}=Max., V_{IN}=3.4V, f_1=0, Outputs Open[10]	0.5	2.0	mA
I_{CCD}	Dynamic Power Supply Current[11]	V_{CC}=Max., One Input Toggling, 50% Duty Cycle, Outputs Open, $\overline{G}$=DIR=GND, GAB=$\overline{GBA}$=GND, $V_{IN}\leq$0.2V or $V_{IN}\geq V_{CC}$–0.2V	0.06	0.12	mA/MHz
I_C	Total Power Supply Current[12]	V_{CC}=Max., f_0=10 MHz, 50% Duty Cycle, Outputs Open, One Bit Toggling at f_1=5 MHz, $\overline{G}$=DIR=GND, GAB=$\overline{GBA}$=GND, $V_{IN}\leq$0.2V or $V_{IN}\geq V_{CC}$–0.2V	0.7	1.4	mA
		V_{CC}=Max., f_0=10 MHz, 50% Duty Cycle, Outputs Open, One Bit Toggling at f_1=5 MHz, $\overline{G}$=DIR=GND, GAB=$\overline{GBA}$=GND, V_{IN}=3.4V or V_{IN}=GND	1.2	3.4	mA
		V_{CC}=Max., f_0=10 MHz, 50% Duty Cycle, Outputs Open, Eight Bits Toggling at f_1=5 MHz, $\overline{G}$=DIR=GND, GAB=$\overline{GBA}$=GND, $V_{IN}\leq$0.2V or $V_{IN}\geq V_{CC}$–0.2V	2.8	5.6[13]	mA
		V_{CC}=Max., f_0=10 MHz, 50% Duty Cycle, Outputs Open, Eight Bits Toggling at f_1=5 MHz, $\overline{G}$=DIR=GND, GAB=$\overline{GBA}$=GND, V_{IN}=3.4V or V_{IN}=GND	5.1	14.6[13]	mA

Notes:

10. Per TTL driven input (V_{IN}=3.4V); 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. $I_C = I_{QUIESCENT} + I_{INPUTS} + I_{DYNAMIC}$
    $I_C = I_{CC}+\Delta I_{CC}D_HN_T+I_{CCD}(f_0/2 + f_1N_1)$
    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.
13. Values for these conditions are examples of the I_{CC} formula. These limits are specified but not tested.

Switching Characteristics Over the Operating Range[14]

Parameter	Description	FCT646T				FCT646AT		Unit	Fig. No.[15]
		Military		Commercial		Commercial			
		Min.	Max.	Min.	Max.	Min.	Max.		
t_{PLH} t_{PHL}	Propagation Delay Bus to Bus	2.0	11.0	1.5	9.0	1.5	6.3	ns	1, 3
t_{PZH} t_{PZL}	Output Enable Time Enable to Bus and DIR to A_n or B_n	2.0	15.0	1.5	14.0	1.5	9.8	ns	1, 7, 8
t_{PHZ} t_{PLZ}	Output Disable Time $\overline{G}$ to Bus and DIR to Bus	2.0	11.0	1.5	9.0	1.5	6.3	ns	1, 7, 8
t_{PLH} t_{PHL}	Propagation Delay Clock to Bus	2.0	10.0	1.5	9.0	1.5	6.3	ns	1, 5
t_{PLH} t_{PHL}	Propagation Delay SBA or SAB to A or B	2.0	12.0	1.5	11.0	1.5	7.7	ns	1, 5
t_S	Set-Up Time HIGH or LOW, Bus to Clock	4.5		4.0		2.0		ns	4
t_H	Hold Time HIGH or LOW, Bus to Clock	2.0		2.0		1.5		ns	4
t_W	Pulse Width, HIGH or LOW [8]	6.0		6.0		5.0		ns	5

Parameter	Description	FCT646CT				Unit	Fig. No.[15]
		Military		Commercial			
		Min.	Max.	Min.	Max.		
t_{PLH} t_{PHL}	Propagation Delay Bus to Bus	1.5	6.0	1.5	5.4	ns	1, 3
t_{PZH} t_{PZL}	Output Enable Time Enable to Bus and DIR to A_n or B_n	1.5	8.9	1.5	7.8	ns	1, 7, 8
t_{PHZ} t_{PLZ}	Output Disable Time $\overline{G}$ to Bus and DIR toBus	1.5	7.7	1.5	6.3	ns	1, 7, 8
t_{PLH} t_{PHL}	Propagation Delay Clock to Bus	1.5	6.3	1.5	5.7	ns	1, 5
t_{PLH} t_{PHL}	Propagation Delay SBA or SAB to A or B	1.5	7.0	1.5	6.2	ns	1, 5
t_S	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	Pulse Width,[8] HIGH or LOW	5.0		5.0		ns	5

Notes:
14. Minimum limits are specified but not tested on Propagation Delays.
15. See “Parameter Measurement Information” in the General Information Section.

Ordering Information

Speed (ns)	Ordering Code	Package Name	Package Type	Operating Range
5.4	CY74FCT646CTQCT	Q13	24-Lead (150-Mil) QSOP	Commercial
	CY74FCT646CTSOC/SOCT	S13	24-Lead (300-Mil) Molded SOIC	
6.0	CY54FCT646CTLMB	L64	28-Square Leadless Chip Carrier	Military
6.3	CY74FCT646ATQCT	Q13	24-Lead (150-Mil) QSOP	Commercial
	CY74FCT646ATSOC/SOCT	S13	24-Lead (300-Mil) Molded SOIC	
9.0	CY74FCT646TQCT	Q13	24-Lead (150-Mil) QSOP	Commercial
	CY74FCT646TSOC/SOCT	S13	24-Lead (300-Mil) Molded SOIC	
11.0	CY54FCT646TLMB	L64	28-Square Leadless Chip Carrier	Military

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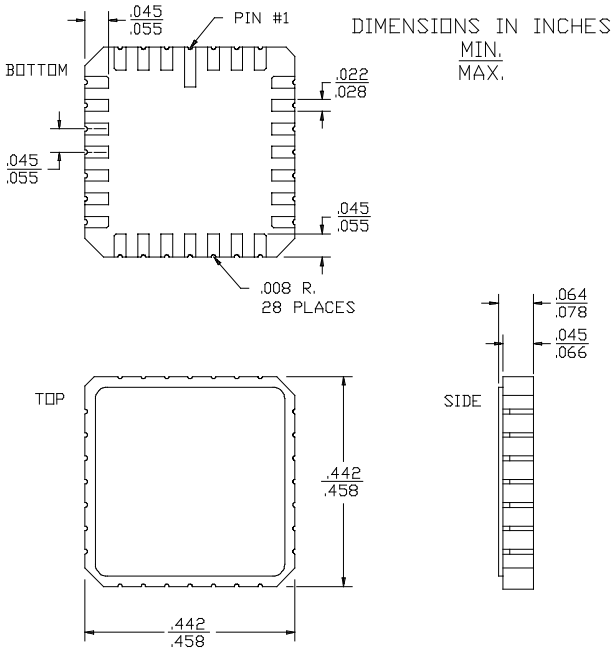
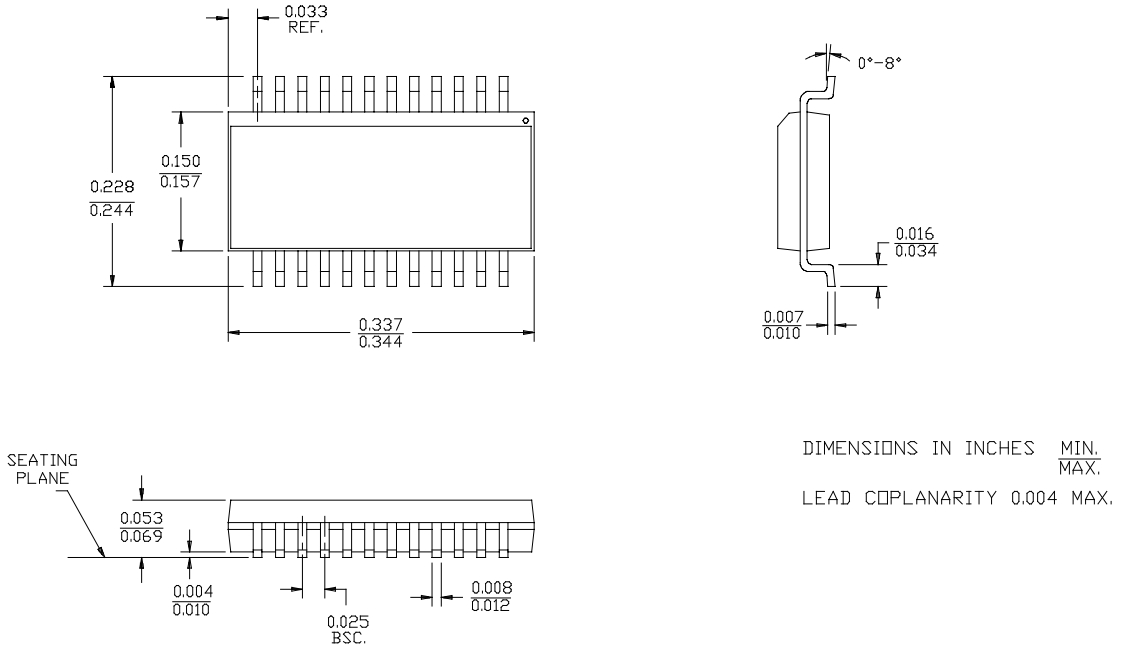
Package Diagrams

28-Square Leadless Chip Carrier L64
MIL–STD–1835 C–4

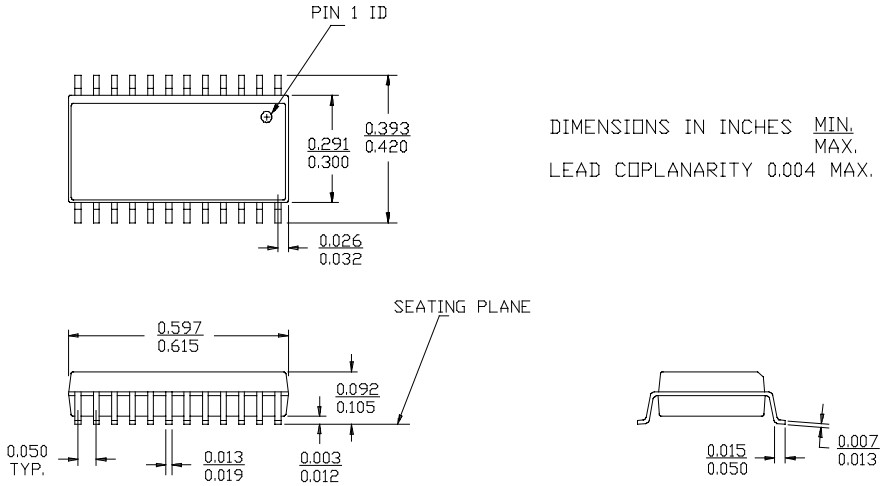


Package Diagrams (continued)

24-Lead Quarter Size Outline Q13



24-Lead (300-Mil) Molded SOIC S13



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