TEXAS INSTRUMENTS

SCCS066 - June 1997 - Revised March 2000

CY74FCT163500

18-Bit Registered Transceiver

Features

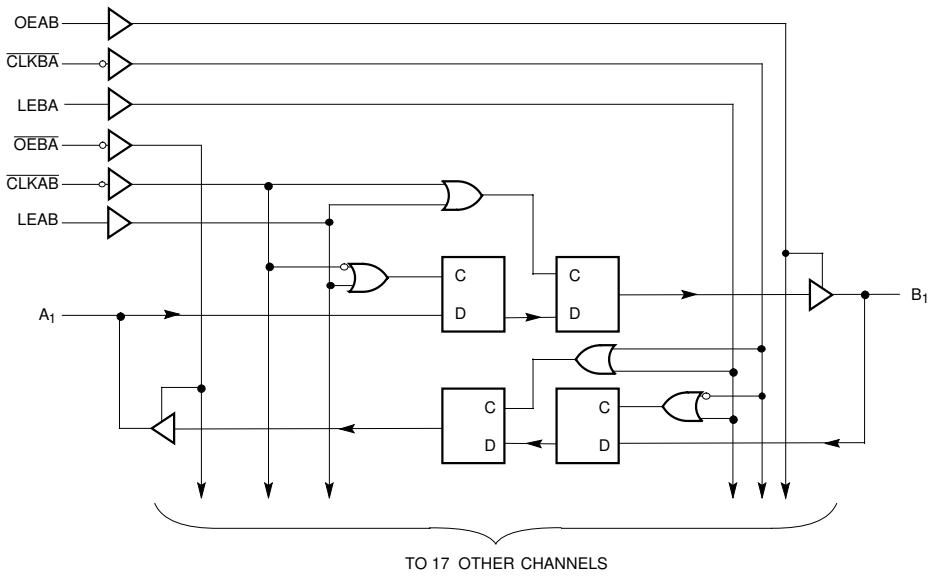
- **Low power, pin-compatible replacement for LCX and LPT families**
- **5V tolerant inputs and outputs**
- **24 mA balanced drive outputs**
- **Power-off disable outputs permits live insertion**
- **Edge-rate control circuitry for reduced noise**
- **FCT-C speed at 4.6 ns**
- **Latch-up performance exceeds JEDEC standard no. 17**
- **ESD > 2000V per MIL-STD-883D, Method 3015**
- **Typical output skew < 250ps**
- **Industrial temperature range of –40˚C to +85˚C**
- **TSSOP (19.6-mil pitch) or SSOP (25-mil pitch)**
- **Typical V_{olp} (ground bounce) performance exceeds Mil Std 883D**
- **V_{CC} = 2.7V to 3.6V**

Functional Description

The CY74FCT163500 is an 18-bit universal bus transceiver that can be operated in transparent, latched, or clock modes by combining D-type latches and D-type flip-flops. Data flow in each direction is controlled by output-enable (OEAB and $\overline{\text{OEBA}}$), latch enable (LEAB and LEBA), and clock inputs ($\overline{\text{CLKAB}}$ and $\overline{\text{CLKBA}}$) inputs. For A-to-B data flow, the device operates in transparent mode when LEAB is HIGH. When LEAB is LOW, the A data is latched if $\overline{\text{CLKAB}}$ is held at a HIGH or LOW logic level. If LEAB is LOW, the A bus data is stored in the latch/flip-flop on the HIGH-to-LOW transition of $\overline{\text{CLKAB}}$. OEAB performs the output enable function on the B port. Data flow from B-to-A is similar to that of A-to-B and is controlled by $\overline{\text{OEBA}}$, LEBA, and CLKBA.

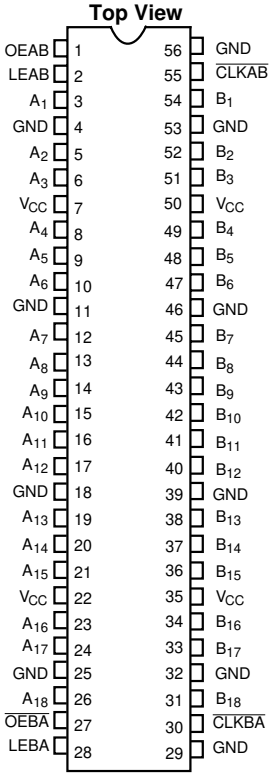
The CY74FCT163500 has 24-mA balanced output drivers with current limiting resistors in the outputs. This reduces the need for external terminating resistors and provides for minimal undershoot and reduced ground bounce.The inputs and outputs are capable of being driven by 5.0V busses, allowing them to be used in mixed voltage systems as translators. The outputs are also designed with a power off disable feature enabling them to be used in applications requiring live insertion.

Logic Block Diagram



Pin Configuration

SSOP/TSSOP
Top View



Pin Summary

Name	Description
OEAB	A-to-B Output Enable Input
$\overline{OEBA}$	B-to-A Output Enable Input (Active LOW)
LEAB	A-to-B Latch Enable Input
LEBA	B-to-A Latch Enable Input
$\overline{CLKAB}$	A-to-B Clock Input (Active LOW)
$\overline{CLKBA}$	B-to-A Clock Input (Active LOW)
A	A-to-B Data Inputs or B-to-A Three-State Outputs
B	B-to-A Data Inputs or A-to-B Three-State Outputs

Function Table[1, 2]

Inputs				Outputs
OEAB	**LEAB**	**$\overline{CLKAB}$**	**A**	**B**
L	X	X	X	Z
H	H	X	L	L
H	H	X	H	H
H	L	↓	L	L
H	L	↓	H	H
H	L	H	X	B[3]
H	L	L	X	B[4]

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

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

Operating Range

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

Notes:

1. H = HIGH Voltage Level. L = LOW Voltage Level. X = Don't Care. Z = HIGH Impedance. ↓ = HIGH-to-LOW Transition.
2. A-to-B data flow is shown, B-to-A data flow is similar but uses $\overline{OEBA}$, LEBA, and $\overline{CLKBA}$.
3. Output level before the indicated steady-state input conditions were established.
4. Output level before the indicated steady-state input conditions were established, provided that $\overline{CLKAB}$ was LOW before LEAB went LOW.
5. Operation beyond the limits set forth may impair the useful life of the device. Unless noted, these limits are over the operating free-air temperature range.
6. Unused inputs must always be connected to an appropriate logic voltage level, preferably either V_{CC} or ground.

Electrical Characteristics 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=5.5V			±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_{ODL}	Output LOW Current[9]	V_{CC}=3.3V, V_{IN}=V_{IH} or V_{IL}, V_{OUT}=1.5V	45		180	mA
I_{ODH}	Output HIGH Current[9]	V_{CC}=3.3V, V_{IN}=V_{IH} or V_{IL}, V_{OUT}=1.5V	–45		–180	mA
V_{OH}	Output HIGH Voltage	V_{CC}=Min., I_{OH}= –0.1 mA	V_{CC}–0.2			V
		V_{CC}=3.0V, I_{OH}= –8 mA	2.4	3.0		V
		V_{CC}=3.0V, I_{OH}= –24 mA	2.0	3.0		V
V_{OL}	Output LOW Voltage	V_{CC}=Min., I_{OL}= 0.1mA			0.2	V
		V_{CC}=Min., I_{OL}= 24 mA		0.3	0.5	
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

Capacitance[8] (T_A = +25˚C, f = 1.0 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

Notes:

7. Typical values are at V_{CC}=3.3V, 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.	$V_{IN} \le 0.2V$, $V_{IN} \ge V_{CC}-0.2V$	0.1	10	µA
ΔI_{CC}	Quiescent Power Supply Current (TTL inputs HIGH)	V_{CC}=Max.	$V_{IN}=V_{CC}-0.6V$[10]	2.0	30	µA
I_{CCD}	Dynamic Power Supply Current[11]	V_{CC}=Max., One Input Toggling, 50% Duty Cycle, Outputs Open, OEAB=$\overline{OEBA}$=V_{CC} or GND	$V_{IN}=V_{CC}$ or V_{IN}=GND	50	75	µA/MHz
I_C	Total Power Supply Current[12]	V_{CC}=Max., f_0=10 MHz ($\overline{CLKAB}$), f_1=5 MHz, 50% Duty Cycle, Outputs Open, One Bit Toggling, OEAB=$\overline{OEBA}$=V_{CC} LEAB=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_0=10 MHz, f_1=2.5 MHz, 50% Duty Cycle, Outputs Open, Eighteen Bits Toggling, OEAB=$\overline{OEBA}$=V_{CC} LEAB=GND	$V_{IN}=V_{CC}$ or V_{IN}=GND	2.5	3.8[13]	mA
			$V_{IN}=V_{CC}-0.6V$ or V_{IN}=GND	2.6	4.1[13]	mA

Notes:

10. Per TTL driven input; 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. $I_C = I_{QUIESCENT} + I_{INPUTS} + I_{DYNAMIC}$
    $I_C = I_{CC}+\Delta I_{CC} D_H N_T + I_{CCD}(f_0 N_C/2 + f_1 N_1)$
    I_{CC} = Quiescent Current with CMOS input levels
    ΔI_{CC} = Power Supply Current for a TTL HIGH input (V_{IN}=3.4V)
    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
    N_C = Number of clock inputs changing at f_1
    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 V_{CC} = 3.0V to 3.6V[14, 15]

Parameter	Description		CY74FCT163500A Min.	CY74FCT163500A Max.	CY74FCT163500C Min.	CY74FCT163500C Max.	Unit	Fig. No.[16]
f_{MAX}	$\overline{CLKAB}$ or $\overline{CLKBA}$ frequency			150		150	MHz	
t_{PLH} t_{PHL}	Propagation Delay A to B or B to A		1.5	5.1	1.5	4.6	ns	1, 3
t_{PLH} t_{PHL}	Propagation Delay LEBA to A, LEAB to B		1.5	5.6	1.5	5.3	ns	1, 5
t_{PLH} t_{PHL}	Propagation Delay $\overline{CLKBA}$ to A, $\overline{CLKAB}$ to B		1.5	5.6	1.5	5.3	ns	1, 5
t_{PZH} t_{PZL}	Output Enable Time $\overline{OEBA}$ to A, OEAB to B		1.5	6.0	1.5	5.4	ns	1, 7, 8
t_{PHZ} t_{PLZ}	Output Disable Time $\overline{OEBA}$ to A, OEAB to B		1.5	5.6	1.5	5.2	ns	1, 7, 8
t_{SU}	Set-Up Time, HIGH or LOW A to $\overline{CLKAB}$, B to $\overline{CLKBA}$		3.0		3.0		ns	9
t_H	Hold Time, HIGH or LOW A to $\overline{CLKAB}$, B to $\overline{CLKBA}$		0		0		ns	9
t_{SU}	Set-Up Time, HIGH or LOW A to LEAB, B to LEBA	Clock HIGH	3.0		3.0		ns	4
		Clock LOW	1.5		1.5		ns	4
t_H	Hold Time, HIGH or LOW A to LEAB, B to LEBA		1.5		1.5		ns	4
t_W	LEAB or LEBA Pulse Width HIGH		3.0		2.5		ns	5
t_W	$\overline{CLKAB}$ or $\overline{CLKBA}$ Pulse Width HIGH or LOW		3.0		3.0		ns	5
$t_{SK(O)}$	Output Skew[17]			0.5		0.5	ns	

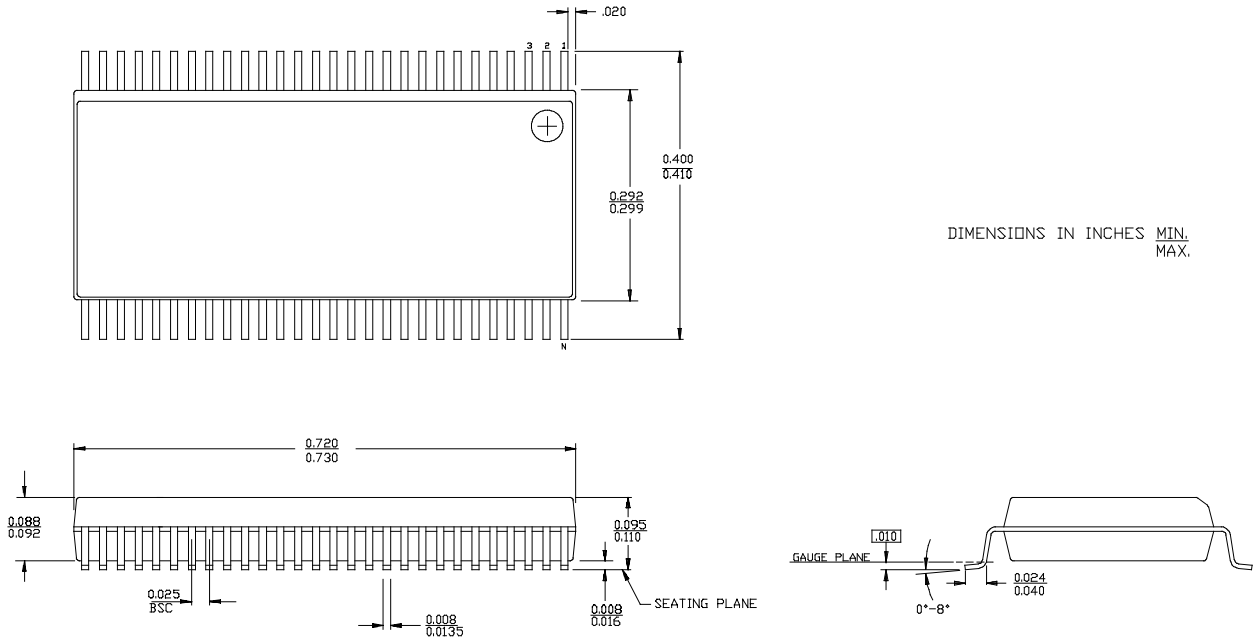
Ordering Information CY74FCT163500

Speed (ns)	Ordering Code	Package Name	Package Type	Operating Range
4.6	CY74FCT163500CPACT	Z56	56-Lead (240-Mil) TSSOP	Industrial
	CY74FCT163500CPVC/PVCT	O56	56-Lead (300-Mil) SSOP	
5.1	CY74FCT163500APVC/PVCT	O56	56-Lead (300-Mil) SSOP	Industrial

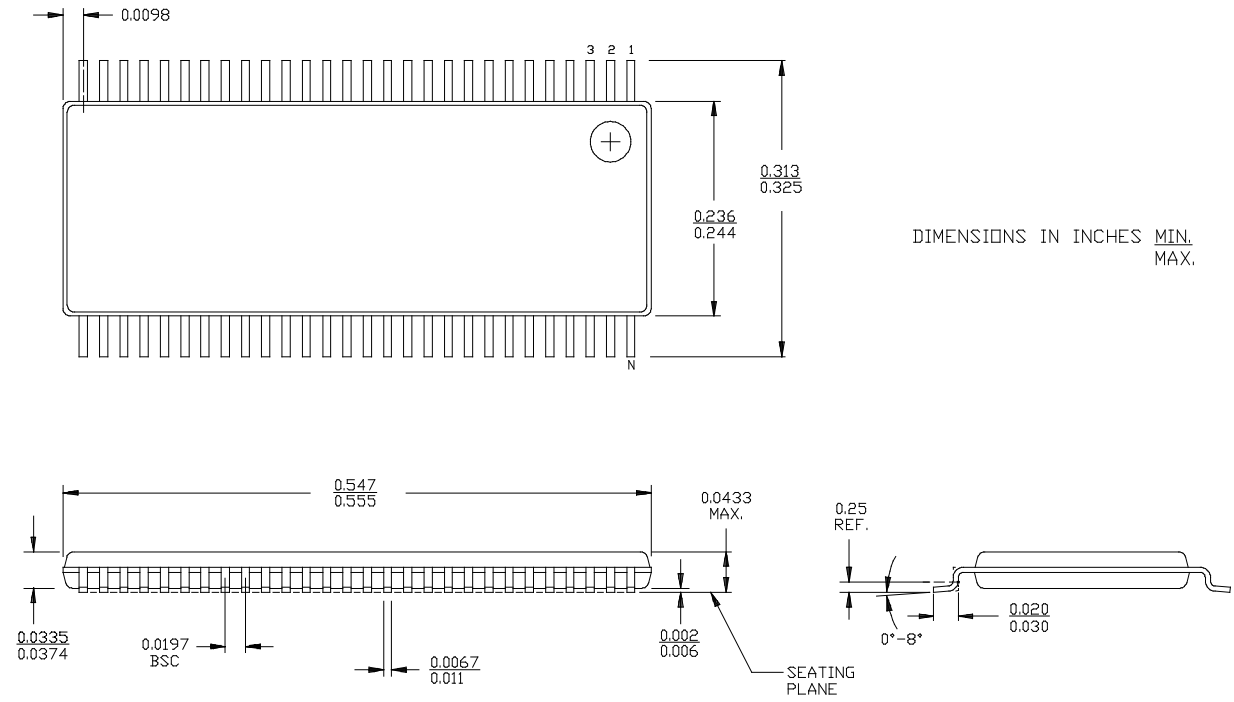
Notes:
14. Minimum limits are specified but not tested on Propagation Delays.
15. For V_{CC} =2.7, propagation delay, output enable and output disable times should be degraded by 20%.
16. See “Parameter Measurement Information” in the General Information section.
17. Skew between any two outputs of the same package switching in the same direction. This parameter is ensured by design.

Package Diagrams

56-Lead Shrunk Small Outline Package O56



56-Lead Thin Shrunk Small Outline Package Z56



PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
CY74FCT163500APVC	OBSOLETE	SSOP	DL	56		TBD	Call TI	Call TI
CY74FCT163500APVCT	OBSOLETE	SSOP	DL	56		TBD	Call TI	Call TI
CY74FCT163500CPAC	OBSOLETE	TSSOP	DGG	56		TBD	Call TI	Call TI
CY74FCT163500CPACT	OBSOLETE	TSSOP	DGG	56		TBD	Call TI	Call TI
CY74FCT163500CPVC	OBSOLETE	SSOP	DL	56		TBD	Call TI	Call TI
CY74FCT163500CPVCT	OBSOLETE	SSOP	DL	56		TBD	Call TI	Call TI

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

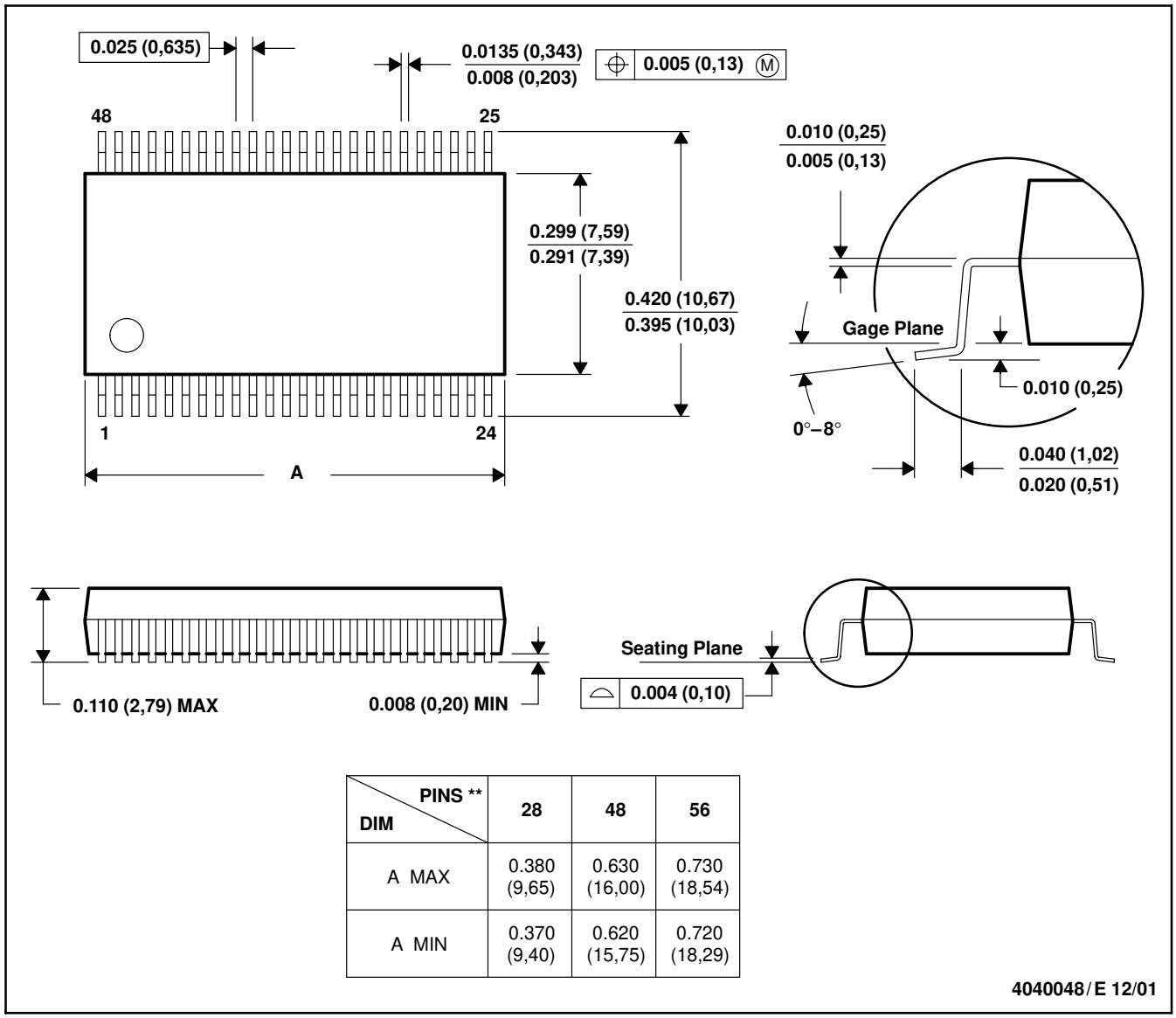
(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

DL (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN



DIM \ PINS **	28	48	56
A MAX	0.380 (9,65)	0.630 (16,00)	0.730 (18,54)
A MIN	0.370 (9,40)	0.620 (15,75)	0.720 (18,29)

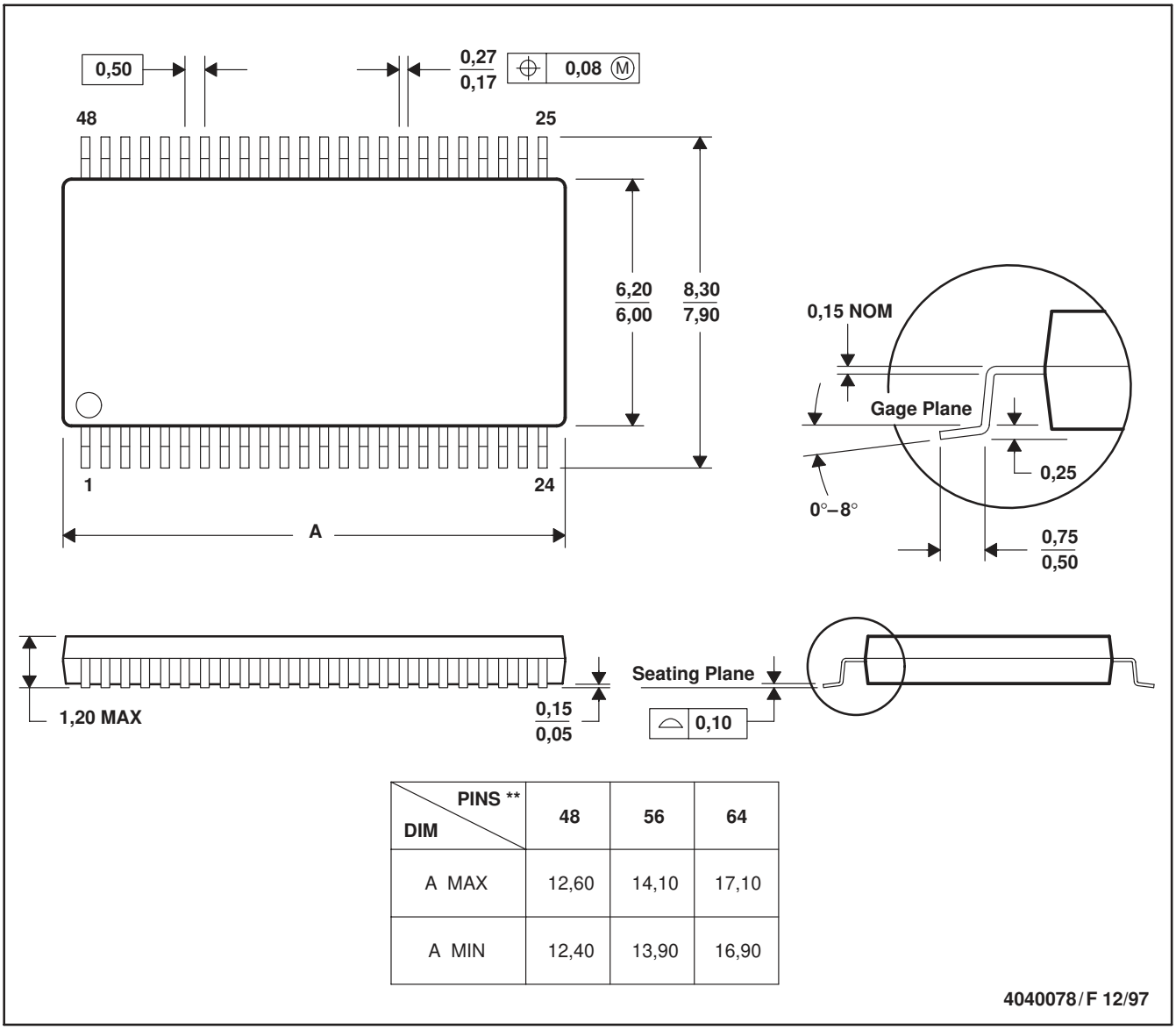
4040048/E 12/01

NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MO-118

MTSS003D – JANUARY 1995 – REVISED JANUARY 1998

DGG (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

48 PINS SHOWN



DIM \ PINS **	48	56	64
A MAX	12,60	14,10	17,10
A MIN	12,40	13,90	16,90

4040078/F 12/97

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
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D. Falls within JEDEC MO-153

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