National Semiconductor

January 1996

DS1776
PI-Bus Transceiver

General Description

The DS1776 is an octal PI-bus Transceiver. The A to B path is latched. B outputs are open collector with series Schottky diode, ensuring minimum B output loading. B outputs also have ramped rise and fall times (2.5 ns typical), ensuring minimum PI-bus ringing. B inputs have glitch rejection circuitry, 4 ns typical.

Designed using National's Bi-CMOS process for both low operating and disabled power. AC performance is optimized for the PI-Bus inter-operability requirements.

The DS1776 is an octal latched transceiver and is intended to provide the electrical interface to a high performance wired-or bus. This bus has a loaded characteristic impedance range of 20Ω to 50Ω and is terminated on each end with a 30Ω to 40Ω resistor.

The DS1776 is an octal bidirectional transceiver with open collector B and TRI-STATE® A port output drivers. A latch function is provided for the A port signals. The B port output driver is designed to sink 100 mA from 2V and features a controlled linear ramp to minimize crosstalk and ringing on the bus.

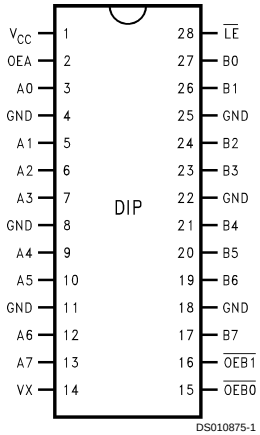
A separate high level control voltage (V_X) is provided to prevent the A side output high level from exceeding future high density processor supply voltage levels. For 5V systems, V_X is tied to V_{CC}.

Features

- Mil-Std-883C qualified
- Similar to BTL
- Low power I_{CCL} = 41 mA max
- B output controlled ramp rate
- B input noise immunity, typically 4 ns
- Available in 28-pin DIP, Flatpak and CLCC
- Pin and function compatible with Signetics 54F776

Pin Configurations

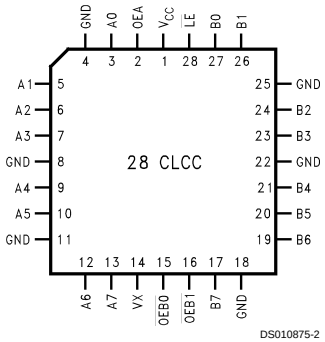
Pin Configuration



DS010875-1

Order Number DS1776E/883 or DS1776J/883
See NS Package E28A or J28B

Pin Configuration



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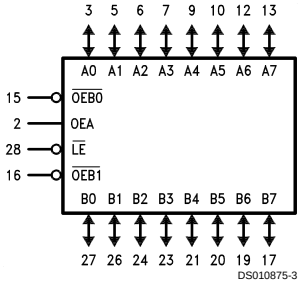
Logic Symbol



DS010875-3

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MIL-STD-883C

DEVICE SPECIFICATIONS

Absolute Maximum Ratings (Notes 1, 2)

The 883 specifications are written to reflect the Rel Electrical Test Specifications (RETS) established by National Semiconductor for this product. For a copy of the latest RETS please contact your local National Semiconductor sales office or distributor.

Supply Voltage (V_{CC}) −0.5V to +7.0V
V_X, V_{OH} Output Level Control Voltage (A Outputs) −0.5V to +7.0V
$\overline{OEB}$ n, OEA, $\overline{LE}$ Input Voltage (V_I) −0.5V to +7.0V
A0–A7, B0–B7 Input Voltage (V_I) −0.5V to +5.5V
Input Current (I_I) −40 mA to +5 mA
Voltage Applied to Output in High Output State (V_O) −0.5V to +V_{CC}V
A0–A7 Current Applied to Output in Low Output State (I_O) 40 mA
B0–B7 Current Applied to Output in Low Output State (I_O) 200 mA
Storage Temperature Range (T_{STG}) −65˚C to +150˚C
Lead Temperature (Soldering 10 Sec.) 260˚C
ESD Tolerance: C_{ZAP} = 120 pF, R_{ZAP} = 1500Ω 0.5 kV

Operating Conditions

	Min	Max	Units
Supply Voltage (V_{CC})	4.5	5.5	V
Operating Temp. Range (T_A)	−55	+125	˚C
Input Rise or Fall Times (t_r, t_f)		50	ns

PI Bus Transceiver DS1776

DC Electrical Characteristics

V_{CC} = 5V ±10% (Unless Otherwise Specified) DC testing temp. groups: 1 = +25˚C, 2 = +125˚C, 3 = −55˚C

Symbol	Parameter		Conditions (Notes 3, 5)		Temp. Group	Min	Typ (Note 4)	Max	Units
V_{IH}	High Level Input Voltage	Except Bn			1, 2, 3	2			V
		Bn				1.6			V
V_{IL}	Low Level Input Voltage	Except Bn			1, 2, 3			0.8	V
		Bn						1.45	V
I_{OH}	High Level Output Current	An	V_{IN} = V_{IH} V_{OH} = V_{CC} − 2.0V		1, 2, 3			−3	mA
	High Level Output Current	Bn	V_{CC} = Max, OEA = $\overline{LE}$ V_{IH} = 2.0V, V_{OH} = 2.1V					100	µA
I_{OL}	Low Level Output Current	An	V_{IN} = V_{IL} V_{OL} = 0.5V		1, 2, 3			20	mA
		Bn	V_{OL} = 1.15V					100	mA
I_{IK}	Input Clamp Current	Except An			1, 2, 3			−18	mA
		An						−40	mA
I_{OZ}	TRI-STATE Output Leakage Current	An Bn			1, 2, 3			±70	µA
V_{OH}	High Level Output Voltage	An	V_{CC} = Min, V_{IH} = 1.9V	I_{OH} = − 3 mA V_X = V_{CC}	1, 2, 3	2.5		V_{CC}	V
				I_{OH} = −0.4 mA V_X = 3.13V to 3.47V		2.5		V_X	V
V_{OL}	Low Output Level Voltage	An	V_{CC}=Min, V_{IL}=1.2V	I_{OL}=20 mA, V_X=V_{CC}				0.5	V
		Bn	V_{CC}=Min, V_{IL}=0.8V	I_{OL}=100 mA I_{OL}=4 mA	1, 2, 3	0.4		1.15	V
V_{IK}	Input Clamp	An	V_{CC}=Min, I_I=−40 mA		1, 2, 3			−0.5	V

DC Electrical Characteristics (Continued)

V_{CC} = 5V ±10% (Unless Otherwise Specified) DC testing temp. groups: 1 = +25˚C, 2 = +125˚C, 3 = −55˚C

Symbol	Parameter		Conditions (Notes 3, 5)		Temp. Group	Min	Typ (Note 4)	Max	Units
	Voltage	Except An	V_{CC}=Min, I_I=−18 mA					−1.2	V
I_{IH2}	Input Current	$\overline{OEBn}$, OEA, $\overline{LE}$	V_{CC}=Min, V_I=7.0V		1, 2, 3		1	100	µA
	at Max	An	V_{CC}=Min, V_I=5.5V				0.01	1	mA
	Input Voltage	Bn	V_{CC}=Min, V_I=5.5V				0.01	1	mA
I_{IH1}	Input Current	$\overline{OEB}$, OEA, $\overline{LE}$	V_{CC}=Max, V_I=2.7V					20	µA
	at Max	B0–B7	V_{CC}=Max, V_I=2.1V					100	µA
	Input Voltage								
I_{IL}	Low Level	$\overline{OEB}$, OEA, $\overline{LE}$	V_{CC}=Max, V_I=0.5V		2, 3	−40			µA
	Input Current				1	−20			µA
		Bn	V_{CC}=Max, V_I=0.3V		1, 2, 3	−100			µA
I_{OZH}	TRI-STATE	An	V_{CC}=Max, V_O=2.7V		1, 2, 3				
$+I_{IH}$	Output Current,							70	µA
	High Level								
	Voltage Applied								
I_{OZH}	TRI-STATE	An	V_{CC}=Max, V_O=0.5V		1, 2, 3				
$+I_{IL}$	Output Current,					−70			µA
	Low Level								
	Voltage Applied								
I_X	High Level		V_{CC}=Max, V_X=V_{CC},		1, 2, 3				
	Control Current		$\overline{LE}$=OEA=$\overline{OEBn}$=2.7V			−100		100	µA
			An=2.7V, Bn=2.0V						
			V_{CC}=Max, V_X=3.14V & 3.47V,		1, 2, 3				
			$\overline{LE}$=OEA=$\overline{OEBn}$=2.7V,			−10		10	mA
			An=2.7V, Bn=2.0V						
I_{OS}	Short-Circuit	An	V_{CC}=Max, Bn=1.9V,		1, 2, 3				
	Output Current		OEA=2.0V,			−60	−75	−150	mA
			$\overline{OEBn}$=2.7V						
	(Note 6)								
I_{CC}	Supply Current	I_{CCH}	V_{CC}=Max, V_{IH} (A)=5.0V		1, 2			37	mA
		I_{CCH}			3			41	mA
		I_{CCL}	V_{CC}=Max, V_{IL}(A)=0.3V		1, 2, 3			38	mA
		I_{CCZ}	V_{CC}=Max, V_{IL}(A)=0.3V		1, 2, 3			35	mA
I_{OFF}	Power Off		Bn=2.1V, V_{CC}=0.0V,		1, 2, 3			100	µA
	Output Current		V_{IL}=Max or V_{IH}=Min						

Note 1: Absolute Maximum Ratings are those values beyond which damage to the device may occur.

Note 2: Unless otherwise specified all voltages are referenced to ground.

Note 3: For conditions shown as Min or Max, use the appropriate value specified under recommended operating conditions. Unless otherwise specified, V_X = V_{CC} for all test conditions.

Note 4: All typical values are at V_{CC} = 5V, T_A = 25˚C.

Note 5: Due to test equipment limitations, actual test conditions are for V_{IH} = 1.9V and for V_{IL} = 1.2V, however the specified test limits and conditions are guaranteed.

Note 6: Not more than one output should be shorted at a time. For testing [<i]nfOS the use of high speed test apparatus and/or sample-and-hold techniques are preferable in order to minimize internal heating and more accurately reflect operational values. Otherwise, prolonged shorting of a High output may raise the chip temperature above normal and thereby cause invalid readings in other parameter tests. In any squence of parameter test [<i]nfOStest should be performed last.

Note 7: Not more than one output should be shorted at a time. For testing I_{OS}, the use of high speed test apparatus and/or sample-and-hold techniques are preferable in order to minimize internal heating and more accurately reflect operational values. Otherwise, prolonged shorting of a High output may raise the chip temperature above normal and thereby cause invalid readings in other parameter tests. In any squence of parameter test, I_{OS} tests should be performed last.

AC Electrical Characteristics

V_{CC} = 5V ± 10% (Unless otherwise specified)
AC testing temp. groups: 1 = +25˚C, 2 = +125˚C, 3 = −55˚C

Path	Parameter	Conditions	Temp. Group	Min	Max	Units
B-TO-A PATH						
t_{PLH}	Propagation Delay B to A	Waveform 1, 2	1, 2, 3	4.5	17	ns
t_{PHL}				6	17	ns
t_{PZH}	Output Enable OEA to A	Waveform 3, 4	1, 2, 3	4	17	ns
t_{PZL}				4	17	ns
t_{PHZ}	Output Disable OEA to A	Waveform 3, 4	1, 2, 3	2	12	ns
t_{PLZ}				2	13	ns
A-TO-B PATH						
t_{PLH}	Propagation Delay A to B	Waveform 1, 2	1, 3	2	13	ns
			2	2	17	ns
t_{PHL}			1, 2, 3	2.5	13	ns
t_{PLH}	Propagation Delay $\overline{LE}$ to B	Waveform 1, 2	1, 3	2	16	ns
			2	2	22	ns
t_{PHL}			1, 2, 3	2	16	ns
t_{PLH}	Enable/Disable $\overline{OEBn}$ to B	Waveform 1, 2	1, 3	2	13	ns
			2	2	16	ns
t_{PHL}			1	3.5	14	ns
			2	3.5	13	ns
			3	3.5	16	ns
t_{TLH}	Transition Time, B Side	1.3V to 1.7V	1, 3	0.5	5.5	ns
			2	0.5	10	ns
t_{THL}		1.7V to 1.3V	1	0.5	5.5	ns
			2	0.5	7	ns
			3	0.5	10	ns
SETUP/HOLD/PULSE WIDTH SPECS						
t_S	A to $\overline{LE}$ Setup	Waveform 5	1, 2, 3	7		ns
t_H	A to $\overline{LE}$ Hold	Waveform 5	1, 2, 3	0		ns
t_W	$\overline{LE}$ Pulse Width Low	Waveform 5	1, 2, 3	12		ns

Description

PIN DESCRIPTION

TABLE 1. Pin Description

Symbol	Pins	Type	Name and Function
A0	3	I/O	TTL Level, latched input/TRI-STATE output (with V_X control option)
A1	5	I/O	
A2	6	I/O	
A3	7	I/O	
A4	9	I/O	
A5	10	I/O	
A6	12	I/O	
A7	13	I/O	

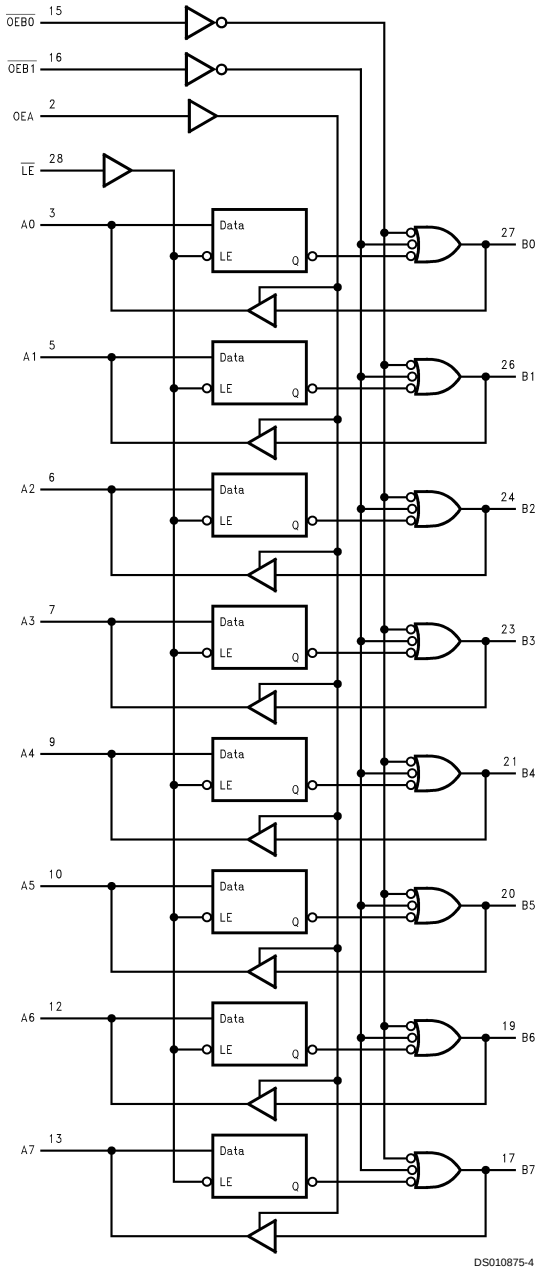
Description (Continued)

TABLE 1. Pin Description (Continued)

Symbol	Pins	Type	Name and Function
B0	27	I/O	Data input with special threshold circuitry to reject noise/Open Collector output, High current drive
B1	26	I/O	
B2	24	I/O	
B3	23	I/O	
B4	21	I/O	
B5	20	I/O	
B6	19	I/O	
B7	17	I/O	
$\overline{OEB}$ 0	15	I	Enables the B outputs when both pins are low
$\overline{OEB}$ 1	16	I	
OEA	2	I	Enables the A outputs when High
$\overline{LE}$	28	I	Latched when High (a special delay feature is built in for proper enabling times)
V_X	14	I	Clamping voltage keeping V_{OH} from rising above V_X ($V_X = V_{CC}$ for normal use)

Description (Continued)

FUNCTION DESCRIPTION



V_{CC} = Pin 1
V_X = Pin 14
GND = Pins 4, 8, 11, 18, 22, 25

FIGURE 1. Functional Logic Diagram

Description (Continued)

TABLE 2. Function Table

Inputs						Latch	Outputs		Mode
An	**Bn** (Note 8)	$\overline{\textbf{LE}}$	**OEA**	$\overline{\textbf{OEB}}$ **0**	$\overline{\textbf{OEB}}$ **1**	**State**	**An**	**Bn**	
H	X	L	L	L	L	H	Z	H	A TRI-STATE, Data from A to B
L	X	L	L	L	L	L	Z	L	
X	X	H	L	L	L	Qn	Z	Qn	A TRI-STATE, Latched Data to B
—	—	L	H	L	L	(Note 10)	(Note 8)	(Note 8)	Feedback: A to B, B to A
—	H	H	H	L	L	H (Note 9)	H	off (Note 9)	Preconditioned Latch Enabling
—	L	H	H	L	L	H (Note 9)	L	off (Note 9)	Data Transfer from B to A
—	—	H	H	L	L	Qn	Qn	Qn	Latch State to A and B
H	X	L	L	H	X	H	Z	off	B off and A TRI-STATE
L	X	L	L	H	X	L	Z	off	
X	X	H	L	H	X	Qn	Z	off	
—	H	L	H	H	X	H	H	off	B off, Data from B to A
—	L	L	H	H	X	L	L	off	
—	H	H	H	H	X	Qn	H	off	
—	L	H	H	H	X	Qn	L	off	
H	X	L	L	X	H	H	Z	off	B off and A TRI-STATE
L	X	L	L	X	H	L	Z	off	
X	X	H	L	X	H	Qn	Z	off	
—	H	L	H	X	H	H	H	off	B off, Data from B to A
—	L	L	H	X	H	L	L	off	
—	H	H	H	X	H	Qn	H	off	
—	L	H	H	X	H	Qn	L	off	

H = High Voltage Level
L = Low Voltage Level
X = Don't Care
— = Input not externally driven
Z = High Impedance (off) state

Qn = High or Low voltage level one setup time prior to the Low-to-High $\overline{\text{LE}}$ transition

Note 8: Condition will cause a feedback loop path; A to B and B to A.

Note 9: The latch must be preconditioned such that B inputs may assume a High or Low level while $\overline{\text{OEB}}$ 0 and $\overline{\text{OEB}}$ 1, are Low and $\overline{\text{LE}}$ is high.

Note 10: Precaution should be taken to ensure that the B inputs do not float. If they do, they are equal to a Low state.

Note 11: off = Applies to "B" (OC) outputs only. Indicates that the outputs are turned off.

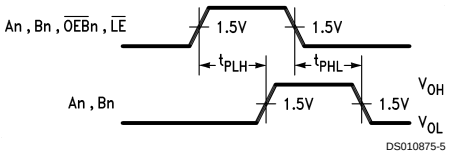
CONTROLLER POWER SEQUENCING OPERATION

The DS1776 has a design feature which controls the output transitions during power up (or down). There are two possible conditions that occur.

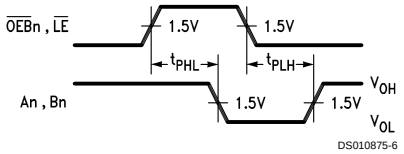
1. When $\overline{\text{LE}}$ = Low and $\overline{\text{OEB}}$ n = Low, the B outputs are disabled until the $\overline{\text{LE}}$ circuit can take control. This feature ensures that the B outputs will follow the A inputs and allow only one transition during power up (or down).
2. If $\overline{\text{LE}}$ = High or $\overline{\text{OEB}}$ n = High, then the B outputs still remain disabled during power up (or down).

Switching Characteristics

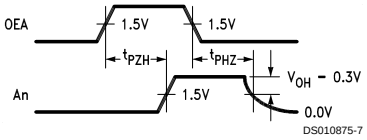
AC WAVEFORMS



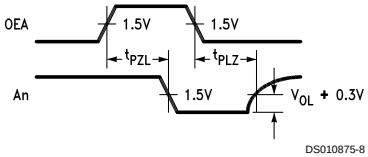
Waveform 1: Propagation Delay for Data to Output



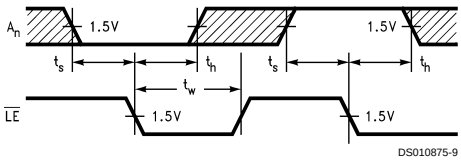
Waveform 2: Propagation Delay for Data to Output



Waveform 3: TRI-STATE Output Enable Time to High Level and Output Disable Time from High Level



Waveform 4: TRI-STATE Output Enable Time to Low Level and Output Disable Time from Low Level

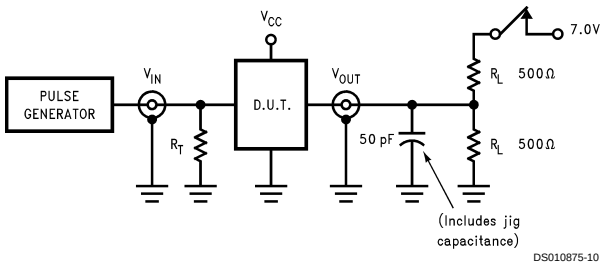


The shaded areas indicate when the input is permitted to change for predictable output performance.

Waveform 5: Data Setup and Hold Times and LE Pulse Widths

TEST CIRCUIT AND WAVEFORMS

Test Circuit for TRI-STATE Outputs on A Side

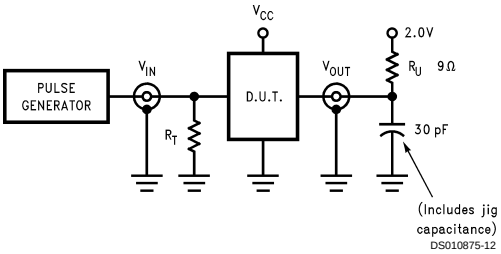


Switch Position

Test	Switch
t_{PLZ}, t_{PZL}	Closed
All Other	Open

Switching Characteristics (Continued)

Test Circuit for TRI-STATE Outputs on B Side



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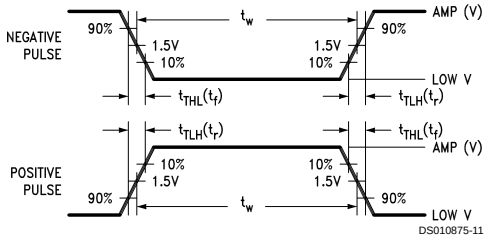
Input Pulse Definition



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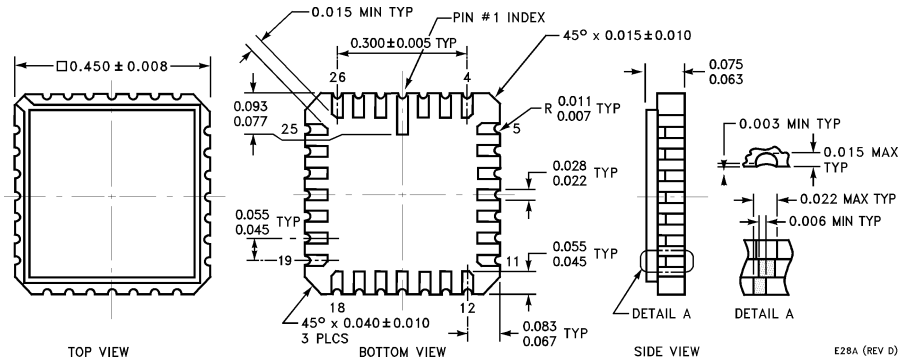
DEFINITIONS

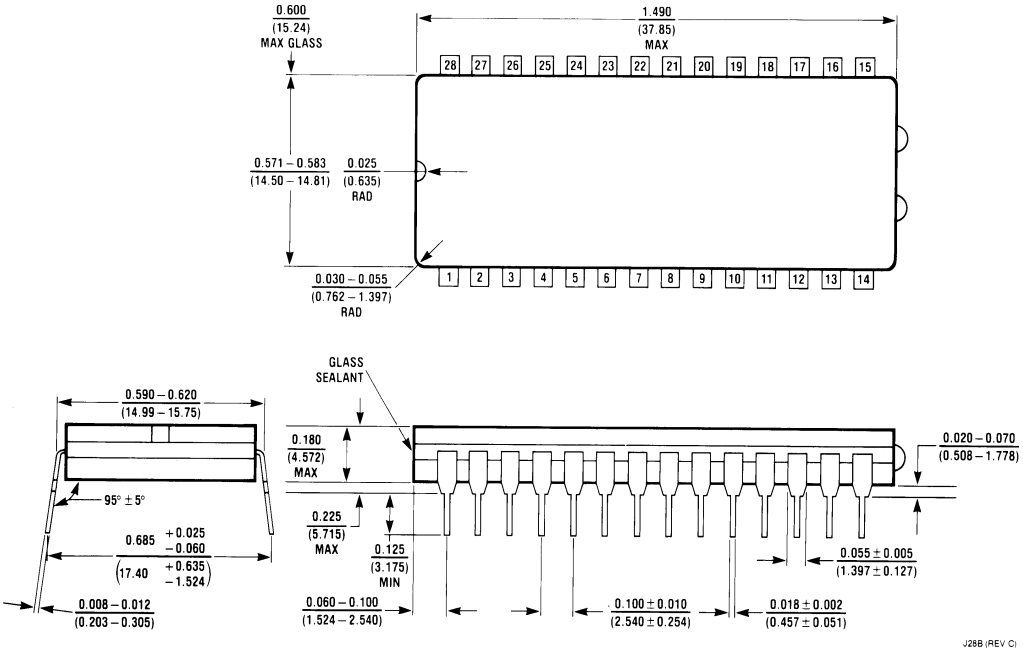
R_L = Load resistor 500Ω
C_L = Load capacitance includes jig and probe capacitance
R_T = Termination resistance should be equal to Z_{OUT} of pulse generators.
R_U = Pull up resistor

	Input Pulse Characteristics					
	Amplitude	**Low V**	**Rep. Rate**	**t_W**	**t_{TLH}**	**t_{THL}**
A Side	3.0V	0.0V	1 MHz	500 ns	2 ns	2 ns
B Side	2.0V	1.0V	1 MHz	500 ns	2 ns	2 ns

Physical Dimensions inches (millimeters) unless otherwise noted

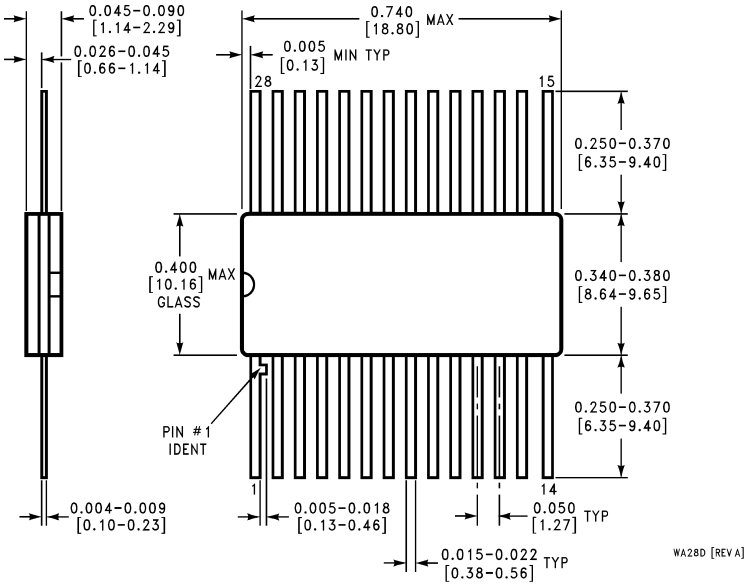


28-Lead Leadless Chip Carrier (E)
Order Number DS1776E/883
NS Package Number E28A



28-Lead Ceramic Dual-In-Line Package (J)
Order Number DS1776J/883
NS Package Number J28B

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



28-Lead Ceramic Flatpak (F)
Order Number DS1776W/883
NS Package Number WA28D

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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