National Semiconductor

September 1995

74ABT2541
Octal Buffer/Line Driver with 25Ω Series Resistors in the Outputs

General Description

The 'ABT2541 is an octal buffer and line driver designed to drive the capacitive inputs of MOS memory drivers, address drivers, clock drivers, and bus-oriented transmitters/receivers. Functionally identical to the 'ABT541.

The 25Ω series resistors in the outputs reduce ringing and eliminate the need for external resistors.

Features

- Guaranteed output skew
- Guaranteed multiple output switching specifications
- Output switching specified for both 50 pF and 250 pF loads
- Guaranteed simultaneously switching noise level and dynamic threshold performance
- Guaranteed latchup protection
- High impedance glitch free bus loading during entire power up and power down cycle
- Nondestructive hot insertion capability
- Disable time less than enable time to avoid bus contention

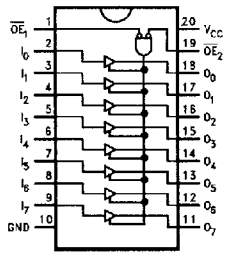
Commercial	Package Number	Package Description
74ABT2541CSC (Note 1)	M20B	20-Lead (0.300" Wide) Molded Small Outline, JEDEC
74ABT2541CSJ (Note 1)	M20D	20-Lead (0.300" Wide) Molded Small Outline, EIAJ
74ABT2541CMSA (Note 1)	MSA20	20-Lead Molded Shrink Small Outline, EIAJ Type II
74ABT2541CMTC (Notes 1, 2)	MTC20	20-Lead Molded Thin Shrink Small Outline, JEDEC

Note 1: Devices also available in 13" reel Use suffix = SCX, SJX, MSAX and MTCX.

Note 2: Contact factory for package availability

Connection Diagram

Pin Assignment for SOIC and SSOP



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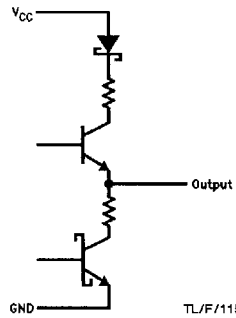
Schematic of Each Output



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Truth Table

Inputs			Outputs
$\overline{OE}_1$	$\overline{OE}_2$	I	ABT2541C
L	L	H	H
H	X	X	Z
X	H	X	Z
L	L	L	L

H = HIGH Voltage Level
L = LOW Voltage Level
X = Immaterial
Z = High Impedance

Pin Names	Description
$\overline{OE}_1$, $\overline{OE}_2$	Output Enable Input (Active Low)
I_0–I_7	Inputs
O_0–O_7	Outputs

TRI-STATE® is a registered trademark of National Semiconductor Corporation.

RRD-B30M115/Printed in U S A.

Absolute Maximum Ratings (Note 1)

Storage Temperature	−65°C to +150°C
Ambient Temperature under Bias	−55°C to +125°C
Junction Temperature under Bias	
Plastic	−55°C to +150°C
V_{CC} Pin Potential to Ground Pin	−0.5V to +7.0V
Input Voltage (Note 2)	−0.5V to +7.0V
Input Current (Note 2)	−30 mA to +5.0 mA
Voltage Applied to Any Output	
in the Disabled or Power-off State	−0.5V to 5.5V
in the HIGH State	−0.5V to V_{CC}
Current Applied to Output	
in LOW State (Max)	twice the rated I_{OL} (mA)
DC Latchup Source Current	−500 mA
Over Voltage Latchup (I/O)	10V

Note 1: Absolute maximum ratings are values beyond which the device may be damaged or have its useful life impaired. Functional operation under these conditions is not implied.

Note 2: Either voltage limit or current limit is sufficient to protect inputs.

Recommended Operating Conditions

Free Air Ambient Temperature	
Commercial	−40°C to +85°C
Supply Voltage	
Commercial	+4.5V to +5.5V
Minimum Input Edge Rate	(ΔV/Δt)
Data Input	50 mV/ns
Enable Input	20 mV/ns

DC Electrical Characteristics

Symbol	Parameter		ABT2541 Min	ABT2541 Typ	ABT2541 Max	Units	V_{CC}	Conditions
V_{IH}	Input HIGH Voltage		2.0			V		Recognized HIGH Signal
V_{IL}	Input LOW Voltage				0.8	V		Recognized LOW Signal
V_{CD}	Input Clamp Diode Voltage				−1.2	V	Min	I_{IN} = −18 mA
V_{OH}	Output HIGH Voltage	74ABT	2.5			V	Min	I_{OH} = −3 mA
		74ABT	2.0			V	Min	I_{OH} = −32 mA
V_{OL}	Output LOW Voltage	74ABT			0.8	V	Min	I_{OL} = 15 mA
I_{IH}	Input HIGH Current				5 5	μA	Max	V_{IN} = 2.7V (Note 2) V_{IN} = V_{CC}
I_{BVI}	Input HIGH Current Breakdown Test				7	μA	Max	V_{IN} = 7.0V
I_{IL}	Input LOW Current				−5 −5	μA	Max	V_{IN} = 0.5V (Note 2) V_{IN} = 0.0V
V_{ID}	Input Leakage Test		4.75			V	0.0	I_{ID} = 1.9 μA All Other Pins Grounded
I_{OZH}	Output Leakage Current				50	μA	0 − 5.5V	V_{OUT} = 2.7V; $\overline{OE}_n$ = 2.0V
I_{OZL}	Output Leakage Current				−50	μA	0 − 5.5V	V_{OUT} = 0.5V; $\overline{OE}_n$ = 2.0V
I_{OS}	Output Short-Circuit Current		−100		−275	mA	Max	V_{OUT} = 0.0V
I_{CEX}	Output High Leakage Current				50	μA	Max	V_{OUT} = V_{CC}
I_{ZZ}	Bus Drainage Test				100	μA	0.0	V_{OUT} = 5.5V; All Others GND
I_{CCH}	Power Supply Current				50	μA	Max	All Outputs HIGH
I_{CCL}	Power Supply Current				30	mA	Max	All Outputs LOW
I_{CCZ}	Power Supply Current				50	μA	Max	$\overline{OE}_n$ = V_{CC}; All Others at V_{CC} or GND
I_{CCT}	Additional I_{CC}/Input	Outputs Enabled			2.5	mA	Max	V_I = V_{CC} − 2.1V Enable Input V_I = V_{CC} − 2.1V Data Input V_I = V_{CC} − 2.1V All Others at V_{CC} or GND
		Outputs TRI-STATE®			2.5	mA		
		Outputs TRI-STATE			50	μA		
I_{CCD}	Dynamic I_{CC} (Note 2)	No Load			0.1	mA/MHz	Max	Outputs Open $\overline{OE}_n$ = GND (Note 1) One Bit Toggling, 50% Duty Cycle

Note 1: For 8 bit toggling, I_{CCD} < 0.8 mA/MHz.

Note 2: Guaranteed, but not tested

DC Electrical Characteristics (SOIC package) (Continued)

Symbol	Parameter	Min	Typ	Max	Units	V_{CC}	Conditions C_L = 50 pF, R_L = 500Ω
V_{OLP}	Quiet Output Maximum Dynamic V_{OL}		0.6	0.8	V	5.0	T_A = 25°C (Note 1)
V_{OLV}	Quiet Output Minimum Dynamic V_{OL}	−0.5	−0.4		V	5.0	T_A = 25°C (Note 1)
V_{OHV}	Minimum High Level Dynamic Output Voltage	2.7	3.1		V	5.0	T_A = 25°C (Note 3)
V_{IHD}	Minimum High Level Dynamic Input Voltage	2.0	1.4		V	5.0	T_A = 25°C (Note 2)
V_{ILD}	Maximum Low Level Dynamic Input Voltage		1.2	0.8	V	5.0	T_A = 25°C (Note 2)

Note 1: Max number of outputs defined as (n) n-1 data inputs are driven 0V to 3V One output at LOW. Guaranteed, but not tested

Note 2: Max number of data inputs (n) switching n-1 inputs switching 0V to 3V Input-under-test switching 3V to threshold (V_{ILD}), 0V to threshold (V_{IHD}) Guaranteed, but not tested.

Note 3: Max number of outputs defined as (n). n − 1 data inputs are driven 0V to 3V. One output HIGH. Guaranteed, but not tested.

AC Electrical Characteristics (SOIC and SSOP package)

Symbol	Parameter	74ABT T_A = +25°C, V_{CC} = +5V, C_L = 50 pF			74ABT T_A = −40°C to +85°C, V_{CC} = 4.5V–5.5V, C_L = 50 pF		Units
		Min	Typ	Max	Min	Max	
t_{PLH}	Propagation Delay	1.0	2.3	3.6	1.0	3.6	ns
t_{PHL}	Data to Outputs	1.0	3.3	4.1	1.0	4.1	
t_{PZH}	Output Enable Time	1.5	3.7	6.0	1.5	6.0	ns
t_{PZL}		1.5	4.3	6.5	1.5	6.5	
t_{PHZ}	Output Disable Time	1.0	3.5	6.0	1.0	6.0	ns
t_{PLZ}		1.0	3.7	5.6	1.0	5.6	

Extended AC Electrical Characteristics (SOIC package)

Symbol	Parameter	74ABT −40°C to +85°C, V_{CC} = 4.5V–5.5V, C_L = 50 pF, 8 Outputs Switching (Note 4)			74ABT T_A = −40°C to +85°C, V_{CC} = 4.5V–5.5V, C_L = 250 pF, 1 Output Switching (Note 5)		74ABT T_A = −40°C to +85°C, V_{CC} = 4.5V–5.5V, C_L = 250 pF, 8 Outputs Switching (Note 6)		Units
		Min	Typ	Max	Min	Max	Min	Max	
f_{toggle}	Max Toggle Frequency		100						MHz
t_{PLH}	Propagation Delay	1.5		5.0	1.5	6.0	2.5	8.5	ns
t_{PHL}	Data to Outputs	1.5		5.5	1.5	10.0	2.5	11.0	
t_{PZH}	Output Enable Time	1.5		6.5	2.5	7.5	2.5	9.5	ns
t_{PZL}		1.5		7.0	2.5	11.0	2.5	12.5	
t_{PHZ}	Output Disable Time	1.0		6.0	(Note 7)		(Note 7)		ns
t_{PLZ}		1.0		6.0					

Note 4: This specification is guaranteed but not tested. The limits apply to propagation delays for all paths described switching in phase (i.e., all low-to-high, high-to-low, etc.)

Note 5: This specification is guaranteed but not tested The limits represent propagation delay with 250 pF load capacitors in place of the 50 pF load capacitors in the standard AC load This specification pertains to single output switching only

Note 6: This specification is guaranteed but not tested The limits represent propagation delays for all paths described switching in phase (i.e., all low-to-high, high-to-low, etc) with 250 pF load capacitors in place of the 50 pF load capacitors in the standard AC load.

Note 7: The TRI-STATE delays are dominated by the RC network (500Ω, 250 pF) on the output and have been excluded from the datasheet.

Skew (SOIC package)

Symbol	Parameter	74ABT $T_A = -40°C$ to $+85°C$ $V_{CC} = 4.5V-5.5V$ $C_L = 50$ pF 8 Outputs Switching (Note 3)	74ABT $T_A = -40°C$ to $+85°C$ $V_{CC} = 4.5V-5.5V$ $C_L = 250$ pF 8 Outputs Switching (Note 4)	Units
		Max	Max	
t_{OSHL} (Note 1)	Pin to Pin Skew HL Transitions	1.3	2.3	ns
t_{OSLH} (Note 1)	Pin to Pin Skew LH Transitions	1.0	1.8	ns
t_{PS} (Note 5)	Duty Cycle LH–HL Skew	2.0	5.0	ns
t_{OST} (Note 1)	Pin to Pin Skew LH/HL Transitions	2.0	5.0	ns
t_{PV} (Note 2)	Device to Device Skew LH/HL Transitions	2.0	5.0	ns

Note 1: Skew is defined as the absolute value of the difference between the actual propagation delays for any two separate outputs of the same device The specification applies to any outputs switching HIGH to LOW (t_{OSHL}), LOW to HIGH (t_{OSLH}), or any combination switching LOW to HIGH and/or HIGH to LOW (t_{OST}) The specification is guaranteed but not tested.

Note 2: Propagation delay variation for a given set of conditions (i.e , temperature and V_{CC}) from device to device This specification is guaranteed but not tested

Note 3: This specification is guaranteed but not tested. The limits apply to propagation delays for all paths described switching in phase (i e., all low-to-high, high-to-low, etc)

Note 4: These specifications guaranteed but not tested The limits represent propagation delays with 250 pF load capacitors in place of the 50 pF load capacitors in the standard AC load

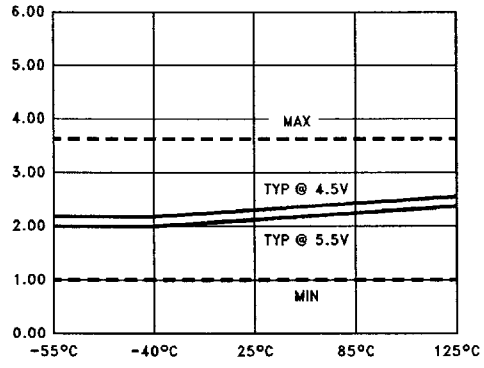
Note 5: This describes the difference between the delay of the LOW-to-HIGH and the HIGH-to-LOW transition on the same pin It is measured across all the outputs (drivers) on the same chip, the worst (largest delta) number is the guaranteed specification. This specification is guaranteed but not tested.

Capacitance

Symbol	Parameter	Typ	Units	Conditions $T_A = 25°C$
C_{IN}	Input Capacitance	5.0	pF	$V_{CC} = 0V$
C_{OUT} (Note 1)	Output Capacitance	9.0	pF	$V_{CC} = 5.0V$

Note 1: C_{OUT} is measured at frequency f = 1 MHz; per MIL-STD-883B, Method 3012

t_{PLH} vs. Temperature (T_A)
$C_L = 50$ pF, 1 Output Switching



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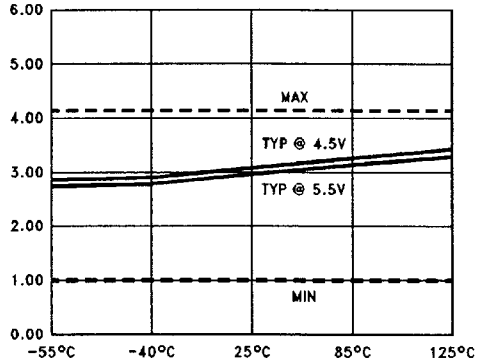
t_{PHL} vs Temperature (T_A)
C_L = 50 pF, 1 Output Switching



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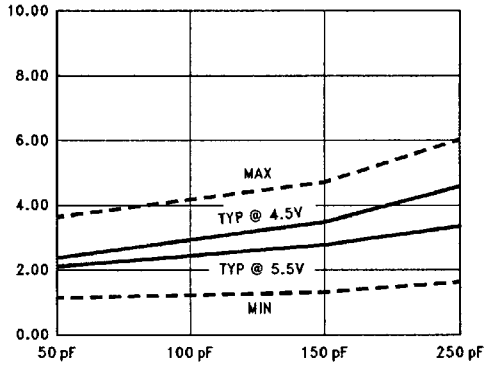
t_{PLH} vs Load Capacitance
1 Output Switching, T_A = 25°C



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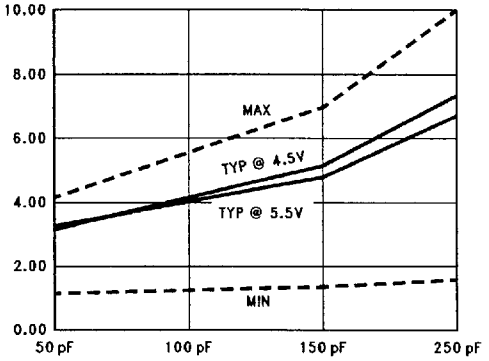
t_{PHL} vs Load Capacitance
1 Output Switching, T_A = 25°C



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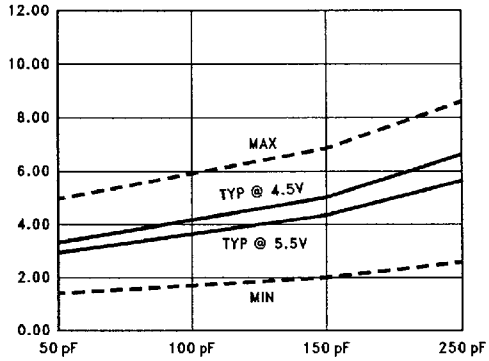
t_{PLH} vs Load Capacitance
8 Outputs Switching,
T_A = −40°C to 85°C



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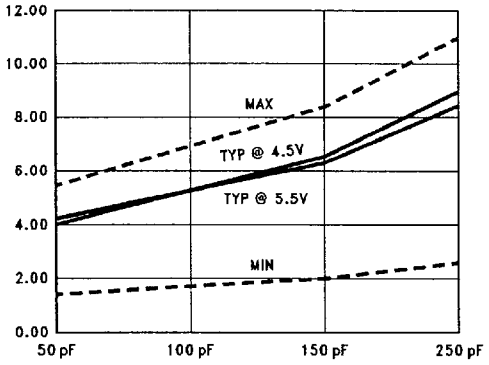
t_{PHL} vs Load Capacitance
8 Outputs Switching, T_A = 25°C



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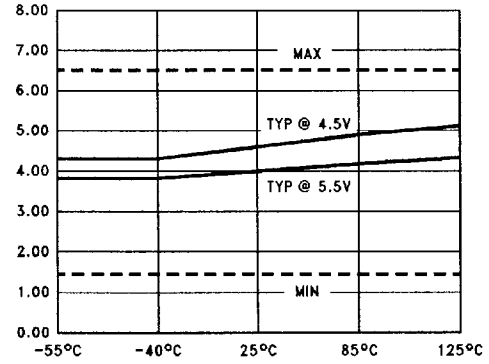
t_{PZL} vs Temperature (T_A)
C_L = 50 pF, 1 Output Switching



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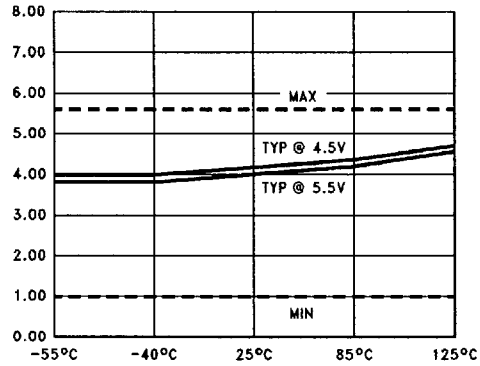
Dashed lines represent design characteristics, for specified guarantees refer to AC Characteristics Table

t_{PLZ} vs Temperature (T_A)
C_L = 50 pF, 1 Output Switching



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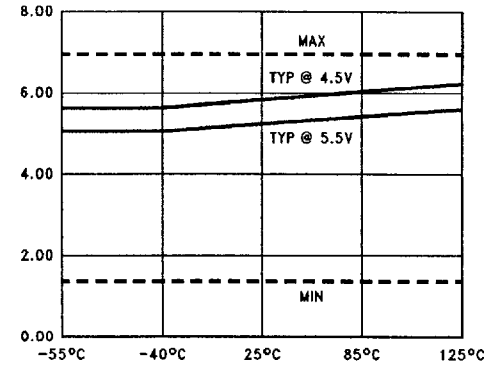
t_{PZL} vs Temperature (T_A)
C_L = 50 pF, 8 Outputs Switching



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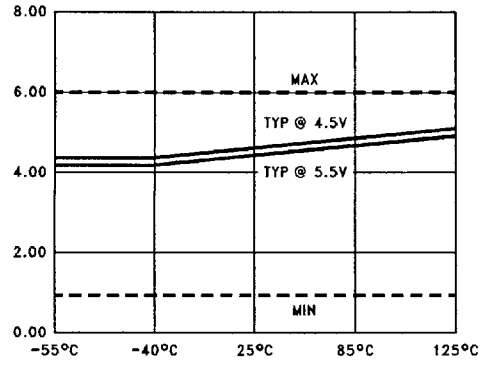
t_{PLZ} vs Temperature (T_A)
C_L = 50 pF, 8 Outputs Switching



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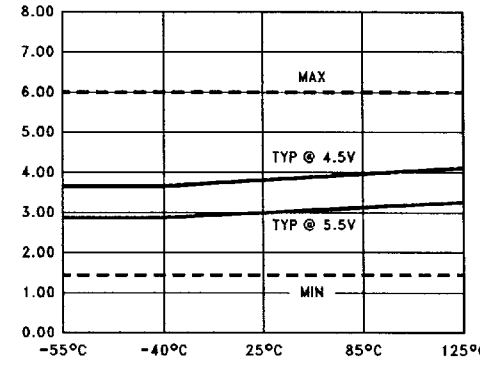
t_{PZH} vs Temperature (T_A)
C_L = 50 pF, 1 Output Switching



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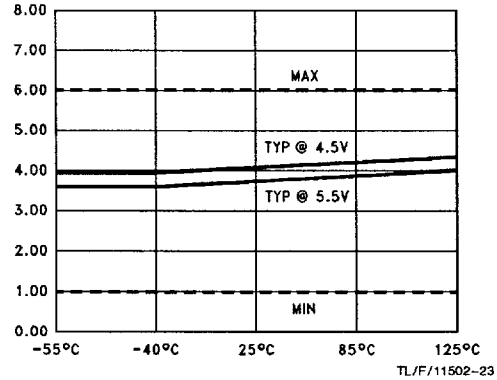
t_{PHZ} vs Temperature (T_A)
C_L = 50 pF, 1 Output Switching



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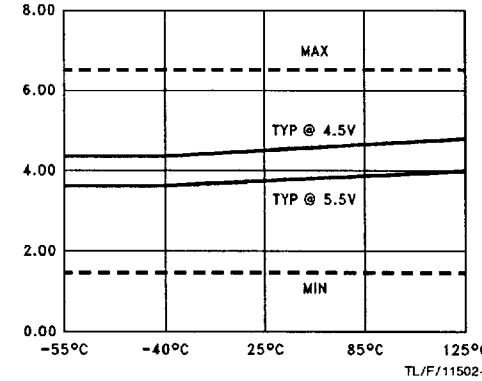
t_{PZH} vs Temperature (T_A)
C_L = 50 pF, 8 Outputs Switching



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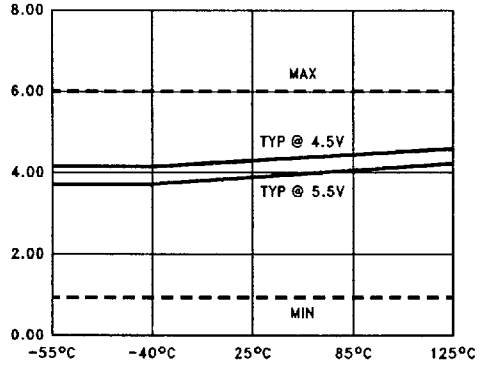
Dashed lines represent design characteristics, for specified guarantees refer to AC Characteristics Table

t_{PHZ} vs Temperature (T_A)
C_L = 50 pF, 8 Outputs Switching



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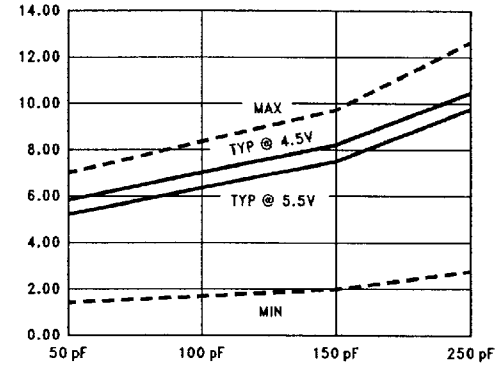
t_{PZL} vs Load Capacitance
8 Outputs Switching, T_A = 25°C



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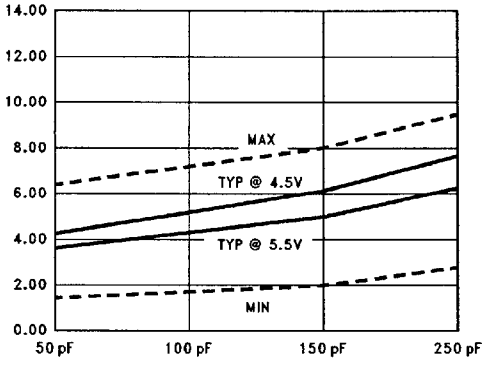
t_{PZH} vs Load Capacitance
8 Outputs Switching, T_A = 25°C



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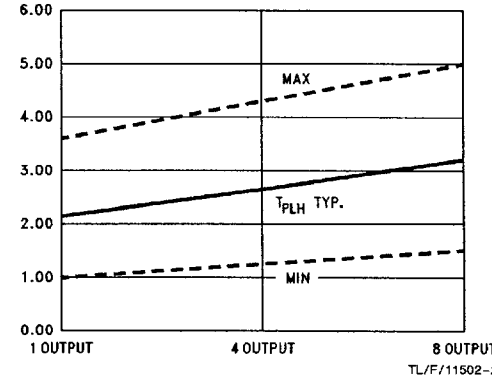
t_{PLH} vs Number Outputs Switching
V_{CC} = 5.0V, T_A = 25°C, C_L = 50 pF



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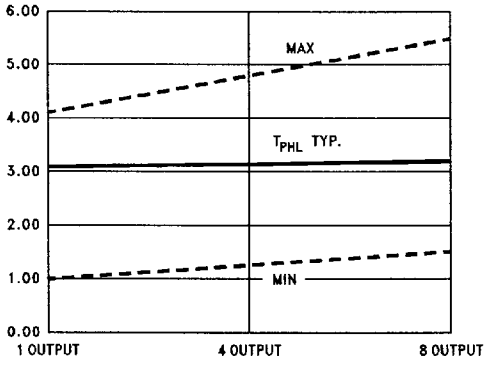
t_{PHL} vs Number Outputs Switching
V_{CC} = 5.0V, T_A = 25°C, C_L = 50 pF



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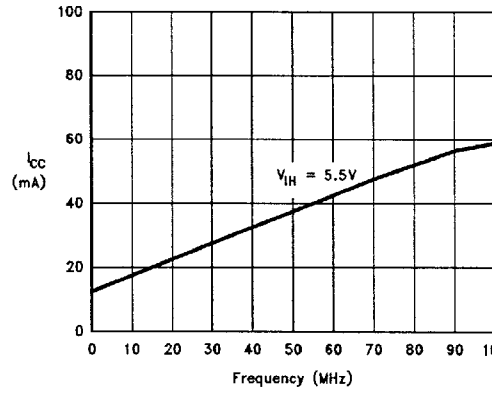
I_{CC} vs Frequency, Average, T_A = 25°C
All outputs unloaded/unterminated



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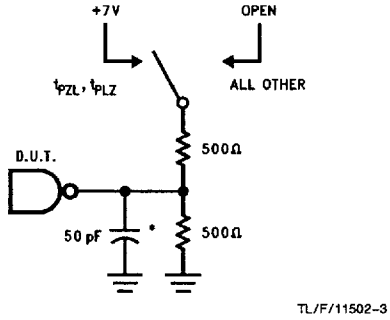
Dashed lines represent design characteristics, for specified guarantees refer to AC Characteristics Table

AC Loading



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*Includes jig and probe capacitance.

FIGURE 1. Standard AC Test Load

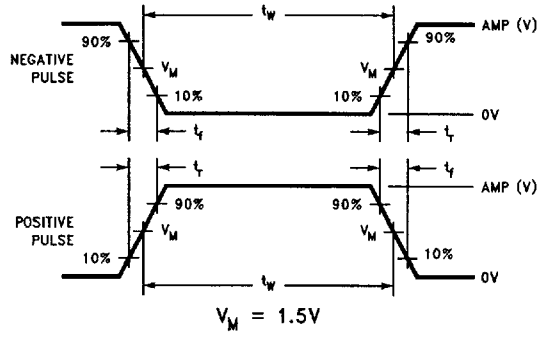

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FIGURE 2a. Test Input Signal Levels

Amplitude	Rep. Rate	t_w	t_r	t_f
3.0V	1 MHz	500 ns	2.5 ns	2.5 ns

FIGURE 2b. Test Input Signal Requirements

AC Waveforms

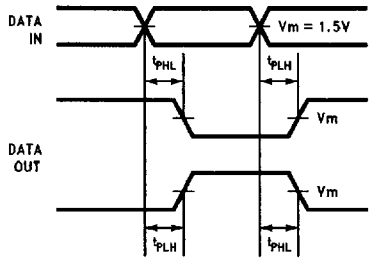

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FIGURE 3. Propagation Delay Waveforms for Inverting and Non-Inverting Functions

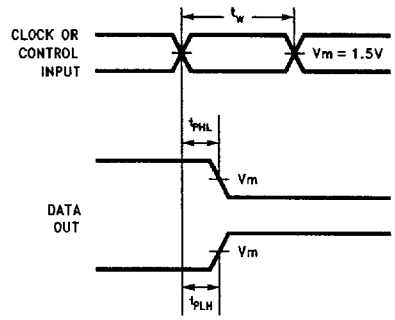

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FIGURE 4. Propagation Delay, Pulse Width Waveforms

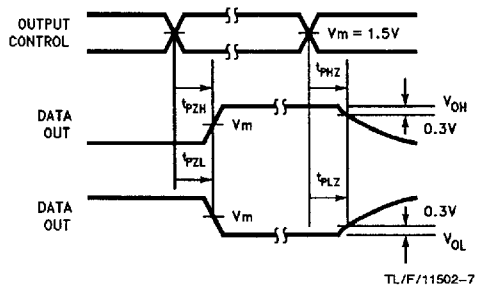

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FIGURE 5. TRI-STATE Output HIGH and LOW Enable and Disable Times

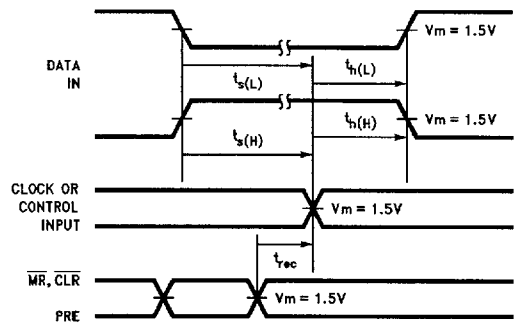

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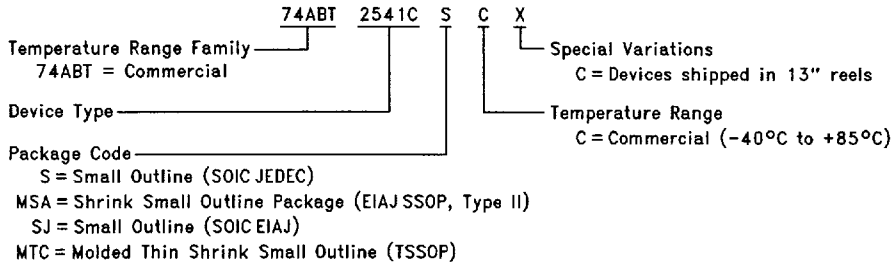
FIGURE 6. Setup Time, Hold Time and Recovery Time Waveforms

Ordering Information

The device number is used to form part of a simplified purchasing code where the package type and temperature range are derived as follows:



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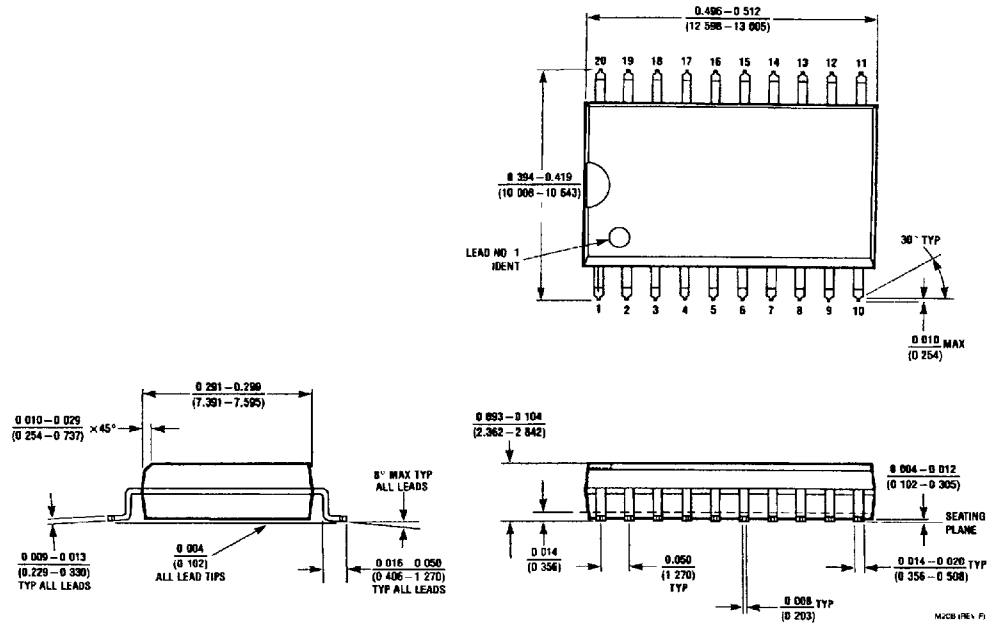
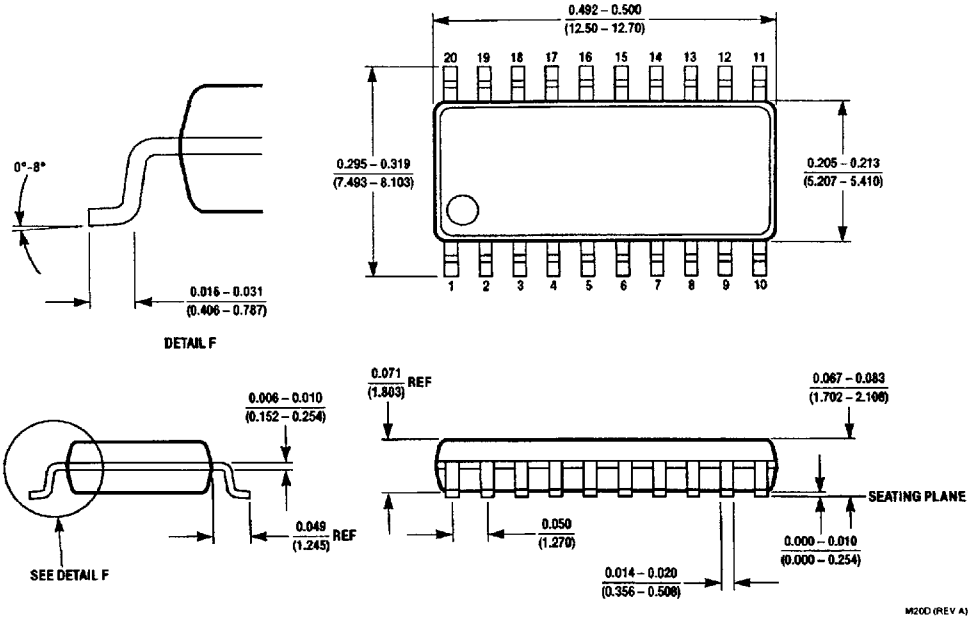
Physical Dimensions inches (millimeters)

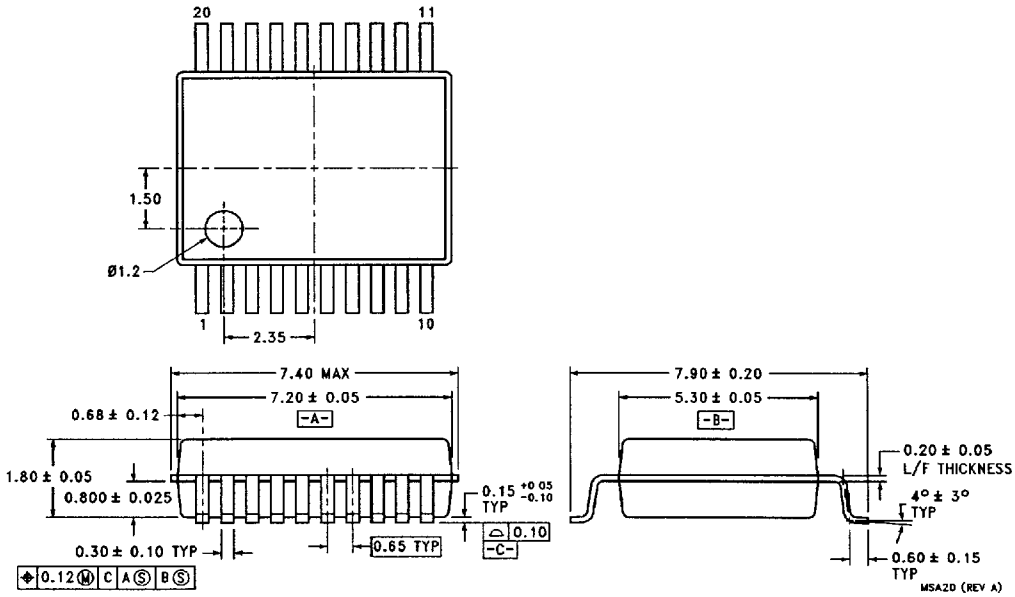


20-Lead Small Outline Integrated Circuit JEDEC (S)
NS Package Number M20B



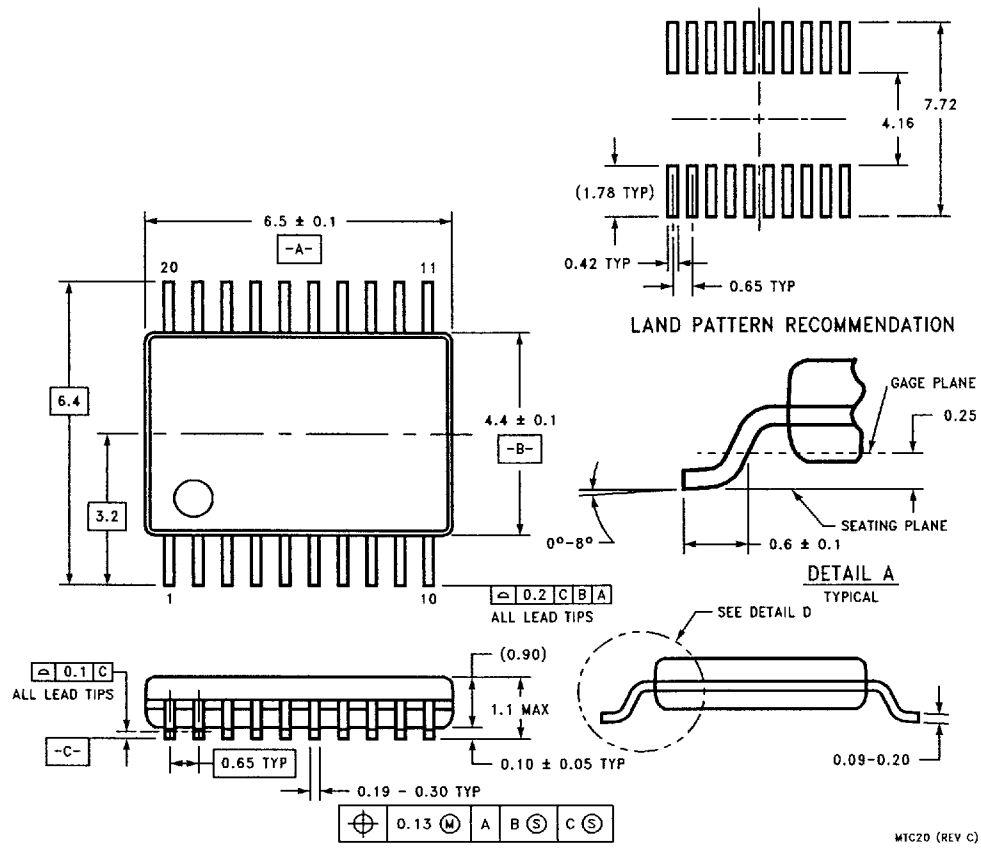
20-Lead Small Outline Integrated Circuit EIAJ (SJ)
NS Package Number M20D

Physical Dimensions millimeters (Continued)



20-Lead Plastic EIAJ SSOP, Type II (MSA)
NS Package Number MSA20

Physical Dimensions millimeters (Continued)



20-Lead Molded Thin Shrink Small Outline Package, JEDEC
NS Package Number MTC20

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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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