

High-Speed CMOS Logic 8-Input Multiplexer/Register, Three-State

SCLS459A - June 2001 - Revised May 2003

Features

- Edge-Triggered Data Flip-Flops
 - Transparent Select Latches
- Buffered Inputs
- 3-State Complementary Outputs
- Bus Line Driving Capability
- Typical Propagation Delay: $V_{CC} = 5V$, $C_L = 15pF$, $T_A = 25^\circ C$
 - Clock to Output = 22ns
- Fanout (Over Temperature Range)
 - Standard Outputs 10 LSTTL Loads
 - Bus Driver Outputs 15 LSTTL Loads
- Wide Operating Temperature Range . . . $-55^\circ C$ to $125^\circ C$
- Balanced Propagation Delay and Transition Times
- Significant Power Reduction Compared to LSTTL Logic ICs
- 4.5V to 5.5V Operation
- Direct LSTTL Input Logic Compatibility, $V_{IL} = 0.8V$ (Max), $V_{IH} = 2V$ (Min)
- CMOS Input Compatibility, $I_I \leq 1\mu A$ at V_{OL} , V_{OH}

Description

The CD74HCT356 consists of data selectors/multiplexers that select one of eight sources. The data select bits (S0, S1, and S2) are stored in transparent latches that are enabled by a low latch enable input (LE).

The data is stored in edge-triggered flip-flops that are triggered by a low-to-high clock transition.

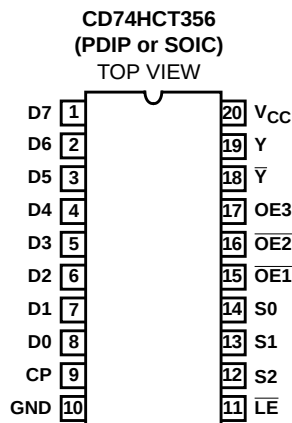
In both types the 3-state outputs are controlled by three output-enable inputs ($\overline{OE1}$, $\overline{OE2}$, and $\overline{OE3}$).

Ordering Information

PART NUMBER	TEMP. RANGE ($^\circ C$)	PACKAGE
CD74HCT356E	-55 to 125	20 Ld PDIP
CD74HCT356M96	-55 to 125	20 Ld SOIC

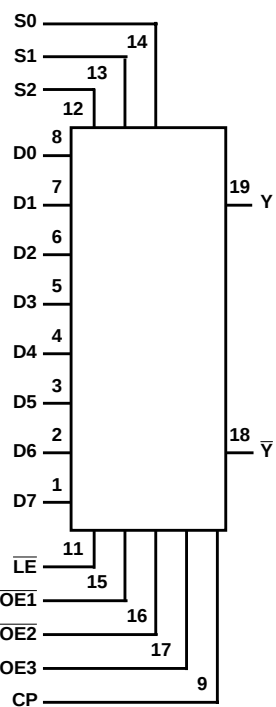
NOTE: When ordering, use the entire part number. The suffix 96 denotes tape and reel.

Pinout



CD74HCT356

Functional Diagram



TRUTH TABLE

INPUTS							OUTPUTS	
SELECT (NOTE 1)			CLOCK	OUTPUT ENABLES				
S2	S1	S0	CP	OE1	OE2	OE3	Y	Y
X	X	X	X	H	X	X	Z	Z
X	X	X	X	X	H	X	Z	Z
X	X	X	X	X	X	L	Z	Z
L	L	L	↑	L	L	H	D0	D0
L	L	L	H or L	L	L	H	D0 _n	D0 _n
L	L	H	↑	L	L	H	D1	D1
L	L	H	H or L	L	L	H	D1 _n	D1 _n
L	H	L	↑	L	L	H	D2	D2
L	H	L	H or L	L	L	H	D2 _n	D2 _n
L	H	H	↑	L	L	H	D3	D3
L	H	H	H or L	L	L	H	D3 _n	D3 _n
H	L	L	↑	L	L	H	D4	D4
H	L	L	H or L	L	L	H	D4 _n	D4 _n
H	L	H	↑	L	L	H	D5	D5
H	L	H	H or L	L	L	H	D5 _n	D5 _n
H	H	L	↑	L	L	H	D6	D6
H	H	L	H or L	L	L	H	D6 _n	D6 _n

CD74HCT356

TRUTH TABLE (Continued)

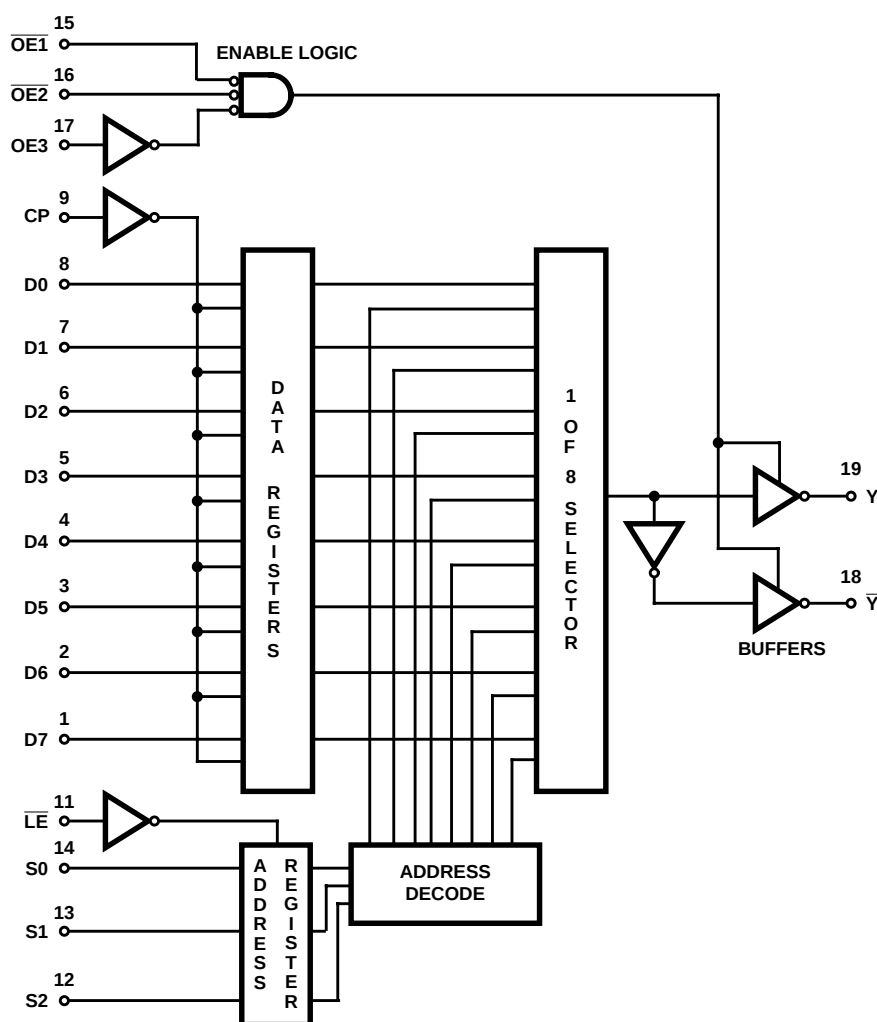
INPUTS							OUTPUTS	
SELECT (NOTE 1)			CLOCK	OUTPUT ENABLES				
S2	S1	S0	CP	$\overline{\text{OE1}}$	$\overline{\text{OE2}}$	OE3	$\overline{\text{Y}}$	Y
H	H	H	↑	L	L	H	$\overline{\text{D7}}$	D7
H	H	H	H or L	L	L	H	$\overline{\text{D7}}_{\text{n}}$	D7 _n

H = High Voltage Level (Steady State); L = Low Voltage Level (Steady State); $\uparrow$ = Transition from Low to High Level; X = Don't Care; Z = High-Impedance State (Off State); $D0_n \dots D7_n$ = the level of steady-state inputs D0 through D7, respectively, before the most recent low-to-high transition of data control.

NOTE:

1. This column shows the input address setup with $\overline{\text{LE}}$ low.

Block Diagram



Logic Diagram

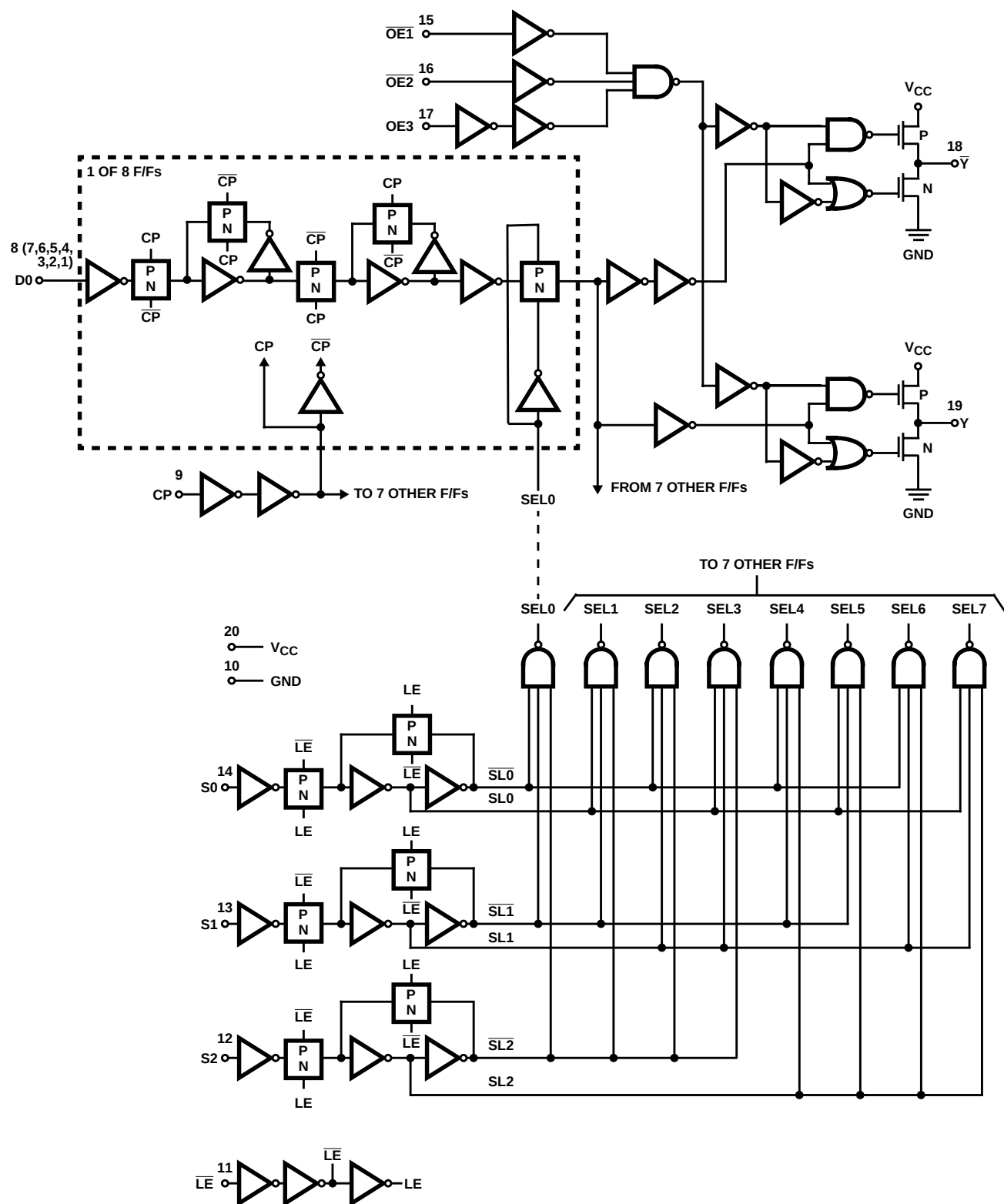


FIGURE 1. LOGIC DIAGRAM

CD74HCT356

Absolute Maximum Ratings

DC Supply Voltage, V_{CC} -0.5V to 7V
 DC Input Diode Current, I_{IK}
 For $V_I < -0.5V$ or $V_I > V_{CC} + 0.5V$ $\pm 20mA$
 DC Output Diode Current, I_{OK}
 For $V_O < -0.5V$ or $V_O > V_{CC} + 0.5V$ $\pm 20mA$
 DC Drain Current, per Output, I_O
 For $-0.5V < V_O < V_{CC} + 0.5V$ $\pm 35mA$
 DC Output Source or Sink Current per Output Pin, I_O
 For $V_O > -0.5V$ or $V_O < V_{CC} + 0.5V$ $\pm 25mA$
 DC V_{CC} or Ground Current, I_{CC} $\pm 50mA$

Thermal Information

Thermal Resistance (Typical, Note 2) θ_{JA} ($^{\circ}C/W$)
 E (PDIP) Package 69
 M (SOIC) Package 58
 Maximum Junction Temperature $150^{\circ}C$
 Maximum Storage Temperature Range $-65^{\circ}C$ to $150^{\circ}C$
 Maximum Lead Temperature (Soldering 10s) $300^{\circ}C$
 (SOIC - Lead Tips Only)

Operating Conditions

Temperature Range, T_A $-55^{\circ}C$ to $125^{\circ}C$
 Supply Voltage Range, V_{CC} 4.5V to 5.5V
 DC Input or Output Voltage, V_I , V_O 0V to V_{CC}
 Input Rise and Fall Time
 2V 1000ns (Max)
 4.5V 500ns (Max)
 6V 400ns (Max)

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTE:

- The package thermal impedance is calculated in accordance with JESD 51-7.

DC Electrical Specifications

PARAMETER	SYMBOL	TEST CONDITIONS		V_{CC} (V)	25 $^{\circ}C$			-40 $^{\circ}C$ TO 85 $^{\circ}C$		-55 $^{\circ}C$ TO 125 $^{\circ}C$		UNITS
		V_I (V)	I_O (mA)		MIN	TYP	MAX	MIN	MAX	MIN	MAX	
High Level Input Voltage	V_{IH}	-	-	4.5 to 5.5	2	-	-	2	-	2	-	V
Low Level Input Voltage	V_{IL}	-	-	4.5 to 5.5	-	-	0.8	-	0.8	-	0.8	V
High Level Output Voltage CMOS Loads	V_{OH}	V_{IH} or V_{IL}	-0.02	4.5	4.4	-	-	4.4	-	4.4	-	V
High Level Output Voltage TTL Loads			-4	4.5	3.98	-	-	3.84	-	3.7	-	V
Low Level Output Voltage CMOS Loads	V_{OL}	V_{IH} or V_{IL}	0.02	4.5	-	-	0.1	-	0.1	-	0.1	V
Low Level Output Voltage TTL Loads			4	4.5	-	-	0.26	-	0.33	-	0.4	V
Input Leakage Current	I_I	V_{CC} to GND	0	5.5	-	-	± 0.1	-	± 1	-	± 1	μA
Quiescent Device Current	I_{CC}	V_{CC} or GND	0	5.5	-	-	8	-	80	-	160	μA
Additional Quiescent Device Current Per Input Pin: 1 Unit Load	ΔI_{CC} (Note 3)	V_{CC} -2.1	-	4.5 to 5.5	-	100	360	-	450	-	490	μA
3-State Leakage Current	I_{OZ}	V_{IL} or V_{IH}	$V_O = V_{CC}$ or GND	5.5	-	-	± 0.5	-	± 5	-	± 10	μA

NOTE:

- For dual-supply systems theoretical worst case ($V_I = 2.4V$, $V_{CC} = 5.5V$) specification is 1.8mA.

CD74HCT356

Input Loading Table

INPUT	UNIT LOADS
D0-D7	0.50
S0, S1, S3	0.70
$\overline{OE1}$, $\overline{OE2}$	0.80
OE3	0.25
$\overline{LE}$	0.25
CP	0.60

NOTE: Unit Load is ΔI_{CC} limit specified in DC Electrical Specifications table, e.g., 360 μ A max at 25°C.

Prerequisite For Switching Specifications

PARAMETER	SYMBOL	TEST CONDITIONS	V _{CC} (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
CP Pulse Width	t _{PLH} , t _{PHL}	-	4.5	16	20	-	25	-	30	-	ns
$\overline{LE}$ Pulse Width	t _{PLH} , t _{PHL}	-	4.5	16	20	-	25	-	30	-	ns
Setup Times Dn → $\overline{E}$	t _{SU}	-	4.5	5	7	-	9	-	11	-	ns
Setup Times Sn → $\overline{LE}$	t _{SU}	-	4.5	5	7	-	9	-	11	-	ns
Hold Times Dn → $\overline{E}$	t _H	-	4.5	9	9	-	11	-	14	-	ns
Hold Times Sn → $\overline{LE}$	t _H	-	4.5	12	12	-	15	-	18	-	ns

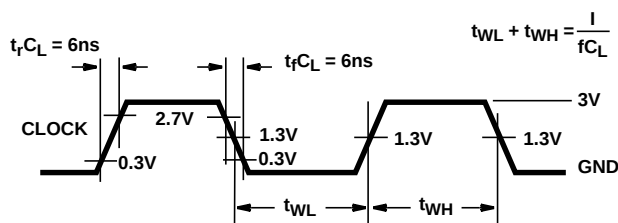
Switching Specifications Input $t_r, t_f = 6\text{ns}$

PARAMETER	SYMBOL	TEST CONDITIONS	V_{CC} (V)	25°C		-40°C TO 85°C	-55°C TO 125°C	UNITS
				TYP	MAX	MAX	MAX	
Propagation Delay, $CP \rightarrow Y, \bar{Y}$	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	4.5	-	51	64	77	ns
		$C_L = 15\text{pF}$	5	22	-	-	-	ns
Propagation Delay, $S_n \rightarrow Y, \bar{Y}$	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	4.5	-	59	74	89	ns
		$C_L = 15\text{pF}$	5	25	-	-	-	ns
Propagation Delay, $\bar{L}\bar{E} \rightarrow Y, \bar{Y}$	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	4.5	-	63	79	94	ns
		$C_L = 15\text{pF}$	5	25	-	-	-	ns
Output Disabling Time	t_{PLZ}, t_{PHZ}	$C_L = 50\text{pF}$	4.5	-	33	41	50	ns
	t_{PLZ}	$C_L = 15\text{pF}$	5	13	-	-	-	ns
	t_{PHZ}	$C_L = 15\text{pF}$	5	15	-	-	-	ns
Output Enabling Time	t_{PLZ}, t_{PHZ}	$C_L = 50\text{pF}$	4.5	-	34	43	51	ns
		$C_L = 15\text{pF}$	5	14	-	-	-	ns
Output Transition Time	t_{TLH}, t_{THL}	$C_L = 50\text{pF}$	4.5	-	12	15	18	ns
Input Capacitance	C_{IN}	-	-	-	10	10	10	pF
3-State Capacitance	C_O	-	-	-	20	20	20	pF
Power Dissipation Capacitance (Notes 4, 5)	C_{PD}	-	5	52	-	-	-	pF

NOTES:

4. C_{PD} is used to determine the dynamic power consumption, per device.
5. $P_D = V_{CC}^2 (C_{PD} + C_L)$ where f_i = Input Frequency, C_L = Output Load Capacitance, V_{CC} = Supply Voltage.

Test Circuits and Waveforms



NOTE: Outputs should be switching from 10% V_{CC} to 90% V_{CC} in accordance with device truth table. For f_{MAX} , input duty cycle = 50%.

FIGURE 2. CLOCK PULSE RISE AND FALL TIMES AND PULSE WIDTH

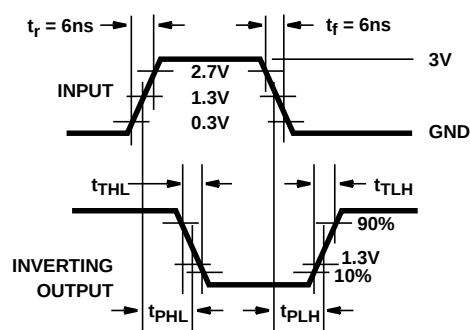


FIGURE 3. TRANSITION TIMES AND PROPAGATION-DELAY TIMES, COMBINATION LOGIC

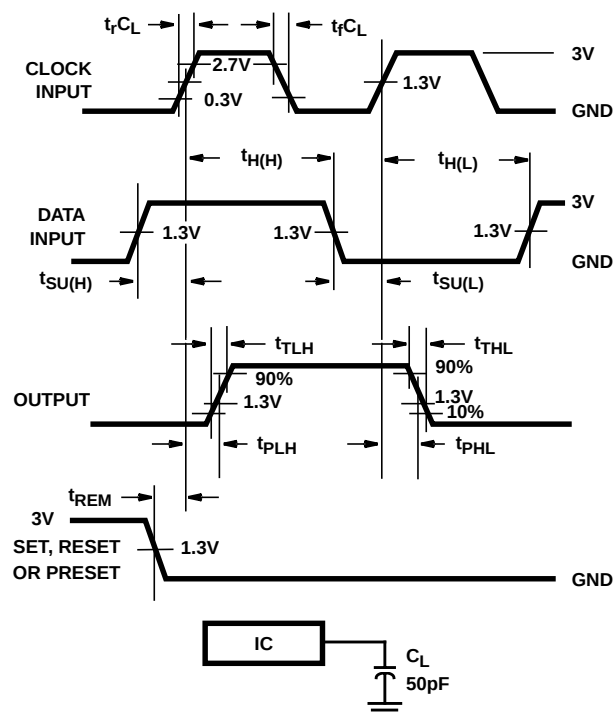
Test Circuits and Waveforms (Continued)

FIGURE 4. SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION-DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

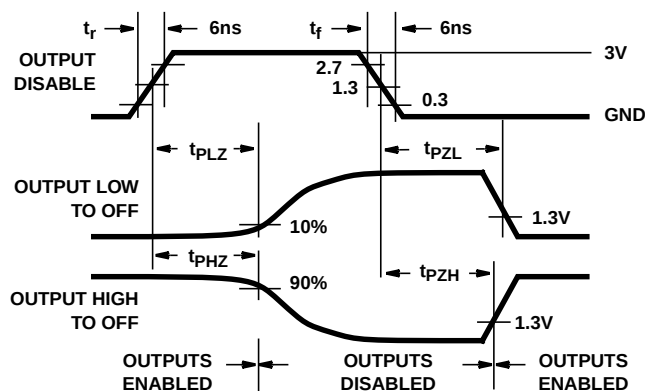
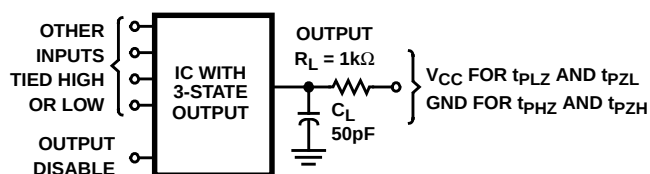


FIGURE 5. 3-STATE PROPAGATION-DELAY WAVEFORM



NOTE: Open-drain waveforms t_{PLZ} and t_{PZL} are the same as those for 3-state shown on the left. The test circuit is Output $R_L = 1k\Omega$ to V_{CC} , $C_L = 50pF$.

FIGURE 6. 3-STATE PROPAGATION-DELAY TEST CIRCUIT

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
CD74HCT356E	Active	Production	PDIP (N) 20	20 TUBE	Yes	NIPDAU	N/A for Pkg Type	-55 to 125	CD74HCT356E
CD74HCT356E.A	Active	Production	PDIP (N) 20	20 TUBE	Yes	NIPDAU	N/A for Pkg Type	-55 to 125	CD74HCT356E

⁽¹⁾ **Status:** For more details on status, see our [product life cycle](#).

⁽²⁾ **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

⁽⁴⁾ **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

⁽⁵⁾ **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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TUBE



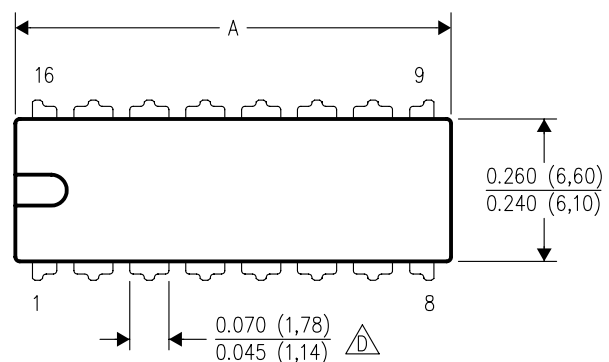
*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
CD74HCT356E	N	PDIP	20	20	506	13.97	11230	4.32
CD74HCT356E.A	N	PDIP	20	20	506	13.97	11230	4.32

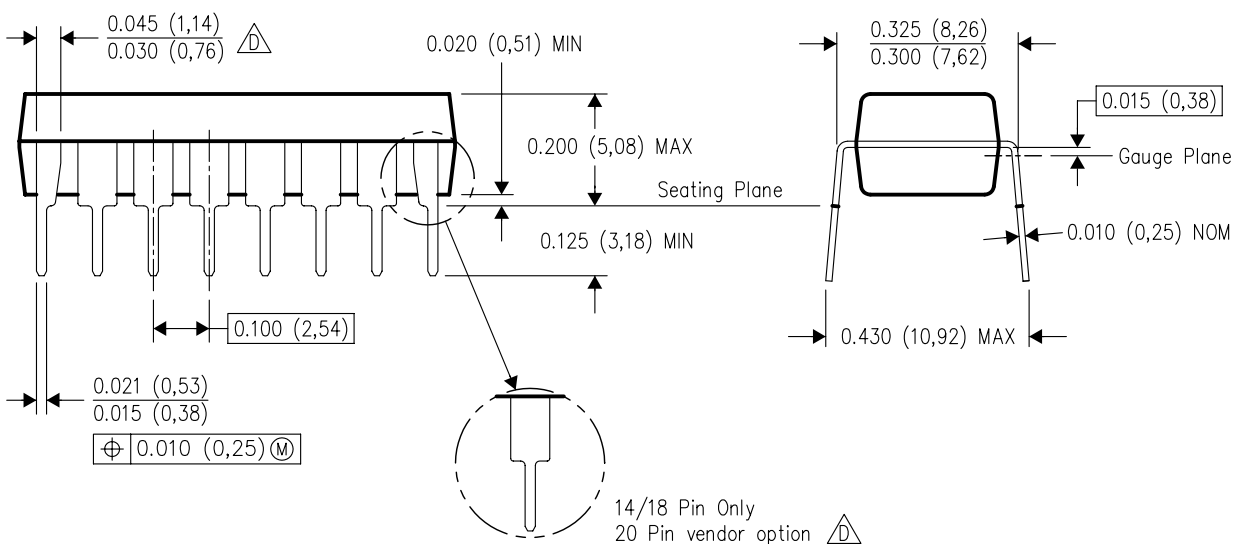
N (R-PDIP-T**)

16 PINS SHOWN

PLASTIC DUAL-IN-LINE PACKAGE



PINS ** DIM	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS-001 VARIATION	AA	BB	AC	AD



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NOTES:

- A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
-  Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
 The 20 pin end lead shoulder width is a vendor option, either half or full width.

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Last updated 10/2025