

February 1998 - Revised July 2003

## High-Speed CMOS Logic 16-Channel Analog Multiplexer/Demultiplexer

### Features

- Wide Analog Input Voltage Range
- Low "ON" Resistance
  - $V_{CC} = 4.5V$  ..... **70Ω (Typ)**
  - $V_{CC} = 6V$  ..... **60Ω (Typ)**
- Fast Switching and Propagation Speeds
- "Break-Before-Make" Switching. .... **6ns (Typ) at 4.5V**
- Available in Both Narrow and Wide-Body Plastic Packages
- Fanout (Over Temperature Range)
  - Standard Outputs ..... **10 LSTTL Loads**
  - Bus Driver Outputs ..... **15 LSTTL Loads**
- Wide Operating Temperature Range . . . **-55°C to 125°C**
- Balanced Propagation Delay and Transition Times
- Significant Power Reduction Compared to LSTTL Logic ICs
- HC Types
  - 2V to 6V Operation
  - High Noise Immunity:  $N_{IL} = 30\%$ ,  $N_{IH} = 30\%$  of  $V_{CC}$  at  $V_{CC} = 5V$
- HCT Types
  - 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 CD74HC4067 and CD74HCT4067 devices are digitally controlled analog switches that utilize silicon-gate CMOS technology to achieve operating speeds similar to LSTTL, with the low power consumption of standard CMOS integrated circuits.

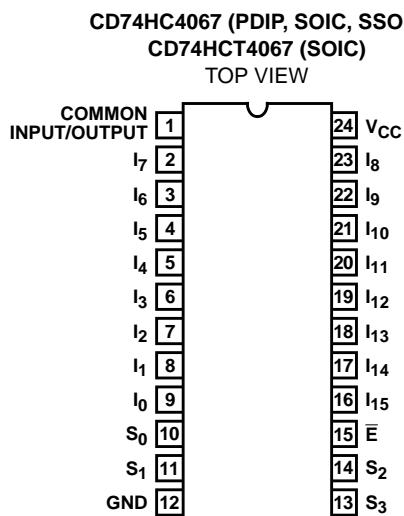
These analog multiplexers/demultiplexers control analog voltages that may vary across the voltage supply range. They are bidirectional switches thus allowing any analog input to be used as an output and vice-versa. The switches have low "on" resistance and low "off" leakages. In addition, these devices have an enable control which when high will disable all switches to their "off" state.

### Ordering Information

PART NUMBER	TEMP. RANGE (°C)	PACKAGE
CD74HC4067E	-55 to 125	24 Ld PDIP
CD74HC4067M	-55 to 125	24 Ld SOIC
CD74HC4067M96	-55 to 125	24 Ld SOIC
CD74HC4067SM96	-55 to 125	24 Ld SSOP
CD74HCT4067M	-55 to 125	24 Ld SOIC

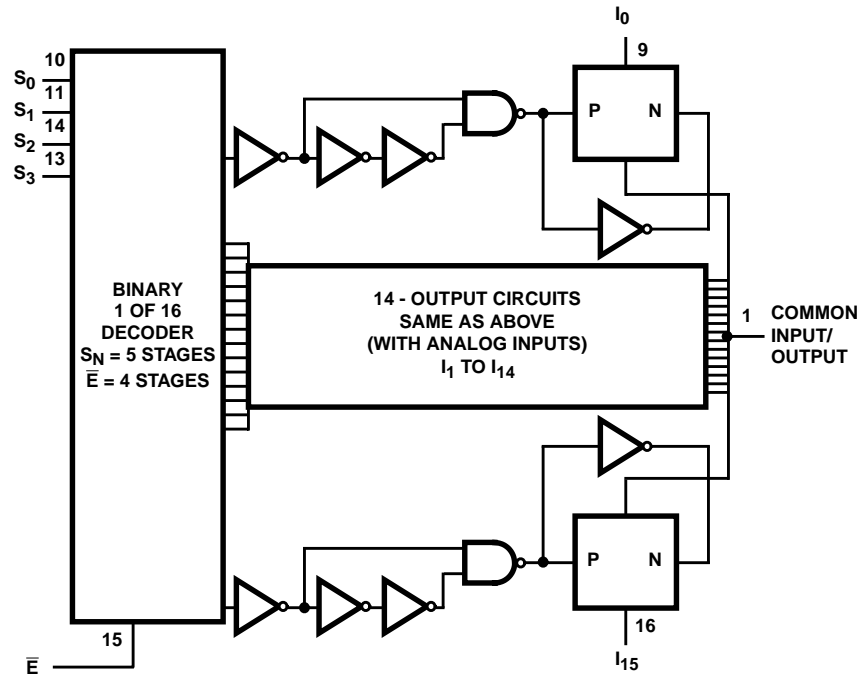
NOTE: When ordering, use the entire part number. The suffix 96 denotes tape and reel.

### Pinout



# CD74HC4067, CD74HCT4067

## Functional Diagram



TRUTH TABLE

S0	S1	S2	S3	$\bar{E}$	SELECTED CHANNEL
X	X	X	X	1	None
0	0	0	0	0	0
1	0	0	0	0	1
0	1	0	0	0	2
1	1	0	0	0	3
0	0	1	0	0	4
1	0	1	0	0	5
0	1	1	0	0	6
1	1	1	0	0	7
0	0	0	1	0	8
1	0	0	1	0	9
0	1	0	1	0	10
1	1	0	1	0	11
0	0	1	1	0	12
1	0	1	1	0	13
0	1	1	1	0	14
1	1	1	1	0	15

H= High Level

L= Low Level

X= Don't Care

# CD74HC4067, CD74HCT4067

## Absolute Maximum Ratings

DC Supply Voltage, $V_{CC}$ (Voltages Referenced to Ground)	-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 Drain Current, $I_O$ For $-0.5V < V_O < V_{CC} + 0.5V$	$\pm 25mA$
DC Output Diode Current, $I_{OK}$ For $V_O < -0.5V$ or $V_O > V_{CC} + 0.5V$	$\pm 20mA$
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)	$\theta_{JA}$ ( $^{\circ}C/W$ )
E (PDIP) Package, Note 1	67
M (SOIC) Package, Note 2	46
SM (SSOP) Package, Note 2	63
Maximum Junction Temperature (Plastic Package)	150 $^{\circ}C$
Maximum Storage Temperature Range	-65 $^{\circ}C$ to 150 $^{\circ}C$

## Operating Conditions

Temperature Range, $T_A$	-55 $^{\circ}C$ to 125 $^{\circ}C$
Supply Voltage Range, $V_{CC}$	
HC Types	.2V to 6V
HCT Types	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.

### NOTES:

1. The package thermal impedance is calculated in accordance with JESD 51-3.
2. The package thermal impedance is calculated in accordance with JESD 51-7.

## DC Electrical Specifications

PARAMETER	SYMBOL	TEST CONDITIONS		V <sub>CC</sub> (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
		V <sub>I</sub> (V)	V <sub>IS</sub> (V)		MIN	TYP	MAX	MIN	MAX	MIN	MAX	
HC TYPES												
High Level Input Voltage	V <sub>IH</sub>	-	-	2	1.5	-	-	1.5	-	1.5	-	V
				4.5	3.15	-	-	3.15	-	3.15	-	V
				6	4.2	-	-	4.2	-	4.2	-	V
Low Level Input Voltage	V <sub>IL</sub>	-	-	2	-	-	0.5	-	0.5	-	0.5	V
				4.5	-	-	1.35	-	1.35	-	1.35	V
				6	-	-	1.8	-	1.8	-	1.8	V
Maximum “ON” Resistance I <sub>O</sub> = 1mA	R <sub>ON</sub>	V <sub>CC</sub> or GND	V <sub>CC</sub> or GND	4.5	-	70	160	-	200	-	240	Ω
				6	-	60	140	-	175	-	210	Ω
		V <sub>CC</sub> to GND	V <sub>CC</sub> to GND	4.5	-	90	180	-	225	-	270	Ω
				6	-	80	160	-	200	-	240	Ω
Maximum “ON” Resistance Between Any Two Switches	ΔR <sub>ON</sub>	-	-	4.5	-	10	-	-	-	-	-	Ω
				6	-	8.5	-	-	-	-	-	Ω
Switch “Off” Leakage Current 16 Channels	I <sub>IZ</sub>	Ē = V <sub>CC</sub>	V <sub>CC</sub> or GND	6	-	-	±0.8	-	±8	-	±8	μA
Logic Input Leakage Current	I <sub>I</sub>	V <sub>CC</sub> or GND	-	6	-	-	±0.1	-	±1	-	±1	μA

# CD74HC4067, CD74HCT4067

## DC Electrical Specifications (Continued)

PARAMETER	SYMBOL	TEST CONDITIONS		$V_{CC}$ (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
		$V_I$ (V)	$V_{IS}$ (V)		MIN	TYP	MAX	MIN	MAX	MIN	MAX	
Quiescent Device Current $I_O = 0\text{mA}$	$I_{CC}$	$V_{CC}$ or GND	-	6	-	-	8	-	80	-	160	$\mu\text{A}$
<b>HCT TYPES</b>												
High Level Input Voltage	$V_{IH}$	-	-	4.5	2	-	-	2	-	2	-	V
Low Level Input Voltage	$V_{IL}$	-	-	4.5	-	-	0.8	-	0.8	-	0.8	V
Maximum "ON" Resistance $I_O = 1\text{mA}$	$R_{ON}$	$V_{CC}$ or GND	$V_{CC}$ or GND	4.5	-	70	160	-	200	-	240	$\Omega$
		$V_{CC}$ to GND	$V_{CC}$ to GND	4.5	-	90	180	-	225	-	270	$\Omega$
Maximum "ON" Resistance Between Any Two Switches	$\Delta R_{ON}$	-	-	4.5	-	10	-	-	-	-	-	$\Omega$
Switch "Off" Leakage Current 16 Channels	$I_{IZ}$	$\bar{E} = V_{CC}$	$V_{CC}$ or GND	6	-	-	$\pm 0.8$	-	$\pm 8$	-	$\pm 8$	$\mu\text{A}$
Logic Input Leakage Current	$I_I$	$V_{CC}$ or GND (Note 3)	-	6	-	-	$\pm 0.1$	-	$\pm 1$	-	$\pm 1$	$\mu\text{A}$
Quiescent Device Current	$I_{CC}$	$V_{CC}$ or GND	-	6	-	-	8	-	80	-	160	$\mu\text{A}$
Additional Quiescent Device Current Per Input Pin: 1 Unit Load	$\Delta I_{CC}$ (Note 4)	$V_{CC}$ -2.1	-	-	-	100	360	-	450	-	490	$\mu\text{A}$

### NOTES:

- Any voltage between  $V_{CC}$  and GND.
- For dual-supply systems theoretical worst case ( $V_I = 2.4\text{V}$ ,  $V_{CC} = 5.5\text{V}$ ) specification is 1.8mA.

### HCT Input Loading Table

INPUT	UNIT LOAD
$S_0 - S_3$	0.5
$\bar{E}$	0.3

NOTE: Unit Load is  $\Delta I_{CC}$  limit specified in DC Electrical Specifications table, e.g., 360 $\mu\text{A}$  max at 25°C.

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

PARAMETER	SYMBOL	TEST CONDITIONS	V <sub>CC</sub> (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
HC TYPES											
Propagation Delay Time Switch In to Out	t <sub>PLH</sub> , t <sub>PHL</sub>	C <sub>L</sub> = 50pF	2	-	-	75	-	95	-	110	ns
			4.5	-	-	15	-	19	-	22	ns
			6	-	-	13	-	16	-	19	ns
		C <sub>L</sub> = 15pF	5	-	6	-	-	-	-	-	ns

# CD74HC4067, CD74HCT4067

## Switching Specifications Input $t_r, t_f = 6\text{ns}$ (Continued)

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	
Switch Turn On $\bar{E}$ to Out	$t_{PZH}, t_{PZL}$	$C_L = 50\text{pF}$	2	-	-	275	-	345	-	415	ns
			4.5	-	-	55	-	69	-	83	ns
			6	-	-	47	-	59	-	71	ns
		$C_L = 15\text{pF}$	5	-	23	-	-	-	-	-	ns
Switch Turn On $S_n$ to Out	$t_{PZH}, t_{PZL}$	$C_L = 50\text{pF}$	2	-	-	300	-	375	-	450	ns
			4.5	-	-	60	-	75	-	90	ns
			6	-	-	51	-	64	-	76	ns
		$C_L = 15\text{pF}$	5	-	25	-	-	-	-	-	ns
Switch Turn Off $\bar{E}$ to Out	$t_{PHZ}, t_{PLZ}$	$C_L = 50\text{pF}$	2	-	-	275	-	345	-	415	ns
			4.5	-	-	55	-	69	-	83	ns
			6	-	-	47	-	59	-	71	ns
		$C_L = 15\text{pF}$	5	-	23	-	-	-	-	-	ns
Switch Turn Off $S_n$ to Out	$t_{PHZ}, t_{PLZ}$	$C_L = 50\text{pF}$	2	-	-	290	-	365	-	435	ns
			4.5	-	-	58	-	73	-	87	ns
			6	-	-	49	-	62	-	74	ns
		$C_L = 50\text{pF}$	5	-	21	-	-	-	-	-	ns
Input (Control) Capacitance	$C_I$	-	-	-	-	10	-	10	-	10	pF
Power Dissipation Capacitance (Notes 5, 6)	$C_{PD}$	-	5	-	93	-	-	-	-	-	pF
<b>HCT TYPES</b>											
Propagation Delay Time Switch In to Out	$t_{PLH}, t_{PHL}$	$C_L = 50\text{pF}$	4.5	-	-	15	-	19	-	22	ns
		$C_L = 15\text{pF}$	5	-	6	-	-	-	-	-	ns
Switch Turn On $\bar{E}$ to Out	$t_{PZH}, t_{PZL}$	$C_L = 50\text{pF}$	4.5	-	-	60	-	75	-	90	ns
		$C_L = 15\text{pF}$	5	-	25	-	-	-	-	-	ns
Switch Turn On $S_n$ to Out	$t_{PZH}, t_{PZL}$	$C_L = 50\text{pF}$	4.5	-	-	60	-	75	-	90	ns
		$C_L = 15\text{pF}$	5	-	25	-	-	-	-	-	ns
Switch Turn Off $\bar{E}$ to Out	$t_{PHZ}, t_{PLZ}$	$C_L = 50\text{pF}$	4.5	-	-	55	-	69	-	83	ns
		$C_L = 15\text{pF}$	5	-	23	-	-	-	-	-	ns
Switch Turn Off $S_n$ to Out	$t_{PHZ}, t_{PLZ}$	$C_L = 50\text{pF}$	4.5	-	-	58	-	73	-	87	ns
		$C_L = 15\text{pF}$	5	-	21	-	-	-	-	-	ns
Input (Control) Capacitance	$C_I$	-	-	-	-	10	-	10	-	10	pF
Power Dissipation Capacitance (Notes 5, 6)	$C_{PD}$	-	5	-	96	-	-	-	-	-	pF

### NOTES:

- $C_{PD}$  is used to determine the dynamic power consumption, per package.
- $P_D = C_{PD} V_{CC}^2 f_i + \sum (C_L + C_S) V_{CC}^2 f_o$  where  $f_i$  = input frequency,  $f_o$  = output frequency,  $C_L$  = output load capacitance,  $C_S$  = switch capacitance,  $V_{CC}$  = supply voltage.

Analog Channel Specifications  $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	$V_{CC}$ (V)	HC/HCT	UNITS
Switch Frequency Response Bandwidth at -3dB (Figure 2)	Figure 4, Notes 7, 8	4.5	89	MHz
Sine Wave Distortion	Figure 5	4.5	0.051	%
Feedthrough Noise E to Switch	Figure 6, Notes 8, 9	4.5	TBE	mV
Feedthrough Noise S to Switch			TBE	mV
Switch "OFF" Signal Feedthrough (Figure 3)	Figure 7	4.5	-75	dB
Switch Input Capacitance, $C_S$		-	5	pF
Common Capacitance, $C_{COM}$		-	50	pF

NOTES:

- Adjust input level for 0dBm at output,  $f = 1\text{MHz}$ .
- $V_{IS}$  is centered at  $V_{CC}/2$ .
- Adjust input for 0dBm at  $V_{IS}$ .

Typical Performance Curves

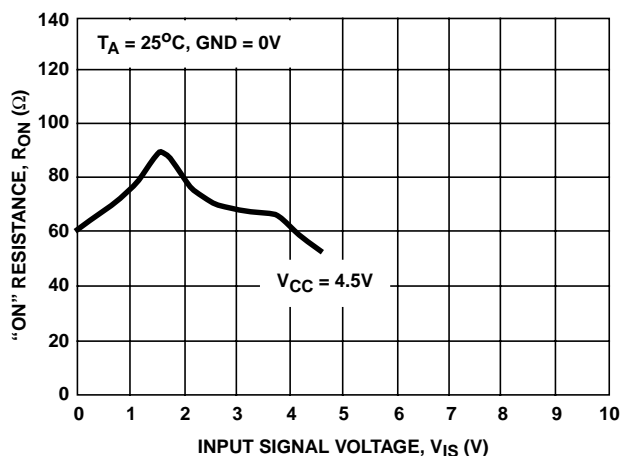


FIGURE 1. TYPICAL "ON" RESISTANCE vs INPUT SIGNAL VOLTAGE

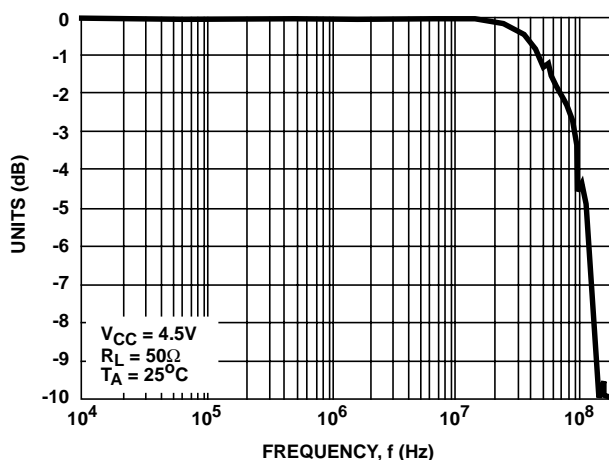


FIGURE 2. TYPICAL SWITCH FREQUENCY RESPONSE

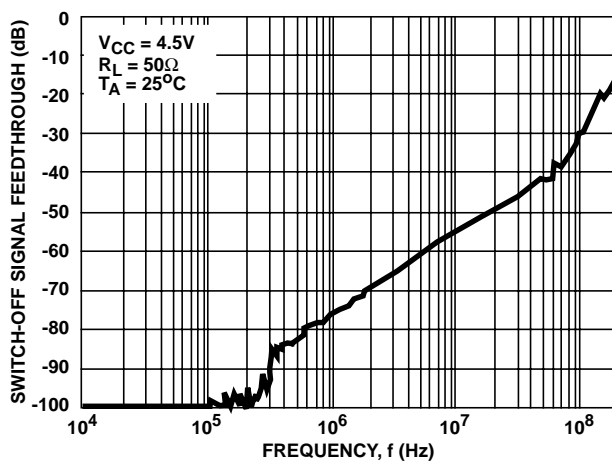


FIGURE 3. TYPICAL SWITCH-OFF SIGNAL FEEDTHROUGH vs FREQUENCY

## Analog Test Circuits

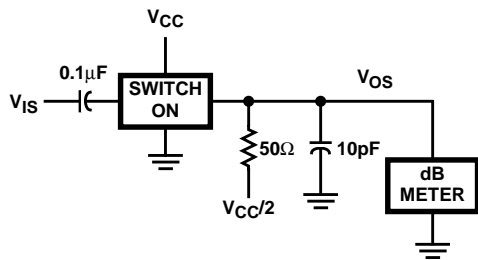


FIGURE 4. FREQUENCY RESPONSE TEST CIRCUIT

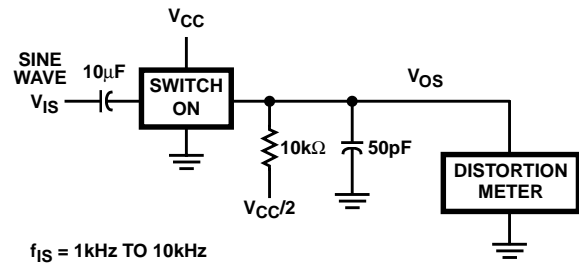


FIGURE 5. SINE WAVE DISTORTION TEST CIRCUIT

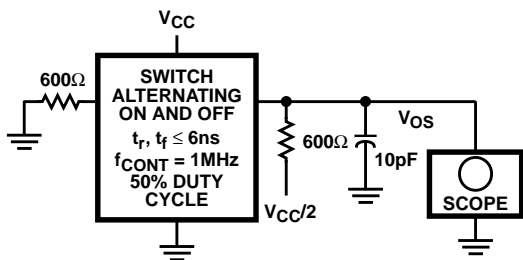


FIGURE 6. CONTROL-TO-SWITCH FEEDTHROUGH NOISE TEST CIRCUIT

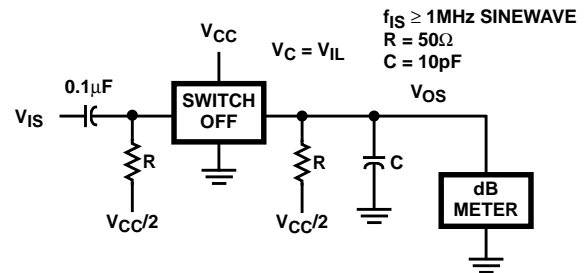


FIGURE 7. SWITCH OFF SIGNAL FEEDTHROUGH TEST CIRCUIT

## Test Circuits and Waveforms

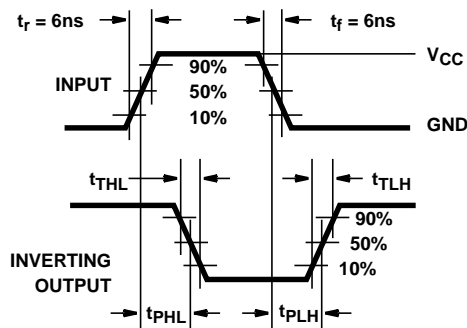


FIGURE 8. HC TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

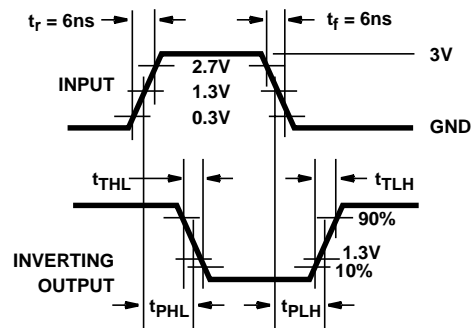
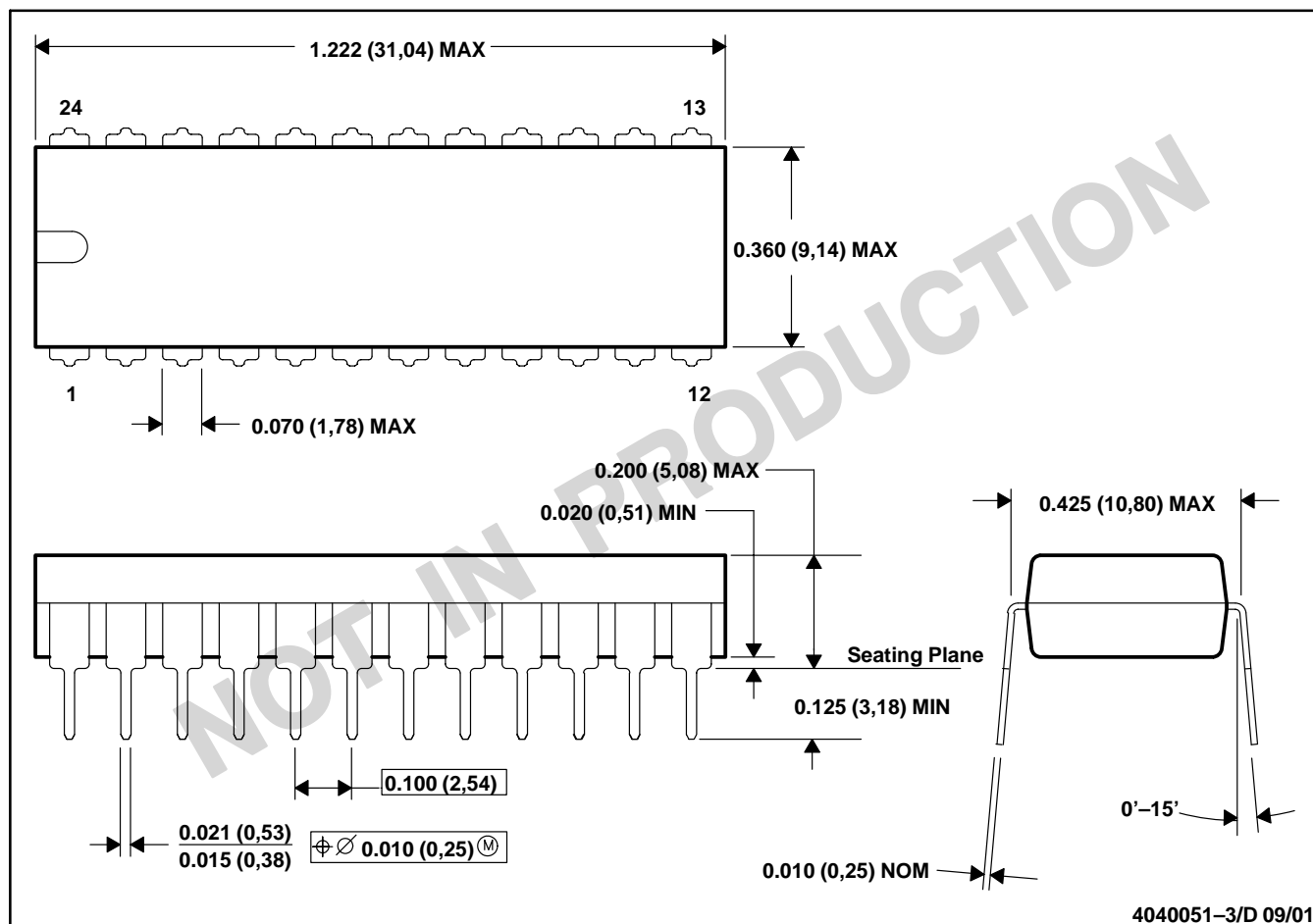


FIGURE 9. HCT TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

N (R-PDIP-T24)

PLASTIC DUAL-IN-LINE



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Falls within JEDEC MS-010



## PLASTIC DUAL-IN-LINE PACKAGE

Technical drawing of a 24-pin connector. The drawing includes a top view, a side view, and a detail view of the pin.

**Top View Dimensions:**

- Overall length:  $A$
- Pin pitch:  $0.060 (1,52) \text{ TYP}$
- Pin 1 and Pin 12 locations are marked.

**Side View Dimensions:**

- Pin height:  $0.200 (5,08) \text{ MAX}$
- Pin diameter:  $0.010 (0,25) (M)$
- Pin diameter tolerance:  $0.021 (0,53) / 0.015 (0,38)$
- Pin diameter tolerance zone:  $0.010 (0,25) (M)$
- Pin diameter tolerance zone:  $0.010 (0,25) \text{ NOM}$
- Pin diameter tolerance zone:  $0.125 (3,18) \text{ MIN}$
- Pin diameter tolerance zone:  $0.100 (2,54)$
- Pin diameter tolerance zone:  $0.020 (0,51) \text{ MIN}$
- Pin diameter tolerance zone:  $0.560 (14,22) / 0.520 (13,21)$

**Detail View Dimensions:**

- Pin diameter:  $0.610 (15,49) / 0.590 (14,99)$
- Pin angle:  $0^\circ - 15^\circ$

DIM \ PINS **	24	28	32	40	48	52
A MAX	1.270 (32,26)	1.450 (36,83)	1.650 (41,91)	2.090 (53,09)	2.450 (62,23)	2.650 (67,31)
A MIN	1.230 (31,24)	1.410 (35,81)	1.610 (40,89)	2.040 (51,82)	2.390 (60,71)	2.590 (65,79)

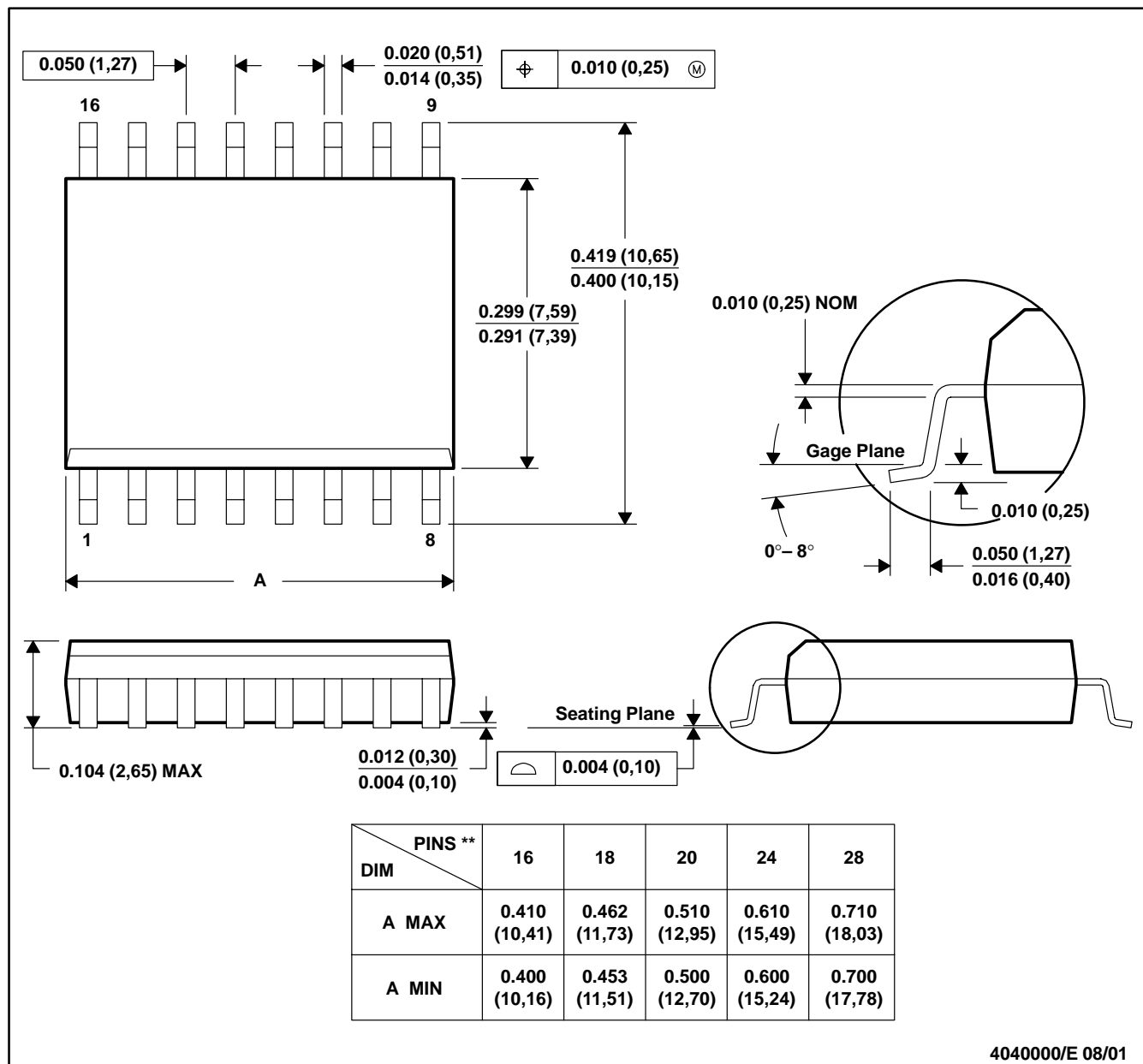
4040053/B 04/95

- NOTES: A. All linear dimensions are in inches (millimeters).  
B. This drawing is subject to change without notice.  
C. Falls within JEDEC MS-011  
D. Falls within JEDEC MS-015 (32 pin only)

DW (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

16 PINS SHOWN



- 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 MS-013

## DB (R-PDSO-G\*\*)

## PLASTIC SMALL-OUTLINE

28 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-150

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DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>	Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>	Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
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		Video & Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
		Wireless	<a href="http://www.ti.com/wireless">www.ti.com/wireless</a>

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