

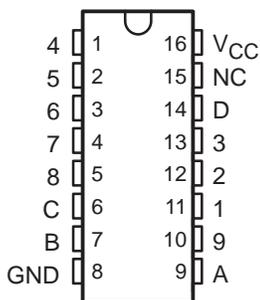
SN54147, SN54148, SN54LS147, SN54LS148 SN74147, SN74148 (TIM9907), SN74LS147, SN74LS148 10-LINE TO 4-LINE AND 8-LINE TO 3-LINE PRIORITY ENCODERS

SDLS053B – OCTOBER 1976 – REVISED MAY 2004

'147, 'LS147

- Encode 10-Line Decimal to 4-Line BCD
- Applications Include:
 - Keyboard Encoding
 - Range Selection

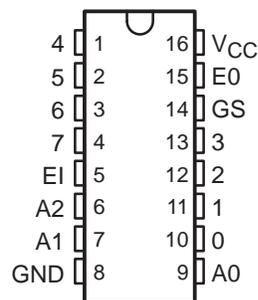
SN54147, SN54LS147 . . . J OR W PACKAGE
SN74147, SN74LS147 . . . D OR N PACKAGE
(TOP VIEW)



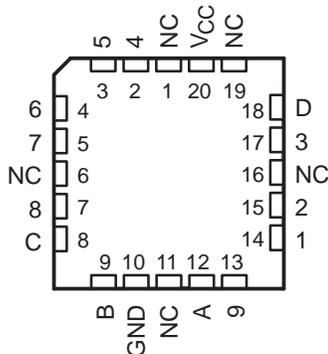
'148, 'LS148

- Encode 8 Data Lines to 3-Line Binary (Octal)
- Applications Include:
 - n-Bit Encoding
 - Code Converters and Generators

SN54148, SN54LS148 . . . J OR W PACKAGE
SN74148, SN74LS148 . . . D, N, OR NS PACKAGE
(TOP VIEW)

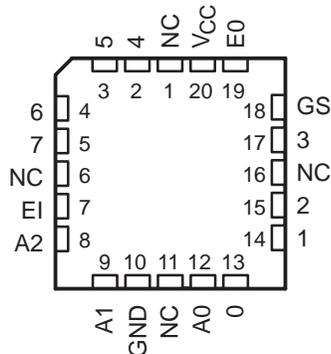


SN54LS147 . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection

SN54LS148 . . . FK PACKAGE
(TOP VIEW)



TYPE	TYPICAL DATA DELAY	TYPICAL POWER DISSIPATION
'147	10 ns	225 mW
'148	10 ns	190 mW
'LS147	15 ns	60 mW
'LS148	15 ns	60 mW

NOTE: The SN54147, SN54LS147, SN54148, SN74147, SN74LS147, and SN74148 are obsolete and are no longer supplied.



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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS
INSTRUMENTS**

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On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

SN54147, SN54148, SN54LS147, SN54LS148
SN74147, SN74148 (TIM9907), SN74LS147, SN74LS148
10-LINE TO 4-LINE AND 8-LINE TO 3-LINE PRIORITY ENCODERS

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description/ordering information

These TTL encoders feature priority decoding of the inputs to ensure that only the highest-order data line is encoded. The '147 and 'LS147 devices encode nine data lines to four-line (8-4-2-1) BCD. The implied decimal zero condition requires no input condition, as zero is encoded when all nine data lines are at a high logic level. The '148 and 'LS148 devices encode eight data lines to three-line (4-2-1) binary (octal). Cascading circuitry (enable input EI and enable output EO) has been provided to allow octal expansion without the need for external circuitry. For all types, data inputs and outputs are active at the low logic level. All inputs are buffered to represent one normalized Series 54/74 or 54/74LS load, respectively.

ORDERING INFORMATION

T _A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	PDIP – N	Tube	SN74LS148N	SN74LS148N
	SOIC – D	Tube	SN74LS148D	LS148
		Tape and reel	SN74LS148DR	
	SOP – NS	Tape and reel	SN74LS148NSR	74LS148
–55°C to 125°C	CDIP – J	Tube	SNJ54LS148J	SNJ54LS148J
	CFP – W	Tube	SNJ54LS148W	SNJ54LS148W
	LCCC – FK	Tube	SNJ54LS148FK	SNJ54LS148FK

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

FUNCTION TABLE – '147, 'LS147

INPUTS									OUTPUTS			
1	2	3	4	5	6	7	8	9	D	C	B	A
H	H	H	H	H	H	H	H	H	H	H	H	H
X	X	X	X	X	X	X	X	L	L	H	H	L
X	X	X	X	X	X	X	L	H	L	H	H	H
X	X	X	X	X	X	L	H	H	H	L	L	L
X	X	X	X	L	H	H	H	H	H	L	L	H
X	X	X	L	H	H	H	H	H	H	L	H	L
X	L	H	H	H	H	H	H	H	H	H	L	H
L	H	H	H	H	H	H	H	H	H	H	H	L

H = high logic level, L = low logic level, X = irrelevant



SN54147, SN54148, SN54LS147, SN54LS148
SN74147, SN74148 (TIM9907), SN74LS147, SN74LS148
10-LINE TO 4-LINE AND 8-LINE TO 3-LINE PRIORITY ENCODERS
SDLS053B – OCTOBER 1976 – REVISED MAY 2004

FUNCTION TABLE – '148, 'LS148

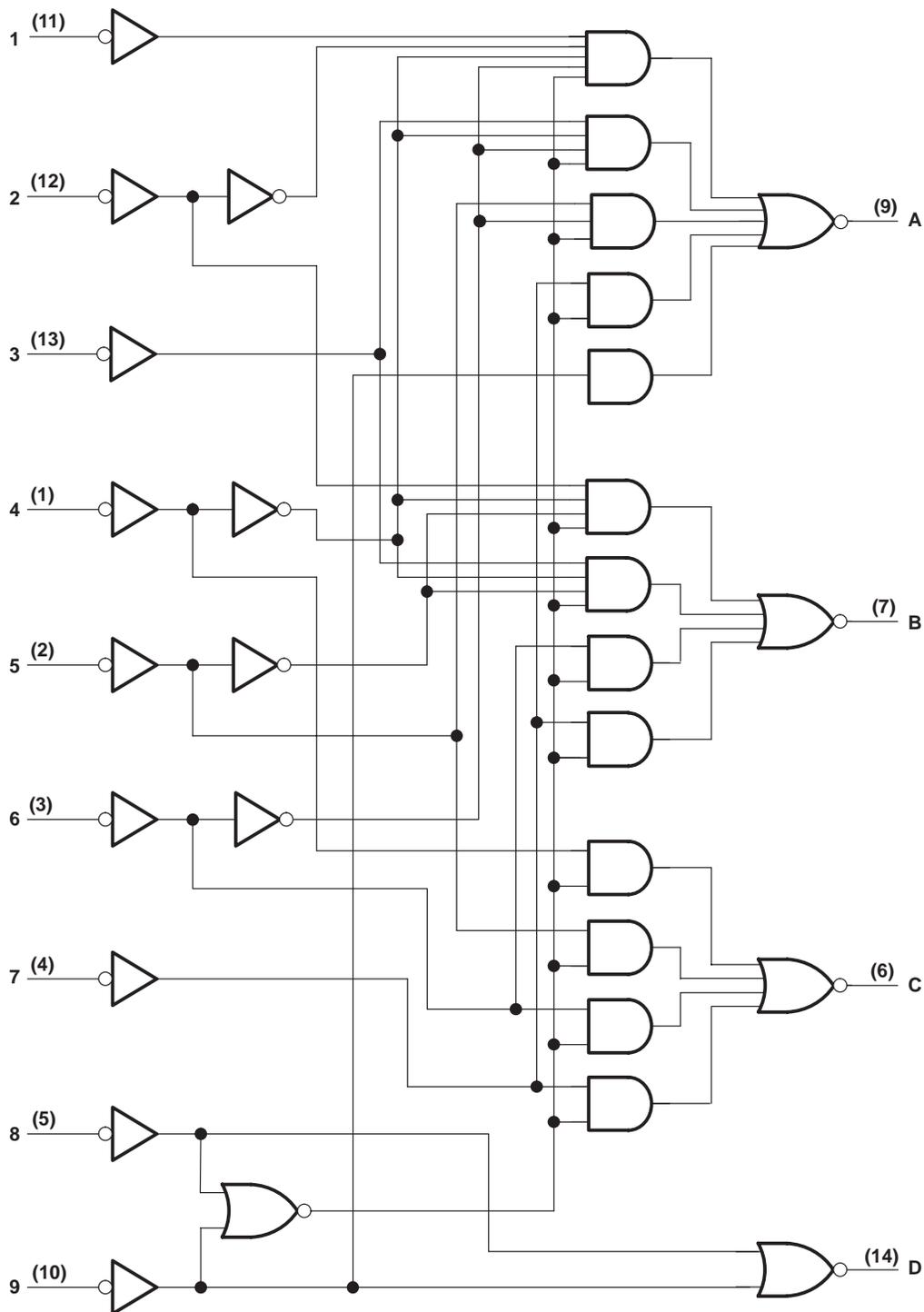
EI	INPUTS								OUTPUTS				
	0	1	2	3	4	5	6	7	A2	A1	A0	GS	EO
H	X	X	X	X	X	X	X	X	H	H	H	H	H
L	H	H	H	H	H	H	H	H	H	H	H	H	L
L	X	X	X	X	X	X	X	L	L	L	L	L	H
L	X	X	X	X	X	X	L	H	L	L	H	L	H
L	X	X	X	X	X	L	H	H	L	H	L	L	H
L	X	X	X	L	H	H	H	H	L	H	H	L	H
L	X	X	L	H	H	H	H	H	H	L	L	L	H
L	X	L	H	H	H	H	H	H	H	H	L	L	H
L	L	H	H	H	H	H	H	H	H	H	H	L	H

H = high logic level, L = low logic level, X = irrelevant

**SN54147, SN54148, SN54LS147, SN54LS148
 SN74147, SN74148 (TIM9907), SN74LS147, SN74LS148
 10-LINE TO 4-LINE AND 8-LINE TO 3-LINE PRIORITY ENCODERS**

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'147, 'LS147 logic diagram (positive logic)



Pin numbers shown are for D, J, N, and W packages.

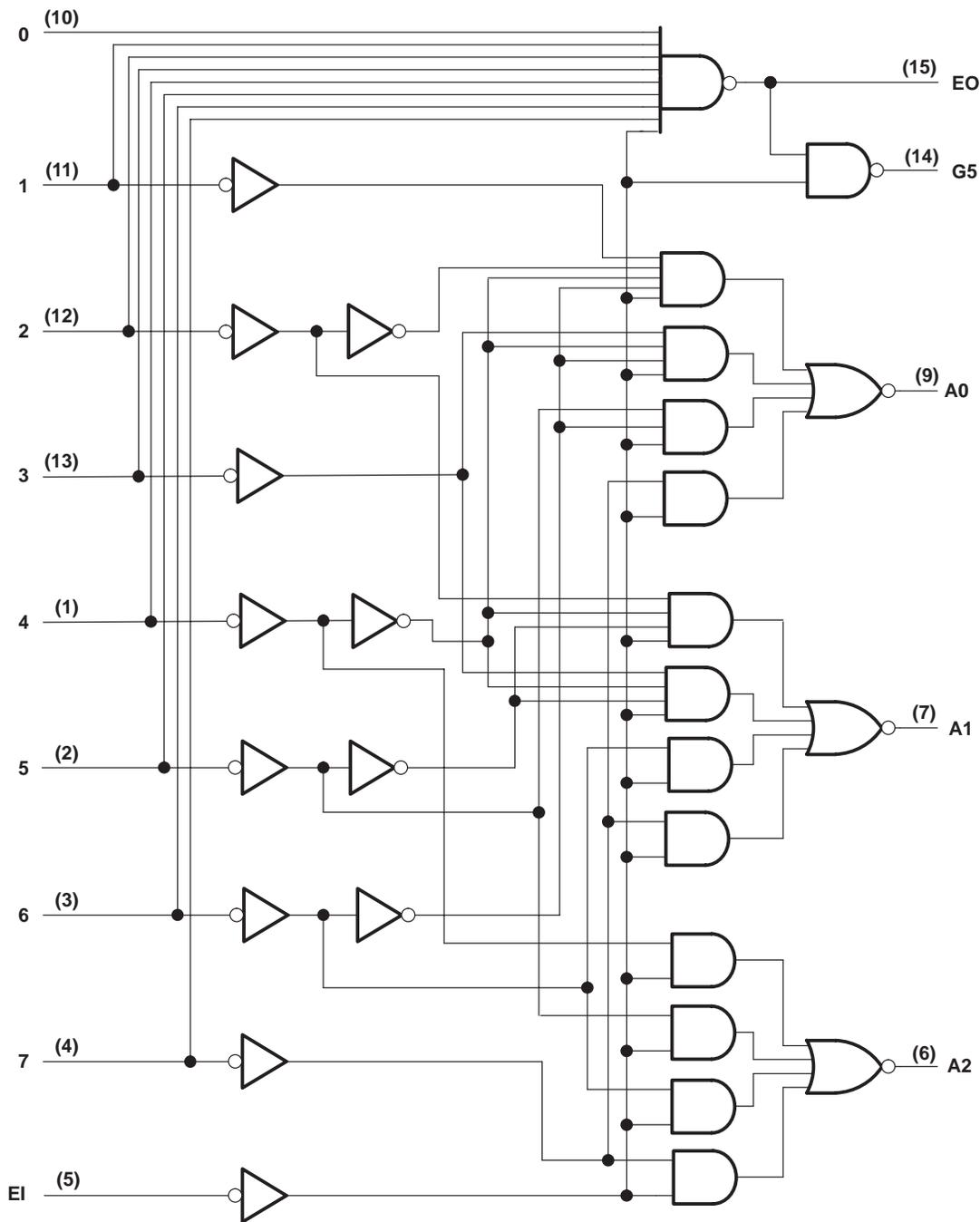


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**SN54147, SN54148, SN54LS147, SN54LS148
SN74147, SN74148 (TIM9907), SN74LS147, SN74LS148
10-LINE TO 4-LINE AND 8-LINE TO 3-LINE PRIORITY ENCODERS**

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'148, 'LS148 logic diagram (positive logic)



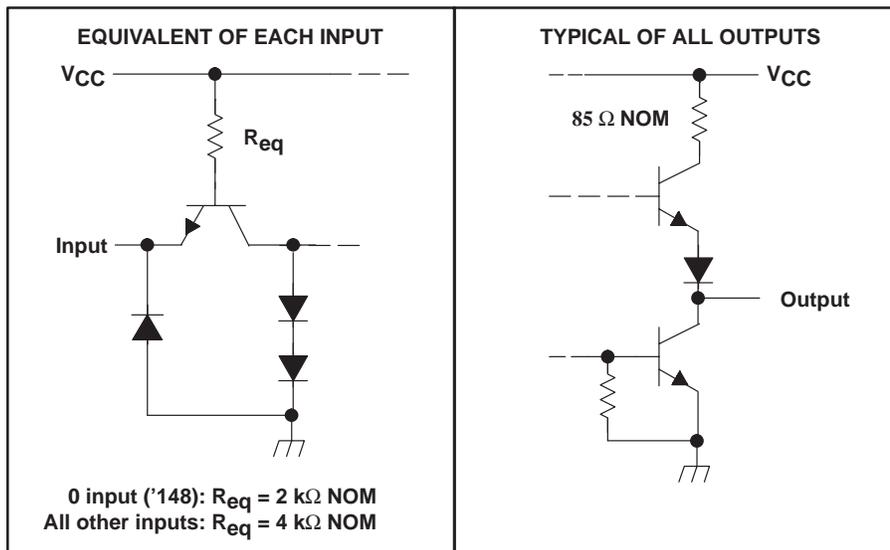
Pin numbers shown are for D, J, N, NS, and W packages.

**SN54147, SN54148, SN54LS147, SN54LS148
 SN74147, SN74148 (TIM9907), SN74LS147, SN74LS148
 10-LINE TO 4-LINE AND 8-LINE TO 3-LINE PRIORITY ENCODERS**

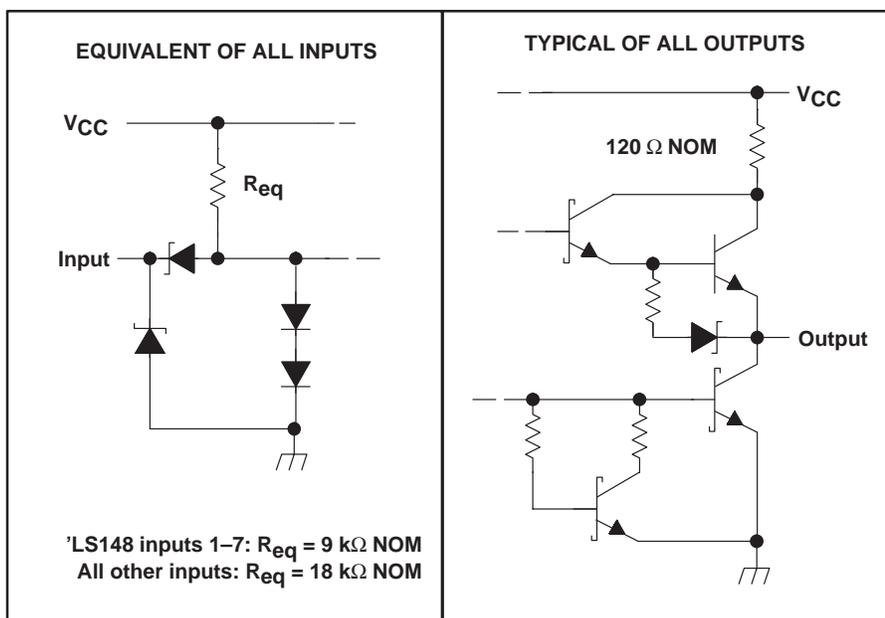
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schematics of inputs and outputs

'147, '148



'LS147, 'LS148



**SN54147, SN54148, SN54LS147, SN54LS148
SN74147, SN74148 (TIM9907), SN74LS147, SN74LS148
10-LINE TO 4-LINE AND 8-LINE TO 3-LINE PRIORITY ENCODERS**

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absolute maximum ratings over operating free-air temperature (unless otherwise noted)†

Supply voltage, V_{CC} (see Note 1)	7 V
Input voltage, V_I : '147, '148	5.5 V
'LS147, 'LS148	7 V
Inter-emitter voltage: '148 only (see Note 2)	5.5 V
Package thermal impedance θ_{JA} (see Note 3): D package	73°C/W
N package	67°C/W
NS package	64°C/W
Storage temperature range, T_{Stg}	–65°C to 150°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES:
1. Voltage values, except inter-emitter voltage, are with respect to the network ground terminal.
 2. This is the voltage between two emitters of a multiple-emitter transistor. For '148 circuits, this rating applies between any two of the eight data lines, 0 through 7.
 3. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions (see Note 4)

	SN54'			SN74'			SN54LS'			SN74LS'			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC} Supply voltage	4.5	5	5.5	4.75	5	5.25	4.5	5	5.5	4.75	5	5.25	V
I_{OH} High-level output current			–800			–800			–400			–400	μA
I_{OL} Low-level output current			16			16			4			8	mA
T_A Operating free-air temperature	–55		125	0		70	–55		125	0		70	°C

NOTE 4: All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.



SN54147, SN54148, SN54LS147, SN54LS148
SN74147, SN74148 (TIM9907), SN74LS147, SN74LS148
10-LINE TO 4-LINE AND 8-LINE TO 3-LINE PRIORITY ENCODERS

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electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	'147			'148			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V _{IH}	High-level input voltage		2			2			V
V _{IL}	Low-level input voltage				0.8			0.8	V
V _{IK}	Input clamp voltage	V _{CC} = MIN, I _I = -12 mA			-1.5			-1.5	V
V _{OH}	High-level output voltage	V _{CC} = MIN, V _{IL} = 0.8 V, V _{IH} = 2 V, I _{OH} = -800 μA	2.4	3.3		2.4	3.3		V
V _{OL}	Low-level output voltage	V _{CC} = MIN, V _{IL} = 0.8 V, V _{IH} = 2 V, I _{OL} = 16 mA		0.2	0.4		0.2	0.4	V
I _I	Input current at maximum input voltage	V _{CC} = MIN, V _I = 5.5 V			1			1	mA
I _{IH}	High-level input current	0 input						40	μA
		Any input except 0	V _{CC} = MAX, V _I = 2.4 V		40			80	
I _{IL}	Low-level input current	0 input						-1.6	mA
		Any input except 0	V _{CC} = MAX, V _I = 0.4 V		-1.6			-3.2	
I _{OS}	Short-circuit output current§	V _{CC} = MAX	-35		-85	-35		-85	mA
I _{CC}	Supply current	V _{CC} = MAX (See Note 5)	Condition 1	50	70	40	60		mA
			Condition 2	42	62	35	55		

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.

§ Not more than one output should be shorted at a time.

NOTE 5: For '147, I_{CC} (Condition 1) is measured with input 7 grounded, other inputs and outputs open; I_{CC} (Condition 2) is measured with all inputs and outputs open. For '148, I_{CC} (Condition 1) is measured with inputs 7 and EI grounded, other inputs and outputs open; I_{CC} (Condition 2) is measured with all inputs and outputs open.

SN54147, SN74147 switching characteristics, V_{CC} = 5 V, T_A = 25°C (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	WAVEFORM	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t _{PLH}	Any	Any	In-phase output	C _L = 15 pF, R _L = 400 Ω		9	14	ns
t _{PHL}						7	11	
t _{PLH}	Any	Any	Out-of-phase output			13	19	ns
t _{PHL}						12	19	



SN54147, SN54148, SN54LS147, SN54LS148
SN74147, SN74148 (TIM9907), SN74LS147, SN74LS148
10-LINE TO 4-LINE AND 8-LINE TO 3-LINE PRIORITY ENCODERS

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SN54148, SN74148 switching characteristics, $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$ (see Figure 1)

PARAMETER†	FROM (INPUT)	TO (OUTPUT)	WAVEFORM	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t _{PLH}	1–7	A0, A1, or A2	In-phase output	C _L = 15 pF, R _L = 400 Ω	10	15	ns	
t _{PHL}								
t _{PLH}	1–7	A0, A1, or A2	Out-of-phase output		12	19	ns	
t _{PHL}								6
t _{PLH}	0–7	EO	Out-of-phase output		14	25	ns	
t _{PHL}								18
t _{PLH}	0–7	GS	In-phase output		14	25	ns	
t _{PHL}								10
t _{PLH}	EI	A0, A1, or A2	In-phase output		10	15	ns	
t _{PHL}								8
t _{PLH}	EI	GS	In-phase output		10	15	ns	
t _{PHL}								10
t _{PLH}	EI	EO	In-phase output		10	15	ns	
t _{PHL}								17

† t_{PLH} = propagation delay time, low-to-high-level output.
t_{PHL} = propagation delay time, high-to-low-level output.

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	SN54LS'		SN74LS'		UNIT	
			MIN	TYP‡	MAX	MIN		TYP‡
V _{IH}	High-level input voltage		2		2		V	
V _{IL}	Low-level input voltage			0.7		0.8	V	
V _{IK}	Input clamp voltage	V _{CC} = MIN, I _I = -18 mA		-1.5		-1.5	V	
V _{OH}	High-level output voltage	V _{CC} = MIN, V _{IL} = 0.8 V, I _{OH} = -400 μA	2.5	3.4	2.7	3.4	V	
V _{OL}	Low-level output voltage	V _{CC} = MIN, V _{IH} = 2 V, V _{IL} = V _{IL} MAX	I _{OL} = 4 mA		0.25	0.4	V	
			I _{OL} = 8 mA			0.35		0.5
I _I	Input current at maximum input voltage	'LS148 inputs 1–7	V _{CC} = MAX, V _I = 7 V		0.2		0.2	mA
		All other inputs			0.1		0.1	
I _{IH}	High-level input current	'LS148 inputs 1–7	V _{CC} = MAX, V _I = 2.7 V		40		40	μA
		All other inputs			20		20	
I _{IL}	Low-level input current	'LS148 inputs 1–7	V _{CC} = MAX, V _I = 0.4 V		-0.8		-0.8	mA
		All other inputs			-0.4		-0.4	
I _{OS}	Short-circuit output current§	V _{CC} = MAX	-20	-100	-20	-100	mA	
I _{CC}	Supply current	V _{CC} = MAX (See Note 6)	Condition 1		12	20	mA	
			Condition 2		10	17		

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.

§ Not more than one output should be shorted at a time.

NOTE 6: For 'LS147, I_{CC} (Condition 1) is measured with input 7 grounded, other inputs and outputs open; I_{CC} (Condition 2) is measured with all inputs and outputs open. For 'LS148, I_{CC} (Condition 1) is measured with inputs 7 and EI grounded, other inputs and outputs open; I_{CC} (Condition 2) is measured with all inputs and outputs open.



SN54147, SN54148, SN54LS147, SN54LS148
SN74147, SN74148 (TIM9907), SN74LS147, SN74LS148
10-LINE TO 4-LINE AND 8-LINE TO 3-LINE PRIORITY ENCODERS

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SN54LS147, SN74LS147 switching characteristics, $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$ (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	WAVEFORM	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	Any	Any	In-phase output	$C_L = 15\text{ pF}$, $R_L = 2\text{ k}\Omega$	12	18	ns	
t_{PHL}					12	18		
t_{PLH}	Any	Any	Out-of-phase output		21	33	ns	
t_{PHL}					15	23		

SN54LS148, SN74LS148 switching characteristics, $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$ (see Figure 2)

PARAMETER†	FROM (INPUT)	TO (OUTPUT)	WAVEFORM	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	1–7	A0, A1, or A2	In-phase output	$C_L = 15\text{ pF}$, $R_L = 2\text{ k}\Omega$	14	18	ns	
t_{PHL}					15	25		
t_{PLH}	1–7	A0, A1, or A2	Out-of-phase output		20	36	ns	
t_{PHL}					16	29		
t_{PLH}	0–7	EO	Out-of-phase output		7	18	ns	
t_{PHL}					25	40		
t_{PLH}	0–7	GS	In-phase output		35	55	ns	
t_{PHL}					9	21		
t_{PLH}	EI	A0, A1, or A2	In-phase output		16	25	ns	
t_{PHL}					12	25		
t_{PLH}	EI	GS	In-phase output		12	17	ns	
t_{PHL}					14	36		
t_{PLH}	EI	EO	In-phase output		12	21	ns	
t_{PHL}					23	35		

† t_{PLH} = propagation delay time, low-to-high-level output

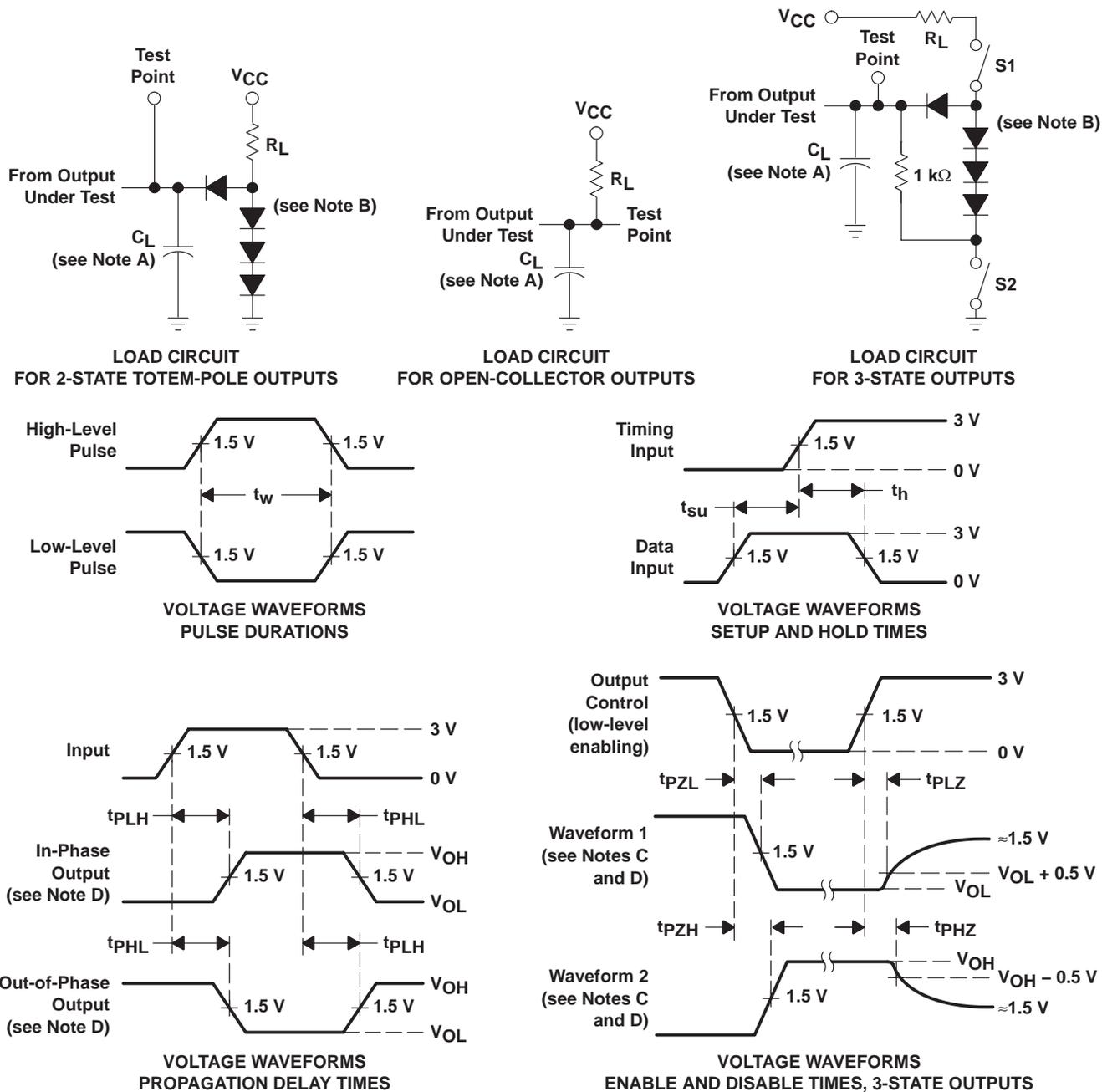
t_{PHL} = propagation delay time, high-to-low-level output



SN54147, SN54148, SN54LS147, SN54LS148
SN74147, SN74148 (TIM9907), SN74LS147, SN74LS148
10-LINE TO 4-LINE AND 8-LINE TO 3-LINE PRIORITY ENCODERS

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PARAMETER MEASUREMENT INFORMATION
SERIES 54/74 DEVICES



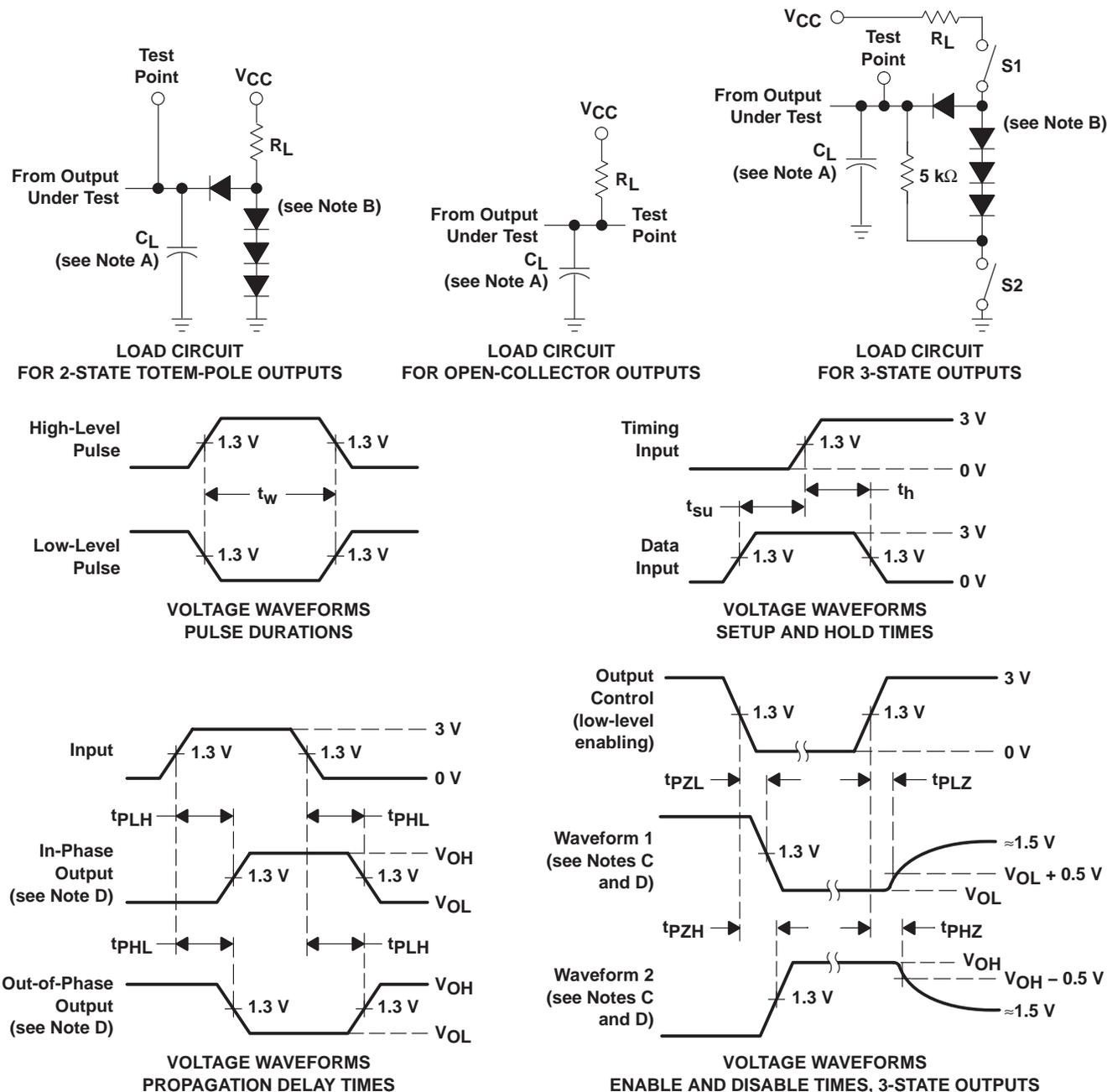
- NOTES:
- A. C_L includes probe and jig capacitance.
 - B. All diodes are 1N3064 or equivalent.
 - C. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
 - D. S1 and S2 are closed for t_{PLH} , t_{PHL} , t_{PHZ} , and t_{PZL} ; S1 is open, and S2 is closed for t_{PZH} ; S1 is closed, and S2 is open for t_{PZL} .
 - E. All input pulses are supplied by generators having the following characteristics: $PRR \leq 1$ MHz, $Z_0 \approx 50 \Omega$; t_r and $t_f \leq 7$ ns for Series 54/74 devices and t_r and $t_f \leq 2.5$ ns for Series 54S/74S devices.
 - F. The outputs are measured one at a time, with one input transition per measurement.

Figure 1. Load Circuits and Voltage Waveforms

**SN54147, SN54148, SN54LS147, SN54LS148
SN74147, SN74148 (TIM9907), SN74LS147, SN74LS148
10-LINE TO 4-LINE AND 8-LINE TO 3-LINE PRIORITY ENCODERS**

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**PARAMETER MEASUREMENT INFORMATION
SERIES 54LS/74LS DEVICES**



- NOTES: A. C_L includes probe and jig capacitance.
 B. All diodes are 1N3064 or equivalent.
 C. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
 D. S1 and S2 are closed for t_{PLH} , t_{PHL} , t_{PHZ} , and t_{PZL} ; S1 is open, and S2 is closed for t_{PZH} ; S1 is closed, and S2 is open for t_{PZL} .
 E. Phase relationships between inputs and outputs have been chosen arbitrarily for these examples.
 F. All input pulses are supplied by generators having the following characteristics: $PRR \leq 1$ MHz, $Z_O \approx 50 \Omega$, $t_r \leq 1.5$ ns, $t_f \leq 2.6$ ns.
 G. The outputs are measured one at a time, with one input transition per measurement.

Figure 2. Load Circuits and Voltage Waveforms



**SN54147, SN54148, SN54LS147, SN54LS148
SN74147, SN74148 (TIM9907), SN74LS147, SN74LS148
10-LINE TO 4-LINE AND 8-LINE TO 3-LINE PRIORITY ENCODERS**

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APPLICATION INFORMATION

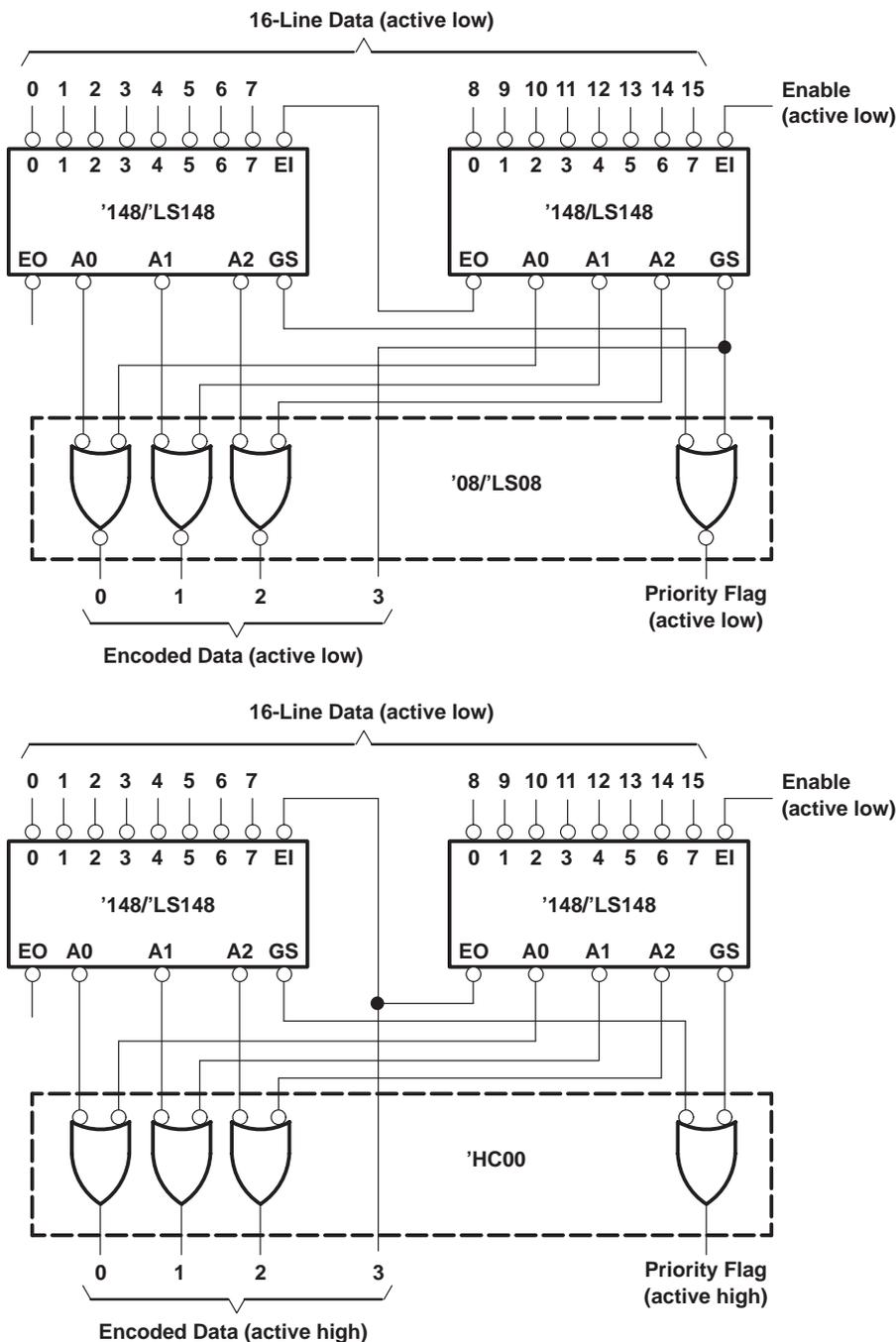


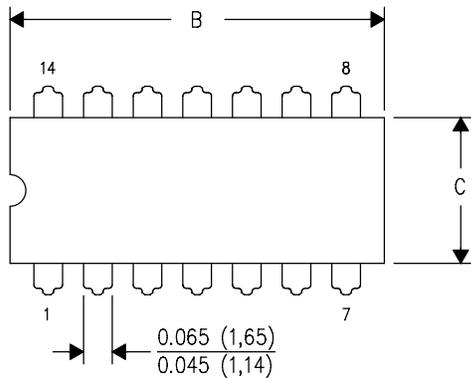
Figure 3. Priority Encoder for 16 Bits

Because the '147/LS147 and '148/LS148 devices are combinational logic circuits, wrong addresses can appear during input transients. Moreover, for the '148/LS148 devices, a change from high to low at EI can cause a transient low on GS when all inputs are high. This must be considered when strobing the outputs.

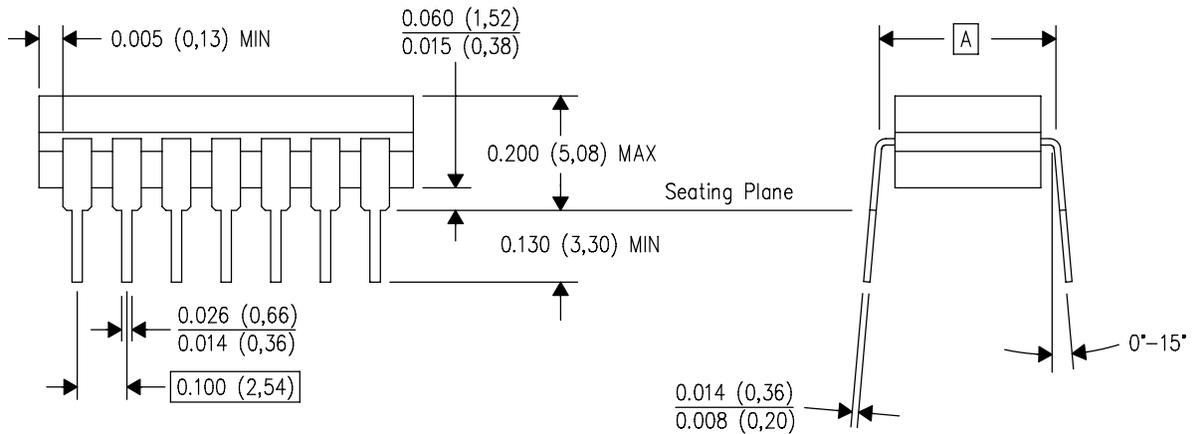
J (R-GDIP-T**)

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



DIM \ PINS **	14	16	18	20
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)

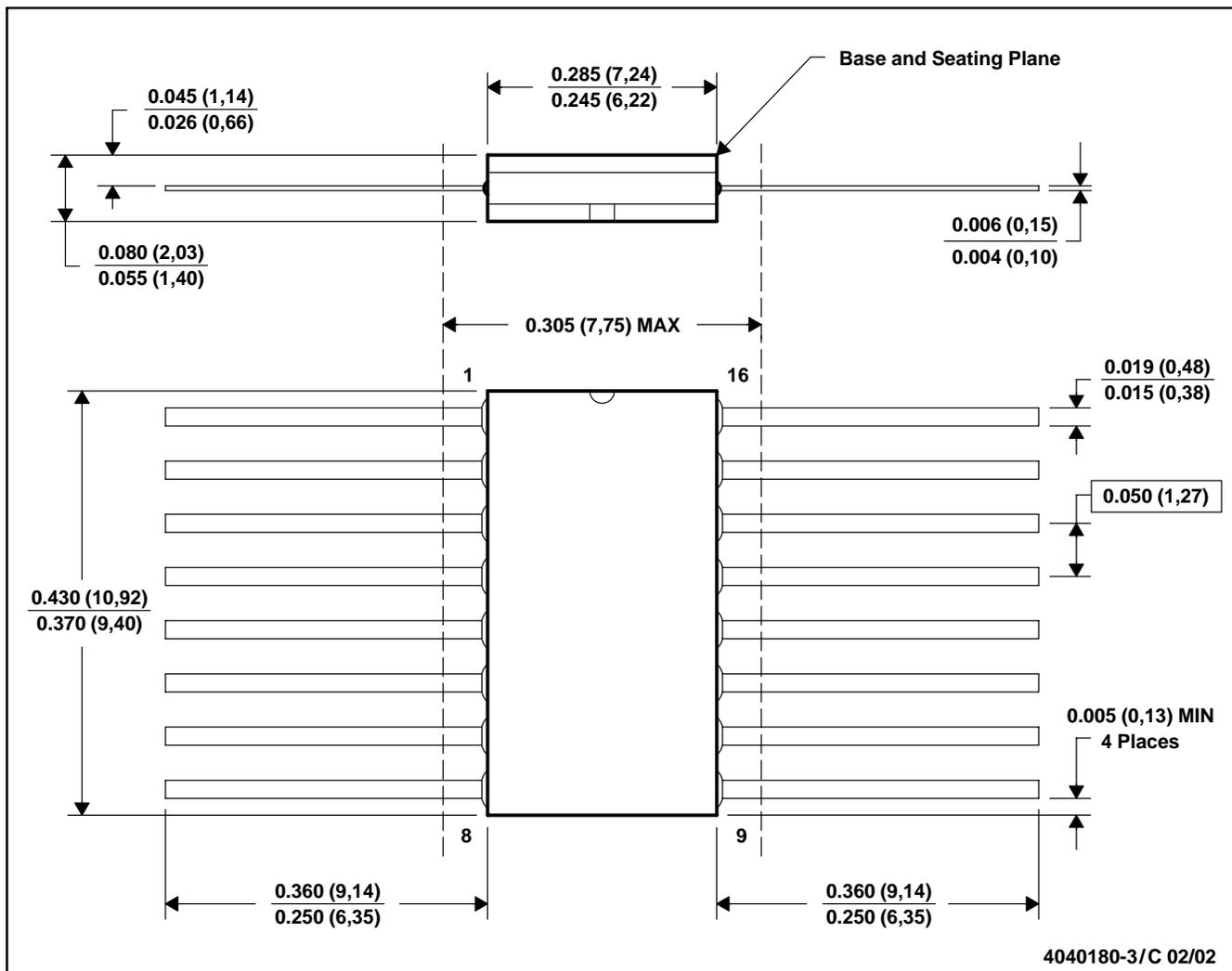


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- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. This package is hermetically sealed with a ceramic lid using glass frit.
 - D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
 - E. Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.

W (R-GDFP-F16)

CERAMIC DUAL FLATPACK

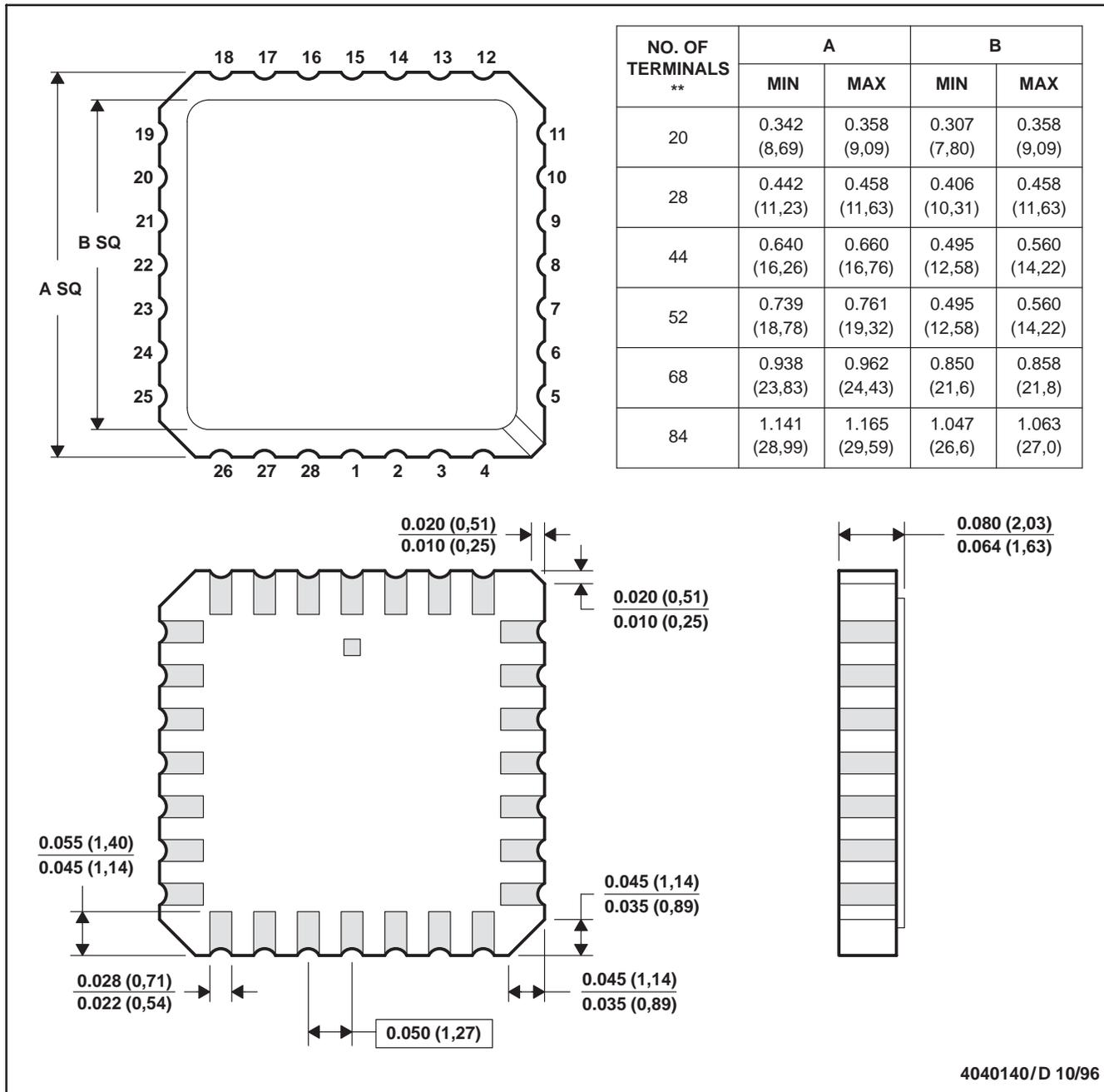


- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. This package can be hermetically sealed with a ceramic lid using glass frit.
 D. Index point is provided on cap for terminal identification only.
 E. Falls within MIL STD 1835 GDFP-1F16 and JEDEC MO-092AC

FK (S-CQCC-N**)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. This package can be hermetically sealed with a metal lid.
 - D. The terminals are gold plated.
 - E. Falls within JEDEC MS-004

N (R-PDIP-T**)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN

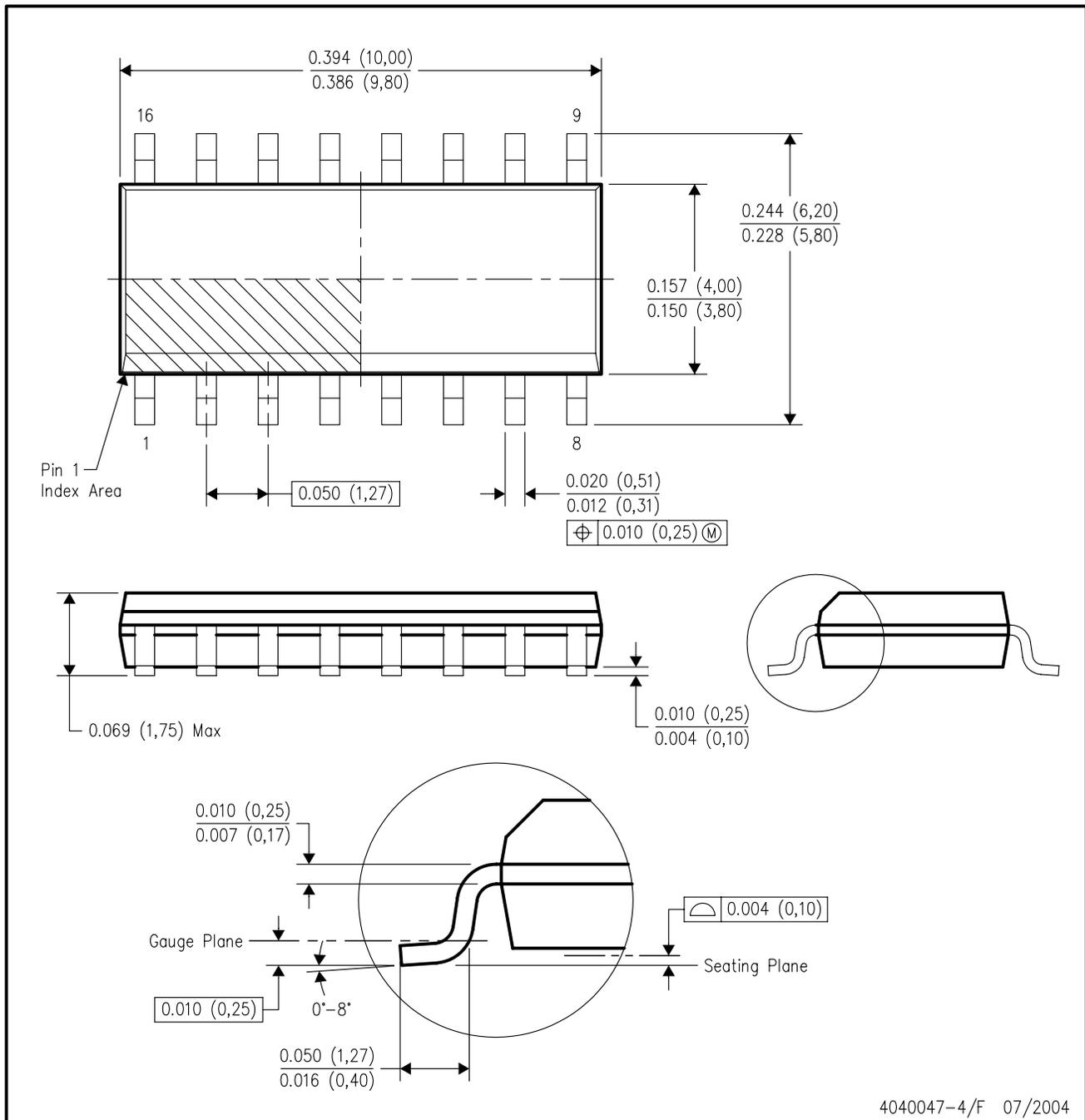


4040049/E 12/2002

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

D (R-PDSO-G16)

PLASTIC SMALL-OUTLINE PACKAGE



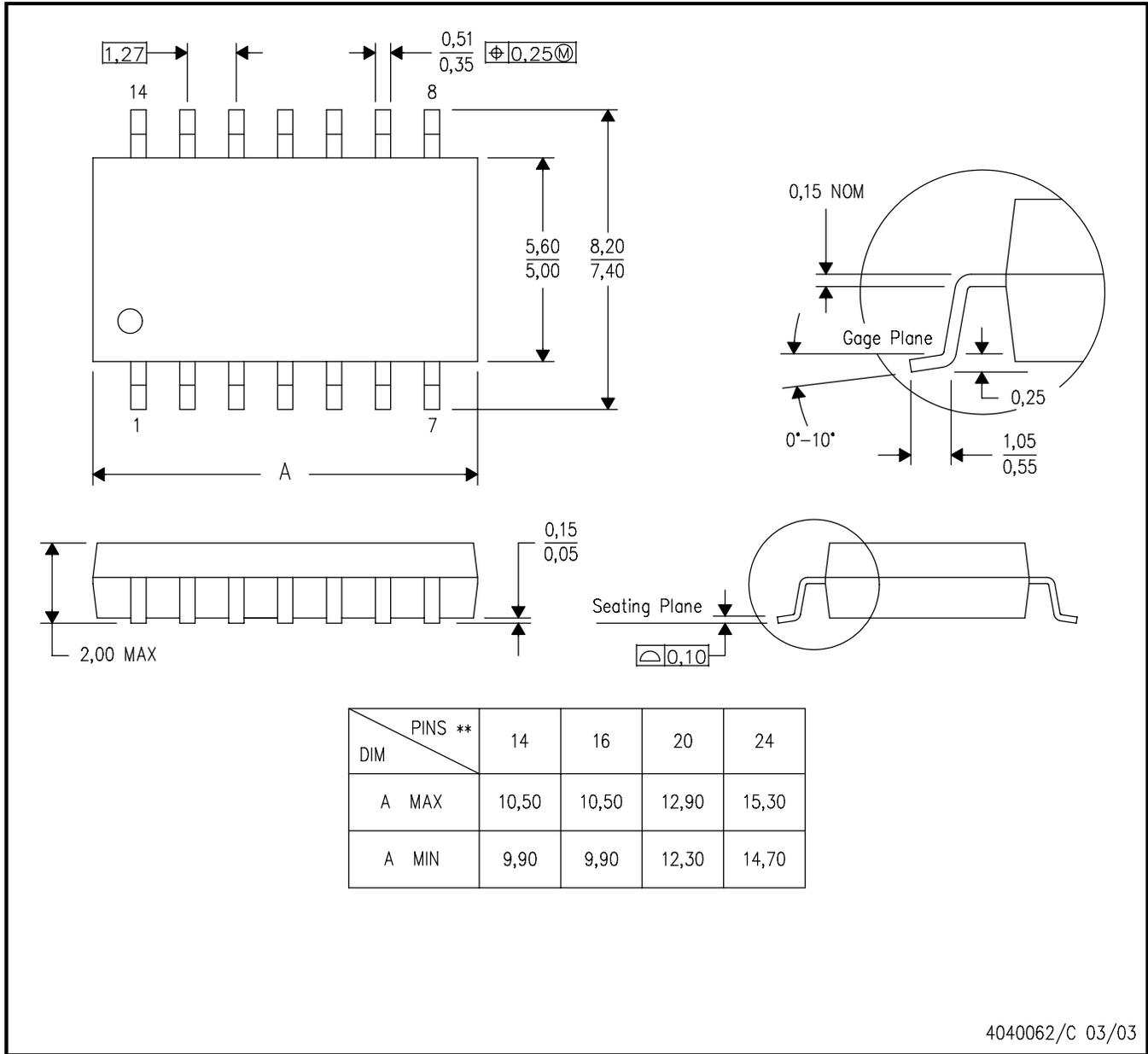
- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 - D. Falls within JEDEC MS-012 variation AC.

MECHANICAL DATA

NS (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14-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.

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