

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

SDLS053 OCTOBER 1978 - REVISED MARCH 1988

## '147, 'LS147

- Encodes 10-Line Decimal to 4-Line BCD
- Applications Include:

Keyboard Encoding  
Range Selection: '148, 'LS148

- Encodes 8 Data Lines to 3-Line Binary (Octal)
- Applications Include:

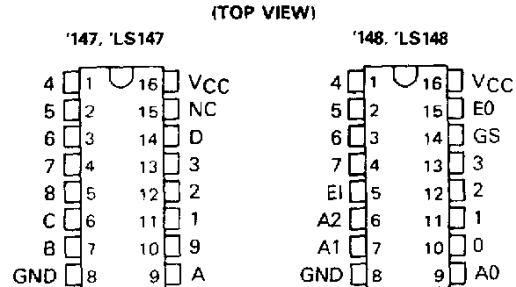
N-Bit Encoding  
Code Converters and Generators

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

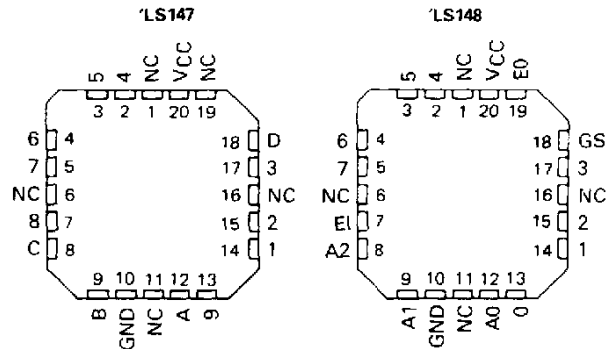
### description

These TTL encoders feature priority decoding of the inputs to ensure that only the highest-order data line is encoded. The '147 and 'LS147 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 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 54LS/74LS load, respectively.

SN54147, SN54LS147,  
SN54148, SN54LS148 . . . J OR W PACKAGE  
SN74147, SN74148 . . . N PACKAGE  
SN74LS147, SN74LS148 . . . D OR N PACKAGE



SN54LS147, SN54LS148 . . . FK PACKAGE  
(TOP VIEW)



NC - No internal connection

'147, 'LS147  
FUNCTION TABLE

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	L
X	X	X	L	H	H	H	H	H	H	L	H	H
X	X	L	H	H	H	H	H	H	H	H	L	L
X	L	H	H	H	H	H	H	H	H	H	L	L
L	H	H	H	H	H	H	H	H	H	H	H	L

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

'148, 'LS148  
FUNCTION TABLE

INPUTS								OUTPUTS					
Ei	0	1	2	3	4	5	6	7	A2	A1	A0	GS	E0
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	L	H	H	L	L	H	L	H
L	X	X	X	X	L	H	H	H	L	H	L	L	H
L	X	X	X	L	H	H	H	H	H	L	L	L	H
L	X	X	L	H	H	H	H	H	H	L	H	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

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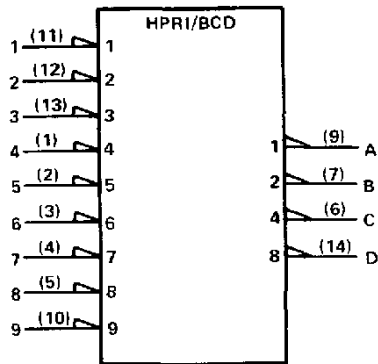
**TEXAS**  
**INSTRUMENTS**

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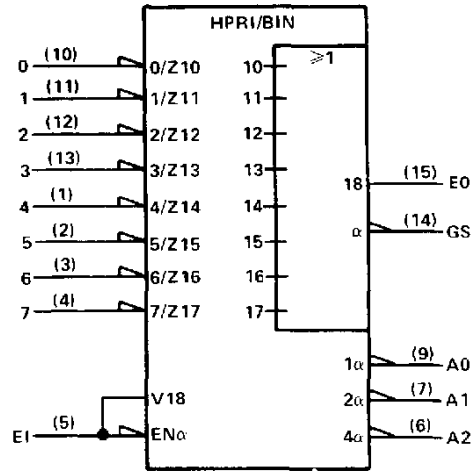
**SN54147, SN54148, SN54LS147, SN54LS148,  
SN74147, SN74148 (TIM9907), SN74LS147, SN74LS148**  
**10-LINE TO 4-LINE AND 8-LINE TO 3-LINE PRIORITY ENCODERS**

**logic symbols†**

'147, 'LS147



'148, 'LS148

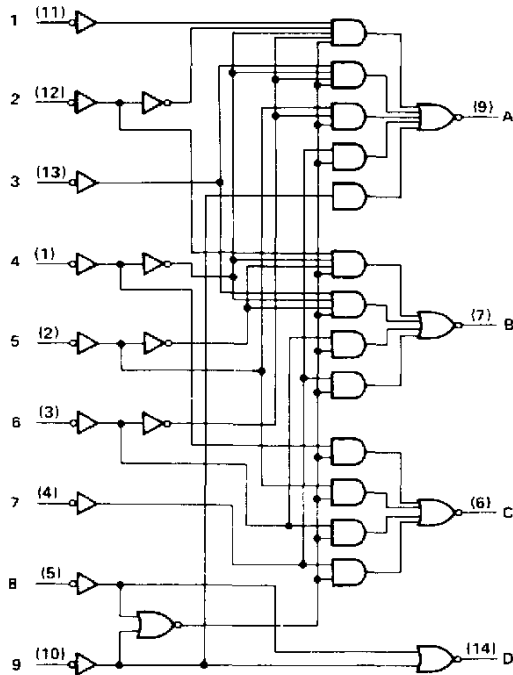


†These symbols are in accordance with ANSI/IEEE Std. 91-1984 and IEC Publication 617-12.

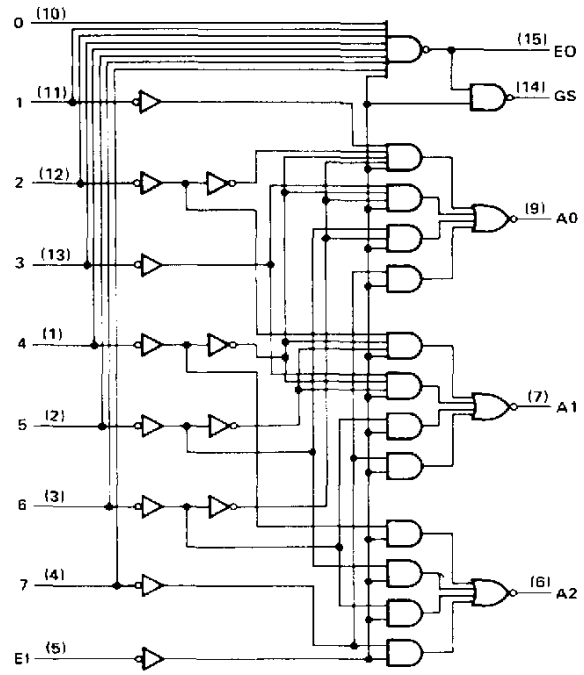
Pin numbers shown are for D, J, N, and W packages.

**logic diagrams**

'147, 'LS147



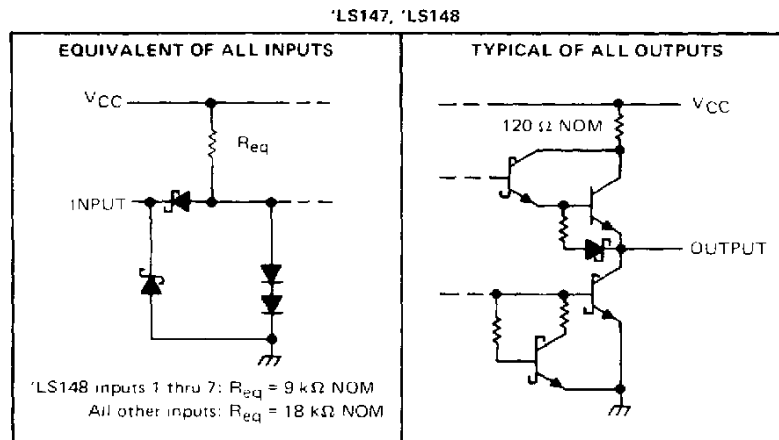
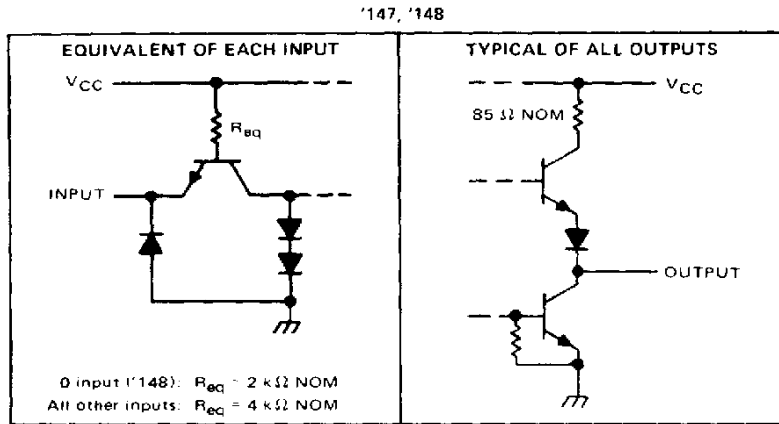
'148, 'LS148



Pin numbers shown are for D, J, N, 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**

schematics of inputs and outputs



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

Supply voltage, $V_{CC}$ (see Note 1)	7 V
Input voltage: '147, '148	5.5 V
'LS147, 'LS148	7 V
Interemitter voltage: '148 only (see Note 2)	5.5 V
Operating free-air temperature range: SN54', SN54LS Circuits	-55°C to 125°C
SN74', SN74LS Circuits	0°C to 70°C
Storage temperature range	-65°C to 150°C

NOTES: 1. Voltage values, except interemitter voltage, are with respect to 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.

recommended operating conditions

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

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

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

PARAMETER		TEST CONDITIONS†	'147		'148		UNIT
			MIN	TYP‡	MAX	MIN	
V <sub>IH</sub>	High-level input voltage		2		2		V
V <sub>IL</sub>	Low-level input voltage		0.8		0.8		V
V <sub>IK</sub>	Input clamp voltage	V <sub>CC</sub> = MIN, I <sub>I</sub> = -12 mA	-1.5		-1.5		V
V <sub>OH</sub>	High-level output voltage	V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V, V <sub>IL</sub> = 0.8 V, I <sub>OH</sub> = -800 µA	2.4	3.3	2.4	3.3	V
V <sub>OL</sub>	Low-level output voltage	V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V, V <sub>IL</sub> = 0.8 V, I <sub>OL</sub> = 16 mA	0.2	0.4	0.2	0.4	V
I <sub>I</sub>	Input current at maximum input voltage	V <sub>CC</sub> = MAX, V <sub>I</sub> = 5.5 V	1		1		mA
I <sub>IH</sub>	High-level input current	0 input			40		µA
		Any input except 0	V <sub>CC</sub> = MAX, V <sub>I</sub> = 2.4 V		80		
I <sub>IL</sub>	Low-level input current	0 input			-1.6		mA
		Any input except 0	V <sub>CC</sub> = MAX, V <sub>I</sub> = 0.4 V		-3.2		
I <sub>OS</sub>	Short-circuit output current <sup>§</sup>	V <sub>CC</sub> = MAX	-35	-85	-35	-85	mA
I <sub>CC</sub>	Supply current	V <sub>CC</sub> = MAX,	Condition 1		40		60
		See Note 3	Condition 2		35		
			50	70	40	60	mA
			42	62	35	55	mA

NOTE 3: For '147, I<sub>CC</sub> (condition 1) is measured with input 7 grounded, other inputs and outputs open; I<sub>CC</sub> (condition 2) is measured with all inputs and outputs open. For '148, I<sub>CC</sub> (condition 1) is measured with inputs 7 and E1 grounded, other inputs and outputs open; I<sub>CC</sub> (condition 2) is measured with all inputs and outputs open.

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

‡ All typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25 °C

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

**SN54147, SN74147 switching characteristics, V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25 °C**

PARAMETER <sup>¶</sup>	FROM (INPUT)	TO (OUTPUT)	WAVEFORM	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t <sub>PLH</sub>	Any	Any	In-phase output	C <sub>L</sub> = 15 pF, R <sub>L</sub> = 400 Ω, See Note 4	9		14	ns
t <sub>PHL</sub>					7		11	
t <sub>PLH</sub>	Any	Any	Out-of-phase output		13		19	ns
t <sub>PHL</sub>					12		19	

**SN54148, SN74148 switching characteristics, V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25 °C**

PARAMETER <sup>¶</sup>	FROM (INPUT)	TO (OUTPUT)	WAVEFORM	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t <sub>PLH</sub>	1 thru 7	A0, A1, or A2	In-phase output	C <sub>L</sub> = 15 pF, R <sub>L</sub> = 400 Ω, See Note 4	10		15	ns
t <sub>PHL</sub>					9		14	
t <sub>PLH</sub>	1 thru 7	A0, A1, or A2	Out-of-phase output		13		19	ns
t <sub>PHL</sub>					12		19	
t <sub>PLH</sub>	0 thru 7	EO	Out-of-phase output		6		10	ns
t <sub>PHL</sub>					14		25	
t <sub>PLH</sub>	0 thru 7	GS	In-phase output		18		30	ns
t <sub>PHL</sub>					14		25	
t <sub>PLH</sub>	E1	A0, A1, or A2	In-phase output		10		15	ns
t <sub>PHL</sub>					10		15	
t <sub>PLH</sub>	E1	GS	In-phase output		8		12	ns
t <sub>PHL</sub>					10		15	
t <sub>PLH</sub>	E1	EO	In-phase output		10		15	ns
t <sub>PHL</sub>					17		30	

¶ t<sub>PLH</sub> = propagation delay time, low-to-high-level output

t<sub>PHL</sub> = propagation delay time, high-to-low-level output

NOTE 4: Load circuits and voltage waveforms are shown in Section 1.

## SN54LS147, SN54LS148, SN74LS147, SN74LS148 10-LINE TO 4-LINE AND 8-LINE TO 3-LINE PRIORITY ENCODERS

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

PARAMETER	TEST CONDITIONS†	SN54LS*		SN74LS*		UNIT
		MIN	TYP‡ MAX	MIN	TYP‡ MAX	
V <sub>IH</sub> High-level input voltage		2		2		V
V <sub>IL</sub> Low-level input voltage			0.7		0.8	V
V <sub>IK</sub> Input clamp voltage	V <sub>CC</sub> = MIN, I <sub>I</sub> = -18 mA		-1.5		-1.5	V
V <sub>OH</sub> High-level output voltage	V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V, V <sub>IL</sub> = 0.8 V, I <sub>OH</sub> = -400 µA	2.5	3.4	2.7	3.4	V
V <sub>OL</sub> Low-level output voltage	V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V, I <sub>OL</sub> = 4 mA		0.25 0.4		0.25 0.4	V
	V <sub>IL</sub> = V <sub>ILmax</sub> , I <sub>OL</sub> = 8 mA				0.35 0.5	
I <sub>I</sub> Input current at maximum input voltage	'LS148 inputs 1 thru 7	V <sub>CC</sub> = MAX, V <sub>I</sub> = 7 V		0.2		mA
	All other inputs			0.1		
I <sub>IH</sub> High-level input current	'LS148 inputs 1 thru 7	V <sub>CC</sub> = MAX, V <sub>I</sub> = 2.7 V		40		µA
	All other inputs			20		
I <sub>IL</sub> Low-level input current	'LS148 inputs 1 thru 7	V <sub>CC</sub> = MAX, V <sub>I</sub> = 0.4 V		-0.8		mA
	All other inputs			-0.4		
I <sub>OS</sub> Short-circuit output current <sup>§</sup>	V <sub>CC</sub> = MAX	-20	-100	-20	-100	mA
I <sub>CC</sub> Supply current	V <sub>CC</sub> = MAX, Condition 1	12	20	12	20	mA
	See Note 5, Condition 2	10	17	10	17	

NOTE 5: For 'LS147, I<sub>CC</sub> (condition 1) is measured with input 7 grounded, other inputs and outputs open, I<sub>CC</sub> (condition 2) is measured with all inputs and outputs open. For 'LS148, I<sub>CC</sub> (condition 1) is measured with inputs 7 and E1 grounded, other inputs and outputs open, I<sub>CC</sub> (condition 2) is measured with all inputs and outputs open.

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

‡ All typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25° C.

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

### SN54LS147, SN74LS147 switching characteristics, V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25° C

PARAMETER <sup>¶</sup>	FROM (INPUT)	TO (OUTPUT)	WAVEFORM	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t <sub>PLH</sub>	Any	Any	In-phase output	C <sub>L</sub> = 15 pF, R <sub>L</sub> = 2 kΩ, See Note 4	12	18	ns	
t <sub>PHL</sub>					12	18		
t <sub>PLH</sub>	Any	Any	Out-of-phase output		21	33	ns	
t <sub>PHL</sub>					15	23		

### SN54LS148, SN74LS148 switching characteristics, V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25° C

PARAMETER <sup>¶</sup>	FROM (INPUT)	TO (OUTPUT)	WAVEFORM	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t <sub>PLH</sub>	1 thru 7	A0, A1, or A2	In-phase output	C <sub>L</sub> = 15 pF, R <sub>L</sub> = 2 kΩ, See Note 4	14	18	ns	
t <sub>PHL</sub>					15	25		
t <sub>PLH</sub>	1 thru 7	A0, A1, or A2	Out-of-phase output		20	36	ns	
t <sub>PHL</sub>					16	29		
t <sub>PLH</sub>	0 thru 7	EO	Out-of-phase output		7	18	ns	
t <sub>PHL</sub>					25	40		
t <sub>PLH</sub>	0 thru 7	GS	In-phase output		35	55	ns	
t <sub>PHL</sub>					9	21		
t <sub>PLH</sub>	E1	A0, A1, or A2	In-phase output		16	25	ns	
t <sub>PHL</sub>					12	25		
t <sub>PLH</sub>	E1	GS	In-phase output		12	17	ns	
t <sub>PHL</sub>					14	36		
t <sub>PLH</sub>	E1	EO	In-phase output		12	21	ns	
t <sub>PHL</sub>					23	35		

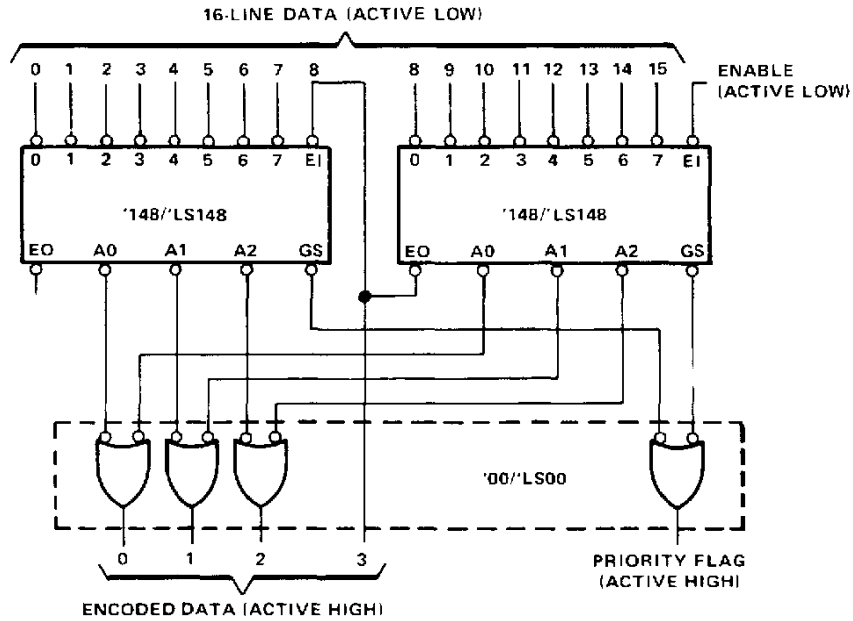
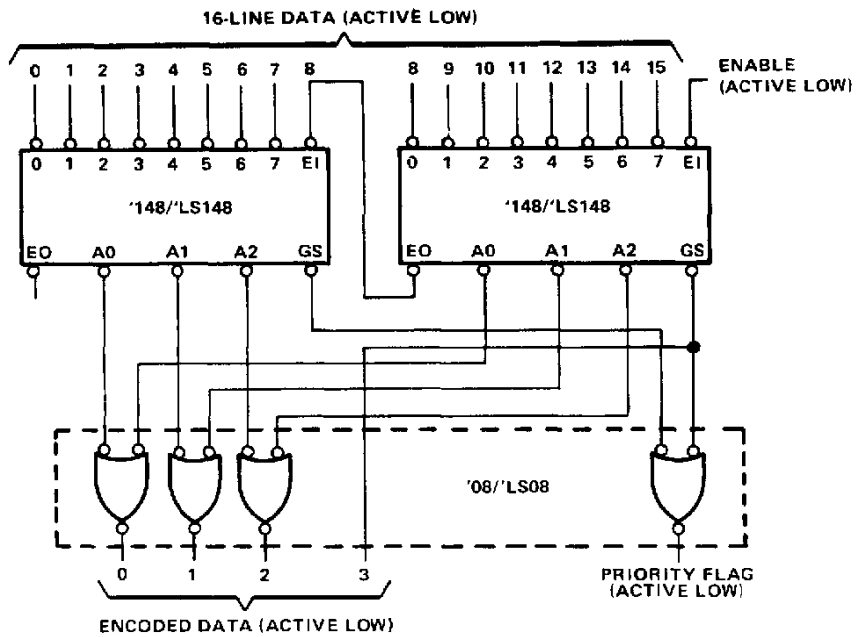
¶ t<sub>PLH</sub> = propagation delay time, low to high level output

t<sub>PHL</sub> = propagation delay time, high to low level output

NOTE 4: Load circuits and voltage waveforms are shown in Section 1.

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

**TYPICAL APPLICATION DATA**



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

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