

# POSITIVE-NAND GATES AND INVERTERS WITH TOTEM-POLE OUTPUTS

## recommended operating conditions

PARAMETER	TEST CONDITIONS <sup>1</sup>	54 FAMILY		SERIES 64H		SERIES 64L		SERIES 64S		SERIES 74S		UNIT
		SERIES 64	SERIES 74	SERIES 64H	SERIES 74H	SERIES 64L	SERIES 74L	SERIES 64S	SERIES 74S	SERIES 64S	SERIES 74S	
Supply voltage, V <sub>CC</sub>		'00, '04, '10, '20, '30	MIN NOM MAX	'H00, 'H04, 'H10, 'H20, 'H30	MIN NOM MAX	'L00, 'L04, 'L10, 'L20, 'L30	MIN NOM MAX	'S00, 'S04, 'S10, 'S20, 'S30, 'S133	MIN NOM MAX	MIN NOM MAX	MIN NOM MAX	V
		4.5 5 5.5	4.5 5 5.5	4.5 5 5.5	4.5 5 5.5	4.5 5 5.5	4.5 5 5.5	4.5 5 5.5	4.5 5 5.5	4.5 5 5.5	4.5 5 5.5	V
High-level output current, I <sub>OH</sub>		4.75 5 5.25	4.75 5 5.25	4.75 5 5.25	4.75 5 5.25	4.75 5 5.25	4.75 5 5.25	4.75 5 5.25	4.75 5 5.25	4.75 5 5.25	4.75 5 5.25	mA
Low-level output current, I <sub>OL</sub>		-400	-400	-400	-400	-400	-400	-400	-400	-400	-400	mA
Operating free-air temperature, T <sub>A</sub>		-55 70	-55 70	-55 70	-55 70	-55 70	-55 70	-55 70	-55 70	-55 70	-55 70	°C

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

PARAMETER	TEST FIGURE	TEST CONDITIONS <sup>1</sup>		SERIES 64H		SERIES 64L		SERIES 64S		SERIES 74S		UNIT
		SERIES 64	SERIES 74	SERIES 64H	SERIES 74H	SERIES 64L	SERIES 74L	SERIES 64S	SERIES 74S	SERIES 64S	SERIES 74S	
V <sub>IH</sub> High-level input voltage	1, 2	2	2	2	2	2	2	2	2	2	2	V
V <sub>IL</sub> Low-level input voltage	1, 2	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.8	V
V <sub>IK</sub> Input clamp voltage	3	V <sub>CC</sub> = MIN, I <sub>I</sub> = 8	0.8	0.8	0.8	0.7	0.7	0.8	0.8	0.8	0.8	V
V <sub>OH</sub> High-level output voltage	1	V <sub>CC</sub> = MIN, I <sub>OH</sub> = MAX	2.4 3.4	2.4 3.5	2.4 3.5	2.4 3.2	2.4 3.3	2.5 3.4	2.5 3.4	2.5 3.4	2.5 3.4	V
V <sub>OL</sub> Low-level output voltage	2	V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V	0.2 0.4	0.2 0.4	0.2 0.4	0.2 0.4	0.15 0.3	0.25 0.4	0.25 0.4	0.25 0.4	0.5	V
I <sub>I</sub> Input current at maximum input voltage	4	V <sub>I</sub> = 5.5 V	1	1	1	0.1	0.1	0.1	0.1	0.1	1	mA
I <sub>IH</sub> High-level input current	4	V <sub>IH</sub> = 2.4 V	40	50	50	10	10	10	10	10	50	μA
I <sub>IL</sub> Low-level input current	5	V <sub>IL</sub> = 0.3 V	-1.5	-2	-2	-0.18	-0.18	-0.18	-0.18	-0.18	-0.4	mA
I <sub>OS</sub> Short-circuit output current*	6	V <sub>CC</sub> = MAX	-20 -55	-40 -100	-3 -15	-20 -100	-3 -15	-20 -100	-3 -15	-20 -100	-40 -100	mA
I <sub>CC</sub> Supply current	7	V <sub>CC</sub> = MAX	-18 -55	-40 -100	-3 -15	-20 -100	-3 -15	-20 -100	-3 -15	-20 -100	-40 -100	mA

<sup>1</sup> For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

<sup>2</sup> All typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.

<sup>3</sup> I<sub>I</sub> = -12 mA for SN64/SN74\*, -8 mA for SN64H/SN74H\*, and -18 mA for SN64LS/SN74LS\* and SN64S/SN74S\*.

\*Not more than one output should be shorted at a time, and for SN64H/SN74H\*, SN64LS/SN74LS\*, and SN64S/SN74S\*, duration of short-circuit should not exceed 1 second.

See table on next page

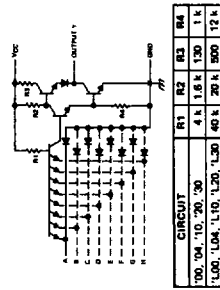
# POSITIVE-NAND GATES AND INVERTERS WITH TOTEM-POLE OUTPUTS

## supply current†

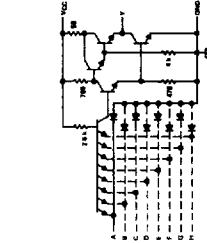
TYPE	I <sub>CCH</sub> (mA) Total with outputs high		I <sub>CCL</sub> (mA) Total with outputs low		I <sub>CC</sub> (mA) Average per gate (50% duty cycle)	
	TYP	MAX	TYP	MAX	TYP	MAX
'00	4	8	12	22	2	2
'04	6	12	18	33	2	2
'10	3	6	9	16.5	2	2
'20	2	4	6	11	2	2
'30	1	2	3	6	2	2
'H00	10	16.8	26	40	4.5	4.5
'H04	16	26	40	58	4.5	4.5
'H10	7.5	12.6	19.5	30	4.5	4.5
'H20	5	8.4	13	20	4.5	4.5
'H30	2.5	4.2	6.5	10	4.5	4.5
'L00	0.44	0.8	1.16	2.04	0.20	0.20
'L04	0.66	1.2	1.74	3.06	0.20	0.20
'L10	0.33	0.6	0.87	1.53	0.20	0.20
'L20	0.22	0.4	0.66	1.02	0.20	0.20
SN64L30	0.11	0.33	0.29	0.51	0.20	0.20
SN74L30	0.11	0.2	0.29	0.51	0.20	0.20
'LS00	0.8	1.6	2.4	4.4	0.4	0.4
'LS04	1.2	2.4	3.6	6.6	0.4	0.4
'LS10	0.6	1.2	1.8	3.3	0.4	0.4
'LS20	0.4	0.8	1.2	2.2	0.4	0.4
'LS30	0.35	0.5	0.6	1.1	0.48	0.48
'S00	10	16	20	36	3.75	3.75
'S04	15	24	30	54	3.75	3.75
'S10	7.5	12	15	27	3.75	3.75
'S20	5	8	10	18	3.75	3.75
'S30	3	6	5.5	10	4.25	4.25
'S133	3	5	5.5	10	4.25	4.25

† Maximum values of I<sub>CC</sub> are over the recommended operating ranges of V<sub>CC</sub> and T<sub>A</sub>; typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.

schematics (each gate)

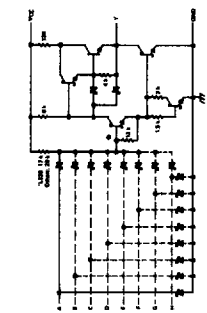


'L00, 'L04, 'L10, 'L20, 'L30, CIRCUITS  
Input clamp diodes not on SN64L/SN74L\* circuits.



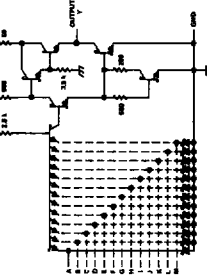
'H00, 'H04, 'H10, 'H20, 'H30 CIRCUITS

Resistor values shown are nominal and in ohms.



'LS00, 'LS04, 'LS10, 'LS20, 'LS30 CIRCUITS

\*The 12-kΩ resistor is not on 'LS30.



'S00, 'S04, 'S10, 'S20, 'S30, 'S133 CIRCUITS

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

TYPE	TEST CONDITIONS#	t <sub>PLH</sub> (ns) Propagation delay time, low-to-high-level output			t <sub>PHL</sub> (ns) Propagation delay time, high-to-low-level output		
		MIN	TYP	MAX	MIN	TYP	MAX
'00, '10	C <sub>L</sub> = 15 pF, R <sub>L</sub> = 400 Ω	11	22	7	15		
'04, '20		12	22	8	15		
'30		13	22	8	15		
'H00	C <sub>L</sub> = 25 pF, R <sub>L</sub> = 280 Ω	5.9	10	6.2	10		
'H04		6	10	6.5	10		
'H10		5.9	10	6.3	10		
'H20	C <sub>L</sub> = 50 pF, R <sub>L</sub> = 4 kΩ	6	10	7	10		
'H30		6.8	10	8.9	12		
'L00, 'L04, 'L10, 'L20		35	60	31	60		
'L30	C <sub>L</sub> = 15 pF, R <sub>L</sub> = 2 kΩ	35	60	70	100		
'LS00, 'LS04		9	15	10	15		
'LS10, 'LS20, 'LS30		8	15	13	20		
'S00, 'S04	C <sub>L</sub> = 15 pF, R <sub>L</sub> = 280 Ω	3	4.5	3	5		
'S10, 'S20		4.5	4.5	5	5		
'S30, 'S133		4	6	4.5	7		
'S30, 'S133	C <sub>L</sub> = 50 pF, R <sub>L</sub> = 280 Ω	5.5	5.5	6.5	6.5		
'S30, 'S133		5.5	5.5	6.5	6.5		

# Load circuits and voltage waveforms are shown on pages 3-10 and 3-11.

# POSITIVE-NAND GATES AND INVERTERS WITH OPEN-COLLECTOR OUTPUTS

## recommended operating conditions

PARAMETER	TEST FIGURE	84 FAMILY		SERIES 84		SERIES 84H		SERIES 84L		SERIES 84LS		SERIES 84S		SERIES 84S		UNIT		
		74 FAMILY	SERIES 74	'01, '02, '06, '12, '22	'101, '102, '105, '122	'101, '102	'101, '102	'101, '102	'101, '102	'101, '102	'101, '102	'101, '102	'101, '102	'101, '102	'101, '102		'101, '102	
Supply voltage, V <sub>CC</sub>			MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	V
High-level output voltage, V <sub>OH</sub>			4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V
Low-level output current, I <sub>OL</sub>			4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	mA
Operating free-air temperature, T <sub>A</sub>			5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	°C

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

PARAMETER	TEST FIGURE	TEST CONDITIONS†		SERIES 84		SERIES 84H		SERIES 84L		SERIES 84LS		SERIES 84S		SERIES 84S		UNIT	
		74 FAMILY	SERIES 74	'01, '02, '06, '12, '22	'101, '102, '105, '122	'101, '102	'101, '102	'101, '102	'101, '102	'101, '102	'101, '102	'101, '102	'101, '102	'101, '102	'101, '102		
V <sub>IH</sub> input voltage	1, 2		0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	V
V <sub>IL</sub> input voltage	1, 2		0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	V
V <sub>IK</sub> input clamp voltage	3	V <sub>CC</sub> - MIN, I <sub>I</sub> = 5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	V
I <sub>OH</sub> output current	1	V <sub>CC</sub> - MIN, V <sub>IL</sub> = V <sub>IL</sub> max, V <sub>OH</sub> = 5.5 V	250	250	250	250	250	250	250	250	250	250	250	250	250	250	μA
V <sub>OL</sub> output voltage	2	V <sub>CC</sub> - MIN, V <sub>IH</sub> = 2 V	0.2	0.4	0.2	0.4	0.2	0.4	0.2	0.4	0.2	0.4	0.2	0.4	0.2	0.4	V
I <sub>I</sub> input current at maximum input voltage	4	V <sub>I</sub> = 5.5 V	1	1	1	1	1	1	1	1	1	1	1	1	1	1	mA
I <sub>IH</sub> input current at high-level input voltage	4	V <sub>I</sub> = 7 V	40	40	40	40	40	40	40	40	40	40	40	40	40	40	μA
I <sub>IL</sub> input current at low-level input voltage	5	V <sub>I</sub> = 0.4 V	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	mA
I <sub>CC</sub> supply current	7	V <sub>CC</sub> - MAX															mA

† 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.

§ I<sub>I</sub> = -12 mA for SN84H/SN74H, -8 mA for SN84LS/SN74LS, and -18 mA for SN84S/SN74S.

See table on next page

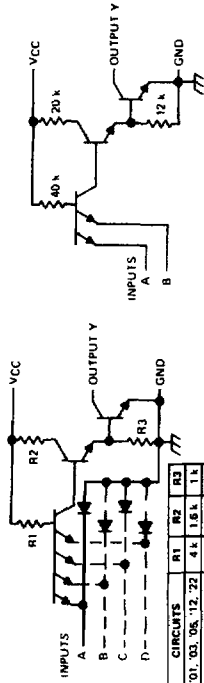
# POSITIVE-NAND GATES AND INVERTERS WITH OPEN-COLLECTOR OUTPUTS

### supply current†

TYPE	I <sub>CC</sub> H (mA) Total with outputs high		I <sub>CC</sub> L (mA) Total with outputs low		I <sub>CC</sub> (mA) Average per Gate (50% duty cycle)	
	TYP	MAX	TYP	MAX	TYP	MAX
'01	4	8	12	22	2	2
'03	4	8	12	22	2	2
'05	6	12	18	33	2	2
'12	3	6	9	16.5	2	2
'22	2	4	6	11	2	2
'H01	6.8	10	26	40	4.1	4.1
'H05	16	26	40	58	4.87	4.87
'H22	3.4	5	13	20	4.1	4.1
'L01	0.44	0.8	1.16	2.04	0.20	0.20
'L03	0.44	0.8	1.16	2.04	0.20	0.20
'LS01	0.8	1.6	2.4	4.4	0.4	0.4
'LS03	0.8	1.6	2.4	4.4	0.4	0.4
'LS05	1.2	2.4	3.6	6.6	0.4	0.4
'LS12	0.7	1.4	1.8	3.3	0.42	0.42
'LS22	0.4	0.8	1.2	2.2	0.4	0.4
'S03	6	13.2	20	36	3.25	3.25
'S05	9	19.8	30	54	3.25	3.25
'S22	3	6.6	10	18	3.25	3.25

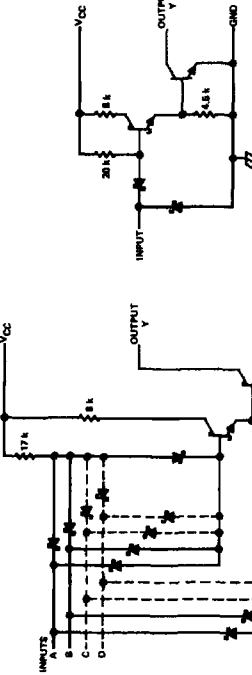
† Maximum values of I<sub>CC</sub> are over the recommended operating ranges of V<sub>CC</sub> and T<sub>A</sub>; typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.

### schematics (each gate)



'L01, 'L03 CIRCUITS

'01, '03, '05, '12, '22, 'H01, 'H05, 'H22 CIRCUITS



'LS05 CIRCUITS

'LS01, 'LS03, 'LS12, 'LS22 CIRCUITS

TYPE	TEST CONDITIONS#	τ <sub>PLH</sub> (ns) Propagation delay time, low-to-high-level output		τ <sub>PHL</sub> (ns) Propagation delay time, high-to-low-level output	
		MIN	TYP	MAX	MAX
'01, '03	C <sub>L</sub> = 15 pF, R <sub>L</sub> = 4 kΩ for τ <sub>PLH</sub> , 400 Ω for τ <sub>PHL</sub>	35	45	8	15
'05		40	55	8	15
'12, '22	C <sub>L</sub> = 25 pF, R <sub>L</sub> = 280 Ω	35	45	8	15
'H01, 'H05, 'H22		10	15	7.5	12
'L01, 'L03	C <sub>L</sub> = 50 pF, R <sub>L</sub> = 4 kΩ	60	90	33	60
'LS01, 'LS03,	C <sub>L</sub> = 15 pF, R <sub>L</sub> = 2 kΩ	17	32	15	28
'LS05, 'LS12, 'LS22		2	5	7.5	2
'S03, 'S05, 'S22	C <sub>L</sub> = 15 pF, R <sub>L</sub> = 280 Ω	2	5	7.5	2
	C <sub>L</sub> = 50 pF, R <sub>L</sub> = 280 Ω	7.5		4.5	7

# Load circuits and voltage waveforms are shown on pages 3-10 and 3-11.

Resistor values shown are nominal and in ohms.

# OPEN-COLLECTOR OUTPUT APPLICATION DATA

## APPLICATION DATA

### combined fan-out and wire-AND capabilities

The open-collector TTL gate, when supplied with a proper load resistor ( $R_L$ ), may be paralleled with other similar TTL gates to perform the wire-AND function, and simultaneously, will drive from one to nine standard loads of its own series. When no other open-collector gates are paralleled, this gate may be used to drive ten loads. For any of these conditions an appropriate load resistor value must be determined for the desired circuit configuration. A maximum resistor value must be determined which will ensure that sufficient load current (to TTL loads) and off current (through paralleled outputs) will be available while the output is high. A minimum resistor value must be determined which will ensure that current through this resistor and sink current from the TTL loads will not cause the output voltage to rise above the low level even if only one of the paralleled outputs is sinking all the currents.

In both conditions (low and high level) the value of  $R_L$  is determined by:

$$R_L = \frac{V_{RL}}{I_{RL}}$$

where  $V_{RL}$  is the voltage drop in volts, and  $I_{RL}$  is the current in amperes.

### high-level (off-state) circuit calculations (see figure A)

The allowable voltage drop across the load resistor ( $V_{RL}$ ) is the difference between  $V_{CC}$  applied and the  $V_{OH}$  level required at the load:

$$V_{RL} = V_{CC} - V_{OH \text{ min}}$$

The total current through the load resistor ( $I_{RL}$ ) is the sum of the load currents ( $I_{IH}$ ) and off-state reverse currents ( $I_{OH}$ ) through each of the wire-AND-connected outputs:

$$I_{RL} = \eta \cdot I_{OH} + N \cdot I_{IH \text{ to TTL loads}}$$

Therefore, calculations for the maximum value of  $R_L$  would be:

$$R_{L(\text{max})} = \frac{V_{CC} - V_{OH \text{ min}}}{\eta \cdot I_{OH} + N \cdot I_{IH}}$$

where  $\eta$  = number of gates wire-AND-connected, and  $N$  = number of standard loads.

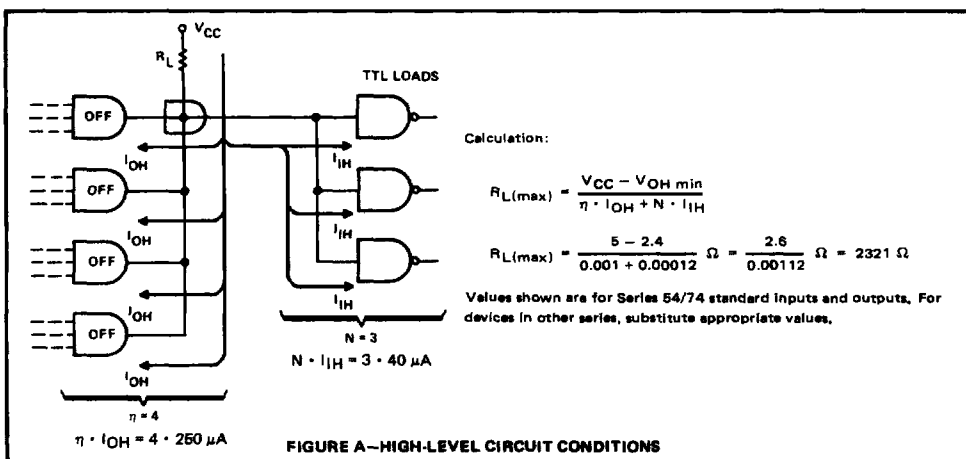


FIGURE A—HIGH-LEVEL CIRCUIT CONDITIONS

# OPEN-COLLECTOR OUTPUT APPLICATION DATA

## APPLICATION DATA

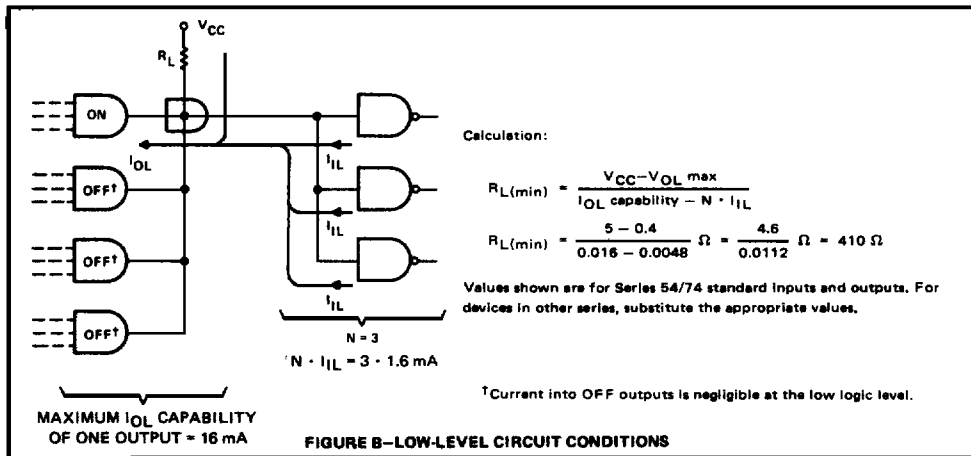
### low-level (on-state) circuit calculations (see figure B)

The current through the resistor must be limited to the maximum sink current of one output transistor. Note that if several output transistors are wire-AND connected, the current through  $R_L$  may be shared by those paralleled transistors. However, unless it can be absolutely guaranteed that more than one transistor will be on during low-level periods, the current must be limited to the recommended maximum  $I_{OL}$ , the maximum current which will ensure that the low-level output voltage,  $V_{OL}$ , will be below  $V_{OL\ max}$ .

Also, fan-out must be considered. Part of  $I_{OL}$  will be supplied from the inputs which are being driven. This reduces the amount of current which can be allowed through  $R_L$ .

Therefore, the equation used to determine the minimum value of  $R_L$  would be:

$$R_{L(\min)} = \frac{V_{CC} - V_{OL\ max}}{I_{OL\ capability} - N \cdot I_{IL}}$$



# POSITIVE-NOR GATES WITH TOTEM-POLE OUTPUTS

## recommended operating conditions

PARAMETER	74 FAMILY		SERIES 54 SERIES 74		SERIES 54L SERIES 74L		SERIES 54LS SERIES 74LS		SERIES 54S SERIES 74S		UNIT
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, V <sub>CC</sub>	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5.5
	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5
High-level output current, I <sub>OH</sub>	-400	-400	-800	-400	-100	-400	-400	-400	-1000	-1000	μA
	-400	-400	-800	-400	-100	-400	-400	-400	-1000	-1000	μA
Low-level output current, I <sub>OL</sub>	16	16	16	16	2	4	2	4	8	8	mA
	16	16	16	16	2	4	2	4	8	8	mA
Operating free-air temperature, T <sub>A</sub>	-55	125	-55	125	-55	125	-55	125	-55	125	°C
	0	70	0	70	0	70	0	70	0	70	°C

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

PARAMETER	TEST FIGURE	TEST CONDITIONS†	SERIES 54		SERIES 54L		SERIES 54LS		SERIES 54S		UNIT	
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX		
V <sub>IH</sub> High-level input voltage	1, 2	54 Family 74 Family	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.8	V	
V <sub>IL</sub> Low-level input voltage	1, 2	54 Family 74 Family	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.8	V	
V <sub>IK</sub> Input clamp voltage	3	V <sub>CC</sub> = MIN, I <sub>I</sub> = 3	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.2	V	
V <sub>OH</sub> High-level output voltage	1	V <sub>CC</sub> = MIN, V <sub>IL</sub> = V <sub>IL</sub> max, I <sub>OH</sub> = MAX	2.4	3.4	2.4	3.3	2.4	3.4	2.5	3.4	V	
V <sub>OL</sub> Low-level output voltage	2	V <sub>CC</sub> = MIN, I <sub>OL</sub> = MAX	0.2	0.4	0.15	0.3	0.25	0.4	0.25	0.4	0.5	V
		I <sub>OL</sub> = 4 mA	0.2	0.4	0.2	0.4	0.35	0.5	0.35	0.5	0.5	V
I <sub>I</sub> Input current at maximum input voltage	4	V <sub>I</sub> = 5.5 V	1	1	0.1	0.1	0.1	0.1	0.1	0.1	1	mA
		V <sub>I</sub> = 7 V	1	1	0.1	0.1	0.1	0.1	0.1	0.1	1	mA
I <sub>IH</sub> High-level input current	4	V <sub>CC</sub> = MAX	40	40	10	10	10	10	10	10	μA	
		V <sub>CC</sub> = MAX	180	180	180	180	180	180	180	180	μA	
I <sub>IL</sub> Low-level input current	5	V <sub>CC</sub> = MAX	-1.6	-1.6	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	mA	
		V <sub>CC</sub> = MAX	-6.4	-6.4	-6.4	-6.4	-6.4	-6.4	-6.4	-6.4	mA	
I <sub>OS</sub> Short-circuit output current‡	6	V <sub>CC</sub> = MAX	-55	-3	-15	-20	-100	-40	-100	-40	mA	
		V <sub>CC</sub> = MAX	-18	-55	-3	-15	-20	-100	-40	-100	mA	
I <sub>CC</sub> Supply current§	7	V <sub>CC</sub> = MAX	-	-	-	-	-	-	-	-	mA	

See table on next page

† 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> = 6 V, T<sub>A</sub> = 25°C.

§ I<sub>I</sub> = -12 mA for SN54/SN74\* and -18 mA for SN54LS/SN74LS\* and SN64S/SN74S\*.

¶ Not more than one output should be shorted at a time, and for SN54LS/SN74LS\* and SN64S/SN74S\*, duration of output short-circuit should not exceed one second.

# POSITIVE-NOR GATES WITH TOTEM-POLE OUTPUTS

## supply current†

TYPE	I <sub>CC</sub> (mA)		I <sub>CL</sub> (mA)		I <sub>CC</sub> (mA)	
	Total with outputs high		Total with outputs low		Average per gate (50% duty cycle)	
	TYP	MAX	TYP	MAX	TYP	MAX
'02	8	16	14	27	2.75	2.75
'25	8	16	10	19	2.25	2.25
'27	10	16	16	26	4.34	4.34
'L02	0.8	1.6	1.4	2.6	0.275	0.275
'LS02	1.6	3.2	2.8	5.4	0.55	0.55
'LS27	2.0	4	3.4	6.8	0.9	0.9
'S02	17	29	26	45	5.38	5.38
'S260	17	29	26	45	10.75	10.75

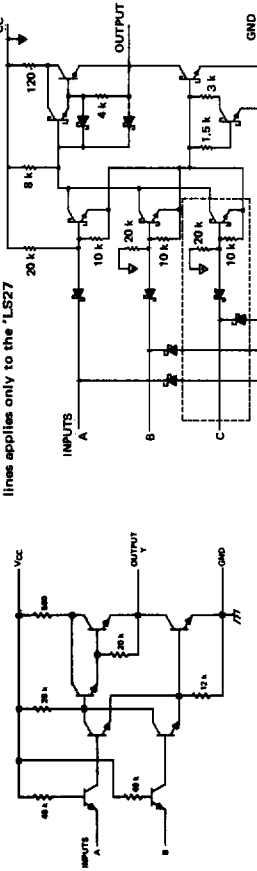
† Maximum values of I<sub>CC</sub> are over the recommended operating ranges of V<sub>CC</sub> and T<sub>A</sub>; typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.

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

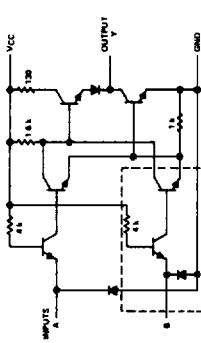
TYPE	TEST CONDITIONS#	t <sub>PLH</sub> (ns)		Propagation delay time, low-to-high-level output		Propagation delay time, high-to-low-level output	
		MIN	TYP	MAX	MIN	TYP	MAX
'02	C <sub>L</sub> = 15 pF, R <sub>L</sub> = 400 Ω	12	15	8	15	8	15
'25		13	22	8	15	8	15
'27		10	15	7	11	7	11
'L02	C <sub>L</sub> = 50 pF, R <sub>L</sub> = 4 kΩ	31	60	35	60	35	60
'LS02, 'LS27		10	15	10	15	10	15
'S02	C <sub>L</sub> = 15 pF, R <sub>L</sub> = 280 Ω	3.5	5.5	3.5	5.5	3.5	5.5
	C <sub>L</sub> = 50 pF, R <sub>L</sub> = 280 Ω	5	5	5	5	5	5
'S260	C <sub>L</sub> = 15 pF, R <sub>L</sub> = 280 Ω	4	5.5	4	6	4	6

# Load circuit and voltage waveforms are shown on pages 3-10 and 3-11.

The portion of the schematic within the dashed lines applies only to the 'LS27

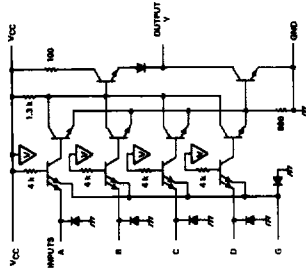


## schematics (each gate)



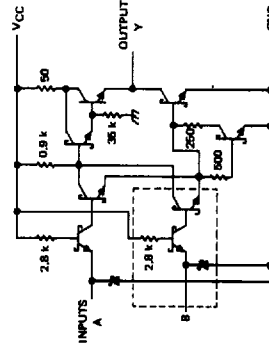
The portion of the schematic within the dashed lines is repeated for the C input of the '27.

## '02, '27 CIRCUIITS



## '25 CIRCUIITS

Resistor values are nominal and in ohms.



The portion of the schematic within the dashed lines is repeated for each additional input of the 'S260, and the 0.9-kΩ resistor is changed to 0.6 kΩ.

## 'S02, 'S260 CIRCUIITS

## 'LS02, 'LS27 CIRCUIITS

## 'L02 CIRCUIITS



# POSITIVE-AND GATES WITH TOTEM-POLE OUTPUTS

## recommended operating conditions

PARAMETER	TEST FIGURE	TEST CONDITIONS <sup>†</sup>	SERIES 54		SERIES 54H		SERIES 54S		SERIES 54S		UNIT
			MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	
Supply Voltage, V <sub>CC</sub>			4.5	5	5.5	4.5	5	5.5	4.5	5	5.5
High-level output current, I <sub>OH</sub>			4.75	5	5.25	4.75	5	5.25	4.75	5	5.25
Low-level output current, I <sub>OL</sub>			-800			-500			-400		-1000
Operating free-air temperature, T <sub>A</sub>			0	70	0	70	0	70	0	70	0

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

PARAMETER	TEST FIGURE	TEST CONDITIONS <sup>†</sup>	SERIES 54		SERIES 54H		SERIES 54S		SERIES 54S		UNIT
			MIN	TYP†	MAX	MIN	TYP†	MAX	MIN	TYP†	
V <sub>IH</sub> High-level input voltage	1, 2		2		2	2		2		2	V
V <sub>IL</sub> Low-level input voltage	1, 2		0.8		0.8	0.8		0.8		0.8	V
V <sub>IK</sub> Input clamp voltage	3	V <sub>CC</sub> = MIN, I <sub>I</sub> = 8	-1.5		-1.5	-1.5		-1.5		-1.5	V
V <sub>OH</sub> High-level output voltage	1	V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V, I <sub>OH</sub> = MAX	2.4	3.4	2.4	3.4	2.5	3.4	2.5	3.4	V
V <sub>OL</sub> Low-level output voltage	2	V <sub>CC</sub> = MIN, I <sub>OL</sub> = MAX	0.2	0.4	0.15	0.3	0.25	0.4	0.25	0.4	V
I <sub>I</sub> Input current at maximum input voltage	4	V <sub>IH</sub> = 2 V, I <sub>OL</sub> = 4 mA	0.2	0.4	0.2	0.4	0.25	0.4	0.25	0.4	mA
I <sub>IH</sub> High-level input current	4	V <sub>CC</sub> = MAX	40		50		0.1				mA
I <sub>IL</sub> Low-level input current	5	V <sub>CC</sub> = MAX	-1.6		-2		20				mA
I <sub>OS</sub> Short circuit output current*	6	V <sub>CC</sub> = MAX	-20	-55	-40	-100	-20	-100	-40	-100	mA
I <sub>CC</sub> Supply current	7	V <sub>CC</sub> = MAX	-18	-55	-40	-100	-20	-100	-40	-100	mA

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

<sup>‡</sup>All typical values are at V<sub>CC</sub> = 2.5 V.

<sup>§</sup>I<sub>I</sub> = -12 mA for SN54/SN74\*, -8 mA for SN54H/SN74H\*, and -18 mA for SN54S/SN74S\* and SN54S/SN74S\*.

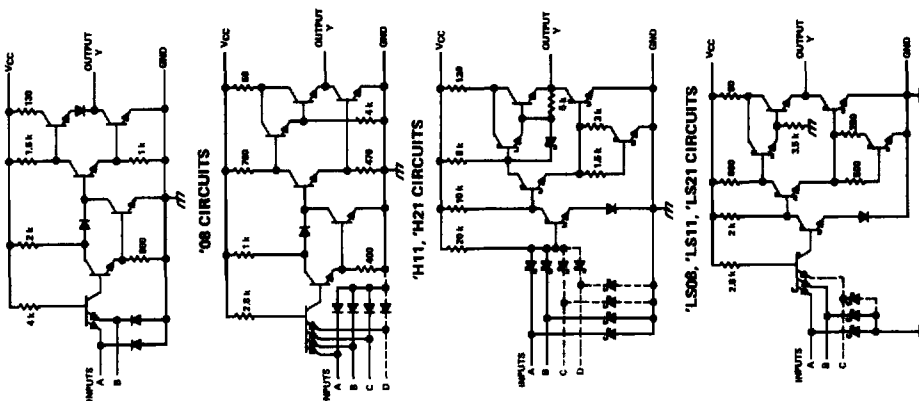
\*Not more than one output should be shorted at a time, and for SN54H/SN74H\*, SN54S/SN74S\* and SN54S/SN74S\*.

duration of output short circuit should not exceed one second.

See table on next page

# POSITIVE-AND GATES WITH TOTEM-POLE OUTPUTS

schematics (each gate)



supply current<sup>†</sup>

TYPE	I <sub>CC</sub> (mA)		I <sub>CL</sub> (mA)		I <sub>CC</sub> (mA)	
	Total with outputs high		Total with outputs low		Average per gate (50% duty cycle)	
	TYP	MAX	TYP	MAX	TYP	MAX
'08	11	21	20	33	3.88	
'H11	18	30	30	48	8	
'H21	12	20	20	32	8	
'LS08	2.4	4.8	4.4	8.8	0.85	
'LS11	1.8	3.6	3.3	6.6	0.85	
'LS21	1.2	2.4	2.2	4.4	0.85	
'S08	18	32	32	57	6.25	
'S11	13.5	24	24	42	6.25	

<sup>†</sup>Maximum values of I<sub>CC</sub> are over the recommended operating ranges of V<sub>CC</sub> and T<sub>A</sub>; typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25° C.

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

TYPE	TEST CONDITIONS#	t <sub>pLH</sub> (ns)		t <sub>pHL</sub> (ns)			
		Propagation delay time, low-to-high-level output		Propagation delay time, high-to-low-level output			
		MIN	TYP	MAX	MIN	TYP	MAX
'08	C <sub>L</sub> = 15 pF, R <sub>L</sub> = 400 Ω		17.5	27	12	19	
'H11, 'H21	C <sub>L</sub> = 25 pF, R <sub>L</sub> = 280 Ω		7.6	12	8.8	12	
'LS08, 'LS11	C <sub>L</sub> = 15 pF, R <sub>L</sub> = 2 kΩ		8	15	10	20	
'LS21	C <sub>L</sub> = 15 pF, R <sub>L</sub> = 280 Ω		4.5	7	5	7.5	
'S08, 'S11	C <sub>L</sub> = 50 pF, R <sub>L</sub> = 280 Ω		6		7.5		

#Load circuit and voltage waveforms are shown on pages 3-10 and 3-11.

'S08, 'S11 CIRCUITS

Resistor values shown are nominal and in ohms.

# POSITIVE-AND GATES WITH OPEN-COLLECTOR OUTPUTS

## recommended operating conditions

	54 FAMILY		SERIES 64		SERIES 64H		SERIES 64LS		SERIES 64S		UNIT	
	74 FAMILY		SERIES 74		SERIES 74H		SERIES 74LS		SERIES 74S			
	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX
Supply Voltage, $V_{CC}$	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5
High-level output voltage, $V_{OH}$	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25
Low-level output current, $I_{OL}$	54 Family		16	74 Family		20	54 Family		4	74 Family		8
Operating free-air temperature, $T_A$	54 Family		-55	74 Family		-55	54 Family		-55	74 Family		-55
	54 Family		0	74 Family		0	54 Family		0	74 Family		0

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

PARAMETER	TEST FIGURE	TEST CONDITIONS†	SERIES 64		SERIES 64H		SERIES 64LS		SERIES 64S		UNIT
			SERIES 74		SERIES 74H		SERIES 74LS		SERIES 74S		
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX
$V_{IH}$ High-level input voltage	1, 2		2		2	2		2	2		V
$V_{IL}$ Low-level input voltage	1, 2		0.8		0.8	0.8		0.7	0.8		V
$V_{IK}$ Input clamp voltage	3	$V_{CC} = \text{MIN}, I_1 = \text{§}$	0.8		0.8	-1.5		-1.5	-1.2		V
$I_{OH}$ High-level output current	1	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{OH} = 5.5 \text{ V}$	250		250	250		100	250		$\mu\text{A}$
$V_{OL}$ Low-level output voltage	2	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}$	0.2	0.4	0.15	0.3	0.25	0.4	0.5		V
$I_1$ Input current at maximum input voltage	4	$V_{CC} = \text{MAX}, I_{OL} = \text{MAX}$	0.2	0.4	0.2	0.4	0.35	0.5	0.5		V
$I_{IH}$ High-level input current	4	$V_{CC} = \text{MAX}, I_{OL} = 4 \text{ mA}$	1		1	0.1		0.1	1		mA
$I_{IL}$ Low-level input current	5	$V_{CC} = \text{MAX}$	40		50	50		20	50		$\mu\text{A}$
$I_{CC}$ Supply current	7	$V_{CC} = \text{MAX}$	-1.6		-2	-2		-0.4	-2		mA

See table on next page

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

‡ All typical values are at  $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$ .

§  $I_1 = -12 \text{ mA}$  for SN64/SN74,  $-8 \text{ mA}$  for SN64H/SN74H, and  $-18 \text{ mA}$  for SN64LS/SN74LS.

# POSITIVE-AND GATES WITH OPEN-COLLECTOR OUTPUTS

## supply current<sup>†</sup>

TYPE	$I_{CCH}$ (mA) Total with outputs high		$I_{CCL}$ (mA) Total with outputs low		$I_{CC}$ (mA) Average per gate (50% duty cycle)	
	TYP	MAX	TYP	MAX	TYP	MAX
'09	11	21	20	33	3.88	
'H15	15	25	30	48	7.5	
'LS09	2.4	4.8	4.4	8.8	0.85	
'LS15	1.8	3.6	3.3	6.6	0.85	
'S09	18	32	32	57	6.25	
'S15	10.5	19.5	24	42	5.75	

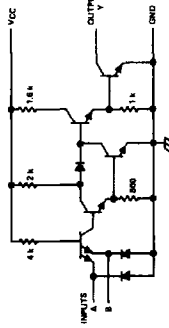
<sup>†</sup>Maximum values of  $I_{CC}$  are over the recommended operating ranges of  $V_{CC}$  and  $T_A$ . Typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

## switching characteristics at $V_{CC} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$

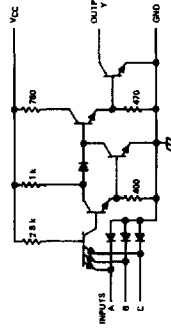
TYPE	TEST CONDITIONS#	$t_{PLH}$ (ns) Propagation delay time, low-to-high-level output		$t_{PHL}$ (ns) Propagation delay time, high-to-low-level output			
		MIN	TYP	MAX	MIN	TYP	MAX
'09	$C_L = 15\text{ pF}$ , $R_L = 400\ \Omega$		21	32	16	24	
'H15	$C_L = 25\text{ pF}$ , $R_L = 280\ \Omega$		12	18	9	13	
'LS09, 'LS15	$C_L = 15\text{ pF}$ , $R_L = 2\text{ k}\Omega$		20	35	17	35	
'S09	$C_L = 15\text{ pF}$ , $R_L = 280\ \Omega$		6.5	10	6.5	10	
	$C_L = 50\text{ pF}$ , $R_L = 280\ \Omega$		9		9		
'S15	$C_L = 15\text{ pF}$ , $R_L = 280\ \Omega$		5.5	8.5	6	9	
	$C_L = 50\text{ pF}$ , $R_L = 280\ \Omega$		8.5		8		

#Load circuit and voltage waveforms are shown on pages 3-10 and 3-11.

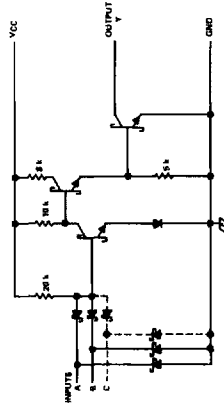
## schematics (each gate)



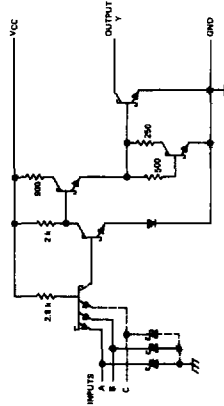
'09 CIRCUITS



'H15 CIRCUITS



'LS09, 'LS15 CIRCUITS



'S09, 'S15 CIRCUITS

Resistor values shown are nominal and in ohms.

# SCHMITT-TRIGGER POSITIVE-NAND GATES AND INVERTERS WITH TOTEM-POLE OUTPUTS

## recommended operating conditions

PARAMETER	54 FAMILY		SERIES 54				SERIES 74LS				SERIES 74ALS				SERIES 74S				UNIT
	74 FAMILY		SERIES 74		'14, '132		'14, '132		'14, '132		'14, '132		'14, '132		'14, '132		'14, '132		
	MIN	TYP	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, $V_{CC}$	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	V
High-level output current, $I_{OH}$			-800			-800			-800			-800			-400			-1000	$\mu$ A
Low-level output current, $I_{OL}$			18			18			18			18			4			20	mA
Operating free-air temperature, $T_A$			-55			125			-55			125			-55			125	$^{\circ}$ C

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

PARAMETER	TEST FIGURE	TEST CONDITIONS <sup>†</sup>				SERIES 54				SERIES 74LS				SERIES 74ALS				SERIES 74S				UNIT	
		SERIES 54		SERIES 74		'13		'14, '132		'13		'14, '132		'13		'14, '132		'13		'14, '132			
		MIN	TYP	MAX	MIN	NOM	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP		MAX
$V_{T+}$ Positive-going threshold voltage	8	$V_{CC} = 5V$				1.5	1.7	2	1.5	1.7	2	1.4	1.6	1.9	1.6	1.77	1.9	1.8	1.9	1.8	1.9	1.9	V
$V_{T-}$ Negative-going threshold voltage	9	$V_{CC} = 5V$				0.8	0.9	1.1	0.6	0.9	1.1	0.5	0.8	1	0.5	0.8	1	1.1	1.22	1.4	1.4	1.4	V
$V_{T+}$ Hysteresis ( $V_{T+} - V_{T-}$ )	8, 9	$V_{CC} = 5V$				0.4	0.8	0.4	0.8	0.4	0.8	0.4	0.8	0.4	0.8	0.2	0.85	0.2	0.85	0.2	0.85	0.2	V
$V_{IK}$ Input clamp voltage	3	$V_{CC} = \text{MIN.}$				-1.5			-1.5			-1.5			1.5			-1.2					V
$V_{OH}$ High-level output voltage	9	$V_{CC} = \text{MAX.}$				2.4	3.4		2.4	3.4		2.5	3.4		2.5	3.4		2.5	3.4		2.5	3.4	V
		$V_I = V_{T-} - \text{min}$				2.4	3.4		2.4	3.4		2.7	3.4		2.7	3.4		2.7	3.4		2.7	3.4	V
$V_{OL}$ Low-level output voltage	8	$V_{CC} = \text{MIN.}$				0.2	0.4		0.2	0.4		0.25	0.4		0.25	0.4		0.25	0.4		0.25	0.4	V
		$V_I = V_{T+} - \text{max}$				0.2	0.4		0.2	0.4		0.25	0.4		0.25	0.4		0.25	0.4		0.25	0.4	V
$I_{T+}$ Input current at positive-going threshold	8	$V_{CC} = 5V, V_I = V_{T+}$				-0.85			-0.43			-0.14			-0.9			-0.9			-0.9		mA
$I_{T-}$ Input current at negative-going threshold	9	$V_{CC} = 5V, V_I = V_{T-}$				-0.85			-0.56			-0.18			-1.1			-1.1			-1.1		mA
$I_{II}$ Input current at maximum input voltage	4	$V_{CC} = \text{MAX}$				1			1			0.1			1			1			1		mA
		$V_I = 5.5V$				1			1			0.1			1			1			1		mA
		$V_I = 7V$				1			1			0.1			1			1			1		mA
$I_{IH}$ High-level input current	4	$V_{CC} = \text{MAX}$				40			40			20			40			20			40		$\mu$ A
		$V_I = 2.4V$				40			40			20			40			20			40		$\mu$ A
		$V_I = 2.7V$				40			40			20			40			20			40		$\mu$ A
$I_{IL}$ Low-level input current	5	$V_{CC} = \text{MAX}$				-1			-1.8			-0.8			-1.2			-0.4			-1.2		mA
		$V_I = 0.4V$				-1			-1.8			-0.8			-1.2			-0.4			-1.2		mA
		$V_I = 0.5V$				-1			-1.8			-0.8			-1.2			-0.4			-1.2		mA
$I_{OS}$ Short-circuit output current <sup>‡</sup>	6	$V_{CC} = \text{MAX}$				-18			-55			-18			-55			-20			-100		mA

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

<sup>‡</sup> All typical values are at  $V_{CC} = 5V, T_A = 25^{\circ}\text{C}$ .

<sup>§</sup>  $I_{II} = -12\text{ mA}$  for SN54/SN74<sup>†</sup> and  $-18\text{ mA}$  for 'LS13, 'LS14, 'LS132, and 'S132.

<sup>¶</sup> Not more than one output should be shorted at a time, and for SN54LS/SN74LS<sup>†</sup> and 'S132, duration of output short-circuit should not exceed one second.

# SCHMITT-TRIGGER POSITIVE-NAND GATES AND INVERTERS WITH TOTEM-POLE OUTPUTS

switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

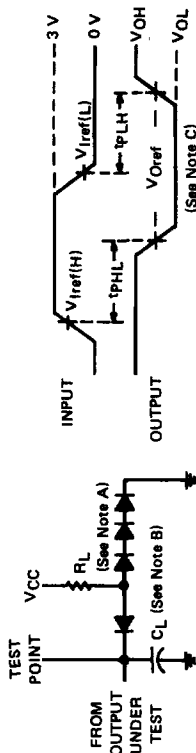
TYPE	TEST CONDITIONS	$t_{PLH}$ (ns)		$t_{PHL}$ (ns)		
		MIN	TYP	MAX	MIN	TYP
'13	$C_L = 15\text{ pF}$ , $R_L = 400\ \Omega$	18	27	15	22	
'14, '132		15	22	15	22	
'LS13		15	22	18	27	
'LS14	$C_L = 15\text{ pF}$ , $R_L = 2\text{ k}\Omega$	15	22	15	22	
'LS132		15	22	15	22	
'S132	$C_L = 15\text{ pF}$ , $R_L = 280\ \Omega$	7	10.5	8.5	13	

supply current<sup>1</sup>

TYPE	$I_{OCH}$ (mA)		$I_{OCL}$ (mA)		$I_{CC}$ (mA)	
	TYP	MAX	TYP	MAX	Average per gate outputs low (50% duty cycle)	
'13	14	23	20	32	8.5	
'14	22	36	39	60	5.1	
'132	15	24	28	40	5.1	
'LS13	2.9	6	4.1	7	1.75	
'LS14	8.6	16	12	21	1.72	
'LS132	5.9	11	8.2	14	1.76	
'S132	28	44	44	68	9	

<sup>1</sup> Maximum values of  $I_{CC}$  are over the recommended operating ranges of  $V_{CC}$  and  $T_A$ . Typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

## PARAMETER MEASUREMENT INFORMATION

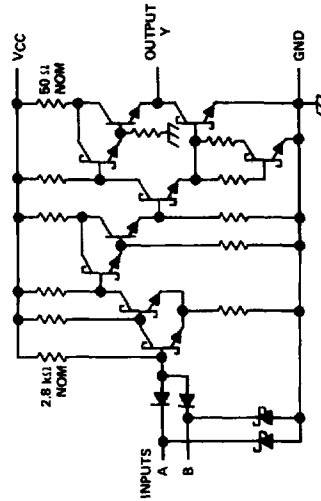
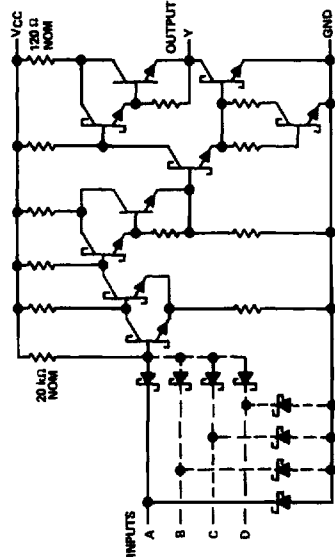
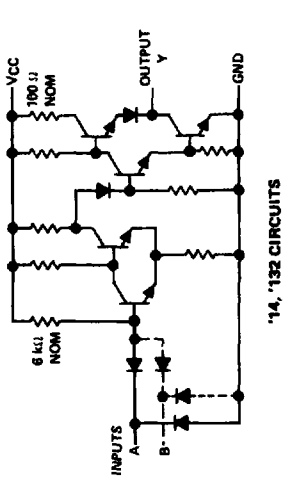
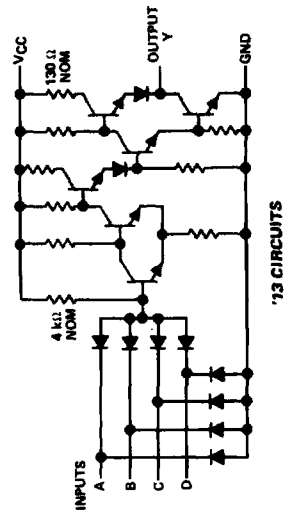


NOTES: A. All diodes are 1N916 or 1N3064.  
B.  $C_L$  includes probe and jig capacitance.  
C. Generator characteristics and reference voltages are:

	Generator Characteristics		Reference Voltages			
	$Z_{out}$	$t_r$	$V_{I\text{ref}}(H)$	$V_{I\text{ref}}(L)$	$V_{O\text{ref}}$	
SNSA/SN74 <sup>1</sup>	50 $\Omega$	1 MHz	10 ns	1.7 V	0.8 V	1.5 V
SNS4LS/SN74LS <sup>1</sup>	50 $\Omega$	1 MHz	15 ns	1.8 V	0.8 V	1.3 V
'S132	50 $\Omega$	1 MHz	2.5 ns	1.8 V	1.2 V	1.5 V

# SCHMITT-TRIGGER POSITIVE-NAND GATES AND INVERTERS WITH TOTEM-POLE OUTPUTS

schematics (each gate)



Resistor values shown are nominal.

# SCHMITT-TRIGGER POSITIVE-NAND GATES AND INVERTERS WITH TOTEM-POLE OUTPUTS

## TYPICAL CHARACTERISTICS OF '13, '14, AND '132 CIRCUITS†

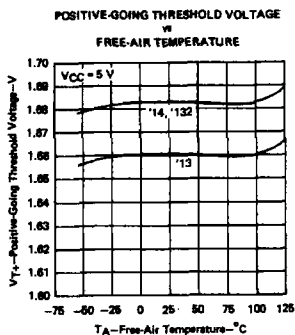


FIGURE 1

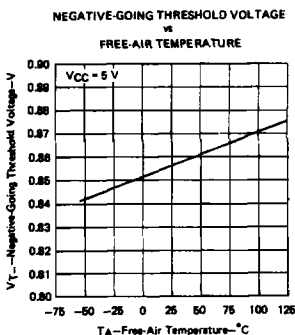


FIGURE 2

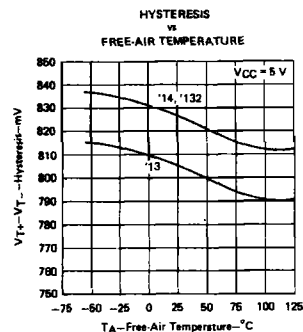


FIGURE 3

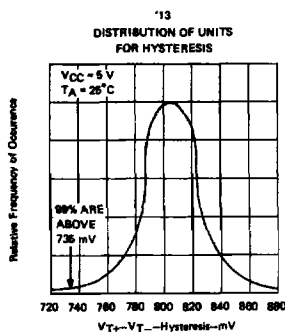


FIGURE 4

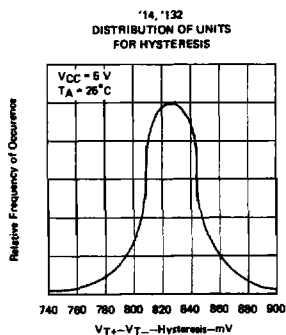


FIGURE 5

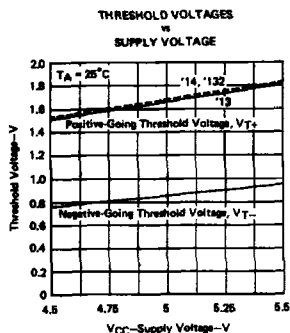


FIGURE 6

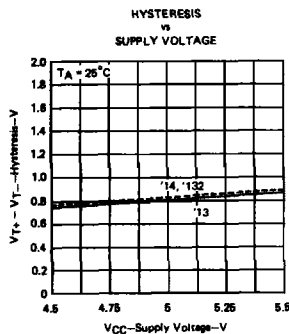


FIGURE 7

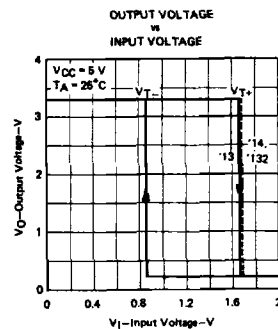


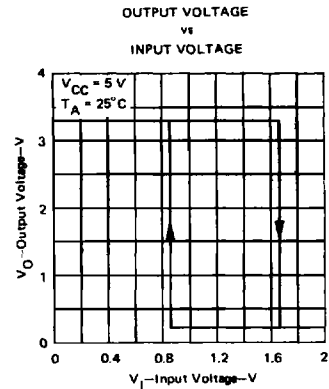
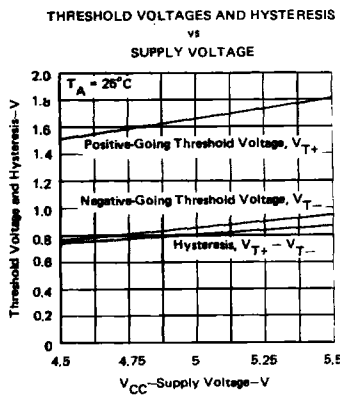
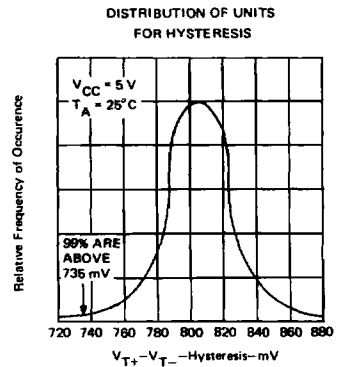
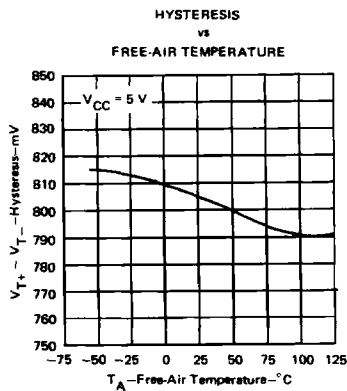
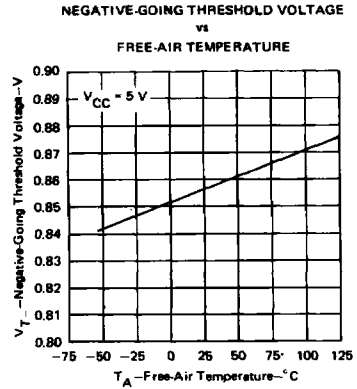
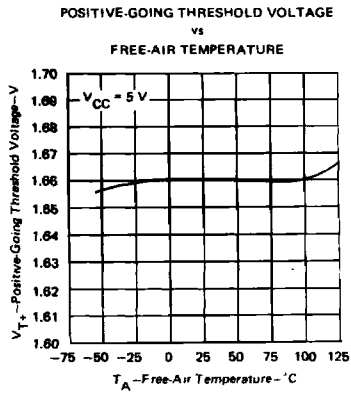
FIGURE 8

†Data for temperatures below 0°C and 70°C and supply voltages below 4.75V and above 5.25 V are applicable for SN5413, SN5414, and SN54132 only.



# SCHMITT-TRIGGER POSITIVE-NAND GATES AND INVERTERS WITH TOTEM-POLE OUTPUTS

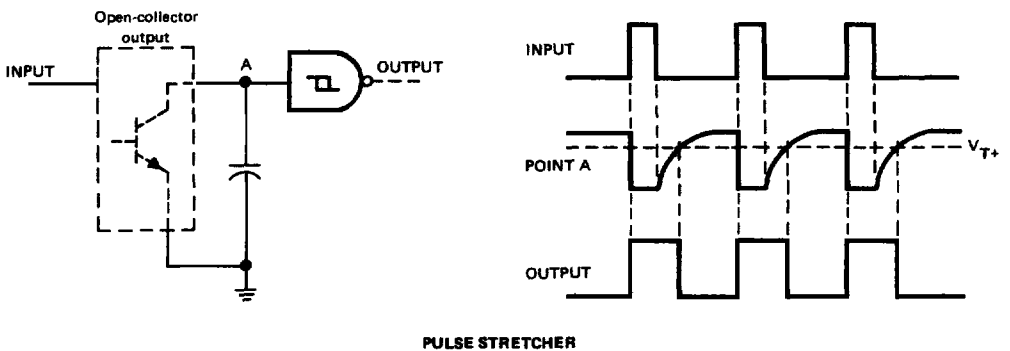
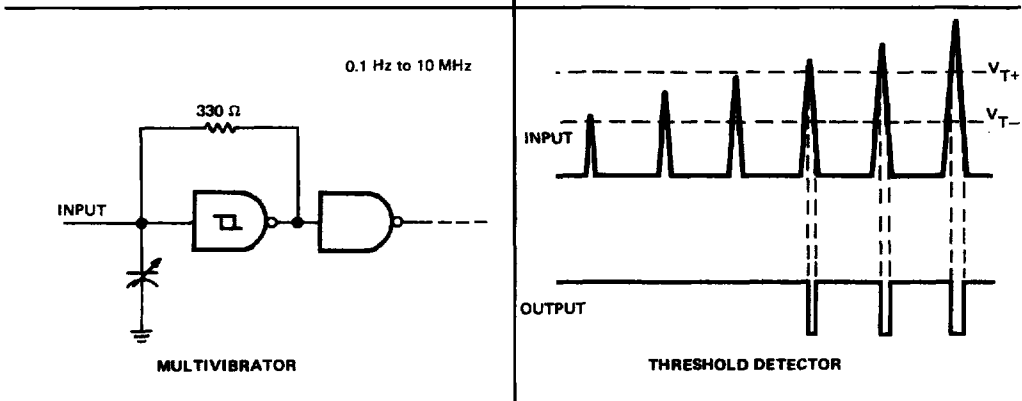
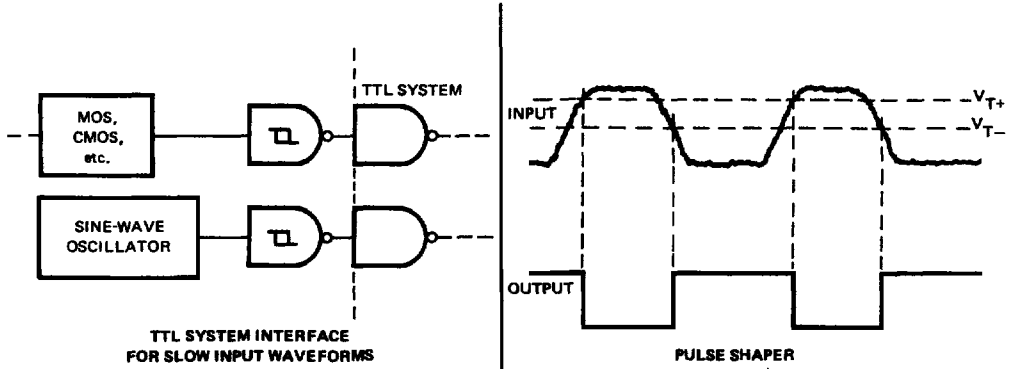
## TYPICAL CHARACTERISTICS OF 'LS13, 'LS14, AND 'LS132 CIRCUITS†



† Data for temperatures below 0°C and above 70°C and supply voltages below 4.75 V and above 5.25 are applicable for SN54LS13, SN54LS14, and SN54LS132 only.

# SCHMITT-TRIGGER POSITIVE-NAND GATES AND INVERTERS WITH TOTEM-POLE OUTPUTS

## TYPICAL APPLICATION DATA



# BUFFERS/CLOCK DRIVERS WITH TOTEM-POLE OUTPUTS

## recommended operating conditions

PARAMETER	TEST CONDITIONS†	SERIES 54		SERIES 54H		SERIES 54LS		SERIES 54S		UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	
Supply voltage, V <sub>CC</sub>		4.5	5	5.5	4.5	5	5.5	4.5	5	5.5
High-level output current, I <sub>OH</sub>		4.75	5	5.25	4.75	5	5.25	4.75	5	5.25
Low-level output current, I <sub>OL</sub>		-2.4		-1.2		-1.5		-1.2		-3
Operating free-air temperature, T <sub>A</sub>		0	70	0	70	0	70	0	70	0

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

PARAMETER	TEST FIGURE	TEST CONDITIONS†	SERIES 54		SERIES 54H		SERIES 54LS		SERIES 54S		UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	
V <sub>IH</sub> High-level input voltage	1, 2		0.8		0.8		0.7		0.8		V
V <sub>IL</sub> Low-level input voltage	1, 2		0.8		0.8		0.8		0.8		V
V <sub>IK</sub> Input clamp voltage	3	V <sub>CC</sub> = MIN, I <sub>I</sub> = §	-1.5		-1.5		-1.5		-1.5		V
V <sub>OH</sub> High-level output voltage	1	V <sub>CC</sub> = MIN, V <sub>IL</sub> = V <sub>IL</sub> max, I <sub>OH</sub> = MAX	2.4	3.4	2.4	3.4	2.5	3.4	2.7	3.4	V
V <sub>OL</sub> Low-level output voltage	2	V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V, I <sub>OL</sub> = 12 mA	0.2	0.4	0.2	0.4	0.2	0.4	0.35	0.5	V
I <sub>I</sub> Input current at maximum input voltage	4	V <sub>CC</sub> = MAX, V <sub>IH</sub> = 2 V	1		1		0.1				mA
I <sub>IH</sub> High-level input current	4	V <sub>CC</sub> = MAX, V <sub>IH</sub> = 2.4 V	40		40		100				µA
I <sub>IL</sub> Low-level input current	5	V <sub>CC</sub> = MAX, V <sub>IL</sub> = 0.4 V	-1.6		-1.6		-4				mA
I <sub>OS</sub> Short-circuit output current*	6	V <sub>CC</sub> = MAX, V <sub>IH</sub> = 0.5 V	-70	-180	-70	-40	-126	-30	-130	-50	mA
I <sub>CC</sub> Supply current	7	V <sub>CC</sub> = MAX	-70	-180	-70	-40	-126	-30	-130	-50	mA

† 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.

§ I<sub>I</sub> = -12 mA for SN54/SN74, -8 mA for SN54H/SN74H, and -18 mA for SN54LS/SN74LS and SN54S/SN74S.

\* Not more than one output should be shorted at a time, and duration of the short-circuit should not exceed one second for all of these circuits except 'S37 and 'S40, or 100 milliseconds for 'S37 and 'S40.

See table on next page

# BUFFERS/CLOCK DRIVERS WITH TOTEM-POLE OUTPUTS

switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

supply current<sup>†</sup>

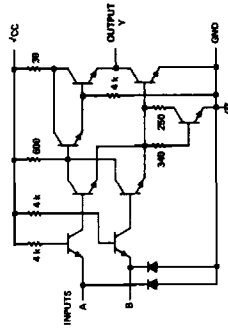
TYPE	I <sub>CCH</sub> (mA) Total with outputs high		I <sub>CCL</sub> (mA) Total with outputs low		I <sub>CC</sub> (mA) Average per gate (50% duty cycle)	
	TYP	MAX	TYP	MAX	TYP	MAX
'28	12	21	33	57	5.63	
'37	9	15.5	34	54	5.38	
'40	4	8	17	27	5.25	
'H40	10.4	16	25	40	8.05	
'LS28	1.8	3.6	6.9	13.8	1.09	
'LS37	0.9	2	6	12	0.85	
'LS40	0.45	1	3	6	0.85	
'S37	20	36	46	80	8.25	
'S40	10	18	25	44	8.75	

<sup>†</sup> Maximum values of I<sub>CC</sub> are over the recommended operating ranges of V<sub>CC</sub> and T<sub>A</sub>; typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.

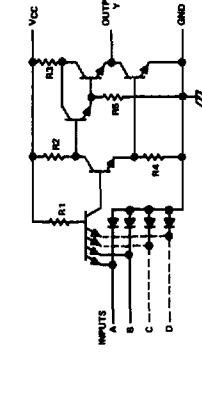
schematics (each gate)

TYPE	TEST CONDITIONS#	t <sub>PLH</sub> (ns) Propagation delay time, low-to-high-level output			t <sub>PHL</sub> (ns) Propagation delay time, high-to-low output		
		MIN	TYP	MAX	MIN	TYP	MAX
'28	C <sub>L</sub> = 50 pF, R <sub>L</sub> = 133 Ω		6	9	8	12	
	C <sub>L</sub> = 150 pF, R <sub>L</sub> = 133 Ω		10	15	12	18	
'37	C <sub>L</sub> = 45 pF, R <sub>L</sub> = 22 Ω		13	22	8	15	
'40	C <sub>L</sub> = 15 pF, R <sub>L</sub> = 133 Ω		13	22	8	15	
'H40	C <sub>L</sub> = 25 pF, R <sub>L</sub> = 93 Ω		8.5	12	6.5	12	
'LS28			12	24	12	24	
'LS37	C <sub>L</sub> = 45 pF, R <sub>L</sub> = 667 Ω		12	24	12	24	
'LS40			12	24	12	24	
'S37	C <sub>L</sub> = 50 pF, R <sub>L</sub> = 93 Ω		4	6.5	4	6.5	
'S40			6		6		

# Load circuit and voltage waveforms are shown on pages 3-10 and 3-11.

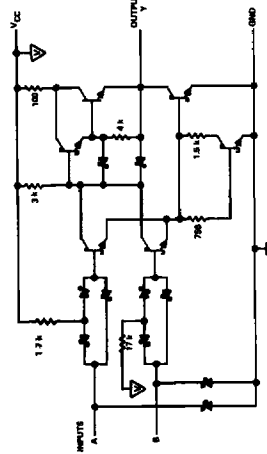


'28 CIRCuits



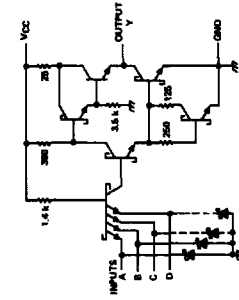
'37, '40, 'H40 CIRCuits

'37	'40	'H40
R1	4 k	4 k
R2	600	600
R3	100	100
R4	400	400
R5	4 k	4 k
R6	4 k	2 k

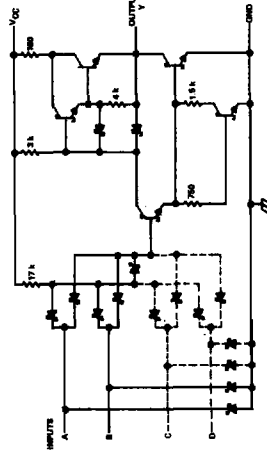


'LS28 CIRCuits

Resistor values shown are nominal and in ohms.



'S37, 'S40 CIRCuits



'LS37, 'LS40 CIRCuits

# 50-OHM/75-OHM LINE DRIVERS

## recommended operating conditions

PARAMETER	TEST FIGURE	TEST CONDITIONS†	SERIES 54		SERIES 54S		SERIES 74S		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, V <sub>CC</sub>			4.5	5.5	4.5	5.5	4.5	5.5	V
High-level output current, I <sub>OH</sub>			4.75	5	4.75	5	4.75	5	mA
Low-level output current, I <sub>OL</sub>					-29	-40			mA
Operating free-air temperature, T <sub>A</sub>			-55	125	-55	125	0	70	°C

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

PARAMETER	TEST FIGURE	TEST CONDITIONS†	SERIES 54		SERIES 54S		SERIES 74S		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
V <sub>IH</sub> High-level input voltage	1, 2		2	0.8	2	0.8	2	0.8	V
V <sub>IL</sub> Low-level input voltage	1, 2								V
V <sub>IK</sub> Input clamp voltage	3	V <sub>CC</sub> = MIN, I <sub>I</sub> = §							V
V <sub>OH</sub> High-level output voltage	1	V <sub>CC</sub> = MIN, V <sub>IL</sub> = 0.8 V, I <sub>OH</sub> = -2.4 mA	54 Family	2.4	3.4				
			74 Family	2.4	3.4				
		V <sub>CC</sub> = MIN, V <sub>IL</sub> = 0.4 V, I <sub>OH</sub> = -13.2 mA		2.4					
		V <sub>CC</sub> = MIN, V <sub>IL</sub> = 0.4 V, I <sub>OH</sub> = MAX		2					
V <sub>OL</sub> Low-level output voltage	2	V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V, I <sub>OL</sub> = 50 Ω to GND	54 Family						
			74 Family						
I <sub>I</sub> Input current at maximum input voltage	4	V <sub>CC</sub> = MAX, V <sub>I</sub> = 5.5 V		0.26	0.4		1	1	mA
I <sub>IH</sub> High-level input current	4	V <sub>CC</sub> = MAX			40			100	μA
		V <sub>IH</sub> = 2.7 V							
I <sub>IL</sub> Low-level input current	5	V <sub>CC</sub> = MAX			-1.6			-4	mA
		V <sub>IL</sub> = 0.5 V							
I <sub>OS</sub> Short-circuit output current‡	6	V <sub>CC</sub> = MAX		-70	-180		-50	-225	mA
		Total, outputs high		12	21		10	18	
		Total, outputs low		33	57		25	44	
I <sub>CC</sub> Supply current	7	V <sub>CC</sub> = 5 V, 50% duty cycle		5.63			8.75		mA
		Average per gate							

† 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.

§ I<sub>I</sub> = -12 mA for '128 and -18 mA for 'S140.

¶ Not more than one output should be shorted at a time, and duration of short circuit should not exceed one second for '128 or 100 milliseconds for 'S140.

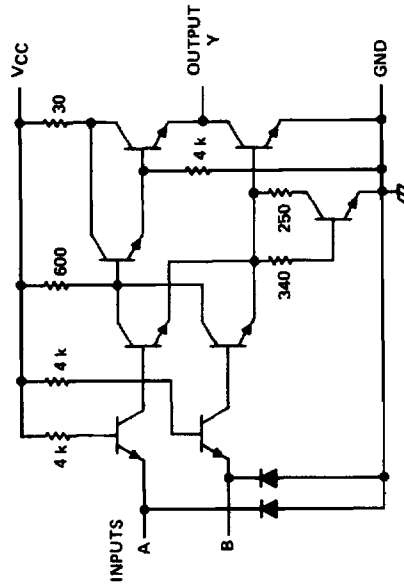
# 50-OHM/75-OHM LINE DRIVERS

switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

TYPE	TEST CONDITIONS#	$t_{PLH}$ (ns)		Propagation delay time, high-to-low-level output	
		MIN	TYP	MAX	TYP
'128	$C_L = 50\text{ pF}$ , $R_L = 133\ \Omega$	6	9	8	12
	$C_L = 150\text{ pF}$ , $R_L = 133\ \Omega$	10	15	12	18
'S140	$C_L = 50\text{ pF}$ , $R_L = 93\ \Omega$	4	6.5	4	6.5
	$C_L = 150\text{ pF}$ , $R_L = 93\ \Omega$	6	6	6	6

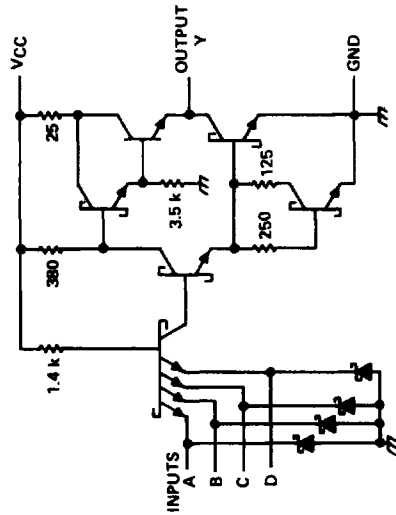
#Load circuit and voltage waveforms are shown on page 3-10.

schematics (each driver)



'128 CIRCUITS

Resistor values shown are nominal and in ohms.



'S140 CIRCUITS

# SERIES 54/74

## BUFFER AND INTERFACE GATES WITH OPEN-COLLECTOR OUTPUTS

### recommended operating conditions

	54 FAMILY 74 FAMILY	SERIES 54' SERIES 74'												UNIT
		'06, '07			'16, '17			'26			'33, '38			
		MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, $V_{CC}$		4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V
High-level output voltage, $V_{OH}$		4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	V
Low-level output current, $I_{OL}$				30			30			30			16	48
Operating free-air temperature, $T_A$		-55	125	-55	125	-55	125	-55	125	-55	125	-55	125	$^{\circ}C$

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

PARAMETER	TEST FIGURE	TEST CONDITIONS†	SERIES 54' SERIES 74'												UNIT
			'06, '07			'16, '17			'26			'33, '38			
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IH}$ High-level input voltage	1, 2		2		2		2		2		2		2	V	
$V_{IL}$ Low-level input voltage	1, 2			0.8		0.8		0.8		0.8		0.8		V	
$V_{JK}$ Input clamp voltage	3	$V_{CC} = \text{MIN}, I_I = -12 \text{ mA}$		-1.5		-1.5		-1.5		-1.5		-1.5		V	
$I_{OH}$ High-level output current	1	$V_{CC} = \text{MIN}, V_I = A$		250		250		250		250		250		$\mu A$	
$V_{OL}$ Low-level output voltage	2	$V_{CC} = \text{MIN}, V_I = A$		0.4		0.4		0.4		0.4		0.4		V	
$I_I$ Input current at maximum input voltage	4	$V_{CC} = \text{MAX}, V_I = 5.5 \text{ V}$		1		1		1		1		1		1 mA	
$I_{IH}$ High-level input current	4	$V_{CC} = \text{MAX}, V_{IH} = 2.4 \text{ V}$		40		40		40		40		40		$\mu A$	
$I_{IL}$ Low-level input current	5	$V_{CC} = \text{MAX}, V_{IL} = 0.4 \text{ V}$		-1.8		-1.8		-1.8		-1.8		-1.8		-1.8 mA	
$I_{CC}$ Supply current	7	$V_{CC} = \text{MAX}$												mA	

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

‡ The input voltage is  $V_{IH} = 2 \text{ V}$  or  $V_{IL} = V_{IL \text{ max}}$ , as appropriate. See tables with test figures 1 and 2.

See table on next page

BUFFER AND INTERFACE GATES WITH OPEN-COLLECTOR OUTPUTS

switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

TYPE	TEST CONDITIONS#		$t_{PLH}$ (ns)		$t_{PHL}$ (ns)	
	TYP	MAX	TYP	MAX	TYP	MAX
'06, '16			10	15	15	23
'07, '17			6	10	20	30
'26			16	24	11	17
'33			10	15	12	18
'38			15	22	16	24
			14	22	11	18

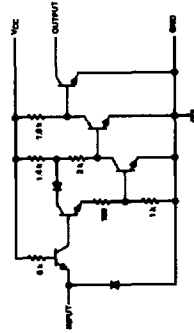
#Load circuit and voltage waveforms are shown on page 3-10.

supply current<sup>†</sup>

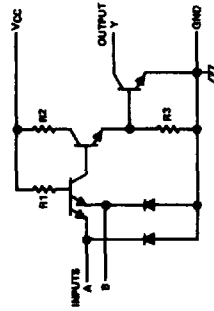
TYPE	$I_{CCH}$ (mA)		$I_{CCL}$ (mA)		$I_{CC}$ (mA)	
	TYP	MAX	TYP	MAX	Average per gate (50% duty cycle)	
'06, '16	30	48	32	51	5.17	
'07, '17	29	41	21	30	4.17	
'26	4	8	12	22	2.00	
'33	12	21	33	57	5.63	
'38	5	8.5	34	54	4.88	

†Maximum values of  $I_{CC}$  shown are over the recommended operating range of  $V_{CC}$  and  $T_A$ ; typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

schematics (each gate)

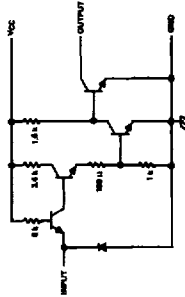


'06, '16 CIRCUITS

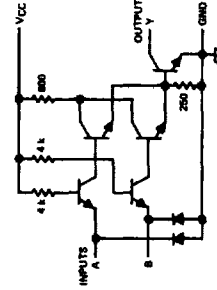


CIRCUITS	R1	R2	R3
'26	4 kΩ	1.5 kΩ	1 kΩ
'38	4 kΩ	600 Ω	400 Ω

'26, '38 CIRCUITS



'07, '17 CIRCUITS



'33 CIRCUITS



# SERIES 54LS/74LS AND SERIES 54S/74S BUFFER AND INTERFACE GATES WITH OPEN-COLLECTOR OUTPUTS

### recommended operating conditions

	54 FAMILY 74 FAMILY	SERIES 54LS SERIES 74LS <sup>†</sup>						SERIES 54S <sup>‡</sup> SERIES 74S <sup>‡</sup>			UNIT			
		'LS26		'LS33		'LS38		'S38		MIN NOM MAX				
		MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM			MAX		
Supply voltage, V <sub>CC</sub>	54 Family 74 Family	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V
High-level output voltage, V <sub>OH</sub>		4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	V
Low-level output current, I <sub>OL</sub>	54 Family 74 Family	15		5.5			5.5			5.5			5.5	V
Operating free-air temperature, T <sub>A</sub>	54 Family 74 Family	4	8	12	24	24	24	24	24	24	24	24	24	mA
	54 Family 74 Family	-65	125	-55	125	-55	125	-55	125	-55	125	-55	125	°C
	54 Family 74 Family	0	70	0	70	0	70	0	70	0	70	0	70	°C

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

PARAMETER	TEST FIGURE	TEST CONDITIONS <sup>†</sup>	SERIES 54LS <sup>‡</sup> SERIES 74LS <sup>‡</sup>						SERIES 54S <sup>‡</sup> SERIES 74S <sup>‡</sup>			UNIT		
			'LS26		'LS33		'LS38		'S38		MIN TYP <sup>‡</sup> MAX			
			MIN	TYP <sup>‡</sup>	MAX	MIN	TYP <sup>‡</sup>	MAX	MIN	TYP <sup>‡</sup>			MAX	
V <sub>IH</sub> High-level input voltage	1, 2		2		2		2		2		2		V	
V <sub>IL</sub> Low-level input voltage	1, 2	54 Family 74 Family	0.7		0.7		0.7		0.7		0.7		0.8	V
V <sub>IK</sub> Input clamp voltage	3	V <sub>CC</sub> = MIN, I <sub>I</sub> = 8	-1.5		-1.5		-1.5		-1.5		-1.5		-1.2	V
I <sub>OH</sub> High-level output current	1	V <sub>CC</sub> = MIN, V <sub>I</sub> = Δ	50		50		50		50		50		250	μA
			1000		1000		1000		1000		1000		250	μA
V <sub>OL</sub> Low-level output voltage	2	V <sub>CC</sub> = MIN, V <sub>I</sub> = Δ	0.25		0.4		0.25		0.4		0.25		0.4	V
			0.35		0.5		0.35		0.5		0.35		0.5	V
			0.25		0.4		0.25		0.4		0.25		0.4	V
I <sub>I</sub> Input current at maximum input voltage	4	V <sub>CC</sub> = MAX V <sub>I</sub> = 7 V	0.1		0.1		0.1		0.1		0.1		0.1	mA
I <sub>IH</sub> High-level input current	4	V <sub>CC</sub> = MAX V <sub>IH</sub> = 2.7 V	20		20		20		20		20		100	μA
I <sub>IL</sub> Low-level input current	5	V <sub>CC</sub> = MAX V <sub>IL</sub> = 0.4 V	-0.4		-0.4		-0.4		-0.4		-0.4		-0.4	mA
I <sub>CC</sub> Supply current	7	V <sub>CC</sub> = MAX											-4	mA

† 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.

§ I<sub>I</sub> = -18 mA for SN54LS/SN74LS<sup>†</sup> and -12 mA for SN54S/SN74S<sup>‡</sup>.

▲ The input voltage is V<sub>IH</sub> = 2 V or V<sub>IL</sub> = V<sub>IL</sub> max, as appropriate. See tables with test figures 1 and 2.

See table on next page

# SERIES 54LS/74LS AND SERIES 54S/74S BUFFER AND INTERFACE GATES WITH OPEN-COLLECTOR OUTPUTS

switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

TYPE	TEST CONDITIONS#	$\Phi_{LH}$ (ns)		Propagation delay time, high-to-low-level output	
		TYP	MAX	TYP	MAX
'LS26	$C_L = 15\text{ pF}$ , $R_L = 2\text{ k}\Omega$	17	32	15	28
'LS33	$C_L = 45\text{ pF}$ , $R_L = 687\ \Omega$	20	32	18	28
'LS38	$C_L = 50\text{ pF}$ , $R_L = 93\ \Omega$	6.5	10	6.5	10
'S38	$C_L = 150\text{ pF}$	9		8.5	

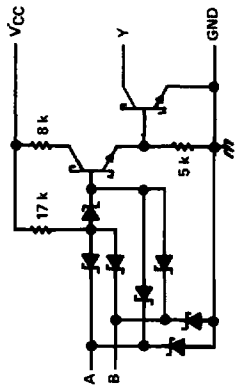
# Load circuit and voltage waveforms are shown on pages 3-10 and 3-11.

supply current†

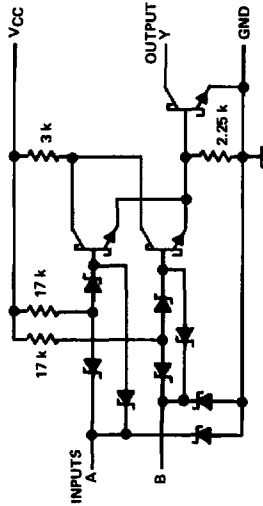
TYPE	$I_{CCH}$ (mA)		$I_{CCL}$ (mA)		$I_{CC}$ (mA)	
	TYP	MAX	TYP	MAX	Average per gate (50% duty cycle)	
'LS26	0.8	1.6	2.4	4.4	0.4	
'LS33	1.8	3.6	6.9	13.8	1.09	
'LS38	0.9	2	6	12	0.88	
'S38	20	36	46	80	8.25	

† Maximum values of  $I_{CC}$  shown are over the recommended operating ranges of  $V_{CC}$  and  $T_A$ ; typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

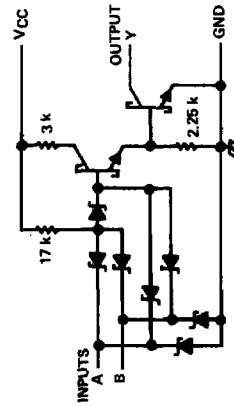
schematics (each gate)



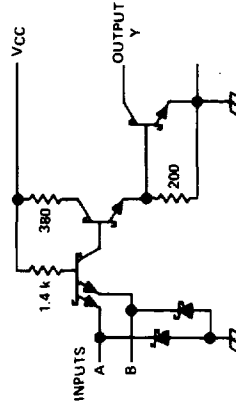
'LS26 CIRCUITS



'LS33 CIRCUITS



'LS38 CIRCUITS



'S38 CIRCUITS

# POSITIVE-OR GATES WITH TOTEM-POLE OUTPUTS

recommended operating conditions

PARAMETER	TEST FIGURE	TEST CONDITIONS <sup>1</sup>	SERIES 54 SERIES 74		SERIES 54LS SERIES 74LS		SERIES 54S SERIES 74S		SERIES 54LS SERIES 74LS		SERIES 54S SERIES 74S		UNIT	
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN		TYP
Supply voltage, V <sub>CC</sub>			4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5	5.25
High-level output current, I <sub>OH</sub>			4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25
Low-level output current, I <sub>OL</sub>					-800			-400			-1000			μA
Operating free-air temperature, T <sub>A</sub>					16			4			20			mA
					16			8			20			mA
					125			125			125			125
					0			0			0			0
					70			70			70			70

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

PARAMETER	TEST FIGURE	TEST CONDITIONS <sup>1</sup>	SERIES 54 SERIES 74		SERIES 54LS SERIES 74LS		SERIES 54S SERIES 74S		SERIES 54LS SERIES 74LS		SERIES 54S SERIES 74S		UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	
V <sub>IH</sub> High-level input voltage	1, 2		2		0.8			0.7					0.8
V <sub>IL</sub> Low-level input voltage	1, 2				0.8			0.8					0.8
V <sub>IK</sub> Input clamp voltage	3	V <sub>CC</sub> = MIN, I <sub>I</sub> = 5			-1.5			-1.5					-1.2
V <sub>OH</sub> High-level output voltage	1	V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V, I <sub>OH</sub> = MAX	2.4	3.4		2.5	3.4		2.5	3.4		2.5	3.4
V <sub>OL</sub> Low-level output voltage	2	V <sub>CC</sub> = MIN, I <sub>OL</sub> = MAX, V <sub>IL</sub> = V <sub>IL max</sub>	0.2	0.4		0.25	0.4		0.25	0.4		0.25	0.4
I <sub>I</sub> Input current at maximum input voltage	4	V <sub>CC</sub> = MAX, V <sub>I</sub> = 5.5 V, V <sub>I</sub> = 7 V			1			0.1					1
I <sub>IH</sub> High-level input current	4	V <sub>CC</sub> = MAX, V <sub>IH</sub> = 2.4 V, V <sub>IH</sub> = 2.7 V			40			20					50
I <sub>IL</sub> Low-level input current	5	V <sub>CC</sub> = MAX, V <sub>IL</sub> = 0.5 V, V <sub>IL</sub> = 0.4 V			-1.6			-0.4					-2
I <sub>OS</sub> Short-circuit output current <sup>‡</sup>	6	V <sub>CC</sub> = MAX, V <sub>CC</sub> = MAX	-20	-55	-20	-55	-20	-100	-40	-100	-40	-100	-100
I <sub>CC</sub> Supply current	7	Total, output high	15	22	15	22	3.1	6.2	18	32	18	32	32
		Total, output low	23	38	23	38	4.9	9.8	38	68	38	68	68
		Average per gate		4.75		1.0							7

<sup>1</sup> For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

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

<sup>‡</sup> I<sub>OS</sub> = -12 mA for SN64/SN74<sup>‡</sup> and -18 mA for SN64LS/SN74LS<sup>‡</sup> and SN64S/SN74S<sup>‡</sup>.

<sup>‡</sup> Not more than one output should be shorted at a time, and for SN64LS/SN74LS<sup>‡</sup> and SN64S/SN74S<sup>‡</sup>, duration of the short-circuit should be less than one second.

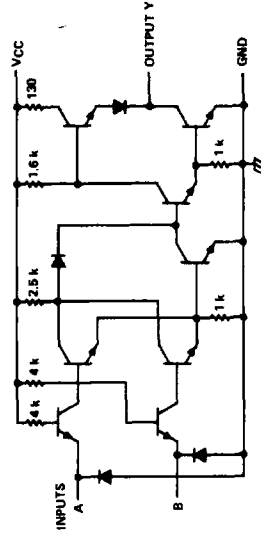
# POSITIVE-OR GATES WITH TOTEM-POLE OUTPUTS

schematics (each gate)

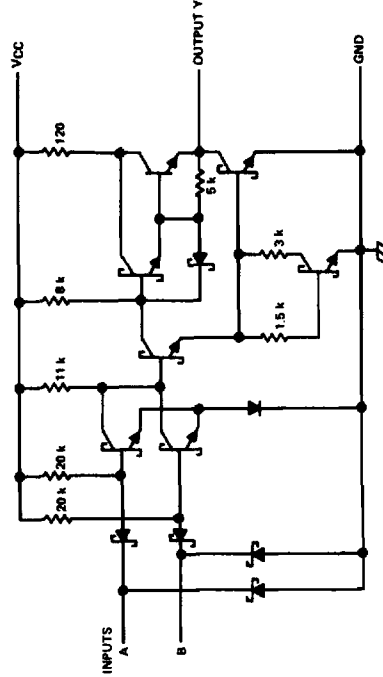
switching characteristics at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

TYPE	TEST CONDITIONS#	$t_{PLH}$ (ns)		Propagation delay time, low-to-high-level output		$t_{PHL}$ (ns)	
		MIN	TYP	MAX	MIN	TYP	MAX
'32	$C_L = 15\text{ pF}$ , $R_L = 400\ \Omega$	10	15	14	14	22	22
'LS32	$C_L = 15\text{ pF}$ , $R_L = 2\text{ k}\Omega$	14	22	14	14	22	22
'S32	$C_L = 15\text{ pF}$ , $R_L = 280\ \Omega$	4	7	4	4	7	7
	$C_L = 50\text{ pF}$ , $R_L = 280\ \Omega$	5		5		5	

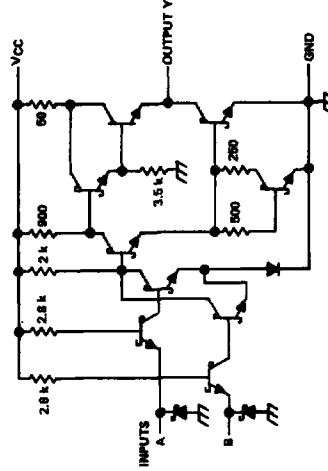
#Load circuit and voltage waveforms are shown on pages 3-10 and 3-11.



'32 CIRCUITS



'LS32 CIRCUITS



'S32 CIRCUITS

Resistor values shown are nominal and in ohms.



# AND-OR-INVERT GATES WITH TOTEM-POLE OUTPUTS

## recommended operating conditions

PARAMETER	TEST FIGURE	TEST CONDITIONS <sup>1</sup>	SERIES 54		SERIES 54H		SERIES 54L		SERIES 54LS		SERIES 54S		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, V <sub>CC</sub>	1, 2		4.5	5.5	4.5	5.5	4.5	5.5	4.5	5.5	4.5	5.5	V
High-level output current, I <sub>OH</sub>	3		4.75	5.25	4.75	5.25	4.75	5.25	4.75	5.25	4.75	5.25	mA
Low-level output current, I <sub>OL</sub>	4		-400	-500	-400	-500	-400	-500	-400	-500	-400	-500	mA
Operating free-air temperature, T <sub>A</sub>	7		0	70	0	70	0	70	0	70	0	70	°C

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

PARAMETER	TEST FIGURE	TEST CONDITIONS <sup>1</sup>	SERIES 54		SERIES 54H		SERIES 54L		SERIES 54LS		SERIES 54S		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
V <sub>IH</sub>	1, 2		2		2		2		2		2	V	
V <sub>IL</sub>	1, 2		0.8		0.8		0.7		0.7		0.7	V	
V <sub>IK</sub>	3	V <sub>CC</sub> = MIN, I <sub>I</sub> = 5	0.8		0.8		0.7		0.8		0.8	V	
V <sub>OH</sub>	1	V <sub>CC</sub> = MIN, V <sub>IL</sub> = V <sub>IL</sub> max, I <sub>OH</sub> = MAX	2.4	3.4	2.4	3.4	2.4	3.3	2.5	3.4	2.5	3.4	V
V <sub>OL</sub>	2	V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V	0.2	0.4	0.2	0.4	0.2	0.4	0.25	0.4	0.25	0.4	V
I <sub>I</sub>	4	V <sub>CC</sub> = MAX, I <sub>I</sub> = 7 V	1		1		1		0.1		0.1	mA	
I <sub>IH</sub>	4	V <sub>CC</sub> = MAX, V <sub>IH</sub> = 2.4 V	40		50		10		20		50	μA	
I <sub>IL</sub>	5	V <sub>CC</sub> = MAX, V <sub>IL</sub> = 0.4 V	-1.8		-2		-0.18		-0.4		-0.4	mA	
I <sub>OS</sub>	6	V <sub>CC</sub> = MAX	-20	-55	-40	-100	-3	-15	-20	-100	-40	-100	mA
I <sub>CC</sub>	7	V <sub>CC</sub> = MAX	-18	-85	-40	-100	-3	-15	-20	-100	-40	-100	mA

<sup>1</sup> For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

<sup>2</sup> All typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.

<sup>3</sup> I<sub>I</sub> = -12 mA for SN54/SN74\*, -8 mA for SN54H/SN74H\*, and -18 mA for SN54LS/SN74LS\* and SN54S/SN74S\*.

\*Not more than one output should be shorted at a time, and for SN54LS/SN74LS\*, SN54H/SN74H\*, and SN54S/SN74S\*, duration of the short-circuit should not exceed one second.

See table on next page

# AND-OR-INVERT GATES WITH TOTEM-POLE OUTPUTS

switching characteristics at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

TYPE	TEST CONDITIONS#	$t_{PLH}$ (ns)		Propagation delay time, low-to-high-level output		$t_{PHL}$ (ns)	
		MIN	TYP	MAX	MIN	TYP	MAX
'51, '54	$C_L = 15\text{ pF}$ , $R_L = 400\ \Omega$	13	22	8	15	8	15
'H51	$C_L = 25\text{ pF}$ , $R_L = 280\ \Omega$	6.8	11	6.2	11	6.2	11
'H54	$C_L = 25\text{ pF}$ , $R_L = 280\ \Omega$	7	11	6.2	11	6.2	11
'L51, 'L54, 'L55	$C_L = 50\text{ pF}$ , $R_L = 4\text{ k}\Omega$	50	90	35	60	35	60
'LS51, 'LS55	$C_L = 15\text{ pF}$ , $R_L = 2\text{ k}\Omega$	12	20	12.5	20	12.5	20
'LS54	$C_L = 15\text{ pF}$ , $R_L = 2\text{ k}\Omega$	12	20	12.5	20	12.5	20
'S51, 'S64	$C_L = 15\text{ pF}$ , $R_L = 280\ \Omega$	3.5	5.5	3.5	5.5	3.5	5.5
	$C_L = 50\text{ pF}$ , $R_L = 280\ \Omega$	5	5	5	5	5	5

# Load circuit and voltage waveforms are shown on pages 3-10 and 3-11.

supply current†

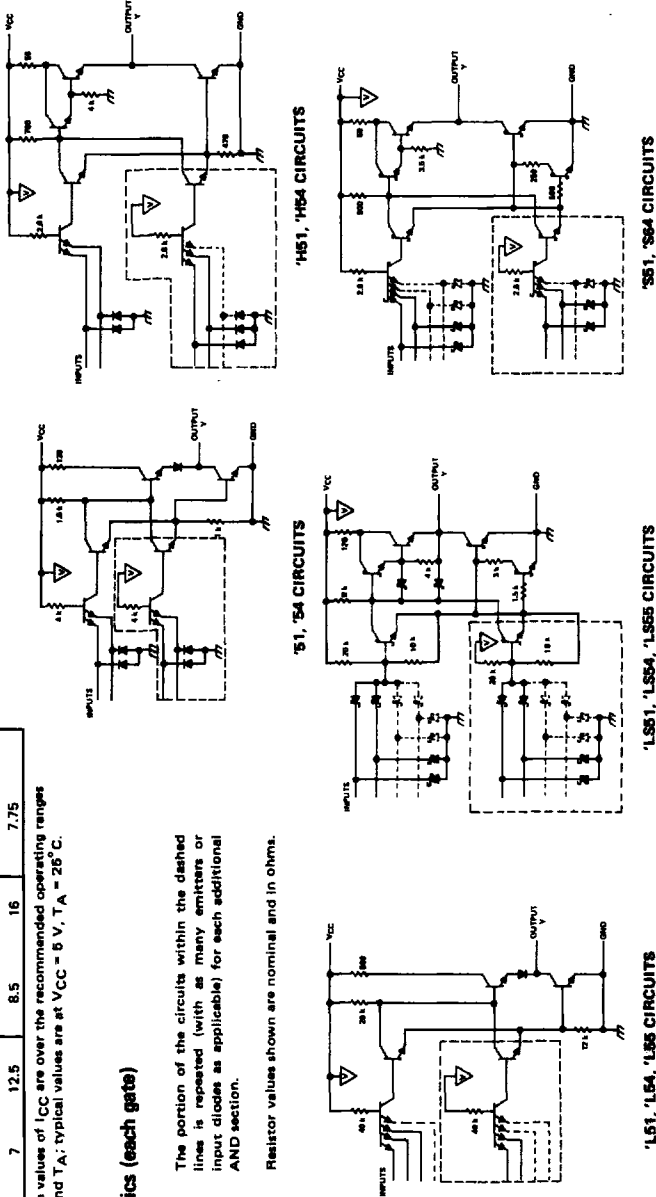
TYPE	$I_{CCH}$ (mA)		$I_{CCL}$ (mA)		$I_{CC}$ (mA)	
	TYP	MAX	TYP	MAX	Average per AOI gate (50% duty cycle)	TYP
'51	4	8	7.4	14	2.85	2.85
'54	4	8	5.1	9.5	4.55	4.55
'H51	8.2	12.8	15.2	24	5.85	5.85
'H54	7.1	11	9.4	14	8.25	8.25
'L51	0.44	0.8	0.76	1.3	0.30	0.30
'L54	0.39	0.8	0.60	0.99	0.50	0.50
'L55	0.22	0.4	0.38	0.65	0.30	0.30
'LS51	0.8	1.6	1.4	2.8	0.55	0.55
'LS54	0.8	1.6	1.0	2	0.9	0.9
'LS55	0.4	0.8	0.7	1.3	0.55	0.55
'S51	5.2	17.8	13.6	22	5.45	5.45
'S64	7	12.5	8.5	16	7.75	7.75

† Maximum values of  $I_{CC}$  are over the recommended operating ranges of  $V_{CC}$  and  $T_A$ ; typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

## schematics (each gate)

The portion of the circuits within the dashed lines is repeated (with as many emitters or input diodes as applicable) for each additional AND section.

Resistor values shown are nominal and in ohms.



# AND-OR-INVERT GATES WITH OPEN-COLLECTOR OUTPUTS

## recommended operating conditions

	'S65			'S74S65			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, $V_{CC}$	4.5	5	5.5	4.75	5	5.25	V
High-level output voltage, $V_{OH}$			5.5			5.5	V
Low-level output current, $I_{OL}$			20			20	mA
Operating free-air temperature, $T_A$	-55		125	0		70	$^{\circ}\text{C}$

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

PARAMETER	TEST FIGURE	TEST CONDITIONS†	'S65			LIMIT
			MIN	TYP‡	MAX	
$V_{IH}$ High-level input voltage	1, 2		2			V
$V_{IL}$ Low-level input voltage	1, 2				0.8	V
$V_{IK}$ Input clamp voltage	3	$V_{CC} = \text{MIN}, I_I = -18 \text{ mA}$			-1.2	V
$I_{OH}$ High-level output current	1	$V_{CC} = \text{MIN}, V_{IH} = 0.8 \text{ V}, V_{OH} = 5.5 \text{ V}$			250	$\mu\text{A}$
$V_{OL}$ Low-level output voltage	2	$V_{CC} = \text{MIN}, V_{IL} = 2 \text{ V}, I_{OL} = 20 \text{ mA}$			0.5	V
$I_I$ Input current at maximum input voltage	4	$V_{CC} = \text{MAX}, V_I = 5.5 \text{ V}$			1	mA
$I_{IH}$ High-level input current	4	$V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$			50	$\mu\text{A}$
$I_{IL}$ Low-level input current	5	$V_{CC} = \text{MAX}, V_I = 0.5 \text{ V}$			-2	mA
$I_{CCH}$ Supply current, output high	7	$V_{CC} = \text{MAX}$		6	11	mA
$I_{CCL}$ Supply current, output low	7	$V_{CC} = \text{MAX}$		8.5	16	mA

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

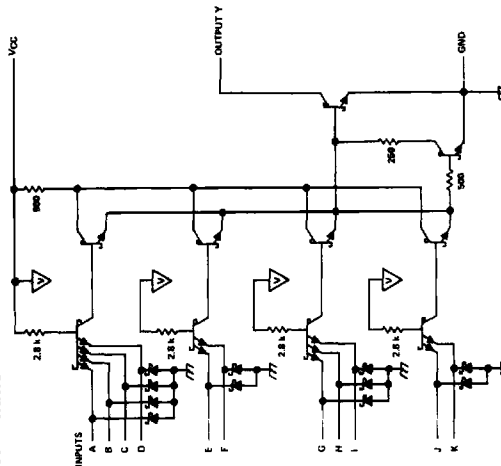
‡ All typical values are at  $V_{CC} = 5 \text{ V}, T_A = 25^{\circ}\text{C}$ .

## switching characteristics, $V_{CC} = 5 \text{ V}, T_A = 25^{\circ}\text{C}$

PARAMETER	TEST CONDITIONS#	'S65			UNIT
		MIN	TYP	MAX	
Propagation delay time, $t_{PLH}$ low-to-high-level output	$C_L = 15 \text{ pF}, R_L = 280 \Omega$	2	5	7.5	ns
Propagation delay time, $t_{PHL}$ high-to-low-level output	$C_L = 50 \text{ pF}, R_L = 280 \Omega$	2	8	8	ns
	$C_L = 15 \text{ pF}, R_L = 280 \Omega$	2	5.5	8.5	ns
	$C_L = 50 \text{ pF}, R_L = 280 \Omega$		6.5		ns

# Load circuit and voltage waveforms are shown on page 3-10.

schematic



Resistor values shown are nominal and in ohms.

# GATES WITH 3-STATE OUTPUTS

## recommended operating conditions

PARAMETER	TEST FIGURE	TEST CONDITIONS†	SERIES 64		SERIES 64LS		SERIES 64S		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, V <sub>CC</sub>	1, 2	54 Family 74 Family	SERIES 64 '126, '126, '426, '426		SERIES 64LS 'LS126A, 'LS126A		SERIES 64S 'S134		V
			MIN	MAX	MIN	MAX	MIN	MAX	
High-level output current, I <sub>OH</sub>	1	54 Family 74 Family	4.5	5.5	4.5	5	4.5	5	mA
			4.75	5	4.75	5	4.75	5	
Low-level output current, I <sub>OL</sub>	2	54 Family 74 Family	-5.2		-2.8		-1		mA
Operating free-air temperature, T <sub>A</sub>	7	54 Family 74 Family	0	70	0	70	0	70	°C

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

PARAMETER	TEST FIGURE	TEST CONDITIONS†	SERIES 64		SERIES 64LS		SERIES 64S		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
V <sub>IH</sub> High-level input voltage	1, 2	54 Family	0.8	0.7	0.8	0.8	0.8	V	
V <sub>IL</sub> Low-level input voltage	1, 2	74 Family	0.8	0.8	0.8	0.8	0.8	V	
V <sub>IK</sub> Input clamp voltage	3	I <sub>I</sub> = §	-1.5		1.5		-1.2	V	
V <sub>OH</sub> High-level output voltage	1	V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V, I <sub>OL</sub> = MAX	2.4	3.3	2.4	2.4	2.4	3.2	V
V <sub>OL</sub> Low-level output voltage	2	V <sub>CC</sub> = MIN, I <sub>OL</sub> = MAX	0.4	0.4	0.25	0.4	0.5	0.5	V
		V <sub>IH</sub> = 2 V, V <sub>IL</sub> = V <sub>IL max</sub> , I <sub>OL</sub> = 12 mA	0.4	0.4	0.35	0.5	0.5	0.5	
I <sub>OZ</sub> Off-state (high-impedance state) output current	19	V <sub>CC</sub> = MAX, V <sub>IH</sub> = 2 V, V <sub>IL</sub> = V <sub>IL max</sub>	40	40	20	20	50	50	µA
		V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V, V <sub>IL</sub> = V <sub>IL max</sub>	-40	-40	-20	-20	-90	-90	
I <sub>I</sub> Input current at maximum input voltage	4	V <sub>I</sub> = 5.5 V, V <sub>CC</sub> = MAX	1	1	0.1	0.1	1	1	mA
I <sub>IH</sub> High-level input current	4	V <sub>IH</sub> = 2.4 V, V <sub>CC</sub> = MAX	40	40	20	20	50	50	µA
I <sub>IL</sub> Low-level input current	5	V <sub>IL</sub> = 0.4 V, V <sub>CC</sub> = MAX	-1.6	-1.6	0.4	0.4	-2	-2	mA
I <sub>OS</sub> Short-circuit output current <sup>¶</sup>	6	V <sub>CC</sub> = MAX	-30	-70	-40	-225	-40	-100	mA
I <sub>CC</sub> Supply current	7	V <sub>CC</sub> = MAX	-26	-70	-40	-225	-40	-100	mA

See table on next page

† 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.  
 § I<sub>I</sub> = -12 mA for SN54/SN74<sup>†</sup> and -18 mA for SN64LS/SN74LS<sup>†</sup> and SN54S/SN74S<sup>†</sup>, duration of the short circuit should not exceed one second.  
 ¶ Not more than one output should be shorted at a time, and for SN64LS/SN74LS<sup>†</sup> and SN54S/SN74S<sup>†</sup>.



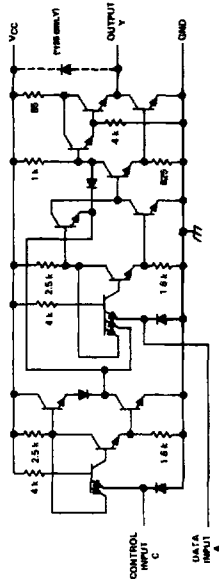
# GATES WITH 3-STATE OUTPUTS

## supply current<sup>†</sup>

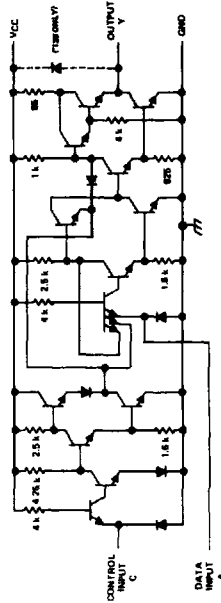
TYPE	TEST CONDITIONS		I <sub>CC</sub> (mA)	
	DATA INPUTS	OUTPUT CONTROLS	MIN	MAX
'125, '425	0 V	4.5 V	32	54
'126, '426	0 V	0 V	36	62
'LS125A	0 V	4.5 V	11	20
'LS126A	0 V	0 V	12	22
'S134	0 V	0 V	7	13
	5 V	0 V	9	16
	5 V	5 V	14	25

<sup>†</sup> Maximum value of I<sub>CC</sub> are over the recommended operating range of V<sub>CC</sub> and T<sub>A</sub>; typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.

## schematics (each gate)



'125A, '425 CIRCUITS



'126A, '426 CIRCUITS

Resistor values shown are nominal and in ohms.

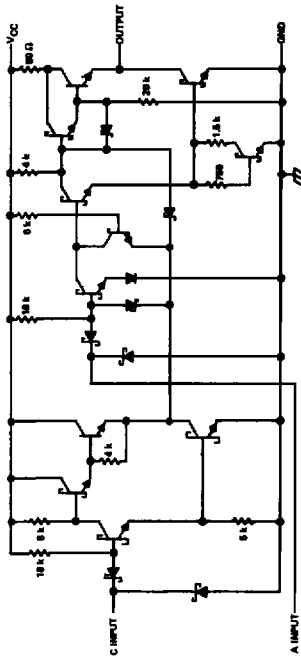
## switching characteristics, V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C

PARAMETER	SERIES 64/74			SERIES 64LS/74LS			SERIES 54S/74S			UNIT		
	TEST CONDITIONS#	'125, '425 TYP	'426 TYP	TEST CONDITIONS#	'LS125A TYP	'LS126A TYP	TEST CONDITIONS#	'S134 TYP	MAX			
t <sub>PLH</sub> Propagation delay time, low-to-high-level output	C <sub>L</sub> = 50 pF, R <sub>L</sub> = 400 Ω	8	13	8	13	9	15	9	15	C <sub>L</sub> = 15 pF, R <sub>L</sub> = 280 Ω	4	6
		12	18	12	18	7	18	8	18	C <sub>L</sub> = 60 pF, R <sub>L</sub> = 280 Ω	5	5.5
t <sub>PHL</sub> Propagation delay time, high-to-low-level output	C <sub>L</sub> = 50 pF, R <sub>L</sub> = 400 Ω	11	17	11	18	12	20	16	25	C <sub>L</sub> = 15 pF, R <sub>L</sub> = 280 Ω	5	7.5
		18	25	16	25	15	25	21	35	C <sub>L</sub> = 50 pF, R <sub>L</sub> = 280 Ω	7	7
t <sub>PZH</sub> Output enable time to high level	C <sub>L</sub> = 5 pF, R <sub>L</sub> = 400 Ω	5	8	10	16	20	20	20	20	C <sub>L</sub> = 50 pF, R <sub>L</sub> = 280 Ω	13	19.5
t <sub>PZL</sub> Output enable time to low level		7	12	12	18	20	20	20	20	C <sub>L</sub> = 5 pF, R <sub>L</sub> = 280 Ω	14	21
t <sub>PZH</sub> Output disable time from high level	C <sub>L</sub> = 5 pF, R <sub>L</sub> = 400 Ω	5	8	10	16	20	20	20	20	C <sub>L</sub> = 50 pF, R <sub>L</sub> = 280 Ω	5.5	8.5
t <sub>PZL</sub> Output disable time from low level		7	12	12	18	20	20	20	20	C <sub>L</sub> = 5 pF, R <sub>L</sub> = 280 Ω	9	14

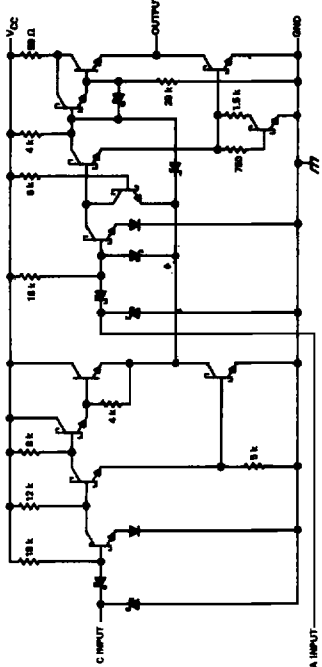
# Load circuit and voltage waveforms are shown on page 3-10 and 3-11.

# GATES WITH 3-STATE OUTPUTS

schematics (each gate)

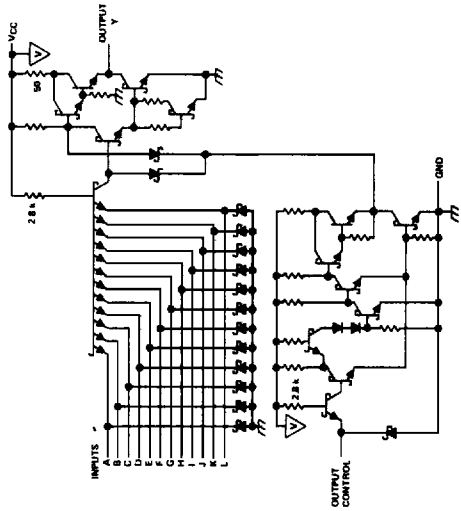


'LS126A CIRCUITS



'LS126A CIRCUITS

Resistor values shown are nominal and in ohms.



'LS134 CIRCUITS

# HEX BUS DRIVERS WITH 3-STATE OUTPUTS

recommended operating conditions

PARAMETER	TEXT FIGURE	TEST CONDITIONS <sup>1</sup>	SERIES 64		SERIES 74		SERIES 84		SERIES 74LS		SERIES 74ALS		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, V <sub>CC</sub>			4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V	
High-level output current, I <sub>OH</sub>			4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	mA	
Low-level output current, I <sub>OL</sub>					-5.2			-2.6			-2.6	mA	
Operating free-air temperature, T <sub>A</sub>			-55	125	-55	125	-55	125	-55	125	125	°C	

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

PARAMETER	TEXT FIGURE	TEST CONDITIONS <sup>1</sup>	SERIES 64		SERIES 74		SERIES 84		SERIES 74LS		SERIES 74ALS		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
V <sub>IH</sub> High-level input voltage	1, 2				0.8							0.7	V
V <sub>IL</sub> Low-level input voltage	1, 2				0.8							0.8	V
V <sub>IK</sub> Input clamp voltage	3	V <sub>CC</sub> = MIN, I <sub>I</sub> = 8			-1.5							-1.5	V
V <sub>OH</sub> High-level output voltage	1	V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V, V <sub>IL</sub> = V <sub>IL</sub> max, I <sub>OH</sub> = MAX	2.4	3.3	2.4	3.3	2.4	3.3	2.4	3.3	2.4	3.3	V
V <sub>OL</sub> Low-level output voltage	2	V <sub>CC</sub> = MIN, I <sub>OL</sub> = MAX			0.4				0.25	0.4	0.25	0.4	V
I <sub>OZ</sub> Off-state (high-impedance state) output current	19	V <sub>CC</sub> = MAX, V <sub>IH</sub> = 2 V, V <sub>IL</sub> = V <sub>IL</sub> max, I <sub>OL</sub> = 12 mA			40				20	40	20	40	μA
I <sub>I</sub> Input current at maximum input voltage	4	V <sub>CC</sub> = MAX			-40				1	-40	1	-40	mA
I <sub>IH</sub> High-level input current	4	V <sub>CC</sub> = MAX			40				0.1	40	0.1	40	mA
I <sub>IL</sub> Low-level input current	A inputs	V <sub>CC</sub> = MAX, V <sub>I</sub> = 0.5 V, Either G input at 2 V			-40					-40		-40	mA
I <sub>IS</sub> Short-circuit output current <sup>2</sup>	G inputs	V <sub>CC</sub> = MAX, V <sub>I</sub> = 0.4 V, Both G inputs at 0.4 V			-1.6					-1.6		-1.6	mA
I <sub>CC</sub> Supply current		V <sub>CC</sub> = MAX			-40					-40		-40	mA

<sup>1</sup> For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

<sup>2</sup> All typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.

<sup>3</sup> I<sub>I</sub> = -12 mA for SN64/SN74 and -18 mA for SN84LS/SN74LS and SN84/SN74S.

<sup>4</sup> Not more than one output should be shorted at a time, and for SN84LS/SN74LS and SN84/SN74S, duration of output short-circuit should not exceed one second.

# HEX BUS DRIVERS WITH 3-STATE OUTPUTS

switching characteristics,  $V_{CC} = 5V$ ,  $T_A = 25^\circ C$ , see note 1

supply current<sup>†</sup>

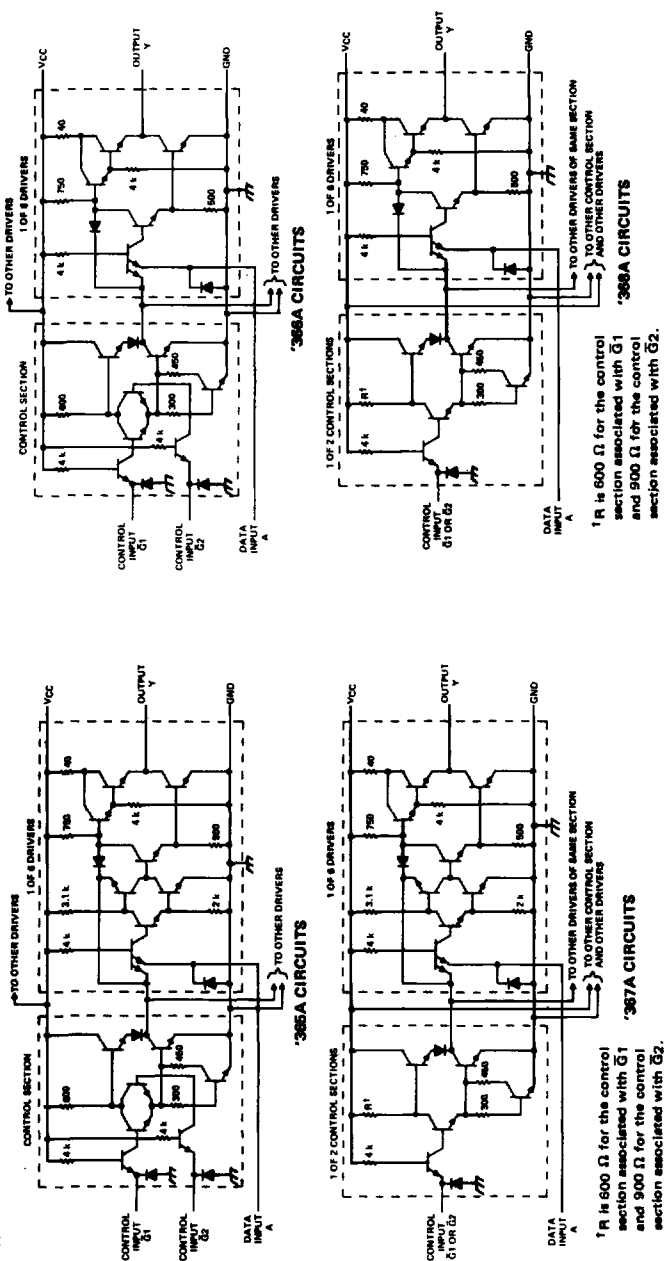
TYPE	DATA INPUTS	OUTPUT CONTROLS	$I_{CC}$ (mA)	
			TYP	MAX
'386A, '387A	0 V	4.5 V	66	85
'386A, '388A	0 V	4.5 V	58	77
'LS386A, 'LS387A	0 V	4.5 V	14	24
'LS386A, 'LS388A	0 V	4.5 V	12	21

† Maximum values of  $I_{CC}$  are over the recommended operating ranges of  $V_{CC}$  and  $T_A$ ; typical values are at  $V_{CC} = 5V$ ,  $T_A = 25^\circ C$ .

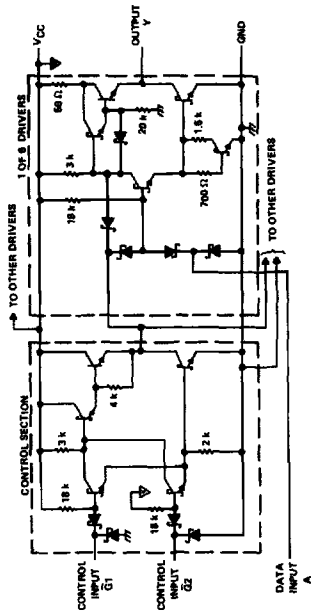
PARAMETER*	TEST CONDITIONS		SERIES 84LS74LS		SERIES 84LS74LS	
	TYP	MAX	'386A, '387A TYP	'386A, '388A TYP	'LS386A, 'LS387A TYP	'LS386A, 'LS388A TYP
$t_{PLH}$	18	17	10	16	7	15
$t_{PHL}$	22	18	9	22	12	18
$t_{PZH}$	35	35	19	35	18	35
$t_{PZL}$	37	37	24	40	28	45
$t_{PHZ}$	11	11	30	30	32	32
$t_{PLZ}$	27	27	35	35	35	35

\*  $t_{PLH}$  = Propagation delay time, low-to-high-level output  
 $t_{PHL}$  = Propagation delay time, high-to-low-level output  
 $t_{PZH}$  = Output enable time to high level  
 $t_{PZL}$  = Output disable time to low level  
 $t_{PHZ}$  = Output enable time to high level  
 $t_{PLZ}$  = Output disable time from low level  
 NOTE 1: Load circuits and voltage waveforms are shown on pages 3-10 and 3-11.

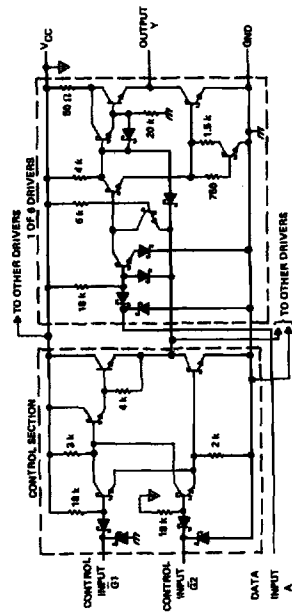
## schematics



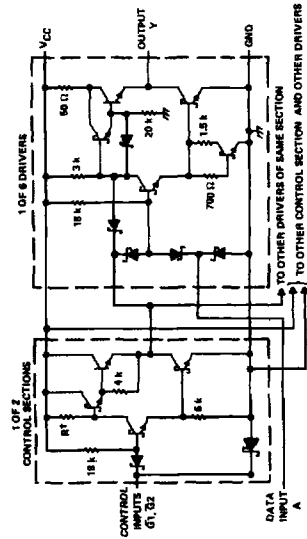
# HEX BUS DRIVERS WITH 3-STATE OUTPUTS



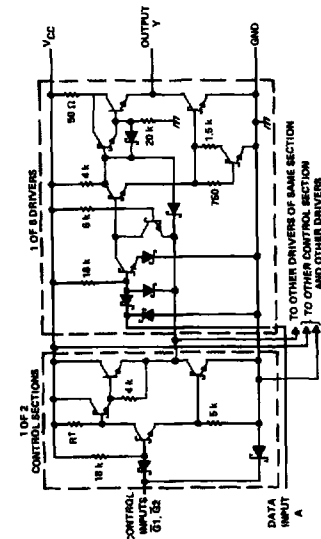
'LS366A CIRCUITS



'LS366A CIRCUITS



'LS368A CIRCUITS



'LS367A CIRCUITS

† R is 5 kΩ for the control section associated with G1 and 8 kΩ for the control section associated with G2.

Resistor values shown are nominal and in ohms

† R is 5 kΩ for the control section associated with G1 and 8 kΩ for the control section associated with G2.

recommended operating conditions

PARAMETER	TEST FIGURE	SERIES 54 SERIES 74						SERIES 64H SERIES 74H			UNIT
		'23		'50, '53		'H50, 'H52, 'H53, 'H55		MIN	NOM	MAX	
Supply voltage, V <sub>CC</sub>		4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V
High-level output current, I <sub>OH</sub>		4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	μA
Low-level output current, I <sub>OL</sub>				-800			-400			-500	μA
Operating free-air temperature range, T <sub>A</sub>	54 Family			16			16			20	°C
	74 Family			16			16			20	°C
Operating free-air temperature range, T <sub>A</sub>	54 Family	-55	125	-55	-55	125	-55	-55	125	-55	°C
	74 Family	0	70	0	70	0	70	0	70	°C	

The '23, '50, and '53 are designed for use with up to four '60 expanders.  
 The 'H50, 'H53, and 'H55 are designed for use with up to four 'H60 expanders or one 'H62 expander.  
 The 'H52 is designed for use with up to six 'H61 expanders.

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

PARAMETER	TEST FIGURE	TEST CONDITIONS†	SERIES 54 SERIES 74			SERIES 64H SERIES 74H			UNIT
			'23	'50, '53	'H50, 'H52, 'H53, 'H55	MIN	TYP‡	MAX	
V <sub>IH</sub> High-level input voltage	1, 2		2	2	2	0.8	0.8	0.8	V
V <sub>IL</sub> Low-level input voltage	1, 2					-1.5	-1.5	-1.5	V
V <sub>IK</sub> Input clamp voltage	3	V <sub>CC</sub> = MIN, I <sub>I</sub> = §							V
V <sub>OH</sub> High-level output voltage	1	V <sub>CC</sub> = MIN, V <sub>I</sub> = Δ, I <sub>OH</sub> = MAX	2.4	3.4	2.4	3.4	2.4	3.4	V
V <sub>OL</sub> Low-level output voltage	2	V <sub>CC</sub> = MIN, V <sub>I</sub> = Δ, I <sub>OL</sub> = MAX	0.2	0.4	0.2	0.4	0.2	0.4	V
I <sub>I</sub> Input current at maximum input voltage	4	V <sub>CC</sub> = MAX, V <sub>I</sub> = 5.5 V		1		1		1	mA
I <sub>IH</sub> High-level input current	Data input	V <sub>CC</sub> = MAX, V <sub>IH</sub> = 2.4 V		40		40		50	μA
	Strobe of '23			160		160			μA
I <sub>IL</sub> Low-level input current	Data input	V <sub>CC</sub> = MAX, V <sub>IL</sub> = 0.4 V		-1.6		-1.6		-2	mA
	Strobe of '23			-6.4		-6.4			mA
I <sub>OS</sub> Short-circuit output current*	54 Family	V <sub>CC</sub> = MAX	-20	-55	-20	-55	-40	-100	mA
	74 Family	V <sub>CC</sub> = MAX	-18	-55	-18	-55	-40	-100	mA
I <sub>CC</sub> Supply current	7	V <sub>CC</sub> = MAX							mA

† 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.

§ I<sub>I</sub> = -12 mA for SN54/SN74\* and -8 mA for SN54H/SN74H\*.

\* The input voltage is V<sub>IH</sub> = 2 V or V<sub>IL</sub> = V<sub>IH</sub> max, as appropriate. See tables with test figures 1 and 2.

† Not more than one output should be shorted at a time, and for the SN54H/SN74H\*, duration of short-circuit should not exceed one second.

See table on next page

# EXPANDABLE GATES

electrical characteristics using expander inputs,  $V_{CC} = \text{MIN}$ ,  $T_A = \text{MIN}$  (unless otherwise noted)

TYPE	$I_X$ (mA) ( $I_X$ for 'H62) Expander current		$V_{BE}(Q)$ (V) Base-emitter voltage of output transistor Q		$V_{OH}$ (V) High-level output voltage		$V_{OL}$ (V) Low-level output voltage			
	TEST CONDITIONS	MIN TYP <sup>‡</sup> MAX	TEST CONDITIONS	MIN TYP <sup>‡</sup> MAX	TEST CONDITIONS	MIN TYP <sup>‡</sup> MAX	TEST CONDITIONS	MIN TYP <sup>‡</sup> MAX		
SN5423	$V_{XX} = 0.4$ V, $I_{OL} = 16$ mA, See Figure 10	-3.5 -2.9 -2.9	$I_X + I_{\bar{X}} = 410$ $\mu$ A, $R_{XX} = 0$ , $I_{OL} = 16$ mA, See Figure 11	1:1	$I_X = 160$ $\mu$ A, $I_{\bar{X}} = -150$ $\mu$ A, $I_{OH} = -400$ $\mu$ A, See Figure 12	2.4	3.4	$I_X + I_{\bar{X}} = 300$ $\mu$ A, $R_{XX} = 114$ $\Omega$ <sup>‡</sup> , $I_{OL} = 16$ mA, See Figure 11	0.2	0.4
SN7423	$V_{XX} = 0.4$ V, $I_{OL} = 16$ mA, See Figure 10	-3.8 -3.1 -3.1	$I_X + I_{\bar{X}} = 620$ $\mu$ A, $R_{XX} = 0$ , $I_{OL} = 16$ mA, See Figure 11	1	$I_X = 270$ $\mu$ A, $I_{\bar{X}} = -270$ $\mu$ A, $I_{OH} = -400$ $\mu$ A, See Figure 12	2.4	3.4	$I_X + I_{\bar{X}} = 430$ $\mu$ A, $R_{XX} = 106$ $\Omega$ <sup>‡</sup> , $I_{OL} = 16$ mA, See Figure 11	0.2	0.4
SN54H50, SN54H53, SN54H55	$V_{\bar{X}} = 1.4$ V, $I_X = 0$ , $I_{OL} = 0$ , See Figure 10	-5.85	$I_X + I_{\bar{X}} = 700$ $\mu$ A, $R_{XX} = 0$ , $I_{OL} = 20$ mA, See Figure 11	1:1	$I_X = 320$ $\mu$ A, $I_{\bar{X}} = -320$ $\mu$ A, $I_{OH} = -500$ $\mu$ A, See Figure 12	2.4	3.4	$I_X + I_{\bar{X}} = 470$ $\mu$ A, $R_{XX} = 88$ $\Omega$ <sup>‡</sup> , $I_{OL} = 20$ mA, See Figure 11	0.2	0.4
SN74H50, SN74H53, SN74H55	$V_{\bar{X}} = 1.4$ V, $I_X = 0$ , $I_{OL} = 0$ , See Figure 10	-6.3	$I_X + I_{\bar{X}} = 1.1$ mA, $R_{XX} = 0$ , $I_{OL} = 20$ mA, See Figure 11	1	$I_X = 570$ $\mu$ A, $I_{\bar{X}} = -570$ $\mu$ A, $I_{OH} = -500$ $\mu$ A, See Figure 12	2.4	3.4	$I_X + I_{\bar{X}} = 600$ $\mu$ A, $R_{XX} = 83$ $\Omega$ <sup>‡</sup> , $I_{OL} = 20$ mA, See Figure 11	0.2	0.4
SN54H62 SN74H62	$V_X = 1$ V, $I_{OH} = -500$ $\mu$ A, See Figure 13	-2.7 -2.9 -5.36			$V_X = 1$ V, $I_{OH} = -500$ $\mu$ A, See Figure 13	2.4	3.4	$I_X = -300$ $\mu$ A, $I_{OL} = 20$ mA, $T_A = \text{MAX}$ , See Figure 14	0.2	0.4

<sup>‡</sup>All typical values are at  $V_{CC} = 5$  V,  $T_A = 25^\circ\text{C}$ .

<sup>‡</sup> $R_{XX}$  equals 114  $\Omega$  for SN5423, 138  $\Omega$  for SN5450 and SN5453, 106  $\Omega$  for SN7423, and 130  $\Omega$  for SN7450 and SN7453.

supply current<sup>†</sup>

TYPE	$I_{CCH}$ (mA) Total with outputs high		$I_{CCL}$ (mA) Total with outputs low		$I_{CC}$ (mA) Average per gate (50% duty cycle)	
	TYP	MAX	TYP	MAX	TYP	TYP
'23	8	16	10	19	4.5	4.5
'50	4	8	7.4	14	2.85	2.85
'53	4	8	5.1	9.5	4.55	4.55
'H50	8.2	12.8	15.2	24	5.85	5.85
'H62	20	31	15.2	24	17.6	17.6
'H53	7.1	11	9.4	14	8.25	8.25
'H55	4.5	6.4	7.5	12	6.00	6.00

<sup>†</sup>Maximum values of  $I_{CC}$  are over the recommended operating ranges of  $V_{CC}$  and  $T_A$ ; typical values are at  $V_{CC} = 5$  V,  $T_A = 25^\circ\text{C}$ .

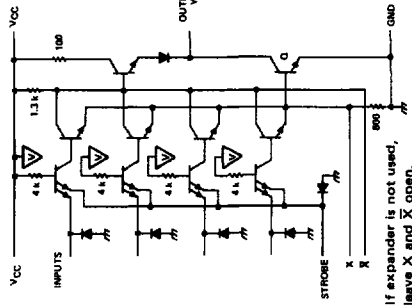
# EXPANDABLE GATES

switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

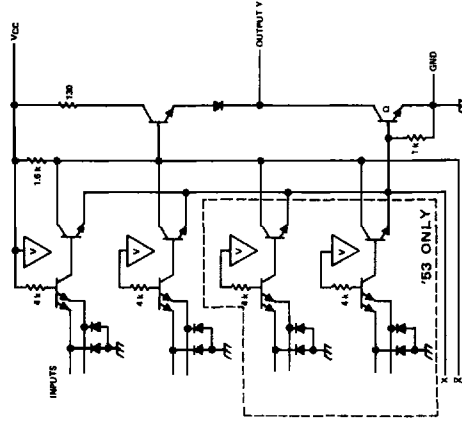
TYPE	TEST CONDITIONS#	$t_{PLH}$ (ns)		$t_{PHL}$ (ns)	
		TYP	MAX	TYP	MAX
'23, '50, '53	$C_L = 15\text{ pF}$ , $R_L = 400\ \Omega$ , Expander pins open	13	22	8	15
'50	$C_L = 15\text{ pF}$ , $R_L = 400\ \Omega$ , From input of '60 expander	15	30	10	20
'H60	$C_L = 25\text{ pF}$ , $R_L = 280\ \Omega$ , Expander pins open	6.8	11	6.2	11
'H62		10.6	15	9.2	15
'H63		7	11	6.2	11
'H65		7	11	6.5	11
'H60		$C_L = 25\text{ pF}$ , $R_L = 280\ \Omega$ , $C = 15\text{ pF}$ (GND to $\bar{X}$ of	11	7.4	7.4
'H62		11.4	7.4	7.4	7.7

#Load circuit and voltage waveforms are shown on page 3-10.

schematics (each gate)



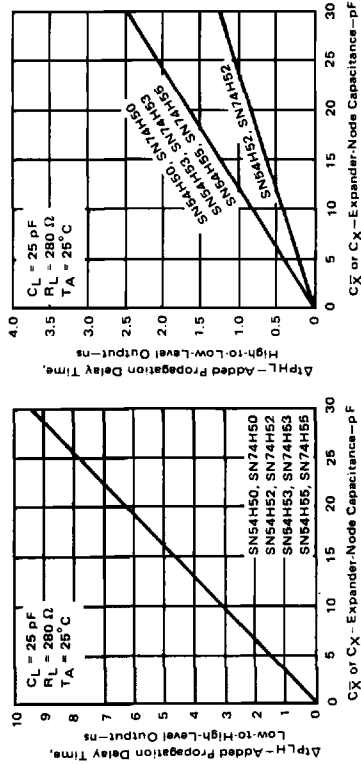
'23 CIRCUITS



'50, '53 CIRCUITS

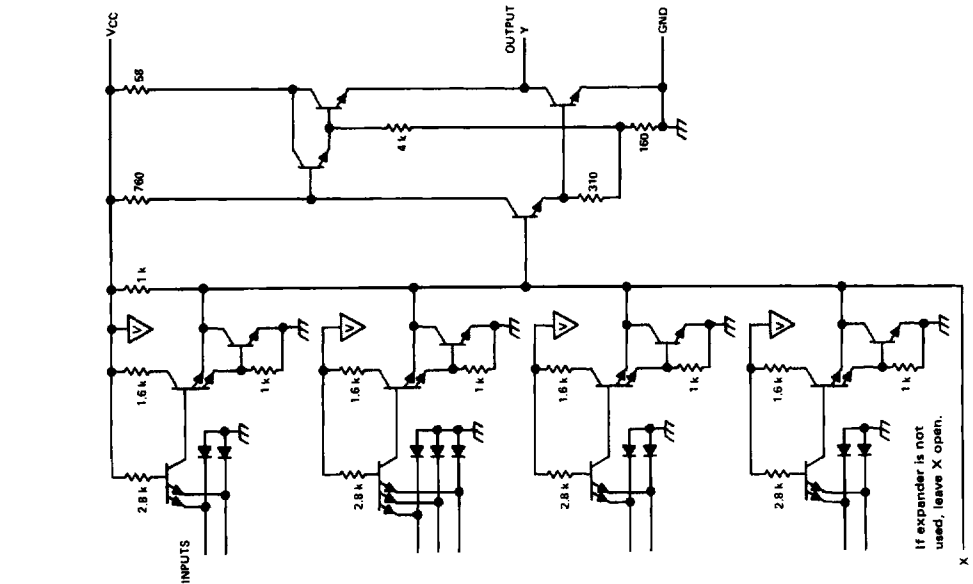
Resistor values shown are nominal and in ohms.

TYPICAL ADDED PROPAGATION DELAY TIME vs EXPANDER-NODE CAPACITANCE



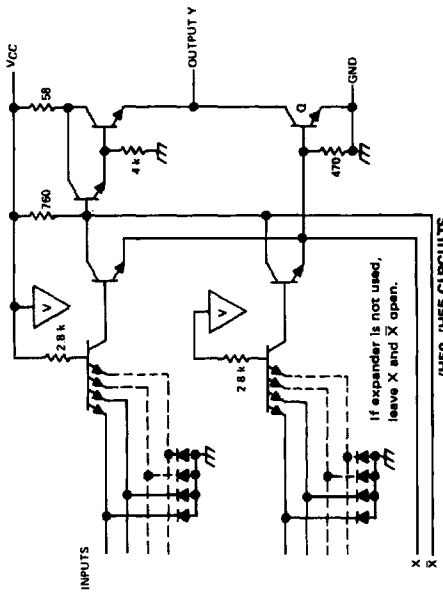


# EXPANDABLE GATES



1H62 CIRCUITS

Resistor values shown are nominal and in ohms.



1H50, 1H65 CIRCUITS

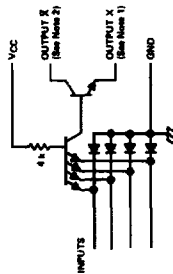
1H63 CIRCUITS

## recommended operating conditions

	SN5480		SN7480		UNIT
	MIN	MAX	MIN	MAX	
Supply voltage, $V_{CC}$	4.5	5.5	4.75	5	5.25 V
Operating free-air temperature, $T_A$	-55	125	0	70	$^{\circ}\text{C}$

The '23, '50, and '53 are designed for use with up to four '60 expanders.

## schematic (each gate)



## '60 CIRCUITS

- NOTES: 1. Connect to X input of '23, '50, or '53 circuit.  
2. Connect to  $\bar{X}$  input of '23, '60, or '53 circuit.

Resistor value shown is nominal and in ohms.

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

PARAMETER	TEST FIGURE	SN5480		SN7480		UNIT
		MIN	TYP†	MAX	MIN	
$V_{IH}$ High-level input voltage	15		2		2	V
$V_{IL}$ Low-level input voltage	16		0.8		0.8	V
$V_{XX(on)}$ On-state voltage between expander outputs	15	$V_{CC} = 4.5\text{ V}$ , $V_{IH} = 2\text{ V}$ , $V_X = 1.1\text{ V}$ , $I_X = 3.5\text{ mA}$ , $T_A = -55^{\circ}\text{C}$		0.4	$V_{CC} = 4.75\text{ V}$ , $V_{IH} = 2\text{ V}$ , $V_X = 1\text{ V}$ , $I_X = 3.8\text{ mA}$ , $T_A = 0^{\circ}\text{C}$	0.4 V
$I_X(on)$ On-state expander current	15	$V_{CC} = 4.5\text{ V}$ , $V_{IH} = 2\text{ V}$ , $V_X = 1.1\text{ V}$ , $I_X = 0$ , $T_A = -55^{\circ}\text{C}$	-0.3		$V_{CC} = 4.75\text{ V}$ , $V_{IH} = 2\text{ V}$ , $V_X = 1\text{ V}$ , $I_X = 0$ , $T_A = 0^{\circ}\text{C}$	-0.43 mA
$I_X(off)$ Off-state expander current	16	$V_{CC} = 4.5\text{ V}$ , $V_{IL} = 0.8\text{ V}$ , $V_X = 4.5\text{ V}$ , $R_X = 1.2\text{ k}\Omega$ , $T_A = -55^{\circ}\text{C}$		150	$V_{CC} = 4.75\text{ V}$ , $V_{IL} = 0.8\text{ V}$ , $V_X = 4.5\text{ V}$ , $R_X = 1.2\text{ k}\Omega$ , $T_A = 0^{\circ}\text{C}$	270 $\mu\text{A}$
$I_I$ Input current at maximum input voltage	4	$V_{CC} = 5.5\text{ V}$ , $V_I = 5.5\text{ V}$		1	$V_{CC} = 5.25\text{ V}$ , $V_I = 5.5\text{ V}$	1 mA
$I_{IH}$ High-level input current	4	$V_{CC} = 5.5\text{ V}$ , $V_I = 2.4\text{ V}$		40	$V_{CC} = 5.25\text{ V}$ , $V_I = 2.4\text{ V}$	40 $\mu\text{A}$
$I_{IL}$ Low-level input current	5	$V_{CC} = 5.5\text{ V}$ , $V_I = 0.4\text{ V}$		-1.6	$V_{CC} = 5.25\text{ V}$ , $V_I = 0.4\text{ V}$	-1.6 mA
$I_{CC(on)}$ Supply current, expander on	7	$V_{CC} = 5.5\text{ V}$ , $V_I = 4.5\text{ V}$ , $V_X = 0.85\text{ V}$ , $I_X = 0$	1.2	2.5	$V_{CC} = 5.25\text{ V}$ , $V_I = 4.5\text{ V}$ , $V_X = 0.85\text{ V}$ , $I_X = 0$	1.2 2.5 mA
$I_{CC(off)}$ Supply current, expander off	7	$V_{CC} = 5.5\text{ V}$ , $V_I = 0$ , $V_X = 0.85\text{ V}$ , $I_X = 0$	2	4	$V_{CC} = 5.25\text{ V}$ , $V_I = 0$ , $V_X = 0.85\text{ V}$ , $I_X = 0$	2 4 mA

† All typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^{\circ}\text{C}$ .

# EXPANDERS

## recommended operating conditions

	SN64H60		SN74H60		UNIT
	MIN	NOM	MAX	MAX	
Supply voltage, V <sub>CC</sub>	4.5	5	5.5	5.26	V
Operating free-air temperature, T <sub>A</sub>	-55		125	0	70 °C

See schematics  
next page

The 'H50, 'H53, and 'H55 are designed for use with up to four 'H60 expanders or one 'H62 expander.

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

PARAMETER	TEST FIGURE	SN64H60, SN64H62		SN74H60, SN74H62		UNIT	
		MIN	TYP <sup>‡</sup> MAX	MIN	TYP <sup>‡</sup> MAX		
V <sub>IH</sub> High-level input voltage	15		2			V	
V <sub>IL</sub> Low-level input voltage	16		0.8			0.8 V	
V <sub>XX(on)</sub> On-state voltage between expander outputs	15	V <sub>CC</sub> = 4.5 V, V <sub>IH</sub> = 2 V, V <sub>X</sub> = 1.1 V, I <sub>X</sub> = 5.85 mA, T <sub>A</sub> = -55°C V <sub>CC</sub> = 5.5 V, V <sub>IH</sub> = 2 V, V <sub>X</sub> = 1 V, I <sub>X</sub> = 7.85 mA, T <sub>A</sub> = 125°C	0.4	V <sub>CC</sub> = 4.75 V, V <sub>IH</sub> = 2 V, V <sub>X</sub> = 1 V, I <sub>X</sub> = 6.3 mA, T <sub>A</sub> = 0°C V <sub>CC</sub> = 5.25 V, V <sub>IH</sub> = 2 V, V <sub>X</sub> = 1 V, I <sub>X</sub> = 7.4 mA, T <sub>A</sub> = 70°C		0.4	V
I <sub>X(on)</sub> On-state expander current	15	V <sub>CC</sub> = 4.5 V, V <sub>IH</sub> = 2 V, V <sub>X</sub> = 1.1 V, I <sub>X</sub> = 0, T <sub>A</sub> = -55°C	-470	V <sub>CC</sub> = 4.75 V, V <sub>IH</sub> = 2 V, V <sub>X</sub> = 1 V, I <sub>X</sub> = 0, T <sub>A</sub> = 0°C	-600	μA	
I <sub>X(off)</sub> Off-state expander current	16	V <sub>CC</sub> = 4.5 V, V <sub>IL</sub> = 0.8 V, V <sub>X</sub> = 4.5 V, R <sub>X</sub> = 575 Ω, T <sub>A</sub> = -55°C		V <sub>CC</sub> = 4.75 V, V <sub>IL</sub> = 0.8 V, V <sub>X</sub> = 4.5 V, R <sub>X</sub> = 575 Ω, T <sub>A</sub> = 0°C		μA	
I <sub>I</sub> Input current at maximum input voltage	4	V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 5.5 V	1	V <sub>CC</sub> = 5.25 V, V <sub>I</sub> = 5.5 V	1	mA	
I <sub>IH</sub> High-level input current	4	V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 2.4 V	50	V <sub>CC</sub> = 5.25 V, V <sub>I</sub> = 2.4 V	50	μA	
I <sub>IL</sub> Low-level input current	5	V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 0.4 V	-2	V <sub>CC</sub> = 5.25 V, V <sub>I</sub> = 0.4 V	-2	mA	
I <sub>CC(on)</sub> Supply current, expander on	7	'H60 V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 4.5 V, V <sub>X</sub> = 0.85 V, I <sub>X</sub> = 0	1.9	V <sub>CC</sub> = 5.25 V, V <sub>I</sub> = 4.5 V, V <sub>X</sub> = 0.85 V, I <sub>X</sub> = 0	1.9	3.5	mA
'H62		3.8	7	3.8	7		
I <sub>CC(off)</sub> Supply current, expander off	7	'H60 V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 0, V <sub>X</sub> = 0.85 V, I <sub>X</sub> = 0	3	V <sub>CC</sub> = 5.25 V, V <sub>I</sub> = 0, V <sub>X</sub> = 0.85 V, I <sub>X</sub> = 0	3	4.5	mA
'H62		6	9	6	9		
C <sub>X</sub> Expander output capacitance	'H60	V <sub>CC</sub> : inputs, and X open; f = 1 MHz	5.4	V <sub>CC</sub> : inputs, and X open; f = 1 MHz	5.4	6.0	pF
	'H62		6.0		6.0		

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

## recommended operating conditions

	SN64H61		SN74H61		UNIT
	MIN	NOM	MAX	MAX	
Supply voltage, $V_{CC}$	4.5	5	5.5	5.25	V
Operating free-air temperature, $T_A$	-55		125	0	$^{\circ}\text{C}$

The 'H52 is designed for use with up to six 'H61 expanders.

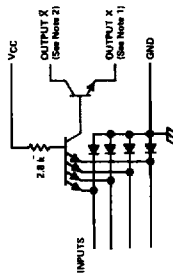
## electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST FIGURE	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
$V_{IH}$ High-level input voltage	17		2		0.8	V
$V_{IL}$ Low-level input voltage	18					V
$V_X(\text{on})$ On-state expander output voltage	17	$V_{CC} = \text{MIN}$ , $V_{IH} = 2\text{ V}$ , $I_X = 4.5\text{ mA}$ for SN64H61, 5.35 mA for SN74H61, $T_A = \text{MIN}$			1	V
$I_X(\text{off})$ Off-state expander current	18	$V_{CC} = \text{MIN}$ , $V_{IL} = 0.8\text{ V}$ , $V_X = 2.2\text{ V}$ , $T_A = \text{MAX}$			50	$\mu\text{A}$
$I_I$ Input current at maximum input voltage	4	$V_{CC} = 5.5\text{ V}$ , $V_I = 5.5\text{ V}$			1	mA
$I_{IH}$ High-level input current	4	$V_{CC} = 5.5\text{ V}$ , $V_I = 2.4\text{ V}$			50	$\mu\text{A}$
$I_{IL}$ Low-level input current	5	$V_{CC} = 5.5\text{ V}$ , $V_I = 0.4\text{ V}$			-2	mA
$I_{CC}(\text{on})$ Supply current, expander on	7	$V_{CC} = 5.5\text{ V}$ , $V_I = 4.5\text{ V}$			11	mA
$I_{CC}(\text{off})$ Supply current, expander off	7	$V_{CC} = 5.5\text{ V}$ , $V_I = 0$			5	mA
$C_X$ Expander output capacitance		$V_{CC}$ and inputs open, $f = 1\text{ MHz}$			5.4	pF

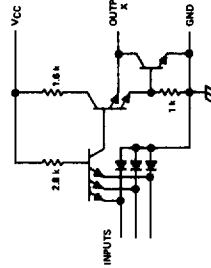
†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡All typical values are at  $V_{CC} = 5\text{ V}$  (except  $C_X$ ).  $T_A = 25^{\circ}\text{C}$ .

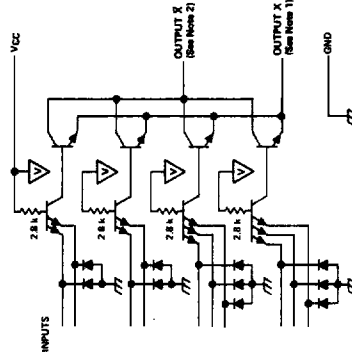
## schematics (each gate)



'H60 CIRCUITS



'H61 CIRCUITS



'H62 CIRCUITS

NOTES: 1. Connect to X input of 'H60, 'H63, or 'H65 circuit.

2. Connect to X input of 'H60, 'H63, or 'H65 circuit.

Resistor values shown are nominal and in ohms.

# SERIES 54/74 FLIP-FLOPS

## recommended operating conditions

	SERIES 54/74		70		72, 73, 76, 107		74		'109		'110		'111		UNIT	
	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM		MAX
Supply voltage, $V_{CC}$	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V
High-level output current, $I_{OH}$	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	$\mu$ A
Low-level output current, $I_{OL}$			-400			-400			-400			-400			-800	$\mu$ A
Pulse width, $t_w$		20		20		16		30		20		16		25		ns
Pre-set or clear low		30		47		37		30		20		25		25		ns
Input setup time, $t_{su}$		20†		0†		20†		20†		10†		20†		0†		ns
Input hold time, $t_h$		5†		0†		5†		5†		6†		5†		30†		ns
Operating free-air temperature, $T_A$	-55	125		-55	125		-55	125		-55	125		-55	125		$^{\circ}$ C

† The arrow indicates the edge of the clock pulse used for reference; † for the rising edge, † for the falling edge.  
 electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†		70		72, 73, 76, 107		74		'109		'110		'111		UNIT
	MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	
$V_{IH}$ High-level input voltage		2	0.8		2	0.8		2		2		2		2	0.8 V
$V_{IL}$ Low-level input voltage			-1.5			-1.5				-1.5		-1.5		-1.5	-1.5 V
$V_{IK}$ Input clamp voltage															
$V_{OH}$ High-level output voltage		2.4	3.4		2.4	3.4		2.4	3.4		2.4	3.4		2.4	3.4 V
$V_{OL}$ Low-level output voltage		0.2	0.4		0.2	0.4		0.2	0.4		0.2	0.4		0.2	0.4 V
$I_I$ Input current at maximum input voltage			1			1			1			1			1 mA
D, J, K, or $\bar{K}$			40			40			40			40			40 $\mu$ A
Clear			80			120			160			160			80 $\mu$ A
Pre-set			80			80			80			160			80 $\mu$ A
Clock			40			80			80			40			40 $\mu$ A
D, J, K, or $\bar{K}$			-1.6			-1.6			-1.6			-1.6			-1.6 V
Clear *			-3.2			-3.2			-4.8			-3.2			-3.2 V
Pre-set *			-3.2			-3.2			-3.2			-3.2			-3.2 V
Clock			-1.6			-3.2			-3.2			-1.6			-4.8 V
Short-circuit			-20			-57			-20			-85			-20 mA
Supply current			-18			-57			-30			-85			-18 mA
$I_{CC}$ (Average per flip-flop)			13			20			9			15			14 20.5 mA

† 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,  $T_A = 25^{\circ}$  C.

\* Clear is tested with pre-set high and pre-set is tested with clear high.

NOTE 1: With all outputs open,  $I_{CC}$  is measured with the Q and  $\bar{Q}$  outputs high in turn. At the time of measurement, the clock input is at 4.5 V for the '70, '110, and '111; and

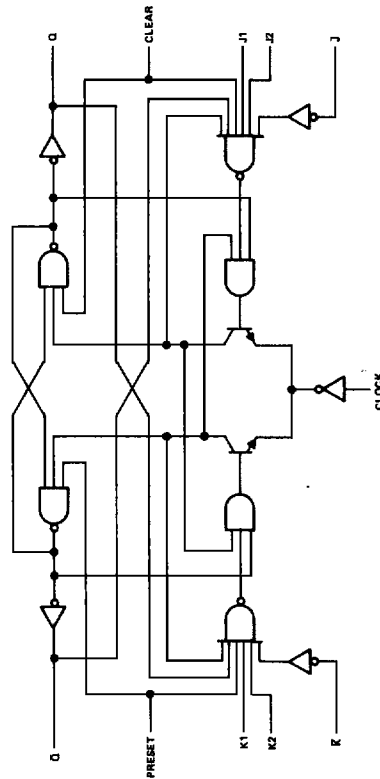
is grounded for all the others.

switching characteristics, VCC = 5 V, TA = 25°C

PARAMETER <sup>1</sup>	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	70		72, 73 76, 107		74		109		110		111		UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
f <sub>max</sub>				20	35	15	20	15	25	25	33	20	25	20	25	MHz
t <sub>PLH</sub>	Preset	Q	C <sub>L</sub> = 15 pF, R <sub>L</sub> = 400 Ω, See Note 2	50		16	25	25		10	15	12	20	12	18	ns
t <sub>PHL</sub>	(as applicable)	$\bar{Q}$		50		25	40	40		23	35	18	25	21	30	
t <sub>PLH</sub>	Clear	Q		50		16	25	25		10	15	12	20	12	18	ns
t <sub>PHL</sub>	(as applicable)	Q		50		25	40	40		17	25	18	25	21	30	
t <sub>PLH</sub>	Clock	Q or $\bar{Q}$		27	50	16	25	14	25	10	16	20	30	12	17	ns
t <sub>PHL</sub>			18	50	25	40	20	40	18	28	13	20	20	30		

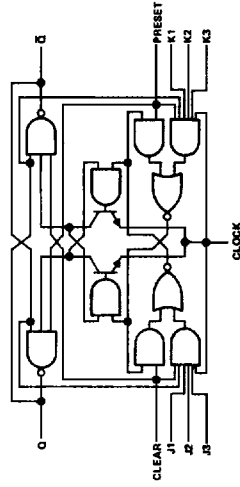
<sup>1</sup>f<sub>max</sub> = maximum clock frequency; t<sub>PLH</sub> = propagation delay time, low-to-high-level output; t<sub>PHL</sub> = propagation delay time, high-to-low-level output.  
NOTE 2: Load circuit and voltage waveforms are shown on page 3-10.

functional block diagrams



70-GATED J-K WITH CLEAR AND PRESET

See following pages for:  
 73-DUAL J-K WITH CLEAR  
 74-DUAL D WITH CLEAR AND PRESET  
 76-DUAL J-K WITH CLEAR AND PRESET  
 107-DUAL J-K WITH CLEAR

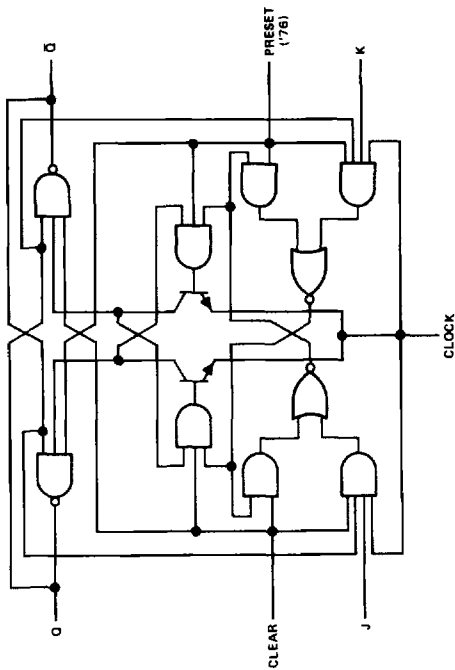


72-GATED J-K WITH CLEAR AND PRESET

109-DUAL  $\bar{J}\bar{K}$  WITH CLEAR AND PRESET  
 110-GATED J-K WITH CLEAR AND PRESET  
 111-DUAL J-K WITH CLEAR AND PRESET

# SERIES 54/74 FLIP-FLOPS

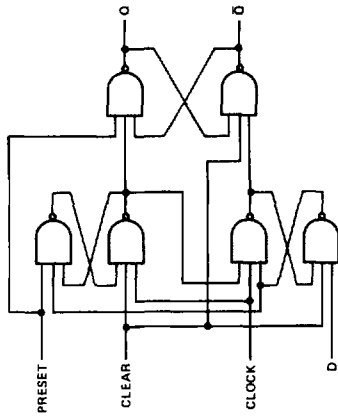
functional block diagrams (continued)



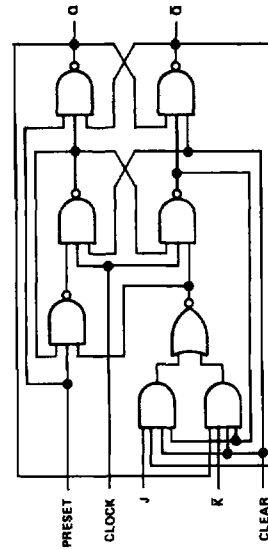
'73-DUAL J-K WITH CLEAR

'76-DUAL J-K WITH CLEAR AND PRESET

'107-DUAL J-K WITH CLEAR

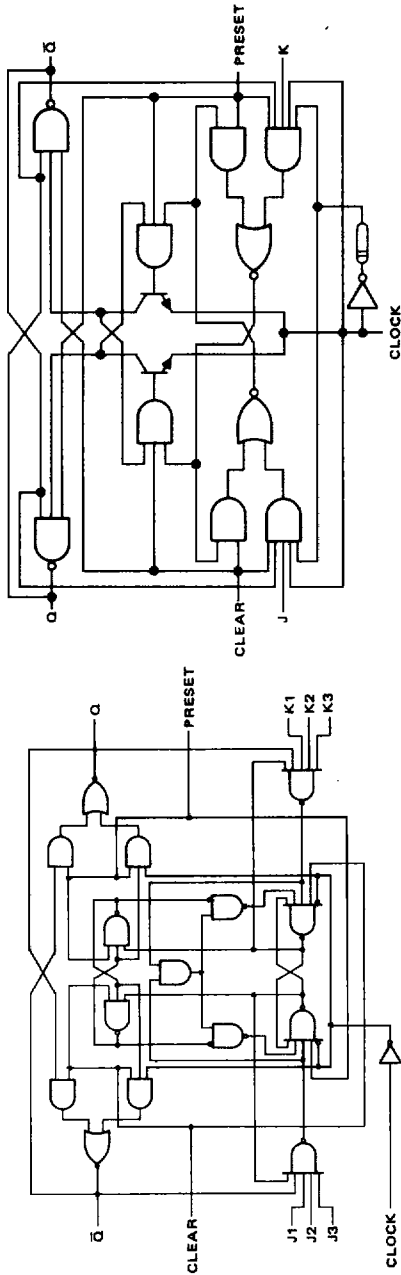


'74-DUAL D WITH CLEAR AND PRESET



'108-DUAL J-K WITH CLEAR AND PRESET

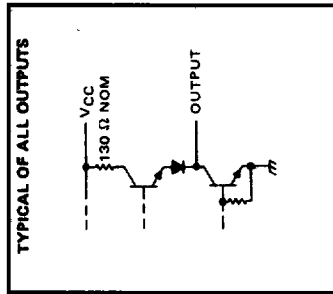
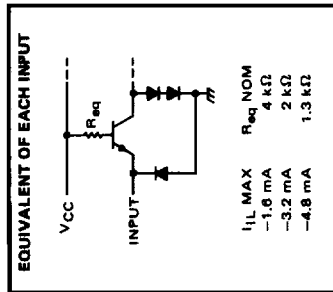
functional block diagrams (continued)



'110-GATED J-K WITH CLEAR AND PRESET

'111-DUAL J-K WITH CLEAR AND PRESET

schematics of inputs and outputs





# SERIES 54H/74H PULSE-TRIGGERED J-K AND EDGE-TRIGGERED D-TYPE FLIP-FLOPS

## recommended operating conditions

	SERIES 54H/74H		'H71		'H72, 'H73, 'H76		'H74		'H78		UNIT		
	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V <sub>CC</sub>	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V
High-level output current, I <sub>OH</sub>	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	μA
Low-level output current, I <sub>OL</sub>			-500			-500			-1000			-800	μA
Pulse width, t <sub>w</sub>			20			20			20			20	ns
Clear or preset low			28			28			13.5			28	ns
High-level data			0†			0†			10†			0†	ns
Low-level data			0†			0†			15†			0†	ns
Operating free-air temperature, T <sub>A</sub>			-55			125			-55			125	°C

† The arrow indicates the edge of the clock pulse used for reference; † for the rising edge, ‡ for the falling edge.

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

PARAMETER	TEST CONDITIONS†		'H71		'H72, 'H73, 'H76		'H74		'H78		UNIT		
	MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V <sub>IH</sub> High-level input voltage			0.8			0.8			0.8			0.8	V
V <sub>IL</sub> Low-level input voltage			-1.5			-1.5			-1.5			-1.5	V
V <sub>IK</sub> Input clamp voltage													V
V <sub>OH</sub> High-level output voltage			2.4			2.4			2.4			2.4	V
V <sub>OL</sub> Low-level output voltage			0.2			0.2			0.2			0.2	V
I <sub>I</sub> Input current at maximum input voltage			1			1			1			1	mA
I <sub>IH</sub> High-level input current	D, J, or K		50			50			50			50	μA
	Clear					100			150			200	μA
	Preset					100			100			100	μA
I <sub>IL</sub> Low-level input current	D, J, or K		-2			-2			-2			-2	μA
	Clear *					-4			-4			-4	μA
	Preset *					-6			-6			-6	μA
I <sub>OS</sub> Short-circuit output current‡			-4			-2			-4			-4	mA
I <sub>CC</sub> Supply current (Average per flip-flop)			-40			-100			-40			-100	mA

† 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.

\* Clear is tested with preset high and preset is tested with clear high.

NOTE 1: With all outputs open, I<sub>CC</sub> is measured with the Q and Q̄ outputs high in turn. At the time of measurement, the clock input is grounded.

# SERIES 54H/74H PULSE-TRIGGERED J-K AND EDGE-TRIGGERED D-TYPE FLIP-FLOPS

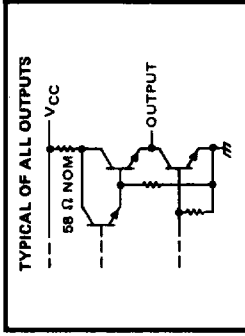
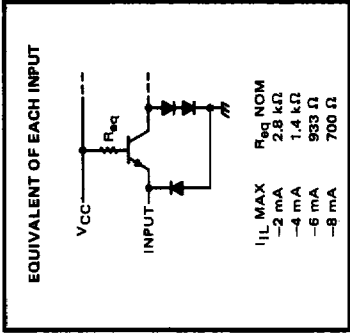
switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

PARAMETER <sup>1</sup>	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'H71, 'H72, 'H73, 'H76, 'H78		'H74		UNIT
				MIN	TYP	MAX	MIN	
$f_{\text{MAX}}$		Q	$C_L = 25\text{ pF}$ , $R_L = 280\ \Omega$ , See Note 2	25	30	35	43	MHZ
$t_{\text{PLH}}$	Preset (as applicable)	$\bar{Q}$		6	13		20	ns
$t_{\text{PHL}}$	Clear (as applicable)	Q		12	24		30	ns
$t_{\text{PLH}}$	(as applicable)	Q		6	13		20	ns
$t_{\text{PHL}}$		Q		12	24		30	ns
$t_{\text{PHL}}$	Clock	Q or $\bar{Q}$		14	21	8.5	15	ns
			22	27	13	20	ns	

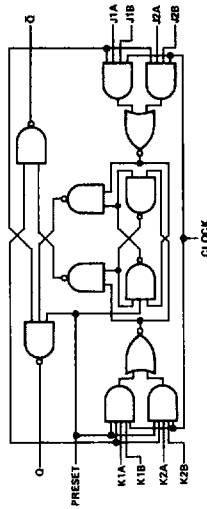
<sup>1</sup>  $t_{\text{max}}$  = maximum clock frequency;  $t_{\text{PLH}}$  = propagation delay time, low-to-high-level output;  $t_{\text{PHL}}$  = propagation delay time, high-to-low-level output.

NOTE 2: Load circuit and voltage waveforms are shown on page 3-10.

schematics of input and outputs



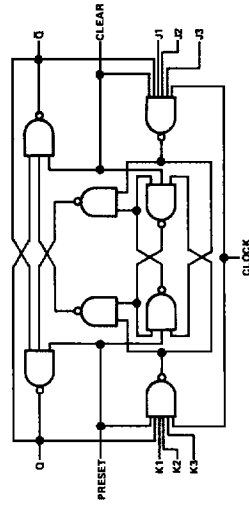
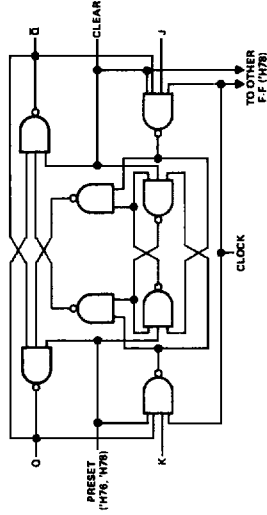
functional block diagrams



'H71-GATED J-K WITH PRESET

Same functional block diagram as for '74, see page G-48.

'H74-DUAL D WITH CLEAR AND PRESET



'H72-GATED J-K WITH CLEAR AND PRESET

# SERIES 54H/74H EDGE-TRIGGERED J-K FLIP-FLOPS

## recommended operating conditions

	SERIES 54H/74H			'H101			'H102, 'H106			'H103			'H108			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, $V_{CC}$	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V
High-level output current, $I_{OH}$	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	$\mu$ A
Low-level output current, $I_{OL}$			-500			-500			-500			-500			-500	mA
Pulse width, $t_p$	Clock high															
	Clock low															
	Clear or preset low															
Setup time, $t_{su}$	High-level data															
	Low-level data															
Hold time, $t_h$	0 $\downarrow$															
	0 $\uparrow$															
Operating free-air temperature, $T_A$	Series 54H															
	Series 74H															

↓ The arrow indicates that the falling edge of the clock pulse is used for reference.

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

PARAMETER	TEST CONDITIONS†	'H101			'H102, 'H106			'H103			'H108			UNIT
		MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	
$V_{IH}$ High-level input voltage		2		0.8		0.8		0.8		0.8		0.8		V
$V_{IL}$ Low-level input voltage				-1.5		-1.5		-1.5		-1.5		-1.5		V
$V_{IK}$ Input clamp voltage														V
$V_{OH}$ High-level output voltage	$V_{CC} = \text{MIN}, I_L = -8 \text{ mA}$ $V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V},$ $V_{IL} = 0.8 \text{ V}, I_{OH} = -600 \mu\text{A}$	2.4	3.4		2.4	3.4		2.4	3.4		2.4	3.4		V
$V_{OL}$ Low-level output voltage	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V},$ $V_{IL} = 0.8 \text{ V}, I_{OL} = 20 \text{ mA}$	0.2	0.4		0.2	0.4		0.2	0.4		0.2	0.4		V
$I_I$ Input current at maximum input voltage	$V_{CC} = \text{MAX}, V_I = 5.5 \text{ V}$	1		1	1		1		1	1		1		mA
$I_{IH}$ High-level input current	Any J or K			50		50		50		50		50		$\mu$ A
	Clear			100		100		100		100		100		$\mu$ A
	Preset			100		100		100		100		100		$\mu$ A
$I_{IL}$ Low-level input current	Any J or K	0	-1	-2	0	-1	-2	0	-1	-2	0	-1	-2	mA
	Clear			-1		-2		-1		-2		-2		mA
	Preset			-1		-2		-1		-2		-2		mA
	Clock			-3		-4.8		-3		-4.8		-6		-9.6
$I_{QS}$ Short-circuit output current‡	$V_{CC} = \text{MAX}$	-40	-100	-100	-40	-100	-100	-40	-100	-100	-40	-100	-100	mA
$I_{CC}$ Supply current (Average per flip-flop)	$V_{CC} = \text{MAX}$ , See Note 1	20	38		20	38		20	38		20	38		mA

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

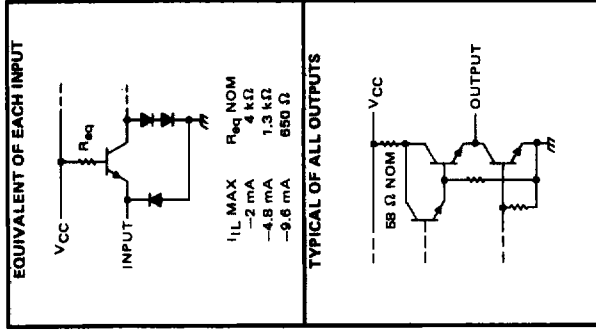
‡ All typical values are at  $V_{CC} = 5 \text{ V}, T_A = 25^\circ \text{C}$ .

§ Not more than one output should be shorted at a time, and duration of short-circuit should not exceed one second.

NOTE 1: With all outputs open,  $I_{CC}$  is measured with the Q and  $\bar{Q}$  outputs high in turn. At the time of measurement, the clock input is grounded.

# SERIES 54H/74H EDGE-TRIGGERED J-K FLIP-FLOPS

schematics of inputs and outputs

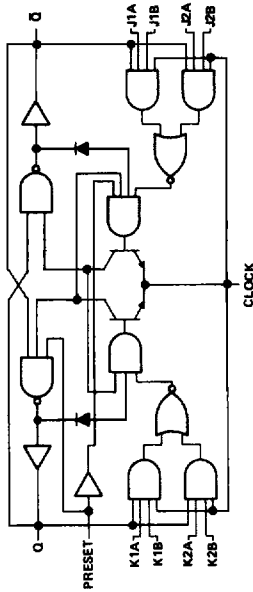


switching characteristics,  $V_{CC} = 5 V$ ,  $T_A = 25^\circ C$

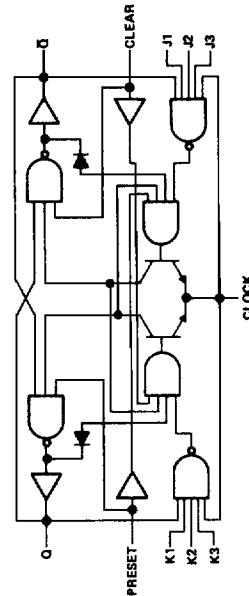
PARAMETER <sup>1</sup>	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS			UNIT
			MIN	TYP	MAX	
$f_{max}$			40	50		MHz
$t_{PLH}$	Preset or clear	Q or $\bar{Q}$		8	12	ns
$t_{PHL}$	Preset or clear (clock high)	Q or $\bar{Q}$		15	20	ns
$t_{PLH}$	Preset or clear (clock low)	Q or $\bar{Q}$		23	35	ns
$t_{PHL}$	Clock	Q or $\bar{Q}$		10	15	ns
$t_{PHL}$		Q or $\bar{Q}$		16	20	ns

<sup>1</sup> $f_{max}$  = maximum clock frequency  
 $t_{PLH}$  = propagation delay time, low-to-high-level output  
 $t_{PHL}$  = propagation delay time, high-to-low-level output  
 NOTE 2: Load circuit and voltage waveforms are shown on page 3-10.

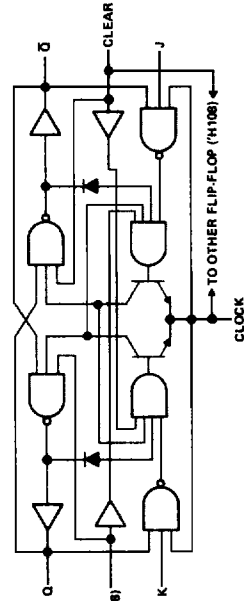
functional block diagrams



'H101—GATED J-K WITH PRESET



'H102—GATED J-K WITH CLEAR AND PRESET



'H103—DUAL J-K WITH CLEAR  
 'H106—DUAL J-K WITH CLEAR AND PRESET  
 'H108—DUAL J-K WITH PRESET, COMMON CLEAR, AND COMMON CLOCK

# SERIES 54L/74L FLIP-FLOPS

## recommended operating conditions

	SERIES 54L/74L	'L71		'L72, 'L73		'L74		'L78		UNIT
		MIN	NOM MAX	MIN	MAX	MIN	NOM MAX	MIN	NOM MAX	
Supply voltage, V <sub>CC</sub>	Series 54L	4.5	5.5	4.5	5.5	4.5	5.5	4.5	5.5	V
	Series 74L	4.75	5.25	4.75	5.25	4.75	5.25	4.75	5.25	V
	Series 54L	-100	-100	-100	-100	-100	-100	-100	-100	μA
High-level output current, I <sub>OH</sub>	Series 74L	-200	-200	-200	-200	-200	-200	-200	-200	mA
Low-level output current, I <sub>OL</sub>	Series 54L	2	2	2	2	2	2	2	2	mA
	Series 74L	3.8	3.8	3.6	3.6	3.6	3.6	3.6	3.6	mA
Pulse width, t <sub>w</sub>	Clock high	200	200	200	200	200	200	200	200	ns
	Clock low	200	200	200	200	200	200	200	200	ns
	Clear or preset low	100	100	100	100	100	100	100	100	ns
Setup time, t <sub>su</sub>		0†	0†	0†	0†	50†	50†	0†	0†	ns
Hold time, t <sub>h</sub>		0‡	0‡	0‡	0‡	15‡	15‡	0‡	0‡	ns
Operating free-air temperature, T <sub>A</sub>	Series 54L	-55	125	-55	125	-55	125	-55	125	°C
	Series 74L	0	70	0	70	0	70	0	70	°C

† The arrow indicates the edge of the clock pulse used for reference; † for the rising edge, ‡ for the falling edge.

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

PARAMETER	TEST CONDITIONS†	'L71		'L72, 'L73		'L74		'L78		UNIT
		MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	
V <sub>IH</sub> High-level input voltage	Clock input	2	2	0.6	0.6	2	2	2	2	V
V <sub>IL</sub> Low-level input voltage	All other inputs			0.7	0.7			0.7	0.7	V
V <sub>OH</sub> High-level output voltage	Series 54L	V <sub>CC</sub> - MIN, V <sub>IH</sub> = 2 V,		2.4	3.3	2.4	3.3	2.4	3.3	V
	Series 74L	V <sub>IL</sub> = V <sub>IL</sub> max, I <sub>OH</sub> = MAX		2.4	3.2	2.4	3.2	2.4	3.2	V
V <sub>OL</sub> Low-level output voltage	Series 54L	V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V,		0.15	0.3	0.15	0.3	0.15	0.3	V
	Series 74L	V <sub>IL</sub> = V <sub>IL</sub> max, I <sub>OL</sub> = MAX		0.2	0.4	0.2	0.4	0.2	0.4	V
I <sub>I</sub> Input current at maximum input voltage	R, S, J, K, or D	100	100	100	100	100	100	100	100	μA
	Clear	200	200	200	200	300	300	400	400	μA
	Preset	200	200	200	200	200	200	200	200	μA
I <sub>IH</sub> High-level input current	Clock	200	200	200	200	200	200	200	200	μA
	R, S, J, K, or D	10	10	10	10	10	10	10	10	μA
	Clear	20	20	20	20	30	30	40	40	μA
I <sub>IL</sub> Low-level input current	Preset	20	20	20	20	20	20	20	20	μA
	Clock	-200	-200	-200	-200	-200	-200	-400	-400	μA
	R, S, J, K, or D	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	mA
I <sub>IOS</sub> Short-circuit output current	Clear	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	mA
	Preset	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	mA
	Clock	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	mA
I <sub>CC</sub> Supply current (Average per flip-flop)	V <sub>CC</sub> = MAX	-3	-15	-3	-15	-3	-15	-3	-15	mA
	V <sub>CC</sub> = MAX, See Note 1	0.76	1.44	0.76	1.44	0.8	1.5	0.76	1.44	mA

† 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.

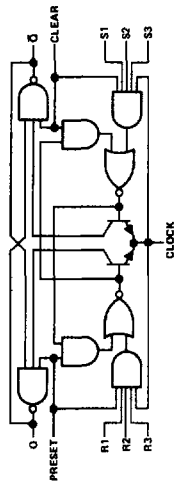
NOTE 1: With all outputs open, I<sub>CC</sub> is measured with the Q and Q̄ outputs high in turn. At the time of measurement, the clock input is grounded.

switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

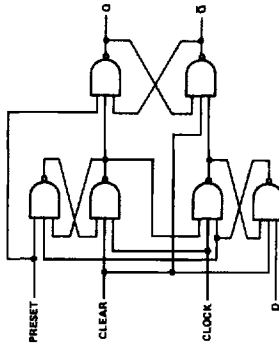
PARAMETER <sup>1</sup>	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'L71, 'L72, 'L73, 'L78		'L74		UNIT
				MIN	TYP	MAX	MIN	
$f_{max}$	Preset or clear	Q or $\bar{Q}$	$C_L = 50\text{ pF}$ , $R_L = 4\text{ k}\Omega$ , See Note 2	2.5	3	2.5	3	MHz
$t_{PLH}$	Preset or clear (clock high)	$\bar{Q}$ or Q		35	75	50	75	ns
$t_{PHL}$	Preset or clear (clock low)	Q or $\bar{Q}$		60	150	80	150	ns.
$t_{PLH}$	Clock	Q or $\bar{Q}$	10	35	75	15	65	100
$t_{PHL}$			10	60	150	15	85	

<sup>1</sup> $f_{max}$  = maximum clock frequency  
<sup>2</sup> $t_{PLH}$  = propagation delay time, low-to-high-level output  
<sup>3</sup> $t_{PHL}$  = propagation delay time, high-to-low-level output  
 NOTE 2: Load circuit and voltage waveforms are shown on page 3-11.

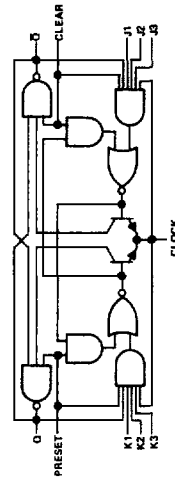
**functional block diagrams**



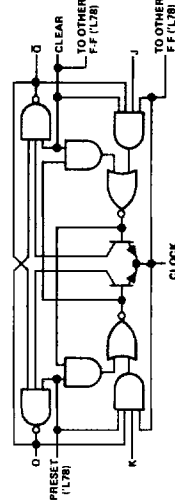
'L71—GATED R-S WITH CLEAR AND PRESET



'L74—DUAL D WITH CLEAR AND PRESET

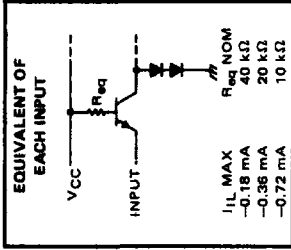


'L72—GATED J-K WITH CLEAR AND PRESET

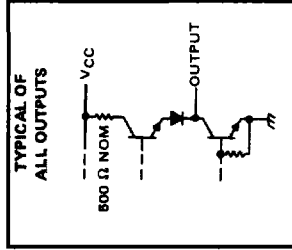


'L73—DUAL J-K WITH CLEAR  
 'L78—DUAL J-K WITH PRESET, COMMON CLEAR,  
 AND COMMON CLOCK

**schematics of inputs and outputs**



$I_{IL}$  MAX  
 -0.18 mA  
 $I_{OL}$  MAX  
 -0.36 mA  
 $R_{eq}$  NOM  
 40 k $\Omega$   
 20 k $\Omega$   
 10 k $\Omega$



800  $\Omega$  NOM

# SERIES 54LS/74LS FLIP-FLOPS

## recommended operating conditions

PARAMETER	SERIES 54LS/74LS		'L574A		'L574A, 'L5712A		'L574A, 'L5714A		'L574A, 'L5712A		'L574A, 'L5714A		'L574A, 'L5712A		'L574A, 'L5714A		UNIT		
	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN		TYP	MAX
Supply voltage, $V_{CC}$	4.5	5	6.5	4.5	5	6.5	4.5	5	6.5	4.5	5	6.5	4.5	5	6.5	4.5	5	6.5	V
High-level output current, $I_{OH}$	4.75	5	6.25	4.75	5	6.25	4.75	5	6.25	4.75	5	6.25	4.75	5	6.25	4.75	5	6.25	mA
Low-level output current, $I_{OL}$	-400			-400			-400			-400			-400			-400			mA
Clock frequency, $f_{clock}$	0	30	0	25	0	30	0	30	0	30	0	30	0	30	0	30	0	30	MHz
Pulse width, $t_p$	25			25			25			25			25			25			ns
Setup time, $t_{su}$	20.1			20.1			20.1			20.1			20.1			20.1			ns
Hold time, $t_h$	0.1			0.1			0.1			0.1			0.1			0.1			ns
Operating free-air temperature, $T_A$	-55	125	85	-55	125	85	-55	125	85	-55	125	85	-55	125	85	-55	125	85	°C

† The arrow indicates the edge of the clock pulse used for reference; † for the rising edge, † for the falling edge.

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

PARAMETER	TEST CONDITIONS†		'L574A		'L574A, 'L5712A		'L574A, 'L5714A		'L574A, 'L5712A		'L574A, 'L5714A		'L574A, 'L5712A		'L574A, 'L5714A		UNIT		
	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN		TYP	MAX
$V_{IH}$ High-level input voltage	2			2			2			2			2			2			V
$V_{IL}$ Low-level input voltage	0.8			0.8			0.8			0.8			0.8			0.8			V
$V_{IK}$ Input clamp voltage	-1.5			-1.5			-1.5			-1.5			-1.5			-1.5			V
$V_{OH}$ High-level output voltage	$V_{CC} - \text{MIN.}$			$V_{CC} - \text{MIN.}$			$V_{CC} - \text{MIN.}$			$V_{CC} - \text{MIN.}$			$V_{CC} - \text{MIN.}$			$V_{CC} - \text{MIN.}$			V
	$V_{IL} - \text{V}_{IL, \text{max.}}$			$V_{IL} - \text{V}_{IL, \text{max.}}$			$V_{IL} - \text{V}_{IL, \text{max.}}$			$V_{IL} - \text{V}_{IL, \text{max.}}$			$V_{IL} - \text{V}_{IL, \text{max.}}$			$V_{IL} - \text{V}_{IL, \text{max.}}$			V
$V_{OL}$ Low-level output voltage	$V_{IL} - \text{V}_{IL, \text{max.}}$			$V_{IL} - \text{V}_{IL, \text{max.}}$			$V_{IL} - \text{V}_{IL, \text{max.}}$			$V_{IL} - \text{V}_{IL, \text{max.}}$			$V_{IL} - \text{V}_{IL, \text{max.}}$			$V_{IL} - \text{V}_{IL, \text{max.}}$			V
	$V_{IH} - \text{V}_{IH, \text{max.}}$			$V_{IH} - \text{V}_{IH, \text{max.}}$			$V_{IH} - \text{V}_{IH, \text{max.}}$			$V_{IH} - \text{V}_{IH, \text{max.}}$			$V_{IH} - \text{V}_{IH, \text{max.}}$			$V_{IH} - \text{V}_{IH, \text{max.}}$			V
Input current at maximum input voltage	0.1			0.1			0.1			0.1			0.1			0.1			mA
	$V_{CC} - \text{MAX.}$			$V_{CC} - \text{MAX.}$			$V_{CC} - \text{MAX.}$			$V_{CC} - \text{MAX.}$			$V_{CC} - \text{MAX.}$			$V_{CC} - \text{MAX.}$			mA
$I_{IH}$ High-level input current	0.3			0.3			0.3			0.3			0.3			0.3			mA
	$V_{CC} - \text{MAX.}$			$V_{CC} - \text{MAX.}$			$V_{CC} - \text{MAX.}$			$V_{CC} - \text{MAX.}$			$V_{CC} - \text{MAX.}$			$V_{CC} - \text{MAX.}$			mA
$I_{IL}$ Low-level input current	0.1			0.1			0.1			0.1			0.1			0.1			mA
	$V_{CC} - \text{MAX.}$			$V_{CC} - \text{MAX.}$			$V_{CC} - \text{MAX.}$			$V_{CC} - \text{MAX.}$			$V_{CC} - \text{MAX.}$			$V_{CC} - \text{MAX.}$			mA
Short-circuit output current <sup>‡</sup>	-20			-20			-20			-20			-20			-20			mA
Supply current	-20			-20			-20			-20			-20			-20			mA
$I_{CC}$ (Total)	4	6		4	6		4	6		4	6		4	6		4	6		mA

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

‡ All typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

§ Not more than one output should be shorted at a time, and duration of short circuit should not exceed one second.

NOTE 1: With all outputs open,  $I_{CC}$  is measured with the Q and  $\bar{Q}$  outputs high in turn. At the time of measurement, the clock input is grounded.

switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

PARAMETER <sup>1</sup>	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'LS73A, 'LS76A, 'LS78A, 'LS107A, 'LS112A, 'LS113A, 'LS114A		'LS74A, 'LS109A		UNIT
				MIN	TYP	MAX	MIN	
$t_{max}$			$C_L = 15\text{ pF}$	30	45	25	33	MHZ
$t_{PLH}$			$R_L = 2\text{ k}\Omega$	15	20	13	26	ns
$t_{PHL}$	Clear, preset, or clock (as appropriate)	Q or $\bar{Q}$	See Note 2	15	20	26	40	ns

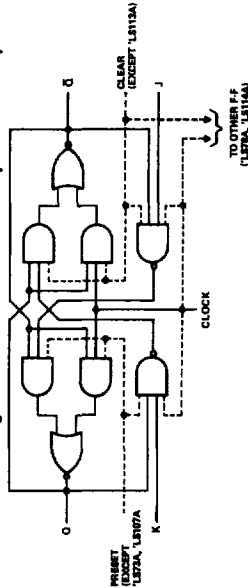
<sup>1</sup> $f_{max}$  = maximum clock frequency

<sup>2</sup> $t_{PLH}$  = propagation delay time, low-to-high-level output

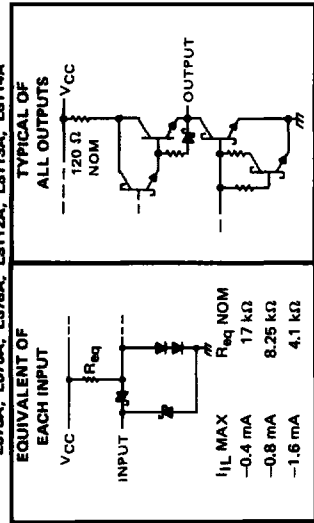
<sup>3</sup> $t_{PHL}$  = propagation delay time, high-to-low-level output

NOTE 2: Load circuit and voltage waveforms are shown on page 3-11.

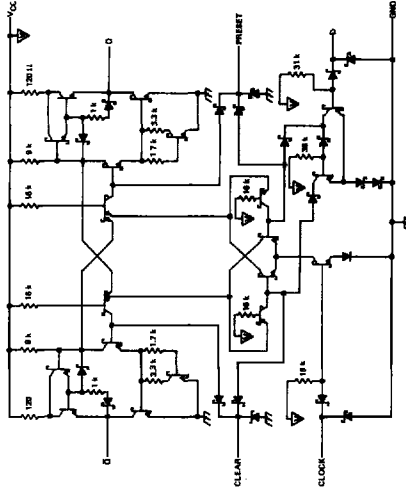
functional block diagrams and schematics of inputs and outputs



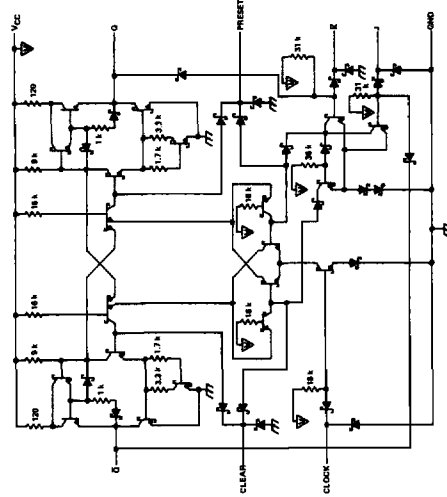
- 'LS73A, 'LS107A—DUAL J-K WITH CLEAR
- 'LS78A, 'LS112A—DUAL J-K WITH CLEAR AND PRESET
- 'LS78A, 'LS114A—DUAL J-K WITH PRESET, COMMON CLEAR, AND COMMON CLOCK
- 'LS113A—DUAL J-K WITH PRESET
- 'LS73A, 'LS76A, 'LS78A, 'LS112A, 'LS113A, 'LS114A



schematics of 'LS74A and 'LS109A



'LS74A—DUAL D WITH CLEAR AND PRESET



'LS109A—DUAL J-K WITH CLEAR AND PRESET



# SERIES 54S/74S FLIP-FLOPS

## recommended operating conditions

	SERIES 54S/74S		'S74		'S112		'S113		'S114		UNIT	
	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN		NOM
Supply voltage, V <sub>CC</sub>	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5
High-level output current, I <sub>OH</sub>	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25
Low-level output current, I <sub>OL</sub>			-1			-1			-1			-1
			20			20			20			20
Pulse width, t <sub>w</sub>			6			6			6			6
			7.3			6.5			6.5			6.5
Clear or preset low			7			8			8			8
High-level data			31			31			31			31
Low-level data			31			31			31			31
Input hold time, t <sub>h</sub>			21			01			01			01
Operating free-air temperature, T <sub>A</sub>	-55		125	-55		125	-55		125	-55		125
			0			70			70			70

† The arrow indicates the edge of the clock pulse used for reference; † for the rising edge, ‡ for the falling edge.

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

PARAMETER	TEST CONDITIONS†	'S74		'S112		'S113		'S114		UNIT
		MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	
V <sub>IH</sub> High-level input voltage		2		2		2		2		V
V <sub>IL</sub> Low-level input voltage	V <sub>CC</sub> = MIN, I <sub>I</sub> = -18 mA		0.8		0.8		0.8		0.8	V
V <sub>IK</sub> Input clamp voltage	V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V,		-1.2		-1.2		-1.2		-1.2	V
V <sub>OH</sub> High-level output voltage	Series 54S	2.5	3.4	2.5	3.4	2.5	3.4	2.5	3.4	V
	Series 74S	2.7	3.4	2.7	3.4	2.7	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,		0.5		0.5		0.5		0.5	V
	V <sub>IL</sub> = 0.8 V, I <sub>OL</sub> = 20 mA		1		1		1		1	mA
I <sub>I</sub> Input current at maximum input voltage	V <sub>CC</sub> = MAX, V <sub>I</sub> = 5.5 V		50		50		50		50	µA
I <sub>IH</sub> High-level input current	J, K, or D		150		100		100		100	µA
	Clear		100		100		100		100	µA
	Preset		100		100		100		100	µA
I <sub>IL</sub> Low-level input current	J, K, or D		-2		-1.6		-1.6		-1.6	mA
	Clear *		-6		-7		-7		-7	mA
	Preset *		-4		-4		-4		-4	mA
I <sub>OS</sub> Short-circuit output current‡	V <sub>CC</sub> = MAX	-40	-100	-40	-100	-40	-100	-40	-100	mA
I <sub>CC</sub> Supply current (average per flip-flop)	V <sub>CC</sub> = MAX, See Note 1	15	25	15	25	15	25	15	25	mA

† 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, and duration of short-circuit should not exceed one second.

† Clear is tested with preset high and preset is tested with clear high.

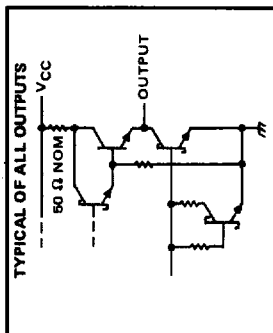
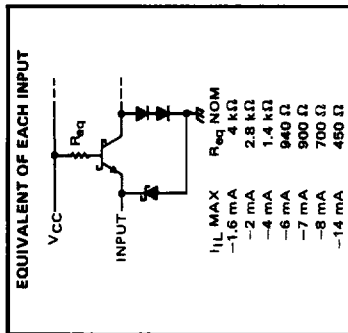
NOTE 1: With all outputs open, I<sub>CC</sub> is measured with the Q and Q outputs high in turn. At the time of measurement, the clock input is grounded.

switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

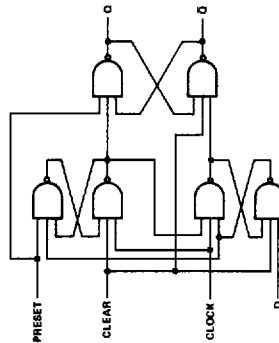
PARAMETER <sup>1</sup>	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS		'S74		'S112, 'S113, 'S114		UNIT
			MIN	MAX	TYP	MAX	MIN	TYP	
$f_{max}$			75	110	4	6	80	125	MHz
$t_{PLH}$	Preset or clear	Q or $\bar{Q}$			9	13.5			ns
$t_{PHL}$	Preset or clear (clock high)	$\bar{Q}$ or Q			5	8			ns
$t_{PLH}$	Preset or clear (clock low)	Q or $\bar{Q}$			6	9			ns
$t_{PHL}$	Clock	Q or $\bar{Q}$			6	9			ns

<sup>1</sup>  $f_{max}$  = maximum clock frequency  
<sup>2</sup>  $t_{PLH}$  = propagation delay time, low-to-high-level output  
<sup>3</sup>  $t_{PHL}$  = propagation delay time, high-to-low-level output  
 NOTE 2: Load circuit and voltage waveforms are shown on page 3-10.

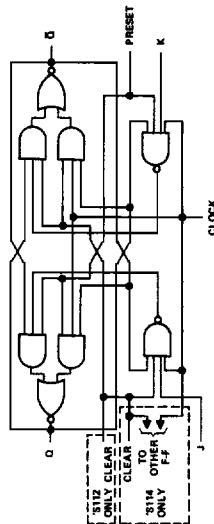
schematics of inputs and outputs



functional block diagrams



'S74-DUAL D WITH CLEAR AND PRESET



'S112-DUAL J-K WITH CLEAR AND PRESET  
 'S113-DUAL J-K WITH PRESET  
 'S114-DUAL J-K WITH PRESET, COMMON CLEAR, AND COMMON CLOCK

# 5- $\bar{R}$ LATCHES

## recommended operating conditions

PARAMETER	54 FAMILY		SN64279		SN64279		SN74LS279		SN74LS279		UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX		
Supply voltage, V <sub>CC</sub>	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V	
High-level output current, I <sub>OH</sub>	4.75	5	5.25	4.5	5	5.25	-800			$\mu$ A	
Low-level output current, I <sub>OL</sub>				16						4	
Operating free-air temperature, T <sub>A</sub>	-55	125	-65	125	-65	125	0	70	0	70	$^{\circ}$ C

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

PARAMETER	TEST CONDITIONS†	SN64279		SN64279		SN74LS279		SN74LS279		UNIT
		MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	
V <sub>IH</sub> High-level output voltage		2		0.8		0.7		0.8		V
V <sub>IL</sub> Low-level output voltage				0.8		0.8		0.8		V
V <sub>IK</sub> Input clamp voltage	V <sub>CC</sub> = MAX, I <sub>I</sub> = §			-1.5		-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> = V <sub>IL</sub> max, I <sub>OH</sub> = MAX	2.4	3.4	2.4	3.4	2.5	3.4	2.7	3.4	V
V <sub>OL</sub> Low-level output voltage	V <sub>CC</sub> = MIN, I <sub>OL</sub> = MAX			0.2	0.4			0.25	0.4	V
	V <sub>IL</sub> = V <sub>IL</sub> max, V <sub>IH</sub> = 2 V			0.2	0.4			0.35	0.4	V
I <sub>I</sub> Input current at maximum input voltage	V <sub>CC</sub> = MAX			1						mA
I <sub>IH</sub> High-level input current	V <sub>CC</sub> = MAX			40						$\mu$ A
	V <sub>CC</sub> = MAX, V <sub>I</sub> = 0.4 V			-1.8		-0.4		-0.4		mA
I <sub>OS</sub> Short-circuit output current*	V <sub>CC</sub> = MAX			-18		-20		-100		mA
	V <sub>CC</sub> = MAX, See note 1			-18		-57		-100		mA
I <sub>CC</sub> Supply current	V <sub>CC</sub> = MAX, See note 1			18	30	3.8	7			mA

† 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 $^{\circ}$ C.

§ I<sub>I</sub> = -12 mA for SN64/SN74 and -18 mA for SN54LS/SN74LS.

\* Not more than one output should be shorted at a time, and for SN64LS/SN74LS, duration of the output short circuit should not exceed one second.

NOTE 1: I<sub>CC</sub> is measured with all I<sub>I</sub> inputs grounded, all S inputs at 4.5 V, and all outputs open.

switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{ C}$

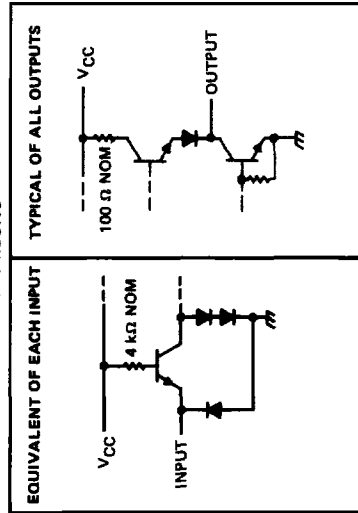
PARAMETER	TEST CONDITIONS		'LS279		UNIT
	MIN	MAX	MIN	MAX	
$t_{pLH}$ Propagation delay time, low-to-high-level output from S input	12	22	12	22	ns
$t_{pHL}$ Propagation delay time, high-to-low-level output from S input	9	15	13	21	
$t_{pHL}$ Propagation delay time, high-to-low-level output from R input	15	27	15	27	

$C_L = 15\text{ pF}$ ,  
See Notes 2 and 3

NOTE 2: Load circuit and voltage waveforms are shown on pages 3-10 and 3-11.  
NOTE 3:  $R_L = 400\ \Omega$  for '279,  $R_L = 2\text{ k}\Omega$  for 'LS279.

schematics of inputs and outputs

'279 CIRCUITS



'LS279 CIRCUITS

