recommended operating conditions

		54 FAMILY 74 FAMILY	SERIES 54 SERIES 74 '00, '04, '10, '20, '30			SERIES 54H SERIES 74H 'H00, 'H04, 'H10, 'H20, 'H30			SERIES 54L SERIES 74L 'L00, 'L04, 'L10, 'L20, 'L30			SERIES 54LS SERIES 74LS 'LS00, 'LS04, 'LS10, 'LS20, 'LS30			SERIES 54S SERIES 74S 'S00, 'S04, 'S10, 'S20, 'S30, 'S133			UNIT
			MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}		54 Family	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
		74 Family	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	
High-level output current, I_{OH}		54 Family			−400			−500			−100			−400			−1000	μA
		74 Family			−400			−500			−200			−400			−1000	
Low-level output current, I_{OL}		54 Family			16			20			2			4			20	mA
		74 Family			16			20			3.6			8			20	
Operating free-air temperature, T_A		54 Family	−55		125	−55		125	−55		125	−55		125	−55		125	°C
		74 Family	0		70	0		70	0		70	0		70	0		70	

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

PARAMETER		TEST FIGURE	TEST CONDITIONS†			SERIES 54 SERIES 74 '00, '04, '10, '20, '30			SERIES 54H SERIES 74H 'H00, 'H04, 'H10, 'H20, 'H30			SERIES 54L SERIES 74L 'L00, 'L04, 'L10, 'L20, 'L30			SERIES 54LS SERIES 74LS 'LS00, 'LS04, 'LS10, 'LS20, 'LS30			SERIES 54S SERIES 74S 'S00, 'S04, 'S10, 'S20, 'S30, 'S133			UNIT
						MIN	TYP‡	MAX	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			V
V_{IL}	Low-level input voltage	1, 2			54 Family			0.8			0.8			0.7			0.7			0.8	V
					74 Family			0.8			0.8			0.7			0.8			0.8	
V_{IK}	Input clamp voltage	3	V_{CC} = MIN,	I_I = §§				−1.5			−1.5						−1.5			−1.2	V
V_{OH}	High-level output voltage	1	V_{CC} = MIN, I_{OH} = MAX	V_{IL} = V_{IL} max,	54 Family	2.4	3.4		2.4	3.5		2.4	3.3		2.5	3.4		2.5	3.4		V
					74 Family	2.4	3.4		2.4	3.5		2.4	3.2		2.7	3.4		2.7	3.4		
V_{OL}	Low-level output voltage	2	V_{CC} = MIN, V_{IH} = 2 V	I_{OL} = MAX	54 Family		0.2	0.4		0.2	0.4		0.15	0.3		0.25	0.4			0.5	V
					74 Family		0.2	0.4		0.2	0.4		0.2	0.4		0.25	0.5			0.5	
				I_{OL} = 4 mA	Series 74LS												0.4				
I_I	Input current at maximum input voltage	4	V_{CC} = MAX		V_I = 5.5 V			1			1			0.1						1	mA
					V_I = 7 V												0.1				
I_{IH}	High-level input current	4	V_{CC} = MAX		V_{IH} = 2.4 V			40			50			10							μA
					V_{IH} = 2.7 V												20			50	
I_{IL}	Low-level input current	5	V_{CC} = MAX		V_{IL} = 0.3 V									−0.18							mA
					V_{IL} = 0.4 V			−1.6			−2						−0.4				
					V_{IL} = 0.5 V															−2	
I_{OS}	Short-circuit output current♦	6	V_{CC} = MAX		54 Family	−20		−55	−40		−100	−3		−15	−20		−100	−40		−100	mA
					74 Family	−18		−55	−40		−100	−3		−15	−20		−100	−40		−100	
I_{CC}	Supply current	7	V_{CC} = MAX			See table on next page															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°C.
§§I_I = −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 SN54H'/SN74H', SN54LS'/SN74LS', and SN54S'/SN74S', duration of short-circuit should not exceed 1 second.

supply current¶

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
'00	4	8	12	22	2
'04	6	12	18	33	2
'10	3	6	9	16.5	2
'20	2	4	6	11	2
'30	1	2	3	6	2
'H00	10	16.8	26	40	4.5
'H04	16	26	40	58	4.5
'H10	7.5	12.6	19.5	30	4.5
'H20	5	8.4	13	20	4.5
'H30	2.5	4.2	6.5	10	4.5
'L00	0.44	0.8	1.16	2.04	0.20
'L04	0.66	1.2	1.74	3.06	0.20
'L10	0.33	0.6	0.87	1.53	0.20
'L20	0.22	0.4	0.58	1.02	0.20
SN54L30	0.11	0.33	0.29	0.51	0.20
SN74L30	0.11	0.2	0.29	0.51	0.20
'LS00	0.8	1.6	2.4	4.4	0.4
'LS04	1.2	2.4	3.6	6.6	0.4
'LS10	0.6	1.2	1.8	3.3	0.4
'LS20	0.4	0.8	1.2	2.2	0.4
'LS30	0.35	0.5	0.6	1.1	0.48
'S00	10	16	20	36	3.75
'S04	15	24	30	54	3.75
'S10	7.5	12	15	27	3.75
'S20	5	8	10	18	3.75
'S30	3	5	5.5	10	4.25
'S133	3	5	5.5	10	4.25

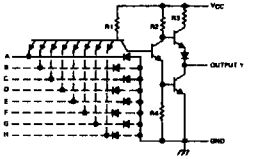
switching characteristics at V_{CC} = 5 V, T_A = 25°C

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
'00, '10	C_L = 15 pF, R_L = 400 Ω		11	22		7	15
'04, '20			12	22		8	15
'30			13	22		8	15
'H00	C_L = 25 pF, R_L = 280 Ω		5.9	10		6.2	10
'H04			6	10		6.5	10
'H10			5.9	10		6.3	10
'H20			6	10		7	10
'H30			6.8	10		8.9	12
'L00, 'L04, 'L10, L20	C_L = 50 pF, R_L = 4 kΩ		35	60		31	60
'L30			35	60		70	100
'LS00, 'LS04 'LS10, 'LS20	C_L = 15 pF, R_L = 2 kΩ		9	15		10	15
'LS30			8	15		13	20
'S00, 'S04	C_L = 15 pF, R_L = 280 Ω		3	4.5		3	5
'S10, 'S20	C_L = 50 pF, R_L = 280 Ω		4.5			5	
'S30, 'S133	C_L = 15 pF, R_L = 280 Ω		4	6		4.5	7
	C_L = 50 pF, R_L = 280 Ω		5.5			6.5	

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

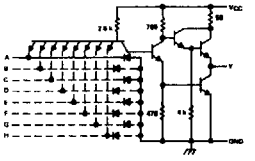
¶Maximum values of I_{CC} are over the recommended operating ranges of V_{CC} and T_A; typical values are at V_{CC} = 5 V, T_A = 25°C.

schematics (each gate)

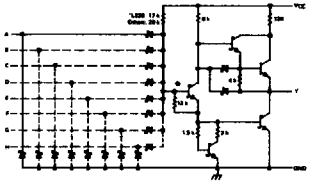


CIRCUIT	R1	R2	R3	R4
'00, '04, '10, '20, '30	4 k	1.6 k	130	1 k
'L00, 'L04, 'L10, 'L20, 'L30	40 k	20 k	500	12 k

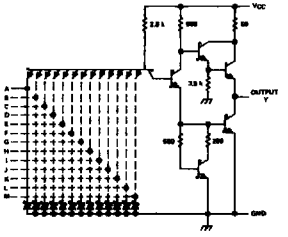
'00, '04, '10, '20, '30
'L00, 'L04, 'L10, 'L20, 'L30, CIRCUITS
Input clamp diodes not on SN54L'/SN74L' circuits.



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



'LS00, 'LS04, 'LS10, 'LS20, 'LS30 CIRCUITS
*The 12-kΩ resistor is not on 'LS30.



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

Resistor values shown are nominal and in ohms.

recommended operating conditions

		54 FAMILY 74 FAMILY	SERIES 54 SERIES 74 '01, '03, '05, '12, '22			SERIES 54H SERIES 74H 'H01, 'H05, 'H22			SERIES 54L SERIES 74L 'L01, 'L03			SERIES 54LS SERIES 74LS 'LS01, 'LS03, 'LS05, 'LS12, 'LS22			SERIES 54S SERIES 74S 'S03, 'S05, 'S22			UNIT
			MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}		54 Family	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
		74 Family	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	
High-level output voltage, V_{OH}					5.5			5.5			5.5			5.5			5.5	V
Low-level output current, I_{OL}		54 Family			16			20			2			4			20	mA
		74 Family			16			20			3.6			8			20	
Operating free-air temperature, T_A		54 Family	−55		125	−55		125	−55		125	−55		125	−55		125	°C
		74 Family	0		70	0		70	0		70	0		70	0		70	

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

PARAMETER		TEST FIGURE	TEST CONDITIONS†			SERIES 54 SERIES 74 '01, '03, '05, '12, '22			SERIES 54H SERIES 74H 'H01, 'H05, 'H22			SERIES 54L SERIES 74L 'L01, 'L03			SERIES 54LS SERIES 74LS 'LS01, 'LS03, 'LS05, 'LS12, 'LS22			SERIES 54S SERIES 74S 'S03, 'S05, 'S22			UNIT
						MIN	TYP‡	MAX	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			V
V_{IL}	Low-level input voltage	1, 2			54 Family			0.8			0.8			0.6			0.7			0.8	V
					74 Family			0.8			0.8			0.8			0.8			0.8	
V_{IK}	Input clamp voltage	3	V_{CC} = MIN,	I_I = §§				−1.5			−1.5						−1.5			−1.2	V
I_{OH}	High-level output current	1	V_{CC} = MIN,	V_{IL} = V_{IL} max,	V_{OH} = 5.5 V			250			250			50			100			250	µA
V_{OL}	Low-level output voltage	2	V_{CC} = MIN, V_{IH} = 2 V	I_{OL} = MAX	54 Family		0.2	0.4		0.2	0.4		0.15	0.3		0.25	0.4			0.5	V
					74 Family		0.2	0.4		0.2	0.4		0.2	0.4		0.35	0.5			0.5	
				I_{OL} = 4 mA	Series 74LS											0.25	0.4				
I_I	Input current at maximum input voltage	4	V_{CC} = MAX		V_I = 5.5 V			1			1			0.1						1	mA
					V_I = 7 V												0.1				
I_{IH}	High-level input current	4	V_{CC} = MAX		V_{IH} = 2.4 V			40			50			10							µA
					V_{IH} = 2.7 V												20			50	
I_{IL}	Low-level input current	5	V_{CC} = MAX		V_{IL} = 0.3 V									−0.18							mA
					V_{IL} = 0.4 V			−1.6			−2						−0.4				
					V_{IL} = 0.5 V															−2	
I_{CC}	Supply current	7	V_{CC} = MAX			See table on next page															mA

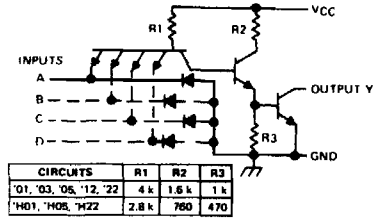
†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§§I_I = −12 mA for SN54'/SN74', −8 mA for SN54H'/SN74H', and −18 mA for SN54LS'/SN74LS' and SN54S'/SN74S'.

supply current¶

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
'01	4	8	12	22	2
'03	4	8	12	22	2
'05	6	12	18	33	2
'12	3	6	9	16.5	2
'22	2	4	6	11	2
'H01	6.8	10	26	40	4.1
'H05	16	26	40	58	4.67
'H22	3.4	5	13	20	4.1
'L01	0.44	0.8	1.16	2.04	0.20
'L03	0.44	0.8	1.16	2.04	0.20
'LS01	0.8	1.6	2.4	4.4	0.4
'LS03	0.8	1.6	2.4	4.4	0.4
'LS05	1.2	2.4	3.6	6.6	0.4
'LS12	0.7	1.4	1.8	3.3	0.42
'LS22	0.4	0.8	1.2	2.2	0.4
'S03	6	13.2	20	36	3.25
'S05	9	19.8	30	54	3.25
'S22	3	6.6	10	18	3.25

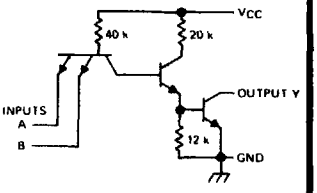
¶Maximum values of I_{CC} are over the recommended operating ranges of V_{CC} and T_A; typical values are at V_{CC} = 5 V, T_A = 25°C.

schematics (each gate)

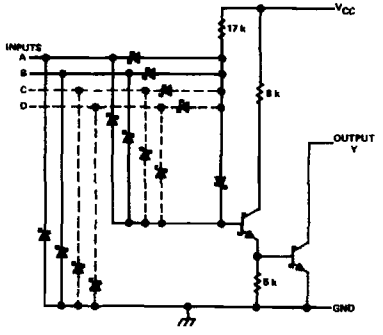


CIRCUITS	R1	R2	R3
'01, '03, '05, '12, '22	4 k	1.6 k	1 k
'H01, 'H05, 'H22	2.8 k	760	470

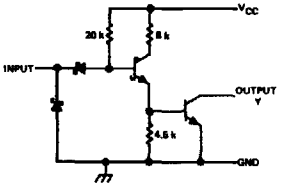
'01, '03, '05, '12, '22, 'H01, 'H05, 'H22 CIRCUITS



'L01, 'L03 CIRCUITS



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

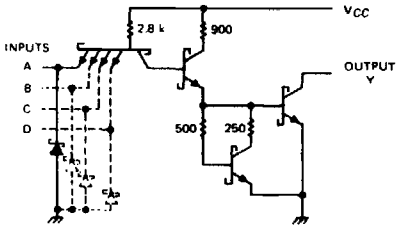


'LS05 CIRCUITS

switching characteristics at V_{CC} = 5 V, T_A = 25°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
'01, '03	C_L = 15 pF, R_L = 4 kΩ for t_{PLH}, 400 Ω for t_{PHL}		35	45		8	15
'05			40	55		8	15
'12, '22			35	45		8	15
'H01, 'H05, 'H22	C_L = 25 pF, R_L = 280 Ω		10	15		7.5	12
'L01, 'L03	C_L = 50 pF, R_L = 4 kΩ		60	90		33	60
'LS01, 'LS03, 'LS05, 'LS12, 'LS22	C_L = 15 pF, R_L = 2 kΩ		17	32		15	28
'S03, 'S05, 'S22	C_L = 15 pF, R_L = 280 Ω	2	5	7.5	2	4.5	7
	C_L = 50 pF, R_L = 280 Ω		7.5			7	

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



'S03, 'S05, 'S22 CIRCUITS

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:

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

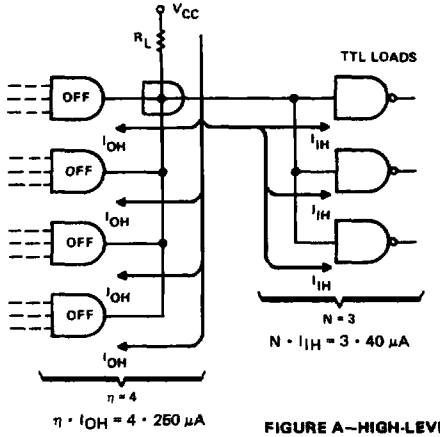
The total current through the load resistor (I_{RL}) is the sum of the load currents (I_{IH}) and off-state reverse currents (I_{OH}) through each of the wire-AND-connected outputs:

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

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

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

where η = number of gates wire-AND-connected, and N = number of standard loads.



Calculation:

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

$$R_{L(max)} = \frac{5 - 2.4}{0.001 + 0.00012}\ \Omega = \frac{2.6}{0.00112}\ \Omega = 2321\ \Omega$$

Values shown are for Series 54/74 standard inputs and outputs. For devices in other series, substitute appropriate values.

FIGURE A—HIGH-LEVEL CIRCUIT CONDITIONS

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APPLICATION DATA

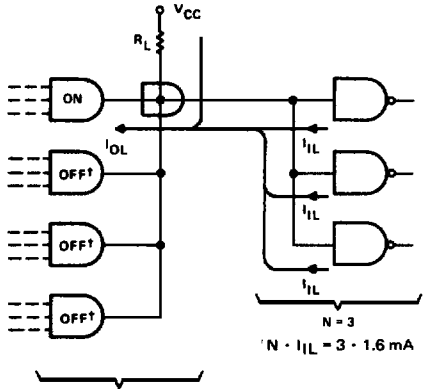
low-level (on-state) circuit calculations (see figure B)

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:

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



Calculation:

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

$$R_{L(min)} = \frac{5 - 0.4}{0.016 - 0.0048}\ \Omega = \frac{4.6}{0.0112}\ \Omega = 410\ \Omega$$

Values shown are for Series 54/74 standard inputs and outputs. For devices in other series, substitute the appropriate values.

†Current into OFF outputs is negligible at the low logic level.

FIGURE B–LOW-LEVEL CIRCUIT CONDITIONS

recommended operating conditions

	54 FAMILY / 74 FAMILY	SERIES 54 / SERIES 74 '02			SERIES 54 / SERIES 74 '25, '27			SERIES 54L / SERIES 74L 'L02			SERIES 54LS / SERIES 74LS 'LS02, 'LS27			SERIES 54S / SERIES 74S 'S02, 'S260			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	54 Family	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
	74 Family	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	
High-level output current, I_{OH}	54 Family			−400			−800			−100			−400			−1000	μA
	74 Family			−400			−800			−200			−400			−1000	
Low-level output current, I_{OL}	54 Family			16			16			2			4			20	mA
	74 Family			16			16			3.6			8			20	
Operating free-air temperature, T_A	54 Family	−55		125	−55		125	−55		125	−55		125	−55		125	°C
	74 Family	0		70	0		70	0		70	0		70	0		70	

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

PARAMETER		TEST FIGURE	TEST CONDITIONS†		SERIES 54 / SERIES 74 '02, '25, '27			SERIES 54L / SERIES 74L 'L02			SERIES 54LS / SERIES 74LS 'LS02 'LS27			SERIES 54S / SERIES 74S 'S02, 'S260			UNIT
					MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH}	High-level input voltage	1, 2			2			2			2			2			V
V_{IL}	Low-level input voltage	1, 2		54 Family			0.8			0.7			0.7			0.8	V
				74 Family			0.8			0.7			0.8			0.8	
V_{IK}	Input clamp voltage	3	V_{CC} = MIN, I_I = §				−1.5						−1.5			−1.2	V
V_{OH}	*High-level output voltage*	1	V_{CC} = MIN, V_{IL} = V_{IL} max, I_{OH} = MAX	54 Family	2.4	3.4		2.4	3.3		2.5	3.4		2.5	3.4		V
				74 Family	2.4	3.4		2.4	3.2		2.7	3.4		2.7	3.4		
V_{OL}	Low-level output voltage	2	V_{CC} = MIN, V_{IH} = 2 V, I_{OL} = MAX	54 Family		0.2	0.4		0.15	0.3		0.25	0.4			0.5	V
				74 Family		0.2	0.4		0.2	0.4		0.35	0.5			0.5	
			I_{OL} = 4 mA	*Series 74LS*								0.25	0.4				
I_I	Input current at maximum input voltage	4	V_{CC} = MAX	V_I = 5.5 V			1			0.1						1	mA
				V_I = 7 V									0.1				
I_{IH}	High-level input current, Data inputs	4	V_{CC} = MAX	V_{IH} = 2.4 V			40			10							μA
	High-level input current, Strobe of '25						160										
	High-level input current, All inputs			V_{IH} = 2.7 V									20			50	
I_{IL}	Low-level input current, All inputs	5	V_{CC} = MAX	V_{IL} = 0.3 V						−0.18							mA
	Low-level input current, Data inputs			V_{IL} = 0.4 V			−1.6						−0.4				
	Low-level input current, Strobe of '25						−6.4										
	Low-level input current, All inputs			V_{IL} = 0.5 V												−2	
I_{OS}	*Short-circuit output current*♦	6	V_{CC} = MAX	54 Family	−20		−55	−3		−15	−20		−100	−40		−100	mA
				74 Family	−18		−55	−3		−15	−20		−100	−40		−100	
I_{CC}	Supply current	7	V_{CC} = MAX		See table on next page												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°C.

§I_I = −12 mA for SN54'/SN74' and −18 mA for SN54LS'/SN74LS' and SN54S/SN74S'.

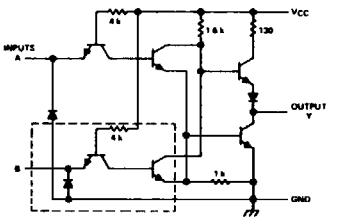
♦Not more than one output should be shorted at a time, and for SN54LS'/SN74LS' and SN54S'/SN74S', duration of output short-circuit should not exceed one second.

supply current¶

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
'02	8	16	14	27	2.75
'25	8	16	10	19	2.25
'27	10	16	16	26	4.34
'L02	0.8	1.6	1.4	2.6	0.275
'LS02	1.6	3.2	2.8	5.4	0.55
'LS27	2.0	4	3.4	6.8	0.9
'S02	17	29	26	45	5.38
'S260	17	29	26	45	10.75

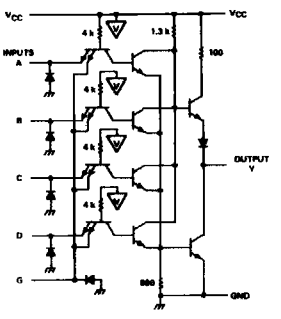
¶Maximum values of I_{CC} are over the recommended operating ranges of V_{CC} and T_A; typical values are at V_{CC} = 5 V, T_A = 25°C.

schematics (each gate)



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

'02, '27 CIRCUITS



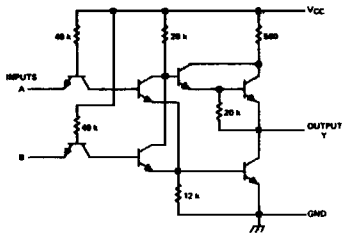
'25 CIRCUITS

switching characteristics at V_{CC} = 5 V, T_A = 25°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
'02	C_L = 15 pF, R_L = 400 Ω		12	15		8	15
'25			13	22		8	15
'27			10	15		7	11
'L02	C_L = 50 pF, R_L = 4 kΩ		31	60		35	60
'LS02, 'LS27	C_L = 15 pF, R_L = 2 kΩ		10	15		10	15
'S02	C_L = 15 pF, R_L = 280 Ω		3.5	5.5		3.5	5.5
	C_L = 50 pF, R_L = 280 Ω		5			5	
'S260	C_L = 15 pF, R_L = 280 Ω		4	5.5		4	6

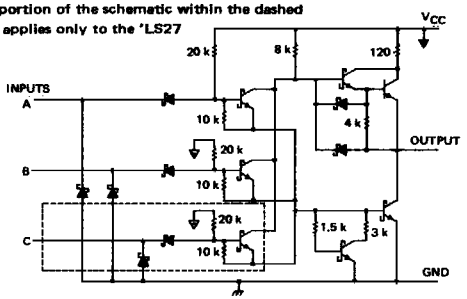
#Load circuit and voltage waveforms are shown on pages 3-10 and 3-11.

Resistor values are nominal and in ohms.

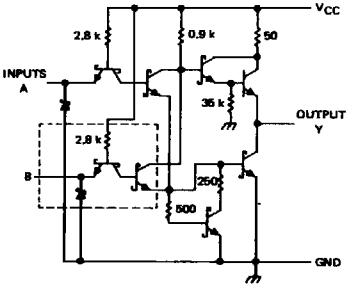


'L02 CIRCUITS

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



'LS02, 'LS27 CIRCUITS



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 CIRCUITS

recommended operating conditions

	54 FAMILY / 74 FAMILY	SERIES 54 / SERIES 74 '08,			SERIES 54H / SERIES 74H 'H11, 'H21			SERIES 54LS / SERIES 74LS 'LS08, 'LS11, 'LS21			SERIES 54S / SERIES 74S 'S08, 'S11			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply Voltage, V_{CC}	54 Family	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V
	74 Family	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	
High-level output current, I_{OH}				−800			−500			−400			−1000	μA
Low-level output current, I_{OL}	54 Family			16			20			4			20	mA
	74 Family			16			20			8			20	
Operating free-air temperature, T_A	54 Family	−55		125	−55		125	−55		125	−55		125	°C
	74 Family	0		70	0		70	0		70	0		70	

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

PARAMETER		TEST FIGURE	TEST CONDITIONS†			SERIES 54 / SERIES 74 '08			SERIES 54H / SERIES 74H 'H11, 'H21			SERIES 54LS / SERIES 74LS 'LS08, 'LS11, 'LS21			SERIES 54S / SERIES 74S 'S08, 'S11			UNIT
						MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH}	High-level input voltage	1, 2				2			2			2			2			V
V_{IL}	Low-level input voltage	1, 2			54 Family			0.8			0.8			0.7			0.8	V
					74 Family			0.8			0.8			0.8			0.8	
V_{IK}	Input clamp voltage	3	V_{CC} = MIN,	I_I = §				−1.5			−1.5			−1.5			−1.2	V
V_{OH}	High-level output voltage	1	V_{CC} = MIN, V_{IH} = 2 V, I_{OH} = MAX		54 Family	2.4	3.4		2.4	3.4		2.5	3.4		2.5	3.4		V
					74 Family	2.4	3.4		2.4	3.4		2.7	3.4		2.7	3.4		
V_{OL}	Low-level output voltage	2	V_{CC} = MIN, V_{IH} = 2 V	I_{OL} = MAX	54 Family		0.2	0.4		0.15	0.3		0.25	0.4			0.5	V
					74 Family		0.2	0.4		0.2	0.4		0.35	0.5			0.5	
				I_{OL} = 4 mA	Series 74LS								0.25	0.4				
I_I	Input current at maximum input voltage	4	V_{CC} = MAX		V_I = 5.5 V			1			0.1						1	mA
					V_I = 7 V									0.1				
I_{IH}	High-level input current	4	V_{CC} = MAX		V_{IH} = 2.4 V			40			50							μA
					V_{IH} = 2.7 V									20			50	
I_{IL}	Low-level input current	5	V_{CC} = MAX		V_{IL} = 0.4 V			−1.6			−2			−0.4				mA
					V_{IL} = 0.5 V												−2	
I_{OS}	Short circuit output current¶	6	V_{CC} = MAX		54 Family	−20		−55	−40		−100	−20		−100	−40		−100	mA
					74 Family	−18		−55	−40		−100	−20		−100	−40		−100	
I_{CC}	Supply current	7	V_{CC} = MAX			See table on next page												mA

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

‡*All typical values are at* V_{CC} = 25°C.

§I_I = −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 SN54H'/SN74H', SN54LS'/SN74LS' and SN54S'/SN74S', duration of output short circuit should not exceed one second.

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supply current¶

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
'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

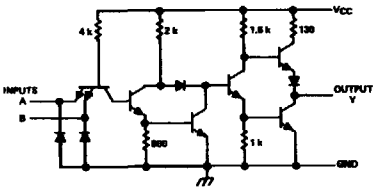
¶Maximum values of I_{CC} are over the recommended operating ranges of V_{CC} and T_A; typical values are at V_{CC} = 5 V, T_A = 25°C.

switching characteristics at V_{CC} = 5 V, T_A = 25°C

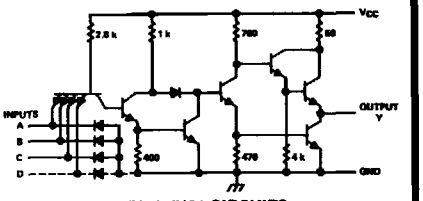
TYPE	TEST CONDITIONS#	t_{PLH} (ns) Propagation delay time, low-to-high-level output			t_{PHL} (ns) Propagation delay time, high-to-low-level output		
		MIN	TYP	MAX	MIN	TYP	MAX
'08	C_L = 15 pF, R_L = 400 Ω		17.5	27		12	19
'H11, 'H21	C_L = 25 pF, R_L = 280 Ω		7.6	12		8.8	12
'LS08, 'LS11 'LS21	C_L = 15 pF, R_L = 2 kΩ		8	15		10	20
'S08, 'S11	C_L = 15 pF, R_L = 280 Ω		4.5	7		5	7.5
	C_L = 50 pF, R_L = 280 Ω		6			7.5	

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

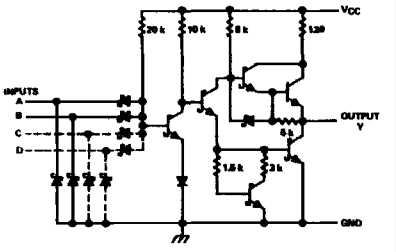
schematics (each gate)



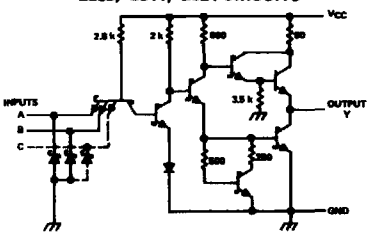
'08 CIRCUITS



'H11, 'H21 CIRCUITS



'LS08, 'LS11, 'LS21 CIRCUITS



'S08, 'S11 CIRCUITS

Resistor values shown are nominal and in ohms.

recommended operating conditions

		54 FAMILY 74 FAMILY	SERIES 54 SERIES 74 '09			SERIES 54H SERIES 74H 'H15			SERIES 54LS SERIES 74LS 'LS09, 'LS15			SERIES 54S SERIES 74S 'S09, 'S15			UNIT
			MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply Voltage, V_{CC}		54 Family	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V
		74 Family	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	
High-level output voltage, V_{OH}					5.5			5.5			5.5			5.5	V
Low-level output current, I_{OL}		54 Family			16			20			4			20	mA
		74 Family			16			20			8			20	
Operating free-air temperature, T_A		54 Family	−55		125	−55		125	−55		125	−55		125	°C
		74 Family	0		70	0		70	0		70	0		70	

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

PARAMETER		TEST FIGURE	TEST CONDITIONS†			SERIES 54 SERIES 74 '09			SERIES 54H SERIES 74H 'H15			SERIES 54LS SERIES 74LS 'LS09, 'LS15			SERIES 54S SERIES 74S 'S09, 'S15			UNIT
						MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH}	High-level input voltage	1, 2				2			2			2			2			V
V_{IL}	Low-level input voltage	1, 2			54 Family			0.8			0.8			0.7			0.8	V
					74 Family			0.8			0.8			0.8			0.8	
V_{IK}	Input clamp voltage	3	V_{CC} = MIN, I_I = §					−1.5			−1.5			−1.5			−1.2	V
I_{OH}	High-level output current	1	V_{CC} = MIN, V_{IH} = 2 V, V_{OH} = 5.5 V,					250			250			100			250	µA
V_{OL}	Low-level output voltage	2	V_{CC} = MIN, V_{IH} = 2 V	I_{OL} = MAX	54 Family		0.2	0.4		0.15	0.3		0.25	0.4			0.5	V
					74 Family		0.2	0.4		0.2	0.4		0.35	0.5			0.5	
				I_{OL} = 4 mA	Series 74LS								0.25	0.4				
I_I	Input current at maximum input voltage	4	V_{CC} = MAX		V_I = 5.5 V			1			0.1						1	mA
					V_I = 7 V									0.1				
I_{IH}	High-level input current	4	V_{CC} = MAX		V_{IH} = 2.4 V			40			50							µA
					V_{IH} = 2.7 V									20			50	
I_{IL}	Low-level input current	5	V_{CC} = MAX		V_{IL} = 0.4 V			−1.6			−2			−0.4				mA
					V_{IL} = 0.5 V												−2	
I_{CC}	Supply current	7	V_{CC} = MAX			See table on next page												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°C.
§I_I = − 12 mA for SN54'/SN74', −8 mA for SN54H'/SN74H', and −18 mA for SN54LS'/SN74LS'.

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supply current¶

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
'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

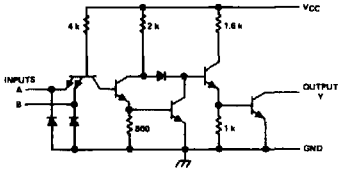
¶Maximum values of I_{CC} are over the recommended operating ranges of V_{CC} and T_A; typical values are at V_{CC} = 5 V, T_A = 25°C.

switching characteristics at V_{CC} = 5 V, T_A = 25°C

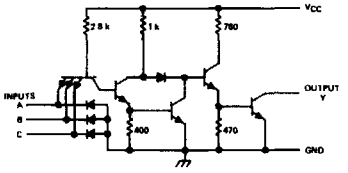
TYPE	TEST CONDITIONS#	t_{PLH} (ns) Propagation delay time, low-to-high-level output			t_{PHL} (ns) Propagation delay time, high-to-low-level output		
		MIN	TYP	MAX	MIN	TYP	MAX
'09	C_L = 15 pF, R_L = 400 Ω		21	32		16	24
'H15	C_L = 25 pF, R_L = 280 Ω		12	18		9	13
'LS09, 'LS15	C_L = 15 pF, R_L = 2 kΩ		20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

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

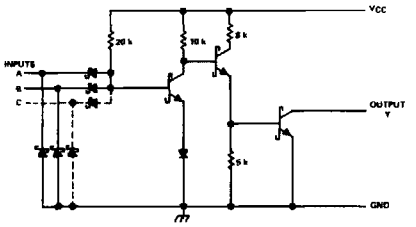
schematics (each gate)



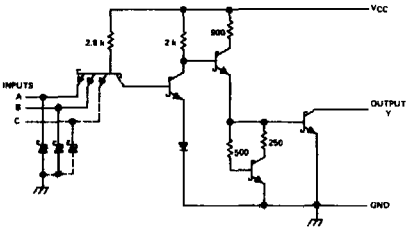
'09 CIRCUITS



'H15 CIRCUITS



'LS09, 'LS15 CIRCUITS



'S09, 'S15 CIRCUITS

Resistor values shown are nominal and in ohms.

recommended operating conditions

	54 FAMILY / 74 FAMILY	SERIES 54 / SERIES 74 '13			SERIES 54 / SERIES 74 '14, '132			SERIES 54LS / SERIES 74LS 'LS13, 'LS14, 'LS132			SERIES 54S / SERIES 74S 'S132			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	54 Family	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V
	74 Family	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	
High level output current, I_{OH}				−800			−800			−400			−1000	μA
Low-level output current, I_{OL}	54 Family			16			16			4			20	mA
	74 Family			16			16			8			20	
Operating free-air temperature, T_A	54 Family	−55		125	−55		125	−55		125	−55		125	°C
	74 Family	0		70	0		70	0		70	0		70	

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

PARAMETER		TEST FIGURE	TEST CONDITIONS†			SERIES 54 / SERIES 74 '13			SERIES 54 / SERIES 74 '14, '132			SERIES 54LS / SERIES 74LS 'LS13, 'LS14, 'LS132			SERIES 54S / SERIES 74S 'S132			UNIT
						MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{T+}	Positive-going threshold voltage	8	V_{CC} = 5 V			1.5	1.7	2	1.5	1.7	2	1.4	1.6	1.9	1.6	1.77	1.9	V
V_{T-}	Negative-going threshold voltage	9	V_{CC} = 5 V			0.6	0.9	1.1	0.6	0.9	1.1	0.5	0.8	1	1.1	1.22	1.4	V
	Hysteresis (V_{T+}-V_{T-})	8, 9	V_{CC} = 5 V			0.4	0.8		0.4	0.8		0.4	0.8		0.2	0.55		V
V_{IK}	Input clamp voltage	3	V_{CC} = MIN,	I_I = §,				−1.5			−1.5			1.5			−1.2	V
V_{OH}	High-level output voltage	9	V_{CC} = MIN, V_I = V_{T-} min	I_{OH} = MAX,	54 Family	2.4	3.4		2.4	3.4		2.5	3.4		2.5	3.4		V
					74 Family	2.4	3.4		2.4	3.4		2.7	3.4		2.7	3.4		
V_{OL}	Low-level output voltage	8	V_{CC} = MIN, V_I = V_{T+} max	I_{OL} = MAX	54 Family		0.2	0.4		0.2	0.4		0.25	0.4			0.5	V
					74 Family		0.2	0.4		0.2	0.4		0.35	0.5			0.5	
				I_{OL} = 4 mA	Series 74LS								0.25	0.4				
I_{T+}	Input current at positive-going threshold	8	V_{CC} = 5 V,	V_I = V_{T+}			−0.65			−0.43			−0.14			−0.9		mA
I_{T-}	Input current at negative-going threshold	9	V_{CC} = 5 V,	V_I = V_{T-}			−0.85			−0.56			−0.18			−1.1		mA
I_I	Input current at maximum input voltage	4	V_{CC} = MAX	V_I = 5.5 V				1			1						1	mA
				V_I = 7 V										0.1				
I_{IH}	High-level input current	4	V_{CC} = MAX	V_I = 2.4 V				40			40							μA
				V_I = 2.7 V										20			50	
I_{IL}	Low-level input current	5	V_{CC} = MAX	V_{IL} = 0.4 V			−1	−1.6		−0.8	−1.2			−0.4				mA
				V_{IL} = 0.5 V													−2	
I_{OS}	Short-circuit output current♦	6	V_{CC} = MAX			−18		−55	−18		−55	−20		−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_{CC} = 5 V, T_A = 25°C.

§I_I = −12 mA for SN54'/SN74' and −18 mA for 'LS13, 'LS14, 'LS132, and 'S132.

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

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supply current¶

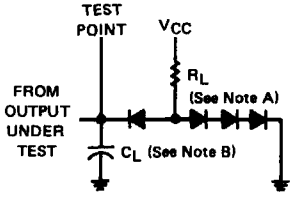
TYPE	I_{CCH} (mA) Total with outputs high		I_{CCL} (mA) Total with outputs low		I_{CC} (mA) Average per gate (50% duty cycle)
	TYP	MAX	TYP	MAX	TYP
'13	14	23	20	32	8.5
'14	22	36	39	60	5.1
'132	15	24	26	40	5.1
'LS13	2.9	6	4.1	7	1.75
'LS14	8.6	16	12	21	1.72
'LS132	5.9	11	8.2	14	1.76
'S132	28	44	44	68	9

¶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°C.

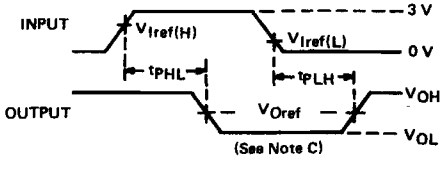
switching characteristics, V_{CC} = 5 V, T_A = 25°C

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
'13	C_L = 15 pF, R_L = 400 Ω		18	27		15	22
'14, '132			15	22		15	22
'LS13	C_L = 15 pF, R_L = 2 kΩ		15	22		18	27
'LS14			15	22		15	22
'LS132			15	22		15	22
'S132	C_L = 15 pF, R_L = 280 Ω		7	10.5		8.5	13

PARAMETER MEASUREMENT INFORMATION



LOAD CIRCUIT

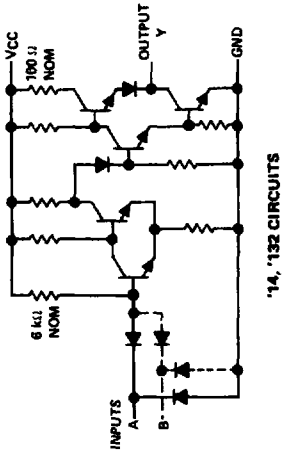


VOLTAGE WAVEFORMS

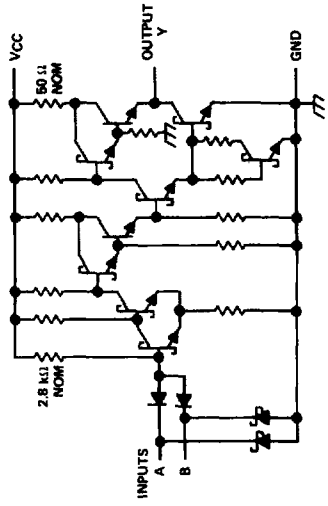
NOTES: A. All diodes are 1N916 or 1N3064.
B. C_L includes probe and jrg capacitance.
C. Generator characteristics and reference voltages are:

	Generator Characteristics				Reference Voltages		
	Z_{out}	PRR	t_r	t_f	$V_{I\,ref(H)}$	$V_{I\,ref(L)}$	$V_{O\,ref}$
SN54'/SN74'	50 Ω	1 MHz	10 ns	10 ns	1.7 V	0.9 V	1.5 V
SN54LS'/SN74LS'	50 Ω	1 MHz	15 ns	6 ns	1.6 V	0.8 V	1.3 V
'S132	50 Ω	1 MHz	2.5 ns	2.5 ns	1.8 V	1.2 V	1.5 V

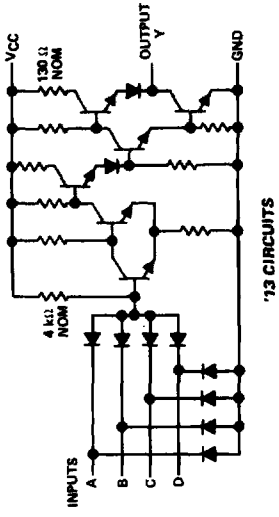
schematics (each gate)



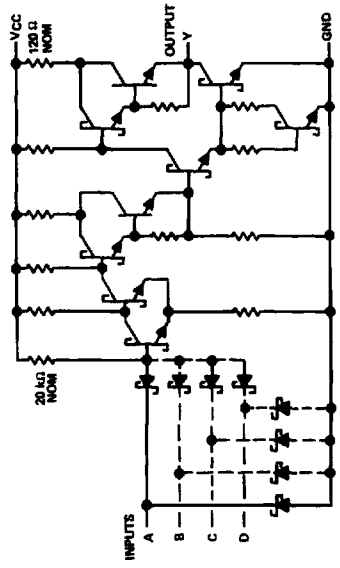
'14, '132 CIRCUITS



'S132 CIRCUITS



'13 CIRCUITS



'LS13, 'LS14, 'LS132 CIRCUITS

Resistor values shown are nominal.

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

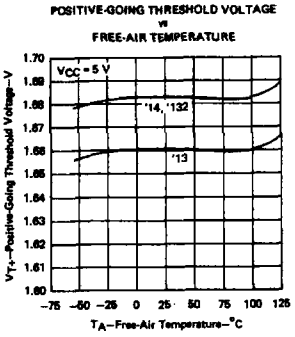


FIGURE 1

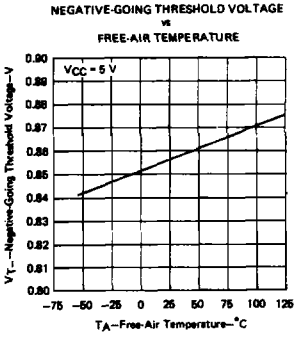


FIGURE 2

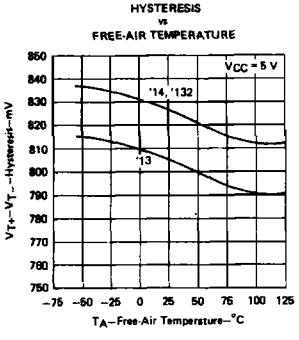


FIGURE 3

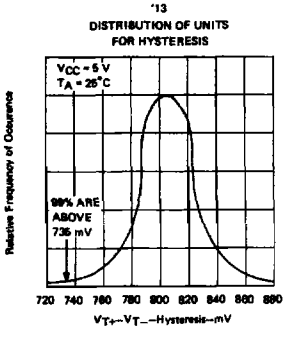


FIGURE 4

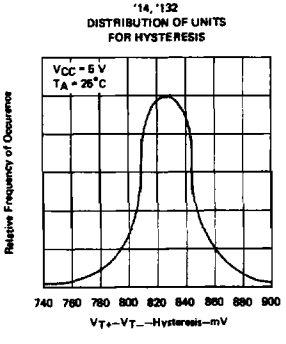


FIGURE 5

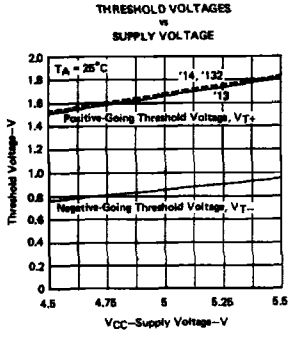


FIGURE 6

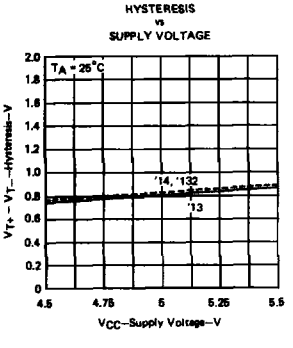


FIGURE 7

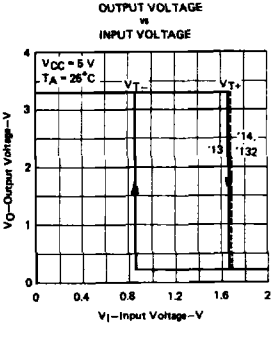
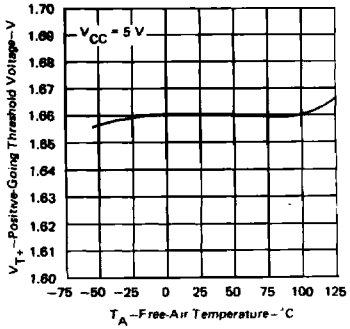


FIGURE 8

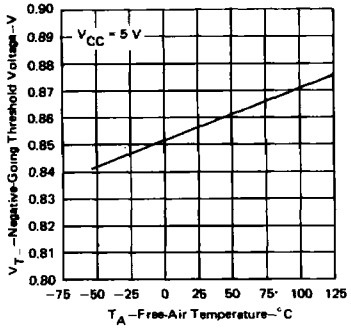
†Data for temperatures below 0°C and 70°C and supply voltages below 4.75V and above 5.25 V are applicable for SN5413, SN5414, and SN54132 only.

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

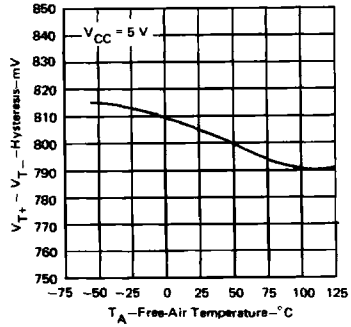
POSITIVE-GOING THRESHOLD VOLTAGE
vs
FREE-AIR TEMPERATURE



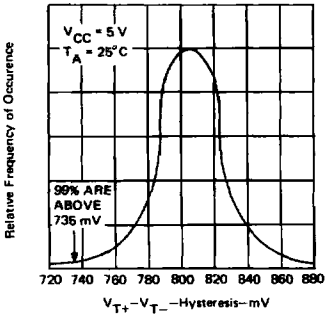
NEGATIVE-GOING THRESHOLD VOLTAGE
vs
FREE-AIR TEMPERATURE



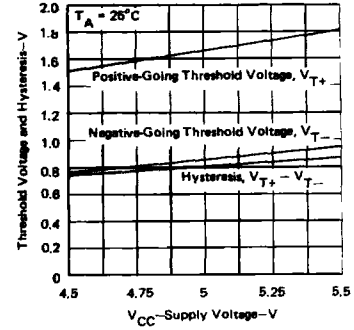
HYSTERESIS
vs
FREE-AIR TEMPERATURE



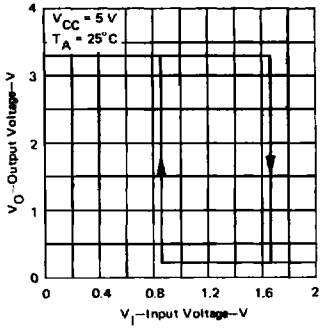
DISTRIBUTION OF UNITS
FOR HYSTERESIS



THRESHOLD VOLTAGES AND HYSTERESIS
vs
SUPPLY VOLTAGE



OUTPUT VOLTAGE
vs
INPUT VOLTAGE



†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.

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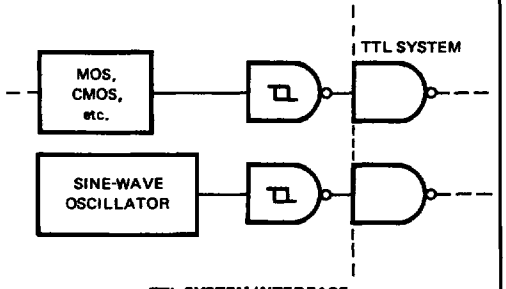
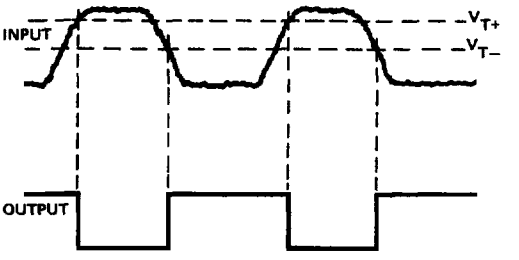
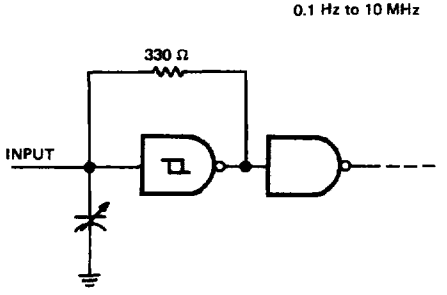
TYPICAL APPLICATION DATA



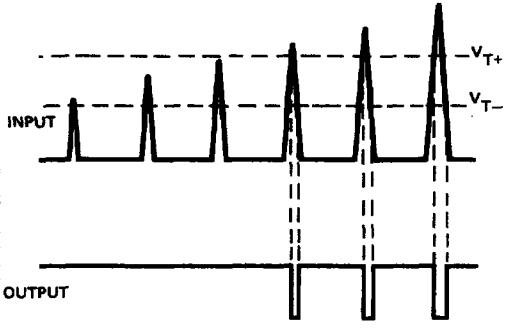
TTL SYSTEM INTERFACE
FOR SLOW INPUT WAVEFORMS



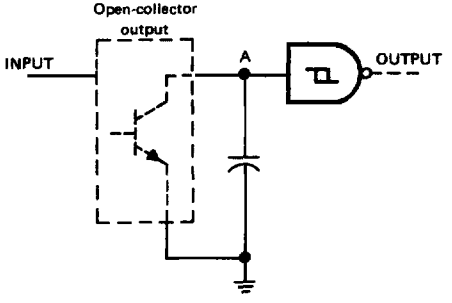
PULSE SHAPER

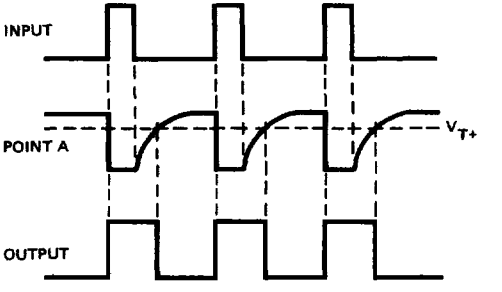


MULTIVIBRATOR



THRESHOLD DETECTOR





PULSE STRETCHER

recommended operating conditions

		54 FAMILY 74 FAMILY	SERIES 54 SERIES 74						SERIES 54H SERIES 74H			SERIES 54LS SERIES 74LS			SERIES 54S SERIES 74S			UNIT
			'28			'37, '40			'H40			'LS28, 'LS37 'LS40			'S37, 'S40			
			MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}		54 Family	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
		74 Family	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	
High-level output current, I_{OH}					−2.4			−1.2			−1.5			−1.2			−3	mA
Low-level output current, I_{OL}		54 Family			48			48			60			12			60	mA
		74 Family			48			48			60			24			60	
Operating free-air temperature, T_A		54 Family	−55		125	−55		125	−55		125	−55		125	−55		125	°C
		74 Family	0		70	0		70	0		70	0		70	0		70	

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

PARAMETER		TEST FIGURE	TEST CONDITIONS†			SERIES 54 SERIES 74						SERIES 54H SERIES 74H			SERIES 54LS SERIES 74LS			SERIES 54S SERIES 74S			UNIT
						'28			'37, '40			'H40			'LS28, 'LS37, 'LS40			'S37, 'S40			
						MIN	TYP‡	MAX	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			V
V_{IL}	Low-level input voltage	1, 2			54 Family			0.8			0.8			0.8			0.7			0.8	V
					74 Family			0.8			0.8			0.8			0.8			0.8	
V_{IK}	Input clamp voltage	3	V_{CC} = MIN, I_I = §					−1.5			−1.5			−1.5			−1.5			−1.2	V
V_{OH}	High-level output voltage	1	V_{CC} = MIN, V_{IL} = V_{IL} max, I_{OH} = MAX		54 Family	2.4	3.4		2.4	3.3		2.4	3.4		2.5	3.4		2.5	3.4		V
					74 Family	2.4	3.4		2.4	3.3		2.4	3.4		2.7	3.4		2.7	3.4		
V_{OL}	Low-level output voltage	2	V_{CC} = MIN, V_{IH} = 2 V	I_{OL} = MAX	54 Family		0.2	0.4		0.2	0.4		0.15	0.3		0.25	0.4			0.5	V
					74 Family		0.2	0.4		0.2	0.4		0.2	0.4		0.35	0.5			0.5	
				I_{OL} = 12 mA	Series 74LS											0.25	0.4				
I_I	Input current at maximum input voltage	4	V_{CC} = MAX		V_I = 5.5 V			1			1			0.1						1	mA
					V_I = 7 V												0.1				
I_{IH}	High-level input current	4	V_{CC} = MAX		V_{IH} = 2.4 V			40			40			100							μA
					V_{IH} = 2.7 V												20			100	
I_{IL}	Low-level input current	5	V_{CC} = MAX		V_{IL} = 0.4 V			−1.6			−1.6			−4			−0.4				mA
					V_{IL} = 0.5 V															−4	
I_{OS}	Short-circuit output current♦	6			54 Family	−70		−180	−20		−70	−40		−125	−30		−130	−50		−225	mA
					74 Family	−70		−180	−18		−70	−40		−125	−30		−130	−50		−225	
I_{CC}	Supply current	7	V_{CC} = MAX			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 V, T_A = 25°C.

§I_I = −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.

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supply current¶

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
'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	8.85
'LS28	1.8	3.6	6.9	13.8	1.09
'LS37	0.9	2	6	12	0.86
'LS40	0.45	1	3	6	0.86
'S37	20	36	46	80	8.25
'S40	10	18	25	44	8.75

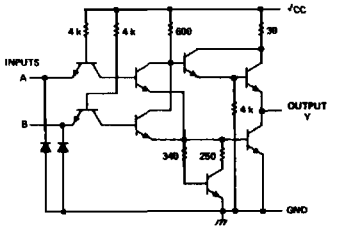
¶Maximum values of I_{CC} are over the recommended operating ranges of V_{CC} and T_A; typical values are at V_{CC} = 5 V, T_A = 25°C.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

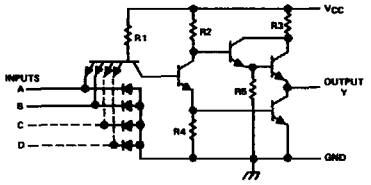
TYPE	TEST CONDITIONS#	t_{PLH} (ns) Propagation delay time, low-to-high-level output			t_{PHL} (ns) Propagation delay time, high-to-low output		
		MIN	TYP	MAX	MIN	TYP	MAX
'28	C_L = 50 pF, R_L = 133 Ω		6	9		8	12
	C_L = 150 pF, R_L = 133 Ω		10	15		12	18
'37	C_L = 45 pF, R_L = 133 Ω		13	22		8	15
'40	C_L = 15 pF, R_L = 133 Ω		13	22		8	15
'H40	C_L = 25 pF, R_L = 93 Ω		8.5	12		6.5	12
'LS28	C_L = 45 pF, R_L = 667 Ω		12	24		12	24
'LS37			12	24		12	24
'LS40			12	24		12	24
'S37	C_L = 50 pF, R_L = 93 Ω		4	6.5		4	6.5
'S40	C_L = 150 pF, R_L = 93 Ω		6			6	

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

schematics (each gate)

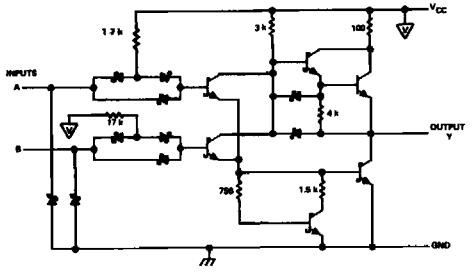


'28 CIRCUITS

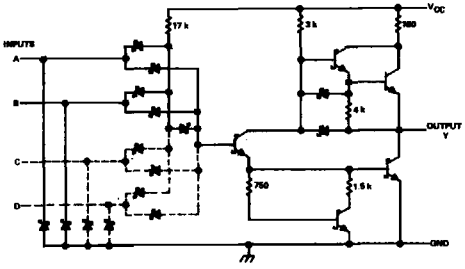


'37, '40, 'H40 CIRCUITS

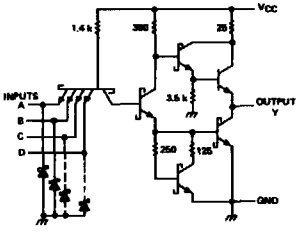
	'37	'40	'H40
R1	4 k	4 k	1.4 k
R2	600	600	390
R3	100	100	45
R4	400	400	250
R5	4 k	4 k	2 k



'LS28 CIRCUITS



'LS37, 'LS40 CIRCUITS



'S37, 'S40 CIRCUITS

Resistor values shown are nominal and in ohms.

recommended operating conditions

	54 FAMILY 74 FAMILY	SERIES 54 SERIES 74 '128			SERIES 54S SERIES 74S 'S140			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	54 Family	4.5	5	5.5	4.5	5	5.5	V
	74 Family	4.75	5	5.25	4.75	5	5.25	
High-level output current, I_{OH}	54 Family			−29			−40	mA
	74 Family			−42.4			−40	
Low-level output current, I_{OL}				48			60	mA
Operating free-air temperature, T_A	54 Family	−55		125	−55		125	°C
	74 Family	0		70	0		70	

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

PARAMETER		TEST FIGURE	TEST CONDITIONS†		SERIES 54 SERIES 74 '128			SERIES 54S SERIES 74S 'S140			UNIT
					MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH}	High-level input voltage	1, 2			2			2			V
V_{IL}	Low-level input voltage	1, 2					0.8			0.8	V
V_{IK}	Input clamp voltage	3	V_{CC} = MIN, I_I = §				−1.5			−1.2	V
V_{OH}	High-level output voltage	1	V_{CC} = MIN, V_{IL} = 0.8 V, I_{OH} = −2.4 mA	54 Family	2.4	3.4					V
				74 Family	2.4	3.4					
			V_{CC} = MIN, V_{IL} = 0.4 V, I_{OH} = −13.2 mA		2.4						
			V_{CC} = MIN, V_{IL} = 0.4 V, I_{OH} = MAX		2						
			V_{CC} = MIN, V_{IL} = 0.8 V, I_{OH} = −3 mA	54 Family				2.5	3.4		
				74 Family				2.7	3.4		
			V_{CC} = MIN, V_{IL} = 0.5 V, R_O = 50 Ω to GND					2			
V_{OL}	Low-level output voltage	2	V_{CC} = MIN, V_{IH} = 2 V, I_{OL} = MAX			0.26	0.4			0.5	V
I_I	Input current at maximum input voltage	4	V_{CC} = MAX, V_I = 5.5 V				1			1	mA
I_{IH}	High-level input current	4	V_{CC} = MAX	V_{IH} = 2.4 V			40				μA
				V_{IH} = 2.7 V						100	
I_{IL}	Low-level input current	5	V_{CC} = MAX	V_{IL} = 0.4 V			−1.6				mA
				V_{IL} = 0.5 V						−4	
I_{OS}	Short-circuit output current♦	6	V_{CC} = MAX		−70		−180	−50		−225	mA
I_{CC}	Supply current, Total, outputs high	7	V_{CC} = MAX			12	21		10	18	mA
	Supply current, Total, outputs low					33	57		25	44	
	Supply current, Average per gate		V_{CC} = 5 V, 50% duty cycle			5.63			8.75		

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§I_I = −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.

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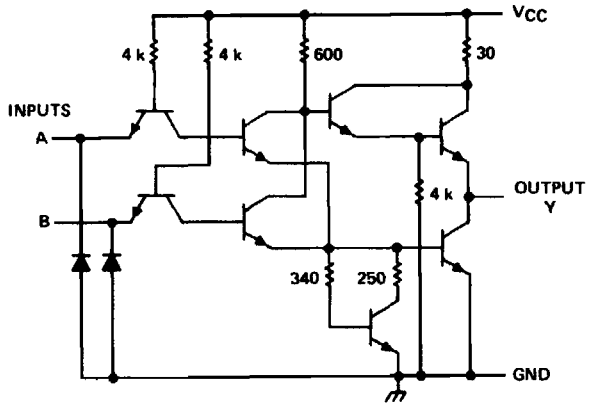
switching characteristics, V_{CC} = 5 V, T_A = 25°C

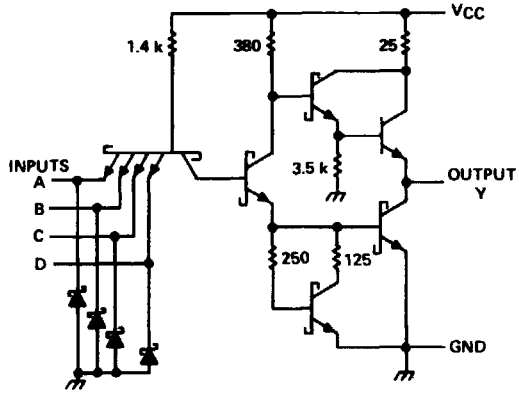
TYPE	TEST CONDITIONS#	t_{PLH} (ns) Propagation delay time, low-to-high-level output			t_{PHL} (ns) Propagation delay time, high-to-low-level output		
		MIN	TYP	MAX	MIN	TYP	MAX
'128	C_L = 50 pF, R_L = 133 Ω		6	9		8	12
	C_L = 150 pF, R_L = 133 Ω		10	15		12	18
'S140	C_L = 50 pF, R_L = 93 Ω		4	6.5		4	6.5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

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

schematics (each driver)



'128 CIRCUITS



'S140 CIRCUITS

Resistor values shown are nominal and in ohms.

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}	54 Family	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V
	74 Family	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	
High-level output voltage, V_{OH}				30			15			15			5.5	V
Low-level output current, I_{OL}	54 Family			30			30			16			48	mA
	74 Family			40			40			16			48	
Operating free-air temperature, T_A	54 Family	−55		125	−55		125	−55		125	−55		125	°C
	74 Family	0		70	0		70	0		70	0		70	

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			V
V_{IL}	Low-level input voltage	1, 2					0.8			0.8			0.8			0.8	V
V_{IK}	Input clamp voltage	3	V_{CC} = MIN, I_I = −12 mA				−1.5			−1.5			−1.5			−1.5	V
I_{OH}	High-level output current	1	V_{CC} = MIN, V_I = ▲	V_{OH} = 12 V									50				μA
				V_{OH} = MAX			250			250			1000			250	
V_{OL}	Low-level output voltage	2	V_{CC} = MIN, V_I = ▲	I_{OL} = 16 mA			0.4			0.4			0.4				V
				I_{OL} = MAX			0.7			0.7			0.4			0.4	
I_I	Input current at maximum input voltage	4	V_{CC} = MAX, V_I = 5.5 V				1			1			1			1	mA
I_{IH}	High-level input current	4	V_{CC} = MAX, V_{IH} = 2.4 V				40			40			40			40	μA
I_{IL}	Low-level input current	5	V_{CC} = MAX, V_{IL} = 0.4 V				−1.6			−1.6			−1.6			−1.6	mA
I_{CC}	Supply current	7	V_{CC} = MAX		See table on next page												mA

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

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

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supply current¶

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
'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

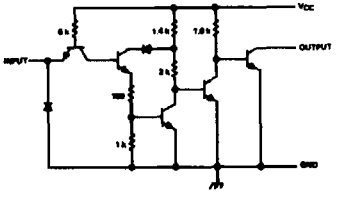
¶Maximum values of I_{CC} shown are over the recommended operating ranges of V_{CC} and T_A; typical values are at V_{CC} = 5 V, T_A = 25°C.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

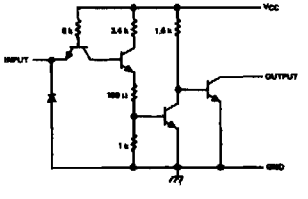
TYPE	TEST CONDITIONS#	t_{PLH} (ns) Propagation delay time, low-to-high-level output		t_{PHL} (ns) Propagation delay time, high-to-low-level output	
		TYP	MAX	TYP	MAX
'06, '16	C_L = 15 pF, R_L = 110 Ω	10	15	15	23
'07, '17		6	10	20	30
'26	C_L = 15 pF, R_L = 1 kΩ	16	24	11	17
'33	C_L = 50 pF, R_L = 133 Ω	10	15	12	18
	C_L = 150 pF, R_L = 133 Ω	15	22	16	24
'38	C_L = 45 pF, R_L = 133 Ω	14	22	11	18

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

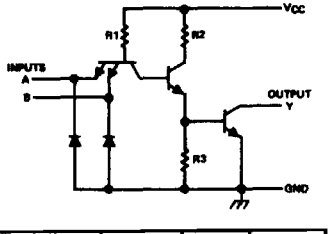
schematics (each gate)



'06, '16 CIRCUITS

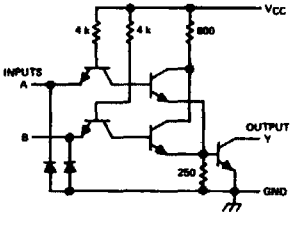


'07, '17 CIRCUITS



CIRCUITS	R1	R2	R3
'26	4 kΩ	1.6 kΩ	1 kΩ
'38	4 kΩ	600 Ω	400 Ω

'26, '38 CIRCUITS



'33 CIRCUITS

recommended operating conditions

	54 FAMILY / 74 FAMILY	SERIES 54LS' SERIES 74LS'									SERIES 54S' SERIES 74S'			UNIT
		'LS26			'LS33			'LS38			'S38			
		MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	54 Family	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V
	74 Family	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	
High-level output voltage, V_{OH}				15			5.5			5.5			5.5	V
Low-level output current, I_{OL}	54 Family			4			12			12			60	mA
	74 Family			8			24			24			60	
Operating free-air temperature, T_A	54 Family	−55		125	−55		125	−55		125	−55		125	°C
	74 Family	0		70	0		70	0		70	0		70	

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

PARAMETER		TEST FIGURE	TEST CONDITIONS†			SERIES 54LS' SERIES 74LS'						SERIES 54S' SERIES 74S'			UNIT
						'LS26			'LS33			'LS38			'S38			
						MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH}	High-level input voltage	1, 2				2			2			2			2			V
V_{IL}	Low-level input voltage	1, 2			54 Family			0.7			0.7			0.7			0.8	V
					74 Family			0.8			0.8			0.8			0.8	
V_{IK}	Input clamp voltage	3	V_{CC} = MIN, I_I = §					−1.5			−1.5			−1.5			−1.2	V
I_{OH}	High-level output current	1	V_{CC} = MIN, V_I = ▲		V_{OH} = 12 V			50										μA
					V_{OH} = MAX			1000			250			250			250	
V_{OL}	Low-level output voltage	2	V_{CC} = MIN, V_I = ▲	I_{OL} = MAX	54 Family	0.25		0.4	0.25		0.4	0.25		0.4			0.5	V
					74 Family	0.35		0.5	0.35		0.5	0.35		0.5			0.5	
				I_{OL} = 4 mA	Series 74LS'	0.25		0.4										
				I_{OL} = 12 mA					0.25		0.4	0.25		0.4				
I_I	Input current at maximum input voltage	4	V_{CC} = MAX		V_I = 5.5 V												1	mA
					V_I = 7 V			0.1			0.1			0.1				
I_{IH}	High-level input current	4	V_{CC} = MAX		V_{IH} = 2.7 V			20			20			20			100	μA
I_{IL}	Low-level input current	5	V_{CC} = MAX		V_{IL} = 0.4 V			−0.4			−0.4			−0.4				mA
					V_{IL} = 0.5 V												−4	
I_{CC}	Supply current	7	V_{CC} = MAX			See table on next page												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°C.
§I_I = −18 mA for SN54LS'/SN74LS' and −12 mA for SN54S'/SN74'.
▲The input voltage is V_{IH} = 2 V or V_{IL} = V_{IL} max, as appropriate. See tables with test figures 1 and 2.

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supply current¶

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
'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	0.86
'S38	20	36	46	80	8.25

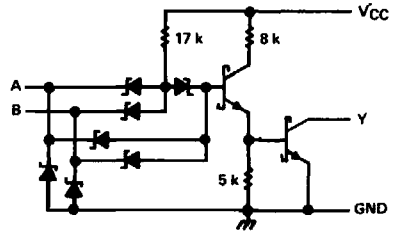
¶Maximum values of I_{CC} shown are over the recommended operating ranges of V_{CC} and T_A; typical values are at V_{CC} = 5 V, T_A = 25°C.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

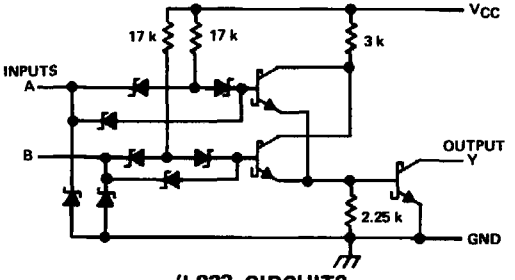
TYPE	TEST CONDITIONS#		t_{PLH} (ns) Propagation delay time, low-to-high-level output		t_{PHL} (ns) Propagation delay time, high-to-low-level output	
			TYP	MAX	TYP	MAX
'LS26	C_L = 15 pF, R_L = 2 kΩ		17	32	15	28
'LS33	C_L = 45 pF, R_L = 667 Ω		20	32	18	28
'LS38			20	32	18	28
'S38	R_L = 93 Ω	C_L = 50 pF	6.5	10	6.5	10
		C_L = 150 pF	9		8.5	

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

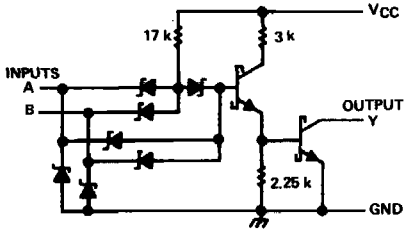
schematics (each gate)



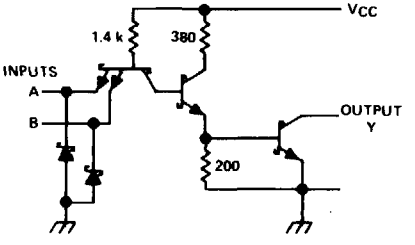
'LS26 CIRCUITS



'LS33 CIRCUITS



'LS38 CIRCUITS



'S38 CIRCUITS

recommended operating conditions

	54 FAMILY / 74 FAMILY	SERIES 54 / SERIES 74 '32			SERIES 54LS / SERIES 74LS 'LS32			SERIES 54S / SERIES 74S 'S32			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	54 Family	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V
	74 Family	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	
High-level output current, I_{OH}				−800			−400			−1000	μA
Low-level output current, I_{OL}	54 Family			16			4			20	mA
	74 Family			16			8			20	
Operating free-air temperature, T_A	54 Family	−55		125	−55		125	−55		125	C
	74 Family	0		70	0		70	0		70	

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

PARAMETER			TEST FIGURE	TEST CONDITIONS†			SERIES 54 / SERIES 74 '32			SERIES 54LS / SERIES 74LS 'LS32			SERIES 54S / SERIES 74S 'S32			UNIT
							MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH}	High-level input voltage		1, 2				2			2			2			V
V_{IL}	Low-level input voltage		1, 2			54 Family			0.8			0.7			0.8	V
						74 Family			0.8			0.8			0.8	
V_{IK}	Input clamp voltage		3	V_{CC} = MIN,	I_I = §				−1.5			−1.5			−1.2	V
V_{OH}	High-level output voltage		1	V_{CC} = MIN, I_{OH} = MAX	V_{IH} = 2 V,	54 Family	2.4	3.4		2.5	3.4		2.5	3.4		V
						74 Family	2.4	3.4		2.7	3.4		2.7	3.4		
V_{OL}	Low-level output voltage		2	V_{CC} = MIN, V_{IL} = V_{IL} max	I_{OL} = MAX	54 Family		0.2	0.4		0.25	0.4			0.5	V
						74 Family		0.2	0.4		0.35	0.5			0.5	
					I_{OL} = 4 mA	Series 74LS					0.25	0.4				
I_I	Input current at maximum input voltage		4	V_{CC} = MAX		V_I = 5.5 V			1						1	mA
						V_I = 7 V						0.1				
I_{IH}	High-level input current		4	V_{CC} = MAX		V_{IH} = 2.4 V			40							μA
						V_{IH} = 2.7 V						20			50	
I_{IL}	Low-level input current		5	V_{CC} = MAX		V_{IL} = 0.4 V			−1.6			−0.4				mA
						V_{IL} = 0.5 V									−2	
I_{OS}	Short-circuit output current♦		6	V_{CC} = MAX		54 Family	−20		−55	−20		−100	−40		−100	mA
						74 Family	−18		−55	−20		−100	−40		−100	
I_{CC}	Supply current	Total, outputs high	7	V_{CC} = MAX				15	22		3.1	6.2		18	32	mA
		Total, outputs low						23	38		4.9	9.8		38	68	
		Average per gate		V_{CC} = 5 V,	50% duty cycle			4.75			1.0			7		

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

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

§I_I = −12 mA for SN54'/SN74' and −18 mA for SN54LS'/SN74LS' and SN54S'/SN74S'.

♦*Not more than one output should be shorted at a time, and for SN54LS'/SN74LS' and SN54S'/SN74S', duration of the short-circuit should be less than one second.*

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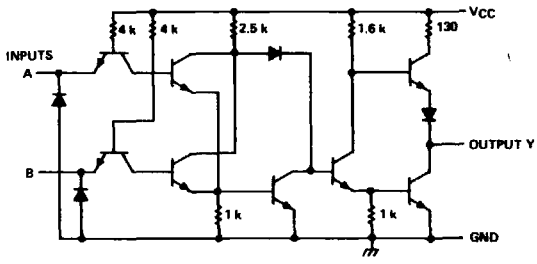
switching characteristics at V_{CC} = 5 V, T_A = 25°C

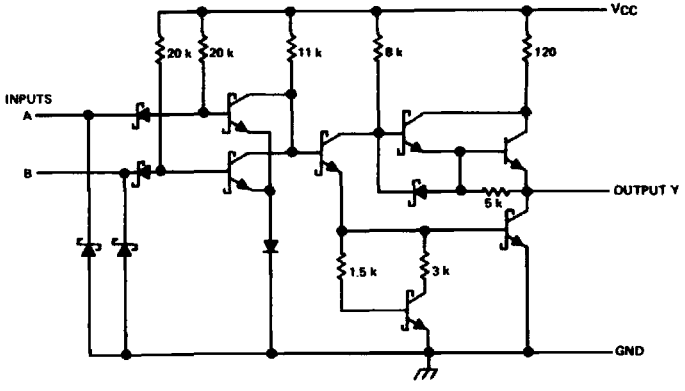
TYPE	TEST CONDITIONS#	t_{PLH} (ns) Propagation delay time, low-to-high-level output			t_{PHL} (ns) Propagation delay time, high-to-low-level output		
		MIN	TYP	MAX	MIN	TYP	MAX
'32	C_L = 15 pF, R_L = 400 Ω		10	15		14	22
'LS32	C_L = 15 pF, R_L = 2 kΩ		14	22		14	22
'S32	C_L = 15 pF, R_L = 280 Ω		4	7		4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

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

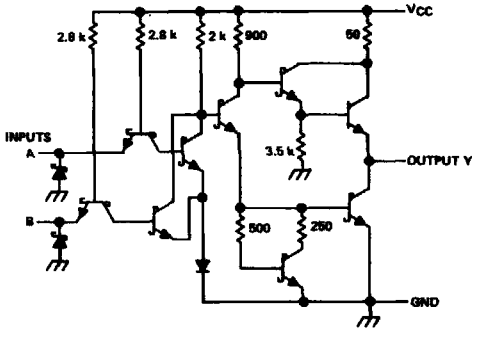
schematics (each gate)



'32 CIRCUITS



'LS32 CIRCUITS



'S32 CIRCUITS

Resistor values shown are nominal and in ohms.

recommended operating conditions

	54 FAMILY / 74 FAMILY	SERIES 54 / SERIES 74 '51, '54			SERIES 54H / SERIES 74H 'H51, 'H54			SERIES 54L / SERIES 74L 'L51, 'L54, 'L55			SERIES 54LS / SERIES 74LS 'LS51, 'LS54, 'LS55			SERIES 54S / SERIES 74S 'S51, 'S54			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	54 Family	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
	74 Family	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	
High-level output current, I_{OH}	54 Family			−400			−500			−100			−400			−1000	μA
	74 Family			−400			−500			−200			−400			−1000	
Low-level output current, I_{OL}	54 Family			16			20			2			4			20	mA
	74 Family			16			20			3.6			8			20	
Operating free-air temperature, T_A	54 Family	−55		125	−55		125	−55		125	−55		125	−55		125	°C
	74 Family	0		70	0		70	0		70	0		70	0		70	

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

PARAMETER		TEST FIGURE	TEST CONDITIONS†			SERIES 54 / SERIES 74 '51, '54			SERIES 54H / SERIES 74H 'H51, 'H54			SERIES 54L / SERIES 74L 'L51, 'L54, 'L55			SERIES 54LS / SERIES 74LS 'LS51, 'LS54, 'LS55			SERIES 54S / SERIES 74S 'S51, 'S54			UNIT
						MIN	TYP‡	MAX	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			V
V_{IL}	Low-level input voltage	1, 2			54 Family			0.8			0.8			0.7			0.7			0.8	V
					74 Family			0.8			0.8			0.7			0.8			0.8	
V_{IK}	Input clamp voltage	3	V_{CC} = MIN,	I_I = §				−1.5			−1.5						−1.5			−1.2	V
V_{OH}	High-level output voltage	1	V_{CC} = MIN, V_{IL} = V_{IL} max, I_{OH} = MAX		74 Family	2.4	3.4		2.4	3.4		2.4	3.3		2.5	3.4		2.5	3.4		V
					54 Family	2.4	3.4		2.4	3.4		2.4	3.2		2.7	3.4		2.7	3.4		
V_{OL}	Low-level output voltage	2	V_{CC} = MIN, V_{IH} = 2 V	I_{OL} = MAX	54 Family		0.2	0.4		0.2	0.4		0.15	0.3		0.25	0.4			0.5	V
					74 Family		0.2	0.4		0.2	0.4		0.2	0.4		0.35	0.5			0.5	
				I_{OL} = 4 mA	Series 74LS											0.25	0.4				
I_I	Input current at maximum input voltage	4	V_{CC} = MAX		V_I = 5.5 V			1			1			0.1						1	mA
					V_I = 7 V												0.1				
I_{IH}	High-level input current	4	V_{CC} = MAX		V_{IH} = 2.4 V			40			50			10							μA
					V_{IH} = 2.7 V												20			50	
I_{IL}	Low-level input current	5	V_{CC} = MAX		V_{IL} = 0.3 V									−0.18							mA
					V_{IL} = 0.4 V			−1.6			−2						−0.4				
					V_{IL} = 0.5 V															−2	
I_{OS}	Short-circuit output current♦	6	V_{CC} = MAX		54 Family	−20		−55	−40		−100	−3		−15	−20		−100	−40		−100	mA
					74 Family	−18		−55	−40		−100	−3		−15	−20		−100	−40		−100	
I_{CC}	Supply current	7	V_{CC} = MAX			See table on next page															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°C.

§I_I = −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.

supply current¶

TYPE	I_{CCH} (mA) Total with outputs high		I_{CCL} (mA) Total with outputs low		I_{CC} (mA) Average per AOI gate (50% duty cycle)
	TYP	MAX	TYP	MAX	TYP
'51	4	8	7.4	14	2.85
'54	4	8	5.1	9.5	4.55
'H51	8.2	12.8	15.2	24	5.85
'H54	7.1	11	9.4	14	8.25
'L51	0.44	0.8	0.76	1.3	0.30
'L54	0.39	0.8	0.60	0.99	0.50
'L55	0.22	0.4	0.38	0.65	0.30
'LS51	0.8	1.6	1.4	2.8	0.55
'LS54	0.8	1.6	1.0	2	0.9
'LS55	0.4	0.8	0.7	1.3	0.55
'S51	8.2	17.8	13.6	22	5.45
'S64	7	12.5	8.5	16	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 V, T_A = 25°C.

switching characteristics at V_{CC} = 5 V, T_A = 25°C

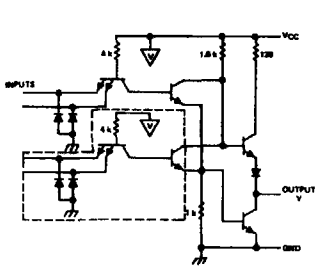
TYPE	TEST CONDITIONS#	t_{PLH} (ns) Propagation delay time, low-to-high-level output			t_{PHL} (ns) Propagation delay time, high-to-low-level output		
		MIN	TYP	MAX	MIN	TYP	MAX
'51, '54	C_L = 15 pF, R_L = 400 Ω		13	22		8	15
'H51	C_L = 25 pF, R_L = 280 Ω		6.8	11		6.2	11
'H54	C_L = 25 pF, R_L = 280 Ω		7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

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

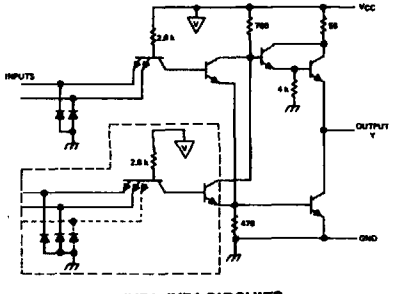
schematics (each gate)

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.

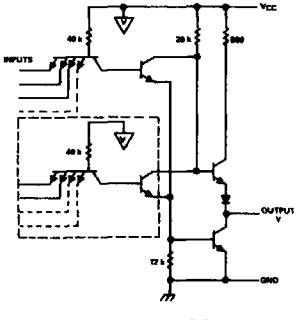
Resistor values shown are nominal and in ohms.



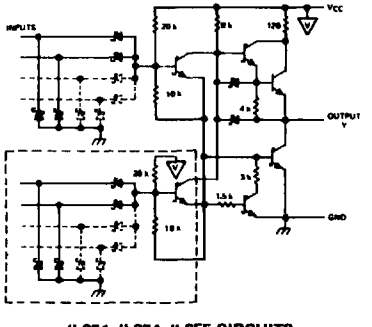
'51, '54 CIRCUITS



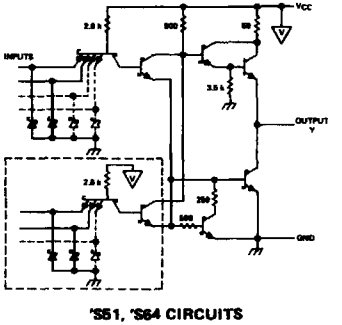
'H51, 'H54 CIRCUITS



'L51, 'L54, 'L55 CIRCUITS



'LS51, 'LS54, 'LS55 CIRCUITS



'S51, 'S64 CIRCUITS

recommended operating conditions

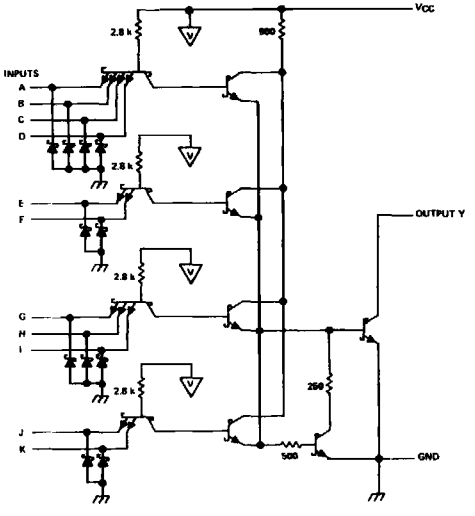
	SN54S65			SN74S65			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output voltage, V_{OH}			5.5			5.5	V
Low-level output current, I_{OL}			20			20	mA
Operating free-air temperature, T_A	−55		125	0		70	°C

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

PARAMETER		TEST FIGURE	TEST CONDITIONS†	'S65 MIN	'S65 TYP‡	'S65 MAX	UNIT
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} = MIN, I_I = −18 mA			−1.2	V
I_{OH}	High-level output current	1	V_{CC} = MIN, V_{IH} = 0.8 V, V_{OH} = 5.5 V			250	μA
V_{OL}	Low-level output voltage	2	V_{CC} = MIN, V_{IL} = 2 V, I_{OL} = 20 mA			0.5	V
I_I	Input current at maximum input voltage	4	V_{CC} = MAX, V_I = 5.5 V			1	mA
I_{IH}	High-level input current	4	V_{CC} = MAX, V_I = 2.7 V			50	μA
I_{IL}	Low-level input current	5	V_{CC} = MAX, V_I = 0.5 V			−2	mA
I_{CCH}	Supply current, output high	7	V_{CC} = MAX		6	11	mA
I_{CCL}	Supply current, output low	7	V_{CC} = 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 V, T_A = 25°C.

schematic



Resistor values shown are nominal and in ohms.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

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

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

TEXAS INSTRUMENTS
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recommended operating conditions

	54 FAMILY / 74 FAMILY	SERIES 54 / SERIES 74 '125, '126, '425, '426			SERIES 54LS / SERIES 74LS 'LS125A, 'LS126A			SERIES 54S / SERIES 74S 'S134			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	54 Family	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V
	74 Family	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	
High-level output current, I_{OH}	54 Family			−2			−1			−2	mA
	74 Family			−5.2			−2.6			−6.5	
Low-level output current, I_{OL}	54 Family			16			12			20	mA
	74 Family			16			24			20	
Operating free-air temperature, T_A	54 Family	−55		125	−55		125	−55		125	°C
	74 Family	0		70	0		70	0		70	

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

PARAMETER		TEST FIGURE	TEST CONDITIONS†		SERIES 54 / SERIES 74 '125, '126, '425, '426			SERIES 54LS / SERIES 74LS 'LS125A, 'LS126A			SERIES 54S / SERIES 74S 'S134			UNIT
					MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH}	High-level input voltage	1, 2			2			2			2			V
V_{IL}	Low-level input voltage	1, 2		54 Family			0.8			0.7			0.8	V
				74 Family			0.8			0.8			0.8	
V_{IK}	Input clamp voltage	3	V_{CC} = MIN,	I_I = §			−1.5			1.5			−1.2	V
V_{OH}	High-level output voltage	1	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL} max,	54 Family	2.4	3.3		2.4			2.4	3.4		V
				74 Family	2.4	3.1		2.4			2.4	3.2		
V_{OL}	Low-level output voltage	2	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL} max	I_{OL} = MAX, 54 Family			0.4		0.25	0.4			0.5	V
				I_{OL} = MAX, 74 Family			0.4		0.35	0.5			0.5	
				I_{OL} = 12 mA, Series 74LS					0.25	0.4				
I_{OZ}	Off-state (high-impedance state) output current	19	V_{CC} = MAX, V_{IH} = 2 V, V_{IL} = V_{IL} max	V_O = 2.4 V			40			20			50	μA
				V_O = 0.4 V			−40			−20				
				V_O = 0.5 V									−50	
I_I	Input current at maximum input voltage	4	V_{CC} = MAX	V_I = 5.5 V			1						1	mA
				V_I = 7 V						0.1				
I_{IH}	High-level input current	4	V_{CC} = MAX	V_{IH} = 2.4 V			40							μA
				V_{IH} = 2.7 V						20			50	
I_{IL}	Low-level input current	5	V_{CC} = MAX	V_{IL} = 0.4 V			−1.6			0.4				mA
				V_{IL} = 0.5 V									−2	
I_{OS}	Short-circuit output current♦	6	V_{CC} = MAX	54 Family	−30		−70	−40		−225	−40		−100	mA
				74 Family	−28		−70	−40		−225	−40		−100	
I_{CC}	Supply current	7	V_{CC} = MAX		See table on next page									mA

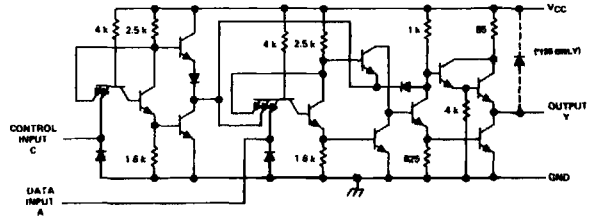
†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§I_I = −12 mA for SN54'/SN74' and −18 mA for SN54LS'/SN74LS' and SN54S'/SN74S'.
♦Not more than one output should be shorted at a time, and for SN54LS'/SN74LS' and SN54S'/SN74S', duration of the short circuit should not exceed one second.

supply current¶

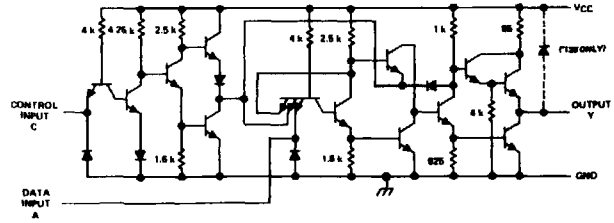
TYPE	TEST CONDITIONS		I_{CC} (mA)		
	DATA INPUTS	OUTPUT CONTROLS	MIN	TYP	MAX
'125, '425	0 V	4.5 V		32	54
'126, '426	0 V	0 V		36	62
'LS125A	0 V	4.5 V		11	20
'LS126A	0 V	0 V		12	22
'S134	0 V	0 V		7	13
	5 V	0 V		9	16
	5 V	5 V		14	25

¶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°C.

schematics (each gate)



'125A, '425 CIRCUITS



'126A, '426 CIRCUITS

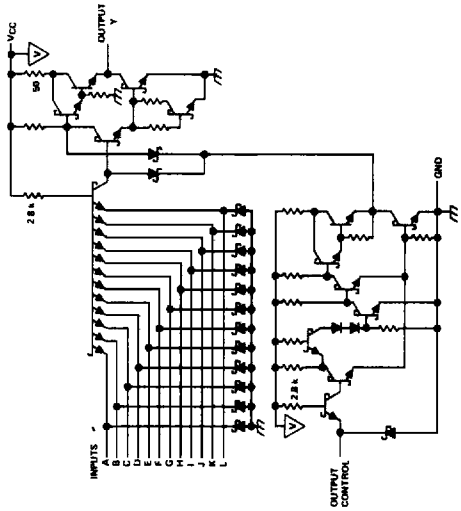
Resistor values shown are nominal and in ohms.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

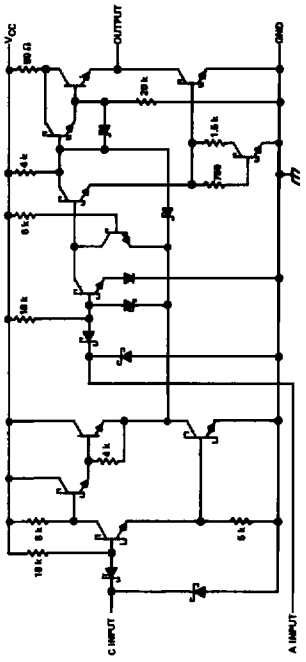
PARAMETER		SERIES 54/74				SERIES 54LS/74LS					SERIES 54S/74S			UNIT
		TEST CONDITIONS#	'125, '425		'126, '426		TEST CONDITIONS#	'LS125A		'LS126A		TEST CONDITIONS#	'S134		
			TYP	MAX	TYP	MAX		TYP	MAX	TYP	MAX		TYP	MAX	
t_{PLH}	Propagation delay time, low-to-high-level output	C_L = 50 pF, R_L = 400 Ω	8	13	8	13	C_L = 45 pF, R_L = 667 Ω	9	15	9	15	C_L = 15 pF, R_L = 280 Ω	4	6	ns
												C_L = 50 pF, R_L = 280 Ω	5.5		
t_{PHL}	Propagation delay time, high-to-low-level output		12	18	12	18		7	18	8	18	C_L = 15 pF, R_L = 280 Ω	5	7.5	ns
												C_L = 50 pF, R_L = 280 Ω	7		
t_{PZH}	Output enable time to high level		11	17	11	18		12	20	16	26	C_L = 50 pF, R_L = 280 Ω	13	19.5	ns
t_{PZL}	Output enable time to low level		16	25	16	25		15	25	21	35		14	21	ns
t_{PHZ}	Output disable time from high level	C_L = 5 pF, R_L = 400 Ω	5	8	10	16	C_L = 5 pF, R_L = 667 Ω		20		25	C_L = 5 pF, R_L = 280 Ω	5.5	8.5	ns
t_{PLZ}	Output disable time from low level		7	12	12	18			20		25		9	14	ns

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

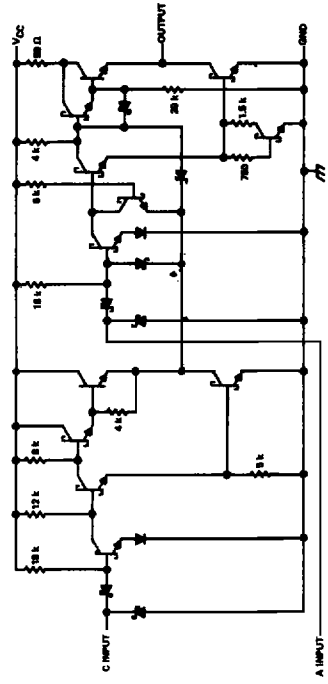
schematics (each gate)



'S134 CIRCUITS



'LS125A CIRCUITS



'LS126A CIRCUITS

Resistor values shown are nominal and in ohms.

recommended operating conditions

		54 FAMILY 74 FAMILY	SERIES 54 SERIES 74 '365A, '366A '367A, '368A			SERIES 54LS SERIES 74LS 'LS365A, 'LS366A 'LS367A, 'LS368A			UNIT
			MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}		54 Family	4.5	5	5.5	4.5	5	5.5	V
		74 Family	4.75	5	5.25	4.75	5	5.25	
High-level output current, I_{OH}		54 Family			−2			−1	mA
		74 Family			−5.2			−2.6	
Low-level output current, I_{OL}		54 Family			32			12	mA
		74 Family			32			24	
Operating free-air temperature, T_A		54 Family	−55		125	−55		125	°C
		74 Family	0		70	0		70	

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

PARAMETER			TEST FIGURE	TEST CONDITIONS†			SERIES 54 SERIES 74 '365A, '366A '367A, '368A			SERIES 54LS SERIES 74LS 'LS365A, 'LS366A 'LS367A, 'LS368A			UNIT
							MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH}	High-level input voltage		1, 2				2			2			V
V_{IL}	Low-level input voltage		1, 2			54 Family			0.8			0.7	V
						74 Family			0.8			0.8	
V_{IK}	Input clamp voltage		3	V_{CC} = MIN,	I_I = §				−1.5			−1.5	V
V_{OH}	High-level output voltage		1	V_{CC} = MIN, V_{IL} = V_{IL} max,	V_{IH} = 2 V, I_{OH} = MAX	54 Family	2.4	3.3		2.4	3.3		V
						74 Family	2.4	3.1		2.4	3.1		
V_{OL}	Low-level output voltage		2	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL} max	I_{OL} = MAX	54 Family			0.4		0.25	0.4	V
						74 Family			0.4		0.35	0.5	
					I_{OL} = 12 mA	Series 74LS					0.25	0.4	
I_{OZ}	Off-state (high-impedance state) output current		19	V_{CC} = MAX, V_{IL} = V_{IL} max	V_{IH} = 2 V,	V_O = 2.4 V			40			20	µA
						V_O = 0.4 V			−40			−20	
I_I	Input current at maximum input voltage		4	V_{CC} = MAX		V_I = 5.5 V			1				mA
						V_I = 7 V						0.1	
I_{IH}	High-level input current		4	V_{CC} = MAX		V_{IH} = 2.4 V			40				µA
						V_{IH} = 2.7 V						20	
I_{IL}	Low-level input current	A inputs		V_{CC} = MAX, Either $\overline{G}$ input at 2 V	V_I = 0.5 V,				−40			−20	µA
				V_{CC} = MAX, Both $\overline{G}$ inputs at 0.4 V	V_I = 0.4 V,				−1.6			−0.4	mA
		$\overline{G}$ inputs		V_{CC} = MAX,	V_I = 0.4 V,				−1.6			−0.4	
I_{OS}	Short-circuit output current♦		6	V_{CC} = MAX			−40		−130	−40		−225	mA
I_{CC}	Supply current		7	V_{CC} = MAX			See table on next page						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°C.

§I_I = −12 mA for SN54'/SN74' and −18 mA for SN54LS'/SN74LS', SN54S/SN74S'.

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

supply current¶

TYPE	DATA INPUTS	OUTPUT CONTROLS	I_{CC} (mA) TYP	I_{CC} (mA) MAX
'365A, '367A	0 V	4.5 V	65	85
'366A, '368A	0 V	4.5 V	59	77
'LS365A, 'LS367A	0 V	4.5 V	14	24
'LS366A, 'LS368A	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} = 5 V, T_A = 25°C.

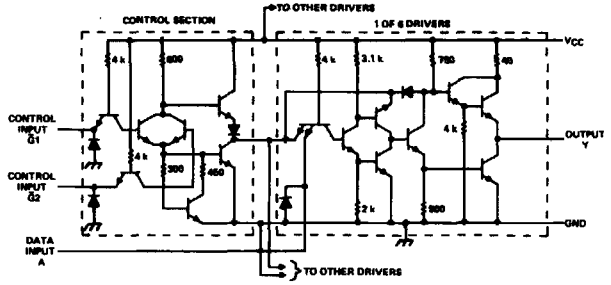
switching characteristics, V_{CC} = 5 V, T_A = 25°C, see note 1

PARAMETER*	TEST CONDITIONS	SERIES 54/74 '365A, '367A TYP	SERIES 54/74 '365A, '367A MAX	SERIES 54/74 '366A, '368A TYP	SERIES 54/74 '366A, '368A MAX	TEST CONDITIONS	SERIES 54LS/74LS 'LS365A, 'LS367A TYP	SERIES 54LS/74LS 'LS365A, 'LS367A MAX	SERIES 54LS/74LS 'LS366A, 'LS368A TYP	SERIES 54LS/74LS 'LS366A, 'LS368A MAX
t_{PLH}	C_L = 50 pF, R_L = 400 Ω		16		17	C_L = 45 pF, R_L = 667 Ω	10	16	7	15
t_{PHL}			22		16		9	22	12	18
t_{PZH}			35		35		19	35	18	35
t_{PZL}			37		37		24	40	28	45
t_{PHZ}	C_L = 5 pF, R_L = 400 Ω		11		11	C_L = 5 pF, R_L = 667 Ω		30		32
t_{PLZ}			27		27			35		35

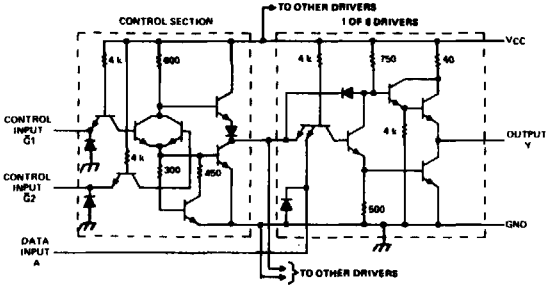
*t_{PLH} = Propagation delay time, low-to-high-level output
t_{PHL} = Propagation delay time, high-to-low-level output
t_{PZH} = Output enable time to high level
t_{PZL} = Output enable time to low level
t_{PHZ} = Output disable time from high level
t_{PLZ} = Output disable time from low level

NOTE 1: Load circuits and voltage waveforms are shown on pages 3-10 and 3-11.

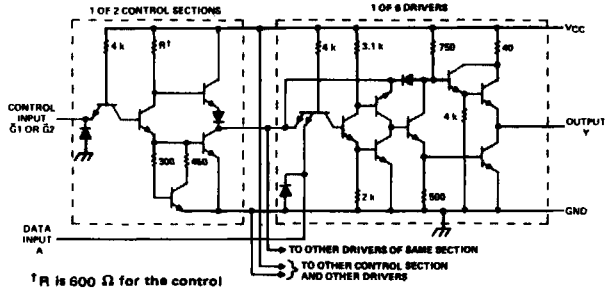
schematics



'365A CIRCUITS

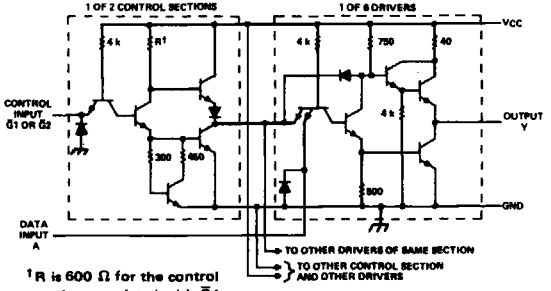


'366A CIRCUITS



†R is 600 Ω for the control section associated with $\overline{G}1$ and 900 Ω for the control section associated with $\overline{G}2$.

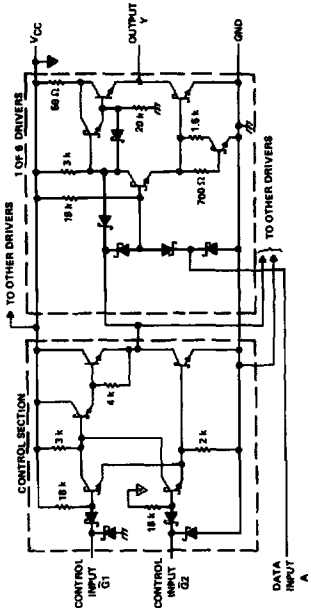
'367A CIRCUITS



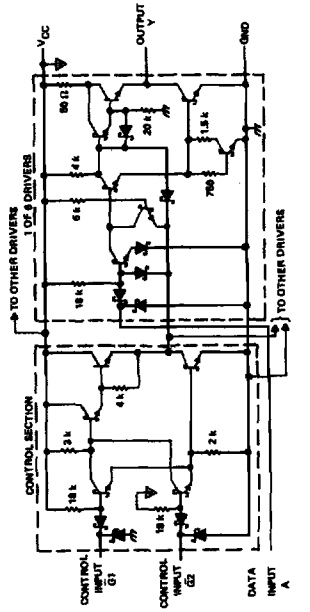
†R is 600 Ω for the control section associated with $\overline{G}1$ and 900 Ω for the control section associated with $\overline{G}2$.

'368A CIRCUITS

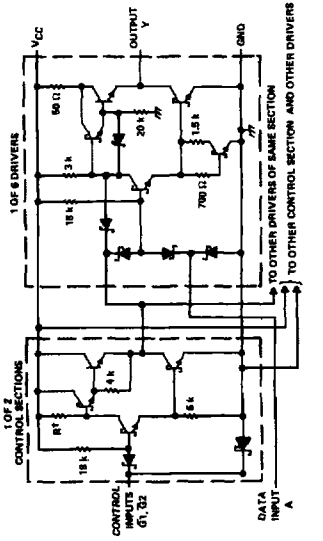
Resistor values shown are nominal and in ohms.



'LS366A CIRCUITS

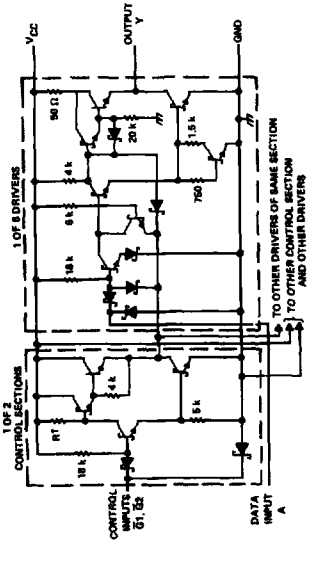


'LS365A CIRCUITS



'LS368A CIRCUITS

†R is 5 kΩ for the control section associated with $\overline{G1}$ and 8 kΩ for the control section associated with $\overline{G2}$.



'LS367A CIRCUITS

†R is 5 kΩ for the control section associated with $\overline{G1}$ and 8 kΩ for the control section associated with $\overline{G2}$.

Resistor values shown are nominal and in ohms

TEXAS INSTRUMENTS
INCORPORATED
POST OFFICE BOX 5012 • DALLAS, TEXAS 75222

recommended operating conditions

	54 FAMILY / 74 FAMILY	SERIES 54 / SERIES 74 '23			SERIES 54 / SERIES 74 '50, '53			SERIES 54H / SERIES 74H 'H50, 'H52, 'H53, 'H55			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	54 Family	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V
	74 Family	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	
High-level output current, I_{OH}				−800			−400			−500	μA
Low-level output current, I_{OL}	54 Family			16			16			20	mA
	74 Family			16			16			20	
Operating free-air temperature range, T_A	54 Family	−55		125	−55		125	−55		125	°C
	74 Family	0		70	0		70	0		70	

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 '23			SERIES 54 / SERIES 74 '50, '53			SERIES 54H / SERIES 74H 'H50, 'H52 'H53, 'H55			UNIT
					MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH} High-level input voltage		1, 2			2			2			2			V
V_{IL} Low-level input voltage		1, 2					0.8			0.8			0.8	V
V_{IK} Input clamp voltage		3	V_{CC} = MIN, I_I = §				−1.5			−1.5			−1.5	V
V_{OH} High-level output voltage		1	V_{CC} = MIN, V_I = ▲,	I_{OH} = MAX	2.4	3.4		2.4	3.4		2.4	3.4		V
V_{OL} Low-level output voltage		2	V_{CC} = MIN, V_I = ▲,	I_{OL} = MAX		0.2	0.4		0.2	0.4		0.2	0.4	V
I_I Input current at maximum input voltage		4	V_{CC} = MAX, V_I = 5.5 V				1			1			1	mA
I_{IH} High-level input current	Data input	4	V_{CC} = MAX, V_{IH} = 2.4 V				40			40			50	μA
	Strobe of '23						160							
I_{IL} Low-level input current	Data inputs	5	V_{CC} = MAX, V_{IL} = 0.4 V				−1.6			−1.6			−2	mA
	Strobe of '23						−6.4							
I_{OS} Short-circuit output current♦		6	V_{CC} = MAX	54 Family	−20		−55	−20		−55	−40		−100	mA
				74 Family	−18		−55	−18		−55	−40		−100	
I_{CC} Supply current		7	V_{CC} = MAX		See table on next page									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°C.
§I_I = −12 mA for SN54'/SN74' and −8 mA for SN54H'/SN74H'.
▲The input voltage is V_{IH} = 2 V or V_{IL} = V_{IL} 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.

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

TYPE	$I_{\overline{X}}$ (mA) (I_X for 'H52) 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‡ MAX	TEST CONDITIONS	MIN	TYP‡ MAX	TEST CONDITIONS	MIN	TYP‡ MAX	TEST CONDITIONS	MIN	TYP‡ MAX
SN5423	$V_{\overline{X}X}$ = 0.4 V,		−3.5	$I_X + I_{\overline{X}}$ = 410 μA,			I_X = 150 μA,			$I_X + I_{\overline{X}}$ = 300 μA,		
SN5450	I_{OL} = 16 mA,		−2.9	$R_{\overline{X}X}$ = 0,		1.1	$I_{\overline{X}}$ = −150 μA,	2.4	3.4	$R_{\overline{X}X}$ = 114 Ω▲		0.2 0.4
SN5453	See Figure 10		−2.9	I_{OL} = 16 mA, See Figure 11			I_{OH} = −400 μA, See Figure 12			I_{OL} = 16 mA, See Figure 11		
SN7423	$V_{\overline{X}X}$ = 0.4 V,		−3.8	$I_X + I_{\overline{X}}$ = 620 μA,			I_X = 270 μA,			$I_X + I_{\overline{X}}$ = 430 μA,		
SN7450	I_{OL} = 16 mA,		−3.1	$R_{\overline{X}X}$ = 0,		1	$I_{\overline{X}}$ = −270 μA,	2.4	3.4	$R_{\overline{X}X}$ = 105 Ω▲		0.2 0.4
SN7453	See Figure 10		−3.1	I_{OL} = 16 mA, See Figure 11			I_{OH} = −400 μA, See Figure 12			I_{OL} = 16 mA, See Figure 11		
SN54H50, SN54H53, SN54H55	$V_{\overline{X}}$ = 1.4 V, I_X = 0, I_{OL} = 0, See Figure 10		−5.85	$I_X + I_{\overline{X}}$ = 700 μA, $R_{\overline{X}X}$ = 0, I_{OL} = 20 mA, See Figure 11		1.1	I_X = 320 μA, $I_{\overline{X}}$ = −320 μA, I_{OH} = −500 μA, See Figure 12	2.4	3.4	$I_X + I_{\overline{X}}$ = 470 μA, $R_{\overline{X}X}$ = 68 Ω, I_{OL} = 20 mA, See Figure 11		0.2 0.4
SN74H50, SN74H53, SN74H55	$V_{\overline{X}}$ = 1.4 V, I_X = 0, I_{OL} = 0, See Figure 10		−6.3	$I_X + I_{\overline{X}}$ = 1.1 mA, $R_{\overline{X}X}$ = 0, I_{OL} = 20 mA, See Figure 11		1	I_X = 570 μA, I_X = −570 μA, I_{OH} = −500 μA, See Figure 12	2.4	3.4	$I_X + I_{\overline{X}}$ = 800 μA, $R_{\overline{X}X}$ = 63 Ω, I_{OL} = 20 mA, See Figure 11		0.2 0.4
SN54H52	V_X = 1 V,	−2.7	−4.5				V_X = 1 V,	2.4	3.4	I_X = −300 μA,		
SN74H52	I_{OH} = −500 μA, See Figure 13	−2.9	−5.36				I_{OH} = −500 μA, See Figure 13			I_{OL} = 20 mA, T_A = MAX, See Figure 14		0.2 0.4

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

▲$R_{\overline{X}X}$ equals 114 Ω for SN5423, 138 Ω for SN5450 and SN5453, 105 Ω for SN7423, and 130 Ω for SN7450 and SN7453.

supply current¶

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
'23	8	16	10	19	4.5
'50	4	8	7.4	14	2.85
'53	4	8	5.1	9.5	4.55
'H50	8.2	12.8	15.2	24	5.85
'H52	20	31	15.2	24	17.6
'H53	7.1	11	9.4	14	8.25
'H55	4.5	6.4	7.5	12	6.00

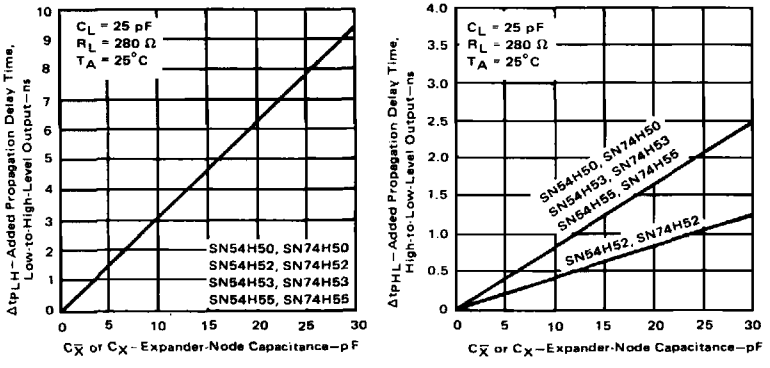
¶Maximum values of I_{CC} are over the recommended operating ranges of V_{CC} and T_A; typical values are at V_{CC} = 5 V, T_A = 25°C.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

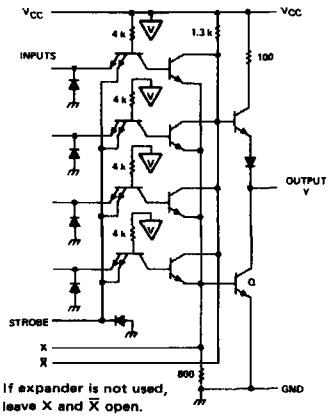
TYPE	TEST CONDITIONS#	t_{PLH} (ns) Propagation delay time, low-to-high-level output		t_{PHL} (ns) Propagation delay time, high-to-low-level output	
		TYP	MAX	TYP	MAX
'23, '50, '53	C_L = 15 pF, R_L = 400 Ω, Expander pins open	13	22	8	15
'50	C_L = 15 pF, R_L = 400 Ω, From input of '60 expander	15	30	10	20
'H50	C_L = 25 pF, R_L = 280 Ω, Expander pins open	6.8	11	6.2	11
'H52		10.6	15	9.2	15
'H53		7	11	6.2	11
'H55		7	11	6.5	11
'H50	C_L = 25 pF, R_L = 280 Ω, C = 15 pF (GND to $\overline{X}$ of 'H50, 'H53, or 'H55; or to X of 'H52)	11		7.4	
'H52		14.8		9.8	
'H53		11.4		7.4	
'H55		11.4		7.7	

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

TYPICAL ADDED PROPAGATION DELAY TIME vs EXPANDER-NODE CAPACITANCE

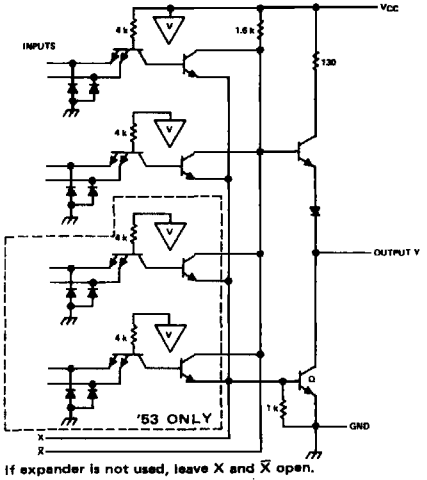


schematics (each gate)



If expander is not used, leave X and $\overline{X}$ open.

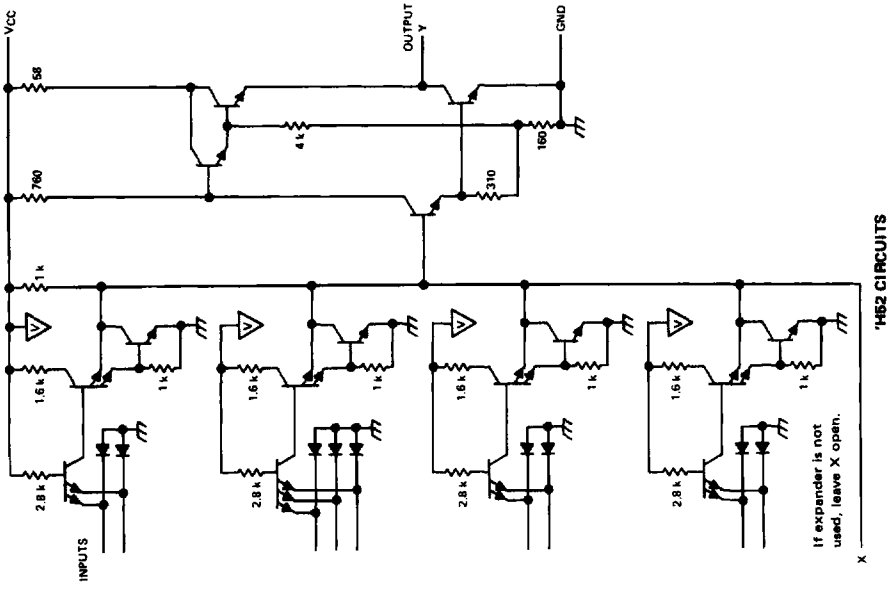
'23 CIRCUITS



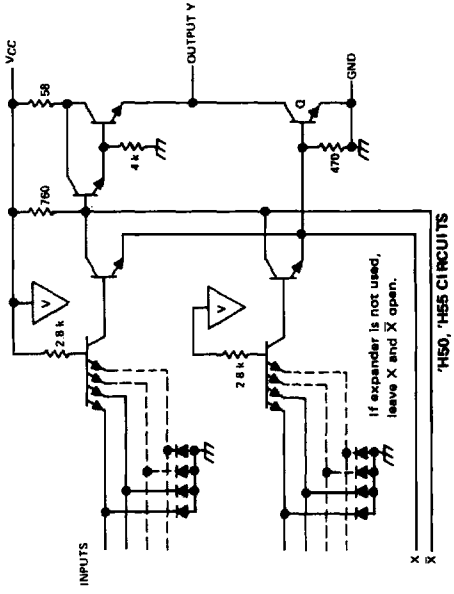
If expander is not used, leave X and $\overline{X}$ open.

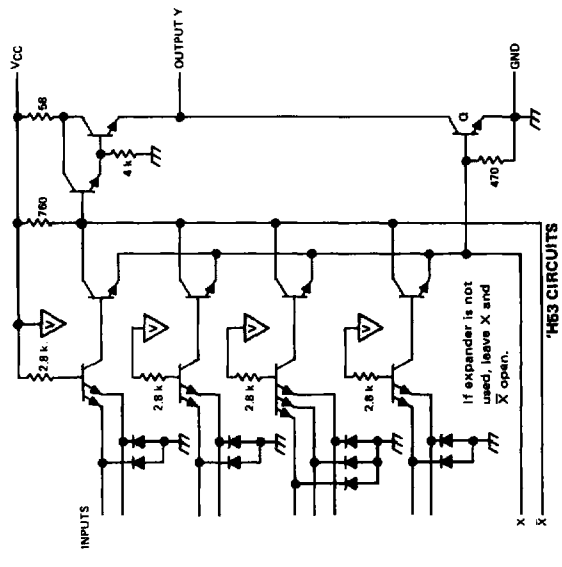
'50, '53 CIRCUITS

Resistor values shown are nominal and in ohms.



Resistor values shown are nominal and in ohms.



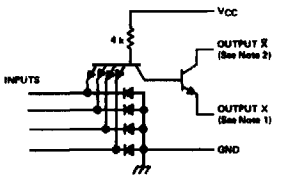


recommended operating conditions

	SN5460			SN7460			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
Operating free-air temperature, T_A	−55		125	0		70	°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 X̄ input of '23, '50, 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	SN5460 TEST CONDITIONS	SN5460 MIN	SN5460 TYP‡	SN5460 MAX	SN7460 TEST CONDITIONS	SN7460 MIN	SN7460 TYP‡	SN7460 MAX	UNIT
V_{IH}	High-level input voltage	15		2				2			V
V_{IL}	Low-level input voltage	16				0.8				0.8	V
$V_{\bar{X}X(on)}$	On-state voltage between expander outputs	15	V_{CC} = 4.5 V, V_{IH} = 2 V, V_X = 1.1 V, $I_{\bar{X}}$ = 3.5 mA, T_A = −55°C			0.4	V_{CC} = 4.75 V, V_{IH} = 2 V, V_X = 1 V, $I_{\bar{X}}$ = 3.8 mA, T_A = 0°C			0.4	V
$I_{X(on)}$	On-state expander current	15	V_{CC} = 4.5 V, V_{IH} = 2 V, V_X = 1.1 V, $I_{\bar{X}}$ = 0, T_A = −55°C	−0.3			V_{CC} = 4.75 V, V_{IH} = 2 V, V_X = 1 V, $I_{\bar{X}}$ = 0, T_A = 0°C	−0.43			mA
$I_{\bar{X}(off)}$	Off-state expander current	16	V_{CC} = 4.5 V, V_{IL} = 0.8 V, $V_{\bar{X}}$ = 4.5 V, R_X = 1.2 kΩ, T_A = −55°C			150	V_{CC} = 4.75 V, V_{IL} = 0.8 V, $V_{\bar{X}}$ = 4.5 V, R_X = 1.2 kΩ, T_A = 0°C			270	μA
I_I	Input current at maximum input voltage	4	V_{CC} = 5.5 V, V_I = 5.5 V			1	V_{CC} = 5.25 V, V_I = 5.5 V			1	mA
I_{IH}	High-level input current	4	V_{CC} = 5.5 V, V_I = 2.4 V			40	V_{CC} = 5.25 V, V_I = 2.4 V			40	μA
I_{IL}	Low-level input current	5	V_{CC} = 5.5 V, V_I = 0.4 V			−1.6	V_{CC} = 5.25 V, V_I = 0.4 V			−1.6	mA
$I_{CC(on)}$	Supply current, expander on	7	V_{CC} = 5.5 V, V_I = 4.5 V, V_X = 0.85 V, $I_{\bar{X}}$ = 0		1.2	2.5	V_{CC} = 5.25 V, V_I = 4.5 V, V_X = 0.85 V, $I_{\bar{X}}$ = 0		1.2	2.5	mA
$I_{CC(off)}$	Supply current, expander off	7	V_{CC} = 5.5 V, V_I = 0, V_X = 0.85 V, $I_{\bar{X}}$ = 0		2	4	V_{CC} = 5.25 V, V_I = 0, V_X = 0.85 V, $I_{\bar{X}}$ = 0		2	4	mA

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

recommended operating conditions

	SN54H60 SN54H62			SN74H60 SN74H62			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
Operating free-air temperature, T_A	−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	SN54H60, SN54H62 TEST CONDITIONS	MIN	TYP‡	MAX	SN74H60, SN74H62 TEST CONDITIONS	MIN	TYP‡	MAX	UNIT
V_{IH}	High-level input voltage		15		2				2			V
V_{IL}	Low-level input voltage		16				0.8				0.8	V
$V_{\overline{X}X(on)}$	On-state voltage between expander outputs		15	V_{CC} = 4.5 V, V_{IH} = 2 V, V_X = 1.1 V, $I_{\overline{X}}$ = 5.85 mA, T_A = −55°C			0.4	V_{CC} = 4.75 V, V_{IH} = 2 V, V_X = 1 V, $I_{\overline{X}}$ = 6.3 mA, T_A = 0°C			0.4	V
				V_{CC} = 5.5 V, V_{IH} = 2 V, V_X = 1 V, $I_{\overline{X}}$ = 7.85 mA, T_A = 125°C			0.4	V_{CC} = 5.25 V, V_{IH} = 2 V, V_X = 1 V, $I_{\overline{X}}$ = 7.4 mA, T_A = 70°C			0.4	
$I_{X(on)}$	On-state expander current		15	V_{CC} = 4.5 V, V_{IH} = 2 V, V_X = 1.1 V, $I_{\overline{X}}$ = 0, T_A = −55°C	−470			V_{CC} = 4.75 V, V_{IH} = 2 V, V_X = 1 V, $I_{\overline{X}}$ = 0, T_A = 0°C	−600			μA
$I_{\overline{X}(off)}$	Off-state expander current		16	V_{CC} = 4.5 V, V_{IL} = 0.8 V, $V_{\overline{X}}$ = 4.5 V, R_X = 575 Ω, T_A = −55°C			320	V_{CC} = 4.75 V, V_{IL} = 0.8 V, $V_{\overline{X}}$ = 4.5 V, R_X = 575 Ω, T_A = 0°C			570	μA
I_I	Input current at maximum input voltage		4	V_{CC} = 5.5 V, V_I = 5.5 V			1	V_{CC} = 5.25 V, V_I = 5.5 V			1	mA
I_{IH}	High-level input current		4	V_{CC} = 5.5 V, V_I = 2.4 V			50	V_{CC} = 5.25 V, V_I = 2.4 V			50	μA
I_{IL}	Low-level input current		5	V_{CC} = 5.5 V, V_I = 0.4 V			−2	V_{CC} = 5.25 V, V_I = 0.4 V			−2	mA
$I_{CC(on)}$	Supply current, expander on	'H60	7	V_{CC} = 5.5 V, V_I = 4.5 V, V_X = 0.85 V, $I_{\overline{X}}$ = 0,		1.9	3.5	V_{CC} = 5.25 V, V_I = 4.5 V, V_X = 0.85 V, $I_{\overline{X}}$ = 0		1.9	3.5	mA
		'H62				3.8	7			3.8	7	
$I_{CC(off)}$	Supply current, expander off	'H60	7	V_{CC} = 5.5 V, V_I = 0, V_X = 0.85 V, $I_{\overline{X}}$ = 0		3	4.5	V_{CC} = 5.25 V, V_I = 0, V_X = 0.85 V, $I_{\overline{X}}$ = 0		3	4.5	mA
		'H62				6	9			6	9	
$C_{\overline{X}}$	Expander output capacitance	'H60		V_{CC}, inputs, and X open; f = 1 MHz		5.4		V_{CC}, inputs, and X open; f = 1 MHz		5.4		pF
		'H62				6.0				6.0		

‡All typical values are at V_{CC} = 5 V (except $C_{\overline{X}}$), T_A = 25°C.

recommended operating conditions

	SN54H61			SN74H61			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
Operating free-air temperature, T_A	−55		125	0		70	°C

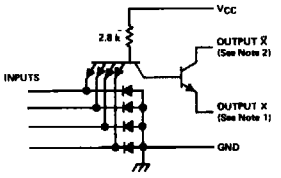
The 'H52 is designed for use with up to six 'H61 expanders.

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

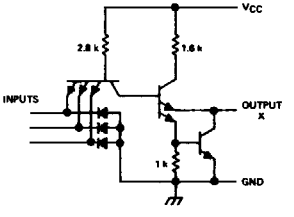
PARAMETER		TEST FIGURE	TEST CONDITIONS	MIN	TYP‡	MAX	UNIT
V_{IH}	High-level input voltage	17		2			V
V_{IL}	Low-level input voltage	18				0.8	V
$V_{X(on)}$	On-state expander-output voltage	17	V_{CC} = MIN, V_{IH} = 2 V, I_X = 4.6 mA for SN54H61, 5.35 mA for SN74H61, T_A = MIN			1	V
$I_{X(off)}$	Off-state expander current	18	V_{CC} = MIN, V_{IL} = 0.8 V, V_X = 2.2 V, T_A = MAX			50	μA
I_I	Input current at maximum input voltage	4	V_{CC} = 5.5 V, V_I = 5.5 V			1	mA
I_{IH}	High-level input current	4	V_{CC} = 5.5 V, V_I = 2.4 V			50	μA
I_{IL}	Low-level input current	5	V_{CC} = 5.5 V, V_I = 0.4 V			−2	mA
$I_{CC(on)}$	Supply current, expander on	7	V_{CC} = 5.5 V, V_I = 4.5 V		11	16	mA
$I_{CC(off)}$	Supply current, expander off	7	V_{CC} = 5.5 V, V_I = 0		5	7	mA
C_X	Expander output capacitance		V_{CC} and inputs open, f = 1 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 V (except C_X), T_A = 25°C.

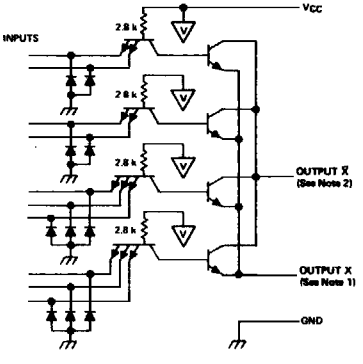
schematics (each gate)



'H60 CIRCUITS



'H61 CIRCUITS



'H62 CIRCUITS

NOTES: 1. Connect to X input of 'H50, 'H53, or 'H55 circuit.
2. Connect to $\overline{X}$ input of 'H50, 'H53, or 'H55 circuit.

Resistor values shown are nominal and in ohms.

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	MIN	NOM	MAX	
Supply voltage, V_{CC}		Series 54	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
		Series 74	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	
High-level output current, I_{OH}					−400			−400			−400			−800			−800			−800	μA
Low-level output current, I_{OL}					16			16			16			16			16			16	mA
Pulse width, t_w	Clock high		20			20			30			20			25			25			ns
	Clock low		30			47			37			20			25			25			
	Preset or clear low		25			25			30			20			25			25			
Input setup time, t_{su}			20↑			0↑			20↑			10↑			20↑			0↑			ns
Input hold time, t_h			5↑			0↓			5↑			6↑			5↑			30↑			ns
Operating free-air temperature, T_A		Series 54	−55		125	−55		125	−55		125	−55		125	−55		125	−55		125	°C
		Series 74	0		70	0		70	0		70	0		70	0		70	0		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†	'70			'72, '73, '76, '107			'74			'109			'110			'111			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		V_{CC} = MIN, I_I = −12 mA			−1.5			−1.5			−1.5			−1.5			−1.5			−1.5	V
V_{OH}	High-level output voltage		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OH} = MAX	2.4	3.4		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		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OL} = 16 mA		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_I	Input current at maximum input voltage		V_{CC} = MAX, V_I = 5.5 V			1			1			1			1			1			1	mA
I_{IH}	High-level input current	D, J, K, or $\overline{R}$	V_{CC} = MAX, V_I = 2.4 V			40			40			40			40			40			40	μA
		Clear				80			80			120			160			160			80	
		Preset				80			80			80			80			160			80	
		Clock				40			80			80			80			40			120	
I_{IL}	Low-level input current	D, J, K, or $\overline{R}$	V_{CC} = MAX, V_I = 0.4 V			−1.6			−1.6			−1.6			−1.6			−1.6			−1.6	mA
		Clear *				−3.2			−3.2			−3.2			−4.8			−3.2			−3.2	
		Preset *				−3.2			−3.2			−1.6			−3.2			−3.2			−3.2	
		Clock				−1.6			−3.2			−3.2			−3.2			−1.6			−4.8	
I_{OS}	Short-circuit output current◆	Series 54	V_{CC} = MAX	−20		−57	−20		−57	−20		−57	−30		−85	−20		−57	−20		−57	mA
		Series 74		−18		−57	−18		−57	−18		−57	−30		−85	−18		−57	−18		−57	
I_{CC}	Supply current (Average per flip-flop)		V_{CC} = MAX, See Note 1		13	26		10	20		8.5	15		9	15		20	34		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°C.

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

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

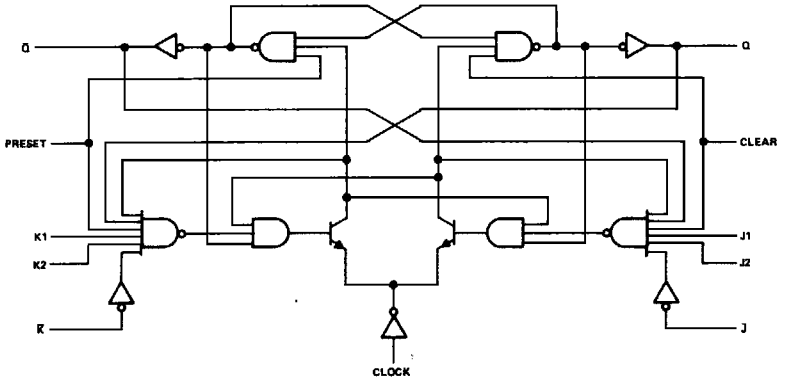
NOTE 1: With all outputs open, I_{CC} is measured with the Q and $\overline{Q}$ outputs high in turn. At the time of measurement, the clock input is at 4.5 V for the '70, '110, and '111; and is grounded for all the others.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

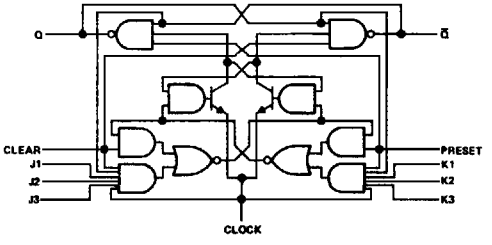
PARAMETER¶	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'70			'72, '73 '76, '107			'74			'109			'110			'111			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
f_{max}				20	35		15	20		15	25		25	33		20	25		20	25		MHz
t_{PLH}	Preset (as applicable)	Q	C_L = 15 pF, R_L = 400 Ω, See Note 2			50		16	25			25		10	15		12	20		12	18	ns
t_{PHL}		$\overline{Q}$				50		25	40			40		23	35		18	25		21	30	
t_{PLH}	Clear (as applicable)	$\overline{Q}$				50		16	25			25		10	15		12	20		12	18	ns
t_{PHL}		Q				50		25	40			40		17	25		18	25		21	30	
t_{PLH}	Clock	Q or $\overline{Q}$			27	50		16	25		14	25		10	16		20	30		12	17	ns
t_{PHL}					18	50		25	40		20	40		18	28		13	20		20	30	

¶ 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



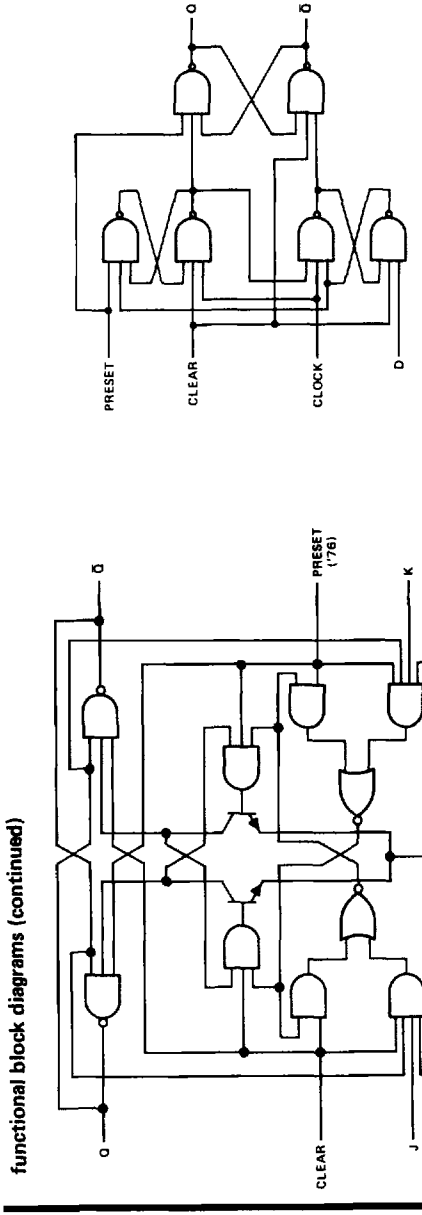
'70—GATED J-K WITH CLEAR AND PRESET



'72—GATED J-K WITH CLEAR AND PRESET

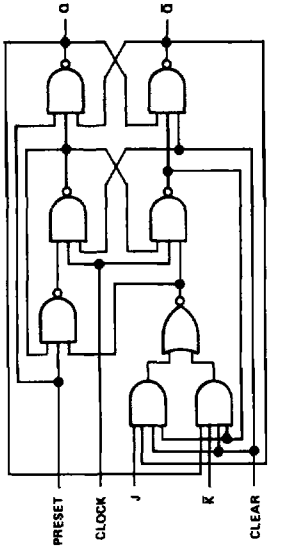
See following pages for:
'73—DUAL J-K WITH CLEAR
'74—DUAL D WITH CLEAR AND PRESET
'76—DUAL J-K WITH CLEAR AND PRESET
'107—DUAL J-K WITH CLEAR
'109—DUAL J-$\overline{K}$ WITH CLEAR AND PRESET
'110—GATED J-K WITH CLEAR AND PRESET
'111—DUAL J-K WITH CLEAR AND PRESET

functional block diagrams (continued)



'74—DUAL D WITH CLEAR AND PRESET

'73—DUAL J-K WITH CLEAR
'76—DUAL J-K WITH CLEAR AND PRESET
'107—DUAL J-K WITH CLEAR



'109—DUAL J-K̄ WITH CLEAR AND PRESET

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functional block diagrams (continued)

'111—DUAL J-K WITH CLEAR AND PRESET

'110—GATED J-K WITH CLEAR AND PRESET

schematics of inputs and outputs

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_{CC}		Series 54H	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V
		Series 74H	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	
High-level output current, I_{OH}					−500			−500			−1000			−500	μA
Low-level output current, I_{OL}					20			20			20			20	mA
Pulse width, t_w	Clock high		12			12			15			12			ns
	Clock low		28			28			13.5			28			
	Clear or preset low		16			16			25			16			
Setup time, t_{su}	High-level data		0↑			0↑			10↑			0↑			ns
	Low-level data		0↑			0↑			15↑			0↑			
Hold time, t_h			0↓			0↓			5↑			0↓			ns
Operating free-air temperature, T_A		Series 54H	−55		125	−55		125	−55		125	−55		125	°C
		Series 74H	0		70	0		70	0		70	0		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†	'H71			'H72, 'H73, 'H76			'H74			'H78			UNIT
				MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH}	High-level input voltage			2			2			2			2			V
V_{IL}	Low-level input voltage					0.8			0.8			0.8			0.8	V
V_{IK}	Input clamp voltage		V_{CC} = MIN, I_I = −8 mA			−1.5			−1.5			−1.5			−1.5	V
V_{OH}	High-level output voltage		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OH} = MAX	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} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OL} = 20 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} = MAX, V_I = 5.5 V			1			1			1			1	mA
I_{IH}	High-level input current	D, J, or K	V_{CC} = MAX, V_I = 2.4 V			50			50			50			50	μA
		Clear							100			150			200	
		Preset				150			100			100			100	
		Clock				100			50			100			100	
I_{IL}	Low-level input current	D, J, or K	V_{CC} = MAX, V_I = 0.4 V			−2			−2			−2			−2	mA
		Clear *							−4			−4			−8	
		Preset *				−6			−4			−2			−4	
		Clock				−4			−2			−4			−4	
I_{OS}	Short-circuit output current♦		V_{CC} = MAX	−40		−100	−40		−100	−40		−100	−40		−100	mA
I_{CC}	Supply current (Average per flip-flop)		V_{CC} = MAX, See Note 1													mA
		Series 54H			19	30		16	25		15	21		16	25	
		Series 74H			19	30		16	25		15	25		16	25	

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
♦Not more than one output should be shorted at a time, and duration of the 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_{CC} is measured with the Q and $\overline{Q}$ outputs high in turn. At the time of measurement, the clock input is grounded.

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switching characteristics, V_{CC} = 5 V, T_A = 25°C

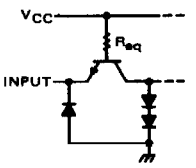
PARAMETER¶	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'H71, 'H72, 'H73, 'H76, 'H78			'H74			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
f_{max}				25	30		35	43		MHz
t_{PLH}	Preset (as applicable)	Q	C_L = 25 pF, R_L = 280 Ω, See Note 2		6	13			20	ns
t_{PHL}		$\overline{Q}$			12	24			30	
t_{PLH}	Clear (as applicable)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

¶ 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.

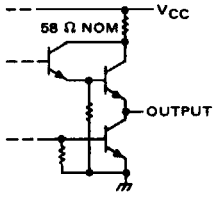
schematics of input and outputs

EQUIVALENT OF EACH INPUT

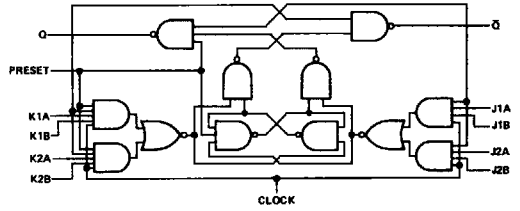


I_{IL} MAX	R_{eq} NOM
−2 mA	2.8 kΩ
−4 mA	1.4 kΩ
−6 mA	933 Ω
−8 mA	700 Ω

TYPICAL OF ALL OUTPUTS



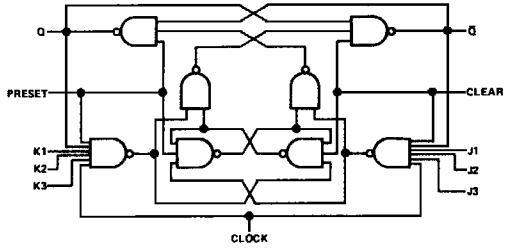
functional block diagrams



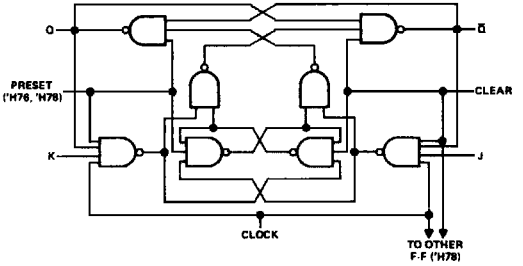
'H71—GATED J-K WITH PRESET

Same functional block diagram as for '74, see page 6-48.

'H74—DUAL D WITH CLEAR AND PRESET



'H72—GATED J-K WITH CLEAR AND PRESET



'H73—DUAL J-K WITH CLEAR
'H76—DUAL J-K WITH CLEAR AND PRESET
'H78—DUAL J-K WITH PRESET, COMMON CLEAR, AND COMMON CLOCK

recommended operating conditions

		SERIES 54H/74H	'H101			'H102, 'H106			'H103			'H108			UNIT
			MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}		Series 54H	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V
		Series 74H	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	
High-level output current, I_{OH}					−500			−500			−500			−500	μA
Low-level output current, I_{OL}					20			20			20			20	mA
Pulse width, t_w	Clock high		10			10			10			10			ns
	Clock low		15			15			15			15			
	Clear or preset low		16			16			16			16			
Setup time, t_{su}	High-level data		10↓			10↓			10↓			10↓			ns
	Low-level data		13↓			13↓			13↓			13↓			
Hold time, t_h			0↓			0↓			0↓			0↓			ns
Operating free-air temperature, T_A		Series 54H	−55		125	−55		125	−55		125	−55		125	°C
		Series 74H	0		70	0		70	0		70	0		70	

↓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			2			2			2			V
V_{IL} Low-level input voltage					0.8			0.8			0.8			0.8	V
V_{IK} Input clamp voltage		V_{CC} = MIN, I_I = −8 mA			−1.5			−1.5			−1.5			−1.5	V
V_{OH} High-level output voltage		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OH} = −500 μA	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} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OL} = 20 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} = MAX, V_I = 5.5 V			1			1			1			1	mA
I_{IH} High-level input current	Any J or K	V_{CC} = MAX, V_I = 2.4 V			50			50			50			50	μA
	Clear							100			100			200	
	Preset				100			100						100	
	Clock		0		−1	0		−1	0		−1	0		−1	mA
I_{IL} Low-level input current	Any J or K	V_{CC} = MAX, V_I = 0.4 V		−1	−2		−1	−2		−1	−2		−1	−2	mA
	Clear						−1	−2		−1	−2		−2	−4	
	Preset			−1	−2		−1	−2					−1	−2	
	Clock			−3	−4.8		−3	−4.8		−3	−4.8		−6	−9.6	
I_{OS} Short-circuit output current♦		V_{CC} = MAX	−40		−100	−40		−100	−40		−100	−40		−100	mA
I_{CC} Supply current (Average per flip-flop)		V_{CC} = 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 V, T_A = 25°C.

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

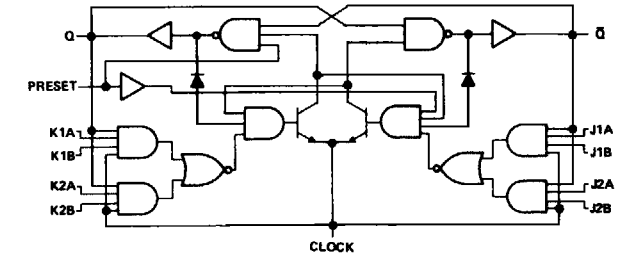
NOTE 1: With all outputs open, I_{CC} is measured with the Q and $\overline{Q}$ outputs high in turn. At the time of measurement, the clock input is grounded.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

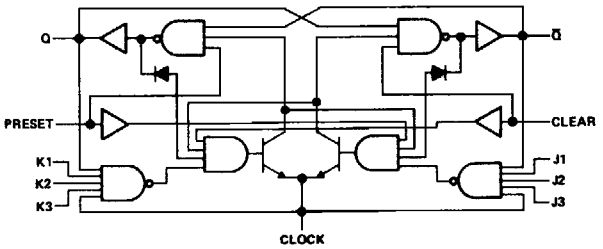
PARAMETER¶	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
f_{max}			C_L = 25 pF, R_L = 280 Ω, See Note 2	40	50		MHz
t_{PLH}	Preset or clear	Q or $\overline{Q}$			8	12	ns
t_{PHL}	Preset or clear (clock high)	$\overline{Q}$ or Q			15	20	ns
	Preset or clear (clock low)				23	35	
t_{PLH}	Clock	Q or $\overline{Q}$			10	15	ns
t_{PHL}					16	20	

¶ 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

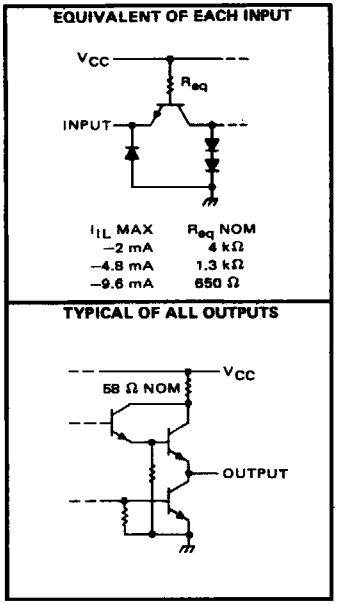


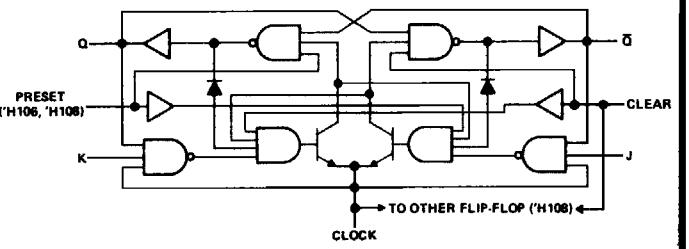
'H101—GATED J-K WITH PRESET



'H102—GATED J-K WITH CLEAR AND PRESET

schematics of inputs and outputs





'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

recommended operating conditions

		SERIES 54L/74L	'L71			'L72, 'L73			'L74			'L78			UNIT
			MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}		Series 54L	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V
		Series 74L	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	
High-level output current, I_{OH}		Series 54L			−100			−100			−100			−100	μA
		Series 74L			−200			−200			−200			−200	
Low-level output current, I_{OL}		Series 54L			2			2			2			2	mA
		Series 74L			3.6			3.6			3.6			3.6	
Pulse width, t_w	Clock high		200			200			200			200			ns
	Clock low		200			200			200			200			
	Clear or preset low		100			100			100			100			
Setup time, t_{su}			0↑			0↑			50↑			0↑			ns
Hold time, t_h			0↓			0↓			15↑			0↓			ns
Operating free-air temperature, T_A		Series 54L	−55		125	−55		125	−55		125	−55		125	°C
		Series 74L	0		70	0		70	0		70	0		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†	'L71			'L72, 'L73			'L74			'L78			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH} High-level input voltage			2			2			2			2			V
V_{IL} Low-level input voltage	Clock input				0.6			0.6			0.7			0.6	V
	All other inputs				0.7			0.7			0.7			0.7	
V_{OH} High-level output voltage	Series 54L	V_{CC} = MIN, V_{IH} = 2 V,	2.4	3.3		2.4	3.3		2.4	3.3		2.4	3.3		V
	Series 74L	V_{IL} = V_{IL} max, I_{OH} = MAX	2.4	3.2		2.4	3.2		2.4	3.2		2.4	3.2		
V_{OL} Low-level output voltage	Series 54L	V_{CC} = MIN, V_{IH} = 2 V,		0.15	0.3		0.15	0.3		0.15	0.3		0.15	0.3	V
	Series 74L	V_{IL} = V_{IL} max, I_{OL} = MAX		0.2	0.4		0.2	0.4		0.2	0.4		0.2	0.4	
I_I Input current at maximum input voltage	R, S, J, K, or D	V_{CC} = MAX, V_I = 5.5 V			100			100			100			100	μA
	Clear				200			200			300			400	
	Preset				200			200			200			200	
	Clock				200			200			200			400	
I_{IH} High-level input current	R, S, J, K, or D	V_{CC} = MAX, V_I = 2.4 V			10			10			10			10	μA
	Clear				20			20			30			40	
	Preset				20			20			20			20	
	Clock				−200			−200			20			−400	
I_{IL} Low-level input current	R, S, J, K, or D	V_{CC} = MAX, V_I = 0.3 V			−0.18			−0.18			−0.18			−0.18	mA
	Clear				−0.36			−0.36			−0.36			−0.72	
	Preset				−0.36			−0.36			−0.18			−0.36	
	Clock				−0.36			−0.36			−0.36			−0.72	
I_{OS} Short-circuit output current		V_{CC} = MAX	−3		−15	−3		−15	−3		−15	−3		−15	mA
I_{CC} Supply current (Average per flip-flop)		V_{CC} = 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_{CC} = 5 V, T_A = 25°C.
NOTE 1: With all outputs open, I_{CC} is measured with the Q and $\overline{Q}$ outputs high in turn. At the time of measurement, the clock input is grounded.

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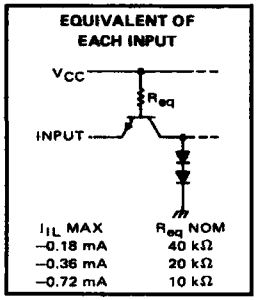
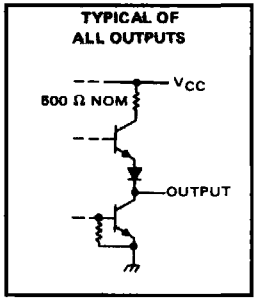
switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER¶	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'L71, 'L72, 'L73, 'L78			'L74			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
f_{max}			C_L = 50 pF, R_L = 4 kΩ, See Note 2	2.5	3		2.5	3		MHz
t_{PLH}	Preset or clear	Q or $\overline{Q}$			35	75		50	75	ns
t_{PHL}	Preset or clear (clock high)	$\overline{Q}$ or Q			60	150		80	150	ns
	Preset or clear (clock low)					200		80	150	
t_{PLH}	Clock	Q or $\overline{Q}$		10	35	75	15	65	100	ns
t_{PHL}				10	60	150	15	65	150	

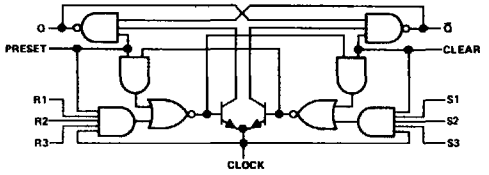
¶f_{max} ≡ maximum clock frequency
t_{PLH} ≡ propagation delay time, low-to-high-level output
t_{PHL} ≡ propagation delay time, high-to-low-level output
NOTE 2: Load circuit and voltage waveforms are shown on page 3-11.

schematics of inputs and outputs

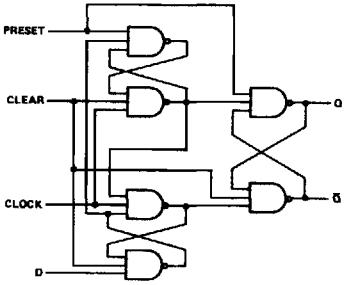




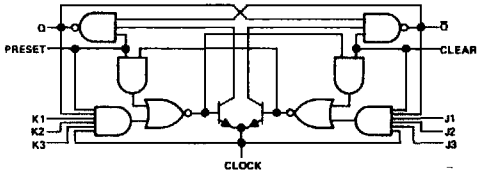
functional block diagrams



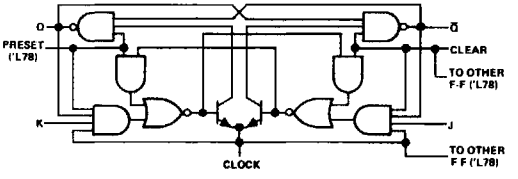
'L71—GATED R-S WITH CLEAR AND PRESET



'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

recommended operating conditions

		SERIES 54LS/74LS	'LS73A, 'LS107A, 'LS113A			'LS74A			'LS76A, 'LS112A			'LS78A, 'LS114A			'LS109A			UNIT
			MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}		Series 54LS	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
		Series 74LS	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	
High-level output current, I_{OH}					−400			−400			−400			−400			−400	μA
Low-level output current, I_{OL}		Series 54LS			4			4			4			4			4	mA
		Series 74LS			8			8			8			8			8	
Clock frequency, f_{clock}			0		30	0		25	0		30	0		30	0		25	MHz
Pulse width, t_w	Clock high		20			25			20			20			25			ns
	Preset or clear low		25			25			25			25			25			
Setup time, t_{su}	High-level data		20↓			25↑			20↓			20↓			20↑			ns
	Low-level data		20↓			20↑			20↓			20↓			20↑			
Hold time, t_h			0↓			5↑			0↓			0↓			5↑			ns
Operating free-air temperature, T_A		Series 54LS	−55		125	−55		125	−55		125	−55		125	−55		125	°C
		Series 74LS	0		70	0		70	0		70	0		70	0		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†		'LS73A, 'LS107A, 'LS113A			'LS74A			'LS76A, 'LS112A			'LS78A, 'LS114A			'LS109A			UNIT
					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			V
V_{IL}	Low-level input voltage	Series 54LS					0.7			0.7			0.7			0.7			0.7	V
		Series 74LS					0.8			0.8			0.8			0.8			0.8	
V_{IK}	Input clamp voltage		V_{CC} = MIN,	I_I = −18 mA			−1.5			−1.5			−1.5			−1.5			−1.5	V
V_{OH}	High-level output voltage	Series 54LS	V_{CC} = MIN,	V_{IH} = 2 V,	2.5	3.4		2.5	3.4		2.5	3.4		2.5	3.4		2.5	3.4		V
		Series 74LS	V_{IL} = V_{IL} max,	I_{OH} = −400 μA	2.7	3.4		2.7	3.4		2.7	3.4		2.7	3.4		2.7	3.4		
V_{OL}	Low-level output voltage	Series 54LS	V_{CC} = MIN,	I_{OL} = MAX		0.25	0.4		0.25	0.4		0.25	0.4		0.25	0.4		0.25	0.4	V
		Series 74LS	V_{IL} = V_{IL} max,			0.35	0.5		0.35	0.5		0.35	0.5		0.35	0.5		0.35	0.5	
		Series 74LS	V_{IH} = 2 V	I_{OL} = 4 mA		0.25	0.4		0.25	0.4		0.25	0.4		0.25	0.4		0.25	0.4	
I_I	Input current at maximum input voltage	D, J, K, or $\overline{R}$	V_{CC} = MAX,	V_I = 7 V			0.1			0.1			0.1			0.1			0.1	mA
		Clear					0.3			0.2			0.3			0.6			0.2	
		Preset					0.3			0.2			0.3			0.3			0.2	
		Clock					0.4			0.1			0.4			0.8			0.1	
I_{IH}	High-level input current	D, J, K, or $\overline{R}$	V_{CC} = MAX,	V_I = 2.7 V			20			20			20			20			20	μA
		Clear					60			40			60			120			40	
		Preset					60			40			60			60			40	
		Clock					80			20			80			160			20	
I_{IL}	Low-level input current	D, J, K, or $\overline{R}$	V_{CC} = MAX,	V_I = 0.4 V			−0.4			−0.4			−0.4			−0.4			−0.4	mA
		Clear					−0.8			−0.8			−0.8			−1.6			−0.8	
		Preset					−0.8			−0.8			−0.8			−0.8			−0.8	
		Clock					−0.8			−0.4			−0.8			−1.6			−0.4	
I_{OS}	Short-circuit output current*	Series 54LS	V_{CC} = MAX		−20		−100	−20		−100	−20		−100	−20		−100	−20		−100	mA
		Series 74LS			−20		−100	−20		−100	−20		−100	−20		−100	−20		−100	
I_{CC}	Supply current (Total)		V_{CC} = MAX,	See Note 1		4	6		4	8		4	6		4	6		4	8	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°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 $\overline{Q}$ outputs high in turn. At the time of measurement, the clock input is grounded.

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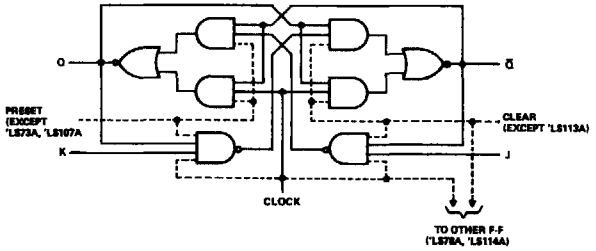
switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER¶	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'LS73A,'LS76A,'LS78A, 'LS107A,'LS112A, 'LS113A,'LS114A			'LS74A, 'LS109A			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
f_{max}			C_L = 15 pF,	30	45		25	33		MHz
t_{PLH}	Clear, preset, or clock (as appropriate)	Q or $\overline{Q}$	R_L = 2 kΩ,		15	20		13	25	ns
t_{PHL}			See Note 2		15	20		25	40	ns

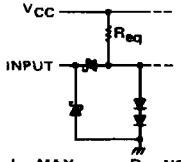
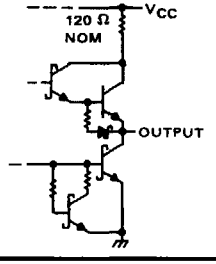
¶f_{max} ≡ maximum clock frequency
t_{PLH} ≡ propagation delay time, low-to-high-level output
t_{PHL} ≡ propagation delay time, high-to-low-level output
NOTE 2: Load circuit and voltage waveforms are shown on page 3-11.

functional block diagrams and schematics of inputs and outputs



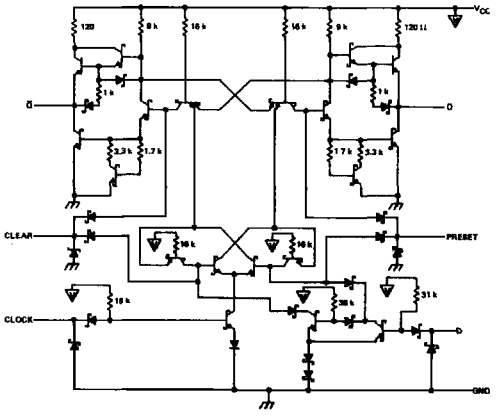
'LS73A, 'LS107A—DUAL J-K WITH CLEAR
'LS76A, 'LS112A—DUAL J-K WITH CLEAR AND PRESET
'LS78A, 'LS114A—DUAL J-K WITH PRESET, COMMON CLEAR, AND COMMON CLOCK
'LS113A—DUAL J-K WITH PRESET

'LS73A, 'LS76A, 'LS78A, 'LS112A, 'LS113A, 'LS114A

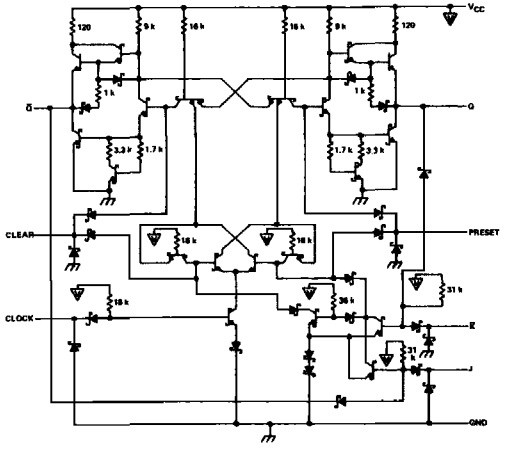
EQUIVALENT OF EACH INPUT	TYPICAL OF ALL OUTPUTS
	

I_{IL} MAX	R_{eq} NOM
−0.4 mA	17 kΩ
−0.8 mA	8.25 kΩ
−1.6 mA	4.1 kΩ

schematics of 'LS74A and 'LS109A



'LS74A—DUAL D WITH CLEAR AND PRESET



'LS109A—DUAL J-$\overline{K}$ WITH CLEAR AND PRESET

recommended operating conditions

		SERIES 54S/74S	'S74			'S112			'S113			'S114			UNIT
			MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}		Series 54S	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V
		Series 74S	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	
High-level output current, I_{OH}					−1			−1			−1			−1	mA
Low-level output current, I_{OL}					20			20			20			20	mA
Pulse width, t_w	Clock high		6			6			6			6			ns
	Clock low		7.3			6.5			6.5			6.5			
	Clear or preset low		7			8			8			8			
Input setup time, t_{su}	High-level data		3↑			3↓			3↓			3↓			ns
	Low-level data		3↑			3↓			3↓			3↓			
Input hold time, t_h			2↑			0↓			0↓			0↓			ns
Operating free-air temperature, T_A		Series 54S	−55		125	−55		125	−55		125	−55		125	°C
		Series 74S	0		70	0		70	0		70	0		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‡	MAX	MIN	TYP‡	MAX	
V_{IH}	High-level input voltage			2			2			2			2			V
V_{IL}	Low-level input voltage					0.8			0.8			0.8			0.8	V
V_{IK}	Input clamp voltage		V_{CC} = MIN, I_I = −18 mA			−1.2			−1.2			−1.2			−1.2	V
V_{OH}	High-level output voltage	Series 54S	V_{CC} = MIN, V_{IH} = 2 V,	2.5	3.4		2.5	3.4		2.5	3.4		2.5	3.4		V
		Series 74S	V_{IL} = 0.8 V, I_{OH} = −1 mA	2.7	3.4		2.7	3.4		2.7	3.4		2.7	3.4		
V_{OL}	Low-level output voltage		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OL} = 20 mA			0.5			0.5			0.5			0.5	V
I_I	Input current at maximum input voltage		V_{CC} = MAX, V_I = 5.5 V			1			1			1			1	mA
I_{IH}	High-level input current	J, K, or D	V_{CC} = MAX, V_I = 2.7 V			50			50			50			50	μA
		Clear				150			100						200	
		Preset				100			100			100			100	
		Clock				100			100			100			200	
I_{IL}	Low-level input current	J, K, or D	V_{CC} = MAX, V_I = 0.5 V			−2			−1.6			−1.6			−1.6	mA
		Clear *				−6			−7						−14	
		Preset *				−4			−7			−7			−7	
		Clock				−4			−4			−4			−8	
I_{OS}	Short-circuit output current♦		V_{CC} = MAX	−40		−100	−40		−100	−40		−100	−40		−100	mA
I_{CC}	Supply current (average per flip-flop)		V_{CC} = 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_{CC} = 5 V, T_A = 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.

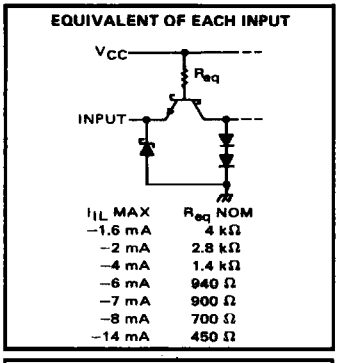
NOTE 1: With all outputs open, I_{CC} is measured with the Q and $\overline{Q}$ outputs high in turn. At the time of measurement, the clock input is grounded.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

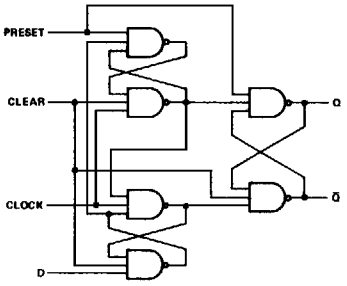
PARAMETER¶	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'S74			'S112, 'S113, 'S114			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
f_{max}			C_L = 15 pF, R_L = 280 Ω, See Note 2	75	110		80	125		MHz
t_{PLH}	Preset or clear	Q or $\overline{Q}$			4	6		4	7	ns
t_{PHL}	Preset or clear (clock high)	$\overline{Q}$ or Q			9	13.5		5	7	ns
	Preset or clear (clock low)				5	8		5	7	
t_{PLH}	Clock	Q or $\overline{Q}$			6	9		4	7	ns
t_{PHL}					6	9		5	7	

¶ 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.

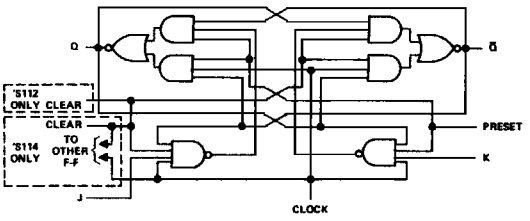
schematics of inputs and outputs



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

recommended operating conditions

	54 FAMILY / 74 FAMILY	SN54279 / SN74279			SN54LS279 / SN74LS279			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	54 Family	4.5	5	5.5	4.5	5	5.5	V
	74 Family	4.75	5	5.25	4.5	5	5.25	
High-level output current, I_{OH}				−800			−400	μA
Low-level output current, I_{OL}	54 Family			16			4	mA
	74 Family			16			8	
Operating free-air temperature, T_A	54 Family	−55		125	−55		125	°C
	74 Family	0		70	0		70	

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

PARAMETER		TEST CONDITIONS†			SN54279 / SN74279			SN54LS279 / SN74LS279			UNIT
					MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH}	High-level output voltage				2			2			V
V_{IL}	Low-level output voltage			54 Family			0.8			0.7	V
				74 Family			0.8			0.8	
V_{IK}	Input clamp voltage	V_{CC} = MAX, I_I = §					−1.5			−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL} max, I_{OH} = MAX		54 Family	2.4	3.4		2.5	3.4		V
				74 Family	2.4	3.4		2.7	3.4		
V_{OL}	Low-level output voltage	V_{CC} = MIN, V_{IL} = V_{IL} max, V_{IH} = 2 V	I_{OL} = MAX	54 Family		0.2	0.4		0.25	0.4	V
				74 Family		0.2	0.4		0.35	0.5	
			I_{OL} = 4 mA	Series 74LS					0.35	0.4	
I_I	Input current at maximum input voltage	V_{CC} = MAX		V_I = 5.5 V			1				mA
				V_I = 7 V						0.1	
I_{IH}	High-level input current	V_{CC} = MAX		V_I = 2.4 V			40				μA
				V_I = 2.7 V						20	
I_{IL}	Low-level input current	V_{CC} = MAX, V_I = 0.4 V					−1.6			−0.4	mA
I_{OS}	Short-circuit output current♦	V_{CC} = MAX		54 Family	−18		−55	−20		−100	mA
				74 Family	−18		−57	−20		−100	
I_{CC}	Supply current	V_{CC} = 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_{CC} = 5 V, T_A = 25°C.
§I_I = −12 mA for SN54'/SN74' and −18 mA for SN54LS'/SN74LS'.
♦Not more than one output should be shorted at a time, and for SN54LS'/SN74LS', duration of the output short circuit should not exceed one second.
NOTE 1: I_{CC} is measured with all $\overline{R}$ inputs grounded, all $\overline{S}$ inputs at 4.5 V, and all outputs open.

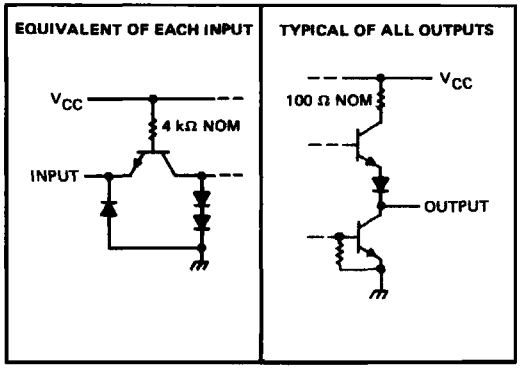
switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	'279			'LS279			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
t_{PLH}	Propagation delay time, low-to-high-level output from $\overline{S}$ input	C_L = 15 pF, See Notes 2 and 3		12	22		12	22	ns
t_{PHL}	Propagation delay time, high-to-low-level output from $\overline{S}$ input			9	15		13	21	
t_{PHL}	Propagation delay time, high-to-low-level output from $\overline{R}$ input			15	27		15	27	

NOTE 2: Load circuit and voltage waveforms are shown on pages 3-10 and 3-11.
NOTE 3: R_L = 400 Ω for '279, R_L = 2 kΩ for 'LS279.

schematics of inputs and outputs

'279 CIRCUITS



'LS279 CIRCUITS