OCTOBER 1976 – REVISED MARCH 1988

- **Complementary Outputs**
- **Direct Overriding Load (Data) Inputs**
- **Gated Clock Inputs**
- **Parallel-to-Serial Data Conversion**

TYPE	TYPICAL MAXIMUM CLOCK FREQUENCY	TYPICAL POWER DISSIPATION
'165	26 MHz	210 mW
'LS165A	35 MHz	90 mW

description

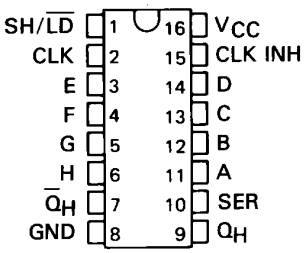
The '165 and 'LS165A are 8-bit serial shift registers that shift the data in the direction of Q_A toward Q_H when clocked. Parallel-in access to each stage is made available by eight individual direct data inputs that are enabled by a low level at the shift/load input. These registers also feature gated clock inputs and complementary outputs from the eighth bit. All inputs are diode-clamped to minimize transmission-line effects, thereby simplifying system design.

Clocking is accomplished through a 2-input positive-NOR gate, permitting one input to be used as a clock-inhibit function. Holding either of the clock inputs high inhibits clocking and holding either clock input low with the shift/load input high enables the other clock input. The clock-inhibit input should be changed to the high level only while the clock input is high. Parallel loading is inhibited as long as the shift/load input is high. Data at the parallel inputs are loaded directly into the register while the shift/load input is low independently of the levels of the clock, clock inhibit, or serial inputs.

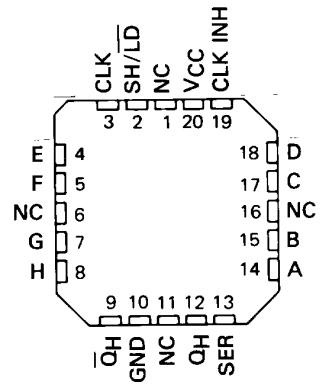
FUNCTION TABLE

INPUTS					INTERNAL OUTPUTS		OUTPUT
SHIFT/$\overline{\text{LOAD}}$	CLOCK INHIBIT	CLOCK	SERIAL	PARALLEL A . . . H	$\overline{Q}_A$	$\overline{Q}_B$	Q_H
L	X	X	X	a . . . h	a	b	h
H	L	L	X	X	Q_{A0}	Q_{B0}	Q_{H0}
H	L	↑	H	X	H	Q_{An}	Q_{Gn}
H	L	↑	L	X	L	Q_{An}	Q_{Gn}
H	H	X	X	X	Q_{A0}	Q_{B0}	Q_{H0}

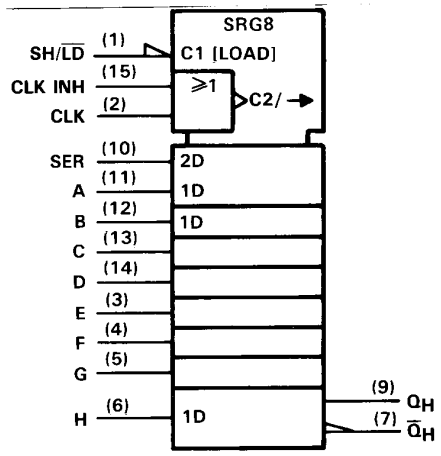
SN54165, SN54LS165A . . . J OR W PACKAGE
SN74165 . . . N PACKAGE
SN74LS165A . . . D OR N PACKAGE
(TOP VIEW)



SN54LS165A . . . FK PACKAGE
(TOP VIEW)



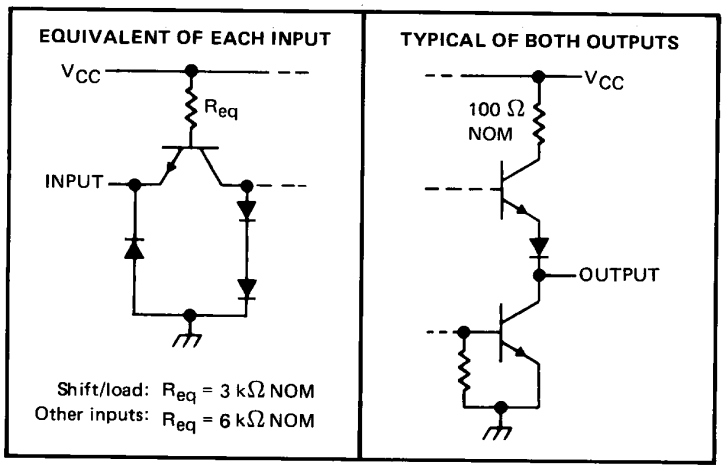
logic symbol†



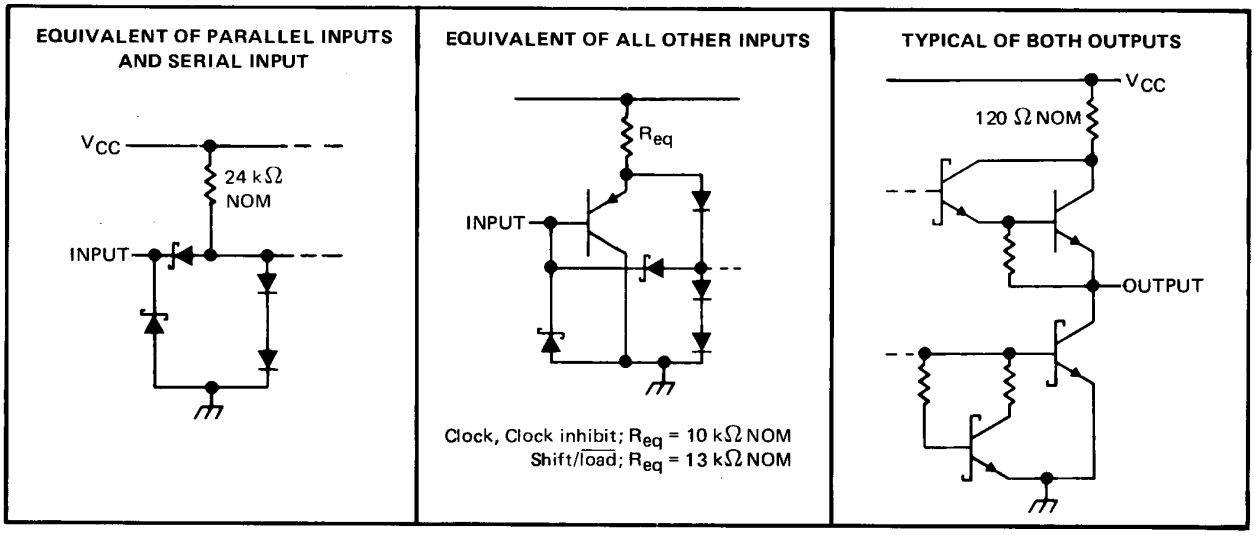
†This symbol is in accordance with ANSI/IEEE Std. 91-1984 and IEC Publication 617-12.
Pin numbers shown are for D, J, N, and W packages.

schematics of inputs and outputs

'165



'LS165A



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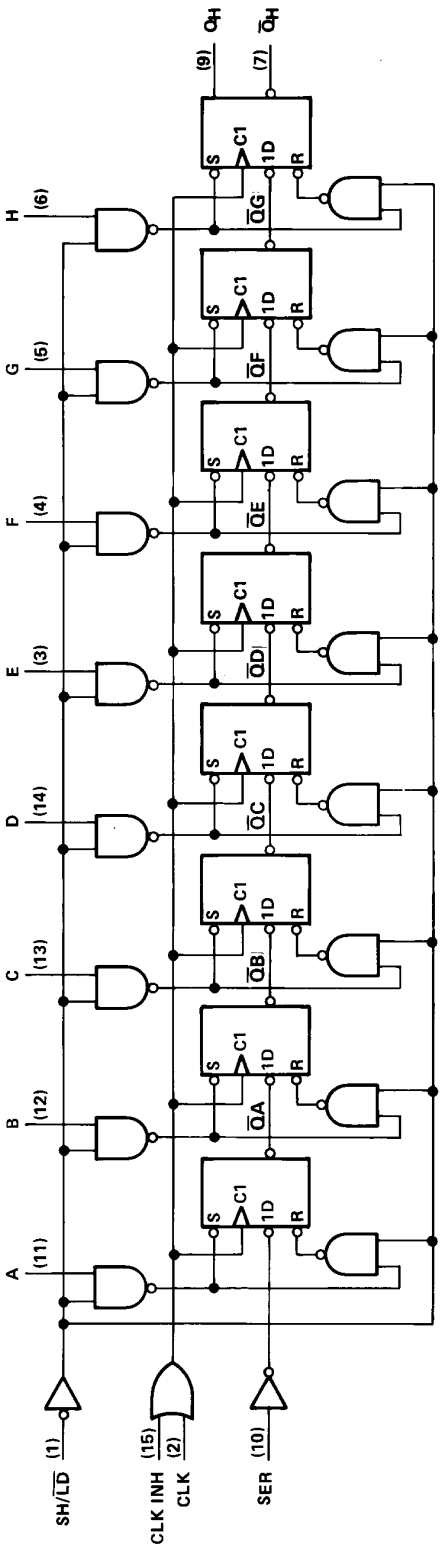
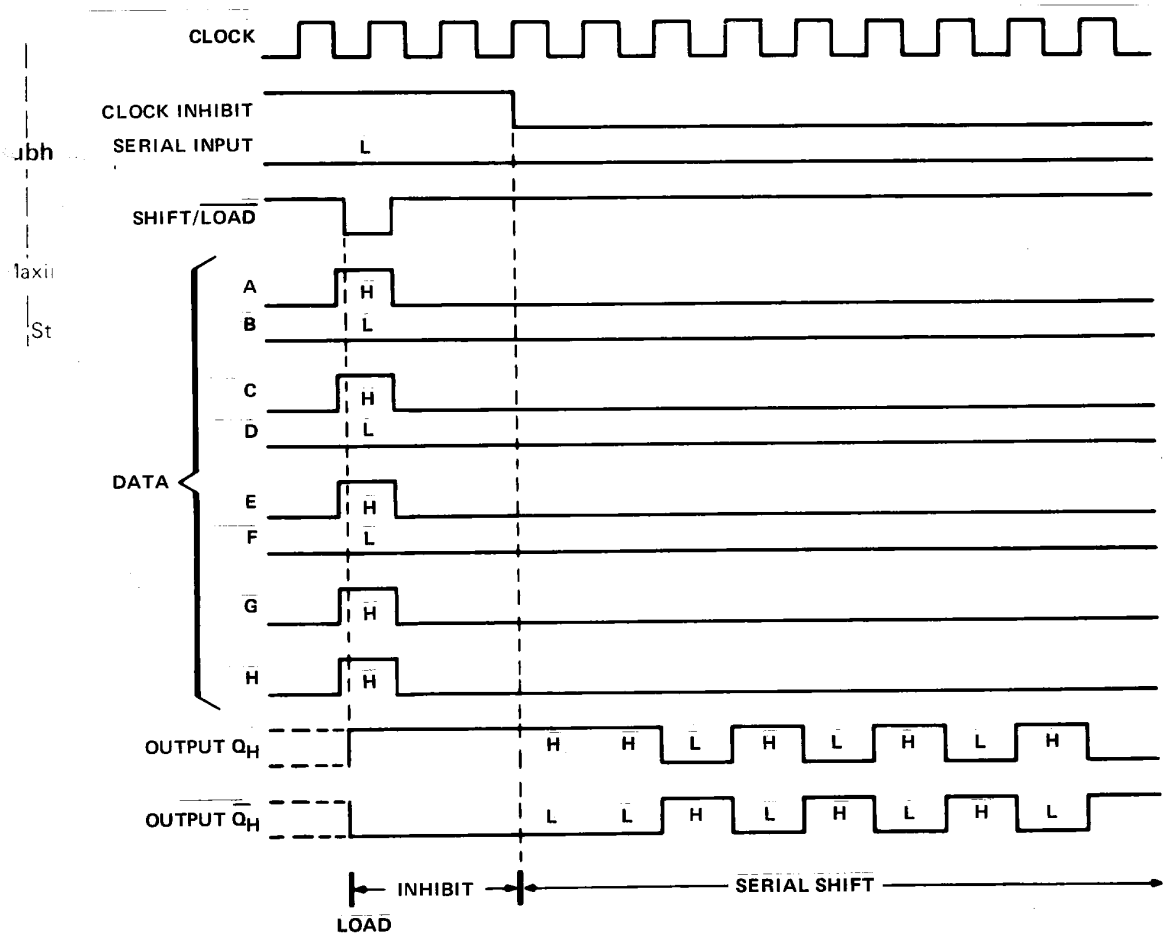
logic diagram (positive logic)



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

typical shift, load, and inhibit sequences



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

Supply voltage, V_{CC} (see Note 1) . . . . . 7 V
Input voltage: SN54165, SN74165 . . . . . 5.5 V
SN54LS165A, SN74LS165A . . . . . 7 V
Interemitter voltage (see Note 2) . . . . . 5.5 V
Operating free-air temperature range: SN54165, SN54LS165A . . . . . −55°C to 125°C
SN74165, SN74LS165A . . . . . 0°C to 70°C
Storage temperature range . . . . . −65°C to 150°C

NOTES 1. Voltage values, except interemitter voltage, are with respect to network ground terminal.
2. This is the voltage between two emitters of a multiple-emitter transistor. This rating applies for the '165 to the shift/load input in conjunction with the clock-inhibit inputs.

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recommended operating conditions

	SN54165			SN74165			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 current, I_{OH}			−800			−800	μA
Low-level output current, I_{OL}			16			16	mA
Clock frequency, f_{clock}	0		20	0		20	MHz
Width of clock input pulse, $t_{w(clock)}$	25			25			ns
Width of load input pulse, $t_{w(load)}$	15			15			ns
Clock-enable setup time, t_{su} (see Figure 1)	30			30			ns
Parallel input setup time, t_{su} (see Figure 1)	10			10			ns
Serial input setup time, t_{su} (see Figure 2)	20			20			ns
Shift setup time, t_{su} (see Figure 2)	45			45			ns
Hold time at any input, t_h	0			0			ns
Operating free-air temperature, T_A	−55		125	0		70	°C

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

PARAMETER		TEST CONDITIONS†	SN54165			SN74165			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH}	High-level input voltage		2			2			V
V_{IL}	Low-level input voltage				0.8			0.8	V
V_{IK}	Input clamp voltage	V_{CC} = MIN, I_I = −12 mA			−1.5			−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OH} = −800 μA	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	V
I_I	Input current at maximum input voltage	V_{CC} = MAX, V_I = 5.5 V			1			1	mA
I_{IH}	High-level input current, Shift/$\overline{load}$	V_{CC} = MAX, V_I = 2.4 V			80			80	μA
	High-level input current, Other inputs				40			40	
I_{IL}	Low-level input current, Shift/$\overline{load}$	V_{CC} = MAX, V_I = 0.4 V			−3.2			−3.2	mA
	Low-level input current, Other inputs				−1.6			−1.6	
I_{OS}	Short-circuit output current§	V_{CC} = MAX	−20		−55	−18		−55	mA
I_{CC}	Supply current	V_{CC} = MAX, See Note 3		42	63		42	63	mA

NOTE 3: With the outputs open, clock inhibit and clock at 4.5 V, and a clock pulse applied to the shift/load input, I_{CC} is measured first with the parallel inputs at 4.5 V, then with the parallel inputs grounded.

†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.

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 = 15 pF, R_L = 400 Ω, See figures 1 thru 3	20	26		MHz
t_{PLH}	$\overline{Load}$	Any			21	31	ns
t_{PHL}					27	40	
t_{PLH}	Clock	Any			16	24	ns
t_{PHL}					21	31	
t_{PLH}	H	Q_H			11	17	ns
t_{PHL}					24	36	
t_{PLH}	H	$\overline{Q}_H$			18	27	ns
t_{PHL}					18	27	

¶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

recommended operating conditions

			SN54LS165A			SN74LS165A			UNIT
			MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage		4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage		2			2			V
V_{IL}	Low-level input voltage				0.7			0.8	V
I_{OH}	High-level output current				−0.4			−0.4	mA
I_{OL}	Low-level output current				4			8	mA
f_{clock}	Clock frequency		0		25	0		25	MHz
t_w(clock)	Width of clock input pulse (See Figure 1)	clock high	15			15			ns
		clock low	25			25			
t_w(load)	Width of load input pulse	clock high	25			25			ns
		clock low	17			17			
t_{su}	Clock-enable setup time (See Figure 1)		30			30			ns
t_{su}	Parallel input setup time (See Figure 1)		10			10			ns
t_{su}	Serial input setup time (See Figure 2)		20			20			ns
t_{su}	Shift setup time (See Figure 2)		45			45			ns
t_h	Hold time at any input		0			0			ns
T_A	Operating free-air temperature		−55		125	0		70	°C

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

PARAMETER	TEST CONDITIONS		SN54LS165A			SN74LS165A			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN, I_I = −18 mA				−1.5			−1.5	V
V_{OH}	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = MAX, I_{OH} = −0.4 mA		2.5	3.5		2.7	3.5		V
V_{OL}	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = MAX,	I_{OL} = 4 mA		0.25	0.4		0.25	0.4	V
		I_{OL} = 8 mA					0.35	0.5	
I_I	V_{CC} = MAX, V_I = 7 V				0.1			0.1	mA
I_{IH}	V_{CC} = MAX, V_I = 2.7 V				20			20	μA
I_{IL}	V_{CC} = MAX, V_I = 0.4 V				−0.4			−0.4	mA
I_{OS}§	V_{CC} = MAX		−20		−100	−20		−100	mA
I_{CC}	V_{CC} = MAX, See Note 3			18	30		18	30	mA

NOTE 3: With the outputs open, clock inhibit and clock at 4.5 V, and a clock pulse applied to the shift/load input, I_{CC} is measured first with the parallel inputs at 4.5 V, then with the parallel inputs grounded.

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

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

PARAMETER¶	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
f_{max}			R_L = 2 kΩ, C_L = 15 pF, See Figures 1 thru 3	25	35		MHz
t_{PLH}	$\overline{Load}$	Any			21	35	ns
t_{PHL}					26	35	
t_{PLH}	Clock	Any			14	25	ns
t_{PHL}					16	25	
t_{PLH}	H	Q_H			13	25	ns
t_{PHL}					24	30	
t_{PLH}	H	$\overline{Q}_H$			19	30	ns
t_{PHL}					17	25	

¶ 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

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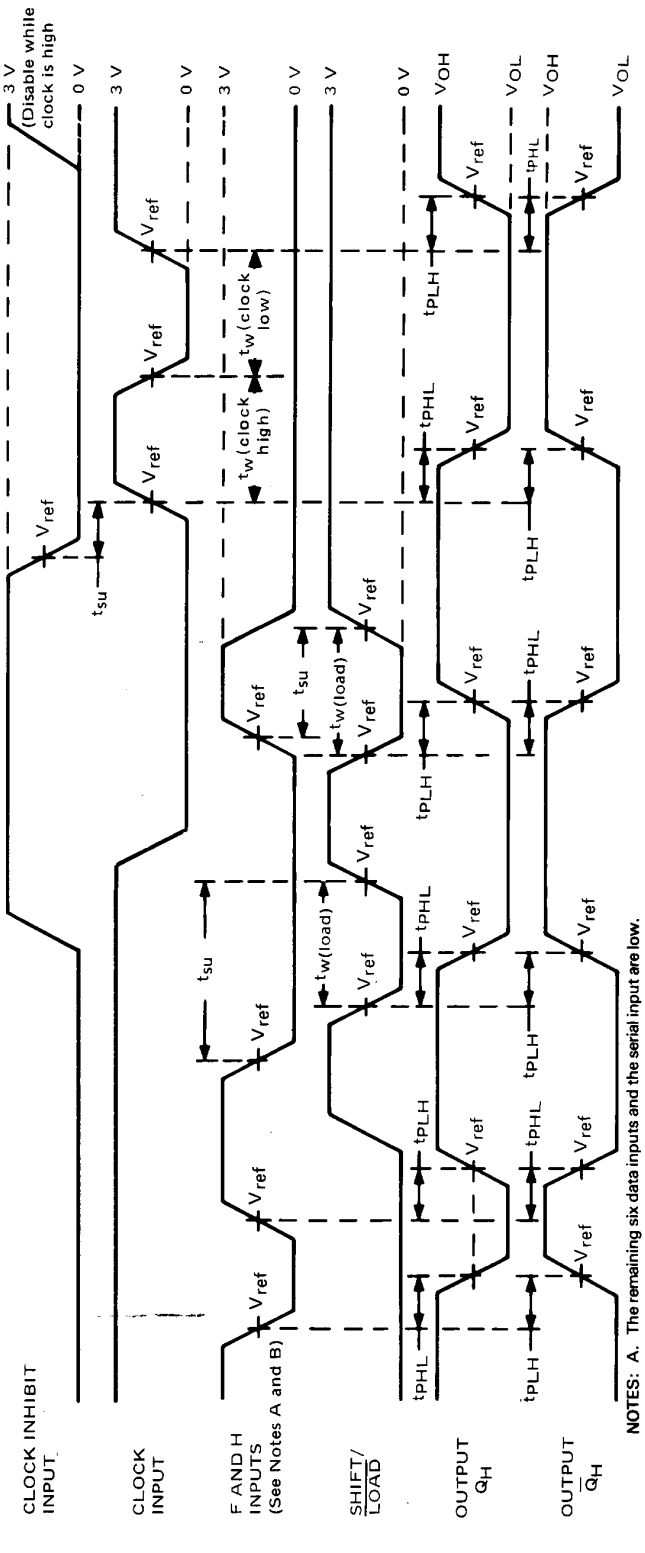
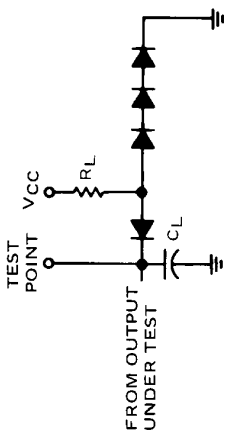
PARAMETER MEASUREMENT INFORMATION



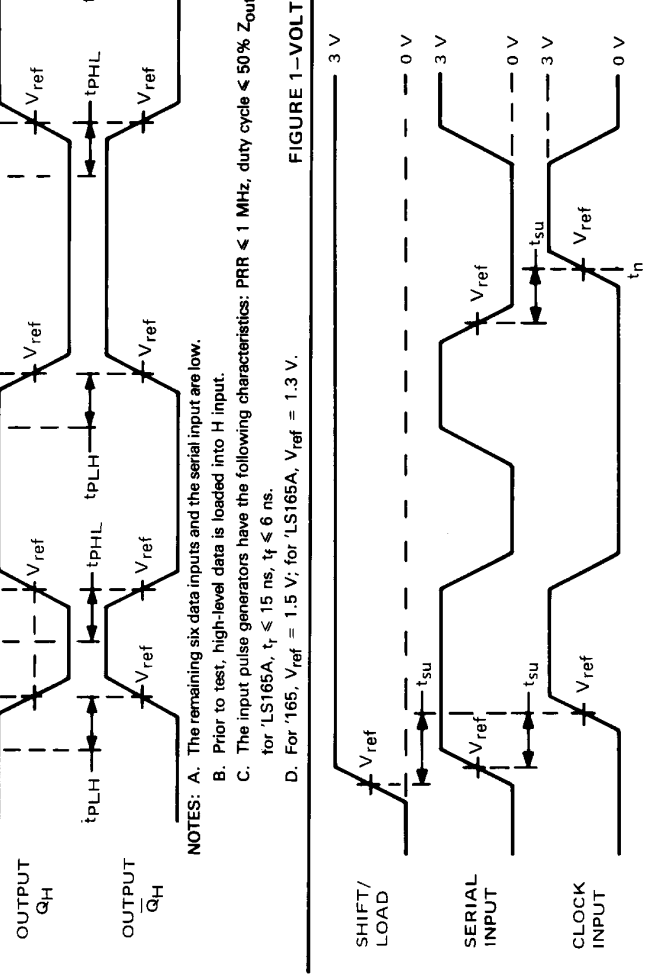
NOTES: A. The remaining six data inputs and the serial input are low.
B. Prior to test, high-level data is loaded into H input.
C. The input pulse generators have the following characteristics: PRR ≤ 1 MHz, duty cycle ≤ 50% $Z_{out} \approx 50\ \Omega$; for '165, $t_r \leq 10$ ns, $t_f \leq 10$ ns; for 'LS165A, $t_r \leq 15$ ns, $t_f \leq 6$ ns.
D. For '165, $V_{ref} = 1.5$ V; for 'LS165A, $V_{ref} = 1.3$ V.

FIGURE 1–VOLTAGE WAVEFORMS



NOTES: A. C_L includes probe and jig capacitance.
B. All diodes are IN3064 or equivalent.

FIGURE 3–LOAD CIRCUIT FOR SWITCHING TESTS



NOTES: A. The eight data inputs and the clock-inhibit input are low. Results are monitored at output Q_H at $t_n + 7$.
B. The input pulse generators have the following characteristics: PRR ≤ 1 MHz, duty cycle ≤ 50%, $Z_{out} \approx 50\ \Omega$; for '165, $t_r \leq 10$ ns, $t_f \leq 10$ ns; for 'LS165A, $t_r \leq 15$ ns, $t_f \leq 6$ ns.
C. For '165, $V_{ref} = 1.5$ V; for 'LS165A, $V_{ref} = 1.3$ V.

FIGURE 2–VOLTAGE WAVEFORMS

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