

SN54166, SN54LS166A, SN74166, SN74LS166A PARALLEL-LOAD 8-BIT SHIFT REGISTERS

OCTOBER 1976 — REVISED MARCH 1988

- Synchronous Load
- Direct Overriding Clear
- Parallel to Serial Conversion

TYPE	TYPICAL CLOCK FREQUENCY	MAXIMUM CLOCK FREQUENCY	TYPICAL POWER DISSIPATION
'166	35 MHz		360 mW
'LS166A	35 MHz		100 mW

description

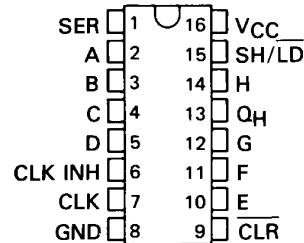
The '166 and 'LS166A 8-bit shift registers are compatible with most other TTL logic families. All '166 and 'LS166A inputs are buffered to lower the drive requirements to one Series 54/74 or Series 54LS/74LS standard load, respectively. Input clamping diodes minimize switching transients and simplify system design.

These parallel-in or serial-in, serial-out shift registers have a complexity of 77 equivalent gates on a monolithic chip. They feature gated clock inputs and an overriding clear input. The parallel-in or serial-in modes are established by the shift/load input. When high, this input enables the serial data input and couples the eight flip-flops for serial shifting with each clock pulse. When low, the parallel (broadside) data inputs are enabled and synchronous loading occurs on the next clock pulse. During parallel loading, serial data flow is inhibited. Clocking is accomplished on the low-to-high-level edge of the clock pulse through a two-input positive NOR gate permitting one input to be used as a clock-enable or clock-inhibit function. Holding either of the clock inputs high inhibits clocking; holding either low enables the other clock input. This, of course, allows the system clock to be free-running and the register can be stopped on command with the other clock input. The clock inhibit input should be changed to the high level only while the clock input is high. A buffered, direct clear input overrides all other inputs, including the clock, and sets all flip-flops to zero.

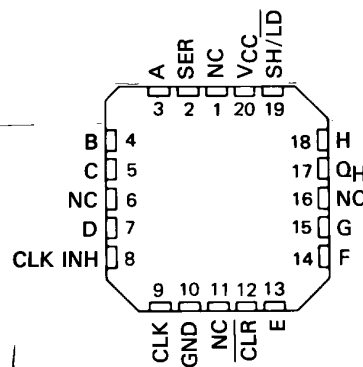
FUNCTION TABLE

CLEAR	INPUTS					INTERNAL OUTPUTS Q _A Q _B	OUTPUT Q _H
	SHIFT/ LOAD	CLOCK INHIBIT	CLOCK	SERIAL	PARALLEL A...H		
L	X	X	X	X	X	L L	L
H	X	L	L	X	X	Q _{A0} Q _{B0}	Q _{H0}
H	L	L	↑	X	a...h	a b	h
H	H	L	↑	H	X	H Q _{An}	Q _{Gn}
H	H	L	↑	L	X	L Q _{An}	Q _{Gn}
H	X	H	↑	X	X	Q _{A0} Q _{B0}	Q _{H0}

SN54166, SN54LS166A ... J OR W PACKAGE
SN74166 ... N PACKAGE
SN74LS166A ... D OR N PACKAGE
(TOP VIEW)

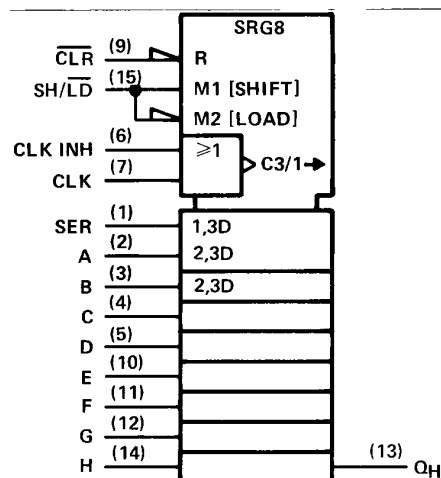


SN54LS166A ... FK PACKAGE
(TOP VIEW)



NC - No internal connection

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.

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TEXAS
INSTRUMENTS

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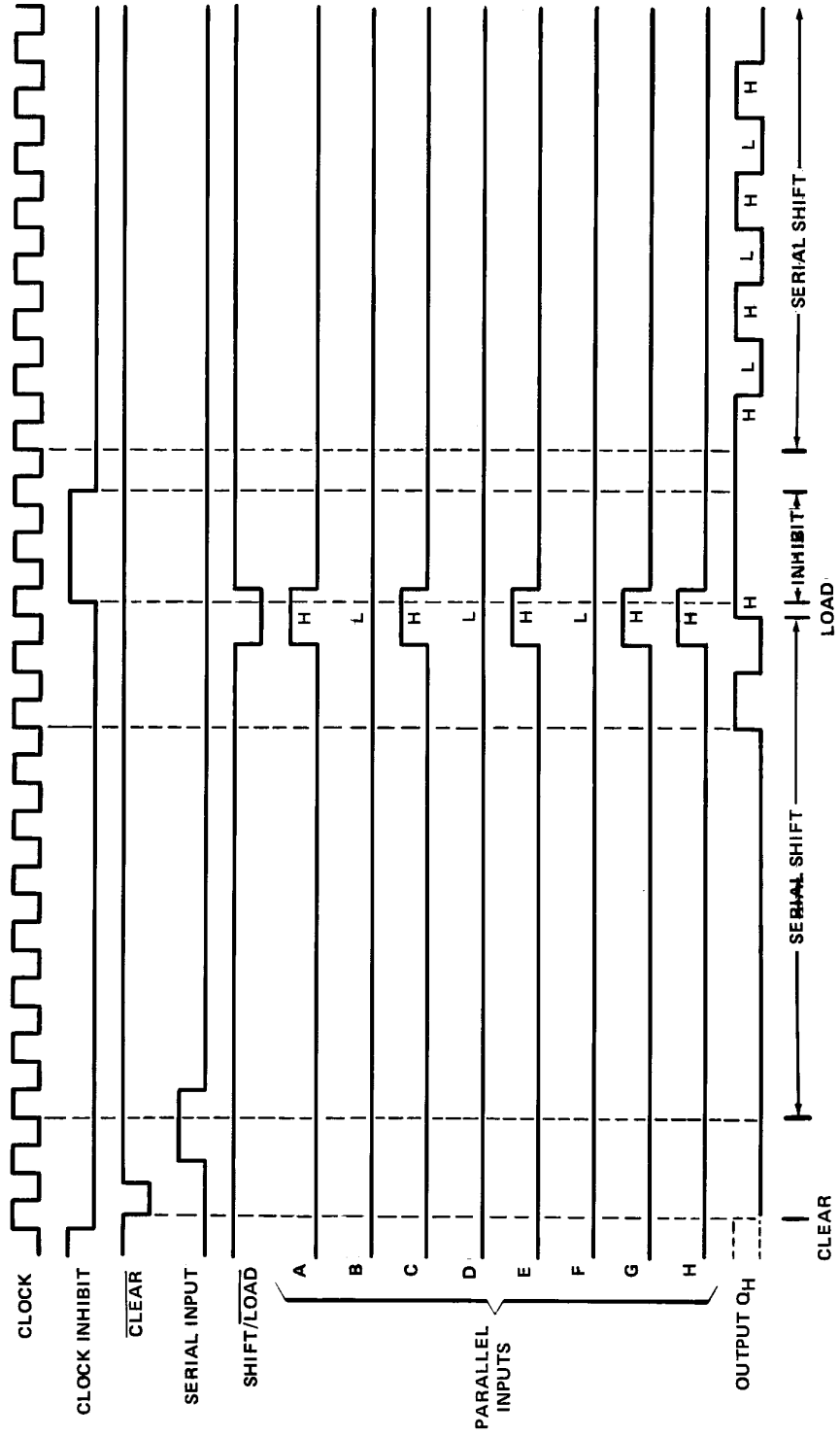
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TTL Devices

**SN54166, SN54LS166A, SN74166, SN74LS166A
PARALLEL-LOAD 8-BIT SHIFT REGISTERS**

typical clear, shift, load, inhibit, and shift sequences



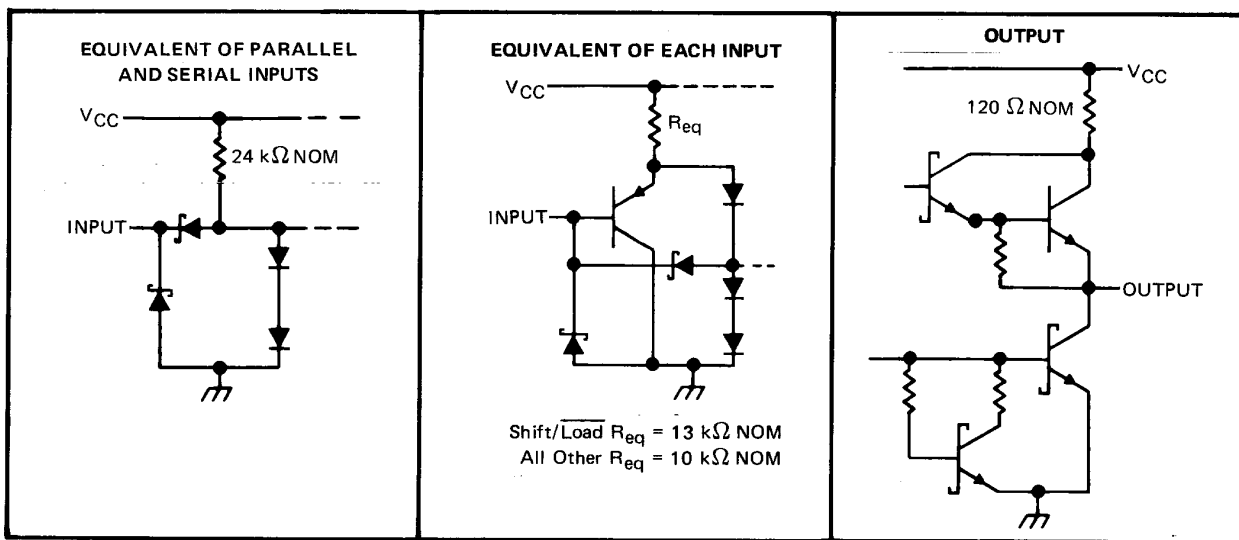
SN54166, SN54LS166A, SN74166, SN74LS166A
PARALLEL-LOAD 8-BIT SHIFT REGISTERS

schematics of inputs and outputs

'166



'LS166A

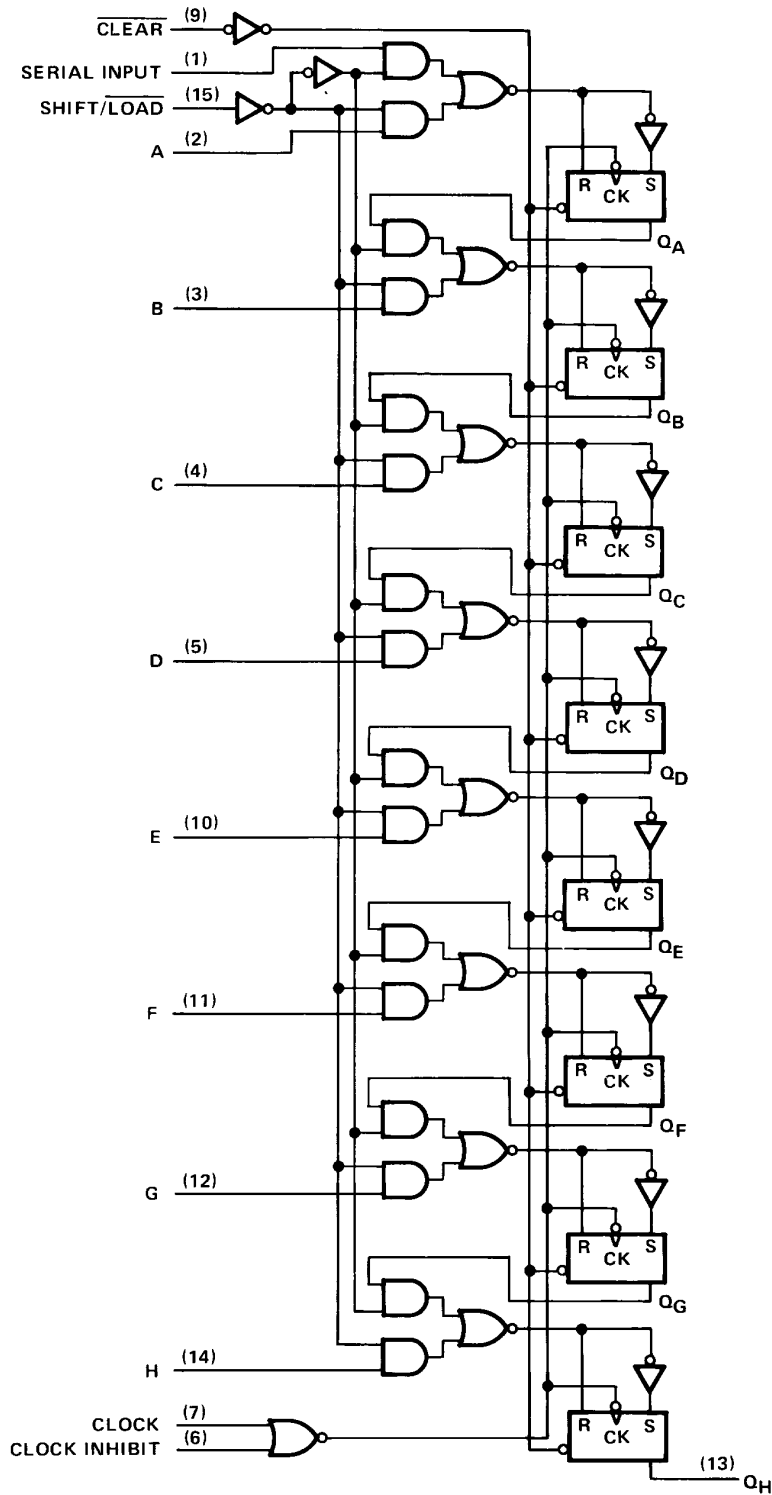


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TTL Devices

SN54166, SN54LS166A, SN74166, SN74LS166A
PARALLEL-LOAD 8-BIT SHIFT REGISTERS

logic diagram (positive logic)



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

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TTL Devices

SN54166, SN74166 PARALLEL-LOAD 8-BIT SHIFT REGISTERS

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

Supply voltage, V_{CC} (see Note 1)	7 V
Input voltage	5.5 V
Operating free-air temperature range: SN54166 (see Note 2)	-55°C to 125°C
SN74166	0°C to 70°C
Storage temperature range	-65°C to 150°C

recommended operating conditions

	SN54166			SN74166			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	μ A
Low-level output current, I_{OL}			16			16	mA
Clock frequency, f_{clock}	0	25		0	25		MHz
Width of clock or clear pulse, t_W (see Figure 1)	20			20			ns
Mode-control setup time, t_{SU}	30			30			ns
Data setup time, t_{SU} (see Figure 1)	20			20			ns
Hold time at any input, t_H (see Figure 1)	0			0			ns
Operating free-air temperature, T_A (see Note 2)	-55	125		0	70		°C

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

PARAMETER	TEST CONDITIONS [†]	SN54166			SN74166			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	$V_{CC} = \text{MIN}, I_I = -12 \text{ mA}$			-1.5			-1.5	V
V_{OH} High-level output voltage	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OH} = -800 \mu\text{A}$	2.4	3.4		2.4	3.4		V
V_{OL} Low-level output voltage	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OL} = 16 \text{ mA}$	0.2	0.4		0.2	0.4		V
I_I Input current at maximum input voltage	$V_{CC} = \text{MAX}, V_I = 5.5 \text{ V}$			1			1	mA
I_{IH} High-level input current	$V_{CC} = \text{MAX}, V_I = 2.4 \text{ V}$			40			40	μ A
I_{IL} Low-level input current	$V_{CC} = \text{MAX}, V_I = 0.4 \text{ V}$			-1.6			-1.6	mA
I_{OS} Short-circuit output current [§]	$V_{CC} = \text{MAX}$	-20	-57		-18	-57		mA
I_{CC} Supply current	$V_{CC} = \text{MAX}$, See Note 3	90	127		90	127		mA

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

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

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

NOTES: 1. Voltage values are with respect to network ground terminal.

2. An SN54166 in the W package operating at free-air temperatures above 113°C requires a heat-sink that provides a thermal resistance from case to free air, $R_{\theta CA}$, of not more than 48°C/W.

3. With all outputs open, 4.5 V applied to the serial input, all other inputs except the clock grounded, I_{CC} is measured after a momentary ground, then 4.5 V, is applied to the clock.

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

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
f_{max} Maximum clock frequency		25	35		MHz
t_{PHL} Propagation delay time, high-to-low-level output from clear			23	35	ns
t_{PHL} Propagation delay time, high-to-low-level output from clock	$C_L = 15 \text{ pF}, R_L = 400 \Omega,$ See Figure 1		20	30	ns
t_{PLH} Propagation delay time, low-to-high-level output from clock			17	26	ns

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TTL Devices

SN54LS166A, SN74LS166A PARALLEL-LOAD 8-BIT SHIFT REGISTERS

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

Supply voltage, V_{CC} (see Note 1)	7 V
Input voltage	7 V
Operating free-air temperature range: SN54LS166A	-55°C to 125°C
SN74LS166A	0°C to 70°C
Storage temperature range	-65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

		SN54LS166A			SN74LS166A			UNIT
		MIN	TYP	MAX	MIN	TYP	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	Width of clear pulse (See Figure 1)	20			20			ns
t_w	Width of clock pulse (See Figure 1)	25			25			
t_{su}	Mode-control setup time	30			30			ns
t_{su}	Data setup time (See Figure 1)	20			20			ns
t_h	Hold time at any input (See Figure 1 and Note 4)	0			0			ns
T_A	Operating free air temperature	-55		125	0		70	°C

NOTE 4: The hold time limit of 0 ns applies only if the rise time is less than or equal to 10 ns.

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

PARAMETER	TEST CONDITIONS †	SN54LS166A			SN74LS166A			UNIT
		MIN	TYP ‡	MAX	MIN	TYP ‡	MAX	
V_{IK}	$V_{CC} = \text{MIN}$, $I_I = -18 \text{ mA}$			-1.5			-1.5	V
V_{OH}	$V_{CC} = \text{MIN}$, $V_{IH} = 2 \text{ V}$, $V_{IL} = \text{MAX}$, $I_{OH} = -0.4 \text{ mA}$	2.5	3.4		2.7	3.4		V
V_{OL}	$V_{CC} = \text{MIN}$, $V_{IH} = 2 \text{ V}$, $V_{IL} = \text{MAX}$	$I_{OL} = 4 \text{ mA}$		0.25	0.4	0.25	0.4	V
		$I_{OL} = 8 \text{ mA}$				0.35	0.5	
I_I	$V_{CC} = \text{MAX}$, $V_I = 7 \text{ V}$			0.1			0.1	mA
I_{IH}	$V_{CC} = \text{MAX}$, $V_I = 2.7 \text{ V}$			20			20	µA
I_{IL}	$V_{CC} = \text{MAX}$, $V_I = 0.4 \text{ V}$			-0.4			-0.4	mA
$I_{OS} §$	$V_{CC} = \text{MAX}$	-20		-100	-20		-100	mA
I_{CC}	$V_{CC} = \text{MAX}$, See Note 5		20	32		20	32	mA

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

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

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

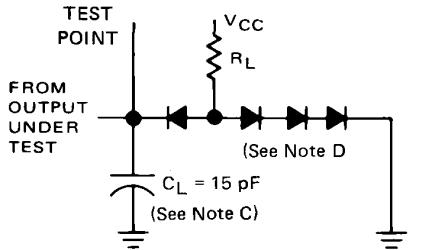
NOTE 5: With all outputs open, 4.5 V applied to the serial input and all other inputs except the clock grounded, I_{CC} is measured after a momentary ground, than 4.5 V, is applied to clock.

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

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT	
f_{max} Maximum clock frequency	$C_L = 15 \text{ pF}$, $R_L = 2 \text{ k}\Omega$, See Figure 1	25	35		MHz	
t_{PHL} Propagation delay time, high-to-low-level output from clear			19	30	ns	
t_{PHL} Propagation delay time, high-to-low-level output from clock			7	14	25	ns
t_{PLH} Propagation delay time, low-to-high-level output from clock			5	11	20	ns

SN54166, SN54LS166A, SN74166, SN74LS166A PARALLEL-LOAD 8-BIT SHIFT REGISTERS

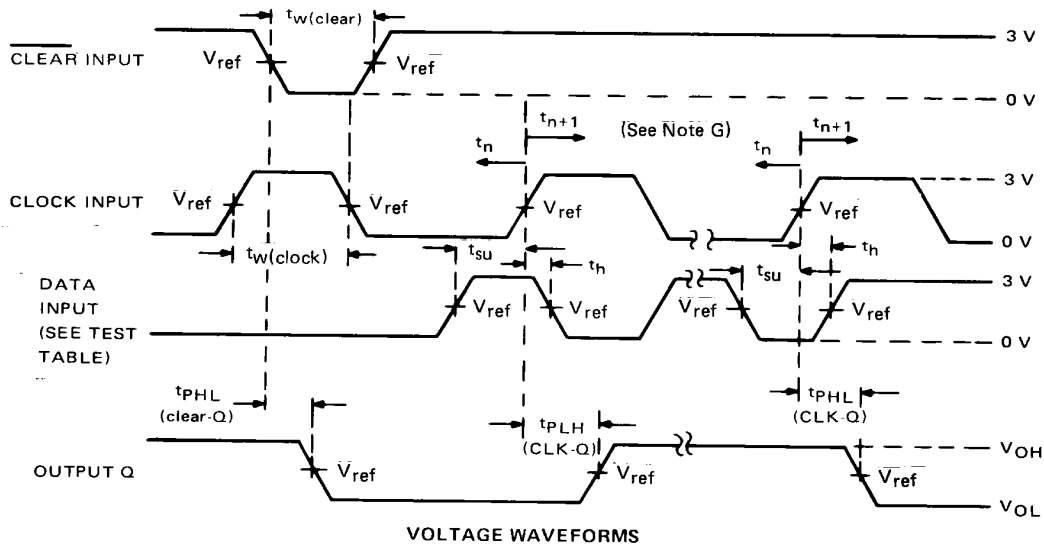
PARAMETER MEASUREMENT INFORMATION



LOAD FOR OUTPUT UNDER TEST

TEST TABLE FOR SYNCHRONOUS INPUTS

DATA INPUT FOR TEST	SHIFT/LOAD	OUTPUT TESTED (SEE NOTE F)
H	0 V	Q_H at t_{n+1}
Serial Input	4.5 V	Q_H at t_{n+8}



VOLTAGE WAVEFORMS

- NOTE: A. All pulse generators have the following characteristics: $Z_{out} \approx 50\Omega$; for '166, $t_r \leq 7$ ns and $t_f \leq 7$ ns; for 'LS166A, $t_r \leq 15$ ns and $t_f \leq 6$ ns.
- B. The clock pulse has the following characteristics: $t_w(\text{clock}) \leq 20$ ns and $\text{PRR} = 1$ MHz. The clear pulse has the following characteristics: $t_w(\text{clear}) \leq 20$ ns and $t_{\text{hold}} = 0$ ns. When testing f_{max} , vary the clock PRR.
- C. C_L includes probe and jig capacitance.
- D. All diodes are 1N3064, 1N916, or equivalent.
- E. A clear pulse is applied prior to each test.
- F. Propagation delay times (t_{PLH} and t_{PHL}) are measured at t_{n+1} . Proper shifting of data is verified at t_{n+8} with a functional test.
- G. t_n = bit time before clocking transition
 t_{n+1} = bit time after one clocking transition
 t_{n+8} = bit time after eight clocking transitions
- H. For '166 $V_{\text{ref}} = 1.5$ V; for 'LS166A $V_{\text{ref}} = 1.3$ V.

FIGURE 1

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