

# SN54164, SN54LS164, SN74164, SN74LS164 8-BIT PARALLEL-OUT SERIAL SHIFT REGISTERS

MARCH 1974 — REVISED MARCH 1988

- Gated Serial Inputs
- Fully Buffered Clock and Serial Inputs
- Asynchronous Clear

SN54164, SN54LS164 . . . J OR W PACKAGE  
SN74164 . . . N PACKAGE  
SN74LS164 . . . D OR N PACKAGE  
(TOP VIEW)



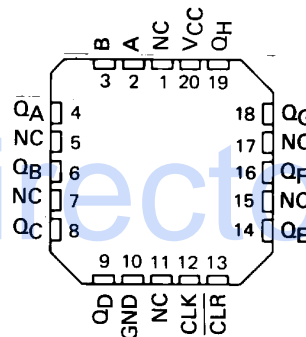
TYPE	TYPICAL MAXIMUM CLOCK FREQUENCY	TYPICAL POWER DISSIPATION
'164	36 MHz	21 mW per bit
'LS164	36 MHz	10 mW per bit

## description

These 8-bit shift registers feature gated serial inputs and an asynchronous clear. The gated serial inputs (A and B) permit complete control over incoming data as a low at either input inhibits entry of the new data and resets the first flip-flop to the low level at the next clock pulse. A high-level input enables the other input which will then determine the state of the first flip-flop. Data at the serial inputs may be changed while the clock is high or low, but only information meeting the setup-time requirements will be entered. Clocking occurs on the low-to-high-level transition of the clock input. All inputs are diode-clamped to minimize transmission-line effects.

The SN54164 and SN54LS164 are characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN74164 and SN74LS164 are characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

SN54LS164 . . . FK PACKAGE  
(TOP VIEW)



NC — No internal connection

FUNCTION TABLE

INPUTS				OUTPUTS		
CLEAR	CLOCK	A	B	QA	QB . . . QH	
L	X	X	X	L	L	L
H	L	X	X	QA0	QB0	QH0
H	↑	H	H	H	QAn	QGn
H	↑	L	X	L	QAn	QGn
H	↑	X	L	L	QAn	QGn

H = high level (steady state), L = low level (steady state)

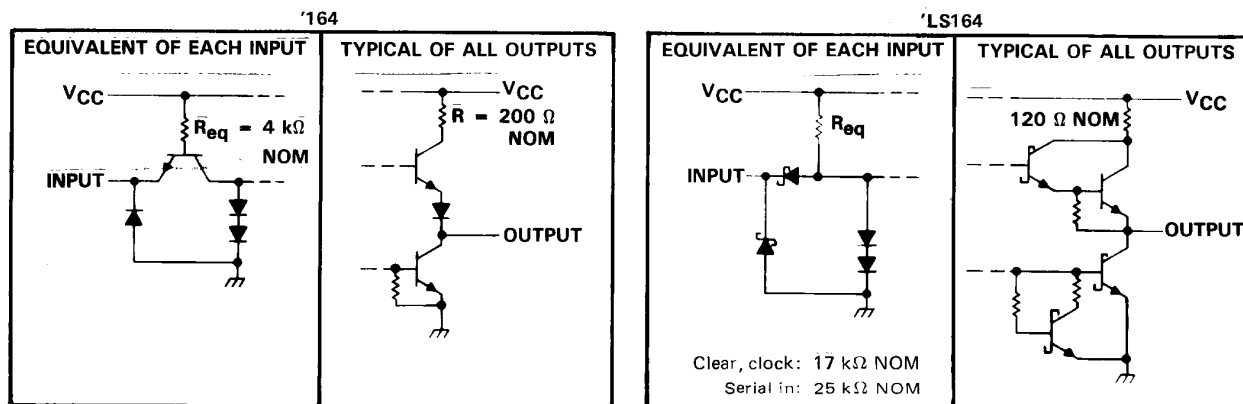
X = irrelevant (any input, including transitions)

↑ = transition from low to high level.

QA0, QB0, QH0 = the level of QA, QB, or QH, respectively, before the indicated steady-state input conditions were established.

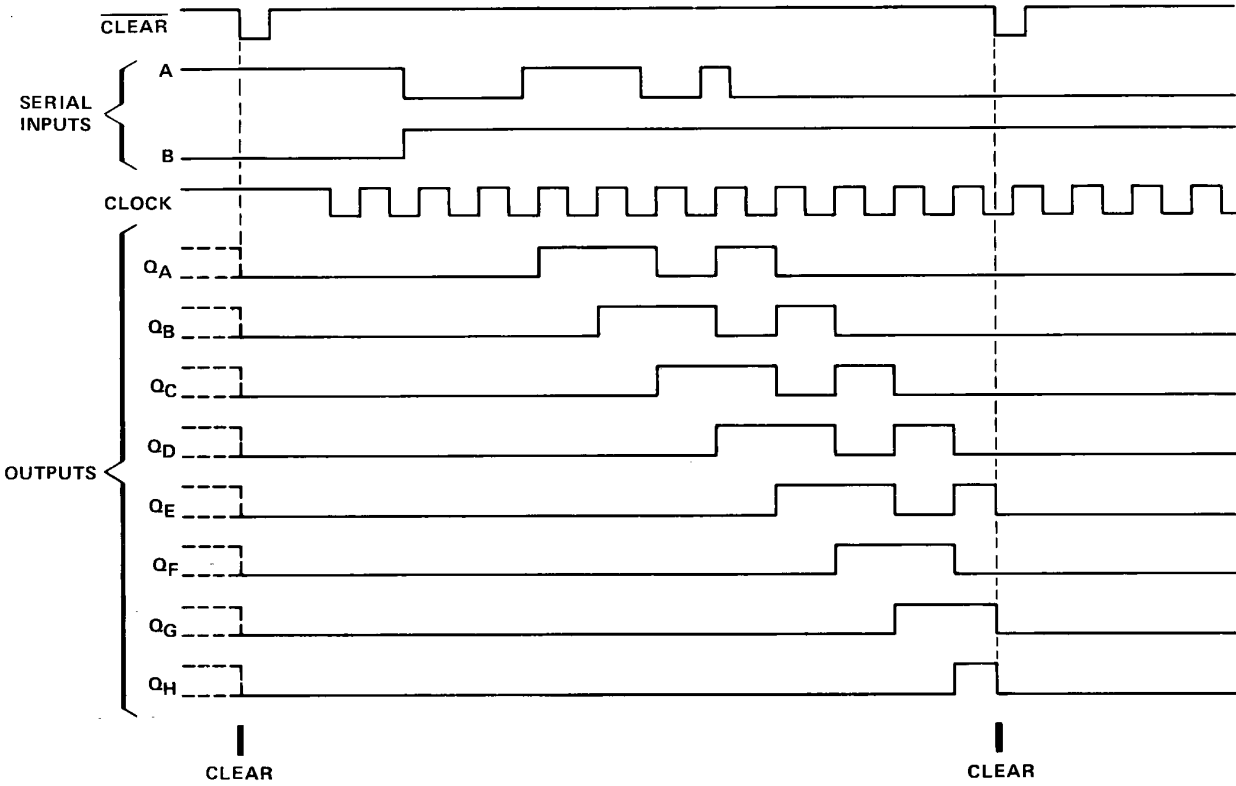
QAn, QGn = the level of QA or QG before the most-recent ↑ transition of the clock; indicates a one-bit shift.

## schematics of inputs and outputs



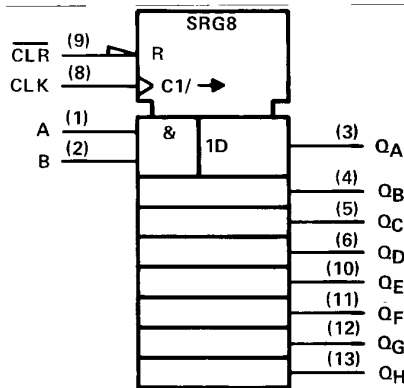
**SN54164, SN54LS164, SN74164, SN74LS164**  
**8-BIT PARALLEL-OUT SERIAL SHIFT REGISTERS**

typical clear, shift, and clear sequences



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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.

# SN54164, SN54LS164, SN74164, SN74LS164 8-BIT PARALLEL-OUT SERIAL SHIFT REGISTER

logic diagram (positive logic)



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

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# SN54164, SN74164

## 8-BIT PARALLEL-OUT SERIAL 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: SN54164	-55°C to 125°C
SN74164	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

	SN54164			SN74164			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, $I_{OH}$			-400			-400	$\mu$ A
Low-level output current, $I_{OL}$			8			8	mA
Clock frequency, $f_{clock}$	0		25	0		25	MHz
Width of clock or clear input pulse, $t_w$	20			20			ns
Data setup time, $t_{SU}$ (see Figure 1)	15			15			ns
Data setup time, $t_{SU}$ (Clear Inactive) (see Figure 1)	20			20			ns
Data hold time, $t_H$ (see Figure 1)	5			5			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†	SN54164			SN74164			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	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OH} = -400 \mu\text{A}$	2.4	3.2		2.4	3.2		V
$V_{OL}$ Low-level output voltage	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OL} = 8 \text{ mA}$		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	$\mu$ 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§	$V_{CC} = \text{MAX}$	-10		-27.5	-9		-27.5	mA
$I_{CC}$ Supply current	$V_{CC} = \text{MAX}, V_I(\text{clock}) = 0.4 \text{ V}$			30			30	mA
	See Note 2 $V_I(\text{clock}) = 2.4 \text{ V}$			37			54	

† For conditions shown at 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 two outputs should be shorted at a time.

NOTE 2:  $I_{CC}$  is measured with outputs open, serial inputs grounded, and a momentary ground, then 4.5 V, applied to clear.

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					MHz
$t_{PHL}$ Propagation delay time, high-to-low-level Q outputs from clear input	$C_L = 15 \text{ pF}$	25	36		ns
	$C_L = 50 \text{ pF}$		24	36	
$t_{PLH}$ Propagation delay time, low-to-high-level Q outputs from clock input	$C_L = 15 \text{ pF}$	8	17	27	ns
	$C_L = 50 \text{ pF}$	10	20	30	
$t_{PHL}$ Propagation delay time, high-to-low-level Q outputs from the clock input	$C_L = 15 \text{ pF}$	10	21	32	ns
	$C_L = 50 \text{ pF}$	10	25	37	

## SN54LS164, SN74LS164 8-BIT PARALLEL-OUT SERIAL 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: SN54LS164 .....	-55°C to 125°C
SN74LS164 .....	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

		SN54LS164			SN74LS164			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
$t_w$	Width of clock or clear input pulse	20			20			ns
$t_{su}$	Data setup time (See Figure 1)	15			15			ns
$t_{su}$	Clear inactive setup time (See Figure 1)	20			20			ns
$t_h$	Data hold time (See Figure 1)	5			5			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†	SN54LS164			SN74LS164			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	3.5		2.7	3.5		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	$I_{OL} = 4 \text{ mA}$		0.25	0.4
		$I_{OL} = 8 \text{ mA}$				$I_{OL} = 8 \text{ mA}$		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 3		16	27		16	27	mA	

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

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

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

NOTE 3:  $I_{CC}$  is measured with outputs open, serial inputs grounded, the clock input at 2.4 V, and a momentary ground, then 4.5 V applied to clear.

### 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	36		MHz
$t_{PHL}$ Propagation delay time, high-to-low-level Q outputs from clear input	$R_L = 2 \text{ k}\Omega, C_L = 15 \text{ pF},$		24	36	ns
$t_{PLH}$ Propagation delay time, low-to-high-level Q outputs from clock input	See Figure 1		17	27	ns
$t_{PHL}$ Propagation delay time, high-to-low-level Q outputs from clock input			21	32	ns

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**SN54164, SN54LS164, SN74164, SN74LS164**  
**8-BIT PARALLEL-OUT SERIAL SHIFT REGISTERS**

**PARAMETER MEASUREMENT INFORMATION**



**TEST CIRCUIT**



**VOLTAGE WAVEFORMS**

- NOTES: A. The pulse generators have the following characteristics: duty cyclé  $\leq 50\%$ ,  $Z_{out} \approx 50 \Omega$ ; for '164,  $t_r \leq 10 \text{ ns}$ ,  $t_f \leq 10 \text{ ns}$ ; and for 'LS164,  $t_r \leq 15 \text{ ns}$ ,  $t_f \leq 6 \text{ ns}$ .
- B.  $C_L$  includes probe and jig capacitance.
- C. All diodes are 1N3064 or equivalent.
- D.  $Q_A$  output is illustrated. Relationship of serial input A and B data to other Q outputs is illustrated in the typical shift sequence.
- E. Outputs are set to the high level prior to the measurement of  $t_{PHL}$  from the clear input.
- F. For '164,  $V_{ref} = 1.5 \text{ V}$ ; for 'LS164,  $V_{ref} = 1.3 \text{ V}$ .

**FIGURE 1—SWITCHING TIMES**

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