

8-Bit Shift Register with Output Storage Register (3-State)

The MC74VHC595 is an advanced high speed 8-bit shift register with an output storage register fabricated with silicon gate CMOS technology.

It achieves high speed operation similar to equivalent Bipolar Schottky TTL while maintaining CMOS low power dissipation.

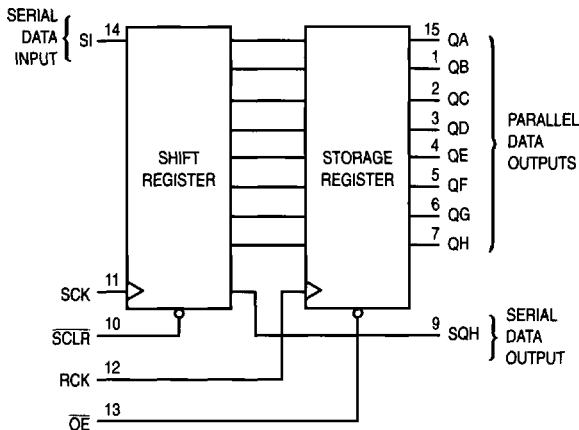
The MC74VHC595 contains an 8-bit static shift register which feeds an 8-bit storage register.

Shift operation is accomplished on the positive going transition of the Shift Clock input (SCK). The output register is loaded with the contents of the shift register on the positive going transition of the Register Clock input (RCK). Since the RCK and SCK signals are independent, parallel outputs can be held stable during the shift operation. And, since the parallel outputs are 3-state, the VHC595 can be directly connected to an 8-bit bus. This register can be used in serial-to-parallel conversion, data receivers, etc.

The internal circuit is composed of three stages, including a buffer output which provides high noise immunity and stable output. The inputs tolerate voltages up to 7V, allowing the interface of 5V systems to 3V systems.

- High Speed: $f_{max} = 185\text{MHz}$ (Typ) at $V_{CC} = 5\text{V}$
- Low Power Dissipation: $I_{CC} = 4\mu\text{A}$ (Max) at $T_A = 25^\circ\text{C}$
- High Noise Immunity: $V_{NIH} = V_{NIL} = 28\% V_{CC}$
- Power Down Protection Provided on Inputs
- Balanced Propagation Delays
- Designed for 2V to 5.5V Operating Range
- Low Noise: $V_{OLP} = 1.0\text{V}$ (Max)
- Pin and Function Compatible with Other Standard Logic Families
- Latchup Performance Exceeds 300mA
- ESD Performance: HBM > 2000V; Machine Model > 200V
- Chip Complexity: 328 FETs or 82 Equivalent Gates

LOGIC DIAGRAM



MC74VHC595



D SUFFIX
16-LEAD SOIC PACKAGE
CASE 751B-05



DT SUFFIX
16-LEAD TSSOP PACKAGE
CASE 948F-01



M SUFFIX
16-LEAD SOIC EIAJ PACKAGE
CASE 966-01

ORDERING INFORMATION

MC74VHCXXXD	SOIC
MC74VHCXXXDT	TSSOP
MC74VHCXXXM	SOIC EIAJ

PIN ASSIGNMENT

QB	[1 •	16]	VCC
QC	[2	15]	QA
QD	[3	14]	SI
QE	[4	13]	OE
QF	[5	12]	RCK
QG	[6	11]	SCK
QH	[7	10]	SCLR
GND	[8	9]	SQH



FUNCTION TABLE

Operation	Inputs					Resulting Function			
	Reset (SCLR)	Serial Input (SI)	Shift Clock (SCK)	Reg Clock (RCK)	Output Enable (OE)	Shift Register Contents	Storage Register Contents	Serial Output (SQH)	Parallel Outputs (QA – QH)
Clear shift register	L	X	X	L, H, ↓	L	L	U	L	U
Shift data into shift register	H	D	↑	L, H, ↓	L	D→SR _A ; SR _N →SR _{N+1}	U	SR _G →SR _H	U
Registers remains unchanged	H	X	L, H, ↓	X	L	U	**	U	**
Transfer shift register contents to storage register	H	X	L, H, ↓	↑	L	U	SR _N →STR _N	*	SR _N
Storage register remains unchanged	X	X	X	L, H, ↓	L	*	U	*	U
Enable parallel outputs	X	X	X	X	L	*	**	*	Enabled
Force outputs into high impedance state	X	X	X	X	H	*	**	*	Z

SR = shift register contents D = data (L, H) logic level
 STR = storage register contents U = remains unchanged

↓ = High-to-Low
 ↑ = Low-to-High

* = depends on Reset and Shift Clock inputs
 ** = depends on Register Clock input

MAXIMUM RATINGS*

Symbol	Parameter	Value	Unit
V _{CC}	DC Supply Voltage	-0.5 to +7.0	V
V _{in}	DC Input Voltage	-0.5 to +7.0	V
V _{out}	DC Output Voltage	-0.5 to V _{CC} + 0.5	V
I _{IJK}	Input Diode Current	-20	mA
I _{OK}	Output Diode Current	±20	mA
I _{out}	DC Output Current, per Pin	±25	mA
I _{CC}	DC Supply Current, V _{CC} and GND Pins	±50	mA
P _D	Power Dissipation in Still Air, SOIC Packages† TSSOP Package†	500 450	mW
T _{stg}	Storage Temperature	-65 to +150	°C

* Absolute maximum continuous ratings are those values beyond which damage to the device may occur. Exposure to these conditions or conditions beyond those indicated may adversely affect device reliability. Functional operation under absolute-maximum-rated conditions is not implied.

† Derating — SOIC Packages: -7 mW/°C from 65° to 125°C
 TSSOP Package: -6.1 mW/°C from 65° to 125°C

This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation, V_{in} and V_{out} should be constrained to the range GND ≤ (V_{in} or V_{out}) ≤ V_{CC}. Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or V_{CC}). Unused outputs must be left open.

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Max	Unit
V _{CC}	DC Supply Voltage	2.0	5.5	V
V _{in}	DC Input Voltage	0	5.5	V
V _{out}	DC Output Voltage	0	V _{CC}	V
T _A	Operating Temperature, All Package Types	-40	+85	°C
t _r , t _f	Input Rise and Fall Time	V _{CC} = 3.3V ±0.3V V _{CC} = 5.0V ±0.5V	0 100 20	ns/V

DC ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Test Conditions	V _{CC} V	T _A = 25°C			T _A = -40 to 85°C		Unit
				Min	Typ	Max	Min	Max	
V _{IH}	Minimum High-Level Input Voltage		2.0 3.0 to 5.5	1.50 V _{CC} × 0.7			1.50 V _{CC} × 0.7		V
V _{IL}	Maximum Low-Level Input Voltage		2.0 3.0 to 5.5			0.50 V _{CC} × 0.3		0.50 V _{CC} × 0.3	V
V _{OH}	Minimum High-Level Output Voltage	V _{in} = V _{IH} or V _{IL} I _{OH} = -50μA	2.0 3.0 4.5	1.9 2.9 4.4	2.0 3.0 4.5		1.9 2.9 4.4		V
		V _{in} = V _{IH} or V _{IL} I _{OH} = -4mA I _{OH} = -8mA	3.0 4.5	2.58 3.94			2.48 3.80		
V _{OL}	Maximum Low-Level Output Voltage	V _{in} = V _{IH} or V _{IL} I _{OL} = 50μA	2.0 3.0 4.5		0.0 0.0 0.0	0.1 0.1 0.1		0.1 0.1 0.1	V
		V _{in} = V _{IH} or V _{IL} I _{OL} = 4mA I _{OL} = 8mA	3.0 4.5			0.36 0.36		0.44 0.44	
I _{OZ}	Three-State Output Off-State Current	V _{in} = V _{IH} or V _{IL} V _{out} = V _{CC} or GND	5.5			± 0.25		± 2.50	μA
I _{in}	Maximum Input Leakage Current	V _{in} = 5.5V or GND	0 to 5.5			± 0.1		± 1.0	μA
I _{CC}	Maximum Quiescent Supply Current	V _{in} = V _{CC} or GND	5.5			4.0		40.0	μA

AC ELECTRICAL CHARACTERISTICS (Input t_r = t_f = 3.0 ns)

Symbol	Parameter	Test Conditions	T _A = 25°C			T _A = -40 to 85°C		Unit
			Min	Typ	Max	Min	Max	
f _{max}	Maximum Clock Frequency (50% Duty Cycle)	V _{CC} = 3.3 ± 0.3V R _L = 1kΩ C _L = 15pF	80	150		70		MHz
		V _{CC} = 5.0 ± 0.5V R _L = 1kΩ C _L = 50pF	55	130		50		
t _{PLH} , t _{PHL}	Propagation Delay, SCK to SQH	V _{CC} = 3.3 ± 0.3V C _L = 15pF C _L = 50pF		8.8 11.3	13.0 16.5	1.0 1.0	15.0 18.5	ns
		V _{CC} = 5.0 ± 0.5V C _L = 15pF C _L = 50pF		6.2 7.7	8.2 10.2	1.0 1.0	9.4 11.4	
t _{PHL}	Propagation Delay, SCL _R to SQH	V _{CC} = 3.3 ± 0.3V C _L = 15pF C _L = 50pF		8.4 10.9	12.8 16.3	1.0 1.0	13.7 17.2	ns
		V _{CC} = 5.0 ± 0.5V C _L = 15pF C _L = 50pF		5.9 7.4	8.0 10.0	1.0 1.0	9.1 11.1	
t _{PLH} , t _{PHL}	Propagation Delay, RCK to QA - QH	V _{CC} = 3.3 ± 0.3V C _L = 15pF C _L = 50pF		7.7 10.2	11.9 15.4	1.0 1.0	13.5 17.0	ns
		V _{CC} = 5.0 ± 0.5V C _L = 15pF C _L = 50pF		5.4 6.9	7.4 9.4	1.0 1.0	8.5 10.5	
t _{pZL} , t _{pZH}	Output Enable Time, OE to QA - QH	V _{CC} = 3.3 ± 0.3V R _L = 1kΩ C _L = 50pF		7.5 9.0	11.5 15.0	1.0 1.0	13.5 17.0	ns
		V _{CC} = 5.0 ± 0.5V R _L = 1kΩ C _L = 50pF		4.8 8.3	8.6 10.6	1.0 1.0	10.0 12.0	

AC ELECTRICAL CHARACTERISTICS (Input $t_r = t_f = 3.0$ ns)

Symbol	Parameter	Test Conditions	$T_A = 25^\circ\text{C}$			$T_A = -40$ to 85°C		Unit
			Min	Typ	Max	Min	Max	
t_{PLZ} , t_{PHZ}	Output Disable Time, OE to QA – QH	$V_{CC} = 3.3 \pm 0.3\text{V}$ $C_L = 50\text{pF}$ $R_L = 1\text{k}\Omega$		12.1	15.7	1.0	16.2	ns
		$V_{CC} = 5.0 \pm 0.5\text{V}$ $C_L = 50\text{pF}$ $R_L = 1\text{k}\Omega$		7.6	10.3	1.0	11.0	
C_{in}	Input Capacitance			4	10		10	pF
C_{out}	Three-State Output Capacitance (Output in High- Impedance State), QA – QH			6			10	

Symbol	Parameter	Typical @ 25°C , $V_{CC} = 5.0\text{V}$		Unit
		7		
C_{PD}	Power Dissipation Capacitance (Note 1.)	87		pF

1. C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation: $I_{CC(OPER)} = C_{PD} \cdot V_{CC} \cdot f_{in} + I_{CC}$. C_{PD} is used to determine the no-load dynamic power consumption; $P_D = C_{PD} \cdot V_{CC}^2 \cdot f_{in} + I_{CC} \cdot V_{CC}$.

NOISE CHARACTERISTICS (Input $t_r = t_f = 3.0$ ns, $C_L = 50$ pF, $V_{CC} = 5.0$ V)

Symbol	Characteristic	$T_A = 25^\circ\text{C}$		Unit
		Typ	Max	
V_{OLP}	Quiet Output Maximum Dynamic V_{OL}	0.8	1.0	V
V_{OLV}	Quiet Output Minimum Dynamic V_{OL}	-0.8	-1.0	V
V_{IHD}	Minimum High Level Dynamic Input Voltage		3.5	V
V_{ILD}	Maximum Low Level Dynamic Input Voltage		1.5	V

TIMING REQUIREMENTS (Input $t_r = t_f = 3.0$ ns)

Symbol	Parameter	V_{CC} V	$T_A = 25^\circ\text{C}$		$T_A = -40$ to 85°C	Unit
			Typ	Limit	Limit	
t_{su}	Setup Time, SI to SCK	3.3 5.0		3.5 3.0	3.5 3.0	ns
$t_{su(H)}$	Setup Time, SCK to RCK	3.3 5.0		8.0 5.0	8.5 5.0	
$t_{su(L)}$	Setup Time, $\overline{\text{SCLR}}$ to RCK	3.3 5.0		8.0 5.0	9.0 5.0	ns
t_h	Hold Time, SI to SCK	3.3 5.0		1.5 2.0	1.5 2.0	
$t_{h(L)}$	Hold Time, $\overline{\text{SCLR}}$ to RCK	3.3 5.0		0 0	0 0	ns
t_{rec}	Recovery Time, $\overline{\text{SCLR}}$ to SCK	3.3 5.0		3.0 2.5	3.0 2.5	
t_w	Pulse Width, SCK or RCK	3.3 5.0		5.0 5.0	5.0 5.0	ns
$t_{w(L)}$	Pulse Width, $\overline{\text{SCLR}}$	3.3 5.0		5.0 5.0	5.0 5.0	

SWITCHING WAVEFORMS

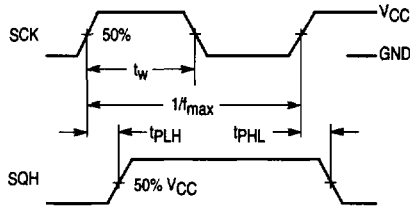


Figure 1.

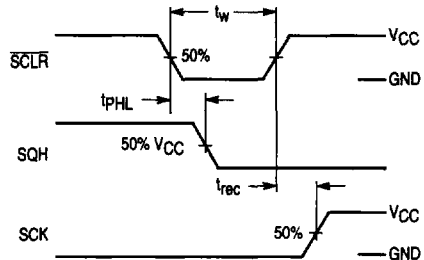


Figure 2.

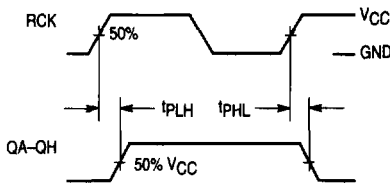


Figure 3.

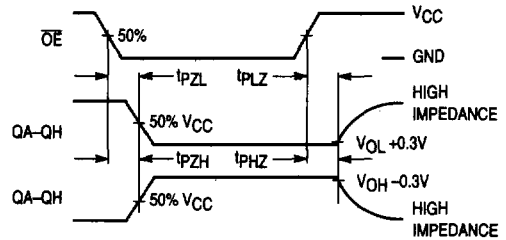


Figure 4.

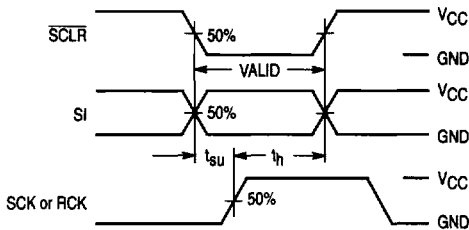


Figure 5.

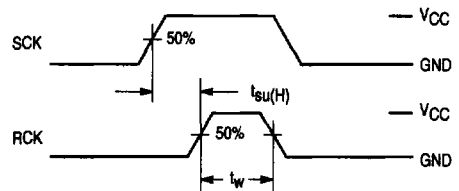
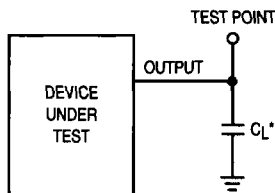


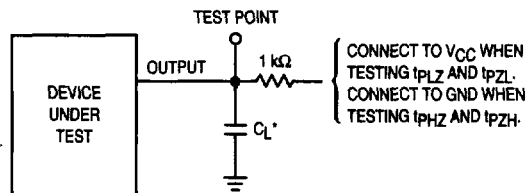
Figure 6.

TEST CIRCUITS



* Includes all probe and jig capacitance

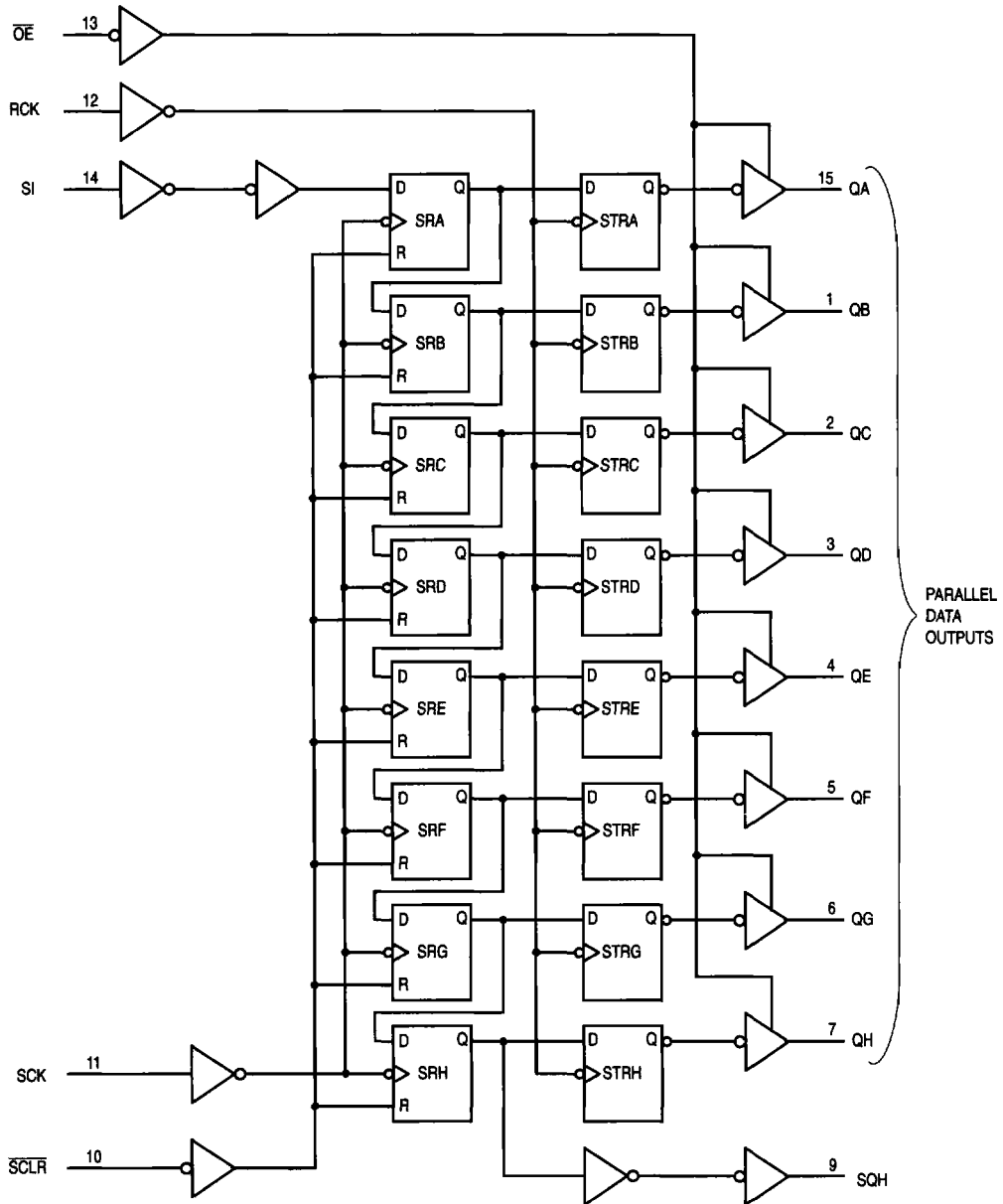
Figure 7.



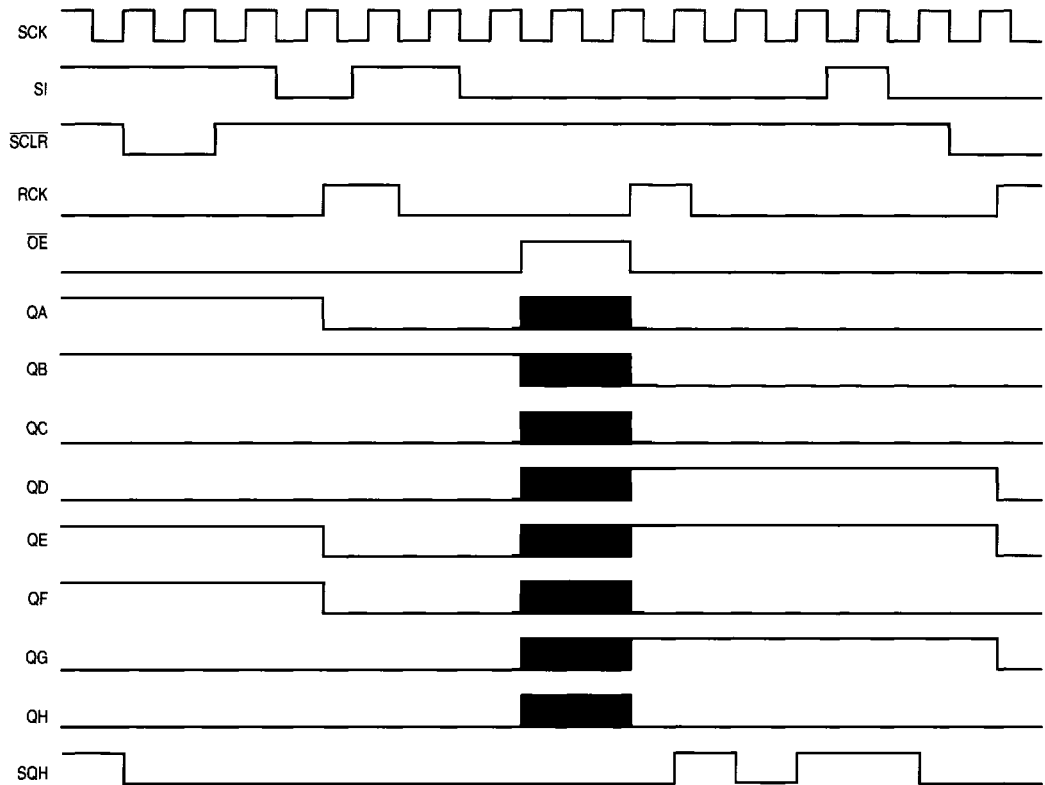
* Includes all probe and jig capacitance

Figure 8.

EXPANDED LOGIC DIAGRAM



TIMING DIAGRAM



NOTE: ████ output is in a high-impedance state.

INPUT EQUIVALENT CIRCUIT

