

MC74VHC595

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.

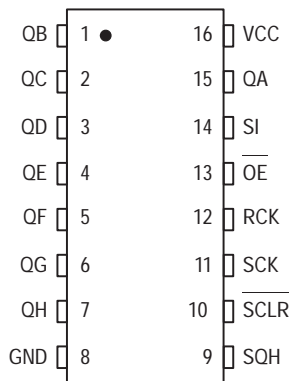
The MC74VHC595 contains an 8-bit static shift register which feeds an 8-bit storage register.

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

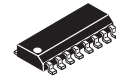
PIN ASSIGNMENT



ON Semiconductor

<http://onsemi.com>

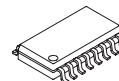
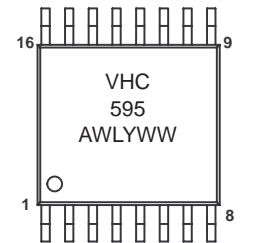
MARKING DIAGRAMS



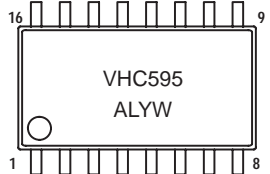
SOIC-16
D SUFFIX
CASE 751B



TSSOP-16
DT SUFFIX
CASE 948F



SOIC EIAJ-16
M SUFFIX
CASE 966



A = Assembly Location
WL = Wafer Lot
YY = Year
WW = Work Week

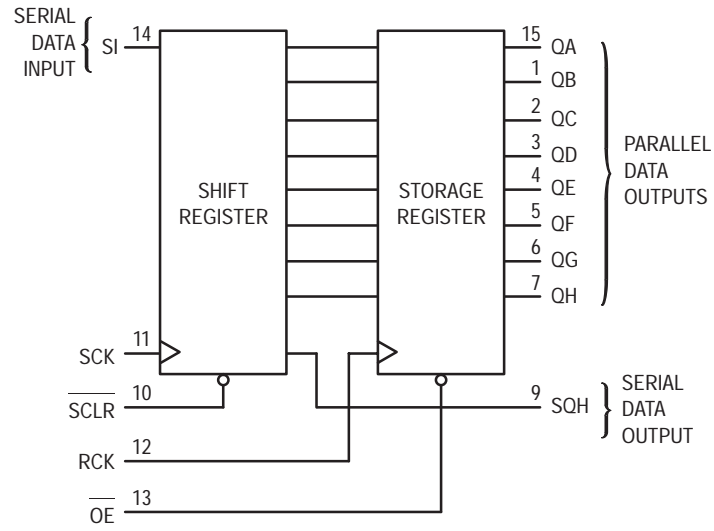
A = Assembly Location A = Assembly Location
WL = Wafer Lot L = Wafer Lot
Y = Year Y = Year
WW = Work Week W = Work Week

ORDERING INFORMATION

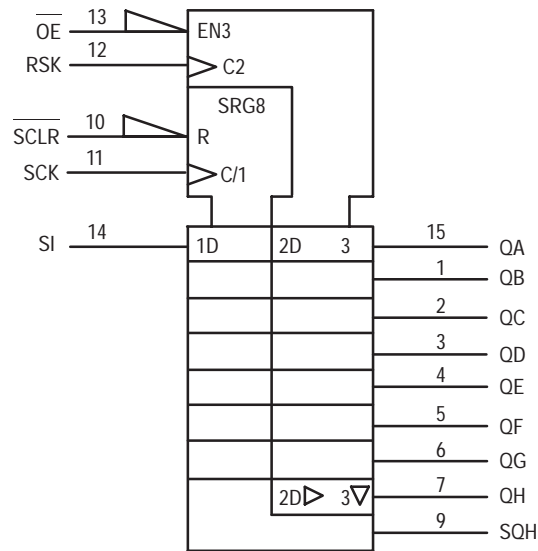
| Device | Package | Shipping |
|----------------|--------------|-----------------|
| MC74VHC595D | SOIC-16 | 48 Units/Rail |
| MC74VHC595DR2 | SOIC-16 | 2500 Units/Reel |
| MC74VHC595DT | TSSOP-16 | 96 Units/Rail |
| MC74VHC595DTEL | TSSOP-16 | 2000 Units/Reel |
| MC74VHC595DTR2 | TSSOP-16 | 2500 Units/Reel |
| MC74VHC595M | SOIC EIAJ-16 | 50 Units/Rail |
| MC74VHC595MEL | SOIC EIAJ-16 | 2000 Units/Reel |

MC74VHC595

LOGIC DIAGRAM

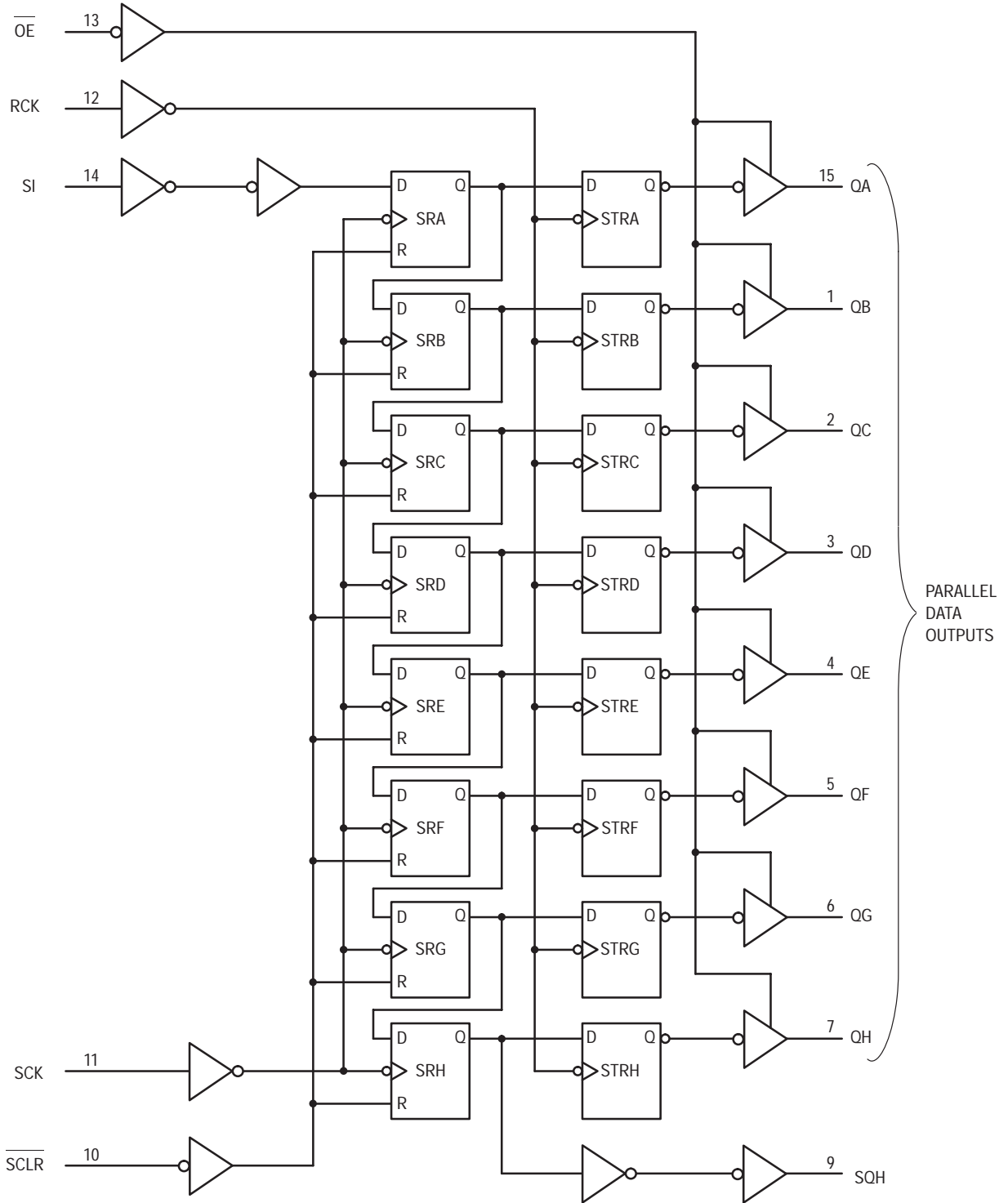


IEC LOGIC SYMBOL



MC74VHC595

EXPANDED LOGIC DIAGRAM



MC74VHC595

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 ↓ = High-to-Low * = depends on Reset and Shift Clock inputs

STR = storage register contents U = remains unchanged ↑ = Low-to-High ** = 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 _{IK} | 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 |

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.

* 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

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 | - 55 | + 125 | °C |
| t _r , t _f | Input Rise and Fall Time | | | |
| | V _{CC} = 3.3V ± 0.3V | 0 | 100 | ns/V |
| | V _{CC} = 5.0V ± 0.5V | 0 | 20 | |

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The θ_{JA} of the package is equal to 1/Derating. Higher junction temperatures may affect the expected lifetime of the device per the table and figure below.

DEVICE JUNCTION TEMPERATURE VERSUS TIME TO 0.1% BOND FAILURES

| Junction Temperature °C | Time, Hours | Time, Years |
|-------------------------|-------------|-------------|
| 80 | 1,032,200 | 117.8 |
| 90 | 419,300 | 47.9 |
| 100 | 178,700 | 20.4 |
| 110 | 79,600 | 9.4 |
| 120 | 37,000 | 4.2 |
| 130 | 17,800 | 2.0 |
| 140 | 8,900 | 1.0 |

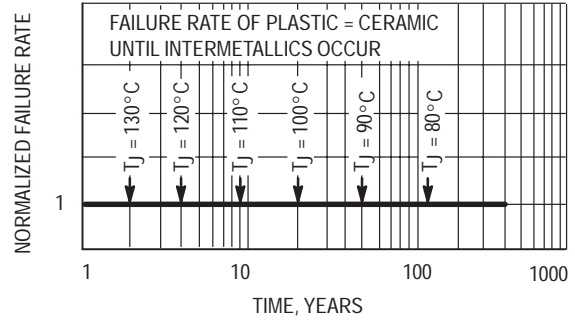


Figure 1. Failure Rate vs. Time Junction Temperature

DC ELECTRICAL CHARACTERISTICS

| Symbol | Parameter | Test Conditions | V _{CC} (V) | T _A = 25°C | | | T _A = ≤ 85°C | | T _A = ≤ 125°C | | Unit |
|-----------------|---|--|---------------------|-----------------------|-----|--------|-------------------------|-------|--------------------------|-------|------|
| | | | | Min | Typ | Max | Min | Max | Min | Max | |
| V _{IH} | Minimum High-Level Input Voltage | | 2.0 | 1.5 | | | 1.5 | | 1.5 | | V |
| | | | 3.0 | 2.1 | | 2.1 | | 2.1 | | | |
| | | | 4.5 | 3.15 | | 3.15 | | 3.15 | | | |
| | | | 5.5 | 3.85 | | 3.85 | | 3.85 | | | |
| V _{IL} | Maximum Low-Level Input Voltage | | 2.0 | | | 0.59 | | 0.59 | | 0.59 | V |
| | | | 3.0 | | | 0.9 | | 0.9 | | 0.9 | |
| | | | 4.5 | | | 1.35 | | 1.35 | | 1.35 | |
| | | | 5.5 | | | 1.65 | | 1.65 | | 1.65 | |
| V _{OH} | Minimum High-Level Output Voltage V _{IN} = V _{IH} or V _{IL} | V _{IN} = V _{IH} or V _{IL} I _{OH} = -50 μA | 2.0 | 1.9 | 2.0 | | 1.9 | | 1.9 | | V |
| | | 3.0 | 2.9 | 3.0 | | 2.9 | | 2.9 | | | |
| | | V _{IN} = V _{IH} or V _{IL} I _{OH} = -4 mA I _{OH} = -8 mA | 4.5 | 4.4 | 4.5 | | 4.4 | | 4.4 | | |
| | | 3.0 | 2.58 | | | 2.48 | | 2.34 | | | |
| | | | 4.5 | 3.94 | | | 3.80 | | 3.66 | | |
| | | | | | | | | | | | |
| V _{OL} | Maximum Low-Level Output Voltage V _{IN} = V _{IH} or V _{IL} | V _{IN} = V _{IH} or V _{IL} I _{OL} = 50 μA | 2.0 | | 0.0 | 0.1 | | 0.1 | | 0.1 | V |
| | | | 3.0 | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | | 4.5 | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | | 3.0 | | | 0.36 | | 0.44 | | 0.52 | |
| | | | 4.5 | | | 0.36 | | 0.44 | | 0.52 | |
| | | | | | | | | | | | |
| I _{IN} | Maximum Input Leakage Current | V _{IN} = 5.5 V or GND | 0 to 5.5 | | | ± 0.1 | | ± 1.0 | | ± 1.0 | μA |
| I _{CC} | Maximum Quiescent Supply Current | V _{IN} = V _{CC} or GND | 5.5 | | | 4.0 | | 40.0 | | 40.0 | μA |
| 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 | | ± 2.5 | | ± 2.5 | μA |

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AC ELECTRICAL CHARACTERISTICS (Input $t_r = t_f = 3.0\text{ns}$)

| Symbol | Parameter | Test Conditions | $T_A = 25^\circ\text{C}$ | | | $T_A = \leq 85^\circ\text{C}$ | | $T_A = \leq 125^\circ\text{C}$ | | Unit |
|--|--|--|--------------------------|------|------|-------------------------------|------|--------------------------------|------|------|
| | | | Min | Typ | Max | Min | Max | Min | Max | |
| f_{max} | Maximum Clock Frequency (50% Duty Cycle) | $V_{\text{CC}} = 3.3 \pm 0.3\text{ V}$ $C_L = 15\text{pF}$ | 80 | 150 | | 70 | | 70 | | MHz |
| | | $R_L = 1\text{ k}\Omega$ $C_L = 50\text{pF}$ | 55 | 130 | | 50 | | 50 | | |
| t_{PLH} , t_{PHL} | Propagation Delay, SCK to SQH | $V_{\text{CC}} = 3.3 \pm 0.3\text{ V}$ $C_L = 15\text{pF}$ | | 8.8 | 13.0 | 1.0 | 15.0 | 1.0 | 15.0 | ns |
| | | $R_L = 1\text{ k}\Omega$ $C_L = 50\text{pF}$ | | 11.3 | 16.5 | 1.0 | 18.5 | 1.0 | 18.5 | |
| t_{PHL} | Propagation Delay, CPLR to SQH | $V_{\text{CC}} = 3.3 \pm 0.3\text{ V}$ $C_L = 15\text{pF}$ | | 8.4 | 12.8 | 1.0 | 13.7 | 1.0 | 13.7 | ns |
| | | $R_L = 1\text{ k}\Omega$ $C_L = 50\text{pF}$ | | 10.9 | 16.3 | 1.0 | 17.2 | 1.0 | 17.2 | |
| t_{PLH} , t_{PHL} | Propagation Delay, RCK to QA–QH | $V_{\text{CC}} = 3.3 \pm 0.3\text{ V}$ $C_L = 15\text{pF}$ | | 7.7 | 11.9 | 1.0 | 13.5 | 1.0 | 13.5 | ns |
| | | $R_L = 1\text{ k}\Omega$ $C_L = 50\text{pF}$ | | 10.2 | 15.4 | 1.0 | 17.0 | 1.0 | 17.0 | |
| t_{PZL} , t_{PZH} | Output Enable Time, OE to QA–QH | $V_{\text{CC}} = 3.3 \pm 0.3\text{ V}$ $C_L = 15\text{pF}$ | | 7.5 | 11.5 | 1.0 | 13.5 | 1.0 | 13.5 | ns |
| | | $R_L = 1\text{ k}\Omega$ $C_L = 50\text{pF}$ | | 9.0 | 15.0 | 1.0 | 17.0 | 1.0 | 17.0 | |
| t_{PLZ} , t_{PHZ} | Output Disable Time, OE to QA–QH | $V_{\text{CC}} = 3.3 \pm 0.3\text{ V}$ $C_L = 50\text{pF}$ | | 12.1 | 15.7 | 1.0 | 16.2 | 1.0 | 16.2 | ns |
| | | $R_L = 1\text{ k}\Omega$ $C_L = 50\text{pF}$ | | 7.6 | 10.3 | 1.0 | 11.0 | 1.0 | 11.0 | |
| C_{IN} | Input Capacitance | | | 4 | 10 | | 10 | | 10 | pF |
| C_{OUT} | Three-State Output Capacitance (Output in High-Impedance State), QA–QH | | | 6 | | | 10 | | 10 | pF |

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

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: $I_{\text{CC(OPER)}} = C_{\text{PD}} \cdot V_{\text{CC}} \cdot f_{\text{in}} + I_{\text{CC}}$. C_{PD} is used to determine the no-load dynamic power consumption; $P_{\text{D}} = C_{\text{PD}} \cdot V_{\text{CC}}^2 \cdot f_{\text{in}} + I_{\text{CC}} \cdot V_{\text{CC}}$.

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

| 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 |

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TIMING REQUIREMENTS (Input $t_r = t_f = 3.0\text{ns}$)

| Symbol | Parameter | VCC V | T _A = 25°C | | T _A = -40 to 85°C | T _A = -55 to 125°C | Unit |
|--------------------|----------------------------|------------|-----------------------|------------|---------------------------------|----------------------------------|------|
| | | | Typ | Limit | Limit | Limit | |
| t _{su} | Setup Time, SI to SCK | 3.3 5.0 | | 3.5 3.0 | 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 | 8.5 5.0 | ns |
| t _{su(L)} | Setup Time, SCLR to RCK | 3.3 5.0 | | 8.0 5.0 | 9.0 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 | 1.5 2.0 | ns |
| t _{h(L)} | Hold Time, SCLR to RCK | 3.3 5.0 | | 0 0 | 0 0 | 1.0 1.0 | ns |
| t _{rec} | Recovery Time, SCLR to SCK | 3.3 5.0 | | 3.0 2.5 | 3.0 2.5 | 3.0 2.5 | ns |
| t _w | Pulse Width, SCK or RCK | 3.3 5.0 | | 5.0 5.0 | 5.0 5.0 | 5.0 5.0 | ns |
| t _{w(L)} | Pulse Width, SCLR | 3.3 5.0 | | 5.0 5.0 | 5.0 5.0 | 5.0 5.0 | ns |

MC74VHC595

SWITCHING WAVEFORMS

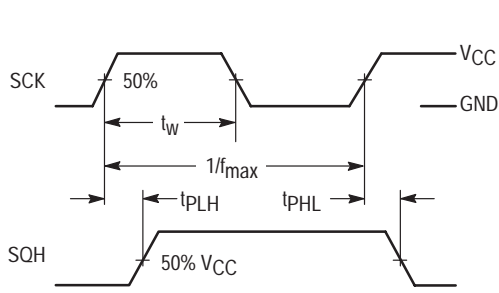


Figure 2.

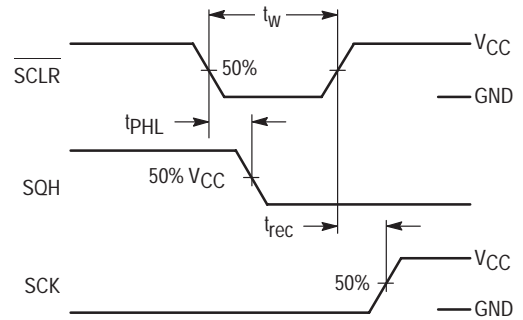


Figure 3.

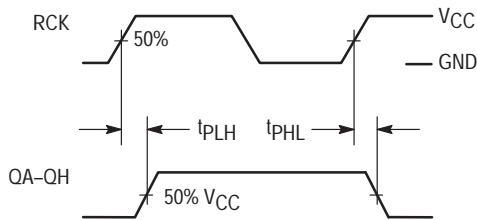


Figure 4.

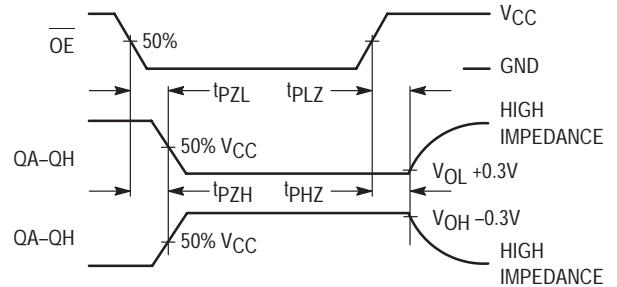


Figure 5.

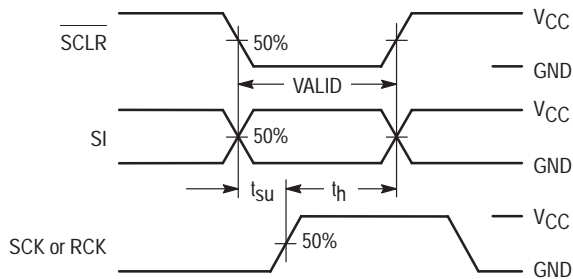


Figure 6.

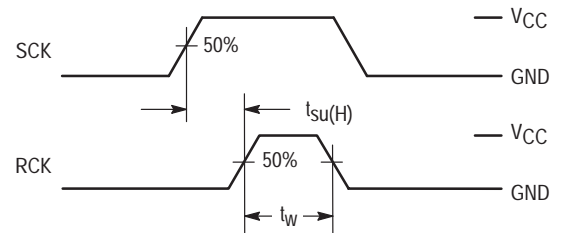
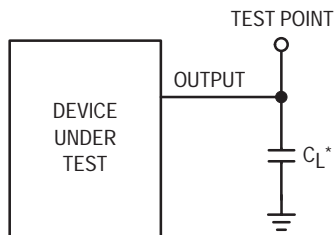


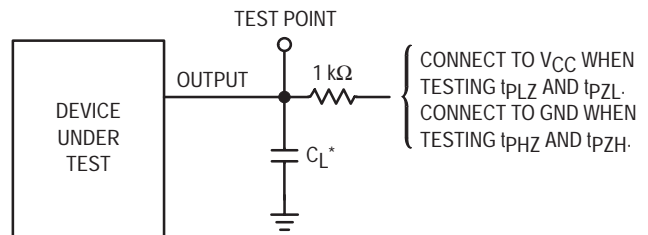
Figure 7.

TEST CIRCUITS



*Includes all probe and jig capacitance

Figure 8.

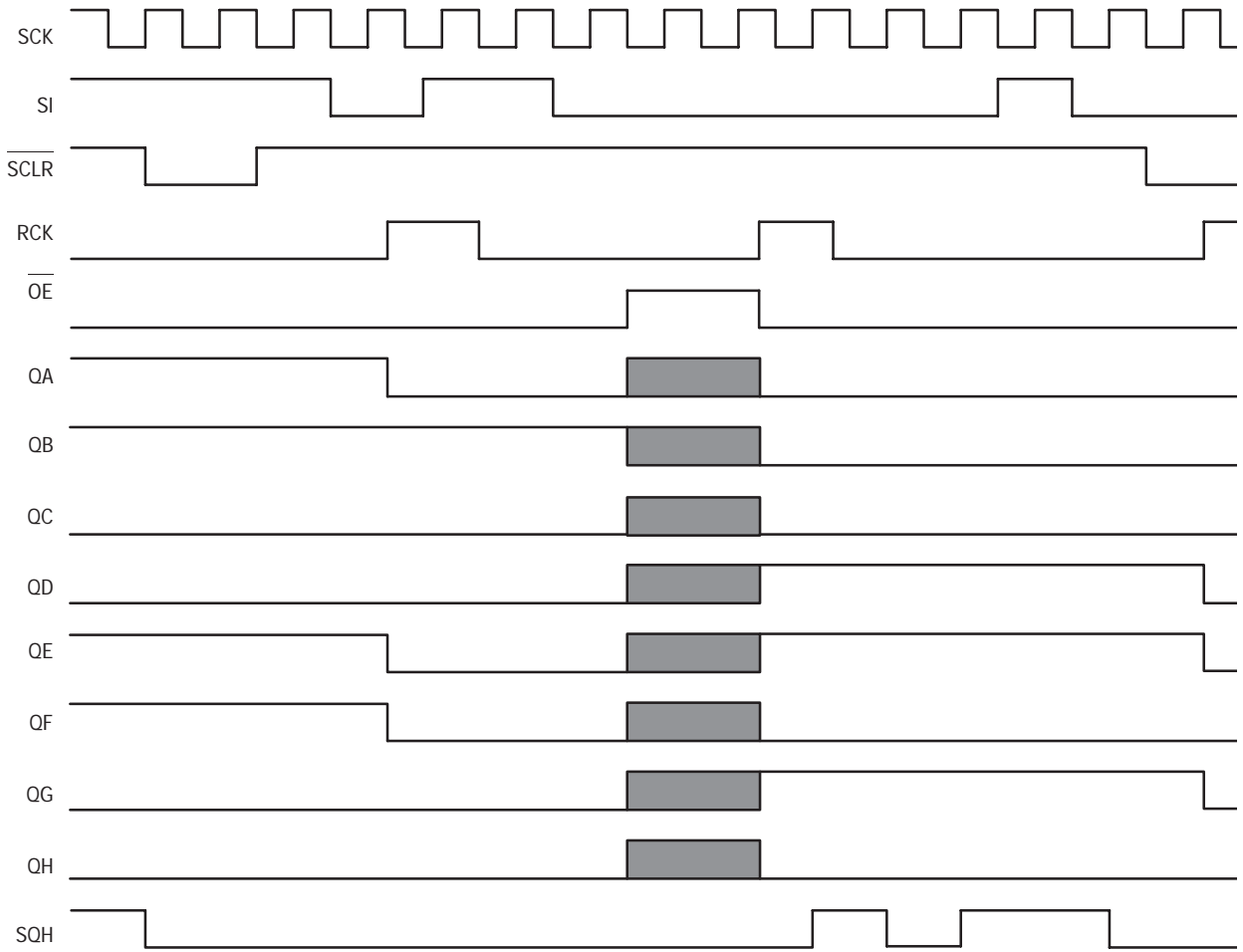



*Includes all probe and jig capacitance

Figure 9.

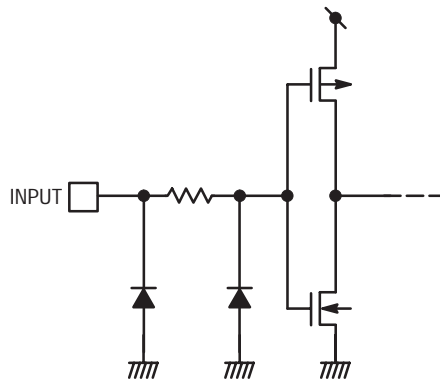
MC74VHC595

TIMING DIAGRAM



NOTE:  output is in a high-impedance state.

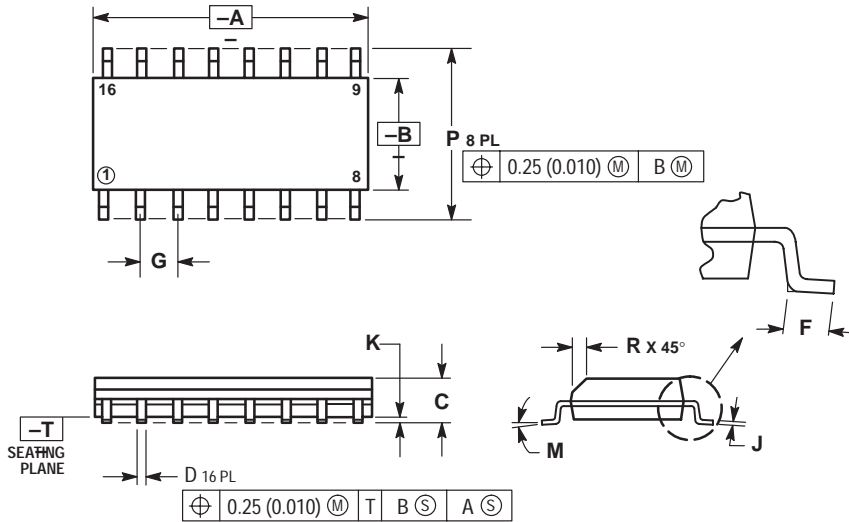
INPUT EQUIVALENT CIRCUIT



MC74VHC595

PACKAGE DIMENSIONS

SOIC-16
D SUFFIX
CASE 751B-05
ISSUE J

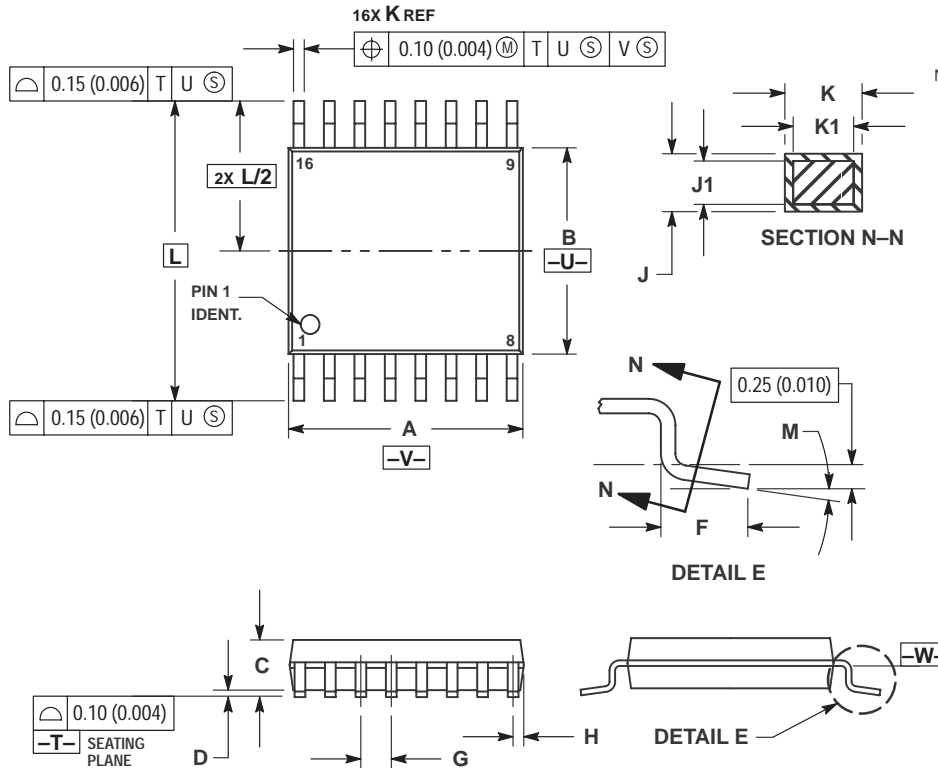


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|-------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | 9.80 | 10.00 | 0.386 | 0.393 |
| B | 3.80 | 4.00 | 0.150 | 0.157 |
| C | 1.35 | 1.75 | 0.054 | 0.068 |
| D | 0.35 | 0.49 | 0.014 | 0.019 |
| F | 0.40 | 1.25 | 0.016 | 0.049 |
| G | 1.27 BSC | | 0.050 BSC | |
| J | 0.19 | 0.25 | 0.008 | 0.009 |
| K | 0.10 | 0.25 | 0.004 | 0.009 |
| M | 0° | 7° | 0° | 7° |
| P | 5.80 | 6.20 | 0.229 | 0.244 |
| R | 0.25 | 0.50 | 0.010 | 0.019 |

TSSOP-16
DT SUFFIX
CASE 948F-01
ISSUE O



NOTES:

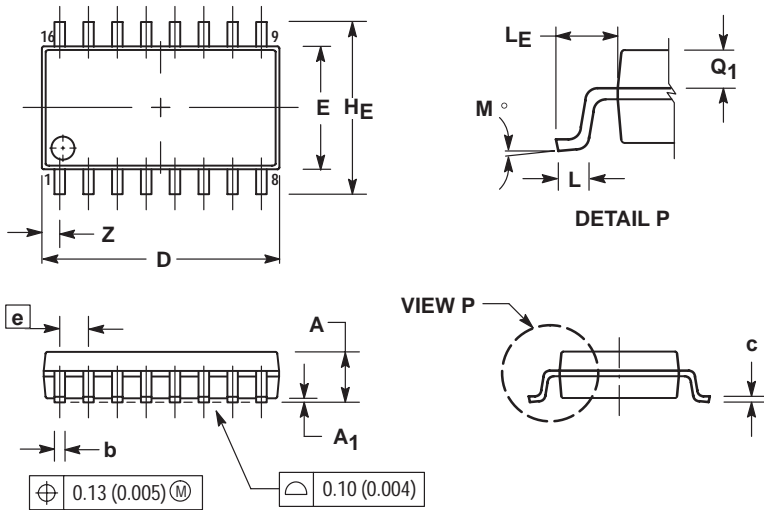
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.90 | 5.10 | 0.193 | 0.200 |
| B | 4.30 | 4.50 | 0.169 | 0.177 |
| C | --- | 1.20 | --- | 0.047 |
| D | 0.05 | 0.15 | 0.002 | 0.006 |
| F | 0.50 | 0.75 | 0.020 | 0.030 |
| G | 0.65 BSC | | 0.026 BSC | |
| H | 0.18 | 0.28 | 0.007 | 0.011 |
| J | 0.09 | 0.20 | 0.004 | 0.008 |
| J1 | 0.09 | 0.16 | 0.004 | 0.006 |
| K | 0.19 | 0.30 | 0.007 | 0.012 |
| K1 | 0.19 | 0.25 | 0.007 | 0.010 |
| L | 6.40 BSC | | 0.252 BSC | |
| M | 0° | 8° | 0° | 8° |

MC74VHC595

PACKAGE DIMENSIONS


SOIC EIAJ-16
M SUFFIX
CASE 966-01
ISSUE O



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS AND ARE MEASURED AT THE PARTING LINE. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
5. THE LEAD WIDTH DIMENSION (b) DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE LEAD WIDTH DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSIONS AND ADJACENT LEAD TO BE 0.46 (0.018).

| DIM | MILLIMETERS | | INCHES | |
|----------------|-------------|-------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | --- | 2.05 | --- | 0.081 |
| A ₁ | 0.05 | 0.20 | 0.002 | 0.008 |
| b | 0.35 | 0.50 | 0.014 | 0.020 |
| c | 0.18 | 0.27 | 0.007 | 0.011 |
| D | 9.90 | 10.50 | 0.390 | 0.413 |
| E | 5.10 | 5.45 | 0.201 | 0.215 |
| e | 1.27 BSC | | 0.050 BSC | |
| H _F | 7.40 | 8.20 | 0.291 | 0.323 |
| L | 0.50 | 0.85 | 0.020 | 0.033 |
| L _F | 1.10 | 1.50 | 0.043 | 0.059 |
| M | 0° | 10° | 0° | 10° |
| Q ₁ | 0.70 | 0.90 | 0.028 | 0.035 |
| Z | --- | 0.78 | --- | 0.031 |

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