

8-Bit Bidirectional Universal Shift Register with Parallel I/O

High-Performance Silicon-Gate CMOS

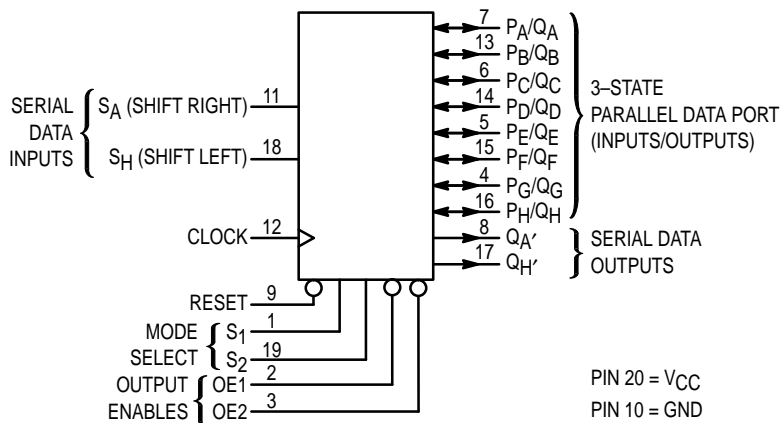
The MC74HC299 is identical in pinout to the LS299. The device inputs are compatible with standard CMOS outputs; with pullup resistors, they are compatible with LSTTL outputs.

The HC299 features a multiplexed parallel input/output data port to achieve full 8-bit handling in a 20 pin package. Due to the large output drive capability and the 3-state feature, this device is ideally suited for interface with bus lines in a bus-oriented system.

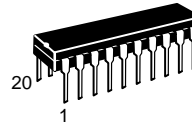
Two Mode-Select inputs and two Output Enable inputs are used to choose the mode of operation as listed in the Function Table. Synchronous parallel loading is accomplished by taking both Mode-Select lines, S₁ and S₂, high. This places the outputs in the high-impedance state, which permits data applied to the data port to be clocked into the register. Reading out of the register can be accomplished when the outputs are enabled. The active-low asynchronous Reset overrides all other inputs.

- Output Drive Capability: 15 LSTTL Loads for Q_A through Q_H
10 LSTTL Loads for Q_A' and Q_H'
- Outputs Directly Interface to CMOS, NMOS, and TTL
- Operating Voltage Range: 2 to 6 V
- Low Input Current: 1 μA
- High Noise Immunity Characteristic of CMOS Devices
- In Compliance with the Requirements Defined by JEDEC Standard No. 7A
- Chip Complexity: 398 FETs or 99.5 Equivalent Gates

LOGIC DIAGRAM



MC74HC299



N SUFFIX
PLASTIC PACKAGE
CASE 738-03

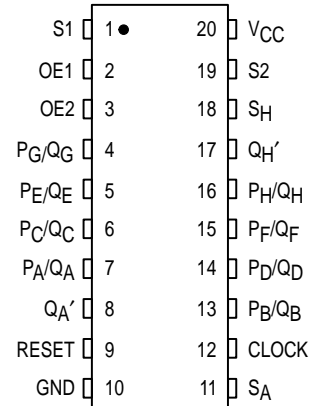


DW SUFFIX
SOIC PACKAGE
CASE 751D-04

ORDERING INFORMATION

MC74HCXXXN Plastic
MC74HCXXXDW SOIC

PIN ASSIGNMENT



MAXIMUM RATINGS*

| Symbol | Parameter | Value | Unit |
|------------------|--|--------------------------------|------|
| V _{CC} | DC Supply Voltage (Referenced to GND) | - 0.5 to + 7.0 | V |
| V _{in} | DC Input Voltage (Referenced to GND) | - 1.5 to V _{CC} + 1.5 | V |
| V _{out} | DC Output Voltage (Referenced to GND) | - 0.5 to V _{CC} + 0.5 | V |
| I _{in} | DC Input Current, per Pin | ± 20 | mA |
| I _{out} | DC Output Current, per Pin | ± 35 | mA |
| I _{CC} | DC Supply Current, V _{CC} and GND Pins | ± 75 | mA |
| P _D | Power Dissipation in Still Air Plastic DIP† SOIC Package† | 750 500 | mW |
| T _{stg} | Storage Temperature | - 65 to + 150 | °C |
| T _L | Lead Temperature, 1 mm from Case for 10 Seconds (Plastic DIP or SOIC Package) | 260 | °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. I/O pins must be connected to a properly terminated line or bus.

* Maximum Ratings are those values beyond which damage to the device may occur. Functional operation should be restricted to the Recommended Operating Conditions.

† Derating — Plastic DIP: - 10 mW/°C from 65° to 125°C

SOIC Package: - 7 mW/°C from 65° to 125°C

For high frequency or heavy load considerations, see Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | Min | Max | Unit | |
|------------------------------------|--|---|-----------------|--------------------|----|
| V _{CC} | DC Supply Voltage (Referenced to GND) | 2.0 | 6.0 | V | |
| V _{in} , V _{out} | DC Input Voltage, Output Voltage (Referenced to GND) | 0 | V _{CC} | V | |
| T _A | Operating Temperature, All Package Types | - 55 | + 125 | °C | |
| t _r , t _f | Input Rise and Fall Time (Figure 1) | V _{CC} = 2.0 V V _{CC} = 4.5 V V _{CC} = 6.0 V | 0 0 0 | 1000 500 400 | ns |

DC ELECTRICAL CHARACTERISTICS (Voltages Referenced to GND)

| Symbol | Parameter | Test Conditions | V _{CC} V | Guaranteed Limit | | | Unit |
|-----------------|---|---|----------------------|------------------|---------|----------|------|
| | | | | - 55 to 25° C | ≤ 85° C | ≤ 125° C | |
| V _{IH} | Minimum High-Level Input Voltage | V _{out} = 0.1 V or V _{CC} - 0.1 V I _{out} ≤ 20 μA | 2.0 | 1.5 | 1.5 | 1.5 | V |
| | | | 4.5 | 3.15 | 3.15 | 3.15 | |
| | | | 6.0 | 4.2 | 4.2 | 4.2 | |
| V _{IL} | Maximum Low-Level Input Voltage | V _{out} = 0.1 V or V _{CC} - 0.1 V I _{out} ≤ 20 μA | 2.0 | 0.3 | 0.3 | 0.3 | V |
| | | | 4.5 | 0.9 | 0.9 | 0.9 | |
| | | | 6.0 | 1.2 | 1.2 | 1.2 | |
| V _{OH} | Minimum High-Level Output Voltage | V _{in} = V _{IH} or V _{IL} I _{out} ≤ 20 μA | 2.0 | 1.9 | 1.9 | 1.9 | V |
| | | | 4.5 | 4.4 | 4.4 | 4.4 | |
| | | | 6.0 | 5.9 | 5.9 | 5.9 | |
| | | | 4.5 | 3.98 | 3.84 | 3.70 | |
| | | | 6.0 | 5.48 | 5.34 | 5.20 | |
| | | | 4.5 | 3.98 | 3.84 | 3.70 | |
| 6.0 | 5.48 | 5.34 | 5.20 | | | | |
| V _{OL} | Maximum Low-Level Output Voltage | V _{in} = V _{IH} or V _{IL} I _{out} ≤ 20 μA | 2.0 | 0.1 | 0.1 | 0.1 | V |
| | | | 4.5 | 0.1 | 0.1 | 0.1 | |
| | | | 6.0 | 0.1 | 0.1 | 0.1 | |
| | | | 4.5 | 0.26 | 0.33 | 0.40 | |
| | | | 6.0 | 0.26 | 0.33 | 0.40 | |
| | | | 4.5 | 0.26 | 0.33 | 0.40 | |
| 6.0 | 0.26 | 0.33 | 0.40 | | | | |
| I _{in} | Maximum Input Leakage Current | V _{in} = V _{CC} or GND | 6.0 | ± 0.1 | ± 1.0 | ± 1.0 | μA |
| I _{OZ} | Maximum Three-State Leakage Current (Q _A thru Q _H) | Output in High-Impedance State V _{in} = V _{IL} or V _{IH} V _{out} = V _{CC} or GND | 6.0 | ± 0.5 | ± 5.0 | ± 10 | μA |
| I _{CC} | Maximum Quiescent Supply Current (per Package) | V _{in} = V _{CC} or GND I _{out} = 0 μA | 6.0 | 8 | 80 | 160 | μA |

NOTE: Information on typical parametric values can be found in Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

AC ELECTRICAL CHARACTERISTICS ($C_L = 50$ pF, Input $t_r = t_f = 6$ ns)

| Symbol | Parameter | VCC V | Guaranteed Limit | | | Unit |
|--------------------------|--|----------|------------------|--------|---------|------|
| | | | - 55 to 25°C | ≤ 85°C | ≤ 125°C | |
| f_{max} | Maximum Clock Frequency (50% Duty Cycle) (Figures 1 and 5) | 2.0 | 5.0 | 4.0 | 3.4 | MHz |
| | | 4.5 | 25 | 20 | 17 | |
| | | 6.0 | 29 | 24 | 20 | |
| t_{PLH} , t_{PHL} | Maximum Propagation Delay, Clock to Q_A' or Q_H' (Figures 1 and 5) | 2.0 | 170 | 215 | 255 | ns |
| | | 4.5 | 34 | 43 | 51 | |
| | | 6.0 | 29 | 37 | 43 | |
| t_{PLH} , t_{PHL} | Maximum Propagation Delay, Clock to Q_A thru Q_H (Figures 1 and 5) | 2.0 | 160 | 200 | 240 | ns |
| | | 4.5 | 32 | 40 | 48 | |
| | | 6.0 | 27 | 34 | 41 | |
| t_{PHL} | Maximum Propagation Delay, Reset to Q_A or Q_H (Figures 2 and 5) | 2.0 | 175 | 220 | 265 | ns |
| | | 4.5 | 35 | 44 | 53 | |
| | | 6.0 | 30 | 37 | 45 | |
| t_{PHL} | Maximum Propagation Delay, Reset to Q_A' thru Q_H' (Figures 2 and 5) | 2.0 | 190 | 240 | 285 | ns |
| | | 4.5 | 38 | 48 | 57 | |
| | | 6.0 | 32 | 41 | 48 | |
| t_{PLZ} , t_{PHZ} | Maximum Propagation Delay, OE1, OE2, S1, or S2 to Q_A thru Q_H (Figures 3 and 6) | 2.0 | 150 | 190 | 225 | ns |
| | | 4.5 | 30 | 38 | 45 | |
| | | 6.0 | 26 | 33 | 38 | |
| t_{PZL} , t_{PZH} | Maximum Propagation Delay, OE1, OE2, S1, or S2 to Q_A thru Q_H (Figures 3 and 6) | 2.0 | 150 | 190 | 225 | ns |
| | | 4.5 | 30 | 38 | 45 | |
| | | 6.0 | 26 | 33 | 38 | |
| t_{TLH} , t_{THL} | Maximum Output Transition Time, Q_A thru Q_H (Figures 1 and 5) | 2.0 | 60 | 75 | 90 | ns |
| | | 4.5 | 12 | 15 | 18 | |
| | | 6.0 | 10 | 13 | 15 | |
| t_{TLH} , t_{THL} | Maximum Output Transition Time, Q_A' or Q_H' (Figures 1 and 5) | 2.0 | 75 | 95 | 110 | ns |
| | | 4.5 | 15 | 19 | 22 | |
| | | 6.0 | 13 | 16 | 19 | |
| C_{in} | Maximum Input Capacitance | — | 10 | 10 | 10 | pF |
| C_{out} | Maximum Three-State Output Capacitance (Output in High-Impedance State), Q_A thru Q_H | — | 15 | 15 | 15 | pF |

NOTES:

1. For propagation delays with loads other than 50 pF, see Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).
2. Information on typical parametric values can be found in Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

| C_{PD} | Power Dissipation Capacitance (Per Package)*, Outputs Enabled | Typical @ 25°C, VCC = 5.0 V | pF |
|----------|---|-----------------------------|----|
| | | 240 | |

* Used to determine the no-load dynamic power consumption: $P_D = C_{PD} V_{CC}^2 f + I_{CC} V_{CC}$. For load considerations, see Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

MC74HC299

TIMING REQUIREMENTS (Input $t_r = t_f = 6$ ns)

| Symbol | Parameter | VCC V | Guaranteed Limit | | | Unit |
|------------|---|----------|------------------|--------|---------|------|
| | | | - 55 to 25°C | ≤ 85°C | ≤ 125°C | |
| t_{su} | Minimum Setup Time, Mode Select S1 or S2 to Clock (Figure 4) | 2.0 | 100 | 125 | 150 | ns |
| | | 4.5 | 20 | 25 | 30 | |
| | | 6.0 | 17 | 21 | 26 | |
| t_{su} | Minimum Setup Time, Data Inputs S _A , S _H , P _A thru P _H to Clock (Figure 4) | 2.0 | 100 | 125 | 150 | ns |
| | | 4.5 | 20 | 25 | 30 | |
| | | 6.0 | 17 | 21 | 26 | |
| t_h | Minimum Hold Time, Clock to Mode Select S1 or S2 (Figure 4) | 2.0 | 120 | 150 | 180 | ns |
| | | 4.5 | 24 | 30 | 36 | |
| | | 6.0 | 20 | 26 | 31 | |
| t_h | Minimum Hold Time, Clock to Data Inputs, S _A , S _H , P _A thru P _H (Figure 4) | 2.0 | 5 | 5 | 5 | ns |
| | | 4.5 | 5 | 5 | 5 | |
| | | 6.0 | 5 | 5 | 5 | |
| t_{rec} | Minimum Recovery Time, Reset Inactive to Clock (Figure 2) | 2.0 | 50 | 65 | 75 | ns |
| | | 4.5 | 10 | 13 | 15 | |
| | | 6.0 | 9 | 11 | 13 | |
| t_w | Minimum Pulse Width, Clock (Figure 1) | 2.0 | 80 | 100 | 120 | ns |
| | | 4.5 | 16 | 20 | 24 | |
| | | 6.0 | 14 | 17 | 20 | |
| t_w | Minimum Pulse Width, Reset (Figure 2) | 2.0 | 80 | 100 | 120 | ns |
| | | 4.5 | 16 | 20 | 24 | |
| | | 6.0 | 14 | 17 | 20 | |
| t_r, t_f | Maximum Input Rise and Fall Times (Figure 1) | 2.0 | 1000 | 1000 | 1000 | ns |
| | | 4.5 | 500 | 500 | 500 | |
| | | 6.0 | 400 | 400 | 400 | |

NOTE: Information on typical parametric values can be found in Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

FUNCTION TABLE

| Inputs | | | | | | | | | Response | | | | | | | | | |
|---------------|-------|----------------|----------------|----------------|------|-------|----------------|----------------|--|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|------------------|------------------|
| Mode | Reset | Mode Select | | Output Enables | | Clock | Serial Inputs | | P _A /Q _A | P _B /Q _B | P _C /Q _C | P _D /Q _D | P _E /Q _E | P _F /Q _F | P _G /Q _G | P _H /Q _H | Q _A ' | Q _H ' |
| | | S ₂ | S ₁ | OE1† | OE2† | | D _A | D _H | | | | | | | | | | |
| Reset | L | X | L | L | L | X | X | X | L | L | L | L | L | L | L | L | L | L |
| | L | L | X | L | L | X | X | X | L | L | L | L | L | L | L | L | L | L |
| | L | H | H | X | X | X | X | X | Q _A through Q _H = Z | | | | | | | | L | L |
| Shift Right | H | L | H | H | X | ↗ | D | X | Shift Right: Q _A through Q _H = Z; D _A → F _A ; F _A → F _B ; etc. | | | | | | | | D | Q _G |
| | H | L | H | X | H | ↗ | D | X | Shift Right: Q _A through Q _H = Z; D _A → F _A ; F _A → F _B ; etc. | | | | | | | | D | Q _G |
| | H | L | H | L | L | ↗ | D | X | Shift Right: D _A → F _A = Q _A ; F _A → F _B = Q _B ; etc. | | | | | | | | D | Q _G |
| Shift Left | H | H | L | H | X | ↘ | X | D | Shift Left: Q _A through Q _H = Z; D _H → F _H ; F _H → F _G ; etc. | | | | | | | | Q _B | D |
| | H | H | L | X | H | ↘ | X | D | Shift Left: Q _A through Q _H = Z; D _H → F _H ; F _H → F _G ; etc. | | | | | | | | Q _B | D |
| | H | H | L | L | L | ↘ | X | D | Shift Left: D _H → F _H = Q _H ; F _H → F _G = Q _G ; etc. | | | | | | | | Q _B | D |
| Parallel Load | H | H | H | X | X | ↗ | X | X | Parallel Load: P _N → F _N | | | | | | | | P _A | P _H |
| Hold | H | L | L | H | X | X | X | X | Hold: Q _A through Q _H = Z; F _N = F _N | | | | | | | | P _A | P _H |
| | H | L | L | X | H | X | X | X | Hold: Q _A through Q _H = Z; F _N = F _N | | | | | | | | P _A | P _H |
| | H | L | L | L | L | X | X | X | Hold: Q _N = Q _N | | | | | | | | P _A | P _H |

Z = high impedance

D = data on serial input

F = flip-flop (see Logic Diagram)

†When one or both output controls are high the eight input/output terminals are disabled to the high impedance state, however, sequential operation or clearing of the register is not affected.

PIN DESCRIPTIONS

DATA INPUTS

S_A (Pin 11)

Serial data input (Shift Right). Data on this input is shifted into the shift register on the rising edge of Clock when S₂ is low and S₁ is high (shift right mode).

S_H (Pin 18)

Serial data input (Shift Left). Data on this input is shifted into the shift register on the rising edge of Clock when S₂ is high and S₁ is low (shift left mode).

P_A through P_H (Pins 7, 13, 6, 14, 5, 15, 4, 16)

Parallel data port inputs. Data on these pins can be parallel loaded into the shift register on the rising edge of Clock when both S₁ and S₂ are high. For any other combination of S₁ and S₂, these pins serve as the outputs of the shift register.

CONTROL INPUTS

Clock (Pin 12)

Clock input. A low-to-high transition on this pin shifts the data at each stage to the next stage (shift right or left mode) or loads the data at the parallel data inputs into the shift register (parallel load mode).

OE1, OE2 (Pins 2, 3)

Active-low output enables. When both OE1 and OE2 are low, the Outputs Q_A through Q_H are enabled. When one or

both output enables are high, the outputs are forced to the high-impedance state; however, sequential operation or clearing of the register is not affected.

Reset (Pin 9)

Active-low reset. A low on this pin resets all stages of the register to a low level. The reset operation is asynchronous.

S1, S2 (Pins 1, 19)

Mode select inputs. The levels present at these pins determine the shift register's mode of operation:

S₁ = S₂ = Low. Hold.S₁ = Low, S₂ High. Shift left.S₁ = High, S₂ Low. Shift right.S₁ = S₂ = High. Parallel load.

OUTPUTS

Q_A' , Q_H' (Pins 8, 17)

Serial data outputs. These are the outputs of the first and last stages of the shift register, respectively. These outputs are not 3-state outputs and have standard drive capabilities.

Q_A through Q_H (Pins 7, 13, 6, 14, 5, 15, 4, 16)

Parallel data port outputs. Shifted data is present at these pins when OE1 and OE2 are low. For all other combinations of OE1 and OE2 these outputs are in the high-impedance state.

SWITCHING WAVEFORMS

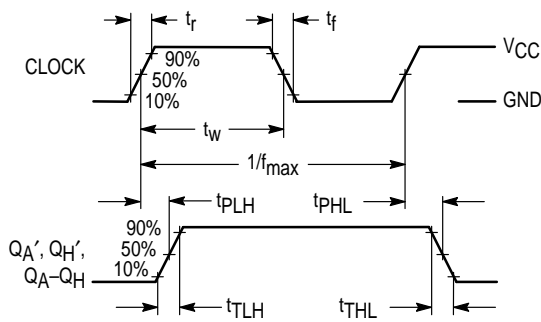


Figure 1.

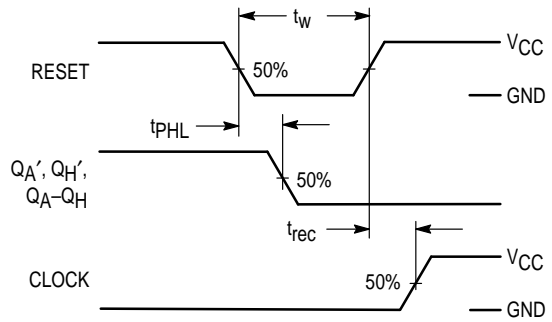


Figure 2.

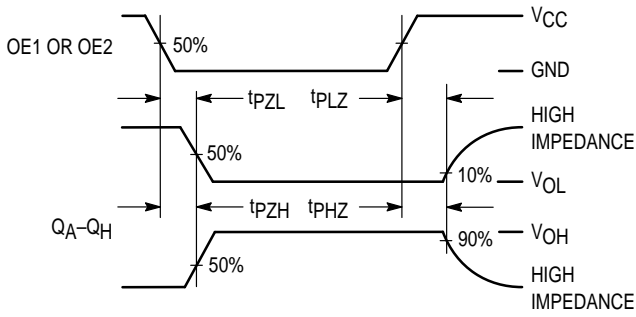


Figure 3a.

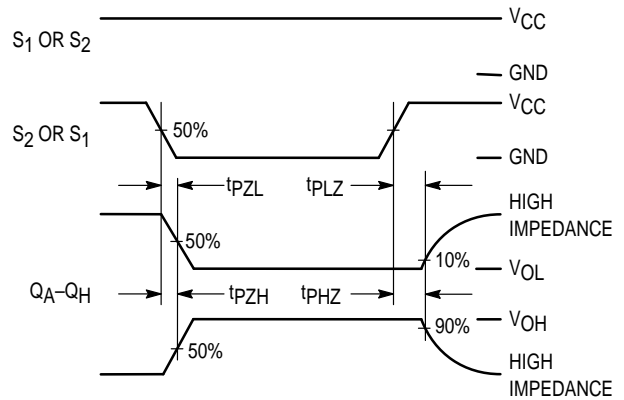


Figure 3b.

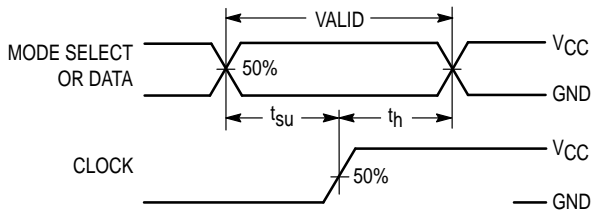
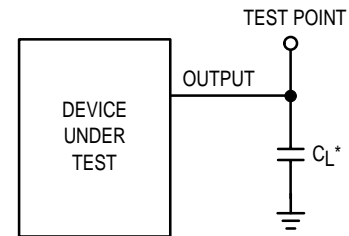
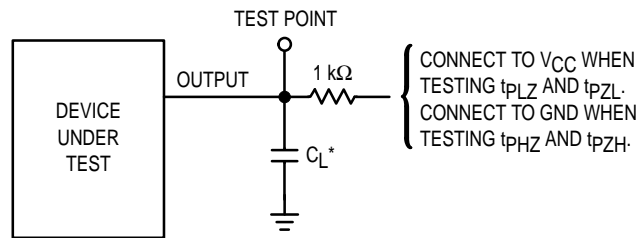


Figure 4.



* Includes all probe and jig capacitance

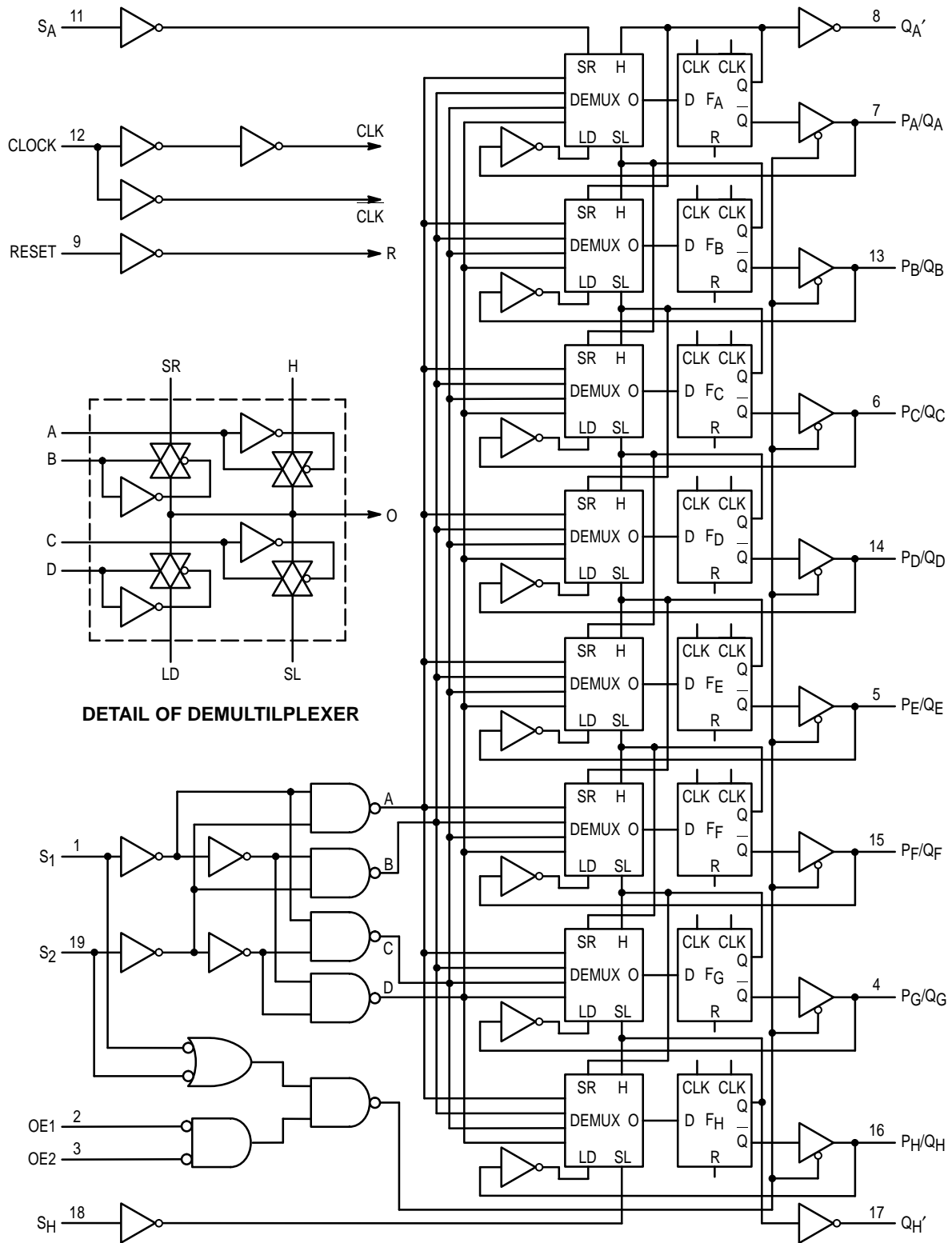
Figure 5. Test Circuit



* Includes all probe and jig capacitance

Figure 6. Test Circuit

EXPANDED LOGIC DIAGRAM



DETAIL OF DEMULTIPLEXER

OUTLINE DIMENSIONS

**N SUFFIX
PLASTIC PACKAGE
CASE 738-03
ISSUE E**

NOTES:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- CONTROLLING DIMENSION: INCH.
- DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
- DIMENSION B DOES NOT INCLUDE MOLD FLASH.

| DIM | INCHES | | MILLIMETERS | |
|-----|-----------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 1.010 | 1.070 | 25.66 | 27.17 |
| B | 0.240 | 0.260 | 6.10 | 6.60 |
| C | 0.150 | 0.180 | 3.81 | 4.57 |
| D | 0.015 | 0.022 | 0.39 | 0.55 |
| E | 0.050 BSC | | 1.27 BSC | |
| F | 0.050 | | 1.27 | |
| G | 0.100 BSC | | 2.54 BSC | |
| J | 0.008 | | 0.21 | |
| K | 0.110 | | 2.80 | |
| L | 0.300 BSC | | 7.62 BSC | |
| M | 0° | | 15° | |
| N | 0.020 | | 0.51 | |

**DW SUFFIX
PLASTIC SOIC PACKAGE
CASE 751D-04
ISSUE E**

NOTES:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- CONTROLLING DIMENSION: MILLIMETER.
- DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
- MAXIMUM MOLD PROTRUSION 0.150 (0.006) PER SIDE.
- DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.13 (0.005) TOTAL IN EXCESS OF D DIMENSION AT MAXIMUM MATERIAL CONDITION.

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|-------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | 12.65 | 12.95 | 0.499 | 0.510 |
| B | 7.40 | 7.60 | 0.292 | 0.299 |
| C | 2.35 | 2.65 | 0.093 | 0.104 |
| D | 0.35 | 0.49 | 0.014 | 0.019 |
| F | 0.50 | 0.90 | 0.020 | 0.035 |
| G | 1.27 BSC | | 0.050 BSC | |
| J | 0.25 | 0.32 | 0.010 | 0.012 |
| K | 0.10 | 0.25 | 0.004 | 0.009 |
| M | 0° | | 7° | |
| P | 10.05 | 10.55 | 0.395 | 0.415 |
| R | 0.25 | 0.75 | 0.010 | 0.029 |

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HONG KONG: Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park,
51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852-26629298

