



THE DATASHEET OF M74HC294RM13TR

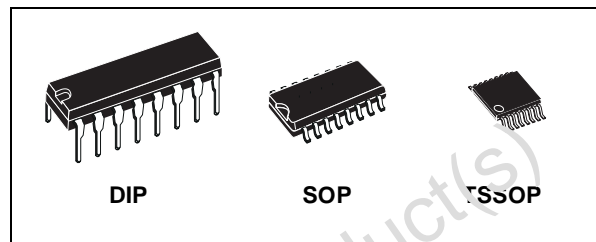




M74HC294

PROGRAMMABLE DIVIDER/TIMER

- HIGH SPEED :
 $f_{MAX} = 75 \text{ MHz (TYP.) at } V_{CC} = 6V$
- LOW POWER DISSIPATION:
 $I_{CC} = 4\mu\text{A (MAX.) at } T_A = 25^\circ\text{C}$
- HIGH NOISE IMMUNITY:
 $V_{NIH} = V_{NIL} = 28 \% V_{CC} \text{ (MIN.)}$
- SYMMETRICAL OUTPUT IMPEDANCE:
 $|I_{OH}| = I_{OL} = 4\text{mA (MIN)}$
- BALANCED PROPAGATION DELAYS:
 $t_{PLH} \approx t_{PHL}$
- WIDE OPERATING VOLTAGE RANGE:
 $V_{CC} \text{ (OPR)} = 2V \text{ to } 6V$
- PIN AND FUNCTION COMPATIBLE WITH
 74 SERIES 294



ORDER CODES

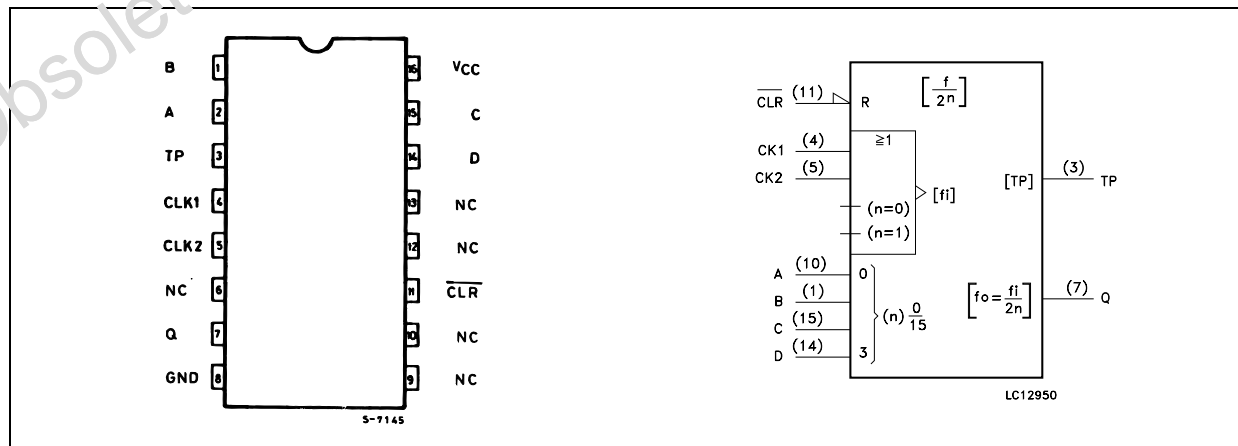
| PACKAGE | TUBE | T & R |
|---------|-------------|----------------|
| DIP | M74HC294B1R | |
| SOP | M74HC294M1R | M74HC294RM13TR |
| TSOP | | M74HC294TTR |

DESCRIPTION

The M74HC294 is an high speed CMOS PROGRAMMABLE DIVIDER/TIMER fabricated with silicon gate C²MOS technology. This device is a programmable frequency divider and has two clock inputs, either one may be used for clock gating. (see the function table). The M74HC294 can divide from 2² to 2¹⁵. This device feature an active-low clear input to initialize

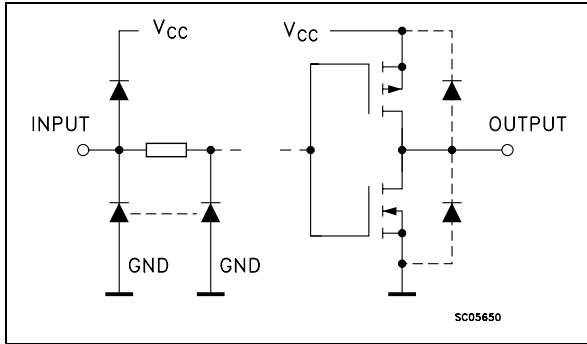
the state of all flip flops. To facilitate incoming inspection, test points (TP) are provided. All inputs are equipped with protection circuits against static discharge and transient excess voltage. This device has Q output with "Totem Pole" configuration and test point TP with "Open Drain" output configuration.

PIN CONNECTION AND IEC LOGIC SYMBOLS

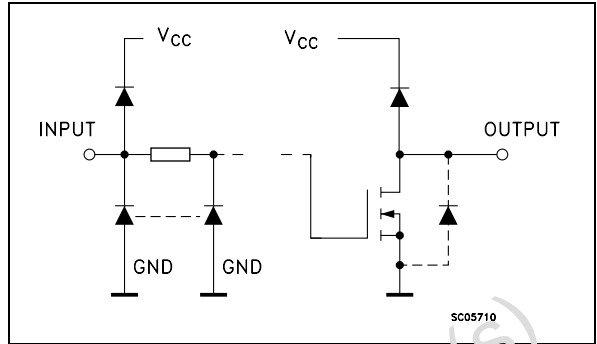


M74HC294

INPUT AND OUTPUT EQUIVALENT CIRCUIT (TOTEM POLE OUTPUT)



INPUT AND OUTPUT EQUIVALENT CIRCUIT (OPEN DRAIN OUTPUT)



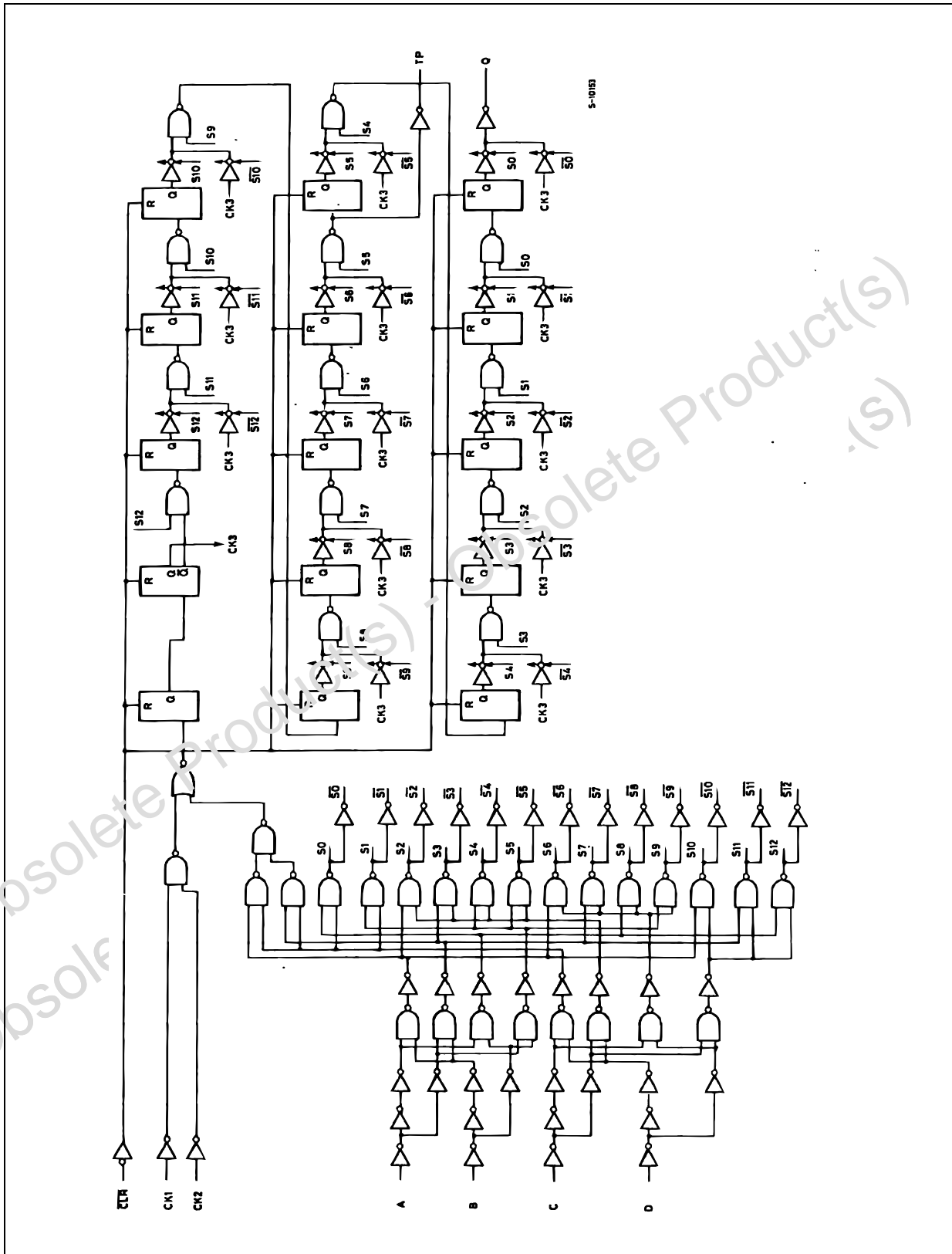
PIN DESCRIPTION

| PIN No | SYMBOL | NAME AND FUNCTION |
|--------------|------------|-------------------------|
| 4, 5 | CLK1, CLK2 | Input Clock |
| 1, 2, 14, 15 | A to E | Program Inputs |
| 3 | TP | Test Point Outputs |
| 11 | CLR | Clear (Active LOW) |
| 7 | Q | Output |
| 8 | GND | Ground (0V) |
| 16 | Vcc | Positive Supply Voltage |

TRUTH TABLE

| $\overline{\text{CLR}}$ | CLK1 | CLK2 | Q OUTPUT MODE |
|-------------------------|-------------|-------------|---------------|
| L | X | X | CLEARED TO L |
| H | \lrcorner | L | UP COUNT |
| H | L | \lrcorner | |
| H | H | X | NO CHANGE |
| H | X | H | |

LOGIC DIAGRAM



This logic diagram has not been used to estimate propagation delays



FUNCTIONAL TABLE

| PROGRAMMING INPUTS | | | | FREQUENCY DIVISION | | | |
|--------------------|---|---|---|--------------------|---------|----------------|---------|
| | | | | Q | | TP | |
| D | C | B | A | BINARY | DECIMAL | BINARY | DECIMAL |
| L | L | L | L | Inhibit | Inhibit | Inhibit | Inhibit |
| L | L | L | H | Inhibit | Inhibit | Inhibit | Inhibit |
| L | L | H | L | 2 ² | 4 | 2 ⁹ | 512 |
| L | L | H | H | 2 ³ | 8 | 2 ⁹ | 512 |
| L | H | L | L | 2 ⁴ | 16 | 2 ⁹ | 512 |
| L | H | L | H | 2 ⁵ | 32 | 2 ⁹ | 512 |
| L | H | H | L | 2 ⁶ | 64 | 2 ⁹ | 512 |
| L | H | H | H | 2 ⁷ | 128 | Disabled Low | |
| H | L | L | L | 2 ⁸ | 256 | 2 ² | 4 |
| H | L | L | H | 2 ⁹ | 512 | 2 ³ | 8 |
| H | L | H | L | 2 ¹⁰ | 1.024 | 2 ⁴ | 16 |
| H | L | H | H | 2 ¹¹ | 2.048 | 2 ⁵ | 32 |
| H | H | L | L | 2 ¹² | 4.096 | 2 ⁶ | 64 |
| H | H | L | H | 2 ¹³ | 8.192 | 2 ⁷ | 128 |
| H | H | H | L | 2 ¹⁴ | 16.384 | 2 ⁸ | 256 |
| H | H | H | H | 2 ¹⁵ | 32.768 | 2 ⁹ | 512 |

ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|-------------------------------------|--------------------------------------|-------------------------------|------|
| V _{CC} | Supply Voltage | -0.5 to +7 | V |
| V _I | DC Input Voltage | -0.5 to V _{CC} + 0.5 | V |
| V _O | DC Output Voltage | -0.5 to V _{CC} + 0.5 | V |
| I _{IK} | DC Input Diode Current | ± 20 | mA |
| I _{OK} | DC Output Diode Current | ± 20 | mA |
| I _O | DC Output Current | ± 25 | mA |
| I _{CC} or I _{GND} | DC V _{CC} or Ground Current | ± 50 | mA |
| P _D | Power Dissipation | 500(*) | mW |
| T _{stg} | Storage Temperature | -65 to +150 | °C |
| T _L | Lead Temperature (10 sec) | 300 | °C |

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied.

(*) 500mW at 65 °C; derate to 300mW by 10mW/°C from 65°C to 85°C

RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | Value | Unit | |
|------------|--------------------------|-----------------|-----------|----|
| V_{CC} | Supply Voltage | 2 to 6 | V | |
| V_I | Input Voltage | 0 to V_{CC} | V | |
| V_O | Output Voltage | 0 to V_{CC} | V | |
| T_{op} | Operating Temperature | -55 to 125 | °C | |
| t_r, t_f | Input Rise and Fall Time | $V_{CC} = 2.0V$ | 0 to 1000 | ns |
| | | $V_{CC} = 4.5V$ | 0 to 500 | ns |
| | | $V_{CC} = 6.0V$ | 0 to 400 | ns |

DC SPECIFICATIONS

| Symbol | Parameter | Test Condition | | Value | | | | | | Unit | |
|----------|-------------------------------|-----------------|-------------------------------|--------------------|------|-----------|------------------------------|---------|-------------------------------|---------|---------|
| | | V_{CC} (V) | | $T_A = 25^\circ C$ | | | $-40 \text{ to } 85^\circ C$ | | $-55 \text{ to } 125^\circ C$ | | |
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | | Max. |
| V_{IH} | High Level Input Voltage | 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} | Low Level Input Voltage | 2.0 | | | | 0.5 | | 0.5 | | 0.5 | V |
| | | 4.5 | | | | 1.35 | | 1.35 | | 1.35 | |
| | | 6.0 | | | | 1.8 | | 1.8 | | 1.8 | |
| V_{OH} | High Level Output Voltage (Q) | 2.0 | $I_O = -20 \mu A$ | 1.9 | 2.0 | | 1.9 | | 1.9 | | V |
| | | 4.5 | $I_O = -20 \mu A$ | 4.4 | 4.5 | | 4.4 | | 4.4 | | |
| | | 6.0 | $I_O = -20 \mu A$ | 5.9 | 6.0 | | 5.9 | | 5.9 | | |
| | | 4.5 | $I_O = -4.0 \text{ mA}$ | 4.18 | 4.31 | | 4.13 | | 4.10 | | |
| | | 6.0 | $I_O = -5.2 \text{ mA}$ | 5.68 | 5.8 | | 5.63 | | 5.60 | | |
| V_{OL} | Low Level Output Voltage (Q) | 2.0 | $I_O = 20 \mu A$ | | 0.0 | 0.1 | | 0.1 | | 0.1 | V |
| | | 4.5 | $I_O = 20 \mu A$ | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | 6.0 | $I_O = 20 \mu A$ | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | 4.5 | $I_O = 4.0 \text{ mA}$ | | 0.17 | 0.26 | | 0.33 | | 0.40 | |
| | | 6.0 | $I_O = 5.2 \text{ mA}$ | | 0.18 | 0.26 | | 0.33 | | 0.40 | |
| V_{OL} | Low Level Output Voltage (TP) | 2.0 | $I_O = 20 \mu A$ | | 0.0 | 0.1 | | 0.1 | | 0.1 | V |
| | | 4.5 | $I_O = 20 \mu A$ | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | 6.0 | $I_O = 20 \mu A$ | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | 4.5 | $I_O = 1.0 \text{ mA}$ | | 0.17 | 0.26 | | 0.33 | | 0.40 | |
| | | 6.0 | $I_O = 1.3 \text{ mA}$ | | 0.18 | 0.26 | | 0.33 | | 0.40 | |
| I_I | Input Leakage Current | 6.0 | $V_I = V_{CC} \text{ or GND}$ | | | ± 0.1 | | ± 1 | | ± 1 | μA |
| I_{CC} | Quiescent Supply Current | 6.0 | $V_I = V_{CC} \text{ or GND}$ | | | 4 | | 40 | | 80 | μA |

M74HC294

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

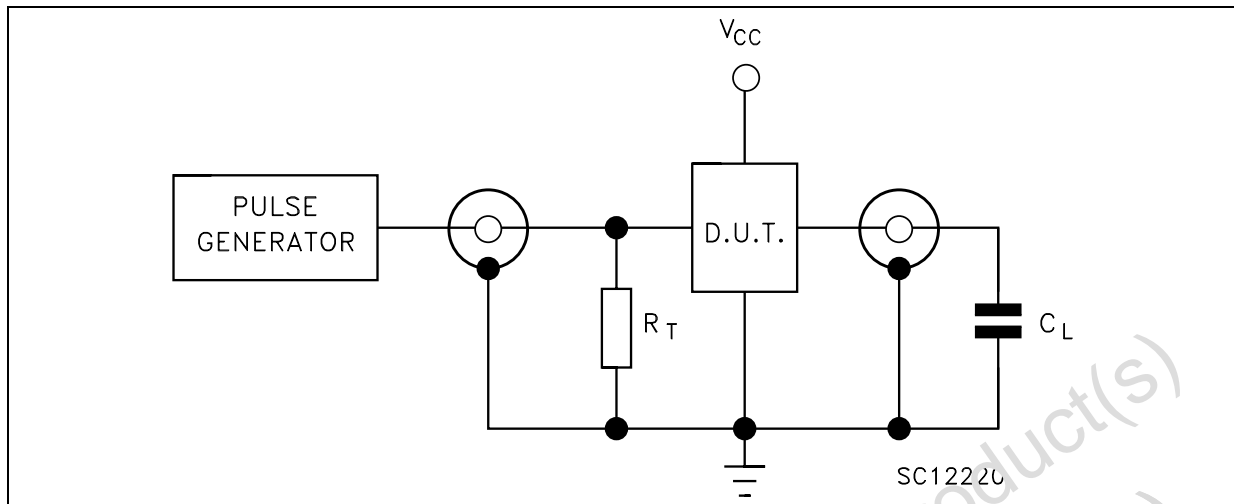
| Symbol | Parameter | Test Condition | | Value | | | | | | Unit | |
|-----------------------|----------------------------------|-----------------|--|--------------------------|------|------|------------------------------------|------|-------------------------------------|------|------|
| | | V_{CC} (V) | | $T_A = 25^\circ\text{C}$ | | | $-40 \text{ to } 85^\circ\text{C}$ | | $-55 \text{ to } 125^\circ\text{C}$ | | |
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | | Max. |
| $t_{TLH} \ t_{THL}$ | Output Transition Time (Q) | 2.0 | | | 30 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 8 | 15 | | 19 | | 22 | |
| | | 6.0 | | | 7 | 13 | | 16 | | 19 | |
| $t_{TLH} \ t_{THL}$ | Output Transition Time (TP) | 2.0 | | | 116 | 225 | | 280 | | 340 | ns |
| | | 4.5 | | | 29 | 45 | | 56 | | 68 | |
| | | 6.0 | | | 25 | 38 | | 48 | | 57 | |
| $t_{PLH} \ t_{PHL}$ | Propagation Delay Time (CLK - Q) | 2.0 | | | 145 | 330 | | 415 | | | ns |
| | | 4.5 | | | 43 | 66 | | 83 | | 15 | |
| | | 6.0 | | | 37 | 56 | | 71 | | 84 | |
| t_{PHL} | Propagation Delay Time (CLR - Q) | 2.0 | | | 110 | 260 | | 325 | | 390 | ns |
| | | 4.5 | | | 34 | 52 | | 65 | | 78 | |
| | | 6.0 | | | 29 | 44 | | 55 | | 66 | |
| f_{MAX} | Maximum Clock Frequency | 2.0 | | 6.0 | 20 | | 5 | | 4 | | MHz |
| | | 4.5 | | 32 | 64 | | 26 | | 21 | | |
| | | 6.0 | | 38 | 75 | | 31 | | 25 | | |
| $t_{W(L)} \ t_{W(H)}$ | Minimum Pulse Width (CLK) | 2.0 | | | 40 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 8 | 15 | | 19 | | 22 | |
| | | 6.0 | | | 7 | 13 | | 16 | | 20 | |
| $t_{W(L)}$ | Minimum Pulse Width (CLR) | 2.0 | | | 40 | 100 | | 125 | | 150 | ns |
| | | 4.5 | | | 10 | 20 | | 25 | | 30 | |
| | | 6.0 | | | 9 | 17 | | 21 | | 26 | |
| t_{REM} | Minimum Removal Time | 2.0 | | | | 0 | | 0 | | 0 | ns |
| | | 4.5 | | | | 0 | | 0 | | 0 | |
| | | 6.0 | | | | | 0 | | 0 | | |

CAPACITIVE CHARACTERISTICS

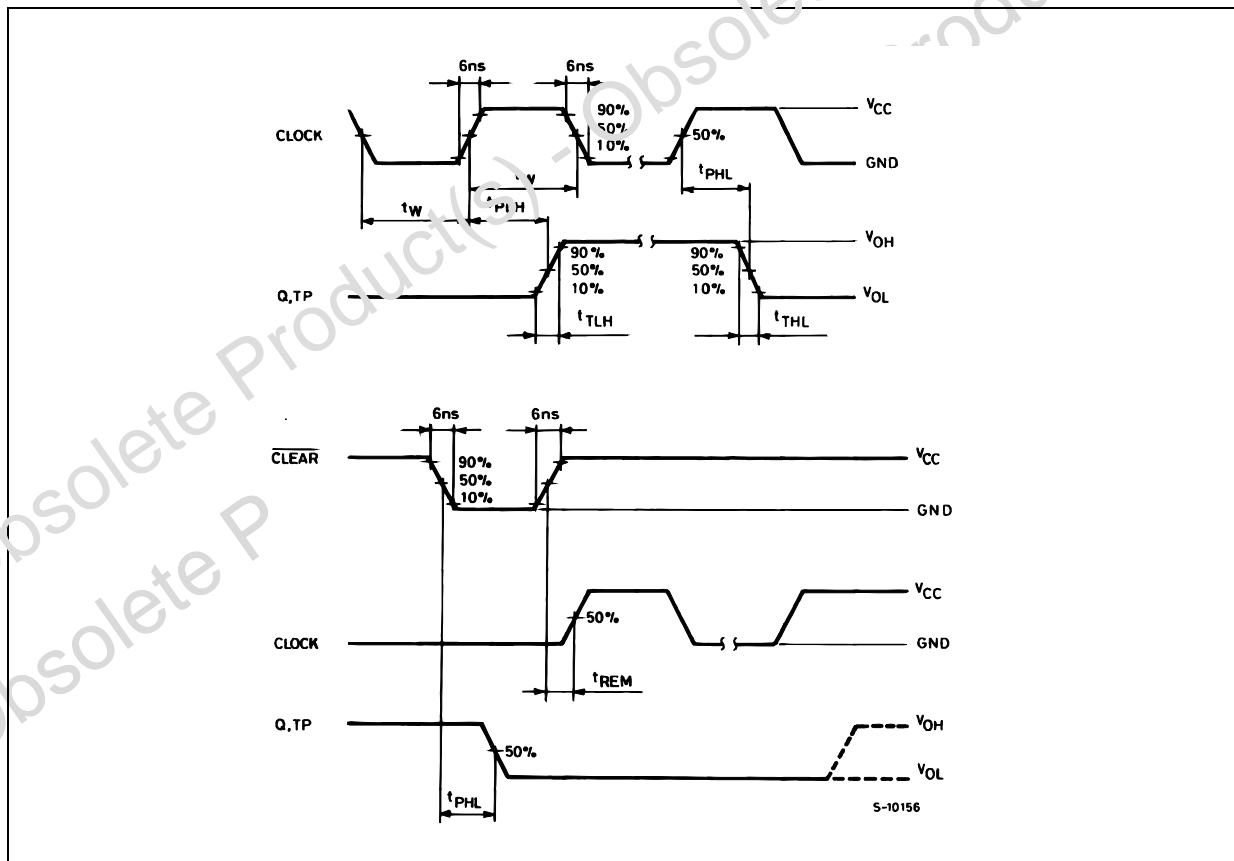
| Symbol | Parameter | Test Condition | | Value | | | | | | Unit | |
|----------|--|-----------------|--|--------------------------|------|------|------------------------------------|------|-------------------------------------|------|------|
| | | V_{CC} (V) | | $T_A = 25^\circ\text{C}$ | | | $-40 \text{ to } 85^\circ\text{C}$ | | $-55 \text{ to } 125^\circ\text{C}$ | | |
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | | Max. |
| C_{IN} | Input Capacitance | 5.0 | | | 5 | 10 | | 10 | | 10 | pF |
| C_{PD} | Power Dissipation Capacitance (note 1) | 5.0 | | | 23 | | | | | | pF |

1) C_{PD} is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation. $I_{CC(oper)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}$

TEST CIRCUIT

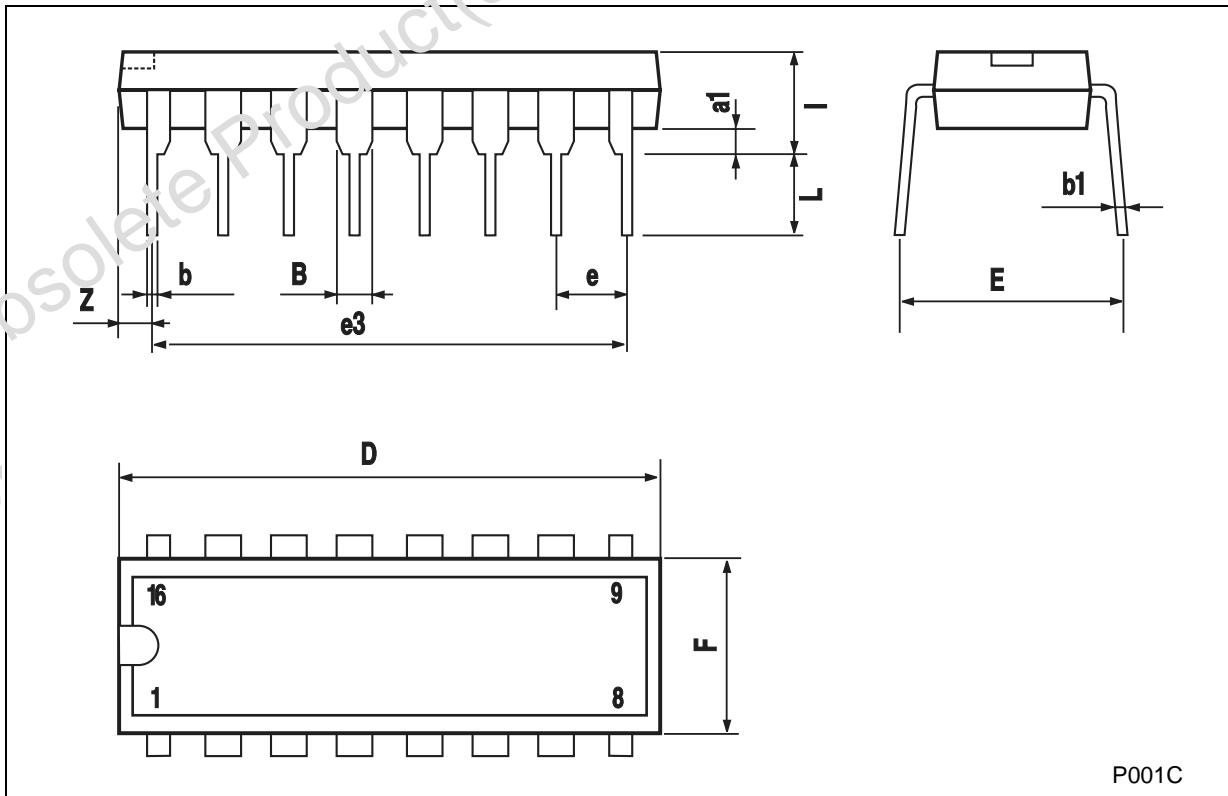


$C_L = 50\text{pF}$ or equivalent (includes jig and probe capacitance)
 $R_T = Z_{OUT}$ of pulse generator (typically 50Ω)

SWITCHING CHARACTERISTICS TEST WAVEFORM : ($f=1\text{MHz}$; 50% duty cycle)

Plastic DIP-16 (0.25) MECHANICAL DATA

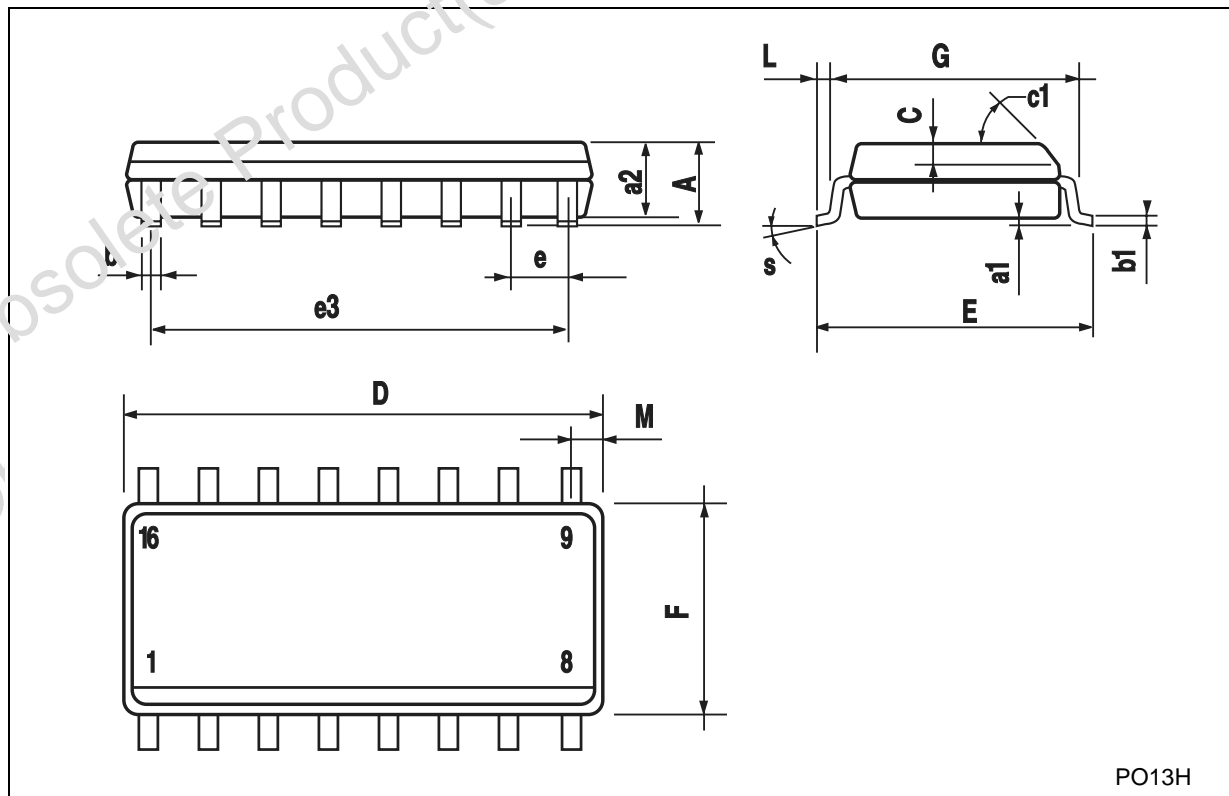
| DIM. | mm. | | | inch | | |
|------|------|-------|------|-------|-------|-------|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| a1 | 0.51 | | | 0.020 | | |
| B | 0.77 | | 1.65 | 0.030 | | 0.065 |
| b | | 0.5 | | | 0.020 | |
| b1 | | 0.25 | | | 0.010 | |
| D | | | 20 | | | 0.787 |
| E | | 8.5 | | | 0.333 | |
| e | | 2.54 | | | 0.100 | |
| e3 | | 17.78 | | | 0.700 | |
| F | | | 7.1 | | | 0.280 |
| I | | | 5.1 | | | 0.201 |
| L | | 3.3 | | | 0.130 | |
| Z | | | 1.27 | | | 0.050 |



P001C

SO-16 MECHANICAL DATA

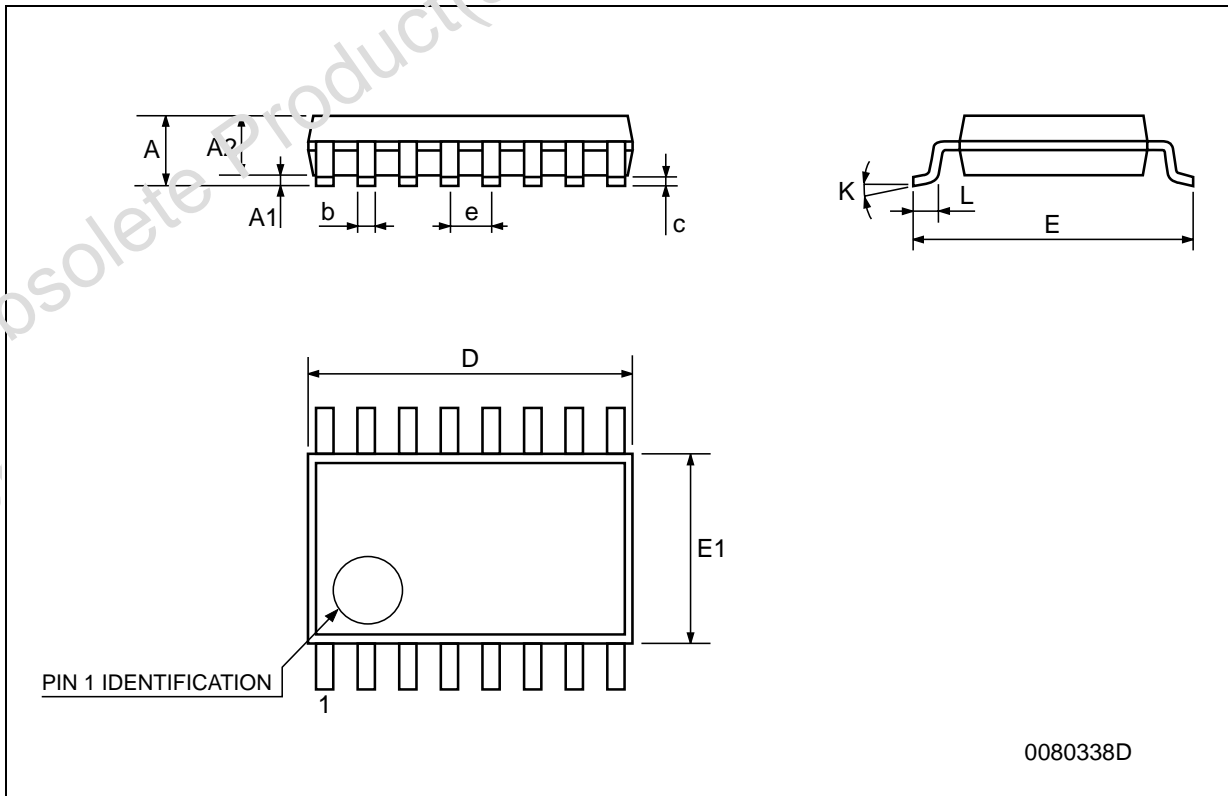
| DIM. | mm. | | | inch | | |
|------|------------|------|------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.75 | | | 0.068 |
| a1 | 0.1 | | 0.2 | 0.003 | | 0.007 |
| a2 | | | 1.65 | | | 0.064 |
| b | 0.35 | | 0.46 | 0.013 | | 0.018 |
| b1 | 0.19 | | 0.25 | 0.007 | | 0.010 |
| C | | 0.5 | | | 0.019 | |
| c1 | 45° (typ.) | | | | | |
| D | 9.8 | | 10 | 0.385 | | 0.393 |
| E | 5.8 | | 6.2 | 0.228 | | 0.244 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 8.89 | | | 0.350 | |
| F | 3.8 | | 4.0 | 0.149 | | 0.157 |
| G | 4.6 | | 5.3 | 0.181 | | 0.208 |
| L | 0.5 | | 1.27 | 0.019 | | 0.050 |
| M | | | 0.62 | | | 0.024 |
| S | 8° (max.) | | | | | |



PO13H

TSSOP16 MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|------|------|----------|------|-------|------------|--------|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.2 | | | 0.047 |
| A1 | 0.05 | | 0.15 | 0.002 | 0.004 | 0.006 |
| A2 | 0.8 | 1 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | | 0.30 | 0.007 | | 0.012 |
| c | 0.09 | | 0.20 | 0.004 | | 0.0089 |
| D | 4.9 | 5 | 5.1 | 0.193 | 0.197 | 0.201 |
| E | 6.2 | 6.4 | 6.6 | 0.244 | 0.252 | 0.260 |
| E1 | 4.3 | 4.4 | 4.48 | 0.169 | 0.173 | 0.176 |
| e | | 0.65 BSC | | | 0.0256 BSC | |
| K | 0° | | 8° | 0° | | 8° |
| L | 0.45 | 0.60 | 0.75 | 0.018 | 0.024 | 0.030 |



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