



# 74VHC374

## OCTAL D-TYPE FLIP FLOP WITH 3 STATE OUTPUTS NON INVERTING

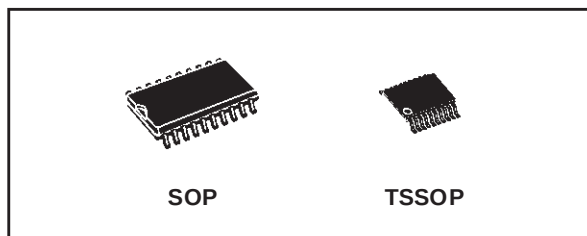
- HIGH SPEED:  
 $f_{MAX} = 270 \text{ MHz (TYP.) at } V_{CC} = 5V$
- LOW POWER DISSIPATION:  
 $I_{CC} = 4 \mu A \text{ (MAX.) at } T_A = 25^\circ C$
- HIGH NOISE IMMUNITY:  
 $V_{NIH} = V_{NIL} = 28\% V_{CC} \text{ (MIN.)}$
- POWER DOWN PROTECTION ON INPUTS
- SYMMETRICAL OUTPUT IMPEDANCE:  
 $|I_{OH}| = I_{OL} = 8 \text{ mA (MIN)}$
- BALANCED PROPAGATION DELAYS:  
 $t_{PLH} \cong t_{PHL}$
- OPERATING VOLTAGE RANGE:  
 $V_{CC(OPR)} = 2V \text{ to } 5.5V$
- PIN AND FUNCTION COMPATIBLE WITH 74 SERIES 374
- IMPROVED LATCH-UP IMMUNITY
- LOW NOISE:  $V_{OLP} = 0.9V \text{ (MAX.)}$

### DESCRIPTION

The 74VHC374 is an advanced high-speed CMOS OCTAL D-TYPE FLIP FLOP with 3 STATE OUTPUTS NON INVERTING fabricated with sub-micron silicon gate and double-layer metal wiring C<sup>2</sup>MOS technology.

These 8 bit D-Type latch are controlled by a clock input (CK) and an output enable input ( $\overline{OE}$ ).

On the positive transition of the clock, the Q outputs will be set to the logic state that were setup at the D inputs.



### ORDER CODES

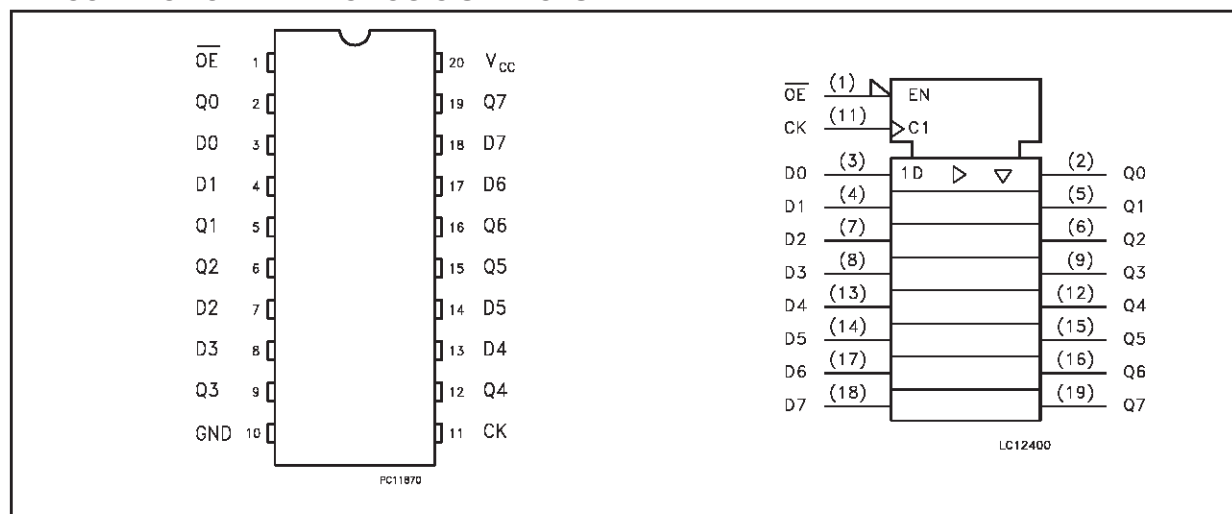
| PACKAGE | TUBE      | T & R       |
|---------|-----------|-------------|
| SOP     | 74VHC374M | 74VHC374MTR |
| TSSOP   |           | 74VHC374TTR |

While the ( $\overline{OE}$ ) input is low, the 8 outputs will be in a normal logic state (high or low logic level) and while high level the outputs will be in a high impedance state.

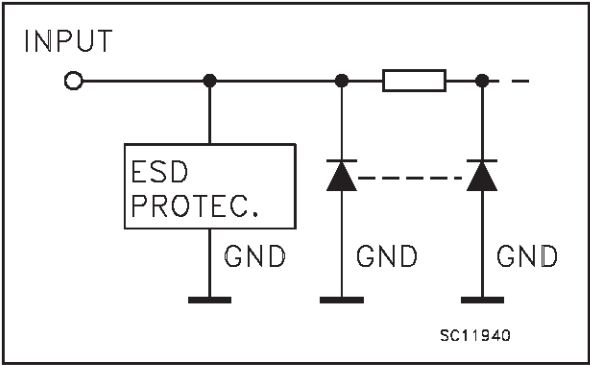
The Output control does not affect the internal operation of flip flops; that is, the old data can be retained or the new data can be entered even while the outputs are off. Power down protection is provided on all inputs and 0 to 7V can be accepted on inputs with no regard to the supply voltage. This device can be used to interface 5V to 3V.

All inputs and outputs are equipped with protection circuits against static discharge, giving them 2KV ESD immunity and transient excess voltage.

### PIN CONNECTION AND IEC LOGIC SYMBOLS



INPUT EQUIVALENT CIRCUIT



PIN DESCRIPTION

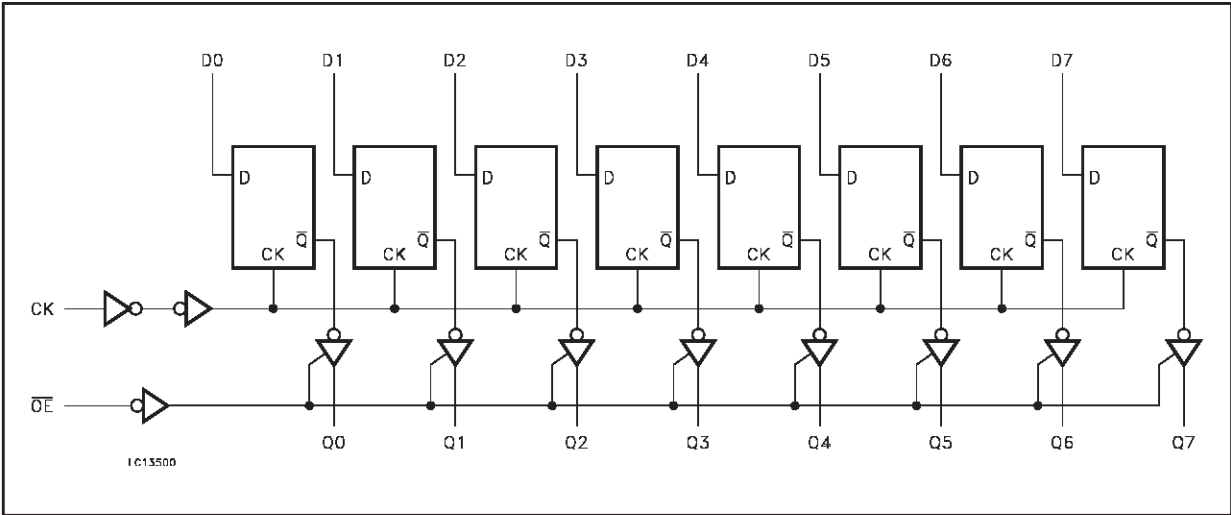
| PIN No                     | SYMBOL          | NAME AND FUNCTION                        |
|----------------------------|-----------------|------------------------------------------|
| 1                          | $\overline{OE}$ | 3 State Output Enable Input (Active LOW) |
| 2, 5, 6, 9, 12, 15, 16,19  | Q0 to Q7        | 3-State Outputs                          |
| 3, 4, 7, 8, 13, 14, 17, 18 | D0 to D7        | Data Inputs                              |
| 11                         | CK              | Clock                                    |
| 10                         | GND             | Ground (0V)                              |
| 20                         | V <sub>CC</sub> | Positive Supply Voltage                  |

TRUTH TABLE

| INPUTS          |    |   | OUTPUT    |
|-----------------|----|---|-----------|
| $\overline{OE}$ | CK | D | Q         |
| H               | X  | X | Z         |
| L               |    | X | NO CHANGE |
| L               |    | L | L         |
| L               |    | H | H         |

X : Don't Care  
Z : High Impedance

LOGIC DIAGRAM



This logic diagram has not be used to estimate propagation delays

**ABSOLUTE MAXIMUM RATINGS**

| Symbol                | Parameter                     | Value                  | Unit |
|-----------------------|-------------------------------|------------------------|------|
| $V_{CC}$              | Supply Voltage                | -0.5 to +7.0           | V    |
| $V_I$                 | DC Input Voltage              | -0.5 to +7.0           | 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       | $\pm 20$               | mA   |
| $I_O$                 | DC Output Current             | $\pm 25$               | mA   |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or Ground Current | $\pm 75$               | mA   |
| $T_{stg}$             | 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.

**RECOMMENDED OPERATING CONDITIONS**

| Symbol   | Parameter                                                                                    | Value               | Unit |
|----------|----------------------------------------------------------------------------------------------|---------------------|------|
| $V_{CC}$ | Supply Voltage                                                                               | 2 to 5.5            | V    |
| $V_I$    | Input Voltage                                                                                | 0 to 5.5            | V    |
| $V_O$    | Output Voltage                                                                               | 0 to $V_{CC}$       | V    |
| $T_{op}$ | Operating Temperature                                                                        | -55 to 125          | °C   |
| dt/dv    | Input Rise and Fall Time (note 1) ( $V_{CC} = 3.3 \pm 0.3V$ )<br>( $V_{CC} = 5.0 \pm 0.5V$ ) | 0 to 100<br>0 to 20 | ns/V |

1)  $V_{IN}$  from 30% to 70% of  $V_{CC}$

## DC SPECIFICATIONS

| Symbol          | Parameter                             | Test Condition         |                                                                                                | Value                 |      |                    |                    |                    |                    |                    |    | Unit |
|-----------------|---------------------------------------|------------------------|------------------------------------------------------------------------------------------------|-----------------------|------|--------------------|--------------------|--------------------|--------------------|--------------------|----|------|
|                 |                                       | V <sub>CC</sub><br>(V) |                                                                                                | T <sub>A</sub> = 25°C |      |                    | -40 to 85°C        |                    | -55 to 125°C       |                    |    |      |
|                 |                                       |                        |                                                                                                | Min.                  | Typ. | Max.               | Min.               | Max.               | Min.               | Max.               |    |      |
| V <sub>IH</sub> | High Level Input Voltage              | 2.0                    |                                                                                                | 1.5                   |      |                    | 1.5                |                    | 1.5                |                    | V  |      |
|                 |                                       | 3.0 to 5.5             |                                                                                                | 0.7V <sub>CC</sub>    |      |                    | 0.7V <sub>CC</sub> |                    | 0.7V <sub>CC</sub> |                    |    |      |
| V <sub>IL</sub> | Low Level Input Voltage               | 2.0                    |                                                                                                |                       |      | 0.5                |                    | 0.5                |                    | 0.5                | V  |      |
|                 |                                       | 3.0 to 5.5             |                                                                                                |                       |      | 0.3V <sub>CC</sub> |                    | 0.3V <sub>CC</sub> |                    | 0.3V <sub>CC</sub> |    |      |
| V <sub>OH</sub> | High Level Output Voltage             | 2.0                    | I <sub>O</sub> =-50 μA                                                                         | 1.9                   | 2.0  |                    | 1.9                |                    | 1.9                |                    | V  |      |
|                 |                                       | 3.0                    | I <sub>O</sub> =-50 μA                                                                         | 2.9                   | 3.0  |                    | 2.9                |                    | 2.9                |                    |    |      |
|                 |                                       | 4.5                    | I <sub>O</sub> =-50 μA                                                                         | 4.4                   | 4.5  |                    | 4.4                |                    | 4.4                |                    |    |      |
|                 |                                       | 3.0                    | I <sub>O</sub> =-4 mA                                                                          | 2.58                  |      |                    | 2.48               |                    | 2.4                |                    |    |      |
|                 |                                       | 4.5                    | I <sub>O</sub> =-8 mA                                                                          | 3.94                  |      |                    | 3.8                |                    | 3.7                |                    |    |      |
| V <sub>OL</sub> | Low Level Output Voltage              | 2.0                    | I <sub>O</sub> =50 μA                                                                          |                       | 0.0  | 0.1                |                    | 0.1                |                    | 0.1                | V  |      |
|                 |                                       | 3.0                    | I <sub>O</sub> =50 μA                                                                          |                       | 0.0  | 0.1                |                    | 0.1                |                    | 0.1                |    |      |
|                 |                                       | 4.5                    | I <sub>O</sub> =50 μA                                                                          |                       | 0.0  | 0.1                |                    | 0.1                |                    | 0.1                |    |      |
|                 |                                       | 3.0                    | I <sub>O</sub> =4 mA                                                                           |                       |      | 0.36               |                    | 0.44               |                    | 0.55               |    |      |
|                 |                                       | 4.5                    | I <sub>O</sub> =8 mA                                                                           |                       |      | 0.36               |                    | 0.44               |                    | 0.55               |    |      |
| I <sub>OZ</sub> | High Impedance Output Leakage Current | 5.5                    | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>V <sub>O</sub> = V <sub>CC</sub> or GND |                       |      | ±0.25              |                    | ± 2.5              |                    | ± 2.5              | μA |      |
| I <sub>I</sub>  | Input Leakage Current                 | 0 to 5.5               | V <sub>I</sub> = 5.5V or GND                                                                   |                       |      | ± 0.1              |                    | ± 1                |                    | ± 1                | μA |      |
| I <sub>CC</sub> | Quiescent Supply Current              | 5.5                    | V <sub>I</sub> = V <sub>CC</sub> or GND                                                        |                       |      | 4                  |                    | 40                 |                    | 40                 | μA |      |

**AC ELECTRICAL CHARACTERISTICS** (Input  $t_r = t_f = 3\text{ns}$ )

| Symbol                                 | Parameter                              | Test Condition         |                        |                      | Value                 |      |      |             |      |              |      | Unit |
|----------------------------------------|----------------------------------------|------------------------|------------------------|----------------------|-----------------------|------|------|-------------|------|--------------|------|------|
|                                        |                                        | V <sub>CC</sub><br>(V) | C <sub>L</sub><br>(pF) |                      | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      | -55 to 125°C |      |      |
|                                        |                                        |                        |                        |                      | Min.                  | Typ. | Max. | Min.        | Max. | Min.         | Max. |      |
| t <sub>PLH</sub><br>t <sub>PHL</sub>   | Propagation Delay<br>Time<br>CK to Q   | 3.3 <sup>(*)</sup>     | 15                     |                      |                       | 8.1  | 12.7 | 1.0         | 15.0 | 1.0          | 15.0 | ns   |
|                                        |                                        | 3.3 <sup>(*)</sup>     | 50                     |                      |                       | 10.6 | 16.2 | 1.0         | 18.5 | 1.0          | 18.5 |      |
|                                        |                                        | 5.0 <sup>(**)</sup>    | 15                     |                      |                       | 5.4  | 8.1  | 1.0         | 9.5  | 1.0          | 9.5  |      |
|                                        |                                        | 5.0 <sup>(**)</sup>    | 50                     |                      |                       | 6.9  | 10.1 | 1.0         | 11.5 | 1.0          | 11.5 |      |
| t <sub>PZL</sub><br>t <sub>PZH</sub>   | Output Enable<br>Time                  | 3.3 <sup>(*)</sup>     | 15                     | R <sub>L</sub> = 1KΩ |                       | 7.1  | 11.0 | 1.0         | 13.0 | 1.0          | 13.0 | ns   |
|                                        |                                        | 3.3 <sup>(*)</sup>     | 50                     | R <sub>L</sub> = 1KΩ |                       | 9.6  | 14.5 | 1.0         | 16.5 | 1.0          | 16.5 |      |
|                                        |                                        | 5.0 <sup>(**)</sup>    | 15                     | R <sub>L</sub> = 1KΩ |                       | 5.1  | 7.6  | 1.0         | 9.0  | 1.0          | 9.0  |      |
|                                        |                                        | 5.0 <sup>(**)</sup>    | 50                     | R <sub>L</sub> = 1KΩ |                       | 6.6  | 9.6  | 1.0         | 11.0 | 1.0          | 11.0 |      |
| t <sub>PLZ</sub><br>t <sub>PHZ</sub>   | Output Disable<br>Time                 | 3.3 <sup>(*)</sup>     | 15                     | R <sub>L</sub> = 1KΩ |                       | 10.2 | 14.0 | 1.0         | 16.0 | 1.0          | 16.0 | ns   |
|                                        |                                        | 3.3 <sup>(*)</sup>     | 50                     | R <sub>L</sub> = 1KΩ |                       | 6.1  | 8.8  | 1.0         | 10.0 | 1.0          | 10.0 |      |
| t <sub>w</sub>                         | Clock Pulse Width<br>HIGH or LOW       | 3.3 <sup>(*)</sup>     |                        |                      |                       |      | 5.0  |             | 5.5  |              | 5.5  | ns   |
|                                        |                                        | 5.0 <sup>(**)</sup>    |                        |                      |                       |      | 5.0  |             | 5.0  |              | 5.0  |      |
| t <sub>s</sub>                         | Setup Time D to CK<br>HIGH or LOW      | 3.3 <sup>(*)</sup>     |                        |                      |                       |      | 4.5  |             | 4.5  |              | 4.5  | ns   |
|                                        |                                        | 5.0 <sup>(**)</sup>    |                        |                      |                       |      | 3.0  |             | 3.0  |              | 3.0  |      |
| t <sub>h</sub>                         | Hold Time D to CK<br>HIGH or LOW       | 3.3 <sup>(*)</sup>     |                        |                      |                       |      | 2.0  |             | 2.0  |              | 2.0  | ns   |
|                                        |                                        | 5.0 <sup>(**)</sup>    |                        |                      |                       |      | 2.0  |             | 2.0  |              | 2.0  |      |
| f <sub>MAX</sub>                       | Maximum Clock<br>Frequency             | 3.3 <sup>(*)</sup>     |                        |                      | 60                    | 250  |      | 60          |      | 60           |      | MHz  |
|                                        |                                        | 5.0 <sup>(**)</sup>    |                        |                      | 100                   | 270  |      | 100         |      | 100          |      |      |
| t <sub>OSLH</sub><br>t <sub>OSHL</sub> | Output to Output<br>Skew time (note 1) | 3.3 <sup>(*)</sup>     | 50                     |                      |                       |      | 1.5  |             | 1.5  |              | 1.5  | ns   |
|                                        |                                        | 5.0 <sup>(**)</sup>    | 50                     |                      |                       |      | 1.0  |             | 1.0  |              | 1.0  |      |

(\*) Voltage range is  $3.3V \pm 0.3V$ (\*\*) Voltage range is  $5.0V \pm 0.5V$ Note 1 : Parameter guaranteed by design.  $t_{SOLH} = |t_{PLHm} - t_{PLHn}|$ ,  $t_{SOHL} = |t_{PHLm} - t_{PHLn}|$ **CAPACITIVE CHARACTERISTICS**

| Symbol           | Parameter                              | Test Condition | Value                 |      |      |             |      |              |    |    | Unit |
|------------------|----------------------------------------|----------------|-----------------------|------|------|-------------|------|--------------|----|----|------|
|                  |                                        |                | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      | -55 to 125°C |    |    |      |
|                  |                                        | Min.           | Typ.                  | Max. | Min. | Max.        | Min. | Max.         |    |    |      |
| C <sub>IN</sub>  | Input Capacitance                      |                |                       | 7    | 10   |             | 10   |              | 10 | pF |      |
| C <sub>OUT</sub> | Output Capacitance                     |                |                       | 9    |      |             |      |              |    | pF |      |
| C <sub>PD</sub>  | Power Dissipation Capacitance (note 1) |                |                       | 32   |      |             |      |              |    | 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.  $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/8$  (per Flip-Flop)

## DYNAMIC SWITCHING CHARACTERISTICS

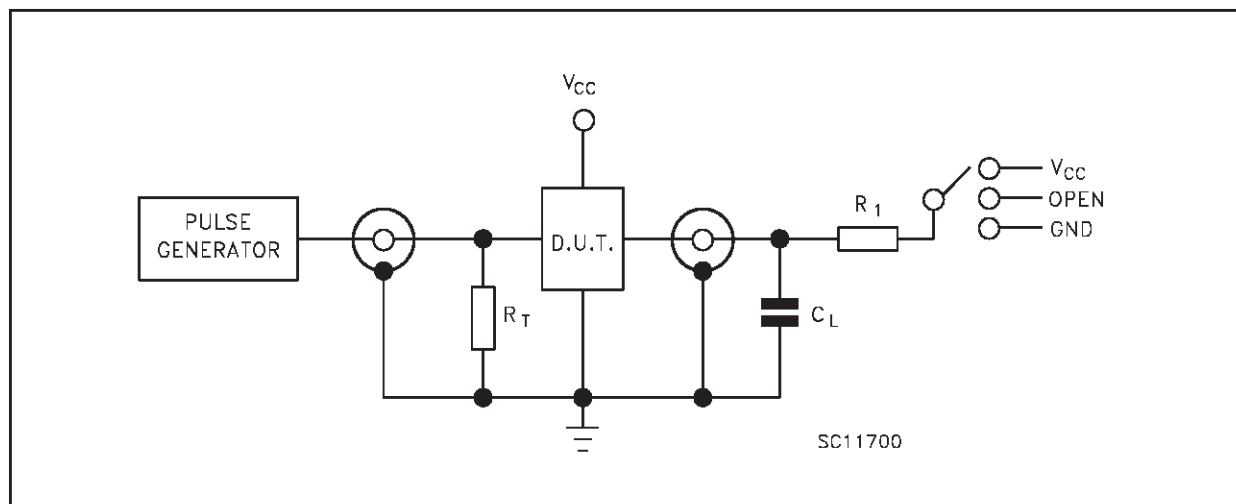
| Symbol           | Parameter                                    | Test Condition         |                        | Value                 |      |      |             |      |              | Unit |      |
|------------------|----------------------------------------------|------------------------|------------------------|-----------------------|------|------|-------------|------|--------------|------|------|
|                  |                                              | V <sub>CC</sub><br>(V) |                        | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      | -55 to 125°C |      |      |
|                  |                                              |                        |                        | Min.                  | Typ. | Max. | Min.        | Max. | Min.         |      | Max. |
| V <sub>OLP</sub> | Dynamic Low Voltage Quiet Output (note 1, 2) | 5.0                    | C <sub>L</sub> = 50 pF |                       | 0.6  | 0.9  |             |      |              |      | V    |
| V <sub>OLV</sub> |                                              |                        |                        | -0.9                  | -0.6 |      |             |      |              |      |      |
| V <sub>IHD</sub> | Dynamic High Voltage Input (note 1, 3)       | 5.0                    |                        | 3.5                   |      |      |             |      |              |      | V    |
| V <sub>ILD</sub> | Dynamic Low Voltage Input (note 1, 3)        | 5.0                    |                        |                       |      |      | 1.5         |      |              |      |      |

1) Worst case package.

2) Max number of outputs defined as (n). Data inputs are driven 0V to 5.0V, (n-1) outputs switching and one output at GND.

3) Max number of data inputs (n) switching. (n-1) switching 0V to 5.0V. Inputs under test switching: 5.0V to threshold (V<sub>ILD</sub>), 0V to threshold (V<sub>IHD</sub>), f=1MHz.

## TEST CIRCUIT

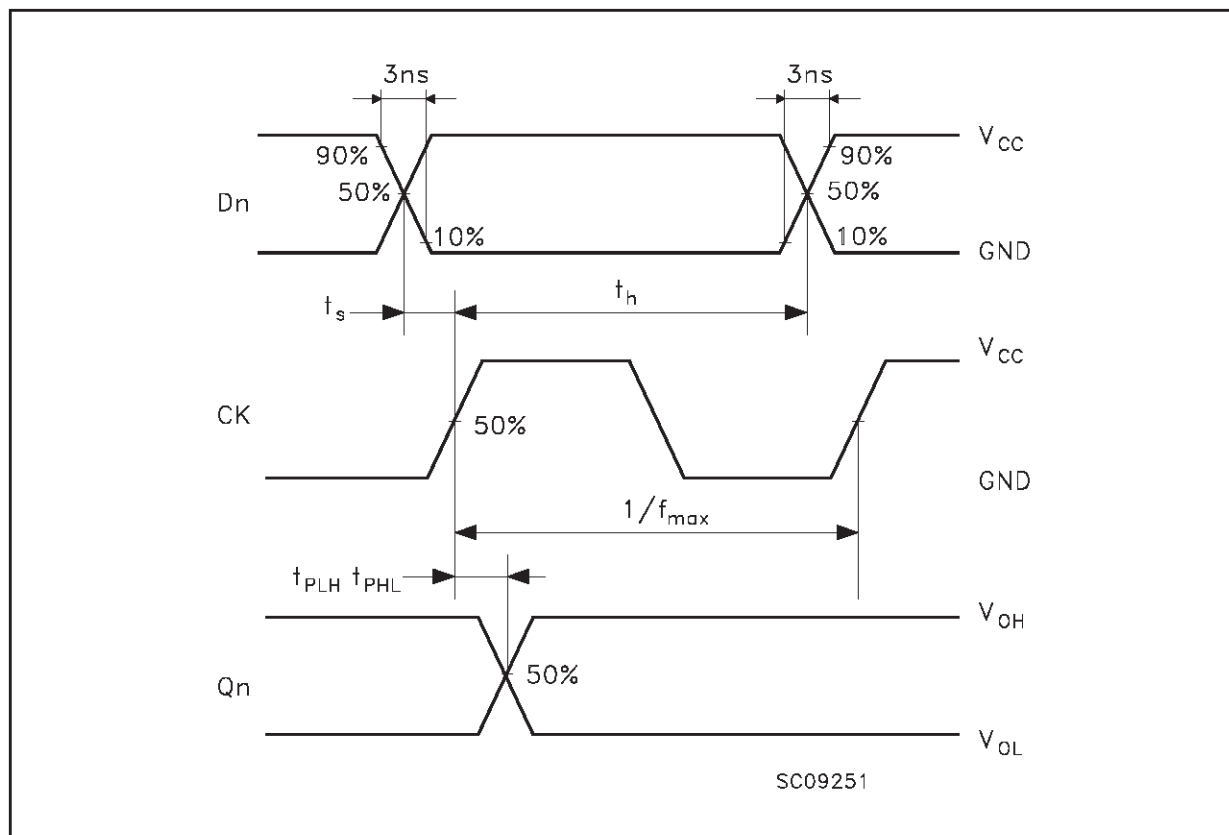


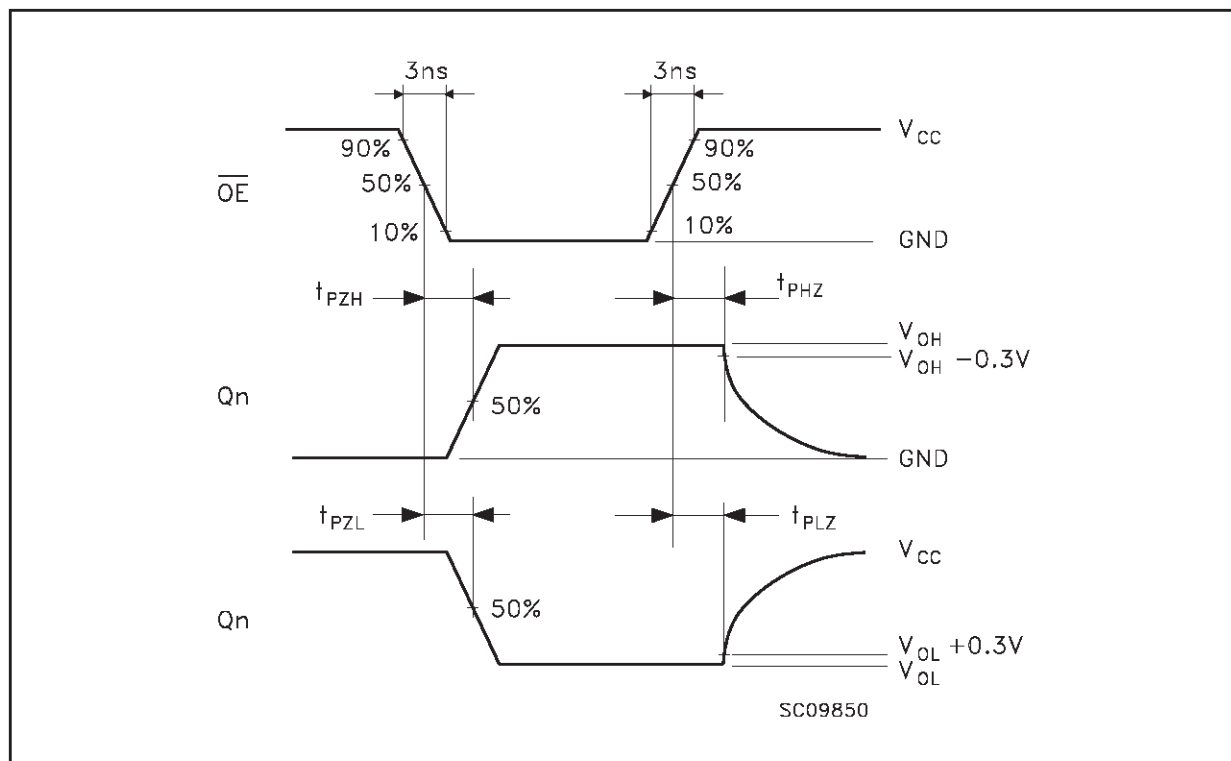
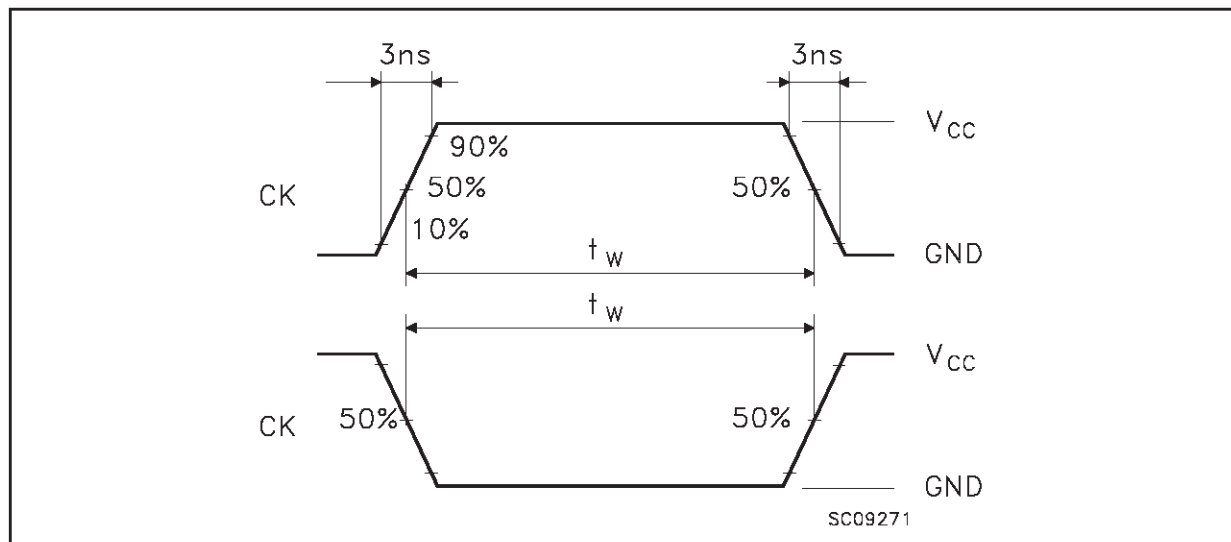
| TEST                                | SWITCH          |
|-------------------------------------|-----------------|
| t <sub>PLH</sub> , t <sub>PHL</sub> | Open            |
| t <sub>PZL</sub> , t <sub>PLZ</sub> | V <sub>CC</sub> |
| t <sub>PZH</sub> , t <sub>PHZ</sub> | GND             |

C<sub>L</sub> = 15/50pF or equivalent (includes jig and probe capacitance)

R<sub>L</sub> = R<sub>1</sub> = 1KΩ or equivalent

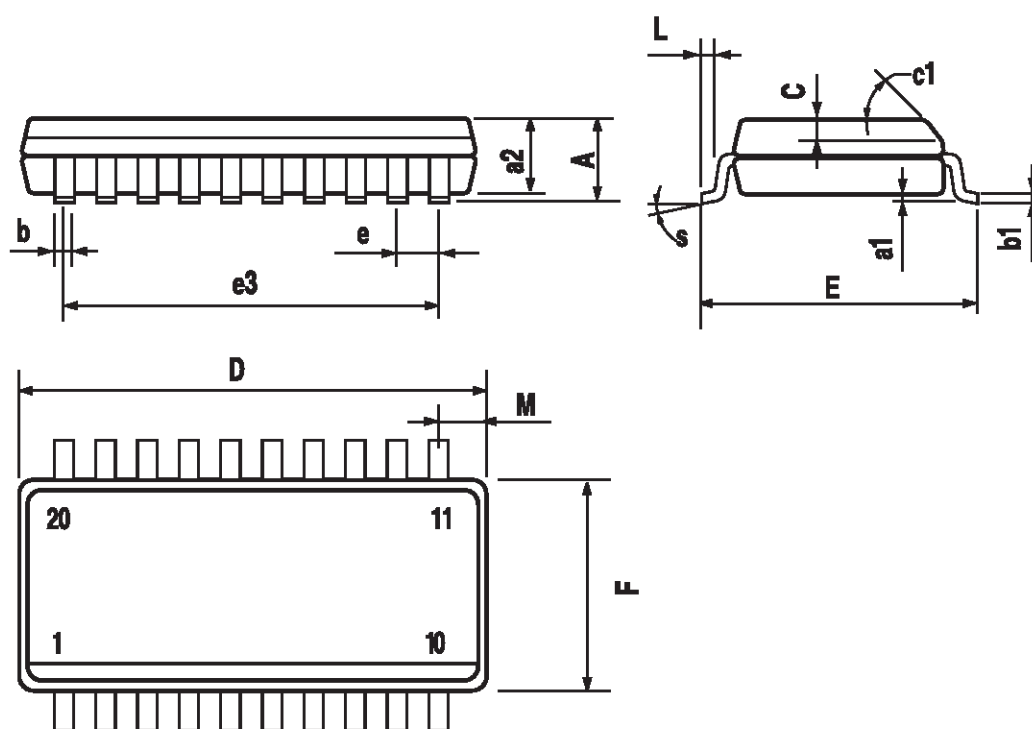
R<sub>T</sub> = Z<sub>OUT</sub> of pulse generator (typically 50Ω)

**WAVEFORM 1: PROPAGATION DELAYS, SETUP AND HOLD TIMES ( $f=1\text{MHz}$ ; 50% duty cycle)**

**WAVEFORM 2: OUTPUT ENABLE AND DISABLE TIMES** ( $f=1\text{MHz}$ ; 50% duty cycle)**WAVEFORM 3: PULSE WIDTH** ( $f=1\text{MHz}$ ; 50% duty cycle)

## SO-20 MECHANICAL DATA

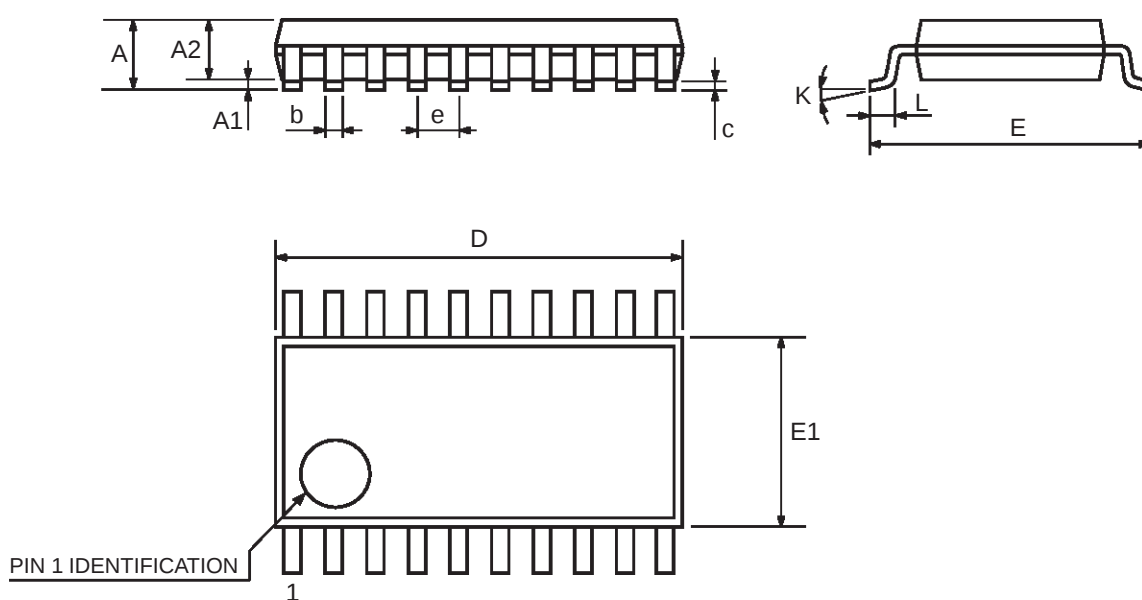
| DIM. | mm.        |       |       | inch  |       |       |
|------|------------|-------|-------|-------|-------|-------|
|      | MIN.       | TYP   | MAX.  | MIN.  | TYP.  | MAX.  |
| A    |            |       | 2.65  |       |       | 0.104 |
| a1   | 0.1        |       | 0.2   | 0.004 |       | 0.008 |
| a2   |            |       | 2.45  |       |       | 0.096 |
| b    | 0.35       |       | 0.49  | 0.014 |       | 0.019 |
| b1   | 0.23       |       | 0.32  | 0.009 |       | 0.012 |
| C    |            | 0.5   |       |       | 0.020 |       |
| c1   | 45° (typ.) |       |       |       |       |       |
| D    | 12.60      |       | 13.00 | 0.496 |       | 0.512 |
| E    | 10.00      |       | 10.65 | 0.393 |       | 0.419 |
| e    |            | 1.27  |       |       | 0.050 |       |
| e3   |            | 11.43 |       |       | 0.450 |       |
| F    | 7.40       |       | 7.60  | 0.291 |       | 0.300 |
| L    | 0.50       |       | 1.27  | 0.020 |       | 0.050 |
| M    |            |       | 0.75  |       |       | 0.029 |
| S    | 8° (max.)  |       |       |       |       |       |



PO13L

## TSSOP20 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    | 6.4  | 6.5      | 6.6  | 0.252 | 0.256      | 0.260  |
| 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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