



# 74ALVCH16374

## LOW VOLTAGE CMOS 16-BIT D-TYPE FLIP-FLOP (3-STATE) WITH 3.6V TOLERANT INPUTS AND OUTPUTS

- 3.6V TOLERANT INPUTS AND OUTPUTS
- HIGH SPEED :
  - $t_{PD} = 4.2 \text{ ns (MAX.) at } V_{CC} = 3.0 \text{ to } 3.6V$
  - $t_{PD} = 5.3 \text{ ns (MAX.) at } V_{CC} = 2.3 \text{ to } 2.7V$
  - $t_{PD} = 6.5 \text{ ns (MAX.) at } V_{CC} = 1.65V$
- POWER DOWN PROTECTION ON INPUTS AND OUTPUTS
- SYMMETRICAL OUTPUT IMPEDANCE:
  - $|I_{OH}| = I_{OL} = 24mA \text{ (MIN) at } V_{CC} = 3.0V$
  - $|I_{OH}| = I_{OL} = 18mA \text{ (MIN) at } V_{CC} = 2.3V$
  - $|I_{OH}| = I_{OL} = 4mA \text{ (MIN) at } V_{CC} = 1.65V$
- OPERATING VOLTAGE RANGE:
  - $V_{CC(OPR)} = 1.65V \text{ to } 3.6V$
- PIN AND FUNCTION COMPATIBLE WITH 74 SERIES 16374
- BUS HOLD PROVIDED ON DATA INPUTS
- LATCH-UP PERFORMANCE EXCEEDS 300mA (JESD 17)
- ESD PERFORMANCE:
  - HBM > 2000V (MIL STD 883 method 3015);
  - MM > 200V

### DESCRIPTION

The 74ALVCH16374 is a low voltage CMOS 16 BIT D-TYPE FLIP-FLOP with 3 STATE OUTPUTS NON INVERTING fabricated with sub-micron silicon gate and five-layer metal wiring C<sup>2</sup>MOS technology. It is ideal for low power and very high speed 1.65 to 3.6V applications; it can be interfaced to 3.6V signal environment for both inputs and outputs.

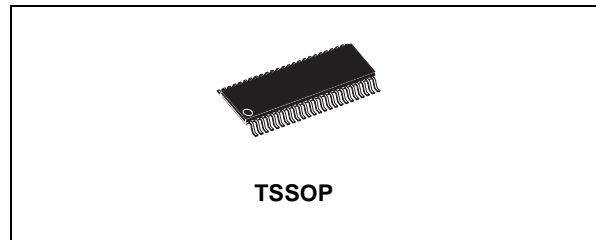
These 16 bit D-TYPE flip-flops are controlled by two clock inputs (nCK) and two output enable inputs (nOE).

On the positive transition of the (nCK), the nQ outputs will be set to the logic state that were set-up at the nD inputs.

While the (nOE) input is low, the outputs (nQ) will be in a normal state (HIGH or LOW logic level) and while high level the outputs will be in a high impedance state. Any 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.

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

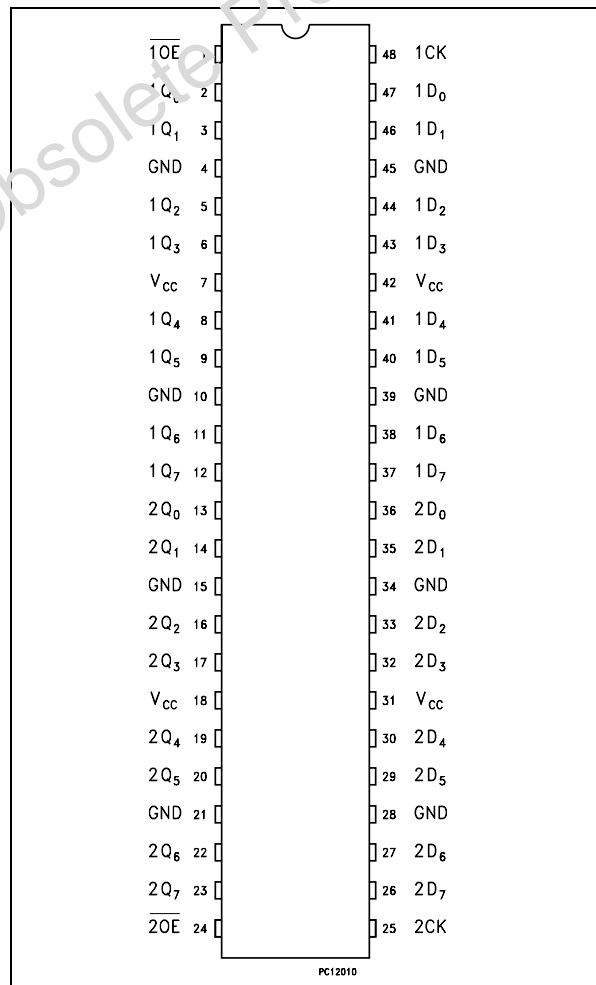
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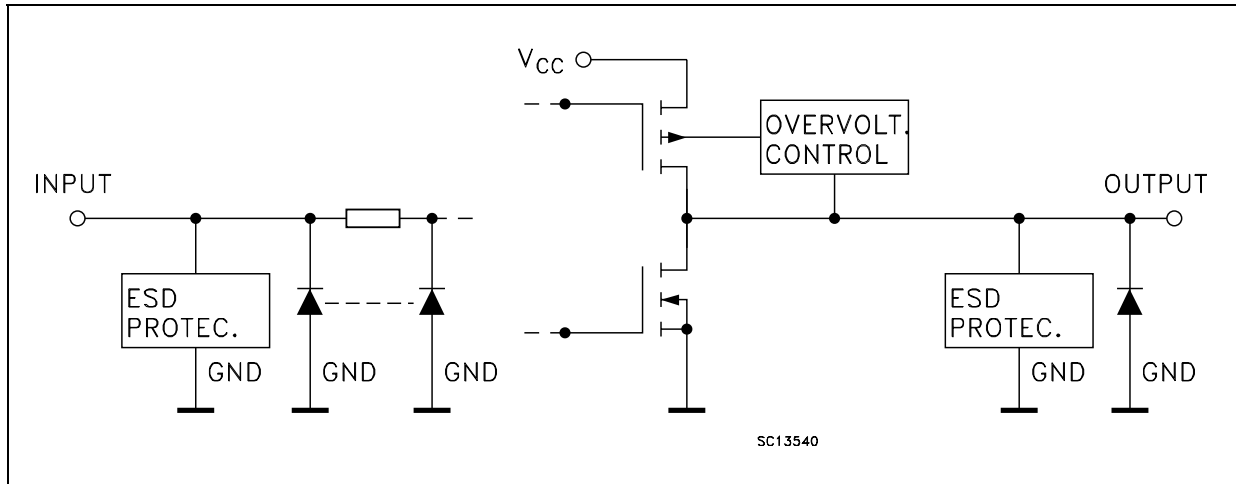
### ORDER CODES

| PACKAGE | TUBE | T & R           |
|---------|------|-----------------|
| TSSOP   |      | 74ALVCH16374TTR |

### PIN CONNECTION



INPUT AND OUTPUT EQUIVALENT CIRCUIT



PIN DESCRIPTION

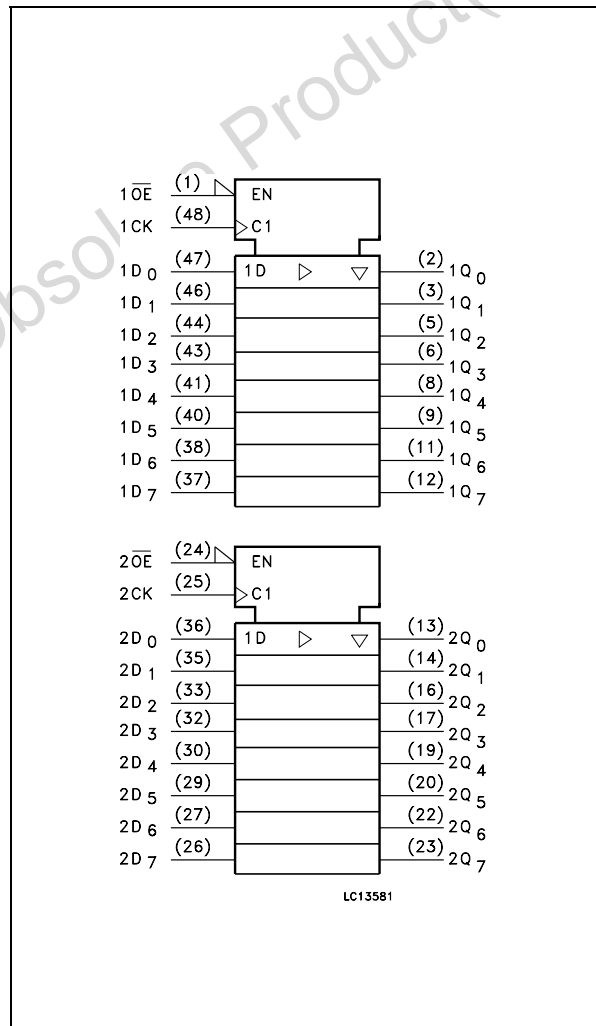
| PIN No                         | SYMBOL     | NAME AND FUNCTION                        |
|--------------------------------|------------|--|
| 1                              | 1OE        | 3 State Output Enable Input (Active LOW) |
| 2, 3, 5, 6, 8, 9, 11, 12       | 1Q0 to 1Q7 | 3-State Outputs                          |
| 13, 14, 16, 17, 19, 20, 22, 23 | 2Q0 to 2Q7 | 3-State Outputs                          |
| 24                             | 2OE        | 3 State Output Enable Input (Active LOW) |
| 25                             | 2CK        | Clock Input                              |
| 36, 35, 33, 32, 30, 29, 27, 26 | 2D0 to 2D7 | Data Inputs                              |
| 47, 46, 44, 43, 41, 40, 38, 37 | 1D0 to 1D7 | Data Inputs                              |
| 48                             | 1CK        | Clock Input                              |
| 4, 10, 15, 21, 28, 34, 39, 45  | GND        | Ground (0V)                              |
| 7, 18, 31, 42                  | VCC        | Positive Supply Voltage                  |

TRUTH TABLE

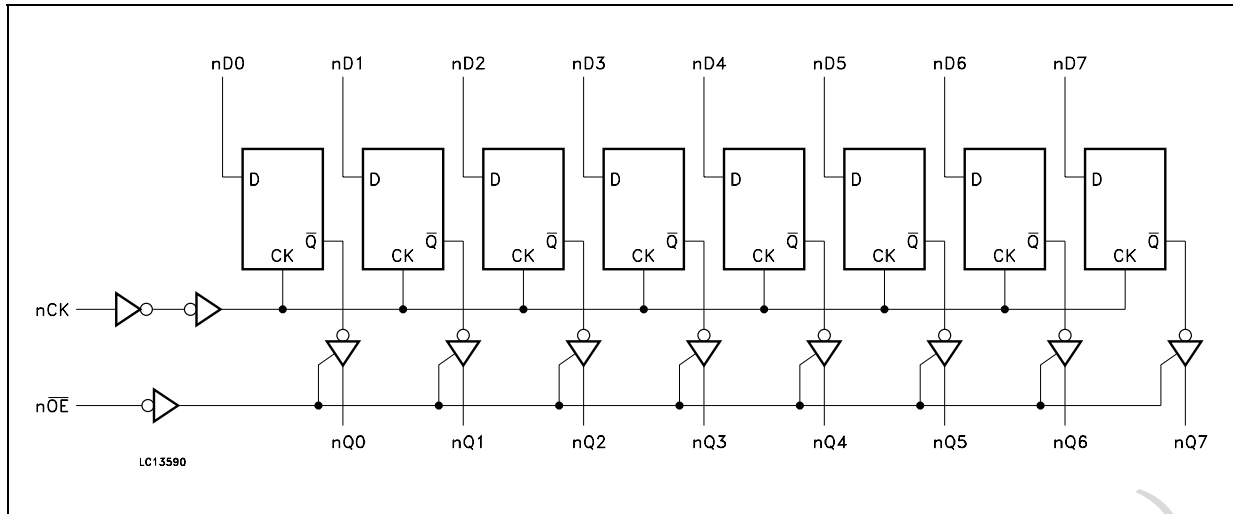
| INPUTS |    |   | OUTPUT    |
|--------|----|---|-----------|
| OE     | CK | D | Q         |
| H      | X  | X | Z         |
| L      |    | X | NO CHANGE |
| L      |    | L | L         |
| L      |    | H | H         |

X : Don't Care  
Z : High Impedance

IEC LOGIC SYMBOLS



## LOGIC DIAGRAM



## ABSOLUTE MAXIMUM RATINGS

| Symbol                | Parameter                                      | Value                  | Unit        |
|-----------------------|--|------------------------|-------------|
| $V_{CC}$              | Supply Voltage                                 | -0.5 to +4.6           | V           |
| $V_I$                 | DC Input Voltage                               | -0.5 to +4.6           | V           |
| $V_O$                 | DC Output Voltage (OFF State)                  | -0.5 to +4.6           | V           |
| $V_O$                 | DC Output Voltage (High or Low State) (note 1) | -0.5 to $V_{CC} + 0.5$ | V           |
| $I_{IK}$              | DC Input Diode Current                         | - 50                   | mA          |
| $I_{OK}$              | DC Output Diode Current (note 2)               | - 50                   | mA          |
| $I_O$                 | DC Output Current                              | $\pm 50$               | mA          |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or Ground Current per Supply Pin   | $\pm 100$              | mA          |
| $P_D$                 | Power Dissipation                              | 400                    | mW          |
| $T_{stg}$             | Storage Temperature                            | -65 to +150            | $^{\circ}C$ |
| $T_L$                 | Lead Temperature (10 sec)                      | 300                    | $^{\circ}C$ |

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

1)  $I_O$  absolute maximum rating must be observed

2)  $V_O < GND$ ,  $V_O > V_{CC}$

## RECOMMENDED OPERATING CONDITIONS

| Symbol              | Parameter   | Value         | Unit        |
|---------------------|---|---------------|-------------|
| $V_{CC}$            | Supply Voltage  | 1.65 to 3.6   | V           |
| $V_I$               | Input Voltage   | -0.3 to 3.6   | V           |
| $V_O$               | Output Voltage (OFF State)                                    | 0 to 3.6      | V           |
| $V_O$               | Output Voltage (High or Low State)                            | 0 to $V_{CC}$ | V           |
| $I_{OH}$ , $I_{OL}$ | High or Low Level Output Current ( $V_{CC} = 3.0$ to $3.6V$ ) | $\pm 24$      | mA          |
| $I_{OH}$ , $I_{OL}$ | High or Low Level Output Current ( $V_{CC} = 2.3$ to $2.7V$ ) | $\pm 12$      | mA          |
| $I_{OH}$ , $I_{OL}$ | High or Low Level Output Current ( $V_{CC} = 1.65V$ )         | $\pm 4$       | mA          |
| $T_{op}$            | Operating Temperature   | -55 to 125    | $^{\circ}C$ |
| dt/dv               | Input Rise and Fall Time (note 1)                             | 0 to 10       | ns/V        |

1)  $V_{IN}$  from 0.8V to 2V at  $V_{CC} = 3.0V$

## DC SPECIFICATIONS

| Symbol             | Parameter                             | Test Condition         |  | Value                |                      |                      |                      | Unit |
|--------------------|---------------------------------------|------------------------|--|----------------------|----------------------|----------------------|----------------------|------|
|                    |                                       | V <sub>CC</sub><br>(V) |  | -40 to 85 °C         |                      | -55 to 125 °C        |                      |      |
|                    |                                       |                        |  | Min.                 | Max.                 | Min.                 | Max.                 |      |
| V <sub>IH</sub>    | High Level Input Voltage              | 1.65 to 1.95           |  | 0.65 V <sub>CC</sub> |                      | 0.65 V <sub>CC</sub> |                      | V    |
|                    |                                       | 2.3 to 2.7             |  | 1.7                  |                      | 1.7                  |                      |      |
|                    |                                       | 2.7 to 3.6             |  | 2.0                  |                      | 2.0                  |                      |      |
| V <sub>IL</sub>    | Low Level Input Voltage               | 1.65 to 1.95           |  |                      | 0.35 V <sub>CC</sub> |                      | 0.35 V <sub>CC</sub> | V    |
|                    |                                       | 2.3 to 2.7             |  |                      | 0.7                  |                      | 0.7                  |      |
|                    |                                       | 2.7 to 3.6             |  |                      | 0.8                  |                      | 0.8                  |      |
| V <sub>OH</sub>    | High Level Output Voltage             | 1.65 to 3.6            | I <sub>O</sub> =-100 μA  | V <sub>CC</sub> -0.2 |                      | V <sub>CC</sub> -0.2 |                      | V    |
|                    |                                       | 1.65                   | I <sub>O</sub> =-4 mA  | 1.2                  |                      | 1.2                  |                      |      |
|                    |                                       | 2.3                    | I <sub>O</sub> =-6 mA  | 2.0                  |                      | 2.0                  |                      |      |
|                    |                                       | 2.3                    | I <sub>O</sub> =-12 mA   | 1.7                  |                      | 1.7                  |                      |      |
|                    |                                       | 2.7                    | I <sub>O</sub> =-12 mA   | 2.2                  |                      | 2.2                  |                      |      |
|                    |                                       | 3.0                    | I <sub>O</sub> =-12 mA   | 2.4                  |                      | 2.4                  |                      |      |
| V <sub>OL</sub>    | Low Level Output Voltage              | 1.65 to 3.6            | I <sub>O</sub> =100 μA   |                      | 0.2                  |                      | 0.2                  | V    |
|                    |                                       | 1.65                   | I <sub>O</sub> =4 mA   |                      | 0.45                 |                      | 0.45                 |      |
|                    |                                       | 2.3                    | I <sub>O</sub> =6 mA   |                      | 0.4                  |                      | 0.4                  |      |
|                    |                                       | 2.3                    | I <sub>O</sub> =12 mA  |                      | 0.7                  |                      | 0.7                  |      |
|                    |                                       | 2.7                    | I <sub>O</sub> =12 mA  |                      | 0.4                  |                      | 0.4                  |      |
|                    |                                       | 3.0                    | I <sub>O</sub> =24 mA  |                      | 0.55                 |                      | 0.55                 |      |
| I <sub>I</sub>     | Input Leakage Current                 | 3.6                    | V <sub>I</sub> = 0 or 3.6V   |                      | ± 5                  |                      | ± 5                  | μA   |
| I <sub>IHOLD</sub> | Bus Hold Input Leakage Current        | 1.65                   | V <sub>I</sub> = 0.58 V  | + 25                 |                      | + 25                 |                      | μA   |
|                    |                                       | 1.65                   | V <sub>I</sub> = 1.07 V  | - 25                 |                      | - 25                 |                      |      |
|                    |                                       | 2.3                    | V <sub>I</sub> = 0.7 V   | + 45                 |                      | + 45                 |                      |      |
|                    |                                       | 2.3                    | V <sub>I</sub> = 1.7 V   | - 45                 |                      | - 45                 |                      |      |
|                    |                                       | 3.0                    | V <sub>I</sub> = 0.8 V   | + 75                 |                      | + 75                 |                      |      |
|                    |                                       | 3.0                    | V <sub>I</sub> = 2 V   | - 75                 |                      | - 75                 |                      |      |
| I <sub>off</sub>   | Power Off Leakage Current             | 0                      | V <sub>I</sub> or V <sub>O</sub> = 3.6V  |                      | 10                   |                      | 20                   | μA   |
| I <sub>OZ</sub>    | High Impedance Output Leakage Current | 3.6                    | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>V <sub>O</sub> = 0 to V <sub>CC</sub> |                      | ± 5                  |                      | ± 10                 | μA   |
| I <sub>CC</sub>    | Quiescent Supply Current              | 3.6                    | V <sub>I</sub> = V <sub>CC</sub> or GND<br>I <sub>O</sub> = 0                                |                      | 20                   |                      | 40                   | μA   |
| ΔI <sub>CC</sub>   | I <sub>CC</sub> incr. per Input       | 3.0 to 3.6             | V <sub>IH</sub> = V <sub>CC</sub> - 0.6V   |                      | 500                  |                      | 750                  | μA   |

## AC ELECTRICAL CHARACTERISTICS

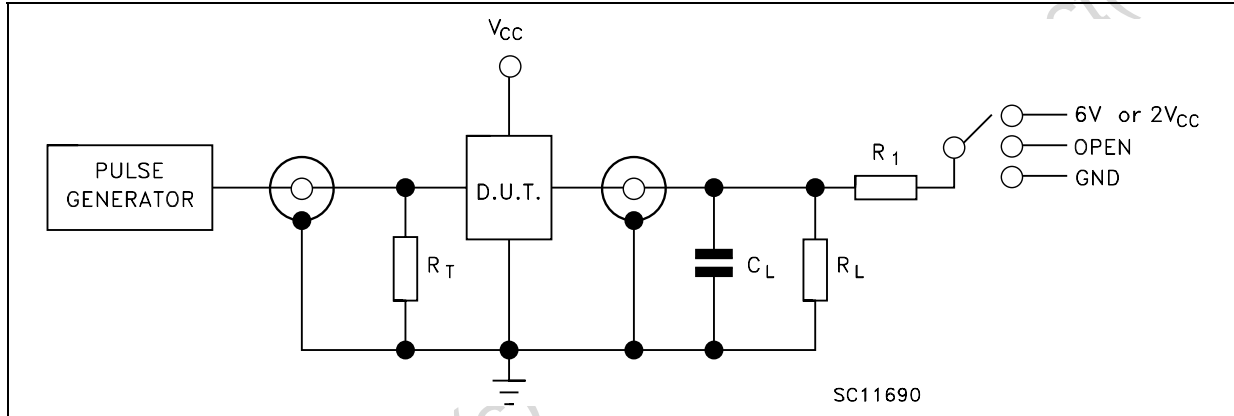
| Symbol                            | Parameter                                 | Test Condition         |                        |                       |   | Value        |      |               |      | Unit |
|-----------------------------------|---|------------------------|------------------------|-----------------------|---|--------------|------|---------------|------|------|
|                                   |   | V <sub>CC</sub><br>(V) | C <sub>L</sub><br>(pF) | R <sub>L</sub><br>(Ω) | t <sub>s</sub> = t <sub>r</sub><br>(ns) | -40 to 85 °C |      | -55 to 125 °C |      |      |
|                                   |   |                        |                        |                       |   | Min.         | Max. | Min.          | Max. |      |
| t <sub>PLH</sub> t <sub>PHL</sub> | Propagation Delay<br>Time CK to Qn        | 1.65 to 1.95           | 30                     | 1000                  | 2.0                                     | 1            | 6.5  | 1             | 6.5  | ns   |
|                                   |   | 2.3 to 2.7             | 30                     | 500                   | 2.0                                     | 1            | 5.3  | 1             | 5.3  |      |
|                                   |   | 2.7                    | 50                     | 500                   | 2.5                                     | 1            | 4.9  | 1             | 4.9  |      |
|                                   |   | 3.0 to 3.6             | 50                     | 500                   | 2.5                                     | 1            | 4.2  | 1             | 4.2  |      |
| t <sub>PZL</sub> t <sub>PZH</sub> | Output Enable Time                        | 1.65 to 1.95           | 30                     | 1000                  | 2.0                                     | 1            | 7.5  | 1             | 7.5  | ns   |
|                                   |   | 2.3 to 2.7             | 30                     | 500                   | 2.0                                     | 1            | 6.2  | 1             | 6.2  |      |
|                                   |   | 2.7                    | 50                     | 500                   | 2.5                                     | 1            | 5.9  | 1             | 5.9  |      |
|                                   |   | 3.0 to 3.6             | 50                     | 500                   | 2.5                                     | 1            | 4.8  | 1             | 4.8  |      |
| t <sub>PLZ</sub> t <sub>PHZ</sub> | Output Disable Time                       | 1.65 to 1.95           | 30                     | 1000                  | 2.0                                     | 1            | 6.5  | 1             | 6.5  | ns   |
|                                   |   | 2.3 to 2.7             | 30                     | 500                   | 2.0                                     | 1            | 5.3  | 1             | 5.3  |      |
|                                   |   | 2.7                    | 50                     | 500                   | 2.5                                     | 1            | 4.7  | 1             | 4.7  |      |
|                                   |   | 3.0 to 3.6             | 50                     | 500                   | 2.5                                     | 1            | 4.3  | 1             | 4.3  |      |
| t <sub>s</sub>                    | Setup Time, HIGH or<br>LOW level Dn to CK | 1.65 to 1.95           | 30                     | 1000                  | 2.0                                     | 1            |      | 1             |      | ns   |
|                                   |   | 2.3 to 2.7             | 30                     | 500                   | 2.0                                     | 1            |      | 1             |      |      |
|                                   |   | 2.7                    | 50                     | 500                   | 2.5                                     | 1            |      | 1             |      |      |
|                                   |   | 3.0 to 3.6             | 50                     | 500                   | 2.5                                     | 1            |      | 1             |      |      |
| t <sub>h</sub>                    | Hold Time High or<br>LOW level Dn to CK   | 1.65 to 1.95           | 30                     | 1000                  | 2.0                                     | 1.5          |      | 1.5           |      | ns   |
|                                   |   | 2.3 to 2.7             | 30                     | 500                   | 2.0                                     | 1.5          |      | 1.5           |      |      |
|                                   |   | 2.7                    | 50                     | 500                   | 2.5                                     | 1.5          |      | 1.5           |      |      |
|                                   |   | 3.0 to 3.6             | 50                     | 500                   | 2.5                                     | 1.5          |      | 1.5           |      |      |
| t <sub>w</sub>                    | CK Pulse Width,<br>HIGH                   | 1.65 to 1.95           | 30                     | 1000                  | 2.0                                     | 4            |      | 4             |      | ns   |
|                                   |   | 2.3 to 2.7             | 30                     | 500                   | 2.0                                     | 3.3          |      | 3.3           |      |      |
|                                   |   | 2.7                    | 50                     | 500                   | 2.5                                     | 3.3          |      | 3.3           |      |      |
|                                   |   | 3.0 to 3.6             | 50                     | 500                   | 2.5                                     | 3.3          |      | 3.3           |      |      |
| f <sub>MAX</sub>                  | Maximum Clock<br>Pulse Frequency          | 1.65 to 1.95           | 30                     | 1000                  | 2.0                                     | 120          |      | 120           |      | MHz  |
|                                   |   | 2.3 to 2.7             | 30                     | 500                   | 2.0                                     | 150          |      | 150           |      |      |
|                                   |   | 2.7                    | 50                     | 500                   | 2.5                                     | 200          |      | 200           |      |      |
|                                   |   | 3.0 to 3.6             | 50                     | 500                   | 2.5                                     | 300          |      | 300           |      |      |

**CAPACITIVE CHARACTERISTICS**

| Symbol           | Parameter  | Test Condition      |  | Value                  |      |      | Unit |
|------------------|--|---------------------|--|------------------------|------|------|------|
|                  |  | V <sub>CC</sub> (V) |  | T <sub>A</sub> = 25 °C |      |      |      |
|                  |  |                     |  | Min.                   | Typ. | Max. |      |
| C <sub>IN</sub>  | Input Capacitance Control Inputs                       | 3.3                 | V <sub>IN</sub> = V <sub>CC</sub> or GND         |                        | 3    |      | pF   |
| C <sub>IN</sub>  | Input Capacitance Data Inputs                          | 3.3                 | V <sub>IN</sub> = V <sub>CC</sub> or GND         |                        | 6    |      | pF   |
| C <sub>OUT</sub> | Output Capacitance                                     | 3.3                 | V <sub>IN</sub> = 0 to V <sub>CC</sub>           |                        | 7    |      | pF   |
| C <sub>PD</sub>  | Power Dissipation Capacitance Output enabled (note 1)  | 3.3                 | f <sub>IN</sub> = 10MHz<br>C <sub>L</sub> = 50pF |                        | 19   |      | pF   |
|                  |  | 2.5                 |  |                        | 16   |      |      |
| C <sub>PD</sub>  | Power Dissipation Capacitance Output disabled (note 1) | 3.3                 | V <sub>IN</sub> = 0 or V <sub>CC</sub>           |                        | 5    |      | pF   |
|                  |  | 2.5                 |  |                        | 4    |      |      |

1) C<sub>PD</sub> 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<sub>CC(opr)</sub> = C<sub>PD</sub> × V<sub>CC</sub> × f<sub>IN</sub> + I<sub>CC</sub>/16 (per circuit)

**TEST CIRCUIT**



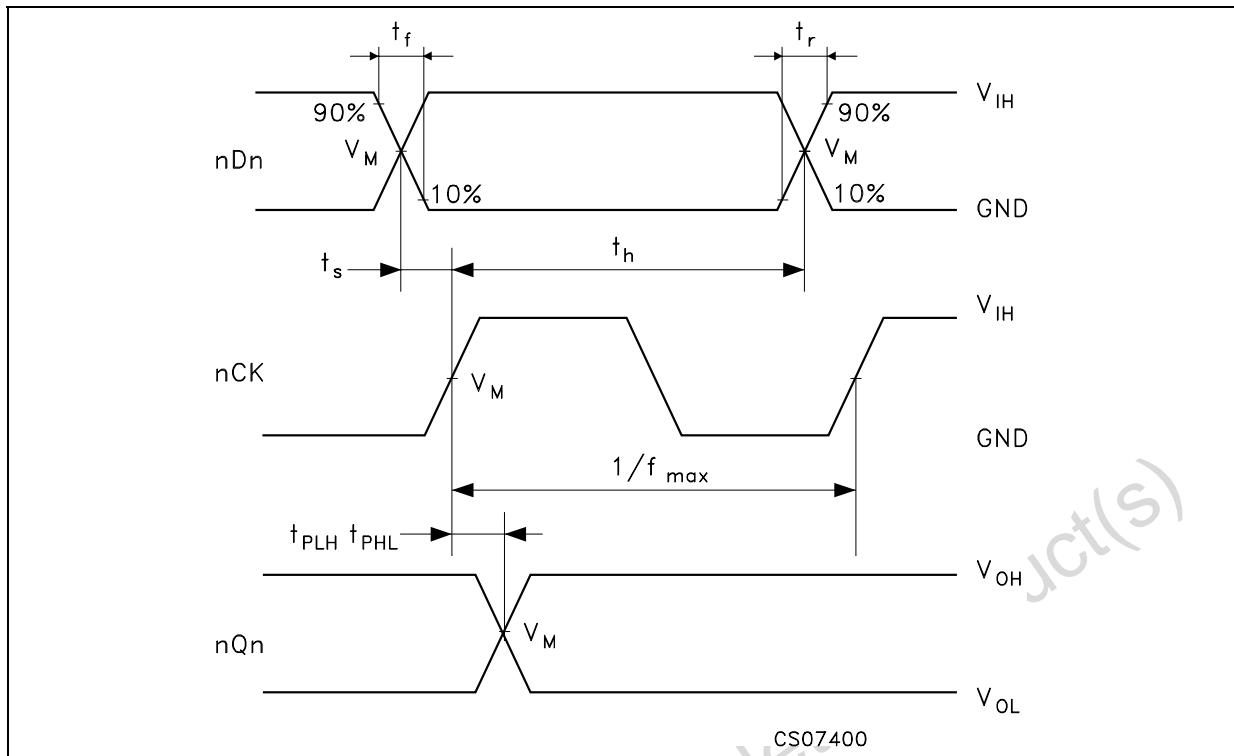
| TEST  | SWITCH           |
|---|------------------|
| t <sub>PLH</sub> , t <sub>PHL</sub>                                 | Open             |
| t <sub>PZL</sub> , t <sub>PLZ</sub> (V <sub>CC</sub> = 3.0 to 3.6V) | 6V               |
| t <sub>PZL</sub> , t <sub>PLZ</sub> (V <sub>CC</sub> = 2.3 to 2.7V) | 2V <sub>CC</sub> |
| t <sub>PZH</sub> , t <sub>PHZ</sub>                                 | GND              |

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

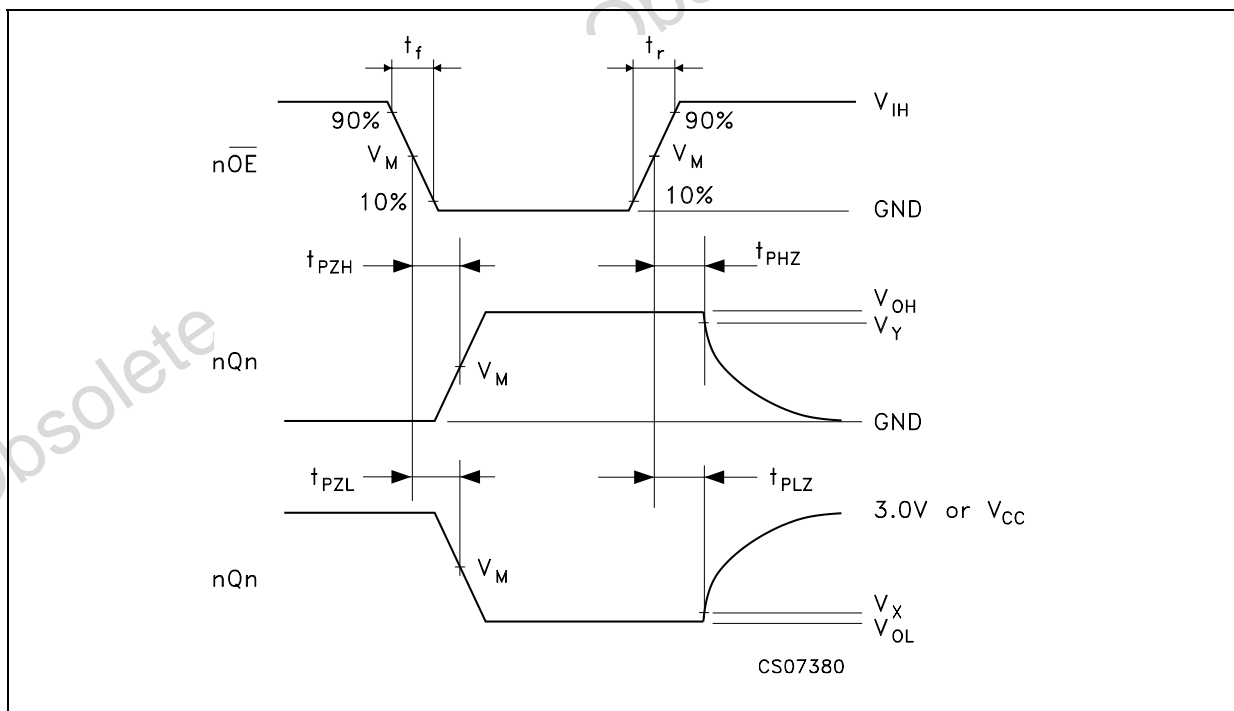
**TEST CIRCUIT AND WAVEFORM SYMBOL VALUE**

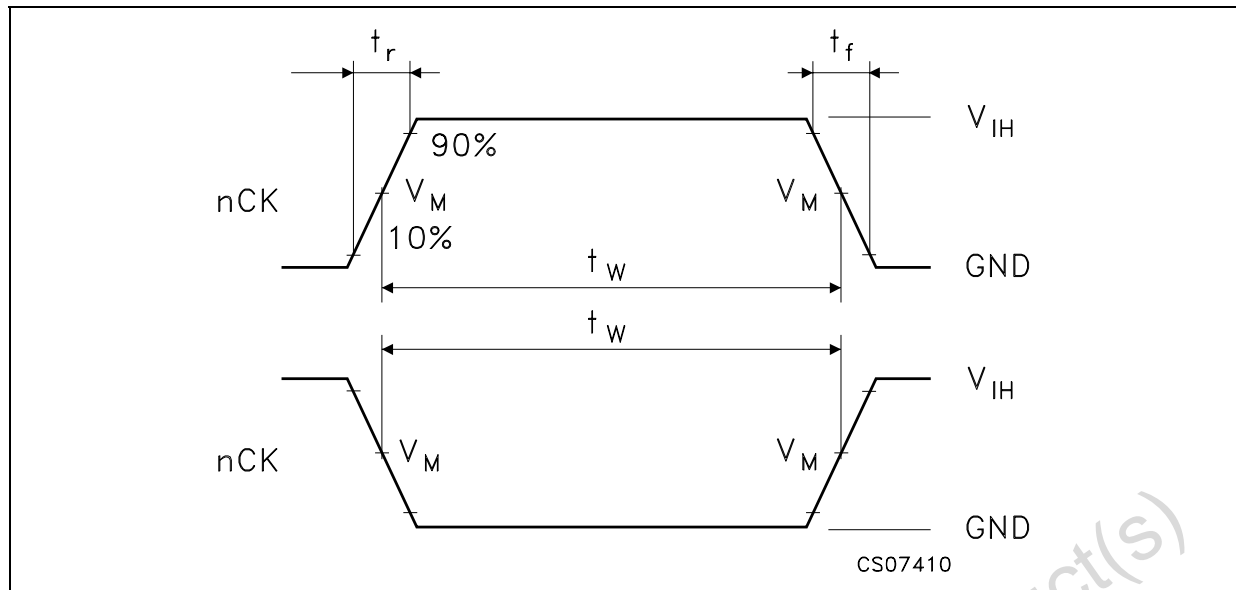
| Symbol                          | V <sub>CC</sub>        |                        |                         |                         |
|---------------------------------|------------------------|------------------------|-------------------------|-------------------------|
|                                 | 3.0 to 3.6V            | 2.7V                   | 2.3 to 2.7V             | 1.65 to 1.95V           |
| V <sub>IH</sub>                 | 2.7V                   | 2.7V                   | V <sub>CC</sub>         | V <sub>CC</sub>         |
| V <sub>M</sub>                  | 1.5V                   | 1.5V                   | V <sub>CC</sub> /2      | V <sub>CC</sub> /2      |
| V <sub>X</sub>                  | V <sub>OL</sub> + 0.3V | V <sub>OL</sub> + 0.3V | V <sub>OL</sub> + 0.15V | V <sub>OL</sub> + 0.15V |
| V <sub>Y</sub>                  | V <sub>OH</sub> - 0.3V | V <sub>OH</sub> - 0.3V | V <sub>OH</sub> - 0.15V | V <sub>OH</sub> - 0.15V |
| C <sub>L</sub>                  | 50pF                   | 50pF                   | 30pF                    | 30pF                    |
| R <sub>L</sub> = R <sub>1</sub> | 500Ω                   | 500Ω                   | 500Ω                    | 1000Ω                   |
| t <sub>r</sub> = t <sub>f</sub> | <2.5ns                 | <2.5ns                 | <2.0ns                  | <2.0ns                  |

**WAVEFORM 1 : PROPAGATION DELAYS, CK MINIMUM PULSE WIDTH, Dn TO CK SETUP AND HOLD TIMES, CK MAXIMUM FREQUENCY ( $f=1\text{MHz}$ ; 50% duty cycle)**



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

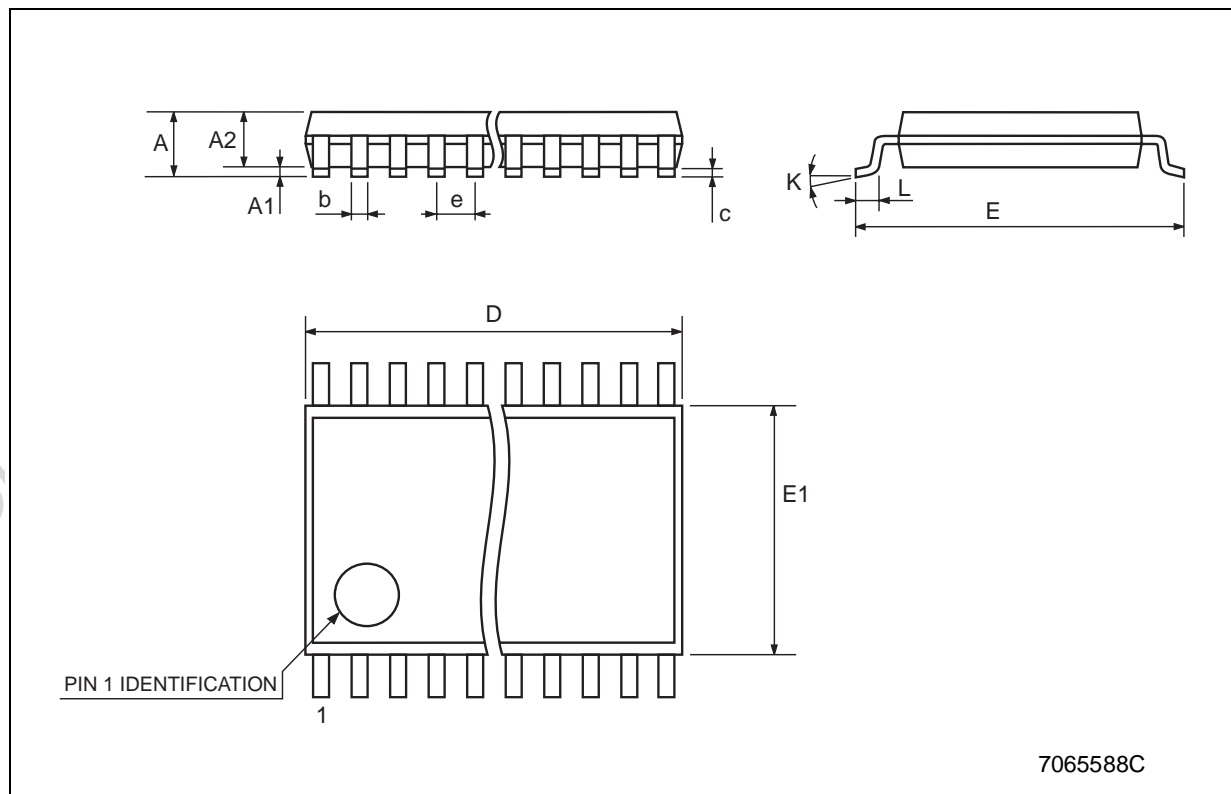


WAVEFORM 3 : CK MINIMUM PULSE WIDTH ( $f=1\text{MHz}$ ; 50% duty cycle)



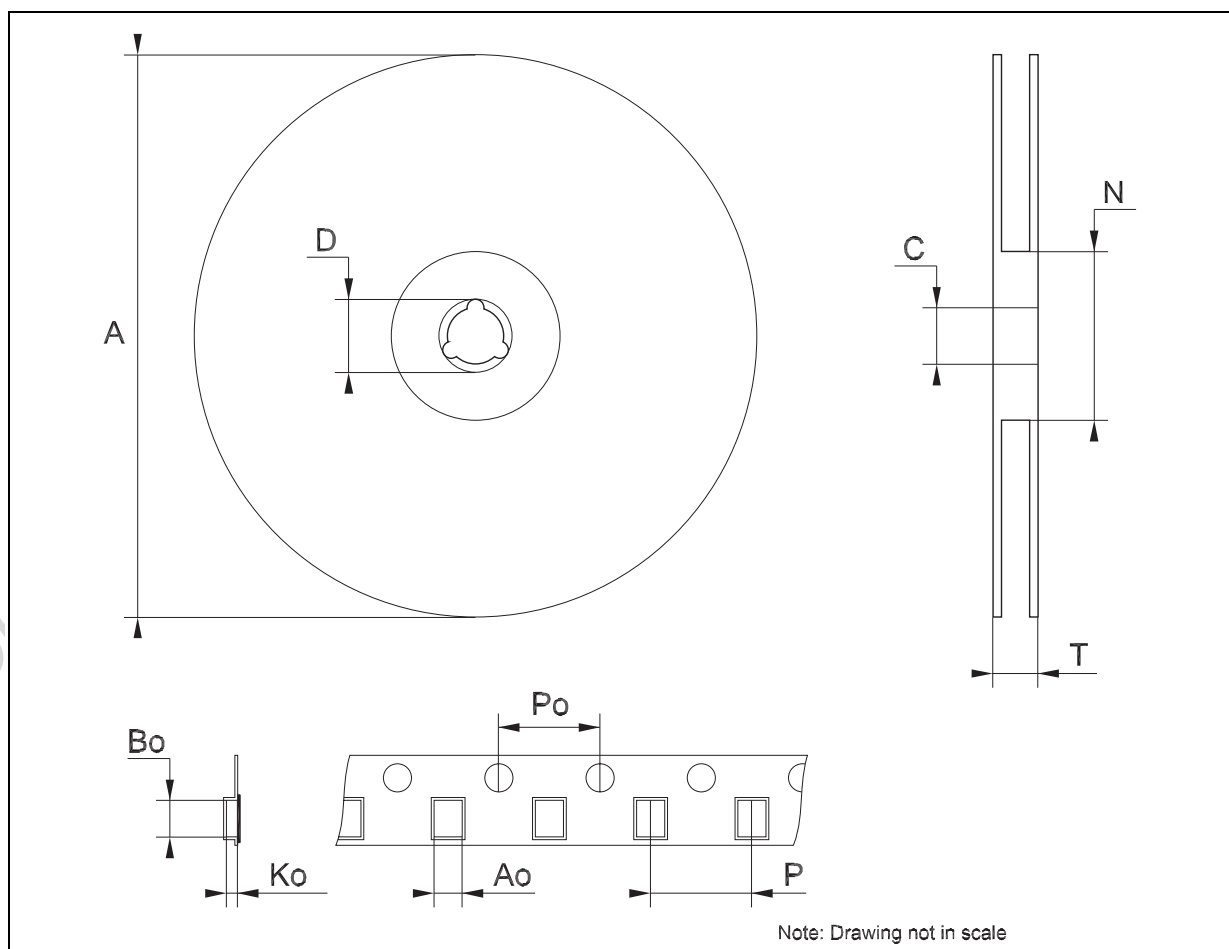
## TSSOP48 MECHANICAL DATA

| DIM. | mm.  |         |      | inch   |            |        |
|------|------|---------|------|--------|------------|--------|
|      | MIN. | TYP     | MAX. | MIN.   | TYP.       | MAX.   |
| A    |      |         | 1.2  |        |            | 0.047  |
| A1   | 0.05 |         | 0.15 | 0.002  |            | 0.006  |
| A2   |      | 0.9     |      |        | 0.035      |        |
| b    | 0.17 |         | 0.27 | 0.0067 |            | 0.011  |
| c    | 0.09 |         | 0.20 | 0.0035 |            | 0.0079 |
| D    | 12.4 |         | 12.6 | 0.488  |            | 0.496  |
| E    |      | 8.1 BSC |      |        | 0.318 BSC  |        |
| E1   | 6.0  |         | 6.2  | 0.236  |            | 0.244  |
| e    |      | 0.5 BSC |      |        | 0.0197 BSC |        |
| K    | 0°   |         | 8°   | 0°     |            | 8°     |
| L    | 0.50 |         | 0.75 | 0.020  |            | 0.030  |



## Tape &amp; Reel TSSOP48 MECHANICAL DATA

| DIM. | mm.  |     |      | inch  |      |        |
|------|------|-----|------|-------|------|--------|
|      | MIN. | TYP | MAX. | MIN.  | TYP. | MAX.   |
| A    |      |     | 330  |       |      | 12.992 |
| C    | 12.8 |     | 13.2 | 0.504 |      | 0.519  |
| D    | 20.2 |     |      | 0.795 |      |        |
| N    | 60   |     |      | 2.362 |      |        |
| T    |      |     | 30.4 |       |      | 1.197  |
| Ao   | 8.7  |     | 8.9  | 0.343 |      | 0.350  |
| Bo   | 13.1 |     | 13.3 | 0.516 |      | 0.524  |
| Ko   | 1.5  |     | 1.7  | 0.059 |      | 0.067  |
| Po   | 3.9  |     | 4.1  | 0.153 |      | 0.161  |
| P    | 11.9 |     | 12.1 | 0.468 |      | 0.476  |



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