



74LCX16374

LOW VOLTAGE CMOS 16-BIT D-TYPE FLIP-FLOP (3-STATE) WITH 5V TOLERANT INPUTS AND OUTPUTS

- 5V TOLERANT INPUTS AND OUTPUTS
- HIGH SPEED :
 $f_{MAX} = 150\text{MHz}$ (MIN.) at $V_{CC} = 3\text{V}$
- POWER DOWN PROTECTION ON INPUTS AND OUTPUTS
- SYMMETRICAL OUTPUT IMPEDANCE:
 $|I_{OH}| = I_{OL} = 24\text{mA}$ (MIN) at $V_{CC} = 3\text{V}$
- PCI BUS LEVELS GUARANTEED AT 24 mA
- BALANCED PROPAGATION DELAYS:
 $t_{PLH} \approx t_{PHL}$
- OPERATING VOLTAGE RANGE:
 $V_{CC}(\text{OPR}) = 2.0\text{V}$ to 3.6V (1.5V Data Retention)
- PIN AND FUNCTION COMPATIBLE WITH 74 SERIES 16374
- LATCH-UP PERFORMANCE EXCEEDS 500mA (JESD 17)
- ESD PERFORMANCE:
 $\text{HBM} > 2000\text{V}$ (MIL STD 883 method 3015);
 $\text{MM} > 200\text{V}$

DESCRIPTION

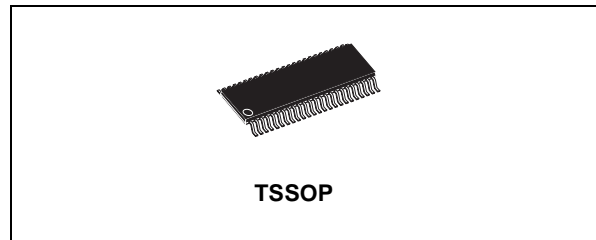
The 74LCX16374 is a low voltage CMOS 16 BIT D-TYPE FLIP-FLOP with 3 STATE OUTPUTS NON INVERTING fabricated with sub-micron silicon gate and double-layer metal wiring C²MOS technology. It is ideal for low power and high speed 3.3V applications; it can be interfaced to 5V signal environment for both inputs 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 setup at the nD inputs. While the (nOE) input is low, the 8 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.

It has same speed performance at 3.3V than 5V AC/ACT family, combined with a lower power consumption.

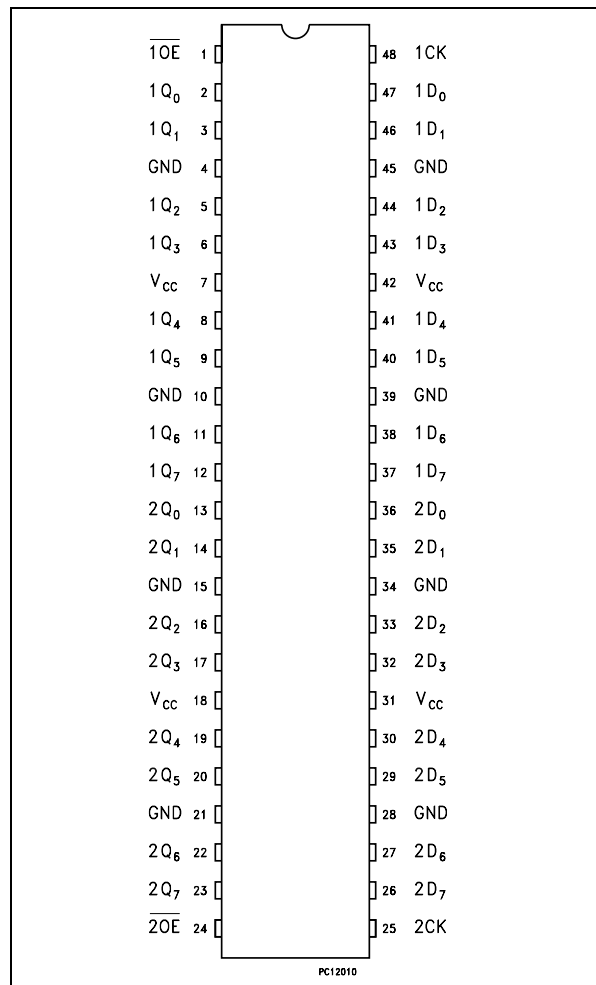
All inputs and outputs are equipped with protection circuits against static discharge, giving them 2KV ESD immunity and transient excess voltage.



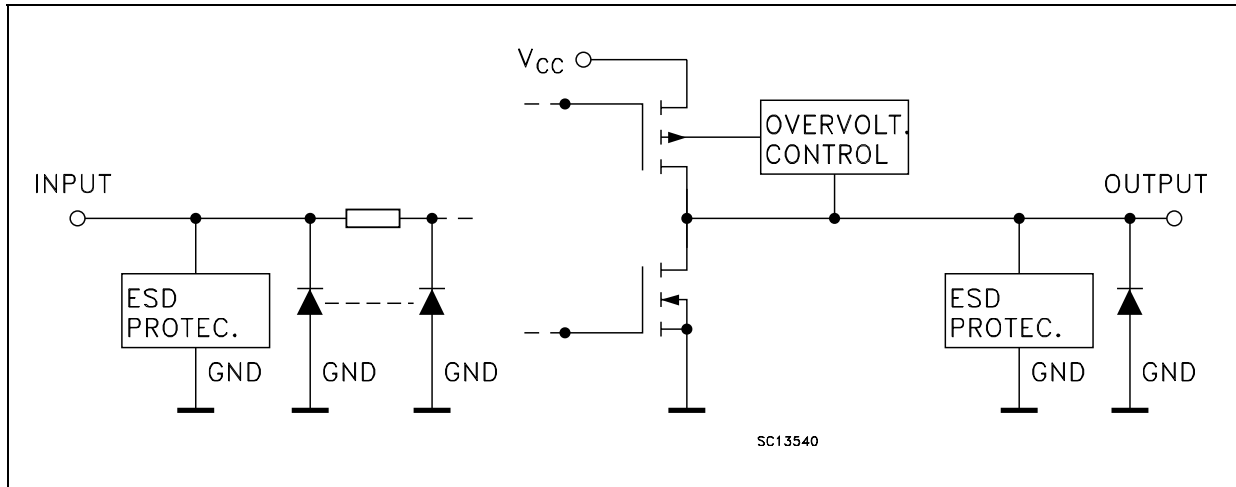
ORDER CODES

| PACKAGE | TUBE | T & R |
|---------|------|---------------|
| TSSOP | | 74LCX16374TTR |

PIN CONNECTION



INPUT AND OUTPUT EQUIVALENT CIRCUIT



PIN DESCRIPTION

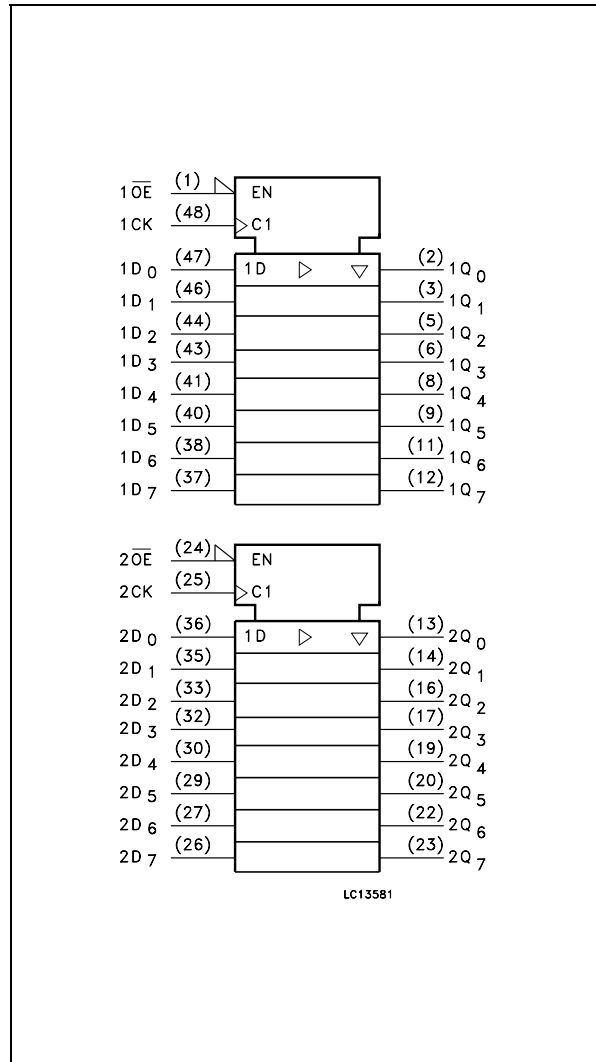
| PIN No | SYMBOL | NAME AND FUNCTION |
|--------------------------------|------------|--|
| 1 | 1OE | 3 State Output Enable Input (Active LOW) |
| 2, 3, 5, 6, 8, 9, 11, 12 | 1Q0 to 1Q7 | 3-State Outputs |
| 13, 14, 16, 17, 19, 20, 22, 23 | 2Q0 to 2Q7 | 3-State Outputs |
| 24 | 2OE | 3 State Output Enable Input (Active LOW) |
| 25 | 2CK | Latch Enable 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 | Latch Enable Input |
| 4, 10, 15, 21, 28, 34, 39, 45 | GND | Ground (0V) |
| 7, 18, 31, 42 | VCC | Positive Supply Voltage |

TRUTH TABLE

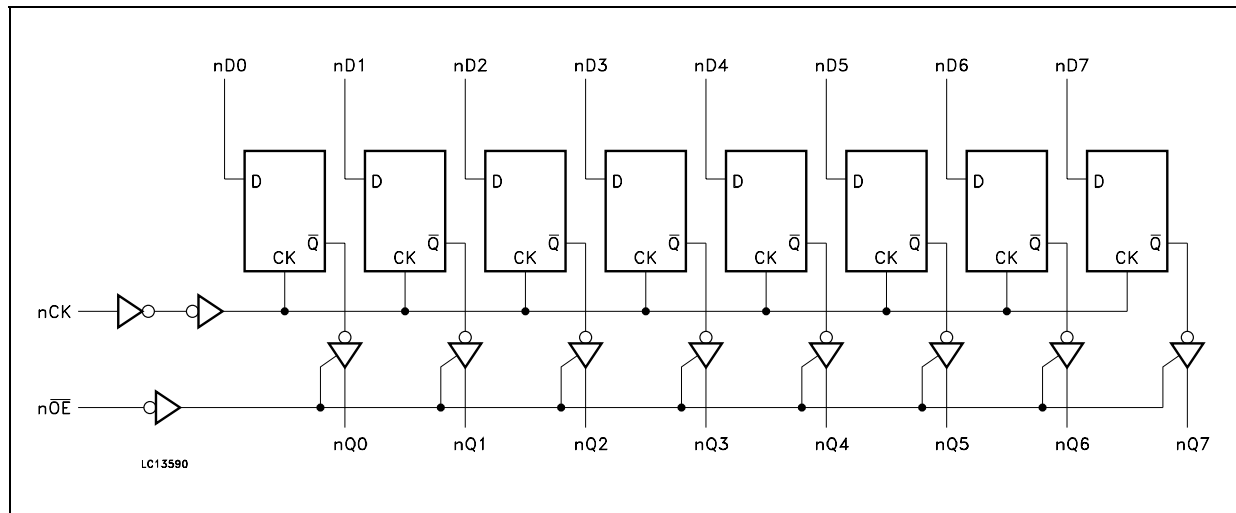
| INPUTS | | | OUTPUT |
|--------|----|---|------------|
| OE | CK | D | Q |
| H | X | X | Z |
| L | | X | NO CHANGE* |
| L | | L | L |
| L | | H | H |

X : Don't Care
Z : High Impedance

IEC LOGIC SYMBOLS



LOGIC DIAGRAM



This logic diagram has not to 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 (OFF State) | -0.5 to +7.0 | 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 | ± 50 | mA |
| I_{CC} | DC Supply Current per Supply Pin | ± 100 | mA |
| I_{GND} | DC Ground Current per Supply Pin | ± 100 | mA |
| 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) $V_O < GND$

RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | Value | Unit |
|------------------|---|---------------|-------------|
| V_{CC} | Supply Voltage (note 1) | 2.0 to 3.6 | V |
| V_I | Input Voltage | 0 to 5.5 | V |
| V_O | Output Voltage (OFF State) | 0 to 5.5 | 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 $3.6V$) | ± 24 | mA |
| I_{OH}, I_{OL} | High or Low Level Output Current ($V_{CC} = 2.7V$) | ± 12 | mA |
| T_{op} | Operating Temperature | -55 to 125 | $^{\circ}C$ |
| dt/dv | Input Rise and Fall Time (note 2) | 0 to 10 | ns/V |

1) Truth Table guaranteed: 1.5V to 3.6V

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

DC SPECIFICATIONS

| Symbol | Parameter | Test Condition | | Value | | | | Unit |
|------------------|---------------------------------------|------------------------|--|----------------------|------|----------------------|------|------|
| | | V _{CC} (V) | | -40 to 85 °C | | -55 to 125 °C | | |
| | | | | Min. | Max. | Min. | Max. | |
| V _{IH} | High Level Input Voltage | 2.7 to 3.6 | | 2.0 | | 2.0 | | V |
| V _{IL} | Low Level Input Voltage | | | | | 0.8 | | 0.8 |
| V _{OH} | High Level Output Voltage | 2.7 to 3.6 | I _O =-100 μA | V _{CC} -0.2 | | V _{CC} -0.2 | | V |
| | | 2.7 | I _O =-12 mA | 2.2 | | 2.2 | | |
| | | 3.0 | I _O =-18 mA | 2.4 | | 2.4 | | |
| | | | I _O =-24 mA | 2.2 | | 2.2 | | |
| V _{OL} | Low Level Output Voltage | 2.7 to 3.6 | I _O =100 μA | | 0.2 | | 0.2 | V |
| | | 2.7 | I _O =12 mA | | 0.4 | | 0.4 | |
| | | 3.0 | I _O =16 mA | | 0.4 | | 0.4 | |
| | | | I _O =24 mA | | 0.55 | | 0.55 | |
| I _I | Input Leakage Current | 2.7 to 3.6 | V _I = 0 to 5.5V | | ± 5 | | ± 5 | μA |
| I _{off} | Power Off Leakage Current | 0 | V _I or V _O = 5.5V | | 10 | | 10 | μA |
| I _{oz} | High Impedance Output Leakage Current | 2.7 to 3.6 | V _I = V _{IH} or V _{IL} V _O = 0 to V _{CC} | | ± 5 | | ± 5 | μA |
| I _{CC} | Quiescent Supply Current | 2.7 to 3.6 | V _I = V _{CC} or GND | | 20 | | 20 | μA |
| | | | V _I or V _O = 3.6 to 5.5V | | ± 20 | | ± 20 | |
| ΔI _{CC} | I _{CC} incr. per Input | 2.7 to 3.6 | V _{IH} = V _{CC} - 0.6V | | 500 | | 500 | μA |

DYNAMIC SWITCHING CHARACTERISTICS

| Symbol | Parameter | Test Condition | | Value | | | Unit |
|------------------|---|------------------------|---|------------------------|------|------|------|
| | | V _{CC} (V) | | T _A = 25 °C | | | |
| | | | | Min. | Typ. | Max. | |
| V _{OLP} | Dynamic Low Level Quiet Output (note 1) | 3.3 | C _L = 50pF V _{IL} = 0V, V _{IH} = 3.3V | | 0.8 | | V |
| V _{OLV} | | | | | -0.8 | | |

1) Number of outputs defined as "n". Measured with "n-1" outputs switching from HIGH to LOW or LOW to HIGH. The remaining output is measured in the LOW state.

AC ELECTRICAL CHARACTERISTICS

| Symbol | Parameter | Test Condition | | | | Value | | | | Unit |
|--|---|------------------------|------------------------|-----------------------|---|--------------|------|---------------|------|------|
| | | V _{CC} (V) | C _L (pF) | R _L (Ω) | t _s = t _r (ns) | -40 to 85 °C | | -55 to 125 °C | | |
| | | | | | | Min. | Max. | Min. | Max. | |
| t _{PLH} t _{PHL} | Propagation Delay Time | 2.7 | 50 | 500 | 2.5 | 1.5 | 6.5 | 1.5 | 6.5 | ns |
| | | 3.0 to 3.6 | | | | 1.5 | 6.2 | 1.5 | 6.2 | |
| t _{PZL} t _{PZH} | Output Enable Time to HIGH and LOW level | 2.7 | 50 | 500 | 2.5 | 1.5 | 6.3 | 1.5 | 6.3 | ns |
| | | 3.0 to 3.6 | | | | 1.5 | 6.1 | 1.5 | 6.1 | |
| t _{PLZ} t _{PHZ} | Output Disable Time from HIGH and LOW level | 2.7 | 50 | 500 | 2.5 | 1.5 | 6.2 | 1.5 | 6.2 | ns |
| | | 3.0 to 3.6 | | | | 1.5 | 6.0 | 1.5 | 6.0 | |
| t _S | Set-Up Time, HIGH or LOW level (Dn to CK) | 2.7 | 50 | 500 | 2.5 | 2.5 | | 2.5 | | ns |
| | | 3.0 to 3.6 | | | | 2.5 | | 2.5 | | |
| t _h | Hold Time, HIGH or LOW level (Dn to CK) | 2.7 | 50 | 500 | 2.5 | 1.5 | | 1.5 | | ns |
| | | 3.0 to 3.6 | | | | 1.5 | | 1.5 | | |
| t _W | CK Pulse Width, HIGH or LOW | 2.7 | 50 | 500 | 2.5 | 3.0 | | 3.0 | | ns |
| | | 3.0 to 3.6 | | | | 3.0 | | 3.0 | | |
| f _{MAX} | Clock Pulse Frequency | 3.0 to 3.6 | 50 | 500 | 2.5 | 170 | | 150 | | MHz |
| t _{OSLH} t _{OSHL} | Output To Output Skew Time (note1, 2) | 3.0 to 3.6 | 50 | 500 | 2.5 | | 1.0 | | 1.0 | ns |

1) Skew is defined as the absolute value of the difference between the actual propagation delay for any two outputs of the same device switching in the same direction, either HIGH or LOW (t_{OSLH} = |t_{PLHm} - t_{PLHn}|, t_{OSHL} = |t_{PHLm} - t_{PHLn}|)

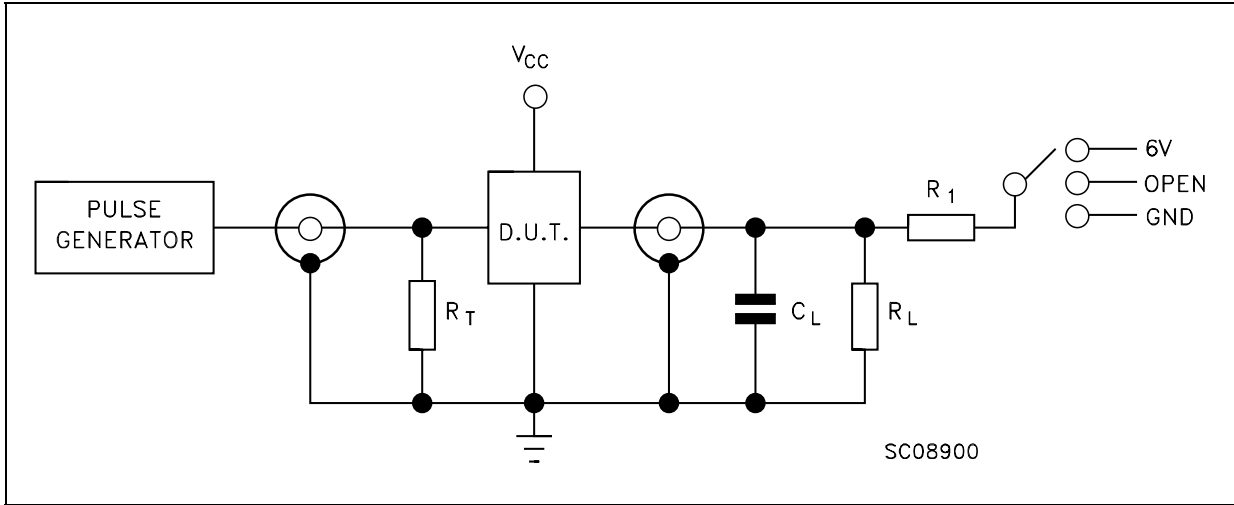
2) Parameter guaranteed by design

CAPACITIVE CHARACTERISTICS

| Symbol | Parameter | Test Condition | | Value | | | Unit |
|------------------|--|------------------------|---|------------------------|------|------|------|
| | | V _{CC} (V) | | T _A = 25 °C | | | |
| | | | | Min. | Typ. | Max. | |
| C _{IN} | Input Capacitance | 3.3 | V _{IN} = 0 to V _{CC} | | 7 | | pF |
| C _{OUT} | Output Capacitance | 3.3 | V _{IN} = 0 to V _{CC} | | 8 | | pF |
| C _{PD} | Power Dissipation Capacitance (note 1) | 3.3 | f _{IN} = 10MHz V _{IN} = 0 or V _{CC} | | 20 | | 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} × V_{CC} × f_{IN} + I_{CC}/16 (per circuit)

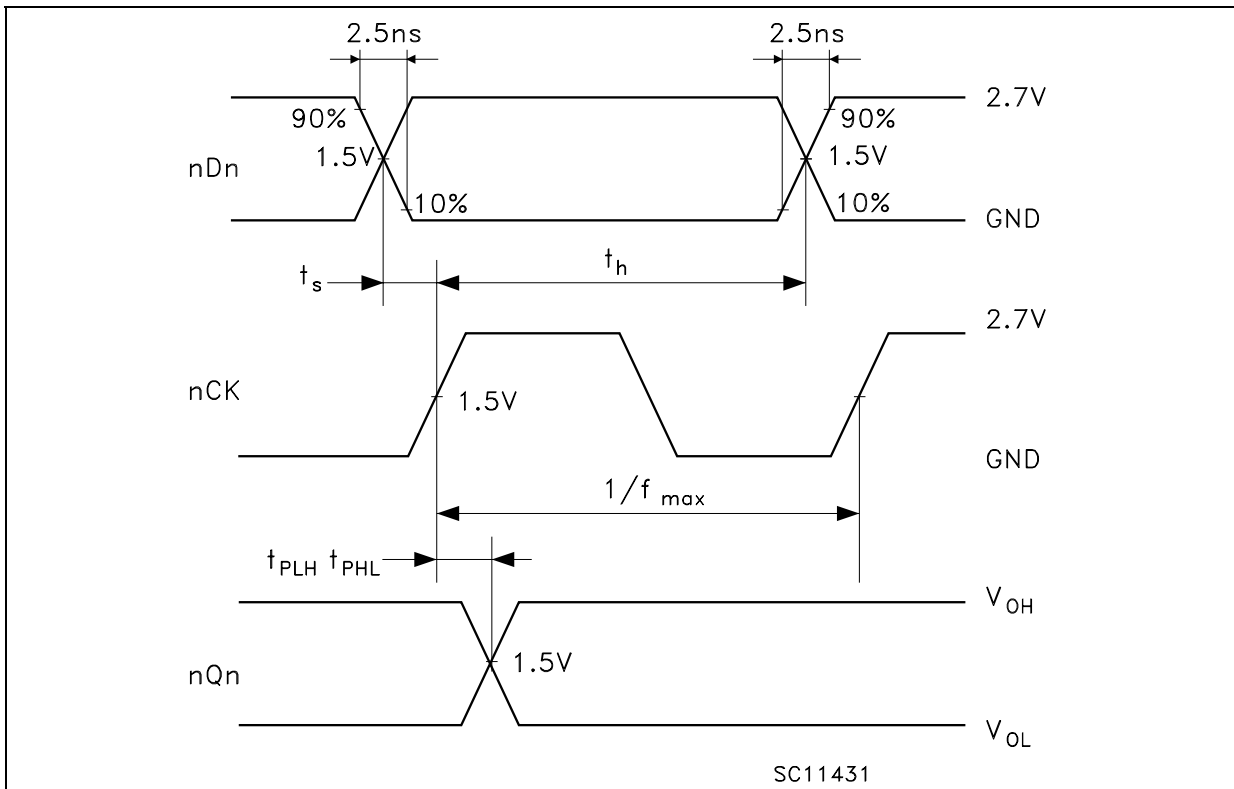
TEST CIRCUIT

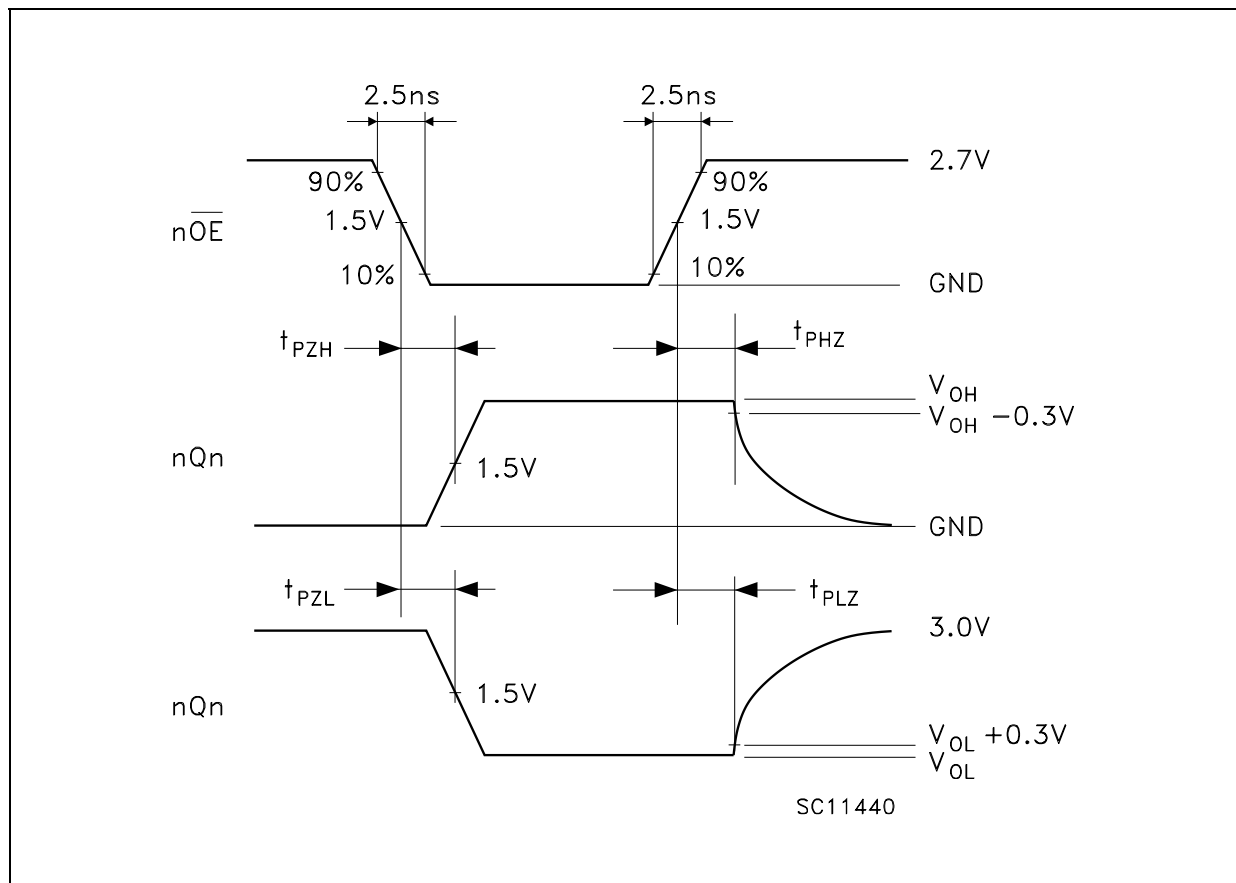
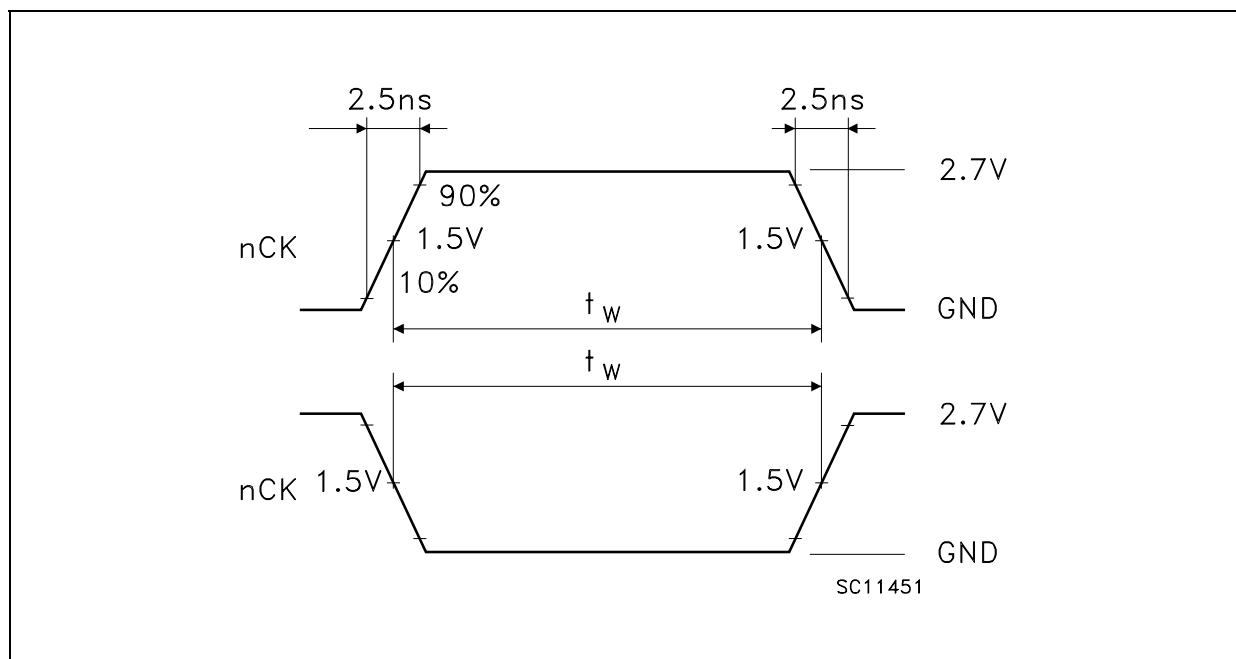


| TEST | SWITCH |
|-----------------------|--------|
| t_{PLH} , t_{PHL} | Open |
| t_{PZL} , t_{PLZ} | 6V |
| t_{PZH} , t_{PHZ} | GND |

C_L = 50 pF or equivalent (includes jig and probe capacitance)
 R_L = R_1 = 500Ω or equivalent
 R_T = Z_{OUT} of pulse generator (typically 50Ω)

WAVEFORM 1 : PROPAGATION DELAYS, SETUP AND HOLD TIMES, MAXIMUM CLOCK FREQUENCY (f=1MHz; 50% duty cycle)



WAVEFORM 2: OUTPUT ENABLE AND DISABLE TIME (f=1MHz; 50% duty cycle)**WAVEFORM 3 : PULSE WIDTH** (f=1MHz; 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 & 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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