# CMOS Logic IC VCX/LCX (Low Voltage) Series Outline

## Outline:

CMOS Logic ICs VCX/VCXH/LCX Series achieves twice the high speed operation of the 5V high speed products (AC, VHC) at a low voltage of 3.3 V. (LCX 120 MHz, VCX 380MHz) The minimum voltage of the operating range is as low as 1.65 V for VCX and 1.2 V for LCX.

This document provides an overview of the product, part numbering method, maximum ratings, electrical characteristics, and measurement methods.

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# 1. General

## 1.1. General

This document describes the VCX/LCX series of C[2]MOS[TM] Logic ICs.

The VCX/LCX series is indicated by the red frame in Figure 1.1.

This series achieves high-speed operation exceeding the speed of conventional 5 V logic (AC/VHC series) at $V_{CC}$ = 3.3 V. The LCX series guarantees operation from 1.8 V. The VCX series guarantees operation from 1.2 V.

The package lineup is wide, from SOP package to ultra-compact US package.

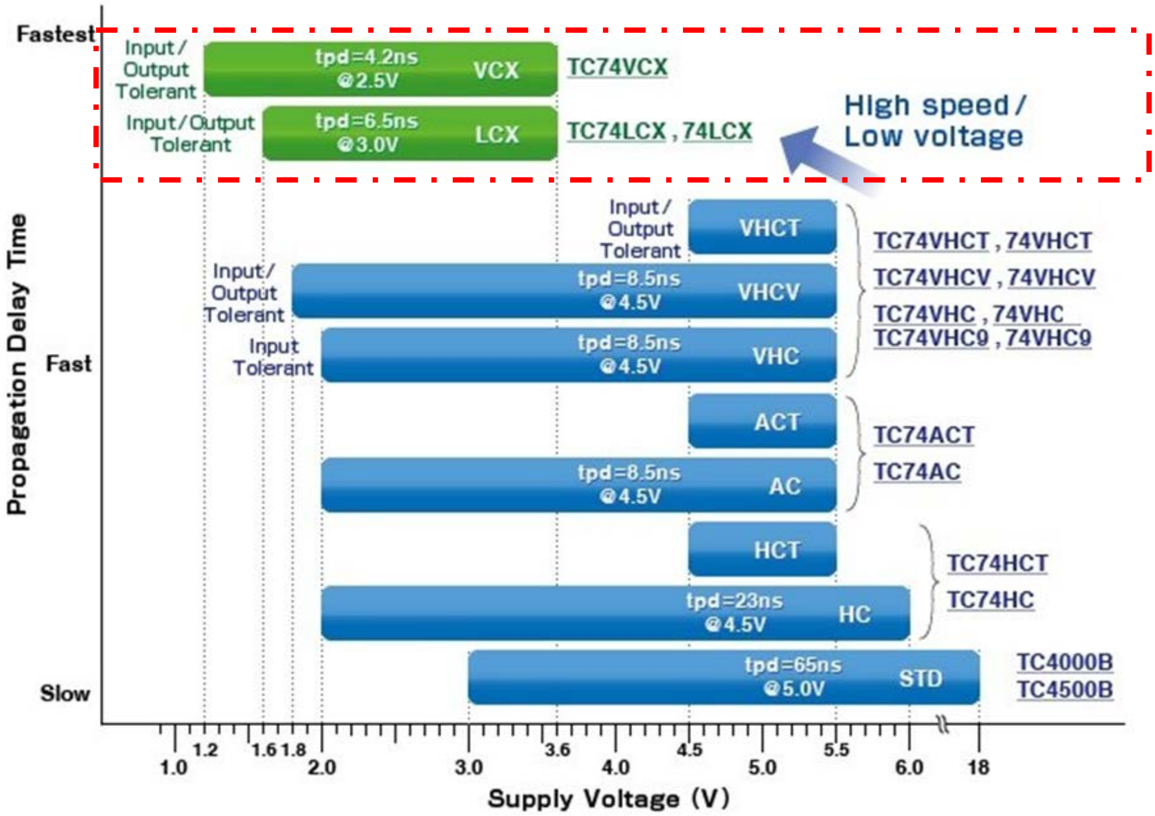



**Figure 1.1 Supply Voltage Range and Propagation Delay Time of Each Series**

## 1.2. Features

### 1.2.1. High-Speed/Low-Voltage Operation

Switching speed of the LCX series offers outstanding performance at low voltages (such as $V_{CC}$ = 3.3 V) compared with 5 V high-speed logic series such as the AC/VHC series. Switching speed of the VCX series at 3.3 V is about twice faster than that of the LCX series. And even at 1.8 V, it exceeds the performance of the conventional 5 V high-speed logic. This is due to the use of dedicated CMOS process technology.

In addition, the VCX/LCX series devices offer high-speed operation, even under heavy load capacitance, due to their lower output impedance. (Please refer to Figure 1.2.)

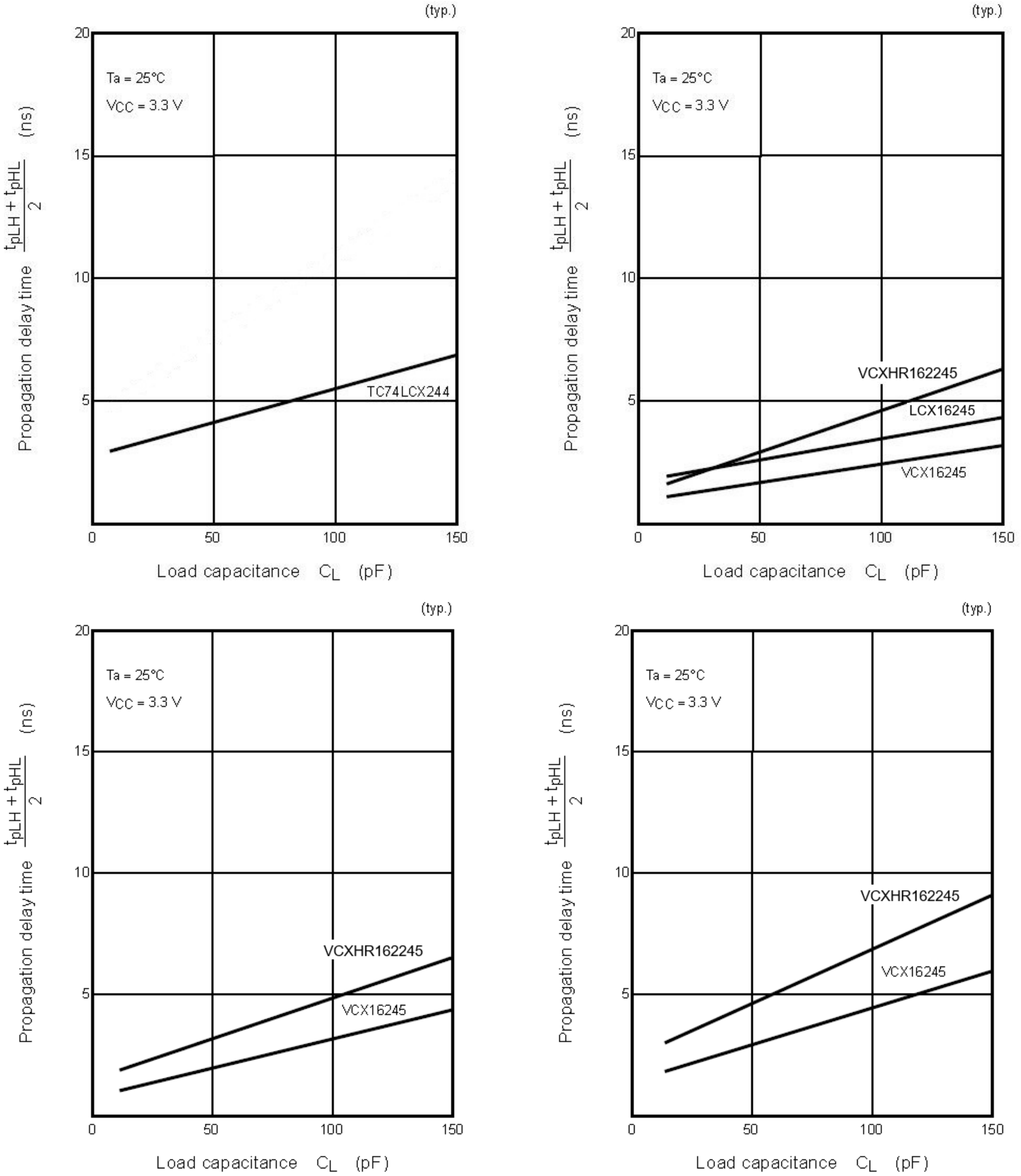


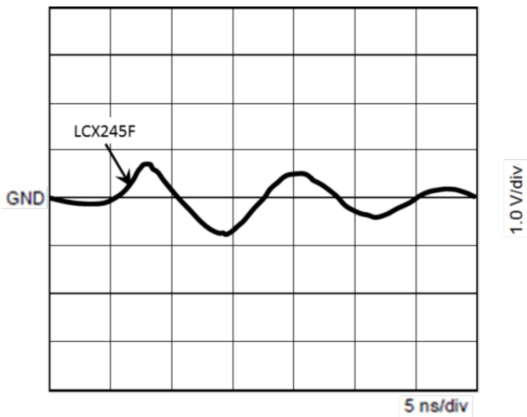

**Figure 1.2 Propagation Delay Time vs. Load Capacitance**

## 1.2.2. Low Noise

The VCX/LCX series are equipped with a slew rate control (SRC) circuit that controls the output transition time in order to reduce the noise generated at the output transition. This circuit reduces noise, such as simultaneous switching noise generated by the inductance of the power supply and GND lines, and noise generated by reflections on the transmission line.

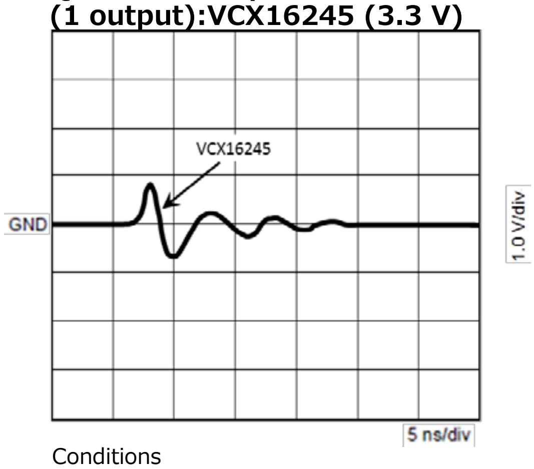
Figures 1.3 and 1.4 show typical simultaneous switching noise generated in the 8- and 16-bit devices. The noise is generated on a single inactive output when switching occurs simultaneously on the other seven outputs (on an 8-bit device) or on the other 15 outputs (on a 16-bit device).

**Quiescent Output Waveform (1 output):LCX245F**



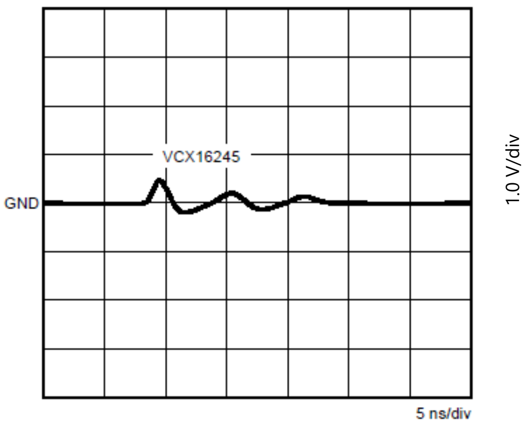

Conditions
$V_{CC}$ = 3.3 V
$C_L$ = 50 pF, $R_L$ = 500 Ω, Ta = 25°C
$C_L$: Load Capacitance
$R_L$: Load Resistance

**Quiescent Output Waveform (1 output):VCX16245 (3.3 V)**



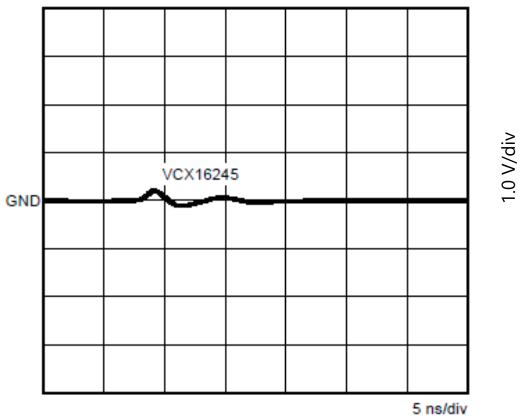

Conditions
$V_{CC}$ = 3.3 V
$C_L$ = 30 pF, $R_L$ = 500 Ω, Ta = 25°C
$C_L$: Load Capacitance
$R_L$: Load Resistance

**Quiescent Output Waveform (1 output):VCX16245 (2.5 V)**




Conditions
$V_{CC}$ = 2.5 V
$C_L$ = 30 pF, $R_L$ = 500 Ω, Ta = 25°C
$C_L$: Load Capacitance
$R_L$: Load Resistance

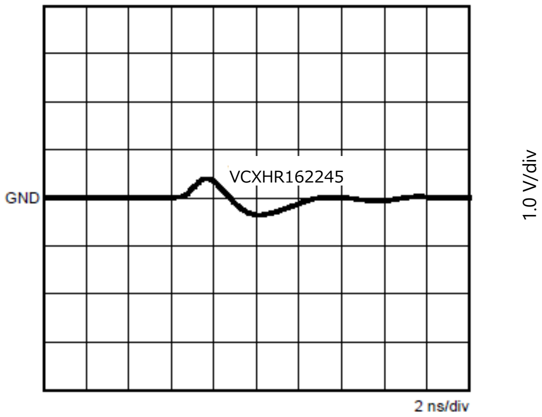
**Quiescent Output Waveform (1 output):VCX16245 (1.8 V)**




Conditions
$V_{CC}$ = 1.8 V
$C_L$ = 30 pF, $R_L$ = 500 Ω, Ta = 25°C
$C_L$: Load Capacitance
$R_L$: Load Resistance

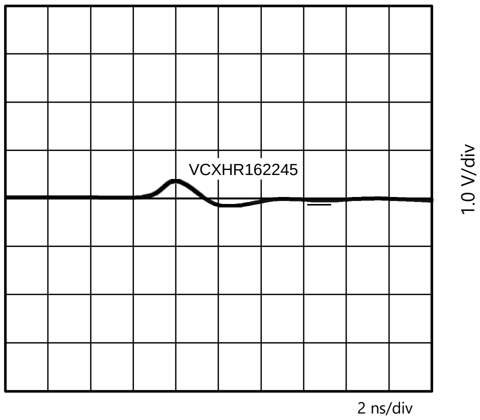
**Figure 1.3 Comparison of Simultaneous Switching Noise (1/2)**

**Quiescent Output Waveform (1 output):VCXHR162245 (3.3 V)**



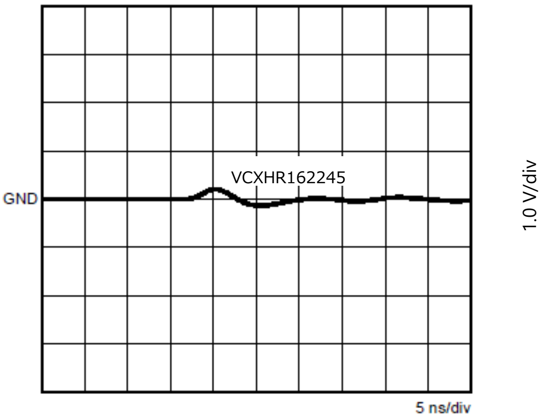

Conditions
$V_{CC}$ = 3.3 V
$C_L$ = 30 pF, $R_L$ = 500 Ω, Ta = 25°C
$C_L$: Load Capacitance
$R_L$: Load Resistance

**Quiescent Output Waveform (1 output):VCXHR162245 (2.5 V)**




Conditions
$V_{CC}$ = 2.5 V
$C_L$ = 30 pF, $R_L$ = 500 Ω, Ta = 25°C
$C_L$: Load Capacitance
$R_L$: Load Resistance

**Quiescent Output Waveform (1 output):VCXHR162245 (1.8 V)**




Conditions
$V_{CC}$ = 1.8 V
$C_L$ = 30 pF, $R_L$ = 500 Ω, Ta = 25°C
$C_L$: Load Capacitance
$R_L$: Load Resistance

**Figure 1.4 Comparison of Simultaneous Switching Noise (2/2)**

### 1.2.3. Interface Capability

The VCX/LCX series adopts an input protection circuit with no diode from input terminal to power supply side. The circuit realizes an input tolerant function and power-down protection, and ensures the voltage of input terminal up to 5.5 V (3.6 V in the case of the VCX series) even if the power supply voltage is lower than 5.5 V (3.6 V in the case of the VCX series).

In addition, the VCX/LCX series adopts an output circuit with no parasitic diode from output terminal to power supply side. The circuit realizes an output tolerant function and power-down protection, and ensures the voltage of output terminal up to 5.5 V (3.6 V in the case of the VCX series) even if the output terminal high-impedance state or the power supply voltage is not applied.

This I/O power-down protection system makes it possible to use VHC series devices on "dual supply systems" or "power management circuits".

Note: The TC74VCXH (bus-hold devices) does not adopt input power-down protection.

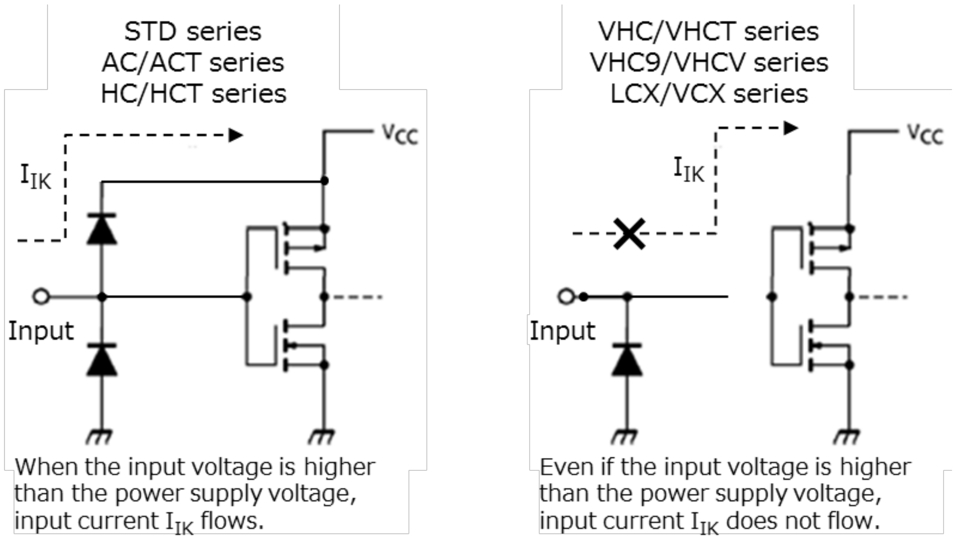



**Figure 1.5 Input Equivalent Circuit for Each Series**

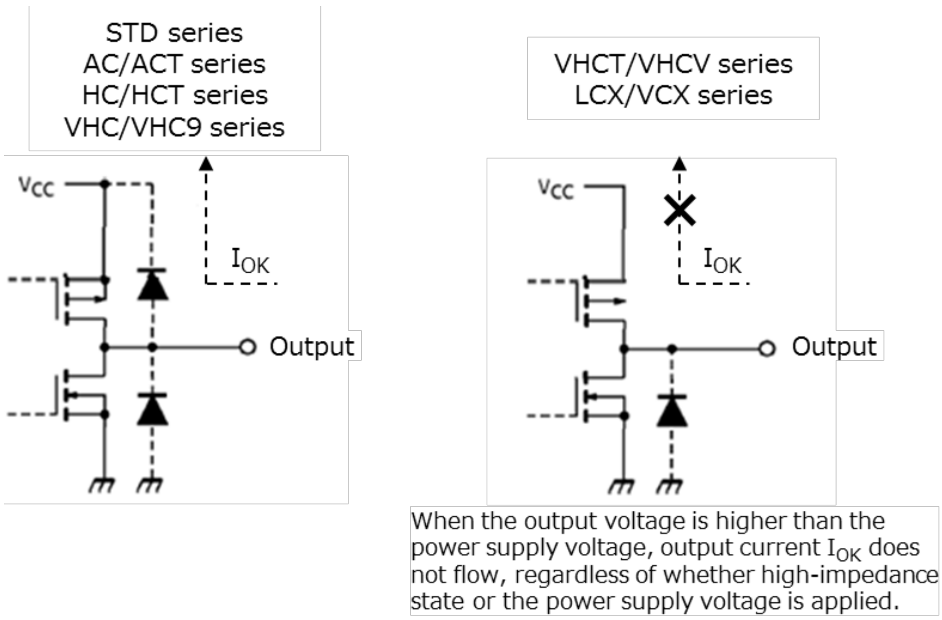



**Figure 1.6 Output Equivalent Circuit for Each Series**

**Table 1.1 Voltage Applicable to I/O Terminals**

| | VCX | VCXH/VCXHR | LCX |
|---|---|---|---|
| Input Voltage Range | | | |
| (Operation) | 0 to 3.6 V | 0 to $V_{CC}$ | 0 to 5.5 V |
| (Power Down) | 0 to 3.6 V | 0 to $V_{CC}$ | 0 to 5.5 V |
| Output Voltage Range | | | |
| (Output Enable) | 0 to $V_{CC}$ | 0 to $V_{CC}$ | 0 to $V_{CC}$ |
| (Output Disable) | 0 to 3.6 V | 0 to 3.6 V | 0 to 5.5 V |
| (Power Down) | 0 to 3.6 V | 0 to 3.6 V | 0 to 5.5 V |

**Table 1.2 Definition of Parameters**

| Parameter | Definition |
|---|---|
| Input tolerant function | A function designed to prevent a current from flowing from an input to the power supply when the input voltage is higher than the power supply voltage or when $V_{CC}$ = 0 V. |
| Output tolerant function | A function designed to prevent a current from flowing from an output to the power supply when the output is in the high-impedance state or when $V_{CC}$ = 0 V. |
| Power-down protection | A function designed to prevent a current from flowing to the power supply terminal even if a voltage is applied to the input and output terminals when $V_{CC}$ = 0 V. |

### 1.2.4. Output Current

Each of the VCX/LCX series has a different output current.

Please refer to Table 1.3.

**Table 1.3 Output Current Per Series**

| | VCX/VCXH | VCXHR | LCX |
|---|---|---|---|
| Output Current ($V_{CC}$ = 3.0 to 3.6 V) | ±24 mA | ±12 mA | ±24 mA |
| ($V_{CC}$ = 2.7 to 3.0 V) | - | - | ±12 mA |
| ($V_{CC}$ = 2.3 to 2.7 V) | ±18 mA | ±8 mA | - |
| ($V_{CC}$ = 1.8 V) | ±6 mA | ±4 mA | - |
| ($V_{CC}$ = 1.65 to 1.95 V) | ±6 mA (Note 1) | - | - |
| ($V_{CC}$ = 1.4 to 1.6 V) | ±2 mA (Note 1) | - | - |

Note 1: Applicable to certain products.

# 2. Method of Designating CMOS Logic IC

## 2.1. Part Naming Conventions

| | | | | |
|---|---|---|---|---|
| TC | (2) | (3) | ( (4) ) | |
| TC74 | (1) | (2) | (3) | ( (4) ) |
| 74 | (1) | (2) | (3) | ( (4) ) |

**Figure 2.1 Part Naming Conventions**

(1) Series, (2) Function, (3) Package, (4) Packing Method

(Example) TC74VCX08FT(EL)

(1) VCX Series, (2) 08 Function, (3) Plastic TSSOP Package, (4) Embossed tape and reel

### (1) Series Definition

Table 2.1 shows each series and the input level.

**Table 2.1 Series Definition**

| Series | Definition |
|---|---|
| Blank | STD series |
| HC | CMOS level input of HC series |
| HCT | TTL level input of HC series |
| AC | CMOS level input of AC series |
| ACT | TTL level input of AC series |
| VHC | CMOS level input of VHC series |
| VHCT | TTL level input of VHC series |
| VHC9 | Schmitt circuit-type input of VHC series |
| VHCV | Schmitt circuit-type input of VHC series<br>Capable of handling twice as much output current as other products in VHC series. |
| LCX | TTL level input of LCX series |
| VCX | TTL level input of VCX series |

### (2) Function

The function number is represented by 2 to 8 alphanumeric characters.

Function numbers are common for all series.

### (3) Package Type

Package classification is common for all series.

| | | |
|---|---|---|
| P··· | Dual in-line package (DIP) | 14/16/20 pin |
| F··· | 200-mil small-outline package (SOP) | 14/16/20 pin |
| D··· | 150-mil small-outline package (SOIC) | 14/16/20 pin |
| FT··· | Thin shrink small-outline package (TSSOP) | 14/16/20/48 pin |
| FK··· | 300-mil small-outline package (US) | 14/16/20 pin |

### (4) Packing Method

Please refer to the Toshiba web page. (URL: https://toshiba.semicon-storage.com/ap-en/top.html)

# 3. Explanation of Rating and Standards

The tables below show common ratings and electrical characteristics for the VCX/LCX series. When the ratings and electrical characteristics are different from those of individual data sheets, the latter take precedence.

For the meanings of the parameters, please refer to the glossary at end of this document.

In VHC series, products with bus-hold function are expressed as VCXH series. And products with bus-hold function and series resistor are expressed as VCXHR series.

## 3.1. Absolute Maximum Ratings

In general, absolute maximum rating values should not be exceeded, in order to guarantee the life and reliability of integrated circuit products.

Absolute maximum ratings should not be exceeded, even for a moment.

When a device is used in excess of any absolute maximum rating, it may not recover, and in many cases, permanent damage will occur.

Table 3.1 shows the common absolute maximum ratings for the VCX/LCX series.

### 3.1.1. VCX Series

**Table 3.1 Absolute Maximum Ratings (VCX Series)**

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Power supply voltage | $V_{CC}$ | -0.5 to 4.6 | V |
| DC input voltage | $V_{IN}$ | -0.5 to 4.6 | V |
| DC output voltage | $V_{OUT}$ | -0.5 to 4.6 (Note 1) | V |
| | | -0.5 to $V_{CC}$ + 0.5 (Note 2) | |
| Input diode current | $I_{IK}$ | -50 | mA |
| Output diode current | $I_{OK}$ | ±50 (Note 3) | mA |
| DC output current | $I_{OUT}$ | ±50 | mA |
| Power dissipation | $P_D$ | 400 | mW |
| DC $V_{CC}$/ground current | $I_{CC}/I_{GND}$ | ±100 | mA |
| Storage temperature | $T_{stg}$ | -65 to 150 | °C |

Note 1: Off-state

Note 2: High or Low state. $I_{OUT}$ absolute maximum rating must be observed.

Note 3: $V_{OUT}$ < GND, $V_{OUT}$ > $V_{CC}$

### 3.1.2. VCXH Series

**Table 3.2 Absolute Maximum Ratings (VCXH Series)**

| Characteristics | | Symbol | Rating | Unit |
|---|---|---|---|---|
| Power supply voltage | | $V_{CC}$ | -0.5 to 4.6 | V |
| DC input voltage | (DIR, $\overline{OE}$) | $V_{IN}$ | -0.5 to 4.6 | V |
| | (An, Bn) | | -0.5 to $V_{CC}$ + 0.5 (Note 1) | |
| DC output voltage | (An, Bn) | $V_{OUT}$ | -0.5 to $V_{CC}$ + 0.5 (Note 2) | V |
| Input diode current | | $I_{IK}$ | ±50 | mA |
| Output diode current | | $I_{OK}$ | ±50 (Note 3) | mA |
| Output current | | $I_{OUT}$ | ±50 | mA |
| Power dissipation | | $P_D$ | 400 | mW |
| DC $V_{CC}$/ground current per supply pin | | $I_{CC}/I_{GND}$ | ±100 | mA |
| Storage temperature | | $T_{stg}$ | -65 to 150 | °C |

Note 1: Off state

Note 2: High or Low state. $I_{OUT}$ absolute maximum rating must be observed.

Note 3: $V_{OUT}$ < GND, $V_{OUT}$ > $V_{CC}$

### 3.1.3. LCX Series

**Table 3.3 Absolute Maximum Ratings (LCX Series)**

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Power supply voltage | $V_{CC}$ | -0.5 to 7.0 | V |
| DC input voltage | $V_{IN}$ | -0.5 to 7.0 | V |
| DC output voltage | $V_{OUT}$ | -0.5 to 7.0 (Note 1) | V |
| | | -0.5 to $V_{CC}$ ± 0.5 (Note 2) | |
| Input diode current | $I_{IK}$ | -50 | mA |
| Output diode current | $I_{OK}$ | ±50 (Note 3) | mA |
| DC output current | $I_{OUT}$ | ±50 | mA |
| Power dissipation | $P_D$ | 180 | mW |
| DC $V_{CC}$/ground current | $I_{CC}/I_{GND}$ | ±100 | mA |
| Storage temperature | $T_{stg}$ | -65 to 150 | °C |

Note 1: Output in OFF state

Note 2: High or Low state. $I_{OUT}$ absolute maximum rating must be observed.

Note 3: $V_{OUT}$ < GND, $V_{OUT}$ > $V_{CC}$

## 3.2. Operating Ranges

These are the conditions under which the operation of the VCX/LCX series devices are guaranteed. When any of these values is exceeded, operation is not guaranteed, even if the value is still within the absolute maximum rating in Tables 3.1 to 3.3.

Unused input terminals must be tied to either $V_{CC}$ or GND.

Tables 3.4 to 3.6 show the common operating ranges for the VCX/LCX series.

### 3.2.1. VCX Series

**Table 3.4 Operating Ranges (VCX Series)**

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Supply voltage | $V_{CC}$ | 1.2 to 3.6 | V |
| Input voltage | $V_{IN}$ | -0.3 to 3.6 | V |
| Output voltage | $V_{OUT}$ | 0 to 3.6 (Note 1) | V |
| | | 0 to $V_{CC}$ (Note 2) | |
| Output current | $I_{OH}/I_{OL}$ | ±24 (Note 3) | mA |
| | | ±18 (Note 4) | |
| | | ±6 (Note 5) | |
| | | ±2 (Note 6) | |
| Operating temperature | $T_{opr}$ | -40 to 85 | °C |
| Input rise and fall time | dt/dv | 0 to 10 (Note 7) | ns/V |

Note 1: Off-state
Note 2: High or low state
Note 3: $V_{CC}$ = 3.0 to 3.6 V
Note 4: $V_{CC}$ = 2.3 to 2.7 V
Note 5: $V_{CC}$ = 1.65 to 1.95 V
Note 6: $V_{CC}$ = 1.4 to 1.6 V
Note 7: $V_{IN}$ = 0.8 to 2.0 V, $V_{CC}$ = 3.0 V

### 3.2.2. VCXH Series

Floating or unused control inputs must be held high or low.

**Table 3.5 Operating Ranges (VCXH Series)**

| Characteristics | | Symbol | Rating | Unit |
|---|---|---|---|---|
| Power supply voltage | | $V_{CC}$ | 1.8 to 3.6 | V |
| | | | 1.2 to 3.6 (Note 1) | |
| Input voltage | (DIR, $\overline{OE}$) | $V_{IN}$ | -0.3 to 3.6 | V |
| | (An, Bn) | | 0 to $V_{CC}$ (Note 2) | |
| Output voltage | (An, Bn) | $V_{OUT}$ | 0 to $V_{CC}$ (Note 3) | V |
| Output current | | $I_{OH}/I_{OL}$ | ±24 (Note 4) | mA |
| | | | ±18 (Note 5) | |
| | | | ±6 (Note 6) | |
| Operating temperature | | $T_{opr}$ | -40 to 85 | °C |
| Input rise and fall time | | dt/dv | 0 to 10 (Note 7) | ns/V |

Note 1: Data retention only
Note 2: OFF state
Note 3: High or low state
Note 4: $V_{CC}$ = 3.0 to 3.6 V
Note 5: $V_{CC}$ = 2.3 to 2.7 V
Note 6: $V_{CC}$ = 1.8 V
Note 7: $V_{IN}$ = 0.8 to 2.0 V, $V_{CC}$ = 3.0 V

### 3.2.3. LCX Series

**Table 3.6 Operating Ranges (LCX Series)**

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Power supply voltage | $V_{CC}$ | 1.65 to 3.6 | V |
| | | 1.5 to 3.6 (Note 1) | |
| Input voltage | $V_{IN}$ | 0 to 5.5 | V |
| Output voltage | $V_{OUT}$ | 0 to 5.5 (Note 2) | V |
| | | 0 to $V_{CC}$ (Note 3) | |
| Output current | $I_{OH}/I_{OL}$ | ±24 (Note 4) | mA |
| | | ±12 (Note 5) | |
| Operating temperature | $T_{opr}$ | -40 to 85 (Note 6)<br>-40 to 125 (Note 6) | °C |
| Input rise and fall time | dt/dv | 0 to 10 (Note 7) | ns/V |

Note 1: Data retention only
Note 2: Output in OFF state
Note 3: High or low state
Note 4: $V_{CC}$ = 3.0 to 3.6 V
Note 5: $V_{CC}$ = 2.7 to 3.0 V
Note 6: Different by products
Note 7: $V_{IN}$ = 0.8 to 2.0 V, $V_{CC}$ = 3.0 V

## 3.3. DC Characteristics

Tables 3.7 to 3.15 show DC characteristics for the VCX/LCX series.

### 3.3.1. VCX Series

#### 3.3.1.1. (Ta = -40 to 85°C, 2.7 V < VCC ≦ 3.6 V)

Table 3.7 DC Characteristics (VCX Series, Ta = -40 to 85°C, 2.7 V < VCC ≦ 3.6 V)

| Characteristics | | Symbol | Test Condition | | VCC (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| Input voltage | High level | VIH | - | | 2.7 to 3.6 | 2.0 | - | V |
| | Low level | VIL | - | | 2.7 to 3.6 | - | 0.8 | |
| Output voltage | High level | VOH | VIN = VIH or VIL | IOH = -100 μA | 2.7 to 3.6 | VCC - 0.2 | - | V |
| | | | | IOH = -12 mA | 2.7 | 2.2 | - | |
| | | | | IOH = -18 mA | 3.0 | 2.4 | - | |
| | | | | IOH = -24 mA | 3.0 | 2.2 | - | |
| | Low level | VOL | VIN = VIH or VIL | IOL = 100 μA | 2.7 to 3.6 | - | 0.2 | |
| | | | | IOL = 12 mA | 2.7 | - | 0.4 | |
| | | | | IOL = 18 mA | 3.0 | - | 0.4 | |
| | | | | IOL = 24 mA | 3.0 | - | 0.55 | |
| Input leakage current | | IIN | VIN = 0 to 3.6 V | | 2.7 to 3.6 | - | ±5.0 | μA |
| 3-state output off-state current | | IOZ | VIN = VIH or VIL<br>VOUT = 0 to 3.6 V | | 2.7 to 3.6 | - | ±10.0 | μA |
| Power off leakage current | | IOFF | VIN, VOUT = 0 to 3.6 V | | 0 | - | 10.0 | μA |
| Quiescent supply current | | ICC | VIN = VCC or GND | | 2.7 to 3.6 | - | 20.0 | μA |
| | | | VCC ≦ (VIN, VOUT) ≦ 3.6 V | | 2.7 to 3.6 | - | ±20.0 | |
| | | ΔICC | VIH = VCC - 0.6 V (per input) | | 2.7 to 3.6 | - | 750 | |

### 3.3.1.2. (Ta = -40 to 85°C, 2.3 V ≦ $V_{CC}$ ≦ 2.7 V)

**Table 3.8 DC Characteristics (VCX Series, Ta = -40 to 85°C, 2.3 V ≦ $V_{CC}$ ≦ 2.7 V)**

| Characteristics | | Symbol | Test Condition | | $V_{CC}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| Input voltage | High level | $V_{IH}$ | - | | 2.3 to 2.7 | 1.6 | - | V |
| | Low level | $V_{IL}$ | - | | 2.3 to 2.7 | - | 0.7 | |
| Output voltage | High level | $V_{OH}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = -100 μA | 2.3 to 2.7 | $V_{CC}$ - 0.2 | - | V |
| | | | | $I_{OH}$ = -6 mA | 2.3 | 2.0 | - | |
| | | | | $I_{OH}$ = -12 mA | 2.3 | 1.8 | - | |
| | | | | $I_{OH}$ = -18 mA | 2.3 | 1.7 | - | |
| | Low level | $V_{OL}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 100 μA | 2.3 to 2.7 | - | 0.2 | |
| | | | | $I_{OL}$ = 12 mA | 2.3 | - | 0.4 | |
| | | | | $I_{OL}$ = 18 mA | 2.3 | - | 0.6 | |
| Input leakage current | | $I_{IN}$ | $V_{IN}$ = 0 to 3.6 V | | 2.3 to 2.7 | - | ±5.0 | μA |
| 3-state output off-state current | | $I_{OZ}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 2.3 to 2.7 | - | ±10.0 | μA |
| Power off leakage current | | $I_{OFF}$ | $V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 0 | - | 10.0 | μA |
| Quiescent supply current | | $I_{CC}$ | $V_{IN}$ = $V_{CC}$ or GND | | 2.3 to 2.7 | - | 20.0 | μA |
| | | | $V_{CC}$ ≦ ($V_{IN}$, $V_{OUT}$) ≦ 3.6 V | | 2.3 to 2.7 | - | ±20.0 | |

### 3.3.1.3. (Ta = -40 to 85°C, 1.65 V ≦ $V_{CC}$ < 2.3 V)

**Table 3.9 DC Characteristics (VCX Series, Ta = -40 to 85°C, 1.65 V ≦ $V_{CC}$ < 2.3 V)**

| Characteristics | | Symbol | Test Condition | | $V_{CC}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| Input voltage | High level | $V_{IH}$ | - | | 1.65 to 2.3 | 0.65 × $V_{CC}$ | - | V |
| | Low level | $V_{IL}$ | - | | 1.65 to 2.3 | - | 0.2 × $V_{CC}$ | |
| Output voltage | High level | $V_{OH}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = -100 μA | 1.65 to 2.3 | $V_{CC}$ - 0.2 | - | V |
| | | | | $I_{OH}$ = -6 mA | 1.65 | 1.25 | - | |
| | Low level | $V_{OL}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 100 μA | 1.65 to 2.3 | - | 0.2 | |
| | | | | $I_{OL}$ = 6 mA | 1.65 | - | 0.3 | |
| Input leakage current | | $I_{IN}$ | $V_{IN}$ = 0 to 3.6 V | | 1.65 to 2.3 | - | ±5.0 | μA |
| 3-state output off-state current | | $I_{OZ}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 1.65 | - | ±10.0 | μA |
| Power off leakage current | | $I_{OFF}$ | $V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 0 | - | 10.0 | μA |
| Quiescent supply current | | $I_{CC}$ | $V_{IN}$ = $V_{CC}$ or GND | | 1.65 to 2.3 | - | 20.0 | μA |
| | | | $V_{CC}$ ≦ ($V_{IN}$, $V_{OUT}$) ≦ 3.6 V | | 1.65 to 2.3 | - | ±20.0 | |

### 3.3.1.4. (Ta = -40 to 85°C, 1.4 V ≦ $V_{CC}$ < 1.65 V)

**Table 3.10 DC Characteristics (VCX Series, Ta = -40 to 85°C, 1.4 V ≦ $V_{CC}$ < 1.65 V)**

| Characteristics | | Symbol | Test Condition | | $V_{CC}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| Input voltage | High level | $V_{IH}$ | - | | 1.4 to 1.65 | 0.65 × $V_{CC}$ | - | V |
| | Low level | $V_{IL}$ | - | | 1.4 to 1.65 | - | 0.05 × $V_{CC}$ | |
| Output voltage | High level | $V_{OH}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = -100 μA | 1.4 to 1.65 | $V_{CC}$ - 0.2 | - | V |
| | | | | $I_{OH}$ = -2 mA | 1.4 | 1.05 | - | |
| | Low level | $V_{OL}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 100 μA | 1.4 to 1.65 | - | 0.05 | |
| | | | | $I_{OL}$ = 2 mA | 1.4 | - | 0.35 | |
| Input leakage current | | $I_{IN}$ | $V_{IN}$ = 0 to 3.6 V | | 1.4 to 1.65 | - | ±5.0 | μA |
| 3-state output off-state current | | $I_{OZ}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 1.4 to 1.65 | - | ±10.0 | μA |
| Power off leakage current | | $I_{OFF}$ | $V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 0 | - | 10.0 | μA |
| Quiescent supply current | | $I_{CC}$ | $V_{IN}$ = $V_{CC}$ or GND | | 1.4 to 1.65 | - | 20.0 | μA |
| | | | $V_{CC}$ ≦ ($V_{IN}$, $V_{OUT}$) ≦ 3.6 V | | 1.4 to 1.65 | - | ±20.0 | |

### 3.3.1.5. (Ta = -40 to 85°C, 1.2 V ≦ $V_{CC}$ < 1.4 V)

**Table 3.11 DC Characteristics (VCX Series, Ta = -40 to 85°C, 1.2 V ≦ $V_{CC}$ < 1.4 V)**

| Characteristics | | Symbol | Test Condition | | $V_{CC}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| Input voltage | High level | $V_{IH}$ | - | | 1.2 to 1.4 | 0.8 × $V_{CC}$ | - | V |
| | Low level | $V_{IL}$ | - | | 1.2 to 1.4 | - | 0.05 × $V_{CC}$ | |
| Output voltage | High level | $V_{OH}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = -100 μA | 1.2 | $V_{CC}$ - 0.1 | - | V |
| | Low level | $V_{OL}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 100 μA | 1.2 | - | 0.05 | |
| Input leakage current | | $I_{IN}$ | $V_{IN}$ = 0 to 3.6 V | | 1.2 | - | ±5.0 | μA |
| 3-state output off-state current | | $I_{OZ}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 1.2 | - | ±10.0 | μA |
| Power off leakage current | | $I_{OFF}$ | $V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 0 | - | 10.0 | μA |
| Quiescent supply current | | $I_{CC}$ | $V_{IN}$ = $V_{CC}$ or GND | | 1.2 | - | 20.0 | μA |
| | | | $V_{CC}$ ≦ ($V_{IN}$, $V_{OUT}$) ≦ 3.6 V | | 1.2 | - | ±20.0 | |

### 3.3.2. VCXH Series

#### 3.3.2.1. (Ta = -40 to 85°C, 2.7 V < VCC ≦ 3.6 V)

**Table 3.12 DC Characteristics (VCXH Series, Ta = -40 to 85°C, 2.7 V < VCC ≦ 3.6 V)**

| Characteristics | | Symbol | Test Condition | | VCC (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| Input voltage | H-level | VIH | - | | 2.7 to 3.6 | 2.0 | - | V |
| | L-level | VIL | - | | 2.7 to 3.6 | - | 0.8 | |
| Output voltage | H-level | VOH | VIN = VIH or VIL | IOH = -100 μA | 2.7 to 3.6 | VCC - 0.2 | - | V |
| | | | | IOH = -12 mA | 2.7 | 2.2 | - | |
| | | | | IOH = -18 mA | 3.0 | 2.4 | - | |
| | | | | IOH = -24 mA | 3.0 | 2.2 | - | |
| | L-level | VOL | VIN = VIH or VIL | IOL = 100 μA | 2.7 to 3.6 | - | 0.2 | |
| | | | | IOL = 12 mA | 2.7 | - | 0.4 | |
| | | | | IOL = 18 mA | 3.0 | - | 0.4 | |
| | | | | IOL = 24 mA | 3.0 | - | 0.55 | |
| Input leakage current (DIR, $\overline{OE}$) | | IIN | VIN = 0 to 3.6 V | | 2.7 to 3.6 | - | ±5.0 | μA |
| Bushold input minimum drive hold current | | II (HOLD) | VIN = 0.8 V | | 3.0 | 75 | - | μA |
| | | | VIN = 2.0 V | | 3.0 | -75 | - | |
| Bushold input over-drive current to change state (Note 1) | | II (OD) | VIN = “L”→”H” | | 3.6 | - | 500 | μA |
| | | | VIN = “H”→”L” | | 3.6 | - | -500 | |
| 3-state output OFF state current | | IOZ | VIN = VIH or VIL<br>VOUT = VCC or GND | | 2.7 to 3.6 | - | ±10.0 | μA |
| Quiescent supply current | | ICC | VIN = VCC or GND | | 2.7 to 3.6 | - | 20.0 | μA |
| Increase in ICC per input | | ΔICC | VIH = VCC - 0.6 V (per input) | | 2.7 to 3.6 | - | 750 | |

Note 1: It is a necessary electric current to change the input in "L" or "H".

### 3.3.2.2. (Ta = -40 to 85°C, 2.3 V ≦ VCC ≦ 2.7 V)

**Table 3.13 DC Characteristics (VCXH Series, Ta = -40 to 85°C, 2.3 V ≦ VCC ≦ 2.7 V)**

| Characteristics | | Symbol | Test Condition | | VCC (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| Input voltage | H-level | $V_{IH}$ | - | | 2.3 to 2.7 | 1.6 | - | V |
| | L-level | $V_{IL}$ | - | | 2.3 to 2.7 | - | 0.7 | |
| Output voltage | H-level | $V_{OH}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = -100 μA | 2.3 to 2.7 | $V_{CC}$ - 0.2 | - | V |
| | | | | $I_{OH}$ = -6 mA | 2.3 | 2.0 | - | |
| | | | | $I_{OH}$ = -12 mA | 2.3 | 1.8 | - | |
| | | | | $I_{OH}$ = -18 mA | 2.3 | 1.7 | - | |
| | L-level | $V_{OL}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 100 μA | 2.3 to 2.7 | - | 0.2 | |
| | | | | $I_{OL}$ = 12 mA | 2.3 | - | 0.4 | |
| | | | | $I_{OL}$ = 18 mA | 2.3 | - | 0.6 | |
| Input leakage current (DIR, $\overline{OE}$) | | $I_{IN}$ | $V_{IN}$ = 0 to 3.6 V | | 2.3 to 2.7 | - | ±5.0 | μA |
| Bushold input minimum drive hold current | | $I_I$ (HOLD) | $V_{IN}$ = 0.7 V | | 2.3 | 45 | - | μA |
| | | | $V_{IN}$ = 1.6 V | | 2.3 | -45 | - | |
| Bushold input over-drive current to change state (Note) | | $I_I$ (OD) | $V_{IN}$ = "L"→"H" | | 2.7 | - | 300 | μA |
| | | | $V_{IN}$ = "H"→"L" | | 2.7 | - | -300 | |
| 3-state output OFF state current | | $I_{OZ}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = $V_{CC}$ or GND | | 2.3 to 2.7 | - | ±10.0 | μA |
| Quiescent supply current | | $I_{CC}$ | $V_{IN}$ = $V_{CC}$ or GND | | 2.3 to 2.7 | - | 20.0 | μA |

Note 1: It is a necessary electric current to change the input in "L" or "H".

### 3.3.2.3. (Ta = -40 to 85°C, 1.8 V ≦ VCC < 2.3 V)

**Table 3.14 DC Characteristics (VCXH Series, Ta = -40 to 85°C, 1.8 V ≦ VCC < 2.3 V)**

| Characteristics | | Symbol | Test Condition | | VCC (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| Input voltage | H-level | $V_{IH}$ | - | | 1.8 to 2.3 | 0.7 × $V_{CC}$ | - | V |
| | L-level | $V_{IL}$ | - | | 1.8 to 2.3 | - | 0.2 × $V_{CC}$ | |
| Output voltage | H-level | $V_{OH}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = -100 μA | 1.8 | $V_{CC}$ - 0.2 | - | V |
| | | | | $I_{OH}$ = -6 mA | 1.8 | 1.4 | - | |
| | L-level | $V_{OL}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 100 μA | 1.8 | - | 0.2 | |
| | | | | $I_{OL}$ = 6 mA | 1.8 | - | 0.3 | |
| Input leakage current (DIR, $\overline{OE}$) | | $I_{IN}$ | $V_{IN}$ = 0 to 3.6 V | | 1.8 | - | ±5.0 | μA |
| Bushold input minimum drive hold current | | $I_I$ (HOLD) | $V_{IN}$ = 0.36 V | | 1.8 | 25 | - | μA |
| | | | $V_{IN}$ = 1.26 V | | 1.8 | -25 | - | |
| Bushold input over-drive current to change state (Note) | | $I_I$ (OD) | $V_{IN}$ = "L"→"H" | | 1.8 | - | 200 | μA |
| | | | $V_{IN}$ = "H"→"L" | | 1.8 | - | -200 | |
| 3-state output OFF state current | | $I_{OZ}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = $V_{CC}$ or GND | | 1.8 | - | ±10.0 | μA |
| Quiescent supply current | | $I_{CC}$ | $V_{IN}$ = $V_{CC}$ or GND | | 1.8 | - | 20.0 | μA |

Note 1: It is a necessary electric current to change the input in "L" or "H".

### 3.3.3. LCX series

**Table 3.15 DC Characteristics (LCX Series) (Ta = -40 to 85°C)**

| Characteristics | | Symbol | Test Condition | | $V_{CC}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| Input voltage | H-level | $V_{IH}$ | - | | 1.65 to 2.3 | $V_{CC}$ × 0.9 | - | V |
| | | | | | 2.3 to 2.7 | 1.7 | - | |
| | | | | | 2.7 to 3.6 | 2.0 | - | |
| | L-level | $V_{IL}$ | - | | 1.65 to 2.3 | - | $V_{CC}$ × 0.1 | |
| | | | | | 2.3 to 2.7 | - | 0.7 | |
| | | | | | 2.7 to 3.6 | - | 0.8 | |
| Output voltage | H-level | $V_{OH}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = -100 μA | 1.65 to 3.6 | $V_{CC}$ - 0.2 | - | V |
| | | | | $I_{OH}$ = -4 mA | 1.65 | 1.05 | - | |
| | | | | $I_{OH}$ = -8 mA | 2.3 | 1.7 | - | |
| | | | | $I_{OH}$ = -12 mA | 2.7 | 2.2 | - | |
| | | | | $I_{OH}$ = -18 mA | 3.0 | 2.4 | - | |
| | | | | $I_{OH}$ = -24 mA | 3.0 | 2.2 | - | |
| | L-level | $V_{OL}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 100 μA | 1.65 to 3.6 | - | 0.2 | |
| | | | | $I_{OL}$ = 4 mA | 1.65 | - | 0.45 | |
| | | | | $I_{OL}$ = 8 mA | 2.3 | - | 0.7 | |
| | | | | $I_{OL}$ = 12 mA | 2.7 | - | 0.4 | |
| | | | | $I_{OL}$ = 16 mA | 3.0 | - | 0.4 | |
| | | | | $I_{OL}$ = 24 mA | 3.0 | - | 0.55 | |
| Input leakage current | | $I_{IN}$ | $V_{IN}$ = 0 to 5.5 V | | 1.65 to 3.6 | - | ±5.0 | μA |
| 3-state output off-state current | | $I_{OZ}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 5.5 V | | 1.65 to 3.6 | - | ±5.0 | μA |
| Power off leakage current | | $I_{OFF}$ | $V_{IN}$/$V_{OUT}$ = 5.5 V | | 0 | - | 10.0 | μA |
| Quiescent supply current | | $I_{CC}$ | $V_{IN}$ = $V_{CC}$ or GND | | 1.65 to 3.6 | - | 10.0 | μA |
| | | | $V_{IN}$/$V_{OUT}$ = 3.6 to 5.5 V | | 1.65 to 3.6 | - | ±10.0 | |
| Increase in $I_{CC}$ per input | | $\Delta I_{CC}$ | $V_{IH}$ = $V_{CC}$ - 0.6 V | | 2.7 to 3.6 | - | 500 | |

# 4. Explanation of Symbols Used in Data sheets

## 4.1. How to Read Truth Table

**Table 4.1 Definition of Symbols Used in Truth Table**

| SYMBOL | DEFINITION |
|---|---|
| H | High level (indicates stationary input or output) |
| L | Low level (indicates stationary input or output) |
| ↑ | Indicates leading edge changing from L to H. |
| ↓ | Indicates leading edge changing from H to L. |
| X | Don’t care (either H or L) |
| Z | High-impedance state |
| a···h | The level of the parallel inputs A to H (either H or L). |
| Q0 | Level of Q just before input condition indicated in truth table |
| Qn | Level of Q just before input active edge ( ↑ or ↓ ) |
| ⊓ | One H-level pulse |
| ⊔ | One L-level pulse |

## 4.2. AC Characteristics

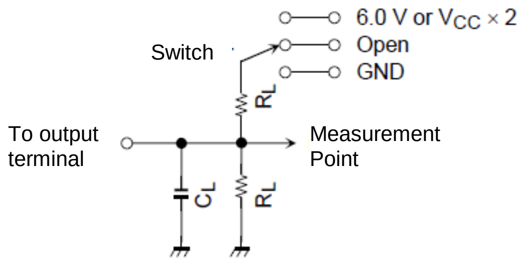
The transient characteristics of the VCX/LCX series are included in the AC characteristics.

Hence, if the AC characteristics are within specification, the transient characteristics will be satisfactory.

Figures 4.1 and 4.2 show measuring circuits of the VCX and LCX. Figures 4.3 and 4.4 show I/O switching waveforms.

(Condition of input waveform: An amplitude range is between $V_{CC}$ and GND, and rise and fall times are 2 ns in the case of the VCX series, and 2.5 ns in the case of the LCX series.)

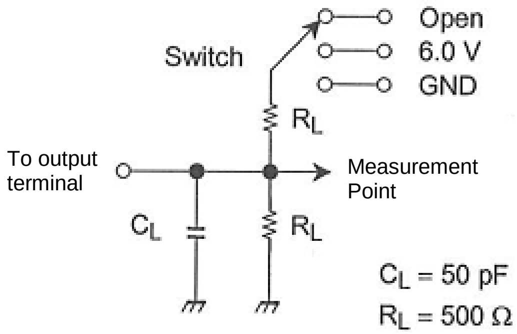
To ensure normal functioning of the device, the following timings must be adhered to.




| Parameter | Switch |
|---|---|
| $t_{pLH}$, $t_{pHL}$ | Open |
| $t_{pLZ}$, $t_{pZL}$ | 6.0 V<br>$V_{CC}$ × 2 @$V_{CC}$ = 3.3 ± 0.3 V<br>@$V_{CC}$ = 2.5 ± 0.2 V<br>@$V_{CC}$ = 1.8 ± 0.15 V<br>@$V_{CC}$ = 1.5 ± 0.1 V<br>@$V_{CC}$ = 1.2 V |
| $t_{pHZ}$, $t_{pZH}$ | GND |

| Symbol | $V_{CC}$ | |
|---|---|---|
| | 3.3 ± 0.3 V<br>2.5 ± 0.2 V<br>1.8 ± 0.15 V | 1.5 ± 0.1 V<br>1.2 V |
| $R_L$ | 500 Ω | 2 kΩ |
| $C_L$ | 30 pF | 15 pF |

**Figure 4.1 Measuring Circuit of Output (VCX Series)**



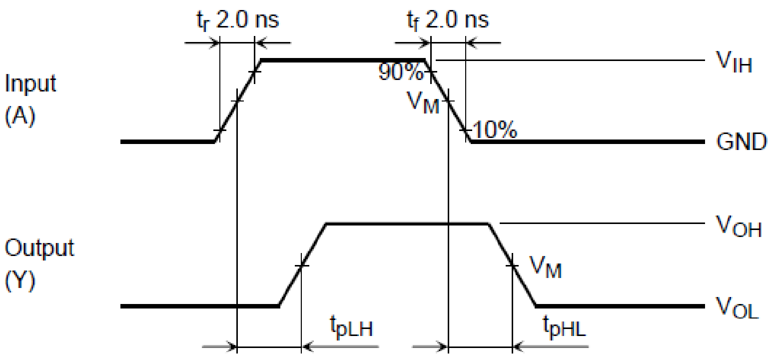

| Parameter | Switch |
|---|---|
| $t_{pLH}$, $t_{pHL}$ | Open |
| $t_{pLZ}$, $t_{pZL}$ | 6.0 V |
| $t_{pHZ}$, $t_{pZH}$ | GND |
| $t_w$, $t_s$, $t_h$, $f_{MAX}$ | Open |

Note: $C_L$ includes the probe capacitance.

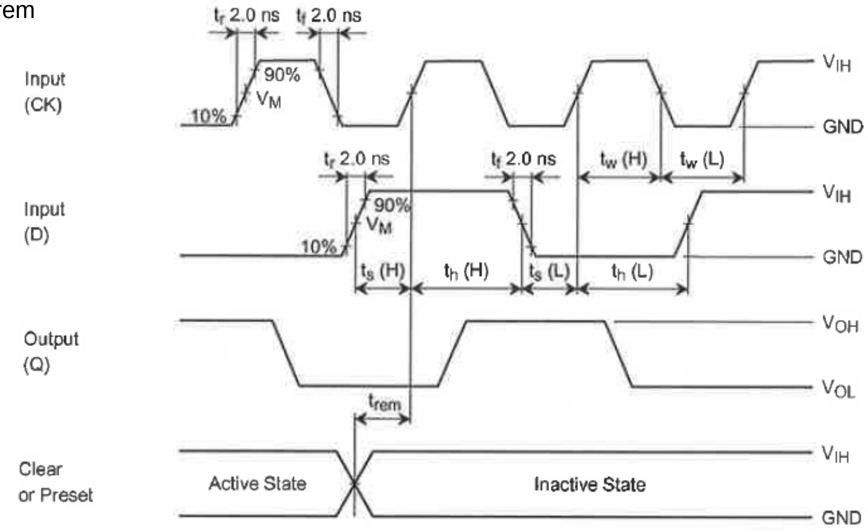
**Figure 4.2 Measuring Circuit of Output (LCX Series)**

### 4.2.1. I/O Switching Waveforms of VCX Series

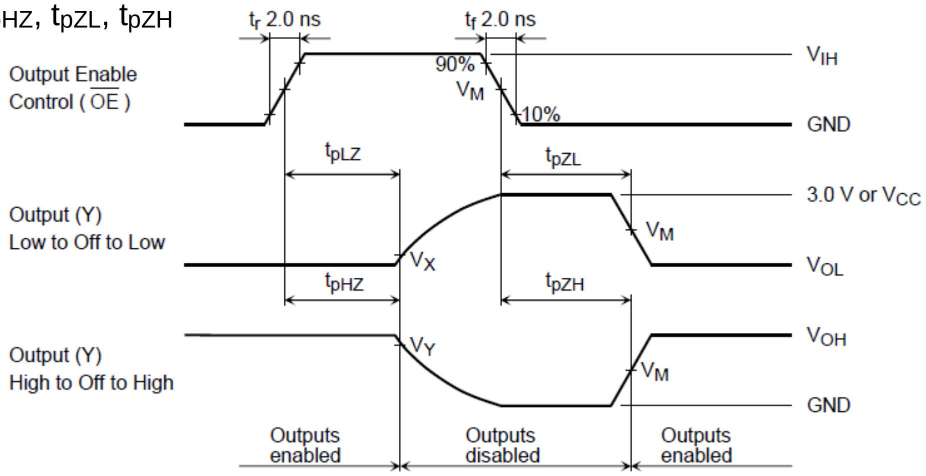
1) $t_{pLH}$,$t_{pHL}$




2) $t_w$, $t_s$, $t_h$, $t_{rem}$




3) $t_{pLZ}$, $t_{pHZ}$, $t_{pZL}$, $t_{pZH}$

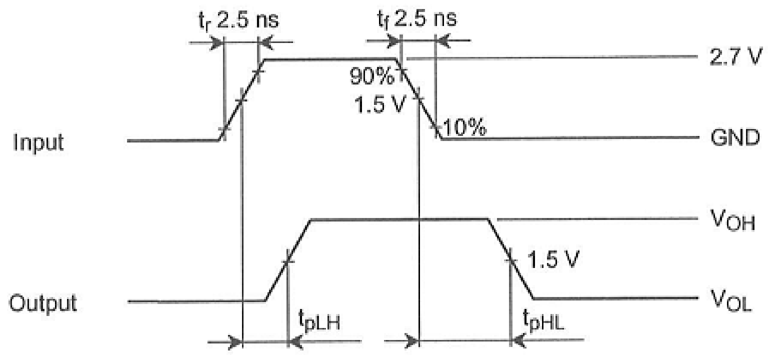



| Symbol | $V_{CC}$ | | | | |
|---|---|---|---|---|---|
| | 3.3 ± 0.3 V | 2.5 ± 0.2 V | 1.8 ± 0.15 V | 1. 5 ± 0.1 V | 1.2 V |
| $V_{IH}$ | 2.7 V | $V_{CC}$ | $V_{CC}$ | $V_{CC}$ | $V_{CC}$ |
| $V_M$ | 1.5 V | $V_{CC}/2$ | $V_{CC}/2$ | $V_{CC}/2$ | $V_{CC}/2$ |
| $V_X$ | $V_{OL}$ + 0.3 V | $V_{OL}$ + 0.15 V | $V_{OL}$ + 0.15 V | $V_{OL}$ + 0.1 V | $V_{OL}$ + 0.1 V |
| $V_Y$ | $V_{OH}$ − 0.3 V | $V_{OH}$ − 0.15 V | $V_{OH}$ − 0.15 V | $V_{OH}$ − 0.1 V | $V_{OH}$ − 0.1 V |

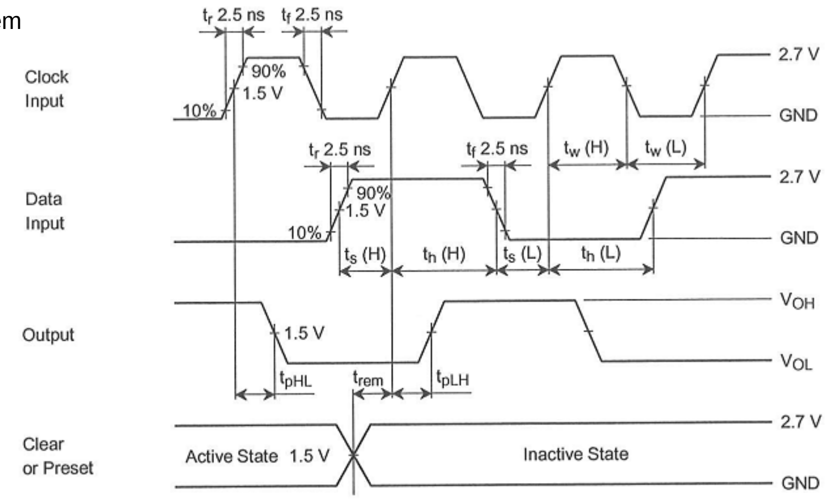
**Figure 4.3 I/O Switching Waveforms of VCX Series**

### 4.2.2. I/O Switching Waveforms of LCX Series

1) $t_{pLH}$, $t_{pHL}$




2) $t_w$, $t_s$, $t_h$, $t_{rem}$




3) $t_{pLZ}$, $t_{pHZ}$, $t_{pZL}$, $t_{pZH}$

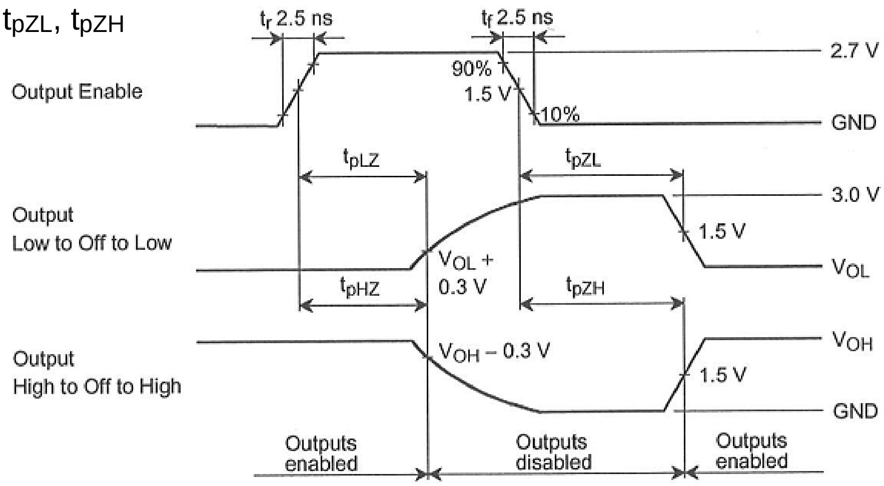



**Figure 4.4 I/O Switching Waveforms of LCX Series**

## 4.3. Standardized Test Procedure for Power Dissipation Capacitance

Measurements for all devices are under the conditions of "$V_{CC}$ = 3.3 V" and "Ta = 25 deg C". And a relatively high frequency, about 10 MHz, is used for measurement of power consumption, because if a device is tested at a high enough frequency, the contribution of the DC supply current to the overall power consumption will be negligible and can be ignored. Devices with 3-state outputs are measured in the enabled state.

In the case of devices that have several circuits in the same package (e.g., LCX16244: 16-BIT BUS BUFFER, LCX04: HEX INVERTER, LCX74: DUAL D-F/F etc.), only one circuit is measured and the result is shown on the data sheet as the $C_{pd}$ per circuit.

In the case of devices that contain several circuits in the same package operating simultaneously from the same clock signal (e.g., LCX373:OCTAL D LATCH etc.), the $C_{pd}$ can be obtained by measuring either the $C_{pd}$ of the device with only one output active, or the $C_{pd}$ with all device outputs active.

The pin states for each IC are listed in the table.

$C_{PD}$ Measuring Condition

**Table 4.2 $C_{PD}$ Measuring Condition**

| Type No. | | Pin No. | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 00 | | P | H | O | X | X | O | G | O | X | X | O | X | X | V | | | | | | | | | | |
| 02 | | O | P | L | O | X | X | G | X | X | O | X | X | O | V | | | | | | | | | | |
| 04 | | P | O | X | O | X | O | G | O | X | O | X | O | X | V | | | | | | | | | | |
| 05 | | P | R | X | O | X | O | G | O | X | O | X | O | X | V | | | | | | | | | | |
| 07 | | P | R | X | O | X | O | G | O | X | O | X | O | X | V | | | | | | | | | | |
| 08 | | P | H | O | X | X | O | G | O | X | X | O | X | X | V | | | | | | | | | | |
| 14 | | P | O | X | O | X | O | G | O | X | O | X | O | X | V | | | | | | | | | | |
| 32 | | P | L | O | X | X | O | G | O | X | X | O | X | X | V | | | | | | | | | | |
| 74 | | H | Q | P | H | O | O | G | O | O | X | X | X | X | V | | | | | | | | | | |
| 86 | | P | L | O | X | X | O | G | O | X | X | O | X | X | V | | | | | | | | | | |
| 125 | | H | P | O | X | X | O | G | O | X | X | O | X | X | V | | | | | | | | | | |
| 126 | | H | P | O | X | X | O | G | O | X | X | O | X | X | V | | | | | | | | | | |
| 138 | | P | L | L | L | L | H | O | G | O | O | O | O | O | O | O | V | | | | | | | | |
| 157 | 1* | P | L | H | O | L | L | O | G | O | L | L | O | L | L | L | V | | | | | | | | |
| 157 | 4* | P | L | H | O | L | H | O | G | O | H | L | O | H | L | L | V | | | | | | | | |
| 240 | | L | P | O | X | O | X | O | X | O | G | X | O | X | O | X | O | X | O | X | V | | | | |
| 244 | | L | P | O | X | O | X | O | X | O | G | X | O | X | O | X | O | X | O | X | V | | | | |
| 245 | | H | P | X | X | X | X | X | X | X | G | O | O | O | O | O | O | O | O | L | V | | | | |
| 257 | 1* | P | L | H | O | X | X | O | G | O | X | X | O | X | X | L | V | | | | | | | | |
| 257 | 4* | P | L | H | O | L | H | O | G | O | H | L | O | H | L | L | V | | | | | | | | |
| 273 | 1* | H | O | Q | X | O | O | X | X | O | G | P | O | X | X | O | O | X | X | O | V | | | | |
| 273 | 8* | H | O | Q | Q | O | O | Q | Q | O | G | P | O | Q | Q | O | O | Q | Q | O | V | | | | |
| 373 | 1* | L | O | Q | X | O | O | X | X | O | G | P | O | X | X | O | O | X | X | O | V | | | | |
| 373 | 8* | L | O | Q | Q | O | O | Q | Q | O | G | P | O | Q | Q | O | O | Q | Q | O | V | | | | |
| 374 | 1* | L | O | Q | X | O | O | X | X | O | G | P | O | X | X | O | O | X | X | O | V | | | | |
| 374 | 8* | L | O | Q | Q | O | O | Q | Q | O | G | P | O | Q | Q | O | O | Q | Q | O | V | | | | |
| 540 | 1* | L | P | X | X | X | X | X | X | X | G | O | O | O | O | O | O | O | O | L | V | | | | |
| 540 | 8* | L | P | P | P | P | P | P | P | P | G | O | O | O | O | O | O | O | O | L | V | | | | |
| 541 | 1* | L | P | X | X | X | X | X | X | X | G | O | O | O | O | O | O | O | O | L | V | | | | |
| 541 | 8* | L | P | P | P | P | P | P | P | P | G | O | O | O | O | O | O | O | O | L | V | | | | |
| 573 | 1* | L | Q | X | X | X | X | X | X | X | G | P | O | O | O | O | O | O | O | O | V | | | | |
| 573 | 8* | L | Q | Q | Q | Q | Q | Q | Q | Q | G | P | O | O | O | O | O | O | O | O | V | | | | |
| 574 | 1* | L | Q | X | X | X | X | X | X | X | G | P | O | O | O | O | O | O | O | O | V | | | | |
| 574 | 8* | L | Q | Q | Q | Q | Q | Q | Q | Q | G | P | O | O | O | O | O | O | O | O | V | | | | |
| 2125 | | H | P | O | X | X | O | G | O | X | X | O | X | X | V | | | | | | | | | | |
| 2244 | | L | P | O | X | O | X | O | X | O | G | X | O | X | O | X | O | X | O | X | V | | | | |
| 2541 | | L | P | X | X | X | X | X | X | X | G | O | O | O | O | O | O | O | O | L | V | | | | |

*: Number of active outputs

**Table 4.3 $C_{PD}$ Measuring Condition (48 pin)**

| Type No. | | Pin No. | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 16245 | | H | O | O | G | O | O | V | O | O | G | O | O | O | O | G | O | O | V | O | O | G | O | O | H |
| 162245 | | H | O | O | G | O | O | V | O | O | G | O | O | O | O | G | O | O | V | O | O | G | O | O | H |
| 163245 | | H | O | O | G | O | O | V | O | O | G | O | O | O | O | G | O | O | V | O | O | G | O | O | H |
| 164245 | | H | O | O | G | O | O | V | O | O | G | O | O | O | O | G | O | O | V | O | O | G | O | O | H |
| 16244 | | L | O | O | G | O | O | V | O | O | G | O | O | O | O | G | O | O | V | O | O | G | O | O | X |

| Type No. | | Pin No. | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 |
| 16245 | | H | X | X | G | X | X | V | X | X | G | X | X | X | X | G | X | X | V | X | X | G | X | P | L |
| 162245 | | H | X | X | G | X | X | V | X | X | G | X | X | X | X | G | X | X | V | X | X | G | X | P | L |
| 163245 | | H | X | X | G | X | X | V | X | X | G | X | X | X | X | G | X | X | V | X | X | G | X | P | L |
| 164245 | | H | X | X | G | X | X | V | X | X | G | X | X | X | X | G | X | X | V | X | X | G | X | P | L |
| 16244 | | X | X | X | G | X | X | V | X | X | G | X | X | X | X | G | X | X | V | X | X | G | X | X | X |

*: Number of active outputs

—Explanation of Symbols—

V = $V_{CC}$ (+3.3 V)

G = GND (0 V)

H = Logic 1 ($V_{CC}$)

L = Logic 0 (GND)

X = Don't Care i.e. $V_{CC}$ or GND (but not switching)

O = Open

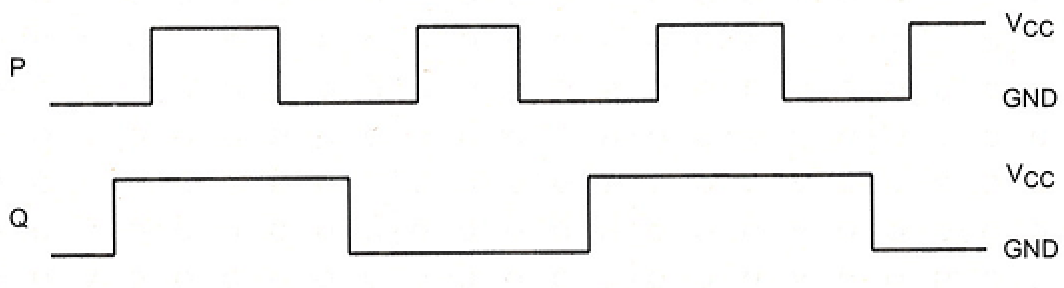
C = A 50-pF* capacitor is inserted between each output pin and GND

*: 30-pF in the case of VCX Series devices

R = 1.0-kΩ pull-up resistor for an additional 3.3-V supply distinct from $V_{CC}$ supply

P = 50% duty cycle input pulse (shown below)

Q = 50% duty cycle half-frequency out-of-phase input pulse (shown below)




Input pulse waveforms

## 4.4. Noise Characteristics and Measurement Circuit

Noise characteristics caused by high-speed switching are specified for the VCX/LCX series.

Noise is generated by rush current flowing through the internal $V_{CC}$ or GND lines of a device when several outputs are switching simultaneously.

Table 4.4 shows an explanation of noise parameters.

Figure 4.5 shows the noise characteristic measurement circuit.

**Table 4.4 Explanation of Noise Parameters**

| Parameter | Symbol | Definition |
|---|---|---|
| Quiet output maximum dynamic $V_{OL}$ | $V_{OLP}$ | The maximum peak voltage induced into an output that is fixed at the Low level when the other outputs are switching simultaneously. |
| Quiet output minimum dynamic $V_{OL}$ | $V_{OLV}$<br>$\lvert V_{OLV} \rvert$ | The minimum peak voltage induced into an output that is fixed at the Low level when the other outputs are switching simultaneously. |
| Quiet output minimum dynamic $V_{OH}$ | $V_{OHV}$ | The minimum peak voltage induced into an output that is fixed at the High level when the other outputs are switching simultaneously. |

Noise characteristic measurement circuit

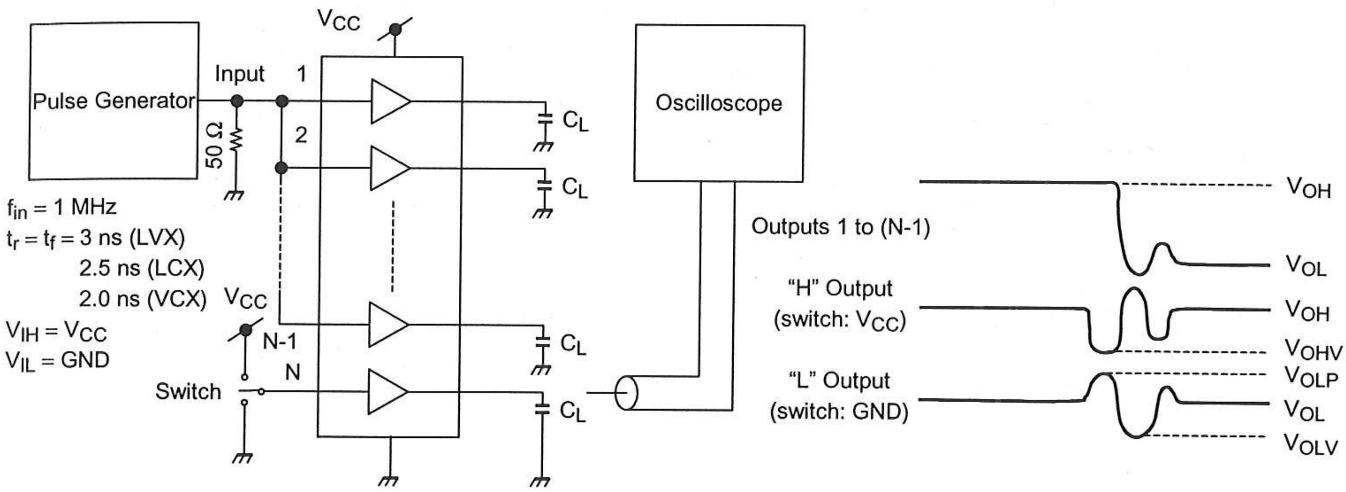



**Figure 4.5 Quiet Output Dynamic $V_{OLP}$ and $V_{OLV}$ Measurement Circuit**

# 5. Other Electrical Characteristics

## 5.1. Power Dissipation

The power dissipation is given by the sum of the quiescent supply current and the dynamic operating current. Therefore, it can be obtained from the following equation:

$$P_D = C_{PD} \cdot f_{IN} \cdot V_{CC}^2 + C_L \cdot f_{OUT} \cdot V_{CC}^2 + I_{CC} \cdot V_{CC}$$

$C_{PD}$ : Power Dissipation Capacitance

$C_L$ : Load Capacitance

$f_{IN}$ : Input Frequency

$f_{OUT}$ : Output Frequency

In the case of CMOS ICs, if inputs are held at $V_{CC}$ or GND, either the N-ch MOS or the P-ch MOS turns off. As a result, the quiescent supply current from $V_{CC}$ to GND is just a few nA at room temperature.

Therefore, the quiescent supply current increases in direct proportion to the power supply voltage and increases exponentially with the temperature.

The dynamic power dissipation of CMOS ICs is calculated by summing the switching currents and the through currents. The switching currents are due to the charging and discharging of each gate capacitance, when the gate in the circuit that includes the output buffer inverts, and the through currents flow from $V_{CC}$ to GND when the P-ch MOS and the N-ch MOS that constitute the gate turn on briefly at the same time during inversion time.

When the rise and fall times of the input signal are small (a few ns), the through current in the gate is negligible compared with the switching current. Thus, the dynamic supply current is determined by the internal capacitance of the IC and the charging and discharging currents of the load capacitance ($C_L$).

However, in specific applications such as crystal oscillators, supply current characteristics depend on the through current, and the result calculated using $C_{PD}$ cannot be used.

## 5.2. Bus-Hold Input Current Characteristics

Table 5.1 lists the bus-hold input current values that are guaranteed for the VCXH16245.
Figure 5.1 shows the bus-hold input current characteristics for the VCXH16245.

**Table 5.1 Guaranteed Bus-Hold Input Current Value for VCXH16245 (μA)**

| Characteristics | $V_{CC}$ (V) | Test Conditions (Ta = −40 to 85°C) | VCXH |
|---|---|---|---|
| Bushold input minimum drive hold current | 1.8 | $V_{IN}$ = 0.36 V | 25 |
| | | $V_{IN}$ = 1.26 V | −25 |
| | 2.3 | $V_{IN}$ = 0.7 V | 45 |
| | | $V_{IN}$ = 1.6 V | −45 |
| | 3.0 | $V_{IN}$ = 0.8 V | 75 |
| | | $V_{IN}$ = 2.0 V | −75 |
| Bushold input over-drive current to change state | 1.8 | An external driver must source at least the specified current to switch from LOW to HIGH. | 200 |
| | | An external driver must sink at least the specified current to switch from HIGH to LOW. | −200 |
| | 2.7 | An external driver must source at least the specified current to switch from LOW to HIGH. | 300 |
| | | An external driver must sink at least the specified current to switch from HIGH to LOW. | −300 |
| | 3.6 | An external driver must source at least the specified current to switch from LOW to HIGH. | 500 |
| | | An external driver must sink at least the specified current to switch from HIGH to LOW. | −500 |

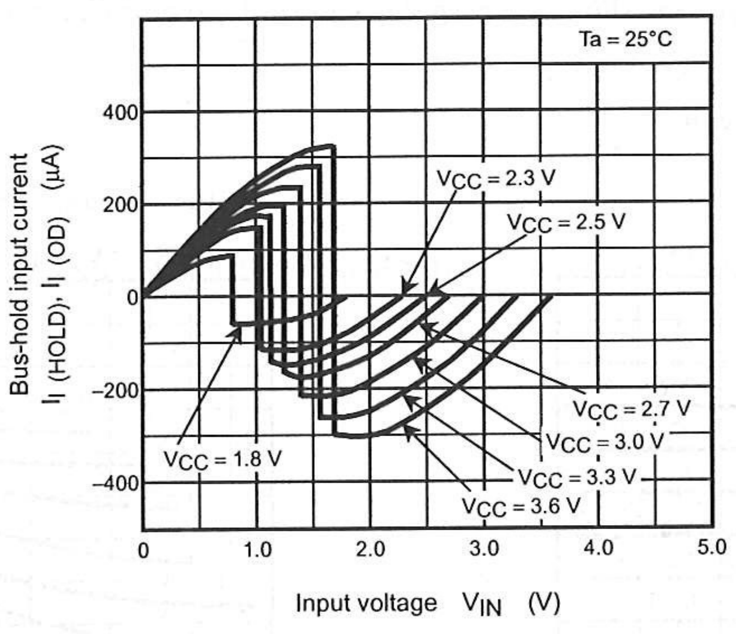



**Figure 5.1 Standard Bus-Hold Input Current Characteristics for VCXH16245**

## 5.3. Output Current Characteristics

Table 5.2 shows the guaranteed value of the output voltage for the VCX/LCX series.

Circuit design can be facilitated by choosing a device from the series (VCX/LCX) most appropriate for the impedance that is to be connected to the device's outputs.

Figures 5.2 and 5.3 (for the VCX series) and Figure 5.4 (for the LCX series) show the respective output current characteristics.

**Table 5.2 Guaranteed Value of Output Voltage for VCX/LCX Series**

| Characteristics | Test Conditions (Ta = −40 to 85°C) | | | VCX | LCX |
|---|---|---|---|---|---|
| | $V_{CC}$ (V) | | | | |
| High-level output voltage (min) | 1.8 | $I_{OH}$ = −6 mA | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | 1.4 | — |
| | 2.3 | $I_{OH}$ = −6 mA | | 2.0 | — |
| | 2.3 | $I_{OH}$ = −12 mA | | 1.8 | — |
| | 2.3 | $I_{OH}$ = −18 mA | | 1.7 | — |
| | 2.7 | $I_{OH}$ = −12 mA | | 2.2 | 2.2 |
| | 3.0 | $I_{OH}$ = −4 mA | | — | — |
| | 3.0 | $I_{OH}$ = −18 mA | | 2.4 | 2.4 |
| | 3.0 | $I_{OH}$ = −24 mA | | 2.2 | 2.2 |
| Low-level output voltage (max) | 1.8 | $I_{OL}$ = 6 mA | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | 0.3 | — |
| | 2.3 | $I_{OL}$ = 12 mA | | 0.4 | — |
| | 2.3 | $I_{OL}$ = 18 mA | | 0.6 | — |
| | 2.7 | $I_{OL}$ = 12 mA | | 0.4 | 0.4 |
| | 3.0 | $I_{OL}$ = 4 mA | | — | — |
| | 3.0 | $I_{OL}$ = 16 mA | | — | 0.4 |
| | 3.0 | $I_{OL}$ = 18 mA | | 0.4 | — |
| | 3.0 | $I_{OL}$ = 24 mA | | 0.55 | 0.55 |

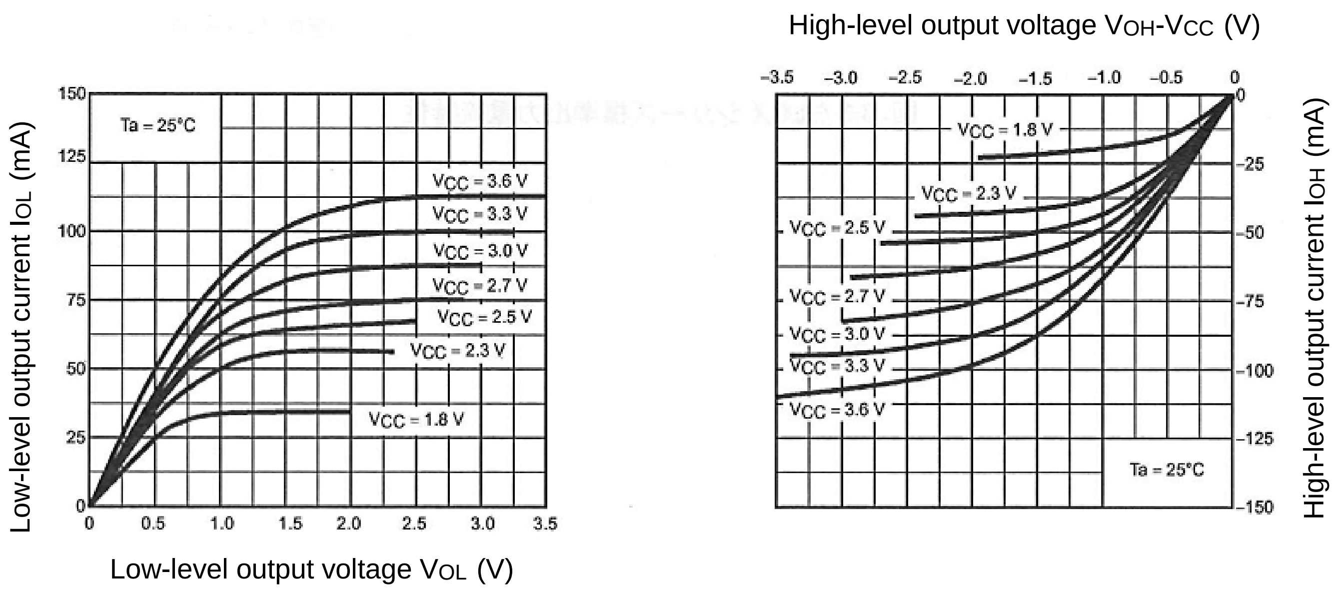



**Figure 5.2 Output Current Characteristics for VCX Series (Typ.)**

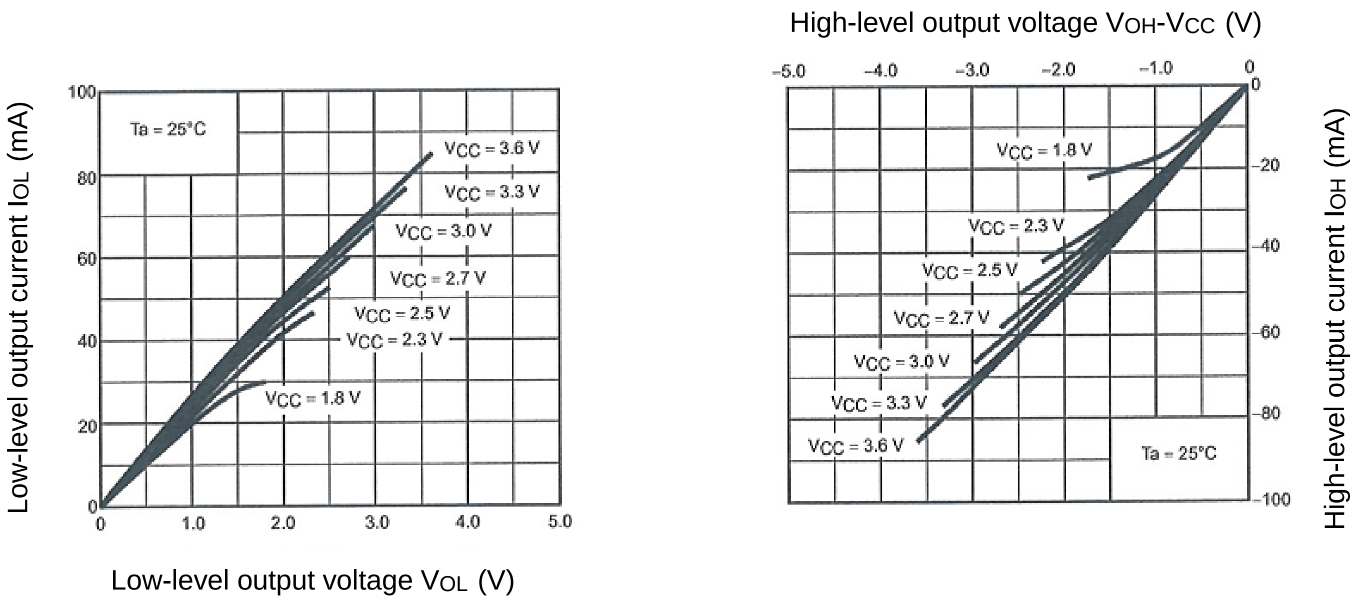



**Figure 5.3 Output Current Characteristics for VCXHR Series (Typ.)**

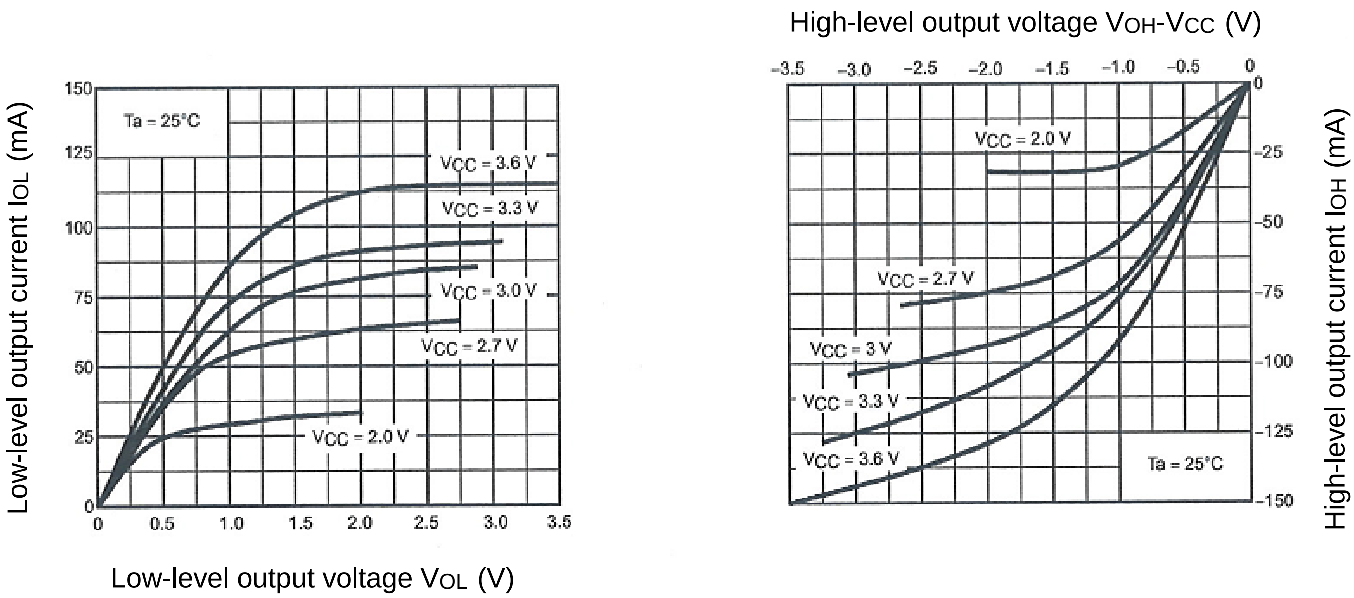



**Figure 5.4 Output Current Characteristics for LCX Series**

## 5.4. AC Electrical Characteristics

### 5.4.1. Capacitive Loading Effects

In the VCX/LCX series, AC characteristics are guaranteed for load capacitances of 30 pF (VCX only) and 50 pF (LCX only). The propagation delay time when using other load capacitances can be obtained using the following equation:

Propagation delay time for a load capacitance of X pF

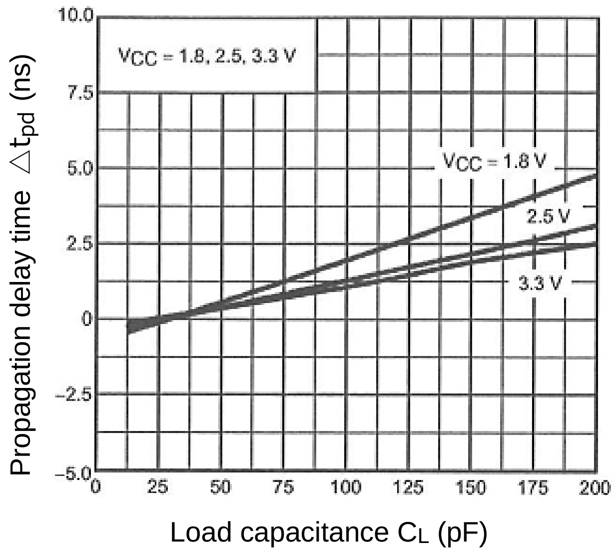
$t_{pd}$(X pF)=A(X pF - 30 pF)+$t_{pd}$(30 pF) ··················VCX series

$t_{pd}$(X pF)=A(X pF - 50 pF)+$t_{pd}$(50 pF) ··················LCX series

A: increase in propagation delay time per unit load capacitance (ns/pF)

Figures 5.5, 5.6, and 5.7 show $\triangle t_{pd}$ for the propagation delay time.

In product-specific specification sheets, guaranteed values are only specified at $C_L$ = 30 pF (VCX only) and $C_L$ = 50 pF (LCX only).

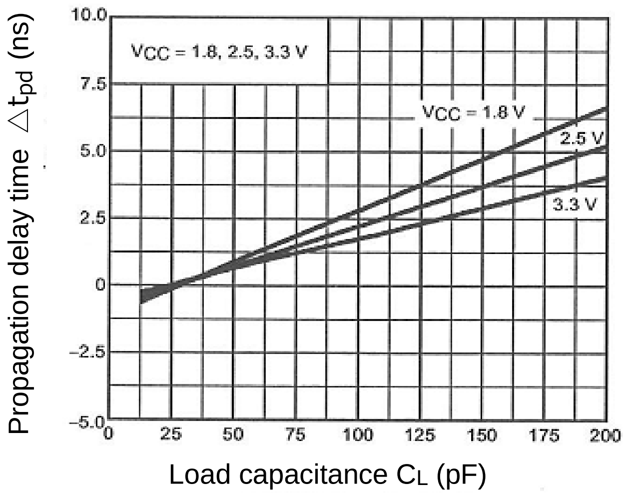



Increase in propagation delay time per unit load capacitance

Ta = 25°C (typ.)

| | |
|---|---|
| $V_{CC}$ = 1.8 V | A = 0.028 (ns/pF) |
| $V_{CC}$ = 2.5 V | A = 0.019 (ns/pF) |
| $V_{CC}$ = 3.3 V | A = 0.015 (ns/pF) |

**Figure 5.5 VCX Series**

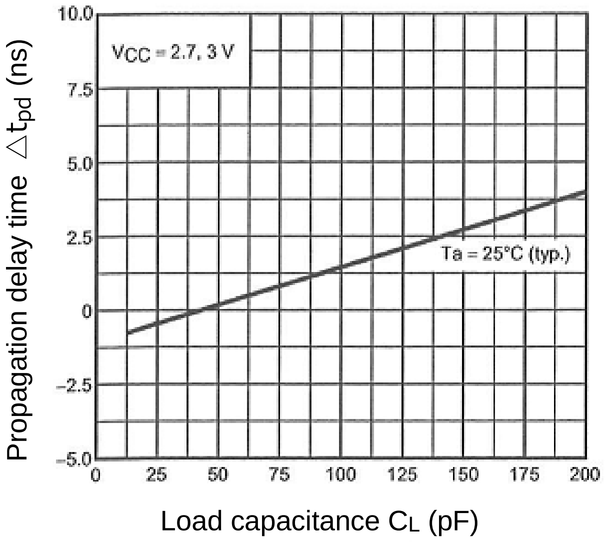



Increase in propagation delay time per unit load capacitance

Ta = 25°C (typ.)

| | |
|---|---|
| $V_{CC}$ = 1.8 V | A = 0.042 (ns/pF) |
| $V_{CC}$ = 2.5 V | A = 0.033 (ns/pF) |
| $V_{CC}$ = 3.3 V | A = 0.030 (ns/pF) |

**Figure 5.6 VCXHR Series**




Increase in propagation delay time per unit load capacitance
Ta = 25°C (typ.)  A = 0.023 (ns/pF)

**Figure 5.7 LCX Series**

### 5.4.2. Output Skew Characteristics

The output-pin-to-pin skew characteristics ($t_{osLH}/t_{osHL}$) for the VCX/LCX series are shown below. These values are items guaranteed by design.

$t_{osLH} = |t_{pLH}(max) - t_{pLH}(min)|$

$t_{osHL} = |t_{pHL}(max) - t_{pHL}(min)|$

(Example)

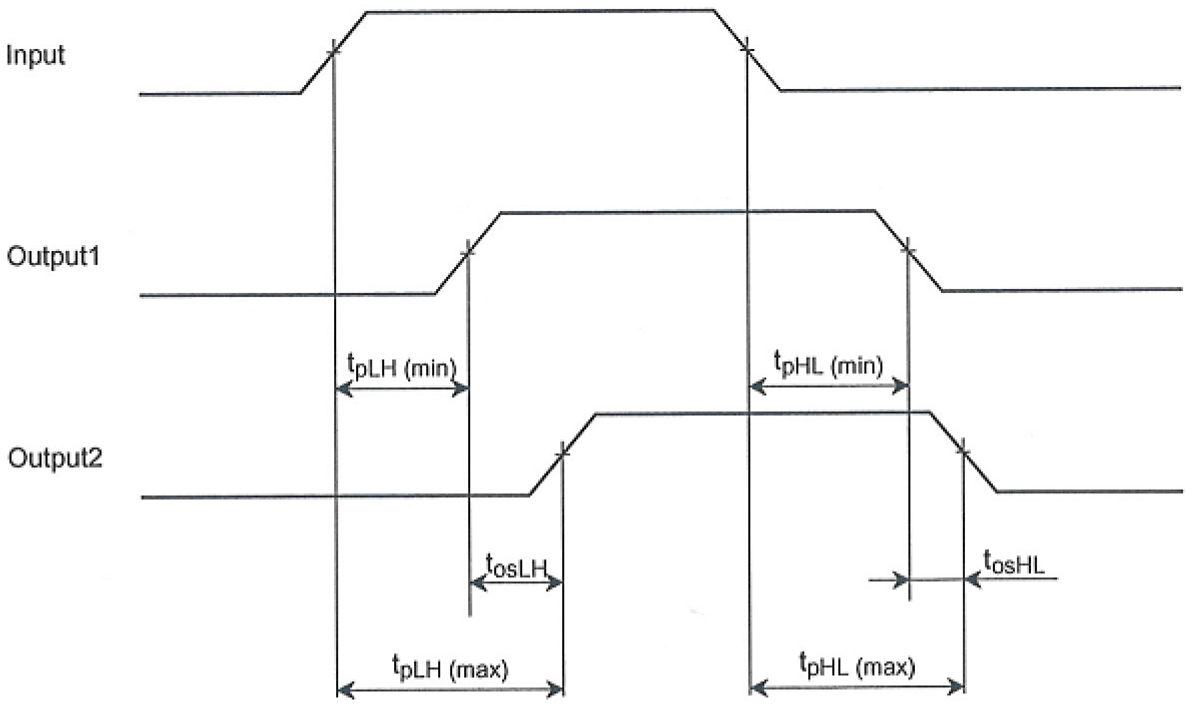



**Figure 5.8 Output Skew Characteristics**

# 6. Glossary of CMOS Logic IC Terms

## 6.1. Absolute Maximum Ratings

| Parameter | Symbol | Definition |
|---|---|---|
| Supply voltage | $V_{DD}$ - $V_{SS}$<br>$V_{CC}$ | The rated voltage of the power supply terminal at which an IC will not suffer breakdown, deterioration of characteristics, or reduced reliability. |
| Supply voltage | $V_{DD}$ - $V_{EE}$<br>$V_{CC}$ - $V_{EE}$ | The rated voltage across the $V_{CC}$, $V_{DD}$ and $V_{EE}$ terminals at which an IC will not suffer breakdown, deterioration of characteristics, or reduced reliability. |
| Input voltage | $V_{IN}$ | The rated voltage of the input terminal at which an IC will not suffer breakdown, deterioration of characteristics, or reduced reliability. |
| Output voltage | $V_{OUT}$ | The rated voltage of the output terminal at which an IC will not suffer breakdown, deterioration of characteristics, or reduced reliability. |
| Switch I/O voltage | $V_{I/O}$ | The rated voltage across the input and output terminals at which an IC will not suffer breakdown, deterioration of characteristics, or reduced reliability. |
| Input diode current | $I_{IK}$ | The rated current of the input terminal at which an IC will not suffer breakdown due to latch-up. |
| Output diode current | $I_{OK}$ | The rated current of the output terminal at which an IC will not suffer breakdown due to latch-up. |
| Output current | $I_{OUT}$ | The rated current that can flow through one output terminal. |
| Switch through current | $I_T$ | The rated current between the input and output terminals of a switch at which an IC will not suffer breakdown, deterioration of characteristics, or reduced reliability. |
| $V_{CC}$/ground current | $I_{CC}$<br>$I_{CC}$ / $I_{GND}$ | The rated current between the power supply and ground terminals at which an IC will not suffer breakdown, deterioration of characteristics, or reduced reliability. As $V_{CC}$ / ground current includes output current, substantial $V_{CC}$ / ground current can flow in an IC having multiple output terminals. |
| Power dissipation | $P_D$ | Power consumption that does not cause IC breakdown over the entire operating temperature range. |
| Storage temperature | $T_{stg}$ | The ambient temperature range over which no deterioration of characteristics or reliability occurs when an IC is stored for a long period of time or is transported with no supply voltage present. |

## 6.2. Operating Ranges

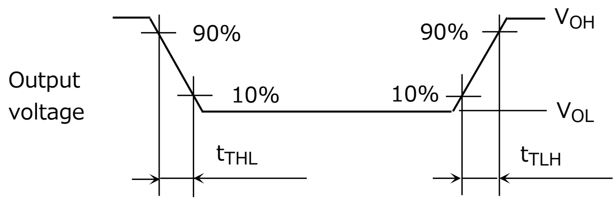
| Parameter | Symbol | Definition |
|---|---|---|
| Supply voltage | $V_{DD}$<br>$V_{CC}$<br>$V_{EE}$<br>$V_{DD}$ – $V_{EE}$<br>$V_{CC}$ - $V_{EE}$ | The supply voltage range over which the normal operation of an IC is guaranteed. |
| Input voltage | $V_{IN}$ | The input voltage range over which the normal operation and electrical characteristics of an IC are guaranteed. |
| Output voltage | $V_{OUT}$ | The output voltage range over which the normal operation and electrical characteristics of an IC are guaranteed. |
| Switch I/O voltage | $V_S$<br>$V_{I/O}$ | The switch I/O voltage range over which the normal operation and electrical characteristics of an IC are guaranteed. |
| Output current | $I_{OUT}$<br>$I_{OH}$ , $I_{OL}$<br>$I_{OL}$ | The maximum output current at which the normal operation and electrical characteristics of an IC are guaranteed. |
| Input rise and fall times | $t_r$,$t_f$<br>dt/dv | The ranges of rise and fall times of an input signal that will not cause malfunction due to oscillation of the output. |
| External capacitor | $C_X$ | The external capacitance range over which the normal operation and electrical characteristics of a multivibrator IC are guaranteed. |
| External resistor | $R_X$ | The external resistance range over which the normal operation and electrical characteristics of a multivibrator IC are guaranteed. |
| Operating temperature | $T_{opr}$ | The operating temperature range over which the normal operation and electrical characteristics of an IC are guaranteed. |

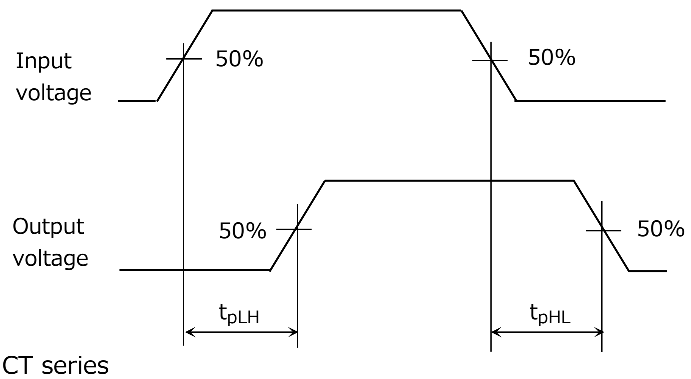
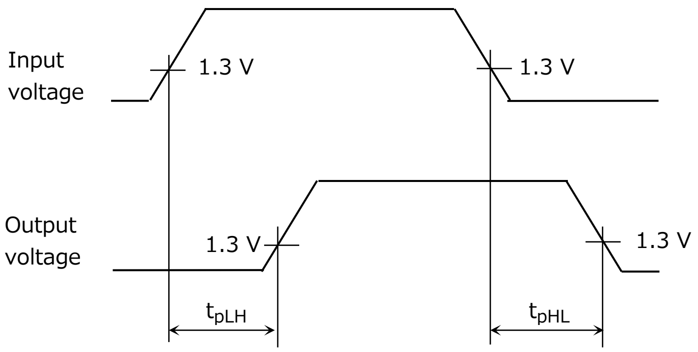
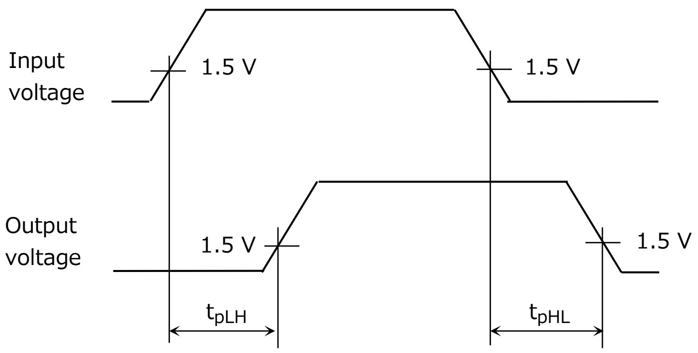
## 6.3. Electrical Characteristics

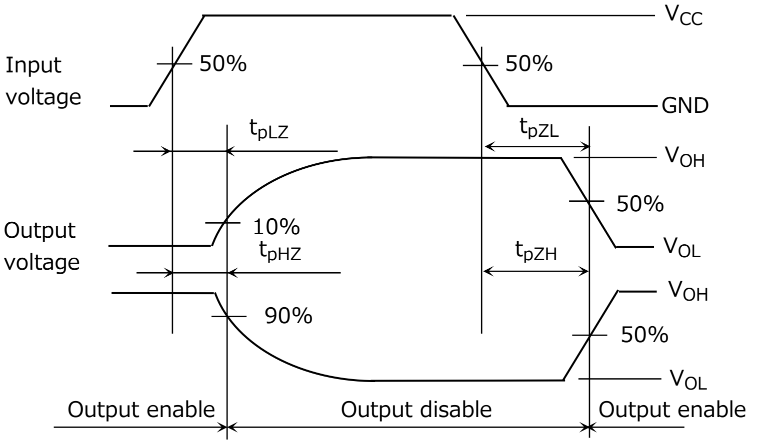
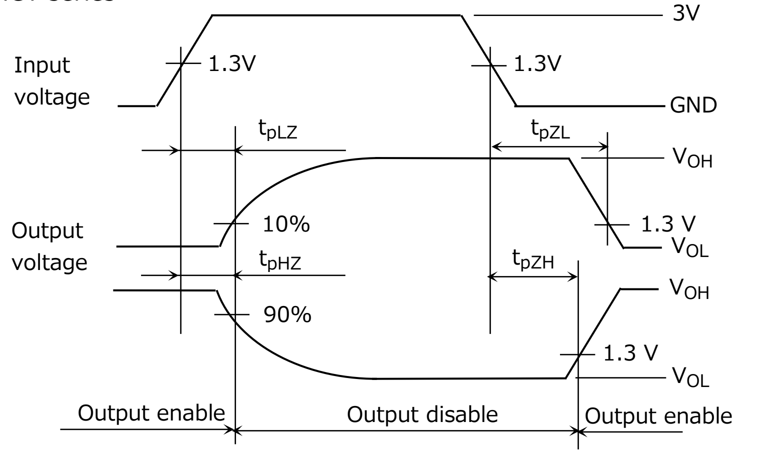
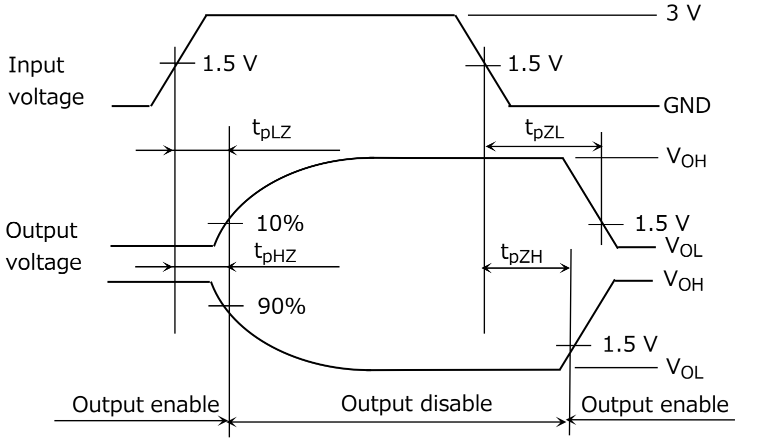
＊電気的特性は測定条件下において規定されます。

| Parameter | Symbol | Definition |
|---|---|---|
| High-level input voltage | $V_{IH}$ | The input voltage at which input of an IC is driven to the High level. |
| Low-level input voltage | $V_{IL}$ | The input voltage at which the input of an IC is driven to the Low level. |
| Positive threshold voltage | $V_P$ | The input threshold voltage at which a Schmitt-trigger input is driven to the High level. |
| Negative threshold voltage | $V_N$ | The input threshold voltage at which a Schmitt-trigger input is driven to the Low level. |
| Hysteresis voltage | $V_H$ | The difference between the positive and negative threshold voltages of a Schmitt-trigger input. |
| High-level output voltage | $V_{OH}$ | The voltage that appears at the output when either VIH or VIL is applied to each input terminal such that the output is set to the High level. |
| Low-level output voltage | $V_{OL}$ | The voltage that appears at the output when either VIH or VIL is applied to each input terminal such that the output is set to the Low level. |
| Power-off leakage current | $I_{OFF}$ | The leakage current that flows into an IC via input and output terminals when the power supply is off. |
| Input leakage current | $I_{IN}$ | The leakage current that flows through the input terminal when a voltage is present at the input terminal of an IC. |
| Output off-state leakage current | $I_{OZ}$ | The leakage current of an IC with an open-drain output that flows through the output terminal when it is in the high-impedance state. |
| Output leakage current (Power-off) | $I_{OPD}$ | The leakage current that flows into an IC via the output terminals when $V_{CC}$ is in the off state ($V_{CC}$ = 0 V) |
| 3-state output off-state leakage current | $I_{OZ}$ | The leakage current of an IC with an open-drain or three-state output that flows through the output terminal when it is in the high-impedance state. |

| Parameter | Symbol | Definition |
|---|---|---|
| Input/output leakage current (Switch off) | $I_{OFF}$ | The leakage current that flows through an IC from the input terminals to the output terminal when the power supply is off. |
| Input/output leakage current (Switch on) | $I_{I/O}$ | The leakage current that flows from the input terminal to the output terminal in the switch-on and open-output states. |
| Control input leakage current | $I_{IN}$ | The leakage current that flows through the control input terminal of an IC when a voltage is applied to the terminal. |
| RX/CX terminal off-state current | $I_{IN}$ | The current that flows through the RX/CX terminal of a multivibrator IC when a voltage is applied to the terminal. |
| T2 terminal input leakage current | $I_{IN}$ | The current that flows through the T2 terminal of a multivibrator IC when a voltage is applied to the terminal. |
| Quiescent supply current | $I_{CC}$ | The current that flows into an IC via the $V_{CC}$ terminal when the $V_{CC}$ or ground level is held constant without changing the input voltage. |
| | $\Delta I_{CC}$ | The current that flows into an IC via the $V_{CC}$ terminal when $V_{CC}$ - 0.6 V is applied to one input terminal. |
| | $I_{CCT}$ | The current that flows into an IC with TTL-level input via the $V_{CC}$ terminal when a TTL-level voltage is applied to one input terminal. |
| Active-state supply current (per circuit) | $I_{CC(opr)}$ | The average current that flows in the no-load condition between the power supply and ground terminals due to an internal circuit operation. |
| On-resistance | $R_{ON}$ | The resistance between the input and the output of an analog switch, multiplexer or demultiplexer IC in the switch-on state. |
| Difference of on-resistance between switches | $\Delta R_{ON}$ | The difference in on-resistance between different input-output pairs of an analog switch, multiplexer or demultiplexer IC. |

| Parameter | Symbol | Definition |
|---|---|---|
| Minimum pulse width | $t_{w(H)}$ $t_{w(L)}$ | The minimum pulse width that is accepted at a clock input, etc. as a normal pulse. |
| Minimum setup time | $t_S$ | The time interval during which data must be stable before the associated input (e.g., clock) changes. For example, when data is latched on the rising edge of a clock pulse, it is necessary to apply data at least $t_S$ before the rising edge of the clock. |
| Minimum hold time | $t_h$ | The time interval during which data must be stable after the active transition of the associated input (e.g., clock). |
| Minimum removal time | $t_{rem}$ | The minimum time between the release of an asynchronous input (e.g., Clear, Preset) and the application of the next input (e.g., clock). |
| Minimum retrigger time | $t_{rr}$ | The minimum time necessary for a multivibrator IC to accept the next trigger signal after having received one. |
| Output transition time | $t_{TLH}$ $t_{THL}$ | The rise and fall times of the output voltage. $t_{TLH}$ is the time from 10% to 90% when the output transitions from Low to High, and $t_{THL}$ is the time from 90% to 10% when the output transitions from High to Low.  |

<table>
<tr><th>Parameter</th><th>Symbol</th><th>Definition</th></tr>
<tr><td>Propagation delay time</td><td>$t_{pLH}$<br>$t_{pHL}$</td><td>The delay time between the application of an input signal and an output response. $t_{pLH}$ is defined as the time required for an output to transition from Low to High, and $t_{pHL}$ is defined as the time required for an output to transition from High to Low.<br><br>HC/VHC series<br>
<br>HCT series<br>
<br>VHCT series<br>
</td></tr>
</table>

<table>
<tr><th>Parameter</th><th>Symbol</th><th>Definition</th></tr>
<tr><td>Output enable time<br>Output disable time</td><td>$t_{pLZ}$<br>$t_{pHZ}$<br>$t_{pZL}$<br>$t_{pZH}$</td><td>The output enable time is defined as the delay time required for a three-state terminal to be driven High or Low after the output control terminal is set to an inactive level. The output disable time is defined as the delay time required for an output terminal to assume the high-impedance state after the output control signal is set to an active level.<br>HC/VHC series<br>
<br>HCT series<br>
<br>VHCT series<br>
</td></tr>
</table>

| Parameter | Symbol | Definition |
|---|---|---|
| Propagation delay time | $\Delta t_{PD}$ | For counter ICs, the delay time defined for an IC from when the Qn output is inverted to when the next output (Qn+1) is inverted. |
| Output pulse width | $t_{wOUT}$ | For multivibrator ICs, the width of the output pulse generated when a prescribed external component is connected and a prescribed voltage is applied. |
| Output pulse width error between circuits (in the same package) | $\Delta t_{wOUT}$ | For multivibrator ICs, a difference in output pulse width between two circuits in the same package. |
| Output skew | $t_{osLH}$ $t_{osHL}$ $t_{osZL}$ | Differences in propagation delay time among output terminals when some outputs in the same package change from the Low level to the High level, from the High level to the Low level, or from the high-impedance state to the Low level. |
| Phase difference between input and output | $\varphi_{I/O}$ | For analog switch, multiplexer and demultiplexer ICs, the delay time from the input to the output when a signal is applied to the input in the switch-on state. |
| Clock frequency | f | The clock frequency at which an IC operates. |
| Maximum clock frequency | $f_{MAX}$ | The maximum clock frequency at which the IC operates normally. |
| Maximum frequency response Phase difference between input and output | $f_{MAX(I/O)}$ $f_{MAX}$ | For analog switch, multiplexer and demultiplexer ICs, the maximum input frequency that the signal can transmit to the output in the switch-on state. |
| Input capacitance | $C_{IN}$ | The capacitance between the input and ground terminals. |
| Control input capacitance | $C_{IN}$ | For analog switch, multiplexer and demultiplexer ICs, the capacitance between the control input and ground terminals. |
| Common terminal capacitance | $C_{IS}$ | For analog switch, multiplexer and demultiplexer ICs, the capacitance between the common and ground terminals in the off state. |
| Switch terminal capacitance | $C_{OS}$ | For analog switch, multiplexer and demultiplexer ICs, the capacitance between the switch and ground terminals in the off state. |

| Parameter | Symbol | Definition |
|---|---|---|
| Feedthrough capacitance | $C_{IOS}$ | For analog switch, multiplexer and demultiplexer ICs, the capacitance between the switch and common terminals in the off state. |
| Bus I/O capacitance | $C_{I/O}$ | The capacitance between the bus and ground terminals. |
| Power dissipation capacitance | $C_{PD}$ | The equivalent internal capacitance of a device calculated by measuring the operating current in the no-load condition. |
| Output capacitance | $C_{OUT}$ | The capacitance between the output and ground terminals for a three-state or open-drain output in the high-impedance state. |
| Sine Wave Distortion | THD | For analog switch, multiplexer and demultiplexer ICs, the distortion rate of the sine wave that is output when a sine wave is input in the on state. |
| Feed-through attenuation (switch off) | FTH | For analog switch, multiplexer and demultiplexer ICs, the ratio of the leakage voltage that appears at the output to the input voltage applied in the off state |
| Crosstalk (control input to signal output) | $X_{talk}$ | For analog switch, multiplexer and demultiplexer ICs, the leakage voltage of a signal to the input and output that occurs when the control input changes. |
| Crosstalk (between any switches) | $X_{talk}$ | For analog switch, multiplexer and demultiplexer ICs, the ratio of the voltage applied to a switch (port) in the on state to the voltage that appears at a switch (port) in the off state |
| Quiet output maximum dynamic $V_{OL}$ | $V_{OLP}$ | The maximum peak voltage induced into an output that is fixed at the Low level when the other outputs are switching simultaneously. |
| Quiet output minimum dynamic $V_{OL}$ | $V_{OLV}$ $\|V_{OLV}\|$ | The minimum peak voltage induced into an output that is fixed at the Low level when the other outputs are switching simultaneously. |
| Quiet output minimum dynamic $V_{OH}$ | $V_{OHV}$ | The minimum peak voltage induced into an output that is fixed at the High level when the other outputs are switching simultaneously. |
| Minimum high-level dynamic input voltage | $V_{IHD}$ | High-level dynamic threshold voltage when all inputs are switching simultaneously |
| Maximum low-level dynamic input voltage | $V_{ILD}$ | Low-level dynamic threshold voltage when all inputs are switching simultaneously. |

## 6.4. Built-in Function

| Parameter | Definition |
|---|---|
| Input tolerant function | A function designed to prevent a current from flowing from an input to the power supply when the input voltage is higher than the power supply voltage or when $V_{CC}$ = 0 V. |
| Output tolerant function | A function designed to prevent a current from flowing from an output to the power supply when the output is in the high-impedance state or when $V_{CC}$ = 0 V. |
| Power-down protection | A function designed to prevent a current from flowing to the power supply terminal even if a voltage is applied to the input and output terminals when $V_{CC}$ = 0 V. |
| Bus-hold function | A function designed to hold the input logic level using a latch circuit even when the input terminal becomes open. |

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