# 3.3V CMOS 16-BIT BIDIRECTIONAL TRANSCEIVER



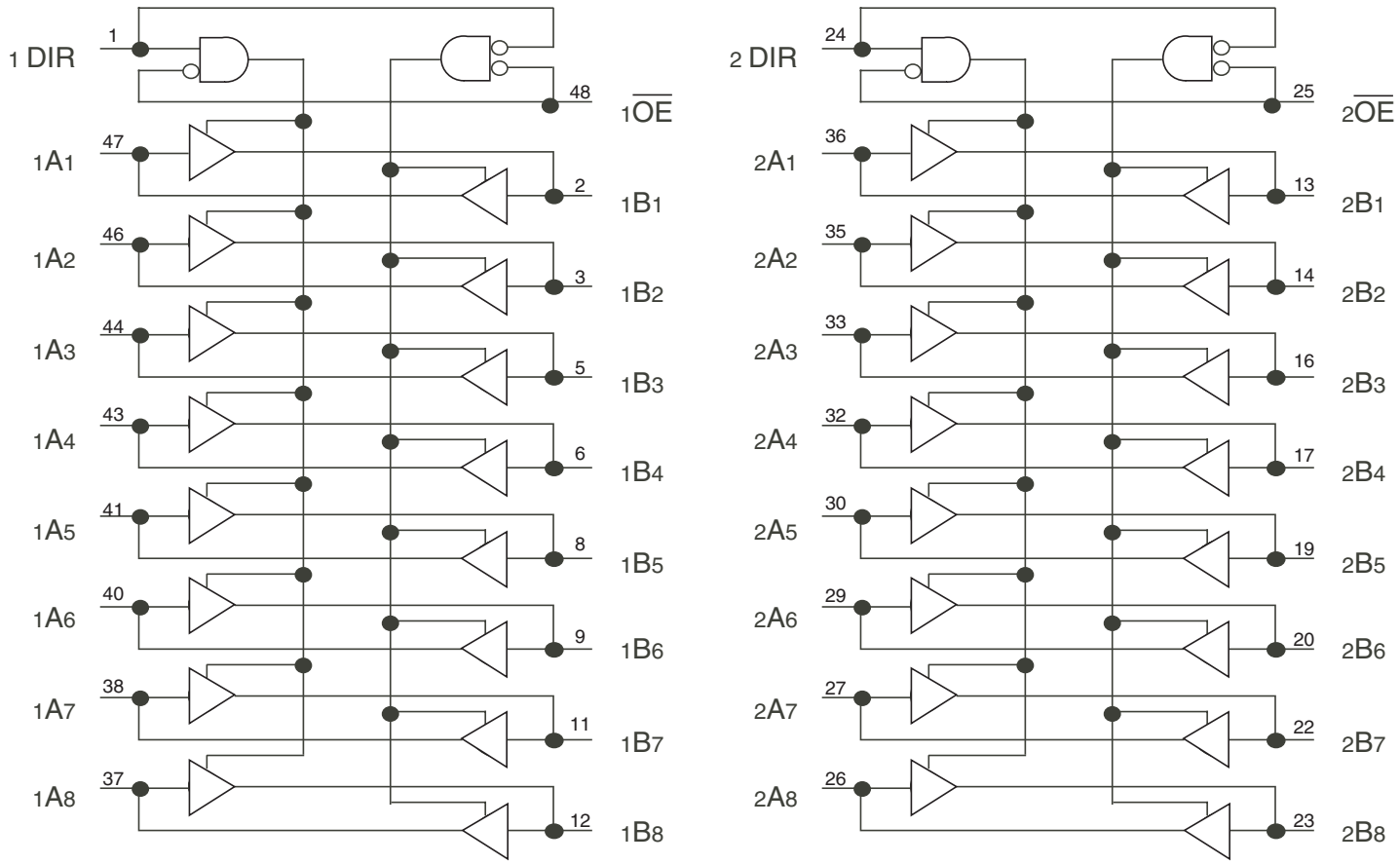
## FEATURES:

- 0.5 MICRON CMOS Technology
- Typical $t_{SK(o)}$ (Output Skew) < 250ps
- ESD > 2000V per MIL-STD-883, Method 3015; > 200V using machine model (C = 200pF, R = 0)
- $V_{CC}$ = 3.3V ± 0.3V, Normal Range, or $V_{CC}$ = 2.7V to 3.6V, Extended Range
- CMOS power levels (0.4µ W typ. static)
- Rail-to-rail output swing for increased noise margin
- Low Ground Bounce (0.3V typ.)
- Inputs (except I/O) can be driven by 3.3V or 5V components
- Available in SSOP, TSSOP, and TVSOP packages

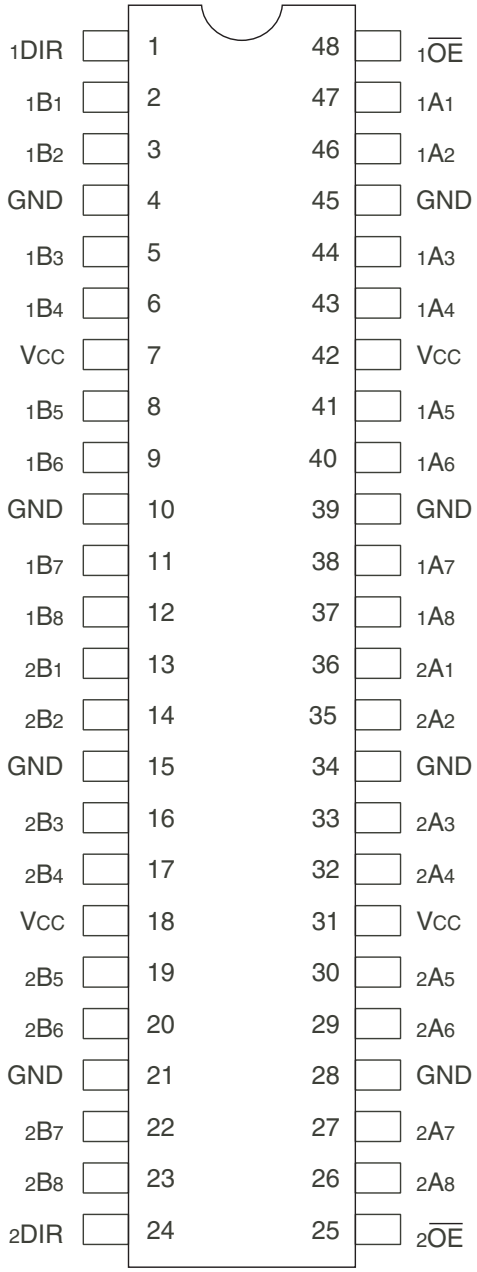
## DESCRIPTION:

The FCT163245 16-bit transceivers are built using advanced dual metal CMOS technology. These high-speed, low-power transceivers are ideal for asynchronous communication between two buses (A and B). The Direction and Output Enable controls are designed to operate these devices as either two independent 8-bit transceivers or one 16-bit transceiver. The direction control pin (xDIR) controls the direction of data flow. The output enable pin ($x\overline{OE}$) overrides the direction control and disables both ports. All inputs are designed with hysteresis for improved noise margin.

## FUNCTIONAL BLOCK DIAGRAM



## PIN CONFIGURATION




**SSOP/ TSSOP/ TVSOP**
**TOP VIEW**

## ABSOLUTE MAXIMUM RATINGS(1)

| Symbol | Description | Max | Unit |
|---|---|---|---|
| $V_{TERM}$(2) | Terminal Voltage with Respect to GND | –0.5 to +4.6 | V |
| $V_{TERM}$(3) | Terminal Voltage with Respect to GND | –0.5 to 7 | V |
| $V_{TERM}$(4) | Terminal Voltage with Respect to GND | –0.5 to $V_{CC}$+0.5 | V |
| $T_{STG}$ | Storage Temperature | –65 to +150 | ° C |
| $I_{OUT}$ | DC Output Current | –60 to +60 | mA |

**NOTES:**
1. Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.
2. Vcc terminals.
3. Input terminals.
4. Outputs and I/O terminals.

## CAPACITANCE ($T_A$ = +25°C, F = 1.0MHz)

| Symbol | Parameter(1) | Conditions | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| $C_{IN}$ | Input Capacitance | $V_{IN}$ = 0V | 3.5 | 6 | pF |
| $C_{OUT}$ | Output Capacitance | $V_{OUT}$ = 0V | 3.5 | 8 | pF |

**NOTE:**
1. This parameter is measured at characterization but not tested.

## PIN DESCRIPTION

| Pin Names | Description |
|---|---|
| x$\overline{OE}$ | Output Enable Input (Active LOW) |
| xDIR | Direction Control Input |
| xAx | Side A Inputs or 3-State Outputs |
| xBx | Side B Inputs or 3-State Outputs |

## FUNCTION TABLE(1)

| Inputs | | Outputs |
|---|---|---|
| x$\overline{OE}$1 | xDIR | |
| L | L | Bus B Data to Bus A |
| L | H | Bus A Data to Bus B |
| H | X | High Z State |

**NOTE:**
1. H = HIGH Voltage Level
   L = LOW Voltage Level
   X = Don't Care
   Z = High-impedance

# DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE

Following Conditions Apply Unless Otherwise Specified:
Industrial: $T_A$ = –40°C to +85°C, $V_{CC}$ = 2.7V to 3.6V

| Symbol | Parameter | Test Conditions[1] | | Min. | Typ.[2] | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $V_{IH}$ | Input HIGH Level (Input pins) | Guaranteed Logic HIGH Level | | 2 | — | 5.5 | V |
| | Input HIGH Level (I/O pins) | | | 2 | — | $V_{CC}$+0.5 | |
| $V_{IL}$ | Input LOW Level (Input and I/O pins) | Guaranteed Logic LOW Level | | –0.5 | — | 0.8 | V |
| $I_{IH}$ | Input HIGH Current (Input pins) | $V_{CC}$ = Max. | $V_I$ = 5.5V | — | — | ±1 | µA |
| | Input HIGH Current (I/O pins) | | $V_I$ = $V_{CC}$ | — | — | ±1 | |
| $I_{IL}$ | Input LOW Current (Input pins) | | $V_I$ = GND | — | — | ±1 | |
| | Input LOW Current (I/O pins) | | $V_I$ = GND | — | — | ±1 | |
| $I_{OZH}$ | High Impedance Output Current | $V_{CC}$ = Max. | $V_O$ = $V_{CC}$ | — | — | ±1 | µA |
| $I_{OZL}$ | (3-State Output pins) | | $V_O$ = GND | — | — | ±1 | |
| $V_{IK}$ | Clamp Diode Voltage | $V_{CC}$ = Min., $I_{IN}$ = –18mA | | — | –0.7 | –1.2 | V |
| $I_{ODH}$ | Output HIGH Current | $V_{CC}$ = 3.3V, $V_{IN}$ = $V_{IH}$ or $V_{IL}$, $V_O$ = 1.5V[3] | | –36 | –60 | –110 | mA |
| $I_{ODL}$ | Output LOW Current | $V_{CC}$ = 3.3V, $V_{IN}$ = $V_{IH}$ or $V_{IL}$, $V_O$ = 1.5V[3] | | 50 | 90 | 200 | mA |
| $V_{OH}$ | Output HIGH Voltage | $V_{CC}$ = Min. | $I_{OH}$ = –0.1mA | $V_{CC}$-0.2 | — | — | V |
| | | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = –3mA | 2.4 | 3 | — | |
| | | $V_{CC}$ = 3V<br>$V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = –8mA | 2.4[5] | 3 | — | |
| $V_{OL}$ | Output LOW Voltage | $V_{CC}$ = Min. | $I_{OL}$ = 0.1mA | — | — | 0.2 | V |
| | | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 16mA | — | 0.2 | 0.4 | |
| | | | $I_{OL}$ = 24mA | — | 0.3 | 0.55 | |
| | | $V_{CC}$ = 3V<br>$V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 24mA | — | 0.3 | 0.5 | |
| $I_{OS}$ | Short Circuit Current[4] | $V_{CC}$ = Max., $V_O$ = GND[3] | | –60 | –135 | –240 | mA |
| $V_H$ | Input Hysteresis | — | | — | 150 | — | mV |
| $I_{CCL}$<br>$I_{CCH}$<br>$I_{CCZ}$ | Quiescent Power Supply Current | $V_{CC}$ = Max.<br>$V_{IN}$ = GND or $V_{CC}$ | | — | 0.1 | 10 | µA |

**NOTES:**
1. For conditions shown as Min. or Max., use appropriate value specified under Electrical Characteristics for the applicable device type.
2. Typical values are at $V_{CC}$ = 3.3V, +25°C ambient.
3. Not more than one output should be shorted at one time. Duration of the test should not exceed one second.
4. This parameter is guaranteed but not tested.
5. $V_{OH}$ = $V_{CC}$–0.6V at rated current.

# POWER SUPPLY CHARACTERISTICS

| Symbol | Parameter | Test Conditions[1] | | Min. | Typ.[2] | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $\Delta I_{CC}$ | Quiescent Power Supply Current<br>TTL Inputs HIGH | $V_{CC}$ = Max.<br>$V_{IN}$ = $V_{CC}$ - 0.6V[3] | | — | 2 | 30 | µA |
| $I_{CCD}$ | Dynamic Power Supply Current[4] | $V_{CC}$ = Max.<br>Outputs Open<br>x$\overline{OE}$ = xDIR = GND<br>One Input Toggling<br>50% Duty Cycle | $V_{IN}$ = $V_{CC}$<br>$V_{IN}$ = GND | — | 50 | 75 | µA/<br>MHz |
| $I_C$ | Total Power Supply Current[6] | $V_{CC}$ = Max.,Outputs Open<br>$f_i$ = 10MHz<br>50% Duty Cycle | $V_{IN}$ = $V_{CC}$<br>$V_{IN}$ = GND | — | 0.5 | 0.8 | mA |
| | | x$\overline{OE}$ = xDIR = GND<br>One Bit Toggling | $V_{IN}$ = $V_{CC}$ - 0.6V<br>$V_{IN}$ = GND | — | 0.5 | 0.8 | |
| | | $V_{CC}$ = Max.,Outputs Open<br>$f_i$ = 2.5MHz<br>50% Duty Cycle | $V_{IN}$ = $V_{CC}$<br>$V_{IN}$ = GND | — | 2 | 3[5] | |
| | | x$\overline{OE}$ = xDIR = GND<br>Sixteen Bits Toggling | $V_{IN}$ = $V_{CC}$ - 0.6V<br>$V_{IN}$ = GND | — | 2 | 3.3[5] | |

**NOTES:**

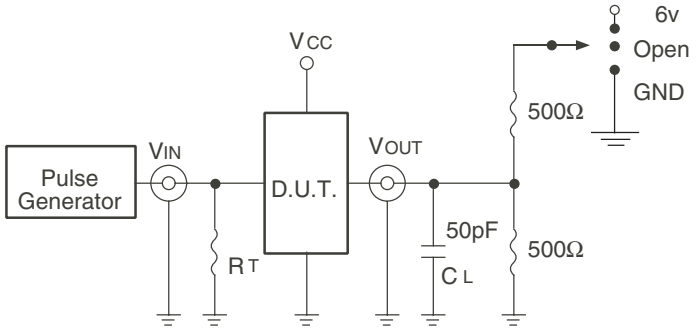
1. For conditions shown as Min. or Max., use appropriate value specified under Electrical Characteristics for the applicable device type.
2. Typical values are at $V_{CC}$ = 3.3V, +25°C ambient.
3. Per TTL driven input. All other inputs at $V_{CC}$ or GND.
4. This parameter is not directly testable, but is derived for use in Total Power Supply Calculations.
5. Values for these conditions are examples of the $I_{CC}$ formula. These limits are guaranteed but not tested.
6. $I_C = I_{QUIESCENT} + I_{INPUTS} + I_{DYNAMIC}$
   $I_C = I_{CC} + \Delta I_{CC} D_H N_T + I_{CCD} (f_{CP} N_{CP}/2 + f_i N_i)$
   $I_{CC}$ = Quiescent Current ($I_{CCL}$, $I_{CCH}$ and $I_{CCZ}$)
   $\Delta I_{CC}$ = Power Supply Current for a TTL High Input
   $D_H$ = Duty Cycle for TTL Inputs High
   $N_T$ = Number of TTL Inputs at $D_H$
   $I_{CCD}$ = Dynamic Current caused by an Input Transition Pair (HLH or LHL)
   $f_{CP}$ = Clock Frequency for Register Devices (Zero for Non-Register Devices)
   $N_{CP}$ = Number of Clock Inputs at $f_{CP}$
   $f_i$ = Input Frequency
   $N_i$ = Number of Inputs at $f_i$

## SWITCHING CHARACTERISTICS OVER OPERATING RANGE[1]

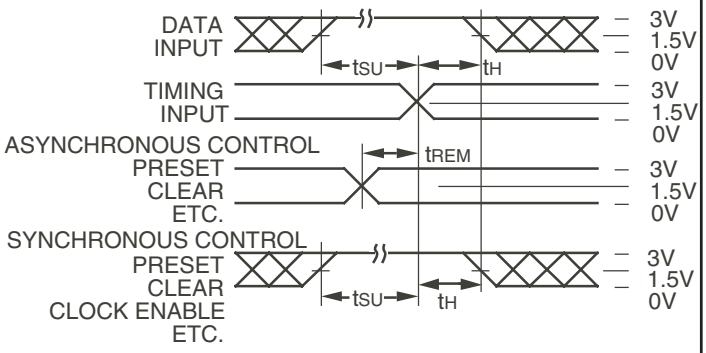
| Symbol | Parameter | Condition[2] | FCT163245A | | FCT163245C | | Unit |
|---|---|---|---|---|---|---|---|
| | | | Min.[3] | Max. | Min.[3] | Max. | |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>A to B, B to A | $C_L$ = 50pF<br>$R_L$ = 500Ω | 1.5 | 4.6 | 1.5 | 4.1 | ns |
| $t_{PZH}$<br>$t_{PZL}$ | Output Enable Time<br>x$\overline{OE}$ to A or B | | 1.5 | 6.2 | 1.5 | 5.8 | ns |
| $t_{PHZ}$<br>$t_{PLZ}$ | Output Disable Time<br>x$\overline{OE}$ to A or B | | 1.5 | 5 | 1.5 | 4.8 | ns |
| $t_{PZH}$<br>$t_{PZL}$ | Output Enable Time<br>xDIR to A or B[4] | | 1.5 | 6.2 | 1.5 | 5.8 | ns |
| $t_{PHZ}$<br>$t_{PLZ}$ | Output Disable Time<br>xDIR to A or B[4] | | 1.5 | 5 | 1.5 | 4.8 | ns |
| $t_{SK}(o)$ | Output Skew[5] | | — | 0.5 | — | 0.5 | ns |

**NOTES:**
1. Propagation Delays and Enable/Disable times are with $V_{CC}$ = 3.3V ±0.3V, Normal Range. For $V_{CC}$ = 2.7V to 3.6V, Extended Range, all Propagation Delays and Enable/Disable times should be degraded by 20%.
2. See test circuit and waveforms.
3. Minimum limits are guaranteed but not tested on Propagation Delays.
4. This parameter is guaranteed but not tested.
5. Skew between any two outputs, of the same package, switching in the same direction. This parameter is guaranteed by design.

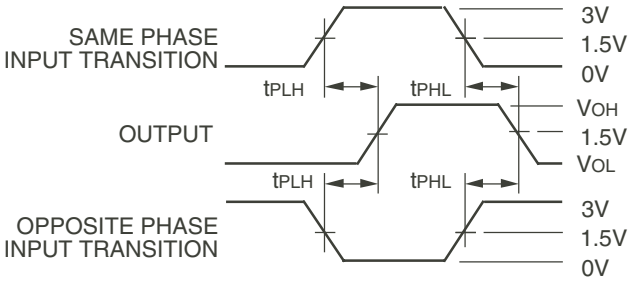
# TEST CIRCUITS AND WAVEFORMS




***Test Circuits for All Outputs***




***Set-up, Hold, and Release Times***




***Propagation Delay***

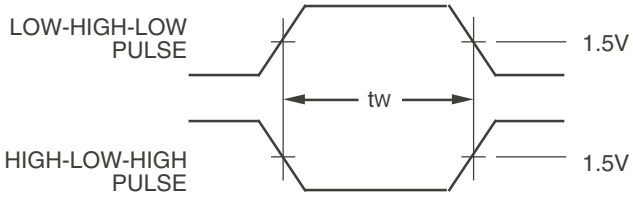
# SWITCH POSITION

| Test | Switch |
|---|---|
| Open Drain<br>Disable Low<br>Enable Low | 6V |
| Disable High<br>Enable High | GND |
| All Other Tests | Open |

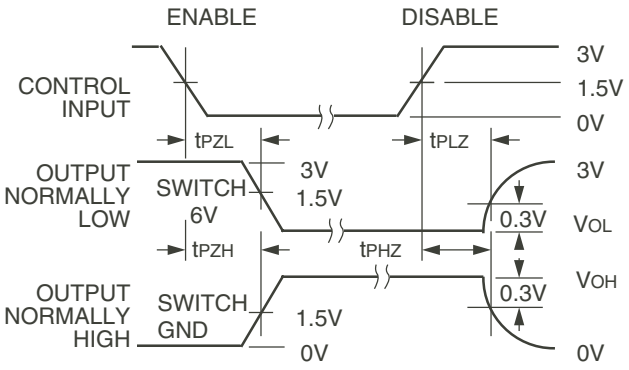
**DEFINITIONS:**

$C_L$ = Load capacitance: includes jig and probe capacitance.

$R_T$ = Termination resistance: should be equal to $Z_{OUT}$ of the Pulse Generator.




***Pulse Width***

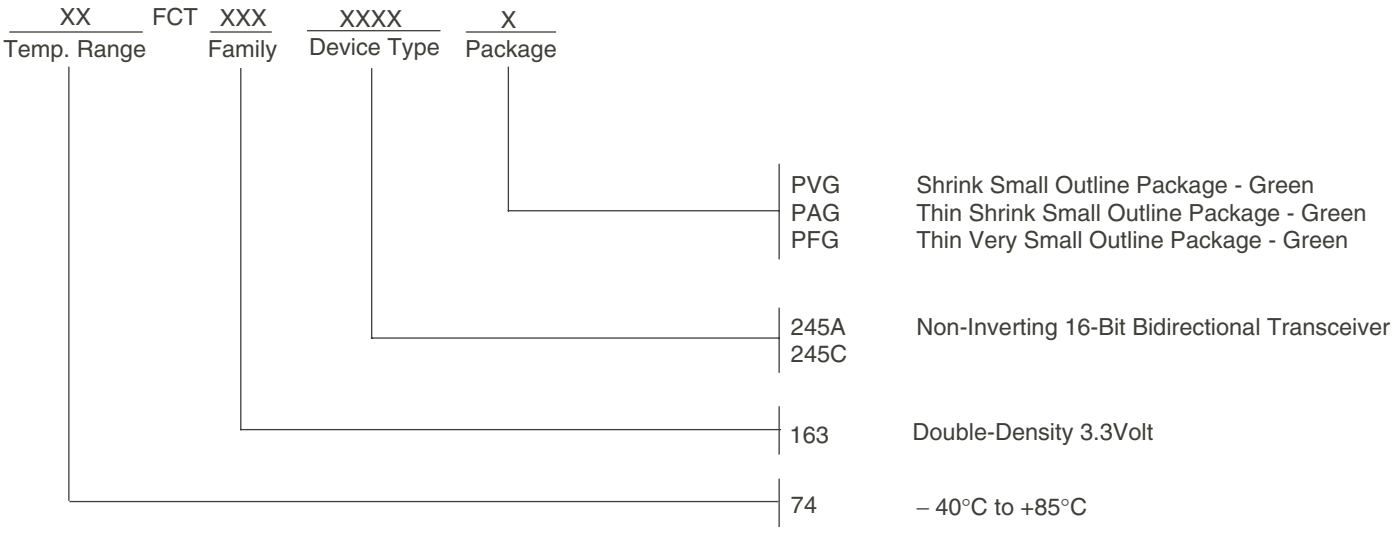



***Enable and Disable Times***

**NOTES:**

1. Diagram shown for input Control Enable-LOW and input Control Disable-HIGH.
2. Pulse Generator for All Pulses: Rate ≤ 1.0MHz; $t_F$ ≤ 2.5ns; $t_R$ ≤ 2.5ns.
3. if $V_{CC}$ is below 3V, input voltage swings should be adjusted not to exceed $V_{CC}$.

## ORDERING INFORMATION




## Datasheet Document History

09/10/09 Pg.7 Updated the ordering information by removing the "IDT" notation and non RoHS part.

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### Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com


### Contact Information

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