CMOS Digital Integrated Circuits Silicon Monolithic

# TC7PCI3212MT,TC7PCI3215MT

## 1. Functional Description

- 2 Differential Channel, 2:1 multiplexer/demultiplexer switch for PCI Express Gen3

## 2. General

The TC7PCI3212MT and TC7PCI3215MT are 2 differential channel, 1-2 multiplexer/demultiplexer for PCI Express Gen3 (8Gbps), or other high-speed interface applications.

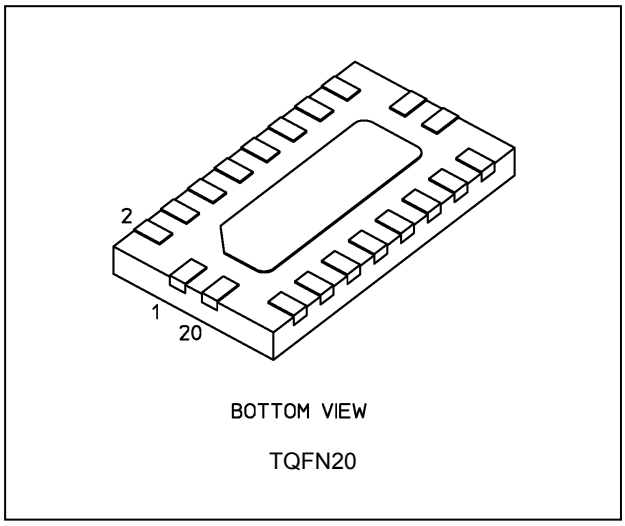
The An+/An- inputs is connected to the Bn+/Bn- or Cn+/Cn- outputs determined by the combination both the select input (SEL) and output enable ($\overline{OE}$). When the output enable ($\overline{OE}$) input is held high-level, the switches are open (high-impedance state) with regardless the state of select inputs and reducing consumption current.

All inputs are equipped with protection circuits against static discharge.

## 3. Features

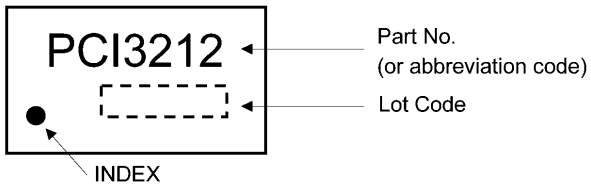
(1) Operating voltage: $V_{CC}$ = 3.0 to 3.6 V
(2) Switch terminal ON-capacitance: $C_{I/O}$ = 1.5 pF Switch On (typ.) @$V_{CC}$ = 3.3 V
(3) ON resistance: $R_{ON}$ = 7.5 Ω (typ.) @$V_{CC}$ = 3.0 V, $V_{IS}$ = 0 V
(4) -3dB Bandwidth: BW = 11.5 GHz (typ.) @ $V_{CC}$ = 3.3 V
(5) Insertion Loss: DDIL = -1 dB (typ.) @ $V_{CC}$ = 3.3 V, f = 4 GHz
(6) Off Isolation: DDOIRR = -20 dB (typ.) @ $V_{CC}$ = 3.3 V, f = 4 GHz
(7) Crosstalk: DDNEXT = -40 dB (typ.) @ $V_{CC}$ = 3.3 V, f = 4 GHz
(8) ESD performance: Machine model ≥ ±200 V, Human body model ≥ ±2000 V
(9) Package: TQFN20

## 4. Packaging

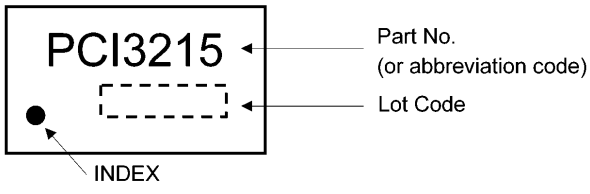



## 5. Marking

TC7PCI3212MT

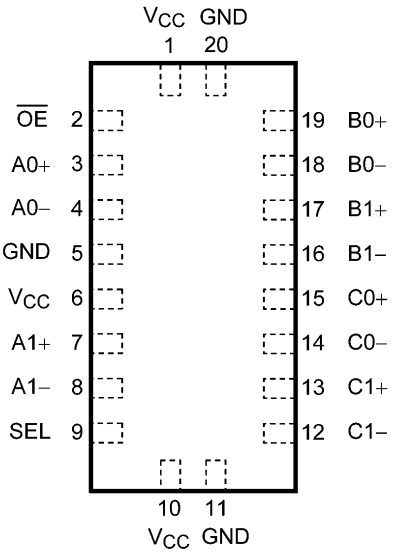



TC7PCI3215MT



## 6. Pin Assignment

TC7PCI3212MT

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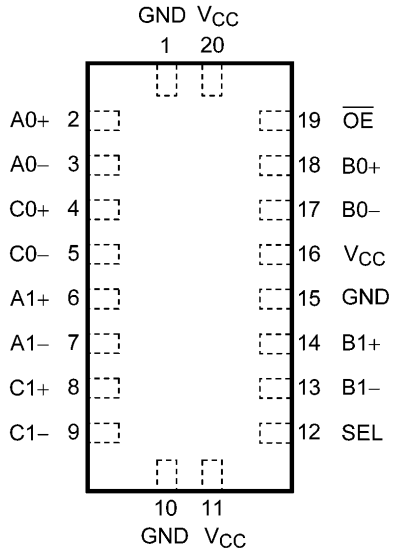
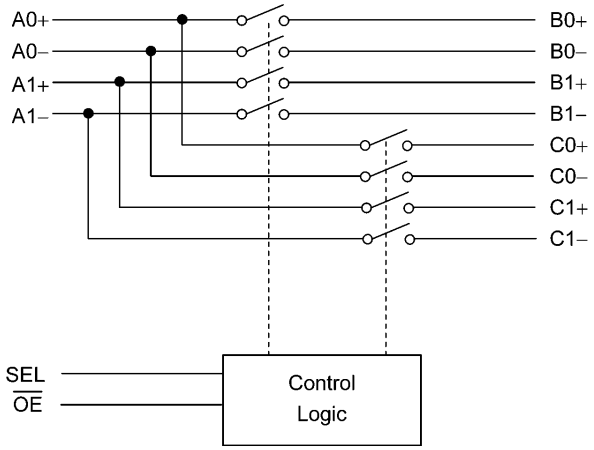



## 7. Block Diagram




## 8. Principle of Operation

### 8.1. Truth Table

| Inputs $\overline{OE}$ | Inputs SEL | Function | Function |
|---|---|---|---|
| L | L | An+ port = Bn+ port, An- port = Bn- port | (n=0,1) |
| L | H | An+ port = Cn+ port, An- port = Cn- port | (n=0,1) |
| H | — | An, Bn, Cn port Disconnect | (n=0,1) |

—: Don't care.

## 9. Absolute Maximum Ratings (Note)

| Characteristics | Symbol | Note | Rating | Unit |
|---|---|---|---|---|
| Supply voltage | $V_{CC}$ | | -0.5 to 4.6 | V |
| Input voltage ($\overline{OE}$, SEL) | $V_{IN}$ | | -0.5 to 4.6 | V |
| Switch I/O voltage | $V_S$ | | -0.5 to $V_{CC}$ +0.5 | V |
| Switch I/O current | $I_S$ | | 50 | mA |
| Power dissipation | $P_D$ | | 500 | mW |
| $V_{CC}$/ground current | $I_{CC}/I_{GND}$ | | ±50 | mA |
| Storage temperature | $T_{stg}$ | | -55 to 125 | °C |

Note: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.
Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.
Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

## 10. Operating Ranges (Note)

| Characteristics | Symbol | Note | Rating | Unit |
|---|---|---|---|---|
| Supply voltage | $V_{CC}$ | | 3.0 to 3.6 | V |
| Input voltage ($\overline{OE}$, SEL) | $V_{IN}$ | | 0 to 3.6 | V |
| Switch I/O voltage | $V_S$ | | 0 to $V_{CC}$ | V |
| Operating temperature | $T_{opr}$ | | -40 to 85 | °C |
| Input rise time | dt/dv | | 0 to 10 | ns/V |
| Input fall time | dt/dv | | 0 to 10 | ns/V |

Note: The operating ranges must be maintained to ensure the normal operation of the device.
Unused control inputs must be tied to either $V_{CC}$ or GND.

## 11. Electrical Characteristics

### 11.1. DC Characteristics (Note) (Unless otherwise specified, $T_a$ = -40 to 85 °C)

| Characteristics | Symbol | Note | Test Condition | $V_{CC}$ (V) | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| High-level input voltage ($\overline{OE}$, SEL) | $V_{IH}$ | | — | 3.0 to 3.6 | 0.65 × $V_{CC}$ | — | — | V |
| Low-level input voltage ($\overline{OE}$, SEL) | $V_{IL}$ | | — | 3.0 to 3.6 | — | — | 0.35 × $V_{CC}$ | V |
| Input leakage current ($\overline{OE}$, SEL) | $I_{IN}$ | | $V_{IN}$ = 0 to 3.6 V | 3.0 to 3.6 | — | — | ±1 | μA |
| Switch OFF-state leakage current | $I_{SZ}$ | | $V_{IS}$ = 0 to $V_{CC}$, $\overline{OE}$ = $V_{CC}$ | 3.0 to 3.6 | — | — | ±1 | μA |
| ON-resistance | $R_{ON}$ | (Note 1) | $V_{IS}$ = 0 V, $I_{IS}$ = 30 mA | 3.0 | — | 7.5 | 11.5 | Ω |
| | $R_{ON}$ | (Note 1) | $V_{IS}$ = 1.2 V, $I_{IS}$ = 30 mA | 3.0 | — | 8.5 | 13.5 | Ω |
| Difference of ON-resistance between switches (bit to bit) | $\Delta R_{ON}$ | (Note 1) | $V_{IS}$ = 0 V, 1.2 V, $I_{IS}$ = 15 mA | 3.0 | — | 0.1 | — | Ω |
| ON-resistance flatness | $R_{ON(flat)}$ | (Note 1) | $V_{IS}$ = 0 V to 1.2 V, $I_{IS}$ = 15 mA | 3.0 | — | 1 | — | Ω |
| Quiescent supply current | $I_{CC}$ | | $V_{IN}$ = $V_{CC}$ or GND, $\overline{OE}$ = $V_{CC}$ | 3.6 | — | — | 1 | μA |
| Quiescent supply current | $I_{CC}$ | | $V_{IN}$ = $V_{CC}$ or GND, $\overline{OE}$ = GND | 3.6 | — | 200 | 500 | μA |

Note : All typical values are at $T_a$ = 25 °C.
Note 1: ON-resistance is measured by measuring the voltage drop across the switch at the indicated current.

## 11.2. AC Characteristics (Note) (Unless otherwise specified, $T_a$ = -40 to 85 °C)

| Characteristics | Symbol | Note | Test Condition | $V_{CC}$ (V) | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| Propagation delay time | $t_{PLH}$/ $t_{PHL}$ | (Note 1) | $C_L$ = 5 pF See Fig. 12.1 | 3.3 ± 0.3 | — | 0.1 | — | ns |
| Turn-ON time (SEL to Output) | $t_{on}$ | | $R_L$ = 50 Ω, $C_L$ = 5 pF See Fig. 12.2 | 3.3 ± 0.3 | — | 10 | 15 | ns |
| Turn-ON time ($\overline{OE}$ to Output) | $t_{on}$ | | $R_L$ = 50 Ω, $C_L$ = 5 pF See Fig. 12.2 | 3.3 ± 0.3 | — | 37 | 50 | μs |
| Turn-OFF time (SEL to Output) | $t_{off}$ | | $R_L$ = 50 Ω, $C_L$ = 5 pF See Fig. 12.2 | 3.3 ± 0.3 | — | 3.5 | 5 | ns |
| Turn-OFF time ($\overline{OE}$ to Output) | $t_{off}$ | | $R_L$ = 50 Ω, $C_L$ = 5 pF See Fig. 12.2 | 3.3 ± 0.3 | — | 5 | 6.5 | ns |
| Break before make | TBBM | | $R_L$ = 50 Ω, $C_L$ = 5 pF See Fig. 12.3 | 3.3 ± 0.3 | 3 | — | 9 | ns |
| Output skew (bit to bit) | $t_{SK(b)}$ | (Note 1) | $C_L$ = 5 pF See Fig. 12.4 | 3.3 ± 0.3 | — | 5 | — | ps |
| Output skew (channel to channel) | $t_{SK(CH)}$ | (Note 1) | $C_L$ = 5 pF See Fig. 12.5 | 3.3 ± 0.3 | — | 10 | — | ps |
| Differential OFF isolation | DDOIRR | (Note 1) | $R_T$ = 50 Ω, f = 4 GHz See Fig. 12.6 | 3.3 ± 0.3 | — | -20 | — | dB |
| Differential Near-end crosstalk | DDNEXT | (Note 1) | $R_T$ = 50 Ω, f = 4 GHz See Fig. 12.7 | 3.3 ± 0.3 | — | -40 | — | dB |
| Differential return loss | DDRL | (Note 1) | $R_T$ = 50 Ω, f = 4 GHz See Fig. 12.8 | 3.3 ± 0.3 | — | -20 | — | dB |
| Differential insertion loss | DDIL | (Note 1) | $R_T$ = 50 Ω, f = 4 GHz See Fig. 12.8 | 3.3 ± 0.3 | — | -1 | — | dB |
| -3dB Bandwidth | BW | (Note 1) | $R_T$ = 50 Ω, $C_L$ = 0 pF See Fig. 12.8 | 3.3 ± 0.3 | — | 11.5 | — | GHz |

Note : All typical values are at $T_a$ = 25 °C.
Note 1: This parameter is guaranteed by design.

## 11.3. Capacitive Characteristics (Note) (Unless otherwise specified, $T_a$ = 25 °C)

| Characteristics | Symbol | Note | Test Condition | $V_{CC}$ (V) | Typ. | Unit |
|---|---|---|---|---|---|---|
| Input capacitance ($\overline{OE}$, SEL) | $C_{IN}$ | | $V_{IN}$ = 0 V | 3.3 | 3 | pF |
| Switch terminal OFF-capacitance (An+, An-) | $C_{I/O}$ | | $\overline{OE}$ = $V_{CC}$, $V_{IS}$ = 0 V | 3.3 | 0.8 | pF |
| Switch terminal OFF-capacitance (Bn+, Bn-, Cn+, Cn-) | | | $\overline{OE}$ = $V_{CC}$, $V_{IS}$ = 0 V | 3.3 | 0.5 | pF |
| Switch terminal ON-capacitance | $C_{I/O}$ | | $\overline{OE}$ = GND, $V_{IS}$ = 0 V | 3.3 | 1.5 | pF |

Note: Parameter guaranteed by design.

## 12. AC Electrical Test Circuit (Fig)

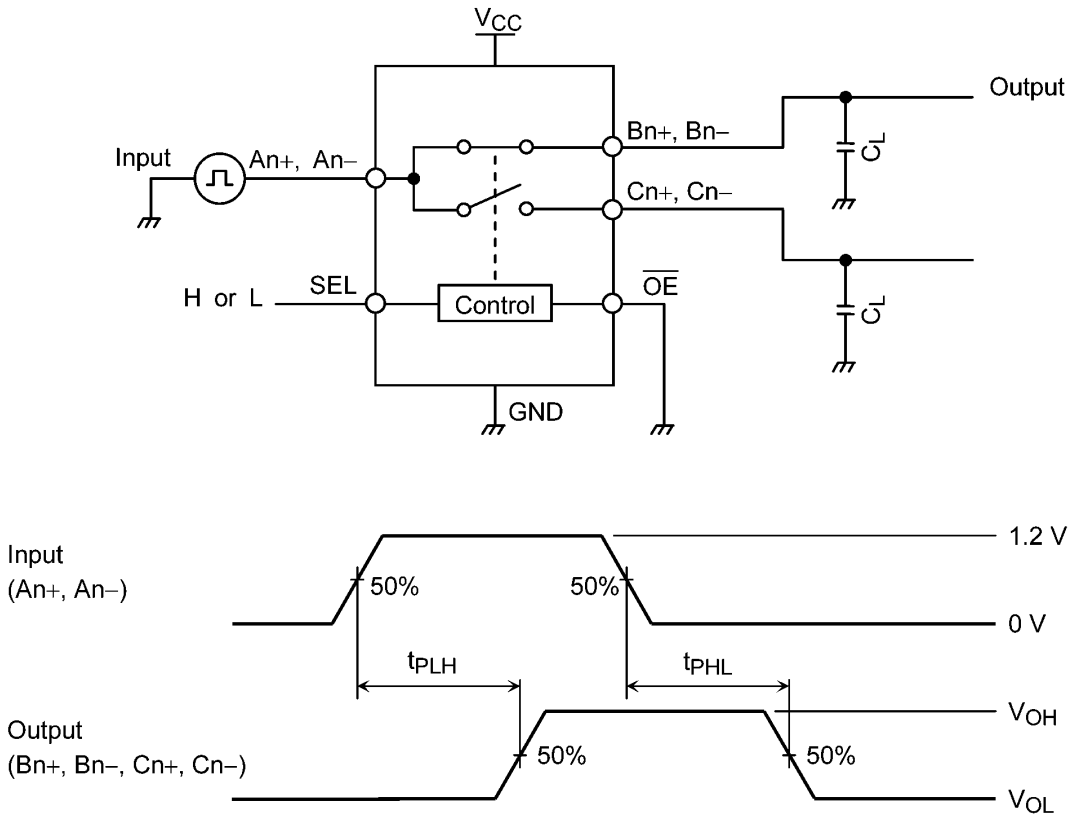



**Fig. 12.1 Propagation delay time**

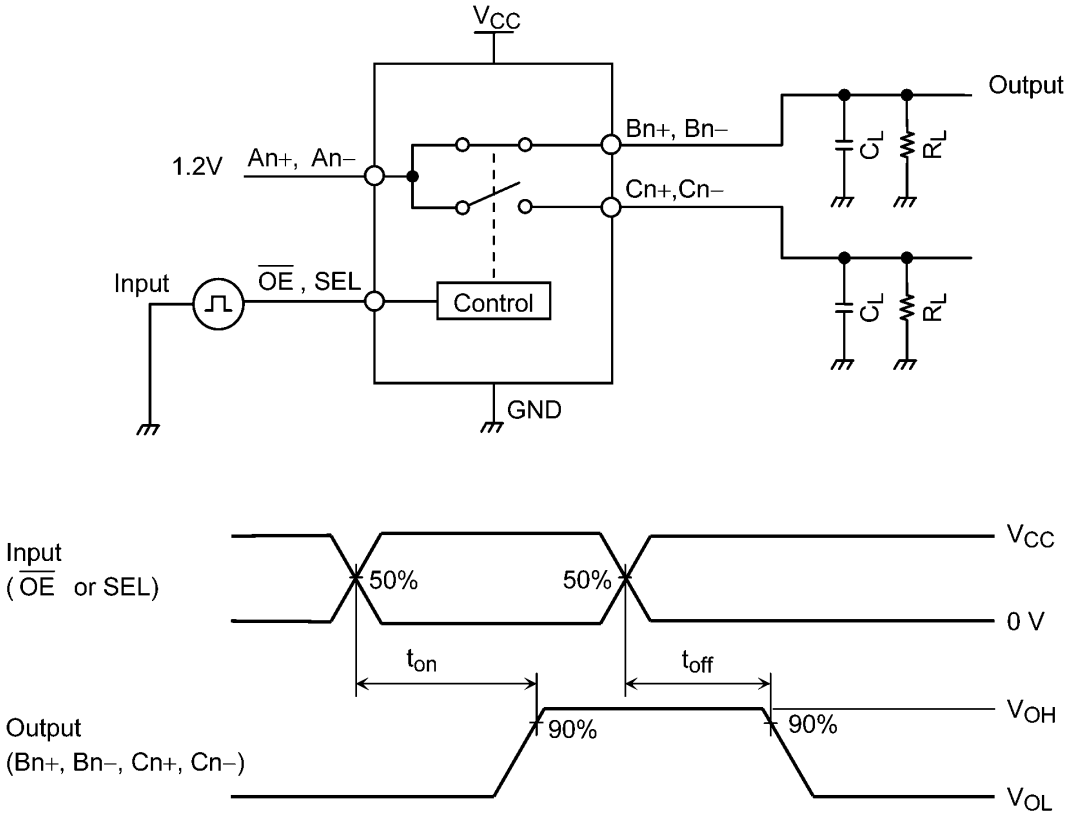



**Fig. 12.2 Turn-ON and Turn-OFF time**

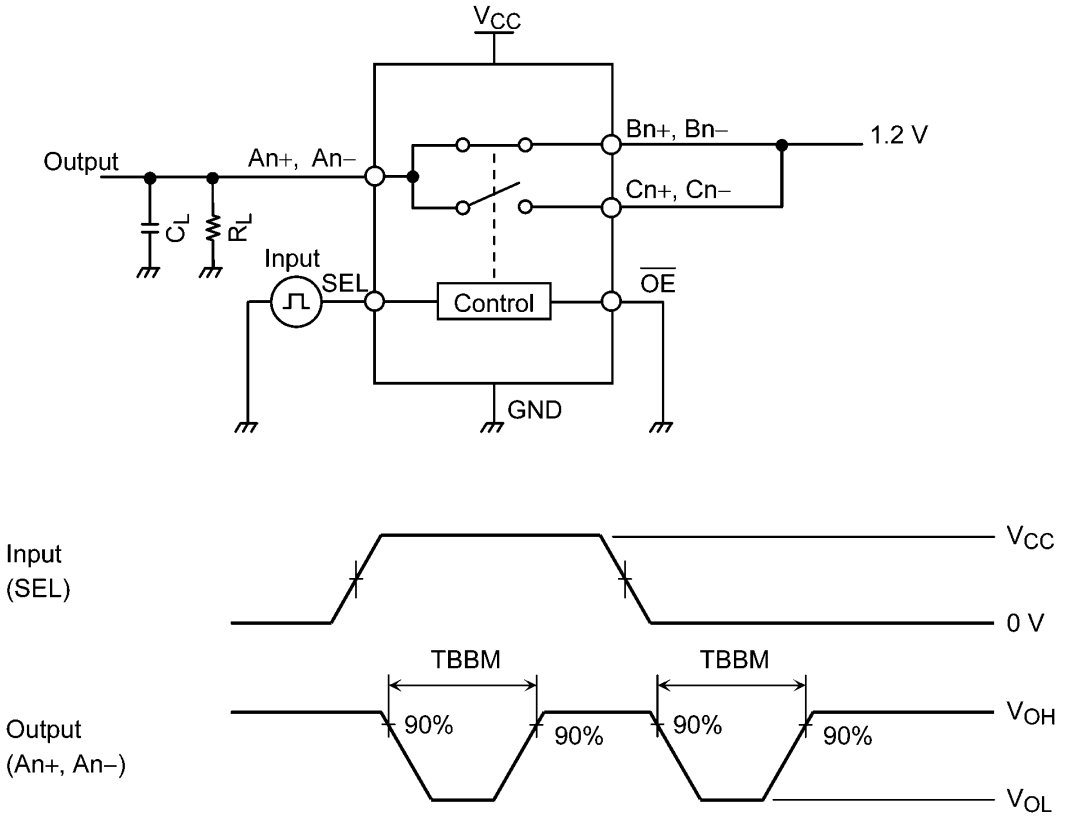



**Fig. 12.3 Break before make**

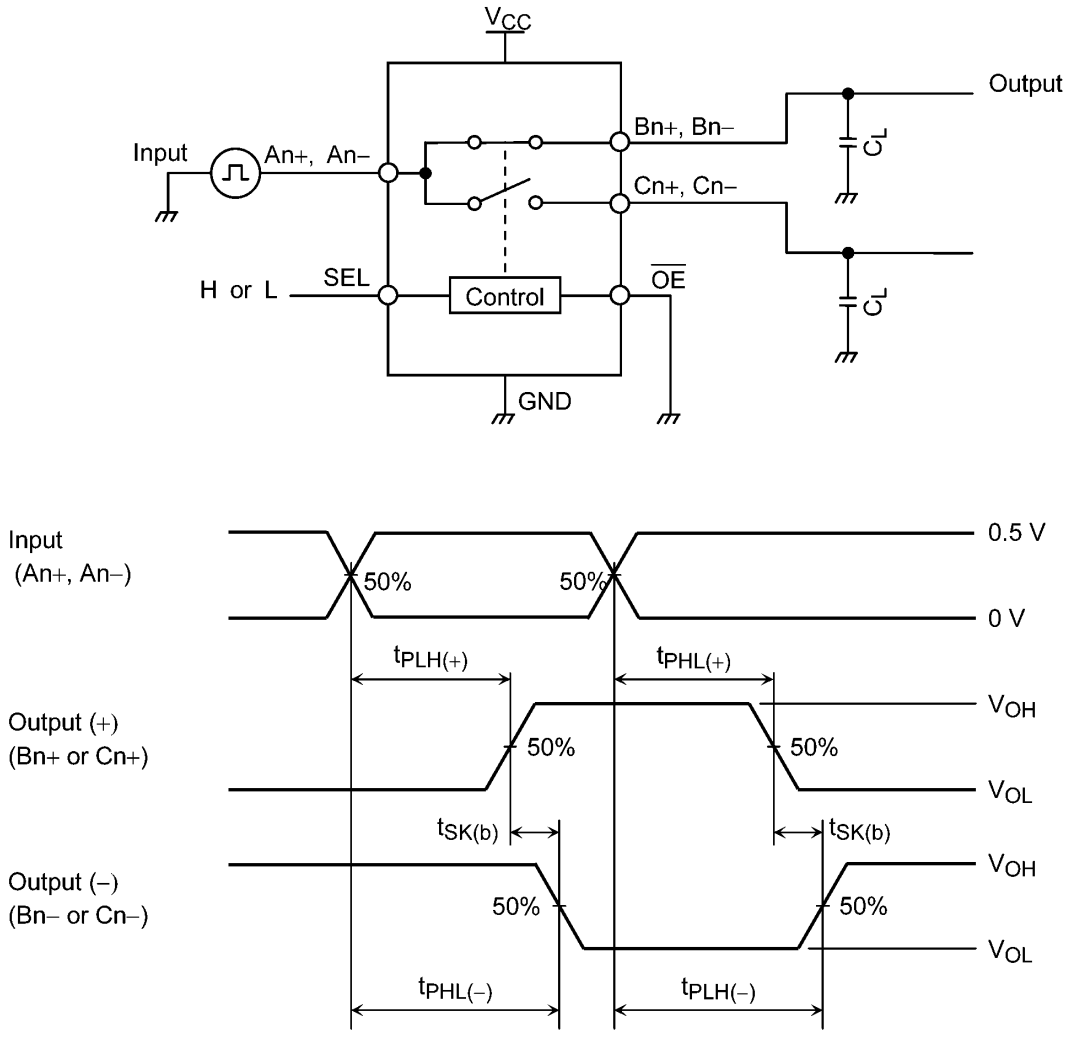



**Fig. 12.4 Output skew (bit to bit)**

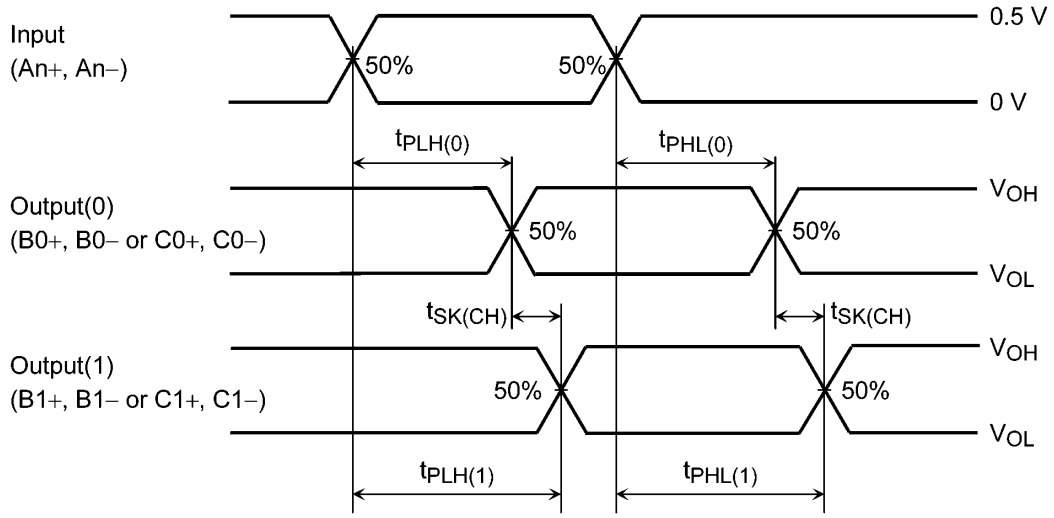
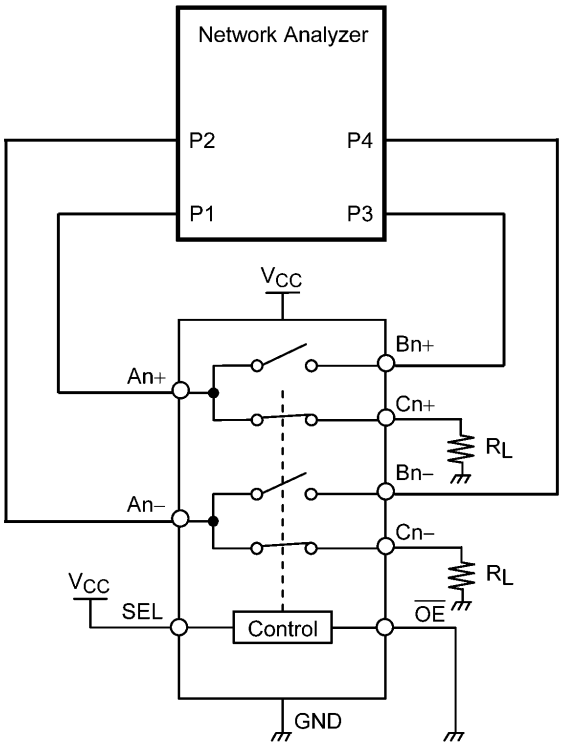
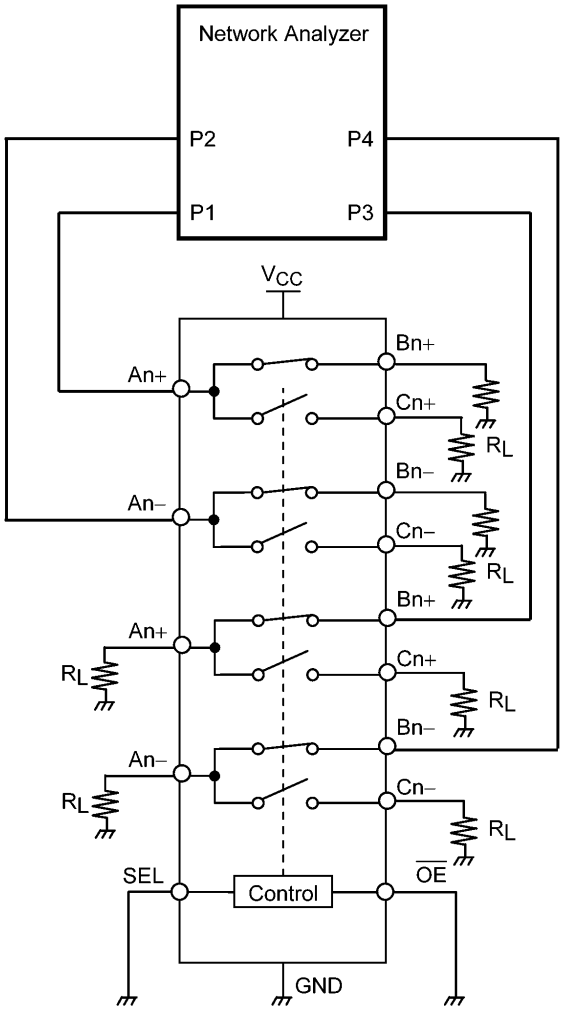



**Fig. 12.5 Output skew (channel to channel)**



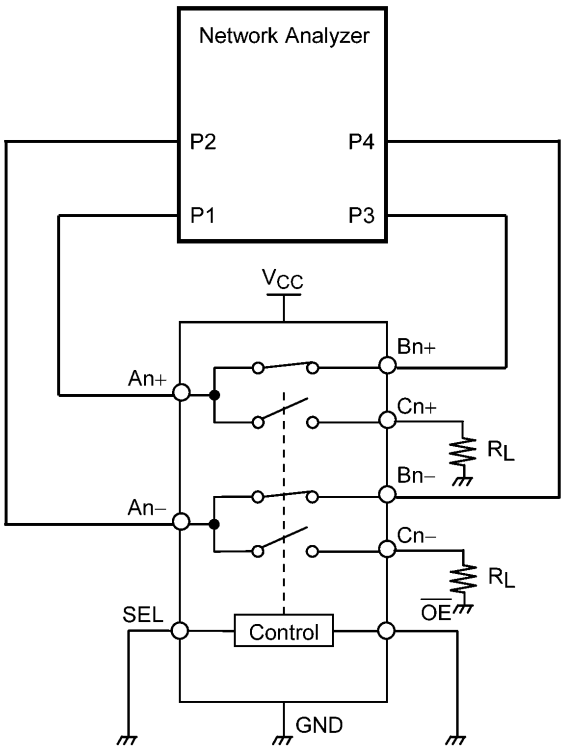

$R_L$ = 50Ω
All unused ports are connected to GND through 50Ω pull-down resistors.

**Fig. 12.6 Differential OFF isolation**




$R_L$ = 50Ω
All unused ports are connected to GND through 50Ω pull-down resistors.

**Fig. 12.7 Differential Near-end crosstalk**

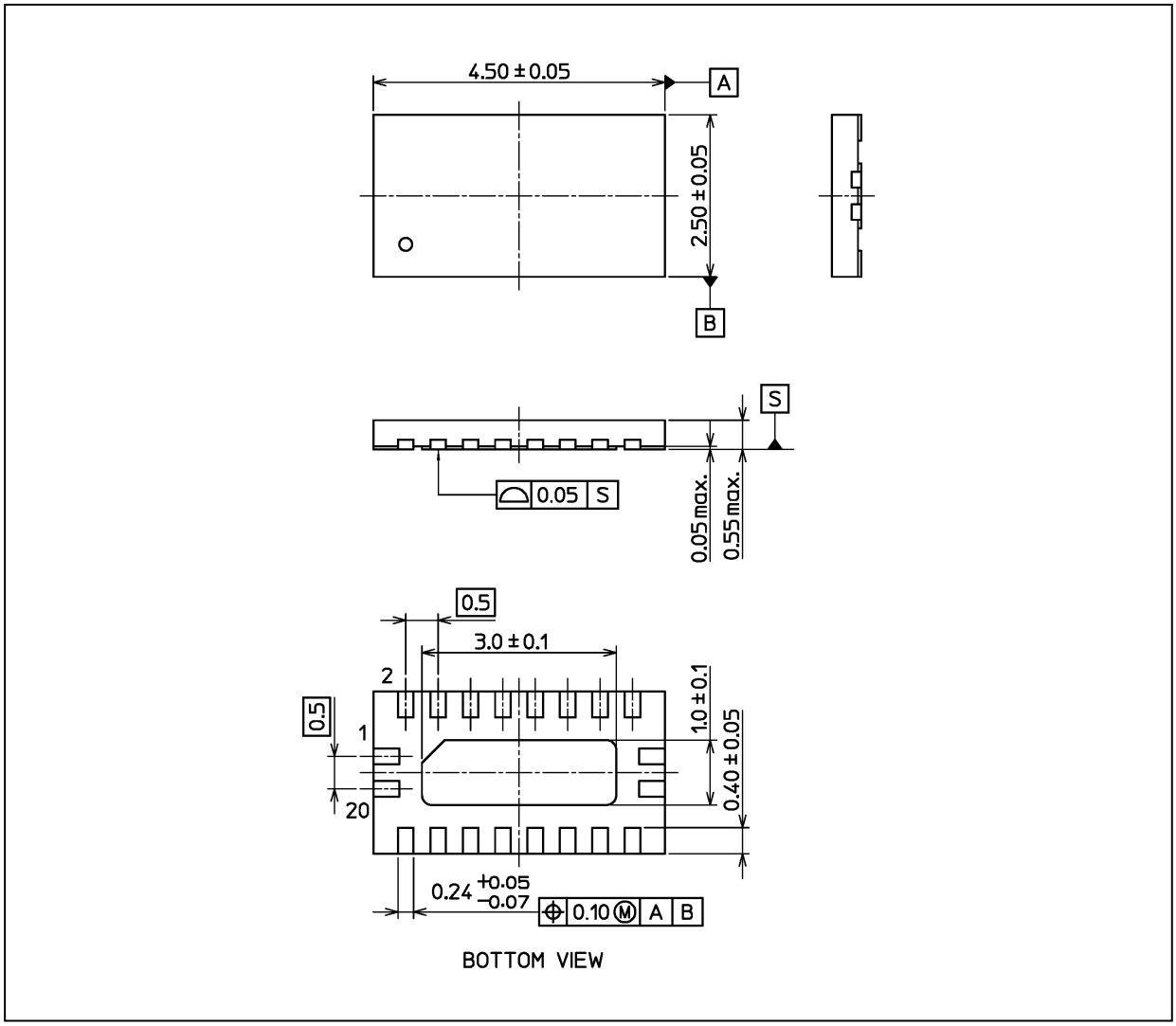



$R_L$ = 50 Ω
All unused ports are connected to GND through 50 Ω pull-down resistors.

**Fig. 12.8 Differential return loss, Differential insertion loss, -3dB Bandwidth**

## Package Dimensions

Unit: mm




Weight: 0.017 g (typ.)

| Package Name(s) |
|---|
| TOSHIBA: P-UQFN20-0305-0.50-001 |
| Nickname: TQFN20 |

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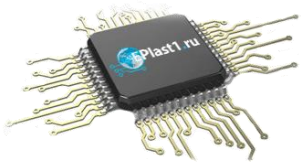


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