

# 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.

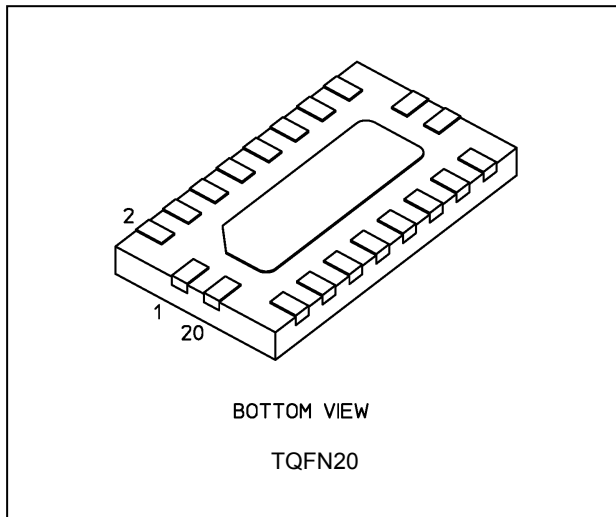
The An+/An- inputs is connected to the Bn+/Bn- or Cn+/Cn- outputs determined by the combination both the select input (SEL) and output enable ( $\overline{OE}$ ). When the output enable ( $\overline{OE}$ ) input is held high-level, the switches are open (high-impedance state) with regardless the state 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:  $C_{IO} = 1.5$  pF Switch On (typ.) @  $V_{CC} = 3.3$  V
- (3) ON resistance:  $R_{ON} = 7.5 \Omega$  (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  $\geq \pm 200$  V, Human body model  $\geq \pm 2000$  V
- (9) Package: TQFN20

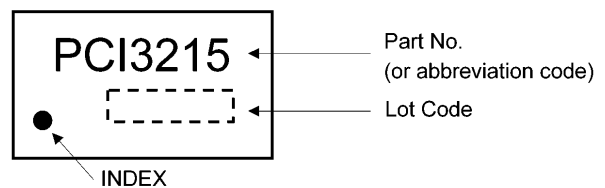
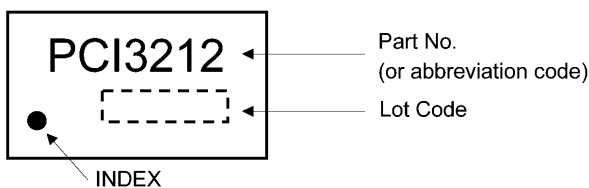
## 4. Packaging



## 5. Marking

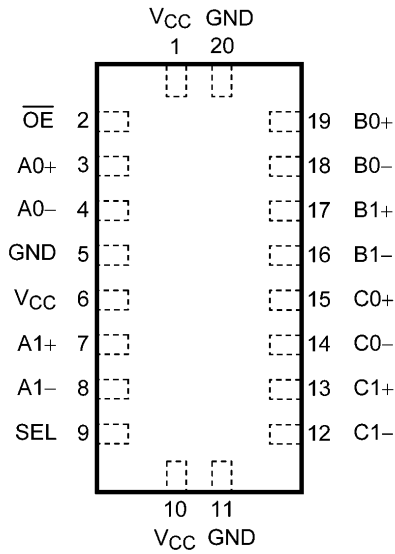
TC7PCI3212MT

TC7PCI3215MT

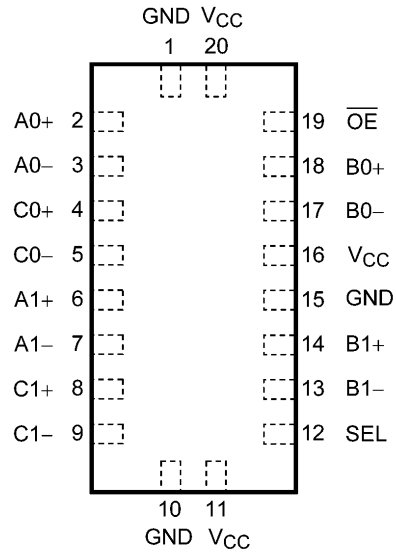


**6. Pin Assignment**

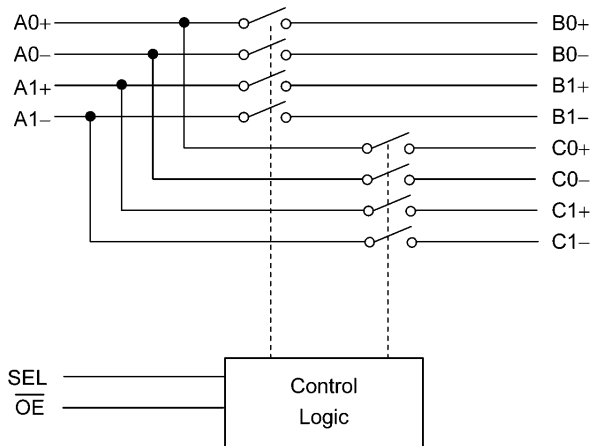
TC7PCI3212MT



TC7PCI3215MT



**7. Block Diagram**



**8. Principle of Operation**

**8.1. Truth Table**

| Inputs<br>OE | Inputs<br>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               | $I_{CC}/I_{GND}$ |      | $\pm 50$               | mA          |
| Storage temperature                    | $T_{stg}$        |      | -55 to 125             | $^{\circ}C$ |

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     | $^{\circ}C$ |
| 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 $85^{\circ}C$ )

| 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   | $0.65 \times V_{CC}$ | —    | —                    | V        |
| Low-level input voltage ( $\overline{OE}$ , SEL)          | $V_{IL}$        |          | —  | 3.0 to 3.6   | —                    | —    | $0.35 \times V_{CC}$ | V        |
| Input leakage current ( $\overline{OE}$ , SEL)            | $I_{IN}$        |          | $V_{IN} = 0$ to $3.6$ V                                | 3.0 to 3.6   | —                    | —    | $\pm 1$              | $\mu A$  |
| Switch OFF-state leakage current                          | $I_{SZ}$        |          | $V_{IS} = 0$ to $V_{CC}$ ,<br>$\overline{OE} = V_{CC}$ | 3.0 to 3.6   | —                    | —    | $\pm 1$              | $\mu A$  |
| ON-resistance   | $R_{ON}$        | (Note 1) | $V_{IS} = 0$ V, $I_{IS} = 30$ mA                       | 3.0          | —                    | 7.5  | 11.5                 | $\Omega$ |
|   | $R_{ON}$        | (Note 1) | $V_{IS} = 1.2$ V, $I_{IS} = 30$ mA                     | 3.0          | —                    | 8.5  | 13.5                 | $\Omega$ |
| 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  | —                    | $\Omega$ |
| ON-resistance flatness                                    | $R_{ON(Flat)}$  | (Note 1) | $V_{IS} = 0$ V to $1.2$ V, $I_{IS} = 15$ mA            | 3.0          | —                    | 1    | —                    | $\Omega$ |
| Quiescent supply current                                  | $I_{CC}$        |          | $V_{IN} = V_{CC}$ or GND,<br>$\overline{OE} = V_{CC}$  | 3.6          | —                    | —    | 1                    | $\mu A$  |
| Quiescent supply current                                  | $I_{CC}$        |          | $V_{IN} = V_{CC}$ or GND,<br>$\overline{OE} = GND$     | 3.6          | —                    | 200  | 500                  | $\mu A$  |

Note : All typical values are at  $T_a = 25^{\circ}C$ .

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<br>See Fig. 12.1                       | $3.3 \pm 0.3$ | —   | 0.1  | —   | ns      |
| Turn-ON time (SEL to Output)               | $t_{on}$          |          | $R_L = 50$ $\Omega$ , $C_L = 5$ pF<br>See Fig. 12.2 | $3.3 \pm 0.3$ | —   | 10   | 15  | ns      |
| Turn-ON time ( $\overline{OE}$ to Output)  | $t_{on}$          |          | $R_L = 50$ $\Omega$ , $C_L = 5$ pF<br>See Fig. 12.2 | $3.3 \pm 0.3$ | —   | 37   | 50  | $\mu$ s |
| Turn-OFF time (SEL to Output)              | $t_{off}$         |          | $R_L = 50$ $\Omega$ , $C_L = 5$ pF<br>See Fig. 12.2 | $3.3 \pm 0.3$ | —   | 3.5  | 5   | ns      |
| Turn-OFF time ( $\overline{OE}$ to Output) | $t_{off}$         |          | $R_L = 50$ $\Omega$ , $C_L = 5$ pF<br>See Fig. 12.2 | $3.3 \pm 0.3$ | —   | 5    | 6.5 | ns      |
| Break before make                          | TBBM              |          | $R_L = 50$ $\Omega$ , $C_L = 5$ pF<br>See Fig. 12.3 | $3.3 \pm 0.3$ | 3   | —    | 9   | ns      |
| Output skew (bit to bit)                   | $t_{SK(b)}$       | (Note 1) | $C_L = 5$ pF<br>See Fig. 12.4                       | $3.3 \pm 0.3$ | —   | 5    | —   | ps      |
| Output skew (channel to channel)           | $t_{SK(CH)}$      | (Note 1) | $C_L = 5$ pF<br>See Fig. 12.5                       | $3.3 \pm 0.3$ | —   | 10   | —   | ps      |
| Differential OFF isolation                 | DDOIRR            | (Note 1) | $R_T = 50$ $\Omega$ , $f = 4$ GHz<br>See Fig. 12.6  | $3.3 \pm 0.3$ | —   | -20  | —   | dB      |
| Differential Near-end crosstalk            | DDNEXT            | (Note 1) | $R_T = 50$ $\Omega$ , $f = 4$ GHz<br>See Fig. 12.7  | $3.3 \pm 0.3$ | —   | -40  | —   | dB      |
| Differential return loss                   | DDRL              | (Note 1) | $R_T = 50$ $\Omega$ , $f = 4$ GHz<br>See Fig. 12.8  | $3.3 \pm 0.3$ | —   | -20  | —   | dB      |
| Differential insertion loss                | DDIL              | (Note 1) | $R_T = 50$ $\Omega$ , $f = 4$ GHz<br>See Fig. 12.8  | $3.3 \pm 0.3$ | —   | -1   | —   | dB      |
| -3dB Bandwidth                             | BW                | (Note 1) | $R_T = 50$ $\Omega$ , $C_L = 0$ pF<br>See Fig. 12.8 | $3.3 \pm 0.3$ | —   | 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 ( $A_n+$ , $A_n-$ )                   | $C_{I/O}$ |      | $\overline{OE} = V_{CC}$ , $V_{IS} = 0$ V | 3.3          | 0.8  | pF   |
| Switch terminal OFF-capacitance ( $B_n+$ , $B_n-$ , $C_n+$ , $C_n-$ ) |           |      | $\overline{OE} = V_{CC}$ , $V_{IS} = 0$ 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)

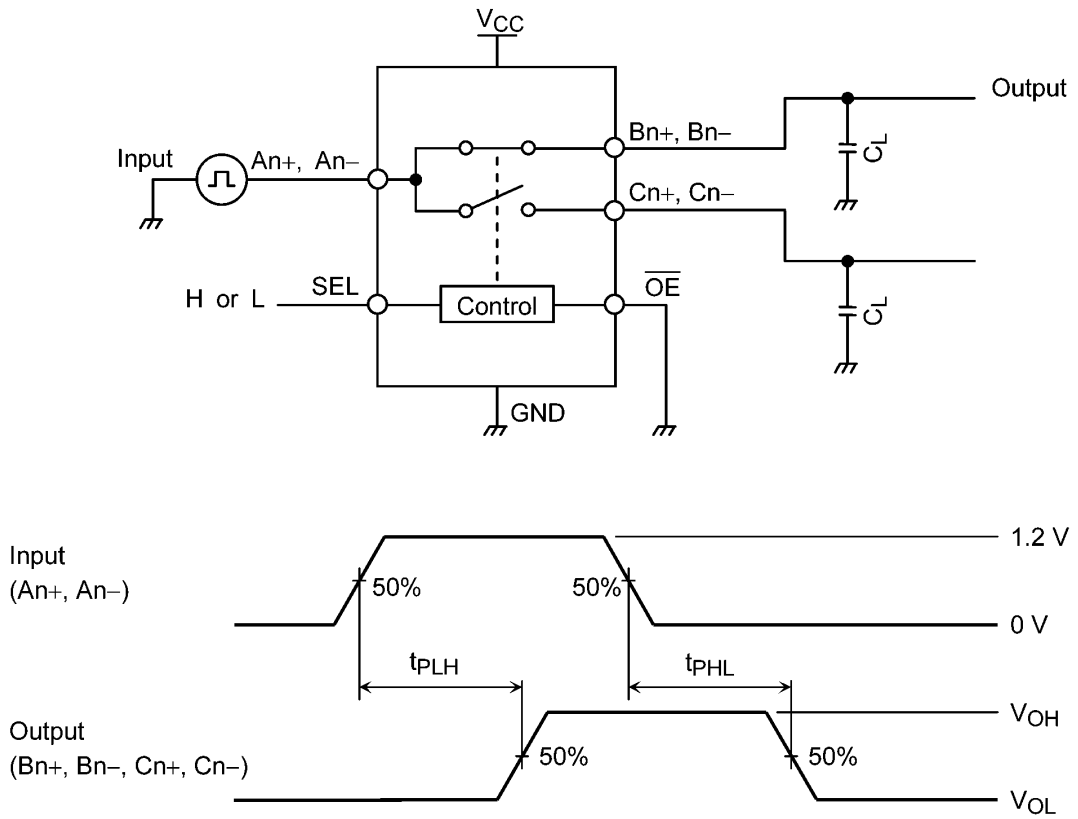
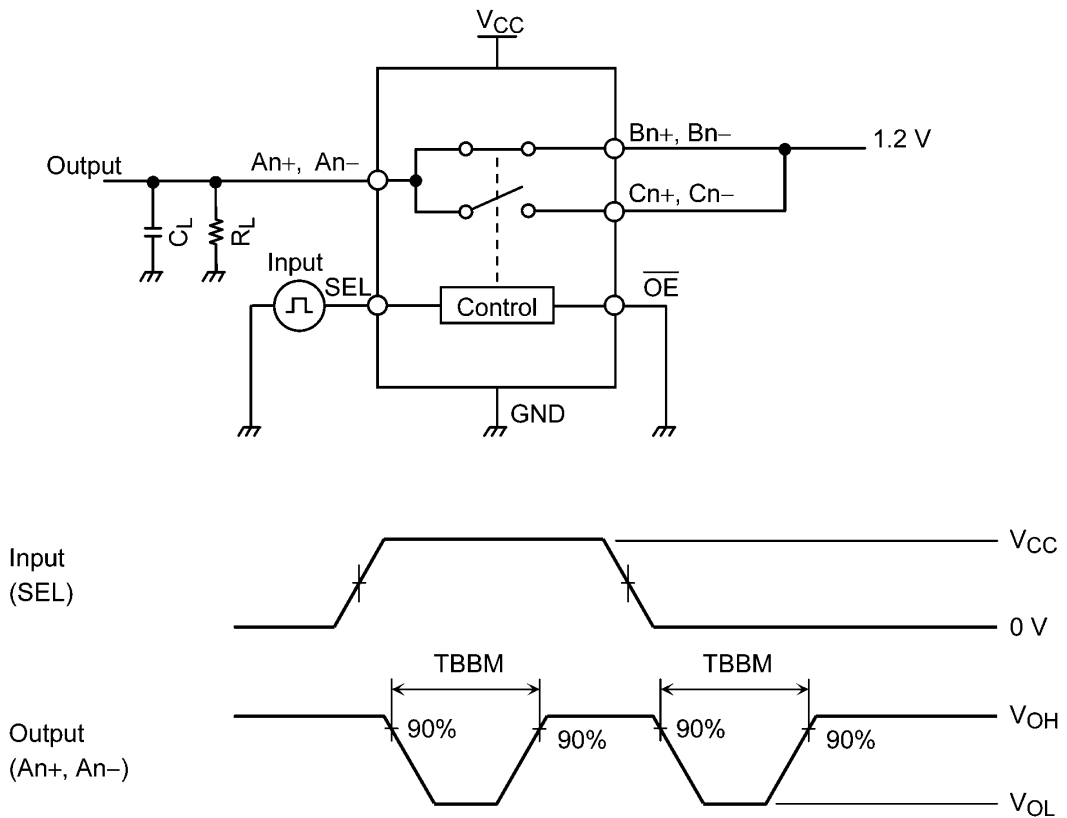
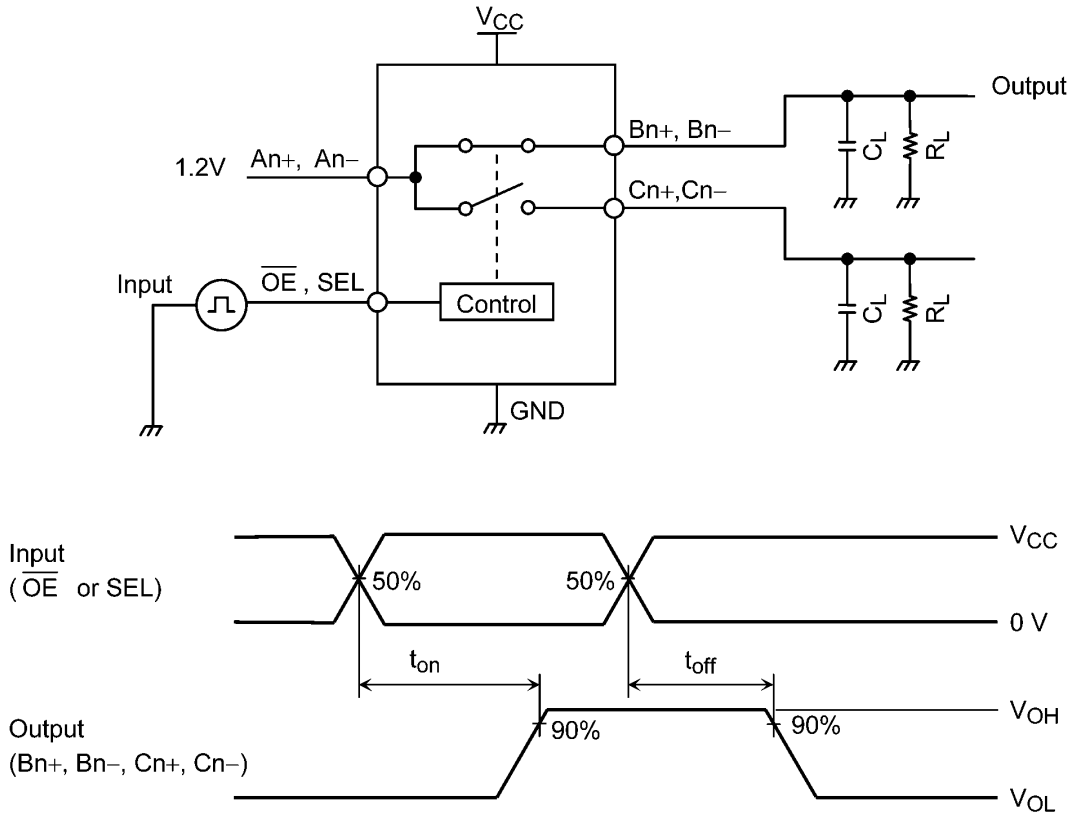
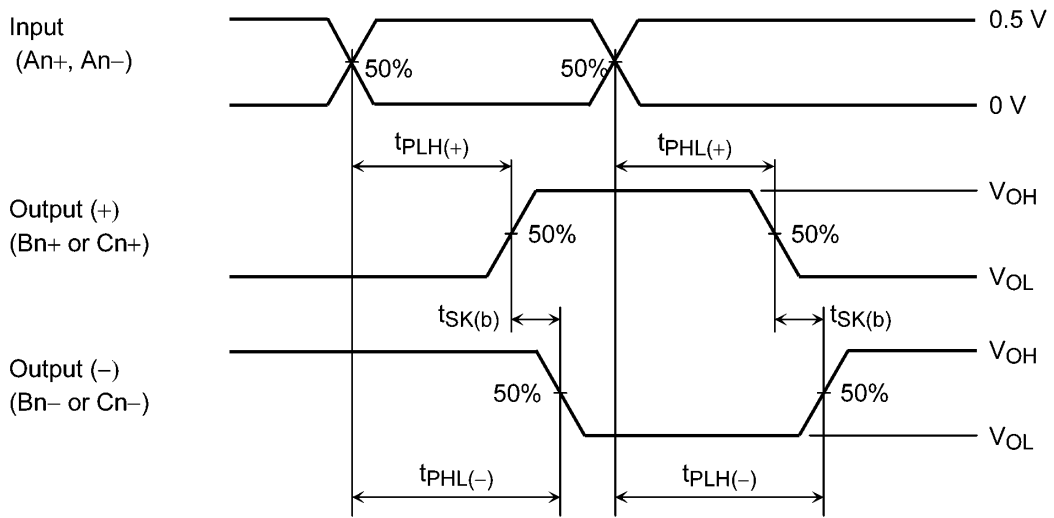
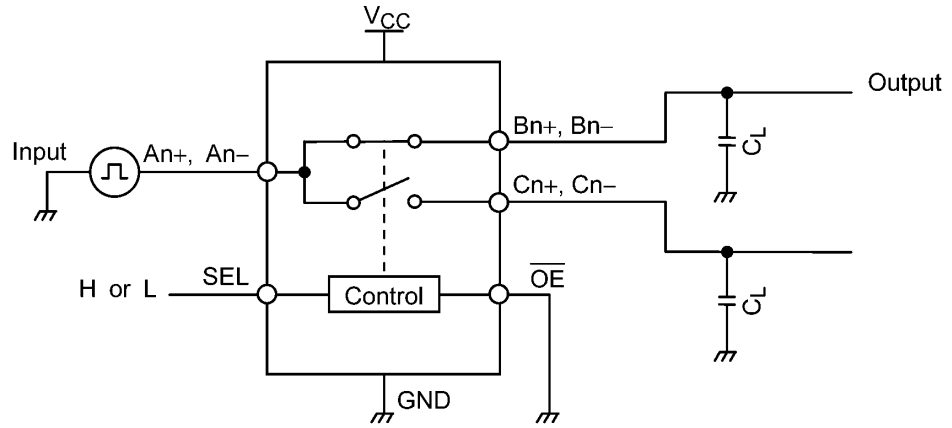
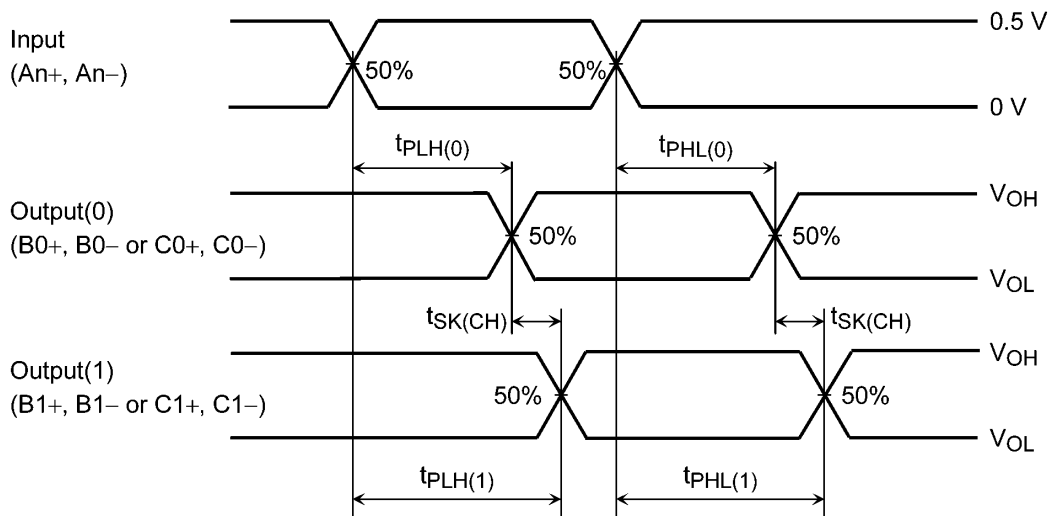


Fig. 12.1 Propagation delay time

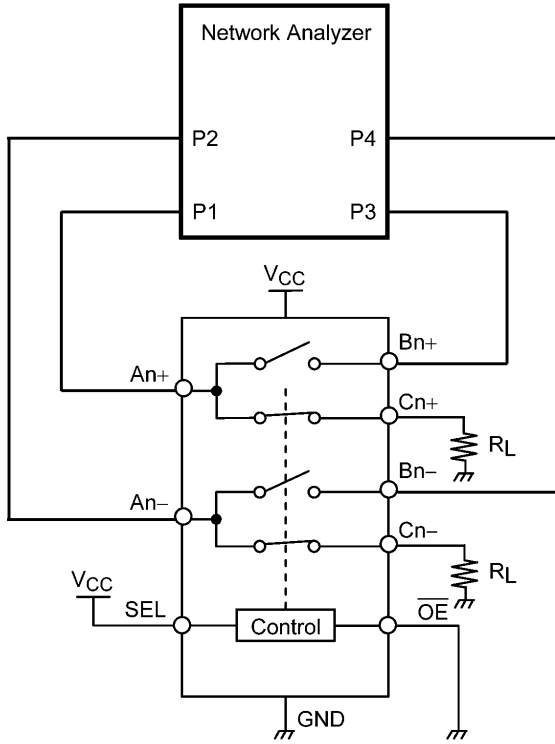




**Fig. 12.4 Output skew (bit to bit)**

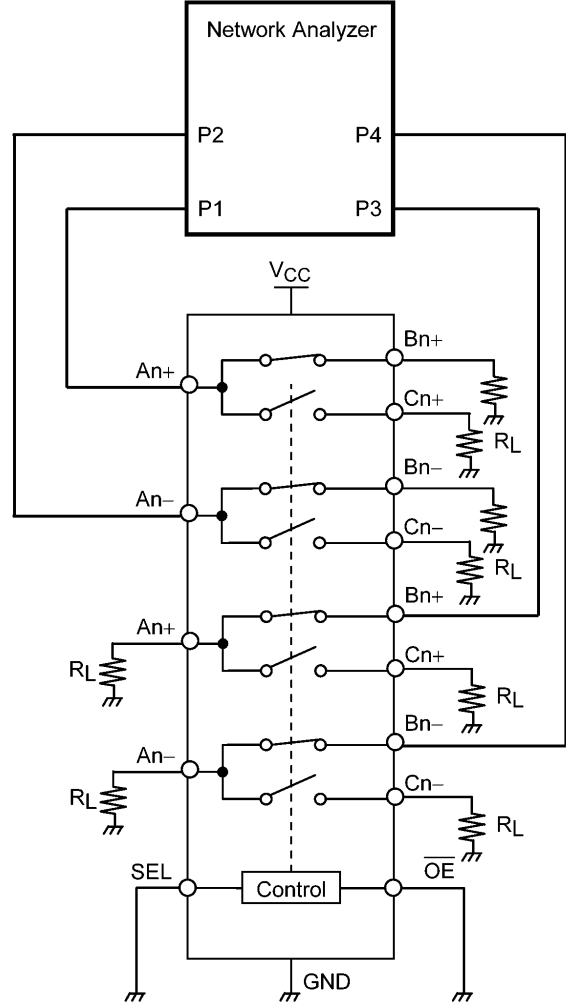


**Fig. 12.5 Output skew (channel to channel)**



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

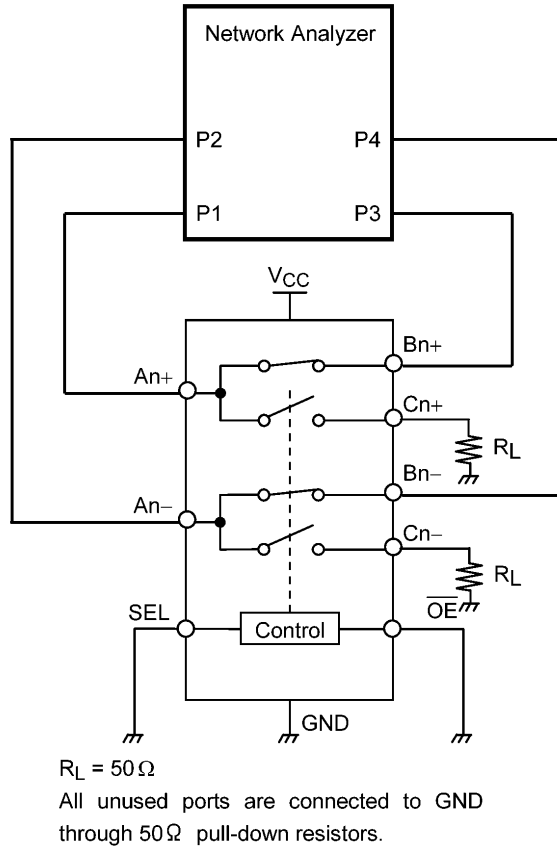
**Fig. 12.6 Differential OFF isolation**



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

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

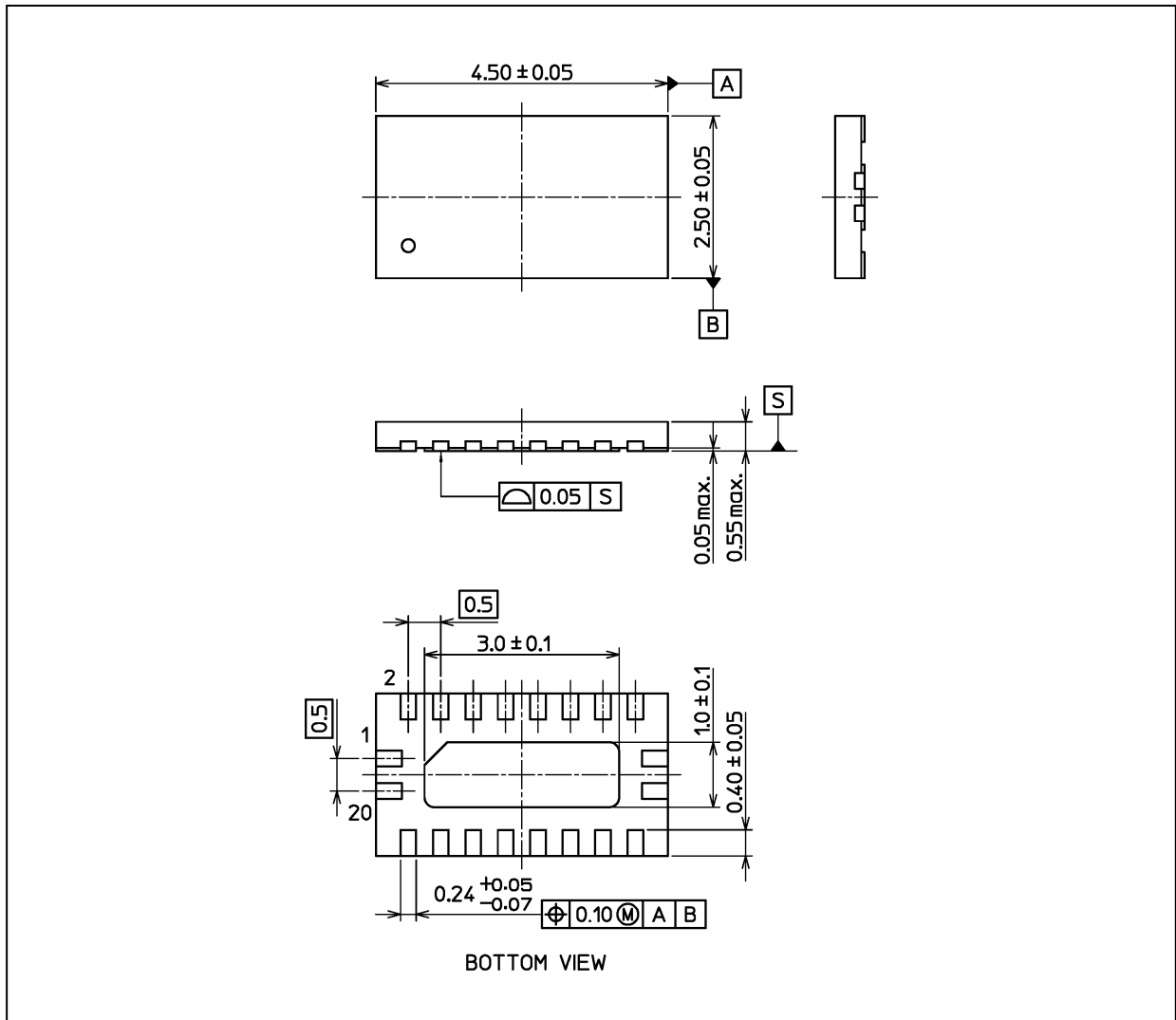




**Fig. 12.8 Differential return loss, Differential insertion loss, -3dB Bandwidth**

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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