



### 4-BIT BIDIRECTIONAL VOLTAGE-LEVEL TRANSLATOR FOR OPEN-DRAIN AND PUSH-PULL APPLICATION

#### DESCRIPTION

This 4-bit non-inverting translator is a bidirectional voltage-level translator and can be used to establish digital switching compatibility between mixed-voltage systems. It uses two separate configurable power-supply rails. The A port is designed to track  $V_{CCA}$ .  $V_{CCA}$  accepts any supply voltage from 1.65V to 3.6V. The B port is designed to track  $V_{CCB}$ .  $V_{CCA}$  must be less than or equal to  $V_{CCB}$ .  $V_{CCB}$  accepts any supply voltage from 2.3V to 5.5V. This allows for low voltage bidirectional translation between any of the 1.8V, 2.5V, 3.3V and 5V voltage nodes.

When the output-enable (OE) input is low, all outputs are placed in the high-impedance state.

The **UTXS0104** is designed so that the OE input circuit is supplied by  $V_{CCA}$ .

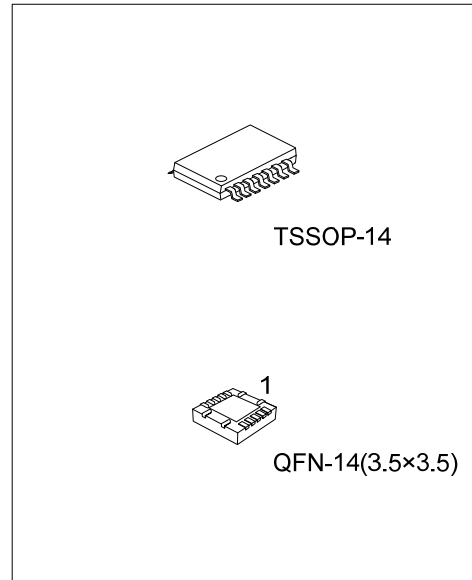
To ensure the high-impedance state during power up or power down, OE should be tied to GND through a pull-down resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver.

#### FEATURES

- \* 1.65V to 3.6V on A Port and 2.3V to 5.5V on B Port ( $V_{CCA} \leq V_{CCB}$ )
- \* No Direction-Control Signal Needed
- \* No Power-Supply Sequencing Required – Either  $V_{CCA}$  or  $V_{CCB}$  Can be Ramped First

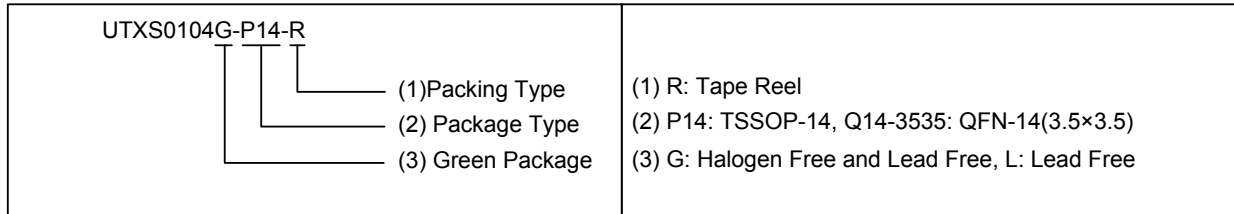
#### APPLICATION

- \* Handset
- \* Smartphone
- \* Tablet
- \* Desktop PC

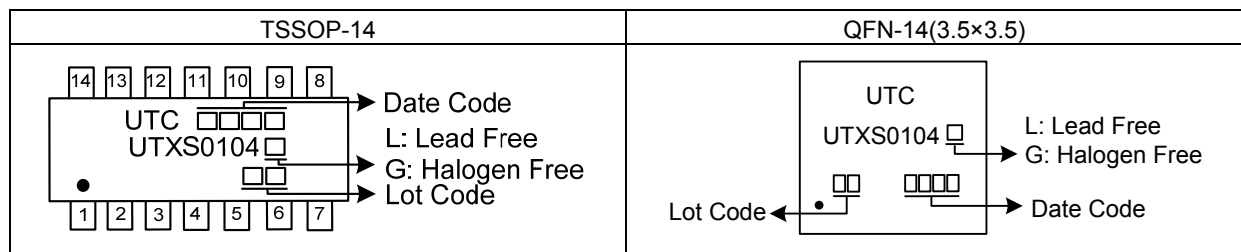


### ORDERING INFORMATION

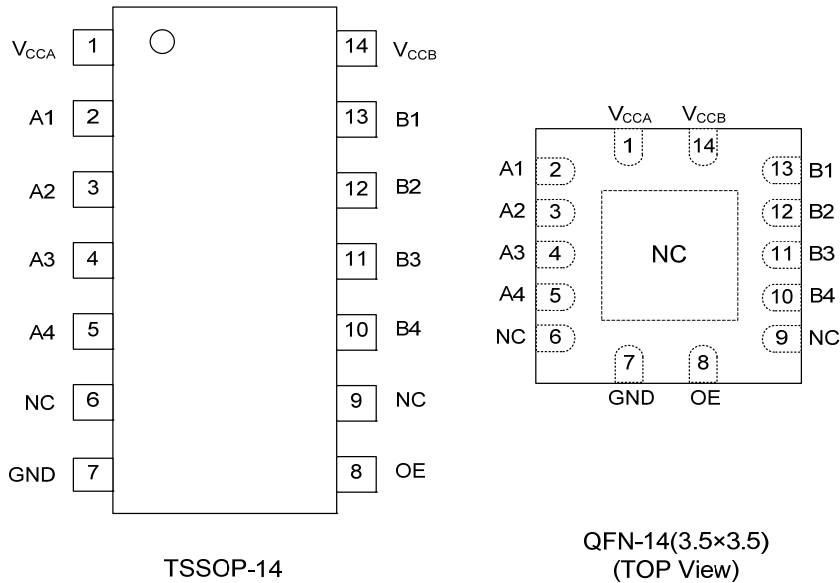
| Ordering Number      |                      | Package         | Packing   |
|----------------------|----------------------|-----------------|-----------|
| Lead Free            | Halogen Free         |                 |           |
| UTXS0104L-P14-R      | UTXS0104G-P14-R      | TSSOP-14        | Tape Reel |
| UTXS0104L-Q14-3535-R | UTXS0104G-Q14-3535-R | QFN-14(3.5×3.5) | Tape Reel |



### MARKING



■ PIN CONFIGURATION



■ PIN DESCRIPTION

| PIN NO.  |                 | PIN NAME         | I/O | DESCRIPTION   |
|----------|-----------------|------------------|-----|---|
| TSSOP-14 | QFN-14(3.5x3.5) |                  |     |   |
| 1        | 1               | V <sub>CCA</sub> |     | A-port supply voltage 1.65V ≤ V <sub>CCA</sub> ≤ 3.6V and V <sub>CCA</sub> ≤ V <sub>CCB</sub> . |
| 2        | 2               | A1               | I/O | Input/output A1. Referenced to V <sub>CCA</sub>   |
| 3        | 3               | A2               | I/O | Input/output A2. Referenced to V <sub>CCA</sub>   |
| 4        | 4               | A3               | I/O | Input/output A3. Referenced to V <sub>CCA</sub>   |
| 5        | 5               | A4               | I/O | Input/output A4. Referenced to V <sub>CCA</sub>   |
| 6        | 6               | NC               |     | No connection. Not internally connected.  |
| 7        | 7               | GND              |     | Ground  |
| 8        | 8               | OE               | I   | Output enable. Pull OE low to place all outputs in 3-state mode. Referenced to V <sub>CCA</sub> |
| 9        | 9               | NC               |     | No connection. Not internally connected.  |
| 10       | 10              | B4               | I/O | Input/output B4. Referenced to V <sub>CCB</sub>   |
| 11       | 11              | B3               | I/O | Input/output B3. Referenced to V <sub>CCB</sub>   |
| 12       | 12              | B2               | I/O | Input/output B2. Referenced to V <sub>CCB</sub>   |
| 13       | 13              | B1               | I/O | Input/output B1. Referenced to V <sub>CCB</sub>   |
| 14       | 14              | V <sub>CCB</sub> |     | B-port supply voltage 2.3V ≤ V <sub>CCB</sub> ≤ 5.5V  |
| -        | Exposed Pad     | NC               |     | Thermal pad   |

Note: I=Input, I/O=Input and Output

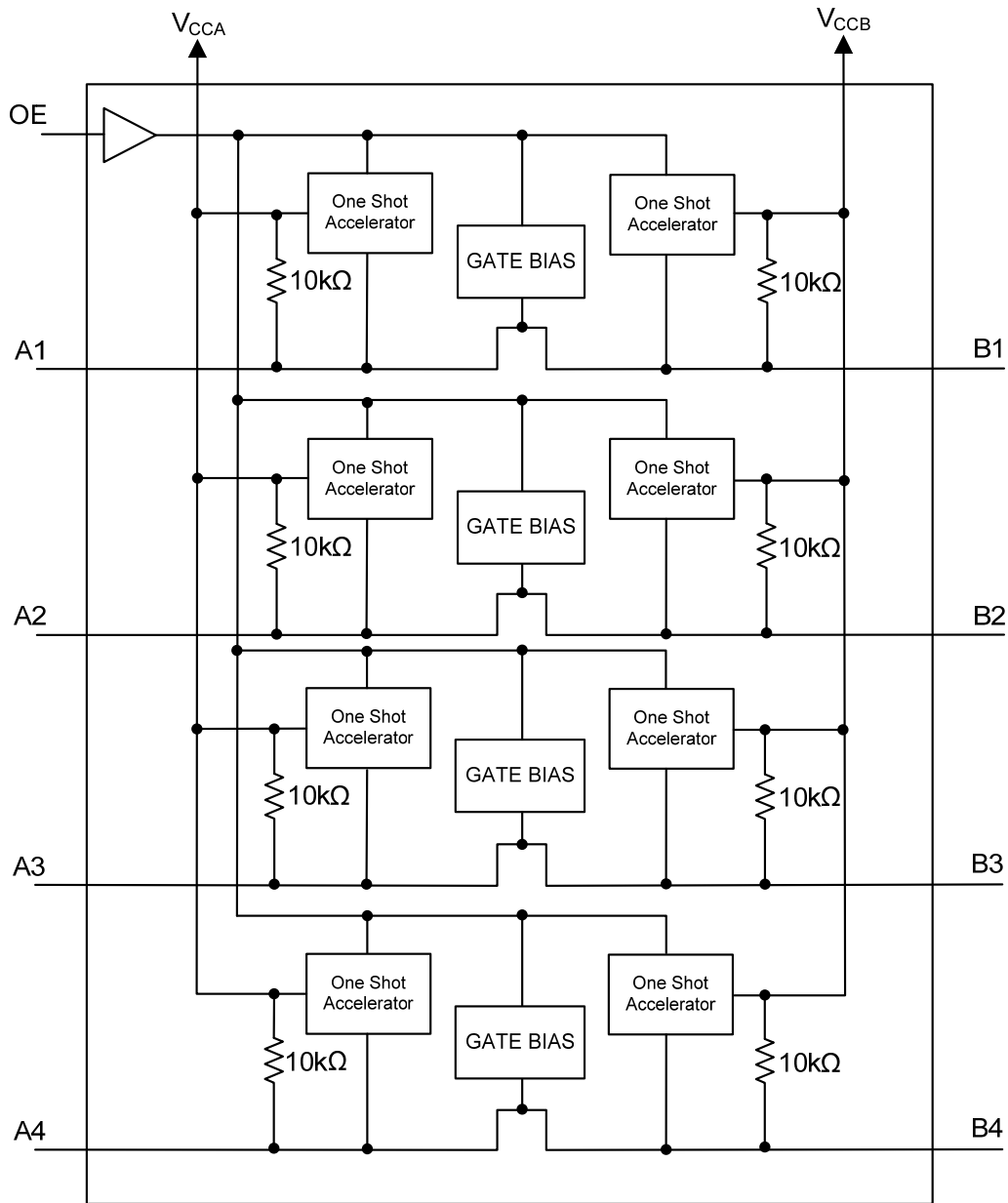
■ FUNCTION TABLE

| SUPPLY VOLTAGE           |                  | INPUT | INPUT/OUTPUT    |                 |
|--------------------------|------------------|-------|-----------------|-----------------|
| V <sub>CCA</sub>         | V <sub>CCB</sub> | OE    | A <sub>n</sub>  | B <sub>n</sub>  |
| 1.65V ~ V <sub>CCB</sub> | 2.3V ~ 5.5V      | L     | Z               | Z               |
| 1.65V ~ V <sub>CCB</sub> | 2.3V ~ 5.5V      | H     | Input or Output | Output or Input |
| GND                      | GND              | X     | Z               | Z               |

Notes: 1. H = High voltage level ; L = Low voltage level ; X = Don't care ; Z = high-impedance OFF-state

2. When either V<sub>CCA</sub> or V<sub>CCB</sub> is at GND level, the device goes into power-down mode.

■ BLOCK DIAGRAM



### ■ ABSOLUTE MAXIMUM RATING

| PARAMETER  |             | SYMBOL             | RATINGS              | UNIT |
|--|-------------|--------------------|----------------------|------|
| Supply Voltage   |             | $V_{CCA}$          | -0.5 ~ 4.6           | V    |
| Supply Voltage   |             | $V_{CCB}$          | -0.5 ~ 6.5           | V    |
| Input Voltage  | A Port      | $V_{IN}$           | -0.5 ~ 4.6           | V    |
|  | B Port      |                    | -0.5 ~ 6.5           | V    |
| Voltage Range Applied to Any Output In the High-Impedance or Power-Off State | A Port      | $V_{OUT}$          | -0.5 ~ 4.6           | V    |
|  | B Port      |                    | -0.5 ~ 6.5           | V    |
| Voltage Range Applied to Any Output In the High or Low State                 | A Port      | $V_{OUT}$          | -0.5 ~ $V_{CCA}+0.5$ | V    |
|  | B Port      |                    | -0.5 ~ $V_{CCB}+0.5$ | V    |
| Input Clamp Current  | $V_{IN}<0$  | $I_{IK}$           | -50                  | mA   |
| Output Clamp Current   | $V_{OUT}<0$ | $I_{OK}$           | -50                  | mA   |
| Continuous Output Current  |             | $I_{OUT}$          | ±50                  | mA   |
| Continuous Current Through $V_{CCA}$ , $V_{CCB}$ , or GND                    |             | $I_{CC} / I_{GND}$ | ±100                 | mA   |
| Storage Temperature  |             | $T_{STG}$          | -65 ~ +150           | °C   |

Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

### ■ RECOMMENDED OPERATING CONDITIONS ( $T_A=25^\circ\text{C}$ , unless otherwise specified)

| PARAMETER                          |             | SYMBOL              | TEST CONDITIONS  | MIN  | TYP           | MAX                  | UNIT      |
|------------------------------------|-------------|---------------------|--|--|---------------|----------------------|-----------|
| Supply Voltage (Note 3)            |             | $V_{CCA}$           |  | 1.65   |               | 3.6                  | V         |
| Supply Voltage (Note 3)            |             | $V_{CCB}$           |  | 2.3  |               | 5.5                  | V         |
| Input Voltage                      |             | $V_{IN}$            |  | 0  |               | $V_{CCI}$            | V         |
| Output Voltage                     | A Port I/Os | $V_{OUT}$           | $V_{CCA}=1.65\text{V}\sim 3.6\text{V}$ ,<br>$V_{CCB}=2.3\text{V}\sim 5.5\text{V}$  | 0  |               | 3.6                  | V         |
|                                    | B Port I/Os |                     |  | 0  |               | 5.5                  | V         |
| High-Level Input Voltage           | A Port I/Os | $V_{IH}$            | $V_{CCA}=1.65\text{V}\sim 1.95\text{V}$ ,<br>$V_{CCB}=2.3\text{V}\sim 5.5\text{V}$ | $V_{CCI}-0.2$  |               | $V_{CCI}$            | V         |
|                                    |             |                     |  | $V_{CCA}=2.3\text{V}\sim 3.6\text{V}$ ,<br>$V_{CCB}=2.3\text{V}\sim 5.5\text{V}$ | $V_{CCI}-0.4$ |                      | $V_{CCI}$ |
|                                    | B Port I/Os |                     | $V_{CCA}=1.65\text{V}\sim 3.6\text{V}$ ,<br>$V_{CCB}=2.3\text{V}\sim 5.5\text{V}$  | $V_{CCI}-0.4$  |               | $V_{CCI}$            | V         |
|                                    | OE Input    |                     |  | $V_{CCA}\times 0.65$   |               | 5.5                  | V         |
| Low-Level Input Voltage            | A Port I/Os | $V_{IL}$            | $V_{CCA}=1.65\text{V}\sim 3.6\text{V}$ ,<br>$V_{CCB}=2.3\text{V}\sim 5.5\text{V}$  | 0  |               | 0.15                 | V         |
|                                    | B Port I/Os |                     |  | 0  |               | 0.15                 | V         |
|                                    | OE Input    |                     |  | 0  |               | $V_{CCA}\times 0.35$ | V         |
| Input Transition Rise or Fall Rate | A Port I/Os | $\Delta t/\Delta v$ | $V_{CCA}=1.65\text{V}\sim 3.6\text{V}$ ,<br>$V_{CCB}=2.3\text{V}\sim 5.5\text{V}$  |  |               | 10                   | ns/V      |
|                                    | B Port I/Os |                     |  |  |               | 10                   | ns/V      |
|                                    | OE Input    |                     |  |  |               | 10                   | ns/V      |
| Operating Temperature              |             | $T_A$               |  | -40  |               | +85                  | °C        |

- Notes: 1.  $V_{CCI}$  is the supply voltage associated with the input port.  
 2.  $V_{CCO}$  is the supply voltage associated with the output port.  
 3.  $V_{CCA}$  must be less than or equal to  $V_{CCB}$ , and  $V_{CCA}$  must not exceed 3.6V.

■ ELECTRICAL CHARACTERISTICS (T<sub>A</sub>=25°C, unless otherwise specified)

| PARAMETER                           |             | SYMBOL                             | TEST CONDITIONS   | MIN   | TYP | MAX  | UNIT |
|-------------------------------------|-------------|------------------------------------|---|---|-----|------|------|
| Port A Output High Voltage          |             | V <sub>OHA</sub>                   | V <sub>CCA</sub> =1.65V~3.6V,<br>V <sub>CCB</sub> =2.3V~5.5V, I <sub>OH</sub> =-20μA,<br>V <sub>IB</sub> ≥ V <sub>CCB</sub> -0.4V | V <sub>CCA</sub><br>×0.8  |     |      | V    |
| Port A Output Low Voltage           |             | V <sub>OLA</sub>                   | V <sub>CCA</sub> =1.65V~3.6V,<br>V <sub>CCB</sub> =2.3V~5.5V, I <sub>OL</sub> =1mA,<br>V <sub>IB</sub> ≤ 0.15V                    |   |     | 0.4  | V    |
| Port B Output High Voltage          |             | V <sub>OHB</sub>                   | V <sub>CCA</sub> =1.65V~3.6V,<br>V <sub>CCB</sub> =2.3V~5.5V, I <sub>OH</sub> =-20μA<br>V <sub>IA</sub> ≥ V <sub>CCA</sub> -0.2V  | V <sub>CCB</sub><br>×0.8  |     |      | V    |
| Port B Output Low Voltage           |             | V <sub>OLB</sub>                   | V <sub>CCA</sub> =1.65V~3.6V,<br>V <sub>CCB</sub> =2.3V~5.5V, I <sub>OL</sub> =1mA,<br>V <sub>IA</sub> ≤ 0.15V                    |   |     | 0.4  | V    |
| Input Leakage Current               | OE          | I <sub>I(LEAK)</sub>               | V <sub>CCA</sub> =1.65V~3.6V,<br>V <sub>CCB</sub> =2.3V~5.5V  | -1  |     | 1    | μA   |
| High-Impedance State Output Current | A or B Port | I <sub>OZ</sub>                    | V <sub>CCA</sub> =1.65V~3.6V,<br>V <sub>CCB</sub> =2.3V~5.5V, OE=GND  | -1  |     | 1    | μA   |
| Supply Current                      |             | I <sub>CCA</sub>                   | V <sub>I</sub> =V <sub>O</sub> =Open,<br>I <sub>O</sub> =0A   | V <sub>CCA</sub> =1.65V~V <sub>CCB</sub> ,<br>V <sub>CCB</sub> =2.3V~5.5V |     | 2.4  | μA   |
|                                     |             |                                    |   | V <sub>CCA</sub> =3.6V,<br>V <sub>CCB</sub> =0V                           |     | 2.2  | μA   |
|                                     |             |                                    |   | V <sub>CCA</sub> =0V,<br>V <sub>CCB</sub> =5.5V                           |     | -1   | μA   |
|                                     |             | I <sub>CCB</sub>                   |   | V <sub>CCA</sub> =1.65V~V <sub>CCB</sub> ,<br>V <sub>CCB</sub> =2.3V~5.5V |     | 12   | μA   |
|                                     |             |                                    |   | V <sub>CCA</sub> =3.6V,<br>V <sub>CCB</sub> =0V                           |     | -1   | μA   |
|                                     |             |                                    |   | V <sub>CCA</sub> =0V,<br>V <sub>CCB</sub> =5.5V                           |     | 1    | μA   |
|                                     |             | I <sub>CCA</sub> +I <sub>CCB</sub> |   | V <sub>CCA</sub> =1.65V~V <sub>CCB</sub> ,<br>V <sub>CCB</sub> =2.3V~5.5V |     | 14.4 | μA   |
| Input Capacitance                   | OE          | C <sub>IN</sub>                    |   |   | 2.5 | pF   |      |
| Output Capacitance                  | A Port      | C <sub>IO</sub>                    | V <sub>CCA</sub> =3.3V, V <sub>CCB</sub> =3.3V  |   |     | 5    | pF   |
|                                     | B Port      |                                    |   |   |     | 12   | pF   |

- Notes: 1. V<sub>CCI</sub> is the supply voltage associated with the input port.  
 2. V<sub>CCO</sub> is the supply voltage associated with the output port.  
 3. V<sub>CCA</sub> must be less than or equal to V<sub>CCB</sub>, and V<sub>CCA</sub> must not exceed 3.6V.

■ SWITCHING CHARACTERISTICS (T<sub>A</sub>=25°C, unless otherwise specified)

| PARAMETER   |   | SYMBOL                      | TEST CONDITIONS                                   |                              | MIN                          | TYP                         | MAX | UNIT |     |    |
|---|---|-----------------------------|---|------------------------------|------------------------------|-----------------------------|-----|------|-----|----|
| Propagation Delay<br>From Input (A) to Output (B) | Push-Pull<br>Driving                              | t <sub>PHL</sub>            | V <sub>CCA</sub> =1.8V±0.15V                      | V <sub>CCB</sub> =2.5V±0.2V  |                              |                             | 5.8 | ns   |     |    |
|   |   |                             |   | V <sub>CCB</sub> =3.3V±0.3V  |                              |                             | 5.9 | ns   |     |    |
|   |   |                             |   | V <sub>CCB</sub> =5V±0.5V    |                              |                             | 7.3 | ns   |     |    |
|   | Open-Drain<br>Driving                             |                             |   | V <sub>CCB</sub> =2.5V±0.2V  | 2.9                          |                             | 8.8 | ns   |     |    |
|   |   |                             |   | V <sub>CCB</sub> =3.3V±0.3V  | 2.9                          |                             | 9.6 | ns   |     |    |
|   |   |                             |   | V <sub>CCB</sub> =5V±0.5V    | 3                            |                             | 10  | ns   |     |    |
|   | Push-Pull<br>Driving                              |                             |   | V <sub>CCA</sub> =2.5V±0.2V  | V <sub>CCB</sub> =2.5V±0.2V  |                             |     |      | 4.0 | ns |
|   |   |                             |   | V <sub>CCB</sub> =3.3V±0.3V  |                              |                             |     |      | 4.2 | ns |
|   |   |                             |   | V <sub>CCB</sub> =5V±0.5V    |                              |                             |     |      | 4.3 | ns |
|   | Open-Drain<br>Driving                             |                             | V <sub>CCB</sub> =2.5V±0.2V                       | 1.7                          |                              |                             |     | 6.3  | ns  |    |
|   |   |                             | V <sub>CCB</sub> =3.3V±0.3V                       | 2                            |                              |                             |     | 6.0  | ns  |    |
|   |   |                             | V <sub>CCB</sub> =5V±0.5V                         | 2.1                          |                              |                             |     | 5.8  | ns  |    |
|   | Push-Pull<br>Driving                              |                             | V <sub>CCA</sub> =3.3V±0.3V                       | V <sub>CCB</sub> =3.3V±0.3V  |                              |                             |     | 3.0  | ns  |    |
|   |   |                             | V <sub>CCB</sub> =5V±0.5V                         |                              |                              |                             |     | 3.9  | ns  |    |
|   |   |                             | V <sub>CCB</sub> =3.3V±0.3V                       | 1.3                          |                              |                             |     | 4.2  | ns  |    |
|   | Open-Drain<br>Driving                             |                             | V <sub>CCB</sub> =5V±0.5V                         | 1.4                          |                              |                             |     | 4.6  | ns  |    |
|   |   |                             | Propagation Delay<br>From Input (B) to Output (A) | Push-Pull<br>Driving         | V <sub>CCA</sub> =1.8V±0.15V | V <sub>CCB</sub> =2.5V±0.2V |     |      | 5.5 | ns |
|   |   |                             |   |                              |                              | V <sub>CCB</sub> =3.3V±0.3V |     |      | 5.7 | ns |
| V <sub>CCB</sub> =5V±0.5V                         |   |                             |   |                              |                              | 5.9                         | ns  |      |     |    |
| Open-Drain<br>Driving                             | V <sub>CCB</sub> =2.5V±0.2V                       | 1.9                         |   |                              |                              |                             |     | 5.3  | ns  |    |
|   | V <sub>CCB</sub> =3.3V±0.3V                       | 1.1                         |   |                              |                              |                             |     | 4.4  | ns  |    |
|   | V <sub>CCB</sub> =5V±0.5V                         | 1.2                         |   |                              |                              |                             |     | 4.0  | ns  |    |
| Push-Pull<br>Driving                              | V <sub>CCA</sub> =2.5V±0.2V                       | V <sub>CCB</sub> =2.5V±0.2V |   |                              |                              |                             | 3.8 | ns   |     |    |
|   | V <sub>CCB</sub> =3.3V±0.3V                       |                             |   |                              |                              |                             | 4.5 | ns   |     |    |
|   | V <sub>CCB</sub> =5V±0.5V                         |                             |   |                              |                              |                             | 5.4 | ns   |     |    |
| Open-Drain<br>Driving                             | V <sub>CCB</sub> =2.5V±0.2V                       | 1.8                         |   |                              |                              | 4.7                         | ns  |      |     |    |
|   | V <sub>CCB</sub> =3.3V±0.3V                       | 2.6                         |   |                              |                              | 4.2                         | ns  |      |     |    |
|   | V <sub>CCB</sub> =5V±0.5V                         | 1.2                         |   |                              |                              | 4.0                         | ns  |      |     |    |
| Push-Pull<br>Driving                              | V <sub>CCA</sub> =3.3V±0.3V                       | V <sub>CCB</sub> =3.3V±0.3V |   |                              |                              | 3.2                         | ns  |      |     |    |
|   | V <sub>CCB</sub> =5V±0.5V                         |                             |   |                              |                              | 4.2                         | ns  |      |     |    |
|   | V <sub>CCB</sub> =3.3V±0.3V                       | 1                           |   |                              |                              | 124                         | ns  |      |     |    |
| Open-Drain<br>Driving                             | V <sub>CCB</sub> =5V±0.5V                         | 1                           |   |                              |                              | 97                          | ns  |      |     |    |
|   | Propagation Delay<br>From Input (A) to Output (B) | Push-Pull<br>Driving        | t <sub>PLH</sub>                                  | V <sub>CCA</sub> =1.8V±0.15V | V <sub>CCB</sub> =2.5V±0.2V  |                             |     | 8.5  | ns  |    |
|   |   |                             |   |                              | V <sub>CCB</sub> =3.3V±0.3V  |                             |     | 8.5  | ns  |    |
| V <sub>CCB</sub> =5V±0.5V                         |   |                             |   |                              |                              |                             | 8.8 | ns   |     |    |
| V <sub>CCB</sub> =2.5V±0.2V                       |   |                             |   |                              | 45                           |                             | 260 | ns   |     |    |
| V <sub>CCB</sub> =3.3V±0.3V                       |   |                             |   |                              | 36                           |                             | 208 | ns   |     |    |
| V <sub>CCB</sub> =5V±0.5V                         |   |                             |   |                              | 27                           |                             | 198 | ns   |     |    |
| Open-Drain<br>Driving                             |   | V <sub>CCA</sub> =2.5V±0.2V |   | V <sub>CCB</sub> =2.5V±0.2V  |                              |                             |     | 6.5  | ns  |    |
|   |   | V <sub>CCB</sub> =3.3V±0.3V |   |                              |                              |                             |     | 6.9  | ns  |    |
|   |   | V <sub>CCB</sub> =5V±0.5V   |   |                              |                              |                             |     | 7.2  | ns  |    |
|   |   | V <sub>CCB</sub> =2.5V±0.2V |   | 43                           |                              | 250                         | ns  |      |     |    |
|   |   | V <sub>CCB</sub> =3.3V±0.3V |   | 36                           |                              | 206                         | ns  |      |     |    |
|   |   | V <sub>CCB</sub> =5V±0.5V   |   | 27                           |                              | 190                         | ns  |      |     |    |
| Push-Pull<br>Driving                              | V <sub>CCA</sub> =3.3V±0.3V                       | V <sub>CCB</sub> =3.3V±0.3V |   |                              |                              | 5.3                         | ns  |      |     |    |
|   | V <sub>CCB</sub> =5V±0.5V                         |                             |   |                              |                              | 5.5                         | ns  |      |     |    |
|   | V <sub>CCB</sub> =3.3V±0.3V                       | 36                          |   | 204                          | ns                           |                             |     |      |     |    |
| Open-Drain<br>Driving                             | V <sub>CCB</sub> =5V±0.5V                         | 28                          |   | 165                          | ns                           |                             |     |      |     |    |

■ SWITCHING CHARACTERISTICS (Cont.)

| PARAMETER   |                         | SYMBOL                 | TEST CONDITIONS         | MIN                     | TYP                    | MAX  | UNIT |    |
|---|-------------------------|------------------------|-------------------------|-------------------------|------------------------|------|------|----|
| Propagation Delay<br>From Input (B) to Output (A) | Push-Pull<br>Driving    | $t_{PLH}$              | $V_{CCA}=1.8V\pm 0.15V$ | $V_{CCB}=2.5V\pm 0.2V$  |                        | 7.5  | ns   |    |
|   |                         |                        |                         | $V_{CCB}=3.3V\pm 0.3V$  |                        | 5.7  | ns   |    |
|   |                         |                        |                         | $V_{CCB}=5V\pm 0.5V$    |                        | 2.7  | ns   |    |
|   | $V_{CCB}=2.5V\pm 0.2V$  |                        |                         | 45                      | 175                    | ns   |      |    |
|   | $V_{CCB}=3.3V\pm 0.3V$  |                        |                         | 36                      | 140                    | ns   |      |    |
|   | $V_{CCB}=5V\pm 0.5V$    |                        |                         | 27                      | 102                    | ns   |      |    |
|   | Open-Drain<br>Driving   |                        | $V_{CCA}=2.5V\pm 0.2V$  | $V_{CCB}=2.5V\pm 0.2V$  |                        | 4.3  | ns   |    |
|   |                         |                        |                         | $V_{CCB}=3.3V\pm 0.3V$  |                        | 3.0  | ns   |    |
|   |                         |                        |                         | $V_{CCB}=5V\pm 0.5V$    |                        | 1.7  | ns   |    |
|   | $V_{CCB}=2.5V\pm 0.2V$  |                        |                         | 44                      | 170                    | ns   |      |    |
|   | $V_{CCB}=3.3V\pm 0.3V$  |                        |                         | 37                      | 140                    | ns   |      |    |
|   | $V_{CCB}=5V\pm 0.5V$    |                        |                         | 27                      | 103                    | ns   |      |    |
|   | Push-Pull<br>Driving    |                        | $V_{CCA}=3.3V\pm 0.3V$  | $V_{CCB}=3.3V\pm 0.3V$  |                        | 4.3  | ns   |    |
|   |                         |                        |                         | $V_{CCB}=5V\pm 0.5V$    |                        | 4.5  | ns   |    |
|   |                         |                        |                         | $V_{CCB}=3.3V\pm 0.3V$  | 3                      | 139  | ns   |    |
|   | $V_{CCB}=5V\pm 0.5V$    |                        |                         | 3                       | 105                    | ns   |      |    |
|   | Open-Drain<br>Driving   |                        |                         | $V_{CCA}=1.8V\pm 0.15V$ | $V_{CCB}=2.5V\pm 0.2V$ |      | 450  | ns |
|   |                         |                        |                         |                         | $V_{CCB}=3.3V\pm 0.3V$ |      | 200  | ns |
| $V_{CCB}=5V\pm 0.5V$                              |                         |                        | 200                     |                         | ns                     |      |      |    |
| Open-Drain<br>Driving                             | $V_{CCA}=2.5V\pm 0.2V$  | $V_{CCB}=2.5V\pm 0.2V$ |                         |                         | 200                    | ns   |      |    |
|   |                         | $V_{CCB}=3.3V\pm 0.3V$ |                         |                         | 200                    | ns   |      |    |
|   |                         | $V_{CCB}=5V\pm 0.5V$   |                         |                         | 200                    | ns   |      |    |
| Open-Drain<br>Driving                             |                         | $V_{CCA}=3.3V\pm 0.3V$ | $V_{CCB}=3.3V\pm 0.3V$  |                         | 200                    | ns   |      |    |
|   |                         |                        | $V_{CCB}=5V\pm 0.5V$    |                         | 200                    | ns   |      |    |
|   |                         |                        | $V_{CCA}=1.8V\pm 0.15V$ | $V_{CCB}=2.5V\pm 0.2V$  |                        | 50   | ns   |    |
| $V_{CCB}=3.3V\pm 0.3V$                            |                         |                        |                         | 40                      | ns                     |      |      |    |
| $V_{CCB}=5V\pm 0.5V$                              |                         |                        |                         | 35                      | ns                     |      |      |    |
| Open-Drain<br>Driving                             | $V_{CCA}=2.5V\pm 0.2V$  |                        |                         | $V_{CCB}=2.5V\pm 0.2V$  |                        | 50   | ns   |    |
|   |                         | $V_{CCB}=3.3V\pm 0.3V$ |                         |                         | 40                     | ns   |      |    |
|   |                         | $V_{CCB}=5V\pm 0.5V$   |                         |                         | 35                     | ns   |      |    |
| Open-Drain<br>Driving                             |                         | $V_{CCA}=3.3V\pm 0.3V$ | $V_{CCB}=3.3V\pm 0.3V$  |                         | 40                     | ns   |      |    |
|   |                         |                        | $V_{CCB}=5V\pm 0.5V$    |                         | 35                     | ns   |      |    |
|   |                         |                        | $V_{CCA}=1.8V\pm 0.15V$ | $V_{CCB}=2.5V\pm 0.2V$  | 3.2                    | 11.9 | ns   |    |
| $V_{CCB}=3.3V\pm 0.3V$                            | 2.3                     |                        |                         | 11.7                    | ns                     |      |      |    |
| $V_{CCB}=5V\pm 0.5V$                              | 2                       |                        |                         | 9.5                     | ns                     |      |      |    |
| Open-Drain<br>Driving                             | $V_{CCA}=2.5V\pm 0.2V$  |                        |                         | $V_{CCB}=2.5V\pm 0.2V$  | 38                     | 165  | ns   |    |
|   |                         | $V_{CCB}=3.3V\pm 0.3V$ |                         | 30                      | 132                    | ns   |      |    |
|   |                         | $V_{CCB}=5V\pm 0.5V$   |                         | 22                      | 95                     | ns   |      |    |
| Open-Drain<br>Driving                             |                         | $V_{CCA}=3.3V\pm 0.3V$ | $V_{CCB}=2.5V\pm 0.2V$  | 2.8                     | 9.3                    | ns   |      |    |
|   |                         |                        | $V_{CCB}=3.3V\pm 0.3V$  | 2.6                     | 8.3                    | ns   |      |    |
|   |                         |                        | $V_{CCB}=5V\pm 0.5V$    | 1.8                     | 7.8                    | ns   |      |    |
| Open-Drain<br>Driving                             | $V_{CCA}=1.8V\pm 0.15V$ |                        | $V_{CCB}=2.5V\pm 0.2V$  | 34                      | 149                    | ns   |      |    |
|   |                         |                        | $V_{CCB}=3.3V\pm 0.3V$  | 28                      | 121                    | ns   |      |    |
|   |                         |                        | $V_{CCB}=5V\pm 0.5V$    | 24                      | 89                     | ns   |      |    |
| Open-Drain<br>Driving                             |                         | $V_{CCA}=2.5V\pm 0.2V$ | $V_{CCB}=3.3V\pm 0.3V$  | 2.3                     | 7.0                    | ns   |      |    |
|   |                         |                        | $V_{CCB}=5V\pm 0.5V$    | 1.9                     | 7.4                    | ns   |      |    |
|   |                         |                        | $V_{CCB}=3.3V\pm 0.3V$  | 25                      | 116                    | ns   |      |    |
| Open-Drain<br>Driving                             | $V_{CCA}=3.3V\pm 0.3V$  |                        | $V_{CCB}=5V\pm 0.5V$    | 19                      | 85                     | ns   |      |    |



■ SWITCHING CHARACTERISTICS (Cont.)

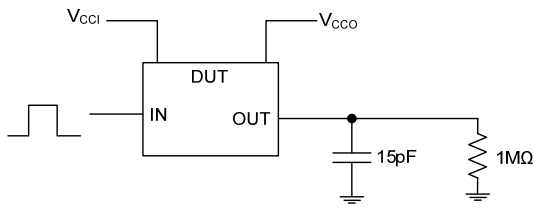
| PARAMETER                             |                                       | SYMBOL                | TEST CONDITIONS        | MIN                   | TYP                   | MAX                    | UNIT                  |     |
|---------------------------------------|---------------------------------------|-----------------------|------------------------|-----------------------|-----------------------|------------------------|-----------------------|-----|
| Input Rise Time<br>(B Port Rise Time) | Push-Pull Driving                     | $t_{rB}$              | $V_{CCA}=1.8V\pm0.15V$ | $V_{CCB}=2.5V\pm0.2V$ | 3.3                   |                        | 13.5                  | ns  |
|                                       |                                       |                       |                        | $V_{CCB}=3.3V\pm0.3V$ | 2.7                   |                        | 11.4                  | ns  |
|                                       |                                       |                       |                        | $V_{CCB}=5V\pm0.5V$   | 2.7                   |                        | 9.5                   | ns  |
|                                       | Open-Drain Driving                    |                       |                        | $V_{CCB}=2.5V\pm0.2V$ | 34                    |                        | 145                   | ns  |
|                                       |                                       |                       |                        | $V_{CCB}=3.3V\pm0.3V$ | 23                    |                        | 106                   | ns  |
|                                       |                                       |                       |                        | $V_{CCB}=5V\pm0.5V$   | 10                    |                        | 58                    | ns  |
|                                       | Push-Pull Driving                     |                       | $V_{CCA}=2.5V\pm0.2V$  | $V_{CCB}=2.5V\pm0.2V$ | 3.2                   |                        | 10.4                  | ns  |
|                                       |                                       |                       |                        | $V_{CCB}=3.3V\pm0.3V$ | 2.9                   |                        | 9.7                   | ns  |
|                                       |                                       |                       |                        | $V_{CCB}=5V\pm0.5V$   | 2.4                   |                        | 8.3                   | ns  |
|                                       | Open-Drain Driving                    |                       |                        | $V_{CCB}=2.5V\pm0.2V$ | 35                    |                        | 151                   | ns  |
|                                       |                                       |                       |                        | $V_{CCB}=3.3V\pm0.3V$ | 24                    |                        | 112                   | ns  |
|                                       |                                       |                       |                        | $V_{CCB}=5V\pm0.5V$   | 12                    |                        | 64                    | ns  |
|                                       | Push-Pull Driving                     |                       | $V_{CCA}=3.3V\pm0.3V$  | $V_{CCB}=3.3V\pm0.3V$ | 2.5                   |                        | 8.0                   | ns  |
|                                       |                                       |                       |                        | $V_{CCB}=5V\pm0.5V$   | 2.1                   |                        | 9.3                   | ns  |
|                                       |                                       |                       |                        | Open-Drain Driving    | $V_{CCB}=3.3V\pm0.3V$ | 26                     |                       | 116 |
|                                       | $V_{CCB}=5V\pm0.5V$                   |                       |                        |                       | 26                    |                        | 116                   | ns  |
|                                       | $V_{CCB}=5V\pm0.5V$                   |                       |                        |                       | 26                    |                        | 116                   | ns  |
|                                       | Input Fall Time<br>(A Port Fall Time) |                       |                        | Push-Pull Driving     | $t_{fA}$              | $V_{CCA}=1.8V\pm0.15V$ | $V_{CCB}=2.5V\pm0.2V$ | 2   |
| $V_{CCB}=3.3V\pm0.3V$                 |                                       | 1.9                   |                        |                       |                       |                        | 7.5                   | ns  |
| $V_{CCB}=5V\pm0.5V$                   |                                       | 1.7                   |                        |                       |                       |                        | 16.7                  | ns  |
| Open-Drain Driving                    |                                       | $V_{CCB}=2.5V\pm0.2V$ | 4.4                    |                       |                       |                        | 6.9                   | ns  |
|                                       |                                       | $V_{CCB}=3.3V\pm0.3V$ | 4.3                    |                       |                       |                        | 6.4                   | ns  |
|                                       |                                       | $V_{CCB}=5V\pm0.5V$   | 4.2                    |                       |                       |                        | 6.1                   | ns  |
| Push-Pull Driving                     |                                       | $V_{CCA}=2.5V\pm0.2V$ | $V_{CCB}=2.5V\pm0.2V$  | 1.9                   |                       |                        | 7.2                   | ns  |
|                                       |                                       |                       | $V_{CCB}=3.3V\pm0.3V$  | 1.9                   |                       |                        | 6.9                   | ns  |
|                                       |                                       |                       | $V_{CCB}=5V\pm0.5V$    | 1.8                   |                       |                        | 6.7                   | ns  |
| Open-Drain Driving                    |                                       |                       | $V_{CCB}=2.5V\pm0.2V$  | 4.4                   |                       |                        | 6.9                   | ns  |
|                                       |                                       |                       | $V_{CCB}=3.3V\pm0.3V$  | 4.3                   |                       |                        | 6.2                   | ns  |
|                                       |                                       |                       | $V_{CCB}=5V\pm0.5V$    | 4.2                   |                       |                        | 5.8                   | ns  |
| Push-Pull Driving                     |                                       | $V_{CCA}=3.3V\pm0.3V$ | $V_{CCB}=3.3V\pm0.3V$  | 2                     |                       |                        | 6.8                   | ns  |
|                                       |                                       |                       | $V_{CCB}=5V\pm0.5V$    | 1.9                   |                       |                        | 6.3                   | ns  |
|                                       |                                       |                       | Open-Drain Driving     | $V_{CCB}=3.3V\pm0.3V$ |                       | 4.3                    |                       | 6.1 |
| $V_{CCB}=5V\pm0.5V$                   |                                       |                       |                        | 4.2                   |                       |                        | 5.7                   | ns  |
| $V_{CCB}=5V\pm0.5V$                   |                                       |                       |                        | 4.2                   |                       |                        | 5.7                   | ns  |
| Input Fall Time<br>(B Port Fall Time) |                                       |                       | Push-Pull Driving      | $t_{fB}$              |                       | $V_{CCA}=1.8V\pm0.15V$ | $V_{CCB}=2.5V\pm0.2V$ | 2.0 |
|                                       | $V_{CCB}=3.3V\pm0.3V$                 | 1.9                   |                        |                       |                       |                        | 9.4                   | ns  |
|                                       | $V_{CCB}=5V\pm0.5V$                   | 1.7                   |                        |                       |                       |                        | 12.5                  | ns  |
|                                       | Open-Drain Driving                    | $V_{CCB}=2.5V\pm0.2V$ | 5.9                    |                       |                       |                        | 13.8                  | ns  |
|                                       |                                       | $V_{CCB}=3.3V\pm0.3V$ | 6.5                    |                       |                       |                        | 16.2                  | ns  |
|                                       |                                       | $V_{CCB}=5V\pm0.5V$   | 5.7                    |                       |                       |                        | 16.2                  | ns  |
|                                       | Push-Pull Driving                     | $V_{CCA}=2.5V\pm0.2V$ | $V_{CCB}=2.5V\pm0.2V$  |                       | 2.2                   |                        | 9.8                   | ns  |
|                                       |                                       |                       | $V_{CCB}=3.3V\pm0.3V$  |                       | 2.4                   |                        | 8.4                   | ns  |
|                                       |                                       |                       | $V_{CCB}=5V\pm0.5V$    |                       | 2.6                   |                        | 8.3                   | ns  |
|                                       | Open-Drain Driving                    |                       | $V_{CCB}=2.5V\pm0.2V$  |                       | 5.1                   |                        | 8.8                   | ns  |
|                                       |                                       |                       | $V_{CCB}=3.3V\pm0.3V$  |                       | 5.4                   |                        | 9.4                   | ns  |
|                                       |                                       |                       | $V_{CCB}=5V\pm0.5V$    |                       | 5.4                   |                        | 10.4                  | ns  |
|                                       | Push-Pull Driving                     | $V_{CCA}=3.3V\pm0.3V$ | $V_{CCB}=3.3V\pm0.3V$  |                       | 2.3                   |                        | 9.3                   | ns  |
|                                       |                                       |                       | $V_{CCB}=5V\pm0.5V$    |                       | 2.4                   |                        | 9.5                   | ns  |
|                                       |                                       |                       | Open-Drain Driving     |                       | $V_{CCB}=3.3V\pm0.3V$ | 5                      |                       | 7.6 |
|                                       | $V_{CCB}=5V\pm0.5V$                   |                       |                        |                       | 4.8                   |                        | 8.3                   | ns  |
|                                       | $V_{CCB}=5V\pm0.5V$                   |                       |                        |                       | 4.8                   |                        | 8.3                   | ns  |

■ SWITCHING CHARACTERISTICS (Cont.)

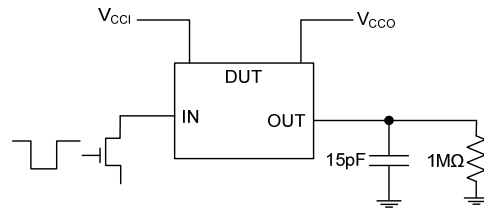
| PARAMETER      |                    | SYMBOL            | TEST CONDITIONS  | MIN | TYP | MAX | UNIT |
|----------------|--------------------|-------------------|--|-----|-----|-----|------|
| Data Rate      | Push-Pull Driving  | f <sub>data</sub> | V <sub>CCA</sub> =1.65V~2.7V,<br>V <sub>CCB</sub> =2.3V~5.5V |     |     | 24  | Mbps |
|                |                    |                   | V <sub>CCA</sub> =3V~3.6V, V <sub>CCB</sub> =3.6V~5.5V       |     |     | 24  | Mbps |
|                | Open-Drain Driving |                   | V <sub>CCA</sub> =1.65V~2.7V,<br>V <sub>CCB</sub> =2.3V~5.5V |     |     | 2   | Mbps |
|                |                    |                   | V <sub>CCA</sub> =3V~3.6V, V <sub>CCB</sub> =3.6V~5.5V       |     |     | 2   | Mbps |
| Pulse Duration | Push-Pull Driving  | t <sub>w</sub>    | V <sub>CCA</sub> =1.65V~2.7V,<br>V <sub>CCB</sub> =2.3V~5.5V | 41  |     |     | ns   |
|                |                    |                   | V <sub>CCA</sub> =3V~3.6V, V <sub>CCB</sub> =3.6V~5.5V       | 41  |     |     | ns   |
|                | Open-Drain Driving |                   | V <sub>CCA</sub> =1.65V~2.7V,<br>V <sub>CCB</sub> =2.3V~5.5V | 500 |     |     | ns   |
|                |                    |                   | V <sub>CCA</sub> =3V~3.6V, V <sub>CCB</sub> =3.6V~5.5V       | 500 |     |     | ns   |

TEST CIRCUIT AND WAVEFORMS

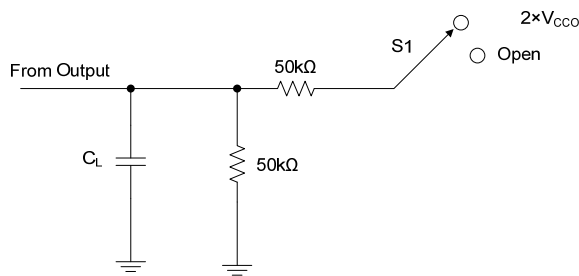
Load Circuits



Data Rate, Pulse Duration, Propagation Delay, Output Rise-Time and Fall-Time Measurement Using a Push-Pull Driver

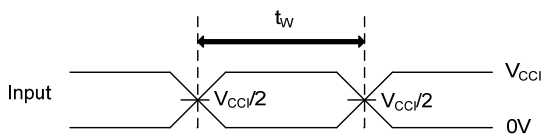


Data Rate, Pulse Duration, Propagation Delay, Output Rise-Time and Fall-Time Measurement Using an Open-Drain Driver

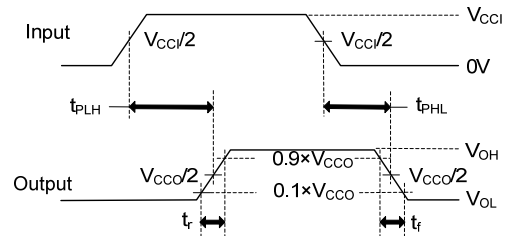


| TEST              | S1                 |
|-------------------|--------------------|
| $t_{PLZ}/t_{PZL}$ | $2 \times V_{CCO}$ |
| $t_{PHZ}/t_{PZH}$ | Open               |

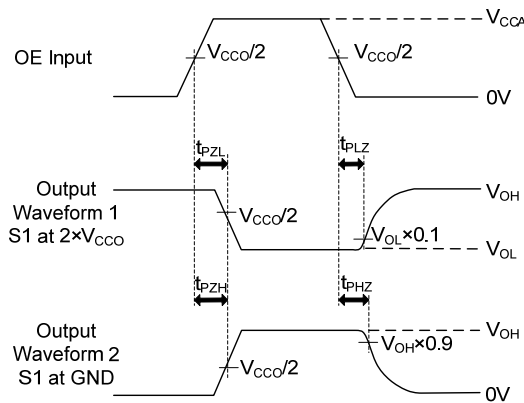
- Notes: 1.  $C_L$  includes probe and jig capacitance.
- 2.  $t_{en}$  is the same as  $t_{PZL}$  and  $t_{PZH}$ .
- $t_{dis}$  is the same as  $t_{PLZ}$  and  $t_{PHZ}$ .
- 3.  $V_{CCI}$  is the supply voltage associated with the input.
- 4.  $V_{CCO}$  is the supply voltage associated with the output.



PULSE DURATION



PROPAGATION DELAY TIMES



ENABLE AND DISABLE TIMES

## ■ DETAILED DESCRIPTION

### Overview

The **UTXS0104** device is a directionless voltage-level translator specifically designed for translating logic voltage levels. The A port is able to accept I/O voltages ranging from 1.65V to 3.6V, while the B port can accept I/O voltages from 2.3V to 5.5V. The device is a pass gate architecture with edge rate accelerators (one shots) to improve the overall data rate. 10kΩ pull-up resistors, commonly used in open-drain applications, have been conveniently integrated so that an external resistor is not needed. While this device is designed for open-drain applications, the device can also translate push-pull CMOS logic outputs.

### Architecture

The **UTXS0104** architecture does not require a direction-control signal to control the direction of data flow from A to B or from B to A.

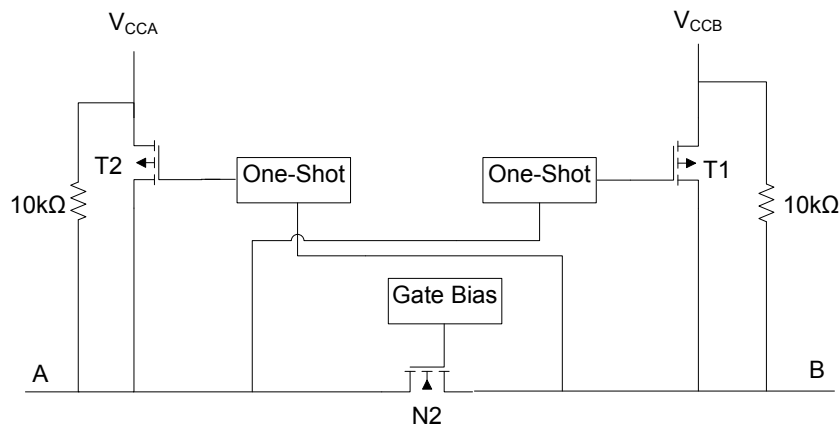


Figure 1. Architecture of UTXB0101 I/O Cell

Each A-port I/O has an internal 10kΩ pull up resistor to  $V_{CCA}$ , and each B-port I/O has an internal 10kΩ pull-up resistor to  $V_{CCB}$ . The output one-shots detect rising edges on the A or B ports. During a rising edge, the one-shot turns on the PMOS transistors (T1, T2) for a short duration, which speeds up the low-to-high transition.

### Input Driver Requirements

The fall time ( $t_{fA}$ ,  $t_{fB}$ ) of a signal depends on the output impedance of the external device driving the data I/Os of the **UTXS0104**. Similarly, the  $t_{PHL}$  and max data rates also depend on the output impedance of the external driver. The values for  $t_{fA}$ ,  $t_{fB}$ ,  $t_{PHL}$ , and maximum data rates in the data sheet assume that the output impedance of the external driver is less than 50Ω.

### Power-Up

During operation, ensure that  $V_{CCA} \leq V_{CCB}$  at all times. During power-up sequencing,  $V_{CCA} \geq V_{CCB}$  does not damage the device, so any power supply can be ramped up first.

### Enable and Disable

The **UTXS0104** has an OE input that is used to disable the device by setting OE low, which places all I/Os in the Hi-Z state. The disable time ( $t_{dis}$ ) indicates the delay between the time when OE goes low and when the outputs actually get disabled (Hi-Z). The enable time ( $t_{en}$ ) indicates the amount of time the user must allow for the one-shot circuitry to become operational after OE is taken high.

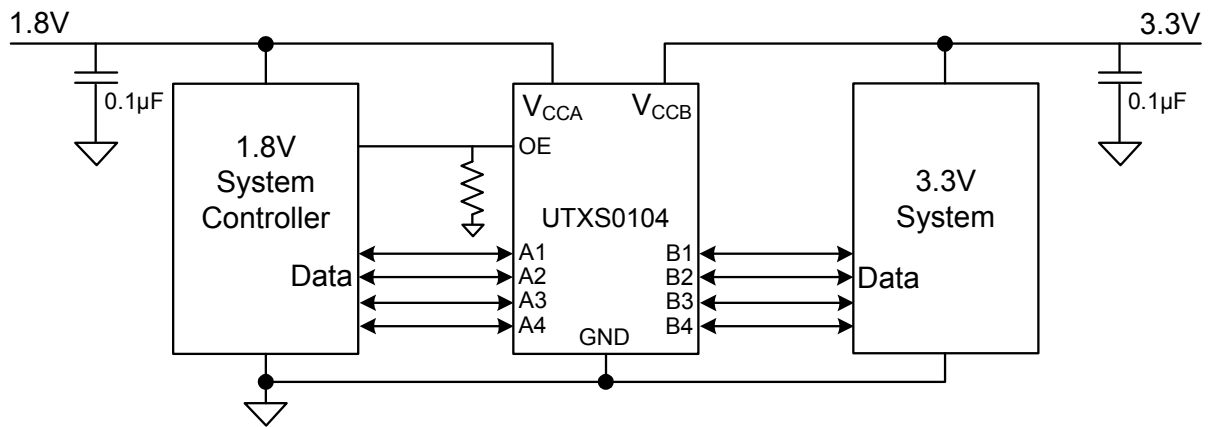
### Pull-up or Pull-down Resistors on I/O Lines

Each A-port I/O has an internal 10kΩ pull-up resistor to  $V_{CCA}$ , and each B-port I/O has an internal 10 kΩ pull-up resistor to  $V_{CCB}$ . If a smaller value of pull-up resistor is required, an external resistor must be added from the I/O to  $V_{CCA}$  or  $V_{CCB}$  (in parallel with the internal 10 kΩ resistors).

### Device Functional Modes

The **UTXS0104** device has two functional modes, enabled and disabled. To disable the device set the OE input low, which places all I/Os in a high impedance state. Setting the OE input high will enable the device.

■ TYPICAL APPLICATION CIRCUIT



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