

TOSHIBA Digital Integrated Circuit Silicon Monolithic

# TC7MPN3245FTG

## Low Voltage/Low Power 4-Bit × 2 Dual Supply Bus Transceiver

The TC7MPN3245FTG is an advanced high-speed CMOS 8-bit dual supply voltage interface bus transceiver, fabricated with silicon gate CMOS technology.

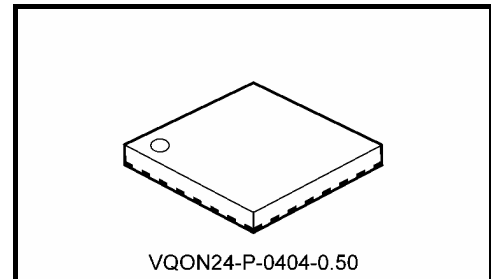
It is also designed with over-voltage tolerant inputs and outputs up to 3.6 V.

Designed for use as an interface between a 1.2-V, 1.5-V, 1.8-V, or 2.5-V bus and a 1.8-V, 2.5-V or 3.6-V bus in mixed 1.2-V, 1.5-V, 1.8-V or 2.5-V/1.8-V, 2.5-V or 3.6-V supply systems.

The A-port interfaces with the 1.2-V, 1.5-V, 1.8-V or 2.5-V bus, the B-port with the 1.8-V, 2.5-V, 3.3-V bus.

The direction of data transmission is determined by the level of the DIR input. The enable input ( $\overline{OE}$ ) can be used to disable the device so that the buses are effectively isolated.

All inputs are equipped with protection circuits against static discharge or transient excess voltage.



Weight: 0.03 g (typ.)

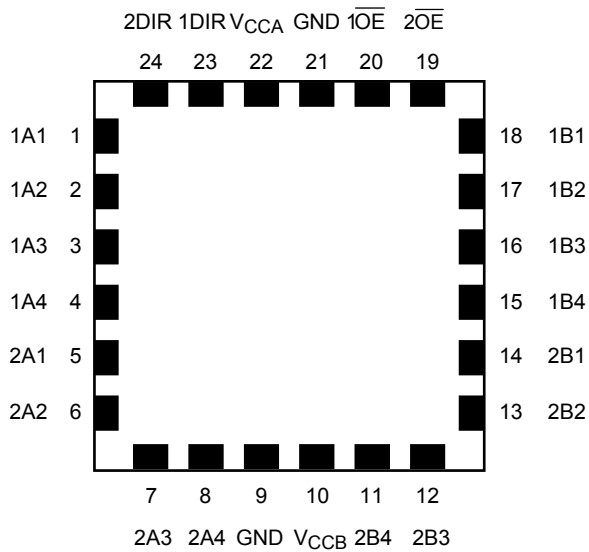
## Features

- Bidirectional interface between 1.2-V and 1.8-V, 1.2-V and 2.5-V, 1.2-V and 3.3-V, 1.5-V and 2.5-V, 1.5-V and 3.3-V, 1.8-V and 2.5-V, 1.8-V and 3.3-V or 2.5-V and 3.3-V buses.
- High-speed operation :  $t_{pd} = 13.7 \text{ ns (max)}$  ( $V_{CCA} = 2.5 \pm 0.2 \text{ V}$ ,  $V_{CCB} = 3.3 \pm 0.3 \text{ V}$ )  
 $t_{pd} = 14.8 \text{ ns (max)}$  ( $V_{CCA} = 1.8 \pm 0.15 \text{ V}$ ,  $V_{CCB} = 3.3 \pm 0.3 \text{ V}$ )  
 $t_{pd} = 16.0 \text{ ns (max)}$  ( $V_{CCA} = 1.5 \pm 0.1 \text{ V}$ ,  $V_{CCB} = 3.3 \pm 0.3 \text{ V}$ )  
 $t_{pd} = 61 \text{ ns (max)}$  ( $V_{CCA} = 1.2 \pm 0.1 \text{ V}$ ,  $V_{CCB} = 3.3 \pm 0.3 \text{ V}$ )  
 $t_{pd} = 18.5 \text{ ns (max)}$  ( $V_{CCA} = 1.8 \pm 0.15 \text{ V}$ ,  $V_{CCB} = 2.5 \pm 0.2 \text{ V}$ )  
 $t_{pd} = 19.7 \text{ ns (max)}$  ( $V_{CCA} = 1.5 \pm 0.1 \text{ V}$ ,  $V_{CCB} = 2.5 \pm 0.2 \text{ V}$ )  
 $t_{pd} = 60 \text{ ns (max)}$  ( $V_{CCA} = 1.2 \pm 0.1 \text{ V}$ ,  $V_{CCB} = 2.5 \pm 0.2 \text{ V}$ )  
 $t_{pd} = 58 \text{ ns (max)}$  ( $V_{CCA} = 1.2 \pm 0.1 \text{ V}$ ,  $V_{CCB} = 1.5 \pm 0.1 \text{ V}$ )
- Output current :  $I_{OHB}/I_{OLB} = \pm 3 \text{ mA (min)}$  ( $V_{CCB} = 3.0 \text{ V}$ )  
 $I_{OHB}/I_{OLB} = \pm 2 \text{ mA (min)}$  ( $V_{CCB} = 2.3 \text{ V}$ )  
 $I_{OHB}/I_{OLB} = \pm 0.5 \text{ mA (min)}$  ( $V_{CCB} = 1.65 \text{ V}$ )  
 $I_{OHA}/I_{OLA} = \pm 9 \text{ mA (min)}$  ( $V_{CCA} = 2.3 \text{ V}$ )  
 $I_{OHA}/I_{OLA} = \pm 3 \text{ mA (min)}$  ( $V_{CCA} = 1.65 \text{ V}$ )  
 $I_{OHA}/I_{OLA} = \pm 1 \text{ mA (min)}$  ( $V_{CCA} = 1.4 \text{ V}$ )
- Latch-up performance:  $\pm 300 \text{ mA}$
- ESD performance: Machine model  $\geq \pm 200 \text{ V}$   
Human body model  $\geq \pm 2000 \text{ V}$
- Ultra-small package: VQON24
- Low current consumption : Using the new circuit significantly reduces current consumption when  $\overline{OE} = \text{“H”}$ .  
Suitable for battery-driven applications such as PDAs and cellular phones.
- Floating A-bus and B-bus are permitted. (when  $\overline{OE} = \text{“H”}$ )  
3.6-V tolerant function and power-down protection provided on all inputs and outputs.

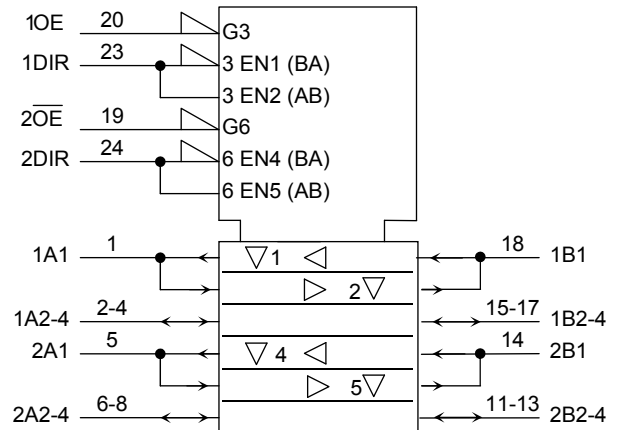
Note 1: Do not apply a signal to any bus pin when it is in the output mode. Damage may result.

Note 2: RA or RMA flux is recommended when mounting the VQON package.

## Pin Assignment (top view)



## IEC Logic Symbol



## Truth Table

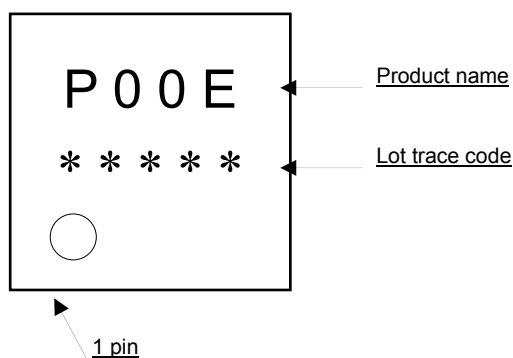
Inputs		Function		Outputs
$\overline{1OE}$	1DIR	Bus 1A1-1A4	Bus 1B1-1B4	
L	L	Output	Input	A = B
L	H	Input	Output	B = A
H	X	Z		Z

Inputs		Function		Outputs
$\overline{2OE}$	2DIR	Bus 2A1-2A4	Bus 2B1-2B4	
L	L	Output	Input	A = B
L	H	Input	Output	B = A
H	X	Z		Z

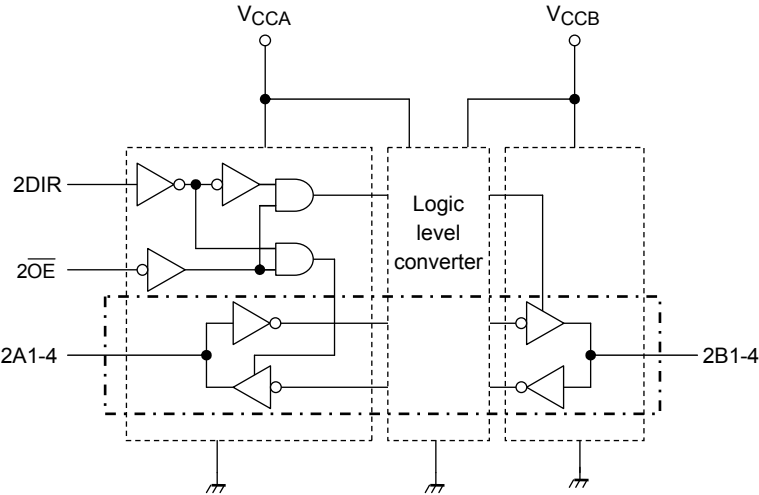
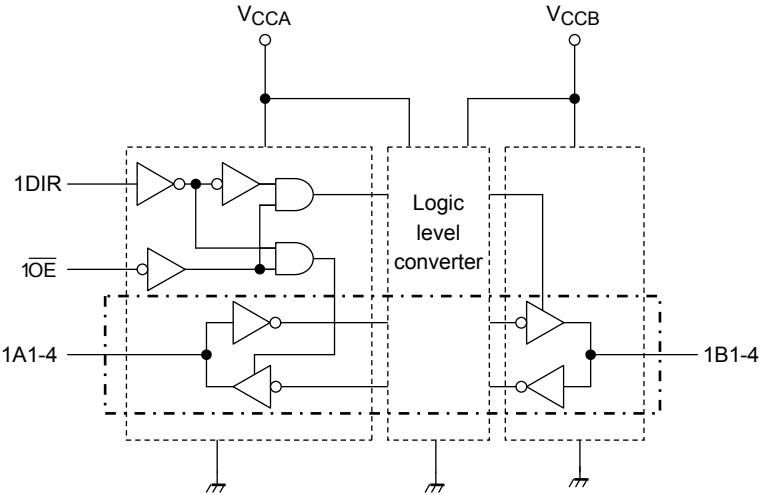
X: Don't care

Z: High impedance

## Marking



Block Diagram



## Absolute Maximum Rating (Note 1)

Characteristics	Symbol	Rating	Unit
Power supply voltage (Note 2)	$V_{CCA}$	-0.5 to 4.6	V
	$V_{CCB}$	-0.5 to 4.6	
DC input voltage (DIR, $\overline{OE}$ )	$V_{IN}$	-0.5 to 4.6	V
DC bus I/O voltage	$V_{IOA}$	-0.5 to 4.6 (Note 3)	V
		-0.5 to $V_{CCA} + 0.5$ (Note 4)	
	$V_{IOB}$	-0.5 to 4.6 (Note 3)	
		-0.5 to $V_{CCB} + 0.5$ (Note 4)	
Input diode current	$I_{IK}$	-50	mA
Output diode current	$I_{I/OK}$	$\pm 50$ (Note 5)	mA
DC output current	$I_{OUTA}$	$\pm 25$	mA
	$I_{OUTB}$	$\pm 6$	
DC $V_{CC}$ /ground current per supply pin	$I_{CCA}$	$\pm 50$	mA
	$I_{CCB}$	$\pm 50$	
Power dissipation	$P_D$	180	mW
Storage temperature	$T_{stg}$	-65 to 150	$^{\circ}\text{C}$

Note 1: Exceeding any of the absolute maximum ratings, even briefly, may 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).

Note 2: Do not supply a voltage to  $V_{CCB}$  pin when  $V_{CCA}$  is in the OFF state.

Note 3: Output in OFF state

Note 4: High or Low state.  $I_{OUT}$  absolute maximum rating must be observed.

Note 5:  $V_{OUT} < \text{GND}$ ,  $V_{OUT} > V_{CC}$

## Operating Ranges (Note1)

Characteristics	Symbol	Rating	Unit
Power supply voltage (Note 2)	$V_{CCA}$	1.1 to 2.7	V
	$V_{CCB}$	1.65 to 3.6	
Input voltage (DIR, $\overline{OE}$ )	$V_{IN}$	0 to 3.6	V
Bus I/O voltage	$V_{IOA}$	0 to 3.6 (Note 3)	V
		0 to $V_{CCA}$ (Note 4)	
	$V_{IOB}$	0 to 3.6 (Note 3)	
		0 to $V_{CCB}$ (Note 4)	
Output current	$I_{OUTA}$	$\pm 9$ (Note 5)	mA
		$\pm 3$ (Note 6)	
		$\pm 1$ (Note 7)	
	$I_{OUTB}$	$\pm 3$ (Note 8)	
		$\pm 2$ (Note 9)	
		$\pm 0.5$ (Note 10)	
Operating temperature	$T_{opr}$	-40 to 85	$^{\circ}\text{C}$
Input rise and fall time	$dt/dv$	0 to 10 (Note 11)	ns/V

Note 1: The operating ranges must be maintained to ensure the normal operation of the device. Unused inputs and bus inputs must be tied to either VCC or GND. Please connect both bus inputs and the bus outputs with VCC or GND when the I/O of the bus terminal changes by the function. In this case, please note that the output is not short-circuited.

Note 2: Do not use when  $V_{CCA} > V_{CCB}$

Note 3: Output in OFF state

Note 4: High or low state

Note 5:  $V_{CCB} = 2.3$  to  $2.7$  V

Note 6:  $V_{CCB} = 1.65$  to  $1.95$  V

Note 7:  $V_{CCB} = 1.4$  to  $1.6$  V

Note 8:  $V_{CCA} = 3.0$  to  $3.6$  V

Note 9:  $V_{CCA} = 2.3$  to  $2.7$  V

Note 10:  $V_{CCA} = 1.65$  to  $1.95$  V

Note 11:  $V_{IN} = 0.8$  to  $2.0$  V,  $V_{CCA} = 2.5$  V,  $V_{CCB} = 3.0$  V

## Electrical Characteristics

### DC Characteristics (2.3 V ≤ V<sub>CCA</sub> ≤ 2.7 V, 2.7 V < V<sub>CCB</sub> ≤ 3.6 V)

Characteristics	Symbol	Test Condition	V <sub>CCA</sub> (V)	V <sub>CCB</sub> (V)	Ta = -40 to 85°C		Unit	
					Min	Max		
H-level input voltage	V <sub>IHA</sub>	DIR, $\overline{OE}$ , An	2.3 to 2.7	2.7 to 3.6	1.6	—	V	
	V <sub>IHB</sub>	Bn	2.3 to 2.7	2.7 to 3.6	2.0	—		
L-level input voltage	V <sub>ILA</sub>	DIR, $\overline{OE}$ , An	2.3 to 2.7	2.7 to 3.6	—	0.7	V	
	V <sub>ILB</sub>	Bn	2.3 to 2.7	2.7 to 3.6	—	0.8		
H-level output voltage	V <sub>OHA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OHA</sub> = -100 μA	2.3 to 2.7	2.7 to 3.6	V <sub>CCA</sub> - 0.2	—	V
			I <sub>OHA</sub> = -9 mA	2.3	2.7 to 3.6	1.7	—	
	V <sub>OHB</sub>		I <sub>OHB</sub> = -100 μA	2.3 to 2.7	2.7 to 3.6	V <sub>CCB</sub> - 0.2	—	
			I <sub>OHB</sub> = -3 mA	2.3 to 2.7	3.0	2.2	—	
L-level output voltage	V <sub>OLA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OLA</sub> = 100 μA	2.3 to 2.7	2.7 to 3.6	—	0.2	V
			I <sub>OLA</sub> = 9 mA	2.3	2.7 to 3.6	—	0.6	
	V <sub>OLB</sub>		I <sub>OLB</sub> = 100 μA	2.3 to 2.7	2.7 to 3.6	—	0.2	
			I <sub>OLB</sub> = 3 mA	2.3 to 2.7	3.0	—	0.55	
3-state output OFF state current	I <sub>OZA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V	2.3 to 2.7	2.7 to 3.6	—	±5.0	μA	
	I <sub>OZB</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V	2.3 to 2.7	2.7 to 3.6	—	±5.0		
Input leakage current	I <sub>IN</sub>	V <sub>IN</sub> (DIR, $\overline{OE}$ ) = 0 to 3.6 V	2.3 to 2.7	2.7 to 3.6	—	±5.0	μA	
Power-off leakage current	I <sub>OFF1</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0 to 3.6 V	0	0	—	5.0	μA	
	I <sub>OFF2</sub>		2.3 to 2.7	0	—	5.0		
	I <sub>OFF3</sub>		2.3 to 2.7	Open	—	5.0		
Quiescent supply current	I <sub>CCA</sub>	V <sub>INA</sub> = V <sub>CCA</sub> or GND V <sub>INB</sub> = V <sub>CCB</sub> or GND	2.3 to 2.7	2.7 to 3.6	—	5.0	μA	
	I <sub>CCB</sub>	V <sub>INA</sub> = V <sub>CCA</sub> or GND V <sub>INB</sub> = V <sub>CCB</sub> or GND	2.3 to 2.7	2.7 to 3.6	—	5.0		
	I <sub>CCA</sub>	V <sub>CCA</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V	2.3 to 2.7	2.7 to 3.6	—	±5.0	μA	
	I <sub>CCB</sub>	V <sub>CCB</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V	2.3 to 2.7	2.7 to 3.6	—	±5.0		
	I <sub>CCTB</sub>	V <sub>INA</sub> = V <sub>CCB</sub> - 0.6 V per input	2.3 to 2.7	2.7 to 3.6	—	750.0	μA	

## DC Characteristics (1.65 V ≤ V<sub>CCA</sub> < 2.3 V, 2.7 V < V<sub>CCB</sub> ≤ 3.6 V)

Characteristics	Symbol	Test Condition	V <sub>CCA</sub> (V)	V <sub>CCB</sub> (V)	Ta = -40 to 85°C		Unit	
					Min	Max		
H-level input voltage	V <sub>IHA</sub>	DIR, $\overline{OE}$ , An	1.65 to 2.3	2.7 to 3.6	$0.65 \times V_{CCA}$	—	V	
	V <sub>IHB</sub>	Bn	1.65 to 2.3	2.7 to 3.6	2.0	—		
L-level input voltage	V <sub>ILA</sub>	DIR, $\overline{OE}$ , An	1.65 to 2.3	2.7 to 3.6	—	$0.35 \times V_{CCA}$	V	
	V <sub>ILB</sub>	Bn	1.65 to 2.3	2.7 to 3.6	—	0.8		
H-level output voltage	V <sub>OHA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OHA</sub> = -100 μA	1.65 to 2.3	2.7 to 3.6	V <sub>CCA</sub> - 0.2	—	V
			I <sub>OHA</sub> = -3 mA	1.65	2.7 to 3.6	1.25	—	
	V <sub>OHB</sub>		I <sub>OHB</sub> = -100 μA	1.65 to 2.3	2.7 to 3.6	V <sub>CCB</sub> - 0.2	—	
			I <sub>OHB</sub> = -3 mA	1.65 to 2.3	3.0	2.2	—	
L-level output voltage	V <sub>OLA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OLA</sub> = 100 μA	1.65 to 2.3	2.7 to 3.6	—	0.2	V
			I <sub>OLA</sub> = 3 mA	1.65	2.7 to 3.6	—	0.3	
	V <sub>OLB</sub>		I <sub>OLB</sub> = 100 μA	1.65 to 2.3	2.7 to 3.6	—	0.2	
			I <sub>OLB</sub> = 3 mA	1.65 to 2.3	3.0	—	0.55	
3-state output OFF state current	I <sub>OZA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V	1.65 to 2.3	2.7 to 3.6	—	±5.0	μA	
	I <sub>OZB</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V	1.65 to 2.3	2.7 to 3.6	—	±5.0		
Input leakage current	I <sub>IN</sub>	V <sub>IN</sub> (DIR, $\overline{OE}$ ) = 0 to 3.6 V	1.65 to 2.3	2.7 to 3.6	—	±2.0	μA	
Power-off leakage current	I <sub>OFF1</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0 to 3.6 V	0	0	—	5.0	μA	
	I <sub>OFF2</sub>		1.65 to 2.3	0	—	5.0		
	I <sub>OFF3</sub>		1.65 to 2.3	Open	—	5.0		
Quiescent supply current	I <sub>CCA</sub>	V <sub>INA</sub> = V <sub>CCA</sub> or GND V <sub>INB</sub> = V <sub>CCB</sub> or GND	1.65 to 2.3	2.7 to 3.6	—	5.0	μA	
	I <sub>CCB</sub>	V <sub>INA</sub> = V <sub>CCA</sub> or GND V <sub>INB</sub> = V <sub>CCB</sub> or GND	1.65 to 2.3	2.7 to 3.6	—	5.0		
	I <sub>CCA</sub>	V <sub>CCA</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V	1.65 to 2.3	2.7 to 3.6	—	±5.0	μA	
	I <sub>CCB</sub>	V <sub>CCB</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V	1.65 to 2.3	2.7 to 3.6	—	±5.0		
	I <sub>CCTB</sub>	V <sub>INB</sub> = V <sub>CCB</sub> - 0.6 V per input	1.65 to 2.3	2.7 to 3.6	—	750.0	μA	

## DC Characteristics (1.4 V ≤ V<sub>CCA</sub> < 1.65 V, 2.7 V < V<sub>CCB</sub> ≤ 3.6 V)

Characteristics	Symbol	Test Condition	V <sub>CCA</sub> (V)	V <sub>CCB</sub> (V)	Ta = -40 to 85°C		Unit	
					Min	Max		
H-level input voltage	V <sub>IHA</sub>	DIR, $\overline{OE}$ , An	1.4 to 1.65	2.7 to 3.6	$0.65 \times V_{CCA}$	—	V	
	V <sub>IHB</sub>	Bn	1.4 to 1.65	2.7 to 3.6	2.0	—		
L-level input voltage	V <sub>ILA</sub>	DIR, $\overline{OE}$ , An	1.4 to 1.65	2.7 to 3.6	—	$0.30 \times V_{CCA}$	V	
	V <sub>ILB</sub>	Bn	1.4 to 1.65	2.7 to 3.6	—	0.8		
H-level output voltage	V <sub>OHA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OHA</sub> = -100 μA	1.4 to 1.65	2.7 to 3.6	V <sub>CCA</sub> - 0.2	—	V
			I <sub>OHA</sub> = -1 mA	1.4	2.7 to 3.6	1.05	—	
	V <sub>OHB</sub>		I <sub>OHB</sub> = -100 μA	1.4 to 1.65	2.7 to 3.6	V <sub>CCB</sub> - 0.2	—	
			I <sub>OHB</sub> = -3 mA	1.4 to 1.65	3.0	2.2	—	
L-level output voltage	V <sub>OLA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OLA</sub> = 100 μA	1.4 to 1.65	2.7 to 3.6	—	0.2	V
			I <sub>OLA</sub> = 1 mA	1.4	2.7 to 3.6	—	0.35	
	V <sub>OLB</sub>		I <sub>OLB</sub> = 100 μA	1.4 to 1.65	2.7 to 3.6	—	0.2	
			I <sub>OLB</sub> = 3 mA	1.4 to 1.65	3.0	—	0.55	
3-state output OFF state current	I <sub>OZA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V	1.4 to 1.65	2.7 to 3.6	—	±5.0	μA	
	I <sub>OZB</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V	1.4 to 1.65	2.7 to 3.6	—	±5.0		
Input leakage current	I <sub>IN</sub>	V <sub>IN</sub> (DIR, $\overline{OE}$ ) = 0 to 3.6 V	1.4 to 1.65	2.7 to 3.6	—	±2.0	μA	
Power-off leakage current	I <sub>OFF1</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0 to 3.6 V	0	0	—	5.0	μA	
	I <sub>OFF2</sub>		1.4 to 1.65	0	—	5.0		
	I <sub>OFF3</sub>		1.4 to 1.65	Open	—	5.0		
Quiescent supply current	I <sub>CCA</sub>	V <sub>INA</sub> = V <sub>CCA</sub> or GND V <sub>INB</sub> = V <sub>CCB</sub> or GND	1.4 to 1.65	2.7 to 3.6	—	5.0	μA	
	I <sub>CCB</sub>	V <sub>INA</sub> = V <sub>CCA</sub> or GND V <sub>INB</sub> = V <sub>CCB</sub> or GND	1.4 to 1.65	2.7 to 3.6	—	5.0		
	I <sub>CCA</sub>	V <sub>CCA</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V	1.4 to 1.65	2.7 to 3.6	—	±5.0	μA	
	I <sub>CCB</sub>	V <sub>CCB</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V	1.4 to 1.65	2.7 to 3.6	—	±5.0		
	I <sub>CCTB</sub>	V <sub>INB</sub> = V <sub>CCB</sub> - 0.6 V per input	1.4 to 1.65	2.7 to 3.6	—	750.0		



## DC Characteristics (1.1 V ≤ V<sub>CCA</sub> < 1.4 V, 2.7 V < V<sub>CCB</sub> ≤ 3.6 V)

Characteristics	Symbol	Test Condition	V <sub>CCA</sub> (V)	V <sub>CCB</sub> (V)	Ta = -40 to 85°C		Unit	
					Min	Max		
H-level input voltage	V <sub>IHA</sub>	DIR, $\overline{OE}$ , An	1.1 to 1.4	2.7 to 3.6	$0.65 \times V_{CCA}$	—	V	
	V <sub>IHB</sub>	Bn	1.1 to 1.4	2.7 to 3.6	2.0	—		
L-level input voltage	V <sub>ILA</sub>	DIR, $\overline{OE}$ , An	1.1 to 1.4	2.7 to 3.6	—	$0.30 \times V_{CCA}$	V	
	V <sub>ILB</sub>	Bn	1.1 to 1.4	2.7 to 3.6	—	0.8		
H-level output voltage	V <sub>OHA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OHA</sub> = -100 μA	1.1 to 1.4	2.7 to 3.6	V <sub>CCA</sub> - 0.2	—	V
	V <sub>OHB</sub>		I <sub>OHB</sub> = -100 μA	1.1 to 1.4	2.7 to 3.6	V <sub>CCB</sub> - 0.2	—	
			I <sub>OHB</sub> = -3 mA	1.1 to 1.4	3.0	2.2	—	
L-level output voltage	V <sub>OLA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OLA</sub> = 100 μA	1.1 to 1.4	2.7 to 3.6	—	0.2	V
	V <sub>OLB</sub>		I <sub>OLB</sub> = 100 μA	1.1 to 1.4	2.7 to 3.6	—	0.2	
			I <sub>OLB</sub> = 3 mA	1.1 to 1.4	3.0	—	0.55	
3-state output OFF state current	I <sub>OZA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V	1.1 to 1.4	2.7 to 3.6	—	±5.0	μA	
	I <sub>OZB</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V	1.1 to 1.4	2.7 to 3.6	—	±5.0		
Input leakage current	I <sub>IN</sub>	V <sub>IN</sub> (DIR, $\overline{OE}$ ) = 0 to 3.6 V	1.1 to 1.4	2.7 to 3.6	—	±2.0	μA	
Power-off leakage current	I <sub>OFF1</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0 to 3.6 V	0	0	—	5.0	μA	
	I <sub>OFF2</sub>		1.1 to 1.4	0	—	5.0		
	I <sub>OFF3</sub>		1.1 to 1.4	Open	—	5.0		
Quiescent supply current	I <sub>CCA</sub>	V <sub>INA</sub> = V <sub>CCA</sub> or GND V <sub>INB</sub> = V <sub>CCB</sub> or GND	1.1 to 1.4	2.7 to 3.6	—	5.0	μA	
	I <sub>CCB</sub>	V <sub>INA</sub> = V <sub>CCA</sub> or GND V <sub>INB</sub> = V <sub>CCB</sub> or GND	1.1 to 1.4	2.7 to 3.6	—	5.0		
	I <sub>CCA</sub>	V <sub>CCA</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V	1.1 to 1.4	2.7 to 3.6	—	±5.0	μA	
	I <sub>CCB</sub>	V <sub>CCB</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V	1.1 to 1.4	2.7 to 3.6	—	±5.0		
	I <sub>CCTB</sub>	V <sub>INB</sub> = V <sub>CCA</sub> - 0.6 V per input	1.1 to 1.4	2.7 to 3.6	—	750.0		

## DC Characteristics (1.65 V ≤ V<sub>CCA</sub> < 2.3 V, 2.3 V ≤ V<sub>CCB</sub> ≤ 2.7 V)

Characteristics	Symbol	Test Condition	V <sub>CCA</sub> (V)	V <sub>CCB</sub> (V)	Ta = -40 to 85°C		Unit	
					Min	Max		
H-level input voltage	V <sub>IHA</sub>	DIR, $\overline{OE}$ , An	1.65 to 2.3	2.3 to 2.7	$0.65 \times V_{CCA}$	—	V	
	V <sub>IHB</sub>	Bn	1.65 to 2.3	2.3 to 2.7	1.6	—		
L-level input voltage	V <sub>ILA</sub>	DIR, $\overline{OE}$ , An	1.65 to 2.3	2.3 to 2.7	—	$0.35 \times V_{CCA}$	V	
	V <sub>ILB</sub>	Bn	1.65 to 2.3	2.3 to 2.7	—	0.7		
H-level output voltage	V <sub>OHA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OHA</sub> = -100 μA	1.65 to 2.3	2.3 to 2.7	V <sub>CCA</sub> - 0.2	—	V
			I <sub>OHA</sub> = -3 mA	1.65	2.3 to 2.7	1.25	—	
	V <sub>OHB</sub>		I <sub>OHB</sub> = -100 μA	1.65 to 2.3	2.3 to 2.7	V <sub>CCB</sub> - 0.2	—	
			I <sub>OHB</sub> = -2 mA	1.65 to 2.3	2.3	1.7	—	
L-level output voltage	V <sub>OLA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OLA</sub> = 100 μA	1.65 to 2.3	2.3 to 2.7	—	0.2	V
			I <sub>OLA</sub> = 3 mA	1.65	2.3 to 2.7	—	0.3	
	V <sub>OLB</sub>		I <sub>OLB</sub> = 100 μA	1.65 to 2.3	2.3 to 2.7	—	0.2	
			I <sub>OLB</sub> = 2 mA	1.65 to 2.3	2.3	—	0.6	
3-state output OFF state current	I <sub>OZA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V	1.65 to 2.3	2.3 to 2.7	—	±5.0	μA	
	I <sub>OZB</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V	1.65 to 2.3	2.3 to 2.7	—	±5.0		
Input leakage current	I <sub>IN</sub>	V <sub>IN</sub> (DIR, $\overline{OE}$ ) = 0 to 3.6 V	1.65 to 2.3	2.3 to 2.7	—	±2.0	μA	
Power-off leakage current	I <sub>OFF1</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0 to 3.6 V	0	0	—	5.0	μA	
	I <sub>OFF2</sub>		1.65 to 2.3	0	—	5.0		
	I <sub>OFF3</sub>		1.65 to 2.3	Open	—	5.0		
Quiescent supply current	I <sub>CCA</sub>	V <sub>INA</sub> = V <sub>CCA</sub> or GND V <sub>INB</sub> = V <sub>CCB</sub> or GND	1.65 to 2.3	2.3 to 2.7	—	5.0	μA	
	I <sub>CCB</sub>	V <sub>INA</sub> = V <sub>CCA</sub> or GND V <sub>INB</sub> = V <sub>CCB</sub> or GND	1.65 to 2.3	2.3 to 2.7	—	5.0		
	I <sub>CCA</sub>	V <sub>CCA</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V	1.65 to 2.3	2.3 to 2.7	—	±5.0	μA	
	I <sub>CCB</sub>	V <sub>CCB</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V	1.65 to 2.3	2.3 to 2.7	—	±5.0		

## DC Characteristics (1.4 V ≤ V<sub>CCA</sub> < 1.65 V, 2.3 V ≤ V<sub>CCB</sub> ≤ 2.7 V)

Characteristics	Symbol	Test Condition	V <sub>CCA</sub> (V)	V <sub>CCB</sub> (V)	Ta = -40 to 85°C		Unit	
					Min	Max		
H-level input voltage	V <sub>IHA</sub>	DIR, $\overline{OE}$ , An	1.4 to 1.65	2.3 to 2.7	$0.65 \times V_{CCA}$	—	V	
	V <sub>IHB</sub>	Bn	1.4 to 1.65	2.3 to 2.7	1.6	—		
L-level input voltage	V <sub>ILA</sub>	DIR, $\overline{OE}$ , An	1.4 to 1.65	2.3 to 2.7	—	$0.30 \times V_{CCA}$	V	
	V <sub>ILB</sub>	Bn	1.4 to 1.65	2.3 to 2.7	—	0.7		
H-level output voltage	V <sub>OHA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OHA</sub> = -100 μA	1.4 to 1.65	2.3 to 2.7	V <sub>CCA</sub> - 0.2	—	V
			I <sub>OHA</sub> = -1 mA	1.4	2.3 to 2.7	1.05	—	
	V <sub>OHB</sub>		I <sub>OHB</sub> = -100 μA	1.4 to 1.65	2.3 to 2.7	V <sub>CCB</sub> - 0.2	—	
			I <sub>OHB</sub> = -2 mA	1.4 to 1.65	2.3	1.7	—	
L-level output voltage	V <sub>OLA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OLA</sub> = 100 μA	1.4 to 1.65	2.3 to 2.7	—	0.2	V
			I <sub>OLA</sub> = 1 mA	1.4	2.3 to 2.7	—	0.35	
	V <sub>OLB</sub>		I <sub>OLB</sub> = 100 μA	1.4 to 1.65	2.3 to 2.7	—	0.2	
			I <sub>OLB</sub> = 2 mA	1.4 to 1.65	2.3	—	0.6	
3-state output OFF state current	I <sub>OZA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V	1.4 to 1.65	2.3 to 2.7	—	±5.0	μA	
	I <sub>OZB</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V	1.4 to 1.65	2.3 to 2.7	—	±5.0		
Input leakage current	I <sub>IN</sub>	V <sub>IN</sub> (DIR, $\overline{OE}$ ) = 0 to 3.6 V	1.4 to 1.65	2.3 to 2.7	—	±2.0	μA	
Power-off leakage current	I <sub>OFF1</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0 to 3.6 V	0	0	—	5.0	μA	
	I <sub>OFF2</sub>		1.4 to 1.65	0	—	5.0		
	I <sub>OFF3</sub>		1.4 to 1.65	Open	—	5.0		
Quiescent supply current	I <sub>CCA</sub>	V <sub>INA</sub> = V <sub>CCA</sub> or GND V <sub>INB</sub> = V <sub>CCB</sub> or GND	1.4 to 1.65	2.3 to 2.7	—	5.0	μA	
	I <sub>CCB</sub>	V <sub>INA</sub> = V <sub>CCA</sub> or GND V <sub>INB</sub> = V <sub>CCB</sub> or GND	1.4 to 1.65	2.3 to 2.7	—	5.0		
	I <sub>CCA</sub>	V <sub>CCA</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V	1.4 to 1.65	2.3 to 2.7	—	±5.0	μA	
	I <sub>CCB</sub>	V <sub>CCB</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V	1.4 to 1.65	2.3 to 2.7	—	±5.0		

## DC Characteristics (1.1 V ≤ V<sub>CCA</sub> < 1.4 V, 2.3 V ≤ V<sub>CCB</sub> ≤ 2.7 V)

Characteristics	Symbol	Test Condition	V <sub>CCA</sub> (V)	V <sub>CCB</sub> (V)	Ta = -40 to 85°C		Unit	
					Min	Max		
H-level input voltage	V <sub>IHA</sub>	DIR, $\overline{OE}$ , An	1.1 to 1.4	2.3 to 2.7	$0.65 \times V_{CCA}$	—	V	
	V <sub>IHB</sub>	Bn	1.1 to 1.4	2.3 to 2.7	1.6	—		
L-level input voltage	V <sub>ILA</sub>	DIR, $\overline{OE}$ , An	1.1 to 1.4	2.3 to 2.7	—	$0.30 \times V_{CCA}$	V	
	V <sub>ILB</sub>	Bn	1.1 to 1.4	2.3 to 2.7	—	0.7		
H-level output voltage	V <sub>OHA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OHA</sub> = -100 μA	1.1 to 1.4	2.3 to 2.7	V <sub>CCA</sub> - 0.2	—	V
	V <sub>OHB</sub>		I <sub>OHB</sub> = -100 μA	1.1 to 1.4	2.3 to 2.7	V <sub>CCB</sub> - 0.2	—	
			I <sub>OHB</sub> = -2 mA	1.1 to 1.4	2.3	1.7	—	
L-level output voltage	V <sub>OLA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OLA</sub> = 100 μA	1.1 to 1.4	2.3 to 2.7	—	0.2	V
	V <sub>OLB</sub>		I <sub>OLB</sub> = 100 μA	1.1 to 1.4	2.3 to 2.7	—	0.2	
			I <sub>OLB</sub> = 2 mA	1.1 to 1.4	2.3	—	0.6	
3-state output OFF state current	I <sub>OZA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V	1.1 to 1.4	2.3 to 2.7	—	±5.0	μA	
	I <sub>OZB</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V	1.1 to 1.4	2.3 to 2.7	—	±5.0		
Input leakage current	I <sub>IN</sub>	V <sub>IN</sub> (DIR, $\overline{OE}$ ) = 0 to 3.6 V	1.1 to 1.4	2.3 to 2.7	—	±2.0	μA	
Power-off leakage current	I <sub>OFF1</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0 to 3.6 V	0	0	—	5.0	μA	
	I <sub>OFF2</sub>		1.1 to 1.4	0	—	5.0		
	I <sub>OFF3</sub>		1.1 to 1.4	Open	—	5.0		
Quiescent supply current	I <sub>CCA</sub>	V <sub>INA</sub> = V <sub>CCA</sub> or GND V <sub>INB</sub> = V <sub>CCB</sub> or GND	1.1 to 1.4	2.3 to 2.7	—	5.0	μA	
	I <sub>CCB</sub>	V <sub>INA</sub> = V <sub>CCA</sub> or GND V <sub>INB</sub> = V <sub>CCB</sub> or GND	1.1 to 1.4	2.3 to 2.7	—	5.0		
	I <sub>CCA</sub>	V <sub>CCA</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V	1.1 to 1.4	2.3 to 2.7	—	±5.0	μA	
	I <sub>CCB</sub>	V <sub>CCB</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V	1.1 to 1.4	2.3 to 2.7	—	±5.0		

**DC Characteristics (1.1 V ≤ V<sub>CCA</sub> < 1.4 V, 1.65 V ≤ V<sub>CCB</sub> < 2.3 V)**

Characteristics	Symbol	Test Condition	V <sub>CCA</sub> (V)	V <sub>CCB</sub> (V)	Ta = -40 to 85°C		Unit	
					Min	Max		
H-level input voltage	V <sub>IHA</sub>	DIR, $\overline{OE}$ , An	1.1 to 1.4	1.65 to 2.3	$0.65 \times V_{CCA}$	—	V	
	V <sub>IHB</sub>	Bn	1.1 to 1.4	1.65 to 2.3	$0.65 \times V_{CCB}$	—		
L-level input voltage	V <sub>ILA</sub>	DIR, $\overline{OE}$ , An	1.1 to 1.4	1.65 to 2.3	—	$0.30 \times V_{CCA}$	V	
	V <sub>ILB</sub>	Bn	1.1 to 1.4	1.65 to 2.3	—	$0.35 \times V_{CCB}$		
H-level output voltage	V <sub>OHA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OHA</sub> = -100 μA	1.1 to 1.4	1.65 to 2.3	V <sub>CCA</sub> - 0.2	—	V
	V <sub>OHB</sub>		I <sub>OHB</sub> = -100 μA	1.1 to 1.4	1.65 to 2.3	V <sub>CCB</sub> - 0.2	—	
			I <sub>OHB</sub> = -0.5 mA	1.1 to 1.4	1.65	1.25	—	
L-level output voltage	V <sub>OLA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OLA</sub> = 100 μA	1.1 to 1.4	1.65 to 2.3	—	0.2	V
	V <sub>OLB</sub>		I <sub>OLB</sub> = 100 μA	1.1 to 1.4	1.65 to 2.3	—	0.2	
			I <sub>OLB</sub> = 0.5 mA	1.1 to 1.4	1.65	—	0.3	
3-state output OFF state current	I <sub>OZA</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V	1.1 to 1.4	1.65 to 2.3	—	±5.0	μA	
	I <sub>OZB</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V	1.1 to 1.4	1.65 to 2.3	—	±5.0		
Input leakage current	I <sub>IN</sub>	V <sub>IN</sub> (DIR, $\overline{OE}$ ) = 0 to 3.6 V	1.1 to 1.4	1.65 to 2.3	—	±2.0	μA	
Power-off leakage current	I <sub>OFF1</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0 to 3.6 V	0	0	—	5.0	μA	
	I <sub>OFF2</sub>		1.1 to 1.4	0	—	5.0		
	I <sub>OFF3</sub>		1.1 to 1.4	Open	—	5.0		
Quiescent supply current	I <sub>CCA</sub>	V <sub>INA</sub> = V <sub>CCA</sub> or GND V <sub>INB</sub> = V <sub>CCB</sub> or GND	1.1 to 1.4	1.65 to 2.3	—	5.0	μA	
	I <sub>CCB</sub>	V <sub>INA</sub> = V <sub>CCA</sub> or GND V <sub>INB</sub> = V <sub>CCB</sub> or GND	1.1 to 1.4	1.65 to 2.3	—	5.0		
	I <sub>CCA</sub>	V <sub>CCA</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V	1.1 to 1.4	1.65 to 2.3	—	±5.0	μA	
	I <sub>CCB</sub>	V <sub>CCB</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V	1.1 to 1.4	1.65 to 2.3	—	±5.0		

## AC Characteristics (Ta = -40 to 85°C, Input: tr = tf = 2.0 ns)

VCCA = 2.5 ± 0.2 V, VCCB = 3.3 ± 0.3 V

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time (Bn → An)	t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2	1.0	5.4	ns
3-state output enable time ( $\overline{OE}$ → An)	t <sub>pZL</sub> t <sub>pZH</sub>	Figure 1, Figure 3	1.0	8.4	
3-state output disable time ( $\overline{OE}$ → An)	t <sub>pLZ</sub> t <sub>pHZ</sub>	Figure 1, Figure 3	1.0	6.7	
Propagation delay time (An → Bn)	t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2	1.0	13.7	ns
3-state output enable time ( $\overline{OE}$ → Bn)	t <sub>pZL</sub> t <sub>pZH</sub>	Figure 1, Figure 3	1.0	16.6	
3-state output disable time ( $\overline{OE}$ → Bn)	t <sub>pLZ</sub> t <sub>pHZ</sub>	Figure 1, Figure 3	1.0	7.2	
Output-to-output skew	t <sub>osLH</sub> t <sub>osHL</sub>	(Note)	—	0.5	ns

Note: Parameter guaranteed by design.

(t<sub>osLH</sub> = |t<sub>pLHm</sub> - t<sub>pLHn</sub>|, t<sub>osHL</sub> = |t<sub>pHLm</sub> - t<sub>pHLn</sub>|)

VCCA = 1.8 ± 0.15 V, VCCB = 3.3 ± 0.3 V

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time (Bn → An)	t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2	1.0	8.9	ns
3-state output enable time ( $\overline{OE}$ → An)	t <sub>pZL</sub> t <sub>pZH</sub>	Figure 1, Figure 3	1.0	13.4	
3-state output disable time ( $\overline{OE}$ → An)	t <sub>pLZ</sub> t <sub>pHZ</sub>	Figure 1, Figure 3	1.0	10.9	
Propagation delay time (An → Bn)	t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2	1.0	14.8	ns
3-state output enable time ( $\overline{OE}$ → Bn)	t <sub>pZL</sub> t <sub>pZH</sub>	Figure 1, Figure 3	1.0	18.9	
3-state output disable time ( $\overline{OE}$ → Bn)	t <sub>pLZ</sub> t <sub>pHZ</sub>	Figure 1, Figure 3	1.0	8.7	
Output-to-output skew	t <sub>osLH</sub> t <sub>osHL</sub>	(Note)	—	0.5	ns

Note: Parameter guaranteed by design.

(t<sub>osLH</sub> = |t<sub>pLHm</sub> - t<sub>pLHn</sub>|, t<sub>osHL</sub> = |t<sub>pHLm</sub> - t<sub>pHLn</sub>|)

**$V_{CCA} = 1.5 \pm 0.1 \text{ V}$ ,  $V_{CCB} = 3.3 \pm 0.3 \text{ V}$**

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time (Bn → An)	$t_{pLH}$ $t_{pHL}$	Figure 1, Figure 2	1.0	10.3	ns
3-state output enable time ( $\overline{OE}$ → An)	$t_{pZL}$ $t_{pZH}$	Figure 1, Figure 3	1.0	18.5	
3-state output disable time ( $\overline{OE}$ → An)	$t_{pLZ}$ $t_{pHZ}$	Figure 1, Figure 3	1.0	13.0	
Propagation delay time (An → Bn)	$t_{pLH}$ $t_{pHL}$	Figure 1, Figure 2	1.0	16.0	ns
3-state output enable time ( $\overline{OE}$ → Bn)	$t_{pZL}$ $t_{pZH}$	Figure 1, Figure 3	1.0	22.8	
3-state output disable time ( $\overline{OE}$ → Bn)	$t_{pLZ}$ $t_{pHZ}$	Figure 1, Figure 3	1.0	10.2	
Output-to-output skew	$t_{oS LH}$ $t_{oS HL}$	(Note)	—	1.5	ns

Note: Parameter guaranteed by design.

( $t_{oS LH} = |t_{pLHm} - t_{pLHn}|$ ,  $t_{oS HL} = |t_{pHLm} - t_{pHLn}|$ )

**$V_{CCA} = 1.2 \pm 0.1 \text{ V}$ ,  $V_{CCB} = 3.3 \pm 0.3 \text{ V}$**

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time (Bn → An)	$t_{pLH}$ $t_{pHL}$	Figure 1, Figure 2	1.0	61	ns
3-state output enable time ( $\overline{OE}$ → An)	$t_{pZL}$ $t_{pZH}$	Figure 1, Figure 3	1.0	95	
3-state output disable time ( $\overline{OE}$ → An)	$t_{pLZ}$ $t_{pHZ}$	Figure 1, Figure 3	1.0	44	
Propagation delay time (An → Bn)	$t_{pLH}$ $t_{pHL}$	Figure 1, Figure 2	1.0	29	ns
3-state output enable time ( $\overline{OE}$ → Bn)	$t_{pZL}$ $t_{pZH}$	Figure 1, Figure 3	1.0	63	
3-state output disable time ( $\overline{OE}$ → Bn)	$t_{pLZ}$ $t_{pHZ}$	Figure 1, Figure 3	1.0	23	
Output-to-output skew	$t_{oS LH}$ $t_{oS HL}$	(Note)	—	1.5	ns

Note: Parameter guaranteed by design.

( $t_{oS LH} = |t_{pLHm} - t_{pLHn}|$ ,  $t_{oS HL} = |t_{pHLm} - t_{pHLn}|$ )

**$V_{CCA} = 1.8 \pm 0.15 \text{ V}$ ,  $V_{CCB} = 2.5 \pm 0.2 \text{ V}$**

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time (Bn → An)	$t_{pLH}$ $t_{pHL}$	Figure 1, Figure 2	1.0	9.1	ns
3-state output enable time ( $\overline{OE}$ → An)	$t_{pZL}$ $t_{pZH}$	Figure 1, Figure 3	1.0	13.5	
3-state output disable time ( $\overline{OE}$ → An)	$t_{pLZ}$ $t_{pHZ}$	Figure 1, Figure 3	1.0	11.8	
Propagation delay time (An → Bn)	$t_{pLH}$ $t_{pHL}$	Figure 1, Figure 2	1.0	18.5	ns
3-state output enable time ( $\overline{OE}$ → Bn)	$t_{pZL}$ $t_{pZH}$	Figure 1, Figure 3	1.0	23.6	
3-state output disable time ( $\overline{OE}$ → Bn)	$t_{pLZ}$ $t_{pHZ}$	Figure 1, Figure 3	1.0	6.9	
Output-to-output skew	$t_{oS LH}$ $t_{oS HL}$	(Note)	—	0.5	ns

Note: Parameter guaranteed by design.

( $t_{oS LH} = |t_{pLHm} - t_{pLHn}|$ ,  $t_{oS HL} = |t_{pHLm} - t_{pHLn}|$ )

**$V_{CCA} = 1.5 \pm 0.1 \text{ V}$ ,  $V_{CCB} = 2.5 \pm 0.2 \text{ V}$**

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time (Bn → An)	$t_{pLH}$ $t_{pHL}$	Figure 1, Figure 2	1.0	10.8	ns
3-state output enable time ( $\overline{OE}$ → An)	$t_{pZL}$ $t_{pZH}$	Figure 1, Figure 3	1.0	18.3	
3-state output disable time ( $\overline{OE}$ → An)	$t_{pLZ}$ $t_{pHZ}$	Figure 1, Figure 3	1.0	14.2	
Propagation delay time (An → Bn)	$t_{pLH}$ $t_{pHL}$	Figure 1, Figure 2	1.0	19.7	ns
3-state output enable time ( $\overline{OE}$ → Bn)	$t_{pZL}$ $t_{pZH}$	Figure 1, Figure 3	1.0	26.6	
3-state output disable time ( $\overline{OE}$ → Bn)	$t_{pLZ}$ $t_{pHZ}$	Figure 1, Figure 3	1.0	8.3	
Output-to-output skew	$t_{oS LH}$ $t_{oS HL}$	(Note)	—	1.5	ns

Note: Parameter guaranteed by design.

( $t_{oS LH} = |t_{pLHm} - t_{pLHn}|$ ,  $t_{oS HL} = |t_{pHLm} - t_{pHLn}|$ )



**$V_{CCA} = 1.2 \pm 0.1 \text{ V}$ ,  $V_{CCB} = 2.5 \pm 0.2 \text{ V}$**

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time (Bn → An)	$t_{pLH}$ $t_{pHL}$	Figure 1, Figure 2	1.0	60	ns
3-state output enable time ( $\overline{OE}$ → An)	$t_{pZL}$ $t_{pZH}$	Figure 1, Figure 3	1.0	95	
3-state output disable time ( $\overline{OE}$ → An)	$t_{pLZ}$ $t_{pHZ}$	Figure 1, Figure 3	1.0	45	
Propagation delay time (An → Bn)	$t_{pLH}$ $t_{pHL}$	Figure 1, Figure 2	1.0	33	ns
3-state output enable time ( $\overline{OE}$ → Bn)	$t_{pZL}$ $t_{pZH}$	Figure 1, Figure 3	1.0	66	
3-state output disable time ( $\overline{OE}$ → Bn)	$t_{pLZ}$ $t_{pHZ}$	Figure 1, Figure 3	1.0	20	
Output-to-output skew	$t_{oS LH}$ $t_{oS HL}$	(Note)	—	1.5	ns

Note: Parameter guaranteed by design.

( $t_{oS LH} = |t_{pLHm} - t_{pLHn}|$ ,  $t_{oS HL} = |t_{pHLm} - t_{pHLn}|$ )

**$V_{CCA} = 1.2 \pm 0.1 \text{ V}$ ,  $V_{CCB} = 1.8 \pm 0.15 \text{ V}$**

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time (Bn → An)	$t_{pLH}$ $t_{pHL}$	Figure 1, Figure 2	1.0	58	ns
3-state output enable time ( $\overline{OE}$ → An)	$t_{pZL}$ $t_{pZH}$	Figure 1, Figure 3	1.0	92	
3-state output disable time ( $\overline{OE}$ → An)	$t_{pLZ}$ $t_{pHZ}$	Figure 1, Figure 3	1.0	47	
Propagation delay time (An → Bn)	$t_{pLH}$ $t_{pHL}$	Figure 1, Figure 2	1.0	43	ns
3-state output enable time ( $\overline{OE}$ → Bn)	$t_{pZL}$ $t_{pZH}$	Figure 1, Figure 3	1.0	78	
3-state output disable time ( $\overline{OE}$ → Bn)	$t_{pLZ}$ $t_{pHZ}$	Figure 1, Figure 3	1.0	20	
Output-to-output skew	$t_{oS LH}$ $t_{oS HL}$	(Note)	—	1.5	ns

Note: Parameter guaranteed by design.

( $t_{oS LH} = |t_{pLHm} - t_{pLHn}|$ ,  $t_{oS HL} = |t_{pHLm} - t_{pHLn}|$ )

## Dynamic Switching Characteristics (Ta = 25°C, Input: tr = tf = 2.0 ns, CL = 30 pF)

Characteristics		Symbol	Test Condition	Test Condition		Typ.	Unit
				VCCA (V)	VCCB (V)		
Quiet output maximum dynamic VOL	A → B	VOLP	VIH = VCC, VIL = 0 V (Note)	2.5	3.3	0.35	V
				1.8	3.3	0.35	
				1.8	2.5	0.25	
	B → A			2.5	3.3	0.6	
				1.8	3.3	0.25	
				1.8	2.5	0.25	
Quiet output minimum dynamic VOL	A → B	VOLV	VIH = VCC, VIL = 0 V (Note)	2.5	3.3	-0.35	V
				1.8	3.3	-0.35	
				1.8	2.5	-0.25	
	B → A			2.5	3.3	-0.6	
				1.8	3.3	-0.25	
				1.8	2.5	-0.25	
Quiet output maximum dynamic VOH	A → B	VOHP	VIH = VCC, VIL = 0 V (Note)	2.5	3.3	2.65	V
				1.8	3.3	2.65	
				1.8	2.5	2.05	
	B → A			2.5	3.3	1.7	
				1.8	3.3	1.3	
				1.8	2.5	1.3	
Quiet output minimum dynamic VOH	A → B	VOHV	VIH = VCC, VIL = 0 V (Note)	2.5	3.3	3.95	V
				1.8	3.3	3.95	
				1.8	2.5	2.95	
	B → A			2.5	3.3	3.3	
				1.8	3.3	2.3	
				1.8	2.5	2.3	

Note: Parameter guaranteed by design.

## Capacitive Characteristics (Ta = 25°C)

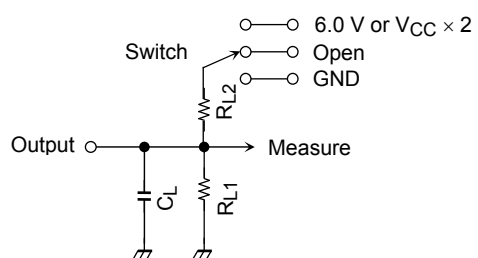
Characteristics	Symbol	Test Circuit			Typ.	Unit		
		DIR	OE	Test Condition				
Input capacitance	CIN	DIR, OE			2.5	3.3	7	pF
Bus I/O capacitance	CI/O	An, Bn			2.5	3.3	8	pF
Power dissipation capacitance (Note)	CPDA	OE = "L"	A → B (DIR = "H")	2.5	3.3	3	pF	
			B → A (DIR = "L")	2.5	3.3	16		
		OE = "H"	A → B (DIR = "H")	2.5	3.3	0		
			B → A (DIR = "L")	2.5	3.3	0		
	CPDB	OE = "L"	A → B (DIR = "H")	2.5	3.3	16		
			B → A (DIR = "L")	2.5	3.3	5		
		OE = "H"	A → B (DIR = "H")	2.5	3.3	0		
			B → A (DIR = "L")	2.5	3.3	0		

Note: CPD is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation:

$$I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/4 \text{ (per bit)}$$

## AC Test Circuit

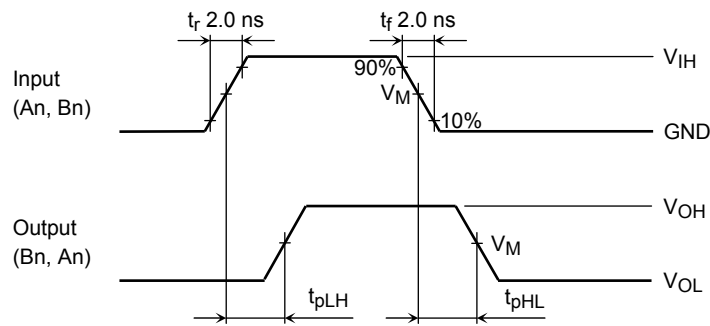


Parameter	Switch
$t_{pLH}$ , $t_{pHL}$	Open
$t_{pLZ}$ , $t_{pZL}$	6.0 V @ $V_{CC} = 3.3 \pm 0.3$ V
	$V_{CC} \times 2$ @ $V_{CC} = 2.5 \pm 0.2$ V
	@ $V_{CC} = 1.8 \pm 0.15$ V
	@ $V_{CC} = 1.5 \pm 0.1$ V
@ $V_{CC} = 1.2 \pm 0.1$ V	
$t_{pHZ}$ , $t_{pZH}$	GND

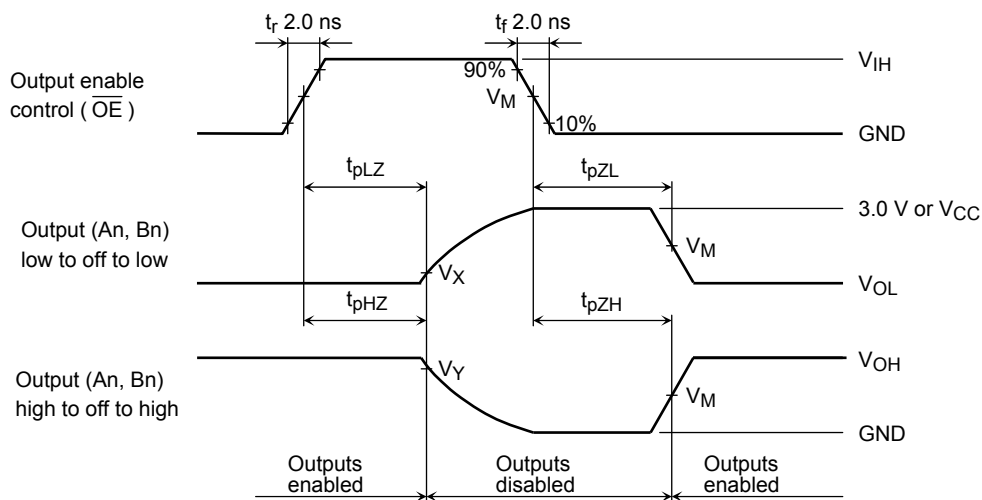
Symbol	$V_{CC}$ (output)			
	$3.3 \pm 0.3$ V $2.5 \pm 0.2$ V	$1.8 \pm 0.15$ V	$1.5 \pm 0.1$ V	$1.2 \pm 0.1$ V
$R_{L1/2A}$	500 $\Omega$	1 k $\Omega$	2 k $\Omega$	10 k $\Omega$
$C_{LA}$	30 pF	30 pF	15 pF	15 pF
$R_{L1B}$	—	—	—	—
$R_{L2B}$	1 k $\Omega$	1 k $\Omega$	1 k $\Omega$	1 k $\Omega$
$C_{LB}$	30 pF	30 pF	30 pF	30 pF

**Figure 1**

**AC Waveform**



**Figure 2**  $t_{pLH}$ ,  $t_{pHL}$



**Figure 3**  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$

Symbol	$V_{CC}$		
	$3.3 \pm 0.3 \text{ V}$	$2.5 \pm 0.2 \text{ V}$ $1.8 \pm 0.15 \text{ V}$	$1.5 \pm 0.1 \text{ V}$ $1.2 \pm 0.1 \text{ V}$
$V_{IH}$	2.7 V	$V_{CC}$	$V_{CC}$
$V_M$	1.5 V	$V_{CC}/2$	$V_{CC}/2$
$V_X$	$V_{OL} + 0.3 \text{ V}$	$V_{OL} + 0.15 \text{ V}$	$V_{OL} + 0.1 \text{ V}$
$V_Y$	$V_{OH} - 0.3 \text{ V}$	$V_{OH} - 0.15 \text{ V}$	$V_{OH} - 0.1 \text{ V}$

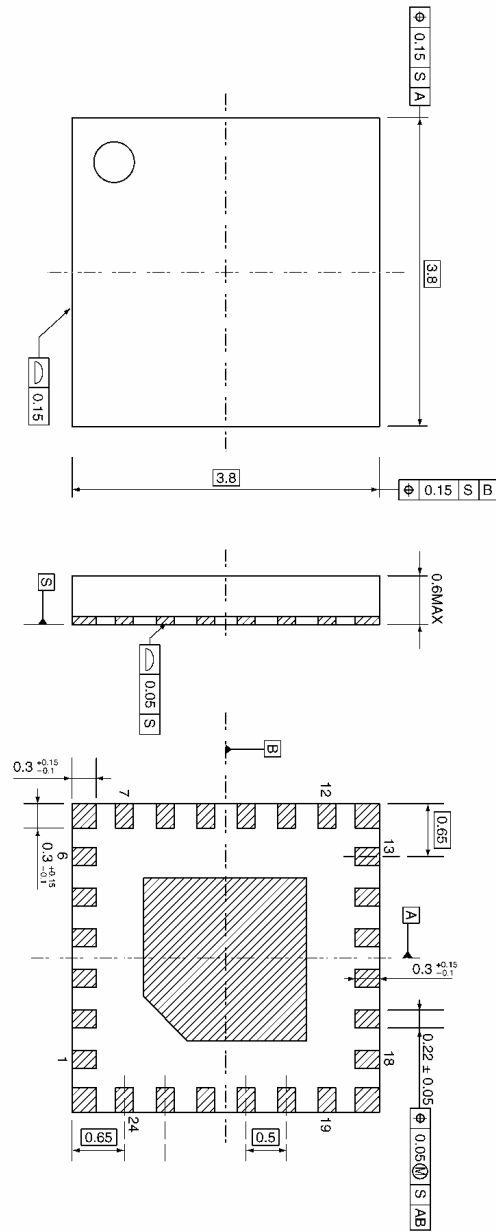
**Package Dimensions**

VQON24-P-0404-0.50

Unit: mm

VQON24-P-0404-0.50

Unit: mm



Weight: 0.03 g (typ.)

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20070701-EN GENERAL

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