

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.

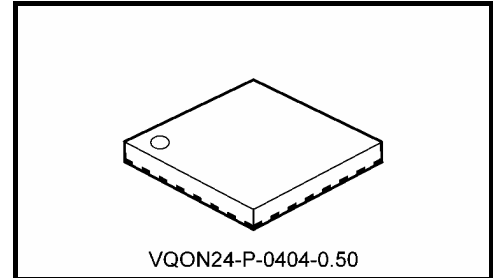
It is also designed with over-voltage tolerant inputs and outputs up to 3.6 V.

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

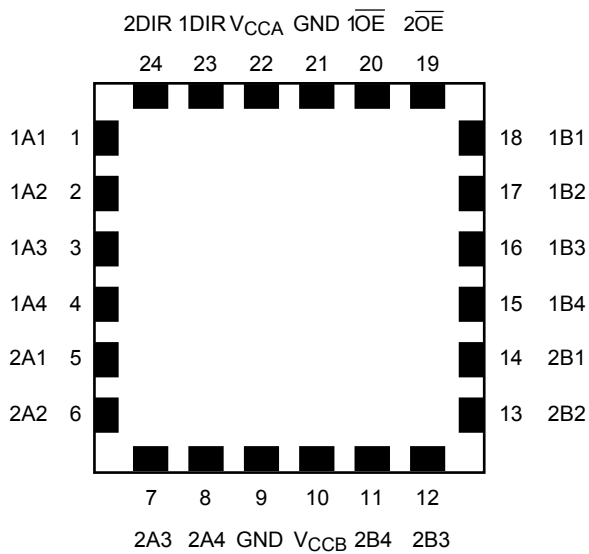
- Bidirectional interface between 1.2-V and 1.8-V, 1.2-V and 2.5-V, 1.2-V and 3.3-V, 1.5-V and 2.5-V, 1.5-V and 3.3-V, 1.8-V and 2.5-V, 1.8-V and 3.3-V or 2.5-V and 3.3-V buses.
- High-speed operation :  $t_{pd} = 13.7 \text{ ns (max)}$  ( $V_{CCA} = 2.5 \pm 0.2 \text{ V}$ ,  $V_{CCB} = 3.3 \pm 0.3 \text{ V}$ )  
 $t_{pd} = 14.8 \text{ ns (max)}$  ( $V_{CCA} = 1.8 \pm 0.15 \text{ V}$ ,  $V_{CCB} = 3.3 \pm 0.3 \text{ V}$ )  
 $t_{pd} = 16.0 \text{ ns (max)}$  ( $V_{CCA} = 1.5 \pm 0.1 \text{ V}$ ,  $V_{CCB} = 3.3 \pm 0.3 \text{ V}$ )  
 $t_{pd} = 61 \text{ ns (max)}$  ( $V_{CCA} = 1.2 \pm 0.1 \text{ V}$ ,  $V_{CCB} = 3.3 \pm 0.3 \text{ V}$ )  
 $t_{pd} = 18.5 \text{ ns (max)}$  ( $V_{CCA} = 1.8 \pm 0.15 \text{ V}$ ,  $V_{CCB} = 2.5 \pm 0.2 \text{ V}$ )  
 $t_{pd} = 19.7 \text{ ns (max)}$  ( $V_{CCA} = 1.5 \pm 0.1 \text{ V}$ ,  $V_{CCB} = 2.5 \pm 0.2 \text{ V}$ )  
 $t_{pd} = 60 \text{ ns (max)}$  ( $V_{CCA} = 1.2 \pm 0.1 \text{ V}$ ,  $V_{CCB} = 2.5 \pm 0.2 \text{ V}$ )  
 $t_{pd} = 58 \text{ ns (max)}$  ( $V_{CCA} = 1.2 \pm 0.1 \text{ V}$ ,  $V_{CCB} = 1.5 \pm 0.1 \text{ V}$ )
- 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.

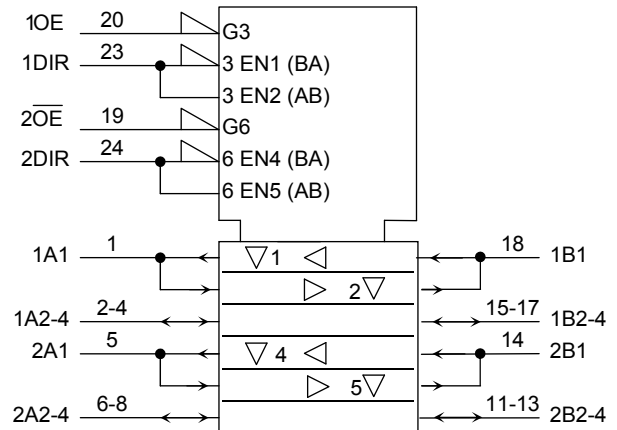
Note 2: RA or RMA flux is recommended when mounting the VQON package.

Start of commercial production  
2006-09

## Pin Assignment (top view)



## IEC Logic Symbol



## Truth Table

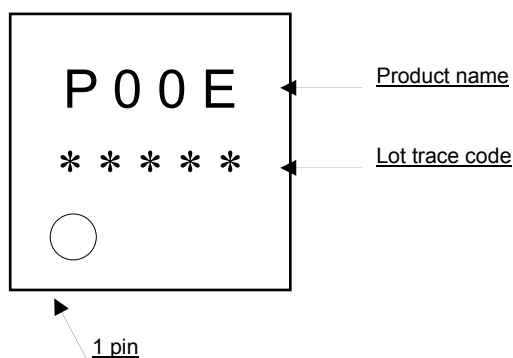
Inputs		Function		Outputs
$\overline{1OE}$	1DIR	Bus 1A1-1A4	Bus 1B1-1B4	
L	L	Output	Input	A = B
L	H	Input	Output	B = A
H	X	Z		Z

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

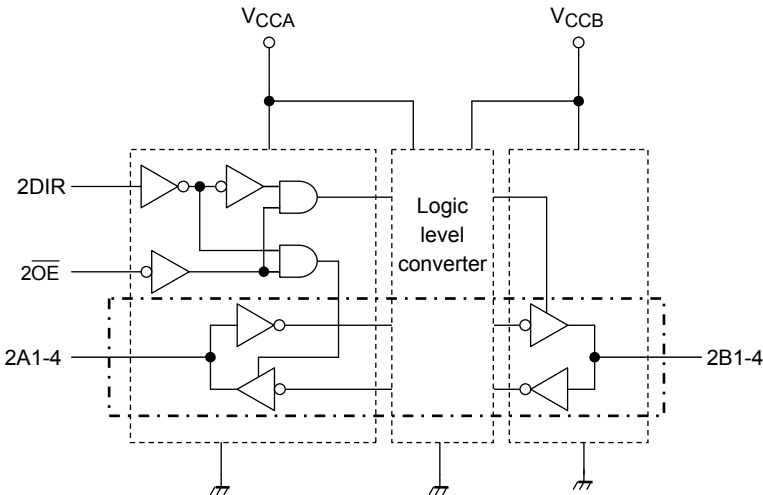
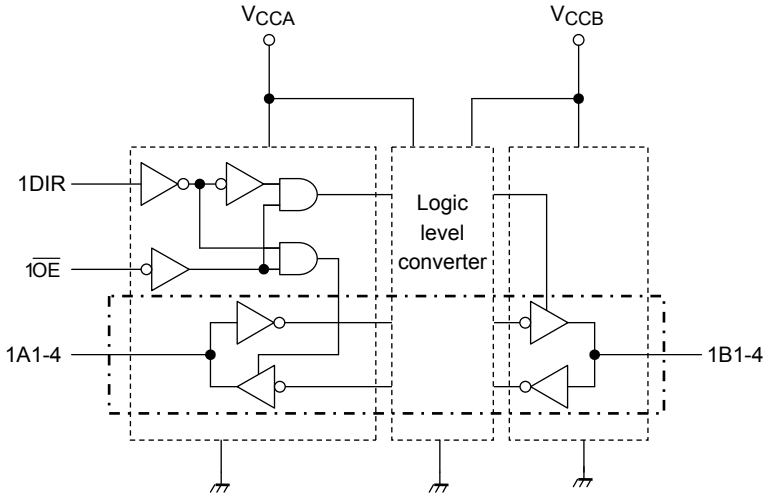
X: Don't care

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	°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:  $V_{OUT} < GND$ ,  $V_{OUT} > V_{CC}$

## 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  $V_{CC}$  or GND. Please connect both bus inputs and the bus outputs with  $V_{CC}$  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	μA	



## 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 ( $1.65\text{ V} \leq V_{CCA} < 2.3\text{ V}$ , $2.3\text{ V} \leq V_{CCB} \leq 2.7\text{ V}$ )

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

## 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	VCCA (V)		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	
	B → A			1.8	2.5	0.25	
				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	
	B → A			1.8	2.5	-0.25	
				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	
	B → A			1.8	2.5	2.05	
				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	
	B → A			1.8	2.5	2.95	
				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)

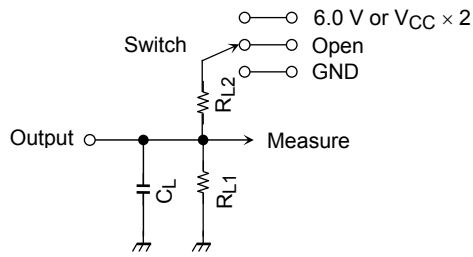
Characteristics		Symbol	Test Circuit		Typ.	Unit	
			VCCA (V)	VCCB (V)			
Input capacitance		CIN	DIR, $\overline{OE}$		7	pF	
Bus I/O capacitance		CI/O	An, Bn		8	pF	
Power dissipation capacitance (Note)	CPDA	$\overline{OE} = "L"$	A → B (DIR = "H")	2.5	3.3	3	pF
			B → A (DIR = "L")	2.5	3.3	16	
		$\overline{OE}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

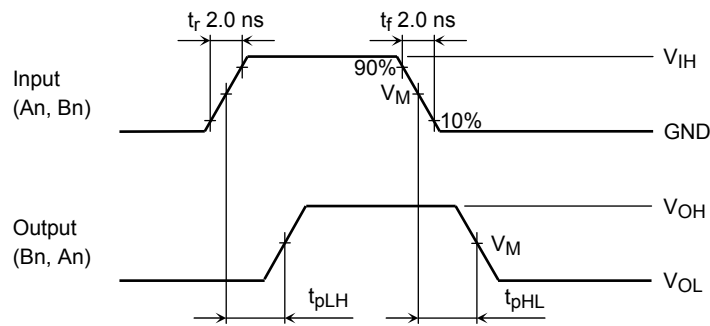


Parameter	Switch
$t_{pLH}, t_{pHL}$	Open
$t_{pLZ}, t_{pZL}$	6.0 V @ $V_{CC} = 3.3 \pm 0.3$ V
	$V_{CC} \times 2$ @ $V_{CC} = 2.5 \pm 0.2$ V
	@ $V_{CC} = 1.8 \pm 0.15$ V
	@ $V_{CC} = 1.5 \pm 0.1$ V
@ $V_{CC} = 1.2 \pm 0.1$ V	
$t_{pHZ}, t_{pZH}$	GND

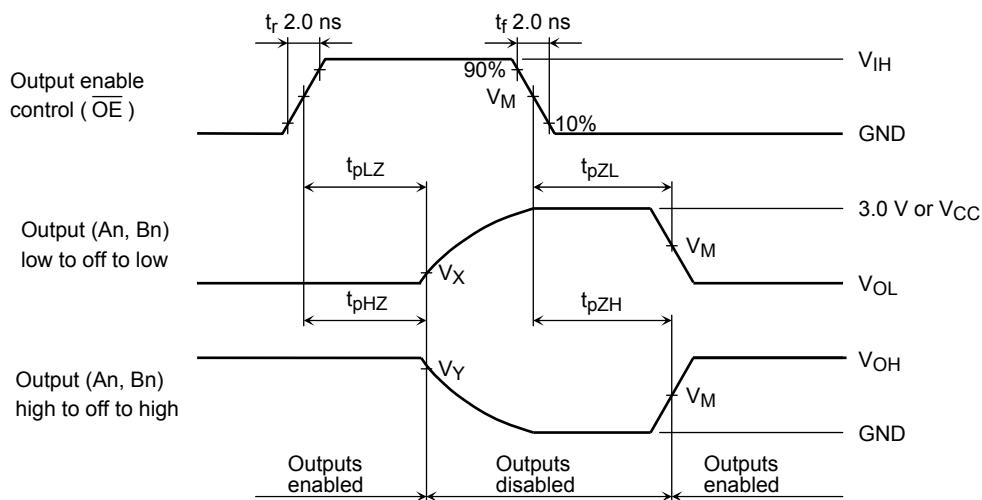
Symbol	$V_{CC}$ (output)			
	$3.3 \pm 0.3$ V $2.5 \pm 0.2$ V	$1.8 \pm 0.15$ V	$1.5 \pm 0.1$ V	$1.2 \pm 0.1$ V
$R_{L1/2A}$	500 $\Omega$	1 k $\Omega$	2 k $\Omega$	10 k $\Omega$
$C_{LA}$	30 pF	30 pF	15 pF	15 pF
$R_{L1B}$	—	—	—	—
$R_{L2B}$	1 k $\Omega$	1 k $\Omega$	1 k $\Omega$	1 k $\Omega$
$C_{LB}$	30 pF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

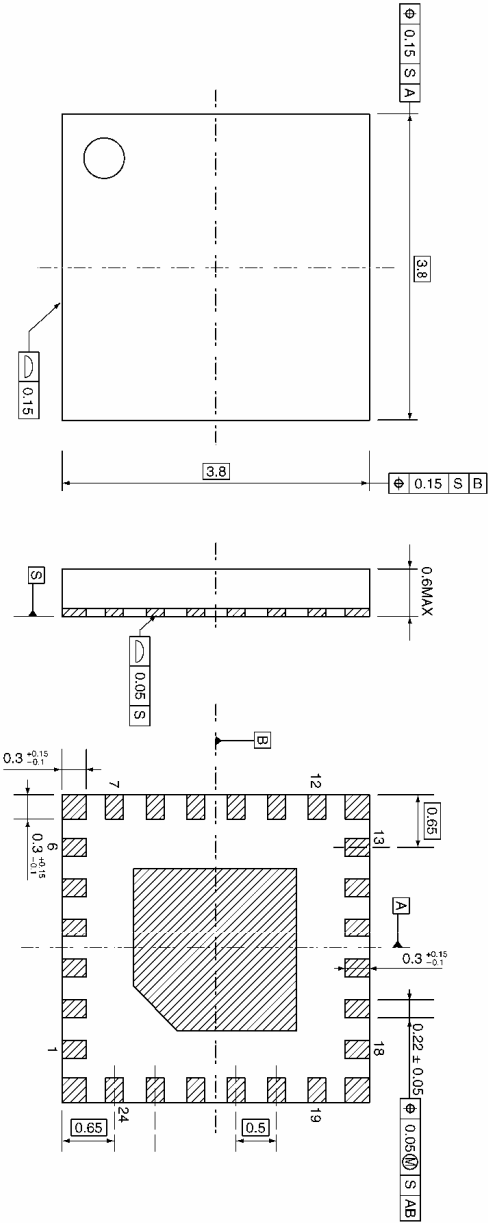
Package Dimensions

VQON24-P-0404-0.50

Unit: mm

VQON24-P-0404-0.50

Unit: mm



Weight: 0.03 g (typ.)

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