NCAS0104-Q1

4-bit Bidirectional Voltage Level Translator

Datasheet (EN) 1.0

Product Overview

The NCAS0104-Q1 is 4-bit bidirectional voltage level translator for open-drain and push-pull applications. It includes two supply pins (V_{CCA} and V_{CCB}), one output-enable (OE) and two 4-bit I/O ports (An and Bn).

V_{CCA} pin accepts any supply voltage from 1.1 V to 3.6 V and V_{CCB} pin accepts any supply voltage from 1.65 V to 5.5 V such that V_{CCA} is less than or equal to V_{CCB}. It makes the device suitable for translating between any of the voltage nodes (1.2V, 1.8 V,2.5 V, 3.3 V and 5.0 V).

The A and B ports (An and Bn) are designed to track V_{CCA} and V_{CCB} respectively. The pin OE is referenced to V_{CCA}. Setting pin OE low causes all outputs in the high-impedance state. Setting pin OE high will enable the device. To be in the high-impedance state during power up or power down, the OE pin must be tied to the GND pin through a pull-down resistor; the minimum value of the resistor is determined by the current sourcing capability of the driver.

Key Features

- AEC-Q100 qualified for automotive applications (Grade 1)
- 1.1 V to 3.6 V on V_{CCA}
- 1.65 V to 5.5 V on V_{CCB} ($V_{CCA} \leq V_{CCB}$)
- Maximum data rates:
  - 24 Mbps maximum (push pull)
  - 2 Mbps (open drain)
- ESD protection exceeds JESD 22:
  - ± 8 kV HBM (A114) for A port
  - ±15 kV HBM (A114) for B port
  - ± 2 kV CDM (C101) for A port
  - ±2 kV CDM (C101) for B port
- IEC 61000-4-2 ESD (B port): ±15 kV Contact Discharge
- Latch-up performance exceeds 100 mA per JESD78E, class II
- RoHS compliance
- Multiple package options

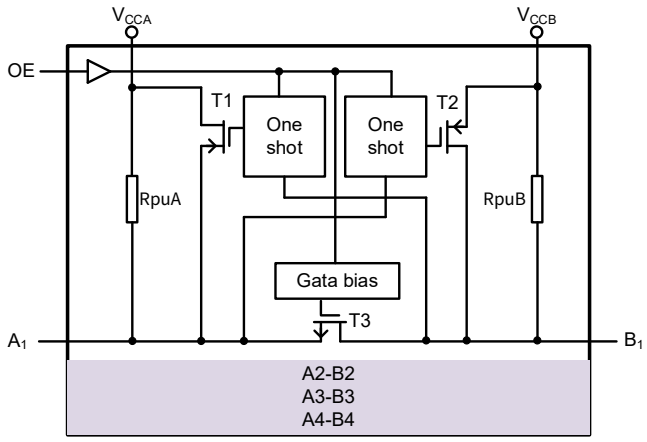
Applications

- Automotive infotainment
- Advance driver assistance systems (ADAS)
- Isolates and level translators between main processor and peripheral modules

Device Information

Part Number	Package	Body Size
NCAS0104-Q1TSKR	TSSOP14	5.00mm ×4.40mm
NCAS0104-Q1QBCR	VQFN14	3.50mm ×3.50mm

Functional Block Diagram



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1. Pin Configuration and Functions

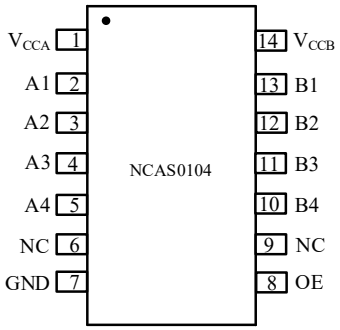


Figure 1. 1 NCAS0104-Q1 TSSOP14 Package

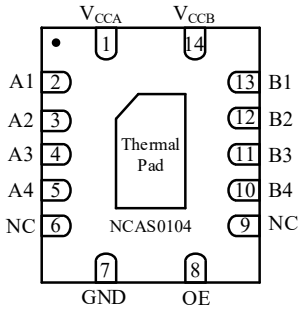


Figure 1. 2 NCAS0104-Q1 VQFN14 Package

Table 1. 1 Pin Configuration and Description of TSSOP14 and VQFN14

NCAS0104 PIN NO.	*SYMBOL*	*FUNCTION*
1	V_{CCA}	A port supply voltage. 1.1 V ≤ V_{CCA} ≤ 3.6 V and V_{CCA} ≤ V_{CCB}.
2,3,4,5	A1/A2/A3/A4	Input-output 1/2/3/4 for the A port (referenced to V_{CCA}).
6, 9	NC	Not connected.
7	GND	Ground
8	OE	Out-enable input (referenced to V_{CCA}). Active high. Setting OE low places all I/Os in high impendance state.
10,11,12,13	B4/B3/B2/B1	Input-output 4/3/2/1 for the B port (referenced to V_{CCB}).
14	V_{CCB}	B port supply voltage. 1.65 V ≤ V_{CCB} ≤ 5.5 V and V_{CCA} ≤ V_{CCB}.
Thermal Pad		Connected to the PCB ground plane to improve thermal coupling

2. Absolute Maximum Ratings

Current into device pins is defined as positive. Current out of device pins is defined as negative. Voltages are referenced to GND.

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Supply voltage	V_{CCA}	-0.5		4.6	V	With respect to GND
	V_{CCB}	-0.5		6.5		
Input voltage	V_I	-0.5		4.6	V	A port, OE
		-0.5		6.5	V	B port
Output voltage	V_O	-0.5		V_{CCA}+0.5	V	Active mode: A port
		-0.5		V_{CCB}+0.5	V	Active mode: B port
		-0.5		4.6	V	3-state and power-down mode: A port
		-0.5		6.5	V	3-state and power-down mode: B port
Input clamping current	I_{IK}	-50			mA	V_I < 0V
Output clamping current	I_{OK}	-50			mA	V_I < 0V
Continuous output current	I_O	-50		50	mA	V_O = 0V to V_{CCA} or V_{CCB}
Supply current	I_{CC}			100	mA	Current of V_{CCA} or V_{CCB}
Ground current	I_{GND}	-100			mA	Current of Ground
Operation temperature	T_a	-40		125	℃	NCAS0104-Q1TSKR, NCAS0104-Q1QBCR
Junction temperature	T_J			150		
Storage temperature	T_{stg}	-65		150		

3. ESD ratings

Symbol	Ratings	Value	Unit
Electrostatic discharge $V_{ESD-HBM1}$ $V_{ESD-HBM2}$	Human body model (JESD22/A114) - 100pF, 1.5kΩ ● B ports (Bn), to GND ● Others	 ±15.0 ±8.0	 kV kV
Electrostatic discharge $V_{ESD-CDM}$	● Charged device model (JESD22/C101)	±2.0	kV
Electrostatic discharge $V_{ESD-system}$	System level ESD (Contact discharge) - 330Ω/150pF unpowered according to IEC 61000-4-2 ● B ports (Bn)	 ±15.0	 kV

4. Recommended Operating Conditions

Parameters	Symbol	Conditions	Min	Max	Unit
Supply voltage	V_{CCA}		1.1	3.6	V
	V_{CCB}		1.65	5.5	V
High-level input voltage	$V_{IH(An)}$	V_{CCA} = 1.1 V ~ 3.6 V V_{CCB} = 1.65 V ~ 5.5 V	V_{CCA} - 0.4	V_{CCA}	V
	$V_{IH(Bn)}$	V_{CCA} = 1.1 V ~ 3.6 V V_{CCB} = 1.65 V ~ 5.5 V	V_{CCB} - 0.4	V_{CCB}	V
	$V_{IH(OE)}$		0.7 * V_{CCA}	5.5	V
Low-level input voltage	$V_{IL(An)}$	V_{CCA} = 1.1 V ~ 3.6 V V_{CCB} = 1.65 V ~ 5.5 V		0.15	V
	$V_{IL(Bn)}$			0.15	V
	$V_{IL(OE)}$			0.3 * V_{CCA}	V
Input transition rise and fall rate	Δt/Δv(An)	A port, push-pull driving V_{CCA} = 1.1 V ~ 3.6 V V_{CCB} = 1.65 V ~ 5.5 V		10	ns/V
	Δt/Δv(Bn)	B port, push-pull driving V_{CCA} = 1.1 V ~ 3.6 V V_{CCB} = 1.65 V ~ 5.5 V		10	ns/V
	Δt/Δv(OE)	OE input V_{CCA} = 1.1 V ~ 3.6 V V_{CCB} = 1.65 V ~ 5.5 V		10	ns/V

5. Thermal Characteristics

Parameters	Symbol	TSSOP14	VQFN14	Unit
Junction-to-air thermal resistance	θ_{JA}	121.0	52.8	℃/W
Junction-to-case (top) thermal resistance	$\theta_{JC(top)}$	50.0	67.7	℃/W
Junction-to-board thermal resistance	θ_{JB}	62.8	28.9	℃/W

6. Specifications

6.1. Electrical Characteristics

V_{CCA} must be no higher than V_{CCB}. Unless otherwise noted, typical values are at T_a = 25°C.

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Supply current						
A port (An, Bn open)	I_{CCA}			10	μA	V_{CCA} = 1.1 V ~ 3.6 V[1], V_{CCB} = 1.65 V ~ 5.5 V
				10		V_{CCA} = 3.6 V, V_{CCB} = 0 V
		-10				V_{CCA} = 0 V, V_{CCB} = 5.5 V
B port (An, Bn open)	I_{CCB}			10	μA	V_{CCA} = 1.1 V ~ 3.6 V[1], V_{CCB} = 1.65 V ~ 5.5 V
		-10				V_{CCA} = 3.6 V, V_{CCB} = 0 V
				10		V_{CCA} = 0 V, V_{CCB} = 5.5 V
A port + B port (An, Bn open)	I_{CCA}+I_{CCB}			20	μA	V_{CCA} = 1.1 V ~ 3.6 V[1], V_{CCB} = 1.65 V ~ 5.5 V
A port (An, Bn open)	I_{CCZA}			10	μA	V_{CCA} = 1.1 V ~ 3.6 V, V_{CCB} = 1.65 V ~ 5.5 V OE = GND
B port (An, Bn open)	I_{CCZB}			10		V_{CCA} = 1.1 V ~ 3.6 V, V_{CCB} = 1.65 V ~ 5.5 V OE = GND
A or B port						
B port (An, Bn open)	$V_{OH(An)}$	0.75*V_{CCA}			V	V_{CCA} = 1.1 V ~ 3.6 V[1], V_{CCB} = 1.65 V ~ 5.5 V, I_{OH} = –20 μA, VI(Bn) ≥ V_{CCB} – 0.4 V
	$V_{OH(Bn)}$	0.75*V_{CCB}				V_{CCA} = 1.1 V ~ 3.6 V[1], V_{CCB} = 1.65 V ~ 5.5 V, I_{OH} = –20 μA, VI(An) ≥ V_{CCA} – 0.4 V
Low-level output voltage	$V_{OL(An)}$			0.4	V	V_{CCA} = 1.1 V ~ 1.2 V[1], V_{CCB} = 1.65 V ~ 1.8 V, I_{OL} = 220 μA, VI(Bn) ≤ 0.15 V
				0.4		V_{CCA} = 1.8 V ~ 2.5 V[1], V_{CCB} = 2.5 V ~ 3.3 V, I_{OL} = 500 μA VI(Bn) ≤ 0.15 V

Parameters	Symbol	Min	Typ	Max	Unit	Comments
				0.5		V_{CCA} = 3.3 V ~ 3.6 V[1], V_{CCB} = 5 V ~ 5.5 V, I_{OL} = 1 mA, VI(Bn) ≤ 0.15 V
	$V_{OL(Bn)}$			0.4	V	V_{CCA} = 1.1 V ~ 1.2 V[1], V_{CCB} = 1.65 V ~ 1.8 V, I_{OL} = 220 μA, VI(An) ≤ 0.15 V
				0.4		V_{CCA} = 1.8 V ~ 2.5 V[1], V_{CCB} = 2.5 V ~ 3.3 V, I_{OL} = 500 μA VI(An) ≤ 0.15 V
				0.5		V_{CCA} = 3.3 V ~ 3.6 V[1], V_{CCB} = 5 V ~ 5.5 V, I_{OL} = 1 mA, VI(An) ≤ 0.15 V
Off-state output current of A or B port	I_{OZ}	-3		3	μA	V_{CCA} = 1.1 V ~ 3.6 V[1], V_{CCB} = 1.65 V ~ 5.5 V, OE = GND
Input-output capacitance of A port	$C_{IO(An)}$			6.5	pF	Guaranteed by design.
Input-output capacitance of B port	$C_{IO(Bn)}$			16.5		
Pin OE						
Input leakage current of OE	$I_{I(OE)}$	-10		10	μA	V_{CCA} = 1.1 V ~ 3.6 V[1], V_{CCB} = 1.65 V ~ 5.5 V, V_{OE} = V_{CCA} / 0V[2]
Input capacitance of OE	$C_{I(OE)}$			4	pF	Guaranteed by design.

[1] V_{CCA} must be less than or equal to V_{CCB}, and V_{CCA} must not exceed 3.6 V.
[2] The OE internally integrates a pull-down resistor, ensuring that the chip is in a disabled state by default after power-up.

6.2. Timing Requirements

V_{CCA} must be no higher than V_{CCB}. Unless otherwise noted, typical values are at T_a = 25°C.

Not tested in production; guaranteed by design.

Parameters	Symbol	Operate conditions	V_{CCB}	Min	Max	Unit
V_{CCA} = 1.2 V						
Data rate	DR	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		20	Mbps
			V_{CCB} = 2.5 V ± 0.2 V		20	
			V_{CCB} = 3.3 V ± 0.3 V		20	
			V_{CCB} = 5 V ± 0.5 V		20	
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V		2	
			V_{CCB} = 2.5 V ± 0.2 V		2	
			V_{CCB} = 3.3 V ± 0.3 V		2	
			V_{CCB} = 5 V ± 0.5 V		2	
Pulse duration (data input)	t_w	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V	50		ns
			V_{CCB} = 2.5 V ± 0.2 V	50		
			V_{CCB} = 3.3 V ± 0.3 V	50		
			V_{CCB} = 5 V ± 0.5 V	50		
		Open-drain driving	V_{CCB} = 1.8 V ± 0.2 V	500		
			V_{CCB} = 2.5 V ± 0.2 V	500		
			V_{CCB} = 3.3 V ± 0.3 V	500		
			V_{CCB} = 5 V ± 0.5 V	500		

Parameters	Symbol	Operate conditions	V_{CCB}	Min	Max	Unit
V_{CCA} = 1.5 V±0.1 V						
Data rate	DR	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		20	Mbps
			V_{CCB} = 2.5 V ± 0.2 V		20	
			V_{CCB} = 3.3 V ± 0.3 V		22	
			V_{CCB} = 5 V ± 0.5 V		24	
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V		2	
			V_{CCB} = 2.5 V ± 0.2 V		2	
			V_{CCB} = 3.3 V ± 0.3 V		2	
			V_{CCB} = 5 V ± 0.5 V		2	
Pulse duration (data input)	t_w	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V	50		ns
			V_{CCB} = 2.5 V ± 0.2 V	50		

Parameters	Symbol	Operate conditions	V_{CCB}	Min	Max	Unit
			V_{CCB} = 3.3 V ± 0.3 V	45		
			V_{CCB} = 5 V ± 0.5 V	41		
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V	500		
			V_{CCB} = 2.5 V ± 0.2 V	500		
			V_{CCB} = 3.3 V ± 0.3 V	500		
			V_{CCB} = 5 V ± 0.5 V	500		
			V_{CCB} = 5 V ± 0.5 V	500		

Parameters	Symbol	Operate conditions	V_{CCB}	Min	Max	Unit
V_{CCA} = 1.8 V±0.15 V						
Data rate	DR	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		18	Mbps
			V_{CCB} = 2.5 V ± 0.2 V		18	
			V_{CCB} = 3.3 V ± 0.3 V		21	
			V_{CCB} = 5 V ± 0.5 V		23	
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V		2	
			V_{CCB} = 2.5 V ± 0.2 V		2	
			V_{CCB} = 3.3 V ± 0.3 V		2	
			V_{CCB} = 5 V ± 0.5 V		2	
Pulse duration (data input)	t_w	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V	55		ns
			V_{CCB} = 2.5 V ± 0.2 V	55		
			V_{CCB} = 3.3 V ± 0.3 V	47		
			V_{CCB} = 5 V ± 0.5 V	43		
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V	500		
			V_{CCB} = 2.5 V ± 0.2 V	500		
			V_{CCB} = 3.3 V ± 0.3 V	500		
			V_{CCB} = 5 V ± 0.5 V	500		

Parameters	Symbol	Operate conditions	V_{CCB}	Min	Max	Unit
V_{CCA} = 2.5 V±0.2 V						
Data rate	DR	Push-pull driving	V_{CCB} = 2.5 V ± 0.2 V		20	Mbps
			V_{CCB} = 3.3 V ± 0.3 V		22	

Parameters	Symbol	Operate conditions	V_{CCB}	Min	Max	Unit
			V_{CCB} = 5 V ± 0.5 V		24	
		Open-drain driving	V_{CCB} = 2.5 V ± 0.2 V		2	
			V_{CCB} = 3.3 V ± 0.3 V		2	
			V_{CCB} = 5 V ± 0.5 V		2	
Pulse duration (data input)	t_w	Push-pull driving	V_{CCB} = 2.5 V ± 0.2 V	50		ns
			V_{CCB} = 3.3 V ± 0.3 V	45		
			V_{CCB} = 5 V ± 0.5 V	41		
		Open-drain driving	V_{CCB} = 2.5 V ± 0.2 V	500		
			V_{CCB} = 3.3 V ± 0.3 V	500		
			V_{CCB} = 5 V ± 0.5 V	500		

Parameters	Symbol	Operate conditions	V_{CCB}	Min	Max	Unit
V_{CCA} = 3.3 V±0.3 V						
Data rate	DR	Push-pull driving	V_{CCB} = 3.3 V ± 0.3 V		22	Mbps
			V_{CCB} = 5 V ± 0.5 V		24	
		Open-drain driving	V_{CCB} = 3.3 V ± 0.3 V		2	
			V_{CCB} = 5 V ± 0.5 V		2	
Pulse duration (data input)	t_w	Push-pull driving	V_{CCB} = 3.3 V ± 0.3 V	45		ns
			V_{CCB} = 5 V ± 0.5 V	41		
		Open-drain driving	V_{CCB} = 3.3 V ± 0.3 V	500		
			V_{CCB} = 5 V ± 0.5 V	500		

6.3. Switching Characteristics

V_{CCA} must be no higher than V_{CCB}. Unless otherwise noted, typical values are at T_a = 25°C.

Not tested in production; guaranteed by design.

Parameters	*Symbol*	*Operate conditions*	*V_{CCB}*	*Min*	*Max*	*Unit*
V_{CCA} = 1.2 V						
Propagation delay time (high to low), from A (input) to B (output)	$t_{PHL(A-B)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		18	ns
			V_{CCB} = 2.5 V ± 0.2 V		15	
			V_{CCB} = 3.3 V ± 0.3 V		15	
			V_{CCB} = 5 V ± 0.5 V		15	
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V		12	
			V_{CCB} = 2.5 V ± 0.2 V		8	
			V_{CCB} = 3.3 V ± 0.3 V		8	
			V_{CCB} = 5 V ± 0.5 V		8	
Propagation delay time (high to low), from B (input) to A (output)	$t_{PHL(B-A)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		15	ns
			V_{CCB} = 2.5 V ± 0.2 V		14	
			V_{CCB} = 3.3 V ± 0.3 V		13	
			V_{CCB} = 5 V ± 0.5 V		10	
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V		13	
			V_{CCB} = 2.5 V ± 0.2 V		12	
			V_{CCB} = 3.3 V ± 0.3 V		11	
			V_{CCB} = 5 V ± 0.5 V		8	
Propagation delay time (low to high), from A (input) to B (output)	$t_{PLH(A-B)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		15	ns
			V_{CCB} = 2.5 V ± 0.2 V		14	
			V_{CCB} = 3.3 V ± 0.3 V		14	
			V_{CCB} = 5 V ± 0.5 V		9	
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V		200	
			V_{CCB} = 2.5 V ± 0.2 V		200	
			V_{CCB} = 3.3 V ± 0.3 V		200	
			V_{CCB} = 5 V ± 0.5 V		200	
Propagation delay time (low to high), from B (input) to A (output)	$t_{PLH(B-A)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		11	ns
			V_{CCB} = 2.5 V ± 0.2 V		9	
			V_{CCB} = 3.3 V ± 0.3 V		8	
			V_{CCB} = 5 V ± 0.5 V		10	
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V		200	

Parameters	Symbol	Operate conditions	V_{CCB}	Min	Max	Unit
			V_{CCB} = 2.5 V ± 0.2 V		200	
			V_{CCB} = 3.3 V ± 0.3 V		200	
			V_{CCB} = 5 V ± 0.5 V		200	
Rise time of A port	$t_{r(An)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		17	ns
			V_{CCB} = 2.5 V ± 0.2 V		15	
			V_{CCB} = 3.3 V ± 0.3 V		15	
			V_{CCB} = 5 V ± 0.5 V		16	
		Open-drain driving[1]	V_{CCB} = 1.8 V ± 0.15 V		300	
			V_{CCB} = 2.5 V ± 0.2 V		300	
			V_{CCB} = 3.3 V ± 0.3 V		250	
			V_{CCB} = 5 V ± 0.5 V		250	
Rise time of B port	$t_{r(Bn)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		14	ns
			V_{CCB} = 2.5 V ± 0.2 V		10	
			V_{CCB} = 3.3 V ± 0.3 V		7	
			V_{CCB} = 5 V ± 0.5 V		5	
		Open-drain driving[1]	V_{CCB} = 1.8 V ± 0.15 V		670	
			V_{CCB} = 2.5 V ± 0.2 V		510	
			V_{CCB} = 3.3 V ± 0.3 V		430	
			V_{CCB} = 5 V ± 0.5 V		310	
Fall time of A port	$t_{f(An)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		12	ns
			V_{CCB} = 2.5 V ± 0.2 V		12	
			V_{CCB} = 3.3 V ± 0.3 V		12	
			V_{CCB} = 5 V ± 0.5 V		9	
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V		16	
			V_{CCB} = 2.5 V ± 0.2 V		16	
			V_{CCB} = 3.3 V ± 0.3 V		15	
			V_{CCB} = 5 V ± 0.5 V		14	
Fall time of B port	$t_{f(Bn)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		9	ns
			V_{CCB} = 2.5 V ± 0.2 V		8	
			V_{CCB} = 3.3 V ± 0.3 V		8	
			V_{CCB} = 5 V ± 0.5 V		8	
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V		10	

Parameters	Symbol	Operate conditions	V_{CCB}	Min	Max	Unit
			V_{CCB} = 2.5 V ± 0.2 V		9	
			V_{CCB} = 3.3 V ± 0.3 V		8	
			V_{CCB} = 5 V ± 0.5 V		8	
Channel-to channel skew	t_{sk}		V_{CCB} = 1.8 V ± 0.15 V		1	ns
			V_{CCB} = 2.5 V ± 0.2 V		1	
			V_{CCB} = 3.3 V ± 0.3 V		1	
			V_{CCB} = 5 V ± 0.5 V		1	
Enable time, from OE (input) to A or B (output)	$t_{en(OE-A)}$ $t_{en(OE-B)}$		V_{CCB} = 1.8 V ± 0.15 V		600	ns
			V_{CCB} = 2.5 V ± 0.2 V		550	
			V_{CCB} = 3.3 V ± 0.3 V		500	
			V_{CCB} = 5 V ± 0.5 V		450	
Disable time, from OE (input) to A or B (output)	$t_{dis(OE-A)}$ $t_{dis(OE-B)}$		V_{CCB} = 1.8 V ± 0.15 V		450	ns
			V_{CCB} = 2.5 V ± 0.2 V		400	
			V_{CCB} = 3.3 V ± 0.3 V		400	
			V_{CCB} = 5 V ± 0.5 V		400	

Parameters	Symbol	Operate conditions	V_{CCB}	Min	Max	Unit
V_{CCA} = 1.5 V±0.1 V						
Propagation delay time (high to low), from A (input) to B (output)	$t_{PHL(A-B)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		14	ns
			V_{CCB} = 2.5 V ± 0.2 V		11	
			V_{CCB} = 3.3 V ± 0.3 V		11	
			V_{CCB} = 5 V ± 0.5 V		12	
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V		11	
			V_{CCB} = 2.5 V ± 0.2 V		8	
			V_{CCB} = 3.3 V ± 0.3 V		7	
			V_{CCB} = 5 V ± 0.5 V		7	
Propagation delay time (high to low), from B (input) to A (output)	$t_{PHL(B-A)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		13	ns
			V_{CCB} = 2.5 V ± 0.2 V		11	
			V_{CCB} = 3.3 V ± 0.3 V		11	
			V_{CCB} = 5 V ± 0.5 V		9	
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V		10	
			V_{CCB} = 2.5 V ± 0.2 V		9	

Parameters	Symbol	Operate conditions	V_{CCB}	Min	Max	Unit
			V_{CCB} = 3.3 V ± 0.3 V		8	
			V_{CCB} = 5 V ± 0.5 V		8	
Propagation delay time (low to high), from A (input) to B (output)	$t_{PLH(A-B)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		12	ns
			V_{CCB} = 2.5 V ± 0.2 V		11	
			V_{CCB} = 3.3 V ± 0.3 V		10	
			V_{CCB} = 5 V ± 0.5 V		9	
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V		200	
			V_{CCB} = 2.5 V ± 0.2 V		200	
			V_{CCB} = 3.3 V ± 0.3 V		200	
			V_{CCB} = 5 V ± 0.5 V		200	
Propagation delay time (low to high), from B (input) to A (output)	$t_{PLH(B-A)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		10	ns
			V_{CCB} = 2.5 V ± 0.2 V		8	
			V_{CCB} = 3.3 V ± 0.3 V		7	
			V_{CCB} = 5 V ± 0.5 V		7	
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V		200	
			V_{CCB} = 2.5 V ± 0.2 V		200	
			V_{CCB} = 3.3 V ± 0.3 V		200	
			V_{CCB} = 5 V ± 0.5 V		200	
Rise time of A port	$t_{r(An)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		14	ns
			V_{CCB} = 2.5 V ± 0.2 V		13	
			V_{CCB} = 3.3 V ± 0.3 V		13	
			V_{CCB} = 5 V ± 0.5 V		15	
		Open-drain driving[1]	V_{CCB} = 1.8 V ± 0.15 V		250	
			V_{CCB} = 2.5 V ± 0.2 V		200	
			V_{CCB} = 3.3 V ± 0.3 V		200	
			V_{CCB} = 5 V ± 0.5 V		150	
Rise time of B port	$t_{r(Bn)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		14	ns
			V_{CCB} = 2.5 V ± 0.2 V		12	
			V_{CCB} = 3.3 V ± 0.3 V		9	
			V_{CCB} = 5 V ± 0.5 V		6	
		Open-drain driving[1]	V_{CCB} = 1.8 V ± 0.15 V		550	
			V_{CCB} = 2.5 V ± 0.2 V		400	

Parameters	Symbol	Operate conditions	V_{CCB}	Min	Max	Unit
			V_{CCB} = 3.3 V ± 0.3 V		350	
			V_{CCB} = 5 V ± 0.5 V		150	
Fall time of A port	$t_{f(An)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		10	ns
			V_{CCB} = 2.5 V ± 0.2 V		9	
			V_{CCB} = 3.3 V ± 0.3 V		8	
			V_{CCB} = 5 V ± 0.5 V		8	
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V		12	
			V_{CCB} = 2.5 V ± 0.2 V		12	
			V_{CCB} = 3.3 V ± 0.3 V		13	
			V_{CCB} = 5 V ± 0.5 V		7	
Fall time of B port	$t_{f(Bn)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		9	ns
			V_{CCB} = 2.5 V ± 0.2 V		8	
			V_{CCB} = 3.3 V ± 0.3 V		8	
			V_{CCB} = 5 V ± 0.5 V		8	
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V		10	
			V_{CCB} = 2.5 V ± 0.2 V		9	
			V_{CCB} = 3.3 V ± 0.3 V		8	
			V_{CCB} = 5 V ± 0.5 V		8	
Channel-to channel skew	t_{sk}		V_{CCB} = 1.8 V ± 0.15 V		1	ns
			V_{CCB} = 2.5 V ± 0.2 V		1	
			V_{CCB} = 3.3 V ± 0.3 V		1	
			V_{CCB} = 5 V ± 0.5 V		1	
Enable time, from OE (input) to A or B (output)	$t_{en(OE-A)}$ $t_{en(OE-B)}$		V_{CCB} = 1.8 V ± 0.15 V		300	ns
			V_{CCB} = 2.5 V ± 0.2 V		400	
			V_{CCB} = 3.3 V ± 0.3 V		400	
			V_{CCB} = 5 V ± 0.5 V		400	
Disable time, from OE (input) to A or B (output)	$t_{dis(OE-A)}$ $t_{dis(OE-B)}$		V_{CCB} = 1.8 V ± 0.15 V		450	ns
			V_{CCB} = 2.5 V ± 0.2 V		400	
			V_{CCB} = 3.3 V ± 0.3 V		400	
			V_{CCB} = 5 V ± 0.5 V		400	

Parameters	Symbol	Operate conditions	V_{CCB}	Min	Max	Unit
V_{CCA} = 1.8 V±0.15 V						
Propagation delay time (high to low), from A (input) to B (output)	$t_{PHL(A-B)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		11	ns
			V_{CCB} = 2.5 V ± 0.2 V		10	
			V_{CCB} = 3.3 V ± 0.3 V		9	
			V_{CCB} = 5 V ± 0.5 V		9	
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V		9	
			V_{CCB} = 2.5 V ± 0.2 V		7	
			V_{CCB} = 3.3 V ± 0.3 V		7	
			V_{CCB} = 5 V ± 0.5 V		7	
Propagation delay time (high to low), from B (input) to A (output)	$t_{PHL(B-A)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		12	ns
			V_{CCB} = 2.5 V ± 0.2 V		11	
			V_{CCB} = 3.3 V ± 0.3 V		10	
			V_{CCB} = 5 V ± 0.5 V		9	
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V		9	
			V_{CCB} = 2.5 V ± 0.2 V		8	
			V_{CCB} = 3.3 V ± 0.3 V		7	
			V_{CCB} = 5 V ± 0.5 V		7	
Propagation delay time (low to high), from A (input) to B (output)	$t_{PLH(A-B)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		10	ns
			V_{CCB} = 2.5 V ± 0.2 V		9	
			V_{CCB} = 3.3 V ± 0.3 V		9	
			V_{CCB} = 5 V ± 0.5 V		8	
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V		200	
			V_{CCB} = 2.5 V ± 0.2 V		200	
			V_{CCB} = 3.3 V ± 0.3 V		200	
			V_{CCB} = 5 V ± 0.5 V		200	
Propagation delay time (low to high), from B (input) to A (output)	$t_{PLH(B-A)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		10	ns
			V_{CCB} = 2.5 V ± 0.2 V		8	
			V_{CCB} = 3.3 V ± 0.3 V		7	
			V_{CCB} = 5 V ± 0.5 V		7	
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V		200	
			V_{CCB} = 2.5 V ± 0.2 V		200	
			V_{CCB} = 3.3 V ± 0.3 V		200	

Parameters	Symbol	Operate conditions	V_{CCB}	Min	Max	Unit
			V_{CCB} = 5 V ± 0.5 V		200	
Rise time of A port	$t_{r(An)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		14	ns
			V_{CCB} = 2.5 V ± 0.2 V		13	
			V_{CCB} = 3.3 V ± 0.3 V		12	
			V_{CCB} = 5 V ± 0.5 V		13	
		Open-drain driving[1]	V_{CCB} = 1.8 V ± 0.15 V		250	
			V_{CCB} = 2.5 V ± 0.2 V		200	
			V_{CCB} = 3.3 V ± 0.3 V		200	
			V_{CCB} = 5 V ± 0.5 V		150	
Rise time of B port	$t_{r(Bn)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		13	ns
			V_{CCB} = 2.5 V ± 0.2 V		12	
			V_{CCB} = 3.3 V ± 0.3 V		9	
			V_{CCB} = 5 V ± 0.5 V		6	
		Open-drain driving[1]	V_{CCB} = 1.8 V ± 0.15 V		600	
			V_{CCB} = 2.5 V ± 0.2 V		450	
			V_{CCB} = 3.3 V ± 0.3 V		350	
			V_{CCB} = 5 V ± 0.5 V		200	
Fall time of A port	$t_{f(An)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		9	ns
			V_{CCB} = 2.5 V ± 0.2 V		8	
			V_{CCB} = 3.3 V ± 0.3 V		8	
			V_{CCB} = 5 V ± 0.5 V		8	
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V		9	
			V_{CCB} = 2.5 V ± 0.2 V		9	
			V_{CCB} = 3.3 V ± 0.3 V		7	
			V_{CCB} = 5 V ± 0.5 V		7	
Fall time of B port	$t_{f(Bn)}$	Push-pull driving	V_{CCB} = 1.8 V ± 0.15 V		6	ns
			V_{CCB} = 2.5 V ± 0.2 V		6	
			V_{CCB} = 3.3 V ± 0.3 V		6	
			V_{CCB} = 5 V ± 0.5 V		6	
		Open-drain driving	V_{CCB} = 1.8 V ± 0.15 V		10	
			V_{CCB} = 2.5 V ± 0.2 V		9	
			V_{CCB} = 3.3 V ± 0.3 V		8	

Parameters	Symbol	Operate conditions	V_{CCB}	Min	Max	Unit
			V_{CCB} = 5 V ± 0.5 V		8	
Channel-to channel skew	t_{sk}		V_{CCB} = 1.8 V ± 0.15 V		1	ns
			V_{CCB} = 2.5 V ± 0.2 V		1	
			V_{CCB} = 3.3 V ± 0.3 V		1	
			V_{CCB} = 5 V ± 0.5 V		1	
Enable time, from OE (input) to A or B (output)	$t_{en(OE-A)}$ $t_{en(OE-B)}$		V_{CCB} = 1.8 V ± 0.15 V		300	ns
			V_{CCB} = 2.5 V ± 0.2 V		300	
			V_{CCB} = 3.3 V ± 0.3 V		300	
			V_{CCB} = 5 V ± 0.5 V		300	
Disable time, from OE (input) to A or B (output)	$t_{dis(OE-A)}$ $t_{dis(OE-B)}$		V_{CCB} = 1.8 V ± 0.15 V		450	ns
			V_{CCB} = 2.5 V ± 0.2 V		450	
			V_{CCB} = 3.3 V ± 0.3 V		450	
			V_{CCB} = 5 V ± 0.5 V		450	

Parameters	Symbol	Operate conditions	V_{CCB}	Min	Max	Unit
V_{CCA} = 2.5 V±0.2 V						
Propagation delay time (high to low), from A (input) to B (output)	$t_{PHL(A-B)}$	Push-pull driving	V_{CCB} = 2.5 V ± 0.2 V		8	ns
			V_{CCB} = 3.3 V ± 0.3 V		8	
			V_{CCB} = 5 V ± 0.5 V		8	
		Open-drain driving	V_{CCB} = 2.5 V ± 0.2 V		8	
			V_{CCB} = 3.3 V ± 0.3 V		8	
			V_{CCB} = 5 V ± 0.5 V		8	
Propagation delay time (high to low), from B (input) to A (output)	$t_{PHL(B-A)}$	Push-pull driving	V_{CCB} = 2.5 V ± 0.2 V		10	ns
			V_{CCB} = 3.3 V ± 0.3 V		9	
			V_{CCB} = 5 V ± 0.5 V		8	
		Open-drain driving	V_{CCB} = 2.5 V ± 0.2 V		8	
			V_{CCB} = 3.3 V ± 0.3 V		8	
			V_{CCB} = 5 V ± 0.5 V		8	
Propagation delay time (low to high), from A (input) to B (output)	$t_{PLH(A-B)}$	Push-pull driving	V_{CCB} = 2.5 V ± 0.2 V		8	ns
			V_{CCB} = 3.3 V ± 0.3 V		8	
			V_{CCB} = 5 V ± 0.5 V		9	
		Open-drain driving	V_{CCB} = 2.5 V ± 0.2 V		200	

Parameters	Symbol	Operate conditions	V_{CCB}	Min	Max	Unit
			V_{CCB} = 3.3 V ± 0.3 V		200	
			V_{CCB} = 5 V ± 0.5 V		200	
Propagation delay time (low to high), from B (input) to A (output)	$t_{PLH(B-A)}$	Push-pull driving	V_{CCB} = 2.5 V ± 0.2 V		8	ns
			V_{CCB} = 3.3 V ± 0.3 V		7	
			V_{CCB} = 5 V ± 0.5 V		6	
		Open-drain driving	V_{CCB} = 2.5 V ± 0.2 V		200	
			V_{CCB} = 3.3 V ± 0.3 V		200	
			V_{CCB} = 5 V ± 0.5 V		200	
Rise time of A port	$t_{r(An)}$	Push-pull driving	V_{CCB} = 2.5 V ± 0.2 V		12	ns
			V_{CCB} = 3.3 V ± 0.3 V		11	
			V_{CCB} = 5 V ± 0.5 V		12	
		Open-drain driving[1]	V_{CCB} = 2.5 V ± 0.2 V		200	
			V_{CCB} = 3.3 V ± 0.3 V		200	
			V_{CCB} = 5 V ± 0.5 V		200	
Rise time of B port	$t_{r(Bn)}$	Push-pull driving	V_{CCB} = 2.5 V ± 0.2 V		12	ns
			V_{CCB} = 3.3 V ± 0.3 V		10	
			V_{CCB} = 5 V ± 0.5 V		6	
		Open-drain driving[1]	V_{CCB} = 2.5 V ± 0.2 V		450	
			V_{CCB} = 3.3 V ± 0.3 V		350	
			V_{CCB} = 5 V ± 0.5 V		150	
Fall time of A port	$t_{f(An)}$	Push-pull driving	V_{CCB} = 2.5 V ± 0.2 V		7	ns
			V_{CCB} = 3.3 V ± 0.3 V		7	
			V_{CCB} = 5 V ± 0.5 V		7	
		Open-drain driving	V_{CCB} = 2.5 V ± 0.2 V		8	
			V_{CCB} = 3.3 V ± 0.3 V		8	
			V_{CCB} = 5 V ± 0.5 V		8	
Fall time of B port	$t_{f(Bn)}$	Push-pull driving	V_{CCB} = 2.5 V ± 0.2 V		8	ns
			V_{CCB} = 3.3 V ± 0.3 V		8	
			V_{CCB} = 5 V ± 0.5 V		8	
		Open-drain driving	V_{CCB} = 2.5 V ± 0.2 V		9	
			V_{CCB} = 3.3 V ± 0.3 V		9	
			V_{CCB} = 5 V ± 0.5 V		9	

Parameters	Symbol	Operate conditions	V_{CCB}	Min	Max	Unit
Channel-to channel skew	t_{sk}		V_{CCB} = 2.5 V ± 0.2 V		1	ns
			V_{CCB} = 3.3 V ± 0.3 V		1	
			V_{CCB} = 5 V ± 0.5 V		1	
Enable time, from OE (input) to A or B (output)	$t_{en(OE-A)}$ $t_{en(OE-B)}$		V_{CCB} = 2.5 V ± 0.2 V		100	ns
			V_{CCB} = 3.3 V ± 0.3 V		150	
			V_{CCB} = 5 V ± 0.5 V		250	
Disable time, from OE (input) to A or B (output)	$t_{dis(OE-A)}$ $t_{dis(OE-B)}$		V_{CCB} = 2.5 V ± 0.2 V		400	ns
			V_{CCB} = 3.3 V ± 0.3 V		400	
			V_{CCB} = 5 V ± 0.5 V		400	

Parameters	Symbol	Operate conditions	V_{CCB}	Min	Max	Unit
V_{CCA} = 3.3 V±0.3 V						
Propagation delay time (high to low), from A (input) to B (output)	$t_{PHL(A-B)}$	Push-pull driving	V_{CCB} = 3.3 V ± 0.3 V		8	ns
			V_{CCB} = 5 V ± 0.5 V		8	
		Open-drain driving	V_{CCB} = 3.3 V ± 0.3 V		8	
			V_{CCB} = 5 V ± 0.5 V		8	
Propagation delay time (high to low), from B (input) to A (output)	$t_{PHL(B-A)}$	Push-pull driving	V_{CCB} = 3.3 V ± 0.3 V		8	ns
			V_{CCB} = 5 V ± 0.5 V		8	
		Open-drain driving	V_{CCB} = 3.3 V ± 0.3 V			
			V_{CCB} = 5 V ± 0.5 V			
Propagation delay time (low to high), from A (input) to B (output)	$t_{PLH(A-B)}$	Push-pull driving	V_{CCB} = 3.3 V ± 0.3 V		7	ns
			V_{CCB} = 5 V ± 0.5 V		7	
		Open-drain driving	V_{CCB} = 3.3 V ± 0.3 V		200	
			V_{CCB} = 5 V ± 0.5 V		200	
Propagation delay time (low to high), from B (input) to A (output)	$t_{PLH(B-A)}$	Push-pull driving	V_{CCB} = 3.3 V ± 0.3 V		7	ns
			V_{CCB} = 5 V ± 0.5 V		5	
		Open-drain driving	V_{CCB} = 3.3 V ± 0.3 V		200	
			V_{CCB} = 5 V ± 0.5 V		200	
Rise time of A port	$t_{r(An)}$	Push-pull driving	V_{CCB} = 3.3 V ± 0.3 V		10	ns
			V_{CCB} = 5 V ± 0.5 V		11	
		Open-drain driving[1]	V_{CCB} = 3.3 V ± 0.3 V		200	
			V_{CCB} = 5 V ± 0.5 V		150	

Parameters	Symbol	Operate conditions	V_{CCB}	Min	Max	Unit
Rise time of B port	$t_{r(Bn)}$	Push-pull driving	V_{CCB} = 3.3 V ± 0.3 V		11	ns
			V_{CCB} = 5 V ± 0.5 V		6	
		Open-drain driving[1]	V_{CCB} = 3.3 V ± 0.3 V		200	
			V_{CCB} = 5 V ± 0.5 V		150	
Fall time of A port	$t_{f(An)}$	Push-pull driving	V_{CCB} = 3.3 V ± 0.3 V		7	ns
			V_{CCB} = 5 V ± 0.5 V		7	
		Open-drain driving	V_{CCB} = 3.3 V ± 0.3 V		7	
			V_{CCB} = 5 V ± 0.5 V		7	
Fall time of B port	$t_{f(Bn)}$	Push-pull driving	V_{CCB} = 3.3 V ± 0.3 V		8	ns
			V_{CCB} = 5 V ± 0.5 V		8	
		Open-drain driving	V_{CCB} = 3.3 V ± 0.3 V		8	
			V_{CCB} = 5 V ± 0.5 V		8	
Channel-to channel skew	t_{sk}		V_{CCB} = 3.3 V ± 0.3 V		1	ns
			V_{CCB} = 5 V ± 0.5 V		1	
Enable time, from OE (input) to A or B (output)	$t_{en(OE-A)}$ $t_{en(OE-B)}$		V_{CCB} = 3.3 V ± 0.3 V		100	ns
			V_{CCB} = 5 V ± 0.5 V		150	
Disable time, from OE (input) to A or B (output)	$t_{dis(OE-A)}$ $t_{dis(OE-B)}$		V_{CCB} = 3.3 V ± 0.3 V		400	ns
			V_{CCB} = 5 V ± 0.5 V		400	

[1] Strongly correlated with the rising speed of the input signal. During open-drain testing, the externally used NMOS model is 2N7002 (from ON semiconductor).

6.4. Parameter Measurement Information

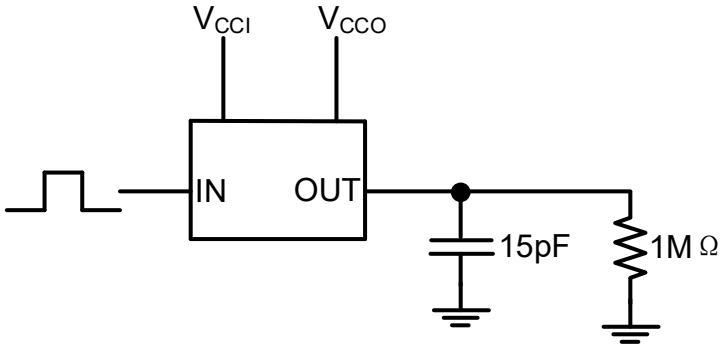


Figure 6. 1 Test circuit for data rate, pulse duration, propagation delay, output rise time, and fall time using push-pull driver

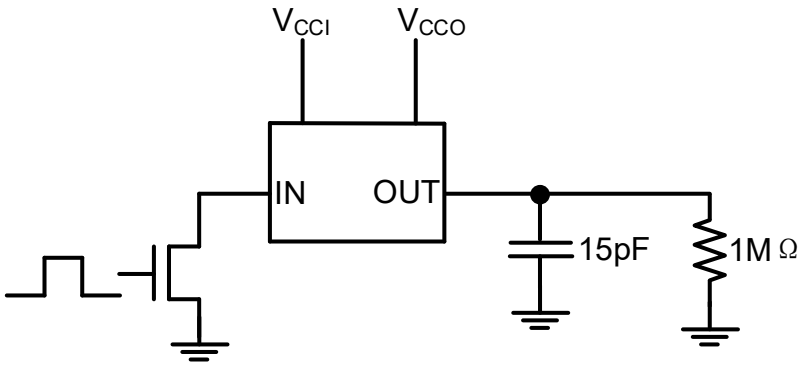


Figure 6. 2 Test circuit for data rate, pulse duration, propagation delay, output rise time, and fall time using open-drain driver

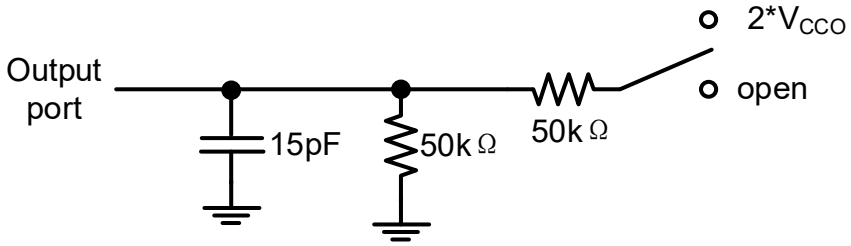


Figure 6. 3 Load circuit for enable time and disable time measurement

Notes:

1. S1 switches to 2×V_{CCO} when t_{PZL} and t_{PLZ} are measured.
2. S1 switches to Open when t_{PZH} and t_{PHZ} are measured.
3. t_{PLZ} and t_{PHZ} are the same as t_{dis}.
4. t_{PZL} and t_{PZH} are the same as t_{en}.
5. V_{CCI} is the VCC associated with the input port.
6. V_{CCO} is the VCC associated with the output port.

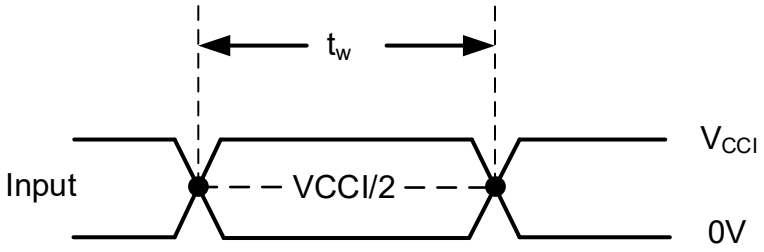


Figure 6. 4 Pulse duration

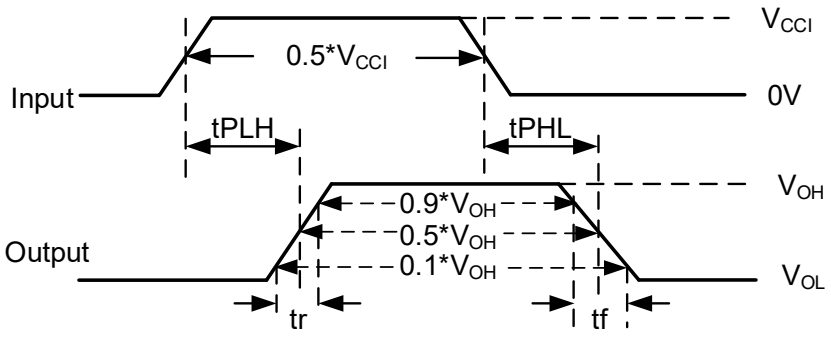


Figure 6. 5 Propagation delay, rise and fall time

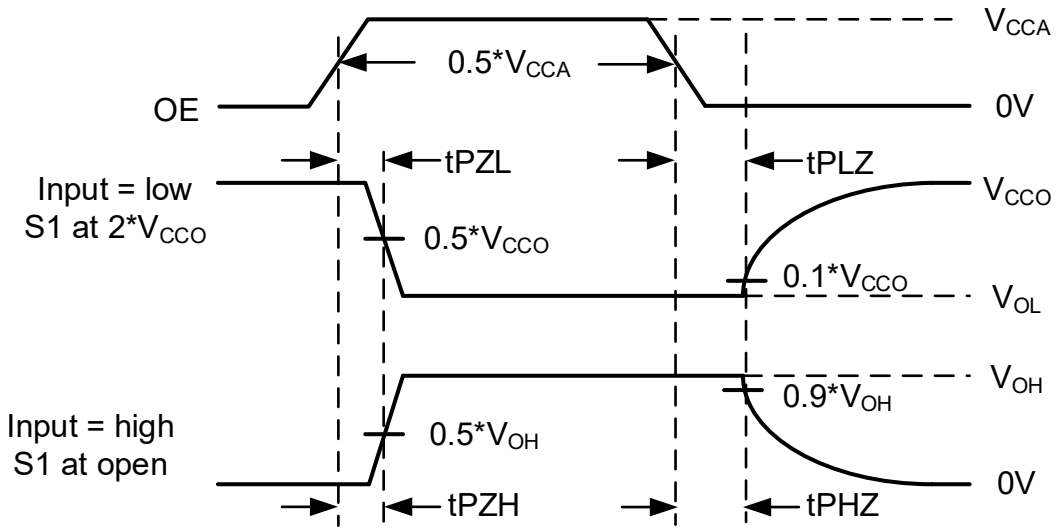


Figure 6. 6 Enable and disable time

7. Function Description

7.1. Overview

NCAS0104-Q1 device is a directionless voltage-level translator specifically designed for translating logic voltage levels. The A port can accept I/O voltages ranging from 1.1 V to 3.6 V, while the B port can accept I/O voltages from 1.65 V to 5.5 V. The device is a pass gate architecture with edge rate accelerators (one shots) to improve the overall data rate. Internal pullup 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.

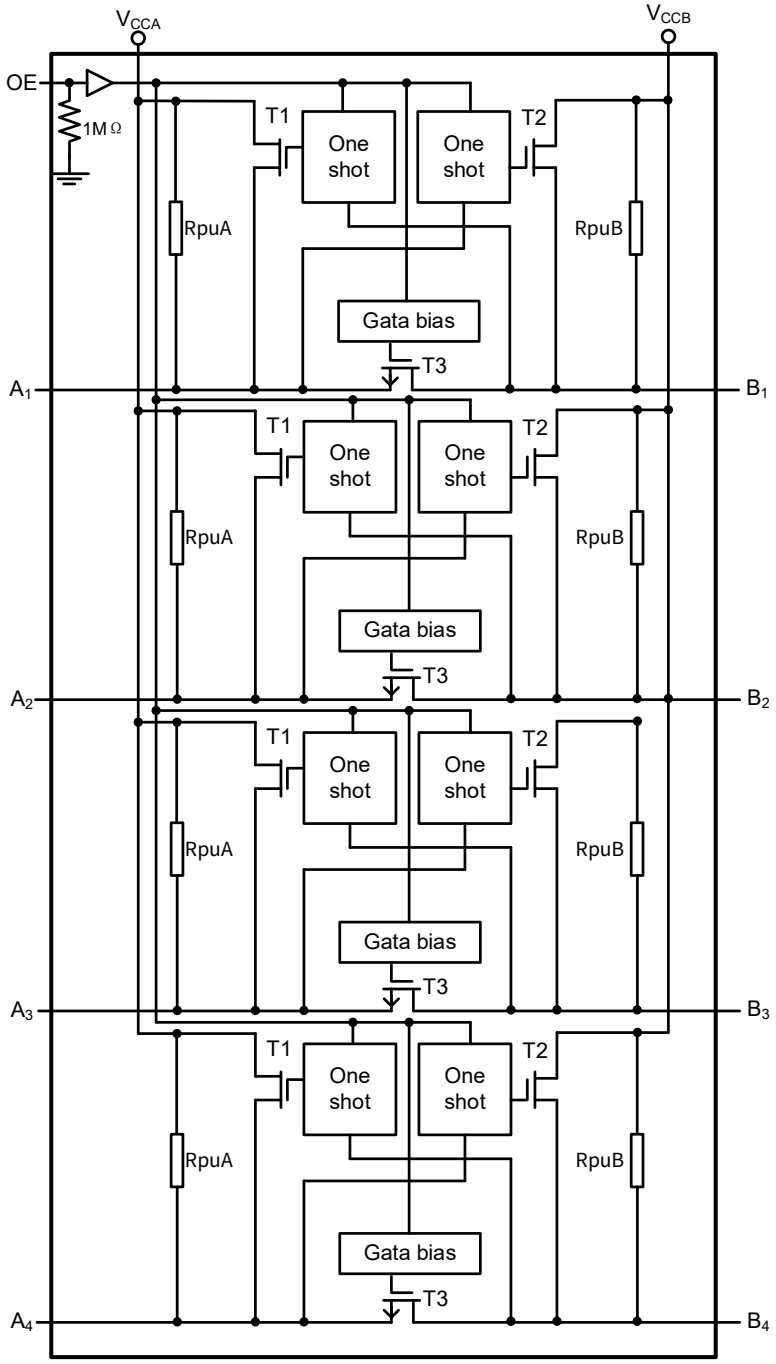


Figure 7. 1 Functional block diagram of NCAS0104-Q1

7.2. Architecture

The NCAS0104-Q1 architecture does not need a direction-control signal to control the direction of data flow from A to B or from B to A. Each A-port I/O has an internal pullup resistor (RpuA) to V_{CCA}, and each B-port I/O has an internal pullup resistor (RpuB) 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.

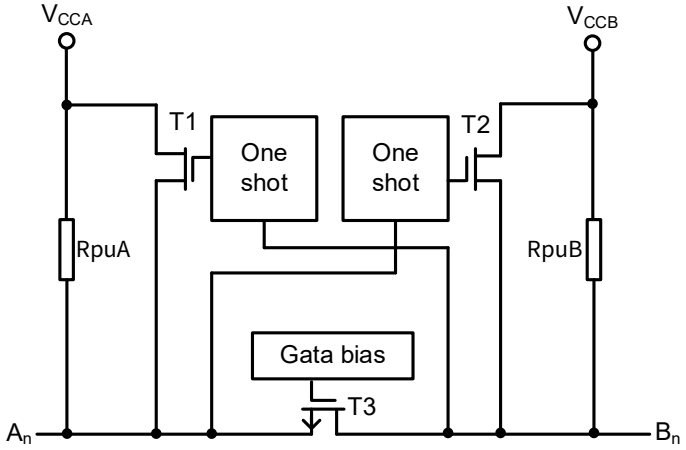


Figure 7. 2 Architecture of NCAS0104-Q1 I/O cell (one channel)

7.3. Input Driver Requirements

The fall time ($t_{f(An)}$, $t_{f(Bn)}$) of a signal depends on the output impedance of the external device driving the data I/Os of the NCAS0104-Q1 device. Similarly, the t_{PHL} and maximum data rate also depend on the output impedance of the external driver. The values for $t_{f(An)}$, $t_{f(Bn)}$, t_{PHL}, and maximum data rate in the datasheet assume that the output impedance of the external driver is less than 50 Ω.

7.4. Power Up

During operation V_{CCA} must never be higher than V_{CCB}, however during power-up $V_{CCA} \geq V_{CCB}$ does not damage the device, so any power supply can be ramped up first. There is no special power-up sequencing required. The NCAS0104-Q1 includes circuitry that disables all output ports when either V_{CCA} or V_{CCB} is switched off.

7.5. Enable and disable

The NCAS0104-Q1 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. To ensure the high-impedance OFF-state during power-up or power-down, pin 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. The OE internally integrates a 1MΩ pull-down resistor, ensuring that the chip is in a disabled state by default after power-up. It is recommended to enable OE only after the V_{CCA} and V_{CCB} have stabilized.

The disable time (tdis) indicates the delay between the time when the OE pin goes low and when the outputs enter the high-impedance state. The enable time (ten) indicates the amount of time the user must allow for the one-shot circuitry to become operational after the OE pin is taken high.

7.6. Pull-up or pull-down resistors on I/O lines

The NCAS0104-Q1 has the smart pull-up resistors dynamically change value based on whether a low or a high is being passed through the I/O line. Each A-port I/O has a pull-up resistor (RpuA) to V_{CCA}, and each B-port I/O has a pull-up resistor (RpuB) to V_{CCB}. RpuA and RpuB have a value of 20kΩ when the output is driving low. RpuA and RpuB have a value of 4kΩ when the output is driving lo when the output is driving high.

If a smaller value of pull-up resistor is required, an external resistor must be added parallel to the internal pull-ups, this will affect the V_{OL} level. When OE goes low the internal pull-ups of the NCAS0104-Q1 are disabled.

8. Typical Application

The NCAS0104-Q1 device can be used in level-translation applications for interfacing devices or systems operating at different interface voltages with one another. The NCAS0104-Q1 device is optimal for use in applications where an open-drain driver is connected to the data I/Os. The NCAS0104-Q1 device can also be used in applications where a push-pull driver is connected to the data I/Os.

Unused I/O pins must not be left floating to prevent oscillation caused by high-impedance inputs, which would affect the chip's power consumption and stability. It is recommended to tie idle I/Os to the corresponding V_{CCA}/V_{CCB}.

When performing the PCB layout for NCAS0104-Q1, the following key points need to be considered:

(1) Power decoupling capacitor placement: Choose ceramic chip capacitors with low Equivalent Series Resistance (ESR) and place them as close as possible to the chip's V_{CCA} and V_{CCB} pins. It is recommended to use capacitors with a voltage rating of 10V and a capacitance of 100nF.

(2) Ground connection and return path design: Ensure a reliable electrical connection between the system's ground and the chip's ground on both sides of the chip. Minimize the length of the ground return path and prevent any discontinuity in the ground plane to guarantee the integrity of the grounding system.

(3) Signal trace layout: Keep signal traces as short and wide as possible. Strictly avoid using connectors to prevent excessive capacitive loading, which could negatively impact signal quality and system performance. One-shot triggers when they detect rising or falling edges. Reflection sand or ringing can cause false triggers. Ringing is also caused by capacitance and inductance of long cables and or traces and can also be amplified by unstable GND or V_{CCA}/V_{CCB}.

(4) Impedance matching design: Reserve positions for series resistors on the I/O signal traces. This allows for impedance matching, which can significantly improve signal integrity and ensure more stable signal transmission.

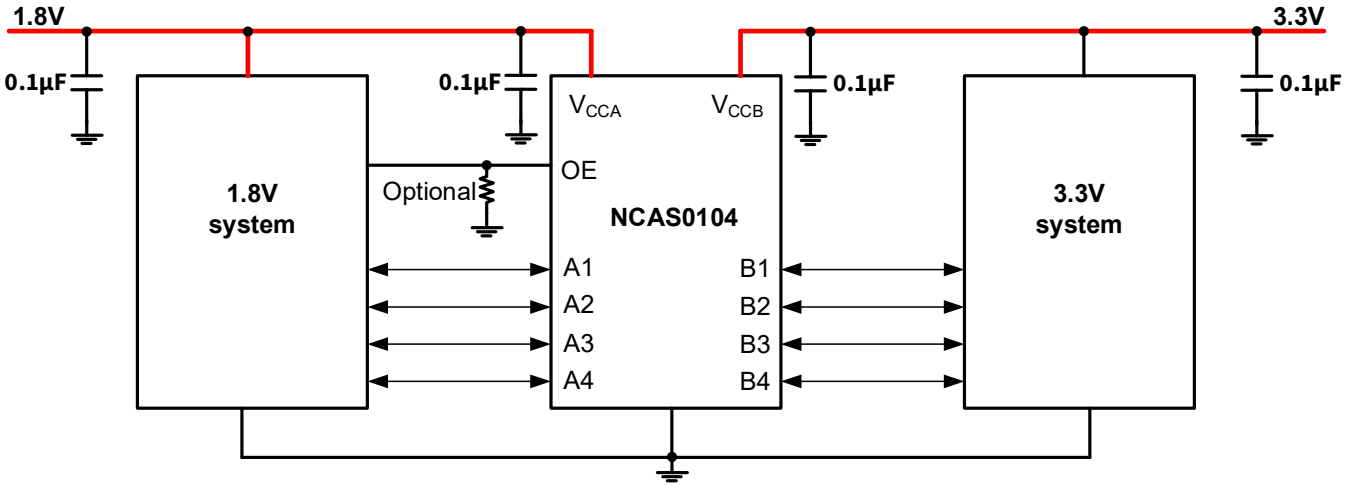
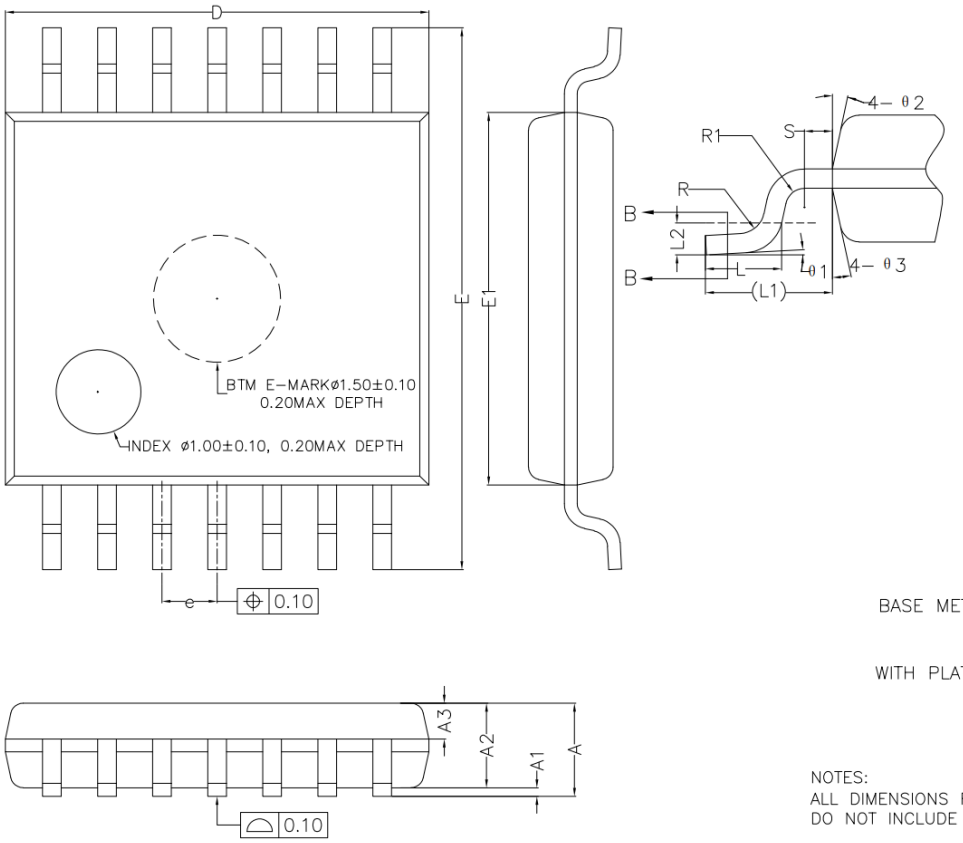


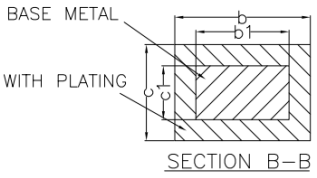
Figure 7. 3 Typical application of NCAS0104-Q1

9. Package Information



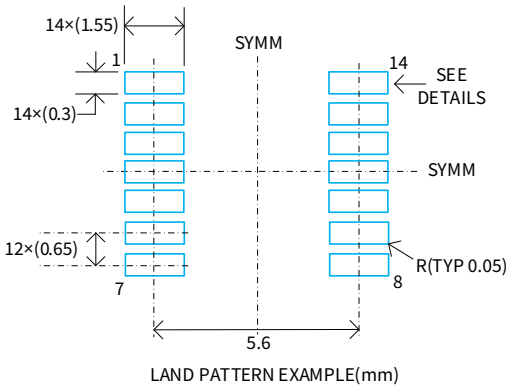
COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	–	–	1.20
A1	0.05	–	0.15
A2	0.90	1.00	1.05
A3	0.32	0.42	0.52
b	0.20	–	0.29
b1	0.19	0.22	0.25
c	0.15	–	0.20
c1	0.14	0.15	0.16
D	4.90	5.00	5.10
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.55	0.65	0.75
L	0.45	0.60	0.75
L1	1.00REF		
L2	0.25BSC		
R	0.09	–	–
R1	0.09	–	–
S	0.20	–	–
θ1	0°	–	8°
θ2	10°	12°	14°
θ3	10°	12°	14°



NOTES:
ALL DIMENSIONS REFER TO JEDEC STANDARD MO-153 AB-1
DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

Figure 8. 1 TSSOP14 package shape and dimension in millimeters for NCAS0104-Q1TSKR



LAND PATTERN EXAMPLE(mm)

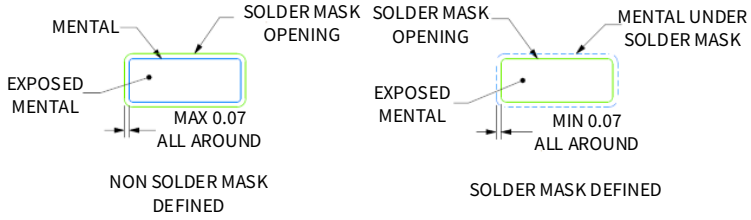
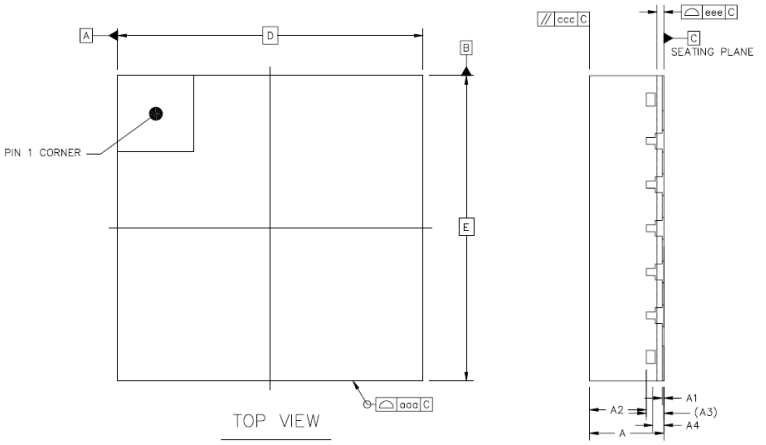
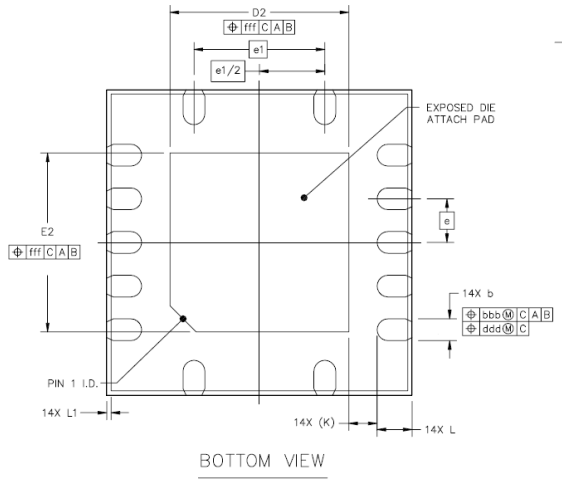


Figure 8. 2 TSSOP14 package board layout example for NCAS0104-Q1TSKR

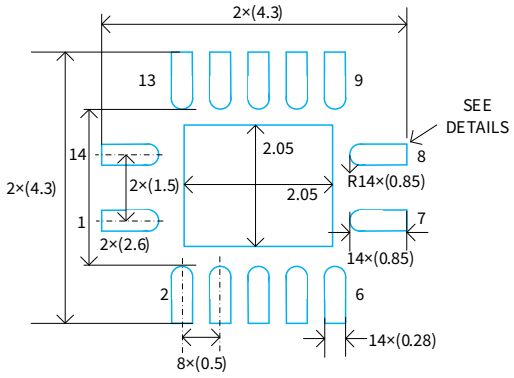


		SYMBOL	MIN	NOM	MAX
TOTAL THICKNESS		A	0.8	0.8500	0.9
STAND OFF		A1	0	0.02	0.0500
MOLD THICKNESS		A2	---	0.65	---
L/F THICKNESS		A3		0.203 REF	
SIDE WETTABLE DEPTH		A4	0.1	---	0.1800
LEAD WIDTH		b	0.2	0.25	0.3
BODY SIZE	X	D		3.5 BSC	
	Y	E		3.5 BSC	
LEAD PITCH		e		0.5 BSC	
		e1		1.5 BSC	
EP SIZE	X	D2	1.95	2.05	2.15
	Y	E2	1.95	2.05	2.15
LEAD LENGTH		L	0.3	0.4	0.5
SIDE WETTABLE WIDTH		L1	0.0100	---	0.0900
LEAD TIP TO EXPOSED PAD EDGE		K		0.325 REF	
PACKAGE EDGE TOLERANCE		aaa		0.1000	
MOLD FLATNESS		ccc		0.1000	
COPLANARITY		eee		0.0800	
LEAD OFFSET		bbb		0.1000	
		ddd		0.0500	
EXPOSED PAD OFFSET		fff		0.1000	



NOTES
1.REFER TO JEDEC MO-220;
2.COPLANARITY APPLIES TO LEADS, CORNER LEADS AND DIE ATTACH PAD;
3.BAN TO USE THE LEVEL 1 ENVIRONMENT-RELATED SUBSTANCES OF JCET PRESCRIBING;
4.FINISH: Cu/EP • Sn8~20s

Figure 8. 3 VQFN14 package shape and dimension in millimeters for NCAS0104-Q1QBCR



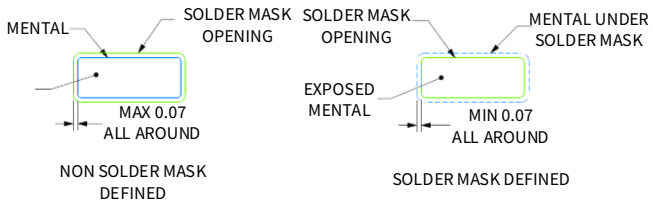
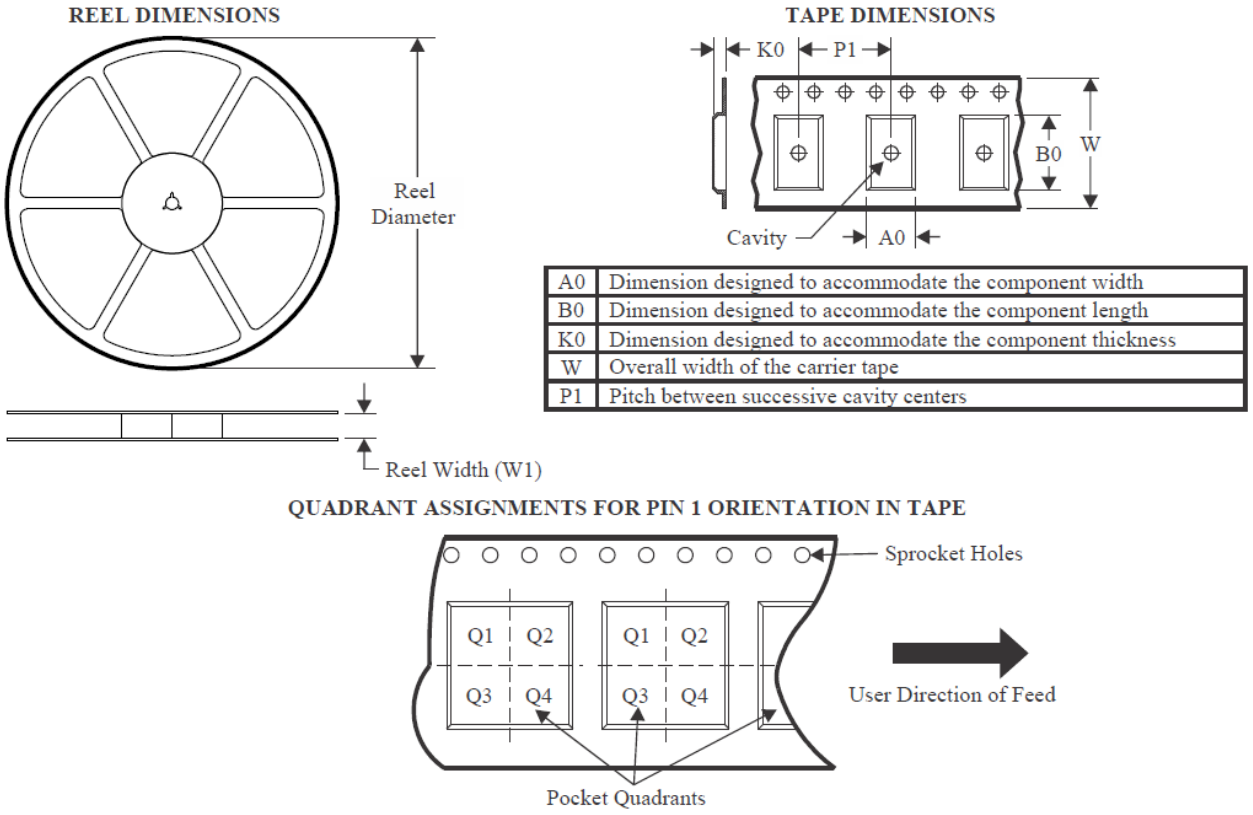


Figure 8. 4 VQFN14 package board layout example for NCAS0104-Q1QBCR

10. Order Information

Part Number	*Operating Temperature*	*MSL*	*Package*	*SPQ*
NCAS0104-Q1TSKR	-40 °C to 125 °C	3	TSSOP14	4000
NCAS0104-Q1QBCR	-40 °C to 125 °C	3	VQFN14	5000

11. Tape and Reel Information



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

Devices	*Package*	*Pins*	*Reel Diameter (mm)*	*Reel Width W1 (mm)*	*A0 (mm)*	*B0 (mm)*	*K0 (mm)*	*P1 (mm)*	*W (mm)*	*Pin1 Quadrant*
NCAS0104-Q1TSKR	TSSOP14	14	330	16.4	6.85	5.45	1.6	8.0	16.0	Q1
NCAS0104-Q1QBCR	VQFN14	14	330	12.4	3.8	3.8	1.1	8.0	12.0	Q1

Figure 10. 1 Tape and Reel Information in millimeters

12. Revision History

Revision	Description	Date
1.0	Initial version.	2026/3/9

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