DESCRIPTION

The AL0104-Q is a 4-bit non-inverting, bidirectional voltage-level translator that provides digital switching compatibility between mixed-voltage systems. It uses two separate configurable power-supply rails. The A ports support operating voltages from 1.65V to 5.5V, while the B ports support operating voltages from 2.3V to 5.5V, with each port voltage tracking its respective VCCA or VCCB supply.

The AL0104-Q supports bidirectional voltage-level translation between 1.8V, 2.5V, 3.3V, and 5V logic levels, enabling reliable interfacing between systems operating at different voltage levels.

When the output-enable (OE) input is low, all I/Os are placed in a high-impedance state, significantly reducing power-supply quiescent current consumption. OE has an internal pull-down current source as long as VCCA is powered. To ensure a high-impedance state during power-up or power-down, OE should be connected to GND through a pull-down resistor. The minimum resistor value is determined by the current-sourcing capability of the driving device.

The AL0104-Q is available in QFN12(1.7x2), QFN14(3.5x3.5) and TSSOP14 packages.

ORDERING INFORMATION

Package Type	Part Number	
QFN12(1.7x2) SPQ: 4,000pcs/Reel	Q12	AL0104Q12VR
		AL0104Q12VR-Q
TSSOP14 SPQ:4,000pcs/Reel	TMX14	AL0104TMX14VR
		AL0104TMX14VR-Q
QFN14(3.5x3.5) SPQ: 5,000pcs/Reel	Q14	AL0104Q14VR
		AL0104Q14VR-Q
Note	R: Tape & Reel V: Halogen free Package Q: AEC-Q	
AiT provides all RoHS products		

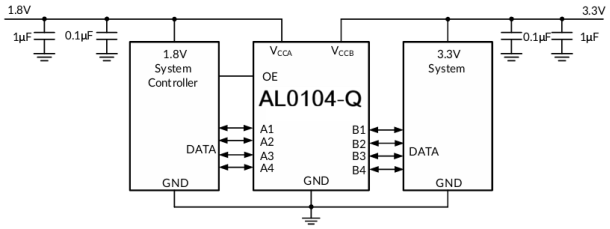
FEATURES

- Suffix Q devices are AEC-Q 100 Qualified.
- Direction-Control Free Operation
- Supports Data Rates:
  24Mbps (Push-Pull Mode)
  2Mbps (Open-Drain Mode)
- Wide Supply Voltage Range: ($V_{CCA} \leq V_{CCB}$)
  V_{CCA}: 1.65V to 5.5V
  V_{CCB}: 2.3V to 5.5V
- V_{CC} Isolation Feature:
  If either V_{CCA} or V_{CCB} is at GND, both A and B ports remain in a High-Impedance state.
- No Power-Supply Sequencing Required:
  Either V_{CCA} or V_{CCB} may be powered up first.
- I_{OFF} Supports Partial Power-Down Operation
- Extended Operating Temperature Range:
  -40°C to +125°C

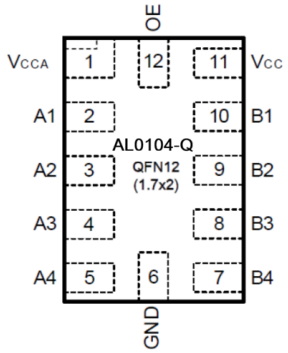
APPLICATION

- Automotive Infotainment
- Advance Driver Assistance Systems (ADAS)
- Telematics

TYPICAL APPLICATION

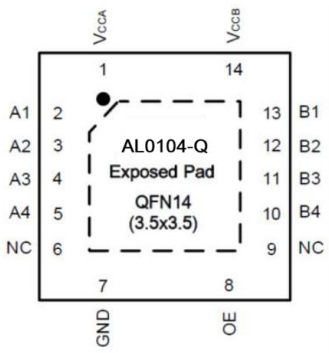


PIN DESCIPTION



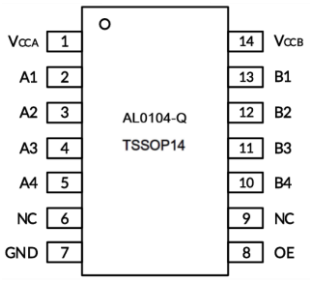
QFN12(1.7x2), Q12

Top View



QFN14(3.5x3.5), Q14

Top View



TSSOP14, TMX14

Top View

PIN#			Symbol	I/O	Function
QFN12	QFN14	TSSOP14			
1	1	1	V_{CCA}	P	A Port Supply Voltage. 1.65V ≤ V_{CCA} ≤ 5.5V and V_{CCA} ≤ V_{CCB}
2	2	2	A1	I/O	Input/output A1. Reference to V_{CCA}.
3	3	3	A2	I/O	Input/output A2. Reference to V_{CCA}.
4	4	4	A3	I/O	Input/output A3. Reference to V_{CCA}.
5	5	5	A4	I/O	Input/output A4. Reference to V_{CCA}.
-	6	6	NC	-	No internal connection.
6	7	7	GND	GND	Ground.
12	8	8	OE	I	Output Enable (Active High). Pull OE low to place all outputs in 3-state mode. Referenced to V_{CCA}.
-	9	9	NC	-	No internal connection.
7	10	10	B4	I/O	Input/output B4. Reference to V_{CCB}.
8	11	11	B3	I/O	Input/output B3. Reference to V_{CCB}.
9	12	12	B2	I/O	Input/output B2. Reference to V_{CCB}.
10	13	13	B1	I/O	Input/output B1. Reference to V_{CCB}.
11	14	14	V_{CCB}	P	B Ports Supply Voltage. 2.3V ≤ V_{CCB} ≤ 5.5V.
	Exposed PAD	Thermal PAD			Exposed pad should be soldered to PCB board and connected to GND or left floating.

I=input, O=output, I/O=input and output, P=power. GND=Ground

ABSOLUTE MAXIMUM RATINGS

T_A = 25°C, unless otherwise specified.

V_{CCA}, Supply Voltage Range		-0.3V ~ + 6V
V_{CCB}, Supply Voltage Range		-0.3V ~ + 6V
V_I (1), Input Voltage Range	A Port	-0.3V ~ + 6V
	B Port	-0.3V ~ + 6V
	OE	-0.3V ~ + 6V
V_O (1), Voltage range applied to any output in the high impedance or power-off state	A Port	-0.3V ~ + 6V
	B Port	-0.3V ~ + 6V
V_O (1)(2), Voltage range applied to any output in the high or low state	A Port	-0.3V ~ V_{CCA} + 0.3V
	B Port	-0.3V ~ V_{CCB} + 0.3V
I_{IK}, Input Clamp Current	V_I < 0V	-50mA
I_{OK}, Output Clamp Current	V_O < 0V	-25mA
I_O, Continuous Output Current		±50mA
I_O, Continuous Current through V_{CCA} V_{CCB} or GND		±100mA
θ_{JA}, Package Thermal Impedance (3)	QFN12(1.7x2)	120°C/W
	TSSOP14	121°C/W
	QFN14(3.5x3.5)	53°C/W
T_J, Junction Temperature (4)		-40℃ ~ +150℃
T_{STG}, Storage Temperature		-65℃ ~ +150℃
$V_{(ESD)}$, Electrostatic Discharge	Human-Body Model (HBM), per AEC Q100-002 (5)	±2000V
	Charged-Device Model (CDM), per AEC Q100-011	±1000V
	Latch-Up (LU), per AEC Q100-004	±100mA

Stresses above may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated in the Electrical Characteristics are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

(1) The input and output negative-voltage ratings may be exceeded if the input and output current ratings are observed.
(2) The value of VCCA and VCCB are provided in the recommended operating conditions table.
(3) The package thermal impedance is calculated in accordance with JESD-51.
(4) The maximum power dissipation is a function of TJ(MAX), RθJA, and TA. The maximum allowable power dissipation at any ambient temperature is PD = (T J(MAX) - TA) / RθJA. All numbers apply for packages soldered directly onto a PCB.
(5) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

RECOMMENDED OPERATING CONDITIONS

T_A = 25°C (Room Temperature), unless otherwise specified.

Parameter	Symbol	Conditions		Min	Typ.	Max	Unit
Supply Voltage	V_{CCA}	-		1.65	-	5.50	V
	V_{CCB}	-		2.30	-	5.50	
High-Level Input Voltage	V_{IH}	A-port I/Os	V_{CCA} = 1.65 V~ 1.95 V V_{CCB} = 2.3 V~ 5.5 V	V_{CCI} – 0.2	-	V_{CCI}	
			V_{CCA} = 2.3 V ~ 5.5 V V_{CCB} = 2.3 V~ 5.5 V	V_{CCI} – 0.4	-	V_{CCI}	
		B-port I/Os	V_{CCA} = 1.65 V~ 5.5 V V_{CCB} = 2.3 V ~ 5.5 V	V_{CCI} – 0.4	-	V_{CCI}	
		OE input	V_{CCA} = 1.65 V~5.5 V V_{CCB} = 2.3 V~ 5.5 V	V_{CCI} x 0.8	-	5.50	
Low-Level Input Voltage	V_{IL}	A-port I/Os	V_{CCA} = 1.65 V~ 1.95 V V_{CCB} = 2.3 V~ 5.5 V	0	-	0.15	V
		B-port I/Os	V_{CCA} = 1.65 V~ 5.5 V V_{CCB} = 2.3 V ~ 5.5 V	0	-	0.15	
		OE input	V_{CCA} = 1.65 V~5.5 V V_{CCB} = 2.3 V~ 5.5 V	0	-	V_{CCA} × 0.25	
Input transition rise or fall rate	(Δt/Δv)	A-port I/Os push-pull driving		-	-	10	V
		B-port I/Os push-pull driving		-	-	10	
		Control input		-	-	10	
Operating free-air temperature	T_A	-		-40	-	+125	°C

ELECTRICAL CHARACTERISTICS

Over recommended operating room 25°C temperature range, unless otherwise specified

Parameter		Conditions		Min (1)	Typ. (2)	Max (3)	Unit
V_{OHA}	Port A Output High Voltage	I_{OH} = -20μA, $V_{IB} \geq V_{CCB} - 0.4V$ V_{CCA}=1.65V~5.5V V_{CCB}=2.3V~5.5V	-40℃ ~ +125℃	V_{CCA} × 0.7	-	-	V
V_{OLA}	Port A Output Low Voltage	I_{OL} = 1mA, $V_{IB} \leq 0.15$ V V_{CCA}=1.65V~5.5V V_{CCB}=2.3V~5.5V	-40℃ ~ +125℃	-	-	0.3	
V_{OHB}	Port B Output High Voltage	I_{OH} = -20μA, $V_{IB} \geq V_{CCB} - 0.2V$ V_{CCA}=1.65V~5.5V V_{CCB}=2.3V~5.5V	-40℃ ~ +125℃	V_{CCB} × 0.7	-	-	
V_{OLB}	Port B Output High Voltage	I_{OL} = 1mA, $V_{IB} \leq 0.15$ V V_{CCA}=1.65V~5.5V V_{CCB}=2.3V~5.5V	-40℃ ~ +125℃	-	-	0.3	
I_I	Input Leakage Current	OE, V_{CCA}=1.65V~5.5V V_{CCB}=2.3V~5.5V	+25℃	-	-	±1	μA
			-40℃ ~ +125℃	-	-	±1.5	
I_{off}	Partial Power Down Current	A Ports, V_{CCA}=0V, V_{CCB}=0V~5.5V	+25℃	-	-	±0.5	μA
			-40℃ ~ +125℃	-	-	±1	
		A Ports, V_{CCA}=0V~5.5V, V_{CCB}=0V~5.5V	+25℃	-	-	±0.5	μA
			-40℃ ~ +125℃	-	-	±1	
I_{OZ}	High-Impedance State Output Current	A or B port, OE=0V V_{CCA}=1.65V~5.5V V_{CCB}=2.3V~5.5V	+25℃	-	-	±0.5	μA
			-40℃ ~ +125℃	-	-	±1	
I_{CCA}	V_{CCA} Supply Current	V_I = V_O = open, I_O = 0 V_{CCA}=1.65V~ V_{CCB} V_{CCB}=2.3V~5.5V	-40℃ ~ +125℃	-	-	1	μA
		V_I = V_O = open, I_O = 0 V_{CCA}=5.5 V, V_{CCB}=0V	-40℃ ~ +125℃	-	-	1	
		V_I = V_O = open, I_O = 0 V_{CCA}=0V, V_{CCB}=5.5V	-40℃ ~ +125℃	-	-	-1	

Parameter		Conditions		Min (1)	Typ. (2)	Max (3)	Unit
I_{CCB}	V_{CCB} Supply Current	V_I = V_O = open, I_O = 0 V_{CCA}=1.65V~ V_{CCB} V_{CCB}=2.3V~5.5V	-40℃ ~ +125℃	-	-	10	μA
		V_I = V_O = open, I_O = 0 V_{CCA}=5.5 V, V_{CCB}=0V	-40℃ ~ +125℃	-	-	-1	
		V_I = V_O = open, I_O = 0 V_{CCA}=0V, V_{CCB}=5.5V	-40℃ ~ +125℃	-	-	1	
I_{CCA} + I_{CCB}	Combined Supply Current	V_I = V_O = open, I_O = 0 V_{CCA}=1.65V~ V_{CCB} V_{CCB}=2.3V~5.5V	-40℃ ~ +125℃	-	-	15	μA
I_{CCAZ}	V_{CCA} Supply Current	V_I = V_{CCI} or 0V, I_O = 0, OE=0V, V_{CCA}=1.65V~ V_{CCB} V_{CCB}=2.3V~5.5V	-40℃ ~ +125℃	-	-	1	μA
I_{CCBZ}	V_{CCB} Supply Current	V_I = V_{CCI} or 0V, I_O = 0, OE=0V, V_{CCA}=2.3V~5.5V V_{CCB}=2.3V~5.5V	-40℃ ~ +125℃	-	-	1	μA
Ci	Input Capacitance	OE, V_{CCA}=3.3V V_{CCB}=3.3V	+25℃	-	2.5	-	pF
C_{IO}	Input-to-Output Internal Capacitance	A Port, V_{CCA}=3.3V V_{CCB}=3.3V	+25℃	-	5	-	pF
		B Port, V_{CCA}=3.3V V_{CCB}=3.3V	+25℃	-	5	-	

(1) V_{CCI} is the V_{CC} associated with the input port.
(2) V_{CCO} is the V_{CC} associated with the output port
(3) V_{CCA} must be less than or equal to V_{CCB}.
(4) Limits are 100% production tested at 25°C. Limits over the operating temperature range are ensured through correlations using statistical quality control (SQC) method.
(5) Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration.
(6) For I/O ports, the parameter I_{OZ} includes the input leakage current.

TIMING REQUIREMENTS

V_{CCA}=1.8V±0.15 V

Parameter		V_{CCB}=2.5V ±0.2V	V_{CCB}=3.3V ±0.2V	V_{CCB}=5V ±0.2V	Unit
		Typ.	Typ.	Typ.	
Data Rate	Push-pull driving	21	22	24	Mbps
	Open-drain driving	2	2	2	
Pulse Duration(t_w)	Push-pull driving (data inputs)	47	45	41	ns
	Open-drain driving (data inputs)	500	500	500	

V_{CCA}=2.5V±0.15 V

Parameter		V_{CCB}=2.5V ±0.2V	V_{CCB}=3.3V ±0.2V	V_{CCB}=5V ±0.2V	Unit
		Typ.	Typ.	Typ.	
Data Rate	Push-pull driving	20	22	24	Mbps
	Open-drain driving	2	2	2	
Pulse Duration(t_w)	Push-pull driving (data inputs)	50	45	41	ns
	Open-drain driving (data inputs)	500	500	500	

V_{CCA}=3.3V±0.15 V

Parameter		V_{CCB}=3.3V ±0.2V	V_{CCB}=5V ±0.2V	Unit
		Typ.	Typ.	
Data Rate	Push-pull driving	23	24	Mbps
	Open-drain driving	2	2	
Pulse Duration(t_w)	Push-pull driving (data inputs)	43	41	ns
	Open-drain driving (data inputs)	500	500	

V_{CCA}=5V±0.15 V

Parameter		V_{CCB}=5V ±0.2V	Unit
		Typ.	
Data Rate	Push-pull driving	24	Mbps
	Open-drain driving	2	
Pulse Duration(t_w)	Push-pull driving (data inputs)	41	ns
	Open-drain driving (data inputs)	500	

SWITCHING CHARACTER

V_{CCA}=1.8V ± 0.15V

Over recommended operating free-air temperature range (unless otherwise noted) (1)

PARAMETER		CONDITIONS		V_{CCB}=2.5V±0.2V			V_{CCB}=3.3V±0.2V			V_{CCB}=5V±0.2V			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{PHL}	Propagation delay time high-to-low output	A-to-B	Push-pull driving	1.2	-	3.8	1.5	-	4.7	2.2	-	6.8	ns
			Open-drain driving	13	-	39.2	13.2	-	39.6	13.3	-	40	
t_{PLH}	Propagation delay time low-to-high output	A-to-B	Push-pull driving	2.1	-	6.3	1.8	-	5.6	1.8	-	5.4	ns
			Open-drain driving	110	-	332	91.5	-	275	71.5	-	215	
t_{PHL}	Propagation delay time high-to-low output	B-to-A	Push-pull driving	1.0	-	3.2	1.0	-	3.0	1.1	-	3.3	ns
			Open-drain driving	13	-	39.2	13	-	39.2	13.1	-	39.3	
t_{PLH}	Propagation delay time low-to-high output	B-to-A	Push-pull driving	0.9	-	2.7	0.8	-	2.4	0.7	-	2.3	ns
			Open-drain driving	86.5	-	260	44.5	-	134	33	-	99	
t_{en}	Enable time	OE-to-A or B		12.5	-	-	10.5	-	31.5	9.5	-	28.5	ns
t_{dis}	Disable time	OE-to-A or B		625	-	-	625	-	1875	625	-	1875	ns
t_{rA}	Input rise time	A port rise time	Push-pull driving	3.4	-	10.4	3.0	-	9.2	2.8	-	8.4	ns
			Open-drain driving	59	-	177	19.5	-	58.5	6.5	-	19.5	
t_{rB}	Input rise time	B port rise time	Push-pull driving	2.9	-	8.7	2.4	-	7.2	2.0	-	6.2	ns
			Open-drain driving	83	-	249	63.5	-	191	37.5	-	113	
t_{fA}	Input fall time	A port fall time	Push-pull driving	1.5	-	4.5	1.4	-	4.2	1.3	-	4.1	ns
			Open-drain driving	0.9	-	2.9	0.8	-	2.6	0.8	-	2.4	
t_{fB}	Input fall time	B port fall time	Push-pull driving	2.4	-	7.2	3.1	-	9.3	4.2	-	12.6	ns
			Open-drain driving	1.1	-	3.5	1.2	-	3.6	1.4	-	4.2	
$t_{SK(O)}$	Skew(time), output	Channel-to-Channel Skew		-	-	-	-	-	0.8	-	-	0.8	ns
Maximum data rata		Push-pull driving		-	21	-	-	22	-	-	24	-	Mbps
		Open-drain driving		-	2	-	-	2	-	-	2	-	

(1) This parameter is ensured by design and/or characterization and is not tested in production.

V_{CCA}=2.5V ± 0.15V

Over recommended operating free-air temperature range (unless otherwise noted) (1)

PARAMETER		CONDITIONS		V_{CCB}=2.5V±0.2V			V_{CCB}=3.3V±0.2V			V_{CCB}=5V±0.2V			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{PHL}	Propagation delay time high-to-low output	A-to-B	Push-pull driving	1.4	-	4.2	1.7	-	5.1	2.5	-	7.5	ns
			Open-drain driving	13.1	-	39.5	13.2	-	39.8	13.3	-	40	
t_{PLH}	Propagation delay time low-to-high output	A-to-B	Push-pull driving	1.3	-	4.1	1.2	-	3.8	1.2	-	3.6	ns
			Open-drain driving	99	-	297	84.5	-	254	65.5	-	197	
t_{PHL}	Propagation delay time high-to-low output	B-to-A	Push-pull driving	1.2	-	3.8	1.2	-	3.6	1.2	-	3.8	ns
			Open-drain driving	13.2	-	39.6	13.2	-	39.8	13.3	-	40	
t_{PLH}	Propagation delay time low-to-high output	B-to-A	Push-pull driving	1.0	-	3.2	1.0	-	3.0	0.9	-	2.9	ns
			Open-drain driving	98	-	294	69	-	207	31.5	-	94.5	
t_{en}	Enable time	OE-to-A or B		12	-	36	10	-	30	8.5	-	25.5	ns
t_{dis}	Disable time	OE-to-A or B		625	-	1875	625	-	1875	625	-	1875	ns
t_{rA}	Input rise time	A port rise time	Push-pull driving	1.7		5.1	1.4	-	4.4	1.3	-	4.1	ns
			Open-drain driving	78	-	234	6	-	138	6.5	-	19.5	
t_{rB}	Input rise time	B port rise time	Push-pull driving	2.3	-	7.1	1.7	-	5.3	1.3	-	4.1	ns
			Open-drain driving	80	-	240	62	-	186	40.5	-	122	
t_{fA}	Input fall time	A port fall time	Push-pull driving	2.5	-	7.7	2.6	-	7.8	2.5	-	7.5	ns
			Open-drain driving	1.0	-	3.2	1.0	-	3.0	0.9	-	2.7	
t_{fB}	Input fall time	B port fall time	Push-pull driving	2.5	-	7.5	3.2	-	9.6	4.3	-	13.1	ns
			Open-drain driving	1.0	-	3.0	1.1	-	3.3	1.4	-	4.2	
$t_{SK(O)}$	Skew(time), output	Channel-to-Channel Skew		-	-	0.8	-	-	0.8	-	-	0.8	ns
Maximum data rata		Push-pull driving		-	20	-	-	22	-	-	24	-	Mbps
		Open-drain driving		-	2	-	-	2	-	-	2	-	

(1) This parameter is ensured by design and/or characterization and is not tested in production.

V_{CCA}=3.3V ± 0.3V

over recommended operating free-air temperature range (unless otherwise noted) (1)

PARAMETER		CONDITIONS		V_{CCB}=3.3V±0.2V			V_{CCB}=5V±0.2V			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
t_{PHL}	Propagation delay time high-to-low output	A-to-B	Push-pull driving	1.8	-	5.4	2.5	-	7.7	ns
			Open-drain driving	13.2	-	39.6	13.3	-	40	
t_{PLH}	Propagation delay time low-to-high output	A-to-B	Push-pull driving	1.1	-	3.5	1.0	-	3.2	ns
			Open-drain driving	77.5	-	232.5	54.5	-	163.5	
t_{PHL}	Propagation delay time high-to-low output	B-to-A	Push-pull driving	1.5	-	4.7	1.6	-	5	ns
			Open-drain driving	13.2	-	39.8	13.3	-	40.1	
t_{PLH}	Propagation delay time low-to-high output	B-to-A	Push-pull driving	0.9	-	2.9	0.9	-	2.7	ns
			Open-drain driving	79	-	237	43.5	-	130.5	
t_{en}	Enable time	OE-to-A or B		9.5	-	28.5	7.5	-	22.5	ns
t_{dis}	Disable time	OE-to-A or B		625	-	1875	625	-	1875	ns
t_{rA}	Input rise time	A port rise time	Push-pull driving	1.1	-	3.5	1.0	-	3.2	ns
			Open-drain driving	58.5		175.5	24	-	72	
t_{rB}	Input rise time	B port rise time	Push-pull driving	1.5		4.5	1.2	-	3.6	ns
			Open-drain driving	58.5	-	175.5	37.5	-	112.5	
t_{fA}	Input fall time	A port fall time	Push-pull driving	4.0	-	12	3.8	-	11.4	ns
			Open-drain driving	1.1	-	3.3	1.0	-	3.2	
t_{fB}	Input fall time	B port fall time	Push-pull driving	4.1	-	12.3	5.4	-	16.2	ns
			Open-drain driving	1.0	-	3.2	1.2	-	3.6	
$t_{SK(O)}$	Skew(time), output	Channel-to-Channel Skew		-	-	0.8	-	-	0.8	ns
Maximum data rata		Push-pull driving		-	23		24	-	-	Mbps
		Open-drain driving		-	2		2	-	-	

V_{CCA}=5V ± 0.35V

over recommended operating free-air temperature range (unless otherwise noted) (1)

PARAMETER		CONDITIONS		V_{CCB}=5V±0.2V			UNIT
				MIN	TYP	MAX	
t_{PHL}	Propagation delay time high-to-low output	A-to-B	Push-pull driving	2.8	-	8.4	ns
			Open-drain driving	13.4	-	40.2	
t_{PLH}	Propagation delay time low-to-high output	A-to-B	Push-pull driving	1.0	-	3.0	ns
			Open-drain driving	77.5	-	232.5	
t_{PHL}	Propagation delay time high-to-low output	B-to-A	Push-pull driving	2.9	-	8.7	ns
			Open-drain driving	13.7	-	41.3	
t_{PLH}	Propagation delay time low-to-high output	B-to-A	Push-pull driving	0.9	-	2.7	ns
			Open-drain driving	80	-	240	
t_{en}	Enable time	OE-to-A or B		1.1	8.5	22.5	25.5
t_{dis}	Disable time	OE-to-A or B		47.5	625	1875	1875
t_{rA}	Input rise time	A port rise time	Push-pull driving	0.9	-	2.9	ns
			Open-drain driving	52.5	-	157.5	
t_{rB}	Input rise time	B port rise time	Push-pull driving	1.1	-	3.5	ns
			Open-drain driving	47.5	-	142.5	
t_{fA}	Input fall time	A port fall time	Push-pull driving	4.5	-	13.5	ns
			Open-drain driving	1.3	-	3.9	
t_{fB}	Input fall time	B port fall time	Push-pull driving	4.4	-	13.4	ns
			Open-drain driving	1.2	-	3.8	
$t_{SK(O)}$	Skew(time), output	Channel-to-Channel Skew		-	-	0.8	ns
Maximum data rata		Push-pull driving		-	24	-	Mbps
		Open-drain driving		-	2	-	

(1) This parameter is ensured by design and/or characterization and is not tested in production.

TYPICAL PERFORMANCE CHARACTERISTICS

Fig 1. Low-Level Output Voltage vs. Low-Level Current

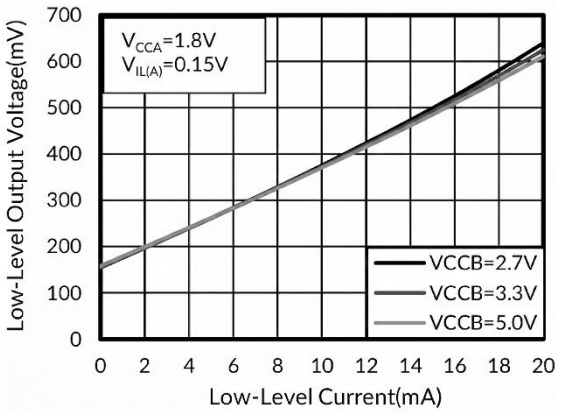


Fig 2. Low-Level Output Voltage vs. Low-Level Current

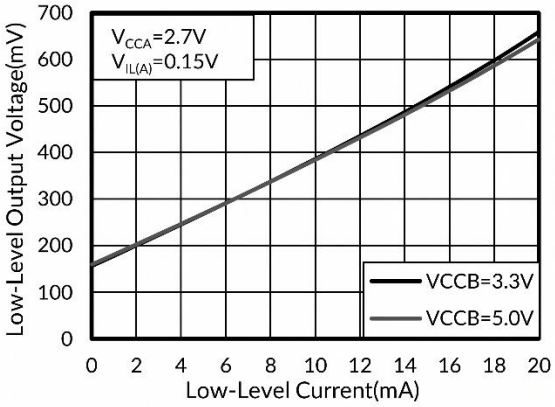


Fig 3. Low-Level Output Voltage vs. Low-Level Current

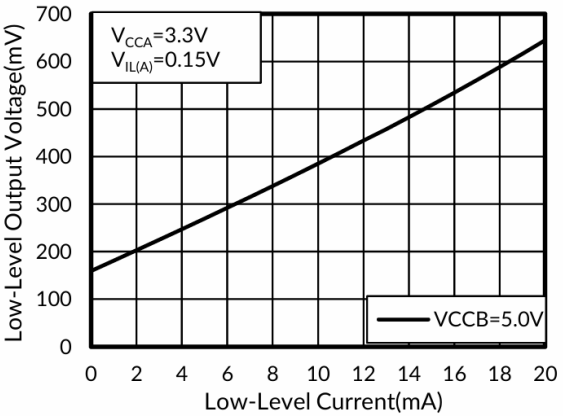


Fig 4. Low-Level Output Voltage vs. Low-Level Current

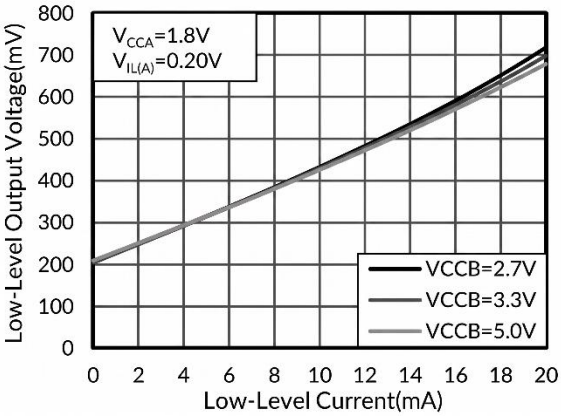


Fig 5. Low-Level Output Voltage vs. Low-Level Current

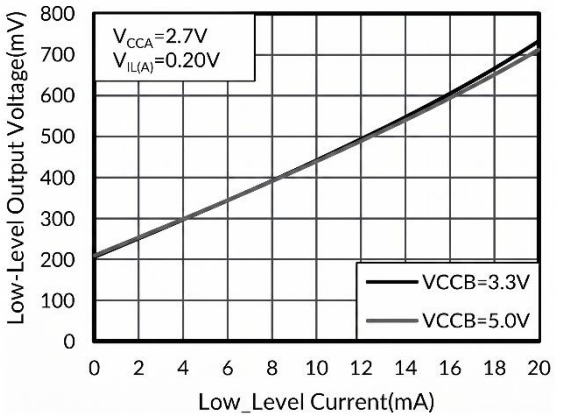


Fig 6. Low-Level Output Voltage vs. Low-Level Current

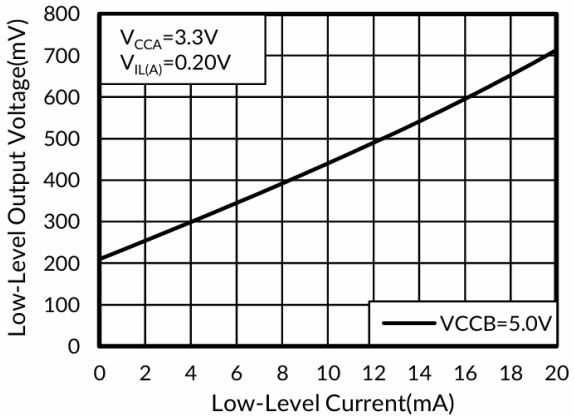


Fig 7. Low-Level Output Voltage vs. Low-Level Current

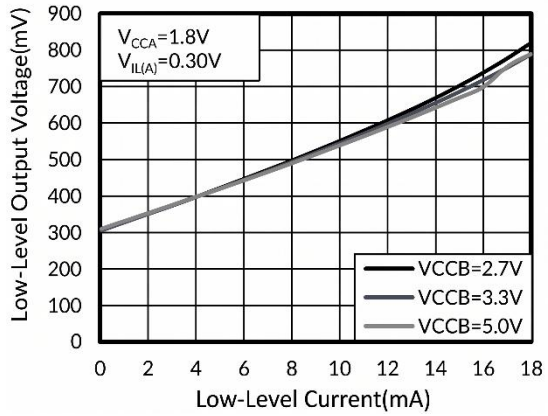


Fig 8. Low-Level Output Voltage vs. Low-Level Current

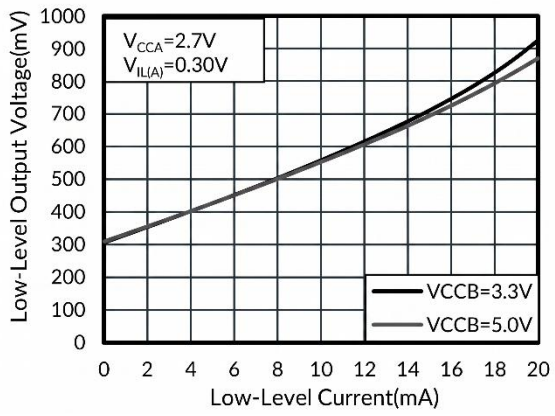


Fig 9. Low-Level Output Voltage vs. Low-Level Current

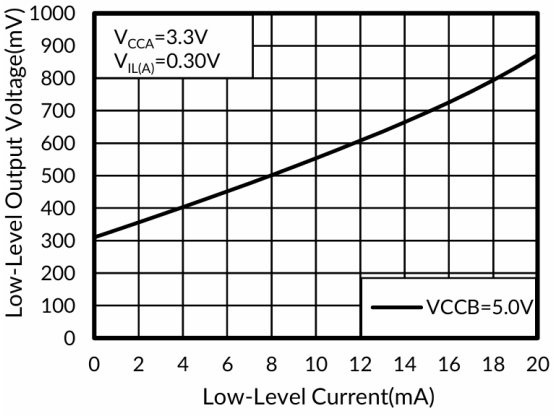


Fig 10. Low-Level Output Voltage vs. Low-Level Current

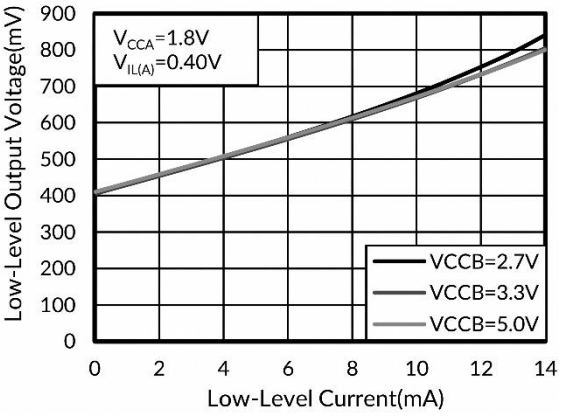


Fig 11. Low-Level Output Voltage vs. Low-Level Current

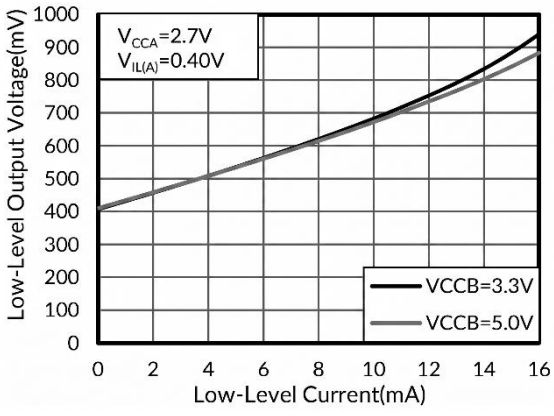


Fig 12. Low-Level Output Voltage vs. Low-Level Current

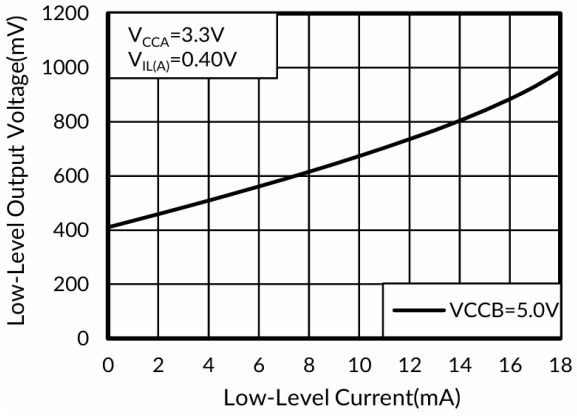


Fig 13. Low-Level Output Voltage vs. Low-Level Current

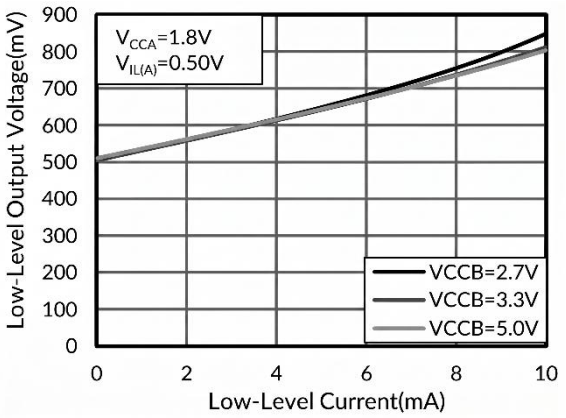


Fig 14. Low-Level Output Voltage vs. Low-Level Current

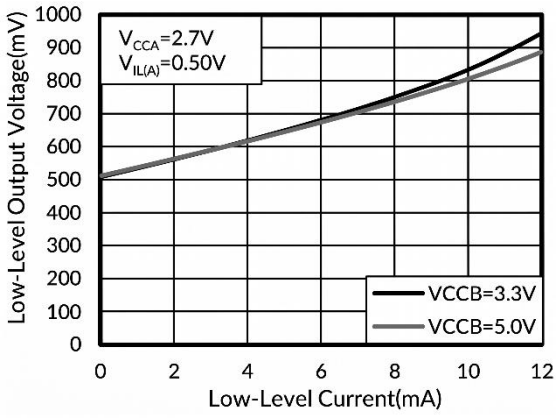
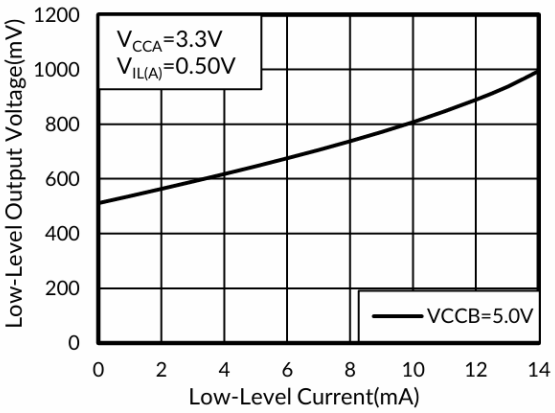


Fig 15. Low-Level Output Voltage vs. Low-Level Current



PARAMETER MEASUREMENT INFORMATION

Unless otherwise noted, all input pulses are supplied by generators having the following characteristics:
PRR 10 MHz
ZO = 50 Ω
dv/dt ≥ 1 V/ns
Note: All input pulses are measured one at a time, with one transition per measurement.

Fig 16. Data Rate, Pulse Duration, Propagation Delay, Output Rise and Fall Time Measurement Using A Push-Pull Driver

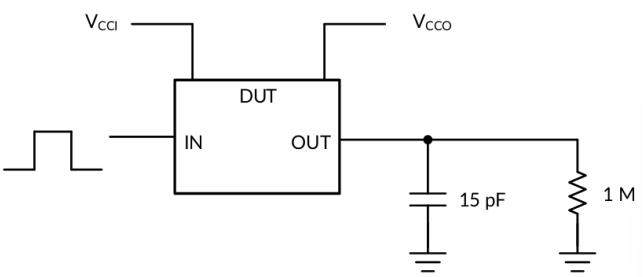


Fig 17. Data Rate, Pulse Duration, Propagation Delay, Output Rise And Fall Time Measurement Using an Open-Drain Drive

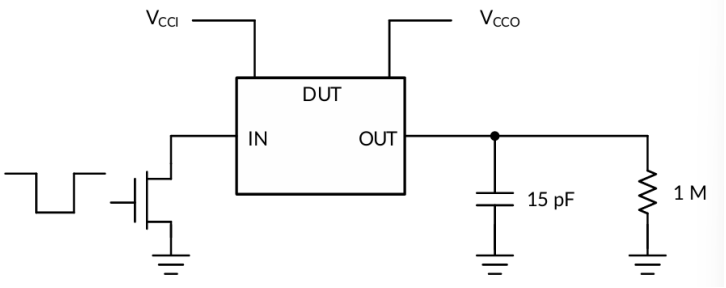
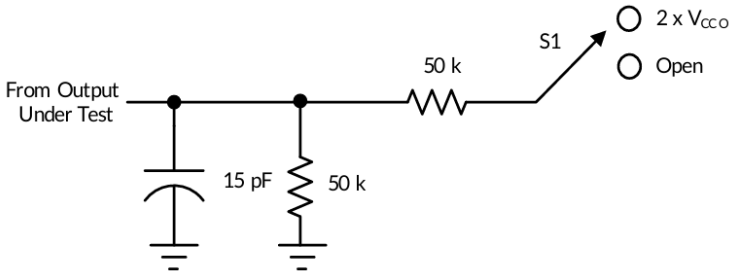


Fig 18. Load Circuit for Enable/Disable Time Measurement

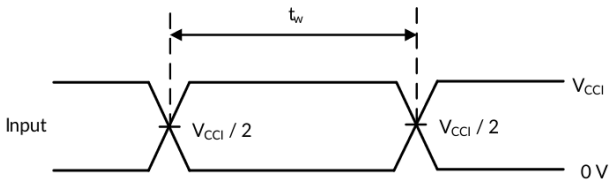


SWITCH CONFIGURATION FOR ENABLE/DISABLE TIMING

TEST	S1
t_{PZL} (1), t_{PLZ} (2)	2 × V_{CCO}
t_{PHZL} (1), t_{PZH} (2)	Open

(1) tPZL and tPZH are the same as ten.
(2) tPLZ and tPHZ are the same as tdis.

Fig 19. Voltage Waveforms Pulse Duration



(1) All input pulses are measured one at a time, with one transition per measurement.

Fig 20. Voltage Waveforms Propagation Delay Times

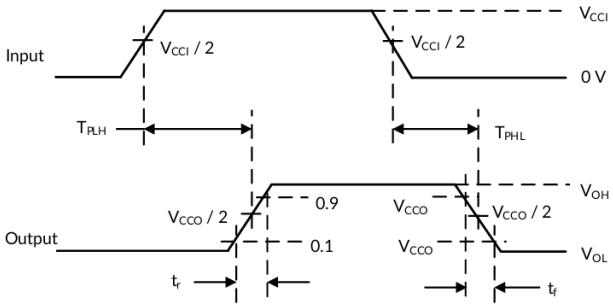
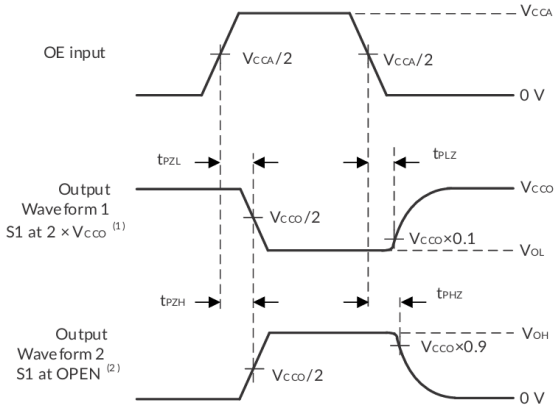
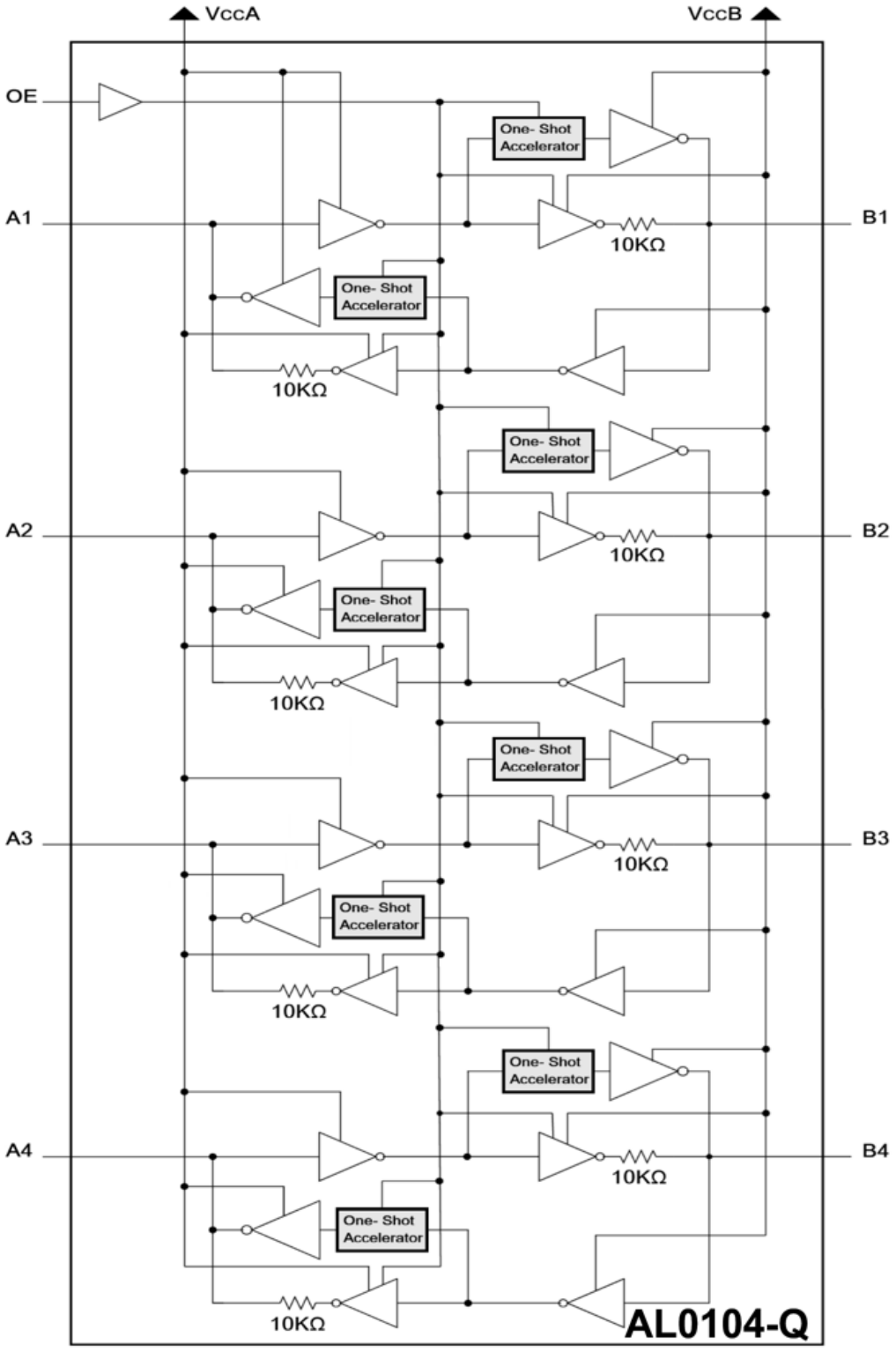


Fig 21. Voltage Waveforms Propagation Delay Times



A. Waveform 1 is for an output with internal such that the output is high, except when OE is high. B. Waveform 2 is for an output with conditions such that the output is low, except when OE is high.

BLOCK DIAGRAM



FEATURE DESCRIPTION

Overview

The AL0104-Q is a directionless voltage-level translator designed to translate logic voltage levels between mixed-voltage systems. The A ports support I/O voltages from 1.65 V to 5.5 V, while the B ports support I/O voltages from 2.3 V to 5.5 V. The device features pass-gate architecture with integrated edge-rate accelerators (one-shots) to improve switching speed and support higher data rates. Integrated 10-kΩ pull-up resistors, commonly used in open-drain applications, eliminate the need for external pull-up resistors.

Although the AL0104-Q is designed primarily for open-drain applications, it can also translate push-pull CMOS logic signals.

Architecture

The AL0104-Q architecture (see Figure 22) is an auto-direction-sensing based translator that does not require a direction-control signal to control the direction of data flow from A to B or from B to A. These two bidirectional channels independently determine the direction of data flow without a direction-control signal. Each I/O pin can be automatically reconfigured as either an input or an output, which is how this auto-direction feature is realized.

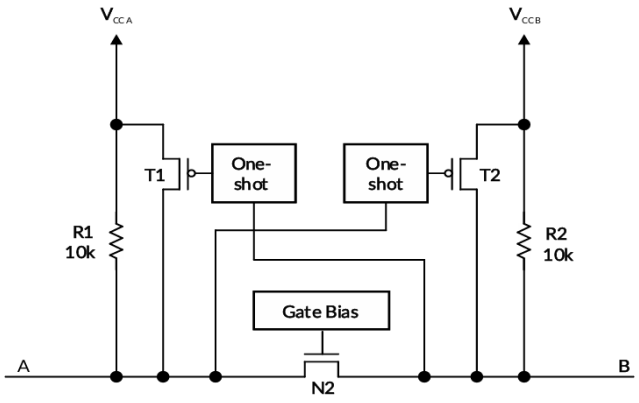


Fig 22. Architecture of AL0104-Q Cell

The AL0104-Q employs two key circuits to enable this voltage translation:

(1) An N-channel pass-gate transistor topology that ties the A-port to the B-port

(2) Output one-shot (O.S.) edge-rate accelerator circuitry to detect and accelerate rising edges on the A or B Ports.

Input Driver Requirements

The continuous dc-current "sinking" capability is determined by the external system-level open-drain (or push pull) drivers that are interfaced to the AL0104-Q I/O pins. Since the high bandwidth of these bidirectional I/O circuits is used to facilitate this fast change from an input to an output and an output to an input, they have a

modest dc-current "sourcing" capability of hundreds of micro-Amps, as determined by the internal 10-kΩ pullup resistors.

The fall time (t_{fA}, t_{fB}) of a signal depends on the edge-rate and output impedance of the external device driving AL0104-Q data I/Os, as well as the capacitive loading on the data lines.

Similarly, the t_{PHL} and max data rates also depend on the output impedance of the external driver. The values for $t_{fA,}$ t_{fB}, t_{PHL} and maximum data rates in the data sheet assume that the output impedance of the external driver is less than 50 Ω.

Output Load Considerations

We recommend careful PCB layout practices with short PCB trace lengths to avoid excessive capacitive loading and to ensure that proper O.S. triggering takes place. PCB signal trace-lengths should be kept short enough such that the round-trip delay of any reflection is less than the one-shot duration. This improves signal integrity by ensuring that any reflection sees a low impedance at the driver. The O.S. circuits have been designed to stay on for approximately 30 ns. The maximum capacitance of the lumped load that can be driven also depends directly on the one-shot duration. With very heavy capacitive loads, the one-shot can time-out before the signal is driven fully to the positive rail. The O.S. duration has been set to best optimize trade-offs between dynamic I_{CC}, load driving capability, and maximum bit-rate considerations. Both PCB trace length and connectors add to the capacitance that the AL0104-Q device output sees, so it is recommended that this lumped-load capacitance be considered to avoid O.S. retriggering, bus contention, output signal oscillations, or other adverse system-level affects.

Enable and Disable

The AL0104-Q device has an OE input that is used to disable the device by setting OE low, which places all I/Os in the Hi-Z state. The disable time (t_{dis}) indicates the delay between the time when OE goes low and when the outputs are disabled (Hi-Z). The enable time (t_{en}) indicates the amount of time the user must allow for the one-shot circuitry to become operational after OE is taken high.

Pullup or Pulldown Resistors on I/O Lines

Each A-port I/O has an internal 10-kΩ pullup resistor to V_{CCA}, and each B-port I/O has an internal 10-kΩ pullup resistor to V_{CCB}. If a smaller value of pullup resistor is required, an external resistor must be added from the I/O to V_{CCA} or V_{CCB} (in parallel with the internal 10-kΩ resistors). Adding lower value pull-up resistors will affect VOL levels, however. The internal pull-ups of the AL0104-Q are disabled when the OE pin is low.

APPLICATION AND IMPLEMENTATION

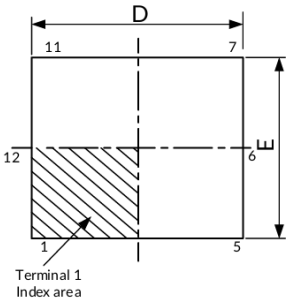
Information in the following applications sections is not part of the AiT-Semi component specification, and AiT-Semi does not guarantee its accuracy or completeness. AiT-Semi's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

Application Information

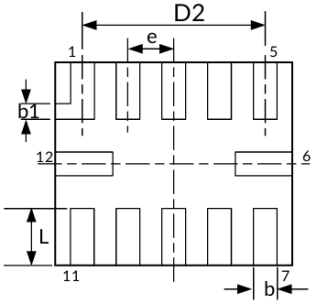
The AL0104-Q device can be used to bridge the digital-switching compatibility gap between two voltage nodes to successfully interface logic threshold levels found in electronic systems. It should be used in a point-to-point topology for interfacing devices or systems operating at different interface voltages with one another. Its primary target application use is for interfacing with open-drain drivers on the data I/Os such as I_2C or 1-wire, where the data is bidirectional and no control signal is available. The device can also be used in applications where a push pull driver is connected to the data I/Os, but the AL0104-Q might be a better option for such push-pull applications.

PACKAGE INFORMATION

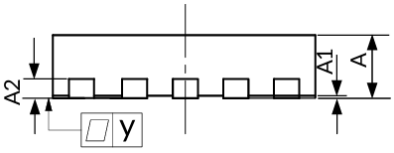
Dimension in QFN12(1.7x2) (Unit: mm)



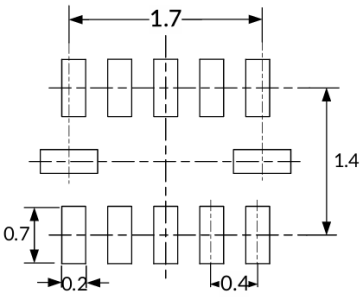
Top View



Bottom View



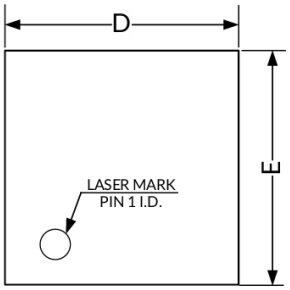
Side View



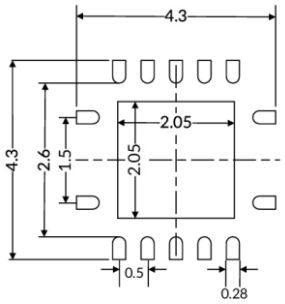
RECOMMENDED LAND PATTERN

Symbol	Min.	Max.
A	-	0.500
A1	0.000	0.050
A2	0.127	
b	0.150	0.250
b1	0.150	
D *	1.900	2.100
D2	1.500	1.700
E *	1.600	1.800
e	0.400	
y	0.050	
L	0.450	0.550

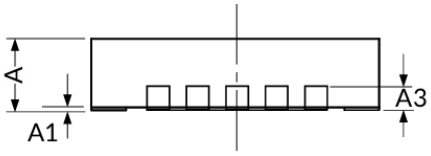
Dimension in QFN14(3.5x3.5) (Unit: mm)



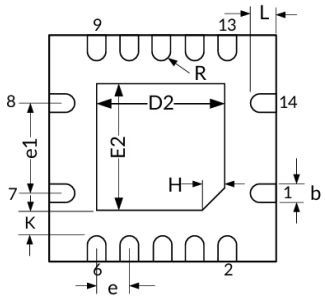
Top View



Bottom View



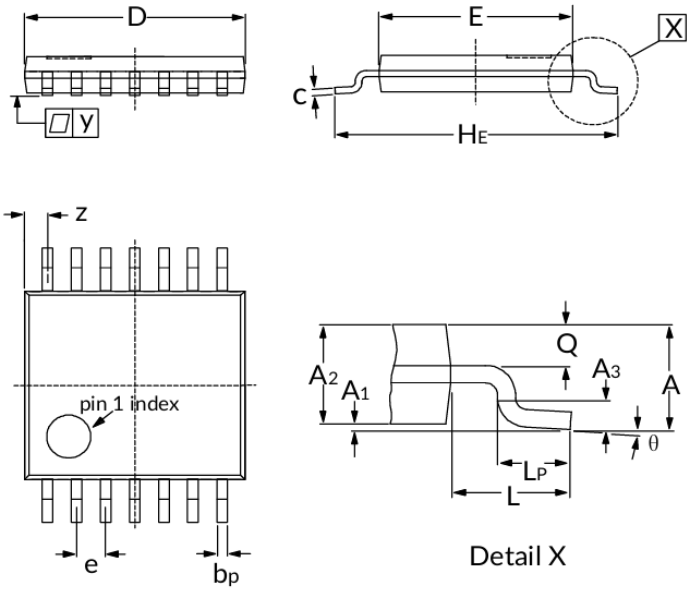
Side View

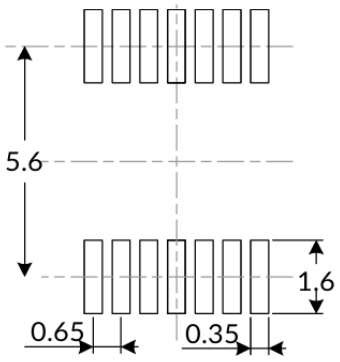


RECOMMENDED LAND PATTERN

Symbol	Min.	Max.
A (1)	0.700	0.800
A1	0.000	0.050
A3	0.200 REF. (2)	
b	0.200	0.300
D (1)	3.400	3.600
D2	1.950	2.150
E (1)	3.400	3.600
E2	1.950	2.150
e	0.500 BSC.	
e1	1.500 BSC.	
H	0.300 REF.	
K	0.225	0.425
L	0.300	0.500
R	0.090	-

Dimension in TSSOP14 (Unit: mm)





RECOMMENDED LAND PATTERN

Symbol	Min.	Max.
A (1)	-	1.100
A1	0.050	0.150
A2	0.800	0.950
A3	0.250	
bp	0.190	0.300
c	0.100	0.200
D (1)	4.900	5.100
E (1)	4.300	4.500
HE	6.200	6.600
e	0.650	
L	1.000	
Lp	0.500	0.750
Q	0.300	0.400
Z	0.380	0.720
y	0.100	
θ	0°	8°

IMPORTANT NOTICE

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