4-Bit Fixed Direction Voltage-Level Translator with Schmitt-Trigger Inputs and 3-State Outputs

1 FEATURES

- **Fully configurable dual-rail design allows each port to operate from 1.1 V to 5.5 V**
- **Up to 200 Mbps support for 3.3 V to 5.0 V**
- **Schmitt-trigger inputs allow for slow and noisy inputs**
- **Inputs with integrated static pull-down resistors prevent channels from floating**
- **High drive strength (up to 12 mA at 5 V)**
- **Low power consumption**
  - **2.5 µA maximum (25°C)**
  - **6 µA maximum (–40°C to 125°C)**
- **V_{CC} isolation and V_{CC} disconnect ($I_{off-float}$) feature**
  - **If either V_{CC} input is <100 mV or disconnected, all outputs are disabled and become high-impedance**
- **I_{off} supports partial-power-down mode operation**
- **Control logic (OE) with $V_{CC(MIN)}$ circuitry allows for control from either A or B port**
- **Operating temperature from –40°C to +125°C**

2 APPLICATIONS

- **Eliminate slow or noisy input signals**
- **Driving indicator LEDs or buzzers**
- **Debouncing a mechanical switch**
- **General purpose I/O level shifting**
- **Push-pull level shifting (UART, SPI, JTAG, and so forth)**

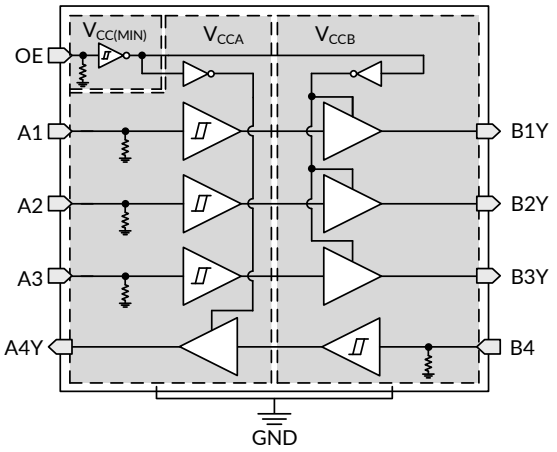
3 DESCRIPTIONS

RXU0304 is a 4-bit, dual-supply noninverting fixed direction voltage level translation device. Ax pins are referenced to V_{CCA} logic level, OE pin can be referenced to either V_{CCA} or V_{CCB} logic levels, and Bx pins are referenced to V_{CCB} logic levels. The A port is able to accept input voltages ranging from 1.1 V to 5.5 V, while the B port can also accept input voltages from 1.1 V to 5.5 V. Fixed direction data transmission can occur from A to B or B to A when OE is set to high in reference to either supply. When OE is set to low, all output pins are in the high-impedance state. See Device Functional Modes for a summary of the operation of the control logic.

Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
RXU0304	TSSOP14	5.00mm×4.40mm
	UQFN1.7X2-12	2.00mm×1.70mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.



RXU0304 Functional Block Diagram

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4 REVISION HISTORY

Note: Page numbers for previous revisions may different from page numbers in the current version.

VERSION	Change Date	Change Item
A.0	2025/11/10	Preliminary version completed

5 PACKAGE/ORDERING INFORMATION (1)

PRODUCT	ORDERING NUMBER	TEMPERATURE RANGE	PACKAGE LEAD	PACKAGE MARKING (2)	MSL (3)	PACKAGE OPTION
RXU0304	RXU0304XQ	-40°C ~125°C	TSSOP14	RXU0304	MSL3	Tape and Reel,4000
	RXU0304XUTQH12	-40°C ~125°C	UQFN1.7X2-12	U0304	MSL3	Tape and Reel,4000

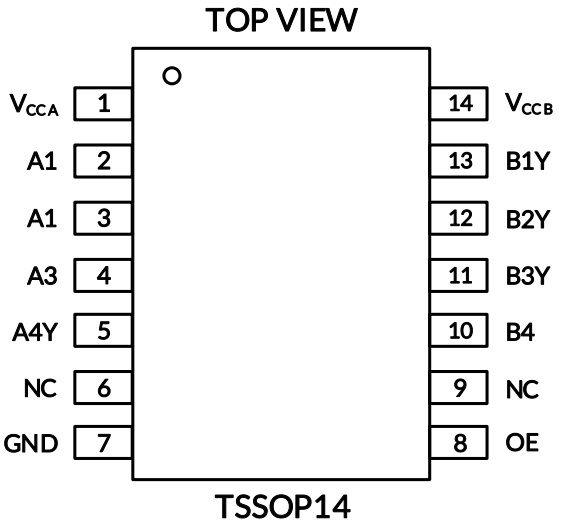
NOTE:

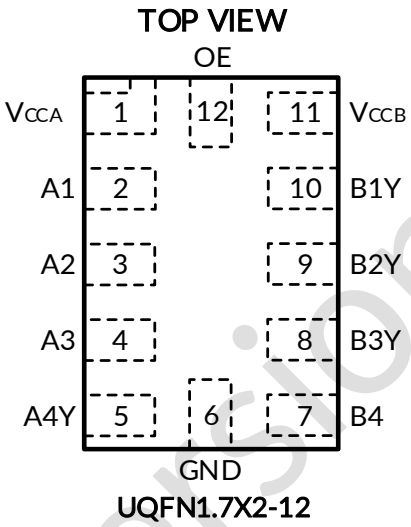
(1) This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the right-hand navigation.

(2) There may be additional marking, which relates to the lot trace code information (data code and vendor code), the logo or the environmental category on the device.

(3) RUNIC classify the MSL level with using the common preconditioning setting in our assembly factory conforming to the JEDEC industrial standard J-STD-20F. Please align with RUNIC if your end application is quite critical to the preconditioning setting or if you have special requirement.

6 PIN CONFIGURATION AND FUNCTIONS





PIN DESCRIPTION

NAME	PIN		I/O (1)	DESCRIPTION
	TSSOP14	UQFN1.7X2-12		
A1	2	2	I	Input A1. Referenced to V_{CCA}.
A2	3	3	I	Input A2. Referenced to V_{CCA}.
A3	4	4	I	Input A3. Referenced to V_{CCA}.
A4Y	5	5	O	Output A4. Referenced to V_{CCA}.
B1Y	13	10	O	Output B1. Referenced to V_{CCB}.
B2Y	12	9	O	Output B2. Referenced to V_{CCB}.
B3Y	11	8	O	Output B3. Referenced to V_{CCB}.
B4	10	7	I	Input B4. Referenced to V_{CCB}.
GND	7	6	-	Ground
NC	6, 9	-	-	No internal connection.
OE	8	12	I	Output Enable. Pull to GND to place all outputs in high-impedance mode. Pull to V_{CCA} or V_{CCB} to enable all outputs.
V_{CCA}	1	1	-	A-port supply voltage. 1.1 V ≤ V_{CCA} ≤ 5.5 V
V_{CCB}	14	11	-	B-port supply voltage. 1.1 V ≤ V_{CCB} ≤ 5.5 V

(1) I=Input, O=Output.

7 SPECIFICATIONS

7.1 Absolute Maximum Ratings

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

SYMBOL	PARAMETER		MIN	MAX	UNIT
V_{CCA}	Supply Voltage Range		-0.5	6.5	V
V_{CCB}	Supply Voltage Range		-0.5	6.5	V
V_I(2)	Input Voltage Range	A port	-0.5	6.5	V
		B port	-0.5	6.5	
		OE	-0.5	6.5	
V_O(2)	Voltage range applied to any output in the high-impedance or power-off state	A port	-0.5	6.5	V
		B port	-0.5	6.5	
V_O(2)(3)	Voltage range applied to any output in the high or low state	A port	-0.5	V_{CCA}+0.5	V
		B port	-0.5	V_{CCB}+0.5	
I_{IK}	Input clamp current	V_I<0		-50	mA
I_{OK}	Output clamp current	Vo<0		-50	mA
I_O	Continuous output current			±50	mA
	Continuous current through V_{CCA}, V_{CCB} or GND			±100	mA
θ_{JA}	Package thermal impedance (4)	TSSOP14		121	°C/W
		UQFN1.7X2-12		120	
T_J	Junction Temperature (5)		-40	150	°C
T_{stg}	Storage temperature		-65	150	

(1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.
(2) The input voltage and output negative-voltage ratings may be exceeded if the input and output current ratings are observed.
(3) The output positive-voltage rating may be exceeded up to 6.5 V maximum if the output current rating is observed.
(4) The package thermal impedance is calculated in accordance with JESD-51.
(5) The maximum power dissipation is a function of $T_{J(MAX)}$, $R_{\theta JA}$, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A) / R_{\theta JA}$. All numbers apply for packages soldered directly onto a PCB.

7.2 ESD Ratings

The following ESD information is provided for handling of ESD-sensitive devices in an ESD protected area only.

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-Body Model (HBM), ANSI/ESDA/JEDEC JS001-2024	±2000	V
		Charged-Device Model (CDM), ANSI/ESDA/JEDEC JS-002-2022	±1000	
		Machine Model (MM), JESD22-A115C (2010)	±200	

ESD SENSITIVITY CAUTION

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

7.3 Recommended Operating Conditions

Over operating free-air temperature range (unless otherwise noted) (1) (2) (3)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNIT
Supply Voltage	V_{CCA}		1.08		5.5	V
	V_{CCB}		1.08		5.5	V
I_{OH}	High-level output current	V_{CCO} = 1.1V			-1.5	mA
		V_{CCO} = 1.4V			-3	
		V_{CCO} = 1.65V			-4.5	
		V_{CCO} = 2.3V			-8	
		V_{CCO} = 3V			-10	
		V_{CCO} = 4.5V			-12	
I_{OL}	Low-level output current	V_{CCO} = 1.1V			1.5	mA
		V_{CCO} = 1.4V			3	
		V_{CCO} = 1.65V			4.5	
		V_{CCO} = 2.3V			8	
		V_{CCO} = 3V			10	
		V_{CCO} = 4.5V			12	
V_I	Input voltage		0		5.5	V
V_O	Output voltage	Active State	0		V_{CCO}	V
		Tri-State	0		5.5	
T_A Operating free-air temperature			-40		125	°C

(1) The A and B sides of an unused data I/O pair must be held in the same state, that is, both at V_{CCI} or both at GND.
(2) V_{CCA} must be less than or equal to V_{CCB} and must not exceed 5.5 V.
(3) V_{CCI} is the supply voltage associated with the input port.

7.4 Electrical Characteristics

over recommended operating free-air temperature range (unless otherwise noted) (1) (2)

PARAMETER		CONDITIONS	V_{CCA}	V_{CCB}	Operating free-air temperature (T_A)									UNIT
					25°C			–40°C to 85°C			-40°C to 125°C			
					MIN(3)	TYP(4)	MAX(3)	MIN(3)	TYP(4)	MAX(3)	MIN(3)	TYP(4)	MAX(3)	
V_{T+}	Positive-going input-threshold voltage	Data Inputs (Ax, Bx) (Referenced to V_{CCI})	1.1V	1.1V				0.44		0.88	0.44		0.88	V
			1.4V	1.4V				0.6		0.98	0.6		0.98	
			1.65V	1.65V				0.76		1.13	0.76		1.13	
			2.3V	2.3V				1.08		1.56	1.08		1.56	
			3V	3V				1.48		1.92	1.48		1.92	
			4.5V	4.5V				2.19		2.74	2.19		2.74	
			5.5V	5.5V				2.65		3.33	2.65		3.33	
		OE (Referenced to V_{CCA} or V_{CCB})	1.1V	1.1V				0.44		0.88	0.44		0.88	V
			1.4V	1.4V				0.6		0.98	0.6		0.98	
			1.65V	1.65V				0.76		1.13	0.76		1.13	
			2.3V	2.3V				1.08		1.56	1.08		1.56	
			3V	3V				1.48		1.92	1.48		1.92	
			4.5V	4.5V				2.19		2.74	2.19		2.74	
			5.5V	5.5V				2.65		3.33	2.65		3.33	
V_{T-}	Negative-going input-threshold voltage	Data Inputs (Ax, Bx) (Referenced to V_{CCI})	1.1V	1.1V				0.17		0.48	0.17		0.48	V
			1.4V	1.4V				0.28		0.59	0.28		0.59	
			1.65V	1.65V				0.35		0.69	0.35		0.69	
			2.3V	2.3V				0.56		0.97	0.56		0.97	
			3V	3V				0.89		1.5	0.89		1.5	
			4.5V	4.5V				1.51		1.97	1.51		1.97	
			5.5V	5.5V				1.88		2.4	1.88		2.4	
		OE (Referenced to V_{CCA} or V_{CCB})	1.1V	1.1V				0.17		0.48	0.17		0.48	V
			1.4V	1.4V				0.28		0.59	0.28		0.59	
			1.65V	1.65V				0.35		0.69	0.35		0.69	
			2.3V	2.3V				0.56		0.97	0.56		0.97	
			3V	3V				0.89		1.5	0.89		1.5	
			4.5V	4.5V				1.51		1.97	1.51		1.97	
			5.5V	5.5V				1.88		2.46	1.88		2.46	
ΔV_T	Input-threshold hysteresis ($V_{T+} - V_{T-}$)	Data Inputs (Ax, Bx) (Referenced to V_{CCI})	1.1V	1.1V				0.2		0.4	0.2		0.4	V
			1.4V	1.4V				0.25		0.5	0.25		0.5	
			1.65V	1.65V				0.3		0.55	0.3		0.55	
			2.3V	2.3V				0.38		0.65	0.38		0.65	
			3V	3V				0.46		0.72	0.46		0.72	
			4.5V	4.5V				0.58		0.93	0.58		0.93	
			5.5V	5.5V				0.69		1.06	0.69		1.06	

Electrical Characteristics (continued)

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

PARAMETER		CONDITIONS	V_{CCA}	V_{CCB}	Operating free-air temperature (T_A)									UNIT
					25°C			–40°C to 85°C			-40°C to 125°C			
					MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
ΔV_T	Input-threshold hysteresis ($V_{T+} - V_{T-}$)	OE (Referenced to V_{CCA} or V_{CCB})	1.1V	1.1V				0.15		0.41	0.15		0.41	V
			1.4V	1.4V				0.2		0.5	0.2		0.5	
			1.65V	1.65V				0.23		0.55	0.23		0.55	
			2.3V	2.3V				0.32		0.65	0.32		0.65	
			3V	3V				0.39		0.72	0.39		0.72	
			4.5V	4.5V				0.57		0.97	0.57		0.97	
			5.5V	5.5V				0.69		1.18	0.69		1.18	
V_{OH}	High-level output voltage (5)	I_{OH} = –0.1mA	1.1V to 5.5V	1.1V to 5.5V	V_{CCO}-0.1			V_{CCO}-0.1			V_{CCO}-0.1			V
		I_{OH} = –0.5mA	1.1V	1.1V	0.82			0.82			0.82			
		I_{OH} = –3mA	1.4V	1.4V	1			1			1			
		I_{OH} = –4.5mA	1.65V	1.65V	1.2			1.2			1.2			
		I_{OH} = –8mA	2.3V	2.3V	1.7			1.7			1.7			
		I_{OH} = –10mA	3V	3V	2.2			2.2			2.2			
		I_{OH} = –12mA	4.5V	4.5V	3.7			3.7			3.7			
V_{OL}	Low-level output voltage (6)	I_{OL} = 0.1mA	1.1V to 5.5V	1.1V to 5.5V			0.1			0.1			0.1	
		I_{OL} = 0.5mA	1.1V	1.1V			0.27			0.27			0.27	
		I_{OL} = 3mA	1.4V	1.4V			0.35			0.35			0.35	
		I_{OL} = 4.5mA	1.65V	1.65V			0.45			0.45			0.45	
		I_{OL} = 8mA	2.3V	2.3V			0.7			0.7			0.7	
		I_{OL} = 10mA	3V	3V			0.8			0.8			0.8	
		I_{OL} = 8mA	4.5V	4.5V			0.55			0.55			0.55	
		I_{OL} = 12mA	4.5V	4.5V			0.8			0.8			0.8	
I_I	Input leakage current	OE V_I=V_{CCI} or GND	1.2V to 3.6V	1.65V to 5.5V	-0.1		1.5	-0.1		2	-0.1		3	µA
		Data Inputs (Ax, Bx) V_I = V_{CCI} or GND			-0.1		1.5	-0.1		1.5	-2		2	
I_{off}	Partial power down current	A Port or B Port V_I or V_O = 0 V-5.5V	0V	0V to 5.5V	–2.5		2.5	-3		3	-3.5		3.5	µA
			0V to 5.5V	0V	–2.5		2.5	-3		3	-3.5		3.5	
$I_{off-float}$	Floating supply Partial power down current	A Port or B Port V_I or V_O = 0 V - 5.5V	Floating (7)	0 V to 5.5 V	–1.5		1.5	-2		2	-2.5		2.5	µA
			0 V to 5.5 V	Floating (7)	–1.5		1.5	-2		2	-2.5		2.5	
I_{OZ}	High-impedance State output current	A or B Port: V_I = V_{CCI} or GND V_O = V_{CCO} or GND OE = GND	1.1V to 5.5V	1.1V to 5.5V	-0.3		0.3	-1		1	-2		2	µA

Electrical Characteristics (continued)

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

PARAMETER		CONDITIONS	V_{CCA}	V_{CCB}	Operating free-air temperature (T_A)									UNIT
					25°C			–40°C to 85°C			-40°C to 125°C			
					MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
I_{CCA}	V_{CCA} supply current	V_I=V_{CCI} or GND I_O = 0	1.1V to 5.5V	1.1V to 5.5V			1.5			2.5			6	µA
			0V	5.5V	-0.3			-1			-1			
			5.5V	0V			1			1.5			3	
		V_I = GND I_O = 0	5.5V	Floating (7)			1.5			7			15	
I_{CCB}	V_{CCB} supply current	V_I=V_{CCI} or GND I_O = 0	1.1V to 5.5V	1.1V to 5.5V			1.5			2.5			6	µA
			0V	5.5V			1			1.5			3	
			5.5V	0V	-0.3			-1			-1			
		V_I = GND I_O = 0	Floating (7)	5.5V			1.5			7			15	
I_{CCA}+ I_{CCB}	Combined supply current	V_I = V_{CCI} or GND I_O = 0	1.1V to 5.5V	1.1V to 5.5V			2.5			3			6	µA
C_i	Input capacitance	V_I=3.3V or GND	3.3V	3.3V		4			4.5			5		pF
C_{io}	Input-to-output internal capacitance	OE=GND	3.3V	3.3V		5			6			6		pF

NOTE:

(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) Limits are 100% production tested at 25°C. Limits over the operating temperature range are ensured through correlations using statistical quality control (SQC) method.

(4) 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.

(5) Tested at V_I = $V_{T+(MAX)}$.

(6) Tested at V_I = $V_{T-(MIN)}$.

(7) Floating is defined as a node that is both not actively driven by an external device and has leakage not exceeding 10nA.

7.5 Switching Characteristics: T_{sk}, T_{MAX}

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

PARAMETER	TEST CONDITIONS		V_{CCI}	V_{CCO}	Operating free-air temperature (T_A) -40°C to 125°C			UNIT
					MIN	TYP	MAX	
T_{MAX} – Maximum Data Rate	50% Duty Cycle Input One channel switching 20% of pulse > 0.7*V_{CCO} 20% of pulse < 0.3*V_{CCO}	Up Translation	3.0V - 3.6V	4.5V - 5.5V	200			Mbps
			1.65V - 1.95V	4.5V - 5.5V	150			
			1.1V - 1.3V	4.5V - 5.5V	30			
			1.65V - 1.95V	3.0V - 3.6V	100			
			1.1V - 1.3V	3.0V - 3.6V	30			
			1.1V - 1.3V	1.65V - 1.95V	20			
		Down Translation	4.5V - 5.5V	3.0V - 3.6V	125			
			4.5V - 5.5V	1.65V - 1.95V	50			
			4.5V - 5.5V	1.1V - 1.3V	10			
			3.0V - 3.6V	1.65V - 1.95V	50			
			3.0V - 3.6V	1.1V - 1.3V	10			
			1.65V - 1.95V	1.1V - 1.3V	10			
t_{sk} - Output skew	Timing skew between any switching outputs on the rising or falling edge	Up Translation	3.0V - 3.6V	4.5V - 5.5V			3	ns
			1.65V - 1.95V	4.5V - 5.5V			10	
			1.1V - 1.3V	4.5V - 5.5V			42	
			1.65V - 1.95V	3.0V - 3.6V			8	
			1.1V - 1.3V	3.0V - 3.6V			42	
			1.1V - 1.3V	1.65V - 1.95V			45	
		Down Translation	4.5V - 5.5V	3.0V - 3.6V			3	
			4.5V - 5.5V	1.65V - 1.95V			10	
			4.5V - 5.5V	1.1V - 1.3V			42	
			3.0V - 3.6V	1.65V - 1.95V			8	
			3.0V - 3.6V	1.1V - 1.3V			42	
			1.65V - 1.95V	1.1V - 1.3V			45	

7.6 Switching Characteristics: V_{CCA} = 1.2V

T_A=25°C, V_{CCA}=1.2V.

PARAMETER		CONDITIONS	V_{CCB}=1.2 ± 0.1V			V_{CCB}=1.5 ± 0.1V			V_{CCB}=1.8 ± 0.15V			V_{CCB}=2.5 ± 0.2V			V_{CCB}=3.3 ± 0.3V			V_{CCB}=5 ± 0.5V			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{Pd}	Propagation delay time	A-to-B	7.0		87	4.8		60	4.0		50	3.2		41	3.0		38	2.9		36	ns
		B-to-A	6.8		86	5.0		63	4.8		60	4.4		56	4.3		54	4.1		51	
t_{dis}	Disable time	OE-to-A	23.4		293	24.7		308	25.1		314	25.9		323	26.7		334	28.4		355	ns
		OE-to- B	18.8		234	14.1		176	12.6		158	12.0		150	11.4		143	12.3		154	
t_{en}	Enable time	OE-to-A	26.8		335	26.0		325	26.0		325	26.8		335	27.7		346	28.6		358	ns
		OE-to- B	28.7		359	23.2		290	21.8		272	20.9		261	19.8		248	19.0		238	

7.7 Switching Characteristics: V_{CCA}=1.5V ± 0.1V

over recommended operating free-air temperature range, V_{CCA}=1.5V±0.1V (unless otherwise noted)

PARAMETER		CONDITIONS	V_{CCB}=1.2 ± 0.1V			V_{CCB}=1.5 ± 0.1V			V_{CCB}=1.8 ± 0.15V			V_{CCB}=2.5 ± 0.2V			V_{CCB}=3.3 ± 0.3V			V_{CCB}=5 ± 0.5V			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{Pd}	Propagation delay time	A-to-B	5.1		64	3.5		44	2.8		35	2.2		27	1.9		24	1.7		21	ns
		B-to-A	4.8		60	3.5		44	3.1		39	2.7		34	2.5		32	2.4		30	
t_{dis}	Disable time	OE-to-A	12.8		160	12.1		151	12.3		154	12.8		160	13.2		165	14.0		174	ns
		OE-to- B	15.8		197	10.0		125	8.3		104	7.0		88	6.5		81	6.4		80	
t_{en}	Enable time	OE-to-A	19.3		241	17.6		221	17.6		220	17.9		224	17.6		220	19.3		242	ns
		OE-to- B	23.8		297	18.1		227	16.3		204	15.1		188	14.3		179	13.6		170	

7.8 Switching Characteristics: V_{CCA}=1.8V ± 0.15V

over recommended operating free-air temperature range, V_{CCA}=1.8V±0.15V (unless otherwise noted)

PARAMETER		CONDITIONS	V_{CCB}=1.2 ± 0.1V			V_{CCB}=1.5 ± 0.1V			V_{CCB}=1.8 ± 0.15V			V_{CCB}=2.5 ± 0.2V			V_{CCB}=3.3 ± 0.3V			V_{CCB}=5 ± 0.5V			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{Pd}	Propagation delay time	A-to-B	4.8		60	3.1		39	2.5		31	2.0		25	1.7		21	1.4		18	ns
		B-to-A	4.0		50	2.8		36	2.5		32	2.2		27	1.9		24	1.9		23	
t_{dis}	Disable time	OE-to-A	9.8		122	8.8		111	8.6		107	8.8		110	8.9		111	9.3		116	ns
		OE-to- B	15.1		188	9.1		114	7.0		87	5.5		68	4.9		61	4.6		57	
t_{en}	Enable time	OE-to-A	17.3		216	15.4		193	15.1		189	14.3		179	15.4		193	15.4		192	ns
		OE-to- B	21.8		272	16.7		209	14.9		187	13.0		163	12.8		160	12.2		152	

7.9 Switching Characteristics: V_{CCA}=2.5V ± 0.2V

over recommended operating free-air temperature range, V_{CCA}=2.5V±0.2V (unless otherwise noted)

PARAMETER		CONDITIONS	V_{CCB}=1.2 ± 0.1V			V_{CCB}=1.5 ± 0.1V			V_{CCB}=1.8 ± 0.15V			V_{CCB}=2.5 ± 0.2V			V_{CCB}=3.3 ± 0.3V			V_{CCB}=5 ± 0.5V			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{Pd}	Propagation delay time	A-to-B	4.5		57	2.8		35	2.2		27	1.6		20	1.3		17	1.2		14	ns
		B-to-A	3.2		41	2.2		27	1.9		24	1.5		19	1.4		17	1.3		16	
t_{dis}	Disable time	OE-to-A	7.2		91	6.0		75	5.6		70	5.4		68	5.5		69	5.6		70	ns
		OE-to- B	14.9		186	8.5		106	6.2		77	4.3		54	3.7		46	3.2		40	
t_{en}	Enable time	OE-to-A	14.1		176	12.7		159	12.5		156	11.9		149	11.6		145	12.0		150	ns
		OE-to- B	19.8		248	15.6		195	13.4		167	11.5		143	11.4		143	10.1		127	

7.10 Switching Characteristics: V_{CCA}=3.3V ± 0.3V

over recommended operating free-air temperature range, V_{CCA}=3.3V±0.3V (unless otherwise noted)

PARAMETER		CONDITIONS	V_{CCB}=1.2 ± 0.1V			V_{CCB}=1.5 ± 0.1V			V_{CCB}=1.8 ± 0.15V			V_{CCB}=2.5 ± 0.2V			V_{CCB}=3.3 ± 0.3V			V_{CCB}=5 ± 0.5V			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{Pd}	Propagation delay time	A-to-B	4.2		52	2.6		32	2.0		25	1.3		17	1.0		13	0.9		11	ns
		B-to-A	3.0		38	1.9		23	1.6		20	1.3		17	1.0		12	0.9		11	
t_{dis}	Disable time	OE-to-A	6.5		81	4.8		60	4.2		52	3.8		47	4.0		50	4.2		52	ns
		OE-to- B	15.0		188	8.2		102	5.8		72	3.7		46	3.2		39	2.8		35	
t_{en}	Enable time	OE-to-A	13.4		167	11.7		146	11.0		137	10.5		131	10.1		126	10.4		130	ns
		OE-to- B	19.0		237	15.0		188	13.0		163	11.5		144	9.8		123	9.4		117	

7.11 Switching Characteristics: V_{CCA}=5.0V ± 0.5V

over recommended operating free-air temperature range, V_{CCA}=5.0V±0.5V (unless otherwise noted)

PARAMETER		CONDITIONS	V_{CCB}=1.2 ± 0.1V			V_{CCB}=1.5 ± 0.1V			V_{CCB}=1.8 ± 0.15V			V_{CCB}=2.5 ± 0.2V			V_{CCB}=3.3 ± 0.3V			V_{CCB}=5 ± 0.5V			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{Pd}	Propagation delay time	A-to-B	3.9		49	2.4		30	1.9		24	1.3		16	1.0		13	0.7		9	ns
		B-to-A	2.9		36	1.7		22	1.4		18	1.1		14	0.8		10	0.7		9	
t_{dis}	Disable time	OE-to-A	6.7		84	4.4		54	3.5		43	2.8		35	2.5		32	2.5		31	ns
		OE-to- B	16.5		206	8.6		108	5.9		74	3.4		43	2.5		31	1.9		24	
t_{en}	Enable time	OE-to-A	12.8		160	10.9		137	10.7		134	10.1		127	9.8		122	9.8		123	ns
		OE-to- B	19.0		237	14.6		183	11.8		148	11.5		143	10.1		126	9.0		113	

7.12 Operating Characteristics

T_A=25°C

PARAMETER		CONDITIONS		V_{CCA}=V_{CCB}						UNIT
				1.2 ± 0.1V	1.5 ± 0.1V	1.8 ± 0.15V	2.5 ± 0.2V	3.3 ± 0.3V	5 ± 0.5V	
				TYP	TYP	TYP	TYP	TYP	TYP	
C_{pdA}	Power dissipation capacitance	C_L=0 f=10MHz t_r=t_f=1ns OE=V_{CCA} (outputs enabled)	A-port input B-port output	2	2	3	3	3	4	pF
			B-port input A-port output	15	15	16	17	18	19	
C_{pdB}	Power dissipation capacitance		A-port input B-port output	15	15	16	17	18	19	
			B-port input A-port output	2	2	3	3	3	4	

7.13 Typical Characteristics

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.

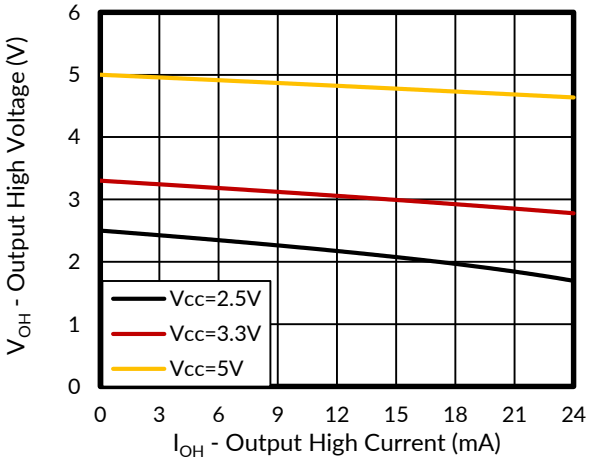


Figure 1. Typical (T_A=25°C) Output High Voltage (V_{OH}) vs Source Current (I_{OH})

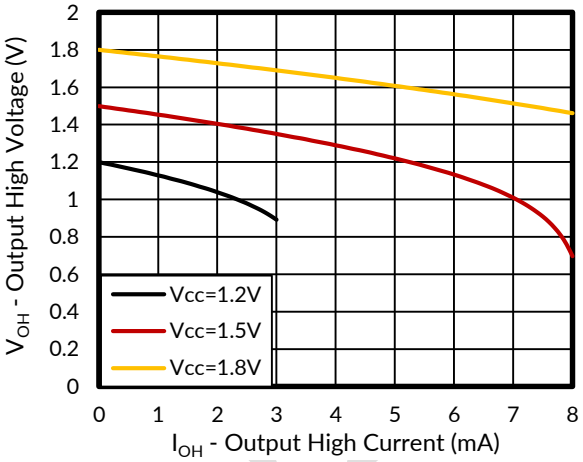


Figure 2. Typical (T_A=25°C) Output High Voltage (V_{OH}) vs Source Current (I_{OH})

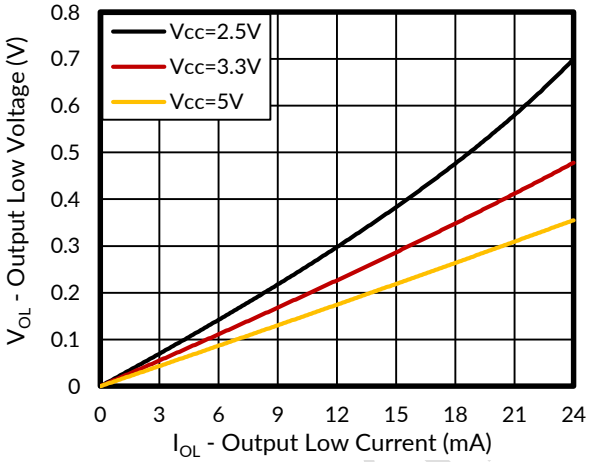


Figure 3. Typical (T_A=25°C) Output Low Voltage (V_{OL}) vs Sink Current (I_{OL})

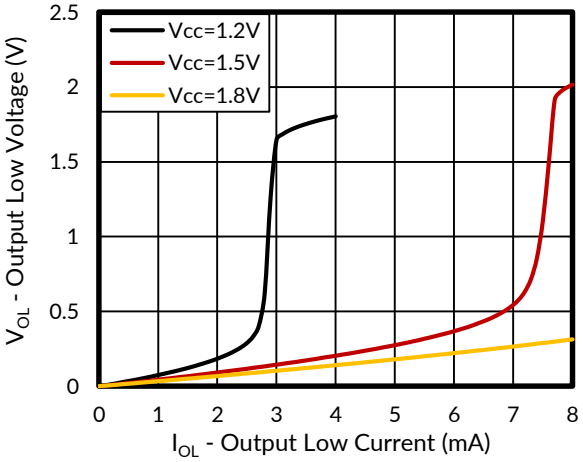


Figure 4. Typical (T_A=25°C) Output Low Voltage (V_{OL}) vs Sink Current (I_{OL})

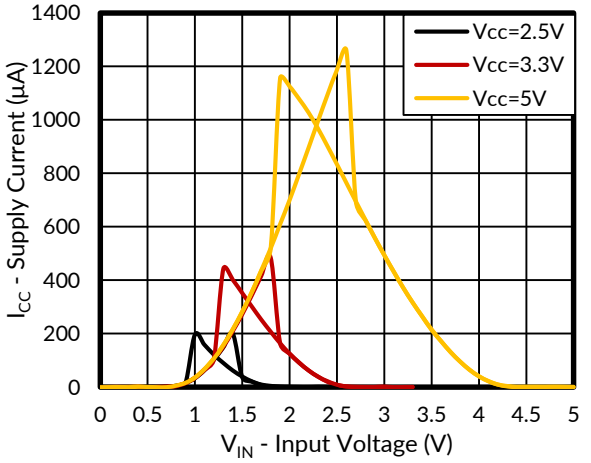


Figure 5. Typical (T_A=25°C) Supply Current (I_{CC}) vs Input Voltage (V_{IN})

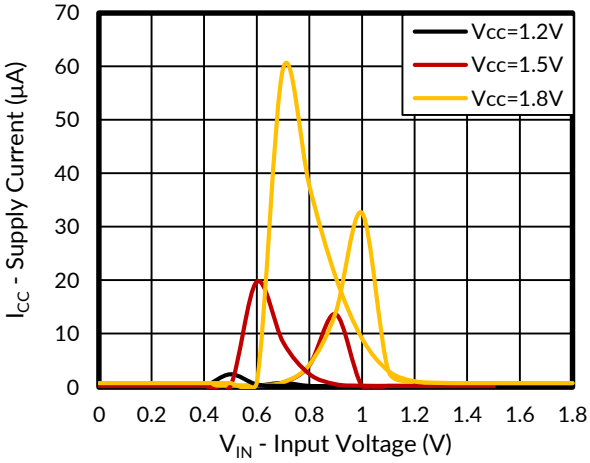
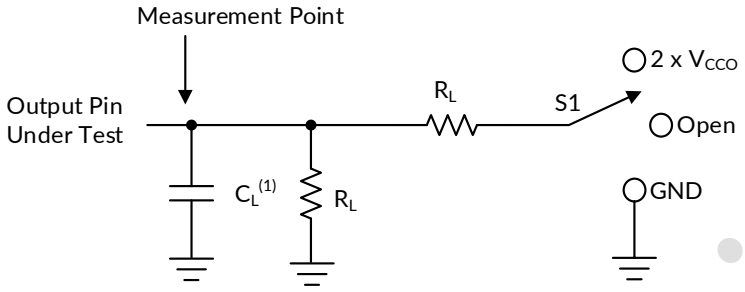


Figure 6. Typical (T_A=25°C) Supply Current (I_{CC}) vs Input Voltage (V_{IN})

8 PARAMETER MEASUREMENT INFORMATION

Unless otherwise noted, generators supply all input pulses that have the following characteristics:

- f = 1 MHz
- Z_O = 50 Ω
- Δt/ΔV ≤ 1 ns/V

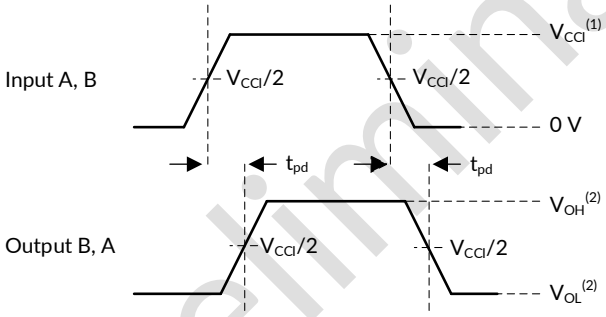


(1) C_L includes probe and jig capacitance.

Figure 7. Load Circuit

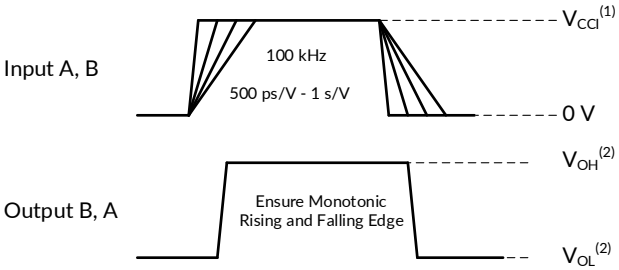
Table 1. Load Circuit Conditions

Parameter		V_{CCO}	R_L	C_L	S_1	V_{TP}
t_{pd}	Propagation (delay) time	1.1 V – 5.5 V	10 kΩ	5 pF	Open	N/A
t_{en}, t_{dis}	Enable time, disable time	1.1 V – 1.6 V	10 kΩ	5 pF	2 × V_{CCO}	0.1 V
		1.65 V – 2.7 V	10 kΩ	5 pF	2 × V_{CCO}	0.15 V
		3.0 V – 5.5 V	10 kΩ	5 pF	2 × V_{CCO}	0.3 V
t_{en}, t_{dis}	Enable time, disable time	1.1 V – 1.6 V	10 kΩ	5 pF	GND	0.1 V
		1.65 V – 2.7 V	10 kΩ	5 pF	GND	0.15 V
		3.0 V – 5.5 V	10 kΩ	5 pF	GND	0.3 V



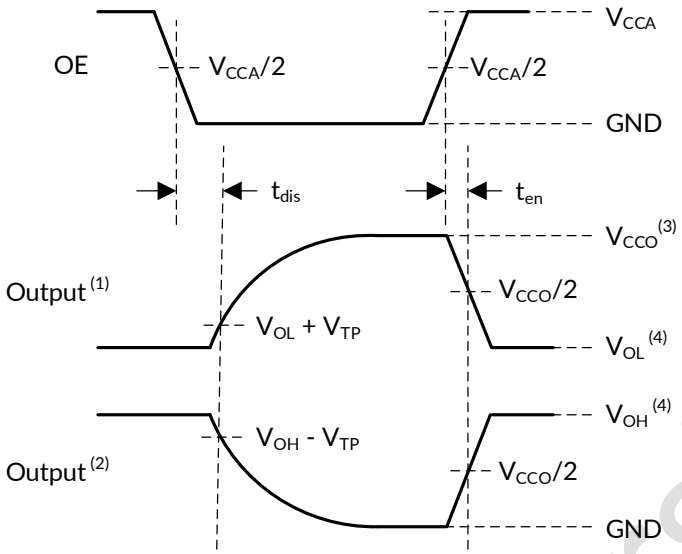
1. V_{CCI} is the supply pin associated with the input port.
2. V_{OH} and V_{OL} are typical output voltage levels that occur with specified R_L, C_L, and S_1.

Figure 8. Propagation Delay



1. V_{CCI} is the supply pin associated with the input port.
2. V_{OH} and V_{OL} are typical output voltage levels that occur with specified R_L, C_L, and S_1.

Figure 9. Input Transition Rise and Fall Rate



1. Output waveform on the condition that input is driven to a valid Logic Low.
2. Output waveform on the condition that input is driven to a valid Logic High.
3. V_{CCO} is the supply pin associated with the output port.
4. V_{OH} and V_{OL} are typical output voltage levels with specified R_L, C_L, and S_1.

Figure 10. Enable Time And Disable Time

9 DETAILED DESCRIPTION

9.1 Overview

The RXU0304 is a 4-bit translating transceiver that uses two individually configurable power-supply rails. The device is operational with V_{CCA} and V_{CCB} supplies as low as 1.1 V and as high as 5.5 V. Additionally, the device can be operated with V_{CCA} = V_{CCB}. The A port is designed to track V_{CCA}, and the B port is designed to track V_{CCB}.

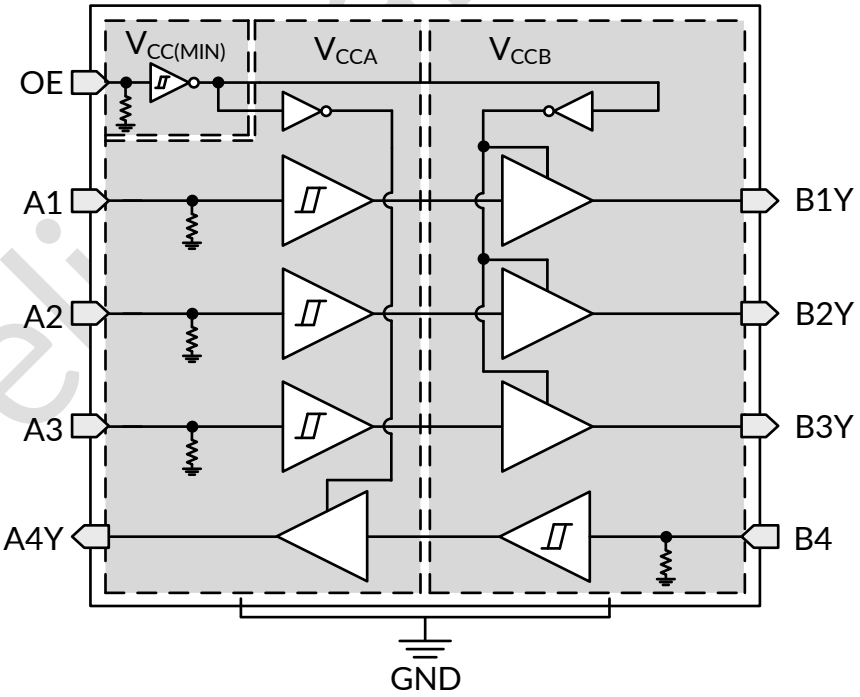
The RXU0304 device is designed for asynchronous communication between data buses, and transmits data with fixed direction from the A bus to the B bus on some channels and from the B bus to the A bus on the remaining channels. The output-enable input (OE) is used to disable the outputs so the buses are effectively isolated. The output-enable pin of the RXU0304 (OE) can be referenced to either V_{CCA} or V_{CCB}. The OE pin can be left floating or externally pulled down to ground to ensure the high-impedance state of the level shifter outputs during power up or power down.

This device is fully specified for partial-power-down applications using the I_{off} current. The I_{off} protection circuitry ensures that no excessive current is drawn from or sourced into an input or output while the device is powered down.

The VCC isolation or VCC disconnect feature ensures that if either VCC is less than 100 mV or disconnected with the complementary supply within recommended operating conditions, outputs are disabled and set to the high-impedance state while the supply current is maintained. The $I_{off-float}$ circuitry ensures that no excessive current is drawn from or sourced into an input or output while the supply is floating.

Glitch-free power supply sequencing allows either supply rail to be powered on or off in any order while providing robust power sequencing performance.

9.2 Functional Block Diagram



9.3 Feature Description

9.3.1 CMOS Schmitt-Trigger Inputs with Integrated Pulldowns

Standard CMOS inputs are high impedance and are typically modeled as a resistor in parallel with the input capacitance given in the Electrical Characteristics. The worst case resistance is calculated with the maximum input voltage, given in the Absolute Maximum Ratings, and the maximum input leakage current, given in the Electrical Characteristics, using ohm's law (R = V ÷ I).

The Schmitt-trigger input architecture provides hysteresis as defined by ΔV_T in the Electrical Characteristics, which makes this device extremely tolerant to slow or noisy inputs. Driving the inputs slowly will increase dynamic current consumption of the device.

9.3.1.1 Inputs with Integrated Static Pull-Down Resistors

This device has 5 MΩ typical integrated weak pull-downs for each input. This feature allows all inputs to be left floating without the concern for unstable outputs or increased current consumption. This also helps to reduce external component count for applications where not all channels are used or need to be fixed low. If an external pull-up is required, it should be no larger than 1 MΩ to avoid contention with the 5 MΩ internal pull-down.

9.3.2 Control Logic (OE) with $V_{CC(MIN)}$ Circuitry

The output-enable input (OE) is used to disable the outputs so the buses are effectively isolated. The output-enable pin of the RXU0304 has $V_{CC(MIN)}$ circuitry, which allows the OE pin to operate with the lower supply voltage. The Over-Voltage Tolerant Inputs feature allows the OE pin to operate with the higher supply voltage. This combination means that the enable pin can be referenced to either V_{CCA} or V_{CCB} supply. Multiple permutations of each device are possible since the controller can be placed on either the A or B port and can still control the enable pin.

9.3.3 Balanced High-Drive CMOS Push-Pull Outputs

A balanced output allows the device to sink and source similar currents. The high drive capability of this device creates fast edges into light loads, so routing and load conditions should be considered to prevent ringing. Additionally, the outputs of this device are capable of driving larger currents than the device can sustain without being damaged. Absolute Maximum Ratings defines the electrical and thermal limits that must be followed at all times.

9.3.4 Partial Power Down (I_{off})

The inputs and outputs for this device enter a high-impedance state when the device is powered down, inhibiting current backflow into the device. The I_{off} in the Electrical Characteristics specifies the maximum leakage into or out of any input or output pin on the device.

9.3.5 VCC Isolation and V_{CC} Disconnect

The outputs for this device are disabled and enter a high-impedance state when either supply is <100 mV or left floating (disconnected), with the complementary supply within recommended operating conditions. It is recommended that the inputs are kept low before floating (disconnecting) either supply.

The $I_{CCx(floating)}$ in the Electrical Characteristics specifies the maximum supply current. The $I_{off(float)}$ in the Electrical Characteristics specifies the maximum leakage into or out of any input or output pin on the device.

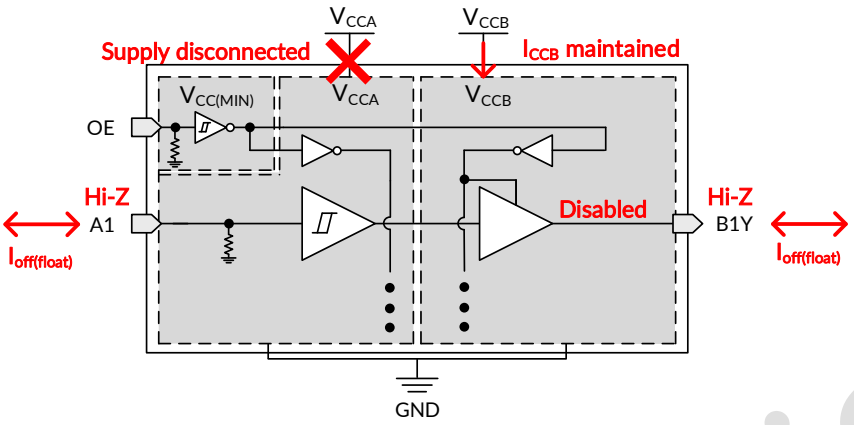


Figure 11. V_{CC} Disconnect Feature

9.3.6 Over-Voltage Tolerant Inputs

Input signals to this device can be driven above the supply voltage so long as they remain below the maximum input voltage value specified in the Recommended Operating Conditions.

9.3.7 Glitch-Free Power Supply Sequencing

Either supply rail may be powered on or off in any order without producing a glitch on the inputs or outputs (that is, where the output erroneously transitions to VCC when it should be held low or vice versa). Glitches of this nature can be misinterpreted by a peripheral as a valid data bit, which could trigger a false device reset of the peripheral, a false device configuration of the peripheral, or even a false data initialization by the peripheral.

9.3.8 Negative Clamping Diodes

Figure 12 depicts the inputs and outputs to this device that have negative clamping diodes.

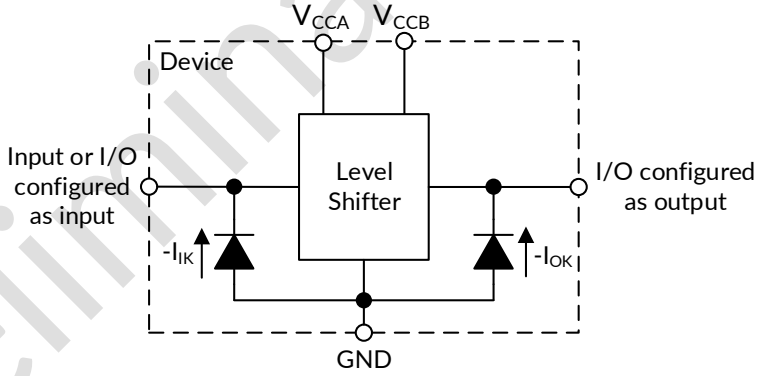


Figure 12. Electrical Placement of Clamping Diodes for Each Input and Output

9.3.9 Fully Configurable Dual-Rail Design

The V_{CCA} and V_{CCB} pins can be supplied at any voltage from 1.1 V to 5.5 V, making the device suitable for translating between any of the voltage nodes (1.2 V, 1.5 V, 1.8 V, 3.3 V, and 5.0 V).

9.3.10 Supports High-Speed Translation

The RXU0304 device can support high data-rate applications. The translated signal data rate can be up to 200 Mbps when the signal is translated from 3.3 V to 5.0 V.

9.4 Device Functional Modes

Table 2. Function Table

CONTROL INPUTS	Port Status		OPERATION
OE	Input	Output	
H	L	L	Unidirectional non-inverting voltage translation
H	H	H	Unidirectional non-inverting voltage translation
L	X	Hi-Z	Isolation

10 APPLICATION AND IMPLEMENTATION

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

10.1 Application Information

The RXU0304 device can be used in level-translation applications for interfacing devices or systems operating at different interface voltages with one another. The RXU0304 device is ideal for use in applications where a push-pull driver is connected to the data Inputs. The max data rate can be up to 200 Mbps when device translates a signal from 3.3 V to 5.0 V.

10.2 Typical Application

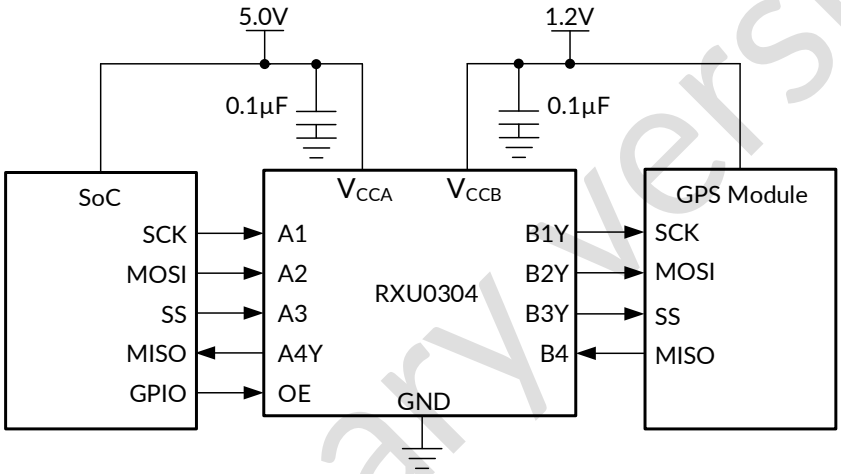


Figure 13. RXU0304 SPI Interface Application

10.2.1 Design Requirements

Use the parameters listed in Table 3 for this design example.

Table 3. Design Parameters

DESIGN PARAMETERS	EXAMPLE VALUES
Input voltage range	1.1 V to 5.5 V
Output voltage range	1.1 V to 5.5 V

10.2.2 Detailed Design Procedure

To begin the design process, determine the following:

- Input voltage range
  - Use the supply voltage of the device that is driving the RXU0304 device to determine the input voltage range. For a valid logic-high, the value must exceed the positive-going input-threshold voltage (V_{T+}) of the input port. For a valid logic low the value must be less than the negative-going input-threshold voltage (V_{T-}) of the input port.
- Output voltage range
  - Use the supply voltage of the device that the RXU0304 device is driving to determine the output voltage range.

11 POWER SUPPLY RECOMMENDATIONS

Always apply a ground reference to the GND pins first. This device is designed for glitch free power sequencing without any supply sequencing requirements such as ramp order or ramp rate.

Glitch-Free Power Supply Sequencing describes how this device was designed with various power supply sequencing methods in mind to help prevent unintended triggering of downstream devices.

12 LAYOUT

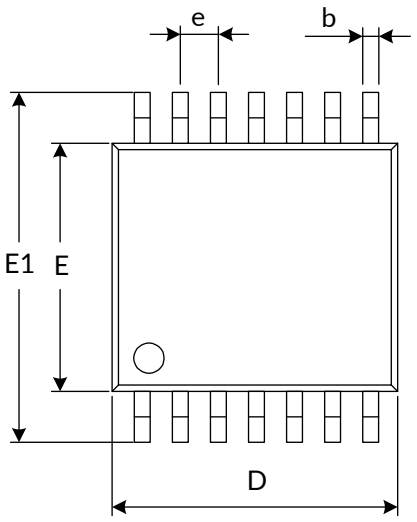
12.1 Layout Guidelines

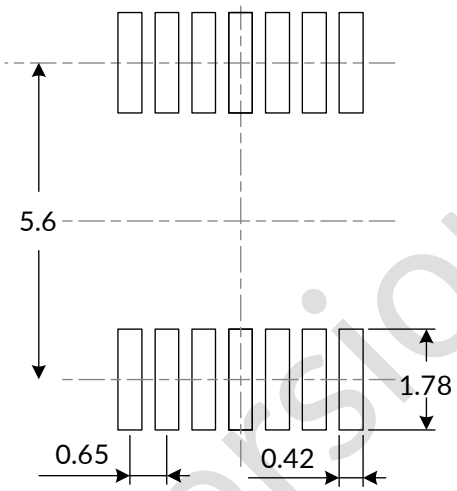
To ensure reliability of the device, following common printed-circuit board layout guidelines are recommended:

- Use bypass capacitors on the power supply pins and place them as close to the device as possible. A 0.1 μF capacitor is recommended, but transient performance can be improved by having 1 μF and 0.1 μF capacitors in parallel as bypass capacitors.
- The high drive capability of this device creates fast edges into light loads so routing and load conditions should be considered to prevent ringing.

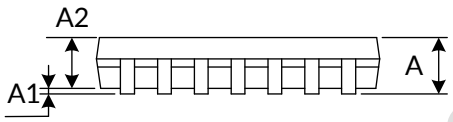
13 PACKAGE OUTLINE DIMENSIONS

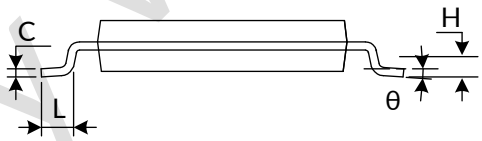
TSSOP14 (3)





RECOMMENDED LAND PATTERN (Unit: mm)



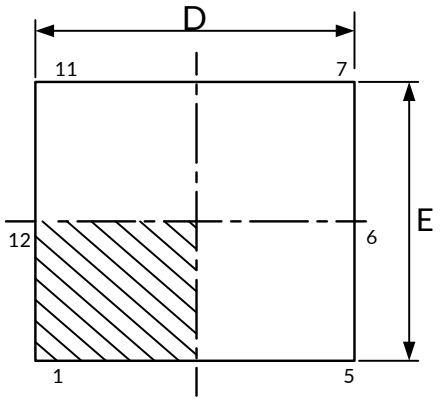


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D (1)	4.860	5.100	0.191	0.201
E (1)	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650(BSC) (2)		0.026(BSC) (2)	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
θ	1°	7°	1°	7°

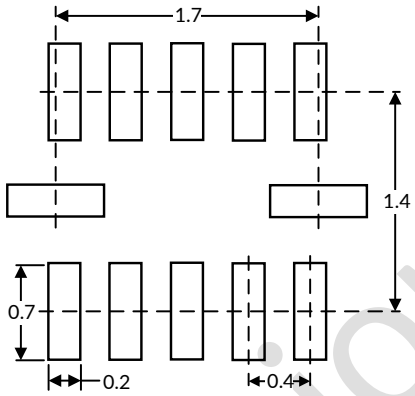
NOTE:

1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

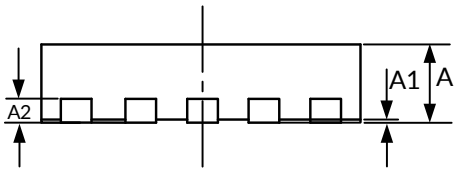
UQFN1.7X2-12 (4)



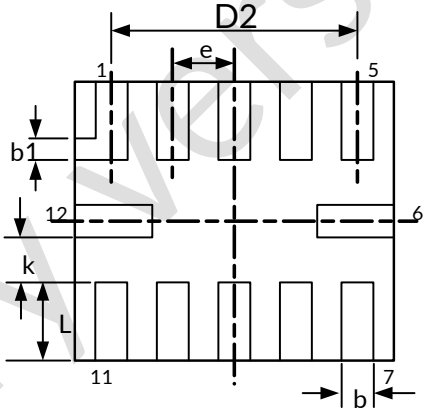
TOP VIEW



RECOMMENDED LAND PATTERN (Unit: mm)



SIED VIEW



BOTTOM VIEW

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)	0.450	0.550	0.018	0.022
A1	0.000	0.050	0.000	0.002
A2	0.152 REF (2)		0.006 REF (2)	
D (1)	1.900	2.100	0.075	0.083
E (1)	1.600	1.800	0.063	0.071
D2	1.500	1.700	0.059	0.067
b	0.150	0.250	0.006	0.010
b1	0.150 REF (2)		0.006 REF (2)	
k	0.250 REF (2)		0.010 REF (2)	
e	0.400 BSC (3)		0.016 BSC (3)	
L	0.400	0.600	0.016	0.024

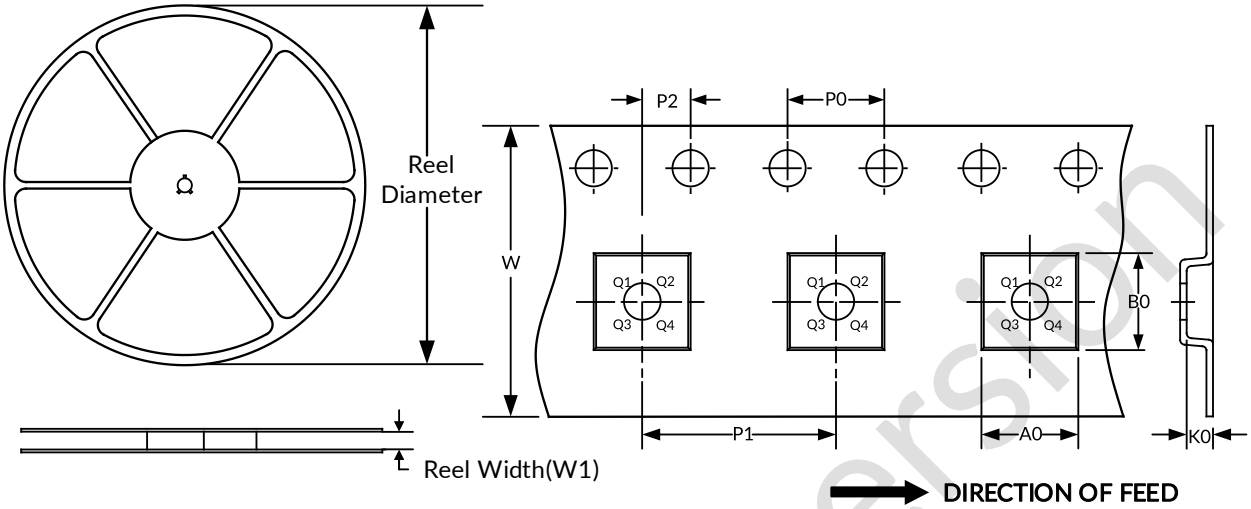
NOTE:

1. Plastic or metal protrusions of 0.075mm maximum per side are not included.
2. REF is the abbreviation for Reference.
3. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
4. This drawing is subject to change without notice.

14 TAPE AND REEL INFORMATION

REEL DIMENSIONS

TAPE DIMENSION



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width(mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
TSSOP14	13”	12.4	6.95	5.60	1.20	4.0	8.0	2.0	12.0	Q1
UQFN1.7X2-12	7”	9.0	1.90	2.30	0.75	4.0	4.0	2.0	8.0	Q1

NOTE:
1. All dimensions are nominal.
2. Plastic or metal protrusions of 0.15mm maximum per side are not included.

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