RS7LS102Q

Bi-directional Level Translator for
Open-drain and Push-Pull Applications

Features

- No Direction-Control
- Max Data Rates
  24Mbps (Push-Pull, 12MHz)
  2Mbps (Open-Drain, 1MHz)
- 1.2V to 3.63V on A ports and 1.2V to 3.63V on B Ports
- VCCA can be Less than, Greater than or Equal to VCCB
- VCC Isolation: If Either VCC is at GND, Both Ports are in the High-Impedance State
- No Power-Supply Sequencing Required: VCCA or VCCB can be Ramped First
- ESD protection exceeds 4000V HBM
- AEC-Q100 qualified, PPAP capable, and manufactured in IATF 16949 certified facilities.
- Extended Temperature: -40°C to +125°C

Application

- Automotive Infotainment
- Advanced Driver Assistance Systems (ADAS)
- Telematics
- I2C / SMBus/UART/GPIO

Block Diagram

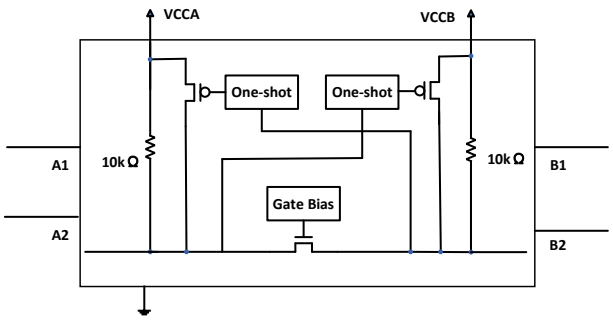


Figure 1: Block Diagram

Description

The RS7LS102Q is a 2-bit configurable dual supply bidirectional auto sensing translator that does not require a directional control pin. The A and B ports are designed to track two different power supply rails, VCCA and VCCB respectively.

A port supporting operating voltages from 1.2V to 3.63V while it tracks the VCCA supply, and the B ports supporting operating voltages from 1.2V to 3.63V while it tracks the VCCB supply. This allows the support of both lower and higher logic signal levels while providing bidirectional translation capabilities between any of the 1.2V,1.8V, 2.5V, and 3.3V voltage nodes.

The translator has integrated 10 kΩ pull-up resistors on the I/O lines. The integrated pull-up resistors are used to pull-up the I/O lines to either VCCA or VCCB. The RS7LS102Q is an excellent match for open-drain applications such as the I2C communication bus.

When the output-enable (EN) input is low, all outputs are placed in the high-impedance state. To ensure the high-impedance state during power up or power down, EN should be tied to GND through a pulldown resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver.

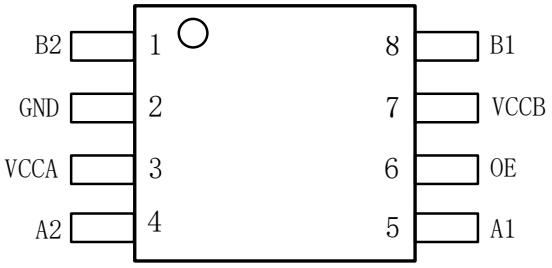
Ordering Information

Part Number	Package	Description
RS7LS102QVE	VSSOP8	2.0mmx2.3mm

Notes
1. E= Pb-free and Green

Pin Configuration

VSSOP8 (Top view)



Pin Name	Pin No. VSSOP8	Type	Description
VCCB	7	Power	A-port supply voltage. 1.2V ≤ VCCB ≤3.63V
B1	8	I/O	Input/output A. Referenced to VCCA.
B2	1	I/O	Input/output A. Referenced to VCCA
OE	6	Input	Output enables (active High). Pull OE low to place all outputs in 3-state mode.
GND	2	GND	Ground.
A2	4	I/O	Input/output A. Referenced to VCCB
A1	5	I/O	Input/output A. Referenced to VCCB
VCCA	3	Power	B-port supply voltage.1.2V ≤ VCCA ≤3.63V

Absolute Maximum Ratings

Symbol	Parameter	MIN	TYP	MAX	Unit
Tstore	Storage Temperature	−65	-	+150	°C
VCCA	DC Supply Voltage port B	-0.3	-	5.5	V
VCCB	DC Supply Voltage port A	-0.3	-	5.5	V
VIOB	Vi(A) referenced DC Input / Output Voltage	-0.3	-	5.5	V
VIOB	Vi(B) referenced DC Input / Output Voltage	-0.3	-	5.5	V
VEN	Enable Control Pin DC Input Voltage	-0.3	-	5.5	V
Ishort	Short circuit duration (I/O to GND)			50	mA

Notes:
Stresses greater than those listed under MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Recommended operation conditions

Symbol	Parameter	MIN	TYP	MAX	Unit
VCCA	VCCA Positive DC Supply Voltage	1.2	-	3.63	V
VCCB	VCCB Positive DC Supply Voltage	1.2	-	3.63	V
VEN	Enable Control Pin Voltage	GND	-	3.63	V
VIO	I/O Pin Voltage	GND	-	3.63	V
Δt /ΔV	Input transition rise or fall time	-	-	10	ns/V
TA	Operating Temperature Range	−40	-	+125	°C

DC Electrical Characteristics

Unless otherwise specified, -40°C≤T_A≤ 125°C, 1.2V≤V_{CCA}≤3.63V, 1.2V≤V_{CCB}≤3.63V

Symbol	Parameter	Test Conditions*1		MIN	TYP	MAX	Unit
VIHA	A port Input HIGH Voltage	2.3V≤VCCA ≤3.63V		VCCA – 0.4			V
		1.2V≤VCCA ＜2.3V		VCCA – 0.2			V
VILA	A port Input LOW Voltage	1.2V≤VCCA≤3.63V		-	-	0.15	V
VIHB	B port Input HIGH Voltage	2.3V≤VCCB ≤3.63V		VCCB – 0.4	-	-	V
		1.2V≤VCCA ＜2.3V		VCCB – 0.2			
VILB	B port Input LOW Voltage	1.2V≤VCCB≤3.63V		-	-	0.15	V
VIH(EN)	Control Pin Input HIGH Voltage	1.2V≤VCCA≤3.63V		0.65*VCCA	-	-	V
VIL(EN)	Control Pin Input LOW Voltage	1.65V≤VCCA≤3.63V		-	-	0.35*VCCA	V
		1.2V≤VCCA＜1.65V				0.15	
VOHA	A port Output HIGH Voltage	A port source current= -20 μA		0.8* VCCA	-	-	V
VOLA	A port Output LOW Voltage	A port sink current =1 mA		-	-	0.4	V
VOHB	B port Output HIGH Voltage	B port source current = -20 μA		0.8*VCCB	-	-	V
VOLB	B port Output LOW Voltage	B port sink current =1 mA		-	-	0.4	V
ICCA	VCCA Supply Current	EN=High	VCCA=1.2V to 3.63V, VCCB=1.2V to 3.63V	-	0.2	2.4	μA
			VCCA= 3.63V, VCCB= 0V	-	-	2	μA
			VCCA= 0V, VCCB=3.63V	-	-	1	μA
ICCB	VCCB Supply Current	EN=High	VCCA=1.2V to 3.63V, VCCB=1.2V to 3.63V	-	0.5	10	μA
			VCCA= 3.63V, VCCB= 0V	-		1	μA
			VCCA= 0V, VCCB=3.63V	-		1	μA
ICCA+ICCB	Combined supply current	EN=High	VCCA=1.2V to 3.63V, VCCB=1.2V to 3.63V			15	μA
ICCZA	Static supply current VCCA	EN=Low	VCCA=1.2V to 3.63V, VCCB=1.2V to 3.63V			8	μA
ICCZB	Static supply current VCCB					8	μA
I_{OZ}	I/O Tri−state Output Mode Leakage Current	A or B port	VCCA=1.2V to 3.63V, VCCB=1.2V to 3.63V			±8	μA
IOFF	Partial power down current	A port	VCCA=0V, VCCB=1.2V to 3.63V			±8	μA
		B port	VCCA=1.2V to 3.63V VCCB=0V			±8	μA
II-EN	Control pin leakage Current	VI = VCCI or GND		-	-	±2	μA
R_{PU}	Pull−Up Resistors I/O A and B	-		-	10	-	kΩ
Ci	EN	VCCA= 3.3V, VCCB= 3.3V		-	-	1	pF
CIO	A port	VCCA= 3.3V, VCCB= 3.3V		-	-	5	pF
	B port	VCCA= 3.3V, VCCB= 3.3V		-	-	5	pF

Note:

1. All units are production tested at T_A = +25°C. Limits over the operating temperature range are guaranteed by design. Typical values are for V_{CCB} = +3.3 V, V_{CCA} = +1.8 V and T_A = +25°C.

AC Electrical characteristics

Timing Characteristics
(C_{LOAD} = 15pF, driver output impedance ≤ 50Ω, R_{LOAD} = 1 MΩ, T_A = -40°C to 125°C)

V_{CCA}= 1.2V±0.1V

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

Symbol	Parameter	Test Conditions	VCCB= 1.8V±0.15V		VCCB= 2.5V±0.2V		V_{CCB} = 3.3V±0.3V		Unit
			MIN	MAX	MIN	MAX	MIN	MAX	
tPHL_AB	Propagation Delay A → B	Push-pull		12		10		10	ns
		Open-drain		30		30		30	ns
tPLH_AB	Propagation Delay A → B	Push-pull		20		15		15	ns
		Open-drain		30		30		30	ns
tPHL_BA	Propagation Delay B → A	Push-pull		12		10		10	ns
		Open-drain		30		30		30	ns
tPLH_BA	Propagation Delay B → A	Push-pull		20		15		15	ns
		Open-drain		50		50		50	ns
tEN	Enable Time	EN to A or B		380		200		200	ns
t_{DIS}	Disable Time	EN to A or B		200		200		200	ns
tRA	A port Rise Time	Push-pull		30		30		30	ns
		Open-drain		160		120		120	ns
t_{RB}	B port Rise Time	Push-pull		30		30		30	ns
		Open-drain		160		160		160	ns
tFA	A port Fall Time	Push-pull		20		20		25	ns
		Open-drain		30		30		30	ns
t_{FB}	B port Fall Time	Push-pull		20		20		25	ns
		Open-drain		30		30		30	ns
tSKEW	Channel to Channel Skew			1		1		1	ns
MDR	Maximum Data Rate	Push-pull	20		20		20		Mbps
		Open-drain	2		2		2		Mbps

V_{CCA}= 1.8V±0.15V

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

Symbol	Parameter	Test Conditions	VCCB= 1.2V±0.1V		VCCB= 2.5V±0.2V		V_{CCB} = 3.3V±0.3V		Unit
			MIN	MAX	MIN	MAX	MIN	MAX	
tPHL_AB	Propagation Delay A → B	Push-pull		12		10		9	ns
		Open-drain		30		30		30	ns
tPLH_AB	Propagation Delay A → B	Push-pull		20		12		11	ns
		Open-drain		30		30		30	ns
tPHL_BA	Propagation Delay B → A	Push-pull		12		9		9	ns
		Open-drain		30		30		30	ns
tPLH_BA	Propagation Delay B → A	Push-pull		20		14		12	ns
		Open-drain		50		50		50	ns
tEN	Enable Time	EN to A or B		200		200		200	ns
t_{DIS}	Disable Time	EN to A or B		200		200		200	ns
t_{RA}	A port Rise Time	Push-pull		30		30		30	ns
		Open-drain		160		120		120	ns
t_{RB}	B port Rise Time	Push-pull		30		30		30	ns
		Open-drain		160		160		160	ns
t_{FA}	A port Fall Time	Push-pull		20		20		25	ns
		Open-drain		30		30		30	ns
t_{FB}	B port Fall Time	Push-pull		20		25		30	ns
		Open-drain		30		30		30	ns
tSKEW	Channel to Channel Skew			1		1		1	ns
MDR	Maximum Data Rate	Push-pull	20		20		24		Mbps
		Open-drain	2		2		2		Mbps

V_{CCA}= 2.5V±0.2V

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

Symbol	Parameter	Test Conditions	VCCB= 1.2V±0.1V		VCCB= 1.8V±0.15V		V_{CCB} = 3.3V±0.3V		Unit
			MIN	MAX	MIN	MAX	MIN	MAX	
tPHL_AB	Propagation Delay A → B	Push-pull		10		9		9	ns
		Open-drain		30		30		30	ns
tPLH_AB	Propagation Delay A → B	Push-pull		15		12		10	ns
		Open-drain		30		30		30	ns
tPHL_BA	Propagation Delay B → A	Push-pull		10		10		9	ns
		Open-drain		30		30		30	ns
tPLH_BA	Propagation Delay B → A	Push-pull		15		12		12	ns
		Open-drain		50		50		50	ns
tEN	Enable Time	EN to A or B		200		200		200	ns
t_{DIS}	Disable Time	EN to A or B		200		200		200	ns
tRA	A port Rise Time	Push-pull		30		30		30	ns
		Open-drain		160		120		120	ns
t_{RB}	B port Rise Time	Push-pull		30		30		30	ns
		Open-drain		160		160		160	ns
tFA	A port Fall Time	Push-pull		20		25		30	ns
		Open-drain		30		30		30	ns
t_{FB}	B port Fall Time	Push-pull		20		20		25	ns
		Open-drain		30		30		30	ns
tSKEW	Channel to Channel Skew			1		1		1	ns
MDR	Maximum Data Rate	Push-pull	20		20		24		Mbps
		Open-drain	2		2		2		Mbps

V_{CCA}= 3.3V±0.3V

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

Symbol	Parameter	Test Conditions	VCCB= 1.2V±0.1V		VCCB= 1.8V±0.15V		V_{CCB} = 2.5V±0.3V		Unit
			MIN	MAX	MIN	MAX	MIN	MAX	
tPHL_AB	Propagation Delay A → B	Push-pull		10		9		9	ns
		Open-drain		30		30		30	ns
tPLH_AB	Propagation Delay A → B	Push-pull		15		12		12	ns
		Open-drain		30		30		30	ns
tPHL_BA	Propagation Delay B → A	Push-pull		10		9		9	ns
		Open-drain		30		30		30	ns
tPLH_BA	Propagation Delay B → A	Push-pull		15		11		10	ns
		Open-drain		50		50		50	ns
tEN	Enable Time	EN to A or B		200		200		200	ns
t_{DIS}	Disable Time	EN to A or B		200		200		200	ns
tRA	A port Rise Time	Push-pull		30		30		30	ns
		Open-drain		160		120		120	ns
t_{RB}	B port Rise Time	Push-pull		30		30		30	ns
		Open-drain		160		160		160	ns
tFA	A port Fall Time	Push-pull		25		25		25	ns
		Open-drain		30		30		30	ns
t_{FB}	B port Fall Time	Push-pull		25		25		25	ns
		Open-drain		30		30		30	ns
tSKEW	Channel to Channel Skew			1		1		1	ns
MDR	Maximum Data Rate	Push-pull	20		24		24		Mbps
		Open-drain	2		2		2		Mbps

Test Circuits

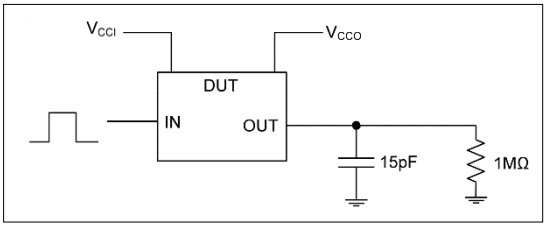


Figure 2 Data Rate, Pulse Duration, Propagation Delay, Output Rise-Time and Fall-Time Measurement Using a Push-Pull Driver

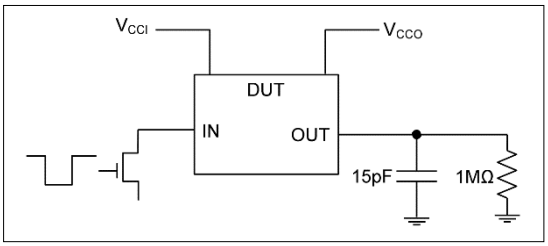
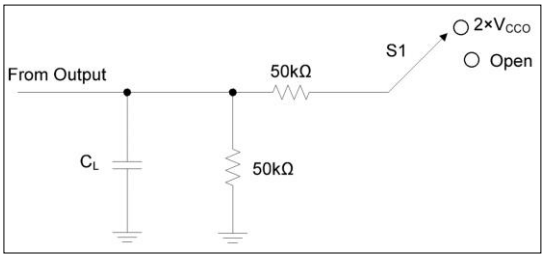


Figure 3 Data Rate, Pulse Duration, Propagation Delay, Output Rise-Time and Fall-Time Measurement Using an Open-Drain Driver



TEST	S1
t_{PZL} ,t_{PLZ} (t_{dis})	2 × V_{CCO}
t_{PHZ} ,t_{PZH} (t_{en})	Open

Figure 4 Load Circuit for Enable-Time and Disable-Time Measurement

Notes:

1. CL includes probe and jig capacitance.
2. t_{en} is the same as t_{PZL} and t_{PZH}. t_{dis} is the same as t_{PLZ} and t_{PHZ}.
3. V_{CCI} is the supply voltage associated with the input.
4. V_{CCO} is the supply voltage associated with the output.

Voltage Waveforms

The outputs are measured one at a time, with one transition per measurement. All input pulses are supplied by generators that have the following characteristics:

PRR ≤10 MHz
Z_O = 50 Ω
dv/dt ≥1 V/ns

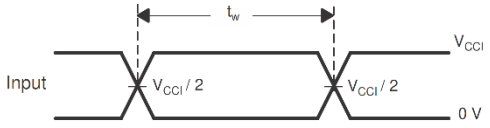


Figure 5 Pulse Duration

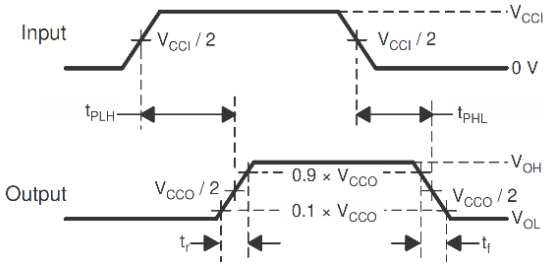


Figure 6 Propagation Delay Times

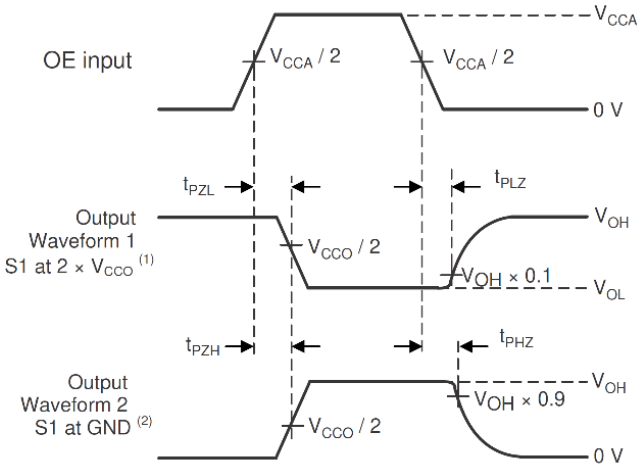


Figure 7 Enable and Disable Times

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

Functional Description

The RS7LS102Q is a 4−bit configurable dual−supply bidirectional auto sensing translator that does not require a directional control pin. The A and B ports are designed to track two different power supply rails, V_{CCA} and V_{CCB} respectively.

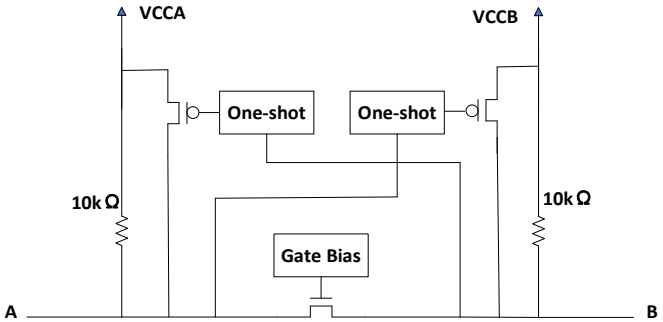


Figure 8 Level Shifter Architecture

Each A-port I/O has an internal 10kΩ pull up resistor to VCCA, and each B-port I/O has an internal 10kΩ pull-up resistor to VCCB. 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 for a short duration, which speeds up the low-to-high transition.

Input Driver Requirements

The rise (tR) and fall (tF) timing parameters of the open drain outputs depend on the magnitude of the pull−up resistors. In -addition, the propagation times (tPD), skew (tSKEW) and maximum data rate depend on the impedance of the device that is connected to the translator. The timing parameters listed in the data sheet assume that the output impedance of the drivers connected to the translator is less than 50 kΩ.

Enable Input (OE)

The RS7LS102Q has an Enable pin (OE) that provides tri-state operation at the I/O pins. Driving the Enable pin to a low logic level minimizes the power consumption of the device and drives the I/O VCCB and I/O VCCA pins to a high impedance state. Normal translation operation occurs when the OE pin is equal to a logic high signal. The OE pin is referenced to the VCCA supply and has overvoltage tolerant protection.

Application Information

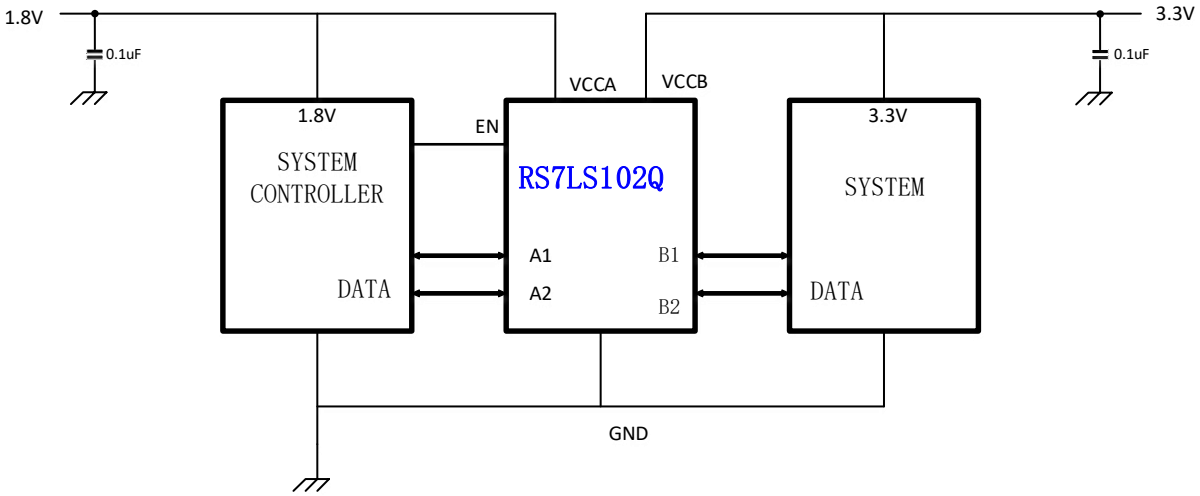


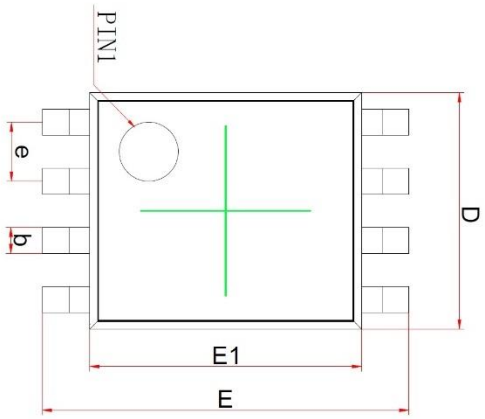
Figure 10 Application Circuit

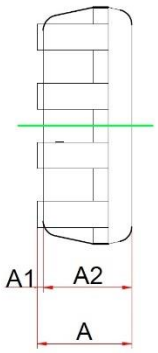
Power Supply Guidelines

During normal operation, supply voltage VCCA can be greater than, less than or equal to VCCB. The sequencing of the power supplies will not damage the device during the power up operation. For optimal performance, 0.01μF to 0.1μF decoupling capacitors should be used on the VCCA and VCCB power supply pins. Ceramic capacitors are a good design choice to filter and bypass any noise signals on the voltage lines to the ground plane of the PCB. The noise immunity will be maximized by placing the capacitors as close as possible to the supply and ground pins, along with minimizing the PCB connection traces.

Package Information

VSSOP8





Symbol	Dimensions In Millimeters		
	Min.	Nor.	Max.
A	--	--	1.000
A1	0.000	--	0.150
A2	0.600	0.750	0.850
A3	0.190	0.200	0.210
b	0.170	0.220	0.270
c	0.080	--	0.230
D	1.900	2.000	2.100
E	3.000	3.100	3.200
E1	2.200	2.300	2.400
e	0.500BSC		
L	0.150	--	0.400
L1	0.400REF.		
θ	0°	--	8°

Note:
1.All dimensions are in mm. Angels in degrees.
2.Dimensions exclude burrs, mold flash or protrusions.
3.Refer Jedec MO-220

VSSOP08 (V08) Rev.0
Raystar Microelectronics Technology Inc.

Revision History

Revision	Description	Date
1.0	Initial Release	2024/10/30