

NLSX4302E

2-Bit 20 Mb/s Dual-Supply Level Translator

The NLSX4302E is a 2-bit configurable dual-supply bidirectional auto sensing translator that does not require a directional control pin. The V_{CC} I/O and V_L I/O ports are designed to track two different power supply rails, V_{CC} and V_L respectively. Both the V_{CC} and V_L supply rails are configurable from 1.5 V to 5.5 V. This allows voltage logic signals on the V_L side to be translated into lower, higher or equal value voltage logic signals on the V_{CC} side, and vice-versa.

The NLSX4302E translator uses external pull-up resistors on the I/O lines. The external pull-up resistors are used to pull up the I/O lines to either V_L or V_{CC} . The NLSX4302E is an excellent match for open-drain applications such as the I²C communication bus.

Features

- V_L can be Less than, Greater than or Equal to V_{CC}
- Wide V_{CC} Operating Range: 1.5 V to 5.5 V
Wide V_L Operating Range: 1.5 V to 5.5 V
- High-Speed with 20 Mb/s Guaranteed Data Rate
- Low Bit-to-Bit Skew
- Enable Input and I/O Pins are Overvoltage Tolerant (OVT) to 5.5 V
- Non-preferential Powerup Sequencing
- Power-Off Protection
- Small Space Saving Package: 1.4 mm x 1.2 mm UQFN8 Package
- These Devices are Pb-Free and are RoHS Compliant

Typical Applications

- I²C, SMBus
- Low Voltage ASIC Level Translation
- Mobile Phones, PDAs, Cameras

Important Information

- ESD Protection for All Pins
 - Human Body Model (HBM) > 6000 V
 - Machine Model (MM) > 400 V



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MARKING DIAGRAMS

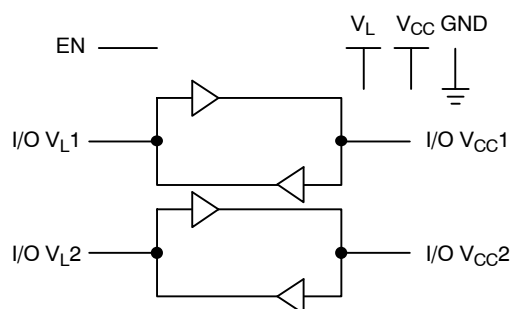


UQFN8
MU SUFFIX
CASE 523AS



E = Specific Device Code
M = Date Code

LOGIC DIAGRAM



ORDERING INFORMATION

Device	Package	Shipping†
NLSX4302EBMUTCG	UQFN8 (Pb-Free)	3000/Tape & Reel

† For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

NLSX4302E

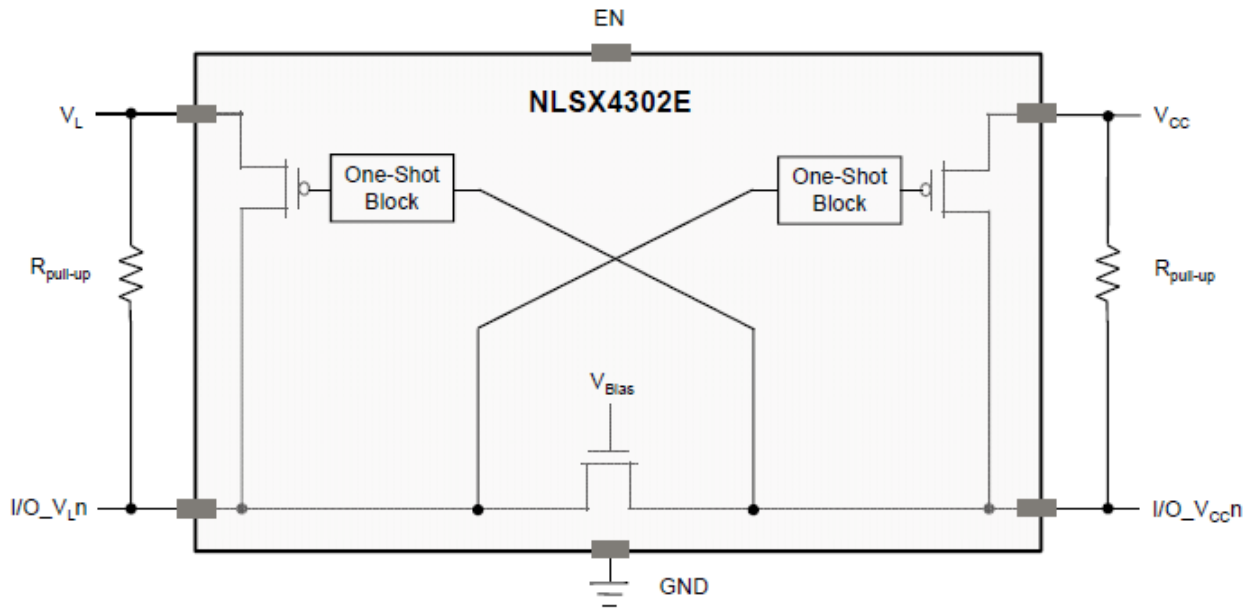


Figure 1. Block Diagram (1 I/O Line)

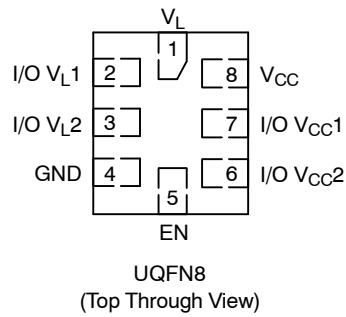


Figure 2. Pin-out Diagram

PIN ASSIGNMENT

Pins	Description
V _{CC}	V _{CC} Supply Voltage
V _L	V _L Supply Voltage
GND	Ground
EN	Output Enable, Referenced to V _L
I/O V _{CC} n	I/O Port, Referenced to V _{CC}
I/O V _L n	I/O Port, Referenced to V _L

FUNCTION TABLE

EN	Operating Mode
L	Hi-Z
H	I/O Buses Connected

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MAXIMUM RATINGS

Symbol	Parameter	Value	Condition	Unit
V _{CC}	High-side DC Supply Voltage	-0.3 to +7.0		V
V _L	High-side DC Supply Voltage	-0.3 to +7.0		V
I/O V _{CC}	V _{CC} -Referenced DC Input/Output Voltage	-0.3 to (V _{CC} + 0.3)		V
I/O V _L	V _L -Referenced DC Input/Output Voltage	-0.3 to (V _L + 0.3)		V
V _{EN}	Enable Control Pin DC Input Voltage	-0.3 to +7.0		V
I _{I/O_SC}	Short-Circuit Duration (I/O V _L and I/O V _{CC} to GND)	40	Continuous	mA
T _{STG}	Storage Temperature	-65 to +150		°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Max	Unit
V _{CC}	High-side Positive DC Supply Voltage	1.5	5.5	V
V _L	High-side Positive DC Supply Voltage	1.5	5.5	V
V _{EN}	Enable Control Pin Voltage	GND	5.5	V
V _{IO_VCC}	I/O Pin Voltage (Side referred to V _{CC})	GND	V _{CC}	V
V _{IO_VL}	I/O Pin Voltage (Side referred to V _L)	GND	V _L	V
Δt/ΔV	Input Transition Rise and Fall Rate I/O V _L - or I/O V _L - Ports, Push-Pull Driving Control Input		10 10	ns/V
T _A	Operating Temperature Range	-40	+85	°C

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DC ELECTRICAL CHARACTERISTICS ($V_L = 1.5\text{ V to }5.5\text{ V}$ and $V_{CC} = 1.5\text{ V to }5.5\text{ V}$, unless otherwise specified) (Note 1)

Symbol	Parameter	Test Conditions (Note 2)	V_L (V)	V_{CC} (V)	-40°C to +85°C			Unit		
					Min	Typ	Max			
V_{IH_VL}	I/O High Level I/O_VL	Data Inputs I/O_VL _n	1.65–5.50	1.65–5.50	$V_L - 0.4$			V		
		Control Input EN	1.65–5.50	1.65–5.50	$V_L \times 0.7$					
V_{IH_VCC}	I/O High Level I/O_VCC	Data Inputs I/O_VCC _n	1.65–5.50	1.65–5.50	$V_{CC} - 0.4$			V		
V_{IL_VL}	I/O Low Level I/O_VL	Data Inputs I/O_VL _n	1.65–5.50	1.65–5.50			0.4	V		
		Control Input EN	1.65–5.50	1.65–5.50			$V_L \times 0.3$			
V_{IL_VCC}	I/O Low Level I/O_VCC	Data Inputs I/O_VCC _n	1.65–5.50	1.65–5.50			0.4	V		
V_{OL}	Low Level Output Voltage	$V_{IL} = 0.15\text{ V}$, $I_{OL} = 6\text{ mA}$	1.65–5.50	1.65–5.50			0.4	V		
I_L	Input Leakage Current	Control Input EN, $V_{IN} = V_L$ or GND	1.65–5.50	1.65–5.50			± 1	μA		
I_{OFF}	Power-Off Leakage Current	I/O_VL _n , I/O_VCC _n	V_{IN} or $V_O = 0$ to 5.5 V	0	0			± 2	μA	
		I/O_VL _n		0	5.50					
		I/O_VCC _n		5.50	0					
I_{OZ}	Tristate Output Mode Leakage Current (Note 3)	I/O_VL _n , I/O_VCC _n	$V_O = 0$ to 5.5 V, EN = V_{IL}	5.50	5.50			± 2	μA	
		I/O_VL _n		$V_O = 0$ to 5.5 V, EN = Don't Care	5.50	0				
		I/O_VCC _n		$V_O = 0$ to 5.5 V, EN = Don't Care	0	5.50				
I_{CC}	Quiescent Supply Current, Active Mode (Notes 4, 5)	V_L	$V_{IN} = V_{CCI}$ or GND, $I_O = 0$, EN = V_{IH_VL}	1.65–5.50	1.65–5.50			5.0	μA	
		V_{CC}								
I_{CCZ}	Quiescent Supply Current, Standby Mode (Notes 4, 5)	V_L	$V_{IN} = V_{CCI}$ or GND, $I_O = 0$, EN = V_{IL_VL}	1.65–5.50	1.65–5.50			5.0	μA	
		V_{CC}								
I_{CC_OFF}	Quiescent Supply Current, Power-Off (Notes 3, 5)	V_L	$V_{IN} = 5.5\text{ V}$ or GND, $I_O = 0$, EN = Don't Care, I/O_VCC to I/O_VL	0	1.65–5.50			2.0	μA	
				1.65–5.50	0					
		V_{CC}	$V_{IN} = 5.5\text{ V}$ or GND, $I_O = 0$, EN = Don't Care, I/O_VL to I/O_VCC	1.65–5.50	0					
				0	1.65–5.50					

1. Typical values are for $V_L = +1.8\text{ V}$, $V_{CC} = +3.3\text{ V}$ and $T_A = +25^\circ\text{C}$.
2. All units are production tested at $T_A = +25^\circ\text{C}$. Limits over the operating temperature range are guaranteed by design.
3. "Don't care" indicates any valid logic level.
4. V_{CCI} is the power supply associated with the input side.
5. Reflects current per supply, V_L or V_{CC} .

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DYNAMIC OUTPUT ELECTRICAL CHARACTERISTICS

OUTPUT RISE / FALL TIMES (Output Load: $C_L = 50$ pF, $R_{PU} = 2.2$ k Ω , push/pull driver, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$) (Note 6)

Symbol	Parameter	V_{CC0} (Note 7)				Unit
		4.5 to 5.5 V	3.0 to 3.6 V	2.3 to 2.7 V	1.65 to 1.95 V	
		Typ	Typ	Typ	Typ	
t_{RISE}	Output Rise Time, I/O_VL _n , I/O_VCC _n	6.4	5	6.5	10.7	ns
t_{FALL}	Output Fall Time, I/O_VL _n , I/O_VCC _n	10	9.5	8.6	9.5	ns

6. Output rise and fall times guaranteed by design and are not production tested.

7. V_{CC0} is the V_L or V_{CC} power supply associated with the output side.

MAXIMUM DATA RATE (Output Load: $C_L = 50$ pF, $R_{PU} = 2.2$ k Ω , push/pull driver, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$) (Note 8)

V_L	Parameter	V_{CC}				Unit
		4.5 to 5.5 V	3.0 to 3.6 V	2.3 to 2.7 V	1.65 to 1.95 V	
		Min	Min	Min	Min	
4.5 to 5.5 V	I/O_VL _n to I/O_VCC _n or I/O_VCC _n to I/O_VL _n	50	41	31	17	MHz
3.0 to 3.6 V		34	35	36	23	MHz
2.3 to 2.7 V		25	27	30	24	MHz
1.65 to 1.95 V		14	16	22	21	MHz

8. Maximum frequency guaranteed by design and is not production tested.

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AC ELECTRICAL CHARACTERISTICS (Output Load: $C_L = 50$ pF, $R_{PU} = 2.2$ k Ω , push/pull driver, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$) (Note 9)

Symbol	Parameter	V _{CC}								Unit
		4.5 to 5.5 V		3.0 to 3.6 V		2.3 to 2.7 V		1.65 to 1.95 V		
		Typ	Max	Typ	Max	Typ	Max	Typ	Max	

V_L = 4.5 to 5.5 V

t _{PLH}	I/O_VL _n to I/O_VCC _n , I/O_VCC _n to I/O_VL _n	2.5	4.3	3	5	3	6.4	4	8.6	ns
t _{PHL}	I/O_VL _n to I/O_VCC _n , I/O_VCC _n to I/O_VL _n	5	8.1	8	13	8	17.3	15	28.5	ns
t _{PZL}	OE to I/O_VI _n , OE to I/O_VCC _n	14	19.6	16	20	22	26.5	33	44	ns
t _{PLZ}	OE to I/O_VI _n , OE to I/O_VCC _n	24	31.4	25	32	24	31.8	28	36.2	ns
t _{skew}	I/O_VL _n to I/O_VCC _n , I/O_VCC _n to I/O_VL _n (Note 10)	0.3	0.3	0.5	0.6	0.8	0.8	1.2	1.9	ns

V_L = 3.0 to 3.6 V

t _{PLH}	I/O_VL _n to I/O_VCC _n , I/O_VCC _n to I/O_VL _n	2.5	4.7	3	5.4	3	6.5	5	9.3	ns
t _{PHL}	I/O_VL _n to I/O_VCC _n , I/O_VCC _n to I/O_VL _n	7	14.2	6	10.1	8	14.6	15	27	ns
t _{PZL}	OE to I/O_VI _n , OE to I/O_VCC _n	15	18.8	18	22.3	19	23.5	29	38.3	ns
t _{PLZ}	OE to I/O_VI _n , OE to I/O_VCC _n	25	34.9	22	27.6	22	27.9	23	28.8	ns
t _{skew}	I/O_VL _n to I/O_VCC _n , I/O_VCC _n to I/O_VL _n (Note 10)	0.4	0.5	0.5	0.6	0.6	0.7	2.5	3.0	ns

V_L = 2.3 to 2.7 V

t _{PLH}	I/O_VL _n to I/O_VCC _n , I/O_VCC _n to I/O_VL _n	3	5.6	4	6	4	7.3	6	10.3	ns
t _{PHL}	I/O_VL _n to I/O_VCC _n , I/O_VCC _n to I/O_VL _n	12	18.1	11	14.1	8	11.9	15	22.1	ns
t _{PZL}	OE to I/O_VI _n , OE to I/O_VCC _n	16	23.7	17	21.5	25	30	31	36.6	ns
t _{PLZ}	OE to I/O_VI _n , OE to I/O_VCC _n	28	33.8	26	31	25	30.8	25	30	ns
t _{skew}	I/O_VL _n to I/O_VCC _n , I/O_VCC _n to I/O_VL _n (Note 10)	0.5	0.7	0.8	1	0.6	0.6	2.3	2.7	ns

V_L = 1.65 to 1.95 V

t _{PLH}	I/O_VL _n to I/O_VCC _n , I/O_VCC _n to I/O_VL _n	5	9	5	9.2	6	9.2	7	12.7	ns
t _{PHL}	I/O_VL _n to I/O_VCC _n , I/O_VCC _n to I/O_VL _n	19	28.3	15	25.5	12	17.3	14	19	ns
t _{PZL}	OE to I/O_VI _n , OE to I/O_VCC _n	23	32.2	22	26.5	25	32	40	72	ns
t _{PLZ}	OE to I/O_VI _n , OE to I/O_VCC _n	35	44	32	38.7	33	36.7	30	36.5	ns
t _{skew}	I/O_VL _n to I/O_VCC _n , I/O_VCC _n to I/O_VL _n (Note 10)	0.5	1.1	1.4	1.5	0.8	1.1	2.0	2.5	ns

9. AC characteristics are guaranteed by design and are not production tested.

10. Skew is the variation of propagation delay between output signals and applies only to output signals on the same port (I/O_VL_n or I/O_VCC_n) and switching with the same polarity (LOW-to-HIGH or HIGH-to-LOW). Skew is defined by applying a single input to the two input channels and measuring the difference in propagation delays between the output channels.

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CAPACITANCE ($T_A = 25^\circ\text{C}$)

Symbol	Parameter	Test Condition	Typical	Unit
C_{IN}	Input Capacitance, Control Pin (EN)	$V_L = V_{CC} = \text{GND}$	2	pF
C_{IO}	Input / Output Capacitance (I/O_VL_n , I/O_VCC_n)	$V_L = V_{CC} = 5\text{ V}, \text{EN} = \text{GND}, I/O_VL_n = I/O_VCC_n = 5\text{ V}$	3	pF
C_{PD}	Power Dissipation Capacitance (Note 11)	$V_L = V_{CC} = 5\text{ V}, \text{EN} = 5\text{ V}, V_{IN} = 5\text{ V or GND}, f = 400\text{ KHz}$	17	pF

11. C_{PD} is defined as the value of the internal equivalent capacitance per channel.

TEST SETUP AND TIMING DEFINITIONS

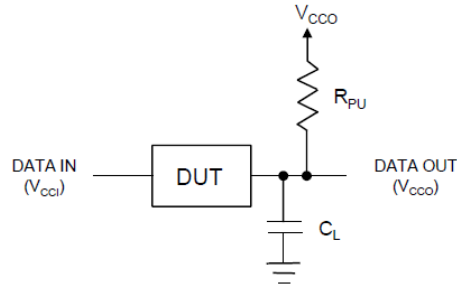


Figure 3. AC Test Circuit

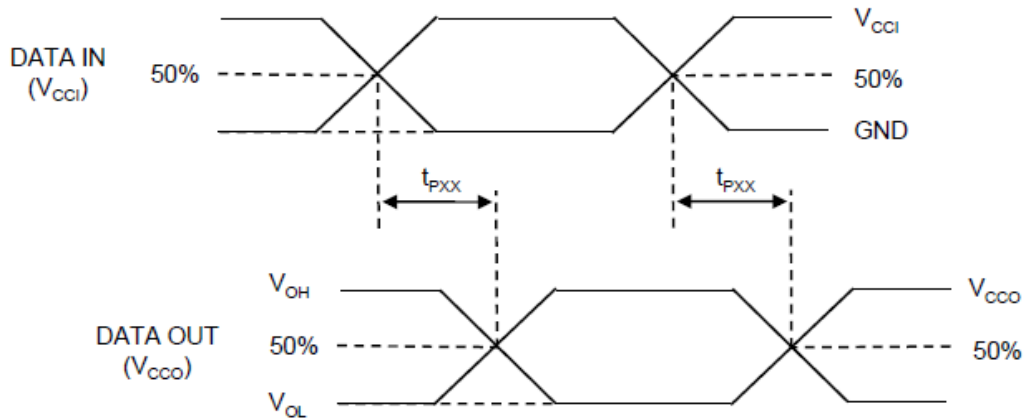


Figure 4. Propagation Delays and Tri-State Measurements

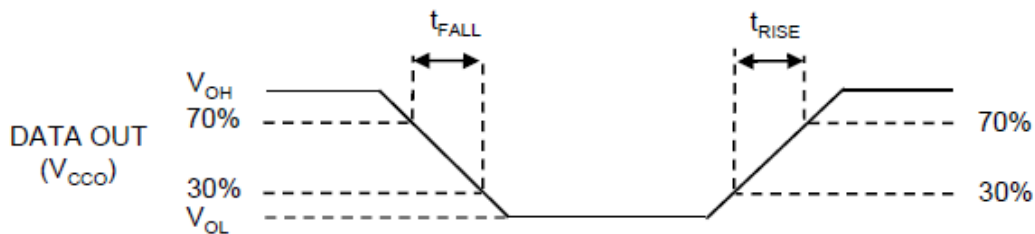


Figure 5. Definition of Rise and Fall Times

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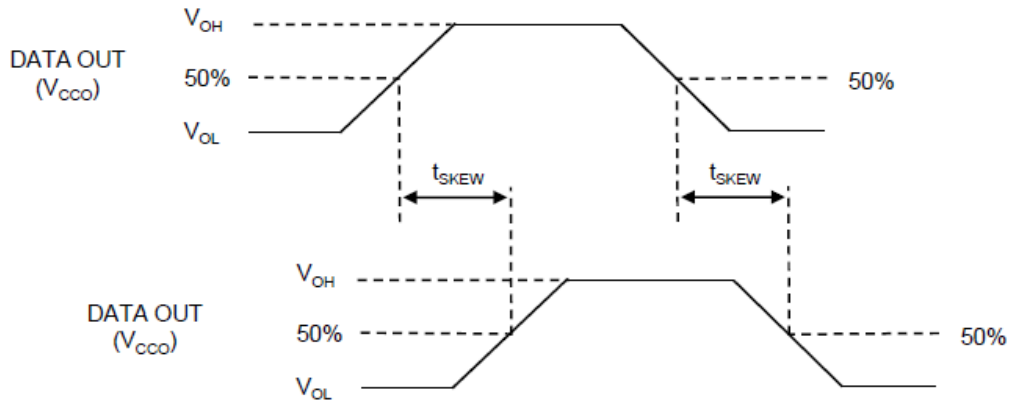


Figure 6. Definition of Output Skew

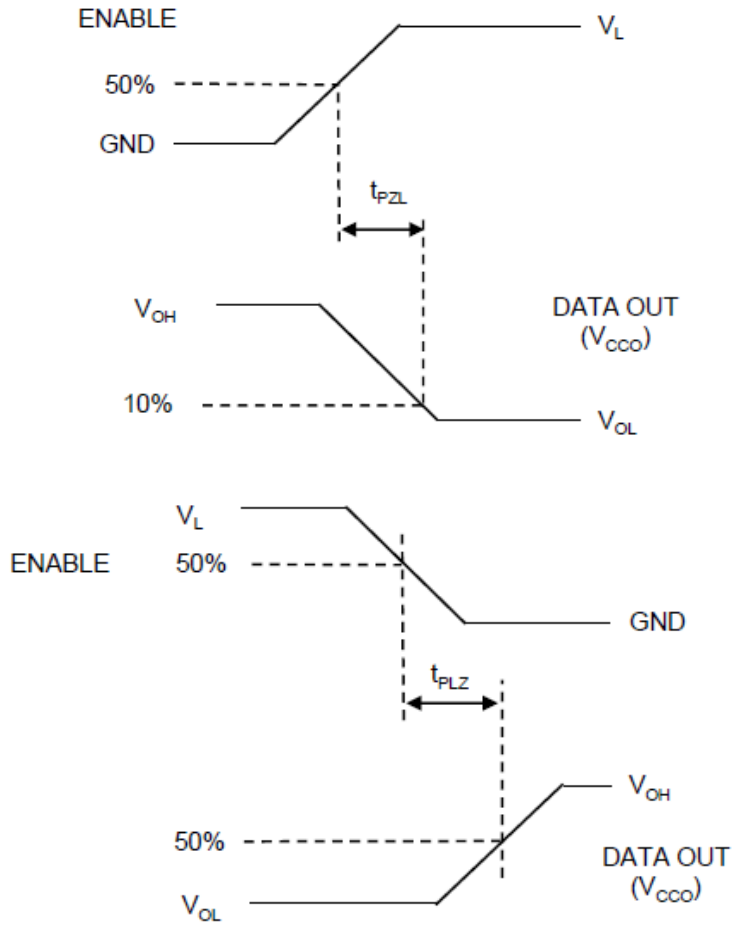


Figure 7. Definition of Output Tri-State Times

APPLICATIONS INFORMATION

Level Translator Architecture

The NLSX4302E auto sense translator provides bi-directional voltage level shifting to transfer data in multiple supply voltage systems. This device has two supply voltages, V_L and V_{CC} , which set the logic levels on the input and output sides of the translator. When used to transfer data from the V_L to the V_{CC} ports, input signals referenced to the V_L supply are translated to output signals with a logic level matched to V_{CC} . In a similar manner, the V_{CC} to V_L translation shifts input signals with a logic level compatible to V_{CC} to an output signal matched to V_L .

The NLSX4302E consists of two bi-directional channels that independently determine the direction of the data flow without requiring a directional pin. The one-shot circuits are used to detect the rising or falling input signals. In addition, the one shots decrease the rise and fall time of the output signal for high-to-low and low-to-high transitions. Each input/output channel requires external pullup resistors.

Enable Input (EN)

The NLSX4302E has an Enable pin (EN) that can be used to minimize the power consumption of the device

when the transmitter is not transmitting data. Normal translation operation occurs when the EN pin is equal to a logic high signal. The EN pin is referenced to the V_L supply and has Overvoltage Tolerant (OVT) protection.

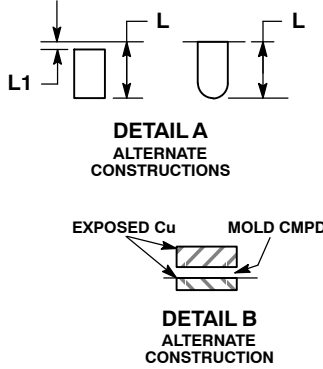
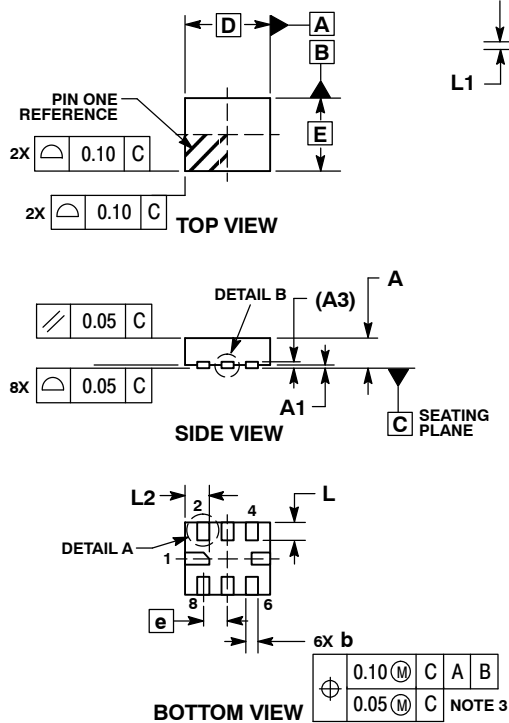
Power Supply Guidelines

The sequencing of the power supplies will not damage the device during the power up operation. In addition, the I/O V_{CC} and I/O V_L pins are in the high impedance state if either supply voltage is equal to 0 V. For optimal performance, 0.01 μ F to 0.1 μ F decoupling capacitors should be used on the V_L and V_{CC} 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.

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PACKAGE DIMENSIONS

UQFN8 1.4x1.2, 0.4P CASE 523AS ISSUE A

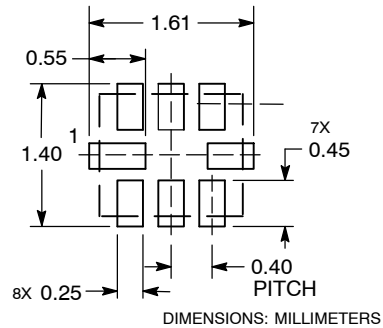


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.25 mm FROM THE TERMINAL TIP.

DIM	MILLIMETERS	
	MIN	MAX
A	0.45	0.55
A1	0.00	0.05
A3	0.13 REF	
b	0.15	0.25
D	1.40 BSC	
E	1.20 BSC	
e	0.40 BSC	
L	0.20	0.40
L1	---	0.15
L2	0.30	0.50

SOLDERING FOOTPRINT*



*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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