

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

## NLSX4302E

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 I<sup>2</sup>C 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

- I<sup>2</sup>C, 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



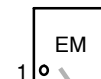
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### MARKING DIAGRAMS

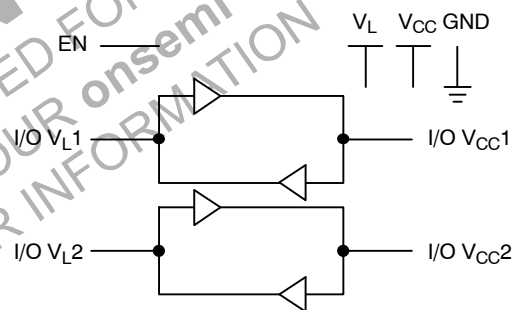


UQFN8  
MU SUFFIX  
CASE 523AS



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

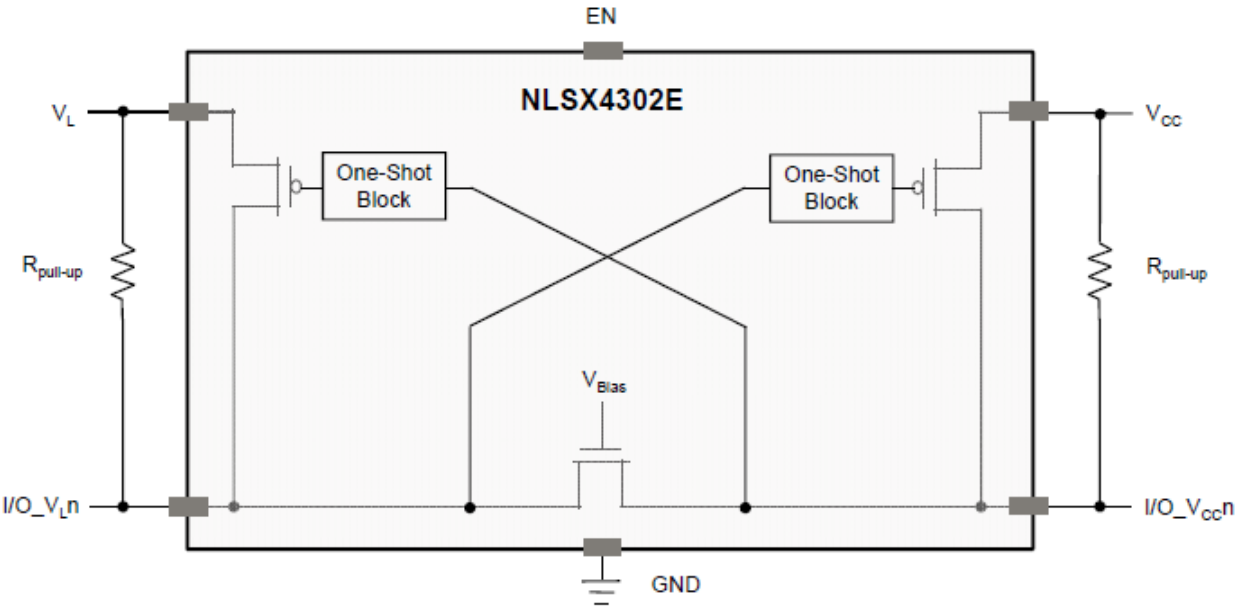


Figure 1. Block Diagram (1 I/O Line)

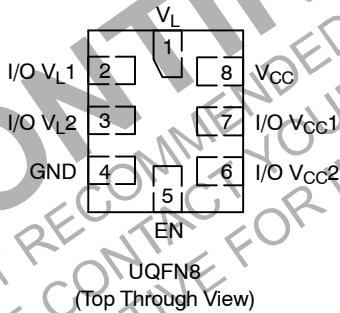


Figure 2. Pin-out Diagram

PIN ASSIGNMENT

Pins	Description
V <sub>CC</sub>	V <sub>CC</sub> Supply Voltage
V <sub>L</sub>	V <sub>L</sub> Supply Voltage
GND	Ground
EN	Output Enable, Referenced to V <sub>L</sub>
I/O V <sub>CC</sub> n	I/O Port, Referenced to V <sub>CC</sub>
I/O V <sub>L</sub> n	I/O Port, Referenced to V <sub>L</sub>

FUNCTION TABLE

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

# MAXIMUM RATINGS

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

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

# RECOMMENDED OPERATING CONDITIONS

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

**DISCONTINUED**  
THIS DEVICE IS NOT RECOMMENDED FOR NEW DESIGN  
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# NLSX4302E

## 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 <sub>n</sub>	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 <sub>n</sub>	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 <sub>n</sub>	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 <sub>n</sub>	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			$\pm 1$	$\mu\text{A}$
$I_{OFF}$	Power-Off Leakage Current	I/O_VL <sub>n</sub> , I/O_VCC <sub>n</sub>	$V_{IN}$ or $V_O = 0$ to $5.5\text{ V}$	0	0		$\pm 2$	$\mu\text{A}$
		I/O_VL <sub>n</sub>		0	5.50			
		I/O_VCC <sub>n</sub>		5.50	0			
$I_{OZ}$	Tristate Output Mode Leakage Current (Note 3)	I/O_VL <sub>n</sub> , I/O_VCC <sub>n</sub>	$V_O = 0$ to $5.5\text{ V}$ , EN = $V_{IL}$	5.50	5.50		$\pm 2$	$\mu\text{A}$
		I/O_VL <sub>n</sub>	$V_O = 0$ to $5.5\text{ V}$ , EN = Don't Care	5.50	0			
		I/O_VCC <sub>n</sub>	$V_O = 0$ to $5.5\text{ V}$ , 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	$\mu\text{A}$
		$V_{CC}$						
$I_{CCZ}$	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	$\mu\text{A}$
		$V_{CC}$						
$I_{CC\_OFF}$	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	$\mu\text{A}$
				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  $V_{CC}$ .

## DYNAMIC OUTPUT ELECTRICAL CHARACTERISTICS

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

Symbol	Parameter	$V_{CCO}$ (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 <sub>n</sub> , I/O_VCC <sub>n</sub>	6.4	5	6.5	10.7	ns
$t_{FALL}$	Output Fall Time, I/O_VL <sub>n</sub> , I/O_VCC <sub>n</sub>	10	9.5	8.6	9.5	ns

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

7.  $V_{CCO}$  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 $\Omega$ , 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 <sub>n</sub> to I/O_VCC <sub>n</sub> or I/O_VCC <sub>n</sub> to I/O_VL <sub>n</sub>	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.

# NLSX4302E

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

Symbol	Parameter	V <sub>CC</sub>								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<sub>L</sub> = 4.5 to 5.5 V

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

### V<sub>L</sub> = 3.0 to 3.6 V

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

### V<sub>L</sub> = 2.3 to 2.7 V

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

### V<sub>L</sub> = 1.65 to 1.95 V

t <sub>PLH</sub>	I/O_VL <sub>n</sub> to I/O_VCC <sub>n</sub> , I/O_VCC <sub>n</sub> to I/O_VL <sub>n</sub>	5	9	5	9.2	6	9.2	7	12.7	ns
t <sub>PHL</sub>	I/O_VL <sub>n</sub> to I/O_VCC <sub>n</sub> , I/O_VCC <sub>n</sub> to I/O_VL <sub>n</sub>	19	28.3	15	25.5	12	17.3	14	19	ns
t <sub>PZL</sub>	OE to I/O_VL <sub>n</sub> , OE to I/O_VCC <sub>n</sub>	23	32.2	22	26.5	25	32	40	72	ns
t <sub>PLZ</sub>	OE to I/O_VL <sub>n</sub> , OE to I/O_VCC <sub>n</sub>	35	44	32	38.7	33	36.7	30	36.5	ns
t <sub>skew</sub>	I/O_VL <sub>n</sub> to I/O_VCC <sub>n</sub> , I/O_VCC <sub>n</sub> to I/O_VL <sub>n</sub> (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<sub>n</sub> or I/O\_VCC<sub>n</sub>) 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.

# NLSX4302E

## 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 $\text{GND}$ , $f = 400\text{ KHz}$	17	pF

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

## TEST SETUP AND TIMING DEFINITIONS

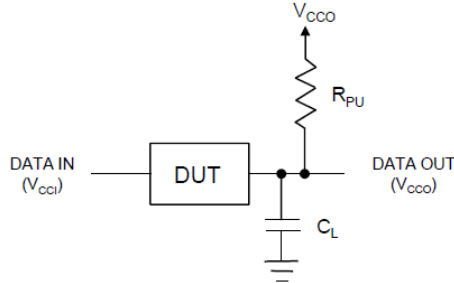


Figure 3. AC Test Circuit

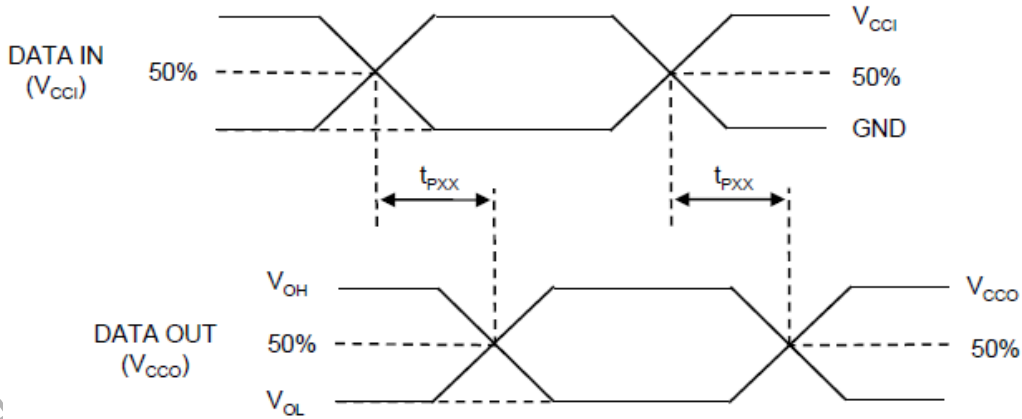


Figure 4. Propagation Delays and Tri-State Measurements

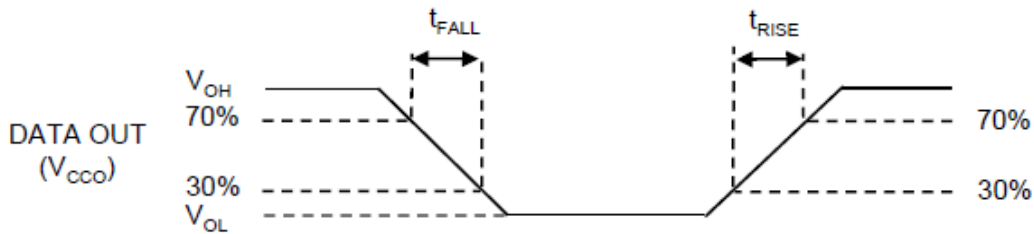


Figure 5. Definition of Rise and Fall Times

# NLSX4302E

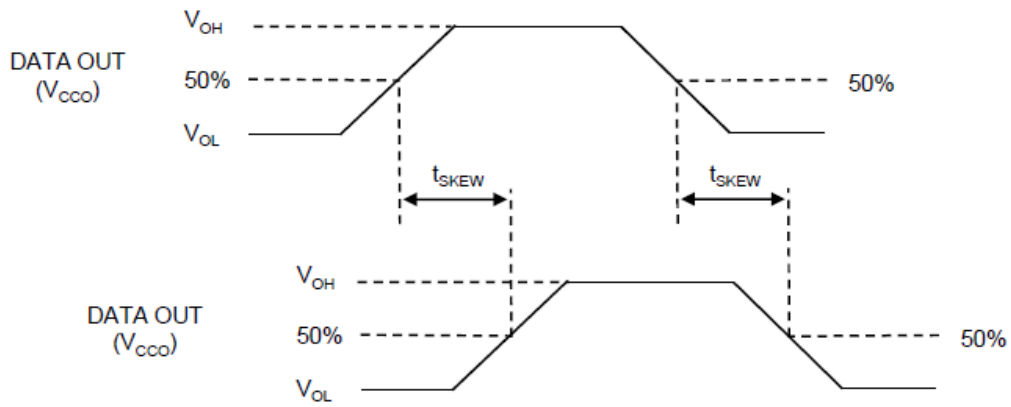


Figure 6. Definition of Output Skew

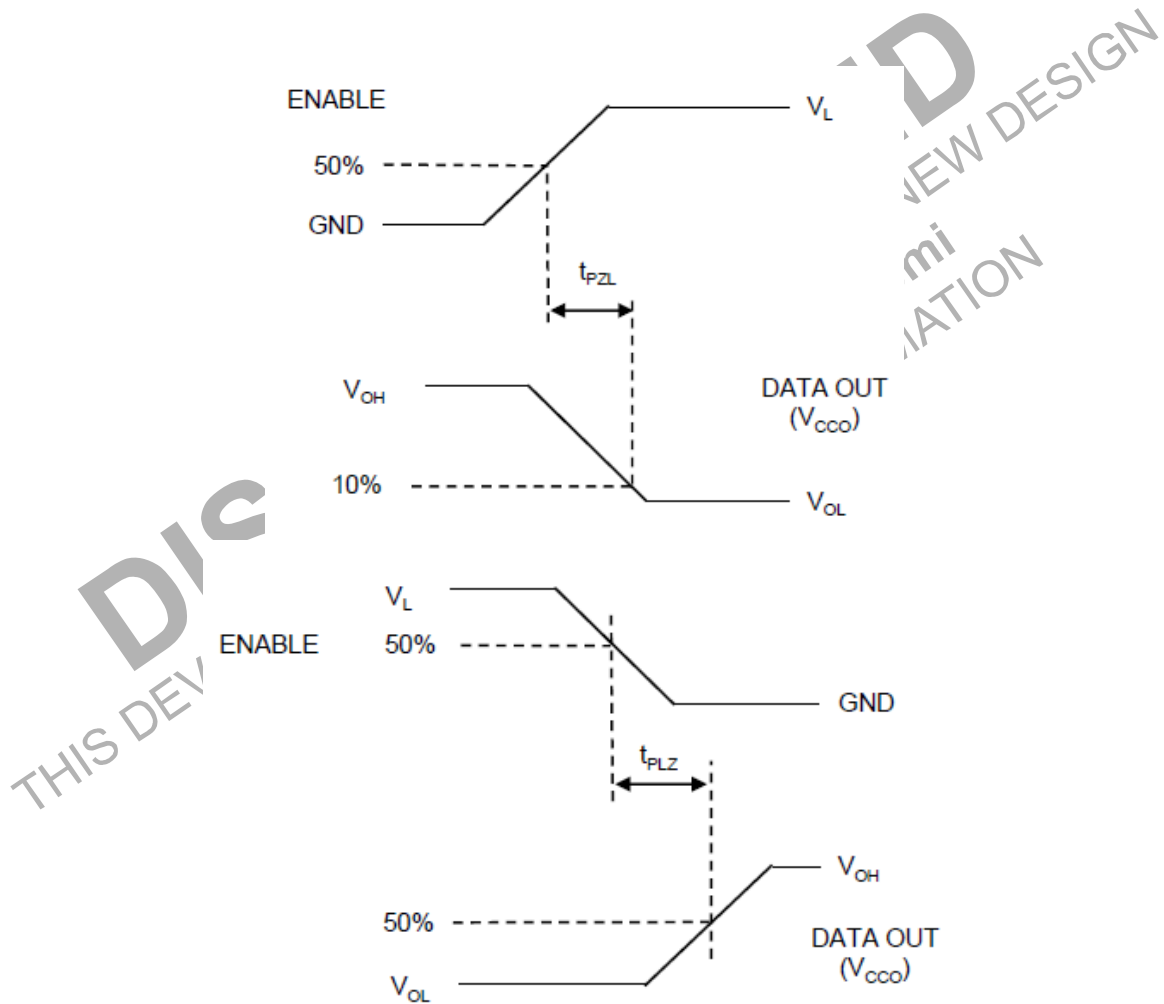


Figure 7. Definition of Output Tri-State Times



## 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  $\mu$ F to 0.1  $\mu$ 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.

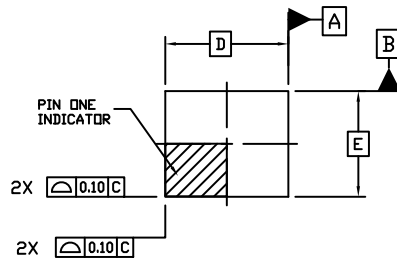
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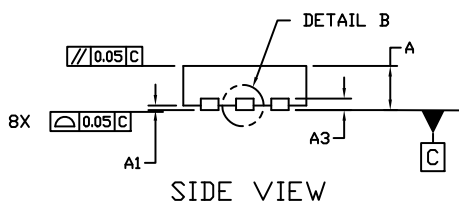
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**UQFN8, 1.40x1.20, 0.40P**  
CASE 523AS  
ISSUE B

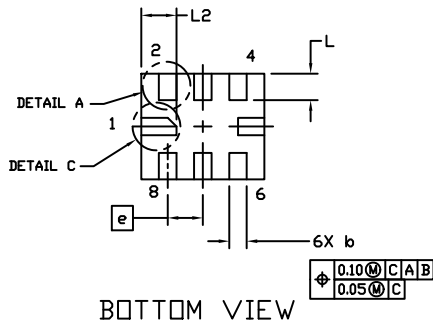
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TOP VIEW



SIDE VIEW



BOTTOM VIEW

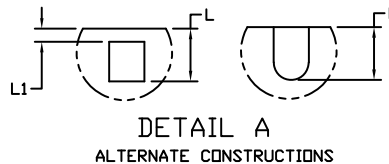
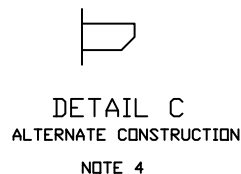
**GENERIC  
MARKING DIAGRAM\***

XX = Specific Device Code  
M = Date Code

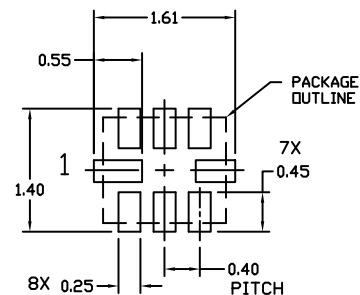
\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

## 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 0.25MM FROM THE TERMINAL TIP.
4. REFER TO SPECIFIC DEVICE DATA SHEET FOR PIN 1 NOTCH LOCATION.


DETAIL B  
ALTERNATE CONSTRUCTION

DETAIL A  
ALTERNATE CONSTRUCTIONS

DETAIL C  
ALTERNATE CONSTRUCTION  
NOTE 4

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


RECOMMENDED  
MOUNTING 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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