

NLSX3014

4-Bit 100 Mb/s Configurable Dual-Supply Level Translator

The NLSX3014 is a 4-bit configurable dual-supply bidirectional level translator without a direction control pin. The I/O V_{CC} and I/O V_L ports are designed to track two different power supply rails, V_{CC} and V_L respectively. The V_{CC} supply rail is configurable from 1.3 V to 4.5 V while the V_L supply rail is configurable from 0.9 V to ($V_{CC} - 0.4$) V. This allows lower voltage logic signals on the V_L side to be translated into higher voltage logic signals on the V_{CC} side, and vice-versa. Both I/O ports are auto-sensing; thus, no direction pin is required.

The Output Enable (EN) input, when Low, disables both I/O ports by putting them in 3-state. This significantly reduces the supply currents from both V_{CC} and V_L . The EN signal is designed to track V_L .

Features

- Wide High-Side V_{CC} Operating Range: 1.3 V to 4.5 V
Wide Low-Side V_L Operating Range: 0.9 V to ($V_{CC} - 0.4$) V
- High-Speed with 100 Mb/s Guaranteed Data Rate for $V_L > 1.6$ V
- Low Bit-to-Bit Skew
- Overvoltage Tolerant Enable and I/O Pins
- Non-preferential Powerup Sequencing
- Small packaging: 1.7 mm x 2.0 mm UQFN12
- This is a Pb-Free Device

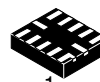
Typical Applications

- Mobile Phones, PDAs, Other Portable Devices



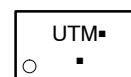
ON Semiconductor®

<http://onsemi.com>



UQFN12
MU SUFFIX
CASE 523AE

MARKING DIAGRAM



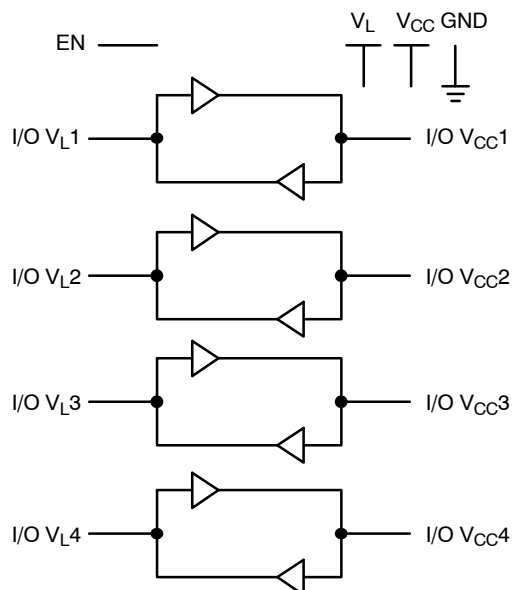
UT = Specific Device Code

M = Date Code

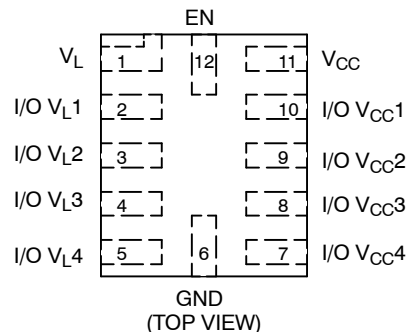
▪ = Pb-Free Package

(Note: Microdot may be in either location)

LOGIC DIAGRAM



PIN ASSIGNMENT



ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 9 of this data sheet.

NLSX3014

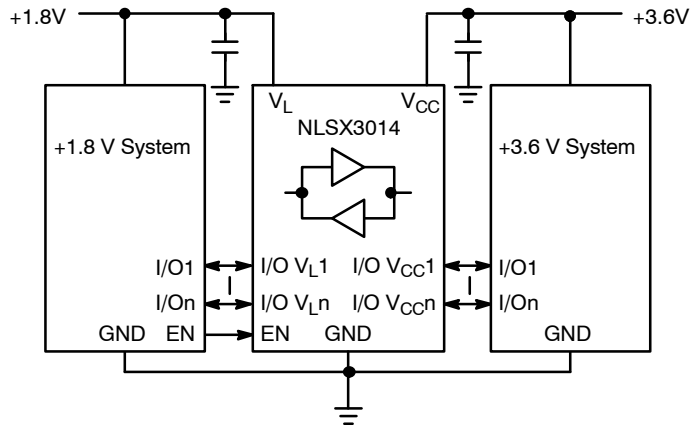


Figure 1. Typical Application Circuit

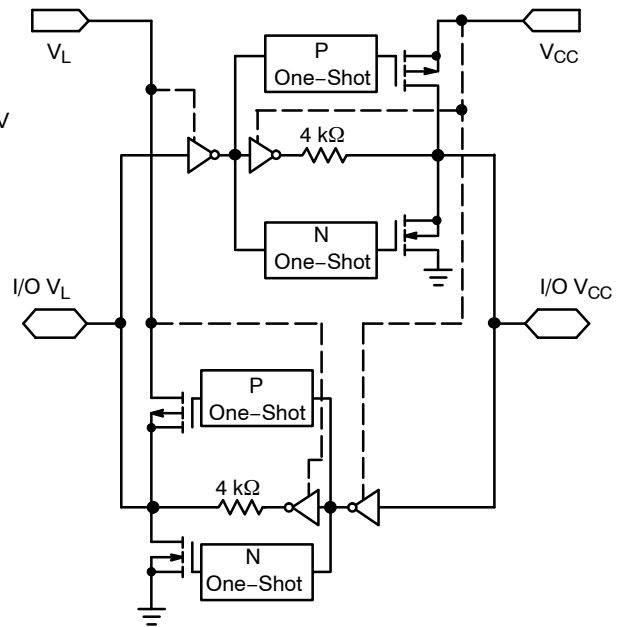


Figure 2. Simplified Functional Diagram (1 I/O Line)
(EN = 1)

PIN ASSIGNMENT

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

FUNCTION TABLE

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

MAXIMUM RATINGS

Symbol	Parameter	Value	Condition	Unit
V _{CC}	V _{CC} Supply Voltage	–0.5 to +5.5		V
V _L	V _L Supply Voltage	–0.5 to +5.5		V
I/O V _{CC}	V _{CC} –Referenced DC Input/Output Voltage	–0.5 to (V _{CC} + 0.3)		V
I/O V _L	V _L –Referenced DC Input/Output Voltage	–0.5 to (V _L + 0.3)		V
V _{EN}	Enable Control Pin DC Input Voltage	–0.5 to +5.5		V
I _{IK}	Input Diode Clamp Current	–50	V _I < GND	mA
I _{OK}	Output Diode Clamp Current	–50	V _O < GND	mA
I _{CC}	DC Supply Current Through V _{CC}	± 100		mA
I _L	DC Supply Current Through V _L	± 100		mA
I _{GND}	DC Ground Current Through Ground Pin	± 100		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}	V _{CC} Supply Voltage	1.3	4.5	V
V _L	V _L Supply Voltage	0.9	V _{CC} – 0.4	V
V _{EN}	Enable Control Pin Voltage	GND	4.5	V
V _{IO}	Bus Input/Output Voltage I/O V _{CC} I/O V _L	GND GND	4.5 4.5	V
T _A	Operating Temperature Range	–40	+85	°C
ΔI/ΔV	Input Transition Rise or Rate V _I , V _{IO} from 30% to 70% of V _{CC} ; V _{CC} = 3.3 V ± 0.3 V	0	10	ns

DC ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Test Conditions (Note 1)	V _{CC} (V) (Note 2)	V _L (V) (Note 3)	-40°C to +85°C			Unit
					Min	Typ (Note 4)	Max	
V _{IHC}	I/O V _{CC} Input HIGH Voltage		1.3 to 4.5	0.9 to (V _{CC} - 0.4)	0.8 * V _{CC}	-	-	V
V _{ILC}	I/O V _{CC} Input LOW Voltage		1.3 to 4.5	0.9 to (V _{CC} - 0.4)	-	-	0.2 * V _{CC}	V
V _{IHL}	I/O V _L Input HIGH Voltage		1.3 to 4.5	0.9 to (V _{CC} - 0.4)	0.8 * V _L	-	-	V
V _{ILL}	I/O V _L Input LOW Voltage		1.3 to 4.5	0.9 to (V _{CC} - 0.4)	-	-	0.2 * V _L	V
V _{IH}	Control Pin Input HIGH Voltage	T _A = +25°C	1.3 to 4.5	0.9 to (V _{CC} - 0.4)	0.8 * V _L	-	-	V
V _{IL}	Control Pin Input LOW Voltage	T _A = +25°C	1.3 to 4.5	0.9 to (V _{CC} - 0.4)	-	-	0.2 * V _L	V
V _{OHC}	I/O V _{CC} Output HIGH Voltage	I/O V _{CC} Source Current = 20 µA	1.3 to 4.5	0.9 to (V _{CC} - 0.4)	0.8 * V _{CC}	-	-	V
V _{OLC}	I/O V _{CC} Output LOW Voltage	I/O V _{CC} Sink Current = 20 µA	1.3 to 4.5	0.9 to (V _{CC} - 0.4)	-	-	0.2 * V _{CC}	V
V _{OHL}	I/O V _L Output HIGH Voltage	I/O V _L Source Current = 20 µA	1.3 to 4.5	0.9 to (V _{CC} - 0.4)	0.8 * V _L	-	-	V
V _{OLL}	I/O V _L Output LOW Voltage	I/O V _L Sink Current = 20 µA	1.3 to 4.5	0.9 to (V _{CC} - 0.4)	-	-	0.2 * V _L	V

1. Normal test conditions are V_{EN} = 0 V, C_{I/OVCC} = 15 pF and C_{I/OVL} = 15 pF, unless otherwise specified.
2. V_{CC} is the supply voltage associated with the high voltage port, and V_{CC} ranges from +1.3 V to 4.5 V under normal operating conditions.
3. V_L is the supply voltage associated with the low voltage port. V_L must be less than or equal to (V_{CC} - 0.4) V during normal operation. However, during startup and shutdown conditions, V_L can be greater than (V_{CC} - 0.4) V.
4. Typical values are for V_{CC} = +2.8 V, V_L = +1.8 V and T_A = +25°C. All units are production tested at T_A = +25°C. Limits over the operating temperature range are guaranteed by design.

POWER CONSUMPTION

Symbol	Parameter	Test Conditions (Note 5)	V _{CC} (V) (Note 6)	V _L (V) (Note 7)	-40°C to +85°C			Unit
					Min	Typ	Max	
I _{Q-VCC}	Supply Current from V _{CC}	EN = V _L ; I/O V _{CCn} = 0 V, I/O V _{Ln} = 0 V, I/O V _{CCn} = V _{CC} or I/O V _{Ln} = V _L and I _o = 0	1.3 to 3.6	0.9 to (V _{CC} - 0.4)	-	-	1.0	µA
I _{Q-VL}	Supply Current from V _L	EN = V _L ; I/O V _{CCn} = 0 V, I/O V _{Ln} = 0 V, I/O V _{CCn} = V _{CC} or I/O V _{Ln} = V _L and I _o = 0	1.3 to 3.6	0.9 to (V _{CC} - 0.4)	-	-	1.0	µA
		EN = V _L ; I/O V _{CCn} = 0 V, I/O V _{Ln} = 0 V, I/O V _{CCn} = V _{CC} or I/O V _{Ln} = (V _{CC} - 0.2 V) and I _o = 0		< (V _{CC} - 0.2)	-	-	2.0	
I _{TS-VCC}	V _{CC} Tristate Output Mode Supply Current	EN = 0 V	1.3 to 3.6	0.9 to (V _{CC} - 0.4)	-	-	1.0	µA
I _{TS-VL}	V _L Tristate Output Mode Supply Current	EN = 0 V	1.3 to 3.6	0.9 to (V _{CC} - 0.4)	-	-	0.2	µA
		EN = 0 V		V _{CC} - 0.2	-	-	2.0	
I _{OZ}	I/O Tristate Output Mode Leakage Current	EN = 0 V	1.3 to 3.6	0.9 to (V _{CC} - 0.4)	-	-	0.15	µA
		EN = 0 V		V _{CC} - 0.2	-	-	2.0	
I _{EN}	Output Enable Pin Input Current	-	1.3 to 3.6	0.9 to (V _{CC} - 0.4)	-	-	1.0	µA

5. Normal test conditions are V_{EN} = 0 V, C_{I/OVCC} = 15 pF and C_{I/OVL} = 15 pF, unless otherwise specified.
6. V_{CC} is the supply voltage associated with the high voltage port, and V_{CC} ranges from +1.3 V to 3.6 V.
7. V_L is the supply voltage associated with the low voltage port. V_L must be less than or equal to (V_{CC} - 0.4) V during normal operation. However, during startup and shutdown conditions, V_L can be greater than (V_{CC} - 0.4) V.

TIMING CHARACTERISTICS

Symbol	Parameter	Test Conditions (Note 8)	V _{CC} (V) (Note 9)	V _L (V) (Note 10)	–40°C to +85°C			Unit
					Min	Typ (Note 11)	Max	
t _{R-VCC}	I/O V _{CC} Rise Time (Output = I/O_V _{CC})	C _{IOVCC} = 15 pF	1.3 to 4.5	0.9 to (V _{CC} – 0.4)		1.3	1.7	ns
			> 2.0	> 1.6		0.9	1.1	
t _{F-VCC}	I/O V _{CC} Falltime (Output = I/O_V _{CC})	C _{IOVCC} = 15 pF	1.3 to 4.5	0.9 to (V _{CC} – 0.4)		0.8	1.2	ns
			> 2.0	> 1.6		0.6	1.0	
t _{R-VL}	I/O V _L Risettime (Output = I/O_V _L)	C _{IOVL} = 15 pF	1.3 to 4.5	0.9 to (V _{CC} – 0.4)		2.7	3.0	ns
			> 2.0	> 1.6		0.8	1.0	
t _{F-VL}	I/O V _L Falltime (Output = I/O_V _L)	C _{IOVL} = 15 pF	1.3 to 4.5	0.9 to (V _{CC} – 0.4)		0.8	1.0	ns
			> 2.0	> 1.6		0.7	0.8	
Z _{O-VCC}	I/O V _{CC} One-Shot Output Impedance		1.3 to 4.5	0.9 to (V _{CC} – 0.4)		30		Ω
Z _{O-VL}	I/O V _L One-Shot Output Impedance		1.3 to 4.5	0.9 to (V _{CC} – 0.4)		30		Ω
t _{PD_VL-VCC}	Propagation Delay (Output = I/O_V _{CC} , t _{PHL} , t _{PLH})	C _{IOVCC} = 15 pF	1.3 to 4.5	0.9 to (V _{CC} – 0.4)		15	17	ns
			> 2.0	> 1.6		4	5	
t _{PD_VCC-VL}	Propagation Delay (Output = I/O_V _L , t _{PHL} , t _{PLH})	C _{IOVL} = 15 pF	1.3 to 4.5	0.9 to (V _{CC} – 0.4)		10	11	ns
			> 2.0	> 1.6		3	4	
t _{SK_VL-VCC}	Channel-to-Channel Skew (Output = I/O_V _{CC})	C _{IOVCC} = 15 pF	1.3 to 4.5	0.9 to (V _{CC} – 0.4)		0.6	1	nS
			> 2.0	> 1.6		0.2	0.8	
t _{SK_VCC-VL}	Channel-to-Channel Skew (Output = I/O_V _L)	C _{IOVCC} = 15 pF	1.3 to 4.5	0.9 to (V _{CC} – 0.4)		0.4	0.6	nS
			> 2.0	> 1.6		0.2	0.3	
	Maximum Data Rate	(Output = I/O_V _{CC} , C _{IOVCC} = 15 pF) (Output = I/O_V _L , C _{IOVL} = 15 pF)	1.3 to 4.5	0.9 to (V _{CC} – 0.4)	60			Mb/s
			> 2.0	> 1.6	100			

8. Normal test conditions are V_{EN} = 0 V, C_{IOVCC} = 15 pF and C_{IOVL} = 15 pF, unless otherwise specified.

9. V_{CC} is the supply voltage associated with the high voltage port, and V_{CC} ranges from +1.3 V to 4.5 V under normal operating conditions.

10. V_L is the supply voltage associated with the low voltage port. V_L must be less than or equal to (V_{CC} – 0.4) V during normal operation. However, during startup and shutdown conditions, V_L can be greater than (V_{CC} – 0.4) V.

11. Typical values are for V_{CC} = +2.8 V, V_L = +1.8 V and T_A = +25°C. All units are production tested at T_A = +25°C. Limits over the operating temperature range are guaranteed by design.

ENABLE / DISABLE TIME MEASUREMENTS

Symbol	Parameter	Test Conditions (Note 12)	V_{CC} (V) (Note 13)	V_L (V) (Note 14)	-40°C to +85°C			Unit
					Min	Typ (Note 15)	Max	
t_{EN-VCC}	Turn-On Enable Time (Output = I/O V_{CC} , t_{pZH})	$C_{IOVCC} = 15$ pF	1.3 to 4.5	0.9 to ($V_{CC} - 0.4$)		80	140	ns
	Turn-On Enable Time (Output = I/O V_{CC} , t_{pZL})	$C_{IOVL} = 15$ pF	1.3 to 4.5	0.9 to ($V_{CC} - 0.4$)		175	300	ns
t_{EN-VL}	Turn-On Enable Time (Output = I/O V_L , t_{pZH})	$C_{IOVCC} = 15$ pF	1.3 to 4.5	0.9 to ($V_{CC} - 0.4$)		250	475	ns
	Turn-On Enable Time (Output = I/O V_L , t_{pZL})	$C_{IOVL} = 15$ pF	1.3 to 4.5	0.9 to ($V_{CC} - 0.4$)		175	250	ns
$t_{DIS-VCC}$	Turn-Off Disable Time (Output = I/O V_{CC} , t_{pHZ})	$C_{IOVCC} = 15$ pF	1.3 to 4.5	0.9 to ($V_{CC} - 0.4$)		90	140	ns
	Propagation Delay (Output = I/O V_{CC} , t_{PLZ})	$C_{IOVL} = 15$ pF	1.3 to 4.5	0.9 to ($V_{CC} - 0.4$)		150	200	ns
t_{DIS-VL}	Turn-Off Disable Time (Output = I/O V_L , t_{pHZ})	$C_{IOVCC} = 15$ pF	1.3 to 4.5	0.9 to ($V_{CC} - 0.4$)		200	300	ns
	Propagation Delay (Output = I/O V_L , t_{PLZ})	$C_{IOVL} = 15$ pF	1.3 to 4.5	0.9 to ($V_{CC} - 0.4$)		150	250	ns

12. Normal test conditions are $V_{EN} = 0$ V, $C_{IOVCC} = 15$ pF and $C_{IOVL} = 15$ pF, unless otherwise specified.

13. V_{CC} is the supply voltage associated with the high voltage port, and V_{CC} ranges from +1.3 V to 4.5 V under normal operating conditions.

14. V_L is the supply voltage associated with the low voltage port. V_L must be less than or equal to ($V_{CC} - 0.4$) V during normal operation. However, during startup and shutdown conditions, V_L can be greater than ($V_{CC} - 0.4$) V.

15. Typical values are for $V_{CC} = +2.8$ V, $V_L = +1.8$ V and $T_A = +25$ °C. All units are production tested at $T_A = +25$ °C. Limits over the operating temperature range are guaranteed by design.

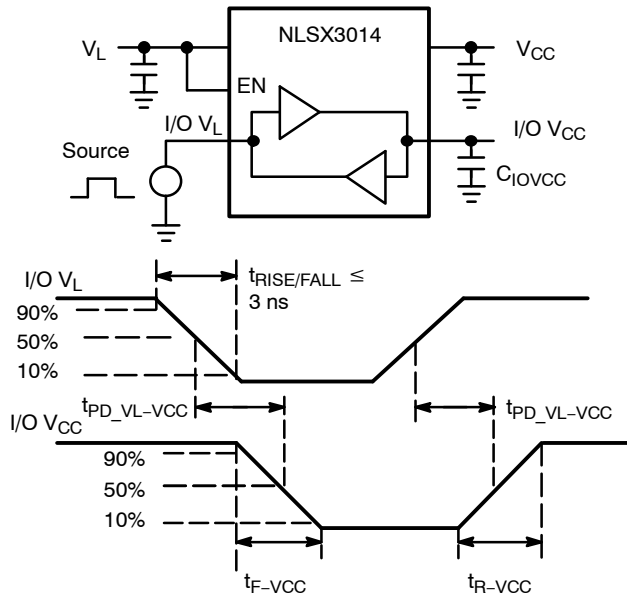


Figure 3. Driving I/O V_L Test Circuit and Timing

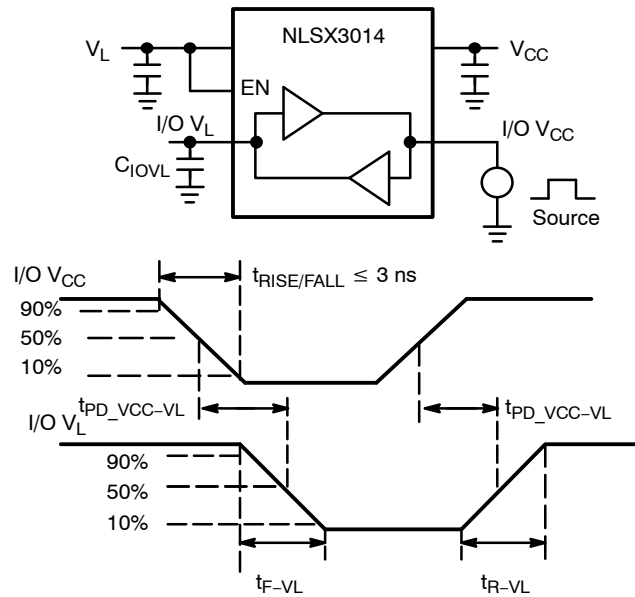
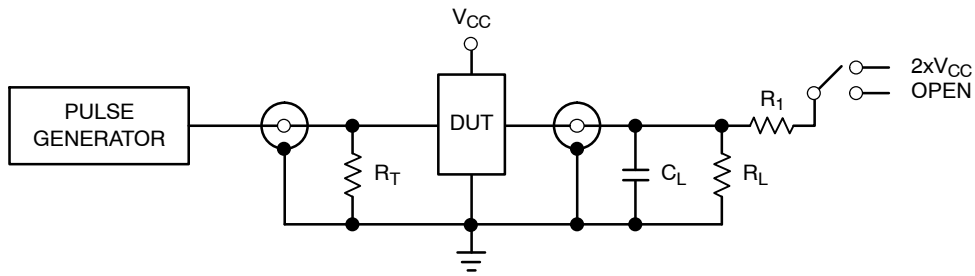


Figure 4. Driving I/O V_{CC} Test Circuit and Timing

NLSX3014



Test	Switch
t_{PZH} , t_{PHZ}	Open
t_{PZL} , t_{PLZ}	$2 \times V_{CC}$

$C_L = 15 \text{ pF}$ or equivalent (Includes jig and probe capacitance)
 $R_L = R_1 = 50 \text{ k}\Omega$ or equivalent
 $R_T = Z_{OUT}$ of pulse generator (typically 50Ω)

Figure 5. Test Circuit for Enable/Disable Time Measurement

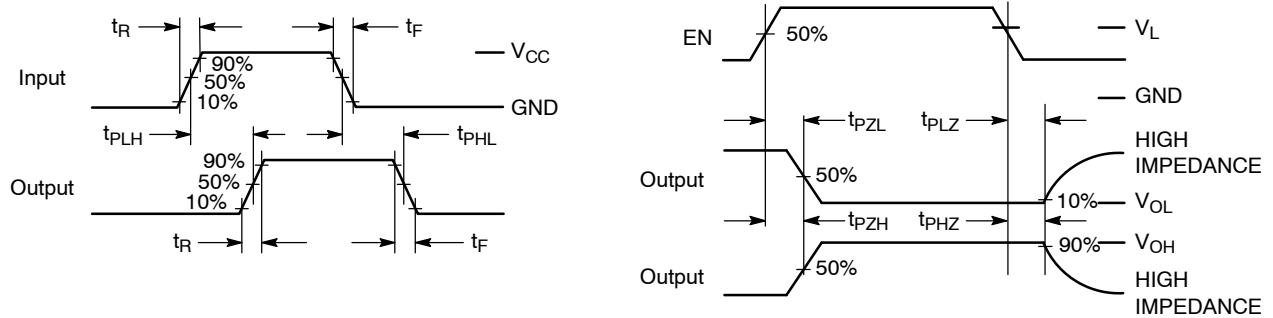


Figure 6. Timing Definitions for Propagation Delays and Enable/Disable Measurement

TEST CONDITIONS

1. $T_A = +25^{\circ}\text{C}$,
2. Input Applied to 1 channel, the other 3 inputs are grounded,
3. $C_{\text{Load}} = 15 \text{ pF}$

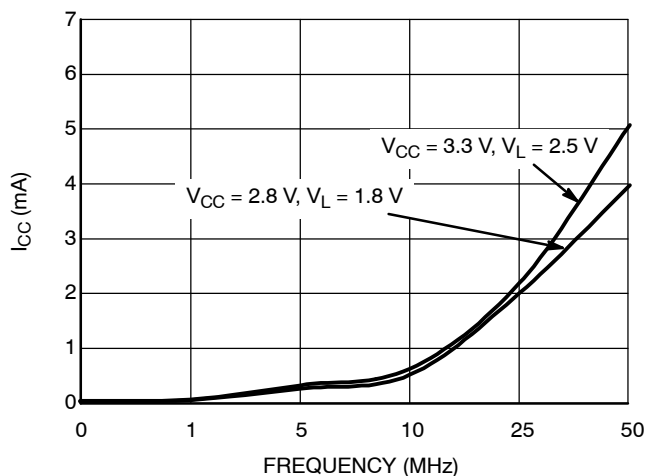


Figure 7. I_{CC} vs. Frequency
(Input = I/O V_{CC} , Output = I/O V_L)

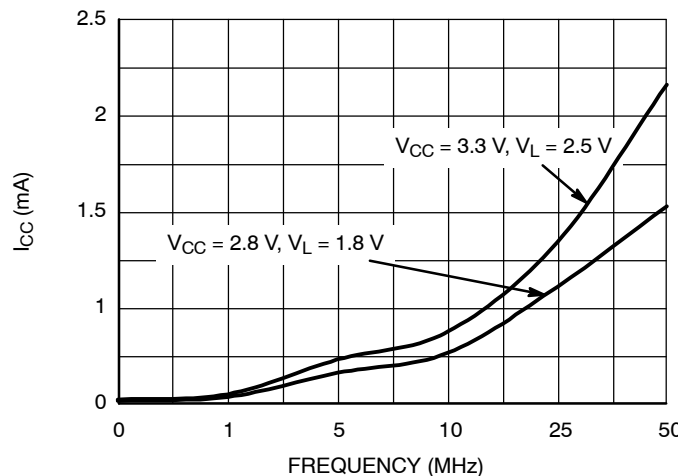


Figure 8. I_L vs. Frequency
(Input = I/O V_{CC} , Output = I/O V_L)

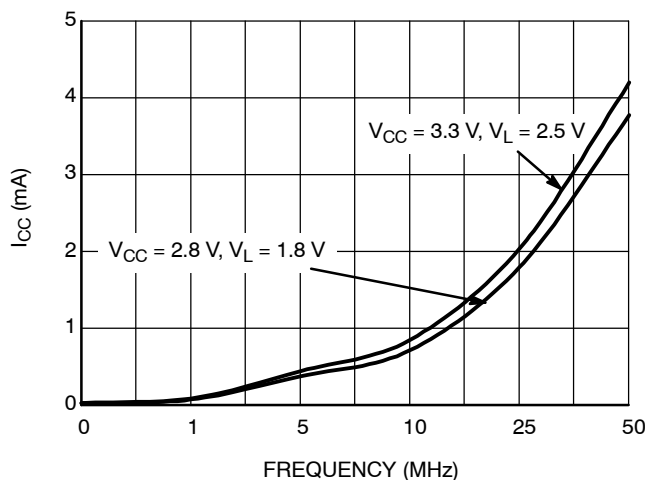


Figure 9. I_{CC} vs. Frequency
(Input = I/O V_L , Output = I/O V_{CC})

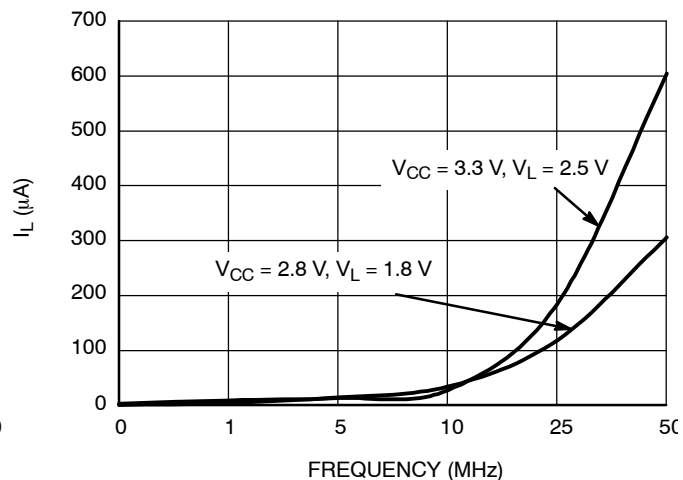


Figure 10. I_L vs. Frequency
(Input = I/O V_L , Output = I/O V_{CC})

IMPORTANT APPLICATIONS INFORMATION

Level Translator Architecture

The NLSX3014 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 NLSX3014 consists of four 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.

Input Driver Requirements

For proper operation, the input driver to the auto sense translator should be capable of driving 2.0 mA of peak output current.

Output Load Requirements

The NLSX3014 is designed to drive CMOS inputs. Resistive pullup or pulldown loads of less than 50 k Ω should not be used with this device. The NLSX3373 or NLSX3378 open-drain auto sense translators are alternate translator options for an application such as the I²C bus that requires pullup resistors.

Enable Input (EN)

The NLSX3014 has an Enable pin (EN) 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 V_{CC} and I/O V_L pins to a high impedance state. 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 Over-Voltage Tolerant (OVT) protection.

Uni-Directional versus Bi-Directional Translation

The NLSX3014 can function as a non-inverting uni-directional translator. One advantage of using the translator as a uni-directional device is that each I/O pin can be configured as either an input or output. The configurable input or output feature is especially useful in applications such as SPI that use multiple uni-directional I/O lines to send data to and from a device. The flexible I/O port of the auto sense translator simplifies the trace connections on the PCB.

Power Supply Guidelines

It is recommended that the V_L supply should be less than or equal to the value of the V_{CC} minus 0.4 V. The sequencing of the power supplies will not damage the device during the power up operation; however, the current consumption of the device will increase if V_L exceeds V_{CC} minus 0.4 V. The Enable (EN) pin can be used to provide power savings. Both I/O ports are tri-stated and in low power consumption state if the EN input equals 0 V.

The enable pin should be used to enter the low current tri-state mode, rather than setting either the V_L or V_{CC} supplies to 0 V. The NLSX3014 will not be damaged if either V_L or V_{CC} is equal to 0 V while the other supply voltage is at a nominal operating value; however, the operation of the translator cannot be guaranteed during single supply operation.

For optimal performance, 0.01 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 power supply 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.

ORDERING INFORMATION

Device	Package	Shipping [†]
NLSX3014MUTAG	UQFN12 (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 Specifications Brochure, BRD8011/D.

MECHANICAL CASE OUTLINE

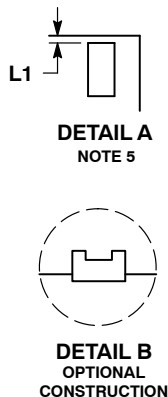
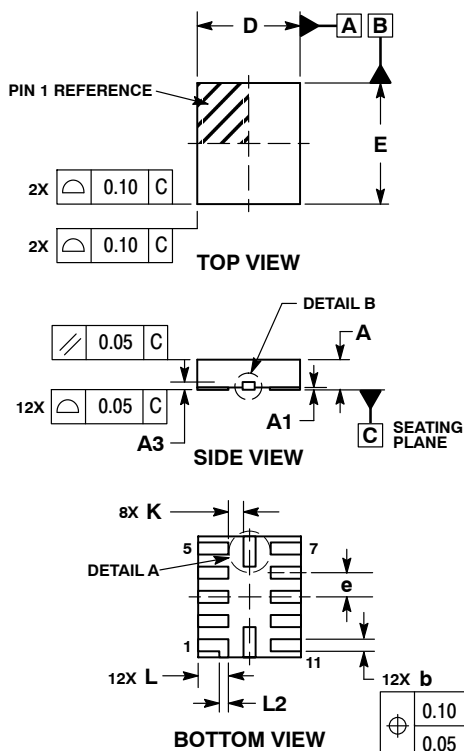
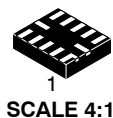
PACKAGE DIMENSIONS

ON Semiconductor®

ON

UQFN12 1.7x2.0, 0.4P
CASE 523AE-01
ISSUE A

DATE 11 JUN 2007

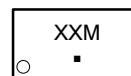


NOTES:

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 0.30 MM FROM TERMINAL TIP.
4. MOLD FLASH ALLOWED ON TERMINALS ALONG EDGE OF PACKAGE. FLASH 0.03 MAX ON BOTTOM SURFACE OF TERMINALS.
5. DETAIL A SHOWS OPTIONAL CONSTRUCTION FOR TERMINALS.

DIM	MILLIMETERS	
	MIN	MAX
A	0.45	0.55
A1	0.00	0.05
A3	0.127 REF	
b	0.15	0.25
D	1.70 BSC	
E	2.00 BSC	
e	0.40 BSC	
K	0.20	----
L	0.45	0.55
L1	0.00	0.03
L2	0.15 REF	

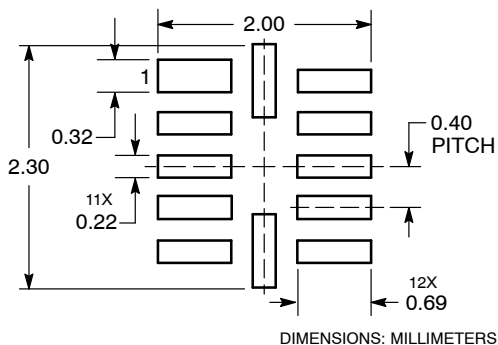
GENERIC MARKING DIAGRAM*



- XX = Specific Device Code
M = Date Code
▪ = Pb-Free Package

*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.

MOUNTING FOOTPRINT SOLDERMASK DEFINED



DOCUMENT NUMBER:	98AON23418D	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
DESCRIPTION:	UQFN12 1.7 X 2.0, 0.4P	PAGE 1 OF 1

ON Semiconductor and ON are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. ON Semiconductor does not convey any license under its patent rights nor the rights of others.

onsemi, **Onsemi**, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi**'s product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:

Email Requests to: orderlit@onsemi.com

onsemi Website: www.onsemi.com

TECHNICAL SUPPORT

North American Technical Support:

Voice Mail: 1 800-282-9855 Toll Free USA/Canada

Phone: 011 421 33 790 2910

Europe, Middle East and Africa Technical Support:

Phone: 00421 33 790 2910

For additional information, please contact your local Sales Representative