

# NLSX5014

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

The NLSX5014 is a 4-bit configurable dual-supply autosensing bidirectional level translator that does not require 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. Both the  $V_{CC}$  and the  $V_L$  supply rails are configurable from 0.9 V to 4.5 V. This allows a logic signal on the  $V_L$  side to be translated to either a higher or a lower logic signal voltage on the  $V_{CC}$  side, and vice-versa.

The NLSX5014 offers the feature that the values of the  $V_{CC}$  and  $V_L$  supplies are independent. Design flexibility is maximized because  $V_L$  can be set to a value either greater than or less than the  $V_{CC}$  supply. In contrast, the majority of competitive auto sense translators have a restriction that the value of the  $V_L$  supply must be equal to less than ( $V_{CC} - 0.4$ ) V.

The NLSX5014 has high output current capability, which allows the translator to drive high capacitive loads such as most high frequency EMI filters. Another feature of the NLSX5014 is that each I/O\_  $V_{Ln}$  and I/O\_  $V_{CCn}$  channel can function as either an input or an output.

An Output Enable (EN) input is available to reduce the power consumption. The EN pin can be used to disable both I/O ports by putting them in 3-state which significantly reduces the supply current from both  $V_{CC}$  and  $V_L$ . The EN signal is referenced to the  $V_L$  supply.

### Features

- Wide  $V_{CC}$ ,  $V_L$  Operating Range: 0.9 V to 4.5 V
- $V_L$  and  $V_{CC}$  are independent
  - $V_L$  may be greater than, equal to, or less than  $V_{CC}$
- High 100 pF Capacitive Drive Capability
- High-Speed with 140 Mb/s Guaranteed Data Rate for  $V_{CC}$ ,  $V_L > 1.8$  V
- Low Bit-to-Bit Skew
- Overvoltage Tolerant Enable and I/O Pins
- Non-preferential Powerup Sequencing
- Power-Off Protection
- Small packaging: 1.7 mm x 2.0 mm UQFN12, SOIC14, TSSOP14
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

### Typical Applications

- Mobile Phones, PDAs, Other Portable Devices

### Important Information

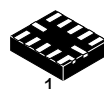
- ESD Protection for All Pins:
  - ♦ HBM (Human Body Model) > 7000 V



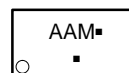
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### MARKING DIAGRAMS

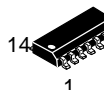


UQFN12  
MU SUFFIX  
CASE 523AE

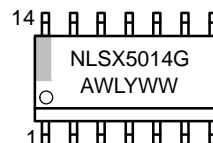


M = Date Code  
▪ = Pb-Free Package

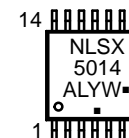
(Note: Microdot may be in either location)



SOIC-14  
D SUFFIX  
CASE 751A



TSSOP-14  
DT SUFFIX  
CASE 948G



A = Assembly Location  
WL, L = Wafer Lot  
YY, Y = Year  
WW, W = Work Week  
G or ▪ = Pb-Free Package  
(Note: Microdot may be in either location)

### ORDERING INFORMATION

Device	Package	Shipping†
NLSX5014MUTAG	UQFN12 (Pb-Free)	3000/Tape & Reel
NLSX5014DR2G	SO-14 (Pb-Free)	2500/Tape & Reel
NLSX5014DTR2G	TSSOP14 (Pb-Free)	2500/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.

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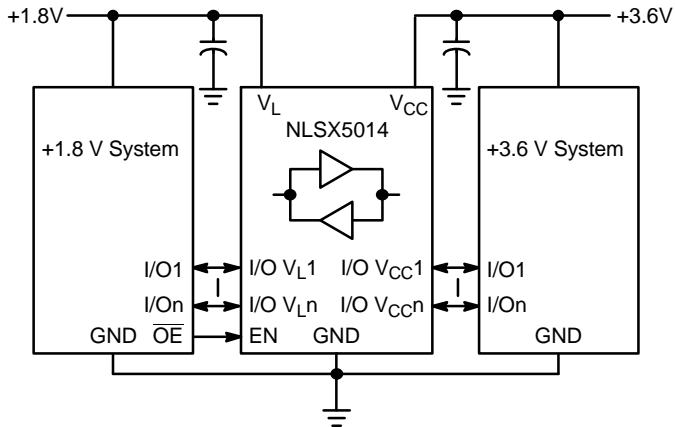


Figure 1. Typical Application Circuit

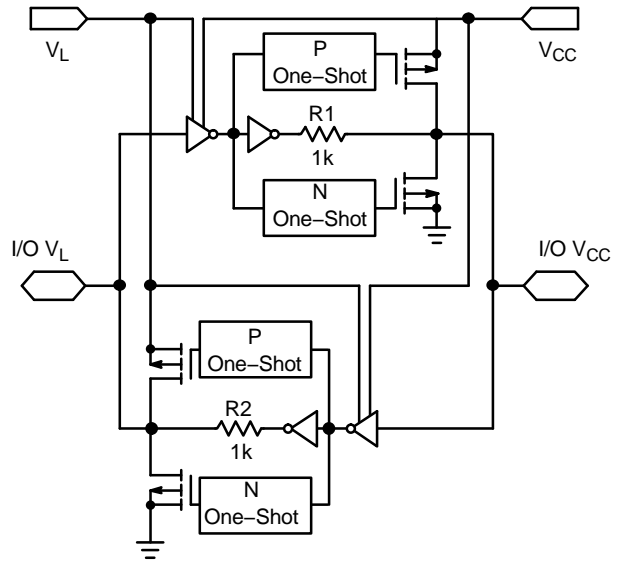


Figure 2. Simplified Functional Diagram (1 I/O Line)

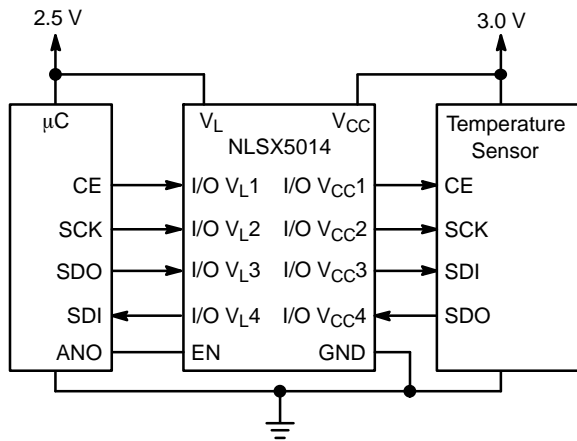


Figure 3. Application Example for  $V_L < V_{CC}$

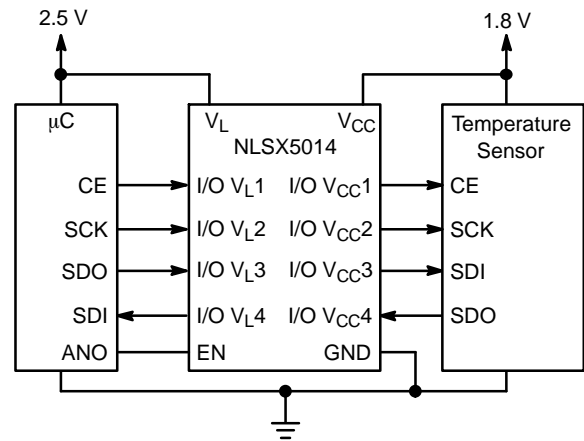


Figure 4. Application Example for  $V_L > V_{CC}$

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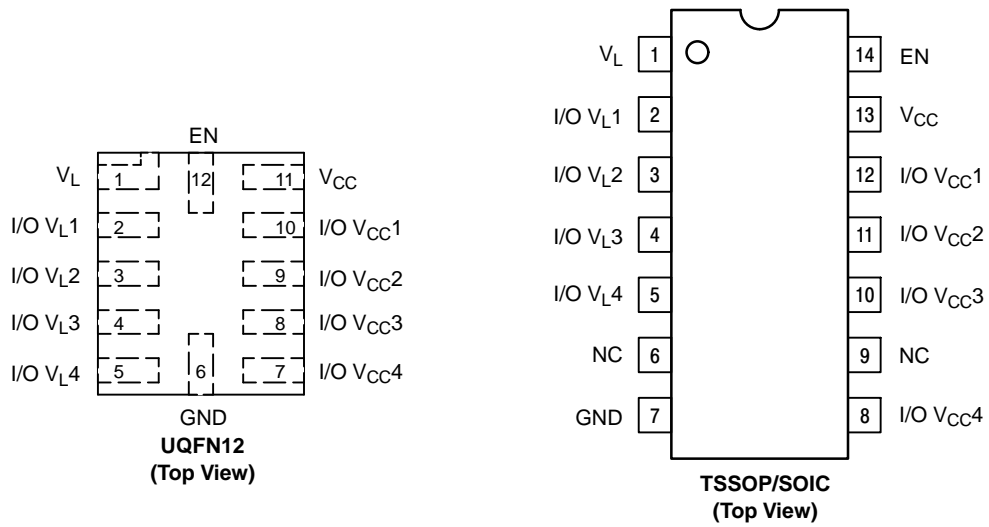


Figure 1. Pin Assignments

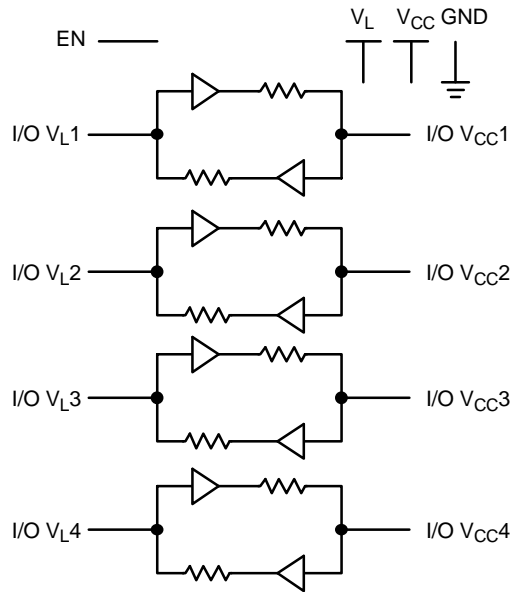


Figure 2. Logic Diagram

## PIN ASSIGNMENT

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

## 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	-0.5 to +5.5		V
$V_L$	Low-side DC Supply Voltage	-0.5 to +5.5		V
I/O $V_{CC}$	$V_{CC}$ -Referenced DC Input/Output Voltage	-0.5 to +5.5		V
I/O $V_L$	$V_L$ -Referenced DC Input/Output Voltage	-0.5 to +5.5		V
$V_I$	Enable Control Pin DC Input Voltage	-0.5 to +5.5		V
$I_{IK}$	DC Input Diode Current	-50	$V_I < GND$	mA
$I_{OK}$	DC Output Diode Current	-50	$V_O < GND$	mA
$I_{CC}$	DC Supply Current Through $V_{CC}$	$\pm 100$		mA
$I_L$	DC Supply Current Through $V_L$	$\pm 100$		mA
$I_{GND}$	DC Ground Current Through Ground Pin	$\pm 100$		mA
$T_{STG}$	Storage Temperature	-65 to +150		$^{\circ}C$
	ESD Rating	Machine Model Human Body Model Charged Device Model LU Pass	400 7000 2000 100	V V V mA

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
$V_{CC}$	High-side Positive DC Supply Voltage	0.9	4.5	V
$V_L$	Low-side Positive DC Supply Voltage	0.9	4.5	V
$V_I$	Enable Control Pin Voltage	GND	4.5	V
$V_{IO}$	Bus Input/Output Voltage	I/O $V_{CC}$ I/O $V_L$	4.5 4.5	V
$T_A$	Operating Temperature Range	-55	+125	$^{\circ}C$
$\Delta t/\Delta V$	Input Transition Rise or Rate $V_I, V_{IO}$ from 30% to 70% of $V_{CC}$ ; $V_{CC} = 3.3 V \pm 0.3 V$	0	10	ns

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

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## DC ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Test Conditions (Note 1)	V <sub>CC</sub> (V) (Note 2)	V <sub>L</sub> (V) (Note 3)	-40°C to +85°C			-55°C to +125°C		Unit
					Min	Typ (Note 4)	Max	Min	Max	
V <sub>IHC</sub>	I/O V <sub>CC</sub> Input HIGH Voltage		0.9 – 4.5	0.9 – 4.5	2/3 * V <sub>CC</sub>	–	–	2/3 * V <sub>CC</sub>	–	V
V <sub>ILC</sub>	I/O V <sub>CC</sub> Input LOW Voltage		0.9 – 4.5	0.9 – 4.5	–	–	1/3 * V <sub>CC</sub>	–	1/3 * V <sub>CC</sub>	V
V <sub>IHL</sub>	I/O V <sub>L</sub> Input HIGH Voltage		0.9 – 4.5	0.9 – 4.5	2/3 * V <sub>L</sub>	–	–	2/3 * V <sub>L</sub>	–	V
V <sub>ILL</sub>	I/O V <sub>L</sub> Input LOW Voltage		0.9 – 4.5	0.9 – 4.5	–	–	1/3 * V <sub>L</sub>	–	1/3 * V <sub>L</sub>	V
V <sub>IH</sub>	Control Pin Input HIGH Voltage	T <sub>A</sub> = +25°C	1.2 – 4.5	1.2 – 4.5	2/3 * V <sub>L</sub>	–	–	2/3 * V <sub>L</sub>	–	V
V <sub>IL</sub>	Control Pin Input LOW Voltage	T <sub>A</sub> = +25°C	1.2 – 4.5	1.2 – 4.5	–	–	1/3 * V <sub>L</sub>	–	1/3 * V <sub>L</sub>	V
V <sub>IH</sub>	Control Pin Input HIGH Voltage	T <sub>A</sub> = +25°C	V <sub>CC</sub> < 1.2	V <sub>L</sub> < 1.2	V <sub>L</sub>	–	–	V <sub>L</sub>	–	V
V <sub>IL</sub>	Control Pin Input LOW Voltage	T <sub>A</sub> = +25°C	V <sub>CC</sub> < 1.2	V <sub>L</sub> < 1.2	–	–	0	–	0	V
V <sub>OHC</sub>	I/O V <sub>CC</sub> Output HIGH Voltage	I/O V <sub>CC</sub> source current = 20 μA	0.9 – 4.5	0.9 – 4.5	0.9 * V <sub>CC</sub>	–	–	0.9 * V <sub>CC</sub>	–	V
V <sub>OLC</sub>	I/O V <sub>CC</sub> Output LOW Voltage	I/O V <sub>CC</sub> sink current = 20 μA	0.9 – 4.5	0.9 – 4.5	–	–	0.2	–	0.2	V
V <sub>OHL</sub>	I/O V <sub>L</sub> Output HIGH Voltage	I/O V <sub>L</sub> source current = 20 μA	0.9 – 4.5	0.9 – 4.5	0.9 * V <sub>L</sub>	–	–	0.9 * V <sub>L</sub>	–	V
V <sub>OLL</sub>	I/O V <sub>L</sub> Output LOW Voltage	I/O V <sub>L</sub> sink current = 20 μA	0.9 – 4.5	0.9 – 4.5	–	–	0.2	–	0.2	V
I <sub>QVCC</sub>	V <sub>CC</sub> Supply Current	EN = V <sub>L</sub> , I <sub>O</sub> = 0 A, (I/O V <sub>CC</sub> = 0 V or V <sub>CC</sub> , I/O V <sub>L</sub> = float) or (I/O V <sub>CC</sub> = float, I/O V <sub>L</sub> = 0 V or V <sub>L</sub> )	0.9 – 4.5	0.9 – 4.5	–	–	1	–	2.5	μA
I <sub>QVL</sub>	V <sub>L</sub> Supply Current		0.9 – 4.5	0.9 – 4.5	–	–	1	–	2.5	μA
I <sub>TS-VCC</sub>	V <sub>CC</sub> Tristate Output Mode Supply Current	T <sub>A</sub> = +25°C, EN = 0 V (I/O V <sub>CC</sub> = 0 V or V <sub>CC</sub> , I/O V <sub>L</sub> = float) or (I/O V <sub>CC</sub> = float, I/O V <sub>L</sub> = 0 V or V <sub>L</sub> )	0.9 – 4.5	0.9 – 4.5	–	–	0.5	–	1.5	μA
I <sub>TS-VL</sub>	V <sub>L</sub> Tristate Output Mode Supply Current		0.9 – 4.5	0.9 – 4.5	–	–	0.5	–	1.5	μA
I <sub>OZ</sub>	I/O Tristate Output Mode Leakage Current	T <sub>A</sub> = +25°C, EN = 0V	0.9 – 4.5	0.9 – 4.5	–	–	±1	–	±1.5	μA
I <sub>I</sub>	Control Pin Input Current	T <sub>A</sub> = +25°C	0.9 – 4.5	0.9 – 4.5	–	–	±1	–	±1	μA
I <sub>OFF</sub>	Power Off Leakage Current	I/O V <sub>CC</sub> = 0 to 4.5V,	0	0	–	–	1	–	1.5	μA
		I/O V <sub>L</sub> = 0 to 4.5 V	0.9 – 4.5	0	–	–	1	–	1.5	
			0	0.9 – 4.5	–	–	1	–	1.5	

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

1. Normal test conditions are V<sub>I</sub> = 0 V, C<sub>I/OVCC</sub> ≤ 15 pF and C<sub>I/OVL</sub> ≤ 15 pF, unless otherwise specified.
2. V<sub>CC</sub> is the supply voltage associated with the I/O V<sub>CC</sub> port, and V<sub>CC</sub> ranges from +0.9 V to 4.5 V under normal operating conditions.
3. V<sub>L</sub> is the supply voltage associated with the I/O V<sub>L</sub> port, and V<sub>L</sub> ranges from +0.9 V to 4.5 V under normal operating conditions.
4. Typical values are for V<sub>CC</sub> = +2.8 V, V<sub>L</sub> = +1.8 V and T<sub>A</sub> = +25°C. All units are production tested at T<sub>A</sub> = +25°C. Limits over the operating temperature range are guaranteed by design.

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## TIMING CHARACTERISTICS

Symbol	Parameter	Test Conditions (Note 5)	V <sub>CC</sub> (V) (Note 6)	V <sub>L</sub> (V) (Note 7)	-55°C to +125°C			Unit
					Min	Typ (Note 8)	Max	
t <sub>R-VCC</sub>	I/O V <sub>CC</sub> Rise Time	C <sub>I OVCC</sub> = 15 pF	0.9 – 4.5	0.9 – 4.5	–	–	8.5	nS
			1.8 – 4.5	1.8 – 4.5	–	–	3.5	
t <sub>F-VCC</sub>	I/O V <sub>CC</sub> Fall Time	C <sub>I OVCC</sub> = 15 pF	0.9 – 4.5	0.9 – 4.5	–	–	8.5	nS
			1.8 – 4.5	1.8 – 4.5	–	–	3.5	
t <sub>R-VL</sub>	I/O V <sub>L</sub> Rise Time	C <sub>I OVL</sub> = 15 pF	0.9 – 4.5	0.9 – 4.5	–	–	8.5	nS
			1.8 – 4.5	1.8 – 4.5	–	–	3.5	
t <sub>F-VL</sub>	I/O V <sub>L</sub> Fall Time	C <sub>I OVL</sub> = 15 pF	0.9 – 4.5	0.9 – 4.5	–	–	8.5	nS
			1.8 – 4.5	1.8 – 4.5	–	–	3.5	
Z <sub>OVCC</sub>	I/O V <sub>CC</sub> One-Shot Output Impedance	(Note 9)	0.9	0.9 – 4.5	–	37	–	Ω
			1.8		–	20	–	
			4.5		–	6.0	–	
Z <sub>OVL</sub>	I/O V <sub>L</sub> One-Shot Output Impedance	(Note 9)	0.9	0.9 – 4.5	–	37	–	Ω
			1.8		–	20	–	
			4.5		–	6.0	–	
t <sub>PD_VL-VCC</sub>	Propagation Delay (Driving I/O V <sub>CC</sub> )	C <sub>I OVCC</sub> = 15 pF	0.9 – 4.5	0.9 – 4.5	–	–	35	nS
			1.8 – 4.5	1.8 – 4.5	–	–	10	
		C <sub>I OVCC</sub> = 30 pF	0.9 – 4.5	0.9 – 4.5	–	–	35	
			1.8 – 4.5	1.8 – 4.5	–	–	10	
		C <sub>I OVCC</sub> = 50 pF	1.0 – 4.5	1.0 – 4.5	–	–	37	
			1.8 – 4.5	1.8 – 4.5	–	–	11	
C <sub>I OVCC</sub> = 100 pF	1.2 – 4.5	1.2 – 4.5	–	–	40			
	1.8 – 4.5	1.8 – 4.5	–	–	13			
t <sub>PD_VCC-VL</sub>	Propagation Delay (Driving I/O V <sub>L</sub> )	C <sub>I OVL</sub> = 15 pF	0.9 – 4.5	0.9 – 4.5	–	–	35	nS
			1.8 – 4.5	1.8 – 4.5	–	–	10	
		C <sub>I OVL</sub> = 30 pF	0.9 – 4.5	0.9 – 4.5	–	–	35	
			1.8 – 4.5	1.8 – 4.5	–	–	10	
		C <sub>I OVL</sub> = 50 pF	1.0 – 4.5	1.0 – 4.5	–	–	37	
			1.8 – 4.5	1.8 – 4.5	–	–	11	
C <sub>I OVL</sub> = 100 pF	1.2 – 4.5	1.2 – 4.5	–	–	40			
	1.8 – 4.5	1.8 – 4.5	–	–	13			
t <sub>SK</sub>	Channel-to-Channel Skew	C <sub>I OVCC</sub> = 15 pF, C <sub>I OVL</sub> = 15 pF (Note 9)	0.9 – 4.5	0.9 – 4.5	–	–	0.15	nS
I <sub>IN_PEAK</sub>	Input Driver Maximum Peak Current	EN = V <sub>L</sub> ; I/O_V <sub>CC</sub> = 1 MHz Square Wave, Amplitude = V <sub>CC</sub> , or I/O_V <sub>L</sub> = 1 MHz Square Wave, Amplitude = V <sub>L</sub> (Note 9)	0.9 – 4.5	0.9 – 4.5	–	–	5.0	mA

5. Normal test conditions are V<sub>I</sub> = 0 V, C<sub>I OVCC</sub> ≤ 15 pF and C<sub>I OVL</sub> ≤ 15 pF, unless otherwise specified.

6. V<sub>CC</sub> is the supply voltage associated with the I/O V<sub>CC</sub> port, and V<sub>CC</sub> ranges from +0.9 V to 4.5 V under normal operating conditions.

7. V<sub>L</sub> is the supply voltage associated with the I/O V<sub>L</sub> port, and V<sub>L</sub> ranges from +0.9 V to 4.5 V under normal operating conditions.

8. Typical values are for V<sub>CC</sub> = +2.8 V, V<sub>L</sub> = +1.8 V and T<sub>A</sub> = +25°C. All units are production tested at T<sub>A</sub> = +25°C. Limits over the operating temperature range are guaranteed by design.

9. Guaranteed by design.

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## TIMING CHARACTERISTICS (continued)

Symbol	Parameter	Test Conditions (Note 10)	V <sub>CC</sub> (V) (Note 11)	V <sub>L</sub> (V) (Note 12)	-55°C to +125°C			Unit	
					Min	Typ (Note 13)	Max		
t <sub>EN-VCC</sub>	I/O_V <sub>CC</sub> Output Enable Time	t <sub>PZH</sub>	C <sub>I<sub>O</sub>V<sub>CC</sub></sub> = 15 pF, I/O_V <sub>L</sub> = V <sub>L</sub>	0.9 – 4.5	0.9 – 4.5	–	–	160	nS
		t <sub>PZL</sub>	C <sub>I<sub>O</sub>V<sub>CC</sub></sub> = 15 pF, I/O_V <sub>L</sub> = 0 V	0.9 – 4.5	0.9 – 4.5	–	–	130	
t <sub>EN-VL</sub>	I/O_V <sub>L</sub> Output Enable Time	t <sub>PZH</sub>	C <sub>I<sub>O</sub>V<sub>L</sub></sub> = 15 pF, I/O_V <sub>CC</sub> = V <sub>CC</sub>	0.9 – 4.5	0.9 – 4.5	–	–	160	nS
		t <sub>PZL</sub>	C <sub>I<sub>O</sub>V<sub>L</sub></sub> = 15 pF, I/O_V <sub>CC</sub> = 0 V	0.9 – 4.5	0.9 – 4.5	–	–	130	
t <sub>DIS-VCC</sub>	I/O_V <sub>CC</sub> Output Disable Time	t <sub>PHZ</sub>	C <sub>I<sub>O</sub>V<sub>CC</sub></sub> = 15 pF, I/O_V <sub>L</sub> = V <sub>L</sub>	0.9 – 4.5	0.9 – 4.5	–	–	210	nS
		t <sub>PLZ</sub>	C <sub>I<sub>O</sub>V<sub>CC</sub></sub> = 15 pF, I/O_V <sub>L</sub> = 0 V	0.9 – 4.5	0.9 – 4.5	–	–	175	
t <sub>DIS-VL</sub>	I/O_V <sub>L</sub> Output Disable Time	t <sub>PHZ</sub>	C <sub>I<sub>O</sub>V<sub>L</sub></sub> = 15 pF, I/O_V <sub>CC</sub> = V <sub>CC</sub>	0.9 – 4.5	0.9 – 4.5	–	–	210	nS
		t <sub>PLZ</sub>	C <sub>I<sub>O</sub>V<sub>L</sub></sub> = 15 pF, I/O_V <sub>CC</sub> = 0 V	0.9 – 4.5	0.9 – 4.5	–	–	175	
MDR	Maximum Data Rate	C <sub>I<sub>O</sub></sub> = 15 pF	0.9 – 4.5	0.9 – 4.5	50	–	–	Mbps	
			1.8 – 4.5	1.8 – 4.5	140	–	–		
		C <sub>I<sub>O</sub></sub> = 30 pF	0.9 – 4.5	0.9 – 4.5	40	–	–		
			1.8 – 4.5	1.8 – 4.5	120	–	–		
		C <sub>I<sub>O</sub></sub> = 50 pF	1.0 – 4.5	1.0 – 4.5	30	–	–		
			1.8 – 4.5	1.8 – 4.5	100	–	–		
C <sub>I<sub>O</sub></sub> = 100 pF	1.2 – 4.5	1.2 – 4.5	20	–	–				
	1.8 – 4.5	1.8 – 4.5	60	–	–				

10. Normal test conditions are V<sub>I</sub> = 0 V, C<sub>I<sub>O</sub>V<sub>CC</sub></sub> ≤ 15 pF and C<sub>I<sub>O</sub>V<sub>L</sub></sub> ≤ 15 pF, unless otherwise specified.

11. V<sub>CC</sub> is the supply voltage associated with the I/O V<sub>CC</sub> port, and V<sub>CC</sub> ranges from +0.9 V to 4.5 V under normal operating conditions.

12. V<sub>L</sub> is the supply voltage associated with the I/O V<sub>L</sub> port, and V<sub>L</sub> ranges from +0.9 V to 4.5 V under normal operating conditions.

13. Typical values are for V<sub>CC</sub> = +2.8 V, V<sub>L</sub> = +1.8 V and T<sub>A</sub> = +25°C. All units are production tested at T<sub>A</sub> = +25°C. Limits over the operating temperature range are guaranteed by design.

# NLSX5014

## DYNAMIC POWER CONSUMPTION ( $T_A = +25^\circ\text{C}$ )

Symbol	Parameter	Test Conditions	V <sub>CC</sub> (V) (Note 14)	V <sub>L</sub> (V) (Note 15)	Typ (Note 16)	Unit
C <sub>PD_VL</sub>	V <sub>L</sub> = Input port, V <sub>CC</sub> = Output Port	C <sub>Load</sub> = 0, f = 1 MHz, EN = V <sub>L</sub> (outputs enabled)	0.9	4.5	39	pF
			1.5	1.8	20	
			1.8	1.5	17	
			1.8	1.8	14	
			1.8	2.8	13	
			2.5	2.5	14	
			2.8	1.8	13	
			4.5	0.9	19	
	V <sub>CC</sub> = Input port, V <sub>L</sub> = Output Port	C <sub>Load</sub> = 0, f = 1 MHz, EN = V <sub>L</sub> (outputs enabled)	0.9	4.5	37	pF
			1.5	1.8	30	
			1.8	1.5	29	
			1.8	1.8	29	
			1.8	2.8	29	
			2.5	2.5	30	
2.8			1.8	29		
		4.5	0.9	19		
C <sub>PD_VCC</sub>	V <sub>L</sub> = Input port, V <sub>CC</sub> = Output Port	C <sub>Load</sub> = 0, f = 1 MHz, EN = V <sub>L</sub> (outputs enabled)	0.9	4.5	29	pF
			1.5	1.8	29	
			1.8	1.5	29	
			1.8	1.8	29	
			1.8	2.8	29	
			2.5	2.5	30	
			2.8	1.8	29	
			4.5	0.9	35	
	V <sub>CC</sub> = Input port, V <sub>L</sub> = Output Port	C <sub>Load</sub> = 0, f = 1 MHz, EN = V <sub>L</sub> (outputs enabled)	0.9	4.5	21	pF
			1.5	1.8	18	
			1.8	1.5	18	
			1.8	1.8	14	
			1.8	2.8	13	
			2.5	2.5	14	
2.8			1.8	13		
		4.5	0.9	30		

14. V<sub>CC</sub> is the supply voltage associated with the I/O V<sub>CC</sub> port, and V<sub>CC</sub> ranges from +0.9 V to 4.5 V under normal operating conditions.

15. V<sub>L</sub> is the supply voltage associated with the I/O V<sub>L</sub> port, and V<sub>L</sub> ranges from +0.9 V to 4.5 V under normal operating conditions.

16. Typical values are at T<sub>A</sub> = +25°C.

17. C<sub>PD\_VL</sub> and C<sub>PD\_VCC</sub> are defined as the value of the IC's equivalent capacitance from which the operating current can be calculated for the V<sub>L</sub> and V<sub>CC</sub> power supplies, respectively. I<sub>CC</sub> = I<sub>CC</sub> (dynamic) + I<sub>CC</sub> (static) ≈ I<sub>CC</sub>(operating) ≈ C<sub>PD</sub> × V<sub>CC</sub> × f<sub>IN</sub> × N<sub>SW</sub> where I<sub>CC</sub> = I<sub>CC\_VCC</sub> + I<sub>CC\_VL</sub> and N<sub>SW</sub> = total number of outputs switching.



# NLSX5014

## STATIC POWER CONSUMPTION ( $T_A = +25^\circ\text{C}$ )

Symbol	Parameter	Test Conditions	V <sub>CC</sub> (V) (Note 18)	V <sub>L</sub> (V) (Note 19)	Typ (Note 20)	Unit
C <sub>PD_VL</sub>	V <sub>L</sub> = Input port, V <sub>CC</sub> = Output Port	C <sub>Load</sub> = 0, f = 1 MHz, EN = GND (outputs disabled)	0.9	4.5	0.01	pF
			1.5	1.8	0.01	
			1.8	1.5	0.01	
			1.8	1.8	0.01	
			1.8	2.8	0.01	
			2.5	2.5	0.01	
			2.8	1.8	0.01	
	4.5	0.9	0.01			
	V <sub>CC</sub> = Input port, V <sub>L</sub> = Output Port	C <sub>Load</sub> = 0, f = 1 MHz, EN = GND (outputs disabled)	0.9	4.5	0.01	pF
			1.5	1.8	0.01	
			1.8	1.5	0.01	
			1.8	1.8	0.01	
			1.8	2.8	0.01	
			2.5	2.5	0.01	
2.8			1.8	0.01		
4.5	0.9	0.01				
C <sub>PD_VCC</sub>	V <sub>L</sub> = Input port, V <sub>CC</sub> = Output Port	C <sub>Load</sub> = 0, f = 1 MHz, EN = GND (outputs disabled)	0.9	4.5	0.01	pF
			1.5	1.8	0.01	
			1.8	1.5	0.01	
			1.8	1.8	0.01	
			1.8	2.8	0.01	
			2.5	2.5	0.01	
			2.8	1.8	0.01	
	4.5	0.9	0.01			
	V <sub>CC</sub> = Input port, V <sub>L</sub> = Output Port	C <sub>Load</sub> = 0, f = 1 MHz, EN = GND (outputs disabled)	0.9	4.5	0.01	pF
			1.5	1.8	0.01	
			1.8	1.5	0.01	
			1.8	1.8	0.01	
			1.8	2.8	0.01	
			2.5	2.5	0.01	
2.8			1.8	0.01		
4.5	0.9	0.01				

18. V<sub>CC</sub> is the supply voltage associated with the I/O V<sub>CC</sub> port, and V<sub>CC</sub> ranges from +0.9 V to 4.5 V under normal operating conditions.

19. V<sub>L</sub> is the supply voltage associated with the I/O V<sub>L</sub> port, and V<sub>L</sub> ranges from +0.9 V to 4.5 V under normal operating conditions.

20. Typical values are at T<sub>A</sub> = +25°C

# NLSX5014

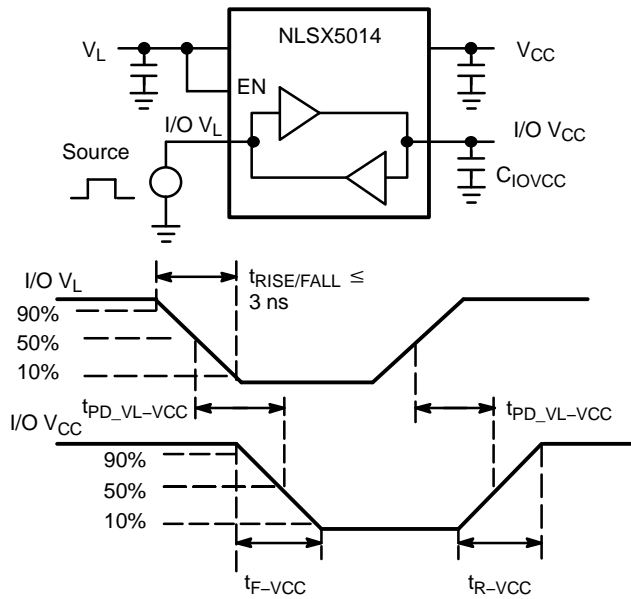


Figure 3. Driving I/O V<sub>L</sub> Test Circuit and Timing

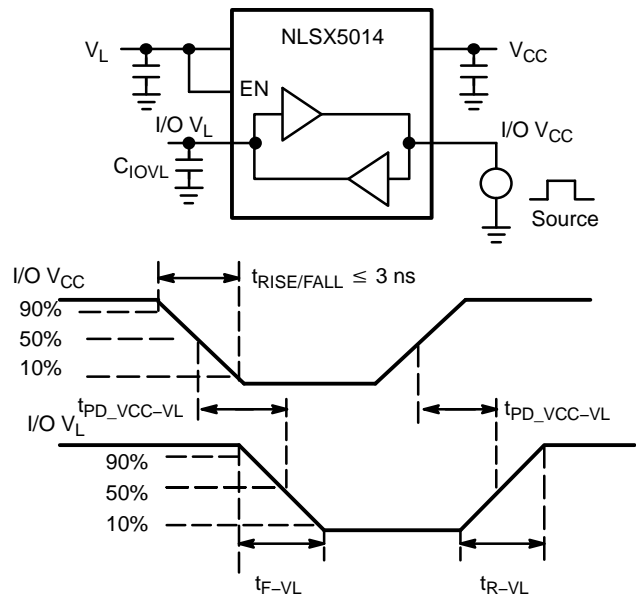
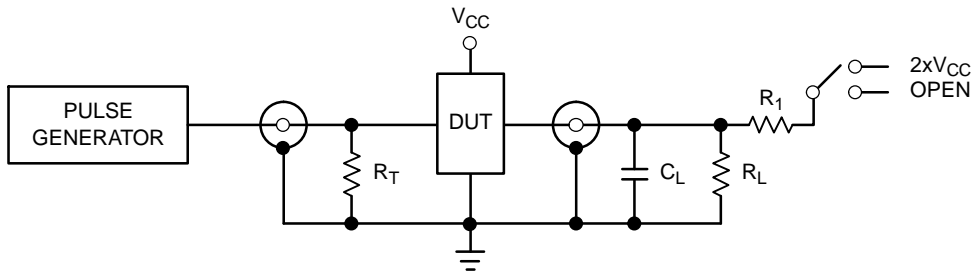


Figure 4. Driving I/O V<sub>CC</sub> Test Circuit and Timing



Test	Switch
t <sub>PZH</sub> , t <sub>PHZ</sub>	Open
t <sub>PZL</sub> , t <sub>PLZ</sub>	2 x V <sub>CC</sub>

C<sub>L</sub> = 15 pF or equivalent (Includes jig and probe capacitance)  
 R<sub>L</sub> = R<sub>1</sub> = 50 kΩ or equivalent  
 R<sub>T</sub> = Z<sub>OUT</sub> of pulse generator (typically 50 Ω)

Figure 5. Test Circuit for Enable/Disable Time Measurement

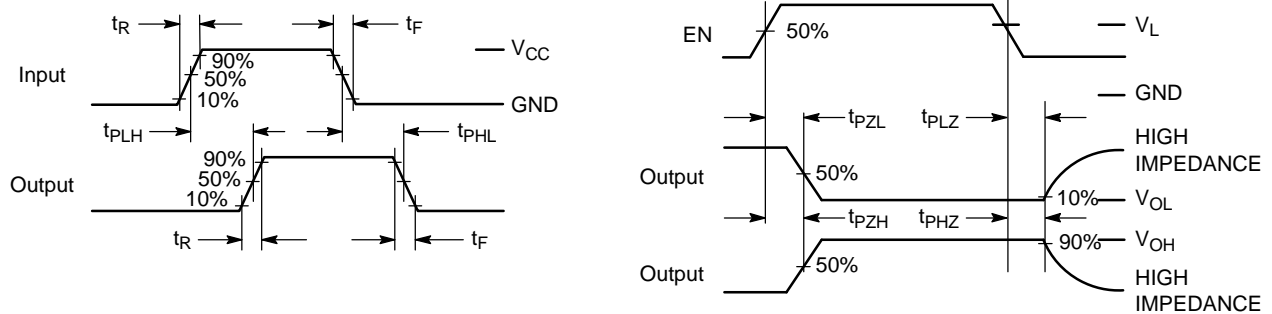


Figure 6. Timing Definitions for Propagation Delays and Enable/Disable Measurement

## IMPORTANT APPLICATIONS INFORMATION

### Level Translator Architecture

The NLSX5014 auto-sense translator provides bi-directional logic voltage level shifting to transfer data in multiple supply voltage systems. These level translators have 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 I/O  $V_L$  to the I/O  $V_{CC}$  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 I/O  $V_{CC}$  to I/O  $V_L$  translation shifts input signals with a logic level compatible to  $V_{CC}$  to an output signal matched to  $V_L$ .

The NLSX5014 translator consists of bi-directional channels that independently determine the direction of the data flow without requiring a directional pin. One-shot circuits are used to detect the rising or falling input signals. In addition, the one-shots decrease the rise and fall times of the output signal for high-to-low and low-to-high transitions.

### Input Driver Requirements

Auto-sense translators such as the NLSX5014 have a wide bandwidth, but a relatively small DC output current rating. The high bandwidth of the bi-directional I/O circuit is used to quickly transform from an input to an output driver and vice versa. The I/O ports have a modest DC current output specification so that the output driver can be over driven when data is sent in the opposite direction. For proper operation, the input driver to the auto-sense translator should be capable of driving 2 mA of peak output current. The bi-directional configuration of the translator results in both input stages being active for a very short time period. Although the peak current from the input signal circuit is relatively large, the average current is small and consistent with a standard CMOS input stage.

### Enable Input (EN)

The NLSX5014 translator 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 NLSX5014 translator 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

The values of the  $V_L$  and  $V_{CC}$  supplies can be set to anywhere between 0.9 and 4.5 V. Design flexibility is maximized because  $V_L$  may be either greater than or less than the  $V_{CC}$  supply. In contrast, the majority of the competitive auto sense translators has a restriction that the value of the  $V_L$  supply must be equal to less than ( $V_{CC} - 0.4$ ) V.

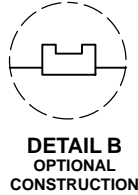
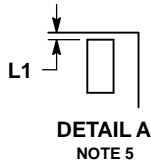
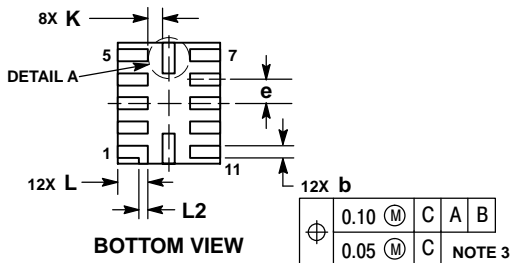
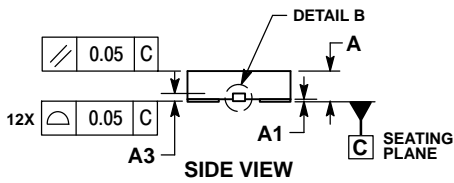
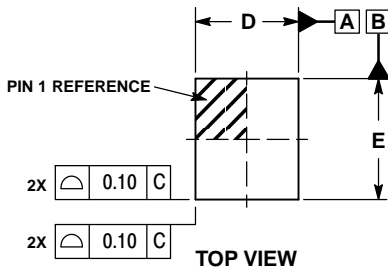
The sequencing of the power supplies will not damage the device during power-up operation. In addition, the I/O  $V_{CC}$  and I/O  $V_L$  pins are in the high impedance state if either supply voltage is equal to 0 V. For optimal performance, 0.01 to 0.1  $\mu$ F decoupling capacitors should be used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

The NLSX5014 translators have a power down feature that provides design flexibility. The output ports are disabled when either power supply is off ( $V_L$  or  $V_{CC} = 0$  V). This feature causes all of the I/O pins to be in the power saving high impedance state.

# NLSX5014

## PACKAGE DIMENSIONS

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

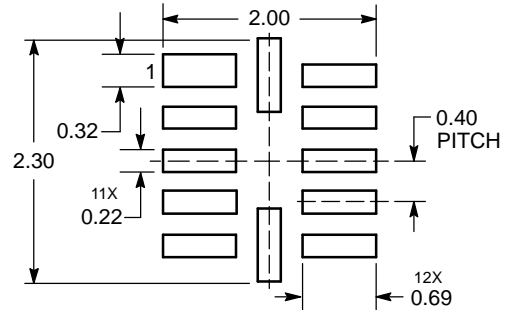


**NOTES:**

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 0.30 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	

**MOUNTING FOOTPRINT  
SOLDERMASK DEFINED**



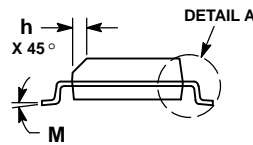
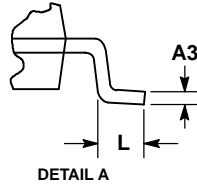
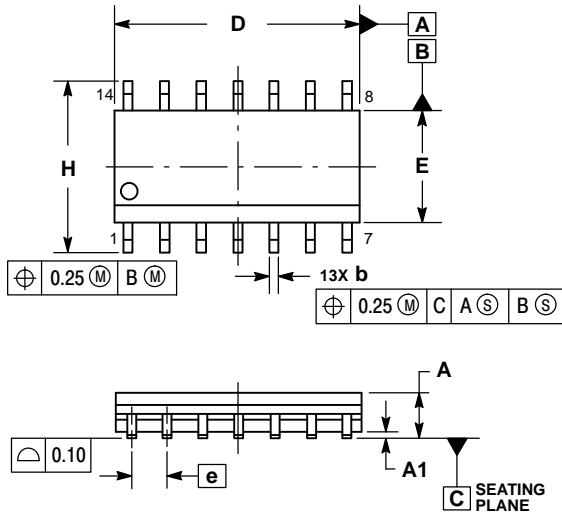
DIMENSIONS: MILLIMETERS

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

# NLSX5014

## PACKAGE DIMENSIONS

SOIC-14  
D SUFFIX  
CASE 751A-03  
ISSUE L

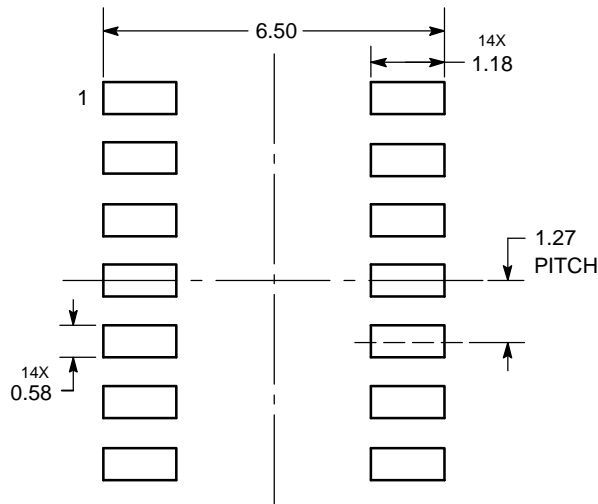


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF AT MAXIMUM MATERIAL CONDITION.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD PROTRUSIONS.
5. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.35	1.75	0.054	0.068
A1	0.10	0.25	0.004	0.010
A3	0.19	0.25	0.008	0.010
b	0.35	0.49	0.014	0.019
D	8.55	8.75	0.337	0.344
E	3.80	4.00	0.150	0.157
e	1.27 BSC		0.050 BSC	
H	5.80	6.20	0.228	0.244
h	0.25	0.50	0.010	0.019
L	0.40	1.25	0.016	0.049
M	0°	7°	0°	7°

### SOLDERING FOOTPRINT\*



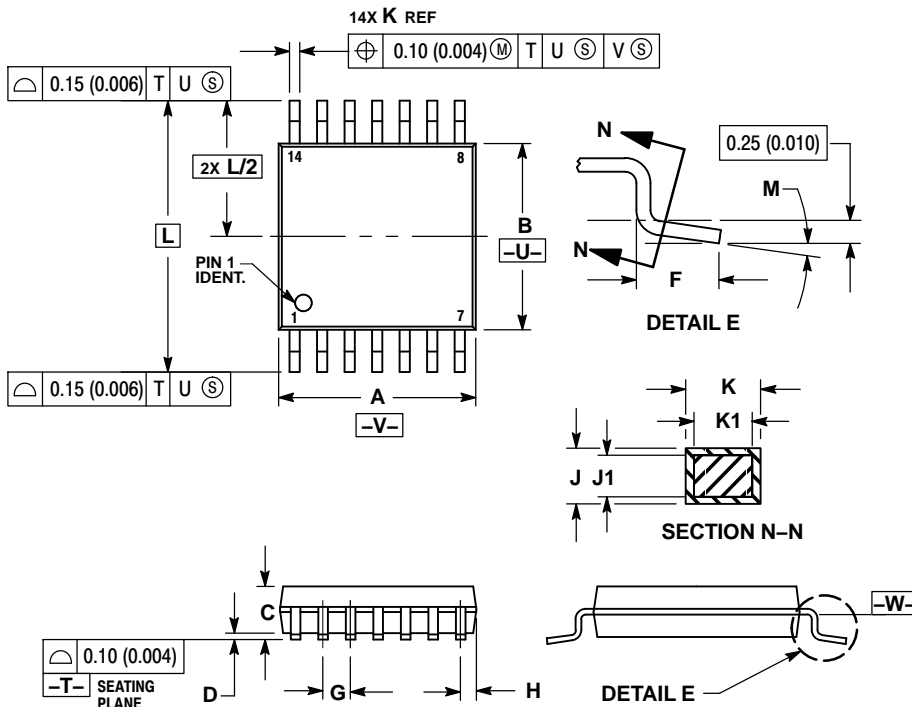
DIMENSIONS: MILLIMETERS

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

# NLSX5014

## PACKAGE DIMENSIONS

TSSOP-14  
DT SUFFIX  
CASE 948G  
ISSUE C

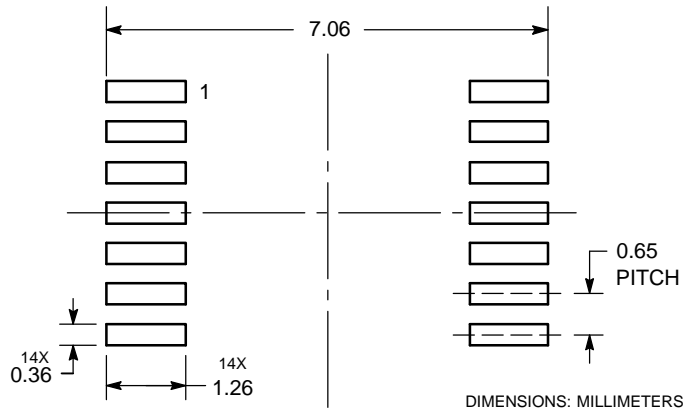


### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.90	5.10	0.193	0.200
B	4.30	4.50	0.169	0.177
C	---	1.20	---	0.047
D	0.05	0.15	0.002	0.006
F	0.50	0.75	0.020	0.030
G	0.65 BSC		0.026 BSC	
H	0.50	0.60	0.020	0.024
J	0.09	0.20	0.004	0.008
J1	0.09	0.16	0.004	0.006
K	0.19	0.30	0.007	0.012
K1	0.19	0.25	0.007	0.010
L	6.40 BSC		0.252 BSC	
M	0°	8°	0°	8°

### SOLDERING FOOTPRINT



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