

NLSV4T240E

4-Bit Dual-Supply Inverting Level Translator

The NLSV4T240E is a 4-bit configurable dual-supply voltage level translator. The input A_n and output B_n ports are designed to track two different power supply rails, V_{CCA} and V_{CCB} respectively. Both supply rails are configurable from 0.9 V to 4.5 V allowing universal low-voltage translation from the input A_n to the output B_n port.

The NLSV4T240E is similar to the NLSV4T240; however, it has enhanced power-off characteristics.

Features

- Wide V_{CCA} and V_{CCB} Operating Range: 0.9 V to 4.5 V
- High-Speed w/ Balanced Propagation Delay
- Inputs and Outputs have OVT Protection to 4.5 V
- Non-preferential V_{CCA} and V_{CCB} Sequencing
- Outputs at 3-State until Active V_{CC} is Reached
- Power-Off Protection
- Outputs Switch to 3-State with V_{CCB} at GND
- Ultra-Small Packaging: 1.7 mm x 2.0 mm UQFN12
- This is a Pb-Free Device

Typical Applications

- Mobile Phones, PDAs, Other Portable Devices

Important Information

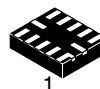
- ESD Protection for All Pins:
 - HBM (Human Body Model) > 6000 V
 - MM (Machine Model) > 300 V



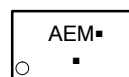
ON Semiconductor®

<http://onsemi.com>

MARKING DIAGRAMS

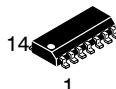


UQFN12
MU SUFFIX
CASE 523AE

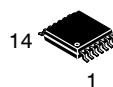
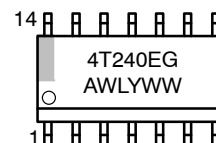


AE = Specific Device Code
M = Date Code
▪ = Pb-Free Package

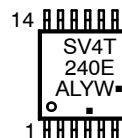
(Note: Microdot may be in either location)



SOIC-14
D SUFFIX
CASE 751A



TSSOP-14
DT SUFFIX
CASE 948G



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

ORDERING INFORMATION

Device	Package	Shipping†
NLSV4T240EMUTAG	UQFN12 (Pb-Free)	3000/Tape & Reel
NLSV4T240EDR2G	SO-14 (Pb-Free)	2500/Tape & Reel
NLSV4T240EDTR2G	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.

NLSV4T240E

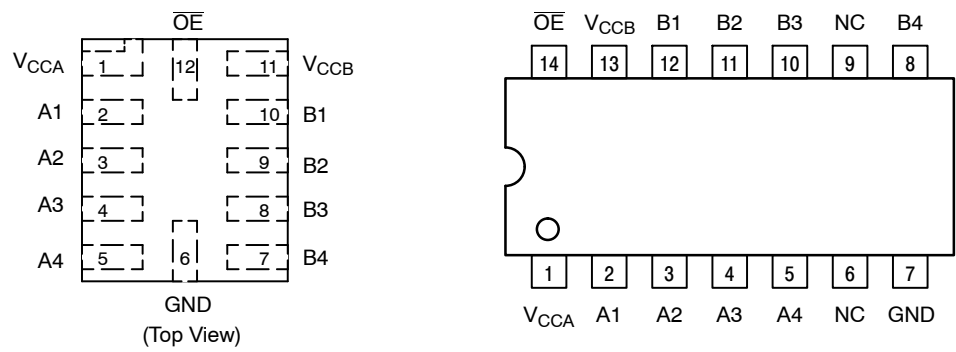


Figure 1. Pin Assignments

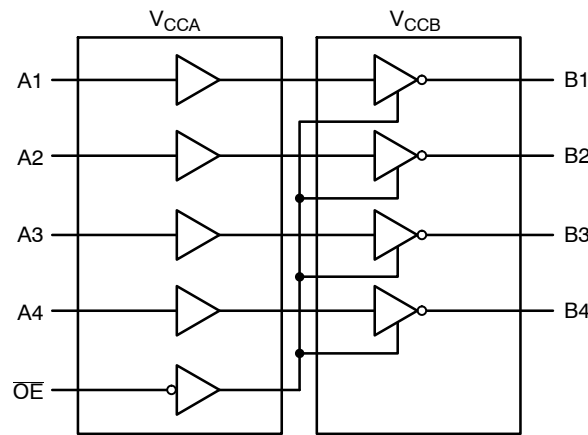


Figure 2. Logic Diagram

PIN ASSIGNMENT

Pin	Function
VCCA	Input Port DC Power Supply
VCCB	Output Port DC Power Supply
GND	Ground
A _n	Input Port
B _n	Output Port
OE	Output Enable

TRUTH TABLE

Inputs		Outputs
OE	A _n	B _n
L	L	H
L	H	L
H	X	3-State

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MAXIMUM RATINGS

Symbol	Rating	Value	Condition	Unit
V_{CCA}, V_{CCB}	DC Supply Voltage	-0.5 to +5.5		V
V_I	DC Input Voltage A_n	-0.5 to +5.5		V
V_C	Control Input $\overline{OE}$	-0.5 to +5.5		V
V_O	DC Output Voltage (Power Down) B_n	-0.5 to +5.5	$V_{CCA} = V_{CCB} = 0$	V
	(Active Mode) B_n	-0.5 to +5.5		V
	(Tri-State Mode) B_n	-0.5 to +5.5		V
I_{IK}	DC Input Diode Current	-20	$V_I < GND$	mA
I_{OK}	DC Output Diode Current	-50	$V_O < GND$	mA
I_O	DC Output Source/Sink Current	± 50		mA
I_{CCA}, I_{CCB}	DC Supply Current Per Supply Pin	± 100		mA
I_{GND}	DC Ground Current per 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_{CCA}, V_{CCB}	Positive DC Supply Voltage	0.9	4.5	V
V_I	Bus Input Voltage	GND	4.5	V
V_C	Control Input $\overline{OE}$	GND	4.5	V
V_{IO}	Bus Output Voltage (Power Down Mode) B_n	GND	4.5	V
	(Active Mode) B_n	GND	V_{CCB}	V
	(Tri-State Mode) B_n	GND	4.5	V
T_A	Operating Temperature Range	-40	+85	°C
$\Delta t / \Delta V$	Input Transition Rise or Rate V_I , from 30% to 70% of V_{CC} ; $V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$	0	10	nS

DC ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Test Conditions	V_{CCA} (V)	V_{CCB} (V)	-40°C to +85°C		Unit
					Min	Max	
V_{IH}	Input HIGH Voltage ($A_n, \overline{OE}$)		3.6 – 4.5	0.9 – 4.5	2.7	–	V
			2.7 – 3.6		2.0	–	
			2.3 – 2.7		1.7	–	
			1.4 – 2.3		$0.75 * V_{CCA}$	–	
			0.9 – 1.4		$0.9 * V_{CCA}$	–	
V_{IL}	Input LOW Voltage ($A_n, \overline{OE}$)		3.6 – 4.5	0.9 – 4.5	–	0.8	V
			2.7 – 3.6		–	0.8	
			2.3 – 2.7		–	0.7	
			1.4 – 2.3		–	$0.35 * V_{CCA}$	
			0.9 – 1.4		–	$0.1 * V_{CCA}$	

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DC ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Test Conditions	V _{CCA} (V)	V _{CCB} (V)	-40°C to +85°C		Unit
					Min	Max	
V _{OH}	Output HIGH Voltage	I _{OH} = -100 µA; V _I = V _{IH}	0.9 – 4.5	0.9 – 4.5	V _{CCB} – 0.2	–	V
		I _{OH} = -0.5 mA; V _I = V _{IH}	0.9	0.9	0.75 * V _{CCB}	–	
		I _{OH} = -2 mA; V _I = V _{IH}	1.4	1.4	1.05	–	
		I _{OH} = -6 mA; V _I = V _{IH}	1.65	1.65	1.25	–	
			2.3	2.3	2.0	–	
		I _{OH} = -12 mA; V _I = V _{IH}	2.3	2.3	1.8	–	
			2.7	2.7	2.2	–	
		I _{OH} = -18 mA; V _I = V _{IH}	2.3	2.3	1.7	–	
			3.0	3.0	2.4	–	
		I _{OH} = -24 mA; V _I = V _{IH}	3.0	3.0	2.2	–	
V _{OL}	Output LOW Voltage	I _{OL} = 100 µA; V _I = V _{IL}	0.9 – 4.5	0.9 – 4.5	–	0.2	V
		I _{OL} = 0.5 mA; V _I = V _{IH}	1.1	1.1	–	0.3	
		I _{OL} = 2 mA; V _I = V _{IH}	1.4	1.4	–	0.35	
		I _{OL} = 6 mA; V _I = V _{IL}	1.65	1.65	–	0.3	
		I _{OL} = 12 mA; V _I = V _{IL}	2.3	2.3	–	0.4	
			2.7	2.7	–	0.4	
		I _{OL} = 18 mA; V _I = V _{IL}	2.3	2.3	–	0.6	
			3.0	3.0	–	0.4	
		I _{OL} = 24 mA; V _I = V _{IL}	3.0	3.0	–	0.55	
I _I	Input Leakage Current	V _I = V _{CCA} or GND	0.9 – 4.5	0.9 – 4.5	-1.0	1.0	µA
I _{OFF}	Power-Off Leakage Current	$\overline{OE} = 0$ V	0 0.9 – 4.5	0.9 – 4.5 0	-1.0 -1.0	1.0 1.0	µA
I _{CCA}	Quiescent Supply Current	V _I = V _{CCA} or GND; I _O = 0, V _{CCA} = V _{CCB}	0.9 – 4.5	0.9 – 4.5	–	2.0	µA
I _{CCB}	Quiescent Supply Current	V _I = V _{CCA} or GND; I _O = 0, V _{CCA} = V _{CCB}	0.9 – 4.5	0.9 – 4.5	–	2.0	µA
I _{CCA} + I _{CCB}	Quiescent Supply Current	V _I = V _{CCA} or GND; I _O = 0, V _{CCA} = V _{CCB}	0.9 – 4.5	0.9 – 4.5	–	4.0	µA
ΔI _{CCA}	Increase in I _{CC} per Input Voltage, Other Inputs at V _{CCA} or GND	V _I = V _{CCA} – 0.6 V; V _I = V _{CCA} or GND	4.5 3.6	4.5 3.6	–	10 5.0	µA
ΔI _{CCB}	Increase in I _{CC} per Input Voltage, Other Inputs at V _{CCA} or GND	V _I = V _{CCA} – 0.6 V; V _I = V _{CCA} or GND	4.5 3.6	4.5 3.6	–	10 5.0	µA
I _{OZ}	I/O Tri-State Output Leakage Current (T _A = 25°C, $\overline{OE} = V_{CCA}$)	V _O = 0 V	4.5	4.5	–	1.0	µA
		V _O = 4.5 V	4.5	4.5	–	10	
		V _O = 0 to 4.5 V	2.5	3.5	–	105	
			3.0	3.75	–	110	
			3.3	3.0	–	75	
			3.75	1.5	–	10	

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TOTAL STATIC POWER CONSUMPTION ($I_{CCA} + I_{CCB}$)

V _{CCA} (V)	-40°C to +85°C										Unit
	V _{CCB} (V)										
	4.5		3.3		2.8		1.8		0.9		
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
4.5		2		2		2		2		< 1.5	μA
3.3		2		2		2		2		< 1.5	μA
2.8		< 2		< 1		< 1		< 0.5		< 0.5	μA
1.8		< 1		< 1		< 0.5		< 0.5		< 0.5	μA
0.9		< 0.5		< 0.5		< 0.5		< 0.5		< 0.5	μA

NOTE: Connect ground before applying supply voltage V_{CCA} or V_{CCB} . This device is designed with the feature that the power-up sequence of V_{CCA} and V_{CCB} will not damage the IC.

AC ELECTRICAL CHARACTERISTICS

Symbol	Parameter	V _{CCA} (V)	-40°C to +85°C										Unit
			V _{CCB} (V)										
			4.5		3.3		2.8		1.8		1.5		
			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
t _{PLH} , t _{PHL} (Note 1)	Propagation Delay, A _n to B _n	4.5		3.0		3.2		3.4		3.7		4.0	nS
		3.6		3.3		3.5		3.7		4.0		4.3	
		2.8		3.5		3.7		3.9		4.2		4.5	
		1.8		3.8		4.0		4.2		4.5		4.8	
		1.5		4.1		4.3		4.5		4.8		5.0	
t _{PZH} , t _{PZL} (Note 1)	Output Enable, OE to B _n	4.5		4.4		4.8		5.2		5.7		6.2	nS
		3.3		4.7		5.1		5.5		6.0		6.5	
		2.8		4.9		5.3		5.7		6.2		6.7	
		1.8		5.2		5.6		6.0		6.5		7.0	
		1.5		5.5		5.9		6.3		6.8		7.3	
t _{PHZ} , t _{PLZ} (Note 1)	Output Disable, OE to B _n	4.5		4.4		4.8		5.2		5.7		6.2	nS
		3.3		4.7		5.1		5.5		6.0		6.5	
		2.8		4.9		5.3		5.7		6.2		6.7	
		1.8		5.2		5.6		6.0		6.5		7.0	
		1.5		5.5		5.9		6.3		6.8		7.3	
t _{OSHL} , t _{OSLH} (Note 1)	Output to Output Skew, Data to Out-put	4.1		0.15		0.15		0.15		0.15		0.15	nS
		3.6		0.15		0.15		0.15		0.15		0.15	
		2.8		0.15		0.15		0.15		0.15		0.15	
		1.8		0.15		0.15		0.15		0.15		0.15	
		1.2		0.15		0.15		0.15		0.15		0.15	

1. Propagation delays defined per Figures 3 and 4.

CAPACITANCE

Symbol	Parameter	Test Conditions	Typ (Note 2)	Unit
C_{IN}	Control Pin Input Capacitance	$V_{CCA} = V_{CCB} = 3.3$ V, $V_I = 0$ V or $V_{CCA/B}$	3.5	pF
$C_{I/O}$	I/O Pin Input Capacitance	$V_{CCA} = V_{CCB} = 3.3$ V, $V_I = 0$ V or $V_{CCA/B}$	5.0	pF
C_{PD}	Power Dissipation Capacitance	$V_{CCA} = V_{CCB} = 3.3$ V, $V_I = 0$ V or V_{CCA} , $f = 10$ MHz	20	pF

2. Typical values are at $T_A = +25^\circ\text{C}$.

3. C_{PD} is defined as the value of the IC's equivalent capacitance from which the operating current can be calculated from:
 $I_{CC(\text{operating})} \cong C_{PD} \times V_{CC} \times f_{IN} \times N_{SW}$ where $I_{CC} = I_{CCA} + I_{CCB}$ and N_{SW} = total number of outputs switching.

NLSV4T240E

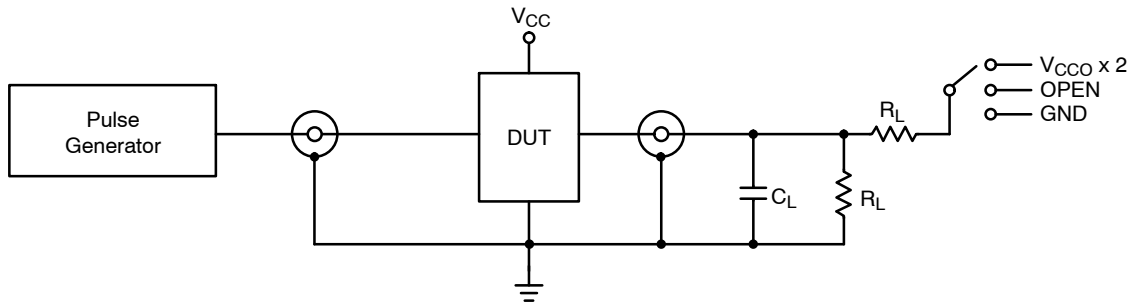
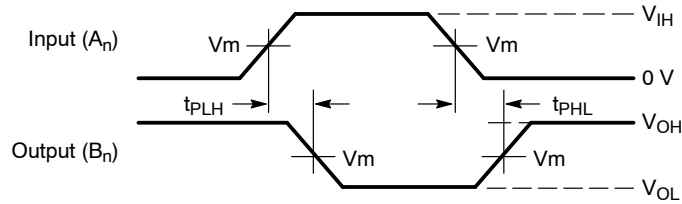


Figure 3. AC (Propagation Delay) Test Circuit

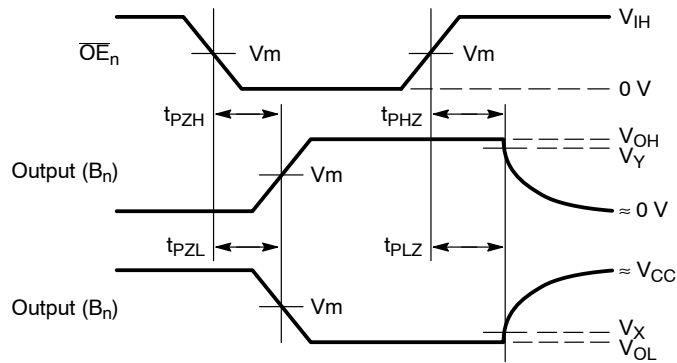
Test	Switch
t_{PLH} , t_{PHL}	OPEN
t_{PLZ} , t_{PZL}	$V_{CCO} \times 2$
t_{PHZ} , t_{PZH}	GND

$C_L = 15 \text{ pF}$ or equivalent (includes probe and jig capacitance)
 $R_L = 2 \text{ k}\Omega$ or equivalent
 Z_{OUT} of pulse generator = 50Ω



Waveform 1 – Propagation Delays

$t_R = t_F = 2.0 \text{ ns}$, 10% to 90%; $f = 1 \text{ MHz}$; $t_W = 500 \text{ ns}$



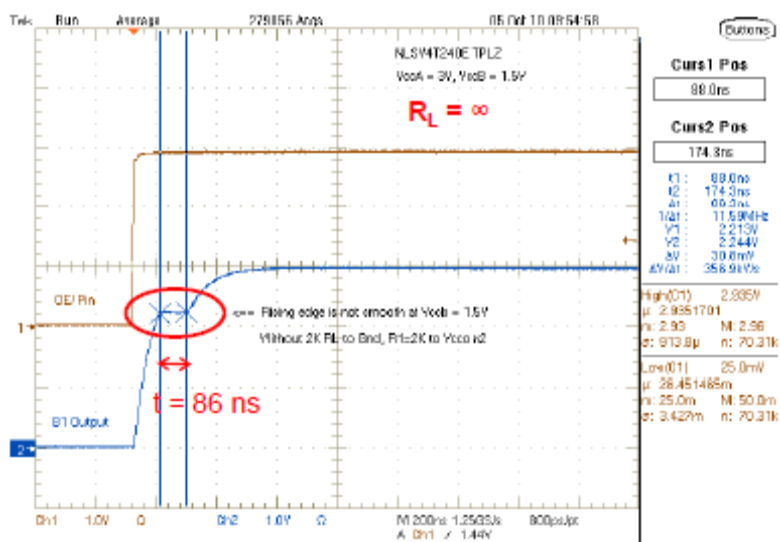
Waveform 2 – Output Enable and Disable Times

$t_R = t_F = 2.0 \text{ ns}$, 10% to 90%; $f = 1 \text{ MHz}$; $t_W = 500 \text{ ns}$

Figure 4. AC (Propagation Delay) Test Circuit Waveforms

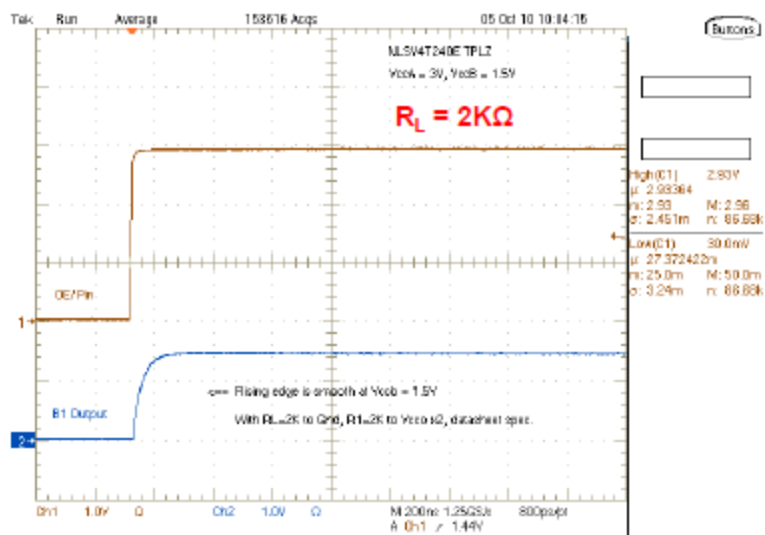
Symbol	V_{CC}				
	3.0 V – 4.5 V	2.3 V – 2.7 V	1.65 V – 1.95 V	1.4 V – 1.6 V	0.9 V – 1.3 V
V_{mA}	$V_{CCA}/2$	$V_{CCA}/2$	$V_{CCA}/2$	$V_{CCA}/2$	$V_{CCA}/2$
V_{mB}	$V_{CCB}/2$	$V_{CCB}/2$	$V_{CCB}/2$	$V_{CCB}/2$	$V_{CCB}/2$
V_X	$V_{OL} \times 0.1$	$V_{OL} \times 0.1$	$V_{OL} \times 0.1$	$V_{OL} \times 0.1$	$V_{OL} \times 0.1$
V_Y	$V_{OH} \times 0.9$	$V_{OH} \times 0.9$	$V_{OH} \times 0.9$	$V_{OH} \times 0.9$	$V_{OH} \times 0.9$

APPLICATIONS INFORMATION



($C_L = 50 \text{ pF}$, $R_L = 2 \text{ k}\Omega$, $R_{\text{pull-up}} = 50 \text{ k}\Omega$, test circuit shown in Figure 3)

Figure 5. Typical Tri-State Output



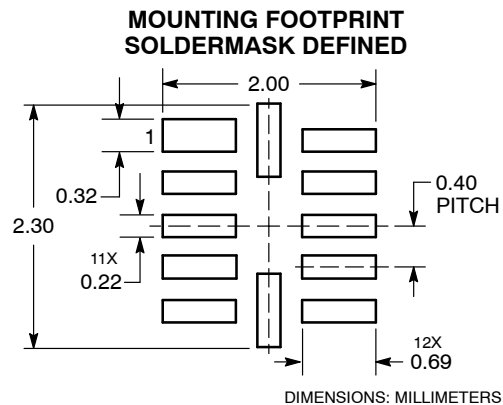
($C_L = 50 \text{ pF}$, $R_L = \infty$, $R_{\text{pull-up}} = 2 \text{ k}\Omega$, test circuit shown in Figure 3)

Figure 6. Typical Tri-State Output

Typical tri-state output waveforms of the NLSX4T240E are shown in Figures 5 and 6. The shape of the output waveform during a tri-state condition corresponding to the disable time (t_{PHZ} , t_{PLZ}) depends on the configuration of the pull-up circuit. Figure 5 shows a smooth monotonically increasing exponentially waveform because a $2 \text{ k}\Omega$ resistance is connected between the output and ground.

Figure 6 shows that the output may have a 'shelf' or a short duration where the slope of the waveform is equal to zero if no load resistance is connected to ground. The NLSX4T240E was created from the NLSV4T240 to minimize the 'shelf' of the waveform during the disable time.

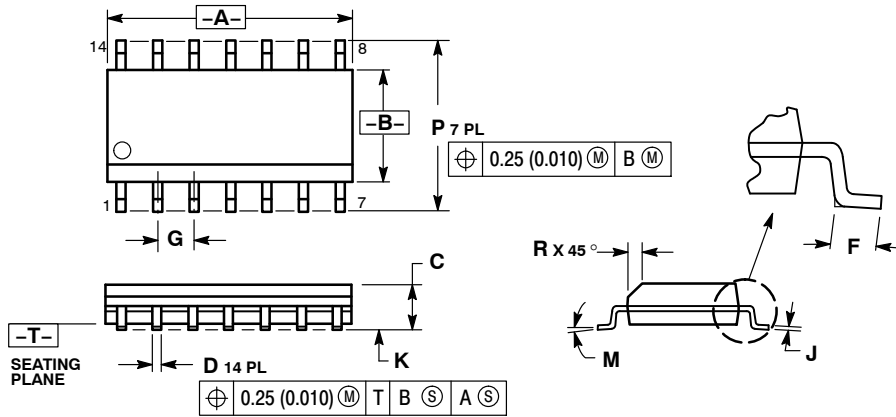
PACKAGE DIMENSIONS



NLSV4T240E

PACKAGE DIMENSIONS

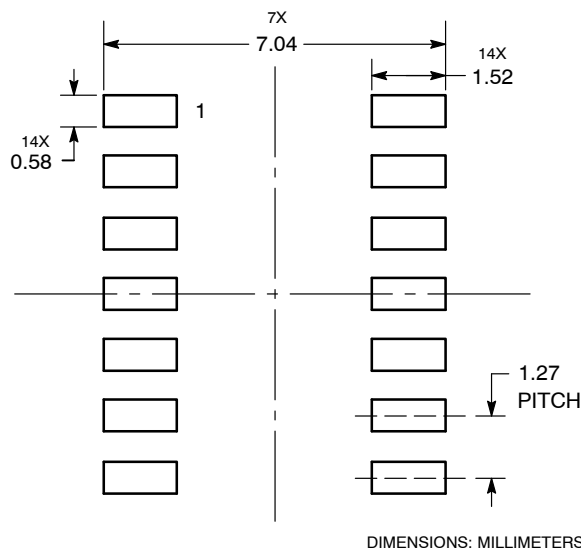
SOIC-14
D SUFFIX
CASE 751A-03
ISSUE J



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: MILLIMETER.
 3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
 4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
 5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.55	8.75	0.337	0.344
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.228	0.244
R	0.25	0.50	0.010	0.019

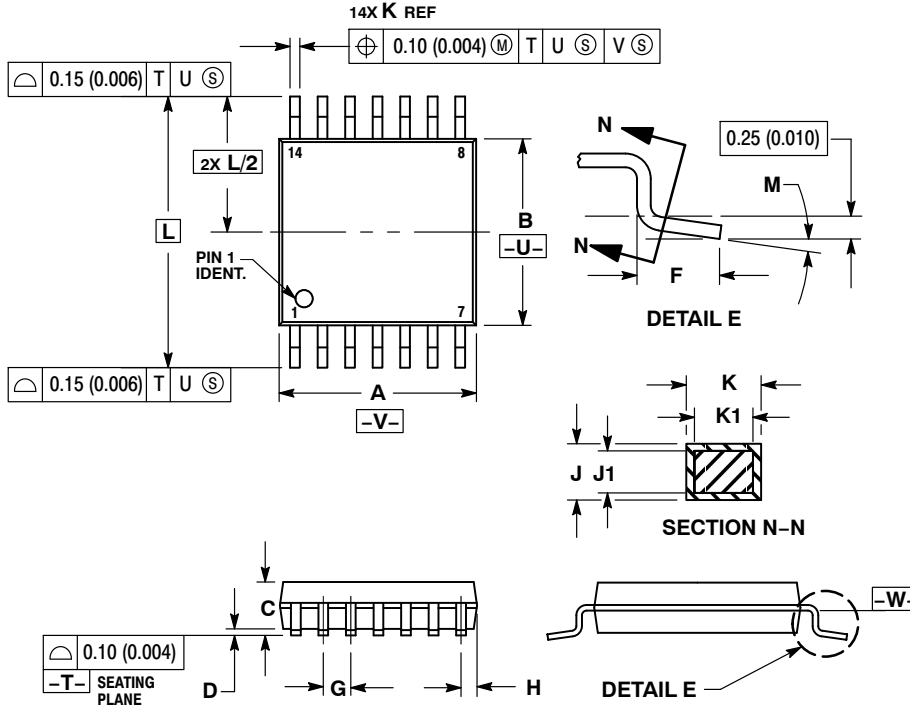
SOLDERING FOOTPRINT



NLSV4T240E

PACKAGE DIMENSIONS

TSSOP-14
DT SUFFIX
CASE 948G-01
ISSUE B

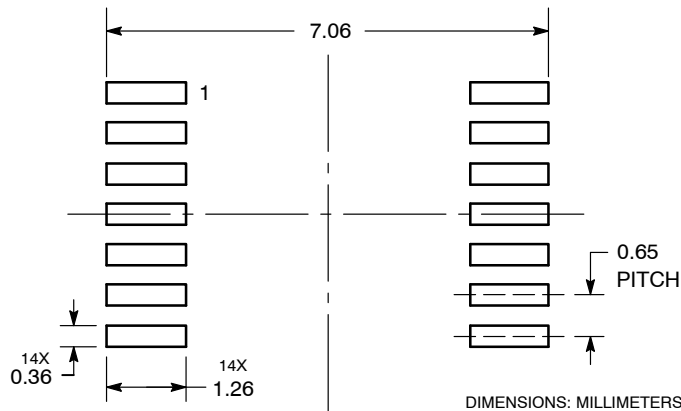


NOTES:

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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