

# ON Semiconductor

## Is Now



To learn more about onsemi™, please visit our website at  
[www.onsemi.com](http://www.onsemi.com)

onsemi and 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 product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://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. Other names and brands may be claimed as the property of others.

# NCS325, NCS2325, NCS4325

## 50 $\mu\text{V}$ Offset, 0.25 $\mu\text{V}/^\circ\text{C}$ , 35 $\mu\text{A}$ , Zero-Drift Operational Amplifier

The NCS325, NCS2325 and NCS4325 are CMOS operational amplifiers providing precision performance. The Zero-Drift architecture allows for continuous auto-calibration, which provides very low offset, near-zero drift over time and temperature, and near flat 1/f noise at only 35  $\mu\text{A}$  (max) quiescent current. These benefits make these devices ideal for precision DC applications. These op amps provide rail-to-rail input and output performance and are optimized for low voltage operation as low as 1.8 V and up to 5.5 V. The single channel NCS325 is available in the space-saving SOT23-5 package. The dual channel NCS2325 is available in Micro8, SOIC-8, and DFN-8. The quad channel NCS4325 is available in SOIC-14.

### Features

- Low Offset Voltage: 14  $\mu\text{V}$  typ, 50  $\mu\text{V}$  max at 25°C for NCS325
- Zero Drift: 0.25  $\mu\text{V}/^\circ\text{C}$  max
- Low Noise: 1  $\mu\text{Vpp}$ , 0.1 Hz to 10 Hz
- Quiescent Current: 21  $\mu\text{A}$  typ, 35  $\mu\text{A}$  max at 25°C
- Supply Voltage: 1.8 V to 5.5 V
- Rail-to-Rail Input and Output
- Internal EMI Filtering
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

### Typical Applications

- Battery Powered Instruments
- Temperature Measurements
- Transducer Applications
- Electronic Scales
- Medical Instrumentation
- Current Sensing



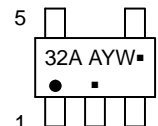
ON Semiconductor®

[www.onsemi.com](http://www.onsemi.com)

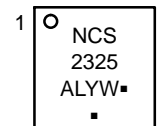
### MARKING DIAGRAMS



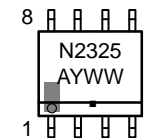
TSOP-5  
(SOT23-5)  
SN SUFFIX  
CASE 483



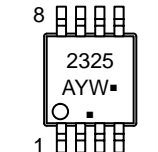
DFN-8  
MN SUFFIX  
CASE 506BW



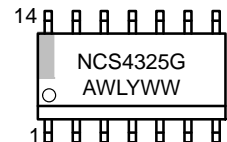
SOIC-8  
D SUFFIX  
CASE 751



MSOP-8  
DM SUFFIX  
CASE 846A



SOIC-14  
D SUFFIX  
CASE 751A



A = Assembly Location  
Y = Year  
WL = Wafer Lot  
W or WW = Work Week  
G or ■ = Pb-Free Package

(Note: Microdot may be in either location)

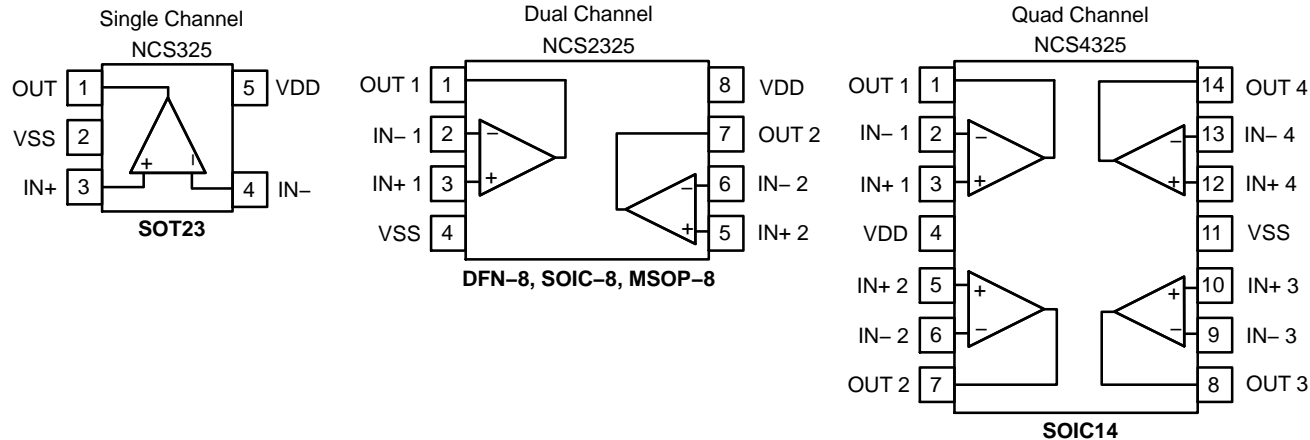
### ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.

This document contains information on some products that are still under development. ON Semiconductor reserves the right to change or discontinue these products without notice.

# NCS325, NCS2325, NCS4325

## PIN CONNECTIONS



## ORDERING INFORMATION

Configuration	Device	Package	Shipping†
Single	NCS325SN2T1G	SOT23-5 / TSOP-5	3000 / Tape & Reel
Dual	NCS2325MNTXG* (In Development)	DFN8	3000 / Tape & Reel
	NCS2325DR2G	SOIC-8	3000 / Tape & Reel
	NCS2325DMR2G	Micro8 / MSOP-8	4000 / Tape & Reel
Quad	NCS4325DR2G	SOIC-14	2500 / 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.

\*Contact local sales office for more information

# NCS325, NCS2325, NCS4325

**ABSOLUTE MAXIMUM RATINGS** Over operating free-air temperature, unless otherwise stated.

Parameter	Rating	Unit
Supply Voltage	6	V

## INPUT AND OUTPUT PINS

Input Voltage (Note 1)	$(V_{SS}) - 0.3$ to $(V_{DD}) + 0.3$	V
Input Current (Note 1)	$\pm 10$	mA
Output Short Circuit Current (Note 2)	Continuous	

## TEMPERATURE

Operating Temperature	-40 to +150	°C
Storage Temperature	-65 to +150	°C
Junction Temperature	+150	°C

## ESD RATINGS (Note 3)

Human Body Model (HBM)	4000	V
Machine Model (MM)	200	V

## OTHER RATINGS

Latch-up Current (Note 4)	100	mA
MSL	Level 1	

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.

1. Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.3 V beyond the supply rails should be current limited to 10 mA or less
2. Short-circuit to ground.
3. This device series incorporates ESD protection and is tested by the following methods:  
ESD Human Body Model tested per AEC-Q100-002 (JEDEC standard: JESD22-A114)  
ESD Machine Model tested per AEC-Q100-003 (JEDEC standard: JESD22-A115)
4. Latch-up Current tested per JEDEC standard: JESD78.

## THERMAL INFORMATION

Thermal Metric	Symbol	Package	Value	Unit
Junction to Ambient (Note 5)	$\theta_{JA}$	SOT23-5 / TSOP-5	235	°C/W
		Micro8 / MSOP-8	298	
		SOIC-8	250	
		DFN-8	130	
		SOIC-14	216	

5. As mounted on an 80x80x1.5 mm FR4 PCB with 650 mm<sup>2</sup> and 2 oz (0.034 mm) thick copper heat spreader. Following JEDEC JESD/EIA 51.1, 51.2, 51.3 test guidelines

## OPERATING CONDITIONS

Parameter	Symbol	Range	Unit
Supply Voltage ( $V_{DD} - V_{SS}$ )	$V_S$	1.8 to 5.5	V
Specified Operating Range	$T_A$	-40 to 125	°C
Input Common Mode Voltage Range	$V_{ICMR}$	$V_{SS}-0.1$ to $V_{DD}+0.1$	V

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.

# NCS325, NCS2325, NCS4325

## ELECTRICAL CHARACTERISTICS: $V_S = 1.8\text{ V}$ to $5.5\text{ V}$

At  $T_A = +25^\circ\text{C}$ ,  $R_L = 10\text{ k}\Omega$  connected to midsupply,  $V_{CM} = V_{OUT}$  = midsupply, unless otherwise noted.

**Boldface** limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ , guaranteed by characterization and/or design.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
-----------	--------	------------	-----	-----	-----	------

### INPUT CHARACTERISTICS

Offset Voltage	$V_{OS}$	NCS325	$V_S = +5\text{ V}$		14	50	$\mu\text{V}$
		NCS2325, NCS4325	$V_S = +5\text{ V}$		14	75	
Offset Voltage Drift vs Temp	$\Delta V_{OS}/\Delta T$	$T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$			<b>0.02</b>	<b>0.25</b>	$\mu\text{V}/^\circ\text{C}$
Input Bias Current	$I_{IB}$				$\pm 50$		pA
Input Offset Current	$I_{OS}$				$\pm 100$		pA
Common Mode Rejection Ratio	CMRR	NCS325	$V_{SS}+0.3 < V_{CM} < V_{DD} - 0.3$ , $V_S = 1.8\text{ V}$	<b>85</b>	108		dB
			$V_{SS}+0.3 < V_{CM} < V_{DD} - 0.3$ , $V_S = 5.5\text{ V}$	<b>90</b>	110		
		NCS2325, NCS4325	$V_{SS}+0.3 < V_{CM} < V_{DD} - 0.3$ , $V_S = 5\text{ V}$	<b>90</b>	110		
			$V_{SS}-0.1 < V_{CM} < V_{DD} + 0.1$ , $V_S = 1.8\text{ V}$		80		
			$V_{SS}-0.1 < V_{CM} < V_{DD} + 0.1$ , $V_S = 5.5\text{ V}$		92		
Input Resistance	$R_{IN}$				15		G $\Omega$
Input Capacitance	$C_{IN}$	NCS325	Differential		1.8		pF
			Common Mode		3.5		pF
		NCS2325, NCS4325	Differential		4.1		pF
			Common Mode		8.0		pF

### OUTPUT CHARACTERISTICS

Output Voltage High	$V_{OH}$	Output swing within $V_{DD}$			12	100	mV
Output Voltage Low	$V_{OL}$	Output swing within $V_{SS}$			8	100	mV
Short Circuit Current	$I_{SC}$				$\pm 5$		mA
Open Loop Output Impedance	$Z_{out-OL}$	$f = 350\text{ kHz}$ , $I_O = 0\text{ mA}$ , $V_S = 1.8\text{ V}$			1.4		k $\Omega$
		$f = 350\text{ kHz}$ , $I_O = 0\text{ mA}$ , $V_S = 5.5\text{ V}$			2.7		
Capacitive Load Drive	$C_L$			See Figure			

### NOISE PERFORMANCE

Voltage Noise Density	$e_N$	$f_{IN} = 1\text{ kHz}$			100		nV / $\sqrt{\text{Hz}}$
Voltage Noise	$e_{P-P}$	$f_{IN} = 0.01\text{ Hz}$ to $1\text{ Hz}$			0.3		$\mu\text{V}_{PP}$
		$f_{IN} = 0.1\text{ Hz}$ to $10\text{ Hz}$			1		$\mu\text{V}_{PP}$
Current Noise Density	$i_N$	$f_{IN} = 10\text{ Hz}$			0.3		pA / $\sqrt{\text{Hz}}$

### DYNAMIC PERFORMANCE

Open Loop Voltage Gain	$A_{VOL}$	$R_L = 10\text{ k}\Omega$ , $V_S = 5.5\text{ V}$			114		dB
Gain Bandwidth Product	GBWP	NCS325	$C_L = 100\text{ pF}$ , $R_L = 10\text{ k}\Omega$		350		kHz
		NCS2325, NCS4325	$C_L = 100\text{ pF}$ , $R_L = 10\text{ k}\Omega$		270		
Phase Margin	$\phi_M$	$C_L = 100\text{ pF}$			60		$^\circ$
Gain Margin	$A_M$	$C_L = 100\text{ pF}$			20		dB
Slew Rate	SR	$G = +1$ , $C_L = 100\text{ pF}$ , $V_S = 1.8\text{ V}$			0.10		V/ $\mu\text{s}$
		$G = +1$ , $C_L = 100\text{ pF}$ , $V_S = 5.5\text{ V}$			0.16		

### POWER SUPPLY

Power Supply Rejection Ratio	PSRR			100	107		dB
		$T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$		<b>95</b>			
Turn-on Time	$t_{ON}$	$V_S = 5\text{ V}$			100		$\mu\text{s}$
Quiescent Current	$I_Q$	No load			21	<b>35</b>	$\mu\text{A}$

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.

# NCS325, NCS2325, NCS4325

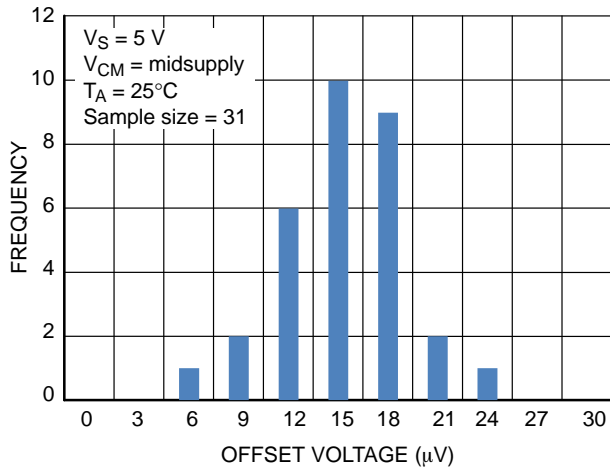


Figure 1. Offset Voltage Distribution

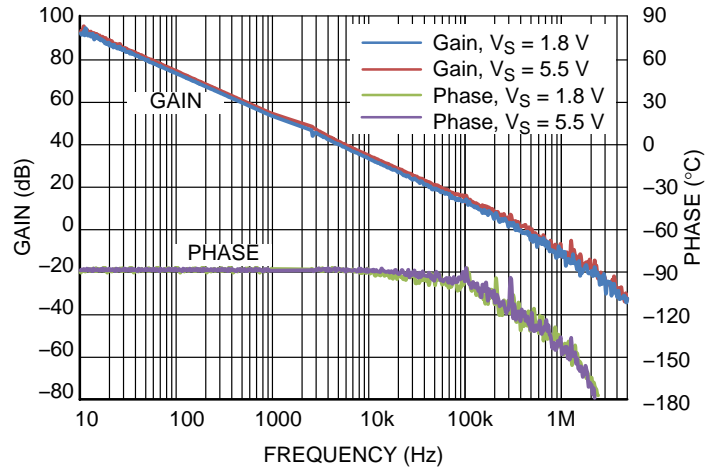


Figure 2. Gain and Phase vs. Frequency

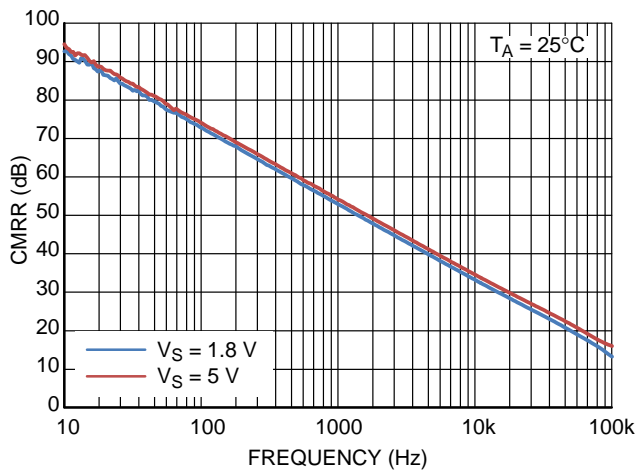


Figure 3. CMRR vs. Frequency

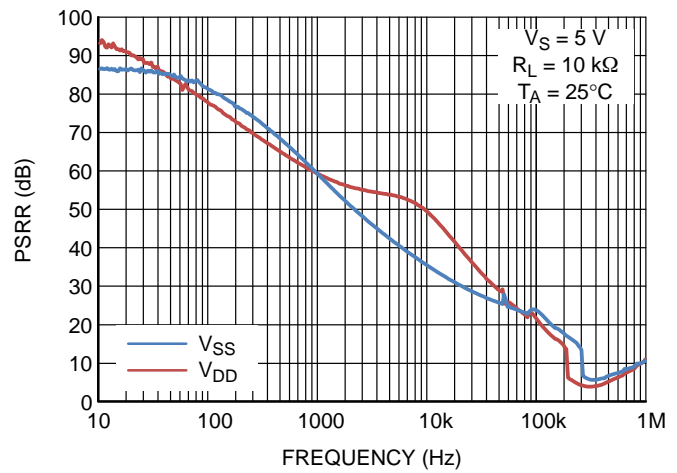


Figure 4. PSRR vs. Frequency

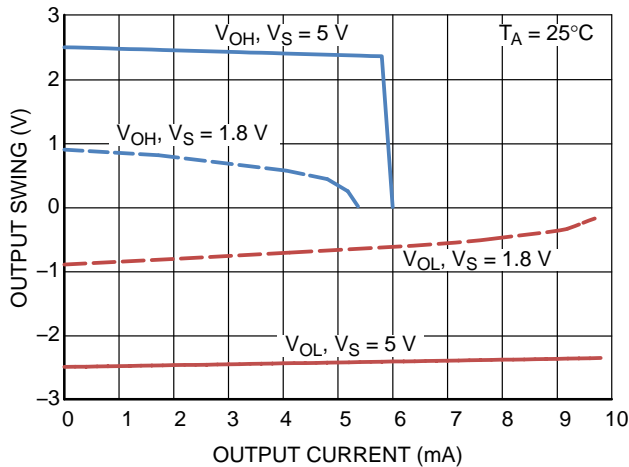


Figure 5. Output Voltage Swing vs. Output Current

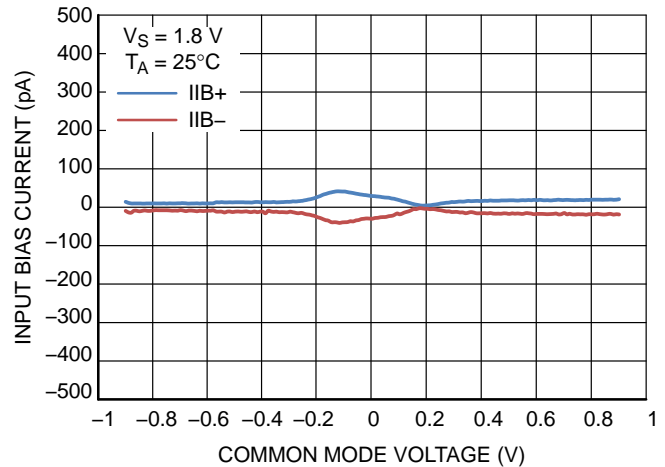
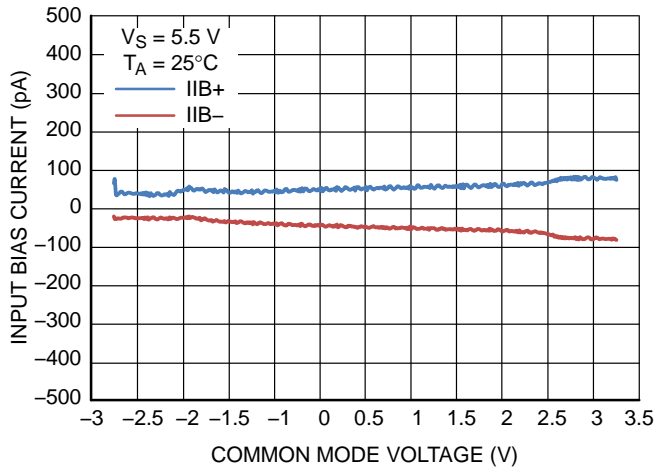
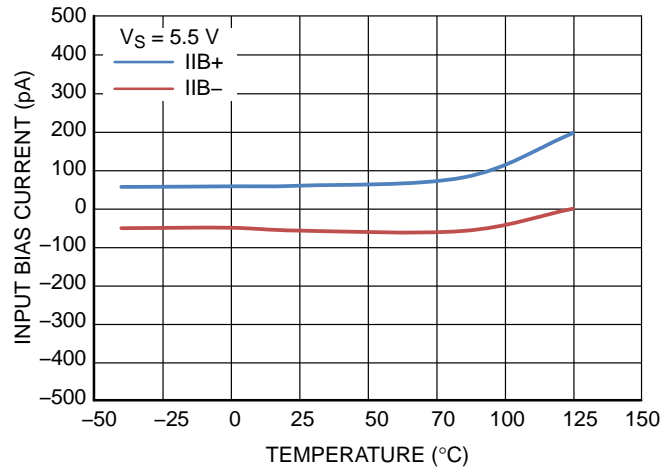


Figure 6. Input Bias Current vs. Common Mode Voltage,  $V_S = 1.8$  V

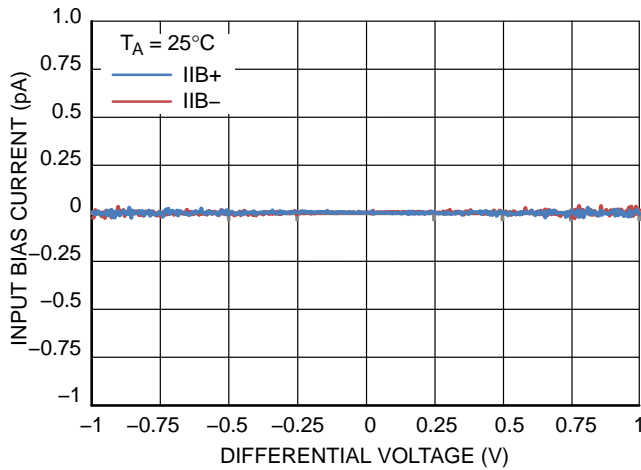
# NCS325, NCS2325, NCS4325



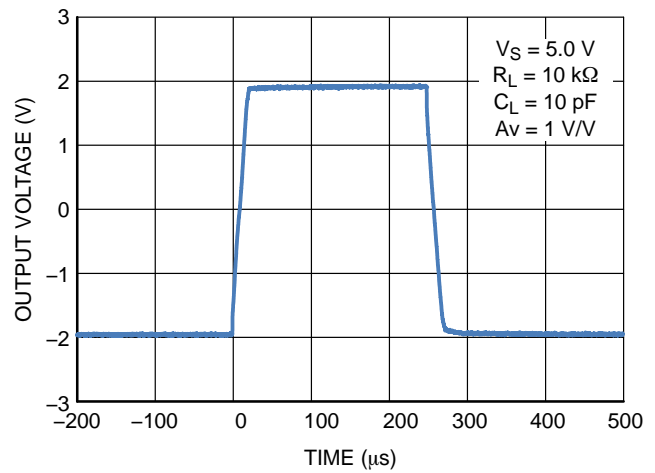
**Figure 7. Input Bias Current vs. Common Mode Voltage,  $V_S = 5.5$  V**



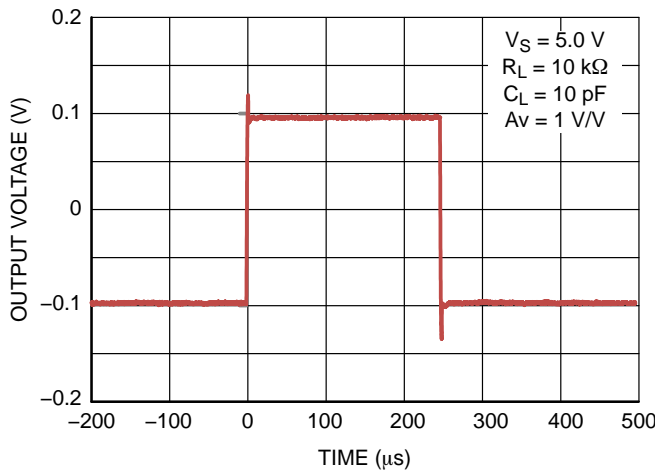
**Figure 8. Input Bias Current vs. Temperature**



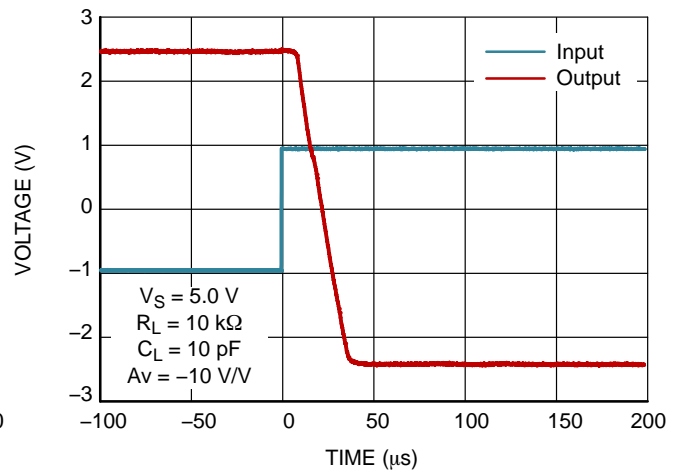
**Figure 9. Input Bias Current vs. Input Differential Voltage**



**Figure 10. Large Signal Step Response**



**Figure 11. Small Signal Step Response**



**Figure 12. Positive Over Voltage Recovery**

# NCS325, NCS2325, NCS4325

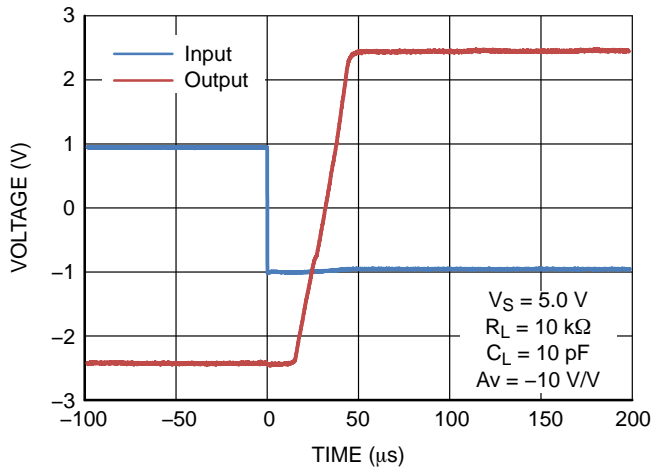


Figure 13. Negative Over Voltage Recovery

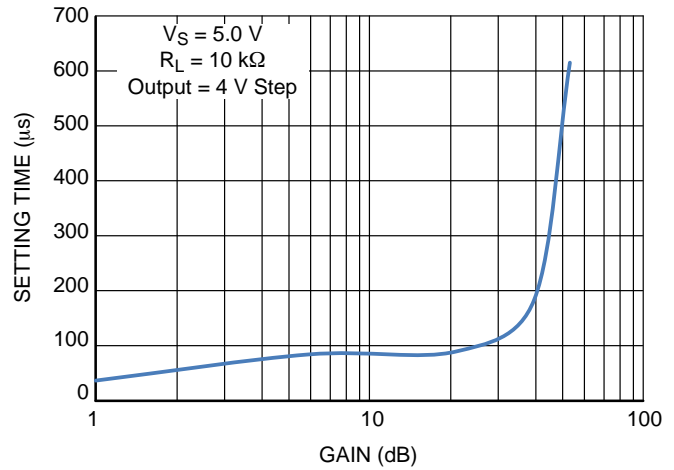


Figure 14. Setting Time vs. Closed Loop Gain

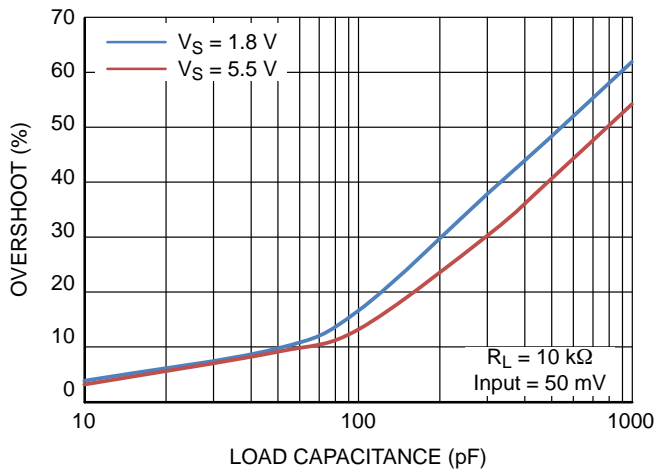


Figure 15. Small Signal Overshoot vs. Load Capacitance

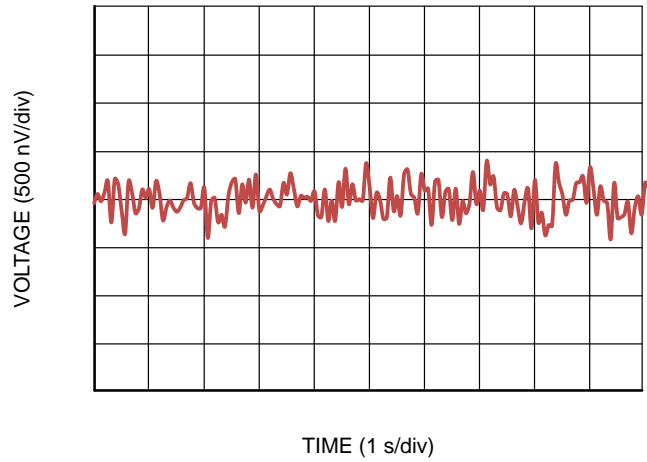


Figure 16. 0.1 Hz to 10 Hz Noise

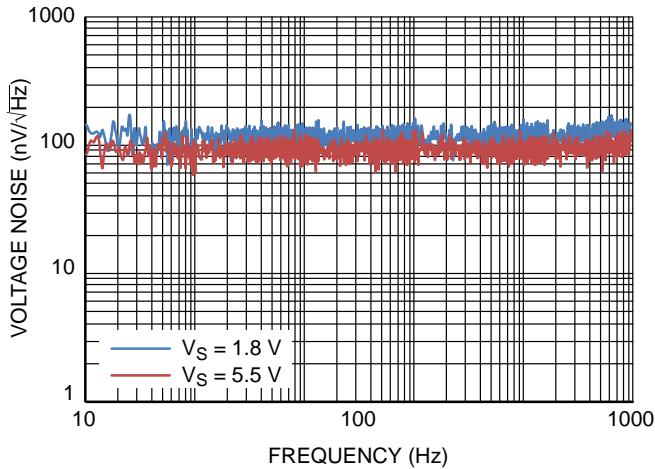


Figure 17. Voltage Noise Spectral Density vs. Frequency

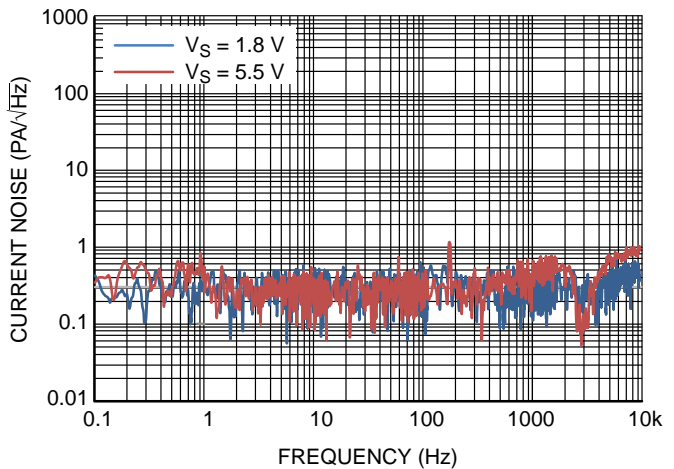


Figure 18. Current Noise Spectral Density vs. Frequency



# NCS325, NCS2325, NCS4325

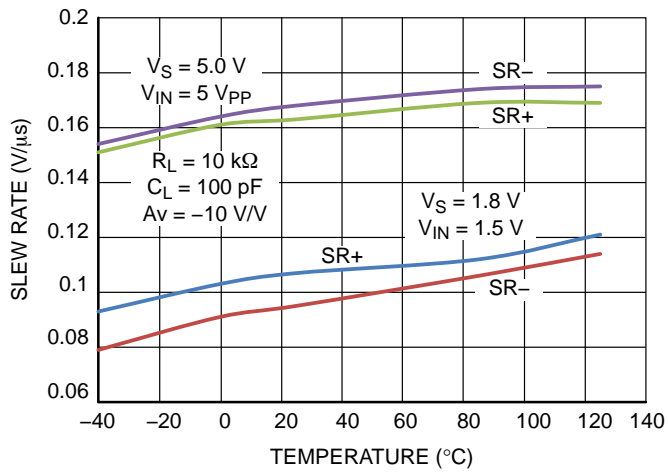


Figure 19. Slew Rate vs. Temperature

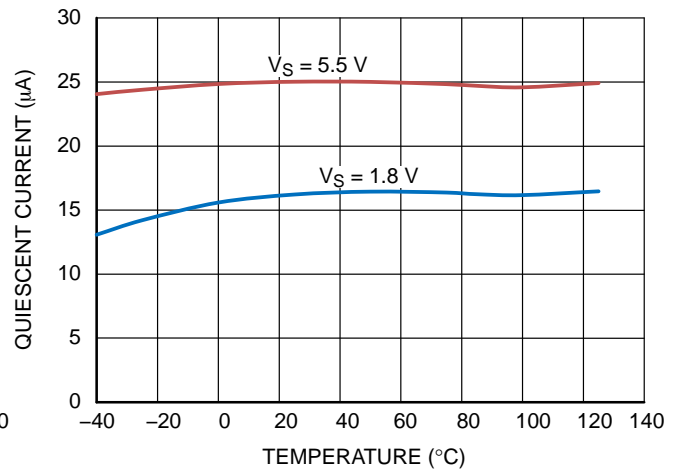


Figure 20. Quiescent Current vs. Temperature

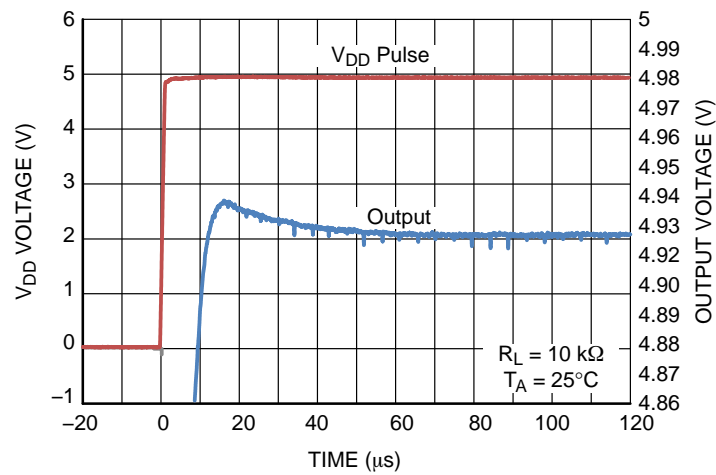


Figure 21. Turn-on Response

## APPLICATIONS INFORMATION

### INPUT VOLTAGE

The NCS325, NCS2325 and NCS4325 have rail-to-rail common mode input voltage range. Diodes between the inputs and the supply rails keep the input voltage from exceeding the rails.

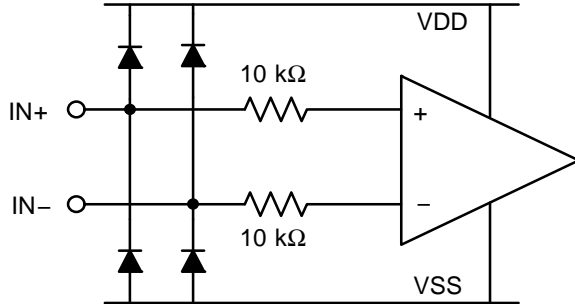


Figure 22. Equivalent Input Circuit

### EMI SUSCEPTIBILITY AND INPUT FILTERING

Op amps have varying amounts of EMI susceptibility. Semiconductor junctions can pick up and rectify EMI signals, creating an EMI-induced voltage offset at the output, adding another component to the total error. Input pins are the most sensitive to EMI. The NCS325, NCS2325 and NCS4325 integrate a low-pass filter to decrease its sensitivity to EMI.

### APPLICATION CIRCUITS

#### Low-Side Current Sensing

The goal of low-side current sensing is to detect over-current conditions or as a method of feedback control. A sense resistor is placed in series with the load to ground. Typically, the value of the sense resistor is less than 100 mΩ to reduce power loss across the resistor. The op amp amplifies the voltage drop across the sense resistor with a gain set by external resistors R1, R2, R3, and R4 (where R1 = R2, R3 = R4). Precision resistors are required for high accuracy, and the gain is set to utilize the full scale of the ADC for the highest resolution.

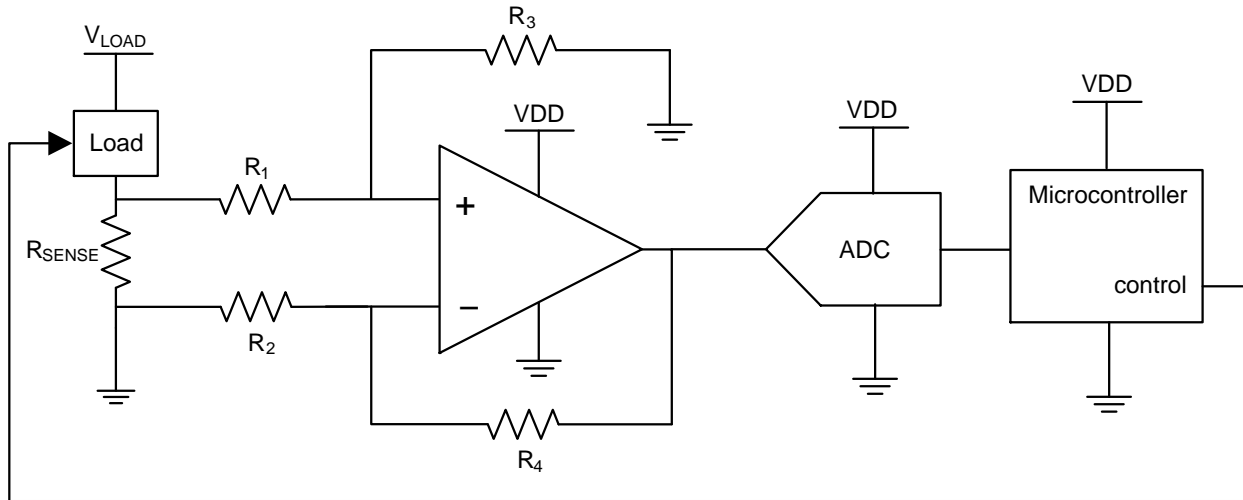


Figure 23. Low-Side Current Sensing

### Differential Amplifier for Bridged Circuits

Sensors to measure strain, pressure, and temperature are often configured in a Wheatstone bridge circuit as shown in Figure 24. In the measurement, the voltage change that is

produced is relatively small and needs to be amplified before going into an ADC. Precision amplifiers are recommended in these types of applications due to their high gain, low noise, and low offset voltage.

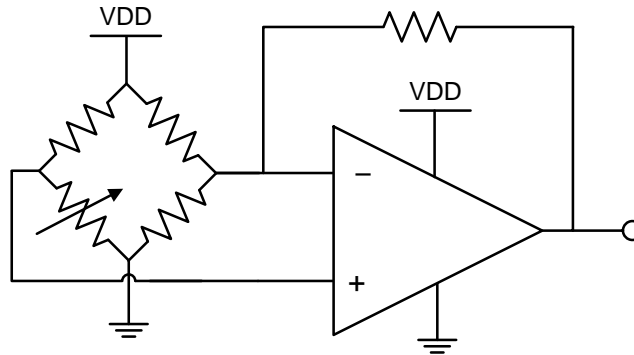


Figure 24. Bridge Circuit Amplification

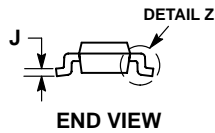
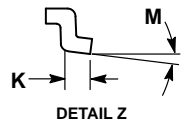
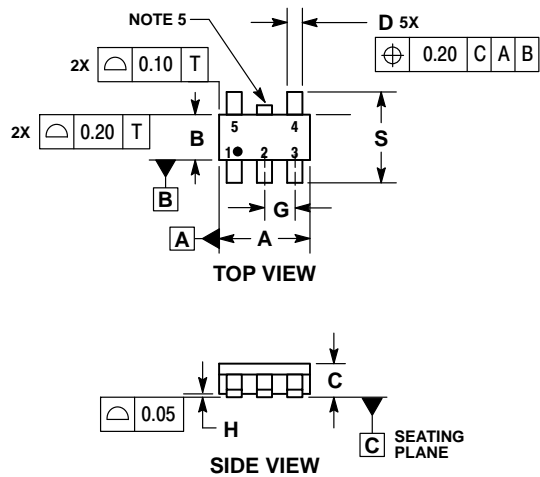
### GENERAL LAYOUT GUIDELINES

To ensure optimum device performance, it is important to follow good PCB design practices. Place 0.1  $\mu$ F decoupling capacitors as close as possible to the supply pins. Keep traces short, utilize a ground plane, choose surface-mount components, and place components as close as possible to

the device pins. These techniques will reduce susceptibility to electromagnetic interference (EMI). Thermoelectric effects can create an additional temperature dependent offset voltage at the input pins. To reduce these effects, use metals with low thermoelectric-coefficients and prevent temperature gradients from heat sources or cooling fans.

PACKAGE DIMENSIONS

TSOP-5  
CASE 483-02  
ISSUE K

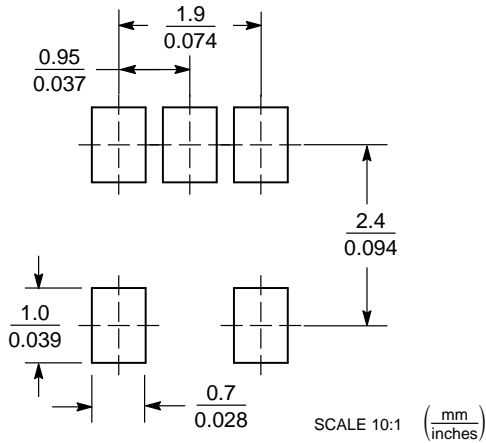


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.15 PER SIDE. DIMENSION A.
5. OPTIONAL CONSTRUCTION: AN ADDITIONAL TRIMMED LEAD IS ALLOWED IN THIS LOCATION. TRIMMED LEAD NOT TO EXTEND MORE THAN 0.2 FROM BODY.

DIM	MILLIMETERS	
	MIN	MAX
A	3.00	BSC
B	1.50	BSC
C	0.90	1.10
D	0.25	0.50
G	0.95	BSC
H	0.01	0.10
J	0.10	0.26
K	0.20	0.60
M	0°	10°
S	2.50	3.00

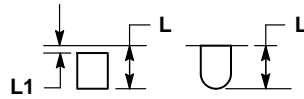
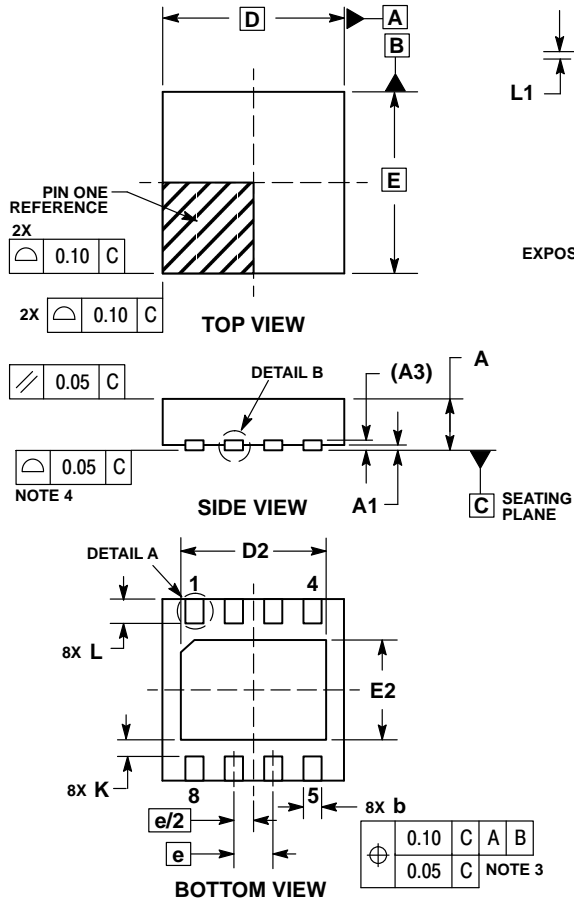
SOLDERING FOOTPRINT\*



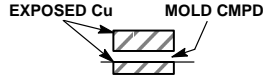
\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

PACKAGE DIMENSIONS

DFN8, 3x3, 0.65P  
CASE 506BW-01  
ISSUE O



**DETAIL A**  
OPTIONAL  
CONSTRUCTIONS



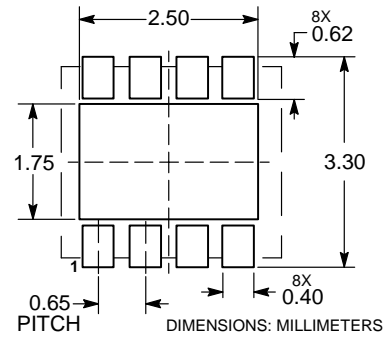
**DETAIL B**  
OPTIONAL  
CONSTRUCTIONS

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 0.30mm FROM THE TERMINAL TIP.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

MILLIMETERS		
DIM	MIN	MAX
A	0.80	1.00
A1	0.00	0.05
A3	0.20	REF
b	0.25	0.35
D	3.00	BSC
D2	2.30	2.50
E	3.00	BSC
E2	1.55	1.75
e	0.65	BSC
K	0.20	---
L	0.35	0.45
L1	0.00	0.15

**RECOMMENDED  
SOLDERING FOOTPRINT\***

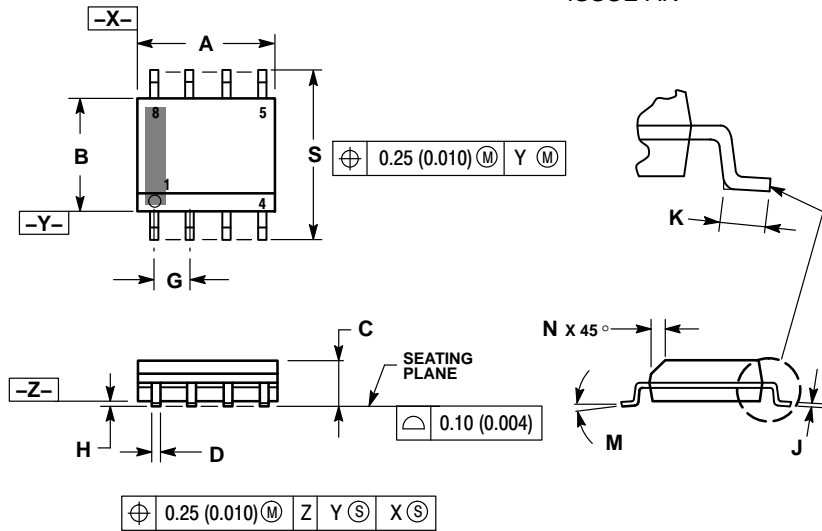


\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# NCS325, NCS2325, NCS4325

## PACKAGE DIMENSIONS

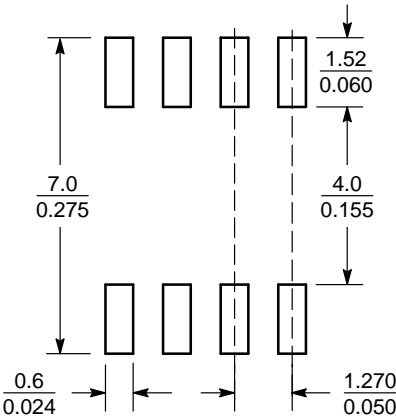
### SOIC-8 NB CASE 751-07 ISSUE AK



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: MILLIMETER.
  3. DIMENSION 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.
  6. 751-01 THRU 751-06 ARE OBSOLETE. NEW STANDARD IS 751-07.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0 °	8 °	0 °	8 °
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

### SOLDERING FOOTPRINT\*



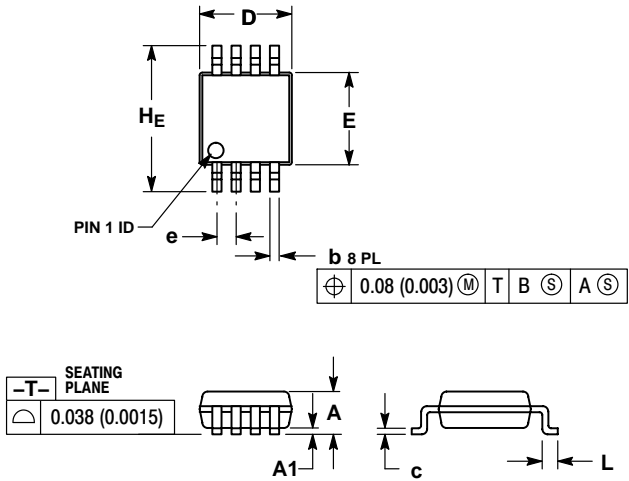
SCALE 6:1 (mm/inches)

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

# NCS325, NCS2325, NCS4325

## PACKAGE DIMENSIONS

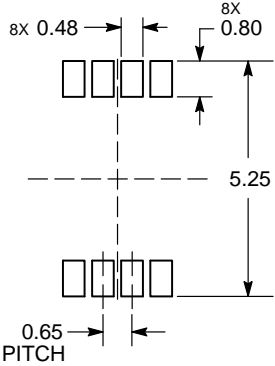
Micro8™  
CASE 846A-02  
ISSUE J



- 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, PROTRUSIONS 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. 846A-01 OBSOLETE, NEW STANDARD 846A-02.

DIM	MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	—	—	1.10	—	—	0.043
A1	0.05	0.08	0.15	0.002	0.003	0.006
b	0.25	0.33	0.40	0.010	0.013	0.016
c	0.13	0.18	0.23	0.005	0.007	0.009
D	2.90	3.00	3.10	0.114	0.118	0.122
E	2.90	3.00	3.10	0.114	0.118	0.122
e	0.65 BSC			0.026 BSC		
L	0.40	0.55	0.70	0.016	0.021	0.028
HE	4.75	4.90	5.05	0.187	0.193	0.199

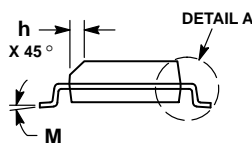
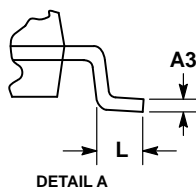
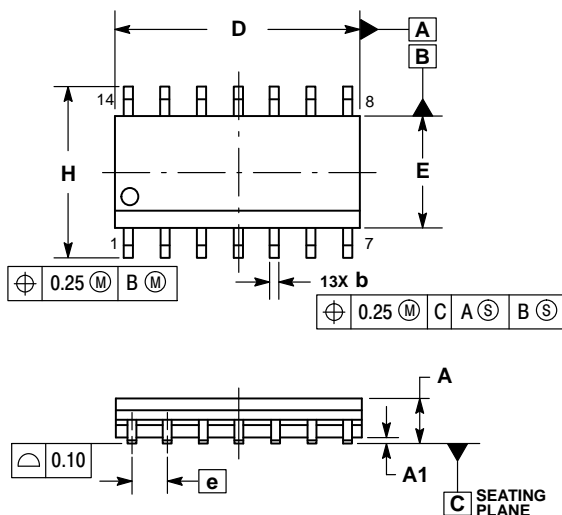
### RECOMMENDED SOLDERING FOOTPRINT\*



DIMENSION: 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.

## PACKAGE DIMENSIONS

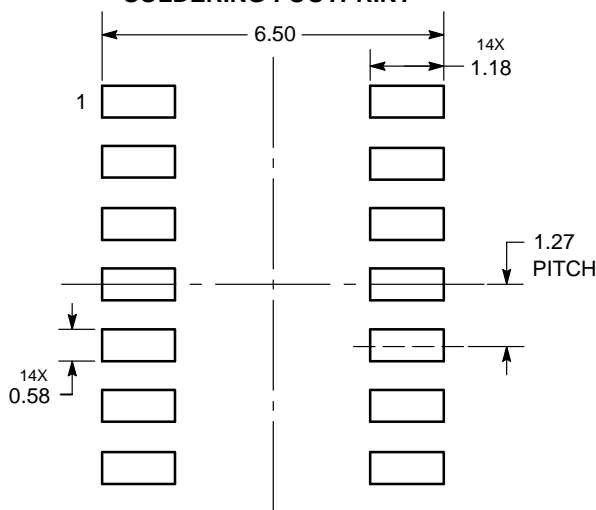
SOIC-14 NB  
CASE 751A-03  
ISSUE L

## 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.

ON Semiconductor and are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marketing.pdf](http://www.onsemi.com/site/pdf/Patent-Marketing.pdf). 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. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor 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. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor 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 ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor 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 ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor 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:

Literature Distribution Center for ON Semiconductor  
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA  
Phone: 303-675-2175 or 800-344-3860 Toll Free USA/Canada  
Fax: 303-675-2176 or 800-344-3867 Toll Free USA/Canada  
Email: [orderlit@onsemi.com](mailto:orderlit@onsemi.com)

N. American Technical Support: 800-282-9855 Toll Free  
USA/Canada  
Europe, Middle East and Africa Technical Support:  
Phone: 421 33 790 2910  
Japan Customer Focus Center  
Phone: 81-3-5817-1050

ON Semiconductor Website: [www.onsemi.com](http://www.onsemi.com)Order Literature: <http://www.onsemi.com/orderlit>

For additional information, please contact your local  
Sales Representative