

NCS333A, NCV333A, NCS2333, NCV2333, NCS4333, NCV4333, NCS333

10 μV Offset, 0.07 $\mu\text{V}/^\circ\text{C}$, Zero-Drift Operational Amplifier

The NCS333/2333/4333 family of zero-drift op amps feature offset voltage as low as 10 μV over the 1.8 V to 5.5 V supply voltage range. The zero-drift architecture reduces the offset drift to as low as 0.07 $\mu\text{V}/^\circ\text{C}$ and enables high precision measurements over both time and temperature. This family has low power consumption over a wide dynamic range and is available in space saving packages. These features make it well suited for signal conditioning circuits in portable, industrial, automotive, medical and consumer markets.

Features

- Gain-Bandwidth Product:
 - ♦ 270 kHz (NCx2333)
 - ♦ 350 kHz (NCx333/A, NCx4333)
- Low Supply Current: 17 μA (typ., at 3.3 V)
- Low Offset Voltage:
 - ♦ 10 μV max for NCS333/A
 - ♦ 30 μV max for NCV333A, NCx2333 and NCx4333
- Low Offset Drift: 0.07 $\mu\text{V}/^\circ\text{C}$ max for NCS333/A
- Wide Supply Range: 1.8 V to 5.5 V
- Wide Temperature Range: -40°C to $+125^\circ\text{C}$
- Rail-to-Rail Input and Output
- Available in Single, Dual and Quad Packages
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable

Applications

- Automotive
- Battery Powered/ Portable Application
- Sensor Signal Conditioning
- Low Voltage Current Sensing
- Filter Circuits
- Bridge Circuits
- Medical Instrumentation

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.



ON Semiconductor®

www.onsemi.com



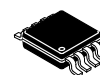
SOT23-5
SN SUFFIX
CASE 483



SC70-5
SQ SUFFIX
CASE 419A



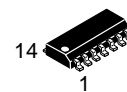
UDFN8
MU SUFFIX
CASE 517AW



MSOP-8
DM SUFFIX
CASE 846A-02



SOIC-8
D SUFFIX
CASE 751



SOIC-14
D SUFFIX
CASE 751A

DEVICE MARKING INFORMATION

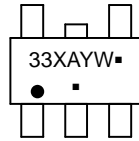
See general marking information in the device marking section on page 2 of this data sheet.

ORDERING INFORMATION

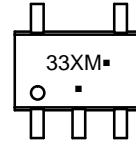
See detailed ordering and shipping information on page 3 of this data sheet.

DEVICE MARKING INFORMATION

Single Channel Configuration NCS333, NCS333A, NCV333A

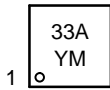


TSOP-5/SOT23-5
CASE 483

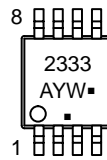


SC70-5
CASE 419A

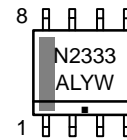
Dual Channel Configuration NCS2333, NCV2333



UDFN8, 2x2, 0.5P
CASE 517AW

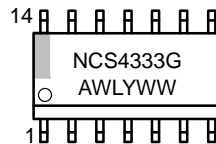


Micro8/MSOP8
CASE 846A-02



SOIC-8
CASE 751

Quad Channel Configuration NCS4333, NCV4333



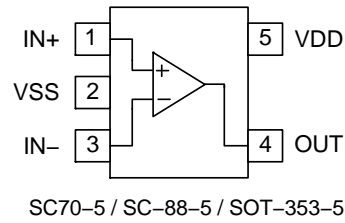
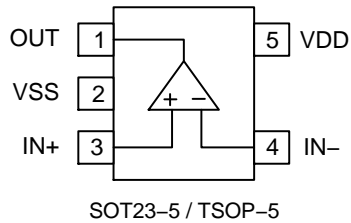
SOIC-14
CASE 751A

- X = Specific Device Code
 E = NCS333 (SOT23-5)
 H = NCS333 (SC70-5)
 G = NCS333A (SOT23-5)
 K = NCS333A (SC70-5)
 M = NCV333A (SOT23-5)
 N = NCV333A (SC70-5)
 A = Assembly Location
 Y = Year
 W = Work Week
 M = Date Code
 G or ■ = Pb-Free Package

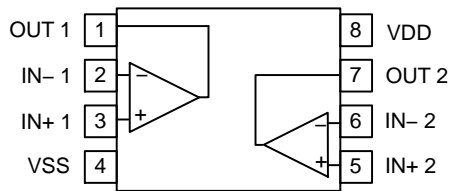
(Note: Microdot may be in either location)

PIN CONNECTIONS

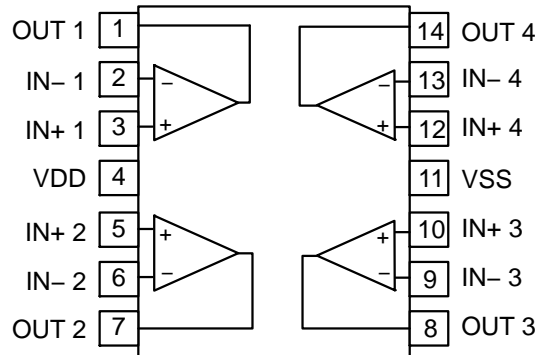
Single Channel Configuration
NCS333, NCS333A, NCV333A



Dual Channel Configuration
NCS2333, NCV2333



Quad Channel Configuration
NCS4333, NCV4333



ORDERING INFORMATION

Configuration	Automotive	Device	Package	Shipping †
Single	No	NCS333SN2T1G	SOT23-5 / TSOP-5	3000 / Tape & Reel
		NCS333ASN2T1G		3000 / Tape & Reel
		NCS333SQ3T2G	SC70-5 / SC-88-5 / SOT-353-5	3000 / Tape & Reel
		NCS333ASQ3T2G* (In Development)		3000 / Tape & Reel
	Yes	NCV333ASQ3T2G* (In Development)	SOT23-5 / TSOP-5	3000 / Tape & Reel
		NCV333ASN2T1G		3000 / Tape & Reel
Dual	No	NCS2333MUTBG* (In Development)	UDFN8	3000 / Tape & Reel
		NCS2333DR2G	SOIC-8	3000 / Tape & Reel
		NCS2333DMR2G	MICRO-8	4000 / Tape & Reel
	Yes	NCV2333DR2G	SOIC-8	3000 / Tape & Reel
		NCV2333DMR2G* (In Development)	MICRO-8	4000 / Tape & Reel
Quad	No	NCS4333DR2G	SOIC-14	2500 / Tape & Reel
	Yes	NCV4333DR2G	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

ABSOLUTE MAXIMUM RATINGS

Over operating free-air temperature, unless otherwise stated.

Parameter	Rating	Unit
Supply Voltage	7	V

INPUT AND OUTPUT PINS

Input Voltage (Note 1)	(VSS) – 0.3 to (VDD) + 0.3	V
Input Current (Note 1)	±10	mA
Output Short Circuit Current (Note 2)	Continuous	

TEMPERATURE

Operating Temperature Range	–40 to +125	°C
Storage Temperature Range	–65 to +150	°C
Junction Temperature	+150	°C

ESD RATINGS (Note 3)

Human Body Model (HBM)	4000	V
Machine Model (MM)	200	V
Charged Device Model (CDM)	2000	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.

- 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
- Short-circuit to ground.
- This device series incorporates ESD protection and is tested by the following methods:
 ESD Human Body Model tested per JEDEC standard JS-001 (AEC-Q100-002)
 ESD Machine Model tested per JEDEC standard JESD22-A115 (AEC-Q100-003)
 ESD Charged Device Model tested per JEDEC standard JESD22-C101 (AEC-Q100-011)
- Latch-up Current tested per JEDEC standard: JESD78.

THERMAL INFORMATION (Note 5)

Parameter	Symbol	Package	Value	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	SOT23–5 / TSOP5	290	°C/W
		SC70–5 / SC–88–5 / SOT–353–5	425	
		Micro8 / MSOP8	298	
		SOIC–8	250	
		UDFN8		
		SOIC–14	216	

- As mounted on an 80x80x1.5 mm FR4 PCB with 650 mm² and 2 oz (0.034 mm) thick copper heat spreader. Following JEDEC JESD/EIA 51.1, 51.2, 51.3 test guidelines

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Range	Unit
Supply Voltage (V _{DD} – V _{SS})	V _S	1.8 to 5.5	V
Specified Operating Temperature Range NCS333 NCx333A, NCx2333, NCx4333	T _A	–40 to 105	°C
		–40 to 125	
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.

NCS333A, NCV333A, NCS2333, NCV2333, NCS4333, NCV4333, NCS333

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

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

Boldface limits apply over the specified temperature range, guaranteed by characterization and/or design.

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
INPUT CHARACTERISTICS							
Offset Voltage	V _{OS}	V _S = +5 V	NCS333, NCS333A		3.5	10	μV
			NCV333A, NCx2333, NCx4333		6.0	30	
Offset Voltage Drift vs Temp	ΔV _{OS} /ΔT	NCS333, NCS333A			0.03	0.07	μV/°C
		NCV333A, V _S = 5 V			0.03	0.14	
		NCx2333, V _S = 5 V			0.04	0.07	
		NCx4333, V _S = 5 V			0.095	0.19	
Offset Voltage Drift vs Supply	ΔV _{OS} /ΔV _S	NCS333, NCS333A	Full temperature range		0.32	5	μV/V
		NCV333A	T _A = +25°C		0.40	5	
			Full temperature range			8	
		NCx2333, NCx4333	T _A = +25°C		0.32	5	
			Full temperature range			12.6	
Input Bias Current (Note 6)	I _{IB}	T _A = +25°C	NCS333, NCx333A		±60	±200	pA
			NCx2333, NCx4333		±60	±400	
		Full temperature range			±400		
Input Offset Current (Note 6)	I _{OS}	T _A = +25°C	NCS333, NCx333A		±50	±400	pA
			NCx2333, NCx4333		±50	±800	
Common Mode Rejection Ratio (Note 7)	CMRR	V _S = 1.8 V			111		dB
		V _S = 3.3 V			118		
		V _S = 5.0 V	NCS333, NCS333A, NCx2333, NCx4333	106	123		
			NCV333A	103	123		
		V _S = 5.5 V			127		
Input Resistance	R _{IN}	Differential			180		GΩ
		Common Mode			90		
Input Capacitance	C _{IN}	NCS333	Differential		2.3		pF
			Common Mode		4.6		
		NCx2333, NCx4333, NCx333A	Differential		4.1		
			Common Mode		7.9		

OUTPUT CHARACTERISTICS

Open Loop Voltage Gain	A_{VOL}	$V_{SS} + 100\text{ mV} < V_O < V_{DD} - 100\text{ mV}$	106	145		dB
Open Loop Output Impedance	Z_{out-OL}	$f = \text{UGBW}$, $I_O = 0\text{ mA}$		300		Ω
Output Voltage High, Referenced to V_{DD}	V_{OH}	$T_A = +25^\circ\text{C}$		10	50	mV
		Full temperature range			70	
Output Voltage Low, Referenced to V_{SS}	V_{OL}	$T_A = +25^\circ\text{C}$		10	50	mV
		Full temperature range			70	

6. Guaranteed by characterization and/or design

7. Specified over the full common mode range: $V_{SS} - 0.1 < V_{CM} < V_{DD} + 0.1$

NCS333A, NCV333A, NCS2333, NCV2333, NCS4333, NCV4333, NCS333

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

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

Boldface limits apply over the specified temperature range, guaranteed by characterization and/or design.

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

OUTPUT CHARACTERISTICS

Output Current Capability	I_O	Sinking Current	NCS333		25	mA
			NCx333A, NCx2333, NCx4333		11	
		Sourcing Current			5.0	
Capacitive Load Drive	C_L		See Figure 13			

NOISE PERFORMANCE

Voltage Noise Density	e_N	$f_{IN} = 1\text{ kHz}$		62		$\text{nV} / \sqrt{\text{Hz}}$
Voltage Noise	e_{P-P}	$f_{IN} = 0.1\text{ Hz to }10\text{ Hz}$		1.1		μV_{PP}
		$f_{IN} = 0.01\text{ Hz to }1\text{ Hz}$		0.5		
Current Noise Density	i_N	$f_{IN} = 10\text{ Hz}$		350		$\text{fA} / \sqrt{\text{Hz}}$
Channel Separation		NCx2333, NCx4333		135		dB

DYNAMIC PERFORMANCE

Gain Bandwidth Product	GBWP	$C_L = 100\text{ pF}$	NCS333, NCx333A, NCx4333		350	kHz
			NCx2333		270	
Gain Margin	A_M	$C_L = 100\text{ pF}$		18		dB
Phase Margin	ϕ_M	$C_L = 100\text{ pF}$		55		$^\circ$
Slew Rate	SR	$G = +1$		0.15		$\text{V}/\mu\text{s}$

POWER SUPPLY

Power Supply Rejection Ratio	PSRR	NCS333, NCS333A	Full temperature range	106	130	dB
		NCx2333, NCx4333, NCV333A	$T_A = +25^\circ\text{C}$	106	130	
			Full temperature range	98		
Turn-on Time	t_{ON}	$V_S = 5\text{ V}$			100	μs
Quiescent Current (Note 8)	I_Q	NCS333, NCS333A, NCx2333, NCx4333	$1.8\text{ V} \leq V_S \leq 3.3\text{ V}$		17	μA
					27	
			$3.3\text{ V} < V_S \leq 5.5\text{ V}$		21	
		NCV333A	$1.8\text{ V} \leq V_S \leq 3.3\text{ V}$		20	
					35	
			$3.3\text{ V} < V_S \leq 5.5\text{ V}$		28	
					45	

8. No load, per channel

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.

TYPICAL CHARACTERISTICS

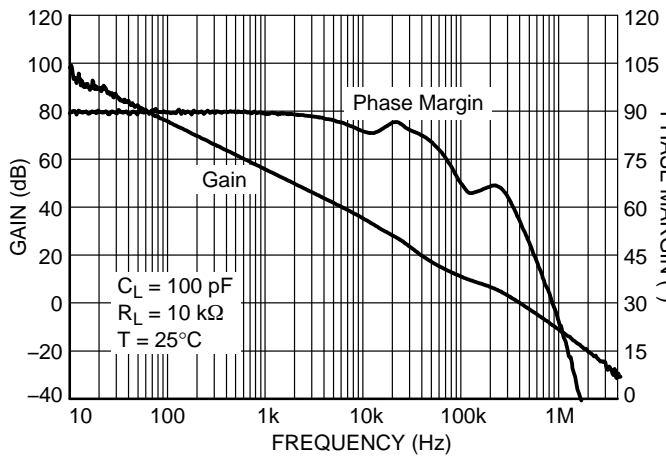


Figure 1. Open Loop Gain and Phase Margin vs. Frequency

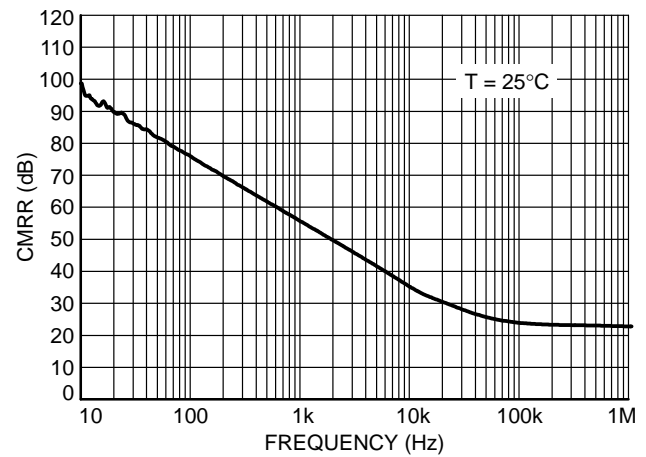


Figure 2. CMRR vs. Frequency

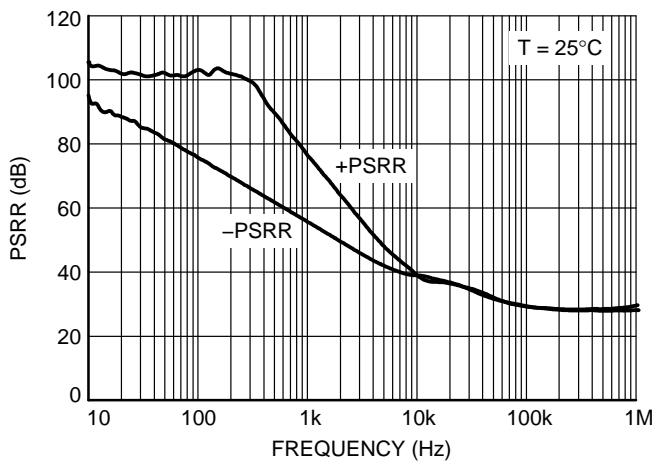


Figure 3. PSRR vs. Frequency

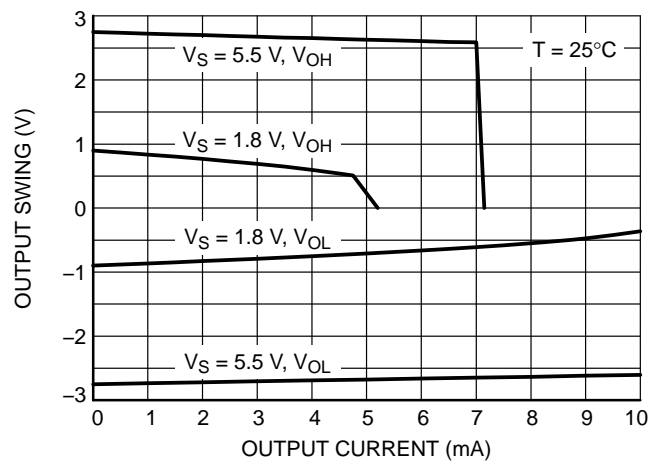


Figure 4. Output Voltage Swing vs. Output Current

TYPICAL CHARACTERISTICS

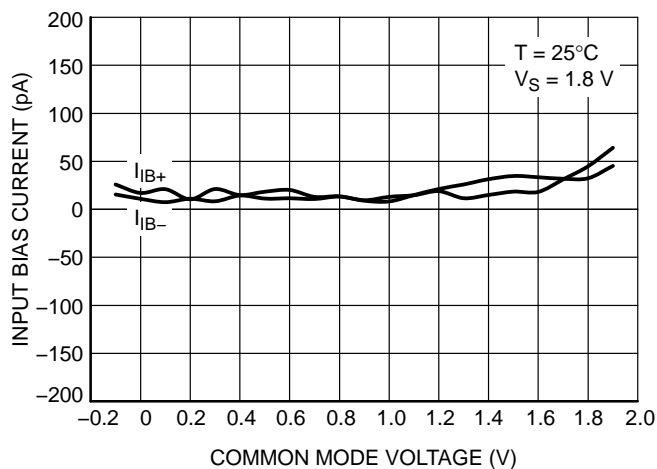


Figure 5. Input Bias Current vs. Common Mode Voltage

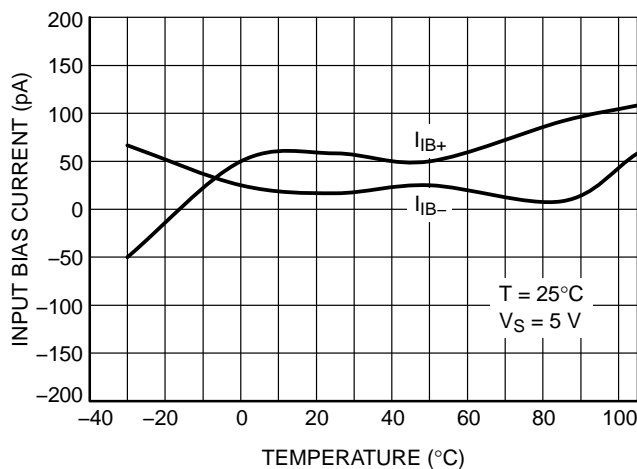


Figure 6. Input Bias Current vs. Temperature

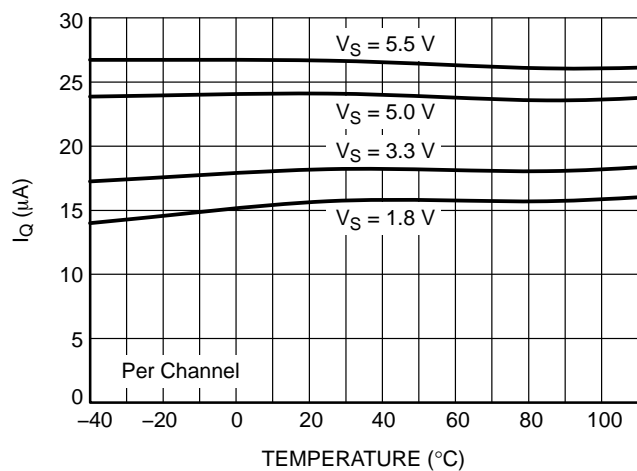


Figure 7. Quiescent Current vs. Temperature

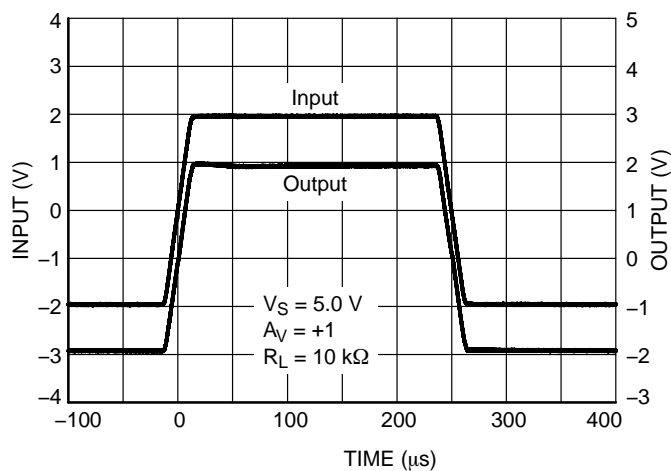


Figure 8. Large Signal Step Response

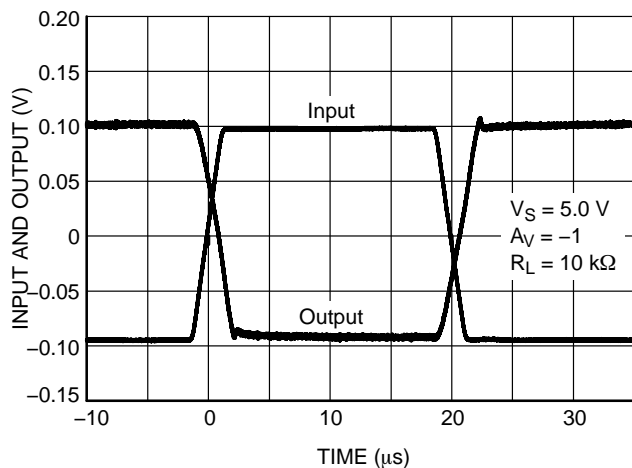


Figure 9. Small Signal Step Response

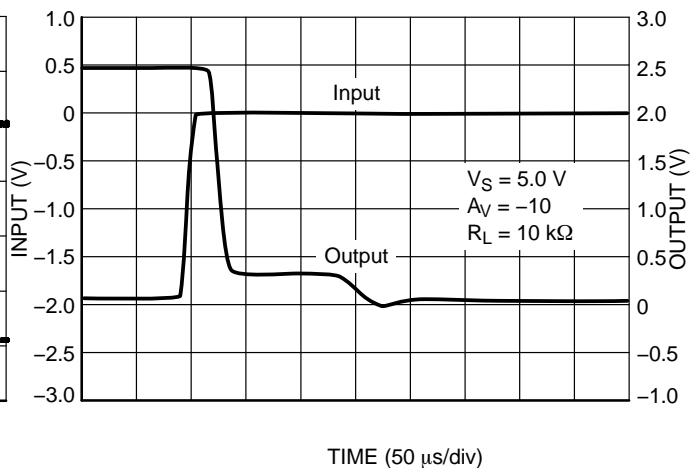


Figure 10. Positive Overvoltage Recovery

TYPICAL CHARACTERISTICS

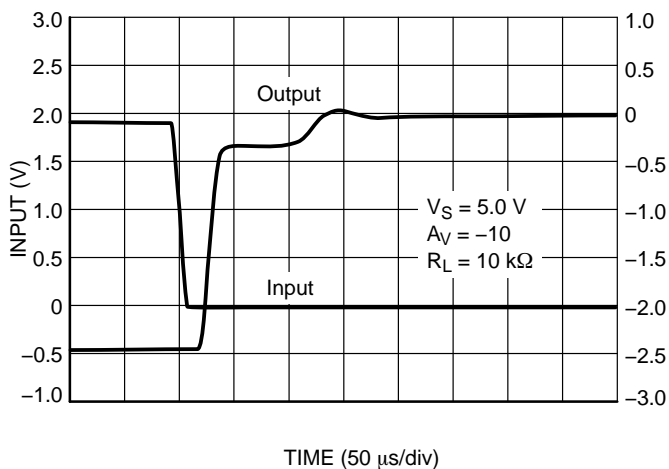


Figure 11. Negative Overvoltage Recovery

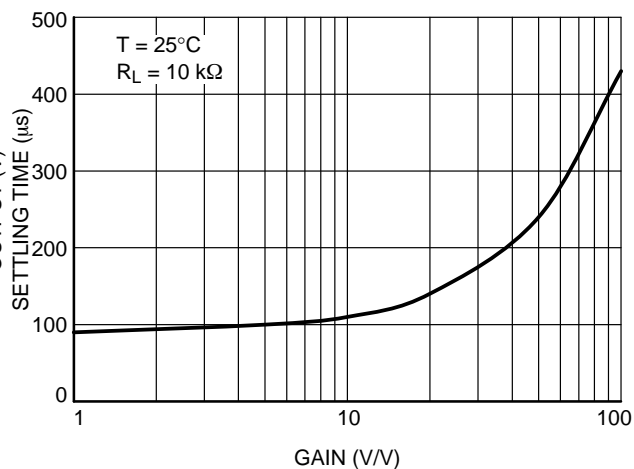


Figure 12. Settling Time to 0.1% vs. Closed-Loop Gain

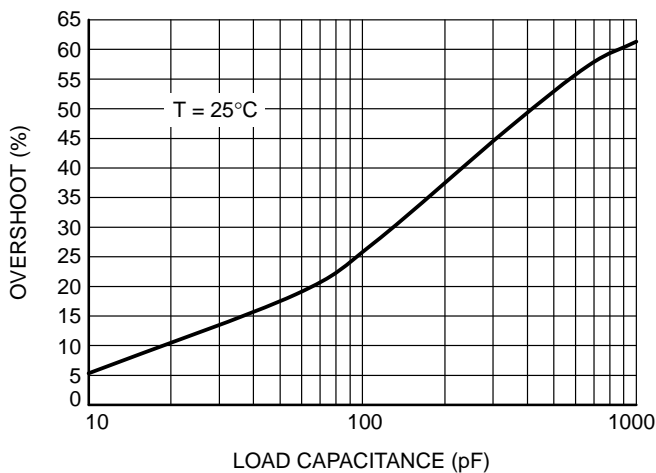


Figure 13. Small-Signal Overshoot vs. Load Capacitance

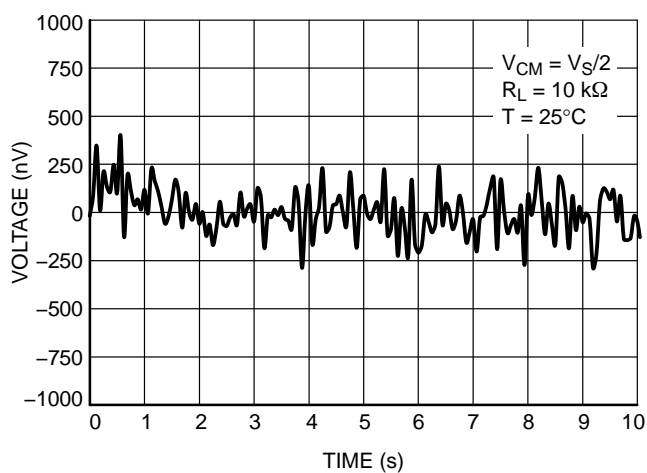


Figure 14. 0.1 Hz to 10 Hz Noise

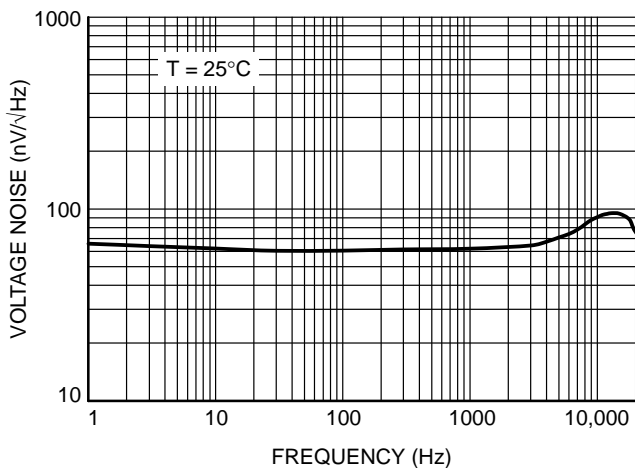


Figure 15. Voltage Noise Density vs. Frequency

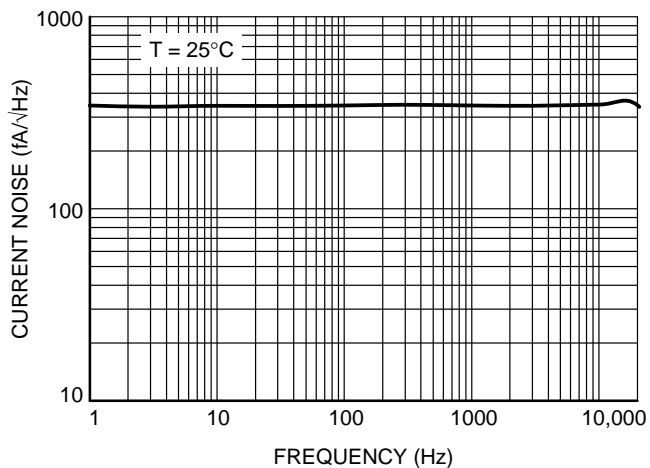


Figure 16. Current Noise Density vs. Frequency

APPLICATIONS INFORMATION

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 $100\text{ m}\Omega$

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 R_1 , R_2 , R_3 , and R_4 (where $R_1 = R_2$, $R_3 = R_4$). Precision resistors are required for high accuracy, and the gain is set to utilize the full scale of the ADC for the highest resolution.

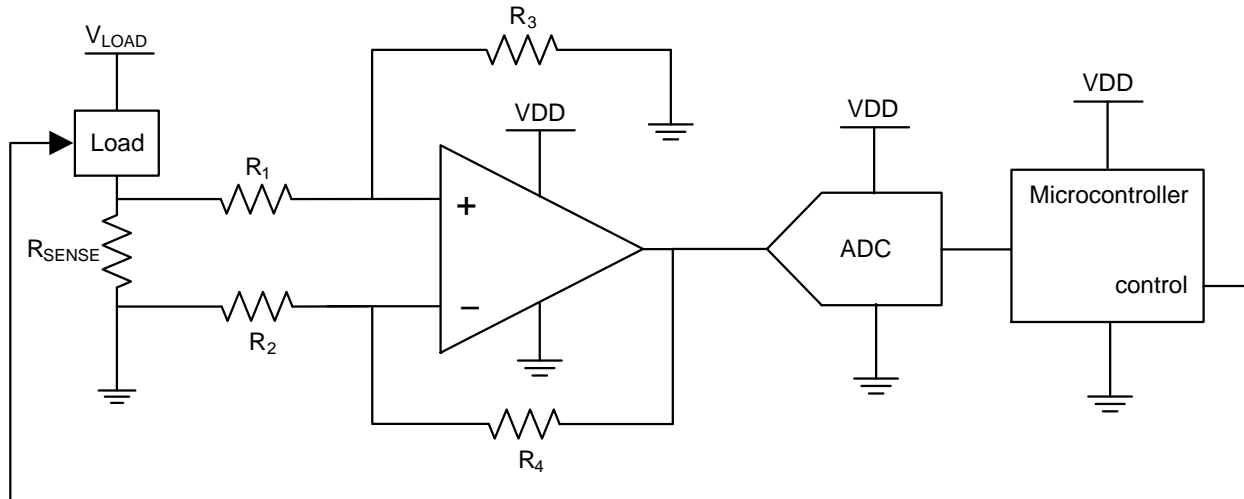


Figure 17. Low-Side Current Sensing

Differential Amplifier for Bridged Circuits

Sensors to measure strain, pressure, and temperature are often configured in a Wheatstone bridge circuit as shown in Figure 18. 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.

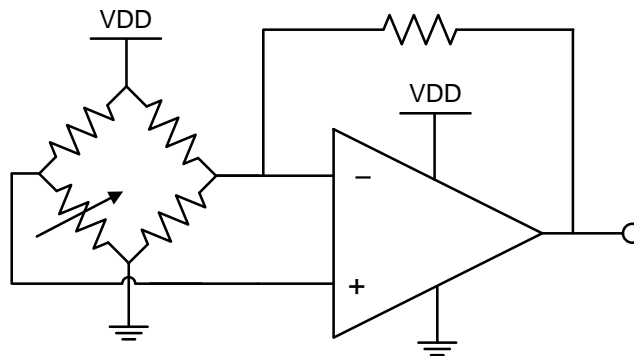


Figure 18. Bridge Circuit Amplification

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 NCS333 op amp family integrates low-pass filters to decrease sensitivity to EMI.

General Layout Guidelines

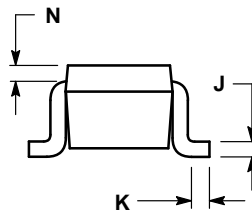
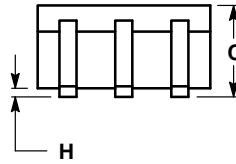
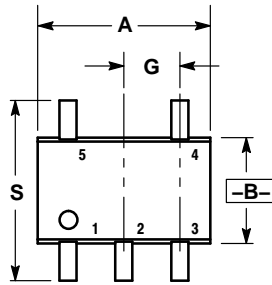
To ensure optimum device performance, it is important to follow good PCB design practices. Place $0.1\text{ }\mu\text{F}$ decoupling capacitors as close as possible to the supply pins. Keep traces short, utilize a ground plane, choose surface-mount components, and place components as close as possible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

SC-88A (SC-70-5/SOT-353)

CASE 419A-02

ISSUE L

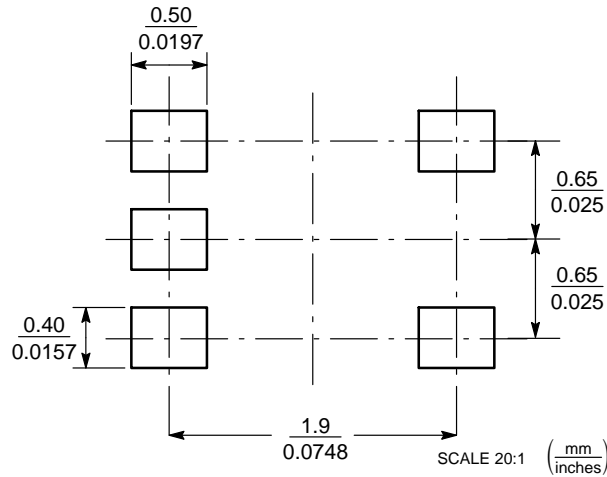


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. 419A-01 OBSOLETE. NEW STANDARD 419A-02.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.071	0.087	1.80	2.20
B	0.045	0.053	1.15	1.35
C	0.031	0.043	0.80	1.10
D	0.004	0.012	0.10	0.30
G	0.026 BSC		0.65 BSC	
H	---	0.004	---	0.10
J	0.004	0.010	0.10	0.25
K	0.004	0.012	0.10	0.30
N	0.008 REF		0.20 REF	
S	0.079	0.087	2.00	2.20

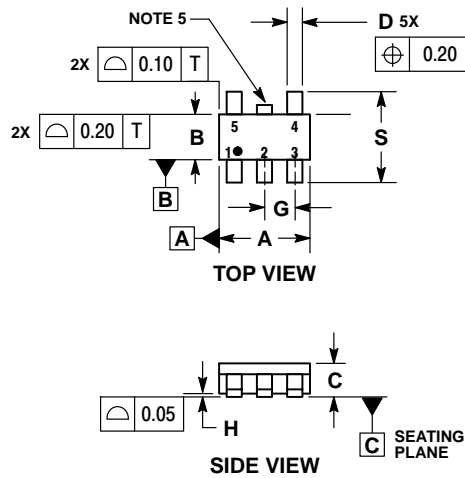
SOLDER FOOTPRINT



*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

TSOP-5
CASE 483-02
ISSUE K

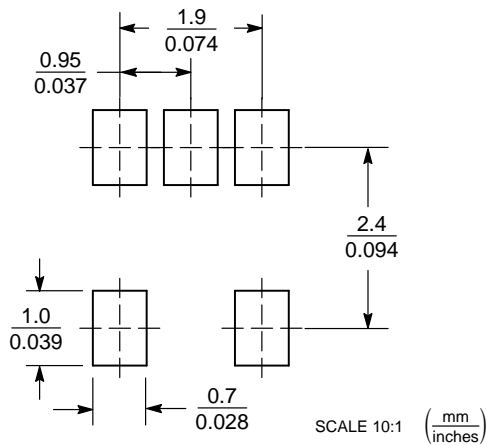


NOTES:

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

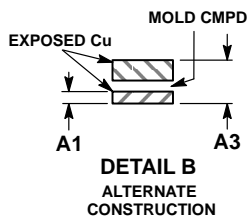
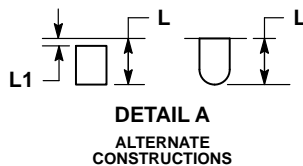
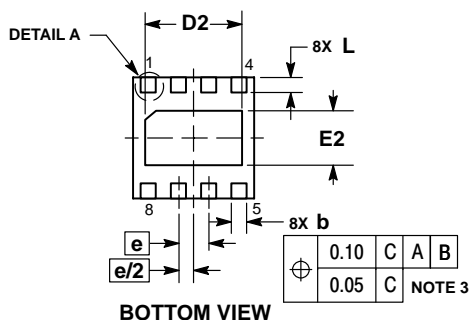
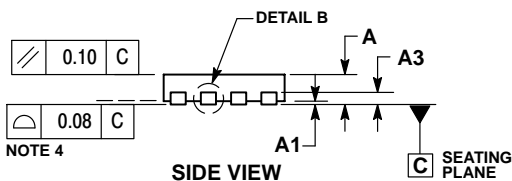
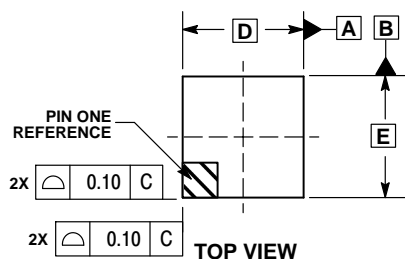
SOLDERING FOOTPRINT*



*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

UDFN8, 2x2
CASE 517AW
ISSUE A

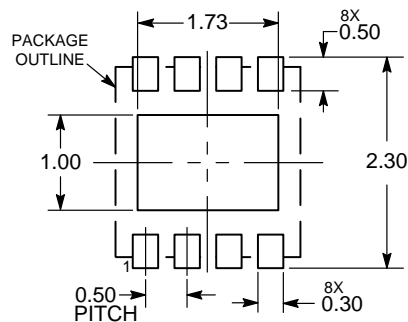


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINALS AND IS MEASURED BETWEEN 0.15 AND 0.30 MM FROM THE TERMINAL TIP.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.
5. FOR DEVICE OPN CONTAINING W OPTION, DETAIL B ALTERNATE CONSTRUCTION IS

NOT APPLICABLE		
MILLIMETERS		
DIM	MIN	MAX
A	0.45	0.55
A1	0.00	0.05
A3	0.13	REF
b	0.18	0.30
D	2.00	BSC
D2	1.50	1.70
E	2.00	BSC
E2	0.80	1.00
e	0.50	BSC
L	0.20	0.45
L1	—	0.15

RECOMMENDED
SOLDERING FOOTPRINT*

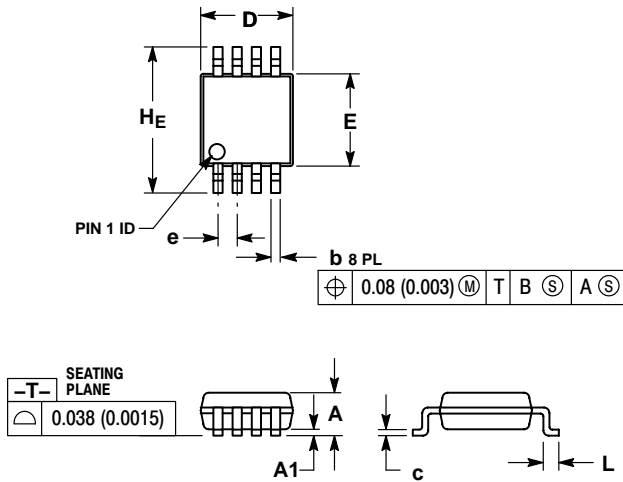


DIMENSIONS: MILLIMETERS

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

PACKAGE DIMENSIONS

Micro8™
CASE 846A-02
ISSUE J

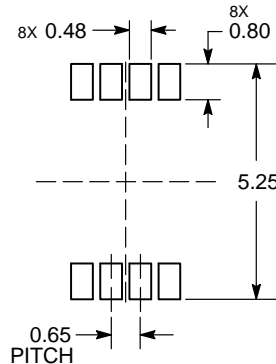


NOTES:

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*

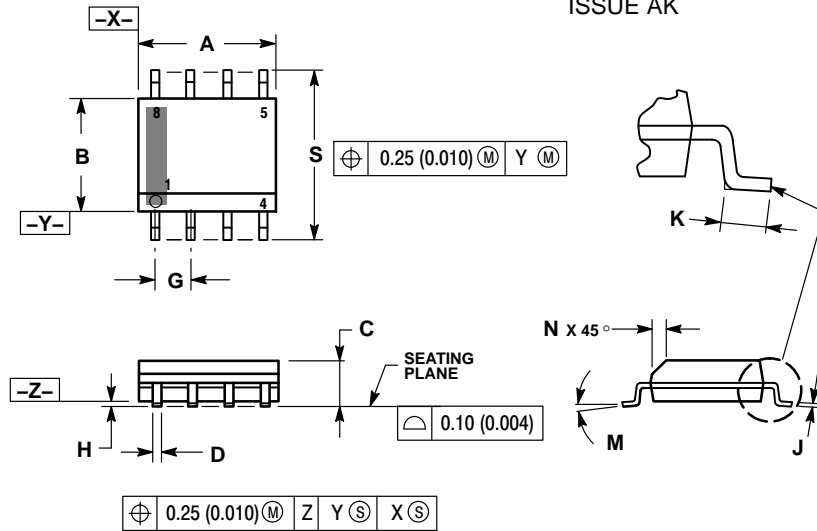


DIMENSION: MILLIMETERS

*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-8 NB
CASE 751-07
ISSUE AK

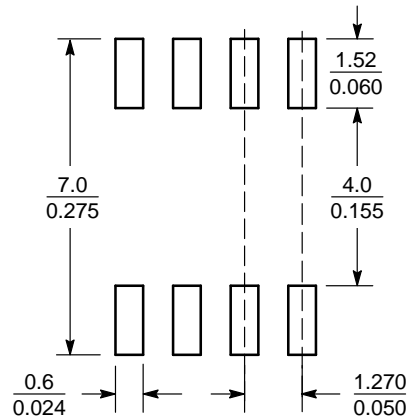


NOTES:

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
E	1.27 BSC		0.050 BSC	
F	0.10	0.25	0.004	0.010
G	0.19	0.25	0.007	0.010
H	0.40	1.27	0.016	0.050
J	0.40	1.27	0.016	0.050
K	0.40	1.27	0.016	0.050
M	0.10	0.25	0.004	0.010
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

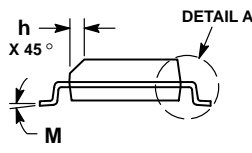
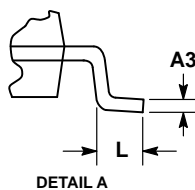
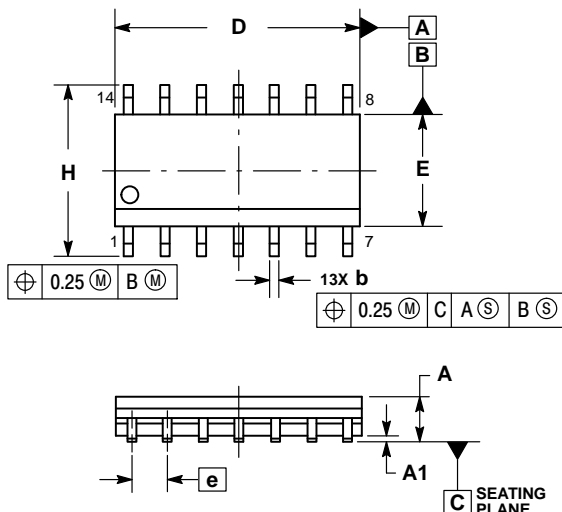
SOLDERING FOOTPRINT*



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.

PACKAGE DIMENSIONS

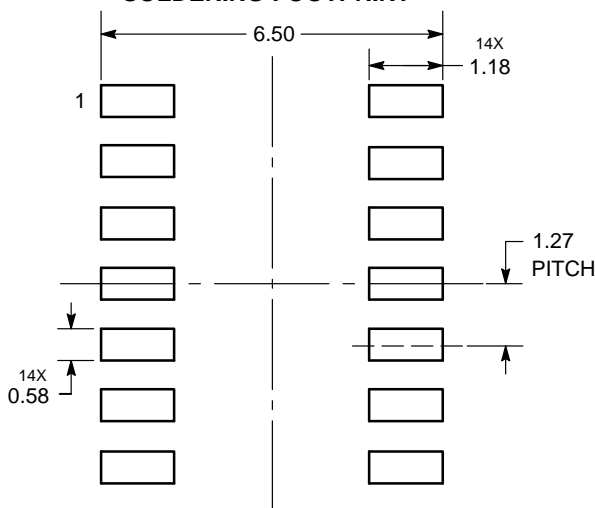
SOIC-14 NB
CASE 751A-03
ISSUE K

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. 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

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.comOrder Literature: <http://www.onsemi.com/orderlit>

For additional information, please contact your local
Sales Representative