

# NCS20071, NCS20072, NCS20074

## Rail-to-Rail Output, 3 MHz BW Operational Amplifier

The NCS2007 series operational amplifiers provide rail-to-rail output operation, 3 MHz bandwidth, and are available in single, dual, and quad configurations. Rail-to-rail operation enables the user to make optimal use of the entire supply voltage range while taking advantage of 3 MHz bandwidth. The NCS2007 can operate on supply voltages as low as 2.7 V over the temperature range of  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . At a 2.7 V supply, the high bandwidth provides a slew rate of  $2.8\text{ V}/\mu\text{s}$  while only consuming  $405\text{ }\mu\text{A}$  of quiescent current per channel. The wide supply range allows the NCS2007 to run on supply voltages as high as 36 V, making it ideal for a broad range of applications. Since this is a CMOS device, high input impedance and low bias currents make it ideal for interfacing to a wide variety of signal sensors. The NCS2007 devices are available in a variety of compact packages.

### Features

- Rail-To-Rail Output
- Wide Supply Range: 2.7 V to 36 V
- Wide Bandwidth: 3 MHz typical at  $V_S = 2.7\text{ V}$
- High Slew Rate:  $2.8\text{ V}/\mu\text{s}$  typical at  $V_S = 2.7\text{ V}$
- Low Supply Current:  $405\text{ }\mu\text{A}$  per channel at  $V_S = 2.7\text{ V}$
- Low Input Bias Current:  $5\text{ pA}$  typical
- Wide Temperature Range:  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$
- Available in a variety of packages
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

### Applications

- Current Sensing
- Signal Conditioning
- Automotive

### End Products

- Notebook Computers
- Portable Instruments
- Power Supplies



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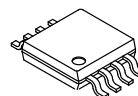
<http://onsemi.com>



**SOT-553  
CASE 463B**



**TSOP-5  
CASE 483**



**Micro8™  
CASE 846AH**



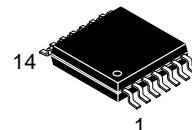
**SOIC-8  
CASE 751**



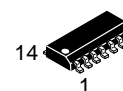
**TSSOP-8  
CASE 948S**



**UDFN8  
CASE 517AC**



**TSSOP-14  
CASE 948G**



**SOIC-14 NB  
CASE 751A**

### DEVICE MARKING INFORMATION

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

### ORDERING INFORMATION

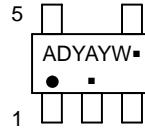
See detailed ordering and shipping information on page 4 of this data sheet.

# NCS20071, NCS20072, NCS20074

## Single Channel Configuration NCS20071, NCV20071

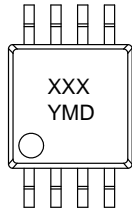


**SOT-553  
CASE 463B**

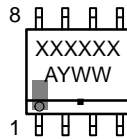


**TSOP-5  
CASE 483**

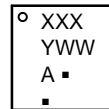
## Dual Channel Configuration NCS20072, NCV20072



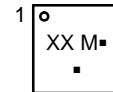
**Micro8™  
CASE 846AH**



**SOIC-8  
CASE 751**

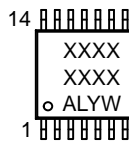


**TSSOP-8  
CASE 948S**

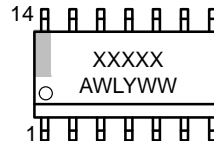


**UDFN8  
CASE 517AC**

## Quad Channel Configuration NCS20074, NCV20074



**TSSOP-14  
CASE 948G**



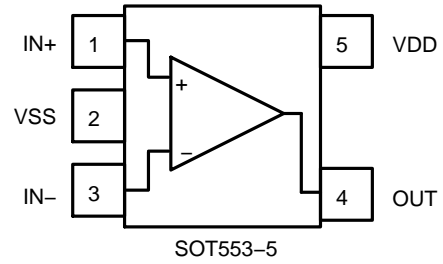
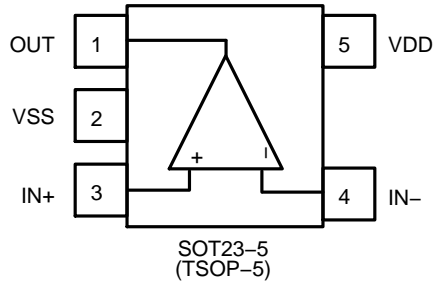
**SOIC-14 NB  
CASE 751A**

X = Specific Device Code  
A, R = Assembly Location  
Y = Year  
WW, W = Work Week  
G or ■ = Pb-Free Package

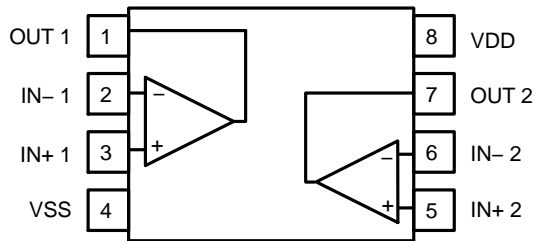
**Figure 1. Marking Diagrams**

# NCS20071, NCS20072, NCS20074

## Single Channel Configuration NCS20071, NCV20071



## Dual Channel Configuration NCS20072, NCV20072



## Quadruple Channel Configuration NCS20074, NCV20074

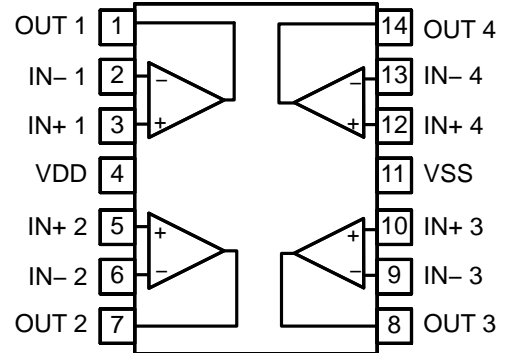


Figure 2. Pin Connections

# NCS20071, NCS20072, NCS20074

## ORDERING INFORMATION

Device	Configuration	Automotive	Marking	Package	Shipping†
NCS20071SN2T1G*	Single	No	*	SOT23-5 (TSOP-5) (Pb-Free)	3000 / Tape and Reel
NCS20071*			*	SOT553-5 (Pb-Free)	4000 / Tape and Reel
NCV20071SN2T1G*		Yes	*	SOT23-5 (TSOP-5) (Pb-Free)	3000 / Tape and Reel
NCV20071*			*	SOT553-5 (Pb-Free)	4000 / Tape and Reel
NCS20072DMR2G*	Dual	No	*	Micro8 (MSOP8) (Pb-Free)	4000 / Tape and Reel
NCS20072DR2G*			*	SOIC-8 (Pb-Free)	2500 / Tape and Reel
NCS20072DTBR2G*			*	TSSOP-8 (Pb-Free)	3000 / Tape and Reel
NCS20072*			*	UDFN8 (Pb-Free)	3000 / Tape and Reel
NCV20072DMR2G*		Yes	*	Micro8 (MSOP8) (Pb-Free)	4000 / Tape and Reel
NCV20072DR2G*			*	SOIC-8 (Pb-Free)	2500 / Tape and Reel
NCV20072DTBR2G*			*	TSSOP-8 (Pb-Free)	3000 / Tape and Reel
NCV20072*			*	UDFN8 (Pb-Free)	3000 / Tape and Reel
NCS20074DR2G	Quad	No	NCS20074	SOIC-14 (Pb-Free)	2500 / Tape and Reel
NCS20074DTBR2G			NCS20074	TSSOP-14 (Pb-Free)	2500 / Tape and Reel
NCV20074DR2G		Yes	NCS20074	SOIC-14 (Pb-Free)	2500 / Tape and Reel
NCV20074DTBR2G			NCS20074	TSSOP-14 (Pb-Free)	2500 / Tape and 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

# NCS20071, NCS20072, NCS20074

## ABSOLUTE MAXIMUM RATINGS (Note 1)

Rating	Symbol	Limit	Unit
Supply Voltage ( $V_{DD} - V_{SS}$ ) (Note 2)	$V_S$	40	V
Input Voltage	$V_I$	$V_{SS} - 0.2$ to $V_{DD} + 0.2$	V
Differential Input Voltage	$V_{ID}$	$\pm V_S$	V
Maximum Input Current	$I_I$	$\pm 10$	mA
Maximum Output Current	$I_O$	$\pm 100$	mA
Continuous Total Power Dissipation (Note 2)	$P_D$	200	mW
Maximum Junction Temperature	$T_J$	150	°C
Storage Temperature Range	$T_{STG}$	-65 to 150	°C
Mounting Temperature (Infrared or Convection – 20 sec)	$T_{mount}$	260	°C
ESD Capability (Note 3)	Human Body Model Machine Model Charged Device Model	ESD <sub>HBM</sub> ESD <sub>MM</sub> ESD <sub>CDM</sub> 2000 150 1000 (C6)	V
Latch-Up Current (Note 3)	$I_{LU}$	100	mA
Moisture Sensitivity Level (Note 3)	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. Refer to ELECTRICAL CHARACTERISTICS and APPLICATION INFORMATION for Safe Operating Area.
2. Continuous short circuit operation to ground at elevated ambient temperature can result in exceeding the maximum allowed junction temperature of 150°C. Output currents in excess of the maximum output current rating over the long term may adversely affect reliability. Shorting output to either VDD or VSS will adversely affect reliability.
3. This device series incorporates ESD protection and is tested by the following methods:  
ESD Human Body Model tested per ANSI/ANSI/ESDA/JEDEC JS-001-2010 (AEC-Q100-002)  
ESD Machine Model tested per JESD22-A115 (AEC-Q100-003)  
ESD Charged Device Model tested per ANSI/ESD S5.3.1-2009 (AEC-Q100-011)
4. Latch-up Current tested per JEDEC standard: JESD78 (AEC-Q100-004)
5. Moisture Sensitivity Level tested per IPC/JEDEC standard: J-STD-020A

## THERMAL INFORMATION

Parameter	Symbol	Package	Value	Unit
Junction-to-Ambient	$\theta_{JA}$	SOT23-5/ TSOP5	235	°C/W
		SOT553-5	250	
		Micro8/MSOP8	238	
		SOIC-8	190	
		TSSOP-8	140	
		UDFN-8	350	
		SOIC-14	156	
		TSSOP-14	190	

## OPERATING RANGES

Parameter	Symbol	Min	Max	Unit
Operating Supply Voltage	$V_S$	2.7	36	V
Differential Input Voltage	$V_{ID}$		$V_S$	V
Input Common Mode Range	$V_{ICM}$	$V_{SS}$	$V_{DD} - 1.35$	V
Ambient Temperature	$T_A$	-40	125	°C

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.

# NCS20071, NCS20072, NCS20074

## ELECTRICAL CHARACTERISTICS AT $V_S = 2.7\text{ V}$

$T_A = 25^\circ\text{C}$ ;  $R_L \geq 10\text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid-supply}$  unless otherwise noted. All limits are guaranteed by testing or statistical analysis.

**Boldface** limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ . (Notes 6, 7)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
<b>INPUT CHARACTERISTICS</b>						
Input Offset Voltage	$V_{OS}$			1.3	$\pm 3$	mV
					<b><math>\pm 4</math></b>	mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	$T_A = 25^\circ\text{C}$ to $125^\circ\text{C}$		2		$\mu\text{V}/^\circ\text{C}$
Input Bias Current	$I_{IB}$	Note 7		5	200	pA
					<b>1500</b>	pA
Input Offset Current	$I_{OS}$	Note 7		2	75	pA
					<b>175</b>	pA
Channel Separation	XTLK	DC		115		dB
Differential Input Resistance	$R_{ID}$			50		$\text{G}\Omega$
Common Mode Input Resistance	$R_{IN}$			5		$\text{G}\Omega$
Differential Input Capacitance	$C_{ID}$			1.5		pF
Common Mode Input Capacitance	$C_{CM}$			3.5		pF
Common Mode Rejection Ratio	CMRR	$V_{CM} = 0\text{ V}$ to $V_{DD} - 1.35\text{ V}$	90	110		dB
			<b>69</b>			

## OUTPUT CHARACTERISTICS

Open Loop Voltage Gain	$A_{VOL}$		96	118		dB
			<b>86</b>			
Output Current Capability	$I_O$	Op amp sinking current		70		mA
		Op amp sourcing current		50		
Output Voltage High	$V_{OH}$	Voltage output swing from positive rail		0.006	0.15	V
					<b>0.22</b>	
Output Voltage Low	$V_{OL}$	Voltage output swing from negative rail		0.005	0.15	V
					<b>0.22</b>	

## AC CHARACTERISTICS

Unity Gain Bandwidth	UGBW	$C_L = 25\text{ pF}$		3		MHz
Slew Rate at Unity Gain	SR	$C_L = 20\text{ pF}$		2.8		$\text{V}/\mu\text{s}$
Phase Margin	$\varphi_m$	$C_L = 25\text{ pF}$		50		$^\circ$
Gain Margin	$A_m$	$C_L = 25\text{ pF}$		14		dB
Settling Time	$t_s$	$V_O = 1\text{ Vpp}$ , Gain = 1, $C_L = 20\text{ pF}$	Settling time to 0.1%	0.6		$\mu\text{s}$
			Settling time to 0.01%	1.2		

## NOISE CHARACTERISTICS

Total Harmonic Distortion plus Noise	THD+N	$V_{IN} = 0.5\text{ Vpp}$ , $f = 1\text{ kHz}$ , $A_v = 1$		0.05		%
Input Referred Voltage Noise	$e_n$	$f = 1\text{ kHz}$		30		$\text{nV}/\sqrt{\text{Hz}}$
		$f = 10\text{ kHz}$		20		
Input Referred Current Noise	$i_n$	$f = 1\text{ kHz}$		0.25		$\text{fA}/\sqrt{\text{Hz}}$

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.

6. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.

7. Performance guaranteed over the indicated operating temperature range by design and/or characterization.

# NCS20071, NCS20072, NCS20074

## ELECTRICAL CHARACTERISTICS AT $V_S = 2.7\text{ V}$

$T_A = 25^\circ\text{C}$ ;  $R_L \geq 10\text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid-supply}$  unless otherwise noted. All limits are guaranteed by testing or statistical analysis.

**Boldface** limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ . (Notes 6, 7)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
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### SUPPLY CHARACTERISTICS

Power Supply Rejection Ratio	PSRR	No Load		114	135	dB
				<b>100</b>		
Power Supply Quiescent Current	$I_{DD}$	Per channel, no load			405	$\mu\text{A}$
					<b>625</b>	

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.

6. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.

7. Performance guaranteed over the indicated operating temperature range by design and/or characterization.

## ELECTRICAL CHARACTERISTICS AT $V_S = 5\text{ V}$

$T_A = 25^\circ\text{C}$ ;  $R_L \geq 10\text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid-supply}$  unless otherwise noted. All limits are guaranteed by testing or statistical analysis.

**Boldface** limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ . (Notes 8, 9)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
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### INPUT CHARACTERISTICS

Input Offset Voltage	$V_{OS}$			1.3	$\pm 3$	mV
					<b><math>\pm 4</math></b>	mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	$T_A = 25^\circ\text{C}$ to $125^\circ\text{C}$		2		$\mu\text{V}/^\circ\text{C}$
Input Bias Current	$I_{IB}$	Note 9		5	200	pA
					<b>1500</b>	<b>pA</b>
Input Offset Current	$I_{OS}$	Note 9		2	75	pA
					175	pA
Channel Separation	XTLK	DC		115		dB
Differential Input Resistance	$R_{ID}$			50		$\text{G}\Omega$
Common Mode Input Resistance	$R_{IN}$			5		$\text{G}\Omega$
Differential Input Capacitance	$C_{ID}$			1.5		pF
Common Mode Input Capacitance	$C_{CM}$			3.5		pF
Common Mode Rejection Ratio	CMRR	$V_{CM} = 0\text{ V}$ to $V_{DD} - 1.35\text{ V}$	105	125		dB
			80			

### OUTPUT CHARACTERISTICS

Open Loop Voltage Gain	$A_{VOL}$		96	120		dB
			<b>86</b>			
Output Current Capability	$I_O$	Op amp sinking current		50		mA
		Op amp sourcing current		60		
Output Voltage High	$V_{OH}$	Voltage output swing from positive rail		0.013	0.20	V
					<b>0.25</b>	
Output Voltage Low	$V_{OL}$	Voltage output swing from negative rail		0.01	0.10	V
					<b>0.15</b>	

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.

8. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.

9. Performance guaranteed over the indicated operating temperature range by design and/or characterization.

# NCS20071, NCS20072, NCS20074

## ELECTRICAL CHARACTERISTICS AT $V_S = 5\text{ V}$

$T_A = 25^\circ\text{C}$ ;  $R_L \geq 10\text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid-supply}$  unless otherwise noted. All limits are guaranteed by testing or statistical analysis.  
**Boldface** limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ . (Notes 8, 9)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
<b>AC CHARACTERISTICS</b>						
Unity Gain Bandwidth	UGBW	$C_L = 25\text{ pF}$		3.2		MHz
Slew Rate at Unity Gain	SR	$C_L = 20\text{ pF}$		2.7		V/ $\mu\text{s}$
Phase Margin	$\varphi_m$	$C_L = 25\text{ pF}$		50		°
Gain Margin	$A_m$	$C_L = 25\text{ pF}$		14		dB
Settling Time	$t_s$	$V_O = 3\text{ Vpp}$ , Gain = 1, $C_L = 20\text{ pF}$	Settling time to 0.1%	1.2		$\mu\text{s}$
			Settling time to 0.01%	5.6		

## NOISE CHARACTERISTICS

Total Harmonic Distortion plus Noise	THD+N	$V_{IN} = 2.5\text{ Vpp}$ , $f = 1\text{ kHz}$ , $A_v = 1$		0.009		%
Input Referred Voltage Noise	$e_n$	$f = 1\text{ kHz}$		30		$\text{nV}/\sqrt{\text{Hz}}$
		$f = 10\text{ kHz}$		20		
Input Referred Current Noise	$i_n$	$f = 1\text{ kHz}$		0.25		$\text{fA}/\sqrt{\text{Hz}}$

## SUPPLY CHARACTERISTICS

Power Supply Rejection Ratio	PSRR	No Load	114	135		dB
			<b>100</b>			
Power Supply Quiescent Current	$I_{DD}$	Per channel, no load		410	530	$\mu\text{A}$
					<b>630</b>	

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.

8. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.

9. Performance guaranteed over the indicated operating temperature range by design and/or characterization.

## ELECTRICAL CHARACTERISTICS AT $V_S = 10\text{ V}$

$T_A = 25^\circ\text{C}$ ;  $R_L \geq 10\text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid-supply}$  unless otherwise noted. All limits are guaranteed by testing or statistical analysis.  
**Boldface** limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ . (Notes 10, 11)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
<b>INPUT CHARACTERISTICS</b>						
Input Offset Voltage	$V_{OS}$			1.3	$\pm 3$	mV
					<b><math>\pm 4</math></b>	<b>mV</b>
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	$T_A = 25^\circ\text{C}$ to $125^\circ\text{C}$		2		$\mu\text{V}/^\circ\text{C}$
Input Bias Current	$I_{IB}$	Note 11		5	200	pA
					<b>1500</b>	<b>pA</b>
Input Offset Current	$I_{OS}$	Note 11		2	75	pA
					<b>175</b>	<b>pA</b>
Channel Separation	XTLK	DC		115		dB
Differential Input Resistance	$R_{ID}$			50		$\text{G}\Omega$
Common Mode Input Resistance	$R_{IN}$			5		$\text{G}\Omega$
Differential Input Capacitance	$C_{ID}$			1.5		pF
Common Mode Input Capacitance	$C_{CM}$			3.5		pF

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.

10. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.

11. Performance guaranteed over the indicated operating temperature range by design and/or characterization.



# NCS20071, NCS20072, NCS20074

## ELECTRICAL CHARACTERISTICS AT $V_S = 10\text{ V}$

$T_A = 25^\circ\text{C}$ ;  $R_L \geq 10\text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid-supply}$  unless otherwise noted. All limits are guaranteed by testing or statistical analysis. Boldface limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ . (Notes 10, 11)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
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### INPUT CHARACTERISTICS

Common Mode Rejection Ratio	CMRR	$V_{CM} = 0\text{ V to }V_{DD} - 1.35\text{ V}$	110	130		dB
			<b>87</b>			

### OUTPUT CHARACTERISTICS

Open Loop Voltage Gain	$A_{VOL}$		98	120		dB
			<b>88</b>			
Output Current Capability	$I_O$	Op amp sinking current		50		mA
		Op amp sourcing current		65		
Output Voltage High	$V_{OH}$	Voltage output swing from positive rail		0.023	0.08	V
					<b>0.10</b>	
Output Voltage Low	$V_{OL}$	Voltage output swing from negative rail		0.022	0.3	V
					<b>0.35</b>	

### AC CHARACTERISTICS

Unity Gain Bandwidth	UGBW	$C_L = 25\text{ pF}$		3.2		MHz
Slew Rate at Unity Gain	SR	$C_L = 20\text{ pF}$		2.2		V/ $\mu\text{s}$
Phase Margin	$\varphi_m$	$C_L = 25\text{ pF}$		50		°
Gain Margin	$A_m$	$C_L = 25\text{ pF}$		14		dB
Settling Time	$t_s$	$V_O = 8.5\text{ Vpp}$ , Gain = 1, $C_L = 20\text{ pF}$	Settling time to 0.1%	3.4		$\mu\text{s}$
			Settling time to 0.01%	6.8		

### NOISE CHARACTERISTICS

Total Harmonic Distortion plus Noise	THD+N	$V_{IN} = 7.5\text{ Vpp}$ , $f = 1\text{ kHz}$ , $A_v = 1$		0.004		%
Input Referred Voltage Noise	$e_n$	$f = 1\text{ kHz}$		30		nV/ $\sqrt{\text{Hz}}$
		$f = 10\text{ kHz}$		20		
Input Referred Current Noise	$i_n$	$f = 1\text{ kHz}$		0.25		fA/ $\sqrt{\text{Hz}}$

### SUPPLY CHARACTERISTICS

Power Supply Rejection Ratio	PSRR	No Load	114	135		dB
			<b>100</b>			
Power Supply Quiescent Current	$I_{DD}$	Per channel, no load		416	540	$\mu\text{A}$
					<b>640</b>	

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.

10. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.

11. Performance guaranteed over the indicated operating temperature range by design and/or characterization.

# NCS20071, NCS20072, NCS20074

## ELECTRICAL CHARACTERISTICS AT $V_S = 36\text{ V}$

$T_A = 25^\circ\text{C}$ ;  $R_L \geq 10\text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid-supply}$  unless otherwise noted. All limits are guaranteed by testing or statistical analysis. Boldface limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ . (Notes 12, 13)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
<b>INPUT CHARACTERISTICS</b>						
Input Offset Voltage	$V_{OS}$			1.3	$\pm 3$	mV
					<b><math>\pm 4</math></b>	<b>mV</b>
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	$T_A = 25^\circ\text{C}$ to $125^\circ\text{C}$		2		$\mu\text{V}/^\circ\text{C}$
Input Bias Current	$I_{IB}$	Note 13		5	200	pA
					<b>1500</b>	<b>pA</b>
Input Offset Current	$I_{OS}$	Note 13		2	75	pA
					<b>175</b>	<b>pA</b>
Channel Separation	XTLK	DC		115		dB
Differential Input Resistance	$R_{ID}$			50		$\text{G}\Omega$
Common Mode Input Resistance	$R_{IN}$			5		$\text{G}\Omega$
Differential Input Capacitance	$C_{ID}$			1.5		pF
Common Mode Input Capacitance	$C_{CM}$			3.5		pF
Common Mode Rejection Ratio	CMRR	$V_{CM} = 0\text{ V}$ to $V_{DD} - 1.35\text{ V}$	120	145		dB
			<b>95</b>			

## OUTPUT CHARACTERISTICS

Open Loop Voltage Gain	$A_{VOL}$		98	120		dB
			<b>88</b>			
Output Current Capability	$I_O$	Op amp sinking current		50		mA
		Op amp sourcing current		65		
Output Voltage High	$V_{OH}$	Voltage output swing from positive rail		0.074	0.10	V
					<b>0.12</b>	
Output Voltage Low	$V_{OL}$	Voltage output swing from negative rail		0.065	0.3	V
					<b>0.35</b>	

## AC CHARACTERISTICS

Unity Gain Bandwidth	UGBW	$C_L = 25\text{ pF}$		3.2		MHz
Slew Rate at Unity Gain	SR	$C_L = 20\text{ pF}$		2.4		$\text{V}/\mu\text{s}$
Phase Margin	$\varphi_m$	$C_L = 25\text{ pF}$		50		$^\circ$
Gain Margin	$A_m$	$C_L = 25\text{ pF}$		14		dB
Settling Time	$t_s$	$V_O = 10\text{ Vpp}$ , Gain = 1, $C_L = 20\text{ pF}$	Settling time to 0.1%	3.2		$\mu\text{s}$
			Settling time to 0.01%	6.8		

## NOISE CHARACTERISTICS

Total Harmonic Distortion plus Noise	THD+N	$V_{IN} = 28.5\text{ Vpp}$ , $f = 1\text{ kHz}$ , $A_v = 1$		0.001		%
Input Referred Voltage Noise	$e_n$	$f = 1\text{ kHz}$		30		$\text{nV}/\sqrt{\text{Hz}}$
		$f = 10\text{ kHz}$		20		
Input Referred Current Noise	$i_n$	$f = 1\text{ kHz}$		0.25		$\text{fA}/\sqrt{\text{Hz}}$

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.

12. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.

13. Performance guaranteed over the indicated operating temperature range by design and/or characterization.

## NCS20071, NCS20072, NCS20074

### ELECTRICAL CHARACTERISTICS AT $V_S = 36\text{ V}$

$T_A = 25^\circ\text{C}$ ;  $R_L \geq 10\text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid-supply}$  unless otherwise noted. All limits are guaranteed by testing or statistical analysis. Boldface limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ . (Notes 12, 13)

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

#### SUPPLY CHARACTERISTICS

Power Supply Rejection Ratio	PSRR	No Load	114	135		dB
			<b>100</b>			
Power Supply Quiescent Current	$I_{DD}$	Per channel, no load		465	600	$\mu\text{A}$
					<b>700</b>	

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.

12. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.

13. Performance guaranteed over the indicated operating temperature range by design and/or characterization.

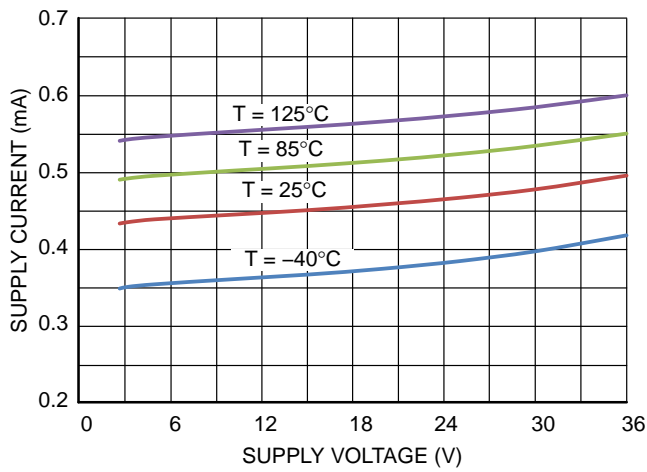


Figure 3. Quiescent Current Per Channel vs. Supply Voltage

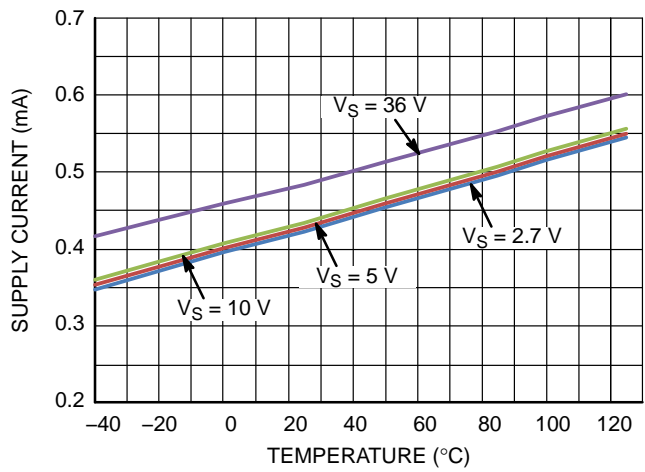


Figure 4. Quiescent Current vs. Temperature

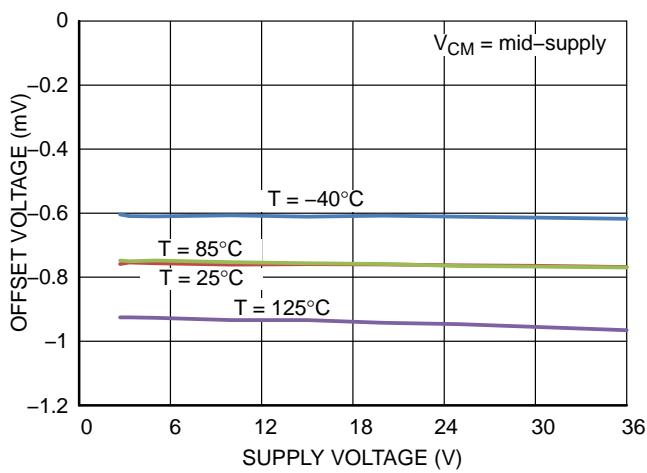


Figure 5. Offset Voltage vs. Supply Voltage

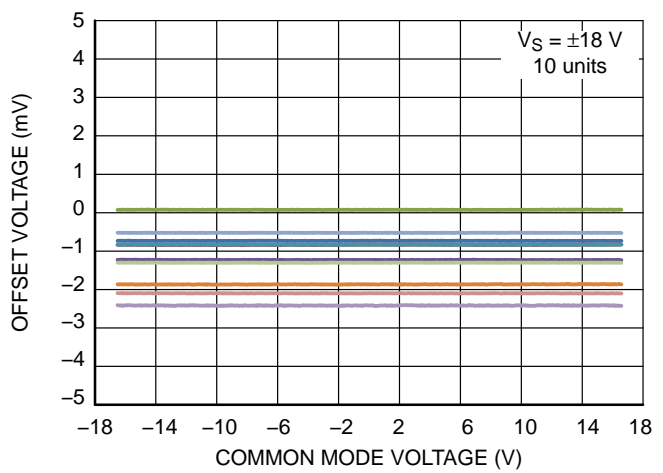


Figure 6. Input Offset Voltage vs. Common Mode Voltage

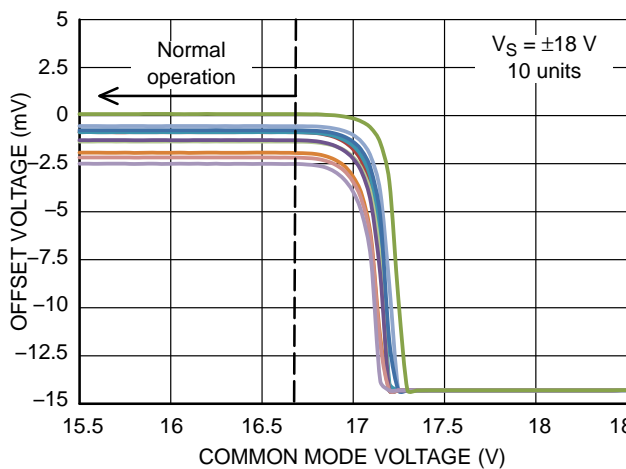


Figure 7. Input Offset Voltage vs. Common Mode Voltage

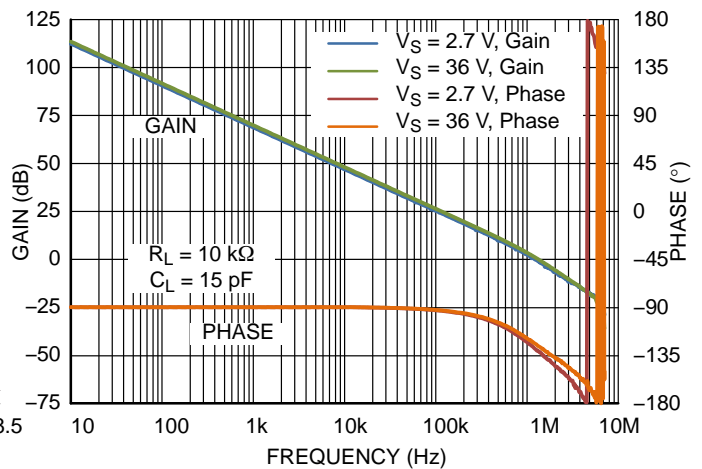


Figure 8. Gain and Phase vs. Frequency

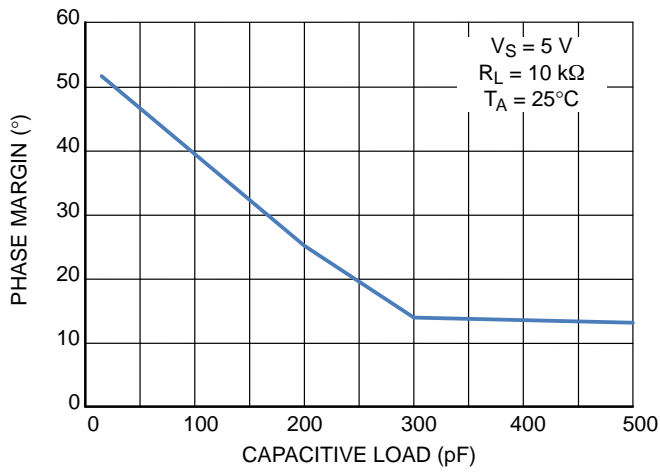


Figure 9. Phase Margin vs. Capacitive Load

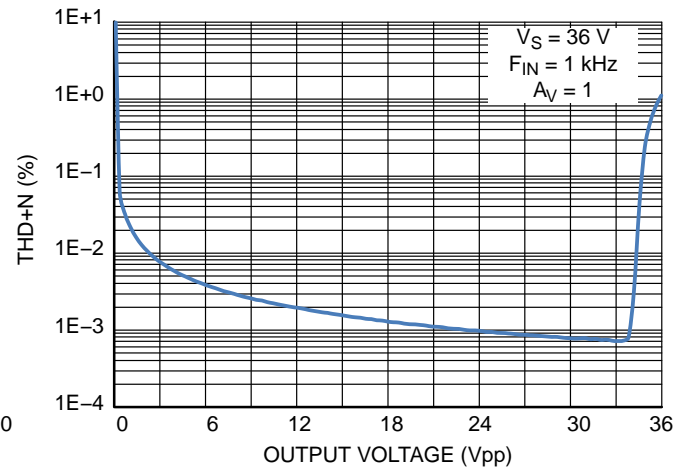


Figure 10. THD+N vs. Output Voltage

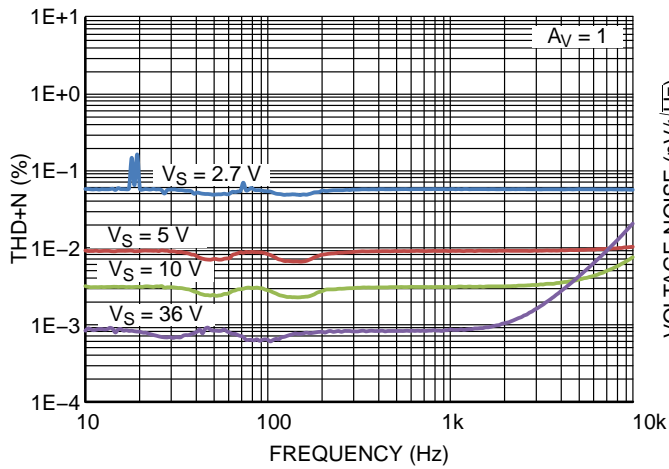


Figure 11. THD+N vs. Frequency

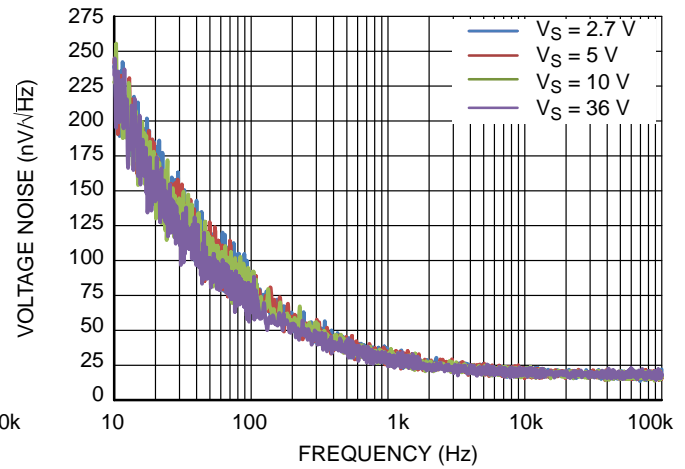


Figure 12. Input Voltage Noise vs. Frequency

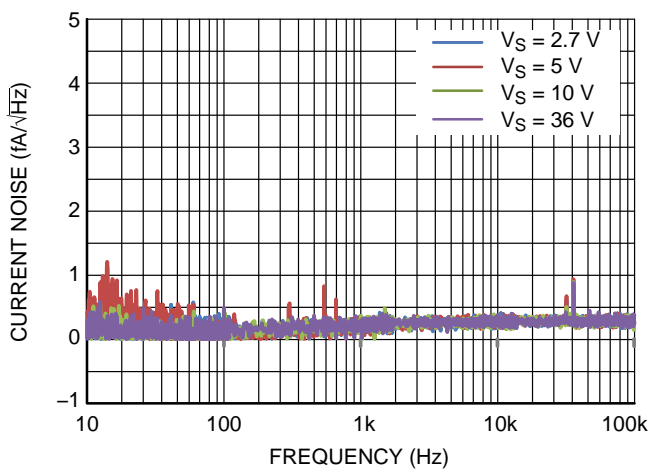


Figure 13. Input Current Noise vs. Frequency

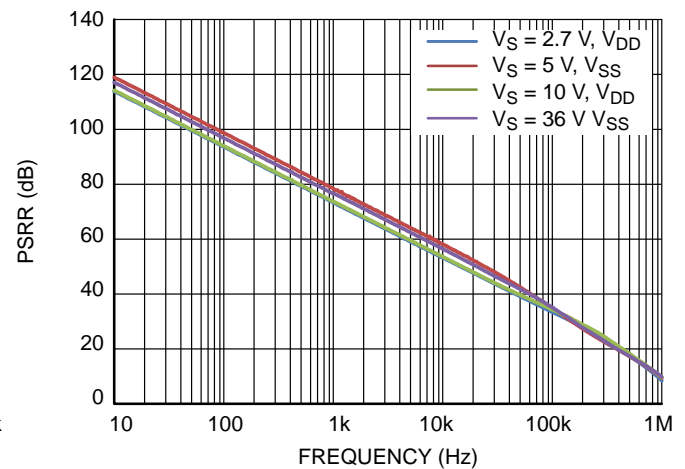


Figure 14. PSRR vs. Frequency

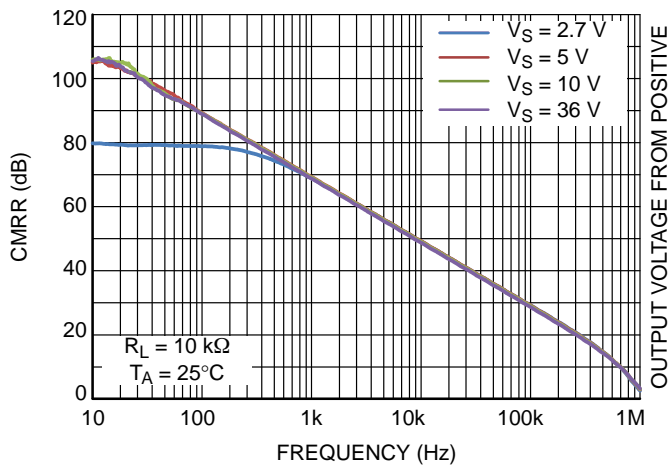


Figure 15. CMRR vs. Frequency

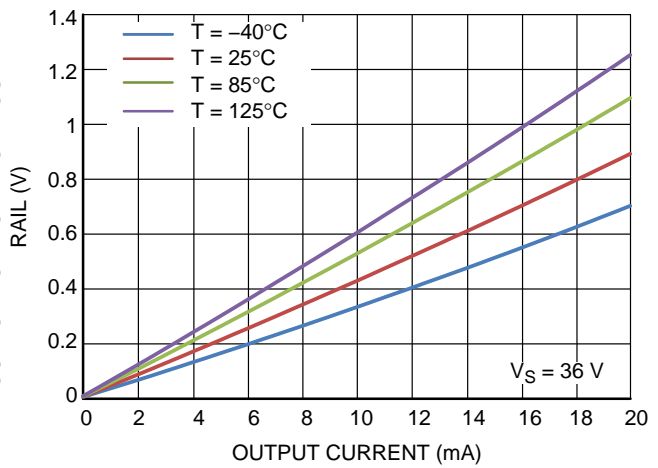


Figure 16. High Level Output vs. Output Current

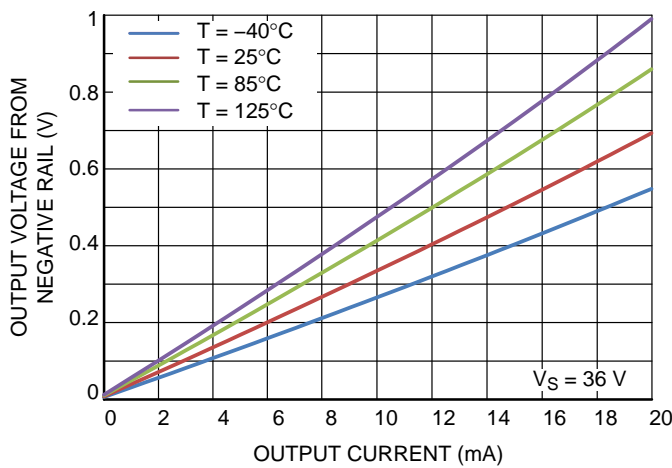


Figure 17. Low Level Output vs. Output Current

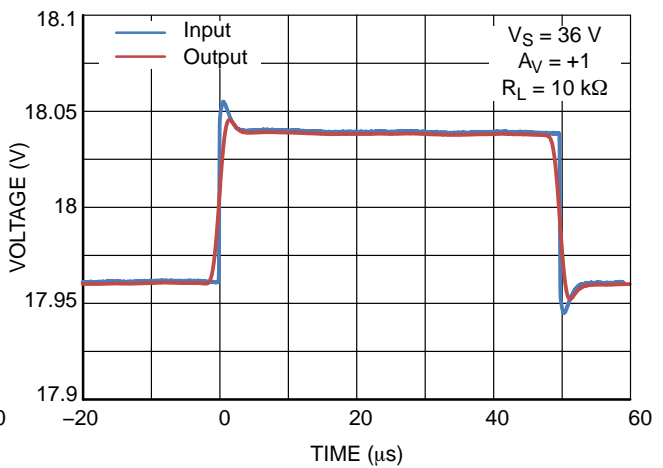


Figure 18. Non-inverting Small Signal Transient Response

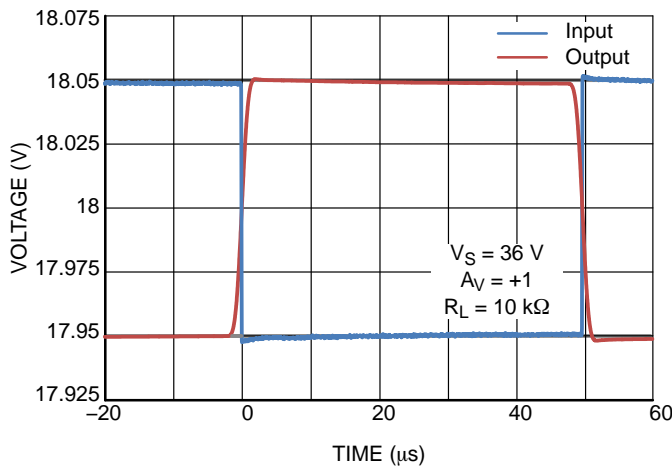


Figure 19. Inverting Small Signal Transient Response

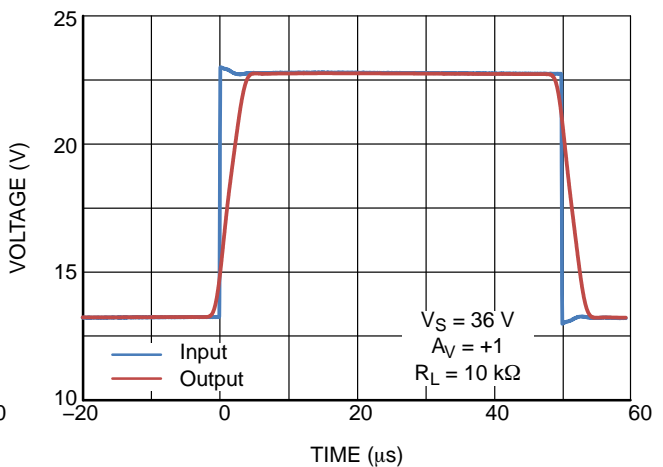


Figure 20. Non-inverting Large Signal Transient Response

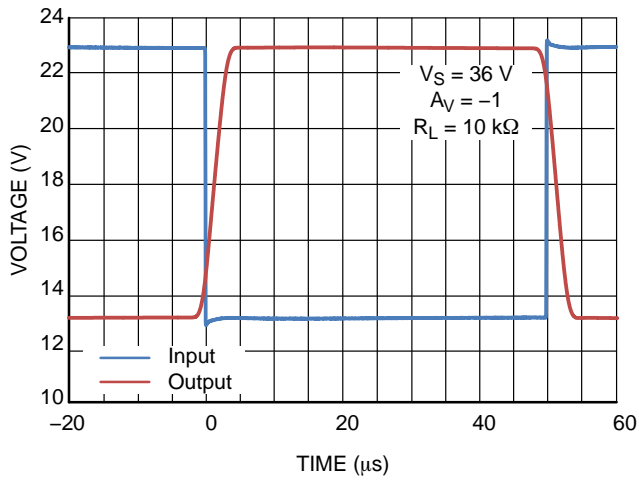


Figure 21. Inverting Large Signal Transient Response

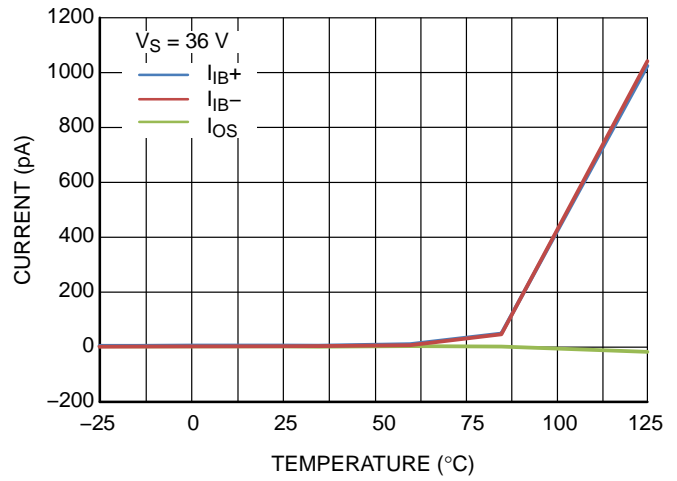


Figure 22. Input Bias and Offset Current vs. Temperature

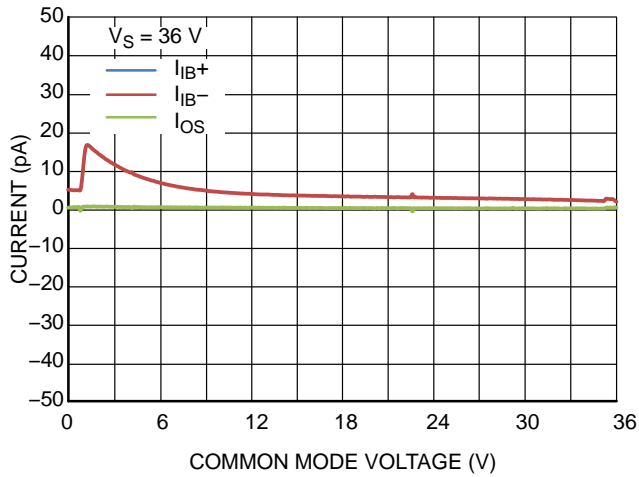


Figure 23. Input Bias Current vs. Common Mode Voltage

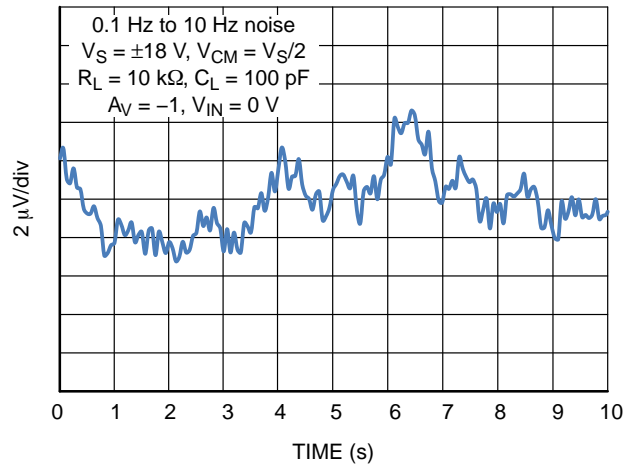


Figure 24. 0.1 Hz to 10 Hz Noise

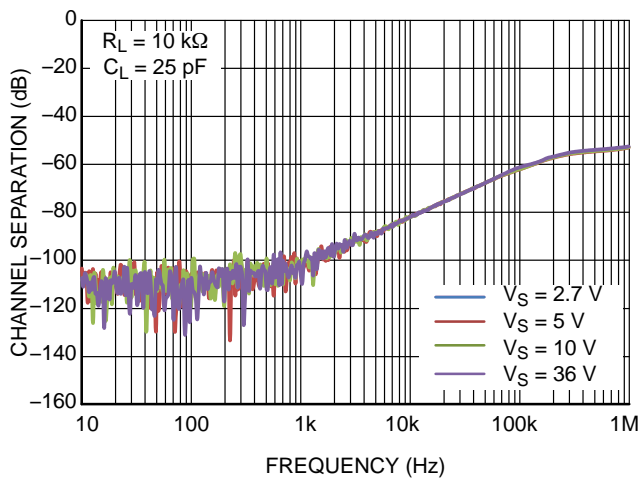


Figure 25. Channel Separation vs. Frequency

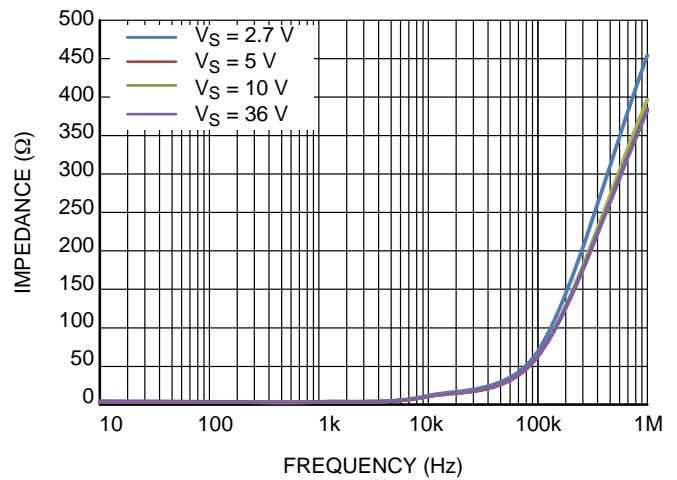


Figure 26. Open Loop Output Impedance

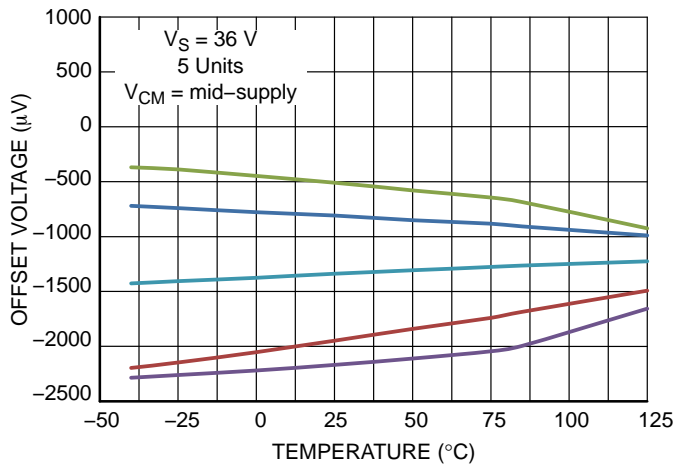


Figure 27. Offset Voltage vs. Temperature

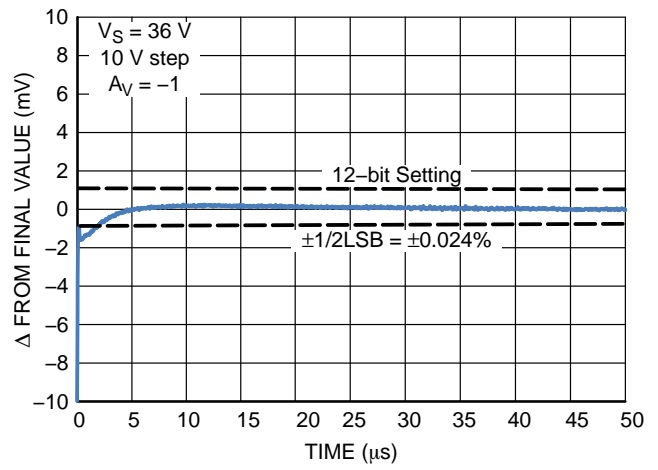


Figure 28. Large Signal Settling Time

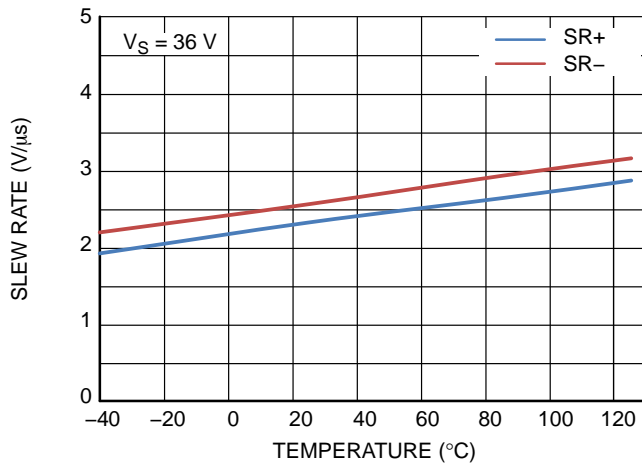
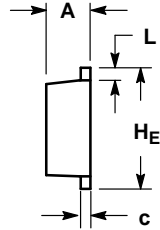
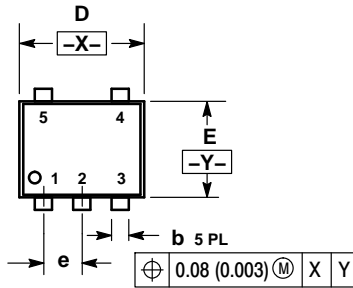


Figure 29. Slew Rate vs. Temperature



PACKAGE DIMENSIONS

SOT-553, 5 LEAD  
CASE 463B  
ISSUE C

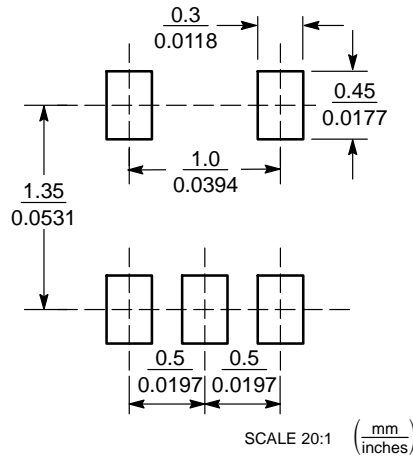


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETERS
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.

DIM	MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.50	0.55	0.60	0.020	0.022	0.024
b	0.17	0.22	0.27	0.007	0.009	0.011
c	0.08	0.13	0.18	0.003	0.005	0.007
D	1.55	1.60	1.65	0.061	0.063	0.065
E	1.15	1.20	1.25	0.045	0.047	0.049
e	0.50 BSC			0.020 BSC		
L	0.10	0.20	0.30	0.004	0.008	0.012
H <sub>E</sub>	1.55	1.60	1.65	0.061	0.063	0.065

RECOMMENDED  
SOLDERING FOOTPRINT\*

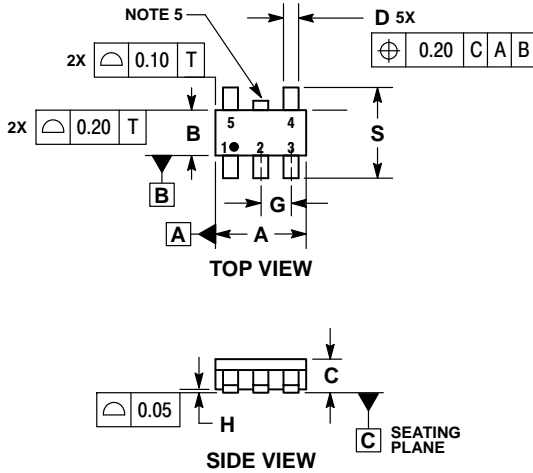


SCALE 20:1 ( $\frac{\text{mm}}{\text{inches}}$ )

\*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

TSOP-5  
CASE 483-02  
ISSUE K

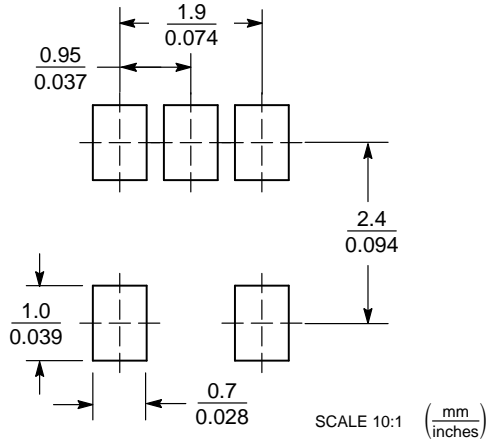


NOTES:

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

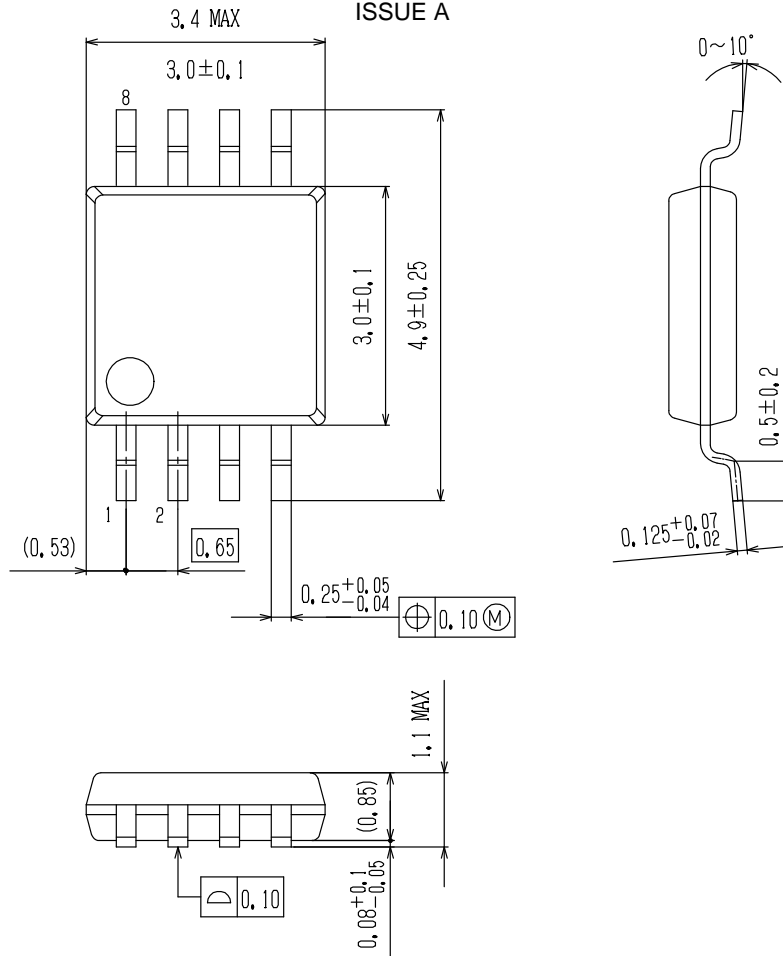
SOLDERING FOOTPRINT\*



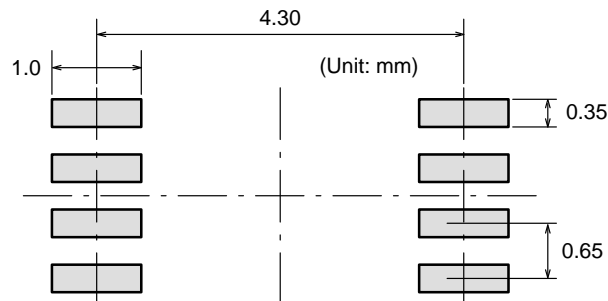
\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

PACKAGE DIMENSIONS

Micro8 / MSOP8 (150 mil)  
CASE 846AH  
ISSUE A



SOLDERING FOOTPRINT\*

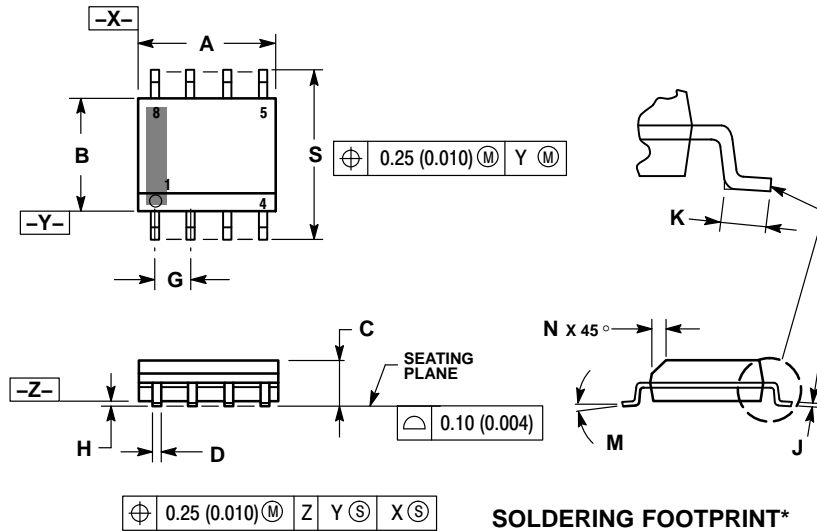


NOTE: The measurements are not to guarantee but for reference only.

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and

PACKAGE DIMENSIONS

SOIC-8 NB  
CASE 751-07  
ISSUE AK

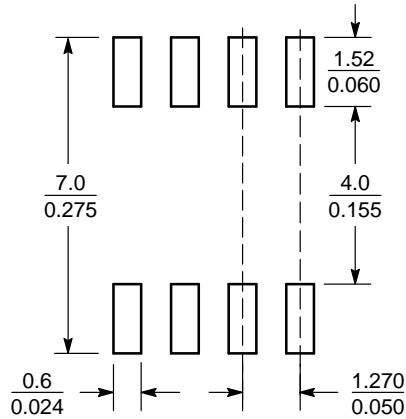


NOTES:

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\*

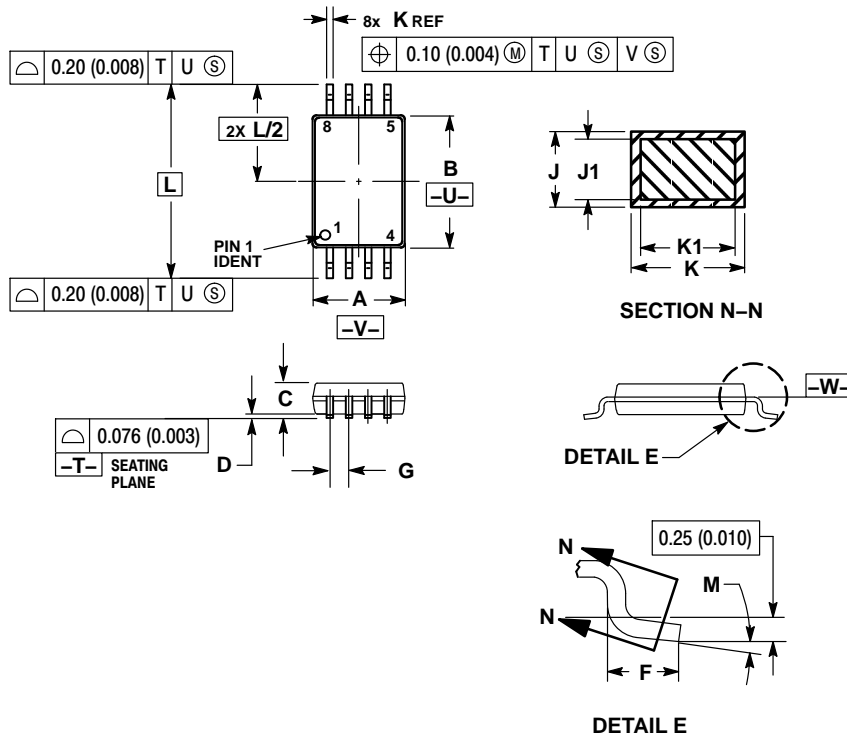


SCALE 6:1 (mm/inches)

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

PACKAGE DIMENSIONS

TSSOP-8  
CASE 948S  
ISSUE C



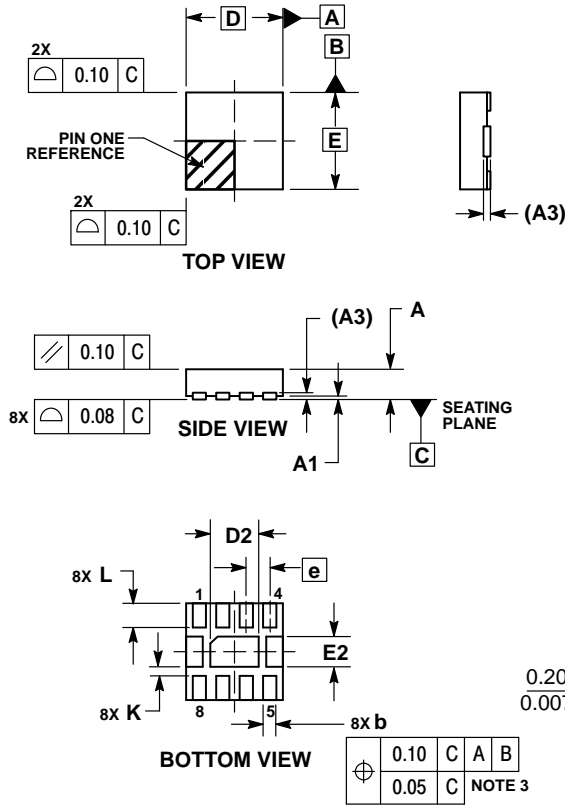
NOTES:

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. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
6. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.90	3.10	0.114	0.122
B	4.30	4.50	0.169	0.177
C	---	1.10	---	0.043
D	0.05	0.15	0.002	0.006
F	0.50	0.70	0.020	0.028
G	0.65 BSC		0.026 BSC	
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°

PACKAGE DIMENSIONS

UDFN8, 1.6x1.6, 0.4P  
CASE 517AC  
ISSUE A

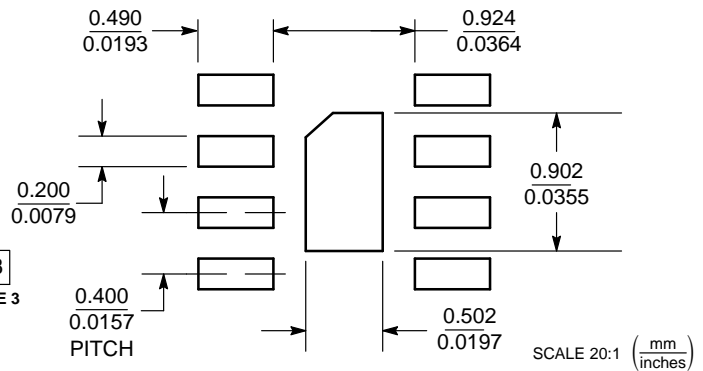


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30 mm FROM TERMINAL.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.
5. EXPOSED PADS CONNECTED TO DIE FLAG. USED AS TEST CONTACTS.

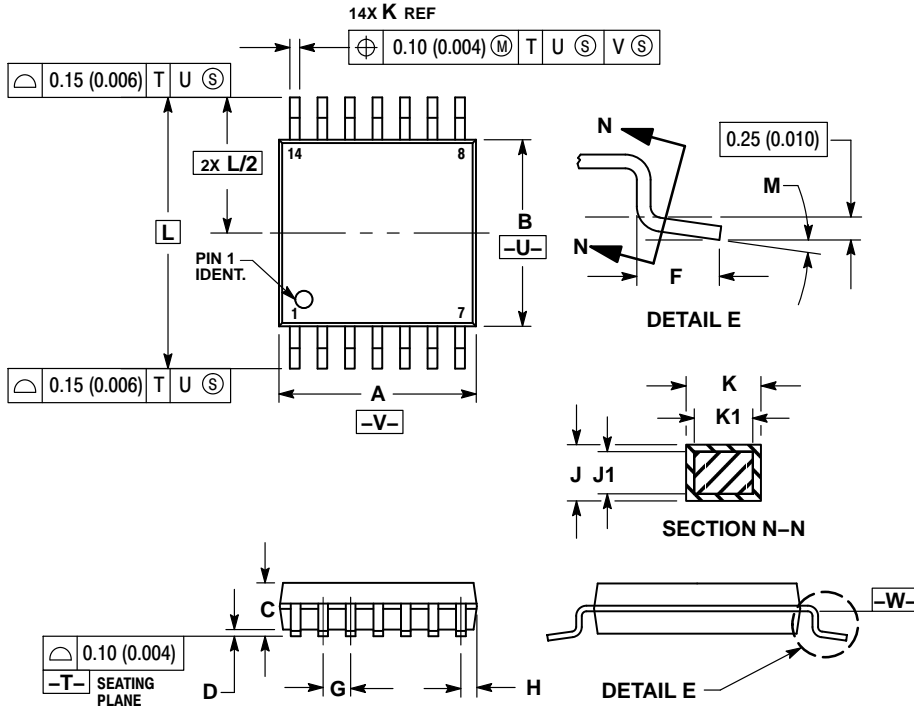
DIM	MILLIMETERS		
	MIN	NOM	MAX
A	0.45	0.50	0.55
A1	0.00	0.03	0.05
A3	0.127 REF		
b	0.15	0.20	0.25
D	1.60 BSC		
D2	0.70	0.80	0.90
E	1.60 BSC		
E2	0.40	0.50	0.60
e	0.40 BSC		
K	0.20	---	---
L	0.20	0.30	0.40

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

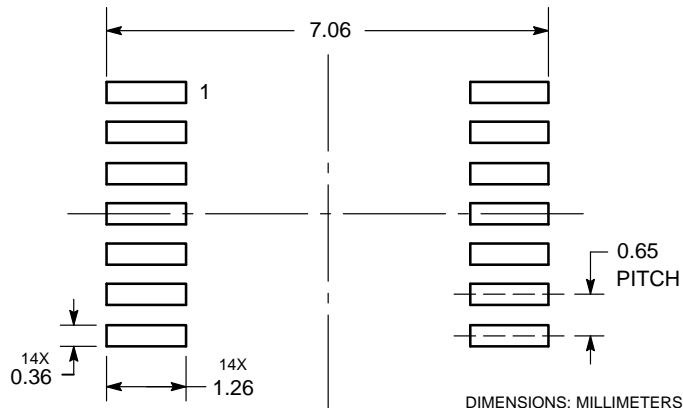
TSSOP-14  
CASE 948G  
ISSUE B

## 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\*

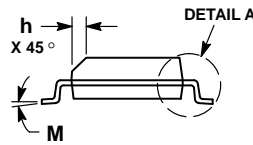
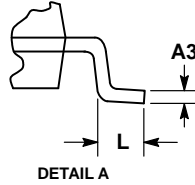
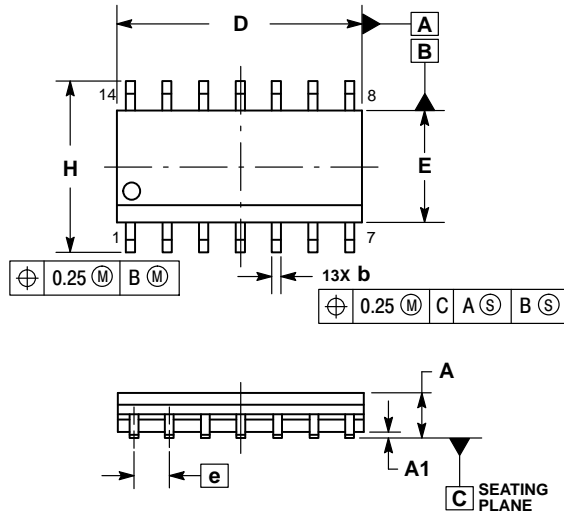


\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# NCS20071, NCS20072, NCS20074

## PACKAGE DIMENSIONS

### SOIC-14 NB CASE 751A-03 ISSUE K

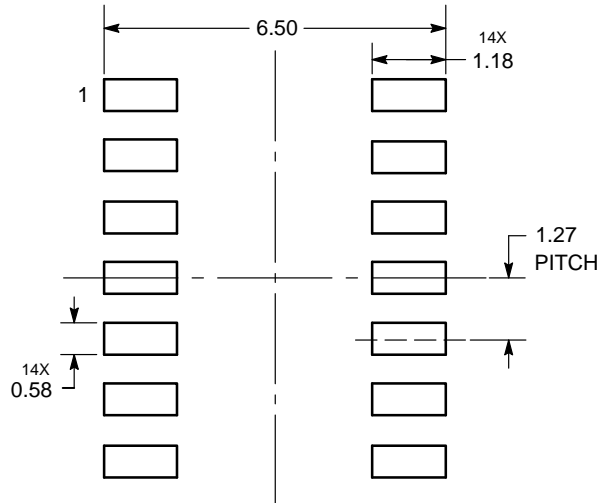


#### NOTES:

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.

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