NCS20071, NCV20071, NCS20072, NCV20072, NCS20074, NCV20074

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

The NCx2007x 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 NCx2007x can operate on supply voltages as low as 2.7 V over the temperature range of −40°C to 125°C. At a 2.7 V supply, the high bandwidth provides a slew rate of 2.8 V/μs while only consuming 405 μA of quiescent current per channel. The wide supply range allows the NCx2007x 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 NCx2007x devices are available in a variety of compact packages. Automotive qualified options are available under the NCV prefix.

Features

- Rail−To−Rail Output
- Wide Supply Range: 2.7 V to 36 V
- Wide Bandwidth: 3 MHz typical at V_S = 2.7 V
- High Slew Rate: 2.8 V/μs typical at V_S = 2.7 V
- Low Supply Current: 405 μA per channel at V_S = 2.7 V
- Low Input Bias Current: 5 pA typical
- Wide Temperature Range: −40°C to 125°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

ON Semiconductor®

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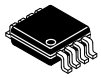
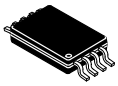
SOT−553
CASE 463B

TSOP−5
CASE 483

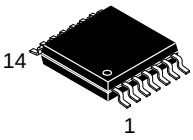


Micro8™
CASE 846A

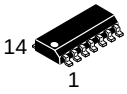
SOIC−8
CASE 751



TSSOP−8
CASE 948S



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.

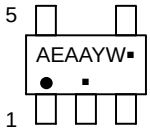
ORDERING INFORMATION

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

MARKING DIAGRAMS

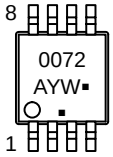
Single Channel Configuration
NCS20071, NCV20071

SOT−553
CASE 463B

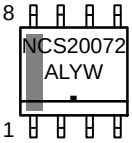


TSOP−5
CASE 483

Dual Channel Configuration
NCS20072, NCV20072



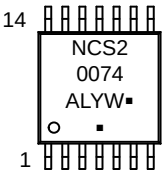
Micro8™
CASE 846A



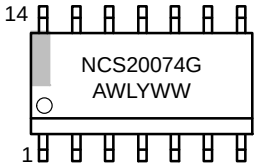
SOIC−8
CASE 751

TSSOP−8
CASE 948S

Quad Channel Configuration
NCS20074, NCV20074



TSSOP−14
CASE 948G

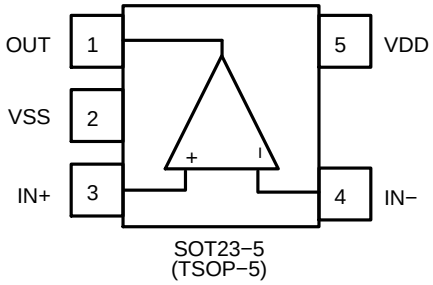


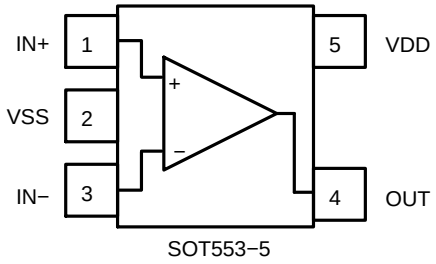
SOIC−14 NB
CASE 751A

XXXXX = Specific Device Code
A = Assembly Location
WL, L = Wafer Lot
Y = Year
WW, W = Work Week
G or ▪ = Pb−Free Package

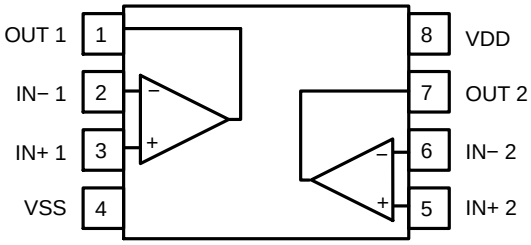
(Note: Microdot may be in either location)

Single Channel Configuration
NCS20071, NCV20071





Dual Channel Configuration
NCS20072, NCV20072



Quadruple Channel Configuration
NCS20074, NCV20074

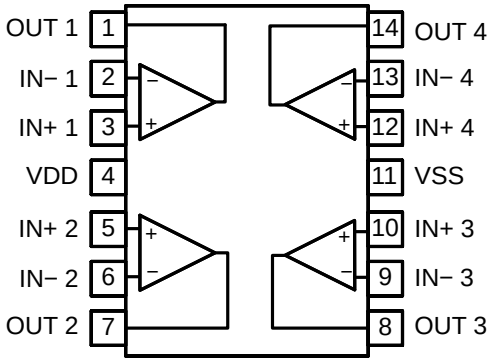


Figure 1. Pin Connections

ORDERING INFORMATION

Device	Configuration	Automotive	Marking	Package	Shipping†
NCS20071SN2T1G	Single	No	AEA	TSOP−5 (Pb−Free)	3000 / Tape and Reel
NCS20071XV53T2G			AL	SOT553−5 (Pb−Free)	4000 / Tape and Reel
NCV20071SN2T1G*		Yes	AEA	TSOP−5 (Pb−Free)	3000 / Tape and Reel
NCV20071XV53T2G*			AL	SOT553−5 (Pb−Free)	4000 / Tape and Reel
NCS20072DMR2G	Dual	No	0072	Micro8 (MSOP8) (Pb−Free)	4000 / Tape and Reel
NCS20072DR2G			NCS20072	SOIC−8 (Pb−Free)	2500 / Tape and Reel
NCS20072DTBR2G			K72	TSSOP−8 (Pb−Free)	2500 / Tape and Reel
NCV20072DMR2G*		Yes	0072	Micro8 (MSOP8) (Pb−Free)	4000 / Tape and Reel
NCV20072DR2G*			NCS20072	SOIC−8 (Pb−Free)	2500 / Tape and Reel
NCV20072DTBR2G*			K72	TSSOP−8 (Pb−Free)	2500 / Tape and Reel
NCS20074DR2G	Quad	No	NCS20074	SOIC−14 (Pb−Free)	2500 / Tape and Reel
NCS20074DTBR2G			NCS2 0074	TSSOP−14 (Pb−Free)	2500 / Tape and Reel
NCV20074DR2G*		Yes	NCS20074	SOIC−14 (Pb−Free)	2500 / Tape and Reel
NCV20074DTBR2G*			NCS2 0074	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.

*NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Rating		Symbol	Limit	Unit
Supply Voltage (V_{DD} – V_{SS}) (Note 4)		V_S	40	V
Input Voltage		V_{CM}	V_{SS} − 0.2 to V_{DD} + 0.2	V
Differential Input Voltage (Note 2)		V_{ID}	±V_s	V
Maximum Input Current		I_{IN}	±10	mA
Maximum Output Current (Note 3)		I_O	±100	mA
Continuous Total Power Dissipation (Note 4)		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 5)	Human Body Model Machine Model − NCx20071 Machine Model − NCx20072, NCx20074 Charged Device Model − NCx20071, NCx20072 Charged Device Model − NCx20074	HBM MM MM CDM CDM	2000 200 150 2000 (C6) 1000 (C6)	V
Latch−Up Current (Note 6)		I_{LU}	100	mA
Moisture Sensitivity Level (Note 7)		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. Maximum input current must be limited to ±10 mA. Series connected resistors of at least 500 Ω on both inputs may be used to limit the maximum input current to ±10 mA.
3. Total power dissipation must be limited to prevent the junction temperature from exceeding the 150°C limit.
4. 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.
5. 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)
6. Latch−up Current tested per JEDEC standard JESD78 (AEC−Q100−004)
7. Moisture Sensitivity Level tested per IPC/JEDEC standard J−STD−020A

THERMAL INFORMATION

Parameter	Symbol	Package	Single Layer Board (Note 8)	Multi−Layer Board (Note 9)	Unit
Junction−to−Ambient	θ_{JA}	SOT23−5 / TSOP5	265	195	°C/W
		SOT553−5	325	244	
		Micro8 / MSOP8	236	167	
		SOIC−8	190	131	
		TSSOP−8	253	194	
		SOIC−14	142	101	
		TSSOP−14	179	128	

8. Values based on a 1S standard PCB according to JEDEC51−3 with 1.0 oz copper and a 300 mm^2 copper area
9. Values based on a 1S2P standard PCB according to JEDEC51−7 with 1.0 oz copper and a 100 mm^2 copper area

OPERATING RANGES

Parameter	Symbol	Min	Max	Unit
Operating Supply Voltage (Single Supply)	V_S	2.7	36	V
Operating Supply Voltage (Split Supply)	V_S	±1.35	±18	V
Differential Input Voltage (Note 10)	V_{ID}		V_S	V
Input Common Mode Voltage Range	V_{CM}	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.

10. Maximum input current must be limited to ±10 mA. See Absolute Maximum Ratings for more information.

ELECTRICAL CHARACTERISTICS AT V_S = 2.7 V

T_A = 25°C; $R_L \geq 10$ kΩ; $V_{CM} = V_{OUT}$ = 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°C to 125°C. (Notes 11, 12)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
INPUT CHARACTERISTICS							
Input Offset Voltage	V_{OS}	NCx20071			1.3	±3.5	mV
						±4.5	
		NCx20072, NCx20074			1.3	±3	
						±4	
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	T_A = 25°C to 125°C			2		µV/°C
Input Bias Current (Note 12)	I_{IB}				5	200	pA
						1500	
Input Offset Current (Note 12)	I_{OS}	NCx20071, NCx20072			2	75	pA
						500	
		NCx20074			2	75	
						200	
Channel Separation	XTLK	DC	NCx20072		100		dB
			NCx20074		115		
Differential Input Resistance	R_{ID}				5		GΩ
Common Mode Input Resistance	R_{IN}				5		GΩ
Differential Input Capacitance	C_{ID}				1.5		pF
Common Mode Input Capacitance	C_{CM}				3.5		pF
Common Mode Rejection Ratio	CMRR	$V_{CM} = V_{SS}$ + 0.2 V to V_{DD} − 1.35 V		90	110		dB
				69			
OUTPUT CHARACTERISTICS							
Open Loop Voltage Gain	A_{VOL}			96	118		dB
				86			
Output Current Capability (Note 13)	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
						0.22	
Output Voltage Low	V_{OL}	Voltage output swing from negative rail			0.005	0.15	V
						0.22	
AC CHARACTERISTICS							
Unity Gain Bandwidth	UGBW	C_L = 25 pF			3		MHz
Slew Rate at Unity Gain	SR	C_L = 20 pF, R_L = 2 kΩ			2.8		V/µs
Phase Margin	φ_m	C_L = 25 pF			50		°
Gain Margin	A_m	C_L = 25 pF			14		dB
Settling Time	t_S	V_O = 1 Vpp, Gain = 1, C_L = 20 pF	Settling time to 0.1%		0.6		µs
			Settling time to 0.01%		1.2		

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.

11. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.
12. Performance guaranteed over the indicated operating temperature range by design and/or characterization.
13. Power dissipation must be limited to prevent junction temperature from exceeding 150°C. See Absolute Maximum Ratings for more information.

ELECTRICAL CHARACTERISTICS AT V_S = 2.7 V

T_A = 25°C; $R_L \geq 10\ k\Omega$; $V_{CM} = V_{OUT}$ = 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°C to 125°C. (Notes 11, 12)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
NOISE CHARACTERISTICS						
Total Harmonic Distortion plus Noise	THD+N	V_{IN} = 0.5 Vpp, f = 1 kHz, Av = 1		0.05		%
Input Referred Voltage Noise	e_n	f = 1 kHz		30		nV/√Hz
		f = 10 kHz		20		
Input Referred Current Noise	i_n	f = 1 kHz		90		fA/√Hz
SUPPLY CHARACTERISTICS						
Power Supply Rejection Ratio	PSRR	No Load	114	135		dB
			100			
Power Supply Quiescent Current	I_{DD}	NCx20071, No load		420	625	μA
					765	
		NCx20072, NCx20074, Per channel, no load		405	525	
					625	

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.
11. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.
12. Performance guaranteed over the indicated operating temperature range by design and/or characterization.
13. Power dissipation must be limited to prevent junction temperature from exceeding 150°C. See Absolute Maximum Ratings for more information.

ELECTRICAL CHARACTERISTICS AT V_S = 5 V

T_A = 25°C; $R_L \geq 10\ k\Omega$; $V_{CM} = V_{OUT}$ = 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°C to 125°C. (Notes 14, 15)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Input Offset Voltage	V_{OS}	NCx20071		1.3	±3.5	mV
					±4.5	
		NCx20072, NCx20074		1.3	±3	
					±4	
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	T_A = 25°C to 125 °C		2		μV/°C
Input Bias Current (Note 15)	I_{IB}			5	200	pA
					1500	
Input Offset Current (Note 15)	I_{OS}	NCx20071, NCx20072		2	75	pA
					500	
		NCx20074		2	75	
					200	
Channel Separation	XTLK	DC, NCx20072		100		dB
		DC, NCx20074		115		
Differential Input Resistance	R_{ID}			5		GΩ
Common Mode Input Resistance	R_{IN}			5		GΩ
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.
14. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.
15. Performance guaranteed over the indicated operating temperature range by design and/or characterization.
16. Power dissipation must be limited to prevent junction temperature from exceeding 150°C. See Absolute Maximum Ratings for more information.

ELECTRICAL CHARACTERISTICS AT V_S = 5 V

T_A = 25°C; $R_L \geq 10\ k\Omega$; $V_{CM} = V_{OUT}$ = 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°C to 125°C. (Notes 14, 15)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
INPUT CHARACTERISTICS							
Common Mode Rejection Ratio	CMRR	$V_{CM} = V_{SS}$ + 0.2 V to V_{DD} − 1.35 V		102	125		dB
				80			
OUTPUT CHARACTERISTICS							
Open Loop Voltage Gain	A_{VOL}			96	120		dB
				86			
Output Current Capability (Note 16)	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
						0.25	
Output Voltage Low	V_{OL}	Voltage output swing from negative rail			0.01	0.10	V
						0.15	
AC CHARACTERISTICS							
Unity Gain Bandwidth	UGBW	C_L = 25 pF			3		MHz
Slew Rate at Unity Gain	SR	C_L = 20 pF, R_L = 2 kΩ			2.7		V/μs
Phase Margin	φ_m	C_L = 25 pF			50		°
Gain Margin	A_m	C_L = 25 pF			14		dB
Settling Time	t_S	V_O = 3 Vpp, Gain = 1, C_L = 20 pF	Settling time to 0.1%		1.2		μs
			Settling time to 0.01%		5.6		
NOISE CHARACTERISTICS							
Total Harmonic Distortion plus Noise	THD+N	V_{IN} = 2.5 Vpp, f = 1 kHz, Av = 1			0.009		%
Input Referred Voltage Noise	e_n	f = 1 kHz			30		nV/√Hz
		f = 10 kHz			20		
Input Referred Current Noise	i_n	f = 1 kHz			90		fA/√Hz
SUPPLY CHARACTERISTICS							
Power Supply Rejection Ratio	PSRR	No Load		114	135		dB
				100			
Power Supply Quiescent Current	I_{DD}	NCx20071	No load		430	635	μA
						775	
		NCx20072, NCx20074	Per channel, no load		410	530	
						630	

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.

14. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.
15. Performance guaranteed over the indicated operating temperature range by design and/or characterization.
16. Power dissipation must be limited to prevent junction temperature from exceeding 150°C. See Absolute Maximum Ratings for more information.

ELECTRICAL CHARACTERISTICS AT V_S = 10 V

T_A = 25°C; $R_L \geq 10$ kΩ; $V_{CM} = V_{OUT}$ = 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°C to 125°C. (Notes 17, 18)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
INPUT CHARACTERISTICS							
Input Offset Voltage	V_{OS}	NCx20071			1.3	±3.5	mV
						±4.5	**mV**
Input Offset Voltage	V_{OS}	NCx20072, NCx20074			1.3	±3	mV
						±4	**mV**
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	T_A = 25°C to 125°C			2		μV/°C
Input Bias Current (Note 18)	I_{IB}				5	200	pA
						1500	
Input Offset Current (Note 18)	I_{OS}	NCx20071, NCx20072			2	75	pA
						500	
		NCx20074			2	75	
						200	
Channel Separation	XTLK	DC	NCx20072		100		dB
			NCx20074		115		
Differential Input Resistance	R_{ID}				5		GΩ
Common Mode Input Resistance	R_{IN}				5		GΩ
Differential Input Capacitance	C_{ID}				1.5		pF
Common Mode Input Capacitance	C_{CM}				3.5		pF
Common Mode Rejection Ratio	CMRR	$V_{CM} = V_{SS}$ + 0.2 V to V_{DD} − 1.35 V		110	130		dB
				87			
OUTPUT CHARACTERISTICS							
Open Loop Voltage Gain	A_{VOL}			98	120		dB
				88			
Output Current Capability (Note 19)	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
						0.10	
Output Voltage Low	V_{OL}	Voltage output swing from negative rail			0.022	0.3	V
						0.35	
AC CHARACTERISTICS							
Unity Gain Bandwidth	UGBW	C_L = 25 pF			3		MHz
Slew Rate at Unity Gain	SR	C_L = 20 pF, R_L = 2 kΩ			2.6		V/μs
Phase Margin	φ_m	C_L = 25 pF			50		°
Gain Margin	A_m	C_L = 25 pF			14		dB
Settling Time	t_S	V_O = 8.5 Vpp, Gain = 1, C_L = 20 pF	Settling time to 0.1%		3.4		μs
			Settling time to 0.01%		6.8		

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.

17. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.
18. Performance guaranteed over the indicated operating temperature range by design and/or characterization.
19. Power dissipation must be limited to prevent junction temperature from exceeding 150°C. See Absolute Maximum Ratings for more information.

ELECTRICAL CHARACTERISTICS AT V_S = 10 V

T_A = 25°C; $R_L \geq 10\ k\Omega$; $V_{CM} = V_{OUT}$ = 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°C to 125°C. (Notes 17, 18)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
NOISE CHARACTERISTICS							
Total Harmonic Distortion plus Noise	THD+N	V_{IN} = 7.5 Vpp, f = 1 kHz, Av = 1			0.004		%
Input Referred Voltage Noise	e_n	f = 1 kHz			30		nV/√Hz
		f = 10 kHz			20		
Input Referred Current Noise	i_n	f = 1 kHz			90		fA/√Hz
SUPPLY CHARACTERISTICS							
Power Supply Rejection Ratio	PSRR	No Load		114	135		dB
				100			
Power Supply Quiescent Current	I_{DD}	NCx20071	No load		430	645	µA
						785	
		NCx20072, NCx20074	Per channel, no load		416	540	
						640	

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.

17. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.
18. Performance guaranteed over the indicated operating temperature range by design and/or characterization.
19. Power dissipation must be limited to prevent junction temperature from exceeding 150°C. See Absolute Maximum Ratings for more information.

ELECTRICAL CHARACTERISTICS AT V_S = 36 V

T_A = 25°C; $R_L \geq 10\ k\Omega$; $V_{CM} = V_{OUT}$ = 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°C to 125°C. (Notes 20, 21)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
INPUT CHARACTERISTICS							
Input Offset Voltage	V_{OS}	NCx20071			1.3	±3.5	mV
						±4.5	**mV**
		NCx20072, NCx20074			1.3	±3	mV
						±4	**mV**
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	T_A = 25°C to 125°C			2		µV/°C
Input Bias Current (Note 21)	I_{IB}				5	200	pA
		NCx20071, NCx20072				**2000**	
		NCx20074				**1500**	
Input Offset Current (Note 21)	I_{OS}	NCx20071, NCx20072			2	75	pA
						1000	
		NCx20074			2	75	
						200	
Channel Separation	XTLK	DC	NCx20072		100		dB
			NCx20074		115		
Differential Input Resistance	R_{ID}				5		GΩ
Common Mode Input Resistance	R_{IN}				5		GΩ

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.

20. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.
21. Performance guaranteed over the indicated operating temperature range by design and/or characterization.
22. Power dissipation must be limited to prevent junction temperature from exceeding 150°C. See Absolute Maximum Ratings for more information.

ELECTRICAL CHARACTERISTICS AT V_S = 36 V

T_A = 25°C; R_L ≥ 10 kΩ; V_{CM} = V_{OUT} = 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°C to 125°C. (Notes 20, 21)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
INPUT CHARACTERISTICS							
Differential Input Capacitance	C_{ID}				1.5		pF
Common Mode Input Capacitance	C_{CM}				3.5		pF
Common Mode Rejection Ratio	CMRR	NCx20071	V_{CM} = V_{SS} + 0.2 V to V_{DD} − 1.35 V	118	135		dB
				95			
		NCx20072	V_{CM} = V_{SS} + 0.2 V to V_{DD} − 1.35 V	120	145		
				95			
		NCx20074	V_{CM} = V_{SS} + 0.2 V to V_{DD} − 1.35 V	120	145		
				85			
OUTPUT CHARACTERISTICS							
Open Loop Voltage Gain	A_{VOL}			98	120		dB
				88			
Output Current Capability (Note 22)	I_O	Op amp sinking current			50		mA
		Op amp sourcing current			65		
Output Voltage High	V_{OH}	Voltage output swing from positive rail	NCx20071		0.074	0.15	V
						0.22	
			NCx20072		0.074	0.10	
						0.15	
			NCx20074		0.074	0.10	
						0.12	
Output Voltage Low	V_{OL}	Voltage output swing from negative rail			0.065	0.3	V
						0.35	
AC CHARACTERISTICS							
Unity Gain Bandwidth	UGBW	C_L = 25 pF			3		MHz
Slew Rate at Unity Gain	SR	C_L = 20 pF, R_L = 2 kΩ			2.4		V/μs
Phase Margin	φ_m	C_L = 25 pF			50		°
Gain Margin	A_m	C_L = 25 pF			14		dB
Settling Time	t_S	V_O = 10 Vpp, Gain = 1, C_L = 20 pF	Settling time to 0.1%		3.2		μs
			Settling time to 0.01%		7		
NOISE CHARACTERISTICS							
Total Harmonic Distortion plus Noise	THD+N	V_{IN} = 28.5 Vpp, f = 1 kHz, Av = 1			0.001		%
Input Referred Voltage Noise	e_n	f = 1 kHz			30		nV/√Hz
		f = 10 kHz			20		
Input Referred Current Noise	i_n	f = 1 kHz			90		fA/√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.

20. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.
21. Performance guaranteed over the indicated operating temperature range by design and/or characterization.
22. Power dissipation must be limited to prevent junction temperature from exceeding 150°C. See Absolute Maximum Ratings for more information.

ELECTRICAL CHARACTERISTICS AT V_S = 36 V

T_A = 25°C; $R_L \geq 10\ k\Omega$; $V_{CM} = V_{OUT}$ = 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°C to 125°C. (Notes 20, 21)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
SUPPLY CHARACTERISTICS							
Power Supply Rejection Ratio	PSRR	No Load		114	135		dB
				100			
Power Supply Quiescent Current	I_{DD}	NCx20071	No load		480	700	µA
						840	
		NCx20072	Per channel, no load		465	570	
						700	
		NCx20074	Per channel, no load		465	600	
						700	

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.

20. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.
21. Performance guaranteed over the indicated operating temperature range by design and/or characterization.
22. Power dissipation must be limited to prevent junction temperature from exceeding 150°C. See Absolute Maximum Ratings for more information.

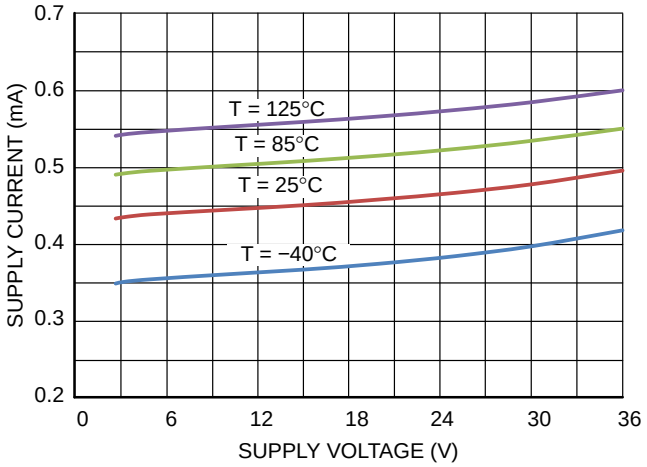


Figure 2. Quiescent Current Per Channel vs. Supply Voltage

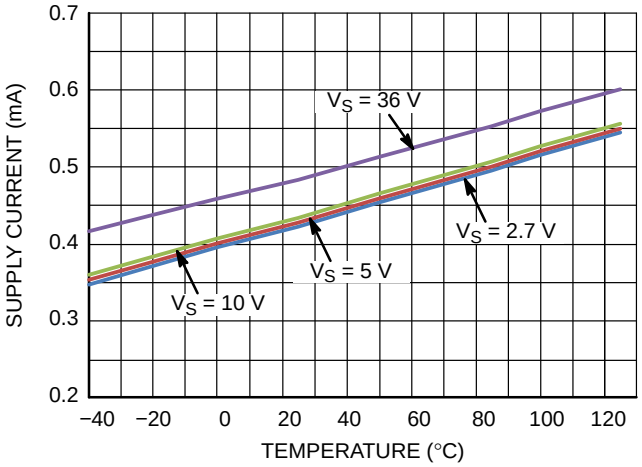


Figure 3. Quiescent Current vs. Temperature

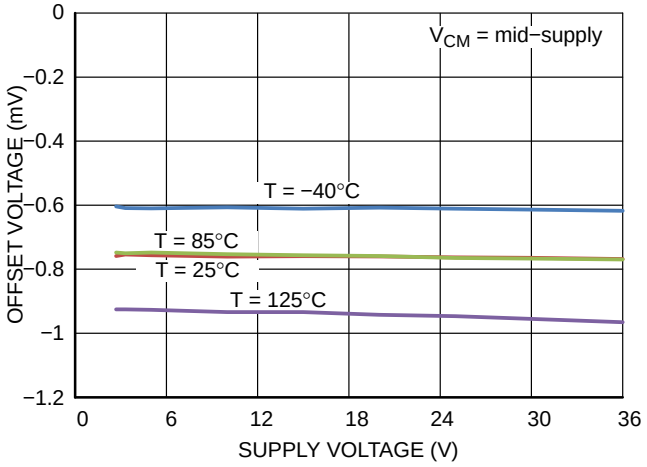


Figure 4. Offset Voltage vs. Supply Voltage

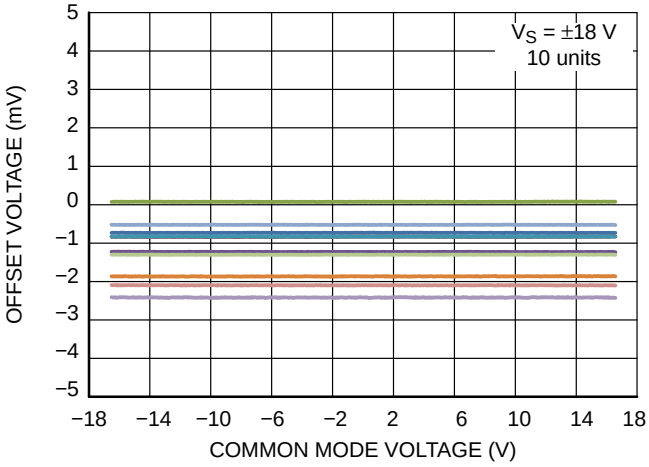


Figure 5. Input Offset Voltage vs. Common Mode Voltage

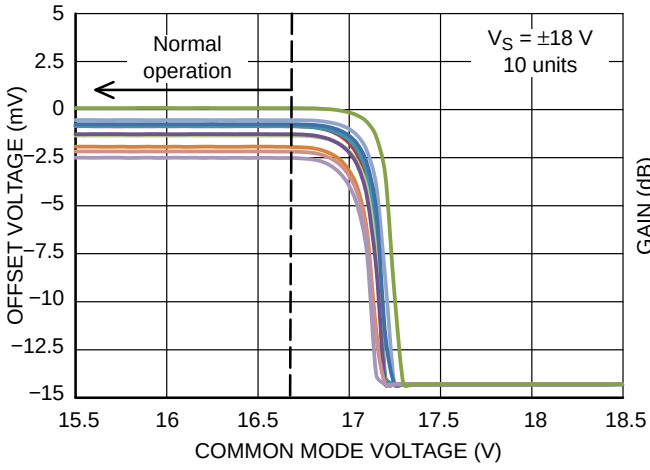


Figure 6. Input Offset Voltage vs. Common Mode Voltage

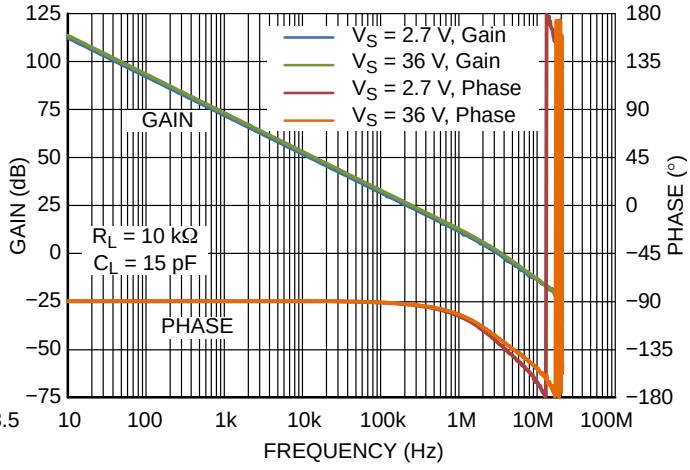


Figure 7. Gain and Phase vs. Frequency

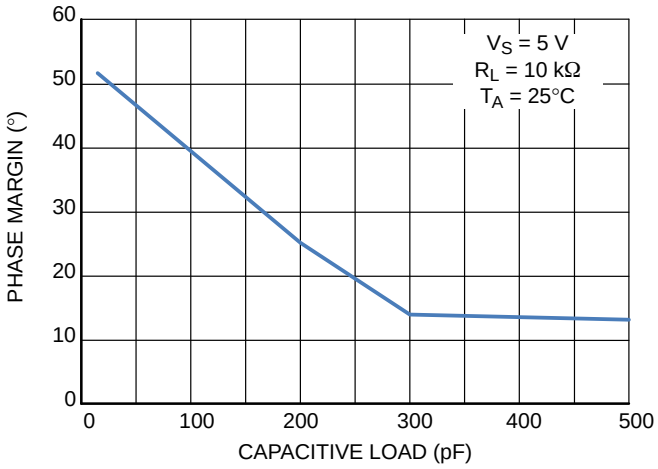


Figure 8. Phase Margin vs. Capacitive Load

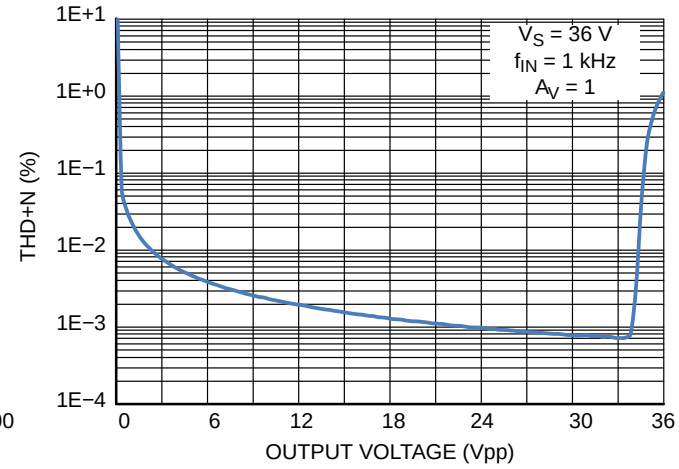


Figure 9. THD+N vs. Output Voltage

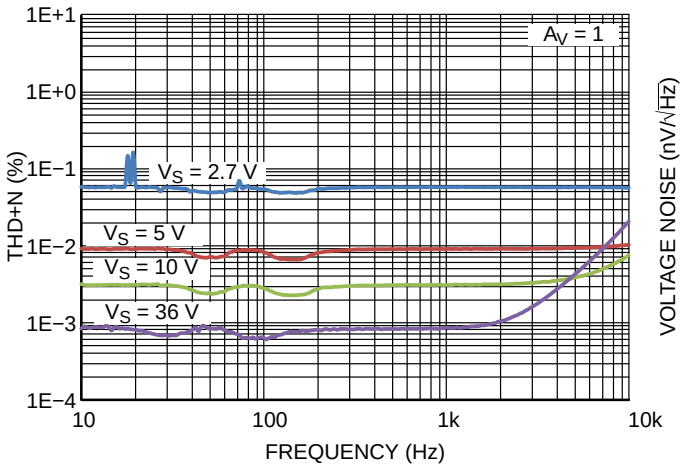


Figure 10. THD+N vs. Frequency

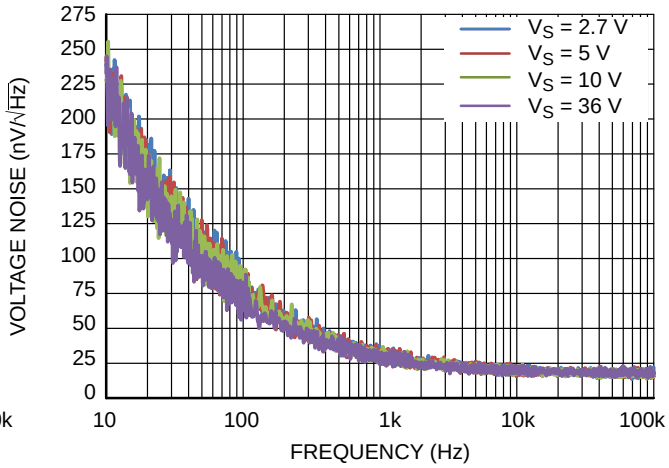


Figure 11. Input Voltage Noise vs. Frequency

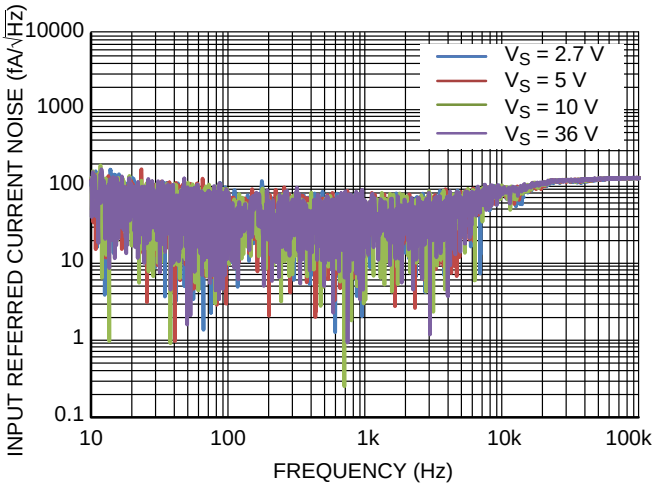


Figure 12. Input Current Noise vs. Frequency

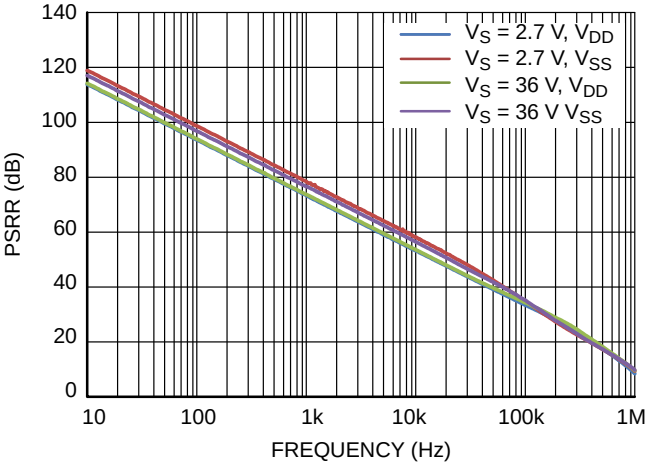


Figure 13. PSRR vs. Frequency

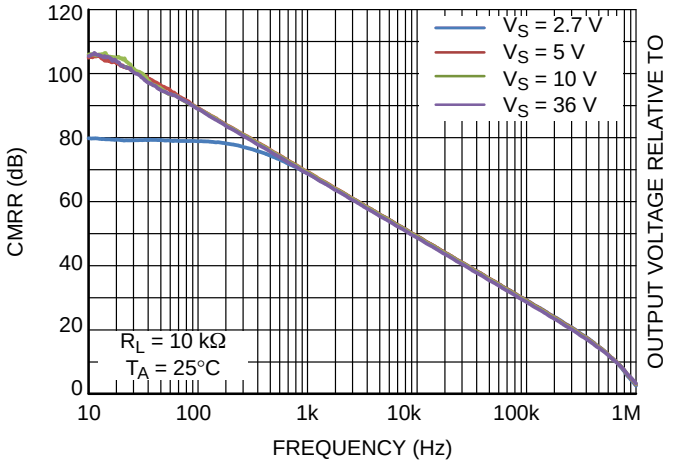


Figure 14. CMRR vs. Frequency

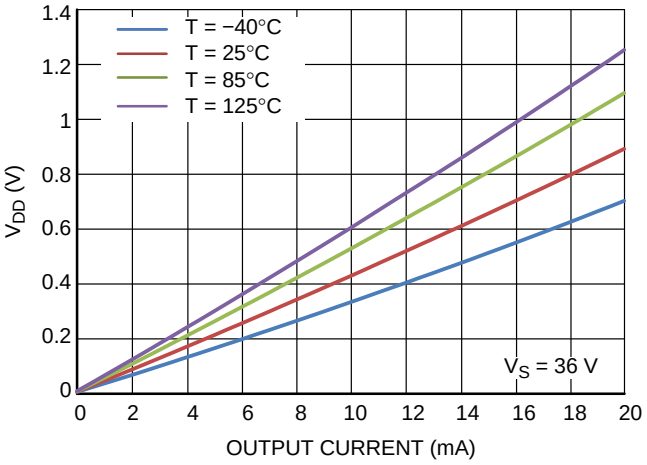


Figure 15. High Level Output vs. Output Current

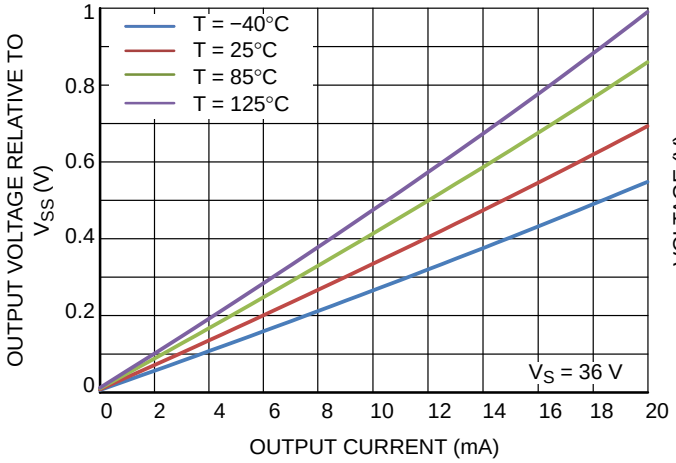


Figure 16. Low Level Output vs. Output Current

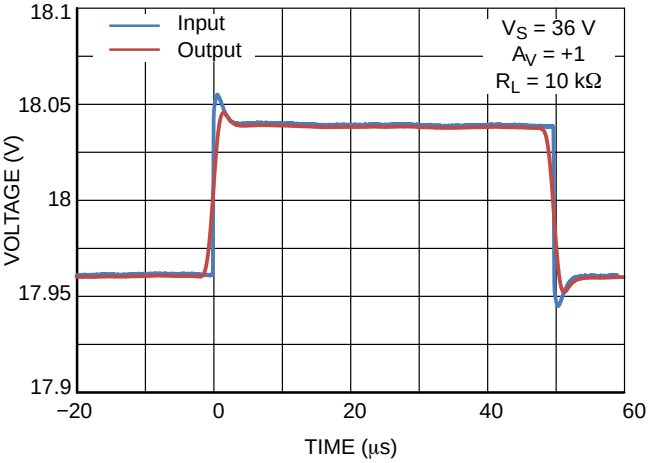


Figure 17. Non−inverting Small Signal Transient Response

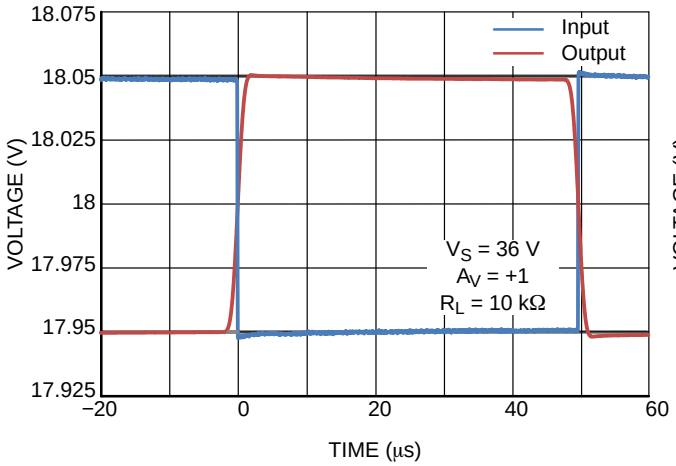


Figure 18. Inverting Small Signal Transient Response

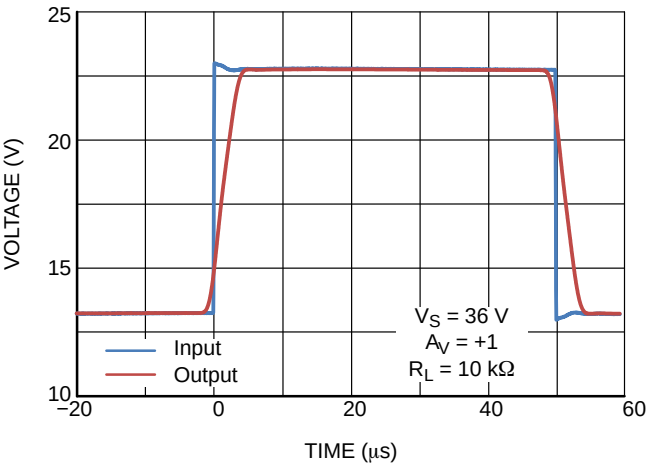


Figure 19. Non−inverting Large Signal Transient Response

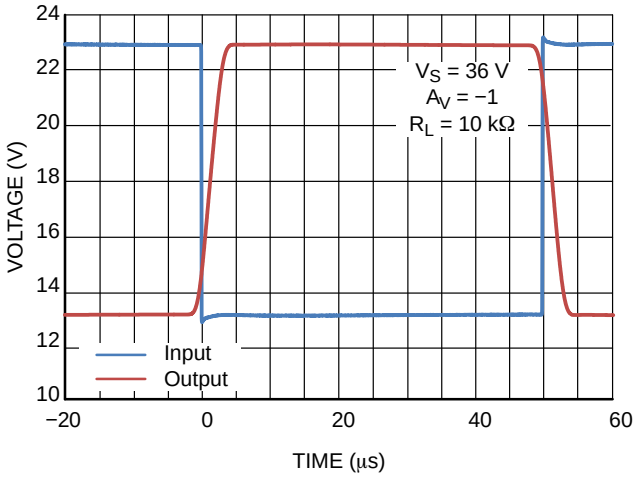


Figure 20. Inverting Large Signal Transient Response

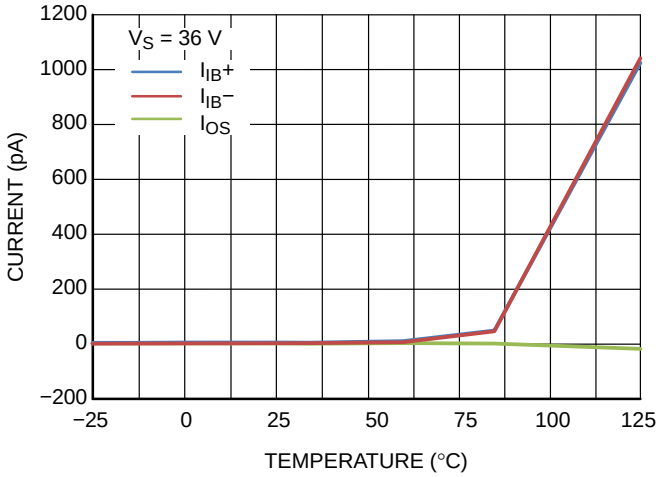


Figure 21. Input Bias and Offset Current vs. Temperature

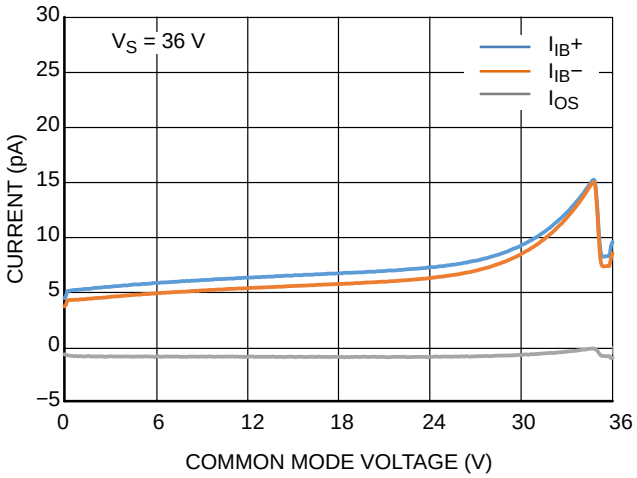


Figure 22. Input Bias Current vs. Common Mode Voltage

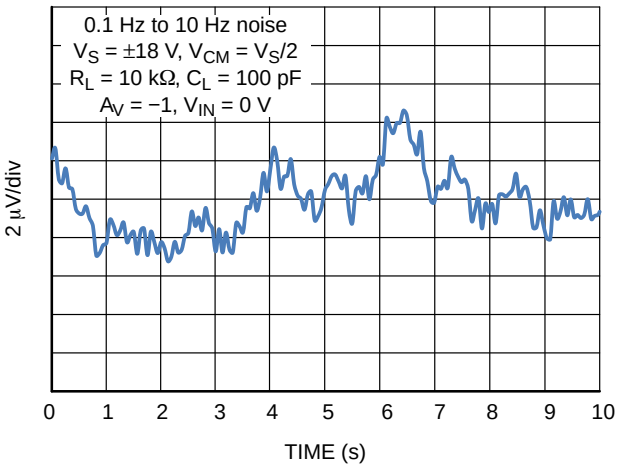


Figure 23. 0.1 Hz to 10 Hz Noise

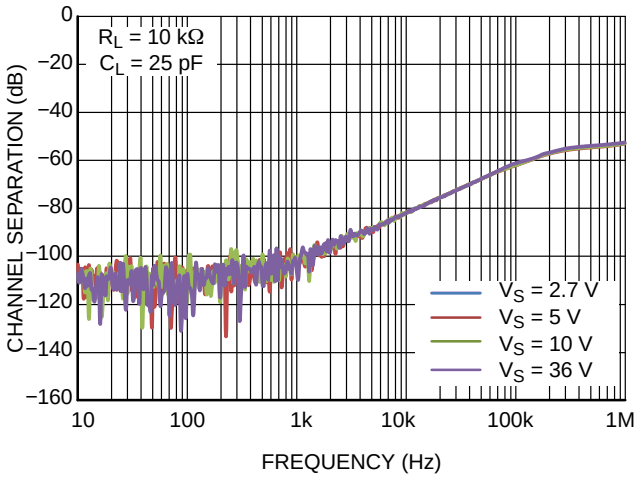


Figure 24. Channel Separation vs. Frequency

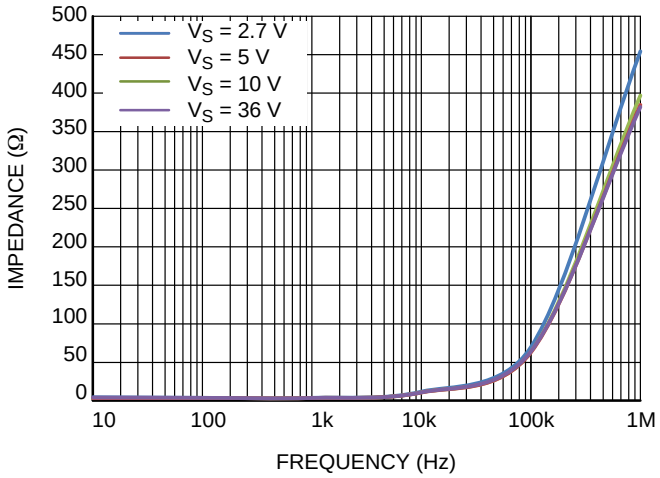


Figure 25. Open Loop Output Impedance

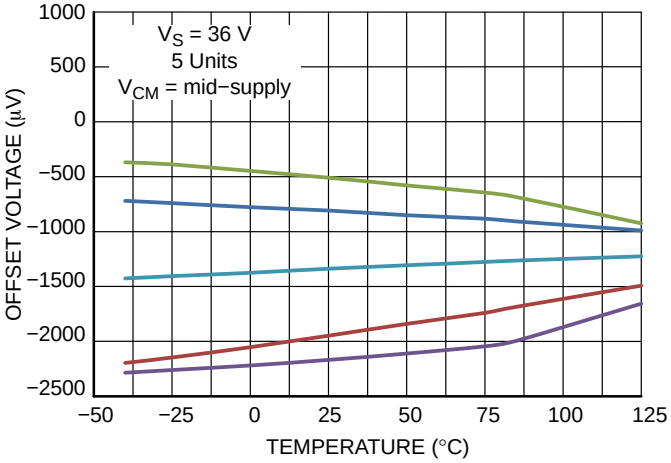


Figure 26. Offset Voltage vs. Temperature

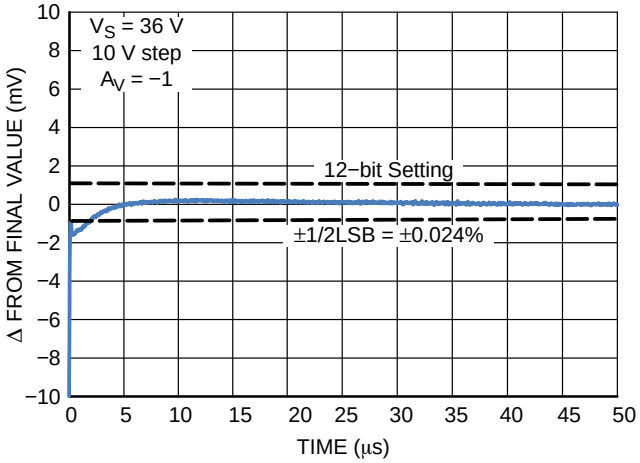


Figure 27. Large Signal Settling Time

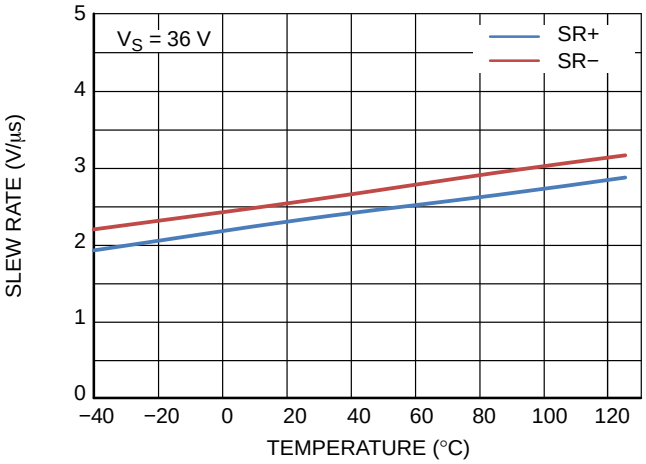


Figure 28. Slew Rate vs. Temperature

APPLICATIONS INFORMATION

Input Circuit

The NCS2007x input stage has a PMOS input pair and ESD protection diodes. The input pair is internally connected by back−to−back Zener diodes with a reverse voltage of 5.5 V. To protect the internal circuitry, the input current must be limited to 10 mA. When operating the NCS2007x at differential voltages greater than V_{ID} = 26 V, series resistors can be added externally to limit the input current flowing between the input pins. Adding 500 Ω resistors in series with the input prevents the current from exceeding 10 mA over the entire operating range up to 36 V.

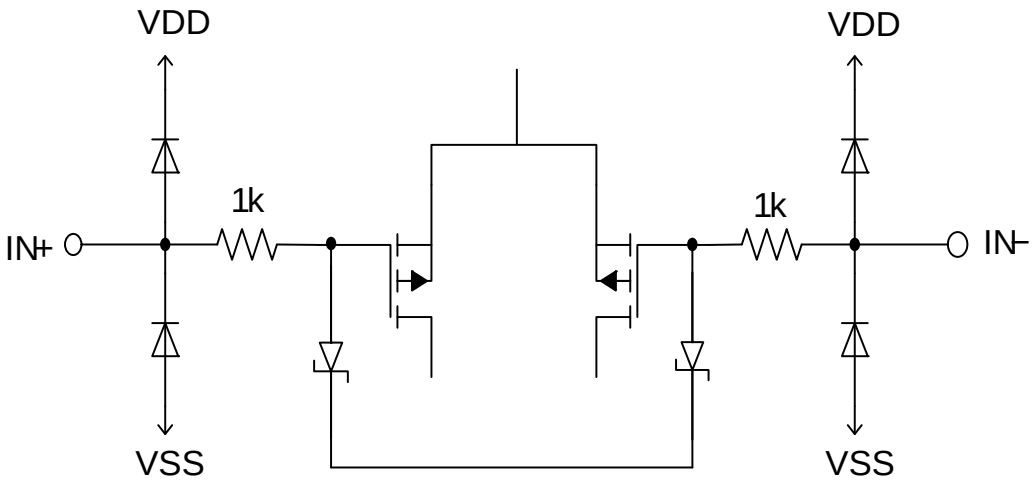


Figure 29. Differential Input Pair

Output

The NCS2007x has a class AB output stage with rail−to−rail output swing.

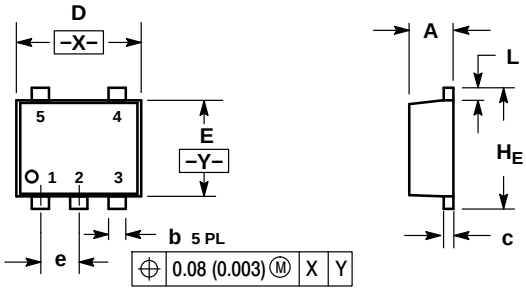
High output currents can cause the junction temperature to exceed the 150°C absolute maximum rating. In the case of a short circuit where the output is connected to either supply rail, the amount of current the op amp can source and sink is described by the output current capability parameter listed in the Electrical Characteristics. The junction temperature at a given power dissipation, P, can be calculated using the following formula:

$T_J = T_A + P \times \theta_{JA}$

The thermal resistance between junction and ambient, θ_{JA}, is provided in the Thermal Information section of this datasheet.

PACKAGE DIMENSIONS

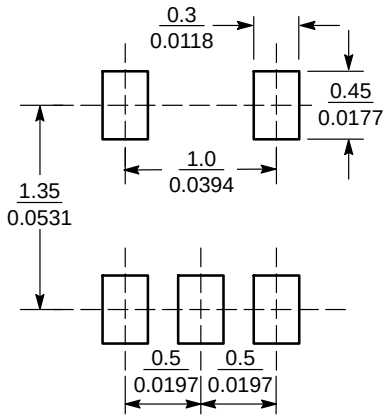
SOT−553, 5 LEAD
CASE 463B
ISSUE C



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.

	MILLIMETERS			INCHES		
DIM	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_E	1.55	1.60	1.65	0.061	0.063	0.065

RECOMMENDED SOLDERING FOOTPRINT*

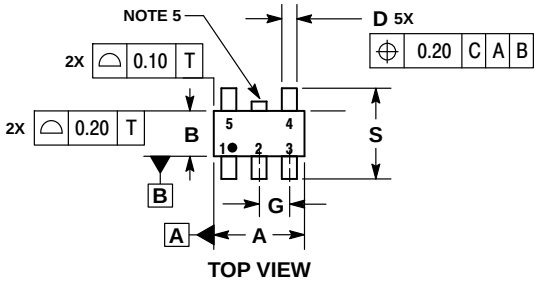


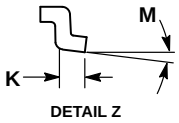
SCALE 20:1 $\left(\frac{\text{mm}}{\text{inches}}\right)$

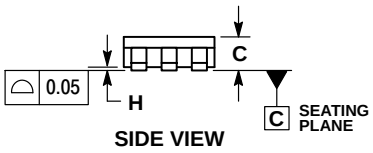
*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

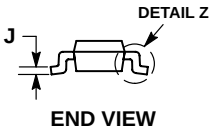
PACKAGE DIMENSIONS

TSOP−5
CASE 483
ISSUE M





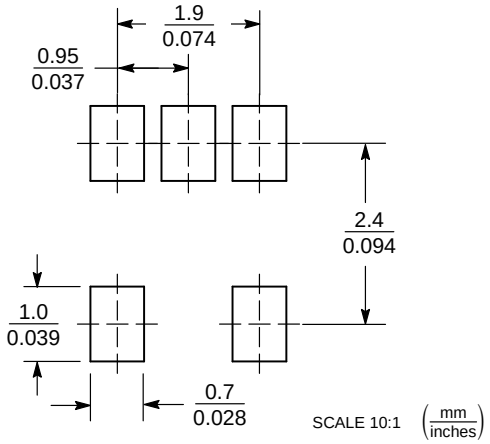




NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS. 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.

	MILLIMETERS	
DIM	MIN	MAX
A	2.85	3.15
B	1.35	1.65
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

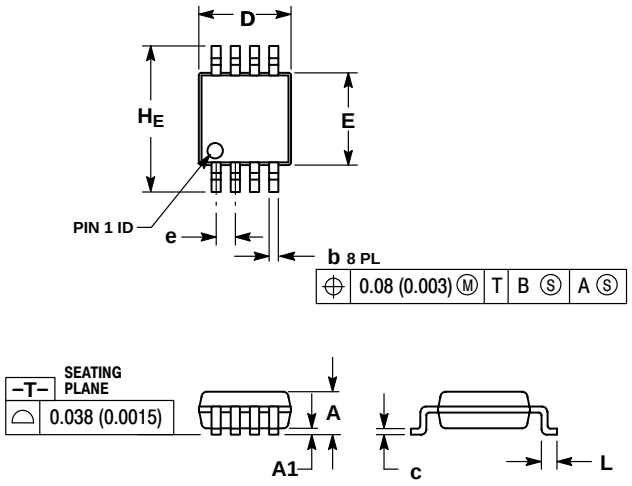
SOLDERING FOOTPRINT*



*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

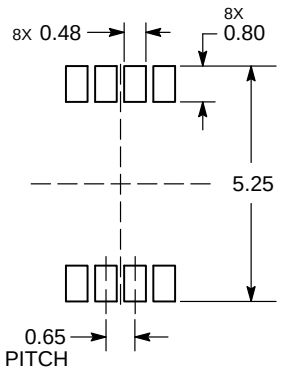
Micro8™
CASE 846A−02
ISSUE J



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.

	MILLIMETERS			INCHES		
DIM	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
H_E	4.75	4.90	5.05	0.187	0.193	0.199

RECOMMENDED SOLDERING FOOTPRINT*

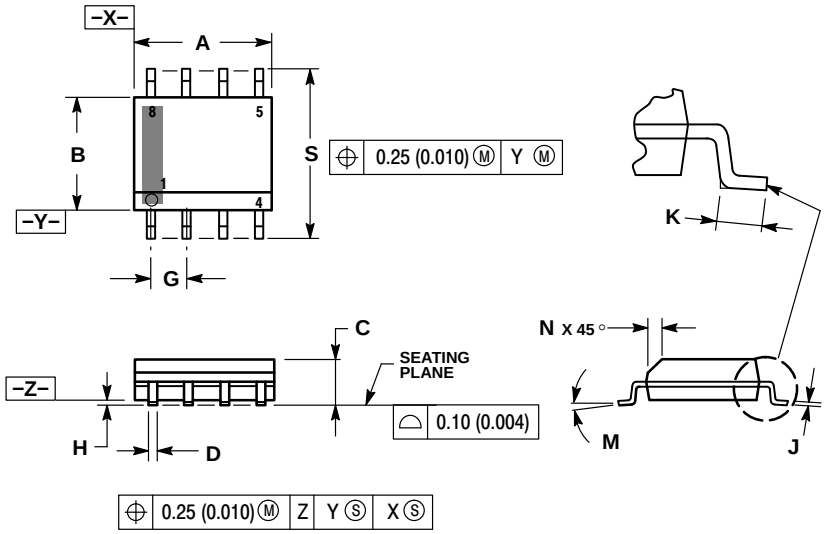


DIMENSION: MILLIMETERS

*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

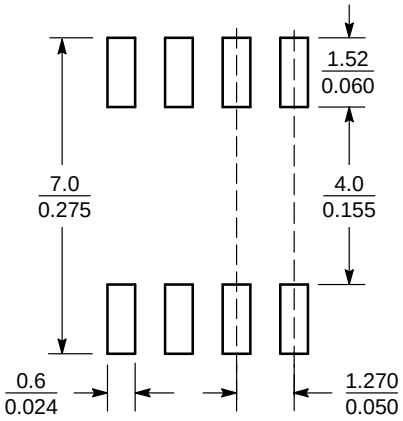
SOIC−8 NB
CASE 751−07
ISSUE AK



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.

	MILLIMETERS		INCHES	
DIM	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*

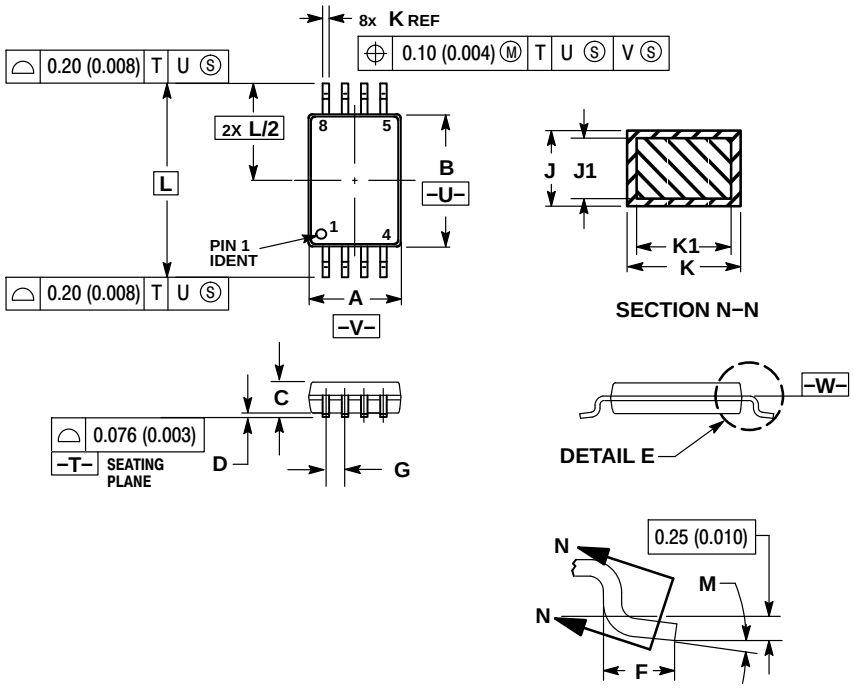


SCALE 6:1 (mm / inches)

*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

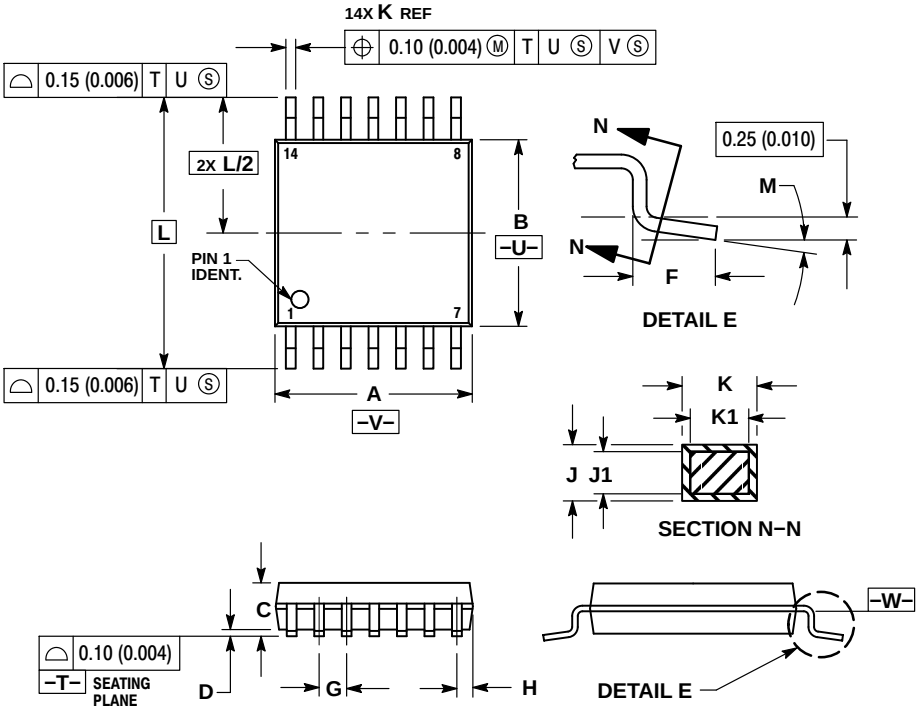


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH. PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD 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−.

	MILLIMETERS		INCHES	
DIM	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

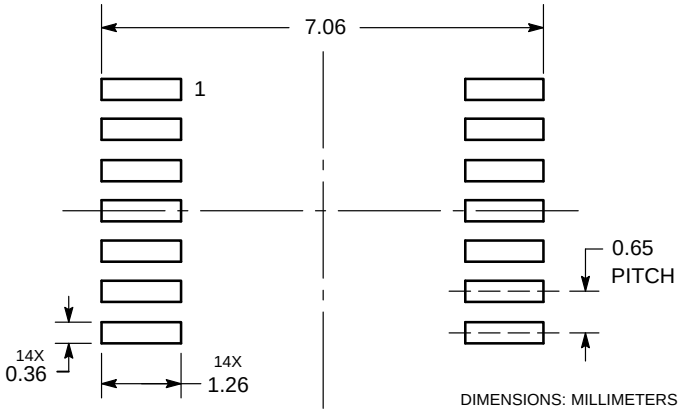
TSSOP−14
CASE 948G
ISSUE C



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

	MILLIMETERS		INCHES	
DIM	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 °

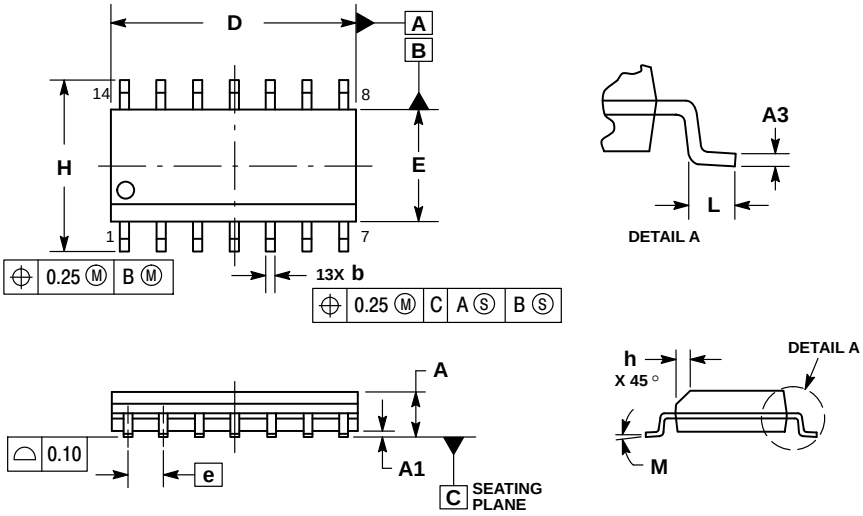
SOLDERING FOOTPRINT*



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

PACKAGE DIMENSIONS

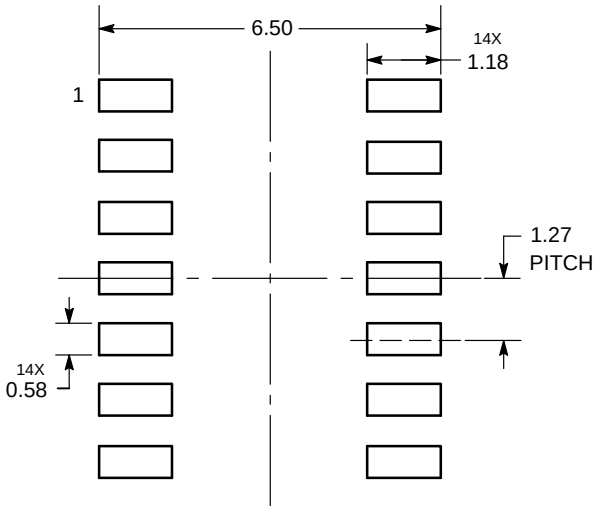
SOIC−14 NB
CASE 751A−03
ISSUE L



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.

	MILLIMETERS		INCHES	
DIM	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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