# 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°C to  $125^{\circ}\text{C}$ . 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 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. 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  $V_S = 2.7 \text{ V}$
- High Slew Rate: 2.8 V/ $\mu$ s typical at V<sub>S</sub> = 2.7 V
- Low Supply Current: 405  $\mu$ A per channel at  $V_S = 2.7 \text{ V}$
- 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

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



### ON Semiconductor®

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SOT-553 CASE 463B

TSOP-5 CASE 483





Micro8<sup>™</sup> 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**

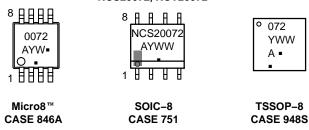
See detailed ordering and shipping information on page 4 of this data sheet.

### **MARKING DIAGRAMS**

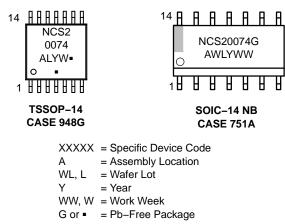
# Single Channel Configuration NCS20071, NCV20071



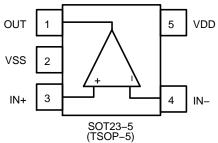
# Dual Channel Configuration NCS20072, NCV20072

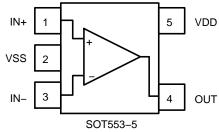


# Quad Channel Configuration NCS20074, NCV20074

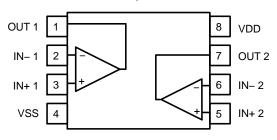


### Single Channel Configuration NCS20071, NCV20071





### Dual Channel Configuration NCS20072, NCV20072



### Quadruple Channel Configuration NCS20074, NCV20074

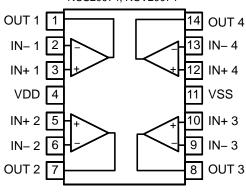


Figure 1. Pin Connections

### **ORDERING INFORMATION**

Device	Configuration	Automotive	Marking	Package	Shipping <sup>†</sup>	
NCS20071SN2T1G (In Development)**		Nia	TBD	TSOP-5 (Pb-Free)	3000 / Tape and Reel	
NCS20071XV53T2G (In Development)**	Cinala	No	TBD	SOT553-5 (Pb-Free)	4000 / Tape and Reel	
NCV20071SN2T1G* (In Development)**	- Single	V	TBD	TSOP-5 (Pb-Free)	3000 / Tape and Reel	
NCV20071XV53T2G* (In Development)**	]	No No	TBD	SOT553-5 (Pb-Free)	4000 / Tape and Reel	
NCS20072DMR2G (In Development)**			0072	Micro8 (MSOP8) (Pb-Free)	4000 / Tape and Reel	
NCS20072DR2G (In Development)**	]	No	NCS20072	SOIC-8 (Pb-Free)	2500 / Tape and Reel	
NCS20072DTBR2G (In Development)**	- Dord		072	TSSOP-8 (Pb-Free)	3000 / Tape and Reel	
NCV20072DMR2G* (In Development)**	- Dual		0072	Micro8 (MSOP8) (Pb-Free)	4000 / Tape and Reel	
NCV20072DR2G* (In Development)**			Yes	NCS20072	SOIC-8 (Pb-Free)	2500 / Tape and Reel
NCV20072DTBR2G* (In Development)**	]		072	TSSOP-8 (Pb-Free)	3000 / Tape and Reel	
NCS20074DR2G		N	NCS20074	SOIC-14 (Pb-Free)	2500 / Tape and Reel	
NCS20074DTBR2G	0	No	NCS2 0074	TSSOP-14 (Pb-Free)	2500 / Tape and Reel	
NCV20074DR2G*	- Quad	V	NCS20074	SOIC-14 (Pb-Free)	2500 / Tape and Reel	
NCV20074DTBR2G*		Yes	NCS2 0074	TSSOP-14 (Pb-Free)	2500 / Tape and Reel	

<sup>†</sup>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.

<sup>\*\*</sup>Contact local sales office for availability.

### ABSOLUTE MAXIMUM RATINGS (Note 1)

	Rating	Symbol	Limit	Unit
Supply Voltage (V <sub>DD</sub> – V <sub>SS</sub>	) (Note 2)	Vs	40	V
Input Voltage		VI	$V_{SS} - 0.2 \text{ to } V_{DD} + 0.2$	V
Differential Input Voltage		$V_{ID}$	±V <sub>S</sub>	V
Maximum Input Current		lı	±10	mA
Maximum Output Current		Io	±100	mA
Continuous Total Power Dis	ssipation (Note 2)	$P_{D}$	200	mW
Maximum Junction Temper	ature	$T_J$	150	°C
Storage Temperature Rang	e	T <sub>STG</sub>	-65 to 150	°C
Mounting Temperature (Infi	rared or Convection – 20 sec)	T <sub>mount</sub>	260	°C
ESD Capability (Note 3)	Human Body Model Machine Model Charged Device Model – NCS20072/NCV20072 Charged Device Model – NCS20074/NCV20074	ESD <sub>HBM</sub> ESD <sub>MM</sub> ESD <sub>CDM</sub> ESD <sub>CDM</sub>	2000 150 2000 1000 (C6)	V
Latch-Up Current (Note 3)		I <sub>LU</sub>	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 CHĂRACTERISTICS 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
		SOT23-5 / TSOP5	235	°C/W
		SOT553-5	250	
		Micro8 / MSOP8	238	
Junction-to-Ambient	$\theta_{\sf JA}$	SOIC-8	190	
		TSSOP-8	140	
		SOIC-14	156	
		TSSOP-14	190	

### **OPERATING RANGES**

Parameter	Symbol	Min	Max	Unit
Operating Supply Voltage	Vs	2.7	36	V
Differential Input Voltage	V <sub>ID</sub>		V <sub>S</sub>	V
Input Common Mode Range	V <sub>ICM</sub>	V <sub>SS</sub>	V <sub>DD</sub> – 1.35	V
Ambient Temperature	T <sub>A</sub>	-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.

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

 $T_A = 25^{\circ}\text{C}$ ;  $R_L \ge 10 \text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid}$ -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°C. (Notes 6, 7)

Parameter	Symbol	Con	ditions	Min	Тур	Max	Unit
INPUT CHARACTERISTICS			<u>.</u>				
Land Office ( ) /elleres					1.3	±3	mV
Input Offset Voltage	Vos					±4	mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	T <sub>A</sub> = 25°	C to 125°C		2		μV/°C
Input Piga Current (Note 7)	l				5	200	рА
Input Bias Current (Note 7)	I <sub>IB</sub>					1500	pА
Input Offset Current (Note 7)	laa				2	75	pА
input Onset Current (Note 1)	los					175	pА
Channel Separation	XTLK	DC	NCx20072		100		dB
опанне зераганоп	XILK	ВС	NCx20074		115		ub
Differential Input Resistance	R <sub>ID</sub>				50		GΩ
Common Mode Input Resistance	R <sub>IN</sub>				5		GΩ
Differential Input Capacitance	$C_{ID}$				1.5		pF
Common Mode Input Capacitance	C <sub>CM</sub>				3.5		pF
Common Mode Rejection Ratio	CMRR	\\ = 0 \\ t	o V <sub>DD</sub> – 1.35 V	90	110		dB
Common Mode Rejection Ratio	CIVIKK	vCW = 0 v ti	7 V <sub>DD</sub> = 1.33 V	69			ub
OUTPUT CHARACTERISTICS							
Open Loop Voltage Gain	A <sub>VOL</sub>			96	118		dB
Open Loop Vollage Cam	AVOL			86			ub
Output Current Capability	I <sub>O</sub>	Op amp si	nking current		70		mA
Output Outlett Capability	10	Op amp so	urcing current		50		IIIA
Output Voltage High	V <sub>OH</sub>	Voltage output swing from positive rail			0.006	0.15	V
Output voltage riigii	VОН	voltage output sw	ing nom positive rail			0.22	v
Output Voltage Low	V <sub>OL</sub>	Voltage output sw	ing from negative rail		0.005	0.15	V
Output voltage Low	VOL	voltage output sw	ing nom negative rail			0.22	V
AC CHARACTERISTICS							
Unity Gain Bandwidth	UGBW	C <sub>L</sub> =	: 25 pF		3		MHz
Slew Rate at Unity Gain	SR	C <sub>L</sub> =	: 20 pF		2.8		V/μs
Phase Margin	$\phi_{\boldsymbol{m}}$	C <sub>L</sub> =	: 25 pF		50		0
Gain Margin	$A_{m}$	C <sub>L</sub> =	: 25 pF		14		dB
Settling Time	to	$V_O = 1 \text{ Vpp},$	Settling time to 0.1%		0.6		
County Time	t <sub>S</sub>	Gain = 1, C <sub>L</sub> = 20 pF	Settling time to 0.01%		1.2		μS
NOISE CHARACTERISTICS							
Total Harmonic Distortion plus Noise	THD+N	$V_{IN} = 0.5 \text{ Vpp},$	f = 1 kHz, Av = 1		0.05		%
Input Referred Voltage Noise	Δ.	f = 1 kHz			30		nV/√ <del>Hz</del>
input itololiou voltage ivolse	e <sub>n</sub>	f = 10 kHz			20		11 0/ 11 12
Input Referred Current Noise	i <sub>n</sub>	f = 1 kHz			0.25		fA/√ <del>Hz</del>

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.

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

### **ELECTRICAL CHARACTERISTICS AT V<sub>S</sub> = 2.7 V**

 $T_A = 25^{\circ}\text{C}$ ;  $R_L \ge 10 \text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid-supply}$  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°C. (Notes 6, 7)

Parameter	Symbol	Conditions		Min	Тур	Max	Unit
SUPPLY CHARACTERISTICS							
	DODD	Nelsad		114	135		-10
Power Supply Rejection Ratio	PSRR	No Load		100			dB
Davies Committee Online and Comment					405	525	
Power Supply Quiescent Current	I <sub>DD</sub>	Per channel, no load				625	μΑ

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 $V_S = 5 \text{ V}$

 $T_A = 25^{\circ}\text{C}$ ;  $R_L \ge 10 \text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid}$ –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°C. (Notes 8, 9)

Parameter	Symbol	Cor	nditions	Min	Тур	Max	Unit
INPUT CHARACTERISTICS							
Innut Offert Veltage	M				1.3	±3	mV
Input Offset Voltage	Vos					±4	mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	$T_A = 25$	°C to 125 °C		2		μV/°C
Input Bias Current (Note 9)	L-				5	200	рА
input bias current (Note 9)	I <sub>IB</sub>					1500	рA
Input Offset Current (Note 9)	laa				2	75	pА
input Onset Current (Note 9)	los					175	pА
Channel Separation	XTLK	DC	NCx20072		100		dB
Chariner Separation	ATER	ВС	NCx20074		115		ub
Differential Input Resistance	R <sub>ID</sub>				50		GΩ
Common Mode Input Resistance	R <sub>IN</sub>				5		GΩ
Differential Input Capacitance	C <sub>ID</sub>				1.5		pF
Common Mode Input Capacitance	C <sub>CM</sub>				3.5		pF
Common Mada Daigatian Datia	CMRR	V 0.V	V <sub>CM</sub> = 0 V to V <sub>DD</sub> – 1.35 V		125		dB
Common Mode Rejection Ratio	CIVIKK	v <sub>CM</sub> = 0 v	10 V <sub>DD</sub> = 1.35 V	80			dB
OUTPUT CHARACTERISTICS							
Open Loop Voltage Gain	Λ			96	120		dB
Open Loop voltage Gain	A <sub>VOL</sub>			86			uБ
Output Current Conchility		Op amp s	sinking current		50		A
Output Current Capability	I <sub>O</sub>	Op amp s	ourcing current		60		- mA
Output Voltage High	V	Voltago outrest o	uing from positive roll		0.013	0.20	.,
Output Voltage High	VOH	V <sub>OH</sub> Voltage output swing from positive rail				0.25	V
Output Valtage Law	M	Voltage outside	uing from nogotive ==!!		0.01	0.10	\/
Output Voltage Low	VOL	V <sub>OL</sub> Voltage output swing from				0.15	V

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 $V_S = 5 \text{ V}$

 $T_A = 25^{\circ}\text{C}$ ;  $R_L \ge 10 \text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid-supply}$  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°C. (Notes 8, 9)

Parameter	Symbol	Conditions		Min	Тур	Max	Unit	
AC CHARACTERISTICS		•	•					
Unity Gain Bandwidth	UGBW	C <sub>L</sub> =	25 pF		3.2		MHz	
Slew Rate at Unity Gain	SR	C <sub>L</sub> =	20 pF		2.7		V/μs	
Phase Margin	$\phi_{\text{m}}$	C <sub>L</sub> =	25 pF		50		0	
Gain Margin	A <sub>m</sub>	C <sub>L</sub> =	25 pF		14		dB	
Cottling Time		$V_O = 3 \text{ Vpp},$	Settling time to 0.1%		1.2			
Settling Time	t <sub>S</sub>	Gain = 1, C <sub>L</sub> = 20 pF Settlin	Settling time to 0.01%		5.6		μS	
NOISE CHARACTERISTICS								
Total Harmonic Distortion plus Noise	THD+N	$V_{IN} = 2.5 \text{ Vpp},$	f = 1 kHz, Av = 1		0.009		%	
January Dafamad Voltaga Naisa		f = 1 kHz			30		->/// <del>  </del>	
Input Referred Voltage Noise	e <sub>n</sub>	f = 1	0 kHz		20		nV/√Hz	
Input Referred Current Noise	i <sub>n</sub>	f = 1	l kHz		0.25		fA/√ <del>Hz</del>	
SUPPLY CHARACTERISTICS								
D 0 1 D 1 # D #	5055			114	135		Ī	
Power Supply Rejection Ratio	PSRR	PSRR No Load		100			dB	
D 0 10: 10 1						410	530	
Power Supply Quiescent Current	$I_{DD}$	Per channel, no load				630	μΑ	

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<sub>S</sub> = 10 V**

 $T_A = 25^{\circ}\text{C}$ ;  $R_L \ge 10 \text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid}$ –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°C. (Notes 10, 11)

Parameter	Symbol	Cond	itions	Min	Тур	Max	Unit
INPUT CHARACTERISTICS	•			•	•		•
Input Offset Voltage	V				1.3	±3	mV
	V <sub>OS</sub>					±4	mV
Offset Voltage Drift	ΔV <sub>OS</sub> /ΔT	T <sub>A</sub> = 25°C	to 125°C		2		μV/°C
Input Bias Current (Note 11)					5	200	рА
	I <sub>IB</sub>					1500	рA
					2	75	pА
Input Offset Current (Note 11)	Ios	NCx20072				400	рA
		NCx2	20074			175	рA
Channel Consention	VTLK	DC	NCx20072		100		-10
Channel Separation	XTLK	DC	NCx20074		115		dB
Differential Input Resistance	R <sub>ID</sub>				50		GΩ
Common Mode Input Resistance	R <sub>IN</sub>				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.

<sup>10.</sup> Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.

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

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

 $T_A = 25^{\circ}\text{C}$ ;  $R_L \ge 10 \text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid}$ -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°C. (Notes 10, 11)

Parameter	Symbol	Cond	litions	Min	Тур	Max	Unit
INPUT CHARACTERISTICS							
Differential Input Capacitance	C <sub>ID</sub>				1.5		pF
Common Mode Input Capacitance	C <sub>CM</sub>				3.5		pF
0 11 1 2 1 1 2 1	01400			110	130		i.
Common Mode Rejection Ratio	CMRR	$V_{CM} = 0 \text{ V to}$	V <sub>DD</sub> – 1.35 V	87			dB
OUTPUT CHARACTERISTICS							
Ones Leen Voltage Cain	۸			98	120		40
Open Loop Voltage Gain	$A_{VOL}$			88			dB
Output Ourse at Ourse at The		Op amp sin	Op amp sinking current		50		4
Output Current Capability	lΟ	Op amp sourcing current			65		mA
Output Valta and High		Valta an autaut audi	an form a native wall		0.023	0.08	V
Output Voltage High	V <sub>OH</sub>	voltage output swil	ng from positive rail			0.10	
Output Malta va Lavo		Malta na code od cod	- form of the self		0.022	0.3	.,,
Output Voltage Low	$V_{OL}$	Voltage output swing from negative rail				0.35	V
AC CHARACTERISTICS							
Unity Gain Bandwidth	UGBW	C <sub>L</sub> = 25 pF			3.2		MHz
Slew Rate at Unity Gain	SR	C <sub>L</sub> =	20 pF		2.2		V/μs
Phase Margin	φm	C <sub>L</sub> =	25 pF		50		٥
Gain Margin	A <sub>m</sub>	C <sub>L</sub> =	25 pF		14		dB
Cottling Time		$V_{O} = 8.5 \text{ Vpp},$ Gain = 1, $C_{L} = 20 \text{ pF}$	Settling time to 0.1%		3.4		
Settling Time	t <sub>S</sub>	Gain = 1, $C_L = 20 \text{ pF}$	Settling time to 0.01%		6.8		μs
NOISE CHARACTERISTICS							
Total Harmonic Distortion plus Noise	THD+N	V <sub>IN</sub> = 7.5 Vpp, f	= 1 kHz, Av = 1		0.004		%
Law et Dafamad Valtaga Naia	_	f = 1	kHz		30		->/// <del>  </del>
Input Referred Voltage Noise	e <sub>n</sub>	f = 10	0 kHz		20		nV/√ <del>Hz</del>
Input Referred Current Noise	i <sub>n</sub>	f = 1 kHz			0.25		fA/√ <del>Hz</del>
SUPPLY CHARACTERISTICS							
Dawer Cumply Dejection Datio	PSRR	No Load		114	135		٩D
Power Supply Rejection Ratio	FORK			100			- dB
Power Supply Quicesent Current		Danie and a land			416	540	Λ
Power Supply Quiescent Current	I <sub>DD</sub>	rei chann	Per channel, no load			640	μΑ

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.

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

### **ELECTRICAL CHARACTERISTICS AT V<sub>S</sub> = 36 V**

 $T_A = 25^{\circ}\text{C}$ ;  $R_L \ge 10 \text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid}$ -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°C. (Notes 12, 13)

Parameter	Symbol	Cond	litions	Min	Тур	Max	Unit	
INPUT CHARACTERISTICS		•			•	-	-	
Lawret Office ( ) Vellages					1.3	±3	mV	
Input Offset Voltage	Vos					±4	mV	
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	T <sub>A</sub> = 25°C	C to 125°C		2		μV/°C	
Input Dica Current (Note 12)					5	200	pA	
Input Bias Current (Note 13)	I <sub>IB</sub>					1500	рA	
					2	75	pA	
Input Offset Current (Note 13)	$I_{OS}$	NCx2	20072			400	pА	
		NCx2	NCx20074			175	рA	
Channel Separation	VTLK	DC	NCx20072		100		dВ	
Channel Separation	XTLK	DC	NCx20074		115		dB	
Differential Input Resistance	R <sub>ID</sub>				50		GΩ	
Common Mode Input Resistance	R <sub>IN</sub>				5		GΩ	
Differential Input Capacitance	C <sub>ID</sub>				1.5		pF	
Common Mode Input Capacitance	C <sub>CM</sub>				3.5		pF	
Occurred Made Defection Defe	OMPD	V 0.V/1-	V 4.05.V	120	145		JD.	
Common Mode Rejection Ratio	CMRR	$V_{CM} = 0 V to$	V <sub>DD</sub> – 1.35 V	95			dB	
OUTPUT CHARACTERISTICS								
Ones Lean Valtage Cain	۸			98	120		٩D	
Open Loop Voltage Gain	$A_{VOL}$			88			dB	
Output Compat Compatility		Op amp sin	king current		50		^	
Output Current Capability	IO	Op amp sou	rcing current		65		- mA	
					0.074	0.10		
Output Voltage High	$V_{OH}$	Voltage output swing from positive rail	NCx20072			0.15	V	
			NCx20074			0.12		
0	.,	V 16			0.065	0.3	.,	
Output Voltage Low	$V_{OL}$	Voltage output swir	ng from negative rail			0.35	V	
AC CHARACTERISTICS								
Unity Gain Bandwidth	UGBW	C <sub>L</sub> =	25 pF		3.2		MHz	
Slew Rate at Unity Gain	SR	C <sub>L</sub> =	20 pF		2.4		V/μs	
Phase Margin	φm	C <sub>L</sub> =	25 pF		50		0	
Gain Margin	A <sub>m</sub>	C <sub>L</sub> =	25 pF		14		dB	
O uti Ti		V <sub>O</sub> = 10 Vpp,	Settling time to 0.1%		3.2			
Settling Time	t <sub>S</sub>	Gain = 1, $C_L = 20 \text{ pF}$	Settling time to 0.01%		6.8		μS	
NOISE CHARACTERISTICS								
Total Harmonic Distortion plus Noise	THD+N	V <sub>IN</sub> = 28.5 Vpp,	f = 1 kHz, Av = 1		0.001		%	
Lament Defermed Malt. N. 1		f = 1	kHz		30		-1//	
Input Referred Voltage Noise	$e_n$	f = 10 kHz			20	i e	nV/√ <del>Hz</del>	

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.

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

### **ELECTRICAL CHARACTERISTICS AT V<sub>S</sub> = 36 V**

 $T_A = 25^{\circ}\text{C}$ ;  $R_L \ge 10 \text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid}$ -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°C. (Notes 12, 13)

Parameter	Symbol	Conditions	Min	Тур	Max	Unit
NOISE CHARACTERISTICS						
Input Referred Current Noise	i <sub>n</sub>	f = 1 kHz		0.25		fA/√ <del>Hz</del>
SUPPLY CHARACTERISTICS						
Develop October Delication Delica	DODD	Nelsed	114	135		dB
Power Supply Rejection Ratio	PSRR	No Load	100			
D	uiescent Current I <sub>DD</sub> Per channe	Parala and and and		465	600	
Power Supply Quiescent Current		Per channel, no load			700	μΑ

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.

<sup>12.</sup> Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.

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

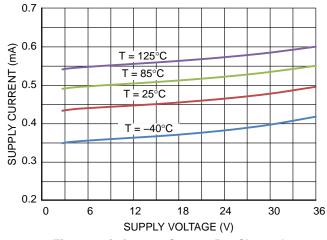


Figure 2. Quiescent Current Per Channel vs. Supply Voltage

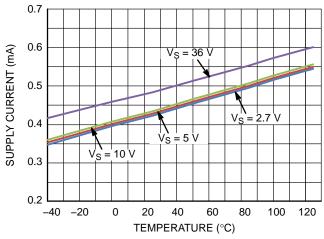


Figure 3. Quiescent Current vs. Temperature

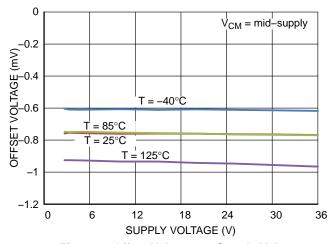


Figure 4. Offset Voltage vs. Supply Voltage

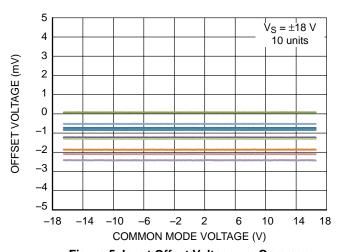


Figure 5. Input Offset Voltage vs. Common Mode Voltage

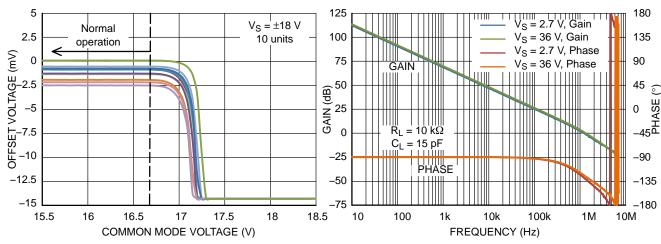


Figure 6. Input Offset Voltage vs. Common Mode Voltage

Figure 7. Gain and Phase vs. Frequency

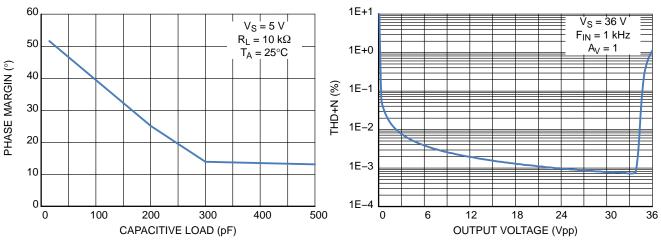


Figure 8. Phase Margin vs. Capacitive Load

Figure 9. THD+N vs. Output Voltage

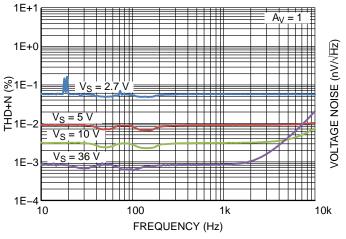


Figure 10. THD+N vs. Frequency

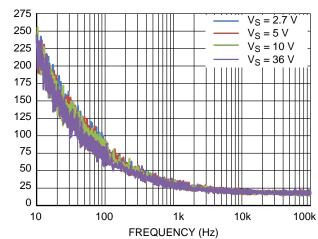


Figure 11. Input Voltage Noise vs. Frequency

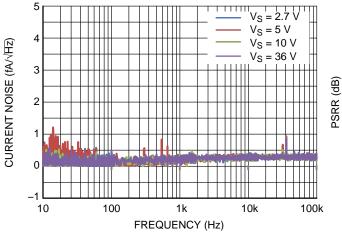


Figure 12. Input Current Noise vs. Frequency

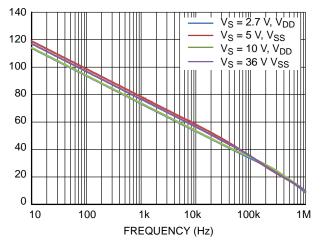
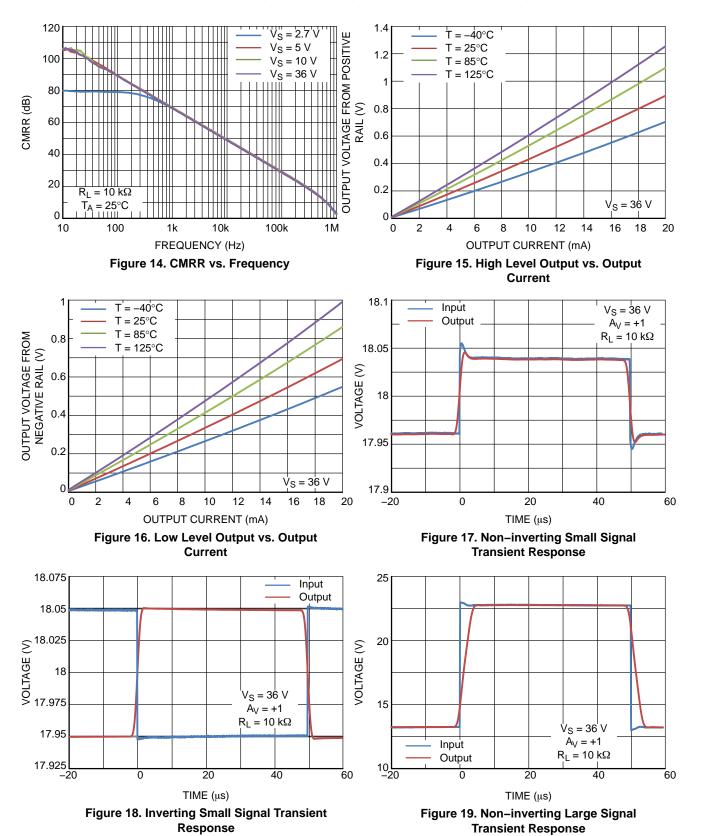


Figure 13. PSRR vs. Frequency



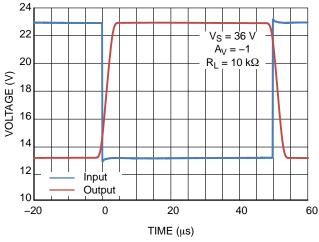


Figure 20. Inverting Large Signal Transient Response

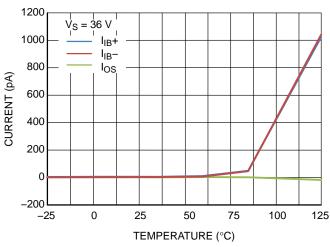


Figure 21. Input Bias and Offset Current vs.
Temperature

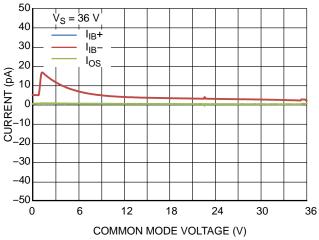


Figure 22. Input Bias Current vs. Common Mode Voltage

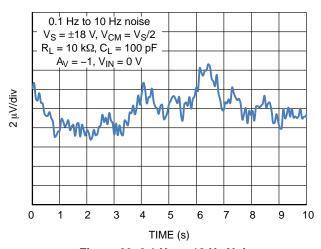


Figure 23. 0.1 Hz to 10 Hz Noise

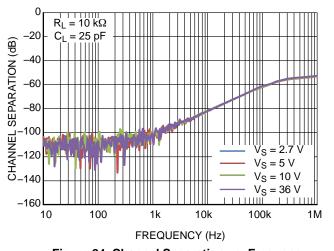


Figure 24. Channel Separation vs. Frequency

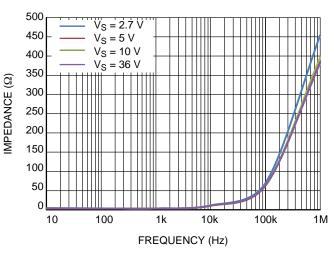
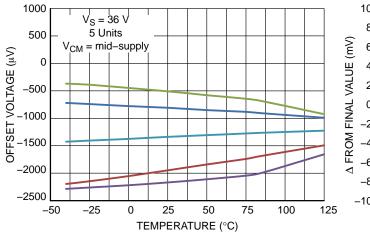


Figure 25. Open Loop Output Impedance



V<sub>S</sub> = 36 V 10 V step 8 6 4 2 0  $\pm 1/2$ LSB =  $\pm 0.024\%$ -2 -4 -6 -8 -10 5 25 10 15 20 30 35 40 45 50 TIME (µs)

Figure 26. Offset Voltage vs. Temperature

Figure 27. Large Signal Settling Time

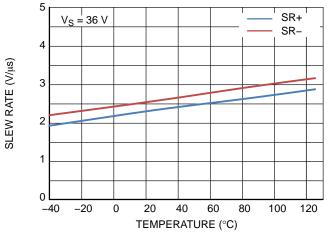
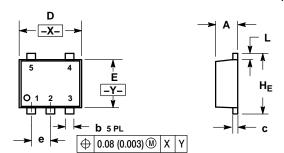


Figure 28. Slew Rate vs. Temperature

### **PACKAGE DIMENSIONS**

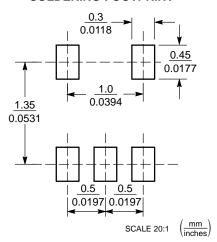
### **SOT-553, 5 LEAD** CASE 463B ISSUE C



- 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. DIADET METER THICKNESS OF BASE MATERIAL.

	MILLIMETERS			INCHES		
DIM	MIN	NOM	MAX	MIN	NOM	MAX
Α	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
С	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
е	0.50 BSC			0.020 BSC		
L	0.10	0.20	0.30	0.004	0.008	0.012
HE	1.55	1.60	1.65	0.061	0.063	0.065

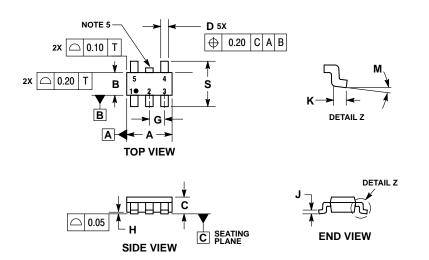
#### **RECOMMENDED SOLDERING FOOTPRINT\***



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

### **PACKAGE DIMENSIONS**

TSOP-5 CASE 483-02 ISSUE K

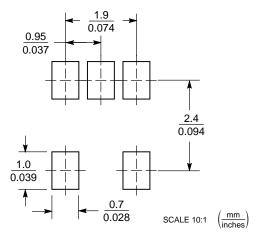


#### NOTES:

- 1. DIMENSIONING AND TOLERANCING PER ASME
- Y14.5M, 1994. CONTROLLING DIMENSION: MILLIMETERS.
- 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			
Α	3.00	BSC			
В	1.50	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			
М	0° 10°				
S	2.50 3.00				

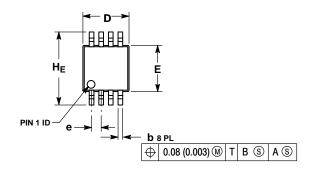
### **SOLDERING FOOTPRINT\***

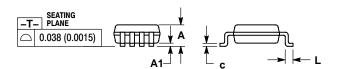


\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

### **PACKAGE DIMENSIONS**

Micro8™ CASE 846A-02 **ISSUE J** 





- NOTES:

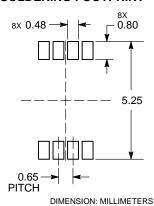
  1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- CONTROLLING DIMENSION: MILLIMETER.
   DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE 3. DIMENSION A DUES NOT INCLUDE MOLLO FLASH, PHOTHOSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.15 (0.06) PER SIDE.

  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
Α			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
С	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
е	0.65 BSC				0.026 BSC	)
L	0.40	0.55	0.70	0.016	0.021	0.028
HE	4.75	4.90	5.05	0.187	0.193	0.199

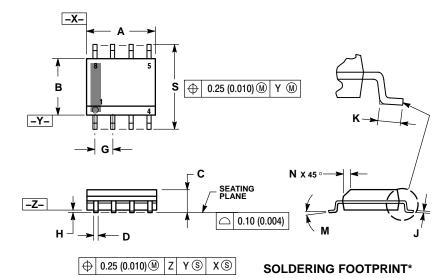
#### **RECOMMENDED SOLDERING FOOTPRINT\***



\*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:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
   CONTROLLING DIMENSION: MILLIMETER.
   DIMENSION A AND B DO NOT INCLUDE

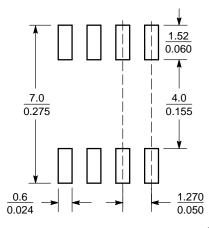
- MOLD PROTRUSION.

  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.

	MILLIN	IETERS	INCHES		
DIM	MIN	MAX	MIN	MAX	
Α	4.80	5.00	0.189	0.197	
В	3.80	4.00	0.150	0.157	
O	1.35	1.75	0.053	0.069	
D	0.33	0.51	0.013	0.020	
G	1.27 BSC		0.050 BSC		
Н	0.10	0.25	0.004	0.010	
J	0.19	0.25	0.007	0.010	
Κ	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	

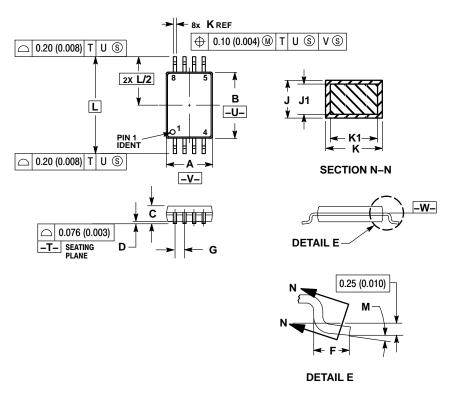


SCALE 6:1

<sup>\*</sup>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.

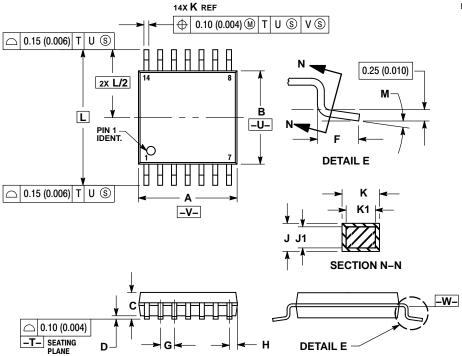
  5. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.

  6. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE –W-.

	MILLIN	IETERS	INCHES		
DIM	MIN	MAX	MIN	MAX	
Α	2.90	3.10	0.114	0.122	
В	4.30	4.50	0.169	0.177	
С		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		
ے	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		
М	0°	8°	0°	8 0	

### **PACKAGE DIMENSIONS**

TSSOP-14 CASE 948G ISSUE B



#### NOTES:

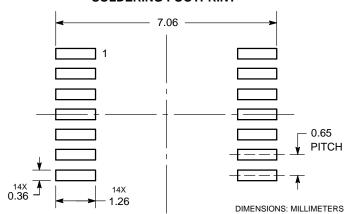
- DIMENSIONING AND TOLERANCING PER
   ANSI V14 5M 1982
- ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: MILLIMETER.
- 3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
- EXCEED 0.15 (0.006) PER SIDE.

  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
- DIMENSION K DOES NOT INCLUDE DAMBAI PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
- TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
- 7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

_					
	MILLIN	IETERS	INCHES		
DIM	MIN	MAX	MIN	MAX	
Α	4.90	5.10	0.193	0.200	
В	4.30	4.50	0.169	0.177	
С		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		
Н	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	
٦	6.40 BSC		0.252	BSC	
М	0 °	8 °	0 °	8 °	

### **SOLDERING FOOTPRINT\***

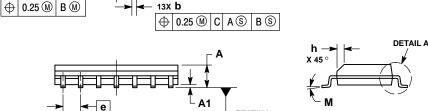


\*For additional information on our Pb–Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

#### PACKAGE DIMENSIONS

SOIC-14 NB

### CASE 751A-03 ISSUE K В Н Н Н DETAIL A

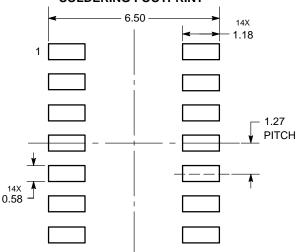


C SEATING PLANE

- 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

	MILLIN	IETERS	INCHES	
DIM	MIN	MAX	MIN	MAX
Α	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
Е	3.80	4.00	0.150	0.157
е	1.27	BSC	0.050 BSC	
Н	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
М	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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