# 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.

#### **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



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SOT-553 CASE 463B

TSOP-5 CASE 483





Micro8<sup>™</sup> 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.

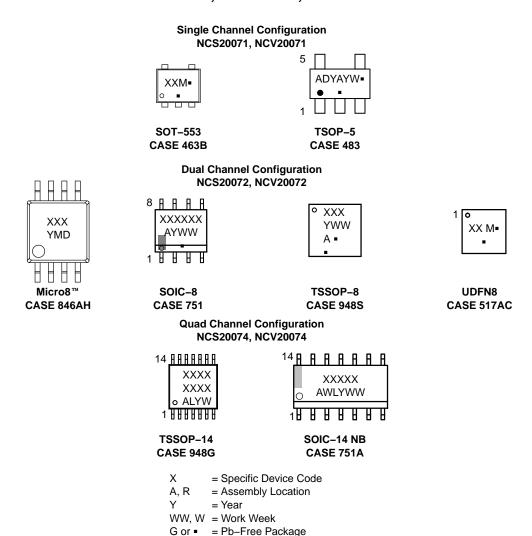
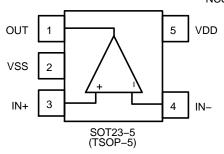
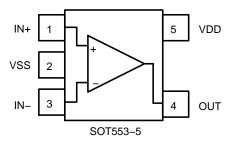


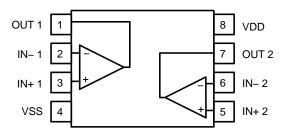
Figure 1. Marking Diagrams

#### Single Channel Configuration NCS20071, NCV20071





#### Dual Channel Configuration NCS20072, NCV20072



#### Quadruple Channel Configuration NCS20074, NCV20074

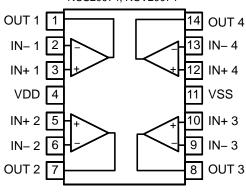


Figure 2. Pin Connections

#### **ORDERING INFORMATION**

Device	Configuration	Automotive	Marking	Package	Shipping <sup>†</sup>									
NCS20071SN2T1G*		No	*	SOT23-5 (TSOP-5) (Pb-Free)	3000 / Tape and Reel									
NCS20071*	O's alla		*	SOT553-5 (Pb-Free)	4000 / Tape and Reel									
NCV20071SN2T1G*	Single	Yes	*	SOT23-5 (TSOP-5) (Pb-Free)	3000 / Tape and Reel									
NCV20071*			*	SOT553-5 (Pb-Free)	4000 / Tape and Reel									
NCS20072DMR2G*			*	Micro8 (MSOP8) (Pb-Free)	4000 / Tape and Reel									
NCS20072DR2G*			*	SOIC-8 (Pb-Free)	2500 / Tape and Reel									
NCS20072DTBR2G*		No -	*	TSSOP-8 (Pb-Free)	3000 / Tape and Reel									
NCS20072*	Ī .		*	UDFN8 (Pb-Free)	3000 / Tape and Reel									
NCV20072DMR2G*	Dual		*	Micro8 (MSOP8) (Pb-Free)	4000 / Tape and Reel									
NCV20072DR2G*			*	SOIC-8 (Pb-Free)	2500 / Tape and Reel									
NCV20072DTBR2G*		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	*	TSSOP-8 (Pb-Free)	3000 / Tape and Reel
NCV20072*			*	UDFN8 (Pb-Free)	3000 / Tape and Reel									
NCS20074DR2G			NCS20074	SOIC-14 (Pb-Free)	2500 / Tape and Reel									
NCS20074DTBR2G	0.01	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.
\*Contact local sales office for more information

#### **ABSOLUTE MAXIMUM RATINGS** (Note 1)

Rating	Symbol	Limit	Unit
Supply Voltage (V <sub>DD</sub> – V <sub>SS</sub> ) (Note 2)	V <sub>S</sub>	40	V
Input Voltage	V <sub>I</sub>	V <sub>SS</sub> – 0.2 to V <sub>DD</sub> + 0.2	V
Differential Input Voltage	V <sub>ID</sub>	±V <sub>S</sub>	V
Maximum Input Current	I <sub>I</sub>	±10	mA
Maximum Output Current	l <sub>O</sub> ±100 n		
Continuous Total Power Dissipation (Note 2)	P <sub>D</sub>	200	mW
Maximum Junction Temperature	TJ	150	°C
Storage Temperature Range	T <sub>STG</sub>	-65 to 150	°C
Mounting Temperature (Infrared or Convection – 20 sec)	T <sub>mount</sub>	260	°C
ESD Capability (Note 3)  Human Body Model Machine Model Charged Device Model	ESD <sub>HBM</sub> ESD <sub>CDM</sub>	2000 150 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 CHARACTERISTICS and APPLICATION INFORMATION for Safe Operating Area.
- 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)
- Latch-up Current tested per JEDEC standard: JESD78 (AEC-Q100-004)
   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	
hunding to Ambient		SOIC-8	190	
Junction-to-Ambient	$\theta_{\sf JA}$	TSSOP-8	140	
		UDFN-8	350	
		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**<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	Cond	litions	Min	Тур	Max	Unit
INPUT CHARACTERISTICS			-		1 71		1
					1.3	±3	mV
Input Offset Voltage	Vos					±4	mV
Offset Voltage Drift	ΔV <sub>OS</sub> /ΔT	T <sub>A</sub> = 25°C	C to 125°C		2		μV/°C
1					5	200	рА
Input Bias Current	I <sub>IB</sub>	No	te 7			1500	рА
Innut Offact Current		No			2	75	pА
Input Offset Current	los	INO	te 7			175	рА
Channel Separation	XTLK	С	OC		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
Common Mode Paination Patin	CMRR			90	110		dB
Common Mode Rejection Ratio	CIVIKK	v <sub>CM</sub> = 0 v to	V <sub>DD</sub> = 1.35 V	69			UD.
OUTPUT CHARACTERISTICS							
Open Loop Voltage Gain	۸			96	118		dB
Open Loop voltage Gain	$A_{VOL}$			86			
Output Current Canability	I-	Op amp sin	king current		70		mA
Output Current Capability	lo	Op amp sou	rcing current		50		
Output Voltage High	V	Voltage output owi	ng from positive roil		0.006	0.15	V
Output Voltage High	V <sub>OH</sub>	voltage output swi	ng from positive rail			0.22	V
Output Voltage Low	Va	Voltago output swir	ng from negative rail		0.005	0.15	V
Output voltage Low	V <sub>OL</sub>	voltage output swii	ig 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	$\phi_{\text{m}}$	C <sub>L</sub> =	25 pF		50		0
Gain Margin	A <sub>m</sub>	C <sub>L</sub> =	25 pF		14		dB
Settling Time	+-	$V_O = 1 \text{ Vpp},$	Settling time to 0.1%		0.6		6
Settling 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		f = 1 kHz			30		nV/√Hz
input Referred voltage Noise	e <sub>n</sub>	f = 10 kHz			20		IIV/ V⊓Z
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 $V_S = 2.7 \text{ V}$

 $T_A = 25^{\circ}\text{C}$ ;  $R_L \ge 10 \text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid-supply}$  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	Conditions		Min	Тур	Max	Unit
SUPPLY CHARACTERISTICS							
Davis Over by Data etter Data	DODD	Natard		114	135		4D
Power Supply Rejection Ratio	PSRR	No Load		100			dB
D	I <sub>DD</sub> Pe	Per channel, no load			405	525	μΑ
Power Supply Quiescent Current						625	

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- 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<sub>S</sub> = 5 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
INPUT CHARACTERISTICS			•			
Innut Offact Valtage	V			1.3	±3	mV
Input Offset Voltage	V <sub>OS</sub>				±4	mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	T <sub>A</sub> = 25°C to 125 °C		2		μV/°C
Input Bias Current	_	Note 9		5	200	рА
input bias Current	I <sub>IB</sub>	Note 9			1500	рA
Input Offset Current	1	Note 9		2	75	pА
Input Onset Current	los	Note 9			175	pА
Channel Separation	XTLK	DC		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
Common Made Deigetien Detic	OMPR	V	105	125		10
Common Mode Rejection Ratio	CMRR	$V_{CM} = 0 \text{ V to } V_{DD} - 1.35 \text{ V}$	80			dB
OUTPUT CHARACTERISTICS						
Open Loop Voltage Gain	۸		96	120		dB
Open Loop voltage Gain	A <sub>VOL</sub>		86			uБ
Output Compat Canability		Op amp sinking current		50		A
Output Current Capability	I <sub>O</sub>	Op amp sourcing current		60		mA
Output Valtage Lligh	V	Voltage output outing from positive and		0.013	0.20	V
Output Voltage High	V <sub>OH</sub>	Voltage output swing from positive rail			0.25	]
Output Valtage Law	V	Voltage output output from pageting and		0.01	0.10	V
Output Voltage Low	V <sub>OL</sub>	Voltage output swing from negative rail			0.15	

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> = 5 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	Cond	litions	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	$\phi_{m}$	C <sub>L</sub> =	25 pF		50		0	
Gain Margin	A <sub>m</sub>	C <sub>L</sub> =	25 pF		14		dB	
0.48		$V_O = 3 \text{ Vpp},$	Settling time to 0.1%		1.2			
Settling Time	t <sub>S</sub>	0 . 4 0 00 5	Settling time to 0.01%		5.6		μS	
NOISE CHARACTERISTICS								
Total Harmonic Distortion plus Noise	THD+N	V <sub>IN</sub> = 2.5 Vpp, 1	f = 1 kHz, Av = 1		0.009		%	
Land Deferred Velters Ne's		f = 1	kHz		30		->///	
Input Referred Voltage Noise	e <sub>n</sub>	f = 1	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			<u>.</u>					
D 0 1 D 1 11 D 11				114	135			
Power Supply Rejection Ratio	PSRR	No	Load -	100			dB	
	I <sub>DD</sub>					410	530	
Power Supply Quiescent Current		Per chann	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	Conditions	Min	Тур	Max	Unit
INPUT CHARACTERISTICS	•				•	
Leaved Office ( Violes as	V			1.3	±3	mV
Input Offset Voltage	V <sub>OS</sub>				±4	mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	$T_A = 25^{\circ}C$ to $125^{\circ}C$		2		μV/°C
Input Bias Current	I <sub>IB</sub>	Note 11		5	200	pА
					1500	рA
Innut Officet Coursest		Note 11		2	75	pА
Input Offset Current	los				175	рA
Channel Separation	XTLK	DC		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

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**<sub>S</sub> = 10 V  $T_A = 25$ °C;  $R_L \ge 10$  kΩ;  $V_{CM} = V_{OUT} = \text{mid}$ –supply unless otherwise noted. All limits are guaranteed by testing or statistical analysis. Boldface limits apply over the specified temperature range,  $T_A = -40$ °C to 125°C. (Notes 10, 11)

Parameter	Symbol	Cond	litions	Min	Тур	Max	Unit
INPUT CHARACTERISTICS		-					
0 11 1 5 1 5 5 5	01400			110	130		i.
Common Mode Rejection Ratio	CMRR	$V_{CM} = 0 V to$	V <sub>DD</sub> – 1.35 V	87			dB
OUTPUT CHARACTERISTICS							
Open Loop Voltage Gain	۸			98	120		dB
Open Loop Voltage Gain	A <sub>VOL</sub>			88			иБ
Output Current Canability		Op amp sin	king current		50		A
Output Current Capability	I <sub>O</sub>	Op amp sou	rcing current		65		mA
Output Voltage High	V	Voltago output awi	Voltage output swing from positive rail		0.023	0.08	V
Output voitage nigh	V <sub>OH</sub>	voltage output swing from positive rail				0.10	V
Output Voltage Low	V	Voltago output owir	Valta an autorit autorit franco a ratio a rail		0.022	0.3	V
Output voltage Low	V <sub>OL</sub>	Voltage output swing from negative rail				0.35	V
AC CHARACTERISTICS							
Unity Gain Bandwidth	UGBW	C <sub>L</sub> =	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
Outline Time		V <sub>O</sub> = 8.5 Vpp,	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, 1	= 1 kHz, Av = 1		0.004		%
Innut Defermed Velters Noise	_	f = 1	kHz		30		*)/// <del>[]=</del>
Input Referred Voltage Noise	e <sub>n</sub>	f = 1	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							
Dower Cumby Dejection Datio	PSRR	No Load		114	135		dB
Power Supply Rejection Ratio	FORK			100			ub ub
Power Supply Ouisseet Current	I=-	Per channel, no load			416	540	^
Power Supply Quiescent Current	I <sub>DD</sub>					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.

11. 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	itions	Min	Тур	Max	Unit
INPUT CHARACTERISTICS							
least Offeet Veltere					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
January Dies Comment		Not	Note 13		5	200	рА
Input Bias Current	I <sub>IB</sub>	NOU	e 13			1500	рA
January Officer Course at		Not	- 12		2	75	рА
Input Offset Current	los	NOU	e 13			175	рA
Channel Separation	XTLK	D	C		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
Common Made Deinstine Detin	CMDD	V 0.V/45	V 4.25.V	120	145		-ID
Common Mode Rejection Ratio	CMRR	$V_{CM} = 0 V \text{ to } V_{DD} - 1.35 V$		95			dB
OUTPUT CHARACTERISTICS							
On and I am Mallana On's				98	120		.ID
Open Loop Voltage Gain	$A_{VOL}$			88			dB
Outrot Compatibility		Op amp sin	king current		50		A
Output Current Capability	lo	Op amp sou	rcing current		65		mA
Outrot Valta and High	\ /	Valta an autaut audi	on financia manaisti ya mail		0.074	0.10	V
Output Voltage High	V <sub>OH</sub>	voitage output swii	ng from positive rail			0.12	
Outrot Value and Leave		Valta na autout audi	(		0.065	0.3	.,
Output Voltage Low	$V_{OL}$	voitage 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	$\phi_{\text{m}}$	C <sub>L</sub> =	25 pF		50		0
Gain Margin	A <sub>m</sub>	C <sub>L</sub> =	25 pF		14		dB
0.411		V <sub>O</sub> = 10 Vpp,	Settling time to 0.1%		3.2		
Settling Time	t <sub>S</sub>	Gain = 1, C <sub>L</sub> = 20 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		%
January Defended Malter at Nicker	_	f = 1	kHz		30		\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
Input Referred Voltage Noise	e <sub>n</sub>	f = 10	) kHz		20		nV/√ <del>Hz</del>
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.

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

Parameter	Symbol	Conditions	Min	Тур	Max	Unit
SUPPLY CHARACTERISTICS						
Davis Over la Daia etia a Datia	PSRR	No Load	114	135		4D
Power Supply Rejection Ratio			100			dB
Power Supply Quiescent Current	I <sub>DD</sub>	Bench and an load		465	600	^
		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.

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.

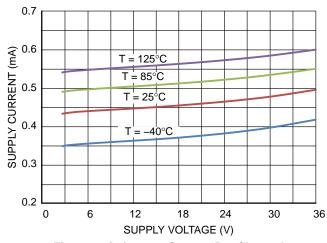


Figure 3. Quiescent Current Per Channel vs. Supply Voltage

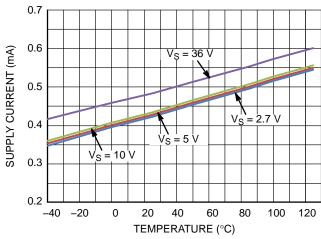


Figure 4. Quiescent Current vs. Temperature

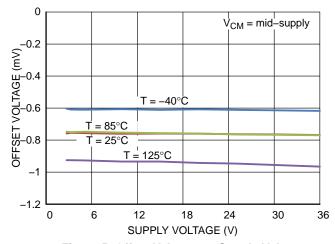


Figure 5. Offset Voltage vs. Supply Voltage

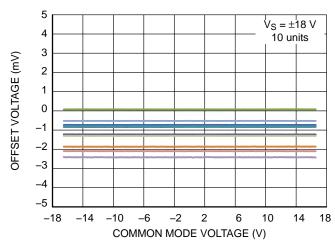


Figure 6. Input Offset Voltage vs. Common Mode Voltage

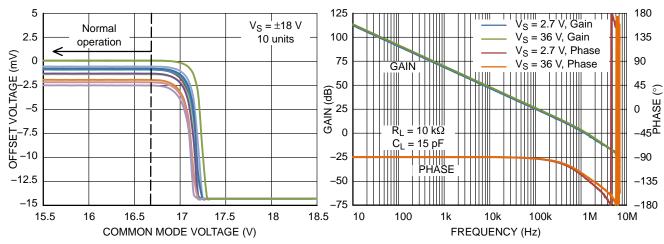


Figure 7. Input Offset Voltage vs. Common Mode Voltage

Figure 8. Gain and Phase vs. Frequency

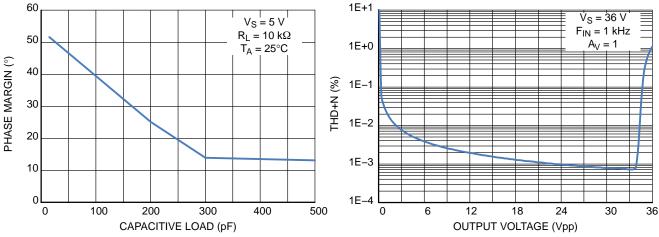


Figure 9. Phase Margin vs. Capacitive Load

Figure 10. THD+N vs. Output Voltage

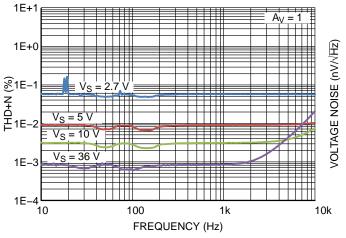


Figure 11. THD+N vs. Frequency

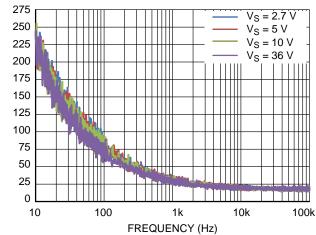


Figure 12. Input Voltage Noise vs. Frequency

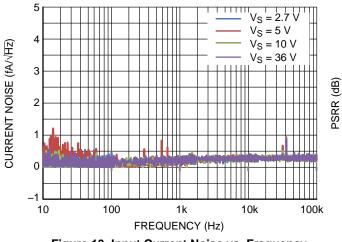


Figure 13. Input Current Noise vs. Frequency

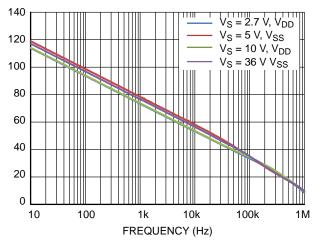
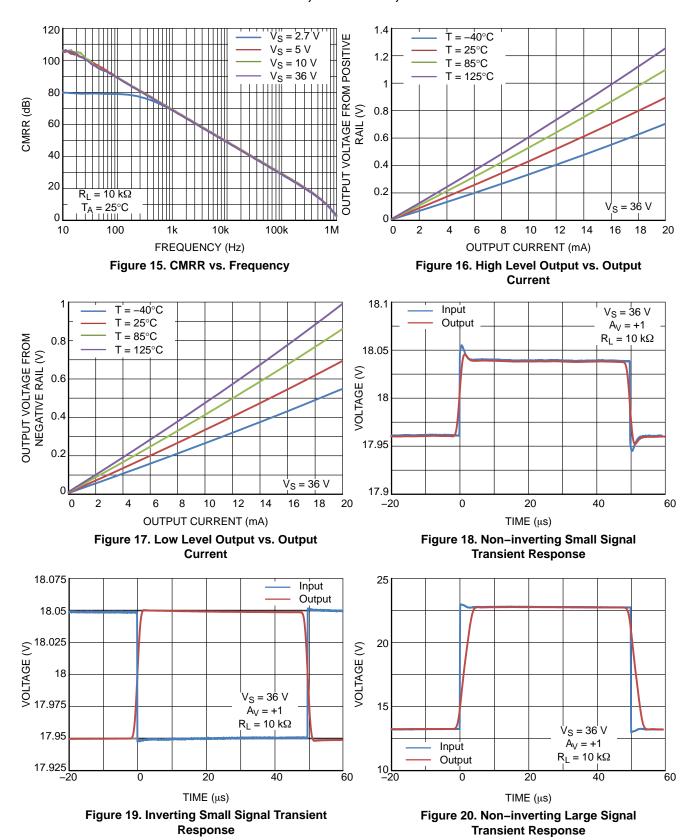


Figure 14. PSRR vs. Frequency



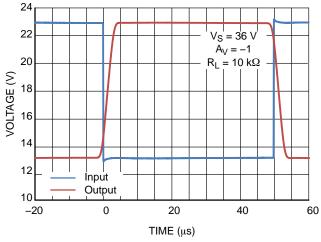


Figure 21. Inverting Large Signal Transient Response

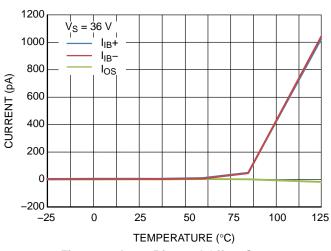


Figure 22. Input Bias and Offset Current vs.
Temperature

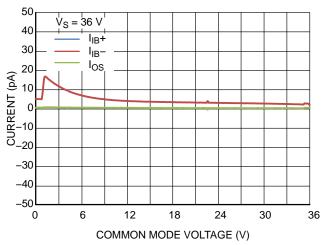


Figure 23. Input Bias Current vs. Common Mode Voltage

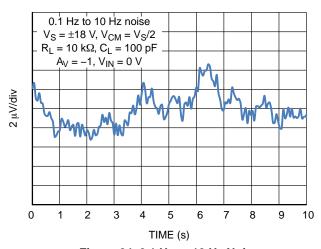


Figure 24. 0.1 Hz to 10 Hz Noise

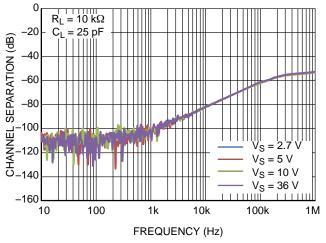


Figure 25. Channel Separation vs. Frequency

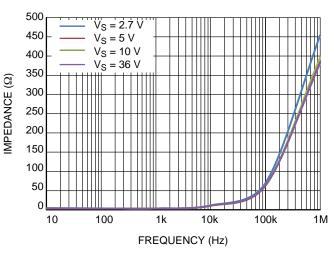


Figure 26. Open Loop Output Impedance

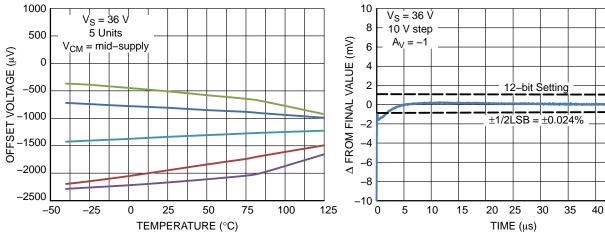


Figure 27. Offset Voltage vs. Temperature

Figure 28. Large Signal Settling Time

45

50

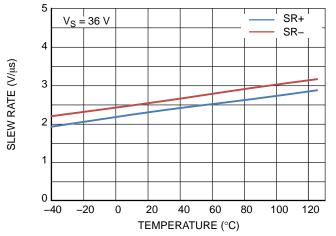
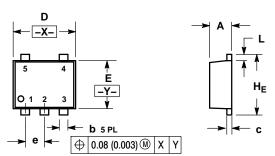


Figure 29. Slew Rate vs. Temperature

#### **PACKAGE DIMENSIONS**

#### **SOT-553, 5 LEAD**

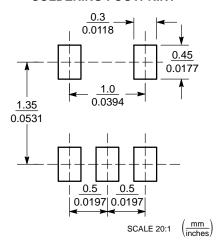
CASE 463B ISSUE C



- 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.

	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

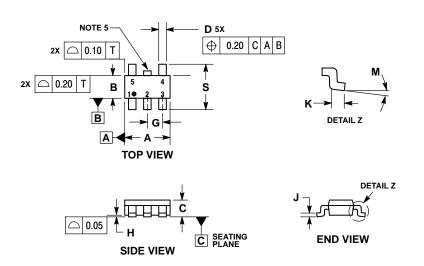
#### **RECOMMENDED SOLDERING FOOTPRINT\***



\*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

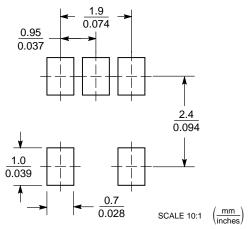


#### NOTES:

- 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	3.00 BSC			
В	1.50	1.50 BSC			
С	0.90	1.10			
D	0.25	0.50			
G	0.95 BSC				
Н	0.01	0.10			
J	0.10	0.26			
K	0.20	0.60			
M	0 °	10 °			
S	2 50	3.00			

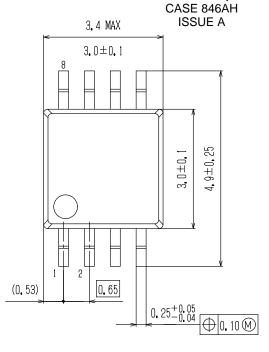
#### **SOLDERING FOOTPRINT\***

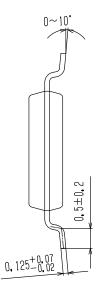


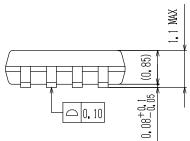
\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

### **PACKAGE DIMENSIONS**

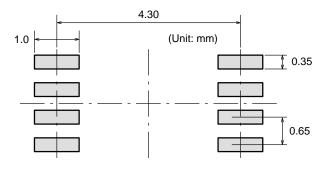
### Micro8 / MSOP8 (150 mil)







## **SOLDERING FOOTPRINT\***

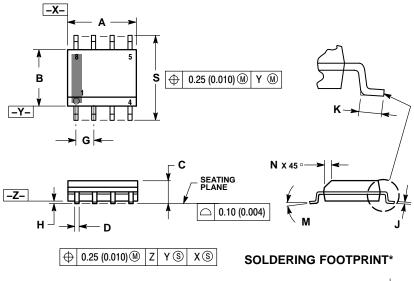


NOTE: The measurements are not to guarantee but for reference only.

\*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:

- NOTES:

  1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

  2. CONTROLLING DIMENSION: MILLIMETER.

  3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.

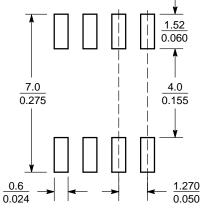
  4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) DED SIDE

- 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	
С	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	
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	

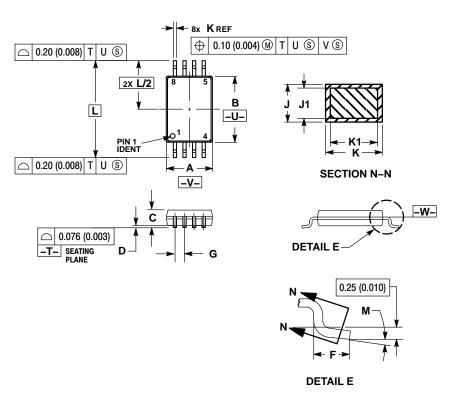


<sup>\*</sup>For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

SCALE 6:1

### **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.

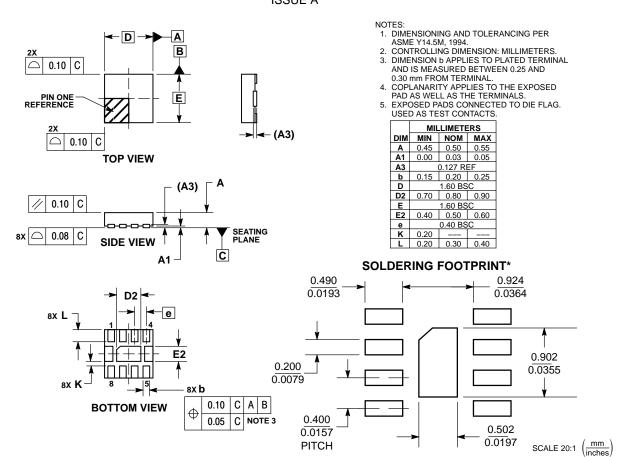
  5. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.

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

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
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	
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

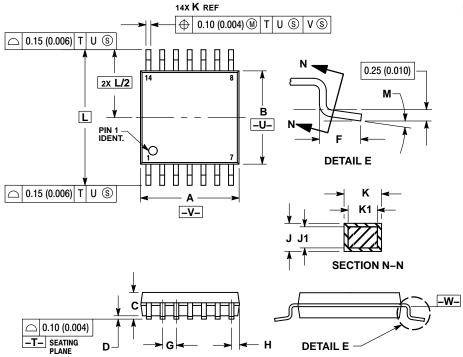
# **UDFN8, 1.6x1.6, 0.4P**CASE 517AC ISSUE A



\*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**



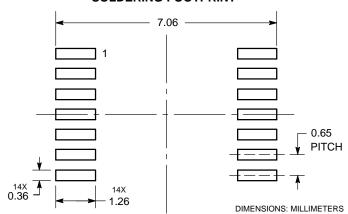
#### NOTES:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982. CONTROLLING DIMENSION: MILLIMETER.

- 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 (0.03) TOTAL IN EXCESS OF THE K DIMENSION AT
- IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
- TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
  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	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		
M	0 °	Q	0 0	80	

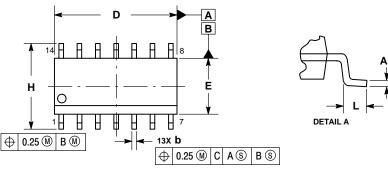
#### **SOLDERING FOOTPRINT\***

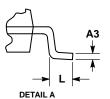


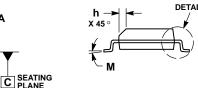
\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

#### PACKAGE DIMENSIONS

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





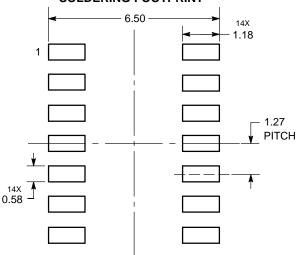


#### NOTES:

- DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
- 2. CONTROLLING DIMENSION: MILLIMETERS.
  3. DIMENSION & 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

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