

# NCS2501

## 1.1 mA 200 MHz Current Feedback Op Amp with Enable Feature

NCS2501 is a 1.1 mA 200 MHz current feedback monolithic operational amplifier featuring high slew rate and low differential gain and phase error. The current feedback architecture allows for a superior bandwidth and low power consumption. This device features an enable pin.

### Features

- -3.0 dB Small Signal BW ( $A_V = +2.0$ ,  $V_O = 0.5 V_{p-p}$ ) 200 MHz Typ
- Slew Rate 450 V/ $\mu$ s
- Supply Current 1.1 mA
- Input Referred Voltage Noise 4.0 nV/ $\sqrt{\text{Hz}}$
- THD -55 dB ( $f = 5.0$  MHz,  $V_O = 2.0 V_{p-p}$ )
- Output Current 100 mA
- Enable Pin Available
- Pin Compatible with EL5160, MAX4180, OPA683
- Pb-Free Packages are Available

### Applications

- Portable Video
- Line Drivers
- Radar/Communication Receivers
- Set Top Box
- NTSC/PAL/HDTV

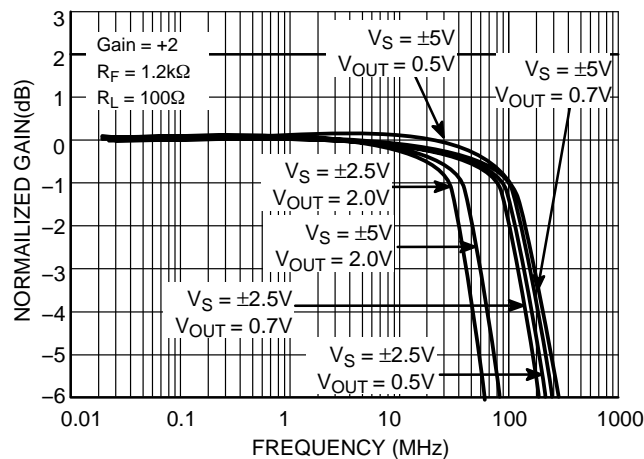


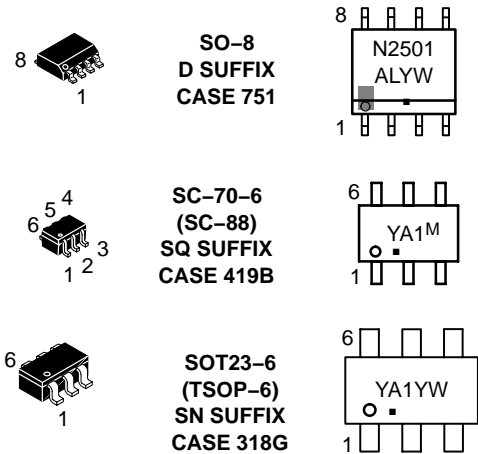
Figure 1. Frequency Response: Gain (dB) vs. Frequency  $A_V = +2.0$ ,  $R_L = 100 \Omega$



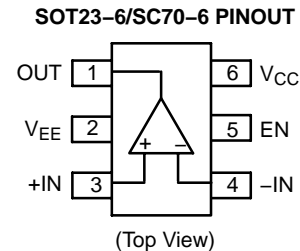
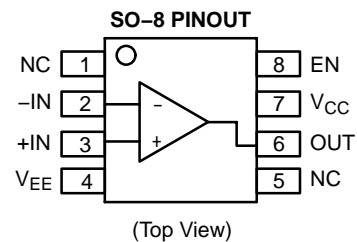
ON Semiconductor®

<http://onsemi.com>

### MARKING DIAGRAMS



YA1, N2501 = NCS2501  
 A = Assembly Location  
 L = Wafer Lot  
 Y = Year  
 W = Work Week  
 M = Date Code  
 ■ = Pb-Free Package



### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 13 of this data sheet.

# NCS2501

## PIN FUNCTION DESCRIPTION

Pin (SO-8)	Pin (SOT23/SC70)	Symbol	Function	Equivalent Circuit
6	1	OUT	Output	
4	2	V <sub>EE</sub>	Negative Power Supply	
3	3	+IN	Non-inverted Input	
2	4	-IN	Inverted Input	See Above
7	6	V <sub>CC</sub>	Positive Power Supply	
8	5	EN	Enable	
1, 8	N/A	NC	No Connect	

## ENABLE PIN TRUTH TABLE

	High*	Low
Enable	Enabled	Disabled

\*Default open state

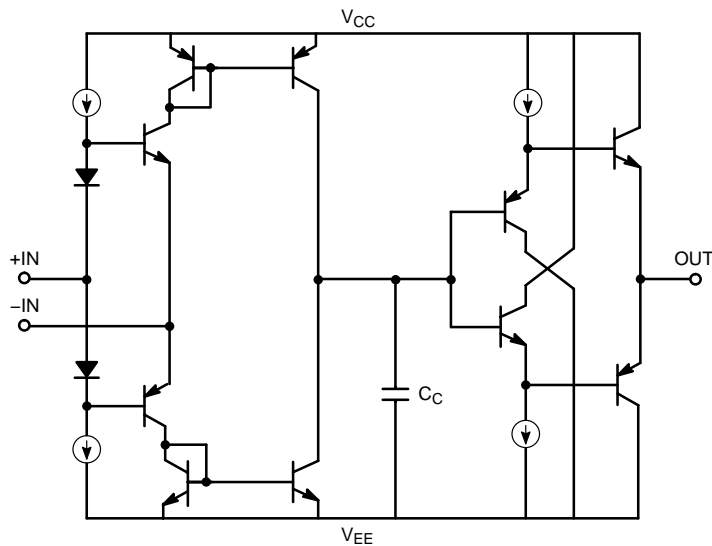


Figure 2. Simplified Device Schematic

# NCS2501

## ATTRIBUTES

Characteristics	Value
ESD	
Human Body Model	2.0 kV (Note 1)
Machine Model	200 V
Charged Device Model	1.0 kV
Moisture Sensitivity (Note 2)	Level 1
Flammability Rating    Oxygen Index: 28 to 34	UL 94 V-0 @ 0.125 in

- 0.8 kV between the input pairs +IN and -IN pins only. All other pins are 2.0 kV.
- For additional information, see Application Note AND8003/D.

## MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit
Power Supply Voltage	$V_S$	11	$V_{DC}$
Input Voltage Range	$V_I$	$\leq V_S$	$V_{DC}$
Input Differential Voltage Range	$V_{ID}$	$\leq V_S$	$V_{DC}$
Output Current	$I_O$	100	mA
Maximum Junction Temperature (Note 3)	$T_J$	150	$^{\circ}C$
Operating Ambient Temperature	$T_A$	-40 to +85	$^{\circ}C$
Storage Temperature Range	$T_{stg}$	-60 to +150	$^{\circ}C$
Power Dissipation	$P_D$	(See Graph)	mW
Thermal Resistance, Junction-to-Air	$R_{\theta JA}$		$^{\circ}C/W$
SO-8		172	
SC70-6		215	
SOT23-6		154	

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

- Power dissipation must be considered to ensure maximum junction temperature ( $T_J$ ) is not exceeded.

## MAXIMUM POWER DISSIPATION

The maximum power that can be safely dissipated is limited by the associated rise in junction temperature. For the plastic packages, the maximum safe junction temperature is  $150^{\circ}C$ . If the maximum is exceeded momentarily, proper circuit operation will be restored as soon as the die temperature is reduced. Leaving the device in the “overheated” condition for an extended period can result in device damage.

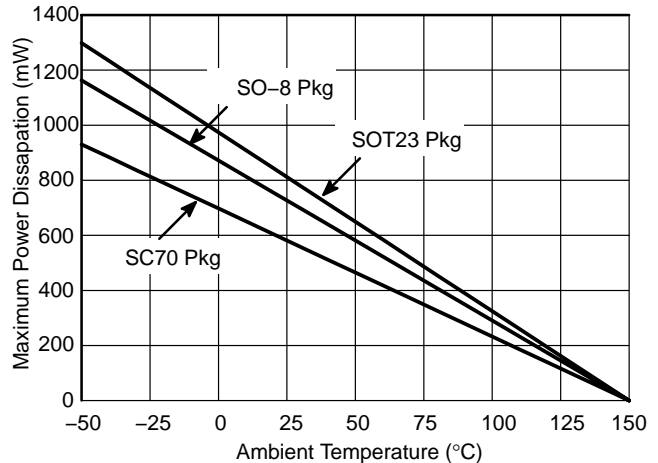


Figure 3. Power Dissipation vs. Temperature

# NCS2501

**AC ELECTRICAL CHARACTERISTICS** ( $V_{CC} = +5.0\text{ V}$ ,  $V_{EE} = -5.0\text{ V}$ ,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ ,  $R_L = 100\ \Omega$  to GND,  $R_F = 1.2\text{ k}\Omega$ ,  $A_V = +2.0$ , Enable is left open, unless otherwise specified).

Symbol	Characteristic	Conditions	Min	Typ	Max	Unit
--------	----------------	------------	-----	-----	-----	------

## FREQUENCY DOMAIN PERFORMANCE

BW	Bandwidth 3.0 dB Small Signal 3.0 dB Large Signal	$A_V = +2.0$ , $V_O = 0.5\text{ V}_{p-p}$ $A_V = +2.0$ , $V_O = 2.0\text{ V}_{p-p}$		200 140		MHz
GF <sub>0.1dB</sub>	0.1 dB Gain Flatness Bandwidth	$A_V = +2.0$		30		MHz
dG	Differential Gain	$A_V = +2.0$ , $R_L = 150\ \Omega$ , $f = 3.58\text{ MHz}$		0.02		%
dP	Differential Phase	$A_V = +2.0$ , $R_L = 150\ \Omega$ , $f = 3.58\text{ MHz}$		0.1		°

## TIME DOMAIN RESPONSE

SR	Slew Rate	$A_V = +2.0$ , $V_{step} = 2.0\text{ V}$		450		V/ $\mu\text{s}$
$t_s$	Settling Time 0.01% 0.1%	$A_V = +2.0$ , $V_{step} = 2.0\text{ V}$ $A_V = +2.0$ , $V_{step} = 2.0\text{ V}$		35 18		ns
$t_r$ $t_f$	Rise and Fall Time	(10%–90%) $A_V = +2.0$ , $V_{step} = 2.0\text{ V}$		5.0		ns
$t_{ON}$	Turn-on Time			900		ns
$t_{OFF}$	Turn-off Time			500		ns

## HARMONIC/NOISE PERFORMANCE

THD	Total Harmonic Distortion	$f = 5.0\text{ MHz}$ , $V_O = 2.0\text{ V}_{p-p}$ , $R_L = 150\ \Omega$		-55		dB
HD2	2nd Harmonic Distortion	$f = 5.0\text{ MHz}$ , $V_O = 2.0\text{ V}_{p-p}$		-67		dBc
HD3	3rd Harmonic Distortion	$f = 5.0\text{ MHz}$ , $V_O = 2.0\text{ V}_{p-p}$		-57		dBc
IP3	Third-Order Intercept	$f = 10\text{ MHz}$ , $V_O = 2.0\text{ V}_{p-p}$		35		dBm
SFDR	Spurious-Free Dynamic Range	$f = 5.0\text{ MHz}$ , $V_O = 2.0\text{ V}_{p-p}$		58		dBc
$e_N$	Input Referred Voltage Noise	$f = 1.0\text{ MHz}$		4.0		nV/ $\sqrt{\text{Hz}}$
$i_N$	Input Referred Current Noise	$f = 1.0\text{ MHz}$ , Inverting $f = 1.0\text{ MHz}$ , Non-Inverting		15 15		pA/ $\sqrt{\text{Hz}}$

# NCS2501

**DC ELECTRICAL CHARACTERISTICS** ( $V_{CC} = +5.0\text{ V}$ ,  $V_{EE} = -5.0\text{ V}$ ,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ ,  $R_L = 100\ \Omega$  to GND,  $R_F = 1.2\text{ k}\Omega$ ,  $A_V = +2.0$ , Enable is left open, unless otherwise specified).

Symbol	Characteristic	Conditions	Min	Typ	Max	Unit
--------	----------------	------------	-----	-----	-----	------

## DC PERFORMANCE

$V_{OS}$	Offset Voltage		-4.0	$\pm 0.7$	+4.0	mV
$\Delta V_{IO}/\Delta T$	Input Offset Voltage Temperature Coefficient			6.0		$\mu\text{V}/^\circ\text{C}$
$I_{IB}$	Input Bias Current	+Input (Non-Inverting), $V_O = 0\text{ V}$ -Input (Inverting), $V_O = 0\text{ V}$ (Note 4)	-4.0 -4.0	$\pm 2.0$ $\pm 0.4$	+4.0 +4.0	$\mu\text{A}$
$\Delta I_{IB}/\Delta T$	Input Bias Current Temperature Coefficient	+Input (Non-Inverting), $V_O = 0\text{ V}$ -Input (Inverting), $V_O = 0\text{ V}$		$\pm 40$ $\pm 10$		$\text{nA}/^\circ\text{C}$
$V_{IH}$	Input High Voltage (Enable) (Note 4)		$V_{CC}-1.5\text{ V}$			V
$V_{IL}$	Input Low Voltage (Enable) (Note 4)				$V_{CC}-3.5\text{ V}$	V

## INPUT CHARACTERISTICS

$V_{CM}$	Input Common Mode Voltage Range (Note 4)		$\pm 3.0$	$\pm 4.0$		V
CMRR	Common Mode Rejection Ratio	(See Graph)	50	55	65	dB
$R_{IN}$	Input Resistance	+Input (Non-Inverting) -Input (Inverting)		4.0 350		$\text{M}\Omega$ $\Omega$
$C_{IN}$	Differential Input Capacitance			1.0		pF

## OUTPUT CHARACTERISTICS

$R_{OUT}$	Output Resistance			0.02		$\Omega$
$V_O$	Output Voltage Swing		$\pm 3.0$	$\pm 3.5$		V
$I_O$	Output Current		$\pm 60$	$\pm 100$		mA

## POWER SUPPLY

$V_S$	Operating Voltage Supply Range			10		V
$I_{S,ON}$	Power Supply Current – Enabled	$V_O = 0\text{ V}$	0.5	1.1	2.0	mA
$I_{S,OFF}$	Power Supply Current – Disabled	$V_O = 0\text{ V}$	0	0.11	0.3	mA
PSRR	Power Supply Rejection Ratio	(See Graph)	50	60	70	dB

4. Guaranteed by design and/or characterization.

# NCS2501

**AC ELECTRICAL CHARACTERISTICS** ( $V_{CC} = +2.5\text{ V}$ ,  $V_{EE} = -2.5\text{ V}$ ,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ ,  $R_L = 100\ \Omega$  to GND,  $R_F = 1.2\text{ k}\Omega$ ,  $A_V = +2.0$ , Enable is left open, unless otherwise specified).

Symbol	Characteristic	Conditions	Min	Typ	Max	Unit
--------	----------------	------------	-----	-----	-----	------

## FREQUENCY DOMAIN PERFORMANCE

BW	Bandwidth 3.0 dB Small Signal 3.0 dB Large Signal	$A_V = +2.0$ , $V_O = 0.5\text{ V}_{p-p}$ $A_V = +2.0$ , $V_O = 1.0\text{ V}_{p-p}$		180 130		MHz
GF <sub>0.1dB</sub>	0.1 dB Gain Flatness Bandwidth	$A_V = +2.0$		15		MHz
dG	Differential Gain	$A_V = +2.0$ , $R_L = 150\ \Omega$ , $f = 3.58\text{ MHz}$		0.02		%
dP	Differential Phase	$A_V = +2.0$ , $R_L = 150\ \Omega$ , $f = 3.58\text{ MHz}$		0.1		°

## TIME DOMAIN RESPONSE

SR	Slew Rate	$A_V = +2.0$ , $V_{step} = 1.0\text{ V}$		350		V/ $\mu\text{s}$
$t_s$	Settling Time 0.01% 0.1%	$A_V = +2.0$ , $V_{step} = 1.0\text{ V}$ $A_V = +2.0$ , $V_{step} = 1.0\text{ V}$		40 18		ns
$t_r$ $t_f$	Rise and Fall Time	(10%–90%) $A_V = +2.0$ , $V_{step} = 1.0\text{ V}$		8.0		ns
$t_{ON}$	Turn-on Time			900		ns
$t_{OFF}$	Turn-off Time			500		ns

## HARMONIC/NOISE PERFORMANCE

THD	Total Harmonic Distortion	$f = 5.0\text{ MHz}$ , $V_O = 1.0\text{ V}_{p-p}$ , $R_L = 150\ \Omega$		-55		dB
HD2	2nd Harmonic Distortion	$f = 5.0\text{ MHz}$ , $V_O = 1.0\text{ V}_{p-p}$		-67		dBc
HD3	3rd Harmonic Distortion	$f = 5.0\text{ MHz}$ , $V_O = 1.0\text{ V}_{p-p}$		-57		dBc
IP3	Third-Order Intercept	$f = 10\text{ MHz}$ , $V_O = 1.0\text{ V}_{p-p}$		35		dBm
SFDR	Spurious-Free Dynamic Range	$f = 5.0\text{ MHz}$ , $V_O = 1.0\text{ V}_{p-p}$		58		dBc
$e_N$	Input Referred Voltage Noise	$f = 1.0\text{ MHz}$		4.0		nV/ $\sqrt{\text{Hz}}$
$i_N$	Input Referred Current Noise	$f = 1.0\text{ MHz}$ , Inverting $f = 1.0\text{ MHz}$ , Non-Inverting		15 15		pA/ $\sqrt{\text{Hz}}$

# NCS2501

**DC ELECTRICAL CHARACTERISTICS** ( $V_{CC} = +2.5\text{ V}$ ,  $V_{EE} = -2.5\text{ V}$ ,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ ,  $R_L = 100\ \Omega$  to GND,  $R_F = 1.2\text{ k}\Omega$ ,  $A_V = +2.0$ , Enable is left open, unless otherwise specified).

Symbol	Characteristic	Conditions	Min	Typ	Max	Unit
<b>DC PERFORMANCE</b>						
$V_{OS}$	Offset Voltage		-4.0	$\pm 0.5$	+4.0	mV
$\Delta V_{IO}/\Delta T$	Input Offset Voltage Temperature Coefficient			6.0		$\mu\text{V}/^\circ\text{C}$
$I_{IB}$	Input Bias Current	+Input (Non-Inverting), $V_O = 0\text{ V}$ -Input (Inverting), $V_O = 0\text{ V}$ (Note 5)	-4.0 -4.0	$\pm 2.0$ $\pm 0.4$	+4.0 +4.0	$\mu\text{A}$
$\Delta I_{IB}/\Delta T$	Input Bias Current Temperature Coefficient	+Input (Non-Inverting), $V_O = 0\text{ V}$ -Input (Inverting), $V_O = 0\text{ V}$		$\pm 40$ $\pm 10$		$\text{nA}/^\circ\text{C}$
$V_{IH}$	Input High Voltage (Enable) (Note 5)		$V_{CC}-1.5\text{ V}$			V
$V_{IL}$	Input Low Voltage (Enable) (Note 5)				$V_{CC}-3.5\text{ V}$	V

## INPUT CHARACTERISTICS

$V_{CM}$	Input Common Mode Voltage Range (Note 5)		$\pm 1.3$	$\pm 1.5$		V
CMRR	Common Mode Rejection Ratio	(See Graph)	50	55	65	dB
$R_{IN}$	Input Resistance	+Input (Non-Inverting) -Input (Inverting)		4.0 350		$\text{M}\Omega$ $\Omega$
$C_{IN}$	Differential Input Capacitance			1.0		pF

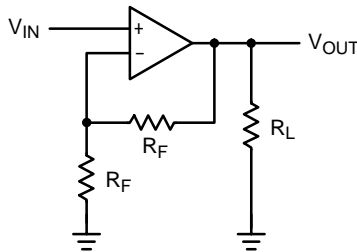
## OUTPUT CHARACTERISTICS

$R_{OUT}$	Output Resistance			0.02		$\Omega$
$V_O$	Output Voltage Swing		$\pm 1.1$	$\pm 1.4$		V
$I_O$	Output Current		$\pm 40$	$\pm 80$		mA

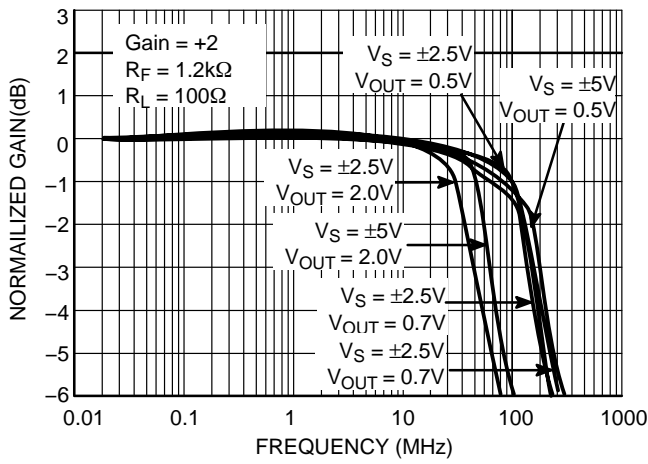
## POWER SUPPLY

$V_S$	Operating Voltage Supply Range			5.0		V
$I_{S,ON}$	Power Supply Current – Enabled	$V_O = 0\text{ V}$	0.5	0.9	1.9	mA
$I_{S,OFF}$	Power Supply Current – Disabled	$V_O = 0\text{ V}$	0	0.05	0.3	mA
PSRR	Power Supply Rejection Ratio	(See Graph)	50	60	70	dB

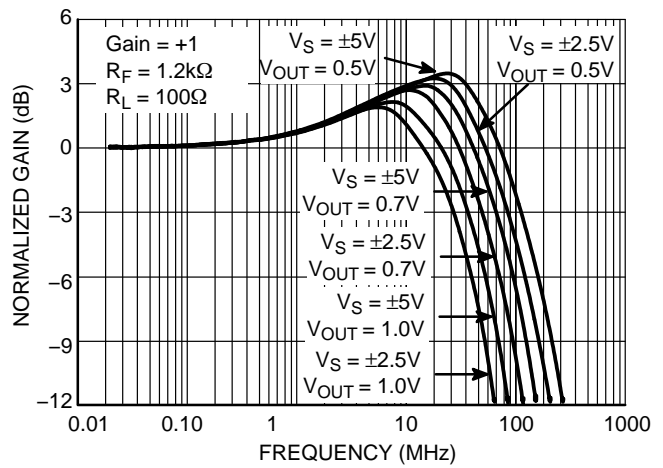
5. Guaranteed by design and/or characterization.



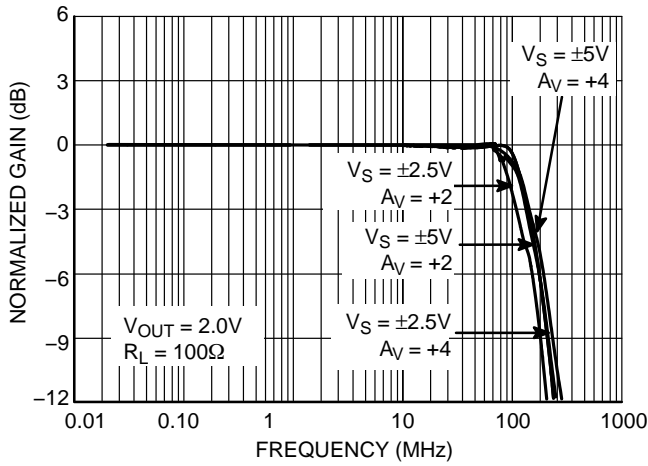
**Figure 4. Typical Test Setup**  
( $A_V = +2.0$ ,  $R_F = 1.8\text{ k}\Omega$  or  $1.2\text{ k}\Omega$  or  $1.0\text{ k}\Omega$ ,  $R_L = 100\ \Omega$ )



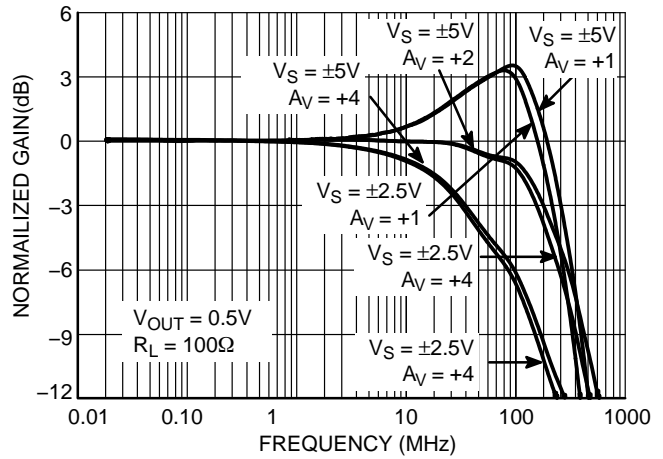
**Figure 5. Frequency Response:**  
**Gain (dB) vs. Frequency**  
 $A_v = +2.0$



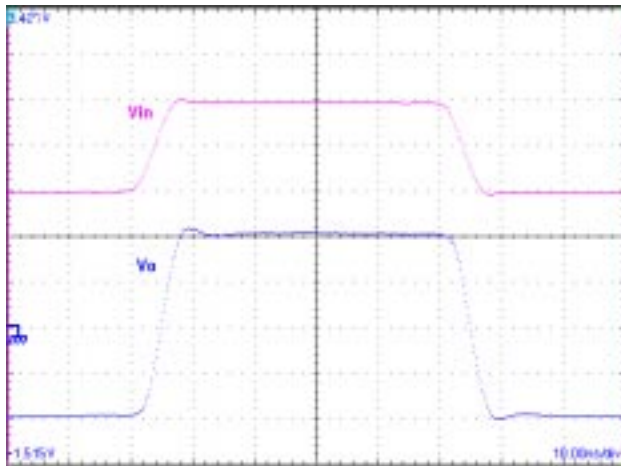
**Figure 6. Frequency Response:**  
**Gain (dB) vs. Frequency**  
 $A_v = +1.0$



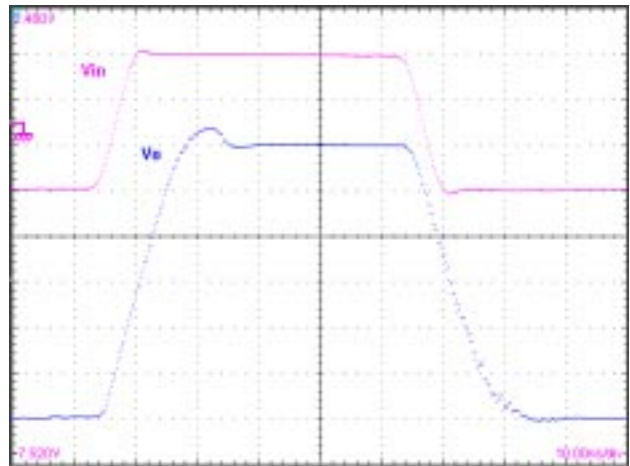
**Figure 7. Large Signal Frequency Response**  
**Gain (dB) vs. Frequency**



**Figure 8. Small Signal Frequency Response**  
**Gain (dB) vs. Frequency**



**Figure 9. Small Signal Step Response**  
**Vertical: 500 mV/div**  
**Horizontal: 10 ns/div**



**Figure 10. Large Signal Step Response**  
**Vertical: 500 mV/div**  
**Horizontal: 10 ns/div**



# NCS2501

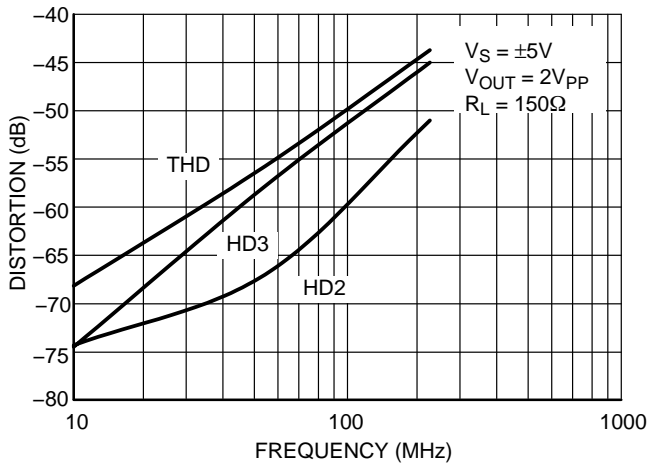


Figure 11. THD, HD2, HD3 vs. Frequency

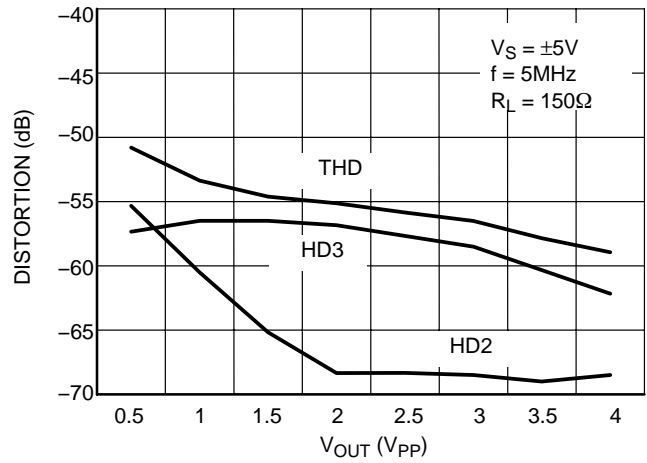


Figure 12. THD, HD2, HD3 vs. Output Voltage

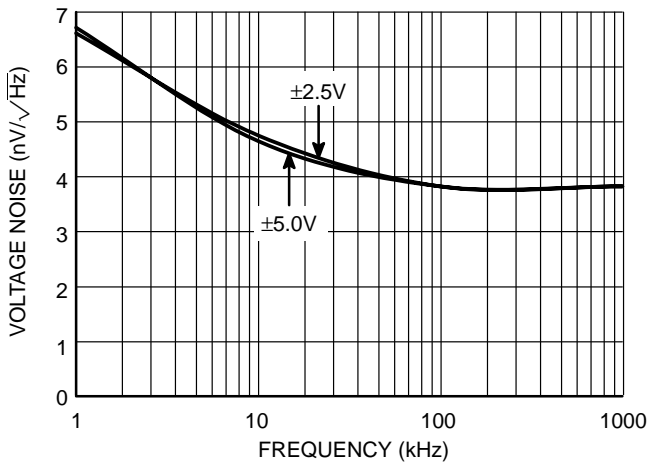


Figure 13. Input Referred Noise vs. Frequency

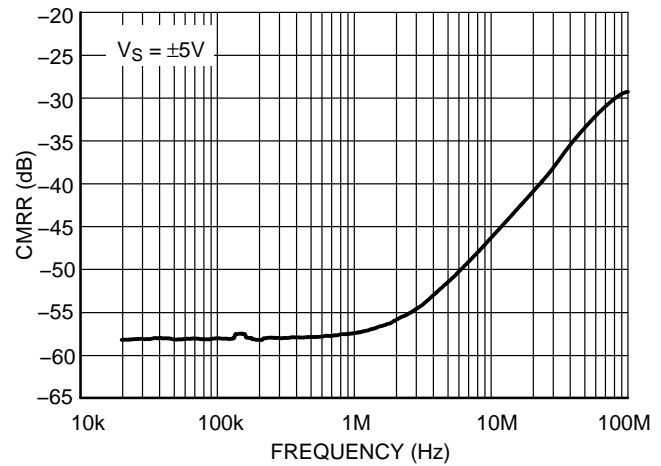


Figure 14. CMRR vs. Frequency

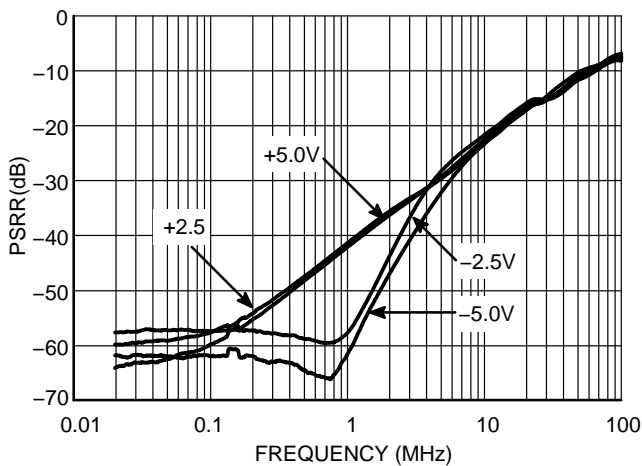


Figure 15. PSRR vs. Frequency

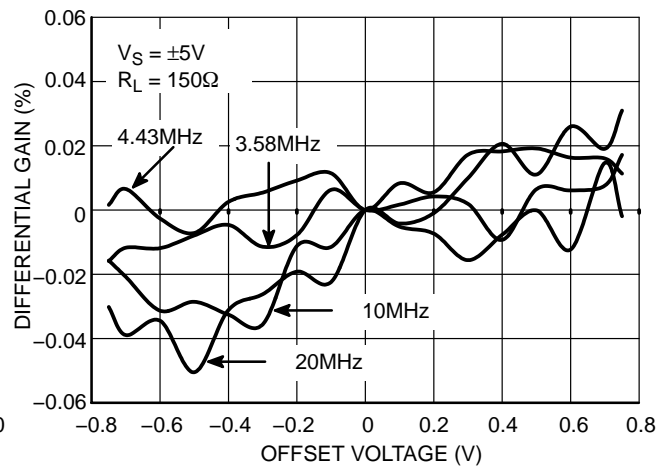


Figure 16. Differential Gain

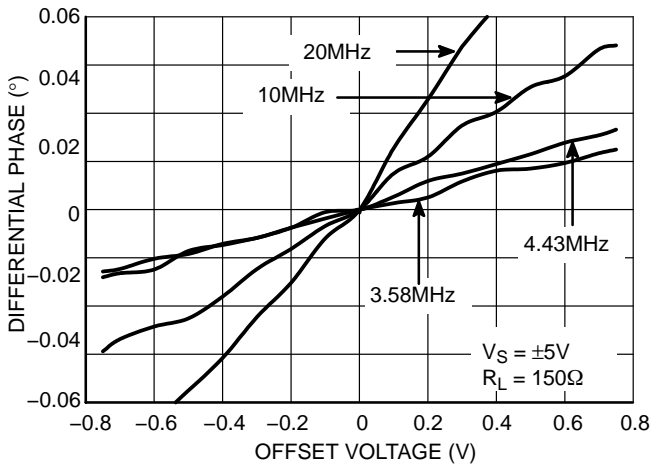


Figure 17. Differential Phase

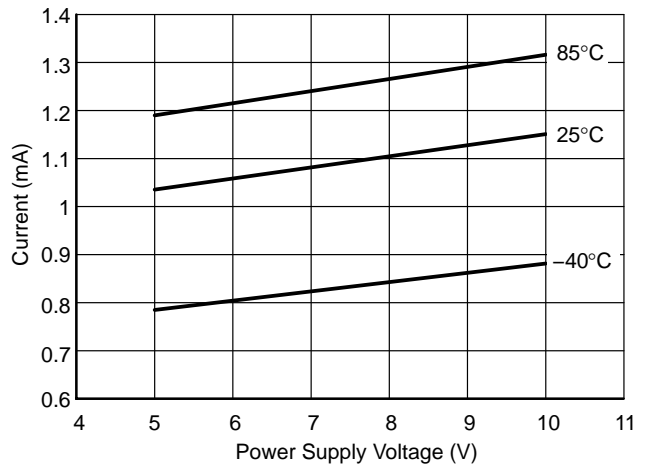


Figure 18. Supply Current vs. Power Supply vs. Temperature (Enabled)

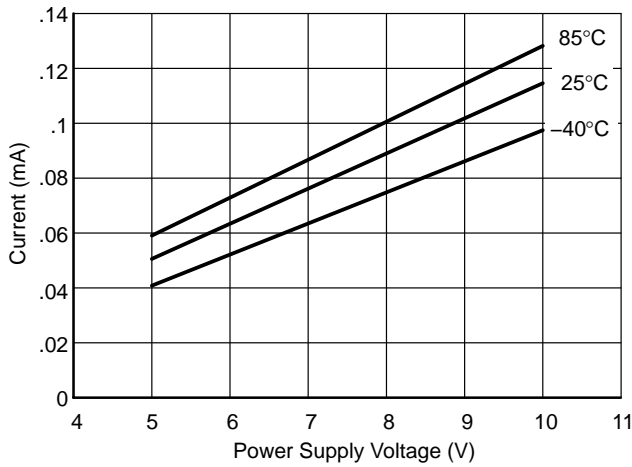


Figure 19. Supply Current vs. Power Supply vs. Temperature (Disabled)

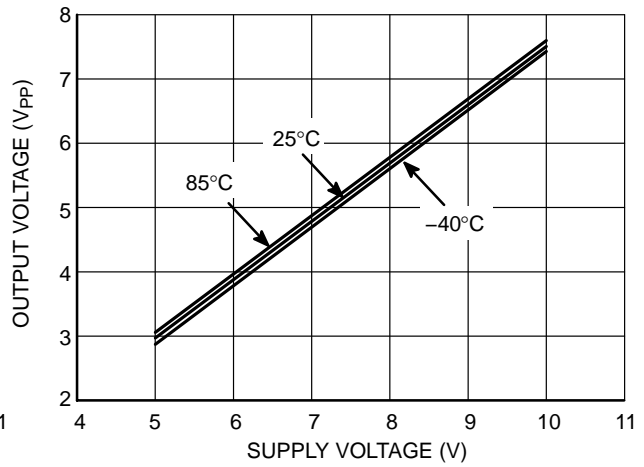


Figure 20. Output Voltage Swing vs. Supply Voltage

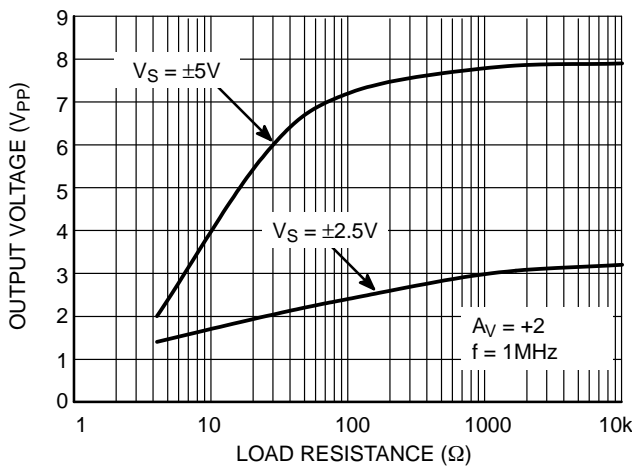


Figure 21. Output Voltage Swing vs. Load Resistance

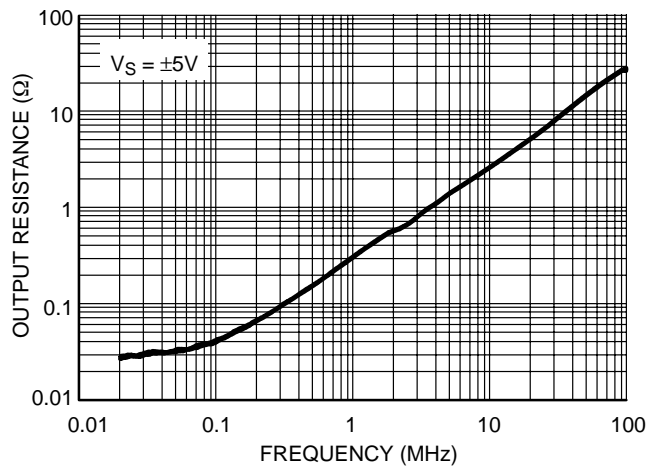


Figure 22. Output Impedance vs. Frequency

# NCS2501

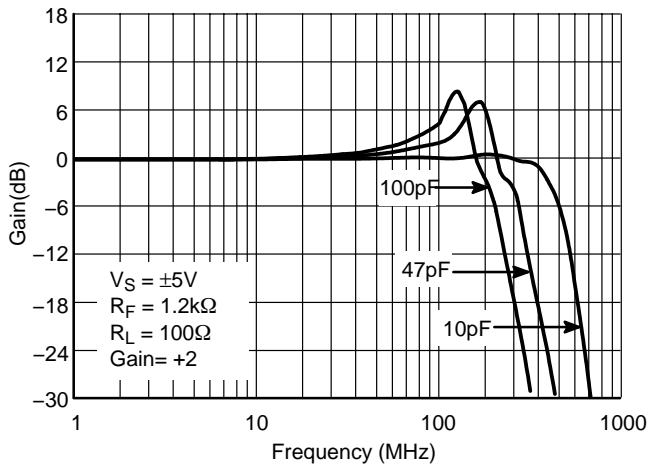


Figure 23. Frequency Response vs. CL

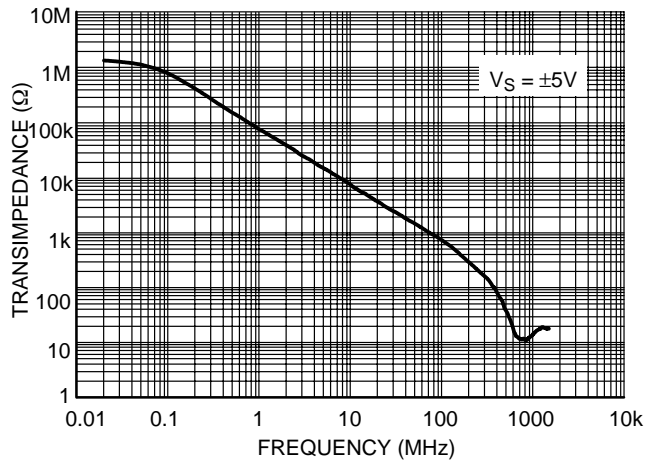


Figure 24. Transimpedance (ROL) vs. Frequency

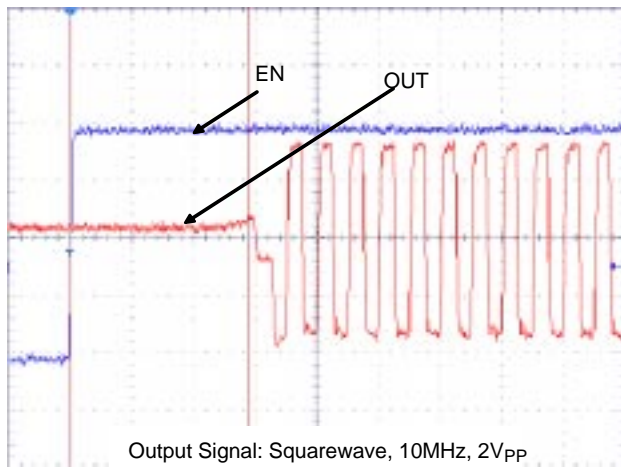


Figure 25. Turn ON Time Delay  
 Horizontal: 4 ns / Div  
 Vertical: 10mV/Div

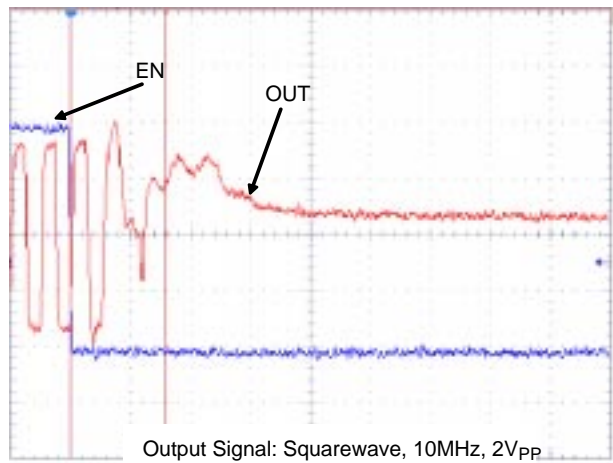
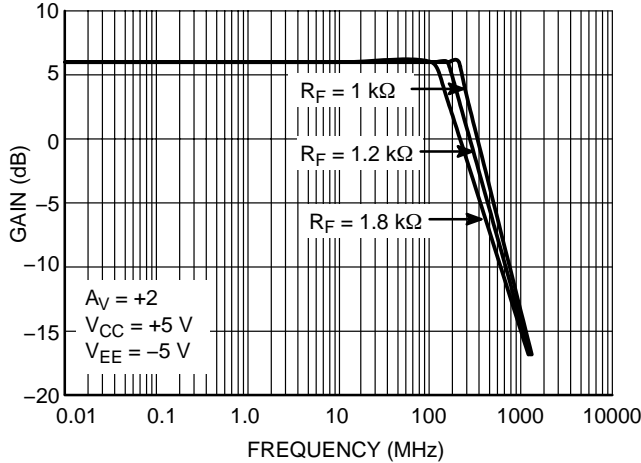


Figure 26. Turn OFF Time Delay  
 Horizontal: 4 ns / Div  
 Vertical: 10mV/Div

**General Design Considerations**

The current feedback amplifier is optimized for use in high performance video and data acquisition systems. For current feedback architecture, its closed-loop bandwidth depends on the value of the feedback resistor. The closed-loop bandwidth is not a strong function of gain, as is for a voltage feedback amplifier, as shown in Figure 27.



**Figure 27. Frequency Response vs.  $R_F$**

The -3.0 dB bandwidth is, to some extent, dependent on the power supply voltages. By using lower power supplies, the bandwidth is reduced, because the internal capacitance increases. Smaller values of feedback resistor can be used at lower supply voltages, to compensate for this affect.

**Feedback and Gain Resistor Selection for Optimum Frequency Response**

A current feedback operational amplifier’s key advantage is the ability to maintain optimum frequency response independent of gain by using appropriate values for the feedback resistor. To obtain a very flat gain response, the feedback resistor tolerance should be considered as well. Resistor tolerance of 1% should be used for optimum flatness. Normally, lowering  $R_F$  resistor from its recommended value will peak the frequency response and extend the bandwidth while increasing the value of  $R_F$  resistor will cause the frequency response to roll off faster. Reducing the value of  $R_F$

resistor too far below its recommended value will cause overshoot, ringing, and eventually oscillation.

Since each application is slightly different, it is worth some experimentation to find the optimal  $R_F$  for a given circuit. A value of the feedback resistor that produces ~0.1 dB of peaking is the best compromise between stability and maximal bandwidth. It is not recommended to use a current feedback amplifier with the output shorted directly to the inverting input.

**Printed Circuit Board Layout Techniques**

Proper high speed PCB design rules should be used for all wideband amplifiers as the PCB parasitics can affect the overall performance. Most important are stray capacitances at the output and inverting input nodes as it can effect peaking and bandwidth. A space (3/16” is plenty) should be left around the signal lines to minimize coupling. Also, signal lines connecting the feedback and gain resistors should be short enough so that their associated inductance does not cause high frequency gain errors. Line lengths less than 1/4” are recommended.

**Video Performance**

This device designed to provide good performance with NTSC, PAL, and HDTV video signals. Best performance is obtained with back terminated loads as performance is degraded as the load is increased. The back termination reduces reflections from the transmission line and effectively masks transmission line and other parasitic capacitances from the amplifier output stage.

**ESD Protection**

This device is protected against electrostatic discharge (ESD) on all pins as specified in the attributes table. Note: Human Body Model for +IN and -IN pins are rated at 0.8 kV while all other pins are rated at 2.0 kV. Under closed-loop operation, the ESD diodes have no effect on circuit performance. However, under certain conditions the ESD diodes will be evident. If the device is driven into a slewing condition, the ESD diodes will clamp large differential voltages until the feedback loop restores closed-loop operation. Also, if the device is powered down and a large input signal is applied, the ESD diodes will conduct.

# NCS2501

## ORDERING INFORMATION

Device	Package	Shipping†
NCS2501SQT2*	SC70-6 (SC88)	3000 Tape & Reel
NCS2501SQT2G*	SC70-6 (SC88) (Pb-Free)	3000 Tape & Reel
NCS2501SNT1	SOT23-6 (TSOP-6)	3000 Tape & Reel
NCS2501SNT1G	SOT23-6 (TSOP-6) (Pb-Free)	3000 Tape & Reel
NCS2501D*	SO-8	98 Units/Rail
NCS2501DR2*	SO-8	2500 Tape & Reel
NCS2501DG*	SO-8 (Pb-Free)	98 Units/Rail
NCS2501DR2G*	SO-8 (Pb-Free)	2500 Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

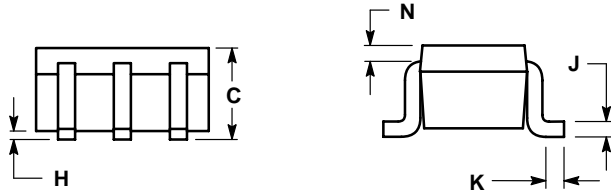
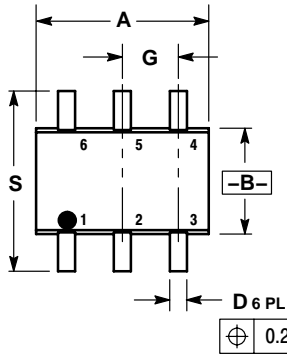
\*Contact ON Semiconductor for ordering information.



# NCS2501

## PACKAGE DIMENSIONS

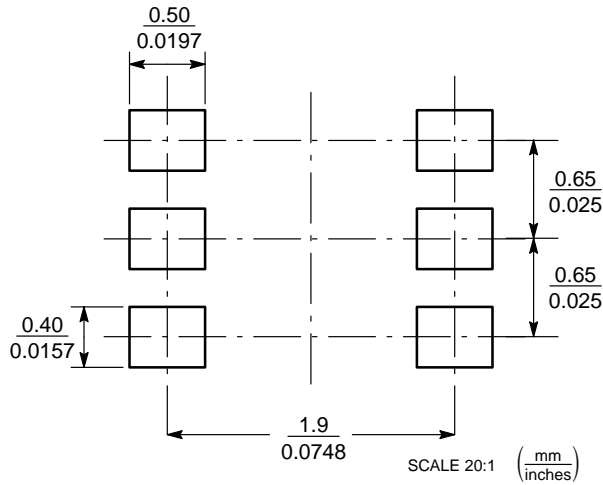
SC-70-6 (SC-88)  
SQ SUFFIX  
CASE 419B-02  
ISSUE U



- NOTES:  
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.  
2. CONTROLLING DIMENSION: INCH.  
3. 419B-01 OBSOLETE, NEW STANDARD 419B-02.

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

### SOLDERING FOOTPRINT\*

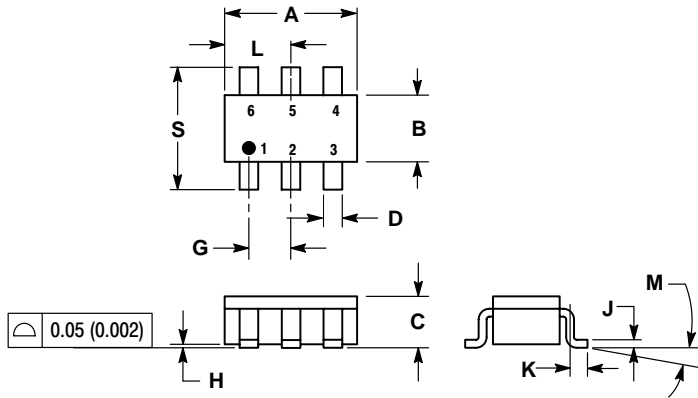


\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# NCS2501

## PACKAGE DIMENSIONS

SOT23-6 (TSOP-6)  
SN SUFFIX  
CASE 318G-02  
ISSUE M

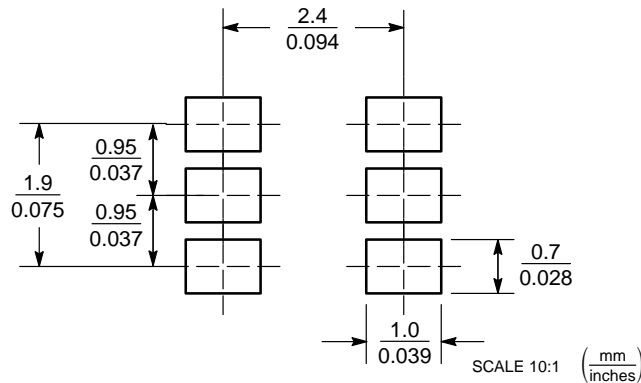


NOTES:

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

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.90	3.10	0.1142	0.1220
B	1.30	1.70	0.0512	0.0669
C	0.90	1.10	0.0354	0.0433
D	0.25	0.50	0.0098	0.0197
G	0.85	1.05	0.0335	0.0413
H	0.013	0.100	0.0005	0.0040
J	0.10	0.26	0.0040	0.0102
K	0.20	0.60	0.0079	0.0236
L	1.25	1.55	0.0493	0.0610
M	0°	10°	0°	10°
S	2.50	3.00	0.0985	0.1181

### 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.

ON Semiconductor and are registered trademarks of Semiconductor Components Industries, LLC (SCILLC). SCILLC reserves the right to make changes without further notice to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. "Typical" parameters which may be provided in SCILLC data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. SCILLC does not convey any license under its patent rights nor the rights of others. SCILLC products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the SCILLC product could create a situation where personal injury or death may occur. Should Buyer purchase or use SCILLC products for any such unintended or unauthorized application, Buyer shall indemnify and hold SCILLC and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that SCILLC was negligent regarding the design or manufacture of the part. SCILLC is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

### PUBLICATION ORDERING INFORMATION

**LITERATURE FULFILLMENT:**  
Literature Distribution Center for ON Semiconductor  
P.O. Box 61312, Phoenix, Arizona 85082-1312 USA  
**Phone:** 480-829-7710 or 800-344-3860 Toll Free USA/Canada  
**Fax:** 480-829-7709 or 800-344-3867 Toll Free USA/Canada  
**Email:** orderlit@onsemi.com

**N. American Technical Support:** 800-282-9855 Toll Free USA/Canada

**Japan:** ON Semiconductor, Japan Customer Focus Center  
2-9-1 Kamimeguro, Meguro-ku, Tokyo, Japan 153-0051  
**Phone:** 81-3-5773-3850

**ON Semiconductor Website:** <http://onsemi.com>

**Order Literature:** <http://www.onsemi.com/litorder>

For additional information, please contact your local Sales Representative.