

# NCS199A1, NCS199A2, NCS199A3

## Current-Shunt Monitor, Voltage Output, Bi-Directional Zero-Drift

The NCS199A1, NCS199A2 and NCS199A3 are voltage output current shunt monitors that can measure voltage across shunts at common-mode voltages from  $-0.3\text{ V}$  to  $26\text{ V}$ , independent of supply voltage. Three fixed gains are available:  $50\text{ V/V}$ ,  $100\text{ V/V}$  or  $200\text{ V/V}$ . The low offset of the zero-drift architecture enables current sensing with maximum drops across the shunt as low as  $10\text{ mV}$  full-scale.

The devices can operate from a single  $+2.7\text{ V}$  to  $+26\text{ V}$  power supply, drawing a maximum of  $100\text{ }\mu\text{A}$  of supply current. All versions are specified over the extended operating temperature range ( $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ ).

### Features

- Wide Common-Mode Input Range  $-0.3\text{ V}$  to  $26\text{ V}$
- Supply Voltage Range from  $2.7\text{ V}$  to  $26\text{ V}$
- Low Offset Voltage  $\pm 150\text{ }\mu\text{V}$  Max
- Low Offset Drift ( $0.5\text{ }\mu\text{V}/^{\circ}\text{C}$ )
- Low Gain Error (max  $1.5\%$ )
- Rail-to-rail Input and Output Capability
- Low Current Consumption (typ  $65\text{ }\mu\text{A}$ ,  $100\text{ }\mu\text{A}$  max)
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable
- These are Pb-free Devices

### Typical Applications

- Current Sensing (High-Side/Low-Side)
- Automotive
- Telecom
- Sensors



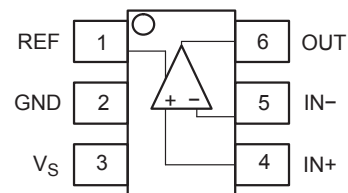
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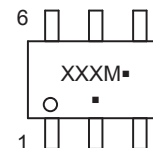


SC70-6  
SQ SUFFIX  
CASE 419B

### PIN CONNECTIONS



### MARKING DIAGRAM



XXX = Specific Device Code (See page 4)

M = Date Code

▪ = Pb-Free Package

(Note: Microdot may be in either location)

Product	Gain	R3-R4	R1-R2
NCS199A1	50	20 k $\Omega$	1 M $\Omega$
NCS199A2	100	10 k $\Omega$	1 M $\Omega$
NCS199A3	200	5 k $\Omega$	1 M $\Omega$

$$V_{\text{OUT}} = (I_{\text{LOAD}} \times R_{\text{SHUNT}}) \text{GAIN} + V_{\text{REF}}$$

### ORDERING INFORMATION

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

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.

# NCS199A1, NCS199A2, NCS199A3

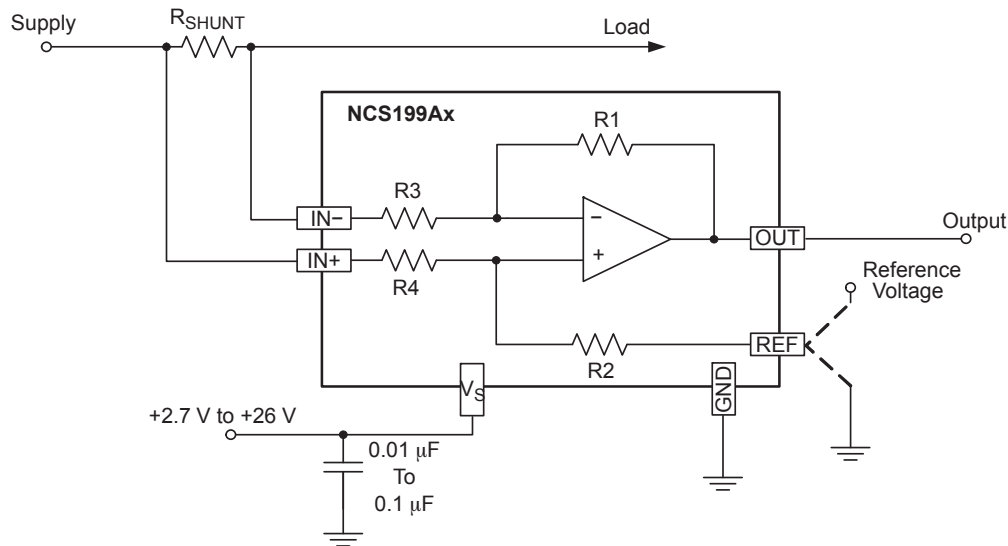


Figure 1. Application Schematic

Table 1. MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Supply Voltage (Note 1)		$V_S$	+26	V
Analog Inputs	Differential ( $V_{IN+} - V_{IN-}$ )	$V_{IN+}, V_{IN-}$	-26 to +26	V
	Common-Mode (Note 2)		GND-0.3 to +26	
REF Input		$V_{REF}$	GND-0.3 to ( $V_S$ ) +0.3	V
Output (Note 2)		$V_{OUT}$	GND-0.3 to ( $V_S$ ) +0.3	V
Input Current into Any Pin (Note 2)			5	mA
Maximum Junction Temperature		$T_{J(max)}$	+150	°C
Storage Temperature Range		TSTG	-65 to +150	°C
ESD Capability, Human Body Model (Note 3)		HBM	±3000	V
ESD Capability, Machine Model (Note 3)		MM	±100	V
Charged Device Model (Note 3)		CDM	±1000	V

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, RECOMMENDED OPERATING RANGES and/or APPLICATION INFORMATION for safe operating parameters.
2. Input voltage at any pin may exceed the voltage shown if current at that pin is limited to 5 mA.
3. This device series incorporates ESD protection and is tested by the following methods  
 ESD Human Body Model tested per AEC-Q100-002 (EIA/JESD22-A114)  
 ESD Machine Model tested per AEC-Q100-003 (EIA/JESD22-A115)  
 ESD Charged Device Model tested per AEC-Q100-011.  
 Latchup Current Maximum Rating: 50 mA per JEDEC standard: JESD78

Table 2. THERMAL CHARACTERISTICS

Rating	Symbol	Value	Unit
Thermal Characteristics, SC70 (Note 4) Thermal Resistance, Junction-to-Air (Note 5)	$R_{\theta JA}$	250	°C/W

4. Refer to ELECTRICAL CHARACTERISTICS, RECOMMENDED OPERATING RANGES and/or APPLICATION INFORMATION for safe operating parameters.
5. Values based on copper area of 645 mm<sup>2</sup> (or 1 in<sup>2</sup>) of 1 oz copper thickness and FR4 PCB substrate.

Table 3. RECOMMENDED OPERATING RANGES

Rating	Symbol	Min	Max	Unit
Supply Voltage	$V_S$	2.7	26	V
Ambient Temperature	$T_A$	-40	125	°C

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

# NCS199A1, NCS199A2, NCS199A3

**Table 4. ELECTRICAL CHARACTERISTICS**

**Boldface** limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ , guaranteed by characterization and/or design. At  $T_A = +25^\circ\text{C}$ ,  $V_{\text{SENSE}} = V_{\text{IN}+} - V_{\text{IN}-}$ ,  $V_S = +5\text{ V}$ ,  $V_{\text{IN}+} = 12\text{ V}$ , and  $V_{\text{REF}} = V_S/2$ , unless otherwise noted.

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
<b>GAIN</b>						
NCS199A1 NCS199A2 NCS199A3		G		50 100 200		V/V
Gain Error	$V_{\text{SENSE}} = -5\text{ mV to }5\text{ mV}$	$G_e$		<b><math>\pm 0.2</math></b>	<b><math>\pm 1.5</math></b>	%
Gain Error vs. Temperature	$T_A = -10^\circ\text{C to }125^\circ\text{C}$			7	20	ppm/ $^\circ\text{C}$
Nonlinearity Error	$V_{\text{SENSE}} = -5\text{ mV to }5\text{ mV}$			$\pm 0.01$		%
Maximum Capacitive Load	No sustained oscillation			1		nF

**VOLTAGE OFFSET**

Offset Voltage	NCS199A1/2/3 NCV199A2	(RTI Note 6), $V_{\text{SENSE}} = 0\text{ mV}$	$V_{\text{OS}}$		$\pm 5.0$ $\pm 20$	$\pm 150$ $\pm 200$	$\mu\text{V}$
Offset Drift	NCS199A2, NCS199A3 NCS199A1		$\delta V/\delta T$		<b>0.1</b> <b>0.5</b>	<b>0.6</b> <b>2.0</b>	$\mu\text{V}/^\circ\text{C}$

**INPUT**

Input Bias Current		$V_{\text{SENSE}} = 0\text{ mV}$	$I_{\text{IB}}$			60	$\mu\text{A}$
Common-Mode Input Voltage Range			$V_{\text{CM}}$	<b>-0.3</b>		<b>26</b>	V
Common-Mode Rejection Ratio	NCS199A2, NCS199A3	$V_S = 5\text{ V}, V_{\text{IN}+} = 2\text{ V to }+26\text{ V},$ $V_{\text{SENSE}} = 0\text{ mV}$	CMRR	<b>100</b>	<b>115</b>		dB
		$V_S = 3.3\text{ V}, V_{\text{IN}+} = 3\text{ V to }+26\text{ V},$ $V_{\text{SENSE}} = 0\text{ mV}$		<b>100</b>	<b>115</b>		dB
		$V_S = 3.3\text{ V}, V_{\text{IN}+} = 0\text{ V to }+26\text{ V},$ $V_{\text{SENSE}} = 0\text{ mV}$ ( $T_A = -10^\circ\text{C to }85^\circ\text{C}$ )		100	120		dB
Common-Mode Rejection Ratio	NCS199A1	$V_S = 5\text{ V}, V_{\text{IN}+} = 2\text{ V to }+26\text{ V},$ $V_{\text{SENSE}} = 0\text{ mV}$	CMRR	<b>97</b>	<b>110</b>		dB
		$V_S = 3.3\text{ V}, V_{\text{IN}+} = 3\text{ V to }+26\text{ V},$ $V_{\text{SENSE}} = 0\text{ mV}$		<b>97</b>	<b>110</b>		dB
		$V_S = 3.3\text{ V}, V_{\text{IN}+} = 0\text{ V to }+26\text{ V},$ $V_{\text{SENSE}} = 0\text{ mV}$ ( $T_A = -10^\circ\text{C to }85^\circ\text{C}$ )		97	115		dB
Common-Mode Rejection Ratio	NCV199A2	$V_S = 5\text{ V}, V_{\text{IN}+} = 2\text{ V to }+26\text{ V},$ $V_{\text{SENSE}} = 0\text{ mV}$	CMRR	<b>95</b>	<b>115</b>		dB
		$V_S = 3.3\text{ V}, V_{\text{IN}+} = 3\text{ V to }+26\text{ V},$ $V_{\text{SENSE}} = 0\text{ mV}$		<b>95</b>	<b>115</b>		dB
		$V_S = 3.3\text{ V}, V_{\text{IN}+} = 0\text{ V to }+26\text{ V},$ $V_{\text{SENSE}} = 0\text{ mV}$ ( $T_A = -10^\circ\text{C to }85^\circ\text{C}$ )		95	120		dB

**OUTPUT**

Output Voltage Low	Referenced from GND $R_L = 10\text{ k}\Omega$ to Ground	$V_{\text{OL}}$		5	50	mV
Output Voltage High	Referenced from $V_S$ $R_L = 10\text{ k}\Omega$ to Ground	$V_{\text{OH}}$		0.05	0.2	V

**DYNAMIC PERFORMANCE**

Bandwidth ( $f_{-3\text{dB}}$ )	$C_{\text{LOAD}} = 10\text{ pF}$ , NCS199A1 $C_{\text{LOAD}} = 10\text{ pF}$ , NCS199A2 $C_{\text{LOAD}} = 10\text{ pF}$ , NCS199A3	BW		100 60 40		kHz
Slew Rate		SR		0.4		V/ $\mu\text{s}$

**NOISE**

Spectral Density, 1 kHz (RTI Note 6)		$e_n$		35		nV/ $\sqrt{\text{Hz}}$
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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. RTI = referenced-to-input.

# NCS199A1, NCS199A2, NCS199A3

**Table 4. ELECTRICAL CHARACTERISTICS**

**Boldface** limits apply over the specified temperature range,  $T_A = -40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ , guaranteed by characterization and/or design. At  $T_A = +25^{\circ}\text{C}$ ,  $V_{\text{SENSE}} = V_{\text{IN}+} - V_{\text{IN}-}$ ,  $V_S = +5\text{ V}$ ,  $V_{\text{IN}+} = 12\text{ V}$ , and  $V_{\text{REF}} = V_S/2$ , unless otherwise noted.

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
<b>POWER SUPPLY</b>						
Operating Voltage Range	$V_{\text{SENSE}} = 0\text{ mV}$	$V_S$	<b>2.7</b>		<b>26</b>	V
Quiescent Current	$V_{\text{SENSE}} = 0\text{ mV}$	$I_{\text{DD}}$		65	100	$\mu\text{A}$
Quiescent Current over Temperature	$V_{\text{SENSE}} = 0\text{ mV}$				<b>115</b>	$\mu\text{A}$
Power Supply Rejection Ratio	$V_S = +2.7\text{ V}$ to $+26\text{ V}$ , $V_{\text{IN}+} = 18\text{ V}$ , $V_{\text{SENSE}} = 0\text{ mV}$	PSRR		$\pm 0.1$	$\pm 10$	$\mu\text{V/V}$

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.

6. RTI = referenced-to-input.

## ORDERING INFORMATION

Device	Gain	Marking	Package	Shipping †
NCS199A1SQT2G	50	ACQ	SC70-6 (Pb-Free)	3000 / Tape and Reel
NCS199A2SQT2G	100	ACR		
NCS199A3SQT2G	200	ACP		
NCV199A2SQT2G* (In Development)**	100	TBD		
NCV199A3SQT2G* (In Development)**	200	TBD		

†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

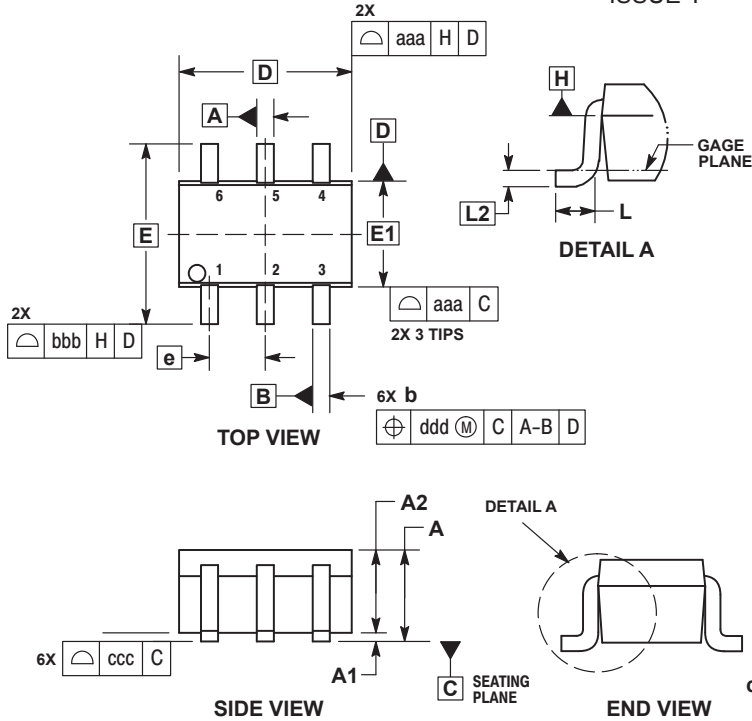
\*NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable.

\*\* Contact local sales office for availability.

# NCS199A1, NCS199A2, NCS199A3

## PACKAGE DIMENSIONS

SC-88/SC70-6/SOT-363  
CASE 419B-02  
ISSUE Y

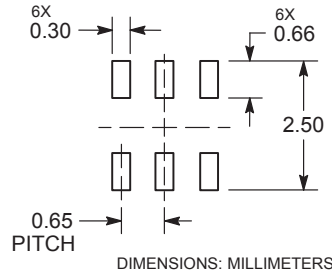


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSIONS D AND E1 DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.20 PER END.
4. DIMENSIONS D AND E1 AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY AND DATUM H.
5. DATUMS A AND B ARE DETERMINED AT DATUM H.
6. DIMENSIONS b AND c APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN 0.08 AND 0.15 FROM THE TIP.
7. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 TOTAL IN EXCESS OF DIMENSION b AT MAXIMUM MATERIAL CONDITION. THE DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OF THE FOOT.

DIM	MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	---	---	1.10	---	---	0.043
A1	0.00	---	0.10	0.000	---	0.004
A2	0.70	0.90	1.00	0.027	0.035	0.039
b	0.15	0.20	0.25	0.006	0.008	0.010
C	0.08	0.15	0.22	0.003	0.006	0.009
D	1.80	2.00	2.20	0.070	0.078	0.086
E	2.00	2.10	2.20	0.078	0.082	0.086
E1	1.15	1.25	1.35	0.045	0.049	0.053
e	0.65 BSC			0.026 BSC		
L	0.26	0.36	0.46	0.010	0.014	0.018
L2	0.15 BSC			0.006 BSC		
aaa	0.15			0.006		
bbb	0.30			0.012		
ccc	0.10			0.004		
ddd	0.10			0.004		

### 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.

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