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 V to 26 V, independent of supply voltage. Three fixed gains are available: 50 V/V, 100 V/V or 200 V/V. The low offset of the zero−drift architecture enables current sensing with maximum drops across the shunt as low as 10 mV full−scale.

The devices can operate from a single +2.7 V to +26 V power supply, drawing a maximum of 100 μA of supply current. All versions are specified over the extended operating temperature range (–40°C to +125°C).

Features

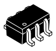
- Wide Common−Mode Input Range −0.3 V to 26 V
- Supply Voltage Range from 2.7 V to 26 V
- Low Offset Voltage ±150 μV Max
- Low Offset Drift (0.5 μV/°C)
- Low Gain Error (max 1.5%)
- Rail−to−rail Input and Output Capability
- Low Current Consumption (typ 65 μA, 100 μA max)
- NCV Prefix for Automotive 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

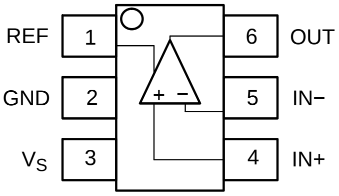
ON Semiconductor®

www.onsemi.com

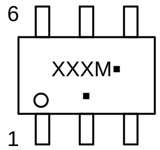


SC70−6
SQ SUFFIX
CASE 419B

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 kΩ	1 MΩ
NCS199A2	100	10 kΩ	1 MΩ
NCS199A3	200	5 kΩ	1 MΩ

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

ORDERING INFORMATION

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

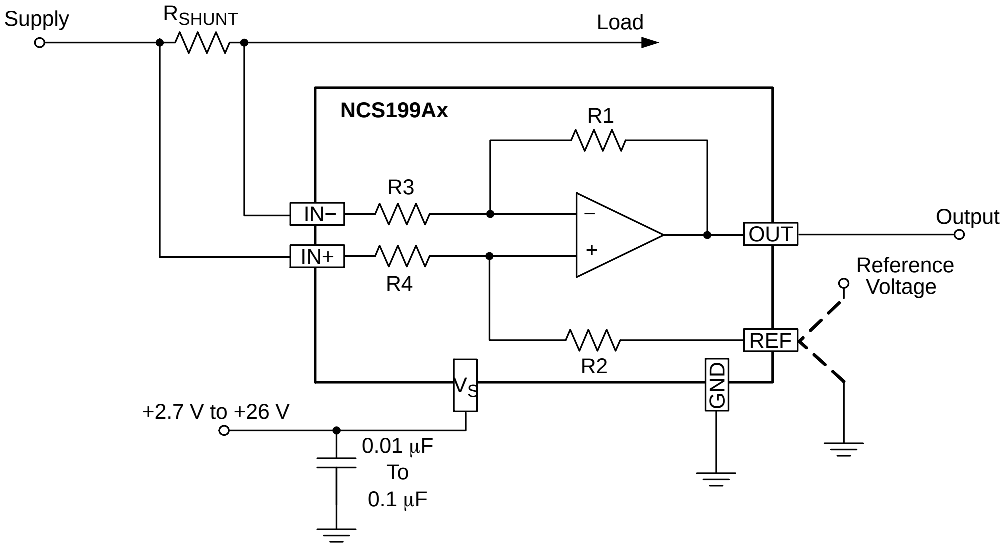


Figure 1. Application Schematic

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^2 (or 1 in^2) 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.

Table 4. ELECTRICAL CHARACTERISTICS

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

Parameter		Test Conditions	Symbol	Min	Typ	Max	Unit
GAIN							
NCS199A1			G		50		V/V
NCS199A2					100		
NCS199A3					200		
Gain Error		V_{SENSE} = −5 mV to 5 mV	G_e		**±0.2**	**±1.5**	%
Gain Error vs. Temperature		T_A = −10°C to 125°C			7	20	ppm/°C
Nonlinearity Error		V_{SENSE} = −5 mV to 5 mV			±0.01		%
Maximum Capacitive Load		No sustained oscillation			1		nF
VOLTAGE OFFSET							
Offset Voltage	NCS199A1/2/3	(RTI Note 6), V_{SENSE} = 0 mV	V_{OS}		±5.0	±150	μV
	NCV199A2				±20	±200	
Offset Drift	NCS199A2, NCS199A3		δV/δT		**0.1**	**0.6**	μV/°C
	NCS199A1				**0.5**	**2.0**	
INPUT							
Input Bias Current		V_{SENSE} = 0 mV	I_{IB}			60	μA
Common−Mode Input Voltage Range			V_{CM}	**−0.3**		**26**	V
Common−Mode Rejection Ratio	NCS199A2, NCS199A3	**V_S = 5 V, V_{IN+} = 2 V to +26 V, V_{SENSE} = 0 mV**	CMRR	**100**	**115**		dB
		V_S = 3.3 V, V_{IN+} = 3 V to +26 V, V_{SENSE} = 0 mV		**100**	**115**		dB
		V_S = 3.3 V, V_{IN+} = 0 V to +26 V, V_{SENSE} = 0 mV (T_A = −10°C to 85°C)		100	120		dB
Common−Mode Rejection Ratio	NCS199A1	**V_S = 5 V, V_{IN+} = 2 V to +26 V, V_{SENSE} = 0 mV**	CMRR	**97**	**110**		dB
		V_S = 3.3 V, V_{IN+} = 3 V to +26 V, V_{SENSE} = 0 mV		**97**	**110**		dB
		V_S = 3.3 V, V_{IN+} = 0 V to +26 V, V_{SENSE} = 0 mV (T_A = −10°C to 85°C)		97	115		dB
Common−Mode Rejection Ratio	NCV199A2	**V_S = 5 V, V_{IN+} = 2 V to +26 V, V_{SENSE} = 0 mV**	CMRR	**95**	**115**		dB
		V_S = 3.3 V, V_{IN+} = 3 V to +26 V, V_{SENSE} = 0 mV		**95**	**115**		dB
		V_S = 3.3 V, V_{IN+} = 0 V to +26 V, V_{SENSE} = 0 mV (T_A = −10°C to 85°C)		95	120		dB
OUTPUT							
Output Voltage Low		Referenced from GND R_L = 10 kΩ to Ground	V_{OL}		5	50	mV
Output Voltage High		Referenced from V_S R_L = 10 kΩ to Ground	V_{OH}		0.05	0.2	V
DYNAMIC PERFORMANCE							
Bandwidth (f_{-3dB})		C_{LOAD} = 10 pF, NCS199A1	BW		100		kHz
		C_{LOAD} = 10 pF, NCS199A2			60		
		C_{LOAD} = 10 pF, NCS199A3			40		
Slew Rate			SR		0.4		V/μs
NOISE							
Spectral Density, 1 kHz (RTI Note 6)			e_n		35		nV/√Hz

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

6. RTI = referenced−to−input.

Table 4. ELECTRICAL CHARACTERISTICS

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

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
POWER SUPPLY						
Operating Voltage Range	V_{SENSE} = 0 mV	V_s	**2.7**		**26**	V
Quiescent Current	V_{SENSE} = 0 mV	I_{DD}		65	100	μA
Quiescent Current over Temperature	V_{SENSE} = 0 mV				**115**	μA
Power Supply Rejection Ratio	V_S = +2.7 V to +26 V, V_{IN+} =18 V, V_{SENSE} = 0 mV	PSRR		±0.1	±10	μV/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		

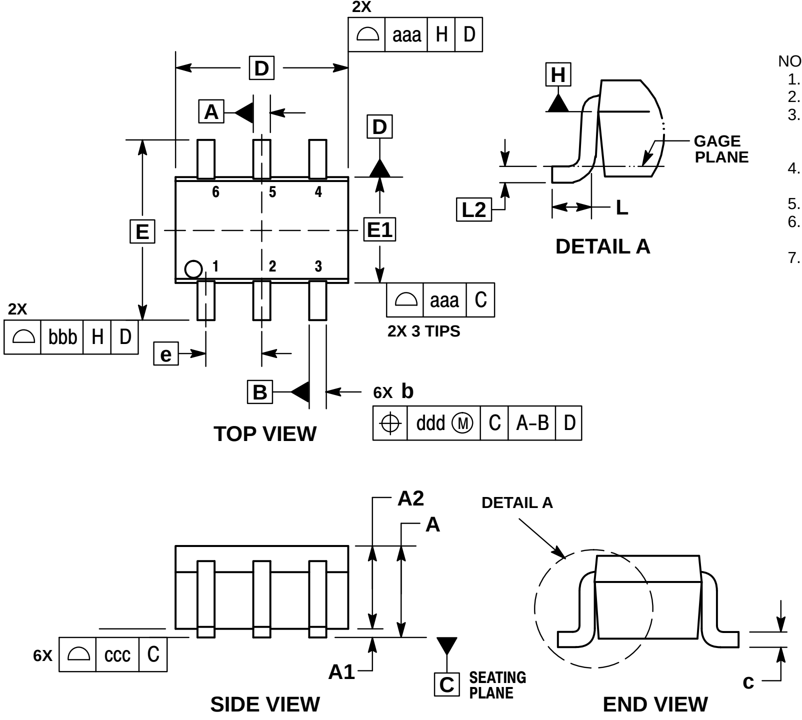
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D

*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.

PACKAGE DIMENSIONS

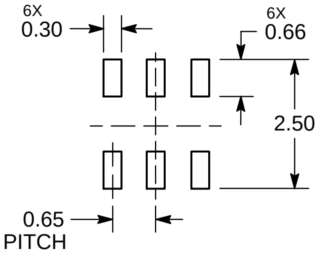
SC−88/SC70−6/SOT−363
CASE 419B−02
ISSUE Y



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.

	MILLIMETERS			INCHES		
DIM	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*



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.

ON Semiconductor and ON are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent−Marking.pdf. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor 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. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor 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. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor 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 ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor 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
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA
Phone: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
Fax: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800−282−9855 Toll Free USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81−3−5817−1050

ON Semiconductor Website: **www.onsemi.com**

Order Literature: http://www.onsemi.com/orderlit

For additional information, please contact your local Sales Representative