NCS21671

Product Preview

Current-Shunt Monitors, Zero-Drift, 26 V Common Mode, Bidirectional, Shutdown

The NCS21671 are a series of voltage output current sense amplifiers offered in gains of 25, 50, 100, and 200 V/V. These parts can measure voltage across shunts at common mode voltages from −0.3 V to 26 V, independent of supply voltage. The low offset of the zero−drift architecture enables current sensing with maximum drops across the shunt as low as 10 mV full−scale. An enable function is provided to reduce current drain through the input pins and power supply pins to negligible levels. These devices can operate from a single +1.7 V to +5.5 V power supply, drawing a maximum of 40 μA of supply current. Available in a low−profile, space−saving 1.4 x 1.8 mm X2QFN10 package.

Features

- Wide Common Mode Input Range: −0.3 V to 26 V
- Supply Voltage Range: 1.7 V to 5.5 V
- Low Offset Voltage: ±35 μV max (G = 200 V/V)
- Low Offset Drift: 0.5 μV/°C
- Low Gain Error: ±0.3% max
- Rail−to−rail Output Capability
- Low Current Consumption: 40 μA max
- Enable Pin to turn off Input and Power Supply Currents
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

Typical Applications

- High−Side Current Sensing
- Low−Side Current Sensing
- Difference Amplifier
- Telecom
- Power Management
- Battery Charging and Discharging

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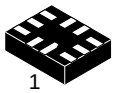
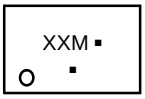


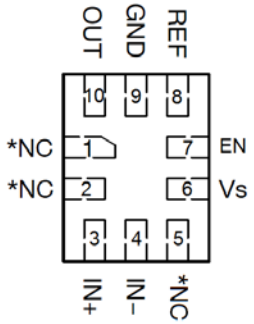
X2QFN10 1.4x1.8, 0.4P
CASE xxx

MARKING DIAGRAM



XX = Specific Device Code
M = Date Code
▪ = Pb−Free Package
(Note: Microdot may be in either location)

PIN CONNECTIONS

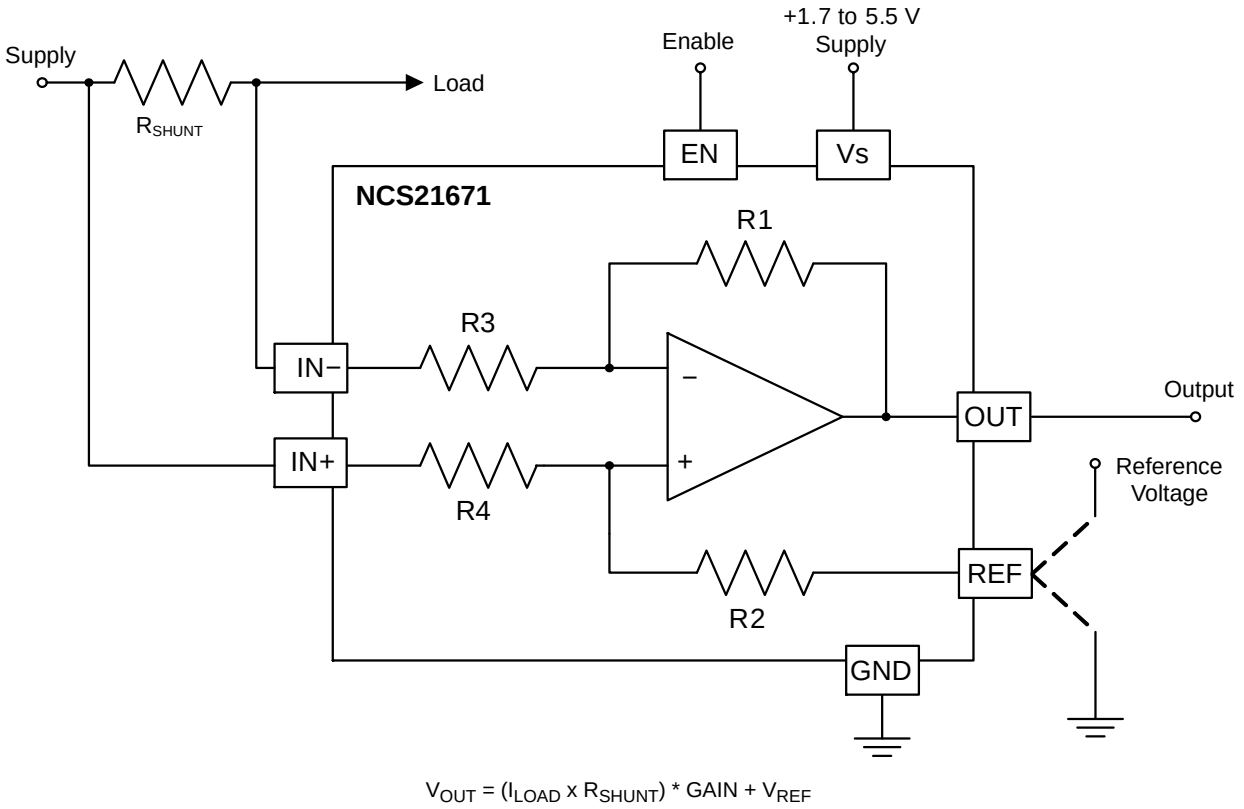


(Top View)

*NC denotes no internal connection. These pins can be left floating or connected to any voltage between VS and GND.

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.



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

Figure 1. Example Application Schematic of High−Side Current Sensing

PIN DESCRIPTION

Pin	Name	Description
1, 2, 5	NC	No internal connection. These pins can be left floating or connected to any voltage between V_S and GND.
3	IN+	Non−inverting input pin. This pin is connected to the high side of the sense resistor.
4	IN−	Inverting input pin. This pin is connected to the low side of the sense resistor.
6	Vs	Supply pin. Connect to the positive supply rail.
7	EN	Enable pin. The part is enabled when EN is logic high. When logic low, the part is in shutdown mode. This pin cannot be floated.
8	REF	Reference pin. This allows for a DC offset at the output. For unidirectional operation, connect to ground. For bidirectional operation, connect to any voltage between V_S and GND.
9	GND	Ground pin. Connect to ground.
10	OUT	Output pin.

ORDERING INFORMATION

Part Number	Gain	R1, R2	R3, R4	Marking	Package	Shipping
NCS21671MY25TAG	25	1 MΩ	40 kΩ		X2QFN10 (Pb−Free / Halogen Free)	
NCS21671MY50TAG	50	1 MΩ	20 kΩ		X2QFN10 (Pb−Free / Halogen Free)	
NCS21671MY100TAG	100	1 MΩ	10 kΩ		X2QFN10 (Pb−Free / Halogen Free)	
NCS21671MY200TAG	200	1 MΩ	5 kΩ		X2QFN10 (Pb−Free / Halogen Free)	

Table 1. MAXIMUM RATINGS

Parameter		Symbol	Rating	Unit
Supply Voltage (Note 1)		V_S	+7	V
Analog Input Voltage	Differential (V_{IN+})−(V_{IN-})	V_{IN+},V_{IN-}	−TBD to +TBD	V
	Common−Mode (Note 2)		GND−0.3 to +30	
REF Input Voltage		V_{REF}	GND−0.3 to (V_S) +0.3	V
EN Input Voltage		V_{EN}	GND−0.3 to (V_S) +0.3	V
Output Voltage		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		T_{STG}	−65 to +150	°C
ESD Capability, Human Body Model (Note 3)		HBM	± 2000	V
ESD Capability, Charged Device Model (Note 3)		CDM	± 1000	V
Latch−up Current (Note 4)			100	mA

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 5mA.
3. This device series incorporates ESD protection and is tested by the following methods:
   ESD Human Body Model tested per JEDEC standard JS−001−2017
   ESD Charged Device Model tested per JEDEC standard JS−002−2014
4. Latch−up Current tested per JEDEC standard JESD78E

Table 2. THERMAL CHARACTERISTICS

Parameter	Symbol	Package	Value	Unit
Thermal Resistance, Junction−to−Air (Notes 5, 6)	θ_{JA}	X2QFN10	TBD	°C/W

5. Refer to ELECTRICAL CHARACTERISTICS, RECOMMENDED OPERATING RANGES and/or APPLICATION INFORMATION for safe operating parameters
6. 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

Parameter	Symbol	Temperature	Min	Max	Unit
Supply Voltage	V_S	T_A = 0°C to 85°C	1.7	5.5	V
		T_A = −40°C to 125°C	1.8	5.5	
Common Mode Input Voltage	V_{CM}	T_A = −40°C to 125°C	−0.3	26	V
Sense Voltage, (V_{IN+}) − (V_{IN-})	V_{SENSE}	T_A = −40°C to 125°C		±26	V

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

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

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Input							
Common Mode Rejection Ratio	CMRR	V_S = +5 V, V_{IN+} = 0V to +26V, V_{SENSE} = 0mV T_A = −40°C to 125°C	G = 25	**94**	114		dB
			G = 50	**99**	120		
			G = 100	**104**	126		
			G = 200	**105**	126		
		V_S = +1.7 V, V_{IN+} = 0V to +26V, V_{SENSE} = 0mV	G = 25		111		
			G = 50		99		
			G = 100		104		
			G = 200		108		
Input Offset Voltage	V_{OS}	V_S = +5 V, V_{SENSE} = 0mV, T_A = −40°C to 125°C	G = 25		±30	**±160**	µV
			G = 50		±20	**±100**	
			G = 100		±10	**±60**	
			G = 200		±0.55	**±35**	
		V_S = +1.7 V, V_{SENSE} = 0mV	G = 25		±112		
			G = 50		±128		
			G = 100		±77		
			G = 200		±45		
Input Offset Voltage Drift vs. Temperature	dV_{OS}/dT	V_S = +5 V, V_{SENSE} = 0 mV T_A = –40°C to +125°C			0.1	**0.5**	µV/°C
		V_S = +1.7 V, V_{SENSE} = 0 mV T_A = –40°C to +125°C			0.5		
Power Supply Rejection Ratio	PSRR	V_S = +1.7 V to +5.5 V, V_{SENSE} = 0mV			±0.1	±10	µV/V
Input Bias Current	I_{IB}	V_{SENSE} = 0mV			30	38	µA
Input Bias Current in Shutdown	I_{IBSD}	V_{SENSE} = 0mV			1.8		nA
		T_A = 0°C to +85°C				**10**	nA
Input Offset Current	I_{IO}	V_{SENSE} = 0mV			±0.1		µA
Output							
Gain	G	G = 25			25		V/V
		G = 50			50		
		G = 100			100		
		G = 200			200		
Gain Error		V_{SENSE} = −5mV to +5mV, T_A = −40°C to 125°C				**±0.3**	%
Gain Error vs Temperature		T_A = −40°C to 125°C			3	**10**	ppm/°C
Nonlinearity Error		V_{SENSE} = −5mV to +5mV			±0.01		%
Maximum Capacitive Load		No sustained oscillation			1		nF
Voltage Output							
Swing to V_S Supply Rail	V_{OH}	R_L = 10 kΩ to GND T_A = –40°C to +125°C			V_S − 0.07	**V_S − 0.2**	V
Swing to GND	V_{OL}	R_L = 10 kΩ to GND T_A = –40°C to +125°C			0.0055	**0.05**	V

Table 4. ELECTRICAL CHARACTERISTICS

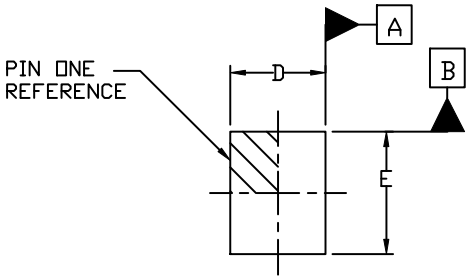
At T_A = +25°C, V_{SENSE} = (V_{IN+}) – (V_{IN-}), V_S = +5V, V_{IN+} = 12V, and V_{REF} = V_S/2, unless otherwise noted. **Boldface** limits apply over the specified temperature range, T_A = –40°C to 125°C unless otherwise noted, guaranteed by characterization and/or design.

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Frequency Response							
Bandwidth (f_{-3dB})	BW	C_{LOAD} = 10pF	G = 25		40		kHz
			G = 50		40		
			G = 100		30		
			G = 200		20		
Slew Rate	SR				0.4		V/µs
Noise							
Voltage Noise Density	e_n				45		nV/√Hz
Power Supply							
Enable Input Threshold Voltage	$V_{th(EN)}$	Logic High (Enabled Mode)		1.3			V
		Logic Low (Shutdown Mode)				0.5	V
Enable Input Leakage Current	I_{EN}	V_{EN} = V_S = +5 V			1.1		µA
		V_{EN} = GND			1.1		µA
Enable Time (Note 7)	t_{ON}	R_L = 10 kΩ to GND			30		µs
Shutdown Time (Note 7)	t_{OFF}	R_L = 10 kΩ to GND			30		µs
Quiescent Current	I_Q	V_{SENSE} = 0mV; T_A = –40°C to +125°C			35	**40**	µA
Quiescent Current in Shutdown	I_{QSD}	V_{SENSE} = 0mV			0.2	1	µA

7. Shutdown Time (t_{OFF}) and Enable Time (t_{ON}) are defined as the time between the 50% point of the signal applied to the EN pin and the point at which the output voltage reaches within 10% of its final value. V_{SENSE} = (0.75 * V_S − V_{REF}) / Gain

PACKAGE DIMENSIONS

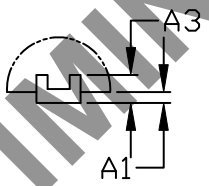
X2QFN10 1.4x1.8
CASE xxx



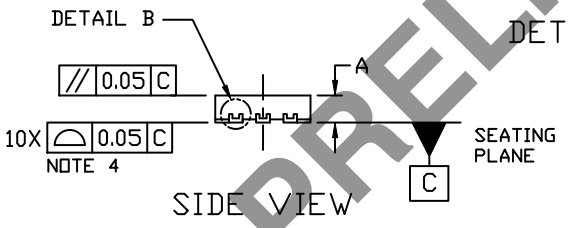
TOP VIEW

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSION b APPLIES TO THE PLATED TERMINALS AND IS MEASURED BETWEEN 0.10 AND 0.20mm FROM THE TERMINAL TIP.
4. PROFILE APPLIES TO THE TERMINALS.

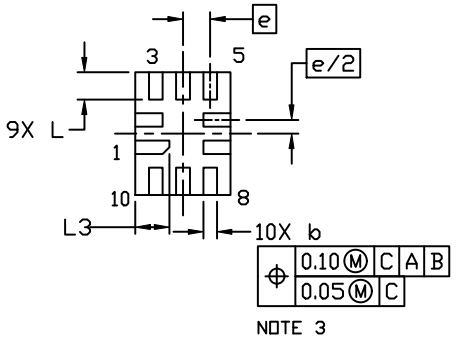
DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
A	0.30	0.35	0.40
A1	---	---	0.05
A3	0.125 REF		
b	0.15	0.20	0.25
D	1.35	1.40	1.45
E	1.75	1.80	1.85
e	0.40 BSC		
L	0.35	0.40	0.45
L3	0.45	0.50	0.55



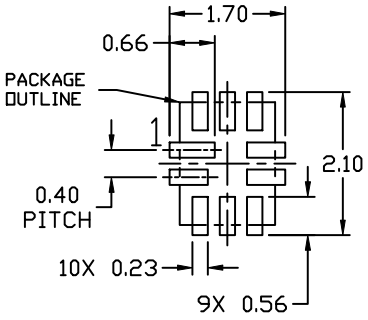
DETAIL B



SIDE VIEW



BOTTOM VIEW



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