

NCS21911 Precision Op Amp

Product Technical Overview

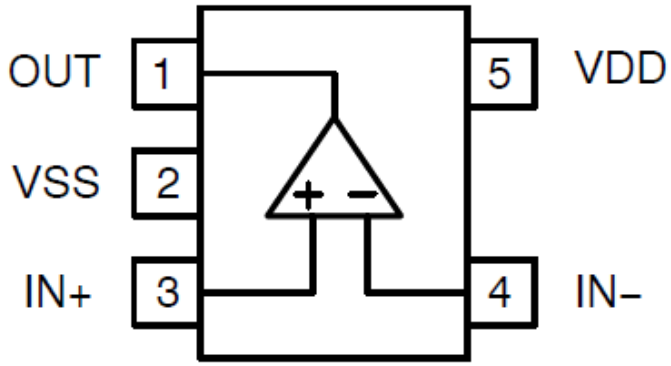
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Introduction to the NCS21911 Zero-Drift Amplifier

The NCS21911 zero-drift precision op amp features low **input offset voltage** that does not drift over temperature and time. This feature makes it ideal for applications where accuracy is needed, such as current sensing and sensor interface.

- Input Offset Voltage: 25 μV max
- Zero-Drift Offset Voltage: 0.085 V/°C max
- Voltage Noise Density: 22 nV/√Hz typical
- Unity Gain Bandwidth: 2 MHz typical
- Supply Voltage: 4 V to 36 V
- Quiescent Current: 570 μA max
- Rail−to−Rail Output



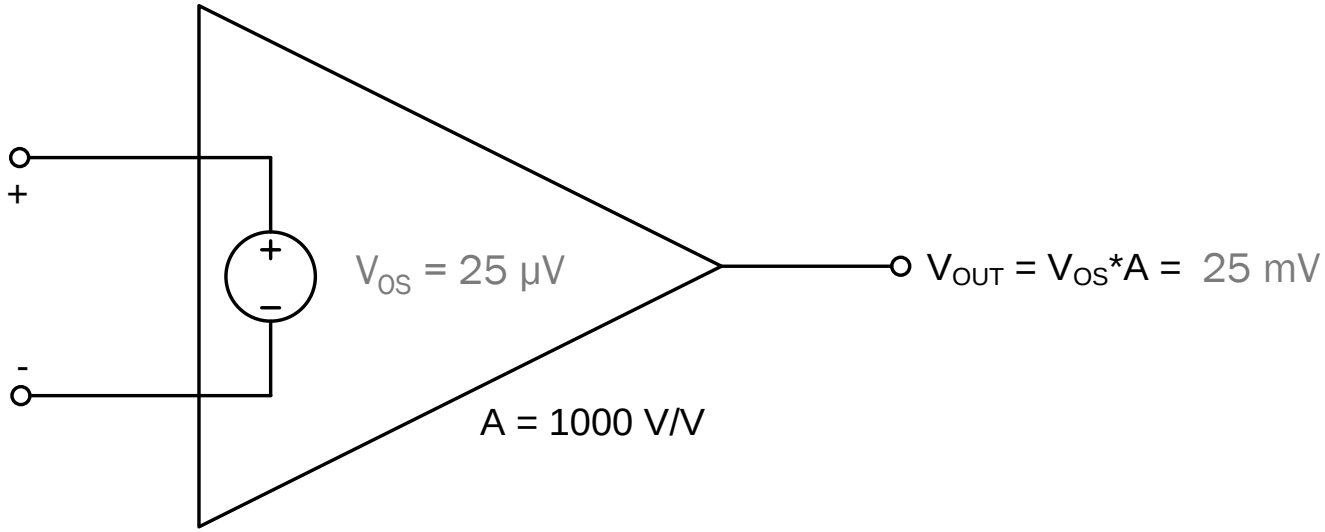
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Precision Op Amp: Key Parameters

Parameter	Symbol	Importance
Input offset voltage	V_{OS}	Lower offset allows lower differential voltages to be measured with accuracy
Input offset voltage drift	dV_{OS}/dT	Low drift (or zero-drift in this case) prevents the offset voltage changing over temperature
Common Mode Rejection Ration	CMRR	High CMRR means that the offset voltage is less susceptible to variation in the common mode voltage
Power Supply Rejection Ratio	PSRR	High PSRR means that the offset voltage is less susceptible to variation in the supply
Open Loop Gain	A_{VOL}	High open loop gain results in better closed loop gain accuracy

Why is Offset Voltage Important?

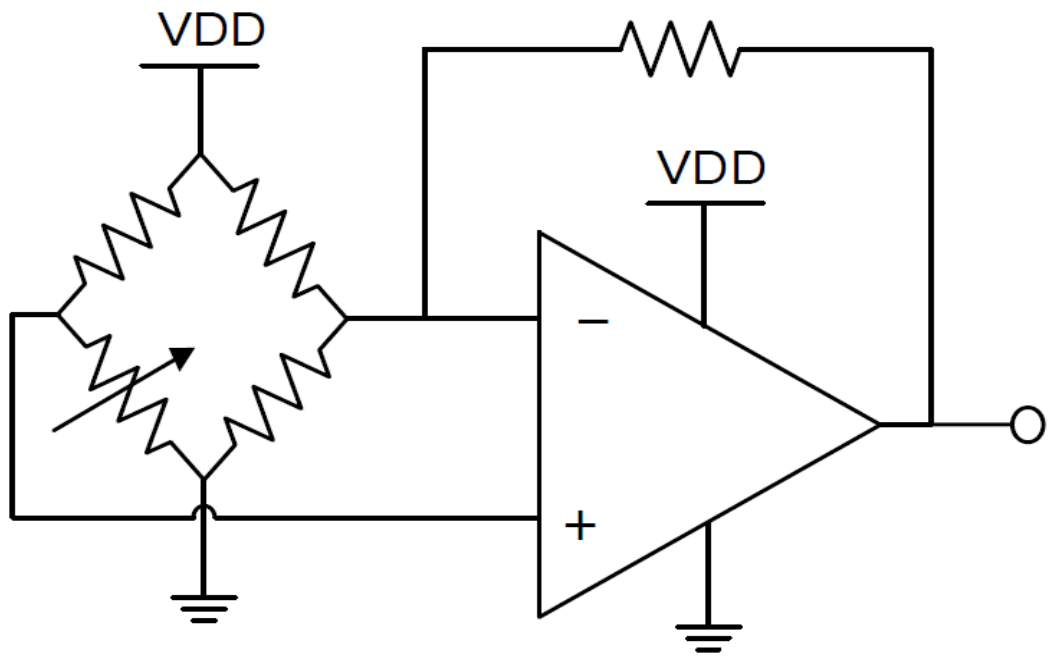
- Input offset voltage, V_{OS}, is inherent in all op amps
- It adds error to the measurement
- This limits how small the measured voltage across the sense resistor can be
- Precision op amps and precision current sense amplifiers can minimize **V_{OS}** and **V_{OS} drift** over time and temperature



Bridge Circuit Amplification

Applications
- Transducer interface
- Sensor interface
- Medical instrumentation

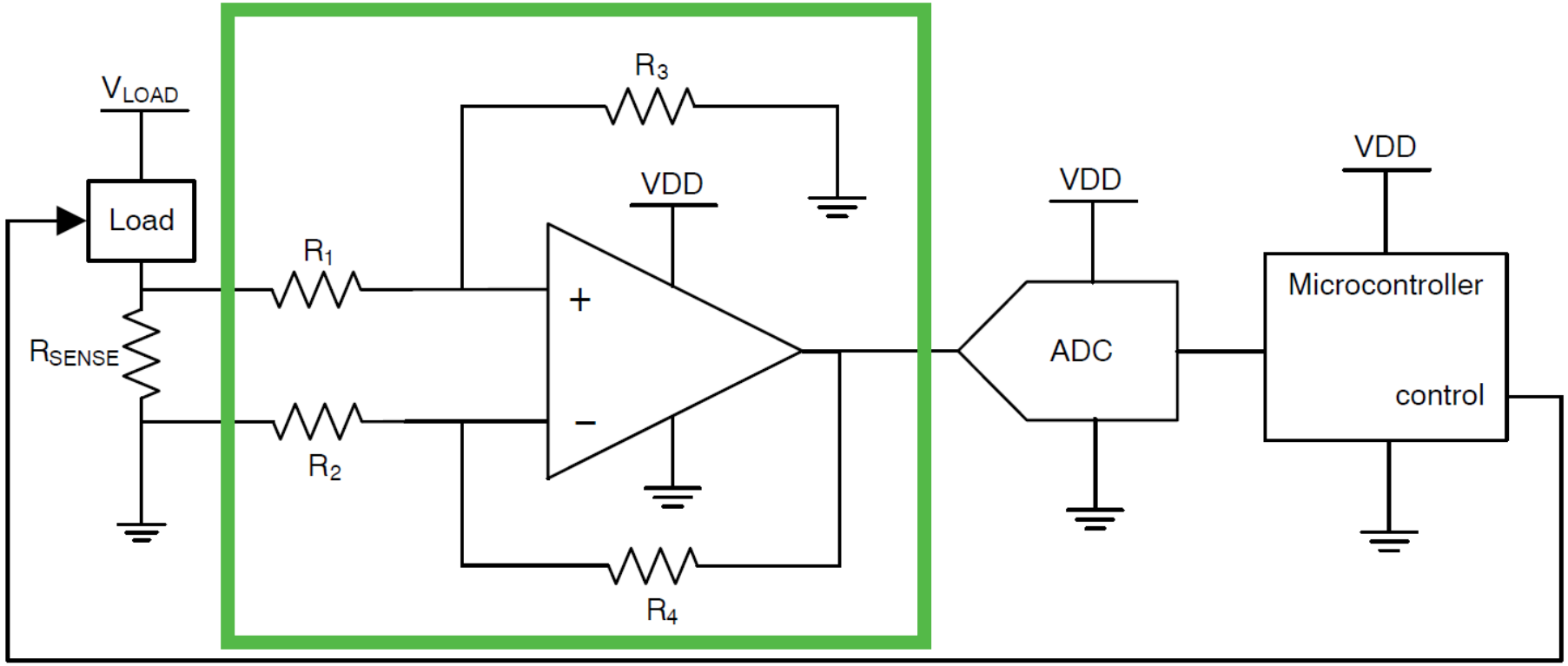
Key parameters
- Offset voltage
- Offset voltage drift
- Noise



Low Side Current Sensing

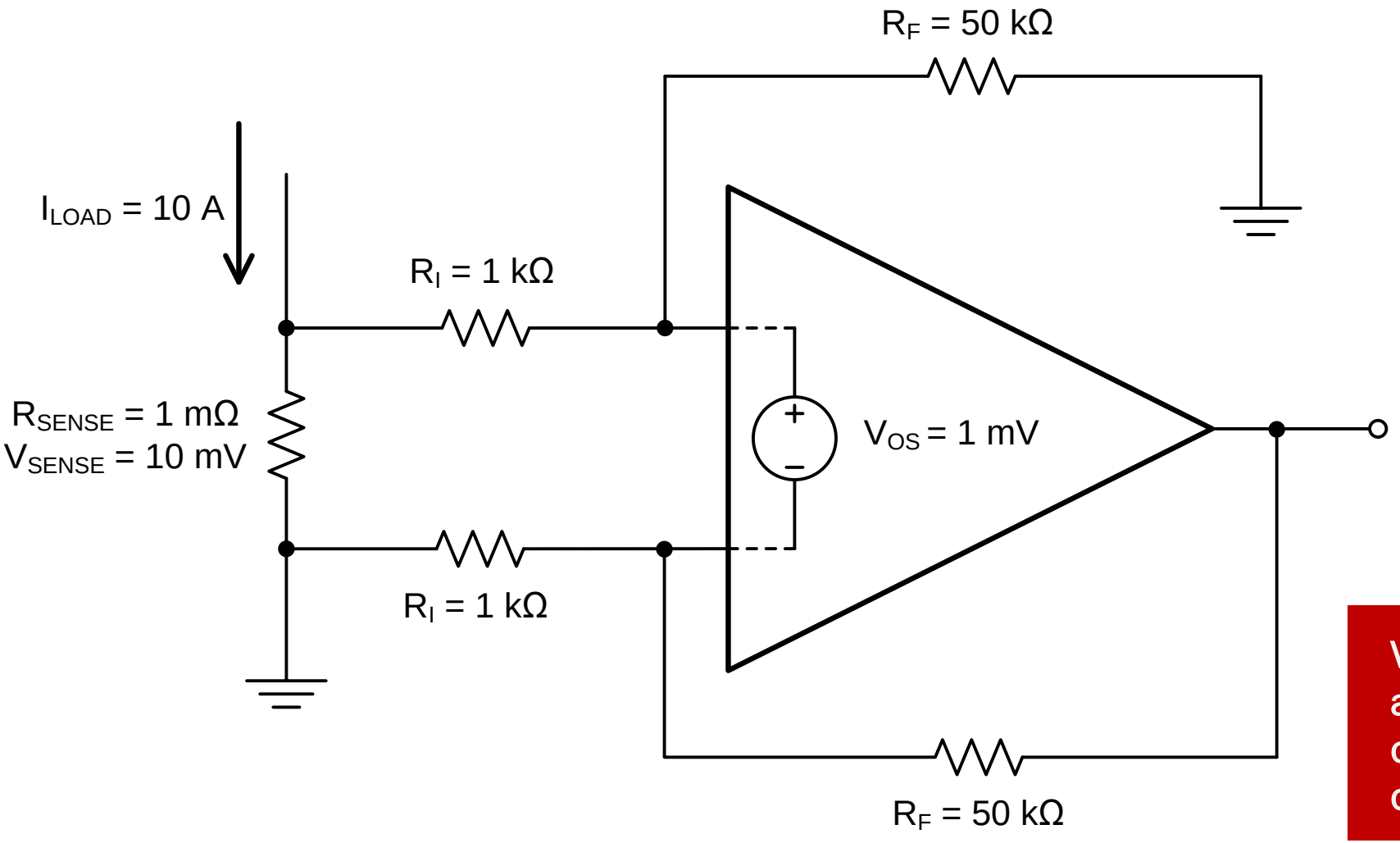
Applications
- Motor control
- Power supply monitoring
- Battery management
- ADC buffer

Key parameters
- Offset voltage
- Offset voltage drift
- Settling time
- Slew rate



Public Information

Low Side Current Sensing with Input Offset Voltage



Closed Loop Gain = 50 V/V

Noise Gain = 51 V/V

$V_{OUT} = (50 * 10\ mV) + \underbrace{(51 * 1\ mV)}_{\text{Error due to } V_{OS}}$

$= 551\ mV$

V_{OS} contributes output error, which affects accuracy. A lower input offset results in a lower output offset error.

Public Information

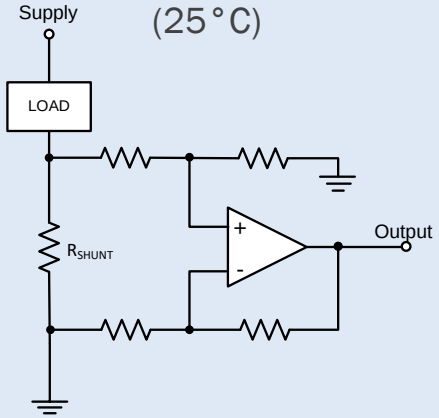
Comparison: Offset Voltage of Different Op Amps

Parameter	Units	NCS21911	NCS20071	LM321
Supply Voltage Range	V	4 to 36	2.7 to 36	3 to 32
Quiescent Current (typ)	mA	0.475	0.420	0.3
Gain Bandwidth	MHz	2	3	1
Input Offset Voltage (max @ 25C)	µV	25	3500	7000
Offset Voltage Drift (max)	µV/°C	0.085	> 2	> 7
Input Bias Current (max @ 25C)	nA	0.5	0.2	> 10
CMRR (typ)	dB	150	135	85
PSRR (typ)	dB	154	135	100
AVOL (typ)	dB	150	120	100
Noise 0.1 Hz to 10Hz	µVpp	0.25	8	?
Voltage Noise Density @ 1 kHz	nV/√Hz	22	30	40
Settling Time to 0.01%	µs	45	7	?
Slew Rate	V/µs	1.6	2.4	0.4

Offset Voltage: Improve Efficiency

LM321

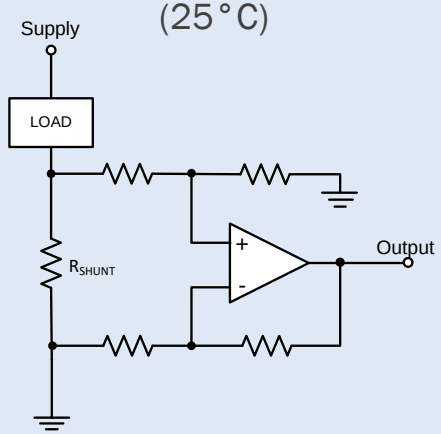
V_{OS} = 7 mV
(25°C)



To achieve 2% offset error:
350 mV shunt drop

NCS20071

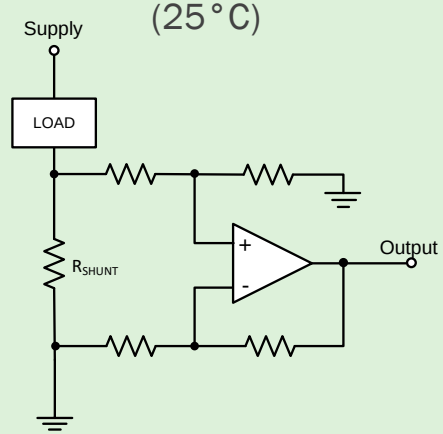
V_{OS} = 3.5 mV
(25°C)



To achieve 2% offset error:
175 mV shunt drop

NCS21911

V_{OS} = 25 µV
(25°C)



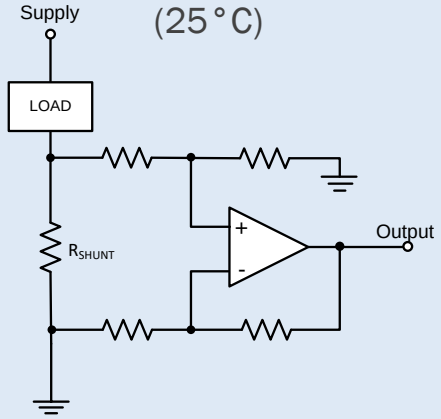
To achieve 2% offset error:
1.25 mV shunt drop

Reduce voltage drop across sense resistor → *Reduce power dissipation* → *System efficiency improves*

Offset Voltage: Improve Accuracy

LM321

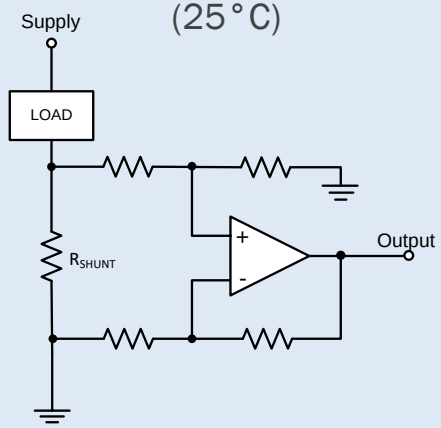
V_{OS} = 7 mV
(25°C)



With a 50 mV shunt drop:
14% offset error

NCS20071

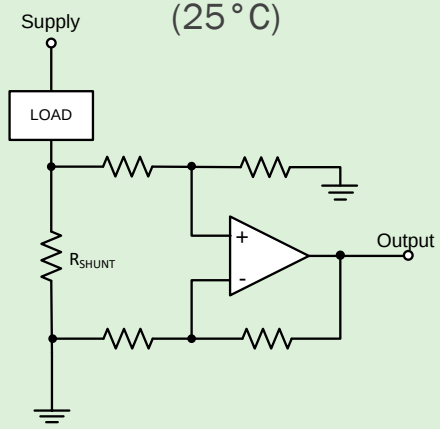
V_{OS} = 3.5 mV
(25°C)



With a 50 mV shunt drop:
7% offset error

NCS21911

V_{OS} = 25 µV
(25°C)

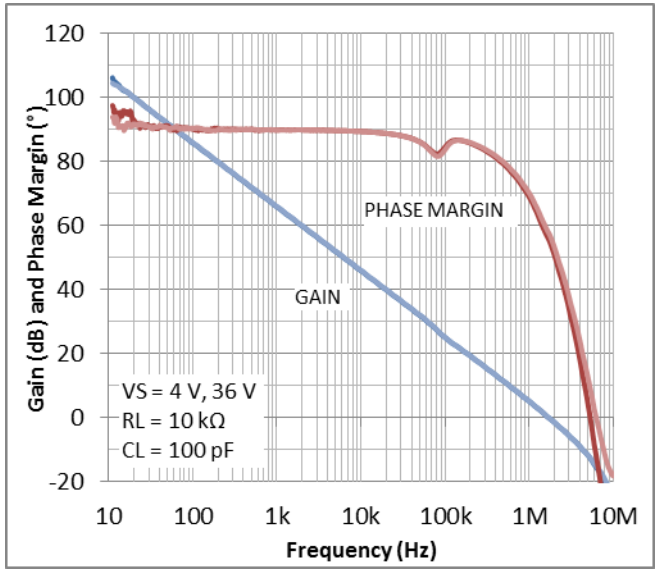


With a 50 mV shunt drop:
0.05% offset error

Reduce offset voltage → *Improve accuracy* → *System performance improves*

Gain Bandwidth

- NCS21911 has a unity gain bandwidth of 2 MHz
  - Having a higher unity bandwidth results in a higher open loop gain at low frequencies → this means improved loop gain accuracy
  - Don't forget to check the –3dB signal bandwidth when putting an op amp in closed loop
- The NCS21911 has an internal, continuous offset correction circuit that corrects the input offset voltage at a frequency of 250 kHz
  - Use the Nyquist theorem to ensure best performance: $f_{in} < 250\ kHz / 2$



NCS21911 Key Features

- The NCS21911 has better CMRR, PSRR, and AVOL performance, which are all key parameters for precision op amps
  - CMRR, PSRR, and AVOL all contribute to accuracy
- A key strength of the NCS21911 lies outside the datasheet specifications:
  - NCS21911 has excellent transient performance, especially at higher frequencies where aliasing typically becomes a problem for the competitor part
- The NCS21911 is a high precision drop-in for general purpose op amps such as NCS20071 and LM321
  - Improving the system efficiency results in system level savings and benefits