Power Supply Sequencing

TI Precision Labs – Current sense amplifiers

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Power supply sequencing

Devices

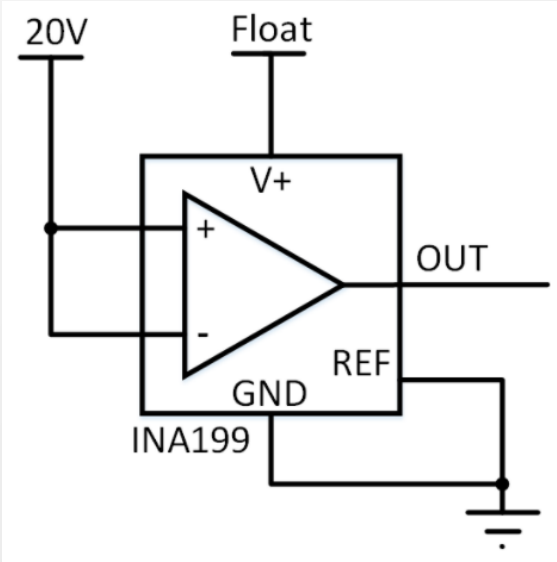
INA190			MIN	MAX	UNIT
V_S	Supply voltage			6	V
V_{IN+}, V_{IN-}	Analog inputs	Differential (V_{IN+}) – (V_{IN-})(2)	–42	42	V
		V_{IN+}, V_{IN-}, with respect to GND(3)	GND – 0.3	42	

10 Power Supply Recommendations

The input circuitry of the INA199 can accurately measure beyond its power-supply voltage, V+. For example, the V+ power supply can be 5 V, whereas the load power-supply voltage can be as high as 26 V. However, the output voltage range of the OUT pin is limited by the voltages on the power-supply pin. Also, the INA199 can withstand the full input signal range up to 26-V range in the input pins, regardless of whether the device has power applied or not.

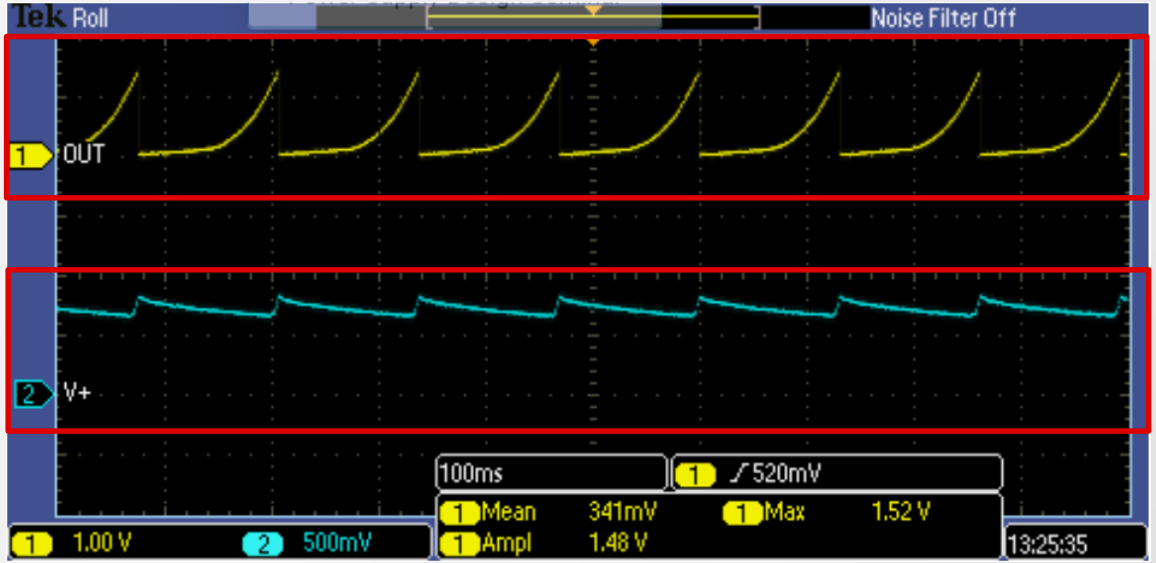
Power supply sequencing: Case 1

Circuit



Vsupply = floating
Vout and Vsupply measured
(10 MΩ probe)

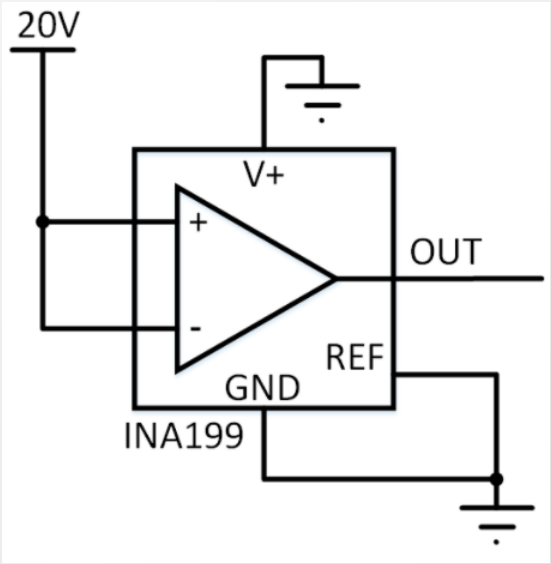
Waveform



Vout(max) ~1.5 V, Vsense = 0 V, Vsupply ~800 mV
Expected Vout is ~0 V (Swing low)

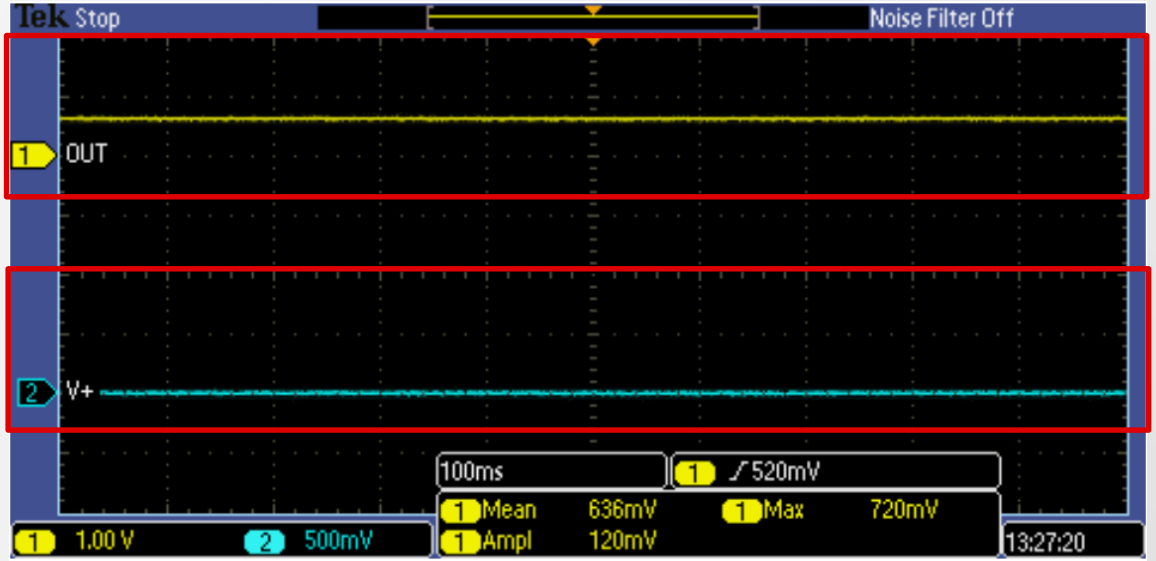
Power supply sequencing: Case 2

Circuit



Vsupply = GND
Vout and Vsupply measured
(10 MΩ probe)

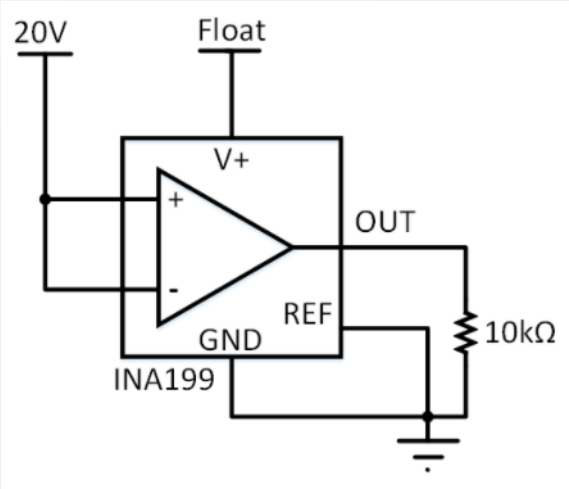
Waveform



Vout = 636 mV, Vsense = 0, Vsupply = 0 V
Expected Vout is ~0 V (Swing low)

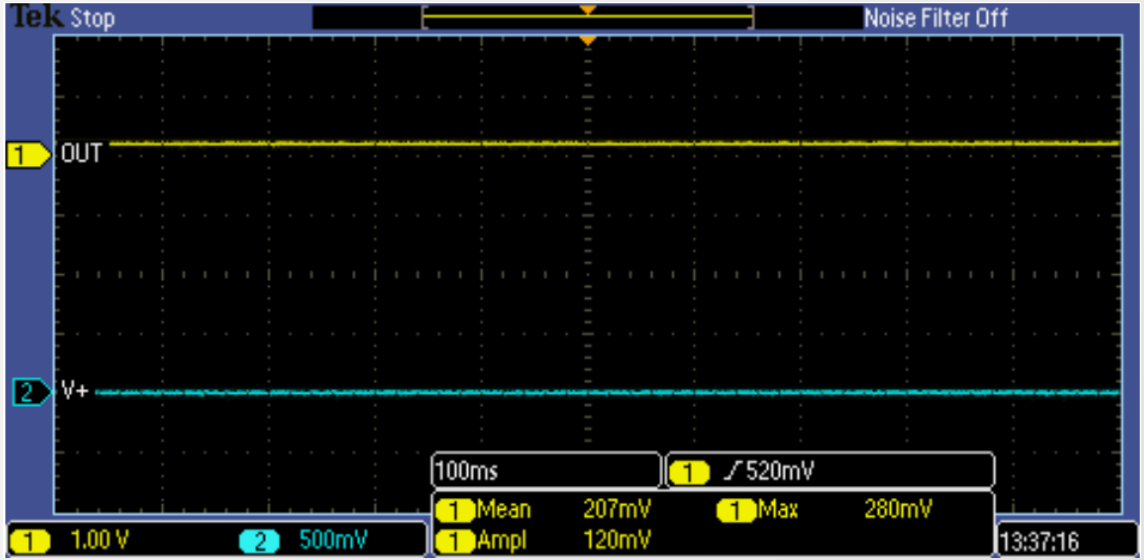
Power supply sequencing: Case 3

Circuit



Vsupply = floating,
(10 MΩ probe)
Vout is gnd through 10 kΩ

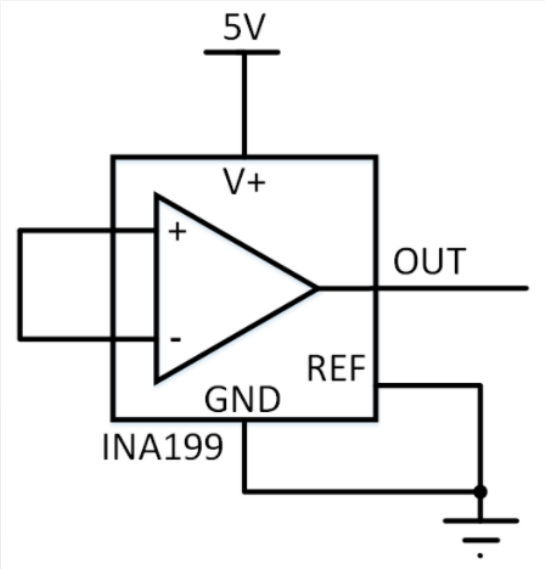
Waveform



Vout = 207 mV, Vsense = 0, Vsupply = 0 mV
Expected Vout is ~0 V (Swing low)

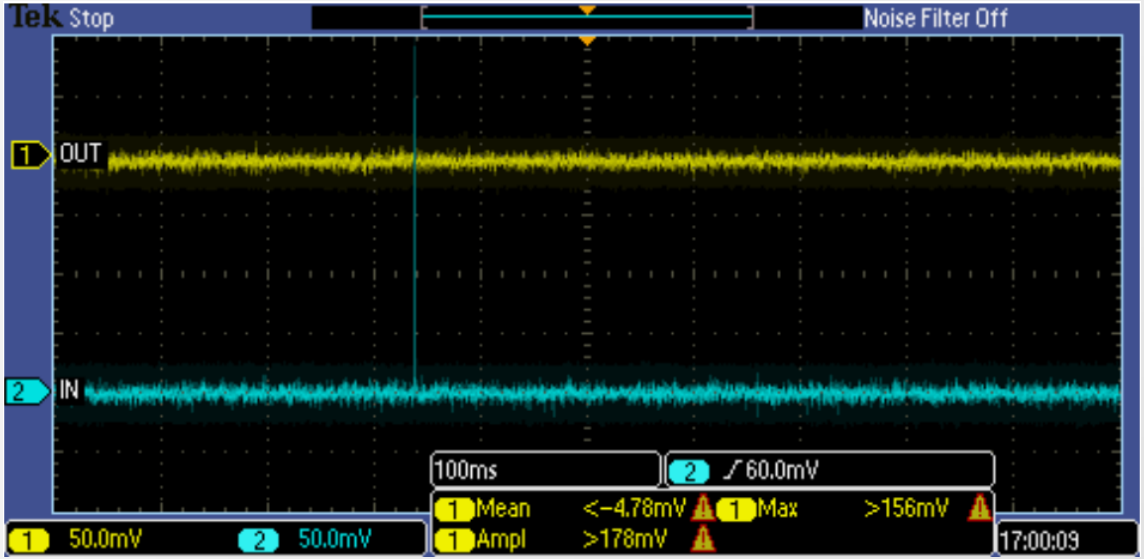
Power supply sequencing: Case 4

Circuit



Vin is shorted, floated
Vout and Vin measured
(10-MΩ probe)

Waveform



Vout = 0 mV, Vsense = 0, Vsupply = 5 V
Expected Vout is ~0 V (Swing low)

Summary

- Current sense amplifiers have an advantage over regular amplifiers because of their ability to withstand input voltage while powered off
- Leaving the supply pin floating can cause unwanted effects on the supply and output pins
- Grounding the supply will help mitigate the unexpected output voltages
- Pulling the output low through a 10-KΩ resistor will make the output voltage predictable
- Leaving the input pins floating is not generally advised

To find more current sense amplifier technical resources and search products, visit ti.com/currentsense

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QUIZ

Power supply sequencing - Quiz

1. When using a current sense amplifier (CSA) having Vcm (common mode voltage) > Vs (supply voltage) is acceptable.
   a) True
   b) False

Power supply sequencing - Quiz

2. Does pulling the output to ground with a small value resistor lower the output voltage when the CSA is powered off? Why?
   a) Yes, the output is zero because the output is shorted to ground
   b) Yes, the new resistor creates a voltage divider with the internal circuity
   c) Yes, the resistor will lower the bandwidth of the CSA causing a lower output
   d) No, the resistor will not lower the output voltage

Power supply sequencing - Quiz

3. When using a CSA, it is generally acceptable to have voltage on the inputs when the CSA is not powered on.
   a) True
   b) False

Power supply sequencing - Quiz

4. A CSA is connected to an ideal comparator used to detect an overcurrent condition. Looking at the table, will the CSA trip the comparator while the CSA is in the off stage? The comparator will trip when its input voltage is 1.1 V.

   a) Yes

   b) No

	Parameter	Specification
CSA	Input voltage	100 mV
	Vref	500 mV
	Gain	5 V/V
	Off stage output voltage	1.2 V

ANSWERS

Power supply sequencing - Quiz

1. When using a current sense amplifier (CSA) having Vcm (common mode voltage) > Vs (supply voltage) is acceptable.
   a) True
   b) False

CSA's have an input stage that will allow for the inputs to be at a higher voltage (up to the allowable maximum) than their supply voltage.

Power supply sequencing - Quiz

2. Does pulling the output to ground with a small value resistor lower the output voltage when the CSA is powered off? Why?
   a) Yes, the output is zero because the output is shorted to ground
   b) Yes, the new resistor creates a voltage divider with the internal circuity
   c) Yes, the resistor will lower the bandwidth of the CSA causing a lower output
   d) No, the resistor will not lower the output voltage

The resistor forms a voltage divider with the internal circuitry of the device and smaller loads ultimately result in more voltage dropping across the internal impedance thereby yielding a lower output voltage

Power supply sequencing - Quiz

3. When using a CSA, it is generally acceptable to have voltage on the inputs when the CSA is not powered on.

a) True

b) False

CSA's input structure allow for the inputs to have a common mode voltage on them when the device is not powered. This also allows to turn off the CSA when the output is not being measured.

Power supply sequencing - Quiz

4. A CSA is connected to an ideal comparator used to detect an overcurrent condition. Looking at the table, will the CSA trip the comparator while the CSA is in the off stage? The comparator will trip when its input voltage is 1.1 V.

a) Yes

b) No

	Parameter	Specification
CSA	Input voltage	100 mV
	Vref	500 mV
	Gain	5 V/V
	Off stage output voltage	1.2 V

The CSA when not properly powered off may exhibit unexpected behavior on the output pin. In this particular case, the output of the CSA will be 1.2 V when it should be 0 V. So, the CSA will trip the comparator.