Analog Engineer's Circuit Data Converters

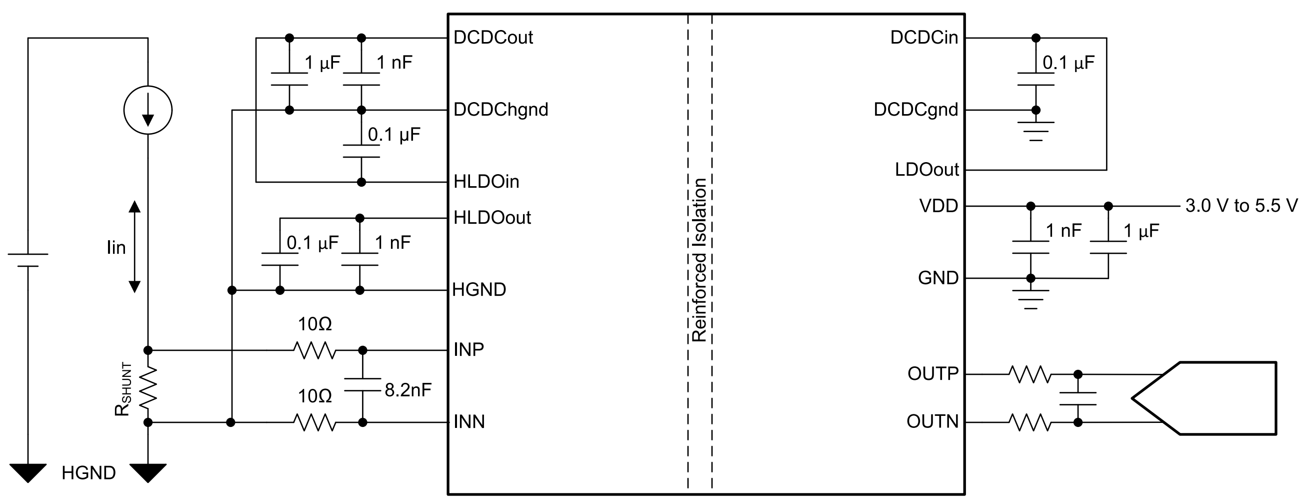
Isolated current-measurement circuit with ±250-mV input and differential output

Design Goals

Current Source		Input Voltage		Output Voltage		Single Power Supply
I_{inMin}	I_{inMax}	Dif V_{INMin}	Dif V_{INMax}	Dif V_{OUTMin}	Dif V_{OUTMax}	V_{DD}
–50A	50A	–250mV	250mV	–2.05V	2.05V	3.0V to 5.5V

Design Description

This isolated single-supply bidirectional current sensing circuit can accurately measure load currents from –50A to 50A. The linear range of the input is from –250mV to 250mV with a differential output range of –2.05V to 2.05V. The gain of the circuit is fixed at 8.2V/V. The design requires 1000-V working voltage to maintain operator safety in a high-voltage application.



Design Notes

1. Select an amplifier with at least 1000-V working voltage across the isolation barrier.
2. Select input filter components to minimize voltage drop from internal bias currents and maintain a –3-dB cutoff frequency of approximately 1MHz.
3. For highest accuracy, use a precision shunt resistor with low temperature coefficient.
4. Select the current shunt for expected peak input current levels.
5. Shunt resistor power should be three to eight times larger than the expected continuous power rating of the system.

Design Steps

1. Determine the transfer equation given the input current range and the fixed gain of the isolation amplifier.

$$V_{OUT} = I_{in} \times Rshunt \times 8.2V$$

2. Determine the maximum shunt resistor.

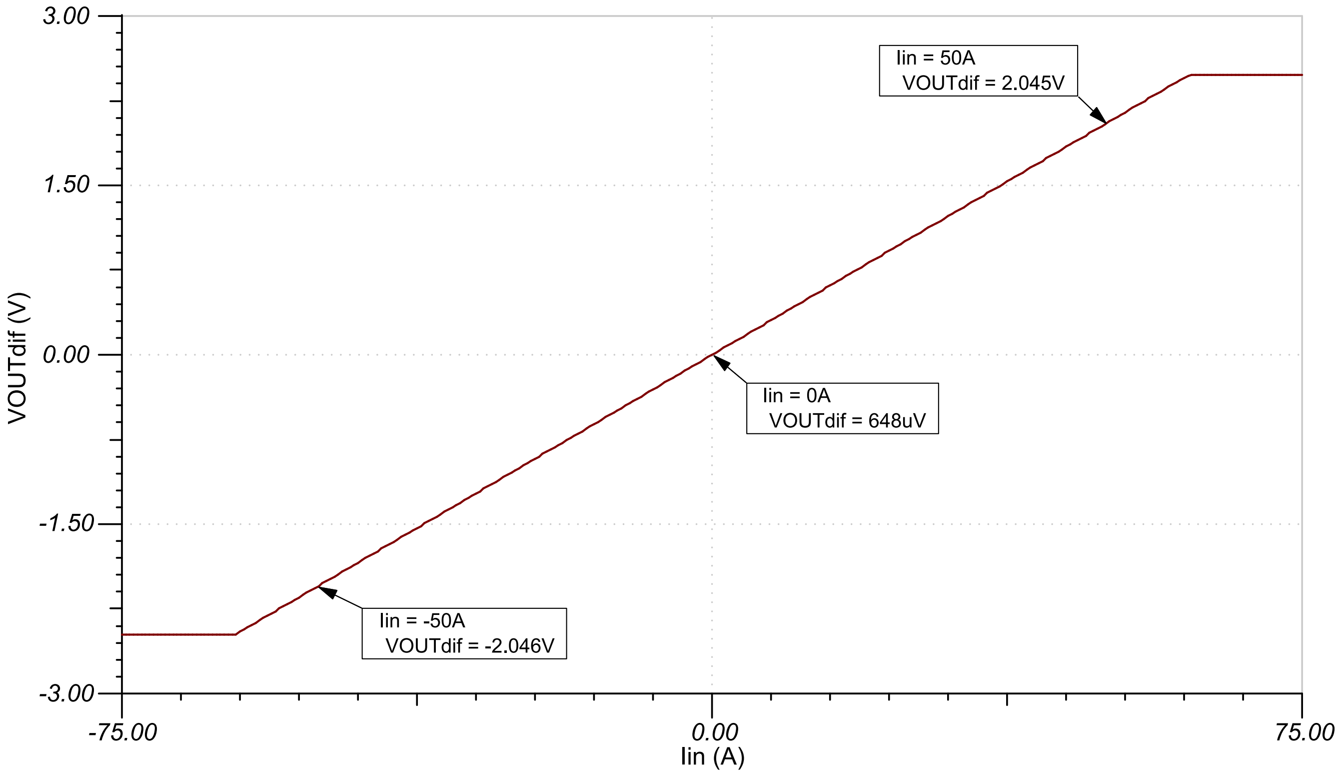
$$Rshunt = \frac{Vshunt}{I_{inMax}} = \frac{250mV}{50A} = 5m\Omega$$

3. Determine the minimum shunt resistor power needed.

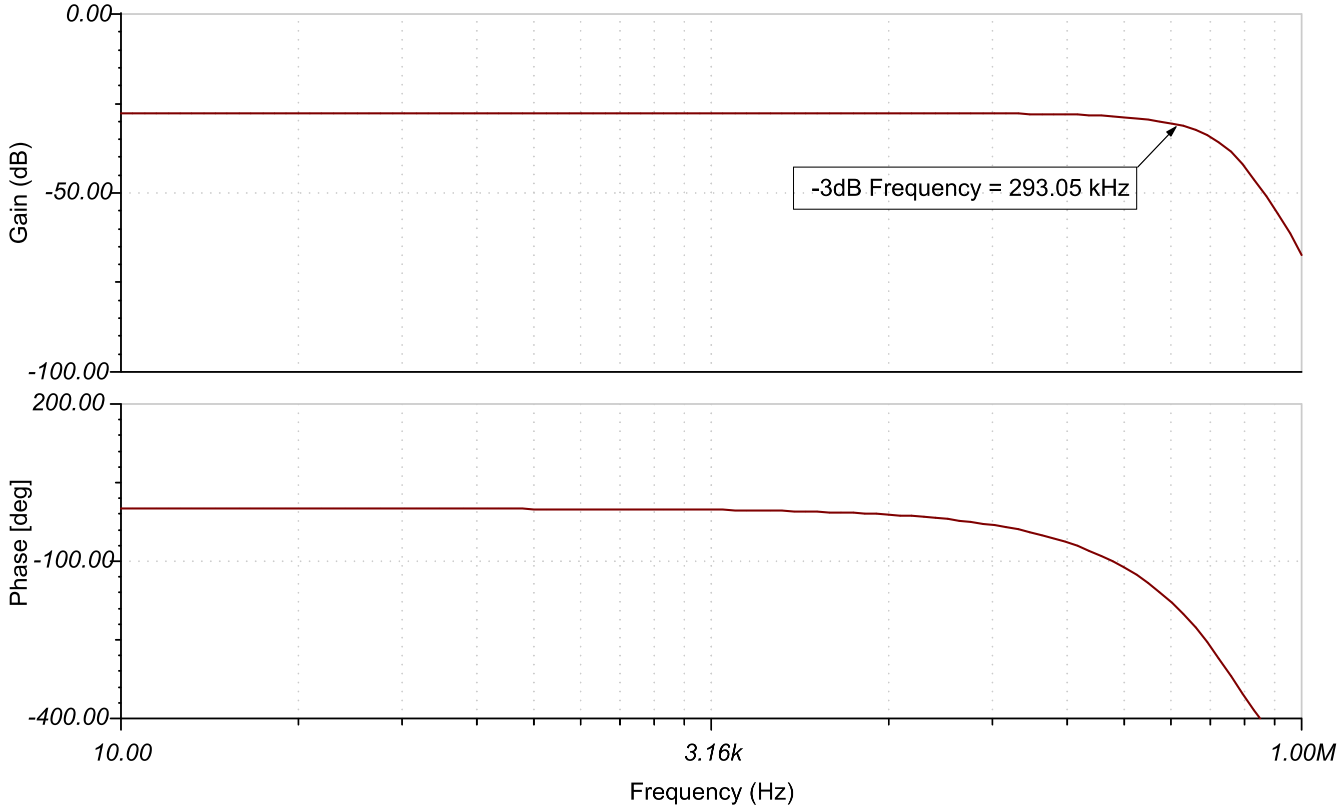
$$Power\ Rshunt = I_{inMax^2} \times Rshunt = 2500 \times 0.005 = 12.5W$$

Design Simulations

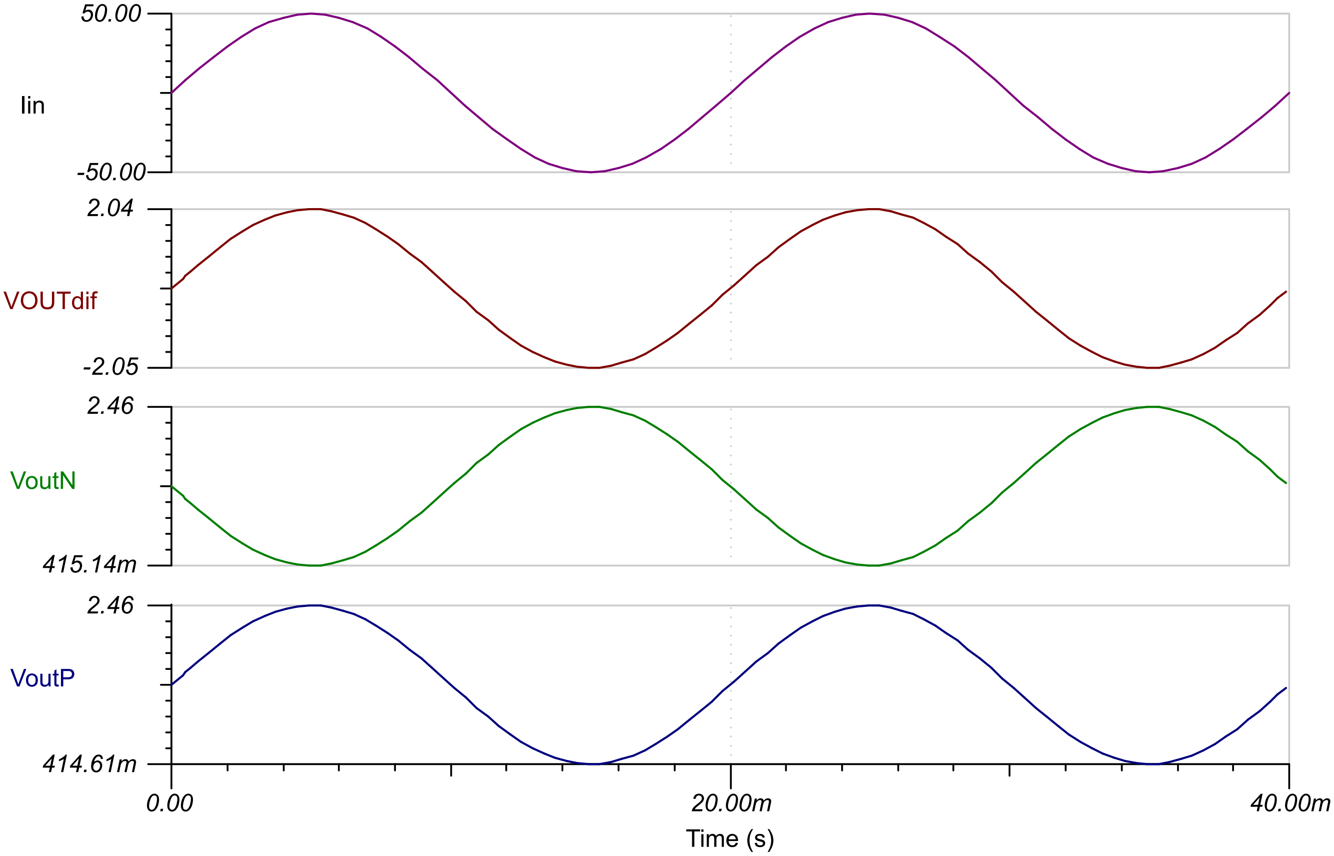
DC Simulation Results



Closed Loop AC Simulation Results



Transient Simulation Results



Design References

See *Analog Engineer's Circuit Cookbooks* for TI's comprehensive circuit library.

Link to Key Files (TINA)

Design files for this circuit – AMC3301 TINA-TI Reference Design

Design Featured Op Amp

AMC3301	
Working voltage	$1000V_{RMS}$
Gain	8.2V/V
Bandwidth	300kHz TYP
Linear input voltage range	±250mV
www.ti.com/product/AMC3301	

Design Alternate Op Amp

AMC3330	
Working voltage	$1000V_{RMS}$
Gain	2V/V
Bandwidth	310kHz TYP
Linear input voltage range	±1000mV
www.ti.com/product/AMC3330-Q1	

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