Development of a Precision Analog Isolation Amplifier Prototype Designed to Isolate Two Distinct Power Supplies

Bautista Fernández
UCO/Lick Engineering Lab
University of California, Santa Cruz

Abstract

The high resolution Echelle spectrograph (Hires) is mounted permanently on Keck 1's right Nasmyth platform and is currently having its CCD detector, Dewar, and CCD controller electronics upgraded. All external interfaces to the new CCD controller are optically isolated due to upgrade requirements of faster readout speeds and lower readout noise. A 50-liter Dewar supplies LN2 to HIRES and contains circuitry power by a switching power supply, thus a precision analog isolation amplifier is required to isolate the noisy output signal from the "quiet" CCD controller environment. The isolation amplifier was created as a prototype based on the circuit diagram provided in HCNR201 data sheet by Agilent technologies. The circuit was tested using a DC supply source and a switching supply source. The circuit was tested for linearity, as well as input noise and output noise. Testing results indicate that the isolation amplifier is working properly with a max error of 0.012% and negligible average error. Error is attributed to the mechanical swing of the variable resistor.

Objective

- Create prototype of a Precision Analog Isolation Amplifier
- Test prototype for linearity and find a linear regression and deviation of data
- Check for input noise and output noise

Figure 2: DC Power Supply used to test prototype

Performance Requirements

- Circuit must be able to isolate two distinct power supplies
- Must operate from 0V to 11V
- Vin must equal to Vout to better than ± 0.5%
- Circuit needs to be as compact as possible with short traces

Figure 3: HIRES CCD Controller Interconnect Chassis houses Switching Power Supply and Prototype

Block Diagram

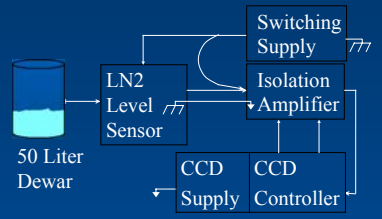

Figure 1: Block Diagram of how the Precision Analog Isolation Amplifier will be connected in HIRES.

Prototype of Isolation Amplifier

- Vin: 0 to 10V
- Size: 1.75" x 1.75"
- Isolates two different power supplies

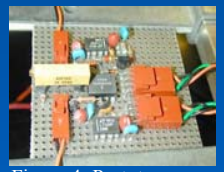

Figure 4: Prototype created with the use of the schematic of Figure 5.

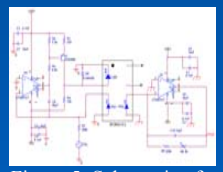

Figure 5: Schematic of Prototype Created with PSpice

Prototype Tests

1. Output Gain resistor = 200kΩ ± 1%
   - DC Power Supply
2. Output Gain resistor = 182kΩ ± 1% and variable 50kΩ
   - DC Power Supply
3. Output Gain resistor = 200kΩ ± 1% and variable 2kΩ
   - DC and Switching Power Supply
4. Output Gain resistor = 200kΩ ± 1% and variable 5kΩ
   - DC and Switching Power Supply

Prototype Results

Test 1	Vout less than Vin Deviation: Min 0.001v to Max 0.073v Max error = 0.765%
Test 2	Vout less than Vin Deviation: Min 0.001v to Max 0.073v Max error = 0.018%
Test 3	Vout ≈ Vin Max error = 0.013% Avg. error = Negligible
Test 4	Vout ≈ Vin Max error = 0.012% Avg. error = Negligible

Table 1: Prototype results for Test 1 trough Test 4.

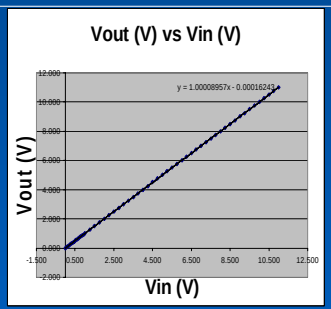

Figure 6: Plot of Vout vs Vin & Linear Regression of Test 4

Prototype Noise

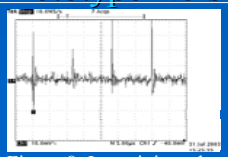

Figure 8: Input injected Noise. Test 4

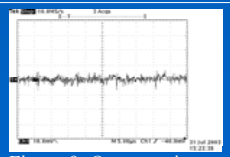

Figure 9: Output noise Test 4

This two Figures were take during test 4, at an input voltage of approximately 5v. Figure 8 show the input injected noise applied to the prototype and Figure 9 shows the output noise produced by the prototype. The Input Injected noise was injected by a Switching Power Supply that switches at a frequency of 90kHz. It is apparent that the input noise does not affect our output.

Conclusion

- Prototype is working properly with a max error of 0.012% and a negligible average error
- Variable resistor needs to be replaced
- Traces were still long

Outstanding Issues

- Form Factor
- Produce PC board layout
- Manufacture PC board
- Replace variable resistor with precision resistors having ratio match tolerance of ± 0.02%
- Utilize Surface Mount Circuit Technology

References

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