Enhanced receiver hardware for physical modeling

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ABSTRACT

With the expectation of increasing the amount that the physical modeling system will be used in the coming years there are efforts to improve efficiency and create a more customizable setup. This upgrade will cover both the input and output aspects of the physical modeling system. This report covers upgrades to the number of receiver channels that can be used simultaneously to record data.

INTRODUCTION

Part of the expansion of the physical modelling system involved increasing the number of channels that can be recorded at one time. The original implementation of the modelling systems used two transducers, one as the source and one as the receiver. To improve the efficiency of the system an eight-channel digitizer was purchased to increase the number active receivers from one to eight. More recently two more eight channel digitizers were purchased to triple the maximum number of recordable channels from eight to twenty-four.

DIGITIZERS

The digitizers chosen for this task are the same as the original eight channel digitizer from GaGe Applied. These are the Faceless Connected Instrument (FCiX) series, Figure 1. They are connected to the recording system using ethernet in a LAN configuration.

FIG. 1. A GaGe FCiX Octupus Digitizer.

The initial setup presented a problem in that the two new units continued to try and use the same IP address, which obviously caused a conflict. This occurred right when the stay at home order from the University of Calgary for the pandemic was put in place. The two units were brough off site and the issue was resolved. They are now back in the lab.

AMPLIFIERS

The digitizers do not perform any function other than simply digitizing the analogue “real world” information into digital information that can be used/processed by a computer/software. The signal that is input to the digitizer from the transducer requires

amplification. The first eight channel digitizer was connected to eight amplifiers built by Olympus Industrial Solutions. The specific units used are the 5660B ultrasonic pre-amp. CREWES approached them with the intent to purchase another sixteen amplifiers. Unfortunately, Olympus has decided not to manufacture these units anymore and focus on their transducer designs instead.

The need for a pre-amp prompted the decision to design them in house. With twenty-four amplifiers in the lab requiring their own separate power connections it could lead to a cluttered area. The goal of this design is to have one power supply for all the amplifier channels creating a “single box” solution.

The prototype amplifier is a two-stage design using AD810 low power video op amps. Originally the first stage was going to use an AD830, however the test circuit failed to provide a useable output and the decision was made to use two AD810s. Figure 2 is the schematic of the circuit design. The circuit was built on a prototyping bread board, Figure 3. The original Olympus amplifiers have a switchable gain from 40dB to 60dB. The hope is to build pre-amplifiers with similar switching ability. This will be achieved by being able to switch the feedback resistor in the first amplification stage.

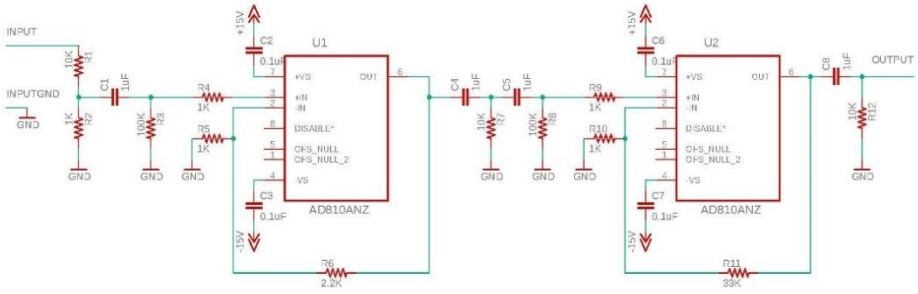

FIG. 2. The two stage amplifier schematic using two AD810s.

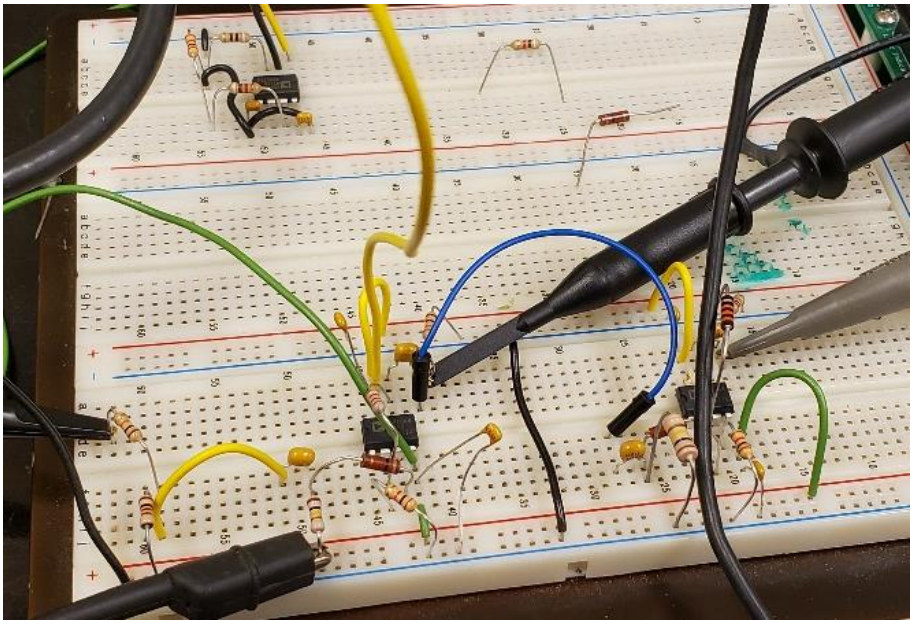

FIG. 3. The two stage AD810 pre-amplifier circuit on breadboard. Note the abandoned AD830 op-amp in the upper left.

Once the first stage of the amplifier was working the second stage was added. Testing was then carried out over various input frequencies to determine what bandwidth the circuit would work best in, Figure 4.

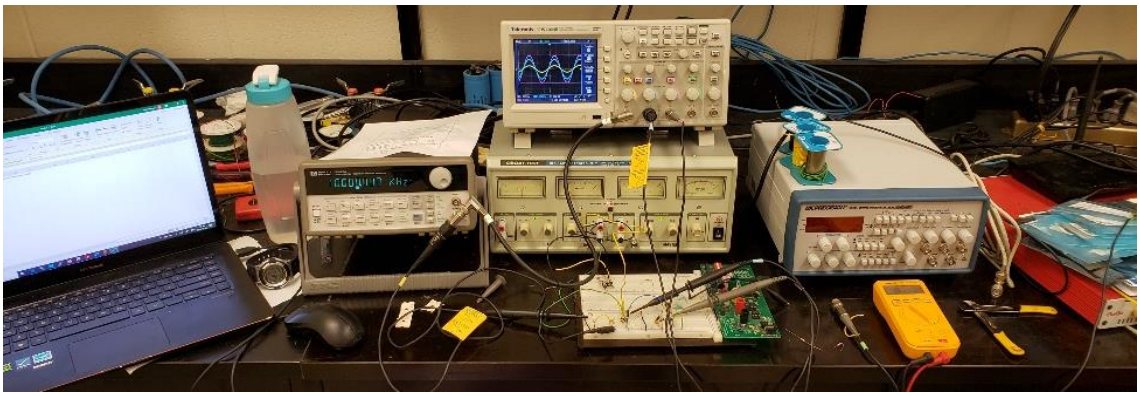

FIG. 4. Testing the two stage amplifier.

As mentioned above, there is a desire to switch between two levels of amplifications. As such, two different amplification setups where used for testing. The first setup had a gain of 34X and the second a gain of 3.2X. This was accomplished by adjusting the feedback resistor of the first AD810, R6 in the schematic, from 33K to 2.2K. Table 1 shows the frequencies tested and the peak to peak voltage of output from the circuit. The input voltage was 200mV peak to peak after the being attenuated by the input voltage divider. Figure 5 and 6 are graphical representations of Table 1.

TABLE 1. Amplifier output values in peak to peak voltage vs. frequency of input at a constant 200mVp-p.

	Output (Vp-p)	
Frequency (KHz)	Rf=33K	Rf=2.2K
1	21.4	2.1
2	21.4	2.1
5	21.4	2.1
10	21.4	2.1
20	21.2	2.1
50	21	2.08
100	20.8	2.04
200	19.6	1.94
300	17.4	1.78
400	15.4	1.64
500	12.6	1.5
600	10.5	1.36
700	8.8	1.19
800	7.32	1.09
900	6.16	1
1000	5.24	0.928
1500	2.66	0.656
2000	1.74	0.524

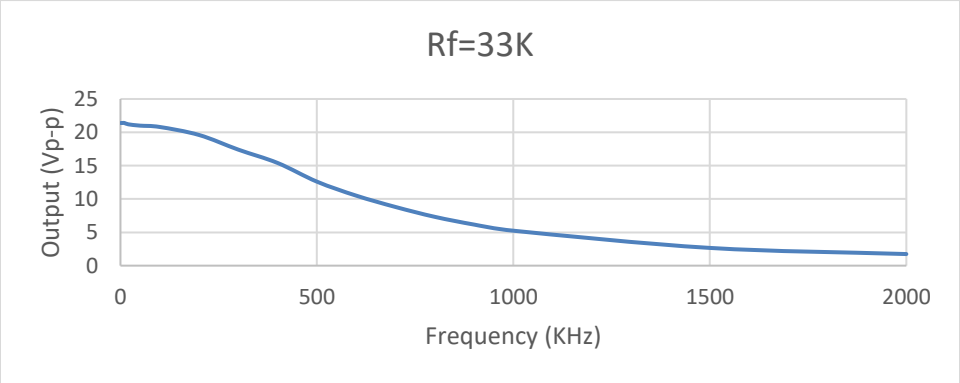

FIG. 5. Peak to peak output voltage vs. input frequency of circuit with Rf set to 33K.

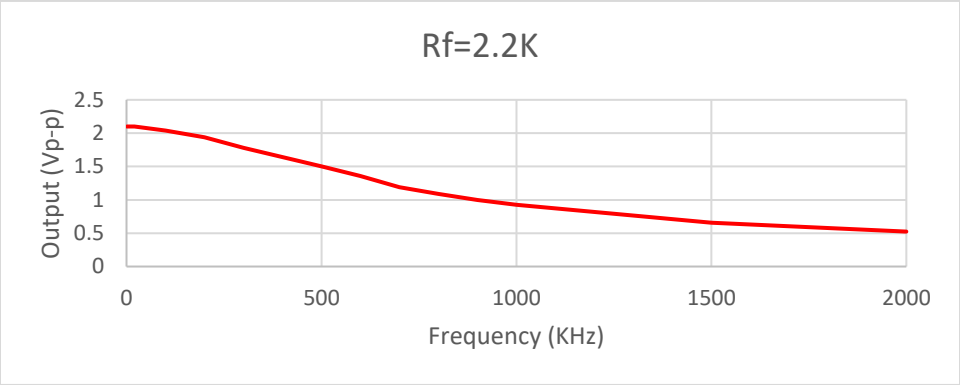

FIG. 6. Peak to peak output voltage vs. input frequency of circuit with Rf set to 2.2K.

One issue that was discovered was the need to reduce the input signal through a voltage divider as the output would become clipped when it exceeded the rail voltages of the power supply, in this case +/- 15V.

FUTURE WORK

The amplification circuit is sensitive to input frequency. The gain is determined by resistor combinations. Further testing is required to optimize the gain over a wider range of input frequencies.

As mentioned before the goal of this unit is to have all the amplifier channels in one unit, but not necessarily on one board. They would all share the same power supply. Connections to the transducers are typically made by either soldering directly to them or employing the use of BNC connectors. The inputs to the digitizers are all SMA style connectors. The pre-amp will use BNC connectors on the inputs and SMA on the outputs to reduce the number of times that cables need to be cut and have connectors soldered to them to be connected to the digitizers.

CONCLUSIONS

Physical modeling is an import aspect of the work that CREWES does. This year has produced a bit of a setback with the amount of time that researchers have been able to spend in the lab as the University of Calgary had to restrict access. With a little more testing the working prototype will be upgraded into a permanent fixture of the lab and triple the amount of data that can be recorded at once. This will not triple the amount of data gathered, but will reduce the amount of time it would take for a survey.

ACKNOWLEDGEMENTS

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