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Abstract

The fourth quarter of the project was dedicated to the manufacturing of the mechanical system for wireless communications and the power generation module and inspection pre assembly of the mechanical components. Another emphasis for the quarter was the development of filter control and signal detection software.

The tasks accomplished during this report period were:

1. Dimensional issues were resolved and revised drawings for manufacturing of the wireless communications gauge and power generator were completed and sent to a machine shop for manufacturing.
2. Finalized the requirements and fittings and connections for testing the tool in the Halliburton flow loop.
3. The new acoustic generator was manufactured successfully and it was delivered during this quarter. The assembly will be outsourced for plastic coating in preparation for hostile environment use.
4. The acoustic two-way communications development continued to progress. The real time firmware for the surface system was developed and the processor was able to detect and process the data frame transmitted from downhole. The analog section of the tool was also developed and it is being tested for filtering capabilities and signal detection and amplification.
5. The new transformer to drive the acoustic generator assembly was manufactured and was successfully tested. Spring mandrel design showed increased acoustic output on the pipe and was implemented.
6. PCBA board carrier with board set was tested for function and fit and is 100% complete.
7. Filter control software is complete and software to allow modification of communication parameters dynamically is 50% complete.
8. All mechanical parts to assemble the wireless gauge and power generator have been received and verified to be within specification.
9. Acoustic generator has been assembled in the tool mandrel and tested successfully.
10. The circuit required to harvest the power generated downhole has been designed and the power generator components have been received.

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Introduction

The Downhole Power Generation and Wireless Communications for Intellligent Completions Application project progressed significantly during the July 01,2003 to September 30, 2003 report period. The goals for this period were to revise the detailed drawings required to manufacture the systems, continue to develop the firmware for the data acquisition and processing software as well as the communications from the surface to downhole. The design for the power generator was also a priority including the type of coating required to prevent erosion of the generator components while in the downhole environment.

The entire wireless gauge and power generator detailed design was completed and turned over to a machine shop for manufacturing of the system. A new bonding was found that can be applied to the power generator hardware located on the flow stream to prevent erosion and damage to the hardware. All mechanical components for the tool have been received from the machine shop. The acoustic two-way communications software was developed and completed during this report period. Using the results of the transmission frequency tests done at the Halliburton facility, additional frequency tables were added. The frequency tables had a variety of duty cycles so optimum power consumption can be determined. A new phase of the development process has been started to provide the digital signal processing required to extract the signal generated by the tool from noises from sources such as downhole and surface pumps, flow and gas injection. The DSP will be performed in real time and separate the signal from noise and amplify the signal after filtering.

A new microprocessor using flash memory is being implemented in the downhole tool to allow the firmware to be upgraded at the surface or downhole. A new filter is also being developed for deployment downhole for detection of the signal on a 2 way communications format.

Executive Summary

The power generation and wireless communications system progressed well during this report period. The tool mandrel was assembled and the acoustic wave generator was installed in the mandrel for testing the system to obtain the proper frequencies for transmission on the tubing. A significant amount of time was devoted to digital signal processing development for detection of the acoustic signal at the surface.

The highlights of the accomplishments for this report period are listed below.

1. Dimensional issues were resolved and revised drawings for manufacturing of the wireless communications gauge and power generator were completed and sent to a machine shop for manufacturing. All parts have been received from the machine shop.
2. Finalized the requirements and fittings and connections for testing the tool in the Halliburton flow loop.
3. The new acoustic generator was manufactured successfully and it was delivered during this quarter. The assembly will be outsourced for coating in preparation for hostile environment use.
4. The acoustic two-way communications development continued to progress. The real time firmware for the surface system was developed and the processor was able to detect and process the data frame transmitted from downhole. The analog section of the tool was also developed and it is being tested for filtering capabilities and signal detection and amplification.

5. The new transformer to drive the acoustic generator assembly was manufactured and was successfully tested. Spring mandrel design showed increased acoustic output on the pipe and was implemented.
6. PCBA board carrier with board set was tested for function and fit and is 100% complete.
7. Filter control software is complete and software to allow modification of communication parameters dynamically is 50% complete.
8. Acoustic generator has been assembled in the tool mandrel and tested successfully.
9. The circuit required to harvest the power generated downhole has been designed and the power generator components have been received. Surface system data processing was enhanced. The enhancements include programmable post amplification after filtering, programmable filter Q, 3 additional 4-20 mA outputs and programmable 4-20 mA output configurations (outputs can be mapped to any sensor).
10. The driver software for both the programmable gain amplifiers and programmable filter was implemented and tested.
11. Power reset software was tested and implemented. This allows the system to recover from a momentary loss of power without human intervention.
12. Power generation mechanical design completed and prototype built.
13. PCBA board carriers with board set was successfully tested for fit and function.

Experimental

Experimental Apparatus-An experimental apparatus consisting of an analog recorder, interface circuit, accelerometer, A/D converter, digital signal processing software, programmable digital signal processor and a data acquisition computer. The accelerometer was used as the physical sensor to receive the acoustic signal. It was interface to the analog recorder using a custom interface circuit. The interface was used again to retrieve the data from the analog recorder. The A/D converter was used to digitize the analog signal and once digitized custom digital signal processing was used for analysis.

Figure 1 shows the digitized unfiltered data and figure 2 shows the filtered data.

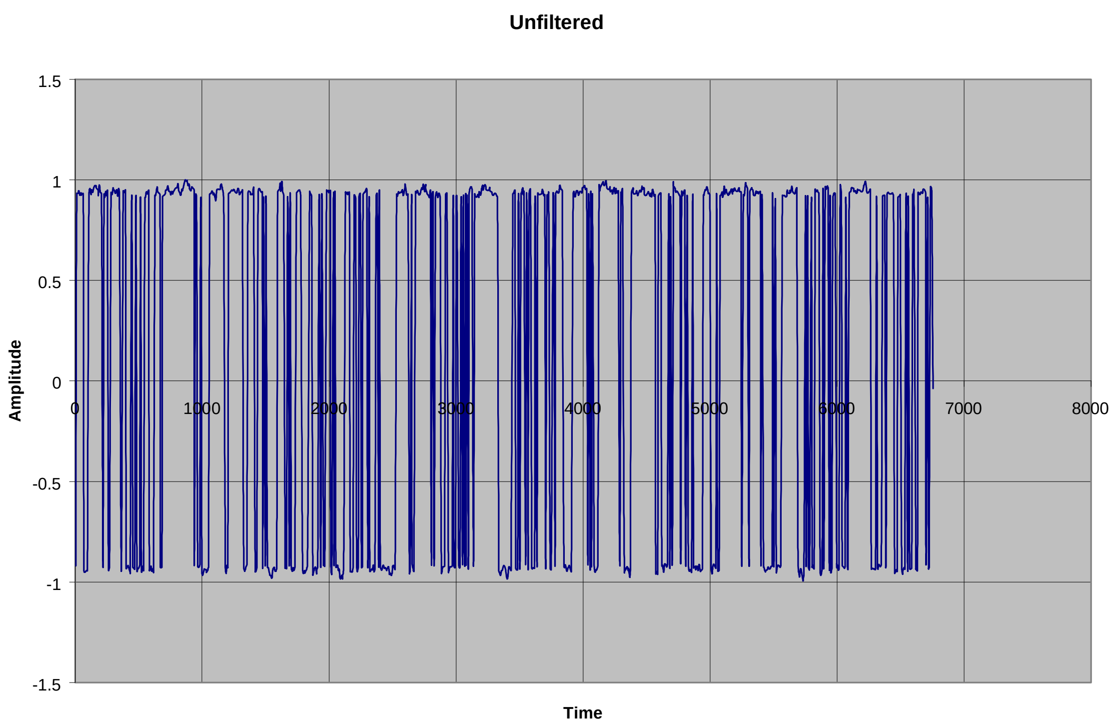

Figure #1

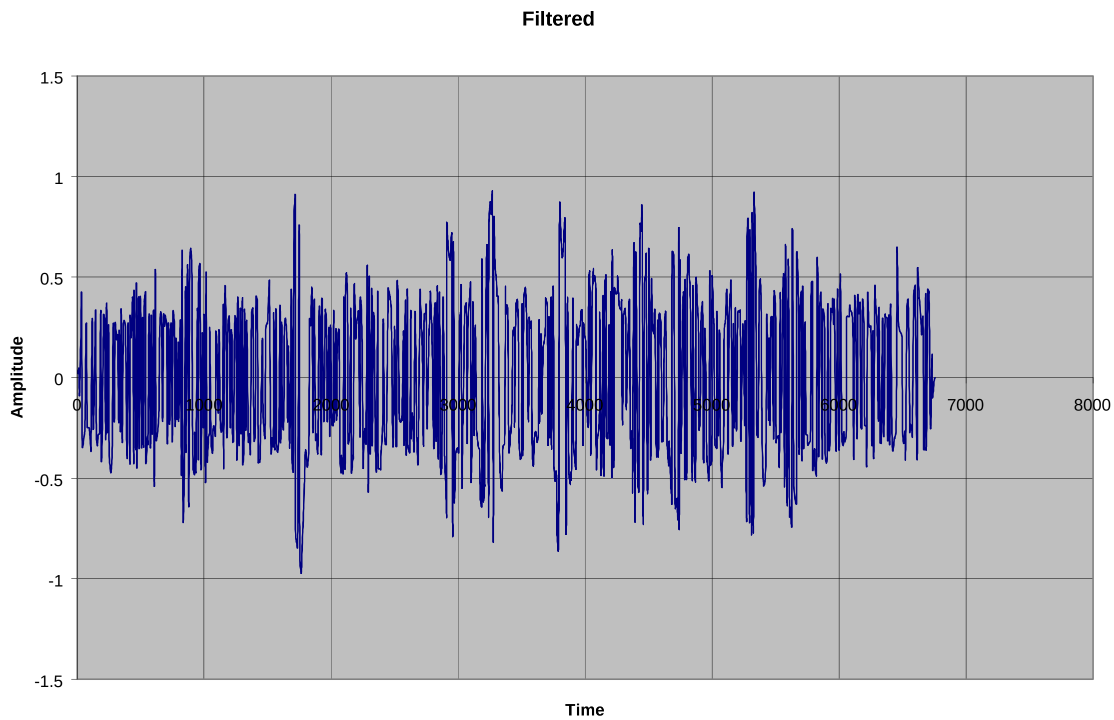

Figure #2

Results and Discussion

Several hours of data was recorded and the signal processing software was used for analysis. From the analysis it was determined that bandpass filtering, using a high quality bandpass filter, would be sufficient to resolve the signal from background noise in that environment. The programmable digital signal processor was used to verify that the filtering could be accomplished in hardware alone. The signal processor selected is field programmable so that it can be configured for a variety of wells and operating conditions. A minimum signal amplitude threshold of 0.6 was implemented to separate the signal from the noise. The results of the filtering are shown in figure #2 which shows a packet that represents a pressure of 2070 pounds per square inch.

Conclusion

The conclusions for the fourth quarter for this project are as following:

- The mechanical components for the entire power generator and downhole communications system have been manufactured and have been received. The mandrel has been assembled and the acoustic generator installed in the mandrel.
- Test data obtained using 4 ½ inch tubing and our tool indicated that enhanced filtering was required to extract the signal from the noise. A significant effort was started this quarter to create the necessary surface digital signal processing techniques to obtain the acoustic signal transmitted from downhole. A 2 step approach is being pursued with the hardware required filtering was tested and implemented while the software filtering is still being developed.
- Enhanced requirements for the surface system were identified and implemented. The enhancements included programmable filters, programmable gains, increased configurability, larger number of outputs and an enhanced user interface.
- The power generator electronics has been design and the parts have been purchased and received at Tubel Technologies. The parts will be assembled to the mandrel and will be sent to be coated for protection in the harsh environment downhole.
- The project is on schedule and should be fully assembled for well testing at the end of this quarter.

References

There are no references related to this project and work performed over the past 3 months.

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List of Acronyms and Abbreviations

There are no acronyms or abbreviations in this report.

Appendices

No appendices.