DATA ACQUISITION SYSTEM FOR A CABLED OCEAN BOTTOM SEISMOMETER (OBS)

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Abstract- Ocean Bottom Seismometers (OBS) are highly used to monitor seismic activities at sea. They are also used to detect tsunamis and generate warning alarms. This paper presents a data acquisition system built for an OBS with capability to synchronize time through IEEE-1588 protocol. This acquisition system provides real time data through the Ethernet making it suitable for OBSs deployed at seafloor observatories.

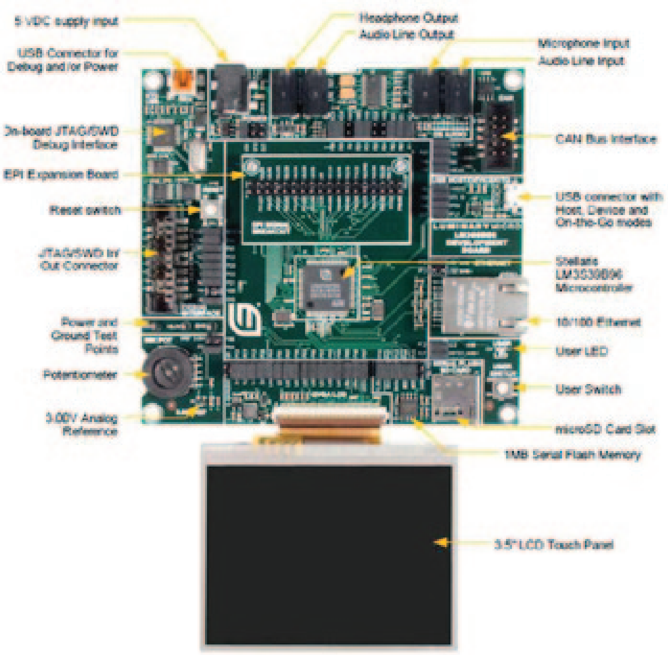
Introduction

Today Ocean Bottom Seismometers (OBS) are very popular and used in many places all around the world to detect seismic activities at the sea bottom. It is enough to mention scientific institutes in United States, Japan, Norway, Germany etc. The seismometer is a detector that is placed in direct contact with the earth to convert very small motions of the earth into electrical signals, which are recorded digitally [1]. In general, OBSs are used to study the sea bottom to detect earthquakes, tsunamis or to find oil reservoirs. In order to monitor continuous seismic activities in the ocean, OBSs are installed in seafloor observatories. OBSEA is a cabled seafloor observatory located 4 kilometers from Vilanova i la Geltru (Spain) in a fishing protected area. The main advantage of this observatory is its uninterrupted power supply to scientific instruments. It allows permanent power supply and avoids problems with battery powered systems. This way, OBSEA can perform real-time observation of multiple parameters in the marine medium. [2]

The acquisition system

Following tools were used in the design of the OBS acquisition system:

- •DK-LM3S9B96 - board equipped with many modules as: SSI, GPIO, GPTM, UART etc. [3]. Used for executing the main program, acquiring data from the ADC board and sending it trough the UDP protocol for monitoring.



- •CS5372-76A – analog-digital converter equipped with a 1 to 4 channel modulator and a digital decimation filter which is required to acquire the correct data. [4]

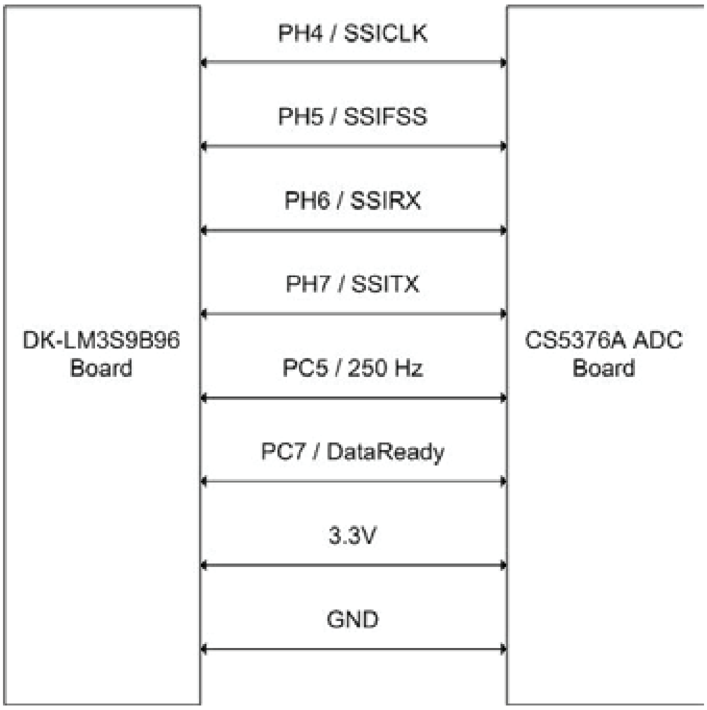


Figure 2: Connection between DK-LM3S9B96 and CS5376A

- •CodeSourcery G++ - compiler where the C code was written. This software was also used to upload and debug programs to the Luminary Micro board.
- •LabVIEW – graphical programming environment used to visualize data transferred through UDP protocol.

The main program is described in the following flow-chart:

As the flow-chart shows, first the system clock was enabled as well as all peripherals as SSI, GPIO bases, timers etc. The next step is to configure GPIO pins for all tasks needed. Later lwIP library was used to set MAC and IP addresses. Another step is to configure a filter in the ADC board to acquire correct data.
The last step is to enable interrupts. Interrupt handler function can be divided into four parts: sending data to ADC board through SSI protocol, acquiring data from ADC board through SSI protocol, processing data (creating frame contains time, date and data), sending data through UDP for monitoring.
Visualization was made by LabVIEW. The data is extracted from the main frame and data for each channel is shown in separate graphs.

(Left) Figure 1: DK-LM3S9B96 board

Figure 3: Flow-chart of main C program

Results
To test the system a sine wave generator was connected to all 4 channels of ADC board. Amplitude of signal is 1Vpp and frequency is 1 Hz. In LabVIEW graph the exact signal generated by the generator can be seen. Then the amplitude and frequency were changed, as well as the input signal from sine wave into square wave. All changes were observed in the LabVIEW graphs.

Conclusions
The data acquisition system of a cabled OBS system was developed. Continuous power supply is needed for the instrument. The system does not need any human intervention, but after some time the clock drift can be noted. Before immersing it under water, the system should be tested for long time to monitor the clock drift . The clock synchronization protocols as IEEE-1588: Precision clock synchronization protocol for networked measurement and control systems are needed to correct the time drift through the Ethernet network.

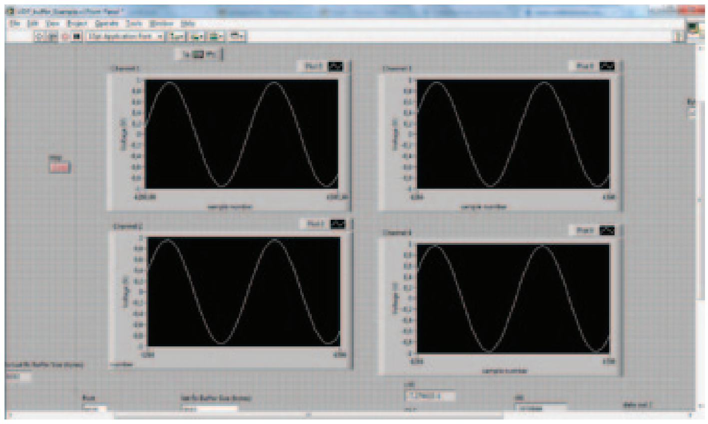


Figure 4: Front Panel of LabVIEW

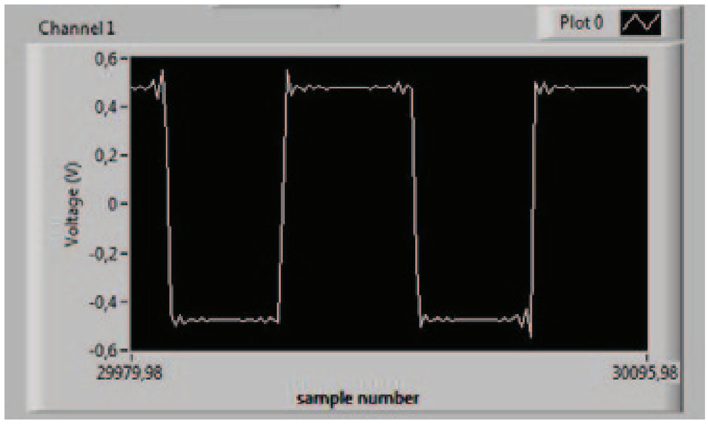


Figure 5: Square wave with noise

References
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