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RESEARCH ARTICLE

DESIGN OF TELEMETRY SYSTEM USING VHDL

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ABSTRACT

Telemetry is nothing but sensing and measuring the information from a location and transmitting it to the host body. The transmission media may be air and space for satellite applications and copper wire and fibre cables for static ground environments like power generation plants. An effective telemetry system plays a vital role in controlling and commanding the aircraft or satellite. The telemetry, tracking and command (TT&C) system of a spacecraft provides the most vital telecommunication link between a satellite and ground station. In this paper, it has been proposed to design a telemetry system using VHDL. The code can be synthesized and simulated using ISE Xilinx software.

INTRODUCTION

Telemetry is a technology through which information at some remote location can be sensed and measured. The information is then transmitted through a channel to the receiver. This information is interpreted and the process is supervised from the host location. Required control is offered at the remote location. Various mediums or methods of transmitting data from one site to another have been used. Data radio provides a wireless method for transmitting the information. Telemetry using radio waves or wireless offers several distinct advantages over other transmission methods. Some of these advantages are

- No transmission lines to be cut or broken.
- Faster response time
- Lower cost compared to leased lines
- Ease of use in remote areas where it is not practical or possible to use wire or coaxial cables
- Easy relocation
- Functional over a wide range of operating conditions

Properly designed radio links can provide low cost, effective and flexible data gathering systems that operate for many years with very little maintenance. The most vital telecommunication link between a satellite and ground station is provided by the Telemetry, Tracking and Command (TT&C) Systems of a spacecraft. It provide the uplink for command, downlink for monitoring the various health parameters through telemetry and much needed tracking information for the satellite for monitoring its position in orbit.

Design Pre-requisite

At the remote site, a sensor or sensors are typically the data source. The output of the sensor(s) is converted to digital data by a small computer device or RTU (Remote Terminal Unit). The RTU is interfaced to a modem device that converts the digital data into an analog signal that can be transmitted over the air. The radio transmitter then transmits the signal to the host site radio receiver. Now the process is reversed. The modem takes the analog signal received and converts it back to a digital form that can be processed by the data recovery equipment. In a typical application, the base or host site requests data from the remote site(s). The base transmits a request to the remote unit telling it to send its data. The base reverts to a receive mode and awaits the transmission from the remote site. After the remote sends its data, it goes back to a receive mode waiting for further instructions to come from the base. Once the base receives the remote site information, it may send additional instructions to that site or continue on to request data from the next remote site. This polling process continues until all the remotes in the system have sent their data.

Today's Telemetry system prefers Pulse Code Modulation (PCM), since it is inadequate. Accuracy is high, with resolution limited only by the analog to digital converter (ADC), and thousands of measurands can be acquired along with digital data from multiple sources. In a PCM-based system, the original PAM multiplexer's analog output is digitized to a parallel format. The Output Formatter along with

Synchronization data for measurand identification merges this, plus other sources of digital data. The Output Formatter serializes the composite parallel data stream to a binary string of pulses (1's and 0's) for transmission on copper wire, fiber cable, or "the ether." The output of the main encoder is filtered and transmitted via radio transmitter and antenna, coax cable, telephone line, tape recorder, etc. Filtering rounds the square data pulses to reduce frequency content and thus the required transmitter bandwidth. At the Ground Station, the received data stream is amplified. Since the transmission path often distorts the already rounded signal, a bit synchronizer reconstructs it to the original serial square wave train. Then, a de-commutator or decom recognizes the synchronization pattern and returns the serial digital stream to parallel data.

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Decom also separates the PCM stream into its original measurands and data. Figure 1 shows a typical Telemetry System.

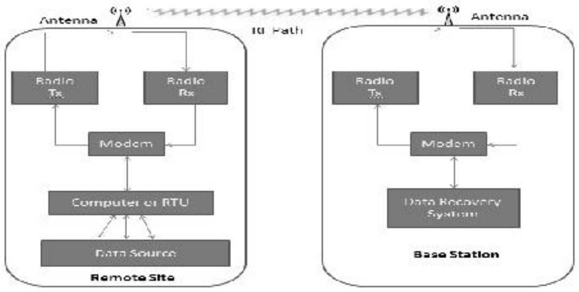

Fig 1 A typical Telemetry System

Design Technique

Manchester coding technique and Binary Frequency Shift Keying Modulation technique has been used here for the design purpose. BFSK technique is incorporated for modulation while Manchester coding technique is to design the code for Telemetry System.

Binary Frequency Shift Keying Technique

Frequency shift keying (FSK) is the most common form of digital modulation in the high-frequency radio spectrum. Binary FSK (usually referred to simply as FSK) is a modulation scheme typically used to send digital information between digital equipment such as tele-printers and computers. The data are transmitted by shifting the frequency of a continuous carrier in a binary manner to one or the other of two discrete frequencies. One frequency is designated as the "mark" frequency and the other as the "space" frequency. The mark and space correspond to binary one and zero, respectively. By convention, mark corresponds to the higher radio frequency. The minimum duration of a mark or space condition is called the element length. An alternate way of specifying element length is in terms of the keying speed. The keying speed in "bauds" is equal to the inverse of the element length in seconds. Frequency measurements of the FSK signal are usually stated in terms of "shift" and center frequency. The shift is the frequency difference between the mark and space frequencies. Shifts are usually in the range of 50 to 1000 Hertz. The deviation is equal to the absolute value of the difference between the center frequency and the mark or space frequencies. Figure 2 illustrates FSK Modulation scheme.

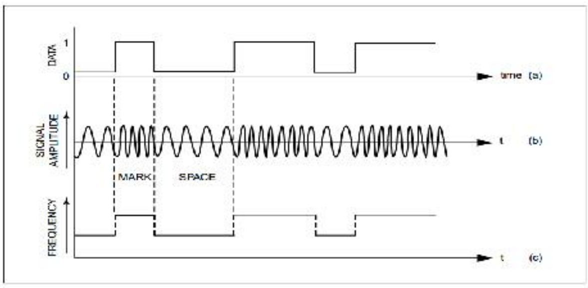

Fig 2 FSK Modulation

Binary data

(a) Frequency modulates the carrier to produce the FSK signal (b) which has the frequency characteristic (c).

Manchester Encoding

Manchester coding technique is a digital coding technique in which all the bits of the binary data are arranged in a particular sequence. Here a bit '1' is represented by transmitting a high voltage for half duration of the input signal and for the next halftime period an inverted signal will be send. When transmitting '0' in Manchester format, for the first half cycle a low voltage will send, and for the next half cycle a high voltage is send as shown in figure 3 The advantage of Manchester coding is that, when sending a data having continuous high signals or continuous low signal (e.g.: 11110000), it is difficult to calculate the number of 1 S and 0s in the data.

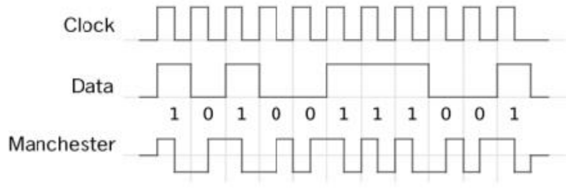

Fig 3 Manchester coding format

Figure 4 illustrates the transmitter and receiver section of a telemetry system. It has been designed using VHDL (Very High Speed Integrated Circuit HDL) code in this project.

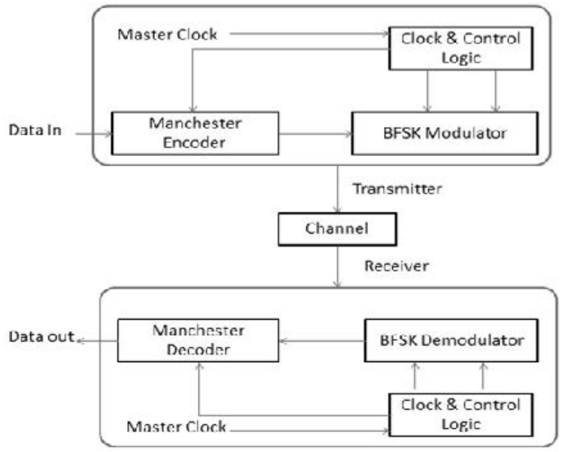

Fig 4 Block diagram of a Telemetry System

RESULT AND DISCUSSION

The following are the results obtained after simulating the VHDL code

Figure 5 shows Transmitter Output

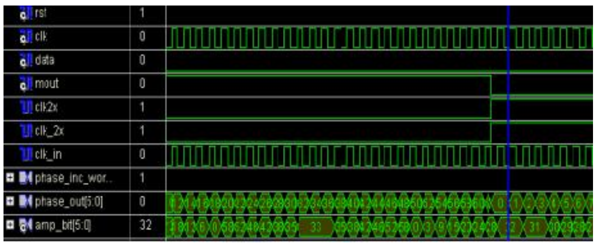

Fig 5 Transmitter Output

Figure 6 shows Receiver Output

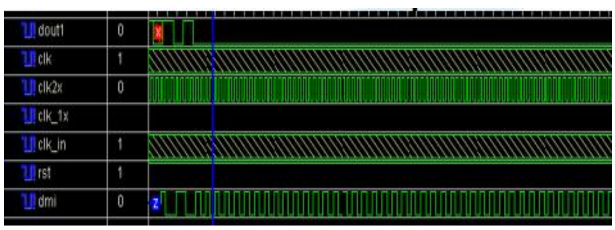

Fig 6 Receiver Output

Figure 7 shows Telemetry Output

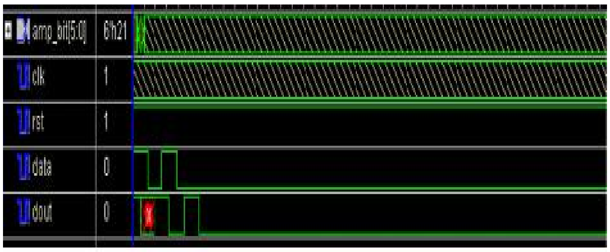

Fig 7 Telemetry Output

CONCLUSION

The Telemetry System is developed to sense data and analyzes it for a better understanding of real time environmental parameters (such as velocity in case of aircrafts). This paper has been designed in Xilinx environment using VHDL code. The transmitter and receiver section have been designed as separate entity and then integrated for the final output. The digital techniques used in design makes the FSK modulator and demodulator sections to be flexible in modifying the frequencies and other parameters. Using advanced technology, an efficient and reliable Telemetry system can be designed.

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