Remotely Controlling of the Parameters Using Labview and W5300 Via Ethernet Interface

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Abstract--- this application will be used to control various parameters such as Gain, Filter Frequency etc. in Electronics and Data Acquisition System. We will be using Ethernet Interface for remotely controlling and LabVIEW software for user interface. The TCP protocol is used for the data communication, which is one of the important features in DAQ systems. The prototype application has been designed using the WIZ830MJ Ethernet controller module which consists of the W5300 SoC chip, which is interfaced with FPGA. The Xilinx's ISE is used to write a VHDL code in FPGA. The FPGA is programmed in such manner using VHDL to set the registers of W5300 to implement protocol in it and data communication for the electronics and data acquisition board. The prototype application has been implemented and tested in the lab. The paper will describe about the hardware and the software for the prototype application.

Keywords: - FPGA, Gain Controller Module, LabVIEW, TCP Protocol, W5300

I. INTRODUCTION

Controlling various parameters remotely such as Gain, Filter Frequency, etc. in Electronics and Data Acquisition System is important in Plasma Research. Currently, the task is fulfilled by using serial communication based on RS-232, CAN but it has shortfalls in speed, end user interface etc... A separate FPGA IC is used to provide the large number of I/Os needed for the design. The VHDL programming in FPGA is used to set different registers of W5300. The gain controller module is interfaced through I/Os of FPGA. As the demands from data acquisition increase faster processing and smaller size of the system becomes necessary. Thus, the basic need which was to be addressed was faster processing of data and integrating the hardware with the FPGA and thereby, controlling the parameters of the electronics and data acquisition system.

WIZnet has developed Ethernet controller module called WIZ830MJ, which is the network module consists of controller chip W5300 (TCP/IP hardwired chip, include PHY), MAG-JACK (RJ45 with X'FMR) and other glue logic.[5] The controller chip W5300 is a 0.18 µm CMOS technology single chip into which 10/100 Ethernet controller, MAC, and TCP/IP are integrated.[3] W5300 is designed for Internet embedded applications where easy implementation, stability, high performance, and effective cost are required.[3] Interface the WIZnet make Ethernet controller module with the FPGA for the implementation of TCP protocol, both the controller module and the FPGA used as server part of TCP protocol. Graphical user interface screen designed in LabVIEW application is used as client part of protocol. For designing the client part of TCP protocol LabVIEW have basic blocks like TCP open connection, TCP write, TCP read, TCP close connection, type cast, error handler block etc… which are used in specific sequence.

The prototype application discussed in this paper has been tested on the hardware made using Ethernet controller module WIZ830MJ with FPGA and connected with GUI through network switch.

II. METHOD

A. Prototype Application

The block diagram and data flow for the prototype application is a shown in Fig 1.

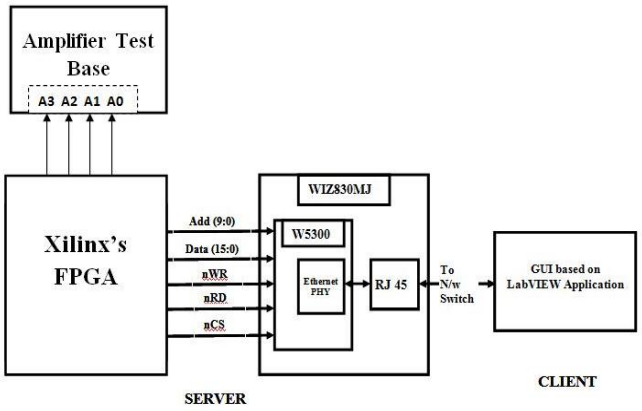

Fig. 1: Prototype application hardware block diagram

As shown in the block diagram here we have used Xilinx's FPGA IC and Ethernet modular controller WIZ830MJ in server side of the TCP protocol in prototype application hardware. TCP protocol is implemented with the help of this server and client portion. TCP protocol server part is implemented in Ethernet controller module by setting its registers through VHDL programming written in Xilinx's FPGA. Ethernet controller module is interfaced with FPGA with address line, data line, write enable, read enable, and chip select line.

LabVIEW is software created by National Instruments. It uses the graphical programming language called G, which does not require any text as in C, C++, etc. The LabVIEW program running on the PC provides the User Interface. It allows the user to input parameter values, which is transmitted to the SoC as a packet through Ethernet interface. As the PC have a Ethernet interface, it sends and receive the data through the Ethernet interface is provided via RJ-45 connector. For the data communication server and client parts connected through the network switch as shown in Figure 1.

Gain controller module block is interfaced with I/Os lines of FPGA as shown in Figure 1. Gain controller module has 4 controlling lines, which are connected to

FPGA and Controlled through GUI made in LabVIEW. Gain controller module consists of combination of two programmable gain amplifier ICs in series named PGA202 and PGA203 with digitally controlled gains of 1, 10, 100, and 1000. The PGA203 provides gains of 1, 2, 4, and 8.

B. Testing of prototype Application using W5300

Before designing the hardware, the prototype has been tested on the testing board. In Xilinx's ISE, VHDL programming is to be done to set different registers of wiznet controller chip to implement TCP protocol in the controller chip. Before remote controlling of parameters, data communication between server and client should be established. To establish the data communication we have to set registers like Mode Register, Common register and socket register in some specific sequence.

First, Initialization of w5300 is processed through three steps: Host interface setting, network information setting, and internal TX/RX memory allocation. In Initialization step w5300 is initialized with IP, Subnet mask, Gateway, MAC address, Setting data bus width, host interface mode & timing, internal TX/RX memory size etc… After this initialization W5300 can transmit the Ping-reply to the Ping-request packet (Auto-ping-reply). After initialization, W5300 can transmit or receive data by opening the SOCKET as TCP, UDP, IPRAW, or MACRAW mode. W5300 supports 8 SOCKETs to be used independently and simultaneously. TCP protocol is to be implemented in Ethernet controller chip for data communication [3]. TCP is the connection-oriented protocol. At the TCP, a connection SOCKET is established by pairing its IP address & port number with the peer's ones [3]. Through this connection SOCKET, data can be transmitted and received. TCP server part consist different stages in implementation like Server open, listen, then establishment of the connection between server and client. After that server will check data coming from client or any data to send client and finally socket close stage. All the stages are implemented by setting registers of W5300 through VHDL programming in FPGA.

Once connection is established between server and client through TCP protocol now move to the next step for remote controlling of parameter here gain parameter will remotely controlled through amplifier test base. The following figure 2 shows the amplifier test base on which will test remote controlling gain parameter and which is used for the purpose of testing the prototype application interfaced with FPGA and Ethernet controller module.

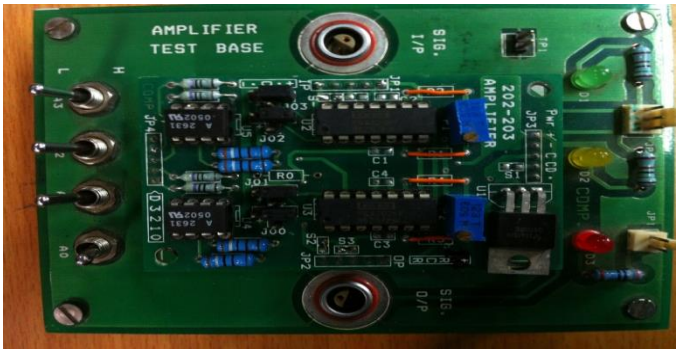

Fig. 2: Amplifier test base for remote controlling of gain parameter

Input to amplifier test base is provided from the function generator and signal output can be seen in the oscilloscope. Four controlling switches A0-A4 is connected to FPGA and controlled from LabVIEW. For the different digital inputs given on those controlling switches the gain of PGA202 and PGA203 is to be set and final output will be displayed in oscilloscope. Here A0, A1 is controlling switches for PGA203 and A2, A3 is controlling switches for PGA202. For the different digital inputs what will be the gain is shown in Table 1.

Table 1 Gain Values When Different Digital Input Given On Controlling Switches

Digital Input on Controlling Switches				**Gain**
PGA202		**PGA203**		
A3	**A2**	**A1**	**A0**	
0	0	0	0	1
0	0	0	1	2
0	0	1	0	4
0	0	1	1	8
0	1	0	0	10
0	1	0	1	20
:	:	:	:	:
:	:	:	:	:
1	1	1	1	8000

III. SIMULATION RESULTS

A. LabVIEW Front Panel Output

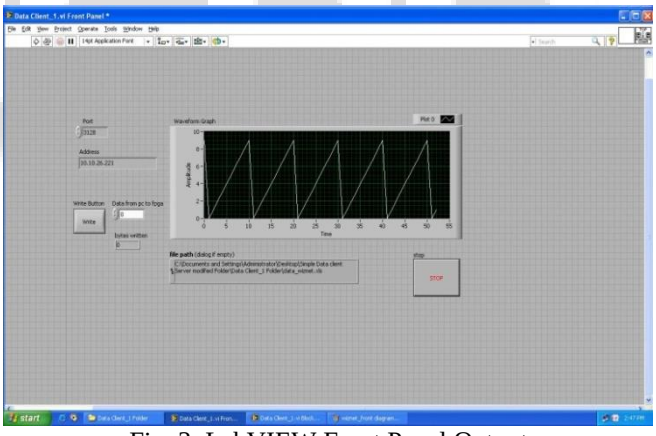

Fig. 3: LabVIEW Front Panel Output

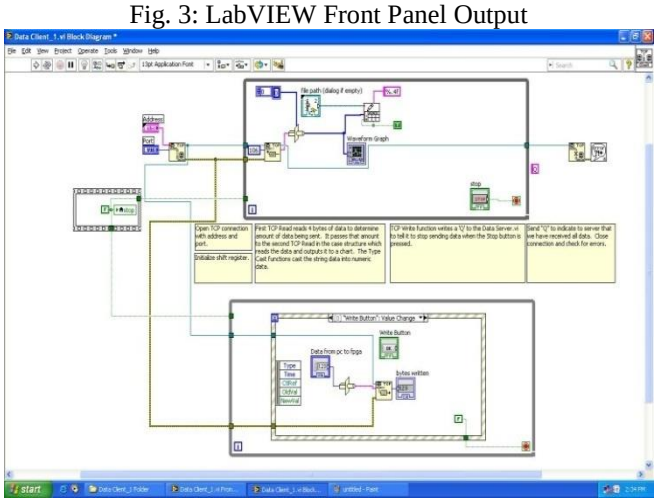

Fig. 4: LabVIEW Back Panel

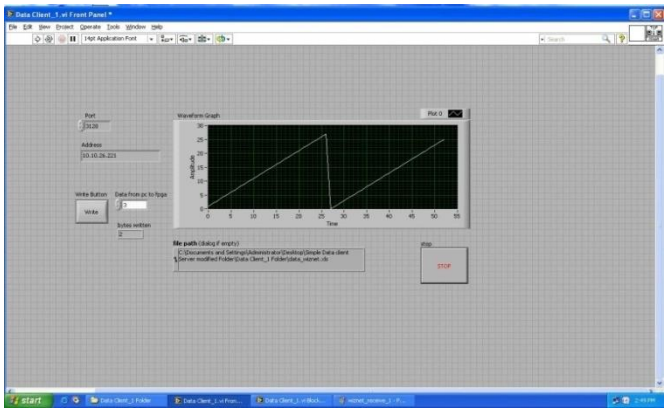

Fig. 5: LabVIEW Front Panel Output

This LabVIEW application is used for remotely controlling the parameters of the Electronics and Data Acquisition System. In Fig. 3, the write button allows the user to set the value of gain parameter which is written box. In this Front panel, the user has to set port address, and Server IP address to make communication with server. The "Write Control and Inputs" facilitates the user to input the values for controlling the parameters. 'WRITE' to write the input value for gain parameter is set to 3(three) so its equivalent 4-bit digital input is given to the controlling switch of the amplifier test base through the FPGA via Ethernet interface. According to the input given on the controlling switches of amplifier test base amplified output will be seen in Oscilloscope which is shown in figures. Ramp wave seen in the front panel is for the proof of data communication is taking place between server and client. This ramp signal is temporary generated through VHDL programming for the testing purpose. Different options like the Write Control input selects button to enable the write operation in the hardware implemented in the FPGA. 'Type' determines button for the type of parameter to be controlled (Gain or Filter) can be placed in LabVIEW front panel.

B. GAIN Control Output

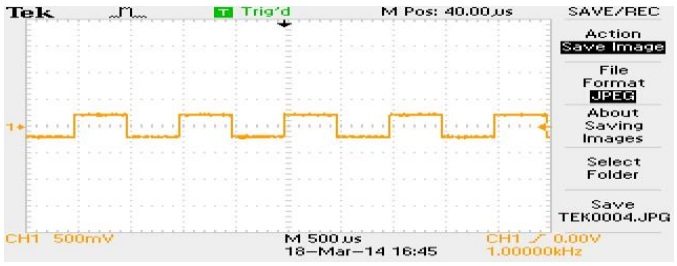

Fig. 6: Signal with gain 1

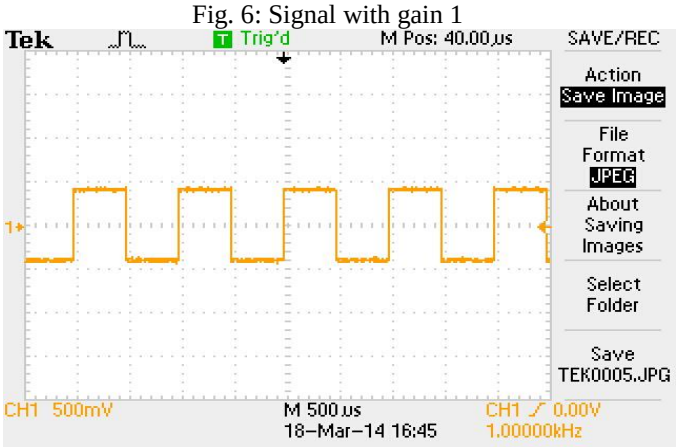

Fig. 7: Signal with gain 2

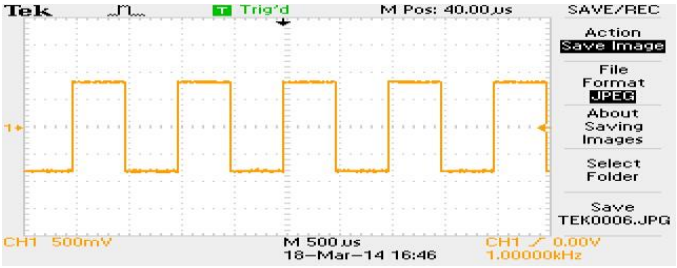

Fig. 8: Signal with gain 4

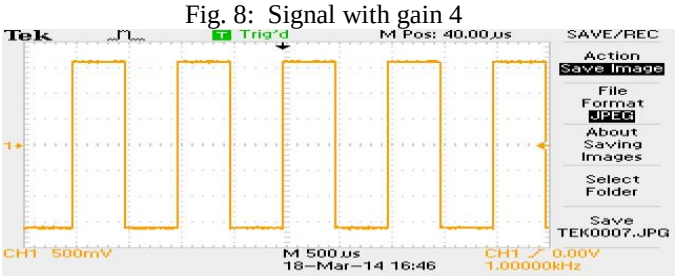

Fig. 9: Signal with gain 8

Fig 6, 7, 8 and 9 shows the output obtained from the gain test. Fig 6 shows the output when the gain has been set to a value of 1. Thus, it is also the same as input. Fig 7 shows the output when the gain is set to 2. Similarly, Fig 8 shows the output for a gain of 4 and Fig 9 shows the output for a gain of 8. The input is a 200mV square wave.

IV. CONCLUSIONS

To utilize the full range of Digitizers, the analog signal inputs should be sufficiently amplified to a reasonable level not exceeding the maximum limit of +/- 5 V. This can be achieved by selecting proper gain of the programmable gain amplifier in step. The Electronics design described here has been tested with full functionality hardware. The parameters (Gain and Cut-off for signal conditioning cards) are being remotely set through a PC having client screen developed in LabVIEW and connected on the ETHERNET link.

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