DESIGN AND IMPLEMENTATION OF THE WIRELESS HIGH VOLTAGE CONTROL SYSTEM

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Abstract

In this paper we will describe the implementation of the wireless link for controlling and monitoring the serial data between control PC and the interface card (general DAQ card), by replacing existing RS232 based remote control system for controlling and monitoring High Voltage Power Supply (120kV/50mA). The enhancement in the reliability is achieved by replacing old RS232 based control system with wireless system by isolating ground loop.

INTRODUCTION

The wireless high voltage control system is designed and developed by replacing existing RS232 based remote control system for controlling and monitoring High Voltage Power Supply (HVPS) having rating 120kV/50mA. This HVPS is used for the extraction of high intensity cw proton beam (20mA). This beam will be further accelerated to 10MeV in a compact cyclotron [1]. Since this HVPS is placed near the ion source where lots of x-rays are emitted, it is mandatory to operate it remotely. The reason for replacing old system with wireless system is to increase the reliability of the system against the high voltage sparks by isolating ground loop. We have used Texas Instrument based CC2500 low power 2.4 GHz RF Transceiver IC [2], this IC is intended for the 2400-2483.5 MHz ISM (Industrial, Scientific and Medical) frequency band. The input and output of the CC2500 is interfaced with the microcontroller which gives the serial 8 bit data. For receiving and sending 8 bit data one unit of this is interfaced with our old interface board for controlling and monitoring the high voltage power supply and the other unit is attached with the control PC. The Interface board is previously designed and developed which have on board 12 bit serial DAC and serial ADC. We have also added hardware and software based slow start scheme so that the High Voltage Power Supply can be operated safely.

CONTROL ALGORITHM

Figure 1 shows the overall flow chart of the control system for HVPS. We have used two module of CC2500. One is interfaced with the control PC, while the other is connected with the interface board. HVPS needed 0 to 10V reference voltage for ramping 0 to 120kV at its output. This voltage is given by 12 bit serial DAC (MCP 4922), while the read back of the HVPS is taken by 12 bit serial ADC (MCP 3208) [3].

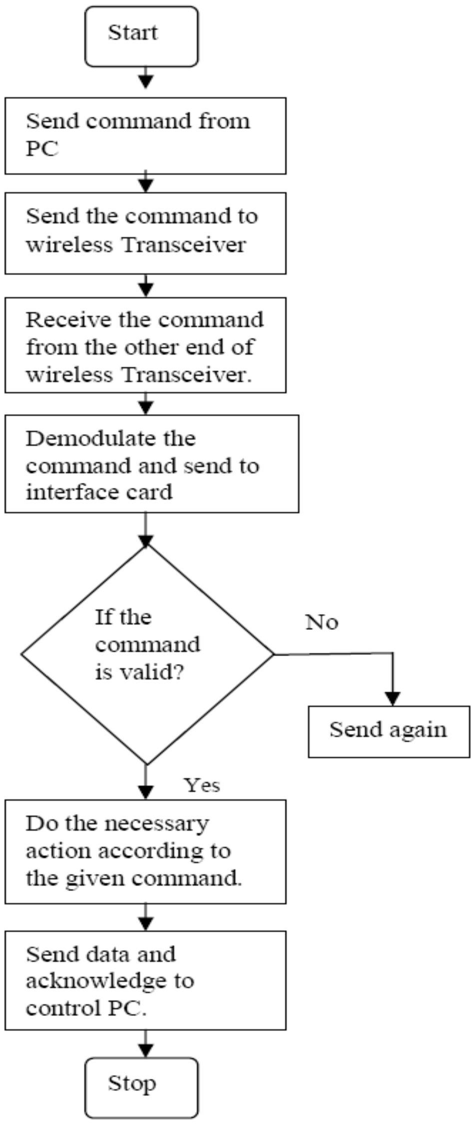

Figure 1: Flow chart for wireless HVPS control.

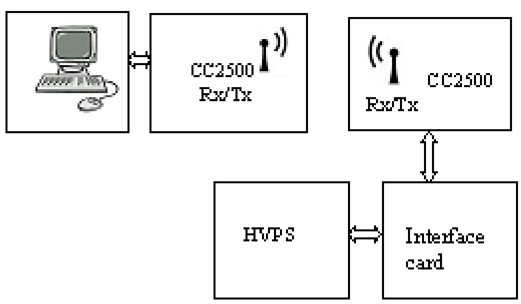

Figure 2: Block diagram of wireless HVPS control.

DAC and ADC are controlled and monitored by 8 bit microcontroller in the interface board. The reference to these DAC and ADC is provided by REF 02 reference IC. We have also incorporated software control slow start in the graphical user interface program developed in Labview7.1 software as well as default hardware type slow start for the safety of HVPS.

Figure 2 shows the block diagram of wireless HVPS control. The wireless control voltages are sent from the control PC via com port, by interfacing with one of the CC2500 module. While in the other end another CC2500 transceiver module receive the wireless signal coming from the control PC, demodulate it and gives the control signal to HVPS via interface card. Interface card has firmware program in the microcontroller by which it controls and monitors the HVPS.

Figure 3 shows the front panel of the GUI that is used for operating HVPS remotely. Three buttons are provided as seen in the figure 3 for making HVPS ON/OFF. When the red LED glows in the GUI only then the control voltage and current can be given. The actual read back can be seen just below the voltage and current control.

Figure 3: GUI for controlling and monitoring HVPS.

Figure 4: CC2500 module front view and back view

Figure 4 shows the front view and back view of the CC2500 module. The red LED gives the indication for transmission of the signal, while the green LED gives the indication for successful reception of the signal. The printed antenna can easily be seen by looking at the back side of the CC2500 transceiver module.

Figure 5 shows the circuit diagram of the interface card that contains the 89S8252 microcontroller, REF 02 reference IC for 12 bit serial DAC (MCP 4922) and 12 bit serial ADC (MCP 3208), voltage doubler and relays for ON/OFF of HVPS. The firmware programming was developed in KEIL-C software.

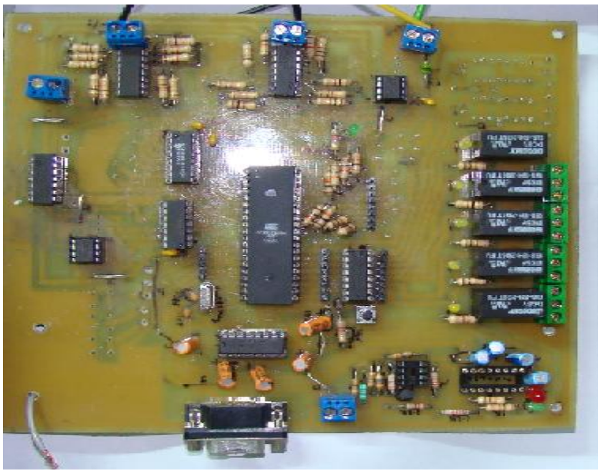

Figure 5: Interface card designed in our lab.

RESULTS

The system is being tested by running 5 to 6 hour every day and it is working satisfactorily. The first plot of figure 6 shows the software control slow start for ramping HVPS that can be varied by adjusting the ramp rate while the next plot shows the hardware slow start incorporated for the protection of the HVPS.

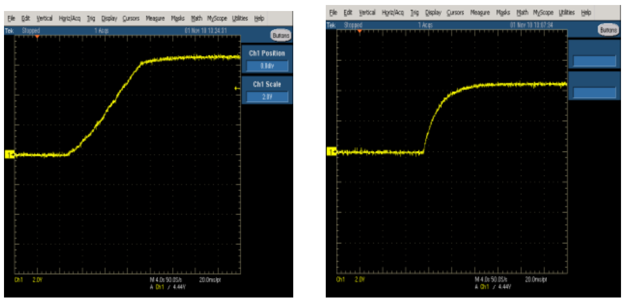

Figure 6: S/W control and H/W control.

REFERENCES

[1] V. S. Pandit, Indian Particle Accelerator Conference InPAC-05 (2005) 13.

[2] CC2500 datasheet manual.

[3] S. Srivastava et al., InPAC-2009, Indore, India.