MULTIPLE HIGH VOLTAGE POWER SUPPLY CONTROLS SOLUTION USING COMPACT, DISTRIBUTED ETHERNET BASED PC BOARDS AND LINUX/WINDOWS BASED GUIS

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Abstract

Compact Ethernet based High voltage PC boards have been developed, tested and produced to use as an integrated HV power supply unit to generate and control voltages varying from 0 to 2000 V dc from any OS independent PC platform. The Neutron gamma array (NAND) project at IUAC will need distributed control of at least 120 such units over a private Local Area Network to bias detectors. These Power supplies are being made as five independent boxes, each box consisting of 24 such HV PC boards and they will be interconnected using network switches. Presently, a compact two layer board with the PICO make DC-DC HV converter mounted on PCB, put together in a group of 24 of them, have been built and fully tested. The advantage of such a system is that, it is easily expandable to a large number of power supplies with low cost, globally accessible, multiple users in a network can set or read any power supply value through an OS independent PC. Control GUI applications are developed using C, IUAC PCLI [2], Qt c++ etc. and have been successfully tested.

INTRODUCTION

A large array of neutron detectors, named NAND [1] is being developed as a nuclear physics experimental facility to use with the beam delivered by the booster LINAC at IUAC. NAND will consist of about 120 detectors in the final phase in which each detector will have organic liquid scintillator cell coupled to Photonics photomultiplier tube. The detectors need to be biased at a dc voltage somewhere below 2000 V. A large number of compact power supply boards developed indigenously (approx. 70), has combined analog & digital circuitry in each PC board which can be addressed with unique MAC (Media Access Control address) and IP (Internet Protocol) address so that each can be specifically selected at a time for read write operations over distributed LAN.

THE HARDWARE

The COTS design of the H/W board for the HV generation and control, using the DC-DC converter module, is given in Fig.1 below. The board used SMD components due to its compact size required to fit-in 24 of them in a single box. The digital section consists of an 8 bit microprocessor (ATMEGA168/328) and an SPI driven Ethernet controller (ENCJ60). The analog section consists of a precise 12 bit DAC (AD 7541) connected to the microprocessor using the parallel bits. A precision Voltage reference of 2.5 V is used externally to generate 0 to 2.5 V at its output. This voltage is amplified using a low offset high precision single supply OPAMP, CA3140, to generate 0-5 V for the DC-DC conversion. The small size PICO make HVP2N is used to generate 0 to -2000 V from a 0 to +5 V input. RJ45 connectors are used for the Ethernet connections to outside world. The block diagram of the HV control unit is given in Fig. 2.

Figure 1: The single compact HV board with Ethernet.

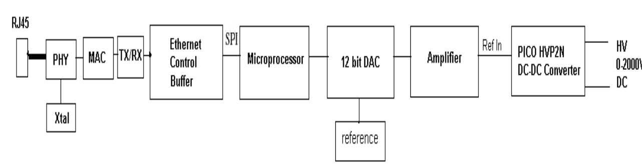

Figure 2: The block diagram of a HV control unit.

THE FIRMWARE

The boards use a small TCP/IP firmware stack. The TCP is used as the HTTP works on TCP protocol. The idea is to build an easiest user interface which brings in HTML code from the web server board into the browser client to perform simple read write operations using a

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small size single data packet TCP. The IP address is firmware coded and can be altered. Also one can program the boards to work as static or dynamic servers.

DISTRIBUTION OVER LAN

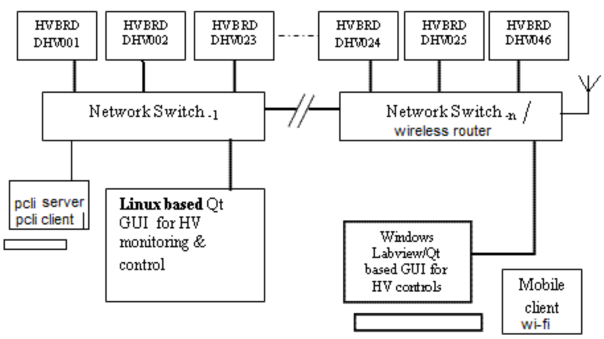

Figure 3: Networking architecture over LAN.

The interconnection of Ethernet based HV boards are done using a 24 port CISCO network switch as given in Fig. 3. Each board has its own MAC and IP; therefore it becomes unique in a network. The Ethernet based boards can be very useful for interconnecting using WiFi, which transforms any IEEE 802.3 device (wired network device) into an 802.11b/g/n wireless client. The inside view of complete 24 channel box is shown in Fig. 4.

Figure 4: The inside view of a 24 channel unit.

WINDOWS & LINUX CONTROL GUI

A high level socket program in c or c++ will allow programmer to easily connect to any HV power supply unit through TCP services by implementing a simple HTTP client which will get request a web page given the hostname and the page name, then read the server answer and output the HTML content of the reply which can contain the HV read-out data. To be able to connect to a service built on top of TCP, we first need to create a socket for the TCP protocol, fill in a network address structure representing our Power supply destination ip and the port to connect to. From there, we will be able to send and receive data over the network.

IUAC uses an in-house developed Linux-c based Client-sever based control system known as PCLI [2] for the entire control of pelletron parameters via. CAMAC for last 25 years. The server of PCLI now has been modified to test NAND power supplies to its hardware support by mapping all the High voltage units to C, N, A, F commands and has been tested successfully and is given below in Fig. 5.

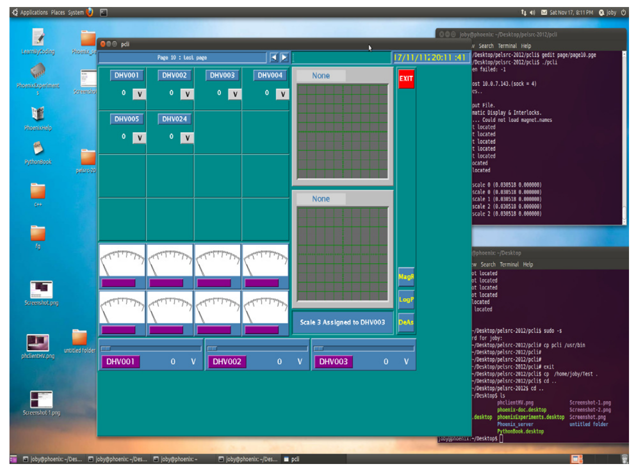

Figure 5: The PCLI control page for NAND power supplies.

Qt is a cross-platform GUI development tool. A Qt application program has also been developed in C++ to control and monitor 24 such power supplies using the Network manager libraries and has been tested from windows & Linux PCs and the screen shot is given below in Fig. 6.

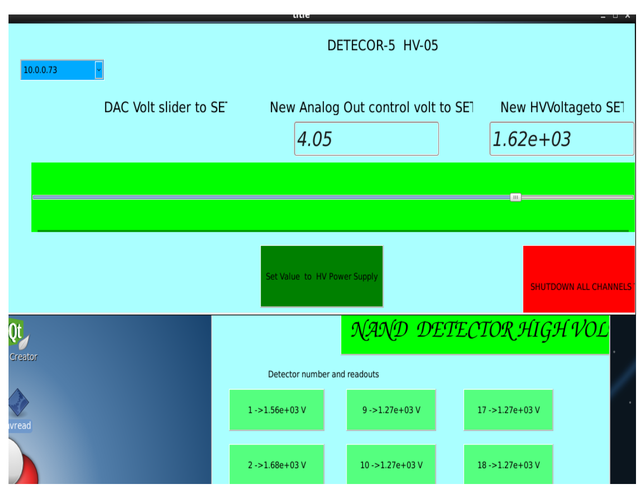

Figure 6: Qt interface for controls & readout.

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SUMMARY

Out of many boards under fabrication, the first phase of 24 such boards housed as a single 19'' mounted box has been tested successfully. The advantage of such a system is, it is easily expandable to a large number of power supplies at a low cost, globally accessible as they have unique addresses; multiple users in a network can set or read any power supply value simultaneously. The disadvantages being the real read back issues due to lack of negative voltage read back circuitries at the load far-end.

ACKNOWLEDGMENT

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REFERENCES

[1] http://www.iuac.res.in/refac/np/nand/nand_main.html

[2] B. P. Ajith Kumar, J. Kannaiyan, P. Sugathan and R. K. Bhowmik, "The NSC 16 MV tandem accelerator control system", Nuclear Instruments and Methods in Physics Research Section A, Volume 343, Issue 2-3, p. 327-330.

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