

GENERAL PURPOSE CRATE (GPC) FOR CONTROL APPLICATIONS

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Abstract

A General Purpose Crate (GPC) capable of handling digital and analog Inputs/Outputs signals has been developed at Inter University Accelerator Centre (IUAC), New Delhi, for accelerator control system applications. The system includes back-plane bus with on board plugged-in single board computer with PC104 and Ethernet interface, running Linux operating system. The bus control logic is designed on the back-plane pcb itself, making the system more rugged. The various types of digital and analog input/output modules can be plugged into the back plane bus randomly with standard euro connectors, which provides highly reliable and dust free contacts. Maximum eight modules can be inserted into the crate. The total power consumption for various types of modules and back-plane controller is approximately 50 watts. The multi-output DC power supply from COSEL has been used in the crate. The general purpose crate is software compatible with the CAMAC crates used in the accelerator control system.

INTRODUCTION

The Inter University Accelerator Centre, a university research facility, has a 16MV tandem accelerator, a super-conducting heavy ion Linear Accelerator(LINAC), Low Energy Ion Beam Facility (LEIBF) and many other facilities, which are running round the clock over many years. The Pelletron and the LINAC have been running under a PC based distributed control system [1]. The accelerator control system uses CAMAC standard for interfacing the various types of devices to the computer. At present around twelve CAMAC crates are placed at various locations around the machine to provide access to the various types of devices from the central control room. Each crate has a dedicated bus controller with a single board computer. All these crate-controllers are connected over a dedicated LAN and are booted from the central control server PC. These home made crate controllers are designed and fabricated in-house.

Since CAMAC standard is getting older and new standards are emerging, the availability of CAMAC crates in the international market is limited. The lack of support for CAMAC standard, high power consumption, weight and high cost of the CAMAC crate prompted us to develop a functional equivalent compatible to the existing system [2]. The General Purpose Crate (GPC) packs the functionality of a mini crate and it keeps the advantage of modularity in the design intact. Like CAMAC standard various types of the analog/digital, input/output modules can be inserted into the crate randomly and are controlled by the back plane bus controller. The bus controller along

with embedded PC are placed on the back plane itself. Different types of modules viz. analog signal inputs (scanning ADCs), analog signal outputs (Digital-to-Analog converters), digital signal inputs, digital signal outputs, input gate output register (IGOR) and beam scanner power supply control modules are designed and fabricated in-house. The light weight and low power consumption makes the GPC crate suitable for using in high voltage decks etc. where the space and power availability are limited. The on-board computer on the back plane bus controller provides the connectivity to the external network using a fibre optic link in case of use on the high voltage deck. The crates are connected over the local area network and communicate over TCP/IP protocol.

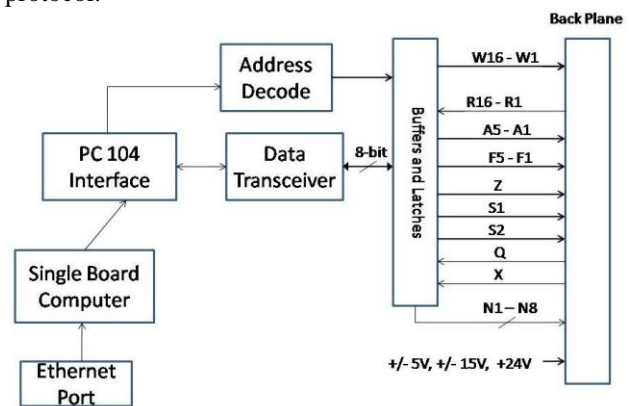


Figure 1: Control signals on the back plane pcb.

HARDWARE

Figure 1 shows the back plane bus control signals along with embedded PC. The most common requirements for any control system are analog/digital signal reads or control through analog/digital signals. We have implemented these requirements by designing the control logic in different types of modules. Each module has a euro connector on the back end to plug the module on back-plane bus and front end has a D-type connector to route the signals for different devices. Mainly five types of modules has been designed and fabricated, which will fulfill our control system requirements. These modules are listed below.

- 12-bit 16-channel scanning ADC (analog-to-digital converter)
- 12-bit 16-channel DAC (digital-to-analog converter)
- Status read (Input Gate)
- Digital control (Output Register)
- X/Y beam scanner control module.
- Input Gate Output Register (IGOR)

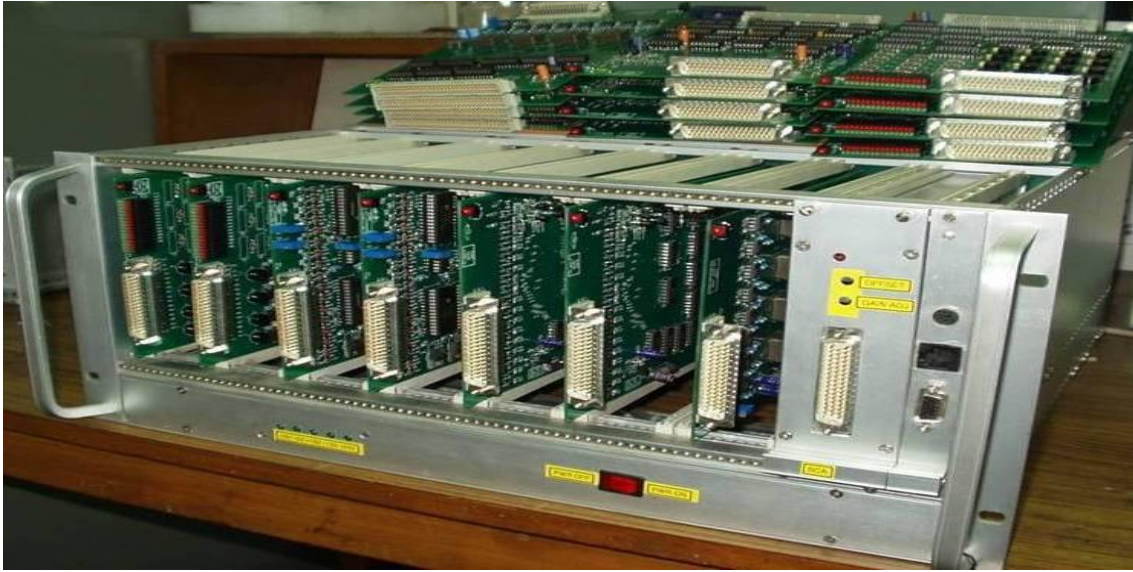


Figure 2: General Purpose Crate (GPC) hardware and different types of modules plugged-in and Ethernet connectivity.

Scanning ADC

The 16 channels 12-bit scanning ADC module is designed keeping in mind the noisy environment of the beam line. The input stage of the ADC module has a filter network of 3db@10Hz for each individual channel.

DAC Module

In the 16 channels DAC module, the converted voltage levels, are buffered and then routed to the front panel connectors for routing through the system I/O cables. The output buffers are low leakage, precision operational amplifiers which can supply 10mA of drive current over full available output voltage range i.e.0-10V.

Output Register Input Gate

The digital control module i.e. Output Register, is containing 16-bit register that drives 16 output circuits. Each output circuit composed of a buffer and a reed relay. Sixteen LEDs are provided on the front panel for monitoring the current state of all the output circuits. For status read 16-bit Input Gate module has been designed. It provides 16 individually isolated contact sense circuits and change-of-state indication (front panel LEDs). The sense circuit detects the presence or absence of voltage at its terminals and is suitable for sensing such remote process contact closures as relay contacts, pressure switches status, solenoid valve status etc.

X/Y beam scanner control Module

The X/Y beam scanner control module is basically a dual channel triangular wave generator. It has remote controlled amplitude as well as frequency control for both channels. 'X' channel can be varied in amplitude from $\pm 10V$ peak value and frequency control from 8Hz-60Hz. Whereas 'Y' channel can be varied in amplitude from

$\pm 10V$ peak value and frequency control over 0.3Hz - 1.3Hz.

IGOR Module

IGOR (Input Gate/Output Register) is a single-width module containing a 16-Bit input gate, a 16-Bit output register, a 1-Bit status input, and three 0.5-second pulse outputs. Full handshaking is provided for the input gate and output register.

SOFTWARE

The Pelletron and LINAC control software is a PC based distributed control system based on linux platform and it runs in a client server mode. The server part of the program runs on the computer attached to the CAMAC or GPC crates. The server program takes care of the hardware details and the complexities of the signals connected to it. Since GPC crate hardware is different from CAMAC so we need to modify only the server program to accommodate changes in the hardware, the client program will remain the same.

CONCLUSION

After thorough testing this GPC crate with the existing control system, we are going to use this setup in the upcoming new Low Energy Ion Beam Facility (LEIBF) at IUAC. The system is highly cost effective, light weight and expandable.

REFERENCES

- [1] B.P. Ajith Kumar, E.T. Subramaniam & Kundan Singh, "Distributed control system for NSC tandem-LINAC", Indian Journal of Pure & Applied Physics, Vol. 39, Jan-Feb 2001, pp 1-3.
- [2] B.P. Ajith Kumar, Kundan Singh & C.P.Safvan, "General Purpose Controller with Embedded PC", InPAC 2005.