MAGNET'S POWER SUPPLIES AND OTHER TECHNOLOGICAL EQUIPMENT CONTROL SYSTEM FOR MMF EXPERIMENTAL AREA

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Abstract

The design principles of the technological equipment control system (CS) for Moscow meson factory experimental area are recalled. Progress in magnet's constant current power supplies operation, vacuum and other control equipment is reported. Attention is particular given to the choise of the built-in interface and the data link between the equipment and the process computers.

Introduction

The first stage of the experimental area of Moscow meson factory [1] is designed for the nuclear and particles physics experiments at the intermediate energies, the solid state physics experiments and other applications with H^- ion and proton beams (one of them can be polarised) with peak current 50 mA at energy 600 MeV.

The main purpose of CS is to produce the appropriate monitoring and control functions to fill the proton storage ring (PSR) and successfully deliver the beams from PSR or linac to the experimental facilities. At first, the CS must provide an efficient and flexible means for setting up the devices which affect the beam parameters and make appropriate corrections to the initial settings. Finally, the system must monitor the healthy of all components and automatically correct for inoperative devices, if it is possible, or at least notify the mashine operators of a failure.

The CS's task is especially demanding because of a large number of devices that affect the beams and a large number of experimental facilities that utilyze beams. Further, the CS must not only work flawlessly, but it must allow for the rapid development and testing of new or upgraded algorithms in order to maximize the experimental facilities performance. In addition, it is very important to reduce the failure rate of the CS for experimental area with beams of the actual intensity.

The MMF linac computer control system is based on DEC line minicomputers (like PDP 11/34) which interface to the equipment through the CAMAC, but these old technology computers are completely obsolete, their maintenance is difficult and expensive. Therefore, the experimental area CS is being designed as the distributed µ-processor clusters are based on the Intel Multibus architecture. Currently, the µ-processor clusters contain single-board computers (SBC) like Intel 86/12 SBC, 512 kilobytes of RAM and 8 kilobytes of EPROM. We can't replace CAMAC fully as it is only commercially available modular standard for a data acquisition on the market and beam diagnostic equipment may be reasonably interfaced to computers only through the CAMAC. However, further experimental area CS efforts will be center on the development of a really multi-µ-processors system so we made up our mind at first to build in distributed technological equipment (magnet's power supplies, vacuum equipment etc.) the modern communication interface. At this way we started to construct the CS from a very small parts and we can integrate them into a larger system later.

Choice of Distributed Equipment Built-in Interface

For control and monitoring large current regulated power supplies for magnets, spectrometers of residual gas in vacuum volumes and vacuum exhaust units the following reasons was adopted : the analog set points and actual current monitoring values would be transmitted in a digital form, the link to the equipment must be cheap as far as it is possible but with no prejudice to the overall reliability. The link must fulfil the requirements for the control of a simple equipment by command/response orders and have transfer capability for driving intelligent subsystems by "message-command". Speed, minimum bit overhead for sinchronization, low error characteristics, large common-mode rejection and matched coupling transformers or optically coupling is required. This is the reasons of our choice of the multidrop bus MIL-1553B used initially in avionics and aerospace applications and now widely used for industrial applications and accelerator control.

Power Supply Interfacing

A block diagram of the power supply as control and monitoring object is shown in Fig.1.

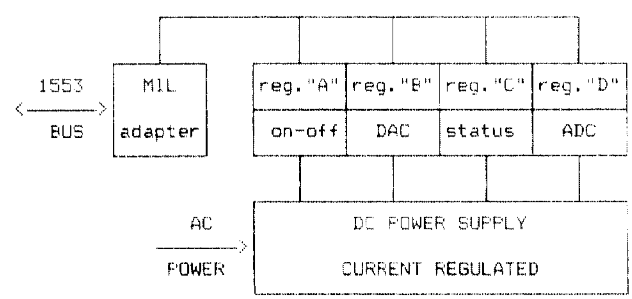

Fig.1. Power Supply Block Diagram

Each power supply connected to the multidrop bus is controlled via the registers A and B and its complete state acquired via the registers C and D. Register A contains the actuation bit pattern. Register C acquires the status like POWER ON, POWER OFF, LOAD ON etc. Register B sends the current control value to the supply and register D acquires its actual current. The power supply MIL 1535B adapter is designed around the Harris HD-15531 IC. The link between adapter and A,B,C,D registers is organised as the dedicated bus. This bus utilizes the HD-1553 chip signals (CLOCK, STROBE IN/OUT, DATA IN/OUT, etc.). The serial to parallel conversion and vice versa of in/out information are realized in registers A,B,C,D.

Vacuum Equipment Interfacing

We start to construct the vacuum system exhaust units and the ionization spectrometers of a residual gas as thè MIL bus slaves. The block diagrams of them are given in Fig.2 and Fig.3 respectively. MIL 1553B adapter is designed around the Harris HD-15531 IC in both cases.

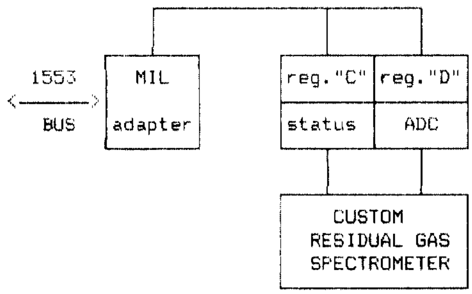

Fig.2. Residual Gas Spectrometer Interfacing

The ionization spectrometer interface registers C and D are read only registers. Register C acquires the status like HIGH VOLTAGE VALID, CATHODE VALID, etc. Register D consist of eight simple registers which containe an actual information about the residual gas composition for each of eight preliminary selected kinds of ions.

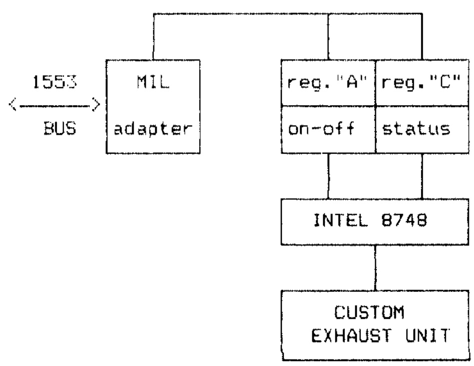

Fig.3. Custom Exhaust Unit Interfacing

The exhaust unit control node core is INTEL 8748 singleship microcomputer, which initiates and controls all steps of "on","off" and "abort" procedures of exhaust unit. Register A contains the actuation bit pattern, register C acquires the status like ON, OFF, etc.

Remote CAMAC Crate Interfacing

A serial crate controller has been designed for use in the experimental area CS. The basic idea of this design was to connect the remote CAMAC crate to μ-processors cluster in simple MIL 1553B "remote terminal" mode. The bit rate is 1 megabit/s, and complete transaction times of about 65 μs are achieved for 16-bit data transfers over cables up to 1000 feet long. One of the objects of the design was simplisity - there are 62 chips in the two board unit.

Additional System Components

To get a computer independent test facilities for MIL 1553B interfaced equipment we designed the MIL 1553B Bus Controller (BC). This is 33 chips one board single width CAMAC slave unit. BC is also used in our facility for the field strength, field uniformity and harmonic content measurement of every magnet of experimental area. The results of this measurements for the quadrupole lenses are given in [2]. The experimental area magnets field measurement system block diagram is shown in Fig.4.

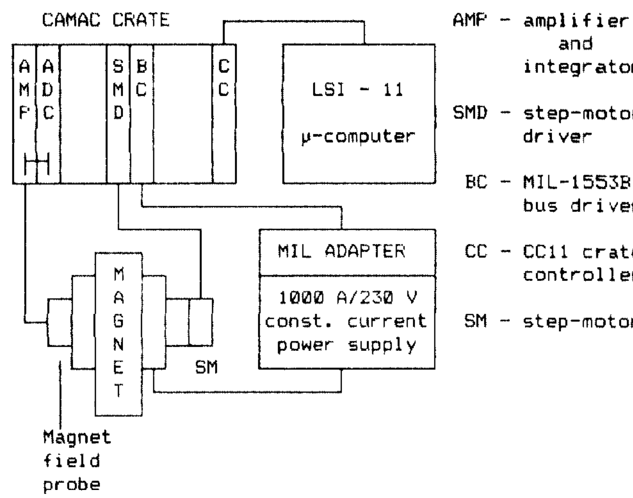

Fig.4. Magnet Field Measurement System

Summary

- the experimental area CS will be construct as the distributed multi-μ-processor system;
- the MIL 1553B interface to link the remote equipment to process computer has been choosed;
- the MIL interface built in large current regulated power supplies for magnets has been designed and tested;
- the MIL Bus Controller in CAMAC and CAMAC Crate Controller to connect the remote CAMAC crates to MIL Bus has been designed and tested;
- we will construct the MIL 1553B Bus Controller in Multibus.

References

[1] M.I. Gratchev at al., "Experimental Area of Moscow Meson Factory", in Proceedings of the XIV International Conference on High Energy Accelerators, Particle Accelerators, vol. 27, pp. 51-58, 1990.

[2] M.V. Akopyan at al., "The Arc-welding of the Radiation Resistant Quadrupole Lens", in Proceedings of the International Seminar on Intermediate Energy Phisics, Moscow, 1990.