LNLS Interlock System

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Abstract

Both, equipment and radiation safety, interlock systems design and performance are described. Equipment protection is achieved by modular interlock stations consisting of one type of printed circuit board and a communication bus. Programming of the boards resides in programmable array logic (PAL) integrated circuits. A second type of board provides for information exchange with the general machine control system. The radiation safety system is built in the traditional way, using conventional relays.

1. INTRODUCTION

LNLS is commissioning a synchrotron radiation source[1] consisting of a 1.2 GeV electron storage ring and a 100 MeV LINAC injector. Radiation safety and machine components interlocking are separately treated. The machine interlock system process 195 inputs into 55 outputs.

From the beginning it was decided that the radiation safety interlock logic would be wired in the well tested conventional way, using relays. In the design of the equipment protection logic, which is subjected to many more changes and adaptations during and after installation, we have decided for a solution which could be easily reprogrammed.

The most flexible hardware can be achieved by using microcontrollers. However, memory based systems, in a noisy environment like a synchrotron light source, are difficult to be made more reliable than the equipment they protect. Thus a second requirement was established: the use of static logic. Programmable array logic (PAL) integrated circuits permit the design of fairly complex static logic which is easily reprogrammable. In this case the control system has also the function of memorizing the faults which may occur momentarily. In any case, every critical equipment has to lock off after a major fault and can only be restarted with a local or remote reset.

Modularity is also a relevant point to be taken into account, since it minimizes construction, installation and maintenance efforts. Thus a modular interlock station was designed making use of a parallel static bus. Distributing several stations near the equipments also minimizes cabling since many signals can be processed locally.

The same bus in each station can be used to inform the machine control system about the status of the several equipments through a special interface card.

2. DESCRIPTION OF THE INTERLOCK STATION

Figure 1 shows the general diagram of an interlock station. Equipments signal OK by closing an isolated contact and the interlock stations signal OK in the same way.

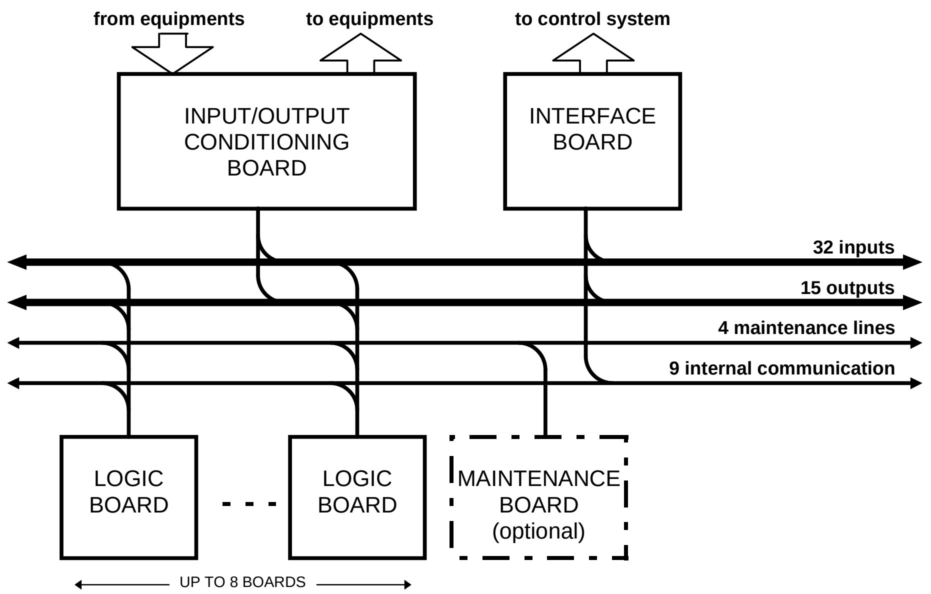

Figure 1:General diagram of an interlock station.

One I/O board conditions 32 inputs by filtering out spurious signals and adapting them to TTL levels (Figures 2 and 3). The I/O board also conditions 15 output signals into isolated contacts. These 47 signals are present in the station bus.

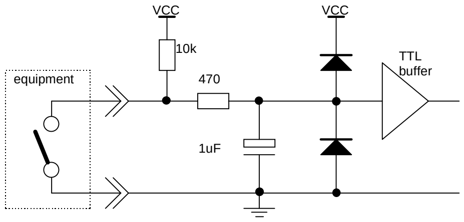

Figure 2: Typical input of the I/O board.

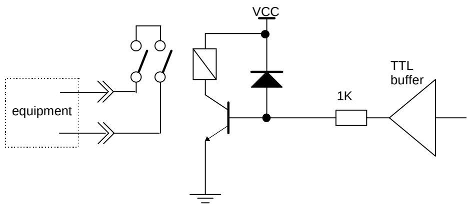

Figure 3: Typical output of the I/O board.

Up to eight programmable logic modules per station process the input signals, producing the outputs or internal communication signals (Figure 4). The nine internal communication lines were introduced to minimize external wiring. The program in any logic module can also take into account the signals present in four maintenance lines, produced by 'maintenance boards' (physically the same as the logic modules) which, when introduced in the subrack, signal the station that the interlock system should enter special states of operation.

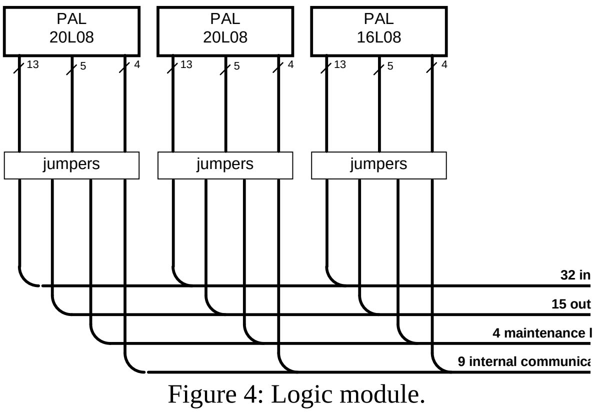

Figure 4: Logic module.

The interface module allows for continuously reading the status of all lines by the general machine control system [2]. Interpretation of these signals is done at the high level layer of the control system, where a database containing the configuration of each interlock stations resides.

With exception of the I/O board, all electronics is mounted on eurocards with 64 pin connectors.

3. CONCLUSIONS

After the cabling work was done for all equipments, programming the necessary interlock logic took only a few days. The approach also facilitated updating the documentation after the many modifications introduced during assembly of the synchrotron light source at LNLS.

Noise immunity of both PAL-based and relay-based systems was found to be at the same level. The system presented here has been operating for nearly two years with only three failures caused by loose connections.

Simplicity, reliability and flexibility of this approach make it a good candidate for the safety system to be used in the LNLS beamlines.

4. REFERENCES

[1] A.R.D.Rodrigues et al., "LNLS Commissioning and Operation", in these proceedings.

[2] P. F. Tavares et al., "LNLS Control System", in these proceedings.