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A SOLID STATE FAIL SAFE RADIATION INTERLOCK SYSTEM

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ABSTRACT

A Fermilab Radiation Safety Interlock System for personnel exclusion is designed to save lives should an unsuspecting person attempt to enter an enclosure that is transporting beam. The interlock system (called "system" for the remainder of this paper) should do two things. First it should function when it is called for, i.e. if a door is opened the beam should trip off. Second, if the hardware should fail it should fail "safe", i.e. the beam should trip off. This paper will deal only with the "fail safeness" of a solid state system, since logically, if a device is fail safe it must "always function correctly", satisfying criteria #1 above. i.e. if the fail safe mechanism shows zero fault, it must be working correctly. This paper proposes such a system.

INTRODUCTION

The problem with the "fail safeness" of a solid state system is that you cannot guarantee the state of a failed component. Devices can fail in either an on or off state. Relay logic will mostly fail in the opened or off condition. However, instances have occurred were relays have failed in the on condition. So while relays have a higher probability of failing safe, they still may be unacceptable when dealing with life saving situations.

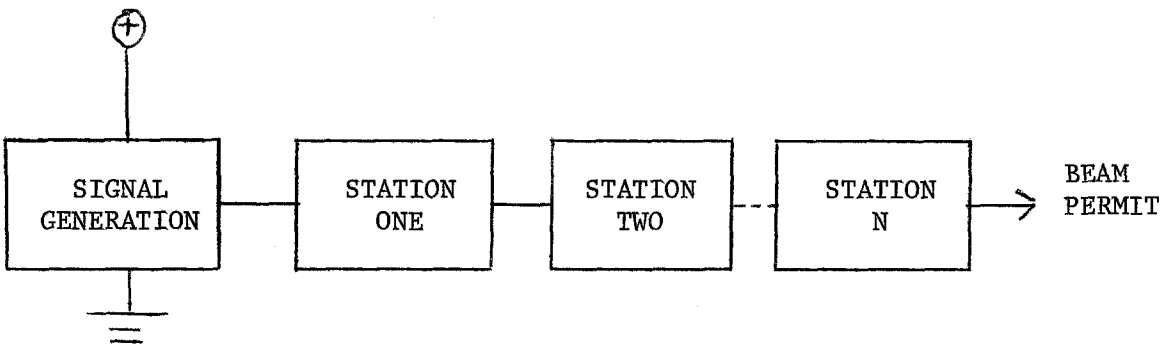
HARDWARE SOLUTION

The system in existance today uses a series of relay closures that pass a non varying signal, usually twenty four volts D.C. Should the security of the interlocked area be violated, the relay should open breaking the loop. If power is interrupted the relays being held in are supposed to open. This is a passive system. Replacing the logic or switches with solid state devices in a passive system does not improve the fail safeness.

To overcome this problem, one need only replace the passive system with an active or dynamic system. This can be described as a system were each and every device or component is required to toggle between its activated and de-activated states. During the toggle the state of the device is tested for correctness. You can compare this to asking a worker "Are you working?" and "Are you not working?" alternately every one thousanth of a second. The answer to both questions should be yes. Any "no" shuts the system down.

CONCLUSION

Detail of how to do the above is not necessary here since the number of ways to do it are limited only by your imagination! Certainly any scheme you can think of is state of the art. Certainly the system would have to be solid state since relays would wear out in a short period of time (relative to a solid state device). The design can be made compatible with existing wiring. The design need not be an expensive one. The following diagram is food for thought.



EACH STATION RECEIVES ITS POWER BY DECODING THE RECEIVED SIGNAL, AS DOES THE BEAM PERMIT SIGNAL