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ELECTRONIC MODULE FOR BEAM SHUTTER CONTROL

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ABSTRACT

A new electronic module to control the beam shutter of a neutron diffractometer is presented. Basically it consists of an electronic circuit that controls the velocity of a high-reduction DC motor coupled to two cylinders that rotate in opposite directions. The opening and closing of the shutter is performed by lining up the two channels in these cylinders and, takes about 1 minute. This module was designed and constructed in the IPEN-CNEN/SP by employing national components.

1. INTRODUCTION

Basically a neutron diffractometer [1] is an experimental facility that employs a neutron beam to investigate for example, crystalline structure, texture of the materials, etc. The IPEN-CNEN/SP posses a such facility installed at the beam–hole #6 of the 5MW, IEA-R1 nuclear research reactor. A schematic diagram of this diffractometer is shown in fig 1. It posses an external shielding inside which the beam shutter is positioned. After the neutron pass through the shutter it reaches a monochromator crystal where is scattered. The resulting beam impinges a sample and the scattered fraction is analyzed by a set of detectors. A detailed description of this spectrometer is in reference [2].

2. GENERAL DESCRIPTION OF THE BEAM SHUTTER CONTROL

The beam shutter has two steel 500 mm diameter x 500 mm length contra-rotating drums each one having a 92 x 92 mm^2 peripheral square channel (Fig. 2). The drums are filled with high density barite concrete and, are coupled each other by a pair of identical gears. Each drum weighs *ca*. 400 kg and is supported by a pair of ball bearings. When the channels are lined up the neutron beam coming from the reactor core reaches the neutron monochromator. The shutter is driven by an *180 VDC/0.1A* electric motor, provided with a 1,100:1 reduction gearbox. A metallic gear attached to the motor drive shaft is coupled to a rubber toothed belt fixed on the surface of one of the drums.
The positioning of both drums is precisely controlled by the present Electronic Control Module. Its frontal panel has three push buttons (*red*, *black* and *green*) that command movement and positioning of both drums simultaneously. To line up the channels, that is, to put the shutter in the position *beam on*, the *red* button of the Module must be pressed energizing the electrical motor. During the movement, both *yellow* and *red* lamps remain lighted on. When the right position is reached an electronic sensor, placed near the end of the rubber belt, acts on the Module, getting the motor off. With the channels lined up, only the

red lamp remains lighted on. In order to obtain the *beam off* condition, the *green* button of the Module must be pressed and, like in the former case, the *green* and *yellow* lamps remain also lighted on during the movement of the drums. When the channels are exactly in opposite positions (*beam off*) another electronic sensor, at the other end of the belt, acts on the electronic module getting the motor off. In this condition only the *green* lamp remains lighted on. The *black* push button is employed to interrupt any time the movement. The system status is always indicated by three lamps, (*red, yellow* and *green*), stacked on a separated pedestal located on the shield of the diffractometer.

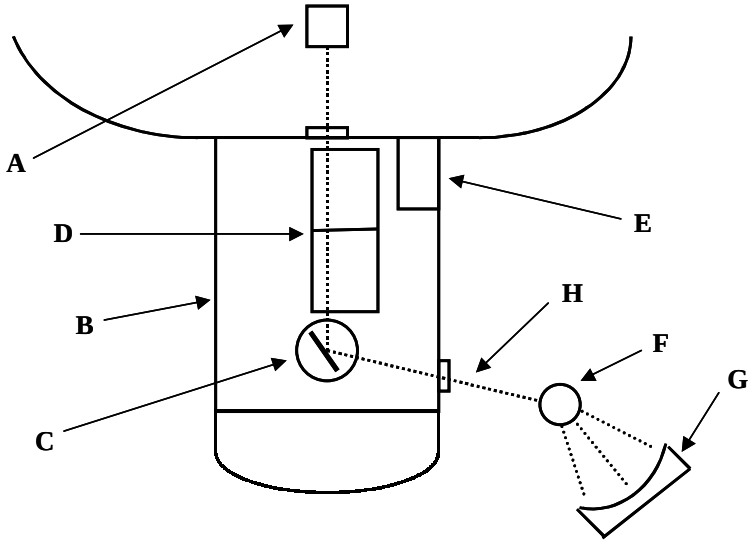

Figure 1. Schematic drawing of the neutron diffractometer (**A**: reactor core; **B**: shielding; **C**: monochromator crystal; **D**: beam shutter; **E**: shutter mechanism; **F**: sample; **G**: detectors; **H**: neutron beam).

Other special features of the electronic module are: 1) a third electrical sensor (a micro-switch) turns off the power of the circuit in case of failure in one of the electric sensors mentioned above; 2) ramps in the tension applied to the motor, with a ramp time adjustable between 0 and 10 seconds, allows a soft acceleration and deceleration of the movement in order to avoid damage in the gears of the system, particularly in the rubber toothed belt.

A block diagram of the electronic circuit is shown in fig. 3. The Module is supplied by 220 VAC and, the Low Voltage Power Supply provides ±12 V to the logic circuit. The Logic Circuit turns on the relays of the DC motor as well as the lamps, either by means of the commands of the Module panel or by the mentioned sensors. A Power Circuit provides suitable current for the DC motor.

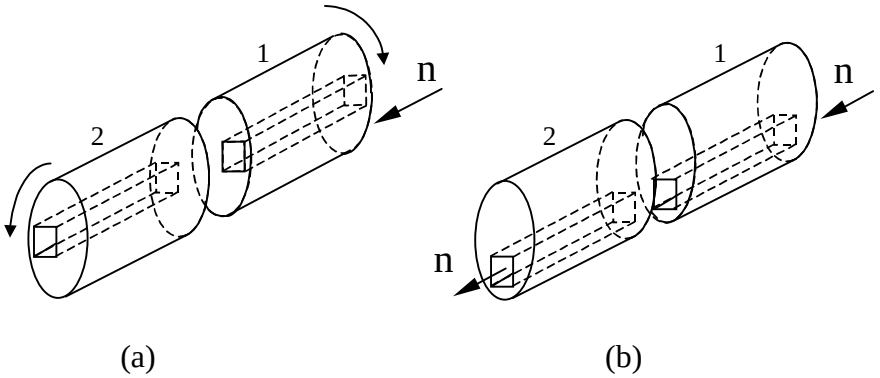

Figure 2. Schematic drawing showing the drums of the Beam Shutter in two different positions. On the left (a), the channels are in opposite positions corresponding to the *beam off* condition. On the right (b), the channels are lined up corresponding to the *beam on* condition.

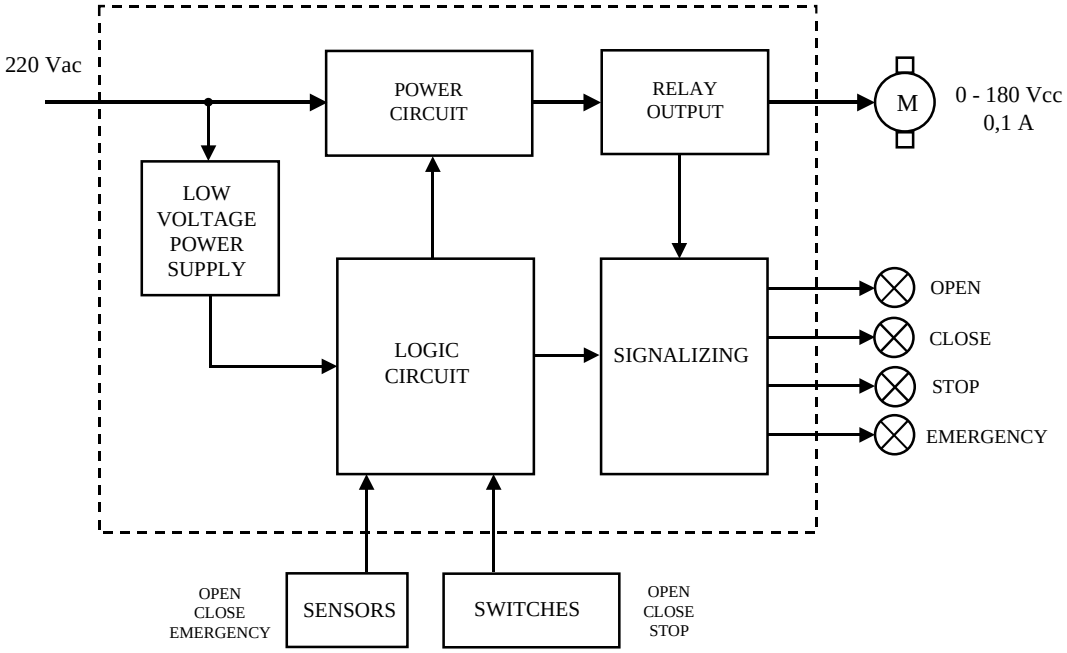

Figure 3. Block diagram of the Electronic Control Module

3. CONCLUSIONS

An electronic module to control the beam shutter of the new IPEN-CNEN/SP neutron diffractometer was presented. This module is not commercially available and has been constructed at the IPEN laboratories. This equipment is operational and operates properly.

ACKOWLEDGMENTS

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