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Station C single wire control system - device card

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STATION "C" SINGLE WIRE CONTROL SYSTEM-DEVICE CARD

Station "C" (low energy separated beam) has recently been equipped with hardware to provide computerized control and monitoring of this beam line. In this pilot project, a semi single-wire system known as a "cluster arrangement" was implemented. In general, the system is designed to accommodate any arbitrary device, but the first devices to be controlled and monitored are the experimental magnet power supplies on the LESB. This tech note describes the handling of control and monitoring parameters by the device cards without delving into circuit details.

In the clustered system, single wire transmission exists between a "central control module" located in an experimenter's trailer and a "remote receiver" located in an area where the magnet power supplies are clustered together. The remote receiver decodes addresses received on a single wire and fans out to all the magnet power supply device cards selecting at any time, one particular device whose address has been decoded. Pertinent data is transferred to the selected device card which interfaces the control system to the magnet power supply.

Control Parameters

In designing the device card, it was attempted at the outset in the station C pilot project, to design in those parameters which conceivably may be required in the future as well as those immediately obvious.

Ready/Rectifiers On/Off Controls. For the magnet power supplies, a "ready" command may be issued which initializes the unit prior to issuing a "rectifiers on" command. In the "ready" state, the power supply blowers are activated and conditions permitting, the power supply interlock chain has been closed and all interlock contacts have settled so that the chain is not bouncing. Now that a "ready" status state exists, (described under Monitoring), a "rectifers on"command will execute exactly what it implies. To match the industrial control nature of the magnet power supplies, both the "ready" and "rectifiers on" commands provide signal levels approximately one second in duration to momentarily actuate interface relays in the power supply which seal themselves. The "ready" command also issues a continuous level constantly energizing another interface relay which will return the power supply to a safe off state in the vent of power failure. When an "off" command is executed, the continuous level issued by the "ready" command is removed and the supply enters a totally off state.

Polarity Control. In the past there has been no remote control of power supply reversing switches. Newer units however, (General Electric and Westinghouse), have solenoid control of reversing switches making remote control of polarity rather easy and therefore reasonable to do. At station C, six such units are used in powering LESB magnets. Polarity control is executed as a result of a momentary logic level applied to an interface relay in the power supply

which actuates one of the two existing reversing switch solenoids to select either polarity A or B. Experimenters have found this capability to be very useful. If polarity reversal is required for any reason, it is not necessary to notify the EAO watch and request watch personnel to go to the supply and physically perform the polarity reversal.

Annunciator Reset. Power supplies that are capable of remote polarity control are also capable of having the fault annunciator reset remotely. Reset is accomplished with a momentary logic level from the device card energizing a solenoid which will clear resettable fault conditions such as DC overload. An experimenter can thus reset this type of fault condition without notifying the EAO watch to do so. If a problem persists or a fault condition such as loss of cooling water which is not resettable occurs, then the watch must be notifed.

Magnet Power Supply Mode Control Through the magnet power supply "Low Level Amplifier Control Module", it is possible to select four modes of power supply regulation; current (I), voltage (V), Hall (H), and High Hall (HH). Provision has been made in the design of the device card to select four modes of operation whether it be the four mentioned or others determined in the future. At present however, no mode selection is possible because the Low Level Amplifier Control Module is not easily modified for remote control and the usefulness of this capability in practical terms is presently not very great since the vast majority of magnet power supplies are always operated in the current regulation mode.

Set-Point Magnitude Control When a data transmission occurs, a selected device card receives twelve bits worth of digital information which represents

a request for a particular power supply output current. If the power supply rectifiers are on, the device card transfers this information to a twelve bit digital-to-analog converter (described in Tech. Note #45) located in the low level amplifier control module which generates an input signal for the power supply control loop.

Monitoring

Status information from magnet power supplies is received by their respective device cards in parallel form and converted to serial data by the device cards when interrogated by the "remote receiver". No status information is assumed as a result of executing commands but rather is positive information obtained from the real status of the power supplies.

Parameters that are monitored essentially correspond to control parameters (i.e. ready/on/off state, polarity, fault annunciator, and set magnitude) but some qualifications are necessary. All power supply annunciators are monitored and indicate legitimate fault conditions but only those supplies capable of remote polarity control also have their polarity monitored as the older mechanical annunciators cannot easily be interfaced. No regulation mode status has been made available from the power supplies for the same reason and the "I" (current) status indicated is a result of hard wiring at terminal connections to the device card. Set point magnitude monitoring is not provided via the device card but is obtained by the system through a single multiplexed analog-to-digital converter contained in the remote receiver.

In addition to this, two operator generated fault conditions can be detected by the device card which will then have these faults noted as part of the status display. The two fault conditions reveal illegal power supply polarity and mode commands. Further details are given under "Interlocking Features".

Interlocking Features

Magnitude Lockout. If a power supply is in the off state, trips out on DC overload, or for any reason has its rectifiers turned off, the request for magnitude is automatically reduced to zero. Prior to turning the rectifiers on however, the magnitude should be set to zero as the low level amplifier will, upon the rectifiers coming on, see whatever magnitude request is being made and the control loop must have control before any sizable step input can be applied.

Mode and Polarity Switch Errors. If an operator attempts to change the power supply polarity or regulation mode with the rectifiers on, the device card disallows such action and indicates that an illegal command has been requested. Polarity and mode can be altered only if the rectifiers are off. In addition, if polarity reversal is to be executed immediately after turning off the rectifiers it is necessary to wait at least twenty seconds before requesting the change. This is necessary because the one second momentary logic control level will not be recognized by the power supply until after a built in twenty second delay to allow magnet fields to decay has elapsed.

Ready/Rectifier on Interlocking. Manual push button operation of a power supply is slow enough so that having turned on the power supply blowers, air flow switches and so forth have stopped bouncing and the rectifiers can be turned on immediately (by hand) thereafter. Working with speeds typical of a computer, this is not the case and it is necessary to disallow rectifier turn-on before the power supply interlock chain has settled so as to prevent rapid cycling of large contactors. It is also necessary to prevent this from happening if with the rectifiers on something (e.g. waterflow) causes intermittent discontinuity of the interlock chain. Device card logic interlocks power

supply control by requiring the power supply "ready" status to be true before requesting "rectifier on" and by disallowing any further turn-on of the rectifiers should the interlock chain be interrupted. An interrupted interlock chain with the rectifiers on therefore will not allow the rectifiers to again be turned on, after having dropped out, since the command exists before the "ready" status line again becomes true.

Power Fail. Storage registers utilized in designing the device cards are volatile devices assuming any arbitrary state with the application of power. Therefore, in the event of a power dip or total power loss, the device card design forces a safe power up state by holding the continuous "ready" control line at the "off" level for each device until it is addressed and deliberately set to a desired control state.

Final Note

A special "zero address" has been designed into the device cards so that all devices, if desired, can be addressed simultaneously . One reason for this is that all power supplies can be initialized to a given state (e.g. ready state) with one transmission. Similarly, all supplies can be simultaneously turned down to some low level during extended AGS down times to conserve power or turned off completely at the end of a run by selecting a single address. For the LESB at station C, the special zero address is 360.

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