Programmable Logic Controller System for the Hall D LH_2 Cryotarget

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This note presents the prototype programmable logic controller (PLC) system developed to control and monitor, locally and remotely, the Hall D LH_2 Cryotarget.

To control and monitor Hall D's LH_2 Cryotarget, the Allen Bradley PLC system (Table I) reads analog voltage and current signals (Table II) and communicates with a Lakeshore 218 cryogenic temperature monitor, a Lakeshore 336 cryogenic temperature controller, and a Cryomech CP1110 pulse tube refrigerator compressor. RSLogix5000 v20 is used to program the PLC and Factory Talk Human Machine Interface (HMI) for user input.

Part #	Item	Function
L35	PLC processor	module controller
IF8	analog input module	0–10 V, 4–20 mA signals
OW16	relay module	gate valve switch
IQ16	24 V input module	status of gate valve switch

TABLE I. Allen Bradley components used in PLC system.

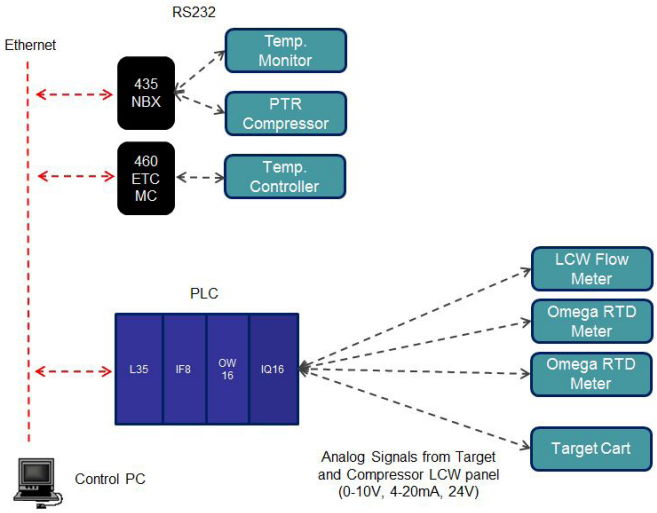

FIG. 1. Overall system map.

The PLC controller uses ethernet for communication. Both the temperature monitor and the refrigerator compressor use RS232 for communication. Therefore, a Real Time Automation, Inc (RTA) 435NBX module is used to convert the RS232 output, Fig. 1. The PLC continuously communicates with the temperature monitor and obtains from sensors four temperature readings, which are displayed on the HMI. The compressor is cycled on or off when a user command is given from the HMI.

The temperature controller uses an RTA 460ETCMC module to format its data before sending it to the PLC, Fig. 1. The temperature controller continuously broadcasts four temperature readbacks——two target condenser temperatures (one sensor being redundant) and two target cell temperatures (one sensor being redundant). Readings are displayed on the HMI.

When the target is being cooled, controlled by a button on the HMI labeled "Fill Target with Liquid", the temperature controller's heater temperature is set to 19±1 K and the target cell 50 W heater is enabled. (If the vacuum gauge is >0.193 psia, the "Fill Target with Liquid" button is disabled.) The compressor is activated and an indicator on the HMI labeled "Target is COOLING: NOT Ready for Beam" flashes.

Once the target is cooled, an HMI indicator labeled "Target is FULL: Ready for Beam" is displayed.

When the "Empty the Target" button is clicked on the HMI, the heater setpoints are changed to 25±1 K and two heaters, 50 W and 100 W, are powered. The indicator labeled "Target is Emptying: Not Ready for Beam" flashes on the HMI when the emptying process has begun. Once the target reaches 25±1 K, an indicator labeled "Target is EMPTY: Ready for Beam" is displayed.

When "Turn Target OFF" is selected on the HMI, first the compressor is turned off, and then the temperature controller's heater setpoints are set to 25±1 K. Both heaters, 50 W

Qty	Item	Mfr.	Part no.	Signal	Readback
2	pressure transducers	NOSHOK	626-60A	4–20 mA	H_2 fill and H_2 return pressures (0–60 psia) to target cell
2	RTD meters	Omega	DP25-RTD	0–10 V	temp. of LCW supply used to cool target compressor
1	flow meter	Gems	250207	0–10 V	flow (GPM) to the target compressor's inlet LCW
1	vacuum gauge	MKS	972	0–10 V	target cell vacuum
1	gate valve			24 V	open/close target gate valve

TABLE II. Analog signals. (LCW = low conductivity water)

and 100 W, turn on, if not already on, until the H_2 return pressure is >24 psia, at which point both heaters are turned off and an indicator on the HMI labeled “Target is WARM” is displayed.

The developed PLC system was implemented successfully in a test run.