Debugging NPS Thermal Readback LabVIEW Program

Aaron Brown
2023-07

Debugging of NPS Thermal Readback LabVIEW Program

During software checkout of the Hall C Neutral Particle Spectrometer the thermal readback LabVIEW program is being used to read the crystal array temperature sensors as well as to control the chillers. This has led to the discovery of new issues that were not seen during initial development and testing of the thermal readback program.

One issue that arose was that the raw voltages for the flow meters attached to both the crystal zone and electronics zone chillers were being sent to the EPICS Chiller Coolant Phoebus GUI instead of the converted values for temperature, pressure, and flow rate, Fig. 1.

The way the program was supposed to work is that all of the values scanned from the Keysight mainframe are stored in one large array called *All Keysight Values*. The flow meter sensors each return voltages between 0 V and 10 V. These voltages are removed from the *All Keysight Values* array (using their index numbers), converted (using conversion factors supplied by the manufacturer), and these converted values are placed back in the same position in the *All Keysight Values* array.

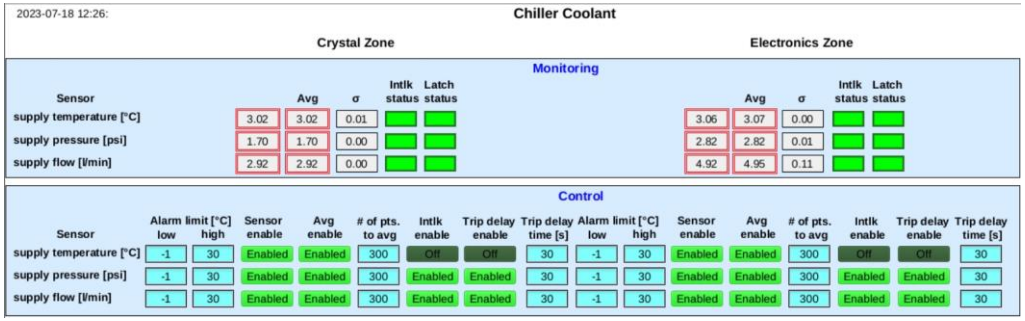
During this phase of testing, only 5 of the 7 multiplexers that are planned to be used for the experimental run are connected. This reduced the number of array elements in the *All Keysight Values* array as when the program scans the multiplexers in the Keysight mainframe, any missing or improperly connected multiplexers are skipped and the scan for those missing or improperly connected multiplexers return an empty set that is placed into the *All Keysight Values* array.

To combat this, I changed the LabVIEW code to include a check to see if the array that is created from each multiplexer scan is empty, Fig. 1. If it is empty, the program inserts an appropriate number of “improbable” numbers into the *All Keysight Values* array where those missing values should have been.

- **Noticed that converted values for chiller coolant temperature, pressure, and flow were not being sent to EPICS**
- **Issue was due to missing multiplexers in Keysight mainframe**
- **Changed LabVIEW code to ensure that the correct values were being sent to the correct PVs even if there are missing multiplexers**

Debugging NPS Thermal Readback LabVIEW Program

This addition to the code means that the length of the *All Keysight Values* array is always the same length and therefore the index number of each sensor is always the same. Now, when the raw voltages are pulled out of the *All Keysight Values* array to be converted and placed back into the array, the index number is correct and the Phoebus GUI receives the correct value for each PV, Fig. 2.



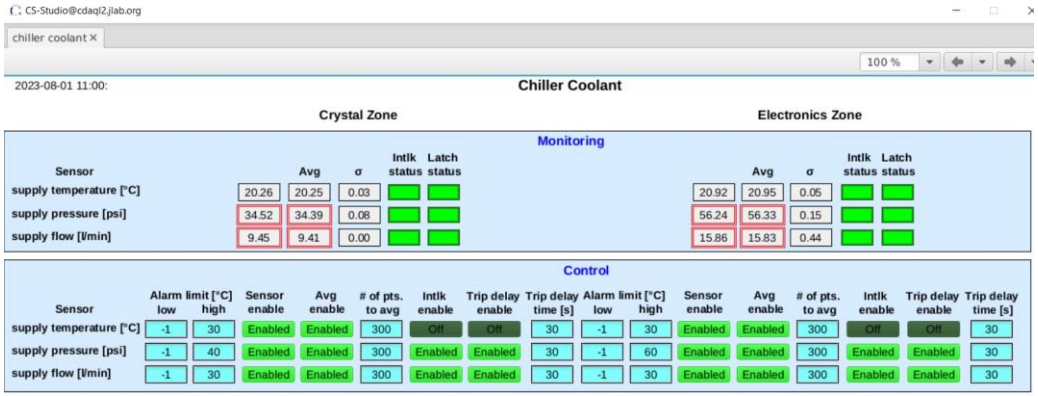
2023-07-18 12:26:

Chiller Coolant

	Crystal Zone					Electronics Zone				
Monitoring										
Sensor		Avg	σ	Intlk status	Latch status		Avg	σ	Intlk status	Latch status
supply temperature [°C]	3.02	3.02	0.01			3.06	3.07	0.00		
supply pressure [psi]	1.70	1.70	0.00			2.82	2.82	0.01		
supply flow [l/min]	2.92	2.92	0.00			4.92	4.95	0.11		

Control																
Sensor	Alarm limit [°C] low	Alarm limit [°C] high	Sensor enable	Avg enable	# of pts. to avg	Intlk enable	Trip delay enable	Trip delay time [s]	Alarm limit [°C] low	Alarm limit [°C] high	Sensor enable	Avg enable	# of pts. to avg	Intlk enable	Trip delay enable	Trip delay time [s]
supply temperature [°C]	-1	30	Enabled	Enabled	300	Off	Off	30	-1	30	Enabled	Enabled	300	Off	Off	30
supply pressure [psi]	-1	30	Enabled	Enabled	300	Enabled	Enabled	30	-1	30	Enabled	Enabled	300	Enabled	Enabled	30
supply flow [l/min]	-1	30	Enabled	Enabled	300	Enabled	Enabled	30	-1	30	Enabled	Enabled	300	Enabled	Enabled	30

FIG.1. Screenshot of chiller coolant Phoebus GUI showing raw voltages



CS-Studio@cdaql2.jlab.org

chiller coolant ×

100 %

2023-08-01 11:00:

Chiller Coolant

	Crystal Zone					Electronics Zone				
Monitoring										
Sensor		Avg	σ	Intlk status	Latch status		Avg	σ	Intlk status	Latch status
supply temperature [°C]	20.26	20.25	0.03			20.92	20.95	0.05		
supply pressure [psi]	34.52	34.39	0.08			56.24	56.33	0.15		
supply flow [l/min]	9.45	9.41	0.00			15.86	15.83	0.44		

Control																
Sensor	Alarm limit [°C] low	Alarm limit [°C] high	Sensor enable	Avg enable	# of pts. to avg	Intlk enable	Trip delay enable	Trip delay time [s]	Alarm limit [°C] low	Alarm limit [°C] high	Sensor enable	Avg enable	# of pts. to avg	Intlk enable	Trip delay enable	Trip delay time [s]
supply temperature [°C]	-1	30	Enabled	Enabled	300	Off	Off	30	-1	30	Enabled	Enabled	300	Off	Off	30
supply pressure [psi]	-1	40	Enabled	Enabled	300	Enabled	Enabled	30	-1	60	Enabled	Enabled	300	Enabled	Enabled	30
supply flow [l/min]	-1	30	Enabled	Enabled	300	Enabled	Enabled	30	-1	30	Enabled	Enabled	300	Enabled	Enabled	30

FIG.2. Screenshot of chiller coolant Phoebus GUI showing converted values