

## LabVIEW Program for the Keysight Switch/Measure Unit of the Hall C Neutral Particle Spectrometer

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This note details the LabVIEW program that reads the sensor values from the Keysight switch/measure unit of the Neutral Particle Spectrometer (NPS).

The LabVIEW program integrated into the sbRIO-based hardware interlock system [1] reads ~180 sensor signals—temperature, relative humidity, flow, pressure, and leak [2]—from the Keysight model 34980A multifunction switch/measure unit of the NPS [3].

The Keysight unit consists of a mainframe, Fig. 1, which accommodates eight, 40-channel multiplexers, Fig. 2. A terminal block, Fig. 3, routes the signals from the sensors to the multiplexer, directly or via D-sub cables.



FIG. 1. Keysight model 34980A multifunction switch/measurement unit.



FIG. 2. Keysight model 34921A 40-channel multiplexer.

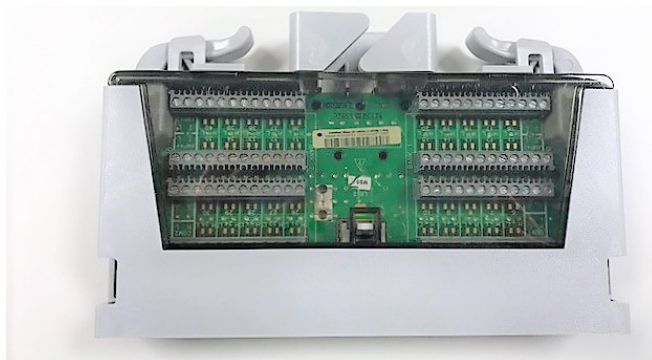
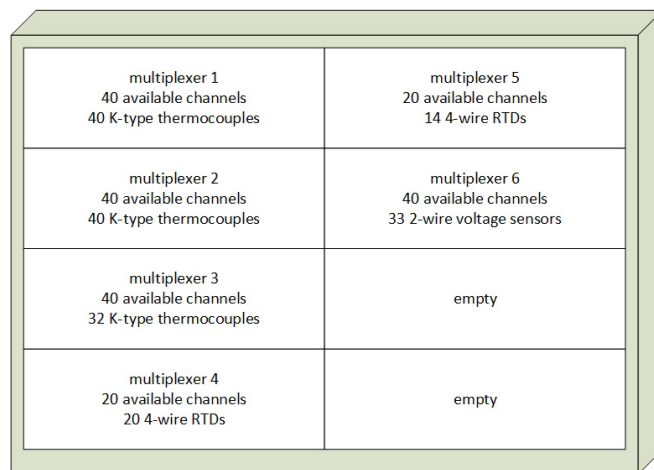


FIG. 3. Keysight model 34921T terminal block.

Figure 4 shows a schematic of the front view of the multiplexers in the mainframe.



Keysight Multiplexer Layout  
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FIG. 4. Schematic of multiplexer layout.

The LabVIEW readout program uses the *Agilent 34980A switch/measure unit* instrument driver package, which includes pre-made virtual instruments (VIs) to communicate with the mainframe via the virtual instrument software architecture connection. Channels of multiplexes 1–3 are configured for the K-type thermocouples using the *Configure Thermocouple* VI. Channels of multiplexers 4 and 5 are configured for the 4-wire RTDs using the *Configure FRTD* VI. Channels for multiplexer 6 are configured to read voltages using the *Configure DC Voltage* VI.

Figure 5 shows the flowchart for scanning the sensors. A channel list is constructed for each multiplexer. Channel lists are passed to the VIs *Measure Thermocouple*, *Measure FRTD*, and *Measure Voltage*, which read the sensors. The *Initiate* VI changes the trigger from the idle state to the wait-for-trigger state and clears the output buffer memory. When the trigger occurs, a measurement is read. The measurement data are sent to the mainframe's output buffer. An *Abort* VI ends the measurement process and the data stored in the mainframe's output buffer are appended to the array *All Keysight Values*. The cycle is repeated for the next multiplexer.

The array *All Keysight Values* is broken into smaller arrays by sensor type, to be shared with other sub-routines in the hardware interlock system via the inter-process communication bus.

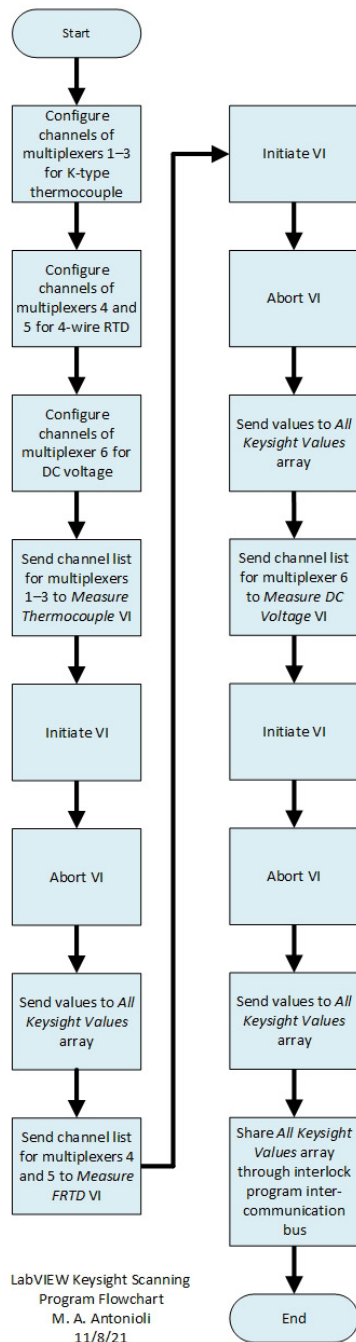


FIG. 5. Flowchart of sensor scanning.

Figure 6 shows an example of an array being developed. Four arrays were created for the K-type thermocouples that will measure the front and rear crystal temperatures. For the tests, ten sensors have been connected to the system, numbers outlined in red. The values read are the room's temperatures in degrees Centigrade.

CZ Thermocouples Back 1	CZ Thermocouples Back 2	CZ Thermocouples Front 1	CZ Thermocouples Front 2
22.3	-3.4	-69.6	-79.2
22.1	-63.2	-65.0	-83.8
21.8	165.1	-73.5	-86.8
22.5	-5.0	-56.4	-93.2
22.1	-141.8	98999%	-81.8
-26.4	-30.4	-101.5	-85.4
123.8	-22.0	-91.3	-82.2
5.4	-35.5	-84.3	-75.8
80.8	21.6	-88.4	-96.6
-25.8	21.5	-126.3	-80.9
164.1	22.9	-88.8	-78.3
8.7	21.2	-111.1	-55.2
-28.1	98999%	-126.6	-54.2
-10.0	-99.1	-58.5	-57.9
98999%	-97.5	-88.8	-68.2
-8.3	-95.4	-105.4	-49.4
72.2	-90.6	-78.9	-42.5
-140.7	-97.3	-89.0	-82.5
-51.7	-104.4	-85.0	-74.5
-151.5	21.5	-61.5	-74.6
98999%	98999%	-64.8	-73.4
-43.4	-95.0	-67.7	-77.7
-41.2	-105.3	-72.3	-82.4
-54.0	-123.9	-55.9	-75.5
-72.4	-116.7	-20.6	-72.9
-185.4	-131.2	-85.0	-81.7
47.2	-92.0	-81.3	-75.6

FIG. 6. Screenshot of developed array.

In summation, the LabVIEW program developed to read the Keysight switch/measure unit of the NPS works as designed.

- [1] [P. Bonneau et al., Program for the Hardware Interlock System of the Hall C Neutral Particle Spectrometer, DSG Note 2021-21, 2021.](#)
- [2] [P. Bonneau et al., Sensors for the Hall C Neutral Particle Spectrometer, DSG Note 2020-35, 2020.](#)
- [3] [P. Bonneau et al., Hardware Interlock System for the Hall C Neutral Particle Spectrometer, DSG Note 2021-15, 2021.](#)