NIST Center for Neutron Research

Upgrade of the Tritium Air Monitoring System

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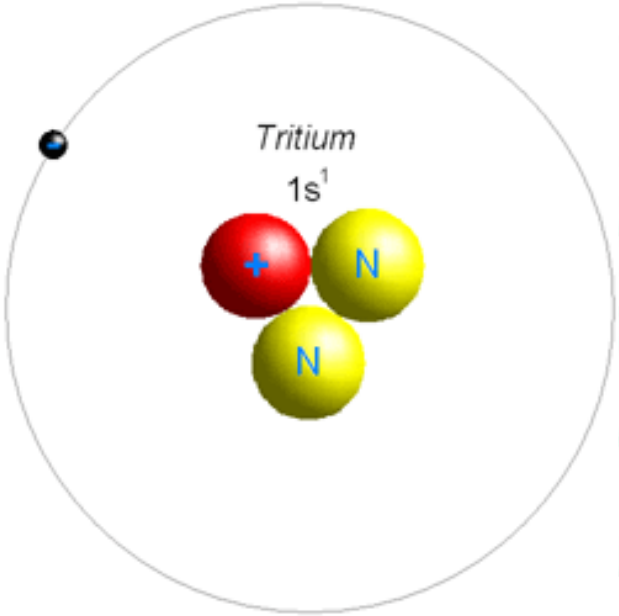
NIST National Institute of Standards and Technology U.S. Department of Commerce

Background

Tritium is an isotope of hydrogen produced as a side effect in the NBSR



Tritium Monitoring System?

- Tritium could leak into the confinement building
- Tritium is a radiation hazard when inhaled or absorbed
- 48 of 65 nuclear sites in the US have leaked Tritium (nbcnews.com)

A Tritium Monitoring System exists to detect leaks and give assurance that the work environment is safe, or a warning if it is not

How it is implemented

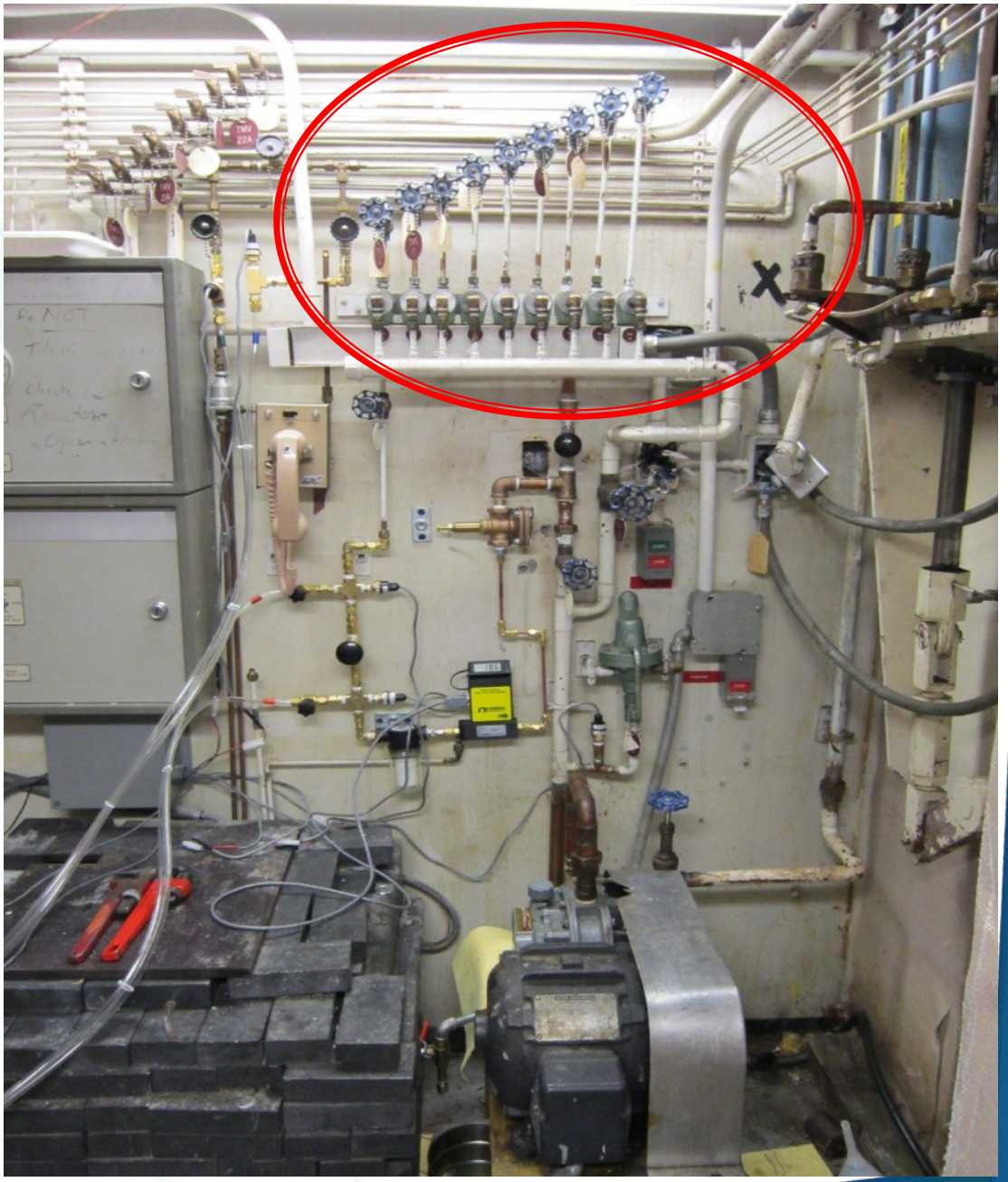
- Nine pipes transport air to basement
- Air is sampled by monitoring machines
- Send input information to PLC
- PLC interprets and sends info to digital recorder

C-01 components

Canberra TAM100s, measure tritium/argon-41 in air

Physical infrastructure of the Tritium Monitoring system ---------->

C-01 components



Existing System Issues

- Digital Recorder operated the valves
  - In the case of a recorder communication or operation failure, the valves would stop switching and the system will fail
  - If modified or settings changed, system may cease to work
- The old recorder was also limited in its functionality in displaying screens and was more difficult to use
  - Button select system
  - Outdated interface

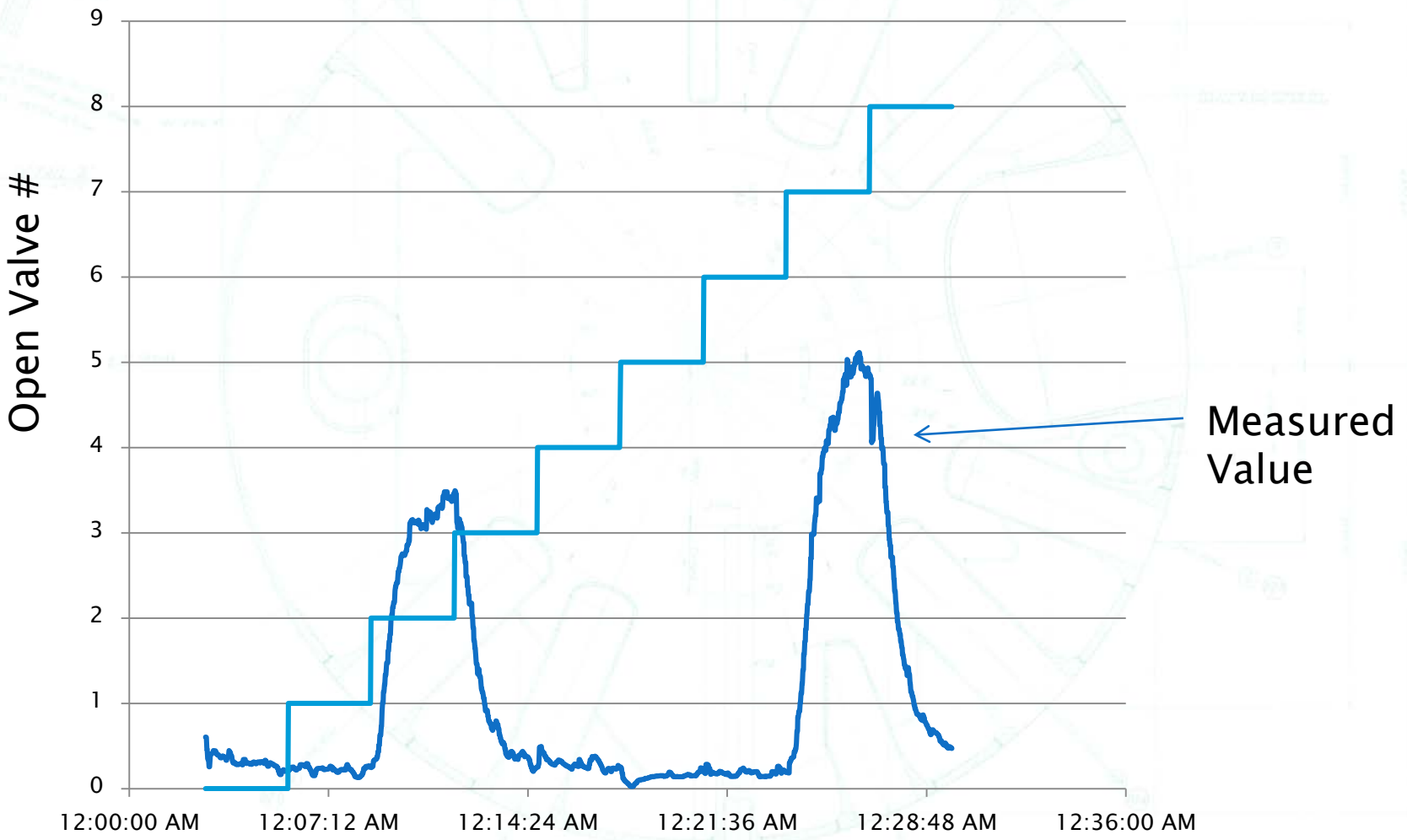
New implementation

- TM1 continuous building monitor
- TM2 continuous process room monitor
- Send analog signals to the PLC
  - Converted to DAC (Derived Air Concentration)
    - "Concentration of radionuclide in air, when breathed by man working 2400 (volume of air) hours a year, that results in one ALI (annual limit of intake)"
      - ALI $\mu Ci = 5$ rems
      - DAC $\mu Ci/m^3 =$ ALI $(\mu Ci)/2400\ (m^3)$

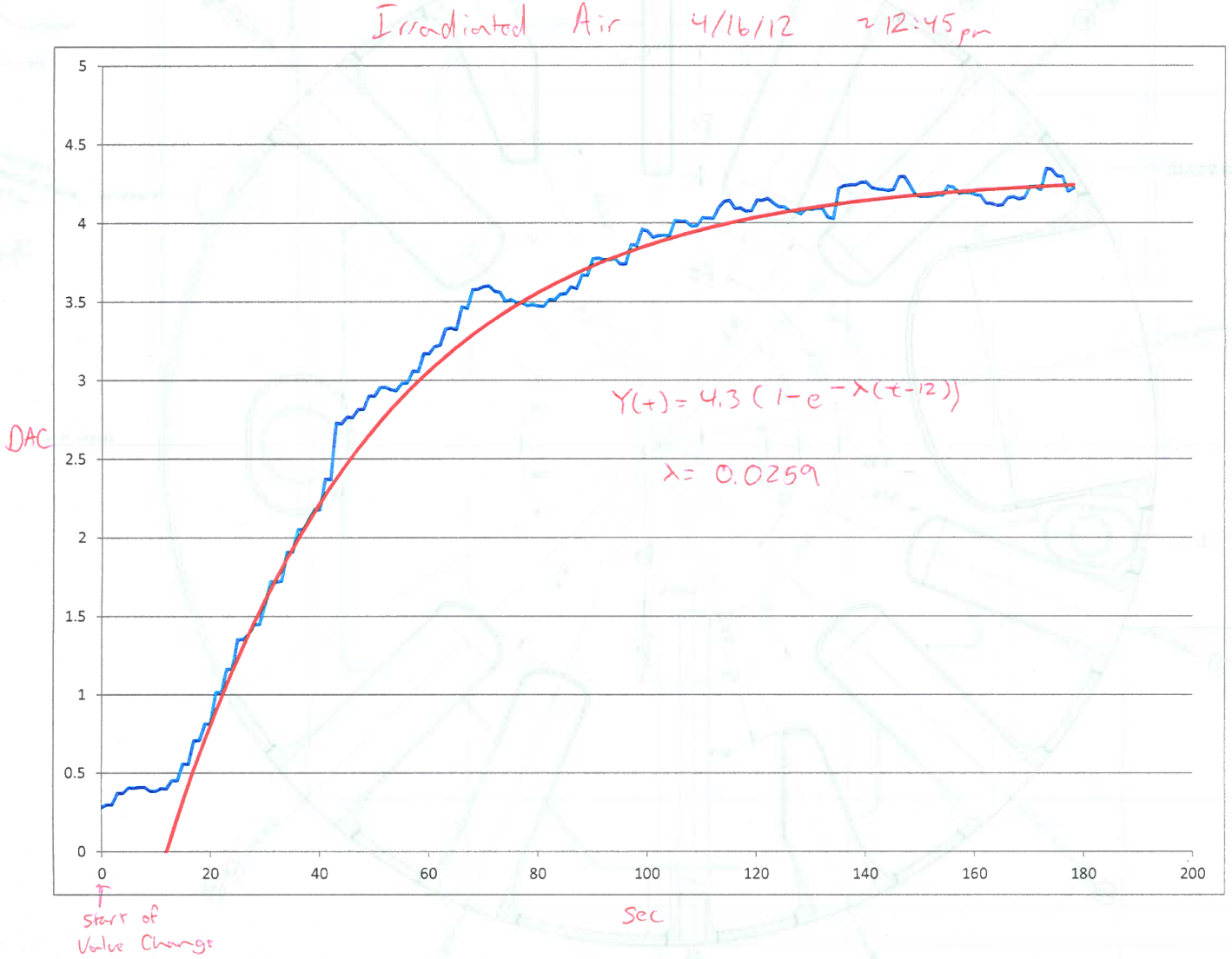
New implementation

- Flow chart logic programming language
  - Controls and times valves
  - Communication
- Modbus TCP protocol to send and receive information
- Advance and hold switch, selected flush time
- The Digital Recorder uses custom screens and settings to display trend screens

TM1 Sample Cycle



Chamber Volume Flush Time

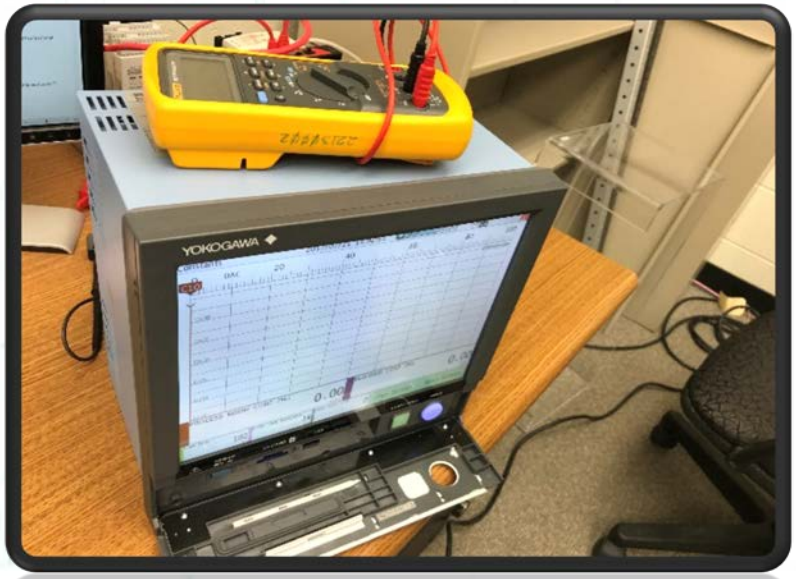


My Project

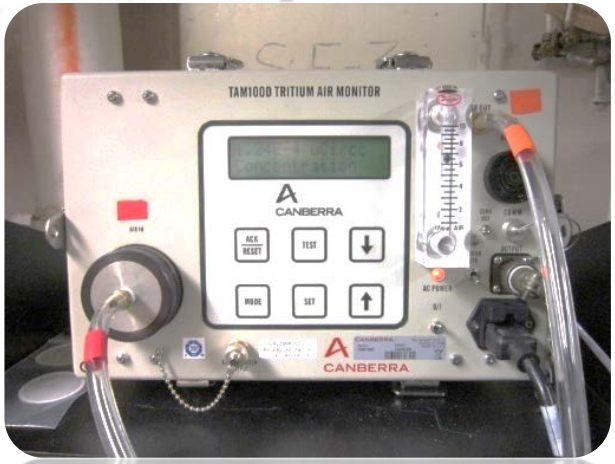
- Reprogram the PLC so that it has more functionality
- Use a different way to communicate with the PLC and the new Recorder
- Configure the recorder to display pertinent information
- Creation of custom screens
- Documentation of system

Yokogawa GX20

- Talked to reactor operators, took suggestions
- Configured custom screens using DAQStudio software
- Used the previous recorders settings
- Created a Mimic Screen
- Drives Alarms



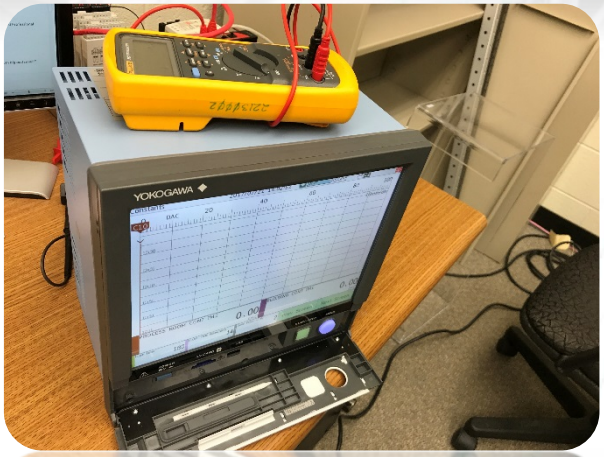
Components



Canberra TAM-100D

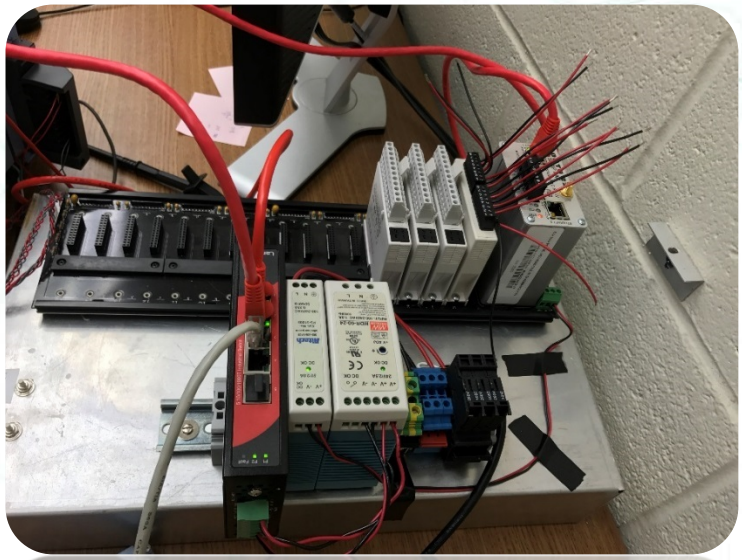
2.5 µCi/mL of ^{3}H = 1 DAC
4-20 mA .027-27000 DAC

Vacuum Pressure sensors



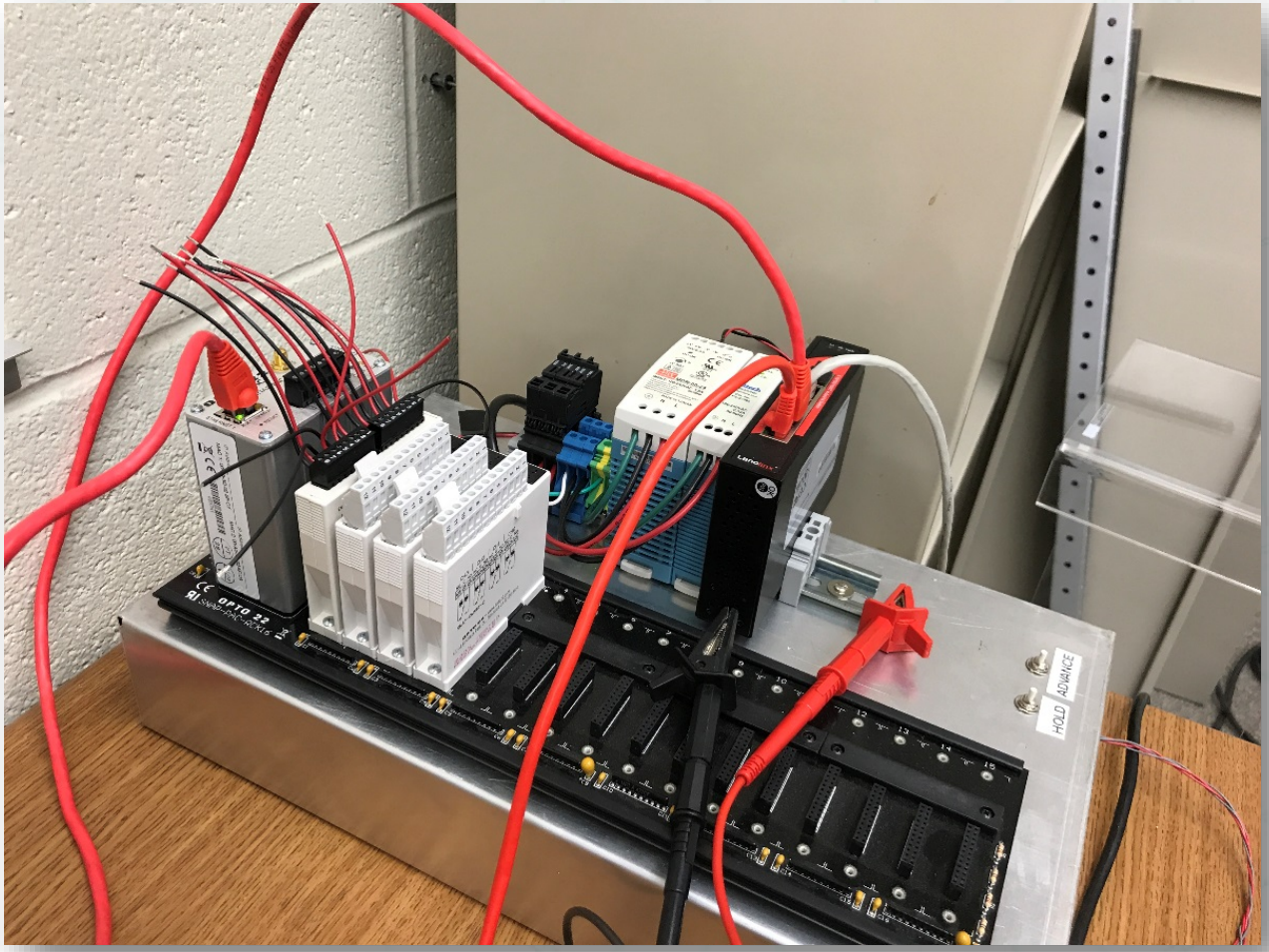
GX20 Digital Recorder

Flow meter



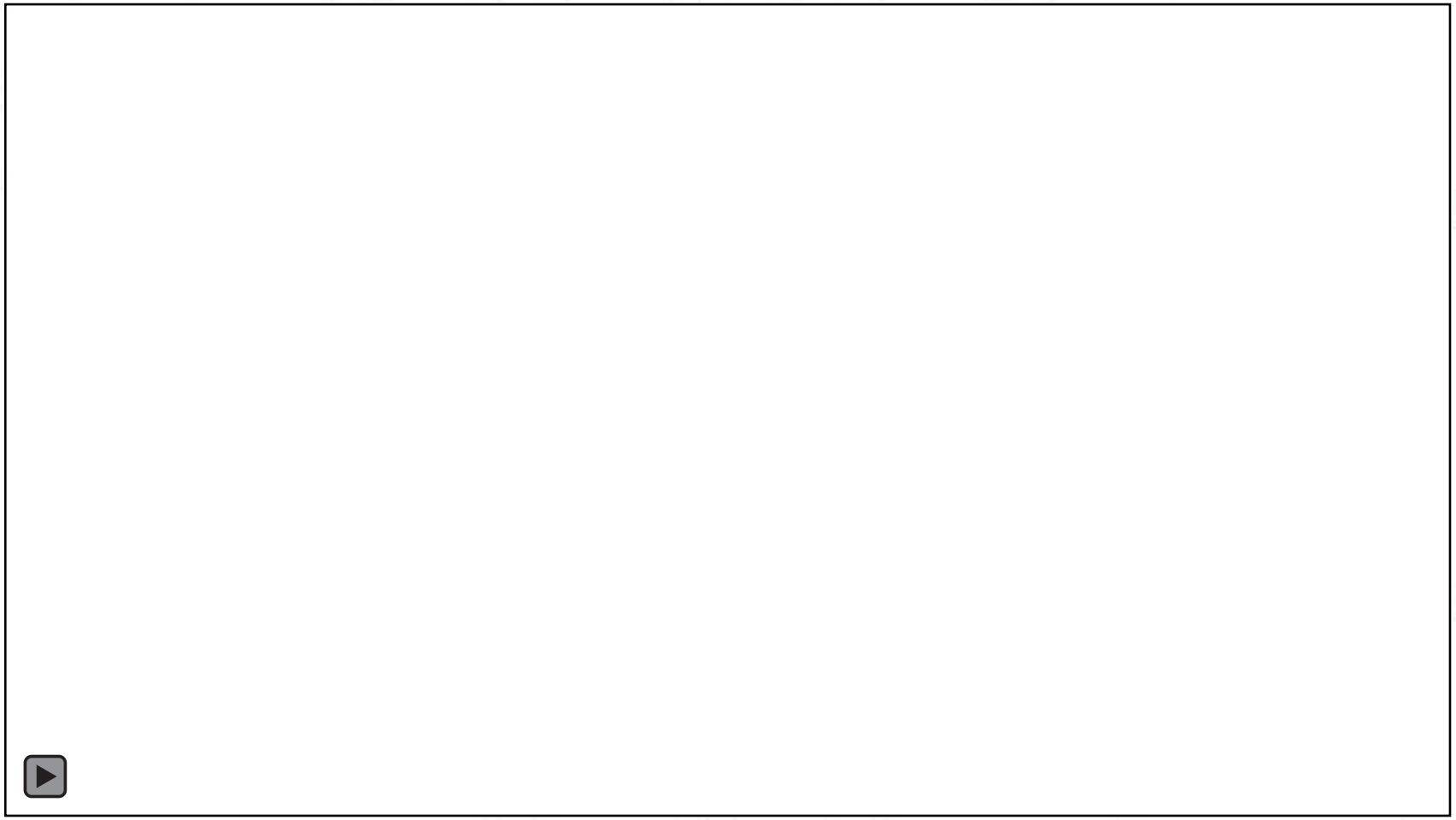
OPTO-22 Rack

PLC Rack

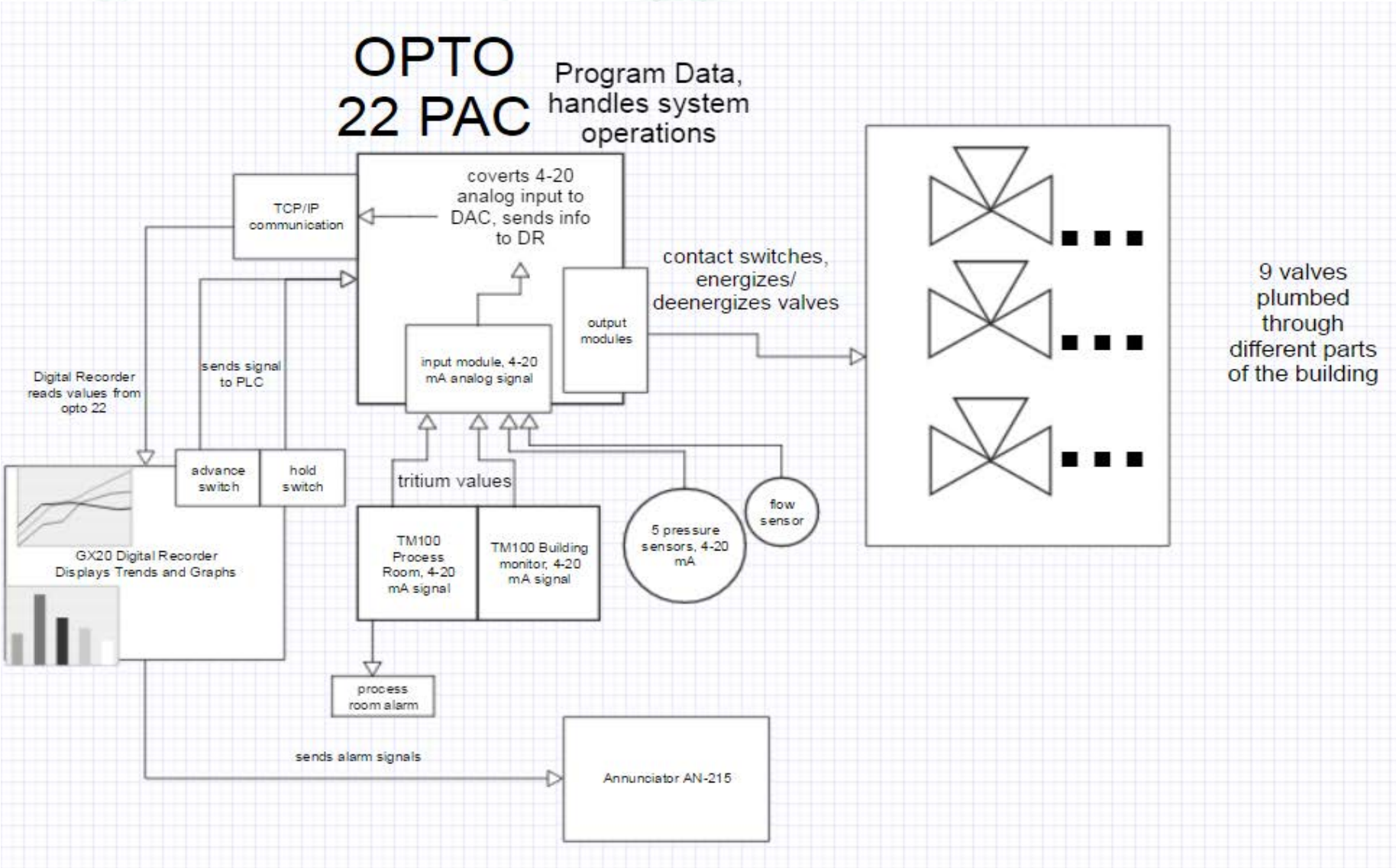


- Input and output modules
- A switch for connecting to a local network to test and debug the system
- OPTO-22 PLC, where code is run

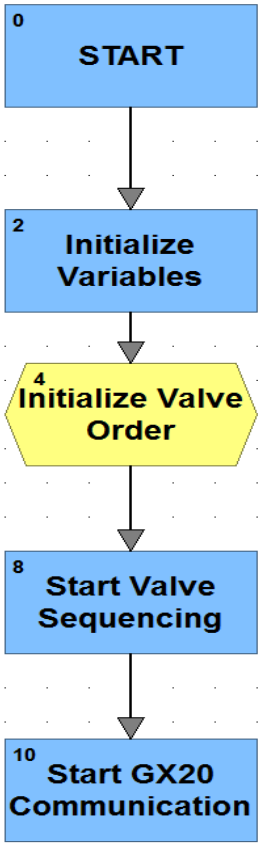
Valve Actuation



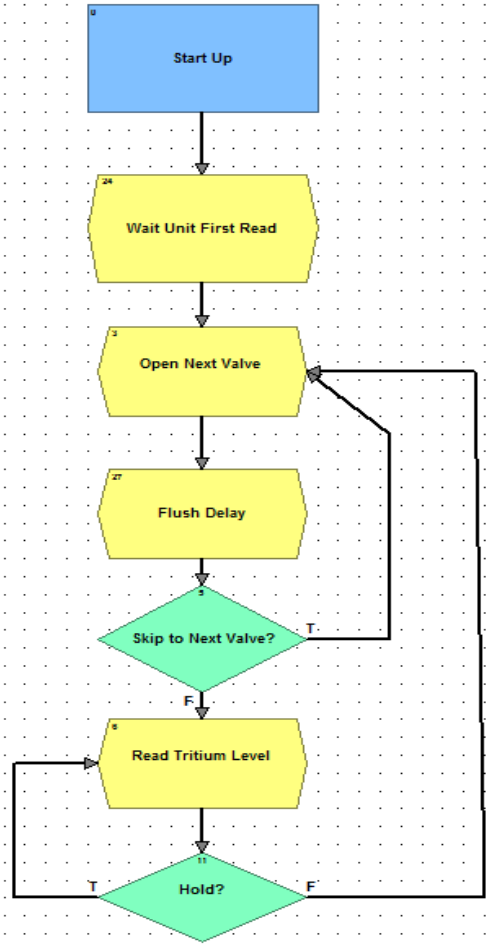
Diagram


OPTO 22 PAC
Program Data, handles system operations
TCP/IP communication
coverts 4-20 analog input to DAC, sends info to DR
output modules
contact switches, energizes/ deenergizes valves
9 valves plumbed through different parts of the building
input module, 4-20 mA analog signal
sends signal to PLC
Digital Recorder reads values from opto 22
advance switch
hold switch
tritium values
GX20 Digital Recorder Displays Trends and Graphs
TM100 Process Room, 4-20 mA signal
TM100 Building monitor, 4-20 mA signal
5 pressure sensors, 4-20 mA
flow sensor
process room alarm
sends alarm signals
Annunciator AN-215

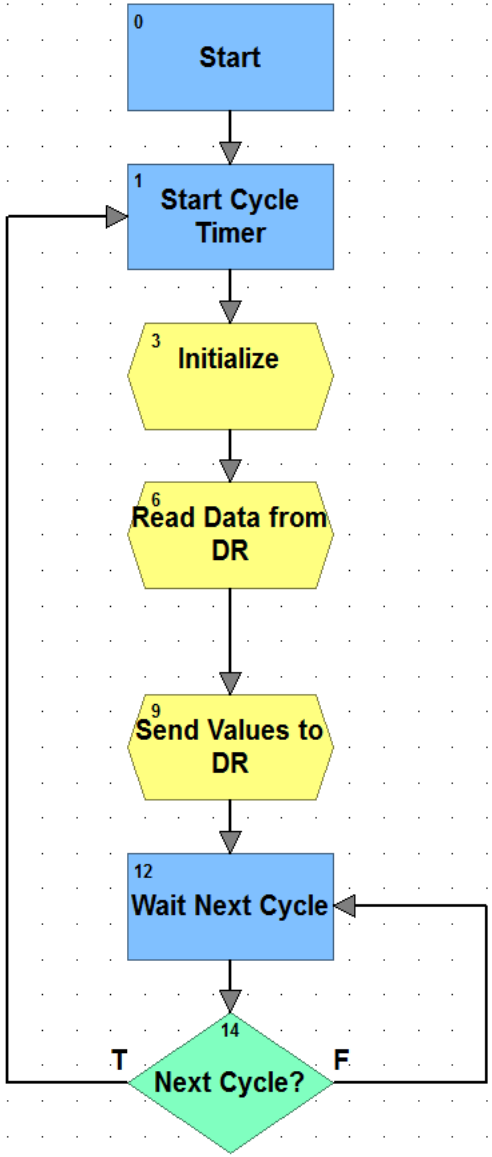
Coding – Flow charts



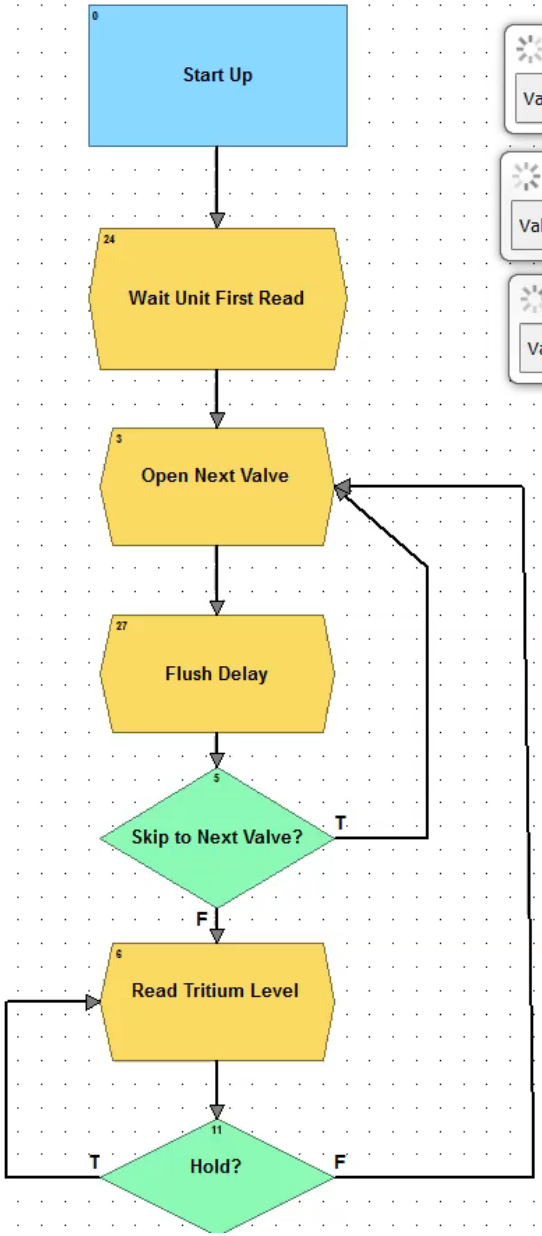
Start up sequence

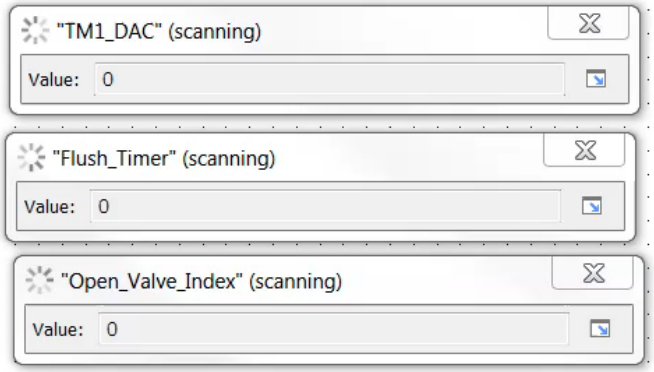


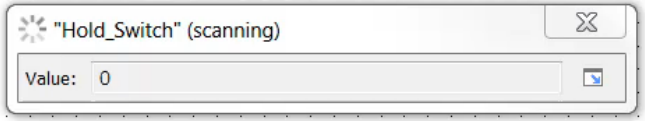
Valve sequence



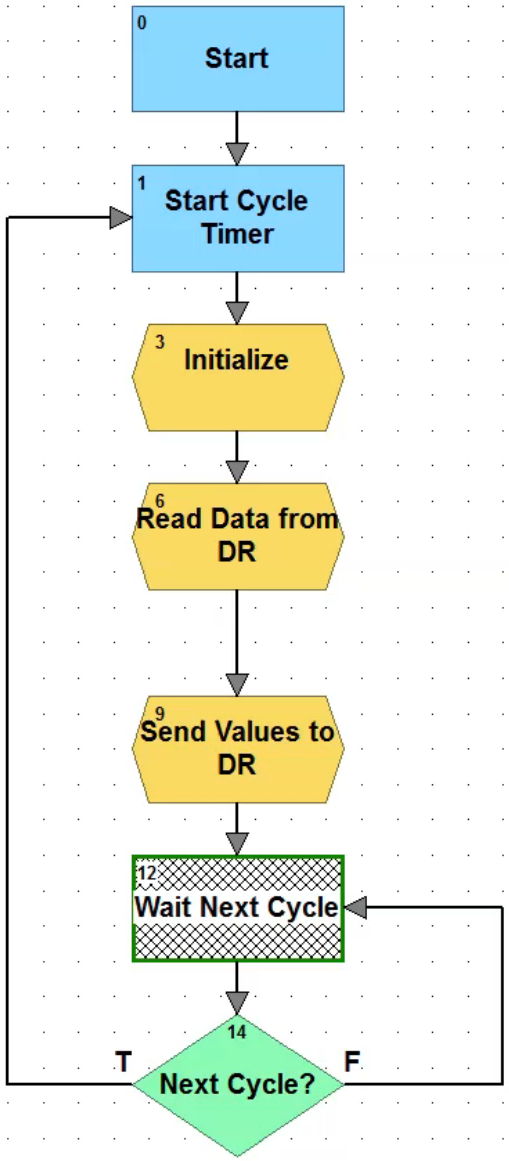
Communication chart







- Input 4–20 mA signal using Processmeter
- Flush timer set on the recorder
- Valve index shows current open valve
- Hold switch holds the valve open for more sampling



"GX20_Send" (scanning)

Name: GX20_Send

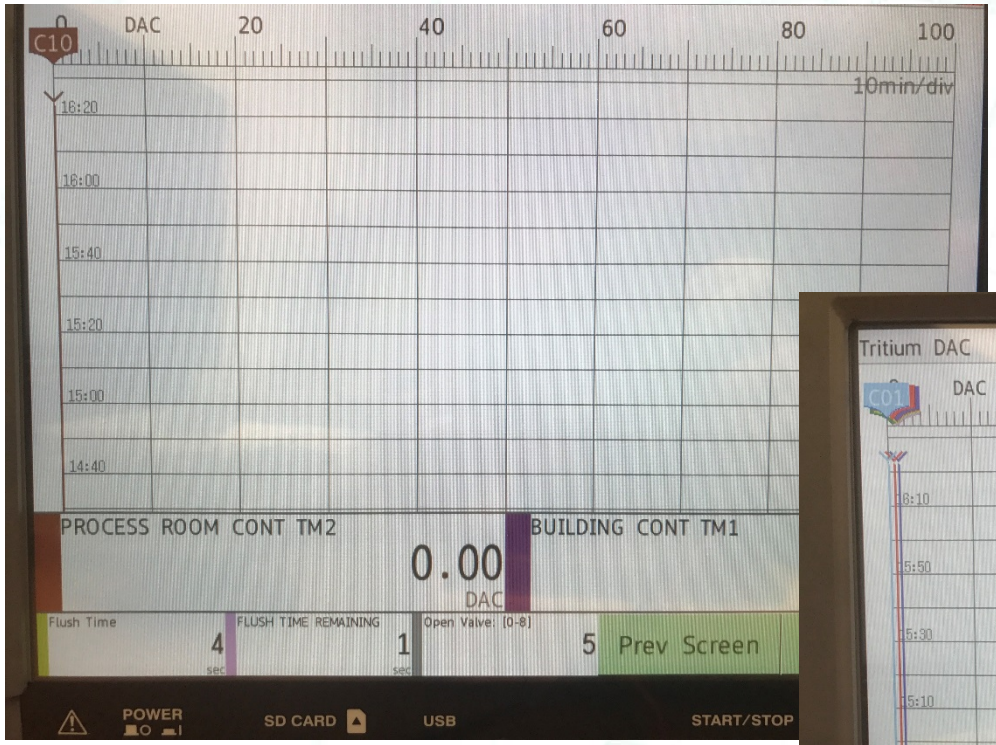
Index	Value
0	0
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	376
21	500
22	375
23	375
24	375
25	-750
26	25
27	83936
28	0

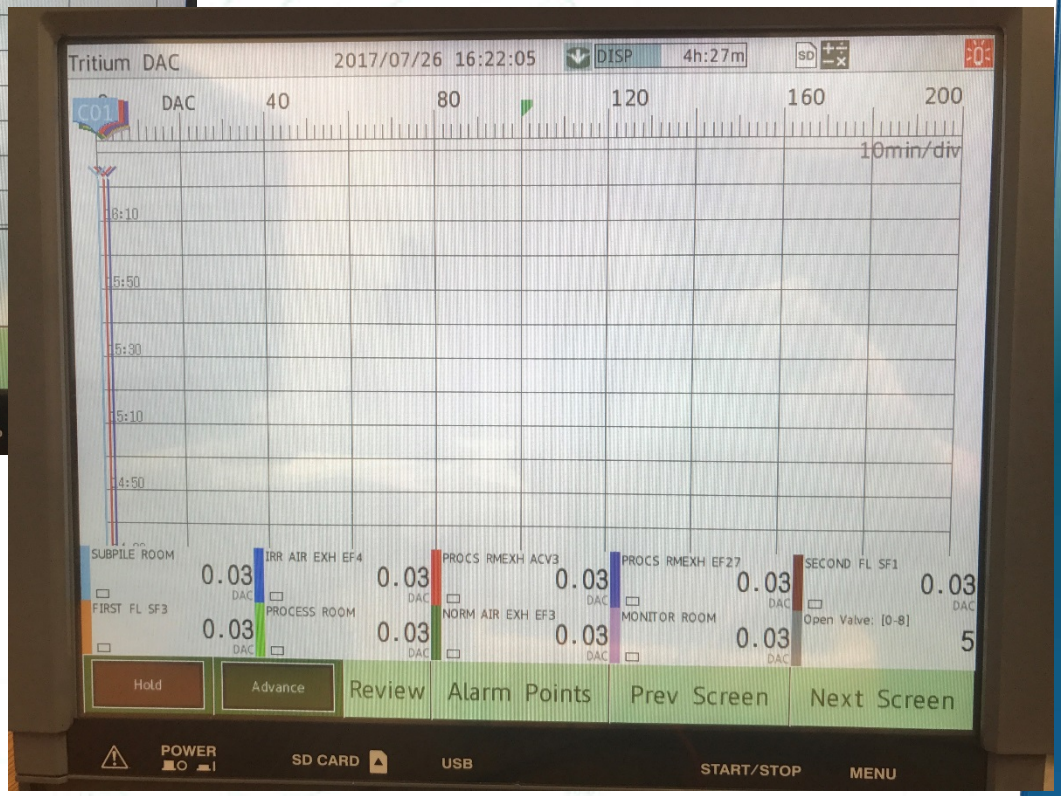
Apply | Watch | DEC | More Info

Communication between recorder and PLC

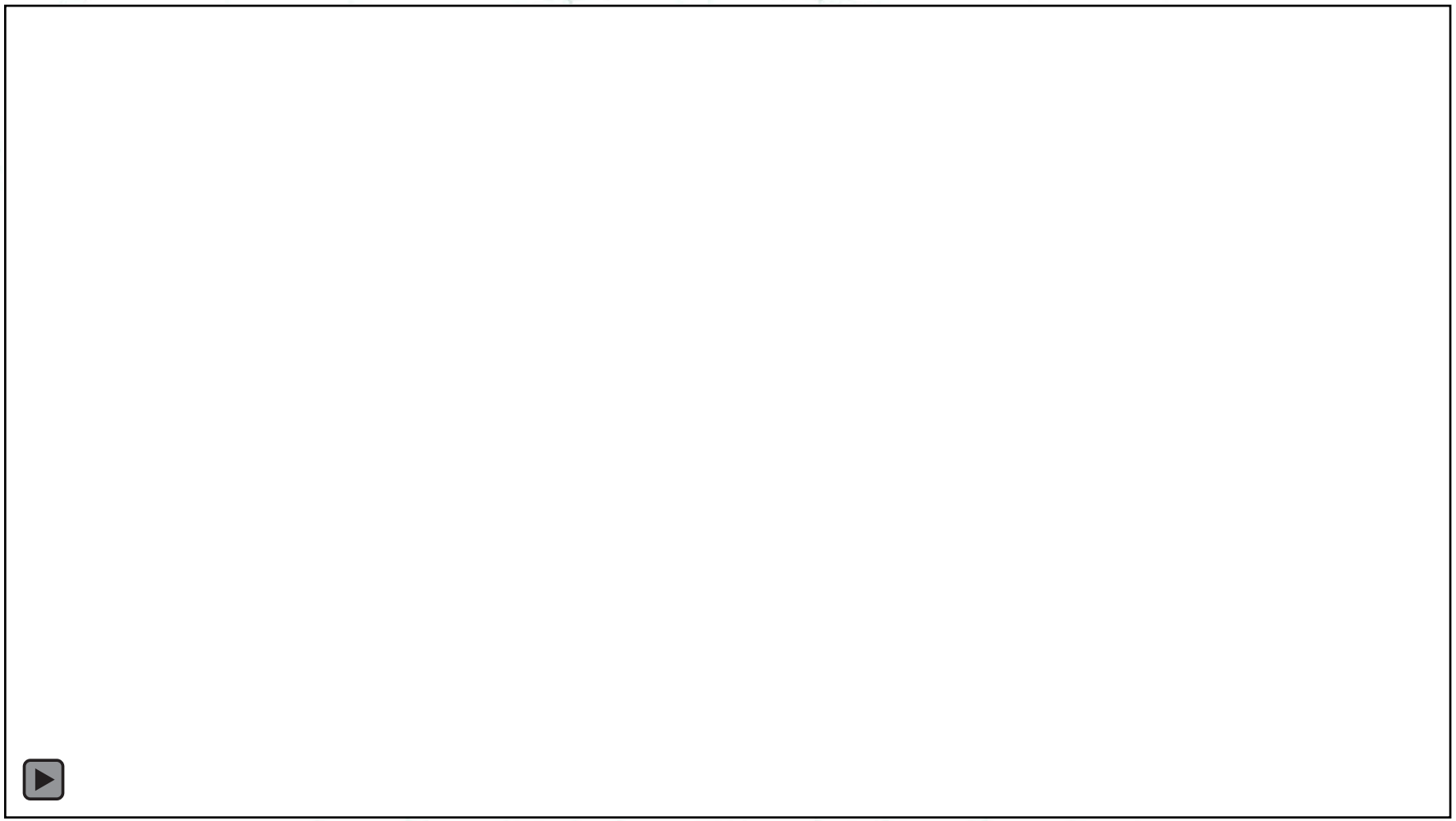
Table of information sent to the recorder

Custom Screen Examples





Mimic Screen



Conclusion

- New Air Monitor system has more functionality to the PLC
- Digital Recorder upgraded, custom displays and touch screen are more user friendly
- The System is better documented
- Room for some minor improvements
  - Removal of Legacy Components
  - Better flush time, considers difference in DAC values, self adjusting

Thank you/acknowledgements

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