

PLC Based Vacuum Controller Upgrade and Integration at the Argonne Tandem Linear Accelerator System

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Transition From Custom Analog Chassis to Full Programmable Logic Control

For several decades the ATLAS Vacuum Control System has been implemented via in-house custom built hardware chassis utilizing a combination of analog logic circuitry and programmable complex programmable logic devices. There currently exist several different revisions of these chassis depending on their intended purpose. For example, some chassis do not provide a remote vacuum pressure reading and some do not support a separate turbo pump, causing additional effort to integrate into the control system.



Methods	Problem	Solution
Silk Screen Front Panel	Difficult to modify after changes in machine or device configuration.	Move to digital touchscreens which allows for updating.
Various Chassis Pump/Gauge Configurations	Each chassis was custom built to handle a specific purpose like Cryostat vacuum or Target Area vacuum stations. With or without Turbo Pumps.	Use a programmable solution to create reusable code blocks for each device and vendor type.
Remote Control and Monitoring	Some chassis have zero monitoring, while others only offer vacuum monitoring, no control.	Select a product which can communicate over a standard TCP/IP Protocol.

Requirements Tracking and Project Management Tools – Fixed Vendors

Publish a fixed list of allowed vacuum equipment and vendors. Published on the Argonne website for Internal and External users.

Category	Manufacturer	Model/Type	Order Info	Supplier	Details
Cryo Pump	BROOKS CTI-CRYOGENICS	CRYO-TORR 8	8033351G002	Vacuum One	CF flanged, Vapor Pressure Gauge, Temp Probe, 1.33 CF Accessory port
Heater Blanket	BROOKS CTI-CRYOGENICS	Kit	8080002K012	Vacuum One	Used for Regeneration of CT 8 Pump, 120VAC
Temp/Controller 1	BROOKS CTI-CRYOGENICS	196443 Microprocessor Based	211998-0001	Vacuum One	10' cable, 2 Set Point Control, Digital Display, 3U chassis mount
Temp/Controller 2	BROOKS CTI-CRYOGENICS	196443 Microprocessor Based	211998-0002	Vacuum One	35' cable, 2 Set Point Control, Digital Display, 3U chassis mount
8200 Compressor	BROOKS CTI-CRYOGENICS	CRYO-TORR 8200	8032549G002	Vacuum One	208VAC 1PH, 1 CT8 pump operation, 1 year absorber life

The final steps of documenting vacuum system requirements was to create a list of devices based on the schematic representation and link them to the desired type of interface. The first four columns document each device in the system and their make and model. Then, the right four columns are used to track each interface method for the PLC.

4	Description	Model #	Controller & Details	# RS-485		# RS-232	CONTACTOR	24V INPUT
				15	0	44	0	11
5	Gauge-CV1	GP - 370 Stabil-Ion	1st Controller Pt# 370501-B1B-T1 (CH.A)	RS485	0	0	0	0
6	Gauge-CV2	GP - 370 Stabil-Ion	2nd Controller Pt# 370501-B1B-T1 (CH.A)	RS485	0	0	0	0
7	Gauge-CV3	GP - 370 Stabil-Ion	3rd Controller Pt# 370501-B1B-T1 (CH.A)	RS485	0	0	0	0
8	Gauge-CV4	GP - 275 Mini Convectron Module	Pt # 275534-EU ref. manual	RS485	1	0	2	0
9	Gauge-CV7	GP - 275 Mini Convectron Module	Pt # 275534-EU ref. manual	RS485	1	0	2	0
10	Gauge-CV8	GP - 275 Mini Convectron Module	Pt # 275534-EU ref. manual	RS485	1	0	2	0
11	Gauge-CV9 LEBL	NOT PURCHASED	Pt # 275534-EU ref. manual	RS485	0	0	0	0
12	Gauge-CV10	GP - 275 Mini Convectron Module	Pt # 275534-EU ref. manual	RS485	0	0	0	0
13	Gauge-CV11	GP - 275 Mini Convectron Module	Pt # 275534-EU ref. manual	RS485	0	0	0	0
14	Gauge-CV12	APG100-XM Pirani	Pt # 275534-EU ref. manual	RS485	0	0	0	0
15	Gauge-CV13	APG100-XM Pirani	TIC#03970100 (CH.#1)	RS485	?	0	0	0
16	Gauge-IG1	GP - 370 Stabil-Ion	TIC#03970100 (CH.#2)	RS485	?	0	0	0
17	Gauge-IG1A	GP - 390 Modular Micro-Ion Full Range Gauge	J1C Controller Pt# 370501-B1B-T1 (CH.IG1)	RS485	0	0	0	0
18	Gauge-IG2	GP - 370 Stabil-Ion	Pt # 390511-3-YG-T ref. manual	RS485	0	0	0	0
19	Gauge-IG2A	GP - 390 Modular Micro-Ion Full Range Gauge	2nd Controller Pt# 370501-B1B-T1 (CH.IG1)	RS485	0	0	0	0
20	Gauge-IG3	GP - 370 Stabil-Ion	Pt # 390511-3-YG-T ref. manual	RS485	0	0	0	0
21	Gauge-IG3A	GP - 390 Modular Micro-Ion Full Range Gauge	3rd Controller Pt# 370501-B1B-T1 (CH.IG1)	RS485	0	0	0	0
22	Gauge-IG4	GP - 370 Stabil-Ion	4th Controller Pt# 370501-B1B-T1 (CH.IG1)	RS485	0	0	0	0
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Reuse Cryogenics Group PLC

The M340 PLCs utilizes Schneider Electric's UnityPro line of software to develop PLC code. Possible programming languages include IEC 61131-3 Ladder Diagram, Structured Text, & Function Block Language.
I/O Modules Available: Digital 24V, Analog, RS232/RS485, Thermocouple, SSI



Conclusion

The first application of this new PLC based Vacuum Control System has been installed at ATLAS for the new Electron Beam Ion Source platform. It has been tested to successfully operate valves and some vacuum interlock operations have been verified. Future work will soon include a second project to use PLC controls for a third ion source. By leveraging reuse of vacuum components and associated code, large economies of scale have been realized versus custom hardware.

Continuing work has been allocated to the development of a standalone test rack which will include a PLC system, touchscreen and a standard vacuum pump configuration of rough pump, turbo, valves, and gauges. This way, further development can take place on an offline system increasing testing speed and reliability.

Remote Control via Internet Browser

