

Performance of PLC Control System with Controlnet and Ethernet Modules

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This note describes the test performed to analyze and evaluate the performance of a Programmable Logic Controller (PLC) control system that has both Controlnet and Ethernet networks, for the Super High Momentum Spectrometer (SHMS) in Hall C.

The PLC control system of the SHMS has eight remote chassis that communicate with the *local* PLC chassis via Controlnet modules. On many occasions, Controlnet modules lost communication with the *local* PLC chassis, causing helium loss and thereby affecting helium supply in other Halls.

Possibly the communication loss is due to radiation damage of the Controlnet modules in the remote chassis, which are located in the SHMS detector hut in Hall C. Since Ethernet modules are supposed to be less prone to radiation damage than the Controlnet modules, a proposed solution is to replace the Controlnet modules with Ethernet modules. Because it is not possible to replace all Controlnet modules with Ethernet modules at one time, a mixed PLC control system, one configured with Controlnet and Ethernet modules, was tested to evaluate its performance.

To establish the baseline for the test, a stand-alone PLC test station was set up and configured to simulate the SHMS PLC control system. The setup comprised three PLC chassis named *local*, *remote #1*, and *remote #2*, using only Controlnet modules. See Appendix for details.

Controlnet network configuration between the *local* and both *remote* PLC chassis was achieved by using *RSNetwork for Controlnet* software, which scheduled Controlnet network in the PLC chassis by assigning *local* PLC chassis at node 01, and *remote #1* and *remote #2* PLC chassis at nodes 02 and 03, respectively, Fig. 1.

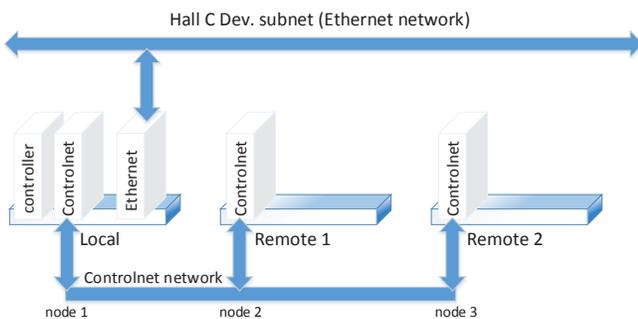


FIG. 1. Setup with only Controlnet modules

A PLC project file (.ADC file) in *RSLOGIX-5000* v.16 with controller properties and required module configurations (firmware revision, connection properties, and Requested Packed Interval) was developed and downloaded on the controller.

The PLC was connected online to check the performance of the CPU controller’s memory, Fig. 2.

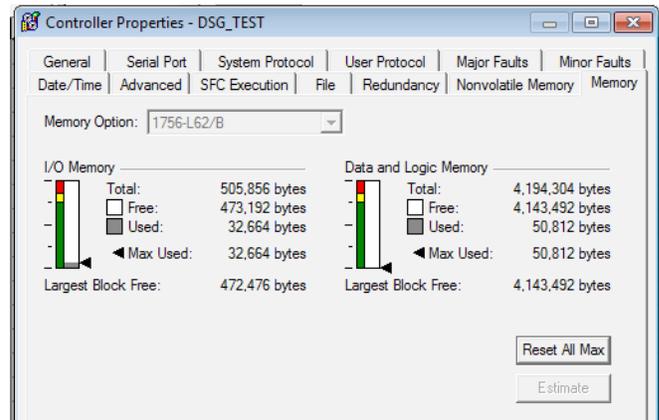


FIG.2. PLC CPU memory performance when *local* PLC chassis is connected with *remote #1* and *remote #2* PLC chassis via Controlnet network.

The controlnet setup was reconfigured for test of the mixed system. PLC chassis *local* and *remote #1* had the same node configurations, but the 1756-CNB/D Controlnet module in *remote #2*, slot 0, was replaced with a 1756-EN2T Ethernet module. No rescheduling of *remote#2* was needed as Ethernet modules do not need a node. Addition of the Ethernet module resulted in the creation of a new Ethernet network between *local* PLC chassis and *remote #2* PLC chassis, Fig. 3.

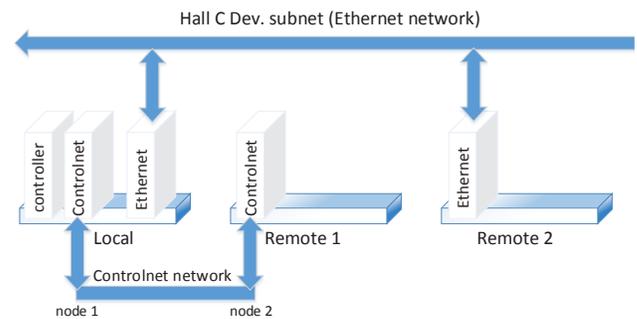


FIG. 3. Setup with Controlnet and Ethernet modules.

A PLC program (.ADC file) was developed and downloaded.

The PLC was connected online to check the performance of the CPU controller’s memory, Fig. 4.

The performance of the PLC control system in the mixed mode compared to the PLC control system running with only

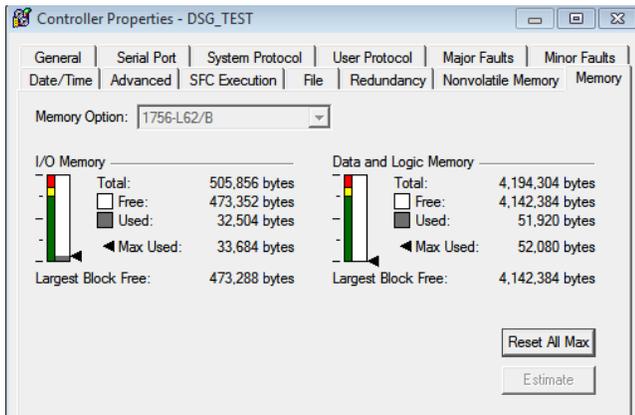


FIG. 4. PLC CPU memory performance when *local* and *remote #1* are connected via Controlnet network and *local* and *remote #2* PLC chassis via Ethernet modules.

Controlnet network modules showed an overall increase in CPU user memory of 0.026% and a decrease of 0.033% in the CPU I/O memory, Table I.

Network	PLC CPU			
	I/O memory		user memory	
	%	KB	%	KB
Only Controlnet	6.833	32.664	1.226	50.812
Ethernet & Controlnet	6.800	32.504	1.2530	51.92
Difference	0.033	0.16	0.0267	1.108

TABLE I. Details of performance of Controlnet system vs. mixed system.

To conclude, tests show that Controlnet and Ethernet modules of the mixed system run in parallel, and that the performance of the CPU's memory in the PLC controller is not affected.

APPENDIX: DETAILS OF THREE PLC CHASSIS

Chassis name	Chassis type	Slot	Module	Firmware	Connection RPI [ms]
Local	1756-A4	0	1756-L62 ControlLogix5562	16.81	—
		1	1756-CNB/D Controlnet	7.016	—
		2	1756-ENBT Ethernet	6.006	—
		3	—	—	—
Remote #1	1756-A10	0	1756-CNB/D	7.016	20
		1	1756-IF16	1.005	100
		2	1756-IF4X0F2F/B	3.005	20
		3	1756-IF16	1.005	100
		4	1756-IF16	1.005	100
		5	1756-IF16	1.005	100
		6	1756-IF16	1.005	100
		7	1756-IF16	1.005	100
		8	1756-OW16I	3.002	20
		9	1756-OW16I	3.002	20
Remote #2	1756-A10	0	1756-CNB/D	7.016	20
		1	1756-IB16D	2.006	20
		2	1756-IB16D	2.006	20
		3	1756-IB16D	2.006	20
		4	1756-OB16D	2.003	20
		5	1756-OB16D	2.003	20
		6	1756-OB16D	2.003	20
		7	1756-OB16D	2.003	20
		8	1756-OB16D	2.003	20
		9	1756-OB16D	2.003	20