



Condition Based Monitoring of Lindt Bar Line

Michaela Harrington

Electrical and Computer Engineering, University of New Hampshire, Durham, NH 03824

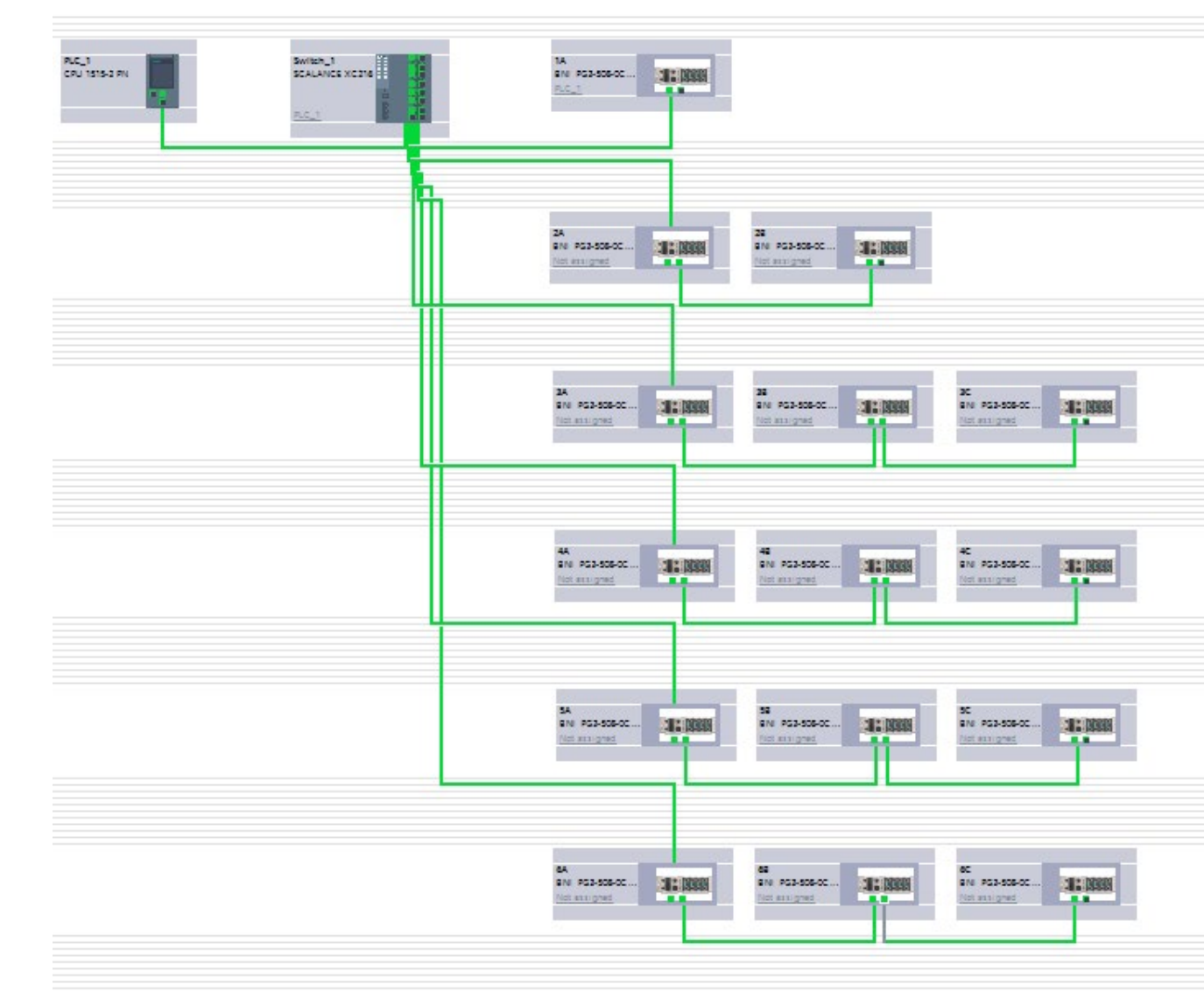


Objectives

- To install and program 83 sensors on the Lindt Bar Line to improve performance visibility
- To tie sensors into Ignition, the SCADA system used by Lindt, to allow data collecting and analysis to be done by employees
- To improve product quality, reduce waste, and move towards preventative maintenance



Network Devices



The PLC, switch, and 15 IO Link Masters were added and connected according to the connection charts.

Programming Set Up

PLC Tag and Type

PLC input mapping

PLC In, Word0

PLC In, Word2

Name	Description	Class	Bit	Bit length	Value range	Gradient	Unit	Unit
Temperature	Current temperature	Integer	1	16	478 to 2000	0.1	°C	°C
OUT1	Status depends on [PLC]	Boolean	1	1	0/1			
OUT2	Status depends on [PLC]	Boolean	0	1	0/1			

Port2_SA110

Name	Data type	Address	Retain	Access	Write	Visible
Port2 word 0	Word	%MW4		✓	✓	✓
Port2 word 2	Word	%MW6		✓	✓	✓

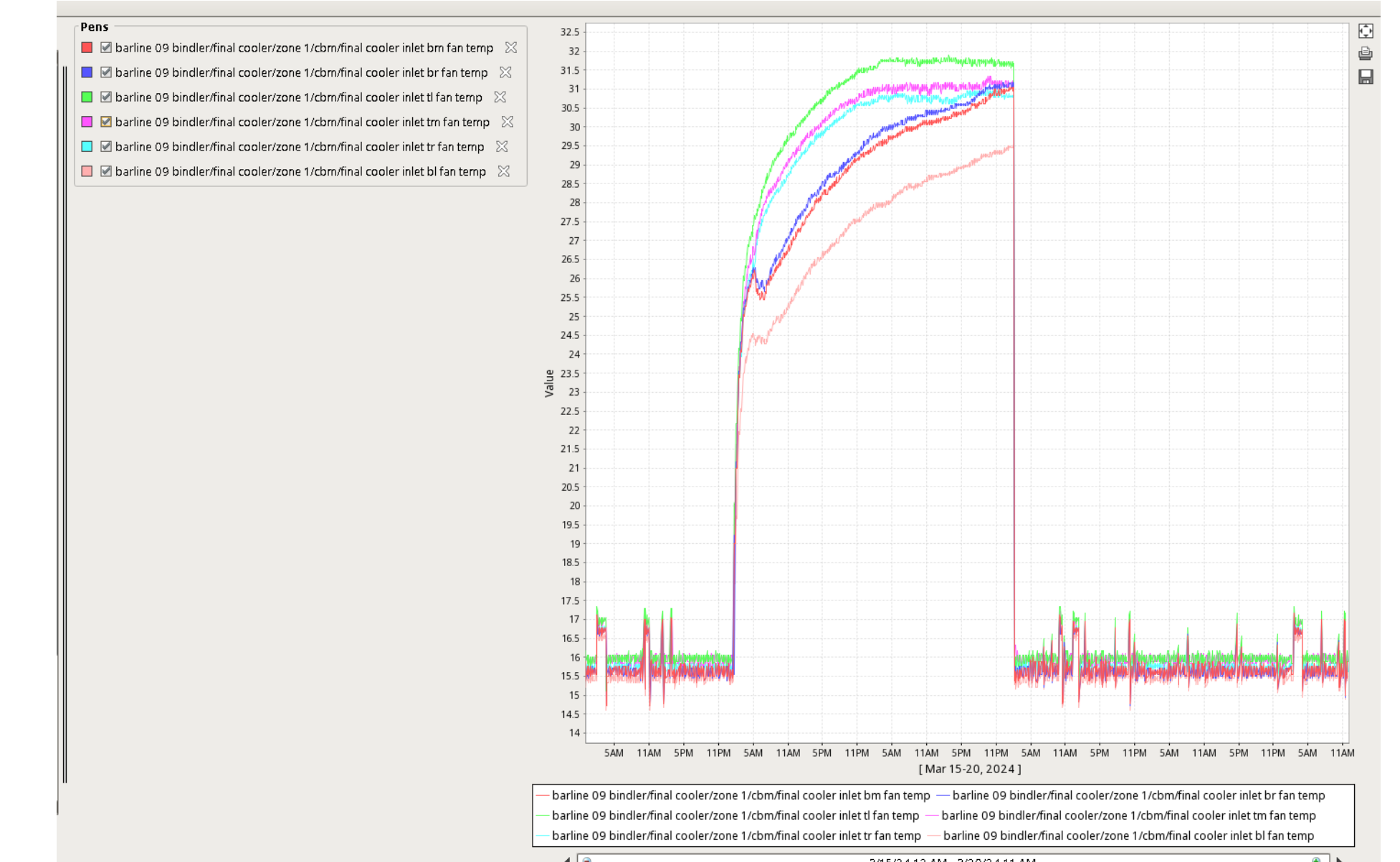
SA110_typ

Name	Data type	Default value	Accessible f.	Write	Visible in
SA110_Flow	Real	0.0	✓	✓	✓
SA110_Temp	Real	0.0	✓	✓	✓
SA110_Out2	Bool	false	✓	✓	✓
SA110_Out1	Bool	false	✓	✓	✓

The user manuals were used to set up 83 tags and 7 types in the Siemens TIA Portal PLC programming software.

Results

- Graphical data representation of sensor measurements in Ignition
- Alarms set with display path in place



Planning

- Investment Request
- Sensor layout
- Master Layout/ Placement
- Purchase Orders
- Installation Management



IO-Link Master Plant 4A (P4AM)	Connection	Location
Profinet LK1	XC216 Port 5	
Profinet LK2	4B LK1	
Power IN	CBM Power Supply	
Power OUT	4B Power IN	
Sensor		
IO-Link Port 0	Humidity Sensor (LDH292)	Inside Wall of Final Cooler Inlet
IO-Link Port 1	Flow/Temp Sensor (SA4110)	Top Left Fan
IO-Link Port 2	Flow/Temp Sensor (SA4110)	Top Middle Fan
IO-Link Port 3	Flow/Temp Sensor (SA4110)	Top Right Fan
IO-Link Port 4	Flow/Temp Sensor (SA4110)	Bottom Left Fan
IO-Link Class B Port 5	Flow/Temp Sensor (SA4110)	Bottom Middle Fan
IO-Link Class B Port 6	Flow/Temp Sensor (SA4110)	Bottom Right Fan
IO-Link Class B Port 7	Flow/Temp Sensor (SA4110)	Bottom Right Fan

Programming

Data Block

Name	Data type	Offset	Start value	Retain	Accessible f.	Write	Visible in	Setpoint
LDH292_Shef_Cooler	LDH292_typ	0.0			✓	✓	✓	
LDH292_Humidity	Real	0.0	0.0		✓	✓	✓	
LDH292_Temp	Real	4.0	0.0		✓	✓	✓	
LDH292_Status	Bool	8.0	0		✓	✓	✓	
SA4110_Shef_Cooler	SA110_typ	10.0			✓	✓	✓	
SA110_Flow	Real	10.0	0.0		✓	✓	✓	
SA110_Temp	Real	14.0	0.0		✓	✓	✓	
SA110_Out2	Bool	18.0	false		✓	✓	✓	
SA110_Out1	Bool	18.1	false		✓	✓	✓	
SA4110_Shef_Cooler	SA110_typ	20.0			✓	✓	✓	
SA110_Flow	Real	20.0	0.0		✓	✓	✓	
SA110_Temp	Real	24.0	0.0		✓	✓	✓	
SA110_Out2	Bool	28.0	false		✓	✓	✓	
SA110_Out1	Bool	28.1	false		✓	✓	✓	
SA4110_Shef_Cooler	SA110_typ	30.0			✓	✓	✓	
SA110_Flow	Real	30.0	0.0		✓	✓	✓	
SA110_Temp	Real	34.0	0.0		✓	✓	✓	
SA110_Out2	Bool	38.0	false		✓	✓	✓	
SA110_Out1	Bool	38.1	false		✓	✓	✓	
SA4110_Shef_Cooler	SA110_typ	40.0			✓	✓	✓	
SA110_Flow	Real	40.0	0.0		✓	✓	✓	
SA110_Temp	Real	44.0	0.0		✓	✓	✓	
SA110_Out2	Bool	48.0	false		✓	✓	✓	
SA110_Out1	Bool	48.1	false		✓	✓	✓	

Each line of the Data Block corresponds to a port on the IO Link Master. This is where the measurement from the sensors is displayed in the PLC.

Function Call

FC_SA4110

Name	Data type	Default value	Comment
Input	Word		
ProcessData_0	Word		
ProcessData_2	Word		
Output	Real		
Flow	Real		
Temp	Real		
Out1	Bool		
Out2	Bool		
InOut	Bool		
Temp	Int		
Flow_T	Int		
Temp_T	Int		

```

CASE FOR WHILE (P-) RECUR
OP_ TO DO_ DO_ (P-) RECUR
1 #Flow_T := WORD_TO_INT(#ProcessData_0)
2 #Flow := INT_TO_REAL(#Flow_T) * 62 //units in cfm
3 #Temp := WORD_TO_INT(STR(18 - #ProcessData_2, W (-2)))
4 #Temp := (INT_TO_REAL(#Temp_3) * 0.1-32)/1.8 // units converted to C
5 #Out1 := WORD_TO_BOOL(#ProcessData_2)
6 #Out2 := WORD_TO_BOOL(STR(18 - #ProcessData_2, W (-2)))
7
8
9
10

```

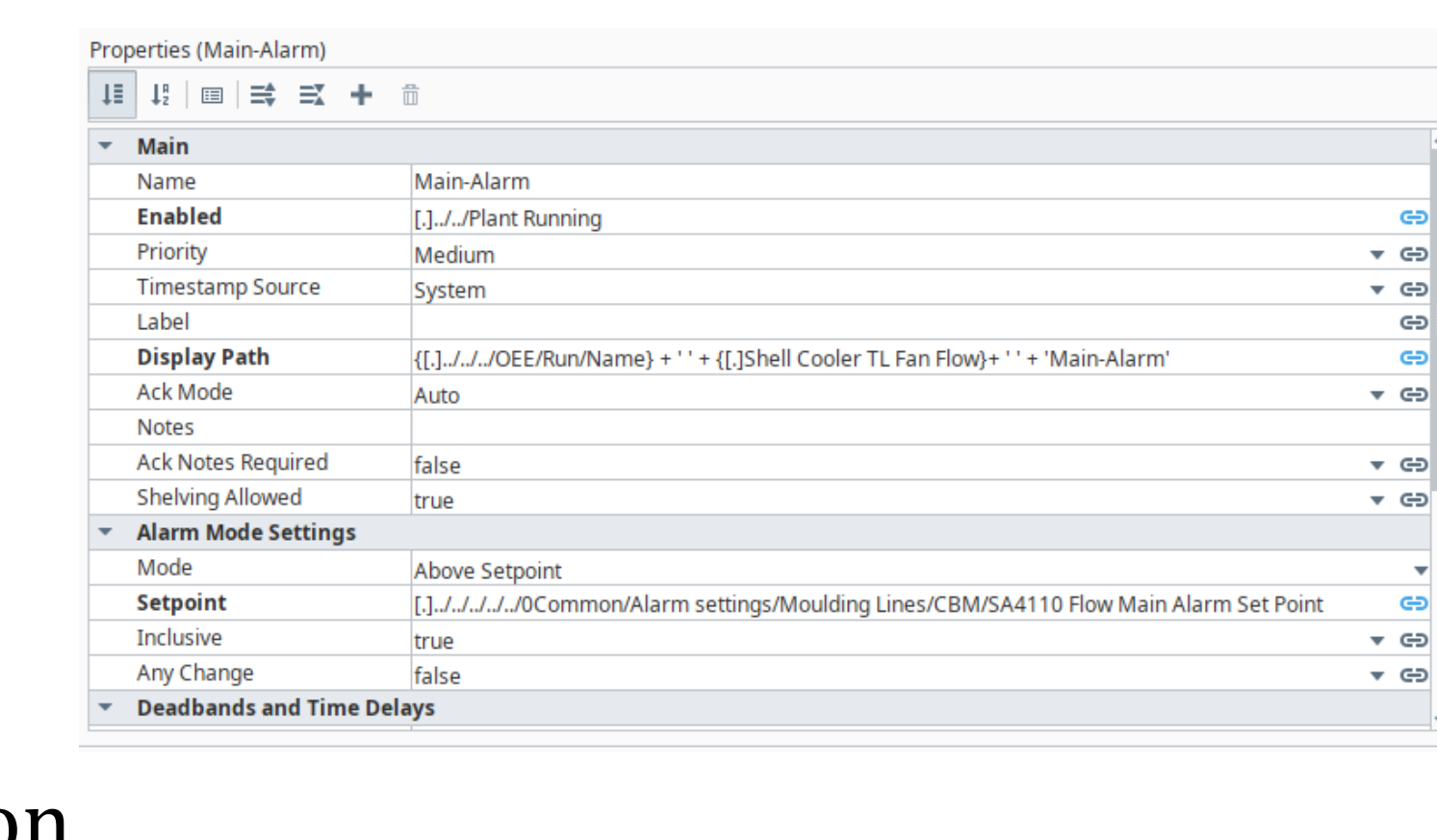
The function calls take the words that come into the PLC and separates them into the desired parameters.

Conclusions

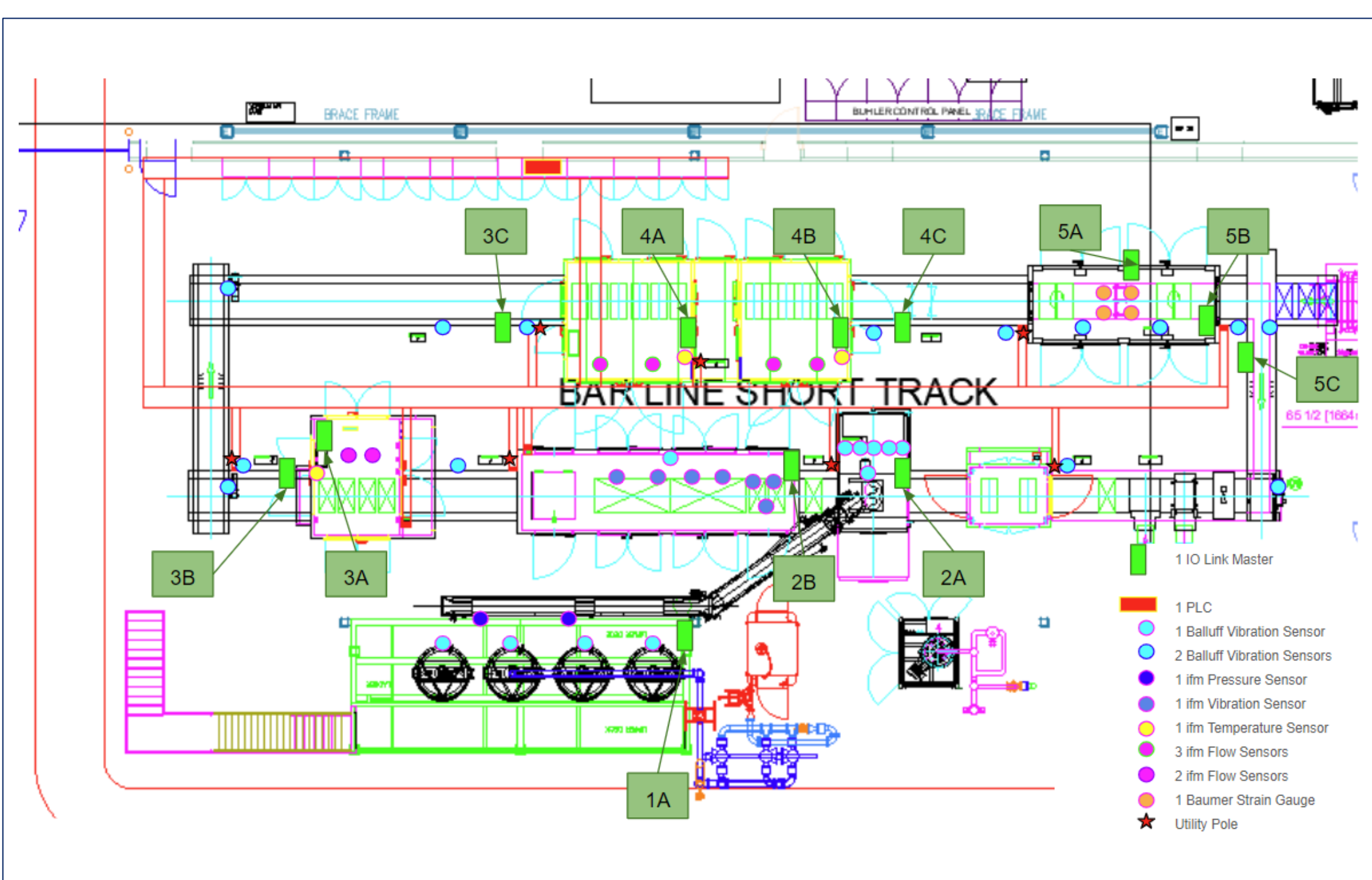
- Everything is connected, programmed, outputting data, and an alarm infrastructure is in place
- Next step is an R&D Trial to fine tune alarm setpoints
- Turn over to maintenance

What I learned...

- Manufacturing controls
- Data types
- Importance of documentation

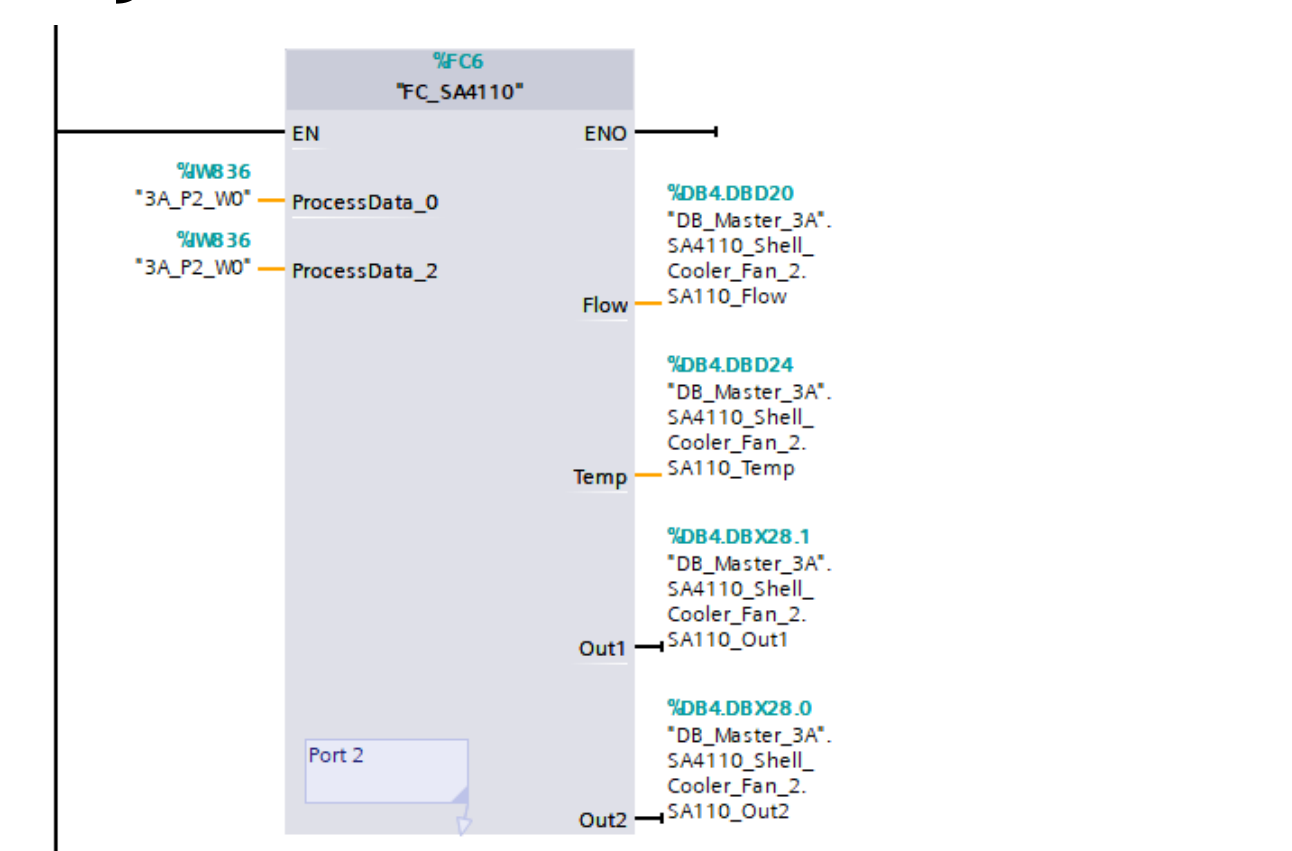


Sensor Layout



Programming Communication

Main (OB1)



In Main OB1, the function call blocks were added for each of the 83 sensors. This is where the data change from tag to type occurs.

Ignition Tag

All Properties

Property	Value
Name	Shell Cooler TR Fan Flow
Tag Group	Barline 09 CBM
Enabled	true
Value	
Value Source	OPC
Data Type	Float
OPC Server	Ignition OPC UA Server
OPC Item Path	[Barline CBM PLC 1]DB4.REAL20
Unit	
Scale Mode	Off
Engineering Units	cm
Engineering Low Limit	0.0
Engineering High Limit	100.0
Engineering Limit Mode	No Clamp
Format String	#.###

Tags were constructed to pull the output data from the PLC into Ignition for centralized data and analysis.

Acknowledgements

Lindt USA
 Controls Engineer - Dave Johnson
 Capital Manager Industrial Engineering - Bill Drumm
 Maintenance Techs - Dennis Olson and Richard Trimmer
 Sr R&D Manager - Emanuele Cavaglia
 Reliability Engineer - Johnathan Millet

Professors - LaCourse, Messner, and Smith

Contractors - Zajac and Florence Electric

