Documentation for the Small PLC Systems installed in USC55 gas room and SH5

The purpose of this document is to overview the main principles of the two small PLC systems installed and programmed by Nikolaos Chrysogelos. The first one was placed in USC 55 inside the gas room and the other one in SH5 and they were responsible for the monitoring of the Bulkhead dry gas quality. The operations, the implementation and the cabling of the PLCs are demonstrated and explained, while the problems that should be avoided are noted and the expansion capabilities of the systems are analysed.

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1. Mini PLC 1212C in the Gas room

1.1 Overview

A simple sketch of what was installed in the Gas Room is given below

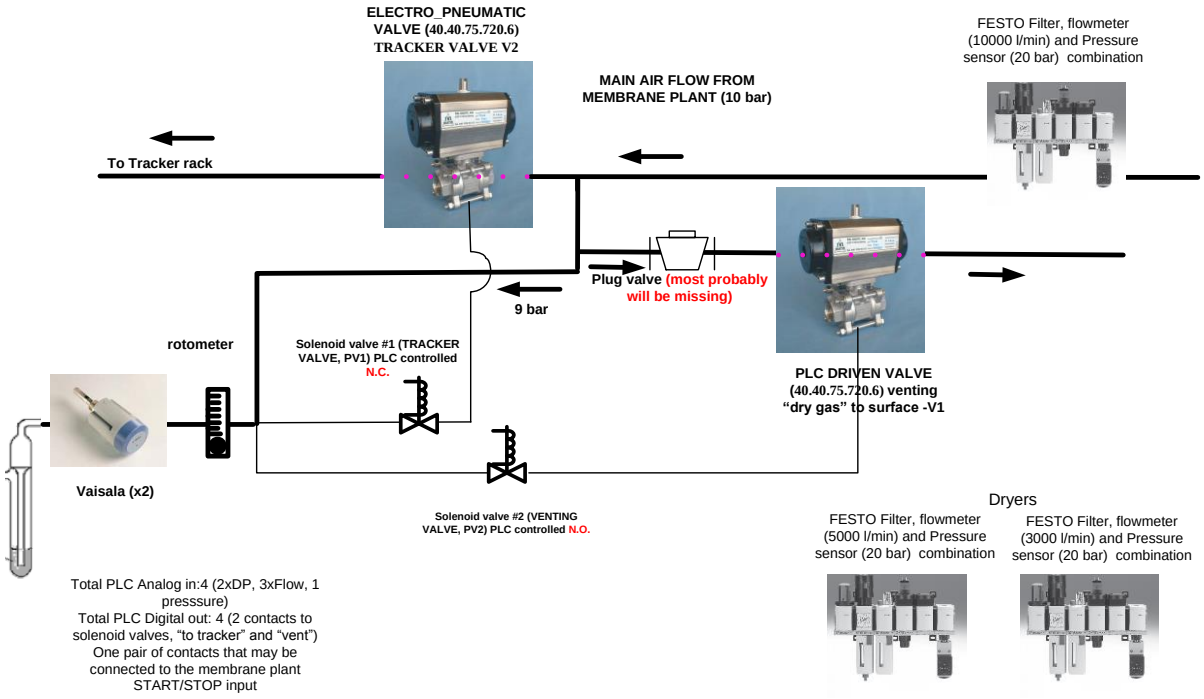

Figure 1. Overview of the system installed in the Gas room.

The new PLC System dedicated to monitoring the quality of the membrane plant outputs and the subsequent controlling of the electropneumatic valves that will allow or not the "dry gas" to enter the Tracker/Bulkheads will use the "small" SIMATIC S7-1200 controller and an accompanying SIMATIC HMI Touch Panel. The system will control/monitor having a total of 6 analogue inputs and 2 digital outputs driving the two electropneumatic valves, PV2, the Tracker Dry Gas valve and PV1, the purging valve. It is important to note that if the relay that drives the venting valve (PV1) is open, the venting valve lets the air flow (Normally Open) while if the relay that drives the Tracker valve (PV2) is closed the Tracker valve stops the gas from flowing in the Tracker (Normally closed). In the absence of power, the Tracker Valve will be Closed and the Venting Valve Open.

The main functionalities of the system are:

1. **Monitoring** , this includes the reading of the values:

Component	Company	Comments
Dry Gas DewPoint #1 (o C)	Vaisala #1	Two dewpoint sensors are used for redundancy
Dry Gas DewPoint #2 (o C)	Vaisala #2	
Pressure #3 (bar)	from the Festo Filter Block	
Flow 10000 #4 (l/min)	from the Festo Filter Block	
Flow 5000 #5 (l/min)	from the Festo Filter Block (Dryer #1)	
Flow 3000 #6 (l/min)	from the Festo Filter Block (Dryer #2)	

- The two Vaisala sensors/ Pressure sensor/ Flow 10000 sensor are measuring the dewpoint/ pressure/ flow of the total amount of Membrane Plant gas (air or nitrogen) going to the three new distribution racks in the Gas Room (and henceforth, to various places in the Tracker periphery).

- The Flowmeter 5000 measures the total flow of Instrument Air into the two Donaldson dryers, one serving the Tracker Inner Volume should the Membrane Plant fail, and one serving the "warm" Tracker cabinets (Cooling Plants essentially).

- The Flowmeter 3000 in fact measures a SUBSET of the flow of #5, since it only measures the flow of Instrument Air into the second Donaldson, the "warm" systems one. They were connected in what is some sort of a partial series arrangement because it would have been very difficult to connect one for each Donaldson. That is also why the different ranges.

2. **Automatic Actions** , when we are in automatic mode, controlling the Input to the Tracker (PV2) and the Venting (PV1) Valve; these are triggered if:

   - If DewPoint #1 OR DewPoint #2 are “too high” for a period longer than 30 seconds, then we close PV2 and open PV1

   - If the Pressure is “too high” for a period longer than 30 seconds we Open PV1 and leave PV2 as it has.

3. **Manual Actions** , when the Manual Mode is selected, we can control the two valves manually forcing them to open or close. In order to activate this mode a password is

required which is valid for **up to 20 minutes**. After the expiration of this time period, the system returns to automatic operation (Username= cms, Password=cms).

4. **Visualisation** , the Touch Panel will look like the figure below; we shall be able to visualize all sensor readings and the status of the valves (with a timestamp)

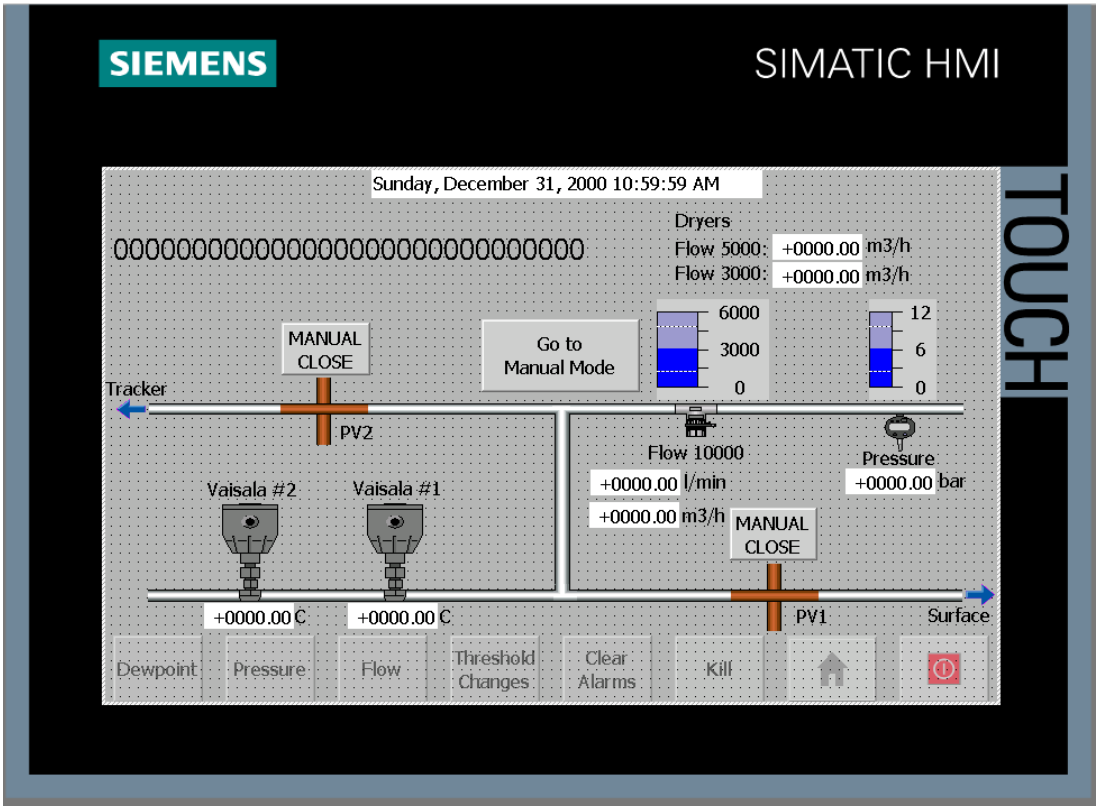

Figure 2. Home screen of the Touch Panel.

- For the Valve status,

If the Tracker valve (NC) will be Open there will be a vertical bar, otherwise a horizontal one.
If the Venting valve (NO) will be Open there will be a vertical bar, otherwise a horizontal one.

There will be an explanation string that:

STATUS PV2(Trk Gas)	STATUS PV1 (Vent)	Warning Message
OPEN	CLOSED	Dry Gas flowing!
OPEN	OPEN	Call expert!
CLOSED	CLOSED	Call expert!
CLOSED	OPEN	Gas venting! Notify expert!

- DewPoint / Pressure / Flow Trend: we will be able to visualize the Dewpoint / Pressure / Flow trend over a period of time (last hour).

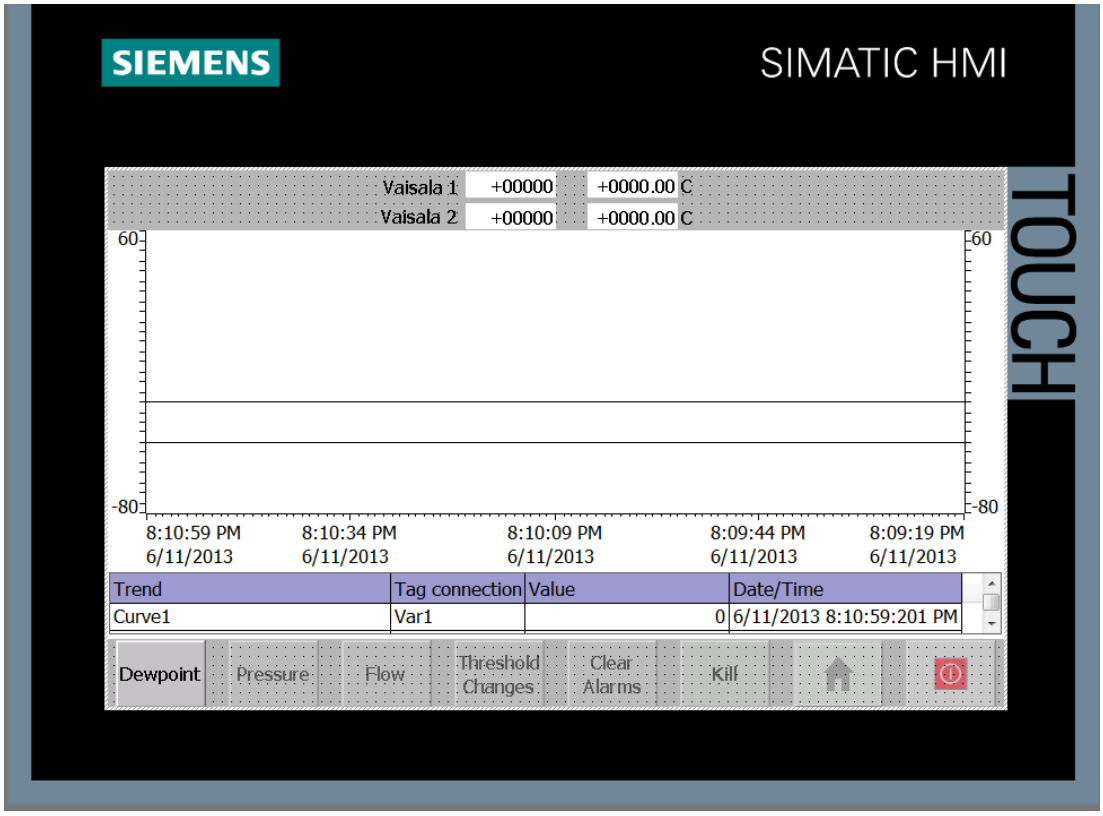

Figure 3. Dewpoint screen.

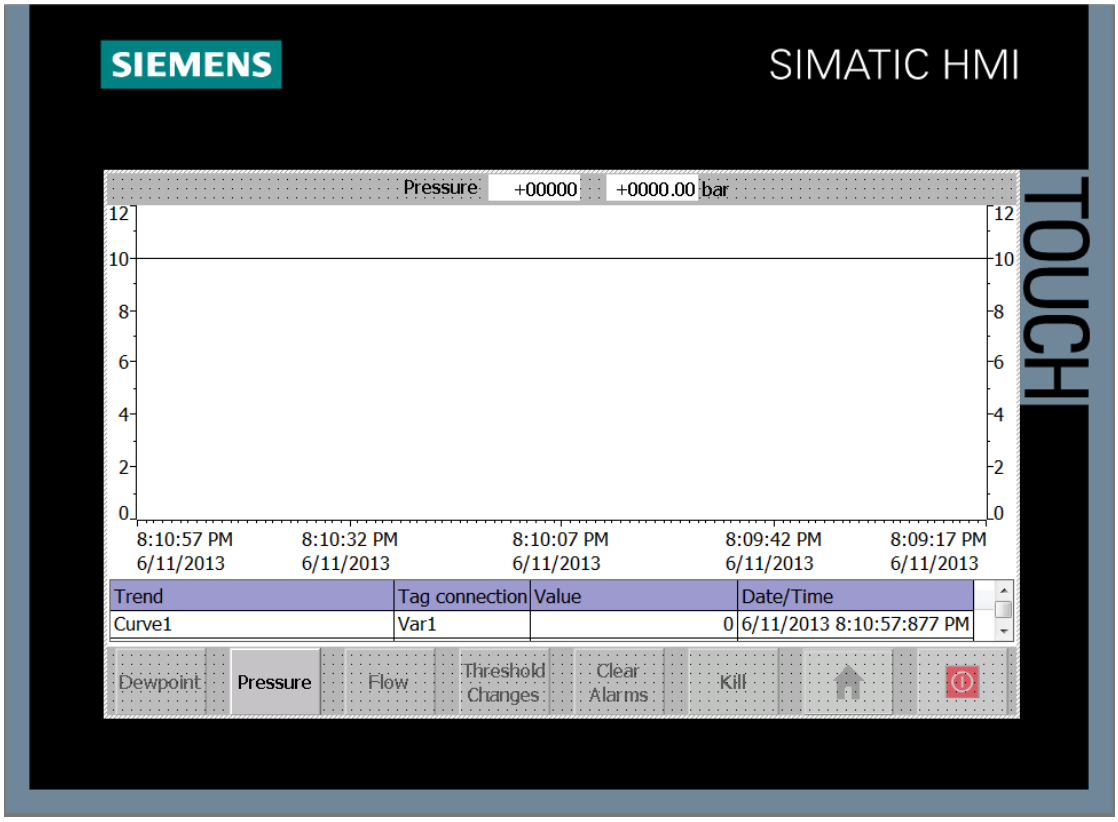

Figure 4. Pressure screen.

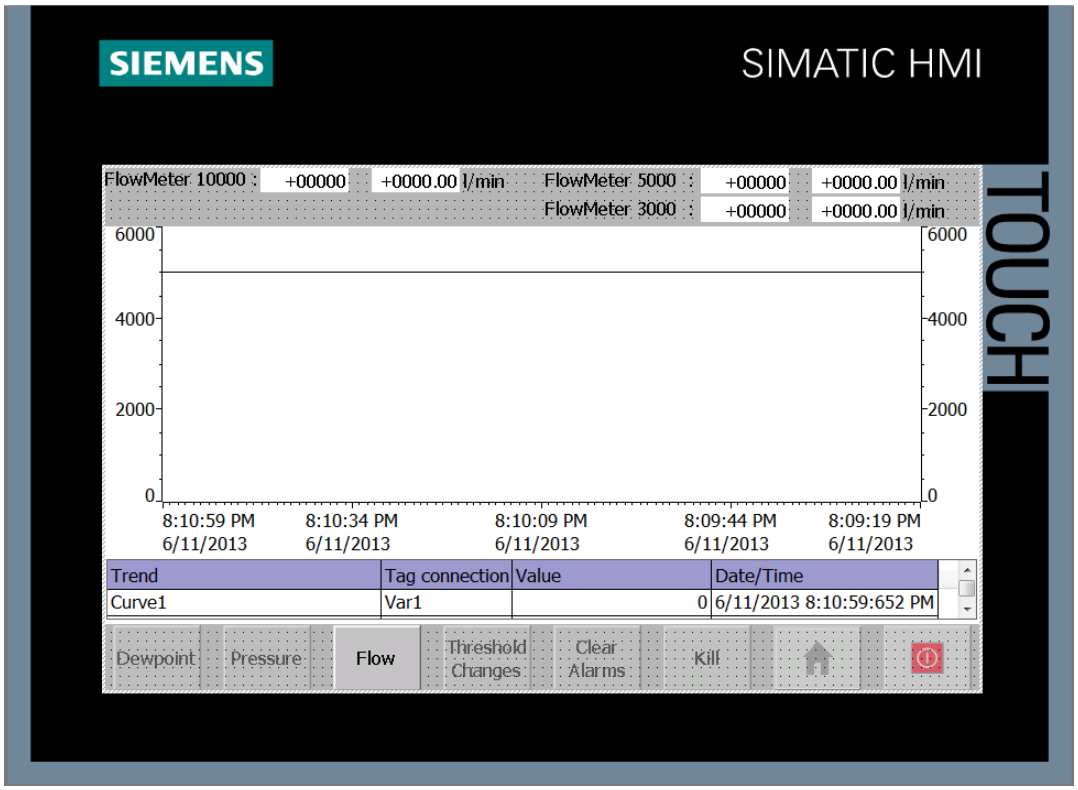

Figure 5. Flow meters screen.

- Threshold Changes: Activate/Change the min/max threshold values of the four sensors (Vaisalas, Pressure, Flow 10000), (under password-see below).

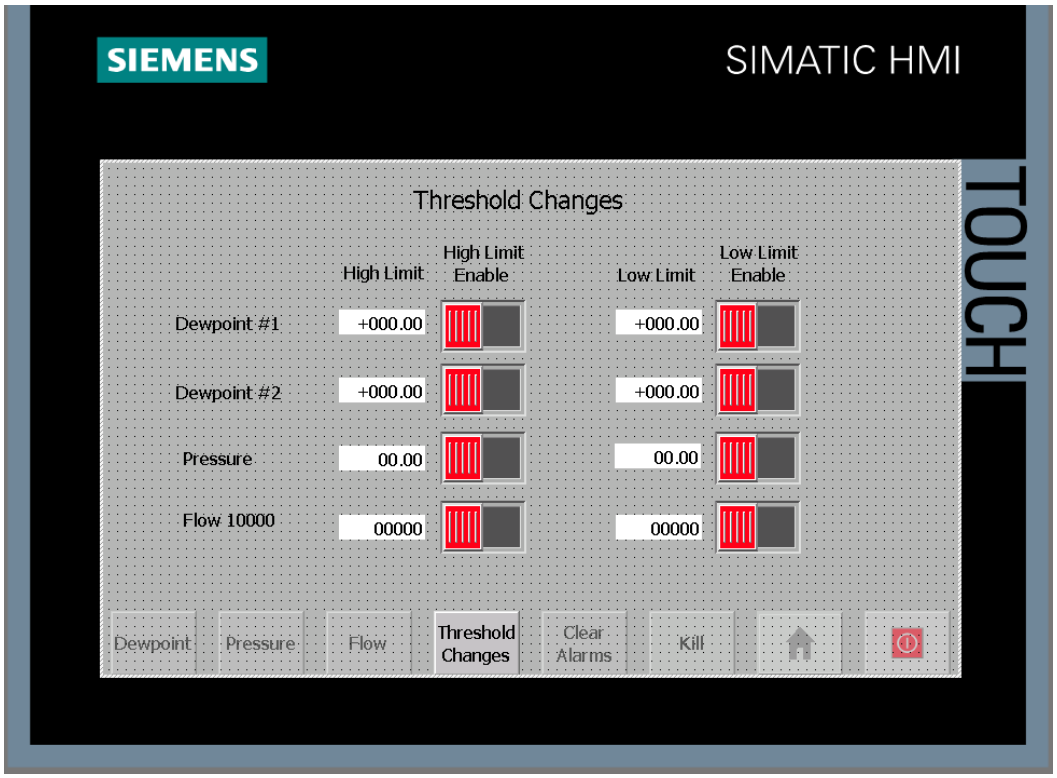

Figure 6. Threshold Changes screen.

- Clear Alarms: After the problems have been fixed, the alarms can be cleared by making use of a touch screen button. At this point, the system will return to the "normal" state (PV2 open, PV1 closed).
- Kill: immediate open of Tracker Valve and close of exhaust Valve. (under password- see below)
- Home: return to home screen which is showed above.
- Exit : exits the display program (the PLC program keeps on running)

5. **Publish Data to PVSS** , the PLC publishes the data (sensor reading + relay outputs) to the PVSS database.

   (There is no option for changing the status of the valves through PVSS, neither of changing the alarm limits)

DB400.DBW24	DewPoint #1
DB400.DBW34	DewPoint #2
DB400.DBW44	Pressure
DB400.DBW54	Flow

DB404	Tracker Relay driving PV1
DB404	Venting Relay driving PV2

- PVSS will be capable to send an "Acknowledge"/ "Kill" signal to the Membrane Plant PLC, which will have the same effect as the "Clear Alarms"/ "Kill" button on the touch-screen.

6. **Logging**, , this includes the logging of the data (sensor reading + relay outputs) in the int9r_lb.CMS_TRK_RHTH.MEMBRANE_PLANT database every **1 minute** as well as in the USB device placed in the HMI screen every **10 seconds**.

7. **Changes Under Password Control**, possibility to change the following values from the Touch Panel and the PVSS Gas Menu under strict password control (Username= cms, Password=cms).

   - Activation/Deactivation/Change DewPoint #1 Threshold (max, min)
   - Activation/Deactivation/Change DewPoint #2 Threshold (max, min)
   - Activation/Deactivation/Change Pressure Threshold (max, min)
   - Activation/Deactivation/Change Flow 10000 Threshold (max, min)

- Force Open/Close of PV1
- Force Open/Close of PV2
- KILL push button – it forces PV2 closed and PV1 open

The option for the force Open/Close of the valves is activated after the press of the Manual Button which leads to manual operation which lasts up to 20 minutes and then it returns to Automatic mode.

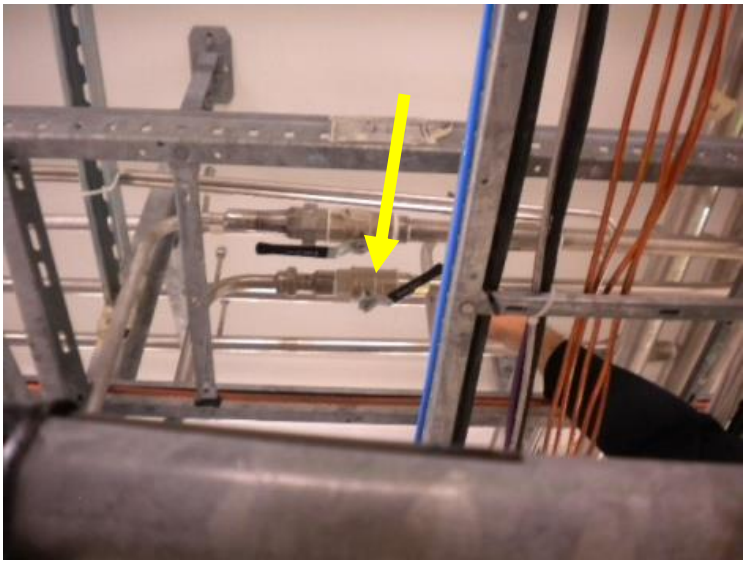

Figure 7. The manual valve should be open for letting gas in the Tracker lines.

Figure 8. Tracker Gas valve (PV2) on the left, Purge Valve (PV1) on the right. The read manual valve should also be opened.

Action matrix		
Condition		
DP1 ≥TH1.OR.DP2 ≥ TH2	**PV2 CLOSED, PV1 OPEN**	**Close input to Tracker, open purge**
Pressure ≥ THp	**PV2 CLOSED**	**Close input to Tracker, leave purge as it is**
No Power	**PV2 CLOSED, PV1 OPEN (?). This is NOT implemented via the PLC but through the wiring of the electrovalves driving the pneumatics.**	**Close input to Tracker, open purge**

- **When the power is restored and provided no alarms are running, the system will go to the "default" state (i.e. PV2 (Gas inlet to the Tracker) open, PV1 (purge) closed).**
- **Alarms can be acknowledged and if they do not occur again, the system will go to the "default" state.**
- **The status of the PV2 valve will depend on the functionality button.**

1.2 Implementation

The overview of the PLC system which was installed in the gas room is shown in the following picture, where the red box indicated as 1 is the PLC controller accompanied by two analogue input modules, blue box 2 is the HMI touch screen interacting with the user and brown box 3 is the protection box in which there is the cabling required for the application.

Figure 9. Overview of the PLC System.

While the two different power supplies used for redundancy are the following;

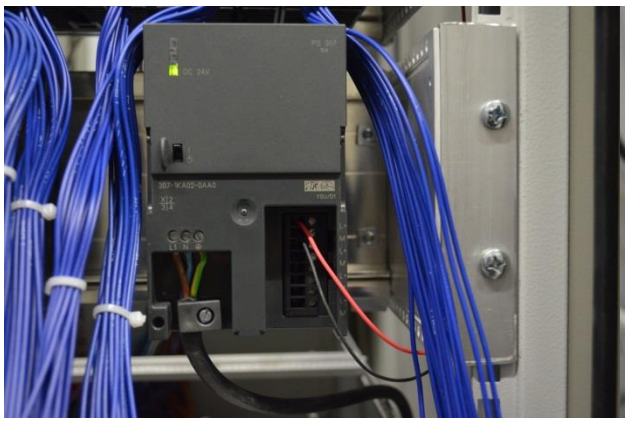

Figure 10. Power Supply 2 used for the sensors.

Figure 11. Power Supply 1 used for the PLC and screen.

A switch is also used in order to implement a connection between the PLC 1212C, the screen and the PVSS.

Figure 12. Switch on the top of the rack.

4 ethernet cables are used;

- for the PLC 1212C,
- for the HMI screen,
- for the connection of the switch to the outlet 9516/01 and
- a temporary one for connection to a PC for software modifications.

For this, IP addresses were requested for each device from the network service of CERN.

PLC 1212C DC/DC/DC	
Device Name	PLCCMTDRYGAS
Location	3524 E-0000
Serial Number	ZVA3YXX004766
IP Address	10.176.2.158
Network Interface Card	00-1C-06-12-9E-CE
Outlet	9516/01

HMI screen	
Device Name	DISPLAYCMTGAS
Location	3524 E-0000
Serial Number	C-D4F66597
IP Address	10.176.2.157
Network Interface Card	00-1B-1B-5A-E4-10
Outlet	9516/01

Pictures of the sensors are also presented,

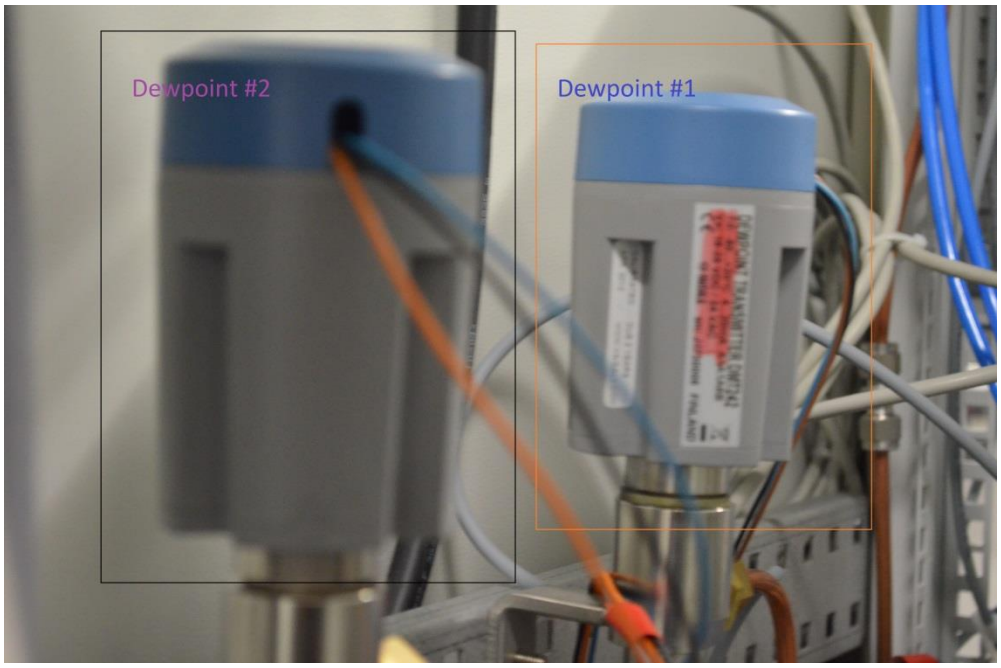

Figure 13. Vaisala sensors for dewpoint measurements.

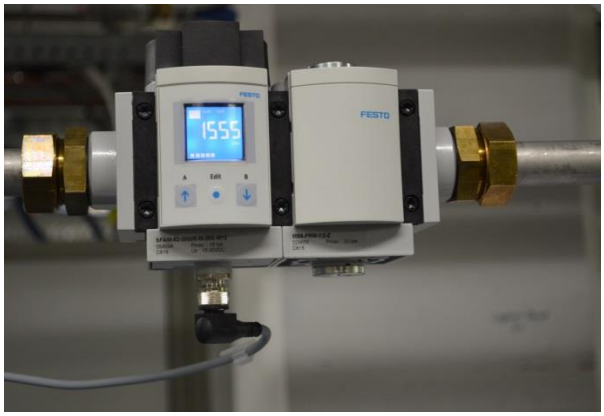

Figure 14. Flow 3,000 l/min measurements from the Festo Filter block.

Figure 15. Flow 5,000l/min measurements from the Festo Filter block.

Figure 16. Pressure and flow 10,000 l/min measurements from the Festo filter block

Figure 17. Tracker and Exhaust electric Valves

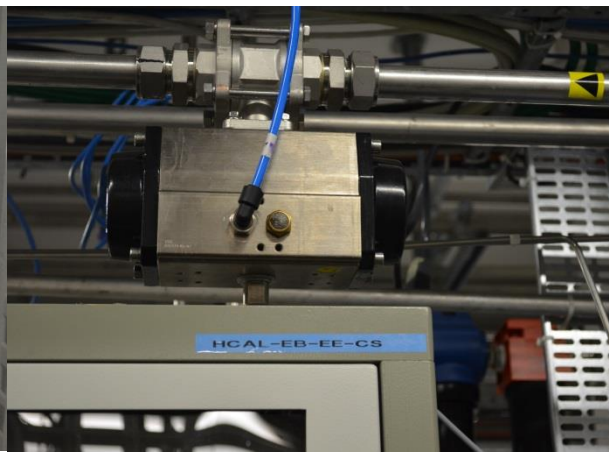

Figure 18. Example of one electropneumatic valve

In the following sections the various parts of the above system are analysed.

1.2.1 PLC system

Figure 19. PLC system used for the application. PLC 1212C and 2 analogue input signal modules are demonstrated.

The Simatic S7-1200 controller series was used and specifically the *CPU 1212C DC/DC/DC* with order No *6ES7 212-1AE31-0XB0*. On the table below you can see its specifications.

Feature		**CPU 1212C**
Physical size (mm)		90 x 100 x 75
User Memory	Work	50 Kbytes
	Load	1 Mbyte
	Retentive	10 Kbytes
Local on-board I/O	Digital	8 inputs/ 6 outputs
	Analog	2 (Voltage) inputs
Process image size	Inputs (I)	1024 bytes
	Outputs (Q)	1024 bytes
Bit Memory (M)		4096 bytes
Signal module (SM) expansion		2
Signal board (SB), Battery board (BB), or communication board (CB)		1
Communication module (CM) (left-side expansion)		3

High-speed counters	Total	4 built-in I/O, 6 with SB
	Single phase	3 at 100 kHz 1 at 30 kHz SB: 2 at 30 kHz
	Quadrature phase	3 at 80 kHz 1 at 20 kHz SB: 2 at 20 kHz
Pulse outputs		4
Memory card		Simatic Memory card (optional)
Real time clock retention time		20 days, typ. / 12 day min. at 40 degrees C (maintenance-free Super Capicator)
PROFINET		1 Ethernet communication port
Real math execution speed		2.3 µs/instruction
Boolean execution speed		0.08 µs/instruction

*More info in s71200_system_manual_en-US_en-US.pdf

Moreover, two Signal Modules were also added to the main PLC controller in order to read analogue inputs from 2 dewpoint, 3 flow, and 1 pressure sensor.

Technical Data	**SM 1231 AI 4 (13 bit)**
Order Number	6ES7 231-4HD30-0XB0
Number of inputs	4 inputs (AI)
Type	Voltage or current (differential), Selectable in groups of 2
Dimensions W x H x D (mm)	45 x 100 x 75
Weight	180 grams
Power dissipation	1.5 W
Current consumption (SM Bus)	80 mA
Current consumption (24 VDC)	45 mA

* More info in specificationss1200.pdf

As can be seen the full expansion capability was employed which is up to 2 SM modules. If in the future, more than two analogue inputs will be added then an upgrade to the type of Signal module 1231 (AI 8) should be done so that they can satisfy the new requirements. Take into account that a Signal Board may also be used but it can only support up to one digital I/O.

The software that was used is the TIA Portal v12 as it is the only one that supports the new PLC 1212C. More details on the program implementation can be found at G:\Projects\CMSTSS\Gas Room\Gas_MonitorSystem_Point5_v2 which is commented for this reason.

Component	PLC Hardware	PLC Software
Vaisala #1	SM (1) AI[0]	Sensors.PLCData[1]
Vaisala #2	SM (1) AI[1]	Sensors.PLCData[2]
Pressure Sensor	SM (1) AI[2]	Sensors.PLCData[3]

Flow Sensors 10,000 l/min	SM (1) AI[3]	Sensors.PLCData[4]
Flow Sensors 5,000 l/min	SM (2) AI[0]	Sensors.PLCData[5]
Flow Sensors 3,000 l/min	SM (2) AI[1]	Sensors.PLCData[6]
Electric Valve 1 == Tracker Valve == PV2	Q 0.2	Relays. PLCData[2]
Electric Valve 2 == Exhaust Valve == PV1	Q 0.0	Relays. PLCData[1]

Converted values

Vaisala[i] = 0.0045211 * SensorCounts[i] – 105 , i=1,2 , [-80..+20] C

Pressure = 0.00072338 *SensorCounts[3] – 4 [0 .. +10] bar

Flow Sensor 10,000 = 0.45211 * SensorCounts[4] – 2500 [0.. 10,000]l/min
Flow Sensor 10,000 = 0.02713 * SensorCounts[4] – 150 [0.. 600] m^3/h

Flow Sensor 5,000 = 0.22606 * SensorCounts[5] – 1250 [0.. 5,000]l/min
Flow Sensor 5,000 = 0.01356 * SensorCounts[5] – 75 [0.. 300] m^3/h

Flow Sensor 3,000 = 0.1356 * SensorCounts[6] – 750 [0.. 3,000]l/min
Flow Sensor 3,000 = 0.0081 * SensorCounts[6] – 45 [0.. 180] m^3/h

More details on the PLC database blocks for internal or PVSS use may be found in (*) or in the program itself (G:\Projects\CMSTSS\Gas Room\Gas_MonitorSystem_Point5_v2).

The data from the PLC for PLC_ID=81 -Date, Analogue signals from all the sensors [RAW 1-6], the status of the Digital Outputs- are logged in the int9r_lb.CMS_TRK_RHTH.MEMBRANE_PLANT database every one minute and to the usb in the screen every 10 seconds. According to the detail that is needed you can retrieve the data from both sources.

Finally, during the testing of the PLC, it was noticed that the digital output **Q0.1 is damaged** although the led was working normally. That's why it is proposed either this DOutput not to be used in the future or change of the complete PLC 1200.

1.2.2 HMI screen-Touch Panel

The HMI screen is shown below. The options of the HMI screen were analysed in the first section and are also explained here,

- Time and Date on the top of the screem
- Helping message to the user according to the status valve
- Dewpoint / Flow / Presure sensors which correspond to the analog input #1 - #6 of the PLC
- Manual/Automatic Mode button for the suitable operation. Password is required!
- Dewpoint / Pressure / Flow buttons provide plots for the measurements during the last hour as well as the raw value readings (current in mA).
- Threshold Changes button, in order to change/activate the min/max values of the sensors on which there will be an alarm and trigger an alarm
- Clear Alarms, if everything is ok the user may clean all the alarms
- Kill button, for immediate open of PV2 and close of PV1. Password is required!
- Home button, to return to the default screen (the one that is below)
- Exit button, to exit the program (the values of the PLC are not affected – we just stop the visualisation)

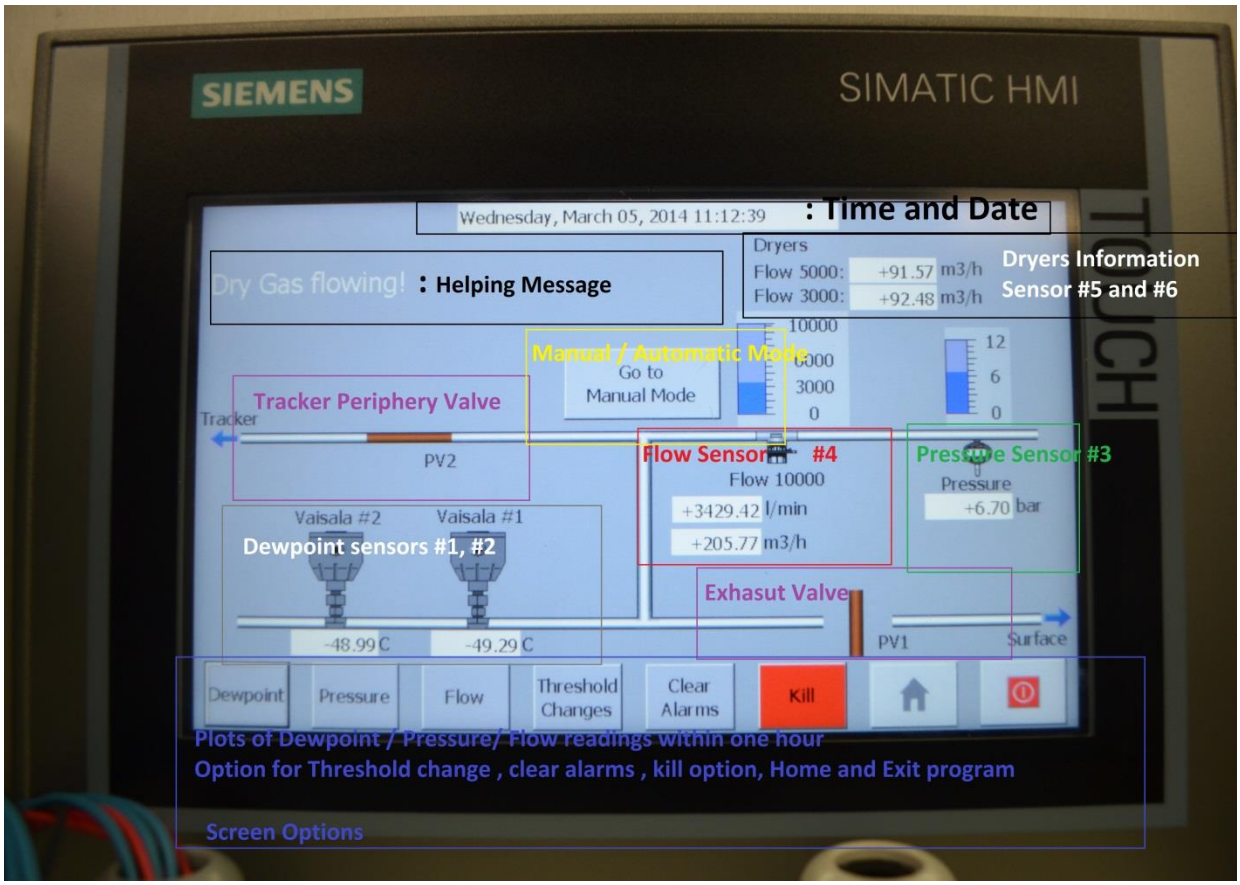

Figure 20. An explaining picture of the Home screen.

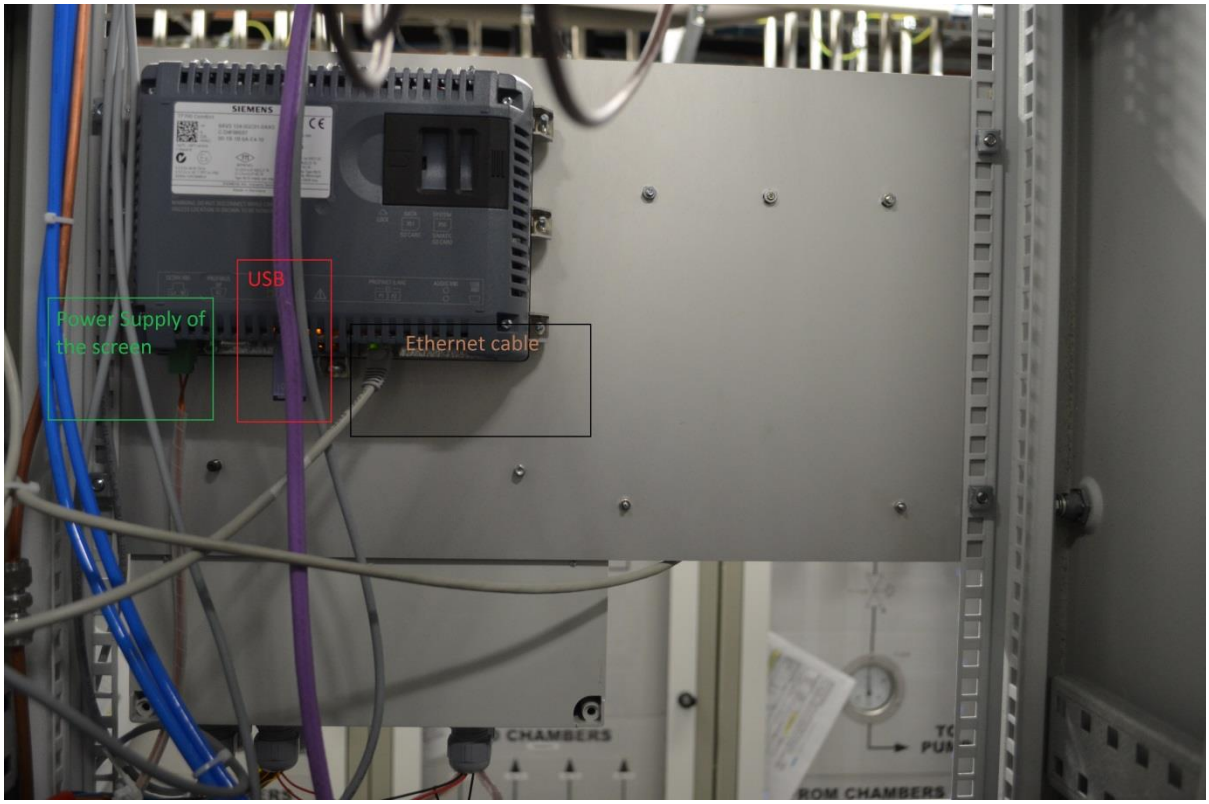

Figure 21. A back picture of the screen and its components.

The HMI screen that was used is the TP700 Comfort, which is 7 inches. Details may be found in Hmi_comfort.pdf

It is noted that the manual mode lasts for up to 20 minutes. With the expiration of this time period the system returns to automatic mode! In this case you have to enter again the username and password to obtain administrative privileges.

Username	cms
Password	cms

As can be seen the data is not only logged in a database but also to a USB device (8GB). So, in case of failure of logging the data in the database (which normally shouldn't happen) or in case that more details are needed since it logs the data every 10 seconds on contrary to the database (1minute) they can also be retrieved by this USB. The user should check every two months about the capacity of the device so as not to be exceeded which would cause loss of data. **Also one problem that was noticed is that after disconnecting and connecting the USB a restart (or even a re-download) of the program of the HMI screen was required as it couldn't find the start of the file that it should write and no data was logged on it.**

1.2.3 Cabling

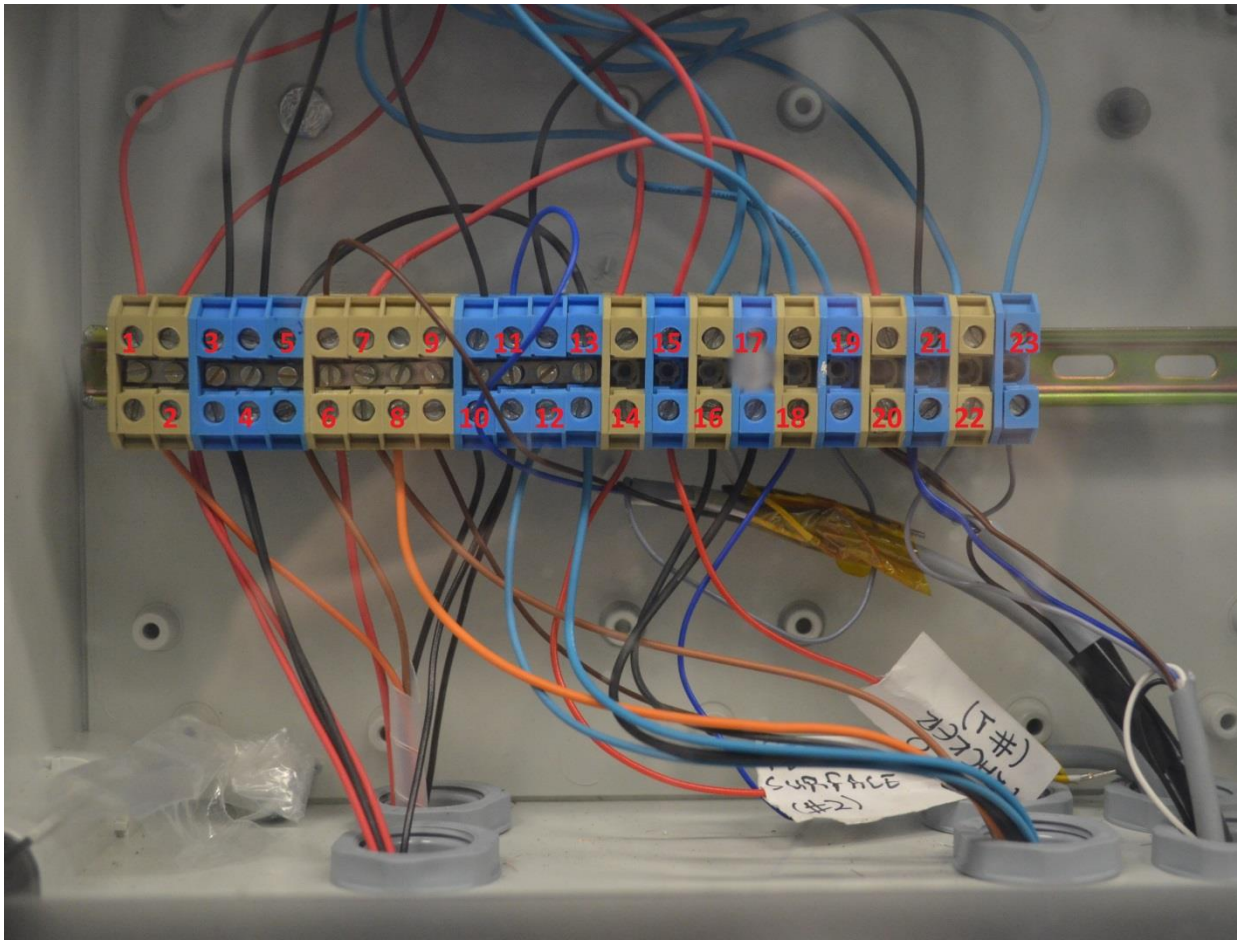

Figure 22. An overview of the Weidmillers inside the safety box.

First we note that two separate power supplies were used. One for the PLC and screen themselves and one for the sensors so that in case of failure or short-circuit of one of the sensors, then the PLC will continue to work as expected.

It is also noted that all the AI[0-3]- as well as the ground of each sensor are connected to the common ground of the two power supplies. The two analogue input signal modules are powered by the extra power supply that the PLC 1212C has.

The safety box that was used is the MNX PCM 200/100 XT produced by Fibox. Its dimensions are 255x180x100 (mm), and the rail that was placed inside is 19cm long. So, up to 30 weidmillers may be installed. On this application we used 23 which means that there is still place for 8 more in the future.

Feature	**MNX PCM 200/100 XT by FIBOX**
Physical size (mm)	255 x 180 x 100
Holes on the top/bottom	One in the center and 8 symmetrically placed right and left from it

* More details may be found in [0900766b81111620.pdf]

On the following table, the cabling for each Weidmiller is provided.

Weidmiller (W/M)	Component	Comments
1 and 2	-Power Supply 1 (24Volts), + -+ source of the screen -+ source of the PLC 1212C -+ source of the Digital Output	The + of the PLC 1212C and HMI screen are connected. Also the + source of the Digital Outputs on the bottom of the PLC
3-5	-Power Supply 1 (0 Volts), - - - source of the screen - - source of the PLC 1212C - - source of the Digital Output	The ground of the PLC 1212C and HMI screen are connected. Also a short-circuit between the ground of the two power supplies is done.
6-9	Power Supply 2 (24 Volts), +	The + source of the two Dewpoint (brown -> #1 Dewpoint and orange -> #2 Dewpoint wires), one Flow 10000 l/min (brown wire), one Pressure (brown wire) sensor.
10-13	Power Supply 2 (0 Volts), -	The ground of the two Dewpoint (blue wires), one Flow (blue wire). (Pressure sensor doesn't have ground wire) Also the ground of the two electric valves are connected here.
14	Q0.0	The exhaust valve
15	Q0.2	The tracker valve
16	SM 1231 AI (1) 0+	The SensorCounts of the Dewpoint sensor #1 (black wire)
17	SM 1231 AI (1) 1+	The SensorCounts of Dewpoint sensor #2 (black wire)
18	SM 1231 AI (1) 2+	The SensorCounts of Pressure senso #3 (blue wire)
19	SM 1231 AI (1) 3+	The SensorCounts of Dewpoint sensor #4 (grey wire)
20	Short circuit with 6-9, Power Supply 2 (24 Volts), +	Because the + cable for the flow sensors 5000 l/min (brown) and 3000 l/min (brown) was too small an extra + Weidmiller was added to connect them

21	Short circuit with 10-13, Power Supply 2 (0 Volts), -	Because the - cable for the flow sensors 5000 l/min (blue) and 3000 l/min (blue) was too small an extra - Weidmiller was added to connect them
22	SM 1231 AI (2) 0+	The SensorCounts of Flow sensor 5000 l/min #5 (grey wire)
23	SM 1231 AI (2) 1+	The SensorCounts of Flow sensor 3000 l/min #6 (grey wire)

Just for further clarification, the colour and the operation of each wire of the sensors is provided below,

Sensor	**Colour**	**Operation**
Dewpoint #1	brown	+ 24Volts
	blue	0 Volts
	black	Signal
Dewpoint #2	orange	+ 24Volts
	blue	0 Volts
	black	Signal
Pressure #3	brown	+24Volts
	blue	Signal
Flow sensor 10000 l/min	brown	+ 24Volts
	blue	0 Volts
	grey	Signal
Flow sensor 5000 l/min	brown	+ 24Volts
	blue	0 Volts
	grey	Signal
Flow sensor 3000 l/min	brown	+ 24Volts
	blue	0 Volts
	grey	Signal

The signal wire of each sensor should be connected to the respective AI [0-3]+ of each signal module. The plus wire of each sensor to the plus source of the power supply 2 and the ground wire to the ground source of power supply 2 (in case of the pressure sensor there is no ground wire). The grounds of the two power supplies are essential to be short-circuited.

The grounds of the two electric valves are connected to the common ground, while the signal cable to the digital output.

1.2.4 Conclusions

PLC Used		1212C DC/DC/DC
Power Supplies		Two in total: One for the PLC and one for the sensors (the y have common ground)
HMI Screen		TP 700 Comfort
Publish/Log Data		• PVSS • USB device (every 10 seconds) • int9r_lb.CMS_TRK_RHTH.MEMBRANE_PLANT (every 1 minute), PLC_ID=81
Digital Inputs of the installed system	Total	8
	Used	0
	Future Use	8
Digital Outputs of the installed system	Total	6
	Used	2 + 1 damaged
	Future Use	3
Analog Inputs of the installed system	Total	8
	Used	6
	Future Use	2
Weidmillers	Total	23
	Used	23
	Future Use	8: May be installed in the current box up to 8 more.
Sensors	Total	6
	Used	2x Vaisalas, 1x Pressure + 1x Flow 10,000 l/min from Festo Filter Block, 1x Flow 5,000 l/min from Festo Filter Block, 1x Flow 3,000 l/min from Festo Filter Block
	Future Use	with the current Signal Modules up to 2 more AI may be used. Possibility of upgrading to SM 1231 with 8 AI and/or addition of a Signal Board 1231 (1 more AI)

2. Mini PLC 1212C in SH5

2.1 Overview

A simple sketch of what was installed in the Gas Room is given below

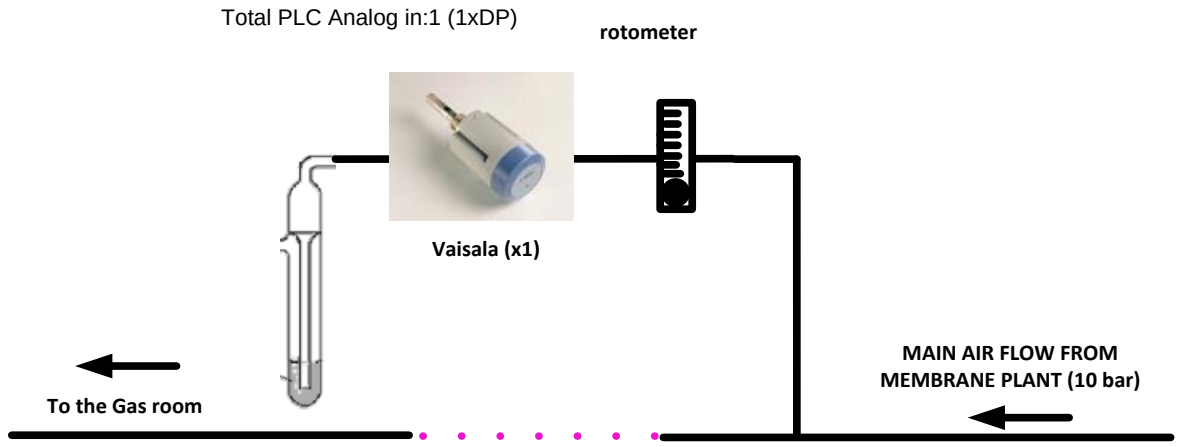

Figure 23. Overview of the system installed in SH5.

The new PLC System dedicated to monitoring the dewpoint (at the moment) of the membrane plant outputs will also use the "small" SIMATIC S7-1200 controller. The system will monitor having a total of 1 analogue input the "dry gas" quality of the plant.

Its main (and only for now) operation is the measuring of the dewpoint of the gas straight after its output from the membrane plant in SH5 and before it will be directed to the gas room.

Moreover, we can detect the following simple utilities of this PLC system;

1. **Logging** , this includes the reading and the logging in the int9r_lb.CMS_TRK_RHTH.MEMBRANE_PLANT database the value:

Component	Company
Dry Gas DewPoint #1 (° C)	Vaisala #1

- The Vaisala sensor is measuring the dewpoint of the total amount of Membrane Plant gas (air or nitrogen) going to the three new distribution racks in the Gas Room (and afterwards, to various places in the Tracker periphery).

2. **Publish Data to PVSS** , the PLC publishes the data (sensor reading) to the PVSS database.

DB400.DBW24	DewPoint #1

2.2 Implementation

The overview of the PLC system which was installed in SH5 is shown in the following picture, where the Power Supply of the system, the PLC 1212C DC/DC/DC, the Ethernet cable, the dewpoint sensor and the rotometer are demonstrated.

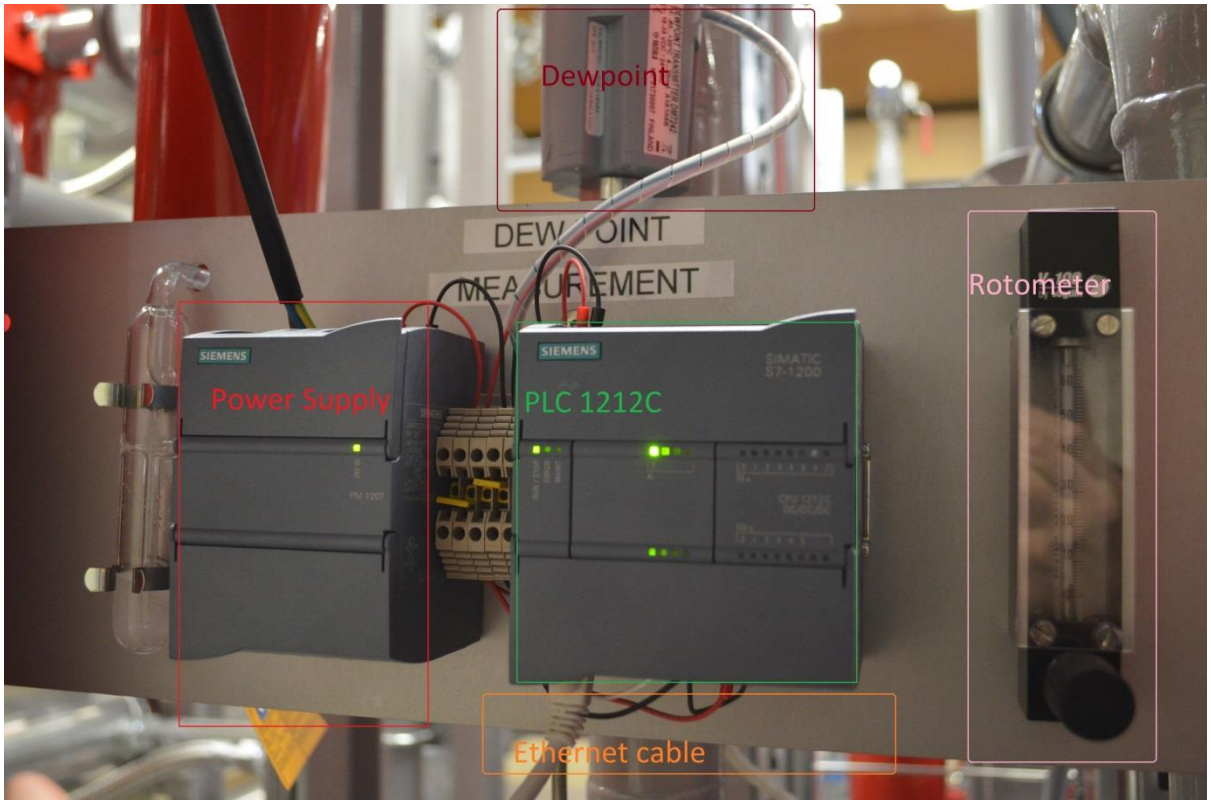

Figure 24. Overview of the PLC system installed in SH5.

The system was placed in a DIN rail 20cm length which allows a Power Supply PM 1207, a 1200 PLC and up to 6 weidmillers to be connected to it.

A switch is also used in order to implement a connection between the PLC 1212C, the int9r_lb.CMS_TRK_RHTH.MEMBRANE_PLANT and PVSS database.

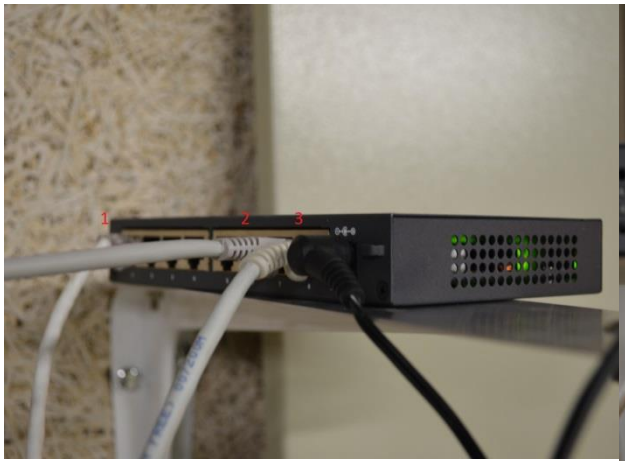

Figure 25. Back picture and connection of the switch in SH5.

Figure 26. Front picture of the switch in SH5.

3 Ethernet cables are used in total by the switch;

- For the PLC 1212C
- For the local computer installed in SH5 (PCCMTSCS6) which can be used to reach the PLC in order to check/change its data/software
- For connection to the outlet 0112/02

For this, IP addresses were requested for each device from the network service of CERN.

PLC 1212C DC/DC/DC	
Device Name	PLCSH5
Location	3584 R-00H8
Serial Number	ZVD2YEC012O1O
IP Address	10.176.91.137
Network Interface Card	00-1C-06-12-9E-8C
Outlet	0112/02

Finally a picture of the dewpoint installed is given.

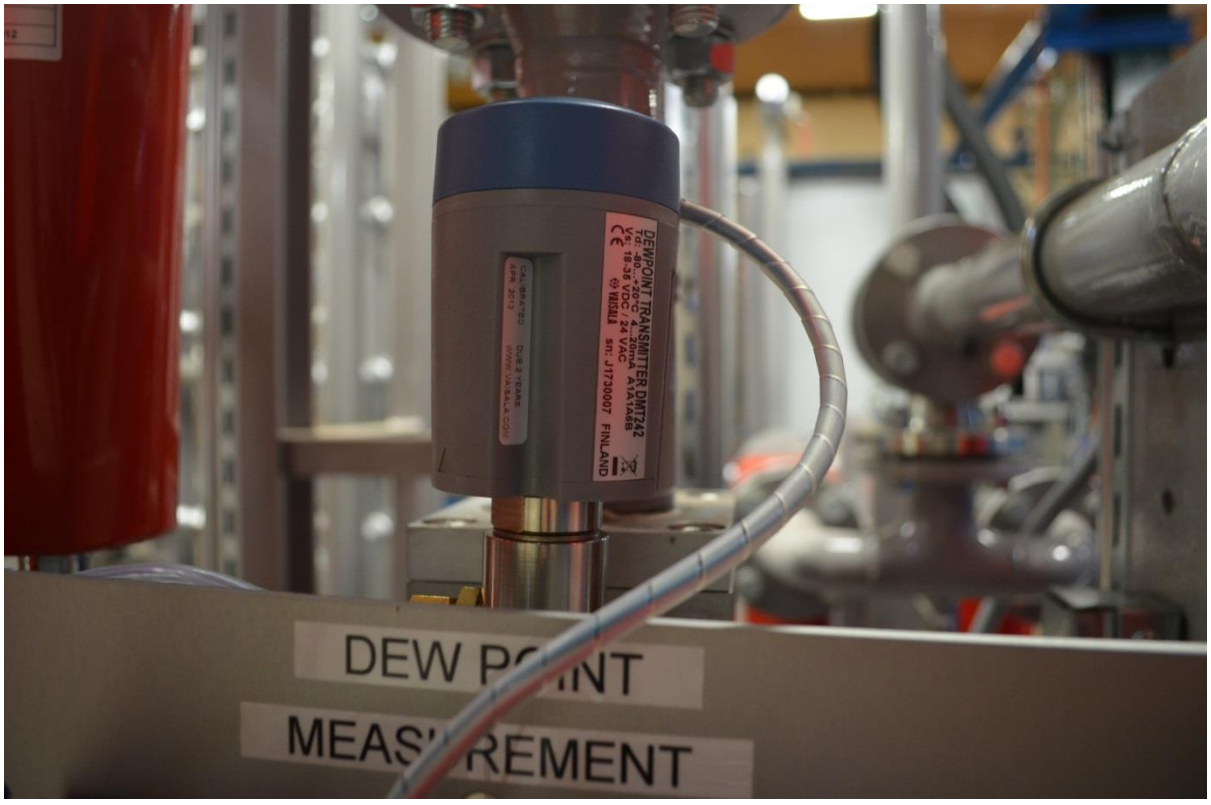

Figure 27. Dewpoint sensor in SH5.

2.2.1 PLC system

The Simatic S7-1200 controller series was used and specifically the *CPU 1212C DC/DC/DC* with order No *6ES7 212-1AE31-0XB0*. More details can be found on the previous chapter as the same PLC was used.

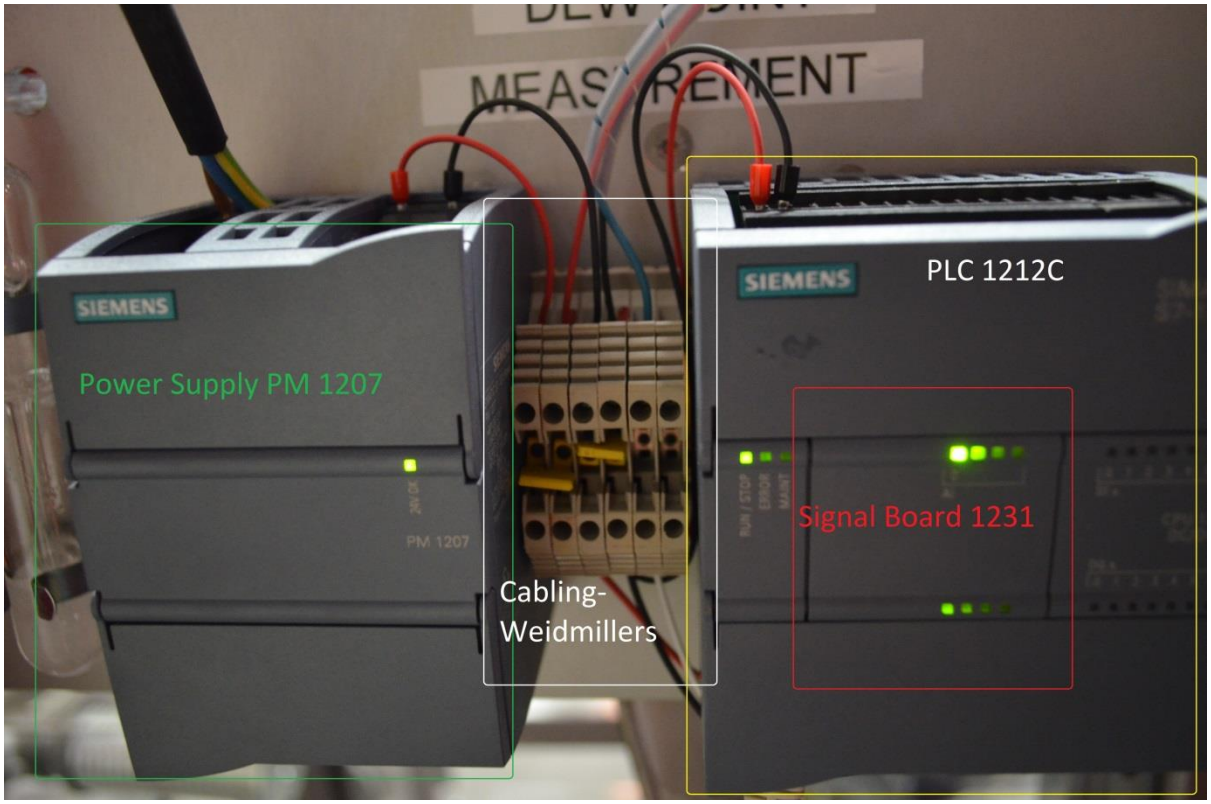

Figure 28. Power supply, PLC controller, Signal Board, cabling.

So the system disposes 8 digital inputs and 6 digital outputs which are all free.

As can be seen in order to read out the sensor an analogue input was required, that's why a Signal Board 1231 AI was used.

Technical Data	**SB 1231 AI 4 (12 bit)**
Order Number	6ES7 231-4HA30-0XB0
Number of inputs	1 input (AI)
Type	Voltage or current (differential)
Dimensions W x H x D (mm)	38 x 62 x 21 mm
Weight	35 grams
Power dissipation	0.4 W
Current consumption (SM Bus)	55 mA
Current consumption (24 VDC)	None

More info may be found in specification s1200.pdf

A wiring diagram for the analog SB is also given

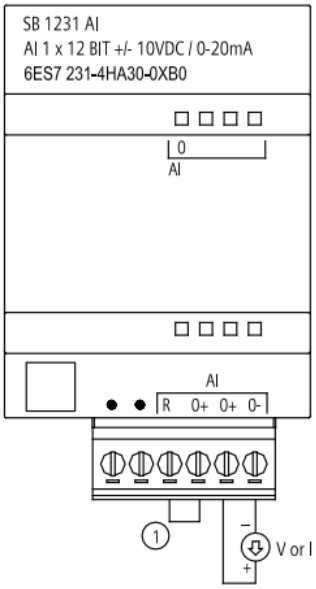

Figure 29. A wiring diagram for the analog SB.

Since all the analogue inputs of the system are used (only one is available from the SB 1231 which is dedicated to the dewpoint sensor), if in the future more analogue inputs will be used then signal modules should be added.

In a first trial a power supply less than 60W was used which was not enough for our system. So, in the end one SIMATIC S7-1200 PM 1207 was placed on the rail which reduced a lot the space for future weidmillers.

Technical Data	**SIMATIC S7-1200 PM 1207**
Order Number	6EP1 332-1SH71
Rated Input Voltage	120/230 V AC
Rated Input Current	1.2/0.67 A
Rated Output Voltage	24 V DC
Rated Output Current	2.5 A
Efficiency (at rated values)	83%
Power losses	12W

*More details may be found in simatic_st70_chap04_english_2011.pdf

The software that was used is the TIA Portal v12 as it is the only one that supports the new PLC 1212C. More details on the program implementation can be found at G:\Projects\CMSTSS\Gas Room\Gas_MonitorSystem_SH5@SH5 which is commented for this reason.

Component	**PLC Hardware**	**PLC Software**
Vaisala #1	SB 1231 AI[0]	Sensors.PLCData[1]

Converted values

Vaisala[i] = 0.0045211 * SensorCounts[i] – 105 , i=1,2 , [-80..+20] C

The data from the PLC for PLC_ID=82 -Date, Analogue signal from the Vaisala [RAW 1] - is logged in the int9r_lb.CMS_TRK_RHTH.MEMBRANE_PLANT database every one minute. Possibitily of publishing the data in PVSS (when it will be connected to the PLC in SH5). No usb device in this application.

2.2.2 Cabling

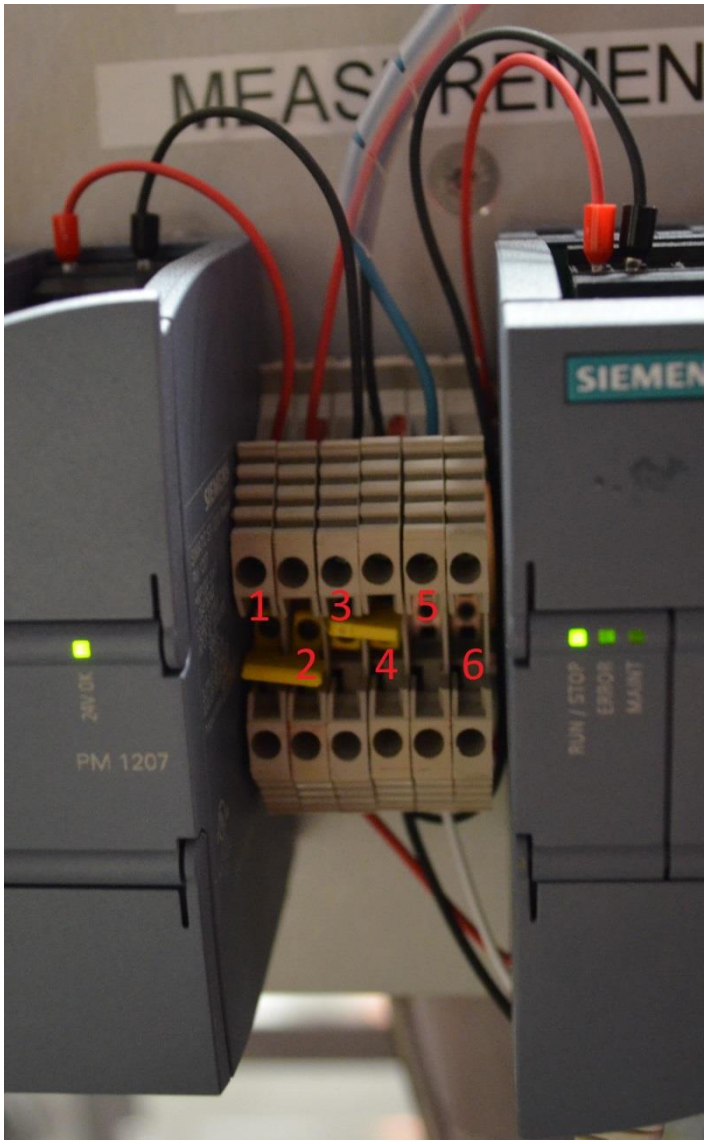

Figure 30. An overview of the Weidmillers used.

The cabling on this case was very simple and straightforward as we only have one sensor. The rail that was used is 20cm long which in combination with the power supply and the PLC allows up to 6 weidmillers to be connected.

It is noted that for this application, only one Power Supply is used which means the same for the PLC and the Vaisala sensor.

On the following table, the cabling for each Weidmiller is provided.

Weidmiller (W/M)	Component	Comments
1 and 2	-Power Supply 1 (24Volts), + - + source of the PLC 1212C - + side of the sensor - + side of the Digital Output	The + of the PLC 1212C and the dewpoint sensor (red wire) are connected. Also the + source of the Digital Outputs on the bottom of the PLC (for future use).
3 and 4	-Power Supply 1 (0 Volts), - - - source of the screen - - source of the PLC 1212C - - source of the Digital Output	The ground of the PLC 1212C, dewpoint sensor (black wire), ground source of the DOutputs of the PLC are connected.
5	SB 1231 AI (1) 0+	The SensorCounts of the Dewpoint sensor #1 (blue wire)
6		Future Use

Just for further clarification, the colour and the operation of each wire of the sensor is provided below,

Sensor	**Colour**	**Operation**
Dewpoint #1	Red	+ 24Volts
	Black	0 Volts
	Blue	Signal

2.2.3 Conclusions

PLC used		1212C DC/DC/DC
Power Supply		1 in total (PM 1207)
Publish/Log Data		• PVSS • int9r_lb.CMS_TRK_RHTH.MEMBRANE_PLANT (every 1 minute), PLC_ID=82
Digital Inputs of the installed system	Total	8
	Used	0
	Future Use	8
Digital Outputs of the installed system	Total	6
	Used	0
	Future Use	6
Analogue Inputs of the installed system	Total	1
	Used	1
	Future Use	0
Weidmillers of the installed system	Total	6
	Used	5
	Future Use	1

So if the system needs to be expanded in the future and more than one Weidmiller is needed then the possibility of adding a new DIN rail underneath the already existed one should be considered.