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DATA PACKAGE 96.14

Higher Plants Compartment HPC1
PLC Control Software Data Package

Prepared by/Préparé par	C. Bourg, O. Gerbi
Reference/Réference	MELiSSA Pilot Plant Frame Contract 19445/05/NL/CP
Issue/Edition	0
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APPROVAL

Title *Titre*	**Higher Plants Compartment HPC1 Acceptance Review Control Data package**	Issue *Edition*	0	Revision *Révision*	0

Prepared by *Auteur*	C. Bourg, O. Gerbi	Date *Date*	04/02/11

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1. Scope

The present datapackage provides the status at the date of approval of the control software activities performed by SHERPA Engineering and NTE during the "Call Off Order 6 – Higher Plant Compartment 1 installation in the MELiSSA Pilot Plant".

HPC1 compartment was designed and constructed in University of Guelph, Canada, from 2005 to 2008. The control activities on HPC1 started in the MPP in 2007 within "Call Off Order 1 – HPC1 control" for the design and construction by NTE of a Schneider PLC cabinet planned to substitute the Argus control cabinet on which UoG was operating the HPC1. In the meantime, SHERPA Engineering developed within COO1 a PLC programme able to control HPC1 when delivered in the MPP.

During the execution of COO6, some modifications of the Schneider control hardware were performed and tested by NTE, and these were summarized in the technical notes TN96.1 and TN96.5 and TN96.11.

Likewise, the PLC programme was modified and tested by SHERPA Engineering in order to control the HPC1 in substitution to the Argus control software. These software modifications are traced in the present datapackage, starting in section 1 with the requirements and control loops descriptions, and then presenting the complete version of the PLC programme in Concept language, in section 2.

In order to operate the control of the HPC1 from the control room of the MPP, a human machine interface (HMI) was developed and tested by NTE in the frame of COO6. The design of the HPC1 HMI is presented in section 3 and the corresponding user manual is presented in section 4.

SECTION 1: Control requirements and Software description (SHERPA Documents), 121 pages

MELiSSA

CIVb : SW Description

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TECHNICAL NOTE TN

MELISSA Pilot Plant Higher Plants Chamber: Control Requirements and Software Description

Prepared by/Préparé par	Christophe Bourg / Olivier Gerbi
Reference/Référence	ESA/UAB Contract 19445/05/NL/CP
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APPROVAL

Title Titre	MELISSA Pilot Plant Higher Plants Chamber: Control Requirements and PLC Software Description	Issue Edition	1	Revision Révision	5

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1. Introduction

The first Higher Plant Compartment (HPC) of the Melissa Pilot Plant was constructed at the University of Guelph, one of the members of the MELISSA consortium.
When the compartment arrived to the MPP, Argus system was implemented as control system management. A Schneider PLC Quantum then, replaced it and a complete new software implementation has been performed by Sherpa.
The main objective of the software is to pilot the complete chamber and in particular the lights, CO2 concentration, temperature, humidity, conductivity and pH. Alarms in the plant compartment are managed by the PLC software.
The objective of the document is to give for each control loop:

- Control Requirements (see Annex F)
- a textual description of the function
- the list and description of the variables involved
- the Control tuning parameters and block diagram
- A description of the Alarms, their triggering conditions and actions.

1.1. Software Configuration

PLC program is developed for the Schneider Quantum PLC using the Concept 2.6 software.
Sections are coded using the IEC1131-3 standard language FBD (Function Block Diagram).
The current software version is **V00_78_CIVB** (08.07.2010). The Version V01_00_CIVB will be created when the PAR sensor thresholds will be implemented.

1.1.1. PLC CONFIGURATION

PLC

1	2	3	4	5	6	7	8	9	10
140CPS11420	140CPU43412A	140NOE77101	CRP03100 RIO HEAD	140DDI84100	140DDI84100	140ACO13000	140DDO35300		
Backplane Power Supply module	CPU module	Ethernet module		16 Digital inputs 10-60 VCC	16 Digital inputs 10-60 VCC	8 Analog output 0-20/4-20 mA	32 Digital output 60VCC		
CIVb_PLC_CPS	CIVb_PLC_CPU	CIVb_PLC_NOE		CIVb_PLC_IO_DDI	CIVb_PLC_IO_DDI	CIVb_PLC_IO_ACO	CIVb_PLC_IO_DDO		
Address				100001->100016	100017->100032	400001->400008	000001->000032		

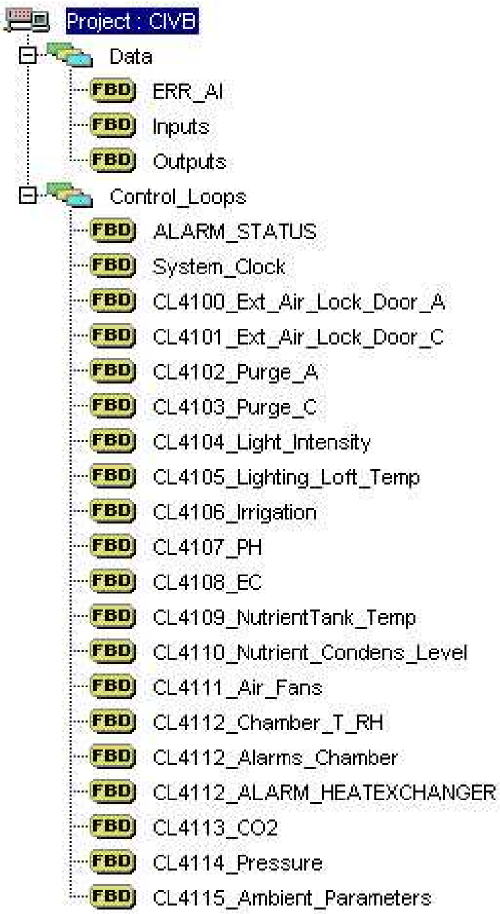
PLC EXPANSION

1	2	3	4	5	6	7	8	9	10
140CPS11420	CRA93100 (RIO Drop)	140AVI03000	140AVI03000	140ATI03000	140ARI03000	140ACI03000	140ARI03000	140ARI03000	140AVO02000
Backplane Power Supply module		8 Analog input 0-10 VDC	8 Analog input 0-10 VDC	8 Analog input -100 / 100mV	8 Analog input Thermistor	8 Analog input - 4/20mA	8 Analog input Thermistor	8 Analog input Thermistor	4 analog outputs 0-10VDC
CIVb _PLC_CPS		CIVb_PLC_IO_AVI	CIVb_PLC_IO_AVI	CIVb_PLC_IO_ATI	CIVb_PLC_IO_ARI	CIVb_PLC_IO_ACI	CIVb_PLC_IO_ARI	CIVb_PLC_IO_ARI	CIVb_PLC_IO_AVO
Address		300001->300009	300010->300018	300055->300064	300028->300036	300064->300072	300037->300045	300046->300054	400009->400012

The internal card configuration is given in annex G.

1.1.2.PLC section List

The following figure show how the software is internally organised.



The folder “Data” groups three subsections.

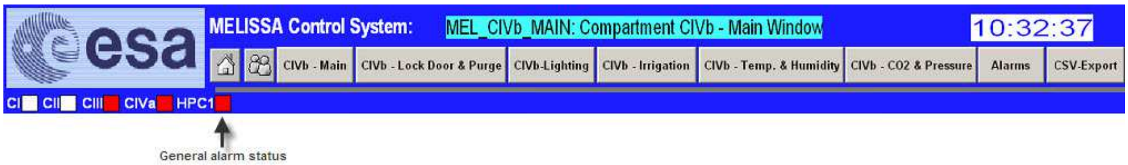
- “ERR_AI” corresponds to the errors generated when an analogical sensor sends no current to the PLC card. It means that the wire of the sensor is broken.
- “Inputs” corresponds to all analogical input channels with the scale configuration.
- “Outputs” corresponds to the analogical output channels with the scale configuration.

The folder “Control_loops” groups all the control loops developed in the following chapters. Only “ALARM_STATUS”, “System_clock” are not detailed.

“ALARM_STATUS” section manages all the HPC1 alarms. It has been implemented to inform the operator, by displaying inside the navigation bar (visible from all the compartment HMI screens) if an alarm is on.

If an alarm high or low is triggered, the tag “HPC1_HighLowAlarm_status” is set and then the square becomes yellow.

If an alarm Very high or Very low is triggered, the tag “HPC1_VeryHighLowAlarm_status” is set then the square becomes red.



“System_clock” section manages the PLC internal clock. The system clock is updated by the supervision to permit the switch ON/OFF of the lights.

1.1.3.Equipment Ranges

Index	Tag Updated 05/05/09	Description	Signal	PLC MEMORY	ELECTRICAL SIGNAL	RANGE	OFF SET	FILTER
1	PT_4102_01	Pressure sensor for airlock A	AI	300001	4-20mA	88.046 to 108.364 kPa	NO	NO
2	PT_4103_01	Pressure sensor for airlock C --> Reaffected to External Pressure	AI	300002	4-20mA	88.046 to 108.364 kPa	NO	NO
3	RT_4104_01	PAR Sensor - A	AI	300055	0-10mV	-5000 to 5000 µmol/s-1/m2	Multiply by 1.32	NO
4	RT_4104_02	PAR Sensor - B	AI	300056	0-10mV	-5000 to 5000 µmol/s-1/m2	Multiply by 1.39	NO
5	RT_4104_03	PAR Sensor - C	AI	300057	0-10mV	-5000 to 5000 µmol/s-1/m2	Multiply by 1.33	NO
6	FSL_4105_01	Flow switch low	AI	300058	0-10mV	0 to 1	NO	NO
7	FSL_4105_02	Flow switch low	AI	300059	0-10mV	0 to 1	NO	NO
8	FSL_4105_03	Flow switch low	AI	300060	0-10mV	0 to 1	NO	NO
9	TT_4105_01	Light Loft Temperature sensor A	AI	300028	Thermistor	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO
10	TT_4105_02	Light Loft Temperature sensor B	AI	300029	Thermistor	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO
11	TT_4105_03	Light Loft Temperature sensor C	AI	300030	Thermistor	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO
12	FT_4106_01	Outlet nutrient flow sensor	AI	300017	0-10V (New one send by Guelph)	4 to 20 L/min	NO	NO
13	AT_4107_01	pH sensor	AI	300003	4-20mA	0-14	-0.8	NO
14	AT_4108_01	Electrical Conductivity of nutrient	AI	300004	4-20mA	0-19.990 mSiemens	-0.26	LAG FILTER (5s)
15	TT_4109_01	Temperature sensor for solution reservoir	AI	300031	Thermistor	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO
16	FT_4111_01	Air velocity sensor	AI	300006	4-20mA	0-50 m/s	NO	NO
17	TT_4112_01	Temperature A1 associated with humidity	AI	300010	4-20mA	-40 to 60 C	NO	NO
18	TT_4112_02	Temperature B1 associated with humidity	AI	300011	4-20mA	-40 to 60 C	NO	NO
19	TT_4112_03	Temperature C1 associated with humidity	AI	300012	4-20mA	-40 to 60 C	NO	NO

Index	Tag Updated 05/05/09	Description	Signal	PLC MEMORY	ELECTRICAL SIGNAL	RANGE	OFF SET	FILTER
20	AT_4112_01	Humidity A1 associated with temp A1	AI	300005	4-20mA	0 to 100%	NO	LAG FILTER (10s)
21	AT_4112_02	Humidity B1 associated with temp B1	AI	300007	4-20mA	0 to 100%	NO	NO
22	AT_4112_03	Humidity C1 associated with temp C1	AI	300008	4-20mA	0 to 100%	NO	LAG FILTER (10s)
23	TT_4112_04	Temperature A2	AI	300032	Thermistor	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO
24	TT_4112_05	Temperature A3	AI	300033	Thermistor	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO
25	TT_4112_06	Temperature A4 --> Reaffected to External T	AI	300034	Thermistor (reaffected to external sensor)	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO
26	TT_4112_07	Temperature B2	AI	300035	Thermistor	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO
27	TT_4112_08	Temperature B3	AI	300037	Themistor	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO
28	TT_4112_09	Temperature B4	AI	300038	Thermistor	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO
29	TT_4112_10	Temperature C2	AI	300039	Thermistor	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO
30	TT_4112_11	Temperature C3	AI	300040	Thermistor	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO
31	TT_4112_12	Temperature C4 --> Reaffected to External T	AI	300041	Thermistor (reaffected to external sensor)	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO
32	TT_4112_13	Temperature for facility chilled water	AI	300042	Thermistor	0 to 60 °C See DFB Block: Thermistor Look up Table)	NO	NO
33	TT_4112_14	Temperature for facility hot water line	AI	300043	Thermistor	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO
34	TT_4112_15	Chilled coil surface temperature	AI	300046	Thermistor	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO
35	TT_4112_16	Heating coil surface temperature	AI	300049	Thermistor	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO
36	TT_4112_17	Chilled Exit temperature	AI	300047	Thermistor	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO
37	TT_4112_18	Hot Exit temperature	AI	300048	Thermistor	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO

Index	Tag Updated 05/05/09	Description	Signal	PLC MEMORY	ELECTRICAL SIGNAL	RANGE	OFF SET	FILTER
38	TT_4112_19 (NEW)	Outlet Air (TO BE CONFIRMED), chilled exchanger	AI	300050	Thermistor	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO
39	TT_4112_20 (NEW)	Outlet Air (TO BE CONFIRMED), hot exchanger	AI	300044	Thermistor	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO
40	TT_4112_21 (NEW)	Inlet water Chilled Exchanger	AI	300051	Thermistor	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO
41	TT_4112_22 (NEW)	Inlet water Hot Exchanger	AI	300052	Thermistor	0 to 60 °C See DFB Block: Thermistor Look up Table	NO	NO
42	S3CV_4112_01_MV	Chilled Water Control Valve	AO	400001	0-10V	0 to 100 %	NO	NO
43	S3CV_4112_02_MV	Hot Water Control Valve	AO	400002	0-10V	0 to 100 %	NO	NO
44	AT_4113_01	CO2 Analyser	AI	300013	4-20mA	0-5000 PPM	NO	LAG FILTER (10s)
45	AT_4113_02	O2 Analyser	AI	300014	4-20mA	0-25%	NO	NO
46	FC_4113_01	CO2 Mass Flow	AI	300016	0-10V	0-2000 mL/min	NO	NO
47	FC_4113_01_SP	CO2 Mass Flow set point	AO	400003	4-20mA	0-1000 mL/min	NO	NO
48	PT_4114_01	Growing Area Pressure	AI	300015	4-20mA	88.046 to 108.364 kPa	NO	NO
49	PT_4114_02	Pressure transmitter	AI	300065	4-20mA	800 to 1200 mbar	NO	NO
50	PT_4114_03	Pressure transmitter	AI	300066	4-20mA	800 to 1200 mbar	NO	NO
51	PT_4114_04	Pressure transmitter	AI	300067	4-20mA	800 to 1200 mbar	NO	NO
52	PT_4114_05	Pressure transmitter	AI	300068	4-20mA	800 to 1200 mbar	NO	NO
53	PT_4114_06	Pressure transmitter	AI	300069	4-20mA	800 to 1200 mbar	NO	NO
54	TT_4115_01	Ambient temperature (NOT CONNECTED)	AI	NC	4-20mA	N/A	NO	NO
55	PT_4115_01	Ambient pressure (NOT CONNECTED)	AI	NC	4-20mA	N/A	NO	NO

1.1.4.Initial Values

The initial values are the values by default when the PLC starts.

Control loops	Tags	Type	Address	Value	Unit	Comments
4100	CL4100_DoorA_open_Time_LIM	TIME	400402	t#1m	minute	Limit of time for triggerred the door alarm of the airlock A
4101	CL4101_DoorC_open_Time_LIM	TIME	400404	t#1m	minute	Limit of time for triggered the door alarm of the airlock C
4102	CL4102_Pressure_LIM_High	REAL	400504	1.03	bar	Max Value Pressure - Side A - Bar
4102	CL4102_PURGETIME	TIME	-	t#20s	second	Purge Duration
4103	CL4103_Pressure_LIM_High	REAL	400506	1.03	bar	Max Value Pressure - Side C - Bar
4103	CL4103_PURGETIME	TIME	-	t#20s	second	Purge Duration
4104	CL4104_StartingDay_Hour	UINT	400182	6	hour	Hour for switch ON light
4104	CL4104_StartingDay_Minute	UINT	400183	0	minute	Minute for the starting light
4104	CL4104_EndingDay_Hour	UINT	400184	22	hour	Hour for the starting light
4104	CL4104_EndingDay_Minute	UINT	400185	0	minute	Minute for the starting light
4104	RT_4104_High_LIM_Sa_OR_Sb	REAL	400406	TBD	µmol/sec/m2	High lighting intensity Limit of ramp Sa or Sb
4104	RT_4104_Low_LIM_Sa_OR_Sb	REAL	400408	TBD	µmol/sec/m2	Low lighting intensity Limit of ramp Sa or Sb
4104	RT_4104_High_LIM_H	REAL	400410	TBD	µmol/sec/m2	High lighting intensity Limit of ramp H
4104	RT_4104_Low_LIM_H	REAL	400412	TBD	µmol/sec/m2	Low lighting intensity Limit of ramp H
4104	RT_4104_High_LIM_SaORsb_H	REAL	400414	TBD	µmol/sec/m2	High lighting intensity Limit of ramp Sa or Sb and H
4104	RT_4104_Low_LIM_SaORsb_H	REAL	400416	TBD	µmol/sec/m2	Low lighting intensity Limit of ramp Sa or Sb and H
4104	RT_4104_High_LIM_Sa_Sb	REAL	400418	TBD	µmol/sec/m2	High lighting intensity Limit of ramp Sa and Sb
4104	RT_4104_Low_LIM_Sa_Sb	REAL	400420	TBD	µmol/sec/m2	Low lighting intensity Limit of ramp Sa and Sb
4104	RT_4104_High_LIM_Sa_Sb_H	REAL	400422	TBD	µmol/sec/m2	High lighting intensity Limit of ramp Sa, Sb and H
4104	RT_4104_Low_LIM_Sa_Sb_H	REAL	400424	TBD	µmol/sec/m2	Low lighting intensity Limit of ramp Sa, Sb and H
4104	RT_4104_High_LIM_Nolight	REAL	400502	TBD	µmol/sec/m2	High limit of photon in the chamber when the lights are switched off
4105	CL4105_TempFan_LIM_H	REAL	400426	42	°C	High temperature limit in the loft
4105	CL4105_TempFan_LIM_HH	REAL	400428	45	°C	Very high temperature limit in the loft
4106	FT_4106_01_LIM_H	REAL	400430	15	L/min	High limit of Irrigation flow
4106	FT_4106_01_LIM_HH	REAL	400432	17	L/min	Very high limit of Irrigation flow
4106	FT_4106_01_LIM_L	REAL	400434	8	L/min	Low limit of Irrigation flow
4106	FT_4106_01_LIM_LL	REAL	400436	6	L/min	Very Low limit of Irrigation flow
4107	CL4107_Ph_SP	REAL	400138	5.9	-	pH set point : from HMI
4107	CL4107_DeadZone	REAL	400140	0.1	-	dead zone for pH control
4107	CL4107_Base_Opening_Time	REAL	400186	0	second	timer for open the BASE valve
4107	CL4107_Acid_Opening_Time	REAL	400188	0	second	timer for open the ACID valve
4107	CL4107_Ph_LIM_H	REAL	400438	6	-	High limit of pH

Control loops	Tags	Type	Address	Value	Unit	Comments
4107	CL4107_Ph_LIM_HH	REAL	400440	7	-	Very high limit of pH
4107	CL4107_Ph_LIM_L	REAL	400442	5.6	-	Low limit of pH
4107	CL4107_Ph_LIM_LL	REAL	400444	5	-	Very Low limit of pH
4108	CL4108_Ec_SP	REAL	400142	1.9	µS/m	EC Set Point : 1900 µS/m
4108	CL4108_Ec_LIM_H	REAL	400446	2.2	-	High limit of EC
4108	CL4108_Ec_LIM_HH	REAL	400448	2.5	µS/m	Very high limit of EC
4108	CL4108_Ec_LIM_L	REAL	400450	1.5	µS/m	Low limit of EC
4108	CL4108_Ec_LIM_LL	REAL	400452	1	µS/m	Very Low limit of EC
4110	CL4110_Level_Time_LIM	TIME	400454	10	minutes	Limit of time for triggered condensate level alarm
4111	CL4111_FT_MIN	REAL	400456	4	m/s	MIN value for Air Flow (unit ?)
4112	TT_4112_AVG_Night_SP	REAL	400144	22	°C	Average chamber temperature set point for the night
4112	AT_4112_AVG_Night_SP	REAL	400146	70	%	Average chamber Humidity set point for the night
4112	TT_4112_AVG_Day_SP	REAL	400148	26	°C	Average chamber temperature set point for the day
4112	AT_4112_AVG_Day_SP	REAL	400150	70	%	Average chamber Humidity set point for the day
4112	CL4112_ColdOutletAir_SP	REAL	400316	20	°C	temperature air set point send by master controller (Humidity) to slave controller (cold exchanger)
4112	CL4112_HotOutletAir_SP	REAL	400318	20	°C	temperature air set point send by master controller (temperature) to slave controller (cold exchanger)
4112	TT_4112_SP	REAL	400320	18	°C	Temperature chamber set point send to controller (calculated function of the day and the night)
4112	AT_4112_SP	REAL	400324	80	%	Humidity chamber set point send to controller (calculated function of the day and the night)
4112	CL4112_Temperature_LIM_H	REAL	400458	28	°C	High temperature limit in the chamber
4112	CL4112_Temperature_LIM_HH	REAL	400460	30	°C	Very high temperature limit in the chamber
4112	CL4112_Temperature_LIM_L	REAL	400462	18	°C	Low temperature limit for the chamber
4112	CL4112_Temperature_LIM_LL	REAL	400464	15	°C	Very low temperature limit for the chamber
4112	CL4112_Humidity_LIM_H	REAL	400466	85	%	High Humidity limit in the chamber
4112	CL4112_Humidity_LIM_HH	REAL	400468	90	%	Very high Humidity limit in the chamber
4112	CL4112_Humidity_LIM_L	REAL	400470	45	%	Low Humidity limit for the chamber
4112	CL4112_Humidity_LIM_LL	REAL	400472	40	%	Very low Humidity limit for the chamber
4112	CL4112_Temp_HotXchanger_LIM_L	REAL	400474	40	°C	Low temperature limit in the hot exchanger
4112	CL4112_Temp_HotXchanger_LIM_LL	REAL	400476	35	°C	Very low temperature limit in the hot exchanger
4112	CL4112_Temp_ColdXchanger_LIM_H	REAL	400478	12	°C	High temperature limit in the cold exchanger
4112	CL4112_Temp_ColdXchanger_LIM_HH	REAL	400480	15	°C	Very high temperature limit in the cold exchanger
4113	FC_4113_01_OP_SP	REAL	400160	0		Mass flow controller internal set point
4113	AT_4113_01_SP	REAL	400162	1000	PPM	CO2 Set Point
4113	CL4113_CO2_LIM_H	REAL	400482	50	PPM	High limit of CO2 in the Chamber. Compared to the set point
4113	CL4113_CO2_LIM_HH	REAL	400484	500	PPM	Very high limit of CO2 in the Chamber. Compared to the set point

Control loops	Tags	Type	Address	Value	Unit	Comments
4113	CL4113_CO2_LIM_L	REAL	400486	-50	PPM	Low limit of CO2 in the Chamber Compared to the set point
4113	CL4113_CO2_LIM_LL	REAL	400488	-100	PPM	Very low limit of CO2 in the Chamber Compared to the set point
4113	CL4113_O2_LIM_H	REAL	400490	23	%	High limit of O2 in the Chamber
4113	CL4113_O2_LIM_HH	REAL	400492	25	%	Very high limit of O2 in the Chamber
4113	CL4113_O2_LIM_L	REAL	400494	19	%	Low limit of O2 in the Chamber
4113	CL4113_O2_LIM_LL	REAL	400496	17	%	Very low limit of O2 in the Chamber
4114	CL4114_Pressure_LIM_H	REAL	400498	1100	mbar	High limit of pressure in the chamber
4114	CL4114_Pressure_LIM_L	REAL	400500	900	mbar	Low limit of pressure in the chamber

1.1.5.DFB Block: Thermistor Look up Table

This block has been created to make a correspondence between the resistor sent by the thermistor and the temperature. For creating this block, we have used the Guelph table given below. As the Thermistor are put in parallel with a 6490 Ω resistor, each value is recalculated as follow:

$$\frac{1}{R_T} = \frac{1}{R_{Th}} + \frac{1}{6490\Omega}$$

We have limited the correspondence table to a minimum of -1°C and a maximum of 60°C.

Temp C	Resistance
-40	100980.0000
-39	94500.0000
-38	88500.0000
-37	82920.0000
-36	77700.0000
-35	72840.0000
-34	68340.0000
-33	64140.0000
-32	60180.0000
-31	56520.0000
-30	53100.0000
-29	49920.0000
-28	46950.0000
-27	44160.0000
-26	41550.0000
-25	39120.0000
-24	36870.0000
-23	34740.0000
-22	32730.0000
-21	30870.0000
-20	29136.0000
-19	27498.0000
-18	25962.0000
-17	24516.0000
-16	23166.0000
-15	21894.0000
-14	20700.0000
-13	19578.0000
-12	18528.0000
-11	17538.0000
-10	16602.0000
-9	15726.0000
-8	14898.0000
-7	14124.0000
-6	13392.0000
-5	12702.0000
-4	12048.0000
-3	11436.0000
-2	10860.0000
-1	10314.0000
0	9798.0000
1	9312.0000
2	8850.0000
3	8418.0000
4	8004.0000
5	7620.0000
6	7254.0000
7	6906.0000

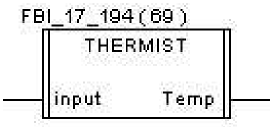
Temp C	Resistance
8	6576.0000
9	6264.0000
10	5970.0000
11	5691.0000
12	5427.0000
13	5178.0000
14	4938.0000
15	4713.0000
16	4500.0000
17	4296.0000
18	4104.0000
19	3921.0000
20	3747.0000
21	3582.0000
22	3426.0000
23	3276.0000
24	3135.0000
25	**3000.0000**
26	2872.20000
27	2749.80000
28	2633.40000
29	2522.40000
30	2417.40000
31	2316.60000
32	2221.20000
33	2129.40000
34	2042.40000
35	1959.60000
36	1880.40000
37	1804.80000
38	1732.80000
39	1663.80000
40	1597.80000
41	1535.40000
42	1475.40000
43	1417.80000
44	1363.20000
45	1310.40000
46	1260.60000
47	1212.60000
48	1166.40000
49	1122.60000
50	1080.60000
51	1040.40000
52	1002.00000
53	964.80000
54	929.40000
55	895.80000

Temp C	Resistance
56	863.40000
57	832.20000
58	802.20000
59	774.00000
60	746.40000
61	720.00000
62	694.80000
63	670.20000
64	647.40000
65	624.60000
66	603.60000
67	582.60000
68	562.80000
69	543.90000
70	525.30000
71	507.90000
72	491.10000
73	474.60000
74	459.00000
75	444.00000
76	429.60000
77	415.50000
78	402.30000
79	389.40000
80	376.80000
81	364.80000
82	353.40000
83	342.30000
84	331.50000
85	321.30000
86	311.40000
87	301.80000
88	292.50000
89	283.560000
90	274.920000
91	266.640000
92	258.600000
93	250.920000
94	243.420000
95	236.220000
96	229.260000
97	222.540000
98	216.060000
99	209.820000
100	203.760000
101	197.880000
102	192.240000
103	186.780000

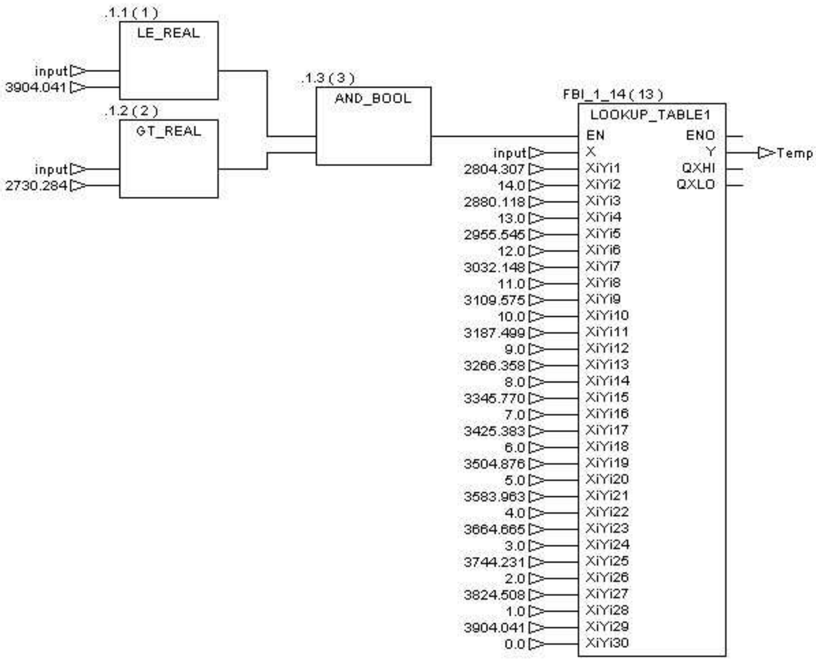
Temp C	Resistance
104	181.500000
105	176.400000
106	171.420000
107	166.680000
108	162.060000
109	157.560000
110	153.240000
111	149.040000
112	144.960000
113	141.060000
114	137.220000
115	133.560000
116	130.020000
117	126.540000
118	123.180000
119	119.940000
120	116.820000
121	113.760000
122	110.820000
123	107.940000
124	105.180000
125	102.480000
126	99.840000
127	97.320000
128	94.860000
129	92.460000
130	90.180000
131	87.900000
132	85.740000
133	83.640000
134	81.600000
135	79.560000
136	77.640000
137	75.780000
138	73.920000
139	72.180000
140	70.440000
141	68.760000
142	67.140000
143	65.520000
144	64.020000
145	62.520000
146	61.080000
147	59.640000
148	58.260000
149	56.910000
150	55.620000

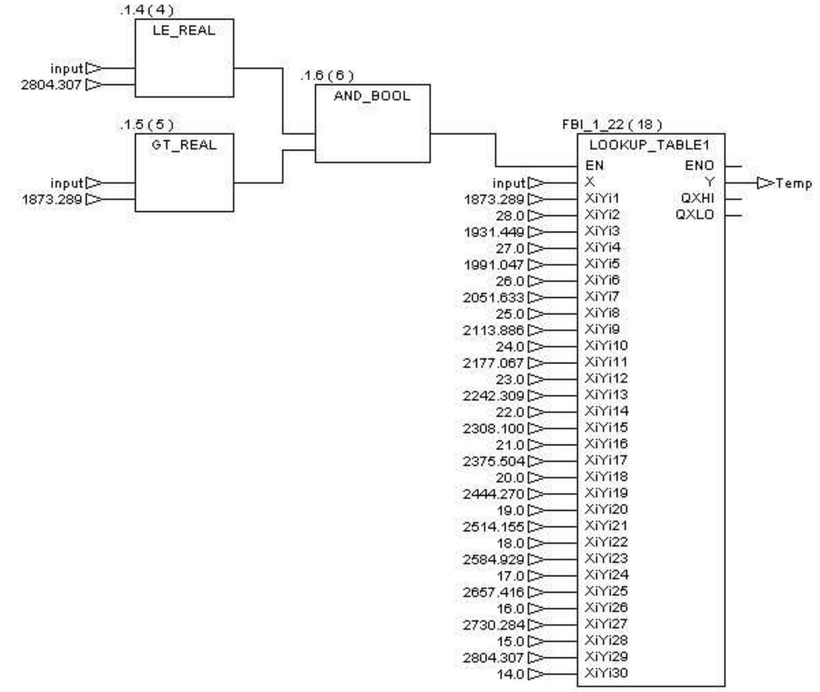
The DFB Block is developed as follow:

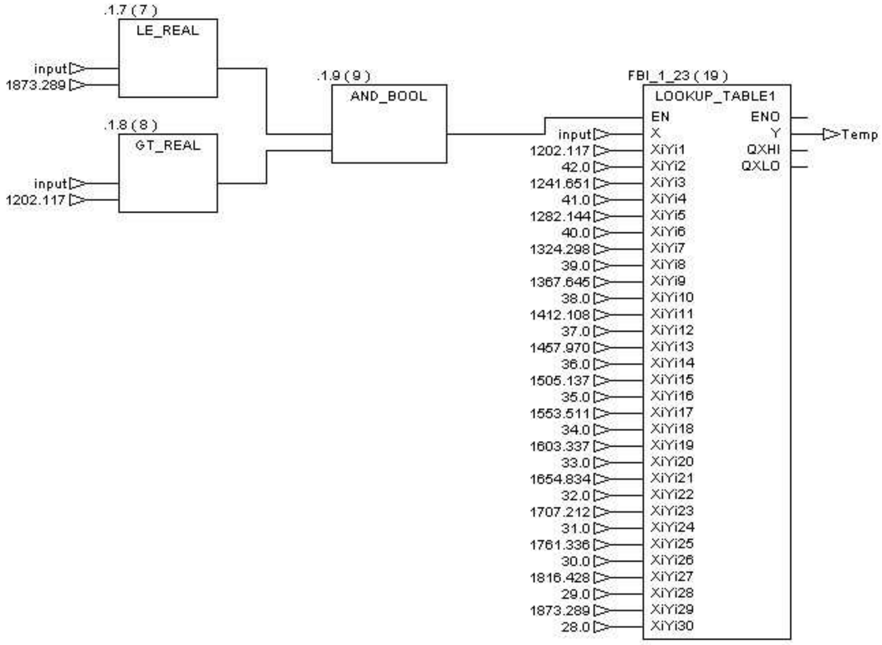
-The block implemented inside the software

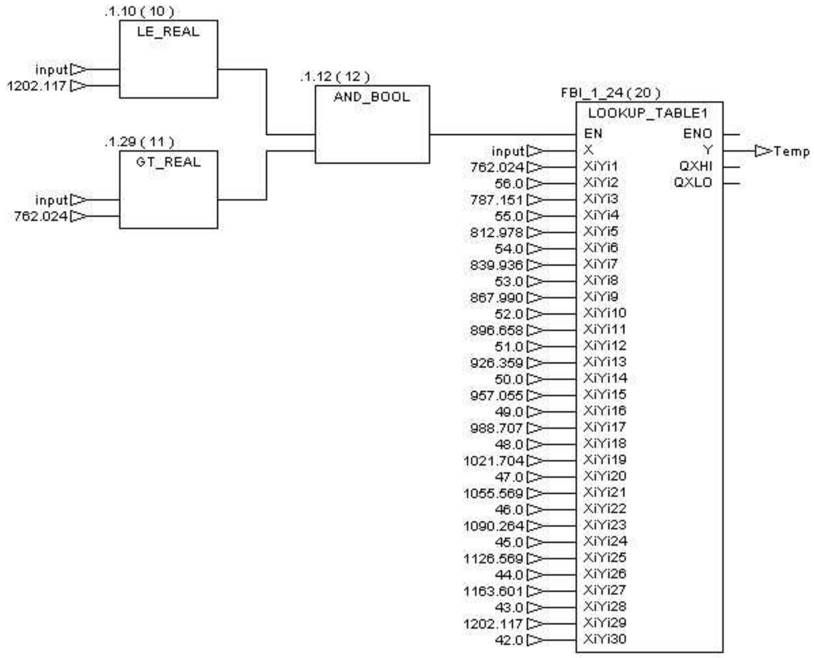


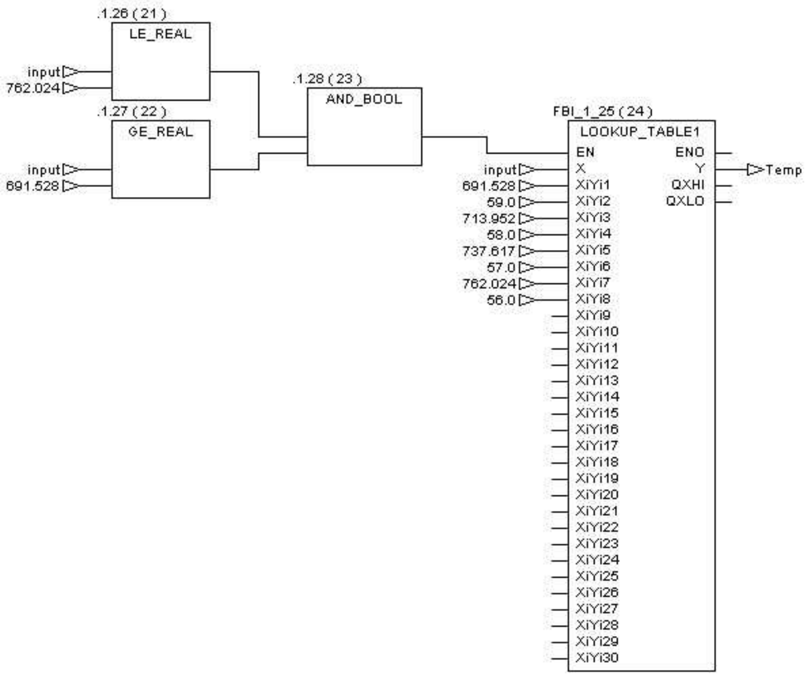
-the internal block




.1.4 (4)
LE_REAL
input
2804.307
.1.5 (5)
GT_REAL
input
1873.289
.1.6 (6)
AND_BOOL
FBI_1_22 (18)
LOOKUP_TABLE1
EN ENO
X Y
Temp
QXHI
QXLO
input
1873.289 XiYi1
28.0 XiYi2
1931.449 XiYi3
27.0 XiYi4
1991.047 XiYi5
26.0 XiYi6
2051.633 XiYi7
25.0 XiYi8
2113.886 XiYi9
24.0 XiYi10
2177.067 XiYi11
23.0 XiYi12
2242.309 XiYi13
22.0 XiYi14
2308.100 XiYi15
21.0 XiYi16
2375.504 XiYi17
20.0 XiYi18
2444.270 XiYi19
19.0 XiYi20
2514.155 XiYi21
18.0 XiYi22
2584.929 XiYi23
17.0 XiYi24
2657.416 XiYi25
16.0 XiYi26
2730.284 XiYi27
15.0 XiYi28
2804.307 XiYi29
14.0 XiYi30

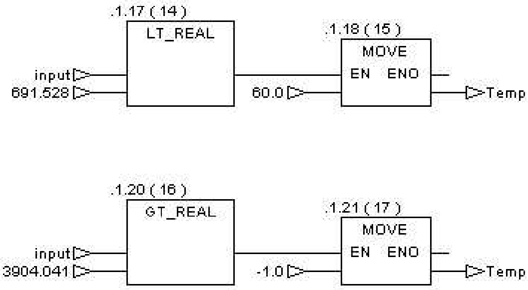

.1.7 (7)
LE_REAL
input
1873.289
.1.8 (8)
GT_REAL
input
1202.117
.1.9 (9)
AND_BOOL
FBI_1_23 (19)
LOOKUP_TABLE1
EN ENO
X Y
Temp
QXHI
QXLO
input
1202.117 XiYi1
42.0 XiYi2
1241.651 XiYi3
41.0 XiYi4
1282.144 XiYi5
40.0 XiYi6
1324.298 XiYi7
39.0 XiYi8
1367.645 XiYi9
38.0 XiYi10
1412.108 XiYi11
37.0 XiYi12
1457.970 XiYi13
36.0 XiYi14
1505.137 XiYi15
35.0 XiYi16
1553.511 XiYi17
34.0 XiYi18
1603.337 XiYi19
33.0 XiYi20
1654.834 XiYi21
32.0 XiYi22
1707.212 XiYi23
31.0 XiYi24
1761.336 XiYi25
30.0 XiYi26
1816.428 XiYi27
29.0 XiYi28
1873.289 XiYi29
28.0 XiYi30


.1.10 (10)
LE_REAL
input
1202.117
.1.29 (11)
GT_REAL
input
762.024
.1.12 (12)
AND_BOOL
FBI_1_24 (20)
LOOKUP_TABLE1
EN
ENO
X
Y
Temp
QXHI
QXLO
input
762.024
56.0
787.151
55.0
812.978
54.0
839.936
53.0
867.990
52.0
896.658
51.0
926.359
50.0
957.055
49.0
988.707
48.0
1021.704
47.0
1055.569
46.0
1090.264
45.0
1126.569
44.0
1163.601
43.0
1202.117
42.0
XiYi1 XiYi2 XiYi3 XiYi4 XiYi5 XiYi6 XiYi7 XiYi8 XiYi9 XiYi10 XiYi11 XiYi12 XiYi13 XiYi14 XiYi15 XiYi16 XiYi17 XiYi18 XiYi19 XiYi20 XiYi21 XiYi22 XiYi23 XiYi24 XiYi25 XiYi26 XiYi27 XiYi28 XiYi29 XiYi30


.1.26 (21)
LE_REAL
input
762.024
.1.27 (22)
GE_REAL
input
691.528
.1.28 (23)
AND_BOOL
FBI_1_25 (24)
LOOKUP_TABLE1
EN
ENO
X
Y
Temp
QXHI
QXLO
input
691.528
59.0
713.952
58.0
737.617
57.0
762.024
56.0
XiYi1 XiYi2 XiYi3 XiYi4 XiYi5 XiYi6 XiYi7 XiYi8 XiYi9 XiYi10 XiYi11 XiYi12 XiYi13 XiYi14 XiYi15 XiYi16 XiYi17 XiYi18 XiYi19 XiYi20 XiYi21 XiYi22 XiYi23 XiYi24 XiYi25 XiYi26 XiYi27 XiYi28 XiYi29 XiYi30

-DFB Block limits:

If the resistor value goes under “691.528” , the temperature value is frozen to 60°C. In the opposite, if the resistor value goes upper than 3904.041, the temperature value is frozen to -1°C.



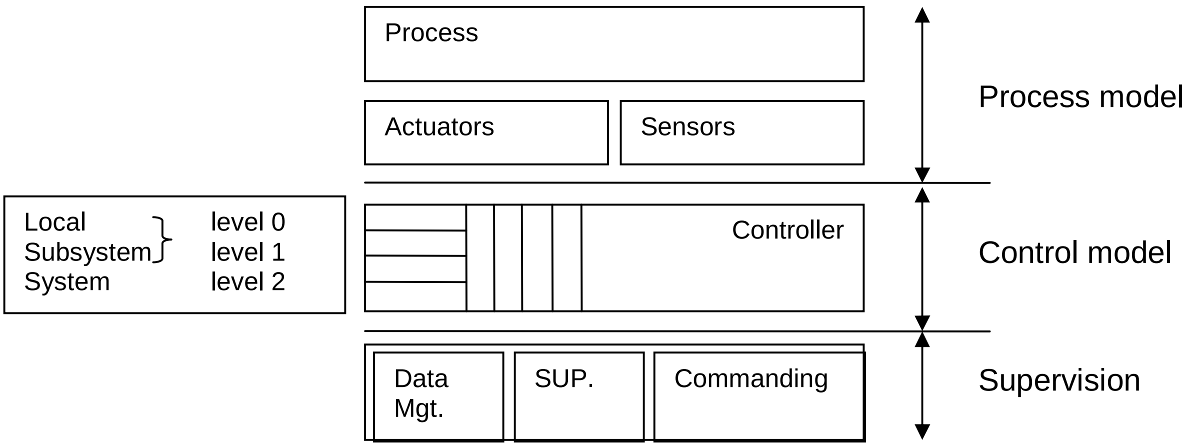
2. System Description

2.1. Control levels

4 levels for the control are commonly used:

- Level 0 control: ancillaries, local regulations
- Level 1 control: dynamic control
- Level 2 control: static/dynamic optimisation
- Level 3 control: planning, sequencing and scheduling.

Different Levels of Model are developed:
Process model including Process, Sensors and Actuators
Control Model: for the Controller and including Local (level 0), subsystem and system (level 1 and 2) control laws.



According to the TN85.5 description, the system was discomposed into several subsystems:

- Chamber Access System
- Lighting System
- Liquid subsystem
- Atmospheric Control

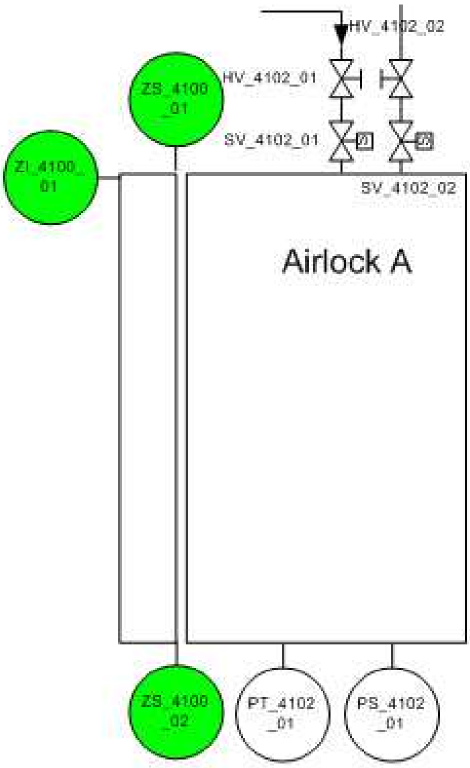
2.2. Control Loops

Hereafter the list of the control loops as programmed in the PLC. It corresponds to the different sections in the software

4100	Exterior Air Lock Door Control - Side A
4101	Exterior Air Lock Door Control - Side C
4102	Air Lock Purge Control - Side A
4103	Air Lock Purge Control - Side C
4104	Light Intensity Control
4105	Lighting Loft Temperature Control
4106	Irrigation System
4107	pH Control
4108	EC Control
4109	Nutrient Tank Temperature Control (NOT IMPLEMENTED)
4110	Nutrient and Condensate Levels Control
4111	Control of Air circulation fans
4112	Chamber Temperature and Humidity Control
4113	CO2 Control
4114	Chamber Pressure
4115	Ambient Parameters (NOT IMPLEMENTED)

Figure 1: Control loop definition

2.3. Exterior Air Lock Door Control - Side A (CL4100)



2.3.1.Function

<u>Following the tests done on this function, and because the air lock is not airtight with the plant chamber, it was decided to deactivate it.</u>

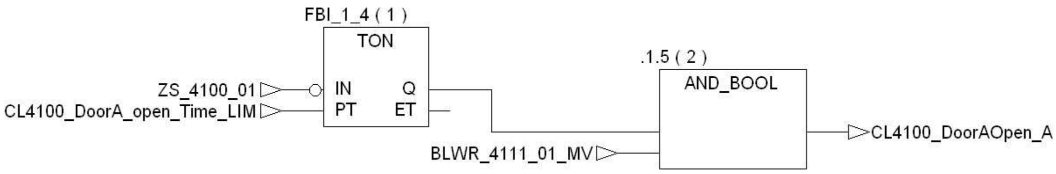
Digital sensors ZS_4100_01 and ZS_4100_02 are linked together. If the door A is opened by the operator then both become '0' and a counter is started.

If the door is open during "CL4100_DoorA_open_Time_LIM" (1 minute) with the Blower BLWR_4111_01 started, an alarm is triggered in the PLC and displayed on the HMI.

PLC Section name	Equipment tag	Type	Address	Comment
CL4100_Ext_Air_Lock_Door_A	ZS_4100_01	DI	100001	Upper Exterior Air Lock Door Contact - Side A
CL4100_Ext_Air_Lock_Door_A	ZS_4100_02	DI	100002	Lower Exterior Air Lock Door Contact - Side A
CL4100_Ext_Air_Lock_Door_A	ZI_4100_01	DO	000001	Led Indicator when door is open - Side A (connected to PLC Cabinet)

Figure 2: Exterior Air Lock Door Control - Side A – EQUIPMENT

2.3.2. Block Diagram



Alarm is triggered when the door is opened more than CL4100_DoorA_open_Time_LIM and the blower BLMR_4111_01_MV is running.

2.3.3. Alarm and Threshold

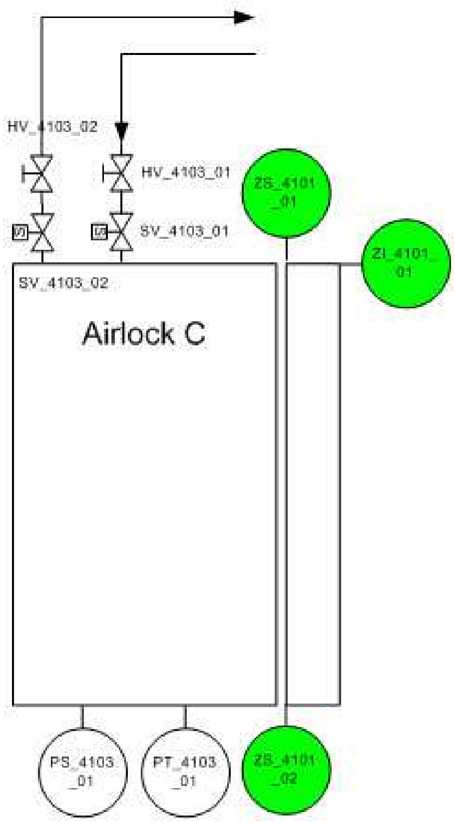
Alarm tag Name	type	Address	description
CL4100_DoorAOpen_A	BOOL	000033	DOOR A opening Alarm Display an alarm on the HMI only if the Blower BLWR_4111_01 is active

Figure 3: Exterior Air Lock Door Control - Side A - ALARM

Threshold tag name	Type	Address	Value	Unit	ACTION
CL4100_DoorA_open_Time_LIM	TIME	400402	1	minute	Display an alarm on the HMI only if the Blower BLWR_4111_01 is active

Figure 4: Exterior Air Lock Door Control - Side A - THRESHOLD

2.4. Exterior Air Lock Door Control - Side C (CL4101)



2.4.1.Function

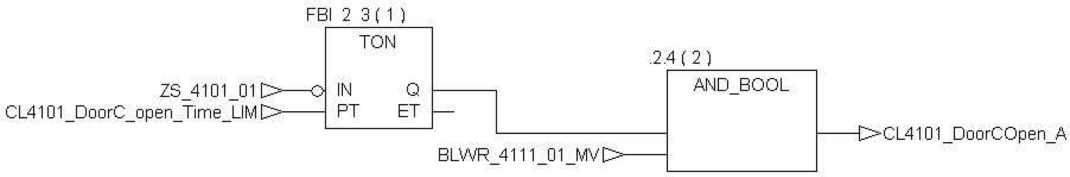
<u>Following the tests done on this function, and because the air lock is not airtight with the plant chamber, it was decided to deactivate it.</u>

Digital sensors ZS_4101_01 and ZS_4101_02 are linked together. If the door C is opened by the operator then both become ‘0’ and a counter is started. If the door is opened during “CL4100_DoorC_open_Time_LIM” (1 minute) with the Blower BLWR_4111_01 started, an alarm is triggered in the PLC and displayed on the HMI.

PLC Section name	Equipment tag	Type	Address	Comment
CL4101_Ext_Air_Lock_Door_C	ZS_4101_01	DI	100003	Upper Exterior Air Lock Door Contact - Side C
CL4101_Ext_Air_Lock_Door_C	ZS_4101_02	DI	100004	Lower Exterior Air Lock Door Contact - Side C
CL4101_Ext_Air_Lock_Door_C	ZI_4101_01	DO	000002	Led Indicator when door is open - Side C (connected to PLC Cabinet)

Figure 5: Exterior Air Lock Door Control - Side C - EQUIPMENT

2.4.2. Block Diagram



Alarm is triggered when the door is opened more than CL4101_DoorC_open_Time_LIM and the blower BLWR_4111_01 is running.

2.4.3. Alarm and Threshold

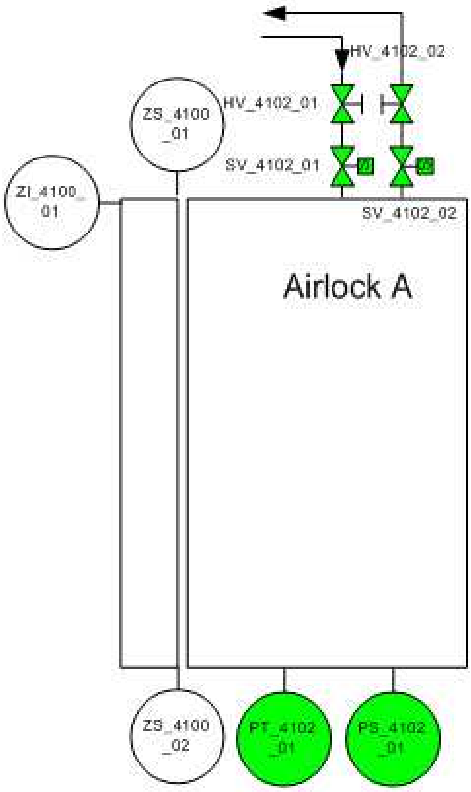
Alarm tag Name	type	Address	description
CL4101_DoorCOpen_A	BOOL	000034	DOOR C opening Alarm Display an alarm on the HMI only if the Blower BLWR_4111_01 is active

Figure 6: Exterior Air Lock Door Control - Side C - ALARM

Threshold tag name	Type	Address	Value	Unit	ACTION
CL4101_DoorC_open_Time_LIM	TIME	400404	1	minute	Display an alarm on the HMI only if the Blower BLWR_4111_01 is active

Figure 7: Exterior Air Lock Door Control - Side C – THRESHOLD

2.5. Air Lock Purge Control - Side A (CL4102)



2.5.1. Function

After a door opening, the air coming from outside needs to be removed out of the chamber and replaced by calibrated air. In order to provide this function, a calibrated air input (SV_4102_01) injects the gas inside the airlock during a defined time (CL4102_PURGETIME = 10 s). When the pressure switch PS_4102_01 is triggered, an output (SV_4102_02) is opened for removing the contaminated air. These actions are done under control of pressure.

The following conditions stop the purge:

If the pressure is higher than 1.03 bar
if the opening door A alarm is ongoing
If PT_4102_01 is in error

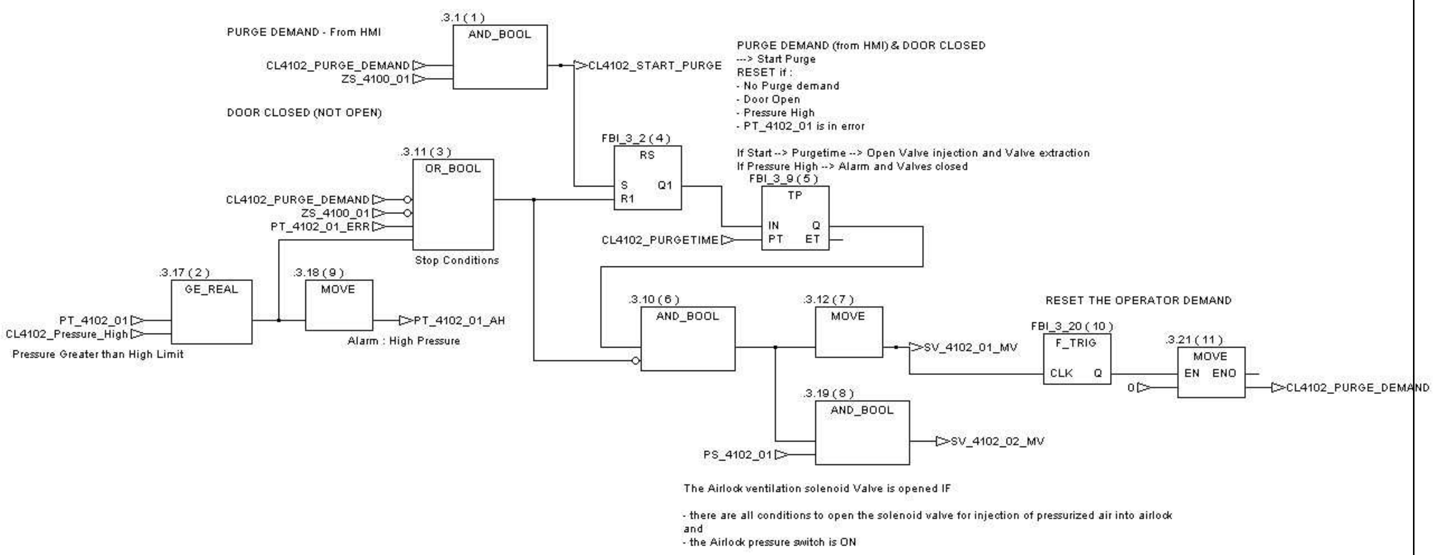
PLC Section name	Equipment tag	Type	Address	Comment
CL4102_Purge_A	SV_4102_01_MV	DO	000007	Solenoid Valve for injection of pressurized air into airlock A
CL4102_Purge_A	SV_4102_02_MV	DO	000008	Airlock A ventilation Solenoid Valve
CL4102_Purge_A	PT_4102_01	AI -> REAL	400013	Pressure sensor for airlock A
CL4102_Purge_A	PS_4102_01	DI	100008	Airlock A pressure Switch

Figure 8: Air Lock Purge Control - Side A- EQUIPMENTS

PLC Section name	Button tag	Type	Address	Comment
CL4102_Purge_A	CL4102_PURGE_DEMAND	BOOL	000175	Trigger the purge of the airlock A. The tag is reset at the end of the purge or if an alarm occurs

Figure 9: Air Lock Purge Control - Side A – OPERATOR INPUT

2.5.2.Block Diagram



2.5.3.Alarms and Threshold

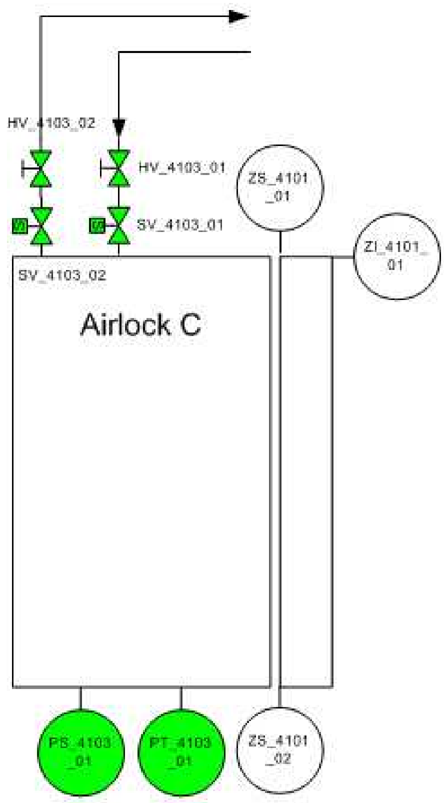
Alarm tag Name	type	Address	description
PT_4102_01_AH	BOOL	000173	triggered during the purge of the Airlock A if the pressure is greater than 1.03 Barg stop the on going purge
PT_4102_01_ERR	BOOL	000035	ERROR is set when the PLC loses the communication with the sensor.

Figure 10: Air Lock Purge Control - Side A - ALARMS

Threshold tag name	Type	Address	Value	Unit	ACTION
CL4102_Pressure_LIM_H	REAL	400504	1.03	Barg	Display an alarm on the HMI and stop the on going purge

Figure 11: Air Lock Purge Control - Side A – THRESHOLD

2.6. Air Lock Purge Control - Side C (CL4103)



2.6.1.Function

After a door opening, the air coming from outside need to be removed out of the chamber and replaced by calibrated air. In order to provide this function, a calibrated air input (SV_4103_01) injects the gas inside the airlock during a defined time (CL4103_PURGETIME = 10 s). At the same moment, an output (SV_4103_02) is opened for removing the contaminated air. These actions are done under control of pressure. The following conditions stop the purge:

If the pressure is higher than 1.03 bar

if the opening door A alarm is ongoing
If PT_4103_01 is in error

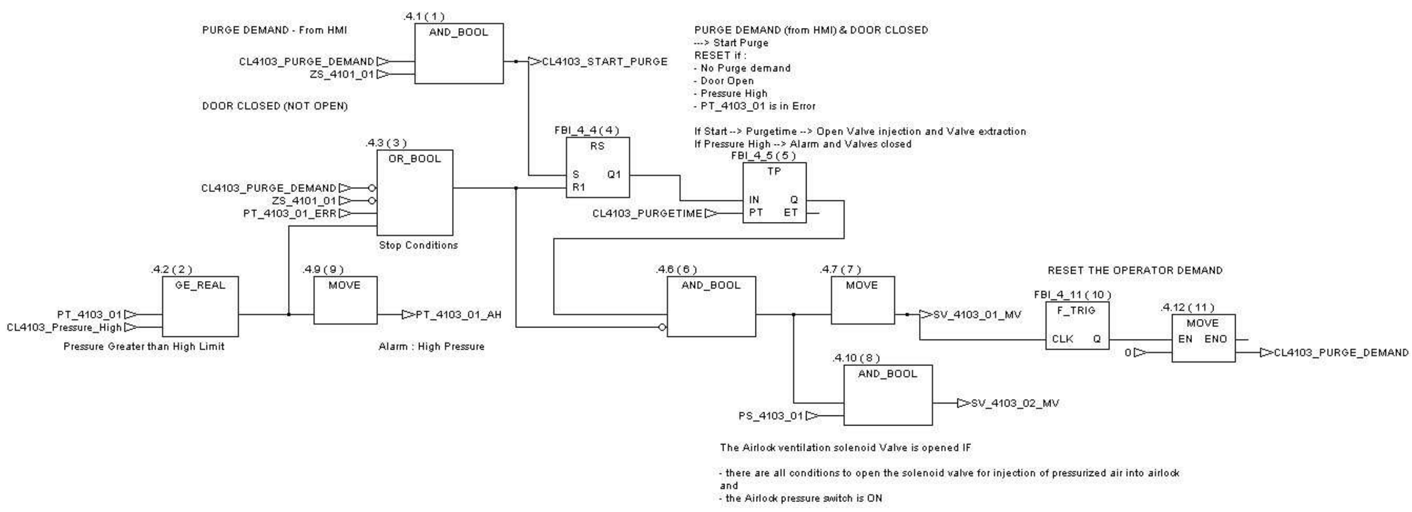
PLC Section name	Equipment tag	Type	Address	Comment
CL4103_Purge_C	SV_4103_01_MV	DO	000009	Solenoid Valve for injection of pressurized air into airlock C
CL4103_Purge_C	SV_4103_02_MV	DO	000010	Airlock C ventilation Solenoid Valve
CL4103_Purge_C	PT_4103_01	AI ->REAL	400015	Pressure sensor for airlock C --> Re-affected to External Pressure
CL4103_Purge_C	PS_4103_01	DI	100009	Airlock A pressure switch

Figure 12: Air Lock Purge Control - Side C - EQUIPMENTS

PLC Section name	tag	Type	Address	Comment
CL4103_Purge_C	CL4103_PURGE_DEMAND	BOOL	000176	Trigger the purge of the airlock C. The tag is reset at the end of the purge or if an alarm occurs

Figure 13: Air Lock Purge Control - Side C – OPERATOR INPUT

2.6.2. Block Diagram



2.6.3. Alarms and Threshold

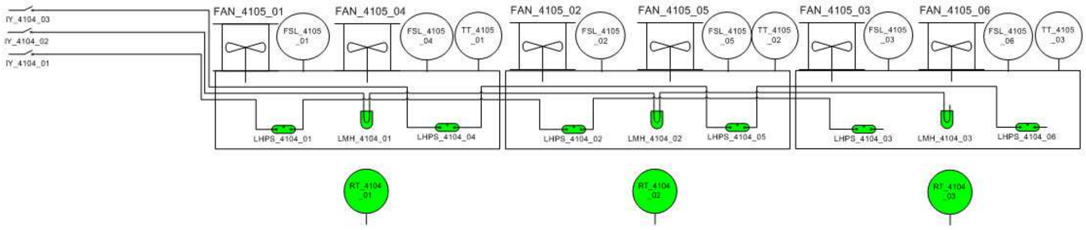
Alarm tag Name	type	Address	description
PT_4103_01_AH	BOOL	000174	triggered during the purge of the Airlock C if the pressure is greater than 1.03 Barg stop the on going purge
PT_4103_01_ERR	BOOL	000036	ERROR is set when the PLC loses the communication with the sensor

Figure 14: Air Lock Purge Control - Side C – ALARMS

Threshold tag name	Type	Address	Value	Unit	ACTION
CL4103_Pressure_LIM_H	REAL	400506	1.03	Barg	Display an alarm on the HMI and stop the on going purge

Figure 15: Air Lock Purge Control - Side C – THRESHOLD

2.7. Light Intensity Control (CL4104)



2.7.1.Function

The strategy is to have three different ways for managing the lights of the chamber.

The operator decides in which mode he will operate the light depending on the action he wants to realize in the chamber.

- In OFF mode, all the lights are switch off.
- In AUTOMATIC mode, the operator can define:
  - the starting hour of the light
  - the stopping hour of the light
  - the light ramps (A(Sa), B(Sb) or C(MH)) to be lighted.

  The PLC Clock system will start and stop the defined light ramp in autonomous way according to the start and stop hours.

  The automatic mode can be set if the blower (BLWR_4111_01) is started and if the very high temperature alarm is not triggered. The automatic mode will be stopped for the same condition.

- In manual mode, the operator only defines the ramp to be lighted instantaneously.

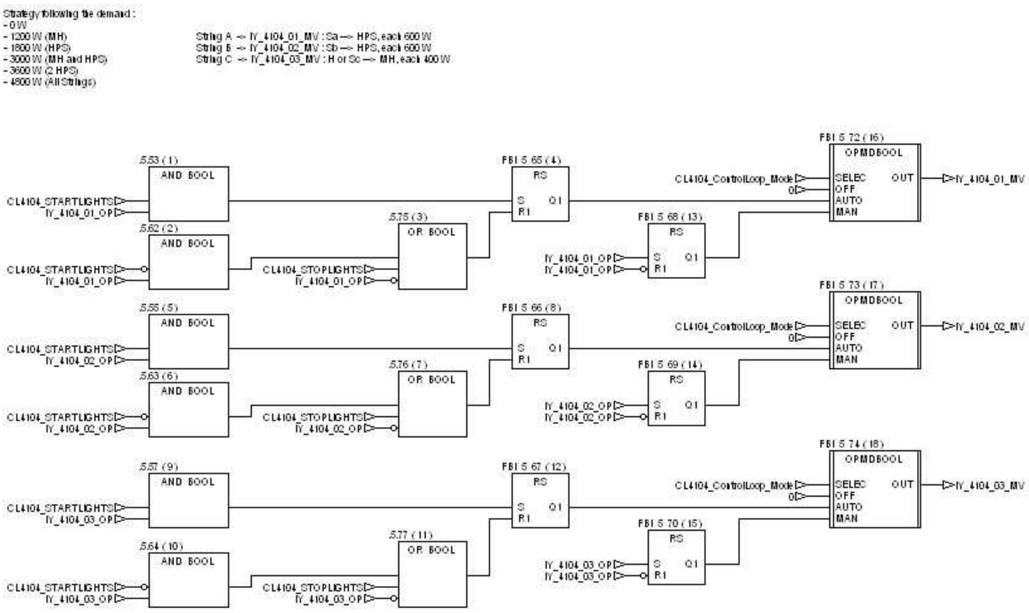
PLC Section name	Equipment tag	Type	Address	Comment
CL4104_Light_Intensity	RT_4104_01	AI ->REAL	400017	PAR Sensor - A
CL4104_Light_Intensity	RT_4104_02	AI ->REAL	400019	PAR Sensor - B
CL4104_Light_Intensity	RT_4104_03	AI ->REAL	400021	PAR Sensor - C
CL4104_Light_Intensity	IY_4104_01_MV	DO	000011	Ramp - A (LAMP Sa)
CL4104_Light_Intensity	IY_4104_02_MV	DO	000012	Ramp - B (LAMP Sb)
CL4104_Light_Intensity	IY_4104_03_MV	DO	000013	Ramp - C (LAMP H)

Figure 16: light Intensity Control – EQUIPMENTS

PLC Section name	tag	Type	Address	Comment
CL4104_Light_Intensity	CL4104_ControlLoop_Mode	INT	400119	Light Mode (Off/Auto/Manu)
CL4104_Light_Intensity	CL4104_StartingDay_Hour	UINT	400182	Day start: hour
CL4104_Light_Intensity	CL4104_StartingDay_Minute	UINT	400183	Day start: minute
CL4104_Light_Intensity	CL4104_EndingDay_Hour	UINT	400184	Day end: hour
CL4104_Light_Intensity	CL4104_EndingDay_Minute	UINT	400185	Day end: minute
CL4104_Light_Intensity	IY_4104_01_OP	BOOL	000143	Turn On/Off lamps - Sa (checkbox in Manual Mode)
CL4104_Light_Intensity	IY_4104_02_OP	BOOL	000144	Turn On/Off lamps - Sb (Checkbox in Manual Mode)
CL4104_Light_Intensity	IY_4104_03_OP	BOOL	000145	Turn On/Off lamps - H (Checkbox in Manual Mode)
CL4104_Light_Intensity	CL4104_STARTLIGHTS	BOOL	000157	indicate if the process is in day time (1) or in night time (2)

Figure 17: light Intensity Control – USER INDICATOR / INPUT

2.7.2.Block Diagram



2.7.3.Alarms and Threshold

Alarm tag Name	type	Address	description
CL4104_Sa_AH	BOOL	000037	Ramp Sa High Intensity Alarm stop the light (CB 20100707: Not implemented/waiting for threshold)
CL4104_Sa_AL	BOOL	000038	Ramp Sa Low Intensity Alarm
CL4104_Sb_AH	BOOL	000039	Ramp Sb High Intensity Alarm stop the light (CB 20100707: Not implemented/waiting for threshold)
CL4104_Sb_AL	BOOL	000040	Ramp Sb Low Intensity Alarm
CL4104_H_AH	BOOL	000041	Ramp H High Intensity Alarm stop the light (CB 20100707: Not implemented/waiting for threshold)
CL4104_H_AL	BOOL	000042	Ramp H Low Intensity Alarm
CL4104_Sa_H_AH	BOOL	000043	Ramp Sa/H High Intensity Alarm stop the light (CB 20100707: Not implemented/waiting for threshold)
CL4104_Sa_H_AL	BOOL	000044	Ramp Sa/H Low Intensity Alarm
CL4104_Sa_Sb_AH	BOOL	000045	Ramp Sa/Sb High Intensity Alarm stop the light (CB 20100707: Not implemented/waiting for threshold)
CL4104_Sa_Sb_AL	BOOL	000046	Ramp Sa/Sb Low Intensity Alarm
CL4104_Sa_Sb_H_AH	BOOL	000047	Ramp Sa/Sb/H High Intensity Alarm stop the light (CB 20100707: Not implemented/waiting for threshold)
CL4104_Sa_Sb_H_AL	BOOL	000048	Ramp Sa/Sb/H Low Intensity Alarm
CL4104_NoLight_AH	BOOL	000049	No Ramp High Intensity Alarm stop the light (CB 20100707: Not implemented/waiting for threshold)
RT_4104_01_ERR	BOOL	000050	ERROR is set when PLC loses the communication with the sensor
RT_4104_02_ERR	BOOL	000051	ERROR is set when PLC loses the communication with the sensor
RT_4104_03_ERR	BOOL	000052	ERROR is set when PLC loses the communication with the sensor

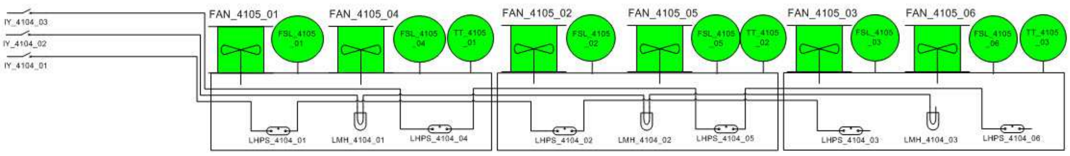
Figure 18: light Intensity Control – ALARMS

Threshold tag name	Type	Address	Value	Unit	ACTION
RT_4104_High_LIM_Sa_OR_Sb	REAL	400406	TBD	µmol/sec/m2	RAMP Sa only or RAMP Sb only (Sodium) / High luminisity LIMIT Display an alarm on the HMI and stop the light
RT_4104_Low_LIM_Sa_OR_Sb	REAL	400408	50	µmol/sec/m2	RAMP Sa only or RAMP Sb only (Sodium) / Low luminisity LIMIT Display an alarm on the HMI and do nothing else
RT_4104_High_LIM_H	REAL	400410	TBD	µmol/sec/m2	RAMP H only (Metal Halide) / High luminisity LIMIT Display an alarm on the HMI and stop the light
RT_4104_Low_LIM_H	REAL	400412	TBD	µmol/sec/m2	RAMP H only (Metal Halide) / Low luminisity LIMIT Display an alarm on the HMI and do nothing else
RT_4104_High_LIM_SaORsb_H	REAL	400414	TBD	µmol/sec/m2	RAMP Sa only or RAMP Sb only (Sodium) / High luminisity LIMIT Display an alarm on the HMI and stop the light
RT_4104_Low_LIM_SaORsb_H	REAL	400416	TBD	µmol/sec/m2	RAMP Sa only or RAMP Sb only (Sodium) / Low luminisity LIMIT Display an alarm on the HMI and do nothing else
RT_4104_High_LIM_Sa_Sb	REAL	400418	TBD	µmol/sec/m2	RAMP Sa and Sb / High luminisity LIMIT Display an alarm on the HMI and stop the light
RT_4104_Low_LIM_Sa_Sb	REAL	400420	TBD	µmol/sec/m2	RAMP Sa and Sb / Low luminisity LIMIT Display an alarm on the HMI and do nothing else
RT_4104_High_LIM_Sa_Sb_H	REAL	400422	TBD	µmol/sec/m2	RAMP Sa and Sb and H / Low luminisity LIMIT Display an alarm on the HMI and stop the light
RT_4104_Low_LIM_Sa_Sb_H	REAL	400424	TBD	µmol/sec/m2	RAMP Sa and Sb and H / Low luminisity LIMIT Display an alarm on the HMI and do nothing else
RT_4104_High_LIM_Nolight	REAL	400502	TBD	µmol/sec/m2	Display an alarm on the HMI and stop the light

Figure 19: light Intensity Control – THRESHOLDS

TBD : To be defined (14.12.09 status).

2.8. Lighting Loft Temperature Control (CL4105)



2.8.1.Function

In order to remove the heat produced by the light, and to prevent any temperature increasing in the chamber, each ramp is equipped with two fans (controlled by one signal), two flow switches (controlled by one signal) and a temperature probe. During the day cycle, if the loft temperature reaches 42°C, the first alarm is set to alert the operator (yellow display on the HMI). If the temperature continues to increase until 45°C, a second alarm is triggered, then immediately after, the lights are switched OFF and the fans are maintained during 20 min to remove heat outside the loft.
The controlled loop can be managed by three modes:

- OFF: All equipments are OFF
- AUTO: All equipments are ON if only one ramp is ON
- MANUAL: The operator decides to switch equipment ON or OFF.

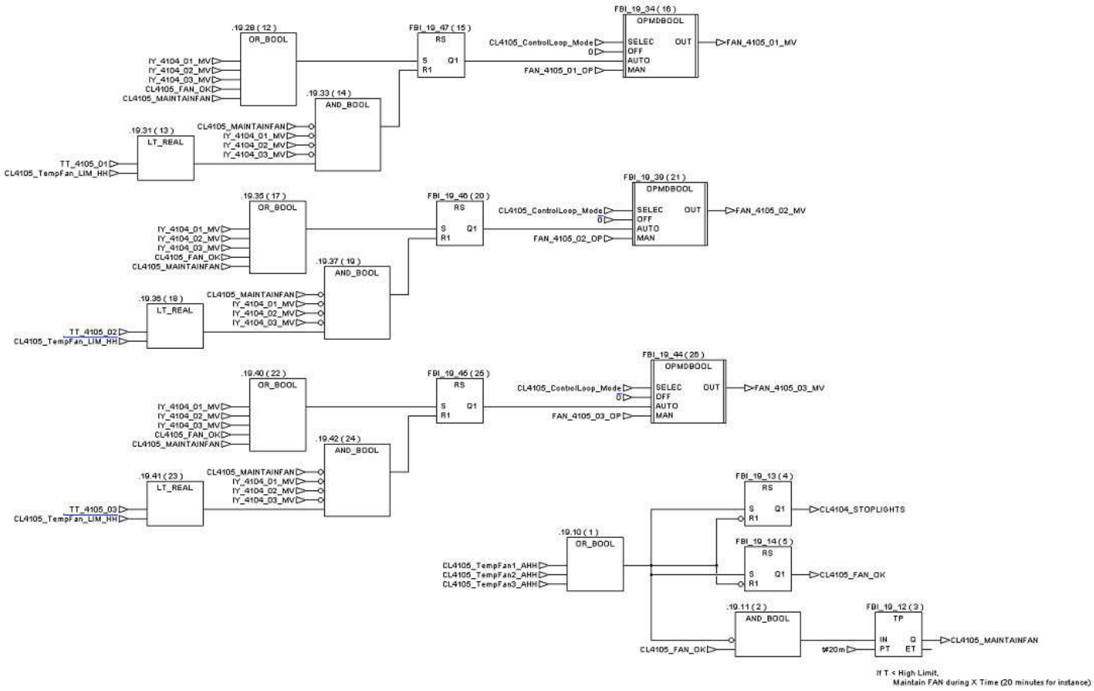
PLC Section name	Equipment tag	Type	Address	Comment
CL4105_Lighting_Loft_Temp	TT_4105_01	AI ->REAL	400023	Light Loft Temperature sensor A
CL4105_Lighting_Loft_Temp	TT_4105_02	AI ->REAL	400025	Light Loft Temperature sensor B
CL4105_Lighting_Loft_Temp	TT_4105_03	AI ->REAL	400027	Light Loft Temperature sensor C
CL4105_Lighting_Loft_Temp	FSL_4105_01	DI	000164	Flow / No flow of Light Loft Fan A
CL4105_Lighting_Loft_Temp	FSL_4105_02	DI	000165	Flow/ No flow of Light Loft Fan B
CL4105_Lighting_Loft_Temp	FSL_4105_03	DI	000166	Flow / No flow of Light Loft Fan C
CL4105_Lighting_Loft_Temp	FAN_4105_01_MV	DO	000003	Fan of Light Loft A
CL4105_Lighting_Loft_Temp	FAN_4105_02_MV	DO	000004	Fan of Light Loft B
CL4105_Lighting_Loft_Temp	FAN_4105_03_MV	DO	000005	Fan of Light Loft C

Figure 20: Lighting Loft Temperature Control – EQUIPMENTS

PLC Section name	Equipment tag	Type	Address	Comment
CL4105_Lighting_Loft_Temp	CL4105_ControlLoop_Mode	INT	400120	Fan Mode (Off/Auto/Manu)
CL4105_Lighting_Loft_Temp	FAN_4105_01_OP	BOOL	000146	Fan On / Off Appears on HMI screen only in Manual Mode
CL4105_Lighting_Loft_Temp	FAN_4105_02_OP	BOOL	000167	Fan On / Off Appears on HMI screen only in Manual Mode
CL4105_Lighting_Loft_Temp	FAN_4105_03_OP	BOOL	000168	Fan On / Off Appears on HMI screen only in Manual Mode

Figure 21: Lighting Loft Temperature Control – USER INDICATOR / INPUT

2.8.2. Block Diagram



2.8.3. Alarms and Threshold

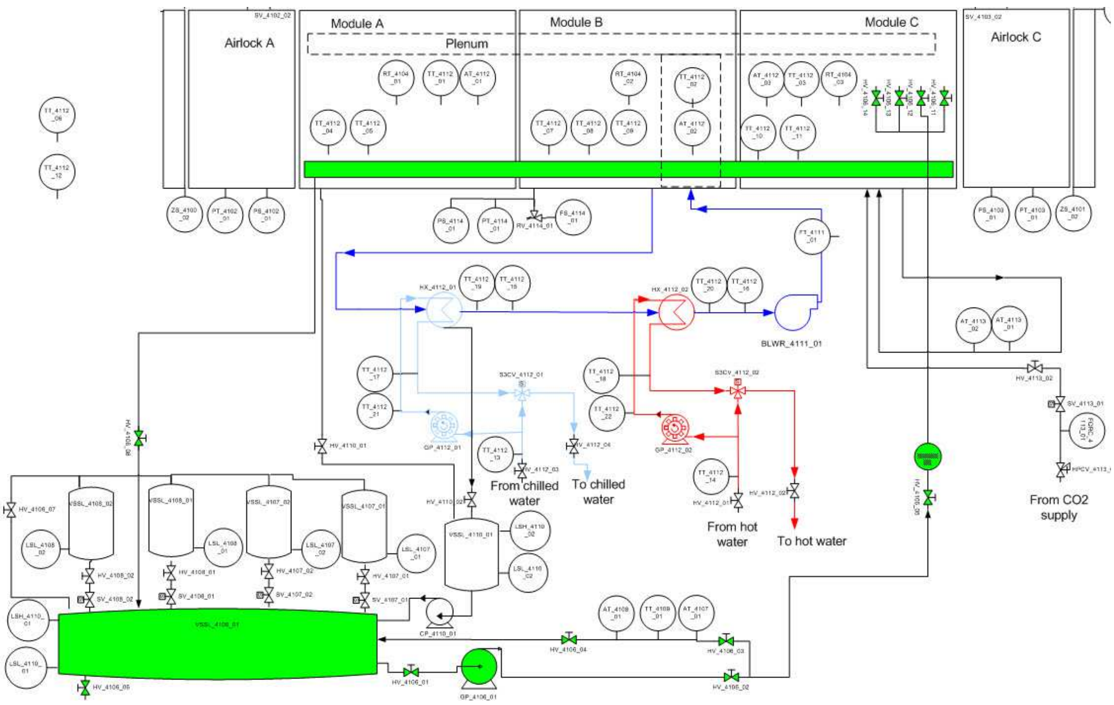
Alarm tag Name	type	Address	description
CL4105_TempFan1_AH	BOOL	000053	Temperature Fan 1 Alarm High
CL4105_TempFan1_AHH	BOOL	000054	Temperature Fan 1 Alarm High High Stop the light system
CL4105_FlowFan1_AL	BOOL	000055	Flow Fan 1 Alarm Low
CL4105_TempFan2_AH	BOOL	000056	Temperature Fan 2 Alarm High
CL4105_TempFan2_AHH	BOOL	000057	Temperature Fan 2 Alarm High High Stop the light system
CL4105_FlowFan2_AL	BOOL	000058	Flow Fan 2 Alarm Low
CL4105_TempFan3_AH	BOOL	000059	Temperature Fan 3 Alarm High
CL4105_TempFan3_AHH	BOOL	000060	Temperature Fan 3 Alarm High High Stop the light system
CL4105_FlowFan3_AL	BOOL	000061	Flow Fan 3 Alarm Low
TT_4105_01_ERR	BOOL	000062	ERROR is set when PLC loses the communication with the sensor
TT_4105_02_ERR	BOOL	000063	ERROR is set when PLC loses the communication with the sensor
TT_4105_03_ERR	BOOL	000064	ERROR is set when PLC loses the communication with the sensor

Figure 22: Lighting Loft Temperature Control – ALARMS

Threshold tag name	Type	Address	Value	Unit	ACTION
CL4105_TempFan_LIM_H	REAL	400426	42	°C	Display an alarm on the HMI High Temperature loft LIMIT
CL4105_TempFan_LIM_HH	REAL	400428	45	°C	Stop the light system Very High Temperature loft LIMIT

Figure 23: Lighting Loft Temperature Control – THRESHOLDS

2.9. Irrigation System (CL4106)



2.9.1.Function

The plants are irrigated by a hydroponic system. The liquid is driven via a pump and four manual valves to 20 trays for feeding the plants. One part of the stream returns directly to the nutrient tank through a ramp equipped with pH and EC sensor. The liquid returns to the nutrient tank (VSSL_4106_01) by gravity. The pump is controlled by a VDF which is configurable in manual way only. The PLC controls the Start and the Stop of the pump. Concerning the alarm, a liquid flow transmitter monitors if the pump works. There are 4 levels of flow alarm (high, very high, low and very low). Only the very low and very high alarm generates a PLC action:

- Due to the analyser position, if the flow goes under 6 litres per minute, the pH and EC probe measurement are not considered as reliable as they should be. According to this, the control loops of EC and of pH are stopped to prevent plant destruction by the hydroponic solution.

The control loop can be managed by three modes:

- OFF: All equipments are OFF
- AUTO: The pump is ON

The control mode can be set if :

- No pH HighHigh Alarm (pH lower than 7)
- No pH LowLow Alarm (pH greater than 5)
- No EC HighHigh Alarm (EC lower than 2.5 mS/cm).
- The Level switch Low of the nutrient tank is not triggered.

➢ MANUAL: The operator decides to switch the pump ON or OFF.

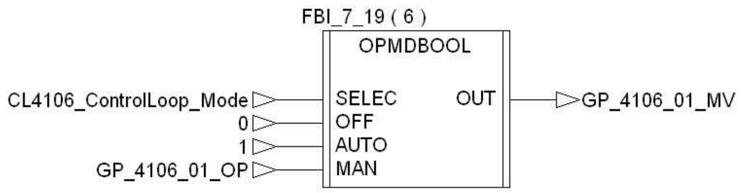
PLC Section name	Equipment tag	Type	Address	Comment
CL4106_Irrigation	GP_4106_01_MV	DO	000014	Main irrigation Pump P2001
CL4106_Irrigation	FT_4106_01	AI ->REAL	400029	Outlet nutrient flow sensor

Figure 24: Irrigation System - EQUIPMENTS

PLC Section name	Equipment tag	Type	Address	Comment
CL4106_Irrigation	CL4106_ControlLoop_Mode	INT	400121	Irrigation Mode (Off/Auto/Manu)
CL4106_Irrigation	GP_4106_01_OP	BOOL	000147	Operator can start or stop the pump in manual mode.

Figure 25: Irrigation System - USER INDICATOR / INPUT

2.9.2. Block Diagram



The block “OPMDBOOL” is a selector block. The select pin can take 3 states corresponding to the 3 modes (OFF / AUTOMATIC / MANUAL).

2.9.3. Alarms and Threshold

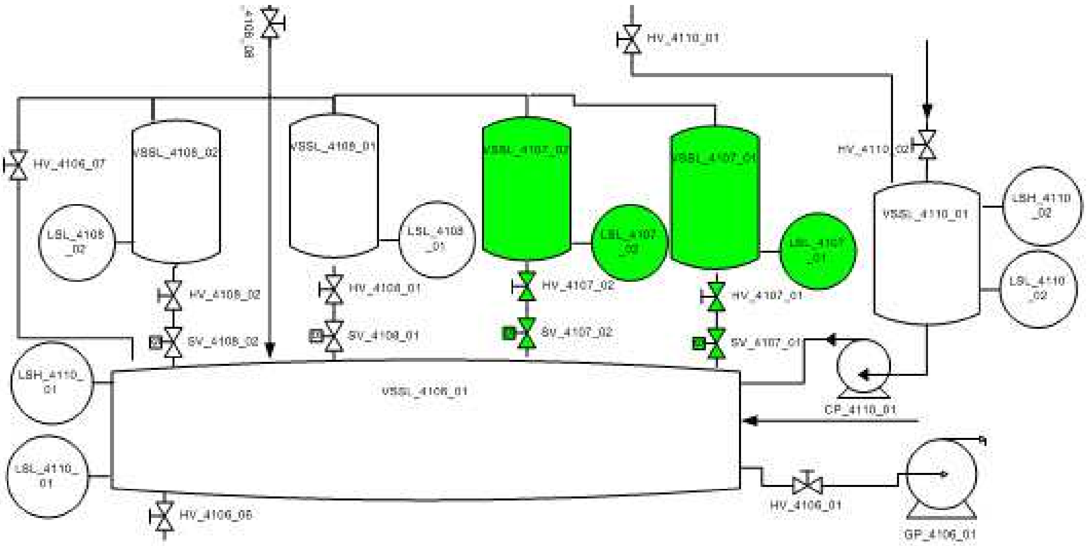
Alarm tag Name	type	Address	description
CL4106_Flow_AH	BOOL	000065	Irrigation Flow Alarm High
CL4106_Flow_AHH	BOOL	000066	Irrigation Flow Alarm High High Stop the irrigation, pH, EC Control Loop
CL4106_Flow_AL	BOOL	000067	Irrigation Flow Alarm Low
CL4106_Flow_ALL	BOOL	000068	Irrigation Flow Alarm Low Low Stop the irrigation, pH, EC Control Loop
CL4106_PumpError_A	BOOL	000069	Control Pump Error Alarm
FT_4106_01_ERR	BOOL	000070	Sensor FT_4106_01 in Error

Figure 26: Irrigation System – ALARMS

Threshold tag name	Type	Address	Value	Unit	ACTION
FT_4106_01_LIM_H	REAL	400430	15	L/Min	Display an alarm on the HMI High Irrigation Flow LIMIT
FT_4106_01_LIM_HH	REAL	400432	17	L/Min	Stop the irrigation, pH, EC Control Loop Very High Irrigation Flow LIMIT
FT_4106_01_LIM_L	REAL	400434	8	L/Min	Display an alarm on the HMI Low Irrigation Flow LIMIT
FT_4106_01_LIM_LL	REAL	400436	6	L/Min	Stop EC and pH control Very Low Irrigation Flow LIMIT

Figure 27: Irrigation System – THRESHOLDS

2.10. pH Control (CL4107)



2.10.1.Function

The pH needs to be monitored and controlled for the plant growth. Only valves are managed. The ACID solution and the BASE solution are added to the nutrient tank by gravity when one of the two valves is opened. Three modes are available.

- OFF: valves are closed.
- AUTOMATIC: The controller adjusts the pH value depending on the set point and the dead zone entered by the operator.
  The automatic mode can be set if
  - the flow meter FT_4106_01 value is above 6 L/min or below 17 L/mn. If not, the control loop will automatically be triggered to OFF mode.
  - pH lower than 7 (Alarm HH)
  - pH higher than 5 (Alarm LL)
  - No pH LL
- MANUAL: the operator selects valves and opening time (in seconds).

PLC Section name	Equipment tag	Type	Address	Comment
CL4107_PH	AT_4107_01	AI ->REAL	400031	pH sensor
CL4107_PH	SV_4107_01_MV	DO	000015	Acid Tank Valve
CL4107_PH	SV_4107_02_MV	DO	000016	Base Tank Valve
CL4107_PH	LSL_4107_01	DI	100010	Acid Tank Level
CL4107_PH	LSL_4107_02	DI	100011	Base Tank Valve

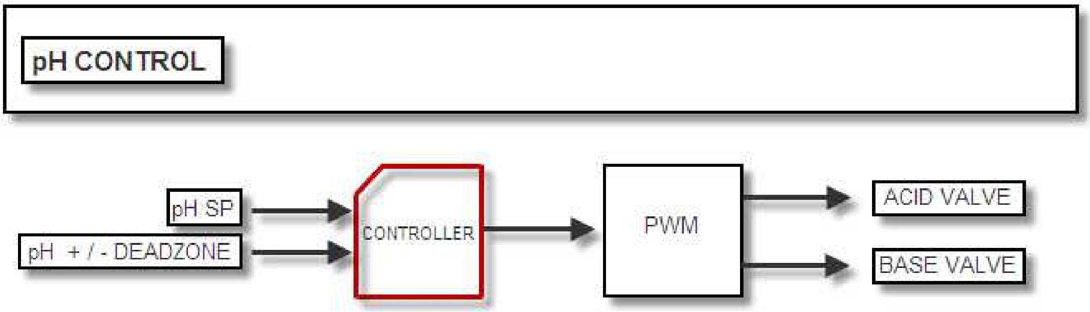
Figure 28: pH Control - EQUIPMENTS

PLC Section name	Equipment tag	Type	Address	Comment
CL4107_PH	CL4107_ControlLoop_Mode	INT	400122	PH Mode (Off/Auto/Manu)
CL4107_PH	SV_4107_01_OP	BOOL	000148	In manual mode, operator decides to open or close the valve.
CL4107_PH	SV_4107_01_OP_Time	UDINT	400227	Time entered by the operator to define the opening period (in sec) of the valve in manual mode
CL4107_PH	SV_4107_02_OP	BOOL	000149	In manual mode, operator decides to open or close the valve.
CL4107_PH	SV_4107_02_OP_Time	UDINT	400229	Time entered by the operator to define the opening period (in sec) of the valve in manual mode
CL4107_PH	CL4107_Base_injection	REAL	400336	the injection is calculated in ml
CL4107_PH	CL4107_Acid_injection	REAL	400338	the injection is calculated in ml
CL4107_PH	CL4107_Base_calibration	REAL	400340	base calibration factor (mL/s)
CL4107_PH	CL4107_Acid_calibration	REAL	400342	Acid calibration factor (mL/s)

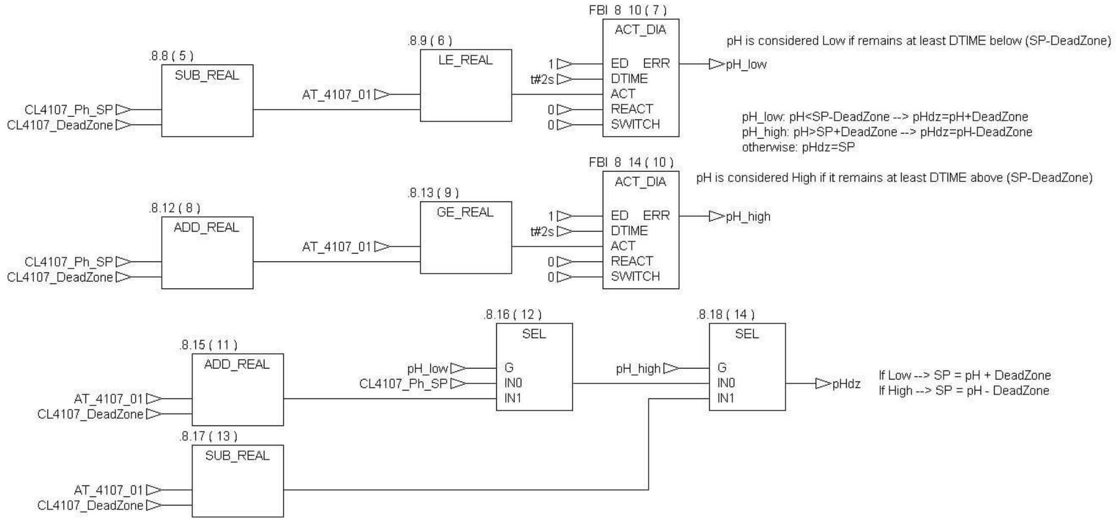
Figure 29: pH Control – USER INDICATOR / INPUT

2.10.2.Block Diagram

2.10.2.1. *Controller*



2.10.2.2. *Calculation of the pH value including dead zone (automatic mode)*



In order to control the pH, the PLC needs to have, at the input of the controller, the process value +/- the dead zone defined by the operator. Depending on the mode pH state (High or low) the dead zone is added (pH high) or subtracted (pH low) to the analyser value. Once done, the calculated value becomes the controlled variable (‘pHdz’).

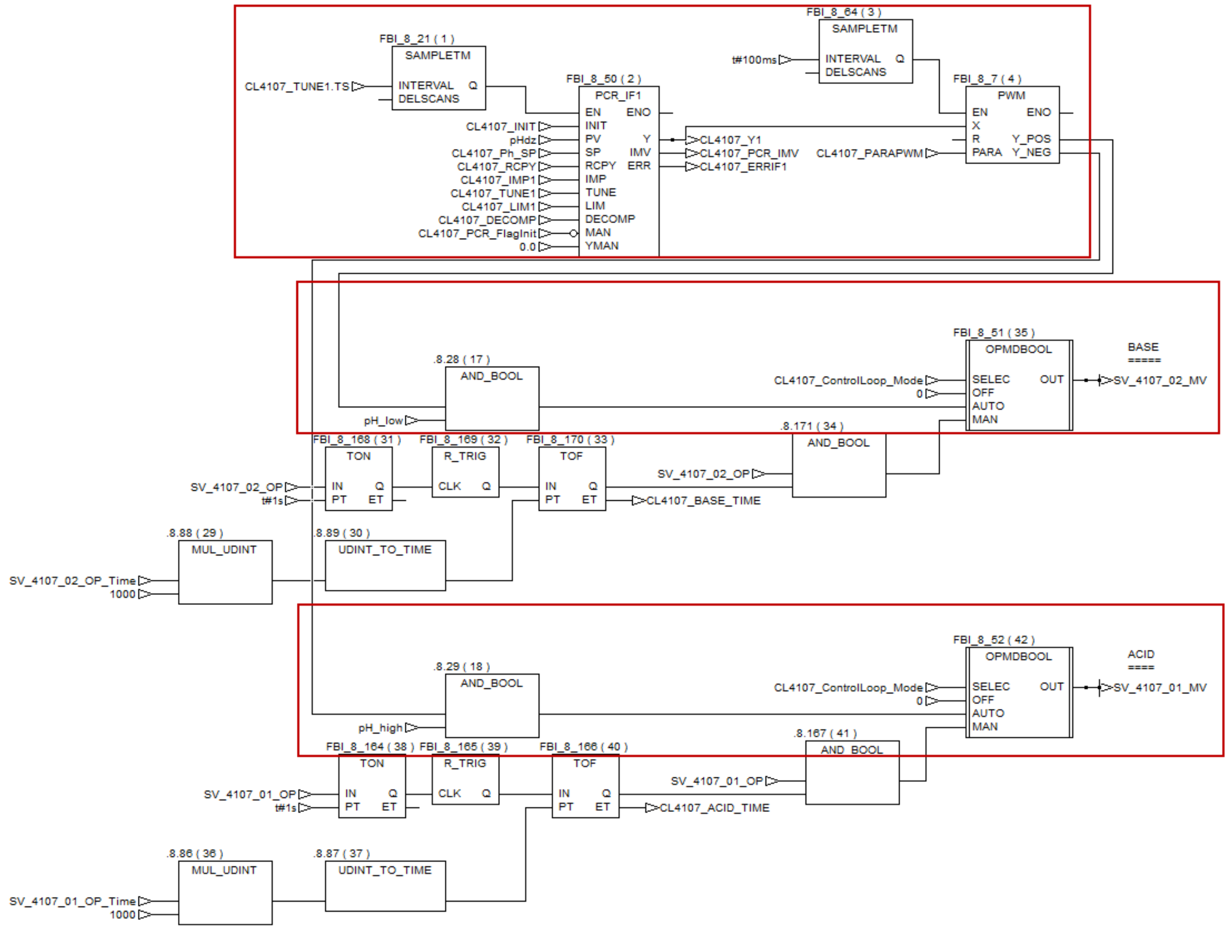
So :

If pH <(SP–DeadZone) we have a pH_low, then pHdz becomes (pH+DeadZone)

If pH >(SP+DeadZone) we have a pH_high, then pHdz becomes (pH-DeadZone)

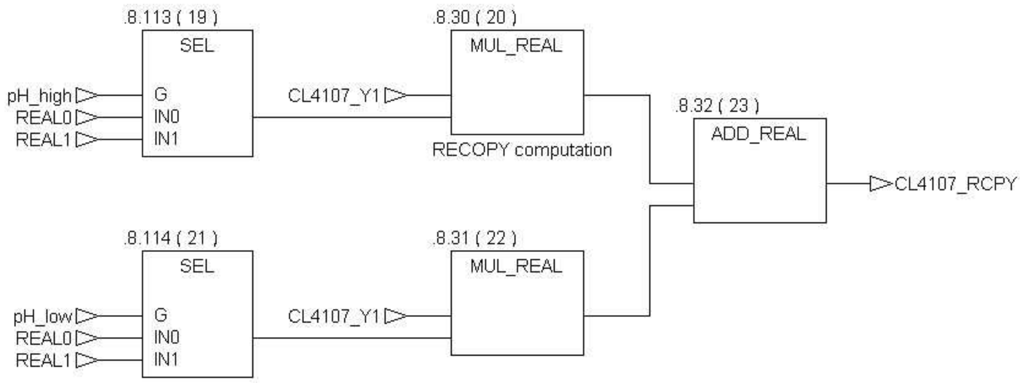
The limit has to be reached during 2 seconds before it is triggered in ph high or low mode.

2.10.2.3. *Controller (automatic mode)*



The control is done by the Predictive control block IF1 (integrative first order) (See annex D). An internal model is linked to the controller representing the pH evolution function of base or acid injection. Depending of this model, the controller will anticipate the changes of the pH value according to the time. As the controller computes an analogical value, the controller output signal is transformed in opening valve time by a PWM block (pulse width modulation) sampled at 100ms.

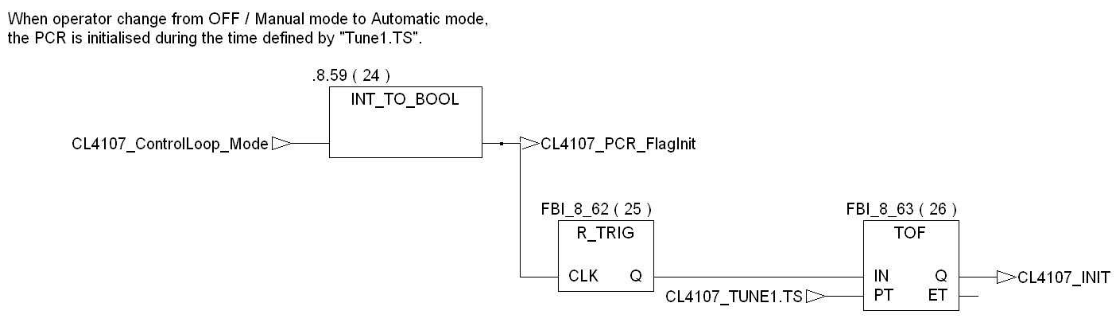
Controller recopy:



The recopy pin is a controller input. It permits to the controller to know what was really applied on equipment compared to what it had calculated previously. For example, if the controller calculates a very short injection, it will be transformed by the PWM into a very short time. In order to preserve equipment life time, limits are configured. It means that sometimes the controller asks for an opening but the valve stay closed. The controller needs to be aware of the situation to make the following computation in a good way.

Here, we have implemented the same logic. If the pH is situated in the Dead zone, the controller still continues to calculate tiny value of injection. To inject BASE or ACID, the PLC tag pH_low or pH_high need to be set. If it is not the case, the controller output is multiplied by 0 then the controller knows that no solution has been injected.

Controller initialization:



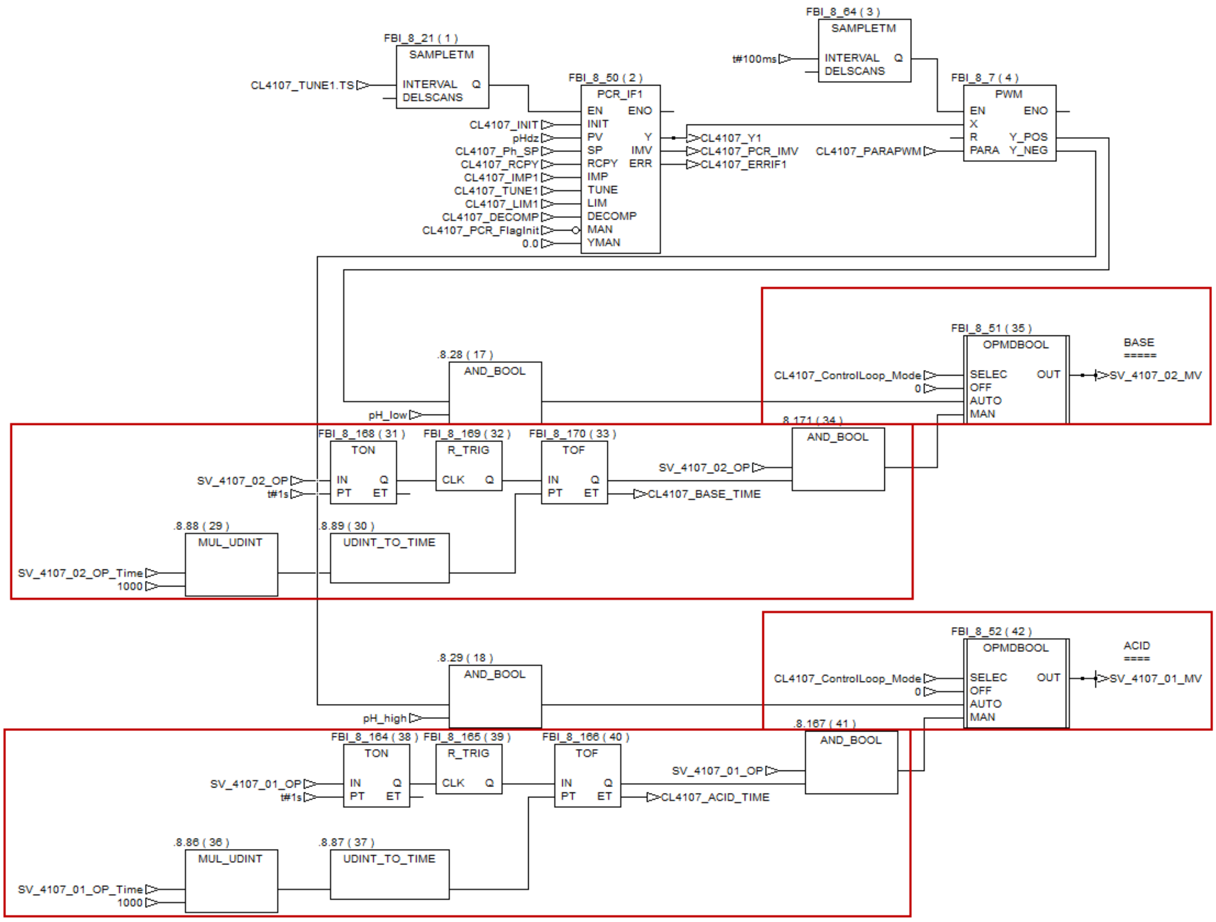
When operator decides to switch the pH in automatic mode, the controller is initialized during its internal sample time. This time (represented by the tag: "CL4107_TUNE1.TS") define the temporal point where the controller makes calculation. The initialization is needed to inform the controller about the current pH state and permit to start the control in good condition.

Controller Parameters:

Controlled Variable	PCR CONTROLER TYPE	DEAD ZONE	ZTR Zone Control	PWM	SAMPLETM	PROCESS VALUE (input)	SET POINT
PH	IF1	0.1 (configurable)	NO	CL4107_PARAPWM t_period : 60s t_pause : 0s t_brake : 0s t_min : 0.1s t_max : 10s up_pos : 1 up_neg : 1	Controller: CL4107_TUNE.TS (60s) PWM : 100ms	pHdz	CL4107_Ph_SP

INTERNAL MODEL PROCESS	TUNE	LIMIT	SELF_CMP	DECOMP	Manipulated Variable (Controller Output in Auto Mode)	Controlled Equipment
CL4107_IMP1 KM : 0.01 TM : 20s DM : 60s	CL4107_TUNE1 TS : 60s H : 2m TRBF : 3m	CL4107_LIM1 YMIN : -0,17 YMAX : 0,17 YRATE : 1	NO	10m	SV_4107_01_MV SV_4107_02_MV	SV_4107_01(acid) SV_4107_02(base)

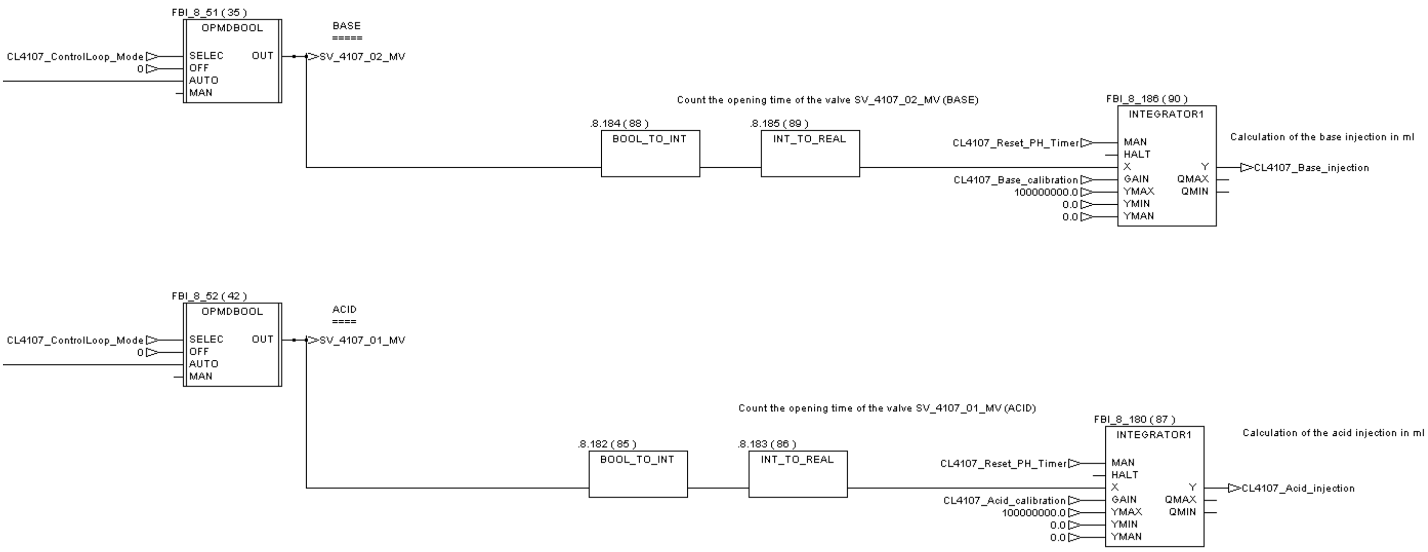
2.10.2.4. *Opening time management for BASE and ACID valves (manual mode)*



In manual mode, the operator defines which valve he wants to open (BASE, ACID or both) and how long.
The operator inputs are reset if one of the following conditions appears:

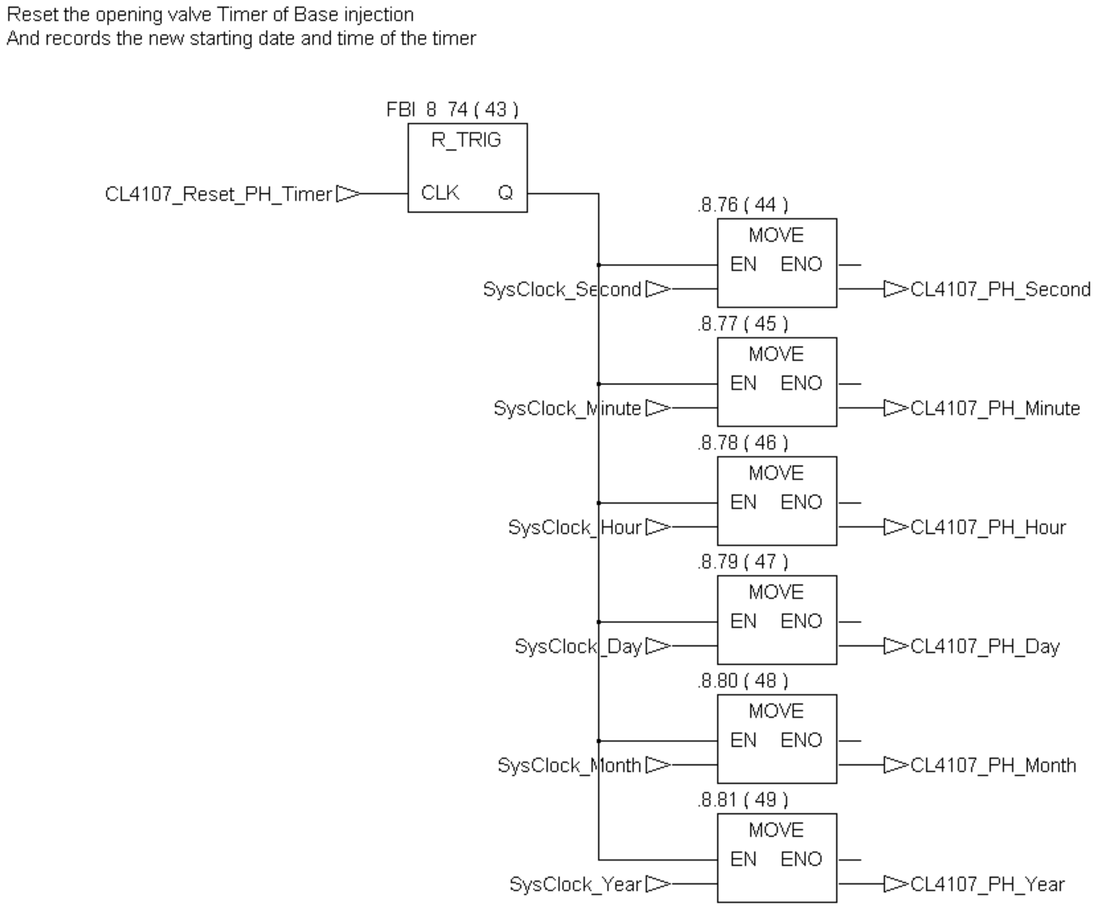
- no time is configured.
- the control loop is set to OFF mode
- the desired opening time is finished. (This condition doesn't appear on the block diagram).

2.10.2.5. *Injection calculation (Automatic mode)*



This function is implemented to have an idea of the quantity injected inside the chamber. This value needs to be analysed with caution according to the hardware managing the pH (Only gravity makes the liquid go inside the nutrient tank). Each time that a valves is opened, an integrator block records the time elapsed of the injection. Then this time is converted into ml thanks to a calibration factor.

2.10.2.6. *Reset of the opening time calculation (operator action)*



2.10.3.Alarms and Threshold

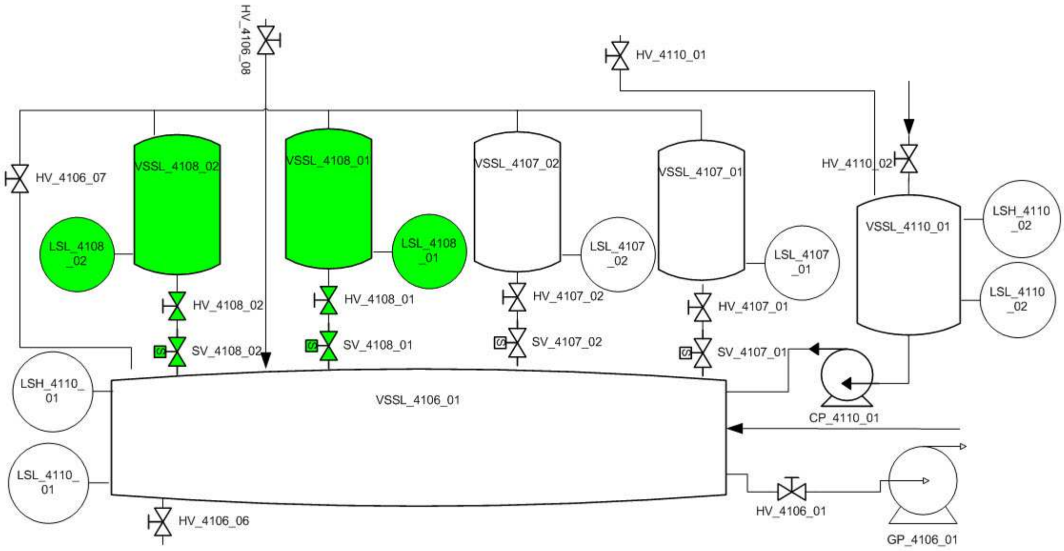
Alarm tag Name	type	Address	description
CL4107_AcidTank_AL	BOOL	000071	Acid Tank Level Low Alarm
CL4107_BaseTank_AL	BOOL	000072	Base Tank Level Low Alarm
CL4107_Ph_AH	BOOL	000073	PH Alarm High
CL4107_Ph_AHH	BOOL	000074	PH Alarm High High Stop the irrigation system and PH and EC control
CL4107_Ph_AL	BOOL	000075	PH Alarm Low
CL4107_Ph_ALL	BOOL	000076	PH Alarm Low Low Stop the irrigation system and PH and EC control
AT_4107_01_ERR	BOOL	000077	Sensor AT_4107_01 in Error

Figure 30: pH Control – ALARMS

Threshold tag name	Type	Address	Value	Unit	ACTION
CL4107_Ph_LIM_H	REAL	400438	6	-	High PH LIMIT Display an alarm on the HMI
CL4107_Ph_LIM_HH	REAL	400440	7	-	Very High PH LIMIT Stop the irrigation system and PH and EC control
CL4107_Ph_LIM_L	REAL	400442	5.6	-	Low PH LIMIT Display an alarm on the HMI
CL4107_Ph_LIM_LL	REAL	400444	5	-	Very Low PH LIMIT Stop the irrigation system and PH and EC control

Figure 31: pH Control – THRESHOLDS

2.11. EC Control (CL4108)



Remark: the P&ID is not updated related to the new metering pumps (09/02/2011)

2.11.1.Function

The Electro Conductivity needs to be monitored and control for the plant growth. Only valves are managed. Each nutrient solution (A & B) is injected to the nutrient tank thanks to a metering pump and a valve. There is no equipment to decrease the EC. Only plant consumption can do it.

Three modes are available.

- OFF: valves are closed.
- AUTOMATIC: The controller adjusts the EC value depending on the set point and the dead zone entered by the operator.
  - The automatic mode can be set if
    - the flow meter FT_4106_01 value is above 6 L/min or below 17 L/mn. If not the control loop will automatically be triggered to OFF mode.
    - EC lower than 2.5 mS/cm (Alarm HH)
- MANUAL: the operator selects valves and opening time (in seconds).

PLC Section name	Equipment tag	Type	Address	Comment
CL4108_EC	AT_4108_01	AI ->REAL	400033	Electrical Conductivity of nutrient
CL4108_EC	SV_4108_01_MV	DO	000017	Stock A inject Valve
CL4108_EC	SV_4108_02_MV	DO	000018	Stock B inject Valve
CL4108_EC	MP_4108_01_MV	DO	000023	Stock A metering pump injection
CL4108_EC	MP_4108_02_MV	DO	000024	Stock B metering pump injection
CL4108_EC	LSL_4108_01	DI	100012	Level sensor Stock A
CL4108_EC	LSL_4108_02	DI	100013	Level sensor Stock B

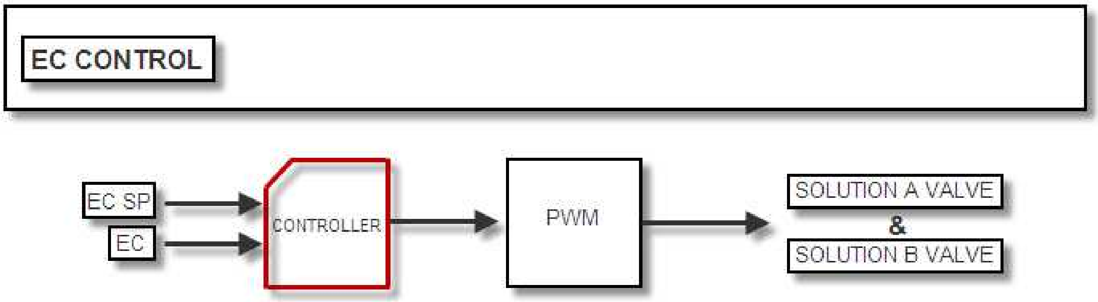
Figure 32 : EC Control - EQUIPEMENTS

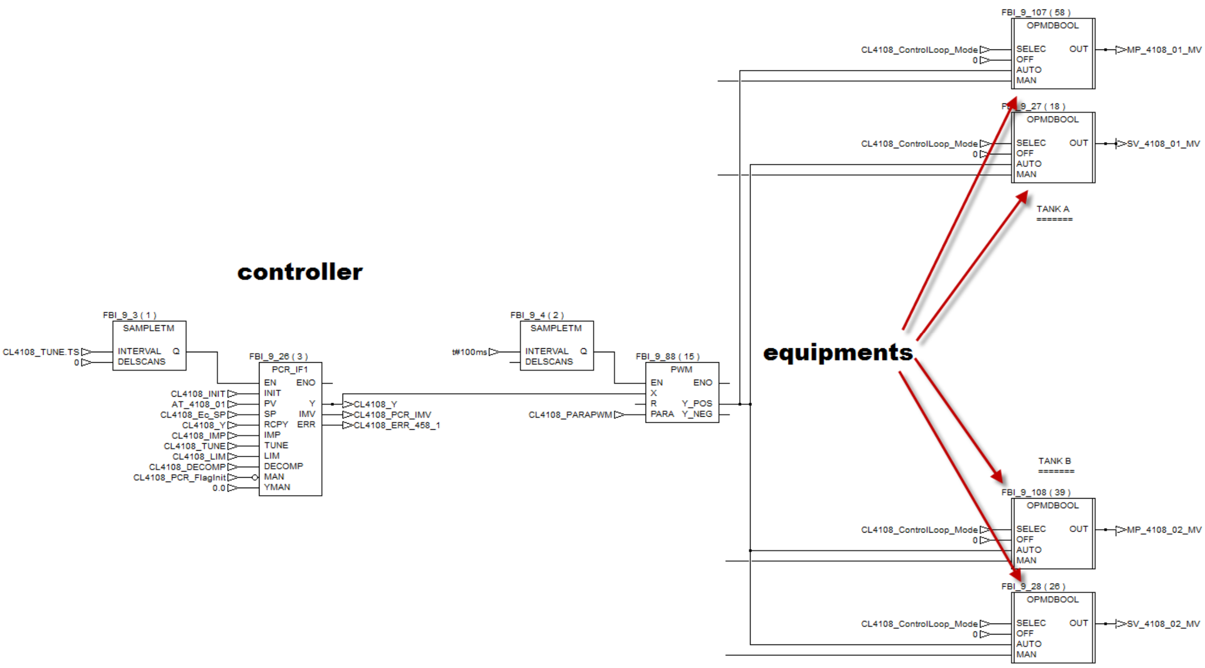
PLC Section name	Equipment tag	Type	Address	Comment
CL4108_EC	CL4108_ControlLoop_Mode	INT	400123	EC Mode (OFF/AUTO/MAN)
CL4108_EC	CL4108_SolA_OP_Time	UDINT	400231	Time entered by the operator: define the opening period (in sec) of the stockA equipment in manual mode
CL4108_EC	CL4108_SolB_OP_Time	UDINT	400390	Time entered by the operator: define the opening period (in sec) of the stockB equipment in manual mode
CL4108_EC	SV_4108_01_OP	BOOL	000150	SV_4108_01 management in manual mode
CL4108_EC	SV_4108_02_OP	BOOL	000151	SV_4108_02 management in manual mode
CL4108_EC	MP_4108_01_OP	BOOL	000184	MP_4108_01 management in manual mode
CL4108_EC	MP_4108_02_OP	BOOL	000185	MP_4108_02 management in manual mode
CL4108_EC	CL4108_Reset_EC_Timer	BOOL	000159	RESET the Timer for both EC valves and set the new starting date and time for Timer
CL4108_EC	CL4108_Ec_SP	REAL	400142	EC Set Point
CL4108_EC	CL4108_SolA_injection	REAL	400344	Solution A injection volume (in ml)
CL4108_EC	CL4108_SolA_calibration	REAL	400346	Solution A calibration factor (mL/s)
CL4108_EC	CL4108_SolB_injection	REAL	400348	Solution B injection volume (in ml)
CL4108_EC	CL4108_SolB_calibration	REAL	400350	Solution B calibration factor (mL/s)
CL4108_EC	CL4108_EC_Opening_Time	REAL	400190	The timer is increasing in second
CL4108_EC	CL4108_EC_Second	BYTE	400221	Date of the last reset done by the operator
CL4108_EC	CL4108_EC_Minute	BYTE	400222	Date of the last reset done by the operator
CL4108_EC	CL4108_EC_Hour	BYTE	400223	Date of the last reset done by the operator
CL4108_EC	CL4108_EC_Day	BYTE	400224	Date of the last reset done by the operator
CL4108_EC	CL4108_EC_Month	BYTE	400225	Date of the last reset done by the operator
CL4108_EC	CL4108_EC_Year	BYTE	400226	Date of the last reset done by the operator

Figure 33 : EC Control - USER INDICATOR / INPUT

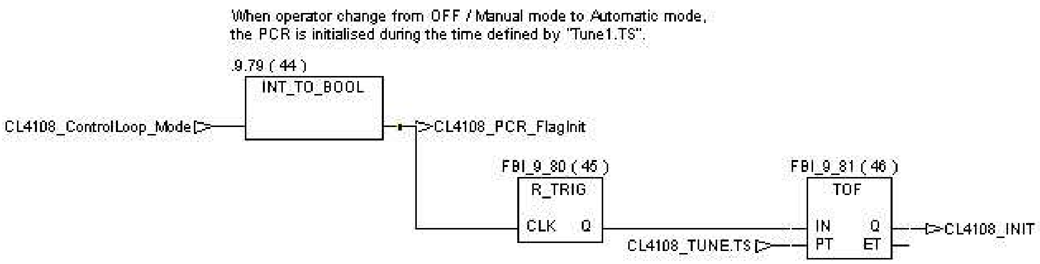
2.11.2. Block Diagram

2.11.2.1. *Controller (automatic mode)*





Controller initialization

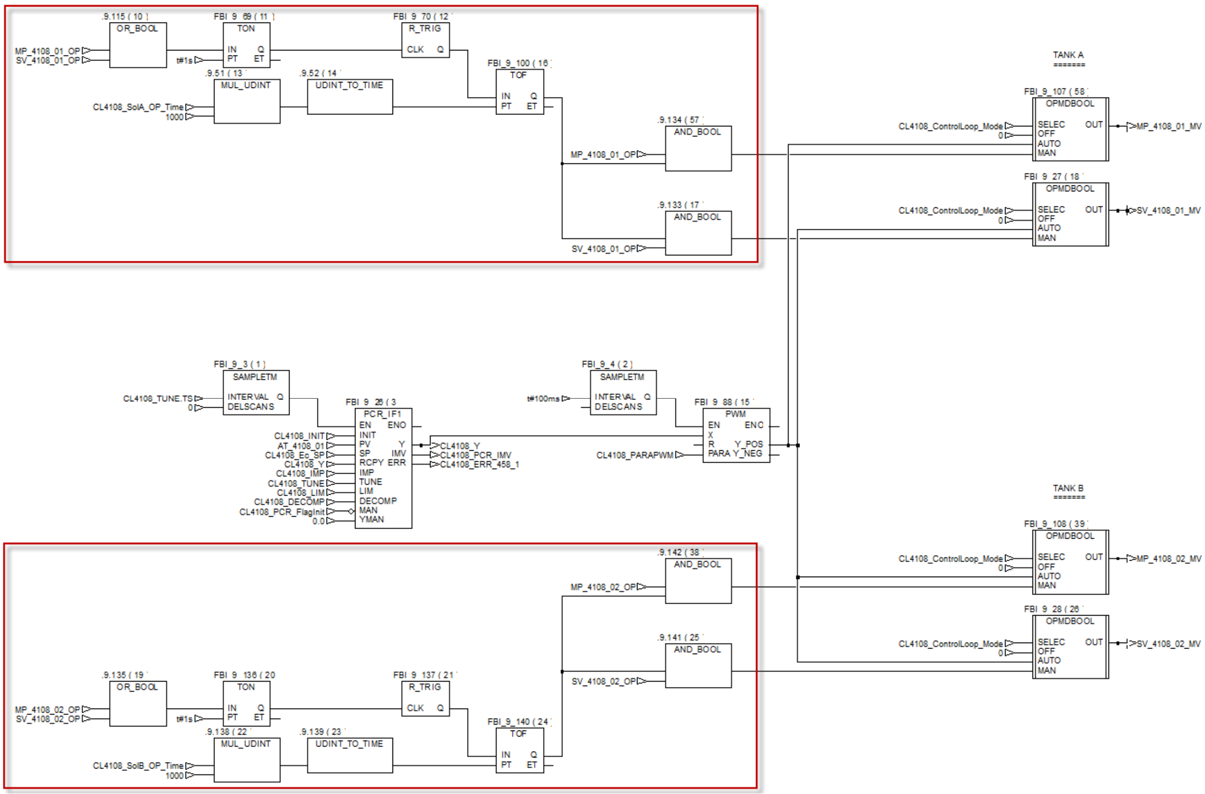


Controller parameter

Controlled Variable	PCR CONTROLER TYPE	DEAD ZONE	ZTR Zone Control	PWM	SAMPLETM	PROCESS VALUE (input)	SET POINT
EC	IF1	NO	NO	CL4108_PARAPWM t_period : 20s t_pause : 0s t_brake : 0s t_min : 0.2s t_max : 10s up_pos : 1 up_neg : -1	Controller: CL4108_TUNE.TS (20s) PWM : 100ms	AT_4108_01	CL4108_Ec_SP

INTERNAL MODEL PROCESS	TUNE	LIMIT	SELF_CMP	DECOMP	Manipulated Variable (Controller Output in Auto Mode)	Controlled Equipment
CL4108_IMP KM : 0.0008 TM : 47s DM : 0s	CL4108_TUNE TS : 20s H : 1m TRBF : 3m	CL4108_LIM1 YMIN : 0 YMAX : 0.5 YRATE : 0.1	NO	10m	SV_4108_01_MV MP_4108_01_MV SV_4108_02_MV MP_4108_02_MV	SV_4108_01 and MP_4108_01 (Nutrient tank1) SV_4108_02 and MP_4108_02 (Nutrient tank 2)

2.11.2.2. *Opening time management in manual mode for Solution A and Solution B (valves /pump)*

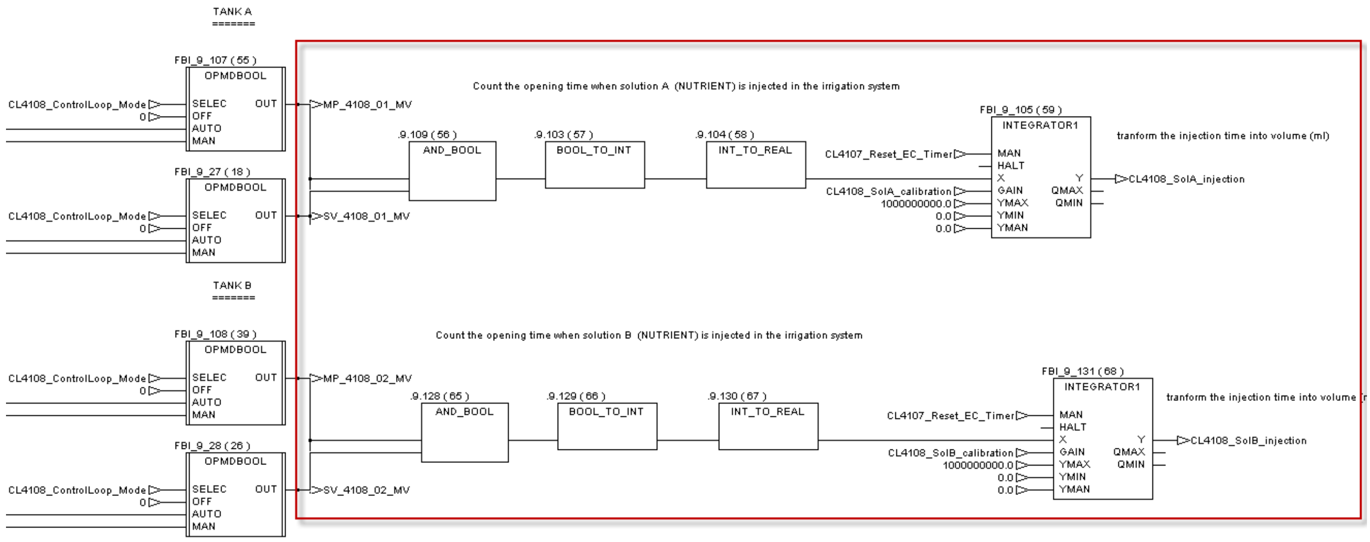


In manual mode, the operator defines which valve and/or pump he wants to activate (Solution A, Solution B or both) and how long. The time is entered by the operator in second. 1 second delay is configured, to be sure that all information coming from the SCADA is taken into account by the PLC before starting.

The operator inputs are reset if one of the following conditions appears:

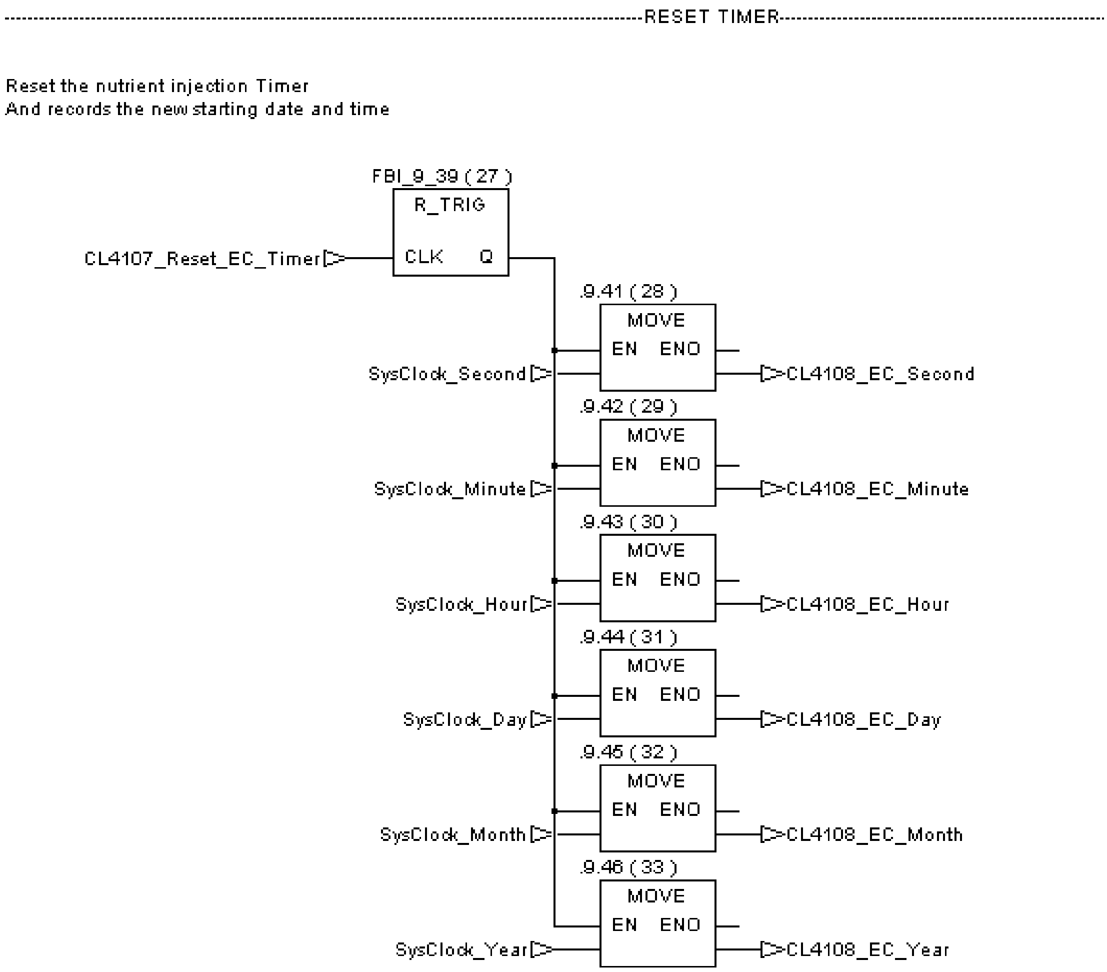
- No time is configured.
- The control loop is set to OFF mode.
- The desired opening time is finished. (This condition doesn't appear on the block diagram).

2.11.2.3. *Injection calculation (Automatic mode)*



Each injection of the Solution A and B are recorded independently (in automatic and Manual Mode). This function provides the amount (in ml) injected since the last reset done by the operator. When the reset is done, the current date is displayed on HMI (The PLC should be well configured). If both pump and valve are activated, the injection done is recorded. A calibration factor, corresponding to the nutrient solution amount injects in one second, permits to have an accurate calculation. This factor is configurable by the operator.

2.11.2.4. *Reset of the opening time calculation (operator action)*



The operator can reset the valves opening timer by clicking on the HMI reset button. Once done, the tag “CL4108_Reset_EC_Timer” is set. The Solution A and Solution B timer are reset then the Start date is configured with the current internal clock of the PLC.

2.11.3.Alarms and Thresholds

Alarm tag Name	type	Address	description
CL4108_NutrientTankA_AL	BOOL	000078	Nutrient Tank A Level Low Alarm
CL4108_NutrientTankB_AL	BOOL	000079	Nutrient Tank B Level Low Alarm
CL4108_Ec_AH	BOOL	000080	Electro-Conductivity Alarm High
CL4108_Ec_AHH	BOOL	000081	Electro-Conductivity Alarm High High Stop the irrigation system and PH and EC control
CL4108_Ec_AL	BOOL	000082	Electro-Conductivity Alarm Low
CL4108_Ec_ALL	BOOL	000083	Electro-Conductivity Alarm Low Low
AT_4108_01_ERR	BOOL	000084	Sensor AT_4108_01 in Error

Figure 34 : EC Control – ALARMS

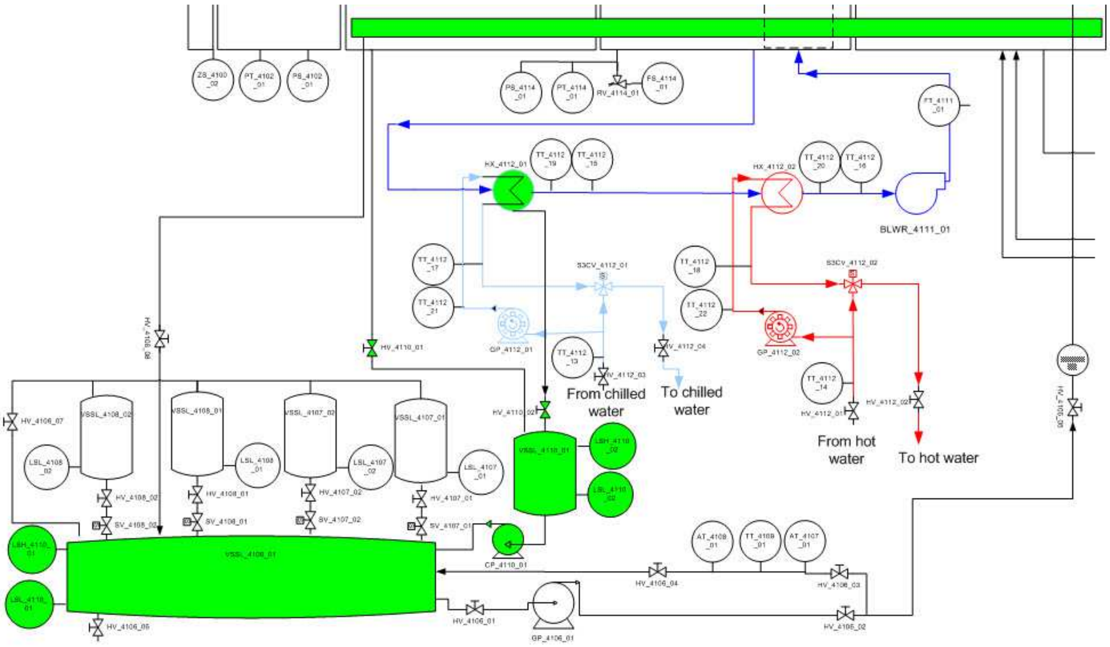
Threshold tag name	Type	Address	Value	Unit	ACTION
CL4108_Ec_LIM_H	REAL	400446	2.2	millisiemens / cm	High Electro Conductivity LIMIT Display an alarm on the HMI
CL4108_Ec_LIM_HH	REAL	400448	2.5	millisiemens / cm	Very High Electro Conductivity LIMIT Stop the irrigation system and PH and EC control
CL4108_Ec_LIM_L	REAL	400450	1.5	millisiemens / cm	Low Electro Conductivity LIMIT Display an alarm on the HMI
CL4108_Ec_LIM_LL	REAL	400452	1	millisiemens / cm	Very Low Electro Conductivity LIMIT Display an alarm on the HMI

Figure 35 : EC Control – THRESHOLDS

2.12. Nutrient Tank Temperature Control (CL4109)

At the beginning of the chamber design, the Nutrient tank was equipped with a heat resistor and a temperature probe. Both equipments were not installed.
This control loop is no longer operational.

2.13. Nutrient and Condensate Levels Control (CL4110)



2.13.1.Function

The aim of this control loop is to bring back to the nutrient tank the water coming from condensate. The condensate water is made on the cold exchanger used to control humidity. This quantity of water needs to be re-injected in the nutrient tank to preserve the pH and EC concentration. Two level switches in the condensate vessel permit to detect the condensate.

The pump management used to drive the liquid inside the nutrient tank is linked to the following logic:

Conditions to start the pump:

- High level in the condensate tank and low level in the nutrient tank
- High level in the condensate tank and NOT low level in the nutrient tank and NOT high level in the nutrient tank
- Not high level for condensate tank and not low level for condensate tank and not high level for nutrient tank and low level for reservoir tank

Conditions to stop the pump:

- Not high level in the condensate tank and low level in the condensate tank and not low level in the nutrient Tank and not high level for nutrient tank
- Not high level for condensate tank and not low level for condensate tank and high level in the nutrient tank

Three modes are available.

- OFF: pump is Stopped
- AUTOMATIC: depending of the logic enounced above
- MANUAL: the operator chooses to start or stop the pump.

PLC Section name	Equipment tag	Type	Address	Comment
CL4110_Nutrient_Condens_Level	LSH_4110_01	DI	100014	High Level sensor for reservoir tank
CL4110_Nutrient_Condens_Level	LSL_4110_01	DI	100015	Low Level sensor for reservoir tank
CL4110_Nutrient_Condens_Level	LSH_4110_02	DI	100016	High Level sensor for condensate tank
CL4110_Nutrient_Condens_Level	LSL_4110_02	DI	100017	Low Level sensor for condensate tank
CL4110_Nutrient_Condens_Level	CP_4110_01_MV	DO	000006	Condensate pump Relay

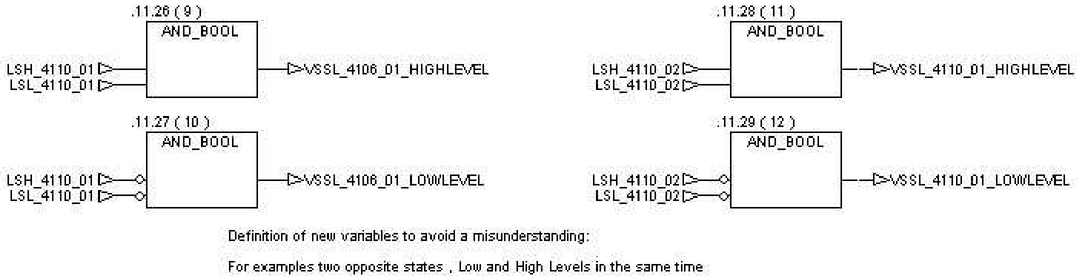
Figure 36 : Nutrient and Condensate Levels Control - EQUIPMENTS

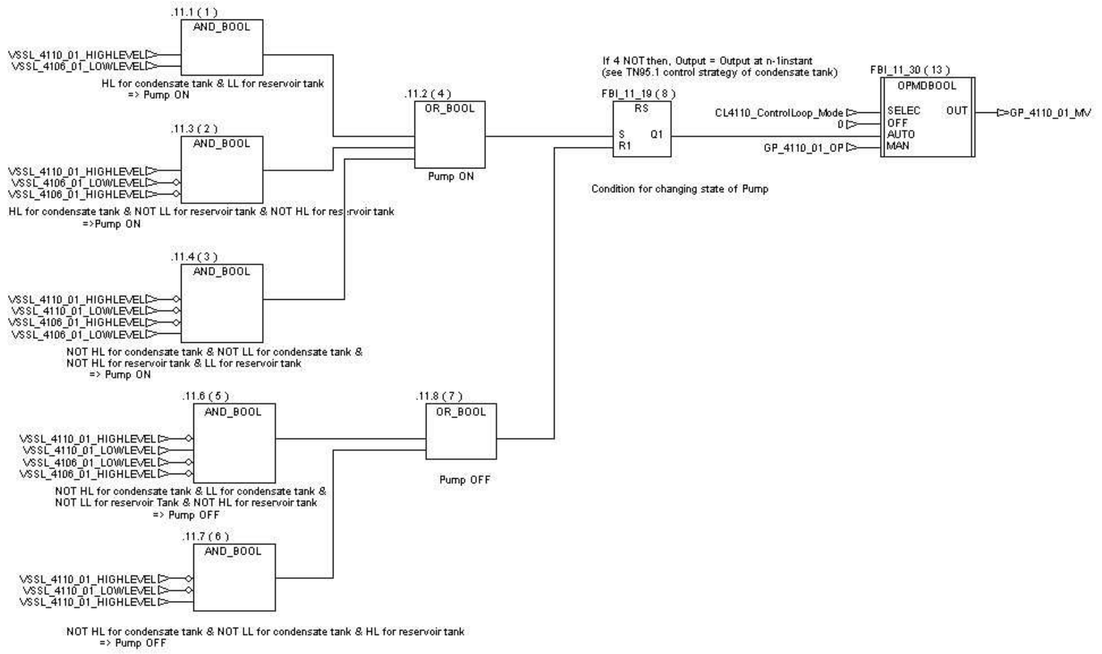
PLC Section name	Equipment tag	Type	Address	Comment
CL4110_Nutrient_Condens_Level	CL4110_ControlLoop_Mode	INT	400124	Nutrient Condensate level Mode (Off/Auto/Manu)
CL4110_Nutrient_Condens_Level	GP_4110_01_OP	BOOL	000152	HMI Pump scheme represents the Button / Only in Manual mode

Figure 37 : Nutrient and Condensate Levels Control - USER INDICATOR / INPUT

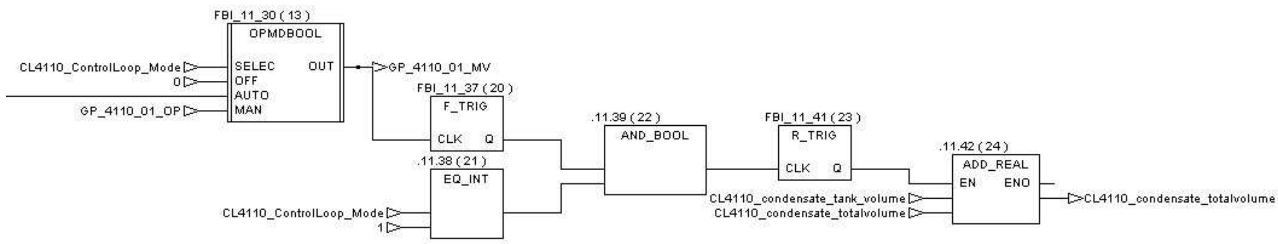
2.13.2.Block Diagram

2.13.2.1. *Pump management*

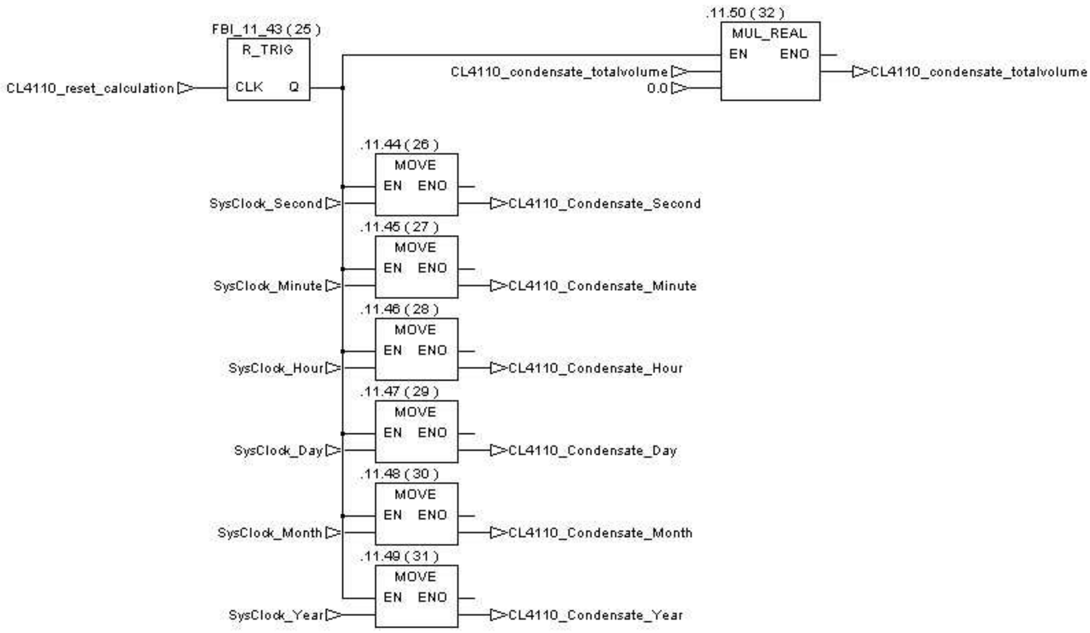




2.13.2.2. *Total condensate volume calculation*



In automatic mode, the total volume of condensate is recorded. When the pump GP_4110_01 switches OFF, the PLC adds the volume contained in the condensate tank between level switch high and level switch low (1 litre) to the total volume already calculated. The starting date of the calculation is recorded to let the operator knows since how long the calculation is done.



The Tag “CL4110_reset_calculation” permits to reset the calculation then to start a new one with the current date.

2.13.3.Alarms and Thresholds

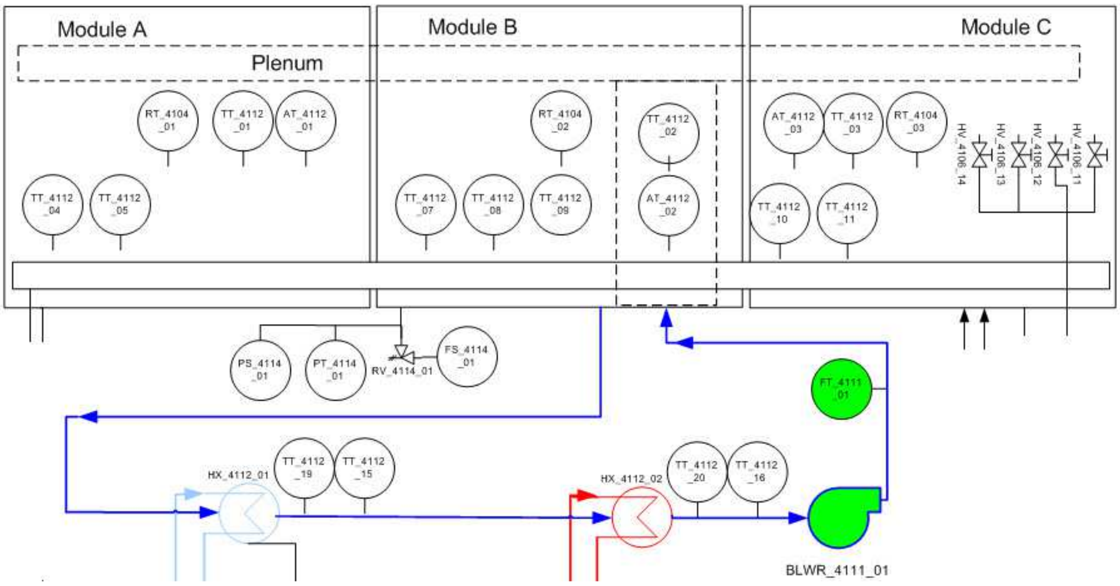
Alarm tag Name	type	Address	description
CL4110_CondensateTank_AH	BOOL	000085	Condensate tank High Level Alarm
CL4110_CondensateTank_AL	BOOL	000086	Condensate tank Low Level Alarm
CL4110_NutrientTank_AH	BOOL	000087	Nutrient tank High Level Alarm
CL4110_NutrientTank_AL	BOOL	000088	Nutrient tank Low Level Alarm
CL4110_CondensateAndNutrient_AH	BOOL	000089	Condensate and Nutrient Tank High Level Alarm
CL4110_CondensateAndNutrient_AL	BOOL	000090	Condensate and Nutrient Tank Low Level Alarm

Figure 38 : Nutrient and Condensate Levels Control - ALARMS

Threshold tag name	Type	Address	Value	Unit	ACTION
CL4110_Level_Time_LIM	TIME	400454	10	minutes	Display an alarm on the HMI Timer Delay for Condensate Level Alarm

Figure 39 : Nutrient and Condensate Levels Control - THRESHOLD

2.14. Control of Air circulation fans (CL4111)



2.14.1.Function

The Blower provides the air circulation inside the chamber. This function is deeply linked with the temperature and humidity control to provide air flow through the cold and hot exchanger. A flow transmitter provides the monitoring of the blower.
Three modes are available.

- OFF: Blower is Stopped
- AUTOMATIC: Blower is started
- MANUAL: the operator chooses to start or stop the blower.

The flow is adjusted manually by the operator.

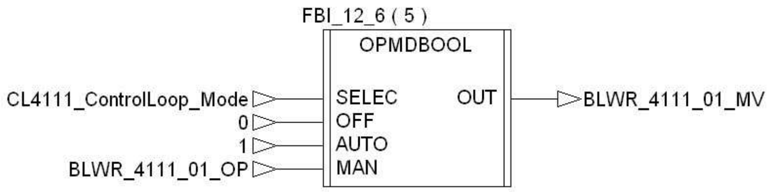
PLC Section name	Equipment tag	Type	Address	Comment
CL4111_Air_Fans	MVFD_4111_01_MV	AO	NOT CONNECTED	Air circulation fan with VFD / not connected
CL4111_Air_Fans	BLWR_4111_01_MV	DO	000019	Blower Relay
CL4111_Air_Fans	FT_4111_01	AI ->REAL	400037	Air velocity sensor

Figure 40 : Control of Air circulation fans – EQUIPMENTS

PLC Section name	Equipment tag	Type	Address	Comment
CL4111_Air_Fans	CL4111_ControlLoop_Mode	INT	400125	Air Fan Mode (Off/Auto/Manu)
CL4111_Air_Fans	BLWR_4111_01_OP	BOOL	000153	Only in Manual mode

Figure 41 : Control of Air circulation fans – USER INDICATOR / INPUT

2.14.2.Block Diagram



2.14.3.Alarms and Thresholds

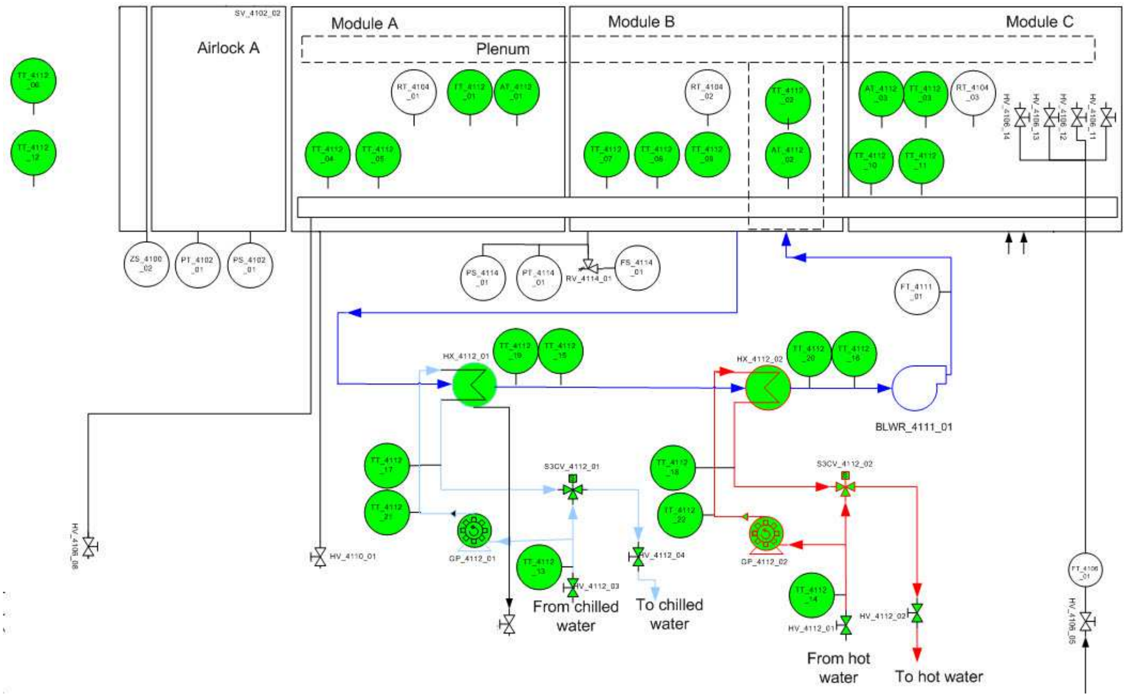
Alarm tag Name	type	Address	description
CL4111_NoFlow_LightOn_A	BOOL	000091	Light without Flow Alarm
CL4111_BlowerError_A	BOOL	000171	Control Blower Error Alarm Alarm ON when blower is ON and Flow is < 4 l/min Stop the light and temperature & Humidty control loop
FT_4111_01_ERR	BOOL	000092	Sensor FT_4111_01 is in Error

Figure 42 : Control of Air circulation fans – ALARMS

Threshold tag name	Type	Address	Value	Unit	ACTION
CL4111_FT_MIN	REAL	400456	4	L/min	mininum flow Alarm link to blower BLWR_4111_01 Stop the light and temperature & Humidty control loop

Figure 43 : Control of Air circulation fans – THRESHOLD

2.15. Temperature and Humidity Control (CL4112)



2.15.1.Function

The temperature exchanger system is divided in two different parts.

- The cold exchanger
- The hot exchanger

Each part has a proportional valve, a gear pump, utility input temperature probe, input exchanger temperature probe, output exchanger temperature probe and two exchanger output air temperature probes.

The chamber temperature is an average between temperature probe of module A and module C. Idem for humidity.

Both heat exchanger output air temperatures are also average between two temperature probes.

The cold exchanger is used to control the Relative Humidity by condensation and the hot exchanger is used to control chamber temperature.

Each heat exchanger is managed by two controllers organised in cascade.

Three modes are available:

- OFF: the pumps and valves of both heat exchanger are OFF (pump stopped and valve closed)

- AUTOMATIC: the operator enters a set point for:
  - -day humidity
  - -night humidity
  - -day temperature
  - -night temperature

  The operator can start the automatic mode if the blower BLWR_4111_01 is ON. In case of Blower failure, the automatic mode will be triggered in OFF mode.

  The automatic mode also triggered the Nutrient and Condensate Level Control loop in automatic mode.
- MANUAL: the operator chooses to start or stop the pump and decides the % of opening of both heat exchanger valves.

PLC Section name	Equipment tag	Type	Address	Comment
CL4112_Chamber_T_RH	TT_4112_01	AI ->REAL	400039	Temperature A1 associated with humidity
CL4112_Chamber_T_RH	TT_4112_04	AI ->REAL	400041	Temperature A2
CL4112_Chamber_T_RH	TT_4112_05	AI ->REAL	400043	Temperature A3
CL4112_Chamber_T_RH	TT_4112_06	AI ->REAL	400045	Temperature A4 --> Reaffected outside
CL4112_Chamber_T_RH	TT_4112_02	AI ->REAL	400047	Temperature B1 associated with humidity
CL4112_Chamber_T_RH	TT_4112_07	AI ->REAL	400049	Temperature B2
CL4112_Chamber_T_RH	TT_4112_08	AI ->REAL	400051	Temperature B3
CL4112_Chamber_T_RH	TT_4112_09	AI ->REAL	400053	Temperature B4
CL4112_Chamber_T_RH	TT_4112_03	AI ->REAL	400055	Temperature C1 associated with humidity
CL4112_Chamber_T_RH	TT_4112_10	AI ->REAL	400057	Temperature C2
CL4112_Chamber_T_RH	TT_4112_11	AI ->REAL	400059	Temperature C3
CL4112_Chamber_T_RH	TT_4112_12	AI ->REAL	400061	Temperature C4 --> Reaffected outside
CL4112_Chamber_T_RH	TT_4112_13	AI ->REAL	400063	Temperature for facility chilled water
CL4112_Chamber_T_RH	TT_4112_14	AI ->REAL	400065	Temperature for facility hot water line
CL4112_Chamber_T_RH	TT_4112_15	AI ->REAL	400067	Chilled coil surface temperature
CL4112_Chamber_T_RH	TT_4112_16	AI ->REAL	400069	Heating coil surface temperature
CL4112_Chamber_T_RH	TT_4112_17	AI ->REAL	400071	Chilled Exit temperature
CL4112_Chamber_T_RH	TT_4112_18	AI ->REAL	400073	Hot Exit temperature
CL4112_Chamber_T_RH	TT_4112_19	AI ->REAL	400075	Outlet Air, chilled exchanger
CL4112_Chamber_T_RH	TT_4112_20	AI ->REAL	400077	Outlet Air, hot exchanger
CL4112_Chamber_T_RH	TT_4112_21	AI ->REAL	400079	Inlet water Chilled Exchanger
CL4112_Chamber_T_RH	TT_4112_22	AI ->REAL	400081	Inlet water Hot Exchanger
CL4112_Chamber_T_RH	AT_4112_01	AI ->REAL	400083	Humidity A1 associated with temp A1
CL4112_Chamber_T_RH	AT_4112_02	AI ->REAL	400085	Humidity B1 associated with temp B1
CL4112_Chamber_T_RH	AT_4112_03	AI ->REAL	400087	Humidity C1 associated with temp C1
CL4112_Chamber_T_RH	S3CV_4112_01_MV	AO	400234	Chilled Water Control Valve
CL4112_Chamber_T_RH	S3CV_4112_02_MV	AO	400236	Hot Water Control Valve
CL4112_Chamber_T_RH	GP_4112_02_MV	DO	000020	Hot water Circulation pump
CL4112_Chamber_T_RH	GP_4112_01_MV	DO	000021	Chilled water Circulation pump

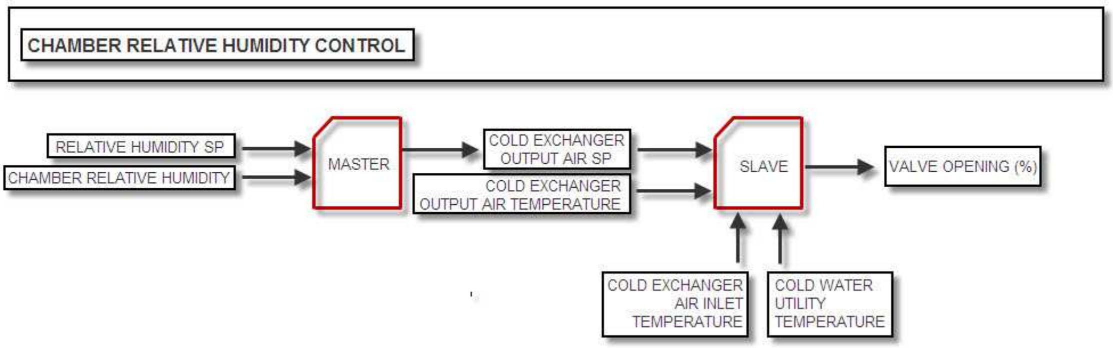
Figure 44: Temperature and Humidity Control - EQUIPMENTS

PLC Section name	Equipment tag	Type	Address	Comment
CL4112_Chamber_T_RH	CL4112_ControlLoop_T_RH_Mode	INT	400127	Chamber temperature And Humidity Mode (Off/Auto/Manu)
CL4112_Chamber_T_RH	TT_4112_AVG_Night_SP	REAL	400144	Temperature Set Point Only in Automatic Mode (Use in Temperature and Humidity control)
CL4112_Chamber_T_RH	TT_4112_AVG_Day_SP	REAL	400148	Temperature Set Point Only in Automatic Mode (Use in Temperature and Humidity control)
CL4112_Chamber_T_RH	AT_4112_AVG_Night_SP	REAL	400146	Humidity Set Point Only in Automatic Mode (Humidity and Temperature control only)
CL4112_Chamber_T_RH	AT_4112_AVG_Day_SP	REAL	400150	Humidity Set Point Only in Automatic Mode (Humidity and Temperature control only)
CL4112_Chamber_T_RH	GP_4112_01_OP	BOOL	000154	HMI Pump scheme represents the Button / Only in Manual mode
CL4112_Chamber_T_RH	GP_4112_02_OP	BOOL	000155	HMI Pump scheme represent the Button / Only in Manual mode
CL4112_Chamber_T_RH	TT_4112_AVG	REAL	400152	Chamber Average Temperature Controlled Temperature
CL4112_Chamber_T_RH	AT_4112_AVG	REAL	400154	Chamber Average Humidity Controlled Humidity
CL4112_Chamber_T_RH	S3CV_4112_01_OP	REAL	400156	S3CV_4112_01 opening (%) Only in Manual mode
CL4112_Chamber_T_RH	S3CV_4112_02_OP	REAL	400158	S3CV_4112_02 opening (%) Only in Manual mode

Figure 45 : Temperature and Humidity Control – USER INDICATOR / INPUT

2.15.2.Block Diagram

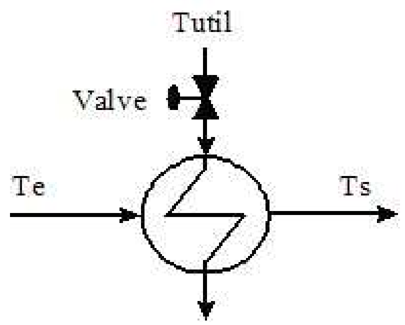
2.15.2.1. *Controller (automatic mode)*



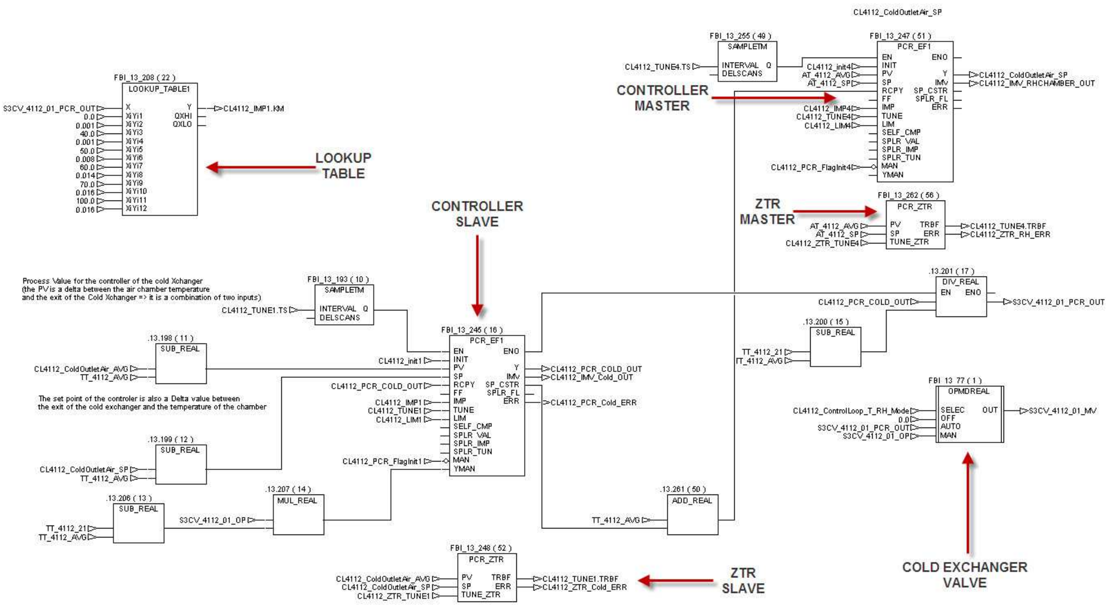
The Relative Humidity is controlled by the cold exchanger. Two controllers, in cascade, provide the calculation to reach the operator set point. The master,

function of the humidity set point, calculates a cold exchanger outlet air temperature set point.
To reach the set point at the output of the cold exchanger, the slave works with Delta value between output air temperature and input air temperature.
The % of the opening valve is then calculated to reach the exchanger output air temperature.
Due to the non linearity of the proportional valve, a lookup table permit to change the controller tuning (only the gain) depending on the % of the opening valve.
A ZTR block (see PCR documentation in annex E) is linked to both controllers. It permits to decrease the speed of the controller response time when the process value is close to the set point.

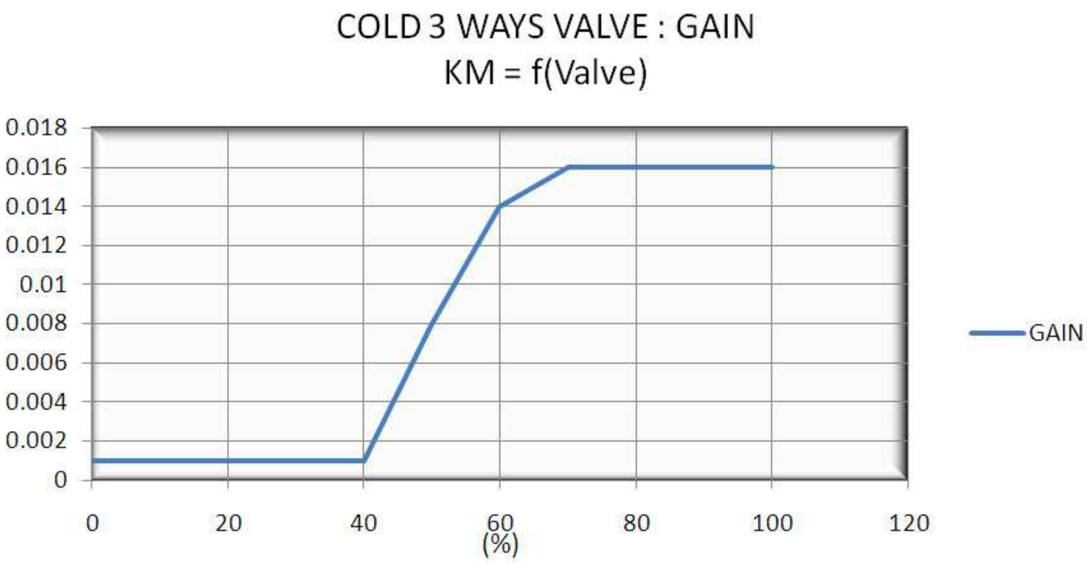
The following equation manages the slave controller:

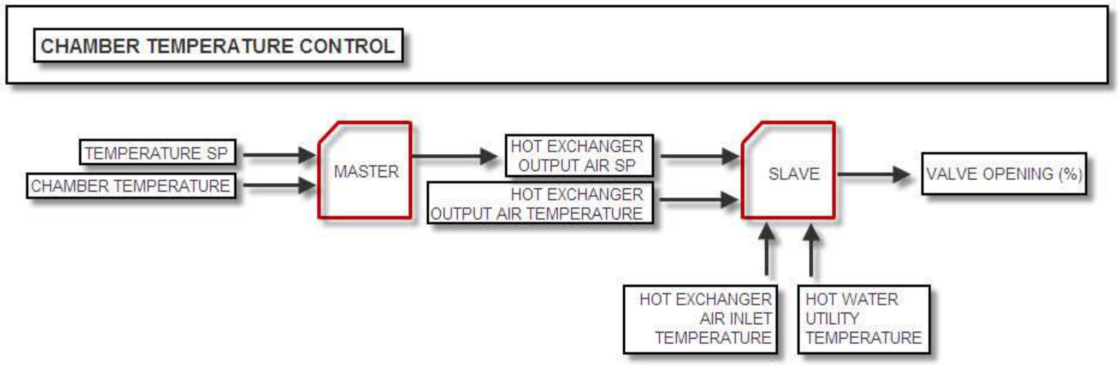
	$Ts - Te = \frac{K.e^{-D.s}}{1+T.s}\cdot valve\cdot\left(Tutil - Te\right)$

With:
Ts = output air temperature
Te = input air temperature
K = gain
D = time delay
T = time constant of the system
Valve = % of the opening valve
Tutil = utility temperature.



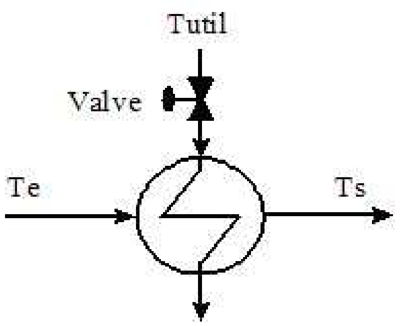
Gain of the cold valve (lookup table)



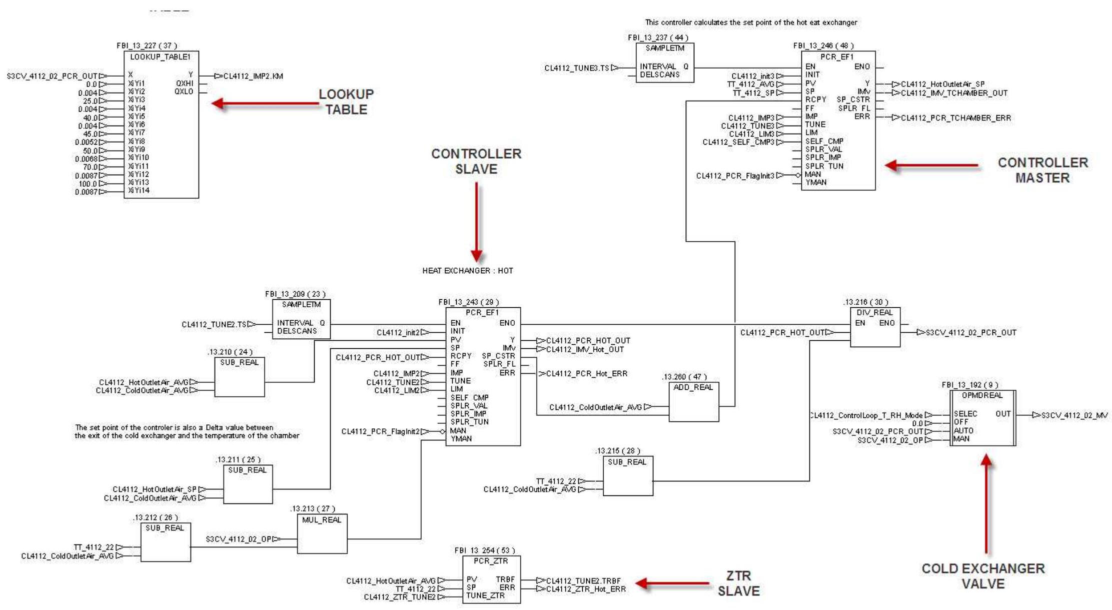


The chamber temperature is controlled by the hot exchanger. Two controllers, in cascade, provide the calculation to reach the operator set point. The master, depending on the temperature set point, calculates a hot exchanger outlet air temperature set point.
To reach the set point at the output of the hot exchanger, the slave works with Delta value between output air temperature and input air temperature.
The % of the opening valve is then calculated to reach the exchanger output air temperature.
Due to the non linearity of the proportional valve, a lookup table permit to change the controller tuning (only the gain) depending on the % of the opening valve.
A ZTR block (see PCR documentation in annex E) is linked to both controllers. It permits to decrease the speed of the controller response time when the process value is close to the set point.

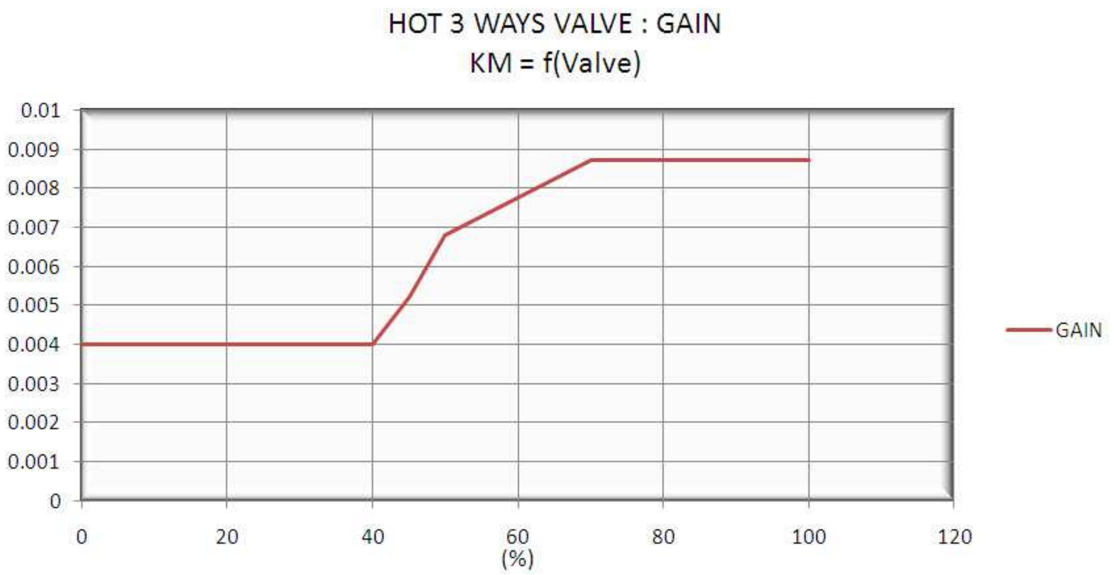
The following equation manages the slave controller:

	$Ts - Te = \frac{K.e^{-D.s}}{1+T.s}\cdot valve\cdot\left(Tutil - Te\right)$

With:
Ts = output air temperature
Te = input air temperature
K = gain
D = delay
T = time constant of the system
Valve = % of the opening valve
Tutil = utility temperature.



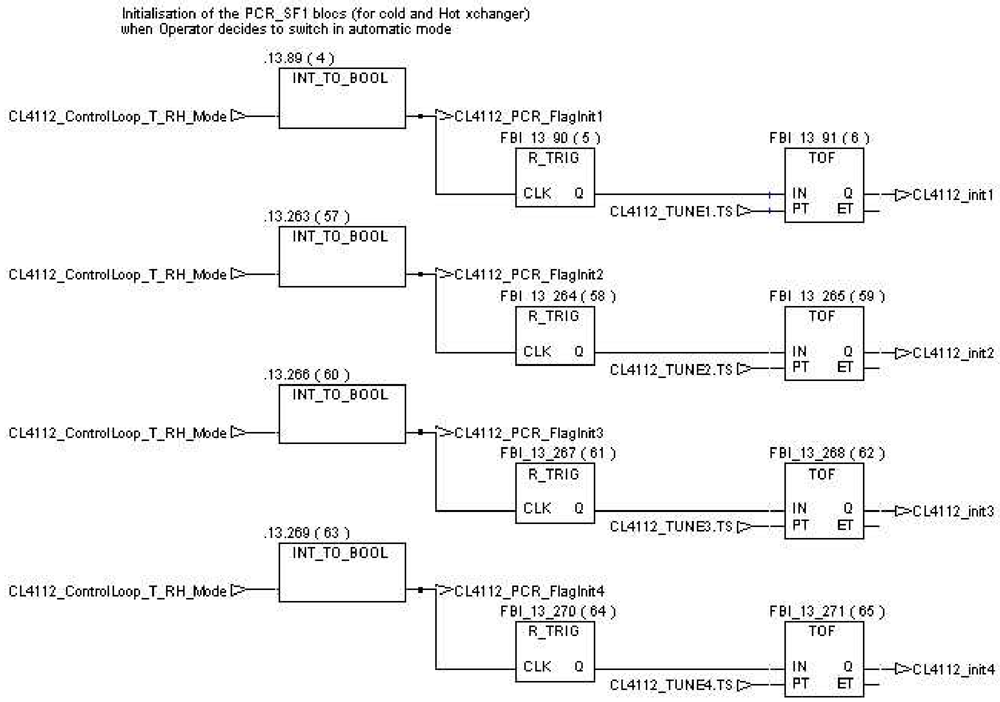
Gain of the hot valve (lookup table)



Controller initialization

When the operator triggers the automatic mode, the four controllers are initialized during their own sample time.

- Cold exchanger
  - Slave initialization: 3 seconds
  - Master initialization: 10 seconds
- Hot exchanger
  - Slave initialization: 1 second
  - Master initialization: 30 seconds



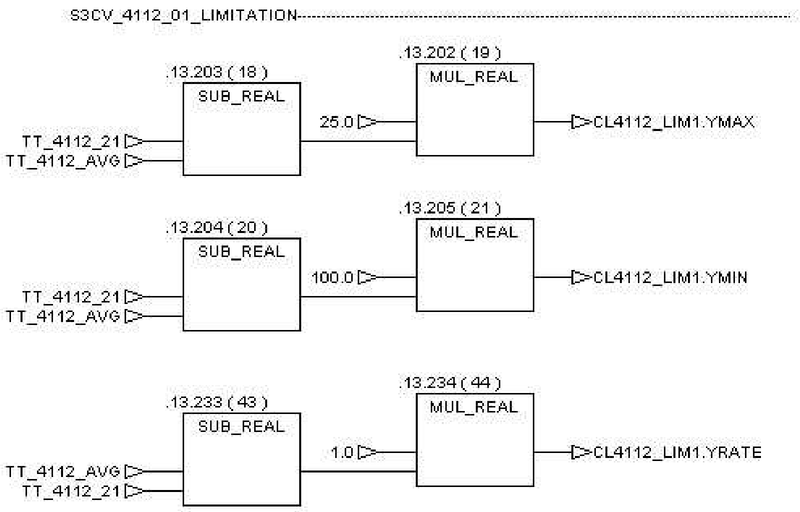
Controller parameters

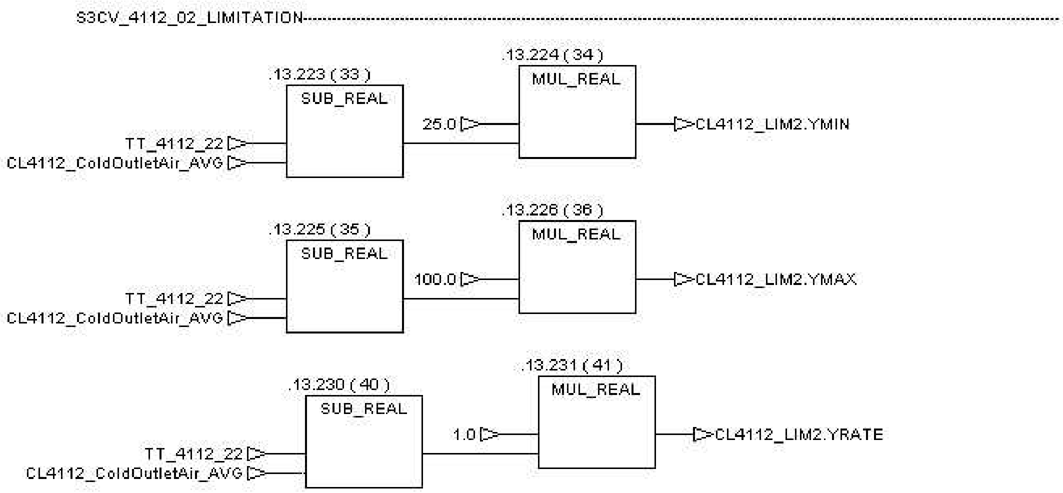
Controlled Variable	PCR CONTROLER TYPE	DEAD ZONE	ZTR Zone Control	PWM	SAMPLETM	PROCESS VALUE (input)	SET POINT
Outlet air of Cold exchanger	EF1	NO	CL4112_ZTR_TUNE1 ZONE : 0.2 TRBF_LO : 6m TRBF_HI : 90m	NO	Controller : CL4112_TUNE1.TS (3s)	CL4112_ColdOutletAir_AVG – TT_4112_AVG	CL4112_ColdOutletAir_SP – TT_4112_AVG
Humidity	EF1	NO	CL4112_ZTR_TUNE4 ZONE : 1 TRBF_LO : 3m TRBF_HI : 120m	NO	CL4112_TUNE4.TS (10s)	AT_4112_AVG	AT_4112_SP
Outlet air of Hot exchanger	EF1	NO	CL4112_ZTR_TUNE2 ZONE : 0.2 TRBF_LO : 2m TRBF_HI : 60m	NO	Controller : CL4112_TUNE2.TS (1s)	CL4112_HotOutletAir_AVG – CL4112_ColdOutletAir_AVG	CL4112_HotOutletAir_SP – CL4112_ColdOutletAir_AVG
Chamber Temperature	EF1	NO	NO	NO	Controller : CL4112_TUNE3.TS (30s)	TT_4112_AVG	TT_4112_SP

Controlled Variable	INTERNAL MODEL PROCESS	TUNE	LIMIT	SELF_CMP	DECOMP	Manipulated Variable (Controller Output in Auto Mode)	Controlled Equipment
Outlet air of Cold exchanger	CL4112_IMP 1 KM : 0.016 TM : 120s DM : 45s	CL4112_TUNE1 TS : 3s H : 3s TRBF : 6m	CL4112_LIM1 YMIN : 0 YMAX : 100 YRATE : 50	NO	NO	CL4112_PCR_COLD_OUT	CL4112_PCR_COLD_OUT / (TT_4112_21 – TT_4112_AVG)
Humidity	CL4112_IMP 4 KM : 3 TM : 50s DM : 20s	CL4112_TUNE4 TS : 10s H : 10s TRBF : 3m	CL4112_LIM4 YMIN : 8 YMAX : 26 YRATE : 0.1	NO	NO	CL4112_ColdOutletAir_SP	Cold exchanger Controller
Outlet air of Hot exchanger	CL4112_IMP 2 KM : 0.0087 TM : 40s DM : 30s	CL4112_TUNE2 TS : 1s H : 1s TRBF : 2m	CL4112_LIM2 YMIN : 8.3 YMAX : 30 YRATE : 200	NO	NO	CL4112_PCR_HOT_OUT	CL4112_PCR_HOT_OUT / (TT_4112_22 – CL4112_ColdOutletAir_AVG)
Chamber Temperature	CL4112_IMP 3 KM : 0.59 TM : 1730s DM : 120s	CL4112_TUNE3 TS : 30s H : 30s TRBF : 60m	CL4112_LIM3 YMIN : 15 YMAX : 45 YRATE : 1	CL4112_SELF_CMP3 KSC : 0.5 TSC : 60m	NO	CL4112_HotOutletAir_SP	Hot exchanger Controller

Valves limits

After some open loop tests on both of three ways valves, it was noticed that under than 25% of opening, the liquid doesn't go inside the exchanger.
As both exchangers are managed by a difference between input temperature and output temperature, the valve limits are computed in the same way.




S3CV_4112_02_LIMITATION
.13.223 (33)
SUB_REAL
.13.224 (34)
MUL_REAL
25.0
TT_4112_22
CL4112_ColdOutletAir_AVG
CL4112_LIM2.YMIN
.13.225 (35)
SUB_REAL
.13.226 (36)
MUL_REAL
100.0
TT_4112_22
CL4112_ColdOutletAir_AVG
CL4112_LIM2.YMAX
.13.230 (40)
SUB_REAL
.13.231 (41)
MUL_REAL
1.0
TT_4112_22
CL4112_ColdOutletAir_AVG
CL4112_LIM2.YRATE

2.15.3.Alarms and Thresholds

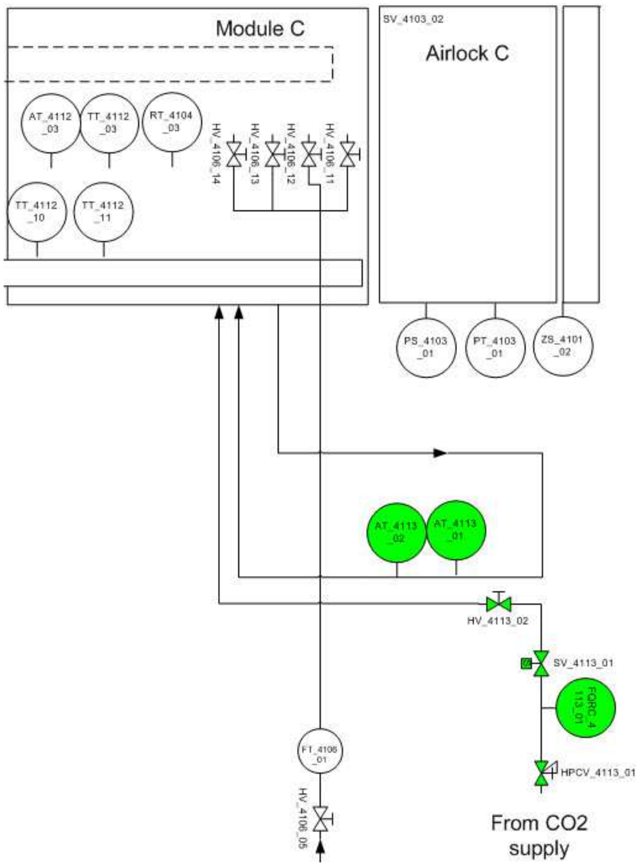
Alarm tag Name	type	Address	description
CL4112_Temp_HotXchanger_AL	BOOL	000160	MPP Utilities Hot Exchanger Alarm Low
CL4112_Temp_HotXchanger_ALL	BOOL	000161	MPP Utilities Hot Exchanger Alarm Low Low
CL4112_Temp_ColdXchanger_AH	BOOL	000162	MPP Utilities Cold Exchanger Alarm High
CL4112_Temp_ColdXchanger_AHH	BOOL	000163	MPP Utilities Cold Exchanger Alarm High High
CL4112_Temperature_AH	BOOL	000093	Chamber Temperature Alarm High
CL4112_Temperature_AHH	BOOL	000094	Chamber Temperature Alarm High High Stop the Lights
CL4112_Temperature_AL	BOOL	000095	Chamber Temperature Alarm Low
CL4112_Temperature_ALL	BOOL	000096	Chamber Temperature Alarm Low Low
CL4112_Humidity_AH	BOOL	000097	Chamber Humidity Alarm High
CL4112_Humidity_AHH	BOOL	000098	Chamber Humidity Alarm High High
CL4112_Humidity_AL	BOOL	000099	Chamber Humidity Alarm Low
CL4112_Humidity_ALL	BOOL	000100	Chamber Humidity Alarm Low Low
TT_4112_01_ERR	BOOL	000101	Sensor TT_4112_01 is in Error
TT_4112_04_ERR	BOOL	000102	Sensor TT_4112_04 is in Error
TT_4112_05_ERR	BOOL	000103	Sensor TT_4112_05 is in Error
TT_4112_06_ERR	BOOL	000104	Sensor TT_4112_06 is in Error
TT_4112_02_ERR	BOOL	000105	Sensor TT_4112_02 is in Error
TT_4112_07_ERR	BOOL	000106	Sensor TT_4112_07 is in Error
TT_4112_08_ERR	BOOL	000107	Sensor TT_4112_08 is in Error
TT_4112_09_ERR	BOOL	000108	Sensor TT_4112_09 is in Error
TT_4112_03_ERR	BOOL	000109	Sensor TT_4112_03 is in Error
TT_4112_10_ERR	BOOL	000110	Sensor TT_4112_10 is in Error
TT_4112_11_ERR	BOOL	000111	Sensor TT_4112_11 is in Error
TT_4112_12_ERR	BOOL	000112	Sensor TT_4112_12 is in Error
TT_4112_13_ERR	BOOL	000113	Sensor TT_4112_13 is in Error
TT_4112_14_ERR	BOOL	000114	Sensor TT_4112_14 is in Error
TT_4112_15_ERR	BOOL	000115	Sensor TT_4112_15 is in Error
TT_4112_16_ERR	BOOL	000116	Sensor TT_4112_16 is in Error
TT_4112_17_ERR	BOOL	000117	Sensor TT_4112_17 is in Error
TT_4112_18_ERR	BOOL	000118	Sensor TT_4112_18 is in Error
TT_4112_19_ERR	BOOL	000119	Sensor TT_4112_19 is in Error
TT_4112_20_ERR	BOOL	000120	Sensor TT_4112_20 is in Error
TT_4112_21_ERR	BOOL	000121	Sensor TT_4112_21 is in Error
TT_4112_22 _ERR	BOOL	000122	Sensor TT_4112_22 is in Error
AT_4112_01_ERR	BOOL	000123	Sensor AT_4112_01 is in Error
AT_4112_02_ERR	BOOL	000124	Sensor AT_4112_02 is in Error
AT_4112_03_ERR	BOOL	000125	Sensor AT_4112_03 is in Error

Figure 46 : Temperature and Humidity Control - ALARMS

Threshold tag name	Type	Address	Value	Unit	ACTION
CL4112_Temperature_LIM_H	REAL	400458	28	°C	High Temperature Chamber LIMIT Display an alarm on the HMI
CL4112_Temperature_LIM_HH	REAL	400460	30	°C	Very High Temperature Chamber LIMIT Stop the Lights
CL4112_Temperature_LIM_L	REAL	400462	18	°C	Low Temperature Chamber LIMIT Display an alarm on the HMI
CL4112_Temperature_LIM_LL	REAL	400464	15	°C	Very Low Temperature Chamber LIMIT Display an alarm on the HMI
CL4112_Humidity_LIM_H	REAL	400466	85	%	High Humidity Chamber LIMIT Display an alarm on the HMI
CL4112_Humidity_LIM_HH	REAL	400468	90	%	Very High Humidity Chamber LIMIT Display an alarm on the HMI
CL4112_Humidity_LIM_L	REAL	400470	45	%	Low Humidity Chamber LIMIT Display an alarm on the HMI
CL4112_Humidity_LIM_LL	REAL	400472	40	%	Very Low Humidity Chamber LIMIT Display an alarm on the HMI
CL4112_Temp_HotXchanger_LIM_L	REAL	400474	40	°C	Low temperature in the hot water Utility Display an alarm on the HMI
CL4112_Temp_HotXchanger_LIM_LL	REAL	400476	35	°C	Very Low temperature in the hot water Utility Display an alarm on the HMI
CL4112_Temp_ColdXchanger_LIM_H	REAL	400478	12	°C	High temperature in the cold water utility Display an alarm on the HMI
CL4112_Temp_ColdXchanger_LIM_HH	REAL	400480	15	°C	Display an alarm on the HMI Very high temperature in the cold water Utility

Figure 47 : Temperature and Humidity Control - THRESHOLDS

2.16. CO2 Control (CL4113)



2.16.1. Function

<u>Important point</u>: *In automatic mode, the CO2 injection is stopped if one of the air lock is open (door contact ZS_4100_01 or ZS_4101_01).*

For a better plant growth, the closed atmosphere of the chamber is maintained to 1000 ppm of CO2. The chamber is equipped with a CO2/O2 analyser, a mass flow controller and a valve, in order to control the CO2 level.

- OFF: the valve is closed and the set point send to the controller is set to 0.
- AUTOMATIC: depending of the logic enounced above.
  Possible improvement: in case of Door opening alarm, the automatic mode is triggered to OFF.
- MANUAL: the operator entered a flow set point in the flow controller.

PLC Section name	Equipment tag	Type	Address	Comment
CL4113_CO2	FC_4113_01	AI ->REAL	400089	CO2 Mass Flow
CL4113_CO2	FC_4113_01_SP	AO	400238	CO2 Mass Flow set point. Send by PLC controller to Flow controller.
CL4113_CO2	AT_4113_01	AI ->REAL	400091	CO2 Analyser
CL4113_CO2	AT_4113_02	AI ->REAL	400093	O2 Analyser
CL4113_CO2	SV_4113_01_MV	DO	000022	CO2 injection line. Solenoid

Figure 48 : CO2 Control - EQUIPMENTS

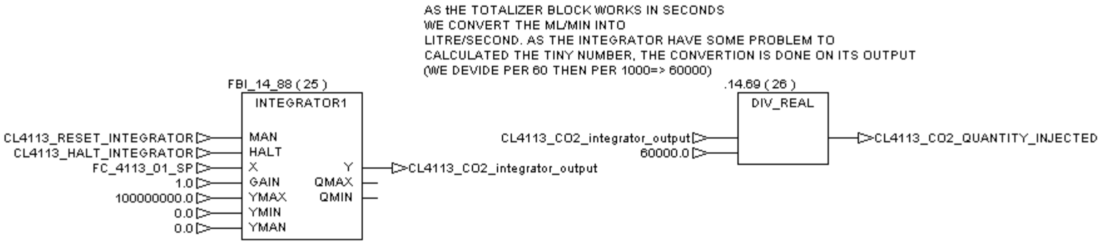
PLC Section name	Equipment tag	Type	Address	Comment
CL4113_CO2	CL4113_ControlLoop_Mode	INT	400128	
CL4113_CO2	FC_4113_01_OP_SP	REAL	400160	CO2 Mass Flow set point set by User in manual mode
CL4113_CO2	AT_4113_01_SP	REAL	400162	CO2 Mass Flow set point set by User in Auto mode (PPM)
CL4113_CO2	SV_4113_01_OP	BOOL	000156	Only in Manual mode
CL4113_CO2	CL4113_CO2_QUANTITY_INJECTED	REAL	400334	calculated volume of CO2 injection in Litre (used the mass flow meter setpoint as input of the integrator block)
CL4113_CO2	CL4113_CO2_QUANTITY_INJECTED2	REAL	400352	Calculated volume of CO2 injection in Litre (used the mass flow meter reading value as input of the integrator block). This tag is added for a test to decide which input will be used in the CO2 injected volume.
CL4113_CO2	CL4113_CO2_injected_in_mol	REAL	400354	CO2 volume injection in Mol (conversion from the tag CL4113_CO2_QUANTITY_INJECTED)
CL4113_CO2	CL4113_Reset_CO2_VOLUME	BOOL	000183	reset the CO2 volume measurement
CL4113_CO2	CL4113_CO2_Second	BYTE	400258	Date of the last reset done by the operator
CL4113_CO2	CL4113_CO2_Minute	BYTE	400259	Date of the last reset done by the operator
CL4113_CO2	CL4113_CO2_Hour	BYTE	400260	Date of the last reset done by the operator
CL4113_CO2	CL4113_CO2_Day	BYTE	400261	Date of the last reset done by the operator
CL4113_CO2	CL4113_CO2_Month	BYTE	400262	Date of the last reset done by the operator
CL4113_CO2	CL4113_CO2_Year	BYTE	400263	Date of the last reset done by the operator

Figure 49 : CO2 Control - USER INDICATOR / INPUT

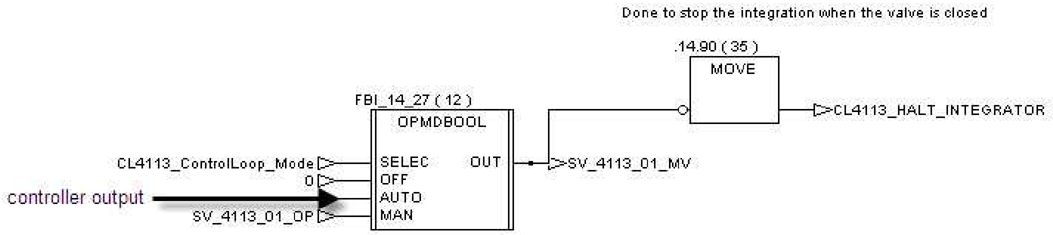
2.16.2.Block Diagram

2.16.2.1. *CO2 volume calculation*

Since April 2010, the CO2 flow is recorded thanks to an integrator block. It computes the volume injected since the last date recorded. As the mass flow controller measurement has a biais, we make the integration on the set point value. This volume calculation is done in manual and automatic mode.



As long as the valve is closed, the integrator calculation is halted.

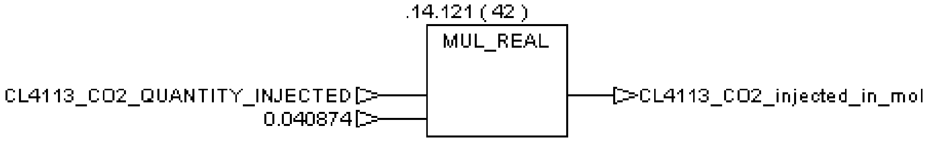


2.16.2.2. *Mole conversion*

The mass flow controller signal is already corrected for NTP (Normal temperature 25C and pressure 1 atm), therefore it is a direct conversion between volume and mole:

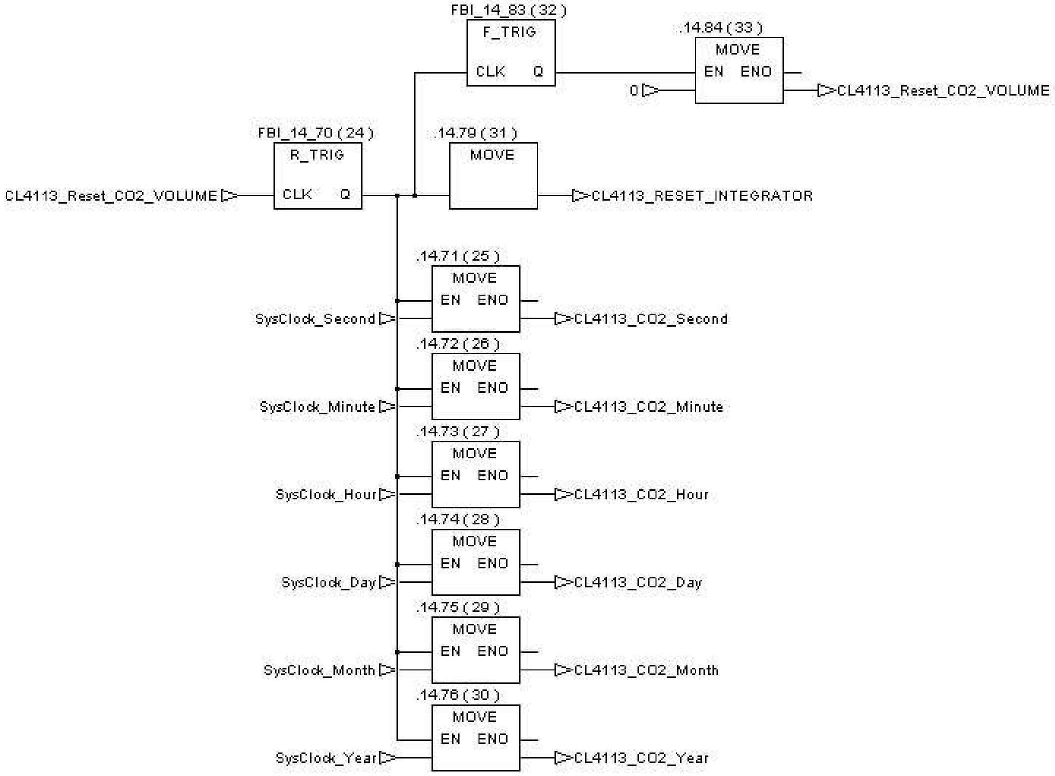
===> 1 mole is equivalent to 24.465 Litres of gas (or 1 Litre is equal to 0.040874 mole)

CALCULATION OF THE VOLUME INJECTED IN MOLE
(THE CALCULATION IS LINKED TO THE MASS FLOW CONTROLLER
SET POINTSEND BY THE PLC)

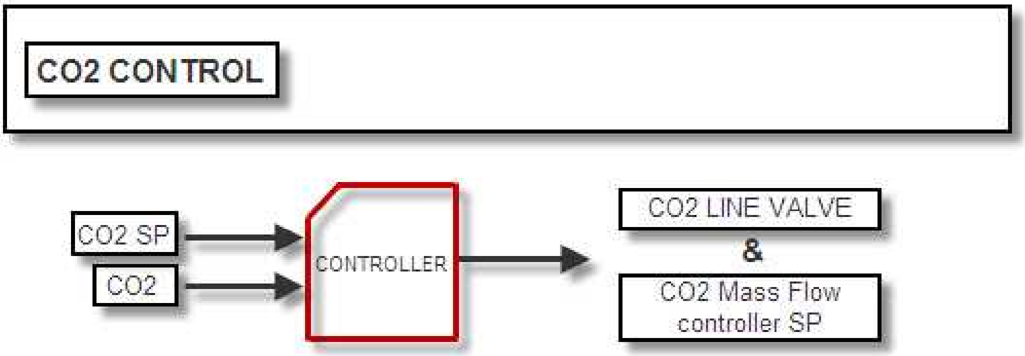


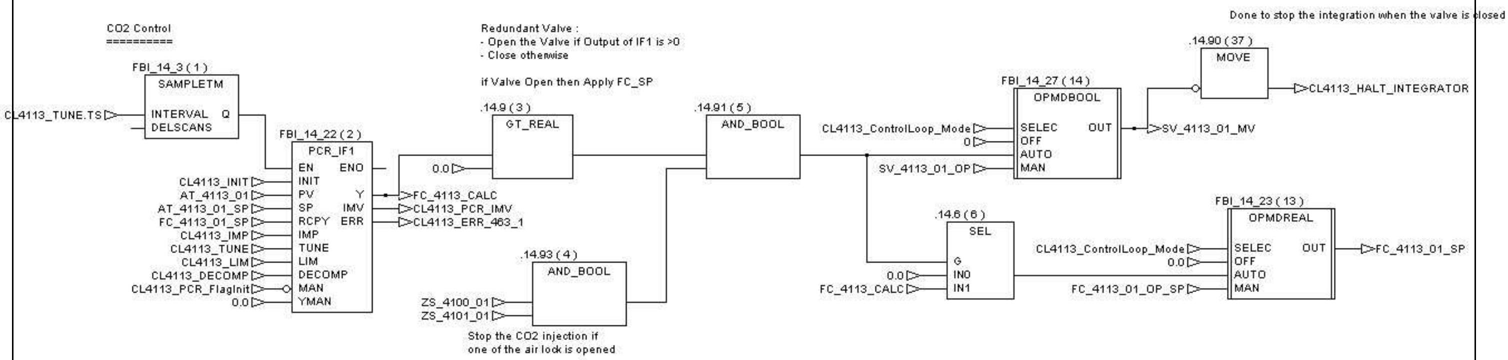
2.16.2.3. *Reset of the CO2 volume calculation*

The volume calculation can be reset (for example at the beginning of a crop test) by an HMI button. When the operator triggers the reset, the PLC date and hour is recorded as the starting date and the volume is reset to zero.



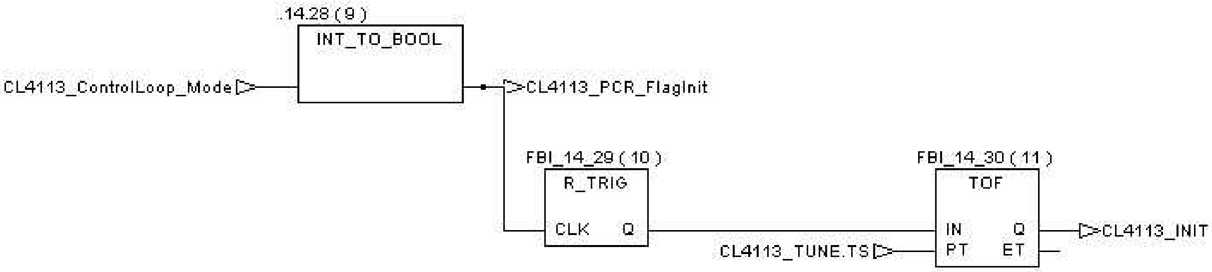
2.16.2.4. *Controller (automatic mode)*





2.16.2.5. *Controller initialization*

When operator change from OFF / Manual mode to Automatic mode,
the PCR is initialised during the time defined by "Tune1.TS".



2.16.2.6. *Controller parameters*

Controlled Variable	PCR CONTROLER TYPE	DEAD ZONE	ZTR Zone Control	PWM	SAMPLETM	PROCESS VALUE (input)	SET POINT
CO2 (SV_4113_01 AND FC_4113_01_SP)	IF1	NO	NO	NO	TUNE.TS (1s)	AT_4113_01	AT_4113_01_SP

Controlled Variable	INTERNAL MODEL PROCESS	TUNE	LIMIT	SELF_CMP	DECOMP	Manipulated Variable (Controller Output in Auto Mode)	Controlled Equipment
CO2 (SV_4113_01 AND FC_4113_01_SP	CL4113_IMP KM : 0.0016 TM : 500s DM : 0s	CL4113_TUNE TS : 1s H : 5s TRBF : 1500s	CL4113_LIM YMIN : 0 YMAX : 500 YRATE : 500	NO	1500s	SV_4113_01_MV FC_4113_01_SP	SV_4113_01 FC_4113_01

2.16.3.Alarms and Thresholds

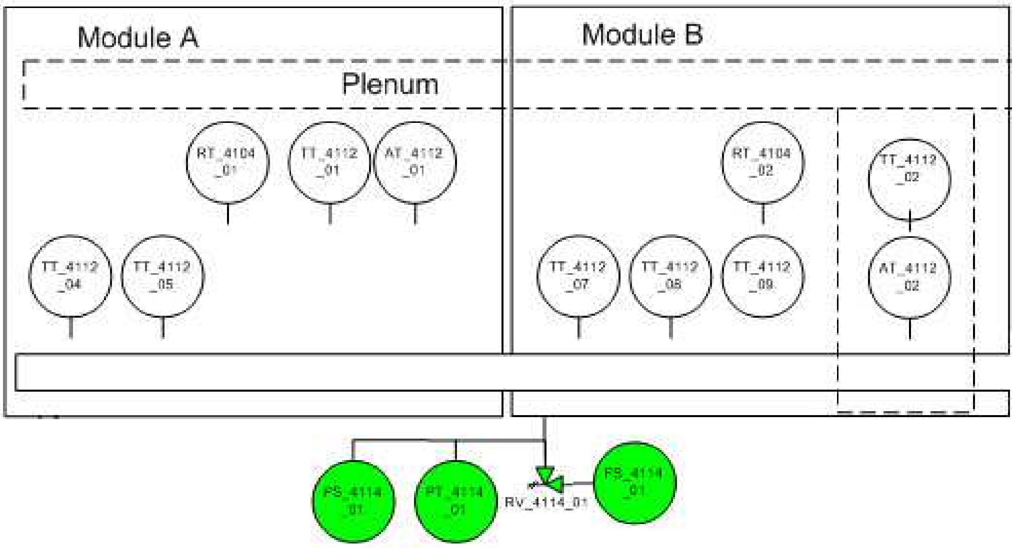
Alarm tag Name	type	Address	description
CL4113_CO2_AH	BOOL	000126	Chamber CO2 Alarm High
CL4113_CO2_AHH	BOOL	000127	Chamber CO2 Alarm High High
CL4113_CO2_AL	BOOL	000128	Chamber CO2 Alarm Low
CL4113_CO2_ALL	BOOL	000129	Chamber CO2 Alarm Low Low
CL4113_O2_AH	BOOL	000130	Chamber O2 Alarm High
CL4113_O2_AHH	BOOL	000131	Chamber O2 Alarm High High
CL4113_O2_AL	BOOL	000132	Chamber O2 Alarm Low
CL4113_O2_ALL	BOOL	000133	Chamber O2 Alarm Low Low
FC_4113_01_ERR	BOOL	000134	Sensor FC_4113_01 is in Error
AT_4113_01_ERR	BOOL	000135	Sensor AT_4113_01 is in Error
AT_4113_02_ERR	BOOL	000136	Sensor AT_4113_02 is in Error

Figure 50 : CO2 Control - ALARMS

Threshold tag name	Type	Address	Value	Unit	ACTION
CL4113_CO2_LIM_H	REAL	400482	+50	PPM	High CO2 Level LIMIT (Only for the day) Display an alarm on the HMI
CL4113_CO2_LIM_HH	REAL	400484	+500	PPM	Very High CO2 Level LIMIT (Only for the Day) Display an alarm on the HMI
CL4113_CO2_LIM_L	REAL	400486	-50	PPM	Low CO2 Level LIMIT Display an alarm on the HMI
CL4113_CO2_LIM_LL	REAL	400488	-100	PPM	Very Low CO2 Level LIMIT Display an alarm on the HMI
CL4113_O2_LIM_H	REAL	400490	23	%	High O2 Level LIMIT Display an alarm on the HMI
CL4113_O2_LIM_HH	REAL	400492	24	%	Very High O2 Level LIMIT Display an alarm on the HMI
CL4113_O2_LIM_L	REAL	400494	No threshold	%	Low O2 Level LIMIT Not Implemented
CL4113_O2_LIM_LL	REAL	400496	No threshold	%	Very Low O2 Level LIMIT Not Implemented

Figure 51 : CO2 Control - THRESHOLDS

2.17. Chamber Pressure (CL4114)



2.17.1.Function

The pressure is controlled in a passive way. Each module has a Teflon bag which permits to regulate the pressure by increasing or decreasing the volume of the chamber.

PLC Section name	Equipment tag	Type	Address	Comment
CL4114_Pressure	PT_4114_01	AI ->REAL	400095	Growing Area Pressure
CL4114_Pressure	PS_4114_01	DI	100018	Pressure Switch
CL4114_Pressure	FS_4114_01	DI	100019	Flow Switch

Figure 52 : Chamber Pressure – EQUIPMENTS

2.17.2.Block Diagram

As the pressure is not controlled, the pressure equipments are not implemented in the software. Only input are configured in order to display the sensor on the HMI.

2.17.3.Alarms and Thresholds

Alarm tag Name	type	Address	description
CL4114_Pressure_AH	BOOL	000137	Chamber Pressure Alarm High
CL4114_Pressure_AL	BOOL	000138	Chamber Pressure Alarm Low
PT_4114_01_ERR	BOOL	000139	Sensor PT_4114_01 is in Error

Figure 53 : Chamber Pressure – ALARMS

Threshold tag name	Type	Address	Value	Unit	ACTION
CL4114_Pressure_LIM_H	REAL	400498	1100	mbar	High pressure LIMIT Display an alarm on the HMI
CL4114_Pressure_LIM_L	REAL	400500	900	mbar	Low Pressure LIMIT Display an alarm on the HMI

Figure 54 : Chamber Pressure – THRESHOLDS

2.18. Ambient Parameters (CL4115)

Not available.

Annex A: Predictive Control. PCR description

Predictive Control

This chapter provides information about the general principles of predictive control and general information about PCR.

General Principles of Model Based Predictive Control

Introduction

A Model Based Predictive Controller is a controller that uses a model in real time for the computation of the control action to be applied. The main aspects of this controller are given below.

Model

The model which is embedded in the controller is a mathematical equation that computes a ‘model’ output which is comparable to the process output PV.
The model represents the relationship linking the process input(s) to the process output.
This model must be identified: the parameters of the model are to be estimated from recorded plant tests.
The model is used to predict the process output and to compute the control action in order to satisfy a given target specified on the PV.

Future Desired Trajectory

At present time (n), the process output is `PV(n)` and the set point value is `SP(n)`. The future desired trajectory (so-called reference trajectory) is the desired behaviour of the process output to move from its present value `PV(n)` to `SP(n)` in the future.

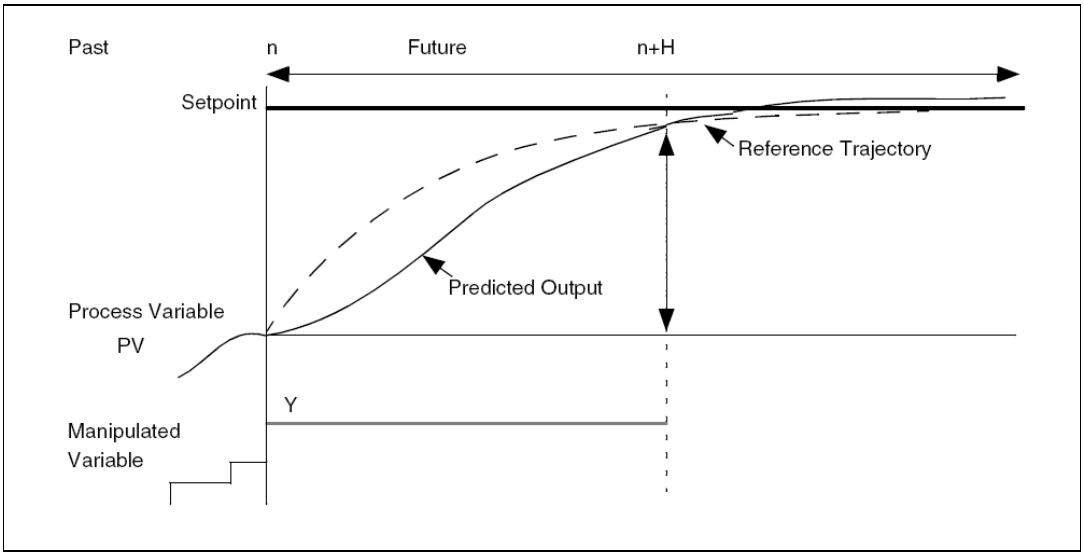


Figure 55: Future desired trajectory

The reference trajectory is computed by a first order system (see above) and the response time of this trajectory is the closed loop response time: the `PV` will respond to a set point step change with the response time given by the user.
The closed loop response time (`TRBF`) is a specification which defines the strength or the smoothness of the controller. There is a trade-off between dynamic performance and robustness. The controller is more robust when the specified `TRBF` is longer.
An intermediate target is selected along that trajectory at a future time `(n+H)`, where `H` is called the coincidence point. A simple rule for the coincidence point is to set it to the third of the 95% response time: `H=TRBF/3`.

Solver

The solver is the part of the controller which computes the control action to be applied in such a way the predicted output at time `(n+H)` is equal to the reference trajectory at the same future instant.
The computed control action takes into account the constraints which limit the input moves (high and low limits and rate of change).

Self Compensation

Some non measured variables may disturb the process.

With unmeasured ramp-type disturbance, a bias between PV and SP may appear. The aim of the self-compensator is to reject this kind of disturbance, and to avoid such a bias.

PCR Description

Introduction

PCR belongs to the Model Based Predictive Control technology and is dedicated to SISO (Single Input Single Output) processes, including feed forwarding facilities.

PCR Design

PCR was initially designed to cope with the control issues met on chemical reactors (batch or continuous). Therefore, that led to some physical modelling of the typical architectures of heat exchanges used on such chemical plants.
The obtained relationships can be represented by non linear first order systems and model based predictive controllers were designed to cope with these targets.
Several complementary functions were developed as complements to these controllers to match the specific requirements of reactor temperature control, such as an efficient SPLIT RANGE module and a smart temperature profile builder linked with a predictive functional controller, which together perform a close tracking of such profiles without overshoots.
Since non linear first order controllers were developed, they can be used profitably on any other kind of SISO process.

Function Blocks

Each PCR module is a programme which is represented as a block with inputs and outputs.
When a control structure is to be integrated, the blocks can be graphically linked (according to the IEC 1131-3 norm) in case of PLCs or DCS boards or embedded into a global programme in case of integration into computers.

Groups

Group	Function Block	Description
Controller	PCR_SF1	simple predictive controller for first order process
	PCR_EF1	enhanced controller for first order process with feed-Forward, cascade with MV constraint transfer, split range, self compensation
	PCR_IF1	controller for integrative first order process
	PCR_EIF1	enhanced controller for integrative first order process with feed-Forward, cascade with MV constraint transfer
	PCR_RD1	ramp & docking set point controller for first order process
	PCR_PAR2	Parabolic set point tracking (for 2nd over-damped order systems)
	PCR_DC3	dedicated Controller for third order process
Generator	PCR_ZTR	zone control with non-linear time response
	PCR_FIL	rate limiter filter
	PCR_RSP	ramp & docking set point generator
Model	PCR_FF1	model for first order feed-forward compensation
	PCR_IFF1	model for feed-forward compensation used with integrative first order system
Supervisor	PCR_SR1	supervisor for two controllers in split range configuration
	PCR_ESR1	enhanced supervisor for 2 controllers in split range configuration with min constraints different from zero

PCR library

Annex B: PCR_SF1 block

Brief Description

Function Description

`PCR_SF1` is an EFB for simple control of first order process with pure time delay.
`PCR_SF1` algorithm is based on predictive control principles:
An internal model of process is used to predict the future behaviour of the system. The model is composed of 3 parameters (see **¡Error! No se encuentra el origen de la referencia.**):

- KM: static gain
- TM: time constant
- DM: pure time delay

The following constraints on the manipulated variable (Y) can be taken into account:

- YMIN: minimum value for Y
- YMAX: maximum value for Y
- YRATE: maximum variation for Y

Transfer Function

The continuous transfer function of the internal model is:

$$u \rightarrow \boxed{\frac{KM}{1+TM \cdot s} \cdot e^{-DM \cdot s}} \rightarrow y_m$$

Figure 56: 1st order model

Representation

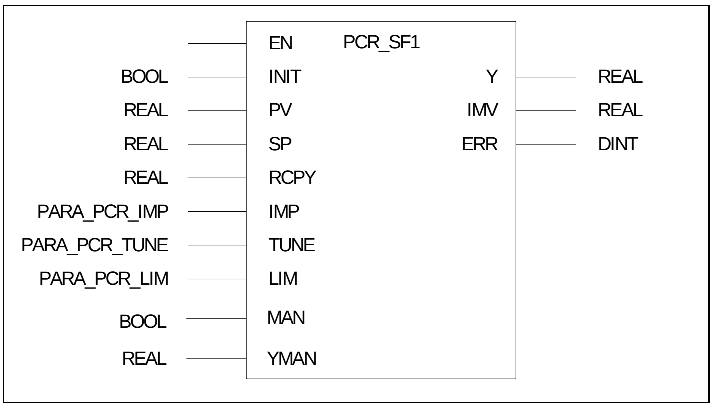


Figure 57: PCR_SF1 block

Parameter Description

Inputs:		
Parameter	**Data Type**	**Meaning**
INIT	BOOL	Command for model INITialization if True
PV	REAL	Process Variable
SP	REAL	Set Point value
RCPY	REAL	ReCoPY of applied Y value
IMP	PARA_PCR_IMP	Internal Model Parameters
TUNE	PARA_PCR_TUNE	Predictive control TUNing parameters
LIM	PARA_PCR_LIM	LIMitations on manipulated variable Y
MAN	BOOL	TRUE = Manual mode
YMAN	REAL	Manual Manipulated Variable

Outputs:		
Parameter	**Data Type**	**Meaning**
Y	REAL	Manipulated variable
IMV	REAL	Internal Model Value: process value estimated by model
ERR	DINT	ERRor code

Type Description

PARA_PCR_IMP: Internal Model Parameters		
Parameter	**Data Type**	**Meaning**
KM	REAL	Static gain
TM	TIME	Time constant
DM	TIME	Pure time delay

PARA_PCR_TUNE: Predictive control TUNing parameters		
Parameter	**Data Type**	**Meaning**
TS	TIME	Sampling time
H	TIME	Coincidence point
TRBF	TIME	95% closed-loop response time

PARA_PCR_LIM: LIMitations on manipulated variable Y		
Parameter	**Data Type**	**Meaning**
YMIN	REAL	MINimum value for Y
YMAX	REAL	MAXimum value for Y
YRATE	REAL	Maximum variation for Y (in unit per second)

Runtime Errors

Value	Meaning	Behaviour
ERR,0: 1	TS = 0	TS is forced to 1
ERR,1: 2	ABS(KM) < 1.0 e-6	KM is forced to +/- 1.0 e-6
ERR,2: 4	DM < 0	DM is forced to 0
ERR,3: 8	DM > 127 * TS	DM is forced to 127 * TS
ERR,4: 16	YRATE < 0	YRATE is forced to 0
ERR,5: 32	YMAX < YMIN	YMIN <-> YMAX and YRATE is forced to 0
ERR,6: 64	TRBF < 0	TRBF is forced to 0
ERR,7: 128	H < TS	H is forced to TS

The runtime error system uses binary type outputs (power of 2). So you can detect several runtime errors occurring at the same time. The output number is the sum of all ERR bits.

Detailed Description

Initialization Mode

The `INIT` flag is used to initialise the current and past states of the internal model. It is needed when the controller inputs (PV, actuator …) are not representative of the process.
For instance: temperature measurement of an empty reactor or opened valve without real action on the process.
Depending on the type of process on which the controller is applied (continuous or batch), the initialisation has to be performed once or at the beginning of each production.
`INIT` has to be done when the process is stabilised, as follows:

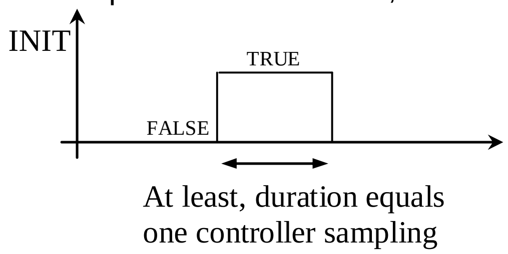


Figure 58: Initialisation

Manual Mode

The manual mode is applied if the input `MAN` is `TRUE`. Then, the output of the control block (`Y`) takes the value of manual manipulated variable `YMAN`.

Annex C: PCR_EF1 block

Brief Description

Function Description

PCR_EF1 is an EFB for enhanced control of first order process with pure time delay.
PCR_EF1 algorithm is based on predictive control principles:
An internal model of process is used to predict the future behaviour of the system. The model is composed of 3 parameters:

- KM: static gain
- TM: time constant
- DM: pure time delay

The following constraints on the manipulated variable (Y) can be taken into account:

- YMIN: minimum value for Y
- YMAX: maximum value for Y
- YRATE: maximum variation for Y

Additional Functions

Compared to PCR_SF1, PCR_EF1 provides the following additional functions:
FEED FORWARD COMPENSATION:

- to take in account a disturbance variable (issued from a disturbance modelling, see PCR_FF1, or from an other controller)

SPLIT RANGE COMPENSATION:

- to optimise the association of controllers, see PCR_SR1

SELF COMPENSATOR:

- to reject unmeasured ramp type disturbances

Representation

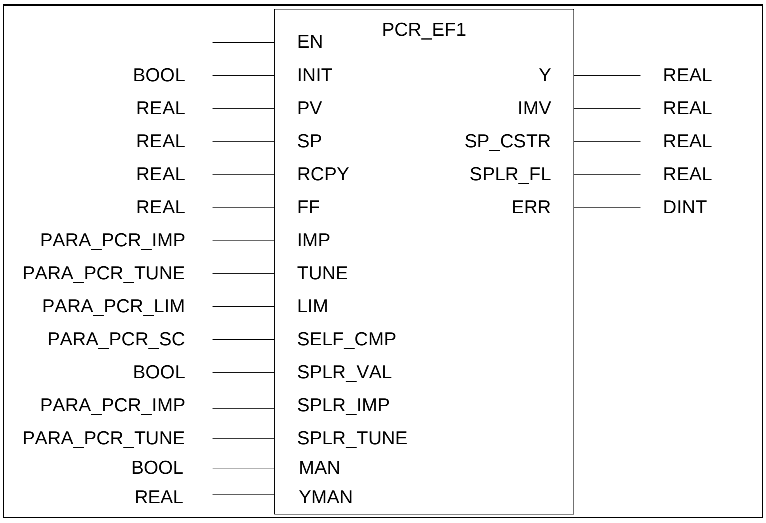


Figure 59: PCR_EF1 block

Parameter Description

Inputs:		
Parameter	**Data Type**	**Meaning**
INIT	BOOL	Command for model INITialization if True
PV	REAL	Process Variable
SP	REAL	Set Point value
RCPY	REAL	ReCoPY of applied Y value
FF	REAL	Feed-forward compensation
IMP	PARA_PCR_IMP	Internal Model Parameters
TUNE	PARA_PCR_TUNE	Predictive control TUNing parameters
LIM	PARA_PCR_LIM	LIMitations on manipulated variable Y
SELF_CMP	PARA_PCR_SC	Self Compensator parameters
SPLR_VAL	BOOL	If True, Split-Range Validation
SPLR_IMP	PARA_PCR_IMP	Internal Model Parameters from associated controller
SPLR_TUNE	PARA_PCR_TUNE	Predictive control TUNing parameters from associated controller
MAN	BOOL	TRUE = Manual mode
YMAN	REAL	Manual Manipulated Variable

Outputs:		
Parameter	**Data Type**	**Meaning**
Y	REAL	Manipulated variable
IMV	REAL	Internal Model Value: process value estimated by model
SP_CSTR	REAL	Set point transferred to upper level
SPLR_FL	REAL	Feed back value for associated controller
ERR	DINT	ERRor code

Type Description

PARA_PCR_IMP: Internal Model Parameters		
Parameter	**Data Type**	**Meaning**
KM	REAL	Static gain
TM	TIME	Time constant
DM	TIME	Pure time delay

PARA_PCR_TUNE: Predictive control TUNing parameters		
Parameter	**Data Type**	**Meaning**
TS	TIME	Sampling time
H	TIME	Coincidence point
TRBF	TIME	95% closed-loop response time

PARA_PCR_LIM: LIMitations on manipulated variable Y		
Parameter	**Data Type**	**Meaning**
YMIN	REAL	MINimum value for Y
YMAX	REAL	MAXimum value for Y
YRATE	REAL	Maximum variation for Y (in unit per second)

PARA_PCR_SC: Self Compensator parameters		
Parameter	**Data Type**	**Meaning**
KSC	REAL	Static gain
TSC	TIME	Time constant

Runtime Errors

Value	Meaning	Behaviour
ERR,0: 1	TS = 0	TS is forced to 1
ERR,1: 2	ABS(KM) < 1.0 e-6	KM is forced to +/- 1.0 e-6
ERR,2: 4	DM < 0	DM is forced to 0
ERR,3: 8	DM > 127 * TS	DM is forced to 127 * TS
ERR,4: 16	YRATE < 0	YRATE is forced to 0
ERR,5: 32	YMAX < YMIN	YMIN <-> YMAX and YRATE is forced to 0
ERR,6: 64	TRBF < 0	TRBF is forced to 0
ERR,7: 128	H < TS	H is forced to TS
Invalid setting in Split Range parameters:		
ERR,8: 256	DM < 0	DM is forced to 0
ERR,9: 512	DM > 127 * TS	DM is forced to 127 * TS
ERR,10: 1024	TRBF < 0	TRBF is forced to 0
ERR,11: 2048	H < TS	H is forced to TS
Invalid setting in Self Compensator parameters:		
ERR,14: 16384	TSC < 0	TSC is forced to 0
ERR,15: 32768	KSC < 0	KSC is forced to 0
ERR,16: 65536	KSC >KSC_MAX	KSC is forced to KSC_MAX (2.0)

The runtime error system uses binary type outputs (power of 2). So you can detect several runtime errors occurring at the same time. The output number is the sum of all ERR bits.

Detailed Description

Cascade Configuration

When a `PCR_EF1` controller is used as a SLAVE controller in a cascaded architecture, it receives a set point from the MASTER controller. If the output Y, computed by the SLAVE controller, is constrained, the MASTER Controller **must know** the value of the set point that can be satisfied by the SLAVE controller.
That value is computed by the SLAVE controller (SP_CSTR) and sent back to the master controller.

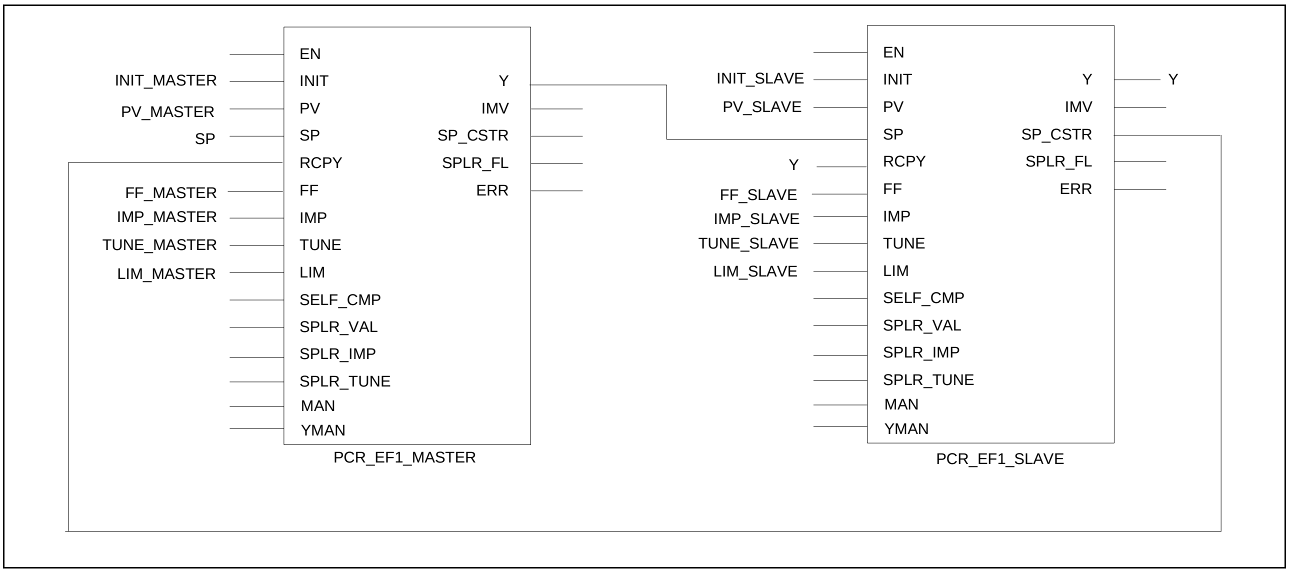


Figure 60: Example of cascade configuration, using PCR_EF1 blocks

Tuning of the Self Compensator Parameters

Some non measured variables may disturb the process. With unmeasured ramp-type disturbance, a bias between `PV` and `SP` may appear. The aim of the self-compensator is to reject this kind of disturbance.
The gain `KSC` and the time constant `TSC` are the parameters of the `PARA_PCR_SC` structure used with the `SELF_CMP` input.
For stability sake, usual values are:
$0 \leq KSC \leq 1$ (KSC=0 means no Self Compensation)
$TSC \geq max(30*TS, 3*TM, TRBF)$

Annex D: PCR_IF1 block

Brief Description

Function Description

`PCR_IF1` is an EFB for control of integrative first order process with pure time delay. The algorithm is based on predictive control principles:
An internal model of process is used to predict the future behaviour of the integrative system with delay. The model is composed of 3 parameters (see Figure 61):

- KM: static gain
- TM: time constant
- DM: pure time delay

The integrative part is decomposed. This is tuned by DECOMP input. For stability sake, it is better to set this input at the maximum value among: 30*TS, 3*TM, TRBF
The following constraints on the manipulated variable (Y) can be taken into account:

- YMIN: minimum value for Y
- YMAX: maximum value for Y
- YRATE: maximum variation for Y

Transfer Function

The continuous transfer function of the internal model is:

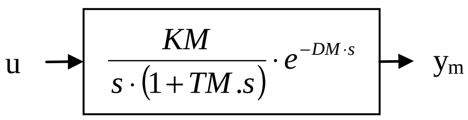


Figure 61: integrative 1st order model

Note for initialization

When the process variable `PV` varies as a ramp before switching on the controller, it is necessary to estimate the slope of this process variable `PV` in order to initialize correctly the model. This estimation is performed during the initialization phase, as long as `INIT` equals `TRUE`. The duration of this phase must be long enough to perform an estimation not biased by the noise. In case of heavy noise, more than ten periods may be required.

Representation

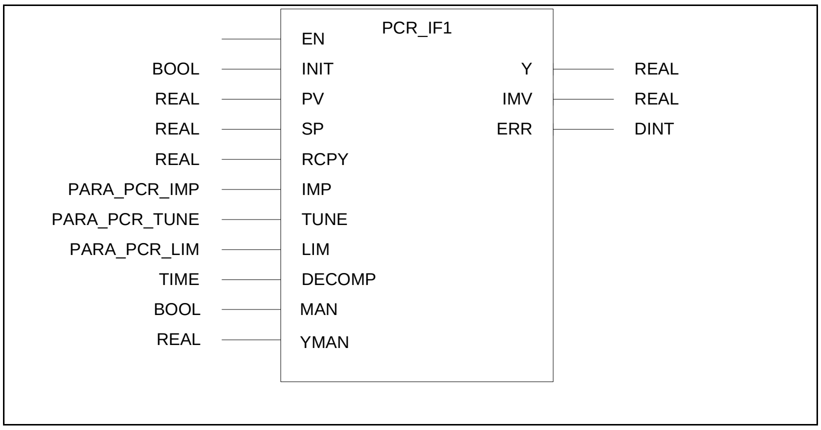


Figure 62: PCR_IF1 block

Parameter Description

Inputs:		
Parameter	**Data Type**	**Meaning**
INIT	BOOL	Command for model INITialization if True
PV	REAL	Process Variable
SP	REAL	Set Point value
RCPY	REAL	ReCoPY of applied Y value
IMP	PARA_PCR_IMP	Internal Model Parameters
TUNE	PARA_PCR_TUNE	Predictive control TUNing parameters
LIM	PARA_PCR_LIM	LIMitations on manipulated variable Y
DECOMP	TIME	Decomposition time constant
MAN	BOOL	TRUE = Manual mode
YMAN	REAL	Manual Manipulated Variable

Outputs:		
Parameter	**Data Type**	**Meaning**
Y	REAL	Manipulated variable
IMV	REAL	Internal Model Value: process value estimated by model
ERR	DINT	ERRor code

Type Description

PARA_PCR_IMP: Internal Model Parameters		
Parameter	**Data Type**	**Meaning**
KM	REAL	Static gain
TM	TIME	Time constant
DM	TIME	Pure time delay

PARA_PCR_TUNE: Predictive control TUNing parameters		
Parameter	**Data Type**	**Meaning**
TS	TIME	Sampling time
H	TIME	Coincidence point
TRBF	TIME	95% closed-loop response time

PARA_PCR_LIM: LIMitations on manipulated variable Y		
Parameter	**Data Type**	**Meaning**
YMIN	REAL	MINimum value for Y
YMAX	REAL	MAXimum value for Y
YRATE	REAL	Maximum variation for Y (in unit per second)

Runtime Errors

Value	Meaning	Behaviour
ERR,0: 1	TS = 0	TS is forced to 1
ERR,1: 2	ABS(KM) < 1.0 e-6	KM is forced to +/- 1.0 e-6
ERR,2: 4	DM < 0	DM is forced to 0
ERR,3: 8	DM > 127 * TS	DM is forced to 127 * TS
ERR,4: 16	YRATE < 0	YRATE is forced to 0
ERR,5: 32	YMAX < YMIN	YMIN <-> YMAX and YRATE is forced to 0
ERR,6: 64	TRBF < 0	TRBF is forced to 0
ERR,7: 128	H < TS	H is forced to TS
ERR,8: 256	DECOMP < 0	Decomposition time constant DECOMP is forced to 0

The runtime error system uses binary type outputs (power of 2). So you can detect several runtime errors occurring at the same time. The output number is the sum of all ERR bits.

Annex E: PCR_ZTR block

Brief Description

Function Description

PCR_ZTR is an EFB for changing automatically the Closed-loop Time-Response (TRBF) when the process variable PV is inside or outside a zone.
PCR_ZTR algorithm is based on basic principle:
When the PV is outside the zone, TRBF is set to TRBF_LO. The Controller will put the system back inside the zone.
When the PV is inside the zone, TRBF varies linearly between TRBF_LO and TRBF_HI as a function of the (PV-SP) deviation.

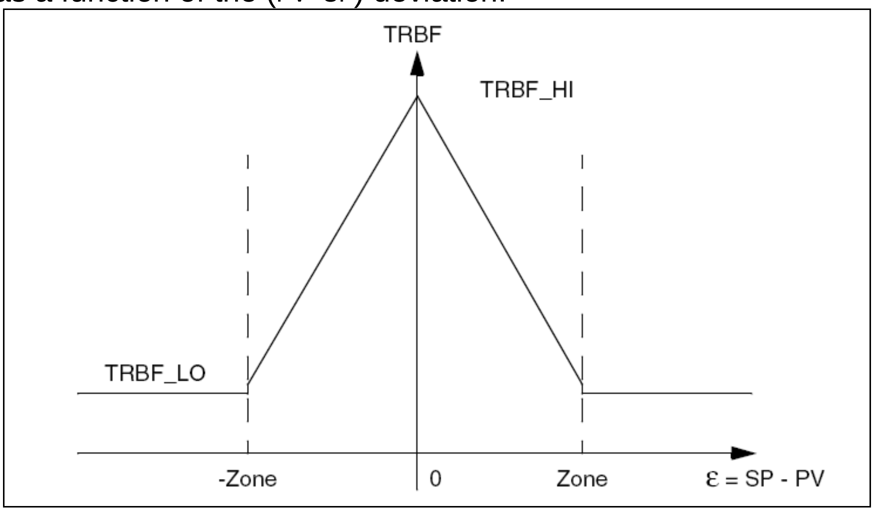


Figure 63: Evolution of TRBF

Representation

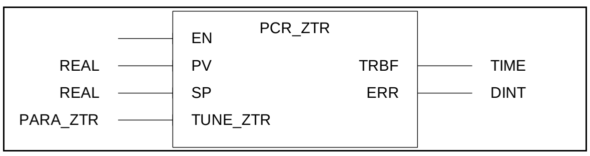


Figure 64: PCR_ZTR block

Parameter Description

Inputs:		
Parameter	**Data Type**	**Meaning**
PV	REAL	Process Variable
SP	REAL	Set Point value
TUNE_ZTR	PARA_ZTR	ZTR Parameters

Outputs:		
Parameter	**Data Type**	**Meaning**
TRBF	TIME	95% closed-loop response time
ERR	DINT	ERRor code

Type Description

PARA_ZTR: ZTR Parameters		
Parameter	**Type**	**Meaning**
ZONE	REAL	Zone value
TRBF_LO	TIME	TRBF Low value
TRBF_HI	TIME	TRBF High value

Runtime Errors

Value	Meaning	Behaviour
ERR,0: 1	TRBF_HI<TRBF_LO	TRBF_HI is set to TRBF_LO
ERR,1: 2	ZONE < 0	ZONE is set to 0

The runtime error system uses binary type outputs (power of 2). So you can detect several runtime errors occurring at the same time. The output number is the sum of all ERR bits.

Detailed Description

Principles

The zone control is a way to obtain a smoother controller when the PV is rather close to its set point in order to avoid active control actions produced by noisy measurements.
The controller is thus less active than when the PV is far from the set point. This technique is not equivalent to a dead zone which does not act as long as the PV is within the dead zone.
The zone control does not leave any constant deviation. It will make the PV move back slowly to the set point value.
When PV is outside the zone, the TRBF is set to TRBF_LO (fastest response)
When PV is inside the zone, TRBF is computed as follows:
`TRBF = TRBF_HI – (TRBF_HI – TRBF_LO) x |EPS| / ZONE`
with: `EPS = SP – PV`
This continuous variation of TRBF with EPS avoids bumps when crossing the zone borders and makes the controller strength proportional to the deviation.

Usage

The output TRBF is to be one of the parameters of the PARA_PCR_TUNE of a controller block.

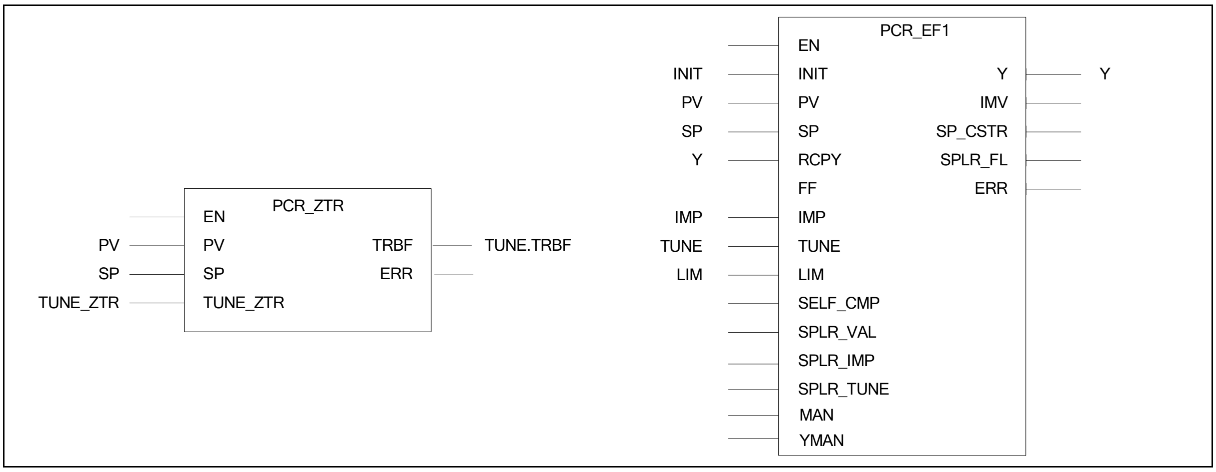


Figure 65: Use of zone control with a PCR_EF1 block

Annex F: Control Requirements

Hereafter are the requirements from an automatic point of view.

Control Loop number	Description	Main Objectives	Performances
4100	Exterior Air Lock Door Control - Side A	Alarm and LED if door open (One of the contactor)	N/A
4101	Exterior Air Lock Door Control - Side C	Alarm and LED if door open (One of the contactor)	N/A
4102	Air Lock Purge Control - Side A	N/A	N/A
4103	Air Lock Purge Control - Side C	N/A	N/A
4104	Light Intensity Control	Switch ON or OFF Lights, following a defined strategy DAY/NIGHT per STRING	N/A
4105	Lighting Loft Temperature Control	Switch Off Lights if temperature above limit	N/A
4106	Irrigation System	N/A	N/A
4107	pH Control	Control the pH between 5.6 and 6	pH = 5.8 +/- 0.2 Time Response : N/A
4108	EC Control	Control EC	EC = 1.9 mS/cm +/- 0.1 Time Response : N/A
4109	Nutrient Tank Temperature Control	N/A	N/A
4110	Nutrient and Condensate Levels Control	Maintain level between MIN and MAX	N/A
4111	Control of Air circulation fans	Continuous Air circulation in the chamber	N/A
4112	Chamber Temperature and Humidity Control	Temperature Set Point control Humidity Set Point control	T Set Point +/- 0.5°C Temperature Response : 60 mn RH Set Point +/- 5 % Humidity Response : 60mn
4113	CO2 Control	Set Point Control	Set Point 1000 ppm +/- 10 ppm
4114	Chamber Pressure	No control	N/A
4115	Ambient Parameters	N/A	N/A

N/A : Non Available

Annex G: PLC Card configuration

PLC Selection

PLC Type	140 CPU 434 12
Exec Id	883
Memory Size	64 K logic
Extended Memory	96K
IEC Runtime	Enabled
IEC Usable Memory Size	892

PLC Memory Partition

Coils	(0x)	1536	000001-001536
Discrete Inputs	(1x)	512	100001-100512
Input registers	(3x)	1024	300001-301024
Holding registers	(4x)	1872	400001-401872

ASCII Setup

Total Message	0
Message area size	0
ASCII Ports	0

Configuration Extensions

Data Protection	No
Peer Cop	No
Hot Standby	No
Ethernet	1
Profibus DP	No

Specials

Battery Coil	No
Timer Register	No
Time Of Day	400200 - 400207
Duplicate coils	No
First Coil Address	-
Watchdog Timeout [ms*10]	25
Online Editing Timeslice [ms]	20

Ethernet Parameters								
Slot	Module Name	IP Cfg	Internet Addr	Subnet Mask	Gateway Addr	Frame Type	Health Block	Diag Block
1-3	140-NOE-771-01	Specify	172.016.000.145	255.255.255.000	172.016.000.145	Ethernet II		

Modbus Port Settings (Bridge Mode: No)									
Port	Baudrate	Data bits	Stop bits	Parity	Delay (ms)	Address	Head Slot	Mode	Protocol
1	9600	8	1	even	10	1	0	RTU	RS232
2	9600	8	1	even	10	1	0	RTU	RS232
3	9600	8	1	even	10	1	0	RTU	RS232

I / O Map

Remote (Head slot 4)							
Drop	Type	Modules	Holdup [ms]	Input-Bits	Output-Bits	Status Reg.	Activate
1	Quantum I/O	8	300	32	160		-
2	Quantum I/O	10	300	1024	64		-

Local Drop

Drop Type: Quantum I/O Drop 1

Slot	Module name	Input Range	Output Range	Module description	In/Out-Type	Timeout-State
1-1	CPS-114-x0			AC PS 115V/230 8A, CPS114-10 summab>		
1-2	CPU-434-12			CPU 2MB 1xMB+ 2xModbus		
1-3	NOE-771-01			ENET 10/100 TCP/IP I/O Scanner		
1-4	CRP-93x-00			RIO Head S908		
1-5	DDI-841-00	100001-100016		DC Input 10-60V 8x2	BIN	
1-6	DDI-841-00	100017-100032		DC Input 10-60V 8x2	BIN	
1-7	ACO-130-00		400001-400008	Analog Output 8 Ch Current		
1-8	DDO-353-00		000001-000032	DC Output 24V 4x8	BIN	0000 0000

Parameter ACO-130-00 (Slot 1-7)			
Channel:	Range Selection:	Timeout State:	User Defined Timeout Value:
1	4..20mA, 0-16000	Last Value	0
2	4..20mA, 0-16000	Last Value	0
3	4..20mA, 0-16000	Last Value	0
4	4..20mA, 0-16000	Last Value	0
5	4..20mA, 0-16000	Last Value	0
6	4..20mA, 0-16000	Last Value	0
7	4..20mA, 0-16000	Last Value	0
8	4..20mA, 0-16000	Last Value	0

Remote (Head slot 4)						
Drop Type: Quantum I/O				Drop 2		
Slot	Module name	Input Range	Output Range	Module description	In/Out-Type	Timeout-State
1-1	CPS-114-x0			AC PS 115V/230 8A, CPS114-10 summab>		
1-2	CRA-93x-00			RIO Drop S908		
1-3	AVI-030-00	300001-300009		Analog Input 8 Ch bipolar		
1-4	AVI-030-00	300010-300018		Analog Input 8 Ch bipolar		
1-5	ATI-030-00	300055-300064		TC Input 8 Ch		
1-6	ARI-030-10	300028-300036		RTD Input 8 Ch		
1-7	ACI-030-00	300065-300073		Analog Input 8 Ch unipolar		
1-8	ARI-030-10	300037-300045		RTD Input 8 Ch		
1-9	ARI-030-10	300046-300054		RTD Input 8 Ch		
1-10	AVO-020-00		400009-400012	Analog Output 4 Ch Volt		

Parameter AVI-030-00 (Slot 1-3)

Data Format: 16-Bit Format

Channel	Range	Channel	Range
1	4mA To +20mA	5	4mA To +20mA
2	4mA To +20mA	6	4mA To +20mA
3	4mA To +20mA	7	4mA To +20mA
4	4mA To +20mA	8	4mA To +20mA

Parameter AVI-030-00 (Slot 1-4)

Data Format: 16-Bit Format

Channel	Range	Channel	Range
1	4mA To +20mA	5	4mA To +20mA
2	4mA To +20mA	6	4mA To +20mA
3	4mA To +20mA	7	0V To +10V
4	4mA To +20mA	8	0V To +10V

Parameter ATI-030-00 (Slot 1-5)

Resolution: 0.1 Deg Output Unit: Centigrade Cold Junction Compensator: On Board

Channel	Not installed	Open circuit test	Raw Output Amplifier	Type
1			100	Undefined
2			100	Undefined
3			100	Undefined
4			25	Undefined
5			25	Undefined
6			25	Undefined
7	X		25	J,Gain=25
8	X		25	J,Gain=25

Parameter ARI-030-10 (Slot 1-6)

Resolution: 0.1 Deg   Output Unit: Centigrade   Value Type: Raw Value

Channel	Disabled	Wire	Type
1		2-Wire	R, 0 to 4000 ohms
2		2-Wire	R, 0 to 4000 ohms
3		2-Wire	R, 0 to 4000 ohms
4		2-Wire	R, 0 to 4000 ohms
5		2-Wire	R, 0 to 4000 ohms
6		2-Wire	R, 0 to 4000 ohms
7		2-Wire	R, 0 to 4000 ohms
8		2-Wire	R, 0 to 4000 ohms

Parameter ARI-030-10 (Slot 1-8)

Resolution: 0.1 Deg   Output Unit: Centigrade   Value Type: Raw Value

Channel	Disabled	Wire	Type
1		2-Wire	R, 0 to 4000 ohms
2		2-Wire	R, 0 to 4000 ohms
3		2-Wire	R, 0 to 4000 ohms
4		2-Wire	R, 0 to 4000 ohms
5		2-Wire	R, 0 to 4000 ohms
6		2-Wire	R, 0 to 4000 ohms
7		2-Wire	R, 0 to 4000 ohms
8		2-Wire	R, 0 to 4000 ohms

Parameter ARI-030-10 (Slot 1-9)

Resolution: 0.1 Deg   Output Unit: Centigrade   Value Type: Raw Value

Channel	Disabled	Wire	Type
1		2-Wire	R, 0 to 4000 ohms
2		2-Wire	R, 0 to 4000 ohms
3		2-Wire	R, 0 to 4000 ohms
4		2-Wire	R, 0 to 4000 ohms
5		2-Wire	R, 0 to 4000 ohms
6		2-Wire	R, 0 to 4000 ohms
7		2-Wire	R, 0 to 4000 ohms
8		2-Wire	R, 0 to 4000 ohms

Parameter AVO-020-00 (Slot 1-10)

Channel	Input-/Output-Type	Timeout Value
1	Last Value	
2	Last Value	
3	Last Value	
4	Last Value	

SECTION 2: PLC Concept programme edition, 132 pages

Project Number:

Creation Date: 07/09/2009 11:27:45

Modification Date: 05/08/2011 07:37:24

Language :

X	SFC
X	FBD
X	LD
X	ST
X	IL
X	LL984
X	DFBs

STATUS:

X	DRAFT
	IN REVIEW
	RELEASED
	IN CHANGE
	INVALID

Description:

Comments:

Author(s): Concept Development Team

Approved:

History of Modification:

Rev.	Date	Author	Description of Modifications
2.0	22.07.96	Concept Team	all

Project properties

```
Database version    : 05/08/2011 07:37:21
PLC related version : 05/08/2011 07:37:21
Global DFB Path     : D:\M_PLC\CIVB\V00_80~1\GLB\
Secure Application  : No
```

P L C - C o n f i g u r a t i o n

PLC Selection

PLC Type	140 CPU 434 12
Exec Id	883
Memory Size	64 K logic
Extended Memory	96K
IEC Runtime	Enabled
IEC Usable Memory Size	892

PLC Memory Partition

Coils	(0x)	1536	000001-001536
Discrete Inputs	(1x)	512	100001-100512
Input registers	(3x)	1024	300001-301024
Holding registers	(4x)	1872	400001-401872

ASCII Setup

Total Message	0
Message area size	0
ASCII Ports	0

Configuration Extensions

Data Protection	No
Peer Cop	No
Hot Standby	No
Ethernet	1
Profibus DP	No

Specials

Battery Coil	No
Timer Register	No
Time Of Day	400200 - 400207
Duplicate coils	No
First Coil Address	-
Watchdog Timeout [ms*10]	25
Online Editing Timeslice [ms]	20

Segment Scheduler						
Schedule	Type of Solve	Reference	Sense	Segment	Drop Input	Drop Output
1	Continuous			1	1	1
2	Continuous			2	2	2
3	End of Logic			3		
4	End of Logic			4		
5	End of Logic			5		
6	End of Logic			6		
7	End of Logic			7		
8	End of Logic			8		
9	End of Logic			9		
10	End of Logic			10		
11	End of Logic			11		
12	End of Logic			12		
13	End of Logic			13		
14	End of Logic			14		
15	End of Logic			15		
16	End of Logic			16		
17	End of Logic			17		
18	End of Logic			18		
19	End of Logic			19		
20	End of Logic			20		
21	End of Logic			21		
22	End of Logic			22		
23	End of Logic			23		
24	End of Logic			24		
25	End of Logic			25		
26	End of Logic			26		
27	End of Logic			27		
28	End of Logic			28		
29	End of Logic			29		
30	End of Logic			30		
31	End of Logic			31		
32	End of Logic			32		

Ethernet Parameters								
Slot	Module Name	IP Cfg	Internet Addr	Subnet Mask	Gateway Addr	Frame Type	Health Block	Diag Block
1-3	140-NOE-771-01	Specify	172.016.000.145	255.255.255.000	172.016.000.145	Ethernet II		

Modbus Port Settings (Bridge Mode: No)									
Port	Baudrate	Data bits	Stop bits	Parity	Delay (ms)	Address	Head Slot	Mode	Protocol
1	9600	8	1	even	10	1	0	RTU	RS232
2	9600	8	1	even	10	1	0	RTU	RS232
3	9600	8	1	even	10	1	0	RTU	RS232

Variable list (Name: All, Type: All, DataType: All, Sorted by: name)

Variable name	Type	DType	Address	Initial value	Comment	Used
ALARM_STATUS	IVAR	SECT_CTRL				0
AT_4107_01	VAR	REAL	400031	6.0	pH sensor	9
AT_4107_01_ERR	VAR	BOOL	000077			2
AT_4107_01_MAX	VAR	REAL		14.0	Scaling parameter for pH	1
AT_4107_01_MIN	VAR	REAL		0.0	Scaling parameter for pH	1
AT_4108_01	VAR	REAL	400033		Electrical Conductivity of nutrient	6
AT_4108_01_ERR	VAR	BOOL	000084			2
AT_4108_01_MAX	VAR	REAL		19.990	mS/m (milliSiemens/m)	1
AT_4108_01_MIN	VAR	REAL		0.0	mS/m (milliSiemens/m)	1
AT_4112_01	VAR	REAL	400083	70.0	% Humidity associated with temperature A1	4
AT_4112_01_ERR	VAR	BOOL	000123			5
AT_4112_02	VAR	REAL	400085	70.0	% Humidity associated with temperature B1	1
AT_4112_02_ERR	VAR	BOOL	000124			2
AT_4112_03	VAR	REAL	400087	70.0	% Humidity associated with temperature C1	3
AT_4112_03_ERR	VAR	BOOL	000125			5
AT_4112_AVG	VAR	REAL	400154		Average Humidity from the 3 Humidity sensors associated with temperature	9
AT_4112_AVG_Day_SP	VAR	REAL	400150	70.0		1
AT_4112_AVG_Night_SP	VAR	REAL	400146	70.0		1
AT_4112_High	VAR	REAL		85.0		0
AT_4112_Low	VAR	REAL		50.0		0
AT_4112_MAX	VAR	REAL		100.0	%RH	3
AT_4112_MIN	VAR	REAL		0.0	%RH	3
AT_4112_SP	VAR	REAL	400324	80.0	%, SET POINT of Humidity	3
AT_4113_01	VAR	REAL	400091		CO2 Analyser. ppm	6
AT_4113_01_ERR	VAR	BOOL	000135			2
AT_4113_01_MAX	VAR	REAL		4000.0	µmol/mol	1
AT_4113_01_MIN	VAR	REAL		0.0	µmol/mol or ppm	1
AT_4113_01_SP	VAR	REAL	400162	1000.0	CO2 Set Point (Should be 1000 ppm or 1000µ mol/mol)	5
AT_4113_02	VAR	REAL	400093	20.0	% O2 Analyser	3
AT_4113_02_ERR	VAR	BOOL	000136			3
AT_4113_02_MAX	VAR	REAL		25.0	%	1
AT_4113_02_MIN	VAR	REAL		0.0	%	1
BLWR_4111_01_MV	VAR	BOOL	000019			4
BLWR_4111_01_OP	VAR	BOOL	000153			1
CL4100_DoorAOpen_A	VAR	BOOL	000033			2
CL4100_DoorA_open_Time_LIM	VAR	TIME	400402	t#1m		1
CL4100_DOOR_OPEN	VAR	BOOL			Exterior Air Lock Open - Side A	0
CL4100_Ext_Air_Lock_Door_A	IVAR	SECT_CTRL				0
CL4101_DoorCOpen_A	VAR	BOOL	000034			2
CL4101_DoorC_open_Time_LIM	VAR	TIME	400404	t#1m		1
CL4101_DOOR_OPEN	VAR	BOOL			Exterior Air Lock Open - Side C	0
CL4101_ExtDoor_C_Open	VAR	BOOL		FALSE	Exterior door C open alarm	0
CL4101_Ext_Air_Lock_Door_C	IVAR	SECT_CTRL				0
CL4102_Pressure_High	VAR	REAL		1030.0	Max Value Pressure - Side A - Bar	1
CL4102_PURGETIME	VAR	TIME		t#10s	Purge Duration	1
CL4102_Purge_A	IVAR	SECT_CTRL				0
CL4102_PURGE_DEMAND	VAR	BOOL	000175		From HMI- Purge Asked	3
CL4102_START_PURGE	VAR	BOOL		FALSE	Start Purge	1
CL4103_Pressure_High	VAR	REAL		1030.0	Max Value Pressure - Side C - Bar	1
CL4103_PURGETIME	VAR	TIME		t#20s	Purge Duration	1
CL4103_Purge_C	IVAR	SECT_CTRL				0
CL4103_PURGE_DEMAND	VAR	BOOL	000176		From HMI - Purge Asked	3
CL4103_START_PURGE	VAR	BOOL		FALSE	Start Purge	1
CL4104_ControlLoop_Mode	VAR	INT	400119			5
CL4104_DAYHOUR	VAR	BOOL				0
CL4104_DURATION_H	VAR	TIME		t#14h	Parameter : Duration ON for MH string (C);	0

table continued...

Variable list (Name: All, Type: All, DataType: All, Sorted by: name)

Variable name	Type	DType	Address	Initial value	Comment	Used
					Day	
CL4104_DURATION_Sa	VAR	TIME		t#30s	Parameter : Duration ON for Sa string (A); Day	0
CL4104_DURATION_Sb	VAR	TIME		t#14h	Parameter : Duration ON for Sb string (B); Day	0
CL4104_Endday_Word	VAR	WORD				6
CL4104_EndingDay_Hour	VAR	UINT	400184	22		1
CL4104_EndingDay_Hour_Byte	VAR	BYTE				2
CL4104_EndingDay_Minute	VAR	UINT	400185	0		1
CL4104_EndingDay_Minute_Byte	VAR	BYTE				2
CL4104_H_Act	VAR	BOOL		FALSE	Activation of String H by Operator (HMI)	0
CL4104_H_AH	VAR	BOOL	000041			2
CL4104_H_AL	VAR	BOOL	000042			2
CL4104_H_ET	VAR	TIME		t#0m	H (String C) elapsed time ON (for HMI)	0
CL4104_H_ET_OFF	VAR	TIME			H (String C) elapsed time OFF (for HMI)	0
CL4104_Light_Intensity	IVAR	SECT_CTRL				0
CL4104_NoLight_AH	VAR	BOOL	000049			2
CL4104_ProcessTime_Word	VAR	WORD				7
CL4104_Sa_Act	VAR	BOOL		FALSE	Activation of Sa by Operator (HMI)	0
CL4104_Sa_AH	VAR	BOOL	000037			2
CL4104_Sa_AL	VAR	BOOL	000038			2
CL4104_Sa_ET	VAR	TIME		t#0m	Sa elapsed time ON (for IHM)	0
CL4104_Sa_ET_OFF	VAR	TIME			Sa elapsed time OFF (for HMI)	0
CL4104_Sa_H_AH	VAR	BOOL	000043			2
CL4104_Sa_H_AL	VAR	BOOL	000044			2
CL4104_Sa_Sb_AH	VAR	BOOL	000045			2
CL4104_Sa_Sb_AL	VAR	BOOL	000046			2
CL4104_Sa_Sb_H_AH	VAR	BOOL	000047			2
CL4104_Sa_Sb_H_AL	VAR	BOOL	000048			2
CL4104_Sb_Act	VAR	BOOL		FALSE	Activation of Sb by Operator	0
CL4104_Sb_AH	VAR	BOOL	000039			2
CL4104_Sb_AL	VAR	BOOL	000040			2
CL4104_Sb_ET	VAR	TIME		t#0m	Sb elapsed time ON (for HMI)	0
CL4104_Sb_ET_OFF	VAR	TIME			Sb elapsed time OFF (for HMI)	0
CL4104_Startday_Word	VAR	WORD				6
CL4104_StartingDay_Hour	VAR	UINT	400182	6		1
CL4104_StartingDay_Hour_Byte	VAR	BYTE				2
CL4104_StartingDay_Minute	VAR	UINT	400183	00		1
CL4104_StartingDay_Minute_Byte	VAR	BYTE				2
CL4104_STARTLIGHTS	VAR	BOOL	000157		Startup light Sequence	9
CL4104_Start_End_Compare	VAR	BOOL				2
CL4104_STOPLIGHTS	VAR	BOOL		FALSE	Demand for Switching Off Lights, for control reason (temperature)	4
CL4104_TIMEOFF_1	VAR	BOOL		FALSE	Sa Switch Off demand : True = Off	0
CL4104_TIMEOFF_2	VAR	BOOL		FALSE	Sb Switch Off demand : True = Off	0
CL4104_TIMEOFF_3	VAR	BOOL		FALSE	MH Switch Off demand : True = Off	0
CL4105_ControlLoop_Mode	VAR	INT	400120			3
CL4105_FAN_OK	VAR	BOOL			FAN OK because Temp greater than high limit	5
CL4105_FlowFan1_AL	VAR	BOOL		FALSE	Air Loft Flow Alarm fan A	2
CL4105_FlowFan2_AL	VAR	BOOL		FALSE	Air Loft Flow Alarm fan B	2
CL4105_FlowFan3_AL	VAR	BOOL		FALSE	Air Loft Flow Alarm fan C	2
CL4105_Lighting_Loft_Temp	IVAR	SECT_CTRL				0
CL4105_MAINTAINFAN	VAR	BOOL		FALSE	Logical for maintaining FAN ON	7
CL4105_STOPFAN	VAR	BOOL		FALSE	Logical for stopping FAN	0
CL4105_TempFan1_AH	VAR	BOOL	000053			2
CL4105_TempFan1_AHH	VAR	BOOL	000054			3

table continued...

Variable list (Name: All, Type: All, DataType: All, Sorted by: name)

Variable name	Type	DType	Address	Initial value	Comment	Used
CL4105_TempFan2_AH	VAR	BOOL	000056			2
CL4105_TempFan2_AHH	VAR	BOOL	000057			3
CL4105_TempFan3_AH	VAR	BOOL	000059			2
CL4105_TempFan3_AHH	VAR	BOOL	000060			3
CL4105_TempFan_LIM_H	VAR	REAL	400426	42.0		3
CL4105_TempFan_LIM_HH	VAR	REAL	400428	45.0	Max (High) Temperature for Loft	6
CL4106_ControlLoop_Mode	VAR	INT	400121			16
CL4106_Flow_AH	VAR	BOOL	000065		T 201 Irrigation Flow Alarm	2
CL4106_Flow_AHH	VAR	BOOL	000066			2
CL4106_Flow_AL	VAR	BOOL	000067			2
CL4106_Flow_ALL	VAR	BOOL	000068			2
CL4106_Irrigation	IVAR	SECT_CTRL				0
CL4106_PumpError_A	VAR	BOOL	000069			2
CL4107_AcidTank_AL	VAR	BOOL	000071		Acid Low Level Alarm	2
CL4107_Acid_calibration	VAR	REAL	400342	0.0	acid calibration factor	1
CL4107_Acid_injection	VAR	REAL	400338	0.0	Injection calculated in ml	1
CL4107_Acid_Opening_Time	VAR	REAL	400188	0.0		1
CL4107_Acid_Opening_Time_OLD	VAR	REAL				0
CL4107_ACID_TIME	VAR	TIME				1
CL4107_BaseTank_AL	VAR	BOOL	000072		Base Low Level Alarm	2
CL4107_Base_calibration	VAR	REAL	400340	0.0	base calibration factor	1
CL4107_Base_injection	VAR	REAL	400336	0.0	Injection calculated in ml	1
CL4107_Base_Opening_Time	VAR	REAL	400186			1
CL4107_Base_Opening_Time_OLD	VAR	REAL				0
CL4107_BASE_TIME	VAR	TIME				1
CL4107_ControlLoop_Mode	VAR	INT	400122			13
CL4107_DeadZone	VAR	REAL	400140	0.1	dead zone for pH control	4
CL4107_DeadZone2	VAR	REAL		0.1		0
CL4107_DECOMP	VAR	TIME		t#10m	DECOMP Parameter	1
CL4107_ERRIF1	VAR	DINT		0	ERRor Indicator EF1_1 control bllock	1
CL4107_IMP1	VAR	PARA_PCR_IMP			Internal Model EF1_1. Acid --> pH	1
KM	COMP	REAL		0.01		
TM	COMP	TIME		t#20s		
DM	COMP	TIME		t#60s		
CL4107_INIT	VAR	BOOL		FALSE	Init Flag for controllers	2
CL4107_LIM1	VAR	PARA_PCR_LIM			Constraints for Acid	1
YMIN	COMP	REAL		-0.17		
YMAX	COMP	REAL		0.17		
YRATE	COMP	REAL		1.0		
CL4107_PARAPWM	VAR	Para_PWM			PWM Parameters	1
t_period	COMP	TIME		t#60s		
t_min	COMP	TIME		t#0.1s		
t_max	COMP	TIME		t#10s		
up_pos	COMP	REAL		1.0		
up_neg	COMP	REAL		1.0		
CL4107_PCR_FlagInit	VAR	BOOL				2
CL4107_PCR_IMV	VAR	REAL	400310			1
CL4107_PH	IVAR	SECT_CTRL				0
CL4107_Ph_AH	VAR	BOOL	000073		pH High Alarm	2
CL4107_Ph_AHH	VAR	BOOL	000074			3
CL4107_Ph_AL	VAR	BOOL	000075		pH Low Alarm	2
CL4107_Ph_ALL	VAR	BOOL	000076			3
CL4107_PH_Day	VAR	BYTE	400218			1
CL4107_PH_Hour	VAR	BYTE	400217			1
CL4107_Ph_LIM_H	VAR	REAL	400438	6.0	High limit of pH	1
CL4107_Ph_LIM_HH	VAR	REAL	400440	7.0		1
CL4107_Ph_LIM_L	VAR	REAL	400442	5.6	Lower limit of pH	1

table continued...

Variable list (Name: All, Type: All, DataType: All, Sorted by: name)

Variable name	Type	DType	Address	Initial value	Comment	Used
CL4107_Ph_LIM_LL	VAR	REAL	400444	5.0		1
CL4107_PH_Minute	VAR	BYTE	400216			1
CL4107_PH_Month	VAR	BYTE	400219			1
CL4107_PH_Second	VAR	BYTE	400215			1
CL4107_Ph_SP	VAR	REAL	400138	5.9	pH set point : from HMI	4
CL4107_PH_Year	VAR	BYTE	400220			1
CL4107_RCPY	VAR	REAL				2
CL4107_Reset_EC_Timer	VAR	BOOL	000159			5
CL4107_Reset_PH_Timer	VAR	BOOL	000158			5
CL4107_TUNE1	VAR	PARA_PCR_TUNE			Tuning Parameters for EF1_1	3
TS	COMP	TIME		t#60s		
H	COMP	TIME		t#2m		
TRBF	COMP	TIME		t#3m		
CL4107_Y1	VAR	REAL	400304	0.0	MV1 computed (Acid)	3
CL4108_ControlLoop_Mode	VAR	INT	400123			16
CL4108_DECOMP	VAR	TIME		t#10m	Decomposition parameter	1
CL4108_EC	IVAR	SECT_CTRL				0
CL4108_Ec_AH	VAR	BOOL	000080		EC High Alarm	2
CL4108_Ec_AHH	VAR	BOOL	000081			3
CL4108_Ec_AL	VAR	BOOL	000082		EC Low Alarm	2
CL4108_Ec_ALL	VAR	BOOL	000083			2
CL4108_EC_Day	VAR	BYTE	400224			1
CL4108_EC_Hour	VAR	BYTE	400223			1
CL4108_Ec_LIM_H	VAR	REAL	400446	2.2		1
CL4108_Ec_LIM_HH	VAR	REAL	400448	2.5		1
CL4108_Ec_LIM_L	VAR	REAL	400450	1.5		1
CL4108_Ec_LIM_LL	VAR	REAL	400452	1.0		1
CL4108_EC_Minute	VAR	BYTE	400222			1
CL4108_EC_Month	VAR	BYTE	400225			1
CL4108_EC_Second	VAR	BYTE	400221			1
CL4108_Ec_SP	VAR	REAL	400142	1.9	EC Set Point : 1900 µS/m	1
CL4108_EC_TIME	VAR	TIME				0
CL4108_EC_Year	VAR	BYTE	400226			1
CL4108_ERR_458_1	VAR	DINT		0	Error Indicator	1
CL4108_IMP	VAR	PARA_PCR_IMP			Internal Model for EC	1
KM	COMP	REAL		0.0008		
TM	COMP	TIME		t#47s		
CL4108_INIT	VAR	BOOL		FALSE	Init Flag for controller	2
CL4108_LIM	VAR	PARA_PCR_LIM			Constraint for MV (0/100)	1
YMAX	COMP	REAL		0.5		
YRATE	COMP	REAL		0.1		
CL4108_NutrientTankA_AL	VAR	BOOL	000078		Stock A Low Level Alarm	2
CL4108_NutrientTankB_AL	VAR	BOOL	000079		Stock B Low Level Alarm	2
CL4108_PARAPWM	VAR	Para_PWM			PWM Parameters	2
t_period	COMP	TIME		t#20s		
t_min	COMP	TIME		t#0.2s		
t_max	COMP	TIME		t#10s		
up_pos	COMP	REAL		1.0		
up_neg	COMP	REAL		-1.0		
CL4108_PCR_FlagInit	VAR	BOOL				2
CL4108_PCR_IMV	VAR	REAL	400326			1
CL4108_RATIO	VAR	REAL		0.7	Ration between the opening duration of TankA and TankB	0
CL4108_SolA_calibration	VAR	REAL	400346	0.0	Solution A: Calibration factor for total volume injection	5
CL4108_SolA_injection	VAR	REAL	400344	0.0	Solution A total volume injection	1
CL4108_SolA_Opening_Time	VAR	REAL	400190			1

table continued...

Variable list (Name: All, Type: All, DataType: All, Sorted by: name)

Variable name	Type	DType	Address	Initial value	Comment	Used
CL4108_SolA_Opening_Time_OLD	VAR	REAL				0
CL4108_SolA_OP_Time	VAR	UDINT	400231		Time entered by the operator: define the opening period (in sec) of the "solution A" equipment in manual mode	4
CL4108_SolB_calibration	VAR	REAL	400350	0.0	Solution B: Calibration factor for calculated injection volume	5
CL4108_SolB_injection	VAR	REAL	400348	0.0	Solution B: total volume injection	1
CL4108_SolB_Opening_Time	VAR	REAL	400300			1
CL4108_SolB_Opening_Time_OLD	VAR	REAL				0
CL4108_SolB_OP_Time	VAR	UDINT	400390		Time entered by the operator: define the opening period (in sec) of the "solution B" equipment in manual mode	4
CL4108_TS	VAR	TIME		t#10s	Sampling Period	0
CL4108_TUNE	VAR	PARA_PCR_TUNE			Tuning Parameters	3
TS	COMP	TIME		t#20s		
H	COMP	TIME		t#1m		
TRBF	COMP	TIME		t#3m		
CL4108_Y	VAR	REAL	400308	0.0	Computed MV	6
CL4109_MAN	VAR	BOOL		TRUE	MANual operating	0
CL4109_NutrientTank_Temp	IVAR	SECT_CTRL				0
CL4109_PARAPWM	VAR	Para_PWM			Parametes of PWM	0
t_period	COMP	TIME		t#1m		
t_max	COMP	TIME		t#1m		
up_pos	COMP	REAL		100.0		
CL4110_A_1	VAR	BOOL			Alarm 1: High Level for both reservoir and condensate tanks and Pump ON	0
CL4110_A_2	VAR	BOOL			Alarm 2: Low Level for both reservoir and condensate tanks and Pump OFF	0
CL4110_A_3	VAR	BOOL			Alarm 3: High Level for reservoir tank and Low Level for condensate tank and Pump OFF	0
CL4110_CondensateAndNutrient_AH	VAR	BOOL	000089			2
CL4110_CondensateAndNutrient_AL	VAR	BOOL	000090			2
CL4110_CondensateTank_AH	VAR	BOOL	000085		Low Level alarm for reservoir tank	2
CL4110_CondensateTank_AL	VAR	BOOL	000086			1
CL4110_Condensate_Day	VAR	BYTE	400254			1
CL4110_Condensate_Hour	VAR	BYTE	400253			1
CL4110_Condensate_Minute	VAR	BYTE	400252			1
CL4110_Condensate_Month	VAR	BYTE	400255			1
CL4110_Condensate_Second	VAR	BYTE	400257			1
CL4110_condensate_tank_volume	VAR	REAL		1.0		1
CL4110_condensate_totalvolume	VAR	REAL	400250			4
CL4110_Condensate_Year	VAR	BYTE	400256			1
CL4110_ControlLoop_Mode	VAR	INT	400124			3
CL4110_Level_Time_LIM	VAR	TIME	400454	t#10m		4
CL4110_NutrientTank_AH	VAR	BOOL	000087		High Level alarm for reservoir tank	2
CL4110_NutrientTank_AL	VAR	BOOL	000088			2
CL4110_Nutrient_Condens_Level	IVAR	SECT_CTRL				0
CL4110_reset_calculation	VAR	BOOL	000182			1
CL4111_AIRFAN	VAR	BOOL		FALSE	From HMI : Ask for AIRFAN	0
CL4111_Air_Fans	IVAR	SECT_CTRL				0
CL4111_BlowerError_A	VAR	BOOL	000171			1
CL4111_ControlLoop_Mode	VAR	INT	400125			2
CL4111_FT_MIN	VAR	REAL	400456	4.0	MIN value for Air Flow (unit ?)	2
CL4111_NoFlow_LightOn_A	VAR	BOOL	000091		Alarm : Flow Rate lower than its limit	2
CL4112_Alarms_Chamber	IVAR	SECT_CTRL				0
CL4112_ALARM_HEATEXCHANGER	IVAR	SECT_CTRL				0
CL4112_B301_Qchilled	VAR	REAL		0.56		0

table continued...

Variable list (Name: All, Type: All, DataType: All, Sorted by: name)

Variable name	Type	DType	Address	Initial value	Comment	Used
CL4112_B301_QCOLDMAX	VAR	REAL		0.56		0
CL4112_B302_Qhot	VAR	REAL		0.19		0
CL4112_Chamber_T_RH	IVAR	SECT_CTRL				0
CL4112_ColdOutletAir_AVG	VAR	REAL	400314			11
CL4112_ColdOutletAir_SP	VAR	REAL	400316	20.0		3
CL4112_ControlLoop_T_Mode	VAR	INT	400126			0
CL4112_ControlLoop_T_RH_Mode	VAR	INT	400127			11
CL4112_DECOMP	VAR	TIME		t#15m		0
CL4112_HotOutletAir_AVG	VAR	REAL	400400			3
CL4112_HotOutletAir_SP	VAR	REAL	400318	20.0		2
CL4112_Humidity_AH	VAR	BOOL	000097			2
CL4112_Humidity_AHH	VAR	BOOL	000098			2
CL4112_Humidity_AL	VAR	BOOL	000099			2
CL4112_Humidity_ALL	VAR	BOOL	000100			2
CL4112_Humidity_LIM_H	VAR	REAL	400466	85.0		1
CL4112_Humidity_LIM_HH	VAR	REAL	400468	90.0		1
CL4112_Humidity_LIM_L	VAR	REAL	400470	45.0		1
CL4112_Humidity_LIM_LL	VAR	REAL	400472	40.0		1
CL4112_IMP1	VAR	PARA_PCR_IMP			Internal Model Parameters (HeatExchange)	2
KM	COMP	REAL		0.016		
TM	COMP	TIME		t#120s		
DM	COMP	TIME		t#45s		
CL4112_IMP2	VAR	PARA_PCR_IMP			Internal Model Parameters (RH)	2
KM	COMP	REAL		0.0087		
TM	COMP	TIME		t#40s		
DM	COMP	TIME		t#30s		
CL4112_IMP3	VAR	PARA_PCR_IMP			Internal Model Parameters (CoolerExchange)	1
KM	COMP	REAL		0.59		
TM	COMP	TIME		t#1730s		
DM	COMP	TIME		t#120s		
CL4112_IMP4	VAR	PARA_PCR_IMP				1
KM	COMP	REAL		3.0		
TM	COMP	TIME		t#50s		
DM	COMP	TIME		t#20s		
CL4112_IMV1	VAR	REAL				0
CL4112_IMV_Cold_OUT	VAR	REAL	400306			1
CL4112_IMV_Hot_OUT	VAR	REAL	400322			1
CL4112_IMV_RHCHAMBER_OUT	VAR	REAL	400328			1
CL4112_IMV_TCHAMBER_OUT	VAR	REAL	400332			1
CL4112_init1	VAR	BOOL		0	Command for model INITialization if TRUE	2
CL4112_init2	VAR	BOOL		1	Command for model INITialization if TRUE	2
CL4112_init3	VAR	BOOL		1	Command for model INITialization if TRUE	2
CL4112_init4	VAR	BOOL				2
CL4112_LIM1	VAR	PARA_PCR_LIM			Limitation on manipulated variable Y for	4
YMAX	COMP	REAL		100.0	PCR_SF1 block (HeatExchange)	
YRATE	COMP	REAL		50.0		
CL4112_LIM2	VAR	PARA_PCR_LIM			Limitation on manipulated variable Y for	4
YMIN	COMP	REAL		8.3	PCR_SF1 block (RH)	
YMAX	COMP	REAL		30.0		
YRATE	COMP	REAL		200.0		
CL4112_LIM3	VAR	PARA_PCR_LIM			Limitation on manipulated variable Y for	1
YMIN	COMP	REAL		15.0	PCR_EF1 block (CoolerExchange)	
YMAX	COMP	REAL		45.0		
YRATE	COMP	REAL		1.0		
CL4112_LIM4	VAR	PARA_PCR_LIM				1
YMIN	COMP	REAL		8.0		
YMAX	COMP	REAL		26.0		

table continued...

Variable list (Name: All, Type: All, DataType: All, Sorted by: name)

Variable name	Type	DType	Address	Initial value	Comment	Used
YRATE	COMP	REAL		0.1		
CL4112_MV_HEATEXCHANGE1	VAR	REAL				0
CL4112_MV_HEATEXCHANGE3	VAR	REAL				0
CL4112_PARA_SCALING	VAR	Para_SCALING				0
CL4112_PARA_SCALING3	VAR	Para_SCALING				0
CL4112_PCR_Cold_ERR	VAR	DINT				1
CL4112_PCR_COLD_OUT	VAR	REAL				3
CL4112_PCR_FlagInit	VAR	BOOL				0
CL4112_PCR_FlagInit1	VAR	BOOL				2
CL4112_PCR_FlagInit2	VAR	BOOL				2
CL4112_PCR_FlagInit3	VAR	BOOL				2
CL4112_PCR_FlagInit4	VAR	BOOL				2
CL4112_PCR_Hot_ERR	VAR	DINT				1
CL4112_PCR_HOT_OUT	VAR	REAL				3
CL4112_PCR_TCHAMBER_ERR	VAR	DINT				1
CL4112_SELF_CMP3	VAR	PARA_PCR_SC				1
KSC	COMP	REAL		0.5		
TSC	COMP	TIME		t#60m		
CL4112_SPLR_IMP3	VAR	PARA_PCR_IMP				0
CL4112_SPLR_TUNE3	VAR	PARA_PCR_TUNE				0
CL4112_SP_CSTR	VAR	REAL				0
CL4112_Tac_SP	VAR	REAL				0
CL4112_Temperature_AH	VAR	BOOL	000093			2
CL4112_Temperature_AHH	VAR	BOOL	000094			3
CL4112_Temperature_AL	VAR	BOOL	000095			2
CL4112_Temperature_ALL	VAR	BOOL	000096			2
CL4112_Temperature_LIM_H	VAR	REAL	400458	28.0		1
CL4112_Temperature_LIM_HH	VAR	REAL	400460	30.0		1
CL4112_Temperature_LIM_L	VAR	REAL	400462	18.0		1
CL4112_Temperature_LIM_LL	VAR	REAL	400464	15.0		1
CL4112_Temp_ColdXchanger_AH	VAR	BOOL	000162			2
CL4112_Temp_ColdXchanger_AHH	VAR	BOOL	000163			2
CL4112_Temp_ColdXchanger_LIM_H	VAR	REAL	400478	12.0		1
CL4112_Temp_ColdXchanger_LIM_HH	VAR	REAL	400480	15.0		1
CL4112_Temp_HotXchanger_AL	VAR	BOOL	000160			2
CL4112_Temp_HotXchanger_ALL	VAR	BOOL	000161			2
CL4112_Temp_HotXchanger_LIM_L	VAR	REAL	400474	40.0		1
CL4112_Temp_HotXchanger_LIM_LL	VAR	REAL	400476	35.0		1
CL4112_Ts	VAR	TIME		t#0.2s		0
CL4112_TUNE1	VAR	PARA_PCR_TUNE			Predictive control Tuning parameters (HeatExchange)	6
TS	COMP	TIME		t#3s		
H	COMP	TIME		t#3s		
TRBF	COMP	TIME		t#6m		
CL4112_TUNE2	VAR	PARA_PCR_TUNE			Predictive control Tuning parameters (RH)	6
TS	COMP	TIME		t#1s		
H	COMP	TIME		t#1s		
TRBF	COMP	TIME		t#2m		
CL4112_TUNE3	VAR	PARA_PCR_TUNE			Predictive control Tuning parameters (CoolerExchange)	5
TS	COMP	TIME		t#30s		
H	COMP	TIME		t#30s		
TRBF	COMP	TIME		t#1h		
CL4112_TUNE4	VAR	PARA_PCR_TUNE				6
TS	COMP	TIME		t#10s		
H	COMP	TIME		t#10s		
TRBF	COMP	TIME		t#3m		
CL4112_TUNE_ZTR1	VAR	PARA_ZTR				0
TRBF_LO	COMP	TIME		t#15s		

table continued...

Variable list (Name: All, Type: All, DataType: All, Sorted by: name)

Variable name	Type	DType	Address	Initial value	Comment	Used
TRBF_HI	COMP	TIME		t#150s		
CL4112_TUNE_ZTR2	VAR	PARA_ZTR				0
TRBF_LO	COMP	TIME		t#60s		
TRBF_HI	COMP	TIME		t#6000s		
CL4112_TUNE_ZTR3	VAR	PARA_ZTR				0
TRBF_LO	COMP	TIME		t#6s		
TRBF_HI	COMP	TIME		t#60s		
CL4112_ZTR_Cold_ERR	VAR	DINT				1
CL4112_ZTR_Hot_ERR	VAR	DINT				1
CL4112_ZTR_RH_ERR	VAR	DINT				1
CL4112_ZTR_TUNE1	VAR	PARA_ZTR				1
ZONE	COMP	REAL		0.2		
TRBF_LO	COMP	TIME		t#6m		
TRBF_HI	COMP	TIME		t#90m		
CL4112_ZTR_TUNE2	VAR	PARA_ZTR				1
ZONE	COMP	REAL		0.2		
TRBF_LO	COMP	TIME		t#2m		
TRBF_HI	COMP	TIME		t#60m		
CL4112_ZTR_TUNE4	VAR	PARA_ZTR				1
ZONE	COMP	REAL		1.0		
TRBF_LO	COMP	TIME		t#3m		
TRBF_HI	COMP	TIME		t#120m		
CL4113_CO2	IVAR	SECT_CTRL				0
CL4113_CO2_AH	VAR	BOOL	000126			2
CL4113_CO2_AHH	VAR	BOOL	000127			2
CL4113_CO2_AL	VAR	BOOL	000128			2
CL4113_CO2_ALL	VAR	BOOL	000129			2
CL4113_CO2_Day	VAR	BYTE	400261			1
CL4113_CO2_Hour	VAR	BYTE	400260			1
CL4113_CO2_injected_in_mol	VAR	REAL	400354	0.0	CO2 volume injection in Mol (conversion from the tag CL4113_CO2_QUANTITY_INJECTED)	1
CL4113_CO2_injected_in_mol2	VAR	REAL	400356	0.0	CO2 volume injection in Mol (conversion from the tag CL4113_CO2_QUANTITY_INJECTED2)	1
CL4113_CO2_integrator2_output	VAR	REAL				2
CL4113_CO2_integrator_output	VAR	REAL		1000000.0		2
CL4113_CO2_LIM_H	VAR	REAL	400482	50.0		1
CL4113_CO2_LIM_HH	VAR	REAL	400484	500.0		1
CL4113_CO2_LIM_L	VAR	REAL	400486	50.0		1
CL4113_CO2_LIM_LL	VAR	REAL	400488	100.0		1
CL4113_CO2_Minute	VAR	BYTE	400259			1
CL4113_CO2_Month	VAR	BYTE	400262			1
CL4113_CO2_QUANTITY_INJECT2_OLD	VAR	REAL				0
CL4113_CO2_QUANTITY_INJECTED	VAR	REAL	400334			2
CL4113_CO2_QUANTITY_INJECTED2	VAR	REAL	400352	0.0	used for a test of the total CO2 injected volume	2
CL4113_CO2_QUANTITY_INJECTED_OLD	VAR	REAL				0
CL4113_CO2_Second	VAR	BYTE	400258			1
CL4113_CO2_TIME	VAR	TIME				0
CL4113_CO2_TOTALIZER_MODE	VAR	Mode_TOTALIZ>				0
CL4113_CO2_TOTALIZER_PARA	VAR	Para_TOTALIZ>				0
thld	COMP	REAL		1000000.0		
CL4113_CO2_TOTALIZER_STATUS	VAR	WORD				0
CL4113_CO2_Year	VAR	BYTE	400263			1
CL4113_ControlLoop_Mode	VAR	INT	400128			3
CL4113_DECOMP	VAR	TIME		t#1500s	Decomp parameter for control	1
CL4113_ERR_463_1	VAR	DINT		0	Error Indicator. IF1 CO2 Control	1

table continued...

Variable list (Name: All, Type: All, DataType: All, Sorted by: name)

Variable name	Type	DType	Address	Initial value	Comment	Used
CL4113_HALT_INTEGRATOR	VAR	BOOL				3
CL4113_IMP	VAR	PARA_PCR_IMP			Internal Model	4
KM	COMP	REAL		0.0016		
TM	COMP	TIME		t#500s		
CL4113_INIT	VAR	BOOL		FALSE	Initialisation Flag for control	2
CL4113_LIM	VAR	PARA_PCR_LIM			Limit Parameters	1
YMAX	COMP	REAL		500.0		
YRATE	COMP	REAL		500.0		
CL4113_O2_AH	VAR	BOOL	000130			2
CL4113_O2_AHH	VAR	BOOL	000131			2
CL4113_O2_AL	VAR	BOOL	000132			1
CL4113_O2_ALL	VAR	BOOL	000133			1
CL4113_O2_LIM_H	VAR	REAL	400490	23.0		1
CL4113_O2_LIM_HH	VAR	REAL	400492	25.0		1
CL4113_O2_LIM_L	VAR	REAL	400494	19.0		0
CL4113_O2_LIM_LL	VAR	REAL	400496	17.0		0
CL4113_PCR_FlagInit	VAR	BOOL				2
CL4113_PCR_IMV	VAR	REAL	400312			1
CL4113_Pulse_RESET	VAR	BOOL				3
CL4113_Pulse_RESET2	VAR	BOOL				3
CL4113_Reset_CO2_VOLUME	VAR	BOOL	000183			2
CL4113_RESET_INTEGRATOR	VAR	BOOL		FALSE		3
CL4113_SV_MAN	VAR	BOOL		TRUE	Operator Agrres to OPEN Redundant if TRUE. if FALSE : Close the Valve.	0
CL4113_TOTAL_QUANTITY	VAR	REAL				4
CL4113_TOTAL_QUANTITY2	VAR	REAL				4
CL4113_TS	VAR	TIME		t#100ms	CL 463 - Sampling Period	0
CL4113_TUNE	VAR	PARA_PCR_TUNE			Tuning Parameters	3
TS	COMP	TIME		t#1s		
H	COMP	TIME		t#5s		
TRBF	COMP	TIME		t#1500s		
CL4114_Pressure	IVAR	SECT_CTRL				0
CL4114_Pressure_AH	VAR	BOOL	000137		High Pressure Alarm	2
CL4114_Pressure_AL	VAR	BOOL	000138			2
CL4114_Pressure_LIM_H	VAR	REAL	400498	1100.0		1
CL4114_Pressure_LIM_L	VAR	REAL	400500	900.0		1
CL4115_Ambient_Parameters	IVAR	SECT_CTRL				0
ERR_AI	IVAR	SECT_CTRL				0
FAN_4105_01_MV	VAR	BOOL	000003		Operation of Light Loft Blower A	2
FAN_4105_01_OP	VAR	BOOL	000146			1
FAN_4105_02_MV	VAR	BOOL	000004		Operation of Light Loft Blower B	2
FAN_4105_02_OP	VAR	BOOL	000167			1
FAN_4105_03_MV	VAR	BOOL	000005		Operation of Light Loft Blower C	2
FAN_4105_03_OP	VAR	BOOL	000168			1
FC_4113_01	VAR	REAL	400089	0.2	L/min CO2 Mass Flow	2
FC_4113_01_ERR	VAR	BOOL	000134			2
FC_4113_01_MAX	VAR	REAL		2000.0	L/min	1
FC_4113_01_MIN	VAR	REAL		0.0	L/min	1
FC_4113_01_OP_SP	VAR	REAL	400160	0.0		1
FC_4113_01_SP	VAR	REAL	400238		CO2 Mass Flow set point	5
FC_4113_01_SP_MAX	VAR	REAL		1000.0	NO INFO ABOUT SPECIFICATION	1
FC_4113_01_SP_MIN	VAR	REAL		0.0	NO INFO ABOUT SPECIFICATION	1
FC_4113_CALC	VAR	REAL			SP Computed by the controller	2
FSL_4105_01	VAR	BOOL	000164		Flow/Noflow of Light Loft Fan A	2
FSL_4105_02	VAR	BOOL	000165		Flow/Noflow of Light Loft Fan B	2
FSL_4105_03	VAR	BOOL	000166		Flow/Noflow of Light Loft Fan C	2
FS_4114_01	VAR	BOOL	100019			0

table continued...

Variable list (Name: All, Type: All, DataType: All, Sorted by: name)

Variable name	Type	DType	Address	Initial value	Comment	Used
FT4106_01_MAX	VAR	REAL		20.0	L/min	1
FT4106_01_MIN	VAR	REAL		4.0	L/min	1
FT_4106_01	VAR	REAL	400029		Outlet nutrient flow sensor	6
FT_4106_01_ERR	VAR	BOOL	000070			2
FT_4106_01_LIM_H	VAR	REAL	400430	20.0	Max of the threshold (seuil) of Irrigation flow	1
FT_4106_01_LIM_HH	VAR	REAL	400432	25.0		2
FT_4106_01_LIM_L	VAR	REAL	400434	8.0	Min of the threshold (seuil) of Irrigation flow	1
FT_4106_01_LIM_LL	VAR	REAL	400436	3.0		1
FT_4111_01	VAR	REAL	400037	0.4	m/s Air velocity sensor	3
FT_4111_01_ERR	VAR	BOOL	000092			2
FT_4111_01_MAX	VAR	REAL		50.0	m/s	1
FT_4111_01_MIN	VAR	REAL		0.0	m/s	1
GP_4106_01_MV	VAR	BOOL	000014		Main irrigation Pump P2001	3
GP_4106_01_OP	VAR	BOOL	000147			1
GP_4110_01_MV	VAR	BOOL	000006		Condensate pump relay	2
GP_4110_01_OP	VAR	BOOL	000152			1
GP_4112_01_MV	VAR	BOOL	000021			1
GP_4112_01_OP	VAR	BOOL	000154			1
GP_4112_02_MV	VAR	BOOL	000020			1
GP_4112_02_OP	VAR	BOOL	000155			1
HPC1_HighLowAlarm_status	VAR	BOOL	000169			1
HPC1_VeryHighLowAlarm_status	VAR	BOOL	000170			1
Inputs	IVAR	SECT_CTRL				0
IY_4104_01_MV	VAR	BOOL	000011		Turn On/Off lamps - A	7
IY_4104_01_OP	VAR	BOOL	000143			20
IY_4104_02_MV	VAR	BOOL	000012		Turn On/Off lamps - B	7
IY_4104_02_OP	VAR	BOOL	000144			20
IY_4104_03_MV	VAR	BOOL	000013		Turn On/Off lamps - C	7
IY_4104_03_OP	VAR	BOOL	000145			20
LSH_4110_01	VAR	BOOL	100014		High Level sensor for reservoir tank	4
LSH_4110_02	VAR	BOOL	100016		High Level sensor for condensate tank	4
LSH_4110_02_A	VAR	BOOL		FALSE	High Level alarm for condensate tank	0
LSL_4107_01	VAR	BOOL	100010		Acid Tank Low Level	3
LSL_4107_02	VAR	BOOL	100011		Base Tank Low Level	3
LSL_4108_01	VAR	BOOL	100012		Low Level sensor Stock A	4
LSL_4108_02	VAR	BOOL	100013		Low Level sensor Stock B	4
LSL_4110_01	VAR	BOOL	100015		Low Level sensor for reservoir tank	5
LSL_4110_02	VAR	BOOL	100017		Low Level sensor for condensate tank	4
LSL_4110_02_A	VAR	BOOL		FALSE	Low Level alarm for condensate tank	0
MP_4108_01_MV	VAR	BOOL	000023		Metering pump of solution A (Nutrient)	1
MP_4108_01_OP	VAR	BOOL	000184		MP_4108_01 management in manual mode	6
MP_4108_02_MV	VAR	BOOL	000024		Metering pump of solution B (Nutrient)	1
MP_4108_02_OP	VAR	BOOL	000185		MP_4108_02 management in manual mode	6
MVFD4111_01_MV_MAX	VAR	REAL		100.0	NO INFO ABOUT SPECIFICATION	0
MVFD4111_01_MV_MIN	VAR	REAL		0.0	NO INFO ABOUT SPECIFICATION	0
MVFD_4111_01_MV	VAR	REAL			Air circulation motor VFD	0
Outputs	IVAR	SECT_CTRL				0
pHdz	VAR	REAL			pH with offset +/- DeadZone if outside DeadZone, SetPoint if inside	2
pH_high	VAR	BOOL			pH higher than setpoint + dead zone	4
pH_low	VAR	BOOL			pH lower than setpoint - dead zone	4
PS_4102_01	VAR	BOOL	100008		Airlock A pressure switch	1
PS_4103_01	VAR	BOOL	100009		Airlock C pressure switch	1
PS_4114_01	VAR	BOOL	100018			0
PT_4102_01	VAR	REAL	400013	1.01	Pressure sensor for airlock A in bar (= 29.	2

table continued...

Variable list (Name: All, Type: All, DataType: All, Sorted by: name)

Variable name	Type	DType	Address	Initial value	Comment	Used
					8 inCH)	
PT_4102_01_AH	VAR	BOOL		FALSE	Airlock A over pressure Alarm	1
PT_4102_01_ERR	VAR	BOOL	000035			3
PT_4102_01_MAX	VAR	REAL		108.364	inCH	2
PT_4102_01_MIN	VAR	REAL		88.046	inCH	2
PT_4103_01	VAR	REAL	400015	1.01	Pressure sensor for airlock C in bar (= 29.8 inCH)	2
PT_4103_01_AH	VAR	BOOL			Airlock C over pressure Alarm	1
PT_4103_01_ERR	VAR	BOOL	000036			3
PT_4114_01	VAR	REAL	400095		Growing Area Pressure	3
PT_4114_01_ERR	VAR	BOOL	000139			2
PT_4114_01_MAX	VAR	REAL		108.364	psi	1
PT_4114_01_MIN	VAR	REAL		88.046	psi	1
PT_4114_02	VAR	REAL	400240			1
PT_4114_02_ERR	VAR	BOOL	000177			0
PT_4114_03	VAR	REAL	400242			1
PT_4114_03_ERR	VAR	BOOL	000178			0
PT_4114_04	VAR	REAL	400244			1
PT_4114_04_ERR	VAR	BOOL	000179			0
PT_4114_05	VAR	REAL	400246			1
PT_4114_05_ERR	VAR	BOOL	000180			0
PT_4114_06	VAR	REAL	400248			1
PT_4114_06_ERR	VAR	BOOL	000181			0
PT_4114_MAX	VAR	REAL		1200.0		5
PT_4114_MIN	VAR	REAL		800.0		5
PT_4115_01	VAR	REAL			Ambient pressure	0
PT_4115_01_ERR	VAR	BOOL	000141			1
PT_4115_01_MAX	VAR	REAL		5.0	psi	0
PT_4115_01_MIN	VAR	REAL		0.0	psi	0
REAL0	VAR	REAL		0.0		2
REAL1	VAR	REAL		1.0		0
RT_4104_01	VAR	REAL	400017		PAR Sensor - A	26
RT_4104_01_A1	VAR	BOOL			Alarm : String ON and PAR Measure outside range	0
RT_4104_01_A2	VAR	BOOL		FALSE	Alarm : String OFF and PAR Measure greater than low limit	0
RT_4104_01_ERR	VAR	BOOL	000050			2
RT_4104_01_MAX	VAR	REAL		5000.0	µmol.S-1.m-2	3
RT_4104_01_MIN	VAR	REAL		-5000.0	µmol.S-1.m-2	3
RT_4104_01_PAR_MAX	VAR	REAL			Greater limit of PAR Measure	0
RT_4104_01_PAR_MIN	VAR	REAL			Lower Limit of PAR Measure	0
RT_4104_02	VAR	REAL	400019		PAR Sensor - B	8
RT_4104_02_A1	VAR	BOOL		FALSE	Alarm : String ON and PAR Measure outside range	0
RT_4104_02_A2	VAR	BOOL			Alarm : String OFF and PAR Measure greater than low limit	0
RT_4104_02_ERR	VAR	BOOL	000051			2
RT_4104_03	VAR	REAL	400021		PAR Sensor - C	8
RT_4104_03_A1	VAR	BOOL		FALSE	Alarm : String ON and PAR Measure outside range	0
RT_4104_03_A2	VAR	BOOL		FALSE	Alarm : String OFF and PAR Measure greater than low limit	0
RT_4104_03_ERR	VAR	BOOL	000052			2
RT_4104_High_LIM_H	VAR	REAL	400410			3
RT_4104_High_LIM_Nolight	VAR	REAL	400502			3
RT_4104_High_LIM_SaORsb_H	VAR	REAL	400414			3
RT_4104_High_LIM_Sa_OR_Sb	VAR	REAL	400406			6

table continued...

Variable list (Name: All, Type: All, DataType: All, Sorted by: name)

Variable name	Type	DType	Address	Initial value	Comment	Used
RT_4104_High_LIM_Sa_Sb	VAR	REAL	400418			3
RT_4104_High_LIM_Sa_Sb_H	VAR	REAL	400422			3
RT_4104_Low_LIM_H	VAR	REAL	400412			3
RT_4104_Low_LIM_SaORsb_H	VAR	REAL	400416			3
RT_4104_Low_LIM_Sa_OR_Sb	VAR	REAL	400408			6
RT_4104_Low_LIM_Sa_Sb	VAR	REAL	400420			3
RT_4104_Low_LIM_Sa_Sb_H	VAR	REAL	400424			3
S3CV4112_01_MV_MIN	VAR	REAL		0.0	%	1
S3CV_4112_01_LIM_Selector	VAR	INT				0
S3CV_4112_01_MaxValue	VAR	BOOL				0
S3CV_4112_01_MinValue	VAR	BOOL				0
S3CV_4112_01_MV	VAR	REAL	400234		Chilled Water Control Valve	2
S3CV_4112_01_MV_MAX	VAR	REAL		100.0	%	1
S3CV_4112_01_OP	VAR	REAL	400156			2
S3CV_4112_01_PCR_OUT	VAR	REAL				3
S3CV_4112_02_MaxValue	VAR	BOOL				0
S3CV_4112_02_MinValue	VAR	BOOL				0
S3CV_4112_02_MV	VAR	REAL	400236		Hot Water Control Valve	2
S3CV_4112_02_MV_MAX	VAR	REAL		100.0	%	1
S3CV_4112_02_MV_MIN	VAR	REAL		0.0	%	1
S3CV_4112_02_OP	VAR	REAL	400158			2
S3CV_4112_02_PCR_OUT	VAR	REAL				3
SC_Activate_Setting	VAR	BOOL	000172			1
SC_Dayweek_SET	VAR	BYTE	400192			1
SC_Day_SET	VAR	BYTE	400195			1
SC_Hour_SET	VAR	BYTE	400196			1
SC_Minute_SET	VAR	BYTE	400197			1
SC_Month_SET	VAR	BYTE	400194			1
SC_Second_SET	VAR	BYTE	400198			1
SC_Year_SET	VAR	BYTE	400193			1
SV_4102_01_MV	VAR	BOOL	000007		Solenoid Valve for injection of pressurized air into airlock A	1
SV_4102_02_MV	VAR	BOOL	000008		Airlock A ventilation Solenoid Valve	1
SV_4103_01_MV	VAR	BOOL	000009		Solenoid Valve for injection of pressurized air into airlock C	1
SV_4103_02_MV	VAR	BOOL	000010		Airlock C ventilation Solenoid Valve	1
SV_4107_01_MV	VAR	BOOL	000015		Acid Tank Valve	1
SV_4107_01_OP	VAR	BOOL	000148			6
SV_4107_01_OP_Time	VAR	UDINT	400227			4
SV_4107_02_MV	VAR	BOOL	000016		Base Tank Valve	1
SV_4107_02_OP	VAR	BOOL	000149			6
SV_4107_02_OP_Time	VAR	UDINT	400229			4
SV_4108_01_MV	VAR	BOOL	000017		Stock A inject Valve	1
SV_4108_01_OP	VAR	BOOL	000150			6
SV_4108_02_MV	VAR	BOOL	000018		Stock B inject Valve	1
SV_4108_02_OP	VAR	BOOL	000151			6
SV_4109_01_MV	VAR	BOOL			Nutrient cooling line valve	0
SV_4113_01_MV	VAR	BOOL	000022		CO2 injection line. Solenoid	1
SV_4113_01_OP	VAR	BOOL	000156			1
SV_4113_OP_Time	VAR	UDINT				0
SysClock_Day	VAR	BYTE	400211			5
SysClock_dayofweek	VAR	BYTE	400208			1
SysClock_Hour	VAR	BYTE	400212			6
SysClock_Minute	VAR	BYTE	400213			6
SysClock_Month	VAR	BYTE	400210			5
SysClock_Second	VAR	BYTE	400214			5
SysClock_Year	VAR	BYTE	400209			5

table continued...

Variable list (Name: All, Type: All, DataType: All, Sorted by: name)

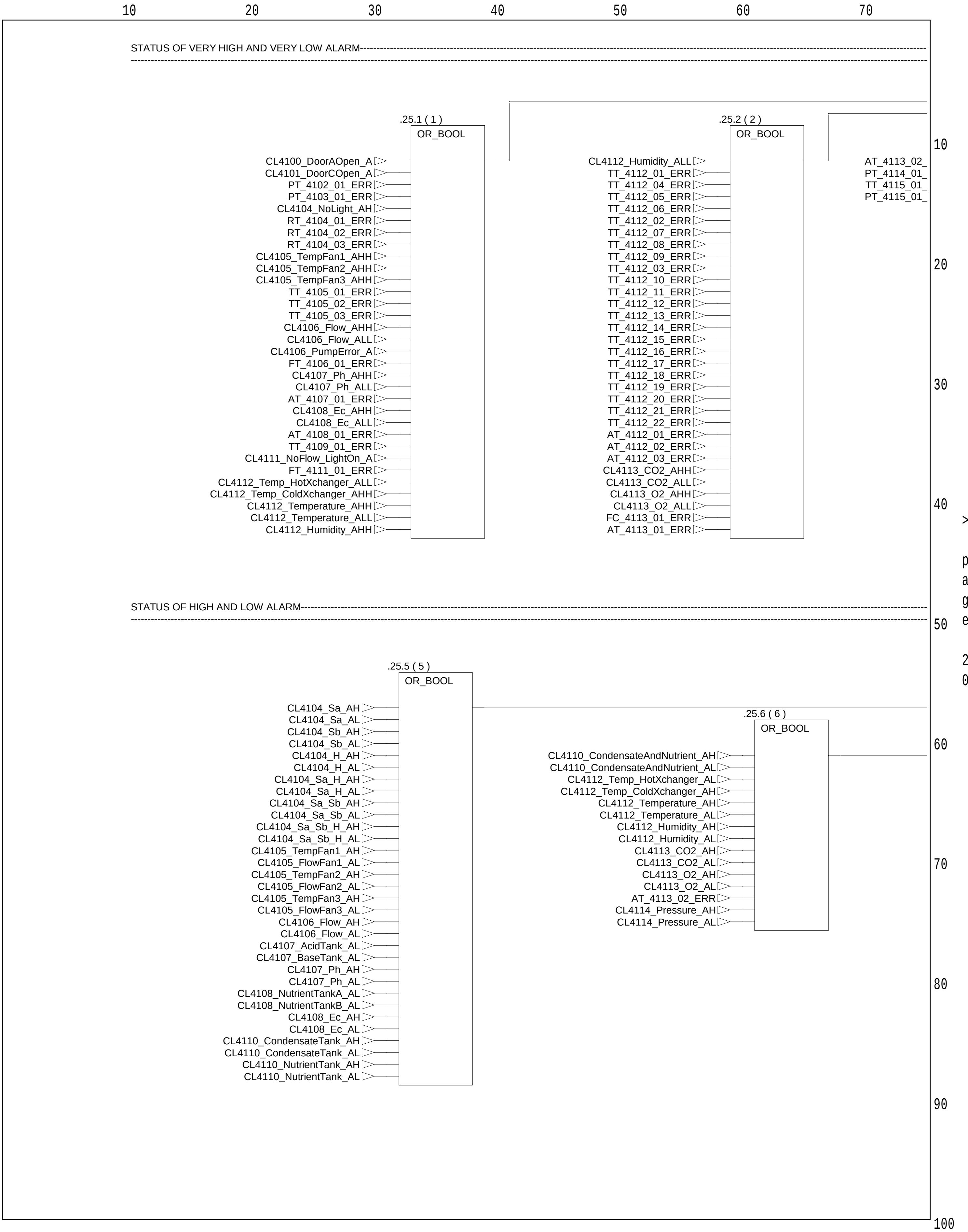
Variable name	Type	DType	Address	Initial value	Comment	Used
System_Clock	IVAR	SECT_CTRL				0
Temperature	VAR	REAL				0
TEST1	VAR	REAL				0
TEST2	VAR	REAL				0
TEST3	VAR	REAL				0
test_bool	VAR	BOOL				1
Test_byte	VAR	BYTE				0
TEST_current	VAR	REAL				0
TEST_OPENING_TIME	VAR	REAL				0
TEST_PARA_INTEG	VAR	Para_INTEG				0
gain	COMP	REAL		1.0		
ymax	COMP	REAL		1000000.0		
TEST_REAL	VAR	REAL				0
test_tag_time	VAR	REAL				0
TEST_TIME	VAR	TIME				0
TEST_TOTAL_OPENING_TIME	VAR	REAL				0
TEST_TOTAL_OPENING_TIME2	VAR	REAL				0
TEST_TOTAL_OPENING_TIME3	VAR	REAL				0
Test_uint	VAR	UINT				0
Thermistor_MAX	VAR	REAL		150.0		0
Thermistor_MIN	VAR	REAL		-5.0		0
TT_4105_01	VAR	REAL	400023		Light Loft Temperature sensor A	4
TT_4105_01_AH	VAR	BOOL			Air Loft Temperature Alarm High	0
TT_4105_01_ERR	VAR	BOOL	000062			2
TT_4105_01_MAX	VAR	REAL		150.0	°C	0
TT_4105_01_MIN	VAR	REAL		0.0	°C	0
TT_4105_02	VAR	REAL	400025		Light Loft Temperature sensor B	4
TT_4105_02_ERR	VAR	BOOL	000063			2
TT_4105_03	VAR	REAL	400027		Light Loft Temperature sensor C	4
TT_4105_03_ERR	VAR	BOOL	000064			2
TT_4109_01	VAR	REAL	400035		Temperature sensor for solution reservoir	1
TT_4109_01_A	VAR	BOOL			Temperature Alarm T 201	0
TT_4109_01_ERR	VAR	BOOL	000142			2
TT_4109_01_MAX	VAR	REAL		150.0	°C	0
TT_4109_01_MIN	VAR	REAL		0.0	°C	0
TT_4109_01_SP	VAR	REAL			Set Point Temperature for solution reservoir	0
TT_4112_01	VAR	REAL	400039	20.0	Temperature A1 associated with humidity	3
TT_4112_01_ERR	VAR	BOOL	000101			5
TT_4112_01_MAX	VAR	REAL		60.0	°C	3
TT_4112_01_MIN	VAR	REAL		-40.0	°C	3
TT_4112_02	VAR	REAL	400047	20.0	Temperature B1 associated with humidity	1
TT_4112_02_ERR	VAR	BOOL	000105			2
TT_4112_03	VAR	REAL	400055	20.0	Temperature C1 associated with humidity	3
TT_4112_03_ERR	VAR	BOOL	000109			5
TT_4112_04	VAR	REAL	400041		Temperature A2	1
TT_4112_04_ERR	VAR	BOOL	000102			2
TT_4112_04_MAX	VAR	REAL		150.0	°C	0
TT_4112_04_MIN	VAR	REAL		0.0	°C	0
TT_4112_05	VAR	REAL	400043		Temperature A3	1
TT_4112_05_ERR	VAR	BOOL	000103			2
TT_4112_06	VAR	REAL	400045		Temperature A4	1
TT_4112_06_ERR	VAR	BOOL	000104			2
TT_4112_07	VAR	REAL	400049		Temperature B2	1
TT_4112_07_ERR	VAR	BOOL	000106			2
TT_4112_08	VAR	REAL	400051		Temperature B3	1
TT_4112_08_Channel	VAR	REAL				0

table continued...

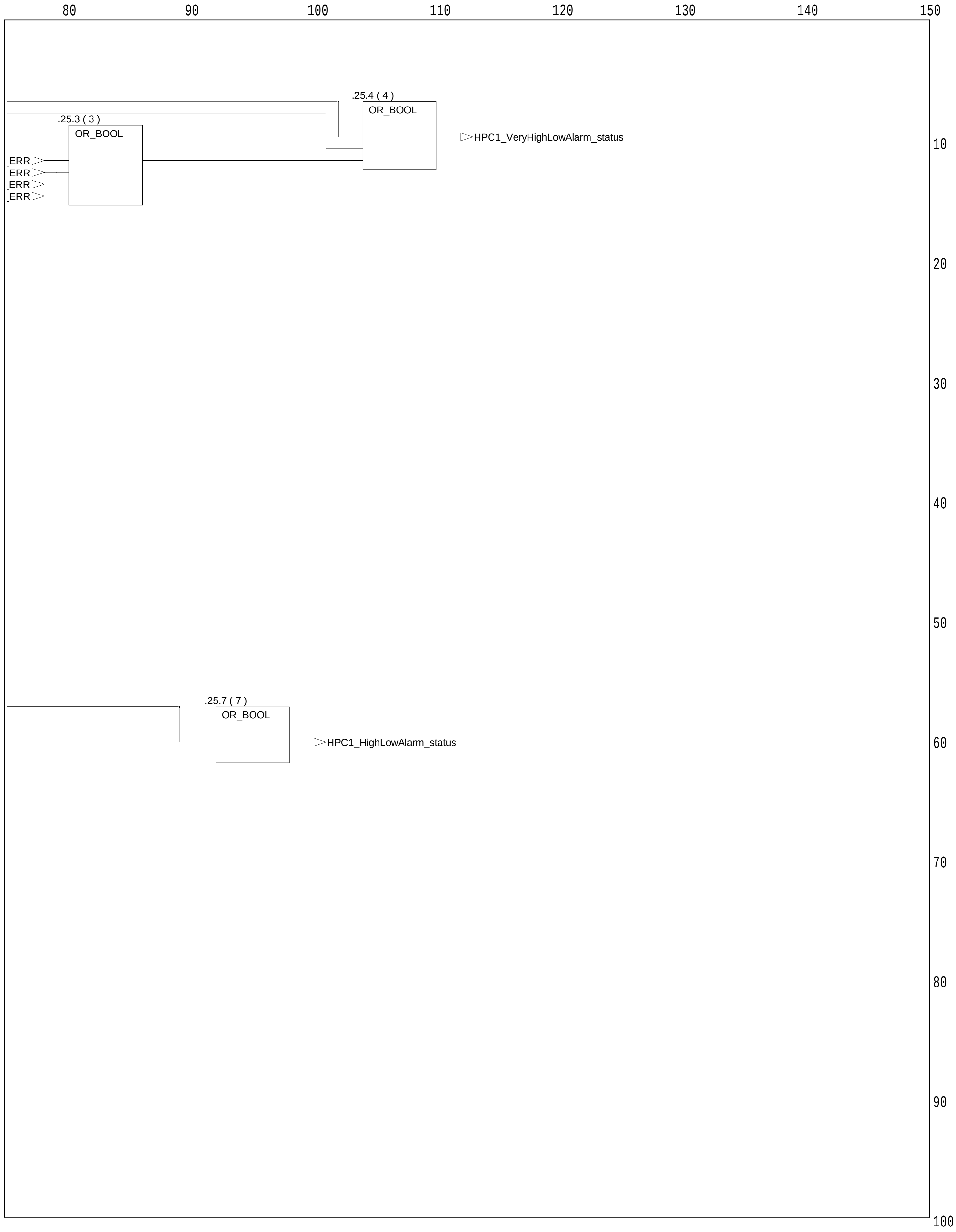
Variable list (Name: All, Type: All, DataType: All, Sorted by: name)

Variable name	Type	DType	Address	Initial value	Comment	Used
TT_4112_08_ERR	VAR	BOOL	000107			2
TT_4112_09	VAR	REAL	400053		Temperature B4	1
TT_4112_09_ERR	VAR	BOOL	000108			2
TT_4112_10	VAR	REAL	400057		Temperature C2	1
TT_4112_10_ERR	VAR	BOOL	000110			2
TT_4112_11	VAR	REAL	400059		Temperature C3	1
TT_4112_11_ERR	VAR	BOOL	000111			2
TT_4112_12	VAR	REAL	400061		Temperature C4	1
TT_4112_12_ERR	VAR	BOOL	000112			2
TT_4112_13	VAR	REAL	400063	8.3	Temperature for facility chilled water	3
TT_4112_13_ERR	VAR	BOOL	000113			2
TT_4112_14	VAR	REAL	400065	49.0	Temperature for facility hot water line	3
TT_4112_14_ERR	VAR	BOOL	000114			2
TT_4112_15	VAR	REAL	400067	12.0	Chilled coil surface temperature	2
TT_4112_15_ERR	VAR	BOOL	000115			2
TT_4112_16	VAR	REAL	400069		Heating coil surface temperature	2
TT_4112_16_ERR	VAR	BOOL	000116			2
TT_4112_17	VAR	REAL	400071		Chilled Exit temperature	1
TT_4112_17_ERR	VAR	BOOL	000117			2
TT_4112_18	VAR	REAL	400073		Hot Exit temperature	1
TT_4112_18_ERR	VAR	BOOL	000118			2
TT_4112_19	VAR	REAL	400075			2
TT_4112_19_ERR	VAR	BOOL	000119			2
TT_4112_20	VAR	REAL	400077			2
TT_4112_20_ERR	VAR	BOOL	000120			2
TT_4112_21	VAR	REAL	400079			6
TT_4112_21_ERR	VAR	BOOL	000121			2
TT_4112_22	VAR	REAL	400081			7
TT_4112_22_ERR	VAR	BOOL	000122			2
TT_4112_AVG	VAR	REAL	400152		Average of the 3 Temperature sensors associated with humidity	16
TT_4112_AVG_Day_SP	VAR	REAL	400148	26.0		1
TT_4112_AVG_ModuleA	VAR	REAL				0
TT_4112_AVG_Night_SP	VAR	REAL	400144	22.0		1
TT_4112_High	VAR	REAL		30.0		0
TT_4112_Low	VAR	REAL		10.0		0
TT_4112_MAX	VAR	REAL				0
TT_4112_MIN	VAR	REAL				0
TT_4112_SP	VAR	REAL	400320	18.0	°C; Temperature SET POINT of chamber	2
TT_4115_01	VAR	REAL			Ambient temperature	0
TT_4115_01_ERR	VAR	BOOL	000140			1
TT_4115_01_MAX	VAR	REAL		150.0	°C	0
TT_4115_01_MIN	VAR	REAL		0.0	°C	0
VSSL_4106_01_HIGHLEVEL	VAR	BOOL				4
VSSL_4106_01_LOWLEVEL	VAR	BOOL				4
VSSL_4110_01_HIGHLEVEL	VAR	BOOL				7
VSSL_4110_01_LOWLEVEL	VAR	BOOL				5
ZI_4100_01	VAR	BOOL	000001			0
ZI_4101_01	VAR	BOOL	000002			0
ZS_4100_01	VAR	BOOL	100001		Upper Exterior Air Lock Door Contact - Side A	4
ZS_4100_02	VAR	BOOL	100002		Lower Exterior Air Lock Door Contact - Side A	0
ZS_4101_01	VAR	BOOL	100003		Upper Exterior Air Lock Door Contact - Side C	4
ZS_4101_02	VAR	BOOL	100004		Lower Exterior Air Lock Door Contact - Side C	0

Graph of section ALARM_STATUS



Graph of section ALARM_STATUS



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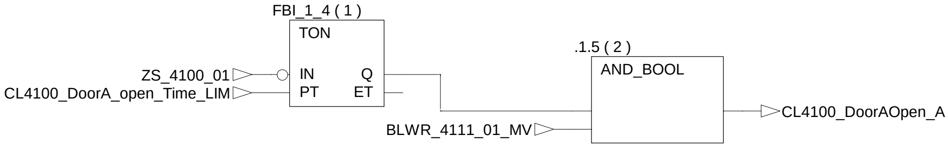
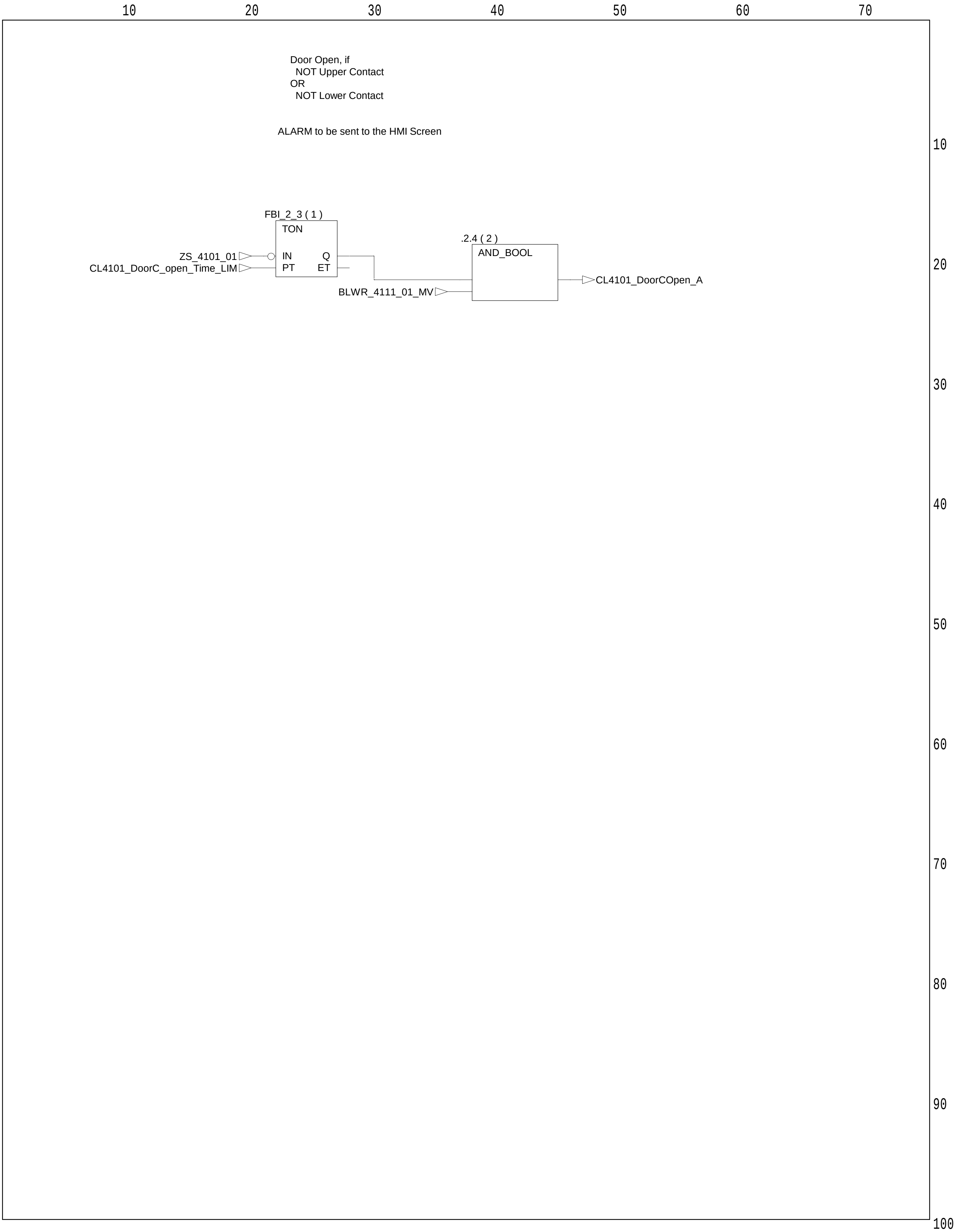
Graph of section CL4100_Ext_Air_Lock_Door_A

Door Open, if
NOT Upper Contact
OR
NOT Lower Contact

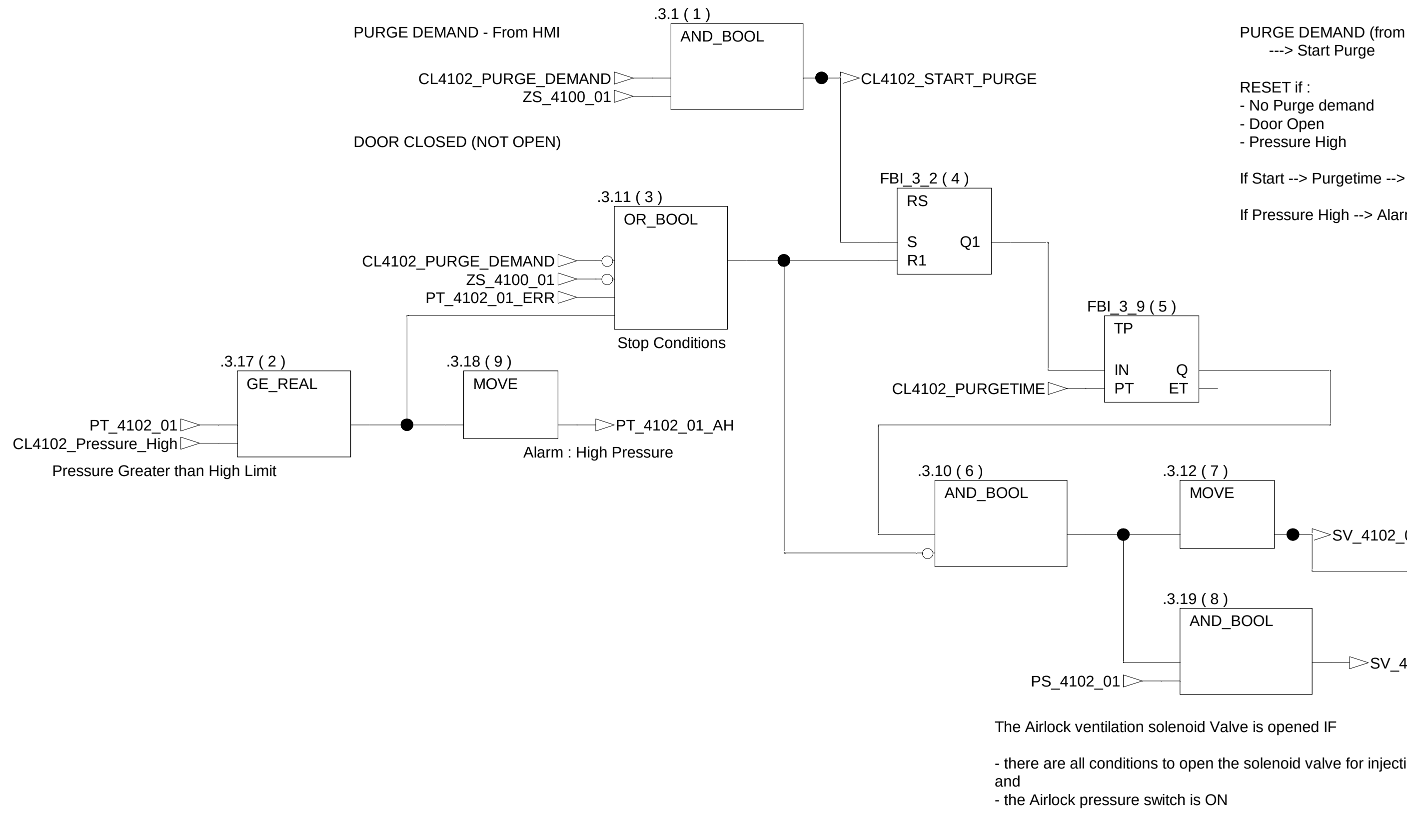
ALARM to be sent to the HMI Screen



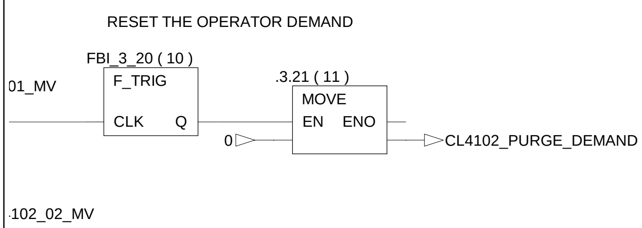
Graph of section CL4101_Ext_Air_Lock_Door_C



Graph of section CL4102_Purge_A



Graph of section CL4102_Purge_A



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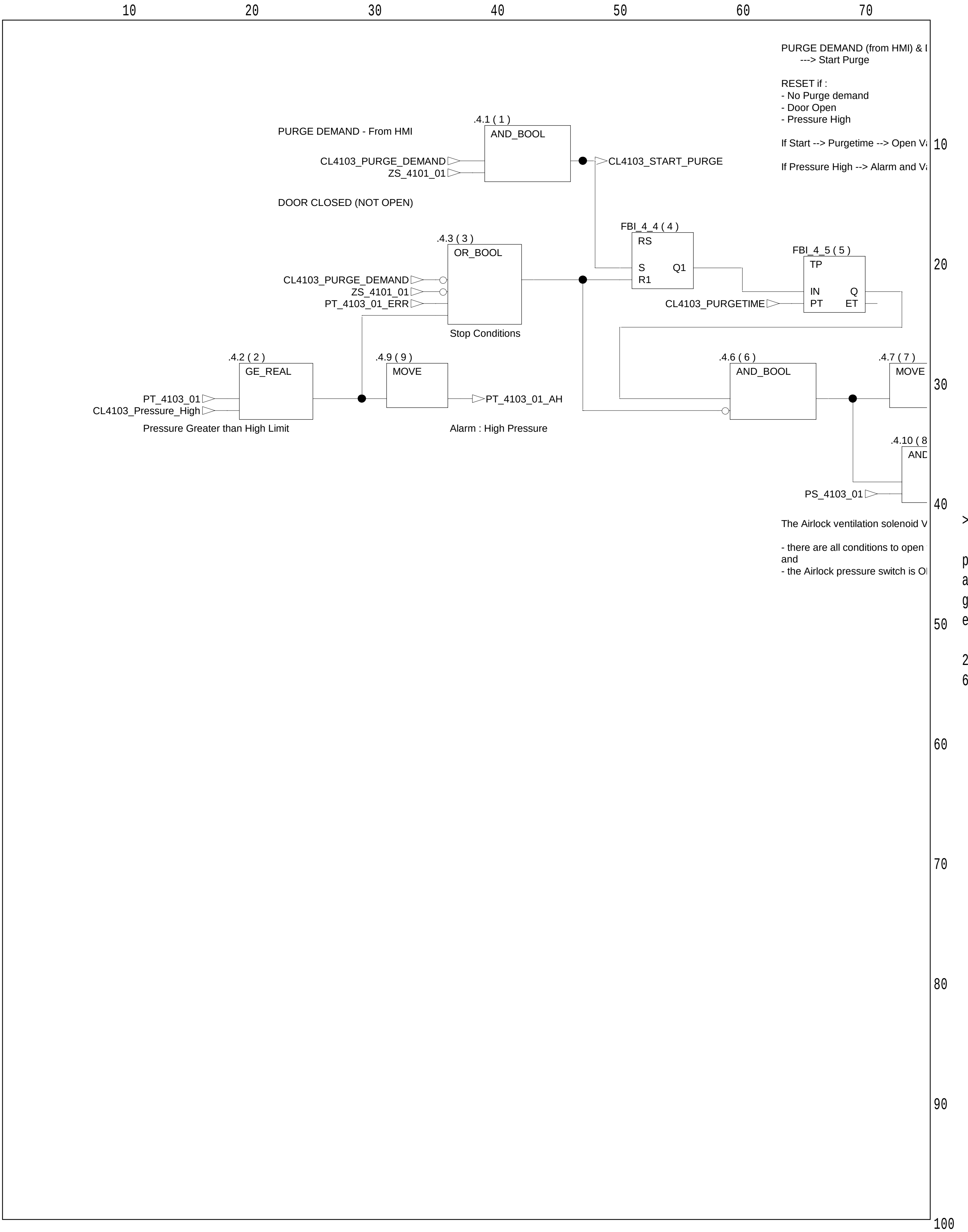
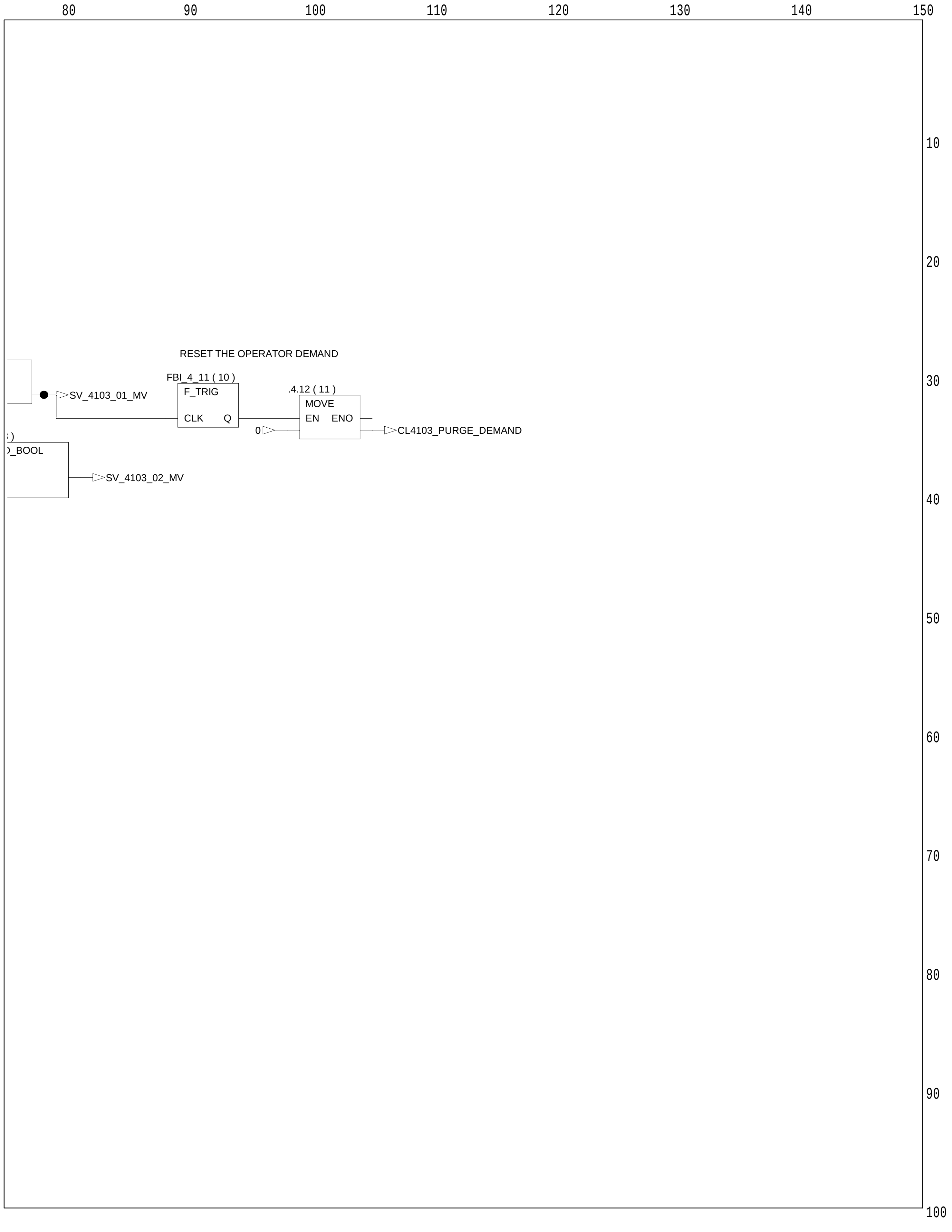
Graph of section CL4103_Purge_C



Graph of section CL4103_Purge_C



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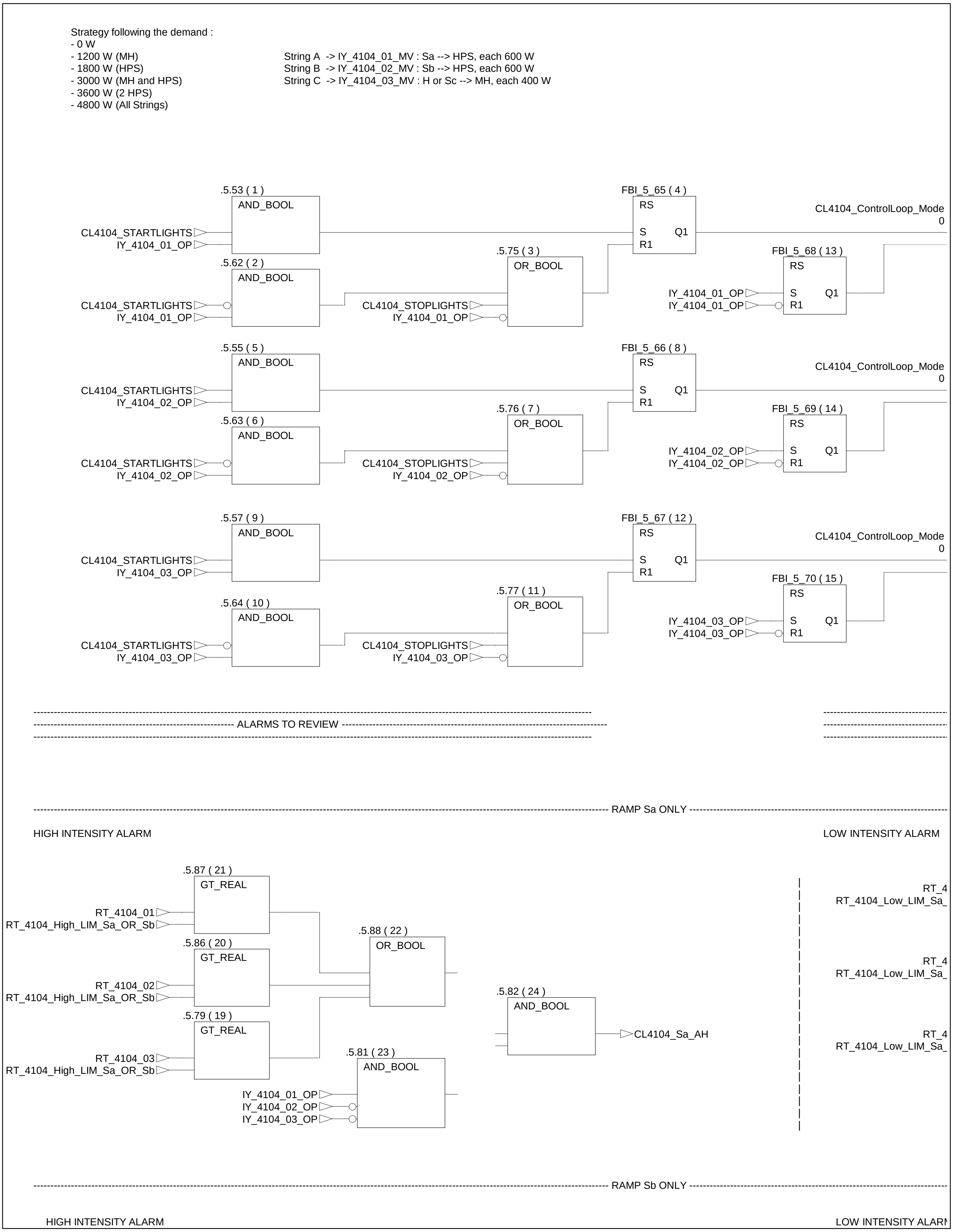
Graph of section CL4104_Light_Intensity



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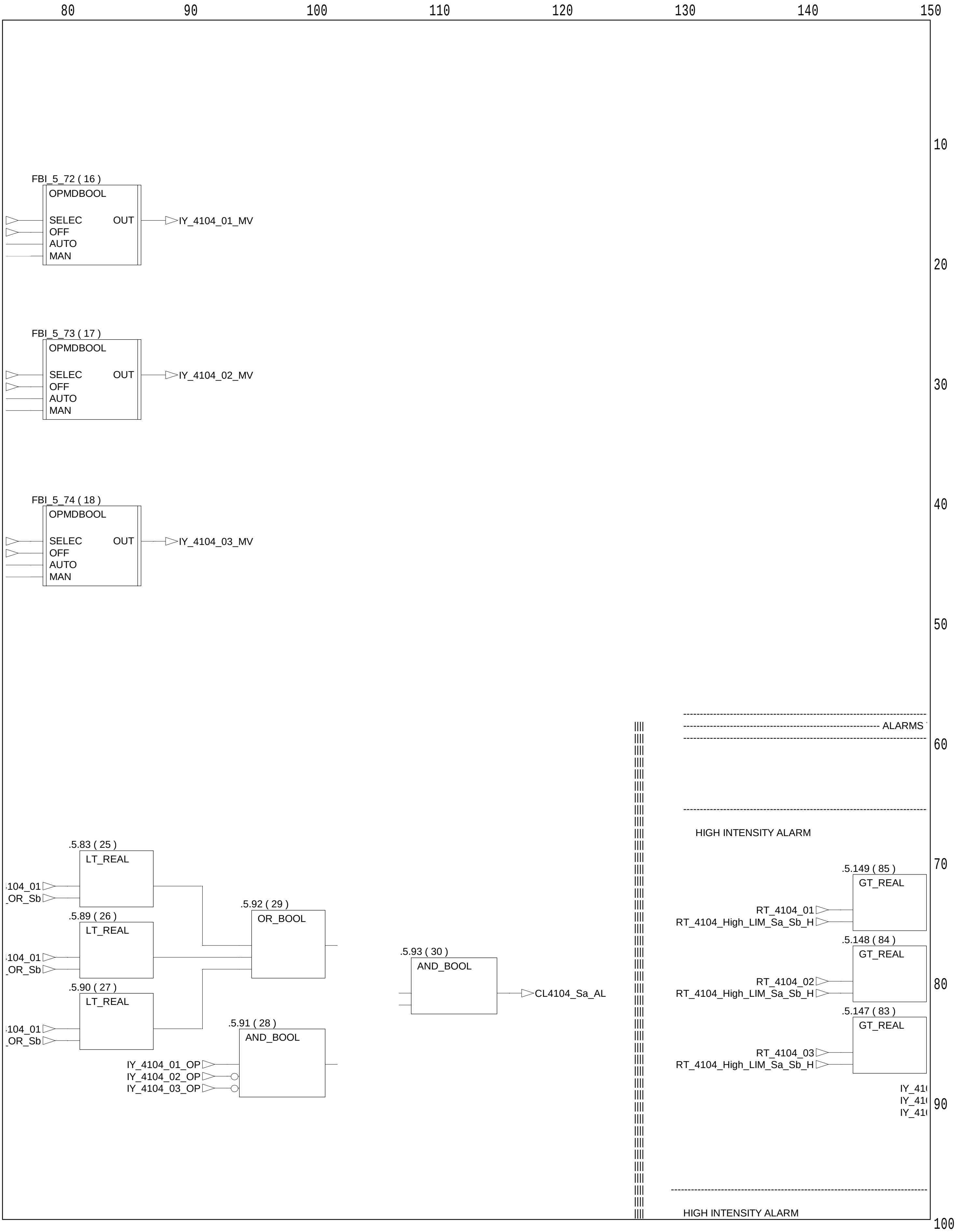
Graph of section CL4104_Light_Intensity



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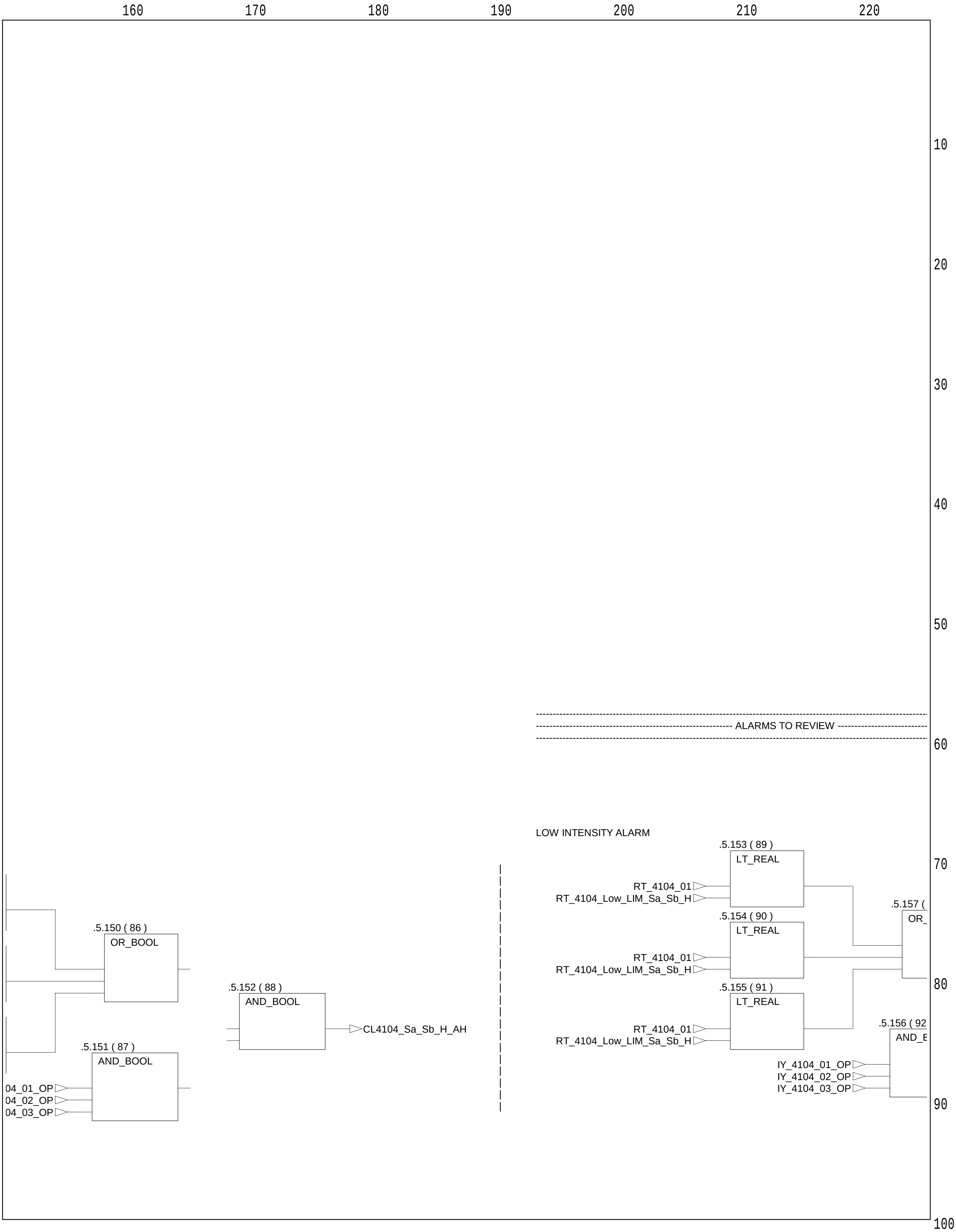
Graph of section CL4104_Light_Intensity



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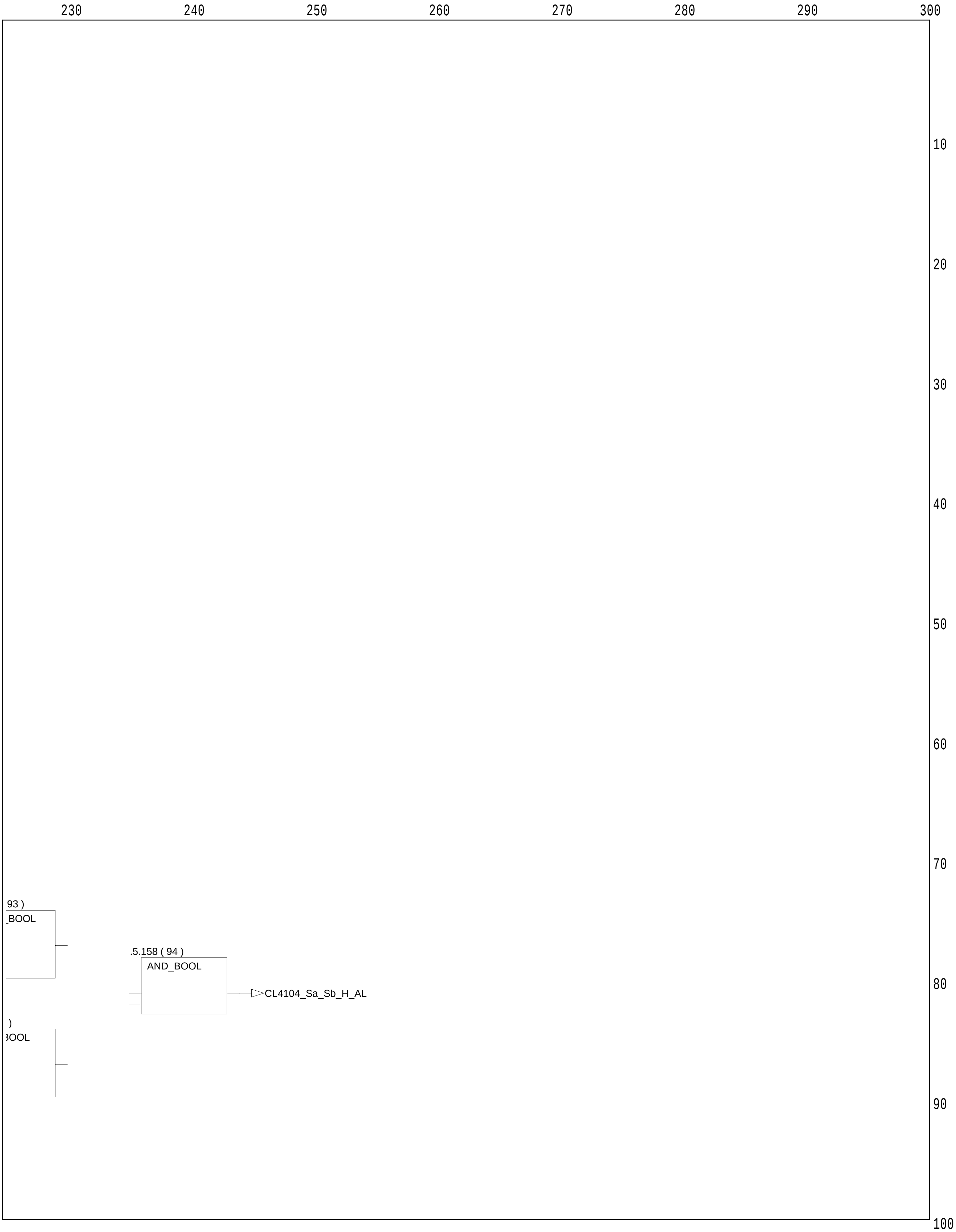
Graph of section CL4104_Light_Intensity



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Graph of section CL4104_Light_Intensity

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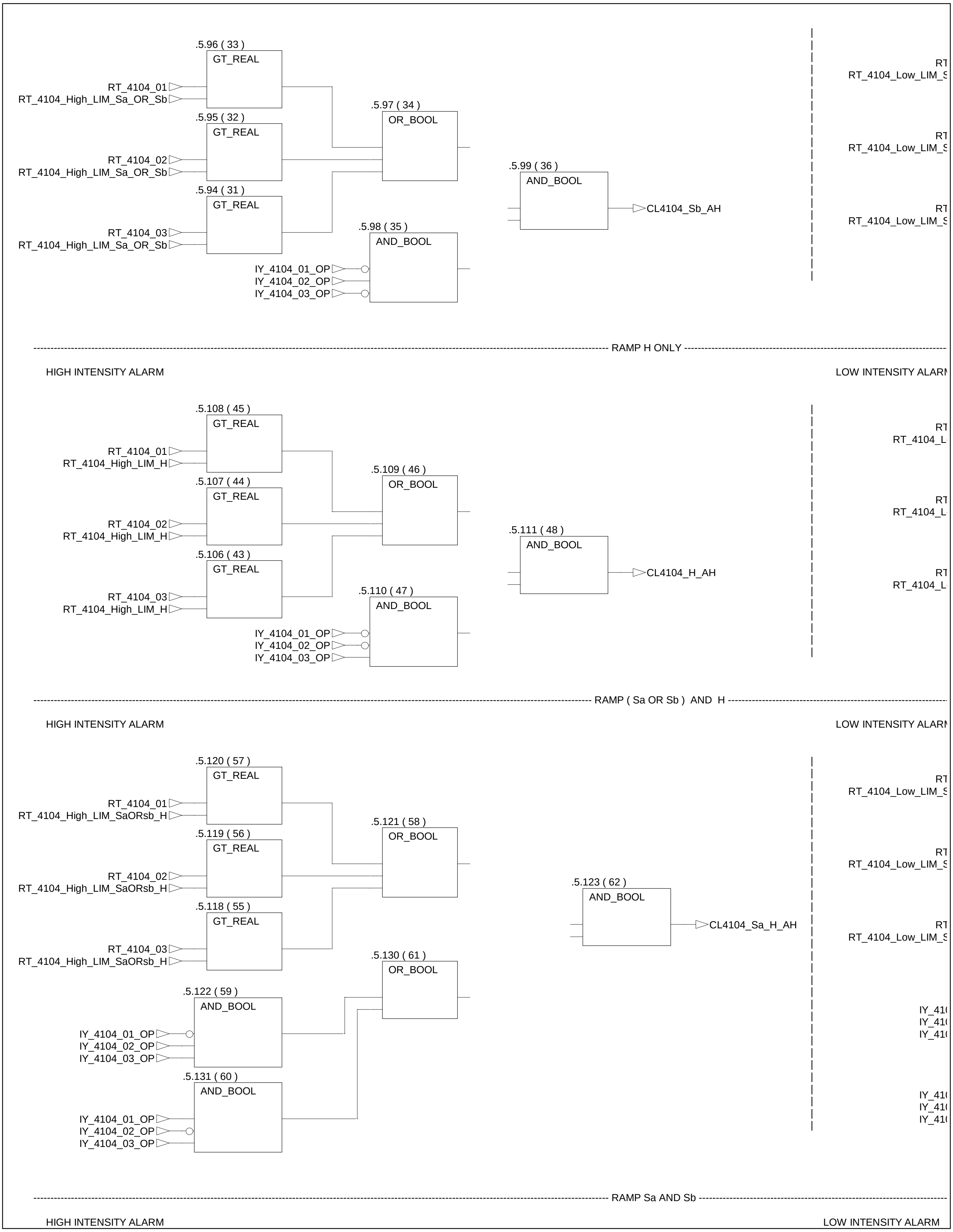

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Graph of section CL4104_Light_Intensity

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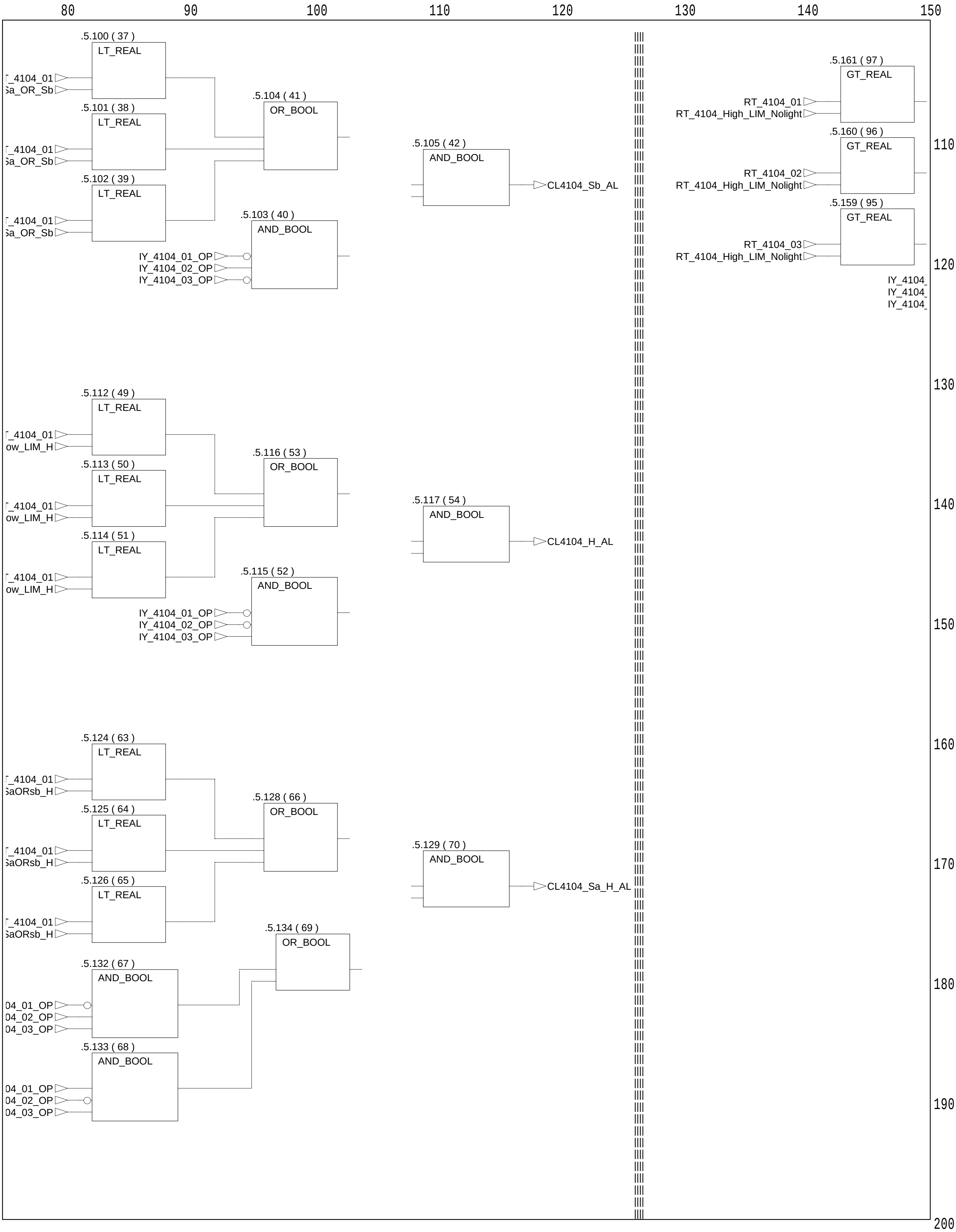

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Graph of section CL4104_Light_Intensity

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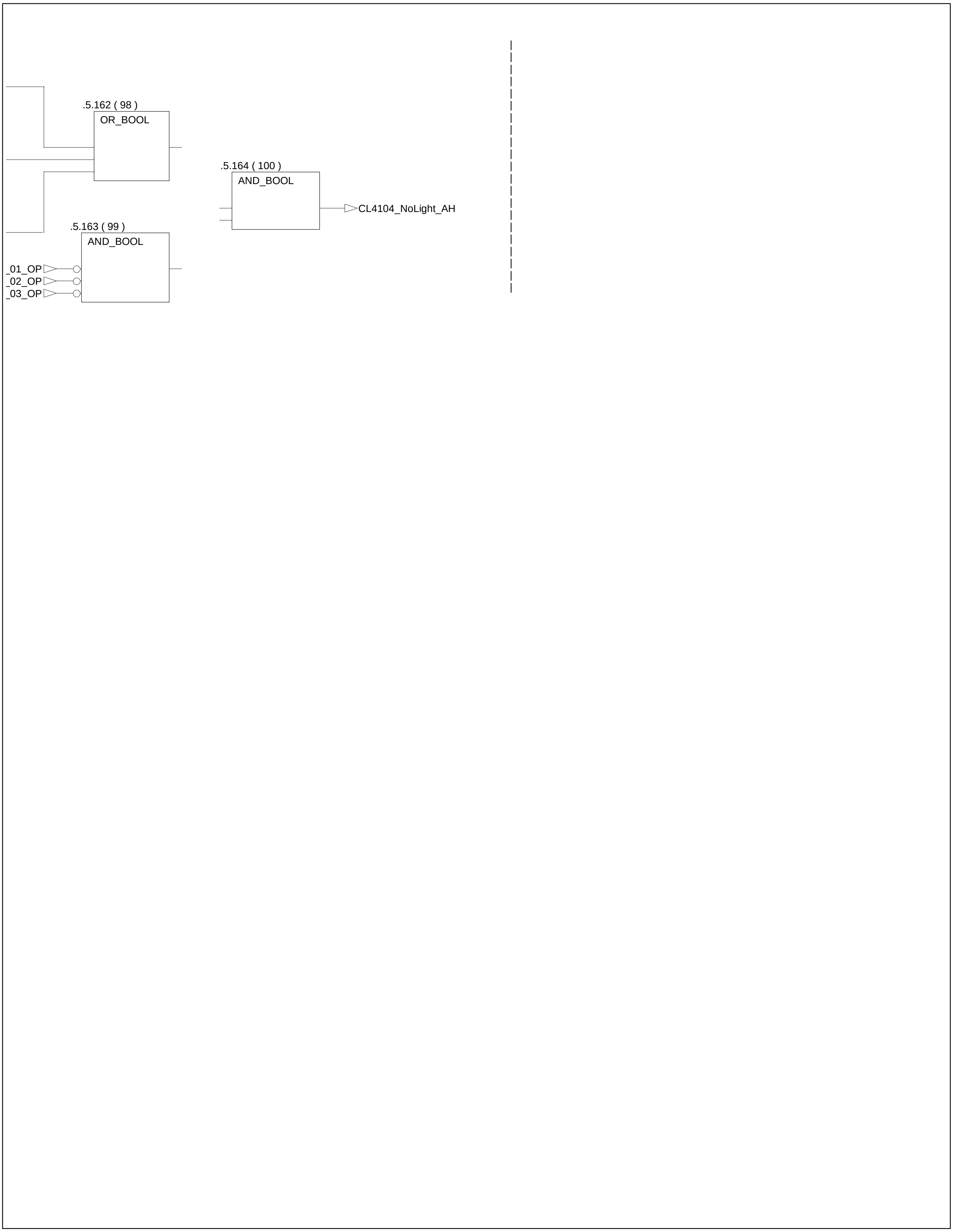

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Graph of section CL4104_Light_Intensity

< page 30

230 240 250 260 270 280 290 300

110
120
130
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170
180
190
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Graph of section CL4104_Light_Intensity

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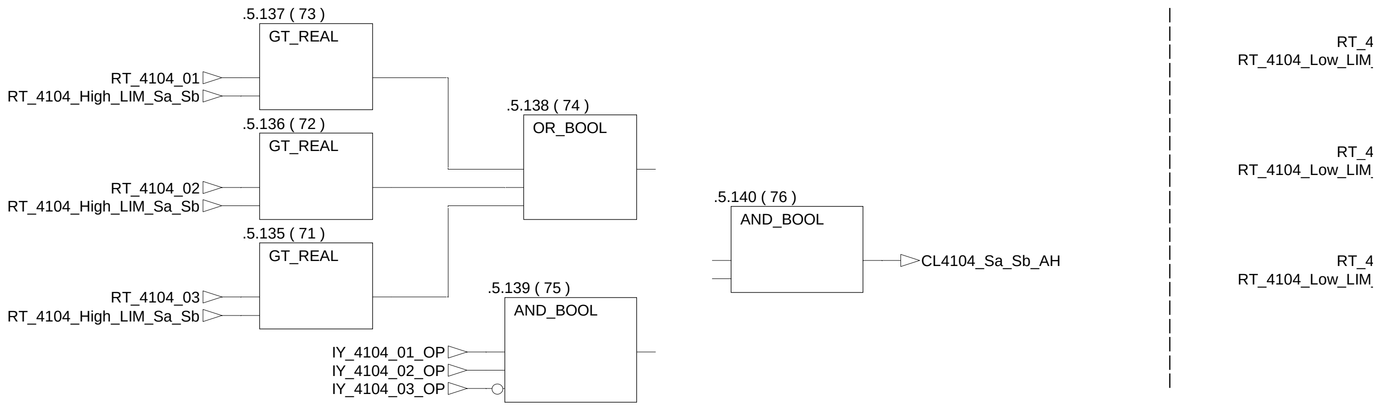

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Graph of section CL4104_Light_Intensity

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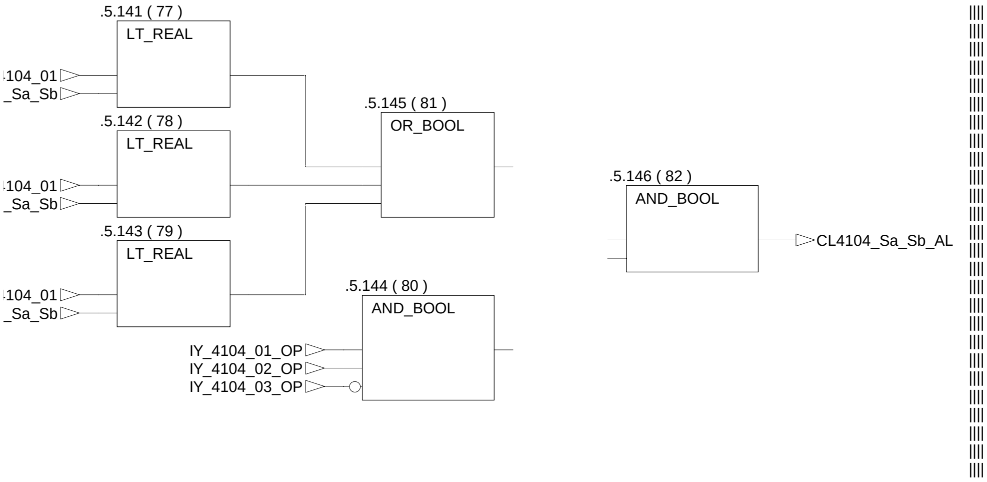

210
220
230

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> page 37

Graph of section CL4104_Light_Intensity

< page 33

160 170 180 190 200 210 220

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Graph of section CL4104_Light_Intensity

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230 240 250 260 270 280 290 300

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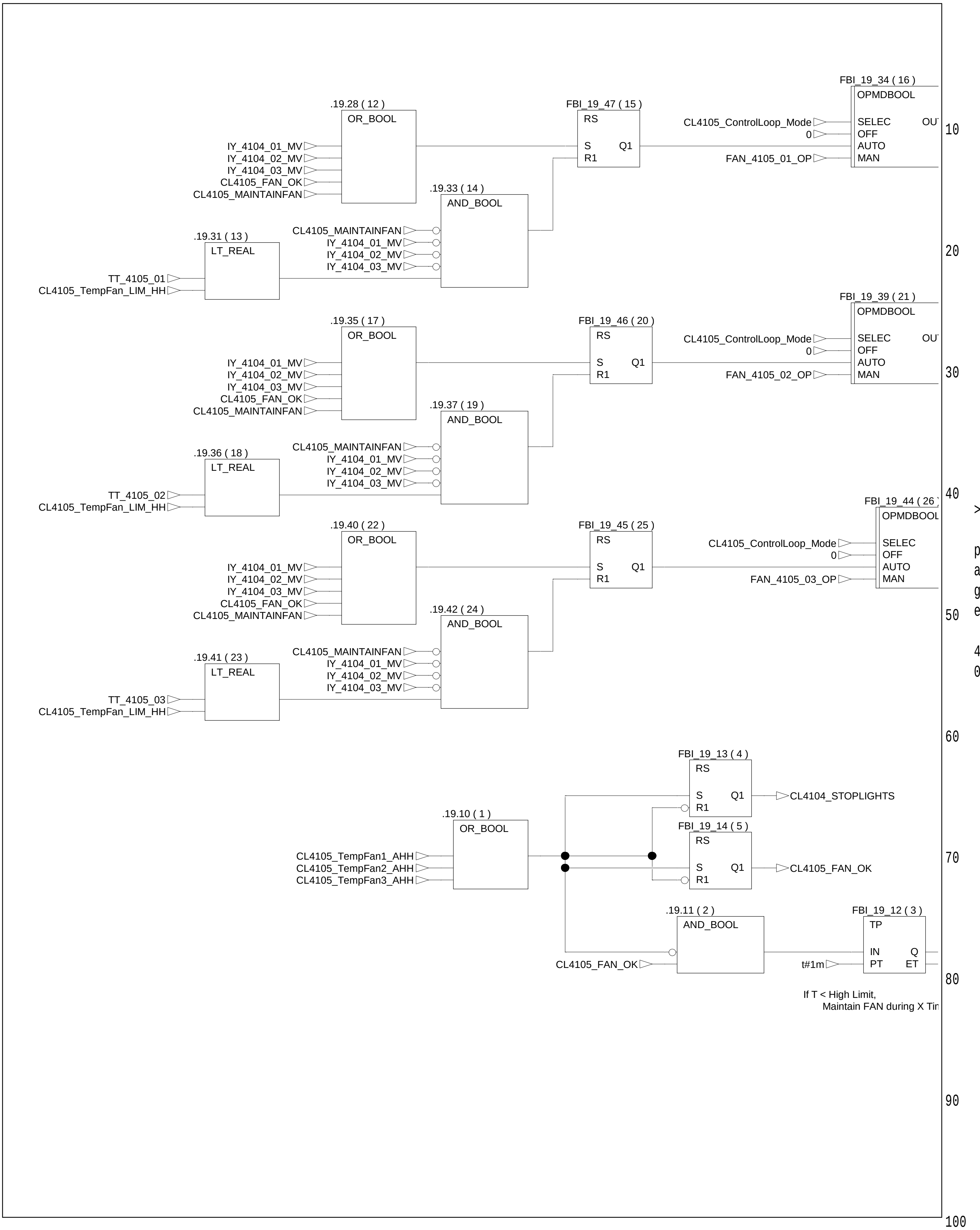
Graph of section CL4105_Lighting_Loft_Temp



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Graph of section CL4105_Lighting_Loft_Temp

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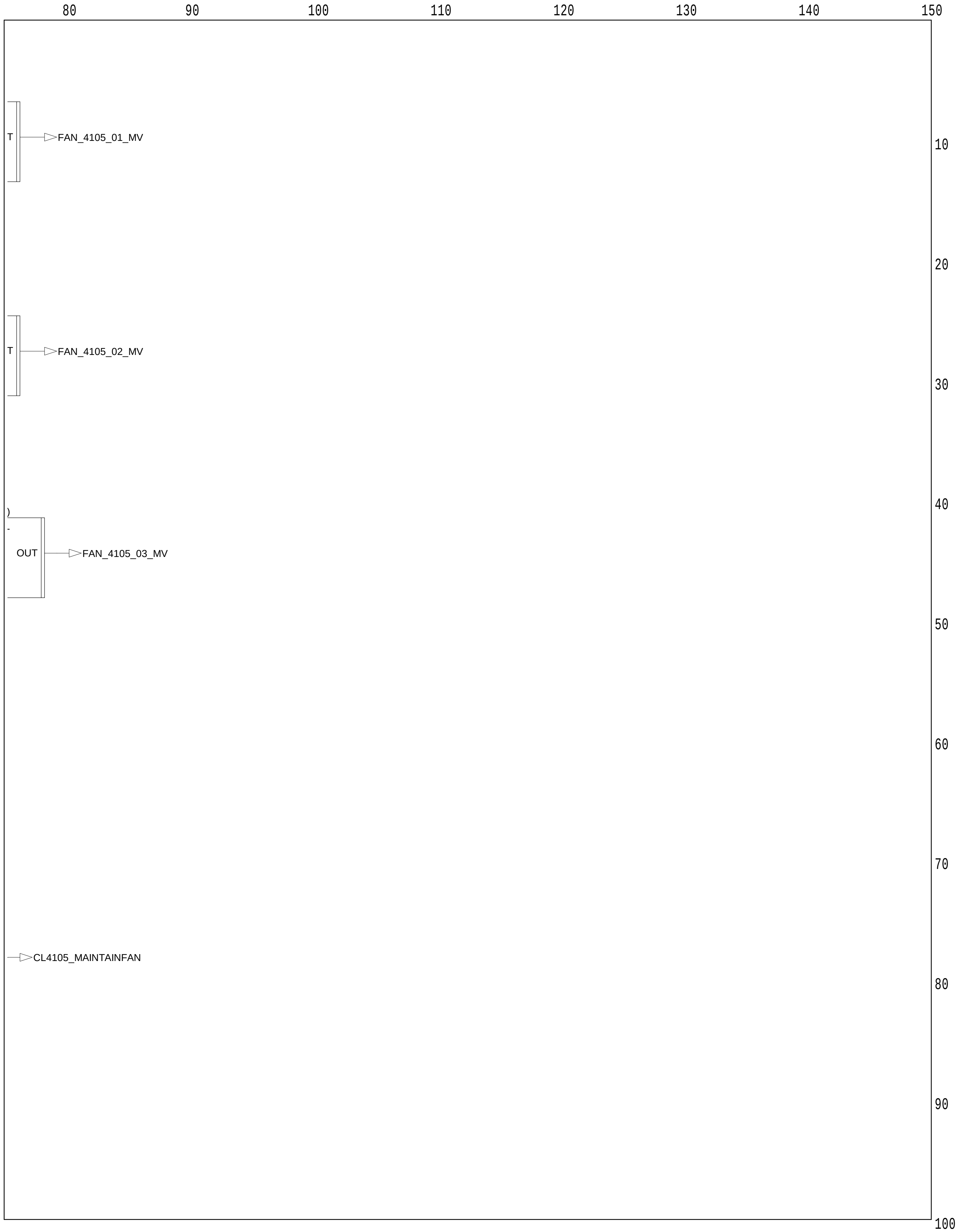

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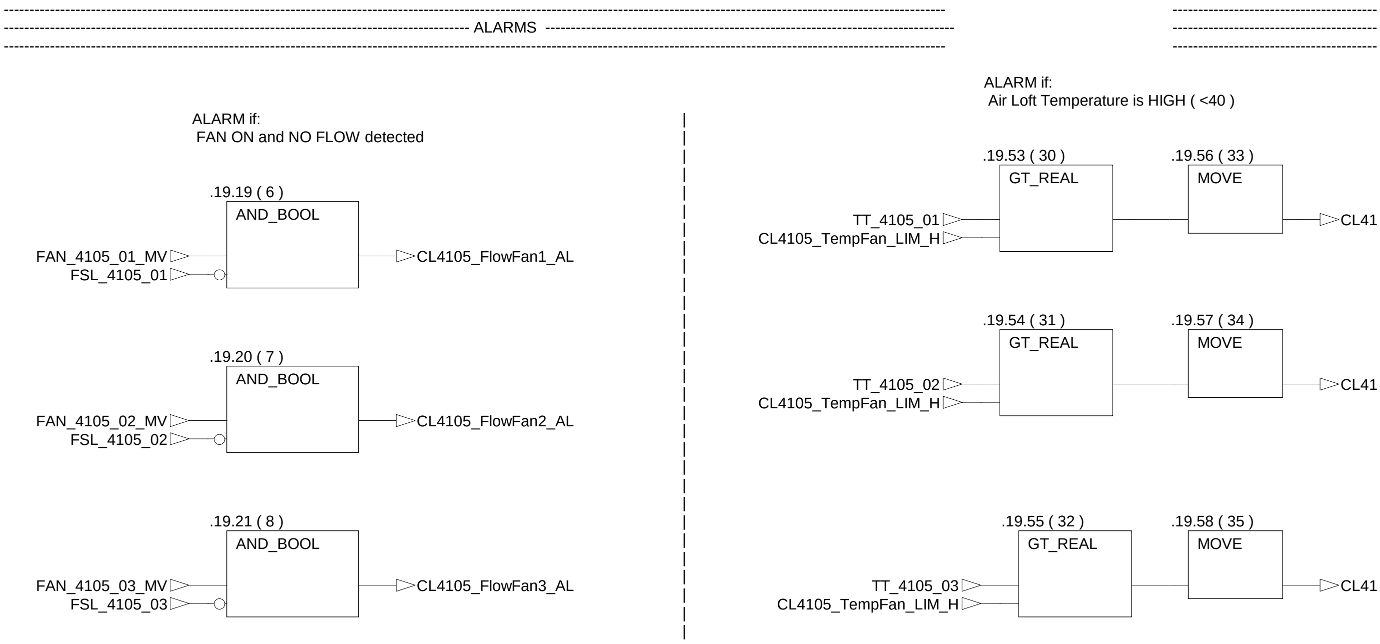
Graph of section CL4105_Lighting_Loft_Temp < page 39



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Graph of section CL4105_Lighting_Loft_Temp

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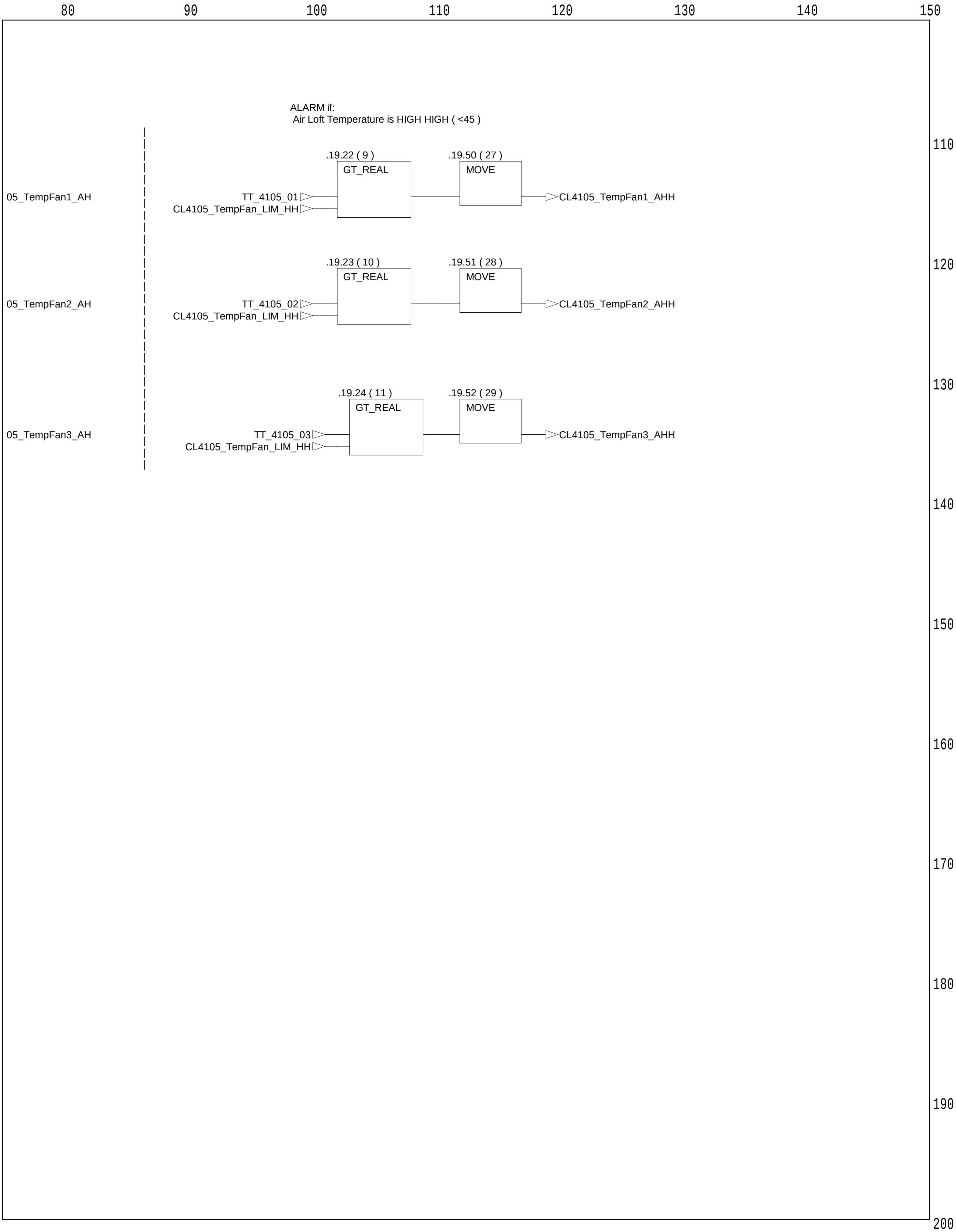

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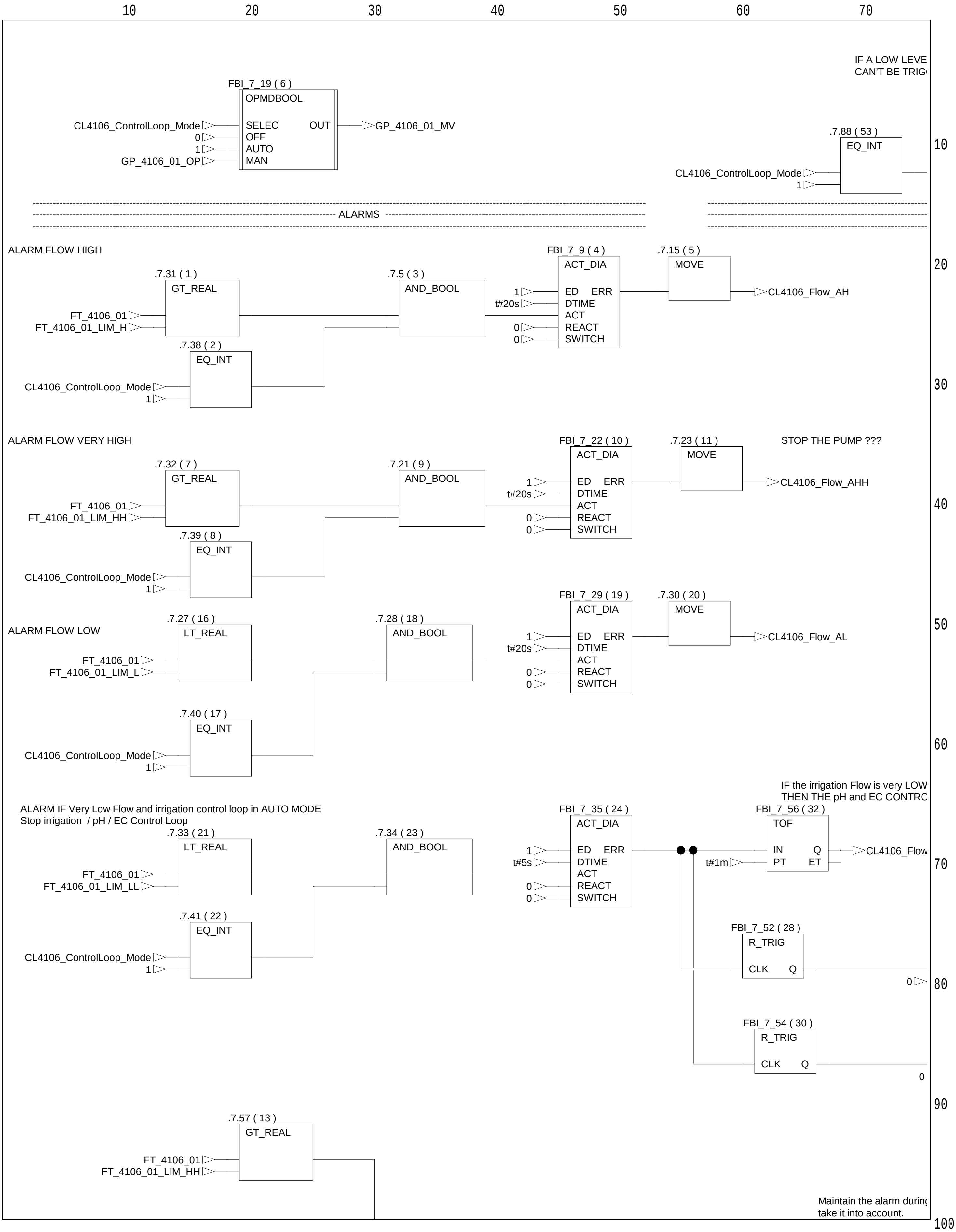
Graph of section CL4106_Irrigation



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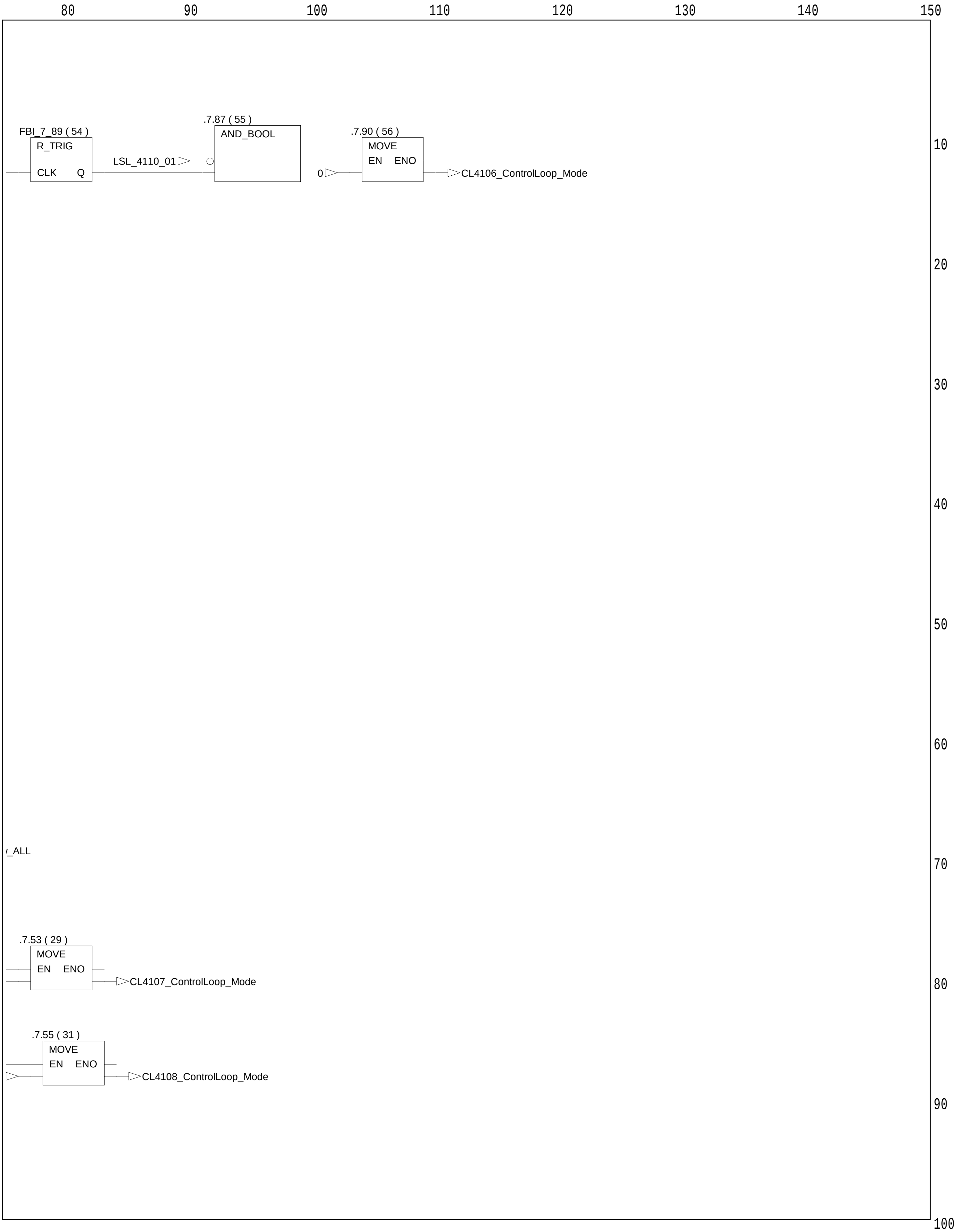
Graph of section CL4106_Irrigation



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Graph of section CL4106_Irrigation

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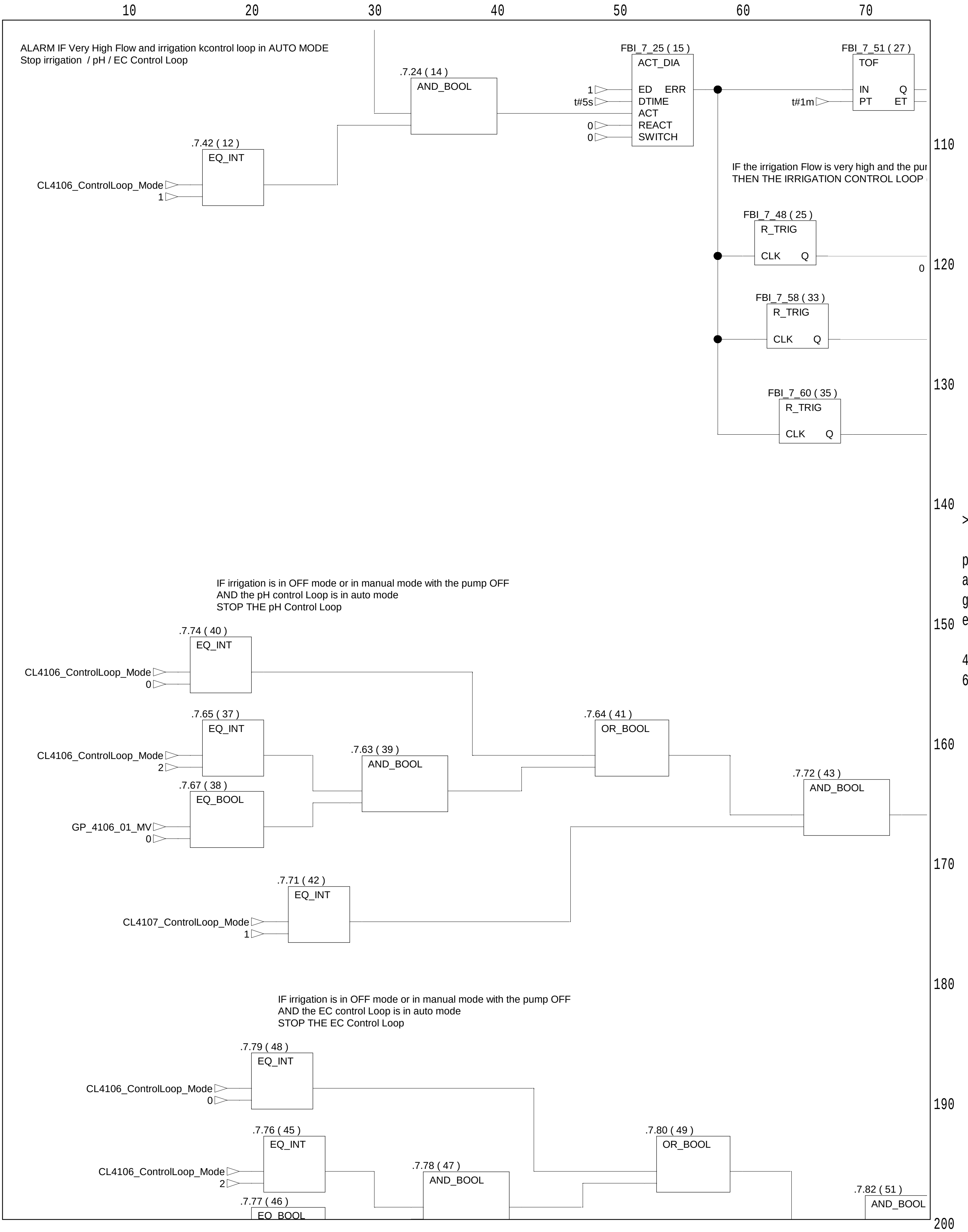

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Graph of section CL4106_Irrigation

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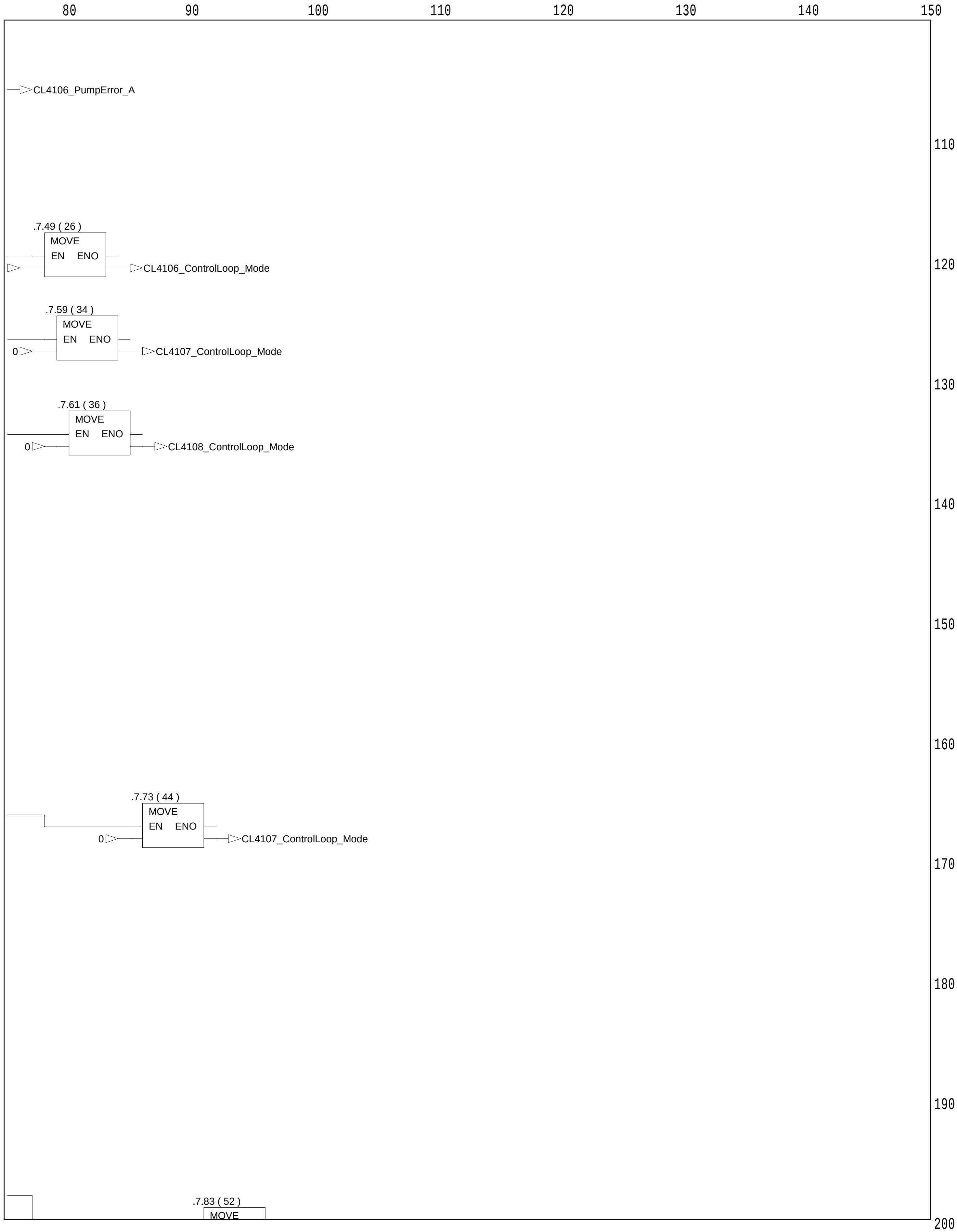

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Graph of section CL4106_Irrigation

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210
220
230

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Graph of section CL4106_Irrigation

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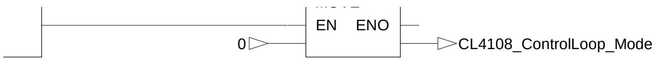

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220

230

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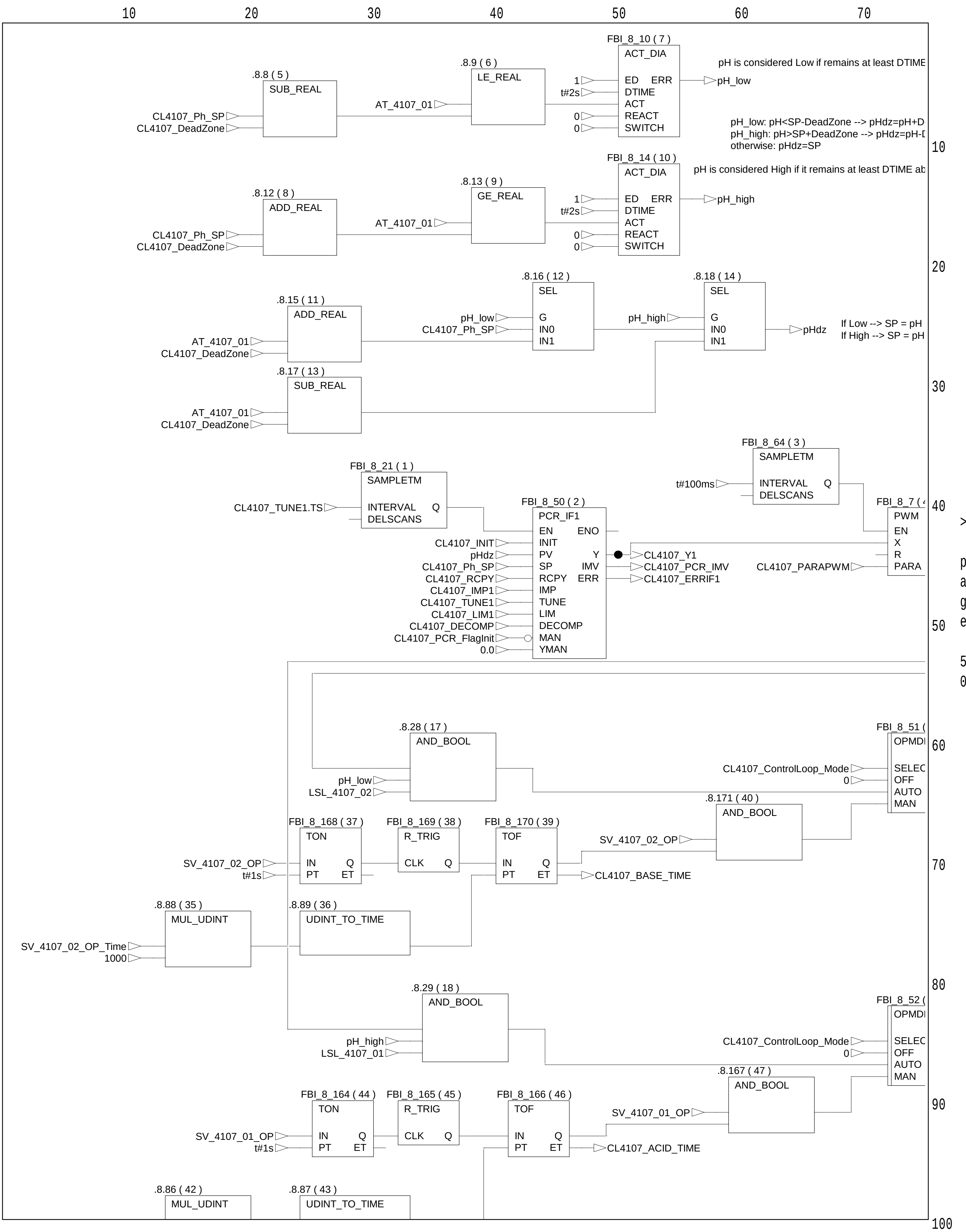
Graph of section CL4107_PH



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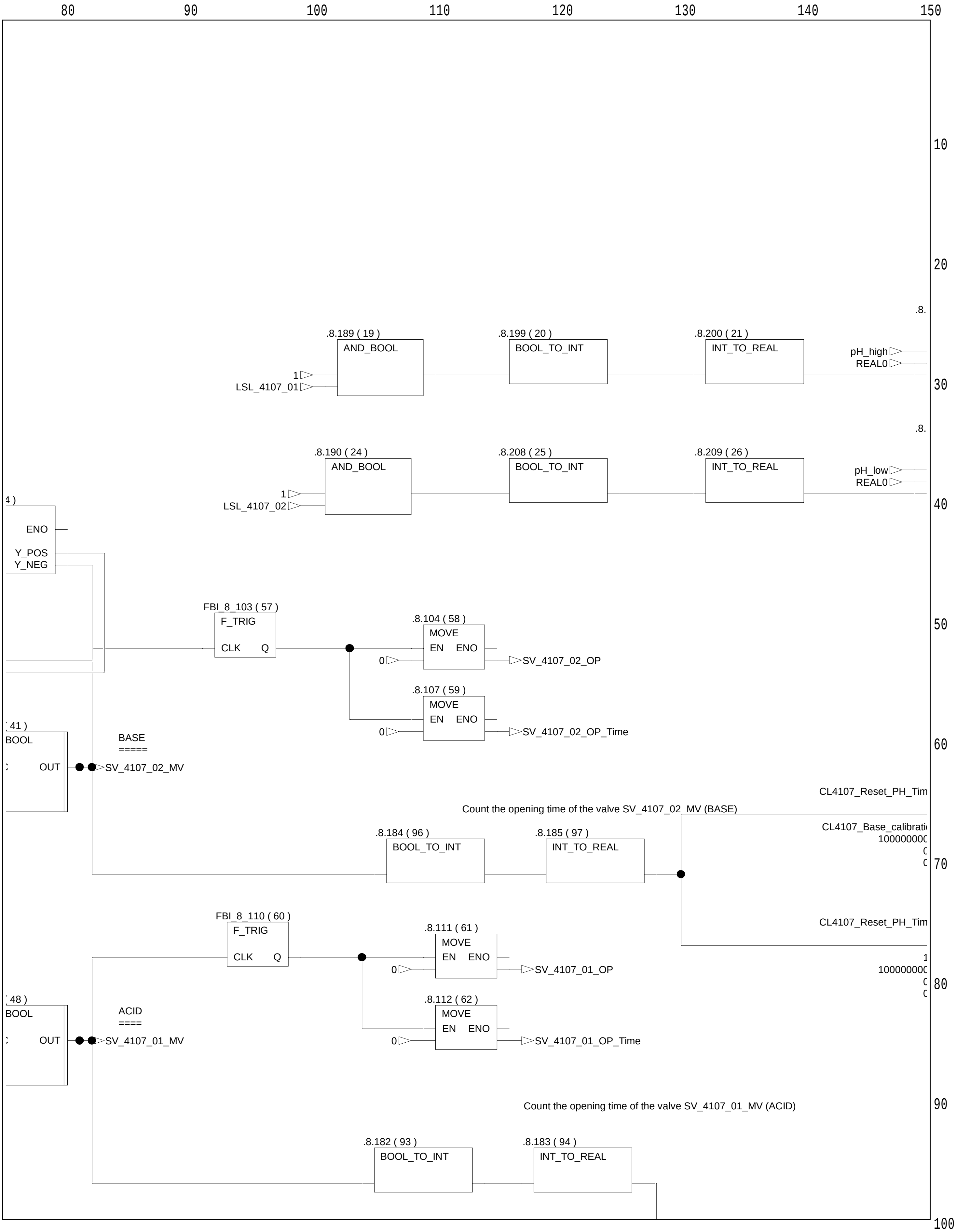
Graph of section CL4107_PH



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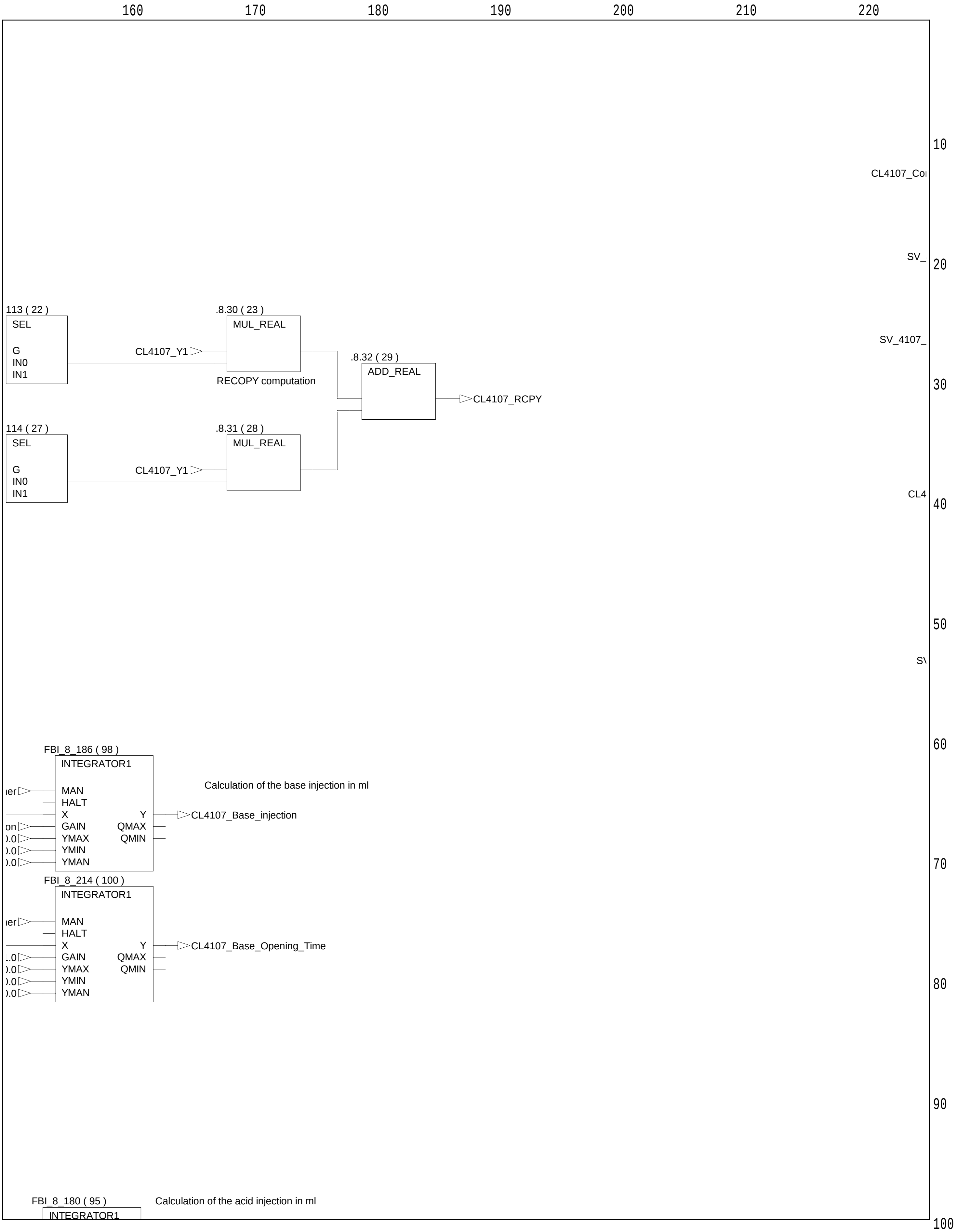
Graph of section CL4107_PH



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Graph of section CL4107_PH

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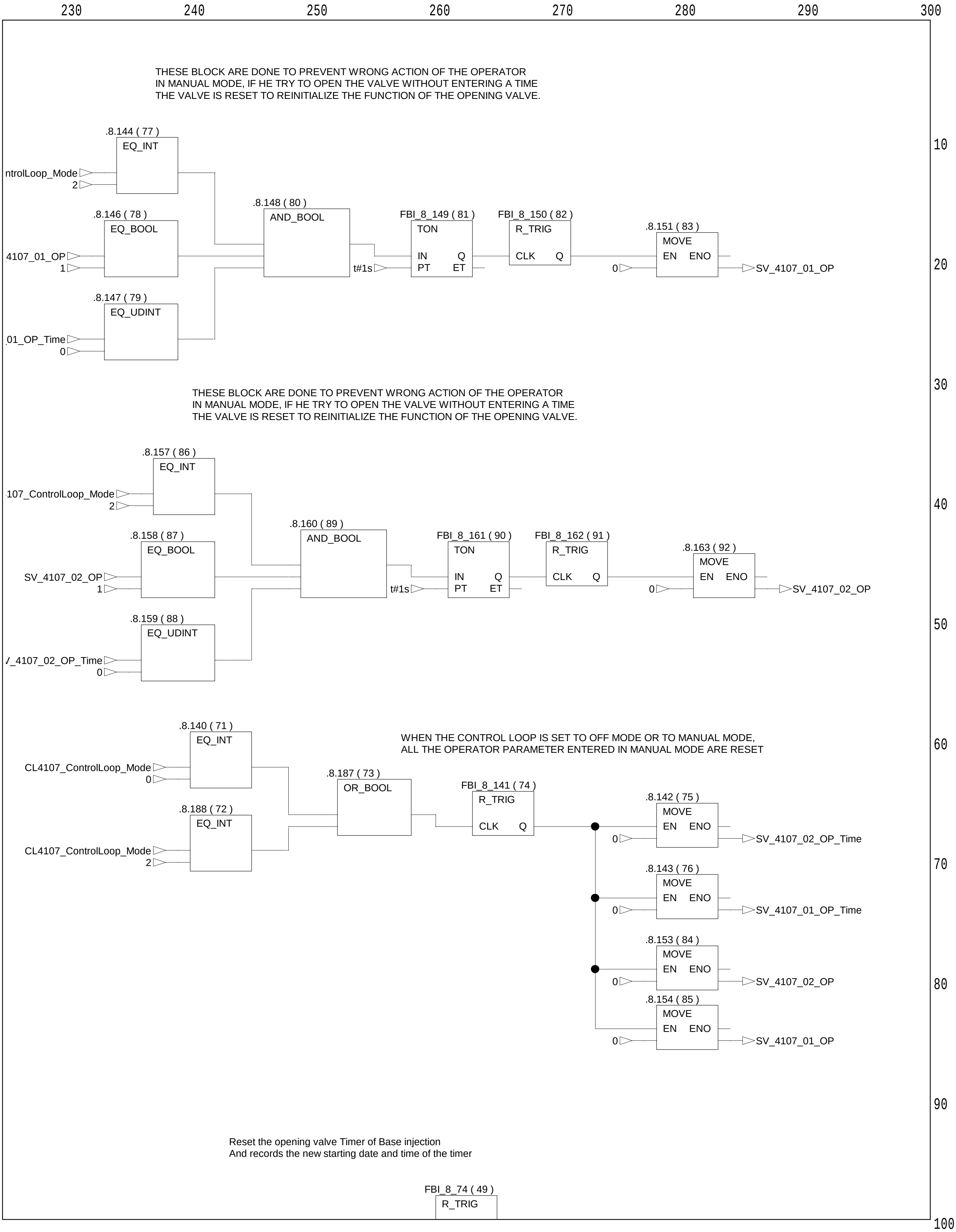

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Graph of section CL4107_PH

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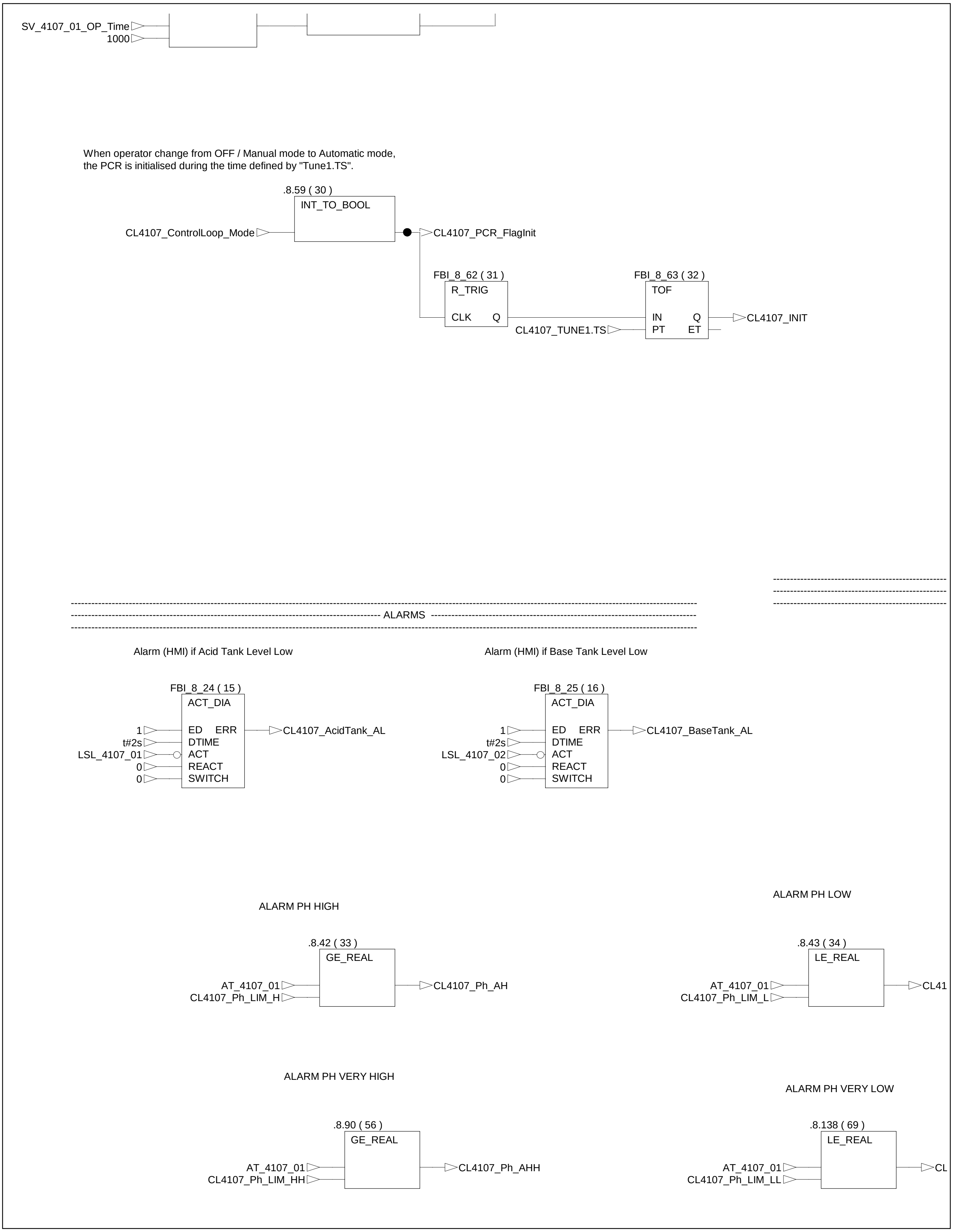

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180
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200

> page 54

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Graph of section CL4107_PH

< page 50

80 90 100 110 120 130 140 150

CL4107_Reset_PH_Timer

CL4107_Acid_calibration
100000000.0
0.0
0.0

110

CL4107_Reset_PH_Timer

1.0
100000000.0
0.0
0.0

120

130

140

150

160

170

07_Ph_AL

180

190

.4107_Ph_ALL

200

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Graph of section CL4107_PH

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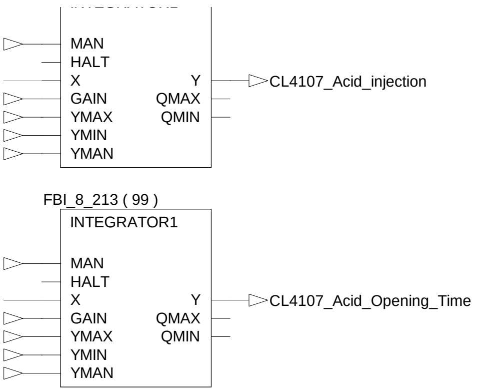

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Graph of section CL4107_PH

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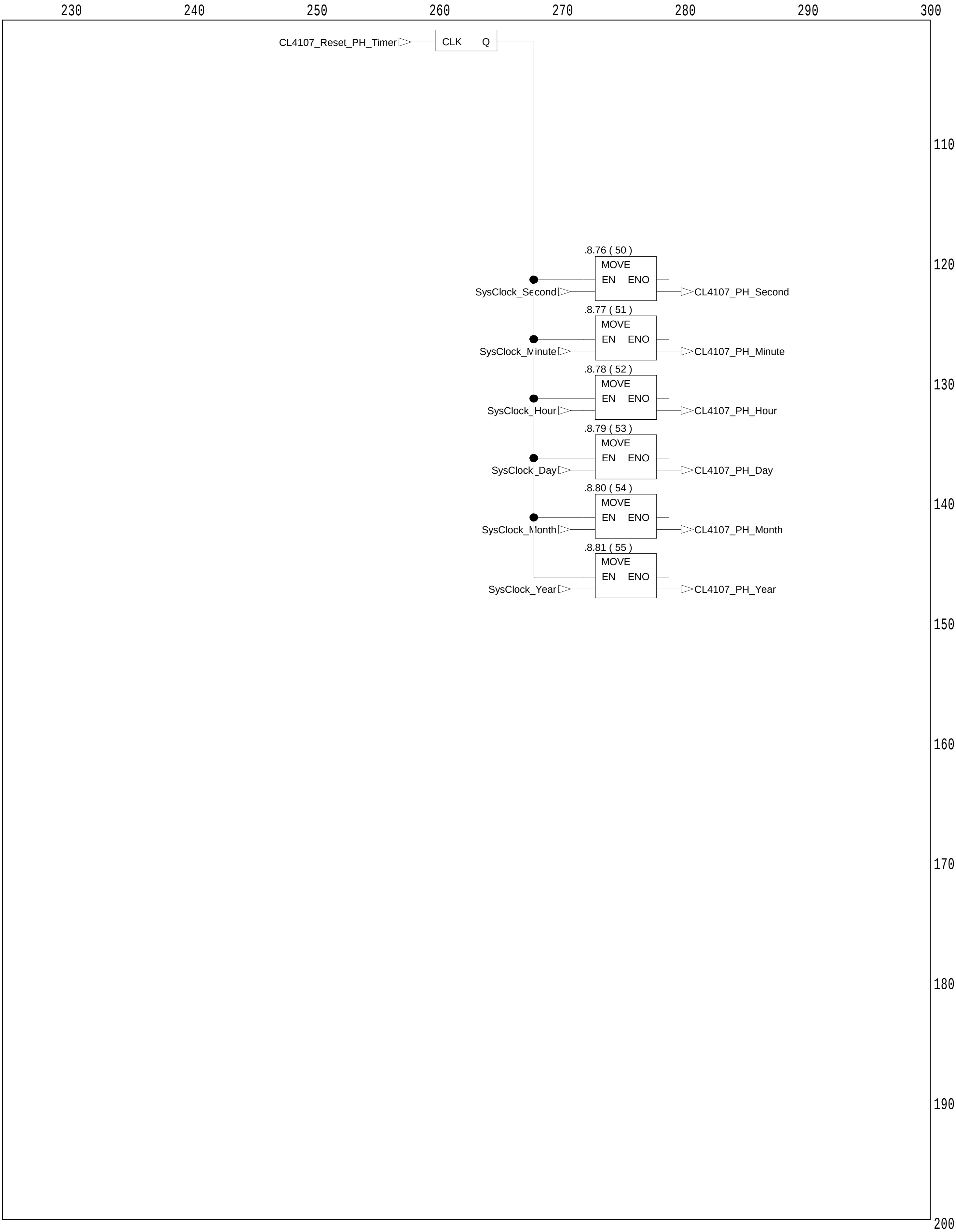

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Graph of section CL4107_PH

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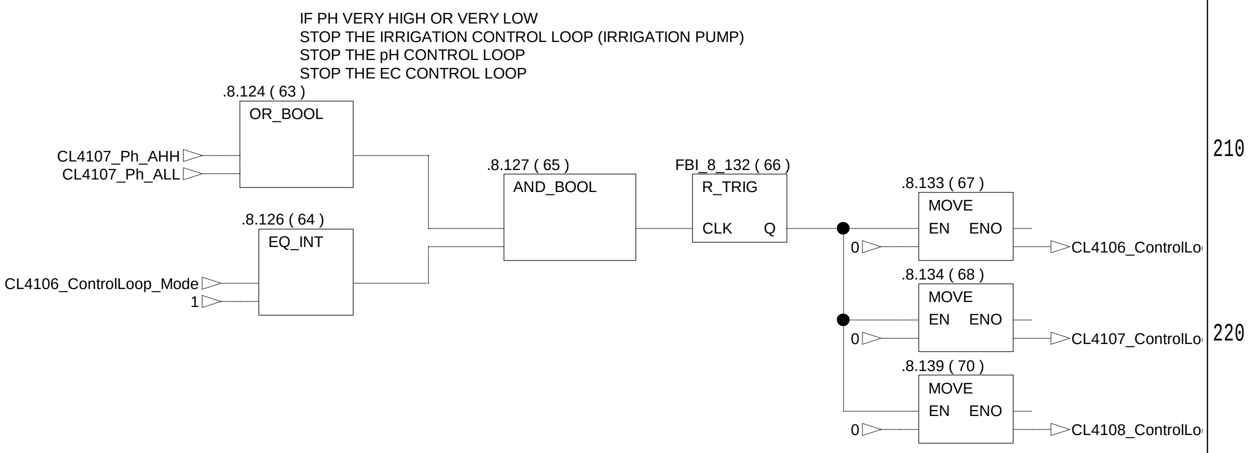

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Graph of section CL4107_PH

< page 54

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210

op_Mode

op_Mode

220

op_Mode

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< page 57

> page 59

Graph of section CL4107_PH

< page 55

160 170 180 190 200 210 220

210

220

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Graph of section CL4107_PH

< page 56

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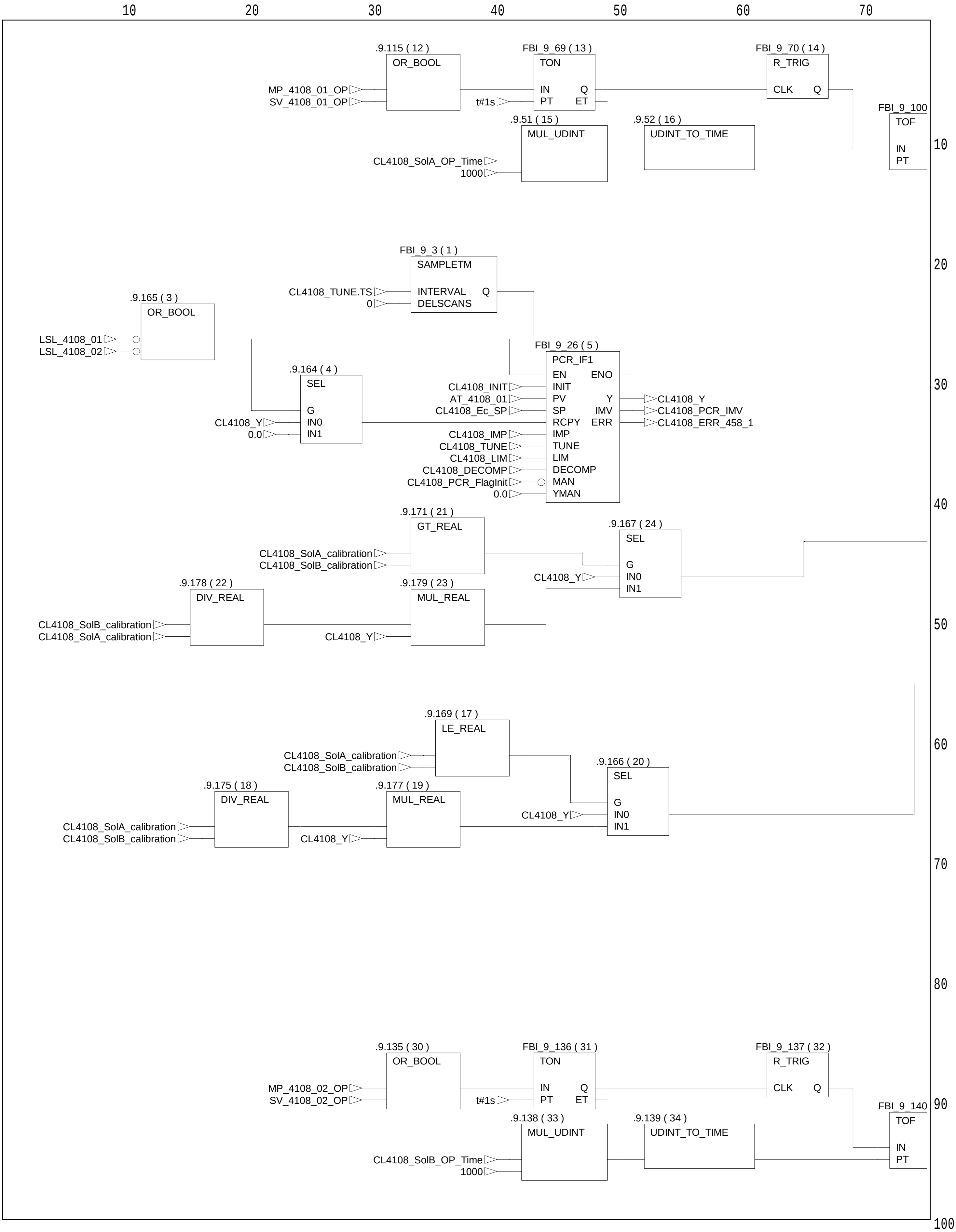
< page 59

Graph of section CL4108_EC



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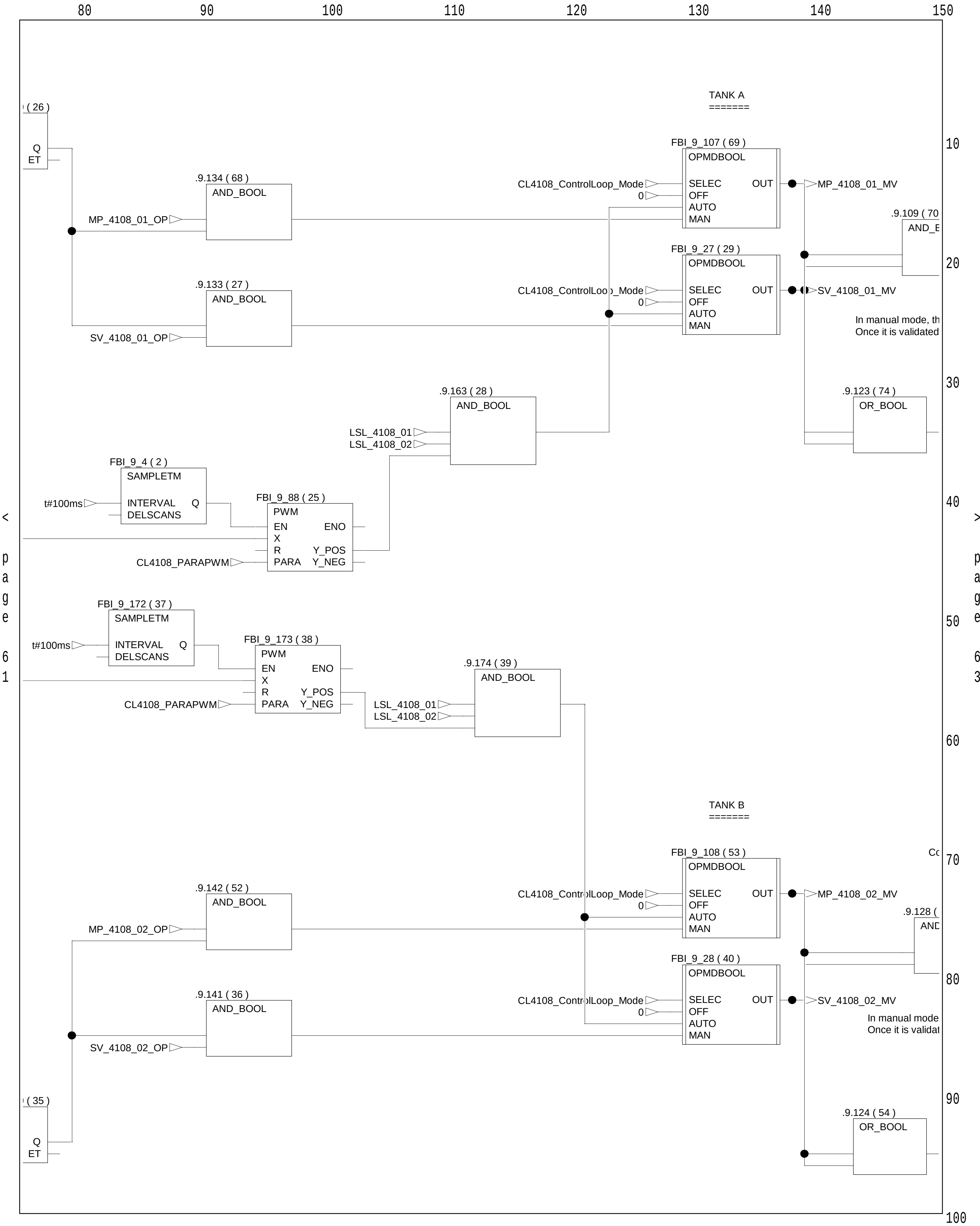
Graph of section CL4108_EC



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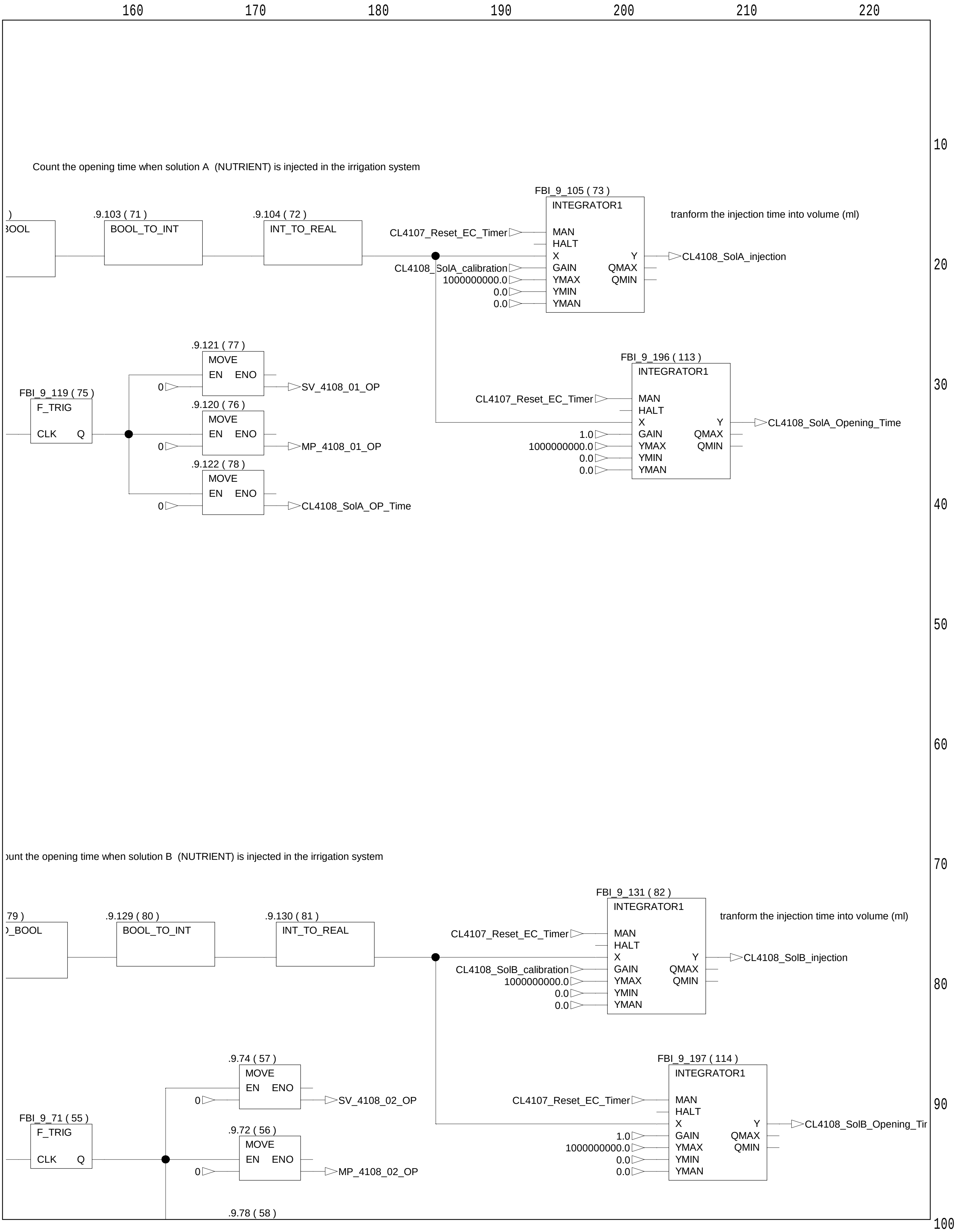
Graph of section CL4108_EC



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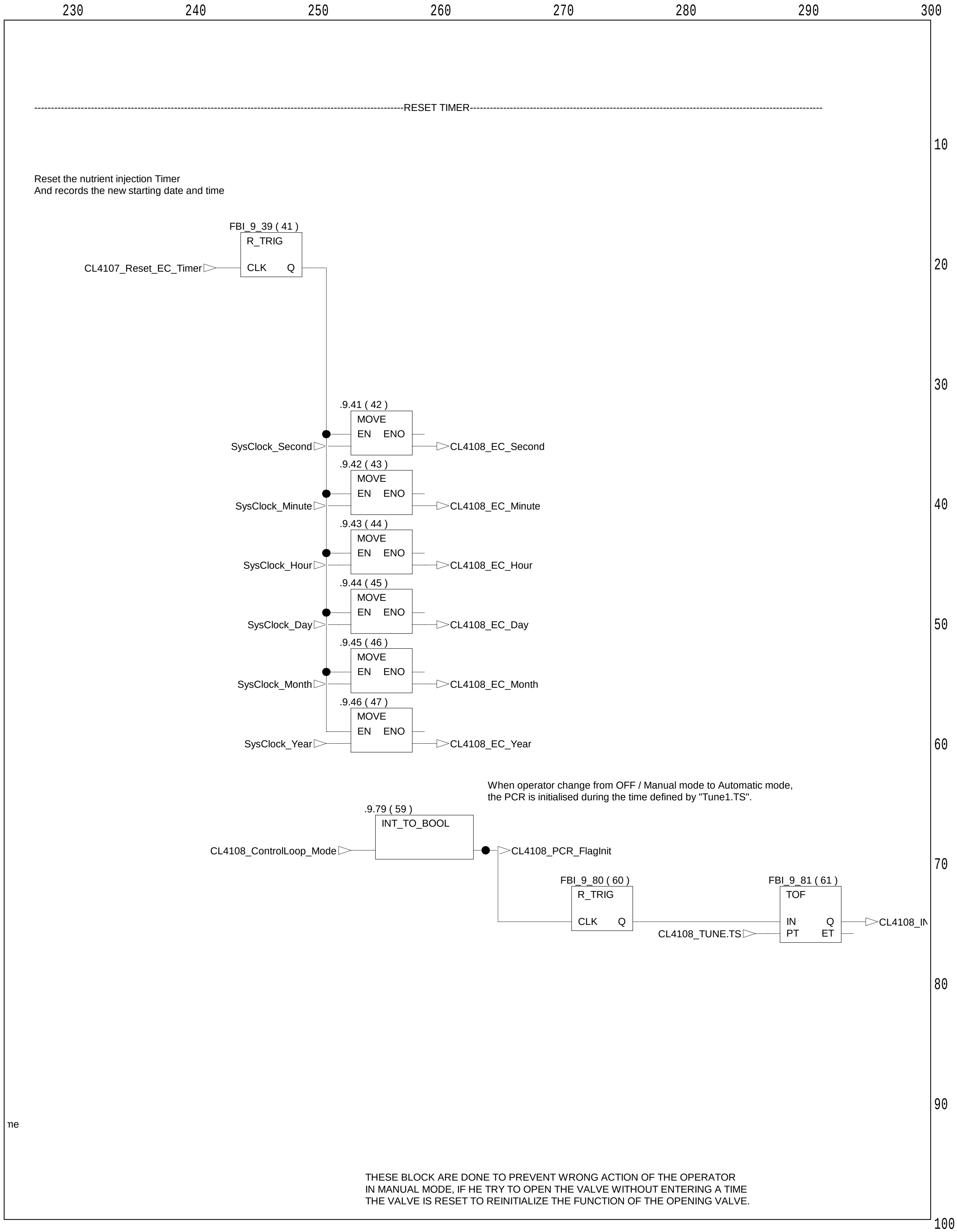
> page 64

> page 68

Graph of section CL4108_EC



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> page 65

> page 69

Graph of section CL4108_EC

< page 64

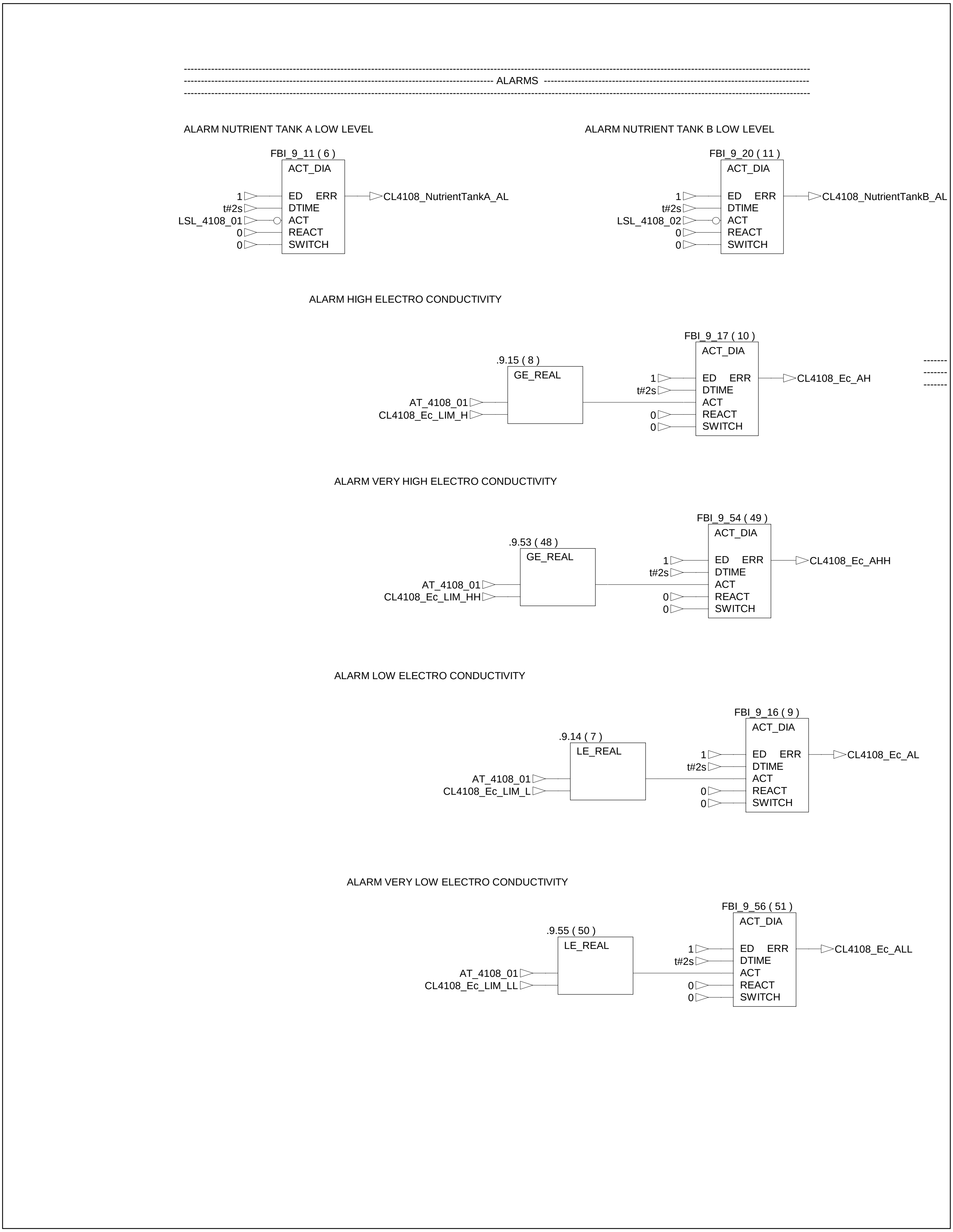
JIT

10 20 30 40 50 60 70 80 90 100

> page 70

Graph of section CL4108_EC

< page 61



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Graph of section CL4108_EC

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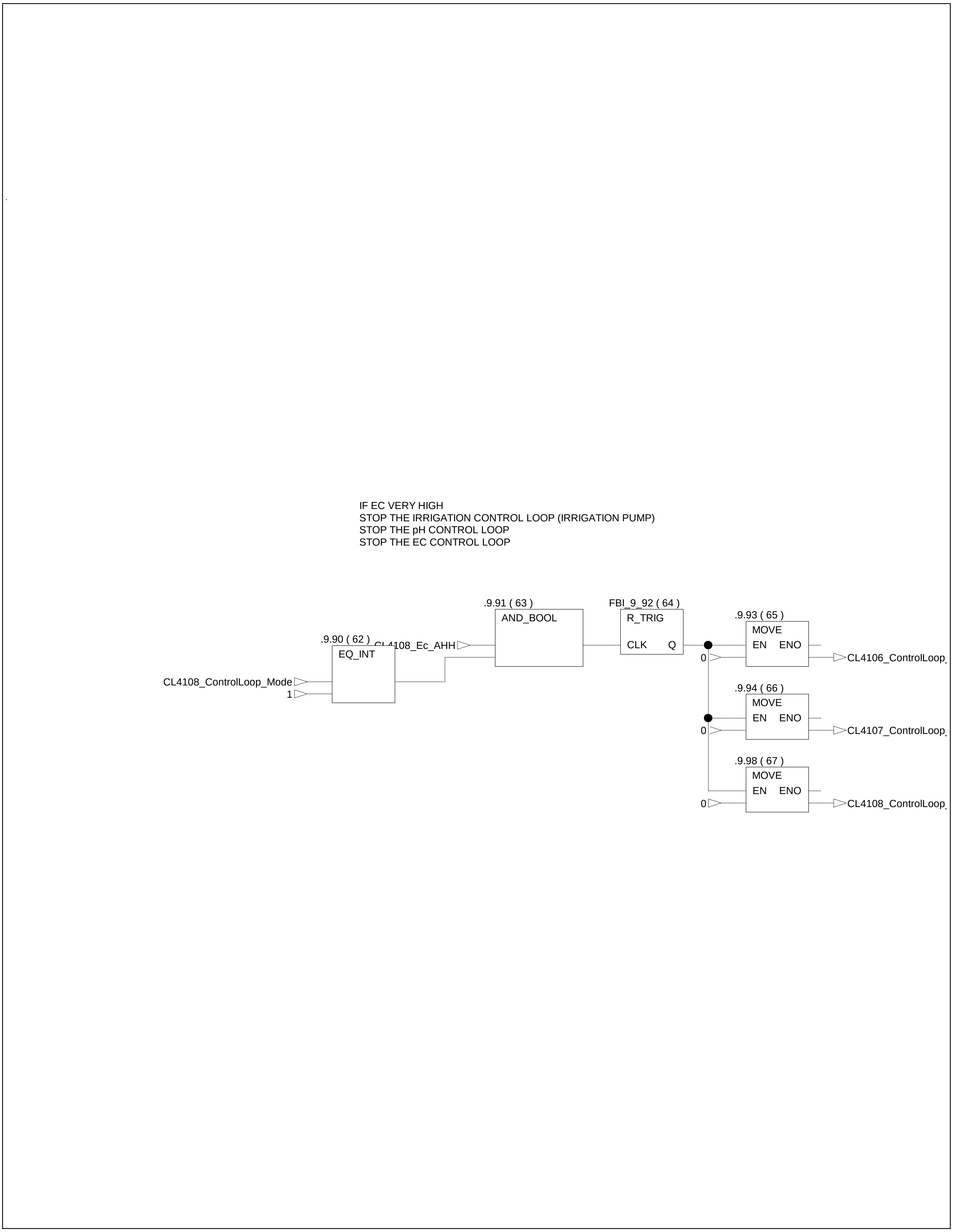

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> page 72

Graph of section CL4108_EC

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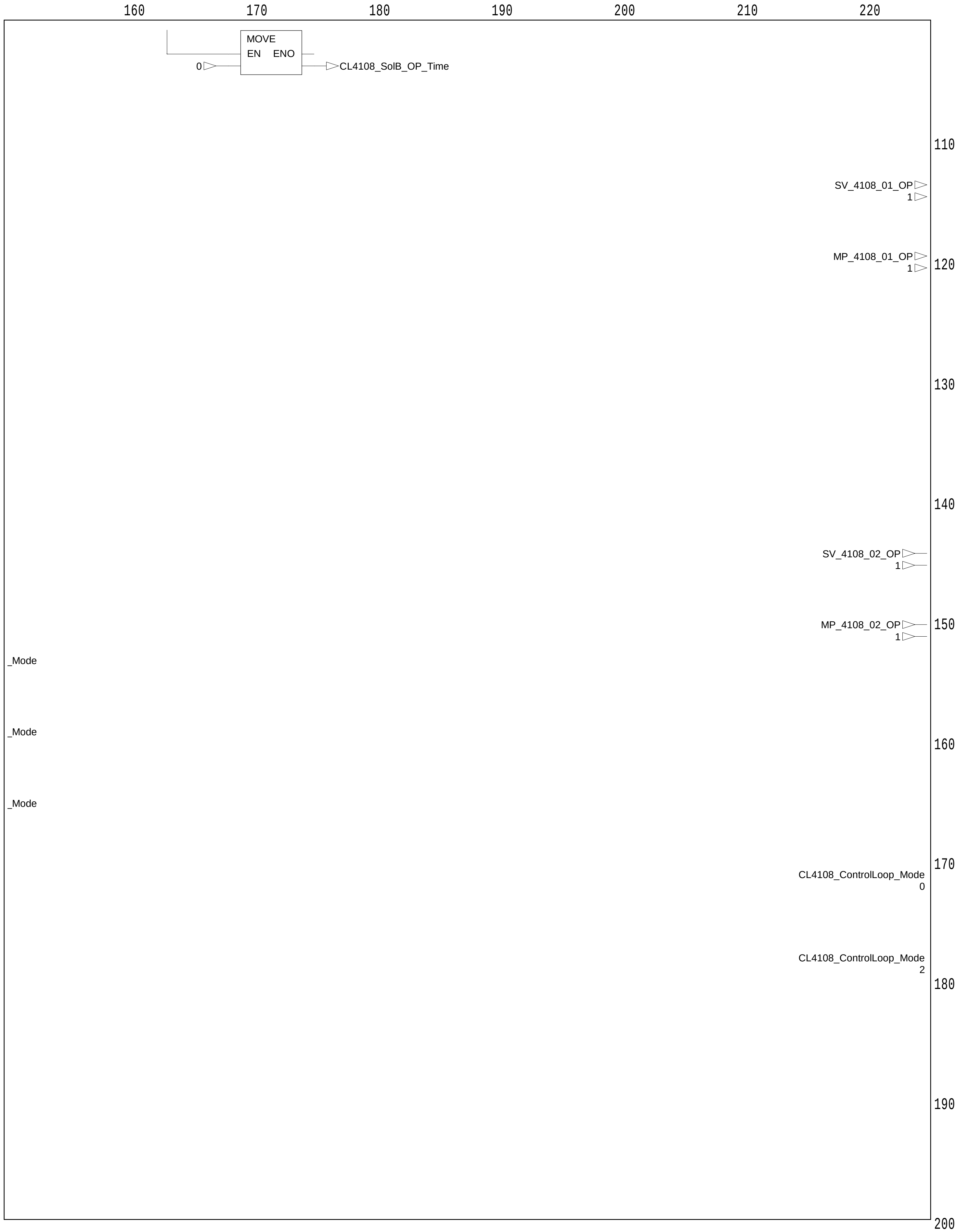

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Graph of section CL4108_EC

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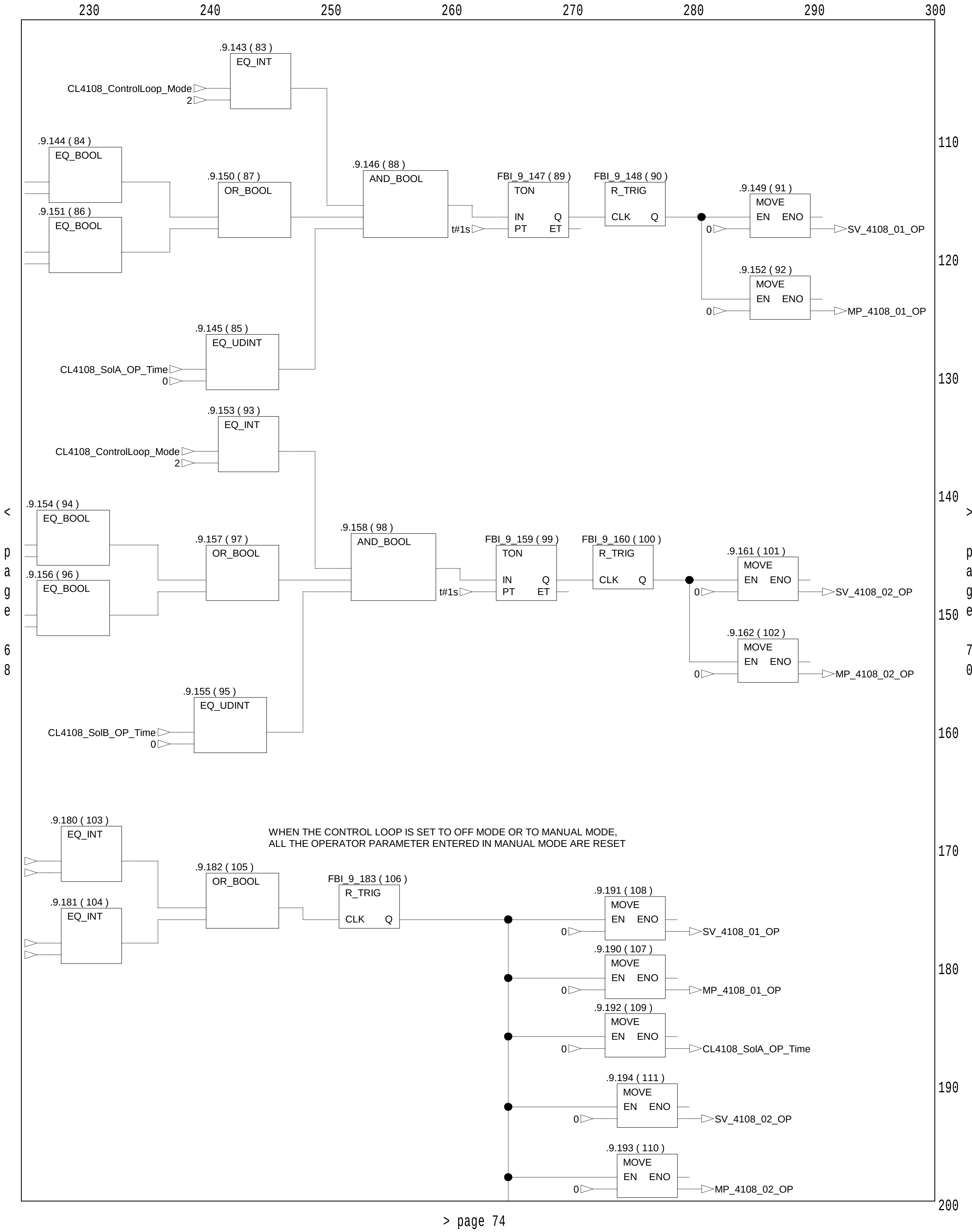

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Graph of section CL4108_EC

< page 65

< page 69

> page 75

Graph of section CL4108_EC

< page 66

10 20 30 40 50 60 70

210

220

230

> page 72

Graph of section CL4108_EC

< page 67

80 90 100 110 120 130 140 150

210

220

230

< page 71

> page 73

Graph of section CL4108_EC

< page 68

160 170 180 190 200 210 220

210

220

230

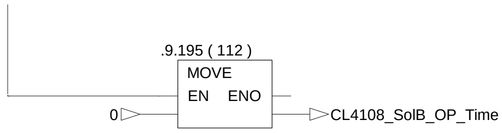
< page 72

> page 74

Graph of section CL4108_EC

< page 69

230 240 250 260 270 280 290 300



210

220

230

< page 73

> page 75

Graph of section CL4108_EC

< page 70

< page 74

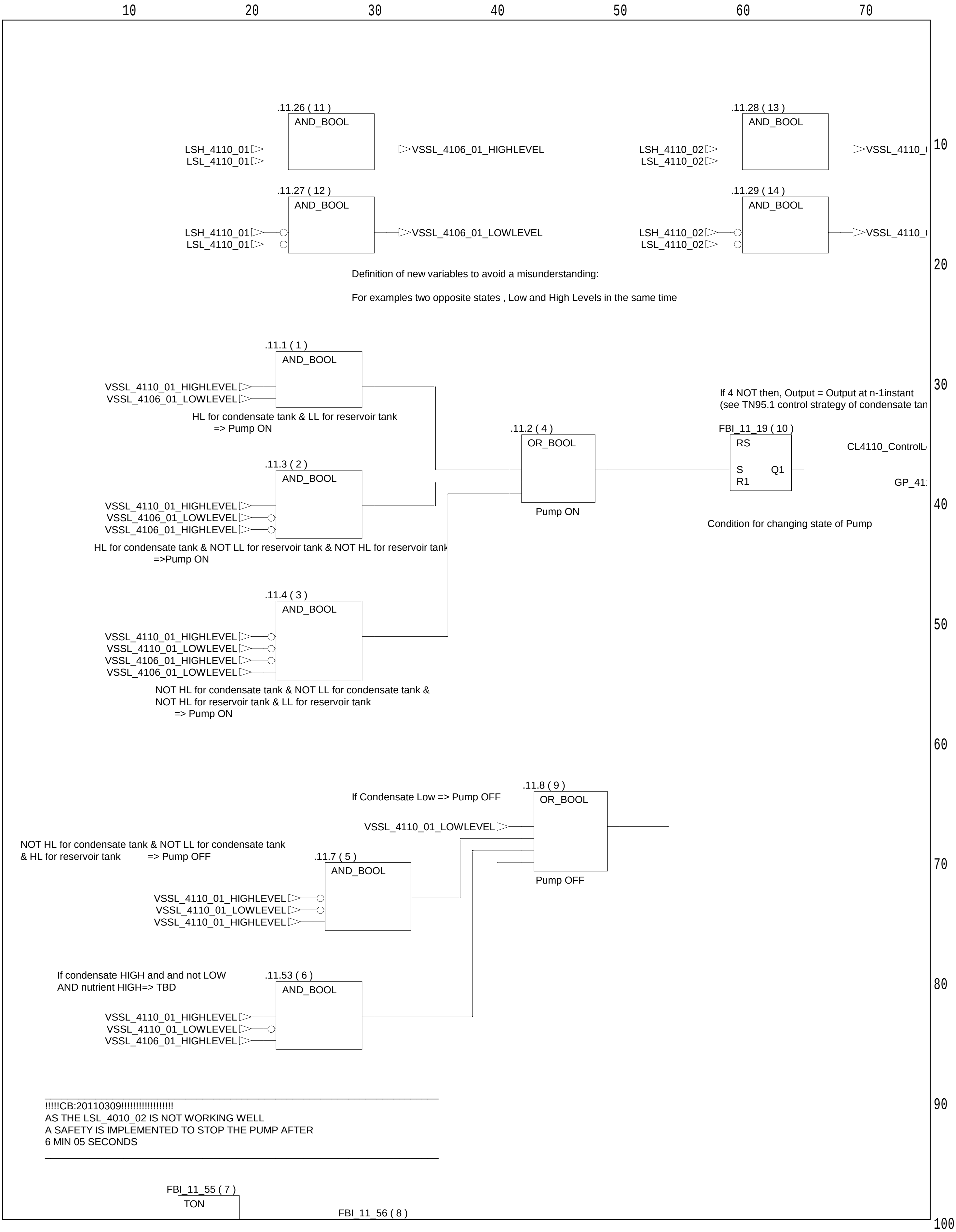
Graph of section CL4109_NutrientTank_Temp

10 20 30 40 50 60 70

CB COMMENT (06 / 05 / 2009) :
This part of the process doesn't exist so the section program had been deleted

10 20 30 40 50 60 70 80 90 100

Graph of section CL4110_Nutrient_Condens_Level



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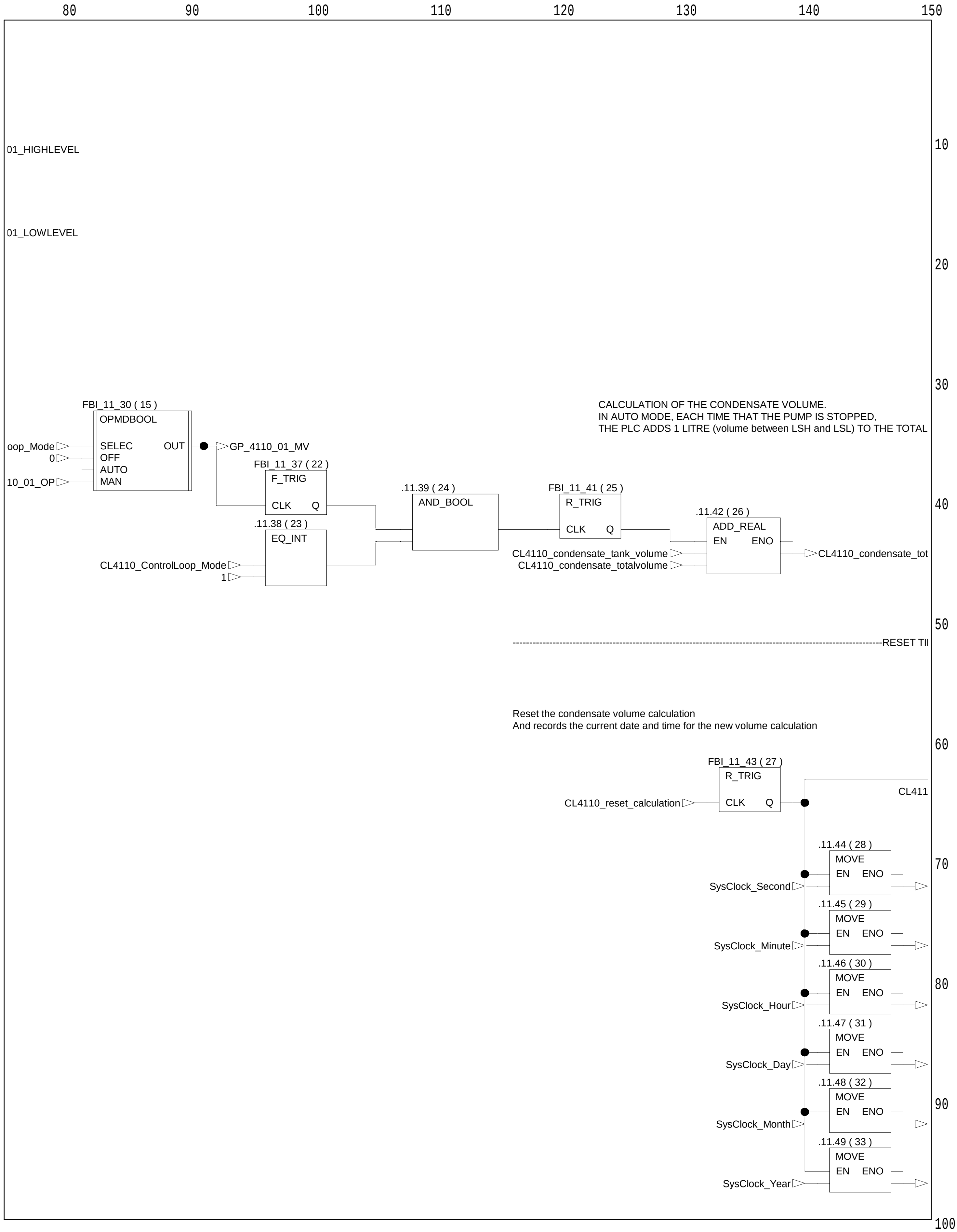
Graph of section CL4110_Nutrient_Condens_Level



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> page 81

Graph of section CL4110_Nutrient_Condens_Level

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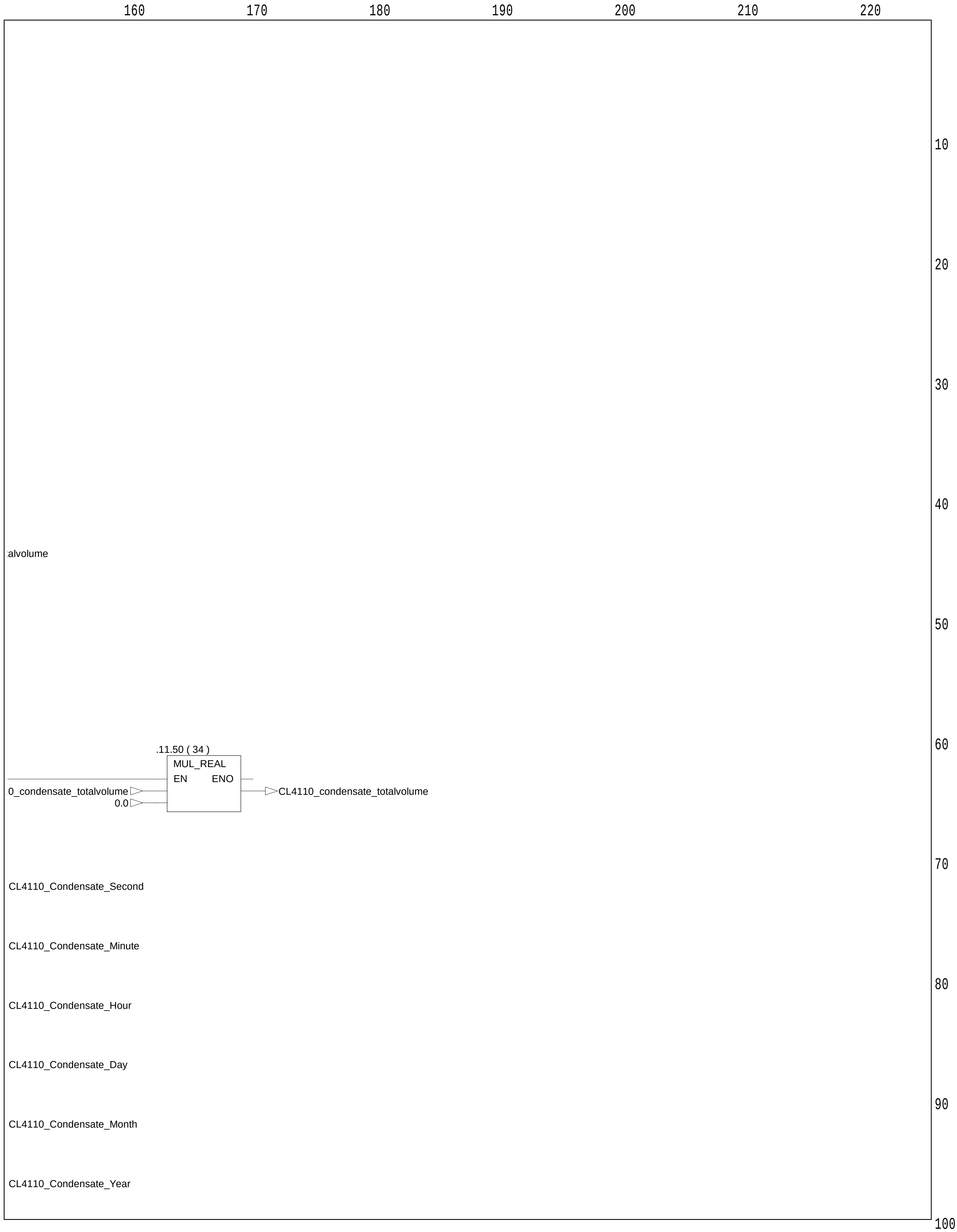

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Graph of section CL4110_Nutrient_Condens_Level

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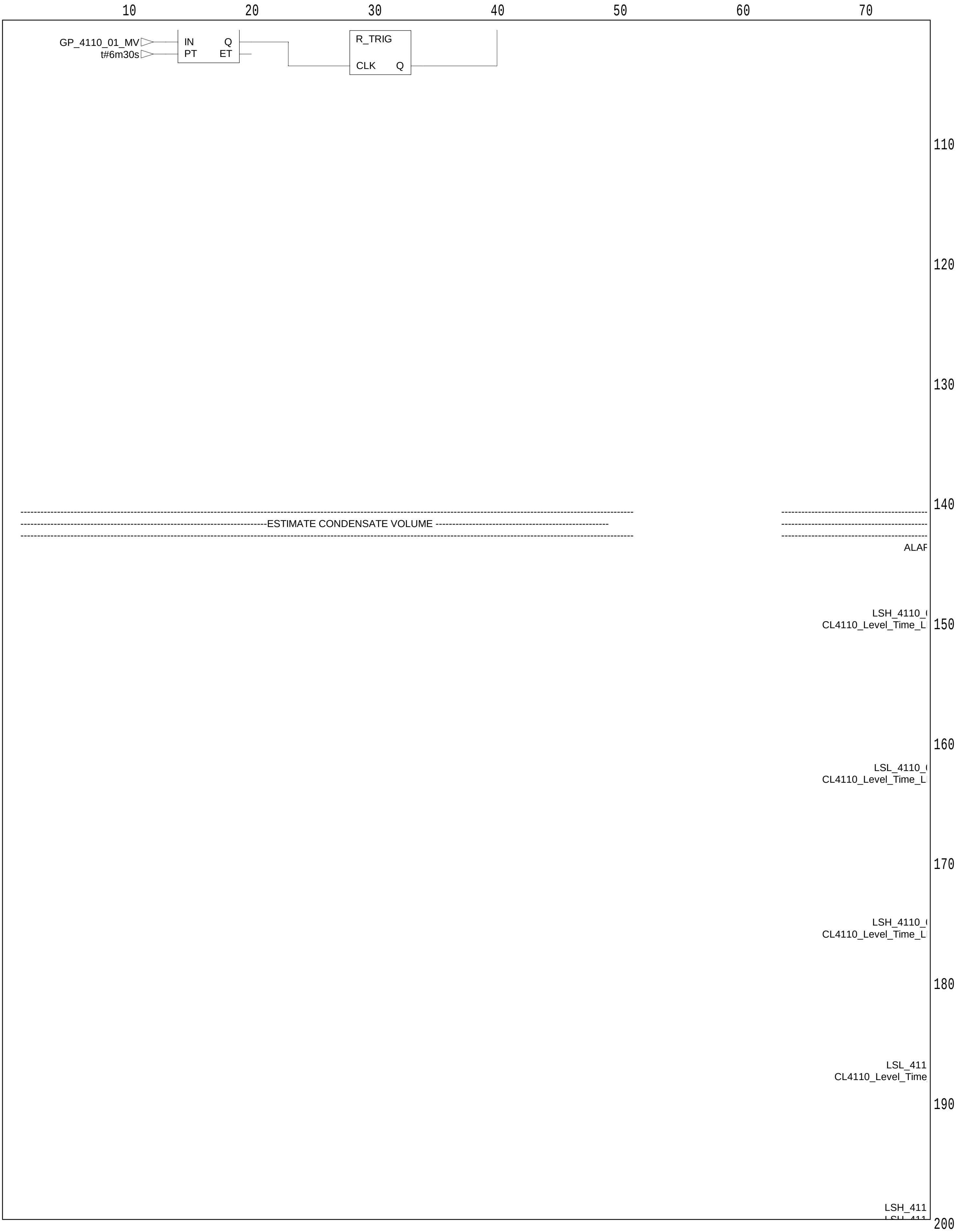

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Graph of section CL4110_Nutrient_Condens_Level

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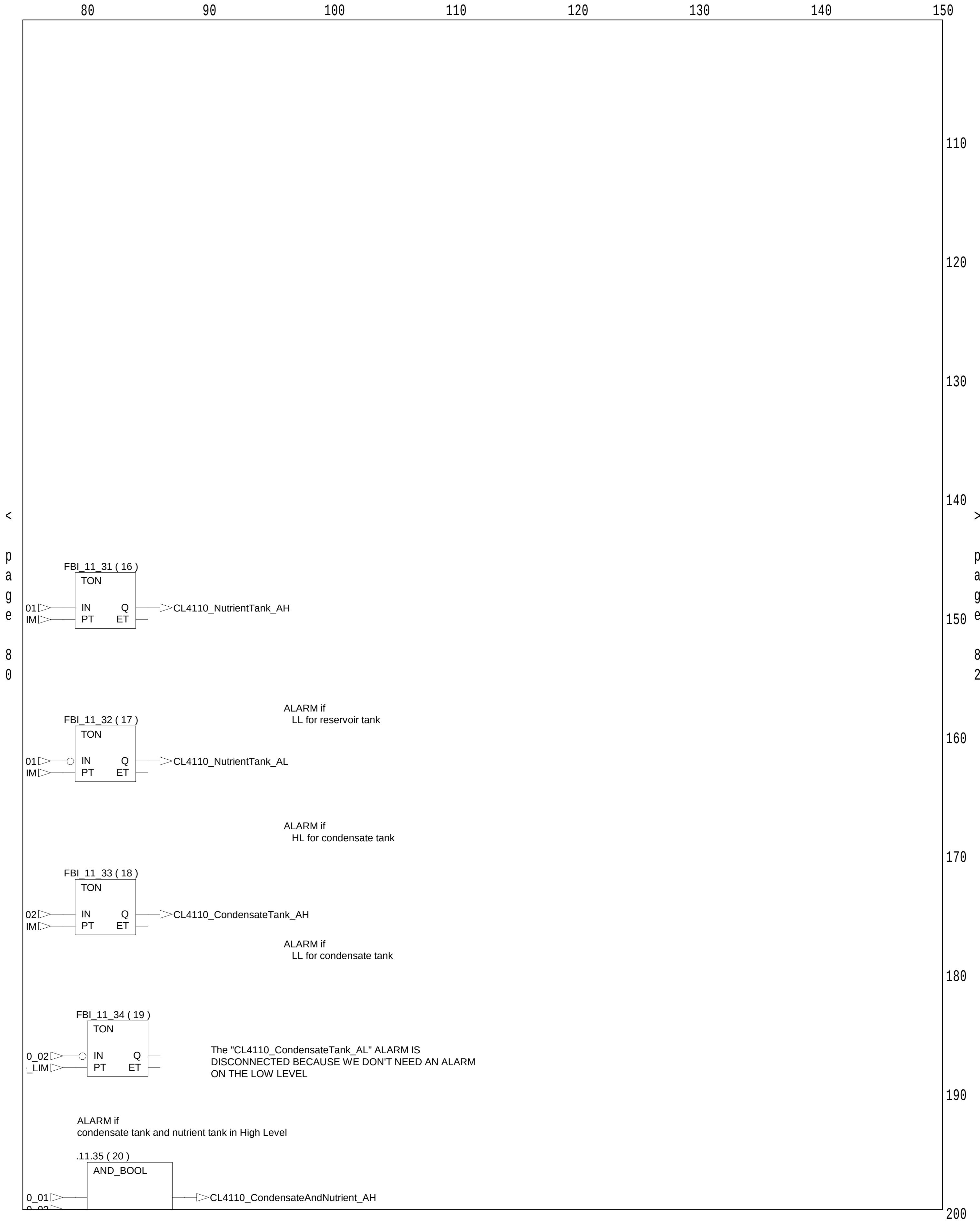

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Graph of section CL4110_Nutrient_Condens_Level

< page 79

160 170 180 190 200 210 220

110 120 130 140 150 160 170 180 190 200

< page 81

> page 85

Graph of section CL4110_Nutrient_Condens_Level

< page 80

10 20 30 40 50 60 70

LSH_411

LSL_411 210
LSL_411

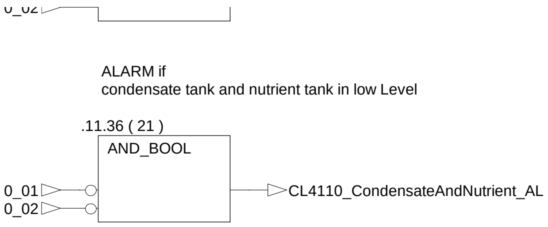
220

230

> page 84

Graph of section CL4110_Nutrient_Condens_Level < page 81

80 90 100 110 120 130 140 150



210

220

230

< page 83

> page 85

Graph of section CL4110_Nutrient_Condens_Level

< page 82

160 170 180 190 200 210 220

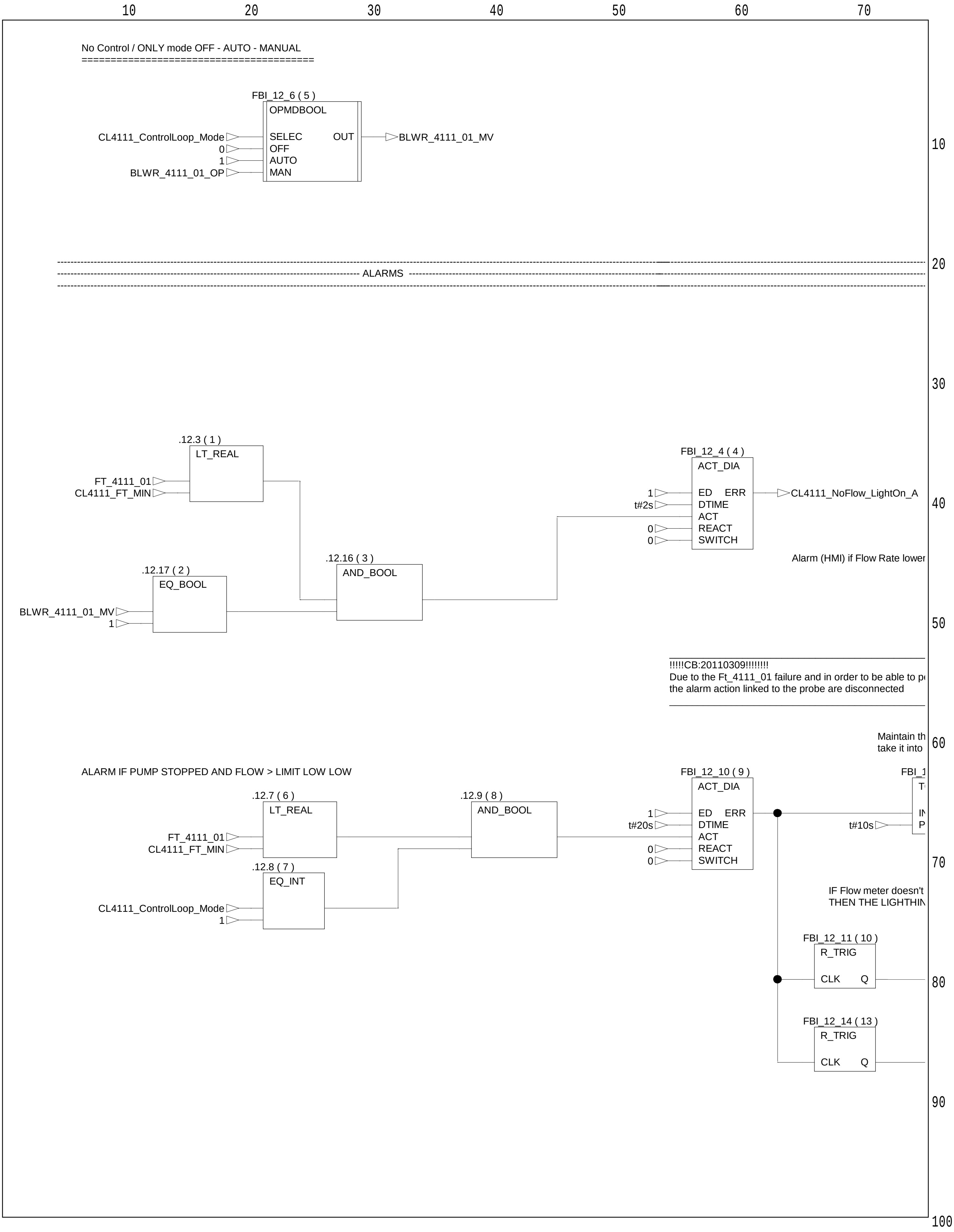
210

220

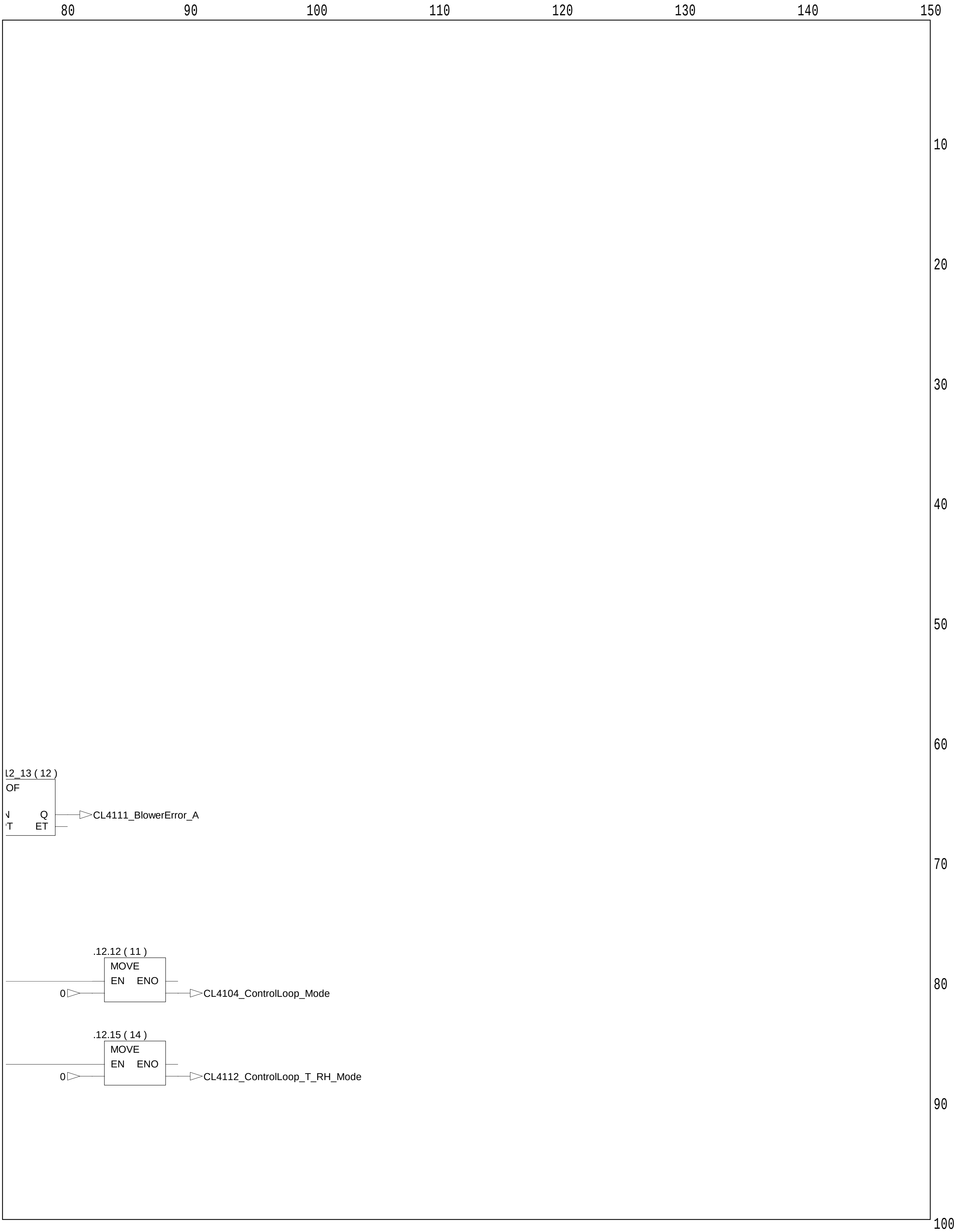
230

< page 84

Graph of section CL4111_Air_Fans



Graph of section CL4111_Air_Fans



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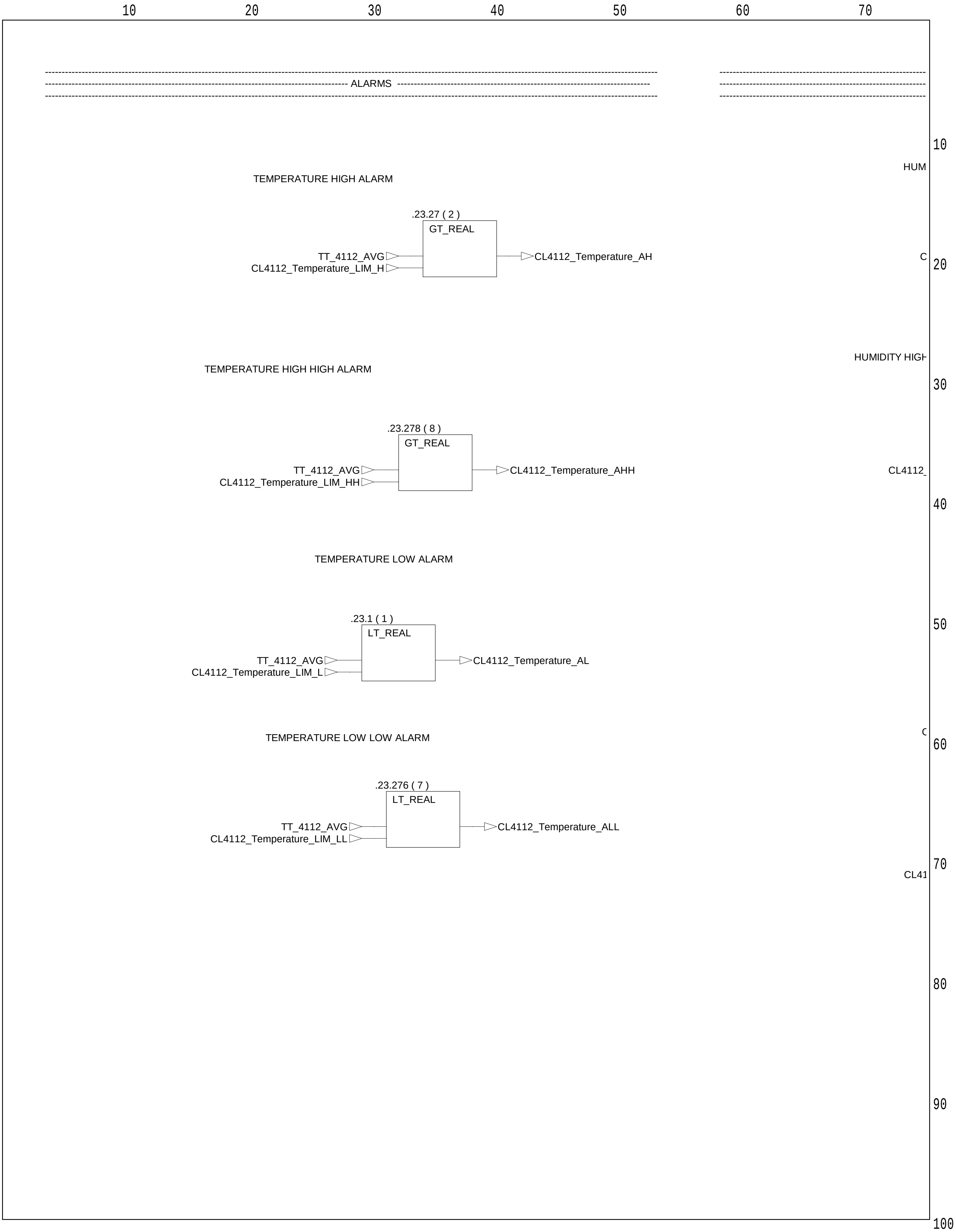
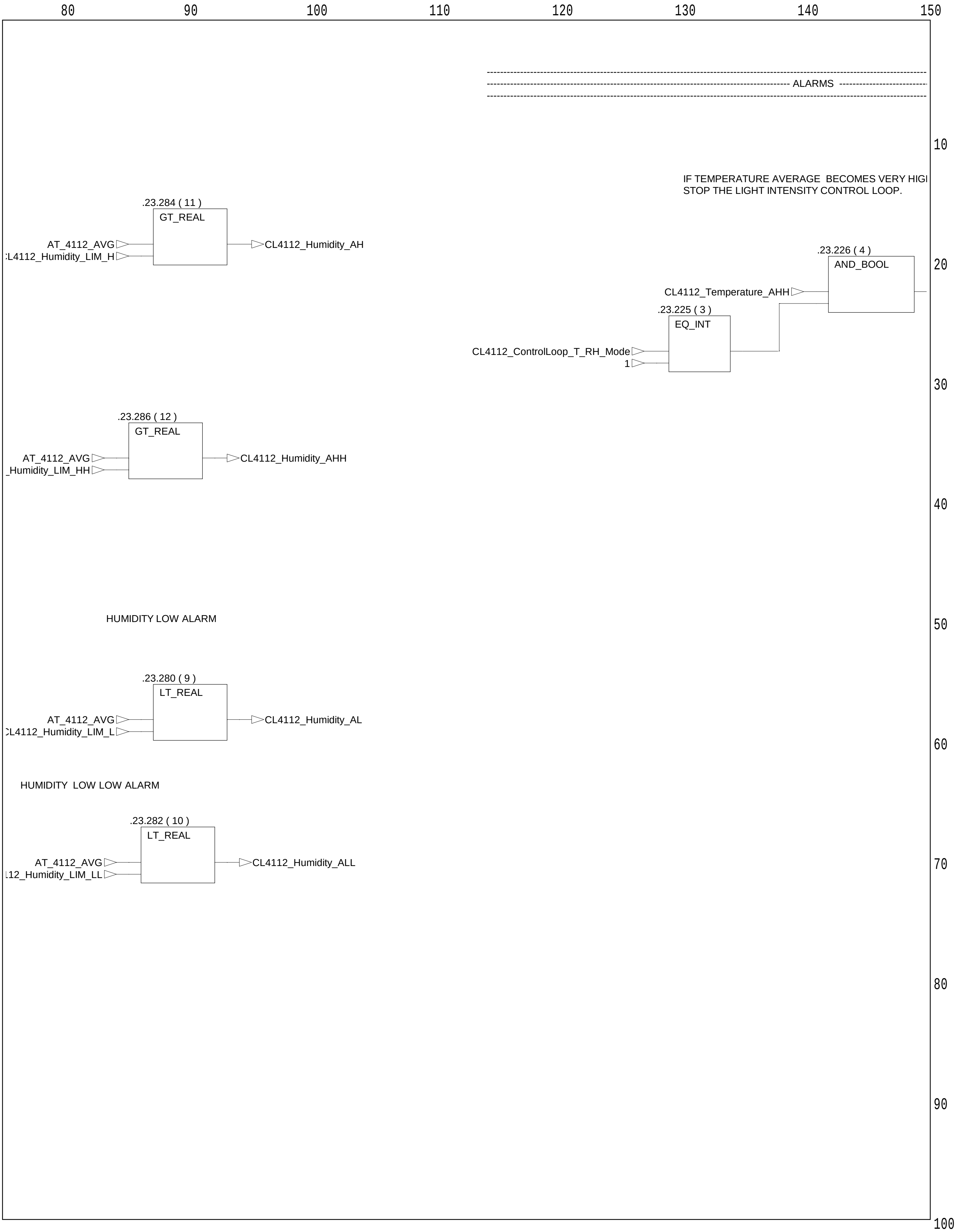
Graph of section CL4112_Alarms_Chamber



Graph of section CL4112_Alarms_Chamber



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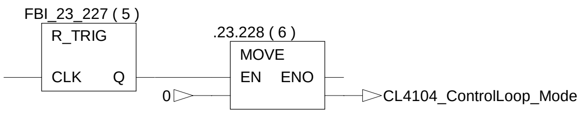
Graph of section CL4112_Alarms_Chamber

ALARMS



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Graph of section CL4112_Alarms_Chamber

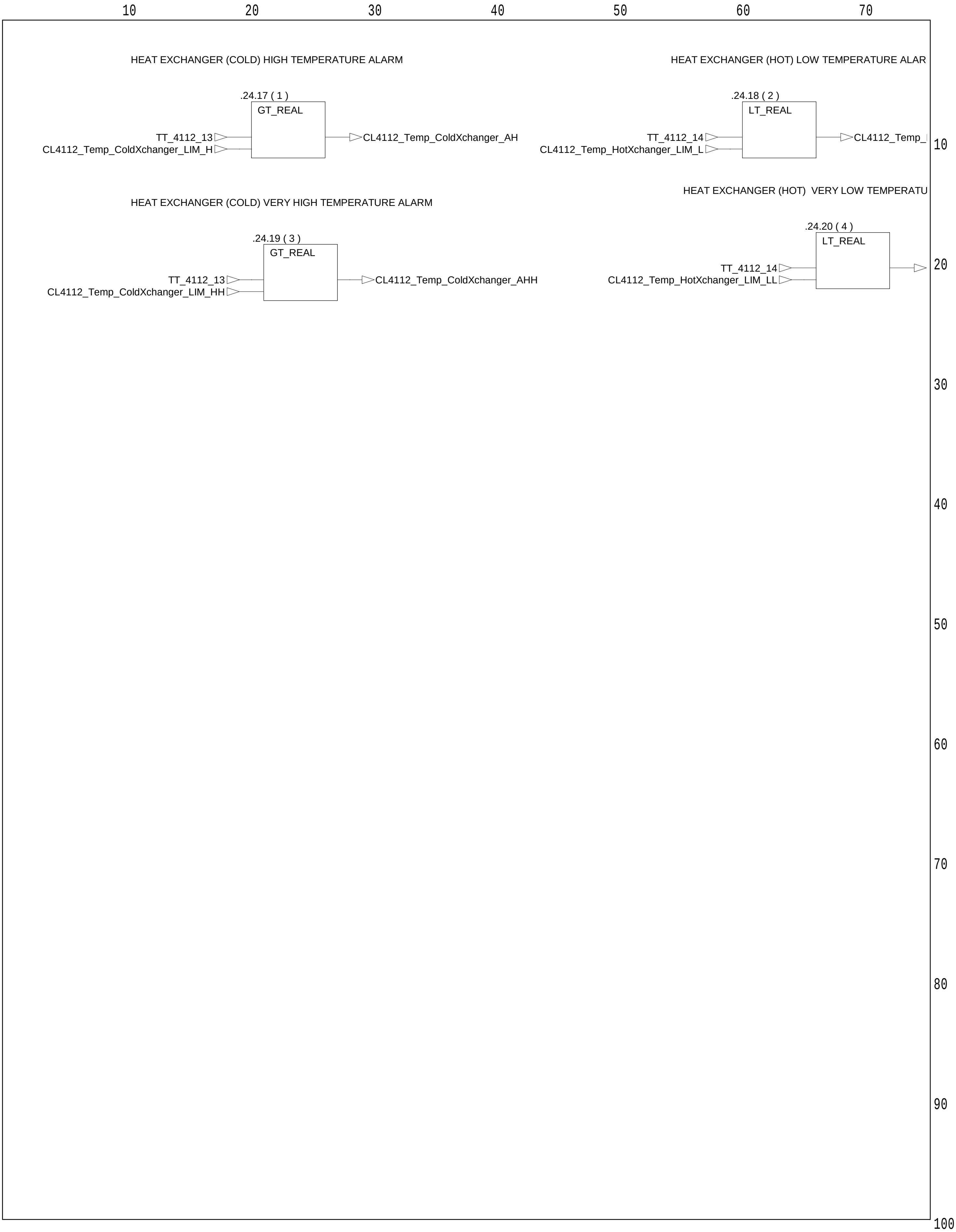
230 240 250 260 270 280 290 300

-- ALARMS --
----

10 20 30 40 50 60 70 80 90 100

< page 90

Graph of section CL4112_ALARM_HEATEXCHANGER



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Graph of section CL4112_ALARM_HEATEXCHANGER

80 90 100 110 120 130 140 150

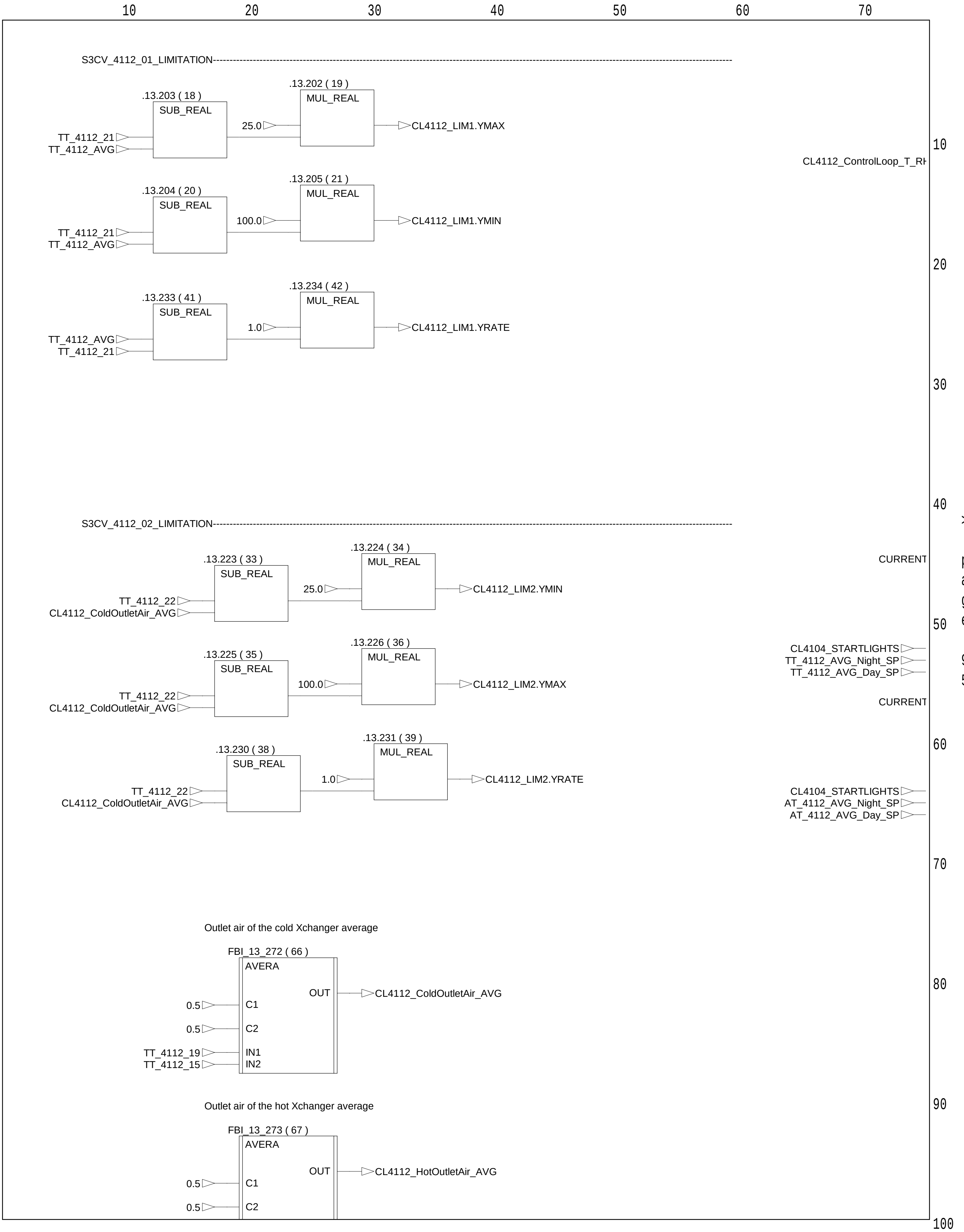
HotXchanger_AL

CL4112_Temp_HotXchanger_ALL

10 20 30 40 50 60 70 80 90 100

< page 92

Graph of section CL4112_Chamber_T_RH



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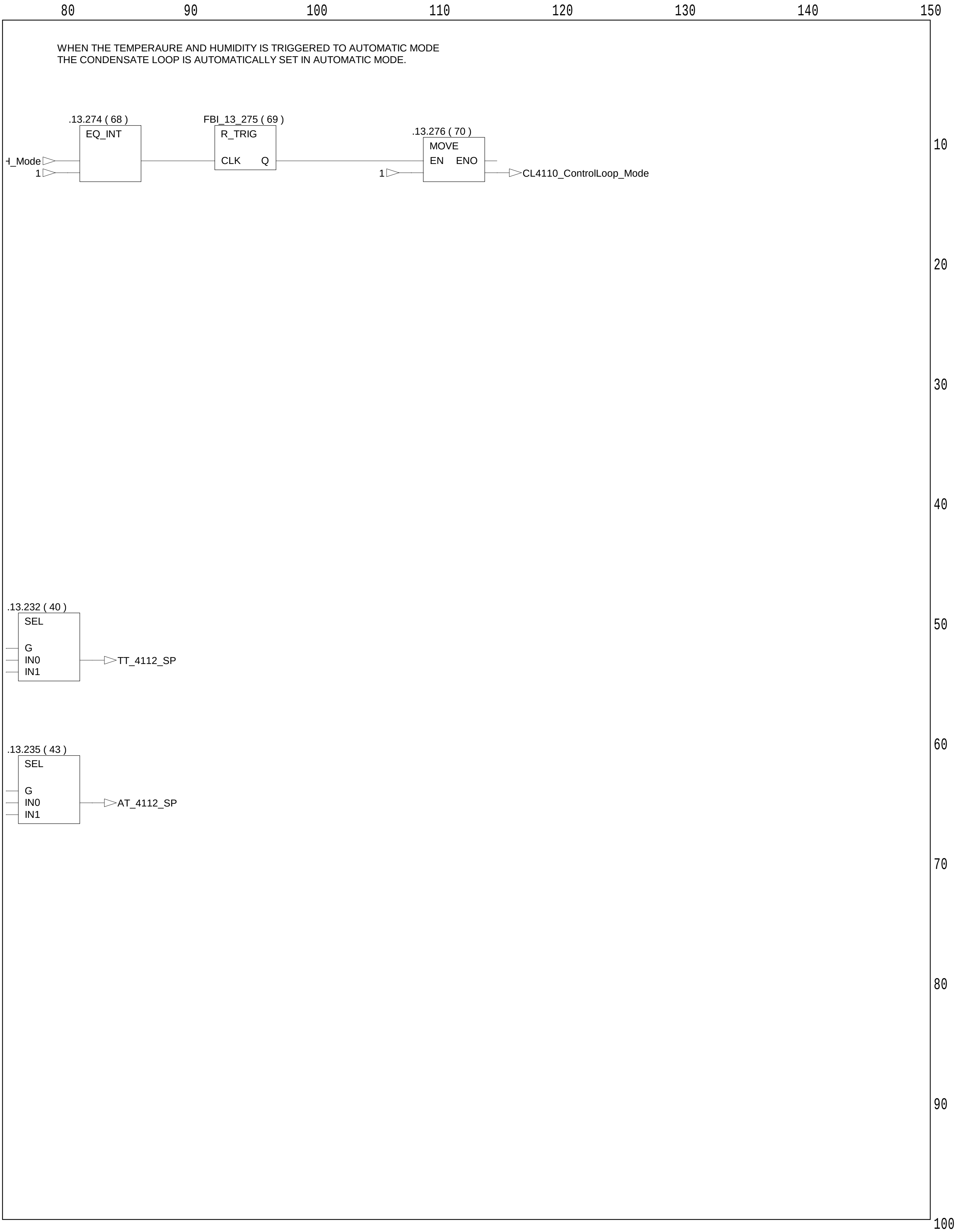
Graph of section CL4112_Chamber_T_RH



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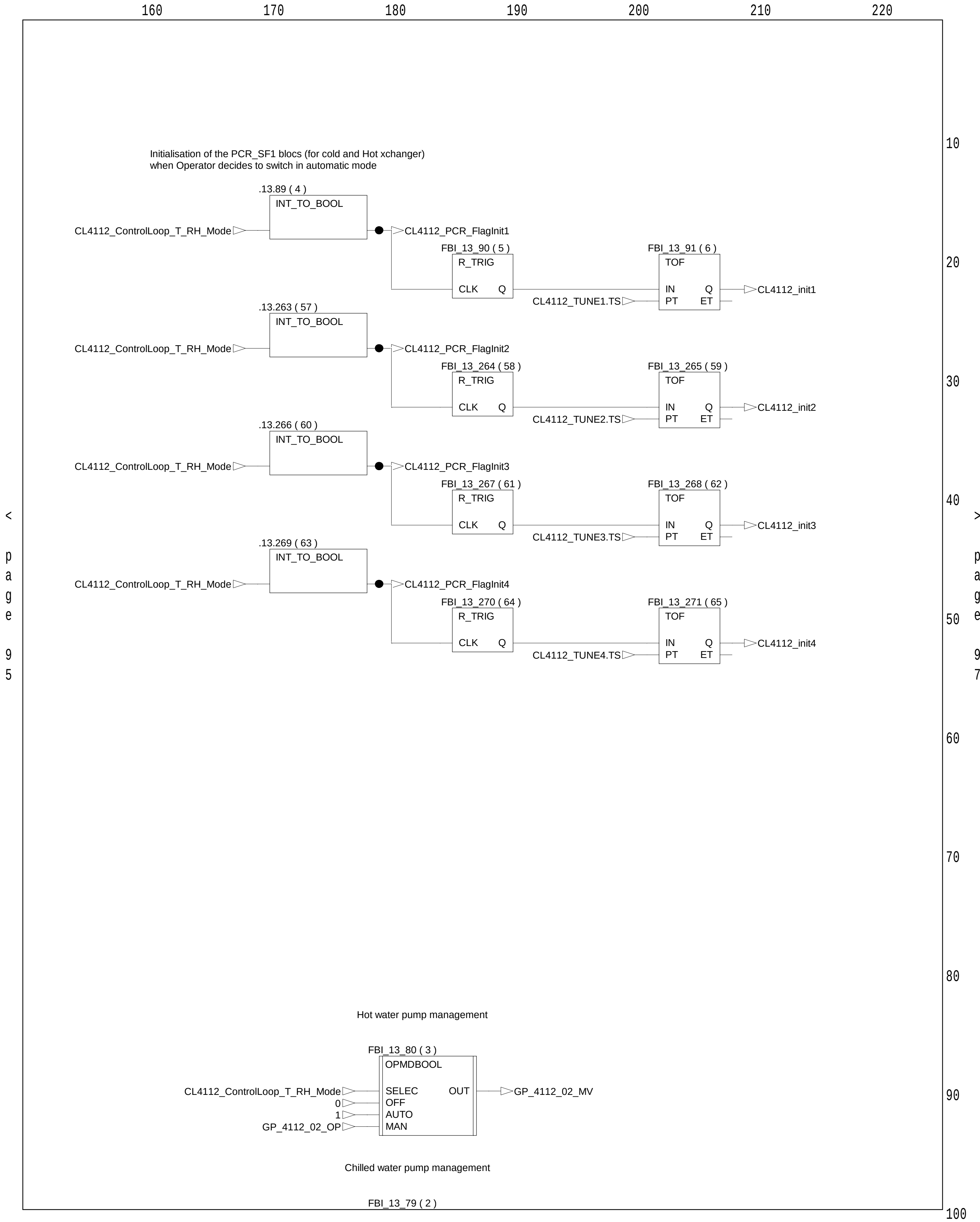
Graph of section CL4112_Chamber_T_RH



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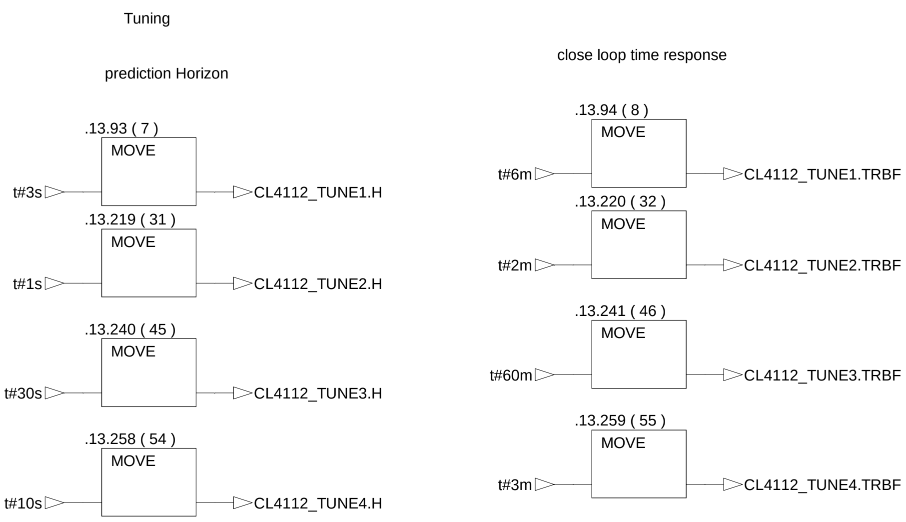
Graph of section CL4112_Chamber_T_RH



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Graph of section CL4112_Chamber_T_RH

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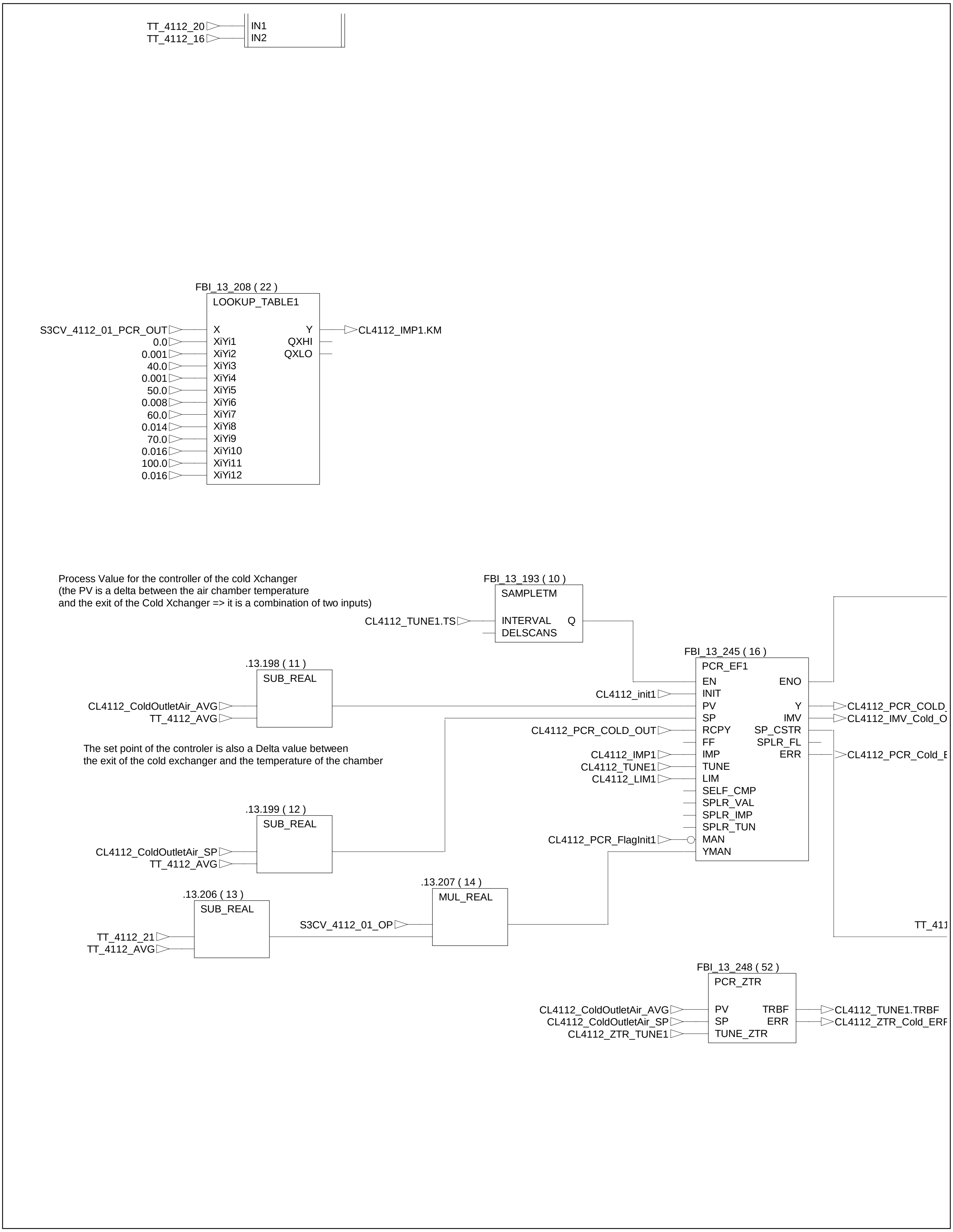

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Graph of section CL4112_Chamber_T_RH

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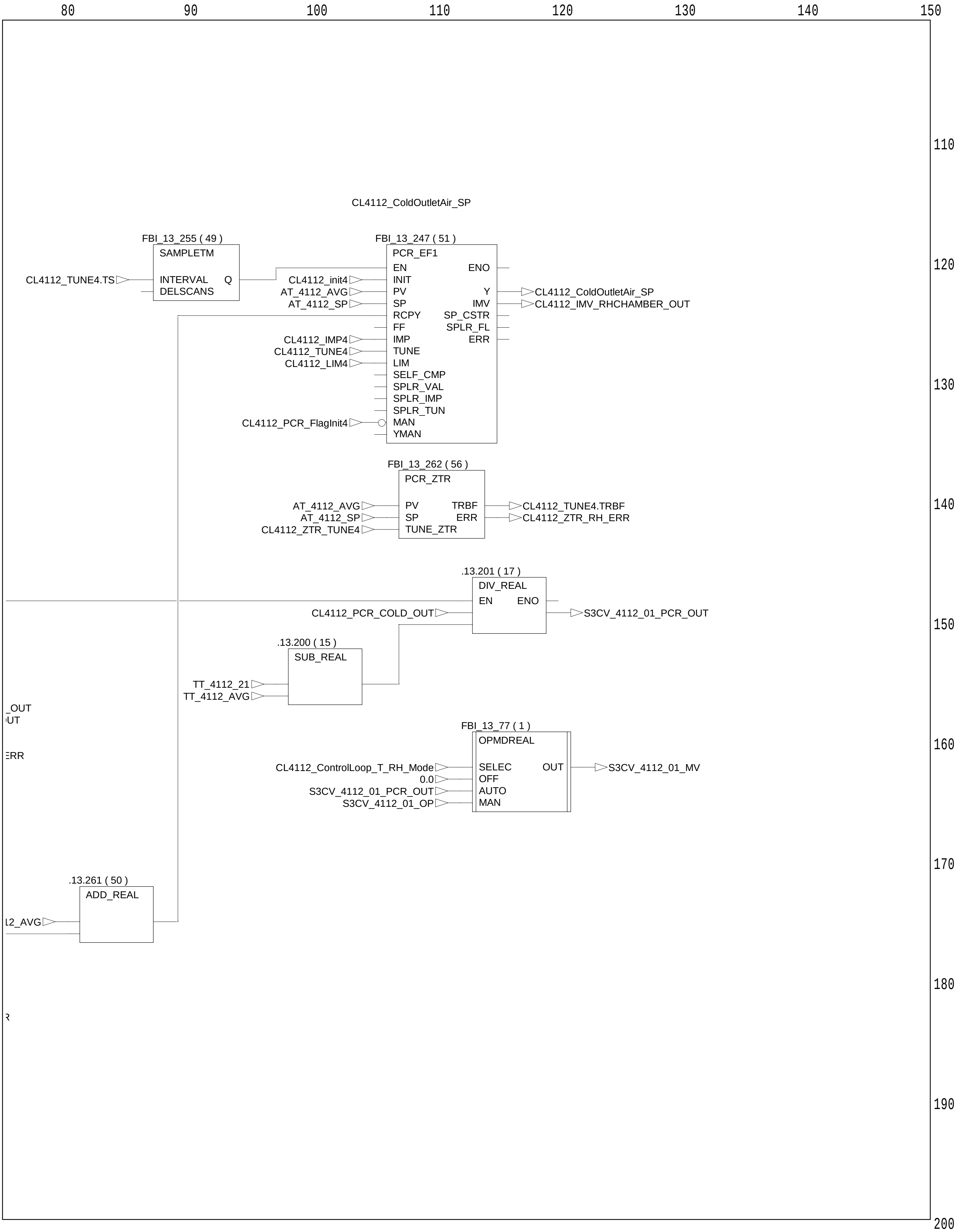

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Graph of section CL4112_Chamber_T_RH

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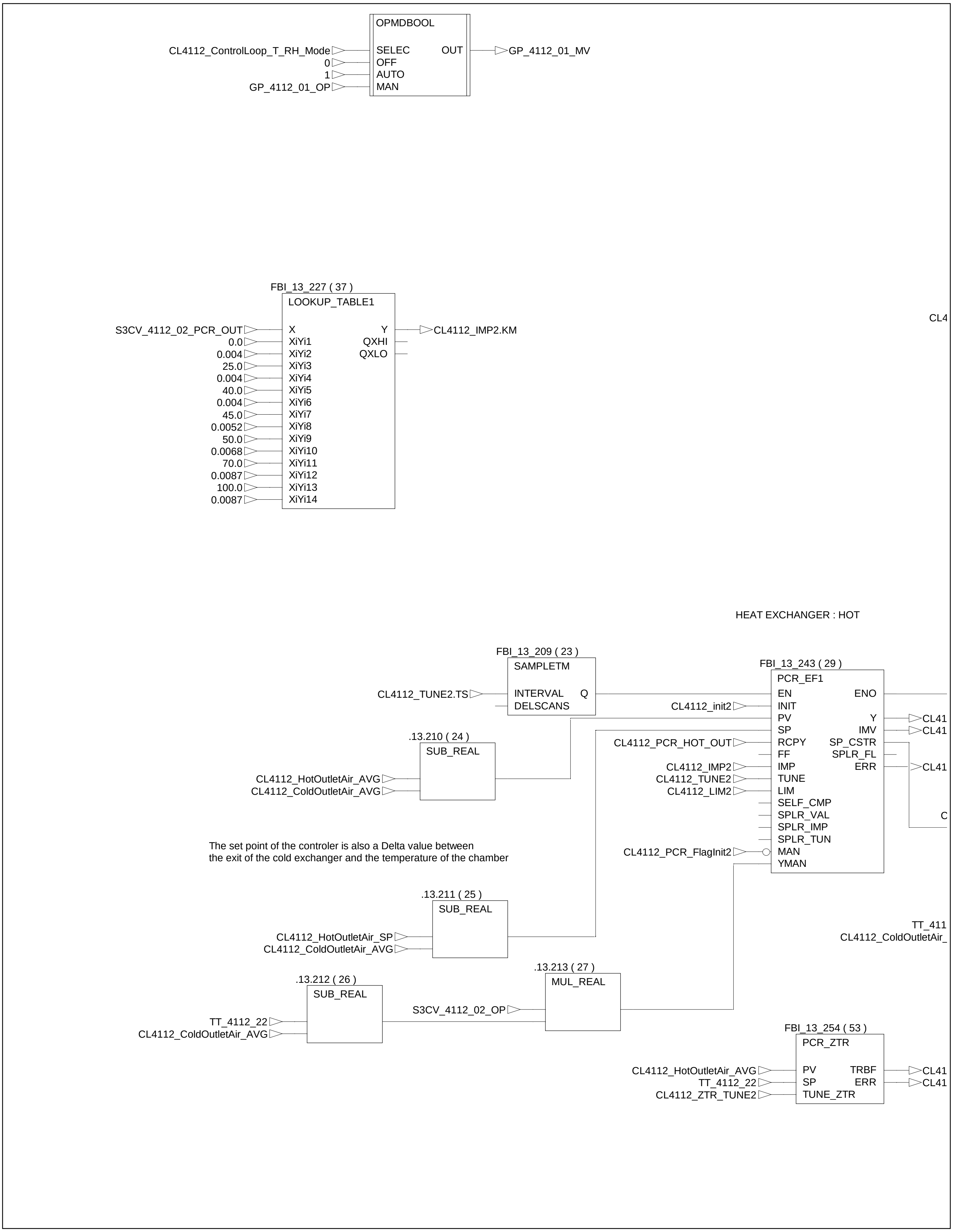

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Graph of section CL4112_Chamber_T_RH

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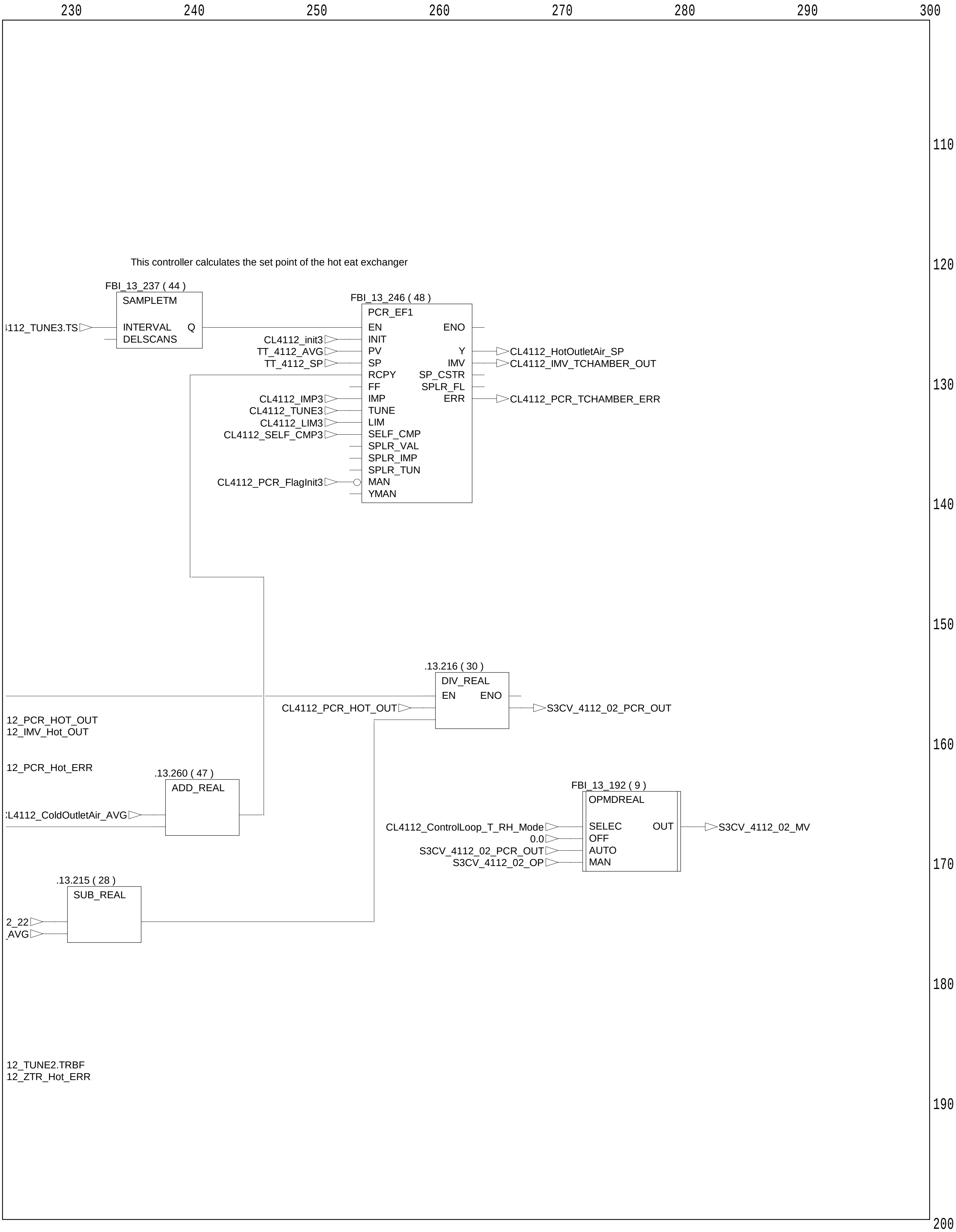

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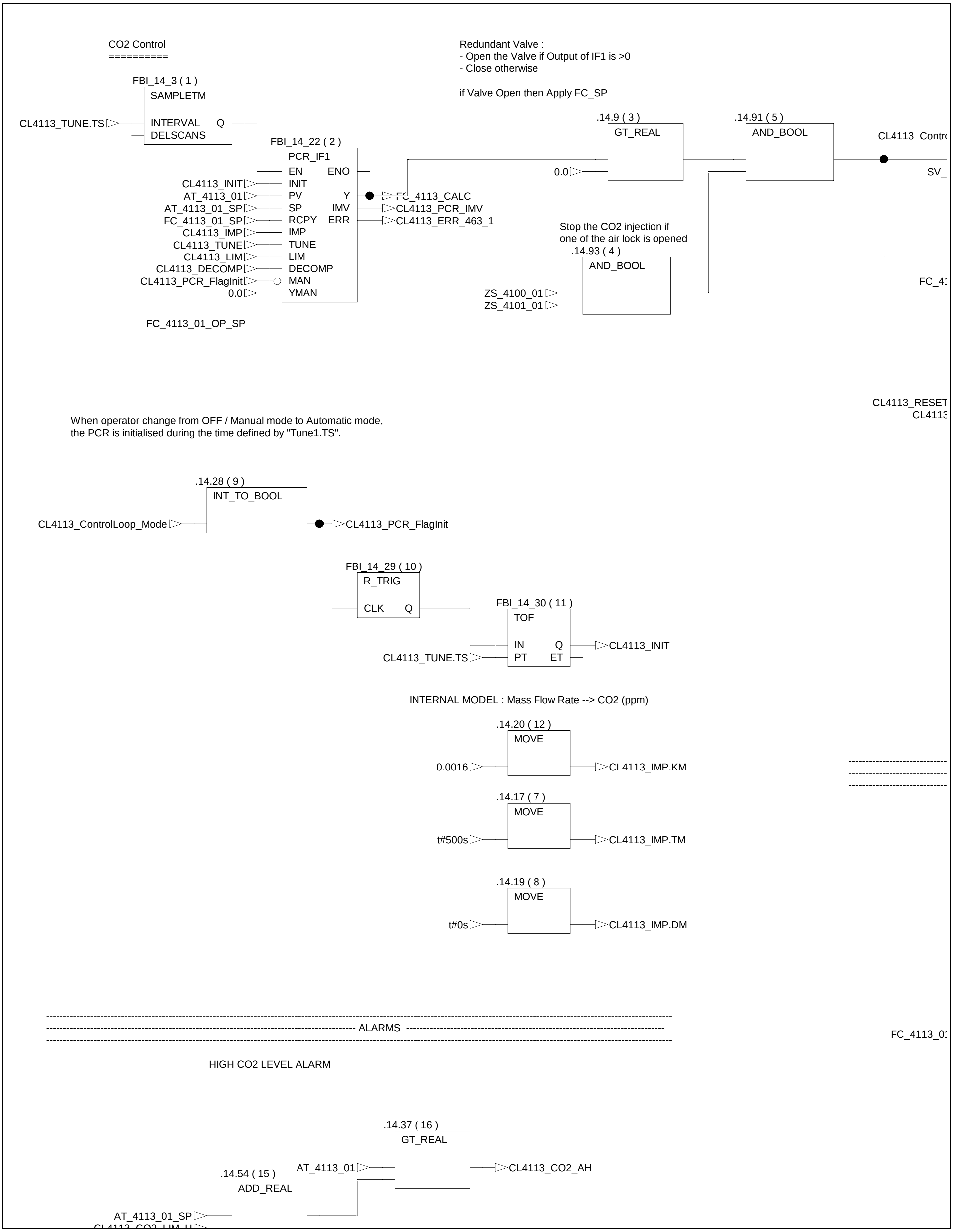
Graph of section CL4113_CO2



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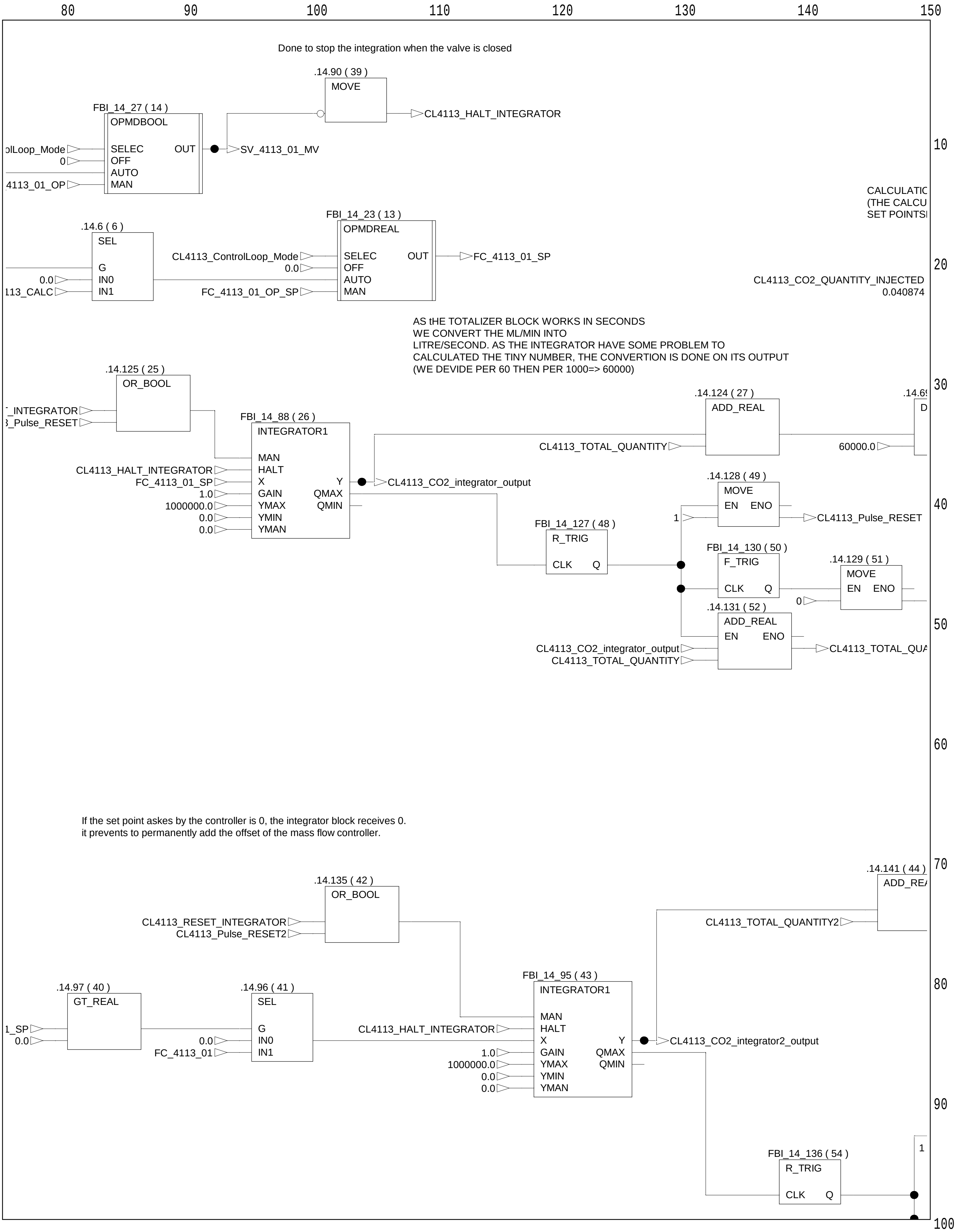
Graph of section CL4113_CO2



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> page 107

Graph of section CL4113_CO2

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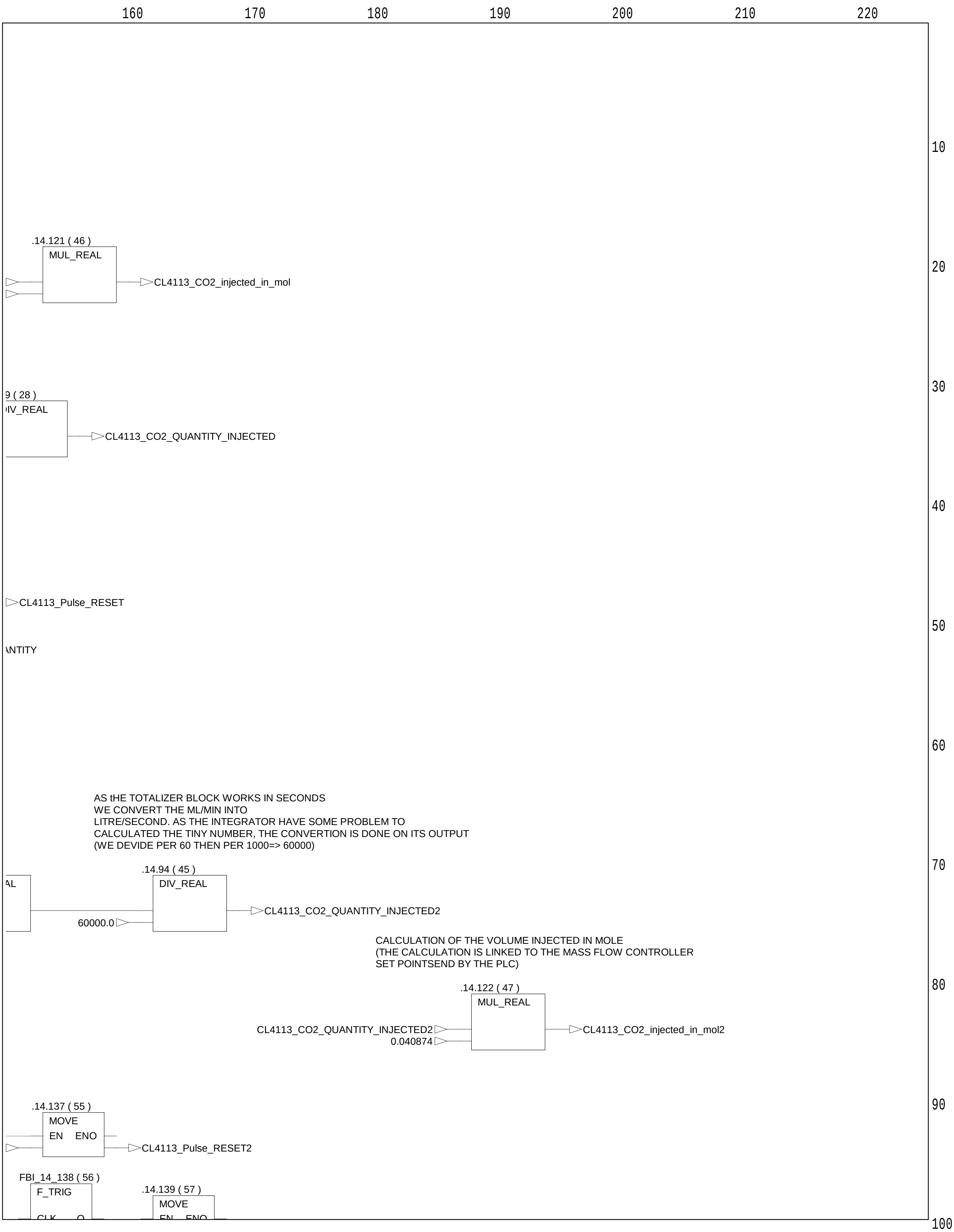

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Graph of section CL4113_CO2

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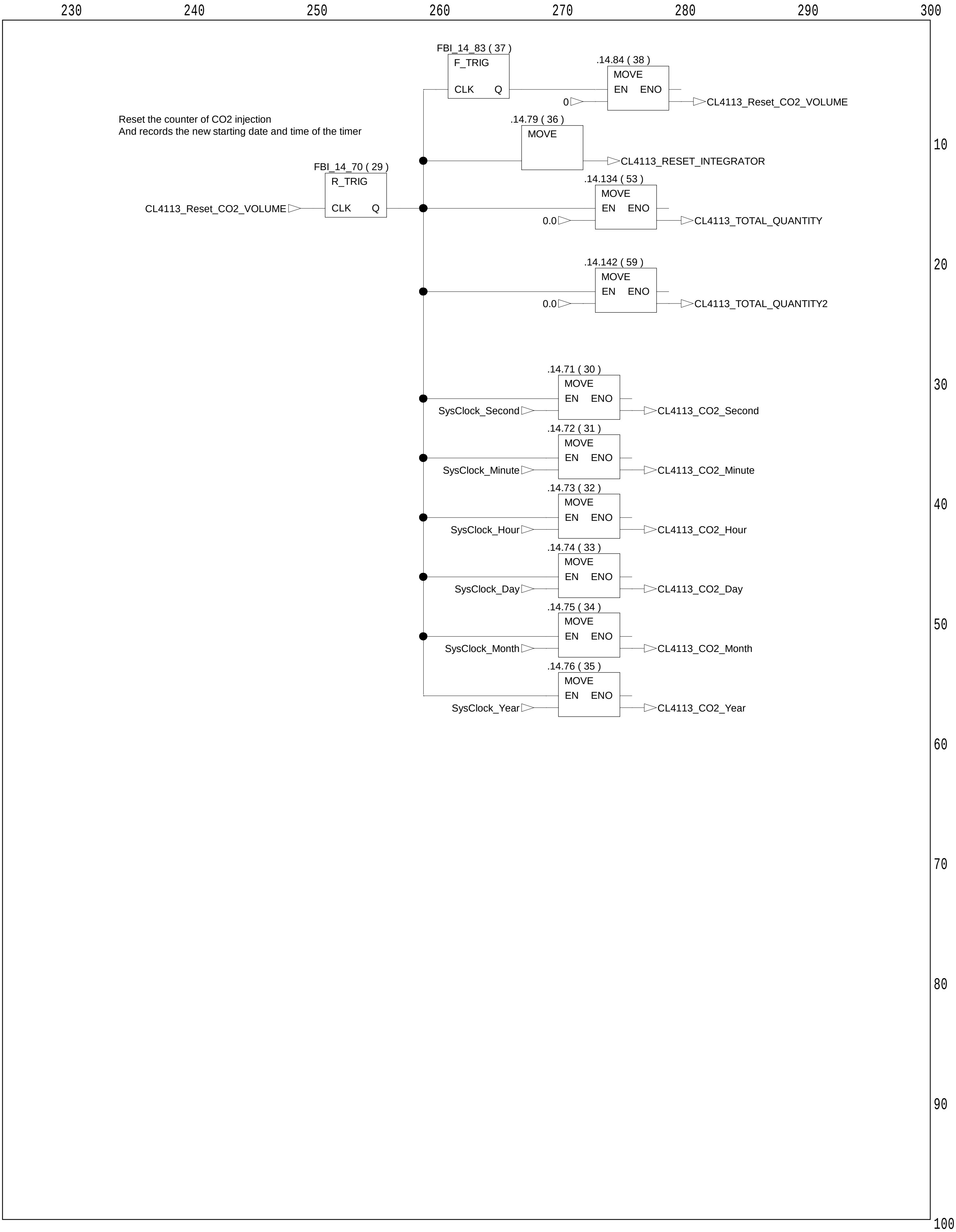

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Graph of section CL4113_CO2

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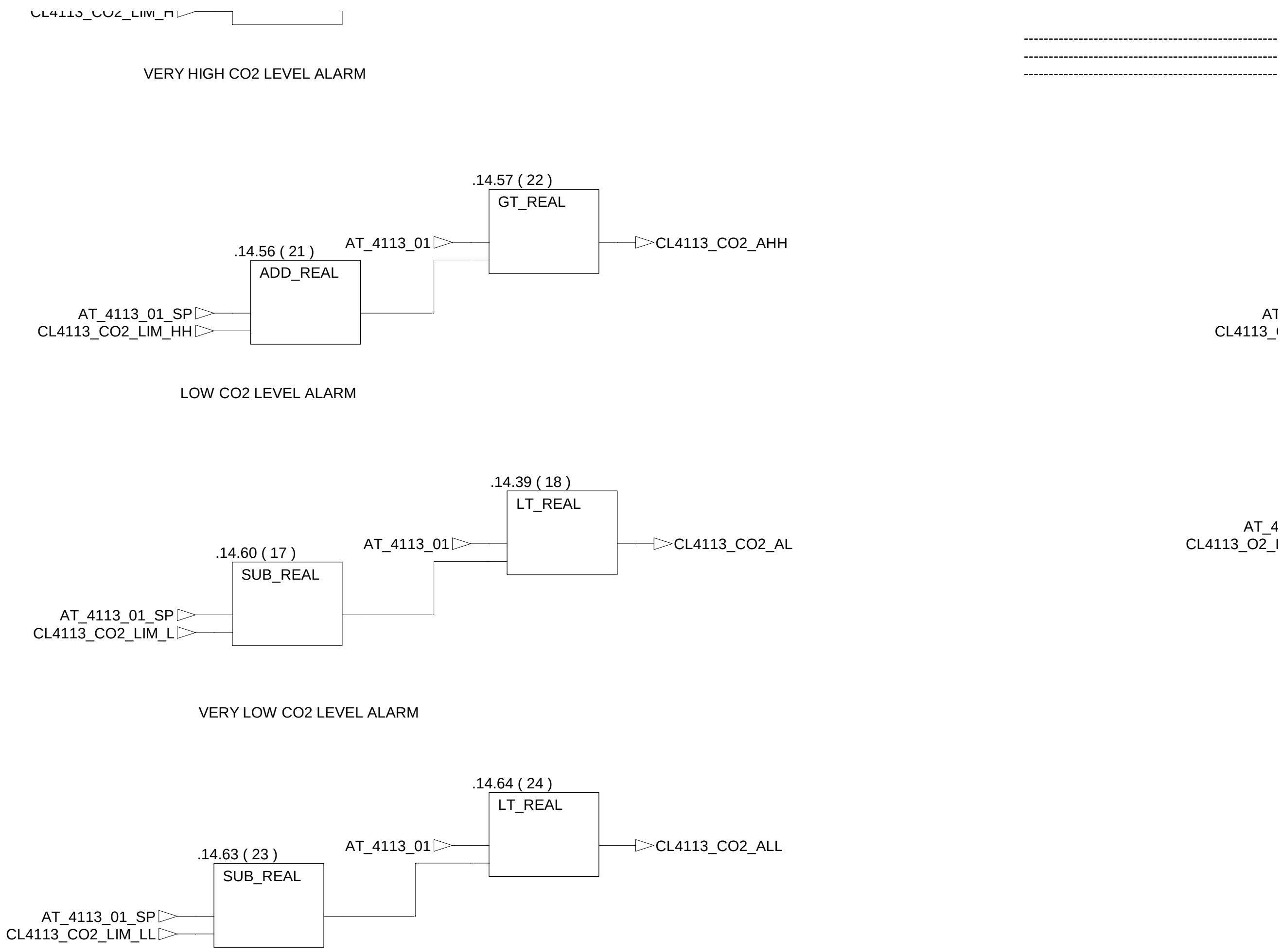

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Graph of section CL4113_CO2

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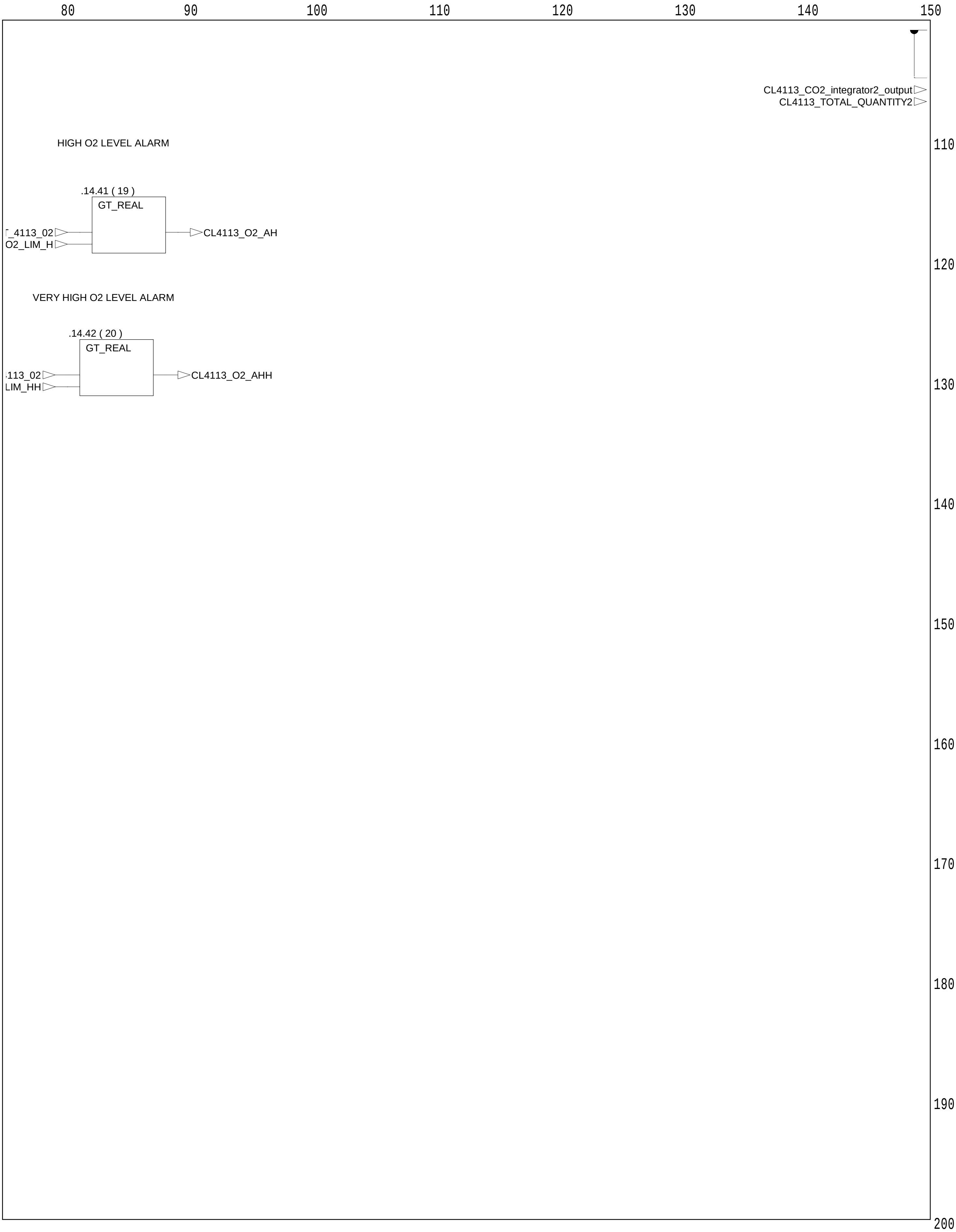

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Graph of section CL4113_CO2

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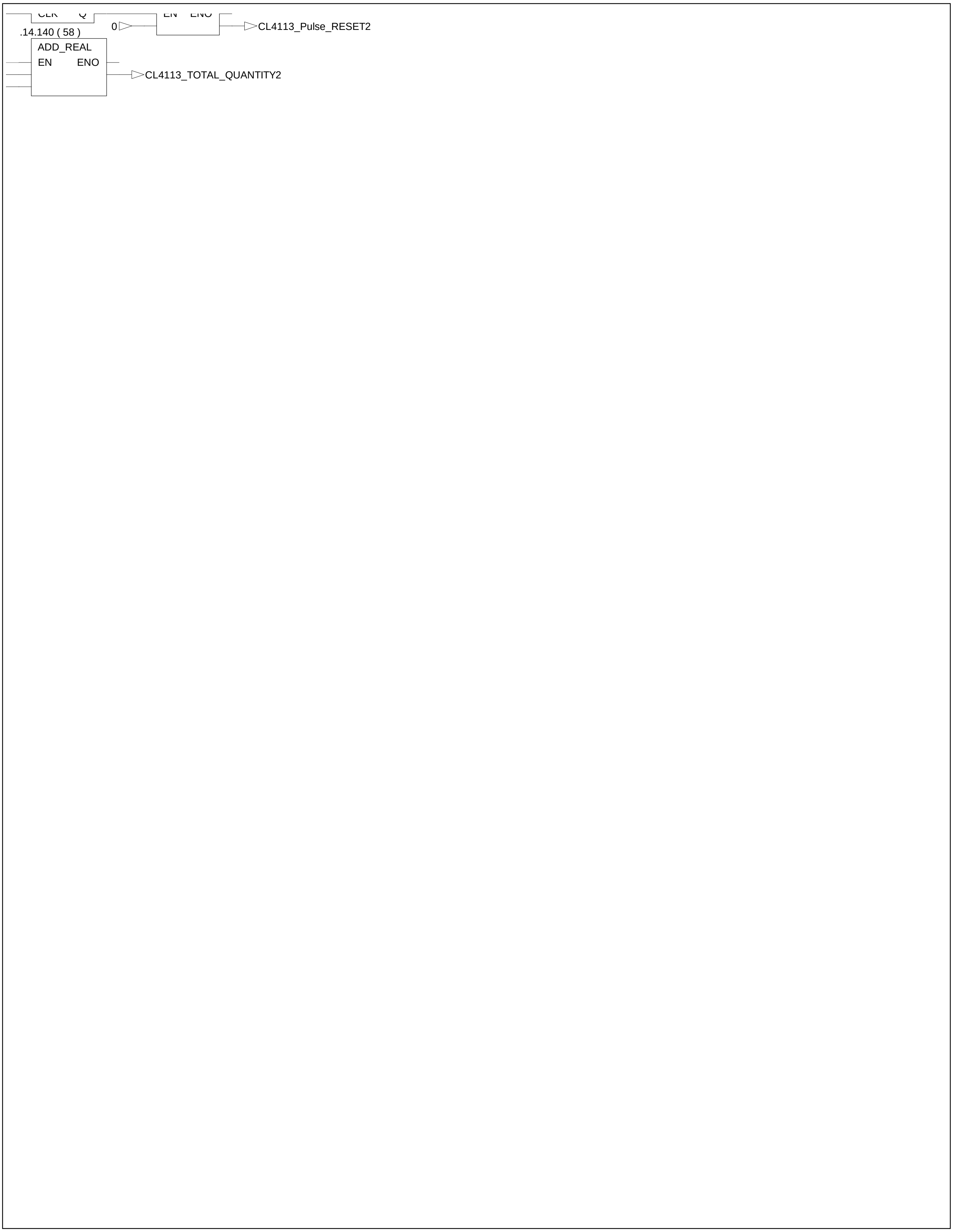

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> page 109

Graph of section CL4113_CO2

< page 105

230 240 250 260 270 280 290 300

< page 108

110 120 130 140 150 160 170 180 190 200

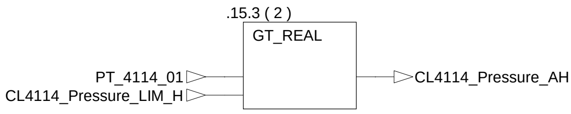
Graph of section CL4114_Pressure

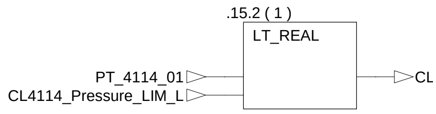
No Control
========

DISPLAY TO BE DONE AT HMI LEVEL

-- ALARMS --

HIGH PRESSURE ALARM (in the chamber)





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page
111

Graph of section CL4114_Pressure

80 90 100 110 120 130 140 150

.4114_Pressure_AL

10 20 30 40 50 60 70 80 90 100

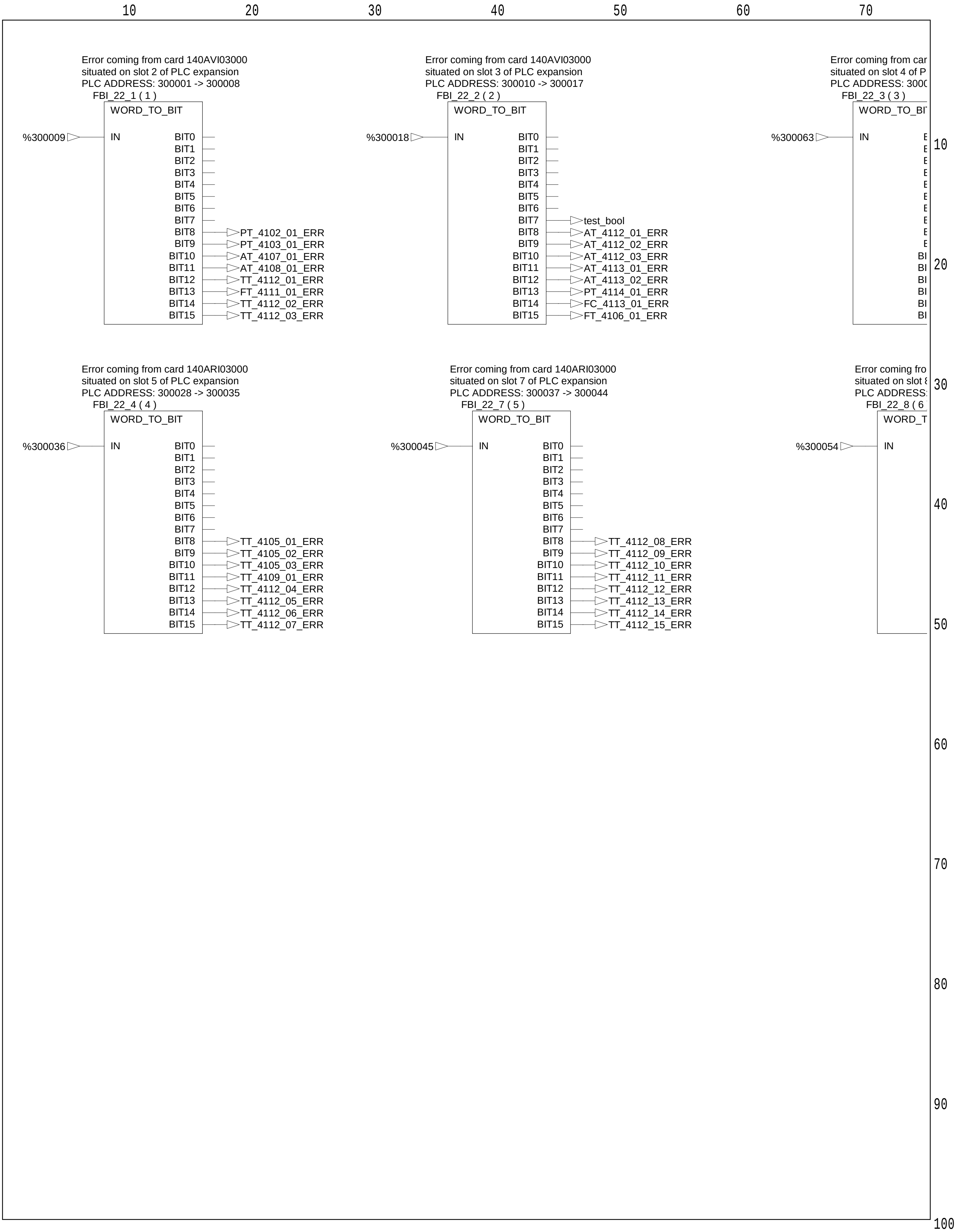
< page 110

Graph of section CL4115_Ambient_Parameters

No Control
========

DISPLAY TO BE DONE AT HMI LEVEL

Graph of section ERR_AI



Graph of section ERR_AI

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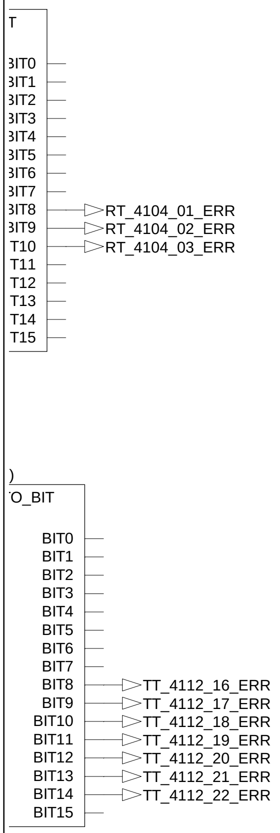
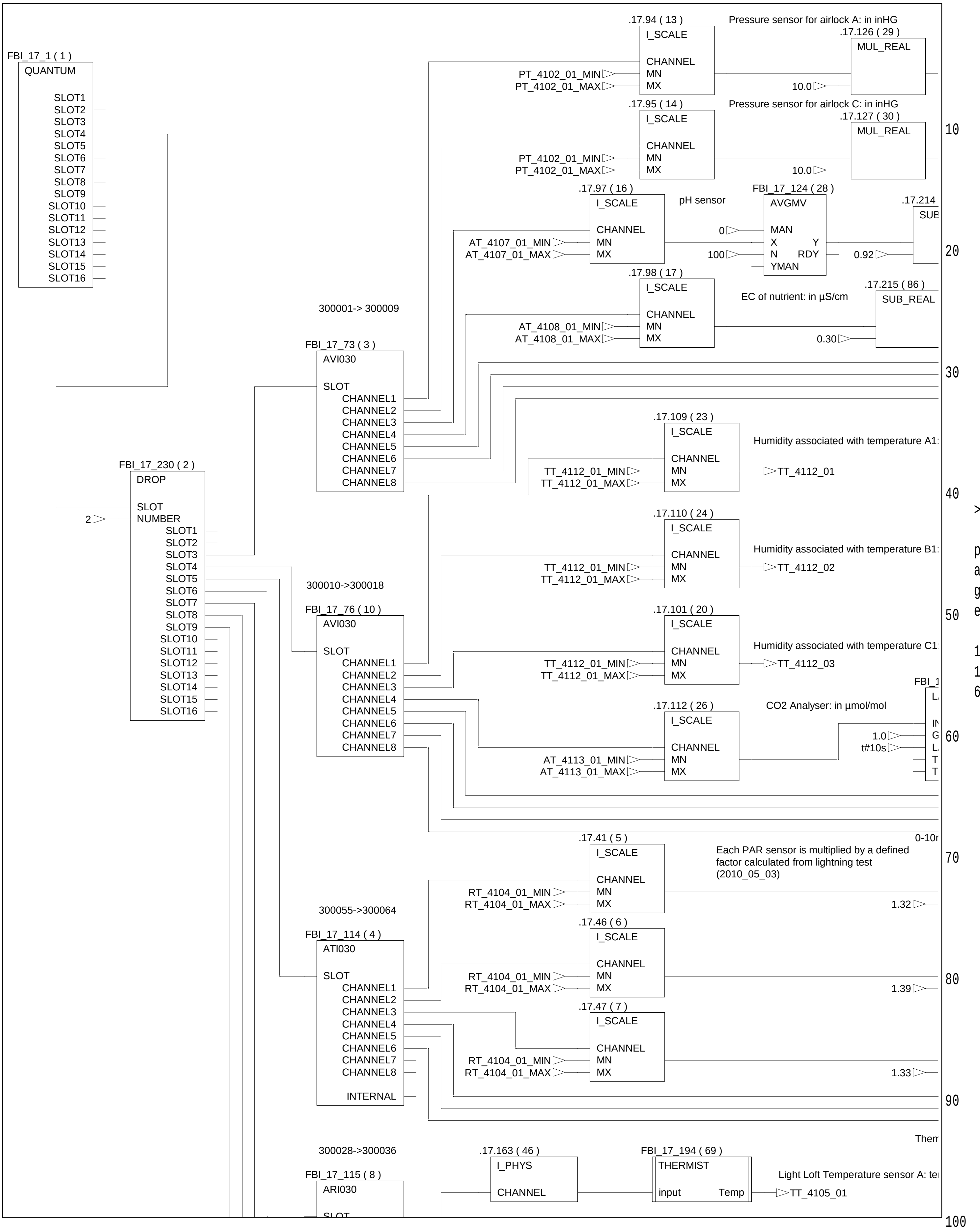


10 20 30 40 50 60 70 80 90 100

< page 113

Graph of section Inputs



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Graph of section Inputs

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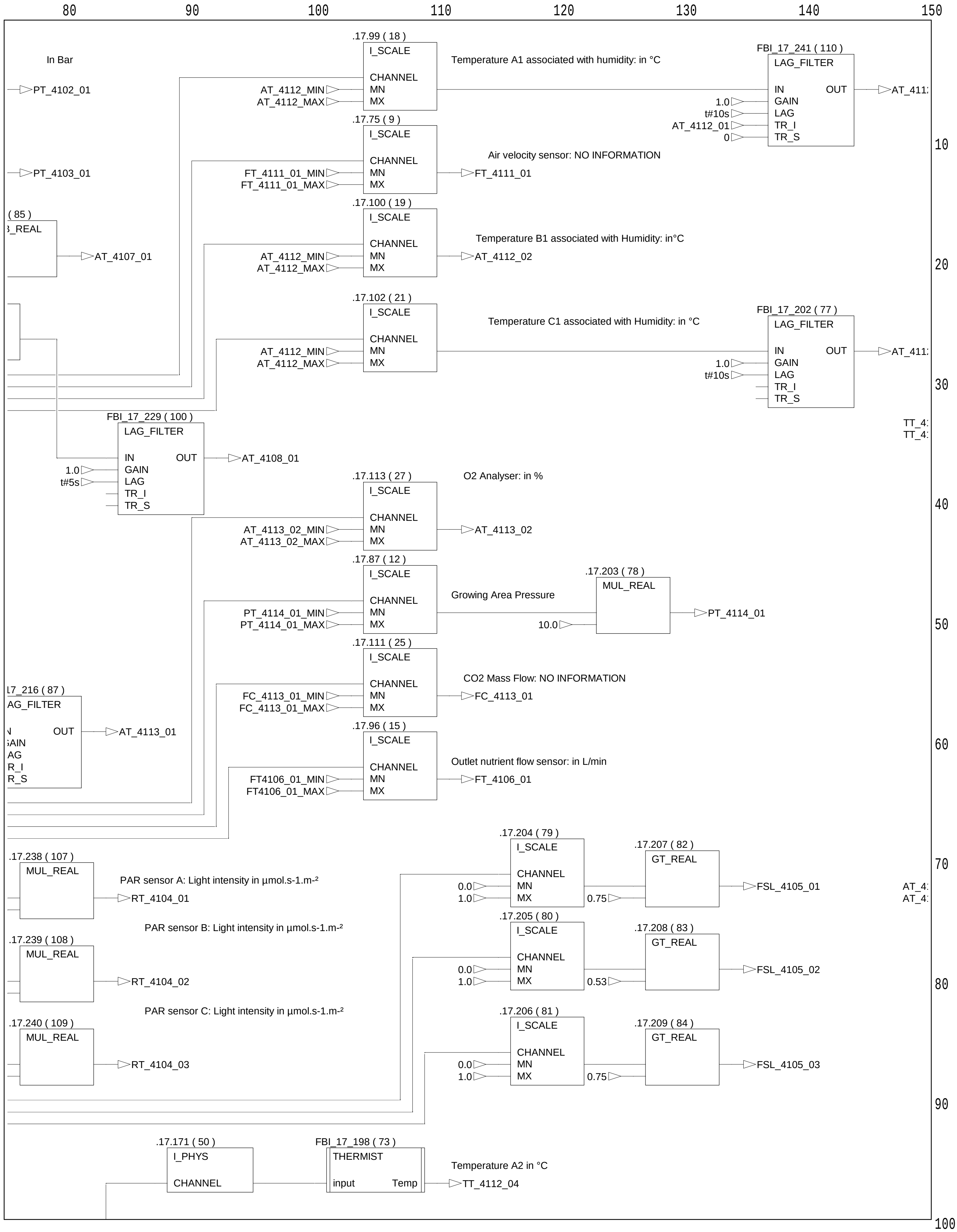

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Graph of section Inputs

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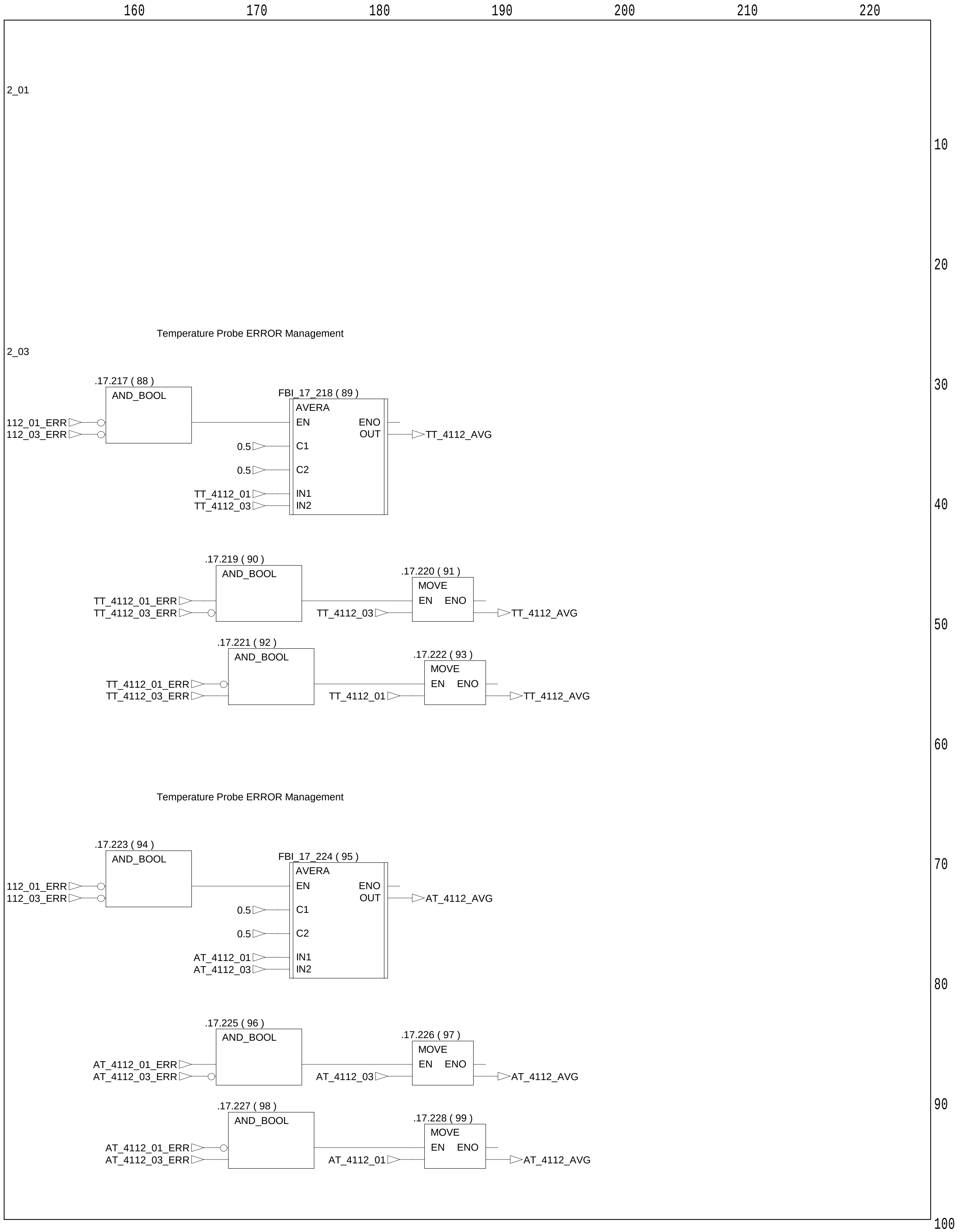

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Graph of section Inputs

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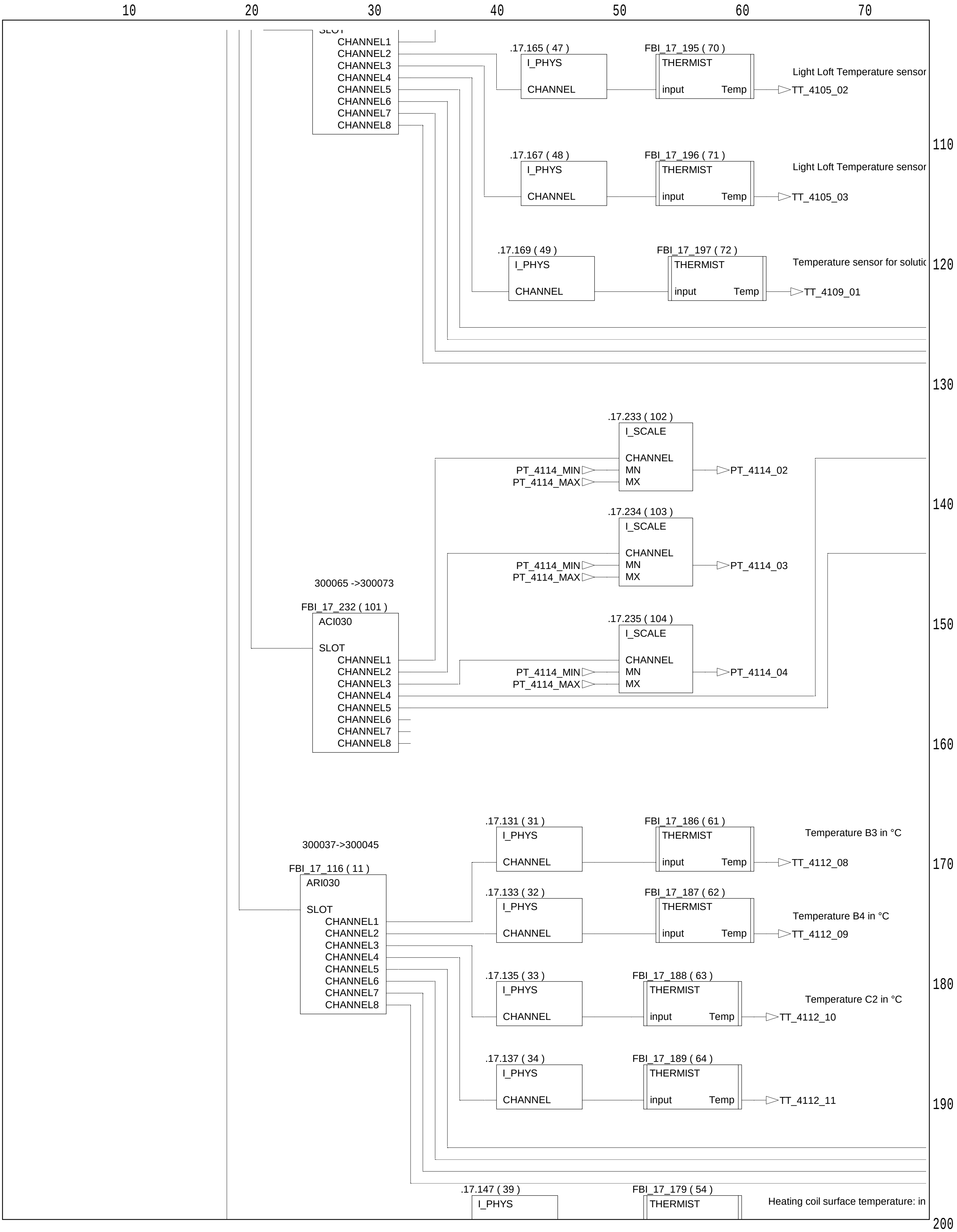

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Graph of section Inputs

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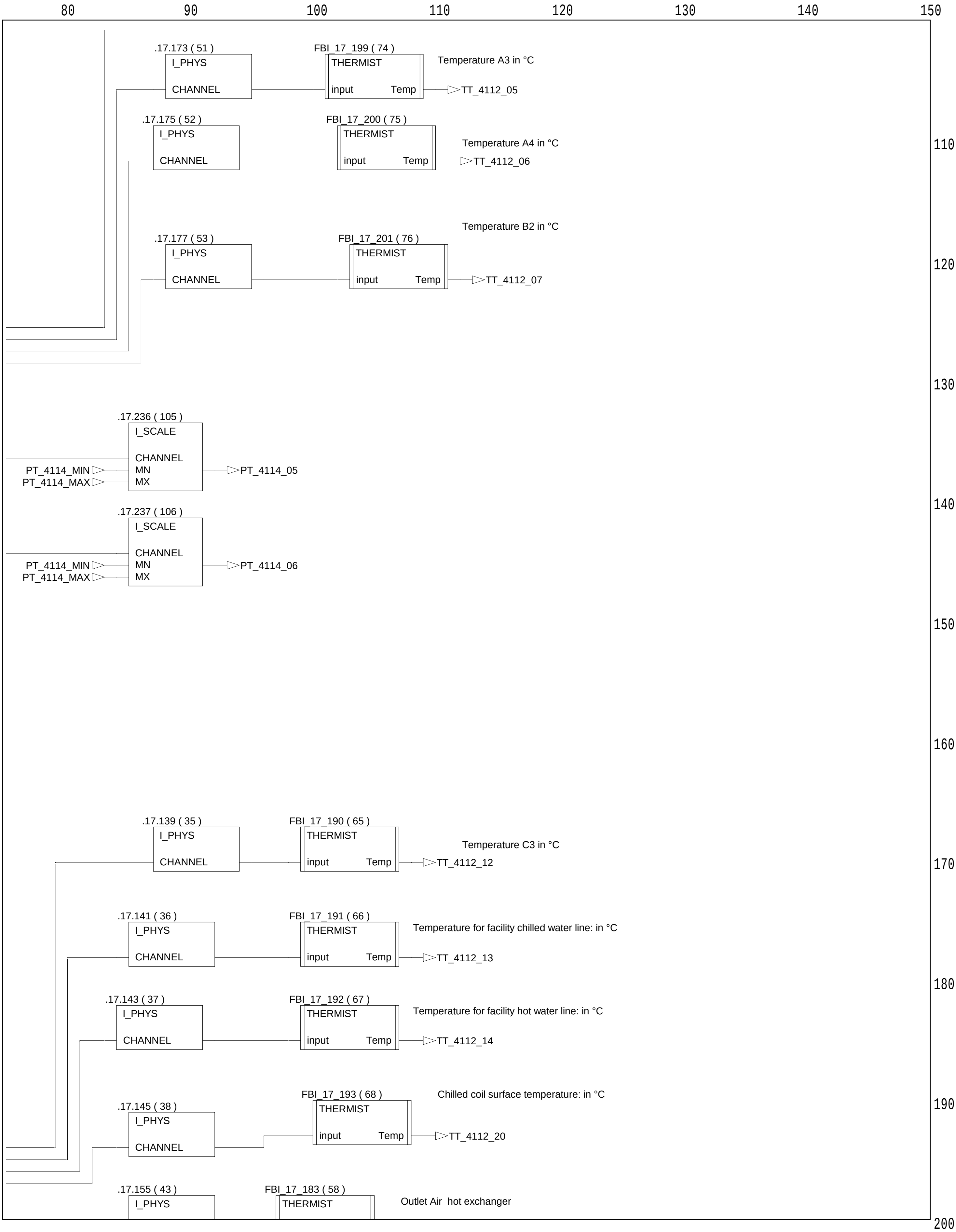

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Graph of section Inputs

< page 117

160 170 180 190 200 210 220

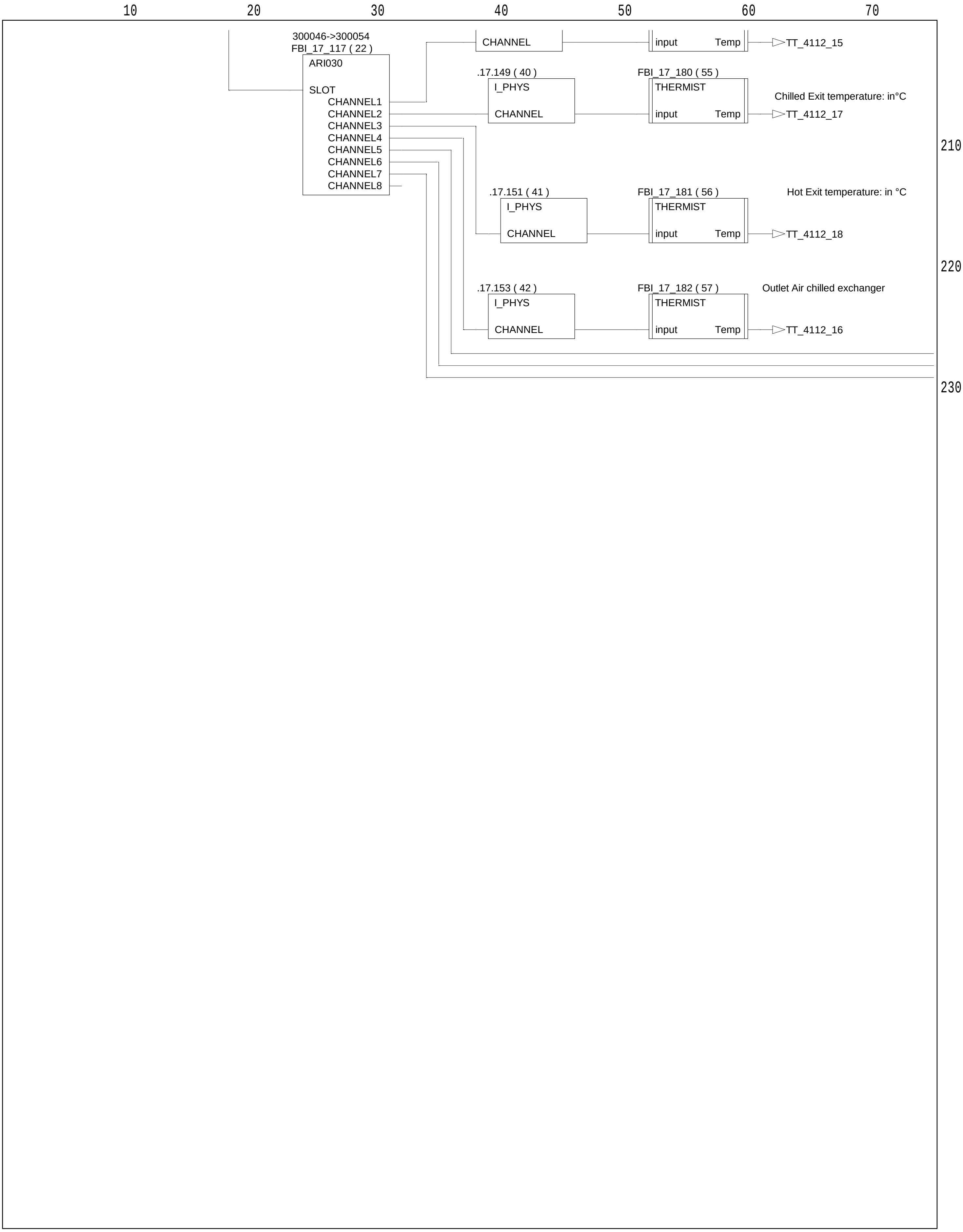
110
120
130
140
150
160
170
180
190
200

< page 119

> page 123

Graph of section Inputs

< page 118



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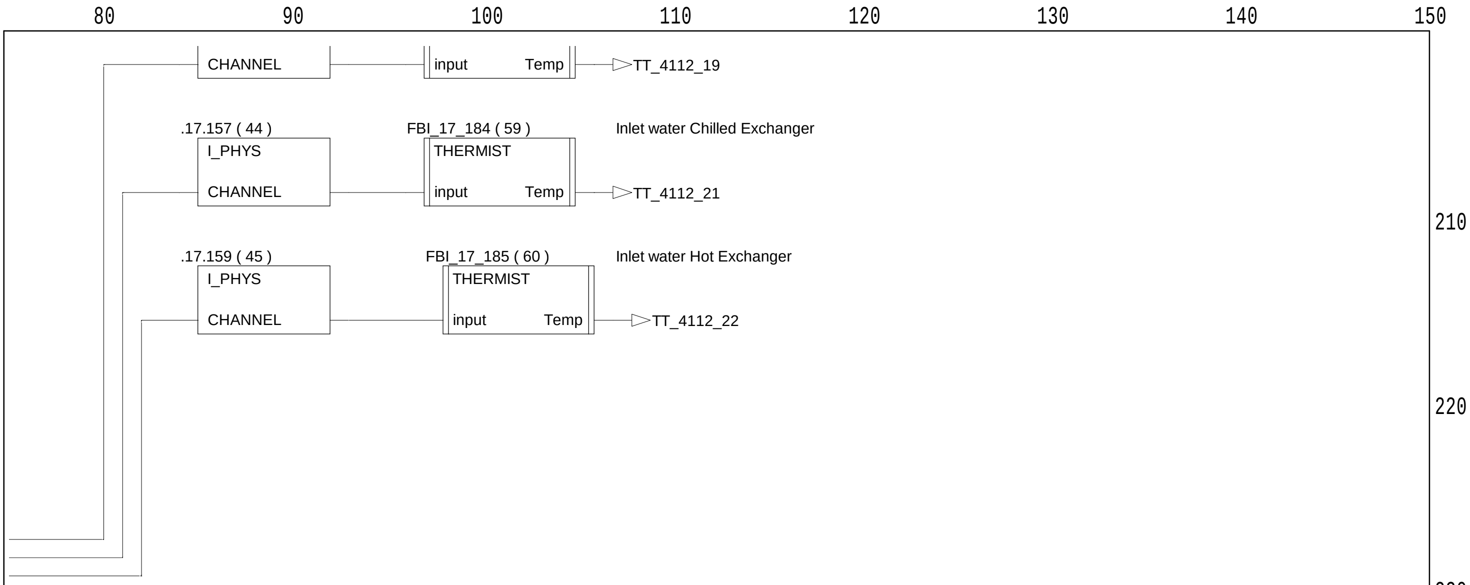
Graph of section Inputs

< page 119



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> page 123

Graph of section Inputs

< page 120

160 170 180 190 200 210 220

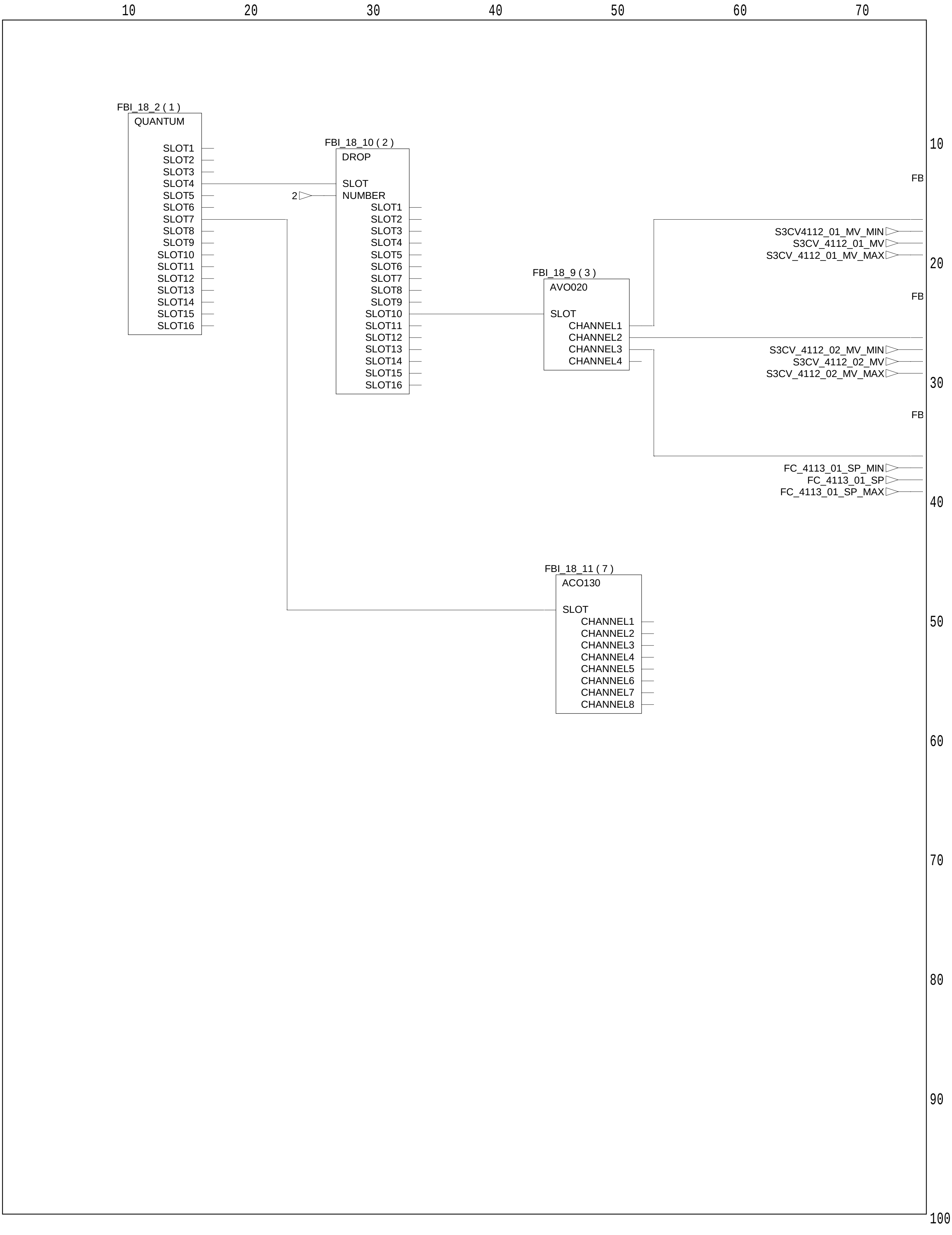
210

220

230

< page 122

Graph of section Outputs



Graph of section Outputs

0 - 10 V

I_18_6 (4)
O_SCALE
CHANNEL
MN
X
MX

Chilled water Control Valve: NO SPECIFICATION

I_18_7 (5)
O_SCALE
CHANNEL
MN
X
MX

Hot water Control Valve: NO INFORMATION

I_18_8 (6)
O_SCALE
CHANNEL
MN
X
MX

CO2 Mass Flow set point: NO INFORMATION

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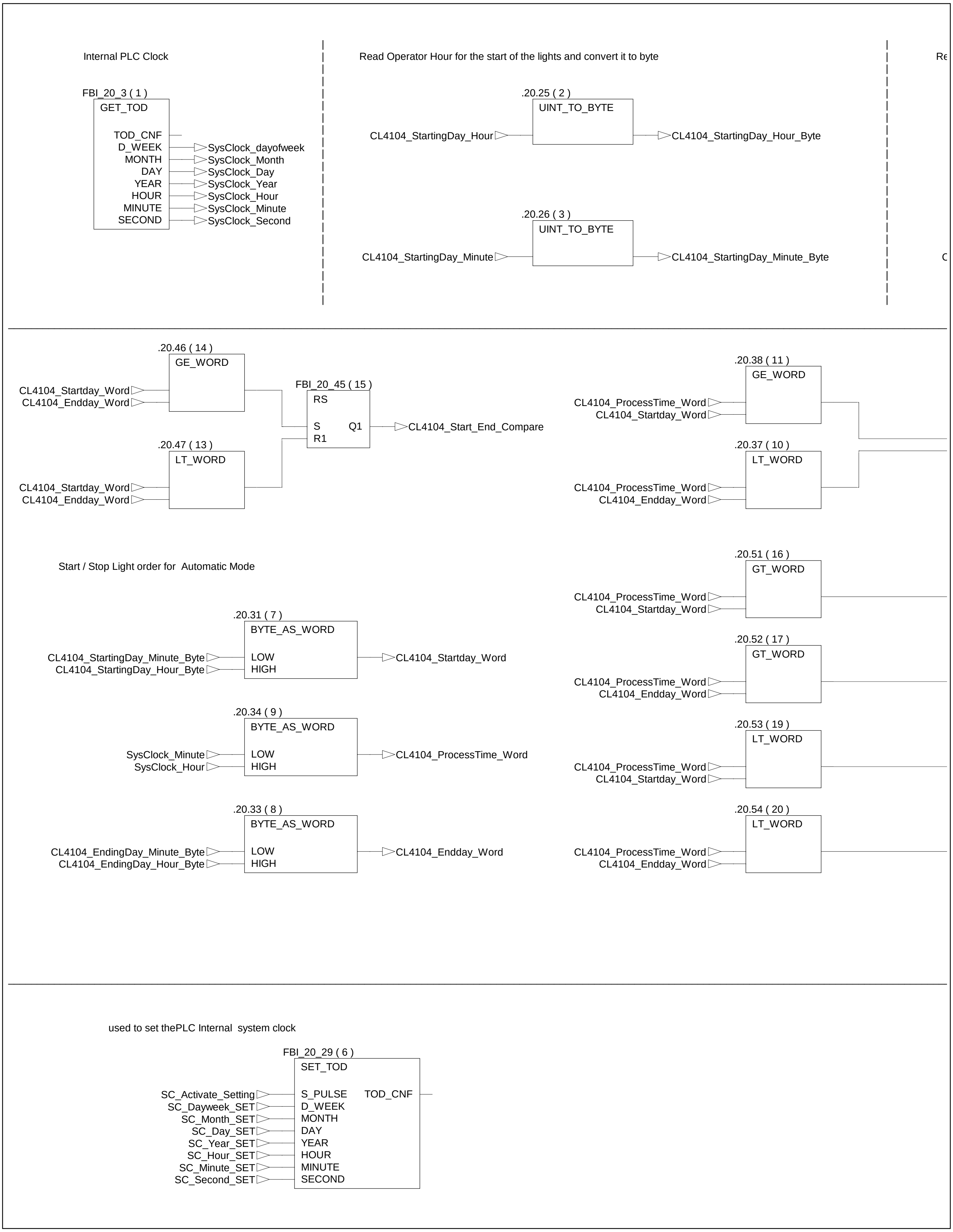
Graph of section System_Clock



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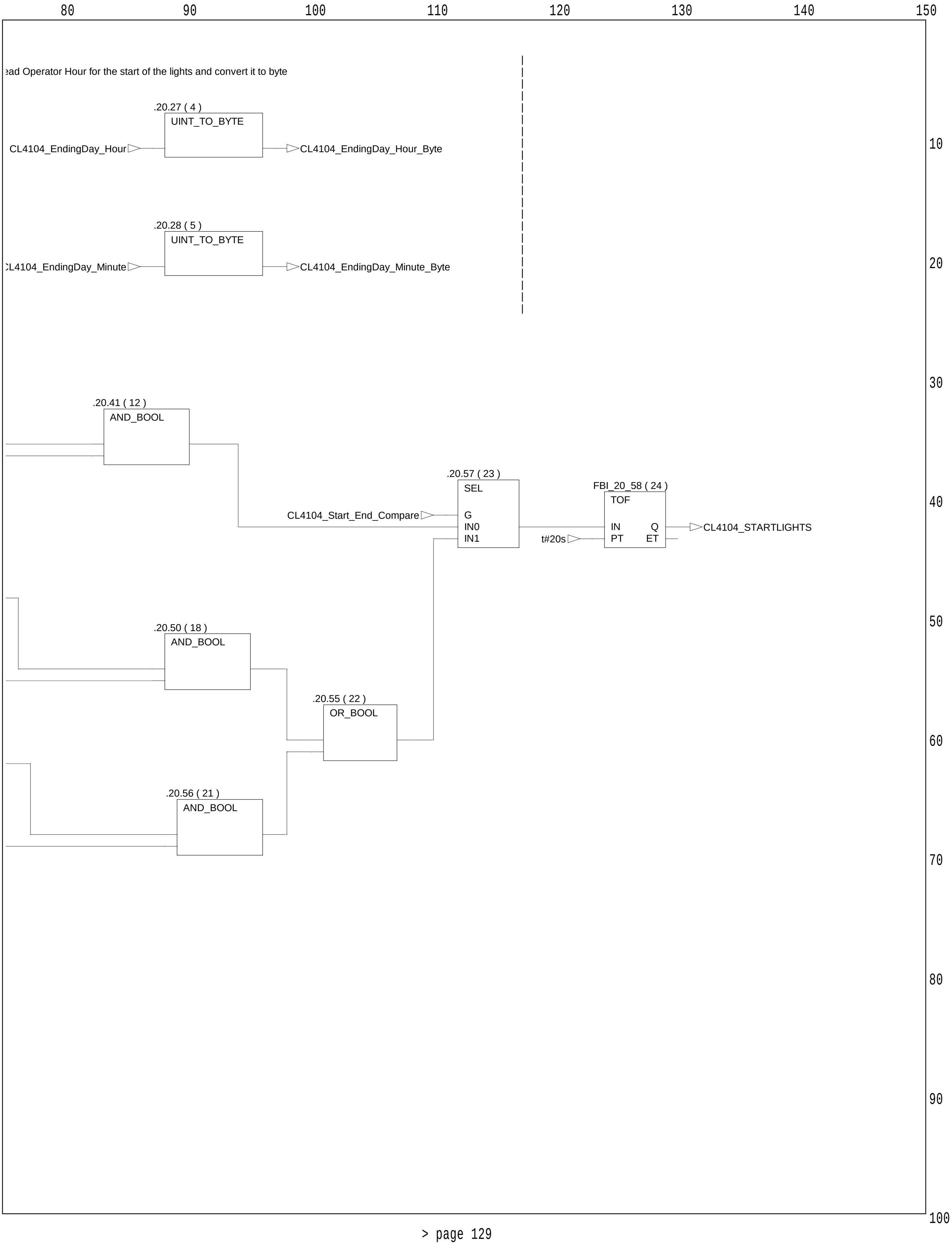
Graph of section System_Clock



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> page 128

> page 129

Graph of section System_Clock

160 170 180 190 200 210 220

10
20
30
40
50
60
70
80
90
100

< page 127

> page 130

Graph of section System_Clock

< page 127

Use to count the opening time of the PH and EC valves

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Graph of section System_Clock

< page 128

80 90 100 110 120 130 140 150

110
120
130
140
150
160
170
180
190
200

< page 129

> page 131

Graph of section System_Clock

< page 129

160 170 180 190 200 210 220

110
120
130
140
150
160
170
180
190
200

< page 130

T A B L E O F C O N T E N T S

SECTION 3: HPC 1 HMI Design (NTE Document ref. : NTE-HPCP2-RP-002, Issue 1.0), 46 pages

MELISSA HPC HMI DESIGN

FOR THE

MELISSA HPC1

APPROVAL LIST		
NAME	SIGNATURE	DATE
Prepared by: J.Carbonell		16/07/2009
Revised by: J.Duatis		17/07/2009
Approved by: E.Creus		17/07/09
Authorised by: J.Duatis		17/07/2009

DISTRIBUTION LIST		
NAME	POSITION	COMPANY
Olivier Gerbi		SHERPA
Christophe Bourg		SHERPA
Arnaud Fossen		MPP
Enrique Peiro		MPP
Raul Moyano		MPP

CHANGE RECORD			
AUTHOR	ISSUE	DATE	CHANGE
J.Carbonell	1.0	10/07/2009	First Version

CONTENTS

1. SCOPE

This document describes the design of the HPC1 HMI displays. The displays have been developed from Sherpa specifications as defined in [R1].

2. REFERENCE DOCUMENTS

2.1 APPLICABLE DOCUMENTS

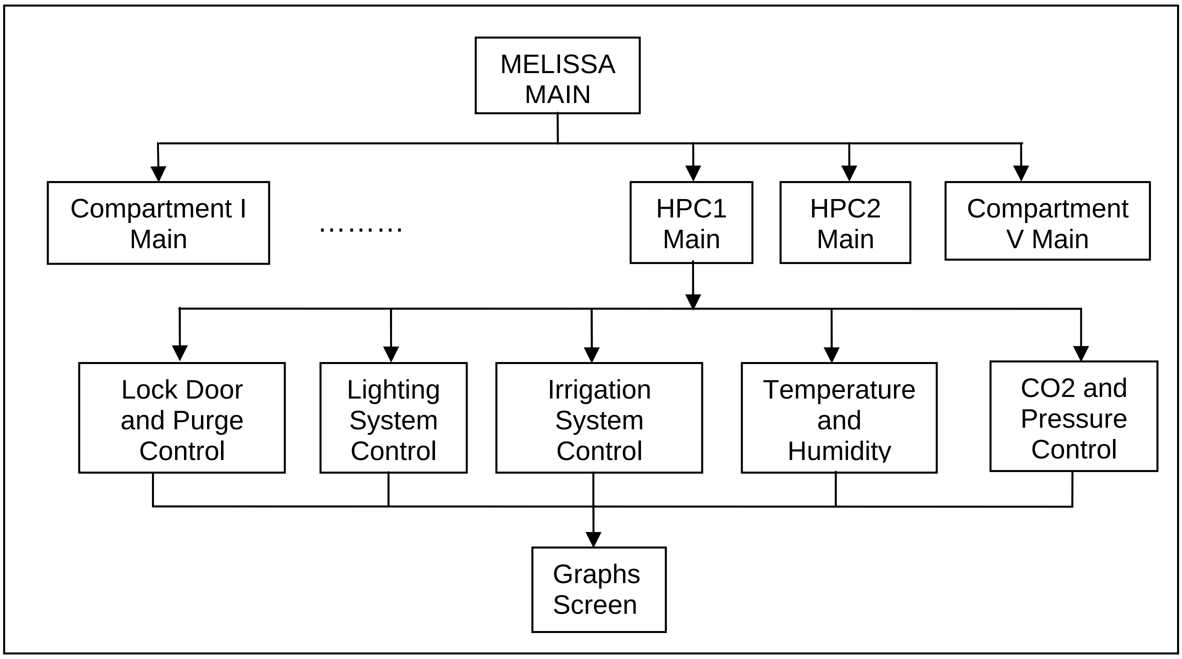
Ref	Title	Reference	Issue	Date
[A1]	Connection and HMI SW Activities on MPP's Compartment CIVb HPC	NTE-HPCP2-OF-001	1.0	Oct.2008
[A2]	MPP rules for tags and labelling	TN 78.72	2.0	Sept. 2008

2.2 REFERENCE DOCUMENTS

Ref	Title	Reference	Issue	Date
[R1]	CIVb_HMI_20090617.xls			
[R2]	Melissa CIVa HMI Design Document for Compartment CIVa	NTE-CIVaP2-RP-003	Draft	03/06/2009

3. HMI DISPLAYS

3.1 Hierarchy



3.2 System Overview Display

To have a general overview of the HPC1 compartment, a general schematic shall appear in the computer display when the user opens CIVb HPC1 system. From this display the user will only be able to visualise the most important variables and not modify settings of the control loops. The changes in the settings of the various loops will be done through dedicated displays as shown in the functional tree above.

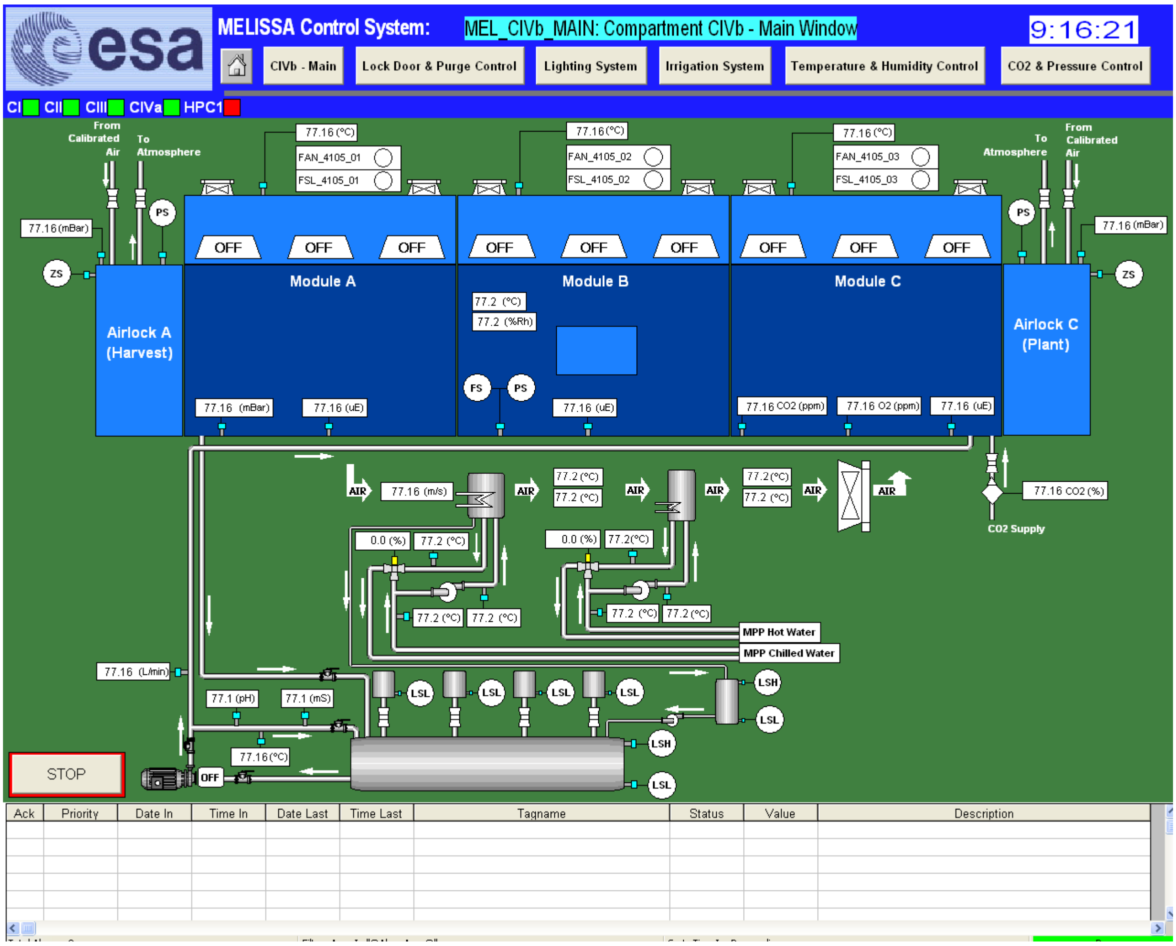


Figure 1: HPC1 Main Display

3.2.1 Tag definition

The following tags are displayed in this display.

Tag Name	Description	Type	HMI address
AT_4107_01	pH sensor	Analogue indicator	400031
AT_4108_01	Electrical conductivity of nutrient	Analogue indicator	400033
AT_4112_AVG	Chamber average humidity	Analogue indicator	400154
AT_4113_01	CO2 Analyzer	Analogue indicator	400091
AT_4113_02	O2 Analyzer	Analogue indicator	400093
BLWR_4111_01_MV	Blower relay	Blower animated	000019
FAN_4105_01_MV	Operation of Light Loft Fan A	Digital indicator	000003

Tag Name	Description	Type	HMI address
FAN_4105_02_MV	Operation of Light Loft Fan B	Digital indicator	000004
FAN_4105_03_MV	Operation of Light Loft Fan C	Digital indicator	000005
FC_4113_01	CO2 Mass Flow	Analogue animated	400089
FS_4114_01	Flow switch	Digital indicator	100019
FSL_4105_01	Flow/No Flow of Light Loft Fan A	Digital indicator	100005
FSL_4105_02	Flow/No Flow of Light Loft Fan B	Digital indicator	100006
FSL_4105_03	Flow/No Flow of Light Loft Fan C	Digital indicator	100007
FT_4106_01	Outlet nutrient flow sensor	Analogue indicator	400029
FT_4111_01	Air velocity sensor	Analogue indicator	400037
GP_4106_01_MV	Main Irrigation Pump	Pump animated	000014
GP_4110_01_MV	Condensate pump relay	Pump animated	000006
GP_4112_01_MV	Chilled water circulation pump	Pump animated	000021
GP_4112_02_MV	Hot water circulation pump	Pump animated	000020
IY_4104_01_MV	Ramps – A (LAMP Sa)	Digital indicator	000011
IY_4104_02_MV	Ramps – B (LAMP Sb)	Digital indicator	000012
IY_4104_03_MV	Ramps- C (LAMP H)	Digital indicator	000013
LSH_4110_01	High level sensor for reservoir tank	Level switch animated	100014
LSH_4110_02	High level sensor for condensate tank	Level switch animated	100016
LSL_4107_01	Acid Tank level	Level switch	100010

Tag Name	Description	Type	HMI address
		animated	
LSL_4107_02	Base Tank level	Level switch animated	100011
LSL_4108_01	Level sensor Stock A	Level switch animated	100012
LSL_4108_02	Level sensor Stock B	Level switch animated	100013
LSL_4110_01	Low level sensor for reservoir tank	Level switch animated	100015
LSL_4110_02	Low level sensor for condensate tank	Level switch animated	100017
PS_4102_01	Airlock A pressure switch	Digital indicator	100008
PS_4103_01	Airlock C pressure switch	Digital indicator	100009
PT_4102_01	Pressure sensor for airlock A	Analogue indicator	400013
PT_4103_01	Pressure sensor for airlock C	Analogue indicator	400015
PT_4114_01	Growing Area Pressure	Analogue indicator	400095
RT_4104_01	PAR Sensor – A	Analogue indicator	400017
RT_4104_02	PAR Sensor – B	Analogue indicator	400019
RT_4104_03	PAR Sensor – C	Analogue indicator	400021
S3CV_4112_01_MV	Chilled water control valve	Analogue indicator	400234
S3CV_4112_02_MV	Hot water control valve	Analogue indicator	400236
STOP	Switch OFF all control loops	Command button	
SV_4102_01_MV	Solenoid valve for injection of pressurized air into airlock A.	2-way valve	000007

Tag Name	Description	Type	HMI address
		animated	
SV_4102_02_MV	Airlock A ventilation Solenoid valve	2-way valve animated	000008
SV_4103_01_MV	Solenoid valve for injection of pressurized air into airlock C	2-way valve animated	000009
SV_4103_02_MV	Airlock C ventilation solenoid valve	2-way valve animated	000010
SV_4107_01_MV	Acid Tank valve	2-way valve animated	000015
SV_4107_02_MV	Base Tank valve	2-way valve animated	000016
SV_4108_01_MV	Stock A inject valve	2-way valve animated	000017
SV_4108_02_MV	Stock B inject valve	2-way valve animated	000018
SV_4113_01_MV	CO2 inject line. Solenoid	2-way valve animated	000022
TT_4105_01	Light Loft Temperature sensor A	Analogue indicator	400023
TT_4105_02	Light Loft Temperature sensor B	Analogue indicator	400025
TT_4105_03	Light Loft Temperature sensor C	Analogue indicator	400027
TT_4109_01	Temperature of nutrient tank	Analogue indicator	400035
TT_4112_13	Temperature for facility chilled water	Analogue indicator	400063
TT_4112_14	Temperature for facility hot water line	Analogue indicator	400065
TT_4112_15	Chilled coil surface temperature	Analogue indicator	400067
TT_4112_16	Heating coil surface temperature	Analogue indicator	400069

Tag Name	Description	Type	HMI address
TT_4112_17	Chilled exit temperature	Analogue indicator	400071
TT_4112_18	Hot exit temperature	Analogue indicator	400073
TT_4112_19	Outlet Air chilled exchanger	Analogue indicator	400075
TT_4112_20	Outlet Air Hot exchanger	Analogue indicator	400077
TT_4112_21	Inlet water chilled exchanger	Analogue indicator	400079
TT_4112_22	Inlet water hot exchanger	Analogue indicator	400081
TT_4112_AVG	Chamber average temperature	Analogue indicator	400152
ZS_4100_01	Upper Exterior Air Lock Door Contact – Side A	Digital indicator	100001
ZS_4101_01	Upper Exterior Air Lock Door Contact – Side C	Digital indicator	100003
PS_41414_01	Pressure switch	Digital indicator	100018

3.3 Lock door and Purge control display

3.3.1 Control Loops

Control Loop identifier	Control Loop Name	Description
4100	Exterior Airlock Door A Alarm	Controller activates an alarm and purge-override condition when door sensors indicate door open. LEDs on the same sensor circuit indicate door open/closed status.
4101	Exterior Airlock Door C Alarm	Controller activates an alarm and purge-override condition when door sensors indicate door open. LEDs on the same sensor circuit indicate door open/closed status.
4102	Airlock A Purge	Controller acts upon user initiated purge sequence by opening gas outlet and inlet solenoids for an empirically determinated mixing period. The purge operation is not allowed or is shut-down (closure of inlet vent) if door open alarm in loop 4100 exists, an over-pressure alarm is indicated or a vent solenoid fails.
4103	Airlock C Purge	Controller acts upon user initiated purge sequence by opening gas outlet and inlet solenoids for an empirically

Control Loop identifie r	Control Loop Name	Description
		determinated mixing period. The purge operation is not allowed or is shut-down (closure of inlet vent) if door open alarm in loop 4101 exists, an over-pressure alarm is indicated or a vent solenoid fails.

3.3.2 Tag definition

The following tags are displayed in this display.

Tag Name	Description	Type	HMI address
IY_4104_01_MV	Ramps – A (LAMP Sa)	Digital indicator	000011
IY_4104_02_MV	Ramps – B (LAMP Sb)	Digital indicator	000012
IY_4104_03_MV	Ramps- C (LAMP H)	Digital indicator	000013
PS_4102_01	Airlock A pressure switch	Digital Indicator	100008
PS_4103_01	Airlock C pressure switch	Digital indicator	100009
PT_4102_01	Pressure sensor for airlock A	Analogue indicator	400013
PT_4103_01	Pressure sensor for airlock C	Analogue indicator	400015
SV_4102_01_MV	Solenoid valve for injection of pressurized air into airlock A.	2-way valve animated	000007
SV_4102_02_MV	Airlock A ventilation Solenoid valve	2-way valve animated	000008
SV_4103_01_MV	Solenoid valve for injection of pressurized air into airlock C	2-way valve animated	000009
SV_4103_02_MV	Airlock C ventilation solenoid valve	2-way valve animated	000010
ZS_4100_01	Upper Exterior Air Lock Door Contact – Side A	Digital indicator	100001
ZS_4101_01	Upper Exterior Air Lock Door Contact – Side C	Digital indicator	100003

3.3.3 Alarm definition

The following alarms are linked with the operation of the Lock Door and purge control display.

TAG NAME	Description	HMI Address
CL4100_DoorOpen_A	Door A Opened	000033
CL4101_DoorOpen_C	Door C opened	000034
PT_4102_01_ERR	Sensor PT_4102_01 is in Error	000035
PT_4103_01_ERR	Sensor PT_4103_01 is in Error	000036

3.3.4 Display

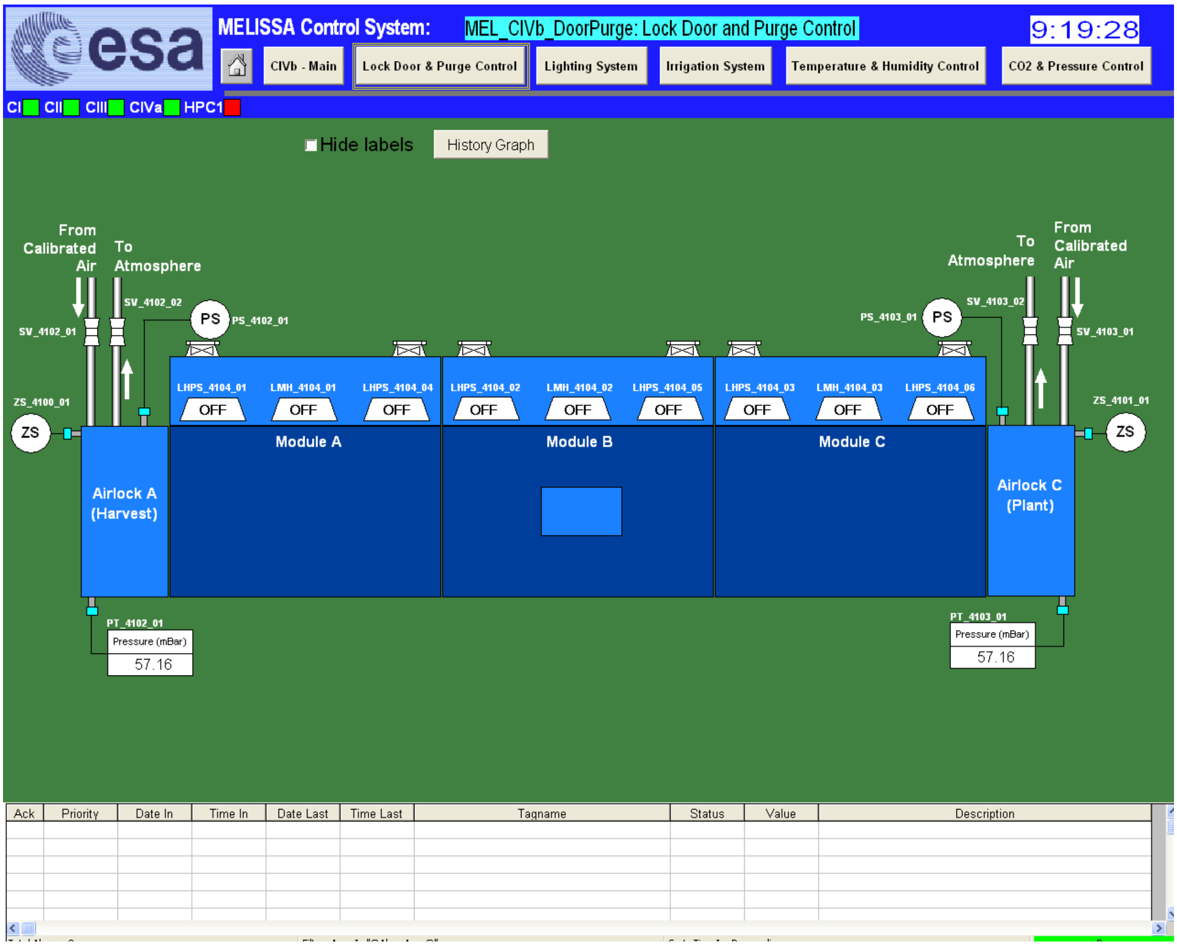


Figure 2: HPC1, Lock Door and Purge Control

Lock Door and Purge control display allow the following actions:

- Hide labels selecting the “Hide labels” check box
- Go on to the history graph clicking on the History graph command button.
- Monitoring analogue and digital indicators.

3.3.5 History Graph

The following tags are monitored by default when the user access to the History Graph from the Lock Door and Purge Control display.

1. PT_4102_01
2. PT_4103_01

3.4 Lighting system control display

3.4.1 Control Loops

The following control loops are implemented in the display:

Control Loop identifier	Control Loop Name	Description
4104	Light Intensity Control	Independent activation of the three lamp strings in accordance with the user defined photoperiod. Alarms are indicated if PAR sensors do not respond to ignition or if air loft temperature (loop 4105) is high.
4105	Lightning Loft Temperature Control	Controller activates all lamp loft fans with the ignition of any lamp string or whenever lamp loft temperature is in excess. Alarms are indicated if loft temperature is high.

3.4.2 Tags definition

The following tags are displayed in this display:

Tag Name	Description	Type	HMI address
CL4104_ControlLoop_Mode	Light Mode (Off/Auto/Man)	Switch animated	400119
CL4105_ControlLoop_Mode	Fan Mode (Off/Auto/Man)	Switch animated	400120
FAN_4105_01_MV	Operation of Light Loft Fan A	Digital indicator	000003
FAN_4105_02_MV	Operation of Light Loft Fan B	Digital indicator	000004

Tag Name	Description	Type	HMI address
FAN_4105_03_MV	Operation of Light Loft Fan C	Digital indicator	000005
FSL_4105_01	Flow/No Flow of Light Loft Fan A	Digital indicator	100005
FSL_4105_02	Flow/No Flow of Light Loft Fan B	Digital indicator	100006
FSL_4105_03	Flow/No Flow of Light Loft Fan C	Digital indicator	100007
IY_4104_01_MV	Ramps – A (LAMP Sa)	Digital indicator	000011
IY_4104_02_MV	Ramps – B (LAMP Sb)	Digital indicator	000012
IY_4104_03_MV	Ramps- C (LAMP H)	Digital indicator	000013
RT_4104_01	PAR Sensor – A	Analogue indicator	400017
RT_4104_02	PAR Sensor – B	Analogue indicator	400019
RT_4104_03	PAR Sensor – C	Analogue indicator	400021
Stop Button	Switch Off CL4104_ControlLoop_mode and CL4105_ControlLoop_mode.	Command button	
TT_4105_01	Light Loft Temperature sensor A	Analogue indicator	400023
TT_4105_02	Light Loft Temperature sensor B	Analogue indicator	400025
TT_4105_03	Light Loft Temperature sensor C	Analogue indicator	400027

3.4.3 Alarm definition

The following alarms are linked with the operation of the Lighting system control display.

TAG NAME	Description	HMI Address
CL4104_H_AH	Ramp H High Intensity Alarm	000041
CL4104_H_AL	Ramp H Low Intensity Alarm	000042
CL4104_NoLight_AH	No Ramp High Intensity Alarm	000049
CL4104_Sa_AH	Ramp Sa High Intensity Alarm	000037

TAG NAME	Description	HMI Address
CL4104_Sa_AL	Ramp Sa Low Intensity Alarm	000038
CL4104_Sa_H_AH	Ramp Sa/H High Intensity Alarm	000043
CL4104_Sa_H_AL	Ramp Sa/H Low Intensity Alarm	000044
CL4104_Sa_Sb_AH	Ramp Sa/Sb High Intensity Alarm	000045
CL4104_Sa_Sb_AL	Ramp Sa/Sb Low Intensity Alarm	000046
CL4104_Sa_Sb_H_AH	Ramp Sa/Sb/H High Intensity Alarm	000047
CL4104_Sa_Sb_H_AL	Ramp Sa/Sb/H Low Intensity Alarm	000048
CL4104_Sb_AH	Ramp Sb High Intensity Alarm	000039
CL4104_Sb_AL	Ramp Sb Low Intensity Alarm	000040
CL4105_FlowFan1_AL	Flow Fan 1 Alarm Low	000055
CL4105_FlowFan2_AL	Flow Fan 2 Alarm Low	000058
CL4105_FlowFan3_AL	Flow Fan 3 Alarm Low	000061
CL4105_TempFan1_AH	Temperature Fan 1 Alarm High	000053
CL4105_TempFan1_AHH	Temperature Fan 1 Alarm High High	000054
CL4105_TempFan2_AH	Temperature Fan 2 Alarm High	000056
CL4105_TempFan2_AHH	Temperature Fan 2 Alarm High High	000057
CL4105_TempFan3_AH	Temperature Fan 3 Alarm High	000059
CL4105_TempFan3_AHH	Temperature Fan 3 Alarm High High	000060
RT_4104_01_ERR	Sensor RT_4104_01 is in Error	000050
RT_4104_02_ERR	Sensor RT_4104_02 is in Error	000051
RT_4104_03_ERR	Sensor RT_4104_03 is in Error	000052
TT_4105_01_ERR	Sensor TT_4105_01 is in Error	000062
TT_4105_02_ERR	Sensor TT_4105_02 is in Error	000063
TT_4105_03_ERR	Sensor TT_4105_03 is in Error	000064

3.4.4 Display

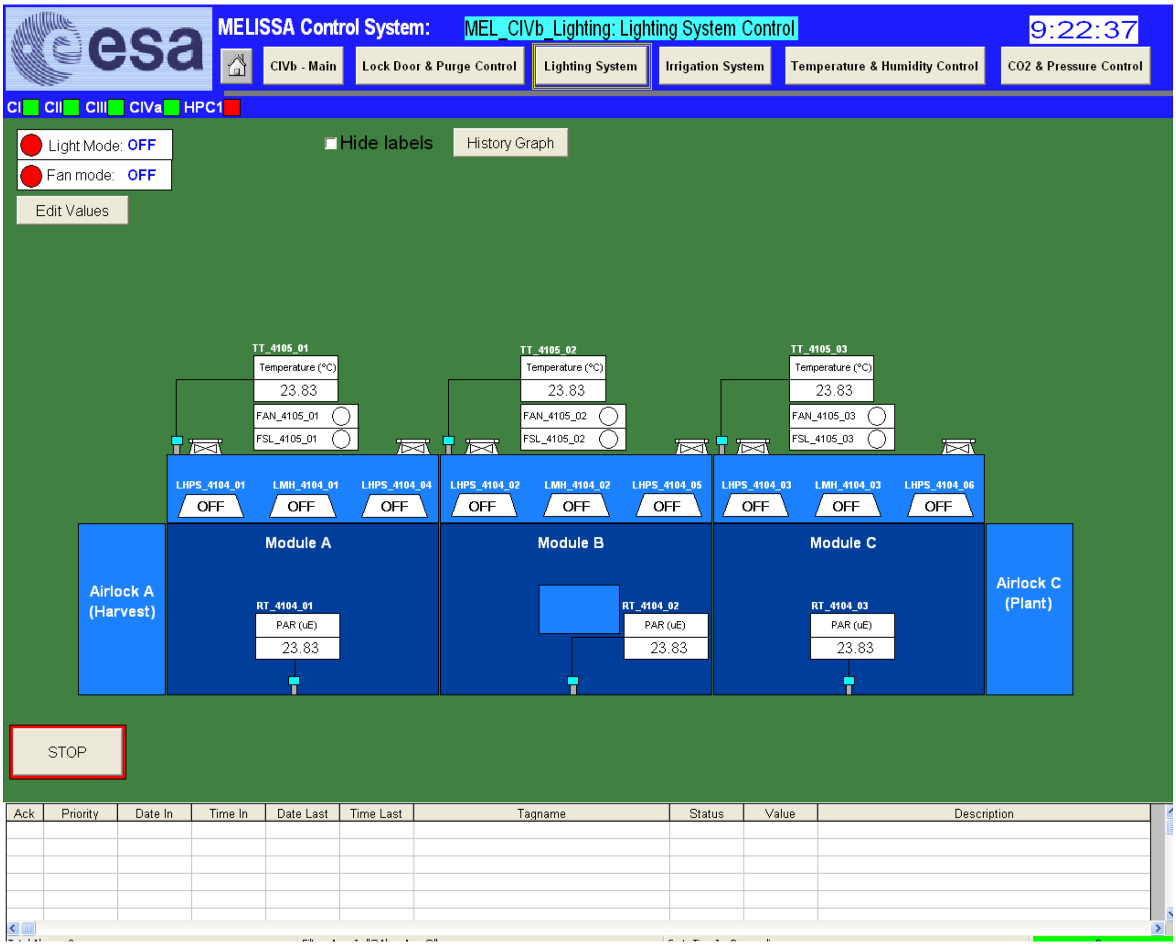


Figure 3: HPC1, Lighting system display

Lighting system control display allows the following actions:

- Hide labels selecting the "Hide labels" check box
- Go on to the history graph clicking on the History graph command button.
- Switch OFF the Light Mode and Fan mode clicking on the "Stop" command button.
- "Edit Values" command button permits to configure the control mode parameters of this display.
- Visualize the hardware status (activate/deactivate) and analogue indicators values.

3.4.5 Control loop configuration window

Light Intensity Control configuration in manual mode:

It permits activate/deactivate independently each string of lights.

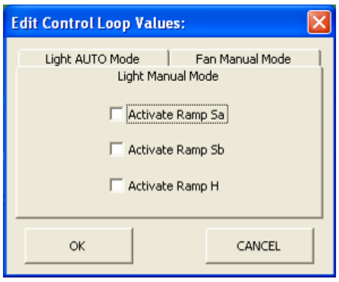


Figure 4: Lighting system configuration in Manual mode

Light Intensity Control configuration in AUTO mode:

User configures the time (hour and minute) when day starts and day ends.

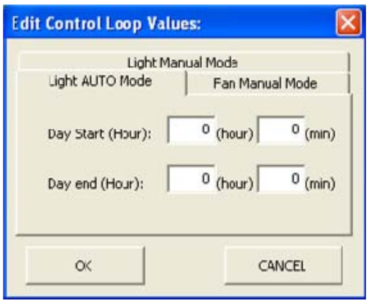


Figure 5: HPC1, Lighting system configuration in AUTO mode

Lighting Loft Temperature Control in manual mode:

Allow activate/deactivate independently lighting loft fan.

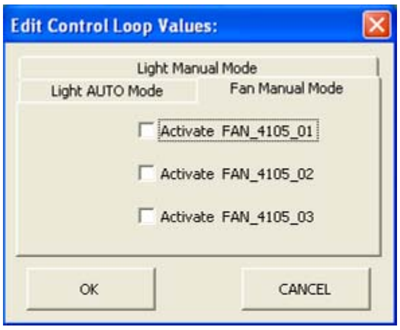


Figure 6: Light Loft Fan configuration in Manual Mode

Control loop parameters:

Tag Name	Description	Type	HMI address
CL4104_EndingDay_Hour	Day end hour	Text Box	400184
CL4104_EndingDay_Minute	Day end minute	Text Box	400185
CL4104_StartingDay_Hour	Day Start Hour	Text Box	400182
CL4104_StartingDay_Minute	Day start minute	Text Box	400183
FAN_4105_01_OP	Turn On/Off FAN_4105_01 in manual mode	Check box	000146
FAN_4105_02_OP	Turn On/Off FAN_4105_02 in manual mode	Check Box	000167
FAN_4105_03_OP	Turn On/Off FAN_4105_03 in manual mode	Check Box	000168
IY_4104_01_OP	Turn On/Off lamps – Sa in manual mode	Check box	000143
IY_4104_02_OP	Turn On/Off lamps – Sb in manual mode	Check box	000144
IY_4104_03_OP	Turn On/Off lamps – H in manual mode	Check box	000145

3.4.6 History Graph

The following tags are monitored by default when the user accesses to the History Graph from the Lighting system display.

1. TT_4105_01
2. TT_4105_02
3. TT_4105_03
4. RT_4104_01
5. RT_4104_02
6. RT_4104_03

3.5 Irrigation system control display

3.5.1 Control Loops

The following control loops are implemented on the display:

Control Loop identifie r	Control Loop Name	Description
4106	Irrigation System	Controller activates the main irrigation pump according to the user defined irrigation period. If operation of the pump is indicated and flow sensor indicates low flow, an alarm is indicated.
4107	pH Control	The controller aims to keep Ph levels in the hydroponics reservoir at demand with automated injections of either acid or base stocks. The injection run-time is determined from empirically determined equilibration times. Alarms are indicated if Ph is out of bounds of if acid/base stock vessels are at low levels.
4108	EC Control	The controller aims to keep EC levels in the hydroponics reservoir at demand with automated injections of either A and B stocks. The injection run-time is determined from empirically determined equilibration times. Alarms are indicated if EC is out of bounds of if stock vessels are at low levels.
4109	Reservoir Temperature	Control of an inlet solenoid feeding chilled water in a closed loop line to the reservoir from the facility.
4110	Condensate Control	Controller activates the return pumping of collected condensate from the condensate vessel to the reservoir if volume levels are within limits.

3.5.2 Tag definition

The following tags are displayed in this display:

Tag Name	Description	Type	HMI address
AT_4107_01	pH sensor	Analogue indicator	400031

Tag Name	Description	Type	HMI address
AT_4108_01	Electrical conductivity of nutrient	Analogue indicator	400033
CL4107_PH_SP	pH set point	User input	400138
CL4108_EC_SP	Electrical conductivity set point	User input	400142
FT_4106_01	Outlet nutrient flow sensor	Analogue indicator	400029
GP_4106_01_MV	Main Irrigation Pump	Pump animated	000014
CP_4110_01_MV	Condensate pump relay	Pump animated	000006
IY_4104_01_MV	Ramps – A (LAMP Sa)	Digital indicator	000011
IY_4104_02_MV	Ramps – B (LAMP Sb)	Digital indicator	000012
IY_4104_03_MV	Ramps- C (LAMP H)	Digital indicator	000013
LSH_4110_01	High level sensor for reservoir tank	Level switch animated	100014
LSH_4110_02	High level sensor for condensate tank	Level switch animated	100016
LSL_4107_01	Acid Tank level	Level switch animated	100010
LSL_4107_02	Base Tank level	Level switch animated	100011
LSL_4108_01	Level sensor Stock A	Level switch animated	100012
LSL_4108_02	Level sensor Stock B	Level switch animated	100013
LSL_4110_01	Low level sensor for reservoir tank	Level switch animated	100015
LSL_4110_02	Low level sensor for condensate tank	Level switch animated	100017
STOP	Switch OFF all control loops	Command button	
SV_4107_01_MV	Acid Tank valve	2-way valve animated	000015
SV_4107_02_MV	Base Tank valve	2-way valve animated	000016

Tag Name	Description	Type	HMI address
SV_4108_01_MV	Stock A inject valve	2-way valve animated	000017
SV_4108_02_MV	Stock B inject valve	2-way valve animated	000018
TT_4109_01	Temperature of nutrient tank	Analogue indicator	400035

3.5.3 Alarm definition

The following alarms are linked with the operation of the Irrigation control system display.

TAG NAME	Description	HMI Address
AT_4107_01_ERR	Sensor AT_4107_01 is in Erro	000077
AT_4108_01_ERR	Sensor AT_4108_01 is in Error	000084
CL4106_Flow_AH	Irrigation Flow Alarm High	000065
CL4106_Flow_AHH	Irrigation Flow Alarm High High	000066
CL4106_Flow_AL	Irrigation Flow Alarm Low	000067
CL4106_Flow_ALL	Irrigation Flow Alarm Low Low	000068
CL4106_PumpError_A	Control Pump Error Alarm	000069
CL4107_AcidTank_AL	Acid Tank Level Low Alarm	000071
CL4107_BaseTank_AL	Base Tank Level Low Alarm	000072
CL4107_pH_AH	pH Alarm High	000073
CL4107_pH_AHH	pH Alarm High High	000074
CL4107_pH_AL	pH Alarm Low	000075
CL4107_pH_ALL	pH Alarm Low Low	000076
CL4108_EC_AH	Electro-Conductivity Alarm High	000080
CL4108_EC_AHH	Electro-Conductivity Alarm High High	000081
CL4108_Ec_AL	Electro-Conductivity Alarm Low	000082
CL4108_Ec_ALL	Electro-Conductivity Alarm Low Low	000083
CL4108_NutrientTankA_AL	Nutrient Tank A Level Low	000078
CL4108_NutrientTankB_AL	Nutrient Tank B Level Low	000079
CL4110_CondensateAndNutrient_AH	Condensate and Nutrient Tank High Level Alarm	000089
CL4110_CondensateAndNut	Condensate and Nutrient Tank Low Level	000090

rient_AL	Alarm	
CL4110_CondensateTank_AH	Condensate tank High level Alarm	000085
CL4110_CondensateTank_AL	Condensate tank Low level Alarm	000086
CL4110_NutrientTank_AH	Nutrient tank High level alarm	000087
CL4110_NutrientTank_AL	Nutrient tank Low Level Alarm	000088
FT_4106_01_ERR	Sensor FT_4106_01 in Error	000070
TT_4109_01_ERR	Sensor TT_4109_01 in Error	000142

3.5.4 Display

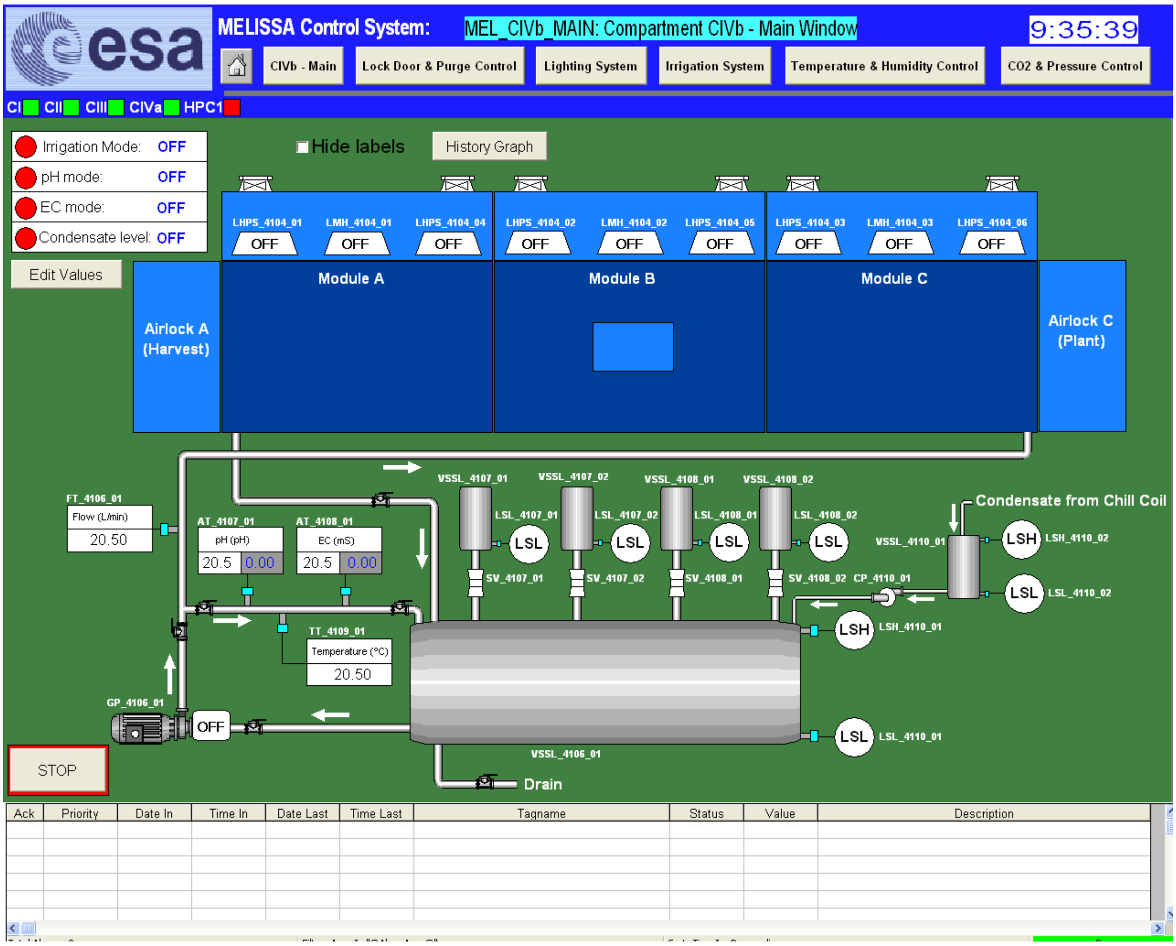


Figure 7: HPC1, Irrigation system display

Irrigation system control display allows the following actions:

- Hide labels selecting the “Hide labels” check box
- Go on to the history graph clicking on the “History graph” command button.
- Switch OFF the Irrigation Mode, pH mode, EC mode and condensate level mode clicking on the “Stop” command button.
- “Edit Values” command button allows configuring the control loops parameters defined in the Irrigation Display.
- Visualize the hardware status (activate/deactivate) and analogue indicators values.
- Modify the pH and EC set points directly from the display.

3.5.5 Control loop configuration window

Irrigation system configuration in manual mode:

Allows activate/deactivate the irrigation pump GP_4106_01 in manual mode selecting on the check box and clicking “OK”.

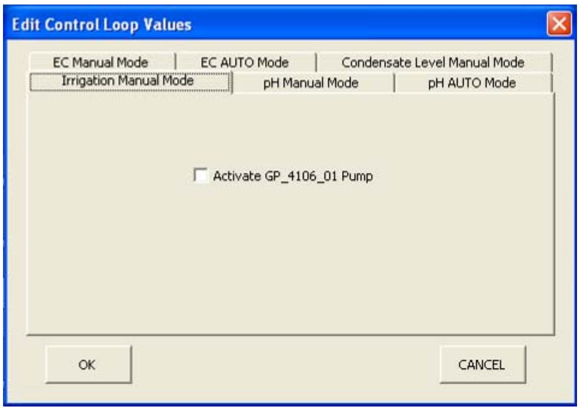


Figure 8: Irrigation system configuration in Manual mode

pH Control configuration in manual mode:

Allows activate/deactivate the acid and base valve in manual mode selecting on the check box and clicking “OK”.

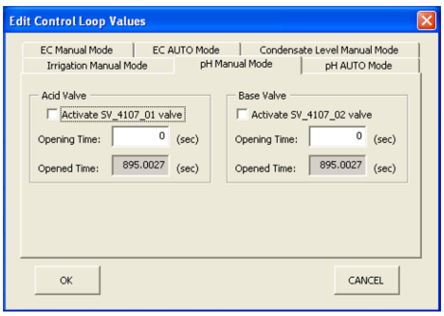


Figure 9: pH configuration in manual mode

pH Control configuration in AUTO mode:

Allows pH set point configuration and its pH dead zone, when the pH is upper than pH set point + pH dead zone or lower than pH set point – pH dead zone a pH alarm is displayed.

The time of the last reset of pH timer is displayed in the form and there is a command button to reset the timer.

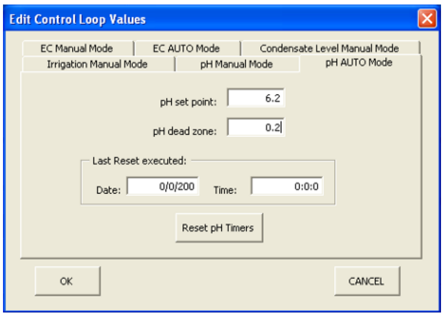


Figure 10: pH configuration in AUTO mode

EC control configuration in manual mode:

Allows activate/deactivate the stock A and B valves in manual mode selecting on the check box and clicking “OK” command button.

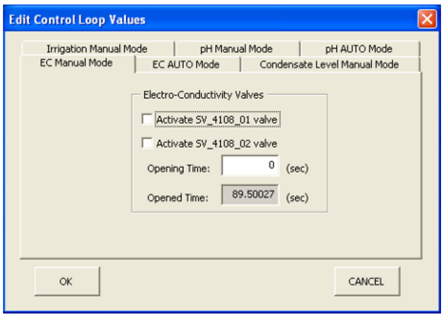


Figure 11: EC configuration in manual mode

EC control configuration in AUTO mode:

Allow EC set point writing in the Text box and clicking “OK” command button. The time of the last reset EC pH timer is displayed in the form and there is a command button to reset the timer.

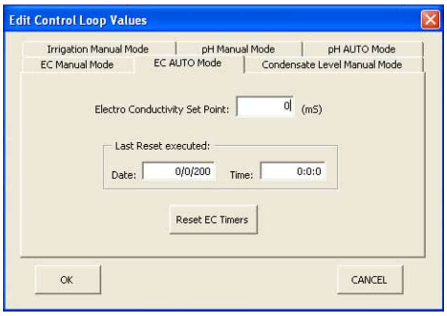


Figure 12: EC configuration in AUTO mode

Condensate control configuration in Manual mode:

Allow activate/deactivate condensate pump CP_4110_01 in manual mode selecting check box and clicking “OK” command button.

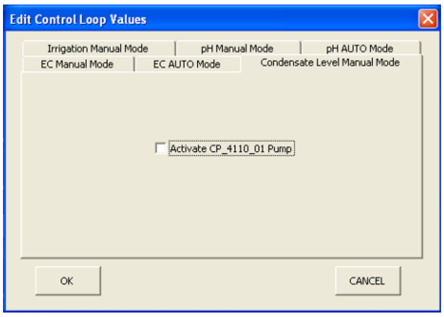


Figure 13: Condensate level configuration in Manual mode

Control loop parameters:

Tag Name	Description	Type	HMI address
CL4107_Acid_Opening_time	Acid opening time indicator	Text box indicator	400187
CL4107_Base_Opening_time	Base opening time indicator	Text box indicator	400186
CL4107_DEADZONE	pH dead zone configuration	Text box	400140
CL4107_PH_SP	pH Set point	Text box	400138
CL4107_Reset_PH_Timer	Reset pH timer	Command button	000158
CL4108_EC_Opening_Time	Opening time indicator	Text box indicator	400188
CL4108_EC_SP	Electro-Conductivity set point	Text box	400142
CL4108_Reset_EC_Timer	Reset EC timer	Command button	000159
GP_4106_01_OP	Turn On/Off Pump in manual mode	Check box	000147
CP_4110_01_OP	Turn On/Off Pump in manual mode	Text box	000152
SV_4107_01_OP	Activate/deactivate valve in manual mode	Check box	000148
SV_4107_01_OP_Time	Base opening time configuration	Text box input	400227
SV_4107_02_OP	Activate/deactivate valve in manual mode	Check box	000149
SV_4107_02_OP_Time	Acid opening time configuration	Text box input	400229
SV_4108_01_OP	Activate/deactivate valve in manual mode	Check box	000150
SV_4108_02_OP	Activate/deactivate valve in manual mode	Check box	000151

Tag Name	Description	Type	HMI address
SV_4108_OP_Time	Opening time configuration	Text box input	400231
CL4107_pH_Second	Date of the last reset done by operator	Indicator	400215
CL4107_pH_Minute	Date of the last reset done by operator	Indicator	400216
CL4107_pH_Hour	Date of the last reset done by operator	Indicator	400217
CL4107_pH_Day	Date of the last reset done by operator	Indicator	400218
CL4107_pH_Month	Date of the last reset done by operator	Indicator	400219
CL4107_pH_Year	Date of the last reset done by operator	Indicator	400220
CL4108_EC_Second	Date of the last reset done by operator	Indicator	400221
CL4108_EC_Minute	Date of the last reset done by operator	Indicator	400222
CL4108_EC_Hour	Date of the last reset done by operator	Indicator	400223
CL4108_EC_Day	Date of the last reset done by operator	Indicator	400224
CL4108_EC_Month	Date of the last reset done by operator	Indicator	400225
CL4108_EC_Year	Date of the last reset done by operator	Indicator	400226

3.5.6 History Graph

The following tags are monitored by default when the user accesses to the History Graph from the Irrigation system display.

1. FT_4106_01
2. AT_4107_01
3. AT_4108_01
4. TT_4109_01

3.6 Temperature and Humidity chamber control display

3.6.1 Control loops

The following control loops are implemented on the display.

Control Loop identifier	Control Loop Name	Description
4111	Air Circulation	The controller activates the VFD and confirms air flow VFD set-point is determined from calibration profiles of air flow volume/speed at various VFD frequencies.
4112	Humidity and Temperature Control	The controller modulates three-way proportional valves feeding chilled and hot water supplies from the facility to the heat exchange coils.

3.6.2 Tags definition

The following tags are displayed in this display:

Tag Name	Description	Type	HMI address
AT_4112_01	Humidity A1 associated with temp A1	Analogue indicator	400083
AT_4112_02	Humidity B1 associated with temperature B1	Analogue indicator	400085
AT_4112_03	Humidity C1 associated with temperature C1	Analogue indicator	400087
AT_4112_AVG	Chamber average humidity	Analogue indicator	400154
AT_4112_AVG_Day_SP	Humidity set point in AUTO mode	User input	400150
AT_4112_AVG_Night_SP	Humidity set point in AUTO mode	User input	400146
BLWR_4111_01_MV	Blower Relay	Blower animated	000019
FT_4111_01	Air velocity sensor	Analogue indicator	400037
GP_4112_01_MV	Chilled water circulation pump	Pump animated	000021
GP_4112_02_MV	Hot water circulation pump	Pump animated	000020
IY_4104_01_MV	Ramps – A (LAMP Sa)	Digital indicator	000011

Tag Name	Description	Type	HMI address
IY_4104_02_MV	Ramps – B (LAMP Sb)	Digital indicator	000012
IY_4104_03_MV	Ramps- C (LAMP H)	Digital indicator	000013
LSH_4110_02	High level sensor for condensate tank	Level switch animated	100016
LSL_4110_02	Low level sensor for condensate tank	Level switch animated	100017
S3CV_4112_01_MV	Chilled water control valve	Analogue indicator	400234
S3CV_4112_02_MV	Hot water control valve	Analogue animated	400236
TT_4112_01	Temperature A1 associated with humidity	Analogue indicator	400039
TT_4112_02	Temperature B1 associated with humidity	Analogue indicator	400047
TT_4112_03	Temperature C1 associated with humidity	Analogue indicator	400055
TT_4112_04	Temperature A2	Analogue indicator	400041
TT_4112_05	Temperature A3	Analogue indicator	400043
TT_4112_06	Temperature A4 → reaffected to External Temperature	Analogue indicator	400045
TT_4112_07	Temperature B2	Analogue indicator	400049
TT_4112_08	Temperature B3	Analogue indicator	400051
TT_4112_09	Temperature B4	Analogue indicator	400053
TT_4112_10	Temperature C2	Analogue indicator	400057
TT_4112_11	Temperature C3	Analogue indicator	400059
TT_4112_12	Temperature C4 → Reflected to external temperature	Analogue indicator	400061
TT_4112_13	Temperature for facility chilled water	Analogue animated	400063

Tag Name	Description	Type	HMI address
TT_4112_14	Temperature for facility hot water line	Analogue animated	400065
TT_4112_15	Chilled coil surface temperature	Analogue animated	400067
TT_4112_16	Heating coil surface temperature	Analogue animated	400069
TT_4112_17	Chilled exit temperature	Analogue indicator	400071
TT_4112_18	Hot exit temperature	Analogue animated	400073
TT_4112_19	Outlet Air, chilled exchanger	Analogue animated	400075
TT_4112_20	Outlet air, hot exchanger	Analogue animated	400077
TT_4112_21	Inlet water chilled exchanger	Analogue animated	400079
TT_4112_22	Inlet water hot exchanger	Analogue animated	400081
TT_4112_AVG	Chamber average temperature	Analogue indicator	400152
TT_4112_AVG_Day_SP	Temperature set point in AUTO mode	User input	400148
TT_4112_AVG_Night_SP	Temperature set point in AUTO mode	User input	400144

3.6.3 Alarm definition

The following alarms are linked with the operation of the Temperature and Humidity control display.

TAG NAME	Description	HMI Address
AT_4112_01_ERR	Sensor AT_4112_01 is in ERROR	000123
AT_4112_02_ERR	Sensor AT_4112_02 is in ERROR	000124
AT_4112_03_ERR	Sensor AT_4112_03 is in ERROR	000125
CL4104_StartLights	Indicate if the process is in day or night time	000157
CL4111_NoFlow_LightOn_A	Light without Flow Alarm	000091
CL4112_Humidity_AH	Chamber Humidity Alarm High	000097

TAG NAME	Description	HMI Address
CL4112_Humidity_AHH	Chamber Humidity Alarm High High	000098
CL4112_Humidity_AL	Chamber Humidity Alarm Low	000099
CL4112_Humidity_ALL	Chamber Humidity Alarm Low Low	000100
CL4112_Temp_ColdXchanger_AH	Cold Exchanger Alarm High	000162
CL4112_Temp_ColdXchanger_AHH	Cold Exchanger Alarm High High	000163
CL4112_Temp_HotXchanger_AL	Hot Exchanger Alarm Low	000160
CL4112_Temp_HotXchanger_ALL	Hot Exchanger Alarm Low Low	000161
CL4112_Temperature_AH	Chamber Temperature Alarm High	000093
CL4112_Temperature_AHH	Chamber Temperature Alarm High High	000094
CL4112_Temperature_AL	Chamber Temperature Alarm Low	000095
CL4112_Temperature_ALL	Chamber Temperature Alarm Low Low	000096
FT_4111_01_ERR	Sensor FT_4111_01 is in Error	000092
TT_4112_01_ERR	Sensor TT_4112_01 is in ERROR	000101
TT_4112_02_ERR	Sensor TT_4112_02 is in ERROR	000105
TT_4112_03_ERR	Sensor TT_4112_03 is in ERROR	000109
TT_4112_04_ERR	Sensor TT_4112_04 is in ERROR	000102
TT_4112_05_ERR	Sensor TT_4112_05 is in ERROR	000103
TT_4112_06_ERR	Sensor TT_4112_06 is in ERROR	000104
TT_4112_07_ERR	Sensor TT_4112_07 is in ERROR	000106
TT_4112_08_ERR	Sensor TT_4112_08 is in ERROR	000107
TT_4112_09_ERR	Sensor TT_4112_09 is in ERROR	000108
TT_4112_10_ERR	Sensor TT_4112_10 is in ERROR	000110
TT_4112_11_ERR	Sensor TT_4112_11 is in ERROR	000111
TT_4112_12_ERR	Sensor TT_4112_12 is in ERROR	000112
TT_4112_13_ERR	Sensor TT_4112_13 is in ERROR	000113
TT_4112_14_ERR	Sensor TT_4112_14 is in ERROR	000114
TT_4112_15_ERR	Sensor TT_4112_15 is in ERROR	000115
TT_4112_16_ERR	Sensor TT_4112_16 is in ERROR	000116
TT_4112_17_ERR	Sensor TT_4112_17 is in ERROR	000117

TAG NAME	Description	HMI Address
TT_4112_18_ERR	Sensor TT_4112_18 is in ERROR	000118
TT_4112_19_ERR	Sensor TT_4112_19 is in ERROR	000119
TT_4112_20_ERR	Sensor TT_4112_20 is in ERROR	000120
TT_4112_21_ERR	Sensor TT_4112_21 is in ERROR	000121
TT_4112_22_ERR	Sensor TT_4112_22 is in ERROR	000122

3.6.4 Display

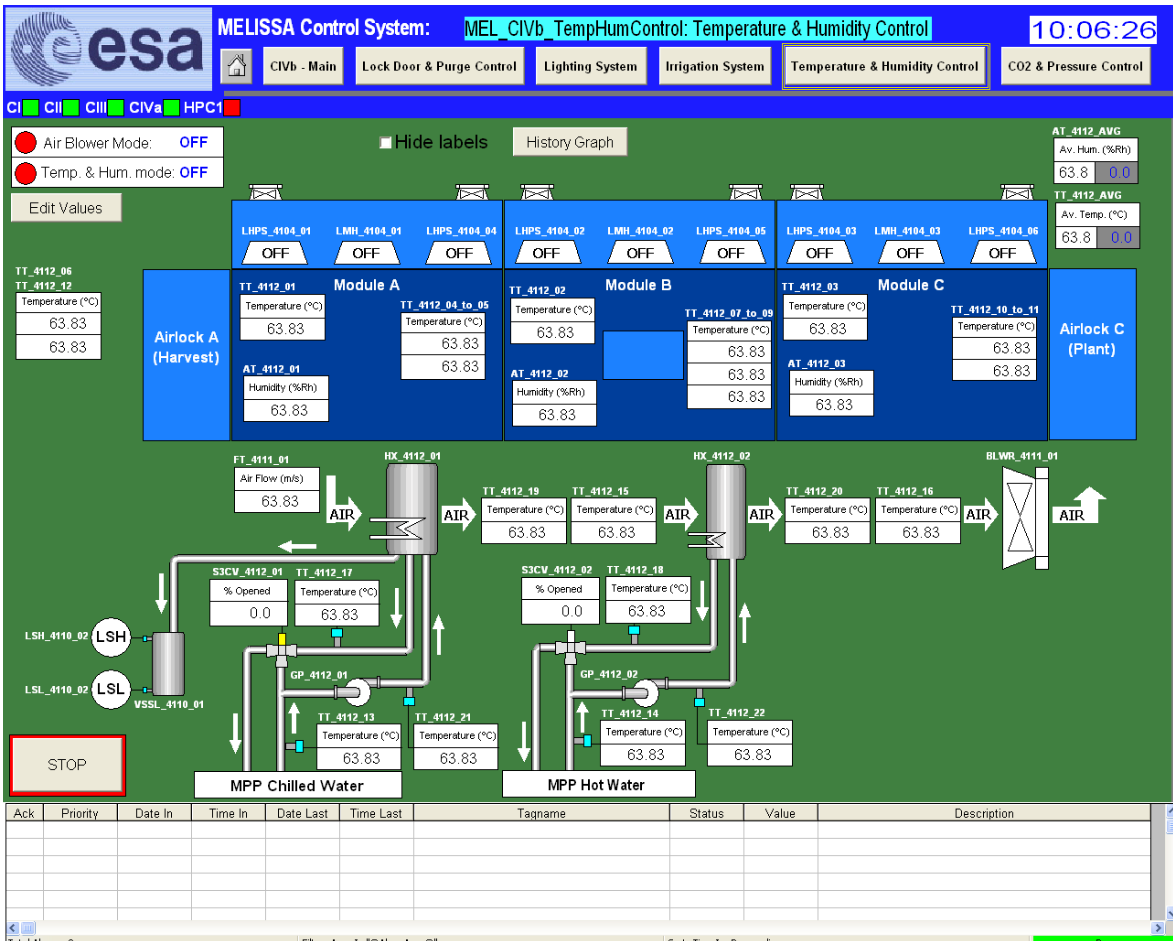


Figure 14: HPC1, Temperature and Humidity Control Display

Temperature and Humidity control display allows the following actions:

- Hide labels selecting the “Hide labels” check box
- Go on to the history graph clicking on the History graph command button.
- Switch OFF the Air Fan, temperature and temperature & humidity mode clicking on the “Stop” command button.
- “Edit values” command button allows configuring the control mode parameters.
- Visualize the hardware status (activated/deactivated) and analogue indicators values.
- Modify the average day temperature set point, average night temperature set point, average day humidity set point and average night humidity set point, depends of CL4104_StartLights (true = day hours, false = night hours) value the data link set point is visible. When CL4104_StartLights = true average day temperature set point and average day humidity set point are visible allowing to modify the value and average night temperature set point and average night humidity set point are not visible and it is not possible to modify the value, for CL4104_StartLights = false is the opposite of the last situation.

3.6.5 Control loop configuration windows

Air Circulation in Manual mode:

Allow activate/deactivate the blower in manual mode selecting the check box and clicking on the “OK” command button.

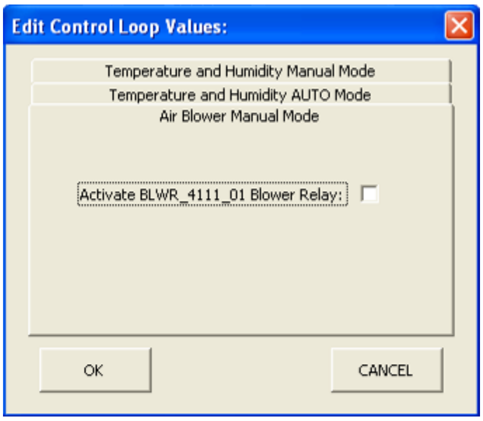


Figure 15: Air Fan configuration in Manual Mode

Temperature and humidity control loop configuration in manual mode:

Allow activate/deactivate of the hot and chill water circulations pumps and set % opening of the 3-way proportional valves.

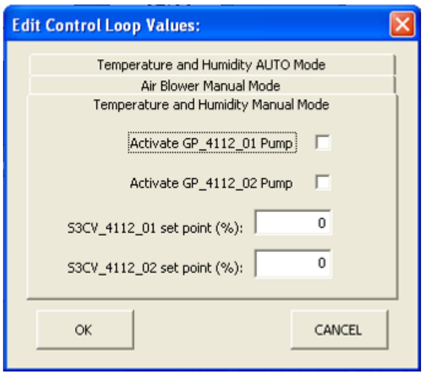


Figure 16: Temperature and Humidity control configuration in Manual Mode

Temperature and Humidity control loop configuration in AUTO mode:

It's the same as last one with the humidity parameters enables.

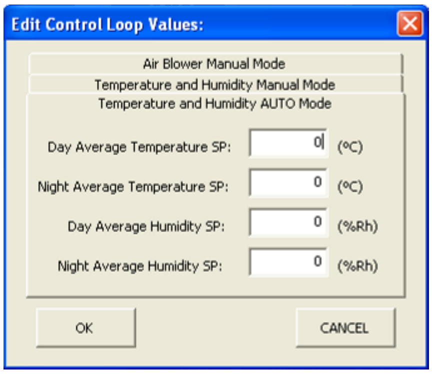


Figure 17: Temperature and Humidity configuration in AUTO mode

Control loop parameters

Tag Name	Description	Type	HMI address
AT_4112_AVG_DAY_SP	Day humidity set point	Text box	400150
AT_4112_AVG_NIGHT_SP	Night humidity set point	Text box	400146
BLWR_4111_01_OP	Activate/Deactivate blower in manual mode	Check box	000153
GP_4112_01_OP	Switch On/Off pump in manual mode	Check box	000154
GP_4112_02_OP	Switch On/Off pump in manual mode	Check box	000155
S3CV_4112_01_OP	% opening valve in manual mode	Text box	400156
S3CV_4112_02_OP	% opening valve in manual mode	Text box	400158

Tag Name	Description	Type	HMI address
TT_4112_AVG_DAY_SP	Day Temperature set point	Text box	400148
TT_4112_AVG_NIGHT_SP	Night temperature set point	Text box	400144

3.6.6 History Graph

The following tags are monitored by default when the user accesses to the History Graph display from the Temperature and Humidity control display:

1. AT_4112_AVG
2. TT_4112_AVG
3. FT_4111_01
4. TT_4112_19
5. TT_4112_20
6. TT_4112_13
7. TT_4112_21
8. TT_4112_17
9. S3CV_4112_01_MV

3.7 CO2 and Pressure Control display

3.7.1 Control loops

Control Loop identifier	Control Loop Name	Description
4113	CO2/O2 Control	The controller maintains CO2 concentrations at demand levels in the growing volume during the user specified photoperiod. Alarms are indicated for out of bound CO2 or high O2 levels.
4114	Passive Pressure	The controller activates an alarm, if passive pressure management fails.

3.7.2 Tag definition

The following tags are displayed in this display:

Tag Name	Description	Type	HMI address
AT_4113_01	CO2 Analyzer	Analogue	400091

Tag Name	Description	Type	HMI address
		indicator	
AT_4113_02	O2 Analyzer	Analogue indicator	400093
FC_4113_01	CO2 Mass Flow	Analogue indicator	400089
FC_4113_01_SP	CO2 Mass flow set point	Analogue indicator	400238
FS_4114_01	Flow switch	Digital indicator	100019
IY_4104_01_MV	Ramps – A (LAMP Sa)	Digital indicator	000011
IY_4104_02_MV	Ramps – B (LAMP Sb)	Digital indicator	000012
IY_4104_03_MV	Ramps- C (LAMP H)	Digital indicator	000013
PT_4114_01	Growing area pressure	Analogue indicator	400095
SV_4113_01_MV	CO2 injection line. Solenoid	2-way valve animated	000022
AT_4113_01_SP	CO2 Analyzer set point	User Input	400162
PS_4114_01	Pressure switch	Digital indicator	100018
TT_4112_06	External chamber temperature	Analogue indicator	400045
TT_4112_12	External chamber temperature	Analogue indicator	400061
PT_4102_01	Pressure sensor for airlock A	Analogue indicator	400013
PT_4103_01	Pressure sensor for airlock C	Analogue indicator	400015

3.7.3 Alarm definition

The following alarms are linked with the operation of the CO2 and pressure control display.

TAG NAME	Description	HMI Address

TAG NAME	Description	HMI Address
AT_4113_01_ERR	Sensor AT_4113_01 is in Error	000135
AT_4113_02_ERR	Sensor AT_4113_03 is in Error	000136
CL4113_CO2_AH	Chamber CO2 Alarm High	000126
CL4113_CO2_AHH	Chamber CO2 Alarm High High	000127
CL4113_CO2_AL	Chamber CO2 Alarm Low	000128
CL4113_CO2_ALL	Chamber CO2 Alarm Low Low	000129
CL4113_O2_AH	Chamber O2 Alarm High	000130
CL4113_O2_AHH	Chamber O2 Alarm High High	000131
CL4113_O2_AL	Chamber O2 Alarm Low	000132
CL4113_O2_ALL	Chamber O2 Alarm Low Low	000133
CL4114_Pressure_AH	Chamber pressure Alarm High	000137
CL4114_Pressure_AL	Chamber pressure Alarm Low	000138
FC_4113_01_ERR	Sensor FC_4113_01 is in Error	000134
PT_4114_01_ERR	Sensor PT_4114_01 is in Error	000139

3.7.4 Display

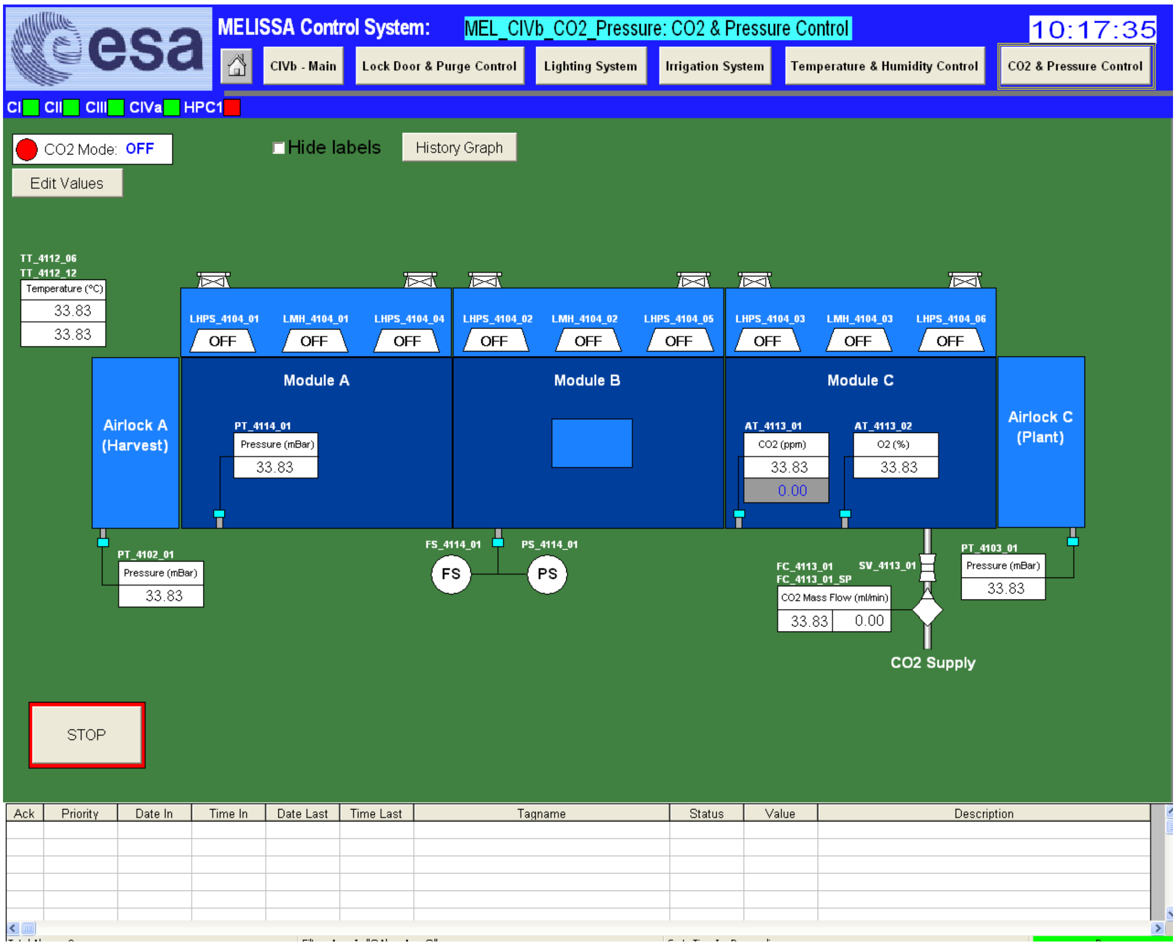


Figure 18: HPC1, CO2 and Pressure control display

CO2 and pressure control display allows the following actions:

- Hide labels selecting the “Hide labels” check box
- Go on to the history graph clicking on the History graph command button.
- Switch OFF the CO2 mode clicking on the “Stop” command button.
- Configure the control mode of the control loop and its parameters.
- Visualize the hardware status (activate/deactivate) and analogue indicators values.
- Modify the CO2 set point directly from display.

3.7.5 Control loop configuration windows

Allow activate/deactivate the CO2 valve and modify the CO2 mass flow set point in manual mode.

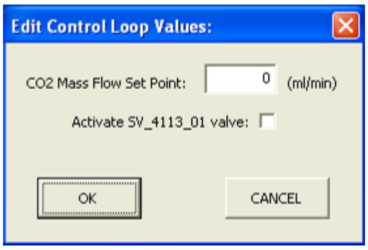


Figure 19: CO2 configuration in Manual mode

Control loop parameters

Tag Name	Description	Type	HMI address
FC_4113_01_OP_SP	CO2 mass flow set point set by user in manual mode	Text box	400160
SV_4113_01_OP	Activate/Deactivate valve in manual mode	Check box	000156

3.7.6 History Graph

The following tags are monitored by default when the user access to the History Graph from the CO2 and pressure control display.

1. PT_4114_01
2. AT_4113_01
3. AT_4113_02
4. FC_4113_01
5. FC_4113_01_SP
6. PT_4102_01
7. PT_4103_01

4. CONTROL LOOP MODE OPERATION DESCRIPTION

In the Upper Left corner of each display there is placed the indicators and configuration of the control loops. To configure the control loops from the display follow these steps:

1. Clicking in the “Edit Values” command button a configure window is displayed to configure the control loops parameters.

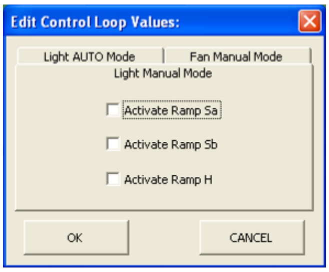


Figure 20: Configuration control loop in manual mode

2. Click on the control loop desired to configure it and window from Figure 22 is displayed. Circle colour and text are animated depending of the mode selected.
   - OFF mode : circle with red background colour and text is "OFF"
   - Manual mode: circle with yellow background colour and text is "MAN"
   - Automatic mode: circle with green background colour and text is "AUTO".

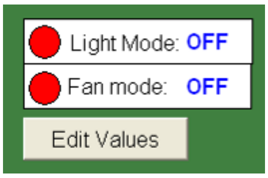


Figure 21: Control Loops indicators and configuration

3. The caption of this form shows the control loop selected and permits to the user to change the mode of operation. The user has to select the mode of operation desired and press OK. Once the user has selected the mode and press OK, the mode will be reflected in the indicators of the Figure 21 (the circle colour and text).

Figure 22: Control Loop Configuration Window

5. HPC1 SYSTEM CLOCK UPDATE

There is a schedule daily executed that updates the HPC1 PLC system clock with the server clock.

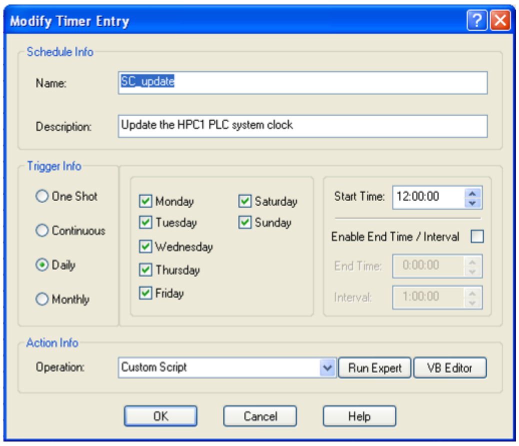


Figure 23: HPC1 PLC system clock schedule configuration

Tag Name	Description	HMI address
CIVB_SYSCLOCK_DAY	Day 1..31	400211
CIVB_SYSCLOCK_DAYOFWEEK	Day of week. 1= Sunday…7=Saturday	400208
CIVB_SYSCLOCK_HOUR	Hour 0…23	400212
CIVB_SYSCLOCK_MIN	Minute 0…59	400213
CIVB_SYSCLOCK_MONTH	Month 1….12	400210
CIVB_SYSCLOCK_SEC	Second 0…59	400214
CIVB_SYSCLOCK_YEAR	Year 0…99	400209
HPC1_SC_ACTIVATE_SETTING	Bit to update the HPC1 PLC system clock	000160

Code implemented

```
Private Sub SC_update_OnTimeOut(ByVal lTimerId As Long)
writevalue "1", "FIX32.MELSRV01.HPC1_SC_ACTIVATE_SETTING.F_CV"
Dim iyear As String
iyear = year(Now)
iyear = Right(iyear, 2)
writevalue iyear, "fix32.melsrv01.civb_sysclock_year.f_cv"
writevalue Month(Now), "FIX32.MELSRV01.CIVB_SYSCLOCK_MONTH.F_CV"
writevalue Day(Now), "FIX32.MELSRV01.CIVB_SYSCLOCK_DAY.F_CV"
writevalue Weekday(Now), "FIX32.MELSRV01.CIVB_SYSCLOCK_DAYOFWEEK.F_CV"
writevalue Hour(Now), "FIX32.MELSRV01.CIVB_SYSCLOCK_HOUR.F_CV"
writevalue Minute(Now), "FIX32.MELSRV01.CIVB_SYSCLOCK_MIN.F_CV"
writevalue Second(Now), "FIX32.MELSRV01.CIVB_SYSCLOCK_SEC.F_CV"
writevalue "0", "FIX32.MELSRV01.HPC1_SC_ACTIVATE_SETTING.F_CV"
End Sub
```

6. HMI DATABASE

HMI database defines the tag names, description, plc address, low and high limit, enable alarming tags, etc. It will be attached in a excel file.

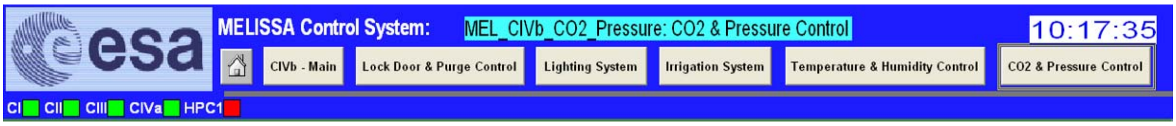
7. GLOBAL ALARM INDICATORS

Alarms are defined in each display.

In the Main Menu there are the general alarm indicators of the each compartment, indicator background colour changes according to:

- Green: There are no alarms activated in the compartment.
- Yellow: some level 1 alarm is activated.
- Red: some level 2 alarm is activated.

In the following picture, compartment CI, CII, CIII and CIVa there isn't any alarm activated and in the compartment CIVb HPC1 there is some level 2 alarm activated.



Look section 3.6 of [R2] to know how to manipulate Alarm display and section 4.0 for alarm and warnings of the analogue indicators displayed in the display.

8. HISTORICAL DATA

Following tags will be stored every 30 seconds. The user will be able to display this data using the historical graph accessible from each display. The following tags are also stored in a Microsoft Access Database every 5 minutes. Microsoft Access is installed in the iFIX client PC and user will be able to access to the database file stored in "Z:\Supervision\PIC\Database\MEL_CIVb_DB.mdb"

To know how to manipulate graphs, see section 3.5 of the [R2]

Tag Name	Description	HMI address
AT_4107_01	pH sensor	400031
AT_4108_01	Electrical conductivity of nutrient	400033
AT_4112_01	Humidity A1 associated with temperature A1	400083
AT_4112_02	Humidity B1 associated with temperature B1	400085
AT_4112_03	Humidity C1 associated with temperature C1	400087
AT_4112_AVG	Chamber average humidity	400154
AT_4112_AVG_DAY_SP	Day time humidity set point in AUTO mode	400150
AT_4112_AVG_NIGHT_SP	Night time humidity set point in AUTO mode	400146
AT_4113_01	CO2 analyzer	400091
AT_4113_01_SP	CO2 set point	400162
AT_4113_02	O2 analyzer	400093

Tag Name	Description	HMI address
BLWR_4111_01_MV	Blower relay	000019
CL4107_DEADZONE	pH dead zone configuration	400140
CL4107_PH_SP	pH set point	400138
CL4108_EC_SP	Electro conductivity set point	400142
FAN_4105_01_MV	Operation of Light Loft Fan A	000003
FAN_4105_02_MV	Operation of Light Loft Fan B	000004
FAN_4105_03_MV	Operation of Light Loft Fan C	000005
FC_4113_01	CO2 Mass flow	400089
FC_4113_01_SP	CO2 mass flow set point	400238
FS_4114_01	Flow switch	100019
PS_4114_01	Pressure switch	100018
FSL_4105_01	Flow/No flow of light loft fan A	100005
FSL_4105_02	Flow/No flow of light loft fan B	100006
FSL_4105_03	Flow/No flow of light loft fan C	100007
FT_4106_01	Outlet nutrient flow sensor	400029
FT_4111_01	Air velocity sensor	400037
GP_4106_01_MV	Main irrigation pump	000014
CP_4110_01_MV	Condensate pump	000006
GP_4112_01_MV	Chilled water circulation pump	000021
GP_4112_02_MV	Hot water circulation pump	000020
IY_4104_01_MV	Ramps – A (Lamp Sa)	000011
IY_4104_02_MV	Ramps – B (Lamp Sb)	000012
IY_4104_03_MV	Ramps – C (Lamp H)	000013
LSH_4110_01	High level sensor for reservoir tank	100014
LSH_4110_02	High level sensor for condensate tank	100016
LSL_4107_01	Acid tank level switch	100010
LSL_4107_02	Base tank level switch	100011
LSL_4108_01	Switch level sensor stock A	100012
LSL_4108_02	Switch level sensor stock B	100013
LSL_4110_01	Low level sensor for reservoir tank	100015
LSL_4110_02	Low level sensor for condensate tank	100017

Tag Name	Description	HMI address
PS_4102_01	Airlock A pressure switch	100008
PS_4103_01	Airlock C pressure switch	100009
PT_4102_01	Pressure sensor for airlock A	400013
PT_4103_01	Pressure sensor for airlock C	400015
PT_4114_01	Growing area pressure	400095
RT_4104_01	PAR Sensor - A	400017
RT_4104_02	PAR Sensor – B	400019
RT_4104_03	PAR Sensor – C	400021
S3CV_4112_01_MV	Chilled water control valve	400234
S3CV_4112_02_MV	Hot water control valve	400236
TT_4105_01	Light Loft Temperature sensor A	400023
TT_4105_02	Light Loft Temperature sensor B	400025
TT_4105_03	Light Loft Temperature sensor C	400027
TT_4109_01	Temperature of nutrient tank	400035
TT_4112_01	Temperature A1 associated with humidity	400039
TT_4112_02	Temperature B1 associated with humidity	400047
TT_4112_03	Temperature C1 associated with humidity	400055
TT_4112_04	Temperature A2	400041
TT_4112_05	Temperature A3	400043
TT_4112_06	Temperature A4	400045
TT_4112_07	Temperature B2	400049
TT_4112_08	Temperature B3	400051
TT_4112_09	Temperature B4	400053
TT_4112_10	Temperature C2	400057
TT_4112_11	Temperature C3	400059
TT_4112_12	Temperature C4	400061
TT_4112_13	Temperature for facility chilled water	400063
TT_4112_14	Temperature for facility hot water line	400065
TT_4112_15	Chilled coil surface temperature	400067
TT_4112_16	Heating coil surface temperature	400069
TT_4112_17	Chilled exit temperature	400071

Tag Name	Description	HMI address
TT_4112_18	Hot exit temperature	400073
TT_4112_19	Outlet air, chilled exchanger	400075
TT_4112_20	Outlet air, hot exchanger	400077
TT_4112_21	Inlet water chilled exchanger	400079
TT_4112_22	Inlet water hot exchanger	400081
TT_4112_AVG	Chamber average temperature	400152
TT_4112_AVG_DAY_SP	Day time temperature set point in AUTO mode	400148
TT_4112_AVG_NIGHT_SP	Night time temperature set point in AUTO mode.	400144
ZS_4100_01	Upper Exterior Air Lock Door Contact – Side A	100001
ZS_4101_01	Upper Exterior Air Lock Door Contact – Side C	100003

9. FILES LIST

In the following table there is a list of the files used and its path. All of them are stored in the server PC.

File name	Path	Description
MELSRV01.MBE	C:\Dynamics\PDB\	Modbus driver configuration
MEL_MBE3.pdb	C:\Dynamics\PDB\	iFIX database file
MEL_Main.grf	D:\Supervision\PIC	Melissa Main display
MEL_MainMenu.grf	D:\Supervision\PIC	Melissa Main menu display
MEL_Alarm_Bar.grf	D:\Supervision\PIC	Alarm bar display
MEL_CIVb_Main.grf	D:\Supervision\PIC	Melissa CIVb Main display
MEL_CIVb_MainMenu.grf	D:\Supervision\PIC	Melissa CIVb Main Menu display
MEL_CIVb_DoorPurge.grf	D:\Supervision\PIC	Lock Door and purge control display
MEL_CIVb_Lighting.grf	D:\Supervision\PIC	Lighting system control display
MEL_CIVb_Irrigation.grf	D:\Supervision\PIC	Irrigation system control

		display.
MEL_CIVb_TempHumControl.grf	D:\Supervision\PIC	Temperature and Humidity control display
MEL_CIVb_CO2_Pressure.grf	D:\Supervision\PIC	CO2 and pressure control display.
iFIX1_trend.grf	D:\Supervision\PIC	Graph display
MEL_CIVb_SAVEVALUES.evs	C:\Dynamics\PDB	Schedule executed every 5 minutes to save data in access file
SystemControl.evs	C:\Dynamics\PDB	Daily execution schedule to update the HPC1 PLC system clock with the server clock.
MEL_CIVb_DB.mdb	D:\Supervision\PIC\Database	Access file where acquired data is stored.
CIVb_MDB.txt	D:\Supervision\PIC\Logs	SQL command executed to save in the access database is stored in txt file.
Historical configuration	D:\Supervision\HTR	There are the historical data assigned to be stored.
Historical data	D:\Supervision\HTRDATA	Historical data packets.
MEL_CIVb_DoorPurge.txt	D:\Supervision\APP\Chart_cfg	Door Purge graph tags configuration
MEL_CIVb_Lighting.txt	D:\Supervision\APP\Chart_cfg	Lighting graph tags configuration
MEL_CIVb_Irrigation.txt	D:\Supervision\APP\Chart_cfg	Irrigation graph tags configuration
MEL_CIVb_TempHumControl.txt	D:\Supervision\APP\Chart_cfg	Temperature and Humidity control graph tags configuration
MEL_CIVb_CO2_Pressure.txt	D:\Supervision\APP\Chart_cfg	CO2 and pressure graph tags configuration.
Configurations.txt	D:\Supervision\APP\Chart_cfg	Displays is using graph configuration.

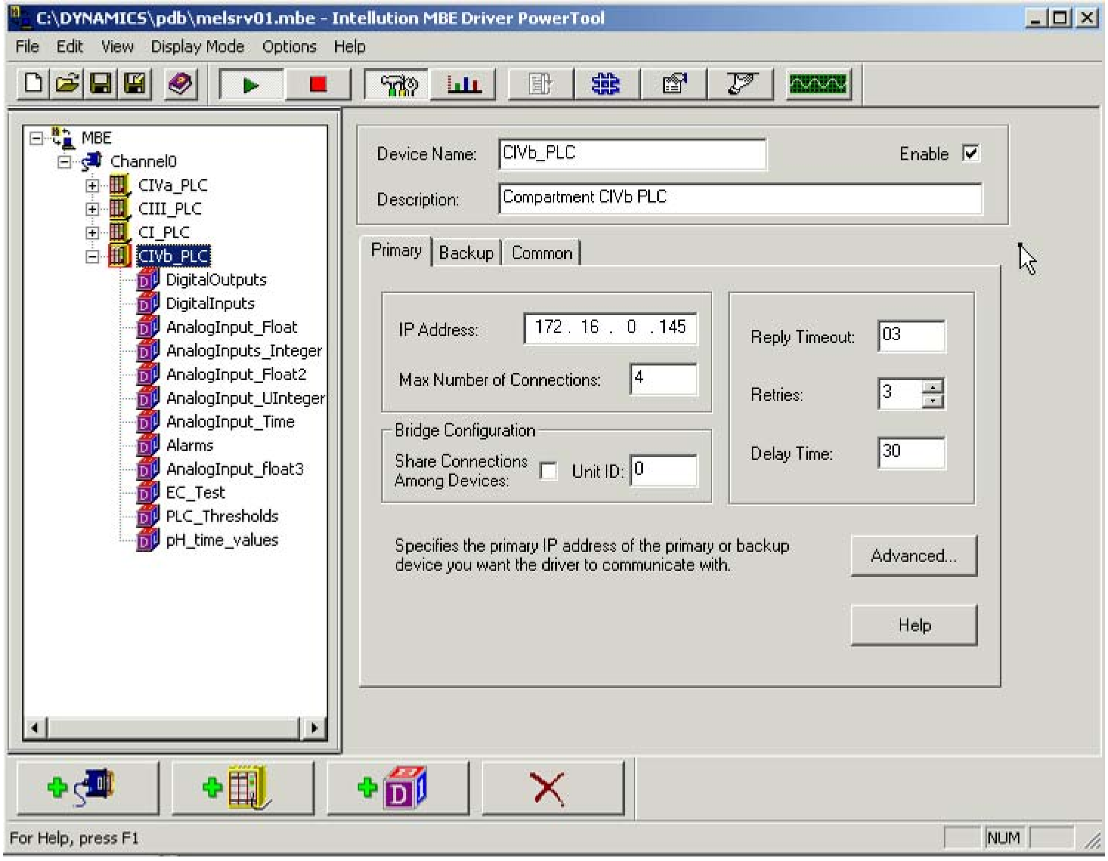


Figure 24: MBE Power Tool

SECTION 4: HPC1 HMI User Manual (NTE Document ref.: NTE-HPCP2-HB-005, Issue 1.0), 42 pages

CIVb HPC1 HMI SW USER MANUAL

FOR THE

MELISSA CS CI

APPROVAL LIST		
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CHANGE RECORD

AUTHOR	ISSUE	DATE	CHANGE
J.Carbonell	1.0	20/07/2009	New Version

CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

1. SCOPE

This Operations Manual is intended to help the operation and maintenance of the Control System Demonstrator for compartment CIVb HPC1 in the MELISSA Plant installed at the UAB.

The detailed design description of this system is provided in the Hardware Design Document and Software Design Document, [R6] and [R7] respectively.

2. REFERENCE DOCUMENTS

2.1 APPLICABLE DOCUMENTS

[A1]	Connection and HMI SW Activities on MPP'S compartment CIVb HPC	NTE-HPCP2-OF-001 Issue 1.0, Oct. 2008

2.2 REFERENCE DOCUMENTS

[R1]	Technical Note 85.74: Higher Plant chamber Prototype for the MELISSA Pilot Plant: Control Systems Document	Issue 1.0, March 2008
[R2]	Technical Note 85.91: Prototype Operations Manual	Issue 1.0, August 2008
[R3]	Technical Note 85.73: Prototype Interface Specifications User Manual	Issue 1.0, May 2008
[R4]	MPP Tag List HPC1 P&ID	Issue 3.0, March 2008
[R5]	CIVb_HMI_20090617.xls (Sherpa)	June 2009
[R6]	NTE-HPC-RP-003 (Melissa Pilot Plant HPC Control Hardware design document)	Issue 2.0 July 2009
[R7]	NTE-HPCP2-RP-002 (Melissa HPC1 HMI Design)	Issue 1.0, July 2009

3. ACRONYMS

EC Electro Conductivity

HPC Higher Plants Compartment

HMI Human Machine Interface

MPP MELiSSA Pilot Plant

4. INTRODUCTION

4.1 Intended Readership

This manual is intended for personnel in charge of the operation of the MELISSA Control System for both maintenance and scientific purposes.

- Investigators responsible of performing in-plant experiments.

- Maintenance and troubleshooting personnel in charge of the installation and maintenance of the MELISSA Pilot Plant Software.

It is expected that users have some basic Microsoft® Windows knowledge and familiarity with the MELISSA Pilot Plant.

Note that no detailed explanation about the operation of third-party software(s) used to implement the Control System is given in this manual, but only reference to their corresponding user manuals when more detail is needed.

4.2 Purpose

The purpose of this document is to provide the user with an understanding of the functions available in the MELISSA CIVb HPC1 HMI Software and a description of the common operations to be performed during its utilisation and maintenance. Following the instructions described in this manual will lead to a better understanding and to obtain a full profit of the MELISSA CIVb HPC1 HMI software utilisation.

4.3 How to use this document

The Overview section is intended for all users. It summarises what this system is used for, into the process of using the MELISSA Pilot Plant.

The Table of Contents can be used to easily locate the detailed description of a specific function.

Maintenance and troubleshooting are addressed in par, 8 and 9 respectively.

4.4 Problem reporting instructions

Problems found must be reported to NTE following the form included in APPENDIX B.

NTE S.A.
Pol. Can Malé s/n
08186 Lliça d'Amunt
Barcelona
Spain
www.nte.es
info@nte.es
Tel.: 93 860 9001
Fax: 93 860 9019

5. OVERVIEW

Higher Plant Compartment (HPC: 4B): Activities on this compartment have been initiated with eight crops: wheat, tomato, potato, soybean, rice spinach, onion and lettuce. Simulations of this HPC require a description of biomass production rates as well as their mineral and proximate compositions. An important number of investigations have been initiated with the University of Guelph to obtain these values, first from open-field data, then in greenhouses.

Environmental considerations (light, nutrients, vapour pressure,…) are of course taking into account. A third aspect of the investigations on the HPC is the study of the higher plant necessary hardware. Studies have been initiated for the light sources as well as nutrients sensors.

Figure 1: HPC1

6. DISPLAYS

6.1 Display hierarchy:

Supervision displays navigation is implemented as follows:

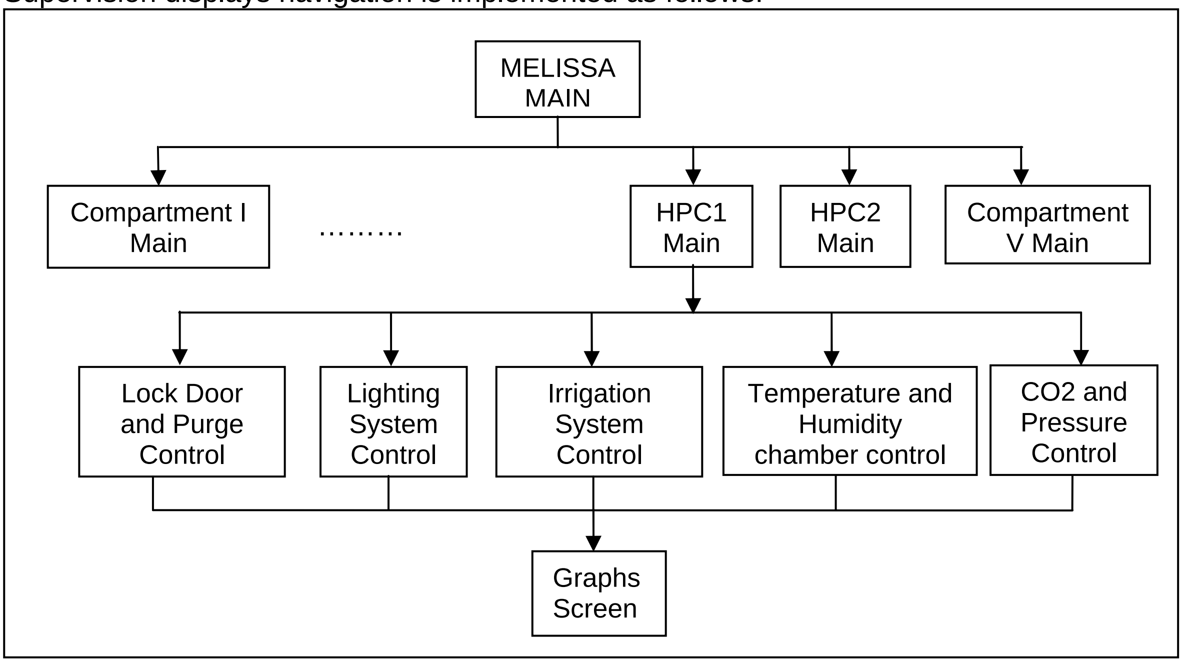

Figure 2: Display hierarchy

A process display has been implemented for every main loop, grouping process variables and control actions.

6.2 MELISSA MAIN WINDOW

From this window, the user can access to the Main window of the each compartment.

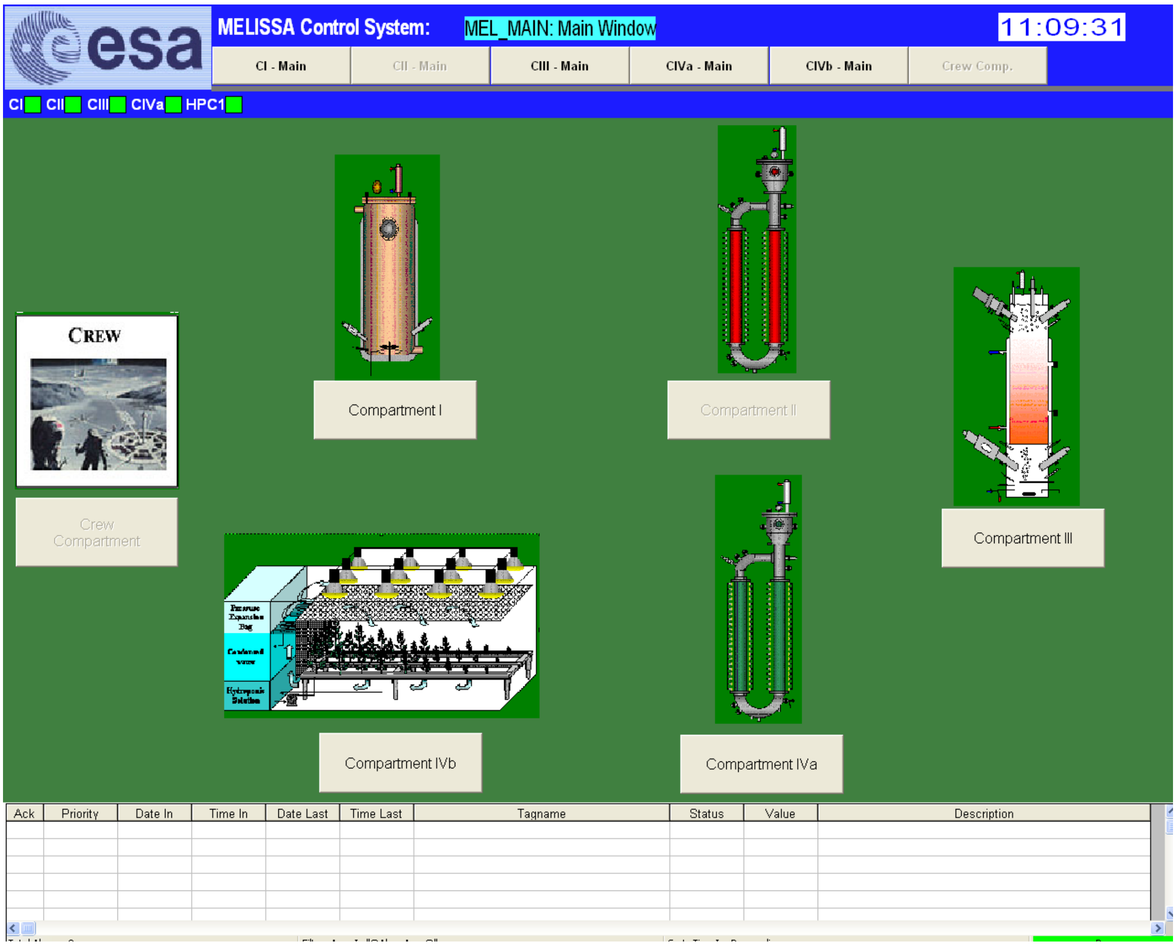

Figure 3: Melissa Main Window

In the Main Menu there are the general alarm indicators of the each compartment, indicator background colour changes according to:

- Green: There are no alarms activated in the compartment.
- Yellow: some level 1 alarm is activated.
- Red: some level 2 alarm is activated.

In the following picture, compartment CI, CII, CIII and CIVa have no alarm activated and in the compartment CIVb HPC1 there is a level 2 alarm activated (indicator in red).

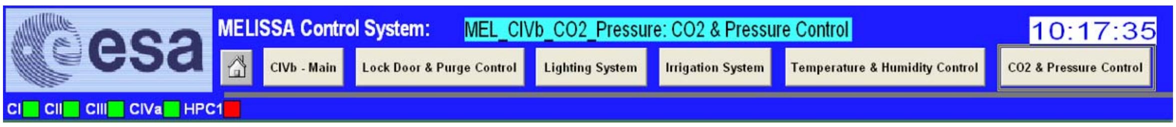

Figure 4: Global alarms

6.3 Compartment CIVb HPC1 Main window

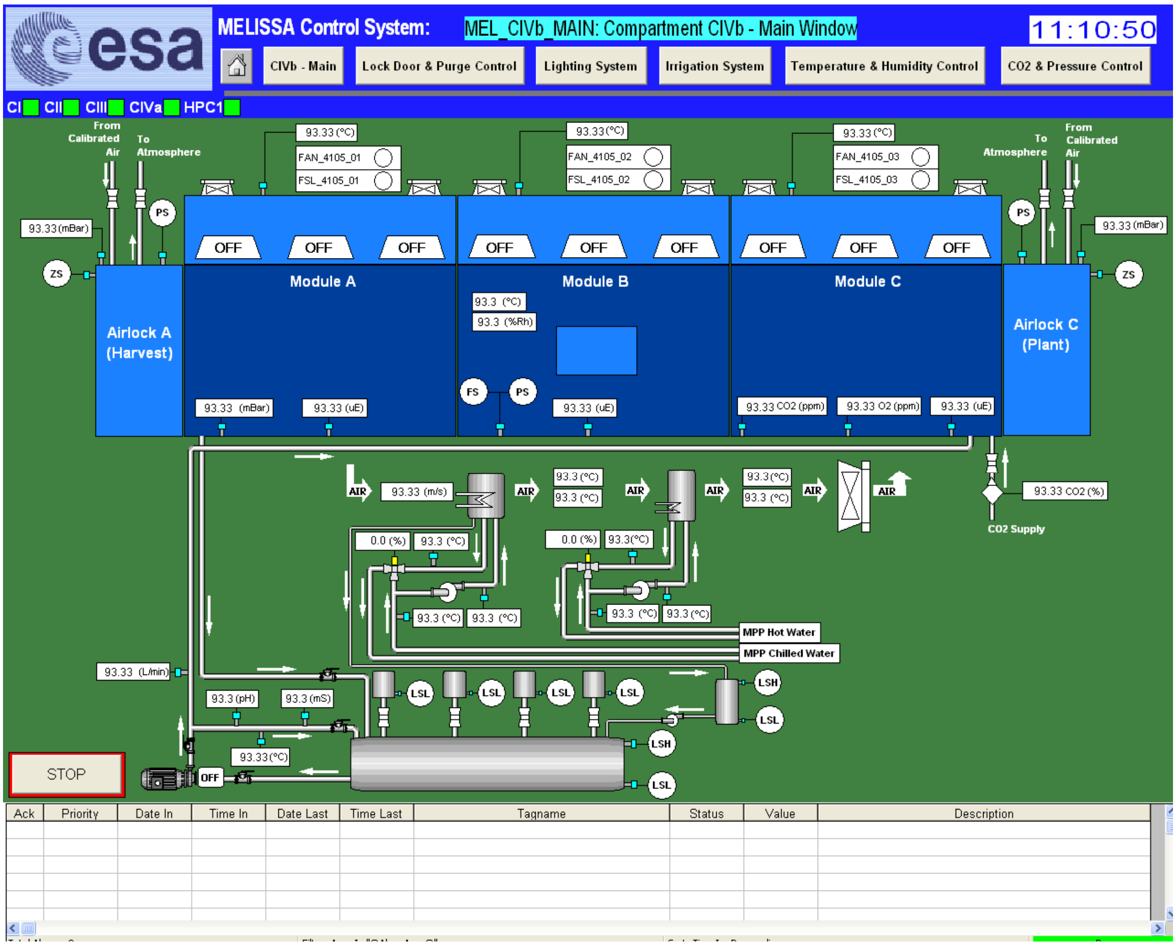

Figure 5: Compartment CIVb HPC1 Main Window

Compartment CIVb HPC1 Main Menu is used to navigate for each subsystem of the CIVb HPC1, to visualize general alarms and configure the CIVb HPC1 system clock.

CIVb HPC1 system clock is configurated pushing a double click over digital clock (Figure 6) and its configuration window (Figure 7) will be displayed.

Figure 6: CIVb HPC1 Main Menu Window

CIVb HPC1 system clock configuration window is opened reading the following values:

- Day of week: CIVb_SysClock_dayofweek (PLC address: 400208)
- Day: CIVb_SysClock_day (PLC address: 400211)
- Month: CIVb_SysClock_month (PLC address: 400210)
- Year: CIVb_SysClock_Year (PLC address: 400209)
- Hour: CIVb_SysClock_Hour (PLC address: 400212)

- Minute: CIVb_SysClock_Min (PLC address: 400213)
- Second: CIVb_SysClock_Sec (PLC address: 400214)

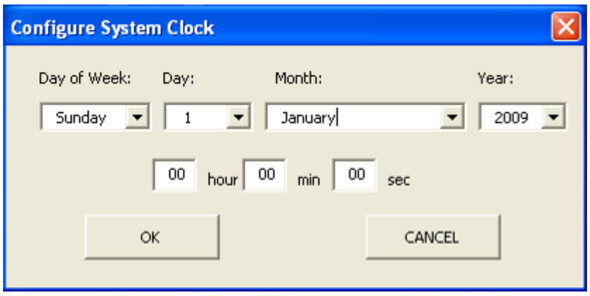

Figure 7: CIVb HPC1 system clock configuration window

The user configures the system clock and press “Ok” command button to write updated values in the following plc address.

- Day of week: HPC1_SysClock_dayofweek_SET (PLC address: 400192)
- Day: HPC1_SysClock_day_SET (PLC address: 400195)
- Month: HPC1_SysClock_month_SET (PLC address: 400194)
- Year: HPC1_SysClock_Year_SET (PLC address: 400193)
- Hour: HPC1_SysClock_Hour_SET (PLC address: 400196)
- Minute: HPC1_SysClock_Minute_SET (PLC address: 400197)
- Second: HPC1_SysClock_Second_SET (PLC address: 400198)

Pressing “CANCEL” command button, the window is closed without writing values.

From the compartment CIVb HPC1 Main Window the user has a general view of the compartment CIVb HPC1 and allows the following actions:

- To have a general view of compartment CIVb HPC1.
- Analogue indicators of the most significant readings.
- Pipes animations.
- Object alarm animation.
- 2-way valves, 3-way proportional valves, pumps, level switch, pipes, lights, fans, fan flow sensor switch, pressure switch, flow switch and blower animations.
- Emergency button command button stops all control loops of the CIVb HPC1.
  - Light Mode (CL4104_ControlLoop_Mode)
  - Fan Mode (CL4105_ControlLoop_Mode)
  - Irrigation Mode (CL4106_ControlLoop_Mode)
  - pH Mode (CL4107_ControlLoop_Mode)
  - EC Mode (CL4108_ControlLoop_Mode)
  - Condensate level Mode (CL4110_ControlLoop_Mode)
  - Air blower Mode (CL4111_ControlLoop_Mode)
  - Temperature and Humidity Mode (CL4112_ControlLoop_Mode)
  - CO2 Mode (CL4113_ControlLoop_Mode)

Following tags are displayed in the CIVb HPC1 main window:

Tag Name	Description
AT_4107_01	pH sensor
AT_4108_01	Electrical conductivity of nutrient
AT_4112_AVG	Chamber average humidity
AT_4113_01	CO2 Analyzer
AT_4113_02	O2 Analyzer
BLWR_4111_01_MV	Blower relay
FAN_4105_01_MV	Operation of Light Loft Fan A
FAN_4105_02_MV	Operation of Light Loft Fan B
FAN_4105_03_MV	Operation of Light Loft Fan C
FC_4113_01	CO2 Mass Flow
FS_4114_01	Flow switch
FSL_4105_01	Flow/No Flow of Light Loft Fan A
FSL_4105_02	Flow/No Flow of Light Loft Fan B
FSL_4105_03	Flow/No Flow of Light Loft Fan C
FT_4106_01	Outlet nutrient flow sensor
FT_4111_01	Air velocity sensor
GP_4106_01_MV	Main Irrigation Pump
GP_4110_01_MV	Condensate pump relay
GP_4112_01_MV	Chilled water circulation pump
GP_4112_02_MV	Hot water circulation pump
IY_4104_01_MV	Ramps – A (LAMP Sa)
IY_4104_02_MV	Ramps – B (LAMP Sb)
IY_4104_03_MV	Ramps- C (LAMP H)
LSH_4110_01	High level sensor for reservoir tank
LSH_4110_02	High level sensor for condensate tank
LSL_4107_01	Acid Tank level
LSL_4107_02	Base Tank level
LSL_4108_01	Level sensor Stock A
LSL_4108_02	Level sensor Stock B
LSL_4110_01	Low level sensor for reservoir tank
LSL_4110_02	Low level sensor for condensate tank
PS_4102_01	Airlock A pressure switch
PS_4103_01	Airlock C pressure switch
PT_4102_01	Pressure sensor for airlock A
PT_4103_01	Pressure sensor for airlock C
PT_4114_01	Growing Area Pressure
RT_4104_01	PAR Sensor – A
RT_4104_02	PAR Sensor – B
RT_4104_03	PAR Sensor – C
S3CV_4112_01_MV	Chilled water control valve
S3CV_4112_02_MV	Hot water control valve
STOP	Switch OFF all control loops
SV_4102_01_MV	Solenoid valve for injection of pressurized air into airlock A.
SV_4102_02_MV	Airlock A ventilation Solenoid valve
SV_4103_01_MV	Solenoid valve for injection of pressurized air into airlock C
SV_4103_02_MV	Airlock C ventilation solenoid valve
SV_4107_01_MV	Acid Tank valve
SV_4107_02_MV	Base Tank valve
SV_4108_01_MV	Stock A inject valve
SV_4108_02_MV	Stock B inject valve
SV_4113_01_MV	CO2 inject line. Solenoid
TT_4105_01	Light Loft Temperature sensor A
TT_4105_02	Light Loft Temperature sensor B
TT_4105_03	Light Loft Temperature sensor C
TT_4109_01	Temperature of nutrient tank

Tag Name	Description
TT_4112_13	Temperature for facility chilled water
TT_4112_14	Temperature for facility hot water line
TT_4112_15	Chilled coil surface temperature
TT_4112_16	Heating coil surface temperature
TT_4112_17	Chilled exit temperature
TT_4112_18	Hot exit temperature
TT_4112_19	Outlet Air chilled exchanger
TT_4112_20	Outlet Air Hot exchanger
TT_4112_21	Inlet water chilled exchanger
TT_4112_22	Inlet water hot exchanger
TT_4112_AVG	Chamber average temperature
ZS_4100_01	Upper Exterior Air Lock Door Contact – Side A
ZS_4101_01	Upper Exterior Air Lock Door Contact – Side C
PS_41414_01	Pressure switch

Table 1 Main window tags

6.4 Lock door and Purge control display

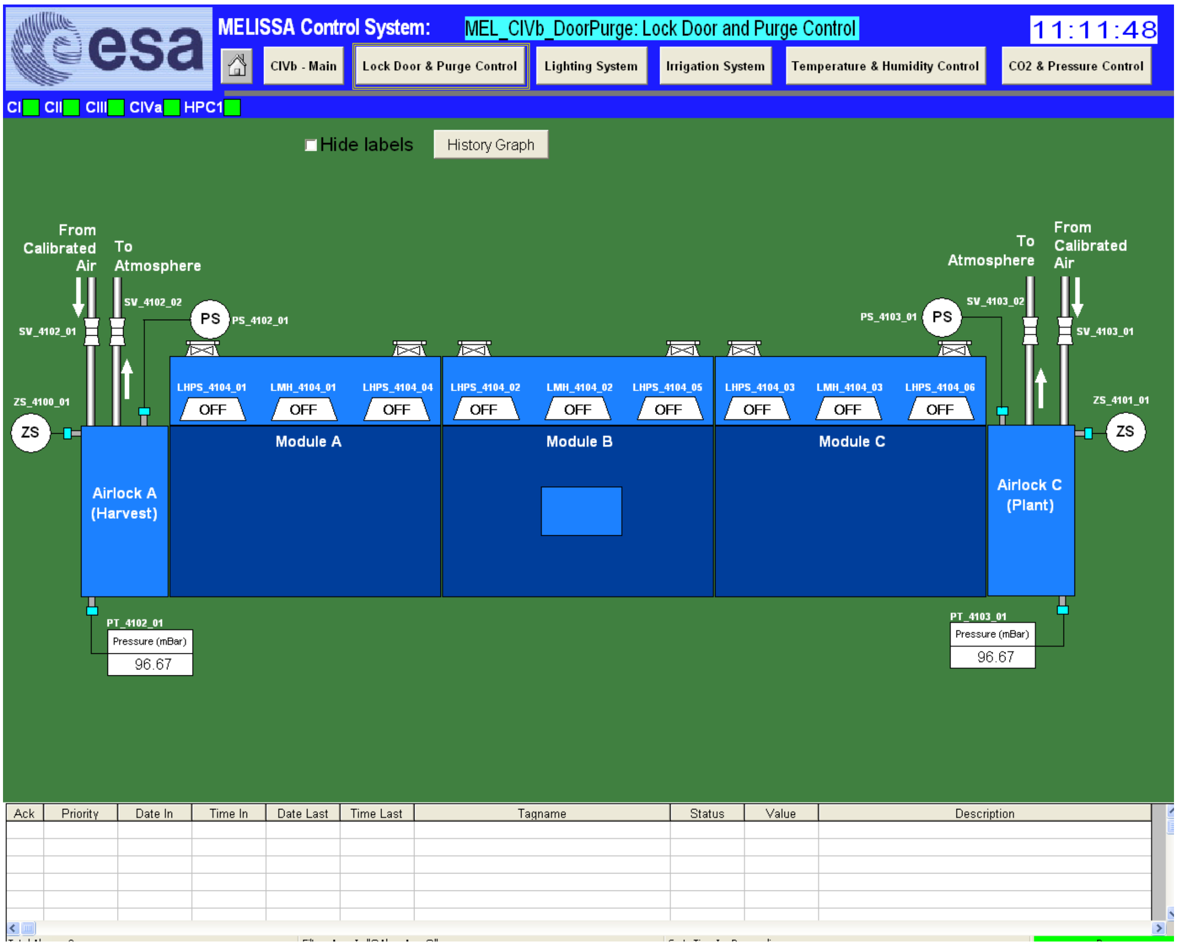

Figure 8: Lock Door and Purge Control Screen

6.4.1 General actions

This display allows the following actions:

- Pipes animated (changing the colour when the gas is flowing).
- 2-way valves, pressure switches, misalignment switch and lights animations.

- Analogue indicators.
- Display the history graph clicking on the History graph command button.
- Hide labels selecting the “Hide labels” check box
- Object alarm animations.

6.4.2 Alarms

6.4.2.1 Door open alarm

Door open Alarm: It’s activated when the door is opened more than 10 minutes and it’s displayed with red colour.

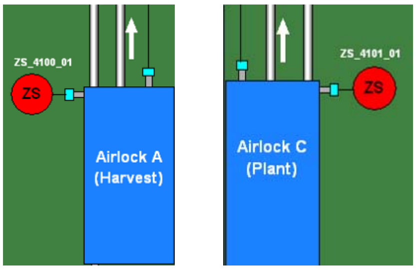

Figure 9: Door open alarm

6.4.2.2 Airlock pressure sensor error

Airlock pressure transducer alarms: “ERR.” Text is displayed when there is some sensor wire broken.

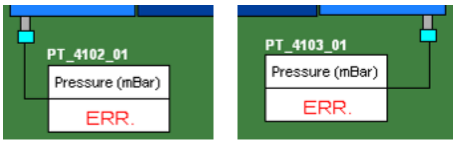

Figure 10: Airlock pressure alarm

6.4.3 Tags

Following tags are displayed in the Lock door and purge control display:

Tag Name	Description
IY_4104_01_MV	Ramps – A (LAMP Sa)
IY_4104_02_MV	Ramps – B (LAMP Sb)
IY_4104_03_MV	Ramps- C (LAMP H)
PS_4102_01	Airlock A pressure switch
PS_4103_01	Airlock C pressure switch
PT_4102_01	Pressure sensor for airlock A
PT_4103_01	Pressure sensor for airlock C
SV_4102_01_MV	Solenoid valve for injection of pressurized air into airlock A.
SV_4102_02_MV	Airlock A ventilation Solenoid valve
SV_4103_01_MV	Solenoid valve for injection of pressurized air into airlock C
SV_4103_02_MV	Airlock C ventilation solenoid valve
ZS_4100_01	Upper Exterior Air Lock Door Contact – Side A
ZS_4101_01	Upper Exterior Air Lock Door Contact – Side C

Table 2 Lock door and purge display tags

6.4.4 Control loops

Control loops in the Lock door and purge control screen:

- Exterior Airlock Door A Alarm
- Exterior Airlock Door C Alarm
- Airlock A Purge
- Airlock C Purge

6.5 Lighting System Display

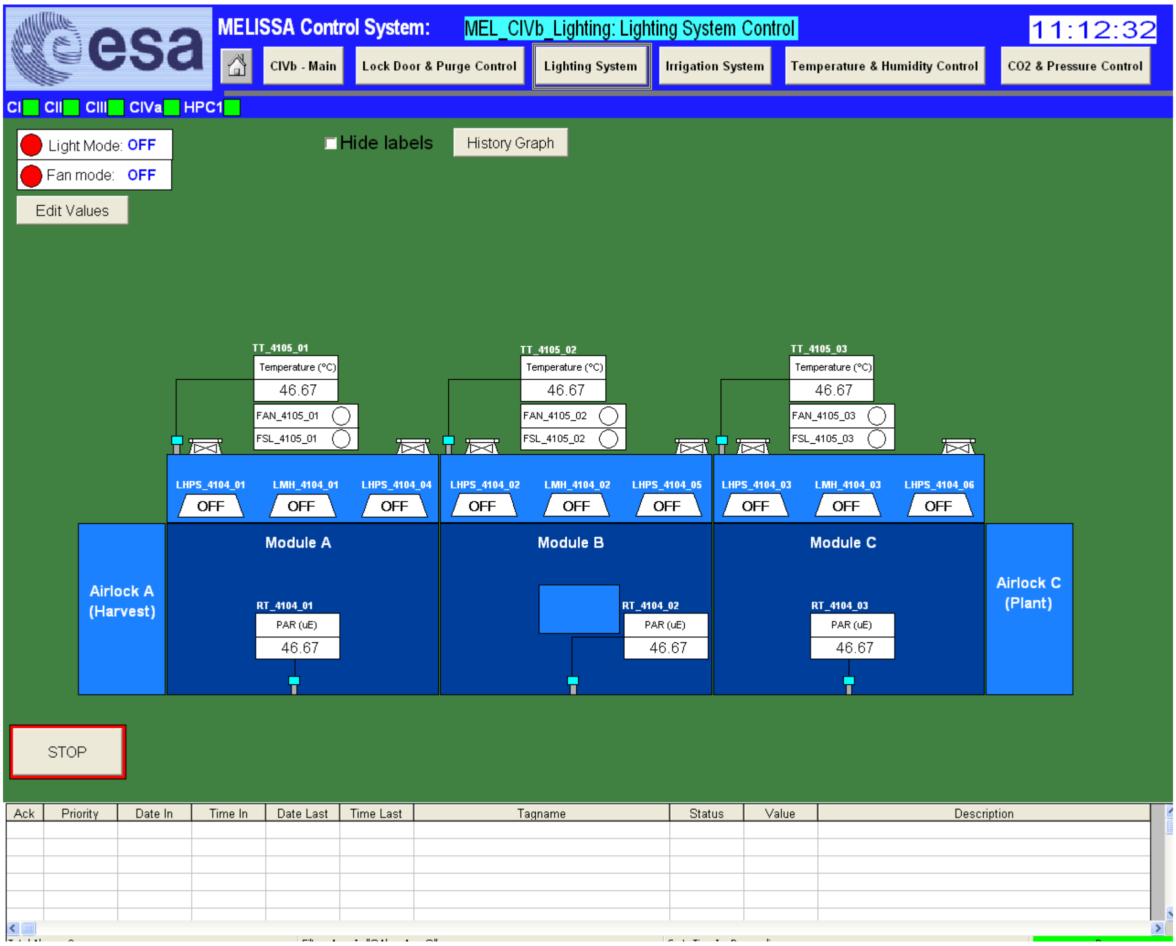

Figure 11: Lighting system screen

6.5.1 General actions

This display allows the following actions:

- Analogue indicators.
- Fans, flow switches and lights animated.
- Display the history graph clicking on the History graph command button.
- Hide labels selecting the “Hide labels” check box.
- Stop command button stops Light Mode and Fan Mode control loops.
- Change Lighting and Light loft temperature control loop mode (OFF, AUTO, MAN) clicking on the control loop desired.

- Edit control loops values clicking in the “Edit Values” command button.
- Object alarm animations.

6.5.2 Alarms

Light Loft Temperature and flow fan alarms:

When Light loft temperature is higher than 42ºC the high alarm is fired (see TT_4105_02 in the following figure) and if it’s higher than 45ºC the high high alarm is fired (see TT_4105_01).

Flow fan alarm is set when fan control signal is set and fan flow sensor is OFF. Alarm is indicated with yellow colour.

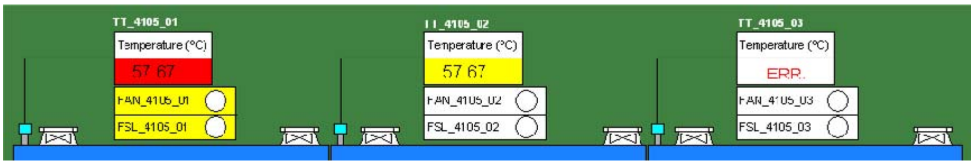

Figure 12: Light Loft Temperature and flow fan alarms

- o Ramp intensity alarm:

Ramp Sa fires an alarm if the following condition is true:

CL4104_Sa_AH OR CL4104_Sa_AL OR CL4104_Sa_H_AH OR CL4104_Sa_H_AL OR CL4104_Sa_Sb_AH OR CL4104_Sa_Sb_AL OR CL4104_Sa_Sb_H_AH OR CL4104_Sa_Sb_H_AL OR CL4104_NoLight_AH

Ramp Sb fires an alarm if the following condition is true:

CL4104_Sb_AH OR CL4104_Sb_AL OR CL4104_Sa_Sb_AH OR CL4104_Sa_Sb_AL OR CL4104_Sa_Sb_H_AH OR CL4104_Sa_Sb_H_AL OR CL4104_NoLight_AH

Ramp H fires an alarm if the following condition is true:

CL4104_H_AH OR CL4104_H_AL OR CL4104_Sa_H_AH OR CL4104_Sa_H_AL OR CL4104_Sa_Sb_H_AH OR CL4104_Sa_Sb_H_AL OR CL4104_NoLight_AH

Figure 13: Ramp intensity alarm

6.5.3 Tags

Following tags are displayed in the Lighting system display:

Tag Name	Description
CL4104_ControlLoop_Mode	Light Mode (Off/Auto/Man)
CL4105_ControlLoop_Mode	Fan Mode (Off/Auto/Man)
FAN_4105_01_MV	Operation of Light Loft Fan A
FAN_4105_02_MV	Operation of Light Loft Fan B
FAN_4105_03_MV	Operation of Light Loft Fan C
FSL_4105_01	Flow/No Flow of Light Loft Fan A
FSL_4105_02	Flow/No Flow of Light Loft Fan B
FSL_4105_03	Flow/No Flow of Light Loft Fan C
IY_4104_01_MV	Ramps – A (LAMP Sa)

Tag Name	Description
IY_4104_02_MV	Ramps – B (LAMP Sb)
IY_4104_03_MV	Ramps- C (LAMP H)
RT_4104_01	PAR Sensor – A
RT_4104_02	PAR Sensor – B
RT_4104_03	PAR Sensor – C
Stop Button	Switch Off CL4104_ControlLoop_mode and CL4105_ControlLoop_mode.
TT_4105_01	Light Loft Temperature sensor A
TT_4105_02	Light Loft Temperature sensor B
TT_4105_03	Light Loft Temperature sensor C

Table 3 Lighting System Display

6.5.4 Control Loops

Control loops executed from lighting system screen:

- Light Intensity control (CL4104_ControlLoop_Mode)
- Lighting Loft Temperature Control (CL4105_ControlLoop_Mode)

6.5.4.1 Light Intensity Control:

To configure the light intensity control and its parameters execute the following steps:

1. Configure the parameters clicking in the “Edit Values” command button.
2. The following picture appears.

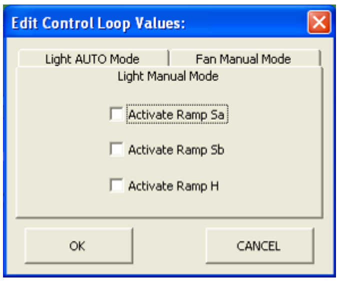

Figure 14: Lighting system configuration in Manual mode

Default tab opened is Manual mode lighting parameters, selecting the other tabs the user can configure the Lighting parameters in Automatic mode and Lighting Loft fan configuration in Manual mode.

“Activate Ramp Sa” checkbox activates Lamps Sa in manual mode (IY_4104_01_OP)

“Activate Ramp Sb” checkbox activates Lamps Sb in manual mode (IY_4104_02_OP)

“Activate Ramp H” checkbox activates Lamps H in manual mode (IY_4104_03_OP)

6.5.4.1.1 Light Intensity Control in Automatic mode

User configures the time (hour and minute) when day starts and day ends, the time between day starts and day ends all lamps are ON and in night hours all lamps are OFF.

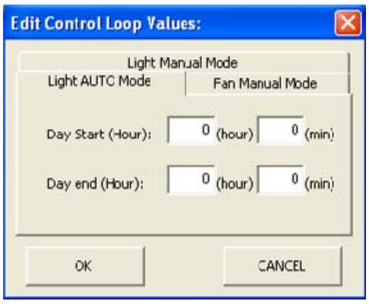

Figure 15: Lighting system configuration in AUTO mode

6.5.4.1.2 Lighting loft temperature control in manual mode

Allow activate/deactivate independently each lighting loft fan.

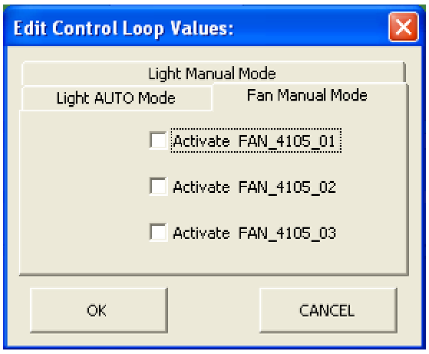

Figure 16: Lighting Loft fan configuration in Manual mode

6.6 Irrigation system display

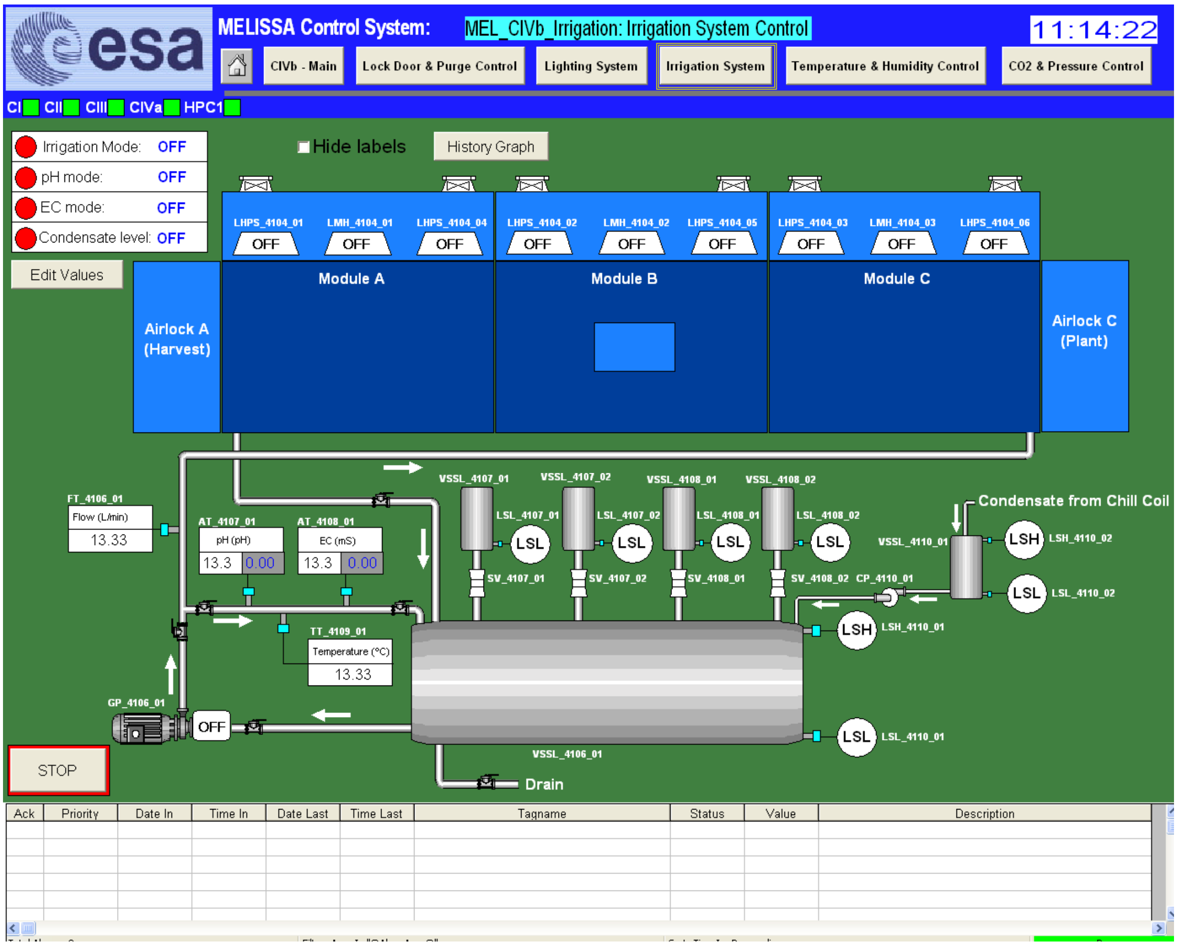

Figure 17: Irrigation system screen

6.6.1 General actions

This display belongs to the Irrigation system and allows the following actions:

- 2-way valves, level switches, pumps, lights animations.
- Analogue indicators.
- Change pH and Electro-conductivity set point modifying the value with blue foreground colour and pressing "Enter" key, confirm window will be displayed to confirm the value changed.

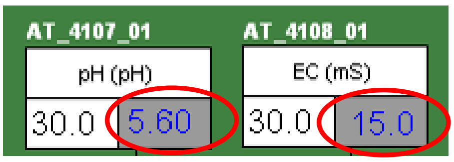

Figure 18: pH and EC set point

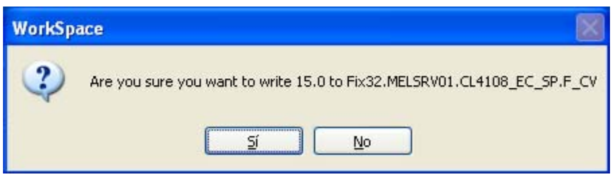

Figure 19: Set point confirmation window

- Change Irrigation, pH, EC and Condensate level control loop mode (OFF, AUTO, MAN) clicking on the control loop desired.
- Edit control loops values clicking in the “Edit Values” command button.
- Display the history graph clicking on the History graph command button.
- Hide labels selecting the “Hide labels” check box
- Stop Irrigation, pH, EC and Condensate level control loops clicking “Stop” command button.
- Alarms animated.

6.6.2 Alarms

6.6.2.1 Control Pump Error Alarm

Control Pump Error Alarm (CL4106_PumpError_A):

Alarm is set when irrigation pump is stopped and the flow sensor value is higher than low low limit.

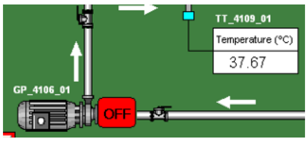

Figure 20: Irrigation Pump alarm

6.6.2.2 Acid/Base tank low level alarm

Acid/Base tank low level alarm (CL4107_AcidTank_AL and CL4107_BaseTank_AL):

Acid and base tank low level alarm is activated when the tank low level switch is set at least for 2 seconds.

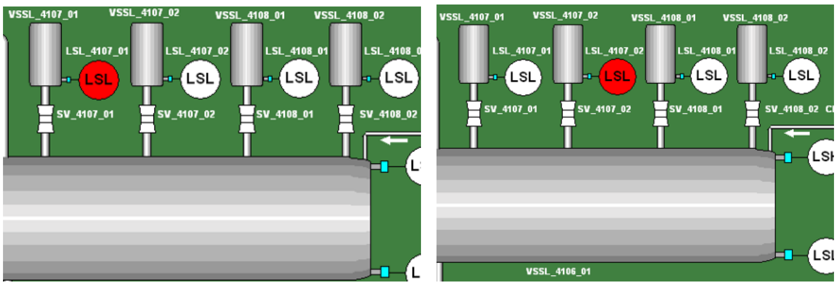

Figure 21: Acid and Base low level tank alarm

6.6.2.3 pH alarm limits and sensor communication errors

pH alarm limits and sensor communication errors:

- High High alarm is activated if ph is higher than (set point + dead zone + 0.)
- High alarm is activated if ph is higher than (set point + deadzone+0.2)
- Low alarm is activated if ph is less tan (set point – dead zone -0.2)
- Low low alarm is activated if ph is less than (set point – dead zone – 0.5)

6.6.2.4 Nutrient tank A/B level alarm

Nutrient tank A/B level low alarm (CL4108_NutrientTankA_AL and CL4108_NutrientTankB_AL):

Nutrient A and B tank low level alarm is activated when the tank low level switch is set at least for 2 seconds.

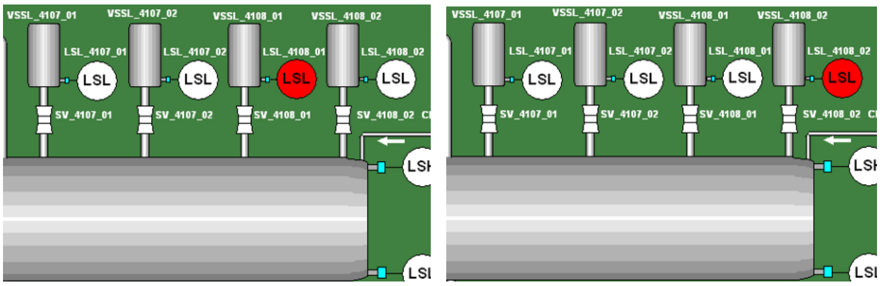

Figure 22: Nutrient A and B low level tank alarm

6.6.2.5 Condensate tank level alarm

Condensate tank High/Low level alarm (CL4110_Condensatetank_AH and CL4110_Condensatetank_AL):

Condensate tank alarm is activated after 10 minutes of the level switch activation.

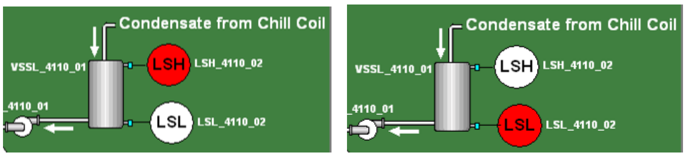

Figure 23: High and Low level alarm of the condensate tank

6.6.2.6 Nutrient tank level alarm

Nutrient tank High/Low Level Alarm (CL4110_Nutrienttank_AH and CL4110_Nutrienttank_AL):

Nutrient tank alarm is activated after 10 minutes elapsed from the level switch activation.

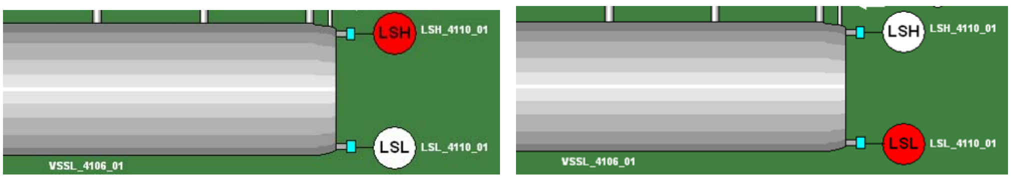

Figure 24: High and Low level alarm of the nutrient tank

6.6.2.7 Condensate & Nutrient tank level alarm

Condensate and Nutrient tank Low Level Alarm (CL4110_Condensate&Nutrient_AL):

Condensate and nutrient tank low level alarm is activated if nutrient tank low level alarm and condensate tank low level alarm are set.

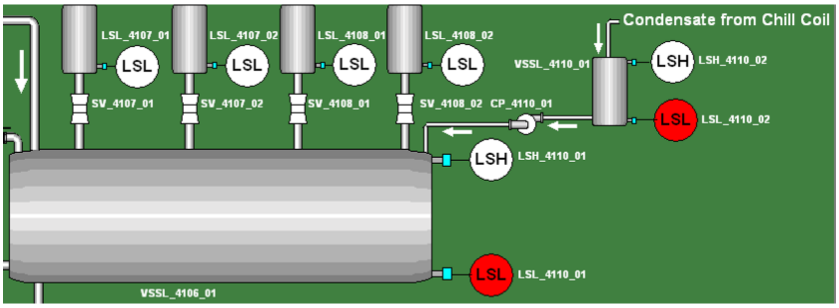

Figure 25: Condensate and Nutrient tank High level alarm

Condensate and Nutrient tank High Level Alarm (CL4110_Condensate&Nutrient_AH):

Condensate and nutrient tank high level alarm is activated if nutrient tank high level alarm and condensate tank high level alarm are set.

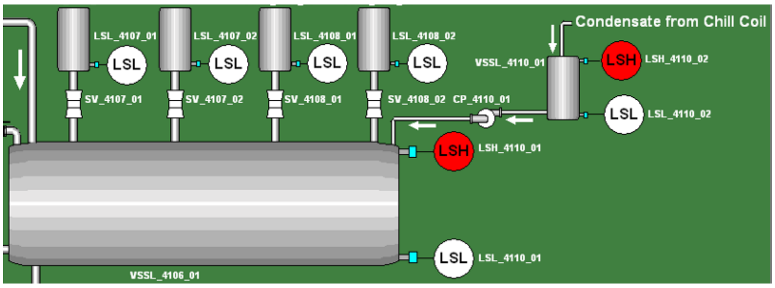

Figure 26: Condensate and Nutrient tank low level alarm

6.6.2.8 Tags

Following tags are displayed in the Irrigation system display:

Tag Name	Description
AT_4107_01	pH sensor
AT_4108_01	Electrical conductivity of nutrient
CL4107_PH_SP	pH set point
CL4108_EC_SP	Electrical conductivity set point
FT_4106_01	Outlet nutrient flow sensor
GP_4106_01_MV	Main Irrigation Pump
CP_4110_01_MV	Condensate pump relay
IY_4104_01_MV	Ramps – A (LAMP Sa)
IY_4104_02_MV	Ramps – B (LAMP Sb)
IY_4104_03_MV	Ramps- C (LAMP H)
LSH_4110_01	High level sensor for reservoir tank
LSH_4110_02	High level sensor for condensate tank
LSL_4107_01	Acid Tank level
LSL_4107_02	Base Tank level
LSL_4108_01	Level sensor Stock A
LSL_4108_02	Level sensor Stock B
LSL_4110_01	Low level sensor for reservoir tank
LSL_4110_02	Low level sensor for condensate tank
STOP	Switch OFF all control loops

Tag Name	Description
SV_4107_01_MV	Acid Tank valve
SV_4107_02_MV	Base Tank valve
SV_4108_01_MV	Stock A inject valve
SV_4108_02_MV	Stock B inject valve
TT_4109_01	Temperature of nutrient tank

Table 4 Irrigation System Display

6.6.3 Control loops

Control loops executed from Irrigation system screen:

- Irrigation system
- pH Control
- EC Control
- Condensate level Control

6.6.3.1 Irrigation system

Irrigation system in Manual mode:

Allows activate/deactivate GP_4106_01 (irrigation pump) in manual mode.

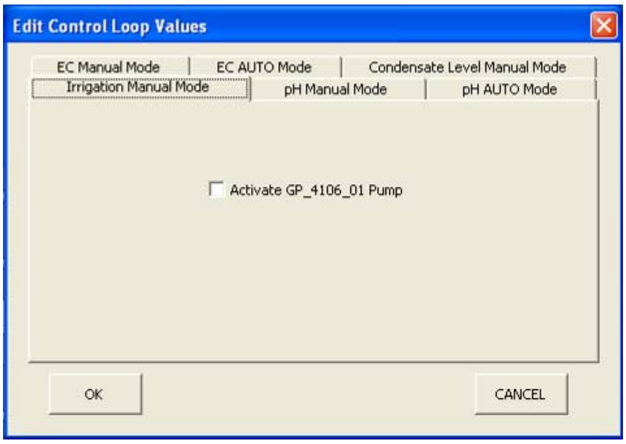

Figure 27: Irrigation system configuration in Manual mode

6.6.3.2 pH Control

6.6.3.2.1 pH control in Manual Mode

It permits to activate/deactivate acid and base valves independently and configures the time in seconds to be the valve opened, the action is executed when “OK” command button is pushed.

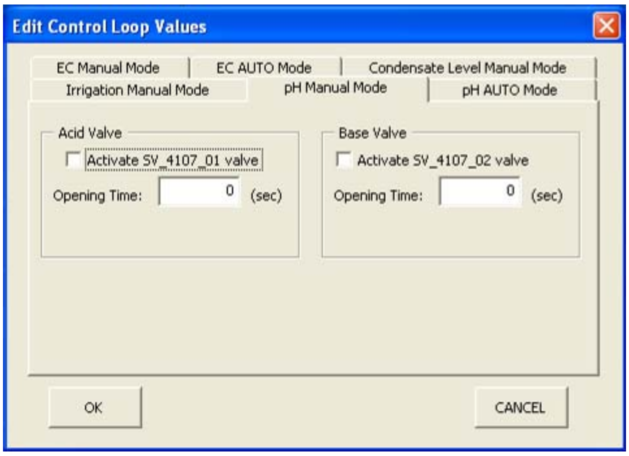

Figure 28: pH configuration in Manual mode

6.6.3.2.2 pH control in Automatic Mode

Allows pH set point configuration and its pH dead zone, when the pH is upper than pH set point + pH dead zone or lower than pH set point – pH dead zone a pH alarm is displayed.

The time of the last reset of pH timer is displayed like an indicator in the form and there is a command button to reset the timer.

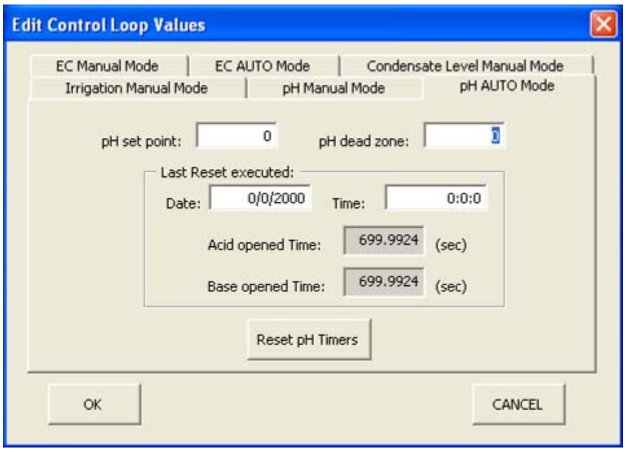

Figure 29: pH configuration in AUTO mode

6.6.3.3 Electro Conductivity control

6.6.3.3.1 Electro-conductivity control in manual mode

Allows activate/deactivate the stock A and B valves and configure the opening time in manual mode selecting on the check box and clicking “OK” command button.

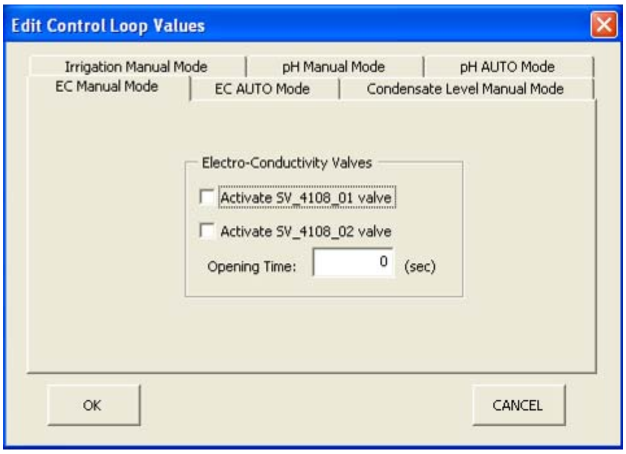

Figure 30: EC configuration in Manual mode

6.6.3.3.2 Electro-conductivity in Automatic mode

Allow EC set point writing in the Text box and clicking “OK” command button. The time of the last reset EC pH timer is displayed in the form and there is a command button to reset the timer.

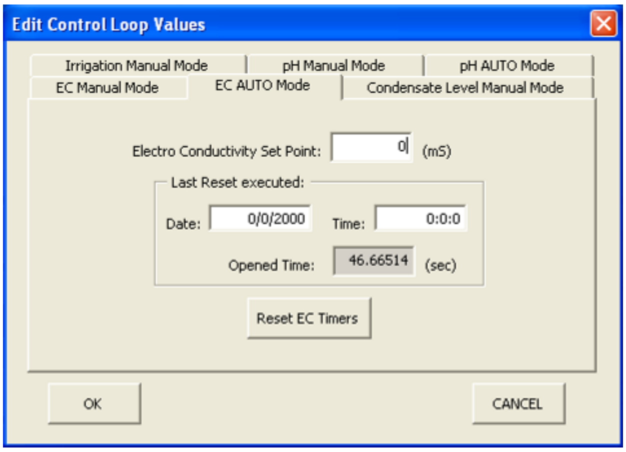

Figure 31: EC configuration in AUTO mode

6.6.3.4 Condensate level control

6.6.3.4.1 Condensate level in Manual mode

Allows activate/deactivate the condensate level pump in manual mode.

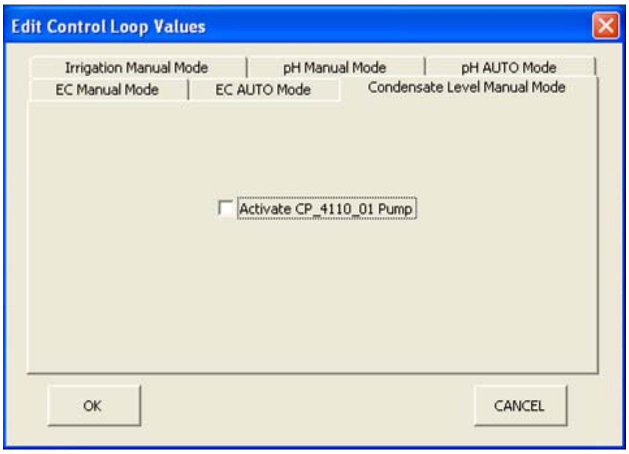

Figure 32: Condensate level configuration in Manual mode

6.7 Temperature and Humidity control display

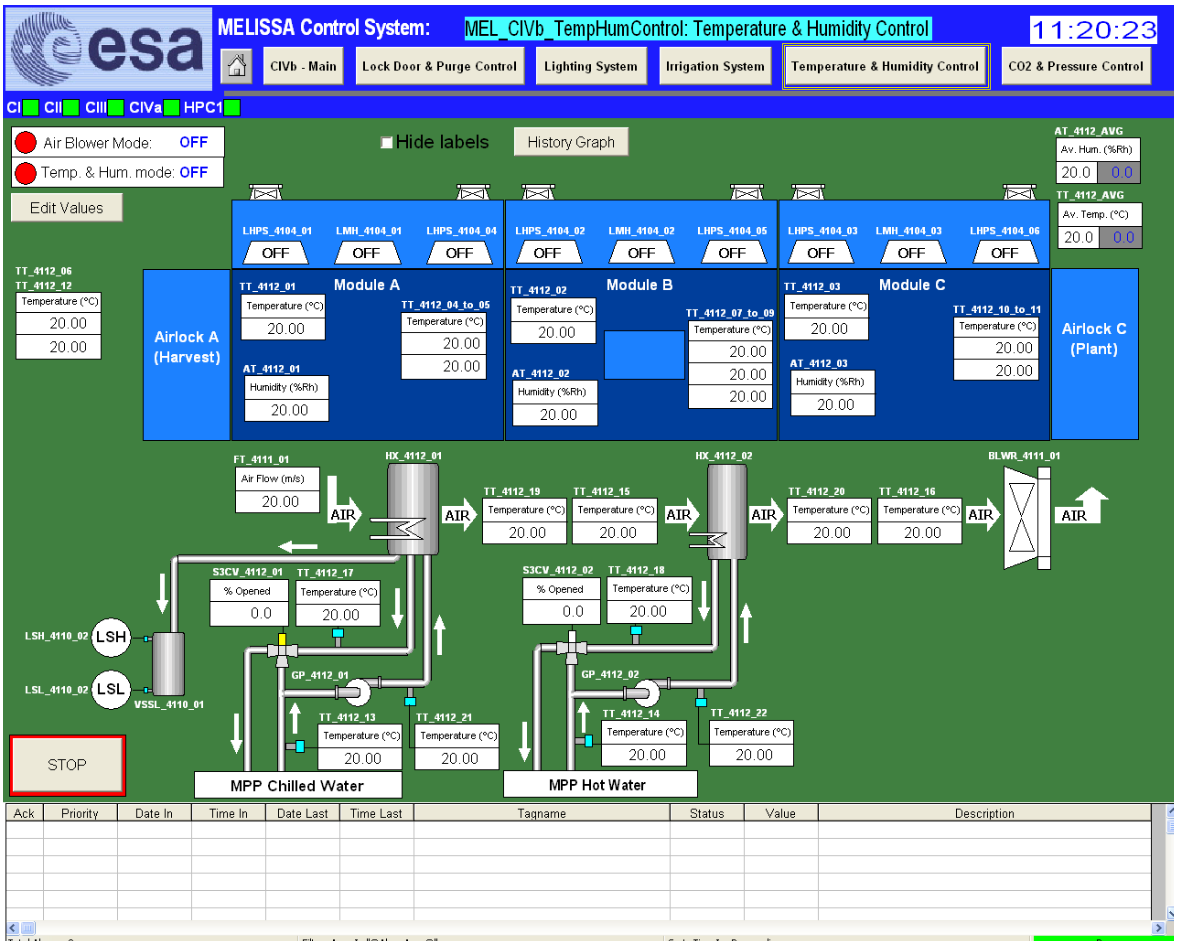

Figure 33: Temperature and Humidity control screen

6.7.1 General actions

This display belongs to the Temperature and Humidity control system and allows the following actions:

- 2-way valves, 3-way proportional valves, blower, level switches, pumps, lights, pipes animations.

- Analogue indicators.
- Modify Average day/night humidity and temperature set point.
- Change Air blower and temperature & humidity control loop mode (OFF, AUTO, MAN) clicking on the control loop desired.
- Edit control loops values clicking in the “Edit Values” command button.
- Display the history graph clicking on the History graph command button.
- Hide labels selecting the “Hide labels” check box.
- Stop Air blower and temperature & humidity control loops clicking “Stop” command button.
- Modify the average day temperature set point, average night temperature set point, average day humidity set point and average night humidity set point, depends of CL4104_StartLights (true = day hours, false = night hours) value the data link set point is visible. When CL4104_StartLights = true average day temperature set point and average day humidity set point are visible allowing to modify the value and average night temperature set point and average night humidity set point are not visible and it is not possible to modify the value, for CL4104_StartLights = false is the opposite of the last situation.
- Alarms animations

6.7.2 Alarms

6.7.2.1 Light blower alarm

Light with flow alarm (CL4111_Noflow_LightOn_A)

This alarm is activated when the blower is off and Lights are ON to avoid over temperature inside the chamber.

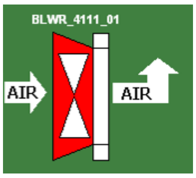

Figure 34: Light with flow alarm

6.7.2.2 Chamber temperature alarm

Chamber temperature alarm limits:

High High alarm is activated if temperature chamber is higher than (temperature set point + 6)

High alarm is activated if temperature chamber is higher than (temperature set point + 4)

Low alarm is activated if temperature chamber is less than (temperature set point - 4)

Low Low alarm is activated if temperature chamber is less than (temperature set point – 15)

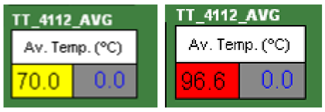

Figure 35: Chamber temperature alarms

6.7.2.3 Chamber Humidity alarm

Chamber Humidity alarm limits:

High High alarm is activated if humidity is higher than (humidity set point + 15)

High alarm is activated if humidity is higher than (humidity set point + 10)

Low alarm is activated if humidity is less than (humidity set point - 10)

Low Low alarm is activated if humidity is less than (humidity set point – 15)

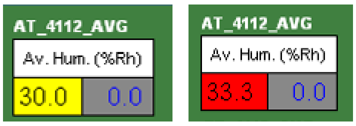

Figure 36: Chamber humidity alarms

6.7.2.4 Blower alarm

Control blower error alarm (CL4111_Blower_Error_A):

Alarm ON when blower is ON and Flow is less than 1, then control loops 4112 and 4104 are stopped.

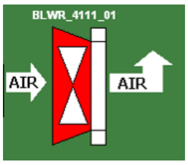

Figure 37: Control blower error alarm

6.7.2.5 Hot exchanger alarm

Hot exchanger alarm low (CL4112_Temp_HotXchanger_AL):

Alarm ON when temperature TT_4112_14 (MPP hot water supply) is less than 44ºC.

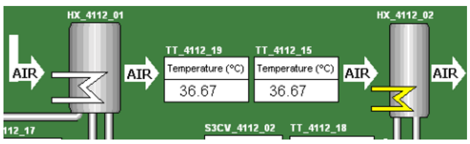

Figure 38: Hot exchanger low alarm

Hot exchanger alarm low low (CL4112_Temp_HotXchanger_ALL):

Alarm ON when temperature TT_4112_14 (MPP hot water supply) is less than 42 ºC.

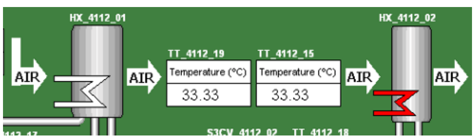

Figure 39: Hot exchanger low low alarm

Cold exchanger alarm high (CL4112_Temp_ColdXchanger_AH):

Alarm On when temperature TT_4112_13 (MPP chilled water supply) is higher than 12ºC.

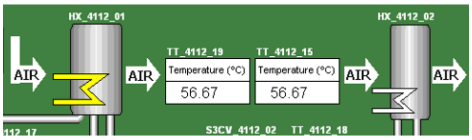

Figure 40: Cold exchanger high alarm

Cold exchanger alarm High High (CL4112_Temp_ColdXchanger_AHH):

Alarm On when temperature TT_4112_13 (MPP chilled water supply) is higher than 14ºC.

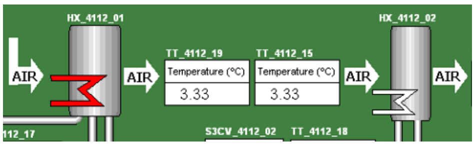

Figure 41: Cold exchanger high high alarm

6.7.2.6 Tags

Following tags are displayed in the temperature and humidity control display:

Tag Name	Description
AT_4112_01	Humidity A1 associated with temp A1
AT_4112_02	Humidity B1 associated with temperature B1
AT_4112_03	Humidity C1 associated with temperature C1
AT_4112_AVG	Chamber average humidity
AT_4112_AVG_Day_SP	Humidity set point in AUTO mode
AT_4112_AVG_Night_SP	Humidity set point in AUTO mode
BLWR_4111_01_MV	Blower Relay
FT_4111_01	Air velocity sensor
GP_4112_01_MV	Chilled water circulation pump
GP_4112_02_MV	Hot water circulation pump
IY_4104_01_MV	Ramps – A (LAMP Sa)
IY_4104_02_MV	Ramps – B (LAMP Sb)
IY_4104_03_MV	Ramps- C (LAMP H)
LSH_4110_02	High level sensor for condensate tank
LSL_4110_02	Low level sensor for condensate tank
S3CV_4112_01_MV	Chilled water control valve
S3CV_4112_02_MV	Hot water control valve
TT_4112_01	Temperature A1 associated with humidity
TT_4112_02	Temperature B1 associated with humidity
TT_4112_03	Temperature C1 associated with humidity
TT_4112_04	Temperature A2
TT_4112_05	Temperature A3
TT_4112_06	Temperature A4 → reaffected to External Temperature
TT_4112_07	Temperature B2
TT_4112_08	Temperature B3
TT_4112_09	Temperature B4
TT_4112_10	Temperature C2
TT_4112_11	Temperature C3
TT_4112_12	Temperature C4 → Reflected to external temperature
TT_4112_13	Temperature for facility chilled water
TT_4112_14	Temperature for facility hot water line
TT_4112_15	Chilled coil surface temperature
TT_4112_16	Heating coil surface temperature
TT_4112_17	Chilled exit temperature

Tag Name	Description
TT_4112_18	Hot exit temperature
TT_4112_19	Outlet Air, chilled exchanger
TT_4112_20	Outlet air, hot exchanger
TT_4112_21	Inlet water chilled exchanger
TT_4112_22	Inlet water hot exchanger
TT_4112_AVG	Chamber average temperature
TT_4112_AVG_Day_SP	Temperature set point in AUTO mode
TT_4112_AVG_Night_SP	Temperature set point in AUTO mode

Table 5 Temperature and Humidity control Display

6.7.3 Control loops

Control loops executed from Temperature and Humidity Control screen:

- Air circulation
- Humidity and Temperature Control

6.7.3.1 Air blower control

6.7.3.1.1 Air blower control in Manual mode

Allow activate/deactivate the blower in manual mode selecting the check box and clicking on the “OK” command button.

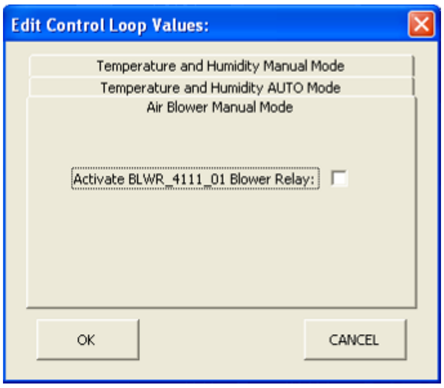

Figure 42: Air Fan configuration in Manual mode

6.7.3.2 Temperature and Humidity control

6.7.3.2.1 Temperature and Humidity Control in Manual mode

Allow activate/deactivate of the hot and chill water circulations pumps and set % opening of the 3-way proportional valves.

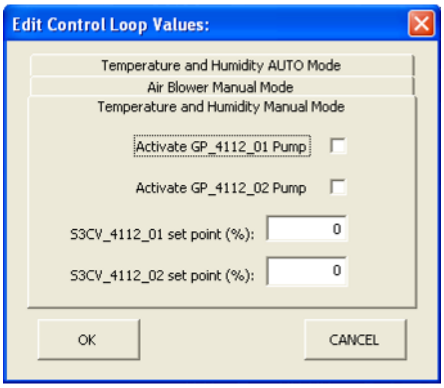

Figure 43: Temperature and Humidity control configuration in Manual mode

6.7.3.2.2 Temperature and Humidity Control in Automatic Mode

It permits to visualize and change the Temperature and Humidity day/night set points.

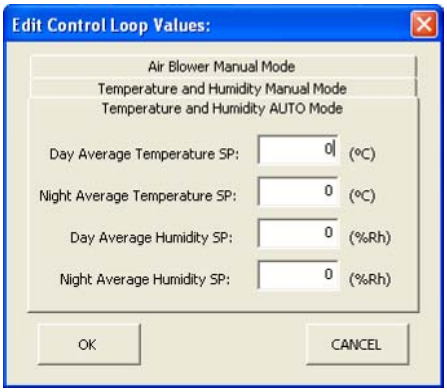

Figure 44: Temperature and Humidity configuration in AUTO mode

6.8 CO2 and Pressure control display

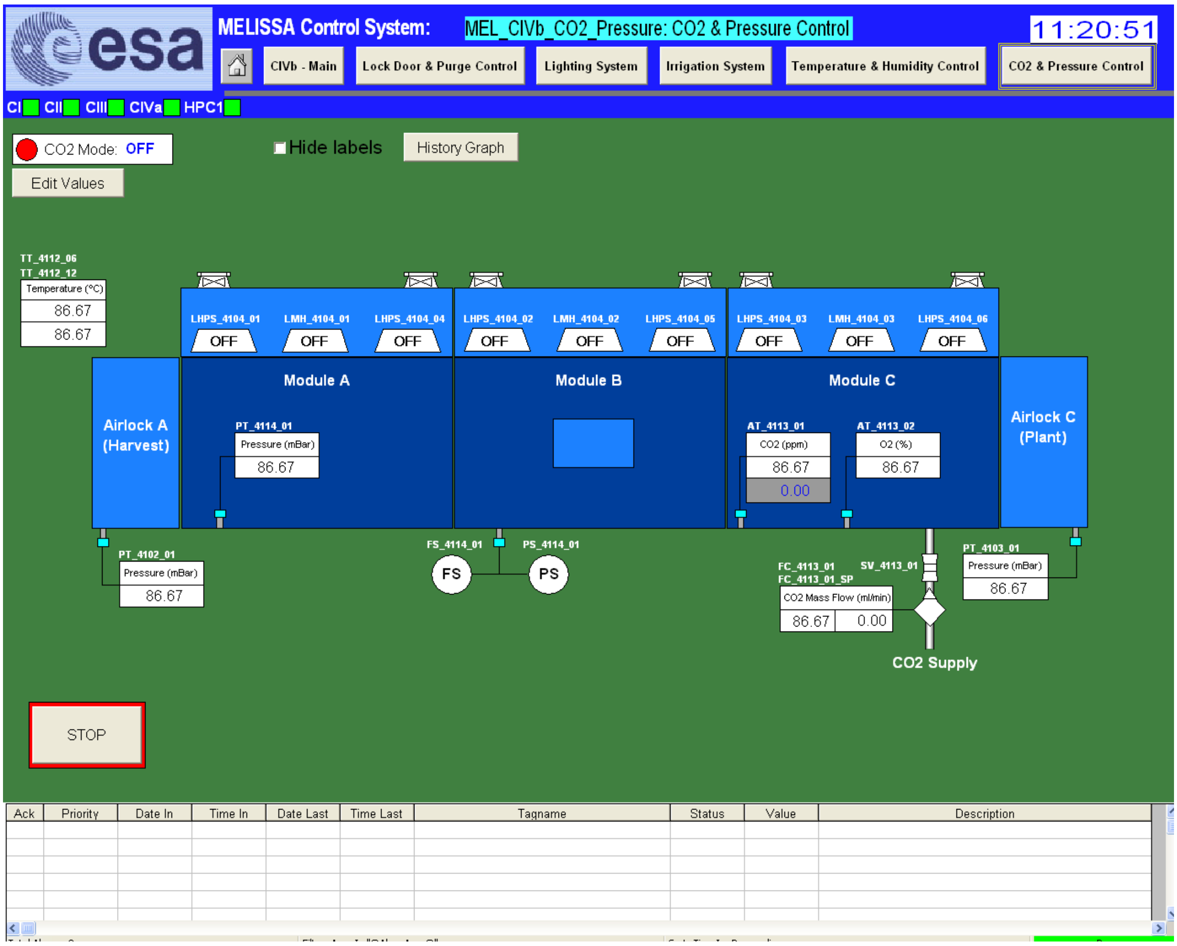

Figure 45: CO2 and Pressure screen

6.8.1 General actions

This display belongs to the CO2 and pressure control and allows the following actions:

- 2-way valve, flow switch, pressure switch and lights animations.
- Analogue indicators.
- Modify CO2 set point.
- Change CO2 control loop mode (OFF, AUTO, MAN) clicking on the control loop desired.
- Edit control loops values clicking in the “Edit Values” command button.
- Display the history graph clicking on the History graph command button.
- Hide labels selecting the “Hide labels” check box
- Stop CO2 control loop clicking “Stop” command button.
- Alarms animated.

6.8.2 Alarms

6.8.2.1 CO2 control alarm

High high alarm is activated when AT_4113_01 (CO2 measure) is higher than (set point +100)

High alarm is activated when AT_4113_01 (CO2 measure) is higher than (set point + 50)

Low alarm is activated when AT_4113_01 (CO2 measure) is less than (set point – 50)

Low low alarm is activated when AT_4113_01 (CO2 measure) is less than (set point -100)

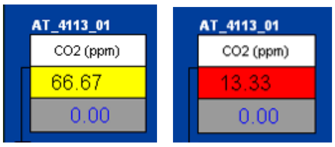

Figure 46: CO2 alarms

6.8.2.2 O2 control alarm

High high alarm is activated when AT_4113_02 (O2 measure) is higher than 25%.

High alarm is activated when AT_4113_02 (O2 measure) is higher than 23%.

Low alarm is activated when AT_4113_02 (O2 measure) is less than 19%.

Low low alarm is activated when AT_4113_02 (O2 measure) is less than 17%.

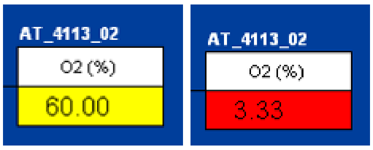

Figure 47: O2 Alarms

6.8.2.3 Growing area pressure control alarm

High alarm is activated when PT_4114_01 (growing area pressure) is higher than 1100.

Low alarm is activated when PT_4114_01 (growing area pressure) is less than 900.

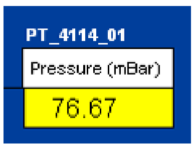

Figure 48: Growing area pressure alarm

6.8.2.4 Tags

Following tags are displayed in the CO2 and Pressure control display:

Tag Name	Description
AT_4113_01	CO2 Analyzer
AT_4113_02	O2 Analyzer
FC_4113_01	CO2 Mass Flow
FC_4113_01_SP	CO2 Mass flow set point
FS_4114_01	Flow switch
IY_4104_01_MV	Ramps – A (LAMP Sa)
IY_4104_02_MV	Ramps – B (LAMP Sb)
IY_4104_03_MV	Ramps- C (LAMP H)

Tag Name	Description
PT_4114_01	Growing area pressure
SV_4113_01_MV	CO2 injection line. Solenoid
AT_4113_01_SP	CO2 Analyzer set point
PS_4114_01	Pressure switch
TT_4112_06	External chamber temperature
TT_4112_12	External chamber temperature
PT_4102_01	Pressure sensor for airlock A
PT_4103_01	Pressure sensor for airlock C

Table 6 CO_2 and pressure control display

6.8.3 Control loops

Control loops executed from CO_2 and pressure control:

- CO2/O2 control
- Passive pressure

6.8.3.1 CO2 control in manual mode

Allow activate/deactivate the CO_2 valve and modify the CO_2 mass flow set point in manual mode.

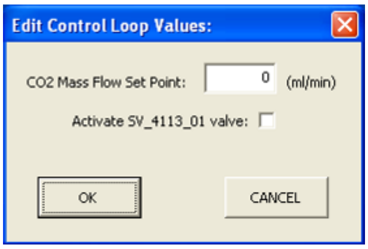

Figure 49: CO2 configuration in Manual mode

7. MASTER CONTROL

The Master Control is executed by the iFix Scheduler module. This module allows the configuration of a task that needs to be executed periodically at fixed time intervals. The tasks can be configured to run in background, and therefore, is not necessary to start a Windows session in the Supervision Server. From this module, algorithms can access to process variables. By default, tasks will be running in background, to perform a change or to initialise a control algorithm, task configuration needs to be changed to run in foreground.

Task configuration is managed from the Supervision Server Workspace application.

In MELISSA compartment CIVb system, following tasks are configured:

- **MEL_CIVb_SAVEVALUES**

This task saves the principal process variable values of the Compartment CIVb HPC1 in the Supervision Database.

- **SystemControl**

This task is a daily execution task that updates the HPC1 PLC system clock with the server clock.

7.1.1 Open configured tasks

To access to configure tasks, from the Supervision Server follow these steps:

1) Open Intellution iFix Workspace application. Application will be started in configuration mode.
2) In the object tree, expand Schedules node. There, a list of scheduled tasks will be presented.
3) To modify one task, double-click it. In the right pane, a table will appear displaying all configuration parameters.

7.1.2 Change the task run mode (foreground/background)

Tasks can be configured to run in foreground or in background. Executing the tasks in foreground will allow the user to test the task by firing its execution manually and initialise algorithm status by changing the run mode. To execute a task in foreground perform following steps:

1) In the iFIX Workspace open the task.
2) Open the pop-up menu, pressing the right mouse button.
3) Select Scheduler Properties. A dialog with Run in Foreground and Run in Background options will appear.
4) In the dialog, select run in foreground.
5) Press OK.
6) Select the task and from the Workspace menu select Workspace and Switch to Run. Task Status is displayed in green showing “Active”. Switching again the Workspace to Configuration mode will stop the task.
7) To restore the run mode to background, open again the configuration dialog, select “Run in background” and confirm changes. Task status will be displayed in green showing “Active”.

In case Biomass production control law or Nitrite estimator tasks need to be initialised before starting a test, change the configuration to run it in foreground and restore the previous configuration to run the task again in background. Task status is displayed in green showing “Active” and if the user switches Workspace mode to Run, it can be verified that the “Number of Times Fired” is reset to 0.

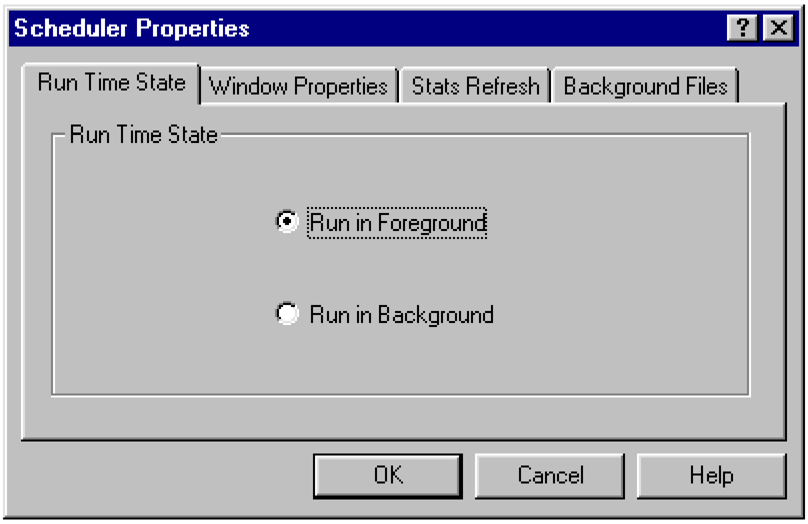

Figure 50. Task foreground/background run mode configuration.

Important

7.1.3 Enable/Disable logs

The Master Control tasks can generate logs to monitor its execution. These logs are stored in the folder SUPERVISION\Pic\Logs. The activation or deactivation of these logs is controlled by a global variable to change the value of this variable perform the following steps:

1) In the iFIX Workspace access to the elements tree.
2) Open the Globals\User branch.
3) Select the EnableLogs item and open the context menu by clicking the right mouse button.
4) Select the “Property Window…” command.
5) Modify the property CurrentValue to True to activate the logs and to False to deactivate it.

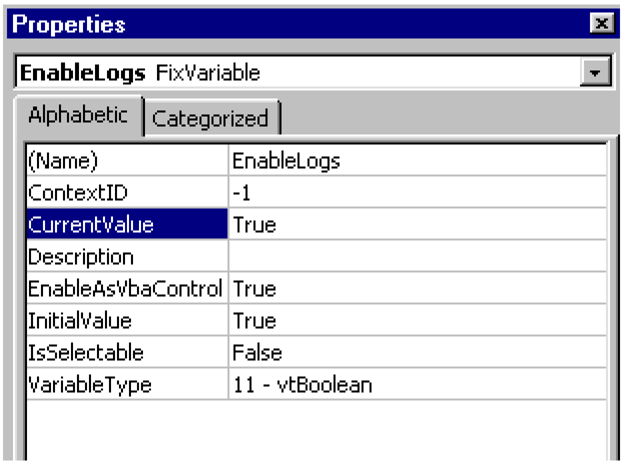

Figure 51. EnableLogs configuration dialog.

7.2 Supervision Database

Supervision Database is updated by means of the tasks MEL_CIVb_SAVEVALUES running under the iFIX Task Scheduler. These tasks are scripts that build the SQL sentence to update the corresponding Microsoft Access® database. Data can be retrieved using the Microsoft Access® application export features.

7.2.1 Change the update rate

It is possible to change the database update rate to adapt it to the characteristics of the current test.
To change the database update rate perform the following steps:
1) Open the corresponding schedule task.
2) Modify the Interval setting (1 in the figure 29).
3) Close the task and confirm save changes.

This action will reset the task, which will be fired at new time interval.

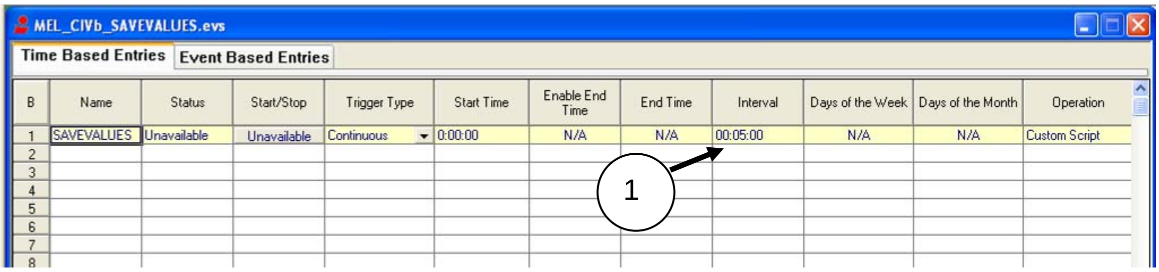

Figure 52: Supervision database task configuration

7.2.2 Compartment IVb HPC1

The following values of the "Compartment CIVb HPC1" are saved in the Supervision Database:

Scheduler Task: MEL_CIVb_SAVEVALUES

File	CIVb_DB.mdb	
Table	CIVb_MeasuredValues	
Column	**Description**	**Type**
DateTime (PK)	Time stamp	Date/Time
ZS_4100_01	Upper Exterior Air Lock Door Contact – Side A	Byte
ZS_4101_01	Upper Exterior Air Lock Door Contact – Side C	Byte
PT_4102_01	Pressure sensor for airlock A	Doble
PS_4102_01	Airlock A pressure switch	Byte
PT_4103_01	Pressure sensor for airlock C	Doble
PS_4103_01	Airlock C pressure switch	Byte
RT_4104_01	PAR – Sensor A	Doble
RT_4104_02	PAR – Sensor B	Doble
RT_4104_03	PAR – Sensor C	Doble
IY_4104_01_MV	Ramps – A	Byte
IY_4104_02_MV	Ramps – B	Byte
IY_4104_03_MV	Ramps – C	Byte
TT_4105_01	Light loft temperature sensor A	Doble
TT_4105_02	Light loft temperature sensor B	Doble
TT_4105_03	Light loft temperature sensor C	Doble
FSL_4105_01	Flow/No flow of light loft Fan A	Byte
FSL_4105_02	Flow/No flow of light loft Fan B	Byte
FSL_4105_03	Flow/No flow of light loft Fan C	Byte
FAN_4105_01_MV	Operation of Light Loft Fan A	Byte
FAN_4105_02_MV	Operation of Light Loft Fan B	Byte
FAN_4105_03_MV	Operation of Light Loft Fan C	Byte
GP_4106_01_MV	Main Irrigation Pump	Byte
FT_4106_01	Outlet nutrient flow sensor	Doble
AT_4107_01	pH sensor	Doble
LSL_4107_01	Acid tank low level switch	Byte
LSL_4107_02	Base tank low level switch	Byte
CL4107_pH_SP	pH set point	Doble
CL4107_Deadzone	pH dead zone configuration	Doble
AT_4108_01	Electrical conductivity of nutrient	Doble
LSL_4108_01	Stock A low level sensor	Byte
LSL_4108_02	Stock B low level sensor	Byte
CL4108_EC_SP	Electro-conductivity set point	Doble
TT_4109_01	Nutrient tank temperature	Doble
LSH_4110_01	High level sensor for reservoir tank	Byte
LSL_4110_01	Low level sensor for reservoir tank	Byte
LSH_4110_02	High level sensor for condensate tank	Byte
LSL_4110_02	Low level sensor for condensate tank	Byte
CP_4110_01_MV	Condensate pump relay	Byte
BLWR_4111_01_MV	Blower relay	Byte
FT_4111_01	Air velocity sensor	Doble
TT_4112_01	Temperature A1 associated with humidity	Doble
TT_4112_04	Temperature A2	Doble
TT_4112_05	Temperature A3	Doble
TT_4112_06	Temperature A4 (reaffected to external T)	Doble

TT_4112_02	Temperature B1 associated with humidity	Doble
TT_4112_07	Temperature B2	Doble
TT_4112_08	Temperature B3	Doble
TT_4112_09	Temperature B4	Doble
TT_4112_03	Temperature C1 associated with humidity	Doble
TT_4112_10	Temperature C2	Doble
TT_4112_11	Temperature C3	Doble
TT_4112_12	Temperature C4 (reaffected to external T)	Doble
TT_4112_13	Temperature for facility chilled water	Doble
TT_4112_14	Temperature for facility hot water line	Doble
TT_4112_15	Chilled coil surface temperature	Doble
TT_4112_16	Heating coil surface temperature	Doble
TT_4112_17	Chilled exit temperature	Doble
TT_4112_18	Hot exit temperature	Doble
TT_4112_19	Outlet air chilled coil	Doble
TT_4112_20	Outlet air hot exchanger	Doble
TT_4112_21	Inlet water chilled exchanger	Doble
TT_4112_22	Inlet water hot exchanger	Doble
AT_4112_01	Humidity A1 associated with temperature A1	Doble
AT_4112_02	Humidity B1 associated with temperature B1	Doble
AT_4112_03	Humidity C1 associated with temperature C1	Doble
S3CV_4112_01_MV	Chilled water control valve	Doble
S3CV_4112_02_MV	Hot water control valve	Doble
GP_4112_02_MV	Hot water circulation pump	Byte
GP_4112_01_MV	Chilled water circulation pump	Byte
TT_4112_AVG_DAY_SP	Day temperature set point	Doble
TT_4112_AVG_NIGHT_SP	Night temperature set point	Doble
AT_4112_AVG_DAY_SP	Day humidity set point	Doble
AT_4112_AVG_NIGHT_SP	Night humidity set point	Doble
TT_4112_AVG	Chamber average temperature	Doble
AT_4112_AVG	Chamber average humidity	Doble
FC_4113_01	CO2 mass flow	Doble
FC_4113_01_SP	CO2 mass flow set point	Doble
AT_4113_01	CO2 analyzer	Doble
AT_4113_02	O2 analyzer	Doble
AT_4113_01_SP	CO2 set point	Doble
PT_4114_01	Growing area pressure	Doble
FS_4114_01	Flow switch	Byte
PS_4114_01	Pressure switch	Byte

Table 7 values saved in the MS Access database

8. MAINTENANCE

8.1 Backup Procedure

To prevent the system to lose the data stored due to a hardware failure, backups of relevant data must be performed regularly. The periodicity will vary depending on the type of experiments currently performed in the Plant. The recommended approach is to perform a backup of data at the end of every experiment and empty the data files.

In addition, a backup of the entire system is recommended each time a change on the configuration is performed in order to avoid loosing these changes.

To perform a backup use the tape device included in the Supervision Server and the Backup software tool accessible from the Windows menu Programs and Accessories.

Important

To perform a full backup using the Windows 2000 Backup tool the files must not be locked or otherwise are skipped. In order to avoid files locked the iFIX service must be stopped. To stop the service, close all iFIX applications and from the Control Panel select Services and stop the iFIX service. This will cause the Master Control to be stopped and therefore *this operation can only be performed when there are not experiments on course. Once the backup process is ended, restart the iFIX service.*

8.2 Data Management

In a regular basis, data generated must be removed in order to prevent the system to run out of disk space. The time will vary depending on the acquisition data rates used. Therefore, when a long test is going to start it is highly recommended to check if data can be reset for the compartment since data are generated independently for each compartment. To reset the data for a compartment perform the following steps:

1. Perform a backup of the corresponding Microsoft Access Database file (mdb) located in the SUPERVISION\PIC\Database.
2. Empty the database file.

9. TROUBLESHOOTING

9.1 Rack power input is interrupted

When the rack power is interrupted the Uninterrupted Power Supply will start beeping. This is to alert that this device is powering the PLC. The power interruption can be caused for several reasons. To detect the cause of the power interruption perform the following steps:

1) Check that the rack receives external power. This can be checked by verifying that other devices have power. In case that the external power is not available the recovery procedure is out of the scope of this instructions.
2) Check the magnetothermic circuit breaker in the AC input. In case that the differential is open is because an over power consumption has occurred. The rack power consumption is limited to 6 Amp @ 220 V 50 Hz. An over power consumption most probably is caused by a short circuit. Review the connections and devices of the rack to identify and solve the short circuit problem and connect again the magnetothermic.
3) Check the differential circuit breaker status in the AC input. In case that the differential is open is because of a current leak. Review the connections and devices of the rack to identify and solve the current leak problem. After detecting and solving the current leak connect the differential circuit breaker.

9.2 Communications with the PLC are broken

In case the supervision displays @@@@ symbols in the variable values can be due to the lost of communications with the PLC.

1) Check the rack receives power. In case that is not powered follow procedure stated in section 13.1.
2) Check the network connection. The network connection can be checked by looking at the led status of the switch (located in the Supervisory Rack) and the led status of the network module of the PLC. If the led are indicate malfunction check the network connectors to the switch and the PLC (plug and unplug the connectors), if still not working check the cable connectivity.

10. APPENDIX B. PROBLEM REPORT FORM

<table>
<tr><td colspan="3">MELISSA Control System Demonstrator - Problem Report</td></tr>
<tr><td>Reported by:</td><td>Identifier:</td><td>Date:</td></tr>
<tr><td colspan="2">Title:</td><td>Reference:</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3">Problem Found</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3">Suspected Cause</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3">Disposition Result</td></tr>
<tr><td colspan="3">Disposition option:
☐ Reject ☐ Repair, rework ☐ Use as is</td></tr>
<tr><td colspan="3">Disposition Date:</td></tr>
<tr><td colspan="3">Actions</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3">Close Out</td></tr>
<tr><td colspan="3">Verification results:</td></tr>
<tr><td>Verified by:

Date:</td><td colspan="2">Authorised by:

Date:</td></tr>
</table>