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DATA PACKAGE 87.3.2

Compartment IVa Acceptance Review

Control Data Package

Prepared by/Préparé par	C. Bourg, O. Gerbi, J. Duatis, E. Creus, J. Carbonell
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APPROVAL

Title *Titre*	Compartment IVa Acceptance Review Control Data Package	Issue *Edition*	0	Revision *Révision*	0

Prepared by *Auteur*	C. Bourg, O. Gerbi, J. Duatis, E. Creus, J. Carbonell	Date *Date*	22/10/10

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Approved by *Approuvé par*	F.Gòdia	Date *Date*	27/10/10

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Page 2

TABLE OF CONTENTS

1. Scope

The present datapackage is a status at the date of approval of the control activities performed on Compartment 4a during Call Off Order 7: automation control for C4a and C3 at the MPP- addendum to COO5. These control activities were the last part of the redesign of the C4a pilot plant reactor carried out by the MPP with the company De Dietrich Engineering (Spain).

Therefore the datapackage presents the outcome of the tasks performed by the subcontractors SHERPA for PLC programme design, implementation and testing on the one hand and on the other hand NTE-SENER for control hardware definition, installation and HMI programme design, implementation and testing.

2. Organization of the datapackage

The datapackage is divided into 4 sections.

The first section deals with the description of the PLC programme, mainly developed by the company SHERPA Engineering, going from the requirements and software description, text of the implemented code, list of tags to the test plan and report of the tests.

The following three sections group the work developed by the company NTE-SENER around the following topics :

- design of the hardware of the PLC cabinet able to communicate with C4a compartment
- testing of the PLC cabinet once built
- design and verification of the Human Machine Interface developed by NTE-SENER to allow the operator to control and supervise the compartment C4a and communicate with the C4a PLC.

The detail of the content of each section is given herebelow and recalled in the front page of each section.

SECTION 1: C1 PLC Software description				
Reference	Title	Version	Edition date	Pages Number
TNxx_CIVa_SHERPA_SWDescription_Draft6.doc	MELISSA Pilot Plant COMPARTMENT IVa : Control Requirements and Software Description	1.0	28/10/10	164
V00_09_CIVa_PRINTABLE_VERSION.pdf	C4a PLC software in printable version	9		175

CIVa_PLC_HMI_20101029.xls	C4a list of tags, control loops, variables for control, tags exchanged between PLC and HMI and alarm thresholds		29/10/10	10
TN22_ControlLoop_TestPlan&Report.doc	Control loops test plan and test report	1.1	Oct. 2010	69
CIVa_Software_Modification.xls	Traceability for future software modification	0	Oct. 2010	1

SECTION 2: PLC Design and wiring				
Reference	Title	Version	Edition date	Pages Number
NTE-CIVaP2-ICD-002	CIVa HARDWARE INTERFACE DOCUMENT	1.1	30/04/10	35
NTE-CIVaP2-RP-006	MELISSA CIVa CONTROL CABINET HARDWARE DESIGN DOCUMENT	1	07/10/09	28

SECTION 3: PLC Cabinet assembly				
Reference	Title	Version	Edition date	Pages Number
NTE-CIVaP2-PR-004	CIVa PLC CONNECTION TEST PROCEDURE	1	08/07/09	13
NTE-CIVaP2-RP-005	CIVa PLC CONNECTION TEST REPORT	1.1	30/04/10	10

SECTION 4: Implementation of remote and local HMIs				
Reference	Title	Version	Edition date	Pages Number
NTE-CIVaP2-RP-007	MELISSA CIVa HMI DESIGN	1.2	30/04/10	41
NTE-CIVaP2-RP-003	MELISSA CIVa LOCAL HMI DESIGN	1.1	30/04/10	19
NTE-CIVaP2-HB-008	CIVa HMI SOFTWARE MANUAL	1.1	30/04/10	50
NTE-CIVaP2-MN-009	Review of CIVa HMI Displays minutes of meeting	1	15/01/10	3

3. Conclusion

All the functionalities of the control hardware have been tested successfully as per the control requirements of C4a.

Concerning the programme of control implemented in the PLC, the basic functions have been successfully tested but need to be further tested in the campaign of functional tests, where some adjustments or fine tunings might be necessary, with a traceability of the modifications.

The HMI screens have been successfully implemented and tested. If adjustments are needed during the functional tests, they will be implemented with traceability of the modifications.

Based on this datapackage, the control hardware and softwares (PLC and HMI) for Compartment 4a are accepted.

SECTION 1: C1 PLC Software description

Reference	Title	Version	Edition date	Pages Number
TNxx_CIVa_SHERPA_SWDescription_Draft6.doc	MELISSA Pilot Plant COMPARTMENT IVa : Control Requirements and Software Description	1.0	28/10/10	164
V00_09_CIVa_PRINTABLE_VERSION.pdf	C4a PLC software in printable version	9		175
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TN22_ControlLoop_TestPlan&Report.doc	Control loops test plan and test report	1.1	Oct. 2010	69
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TECHNICAL NOTE TN

MELISSA Pilot Plant COMPARTMENT IVa: Control Requirements and Software Description

Prepared by/Préparé par	Christophe Bourg / Olivier Gerbi
Reference/Référence	
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Authors Auteur	Christophe Bourg / Olivier Gerbi	Date Date	28/10/2010

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TABLE OF CONTENT

TABLE OF FIGURES

1. Introduction

The compartment CIVa, designed by De Dietrich company, has been completely installed in the Melissa Pilot Plant in march 2010. Its main objective is to recycle the CO2 coming from the crew into O2 to permit gas regeneration inside the closed ecosystem. A second objective is to provide food to the crew thanks to the micro algae “Arthrospira Platensis”.
Managed by an internal software developed by Sherpa, a Schneider PLC Quantum controls equipments of the bioreactor.
The main objective of the software is to controlled Inlet and outlet liquid flow, Inlet and outlet gas flow, temperature and level (influent, bioreactor and effluent tank), pH, pressure and outlet gas composition of the bioreactor.
The objective of the document is to give for each control loop:

- Control Requirements (see Annex A)
- 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_09_CIVA** (08.01.2010). The Version V01_00_CIVA will be created when the whole compartment function will be validated by the end user (UAB/ESA)

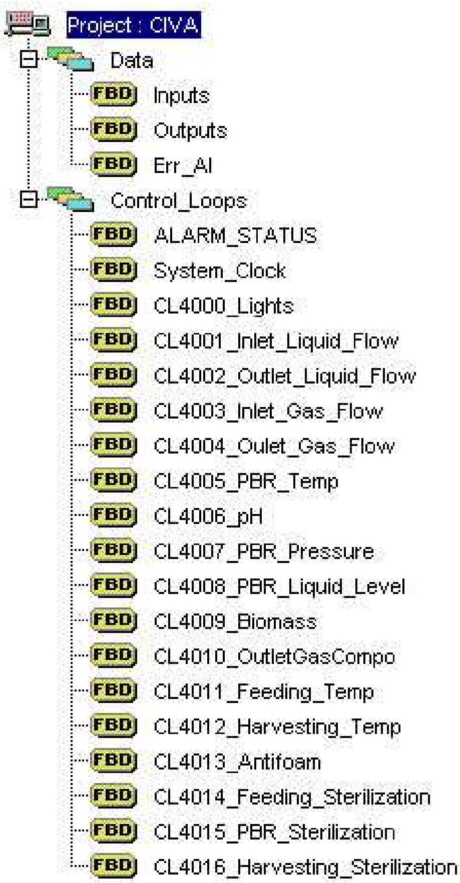
1.1.1.PLC CONFIGURATION

PLC									
1	2	3	4	5	6	7	8	9	10
140CPS11420	140CPU43412A	140NOE77101	140ACI03000	140AVI03000	140AVO02000	140AVO02000	140ACO13000	140DDM39000	140XBE10000
Backplane Power Supply module	CPU module	Ethernet module	8 Analog current Input (ACI 1)	8 Analog voltage Input (AVI 1)	4 Analog voltage Output (AVO 1)	4 Analog voltage Output (AVO 2)	8 Analog current Output (ACO 1)	Digital Input/Output	Rack expansion
CIVa_PLC_CPS	CIVa_PLC_CPU	CIVa_PLC_NOE	CIVa_PLC_IO_ACI1	CIVb_PLC_IO_AVI1	CIVa_PLC_IO_AVO1	CIVa_PLC_IO_AVO2	CIVa_PLC_IO_ACO1	CIVa_PLC_IO_DDM1	CIVb_PLC_XBE
Address			300100 --> 300108	300109->300117	400100->400103	400104->400107	400108->400115	Inputs:100065 ->100080 Outputs:000065->000072	
			8 inputs available	**4 inputs available**	**No outputs available**	**3 outputs available**	**No outputs available**		

PLC EXPANSION									
1	2	3	4	5	6	7	8	9	10
140CPS11420	140DDI35300	140DDO35300	140ACI04000	140ACI04000	140ACO13000				140XBE10000
Backplane Power Supply module	32 Digital Input 24V	32 Digital Output 24V	16 Analog current Input (ACI 2)	16 Analog current Input (ACI 3)	8 Analog current Output (ACO 2)				Rack expansion
CIVa_PLC_CPS	CIVa_PLC_DDI1	CIVa_PLC_DDO1	CIVa_PLC_ACI2	CIVa_PLC_ACI3	CIVa_PLC_ACO2				CIVb_PLC_XBE
Address	100081->100112	000081 -> 000112	300118 -> 300134	300135 -> 300151	400116 --> 400123				
	no inputs available	**6 outputs available**	**No inputs available**	**3 INPUTS AVAILABLE**	**8 outputs available**				

1.1.2.PLC section List

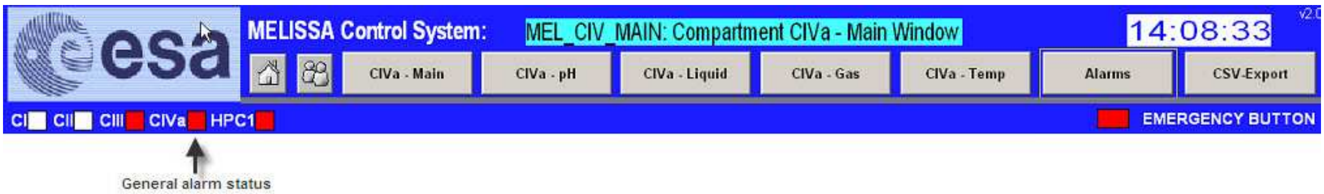
The following figure shows how the software is internally organised.



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 CIVa 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 going.
If an alarm high or low is triggered, the tag “CIVA_HighLowAlarm_status” is set and then the square becomes yellow.
If an alarm Very high or Very low is triggered, the tag “CIVA_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 recording of the pH valve opening time during injection in automatic mode. It also permits to open the pH valve in manual mode during a defined time..

1.1.3. Equipment Ranges

Index	Tags	Description	Signal	PLC Address	ELECTRICAL SIGNAL	RANGE	OFF SET	FILTER
1	IRC_4000_MV	Light Intensity	REAL->AO	400115	4/20 mA	0 – 100 %		
2	IT_4000_01	Light Power Phase1	AI ->REAL	300145	4/20 mA	N/A		
3	IT_4000_02	Light Power Phase2	AI ->REAL	300146	4/20 mA	N/A		
4	IT_4000_03	Light Power Phase3	AI ->REAL	300147	4/20 mA	N/A		
5	CL4001_PumpSpeed	Flow to the inlet pump (OLD NAME:GP_4001_01_MV2)	REAL->AO	400109	4/20 mA	0 -100%		
6	GP_4001_03_MV2	Speed Agitator (VS_4001_01)	REAL->AO	400113	4/20 mA	0- 100 %		
7	FT_4001_01	Total liquid inlet flow to reactor	AI ->REAL	300130	4/20 mA	0 – 4 L/H		
8	LT_4001_01	Level (guided microwave)	AI ->REAL	300131	4/20 mA	6.359 – 185.69 L		
9	DPT_4001_01	Diff. Pressure Filter	AI ->REAL	300138	4/20 mA	0 – 1017 mbar		
10	DPT_4001_02	Diff. Pressure Filter	AI ->REAL	300139	4/20 mA	0 – 1017 mbar		
11	CL4002_PumpSpeed	Flow to the outlet pump (OLD NAME:GP_4002_01_MV2)	REAL->AO	400111	4/20 mA	0 – 100 %		
12	GP_4002_03_MV2	Speed Agitator (VS_4002_01)	REAL->AO	400114	4/20 mA	0 – 100 %		
13	WT_4002_01	Weight Balance (VS_4002_01)	AI ->REAL	300132	4/20 mA	0 – 200 kg		
14	FQRC_4003_01_SP	Mass Flow CO2 Inlet set point	REAL->AO	400100	0-5 V	0 – 5000 mL/mn		

Index	Tags	Description	Signal	PLC Address	ELECTRICAL SIGNAL	RANGE	OFF SET	FILTER
15	FQRC_4003_02_SP	Mass Flow Air Inlet set point	REAL->AO	400101	0-5 V	0 – 30000 mL/mn		
16	FQRC_4003_03_SP	Mass Flow Circulated Air set point	REAL->AO	400102	0-5 V	0 – 30000 mL/mn		
17	FQRC_4003_04_SP	Total Mass Flow Air Inlet set point	REAL->AO	400103	0-5 V	0 – 30000 mL/mn		
18	FQRC_4003_01	Mass Flow CO2 Inlet	AI ->REAL	300109	0-5 V	0 – 5000 mL/mn		
19	FQRC_4003_02	Mass Flow Air Inlet	AI ->REAL	300110	0-5 V	0 – 30000 mL/mn		
20	FQRC_4003_03	Mass Flow recirculated Air	AI ->REAL	300111	0-5 V	0 – 30000 mL/mn		
21	FQRC_4003_04	Total Mass Flow Air Inlet	AI ->REAL	300112	0-5 V	0 – 30000 mL/mn		
22	SCV_4004_01_MV	Flow control Air outlet valve	REAL->AO	400108	4/20 mA	0 – 100 %		
23	FT_4004_01	Total air outlet from reactor	AI ->REAL	300129	4/20 mA	0 – 2000 mL/mn		
24	DPT_4004_01	Diff. Pressure Filter	AI ->REAL	300140	4/20 mA	0 – 3000 mbar		
25	BLWR_4005_01_MV2	Blower air	REAL->AO	400104	0-10 V	0 – 100%		
26	TT_4005_01	Reactor Temp.	AI ->REAL	300141	4/20 mA	0 – 150 ℃		
27	AT_4006_01	pH	AI ->REAL	300127	4/20 mA	0 - 12		
28	TT_4006_01	Temp. For pH	AI ->REAL	300128	4/20 mA	0 – 140 ℃		
29	AT_4006_02	pH	AI ->REAL	300125	4/20 mA	0 - 12		
30	TT_4006_02	Temp. For pH	AI ->REAL	300126	4/20 mA	0 – 140 ℃		

Index	Tags	Description	Signal	PLC Address	ELECTRICAL SIGNAL	RANGE	OFF SET	FILTER
31	PT_4007_01	Reactor Pressure	AI ->REAL	300135	4/20 mA	0 – 500 mbar		
32	PT_4007_02	Reactor Pressure	AI ->REAL	300136	4/20 mA	-1000 – 5000 mbar		
33	PT_4008_01	pressure transmitter	AI ->REAL	300133	4/20 mA	0 – 500 mbar		
34	AT_4009_01	Biomass	AI ->REAL	300118	4/20 mA	0 – 5 g/L		
35	AT_4009_02	Biomass	AI ->REAL	300119	4/20 mA	0 – 5 g/L		
36	AT_4009_FAILURE_IND	OLD NAME: TT_4009_01	AI ->REAL	300120	4/20 mA	4 – 20		
37	AT_4010_01	CO2analyser	AI ->REAL	300121	4/20 mA	0 – 50000 ppm		
38	AT_4010_02	O2 analyser	AI ->REAL	300122	4/20 mA	0 – 25 %		
39	AT_4010_03	Dissolved O2	AI ->REAL	300123	4/20 mA	0 – 100 %		
40	PT_4010_01	Outlet Gas Pressure	AI ->REAL	300137	4/20 mA	-1000 – 5000 mbar		
41	TT_4010_01	Analyser Temp.(OLD NAME: TT_4010_02)	AI ->REAL	300143	4/20 mA	0 – 150 ℃		
42	TT_4011_01	Inlet Vessel Temp.	AI ->REAL	300142	4/20 mA	-10 – 150 ℃		
43	TT_4012_01	Vessel Temp.	AI ->REAL	300144	4/20 mA	-50 – 250 ℃		

1.1.4.Initial Values

The following acronyms are used for the tags identities:
FB: Feed back
PS: pressure switch
IT: Intensity transmitter
FT: Flow transmitter
LT: Level transmitter
DPT: Differential pressure transmitter
PT: Pressure Transmitter
WT: Weight transmitter
FQRC: Flow Quantity recording Controller (Mass Flow Controller)
TT: Temperature Transmitter
AT: Analyzer Transmitter
LIM: Limit
AH: High Alarm
AHH: Very High Alarm
AL: Low alarm
ALL: Very Low Alarm

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

Control Loop	Threshold variable name	Type	HMI Address	Value	Unit	Comments
All Valves	FB_TIME_LIM	TIME	400704	5	seconds	time limit for triggered the valve feedback alarm
All Pressure switch	PS_TIME_LIM	TIME	400706	10	seconds	time limit for triggered the pressure switch alarm
4000	IT_4000_01_LIM_AH	REAL	400500	TBD	W	High power limit on phase 1
4000	IT_4000_01_LIM_AL	REAL	400502	TBD	W	Low power limit on phase 1
4000	IT_4000_02_LIM_AH	REAL	400504	TBD	W	High power limit on phase 2
4000	IT_4000_02_LIM_AL	REAL	400506	TBD	W	Low power limit on phase 2
4000	IT_4000_03_LIM_AH	REAL	400508	TBD	W	High power limit on phase 3
4000	IT_4000_03_LIM_AL	REAL	400510	TBD	W	Low power limit on phase 3
4001	FT_4001_01_SP	REAL	400304	0.6	L/h	Flow Rate Set Point (L/H)
4001	FT_4001_01_LIM_AHH	REAL	400512	0.2	L/h	Implement a time for triggering alarm (5min). Compare to the set point
4001	FT_4001_01_LIM_AH	REAL	400514	0.1	L/h	Implement a time for triggering alarm (5min). Compare to the set point
4001	FT_4001_01_LIM_AL	REAL	400516	-0.1	L/h	Implement a time for triggering alarm (5min). Compare to the set point
4001	FT_4001_01_LIM_ALL	REAL	400518	-0.2	L/h	Implement a time for triggering alarm (5min). Compare to the set point

Control Loop	Threshold variable name	Type	HMI Address	Value	Unit	Comments
4001	LT_4001_01_LIM_AHH	REAL	400520	140	Liter	Feeding tank volume: 160 liters. Working Volume: 120 liters. The sensor need to be calibrated referring to the volume law provide by De Dietrich
4001	LT_4001_01_LIM_AH	REAL	400522	130	Liter	Feeding tank volume: 160 liters. Working Volume: 120 liters. The sensor need to be calibrated referring to the volume law provide by De Dietrich
4001	LT_4001_01_LIM_AL	REAL	400524	20	Liter	Feeding tank volume: 160 liters. Working Volume: 120 liters. The sensor need to be calibrated referring to the volume law provide by De Dietrich
4001	LT_4001_01_LIM_ALL	REAL	400526	5	Liter	Feeding tank volume: 160 liters. Working Volume: 120 liters. The sensor need to be calibrated referring to the volume law provide by De Dietrich
4001	DPT_4001_01_LIM_AHH	REAL	400528	300	mBar	Very high limit of differential pressure in inlet liquid loop The maximum admissible pressure for the membrane has to be confirmed by Enrique / De Dietrich
4001	DPT_4001_01_LIM_AH	REAL	400530	200	mBar	High limit of differential pressure in inlet liquid loop
4001	DPT_4001_01_LIM_ALL	REAL	400532	TBD	mBar	Very low limit of differential pressure in inlet liquid loop
4001	DPT_4001_01_LIM_AL	REAL	400534	TBD	mBar	Low limit of differential pressure in inlet liquid loop
4001	DPT_4001_02_LIM_AHH	REAL	400536	300	mBar	Very high limit of differential pressure in inlet liquid loop The maximum admissible pressure for the membrane has to be confirmed by Enrique / De Dietrich
4001	DPT_4001_02_LIM_AH	REAL	400538	200	mBar	High limit of differential pressure in inlet liquid loop
4001	DPT_4001_02_LIM_AL	REAL	400540	TBD	mBar	Low limit of differential pressure in inlet liquid loop
4001	DPT_4001_02_LIM_ALL	REAL	400542	TBD	mBar	Very low limit of differential pressure in inlet liquid loop
4002	WT_4002_01_LIM_AH	REAL	400544	100	kg	Harvest tank volume: 120 liters. Working Volume: 90 liters. The sensor need to be calibrated referring to the volume law provide by De Dietrich
4002	WT_4002_01_LIM_AHH	REAL	400546	110	kg	Harvest tank volume: 120 liters. Working Volume: 90 liters. The sensor need to be calibrated referring to the volume law provide by De Dietrich

Control Loop	Threshold variable name	Type	HMI Address	Value	Unit	Comments
4002	WT_4002_01_LIM_AL	REAL	400548	20	kg	Harvest tank volume: 120 liters. Working Volume: 90 liters. The sensor need to be calibrated referring to the volume law provide by De Dietrich
4002	WT_4002_01_LIM_ALL	REAL	400550	10	kg	Harvest tank volume: 120 liters. Working Volume: 90 liters. The sensor need to be calibrated referring to the volume law provide by De Dietrich
4003	FQRC_4003_01_LIM_AHH	REAL	400710	50	ml/min	Alarm is triggered after 10s
4003	FQRC_4003_01_LIM_AH	REAL	400712	20	ml/min	Alarm is triggered after 10s
4003	FQRC_4003_01_LIM_ALL	REAL	400714	-50	ml/min	Alarm is triggered after 10s
4003	FQRC_4003_01_LIM_AL	REAL	400716	-20	ml/min	Alarm is triggered after 10s
4003	FQRC_4003_02_LIM_AHH	REAL	400718	300	ml/min	Alarm is triggered after 10s
4003	FQRC_4003_02_LIM_AH	REAL	400720	100	ml/min	Alarm is triggered after 10s
4003	FQRC_4003_02_LIM_ALL	REAL	400740	-300	ml/min	Alarm is triggered after 10s
4003	FQRC_4003_02_LIM_AL	REAL	400722	-100	ml/min	Alarm is triggered after 10s
4003	FQRC_4003_03_LIM_AHH	REAL	400724	300	ml/min	Alarm is triggered after 10s
4003	FQRC_4003_03_LIM_AH	REAL	400726	100	ml/min	Alarm is triggered after 10s
4003	FQRC_4003_03_LIM_ALL	REAL	400728	-300	ml/min	Alarm is triggered after 10s
4003	FQRC_4003_03_LIM_AL	REAL	400730	-100	ml/min	Alarm is triggered after 10s
4003	FQRC_4003_04_LIM_AHH	REAL	400732	300	ml/min	Alarm is triggered after 10s
4003	FQRC_4003_04_LIM_AH	REAL	400734	100	ml/min	Alarm is triggered after 10s
4003	FQRC_4003_04_LIM_ALL	REAL	400736	-300	ml/min	Alarm is triggered after 10s
4003	FQRC_4003_04_LIM_AL	REAL	400738	-100	ml/min	Alarm is triggered after 10s
4004	FT_4004_01_SP	REAL	400216	TBD	L/min	Outlet gas flow set. Only when 4004 in Automatic Mode and 4007 not in Auto
4004	FT_4004_01_LIM_AHH	REAL	400552	1	L/min	When the Outlet gas flow control loop is in automatic mode, the threshold is linked to Outlet flow set point. When the bioreactor pressure control is in automatic mode, the threshold is linked to the inlet gas flow set point.
4004	FT_4004_01_LIM_AH	REAL	400554	0.5	L/min	same than above
4004	FT_4004_01_LIM_ALL	REAL	400556	-1	L/min	same than above
4004	FT_4004_01_LIM_AL	REAL	400558	-0.5	L/min	same than above
4004	DPT_4004_01_LIM_AHH	REAL	400560	300	mbar	Very High limit of Differential pressure in outlet gas flow line
4004	DPT_4004_01_LIM_AH	REAL	400562	200	mbar	High limit of Differential pressure in outlet gas flow line
4004	DPT_4004_01_LIM_ALL	REAL	400564	TBD	mbar	FOR THE MOMENT -300 mbar

Control Loop	Threshold variable name	Type	HMI Address	Value	Unit	Comments
4004	DPT_4004_01_LIM_AL	REAL	400566	TBD	mbar	FOR THE MOMENT -200 mbar
4005	TT_4005_01_SP	REAL	400222	36	ºC	Bioreactor Temperature Set Point
4005	TT_4005_01_LIM_AHH	REAL	400568	4	ºC	The light will return to nominal intensity when the temperature is 1℃ above the setpoint.
4005	TT_4005_01_LIM_AH	REAL	400570	1	ºC	Temperature high limit threshold
4005	TT_4005_01_LIM_ALL	REAL	400572	-4	ºC	the blower will be restarted when the temperature reach -1°C compare to the set point
4005	TT_4005_01_LIM_AL	REAL	400574	-1	ºC	Temperature low limit threshold
4006	WT_4006_01_LIM_AL	REAL	400576	1	Kg	pH tank low limit threshold (Acid)
4006	WT_4006_01_LIM_ALL	REAL	400578	0.5	Kg	pH tank very low limit threshold (Acid)
4006	WT_4006_02_LIM_AL	REAL	400580	1	Kg	pH tank low limit threshold (Base)
4006	WT_4006_02_LIM_ALL	REAL	400582	0.5	Kg	pH tank very low limit threshold (Base)
4006	AT_4006_SP	REAL	400224	9.7	pH	Bioreactor pH Set Point
4006	CL4006_pH_DeadZone	REAL	400316	0.15	pH	pH dead zone
4006	CL4006_pH_LIM_AHH	REAL	400584	10.5 (fix value)	pH	pH measurement very high limit threshold
4006	CL4006_PH_LIM_AH	REAL	400586	0.2	pH	The value need To be ajusted with the control test done by sherpa
4006	CL4006_PH_LIM_AL	REAL	400588	-0.2	pH	The value need To be ajusted with the control test done by sherpa
4006	CL4006_PH_LIM_ALL	REAL	400590	8.5 (fix value)	pH	pH measurement very low limit threshold
4006	AT_4006_SENSOR_DEVIATION_LIM	REAL	400708	0.5	pH	The alarm is permanently checking the sensor deviation. Even if you choose only one of the two sensor.
4007	PT_4007_SP	REAL	400226	80	mbar	Bioreactor pressure set point
4007	PT_4007_01_LIM_AH	REAL	400592	100	mbar	Bioreactor pressure high limit for sensor PT_4007_01
4007	PT_4007_01_LIM_AHH	REAL	400594	500	mbar	Bioreactor pressure very high limit for sensor PT_4007_01 Wait the UAB Decision concerning the third threshold linked to the bioreactor safety.
4007	PT_4007_01_LIM_AL	REAL	400596	40 (fix value)	mbar	Bioreactor pressure low limit for sensor PT_4007_01
4007	PT_4007_01_LIM_ALL	REAL	400598	0 (fix value)	mbar	Bioreactor pressure very low limit for sensor PT_4007_01

Control Loop	Threshold variable name	Type	HMI Address	Value	Unit	Comments
4007	PT_4007_02_LIM_AH	REAL	400600	100	mbar	Bioreactor pressure high limit high for sensor PT_4007_02
4007	PT_4007_02_LIM_AHH	REAL	400602	500	mbar	Bioreactor pressure very high limit for sensor PT_4007_02
4007	PT_4007_02_LIM_AL	REAL	400604	40(fix value)	mbar	Bioreactor pressure low limit for sensor PT_4007_02
4007	PT_4007_02_LIM_ALL	REAL	400606	0(fix value)	mbar	Bioreactor pressure very low limit for sensor PT_4007_02
4008	WT_4008_SP	REAL	400228	85	Kg	Bioreactor level set point
4008	WT_4008_01_LIM_AH	REAL	400608	88	Kg	High Limit in Bioreactor level (weight transmitter)
4008	WT_4008_01_LIM_AHH	REAL	400610	90	Kg	Very High Limit in Bioreactor level (weight transmitter)
4008	WT_4008_01_LIM_AL	REAL	400612	84	Kg	Low Limit in Bioreactor level (weight transmitter)
4008	WT_4008_01_LIM_ALL	REAL	400614	82	Kg	Very low Limit in Bioreactor level (weight transmitter)
4009	AT_4009_SP	REAL	400232	1.5	g/l	Biomass set point
4009	AT_4009_01_LIM_AH	REAL	400616	3(fix value)	g/l	High limit of biomass sensor 1 UAB needs to confirmed the value
4009	AT_4009_01_LIM_AHH	REAL	400618	3.5(fix value)	g/l	Very High limit of biomass sensor 1 UAB needs to confirmed the value
4009	AT_4009_01_LIM_AL	REAL	400620	1.2(fix value)	g/l	Low limit of biomass sensor 1 UAB needs to confirmed the value
4009	AT_4009_01_LIM_ALL	REAL	400622	1(fix value)	g/l	Very Low limit of biomass sensor 1 UAB needs to confirmed the value
4009	AT_4009_02_LIM_AH	REAL	400624	3(fix value)	g/l	High limit of biomass sensor 2 UAB needs to confirmed the value
4009	AT_4009_02_LIM_AHH	REAL	400626	3.5(fix value)	g/l	Very High limit of biomass sensor 2 UAB needs to confirmed the value
4009	AT_4009_02_LIM_AL	REAL	400628	1.2(fix value)	g/l	Lowlimit of biomass sensor 2 UAB needs to confirmed the value
4009	AT_4009_02_LIM_ALL	REAL	400630	1(fix value)	g/l	Very Low limit of biomass sensor 2 UAB needs to confirmed the value
4009	AT_4009_SENSORFAILLURE_LIM	REAL	400632	10(fix value)	mA	OLD TAG: TT_4009_01_LIM_AL
4010	CL4010_O2_SP	REAL	400320	21	%	O2 set point

Control Loop	Threshold variable name	Type	HMI Address	Value	Unit	Comments
4010	AT_4010_01_LIM_AH	REAL	400640	450(fix value)	ppm	High Limit of CO2 To be defined after (related with the CV integration
4010	AT_4010_01_LIM_AHH	REAL	400642	500(fix value)	ppm	Very High Limit of CO2 To be defined after (related with the CV integration
4010	AT_4010_01_LIM_AL	REAL	400644	350(fix value)	ppm	Low limit of CO2 To be defined after (related with the CV integration
4010	AT_4010_01_LIM_ALL	REAL	400646	300(fix value)	ppm	Very Low limit of CO2 To be defined after (related with the CV integration
4010	AT_4010_02_LIM_AH	REAL	400648	22(fix value)	%	High limit of O2 To be defined after (related with the CV integration
4010	AT_4010_02_LIM_AHH	REAL	400650	24(fix value)	%	Very High limit of O2 To be defined after (related with the CV integration
4010	AT_4010_02_LIM_AL	REAL	400652	20(fix value)	%	Low limit of O2 To be defined after (related with the CV integration
4010	AT_4010_02_LIM_ALL	REAL	400654	19.5(fix value)	%	Very Low limit of O2 To be defined after (related with the CV integration
4010	AT_4010_03_LIM_AH	REAL	400656	90(fix value)	%	High limit of dissolve O2 To be defined after (related with the CV integration
4010	AT_4010_03_LIM_AHH	REAL	400658	95(fix value)	%	Very High limit of dissolve O2 To be defined after (related with the CV integration
4010	AT_4010_03_LIM_AL	REAL	400660	70(fix value)	%	Low limit of dissolve O2 To be defined after (related with the CV integration
4010	AT_4010_03_LIM_ALL	REAL	400662	65(fix value)	%	Very Low limit of dissolve O2 To be defined after (related with the CV integration
4010	PT_4010_01_LIM_AH	REAL	400672	80	mbar	High pressure limit in Outlet gas composition line
4010	PT_4010_01_LIM_AHH	REAL	400674	100	mbar	Very High pressure limit in Outlet gas composition line
4010	PT_4010_01_LIM_AL	REAL	400676	20	mbar	Low pressure limit in Outlet gas composition line
4010	PT_4010_01_LIM_ALL	REAL	400678	0	mbar	Very Low pressure limit in Outlet gas composition line
4010	TT_4010_01_LIM_AH	REAL	400680	?	ºC	High limit of temperature transmitter of gas analyzer UAB needs to defined the value
4010	TT_4010_01_LIM_AHH	REAL	400682	?	ºC	Very High limit of temperature transmitter of gas analyzer UAB needs to defined the value
4010	TT_4010_01_LIM_AL	REAL	400684	?	ºC	Low limit of temperature transmitter of gas analyzer UAB needs to defined the value

Control Loop	Threshold variable name	Type	HMI Address	Value	Unit	Comments
4010	TT_4010_01_LIM_ALL	REAL	400686	?	ºC	Very Low limit of temperature transmitter of gas analyzer UAB needs to defined the value
4011	TT_4011_SP	REAL	400234	10	℃	Inflient temperature set point
4011	TT_4011_01_LIM_AH	REAL	400688	1	ºC	Influent tank High limit of temperature transmitter Compare to the set pont
4011	TT_4011_01_LIM_AHH	REAL	400690	2	ºC	Influent tank Very High limit of temperature transmitter Compare to the set pont
4011	TT_4011_01_LIM_AL	REAL	400692	-1	ºC	Influent tank Low limit of temperature transmitter Compare to the set pont. Action will be defined after with the close loop
4011	TT_4011_01_LIM_ALL	REAL	400694	-2	ºC	Influent tank Very Low limit of temperature transmitter Compare to the set pont
4012	TT_4012_SP	REAL	400236	10	℃	Inflient temperature set point
4012	TT_4012_01_LIM_AH	REAL	400696	1	ºC	Effluent tank High limit of temperature transmitter Compare to the set pont
4012	TT_4012_01_LIM_AHH	REAL	400698	2	ºC	Effluent tank Very High limit of temperature transmitter Compare to the set pont. Action will be defined after with the close loop
4012	TT_4012_01_LIM_AL	REAL	400700	-1	ºC	Effluent tank Low limit of temperature transmitter Compare to the set pont
4012	TT_4012_01_LIM_ALL	REAL	400702	-2	ºC	Effluent tank Very Low limit of temperature transmitter Compare to the set pont

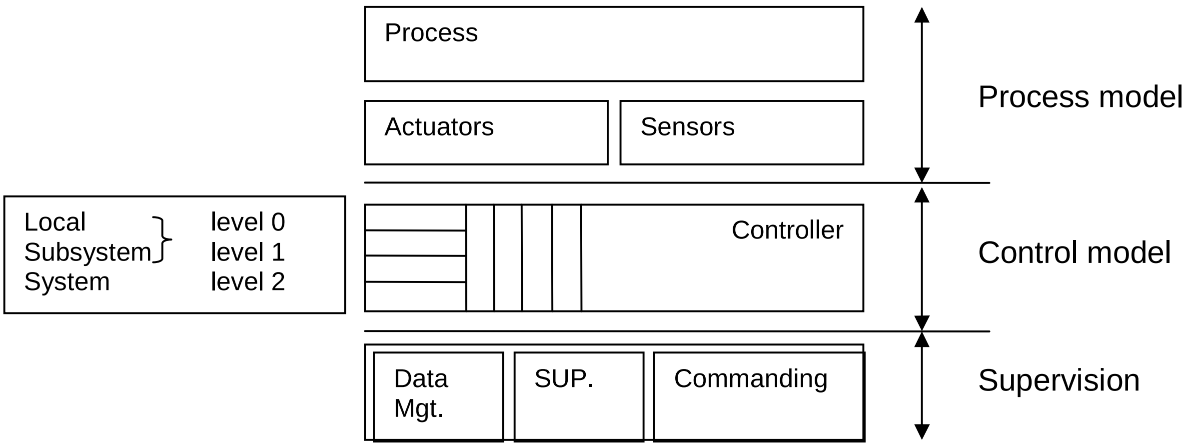
2. System Description

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.



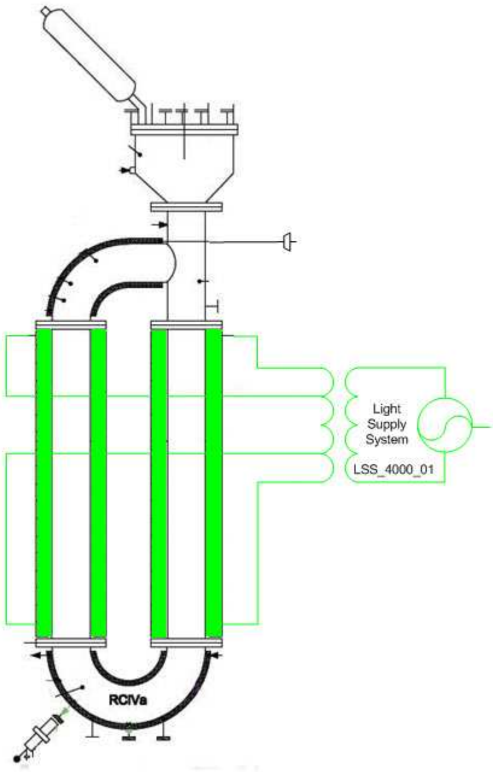
2.2. Control Loops

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

New Control Loop	***Control Loop Name***	***Location***	***FBD_Name***
4000	CIVa Bioreactor lighting control	PBR	CL4000_Lights
4001	Inlet liquid flow control	Inlet	CL4001_Inlet_Liquid_Flow
4002	Outlet liquid flow control	Outlet	CL4002_Outlet_Liquid_Flow
4003	Inlet gas flow control	Inlet	CL4003_Inlet_Gas_Flow
4004	Outlet gas flow control	Outlet	CL4004_Outlet_Gas_Flow
4005	Bioreactor temperature control	PBR	CL4005_PBR_Temp
4006	Bioreactor pH control	PBR	CL4006_pH
4007	Bioreactor pressure control	PBR	CL4007_PBR_Pressure
4008	Bioreactor liquid level control	PBR	CL4008_PBR_Liquid_Level
4009	Bioreactor biomass production control	PBR	CL4009_Biomass
4010	Bioreactor outlet gas composition control	PBR	CL4010_OutletGasCompo
4011	Feeding tank temperature control	Influent	CL4011_Feeding_Temp
4012	Harvesting tank temperature control	Harvest	CL4012_Harvesting_Temp
4013	Antifoam control	PBR	CL4013_Antifoam
4014	Feeding tank sterilization	Influent	CL4014_Feeding_Sterilization
4015	CIVa Bioreactor sterilization	PBR	CL4015_PBR_Sterilization
4016	Harvesting tank sterilization	Harvest	CL4016_Harvesting_Sterilization

Figure 1: Control loop definition

2.3. Bioreactor lighting control (CL4000)



2.3.1.Function

The lights are the controlled equipment for the O2 production done by the Arthrospira Platensis.

The operator decides in which mode he will operate the lights.

- In OFF mode, all the lights are switched off.
- In AUTOMATIC mode, the user enters a set point in Watt/m^2 which is converted into a % of light intensity. This control loop is linked to the O2 production. If the “Bioreactor Outlet Gas Composition” (CL4010) is in automatic mode, the controller of lights becomes a

slave controller. For more details, see the chapter of the “Bioreactor Outlet Gas Composition Control”.

- In manual mode, the operator defines the percentage of light intensity.

Due to the link with the gas Outlet composition control loop, some management of the lighting control mode are done.

- If O2 is in automatic mode and the operator decides to trigger the lights control in manual mode, the O2 control goes in OFF mode.

- If O2 control is in OFF or Manual mode and the operator decides to trigger the light control in Automatic mode, the light control stays in Manual mode. This is done to prevent error linked to the O2 set point (wrong manipulation done by the operator).

- If O2 control is in Automatic mode, the lights are automatically triggered in Automatic mode.

PLC Section name	Equipment tag	Type	Address	Comment
CL4000_Lights	IRC_4000_MV	AO	400262	Light Intensity (%) applied to the lights
CL4000_Lights	IT_4000_01	AI	400184	Light Power Phase1
CL4000_Lights	IT_4000_02	AI	400186	Light Power Phase2
CL4000_Lights	IT_4000_03	AI	400188	Light Power Phase3

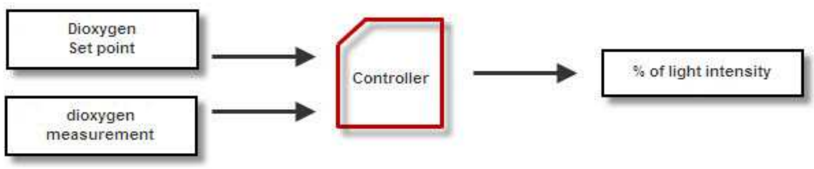
Figure 2: Bioreactor lighting control – EQUIPMENT

PLC Section name	tag	Type	Address	Comment
CL4000_Lights	IT_4000_PWR	REAL	400190	Lights Power (W)
CL4000_Lights	CL4000_ControlLoop_Mode	INT	400268	Lightning Mode (Off/Auto/Manu)
CL4000_Lights	I_4000_SP	REAL	400192	Set point (%) asked by the operator in manual mode

Figure 3: Bioreactor lighting control – OPERATOR INPUT

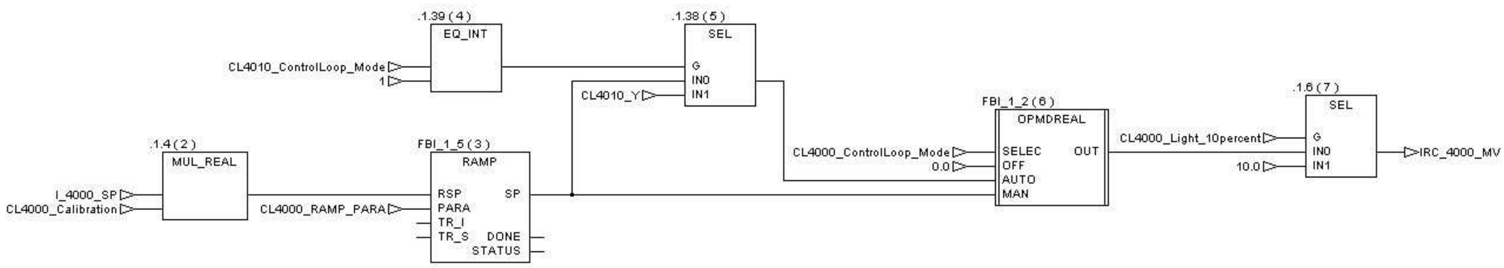
2.3.2.Block Diagram

For the Moment:

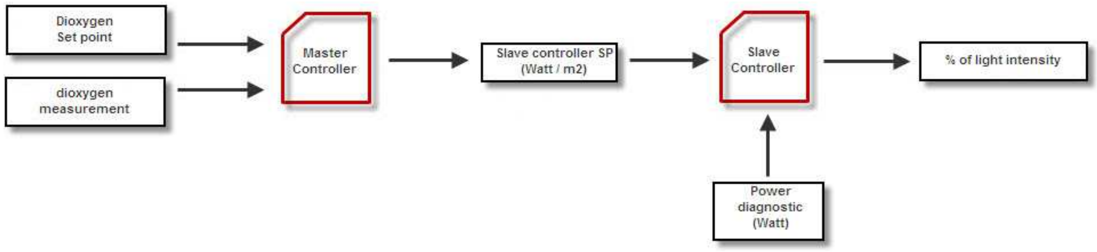


In case of blower failure or very high temperature alarm, the light intensity is reduced to 10%.

Important point: according to the curve giving the W/m^2 function of the % of light intensity, the 10% value is equal to 0. This point needs a discussion with ESA and UAB to determine the definitive value of low % of light intensity.



In the future:



With CL4000_Y coming from the Output of the controller (CL4000 in auto mode) with:

-I_4000_SP (W/m^2) set point sent by master controller (gas composition Loop) when CL4010 is in automatic mode OR set point directly entered by the operator (also in W/m^2) when CL4010 is in OFF mode

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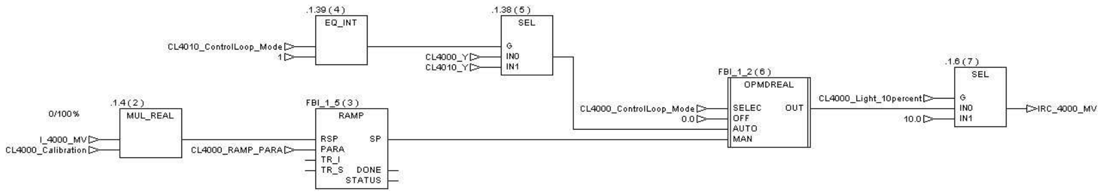
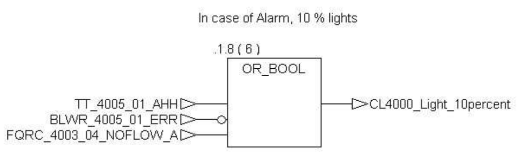
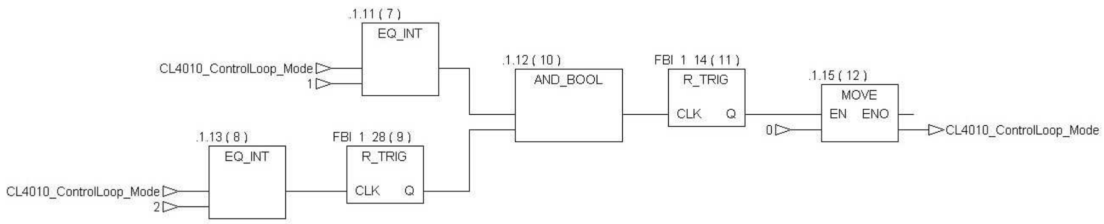
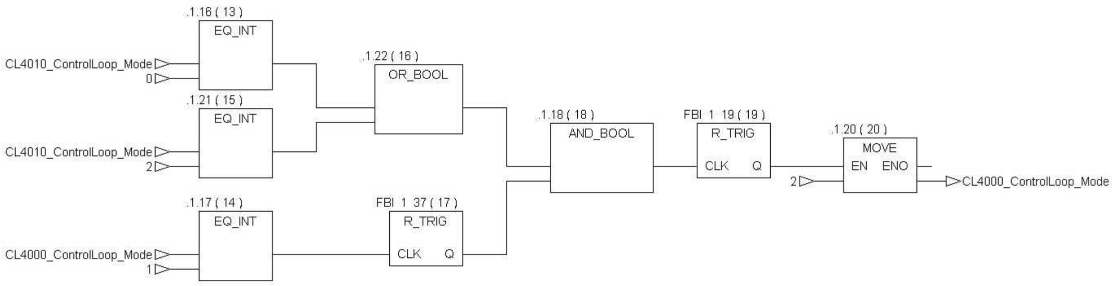




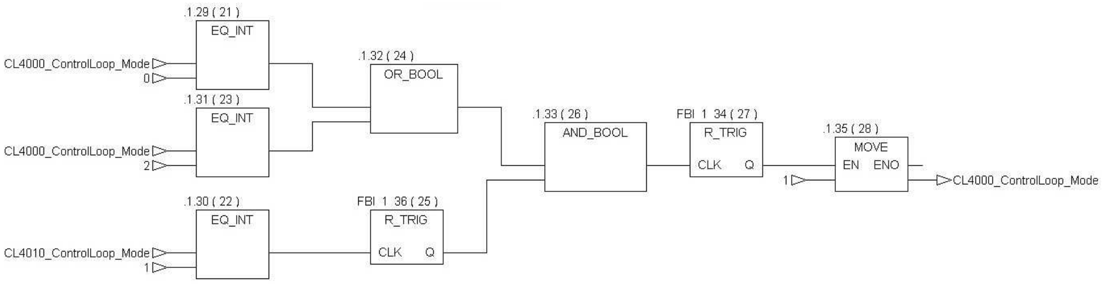
If O2 is in AUTO mode and the operator decides to trigger the light in manual mode, the O2 control goes into OFF mode.



If O2 is in OFF mode or MANUAL mode, then the operator decides to trigger the light in AUTOMATIC mode, the Light mode stays in MANUAL mode.



The PLC triggers automatically the light mode in AUTOMATIC mode if the operator switches the O2 control in AUTOMATIC mode.



2.3.3. Alarm and Threshold

Alarm tag Name	type	Address	description
IT_4000_01_AH	BOOL	000201	High intensity on phase 1
IT_4000_01_AL	BOOL	000202	Low intensity on phase 1
IT_4000_02_AH	BOOL	000203	High intensity on phase 2
IT_4000_02_AL	BOOL	000204	Low intensity on phase 2
IT_4000_03_AH	BOOL	000205	High intensity on phase 3
IT_4000_03_AL	BOOL	000206	Low intensity on phase 3
IT_4000_01_ERR	BOOL	000113	Light Intensity Phase1 Sensor Link Error
IT_4000_02_ERR	BOOL	000114	Light Intensity Phase2 Sensor Link Error
IT_4000_03_ERR	BOOL	000115	Light Intensity Phase3 Sensor Link Error

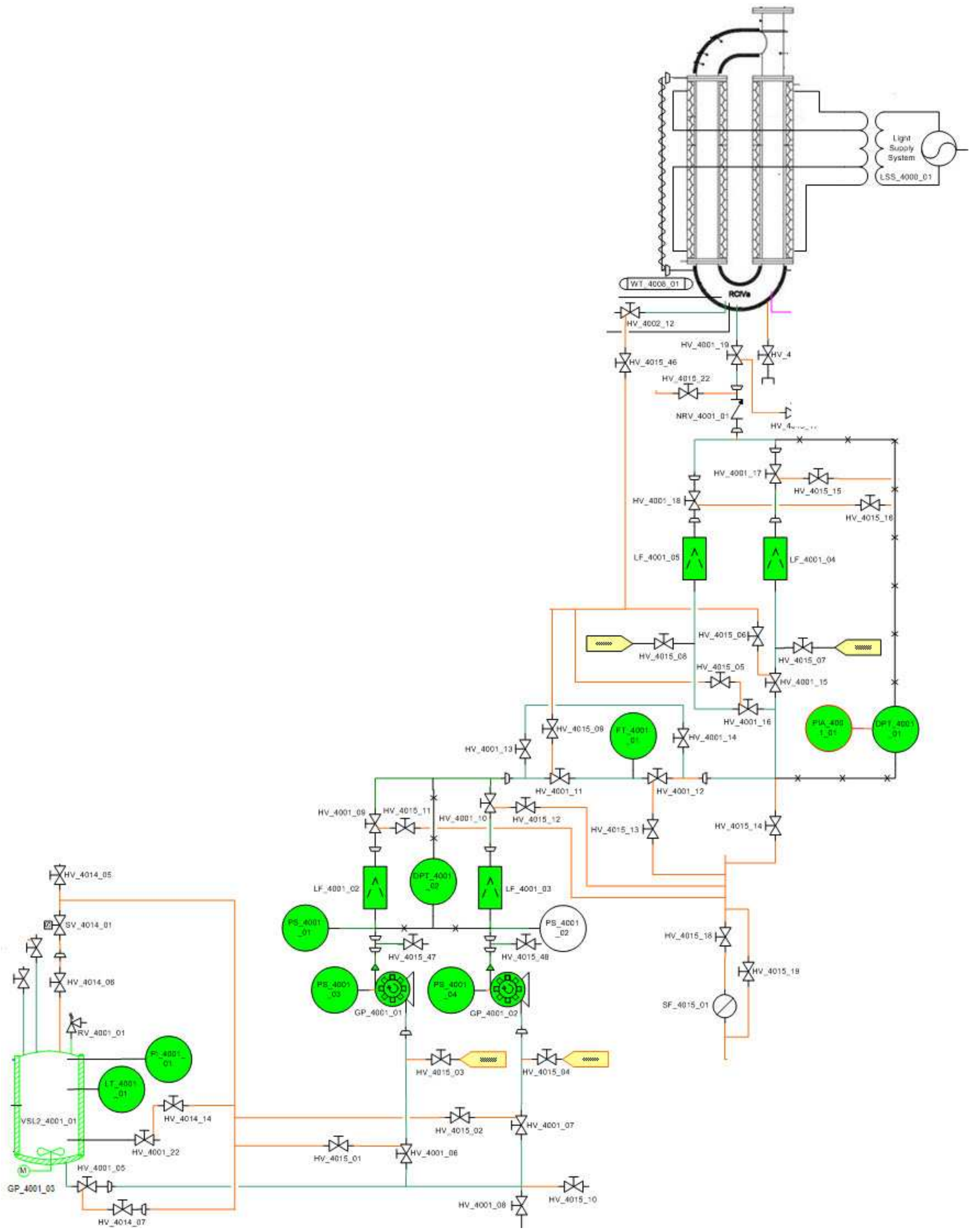
Figure 4: Bioreactor lighting control – ALARM

Threshold tag name	Type	Address	Value	Unit	ACTION
IT_4000_01_LIM_AH	REAL	400500	TBD	(W)	TBD
IT_4000_01_LIM_AL	REAL	400502	TBD	(W)	TBD

IT_4000_02_LIM_AH	REAL	400504	TBD	(W)	TBD
IT_4000_02_LIM_AL	REAL	400506	TBD	(W)	TBD
IT_4000_03_LIM_AH	REAL	400508	TBD	(W)	TBD
IT_4000_03_LIM_AL	REAL	400510	TBD	(W)	TBD

Figure 5: Bioreactor lighting control – THRESHOLD

2.4. Inlet Liquid Flow (CL4001)



2.4.1.Function

The aim of this loop is to control the flow of medium from influent tank to the bioreactor. The Arthrospira Platensis need a define quantity of medium for growing and producing dioxygen. The nominal inlet liquid flow is about 0.6 litre per hour.

PLC Section name	Equipment tag	Type	Address	Comment
CL4001_Inlet_Liquid_Flow	PS_4001_01	DI	100082	Pressure pump GP_4001_01
CL4001_Inlet_Liquid_Flow	PS_4001_02	DI	100083	Pressure pump GP_4001_02
CL4001_Inlet_Liquid_Flow	PS_4001_03	DI	100106	Pressure switch membrane GP_4001_01
CL4001_Inlet_Liquid_Flow	PS_4001_04	DI	100107	Pressure switch membrane GP_4001_02
CL4001_Inlet_Liquid_Flow	GP_4001_01_MV1	DO	000091	Start/Stop of the pump
CL4001_Inlet_Liquid_Flow	GP_4001_02_MV1	DO	000090	Start/Stop of the pump
CL4001_Inlet_Liquid_Flow	GP_4001_03_MV1	DO	000109	Start/Stop of the agitator
CL4001_Inlet_Liquid_Flow	CL4001_PumpSpeed	REAL-->AO	400250	Flow to the inlet pump (OLD NAME:GP_4001_01_MV2)
CL4001_Inlet_Liquid_Flow	GP_4001_03_MV2	REAL-->AO	400258	Speed Agitator (VS_4001_01)
CL4001_Inlet_Liquid_Flow	FT_4001_01	AI ->REAL	400148	Total liquid inlet flow to reactor
CL4001_Inlet_Liquid_Flow	LT_4001_01	AI ->REAL	400150	Level (guided microwave)
CL4001_Inlet_Liquid_Flow	DPT_4001_01	AI ->REAL	400162	Diff. Pressure Filter
CL4001_Inlet_Liquid_Flow	DPT_4001_02	AI ->REAL	400164	Diff. Pressure Filter

Figure 6: Inlet Liquid Flow – EQUIPMENT

PLC Section name	tag	Type	Address	Comment
CL4001_Inlet_Liquid_Flow	CL4001_Agitator_Mode	INT	400270	Agitator Mode (Off/Auto/Manu)
CL4001_Inlet_Liquid_Flow	GP_4001_03_MV2_OP	REAL	400196	Blender speed (%)
CL4001_Inlet_Liquid_Flow	GP_4001_03_MV1_OP	BOOL	000146	Blender (ON/OFF)
CL4001_Inlet_Liquid_Flow	CL4001_ControlLoop_Mode	INT	400272	Mode management (Off/Auto/Manu)
CL4001_Inlet_Liquid_Flow	GP_4001_01_SEL	BOOL	000147	Pump should be selected before CONTROL in AUTO
CL4001_Inlet_Liquid_Flow	GP_4001_02_SEL	BOOL	000148	Pump should be selected before CONTROL in AUTO
CL4001_Inlet_Liquid_Flow	CL4001_PumpSpeed_OP	REAL	400198	Define pump speed in %(for both inlet liquid pump)
CL4001_Inlet_Liquid_Flow	GP_4001_01_MV1_OP	BOOL	000149	To start the pump in manual mode if the pump selected
CL4001_Inlet_Liquid_Flow	GP_4001_02_MV1_OP	BOOL	000150	To start the pump in manual mode if the pump selected
CL4001_Inlet_Liquid_Flow	CL4001_INLETPUMP_VARIATOR	BOOL	000111	start the variator which control the inlet liquid pump. Automatic management (hidden for the operator)

Figure 7: Inlet liquid Flow - OPERATOR INPUT

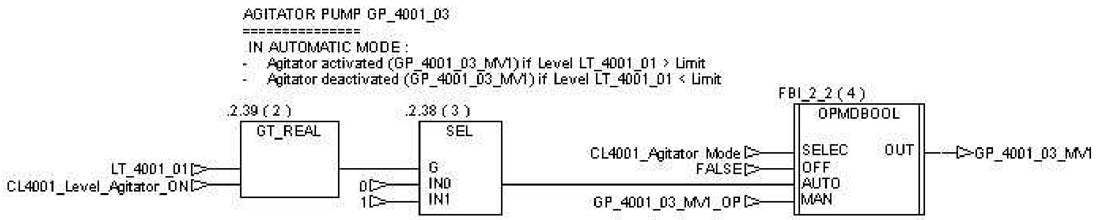
2.4.2.Block Diagram

2.4.2.1. *Agitator:*

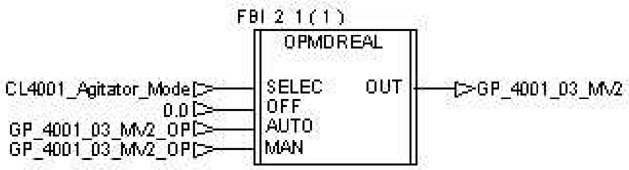
The agitator management depends on the mode chosen by the operator:

- OFF mode: The agitator is switched OFF
- MANual Mode: The operator decides to switch it ON or OFF.
- AUTOmatic mode: The agitator is switched to ON depending on the level of the influent tank. It permits to preserve it in case of very low level.

Important point: The limit “CL4001_Level_Agitator_ON” needs to be defined
The tag “CL4001_Level_Agitator_ON” represents the limit of the Influent tank level which triggers the agitator.



The speed of the agitator is configurable by the operator in manual and automatic mode.



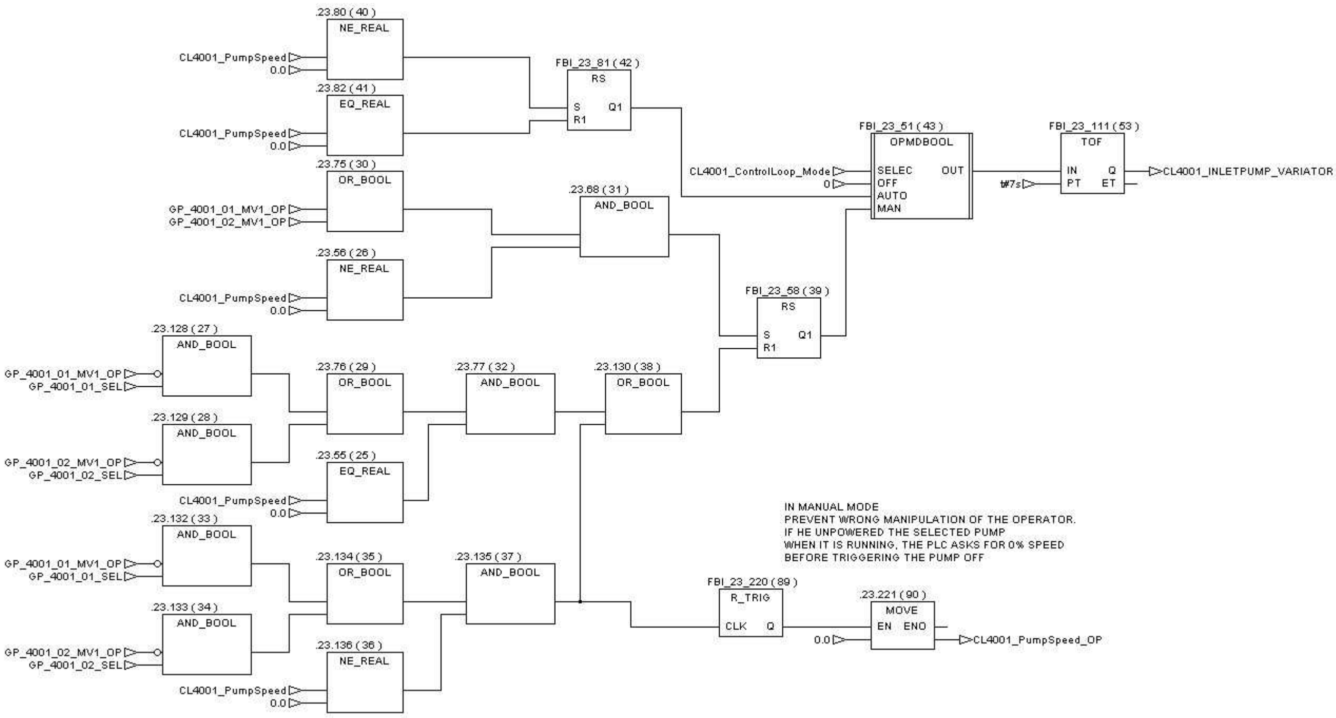
2.4.2.2. *Inlet liquid pump management:*

Both inlet liquid pumps are managed by one variator with a channel selection. According to this design, the way of managing the variator and because Pro Control asks to powered off the variator in case of 0 % speed, the inlet liquid pumps have a dedicated way of working.
Before starting or stopping one of the two pumps, the software needs to manage variator state.
The following block diagram show how the variator is piloted. Depending on the mode that the operator selects, the following conditions are implemented:

IN MANUAL MODE
If one of the two pumps is triggered to “ON”, with a speed non equal to 0%, the variator is powered.
If the selected pump is stopped with or without a speed equal to 0, the variator is unpowered after 7 seconds. This time is added to be sure that the variator doesn’t enter in safety state (which locks it).
If the operator decides to unpower the pump without reset the speed, the pump speed is forced by the PLC to 0%, then the pump is unpowered..

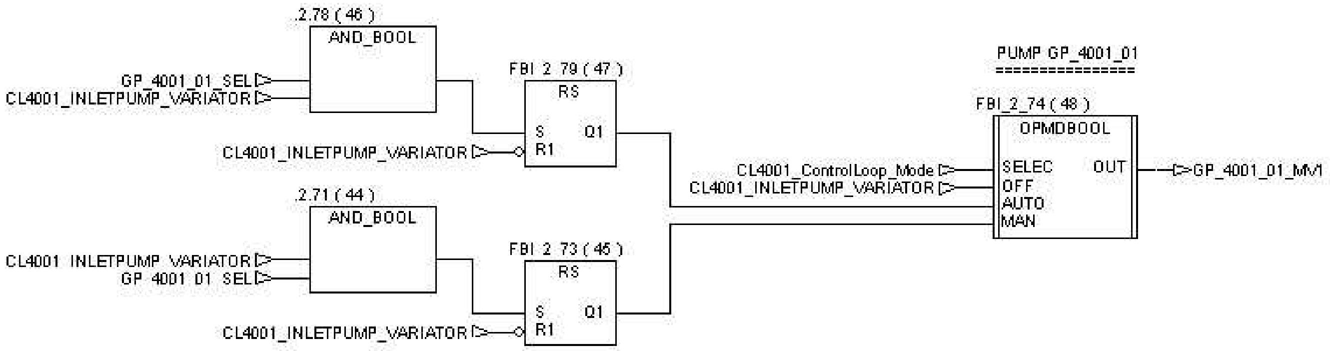
IN AUTOMATIC MODE
If the speed of the selected pump is non equal to 0%, the variator is powered.

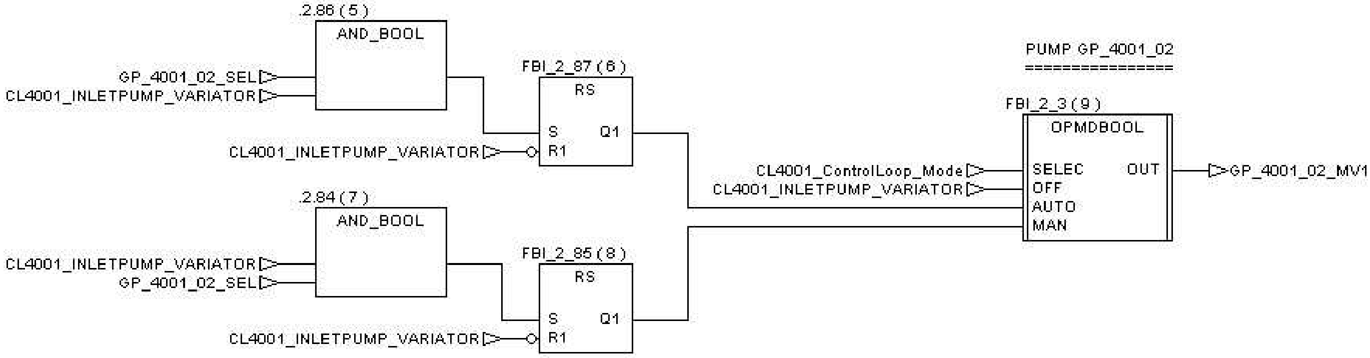
If the speed of the selected pump is equal to 0% for more that 7 seconds, the variator is unpowered.



The next step concerns the ON/OFF management of the pump. The operator needs to select one then the state of the pump is linked to the variator state:

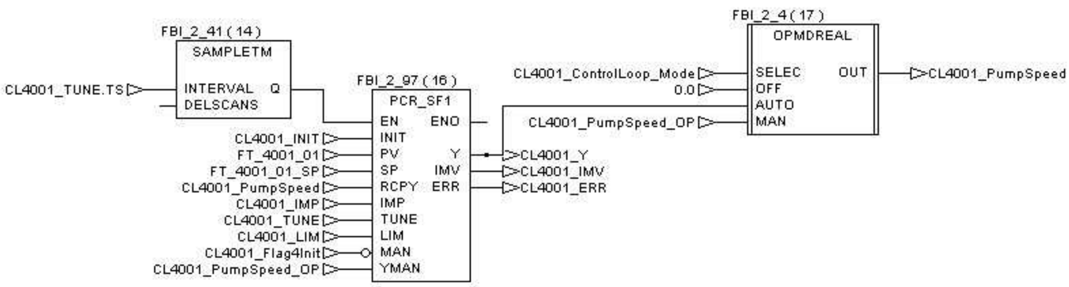
-Variator ON / pump selection → Pump Selected ON
-Variator OFF →Pump Selected OFF


.2.78 (46)
AND_BOOL
GP_4001_01_SEL
CL4001_INLETPUMP_VARIATOR
FBI_2_79 (47)
RS
S
Q1
R1
CL4001_INLETPUMP_VARIATOR
.2.71 (44)
AND_BOOL
CL4001_INLETPUMP_VARIATOR
GP_4001_01_SEL
FBI_2_73 (45)
RS
S
Q1
R1
CL4001_INLETPUMP_VARIATOR
PUMP GP_4001_01
FBI_2_74 (48)
OPMDBOOL
CL4001_ControlLoop_Mode
CL4001_INLETPUMP_VARIATOR
SELEC
OFF
AUTO
MAN
OUT
GP_4001_01_MM



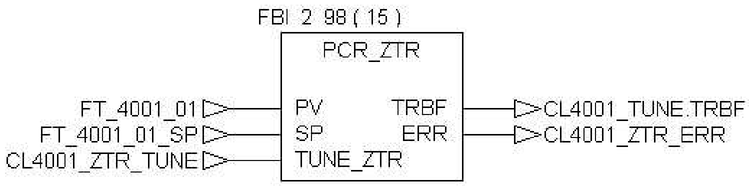
2.4.2.2.1. Controller

The control is done by the Predictive control block SF1 (Simple predictive controller for first order process) (See annex B). An internal model represents the flow function of the pump speed. Depending of this model, the controller will adjust the flow variation to maintain the desired set point.



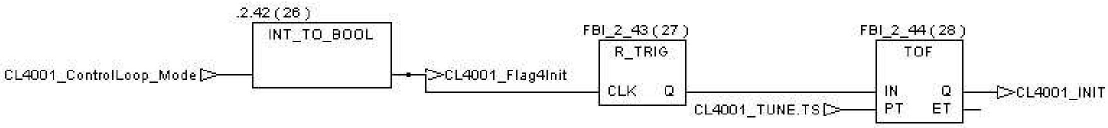
2.4.2.2.2. Bock ZTR

The block "ZTR" permits to increase the closed loop response time of the controller when the process value enter in a define zone (see annexE). The control becomes smoother inside this zone.



2.4.2.2.3. Controller initialization

When the operator decides to switch to the automatic mode, the controller is initialized during the sample time (see controller parameters)



2.4.2.2.4. Controller parameters

Controlled Variable	**PCR CONTROLER TYPE**	**DEAD ZONE**	**ZTR Zone Control**	**PWM**	**SAMPLETM**	**PROCESS VALUE (input)**	**SET POINT**
Pump speed of inlet flow (CL4001_PumpSpeed)	SF1	NO	Zone: 0.025 TRBF_LO: 3m TRBF_HI: 10m	NO	CL4001_TUNE	FT_4001_01	FT_4001_01_SP

INTERNAL MODEL PROCESS	**TUNE**	**LIMIT**	**SELF_CMP**	**DECOMP**	**Manipulated Variable (Controller Output in Auto Mode)**	**Controlled Equipment**
KM : 0.038 TM : 60s DM : 0s	TS : 2s H : 2s TRBF : 3m	CL4001_LIM YMIN : 0 YMAX : 100 YRATE : 100	NO	NO	CL4001_PumpSpeed	GP_4001_01_MV2

2.4.3. Alarm and Threshold

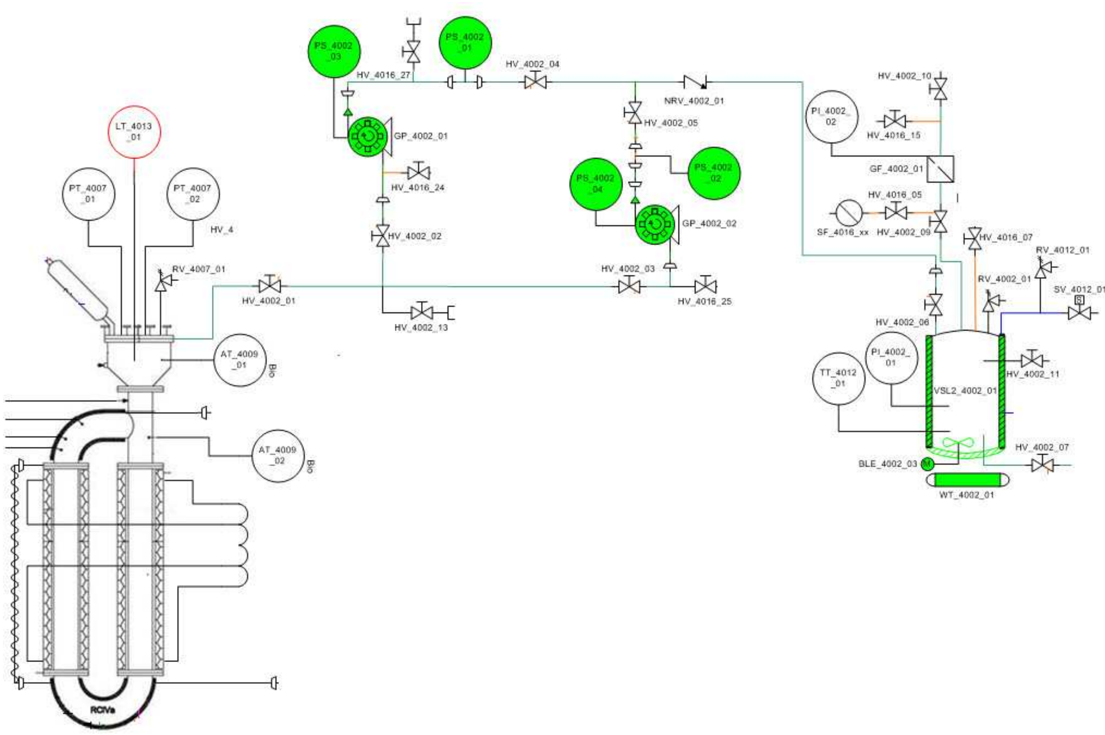
Alarm tag Name	type	Address	description
PS_4001_01_ A	BOOL	000315	Pressure switch alarm triggered by timer
PS_4001_02_ A	BOOL	000316	Pressure switch alarm triggered by timer
GP_4001_01_ERR	DI	100099	Thermal protection to the pump
GP_4001_02_ERR	DI	100100	Thermal protection to the pump
GP_4001_03_ERR	DI	100105	Thermal protection of agitator motor
PS_4001_03_ A	BOOL	000317	Pressure switch alarm triggered by timer
PS_4001_04_ A	BOOL	000318	Pressure switch alarm triggered by timer
FT_4001_01_AHH	BOOL	000207	Flow transmitter Very High alarm
FT_4001_01_AH	BOOL	000208	Flow transmitter High alarm
FT_4001_01_AL	BOOL	000209	Flow transmitter low alarm
FT_4001_01_ALL	BOOL	000210	Flow transmitter Very Low alarm
LT_4001_01_AHH	BOOL	000211	Level transmitter Very High alarm
LT_4001_01_AH	BOOL	000212	Level transmitter High alarm
LT_4001_01_AL	BOOL	000213	Level transmitter low alarm
LT_4001_01_ALL	BOOL	000214	Level transmitter Very Low alarm
DPT_4001_01_AHH	BOOL	000215	Differential Pressure transmitter 1 Very High alarm
DPT_4001_01_AH	BOOL	000216	Differential Pressure transmitter 1 High alarm
DPT_4001_01_ALL	BOOL	000217	Differential Pressure transmitter 1 Very Low 1 alarm
DPT_4001_01_AL	BOOL	000218	Differential Pressure transmitter 1 low alarm
DPT_4001_02_AHH	BOOL	000219	Differential Pressure transmitter 2 Very High alarm
DPT_4001_02_AH	BOOL	000220	Differential Pressure transmitter 2 High alarm
DPT_4001_02_AL	BOOL	000221	Differential Pressure transmitter 2 Very Low 1 alarm
DPT_4001_02_ALL	BOOL	000222	Differential Pressure transmitter 2 low alarm
FT_4001_01_ERR	BOOL	000116	Flow transmitter Link Error
LT_4001_01_ERR	BOOL	000117	Level transmitter Link Error
DPT_4001_01_ERR	BOOL	000118	Diff. Pressure transmitter Link Error
DPT_4001_02_ERR	BOOL	000119	Diff. Pressure transmitter Link Error

Figure 8: Inlet Liquid Flow – ALARM

Threshold tag name	Type	Address	Value	Unit	Action
FT_4001_01_LIM_AHH	REAL	400512	0.2	(L/h)	Displays alarm on HMI only in automatic mode Time for triggering alarm =5min. Compare to the set point
FT_4001_01_LIM_AH	REAL	400514	0.1	(L/h)	Displays alarm on HMI only in automatic mode Time for triggering alarm =5min. Compare to the set point
FT_4001_01_LIM_AL	REAL	400516	-0.1	(L/h)	Displays alarm on HMI only in automatic mode Time for triggering alarm =5min. Compare to the set point
FT_4001_01_LIM_ALL	REAL	400518	-0.2	(L/h)	Displays alarm on HMI only in automatic mode Time for triggering alarm =5min. Compare to the set point
LT_4001_01_LIM_AHH	REAL	400520	140	Litre	Displays alarm on HMI Feeding tank volume: 160 liters. Working Volume: 120 liters. The sensor need to be calibrated referring to the volume law provide by De Dietrich
LT_4001_01_LIM_AH	REAL	400522	130	Litre	Displays alarm on HMI Feeding tank volume: 160 liters. Working Volume: 120 liters. The sensor need to be calibrated referring to the volume law provide by De Dietrich
LT_4001_01_LIM_AL	REAL	400524	20	Litre	Displays alarm on HMI Feeding tank volume: 160 liters. Working Volume: 120 liters. The sensor need to be calibrated referring to the volume law provide by De Dietrich
LT_4001_01_LIM_ALL	REAL	400526	5	Litre	Stop the inlet flow control loop (only in automatic mode) Feeding tank volume: 160 liters. Working Volume: 120 liters. The sensor need to be calibrated referring to the volume law provide by De Dietrich
DPT_4001_01_LIM_AHH	REAL	400528	300	mBar	Stop the inlet flow control loop after 5 seconds The maximum admissible pressure for the membrane has to be confirmed by Enrique / De Dietrich
DPT_4001_01_LIM_AH	REAL	400530	200	mBar	Displays alarm on HMI
DPT_4001_01_LIM_ALL	REAL	400532	TBD	mBar	Stop the inlet flow control loop
DPT_4001_01_LIM_AL	REAL	400534	TBD	mBar	Displays alarm on HMI
DPT_4001_02_LIM_AHH	REAL	400536	300	mBar	Stop the inlet flow control loop The maximum admissible pressure for the membrane has to be confirmed by Enrique / De Dietrich
DPT_4001_02_LIM_AH	REAL	400538	200	mBar	Displays alarm on HMI
DPT_4001_02_LIM_AL	REAL	400540	TBD	mBar	Displays alarm on HMI
DPT_4001_02_LIM_ALL	REAL	400542	TBD	mBar	Stop the inlet flow control loop

Figure 9: Inlet Liquid Flow – THRESHOLD

2.5. Outlet Liquid Flow (CL4002)



2.5.1.Function

The Outlet liquid flow provides the action variable to regulate the bioreactor level. According to the level chosen and the inlet flow set point, the speed of the pump will be adjusted to keep constant the level in the bioreactor. The Effluent tank receives the Arthrospira Platensis and medium. Due to the link with the bioreactor level control loop, no controller is implemented in the PLC software.

PLC Section name	Equipment tag	Type	Address	Comment
CL4002_Outlet_Liquid_Flow	PS_4002_01	DI	100084	Pressure pump GP_4002_01
CL4002_Outlet_Liquid_Flow	PS_4002_02	DI	100085	Pressure pump GP_4002_01
CL4002_Outlet_Liquid_Flow	PS_4002_03	DI	100108	Pressure Switch membrane GP_4002_01
CL4002_Outlet_Liquid_Flow	GP_4002_01_MV1	DO	000089	Start/Stop of the pump
CL4002_Outlet_Liquid_Flow	GP_4002_02_MV1	DO	000104	Start/Stop of the pump
CL4002_Outlet_Liquid_Flow	GP_4002_03_MV1	DO	000110	Start/Stop of the agitator
CL4002_Outlet_Liquid_Flow	CL4002_PumpSpeed	REAL-->AO	400254	Flow to the outlet pump (OLD NAME:GP_4002_01_MV2)
CL4002_Outlet_Liquid_Flow	GP_4002_03_MV2	REAL-->AO	400260	Speed Agitator (VS_4002_01)
CL4002_Outlet_Liquid_Flow	WT_4002_01	AI ->REAL	400152	Weight Balance (VS_4002_01)

Figure 10: Outlet Liquid Flow - EQUIPMENTS

PLC Section name	Button tag	Type	Address	Comment
CL4002_Outlet_Liquid_Flow	CL4002_Agitator_Mode	INT	400274	Agitator Mode (Off/Auto/Manu)
CL4002_Outlet_Liquid_Flow	GP_4002_03_MV2_OP	REAL	400202	Agitator Speed (%) Entered by the user
CL4002_Outlet_Liquid_Flow	GP_4002_03_MV1_OP	BOOL	000151	GP_4002_03 ON/OFF In Agitator Manual Mode
CL4002_Outlet_Liquid_Flow	CL4002_ControlLoop_Mode	INT	400276	Outlet Flow Mode (Off/Auto/Manu)
CL4002_Outlet_Liquid_Flow	GP_4002_01_SEL	BOOL	000152	Select Pump GP_4002_01. Pump should be selected before CONTROL in AUTO
CL4002_Outlet_Liquid_Flow	GP_4002_02_SEL	BOOL	000153	Select Pump GP_4002_02 Pump should be selected before CONTROL in AUTO
CL4002_Outlet_Liquid_Flow	CL4002_PumpSpeed_OP	REAL	400204	CL4002_PumpSpeed (%) Define both pump speed (OLD NAME: GP_4002_01_MV2_OP)
CL4002_Outlet_Liquid_Flow	GP_4002_01_MV1_OP	BOOL	000154	GP_4002_01 ON/OFF In MANUAL Mode. if pump selected
CL4002_Outlet_Liquid_Flow	GP_4002_02_MV1_OP	BOOL	000155	GP_4002_02 ON/OFF In MANUAL Mode. if pump selected
CL4001_Outlet_Liquid_Flow	CL4002_OUTLETPUMP_VARIATOR	BOOL	000112	start the variator which control the Outlet pump

Figure 11: Outlet Liquid Flow - OPERATOR INPUT

2.5.2.Block Diagram

2.5.2.1. *Agitator:*

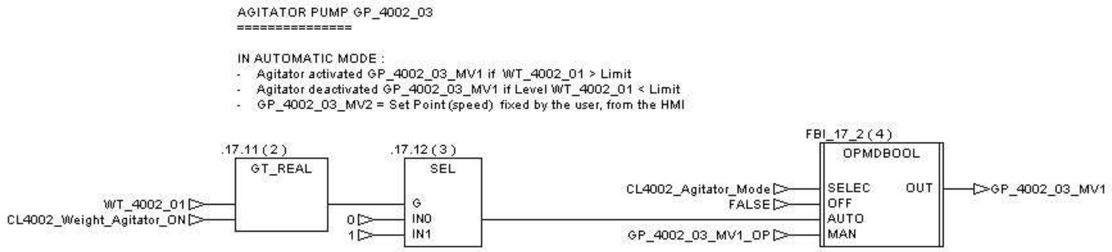
The agitator management depends on the mode chosen by the operator:

OFF mode: The agitator is switched OFF

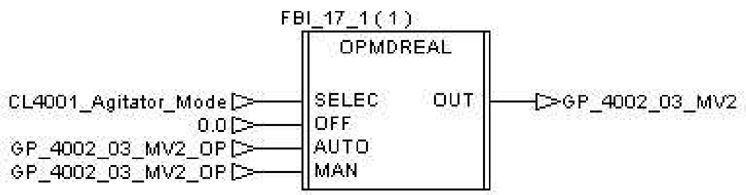
MANual Mode: The operator decides to switch it ON or OFF.

AUTOmatic mode: The agitator is switched to ON depending on the level of the influent tank. It permits to preserve it in case of very low level.

Important point: The limit "CL4002_Weight_Agitator_ON" needs to be defined
The tag "CL4002_Weight_Agitator_ON" represents the limit of the Effluent tank weight which triggers the agitator.



The speed of the agitator is configurable by the operator in manual and automatic mode.



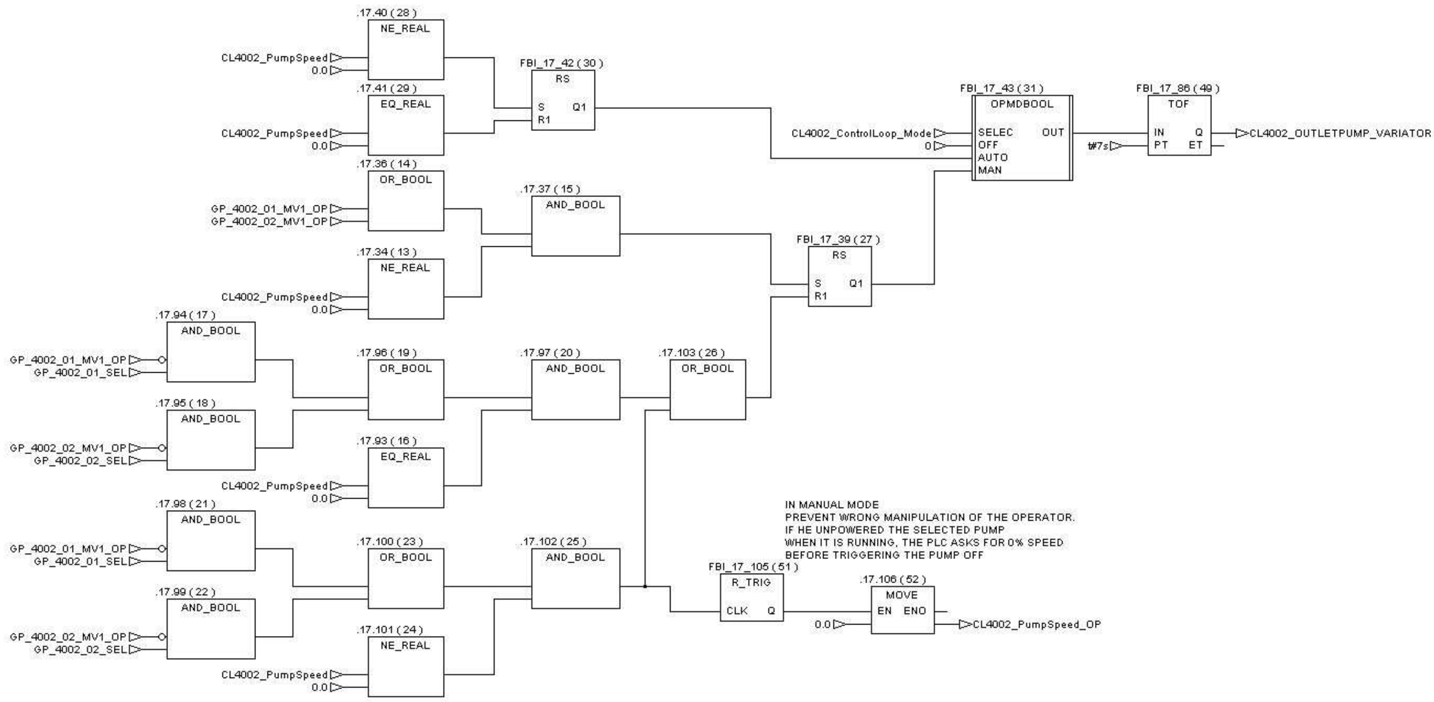
2.5.2.2. *Outlet liquid pump management*

Important: *In the current configuration, only one pump is installed for the Outlet flow. According to what was designed, and because the compartment CIVA should have two pumps in the future, we have decided to implement in the* *software the logic for the two pumps. The operator cannot select the second pump on the HMI even if the logic exists into the PLC.*

Both Outlet liquid pumps are managed by one variator with a channel selection. According to this design, the way of managing the variator and because Pro Control asks to powered off the variator in case of 0 % speed, the outlet liquid pumps have a dedicated way of working.
Before starting or stopping one of the two pumps, the software needs to manage the variator state.
The following block diagram shows how the variator is managed. Depending on the mode chosen, the following conditions are implemented:

IN MANUAL MODE
If one of the two pumps is triggered to “ON”, with a speed non equal to 0%, the variator is powered.
If the selected pump is stopped with or without a speed equal to 0, the variator is unpowered after 7 seconds. This time is added to be sure that the variator doesn’t enter in safety state (which locks it).
If the operator decides to unpower the pump without reset the speed, the pump speed is forced by the PLC to 0%, then the pump is unpowered.

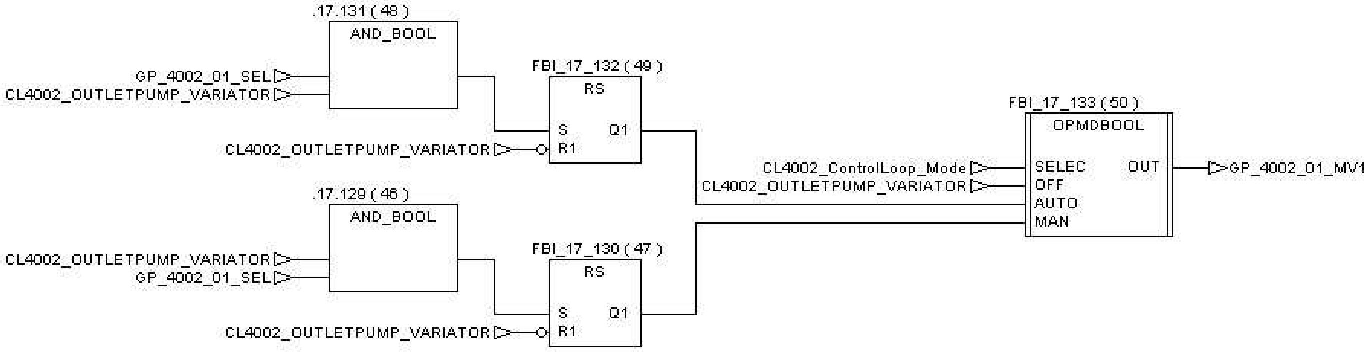
IN AUTOMATIC MODE
If the speed of the selected pump is non equal to 0%, the variator is powered.
If the speed of the selected pump is equal to 0% for more that 7 seconds, the variator is unpowered.



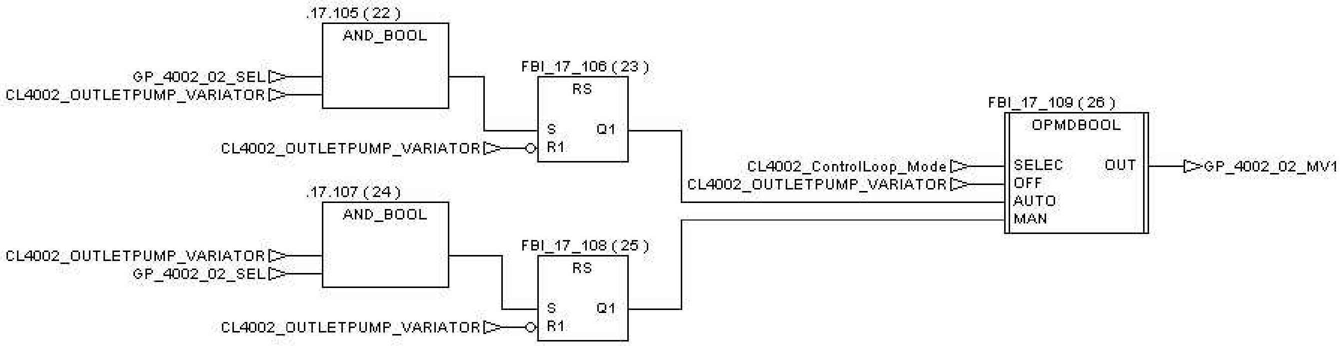
The next step concerned the ON/OFF management of the pump. The operator needs to select one then the state of the pump is linked to the variator state:

-Variator ON & pump selection → Pump ON
-Variator OFF → Pump Selected OFF

2.5.2.2.1. GP 4002 01 management



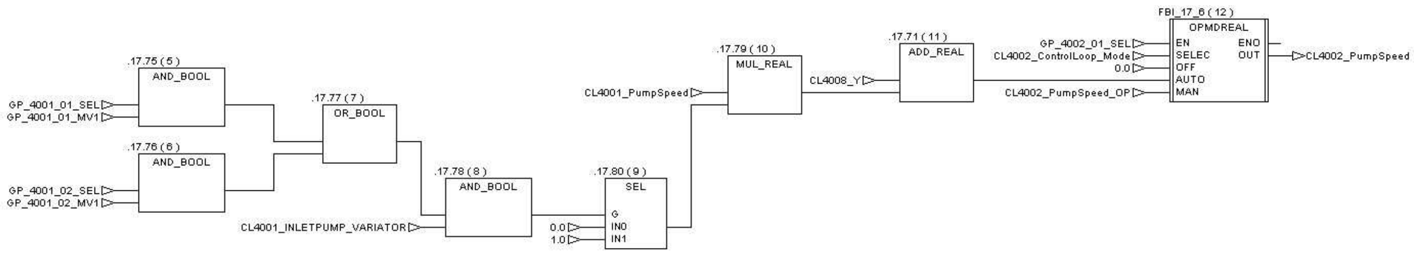
2.5.2.2.2. GP 4002 02 management



2.5.2.3. *Pump speed management*

Depending on the choice of the operator, the speed of the pump is managed differently. Three modes are available

OFF mode:	The selected pump is OFF
MANual mode:	The operator specifies in % the speed to be applied to the selected pump.
AUTOmatic mode:	The level of the Bioreactor is linked to the outlet flow. As the controller is not aware of the speed of the inlet liquid flow pump, the PLC adds this speed to the controller output in order to reach exactly what it computes. This mode is directly triggered when the operator switches the bioreactor level in automatic mode. The opposite situation happens if the operator decides to trigger the Outlet liquid flow in manual / OFF mode. In this case the bioreactor Level control goes in OFF (this function is detail in the chapter “Bioreactor level control”).



2.5.3.Alarms and Threshold

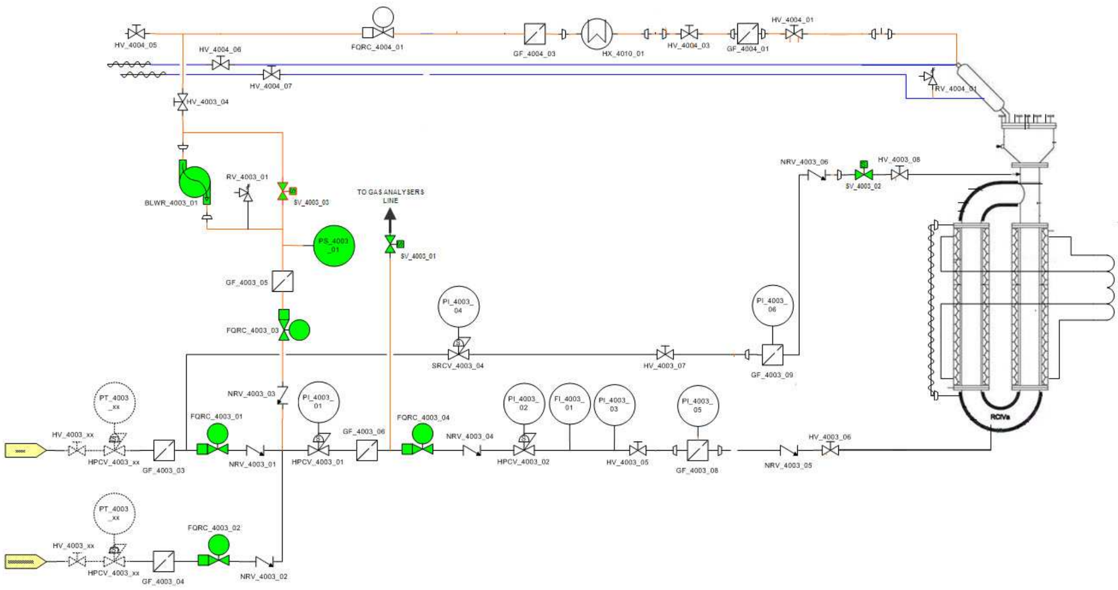
Alarm tag Name	type	Address	description
PS_4002_01_A	BOOL	000319	Pressure switch alarm triggered by timer
PS_4002_02_A	BOOL	000320	Pressure switch alarm triggered by timer
GP_4002_01_ERR	DI	100101	Thermal protection to the pump
GP_4002_02_ERR	DI	100102	Thermal protection to the pump
GP_4002_03_ERR	DI	100104	Thermal protection of agitator motor
PS_4002_03_A	BOOL	000321	Pressure switch alarm triggered by timer
WT_4002_01_AH	BOOL	000223	Effluent tank weight high alarm
WT_4002_01_AHH	BOOL	000224	Effluent tank weight very high alarm
WT_4002_01_AL	BOOL	000225	Effluent tank weight low alarm
WT_4002_01_ALL	BOOL	000226	Effluent tank weight very low alarm
WT_4002_01_ERR	BOOL	000120	Weight Balance (VS_4002_01) Sensor Link Error

Figure 12: Outlet Liquid Flow - ALARMS

Threshold tag name	Type	Address	Value	Unit	ACTION
WT_4002_01_LIM_AH	REAL	400544	100	kg	Displays an alarm on HMI Harvest tank volume: 120 liters. Working Volume: 90 liters. The sensor need to be calibrated referring to the volume law provide by De Dietrich
WT_4002_01_LIM_AHH	REAL	400546	110	kg	Stop the inlet flow, the outlet flow and the bioreactor level control loop Harvest tank volume: 120 liters. Working Volume: 90 liters. The sensor need to be calibrated referring to the volume law provide by De Dietrich
WT_4002_01_LIM_AL	REAL	400548	20	kg	Displays alarm on HMI Harvest tank volume: 120 liters. Working Volume: 90 liters. The sensor need to be calibrated referring to the volume law provide by De Dietrich
WT_4002_01_LIM_ALL	REAL	400550	10	kg	Displays alarm on HMI Harvest tank volume: 120 liters. Working Volume: 90 liters. The sensor need to be calibrated referring to the volume law provide by De Dietrich

Figure 13: Outlet Liquid Flow – THRESHOLD

2.6. Inlet Gas Flow (CL4003)



2.6.1.Function

The inlet gas flow corresponds to three different inputs of gas:

-Air Inlet flow

-CO2 flow (closely linked to pH mode management)

-recycle flow (recirculation of gas coming from bioreactor pushed by a blower)

Each of them is controlled with a mass flow controller.

Another mass flow controller (situated at the entrance of the bioreactor) provides a common regulated gas entry.

Three modes are available:

- OFF mode: no flow circulates.
- AUTOMATIC mode: The Air Inlet mass flow controller depends of the three other mass flow controllers. Function of the pH mode, the gas recirculation line and the total gas flow, the set point of Air Inlet Mass flow controller is set to respect the Total Flow set point.
- MANUAL mode: the recycle blower, the valves and mass flow controller can be configured in autonomous way by the operator.

He also can short cut the Bioreactor to analyse directly the "inlet gas flow".

PLC Section name	Equipment tag	Type	Address	Comment
CL4003_Inlet_Gas_Flow	SV_4003_03_FB	DI	100094	Circulated gas blower bypass (OLD NAME: SV_4003_04_FB)
CL4003_Inlet_Gas_Flow	SV_4003_02_FB	DI	100095	Reactor air inlet (biomass sensor cleaning)(OLD NAME: SV_4003_03_FB)
CL4003_Inlet_Gas_Flow	SV_4003_01_FB	DI	100097	Analyzer gas inlet (reactor inlet) (OLD NAME:SV_4003_02_FB)
CL4003_Inlet_Gas_Flow	PS_4003_01	DI	100110	Pressure switch bypass for recycling
CL4003_Inlet_Gas_Flow	SV_4003_03_MV	DO	000096	Circulated gas blower bypass (OLD NAME:SV_4003_04_MV)
CL4003_Inlet_Gas_Flow	SV_4003_02_MV	DO	000095	Reactor air inlet (biomass cleaning) (OLD NAME:SV_4003_03_MV)
CL4003_Inlet_Gas_Flow	SV_4003_01_MV	DO	000093	Analyzer gas inlet (reactor inlet) (OLD NAME:SV_4003_02_MV)
CL4003_Inlet_Gas_Flow	BLWR_4003_01_MV1	DO	000103	Start/Stop of the blower
CL4003_Inlet_Gas_Flow	FQRC_4003_01_SP	REAL-->AO	400238	Mass Flow CO2 Inlet set point
CL4003_Inlet_Gas_Flow	FQRC_4003_02_SP	REAL-->AO	400240	Mass Flow Air Inlet set point
CL4003_Inlet_Gas_Flow	FQRC_4003_03_SP	REAL-->AO	400242	Mass Flow Circulated Air set point
CL4003_Inlet_Gas_Flow	FQRC_4003_04_SP	REAL-->AO	400244	Total Mass Flow Air Inlet set point
CL4003_Inlet_Gas_Flow	FQRC_4003_01	AI ->REAL	400176	Mass Flow CO2 Inlet
CL4003_Inlet_Gas_Flow	FQRC_4003_02	AI ->REAL	400178	Mass Flow Air Inlet
CL4003_Inlet_Gas_Flow	FQRC_4003_03	AI ->REAL	400180	Mass Flow recirculated Air
CL4003_Inlet_Gas_Flow	FQRC_4003_04	AI ->REAL	400182	Total Mass Flow controller

Figure 14: Inlet Gas Flow – EQUIPMENTS

PLC Section name	tag	Type	Address	Comment
CL4003_Inlet_Gas_Flow	CL4003_Recycle_Mode	INT	400278	Recycle Mode (Off/Auto/Manu)
CL4003_Inlet_Gas_Flow	BLWR_4003_01_MV1_OP	BOOL	000156	BLOWER ON/OFF If Recycle is in MANUAL Mode.
CL4003_Inlet_Gas_Flow	FQRC_4003_03_SP_OP	REAL	400208	Recycle Flow Either Auto or Manual Mode
CL4003_Inlet_Gas_Flow	CL4003_ControlLoop_Mode	INT	400280	Gas Inlet Mode (Off/Auto/Manu)
CL4003_Inlet_Gas_Flow	FQRC_4003_04_SP_OP	REAL	400210	Total Air Flow Set Point Only in AUTO Mode
CL4003_Inlet_Gas_Flow	FQRC_4003_01_SP_OP	REAL	400212	CO2 Set Point Only if Not used by PH Control
CL4003_Inlet_Gas_Flow	FQRC_4003_02_SP_OP	REAL	400214	Air Inlet Set Point Only in Manual Mode --> Total is displayed
CL4003_Inlet_Gas_Flow	SV_4003_02_OP	BOOL	000167	biomass sensor Cleaning Valve Only Manipulable In Manual Mode (OLD NAME: SV_4003_03_OP)
CL4003_Inlet_Gas_Flow	SV_4003_01_OP	BOOL	000331	Only Manipulable In Manual Mode (OLD NAME: SV_4003_02_OP)
CL4003_Inlet_Gas_Flow	SV_4003_03_OP	BOOL	000332	Only Manipulable In Manual Mode (OLD NAME: SV_4003_04_OP)

Figure 15: Inlet Gas Flow – OPERATOR INPUT

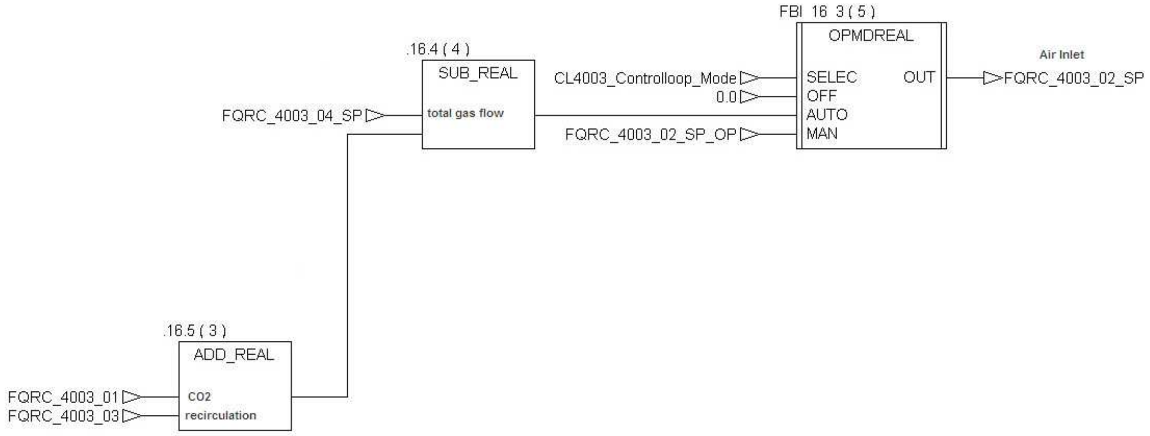
2.6.2.Block Diagram

2.6.2.1. *Air inlet flow calculation*

The air inlet set point in automatic mode is the consequence is calculated as follow:

Total gas flow - (CO2 flow + Recirculation flow) = Air inlet flow

In manual mode, the operator enters a set point in ml/min.



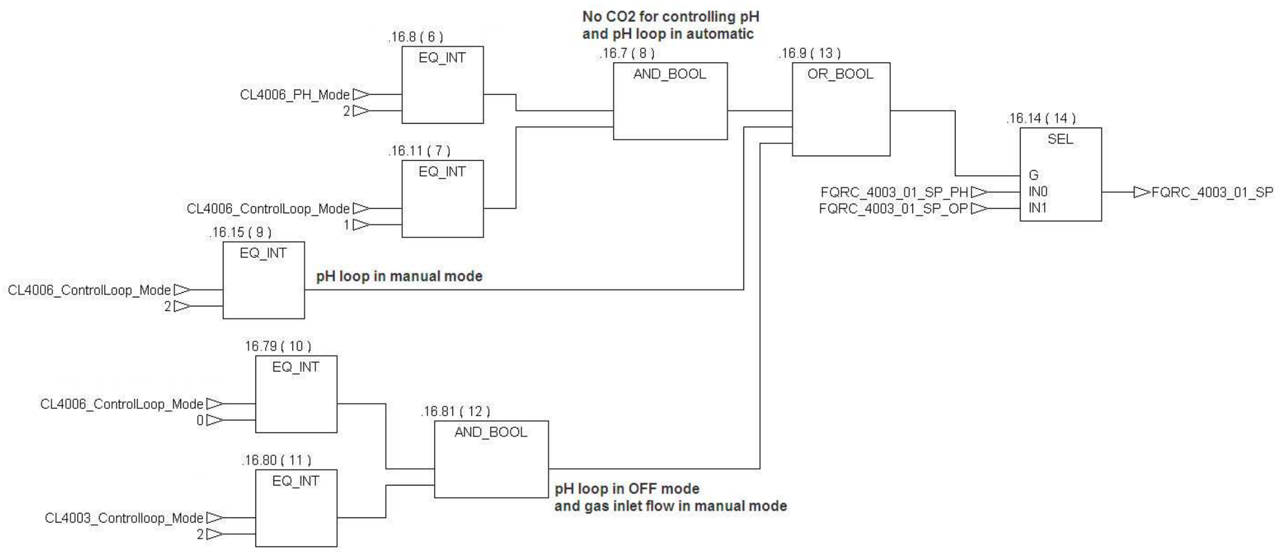
2.6.2.2. *CO2 flow management*

In the MELISSA closed loop, the CO2 is used for controlling the pH and for the plants growth. Because the Bioreactor will be tested for a long period in an autonomous way, the CO2 will also be used for simulating the crew breathing. According to this point, we have decided to include the CO2 mass flow controller into the inlet gas flow control loop.

As seen previously, the CO2 is taken into account in the total gas flow strategy. A block “selector” is used to determine if:

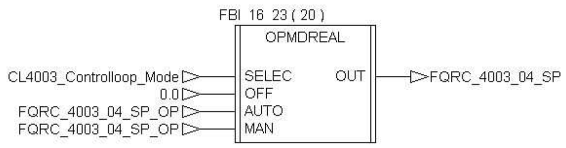
-If the CO2 injection is calculated by the pH controller (pH in automatic mode with CO2)

-If the operator chooses to send a continuous flow to the bioreactor (pH in manual mode or in automatic mode without CO2 use).



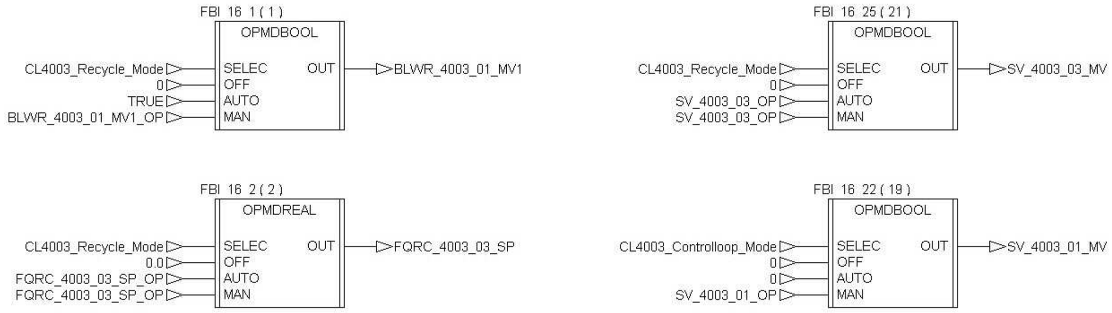
2.6.2.3. *Total gas set point management*

The total gas set point is managed by the operator. The set point entered is the same for automatic mode and manual mode.



2.6.2.4. *Recycle gas line management*

The recirculation line has (for the moment) no software controller. The recycle flow is controlled by a mass flow controller permitting to reach the set point given by the operator.
When the connection between CIVa and CV will be implemented, the recycle line will give the ability to re-inject the gas inside the bioreactor in case of too high CO2 concentration.



2.6.3. Alarms and Threshold

Alarm tag Name	type	Address	description
PS_4003_01_A	BOOL	000322	Pressure switch alarm triggered by timer
SV_4003_03_A	BOOL	000227	Triggered by a time (OLD NAME: SV_4003_04_A)
SV_4003_02_A	BOOL	000228	Triggered by a time(OLD NAME: SV_4003_03_A)
SV_4003_01_A	BOOL	000229	Triggered by a time (OLD NAME: SV_4003_02_A)
FQRC_4003_01_AHH	BOOL	000337	CO2 Mass flow controller very high alarm
FQRC_4003_01_AH	BOOL	000338	CO2 Mass flow controller high alarm
FQRC_4003_01_AL	BOOL	000339	CO2 Mass flow controller low alarm
FQRC_4003_01_ALL	BOOL	000340	CO2 Mass flow controller very low alarm
FQRC_4003_02_AHH	BOOL	000341	Air Inlet Mass flow controller very high alarm
FQRC_4003_02_AH	BOOL	000342	Air Inlet Mass flow controller high alarm
FQRC_4003_02_AL	BOOL	000343	Air Inlet Mass flow controller low alarm
FQRC_4003_02_ALL	BOOL	000344	Air Inlet Mass flow controller very low alarm
FQRC_4003_03_AHH	BOOL	000345	Recirculated Air Mass flow controller very high alarm
FQRC_4003_03_AH	BOOL	000346	Recirculated Air Mass flow controller high alarm
FQRC_4003_03_AL	BOOL	000347	Recirculated Air Mass flow controller low alarm
FQRC_4003_03_ALL	BOOL	000348	Recirculated Air Mass flow controller very low alarm

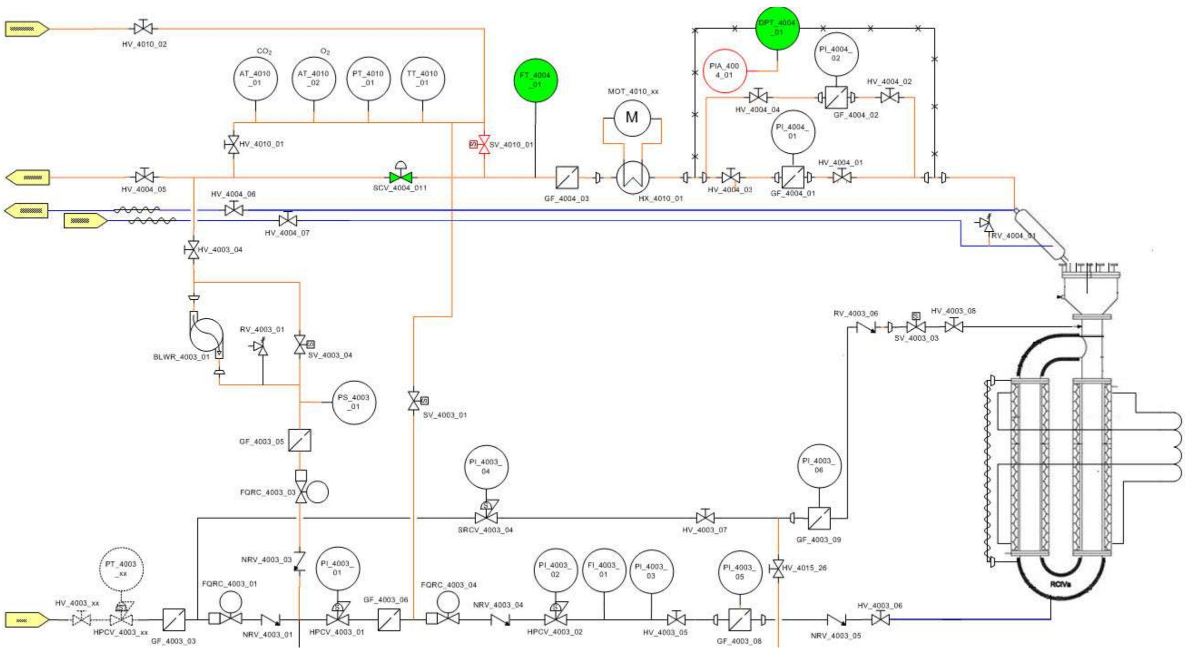
FQRC_4003_04_AHH	BOOL	000349	Total gas Mass flow controller very high alarm
FQRC_4003_04_AH	BOOL	000350	Total gas Mass flow controller high alarm
FQRC_4003_04_AL	BOOL	000351	Total gas Mass flow controller low alarm
FQRC_4003_04_ALL	BOOL	000352	Total gas Mass flow controller very low alarm
FQRC_4003_04_NOFLOW_A	BOOL	000353	No flow detected by total gas Mass flow controller
FQRC_4003_01_ERR	BOOL	000121	Mass Flow CO2 Inlet Sensir Link Error
FQRC_4003_02_ERR	BOOL	000122	Mass Flow Air Inlet Sensor Link Error
FQRC_4003_03_ERR	BOOL	000123	Mass Flow Circulated Air Sensor Link Error
FQRC_4003_04_ERR	BOOL	000124	Total Mass Flow Air Inlet Sensor Link Error

Figure 16: Inlet Gas Flow – ALARMS

Threshold tag name	**Type**	**Address**	**Value**	**Unit**	**Action**	**Threshold tag name**
FQRC_4003_01_LIM_AHH	REAL	400710	50	ml/min	Displays alarm on HMI (wait for information about action to do)	Displays alarm on HMI (wait for information about action to do) Alarm is triggered after 10s
FQRC_4003_01_LIM_AH	REAL	400712	20	ml/min	Displays alarm on HMI	Displays alarm on HMI Alarm is triggered after 10s
FQRC_4003_01_LIM_ALL	REAL	400714	-50	ml/min	Displays alarm on HMI	Displays alarm on HMI Alarm is triggered after 10s
FQRC_4003_01_LIM_AL	REAL	400716	-20	ml/min	Displays alarm on HMI	Displays alarm on HMI Alarm is triggered after 10s
FQRC_4003_02_LIM_AHH	REAL	400718	300	ml/min	Displays alarm on HMI	Displays alarm on HMI Alarm is triggered after 10s
FQRC_4003_02_LIM_AH	REAL	400720	100	ml/min	Displays alarm on HMI	Displays alarm on HMI Alarm is triggered after 10s
FQRC_4003_02_LIM_ALL	REAL	400740	-300	ml/min	Displays alarm on HMI	Displays alarm on HMI Alarm is triggered after 10s
FQRC_4003_02_LIM_AL	REAL	400722	-100	ml/min	Displays alarm on HMI	Displays alarm on HMI Alarm is triggered after 10s
FQRC_4003_03_LIM_AHH	REAL	400724	300	ml/min	Displays alarm on HMI	Displays alarm on HMI Alarm is triggered after 10s
FQRC_4003_03_LIM_AH	REAL	400726	100	ml/min	Displays alarm on HMI	Displays alarm on HMI Alarm is triggered after 10s
FQRC_4003_03_LIM_ALL	REAL	400728	-300	ml/min	Displays alarm on HMI	Displays alarm on HMI Alarm is triggered after 10s
FQRC_4003_03_LIM_AL	REAL	400730	-100	ml/min	Displays alarm on HMI	Displays alarm on HMI Alarm is triggered after 10s
FQRC_4003_04_LIM_AHH	REAL	400732	300	ml/min	Displays alarm on HMI	Displays alarm on HMI Alarm is triggered after 10s
FQRC_4003_04_LIM_AH	REAL	400734	100	ml/min	Displays alarm on HMI	Displays alarm on HMI Alarm is triggered after 10s
FQRC_4003_04_LIM_ALL	REAL	400736	-300	ml/min	Displays alarm on HMI	Displays alarm on HMI Alarm is triggered after 10s
FQRC_4003_04_LIM_AL	REAL	400738	-100	ml/min	Displays alarm on HMI	Displays alarm on HMI Alarm is triggered after 10s

Figure 17: Inlet Gas Flow – THRESHOLD

2.7. Outlet gas flow (CL4004)



2.7.1.Function

The Outlet gas flow is done to provide the good concentration of O2 flow to the crew compartment. According to discussion with UAB, this control loop will not be used until the connection with compartment V will be designed. Despite this, we (ESA/UAB/SHERPA ENGINNERING) have decided to maintain it. As the equipment controlled (SCV_4004_01) is the same than the “Bioreactor Pressure Control” loop, some caution needs to be implemented in the software. The priority has been given to the bioreactor pressure control so depending of the mode of this loop, the Outlet gas flow mode can change. These priorities are detailed in the “Bioreactor Pressure Control” chapter.
Three modes are available:

- OFF Mode: all equipments are closed
- AUTOMATIC Mode:the operator enters a set point. The flow is controlled by the proportional valve SCV_4004_01.

- MANUAL mode: The Operator can open the proportional valve by entering an opening percentage.

PLC Section name	Equipment tag	Type	Address	Comment
CL4004_Outlet_Gas_Flow	SCV_4004_01_MV	REAL-->AO	400248	Flow control Air outlet valve
CL4004_Outlet_Gas_Flow	FT_4004_01	AI ->REAL	400146	Total air outlet from reactor
CL4004_Outlet_Gas_Flow	DPT_4004_01	AI ->REAL	400166	Differential Pressure Filter

Figure 18: Outlet gas flow – EQUIPMENTS

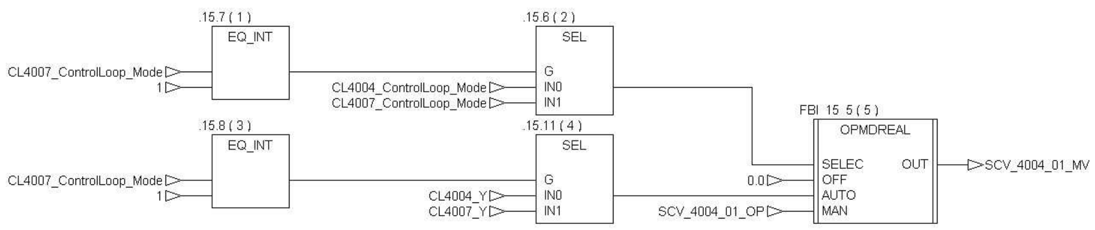
PLC Section name	tag	Type	Address	Comment
CL4004_Outlet_Gas_Flow	CL4004_ControlLoop_Mode	INT	400282	Oulet Gas Mode (Off/Auto/Manu) If 4007 in AUTO, 4004 is triggered in auto mode
CL4004_Outlet_Gas_Flow	FT_4004_01_SP	REAL	400216	Flow Set Point Only when 4004 in Automatic Mode and 4007 not in Auto
CL4004_Outlet_Gas_Flow	SCV_4004_01_OP	REAL	400218	Valve Opening Only in Manual Mode

Figure 19: Outlet gas flow – OPERATOR INPUTS

2.7.2.Block Diagram

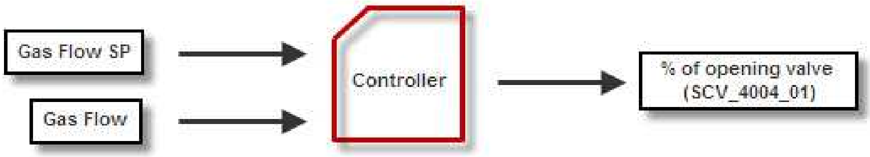
2.7.2.1. *Proportional outlet gas flow valve (SCV_4004_01)*

Depending on the process strategy chosen (Outlet gas flow or bioreactor pressure), the valve is managed in automatic mode by two different controllers.

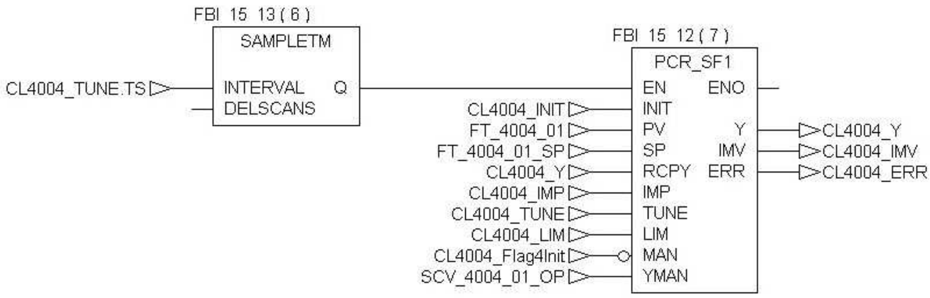


2.7.2.2. *Controller*

NEED TO BE TUNED WITH OPEN LOOP TEST

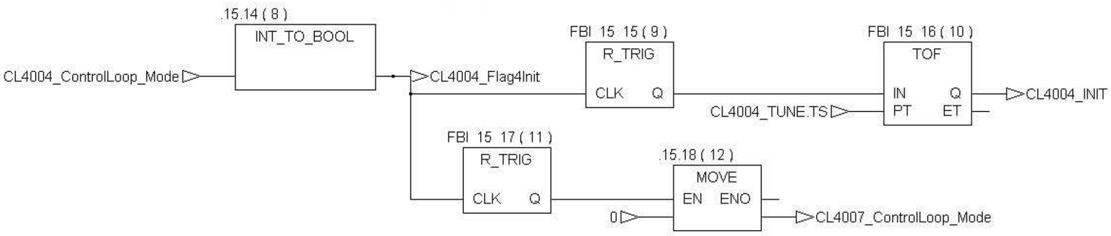


The control is done by the Predictive control block SF1 (Simple predictive controller for first order process) (See annex B).



2.7.2.3. *Controller initialization*

When the operator switches to automatic mode, the controller is initialized during the sample time (see controller parameters) and the Bioreactor pressure control loop is triggered to OFF mode.



2.7.2.4. *Controller parameters*

WAITING FOR OPEN LOOP TEST

Controlled Variable	PCR CONTROLER TYPE	DEAD ZONE	ZTR Zone Control	PWM	SAMPLETM	PROCESS VALUE (input)	SET POINT
% of opening valve (SCV_4004_01)	SF1	NO	NO	NO	CL4004_TUNE.TS	FT_4004_01	FT_4004_01_SP

INTERNAL MODEL PROCESS	TUNE	LIMIT	SELF_CMP	DECOMP	Manipulated Variable (Controller Output in Auto Mode)	Controlled Equipment
KM : 0 TM : 0 DM :0	TS : H : TRBF :	CL4004_LIM YMIN : YMAX : YRATE :	NO	NO	CL4004_Y	SCV_4004_01_MV

2.7.3. Alarms and Threshold

Alarm tag Name	type	Address	description
FT_4004_01_AHH	BOOL	000231	Outlet gas flow very high alarm
FT_4004_01_AH	BOOL	000232	Outlet gas flow high alarm
FT_4004_01_ALL	BOOL	000233	Outlet gas flow very low alarm
FT_4004_01_AL	BOOL	000234	Outlet gas flow low alarm
DPT_4004_01_AHH	BOOL	000235	Differential pressure very high alarm
DPT_4004_01_AH	BOOL	000236	Differential pressure high alarm
DPT_4004_01_ALL	BOOL	000237	Differential pressure very low alarm
DPT_4004_01_AL	BOOL	000238	Differential pressure low alarm
FT_4004_01_ERR	BOOL	000125	Total air outlet from reactor Sensor Link Error
DPT_4004_01_ERR	BOOL	000126	Diff. Pressure Filter Sensor Link Error

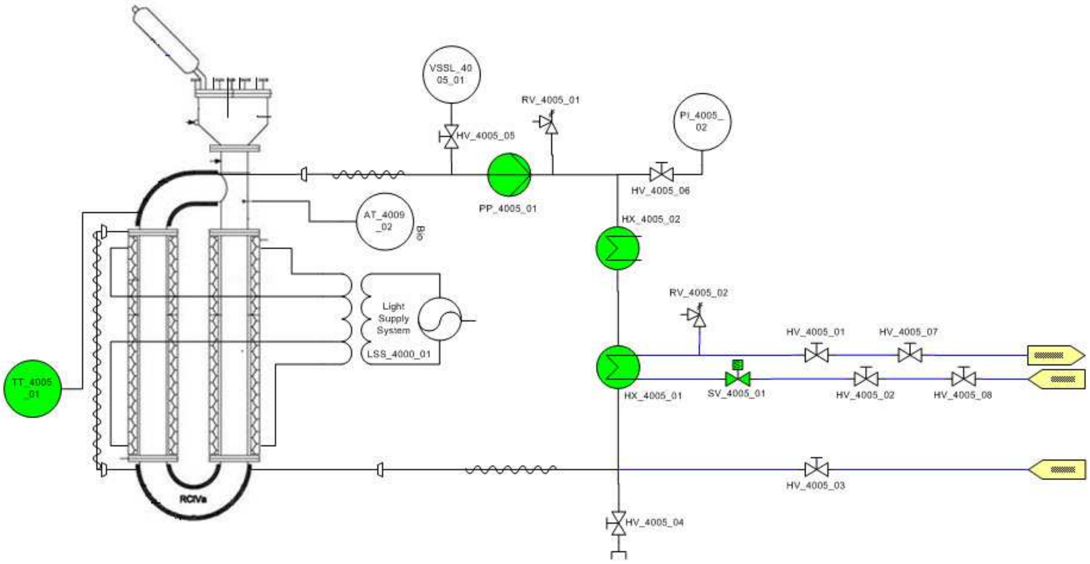
Figure 20: Outlet gas flow – ALARMS

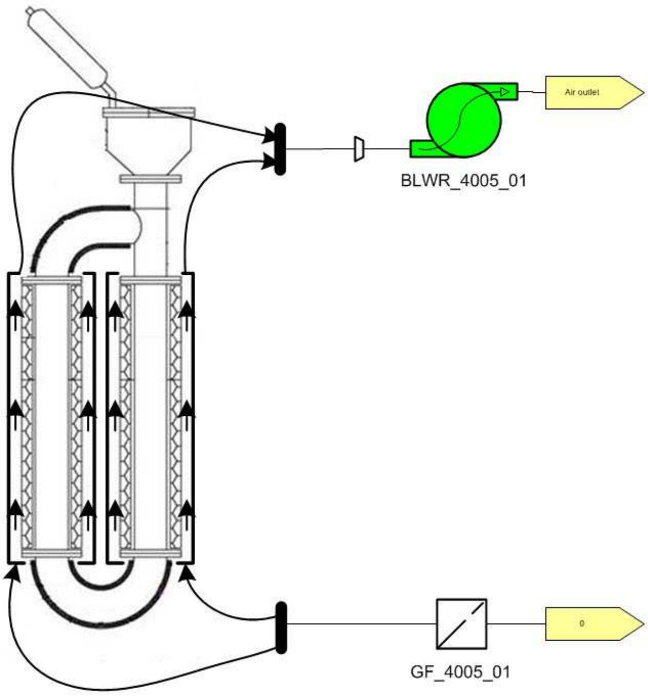
Threshold tag name	Type	Address	Value	Unit	Action
FT_4004_01_LIM_AHH	REAL	400552	1	(L/min)	Displays alarm on HMI When the Outlet gas flow control loop is in automatic mode, the threshold is linked to Outlet flow setpoint. When the bioreactor pressure control is in automatic mode, the threshold is linked to the inlet gas flow set point.
FT_4004_01_LIM_AH	REAL	400554	0.5	(L/min)	Displays alarm on HMI same than above
FT_4004_01_LIM_ALL	REAL	400556	-1	(L/min)	Displays alarm on HMI same than above
FT_4004_01_LIM_AL	REAL	400558	-0.5	(L/min)	Displays alarm on HMI same than above
DPT_4004_01_LIM_AHH	REAL	400560	300	(mbar)	Displays alarm on HMI
DPT_4004_01_LIM_AH	REAL	400562	200	(mbar)	Displays alarm on HMI
DPT_4004_01_LIM_ALL	REAL	400564	TBD	(mbar)	Displays alarm on HMI FOR THE MOMENT -300 mbar
DPT_4004_01_LIM_AL	REAL	400566	TBD	(mbar)	Displays alarm on HMI FOR THE MOMENT -200 mbar

Figure 21: Outlet gas flow – THRESHOLDS

TBD : To be defined (14.01.10 status).

2.8. Bioreactor temperature control (CL4005)





2.8.1.Function

The temperature is controlled by three different equipments. On one hand, a cold water utility provides by a heat exchanger the cooling function. A dedicated blower is also installed to remove out of the lights area the produced heat. In most of cases, the reactor needs to be cooled because of the lights. On the other hand, a resistor permits in case of temperature decreasing to warm the bioreactor jacket.

Three modes are available:

- OFF mode: All equipments are OFF. The control loop is stopped.
- AUTOMATIC mode: Only the heat exchanger is managed by a controller. The blower is ON and its speed is configurable by the operator. The resistor is managed by an hysteresis logic.
- MANUAL mode: All equipments are configurable by the operator.

PLC Section name	Equipment tag	Type	Address	Comment
CL4005_PBR_Temp	SV_4005_01_MV	DO	000088	Cooling water outlet valve

CL4005_PBR_Temp	SV_4005_01_FB	DI	100086	Feed back of the Cooling water outlet valve
CL4005_PBR_Temp	PP_4005_01_MV1	DO	000102	Start/Stop of the pump
CL4005_PBR_Temp	BLWR_4005_01_MV1	DO	000099	Start/Stop of the extractor
CL4005_PBR_Temp	HX_4005_02_MV1	DO	000100	Start/Stop electrical resistance
CL4005_PBR_Temp	BLWR_4005_01_MV2	REAL->AO	400246	Blower air speed
CL4005_PBR_Temp	TT_4005_01	AI ->REAL	400168	Reactor Temp.

Figure 22: Bioreactor Temperature Control – EQUIPMENTS

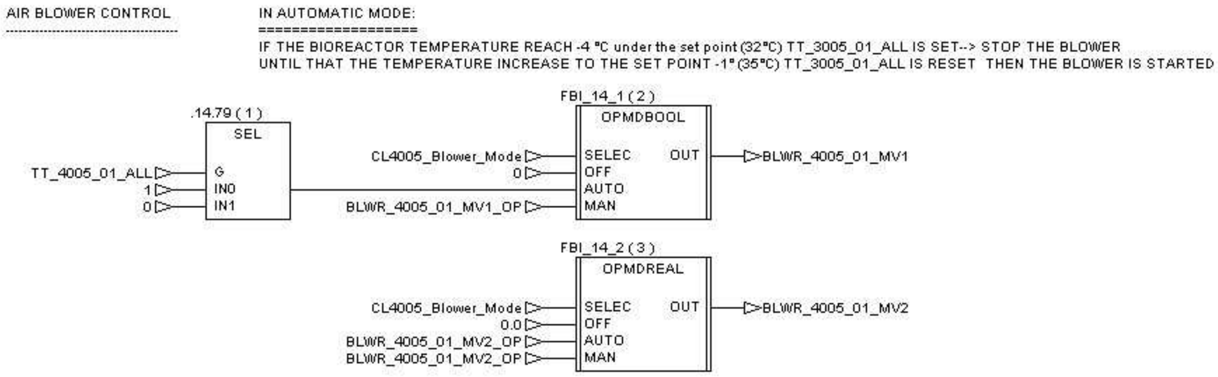
PLC Section name	Equipment tag	Type	Address	Comment
CL4005_PBR_Temp	TT_4005_01_Filtered	REAL	400306	Bioreactor temperature sensor filtered (avg on the last 10 seconds)
CL4005_PBR_Temp	CL4005_Blower_Mode	INT	400284	Blower Mode (Off/Auto/Manu)
CL4005_PBR_Temp	CL4005_ControlLoop_Mode	INT	400286	Temperature Mode (Off/Auto/Manu)
CL4005_PBR_Temp	BLWR_4005_01_MV1_OP	BOOL	000157	Blower ON/OFF In Manual Blower Mode
CL4005_PBR_Temp	BLWR_4005_01_MV2_OP	REAL	400220	Blower Speed Blower Auto or Manual Mode
CL4005_PBR_Temp	TT_4005_01_SP	REAL	400222	Temperature Set Point
CL4005_PBR_Temp	PP_4005_01_OP	BOOL	000158	Pump On/Off In Manual Mode
CL4005_PBR_Temp	HX_4005_02_OP	BOOL	000159	Heat exchanger In Manual Mode
CL4005_PBR_Temp	SV_4005_01_OP	BOOL	000160	Valve ON/OFF In Manual Mode

Figure 23: Bioreactor Temperature Control – OPERATOR INPUTS

2.8.2.Block Diagram

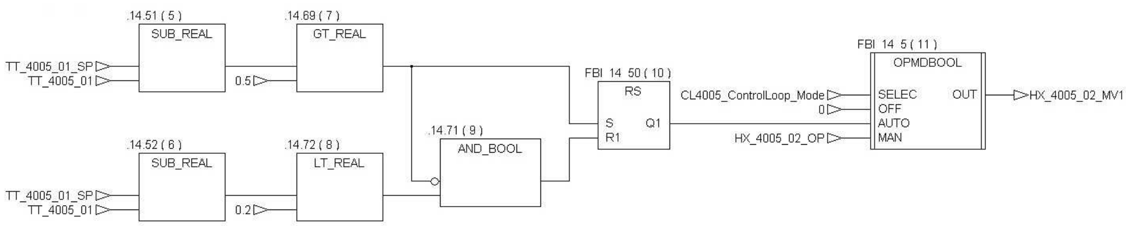
2.8.2.1. *Blower management*

The blower should always being running as long as the light are switched ON. In case off light failure, the heat produced by them stopped so the blower doesn't needs to cool the bioreactor. For that, the PLC stops the blower when the alarm TT_4005_01_ALL is triggered (4° under the Set point). When the temperature increases, the alarm is reset when temperature arrives to 1℃ under the set point. Once done, the PLC starts the Blower to the speed defined by the user.



2.8.2.2. *Hot resistor management*

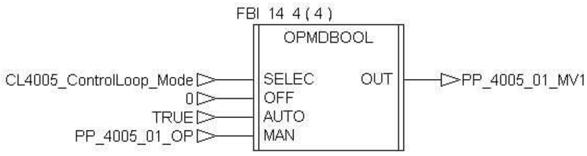
If the Bioreactor temperature is lower than 0.5℃ from the set point, the resistor (HX_4005_02) is switched ON.
At the opposite, If the Bioreactor temperature is lower than 0.2℃ from the set point, the resistor is switched OFF



2.8.2.3. *Heat exchanger pump management*

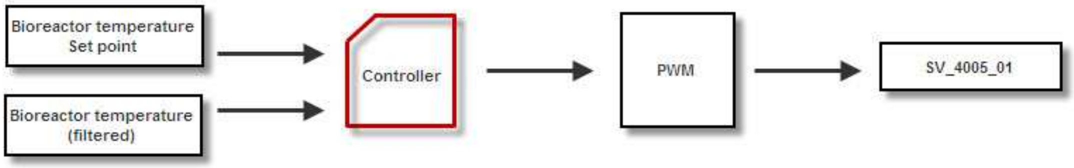
The pump is:

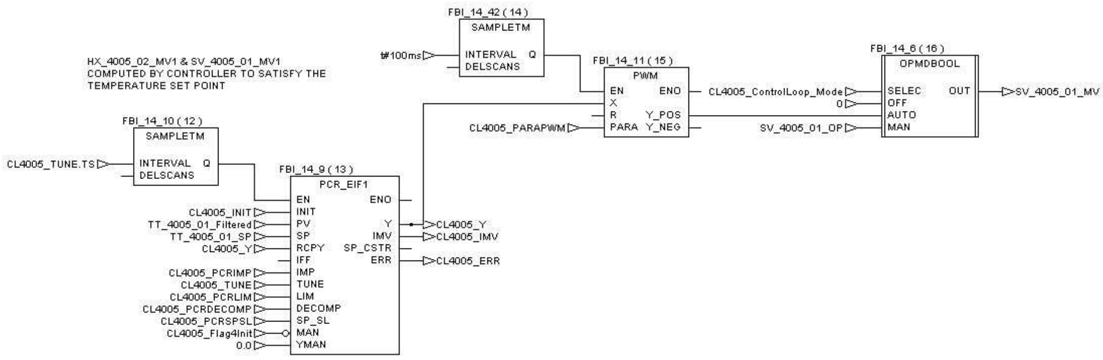
- OFF in OFF mode
- ON in AUTOmatic mode
- ON or OFF in manual mode depending on the choice of the operator.



2.8.2.4. *Controller*

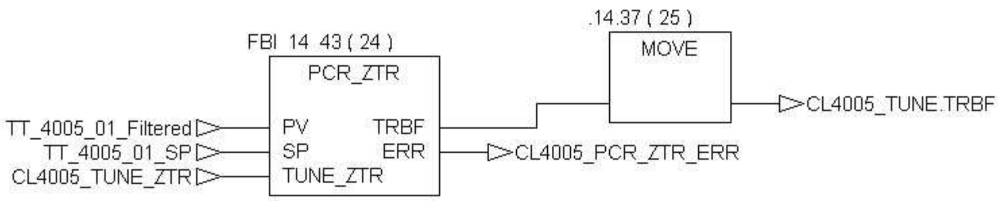
The control by the cooling system is done by a predictive block called EIF1 (integrative first order process with feed forward, cascade and ramp set point). This block is detailed in the annexe E.





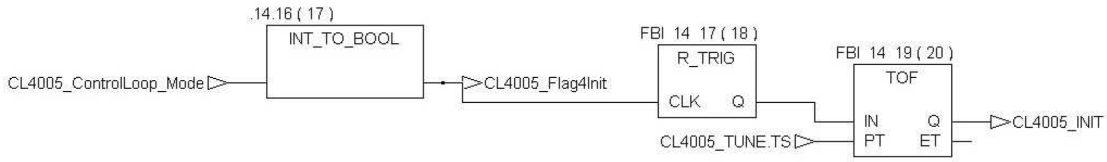
2.8.2.5. *Block ZTR*

The block “ZTR” permits to increase the closed loop response time of the controller when the process value enter in a define zone (see annexe F). The control becomes smoother inside this zone.


FBI_14_43 (24)
PCR_ZTR
.14.37 (25)
MOVE
TT_4005_01_Filtered
TT_4005_01_SP
CL4005_TUNE_ZTR
PV
SP
TUNE_ZTR
TRBF
ERR
CL4005_PCR_ZTR_ERR
CL4005_TUNE.TRBF

2.8.2.6. *Controller initialization*

When the operator switches to automatic mode, the controller is initialized during the sample time (see controller parameters).



2.8.2.7. *Controller parameters*

Controlled Variable	**PCR CONTROLER TYPE**	**DEAD ZONE**	**ZTR Zone Control**	**PWM**	**SAMPLETM**	**PROCESS VALUE (input)**	**SET POINT**
SV_4005_01	SF1	NO	ZONE :0.05 TRBF_LO :8 m TRBF_HI :15m	NO	CL4005_TUNE.TS	TT_4005_01_Filtered	TT_4005_01_SP

INTERNAL MODEL PROCESS	**TUNE**	**LIMIT**	**SELF_CMP**	**DECOMP**	**Manipulated Variable (Controller Output in Auto Mode)**	**Controlled Equipment**
KM : -0.012 TM : 140s DM :30s	TS : 1s H : 20s TRBF : 480s	CL4005_PCRLIM YMIN : 0 YMAX : 1 YRATE : 1	NO	2 m	CL4005_Y	SV_4005_01_MV

2.8.3. Alarms and Threshold

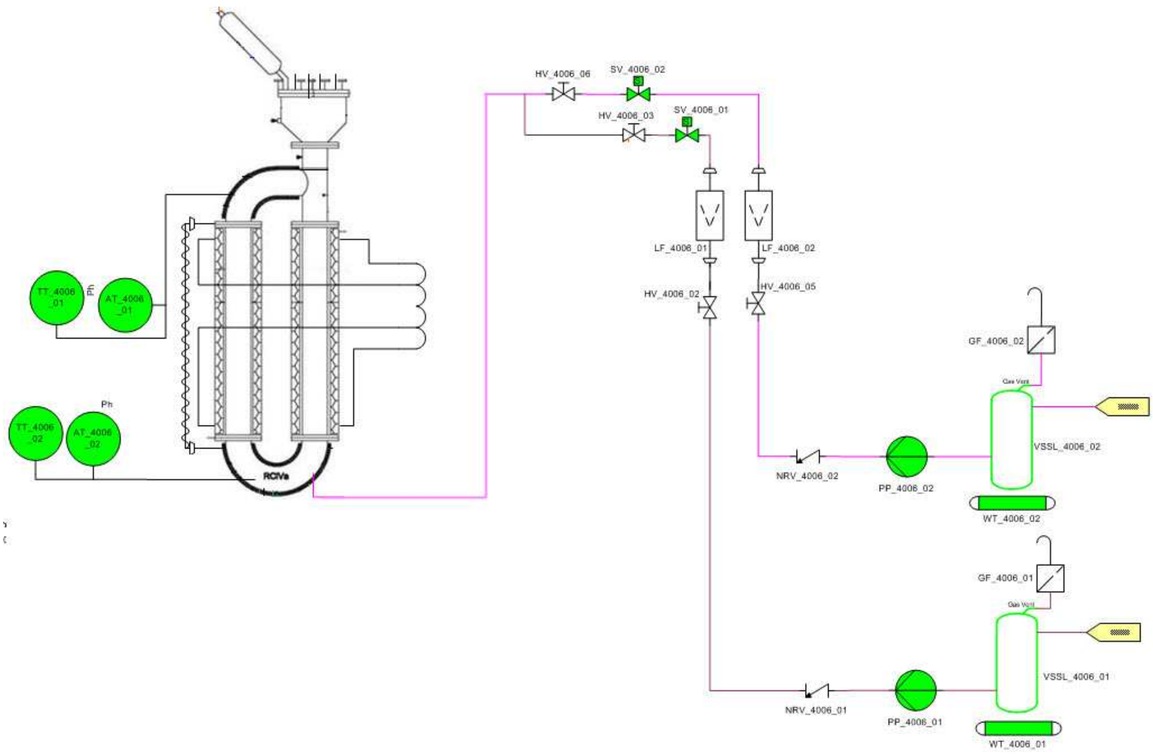
Alarm tag Name	**type**	**Address**	**description**
BLWR_4005_01_ERR	DI	100103	Thermal protection of extractor
SV_4005_01_A	BOOL	000323	Alarm of the Cooling water outlet valve (triggered by a timer)
TT_4005_01_AHH	BOOL	000239	Bioreactor temperature very high alarm
TT_4005_01_AH	BOOL	000240	Bioreactor temperature high alarm
TT_4005_01_ALL	BOOL	000241	Bioreactor temperature very low alarm
TT_4005_01_AL	BOOL	000242	Bioreactor temperature very low alarm
TT_4005_01_ERR	BOOL	000127	Bioreactor temperature Sensor Link Error

Figure 24: Bioreactor Temperature Control – ALARMS

Threshold tag name	Type	Address	Value	Unit	Action
TT_4005_01_LIM_AHH	REAL	400568	4	ºC	The light will return to nominal intensity when the temperature is 1℃ above the setpoint.
TT_4005_01_LIM_AH	REAL	400570	1	ºC	Temperature high limit threshold
TT_4005_01_LIM_ALL	REAL	400572	-4	ºC	the blower will be restarted when the temperature reach -1°C compare to the setpoint
TT_4005_01_LIM_AL	REAL	400574	-1	ºC	Temperature low limit threshold

Figure 25: Bioreactor Temperature Control – THRESHOLDS

2.9. Bioreactor pH control (CL4006)



2.9.1.Function

The pH needs to be monitored and controlled for the growth of Arthrospira Platensis. The pH control can be done by three different ways:

pH mode 0: CO2 only. As the Arthrospira Platensis increases the pH, the CO2 provides the way to decrease it.

pH mode 1: CO2 and BASE

pH mode 2: ACID and BASE.

Two controllers are designed depending on the selected mode. One for ACID and BASE pumps injection and one for the CO2 injection linked to a mass flow controller.
The ACID solution and the BASE solution are added to the bioreactor by peristaltic pumps and valves.

The operator can select the measurement to control (probe1/probe2/average of probe 1&2). Due to this choice, an error probe management is implemented (explained in the block diagram chapter).
Three modes are available.

- OFF: valves are closed and pumps are stopped

- AUTOMATIC: The controller adjusts the pH value depending on:
  -The set point and the dead zone entered by the operator.
  -The chosen pH mode.
- MANUAL: the operator selects valves, pumps and opening time (in seconds) to inject ACID, BASE or CO2.

PLC Section name	Equipment tag	Type	Address	Comment
CL4006_pH	SV_4006_01_FB	DI	100091	Acid Inlet reactor
CL4006_pH	SV_4006_02_FB	DI	100092	Base Inlet reactor
CL4006_pH	SV_4006_01_MV	DO	000083	Acid Inlet reactor
CL4006_pH	SV_4006_02_MV	DO	000082	Base Inlet reactor
CL4006_pH	PP_4006_01_MV1	DO	000098	Start/Stop of the pump
CL4006_pH	PP_4006_02_MV1	DO	000097	Start/Stop of the pump
CL4006_pH	WT_4006_01	Eth	400264	Balance Acid
CL4006_pH	WT_4006_02	Eth	400266	Base Acid
CL4006_pH	AT_4006_01	AI ->REAL	400138	pH probe 1
CL4006_pH	TT_4006_01	AI ->REAL	400140	Temp. For pH
CL4006_pH	AT_4006_02	AI ->REAL	400142	pH probe 2
CL4006_pH	TT_4006_02	AI ->REAL	400144	Temp. For pH

Figure 26: Bioreactor pH control - EQUIPMENTS

PLC Section name	Equipment tag	Type	Address	Comment
CL4006_pH	CL4006_PH_Mode	INT	400288	Mode of Regulation (CO2,CO2/BASE,ACID/BASE)
CL4006_pH	CL4006_ControlLoop_Mode	INT	400290	Control Mode (Off/Auto/Manu
CL4006_pH	CL4006_PH_PROBE_SELECTION	INT	400277	PH Probe Selector 0: AT_4006_01 // 1: AT_4006_02 // 2 :AT_4006_AVG
CL4006_pH	AT_4006_AVG	REAL	400318	PH Probe AVERAGE PROVIDE THE AVERAGE OF BOTH pH PROBE
CL4006_pH	AT_4006_SP	REAL	400224	pH Set Point
CL4006_pH	SV_4006_01_OP	BOOL	000162	ON/OFF In Manual Mode
CL4006_pH	SV_4006_02_OP	BOOL	000163	ON/OFF In Manual Mode
CL4006_pH	PP_4006_01_OP	BOOL	000164	In Manual Mode
CL4006_pH	PP_4006_02_OP	BOOL	000165	ON/OFF In Manual Mode

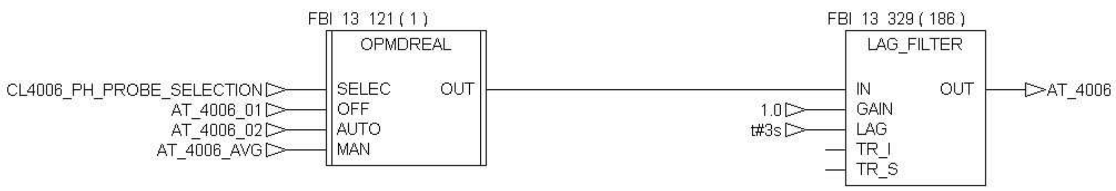
CL4006_pH	CL4006_pH_DeadZone	REAL	400316	pH Dead Zone Absolute value which define a Zone arround the Set point where the control is not active
CL4006_pH	CL4006_ACID_OP_Time	UDINT	400370	Time enterered by the operator : define the ACID injection time in second
CL4006_pH	CL4006_BASE_OP_Time	UDINT	400372	Time enterered by the operator : define the BASE injection time in second
CL4006_pH	CL4006_Base_Opening_Time	REAL	400312	Base injection time (s) The timer is increasing in second
CL4006_pH	CL4006_Acid_Opening_Time	REAL	400314	Acid injection time (s) The timer is increasing in second
CL4006_pH	CL4006_pH_Second	BYTE	400422	Date of the last reset done by the operator
CL4006_pH	CL4006_pH_Minute	BYTE	400423	Date of the last reset done by the operator
CL4006_pH	CL4006_pH_Hour	BYTE	400424	Date of the last reset done by the operator
CL4006_pH	CL4006_pH_Day	BYTE	400425	Date of the last reset done by the operator
CL4006_pH	CL4006_pH_Month	BYTE	400426	Date of the last reset done by the operator
CL4006_pH	CL4006_pH_Year	BYTE	400427	Date of the last reset done by the operator
CL4006_pH	CL4006_pH_Reset_timer	BOOL	000326	Date of the last reset done by the operator

Figure 27: Bioreactor pH control - OPERATOR INPUTS

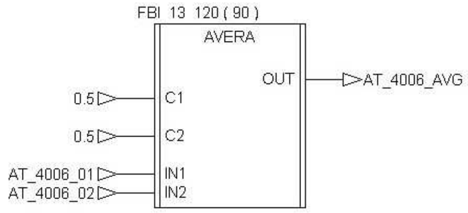
2.9.2.Block Diagram

2.9.2.1. *pH probe selection*

The operator can choose both probes separately or the average of the two probes.
Following the chosen measurement, a 3 seconds filter is implemented (lag filter block).

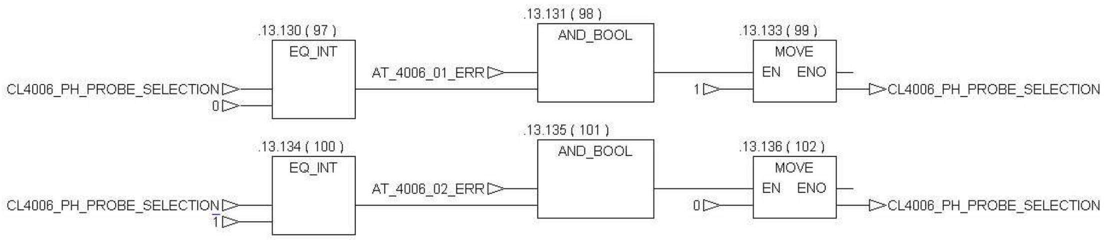


2.9.2.2. *pH probe average calculation*

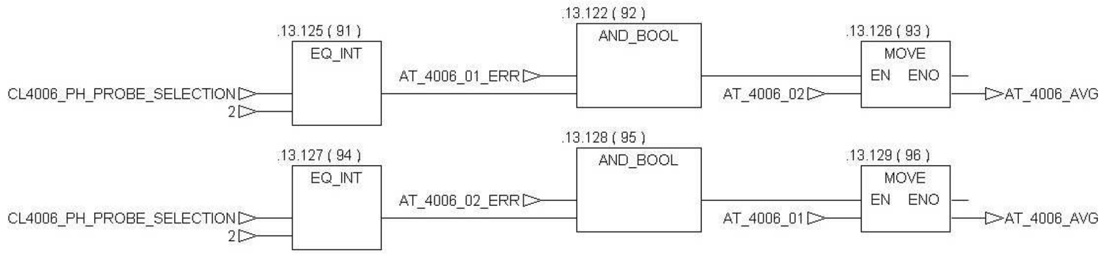


2.9.2.3. *pH probe error management*

If the operator selected probe goes into failure, the PLC automatically takes the second probe as current measurement.

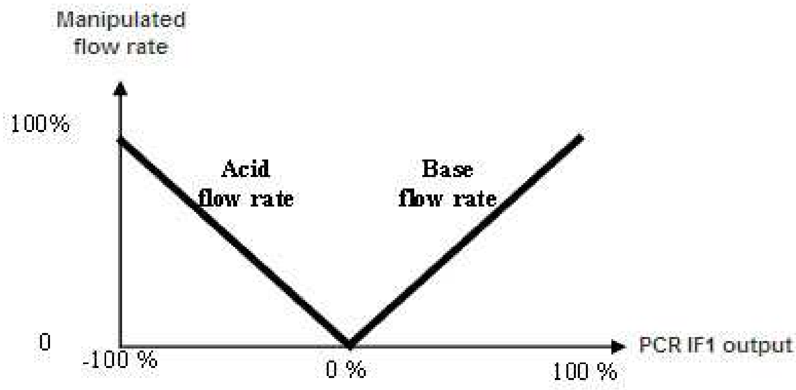


In case of average measurement, if one of the two probes goes into failure, the controlled value becomes the other probe.



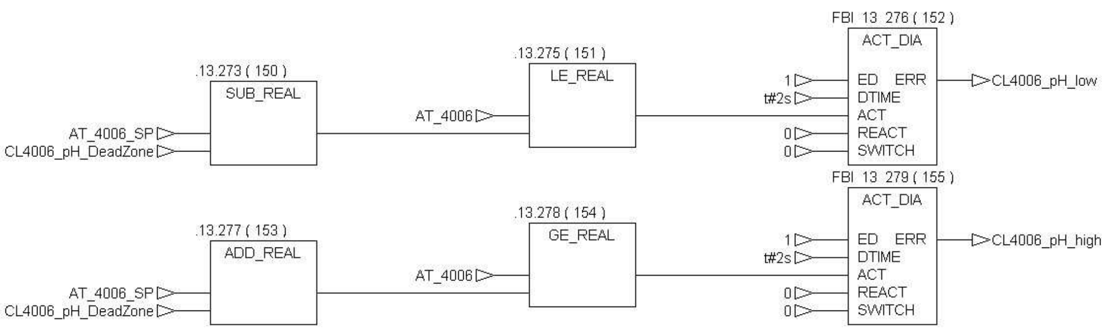
2.9.2.1. *Dead Zone implementation and process value calculation*

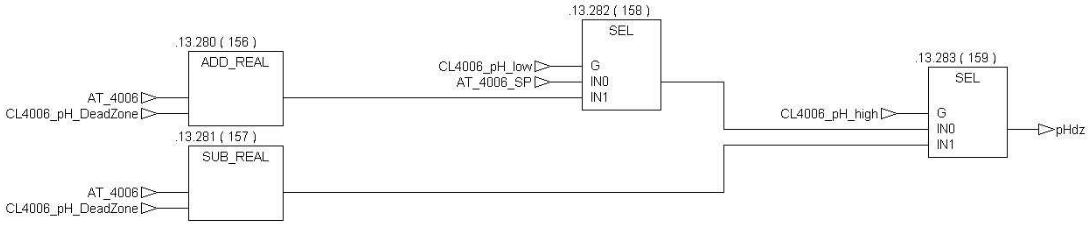
The split range logic is implemented for the pH control. The following scheme gives an explanation of the split range logic:



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 analyzer value.
Once added, the calculated value becomes the process value measurement: "**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 pH low mode.



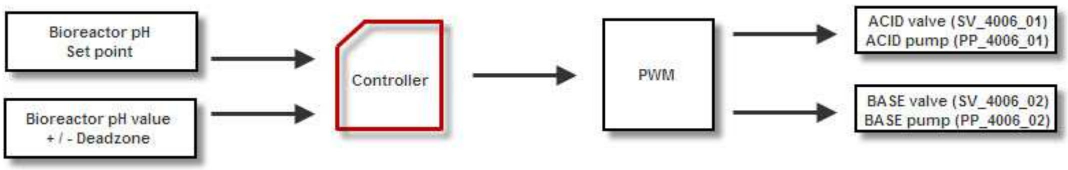


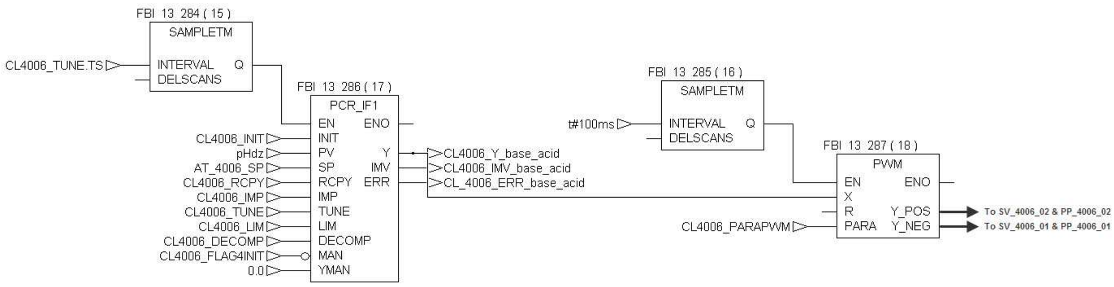
2.9.2.2. *Controllers*

As explained previously, depending on the chosen mode (CO2 / CO2 and BASE / ACID and BASE), only one or both controller will be initialized.

2.9.2.2.1. Controller ACID & BASE

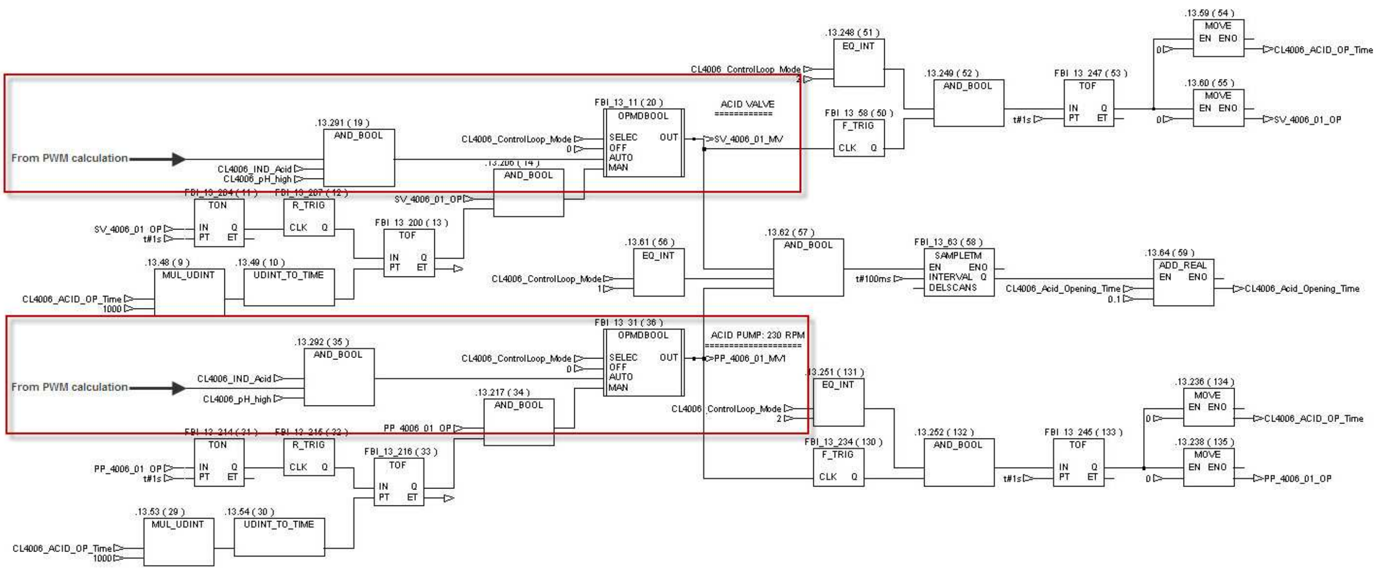
Depending of the dead zone configured by the operator and the pH measurement to be controlled, the controller will decide to inject ACID or BASE. In both case the valve and the pump are managed simultaneously. If the pH mode is CO2 and BASE the controller limits management change to lock the controller in case of pH low (see controller limit management).
As the pumps and the valves are managed in a Boolean logic, a PWM block is implemented to convert analogical signal coming from the controller into time. For more details on PWM block, see annex G.





2.9.2.2.1.1. Acid valve and pump management

In automatic mode, if the operator has chosen the pH mode including ACID solution and depending on the controller calculation, the ACID valve and the ACID pump will be simultaneously opened for injection.



In manual mode, the operator chooses to open valve, pump or both during a defined time. The red rectangle (on the following scheme) corresponds to the implementation of this function.

The green rectangle corresponds to the reset of the time and the selected equipment after the task has been executed.

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 over. (This condition doesn't appear on the block diagram).

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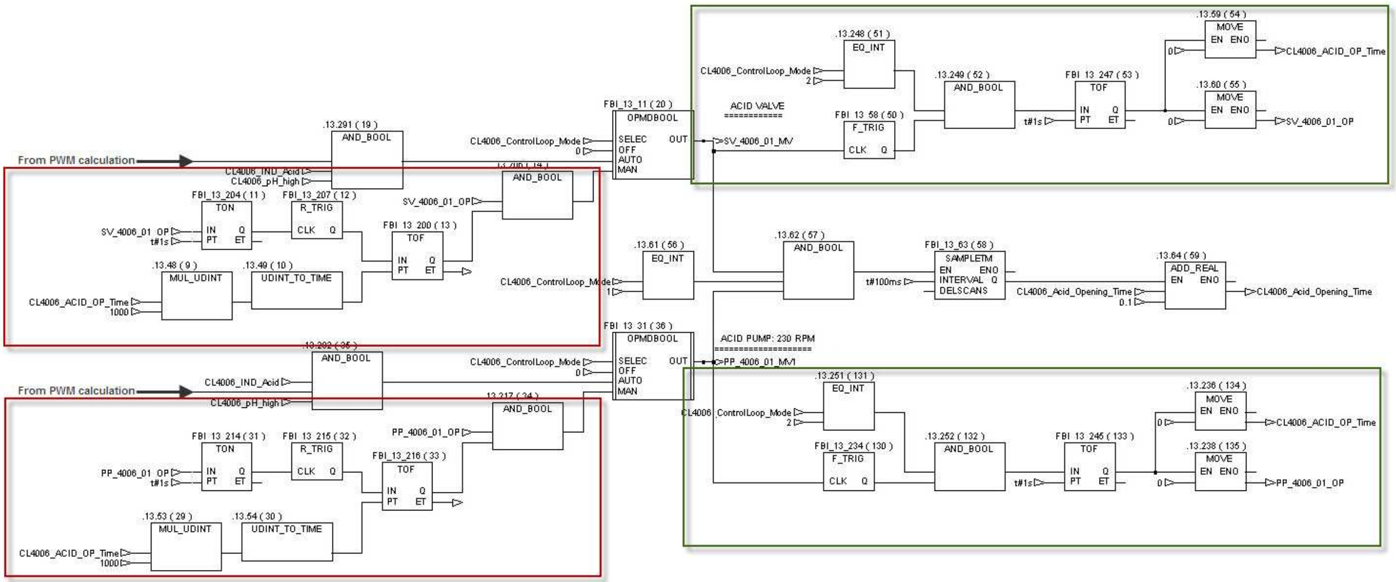
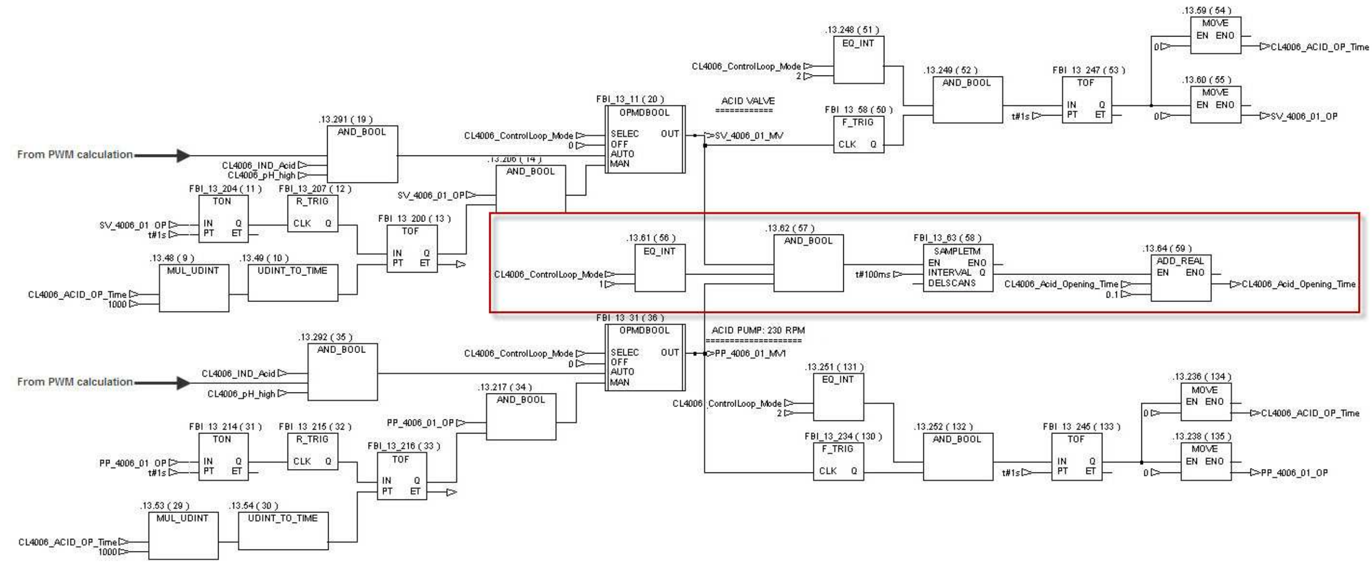


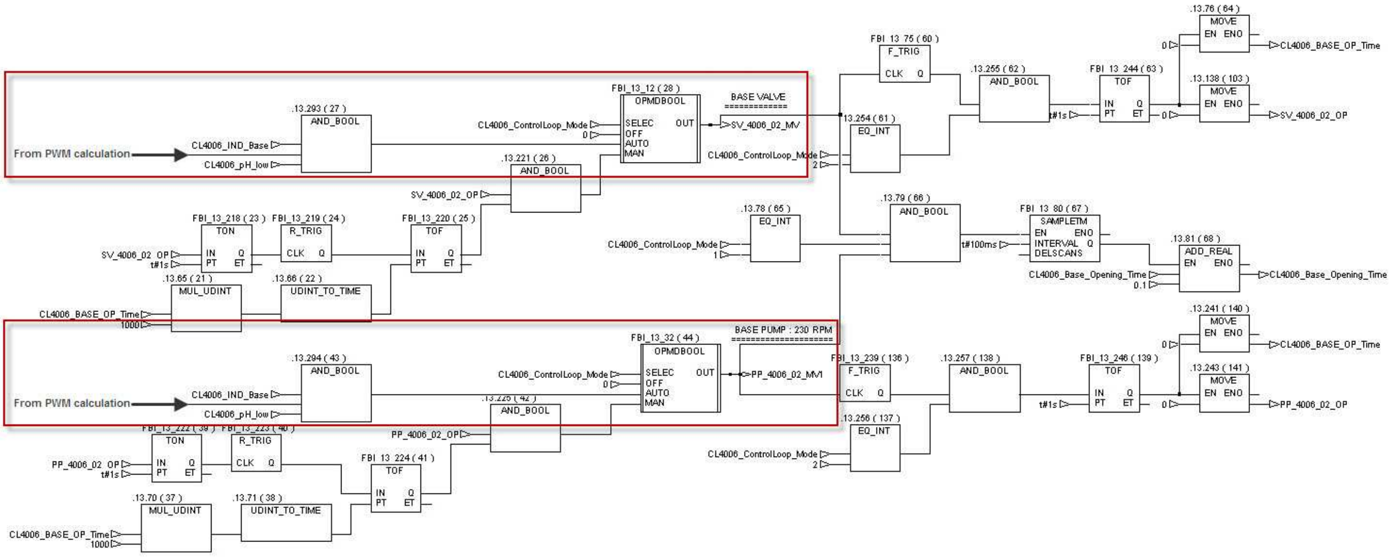
2.9.2.2.1.1.<u>Acid valve and pump opening time records</u>

In automatic mode, when the controller asks for ACID injection, the PLC records how long lasted the injection. A starting date is also recorded to be able to calculate the quantity of ACID injected during an elapsed time. The sampling time of record is 100 ms.
The operator can reset this time (see “reset opening time” section)



2.9.2.2.1.1. Base valve and pump management

In automatic mode, if the operator has chosen the pH mode including BASE solution and depending on the controller calculation, the BASE valve and the BASE pump will be simultaneously opened for injection.



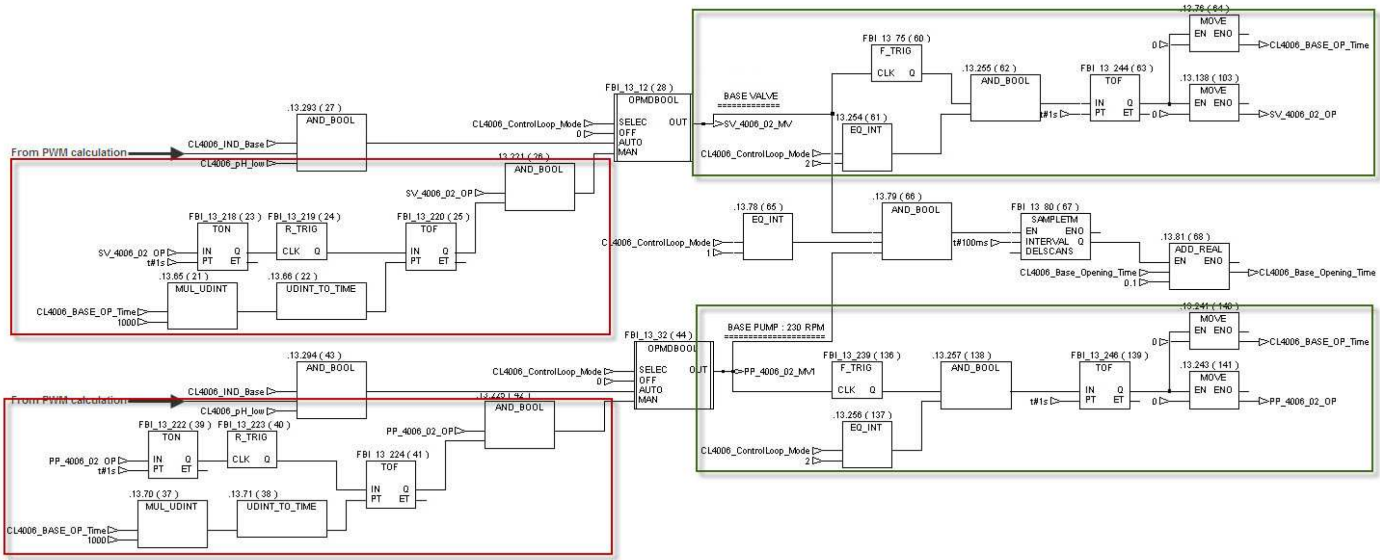
In manual mode, the operator chooses to open valve, pump or both during a defined time. The red rectangle (on the following scheme) corresponds to the implementation of this function.

The green rectangle corresponds to the reset of the time and the selected equipment after the task has been executed.

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

- no time is configured.
- the control loop is set to OFF mode

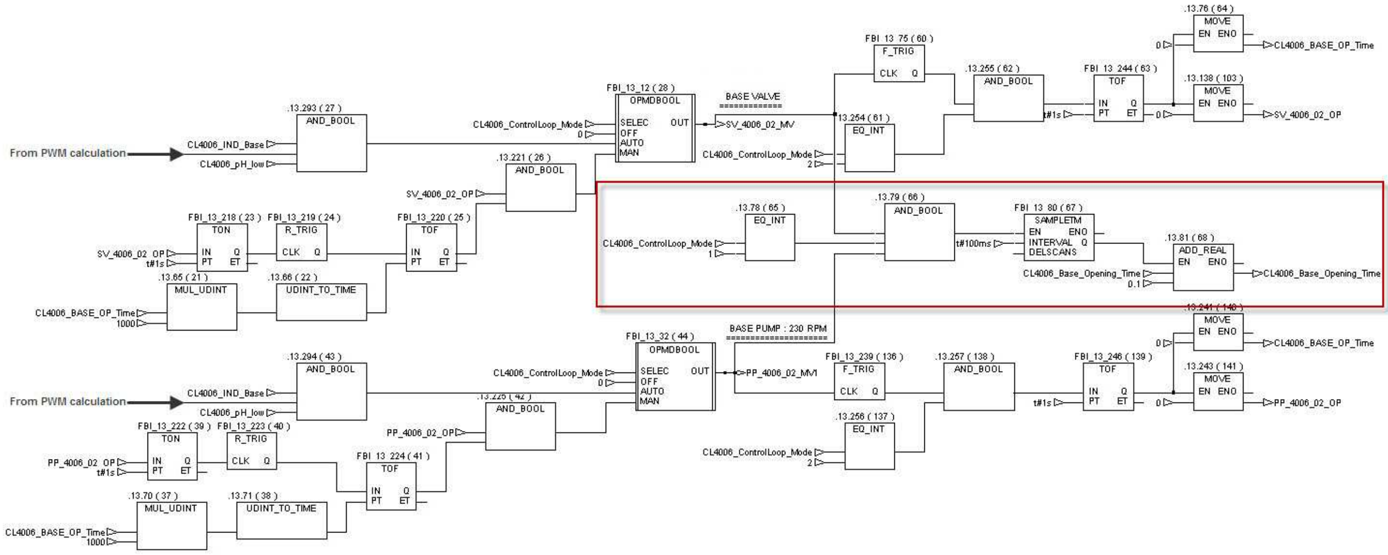
the desired opening time is over. (This condition doesn't appear on the block diagram).



2.9.2.2.1.1.Base valve and pump opening time records

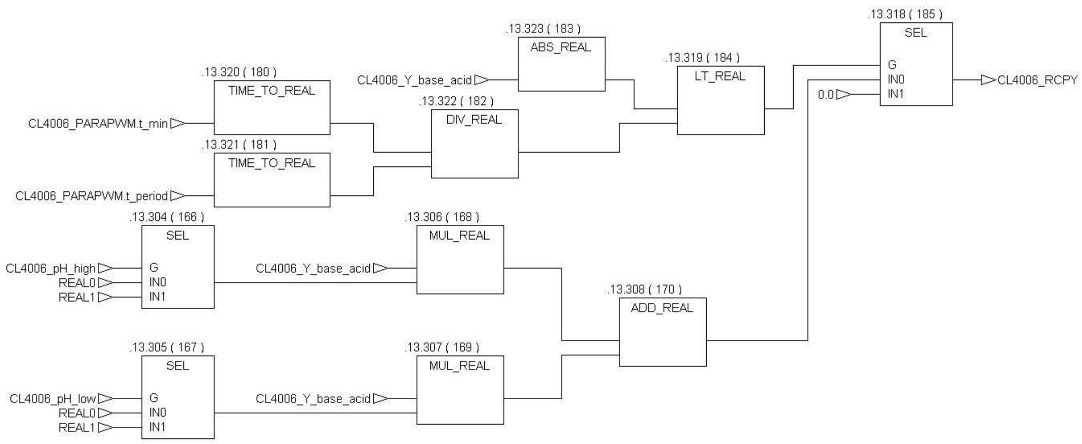
In automatic mode, when the controller asks for BASE injection, the PLC records how long lasted the injection. A starting date is also recorded to be able to calculate the quantity of BASE injected during an elapsed time. The sampling time of record is 100 ms.

The operator can reset this time (see “reset opening time” section)



2.9.2.2.1.2. Controller ACID and BASE recopy

The recopy (RCPY pin of the controller block) corresponds to the real action applied to the process whatever is the calculation of the controller.
In order to preserve equipments from too little opening time calculation, and to let the controller knows that its calculation has not be applied (to conserve the validity of the predictive model), the logic recopy of the controller is implemented as follow:
If the time calculated (for BASE or ACID) is lower than the minimum time of injection of the PWM (1s) divided by calculation period of the PWM (30s), the controller recopy is 0.



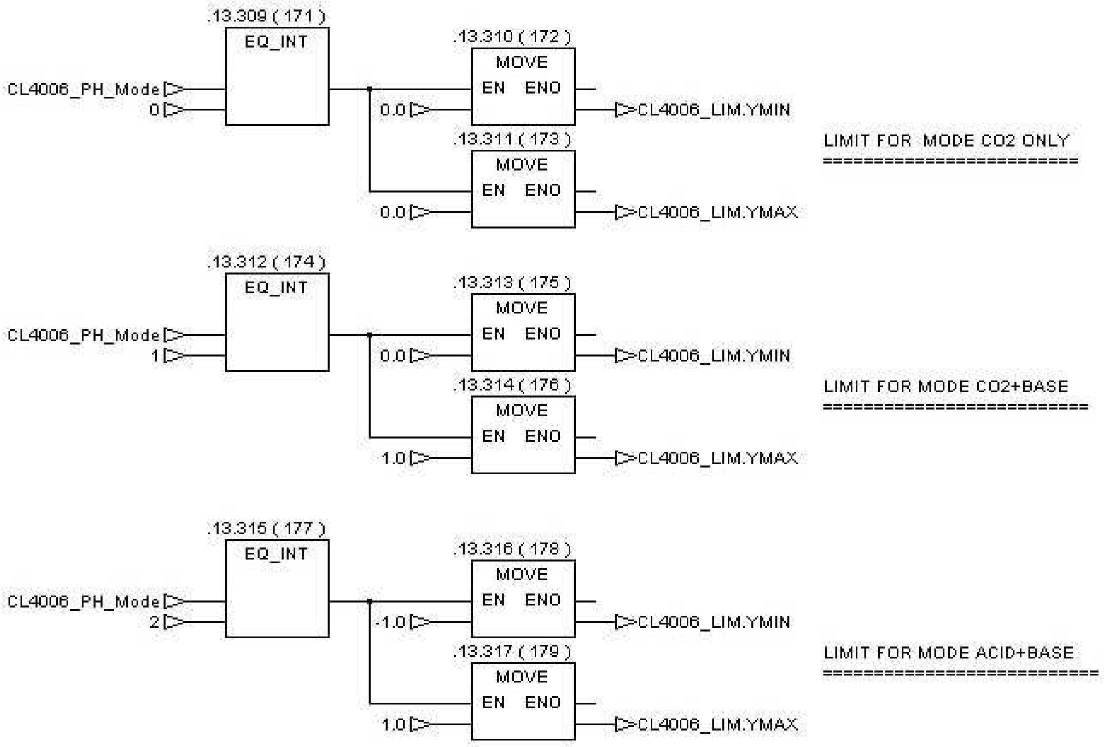
2.9.2.2.1.3.Controller ACID and Base limits

Depending of the pH mode (CO2 only / CO2+BASE / ACID+BASE) the controller has different constraints on its output:

Mode CO2 only : YMIN AND YMAX=0 (the controller is blocked)

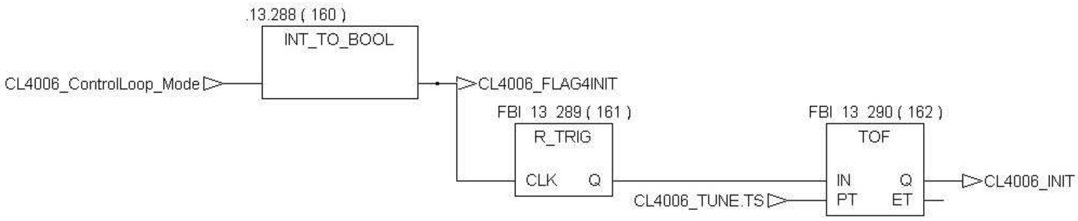
Mode CO2+BASE: YMIN=0 AND YMAX=1 (the controller cannot inject ACID)

Mode ACID+BASE: YMIN=-1 AND YMAX=1(the controller can inject both)



2.9.2.2.1.4. Acid and Base Controller Initialization

When the operator decides to switch to automatic mode, the controller is initialized during the sample time (see controller parameters).



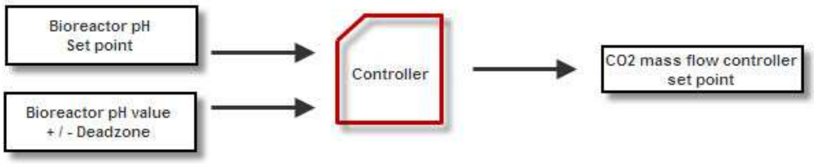
2.9.2.2.1.5. Acid and Base Controller Parameter

Controlled Variable	PCR CONTROLER TYPE	DEAD ZONE	ZTR Zone Control	PWM	SAMPLETM	PROCESS VALUE (input)	SET POINT
SV_4006_01 SV_4006_02 PP_4006_01 PP_4006_02	IF1	YES configurable	NO	CL4006_PARAPWM t_period : 30s t_pause : 0s t_brake : 0s t_min : 1s t_max : 30s up_pos : 1 up_neg : 1	CL4006_TUNE.TS	pHdz	AT_4006_01_SP

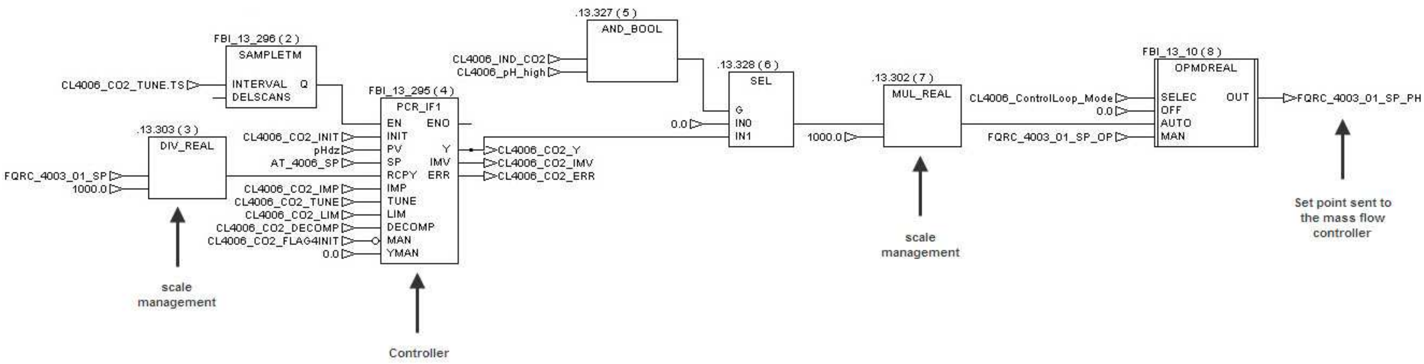
INTERNAL MODEL PROCESS	TUNE	LIMIT	SELF_CMP	DECOMP	Manipulated Variable (Controller Output in Auto Mode)	Controlled Equipment
KM : 0.0005 TM : 0s DM :15s	TS : 30s H : 5m TRBF : 15m	CL4006_LIM Depends on the pH mode (see Controller ACID and Base limits	NO	15 m	CL4006_Y_base_acid	SV_4006_01_MV SV_4006_02_MV PP_4006_01_MV1 PP_4006_02_MV1

2.9.2.2.2. Controller CO2

The controller which manages the CO2 is linked to a mass flow controller. The output of the predictive controller block IF1 sends a set point in ml/min to the mass flow controller.

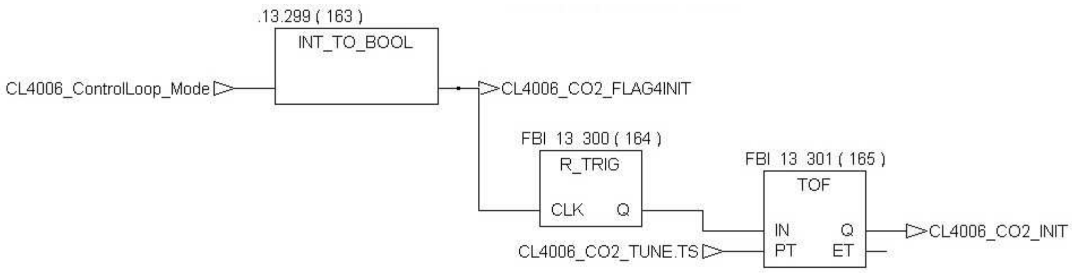


Important point: Because PCR block doesn't accept value lower than 10^{-7} and the gain value is 10^{-8}, we need to change the unit of the PCR equation.
For that, we have decided to convert the unit of the flow from "ml" to "litre".
According to this change we multiply the controller output by 1000 to re-pass in ml unit after the controller.
The logic also concerns the recopy and the limits of the controller.



2.9.2.2.2.1. CO2 Controller Initialization

When the operator decides to switch to automatic mode, the controller is initialized during the sample time (see controller parameters).



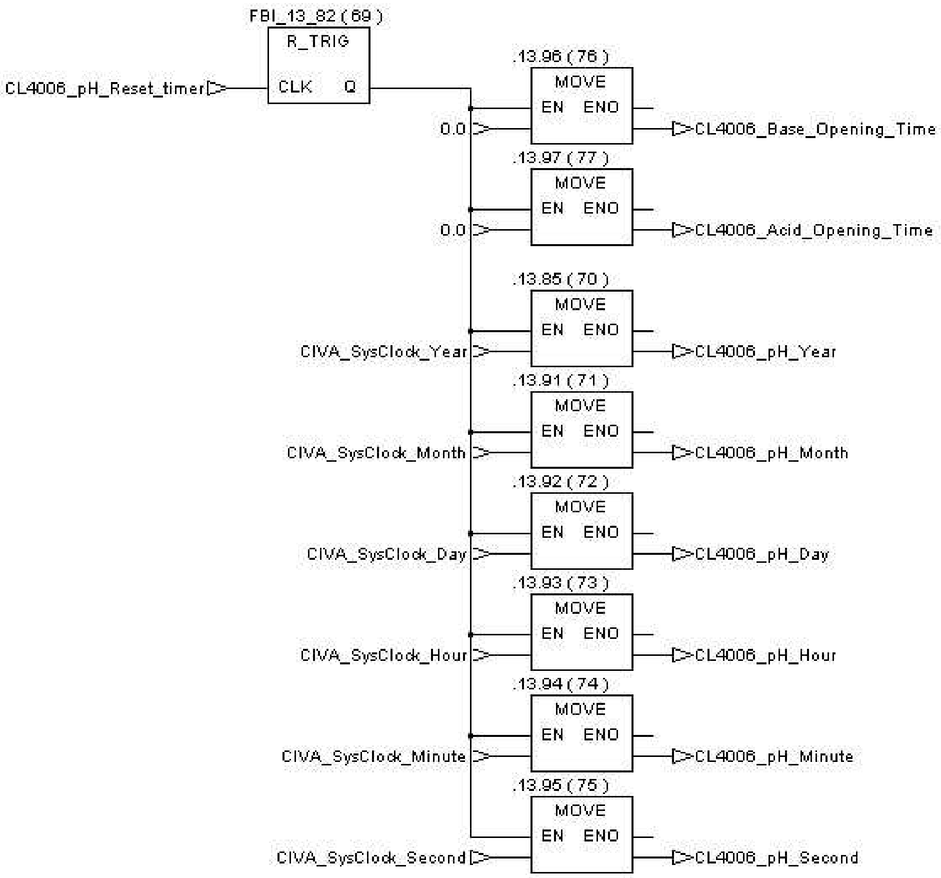
2.9.2.2.2.2. CO2 Controller Parameter

Controlled Variable	PCR CONTROLER TYPE	DEAD ZONE	ZTR Zone Control	PWM	SAMPLETM	PROCESS VALUE (input)	SET POINT
FQRC_4003_01	IF1	YES configurable	NO	NO	CL4006_CO2_TUNE.TS	pHdz	AT_4006_01_SP

INTERNAL MODEL PROCESS	TUNE	LIMIT	SELF_CMP	DECOMP	Manipulated Variable (Controller Output in Auto Mode)	Controlled Equipment
KM : 0.0001 TM : 0s DM :0s	TS : 1s H : 10s TRBF : 30s	CL4006_CO2_LIM YMIN: 0 YMAX: 0.12 YRATE: 0.12	NO	30s	CL4006_CO2_Y	FQRC_4003_01_SP

2.9.2.3. *Reset timer function.*

The operator can reset the timer recording the ACID and BASE injection time. The PLC current date is then recorded as the starting point of the timer.



2.9.3. Alarms and Threshold

Alarm tag Name	type	Address	description
SV_4006_01_A	BOOL	000243	pH ACID Valve Alarm triggered by timer
SV_4006_02_A	BOOL	000244	pH BASE Valve Alarm triggered by timer
WT_4006_01_AL	BOOL	000245	Low level alarm in ACID tank
WT_4006_01_ALL	BOOL	000246	Very Low level alarm in ACID tank
WT_4006_02_AL	BOOL	000247	Low level alarm in BASE tank

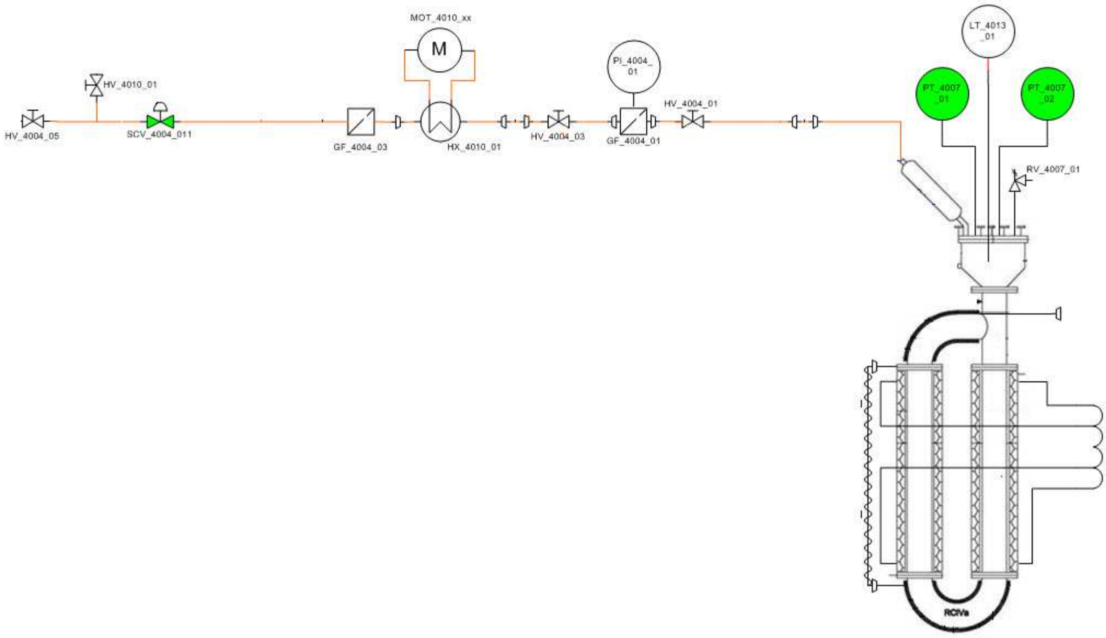
WT_4006_02_ALL	BOOL	000248	Very Low level alarm in BASE tank
CL4006_pH_AHH	BOOL	000249	Very high pH alarm in bioreactor
CL4006_PH_AH	BOOL	000250	High pH alarm in bioreactor
CL4006_PH_AL	BOOL	000251	Low pH alarm in bioreactor
CL4006_PH_ALL	BOOL	000252	Very low pH alarm in bioreactor
AT_4006_01_ERR	BOOL	000128	pH Sensor Link Error
TT_4006_01_ERR	BOOL	000129	Temp. For pH Sensor Link Error
AT_4006_02_ERR	BOOL	000130	pH Sensor Link Error
TT_4006_02_ERR	BOOL	000131	Temp. For pH Sensor Link Error
AT_4006_SENSOR_DEVIATION_A	BOOL	000336	Triggered when the pH gap between the two probe is more than 2

Figure 28: Bioreactor pH control - ALARMS

Threshold tag name	Type	Address	Value	Unit	Action
WT_4006_01_LIM_AL	REAL	400576	1	(Kg.)	Displays alarm on HMI
WT_4006_01_LIM_ALL	REAL	400578	0.5	(Kg.)	Start the CO2 and BASE pH mode in automatic mode
WT_4006_02_LIM_AL	REAL	400580	1	(Kg.)	Displays alarm on HMI
WT_4006_02_LIM_ALL	REAL	400582	0.5	(Kg.)	Displays alarm on HMI
CL4006_pH_LIM_AHH	REAL	400584	10.5 (fix value)	(pH)	Cut the Controller
CL4006_PH_LIM_AH	REAL	400586	0.2	(pH)	Displays alarm on HMI The value need To be ajusted with the control test done by sherpa
CL4006_PH_LIM_AL	REAL	400588	-0.2	(pH)	Displays alarm on HMI The value need To be ajusted with the control test done by sherpa
CL4006_PH_LIM_ALL	REAL	400590	8.5 (fix value)	(pH)	Cut the Controller
AT_4006_SENSOR_DEVIATION_LIM	REAL	400708	0.5	(pH)	Displays alarm on HMI The alarm is permanently checking the sensor deviation. Even if you choose only one of the two sensor.

Figure 29: Bioreactor pH control - THRESHOLDS

2.10. Bioreactor pressure control (CL4007)



2.10.1.Function

The aim of this control loop is to maintain pressure inside the bioreactor. Two probes are installed (with two different ranges). As explained in the “Outlet gas flow” control loop chapter, ESA, UAB and Sherpa Engineering have decided to keep both control loops even if both control loops manage the same equipment (proportional valve SCV_4004_01). The consequence is that the operator needs to define which loop has to be activated, then automatically, the non selected loop is triggered to OFF.

Three modes are available:

- OFF: The control is stopped.

- AUTOMATIC: The controller adjusts SCV_4004_01 to regulate bioreactor pressure depending on the set point.

- MANUAL: No manual mode. The controlled equipment is SCV_4004_01. Only control loop 4004 in manual can control the valve. To Be Discussed with UAB.

PLC Section name	Equipment tag	Type	Address	Comment
CL4007_PBR_Pressure	PT_4007_01	AI ->REAL	400156	Bioreactor Pressure probe 1
CL4007_PBR_Pressure	PT_4007_02	AI ->REAL	400158	Bioreactor Pressure probe 2

Figure 30: Bioreactor pressure control - EQUIPEMENTS

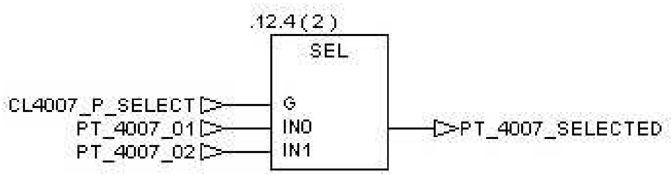
PLC Section name	Equipment tag	Type	Address	Comment
CL4007_PBR_Pressure	CL4007_ControlLoop_Mode	INT	400292	Control Mode (Off/Auto/Manu) To Authorize AUTO, 4004 Shall be in AUTO
CL4007_PBR_Pressure	CL4007_P_SELECT	BOOL	000166	Pressure Probe Selector Off : Probe 1. On : Probe 2
CL4007_PBR_Pressure	PT_4007_SP	REAL	400226	Pressure Set point (OLD NAME:PT_4007_01_SP)

Figure 31: Bioreactor pressure control – OPERATOR INPUTS

2.10.2.Block Diagram

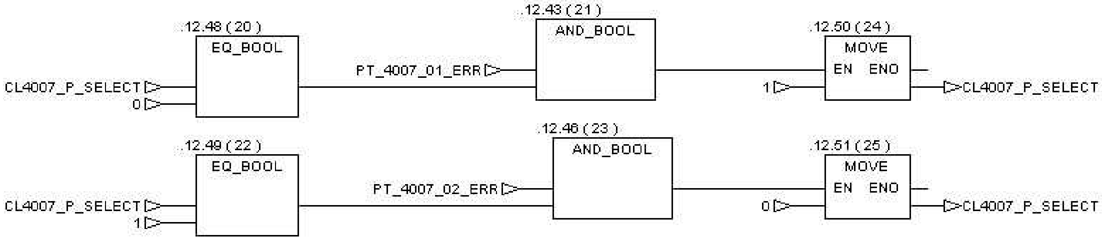
2.10.2.1. *Probe selection*

Two probes with a different range are connected to the process. PT_4007_01 goes from -1 to 1.5 bars and PT_4007_02 goes from -1 to 5 bar. Due to this difference and after having discussed with UAB and ESA, no average is done for the pressure. Only the selection of the probe is implemented.

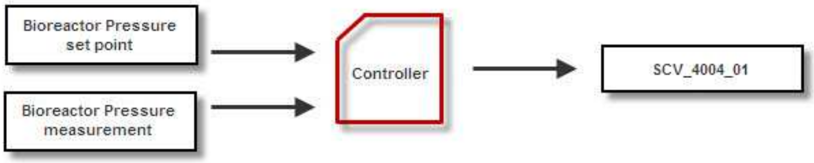


2.10.2.2. *Pressure probe error management*

If one of the probes goes into failure, the PLC automatically changes the probe selector.

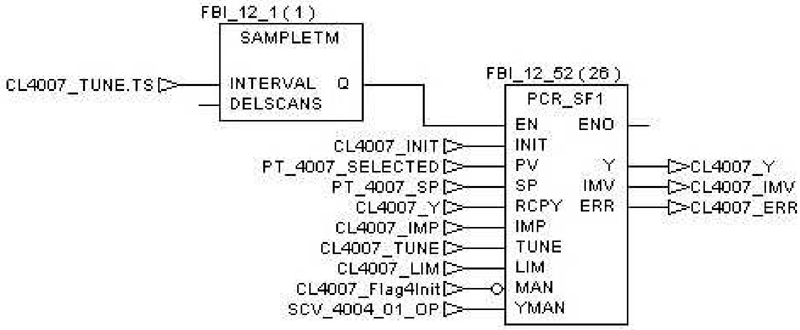


2.10.2.3. *Pressure controller*



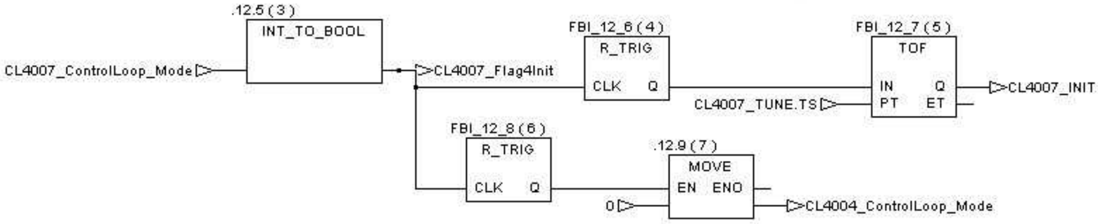
Depending on the selected, the control will adjust the bioreactor pressure to the set point by managing the proportional valve SCV_4004_01.

As a reminder: the proportional valve can be controlled by two loops in automatic mode (Outlet Gas Flow Control and bioreactor pressure control). If one of the two loops is triggered in Automatic mode, the other is switched to OFF mode.



2.10.2.4. *Pressure controller initialization*

When the control loop is triggered in automatic, the Outlet gas flow loop is switched OFF.



2.10.2.5. *Pressure controller parameters*

Controlled Variable	**PCR CONTROLER TYPE**	**DEAD ZONE**	**ZTR Zone Control**	**PWM**	**SAMPLETM**	**PROCESS VALUE (input)**	**SET POINT**
SCV_4004_01	SF1	NO	NO	NO	CL4007_TUNE.TS	PT_4007_SELECTED	PT_4007_SP

INTERNAL MODEL PROCESS	**TUNE**	**LIMIT**	**SELF_CMP**	**DECOMP**	**Manipulated Variable (Controller Output in Auto Mode)**	**Controlled Equipment**
KM : -40 TM : 30s DM :0s	TS : 1s H : 1s TRBF : 60s	CL4007_LIM YMIN: 56 YMAX: 60 YRATE: 1	NO	NO	CL4007_Y	SCV_4004_01_MV

2.10.3.Alarms and Threshold

Alarm tag Name	type	Address	description
PT_4007_01_AH	BOOL	000253	Probe 1 High pressure alarm
PT_4007_01_AHH	BOOL	000254	Probe 1Very High pressure alarm
PT_4007_01_AL	BOOL	000255	Probe 1 Low pressure alarm
PT_4007_01_ALL	BOOL	000256	Probe 1Very Low pressure alarm
PT_4007_02_AH	BOOL	000257	Probe 2 High pressure alarm
PT_4007_02_AHH	BOOL	000258	Probe 2 Very High pressure alarm
PT_4007_02_AL	BOOL	000259	Probe 2 Low pressure alarm

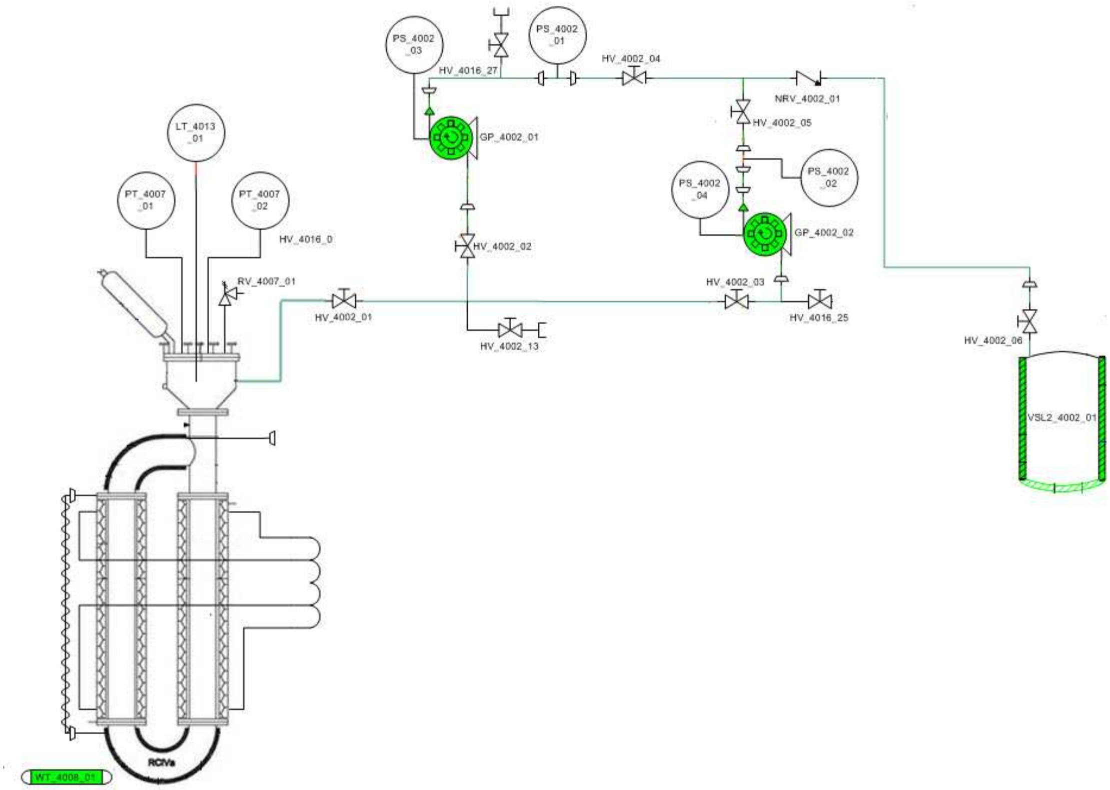
PT_4007_02_ALL	BOOL	000260	Probe 2 Very Low pressure alarm
PT_4007_01_ERR	BOOL	000132	Reactor Pressure Sensor Link Error
PT_4007_02_ERR	BOOL	000133	Reactor Pressure Sensor Link Error

Figure 32: Bioreactor pressure control – ALARMS

Threshold tag name	Type	Address	Value	Unit	Action
PT_4007_01_LIM_AH	REAL	400592	100	(mbar)	Displays alarm on HMI
PT_4007_01_LIM_AHH	REAL	400594	500	(mbar)	Displays alarm on HMI Wait the UAB Decision concerning the third threshold linked to the bioreactor safety
PT_4007_01_LIM_AL	REAL	400596	40 (fix value)	(mbar)	Displays alarm on HMI
PT_4007_01_LIM_ALL	REAL	400598	0 (fix value)	(mbar)	Displays alarm on HMI
PT_4007_02_LIM_AH	REAL	400600	100	(mbar)	Displays alarm on HMI
PT_4007_02_LIM_AHH	REAL	400602	500	(mbar)	Displays alarm on HMI
PT_4007_02_LIM_AL	REAL	400604	40(fix value)	(mbar)	Displays alarm on HMI
PT_4007_02_LIM_ALL	REAL	400606	0(fix value)	(mbar)	Displays alarm on HMI

Figure 33: Bioreactor pressure control – THRESHOLDS

2.11. Bioreactor Liquid Level Control (CL4008)



2.11.1. Function

As the bioreactor is in permanently feeding with medium, the bioreactor level is controlled by the outlet liquid line. The pump management is explained in the chapter “Outlet Liquid Flow control”. Because the controlled equipment is not in the same control loop, the manual mode doesn’t exist.

As a reminder, the current design provides only one pump (even if the final one has two). As both control loops are closely linked, the following conditions happen (they are shown in the block diagram chapter):

-if the level is triggered in automatic mode, the outlet liquid flow loop is also switched in automatic.

-if the outlet liquid flow is triggered in manual mode, the bioreactor level control loop is switched OFF.

-If the bioreactor level is in OFF mode, the Outlet liquid flow cannot be triggered in auto mode.

Two modes are available:

- OFF: The control is stopped.
- AUTOMATIC: The controller adjusts speed of the outlet liquid flow pump to regulate bioreactor level depending on the set point.
- MANUAL: No manual mode.

PLC Section name	Equipment tag	Type	Address	Comment
CL4008_PBR_Liquid_Level	WT_4008_01	AI ->REAL	400154	Weight Balance (BioReactor)

Figure 34 : Bioreactor Liquid Level control – EQUIPEMENTS

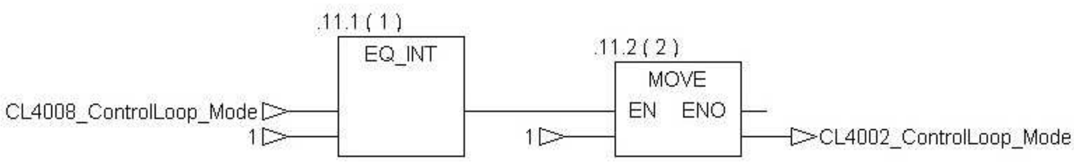
PLC Section name	Equipment tag	Type	Address	Comment
CL4008_PBR_Liquid_Level	CL4008_ControlLoop_Mode	INT	400294	Control Mode (Off/Auto). The manual mode doesn't exist. To Authorize AUTO, 4002 Shall be in AUTO
CL4008_PBR_Liquid_Level	WT_4008_SP	REAL	400228	Level Set Point (or Weight to be defined)

Figure 35 : Bioreactor Liquid Level control – OPERATOR INPUTS

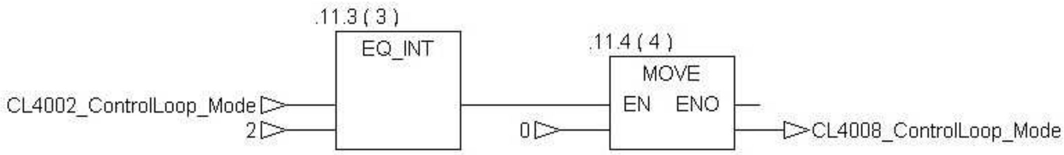
2.11.2.Block Diagram

2.11.2.1. *Control loop mode management*

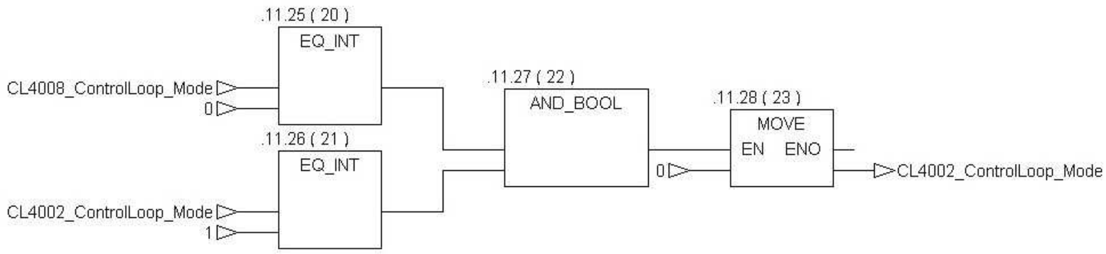
If the level is triggered in automatic mode, the outlet liquid flow loop is also switched in automatic.



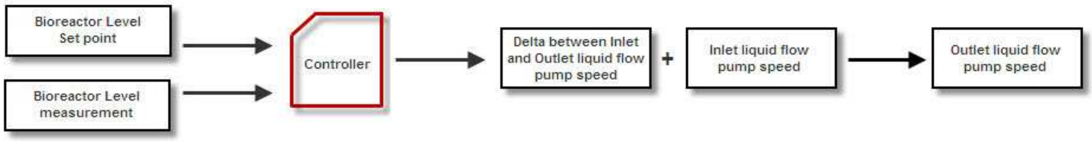
If the outlet liquid flow is triggered in manual mode, the bioreactor level control loop is switched OFF.



If the bioreactor level is in OFF mode, the Outlet liquid flow cannot be triggered in auto mode

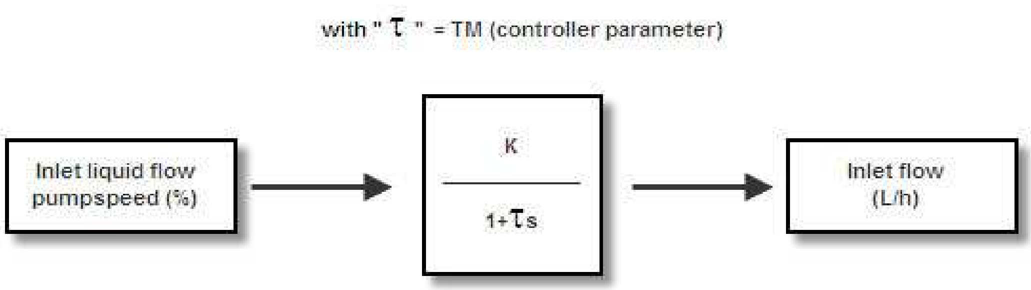


2.11.2.2. *Controller*

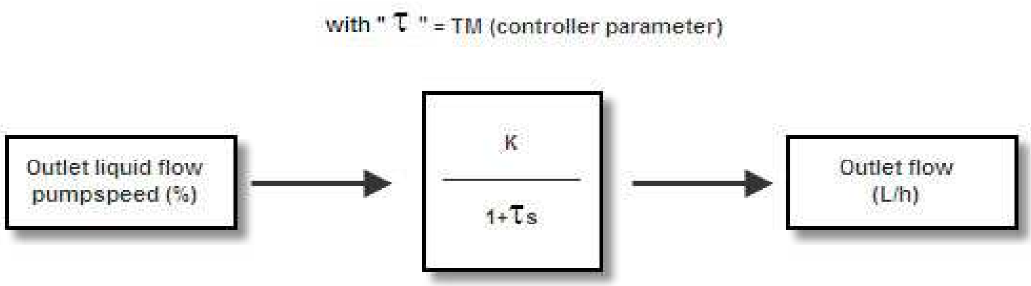


2.11.2.2.1. Logic explanation

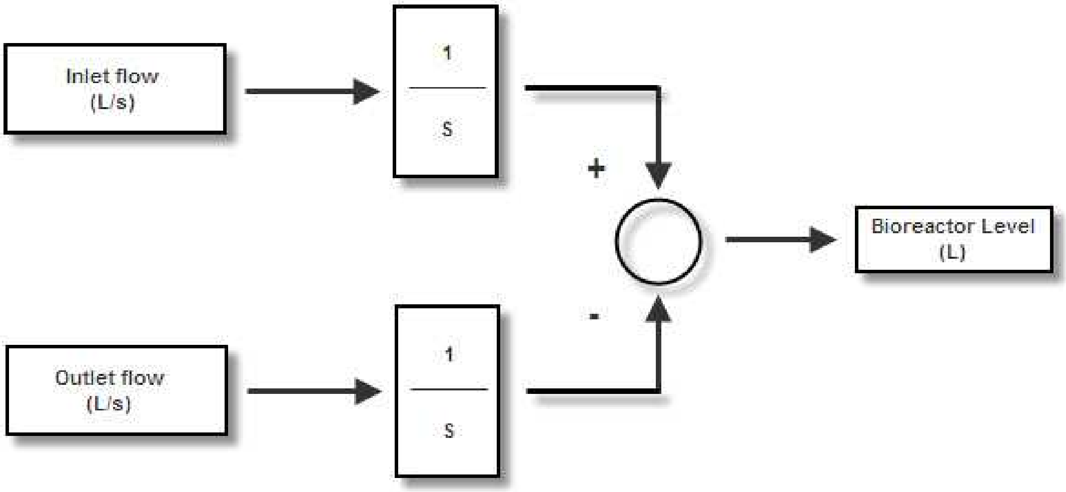
The model of the Inlet Liquid Flow is:



Even if we don’t have any flow meter equipment in the Outlet liquid flow, the logic of this loop is similar:

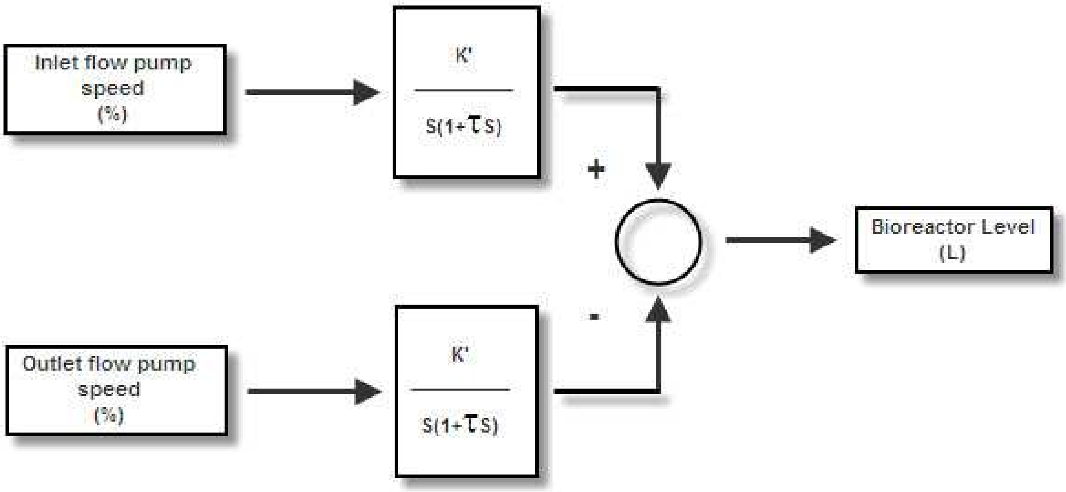


The Level model is:



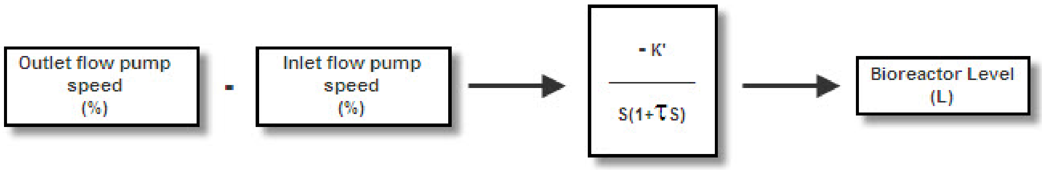
Important point: The flow is expressed in L/s.

By regrouping the Level model with the Inlet and Outlet liquid flow model, we obtain the following scheme:

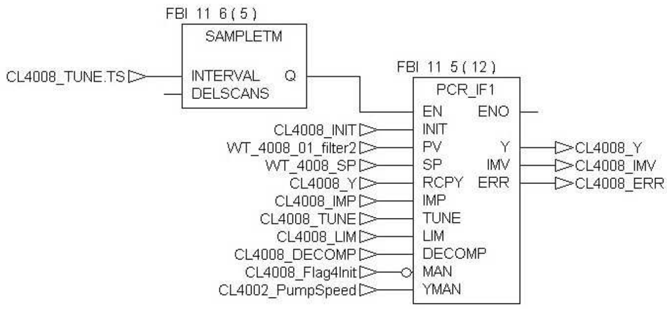


Important point: due to the flow expressed in L/s the gain K' represent the gain K/3600 (conversion from L/h to L/s)

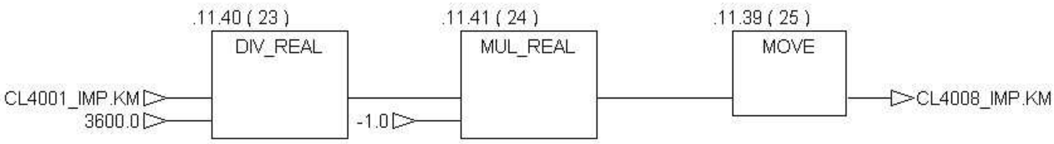
Finally we have the following expression:



The bioreactor level controller implemented is an integrator first order predictive block (see annex D). The parameters are detailed in the chapter “controller parameter”.



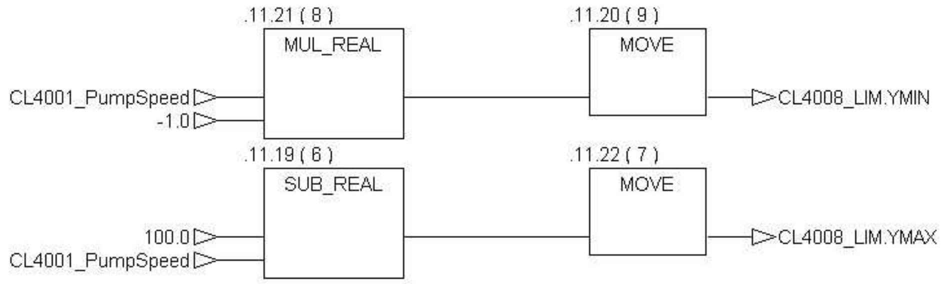
As explained above, the gain of the level controller is the same gain than the Inlet liquid flow loop control but converted from L/h to L/s. The sign is opposite because, physically, the Outlet liquid pump removed the liquid from the bioreactor.



2.11.2.3. *Controller limits*

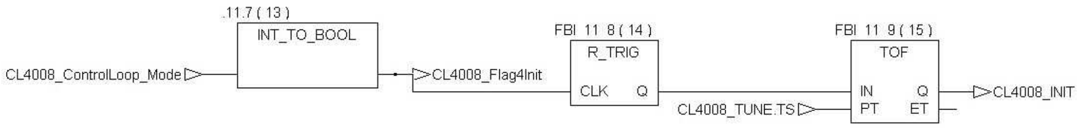
The Limits are calculated in real time. The controller output corresponds to outlet flow pump speed – inlet flow pump speed. Thus, the limit of pump speed of the outlet liquid flow is:

(0–CL4002_PumpSpeed)<CL4002_PumpSpeed-CL4001_PumpSpeed<(100-CL4001_PumpSpeed)



2.11.2.4. *Controller initialisation*

When the operator decides to switch in automatic mode, the controller is initialized during the sample time (see controller parameters).



2.11.2.5. *Controller parameters*

Controlled Variable	**PCR CONTROLER TYPE**	**DEAD ZONE**	**ZTR Zone Control**	**PWM**	**SAMPLETM**	**PROCESS VALUE (input)**	**SET POINT**
CL4002_PumpSpeed	IF1	NO	NO	NO	CL4008_TUNE.TS	WT_4008_01_filter2	WT_4008_SP

INTERNAL MODEL PROCESS	**TUNE**	**LIMIT**	**SELF_CMP**	**DECOMP**	**Manipulated Variable (Controller Output in Auto Mode)**	**Controlled Equipment**
KM : -0.038 TM : 12m DM :0s	TS : 10s H : 10m TRBF : 30m	CL4008_LIM calculated in real time depending on the inlet liquid flow YRATE: 100	NO	30m	CL4008_Y	GP_4002_01_MV2

2.11.3.Alarms and Thresholds

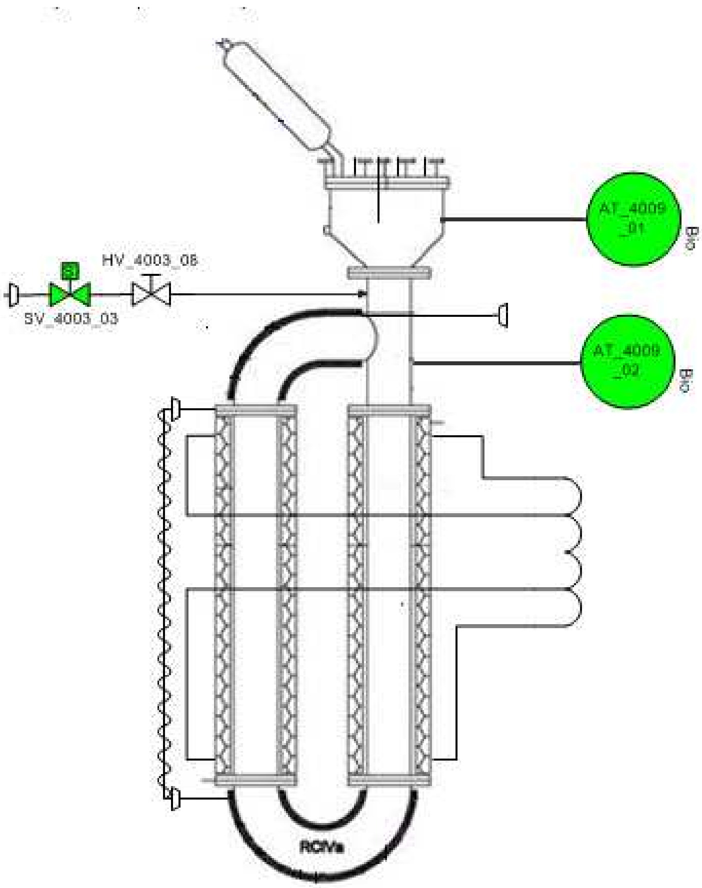
Alarm tag Name	type	Address	description
WT_4008_01_AH	BOOL	000261	Bioreactor High level alarm
WT_4008_01_AHH	BOOL	000262	Bioreactor Very High level alarm
WT_4008_01_AL	BOOL	000263	Bioreactor Low level alarm
WT_4008_01_ALL	BOOL	000264	Bioreactor Very Low level alarm
WT_4008_01_ERR	BOOL	000134	Weight Balance (Reactor) Sensor Link Error

Figure 36 : Bioreactor Liquid Level control – ALARMS

Threshold tag name	Type	Address	Value	Unit	Action
WT_4008_01_LIM_AH	REAL	400608	88(fix value)	(Kg.)	Displays alarm on HMI
WT_4008_01_LIM_AHH	REAL	400610	90(fix value)	(Kg.)	Stop the Inlet liquid Flow loop
WT_4008_01_LIM_AL	REAL	400612	84(fix value)	(Kg.)	Displays alarm on HMI
WT_4008_01_LIM_ALL	REAL	400614	82(fix value)	(Kg.)	Displays alarm on HMI

Figure 37 : Bioreactor Liquid Level Control – THRESHOLDS

2.12. Bioreactor biomass production Control (CL4109)



2.12.1.Function

The aim of this loop is to monitor the biomass production. Previously, this production was controlled. After discussion with UAB and ESA, the priority is given to the dioxygen production. Thus, as soon as the biomass is greater than 1 g/L, the production of dioxygen can be controlled.

By the way, the loop as two functions:

-The calculation of the Biomass production.

-To clean both biomass sensors by the specific bioreactor air inlet.

As no real control is done on this loop, only cleaning biomass sensor has three modes:

- OFF: The cleaning timer is OFF.
- AUTOMATIC: The cleaning of the sensors is done during 5 seconds every 5 minutes.
- MANUAL: the valve SV_4003_02 can inject air on biomass sensor.

PLC Section name	Equipment tag	Type	Address	Comment
CL4009_Biomass	AT_4009_01	AI ->REAL	400124	Biomass sensor 1
CL4009_Biomass	AT_4009_02	AI ->REAL	400126	Biomass sensor 2
CL4009_Biomass	AT_4009_AVG	REAL	400310	Biomass Sensor AVERAGE. (This is not an equipment but a software calculation)
CL4009_Biomass	AT_4009_FAILURE_IND	AI ->REAL	400128	OLD NAME: TT_4009_01

Figure 38 : Bioreactor Biomass production Control – EQUIPEMENTS

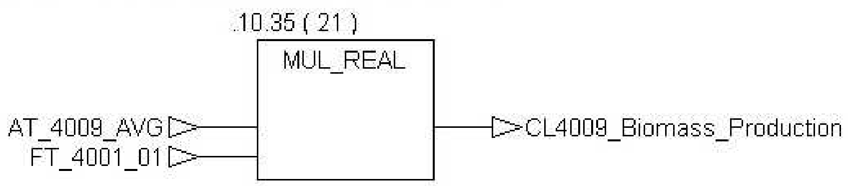
PLC Section name	Equipment tag	Type	Address	Comment
CL4009_Biomass	CL4009_Biomass_Cleaning_Mode	INT	400296	Biomass Cleaning Mode (Off/Auto/Manu)
CL4009_Biomass	CL4009_Biomass_Production	REAL	400230	Biomass Production (g/H) (Information)

Figure 39: Bioreactor Biomass production Control - -OPERATOR INPUT

2.12.2.Block Diagram

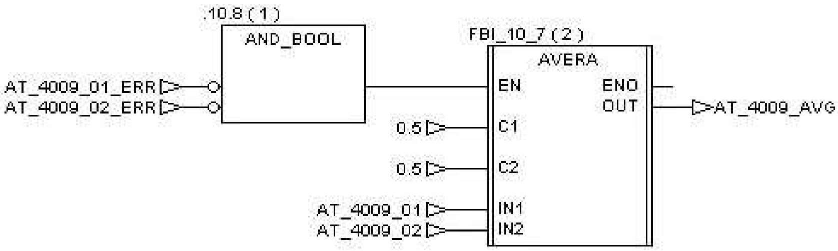
2.12.2.1. *Biomass production*

The biomass production corresponds to the biomass sensor average multiplied by the inlet liquid flow.

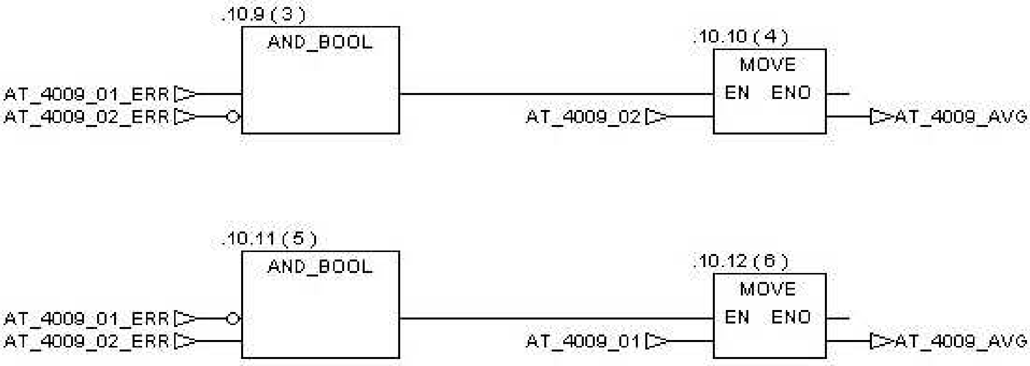


2.12.2.2. *Error probe management*

If no sensor failure is detected, the biomass measurement for the production calculation is done with the average of both probe measurement.

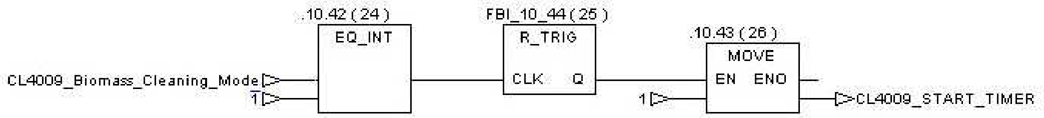


If a failure is detected on one of the probe, the second measurement is taken as the average measurement.

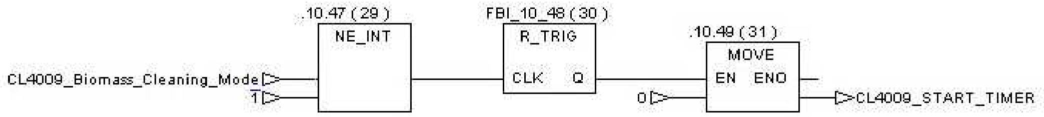


2.12.2.3. *Timer management*

When the Cleaning mode is set to automatic, the timer starts.

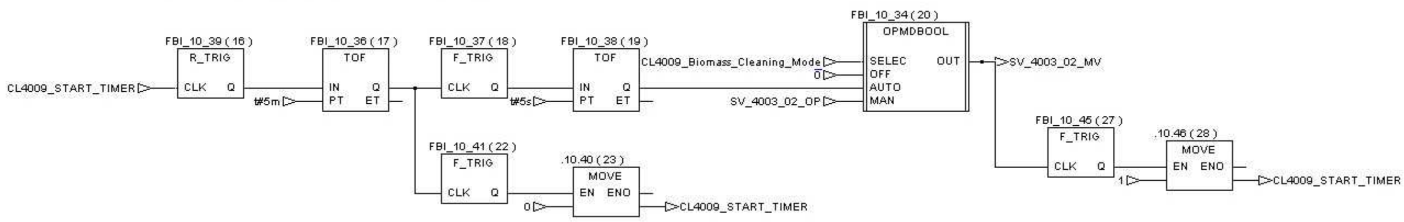


When the Cleaning mode is set in manual mode or OFF mode, the timer is stopped.



2.12.2.4. *Timer*

Every 5 minutes, air is injected on the biomass probes via the valve SV_4003_02 during 5 seconds.



2.12.3.Alarms and Thresholds

Alarm tag Name	type	Address	description
AT_4009_01_AH	BOOL	000265	High biomass Alarm on sensor 1
AT_4009_01_AHH	BOOL	000266	Very high biomass Alarm on sensor 1
AT_4009_01_AL	BOOL	000267	Low biomass Alarm on sensor 1
AT_4009_01_ALL	BOOL	000268	Very low biomass Alarm on sensor 1
AT_4009_02_AH	BOOL	000269	High biomass Alarm on sensor 2
AT_4009_02_AHH	BOOL	000270	Very high biomass Alarm on sensor 2
AT_4009_02_AL	BOOL	000271	Low biomass Alarm on sensor 2
AT_4009_02_ALL	BOOL	000272	Very low biomass Alarm on sensor 2

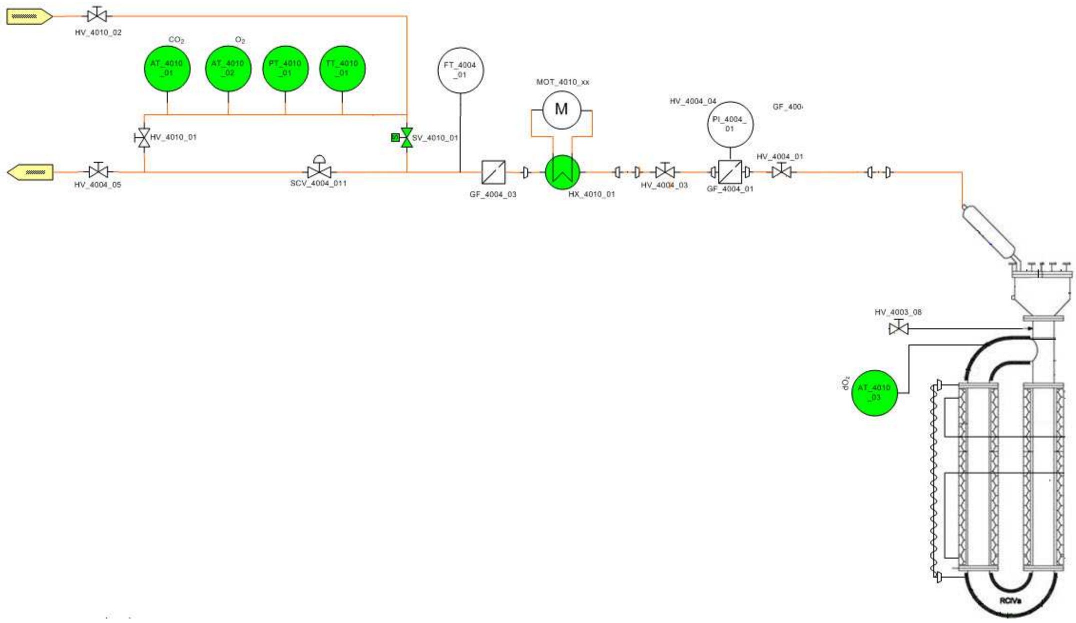
AT_4009_SENSORFAILLURE	BOOL	000273	OLD TAG:TT_4009_01_AH
AT_4009_01_ERR	BOOL	000135	Biomass Sensor Link Error
AT_4009_02_ERR	BOOL	000136	Biomass Sensor Link Error
AT_4009_FAILURE_IND_ERR	BOOL	000137	OLD NAME: TT_4009_01_ERR

Figure 40 : Bioreactor Biomass production Control – ALARMS

Threshold tag name	Type	Address	Value	Unit	Action
AT_4009_01_LIM_AH	REAL	400616	3(fix value)	(g/l)	Displays alarm on HMI UAB needs to confirmed the value
AT_4009_01_LIM_AHH	REAL	400618	3.5(fix value)	(g/l)	Displays alarm on HMI UAB needs to confirmed the value
AT_4009_01_LIM_AL	REAL	400620	1.2(fix value)	(g/l)	Displays alarm on HMI UAB needs to confirmed the value
AT_4009_01_LIM_ALL	REAL	400622	1(fix value)	(g/l)	Displays alarm on HMI UAB needs to confirmed the value
AT_4009_02_LIM_AH	REAL	400624	3(fix value)	(g/l)	Displays alarm on HMI UAB needs to confirmed the value
AT_4009_02_LIM_AHH	REAL	400626	3.5(fix value)	(g/l)	Displays alarm on HMI UAB needs to confirmed the value
AT_4009_02_LIM_AL	REAL	400628	1.2(fix value)	(g/l)	Displays alarm on HMI UAB needs to confirmed the value
AT_4009_02_LIM_ALL	REAL	400630	1(fix value)	(g/l)	Displays alarm on HMI UAB needs to confirmed the value
AT_4009_SENSORFAILLURE_LIM	REAL	400632	10(fix value)	(mA)	Displays alarm on HMI OLD TAG: TT_4009_01_LIM_AL

Figure 41 : Bioreactor Biomass production Control – THRESHOLDS

2.13. Bioreactor outlet gas composition control (CL4010)



2.13.1.Function

This control loop contains all gas analyzers of the compartment. They can be sorted in 2 different parts:

-The gas line analyzer groups CO2 and O2 analyzer. This part is linked to the primary function of the CIVa which converts CO2 into Dioxygen for the crew. The O2 production is controlled by the lights.

-The bioreactor analyzer which measures the concentration of dioxygen dissolved inside the bioreactor. This measurement is not controlled.

Up to now: Depending on the dioxygen set point, the controller will adjust the light intensity.

What will be done in the future:

Important point: To implement the following strategy we need to have the Power measurement of the lights permitting an accuracy conversion from W/m^2 to % of light intensity.

Depending on the O2 set point entered by the operator, the Gas composition controller (Master controller) will compute a set point (In W/m^2) sent to the lights controller (Slave). Then the slave controller will compute a % of light intensity.
The slave controller adjusts the set point function of the total power delivered to the lights. It means that, if some lights are broken, the Slave controller will take them into account in its computation. It implies that a model between number of lights and power consumption is known.

The consequence of the link of these two loops is that both modes management are closely dependent.
The logical way to organise them depends on the controller links. The priority goes from master to slave:

If the master is ON, the slave is forced to ON.
If the slave is OFF, the master is forced to OFF.
If the master is OFF, the slave can be ON or OFF. In ON mode, the operator needs to give a set point in W/m^2 (when the master controller is stopped, the last set point sent to the slave controller is conserved). In OFF mode, the operator manages directly the lights, so the set point is given in % of intensity.
.

PLC Section name	Equipment tag	Type	Address	Comment
CL4010_OutletGasCompo	SV_4010_01_FB	DI	100093	Gas Inlet analyzer
CL4010_OutletGasCompo	SV_4010_01_MV	DO	000081	Gas Inlet analyzer (reactor outlet)
CL4010_OutletGasCompo	HX_4010_01_MV1	-	NO CONNECTION	Start/Stop Post condenser
CL4010_OutletGasCompo	AT_4010_01	AI ->REAL	400130	CO2analyzer
CL4010_OutletGasCompo	AT_4010_02	AI ->REAL	400132	O2 analyzer
CL4010_OutletGasCompo	AT_4010_03	AI ->REAL	400134	Dissolved O2
CL4010_OutletGasCompo	PT_4010_01	AI ->REAL	400160	Outlet Gas Pressure
CL4010_OutletGasCompo	TT_4010_01	AI ->REAL	400172	Analyzer Temp.(OLD NAME: TT_4010_02)

Figure 42 : Bioreactor outlet gas composition control - EQUIPMENTS

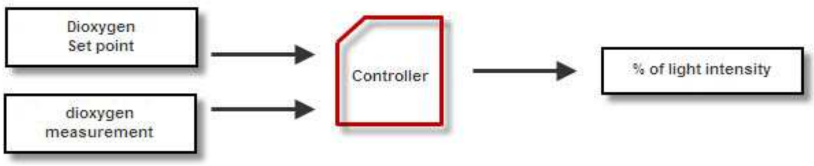
PLC Section name	Equipment tag	Type	Address	Comment
CL4010_OutletGasCompo	CL4010_ControlLoop_Mode	INT	400275	Outlet gas composition mode (Off/Auto/Manu)
CL4010_OutletGasCompo	SV_4010_01_OP	BOOL	000333	SV_4010_01_OP Use only in manual mode
CL4010_OutletGasCompo	CL4010_O2_SP	REAL	400320	O2 SET POINT Set point to control Oxygen in automatic mode

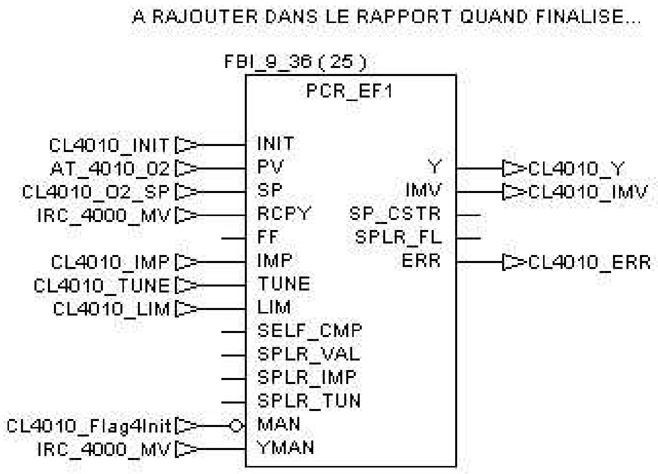
Figure 43 : Bioreactor outlet gas composition control - OPERATOR INPUTS

2.13.2.Block Diagram

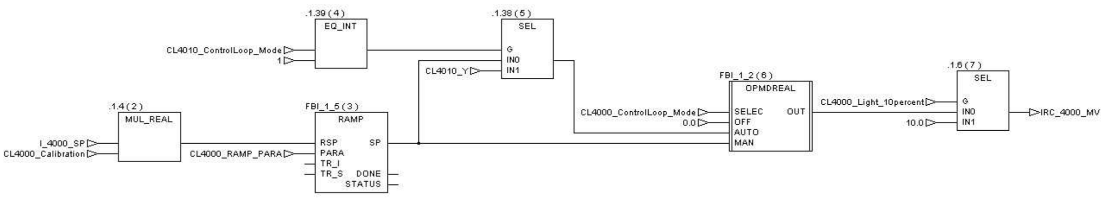
2.13.2.1. *Controller*

Up to Now:

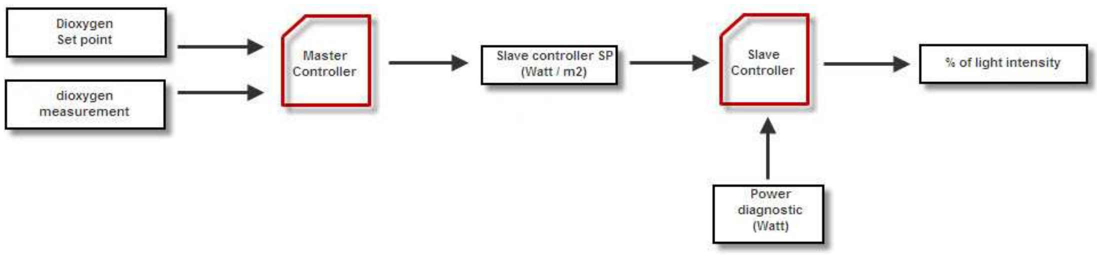




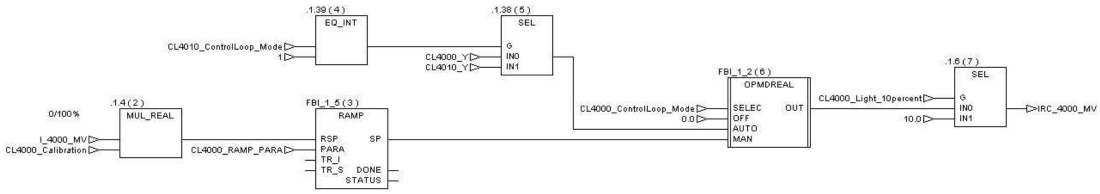
Yet, the tag “I_4000_SP” has a scale: 0 → 100 %.



What will be done in the future:



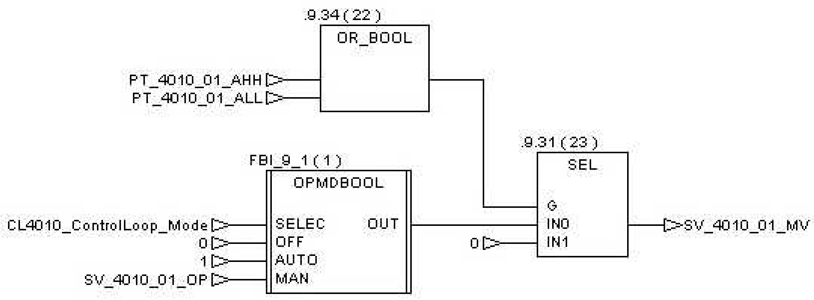
I_4000_SP (W/m^2) Set point sent by master controller when CL4010 is in auto mode.
I_4000_MV will have a scale: 0→100% of lights intensity.



2.13.2.2. *Analyzer safety*

In case of very High or very Low pressure, the valve SV_4010_01 is automatically closed to protect the analyzer input.
By the way, in case of normal pressure, this valve is

- closed in OFF mode,
- Opened in automatic mode
- Opened or closed in manual mode.



2.13.3.Alarms and Thresholds

Alarm tag Name	type	Address	description
AT_4010_01_AH	BOOL	000278	High level alarm of CO2
AT_4010_01_AHH	BOOL	000279	Very high level alarm of CO2
AT_4010_01_AL	BOOL	000280	Low level alarm of CO2
AT_4010_01_ALL	BOOL	000281	Very low level alarm of CO2
AT_4010_02_AH	BOOL	000282	High level alarm of O2
AT_4010_02_AHH	BOOL	000283	Very high level alarm of O2
AT_4010_02_AL	BOOL	000284	Low level alarm of O2
AT_4010_02_ALL	BOOL	000285	Very low level alarm of O2
AT_4010_03_AH	BOOL	000286	High level alarm of Dissolved O2
AT_4010_03_AHH	BOOL	000287	Very high level alarm of Dissolved O2
AT_4010_03_AL	BOOL	000288	Low level alarm of Dissolved O2
AT_4010_03_ALL	BOOL	000289	Very low level alarm of Dissolve O2
PT_4010_01_AH	BOOL	000294	High pressure alarm in gas composition line
PT_4010_01_AHH	BOOL	000295	Very high pressure alarm of gas composition line
PT_4010_01_AL	BOOL	000296	Low pressure alarm of gas composition line
PT_4010_01_ALL	BOOL	000297	Very low pressure alarm of gas composition line
TT_4010_01_AH	BOOL	000298	High temperature alarm in CO2/O2 analyzer OLD NAME : TT_4010_02_AH
TT_4010_01_AHH	BOOL	000299	Very high temperature alarm in CO2/O2 analyzer OLD NAME : TT_4010_02_AHH
TT_4010_01_AL	BOOL	000300	Low temperature alarm in CO2/O2 analyzer OLD NAME : TT_4010_02_AL
TT_4010_01_ALL	BOOL	000301	Very low temperature alarm in CO2/O2 analyzer OLD NAME : TT_4010_02_ALL
AT_4010_01_ERR	BOOL	000138	CO2 analyzer Sensor Link Error
AT_4010_02_ERR	BOOL	000139	O2 analyzer Sensor Link Error
AT_4010_03_ERR	BOOL	000140	Dissolved O2 Sensor Link Error
TT_4010_02_ERR	BOOL	000141	Temp. Meas. (Dissolved O2) Sensor Link Error
PT_4010_01_ERR	BOOL	000142	Outlet Gas Pressure Sensor Link Error
TT_4010_01_ERR	BOOL	000143	Analyzer Temp. Sensor Link Error

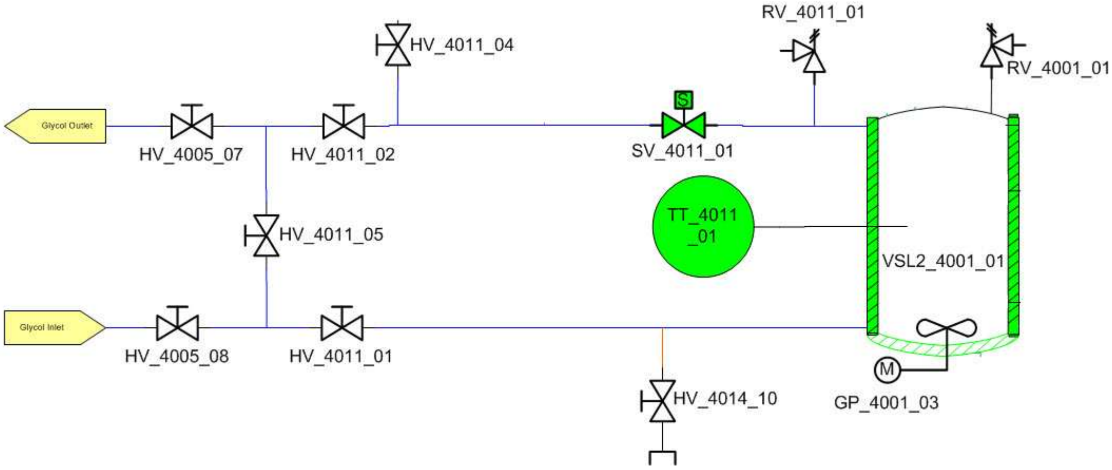
Figure 44: Bioreactor outlet gas composition control - ALARMS

Threshold tag name	Type	Address	Value	Unit	Action
AT_4010_01_LIM_AH	REAL	400640	450(fix value)	(ppm)	Displays alarm on HMI To be defined after (related with the CV integration
AT_4010_01_LIM_AHH	REAL	400642	500(fix value)	(ppm)	Displays alarm on HMI To be defined after (related with the CV integration
AT_4010_01_LIM_AL	REAL	400644	350(fix value)	(ppm)	Displays alarm on HMI To be defined after (related with the CV integration
AT_4010_01_LIM_ALL	REAL	400646	300(fix value)	(ppm)	Displays alarm on HMI

					To be defined after (related with the CV integration
AT_4010_02_LIM_AH	REAL	400648	22(fix value)	(%)	Displays alarm on HMI To be defined after (related with the CV integration
AT_4010_02_LIM_AHH	REAL	400650	24(fix value)	(%)	Put the light to 10% To be defined after (related with the CV integration
AT_4010_02_LIM_AL	REAL	400652	20(fix value)	(%)	Displays alarm on HMI To be defined after (related with the CV integration
AT_4010_02_LIM_ALL	REAL	400654	19.5(fix value)	(%)	Displays alarm on HMI To be defined after (related with the CV integration
AT_4010_03_LIM_AH	REAL	400656	90(fix value)	(%)	Displays alarm on HMI To be defined after (related with the CV integration
AT_4010_03_LIM_AHH	REAL	400658	95(fix value)	(%)	Displays alarm on HMI To be defined after (related with the CV integration
AT_4010_03_LIM_AL	REAL	400660	70(fix value)	(%)	Displays alarm on HMI To be defined after (related with the CV integration
AT_4010_03_LIM_ALL	REAL	400662	65(fix value)	(%)	Displays alarm on HMI To be defined after (related with the CV integration
PT_4010_01_LIM_AH	REAL	400672	80	(mbar)	Displays alarm on HMI To be defined after (related with the CV integration
PT_4010_01_LIM_AHH	REAL	400674	100	(mbar)	close the SV_4010_01 maintain the control of light to the same value.
PT_4010_01_LIM_AL	REAL	400676	20	(mbar)	Displays alarm on HMI
PT_4010_01_LIM_ALL	REAL	400678	0	(mbar)	close the SV_4010_01 maintain the control of light to the same value.
TT_4010_01_LIM_AH	REAL	400680	?	(ºC)	Displays alarm on HMI UAB needs to confirmed the value
TT_4010_01_LIM_AHH	REAL	400682	?	(ºC)	close the SV_4010_01 maintain the control of light to the same value. UAB needs to confirmed the value
TT_4010_01_LIM_AL	REAL	400684	?	(ºC)	Displays alarm on HMI UAB needs to confirmed the value
TT_4010_01_LIM_ALL	REAL	400686	?	(ºC)	Displays alarm on HMI UAB needs to confirmed the value

Figure 45 : Bioreactor outlet gas composition control - THRESHOLD

2.14. Feeding Tank Temperature Control (CL4011)



2.14.1.Function

Before entering inside the bioreactor, the Medium (Zarouk) which provides nutrient to Arthrospira Platensis, is maintained to a low temperature. This is done by MPP cold water utilities. The cold water circulates inside the Influent jacket. A boolean valve manages the circulation. Even if the current MPP utilities do not permit to reach this set point, a controller maintained the temperature to the minimum reachable temperature (around 10℃).

PLC Section name	Equipment tag	Type	Address	Comment
CL4011_Feeding_Temp	SV_4011_01_FB	DI	100087	Feed back of Cooling water outlet valve
CL4011_Feeding_Temp	SV_4011_01_MV	DO	000087	Cooling water outlet valve
CL4011_Feeding_Temp	TT_4011_01	AI ->REAL	400170	Inlet Vessel Temp.

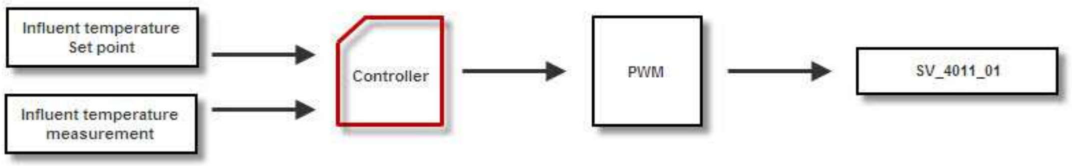
Figure 46 : Feeding tank Temperature Control – EQUIPMENTS

PLC Section name	Equipment tag	Type	Address	Comment
CL4011_Feeding_Temp	CL4011_ControlLoop_Mode	INT	400300	Feeding Tank Temperature Control
CL4011_Feeding_Temp	TT_4011_SP	REAL	400234	Feeding Tank Temp. Set Point
CL4011_Feeding_Temp	SV_4011_01_OP	BOOL	000168	Valve ON/OFF Only in Manual Mode

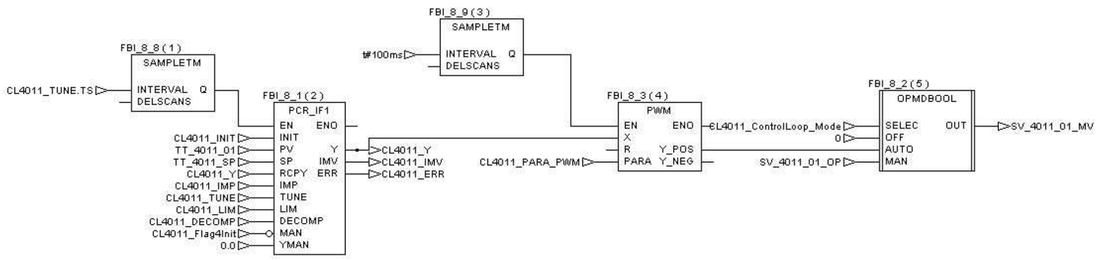
Figure 47 : Feeding tank Temperature Control – OPERATOR INPUTS

2.14.2.Block Diagram

2.14.2.1. *Controller*

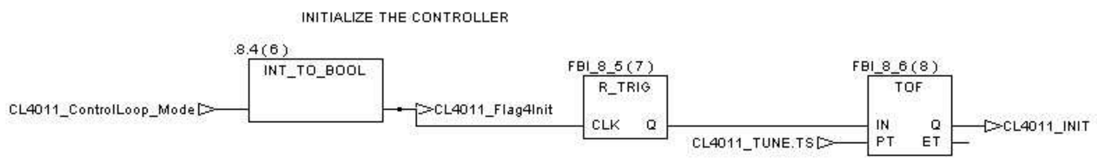


A predictive block “IF1” controls the Influent temperature (for more details on the block, see annex D). The signal is then converted into time by a PWM block because the controlled equipment is a Boolean valve. For more details on PWM block, see annex G.



2.14.2.2. *Controller initialization*

When the operator decides to switch in automatic mode, the controller is initialized during the sample time (see controller parameters).



2.14.2.3. *Controller parameter*

Controlled Variable	PCR CONTROLER TYPE	DEAD ZONE	ZTR Zone Control	PWM	SAMPLETM	PROCESS VALUE (input)	SET POINT
SV_4011_01	IF1	NO	NO	CL4011_PARAPWM t_period : 30s t_pause : 0s t_brake : 0s t_min : 2s t_max : 30s up_pos : 1 up_neg : 0	CL4011_TUNE.TS	TT_4011_01	TT_4011_SP

INTERNAL MODEL PROCESS	TUNE	LIMIT	SELF_CMP	DECOMP	Manipulated Variable (Controller Output in Auto Mode)	Controlled Equipment
KM : -0.0005 TM : 630s DM :0s	TS : 30s H : 200s TRBF : 30m	CL4011_LIM Y_MIN: 0 Y_MIN: 1 YRATE: 1	NO	30m	CL4011_Y	SV_4011_01_MV

2.14.3.Alarms and Thresholds

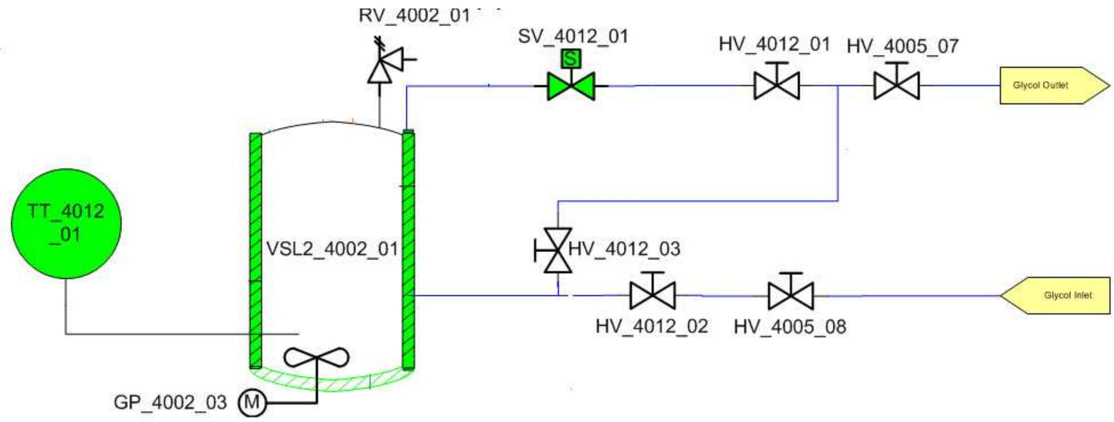
Alarm tag Name	type	Address	description
SV_4011_01_A	BOOL	000302	Valve in alarm / No feed back received
TT_4011_01_AH	BOOL	000303	High temperature alarm in influent tank
TT_4011_01_AHH	BOOL	000304	Very high temperature alarm in influent tank
TT_4011_01_AL	BOOL	000305	Low temperature alarm in influent tank
TT_4011_01_ALL	BOOL	000306	Very low temperature alarm in influent tank
TT_4011_01_ERR	BOOL	000144	Inlet Vessel Temp. Sensor Link Error

Figure 48 : Feeding tank Temperature Control – ALARMS

Threshold tag name	Type	Address	Value	Unit	Action
TT_4011_01_LIM_AH	REAL	400688	1	(ºC)	Displays alarm on HMI Compare to the set pont
TT_4011_01_LIM_AHH	REAL	400690	2	(ºC)	Displays alarm on HMI Compare to the set pont
TT_4011_01_LIM_AL	REAL	400692	-1	(ºC)	Displays alarm on HMI Compare to the set pont. Action will be defined after with the close loop
TT_4011_01_LIM_ALL	REAL	400694	-2	(ºC)	Displays alarm on HMI Compare to the set pont

Figure 49 : Feeding tank Temperature Control – THRESHOLD

2.15. Harvesting Tank Temperature Control (CL4012)



2.15.1.Function

Depending on the bioreactor level control, the effluent tank collects exceed of medium and Arthrospira Platensis. Before using it as food, the mixture is conserved at a low temperature. This is done by MPP cold water utilities. The cold water, managed by a Boolean valve, circulates inside the effluent tank jacket. Even if the current MPP utilities do not permit to reach this set point, a controller maintains the temperature to the minimum reachable temperature (around 10°C).

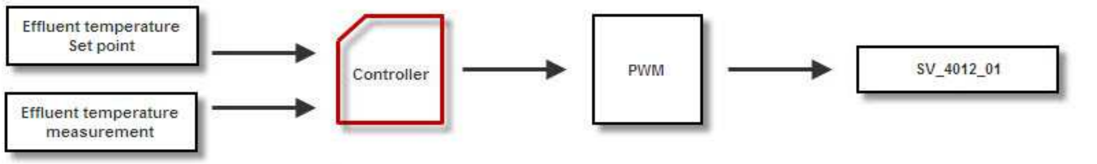
PLC Section name	Equipment tag	Type	Address	Comment
CL4012_Harvesting_Temp	SV_4012_01_FB	DI	100089	Feed back of Cooling water effluent tank valve
CL4012_Harvesting_Temp	SV_4012_01_MV	DO	000085	Feed back of Cooling water effluent tank valve
CL4012_Harvesting_Temp	TT_4012_01	AI ->REAL	400174	Vessel Temp.

Figure 50: Harvesting tank Temperature Control – EQUIPMENTS

PLC Section name	Equipment tag	Type	Address	Comment
CL4012_Harvesting_Temp	CL4012_ControlLoop_Mode	INT	400302	Feeding Tank Temperature Control
CL4012_Harvesting_Temp	TT_4012_SP	REAL	400236	Harvesting Tank Temp. Set Point
CL4012_Harvesting_Temp	SV_4012_01_OP	BOOL	000169	Valve ON/OFF Only in Manual Mode

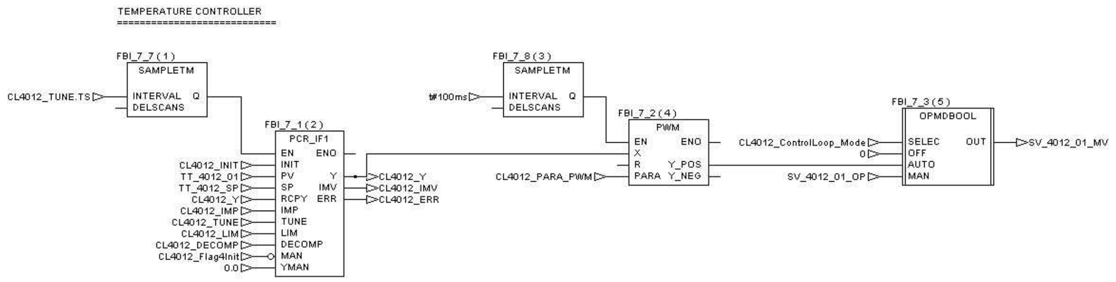
Figure 51 : Harvesting tank Temperature Control – OPERATOR INPUTS

2.15.2.Block Diagram

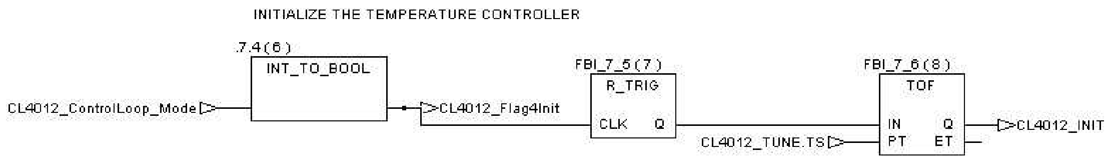


A predictive block “IF1” controls the Influent temperature (for more details on the block, see annex D). The signal is then converted into time by a PWM block because the controlled equipment is a Boolean valve. For more details on PWM block, see annex G.

2.15.2.1. *Controller*



2.15.2.2. *Controller initialization*



2.15.2.3. *Controller Parameter*

Controlled Variable	PCR CONTROLER TYPE	DEAD ZONE	ZTR Zone Control	PWM	SAMPLETM	PROCESS VALUE (input)	SET POINT

SV_4012_01	IF1	NO	NO	CL4012_PARAPWM t_period : 30s t_pause : 0s t_brake : 0s t_min : 2s t_max : 30s up_pos : 1 up_neg : 0	CL4012_TUNE.TS	TT_4012_01	TT_4012_SP

INTERNAL MODEL PROCESS	**TUNE**	**LIMIT**	**SELF_CMP**	**DECOMP**	**Manipulated Variable (Controller Output in Auto Mode)**	**Controlled Equipment**
KM : -0.0005 TM : 630s DM :0s	TS : 30s H : 200s TRBF : 30m	CL4012_LIM Y_MIN: 0 Y_MIN: 1 YRATE: 1	NO	30m	CL4012_Y	SV_4012_01_MV

2.15.3.Alarms and Thresholds

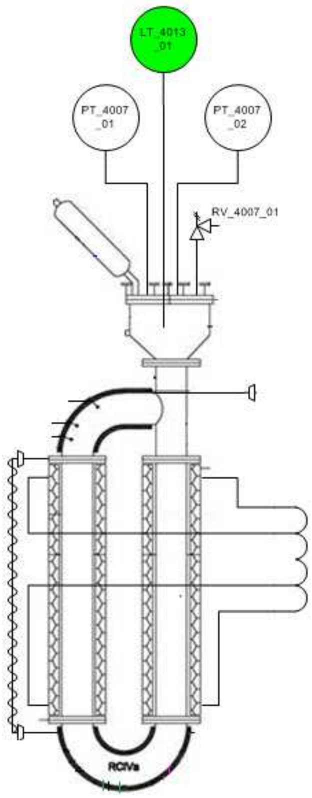
Alarm tag Name	type	Address	description
SV_4012_01_A	BOOL	000307	Valve in alarm / No feed back received
TT_4012_01_AH	BOOL	000308	High temperature alarm in effluent tank
TT_4012_01_AHH	BOOL	000309	Very high temperature alarm in effluent tank
TT_4012_01_AL	BOOL	000310	Low temperature alarm in effluent tank
TT_4012_01_ALL	BOOL	000311	Very low temperature alarm in effluent tank
TT_4012_01_ERR	BOOL	000145	Vessel Temp. Sensor Link Error

Figure 52 : Harvesting tank Temperature Control – ALARMS

Threshold tag name	Type	Address	Value	Unit	Action
TT_4012_01_LIM_AH	REAL	400696	1	(ºC)	Displays alarm on HMI Compare to the set pont
TT_4012_01_LIM_AHH	REAL	400698	2	(ºC)	Displays alarm on HMI Compare to the set pont. Action will be defined after with the close loop
TT_4012_01_LIM_AL	REAL	400700	-1	(ºC)	Displays alarm on HMI Compare to the set pont
TT_4012_01_LIM_ALL	REAL	400702	-2	(ºC)	Displays alarm on HMI Compare to the set pont

Figure 53 : Harvesting tank Temperature Control – THRESHOLDS

2.16. Antifoam control (CL4013)



2.16.1.Function

PLC Section name	Equipment tag	Type	Address	Comment
CL4013_Antifoam	LS_4013_01	DI	100081	Foam measurement

Figure 54 : Antifoam Control – EQUIPMENTS

No Operator inputs

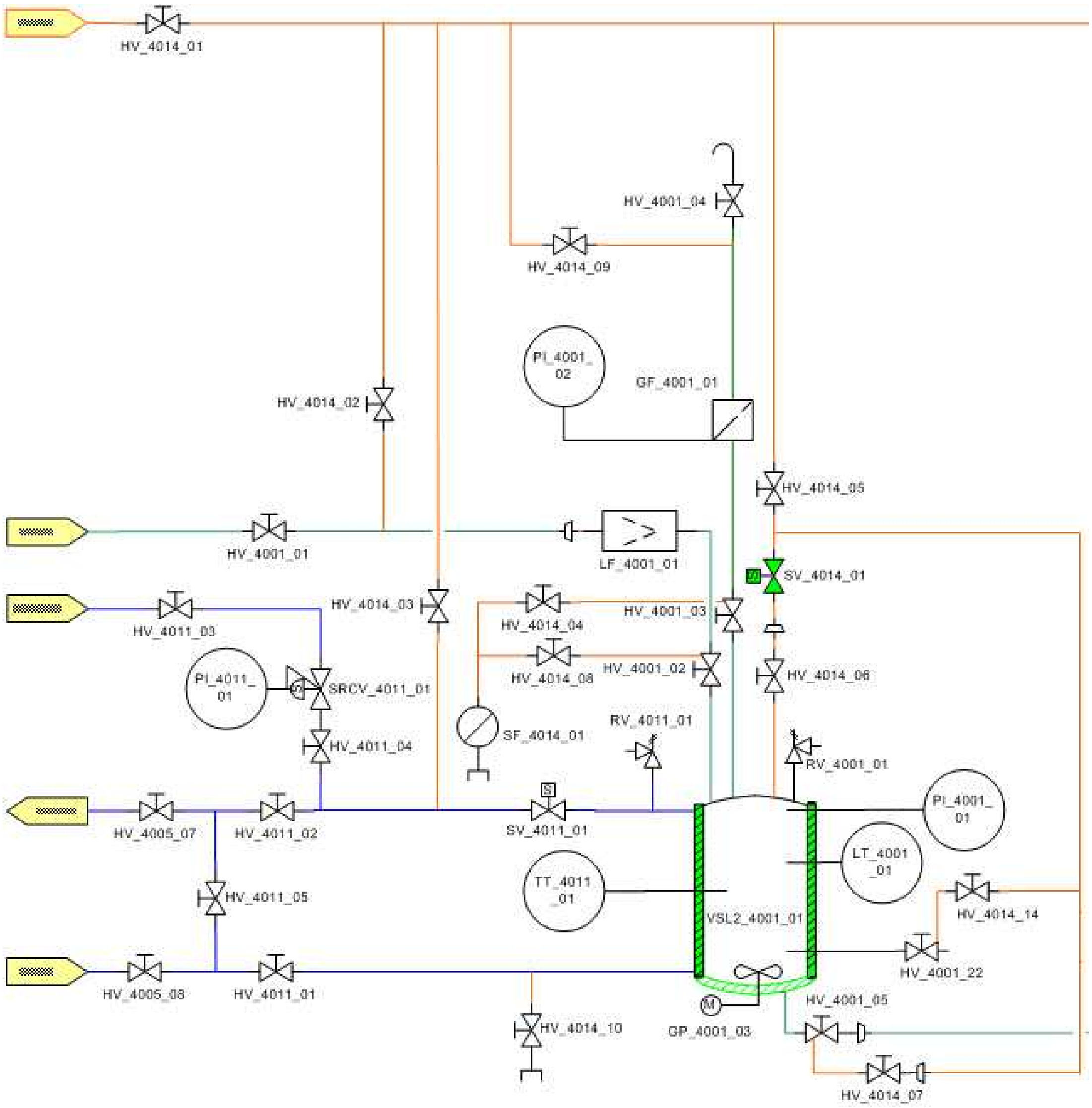
2.16.2.Block Diagram

No software implementation

2.16.3.Alarms and Thresholds

No alarms thus no threshold.
To be discussed when some test will be performed

2.17. Feeding Tank Sterilization (CL4014)



2.17.1.Function

PLC Section name	Equipment tag	Type	Address	Comment
CL4014_Feeding_Sterilization	SV_4014_01_FB	DI	100088	Steam inlet valve Feed back
CL4014_Feeding_Sterilization	SV_4014_01_MV	DO	000086	Steam inlet valve

Figure 55 : Feeding Tank Sterilization – EQUIPMENTS

PLC Section name	Equipment tag	Type	Address	Comment
CL4014_Feeding_Sterilization	CL4014_ControlLoop_Mode	INT	400269	Feeding Tank Sterilization Control
CL4014_Feeding_Sterilization	SV_4014_01_OP	BOOL	000327	Valve ON/OFF Only in Manual Mode

Figure 56: Feeding Tank Sterilization – OPERATOR INPUTS

2.17.2.Block Diagram

No software implementation

2.17.3.Alarms and Thresholds

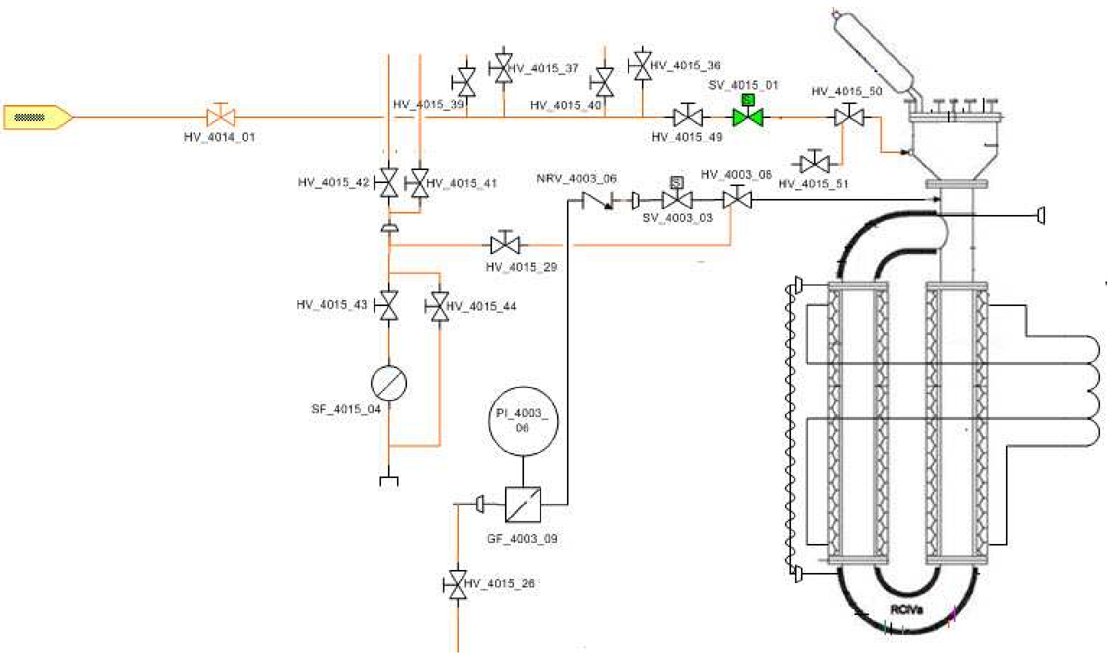
Alarm tag Name	type	Address	description
SV_4014_01_A	BOOL	000312	Valve in alarm / No feed back received

Figure 57 : Feeding Tank Sterilization – ALARMS

Threshold tag name	Type	Address	Value	Unit	Action
FB_TIME_LIM	TIME	400704	5	seconds	Display alarm on HMI

Figure 58 : Feeding Tank Sterilization – THRESHOLDS

2.18. PBR Tank Sterilization (CL4015)



2.18.1.Function

PLC Section name	Equipment tag	Type	Address	Comment
CL4015_PBR_Sterilization	SV_4015_01_FB	DI	100098	Steam inlet valve Feed back
CL4015_PBR_Sterilization	SV_4015_01_MV	DO	000092	Steam inlet valve

Figure 59: PBR Tank Sterilization – EQUIPMENTS

PLC Section name	Equipment tag	Type	Address	Comment
CL4015_PBR_Sterilization	CL4015_ControlLoop_Mode	INT	400271	Harvesting Tank Sterilization Control
CL4015_PBR_Sterilization	SV_4015_01_OP	BOOL	000328	Valve ON/OFF Only in Manual Mode

Figure 60: PBR Tank Sterilization – OPERATOR INPUTS

2.18.2.Block Diagram

No software implementation

2.18.3.Alarms and Thresholds

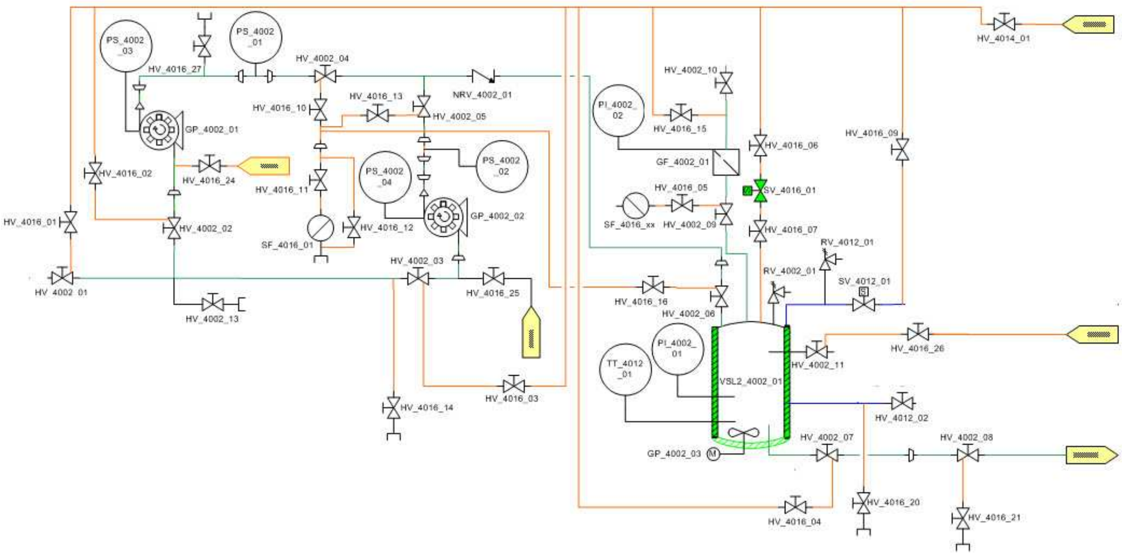
Alarm tag Name	type	Address	description
SV_4015_01_A	BOOL	000313	Valve in alarm / No feed back received

Figure 61 : PBR Tank Sterilization – ALARMS

Threshold tag name	Type	Address	Value	Unit	Action
FB_TIME_LIM	TIME	400704	5	seconds	Display alarm on HMI

Figure 62 : PBR Tank Sterilization – THRESHOLDS

2.19. Harvesting Tank Sterilization (CL4015)



2.19.1.Function

PLC Section name	Equipment tag	Type	Address	Comment
CL4016_Harvesting_Sterilization	SV_4016_01_FB	DI	100090	Steam inlet valve Feed back
CL4016_Harvesting_Sterilization	SV_4016_01_MV	DO	000084	Steam inlet valve

Figure 63: Harvesting Tank Sterilisation – EQUIPMENTS

PLC Section name	Equipment tag	Type	Address	Comment
CL4016_Harvesting_Sterilization	CL4016_ControlLoop_Mode	INT	400273	Harvesting Tank Sterilization Control
CL4016_Harvesting_Sterilization	SV_4016_01_OP	BOOL	000329	Valve ON/OFF Only in Manual Mode

Figure 64: Harvesting Tank Sterilisation – OPERATOR INPUTS

2.19.2.Block Diagram

No software implementation

2.19.3.Alarms and Thresholds

Alarm tag Name	type	Address	description
SV_4016_01_A	BOOL	000314	Valve in alarm / No feed back received

Figure 65 : Harvesting Tank Sterilisation – ALARMS

Threshold tag name	Type	Address	Value	Unit	Action
FB_TIME_LIM	TIME	400704	5	seconds	Display alarm on HMI

Figure 66 : Harvesting Tank Sterilisation – THRESHOLDS

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.

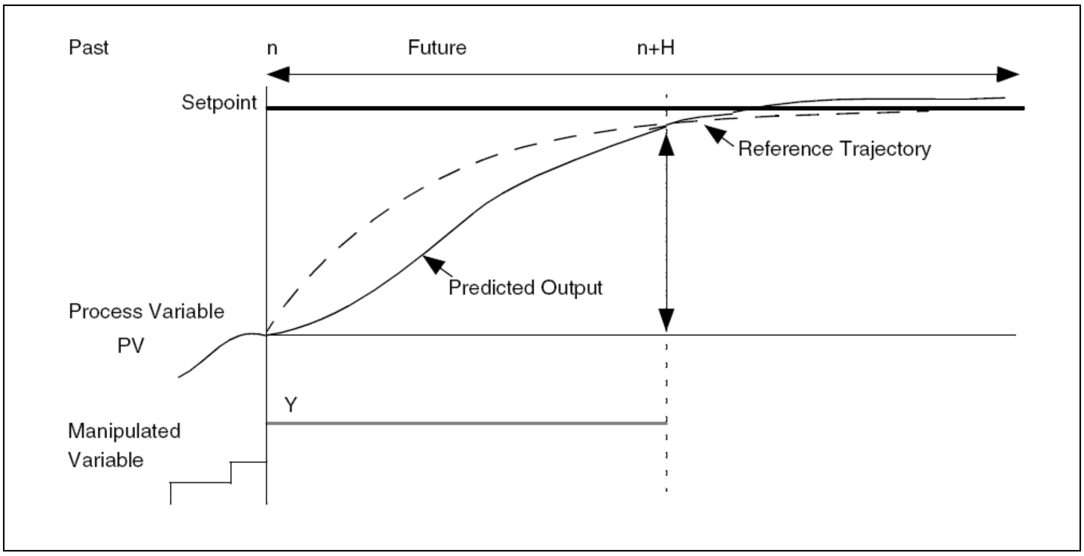


Figure 67: Future desired trajectory

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 **Erreur ! Source du renvoi introuvable.**):

- 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:

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

Figure 68: 1st order model

Representation

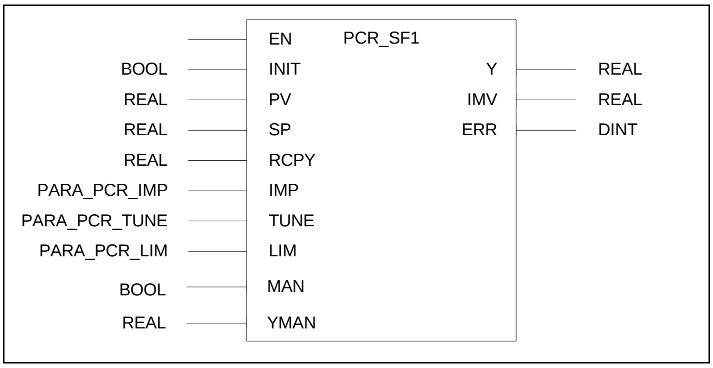


Figure 69: PCR_SF1 block

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:

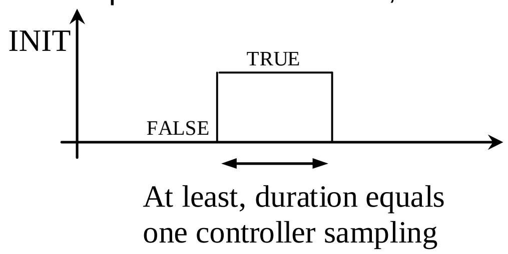


Figure 70: Initialisation

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

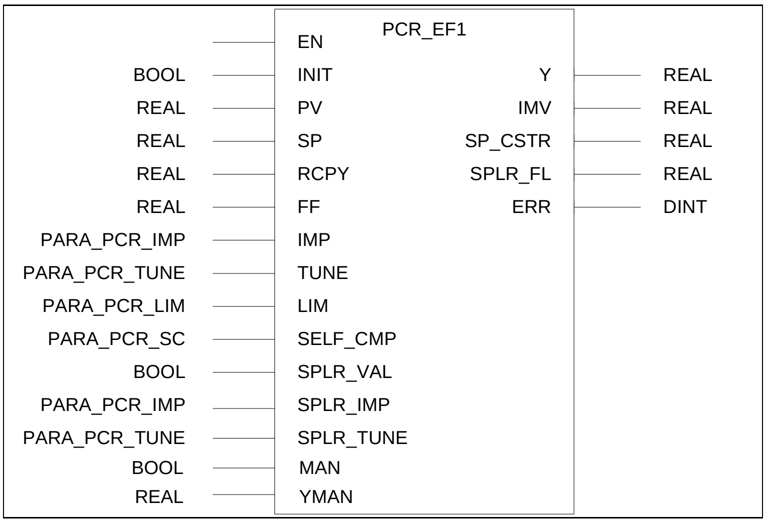


Figure 71: PCR_EF1 block

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.

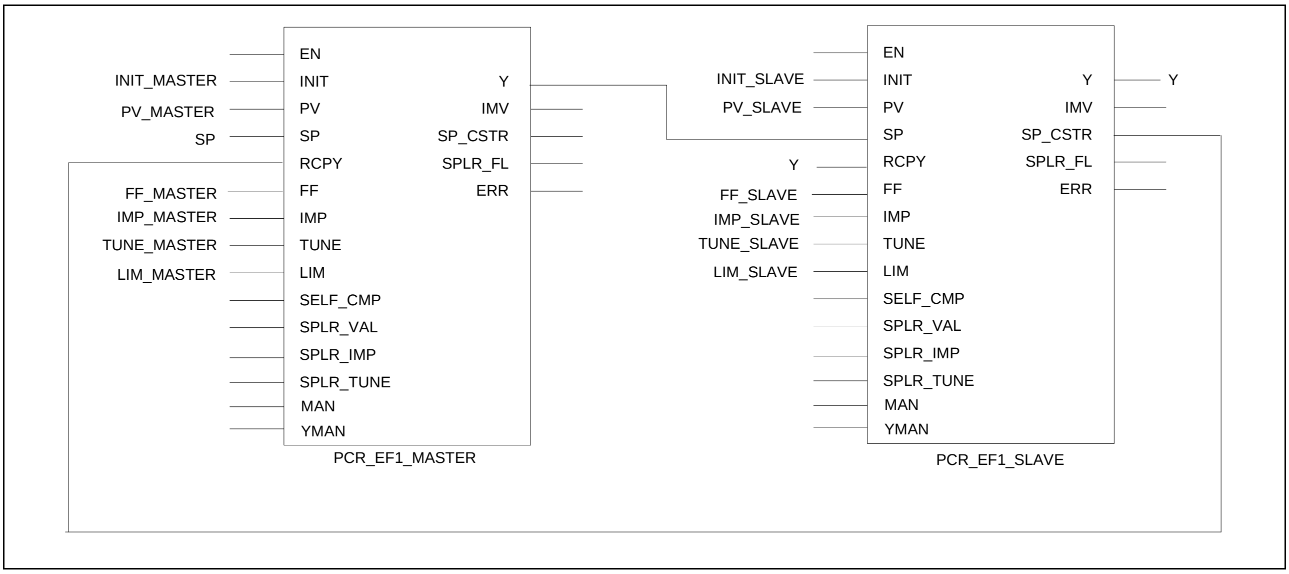


Figure 72: Example of cascade configuration, using PCR_EF1 blocks

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 73):

- 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:

$$u \longrightarrow \boxed{\frac{KM}{s\cdot(1+TM.s)}\cdot e^{-DM\cdot s}} \longrightarrow y_m$$

Figure 73: 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

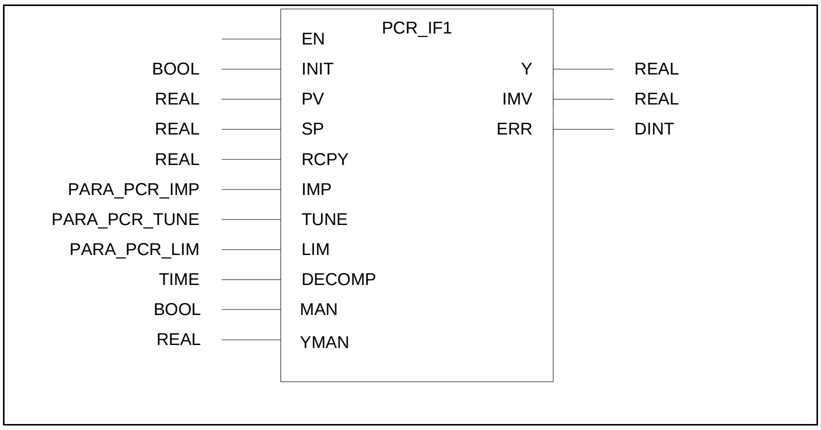


Figure 74: PCR_IF1 block

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_ EIF1

Enhanced controller: Integrative First order process with Feed-Forward, constraint transfer, ramp set point (PCR_EIF1)
Brief Description

PCR_EIF1 is an EFB for enhanced control of integrative first order process with pure time delay.
PCR_EIF1 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 :

- 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 between : 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

Compared to PCR_IF1, PCR_EIF1 provides the following additional functions:

FEED FORWARD COMPENSATION: to take in account a disturbance variable (issued from a disturbance modelling (see PCR_IFF1) or from an other controller)

CONSTRAINTS TRANSFERRING

Follow up of ramp set points

Note for initialization:
When the process variable PV varies as a ramp before switching on the controller, it is necessary to identify 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.

Symbol

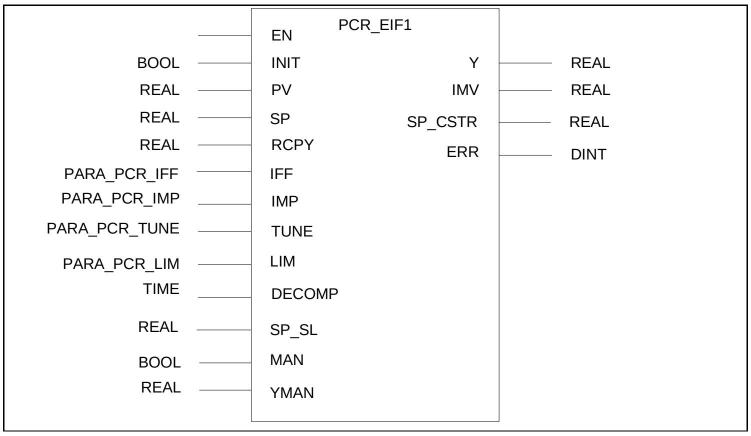


Figure 75: PCR_EIF1 block

Parameters Description

Inputs:		
Parameter	**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
IFF	PARA_PCR_IFF	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
DECOMP	TIME	Decomposition time constant
SP_SL	REAL	Slope (in unit per second) of the future set point
MAN	BOOL	TRUE = Manual mode
YMAN	REAL	Manual Manipulated Variable

Outputs:		
Parameter	**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
ERR	DINT	ERRor code

Type Description

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

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

PARA_PCR_IFF : Feed-Forward Compensation		
Parameter	**Type**	**Meaning**
IFF1	REAL	Feed-forward compensation for process output estimation
IFF2	REAL	Feed-forward compensation at the coincidence point

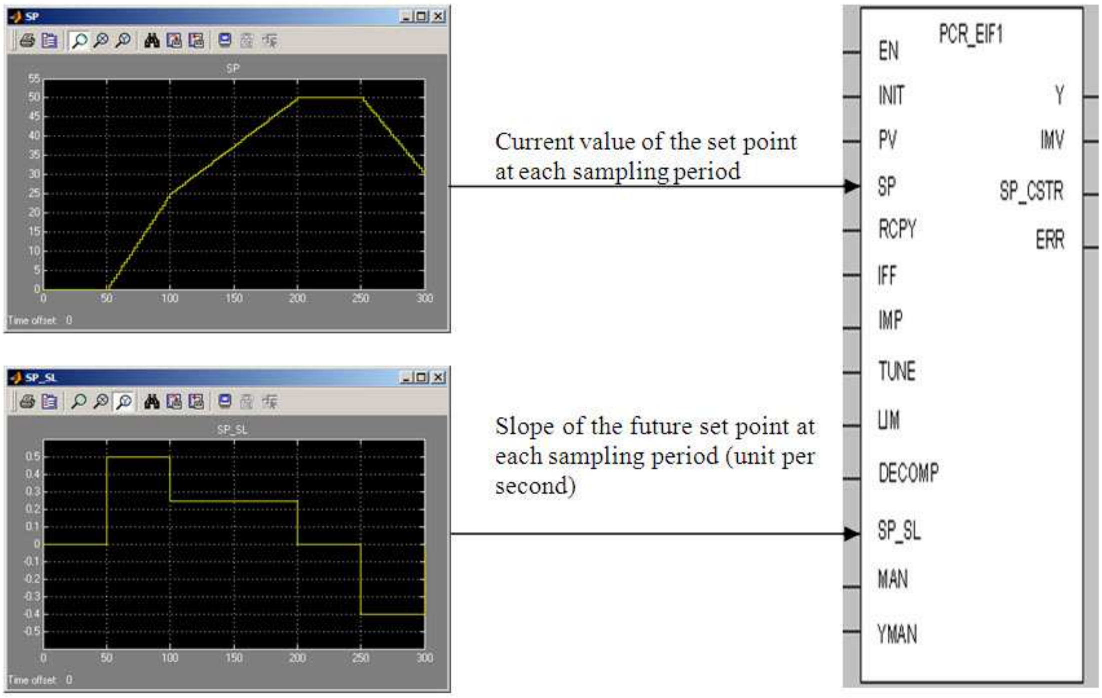
PARA_PCR_LIM : LIMitations on manipulated variable Y		
Parameter	**Type**	**Meaning**
YMIN	REAL	MINimum value for Y
YMAX	REAL	MAXimum value for Y
YRATE	REAL	Maximum variation for Y (in unit per second)

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.

Configuration of EIF1 in case of ramp set point



Annex F: 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.

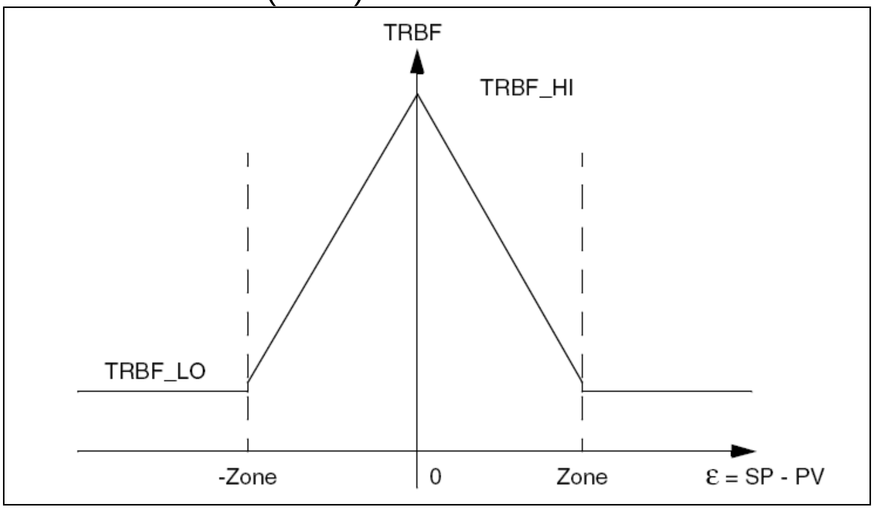


Figure 76: Evolution of TRBF

Representation

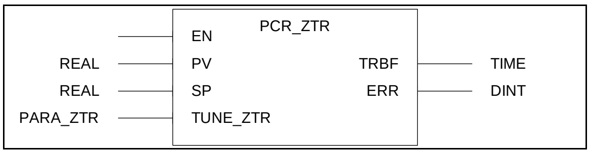


Figure 77: PCR_ZTR block

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.

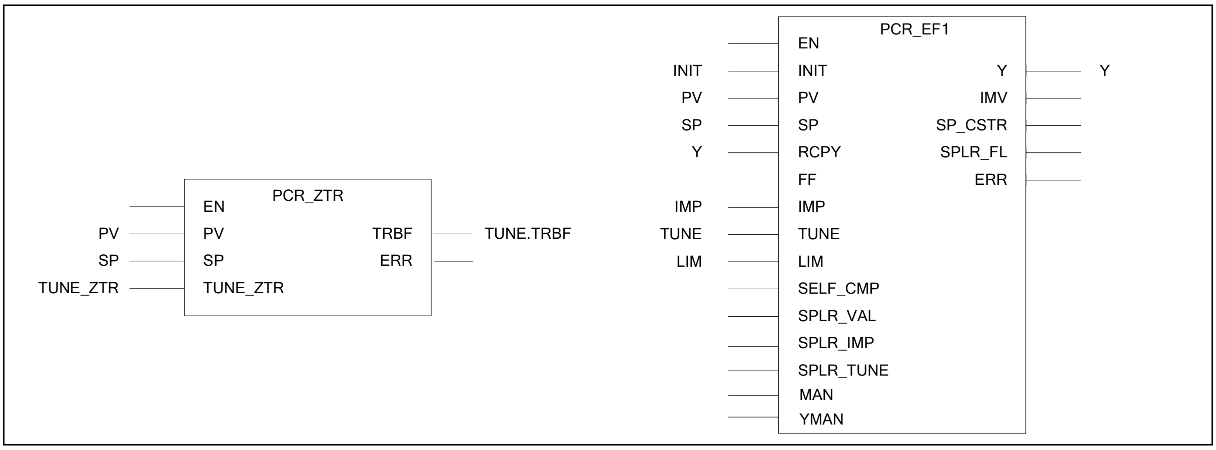


Figure 78: Use of zone control with a PCR_EF1 block

Annex G: PWM Block

Brief description

Block usage

Actuators are driven not only by analog quantities, but also through binary actuating signals. The conversion of analog values into binary output signals is achieved for example, through pulse width modulation (PWM) or pulse duration modulation (PDM).In this context, the preset mean energy level of the actuator is to correspond to the analog input value (X) of the block.

Function description

The function block PWM serves to convert analog values into digital output signals for Concept. In pulse width modulation (PWM), a 1-signal is emitted, at a constant clock rate, for a duration that is a function of the analog value. The adjusted average energy corresponds to the quotient of the fixed duty cycle T_on and the variable cycle period. In order that the adjusted average energy also corresponds to the analog input variable X, the following must apply:

$T\_on \sim X$

EN and ENO can be projected as additional parameter

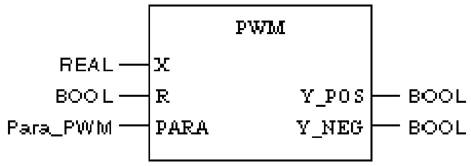
Display

General information about the actuator drive

In general, the binary actuator drive is performed by two binary signals Y_POS and Y_NEG. On a motor the output Y_POS corresponds to the signal "clockwise rotation" and the output Y_NEG the signal "counter-clockwise rotation". For an oven the outputs Y_POS and Y_NEG could be interpreted as corresponding to "heating" and "cooling". Should the actuating drive in question be a motor, it is possible that to avoid over travel for non-self-locking gearboxes, a brake pulse must be output after the engage signal. In order to protect the power electronics, there must be a pause time after switching on T_on and before the brake impulse t_brake so as to avoid short circuits.

Symbol

Block display



PWM parameter description

Block parameter description

Parameter	Data type	Meaning
X	REAL	Input variable
R	BOOL	Reset mode ("1" = Reset)
PARA	Para_PWM	Parameter
Y_POS	BOOL	Positive X value output
Y_NEG	BOOL	Negative X value output

Parameter description Para_PWM

Data structure description

Element	Data type	Meaning
t_period	TIME	Length of period
t_pause	TIME	Pause time
t_brake	TIME	Braking time
t_min	TIME	Minimum actuating pulse time (in sec)
t_max	TIME	Maximum actuating pulse time (in sec)
up_pos	REAL	Upper limiting value for positive X values
up_neg	REAL	Upper limiting value for negative X values

Formulas

The pulse length for Y_POS and Y_NEG

The pulse length T_on for output Y_pos amd Y_neg is determined by the following equations:

Output	Formula	Condition
Y_POS	$T\_on = t\_period \times \frac{X}{up\_pos}$	$0 \leq X \leq up\_pos$
Y_NEG	$T\_on = t\_period \times \frac{\lvert X \rvert}{up\_neg}$	$up\_neg \leq -X \leq 0$

Parametering rule

For correct operation the following rules should be observed:

- $(2 \times t\_pause + t\_brake + t\_max) \leq t\_period$
- From the parameters up_pos and up_neg only the value is evaluated.

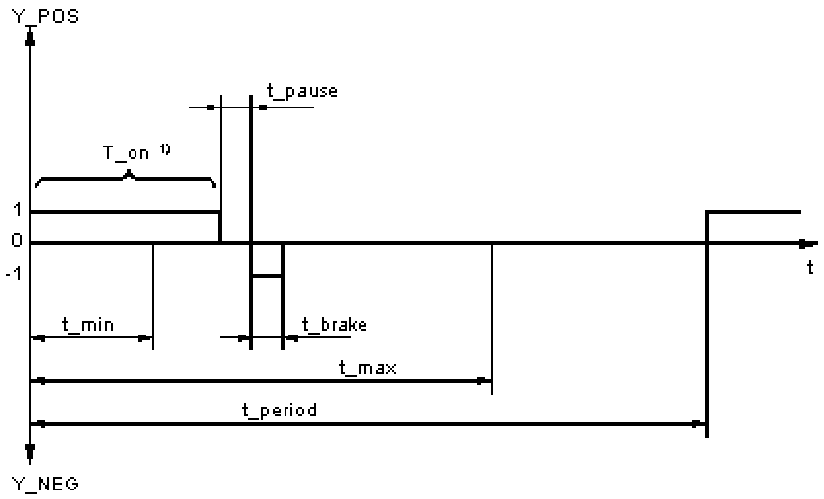
Detailed description

Block mode of operation

The period determines the time, in which the actuating pulses ("1" signal on output Y_POS resp. Y_NEG) are regularly output, i.e. in a constant time-slot pattern. The parameter t_min specifies the minimum pulse length, i.e. the shortest time span for which the output Y_POS and/or Y_NEG should carry "1" signal. If the length of impulse calculated according to the equation in the section "Formulas" is shorter than t_min, then there will be no impulse throughout the whole period. The parameter t_max specifies the minimum pulse length, i.e. the shortest time span in which the output Y_POS resp. Y_NEG should carry "1" signal. Pulse output length is then limited to t_max, should the pulse duration calculated by the above stated formula be greater. It is advisable to perform a freely definable pause time of t_pause = 10 or 20 ms between the actuating and brake pulses to protect the power electronics (hopefully preventing simultaneous firing of the anti parallel connected thyristors).Parameter t_pause specifies the time interval that should be waited after the "1" signal on output Y_POS (Y_NEG), before the opposite output Y_NEG (Y_POS) goes to "1" signal for time span t_brake. The action in question here is a brake pulse, which should take place after the pause time. A pause time of t_pause = 20 ms (t_pause =0.02) corresponds to an interruption of the firing angle control for two half waves. That should guarantee a sufficiently large safety margin for the prevention of short-circuits resp. triggering of the suppressor circuitry as a consequence of antiparallel thyristors firing.

Time ratios display

An overview of the ratios between times is shown in the following diagram:



1 Variable turn-on time. The parameter up_pos mark those positive values of input variable X, for which output Y_POS would continuously carry "1", assuming:

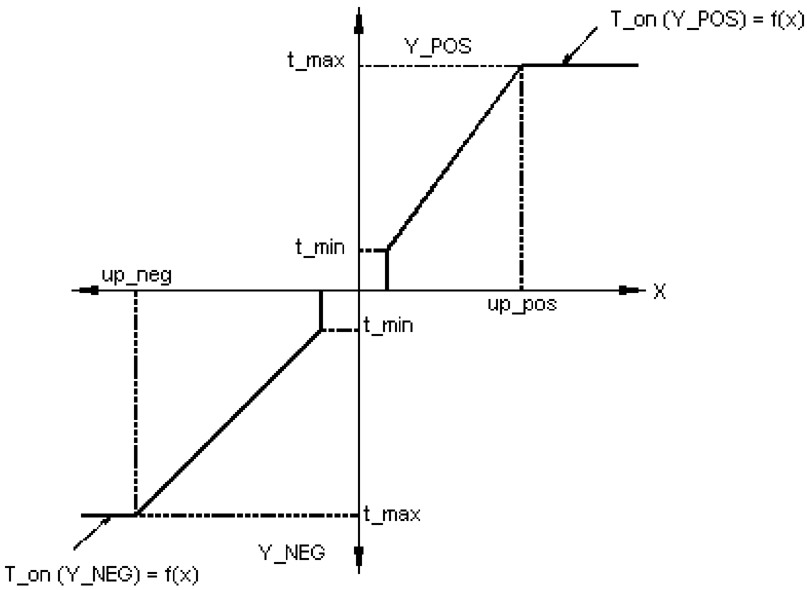
t_pause = t_brake = 0 and t_max = t_period.

The parameter up_neg mark those positive values of input variable X, for which output Y_NEG would continuously carry "1", assuming:

t_pause = t_brake = 0 and t_max = t_period.

Time-span dependency

The dependency of the time duration in which the output Y_POS (Y_NEG) carries a 1-signal, on the input variable X is illustrated in the following diagram (again the figure has put t_pause = t_brake = 0)



Operating mode

In reset mode R = "1", outputs Y_POS and Y_NEG are set to "0" signal. The internal time meters are also standardized, so that the function block begins the transfer to R=0 with the output of a new 1 signal on the associated output.

Boundary conditions

If the PWM block is operated together with a PID controller, then the period t_period should be so selected, that it corresponds to the PID controller's scan time. It is then guaranteed that every new actuating signal from the PID controller within the period time can be fully processed. The PDM scan time should be in proportion with the period vs. pulse time. Though this the smallest possible actuating pulse will be specified. The following ratio is recommended:

t_period/scan time (PWM) >= 10

Example for the PWM block

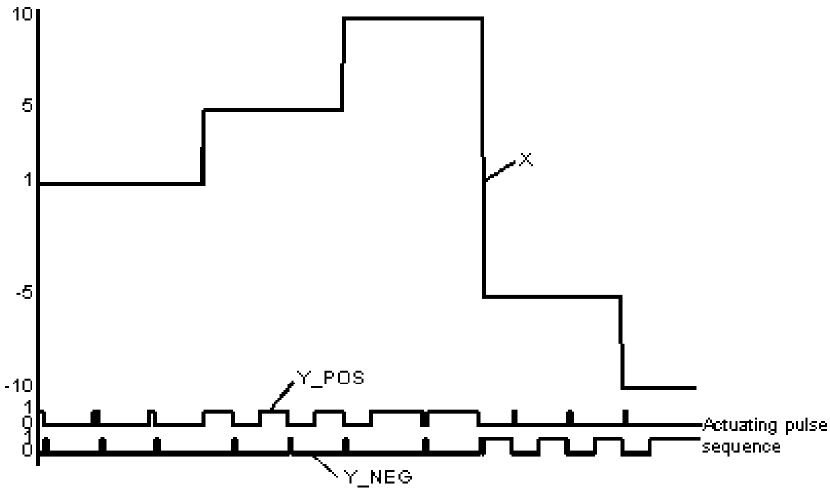
Overview
In the examples, the signal sequences on the outputs Y_POS and Y_NEG are shown for various X input signal values. The examples differ with respect to their selected parameter assignments. The following examples on the PMW function block are to be found in this section
Step Response 1
Step Response 2

Step Response 1

The following parameter specifications apply to the step response 1 display:

Parameter	Settings
t_period	4 s
t_min	0,2 s
t_max	3,8 s
t_pause	0.1 s
t_brake	0.2 s
up_pos	10
up_neg	10

Step Response 1 timing diagram



X analog signal

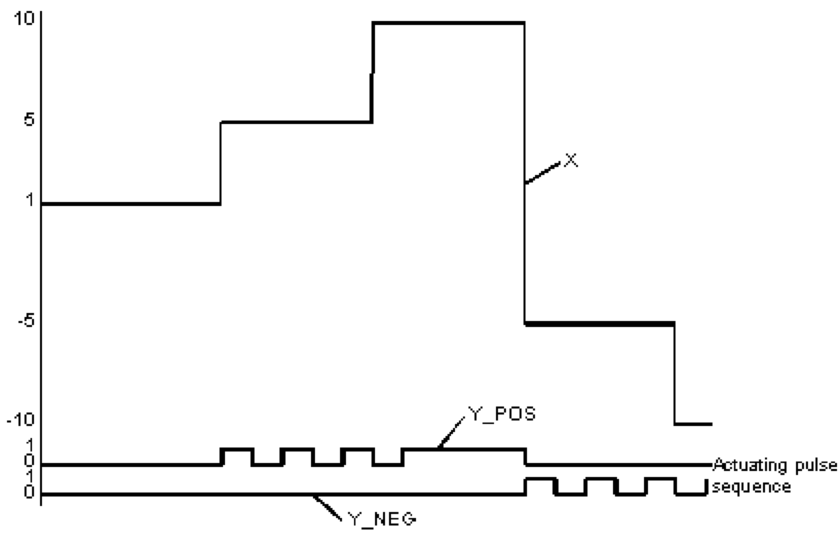
It is easily seen that the time span in which output Y_POS carries "1" signal is directly proportional to input signal X. In addition, it can be seen that a short Y_NEG-signal follows every Y_POS signal, and vice versa. This can be attributed to the non-"0" t_brake parameter. Y_NEG output time span is directly proportional to negative X input signal values. A short Y_POS pulse as brake pulse also follows the Y_NEG pulse here as well.

Step Response 2

The following parameter specifications apply to the step response 2 display:

Parameter	Settings
t_period	4 s
t_min	0.5 s
t_max	4 s
t_pause	0 s
t_brake	0 s
up_pos	10
up_neg	10

Step Response 2 timing diagram



X analog signal

The difference to the example "step response 1" is, that here the pause and brake pulses are dropped, as here the appropriate parameters were configured to "0". It is noticeable that pulses are no longer output for very small X input signals. This is directly attributable to the effect of time t_min.

Moreover a continuous pulse is output for large X input signals (X = up_pos or up_neg). This is related to having selected t_max = t

Annex H: Control Requirements

Hereafter are the requirements from an automatic point of view.

Control Loop number	Description	Objective	Performances
4000	CIVa Bioreactor lighting control	Control Lights Intensity	133 W/m² +/- 3 W/m²
4001	Inlet liquid flow control	Control Liquid Flow Rate (between 0.15 and 0.6 L/H)	Flow = 0.77 L/h ?? +/- Time Response TBD
4002	Outlet liquid flow control	Flow Control in cascade with 4008, level control	Accuracy linked to Level control accuracy
4003	Inlet gas flow control	Control gas inlet, with air process, recycle flow	Recycle Gas = 2.2 nL/min
4004	Outlet gas flow control	Flow Control	Accuracy linked to Pressure accuracy
4005	Bioreactor temperature control	Control PBR temperature	T = 36 ℃ +/- Time Response TBD
4006	Bioreactor pH control	Control pH in the PBR	pH = 9.5 +/- 0.1 Time Response TBD
4007	Bioreactor pressure control	Control Pressure into the PBR (with CL 4004)	P < 80 mbar +/- 1 mbar Time Response TBD
4008	Bioreactor liquid level control	Level controlled with Outlet Liquid	Level = 77 L +/- Time Response TBD
4009	Bioreactor biomass production control	Control Biomass Production and Concentration	Biomass_Conc = 1 g/L +/- 5% Biomass_Prod = 10 mg/L/h
4010	Bioreactor outlet gas composition control	Not Yet Implemented	
4011	Feeding tank temperature control	Control the temp. or maintain it lower than …	T < TBD
4012	Harvesting tank temperature control	Control the temp. or maintain it lower than …	T < TBD
4013	Antifoam control	No Control	
4014	Feeding tank sterilization		
4015	CIVa Bioreactor sterilization		
4016	Harvesting tank sterilization		

N/A : Non Available

Project Number:

Creation Date: 10/06/2009 11:52:16

Modification Date: 07/03/2011 13:34:04

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    : 13/01/2011 15:42:43
PLC related version : 13/01/2011 15:42:43
Global DFB Path     : D:\CIV_PL~1\V00_09\GLB\
Secure Application  : No
```

Project structure

Project : CIVA

- Group:Data
  - FBD:Inputs
  - FBD:Outputs
  - FBD:Err_AI
- Group:Control_Loops
  - FBD:EMERGENCY_BUTTON
  - FBD:ALARM_STATUS
  - FBD:System_Clock
  - FBD:CL4000_Lights
  - FBD:CL4001_Inlet_Liquid_Flow
  - FBD:CL4002_Outlet_Liquid_Flow
  - FBD:CL4003_Inlet_Gas_Flow
  - FBD:CL4004_Oulet_Gas_Flow
  - FBD:CL4005_PBR_Temp
  - FBD:CL4006_pH
  - FBD:CL4007_PBR_Pressure
  - FBD:CL4008_PBR_Liquid_Level
  - FBD:CL4009_Biomass
  - FBD:CL4010_OutletGasCompo
  - FBD:CL4011_Feeding_Temp
  - FBD:CL4012_Harvesting_Temp
  - FBD:CL4013_Antifoam
  - FBD:CL4014_Feeding_Sterilization
  - FBD:CL4015_PBR_Sterilization
  - FBD:CL4016_Harvesting_Sterilization

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)	512	300001-300512
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	400400 - 400407
Duplicate coils	No
First Coil Address	-
Watchdog Timeout [ms*10]	30
Online Editing Timeslice [ms]	20

Segment Scheduler						
Schedule	Type of Solve	Reference	Sense	Segment	Drop Input	Drop Output
1	Continuous			1	1	1
2	End of Logic			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	172.016.000.141	255.255.255.000	172.016.000.141	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 0)

Drop	Type	Modules	Holdup [ms]	Input-Bits	Output-Bits	Status Reg.	Activate
1	Quantum I/O	15	300	880	424		-

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	ACI-030-00	300100-300108		Analog Input 8 Ch unipolar		
1-5	AVI-030-00	300109-300117		Analog Input 8 Ch bipolar		
1-6	AVO-020-00		400100-400103	Analog Output 4 Ch Volt		
1-7	AVO-020-00		400104-400107	Analog Output 4 Ch Volt		
1-8	ACO-130-00		400108-400115	Analog Output 8 Ch Current		
1-9	DDM-390-00	100065-100080	000065-000072	DC Input/Output 24V 16/8	BIN BIN	0000
2-1	CPS-114-x0			AC PS 115V/230 8A, CPS114-10 summab>		
2-2	DDI-353-00	100081-100112		DC Input 24V 4x8	BIN	
2-3	DDO-353-00		000081-000112	DC Output 24V 4x8	BIN	0000 0000
2-4	ACI-040-00	300118-300134		Analog Input 16 Ch Current		
2-5	ACI-040-00	300135-300151		Analog Input 16 Ch Current		
2-6	ACO-130-00		400116-400123	Analog Output 8 Ch Current		

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

Data Format: 16-Bit Format

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

Parameter AVO-020-00 (Slot 1-6)

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

Parameter AVO-020-00 (Slot 1-7)

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

Parameter ACO-130-00 (Slot 1-8)

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

Parameter ACI-040-00 (Slot 2-4)

Channel	Range	Channel	Range
1	4..20mA, 0-16000	9	4..20mA, 0-16000
2	4..20mA, 0-16000	10	4..20mA, 0-16000
3	4..20mA, 0-16000	11	4..20mA, 0-16000
4	4..20mA, 0-16000	12	4..20mA, 0-16000
5	4..20mA, 0-16000	13	4..20mA, 0-16000
6	4..20mA, 0-16000	14	4..20mA, 0-16000
7	4..20mA, 0-16000	15	4..20mA, 0-16000
8	4..20mA, 0-16000	16	4..20mA, 0-16000

Parameter ACI-040-00 (Slot 2-5)

Channel	Range	Channel	Range
1	4..20mA, 0-16000	9	4..20mA, 0-16000
2	4..20mA, 0-16000	10	4..20mA, 0-16000
3	4..20mA, 0-16000	11	4..20mA, 0-16000
4	4..20mA, 0-16000	12	4..20mA, 0-16000
5	4..20mA, 0-16000	13	4..20mA, 0-16000
6	4..20mA, 0-16000	14	4..20mA, 0-16000
7	4..20mA, 0-16000	15	4..20mA, 0-16000
8	4..20mA, 0-16000	16	4..20mA, 0-16000

Parameter ACO-130-00 (Slot 2-6)

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

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_4006	VAR	REAL	400828		pH to be controlled after selection between the 2 probes	9
AT_4006_01	VAR	REAL	400138		pH Probe 1	6
AT_4006_01_ERR	VAR	BOOL	000128		pH1 Link Error	4
AT_4006_01_MAX	VAR	REAL		12.0	pH Probe 1 Scale MAX	1
AT_4006_01_MIN	VAR	REAL		0.0	pH Probe 1 Scale MIN	1
AT_4006_02	VAR	REAL	400142		pH Probe 2	6
AT_4006_02_ERR	VAR	BOOL	000130		pH2 Link Error	4
AT_4006_02_MAX	VAR	REAL		12.0	pH Probe 2 Scale MAX	1
AT_4006_02_MIN	VAR	REAL		0.0	pH Probe 2 Scale MIN	1
AT_4006_AVG	VAR	REAL	400318			4
AT_4006_Delta	VAR	REAL			Delta pH to SP	0
AT_4006_SENSOR_DEVIATION_A	VAR	BOOL	000336			2
AT_4006_SENSOR_DEVIATION_LIM	VAR	REAL	400708	0.5		2
AT_4006_SP	VAR	REAL	400224	9.7	pH Set Point	7
AT_4009_01	VAR	REAL	400124		Biomass Probe 1	7
AT_4009_01_AH	VAR	BOOL	000265			2
AT_4009_01_AHH	VAR	BOOL	000266			2
AT_4009_01_AL	VAR	BOOL	000267			2
AT_4009_01_ALL	VAR	BOOL	000268			2
AT_4009_01_ERR	VAR	BOOL	000135		Biomass1 Link Error	5
AT_4009_01_LIM_AH	VAR	REAL	400616	3.0		1
AT_4009_01_LIM_AHH	VAR	REAL	400618	3.5		1
AT_4009_01_LIM_AL	VAR	REAL	400620	1.2		1
AT_4009_01_LIM_ALL	VAR	REAL	400622	1.0		1
AT_4009_01_MAX	VAR	REAL		5.0	Biomass Probe 1 Scale MAX	1
AT_4009_01_MIN	VAR	REAL		0.0	Biomass Probe 1 Scale MIN	1
AT_4009_02	VAR	REAL	400126		Biomass Probe 2	7
AT_4009_02_AH	VAR	BOOL	000269			2
AT_4009_02_AHH	VAR	BOOL	000270			2
AT_4009_02_AL	VAR	BOOL	000271			2
AT_4009_02_ALL	VAR	BOOL	000272			2
AT_4009_02_ERR	VAR	BOOL	000136		Biomass2 Link Error	5
AT_4009_02_LIM_AH	VAR	REAL	400624	3.0		1
AT_4009_02_LIM_AHH	VAR	REAL	400626	3.5		1
AT_4009_02_LIM_AL	VAR	REAL	400628	1.2		1
AT_4009_02_LIM_ALL	VAR	REAL	400630	1.0		1
AT_4009_02_MAX	VAR	REAL		5.0	Biomass Probe 2 Scale MAX	1
AT_4009_02_MIN	VAR	REAL		0.0	Biomass Probe 2 Scale MIN	1
AT_4009_AVG	VAR	REAL	400310			4
AT_4009_FAILURE_IND	VAR	REAL	400128		Temp. Meas. (Biomass Sensor)	2
AT_4009_FAILURE_IND_ERR	VAR	BOOL	000137		Temp Biomass Link Error	2
AT_4009_FAILURE_IND_MAX	VAR	REAL		20.0	Temp. Meas. (Biomass Sensor) Scale MAX	1
AT_4009_FAILURE_IND_MIN	VAR	REAL		4.0	Temp. Meas. (Biomass Sensor) Scale MIN	1
AT_4009_SENSORFAILLURE	VAR	BOOL	000273			2
AT_4009_SENSORFAILLURE_LIM	VAR	REAL	400632	10.0		1
AT_4009_SP	VAR	REAL	400232		Biomass Concentration Set Point (g/l)	0
AT_4010_01	VAR	REAL	400130		CO2/O2 analyser	5
AT_4010_01_AH	VAR	BOOL	000278			2
AT_4010_01_AHH	VAR	BOOL	000279			2
AT_4010_01_AL	VAR	BOOL	000280			2
AT_4010_01_ALL	VAR	BOOL	000281			2
AT_4010_01_ERR	VAR	BOOL	000138		CO2 Link Error	2
AT_4010_01_LIM_AH	VAR	REAL	400640	450.0		1
AT_4010_01_LIM_AHH	VAR	REAL	400642	500.0		1
AT_4010_01_LIM_AL	VAR	REAL	400644	350.0		1
AT_4010_01_LIM_ALL	VAR	REAL	400646	300.0		1

table continued...

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

Variable name	Type	DType	Address	Initial value	Comment	Used
AT_4010_01_MAX	VAR	REAL		50000.0	CO2/O2 analyser Scale MAX	1
AT_4010_01_MIN	VAR	REAL		0.0	CO2/O2 analyser Scale MIN	1
AT_4010_02	VAR	REAL	400132		CO2/O2 analyser	6
AT_4010_02_AH	VAR	BOOL	000282			2
AT_4010_02_AHH	VAR	BOOL	000283			2
AT_4010_02_AL	VAR	BOOL	000284			2
AT_4010_02_ALL	VAR	BOOL	000285			2
AT_4010_02_ERR	VAR	BOOL	000139		O2 Link Error	2
AT_4010_02_LIM_AH	VAR	REAL	400648	22.0		1
AT_4010_02_LIM_AHH	VAR	REAL	400650	24.0		1
AT_4010_02_LIM_AL	VAR	REAL	400652	20.0		1
AT_4010_02_LIM_ALL	VAR	REAL	400654	19.5		1
AT_4010_02_MAX	VAR	REAL		25.0	CO2/O2 analyser Scale MAX	1
AT_4010_02_MIN	VAR	REAL		0.0	CO2/O2 analyser Scale MIN	1
AT_4010_03	VAR	REAL	400134		Dissolved O2	5
AT_4010_03_AH	VAR	BOOL	000286			2
AT_4010_03_AHH	VAR	BOOL	000287			2
AT_4010_03_AL	VAR	BOOL	000288			2
AT_4010_03_ALL	VAR	BOOL	000289			2
AT_4010_03_ERR	VAR	BOOL	000140		Dissolved O2 Link Error	2
AT_4010_03_LIM_AH	VAR	REAL	400656	90.0		1
AT_4010_03_LIM_AHH	VAR	REAL	400658	95.0		1
AT_4010_03_LIM_AL	VAR	REAL	400660	70.0		1
AT_4010_03_LIM_ALL	VAR	REAL	400662	65.0		1
AT_4010_03_MAX	VAR	REAL		100.0	Dissolved O2 Scale MAX	1
AT_4010_03_MIN	VAR	REAL		0.0	Dissolved O2 Scale MIN	1
BLWR_4003_01_MV1	VAR	BOOL	000103		Start/Stop of the blower	1
BLWR_4003_01_MV1_OP	VAR	BOOL	000156		BLOWER ON/OFF	1
BLWR_4005_01_AUTO	VAR	REAL				3
BLWR_4005_01_ERR	VAR	BOOL	100103		Thermal protection of extractor	1
BLWR_4005_01_MV1	VAR	BOOL	000099		Start/Stop of the extractor	1
BLWR_4005_01_MV1_OP	VAR	BOOL	000157		Blower ON/OFF (from HMI)	1
BLWR_4005_01_MV2	VAR	REAL	400246		Blower air	2
BLWR_4005_01_MV2_MAX	VAR	REAL		100.0	Blower air Scale MAX	1
BLWR_4005_01_MV2_MIN	VAR	REAL		0.0	Blower air Scale MIN	1
BLWR_4005_01_MV2_OP	VAR	REAL	400220		Blower Speed (User defined by HMI)	1
CIVa_Emergency_Button	VAR	BOOL	000200			2
CIVa_General_alarm_status	VAR	INT	400279	0		4
CIVA_HighLowAlarm_status	VAR	BOOL	000334			5
CIVA_SC_Activate_Setting	VAR	BOOL	000324			1
CIVA_SysClock_Day	VAR	BYTE	400411			2
CIVA_SysClock_dayofweek	VAR	BYTE	400408			1
CIVA_SysClock_dayofweek_SET	VAR	BYTE	400415			1
CIVA_SysClock_Day_SET	VAR	BYTE	400418			1
CIVA_SysClock_Hour	VAR	BYTE	400412			2
CIVA_SysClock_Hour_SET	VAR	BYTE	400419			1
CIVA_SysClock_Minute	VAR	BYTE	400413			2
CIVA_SysClock_Minute_SET	VAR	BYTE	400420			1
CIVA_SysClock_Month	VAR	BYTE	400410			2
CIVA_SysClock_Month_SET	VAR	BYTE	400417			1
CIVA_SysClock_Second	VAR	BYTE	400414			2
CIVA_SysClock_Second_SET	VAR	BYTE	400421			1
CIVA_SysClock_Year	VAR	BYTE	400409			2
CIVA_SysClock_Year_SET	VAR	BYTE	400416			1
CIVA_VeryHighLowAlarm_status	VAR	BOOL	000335			5
CL4000_Calibration	VAR	REAL		1.0	Calibration Coeff. W/m2 --> 0/100 % lights	1
CL4000_ControlLoop_Mode	VAR	INT	400268		Lightning Mode (Off/Auto/Manu)	8

table continued...

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

Variable name	Type	DType	Address	Initial value	Comment	Used
CL4000_Lights	IVAR	SECT_CTRL				0
CL4000_Light_10percent	VAR	BOOL				2
CL4000_RAMP_PARA	VAR	Para_RAMP			Ramp. for Lights 6.67 % / seconds	1
inc_rate	COMP	REAL		6.67		
dec_rate	COMP	REAL		6.67		
CL4001_Agitator_Mode	VAR	INT	400270		Agitator Mode (Off/Auto/Manu)	3
CL4001_ControlLoop_Mode	VAR	INT	400272		Inlet Flow Mode (Off/Auto/Manu)	15
CL4001_ERR	VAR	DINT				1
CL4001_Flag4Init	VAR	BOOL				0
CL4001_IMP	VAR	PARA_PCR_IMP				2
KM	COMP	REAL		0.038		
TM	COMP	TIME		t#60s		
CL4001_IMV	VAR	REAL	400824			1
CL4001_INIT	VAR	BOOL				2
CL4001_INLETPUMP_VARIATOR	VAR	BOOL	000111			12
CL4001_Inlet_Liquid_Flow	IVAR	SECT_CTRL				0
CL4001_Level_Agitator_ON	VAR	REAL				1
CL4001_LIM	VAR	PARA_PCR_LIM				1
YMAX	COMP	REAL		100.0		
YRATE	COMP	REAL		100.0		
CL4001_PumpSpeed	VAR	REAL	400250		Flow to the inlet pump 1	11
CL4001_PumpSpeed_OP	VAR	REAL	400198		GP_4001_01 Speed (%)	4
CL4001_TUNE	VAR	PARA_PCR_TUNE				3
TS	COMP	TIME		t#2s		
H	COMP	TIME		t#2s		
TRBF	COMP	TIME		t#3m		
CL4001_Y	VAR	REAL	400822			1
CL4001_ZTR_ERR	VAR	DINT				1
CL4001_ZTR_TUNE	VAR	PARA_ZTR				1
ZONE	COMP	REAL		0.025		
TRBF_LO	COMP	TIME		t#3m		
TRBF_HI	COMP	TIME		t#30m		
CL4002_Agitator_Mode	VAR	INT	400274		Agitator Mode (Off/Auto/Manu)	1
CL4002_ControlLoop_Mode	VAR	INT	400276		Outlet Flow Mode (Off/Auto/Manu)	10
CL4002_DERIV_MODE	VAR	Mode_MH				3
CL4002_DERIV_PARA	VAR	Para_DERIV				2
gain	COMP	REAL		1.0		
CL4002_EstimatedFlow_TEST	VAR	REAL				1
CL4002_EstimatedOutletLiquidFlow	VAR	REAL	400326	0.0		1
CL4002_OUTLETPUMP_VARIATOR	VAR	BOOL	000112			11
CL4002_Outlet_Liquid_Flow	IVAR	SECT_CTRL				0
CL4002_PumpSpeed	VAR	REAL	400254		Flow to the outlet pump 1	8
CL4002_PumpSpeed_OP	VAR	REAL	400204		GP_4002_01 Speed (%)	2
CL4002_Weight_Agitator_ON	VAR	REAL				1
CL4003_Controlloop_Mode	VAR	INT	400280		Air Inlet Mode (Off/Auto/Manu)	6
CL4003_Inlet_Gas_Flow	IVAR	SECT_CTRL				0
CL4003_Recycle_Mode	VAR	INT	400278		Recycle Mode (Off/Auto/Manu)	3
CL4004_ALARM_SELECTION	VAR	BOOL				6
CL4004_ControlLoop_Mode	VAR	INT	400282		Oulet Gas Mode (Off/Auto/Manu)	8
CL4004_ERR	VAR	DINT				1
CL4004_Flag4Init	VAR	BOOL				2
CL4004_IMP	VAR	PARA_PCR_IMP				1
CL4004_IMV	VAR	REAL	400808			1
CL4004_INIT	VAR	BOOL				2
CL4004_LIM	VAR	PARA_PCR_LIM				1
CL4004_Oulet_Gas_Flow	IVAR	SECT_CTRL				0
CL4004_TUNE	VAR	PARA_PCR_TUNE				3

table continued...

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

Variable name	Type	DType	Address	Initial value	Comment	Used
CL4004_Y	VAR	REAL	400806			2
CL4005_Blower_Mode	VAR	INT	400284		Blower Mode (Off/Auto/Manu)	2
CL4005_ControlLoop_Mode	VAR	INT	400286		Temperature Mode (Off/Auto/Manu)	5
CL4005_ERR	VAR	DINT				1
CL4005_Flag4Init	VAR	BOOL				2
CL4005_IFF1_ERR	VAR	DINT				0
CL4005_IFF1_IMP	VAR	PARA_PCR_IMP				0
KM	COMP	REAL		0.012		
TM	COMP	TIME		t#265s		
DM	COMP	TIME		t#37s		
CL4005_IMV	VAR	REAL	400308			1
CL4005_INIT	VAR	BOOL		TRUE		2
CL4005_PARAPWM	VAR	Para_PWM				3
t_period	COMP	TIME		t#5s		
t_min	COMP	TIME		t#0.5s		
t_max	COMP	TIME		t#5s		
up_pos	COMP	REAL		1.0		
up_neg	COMP	REAL		1.0		
CL4005_PBR_Temp	IVAR	SECT_CTRL				0
CL4005_PCRDECOMP	VAR	TIME		t#8m		1
CL4005_PCRIMP	VAR	PARA_PCR_IMP				1
KM	COMP	REAL		-0.0097		
TM	COMP	TIME		t#190s		
DM	COMP	TIME		t#25s		
CL4005_PCRLIM	VAR	PARA_PCR_LIM				1
YMIN	COMP	REAL		-1.0		
YMAX	COMP	REAL		1.0		
YRATE	COMP	REAL		1.0		
CL4005_PCRSPSL	VAR	REAL				0
CL4005_PCR_ZTR_ERR	VAR	DINT				1
CL4005_RCPY	VAR	REAL		0.0		2
CL4005_Temp_deadzone	VAR	REAL		0.1		4
CL4005_Temp_High	VAR	BOOL				6
CL4005_Temp_Low	VAR	BOOL				6
CL4005_TEMP_PBR_AH	VAR	BOOL	000170			0
CL4005_TEMP_PBR_AHH	VAR	BOOL	000171			0
CL4005_TUNE	VAR	PARA_PCR_TUNE				4
TS	COMP	TIME		t#5s		
H	COMP	TIME		t#1m		
TRBF	COMP	TIME		t#480s		
CL4005_TUNE_ZTR	VAR	PARA_ZTR				1
ZONE	COMP	REAL		0.05		
TRBF_LO	COMP	TIME		t#10m		
TRBF_HI	COMP	TIME		t#10m		
CL4005_Y	VAR	REAL				4
CL4006_Acid_Opening_Time	VAR	REAL	400314	0.0		2
CL4006_ACID_OP_Time	VAR	UDINT	400370	0		6
CL4006_Base_Opening_Time	VAR	REAL	400312			2
CL4006_BASE_OP_Time	VAR	UDINT	400372	0		6
CL4006_CO2_DECOMP	VAR	TIME		t#30s		1
CL4006_CO2_ERR	VAR	DINT				1
CL4006_CO2_FLAG4INIT	VAR	BOOL				2
CL4006_CO2_IMP	VAR	PARA_PCR_IMP				1
KM	COMP	REAL		-1.000000E-04		
CL4006_CO2_IMV	VAR	REAL				1
CL4006_CO2_INIT	VAR	BOOL				2
CL4006_CO2_LIM	VAR	PARA_PCR_LIM				1

table continued...

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

Variable name	Type	DType	Address	Initial value	Comment	Used
YMAX	COMP	REAL		0.12		
YRATE	COMP	REAL		0.12		
CL4006_CO2_RCPY	VAR	REAL				0
CL4006_CO2_TUNE	VAR	PARA_PCR_TUNE				3
TS	COMP	TIME		t#1s		
H	COMP	TIME		t#10s		
TRBF	COMP	TIME		t#30s		
CL4006_CO2_Y	VAR	REAL				1
CL4006_ControlLoop_Mode	VAR	INT	400290		Control Mode (Off/Auto/Manu)	25
CL4006_DECOMP	VAR	TIME		t#15m		1
CL4006_FLAG4INIT	VAR	BOOL				2
CL4006_IMP	VAR	PARA_PCR_IMP				1
KM	COMP	REAL		0.0005		
DM	COMP	TIME		t#15s		
CL4006_IMV_base_acid	VAR	REAL				1
CL4006_IND_Acid	VAR	BOOL				3
CL4006_IND_Base	VAR	BOOL				3
CL4006_IND_CO2	VAR	BOOL				2
CL4006_INIT	VAR	BOOL				2
CL4006_LIM	VAR	PARA_PCR_LIM				7
YMIN	COMP	REAL		-1.0		
YMAX	COMP	REAL		1.0		
YRATE	COMP	REAL		1.0		
CL4006_OffsetCO2	VAR	REAL		0.0		0
CL4006_PARAPWM	VAR	Para_PWM				3
t_period	COMP	TIME		t#30s		
t_min	COMP	TIME		t#1s		
t_max	COMP	TIME		t#30s		
up_pos	COMP	REAL		1.0		
up_neg	COMP	REAL		1.0		
CL4006_pH	IVAR	SECT_CTRL				0
CL4006_PH_A	VAR	BOOL				0
CL4006_PH_AH	VAR	BOOL	000250			2
CL4006_pH_AHH	VAR	BOOL	000249			2
CL4006_PH_AL	VAR	BOOL	000251			2
CL4006_PH_ALL	VAR	BOOL	000252			2
CL4006_pH_Day	VAR	BYTE	400425	0		1
CL4006_pH_DeadZone	VAR	REAL	400316	0.15		4
CL4006_pH_high	VAR	BOOL				6
CL4006_pH_Hour	VAR	BYTE	400424	0		1
CL4006_PH_LIM_AH	VAR	REAL	400586	0.2		1
CL4006_pH_LIM_AHH	VAR	REAL	400584	10.5		1
CL4006_PH_LIM_AL	VAR	REAL	400588	-0.2		1
CL4006_PH_LIM_ALL	VAR	REAL	400590	8.5		1
CL4006_pH_low	VAR	BOOL				5
CL4006_pH_Minute	VAR	BYTE	400423			1
CL4006_PH_Mode	VAR	INT	400288	2	Mode of Regulation (CO2,CO2/BASE,ACID/BASE)	12
CL4006_pH_Month	VAR	BYTE	400426	0		1
CL4006_PH_PROBE_SELECTION	VAR	INT	400277			7
CL4006_pH_Reset_timer	VAR	BOOL	000326			3
CL4006_pH_Second	VAR	BYTE	400422	0		1
CL4006_PH_SELECT	VAR	BOOL	000161		PH Probe Selector	0
CL4006_pH_Year	VAR	BYTE	400427	0		1
CL4006_PID_KD	VAR	REAL		0.01		0
CL4006_PID_KI	VAR	REAL		100.0		0
CL4006_PID_KP	VAR	REAL		5.0		0
CL4006_PID_YMAX	VAR	REAL		5.0		0

table continued...

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

Variable name	Type	DType	Address	Initial value	Comment	Used
CL4006_PID_YMIN	VAR	REAL		0.0		0
CL4006_RCPY	VAR	REAL				2
CL4006_TIME_ALARM_PH	VAR	TIME		t#15m		0
CL4006_TUNE	VAR	PARA_PCR_TUNE				3
TS	COMP	TIME		t#30s		
H	COMP	TIME		t#5m		
TRBF	COMP	TIME		t#15m		
CL4006_Y_base_acid	VAR	REAL				4
CL4007_ControlLoop_Mode	VAR	INT	400292		Control Mode (Off/Auto/Manu)	18
CL4007_ERR	VAR	DINT				1
CL4007_Flag4Init	VAR	BOOL				2
CL4007_IMP	VAR	PARA_PCR_IMP				2
KM	COMP	REAL		-40.0		
TM	COMP	TIME		t#36.2s		
DM	COMP	TIME		t#4.5s		
CL4007_IMV	VAR	REAL	400804			1
CL4007_INIT	VAR	BOOL				2
CL4007_LIM	VAR	PARA_PCR_LIM				1
YMIN	COMP	REAL		40.0		
YMAX	COMP	REAL		60.0		
YRATE	COMP	REAL		1.0		
CL4007_PBR_Pressure	IVAR	SECT_CTRL				0
CL4007_P_SELECT	VAR	BOOL	000166		Pessure Probe Selector	5
CL4007_TUNE	VAR	PARA_PCR_TUNE				3
TS	COMP	TIME		t#1s		
H	COMP	TIME		t#1s		
TRBF	COMP	TIME		t#1m		
CL4007_Y	VAR	REAL	400802	0.0		3
CL4008_ControlLoop_Mode	VAR	INT	400294		Control Mode (Off/Auto/Manu)	5
CL4008_DECOMP	VAR	TIME		t#30m		1
CL4008_ERR	VAR	DINT				1
CL4008_Flag4Init	VAR	BOOL				2
CL4008_IMP	VAR	PARA_PCR_IMP				2
KM	COMP	REAL		-0.038		
TM	COMP	TIME		t#12m		
CL4008_IMV	VAR	REAL	400812			1
CL4008_INIT	VAR	BOOL				2
CL4008_LIM	VAR	PARA_PCR_LIM				3
YRATE	COMP	REAL		100.0		
CL4008_PBR_Liquid_Level	IVAR	SECT_CTRL				0
CL4008_TUNE	VAR	PARA_PCR_TUNE				3
TS	COMP	TIME		t#10s		
H	COMP	TIME		t#10m		
TRBF	COMP	TIME		t#30m		
CL4008_Y	VAR	REAL	400810			3
CL4009_Biomass	IVAR	SECT_CTRL				0
CL4009_Biomass_Cleaning_Mode	VAR	INT	400296		Biomass Cleaning Mode (Off/Auto/Manu)	3
CL4009_Biomass_Production	VAR	REAL	400230		Biomass Production (g/L/H)	1
CL4009_BIOMASS_SEL	VAR	BOOL				0
CL4009_ControlLoop_Mode	VAR	INT	400298		Biomass Control Mode	1
CL4009_ERR	VAR	DINT				0
CL4009_Flag4Init	VAR	BOOL				0
CL4009_IMP	VAR	PARA_PCR_IMP				0
CL4009_IMV	VAR	REAL				0
CL4009_INIT	VAR	BOOL				0
CL4009_LIM	VAR	PARA_PCR_LIM				0
CL4009_START_TIMER	VAR	BOOL				5

table continued...

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

Variable name	Type	DType	Address	Initial value	Comment	Used
CL4009_TUNE	VAR	PARA_PCR_TUNE				0
CL4009_Y	VAR	REAL				0
CL4010_ControlLoop_Mode	VAR	INT	400275			9
CL4010_ERR	VAR	DINT				1
CL4010_Flag4Init	VAR	BOOL				2
CL4010_IMP	VAR	PARA_PCR_IMP				1
CL4010_IMV	VAR	REAL				1
CL4010_INIT	VAR	BOOL				2
CL4010_LIM	VAR	PARA_PCR_LIM				1
CL4010_O2_PRODUCTION	VAR	REAL	400328	0.0		0
CL4010_O2_SP	VAR	REAL	400320	21.0		1
CL4010_OutletGasCompo	IVAR	SECT_CTRL				0
CL4010_TUNE	VAR	PARA_PCR_TUNE				2
CL4010_Y	VAR	REAL				2
CL4011_ControlLoop_Mode	VAR	INT	400300		Feeding Tank Temperature Control	7
CL4011_DECOMP	VAR	TIME		t#30m		1
CL4011_ERR	VAR	DINT				1
CL4011_Feeding_Temp	IVAR	SECT_CTRL				0
CL4011_Flag4Init	VAR	BOOL				2
CL4011_IMP	VAR	PARA_PCR_IMP				1
KM	COMP	REAL		-0.0005		
TM	COMP	TIME		t#630s		
CL4011_IMV	VAR	REAL	400816			1
CL4011_INIT	VAR	BOOL				2
CL4011_LIM	VAR	PARA_PCR_LIM				1
YMAX	COMP	REAL		1.0		
YRATE	COMP	REAL		1.0		
CL4011_PARA_PWM	VAR	Para_PWM				1
t_period	COMP	TIME		t#30s		
t_min	COMP	TIME		t#2s		
t_max	COMP	TIME		t#30s		
up_pos	COMP	REAL		1.0		
CL4011_TUNE	VAR	PARA_PCR_TUNE				3
TS	COMP	TIME		t#30s		
H	COMP	TIME		t#200s		
TRBF	COMP	TIME		t#30m		
CL4011_Y	VAR	REAL	400814			3
CL4012_ControlLoop_Mode	VAR	INT	400302		Feeding Tank Temperature Control	7
CL4012_DECOMP	VAR	TIME		t#30m		1
CL4012_ERR	VAR	DINT				1
CL4012_Flag4Init	VAR	BOOL				2
CL4012_Harvesting_Temp	IVAR	SECT_CTRL				0
CL4012_IMP	VAR	PARA_PCR_IMP				1
KM	COMP	REAL		-0.0005		
TM	COMP	TIME		t#630s		
CL4012_IMV	VAR	REAL	400820			1
CL4012_INIT	VAR	BOOL				2
CL4012_LIM	VAR	PARA_PCR_LIM				1
YMAX	COMP	REAL		1.0		
YRATE	COMP	REAL		1.0		
CL4012_PARA_PWM	VAR	Para_PWM				1
t_period	COMP	TIME		t#30s		
t_min	COMP	TIME		t#2s		
t_max	COMP	TIME		t#30s		
up_pos	COMP	REAL		1.0		
CL4012_TUNE	VAR	PARA_PCR_TUNE				3
TS	COMP	TIME		t#30s		

table continued...

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

Variable name	Type	DType	Address	Initial value	Comment	Used
H	COMP	TIME		t#200s		
TRBF	COMP	TIME		t#30m		
CL4012_Y	VAR	REAL	400818			3
CL4013_Antifoam	IVAR	SECT_CTRL				0
CL4014_ControlLoop_Mode	VAR	INT	400269			2
CL4014_Feeding_Sterilization	IVAR	SECT_CTRL				0
CL4015_ControlLoop_Mode	VAR	INT	400271			2
CL4015_PBR_Sterilization	IVAR	SECT_CTRL				0
CL4016_ControlLoop_Mode	VAR	INT	400273			2
CL4016_Harvesting_Sterilization	IVAR	SECT_CTRL				0
CL_4006_ERR_base_acid	VAR	DINT				1
DPT_4001_01	VAR	REAL	400162		Diff. Pressure Filter Pump1	5
DPT_4001_01_AH	VAR	BOOL	000216			2
DPT_4001_01_AHH	VAR	BOOL	000215			2
DPT_4001_01_AL	VAR	BOOL	000218			2
DPT_4001_01_ALL	VAR	BOOL	000217			2
DPT_4001_01_ERR	VAR	BOOL	000118		Diff Pressure Filter Pump1 Link Error	2
DPT_4001_01_LIM_AH	VAR	REAL	400530	200.0		1
DPT_4001_01_LIM_AHH	VAR	REAL	400528	300.0		1
DPT_4001_01_LIM_AL	VAR	REAL	400534			1
DPT_4001_01_LIM_ALL	VAR	REAL	400532			1
DPT_4001_01_MAX	VAR	REAL		1017.0	Diff. Pressure Filter Pump1 Scale MAX	1
DPT_4001_01_MIN	VAR	REAL		0.0	Diff. Pressure Filter Pump1 Scale MIN	1
DPT_4001_02	VAR	REAL	400164		Diff. Pressure Filter Pump2	5
DPT_4001_02_AH	VAR	BOOL	000220			2
DPT_4001_02_AHH	VAR	BOOL	000219			2
DPT_4001_02_AL	VAR	BOOL	000221			2
DPT_4001_02_ALL	VAR	BOOL	000222			2
DPT_4001_02_ERR	VAR	BOOL	000119		Diif Pressure Filter Pump2 Link Error	2
DPT_4001_02_LIM_AH	VAR	REAL	400538	200.0		1
DPT_4001_02_LIM_AHH	VAR	REAL	400536	400.0		1
DPT_4001_02_LIM_AL	VAR	REAL	400540			1
DPT_4001_02_LIM_ALL	VAR	REAL	400542			1
DPT_4001_02_MAX	VAR	REAL		1017.0	Diff. Pressure Filter Pump2 Scale MAX	1
DPT_4001_02_MIN	VAR	REAL		0.0	Diff. Pressure Filter Pump2 Scale MIN	1
DPT_4004_01	VAR	REAL	400166		Diff. Pressure Filter	5
DPT_4004_01_AH	VAR	BOOL	000236			2
DPT_4004_01_AHH	VAR	BOOL	000235			2
DPT_4004_01_AL	VAR	BOOL	000238			2
DPT_4004_01_ALL	VAR	BOOL	000237			2
DPT_4004_01_ERR	VAR	BOOL	000126		Diff Pressure Filter Link Error	2
DPT_4004_01_LIM_AH	VAR	REAL	400562	200.0		1
DPT_4004_01_LIM_AHH	VAR	REAL	400560	300.0		1
DPT_4004_01_LIM_AL	VAR	REAL	400566	-200.0		1
DPT_4004_01_LIM_ALL	VAR	REAL	400564	-300.0		1
DPT_4004_01_MAX	VAR	REAL		3000.0	Diff. Pressure Filter Scale MAX	1
DPT_4004_01_MIN	VAR	REAL		0.0	Diff. Pressure Filter Scale MIN	1
EMERGENCY_BUTTON	IVAR	SECT_CTRL				0
Emergency_Button_01	VAR	BOOL	100111		Emergency Button 1	1
Emergency_Button_02	VAR	BOOL	100112		Emergency Button 2	1
Emergency_Button_03	VAR	BOOL	100065		Emergency Button 3	0
Err_AI	IVAR	SECT_CTRL				0
FB_TIME_LIM	VAR	TIME	400704	t#5s		13
FQRC_4003_01	VAR	REAL	400176		Mass Flow CO2 Inlet	6
FQRC_4003_01_AH	VAR	BOOL	000338			2
FQRC_4003_01_AHH	VAR	BOOL	000337			2
FQRC_4003_01_AL	VAR	BOOL	000339			2

table continued...

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

Variable name	Type	DType	Address	Initial value	Comment	Used
FQRC_4003_01_ALL	VAR	BOOL	000340			2
FQRC_4003_01_ERR	VAR	BOOL	000121		Mass Flow CO2 Link Error	2
FQRC_4003_01_LIM_AH	VAR	REAL	400712	20.0		1
FQRC_4003_01_LIM_AHH	VAR	REAL	400710	50.0		1
FQRC_4003_01_LIM_AL	VAR	REAL	400716	-20.0		1
FQRC_4003_01_LIM_ALL	VAR	REAL	400714	-50.0		1
FQRC_4003_01_MAX	VAR	REAL		5000.0	Mass Flow CO2 Inlet Scale MAX	1
FQRC_4003_01_MIN	VAR	REAL		0.0	Mass Flow CO2 Inlet Scale MIN	1
FQRC_4003_01_OFFSET	VAR	REAL				1
FQRC_4003_01_SP	VAR	REAL	400238		Mass Flow CO2 Inlet set point	7
FQRC_4003_01_SP_MAX	VAR	REAL		5000.0	Mass Flow CO2 Inlet set point Scale MAX	1
FQRC_4003_01_SP_MIN	VAR	REAL		0.0	Mass Flow CO2 Inlet set point Scale MIN	1
FQRC_4003_01_SP_OP	VAR	REAL	400212		CO2 Set Point	2
FQRC_4003_01_SP_PH	VAR	REAL			CO2 SP Sent to the FQRC and Calculated by The PH Controller	2
FQRC_4003_02	VAR	REAL	400178		Mass Flow Air Inlet	5
FQRC_4003_02_AH	VAR	BOOL	000342			2
FQRC_4003_02_AHH	VAR	BOOL	000341			2
FQRC_4003_02_AL	VAR	BOOL	000343			2
FQRC_4003_02_ALL	VAR	BOOL	000344			2
FQRC_4003_02_ERR	VAR	BOOL	000122		Mass Flow Air Inlet Link Error	2
FQRC_4003_02_LIM_AH	VAR	REAL	400720	100.0		1
FQRC_4003_02_LIM_AHH	VAR	REAL	400718	300.0		1
FQRC_4003_02_LIM_AL	VAR	REAL	400722	-100.0		1
FQRC_4003_02_LIM_ALL	VAR	REAL	400740	-300.0		1
FQRC_4003_02_MAX	VAR	REAL		30000.0	Mass Flow Air Inlet Scale MAX	1
FQRC_4003_02_MIN	VAR	REAL		0.0	Mass Flow Air Inlet Scale MIN	1
FQRC_4003_02_SP	VAR	REAL	400240		Mass Flow Air Inlet set point	6
FQRC_4003_02_SP_MAX	VAR	REAL		30000.0	Mass Flow Air Inlet set point Scale MAX	1
FQRC_4003_02_SP_MIN	VAR	REAL		0.0	Mass Flow Air Inlet set point Scale MIN	1
FQRC_4003_02_SP_OP	VAR	REAL	400214		Air Inlet Set Point	1
FQRC_4003_03	VAR	REAL	400180		Mass Flow Circulated Air	6
FQRC_4003_03_AH	VAR	BOOL	000346			2
FQRC_4003_03_AHH	VAR	BOOL	000345			2
FQRC_4003_03_AL	VAR	BOOL	000347			2
FQRC_4003_03_ALL	VAR	BOOL	000348			2
FQRC_4003_03_ERR	VAR	BOOL	000123		Mass Flow Circulated Air Link Error	2
FQRC_4003_03_LIM_AH	VAR	REAL	400726	100.0		1
FQRC_4003_03_LIM_AHH	VAR	REAL	400724	300.0		1
FQRC_4003_03_LIM_AL	VAR	REAL	400730	-100.0		1
FQRC_4003_03_LIM_ALL	VAR	REAL	400728	-300.0		1
FQRC_4003_03_MAX	VAR	REAL		30000.0	Mass Flow Circulated Air Scale MAX	1
FQRC_4003_03_MIN	VAR	REAL		0.0	Mass Flow Circulated Air Scale MIN	1
FQRC_4003_03_SP	VAR	REAL	400242		Mass Flow Circulated Air set point	6
FQRC_4003_03_SP_MAX	VAR	REAL		30000.0	Mass Flow Circulated Air set point Scale MAX	1
FQRC_4003_03_SP_MIN	VAR	REAL		0.0	Mass Flow Circulated Air set point Scale MIN	1
FQRC_4003_03_SP_OP	VAR	REAL	400208		Recycle Flow	2
FQRC_4003_04	VAR	REAL	400182		Total Mass Flow Air Inlet	6
FQRC_4003_04_AH	VAR	BOOL	000350			2
FQRC_4003_04_AHH	VAR	BOOL	000349			2
FQRC_4003_04_AL	VAR	BOOL	000351			2
FQRC_4003_04_ALL	VAR	BOOL	000352			2
FQRC_4003_04_ERR	VAR	BOOL	000124		Total Mass Flow Air Link Error	3
FQRC_4003_04_LIM_AH	VAR	REAL	400734	100.0		1
FQRC_4003_04_LIM_AHH	VAR	REAL	400732	300.0		1

table continued...

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

Variable name	Type	DType	Address	Initial value	Comment	Used
FQRC_4003_04_LIM_AL	VAR	REAL	400738	-100.0		1
FQRC_4003_04_LIM_ALL	VAR	REAL	400736	-300.0		1
FQRC_4003_04_MAX	VAR	REAL		30000.0	Total Mass Flow Air Inlet Scale MAX	1
FQRC_4003_04_MIN	VAR	REAL		0.0	Total Mass Flow Air Inlet Scale MIN	1
FQRC_4003_04_NOFLOW_A	VAR	BOOL	000353			2
FQRC_4003_04_SP	VAR	REAL	400244	2.1	Total Mass Flow Air Inlet set point	8
FQRC_4003_04_SP_MAX	VAR	REAL		30000.0	Total Mass Flow Air Inlet set point Scale MAX	1
FQRC_4003_04_SP_MIN	VAR	REAL		0.0	Total Mass Flow Air Inlet set point Scale MIN	1
FQRC_4003_04_SP_OP	VAR	REAL	400210		Total Air Flow Set Point	4
FT_4001_01	VAR	REAL	400148		Total liquid inlet flow to reactor	8
FT_4001_01_AH	VAR	BOOL	000208			2
FT_4001_01_AHH	VAR	BOOL	000207			2
FT_4001_01_AL	VAR	BOOL	000209			2
FT_4001_01_ALL	VAR	BOOL	000210			2
FT_4001_01_ERR	VAR	BOOL	000116		Total Liquid Inlet Flow Link Error	2
FT_4001_01_LIM_AH	VAR	REAL	400514	0.1		1
FT_4001_01_LIM_AHH	VAR	REAL	400512	0.2		1
FT_4001_01_LIM_AL	VAR	REAL	400516	-0.1		1
FT_4001_01_LIM_ALL	VAR	REAL	400518	-0.2		1
FT_4001_01_MAX	VAR	REAL		4.0	Total liquid inlet flow to reactor Scale MAX	1
FT_4001_01_MIN	VAR	REAL		0.0	Total liquid inlet flow to reactor Scale MIN	1
FT_4001_01_SP	VAR	REAL	400304	0.6	Inlet Liquid Flow Rate Set Point (L/H)	10
FT_4001_01_without_filter	VAR	REAL	400830			1
FT_4004_01	VAR	REAL	400146		Total air outlet from reactor	6
FT_4004_01_AH	VAR	BOOL	000232			2
FT_4004_01_AHH	VAR	BOOL	000231			2
FT_4004_01_AL	VAR	BOOL	000234			2
FT_4004_01_ALL	VAR	BOOL	000233			2
FT_4004_01_ERR	VAR	BOOL	000125		Total Air Outlet Link Error	2
FT_4004_01_LIM_AH	VAR	REAL	400554	0.5		1
FT_4004_01_LIM_AHH	VAR	REAL	400552	1.0		1
FT_4004_01_LIM_AL	VAR	REAL	400558	-0.5		1
FT_4004_01_LIM_ALL	VAR	REAL	400556	-1.0		1
FT_4004_01_MAX	VAR	REAL		20000.0	Total air outlet from reactor Scale MAX	1
FT_4004_01_MIN	VAR	REAL		0.0	Total air outlet from reactor Scale MIN	1
FT_4004_01_SP	VAR	REAL	400216		Flow Set Point	5
GP_4001_01_ERR	VAR	BOOL	100099		Thermal protection to the inlet pump 1	0
GP_4001_01_MV1	VAR	BOOL	000091		Start/Stop of the inlet pump 1	2
GP_4001_01_MV1_OP	VAR	BOOL	000149		GP_4001_01 ON/OFF	3
GP_4001_01_MV2_MAX	VAR	REAL		100.0	Flow to the inlet pump 1 Scale MAX	1
GP_4001_01_MV2_MIN	VAR	REAL		0.0	Flow to the inlet pump 1 Scale MIN	1
GP_4001_01_SEL	VAR	BOOL	000147		Check Box. Select Pump GP_4001_01 (or click screen ?)	5
GP_4001_02_ERR	VAR	BOOL	100100		Thermal protection to the inlet pump 2	0
GP_4001_02_MV1	VAR	BOOL	000090		Start/Stop of the inlet pump 2	2
GP_4001_02_MV1_OP	VAR	BOOL	000150		GP_4001_02 ON/OFF	3
GP_4001_02_MV2	VAR	REAL	400252		Flow to the inlet pump 2	1
GP_4001_02_MV2_MAX	VAR	REAL		100.0	Flow to the inlet pump 2 Scale MAX	1
GP_4001_02_MV2_MIN	VAR	REAL		0.0	Flow to the inlet pump 2 Scale MIN	1
GP_4001_02_MV2_OP	VAR	REAL	400200		GP_4001_02 Speed (%)	0
GP_4001_02_SEL	VAR	BOOL	000148		Check Box. Select Pump GP_4001_02 (or click screen ?)	5
GP_4001_03_ERR	VAR	BOOL	100105		Thermal protection of agitator motor	0

table continued...

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

Variable name	Type	DType	Address	Initial value	Comment	Used
GP_4001_03_MV1	VAR	BOOL	000110		Start/Stop of the agitator	1
GP_4001_03_MV1_OP	VAR	BOOL	000146		GP_4001_03 ON/OFF	1
GP_4001_03_MV2	VAR	REAL	400258		Speed Agitator (VS_4001_01)	2
GP_4001_03_MV2_MAX	VAR	REAL		100.0	Speed Agitator (VS_4001_01) Scale MAX	1
GP_4001_03_MV2_MIN	VAR	REAL		0.0	Speed Agitator (VS_4001_01) Scale MIN	1
GP_4001_03_MV2_OP	VAR	REAL	400196		GP_4001_03 Speed (%)	2
GP_4002_01_ERR	VAR	BOOL	100101		Thermal protection to the outlet pump 1	0
GP_4002_01_MV1	VAR	BOOL	000089		Start/Stop of the outlet pump 1	1
GP_4002_01_MV1_OP	VAR	BOOL	000154		GP_4002_01 ON/OFF	3
GP_4002_01_MV2_MAX	VAR	REAL		100.0	Flow to the outlet pump 1 Scale MAX	1
GP_4002_01_MV2_MIN	VAR	REAL		0.0	Flow to the outlet pump 1 Scale MIN	1
GP_4002_01_SEL	VAR	BOOL	000152		Check Box. Select Pump GP_4002_01 (or click screen ?)	5
GP_4002_02_ERR	VAR	BOOL	100102		Thermal protection to the outlet pump 2	0
GP_4002_02_MV1	VAR	BOOL	000104		Start/Stop of the outlet pump 2	1
GP_4002_02_MV1_OP	VAR	BOOL	000155		GP_4002_02 ON/OFF	3
GP_4002_02_MV2	VAR	REAL	400256		Flow to the outlet pump 2	1
GP_4002_02_MV2_MAX	VAR	REAL		100.0	Flow to the outlet pump 2 Scale MAX	1
GP_4002_02_MV2_MIN	VAR	REAL		0.0	Flow to the outlet pump 2 Scale MIN	1
GP_4002_02_MV2_OP	VAR	REAL	400206		GP_4002_02 Speed (%)	0
GP_4002_02_SEL	VAR	BOOL	000153		Check Box. Select Pump GP_4002_02 (or click screen ?)	4
GP_4002_03_ERR	VAR	BOOL	100104		Thermal protection of agitator motor	0
GP_4002_03_MV1	VAR	BOOL	000109		Start/Stop of the agitator	1
GP_4002_03_MV1_OP	VAR	BOOL	000151		GP_4002_03 ON/OFF	1
GP_4002_03_MV2	VAR	REAL	400260		Speed Agitator (VS_4002_01)	2
GP_4002_03_MV2_MAX	VAR	REAL		100.0	Speed Agitator (VS_4002_01) Scale MAX	1
GP_4002_03_MV2_MIN	VAR	REAL		0.0	Speed Agitator (VS_4002_01) Scale MIN	1
GP_4002_03_MV2_OP	VAR	REAL	400202		GP_4002_03 Speed (%)	2
HX_4005_02_MV1	VAR	BOOL	000100		Start/Stop electrical resistance	1
HX_4005_02_OP	VAR	BOOL	000159		HX ON/OFF	1
Inputs	IVAR	SECT_CTRL				0
IRC_4000_MV	VAR	REAL	400262		Light Intensity (%age ?)	7
IRC_4000_MV_MAX	VAR	REAL		100.0	Light Intensity (%age ?) Scale MAX	1
IRC_4000_MV_MIN	VAR	REAL		0.0	Light Intensity (%age ?) Scale MIN	1
IT_4000_01	VAR	REAL	400184		Light Power Phase1	2
IT_4000_01_AH	VAR	BOOL	000201			0
IT_4000_01_AL	VAR	BOOL	000202			0
IT_4000_01_ERR	VAR	BOOL	000113		Light Power Ph1 Link Error	1
IT_4000_01_LIM_AH	VAR	REAL	400500			0
IT_4000_01_LIM_AL	VAR	REAL	400502			0
IT_4000_01_MAX	VAR	REAL			Light Power Phase1 Scale MAX	1
IT_4000_01_MIN	VAR	REAL			Light Power Phase1 Scale MIN	1
IT_4000_02	VAR	REAL	400186		Light Power Phase2	2
IT_4000_02_AH	VAR	BOOL	000203			0
IT_4000_02_AL	VAR	BOOL	000204			0
IT_4000_02_ERR	VAR	BOOL	000114		Light Power Ph2 Link Error	1
IT_4000_02_LIM_AH	VAR	REAL	400504			0
IT_4000_02_LIM_AL	VAR	REAL	400506			0
IT_4000_02_MAX	VAR	REAL			Light Power Phase2 Scale MAX	1
IT_4000_02_MIN	VAR	REAL			Light Power Phase2 Scale MIN	1
IT_4000_03	VAR	REAL	400188		Light Power Phase3	2
IT_4000_03_AH	VAR	BOOL	000205			0
IT_4000_03_AL	VAR	BOOL	000206			0
IT_4000_03_ERR	VAR	BOOL	000115		Light Power Ph3 Link Error	1
IT_4000_03_LIM_AH	VAR	REAL	400508			0
IT_4000_03_LIM_AL	VAR	REAL	400510			0

table continued...

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

Variable name	Type	DType	Address	Initial value	Comment	Used
IT_4000_03_MAX	VAR	REAL			Light Power Phase3 Scale MAX	1
IT_4000_03_MIN	VAR	REAL			Light Power Phase3 Scale MIN	1
IT_4000_PWR	VAR	REAL	400190		Lights Power (W ?)	1
I_4000_MV	VAR	REAL	400194		%age fixed by the user (%)	0
I_4000_SP	VAR	REAL	400192		Set Point fixed by the user (W/m2)	1
LS_4013_01	VAR	BOOL	100081		Foam measurement	0
LT_4001_01	VAR	REAL	400150		Level (guided microwave)	6
LT_4001_01_AH	VAR	BOOL	000212			2
LT_4001_01_AHH	VAR	BOOL	000211			2
LT_4001_01_AL	VAR	BOOL	000213			2
LT_4001_01_ALL	VAR	BOOL	000214			3
LT_4001_01_ERR	VAR	BOOL	000117		Level Link Error	2
LT_4001_01_LIM_AH	VAR	REAL	400522	130.0		1
LT_4001_01_LIM_AHH	VAR	REAL	400520	140.0		1
LT_4001_01_LIM_AL	VAR	REAL	400524	20.0		1
LT_4001_01_LIM_ALL	VAR	REAL	400526	6.5		1
LT_4001_01_MAX	VAR	REAL		185.67	Level (guided microwave) Scale MAX	1
LT_4001_01_MIN	VAR	REAL		6.359	Level (guided microwave) Scale MIN	1
Outputs	IVAR	SECT_CTRL				0
pHdz	VAR	REAL				3
PP_4005_01_MV1	VAR	BOOL	000102		Start/Stop of the pump PP_4005_01	1
PP_4005_01_OP	VAR	BOOL	000158		Pump On/Off	1
PP_4006_01_MV1	VAR	BOOL	000098		Start/Stop of the pump PP_4006_01	1
PP_4006_01_OP	VAR	BOOL	000164		Acid Pump ON/OFF	6
PP_4006_02_MV1	VAR	BOOL	000097		Start/Stop of the pump PP_4006_02	1
PP_4006_02_OP	VAR	BOOL	000165		Base Pump ON/OFF	6
PS_4001_01	VAR	BOOL	100082		Pressure pump GP_4001_01	1
PS_4001_01_A	VAR	BOOL	000315			2
PS_4001_02	VAR	BOOL	100083		Pressure pump GP_4001_02	1
PS_4001_02_A	VAR	BOOL	000316			2
PS_4001_03	VAR	BOOL	100106		Pressure switch membrane GP_4001_01	1
PS_4001_03_A	VAR	BOOL	000317			2
PS_4001_04	VAR	BOOL	100107		Pressure switch membrane GP_4001_02	1
PS_4001_04_A	VAR	BOOL	000318			2
PS_4002_01	VAR	BOOL	100084		Pressure pump GP_4002_01	1
PS_4002_01_A	VAR	BOOL	000319			2
PS_4002_02	VAR	BOOL	100085		Pressure pump GP_4002_01	1
PS_4002_02_A	VAR	BOOL	000320			2
PS_4002_03	VAR	BOOL	100108		Pressure switch membrane GP_4002_01	1
PS_4002_03_A	VAR	BOOL	000321			2
PS_4002_04	VAR	BOOL	100109		Pressure switch membrane GP_4002_02	0
PS_4003_01	VAR	BOOL	100110		Pressure switch bypass for recycling	1
PS_4003_01_A	VAR	BOOL	000322			3
PS_TIME_LIM	VAR	TIME	400706	t#10s		8
PT_4007_01	VAR	REAL	400156		Reactor Pressure Probe 1	7
PT_4007_01_AH	VAR	BOOL	000253			2
PT_4007_01_AHH	VAR	BOOL	000254			2
PT_4007_01_AHHH	VAR	BOOL	000354			2
PT_4007_01_AL	VAR	BOOL	000255			2
PT_4007_01_ALL	VAR	BOOL	000256			2
PT_4007_01_ERR	VAR	BOOL	000132		Pressure1 Link Error	5
PT_4007_01_LIM_AH	VAR	REAL	400592	20.0		1
PT_4007_01_LIM_AHH	VAR	REAL	400594	420.0		1
PT_4007_01_LIM_AHHH	VAR	REAL	400742	1500.0		1
PT_4007_01_LIM_AL	VAR	REAL	400596	-40.0		1
PT_4007_01_LIM_ALL	VAR	REAL	400598	-80.0		1
PT_4007_01_MAX	VAR	REAL		500.0	Reactor Pressure Probe 1 Scale MAX	1

table continued...

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

Variable name	Type	DType	Address	Initial value	Comment	Used
PT_4007_01_MIN	VAR	REAL		0.0	Reactor Pressure Probe 1 Scale MIN	1
PT_4007_02	VAR	REAL	400158		Reactor Pressure Probe 2	7
PT_4007_02_AH	VAR	BOOL	000257			2
PT_4007_02_AHH	VAR	BOOL	000258			2
PT_4007_02_AHHH	VAR	BOOL	000355			2
PT_4007_02_AL	VAR	BOOL	000259			2
PT_4007_02_ALL	VAR	BOOL	000260			2
PT_4007_02_ERR	VAR	BOOL	000133		Pressure2 Link Error	3
PT_4007_02_LIM_AH	VAR	REAL	400600	20.0		1
PT_4007_02_LIM_AHH	VAR	REAL	400602	420.0		1
PT_4007_02_LIM_AHHH	VAR	REAL	400744	1500.0		1
PT_4007_02_LIM_AL	VAR	REAL	400604	-40.0		1
PT_4007_02_LIM_ALL	VAR	REAL	400606	-80.0		1
PT_4007_02_MAX	VAR	REAL		5000.0	Reactor Pressure Probe 2 Scale MAX	1
PT_4007_02_MIN	VAR	REAL		-1000.0	Reactor Pressure Probe 2 Scale MIN	1
PT_4007_SELECTED	VAR	REAL	400800			2
PT_4007_SP	VAR	REAL	400226	80.0	Pressure Set Point	9
PT_4010_01	VAR	REAL	400160		Outlet Gas Pressure	5
PT_4010_01_AH	VAR	BOOL	000294			2
PT_4010_01_AHH	VAR	BOOL	000295			3
PT_4010_01_AL	VAR	BOOL	000296			2
PT_4010_01_ALL	VAR	BOOL	000297			3
PT_4010_01_ERR	VAR	BOOL	000142		Outlet Gas Pressure Link Error	2
PT_4010_01_LIM_AH	VAR	REAL	400672	80.0		1
PT_4010_01_LIM_AHH	VAR	REAL	400674	100.0		1
PT_4010_01_LIM_AL	VAR	REAL	400676	20.0		1
PT_4010_01_LIM_ALL	VAR	REAL	400678			1
PT_4010_01_MAX	VAR	REAL		5000.0	Outlet Gas Pressure Scale MAX	1
PT_4010_01_MIN	VAR	REAL		-1000.0	Outlet Gas Pressure Scale MIN	1
REAL0	VAR	REAL		0.0		4
REAL1	VAR	REAL		1.0		4
SCV_4004_01_MV	VAR	REAL	400248		Flow control Air outlet valve	4
SCV_4004_01_MV_MAX	VAR	REAL		100.0	Flow control Air outlet valve Scale MAX	1
SCV_4004_01_MV_MIN	VAR	REAL		0.0	Flow control Air outlet valve Scale MIN	1
SCV_4004_01_OP	VAR	REAL	400218		Valve Opening	2
SV_4003_01_A	VAR	BOOL	000229			2
SV_4003_01_FB	VAR	BOOL	100097		Analyser gas inlet (reactor inlet) FB	1
SV_4003_01_MV	VAR	BOOL	000093		Analyser gas inlet (reactor inlet)	1
SV_4003_01_OP	VAR	BOOL	000331			1
SV_4003_02_A	VAR	BOOL	000228			2
SV_4003_02_FB	VAR	BOOL	100095		Reactor air inlet (biomass sensor cleaning) FB	1
SV_4003_02_MV	VAR	BOOL	000095		Reactor air inlet (biomass cleaning)	1
SV_4003_02_OP	VAR	BOOL	000167		Cleaning Valve	1
SV_4003_03_A	VAR	BOOL	000227			2
SV_4003_03_FB	VAR	BOOL	100094		Circulated gas blower bypass FB	1
SV_4003_03_MV	VAR	BOOL	000096		Circulated gas blower bypass	1
SV_4003_03_OP	VAR	BOOL	000332			1
SV_4005_01_A	VAR	BOOL	000323			2
SV_4005_01_FB	VAR	BOOL	100086		Cooling water outlet valve FB	1
SV_4005_01_MV	VAR	BOOL	000088		Cooling water outlet valve	1
SV_4005_01_OP	VAR	BOOL	000160		SV_4005_01 ON/OFF HMI	1
SV_4006_01_A	VAR	BOOL	000243			2
SV_4006_01_FB	VAR	BOOL	100091		Acid Inlet reactor FB	1
SV_4006_01_MV	VAR	BOOL	000083		Acid Inlet reactor	1
SV_4006_01_OP	VAR	BOOL	000162		Acide Valve ON/OFF	6
SV_4006_02_A	VAR	BOOL	000244			2

table continued...

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

Variable name	Type	DType	Address	Initial value	Comment	Used
SV_4006_02_FB	VAR	BOOL	100092		Base Inlet reactor FB	1
SV_4006_02_MV	VAR	BOOL	000082		Base Inlet reactor	1
SV_4006_02_OP	VAR	BOOL	000163		Base Valve ON/OFF	6
SV_4010_01_A	VAR	BOOL	000277			2
SV_4010_01_FB	VAR	BOOL	100093		Gas Inlet analyser (reactor outlet) FB	2
SV_4010_01_MV	VAR	BOOL	000081		Gas Inlet analyser (reactor outlet)	3
SV_4010_01_OP	VAR	BOOL	000333			1
SV_4011_01_A	VAR	BOOL	000302			2
SV_4011_01_FB	VAR	BOOL	100087		Cooling water outlet valve FB	1
SV_4011_01_MV	VAR	BOOL	000087		Cooling water outlet valve	1
SV_4011_01_OP	VAR	BOOL	000168		Valve ON/OFF	1
SV_4012_01_A	VAR	BOOL	000307			2
SV_4012_01_FB	VAR	BOOL	100089		Cooling water outlet valve FB	1
SV_4012_01_MV	VAR	BOOL	000085		Cooling water outlet valve	1
SV_4012_01_OP	VAR	BOOL	000169		Valve ON/OFF	1
SV_4014_01_A	VAR	BOOL	000312			2
SV_4014_01_FB	VAR	BOOL	100088		Steam inlet valve FB	1
SV_4014_01_MV	VAR	BOOL	000086		Steam inlet valve	1
SV_4014_01_OP	VAR	BOOL	000327			2
SV_4015_01_A	VAR	BOOL	000313			2
SV_4015_01_FB	VAR	BOOL	100098		Steam inlet valve FB	1
SV_4015_01_MV	VAR	BOOL	000092		Reactor Steam inlet valve	1
SV_4015_01_OP	VAR	BOOL	000328			2
SV_4016_01_A	VAR	BOOL	000314			2
SV_4016_01_FB	VAR	BOOL	100090		Steam Inlet Valve FB	1
SV_4016_01_MV	VAR	BOOL	000084		Steam Inlet Valve	1
SV_4016_01_OP	VAR	BOOL	000329			2
System_Clock	IVAR	SECT_CTRL				0
Temp_dz	VAR	REAL				2
test	VAR	BOOL				1
TEST_TIME	VAR	TIME		t#7s		1
TEST_TIME2	VAR	TIME				1
TEST_TIME4	VAR	TIME				1
the_time	VAR	REAL				1
TIMER	VAR	TIME				2
TT_4005_01	VAR	REAL	400168		Reactor Temp.	1
TT_4005_01_AH	VAR	BOOL	000240			2
TT_4005_01_AHH	VAR	BOOL	000239			3
TT_4005_01_AL	VAR	BOOL	000242			2
TT_4005_01_ALL	VAR	BOOL	000241			3
TT_4005_01_ERR	VAR	BOOL	000127		Reactor Temp. Link Error	2
TT_4005_01_Filtered	VAR	REAL	400306			13
TT_4005_01_Filtered_Gain	VAR	REAL		1.0		1
TT_4005_01_Filtered_Lag	VAR	TIME		t#10s		1
TT_4005_01_LIM_AH	VAR	REAL	400570	1.0		1
TT_4005_01_LIM_AHH	VAR	REAL	400568	4.0		1
TT_4005_01_LIM_AL	VAR	REAL	400574	-1.0		1
TT_4005_01_LIM_ALL	VAR	REAL	400572	-4.0		1
TT_4005_01_MAX	VAR	REAL		150.0	Reactor Temp. Scale MAX	1
TT_4005_01_MIN	VAR	REAL		0.0	Reactor Temp. Scale Min	1
TT_4005_01_SP	VAR	REAL	400222	36.0	Temperature Set Point	15
TT_4005_01_SP_controller	VAR	REAL				4
TT_4006_01	VAR	REAL	400140		Temp. For pH1	1
TT_4006_01_ERR	VAR	BOOL	000129		Temp for pH1 Link Error	2
TT_4006_01_MAX	VAR	REAL		140.0	Temp. For pH1 Scale Max	1
TT_4006_01_MIN	VAR	REAL		0.0	Temp. For pH1 Scale Min	1
TT_4006_02	VAR	REAL	400144		Temp. For pH2 Scale MIN	1

table continued...

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

Variable name	Type	DType	Address	Initial value	Comment	Used
TT_4006_02_ERR	VAR	BOOL	000131		Temp for pH2 Link Error	2
TT_4006_02_MAX	VAR	REAL		140.0	Temp. For pH2 Scale MAX	1
TT_4006_02_MIN	VAR	REAL		0.0	Temp. For pH2 Scale MIN	1
TT_4009_01_AHH	VAR	BOOL	000274			0
TT_4009_01_AL	VAR	BOOL	000275			0
TT_4009_01_ALL	VAR	BOOL	000276			0
TT_4010_01	VAR	REAL	400172		Analyser Temp.	5
TT_4010_01_AH	VAR	BOOL	000298			2
TT_4010_01_AHH	VAR	BOOL	000299			2
TT_4010_01_AL	VAR	BOOL	000300			2
TT_4010_01_ALL	VAR	BOOL	000301			2
TT_4010_01_ERR	VAR	BOOL	000143		Analyser Temp Link Error	2
TT_4010_01_LIM_AH	VAR	REAL	400680	35.0		1
TT_4010_01_LIM_AHH	VAR	REAL	400682	40.0		1
TT_4010_01_LIM_AL	VAR	REAL	400684	15.0		1
TT_4010_01_LIM_ALL	VAR	REAL	400686	10.0		1
TT_4010_01_MAX	VAR	REAL		150.0	Analyser Temp. Scale MAX	1
TT_4010_01_MIN	VAR	REAL		0.0	Analyser Temp. Scale MIN	1
TT_4010_02	VAR	REAL	400136		Temp. Meas. (Dissolved O2)	1
TT_4010_02_AH	VAR	BOOL	000290			0
TT_4010_02_AHH	VAR	BOOL	000291			0
TT_4010_02_AL	VAR	BOOL	000292			0
TT_4010_02_ALL	VAR	BOOL	000293			0
TT_4010_02_ERR	VAR	BOOL	000141		Temp Meas (DO2) Link Error	2
TT_4010_02_LIM_AH	VAR	REAL	400664			0
TT_4010_02_LIM_AHH	VAR	REAL	400666			0
TT_4010_02_LIM_AL	VAR	REAL	400668			0
TT_4010_02_LIM_ALL	VAR	REAL	400670			0
TT_4010_02_MAX	VAR	REAL		70.0	Temp. Meas. (Dissolved O2) Scale MAX	1
TT_4010_02_MIN	VAR	REAL		0.0	Temp. Meas. (Dissolved O2) Scale MIN	1
TT_4011_01	VAR	REAL	400170		Inlet Vessel Temp.	6
TT_4011_01_AH	VAR	BOOL	000303			2
TT_4011_01_AHH	VAR	BOOL	000304			2
TT_4011_01_AL	VAR	BOOL	000305			2
TT_4011_01_ALL	VAR	BOOL	000306			2
TT_4011_01_ERR	VAR	BOOL	000144		Inlet Vessel Temp Link Error	2
TT_4011_01_LIM_AH	VAR	REAL	400688	1.0		1
TT_4011_01_LIM_AHH	VAR	REAL	400690	2.0		1
TT_4011_01_LIM_AL	VAR	REAL	400692	-1.0		1
TT_4011_01_LIM_ALL	VAR	REAL	400694	-2.0		1
TT_4011_01_MAX	VAR	REAL		150.0	Inlet Vessel Temp. Scale MAX	1
TT_4011_01_MIN	VAR	REAL		-10.0	Inlet Vessel Temp. Scale MIN	1
TT_4011_SP	VAR	REAL	400234		Feeding Tank Temp. Set Point	6
TT_4012_01	VAR	REAL	400174		Vessel Temp.	6
TT_4012_01_AH	VAR	BOOL	000308			2
TT_4012_01_AHH	VAR	BOOL	000309			2
TT_4012_01_AL	VAR	BOOL	000310			2
TT_4012_01_ALL	VAR	BOOL	000311			2
TT_4012_01_ERR	VAR	BOOL	000145		Vessel Temp Link Error	2
TT_4012_01_LIM_AH	VAR	REAL	400696	1.0		1
TT_4012_01_LIM_AHH	VAR	REAL	400698	2.0		1
TT_4012_01_LIM_AL	VAR	REAL	400700	-1.0		1
TT_4012_01_LIM_ALL	VAR	REAL	400702	-2.0		1
TT_4012_01_MAX	VAR	REAL		250.0	Vessel Temp. Scale MAX	1
TT_4012_01_MIN	VAR	REAL		-50.0	Vessel Temp. Scale MIN	1
TT_4012_SP	VAR	REAL	400236		Harvesting Tank Temp. Set Point	4
WT_4002_01	VAR	REAL	400152		Weight Balance (VS_4002_01)	8

table continued...

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

Variable name	Type	DType	Address	Initial value	Comment	Used
WT_4002_01_AH	VAR	BOOL	000223			2
WT_4002_01_AHH	VAR	BOOL	000224			2
WT_4002_01_AL	VAR	BOOL	000225			2
WT_4002_01_ALL	VAR	BOOL	000226			2
WT_4002_01_ERR	VAR	BOOL	000120		Weight Balance (VS_4002_01) Link Error	2
WT_4002_01_LIM_AH	VAR	REAL	400544	100.0		1
WT_4002_01_LIM_AHH	VAR	REAL	400546	110.0		1
WT_4002_01_LIM_AL	VAR	REAL	400548	20.0		1
WT_4002_01_LIM_ALL	VAR	REAL	400550	10.0		1
WT_4002_01_MAX	VAR	REAL		200.0	Weight Balance (VS_4002_01) Scale MAX	1
WT_4002_01_MIN	VAR	REAL			Weight Balance (VS_4002_01) Scale MIN	1
WT_4006_01	VAR	REAL	400264		Balance acid (RS232 converted to Ethernet)	2
WT_4006_01_AL	VAR	BOOL	000245			2
WT_4006_01_ALL	VAR	BOOL	000246			2
WT_4006_01_LIM_AL	VAR	REAL	400576	1.0		1
WT_4006_01_LIM_ALL	VAR	REAL	400578	0.5		1
WT_4006_02	VAR	REAL	400266		Balance base (RS232 converted to Ethernet)	2
WT_4006_02_AL	VAR	BOOL	000247			2
WT_4006_02_ALL	VAR	BOOL	000248			2
WT_4006_02_LIM_AL	VAR	REAL	400580	1.0		1
WT_4006_02_LIM_ALL	VAR	REAL	400582	0.5		1
WT_4008_01	VAR	REAL	400154		Weight Balance (Reactor)	5
WT_4008_01_AH	VAR	BOOL	000261			2
WT_4008_01_AHH	VAR	BOOL	000262			2
WT_4008_01_AL	VAR	BOOL	000263			2
WT_4008_01_ALL	VAR	BOOL	000264			2
WT_4008_01_ERR	VAR	BOOL	000134		Weight Balance (Reactor) Link Error	2
WT_4008_01_filter	VAR	REAL	400322			1
WT_4008_01_filter2	VAR	REAL	400324			2
WT_4008_01_LIM_AH	VAR	REAL	400608	88.0		1
WT_4008_01_LIM_AHH	VAR	REAL	400610	90.0		1
WT_4008_01_LIM_AL	VAR	REAL	400612	84.0		1
WT_4008_01_LIM_ALL	VAR	REAL	400614	82.0		1
WT_4008_01_MAX	VAR	REAL		500.0	Weight Balance (Reactor) Scale MAX	1
WT_4008_01_MIN	VAR	REAL		0.0	Weight Balance (Reactor) Scale MIN	1
WT_4008_SP	VAR	REAL	400228		Level Set Point (or Weight to be defined)	1

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
AT_4006	FBD:CL4006_pH	SUB_REAL	.13.112	148,196	IN1	R
	FBD:CL4006_pH	GT_REAL	.13.113	179,178	IN1	R
	FBD:CL4006_pH	SUB_REAL	.13.118	155,225	IN1	R
	FBD:CL4006_pH	LT_REAL	.13.119	179,208	IN1	R
	FBD:CL4006_pH	LE_REAL	.13.275	31,33	IN1	R
	FBD:CL4006_pH	GE_REAL	.13.278	31,42	IN1	R
	FBD:CL4006_pH	ADD_REAL	.13.280	7,51	IN1	R
	FBD:CL4006_pH	SUB_REAL	.13.281	7,57	IN1	R
	FBD:CL4006_pH	LAG_FILTER	FBI_13_329	56,22	OUT	W
AT_4006_01	FBD:Inputs	I_SCALE	.20.15	79,52	Y	W
	FBD:CL4006_pH	AVERA	FBI_13_120	1,12	IN1	R
	FBD:CL4006_pH	OPMDREAL	FBI_13_121	12,23	OFF	R
	FBD:CL4006_pH	MOVE	.13.129	70,15	IN	R
	FBD:CL4006_pH	SUB_REAL	.13.263	221,201	IN1	R
	FBD:CL4006_pH	SUB_REAL	.13.271	215,213	IN1	R
AT_4006_01_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_3	25,32	BIT7	W
	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,97	IN24	R
	FBD:CL4006_pH	AND_BOOL	.13.122	54,7	IN1	R
	FBD:CL4006_pH	AND_BOOL	.13.131	121,7	IN1	R
AT_4006_01_MAX	FBD:Inputs	I_SCALE	.20.15	62,53	MX	R
AT_4006_01_MIN	FBD:Inputs	I_SCALE	.20.15	62,52	MN	R
AT_4006_02	FBD:Inputs	I_SCALE	.20.16	122,53	Y	W
	FBD:CL4006_pH	AVERA	FBI_13_120	1,13	IN2	R
	FBD:CL4006_pH	OPMDREAL	FBI_13_121	12,24	AUTO	R
	FBD:CL4006_pH	MOVE	.13.126	70,8	IN	R
	FBD:CL4006_pH	SUB_REAL	.13.263	221,202	IN2	R
	FBD:CL4006_pH	SUB_REAL	.13.271	215,214	IN2	R
AT_4006_02_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_3	25,34	BIT9	W
	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,99	IN26	R
	FBD:CL4006_pH	AND_BOOL	.13.128	54,14	IN1	R
	FBD:CL4006_pH	AND_BOOL	.13.135	122,14	IN1	R
AT_4006_02_MAX	FBD:Inputs	I_SCALE	.20.16	105,54	MX	R
AT_4006_02_MIN	FBD:Inputs	I_SCALE	.20.16	105,53	MN	R
AT_4006_AVG	FBD:CL4006_pH	AVERA	FBI_13_120	20,7	OUT	W
	FBD:CL4006_pH	OPMDREAL	FBI_13_121	12,25	MAN	R
	FBD:CL4006_pH	MOVE	.13.126	86,8	OUT	W
	FBD:CL4006_pH	MOVE	.13.129	86,15	OUT	W
AT_4006_SENSOR_DEVIATION_A	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,101	IN28	R
	FBD:CL4006_pH	OR_BOOL	.13.269	269,206	OUT	W
AT_4006_SENSOR_DEVIATION_LIM	FBD:CL4006_pH	GT_REAL	.13.268	240,214	IN2	R
	FBD:CL4006_pH	MUL_REAL	.13.270	227,208	IN1	R
AT_4006_SP	FBD:CL4006_pH	SUB_REAL	.13.112	148,197	IN2	R
	FBD:CL4006_pH	SUB_REAL	.13.118	155,226	IN2	R
	FBD:CL4006_pH	SUB_REAL	.13.273	13,34	IN1	R
	FBD:CL4006_pH	ADD_REAL	.13.277	13,43	IN1	R
	FBD:CL4006_pH	SEL	.13.282	32,50	IN0	R
	FBD:CL4006_pH	PCR_IF1	FBI_13_286	14,70	SP	R
	FBD:CL4006_pH	PCR_IF1	FBI_13_295	94,166	SP	R
AT_4009_01	FBD:Inputs	I_SCALE	.20.9	94,28	Y	W
	FBD:CL4009_Biomass	AVERA	FBI_10_7	35,21	IN1	R
	FBD:CL4009_Biomass	MOVE	.10.12	92,18	IN	R
	FBD:CL4009_Biomass	GT_REAL	.10.17	7,85	IN1	R
	FBD:CL4009_Biomass	GT_REAL	.10.19	7,97	IN1	R
	FBD:CL4009_Biomass	LT_REAL	.10.21	8,109	IN1	R
	FBD:CL4009_Biomass	LT_REAL	.10.23	8,121	IN1	R
AT_4009_01_AH	FBD:ALARM_STATUS	OR_BOOL	.22.2	37,22	IN3	R
	FBD:CL4009_Biomass	GT_REAL	.10.17	24,85	OUT	W
AT_4009_01_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,79	IN6	R

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
	FBD:CL4009_Biomass	GT_REAL	.10.19	24,97	OUT	W
AT_4009_01_AL	FBD:ALARM_STATUS	OR_BOOL	.22.2	37,23	IN4	R
	FBD:CL4009_Biomass	LT_REAL	.10.21	25,109	OUT	W
AT_4009_01_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,80	IN7	R
	FBD:CL4009_Biomass	LT_REAL	.10.23	25,121	OUT	W
AT_4009_01_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_3	25,25	BIT0	W
	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,84	IN11	R
	FBD:CL4009_Biomass	AND_BOOL	.10.8	19,15	IN1	R
	FBD:CL4009_Biomass	AND_BOOL	.10.9	71,7	IN1	R
	FBD:CL4009_Biomass	AND_BOOL	.10.11	71,17	IN1	R
AT_4009_01_LIM_AH	FBD:CL4009_Biomass	GT_REAL	.10.17	7,86	IN2	R
AT_4009_01_LIM_AHH	FBD:CL4009_Biomass	GT_REAL	.10.19	7,98	IN2	R
AT_4009_01_LIM_AL	FBD:CL4009_Biomass	LT_REAL	.10.21	8,110	IN2	R
AT_4009_01_LIM_ALL	FBD:CL4009_Biomass	LT_REAL	.10.23	8,122	IN2	R
AT_4009_01_MAX	FBD:Inputs	I_SCALE	.20.9	77,29	MX	R
AT_4009_01_MIN	FBD:Inputs	I_SCALE	.20.9	77,28	MN	R
AT_4009_02	FBD:Inputs	I_SCALE	.20.12	94,35	Y	W
	FBD:CL4009_Biomass	AVERA	FBI_10_7	35,22	IN2	R
	FBD:CL4009_Biomass	MOVE	.10.10	92,8	IN	R
	FBD:CL4009_Biomass	GT_REAL	.10.25	46,91	IN1	R
	FBD:CL4009_Biomass	GT_REAL	.10.27	46,103	IN1	R
	FBD:CL4009_Biomass	LT_REAL	.10.29	47,115	IN1	R
	FBD:CL4009_Biomass	LT_REAL	.10.31	47,127	IN1	R
AT_4009_02_AH	FBD:ALARM_STATUS	OR_BOOL	.22.2	37,24	IN5	R
	FBD:CL4009_Biomass	GT_REAL	.10.25	63,91	OUT	W
AT_4009_02_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,81	IN8	R
	FBD:CL4009_Biomass	GT_REAL	.10.27	63,103	OUT	W
AT_4009_02_AL	FBD:ALARM_STATUS	OR_BOOL	.22.2	37,25	IN6	R
	FBD:CL4009_Biomass	LT_REAL	.10.29	64,115	OUT	W
AT_4009_02_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,82	IN9	R
	FBD:CL4009_Biomass	LT_REAL	.10.31	64,127	OUT	W
AT_4009_02_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_3	25,26	BIT1	W
	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,85	IN12	R
	FBD:CL4009_Biomass	AND_BOOL	.10.8	19,16	IN2	R
	FBD:CL4009_Biomass	AND_BOOL	.10.9	71,8	IN2	R
	FBD:CL4009_Biomass	AND_BOOL	.10.11	71,18	IN2	R
AT_4009_02_LIM_AH	FBD:CL4009_Biomass	GT_REAL	.10.25	46,92	IN2	R
AT_4009_02_LIM_AHH	FBD:CL4009_Biomass	GT_REAL	.10.27	46,104	IN2	R
AT_4009_02_LIM_AL	FBD:CL4009_Biomass	LT_REAL	.10.29	47,116	IN2	R
AT_4009_02_LIM_ALL	FBD:CL4009_Biomass	LT_REAL	.10.31	47,128	IN2	R
AT_4009_02_MAX	FBD:Inputs	I_SCALE	.20.12	77,36	MX	R
AT_4009_02_MIN	FBD:Inputs	I_SCALE	.20.12	77,35	MN	R
AT_4009_AVG	FBD:CL4009_Biomass	AVERA	FBI_10_7	54,16	OUT	W
	FBD:CL4009_Biomass	MOVE	.10.10	108,8	OUT	W
	FBD:CL4009_Biomass	MOVE	.10.12	108,18	OUT	W
	FBD:CL4009_Biomass	MUL_REAL	.10.35	18,72	IN1	R
AT_4009_FAILURE_IND	FBD:Inputs	I_SCALE	.20.20	126,32	Y	W
	FBD:CL4009_Biomass	GT_REAL	.10.32	16,138	IN1	R
AT_4009_FAILURE_IND_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_3	25,27	BIT2	W
	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,86	IN13	R
AT_4009_FAILURE_IND_MAX	FBD:Inputs	I_SCALE	.20.20	109,33	MX	R
AT_4009_FAILURE_IND_MIN	FBD:Inputs	I_SCALE	.20.20	109,32	MN	R
AT_4009_SENSORFAILLURE	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,83	IN10	R
	FBD:CL4009_Biomass	GT_REAL	.10.32	33,138	OUT	W
AT_4009_SENSORFAILLURE_LIM	FBD:CL4009_Biomass	GT_REAL	.10.32	16,139	IN2	R
AT_4010_01	FBD:Inputs	I_SCALE	.20.11	134,40	Y	W
	FBD:CL4010_OutletGasCompo	LT_REAL	.9.15	80,120	IN1	R

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
	FBD:CL4010_OutletGasCompo	LT_REAL	.9.16	80,131	IN1	R
	FBD:CL4010_OutletGasCompo	GT_REAL	.9.17	80,99	IN1	R
	FBD:CL4010_OutletGasCompo	GT_REAL	.9.18	80,111	IN1	R
AT_4010_01_AH	FBD:ALARM_STATUS	OR_BOOL	.22.2	37,26	IN7	R
	FBD:CL4010_OutletGasCompo	GT_REAL	.9.17	97,99	OUT	W
AT_4010_01_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,88	IN15	R
	FBD:CL4010_OutletGasCompo	GT_REAL	.9.18	97,111	OUT	W
AT_4010_01_AL	FBD:ALARM_STATUS	OR_BOOL	.22.2	37,27	IN8	R
	FBD:CL4010_OutletGasCompo	LT_REAL	.9.15	97,120	OUT	W
AT_4010_01_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,89	IN16	R
	FBD:CL4010_OutletGasCompo	LT_REAL	.9.16	97,131	OUT	W
AT_4010_01_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_3	25,28	BIT3	W
	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,98	IN25	R
AT_4010_01_LIM_AH	FBD:CL4010_OutletGasCompo	GT_REAL	.9.17	80,100	IN2	R
AT_4010_01_LIM_AHH	FBD:CL4010_OutletGasCompo	GT_REAL	.9.18	80,112	IN2	R
AT_4010_01_LIM_AL	FBD:CL4010_OutletGasCompo	LT_REAL	.9.15	80,121	IN2	R
AT_4010_01_LIM_ALL	FBD:CL4010_OutletGasCompo	LT_REAL	.9.16	80,132	IN2	R
AT_4010_01_MAX	FBD:Inputs	I_SCALE	.20.11	117,41	MX	R
AT_4010_01_MIN	FBD:Inputs	I_SCALE	.20.11	117,40	MN	R
AT_4010_02	FBD:Inputs	I_SCALE	.20.13	152,43	Y	W
	FBD:CL4010_OutletGasCompo	LT_REAL	.9.10	10,123	IN1	R
	FBD:CL4010_OutletGasCompo	LT_REAL	.9.12	10,135	IN1	R
	FBD:CL4010_OutletGasCompo	GT_REAL	.9.13	10,102	IN1	R
	FBD:CL4010_OutletGasCompo	GT_REAL	.9.14	10,114	IN1	R
	FBD:CL4010_OutletGasCompo	PCR_EF1	FBI_9_36	11,31	PV	R
AT_4010_02_AH	FBD:ALARM_STATUS	OR_BOOL	.22.2	37,28	IN9	R
	FBD:CL4010_OutletGasCompo	GT_REAL	.9.13	27,102	OUT	W
AT_4010_02_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,90	IN17	R
	FBD:CL4010_OutletGasCompo	GT_REAL	.9.14	27,114	OUT	W
AT_4010_02_AL	FBD:ALARM_STATUS	OR_BOOL	.22.2	37,29	IN10	R
	FBD:CL4010_OutletGasCompo	LT_REAL	.9.10	27,123	OUT	W
AT_4010_02_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,91	IN18	R
	FBD:CL4010_OutletGasCompo	LT_REAL	.9.12	27,135	OUT	W
AT_4010_02_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_3	25,29	BIT4	W
	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,99	IN26	R
AT_4010_02_LIM_AH	FBD:CL4010_OutletGasCompo	GT_REAL	.9.13	10,103	IN2	R
AT_4010_02_LIM_AHH	FBD:CL4010_OutletGasCompo	GT_REAL	.9.14	10,115	IN2	R
AT_4010_02_LIM_AL	FBD:CL4010_OutletGasCompo	LT_REAL	.9.10	10,124	IN2	R
AT_4010_02_LIM_ALL	FBD:CL4010_OutletGasCompo	LT_REAL	.9.12	10,136	IN2	R
AT_4010_02_MAX	FBD:Inputs	I_SCALE	.20.13	135,44	MX	R
AT_4010_02_MIN	FBD:Inputs	I_SCALE	.20.13	135,43	MN	R
AT_4010_03	FBD:Inputs	I_SCALE	.20.21	168,47	Y	W
	FBD:CL4010_OutletGasCompo	LT_REAL	.9.19	134,120	IN1	R
	FBD:CL4010_OutletGasCompo	LT_REAL	.9.20	134,131	IN1	R
	FBD:CL4010_OutletGasCompo	GT_REAL	.9.21	134,99	IN1	R
	FBD:CL4010_OutletGasCompo	GT_REAL	.9.22	134,111	IN1	R
AT_4010_03_AH	FBD:ALARM_STATUS	OR_BOOL	.22.2	37,30	IN11	R
	FBD:CL4010_OutletGasCompo	GT_REAL	.9.21	151,99	OUT	W
AT_4010_03_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,92	IN19	R
	FBD:CL4010_OutletGasCompo	GT_REAL	.9.22	151,111	OUT	W
AT_4010_03_AL	FBD:ALARM_STATUS	OR_BOOL	.22.2	37,31	IN12	R
	FBD:CL4010_OutletGasCompo	LT_REAL	.9.19	151,120	OUT	W
AT_4010_03_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,93	IN20	R
	FBD:CL4010_OutletGasCompo	LT_REAL	.9.20	151,131	OUT	W
AT_4010_03_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_3	25,30	BIT5	W
	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,100	IN27	R
AT_4010_03_LIM_AH	FBD:CL4010_OutletGasCompo	GT_REAL	.9.21	134,100	IN2	R

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
AT_4010_03_LIM_AHH	FBD:CL4010_OutletGasCompo	GT_REAL	.9.22	134,112	IN2	R
AT_4010_03_LIM_AL	FBD:CL4010_OutletGasCompo	LT_REAL	.9.19	134,121	IN2	R
AT_4010_03_LIM_ALL	FBD:CL4010_OutletGasCompo	LT_REAL	.9.20	134,132	IN2	R
AT_4010_03_MAX	FBD:Inputs	I_SCALE	.20.21	151,48	MX	R
AT_4010_03_MIN	FBD:Inputs	I_SCALE	.20.21	151,47	MN	R
BLWR_4003_01_MV1	FBD:CL4003_Inlet_Gas_Flow	OPMDBOOL	FBI_16_1	31,11	OUT	W
BLWR_4003_01_MV1_OP	FBD:CL4003_Inlet_Gas_Flow	OPMDBOOL	FBI_16_1	12,14	MAN	R
BLWR_4005_01_AUTO	FBD:CL4005_PBR_Temp	OPMDREAL	FBI_14_2	73,12	AUTO	R
	FBD:CL4005_PBR_Temp	MOVE	.14.140	44,20	OUT	W
	FBD:CL4005_PBR_Temp	MOVE	.14.143	45,26	OUT	W
BLWR_4005_01_ERR	FBD:CL4000_Lights	OR_BOOL	.1.8	7,67	IN2	R
BLWR_4005_01_MV1	FBD:CL4005_PBR_Temp	OPMDBOOL	FBI_14_1	54,10	OUT	W
BLWR_4005_01_MV1_OP	FBD:CL4005_PBR_Temp	OPMDBOOL	FBI_14_1	35,13	MAN	R
BLWR_4005_01_MV2	FBD:Outputs	O_SCALE	FBI_19_18	69,26	X	R
	FBD:CL4005_PBR_Temp	OPMDREAL	FBI_14_2	92,10	OUT	W
BLWR_4005_01_MV2_MAX	FBD:Outputs	O_SCALE	FBI_19_18	69,27	MX	R
BLWR_4005_01_MV2_MIN	FBD:Outputs	O_SCALE	FBI_19_18	69,25	MN	R
BLWR_4005_01_MV2_OP	FBD:CL4005_PBR_Temp	OPMDREAL	FBI_14_2	73,13	MAN	R
CIVa_Emergency_Button	FBD:EMERGENCY_BUTTON	MOVE	.24.2	61,17	OUT	W
	FBD:EMERGENCY_BUTTON	MOVE	.24.22	59,9	OUT	W
CIVa_General_alarm_status	FBD:ALARM_STATUS	MOVE	.22.10	42,131	OUT	W
	FBD:ALARM_STATUS	MOVE	.22.12	42,140	OUT	W
	FBD:ALARM_STATUS	MOVE	.22.14	42,149	OUT	W
	FBD:ALARM_STATUS	MOVE	.22.16	42,157	OUT	W
CIVA_HighLowAlarm_status	FBD:ALARM_STATUS	OR_BOOL	.22.3	90,15	OUT	W
	FBD:ALARM_STATUS	AND_BOOL	.22.9	10,130	IN1	R
	FBD:ALARM_STATUS	AND_BOOL	.22.11	10,139	IN1	R
	FBD:ALARM_STATUS	AND_BOOL	.22.13	10,148	IN1	R
	FBD:ALARM_STATUS	AND_BOOL	.22.15	10,156	IN1	R
CIVA_SC_Activate_Setting	FBD:System_Clock	SET_TOD	FBI_21_2	43,9	S_PULSE	R
CIVA_SysClock_Day	FBD:System_Clock	GET_TOD	FBI_21_1	20,13	DAY	W
	FBD:CL4006_pH	MOVE	.13.92	269,164	IN	R
CIVA_SysClock_dayofweek	FBD:System_Clock	GET_TOD	FBI_21_1	20,11	D_WEEK	W
CIVA_SysClock_dayofweek_SET	FBD:System_Clock	SET_TOD	FBI_21_2	43,10	D_WEEK	R
CIVA_SysClock_Day_SET	FBD:System_Clock	SET_TOD	FBI_21_2	43,12	DAY	R
CIVA_SysClock_Hour	FBD:System_Clock	GET_TOD	FBI_21_1	20,15	HOUR	W
	FBD:CL4006_pH	MOVE	.13.93	269,169	IN	R
CIVA_SysClock_Hour_SET	FBD:System_Clock	SET_TOD	FBI_21_2	43,14	HOUR	R
CIVA_SysClock_Minute	FBD:System_Clock	GET_TOD	FBI_21_1	20,16	MINUTE	W
	FBD:CL4006_pH	MOVE	.13.94	269,174	IN	R
CIVA_SysClock_Minute_SET	FBD:System_Clock	SET_TOD	FBI_21_2	43,15	MINUTE	R
CIVA_SysClock_Month	FBD:System_Clock	GET_TOD	FBI_21_1	20,12	MONTH	W
	FBD:CL4006_pH	MOVE	.13.91	269,159	IN	R
CIVA_SysClock_Month_SET	FBD:System_Clock	SET_TOD	FBI_21_2	43,11	MONTH	R
CIVA_SysClock_Second	FBD:System_Clock	GET_TOD	FBI_21_1	20,17	SECOND	W
	FBD:CL4006_pH	MOVE	.13.95	269,179	IN	R
CIVA_SysClock_Second_SET	FBD:System_Clock	SET_TOD	FBI_21_2	43,16	SECOND	R
CIVA_SysClock_Year	FBD:System_Clock	GET_TOD	FBI_21_1	20,14	YEAR	W
	FBD:CL4006_pH	MOVE	.13.85	269,154	IN	R
CIVA_SysClock_Year_SET	FBD:System_Clock	SET_TOD	FBI_21_2	43,13	YEAR	R
CIVA_VeryHighLowAlarm_status	FBD:ALARM_STATUS	OR_BOOL	.22.8	114,74	OUT	W
	FBD:ALARM_STATUS	AND_BOOL	.22.9	10,131	IN2	R
	FBD:ALARM_STATUS	AND_BOOL	.22.11	10,140	IN2	R
	FBD:ALARM_STATUS	AND_BOOL	.22.13	10,149	IN2	R
	FBD:ALARM_STATUS	AND_BOOL	.22.15	10,157	IN2	R
CL4000_Calibration	FBD:CL4000_Lights	MUL_REAL	.1.4	4,38	IN2	R
CL4000_ControlLoop_Mode	FBD:EMERGENCY_BUTTON	MOVE	.24.3	45,23	OUT	W

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
	FBD:CL4000_Lights	OPMDREAL	FBI_1_2	67,34	SELEC	R
	FBD:CL4000_Lights	EQ_INT	.1.17	52,89	IN1	R
	FBD:CL4000_Lights	MOVE	.1.20	112,84	OUT	W
	FBD:CL4000_Lights	EQ_INT	.1.29	49,101	IN1	R
	FBD:CL4000_Lights	EQ_INT	.1.31	49,107	IN1	R
	FBD:CL4000_Lights	MOVE	.1.35	109,109	OUT	W
	FBD:CL4010_OutletGasCompo	INT_TO_BOOL	.9.37	7,59	IN	R
CL4000_Light_10percent	FBD:CL4000_Lights	SEL	.1.6	89,33	G	R
	FBD:CL4000_Lights	OR_BOOL	.1.8	24,66	OUT	W
CL4000_RAMP_PARA	FBD:CL4000_Lights	RAMP	FBI_1_5	23,38	PARA	R
CL4001_Agitator_Mode	FBD:CL4001_Inlet_Liquid_F>low	OPMDREAL	FBI_23_1	93,8	SELEC	R
	FBD:CL4001_Inlet_Liquid_F>low	OPMDBOOL	FBI_23_2	57,10	SELEC	R
	FBD:CL4002_Outlet_Liquid_>Flow	OPMDREAL	FBI_17_1	11,27	SELEC	R
CL4001_ControlLoop_Mode	FBD:EMERGENCY_BUTTON	MOVE	.24.4	45,28	OUT	W
	FBD:CL4001_Inlet_Liquid_F>low	OPMDBOOL	FBI_23_3	134,135	SELEC	R
	FBD:CL4001_Inlet_Liquid_F>low	OPMDREAL	FBI_23_4	47,41	SELEC	R
	FBD:CL4001_Inlet_Liquid_F>low	INT_TO_BOOL	.23.42	12,61	IN	R
	FBD:CL4001_Inlet_Liquid_F>low	OPMDBOOL	FBI_23_51	147,49	SELEC	R
	FBD:CL4001_Inlet_Liquid_F>low	OPMDBOOL	FBI_23_74	134,105	SELEC	R
	FBD:CL4001_Inlet_Liquid_F>low	MOVE	.23.151	247,179	OUT	W
	FBD:CL4001_Inlet_Liquid_F>low	EQ_INT	.23.193	241,22	IN1	R
	FBD:CL4001_Inlet_Liquid_F>low	EQ_INT	.23.196	240,39	IN1	R
	FBD:CL4001_Inlet_Liquid_F>low	EQ_INT	.23.211	235,57	IN1	R
	FBD:CL4001_Inlet_Liquid_F>low	EQ_INT	.23.214	235,75	IN1	R
	FBD:CL4001_Inlet_Liquid_F>low	EQ_INT	.23.217	250,116	IN1	R
	FBD:CL4001_Inlet_Liquid_F>low	MOVE	.23.219	295,116	OUT	W
	FBD:CL4001_Inlet_Liquid_F>low	MOVE	.23.237	248,213	OUT	W
	FBD:CL4002_Outlet_Liquid_>Flow	MOVE	.17.104	194,40	OUT	W
CL4001_ERR	FBD:CL4001_Inlet_Liquid_F>low	PCR_SF1	FBI_23_97	41,48	ERR	W
CL4001_IMP	FBD:CL4001_Inlet_Liquid_F>low	PCR_SF1	FBI_23_97	24,49	IMP	R
CL4001_IMP.KM	FBD:CL4008_PBR_Liquid_Lev>el	DIV_REAL	.11.40	65,52	IN1	R
CL4001_IMV	FBD:CL4001_Inlet_Liquid_F>low	PCR_SF1	FBI_23_97	41,47	IMV	W
CL4001_INIT	FBD:CL4001_Inlet_Liquid_F>low	INT_TO_BOOL	.23.42	31,61	OUT	W
	FBD:CL4001_Inlet_Liquid_F>low	PCR_SF1	FBI_23_97	24,45	INIT	R

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
CL4001_INLETPUMP_VARIATOR	FBD:CL4001_Inlet_Liquid_F>low	OPMDBOOL	FBI_23_3	134,136	OFF	R
	FBD:CL4001_Inlet_Liquid_F>low	AND_BOOL	.23.84	96,140	IN1	R
	FBD:CL4001_Inlet_Liquid_F>low	RS	FBI_23_85	108,144	R1	R
	FBD:CL4001_Inlet_Liquid_F>low	AND_BOOL	.23.86	96,131	IN2	R
	FBD:CL4001_Inlet_Liquid_F>low	AND_BOOL	.23.71	96,110	IN1	R
	FBD:CL4001_Inlet_Liquid_F>low	AND_BOOL	.23.78	96,101	IN2	R
	FBD:CL4001_Inlet_Liquid_F>low	RS	FBI_23_73	108,114	R1	R
	FBD:CL4001_Inlet_Liquid_F>low	OPMDBOOL	FBI_23_74	134,106	OFF	R
	FBD:CL4001_Inlet_Liquid_F>low	RS	FBI_23_79	108,104	R1	R
	FBD:CL4001_Inlet_Liquid_F>low	RS	FBI_23_87	108,134	R1	R
	FBD:CL4001_Inlet_Liquid_F>low	TOF	FBI_23_111	178,49	Q	W
	FBD:CL4002_Outlet_Liquid_>Flow	AND_BOOL	.17.78	34,58	IN2	R
CL4001_Level_Agitator_ON	FBD:CL4001_Inlet_Liquid_F>low	GT_REAL	.23.39	23,12	IN2	R
CL4001_LIM	FBD:CL4001_Inlet_Liquid_F>low	PCR_SF1	FBI_23_97	24,51	LIM	R
CL4001_PumpSpeed	FBD:Outputs	O_SCALE	FBI_19_12	70,41	X	R
	FBD:CL4001_Inlet_Liquid_F>low	OPMDREAL	FBI_23_4	66,41	OUT	W
	FBD:CL4001_Inlet_Liquid_F>low	EQ_REAL	.23.55	104,75	IN1	R
	FBD:CL4001_Inlet_Liquid_F>low	NE_REAL	.23.56	104,59	IN1	R
	FBD:CL4001_Inlet_Liquid_F>low	NE_REAL	.23.80	104,40	IN1	R
	FBD:CL4001_Inlet_Liquid_F>low	EQ_REAL	.23.82	104,46	IN1	R
	FBD:CL4001_Inlet_Liquid_F>low	PCR_SF1	FBI_23_97	24,48	RCPY	R
	FBD:CL4001_Inlet_Liquid_F>low	NE_REAL	.23.136	104,90	IN1	R
	FBD:CL4002_Outlet_Liquid_>Flow	MUL_REAL	.17.79	59,52	IN1	R
	FBD:CL4008_PBR_Liquid_Lev>el	SUB_REAL	.11.19	52,38	IN2	R
	FBD:CL4008_PBR_Liquid_Lev>el	MUL_REAL	.11.21	52,31	IN1	R
CL4001_PumpSpeed_OP	FBD:CL4001_Inlet_Liquid_F>low	OPMDREAL	FBI_23_4	47,44	MAN	R
	FBD:CL4001_Inlet_Liquid_F>low	PCR_SF1	FBI_23_97	24,53	YMAN	R
	FBD:CL4001_Inlet_Liquid_F>low	MOVE	.23.221	163,86	OUT	W
	FBD:CL4001_Inlet_Liquid_F>low	MOVE	.23.222	62,64	OUT	W

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
CL4001_TUNE.TS	FBD:CL4001_Inlet_Liquid_F>low	SAMPLETM	FBI_23_41	12,42	INTERVAL	R
	FBD:CL4001_Inlet_Liquid_F>low	PCR_SF1	FBI_23_97	24,50	TUNE	R
CL4001_TUNE.TRBF	FBD:CL4001_Inlet_Liquid_F>low	PCR_ZTR	FBI_23_98	41,72	TRBF	W
CL4001_Y	FBD:CL4001_Inlet_Liquid_F>low	PCR_SF1	FBI_23_97	41,46	Y	W
CL4001_ZTR_ERR	FBD:CL4001_Inlet_Liquid_F>low	PCR_ZTR	FBI_23_98	41,73	ERR	W
CL4001_ZTR_TUNE	FBD:CL4001_Inlet_Liquid_F>low	PCR_ZTR	FBI_23_98	23,74	TUNE_ZTR	R
CL4002_Agitator_Mode	FBD:CL4002_Outlet_Liquid_>Flow	OPMDBOOL	FBI_17_2	47,16	SELEC	R
CL4002_ControlLoop_Mode	FBD:EMERGENCY_BUTTON	MOVE	.24.5	45,33	OUT	W
	FBD:CL4002_Outlet_Liquid_>Flow	OPMDREAL	FBI_17_6	94,44	SELEC	R
	FBD:CL4002_Outlet_Liquid_>Flow	OPMDBOOL	FBI_17_43	80,117	SELEC	R
	FBD:CL4002_Outlet_Liquid_>Flow	OPMDBOOL	FBI_17_51	97,176	SELEC	R
	FBD:CL4002_Outlet_Liquid_>Flow	OPMDBOOL	FBI_17_59	94,207	SELEC	R
	FBD:CL4002_Outlet_Liquid_>Flow	OPMDBOOL	FBI_17_112	45,73	SELEC	R
	FBD:CL4008_PBR_Liquid_Lev>el	MOVE	.11.2	34,9	OUT	W
	FBD:CL4008_PBR_Liquid_Lev>el	EQ_INT	.11.3	7,19	IN1	R
	FBD:CL4008_PBR_Liquid_Lev>el	EQ_INT	.11.26	57,15	IN1	R
	FBD:CL4008_PBR_Liquid_Lev>el	MOVE	.11.28	99,13	OUT	W
CL4002_DERIV_MODE	FBD:CL4002_Outlet_Liquid_>Flow	DERIV	FBI_17_107	90,73	MODE	R
CL4002_DERIV_MODE.man	FBD:CL4002_Outlet_Liquid_>Flow	OPMDBOOL	FBI_17_112	64,73	OUT	W
	FBD:CL4002_Outlet_Liquid_>Flow	DERIV	FBI_17_116	85,92	MODE	R
CL4002_DERIV_PARA	FBD:CL4002_Outlet_Liquid_>Flow	DERIV	FBI_17_107	90,74	PARA	R
	FBD:CL4002_Outlet_Liquid_>Flow	DERIV	FBI_17_116	85,93	PARA	R
CL4002_EstimatedFlow_TEST	FBD:CL4002_Outlet_Liquid_>Flow	AVGMV	FBI_17_119	150,94	Y	W
CL4002_EstimatedOutletLiquidFlow	FBD:CL4002_Outlet_Liquid_>Flow	MUL_REAL	.17.109	120,72	OUT	W
CL4002_OUTLETPUMP_VARIATOR	FBD:CL4002_Outlet_Liquid_>Flow	AND_BOOL	.17.45	51,180	IN1	R
	FBD:CL4002_Outlet_Liquid_>Flow	RS	FBI_17_47	66,183	R1	R
	FBD:CL4002_Outlet_Liquid_>Flow	AND_BOOL	.17.48	45,171	IN2	R
	FBD:CL4002_Outlet_Liquid_>Flow	AND_BOOL	.17.52	40,202	IN2	R
	FBD:CL4002_Outlet_Liquid_>Flow	RS	FBI_17_54	65,202	R1	R

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
	FBD:CL4002_Outlet_Liquid_>Flow	AND_BOOL	.17.56	50,207	IN1	R
	FBD:CL4002_Outlet_Liquid_>Flow	RS	FBI_17_50	65,174	R1	R
	FBD:CL4002_Outlet_Liquid_>Flow	OPMDBOOL	FBI_17_51	97,177	OFF	R
	FBD:CL4002_Outlet_Liquid_>Flow	RS	FBI_17_58	63,211	R1	R
	FBD:CL4002_Outlet_Liquid_>Flow	OPMDBOOL	FBI_17_59	94,208	OFF	R
	FBD:CL4002_Outlet_Liquid_>Flow	TOF	FBI_17_86	110,117	Q	W
CL4002_PumpSpeed	FBD:Outputs	O_SCALE	FBI_19_14	57,52	X	R
	FBD:CL4002_Outlet_Liquid_>Flow	OPMDREAL	FBI_17_6	113,44	OUT	W
	FBD:CL4002_Outlet_Liquid_>Flow	NE_REAL	.17.34	32,130	IN1	R
	FBD:CL4002_Outlet_Liquid_>Flow	NE_REAL	.17.40	32,111	IN1	R
	FBD:CL4002_Outlet_Liquid_>Flow	EQ_REAL	.17.41	32,117	IN1	R
	FBD:CL4002_Outlet_Liquid_>Flow	EQ_REAL	.17.93	32,145	IN1	R
	FBD:CL4002_Outlet_Liquid_>Flow	NE_REAL	.17.101	32,160	IN1	R
	FBD:CL4008_PBR_Liquid_Lev>el	PCR_IF1	FBI_11_5	25,47	YMAN	R
CL4002_PumpSpeed_OP	FBD:CL4002_Outlet_Liquid_>Flow	OPMDREAL	FBI_17_6	94,47	MAN	R
	FBD:CL4002_Outlet_Liquid_>Flow	MOVE	.17.106	88,156	OUT	W
CL4002_Weight_Agitator_ON	FBD:CL4002_Outlet_Liquid_>Flow	GT_REAL	.17.11	9,18	IN2	R
CL4003_Controlloop_Mode	FBD:EMERGENCY_BUTTON	MOVE	.24.6	45,38	OUT	W
	FBD:CL4003_Inlet_Gas_Flow	OPMDREAL	FBI_16_3	43,39	SELEC	R
	FBD:CL4003_Inlet_Gas_Flow	OPMDREAL	FBI_16_23	82,55	SELEC	R
	FBD:CL4003_Inlet_Gas_Flow	EQ_INT	.16.80	8,92	IN1	R
	FBD:CL4003_Inlet_Gas_Flow	VALVBOOL	FBI_16_83	65,21	SELECT	R
	FBD:CL4007_PBR_Pressure	MOVE	.12.98	99,132	OUT	W
CL4003_Recycle_Mode	FBD:CL4003_Inlet_Gas_Flow	OPMDBOOL	FBI_16_1	12,11	SELEC	R
	FBD:CL4003_Inlet_Gas_Flow	OPMDREAL	FBI_16_2	13,21	SELEC	R
	FBD:CL4003_Inlet_Gas_Flow	VALVBOOL	FBI_16_84	94,9	SELECT	R
CL4004_ALARM_SELECTION	FBD:CL4004_Oulet_Gas_Flow	SEL	.15.40	9,117	G	R
	FBD:CL4004_Oulet_Gas_Flow	MOVE	.15.42	61,90	OUT	W
	FBD:CL4004_Oulet_Gas_Flow	MOVE	.15.44	62,96	OUT	W
	FBD:CL4004_Oulet_Gas_Flow	SEL	.15.47	9,144	G	R
	FBD:CL4004_Oulet_Gas_Flow	SEL	.15.54	9,172	G	R
	FBD:CL4004_Oulet_Gas_Flow	SEL	.15.62	11,197	G	R
CL4004_ControlLoop_Mode	FBD:EMERGENCY_BUTTON	MOVE	.24.7	45,43	OUT	W
	FBD:CL4004_Oulet_Gas_Flow	INT_TO_BOOL	.15.14	8,68	IN	R
	FBD:CL4004_Oulet_Gas_Flow	EQ_INT	.15.24	46,105	IN1	R
	FBD:CL4004_Oulet_Gas_Flow	EQ_INT	.15.41	26,89	IN1	R
	FBD:CL4004_Oulet_Gas_Flow	EQ_INT	.15.50	46,132	IN1	R
	FBD:CL4004_Oulet_Gas_Flow	EQ_INT	.15.57	46,160	IN1	R
	FBD:CL4004_Oulet_Gas_Flow	EQ_INT	.15.64	48,185	IN1	R
	FBD:CL4007_PBR_Pressure	MOVE	.12.9	51,63	OUT	W
CL4004_ERR	FBD:CL4004_Oulet_Gas_Flow	PCR_SF1	FBI_15_12	42,50	ERR	W

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
CL4004_Flag4Init	FBD:CL4004_Oulet_Gas_Flow	PCR_SF1	FBI_15_12	25,54	MAN	R
	FBD:CL4004_Oulet_Gas_Flow	INT_TO_BOOL	.15.14	27,68	OUT	W
CL4004_IMP	FBD:CL4004_Oulet_Gas_Flow	PCR_SF1	FBI_15_12	25,51	IMP	R
CL4004_IMV	FBD:CL4004_Oulet_Gas_Flow	PCR_SF1	FBI_15_12	42,49	IMV	W
CL4004_INIT	FBD:CL4004_Oulet_Gas_Flow	PCR_SF1	FBI_15_12	25,47	INIT	R
	FBD:CL4004_Oulet_Gas_Flow	TOF	FBI_15_16	61,69	Q	W
CL4004_LIM	FBD:CL4004_Oulet_Gas_Flow	PCR_SF1	FBI_15_12	25,53	LIM	R
CL4004_TUNE	FBD:CL4004_Oulet_Gas_Flow	PCR_SF1	FBI_15_12	25,52	TUNE	R
CL4004_TUNE.TS	FBD:CL4004_Oulet_Gas_Flow	SAMPLETM	FBI_15_13	5,46	INTERVAL	R
CL4004_TUNE.TS	FBD:CL4004_Oulet_Gas_Flow	TOF	FBI_15_16	45,70	PT	R
CL4004_Y	FBD:CL4004_Oulet_Gas_Flow	PCR_SF1	FBI_15_12	25,50	RCPY	R
	FBD:CL4004_Oulet_Gas_Flow	PCR_SF1	FBI_15_12	42,48	Y	W
CL4005_Blower_Mode	FBD:CL4005_PBR_Temp	OPMDBOOL	FBI_14_1	35,10	SELEC	R
	FBD:CL4005_PBR_Temp	OPMDREAL	FBI_14_2	73,10	SELEC	R
CL4005_ControlLoop_Mode	FBD:EMERGENCY_BUTTON	MOVE	.24.8	45,48	OUT	W
	FBD:CL4005_PBR_Temp	OPMDBOOL	FBI_14_4	60,45	SELEC	R
	FBD:CL4005_PBR_Temp	OPMDBOOL	FBI_14_5	122,94	SELEC	R
	FBD:CL4005_PBR_Temp	INT_TO_BOOL	.14.16	12,137	IN	R
	FBD:CL4005_PBR_Temp	VALVBOOL	FBI_14_144	124,82	SELECT	R
CL4005_ERR	FBD:CL4005_PBR_Temp	PCR_IF1	FBI_14_125	59,89	ERR	W
CL4005_Flag4Init	FBD:CL4005_PBR_Temp	INT_TO_BOOL	.14.16	31,137	OUT	W
	FBD:CL4005_PBR_Temp	PCR_IF1	FBI_14_125	42,94	MAN	R
CL4005_IMV	FBD:CL4005_PBR_Temp	PCR_IF1	FBI_14_125	59,88	IMV	W
CL4005_INIT	FBD:CL4005_PBR_Temp	TOF	FBI_14_19	65,138	Q	W
	FBD:CL4005_PBR_Temp	PCR_IF1	FBI_14_125	42,86	INIT	R
CL4005_PARAPWM	FBD:CL4005_PBR_Temp	PWM	FBI_14_11	77,88	PARA	R
CL4005_PARAPWM.t_min	FBD:CL4005_PBR_Temp	TIME_TO_REAL	.14.119	115,159	IN	R
CL4005_PARAPWM.t_period	FBD:CL4005_PBR_Temp	TIME_TO_REAL	.14.120	115,164	IN	R
CL4005_PCRDECOMP	FBD:CL4005_PBR_Temp	PCR_IF1	FBI_14_125	42,93	DECOMP	R
CL4005_PCRIMP	FBD:CL4005_PBR_Temp	PCR_IF1	FBI_14_125	42,90	IMP	R
CL4005_PCRLIM	FBD:CL4005_PBR_Temp	PCR_IF1	FBI_14_125	42,92	LIM	R
CL4005_PCR_ZTR_ERR	FBD:CL4005_PBR_Temp	PCR_ZTR	FBI_14_43	29,157	ERR	W
CL4005_RCPY	FBD:CL4005_PBR_Temp	SEL	.14.124	184,156	OUT	W
	FBD:CL4005_PBR_Temp	PCR_IF1	FBI_14_125	42,89	RCPY	R
CL4005_Temp_deadzone	FBD:CL4005_PBR_Temp	SUB_REAL	.14.104	124,126	IN2	R
	FBD:CL4005_PBR_Temp	ADD_REAL	.14.107	124,135	IN2	R
	FBD:CL4005_PBR_Temp	ADD_REAL	.14.110	118,143	IN2	R
	FBD:CL4005_PBR_Temp	SUB_REAL	.14.111	118,149	IN2	R
CL4005_Temp_High	FBD:CL4005_PBR_Temp	ACT_DIA	FBI_14_109	176,131	ERR	W
	FBD:CL4005_PBR_Temp	SEL	.14.113	165,143	G	R
	FBD:CL4005_PBR_Temp	SEL	.14.114	110,169	G	R
	FBD:CL4005_PBR_Temp	AND_BOOL	.14.128	100,85	IN2	R
	FBD:CL4005_PBR_Temp	SUB_REAL	.14.134	5,84	EN	R
	FBD:CL4005_PBR_Temp	AND_BOOL	.14.135	5,103	IN2	R
CL4005_Temp_Low	FBD:CL4005_PBR_Temp	ACT_DIA	FBI_14_106	176,122	ERR	W
	FBD:CL4005_PBR_Temp	SEL	.14.112	143,140	G	R
	FBD:CL4005_PBR_Temp	SEL	.14.115	110,178	G	R
	FBD:CL4005_PBR_Temp	AND_BOOL	.14.127	98,97	IN2	R
	FBD:CL4005_PBR_Temp	ADD_REAL	.14.133	5,91	EN	R
	FBD:CL4005_PBR_Temp	AND_BOOL	.14.135	5,102	IN1	R
CL4005_TUNE.TS	FBD:CL4005_PBR_Temp	SAMPLETM	FBI_14_10	30,81	INTERVAL	R
CL4005_TUNE.TS	FBD:CL4005_PBR_Temp	TOF	FBI_14_19	49,139	PT	R
CL4005_TUNE.TRBF	FBD:CL4005_PBR_Temp	MOVE	.14.37	46,154	OUT	W
	FBD:CL4005_PBR_Temp	PCR_IF1	FBI_14_125	42,91	TUNE	R
CL4005_TUNE_ZTR	FBD:CL4005_PBR_Temp	PCR_ZTR	FBI_14_43	11,158	TUNE_ZTR	R
CL4005_Y	FBD:CL4005_PBR_Temp	MUL_REAL	.14.116	129,169	IN1	R
	FBD:CL4005_PBR_Temp	MUL_REAL	.14.117	129,178	IN1	R

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
	FBD:CL4005_PBR_Temp	ABS_REAL	.14.122	137,156	IN	R
	FBD:CL4005_PBR_Temp	PCR_IF1	FBI_14_125	59,87	Y	W
CL4006_Acid_Opening_Time	FBD:CL4006_pH	MOVE	.13.97	285,148	OUT	W
	FBD:CL4006_pH	INTEGRATOR1	FBI_13_349	233,69	Y	W
CL4006_ACID_OP_Time	FBD:CL4006_pH	MUL_UDINT	.13.48	91,72	IN1	R
	FBD:CL4006_pH	MUL_UDINT	.13.53	82,97	IN1	R
	FBD:CL4006_pH	MOVE	.13.59	214,49	OUT	W
	FBD:CL4006_pH	MOVE	.13.162	295,59	OUT	W
	FBD:CL4006_pH	EQ_UDINT	.13.184	179,39	IN1	R
	FBD:CL4006_pH	MOVE	.13.236	209,77	OUT	W
CL4006_Base_Opening_Time	FBD:CL4006_pH	MOVE	.13.96	285,143	OUT	W
	FBD:CL4006_pH	INTEGRATOR1	FBI_13_346	250,113	Y	W
CL4006_BASE_OP_Time	FBD:CL4006_pH	MUL_UDINT	.13.65	101,120	IN1	R
	FBD:CL4006_pH	MUL_UDINT	.13.70	97,142	IN1	R
	FBD:CL4006_pH	MOVE	.13.76	230,90	OUT	W
	FBD:CL4006_pH	MOVE	.13.161	295,53	OUT	W
	FBD:CL4006_pH	EQ_UDINT	.13.191	180,19	IN1	R
	FBD:CL4006_pH	MOVE	.13.241	228,122	OUT	W
CL4006_CO2_DECOMP	FBD:CL4006_pH	PCR_IF1	FBI_13_295	94,171	DECOMP	R
CL4006_CO2_ERR	FBD:CL4006_pH	PCR_IF1	FBI_13_295	111,167	ERR	W
CL4006_CO2_FLAG4INIT	FBD:CL4006_pH	PCR_IF1	FBI_13_295	94,172	MAN	R
	FBD:CL4006_pH	INT_TO_BOOL	.13.299	106,180	OUT	W
CL4006_CO2_IMP	FBD:CL4006_pH	PCR_IF1	FBI_13_295	94,168	IMP	R
CL4006_CO2_IMV	FBD:CL4006_pH	PCR_IF1	FBI_13_295	111,166	IMV	W
CL4006_CO2_INIT	FBD:CL4006_pH	PCR_IF1	FBI_13_295	94,164	INIT	R
	FBD:CL4006_pH	TOF	FBI_13_301	134,187	Q	W
CL4006_CO2_LIM	FBD:CL4006_pH	PCR_IF1	FBI_13_295	94,170	LIM	R
CL4006_CO2_TUNE	FBD:CL4006_pH	PCR_IF1	FBI_13_295	94,169	TUNE	R
CL4006_CO2_TUNE.TS	FBD:CL4006_pH	SAMPLETM	FBI_13_296	72,160	INTERVAL	R
CL4006_CO2_TUNE.TS	FBD:CL4006_pH	TOF	FBI_13_301	118,188	PT	R
CL4006_CO2_Y	FBD:CL4006_pH	PCR_IF1	FBI_13_295	111,165	Y	W
CL4006_ControlLoop_Mode	FBD:EMERGENCY_BUTTON	MOVE	.24.9	45,53	OUT	W
	FBD:CL4003_Inlet_Gas_Flow	EQ_INT	.16.11	17,73	IN1	R
	FBD:CL4003_Inlet_Gas_Flow	EQ_INT	.16.15	6,78	IN1	R
	FBD:CL4003_Inlet_Gas_Flow	EQ_INT	.16.79	8,85	IN1	R
	FBD:CL4006_pH	OPMDREAL	FBI_13_10	161,162	SELEC	R
	FBD:CL4006_pH	OPMDBOOL	FBI_13_31	136,78	SELEC	R
	FBD:CL4006_pH	OPMDBOOL	FBI_13_32	154,126	SELEC	R
	FBD:CL4006_pH	EQ_INT	.13.61	139,70	IN1	R
	FBD:CL4006_pH	EQ_INT	.13.78	163,113	IN1	R
	FBD:CL4006_pH	EQ_INT	.13.158	234,50	IN1	R
	FBD:CL4006_pH	EQ_INT	.13.181	180,25	IN1	R
	FBD:CL4006_pH	EQ_INT	.13.188	181,5	IN1	R
	FBD:CL4006_pH	EQ_INT	.13.248	162,50	IN1	R
	FBD:CL4006_pH	EQ_INT	.13.251	156,82	IN1	R
	FBD:CL4006_pH	EQ_INT	.13.254	180,104	IN1	R
	FBD:CL4006_pH	EQ_INT	.13.256	175,143	IN1	R
	FBD:CL4006_pH	EQ_INT	.13.261	177,220	IN1	R
	FBD:CL4006_pH	INT_TO_BOOL	.13.288	8,135	IN	R
	FBD:CL4006_pH	INT_TO_BOOL	.13.299	87,180	IN	R
	FBD:CL4006_pH	EQ_INT	.13.331	171,190	IN1	R
	FBD:CL4006_pH	MOVE	.13.338	204,185	OUT	W
	FBD:CL4006_pH	MOVE	.13.339	204,215	OUT	W
	FBD:CL4006_pH	EQ_INT	.13.343	234,56	IN1	R
	FBD:CL4006_pH	VALVBOOL	FBI_13_350	144,58	SELECT	R
	FBD:CL4006_pH	VALVBOOL	FBI_13_351	159,97	SELECT	R
CL4006_DECOMP	FBD:CL4006_pH	PCR_IF1	FBI_13_286	14,75	DECOMP	R

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
CL4006_FLAG4INIT	FBD:CL4006_pH	PCR_IF1	FBI_13_286	14,76	MAN	R
	FBD:CL4006_pH	INT_TO_BOOL	.13.288	27,135	OUT	W
CL4006_IMP	FBD:CL4006_pH	PCR_IF1	FBI_13_286	14,72	IMP	R
CL4006_IMV_base_acid	FBD:CL4006_pH	PCR_IF1	FBI_13_286	31,70	IMV	W
CL4006_IND_Acid	FBD:CL4006_pH	EQ_INT	.13.35	101,43	OUT	W
	FBD:CL4006_pH	AND_BOOL	.13.291	108,59	IN2	R
	FBD:CL4006_pH	AND_BOOL	.13.292	106,80	IN1	R
CL4006_IND_Base	FBD:CL4006_pH	OR_BOOL	.13.37	123,38	OUT	W
	FBD:CL4006_pH	AND_BOOL	.13.293	118,103	IN1	R
	FBD:CL4006_pH	AND_BOOL	.13.294	119,128	IN1	R
CL4006_IND_CO2	FBD:CL4006_pH	OR_BOOL	.13.36	123,25	OUT	W
	FBD:CL4006_pH	AND_BOOL	.13.327	113,160	IN1	R
CL4006_INIT	FBD:CL4006_pH	PCR_IF1	FBI_13_286	14,68	INIT	R
	FBD:CL4006_pH	TOF	FBI_13_290	53,140	Q	W
CL4006_LIM	FBD:CL4006_pH	PCR_IF1	FBI_13_286	14,74	LIM	R
CL4006_LIM.YMIN	FBD:CL4006_pH	MOVE	.13.310	30,94	OUT	W
CL4006_LIM.YMAX	FBD:CL4006_pH	MOVE	.13.311	30,99	OUT	W
CL4006_LIM.YMIN	FBD:CL4006_pH	MOVE	.13.313	30,106	OUT	W
CL4006_LIM.YMAX	FBD:CL4006_pH	MOVE	.13.314	30,111	OUT	W
CL4006_LIM.YMIN	FBD:CL4006_pH	MOVE	.13.316	30,119	OUT	W
CL4006_LIM.YMAX	FBD:CL4006_pH	MOVE	.13.317	30,124	OUT	W
CL4006_PARAPWM	FBD:CL4006_pH	PWM	FBI_13_287	50,74	PARA	R
CL4006_PARAPWM.t_min	FBD:CL4006_pH	TIME_TO_REAL	.13.320	9,153	IN	R
CL4006_PARAPWM.t_period	FBD:CL4006_pH	TIME_TO_REAL	.13.321	9,158	IN	R
CL4006_PH_AH	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,41	IN27	R
	FBD:CL4006_pH	AND_BOOL	.13.332	200,193	OUT	W
CL4006_pH_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,95	IN22	R
	FBD:CL4006_pH	GT_REAL	.13.113	196,178	OUT	W
CL4006_PH_AL	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,42	IN28	R
	FBD:CL4006_pH	AND_BOOL	.13.262	206,223	OUT	W
CL4006_PH_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,96	IN23	R
	FBD:CL4006_pH	LT_REAL	.13.119	196,208	OUT	W
CL4006_pH_Day	FBD:CL4006_pH	MOVE	.13.92	285,164	OUT	W
CL4006_pH_DeadZone	FBD:CL4006_pH	SUB_REAL	.13.273	13,35	IN2	R
	FBD:CL4006_pH	ADD_REAL	.13.277	13,44	IN2	R
	FBD:CL4006_pH	ADD_REAL	.13.280	7,52	IN2	R
	FBD:CL4006_pH	SUB_REAL	.13.281	7,58	IN2	R
CL4006_pH_high	FBD:CL4006_pH	ACT_DIA	FBI_13_279	65,40	ERR	W
	FBD:CL4006_pH	SEL	.13.283	54,52	G	R
	FBD:CL4006_pH	AND_BOOL	.13.291	108,60	IN3	R
	FBD:CL4006_pH	AND_BOOL	.13.292	106,82	IN3	R
	FBD:CL4006_pH	SEL	.13.304	4,163	G	R
	FBD:CL4006_pH	AND_BOOL	.13.327	113,161	IN2	R
CL4006_pH_Hour	FBD:CL4006_pH	MOVE	.13.93	285,169	OUT	W
CL4006_PH_LIM_AH	FBD:CL4006_pH	GT_REAL	.13.115	169,198	IN2	R
CL4006_pH_LIM_AHH	FBD:CL4006_pH	GT_REAL	.13.113	179,179	IN2	R
CL4006_PH_LIM_AL	FBD:CL4006_pH	LT_REAL	.13.117	176,227	IN2	R
CL4006_PH_LIM_ALL	FBD:CL4006_pH	LT_REAL	.13.119	179,209	IN2	R
CL4006_pH_low	FBD:CL4006_pH	ACT_DIA	FBI_13_276	65,31	ERR	W
	FBD:CL4006_pH	SEL	.13.282	32,49	G	R
	FBD:CL4006_pH	AND_BOOL	.13.293	118,105	IN3	R
	FBD:CL4006_pH	AND_BOOL	.13.294	119,130	IN3	R
	FBD:CL4006_pH	SEL	.13.305	4,172	G	R
CL4006_pH_Minute	FBD:CL4006_pH	MOVE	.13.94	285,174	OUT	W
CL4006_PH_Mode	FBD:CL4003_Inlet_Gas_Flow	EQ_INT	.16.8	17,66	IN1	R
	FBD:CL4006_pH	EQ_INT	.13.33	85,25	IN1	R
	FBD:CL4006_pH	EQ_INT	.13.34	85,34	IN1	R

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
	FBD:CL4006_pH	EQ_INT	.13.35	85,43	IN1	R
	FBD:CL4006_pH	EQ_INT	.13.309	2,93	IN1	R
	FBD:CL4006_pH	EQ_INT	.13.312	2,105	IN1	R
	FBD:CL4006_pH	EQ_INT	.13.315	2,118	IN1	R
	FBD:CL4006_pH	EQ_INT	.13.333	48,220	IN1	R
	FBD:CL4006_pH	MOVE	.13.335	107,221	OUT	W
	FBD:CL4007_PBR_Pressure	EQ_INT	.12.95	40,138	IN1	R
	FBD:CL4007_PBR_Pressure	EQ_INT	.12.99	40,145	IN1	R
	FBD:CL4007_PBR_Pressure	MOVE	.12.101	99,138	OUT	W
CL4006_pH_Month	FBD:CL4006_pH	MOVE	.13.91	285,159	OUT	W
CL4006_PH_PROBE_SELECTION	FBD:CL4006_pH	OPMDREAL	FBI_13_121	12,22	SELEC	R
	FBD:CL4006_pH	EQ_INT	.13.125	38,8	IN1	R
	FBD:CL4006_pH	EQ_INT	.13.127	38,15	IN1	R
	FBD:CL4006_pH	EQ_INT	.13.130	105,8	IN1	R
	FBD:CL4006_pH	MOVE	.13.133	150,8	OUT	W
	FBD:CL4006_pH	EQ_INT	.13.134	106,15	IN1	R
	FBD:CL4006_pH	MOVE	.13.136	151,15	OUT	W
CL4006_pH_Reset_timer	FBD:CL4006_pH	R_TRIG	FBI_13_82	256,141	CLK	R
	FBD:CL4006_pH	INTEGRATOR1	FBI_13_346	231,111	MAN	R
	FBD:CL4006_pH	INTEGRATOR1	FBI_13_349	214,67	MAN	R
CL4006_pH_Second	FBD:CL4006_pH	MOVE	.13.95	285,179	OUT	W
CL4006_pH_Year	FBD:CL4006_pH	MOVE	.13.85	285,154	OUT	W
CL4006_RCPY	FBD:CL4006_pH	PCR_IF1	FBI_13_286	14,71	RCPY	R
	FBD:CL4006_pH	SEL	.13.318	78,150	OUT	W
CL4006_TUNE.TS	FBD:CL4006_pH	SAMPLETM	FBI_13_284	3,63	INTERVAL	R
	FBD:CL4006_pH	PCR_IF1	FBI_13_286	14,73	TUNE	R
CL4006_TUNE.TS	FBD:CL4006_pH	TOF	FBI_13_290	37,141	PT	R
CL4006_Y_base_acid	FBD:CL4006_pH	PCR_IF1	FBI_13_286	31,69	Y	W
	FBD:CL4006_pH	MUL_REAL	.13.306	23,163	IN1	R
	FBD:CL4006_pH	MUL_REAL	.13.307	23,172	IN1	R
	FBD:CL4006_pH	ABS_REAL	.13.323	31,150	IN	R
CL4007_ControlLoop_Mode	FBD:EMERGENCY_BUTTON	MOVE	.24.10	45,58	OUT	W
	FBD:CL4004_Oulet_Gas_Flow	OPMDREAL	FBI_15_5	50,29	SELEC	R
	FBD:CL4004_Oulet_Gas_Flow	MOVE	.15.18	49,76	OUT	W
	FBD:CL4004_Oulet_Gas_Flow	EQ_INT	.15.43	27,95	IN1	R
	FBD:CL4004_Oulet_Gas_Flow	EQ_INT	.15.45	46,111	IN1	R
	FBD:CL4004_Oulet_Gas_Flow	EQ_INT	.15.51	46,138	IN1	R
	FBD:CL4004_Oulet_Gas_Flow	EQ_INT	.15.58	46,166	IN1	R
	FBD:CL4004_Oulet_Gas_Flow	EQ_INT	.15.65	48,191	IN1	R
	FBD:CL4007_PBR_Pressure	INT_TO_BOOL	.12.5	10,55	IN	R
	FBD:CL4007_PBR_Pressure	EQ_INT	.12.54	27,83	IN1	R
	FBD:CL4007_PBR_Pressure	EQ_INT	.12.55	29,104	IN1	R
	FBD:CL4007_PBR_Pressure	EQ_INT	.12.59	26,176	IN1	R
	FBD:CL4007_PBR_Pressure	EQ_INT	.12.63	26,202	IN1	R
	FBD:CL4007_PBR_Pressure	EQ_INT	.12.67	108,86	IN1	R
	FBD:CL4007_PBR_Pressure	EQ_INT	.12.71	109,102	IN1	R
	FBD:CL4007_PBR_Pressure	EQ_INT	.12.75	107,175	IN1	R
	FBD:CL4007_PBR_Pressure	EQ_INT	.12.79	105,192	IN1	R
	FBD:CL4007_PBR_Pressure	MOVE	.12.104	153,9	OUT	W
CL4007_ERR	FBD:CL4007_PBR_Pressure	PCR_SF1	FBI_12_52	54,37	ERR	W
CL4007_Flag4Init	FBD:CL4007_PBR_Pressure	INT_TO_BOOL	.12.5	29,55	OUT	W
	FBD:CL4007_PBR_Pressure	PCR_SF1	FBI_12_52	37,41	MAN	R
CL4007_IMP	FBD:CL4007_PBR_Pressure	PCR_SF1	FBI_12_52	37,38	IMP	R
CL4007_IMP.KM	FBD:CL4007_PBR_Pressure	LOOKUP_TABLE1	FBI_12_105	111,26	Y	W
CL4007_IMV	FBD:CL4007_PBR_Pressure	PCR_SF1	FBI_12_52	54,36	IMV	W
CL4007_INIT	FBD:CL4007_PBR_Pressure	TOF	FBI_12_7	63,56	Q	W
	FBD:CL4007_PBR_Pressure	PCR_SF1	FBI_12_52	37,34	INIT	R

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
CL4007_LIM	FBD:CL4007_PBR_Pressure	PCR_SF1	FBI_12_52	37,40	LIM	R
CL4007_P_SELECT	FBD:CL4007_PBR_Pressure	SEL	.12.4	8,9	G	R
	FBD:CL4007_PBR_Pressure	EQ_BOOL	.12.48	49,8	IN1	R
	FBD:CL4007_PBR_Pressure	EQ_BOOL	.12.49	49,15	IN1	R
	FBD:CL4007_PBR_Pressure	MOVE	.12.50	102,8	OUT	W
	FBD:CL4007_PBR_Pressure	MOVE	.12.51	102,15	OUT	W
CL4007_TUNE.TS	FBD:CL4007_PBR_Pressure	SAMPLETM	FBI_12_1	16,31	INTERVAL	R
CL4007_TUNE.TS	FBD:CL4007_PBR_Pressure	TOF	FBI_12_7	47,57	PT	R
	FBD:CL4007_PBR_Pressure	PCR_SF1	FBI_12_52	37,39	TUNE	R
CL4007_Y	FBD:CL4004_Oulet_Gas_Flow	OPMDREAL	FBI_15_5	50,31	AUTO	R
	FBD:CL4007_PBR_Pressure	PCR_SF1	FBI_12_52	37,37	RCPY	R
	FBD:CL4007_PBR_Pressure	PCR_SF1	FBI_12_52	54,35	Y	W
CL4008_ControlLoop_Mode	FBD:EMERGENCY_BUTTON	MOVE	.24.11	83,24	OUT	W
	FBD:CL4008_PBR_Liquid_Lev>el	EQ_INT	.11.1	7,8	IN1	R
	FBD:CL4008_PBR_Liquid_Lev>el	MOVE	.11.4	34,20	OUT	W
	FBD:CL4008_PBR_Liquid_Lev>el	INT_TO_BOOL	.11.7	7,59	IN	R
	FBD:CL4008_PBR_Liquid_Lev>el	EQ_INT	.11.25	57,9	IN1	R
CL4008_DECOMP	FBD:CL4008_PBR_Liquid_Lev>el	PCR_IF1	FBI_11_5	25,45	DECOMP	R
CL4008_ERR	FBD:CL4008_PBR_Liquid_Lev>el	PCR_IF1	FBI_11_5	42,41	ERR	W
CL4008_Flag4Init	FBD:CL4008_PBR_Liquid_Lev>el	PCR_IF1	FBI_11_5	25,46	MAN	R
	FBD:CL4008_PBR_Liquid_Lev>el	INT_TO_BOOL	.11.7	26,59	OUT	W
CL4008_IMP	FBD:CL4008_PBR_Liquid_Lev>el	PCR_IF1	FBI_11_5	25,42	IMP	R
CL4008_IMP.KM	FBD:CL4008_PBR_Liquid_Lev>el	MOVE	.11.39	104,52	OUT	W
CL4008_IMV	FBD:CL4008_PBR_Liquid_Lev>el	PCR_IF1	FBI_11_5	42,40	IMV	W
CL4008_INIT	FBD:CL4008_PBR_Liquid_Lev>el	PCR_IF1	FBI_11_5	25,38	INIT	R
	FBD:CL4008_PBR_Liquid_Lev>el	TOF	FBI_11_9	56,60	Q	W
CL4008_LIM	FBD:CL4008_PBR_Liquid_Lev>el	PCR_IF1	FBI_11_5	25,44	LIM	R
CL4008_LIM.YMIN	FBD:CL4008_PBR_Liquid_Lev>el	MOVE	.11.20	82,31	OUT	W
CL4008_LIM.YMAX	FBD:CL4008_PBR_Liquid_Lev>el	MOVE	.11.22	82,37	OUT	W
CL4008_TUNE	FBD:CL4008_PBR_Liquid_Lev>el	PCR_IF1	FBI_11_5	25,43	TUNE	R
CL4008_TUNE.TS	FBD:CL4008_PBR_Liquid_Lev>el	SAMPLETM	FBI_11_6	3,32	INTERVAL	R
CL4008_TUNE.TS	FBD:CL4008_PBR_Liquid_Lev>el	TOF	FBI_11_9	40,61	PT	R
CL4008_Y	FBD:CL4002_Outlet_Liquid_>Flow	ADD_REAL	.17.71	71,46	IN1	R
	FBD:CL4008_PBR_Liquid_Lev>el	PCR_IF1	FBI_11_5	25,41	RCPY	R
	FBD:CL4008_PBR_Liquid_Lev>el	PCR_IF1	FBI_11_5	42,39	Y	W

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
CL4009_Biomass_Cleaning_Mode	FBD:CL4009_Biomass	EQ_INT	.10.42	20,42	IN1	R
	FBD:CL4009_Biomass	NE_INT	.10.47	81,43	IN1	R
	FBD:CL4009_Biomass	VALVBOOL	FBI_10_51	62,52	SELECT	R
CL4009_Biomass_Production	FBD:CL4009_Biomass	MUL_REAL	.10.35	35,72	OUT	W
CL4009_ControlLoop_Mode	FBD:EMERGENCY_BUTTON	MOVE	.24.12	83,29	OUT	W
CL4009_START_TIMER	FBD:CL4009_Biomass	R_TRIG	FBI_10_39	7,54	CLK	R
	FBD:CL4009_Biomass	MOVE	.10.40	55,63	OUT	W
	FBD:CL4009_Biomass	MOVE	.10.43	55,43	OUT	W
	FBD:CL4009_Biomass	MOVE	.10.46	102,51	OUT	W
	FBD:CL4009_Biomass	MOVE	.10.49	118,44	OUT	W
CL4010_ControlLoop_Mode	FBD:EMERGENCY_BUTTON	MOVE	.24.13	83,34	OUT	W
	FBD:CL4000_Lights	EQ_INT	.1.11	67,56	IN1	R
	FBD:CL4000_Lights	EQ_INT	.1.13	57,64	IN1	R
	FBD:CL4000_Lights	MOVE	.1.15	113,60	OUT	W
	FBD:CL4000_Lights	EQ_INT	.1.16	52,76	IN1	R
	FBD:CL4000_Lights	EQ_INT	.1.21	52,82	IN1	R
	FBD:CL4000_Lights	EQ_INT	.1.30	49,114	IN1	R
	FBD:CL4000_Lights	EQ_INT	.1.39	29,29	IN1	R
	FBD:CL4010_OutletGasCompo	OPMDBOOL	FBI_9_1	13,18	SELEC	R
CL4010_ERR	FBD:CL4010_OutletGasCompo	PCR_EF1	FBI_9_36	31,35	ERR	W
CL4010_Flag4Init	FBD:CL4010_OutletGasCompo	PCR_EF1	FBI_9_36	11,42	MAN	R
	FBD:CL4010_OutletGasCompo	INT_TO_BOOL	.9.37	26,59	OUT	W
CL4010_IMP	FBD:CL4010_OutletGasCompo	PCR_EF1	FBI_9_36	11,35	IMP	R
CL4010_IMV	FBD:CL4010_OutletGasCompo	PCR_EF1	FBI_9_36	31,32	IMV	W
CL4010_INIT	FBD:CL4010_OutletGasCompo	PCR_EF1	FBI_9_36	11,30	INIT	R
	FBD:CL4010_OutletGasCompo	TOF	FBI_9_39	60,60	Q	W
CL4010_LIM	FBD:CL4010_OutletGasCompo	PCR_EF1	FBI_9_36	11,37	LIM	R
CL4010_O2_SP	FBD:CL4010_OutletGasCompo	PCR_EF1	FBI_9_36	11,32	SP	R
CL4010_TUNE	FBD:CL4010_OutletGasCompo	PCR_EF1	FBI_9_36	11,36	TUNE	R
CL4010_TUNE.TS	FBD:CL4010_OutletGasCompo	TOF	FBI_9_39	44,61	PT	R
CL4010_Y	FBD:CL4000_Lights	SEL	.1.38	44,31	IN1	R
	FBD:CL4010_OutletGasCompo	PCR_EF1	FBI_9_36	31,31	Y	W
CL4011_ControlLoop_Mode	FBD:EMERGENCY_BUTTON	MOVE	.24.14	83,39	OUT	W
	FBD:CL4011_Feeding_Temp	INT_TO_BOOL	.8.4	15,36	IN	R
	FBD:CL4011_Feeding_Temp	EQ_INT	.8.12	41,60	IN1	R
	FBD:CL4011_Feeding_Temp	EQ_INT	.8.16	40,76	IN1	R
	FBD:CL4011_Feeding_Temp	EQ_INT	.8.20	38,93	IN1	R
	FBD:CL4011_Feeding_Temp	EQ_INT	.8.24	40,110	IN1	R
	FBD:CL4011_Feeding_Temp	VALVBOOL	FBI_8_29	88,15	SELECT	R
CL4011_DECOMP	FBD:CL4011_Feeding_Temp	PCR_IF1	FBI_8_1	20,23	DECOMP	R
CL4011_ERR	FBD:CL4011_Feeding_Temp	PCR_IF1	FBI_8_1	37,19	ERR	W
CL4011_Flag4Init	FBD:CL4011_Feeding_Temp	PCR_IF1	FBI_8_1	20,24	MAN	R
	FBD:CL4011_Feeding_Temp	INT_TO_BOOL	.8.4	34,36	OUT	W
CL4011_IMP	FBD:CL4011_Feeding_Temp	PCR_IF1	FBI_8_1	20,20	IMP	R
CL4011_IMV	FBD:CL4011_Feeding_Temp	PCR_IF1	FBI_8_1	37,18	IMV	W
CL4011_INIT	FBD:CL4011_Feeding_Temp	PCR_IF1	FBI_8_1	20,16	INIT	R
	FBD:CL4011_Feeding_Temp	TOF	FBI_8_6	68,37	Q	W
CL4011_LIM	FBD:CL4011_Feeding_Temp	PCR_IF1	FBI_8_1	20,22	LIM	R
CL4011_PARA_PWM	FBD:CL4011_Feeding_Temp	PWM	FBI_8_3	63,18	PARA	R
CL4011_TUNE	FBD:CL4011_Feeding_Temp	PCR_IF1	FBI_8_1	20,21	TUNE	R
CL4011_TUNE.TS	FBD:CL4011_Feeding_Temp	TOF	FBI_8_6	52,38	PT	R
CL4011_TUNE.TS	FBD:CL4011_Feeding_Temp	SAMPLETM	FBI_8_8	3,10	INTERVAL	R
CL4011_Y	FBD:CL4011_Feeding_Temp	PCR_IF1	FBI_8_1	20,19	RCPY	R
	FBD:CL4011_Feeding_Temp	PCR_IF1	FBI_8_1	37,17	Y	W
	FBD:CL4011_Feeding_Temp	PWM	FBI_8_3	63,16	X	R
CL4012_ControlLoop_Mode	FBD:EMERGENCY_BUTTON	MOVE	.24.15	83,44	OUT	W
	FBD:CL4012_Harvesting_Temp	INT_TO_BOOL	.7.4	19,41	IN	R

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
	FBD:CL4012_Harvesting_Temp	EQ_INT	.7.11	38,69	IN1	R
	FBD:CL4012_Harvesting_Temp	EQ_INT	.7.15	37,85	IN1	R
	FBD:CL4012_Harvesting_Temp	EQ_INT	.7.18	35,102	IN1	R
	FBD:CL4012_Harvesting_Temp	EQ_INT	.7.22	37,119	IN1	R
	FBD:CL4012_Harvesting_Temp	VALVBOOL	FBI_7_26	76,20	SELECT	R
CL4012_DECOMP	FBD:CL4012_Harvesting_Temp	PCR_IF1	FBI_7_1	17,26	DECOMP	R
CL4012_ERR	FBD:CL4012_Harvesting_Temp	PCR_IF1	FBI_7_1	34,22	ERR	W
CL4012_Flag4Init	FBD:CL4012_Harvesting_Temp	PCR_IF1	FBI_7_1	17,27	MAN	R
	FBD:CL4012_Harvesting_Temp	INT_TO_BOOL	.7.4	38,41	OUT	W
CL4012_IMP	FBD:CL4012_Harvesting_Temp	PCR_IF1	FBI_7_1	17,23	IMP	R
CL4012_IMV	FBD:CL4012_Harvesting_Temp	PCR_IF1	FBI_7_1	34,21	IMV	W
CL4012_INIT	FBD:CL4012_Harvesting_Temp	PCR_IF1	FBI_7_1	17,19	INIT	R
	FBD:CL4012_Harvesting_Temp	TOF	FBI_7_6	72,42	Q	W
CL4012_LIM	FBD:CL4012_Harvesting_Temp	PCR_IF1	FBI_7_1	17,25	LIM	R
CL4012_PARA_PWM	FBD:CL4012_Harvesting_Temp	PWM	FBI_7_2	50,23	PARA	R
CL4012_TUNE	FBD:CL4012_Harvesting_Temp	PCR_IF1	FBI_7_1	17,24	TUNE	R
CL4012_TUNE.TS	FBD:CL4012_Harvesting_Temp	TOF	FBI_7_6	56,43	PT	R
CL4012_TUNE.TS	FBD:CL4012_Harvesting_Temp	SAMPLETM	FBI_7_7	4,13	INTERVAL	R
CL4012_Y	FBD:CL4012_Harvesting_Temp	PCR_IF1	FBI_7_1	17,22	RCPY	R
	FBD:CL4012_Harvesting_Temp	PCR_IF1	FBI_7_1	34,20	Y	W
	FBD:CL4012_Harvesting_Temp	PWM	FBI_7_2	50,21	X	R
CL4014_ControlLoop_Mode	FBD:EMERGENCY_BUTTON	MOVE	.24.16	83,49	OUT	W
	FBD:CL4014_Feeding_Steril> ization	VALVBOOL	FBI_5_2	9,10	SELECT	R
CL4015_ControlLoop_Mode	FBD:EMERGENCY_BUTTON	MOVE	.24.17	83,54	OUT	W
	FBD:CL4015_PBR_Sterilizat> ion	VALVBOOL	FBI_4_2	6,10	SELECT	R
CL4016_ControlLoop_Mode	FBD:EMERGENCY_BUTTON	MOVE	.24.20	83,59	OUT	W
	FBD:CL4016_Harvesting_Ste> rilization	VALVBOOL	FBI_3_2	8,10	SELECT	R
CL_4006_ERR_base_acid	FBD:CL4006_pH	PCR_IF1	FBI_13_286	31,71	ERR	W
DPT_4001_01	FBD:Inputs	I_SCALE	.20.29	100,91	Y	W
	FBD:CL4001_Inlet_Liquid_F> low	GT_REAL	.23.31	194,175	IN1	R
	FBD:CL4001_Inlet_Liquid_F> low	LT_REAL	.23.32	252,162	IN1	R
	FBD:CL4001_Inlet_Liquid_F> low	GT_REAL	.23.30	203,164	IN1	R
	FBD:CL4001_Inlet_Liquid_F> low	LT_REAL	.23.33	253,173	IN1	R
DPT_4001_01_AH	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,19	IN5	R
	FBD:CL4001_Inlet_Liquid_F> low	ACT_DIA	FBI_23_230	235,162	ERR	W
DPT_4001_01_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,82	IN9	R
	FBD:CL4001_Inlet_Liquid_F> low	ACT_DIA	FBI_23_234	225,173	ERR	W
DPT_4001_01_AL	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,20	IN6	R
	FBD:CL4001_Inlet_Liquid_F> low	ACT_DIA	FBI_23_231	282,160	ERR	W
DPT_4001_01_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,83	IN10	R
	FBD:CL4001_Inlet_Liquid_F> low	ACT_DIA	FBI_23_232	288,171	ERR	W
DPT_4001_01_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_4	25,48	BIT3	W
	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,88	IN15	R
DPT_4001_01_LIM_AH	FBD:CL4001_Inlet_Liquid_F> low	GT_REAL	.23.30	203,165	IN2	R
DPT_4001_01_LIM_AHH	FBD:CL4001_Inlet_Liquid_F>	GT_REAL	.23.31	194,176	IN2	R

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
	low					
DPT_4001_01_LIM_AL	FBD:CL4001_Inlet_Liquid_F>low	LT_REAL	.23.32	252,163	IN2	R
DPT_4001_01_LIM_ALL	FBD:CL4001_Inlet_Liquid_F>low	LT_REAL	.23.33	253,174	IN2	R
DPT_4001_01_MAX	FBD:Inputs	I_SCALE	.20.29	83,92	MX	R
DPT_4001_01_MIN	FBD:Inputs	I_SCALE	.20.29	83,91	MN	R
DPT_4001_02	FBD:Inputs	I_SCALE	.20.30	73,92	Y	W
	FBD:CL4001_Inlet_Liquid_F>low	GT_REAL	.23.34	194,189	IN1	R
	FBD:CL4001_Inlet_Liquid_F>low	GT_REAL	.23.35	194,203	IN1	R
	FBD:CL4001_Inlet_Liquid_F>low	LT_REAL	.23.36	250,193	IN1	R
	FBD:CL4001_Inlet_Liquid_F>low	LT_REAL	.23.37	250,204	IN1	R
DPT_4001_02_AH	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,21	IN7	R
	FBD:CL4001_Inlet_Liquid_F>low	ACT_DIA	FBI_23_225	227,187	ERR	W
DPT_4001_02_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,84	IN11	R
	FBD:CL4001_Inlet_Liquid_F>low	ACT_DIA	FBI_23_227	228,201	ERR	W
DPT_4001_02_AL	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,22	IN8	R
	FBD:CL4001_Inlet_Liquid_F>low	ACT_DIA	FBI_23_228	284,191	ERR	W
DPT_4001_02_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,85	IN12	R
	FBD:CL4001_Inlet_Liquid_F>low	ACT_DIA	FBI_23_229	285,202	ERR	W
DPT_4001_02_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_4	25,49	BIT4	W
	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,89	IN16	R
DPT_4001_02_LIM_AH	FBD:CL4001_Inlet_Liquid_F>low	GT_REAL	.23.34	194,190	IN2	R
DPT_4001_02_LIM_AHH	FBD:CL4001_Inlet_Liquid_F>low	GT_REAL	.23.35	194,204	IN2	R
DPT_4001_02_LIM_AL	FBD:CL4001_Inlet_Liquid_F>low	LT_REAL	.23.36	250,194	IN2	R
DPT_4001_02_LIM_ALL	FBD:CL4001_Inlet_Liquid_F>low	LT_REAL	.23.37	250,205	IN2	R
DPT_4001_02_MAX	FBD:Inputs	I_SCALE	.20.30	56,93	MX	R
DPT_4001_02_MIN	FBD:Inputs	I_SCALE	.20.30	56,92	MN	R
DPT_4004_01	FBD:Inputs	I_SCALE	.20.39	166,96	Y	W
	FBD:CL4004_Oulet_Gas_Flow	LT_REAL	.15.36	125,104	IN1	R
	FBD:CL4004_Oulet_Gas_Flow	GT_REAL	.15.37	126,92	IN1	R
	FBD:CL4004_Oulet_Gas_Flow	GT_REAL	.15.38	162,91	IN1	R
	FBD:CL4004_Oulet_Gas_Flow	LT_REAL	.15.39	164,102	IN1	R
DPT_4004_01_AH	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,35	IN21	R
	FBD:CL4004_Oulet_Gas_Flow	GT_REAL	.15.37	143,92	OUT	W
DPT_4004_01_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,83	IN10	R
	FBD:CL4004_Oulet_Gas_Flow	GT_REAL	.15.38	179,91	OUT	W
DPT_4004_01_AL	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,36	IN22	R
	FBD:CL4004_Oulet_Gas_Flow	LT_REAL	.15.36	142,104	OUT	W
DPT_4004_01_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,84	IN11	R
	FBD:CL4004_Oulet_Gas_Flow	LT_REAL	.15.39	181,102	OUT	W
DPT_4004_01_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_4	25,50	BIT5	W
	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,86	IN13	R
DPT_4004_01_LIM_AH	FBD:CL4004_Oulet_Gas_Flow	GT_REAL	.15.37	126,93	IN2	R
DPT_4004_01_LIM_AHH	FBD:CL4004_Oulet_Gas_Flow	GT_REAL	.15.38	162,92	IN2	R

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
DPT_4004_01_LIM_AL	FBD:CL4004_Oulet_Gas_Flow	LT_REAL	.15.36	125,105	IN2	R
DPT_4004_01_LIM_ALL	FBD:CL4004_Oulet_Gas_Flow	LT_REAL	.15.39	164,103	IN2	R
DPT_4004_01_MAX	FBD:Inputs	I_SCALE	.20.39	149,97	MX	R
DPT_4004_01_MIN	FBD:Inputs	I_SCALE	.20.39	149,96	MN	R
Emergency_Button_01	FBD:EMERGENCY_BUTTON	OR_BOOL	.24.1	14,15	IN1	R
Emergency_Button_02	FBD:EMERGENCY_BUTTON	OR_BOOL	.24.1	14,16	IN2	R
FB_TIME_LIM	FBD:CL4003_Inlet_Gas_Flow	VALVBOOL	FBI_16_83	65,27	TIMER	R
	FBD:CL4003_Inlet_Gas_Flow	VALVBOOL	FBI_16_84	94,15	TIMER	R
	FBD:CL4005_PBR_Temp	VALVBOOL	FBI_14_144	124,88	TIMER	R
	FBD:CL4006_pH	VALVBOOL	FBI_13_350	144,64	TIMER	R
	FBD:CL4006_pH	VALVBOOL	FBI_13_351	159,103	TIMER	R
	FBD:CL4009_Biomass	VALVBOOL	FBI_10_51	62,58	TIMER	R
	FBD:CL4010_OutletGasCompo	ACT_DIA	FBI_9_41	67,15	DTIME	R
	FBD:CL4010_OutletGasCompo	ACT_DIA	FBI_9_43	67,24	DTIME	R
	FBD:CL4011_Feeding_Temp	VALVBOOL	FBI_8_29	88,21	TIMER	R
	FBD:CL4012_Harvesting_Temp	VALVBOOL	FBI_7_26	76,26	TIMER	R
	FBD:CL4014_Feeding_Steril>ization	VALVBOOL	FBI_5_2	9,16	TIMER	R
	FBD:CL4015_PBR_Sterilizat>ion	VALVBOOL	FBI_4_2	6,16	TIMER	R
	FBD:CL4016_Harvesting_Ste>rilization	VALVBOOL	FBI_3_2	8,16	TIMER	R
FQRC_4003_01	FBD:Inputs	I_SCALE	.20.35	72,7	Y	W
	FBD:CL4003_Inlet_Gas_Flow	ADD_REAL	.16.5	10,56	IN1	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.30	4,162	IN1	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.33	4,170	IN1	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.36	4,178	IN1	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.40	4,185	IN1	R
FQRC_4003_01_AH	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,25	IN11	R
	FBD:CL4003_Inlet_Gas_Flow	TON	FBI_16_35	53,170	Q	W
FQRC_4003_01_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,100	IN27	R
	FBD:CL4003_Inlet_Gas_Flow	TON	FBI_16_32	53,162	Q	W
FQRC_4003_01_AL	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,26	IN12	R
	FBD:CL4003_Inlet_Gas_Flow	TON	FBI_16_38	53,178	Q	W
FQRC_4003_01_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,101	IN28	R
	FBD:CL4003_Inlet_Gas_Flow	TON	FBI_16_42	53,185	Q	W
FQRC_4003_01_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_2	25,13	BIT8	W
	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,77	IN4	R
FQRC_4003_01_LIM_AH	FBD:CL4003_Inlet_Gas_Flow	GT_REAL	.16.34	25,171	IN2	R
FQRC_4003_01_LIM_AHH	FBD:CL4003_Inlet_Gas_Flow	GT_REAL	.16.31	25,163	IN2	R
FQRC_4003_01_LIM_AL	FBD:CL4003_Inlet_Gas_Flow	LT_REAL	.16.39	25,179	IN2	R
FQRC_4003_01_LIM_ALL	FBD:CL4003_Inlet_Gas_Flow	LT_REAL	.16.41	25,186	IN2	R
FQRC_4003_01_MAX	FBD:Inputs	I_SCALE	.20.35	55,8	MX	R
FQRC_4003_01_MIN	FBD:Inputs	I_SCALE	.20.35	55,7	MN	R
FQRC_4003_01_OFFSET	FBD:Inputs	SUB_REAL	.20.51	90,5	OUT	W
FQRC_4003_01_SP	FBD:Outputs	O_SCALE	FBI_19_8	80,6	X	R
	FBD:CL4003_Inlet_Gas_Flow	SEL	.16.14	71,72	OUT	W
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.30	4,163	IN2	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.33	4,171	IN2	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.36	4,179	IN2	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.40	4,186	IN2	R
	FBD:CL4006_pH	DIV_REAL	.13.303	70,167	IN1	R
FQRC_4003_01_SP_MAX	FBD:Outputs	O_SCALE	FBI_19_8	80,7	MX	R
FQRC_4003_01_SP_MIN	FBD:Outputs	O_SCALE	FBI_19_8	80,5	MN	R
FQRC_4003_01_SP_OP	FBD:CL4003_Inlet_Gas_Flow	SEL	.16.14	55,73	IN1	R
	FBD:CL4006_pH	OPMDREAL	FBI_13_10	161,165	MAN	R
FQRC_4003_01_SP_PH	FBD:CL4003_Inlet_Gas_Flow	SEL	.16.14	55,72	IN0	R

table continued...

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
	FBD:CL4006_pH	OPMDREAL	FBI_13_10	180,162	OUT	W
FQRC_4003_02	FBD:Inputs	I_SCALE	.20.36	73,16	Y	W
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.43	76,162	IN1	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.46	76,170	IN1	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.49	76,178	IN1	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.52	76,185	IN1	R
FQRC_4003_02_AH	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,27	IN13	R
	FBD:CL4003_Inlet_Gas_Flow	TON	FBI_16_48	125,170	Q	W
FQRC_4003_02_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,102	IN29	R
	FBD:CL4003_Inlet_Gas_Flow	TON	FBI_16_45	125,162	Q	W
FQRC_4003_02_AL	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,28	IN14	R
	FBD:CL4003_Inlet_Gas_Flow	TON	FBI_16_51	125,178	Q	W
FQRC_4003_02_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,103	IN30	R
	FBD:CL4003_Inlet_Gas_Flow	TON	FBI_16_54	125,185	Q	W
FQRC_4003_02_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_2	25,14	BIT9	W
	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,78	IN5	R
FQRC_4003_02_LIM_AH	FBD:CL4003_Inlet_Gas_Flow	GT_REAL	.16.47	97,171	IN2	R
FQRC_4003_02_LIM_AHH	FBD:CL4003_Inlet_Gas_Flow	GT_REAL	.16.44	97,163	IN2	R
FQRC_4003_02_LIM_AL	FBD:CL4003_Inlet_Gas_Flow	LT_REAL	.16.50	97,179	IN2	R
FQRC_4003_02_LIM_ALL	FBD:CL4003_Inlet_Gas_Flow	LT_REAL	.16.53	97,186	IN2	R
FQRC_4003_02_MAX	FBD:Inputs	I_SCALE	.20.36	56,17	MX	R
FQRC_4003_02_MIN	FBD:Inputs	I_SCALE	.20.36	56,16	MN	R
FQRC_4003_02_SP	FBD:Outputs	O_SCALE	FBI_19_9	55,8	X	R
	FBD:CL4003_Inlet_Gas_Flow	OPMDREAL	FBI_16_3	62,39	OUT	W
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.43	76,163	IN2	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.46	76,171	IN2	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.49	76,179	IN2	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.52	76,186	IN2	R
FQRC_4003_02_SP_MAX	FBD:Outputs	O_SCALE	FBI_19_9	55,9	MX	R
FQRC_4003_02_SP_MIN	FBD:Outputs	O_SCALE	FBI_19_9	55,7	MN	R
FQRC_4003_02_SP_OP	FBD:CL4003_Inlet_Gas_Flow	OPMDREAL	FBI_16_3	43,42	MAN	R
FQRC_4003_03	FBD:Inputs	I_SCALE	.20.37	120,9	Y	W
	FBD:CL4003_Inlet_Gas_Flow	ADD_REAL	.16.5	10,57	IN2	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.55	149,162	IN1	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.58	149,170	IN1	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.61	149,178	IN1	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.64	149,185	IN1	R
FQRC_4003_03_AH	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,29	IN15	R
	FBD:CL4003_Inlet_Gas_Flow	TON	FBI_16_60	198,170	Q	W
FQRC_4003_03_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,104	IN31	R
	FBD:CL4003_Inlet_Gas_Flow	TON	FBI_16_57	198,162	Q	W
FQRC_4003_03_AL	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,30	IN16	R
	FBD:CL4003_Inlet_Gas_Flow	TON	FBI_16_63	198,178	Q	W
FQRC_4003_03_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,105	IN32	R
	FBD:CL4003_Inlet_Gas_Flow	TON	FBI_16_66	198,185	Q	W
FQRC_4003_03_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_2	25,15	BIT10	W
	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,79	IN6	R
FQRC_4003_03_LIM_AH	FBD:CL4003_Inlet_Gas_Flow	GT_REAL	.16.59	170,171	IN2	R
FQRC_4003_03_LIM_AHH	FBD:CL4003_Inlet_Gas_Flow	GT_REAL	.16.56	170,163	IN2	R
FQRC_4003_03_LIM_AL	FBD:CL4003_Inlet_Gas_Flow	LT_REAL	.16.62	170,179	IN2	R
FQRC_4003_03_LIM_ALL	FBD:CL4003_Inlet_Gas_Flow	LT_REAL	.16.65	170,186	IN2	R
FQRC_4003_03_MAX	FBD:Inputs	I_SCALE	.20.37	103,10	MX	R
FQRC_4003_03_MIN	FBD:Inputs	I_SCALE	.20.37	103,9	MN	R
FQRC_4003_03_SP	FBD:Outputs	O_SCALE	FBI_19_10	80,17	X	R
	FBD:CL4003_Inlet_Gas_Flow	OPMDREAL	FBI_16_2	32,21	OUT	W
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.55	149,163	IN2	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.58	149,171	IN2	R

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

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.61	149,179	IN2	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.64	149,186	IN2	R
FQRC_4003_03_SP_MAX	FBD:Outputs	O_SCALE	FBI_19_10	80,18	MX	R
FQRC_4003_03_SP_MIN	FBD:Outputs	O_SCALE	FBI_19_10	80,16	MN	R
FQRC_4003_03_SP_OP	FBD:CL4003_Inlet_Gas_Flow	OPMDREAL	FBI_16_2	13,23	AUTO	R
	FBD:CL4003_Inlet_Gas_Flow	OPMDREAL	FBI_16_2	13,24	MAN	R
FQRC_4003_04	FBD:Inputs	I_SCALE	.20.38	102,16	Y	W
	FBD:CL4003_Inlet_Gas_Flow	EQ_REAL	.16.27	4,146	IN1	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.67	223,162	IN1	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.70	223,170	IN1	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.73	223,178	IN1	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.76	223,185	IN1	R
FQRC_4003_04_AH	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,31	IN17	R
	FBD:CL4003_Inlet_Gas_Flow	TON	FBI_16_72	272,170	Q	W
FQRC_4003_04_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,74	IN1	R
	FBD:CL4003_Inlet_Gas_Flow	TON	FBI_16_69	272,162	Q	W
FQRC_4003_04_AL	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,32	IN18	R
	FBD:CL4003_Inlet_Gas_Flow	TON	FBI_16_75	272,178	Q	W
FQRC_4003_04_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,75	IN2	R
	FBD:CL4003_Inlet_Gas_Flow	TON	FBI_16_78	272,185	Q	W
FQRC_4003_04_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_2	25,16	BIT11	W
	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,80	IN7	R
	FBD:CL4003_Inlet_Gas_Flow	OR_BOOL	.16.29	23,147	IN2	R
FQRC_4003_04_LIM_AH	FBD:CL4003_Inlet_Gas_Flow	GT_REAL	.16.71	244,171	IN2	R
FQRC_4003_04_LIM_AHH	FBD:CL4003_Inlet_Gas_Flow	GT_REAL	.16.68	244,163	IN2	R
FQRC_4003_04_LIM_AL	FBD:CL4003_Inlet_Gas_Flow	LT_REAL	.16.74	244,179	IN2	R
FQRC_4003_04_LIM_ALL	FBD:CL4003_Inlet_Gas_Flow	LT_REAL	.16.77	244,186	IN2	R
FQRC_4003_04_MAX	FBD:Inputs	I_SCALE	.20.38	85,17	MX	R
FQRC_4003_04_MIN	FBD:Inputs	I_SCALE	.20.38	85,16	MN	R
FQRC_4003_04_NOFLOW_A	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,76	IN3	R
	FBD:CL4000_Lights	OR_BOOL	.1.8	7,68	IN3	R
FQRC_4003_04_SP	FBD:Outputs	O_SCALE	FBI_19_11	56,20	X	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.4	23,41	IN1	R
	FBD:CL4003_Inlet_Gas_Flow	OPMDREAL	FBI_16_23	101,55	OUT	W
	FBD:CL4003_Inlet_Gas_Flow	NE_REAL	.16.26	4,140	IN1	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.67	223,163	IN2	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.70	223,171	IN2	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.73	223,179	IN2	R
	FBD:CL4003_Inlet_Gas_Flow	SUB_REAL	.16.76	223,186	IN2	R
FQRC_4003_04_SP_MAX	FBD:Outputs	O_SCALE	FBI_19_11	56,21	MX	R
FQRC_4003_04_SP_MIN	FBD:Outputs	O_SCALE	FBI_19_11	56,19	MN	R
FQRC_4003_04_SP_OP	FBD:CL4003_Inlet_Gas_Flow	OPMDREAL	FBI_16_23	82,57	AUTO	R
	FBD:CL4003_Inlet_Gas_Flow	OPMDREAL	FBI_16_23	82,58	MAN	R
	FBD:CL4007_PBR_Pressure	MOVE	.12.85	77,109	OUT	W
	FBD:CL4007_PBR_Pressure	MOVE	.12.88	157,108	OUT	W
FT_4001_01	FBD:Inputs	LAG_FILTER	FBI_20_46	178,70	OUT	W
	FBD:CL4001_Inlet_Liquid_F>low	PCR_SF1	FBI_23_97	24,46	PV	R
	FBD:CL4001_Inlet_Liquid_F>low	PCR_ZTR	FBI_23_98	23,72	PV	R
	FBD:CL4001_Inlet_Liquid_F>low	SUB_REAL	.23.189	213,15	IN1	R
	FBD:CL4001_Inlet_Liquid_F>low	SUB_REAL	.23.191	212,32	IN1	R
	FBD:CL4001_Inlet_Liquid_F>low	SUB_REAL	.23.207	216,50	IN1	R
	FBD:CL4001_Inlet_Liquid_F>	SUB_REAL	.23.209	215,68	IN1	R

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
	low					
	FBD:CL4009_Biomass	MUL_REAL	.10.35	18,73	IN2	R
FT_4001_01_AH	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,15	IN1	R
	FBD:CL4001_Inlet_Liquid_F> low	TON	FBI_23_195	285,15	Q	W
FT_4001_01_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,78	IN5	R
	FBD:CL4001_Inlet_Liquid_F> low	TON	FBI_23_198	284,32	Q	W
FT_4001_01_AL	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,16	IN2	R
	FBD:CL4001_Inlet_Liquid_F> low	TON	FBI_23_213	279,50	Q	W
FT_4001_01_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,79	IN6	R
	FBD:CL4001_Inlet_Liquid_F> low	TON	FBI_23_216	279,68	Q	W
FT_4001_01_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_3	25,37	BIT12	W
	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,86	IN13	R
FT_4001_01_LIM_AH	FBD:CL4001_Inlet_Liquid_F> low	GT_REAL	.23.190	234,16	IN2	R
FT_4001_01_LIM_AHH	FBD:CL4001_Inlet_Liquid_F> low	GT_REAL	.23.192	233,33	IN2	R
FT_4001_01_LIM_AL	FBD:CL4001_Inlet_Liquid_F> low	LT_REAL	.23.208	236,51	IN2	R
FT_4001_01_LIM_ALL	FBD:CL4001_Inlet_Liquid_F> low	LT_REAL	.23.210	235,69	IN2	R
FT_4001_01_MAX	FBD:Inputs	I_SCALE	.20.18	137,71	MX	R
FT_4001_01_MIN	FBD:Inputs	I_SCALE	.20.18	137,70	MN	R
FT_4001_01_SP	FBD:CL4001_Inlet_Liquid_F> low	PCR_SF1	FBI_23_97	24,47	SP	R
	FBD:CL4001_Inlet_Liquid_F> low	PCR_ZTR	FBI_23_98	23,73	SP	R
	FBD:CL4001_Inlet_Liquid_F> low	SUB_REAL	.23.189	213,16	IN2	R
	FBD:CL4001_Inlet_Liquid_F> low	SUB_REAL	.23.191	212,33	IN2	R
	FBD:CL4001_Inlet_Liquid_F> low	SUB_REAL	.23.207	216,51	IN2	R
	FBD:CL4001_Inlet_Liquid_F> low	SUB_REAL	.23.209	215,69	IN2	R
	FBD:CL4004_Oulet_Gas_Flow	SEL	.15.40	9,119	IN1	R
	FBD:CL4004_Oulet_Gas_Flow	SEL	.15.47	9,146	IN1	R
	FBD:CL4004_Oulet_Gas_Flow	SEL	.15.54	9,174	IN1	R
	FBD:CL4004_Oulet_Gas_Flow	SEL	.15.62	11,199	IN1	R
FT_4001_01_without_filter	FBD:Inputs	MOVE	.20.52	191,80	OUT	W
FT_4004_01	FBD:Inputs	I_SCALE	.20.23	141,62	Y	W
	FBD:CL4004_Oulet_Gas_Flow	PCR_SF1	FBI_15_12	25,48	PV	R
	FBD:CL4004_Oulet_Gas_Flow	SUB_REAL	.15.19	25,117	IN1	R
	FBD:CL4004_Oulet_Gas_Flow	SUB_REAL	.15.48	25,144	IN1	R
	FBD:CL4004_Oulet_Gas_Flow	SUB_REAL	.15.55	25,172	IN1	R
	FBD:CL4004_Oulet_Gas_Flow	SUB_REAL	.15.63	27,197	IN1	R
FT_4004_01_AH	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,33	IN19	R
	FBD:CL4004_Oulet_Gas_Flow	AND_BOOL	.15.23	88,116	OUT	W
FT_4004_01_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,81	IN8	R
	FBD:CL4004_Oulet_Gas_Flow	AND_BOOL	.15.53	88,143	OUT	W
FT_4004_01_AL	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,34	IN20	R
	FBD:CL4004_Oulet_Gas_Flow	AND_BOOL	.15.60	88,171	OUT	W
FT_4004_01_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,82	IN9	R
	FBD:CL4004_Oulet_Gas_Flow	AND_BOOL	.15.68	90,196	OUT	W

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
FT_4004_01_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_3	25,36	BIT11	W
	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,85	IN12	R
FT_4004_01_LIM_AH	FBD:CL4004_Oulet_Gas_Flow	GT_REAL	.15.20	46,118	IN2	R
FT_4004_01_LIM_AHH	FBD:CL4004_Oulet_Gas_Flow	GT_REAL	.15.49	46,145	IN2	R
FT_4004_01_LIM_AL	FBD:CL4004_Oulet_Gas_Flow	LT_REAL	.15.61	46,173	IN2	R
FT_4004_01_LIM_ALL	FBD:CL4004_Oulet_Gas_Flow	LT_REAL	.15.67	48,198	IN2	R
FT_4004_01_MAX	FBD:Inputs	I_SCALE	.20.23	124,63	MX	R
FT_4004_01_MIN	FBD:Inputs	I_SCALE	.20.23	124,62	MN	R
FT_4004_01_SP	FBD:CL4004_Oulet_Gas_Flow	PCR_SF1	FBI_15_12	25,49	SP	R
	FBD:CL4004_Oulet_Gas_Flow	SEL	.15.40	9,118	IN0	R
	FBD:CL4004_Oulet_Gas_Flow	SEL	.15.47	9,145	IN0	R
	FBD:CL4004_Oulet_Gas_Flow	SEL	.15.54	9,173	IN0	R
	FBD:CL4004_Oulet_Gas_Flow	SEL	.15.62	11,198	IN0	R
GP_4001_01_MV1	FBD:CL4001_Inlet_Liquid_F> low	OPMDBOOL	FBI_23_74	153,105	OUT	W
	FBD:CL4002_Outlet_Liquid_> Flow	AND_BOOL	.17.75	6,52	IN2	R
GP_4001_01_MV1_OP	FBD:CL4001_Inlet_Liquid_F> low	OR_BOOL	.23.75	104,52	IN1	R
	FBD:CL4001_Inlet_Liquid_F> low	AND_BOOL	.23.128	91,65	IN1	R
	FBD:CL4001_Inlet_Liquid_F> low	AND_BOOL	.23.132	91,80	IN1	R
GP_4001_01_MV2_MAX	FBD:Outputs	O_SCALE	FBI_19_12	70,42	MX	R
GP_4001_01_MV2_MIN	FBD:Outputs	O_SCALE	FBI_19_12	70,40	MN	R
GP_4001_01_SEL	FBD:CL4001_Inlet_Liquid_F> low	AND_BOOL	.23.71	96,111	IN2	R
	FBD:CL4001_Inlet_Liquid_F> low	AND_BOOL	.23.78	96,100	IN1	R
	FBD:CL4001_Inlet_Liquid_F> low	AND_BOOL	.23.128	91,66	IN2	R
	FBD:CL4001_Inlet_Liquid_F> low	AND_BOOL	.23.132	91,81	IN2	R
	FBD:CL4002_Outlet_Liquid_> Flow	AND_BOOL	.17.75	6,51	IN1	R
GP_4001_02_MV1	FBD:CL4001_Inlet_Liquid_F> low	OPMDBOOL	FBI_23_3	153,135	OUT	W
	FBD:CL4002_Outlet_Liquid_> Flow	AND_BOOL	.17.76	6,59	IN2	R
GP_4001_02_MV1_OP	FBD:CL4001_Inlet_Liquid_F> low	OR_BOOL	.23.75	104,53	IN2	R
	FBD:CL4001_Inlet_Liquid_F> low	AND_BOOL	.23.129	91,72	IN1	R
	FBD:CL4001_Inlet_Liquid_F> low	AND_BOOL	.23.133	91,87	IN1	R
GP_4001_02_MV2	FBD:Outputs	O_SCALE	FBI_19_13	82,47	X	R
GP_4001_02_MV2_MAX	FBD:Outputs	O_SCALE	FBI_19_13	82,48	MX	R
GP_4001_02_MV2_MIN	FBD:Outputs	O_SCALE	FBI_19_13	82,46	MN	R
GP_4001_02_SEL	FBD:CL4001_Inlet_Liquid_F> low	AND_BOOL	.23.84	96,141	IN2	R
	FBD:CL4001_Inlet_Liquid_F> low	AND_BOOL	.23.86	96,130	IN1	R
	FBD:CL4001_Inlet_Liquid_F> low	AND_BOOL	.23.129	91,73	IN2	R
	FBD:CL4001_Inlet_Liquid_F> low	AND_BOOL	.23.133	91,88	IN2	R
	FBD:CL4002_Outlet_Liquid_>	AND_BOOL	.17.76	6,58	IN1	R

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
	Flow					
GP_4001_03_MV1	FBD:CL4001_Inlet_Liquid_F>low	OPMDBOOL	FBI_23_2	76,10	OUT	W
GP_4001_03_MV1_OP	FBD:CL4001_Inlet_Liquid_F>low	OPMDBOOL	FBI_23_2	57,13	MAN	R
GP_4001_03_MV2	FBD:Outputs	O_SCALE	FBI_19_16	59,62	X	R
	FBD:CL4001_Inlet_Liquid_F>low	OPMDREAL	FBI_23_1	112,8	OUT	W
GP_4001_03_MV2_MAX	FBD:Outputs	O_SCALE	FBI_19_16	59,63	MX	R
GP_4001_03_MV2_MIN	FBD:Outputs	O_SCALE	FBI_19_16	59,61	MN	R
GP_4001_03_MV2_OP	FBD:CL4001_Inlet_Liquid_F>low	OPMDREAL	FBI_23_1	93,10	AUTO	R
	FBD:CL4001_Inlet_Liquid_F>low	OPMDREAL	FBI_23_1	93,11	MAN	R
GP_4002_01_MV1	FBD:CL4002_Outlet_Liquid_>Flow	OPMDBOOL	FBI_17_51	116,176	OUT	W
GP_4002_01_MV1_OP	FBD:CL4002_Outlet_Liquid_>Flow	OR_BOOL	.17.36	32,123	IN1	R
	FBD:CL4002_Outlet_Liquid_>Flow	AND_BOOL	.17.94	16,135	IN1	R
	FBD:CL4002_Outlet_Liquid_>Flow	AND_BOOL	.17.98	16,150	IN1	R
GP_4002_01_MV2_MAX	FBD:Outputs	O_SCALE	FBI_19_14	57,53	MX	R
GP_4002_01_MV2_MIN	FBD:Outputs	O_SCALE	FBI_19_14	57,51	MN	R
GP_4002_01_SEL	FBD:CL4002_Outlet_Liquid_>Flow	OPMDREAL	FBI_17_6	94,43	EN	R
	FBD:CL4002_Outlet_Liquid_>Flow	AND_BOOL	.17.45	51,181	IN2	R
	FBD:CL4002_Outlet_Liquid_>Flow	AND_BOOL	.17.48	45,170	IN1	R
	FBD:CL4002_Outlet_Liquid_>Flow	AND_BOOL	.17.94	16,136	IN2	R
	FBD:CL4002_Outlet_Liquid_>Flow	AND_BOOL	.17.98	16,151	IN2	R
GP_4002_02_MV1	FBD:CL4002_Outlet_Liquid_>Flow	OPMDBOOL	FBI_17_59	113,207	OUT	W
GP_4002_02_MV1_OP	FBD:CL4002_Outlet_Liquid_>Flow	OR_BOOL	.17.36	32,124	IN2	R
	FBD:CL4002_Outlet_Liquid_>Flow	AND_BOOL	.17.95	16,142	IN1	R
	FBD:CL4002_Outlet_Liquid_>Flow	AND_BOOL	.17.99	16,157	IN1	R
GP_4002_02_MV2	FBD:Outputs	O_SCALE	FBI_19_15	82,58	X	R
GP_4002_02_MV2_MAX	FBD:Outputs	O_SCALE	FBI_19_15	82,59	MX	R
GP_4002_02_MV2_MIN	FBD:Outputs	O_SCALE	FBI_19_15	82,57	MN	R
GP_4002_02_SEL	FBD:CL4002_Outlet_Liquid_>Flow	AND_BOOL	.17.52	40,201	IN1	R
	FBD:CL4002_Outlet_Liquid_>Flow	AND_BOOL	.17.56	50,208	IN2	R
	FBD:CL4002_Outlet_Liquid_>Flow	AND_BOOL	.17.95	16,143	IN2	R
	FBD:CL4002_Outlet_Liquid_>Flow	AND_BOOL	.17.99	16,158	IN2	R
GP_4002_03_MV1	FBD:CL4002_Outlet_Liquid_>Flow	OPMDBOOL	FBI_17_2	66,16	OUT	W
GP_4002_03_MV1_OP	FBD:CL4002_Outlet_Liquid_>Flow	OPMDBOOL	FBI_17_2	47,19	MAN	R

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
GP_4002_03_MV2	FBD:Outputs	O_SCALE	FBI_19_17	69,70	X	R
	FBD:CL4002_Outlet_Liquid_>Flow	OPMDREAL	FBI_17_1	30,27	OUT	W
GP_4002_03_MV2_MAX	FBD:Outputs	O_SCALE	FBI_19_17	69,71	MX	R
GP_4002_03_MV2_MIN	FBD:Outputs	O_SCALE	FBI_19_17	69,69	MN	R
GP_4002_03_MV2_OP	FBD:CL4002_Outlet_Liquid_>Flow	OPMDREAL	FBI_17_1	11,29	AUTO	R
	FBD:CL4002_Outlet_Liquid_>Flow	OPMDREAL	FBI_17_1	11,30	MAN	R
HX_4005_02_MV1	FBD:CL4005_PBR_Temp	OPMDBOOL	FBI_14_5	141,94	OUT	W
HX_4005_02_OP	FBD:CL4005_PBR_Temp	OPMDBOOL	FBI_14_5	122,97	MAN	R
IRC_4000_MV	FBD:Outputs	O_SCALE	FBI_19_19	82,75	X	R
	FBD:CL4000_Lights	SEL	.1.6	105,34	OUT	W
	FBD:CL4005_PBR_Temp	LT_REAL	.14.137	14,19	IN1	R
	FBD:CL4005_PBR_Temp	GE_REAL	.14.142	14,25	IN1	R
	FBD:CL4005_PBR_Temp	MOVE	.14.143	29,26	IN	R
	FBD:CL4010_OutletGasCompo	PCR_EF1	FBI_9_36	11,33	RCPY	R
	FBD:CL4010_OutletGasCompo	PCR_EF1	FBI_9_36	11,43	YMAN	R
IRC_4000_MV_MAX	FBD:Outputs	O_SCALE	FBI_19_19	82,76	MX	R
IRC_4000_MV_MIN	FBD:Outputs	O_SCALE	FBI_19_19	82,74	MN	R
IT_4000_01	FBD:Inputs	I_SCALE	.20.40	92,112	Y	W
	FBD:CL4000_Lights	ADD_REAL	.1.1	67,129	IN1	R
IT_4000_01_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_4	25,55	BIT10	W
IT_4000_01_MAX	FBD:Inputs	I_SCALE	.20.40	75,113	MX	R
IT_4000_01_MIN	FBD:Inputs	I_SCALE	.20.40	75,112	MN	R
IT_4000_02	FBD:Inputs	I_SCALE	.20.41	73,119	Y	W
	FBD:CL4000_Lights	ADD_REAL	.1.1	67,130	IN2	R
IT_4000_02_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_4	25,56	BIT11	W
IT_4000_02_MAX	FBD:Inputs	I_SCALE	.20.41	56,120	MX	R
IT_4000_02_MIN	FBD:Inputs	I_SCALE	.20.41	56,119	MN	R
IT_4000_03	FBD:Inputs	I_SCALE	.20.42	67,128	Y	W
	FBD:CL4000_Lights	ADD_REAL	.1.1	67,131	IN3	R
IT_4000_03_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_4	25,57	BIT12	W
IT_4000_03_MAX	FBD:Inputs	I_SCALE	.20.42	50,129	MX	R
IT_4000_03_MIN	FBD:Inputs	I_SCALE	.20.42	50,128	MN	R
IT_4000_PWR	FBD:CL4000_Lights	ADD_REAL	.1.1	84,129	OUT	W
I_4000_SP	FBD:CL4000_Lights	MUL_REAL	.1.4	4,37	IN1	R
LT_4001_01	FBD:Inputs	I_SCALE	.20.19	129,75	Y	W
	FBD:CL4001_Inlet_Liquid_F>low	GT_REAL	.23.39	23,11	IN1	R
	FBD:CL4001_Inlet_Liquid_F>low	GT_REAL	.23.199	212,93	IN1	R
	FBD:CL4001_Inlet_Liquid_F>low	GT_REAL	.23.200	211,106	IN1	R
	FBD:CL4001_Inlet_Liquid_F>low	LT_REAL	.23.201	257,94	IN1	R
	FBD:CL4001_Inlet_Liquid_F>low	LT_REAL	.23.202	256,105	IN1	R
LT_4001_01_AH	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,17	IN3	R
	FBD:CL4001_Inlet_Liquid_F>low	ACT_DIA	FBI_23_203	242,91	ERR	W
LT_4001_01_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,80	IN7	R
	FBD:CL4001_Inlet_Liquid_F>low	ACT_DIA	FBI_23_204	241,104	ERR	W
LT_4001_01_AL	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,18	IN4	R
	FBD:CL4001_Inlet_Liquid_F>low	ACT_DIA	FBI_23_205	286,92	ERR	W

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
LT_4001_01_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,81	IN8	R
	FBD:CL4001_Inlet_Liquid_F> low	ACT_DIA	FBI_23_206	286,103	ERR	W
	FBD:CL4001_Inlet_Liquid_F> low	AND_BOOL	.23.218	266,115	IN1	R
LT_4001_01_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_3	25,38	BIT13	W
	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,87	IN14	R
LT_4001_01_LIM_AH	FBD:CL4001_Inlet_Liquid_F> low	GT_REAL	.23.199	212,94	IN2	R
LT_4001_01_LIM_AHH	FBD:CL4001_Inlet_Liquid_F> low	GT_REAL	.23.200	211,107	IN2	R
LT_4001_01_LIM_AL	FBD:CL4001_Inlet_Liquid_F> low	LT_REAL	.23.201	257,95	IN2	R
LT_4001_01_LIM_ALL	FBD:CL4001_Inlet_Liquid_F> low	LT_REAL	.23.202	256,106	IN2	R
LT_4001_01_MAX	FBD:Inputs	I_SCALE	.20.19	112,76	MX	R
LT_4001_01_MIN	FBD:Inputs	I_SCALE	.20.19	112,75	MN	R
pHdz	FBD:CL4006_pH	SEL	.13.283	70,53	OUT	W
	FBD:CL4006_pH	PCR_IF1	FBI_13_286	14,69	PV	R
	FBD:CL4006_pH	PCR_IF1	FBI_13_295	94,165	PV	R
PP_4005_01_MV1	FBD:CL4005_PBR_Temp	OPMDBOOL	FBI_14_4	79,45	OUT	W
PP_4005_01_OP	FBD:CL4005_PBR_Temp	OPMDBOOL	FBI_14_4	60,48	MAN	R
PP_4006_01_MV1	FBD:CL4006_pH	OPMDBOOL	FBI_13_31	155,78	OUT	W
PP_4006_01_OP	FBD:CL4006_pH	OR_BOOL	.13.183	166,32	IN1	R
	FBD:CL4006_pH	MOVE	.13.186	241,27	OUT	W
	FBD:CL4006_pH	MOVE	.13.195	295,65	OUT	W
	FBD:CL4006_pH	TON	FBI_13_214	85,91	IN	R
	FBD:CL4006_pH	AND_BOOL	.13.217	120,85	IN1	R
	FBD:CL4006_pH	MOVE	.13.238	209,83	OUT	W
PP_4006_02_MV1	FBD:CL4006_pH	OPMDBOOL	FBI_13_32	173,126	OUT	W
PP_4006_02_OP	FBD:CL4006_pH	OR_BOOL	.13.189	167,12	IN1	R
	FBD:CL4006_pH	MOVE	.13.193	243,10	OUT	W
	FBD:CL4006_pH	MOVE	.13.197	295,75	OUT	W
	FBD:CL4006_pH	TON	FBI_13_222	98,135	IN	R
	FBD:CL4006_pH	AND_BOOL	.13.225	133,132	IN1	R
	FBD:CL4006_pH	MOVE	.13.243	228,128	OUT	W
PS_4001_01	FBD:CL4001_Inlet_Liquid_F> low	TON	FBI_23_93	210,132	IN	R
PS_4001_01_A	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,74	IN1	R
	FBD:CL4001_Inlet_Liquid_F> low	TON	FBI_23_93	226,132	Q	W
PS_4001_02	FBD:CL4001_Inlet_Liquid_F> low	TON	FBI_23_94	210,140	IN	R
PS_4001_02_A	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,75	IN2	R
	FBD:CL4001_Inlet_Liquid_F> low	TON	FBI_23_94	226,140	Q	W
PS_4001_03	FBD:CL4001_Inlet_Liquid_F> low	TON	FBI_23_95	242,131	IN	R
PS_4001_03_A	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,76	IN3	R
	FBD:CL4001_Inlet_Liquid_F> low	TON	FBI_23_95	258,131	Q	W
PS_4001_04	FBD:CL4001_Inlet_Liquid_F> low	TON	FBI_23_96	243,139	IN	R
PS_4001_04_A	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,77	IN4	R
	FBD:CL4001_Inlet_Liquid_F> low	TON	FBI_23_96	259,139	Q	W
PS_4002_01	FBD:CL4002_Outlet_Liquid_>	TON	FBI_17_60	133,9	IN	R

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
	Flow					
PS_4002_01_A	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,90	IN17	R
	FBD:CL4002_Outlet_Liquid_> Flow	TON	FBI_17_60	149,9	Q	W
PS_4002_02	FBD:CL4002_Outlet_Liquid_> Flow	TON	FBI_17_61	133,17	IN	R
PS_4002_02_A	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,91	IN18	R
	FBD:CL4002_Outlet_Liquid_> Flow	TON	FBI_17_61	149,17	Q	W
PS_4002_03	FBD:CL4002_Outlet_Liquid_> Flow	TON	FBI_17_62	165,8	IN	R
PS_4002_03_A	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,92	IN19	R
	FBD:CL4002_Outlet_Liquid_> Flow	TON	FBI_17_62	181,8	Q	W
PS_4003_01	FBD:CL4003_Inlet_Gas_Flow	TON	FBI_16_16	5,102	IN	R
PS_4003_01_A	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,96	IN23	R
	FBD:CL4003_Inlet_Gas_Flow	TON	FBI_16_16	21,102	Q	W
	FBD:CL4003_Inlet_Gas_Flow	SEL	.16.82	73,11	G	R
PS_TIME_LIM	FBD:CL4001_Inlet_Liquid_F> low	TON	FBI_23_93	210,133	PT	R
	FBD:CL4001_Inlet_Liquid_F> low	TON	FBI_23_94	210,141	PT	R
	FBD:CL4001_Inlet_Liquid_F> low	TON	FBI_23_95	242,132	PT	R
	FBD:CL4001_Inlet_Liquid_F> low	TON	FBI_23_96	243,140	PT	R
	FBD:CL4002_Outlet_Liquid_> Flow	TON	FBI_17_60	133,10	PT	R
	FBD:CL4002_Outlet_Liquid_> Flow	TON	FBI_17_61	133,18	PT	R
	FBD:CL4002_Outlet_Liquid_> Flow	TON	FBI_17_62	165,9	PT	R
	FBD:CL4003_Inlet_Gas_Flow	TON	FBI_16_16	5,103	PT	R
PT_4007_01	FBD:Inputs	I_SCALE	.20.26	165,83	Y	W
	FBD:CL4007_PBR_Pressure	SEL	.12.4	8,10	IN0	R
	FBD:CL4007_PBR_Pressure	SUB_REAL	.12.10	7,76	IN1	R
	FBD:CL4007_PBR_Pressure	SUB_REAL	.12.12	8,97	IN1	R
	FBD:CL4007_PBR_Pressure	SUB_REAL	.12.57	5,169	IN1	R
	FBD:CL4007_PBR_Pressure	SUB_REAL	.12.61	5,195	IN1	R
	FBD:CL4007_PBR_Pressure	GT_REAL	.12.81	14,118	IN1	R
PT_4007_01_AH	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,43	IN29	R
	FBD:CL4007_PBR_Pressure	AND_BOOL	.12.53	57,76	OUT	W
PT_4007_01_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,102	IN29	R
	FBD:CL4007_PBR_Pressure	AND_BOOL	.12.56	59,97	OUT	W
PT_4007_01_AHHH	FBD:CL4007_PBR_Pressure	GT_REAL	.12.81	31,118	OUT	W
	FBD:CL4007_PBR_Pressure	OR_BOOL	.12.100	51,131	IN1	R
PT_4007_01_AL	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,44	IN30	R
	FBD:CL4007_PBR_Pressure	AND_BOOL	.12.60	56,169	OUT	W
PT_4007_01_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,103	IN30	R
	FBD:CL4007_PBR_Pressure	AND_BOOL	.12.64	56,195	OUT	W
PT_4007_01_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_4	25,45	BIT0	W
	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,74	IN1	R
	FBD:CL4007_PBR_Pressure	AND_BOOL	.12.43	69,7	IN1	R
	FBD:CL4007_PBR_Pressure	AND_BOOL	.12.103	122,7	IN1	R
	FBD:CL4007_PBR_Pressure	AND_BOOL	.12.103	122,8	IN2	R
PT_4007_01_LIM_AH	FBD:CL4007_PBR_Pressure	GT_REAL	.12.11	26,77	IN2	R
PT_4007_01_LIM_AHH	FBD:CL4007_PBR_Pressure	GT_REAL	.12.13	28,98	IN2	R

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
PT_4007_01_LIM_AHHH	FBD:CL4007_PBR_Pressure	GT_REAL	.12.81	14,119	IN2	R
PT_4007_01_LIM_AL	FBD:CL4007_PBR_Pressure	LT_REAL	.12.20	25,170	IN2	R
PT_4007_01_LIM_ALL	FBD:CL4007_PBR_Pressure	LT_REAL	.12.62	25,196	IN2	R
PT_4007_01_MAX	FBD:Inputs	I_SCALE	.20.26	148,84	MX	R
PT_4007_01_MIN	FBD:Inputs	I_SCALE	.20.26	148,83	MN	R
PT_4007_02	FBD:Inputs	I_SCALE	.20.27	146,88	Y	W
	FBD:CL4007_PBR_Pressure	SEL	.12.4	8,11	IN1	R
	FBD:CL4007_PBR_Pressure	SUB_REAL	.12.65	88,79	IN1	R
	FBD:CL4007_PBR_Pressure	SUB_REAL	.12.69	89,95	IN1	R
	FBD:CL4007_PBR_Pressure	SUB_REAL	.12.73	86,168	IN1	R
	FBD:CL4007_PBR_Pressure	SUB_REAL	.12.77	84,185	IN1	R
	FBD:CL4007_PBR_Pressure	GT_REAL	.12.82	107,120	IN1	R
PT_4007_02_AH	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,45	IN31	R
	FBD:CL4007_PBR_Pressure	AND_BOOL	.12.68	138,79	OUT	W
PT_4007_02_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,104	IN31	R
	FBD:CL4007_PBR_Pressure	AND_BOOL	.12.72	139,95	OUT	W
PT_4007_02_AHHH	FBD:CL4007_PBR_Pressure	GT_REAL	.12.82	124,120	OUT	W
	FBD:CL4007_PBR_Pressure	OR_BOOL	.12.100	51,132	IN2	R
PT_4007_02_AL	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,46	IN32	R
	FBD:CL4007_PBR_Pressure	AND_BOOL	.12.76	137,168	OUT	W
PT_4007_02_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,105	IN32	R
	FBD:CL4007_PBR_Pressure	AND_BOOL	.12.80	135,185	OUT	W
PT_4007_02_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_4	25,46	BIT1	W
	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,75	IN2	R
	FBD:CL4007_PBR_Pressure	AND_BOOL	.12.46	70,14	IN1	R
PT_4007_02_LIM_AH	FBD:CL4007_PBR_Pressure	GT_REAL	.12.66	107,80	IN2	R
PT_4007_02_LIM_AHH	FBD:CL4007_PBR_Pressure	GT_REAL	.12.70	108,96	IN2	R
PT_4007_02_LIM_AHHH	FBD:CL4007_PBR_Pressure	GT_REAL	.12.82	107,121	IN2	R
PT_4007_02_LIM_AL	FBD:CL4007_PBR_Pressure	LT_REAL	.12.74	106,169	IN2	R
PT_4007_02_LIM_ALL	FBD:CL4007_PBR_Pressure	LT_REAL	.12.78	104,186	IN2	R
PT_4007_02_MAX	FBD:Inputs	I_SCALE	.20.27	129,89	MX	R
PT_4007_02_MIN	FBD:Inputs	I_SCALE	.20.27	129,88	MN	R
PT_4007_SELECTED	FBD:CL4007_PBR_Pressure	SEL	.12.4	24,10	OUT	W
	FBD:CL4007_PBR_Pressure	PCR_SF1	FBI_12_52	37,35	PV	R
PT_4007_SP	FBD:CL4007_PBR_Pressure	SUB_REAL	.12.10	7,77	IN2	R
	FBD:CL4007_PBR_Pressure	SUB_REAL	.12.12	8,98	IN2	R
	FBD:CL4007_PBR_Pressure	PCR_SF1	FBI_12_52	37,36	SP	R
	FBD:CL4007_PBR_Pressure	SUB_REAL	.12.57	5,170	IN2	R
	FBD:CL4007_PBR_Pressure	SUB_REAL	.12.61	5,196	IN2	R
	FBD:CL4007_PBR_Pressure	SUB_REAL	.12.65	88,80	IN2	R
	FBD:CL4007_PBR_Pressure	SUB_REAL	.12.69	89,96	IN2	R
	FBD:CL4007_PBR_Pressure	SUB_REAL	.12.73	86,169	IN2	R
	FBD:CL4007_PBR_Pressure	SUB_REAL	.12.77	84,186	IN2	R
PT_4010_01	FBD:Inputs	I_SCALE	.20.28	126,91	Y	W
	FBD:CL4010_OutletGasCompo	LT_REAL	.9.27	228,120	IN1	R
	FBD:CL4010_OutletGasCompo	LT_REAL	.9.28	228,131	IN1	R
	FBD:CL4010_OutletGasCompo	GT_REAL	.9.29	228,99	IN1	R
	FBD:CL4010_OutletGasCompo	GT_REAL	.9.30	228,111	IN1	R
PT_4010_01_AH	FBD:ALARM_STATUS	OR_BOOL	.22.2	37,32	IN13	R
	FBD:CL4010_OutletGasCompo	GT_REAL	.9.29	245,99	OUT	W
PT_4010_01_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,94	IN21	R
	FBD:CL4010_OutletGasCompo	GT_REAL	.9.30	245,111	OUT	W
	FBD:CL4010_OutletGasCompo	OR_BOOL	.9.34	23,10	IN1	R
PT_4010_01_AL	FBD:ALARM_STATUS	OR_BOOL	.22.2	37,33	IN14	R
	FBD:CL4010_OutletGasCompo	LT_REAL	.9.27	245,120	OUT	W
PT_4010_01_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,95	IN22	R
	FBD:CL4010_OutletGasCompo	LT_REAL	.9.28	245,131	OUT	W

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
	FBD:CL4010_OutletGasCompo	OR_BOOL	.9.34	23,11	IN2	R
PT_4010_01_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_4	25,47	BIT2	W
	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,102	IN29	R
PT_4010_01_LIM_AH	FBD:CL4010_OutletGasCompo	GT_REAL	.9.29	228,100	IN2	R
PT_4010_01_LIM_AHH	FBD:CL4010_OutletGasCompo	GT_REAL	.9.30	228,112	IN2	R
PT_4010_01_LIM_AL	FBD:CL4010_OutletGasCompo	LT_REAL	.9.27	228,121	IN2	R
PT_4010_01_LIM_ALL	FBD:CL4010_OutletGasCompo	LT_REAL	.9.28	228,132	IN2	R
PT_4010_01_MAX	FBD:Inputs	I_SCALE	.20.28	109,92	MX	R
PT_4010_01_MIN	FBD:Inputs	I_SCALE	.20.28	109,91	MN	R
REAL0	FBD:CL4005_PBR_Temp	SEL	.14.114	110,170	IN0	R
	FBD:CL4005_PBR_Temp	SEL	.14.115	110,179	IN0	R
	FBD:CL4006_pH	SEL	.13.304	4,164	IN0	R
	FBD:CL4006_pH	SEL	.13.305	4,173	IN0	R
REAL1	FBD:CL4005_PBR_Temp	SEL	.14.114	110,171	IN1	R
	FBD:CL4005_PBR_Temp	SEL	.14.115	110,180	IN1	R
	FBD:CL4006_pH	SEL	.13.304	4,165	IN1	R
	FBD:CL4006_pH	SEL	.13.305	4,174	IN1	R
SCV_4004_01_MV	FBD:Outputs	O_SCALE	FBI_19_7	81,33	X	R
	FBD:CL4004_Oulet_Gas_Flow	OPMDREAL	FBI_15_5	69,29	OUT	W
	FBD:CL4007_PBR_Pressure	PCR_SF1	FBI_12_52	37,42	YMAN	R
	FBD:CL4007_PBR_Pressure	LOOKUP_TABLE1	FBI_12_105	91,26	X	R
SCV_4004_01_MV_MAX	FBD:Outputs	O_SCALE	FBI_19_7	81,34	MX	R
SCV_4004_01_MV_MIN	FBD:Outputs	O_SCALE	FBI_19_7	81,32	MN	R
SCV_4004_01_OP	FBD:CL4004_Oulet_Gas_Flow	OPMDREAL	FBI_15_5	50,32	MAN	R
	FBD:CL4004_Oulet_Gas_Flow	PCR_SF1	FBI_15_12	25,55	YMAN	R
SV_4003_01_A	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,99	IN26	R
	FBD:CL4003_Inlet_Gas_Flow	VALVBOOL	FBI_16_83	84,22	ALARM	W
SV_4003_01_FB	FBD:CL4003_Inlet_Gas_Flow	VALVBOOL	FBI_16_83	65,26	FEEDBACK	R
SV_4003_01_MV	FBD:CL4003_Inlet_Gas_Flow	VALVBOOL	FBI_16_83	84,21	MV	W
SV_4003_01_OP	FBD:CL4003_Inlet_Gas_Flow	VALVBOOL	FBI_16_83	65,24	MANUAL	R
SV_4003_02_A	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,98	IN25	R
	FBD:CL4009_Biomass	VALVBOOL	FBI_10_51	81,53	ALARM	W
SV_4003_02_FB	FBD:CL4009_Biomass	VALVBOOL	FBI_10_51	62,57	FEEDBACK	R
SV_4003_02_MV	FBD:CL4009_Biomass	VALVBOOL	FBI_10_51	81,52	MV	W
SV_4003_02_OP	FBD:CL4009_Biomass	VALVBOOL	FBI_10_51	62,55	MANUAL	R
SV_4003_03_A	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,97	IN24	R
	FBD:CL4003_Inlet_Gas_Flow	VALVBOOL	FBI_16_84	113,10	ALARM	W
SV_4003_03_FB	FBD:CL4003_Inlet_Gas_Flow	VALVBOOL	FBI_16_84	94,14	FEEDBACK	R
SV_4003_03_MV	FBD:CL4003_Inlet_Gas_Flow	VALVBOOL	FBI_16_84	113,9	MV	W
SV_4003_03_OP	FBD:CL4003_Inlet_Gas_Flow	SEL	.16.82	73,12	IN0	R
SV_4005_01_A	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,87	IN14	R
	FBD:CL4005_PBR_Temp	VALVBOOL	FBI_14_144	143,83	ALARM	W
SV_4005_01_FB	FBD:CL4005_PBR_Temp	VALVBOOL	FBI_14_144	124,87	FEEDBACK	R
SV_4005_01_MV	FBD:CL4005_PBR_Temp	VALVBOOL	FBI_14_144	143,82	MV	W
SV_4005_01_OP	FBD:CL4005_PBR_Temp	VALVBOOL	FBI_14_144	124,85	MANUAL	R
SV_4006_01_A	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,91	IN18	R
	FBD:CL4006_pH	VALVBOOL	FBI_13_350	163,59	ALARM	W
SV_4006_01_FB	FBD:CL4006_pH	VALVBOOL	FBI_13_350	144,63	FEEDBACK	R
SV_4006_01_MV	FBD:CL4006_pH	VALVBOOL	FBI_13_350	163,58	MV	W
SV_4006_01_OP	FBD:CL4006_pH	MOVE	.13.60	214,55	OUT	W
	FBD:CL4006_pH	OR_BOOL	.13.183	166,33	IN2	R
	FBD:CL4006_pH	MOVE	.13.187	241,32	OUT	W
	FBD:CL4006_pH	MOVE	.13.196	295,70	OUT	W
	FBD:CL4006_pH	TON	FBI_13_204	90,65	IN	R
	FBD:CL4006_pH	AND_BOOL	.13.206	125,62	IN1	R
SV_4006_02_A	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,92	IN19	R
	FBD:CL4006_pH	VALVBOOL	FBI_13_351	178,98	ALARM	W

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
SV_4006_02_FB	FBD:CL4006_pH	VALVBOOL	FBI_13_351	159,102	FEEDBACK	R
SV_4006_02_MV	FBD:CL4006_pH	VALVBOOL	FBI_13_351	178,97	MV	W
SV_4006_02_OP	FBD:CL4006_pH	MOVE	.13.138	231,97	OUT	W
	FBD:CL4006_pH	OR_BOOL	.13.189	167,13	IN2	R
	FBD:CL4006_pH	MOVE	.13.194	243,15	OUT	W
	FBD:CL4006_pH	MOVE	.13.198	295,80	OUT	W
	FBD:CL4006_pH	TON	FBI_13_218	105,114	IN	R
	FBD:CL4006_pH	AND_BOOL	.13.221	139,108	IN1	R
SV_4010_01_A	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,87	IN14	R
	FBD:CL4010_OutletGasCompo	OR_BOOL	.9.42	95,18	OUT	W
SV_4010_01_FB	FBD:CL4010_OutletGasCompo	ACT_DIA	FBI_9_41	67,17	REACT	R
	FBD:CL4010_OutletGasCompo	ACT_DIA	FBI_9_43	67,26	REACT	R
SV_4010_01_MV	FBD:CL4010_OutletGasCompo	SEL	.9.31	51,18	OUT	W
	FBD:CL4010_OutletGasCompo	ACT_DIA	FBI_9_41	67,16	ACT	R
	FBD:CL4010_OutletGasCompo	ACT_DIA	FBI_9_43	67,25	ACT	R
SV_4010_01_OP	FBD:CL4010_OutletGasCompo	OPMDBOOL	FBI_9_1	13,21	MAN	R
SV_4011_01_A	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,104	IN31	R
	FBD:CL4011_Feeding_Temp	VALVBOOL	FBI_8_29	107,16	ALARM	W
SV_4011_01_FB	FBD:CL4011_Feeding_Temp	VALVBOOL	FBI_8_29	88,20	FEEDBACK	R
SV_4011_01_MV	FBD:CL4011_Feeding_Temp	VALVBOOL	FBI_8_29	107,15	MV	W
SV_4011_01_OP	FBD:CL4011_Feeding_Temp	VALVBOOL	FBI_8_29	88,18	MANUAL	R
SV_4012_01_A	FBD:ALARM_STATUS	OR_BOOL	.22.7	80,79	IN6	R
	FBD:CL4012_Harvesting_Temp	VALVBOOL	FBI_7_26	95,21	ALARM	W
SV_4012_01_FB	FBD:CL4012_Harvesting_Temp	VALVBOOL	FBI_7_26	76,25	FEEDBACK	R
SV_4012_01_MV	FBD:CL4012_Harvesting_Temp	VALVBOOL	FBI_7_26	95,20	MV	W
SV_4012_01_OP	FBD:CL4012_Harvesting_Temp	VALVBOOL	FBI_7_26	76,23	MANUAL	R
SV_4014_01_A	FBD:ALARM_STATUS	OR_BOOL	.22.7	80,80	IN7	R
	FBD:CL4014_Feeding_Steril> ization	VALVBOOL	FBI_5_2	28,11	ALARM	W
SV_4014_01_FB	FBD:CL4014_Feeding_Steril> ization	VALVBOOL	FBI_5_2	9,15	FEEDBACK	R
SV_4014_01_MV	FBD:CL4014_Feeding_Steril> ization	VALVBOOL	FBI_5_2	28,10	MV	W
SV_4014_01_OP	FBD:CL4014_Feeding_Steril> ization	VALVBOOL	FBI_5_2	9,12	AUTO	R
	FBD:CL4014_Feeding_Steril> ization	VALVBOOL	FBI_5_2	9,13	MANUAL	R
SV_4015_01_A	FBD:ALARM_STATUS	OR_BOOL	.22.7	80,81	IN8	R
	FBD:CL4015_PBR_Sterilizat> ion	VALVBOOL	FBI_4_2	25,11	ALARM	W
SV_4015_01_FB	FBD:CL4015_PBR_Sterilizat> ion	VALVBOOL	FBI_4_2	6,15	FEEDBACK	R
SV_4015_01_MV	FBD:CL4015_PBR_Sterilizat> ion	VALVBOOL	FBI_4_2	25,10	MV	W
SV_4015_01_OP	FBD:CL4015_PBR_Sterilizat> ion	VALVBOOL	FBI_4_2	6,12	AUTO	R
	FBD:CL4015_PBR_Sterilizat> ion	VALVBOOL	FBI_4_2	6,13	MANUAL	R
SV_4016_01_A	FBD:ALARM_STATUS	OR_BOOL	.22.7	80,82	IN9	R
	FBD:CL4016_Harvesting_Ste> rilization	VALVBOOL	FBI_3_2	27,11	ALARM	W
SV_4016_01_FB	FBD:CL4016_Harvesting_Ste> rilization	VALVBOOL	FBI_3_2	8,15	FEEDBACK	R
SV_4016_01_MV	FBD:CL4016_Harvesting_Ste> rilization	VALVBOOL	FBI_3_2	27,10	MV	W
SV_4016_01_OP	FBD:CL4016_Harvesting_Ste> rilization	VALVBOOL	FBI_3_2	8,12	AUTO	R

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
	FBD:CL4016_Harvesting_Ste>rilization	VALVBOOL	FBI_3_2	8,13	MANUAL	R
Temp_dz	FBD:CL4005_PBR_Temp	SEL	.14.113	181,144	OUT	W
	FBD:CL4005_PBR_Temp	PCR_IF1	FBI_14_125	42,87	PV	R
test	FBD:CL4005_PBR_Temp	RS	FBI_14_50	53,57	Q1	W
TEST_TIME	FBD:CL4006_pH	TOF	FBI_13_200	130,69	ET	W
TEST_TIME2	FBD:CL4006_pH	TOF	FBI_13_216	125,92	ET	W
TEST_TIME4	FBD:CL4001_Inlet_Liquid_F>low	TON	FBI_23_213	279,51	ET	W
the_time	FBD:System_Clock	TIME_TO_REAL	.21.5	69,41	OUT	W
TIMER	FBD:System_Clock	SYSCLOCK	FBI_21_3	39,37	TIMER	W
	FBD:System_Clock	TIME_TO_REAL	.21.5	50,41	IN	R
TT_4005_01	FBD:Inputs	I_SCALE	.20.31	146,100	Y	W
TT_4005_01_AH	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,37	IN23	R
	FBD:CL4005_PBR_Temp	GT_REAL	.14.54	191,14	OUT	W
TT_4005_01_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,88	IN15	R
	FBD:CL4000_Lights	OR_BOOL	.1.8	7,66	IN1	R
	FBD:CL4005_PBR_Temp	HYST_REAL	FBI_14_75	192,29	IND	W
TT_4005_01_AL	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,38	IN24	R
	FBD:CL4005_PBR_Temp	LT_REAL	.14.61	192,48	OUT	W
TT_4005_01_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,89	IN16	R
	FBD:CL4005_PBR_Temp	SEL	.14.79	13,11	G	R
	FBD:CL4005_PBR_Temp	SR	FBI_14_90	204,67	Q1	W
TT_4005_01_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_4	25,51	BIT6	W
	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,90	IN17	R
TT_4005_01_Filtered	FBD:Inputs	LAG_FILTER	FBI_20_45	166,107	OUT	W
	FBD:CL4005_PBR_Temp	PCR_ZTR	FBI_14_43	11,156	PV	R
	FBD:CL4005_PBR_Temp	SUB_REAL	.14.51	5,54	IN2	R
	FBD:CL4005_PBR_Temp	SUB_REAL	.14.52	3,63	IN2	R
	FBD:CL4005_PBR_Temp	SUB_REAL	.14.53	148,14	IN1	R
	FBD:CL4005_PBR_Temp	SUB_REAL	.14.59	149,48	IN1	R
	FBD:CL4005_PBR_Temp	HYST_REAL	FBI_14_75	174,29	X	R
	FBD:CL4005_PBR_Temp	LT_REAL	.14.88	166,62	IN1	R
	FBD:CL4005_PBR_Temp	GT_REAL	.14.89	166,70	IN1	R
	FBD:CL4005_PBR_Temp	LE_REAL	.14.105	142,124	IN1	R
	FBD:CL4005_PBR_Temp	GE_REAL	.14.108	142,133	IN1	R
	FBD:CL4005_PBR_Temp	ADD_REAL	.14.110	118,142	IN1	R
	FBD:CL4005_PBR_Temp	SUB_REAL	.14.111	118,148	IN1	R
TT_4005_01_Filtered_Gain	FBD:Inputs	LAG_FILTER	FBI_20_45	148,108	GAIN	R
TT_4005_01_Filtered_Lag	FBD:Inputs	LAG_FILTER	FBI_20_45	148,109	LAG	R
TT_4005_01_LIM_AH	FBD:CL4005_PBR_Temp	GT_REAL	.14.54	174,15	IN2	R
TT_4005_01_LIM_AHH	FBD:CL4005_PBR_Temp	ADD_REAL	.14.73	149,31	IN2	R
TT_4005_01_LIM_AL	FBD:CL4005_PBR_Temp	LT_REAL	.14.61	175,49	IN2	R
TT_4005_01_LIM_ALL	FBD:CL4005_PBR_Temp	ADD_REAL	.14.76	137,63	IN2	R
TT_4005_01_MAX	FBD:Inputs	I_SCALE	.20.31	129,101	MX	R
TT_4005_01_MIN	FBD:Inputs	I_SCALE	.20.31	129,100	MN	R
TT_4005_01_SP	FBD:CL4005_PBR_Temp	PCR_ZTR	FBI_14_43	11,157	SP	R
	FBD:CL4005_PBR_Temp	SUB_REAL	.14.51	5,53	IN1	R
	FBD:CL4005_PBR_Temp	SUB_REAL	.14.52	3,62	IN1	R
	FBD:CL4005_PBR_Temp	SUB_REAL	.14.53	148,15	IN2	R
	FBD:CL4005_PBR_Temp	SUB_REAL	.14.59	149,49	IN2	R
	FBD:CL4005_PBR_Temp	ADD_REAL	.14.73	149,30	IN1	R
	FBD:CL4005_PBR_Temp	ADD_REAL	.14.74	156,37	IN1	R
	FBD:CL4005_PBR_Temp	ADD_REAL	.14.76	137,62	IN1	R
	FBD:CL4005_PBR_Temp	ADD_REAL	.14.83	137,71	IN1	R
	FBD:CL4005_PBR_Temp	SUB_REAL	.14.104	124,125	IN1	R
	FBD:CL4005_PBR_Temp	ADD_REAL	.14.107	124,134	IN1	R

table continued...

Variable usage (Name: All, Type: All, DataType: All, Sorted by: name)						
Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
	FBD:CL4005_PBR_Temp	SEL	.14.112	143,141	IN0	R
	FBD:CL4005_PBR_Temp	ADD_REAL	.14.133	5,92	IN1	R
	FBD:CL4005_PBR_Temp	SUB_REAL	.14.134	5,85	IN1	R
	FBD:CL4005_PBR_Temp	MOVE	.14.136	21,105	IN	R
TT_4005_01_SP_controller	FBD:CL4005_PBR_Temp	PCR_IF1	FBI_14_125	42,88	SP	R
	FBD:CL4005_PBR_Temp	ADD_REAL	.14.133	22,92	OUT	W
	FBD:CL4005_PBR_Temp	SUB_REAL	.14.134	22,85	OUT	W
	FBD:CL4005_PBR_Temp	MOVE	.14.136	37,105	OUT	W
TT_4006_01	FBD:Inputs	I_SCALE	.20.22	168,60	Y	W
TT_4006_01_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_3	25,33	BIT8	W
	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,98	IN25	R
TT_4006_01_MAX	FBD:Inputs	I_SCALE	.20.22	151,61	MX	R
TT_4006_01_MIN	FBD:Inputs	I_SCALE	.20.22	151,60	MN	R
TT_4006_02	FBD:Inputs	I_SCALE	.20.17	104,50	Y	W
TT_4006_02_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_3	25,35	BIT10	W
	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,100	IN27	R
TT_4006_02_MAX	FBD:Inputs	I_SCALE	.20.17	87,51	MX	R
TT_4006_02_MIN	FBD:Inputs	I_SCALE	.20.17	87,50	MN	R
TT_4010_01	FBD:Inputs	I_SCALE	.20.33	101,103	Y	W
	FBD:CL4010_OutletGasCompo	LT_REAL	.9.23	177,121	IN1	R
	FBD:CL4010_OutletGasCompo	LT_REAL	.9.24	177,132	IN1	R
	FBD:CL4010_OutletGasCompo	GT_REAL	.9.25	177,100	IN1	R
	FBD:CL4010_OutletGasCompo	GT_REAL	.9.26	177,112	IN1	R
TT_4010_01_AH	FBD:ALARM_STATUS	OR_BOOL	.22.2	37,34	IN15	R
	FBD:CL4010_OutletGasCompo	GT_REAL	.9.25	194,100	OUT	W
TT_4010_01_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,96	IN23	R
	FBD:CL4010_OutletGasCompo	GT_REAL	.9.26	194,112	OUT	W
TT_4010_01_AL	FBD:ALARM_STATUS	OR_BOOL	.22.2	37,35	IN16	R
	FBD:CL4010_OutletGasCompo	LT_REAL	.9.23	194,121	OUT	W
TT_4010_01_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,97	IN24	R
	FBD:CL4010_OutletGasCompo	LT_REAL	.9.24	194,132	OUT	W
TT_4010_01_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_4	25,53	BIT8	W
	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,103	IN30	R
TT_4010_01_LIM_AH	FBD:CL4010_OutletGasCompo	GT_REAL	.9.25	177,101	IN2	R
TT_4010_01_LIM_AHH	FBD:CL4010_OutletGasCompo	GT_REAL	.9.26	177,113	IN2	R
TT_4010_01_LIM_AL	FBD:CL4010_OutletGasCompo	LT_REAL	.9.23	177,122	IN2	R
TT_4010_01_LIM_ALL	FBD:CL4010_OutletGasCompo	LT_REAL	.9.24	177,133	IN2	R
TT_4010_01_MAX	FBD:Inputs	I_SCALE	.20.33	84,104	MX	R
TT_4010_01_MIN	FBD:Inputs	I_SCALE	.20.33	84,103	MN	R
TT_4010_02	FBD:Inputs	I_SCALE	.20.14	148,51	Y	W
TT_4010_02_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_3	25,31	BIT6	W
	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,101	IN28	R
TT_4010_02_MAX	FBD:Inputs	I_SCALE	.20.14	131,52	MX	R
TT_4010_02_MIN	FBD:Inputs	I_SCALE	.20.14	131,51	MN	R
TT_4011_01	FBD:Inputs	I_SCALE	.20.32	131,113	Y	W
	FBD:CL4011_Feeding_Temp	PCR_IF1	FBI_8_1	20,17	PV	R
	FBD:CL4011_Feeding_Temp	SUB_REAL	.8.10	15,53	IN1	R
	FBD:CL4011_Feeding_Temp	SUB_REAL	.8.14	14,69	IN1	R
	FBD:CL4011_Feeding_Temp	SUB_REAL	.8.18	12,86	IN1	R
	FBD:CL4011_Feeding_Temp	SUB_REAL	.8.23	14,103	IN1	R
TT_4011_01_AH	FBD:ALARM_STATUS	OR_BOOL	.22.2	37,36	IN17	R
	FBD:CL4011_Feeding_Temp	AND_BOOL	.8.13	73,54	OUT	W
TT_4011_01_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,105	IN32	R
	FBD:CL4011_Feeding_Temp	AND_BOOL	.8.17	72,70	OUT	W
TT_4011_01_AL	FBD:ALARM_STATUS	OR_BOOL	.22.2	37,37	IN18	R
	FBD:CL4011_Feeding_Temp	AND_BOOL	.8.21	70,87	OUT	W
TT_4011_01_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.7	80,74	IN1	R

table continued...

Variable usage (Name: All, Type: All, DataType: All, Sorted by: name)						
Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
	FBD:CL4011_Feeding_Temp	AND_BOOL	.8.26	72,104	OUT	W
TT_4011_01_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_4	25,52	BIT7	W
	FBD:ALARM_STATUS	OR_BOOL	.22.7	80,75	IN2	R
TT_4011_01_LIM_AH	FBD:CL4011_Feeding_Temp	GT_REAL	.8.11	41,54	IN2	R
TT_4011_01_LIM_AHH	FBD:CL4011_Feeding_Temp	GT_REAL	.8.15	40,70	IN2	R
TT_4011_01_LIM_AL	FBD:CL4011_Feeding_Temp	LT_REAL	.8.22	38,87	IN2	R
TT_4011_01_LIM_ALL	FBD:CL4011_Feeding_Temp	LT_REAL	.8.25	40,104	IN2	R
TT_4011_01_MAX	FBD:Inputs	I_SCALE	.20.32	114,114	MX	R
TT_4011_01_MIN	FBD:Inputs	I_SCALE	.20.32	114,113	MN	R
TT_4011_SP	FBD:CL4011_Feeding_Temp	PCR_IF1	FBI_8_1	20,18	SP	R
	FBD:CL4011_Feeding_Temp	SUB_REAL	.8.10	15,54	IN2	R
	FBD:CL4011_Feeding_Temp	SUB_REAL	.8.14	14,70	IN2	R
	FBD:CL4011_Feeding_Temp	SUB_REAL	.8.18	12,87	IN2	R
	FBD:CL4011_Feeding_Temp	SUB_REAL	.8.23	14,104	IN2	R
	FBD:CL4012_Harvesting_Temp	SUB_REAL	.7.17	9,96	IN2	R
TT_4012_01	FBD:Inputs	I_SCALE	.20.34	76,106	Y	W
	FBD:CL4012_Harvesting_Temp	PCR_IF1	FBI_7_1	17,20	PV	R
	FBD:CL4012_Harvesting_Temp	SUB_REAL	.7.9	12,62	IN1	R
	FBD:CL4012_Harvesting_Temp	SUB_REAL	.7.13	11,78	IN1	R
	FBD:CL4012_Harvesting_Temp	SUB_REAL	.7.17	9,95	IN1	R
	FBD:CL4012_Harvesting_Temp	SUB_REAL	.7.21	11,112	IN1	R
TT_4012_01_AH	FBD:ALARM_STATUS	OR_BOOL	.22.2	37,38	IN19	R
	FBD:CL4012_Harvesting_Temp	AND_BOOL	.7.12	70,63	OUT	W
TT_4012_01_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.7	80,76	IN3	R
	FBD:CL4012_Harvesting_Temp	AND_BOOL	.7.16	69,79	OUT	W
TT_4012_01_AL	FBD:ALARM_STATUS	OR_BOOL	.22.2	37,39	IN20	R
	FBD:CL4012_Harvesting_Temp	AND_BOOL	.7.20	67,96	OUT	W
TT_4012_01_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.7	80,77	IN4	R
	FBD:CL4012_Harvesting_Temp	AND_BOOL	.7.24	69,113	OUT	W
TT_4012_01_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_4	25,54	BIT9	W
	FBD:ALARM_STATUS	OR_BOOL	.22.7	80,78	IN5	R
TT_4012_01_LIM_AH	FBD:CL4012_Harvesting_Temp	GT_REAL	.7.10	38,63	IN2	R
TT_4012_01_LIM_AHH	FBD:CL4012_Harvesting_Temp	GT_REAL	.7.14	37,79	IN2	R
TT_4012_01_LIM_AL	FBD:CL4012_Harvesting_Temp	LT_REAL	.7.19	35,96	IN2	R
TT_4012_01_LIM_ALL	FBD:CL4012_Harvesting_Temp	LT_REAL	.7.23	37,113	IN2	R
TT_4012_01_MAX	FBD:Inputs	I_SCALE	.20.34	59,107	MX	R
TT_4012_01_MIN	FBD:Inputs	I_SCALE	.20.34	59,106	MN	R
TT_4012_SP	FBD:CL4012_Harvesting_Temp	PCR_IF1	FBI_7_1	17,21	SP	R
	FBD:CL4012_Harvesting_Temp	SUB_REAL	.7.9	12,63	IN2	R
	FBD:CL4012_Harvesting_Temp	SUB_REAL	.7.13	11,79	IN2	R
	FBD:CL4012_Harvesting_Temp	SUB_REAL	.7.21	11,113	IN2	R
WT_4002_01	FBD:Inputs	I_SCALE	.20.24	99,73	Y	W
	FBD:CL4002_Outlet_Liquid_>Flow	GT_REAL	.17.11	9,17	IN1	R
	FBD:CL4002_Outlet_Liquid_>Flow	GT_REAL	.17.64	132,35	IN1	R
	FBD:CL4002_Outlet_Liquid_>Flow	GT_REAL	.17.65	167,34	IN1	R
	FBD:CL4002_Outlet_Liquid_>Flow	LT_REAL	.17.70	166,48	IN1	R
	FBD:CL4002_Outlet_Liquid_>Flow	LT_REAL	.17.68	130,48	IN1	R
	FBD:CL4002_Outlet_Liquid_>Flow	AVGMV	FBI_17_113	64,66	X	R
	FBD:CL4002_Outlet_Liquid_>Flow	AVGMV	FBI_17_120	48,91	X	R
WT_4002_01_AH	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,23	IN9	R

table continued...

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

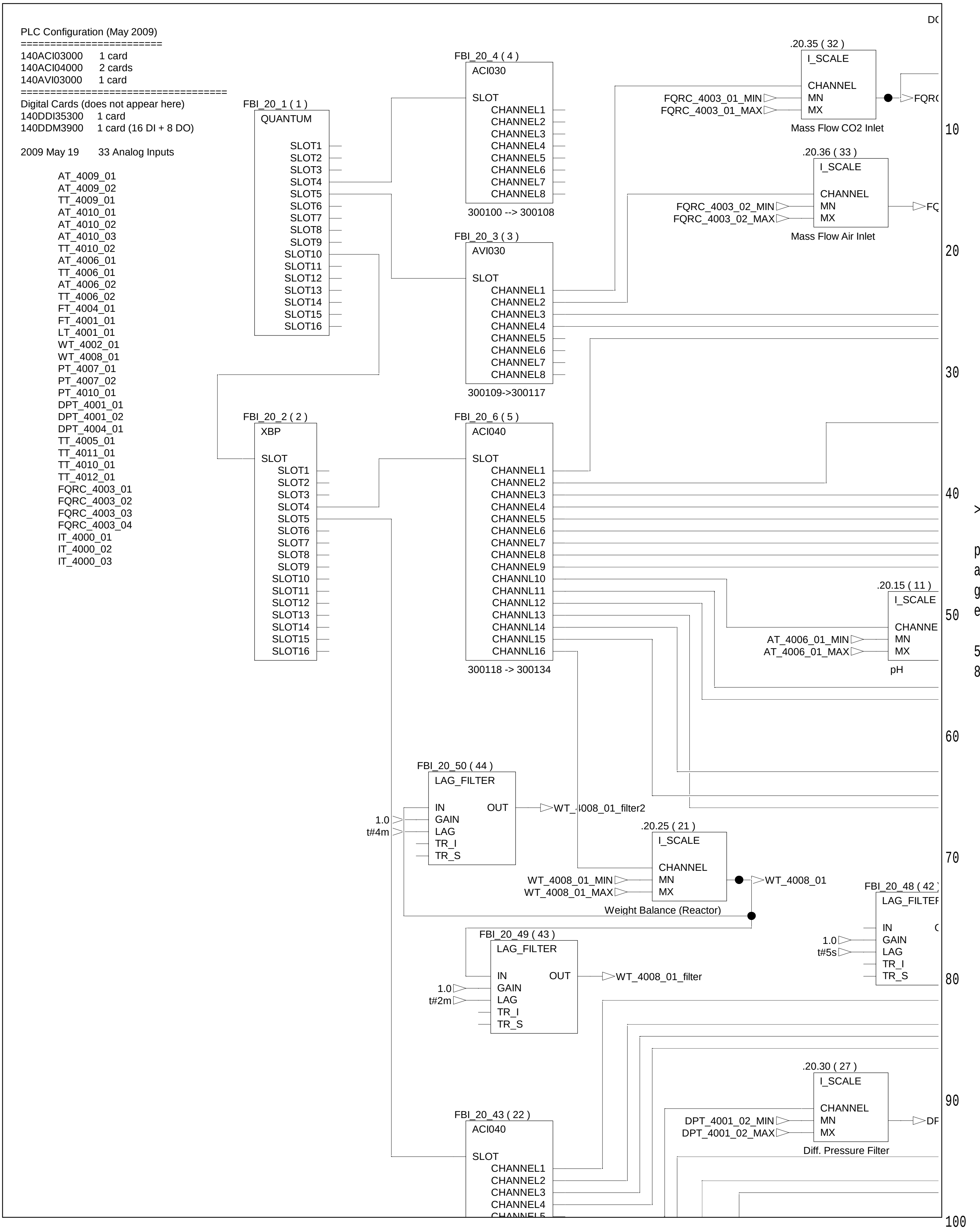
Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
	FBD:CL4002_Outlet_Liquid_>Flow	GT_REAL	.17.64	149,35	OUT	W
WT_4002_01_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,93	IN20	R
	FBD:CL4002_Outlet_Liquid_>Flow	GT_REAL	.17.65	184,34	OUT	W
WT_4002_01_AL	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,24	IN10	R
	FBD:CL4002_Outlet_Liquid_>Flow	LT_REAL	.17.68	147,48	OUT	W
WT_4002_01_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,94	IN21	R
	FBD:CL4002_Outlet_Liquid_>Flow	LT_REAL	.17.70	183,48	OUT	W
WT_4002_01_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_3	25,39	BIT14	W
	FBD:ALARM_STATUS	OR_BOOL	.22.4	10,95	IN22	R
WT_4002_01_LIM_AH	FBD:CL4002_Outlet_Liquid_>Flow	GT_REAL	.17.64	132,36	IN2	R
WT_4002_01_LIM_AHH	FBD:CL4002_Outlet_Liquid_>Flow	GT_REAL	.17.65	167,35	IN2	R
WT_4002_01_LIM_AL	FBD:CL4002_Outlet_Liquid_>Flow	LT_REAL	.17.68	130,49	IN2	R
WT_4002_01_LIM_ALL	FBD:CL4002_Outlet_Liquid_>Flow	LT_REAL	.17.70	166,49	IN2	R
WT_4002_01_MAX	FBD:Inputs	I_SCALE	.20.24	82,74	MX	R
WT_4002_01_MIN	FBD:Inputs	I_SCALE	.20.24	82,73	MN	R
WT_4006_01	FBD:CL4006_pH	LT_REAL	.13.109	47,226	IN1	R
	FBD:CL4006_pH	LT_REAL	.13.103	46,205	IN1	R
WT_4006_01_AL	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,39	IN25	R
	FBD:CL4006_pH	LT_REAL	.13.103	63,205	OUT	W
WT_4006_01_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,93	IN20	R
	FBD:CL4006_pH	TON	FBI_13_336	74,226	Q	W
WT_4006_01_LIM_AL	FBD:CL4006_pH	LT_REAL	.13.103	46,206	IN2	R
WT_4006_01_LIM_ALL	FBD:CL4006_pH	LT_REAL	.13.109	47,227	IN2	R
WT_4006_02	FBD:CL4006_pH	LT_REAL	.13.110	125,213	IN1	R
	FBD:CL4006_pH	LT_REAL	.13.111	126,224	IN1	R
WT_4006_02_AL	FBD:ALARM_STATUS	OR_BOOL	.22.1	15,40	IN26	R
	FBD:CL4006_pH	LT_REAL	.13.110	142,213	OUT	W
WT_4006_02_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.5	35,94	IN21	R
	FBD:CL4006_pH	LT_REAL	.13.111	143,224	OUT	W
WT_4006_02_LIM_AL	FBD:CL4006_pH	LT_REAL	.13.110	125,214	IN2	R
WT_4006_02_LIM_ALL	FBD:CL4006_pH	LT_REAL	.13.111	126,225	IN2	R
WT_4008_01	FBD:Inputs	I_SCALE	.20.25	60,72	Y	W
	FBD:CL4008_PBR_Liquid_Lev>el	GT_REAL	.11.11	5,73	IN1	R
	FBD:CL4008_PBR_Liquid_Lev>el	GT_REAL	.11.13	5,89	IN1	R
	FBD:CL4008_PBR_Liquid_Lev>el	LT_REAL	.11.15	54,77	IN1	R
	FBD:CL4008_PBR_Liquid_Lev>el	LT_REAL	.11.17	53,93	IN1	R
WT_4008_01_AH	FBD:ALARM_STATUS	OR_BOOL	.22.2	37,20	IN1	R
	FBD:CL4008_PBR_Liquid_Lev>el	GT_REAL	.11.11	22,73	OUT	W
WT_4008_01_AHH	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,76	IN3	R
	FBD:CL4008_PBR_Liquid_Lev>el	GT_REAL	.11.13	22,89	OUT	W
WT_4008_01_AL	FBD:ALARM_STATUS	OR_BOOL	.22.2	37,21	IN2	R
	FBD:CL4008_PBR_Liquid_Lev>el	LT_REAL	.11.15	71,77	OUT	W

table continued...

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

Variable name	Used in section	Type	Instance/Network	at	Pin	R/W
WT_4008_01_ALL	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,77	IN4	R
	FBD:CL4008_PBR_Liquid_Lev>el	LT_REAL	.11.17	70,93	OUT	W
WT_4008_01_ERR	FBD:Err_AI	WORD_TO_BIT	FBI_18_3	25,40	BIT15	W
	FBD:ALARM_STATUS	OR_BOOL	.22.6	59,78	IN5	R
WT_4008_01_filter	FBD:Inputs	LAG_FILTER	FBI_20_49	48,80	OUT	W
WT_4008_01_filter2	FBD:Inputs	LAG_FILTER	FBI_20_50	43,66	OUT	W
	FBD:CL4008_PBR_Liquid_Lev>el	PCR_IF1	FBI_11_5	25,39	PV	R
WT_4008_01_LIM_AH	FBD:CL4008_PBR_Liquid_Lev>el	GT_REAL	.11.11	5,74	IN2	R
WT_4008_01_LIM_AHH	FBD:CL4008_PBR_Liquid_Lev>el	GT_REAL	.11.13	5,90	IN2	R
WT_4008_01_LIM_AL	FBD:CL4008_PBR_Liquid_Lev>el	LT_REAL	.11.15	54,78	IN2	R
WT_4008_01_LIM_ALL	FBD:CL4008_PBR_Liquid_Lev>el	LT_REAL	.11.17	53,94	IN2	R
WT_4008_01_MAX	FBD:Inputs	I_SCALE	.20.25	43,73	MX	R
WT_4008_01_MIN	FBD:Inputs	I_SCALE	.20.25	43,72	MN	R
WT_4008_SP	FBD:CL4008_PBR_Liquid_Lev>el	PCR_IF1	FBI_11_5	25,40	SP	R

Graph of section Inputs



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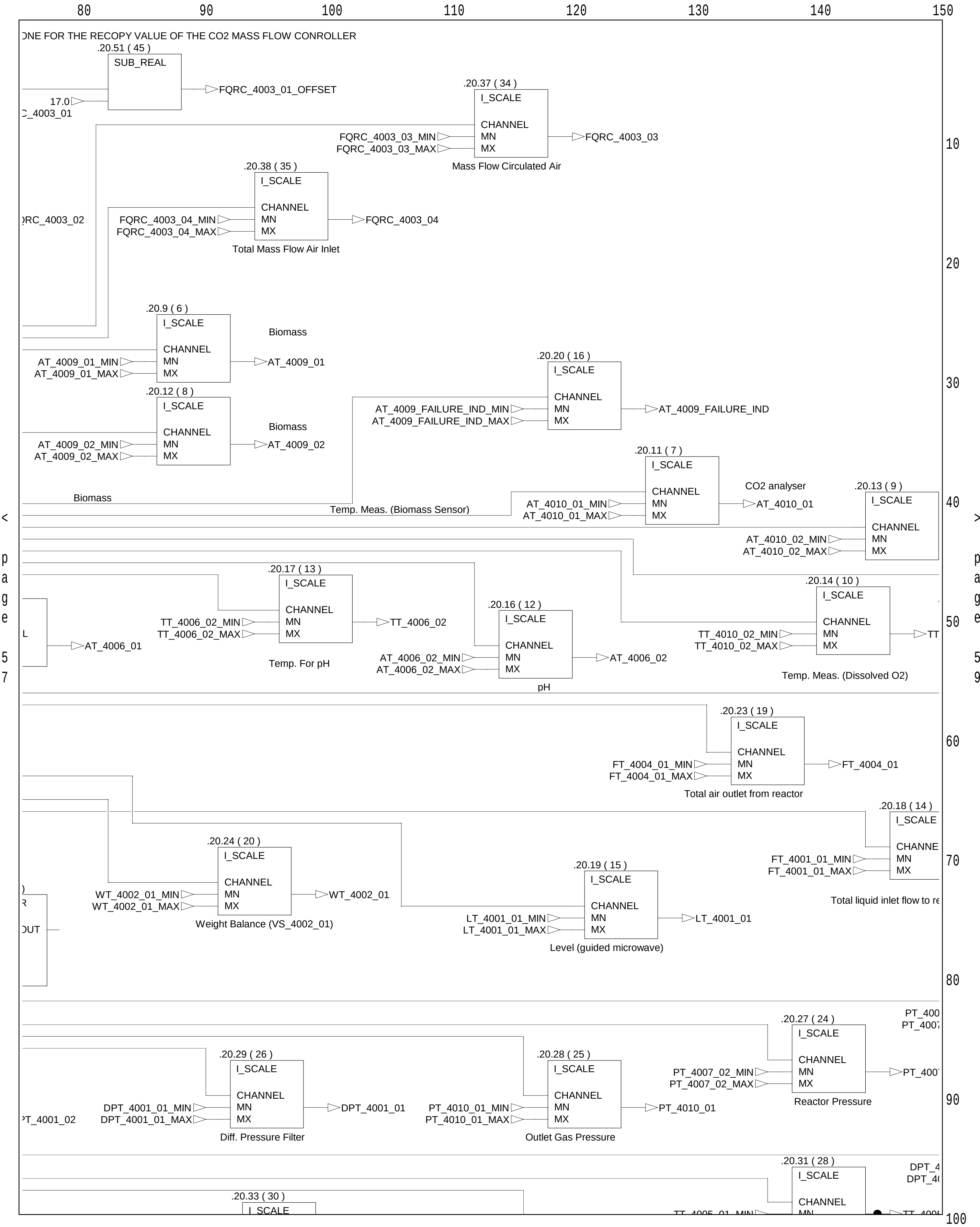
Graph of section Inputs



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Graph of section Inputs

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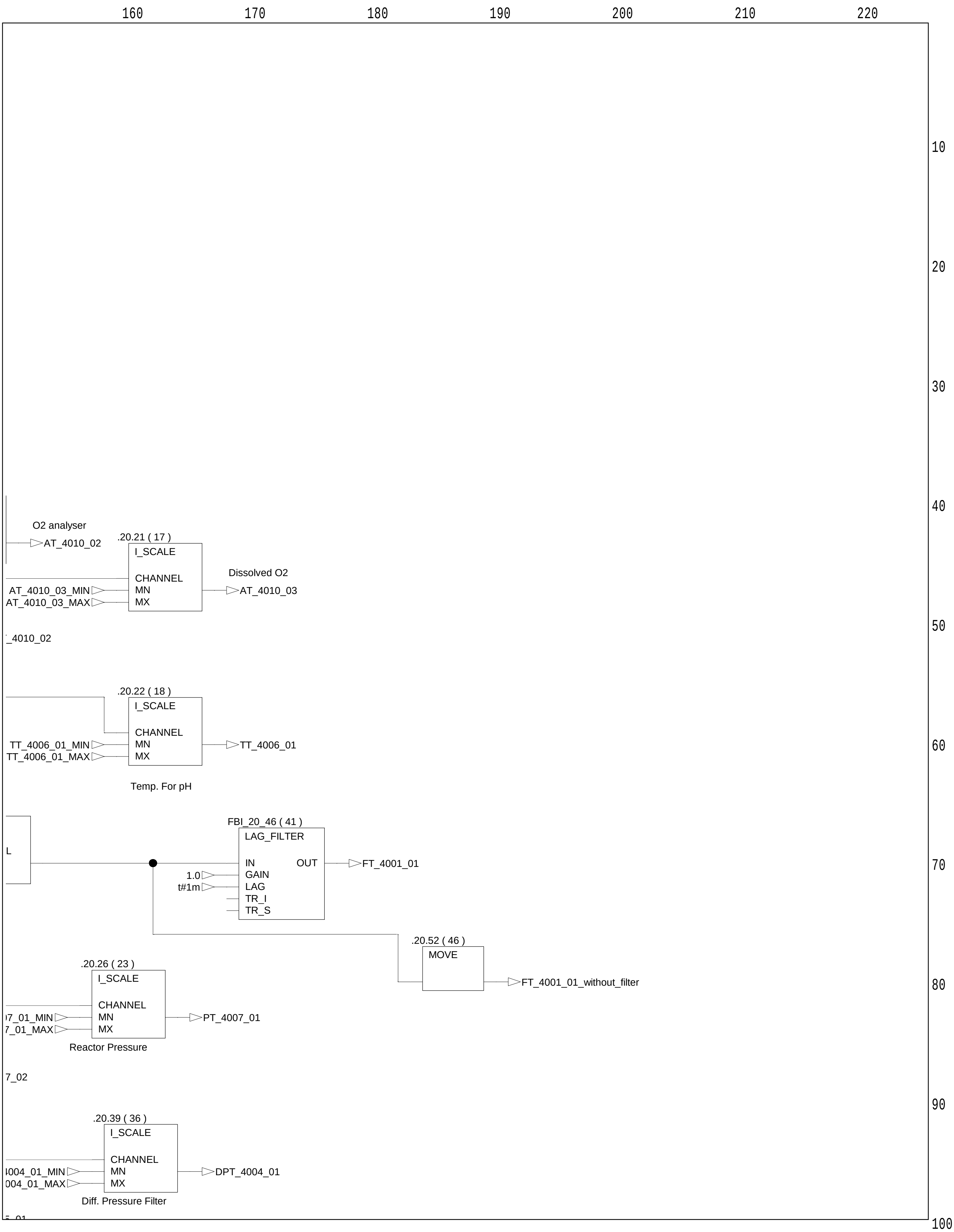

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Graph of section Inputs

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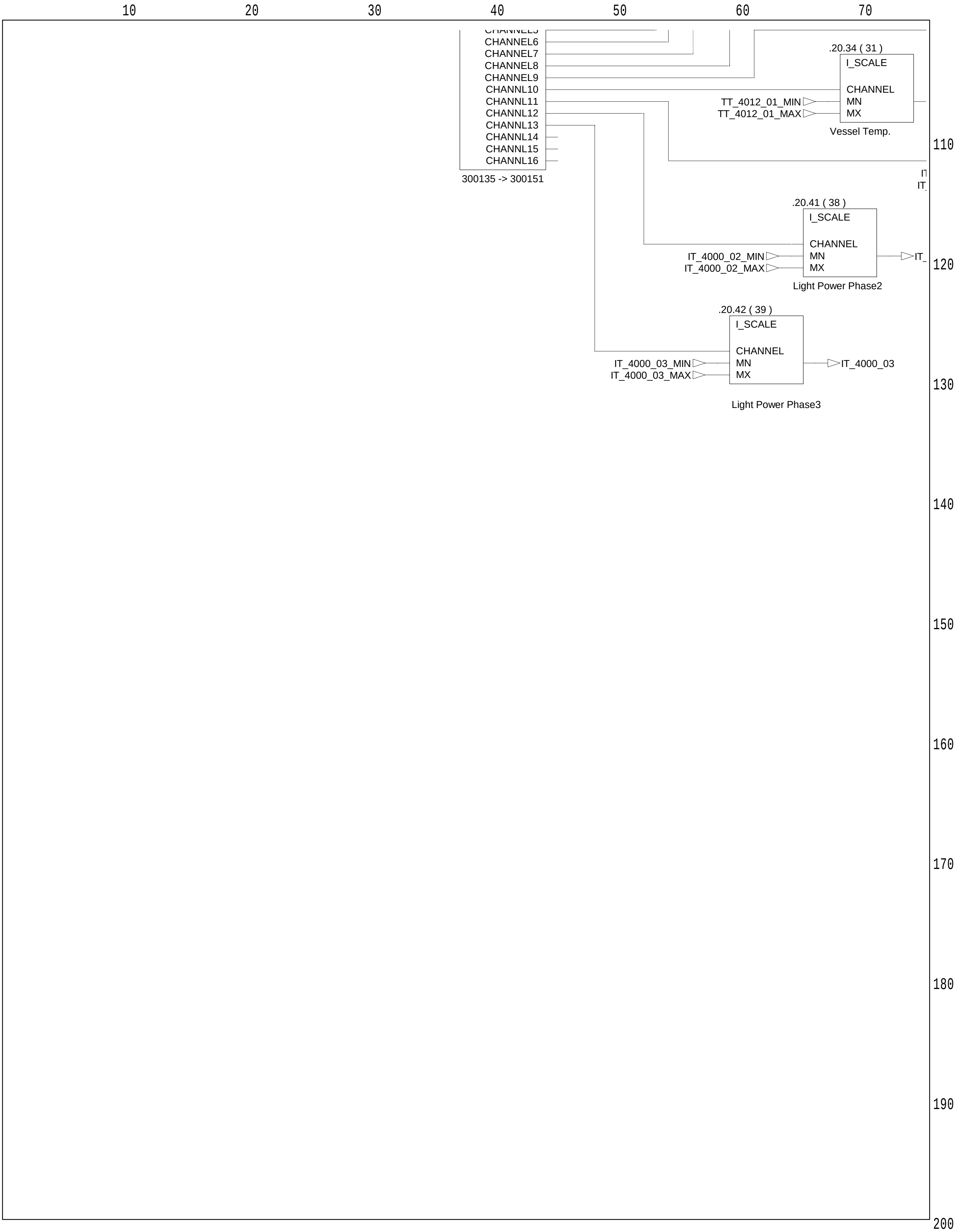

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Graph of section Inputs

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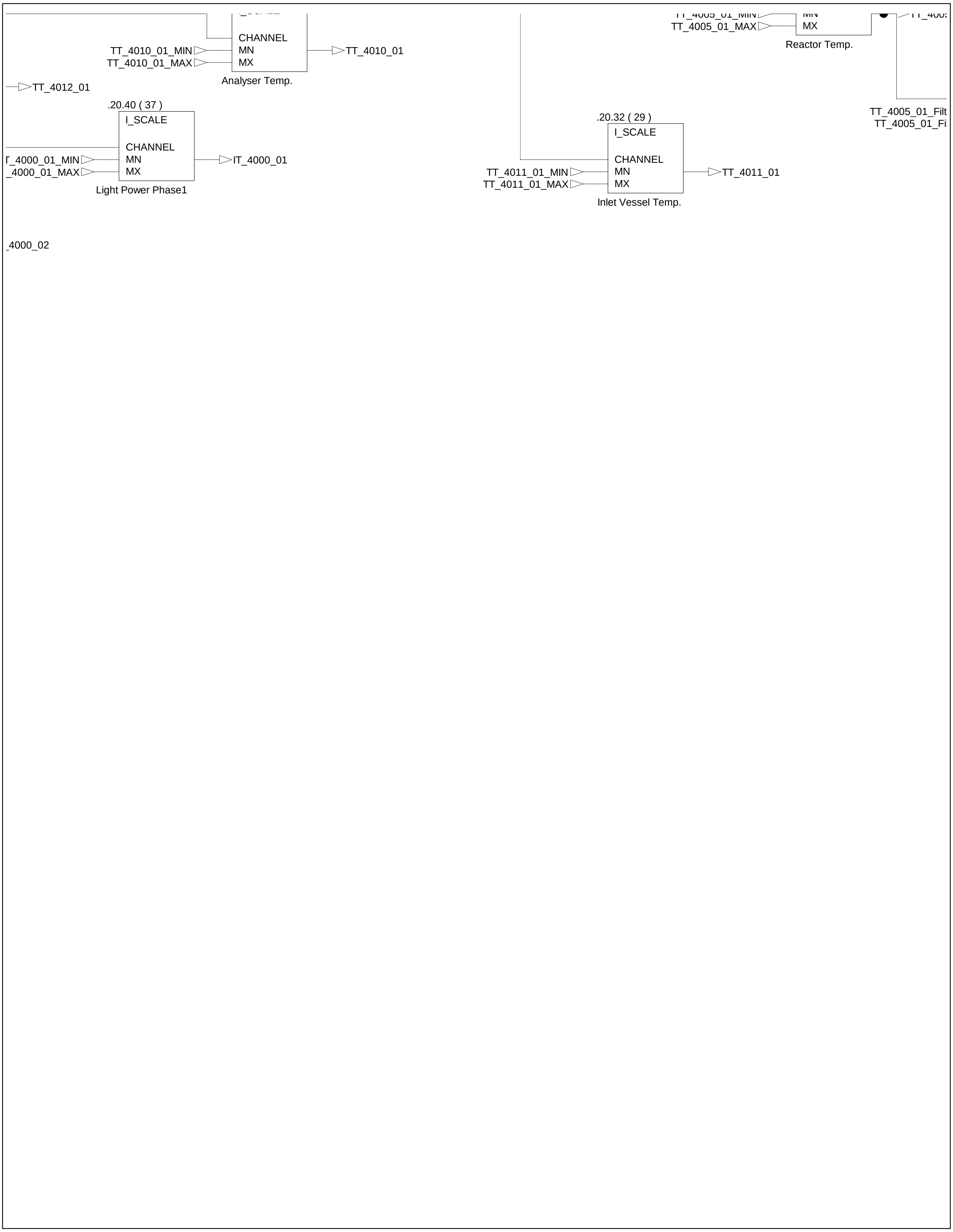

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Graph of section Inputs

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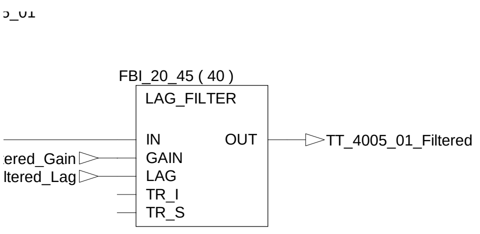

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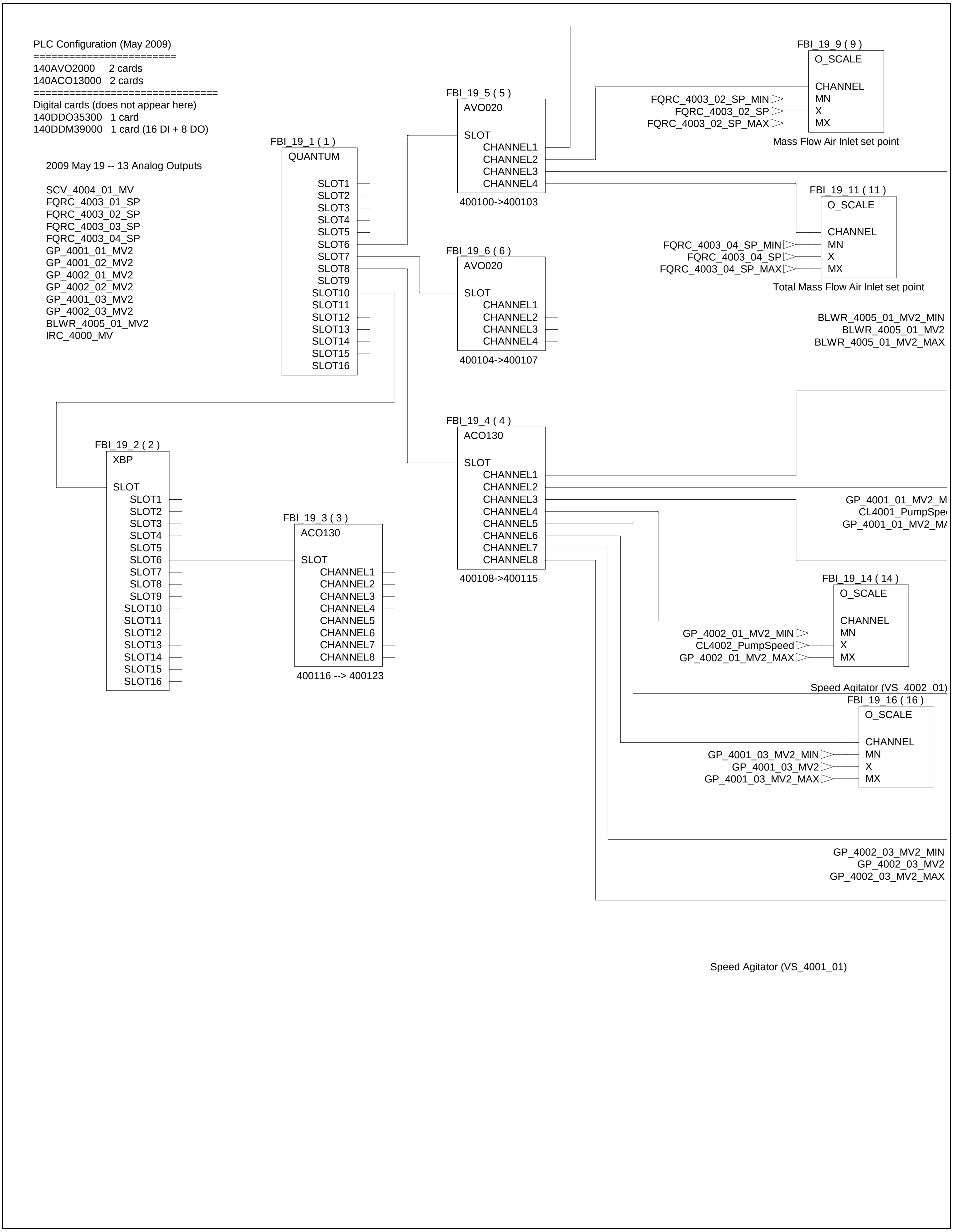
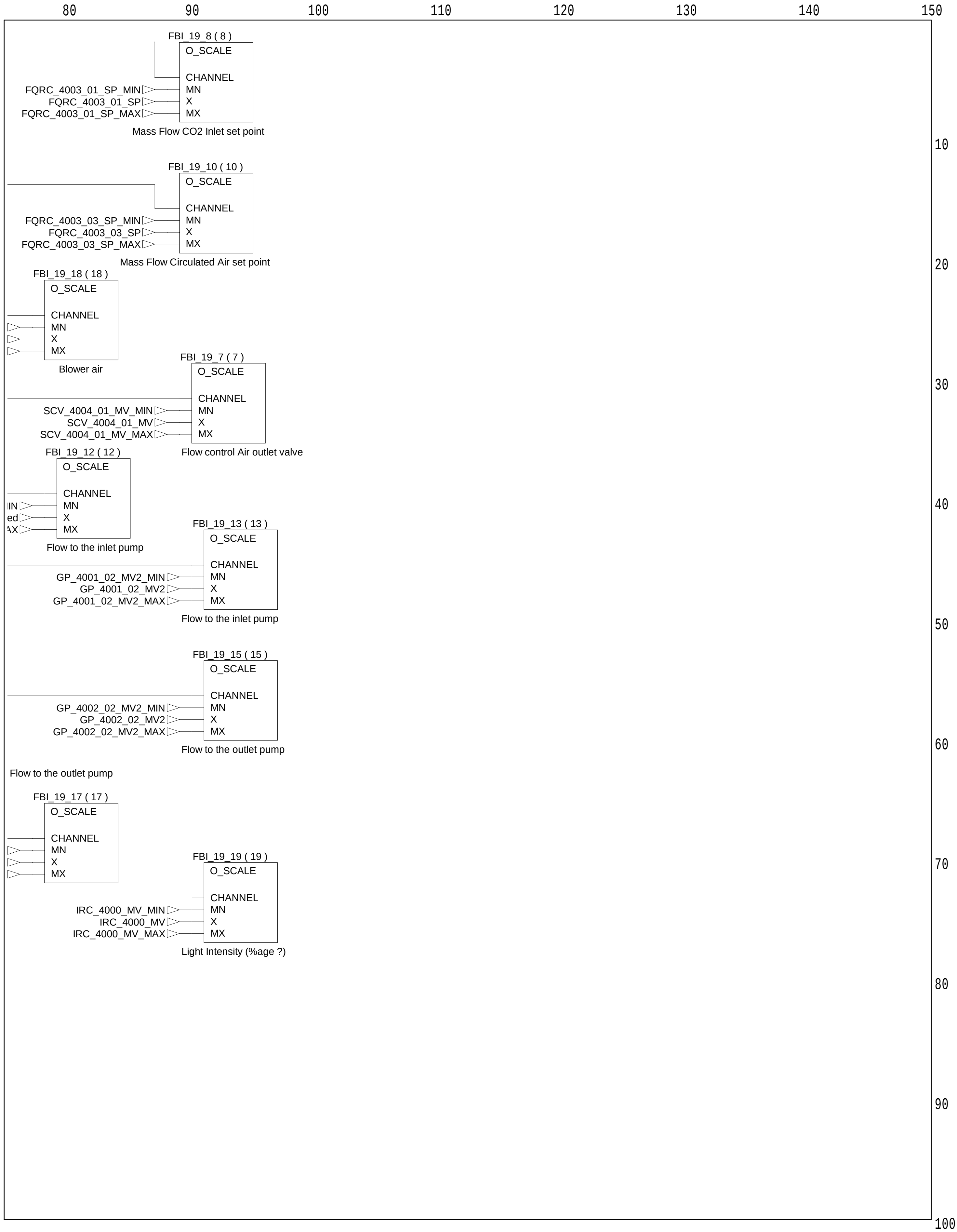
Graph of section Outputs



Graph of section Outputs



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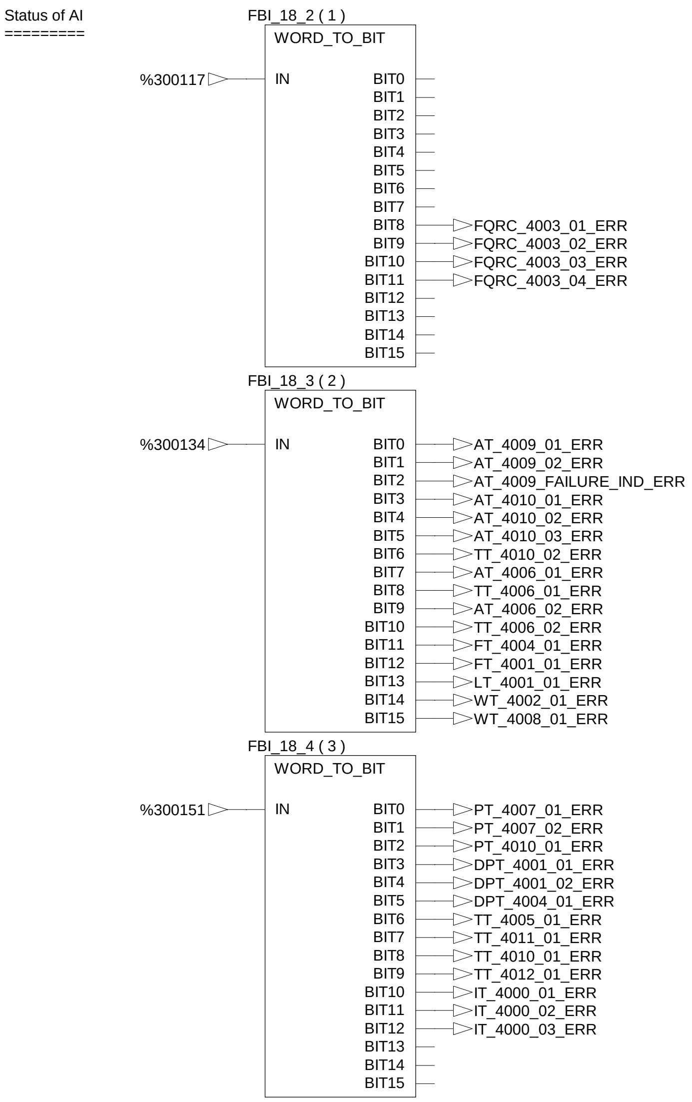
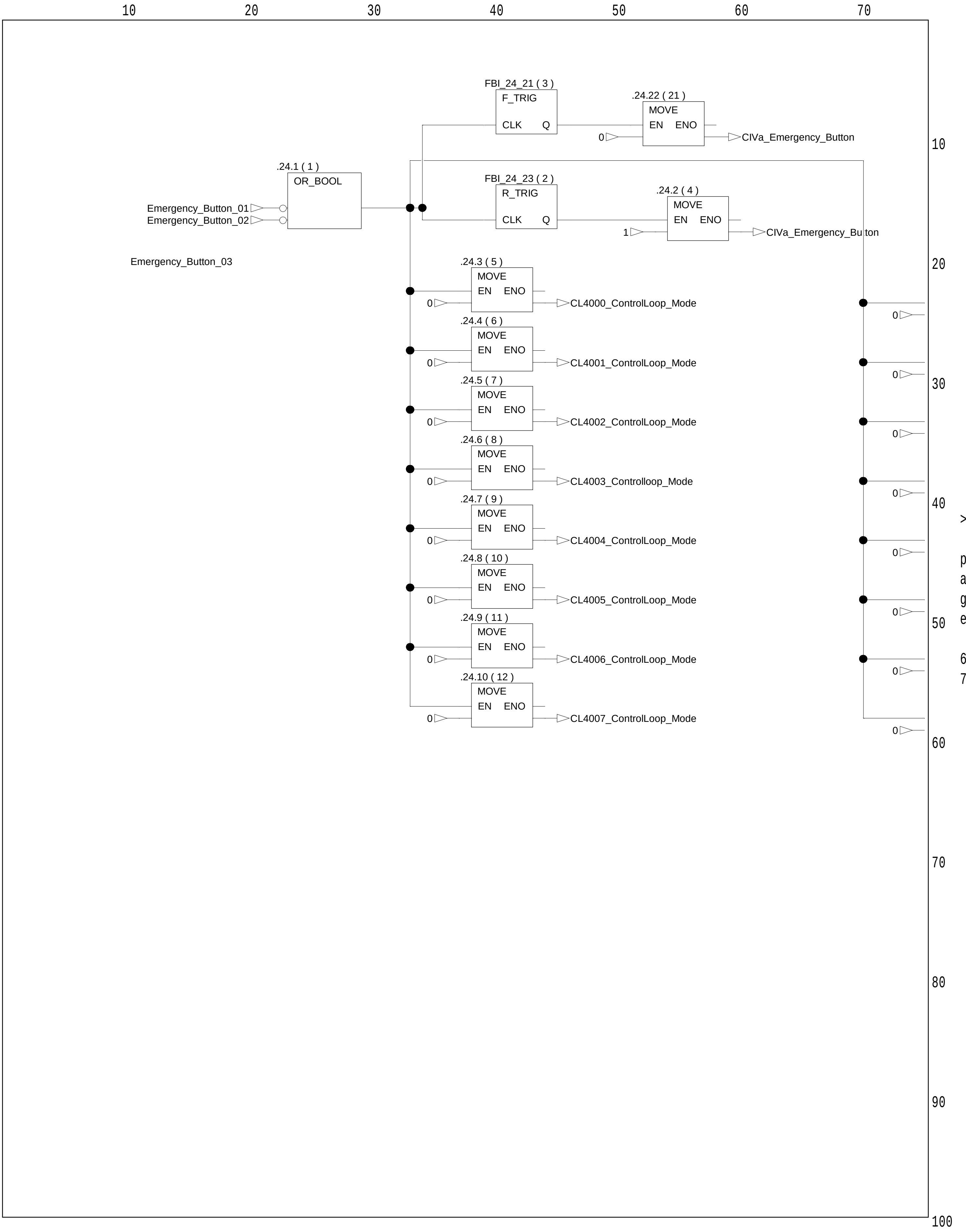
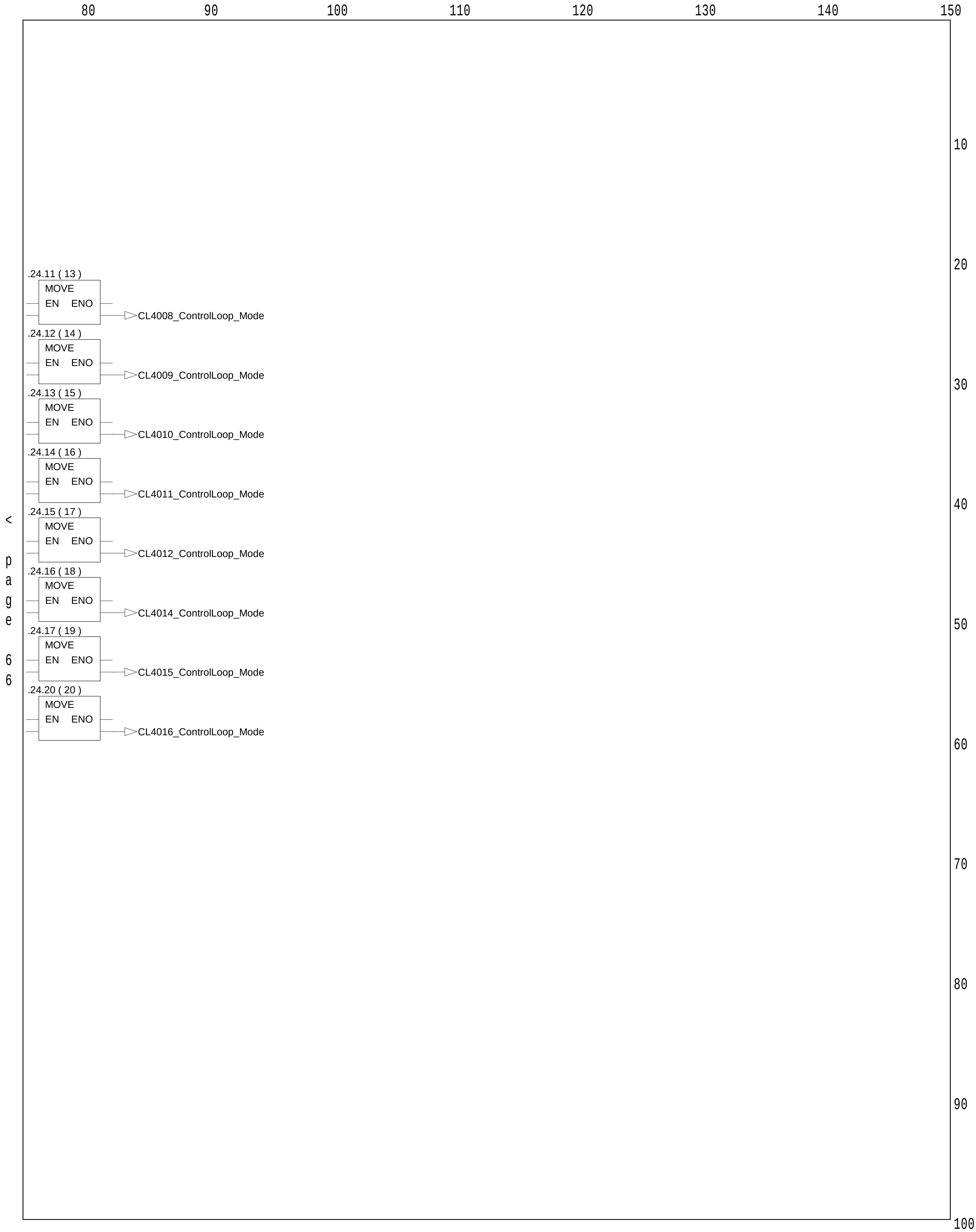
Graph of section Err_AI



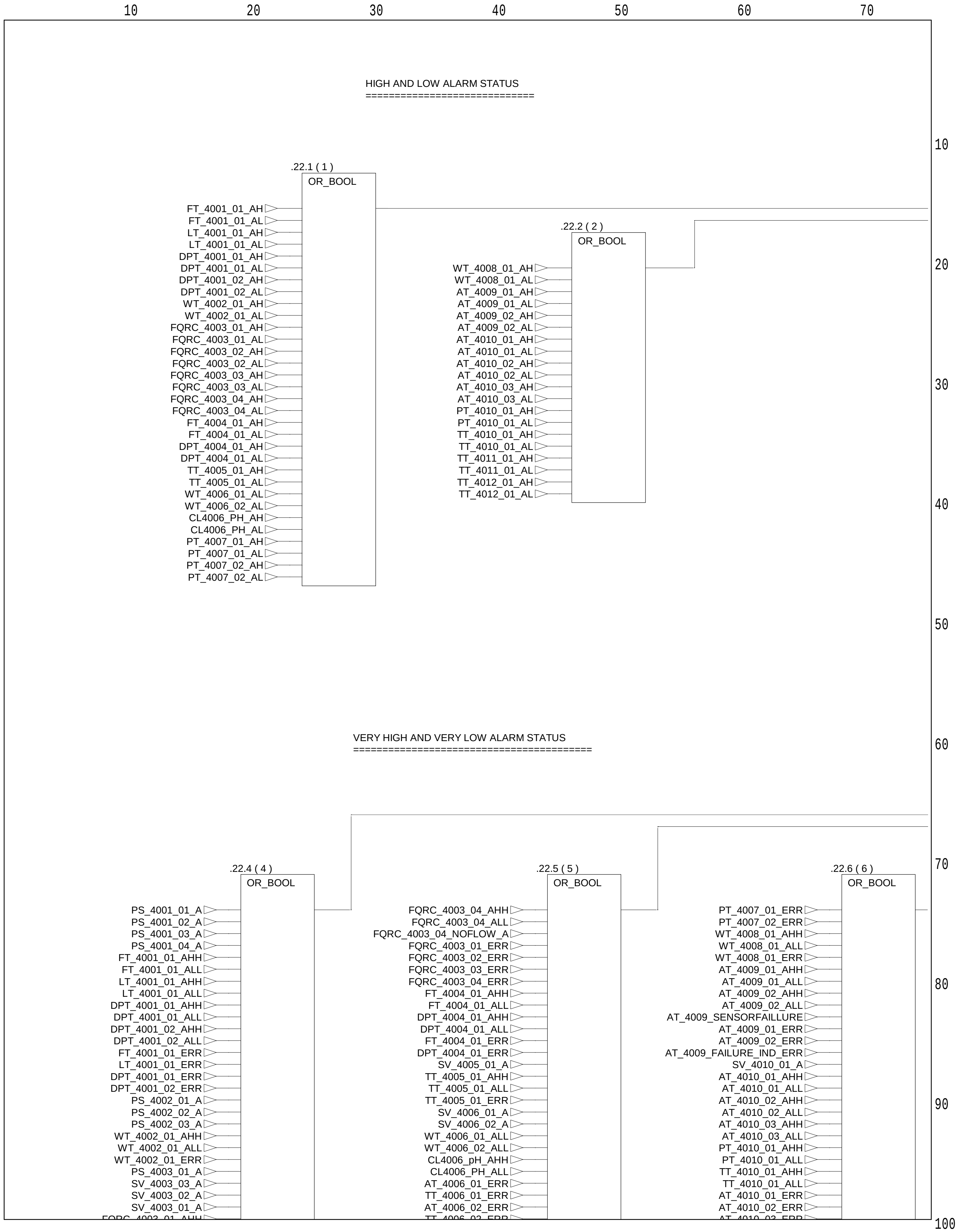
Graph of section EMERGENCY_BUTTON



Graph of section EMERGENCY_BUTTON



Graph of section ALARM_STATUS



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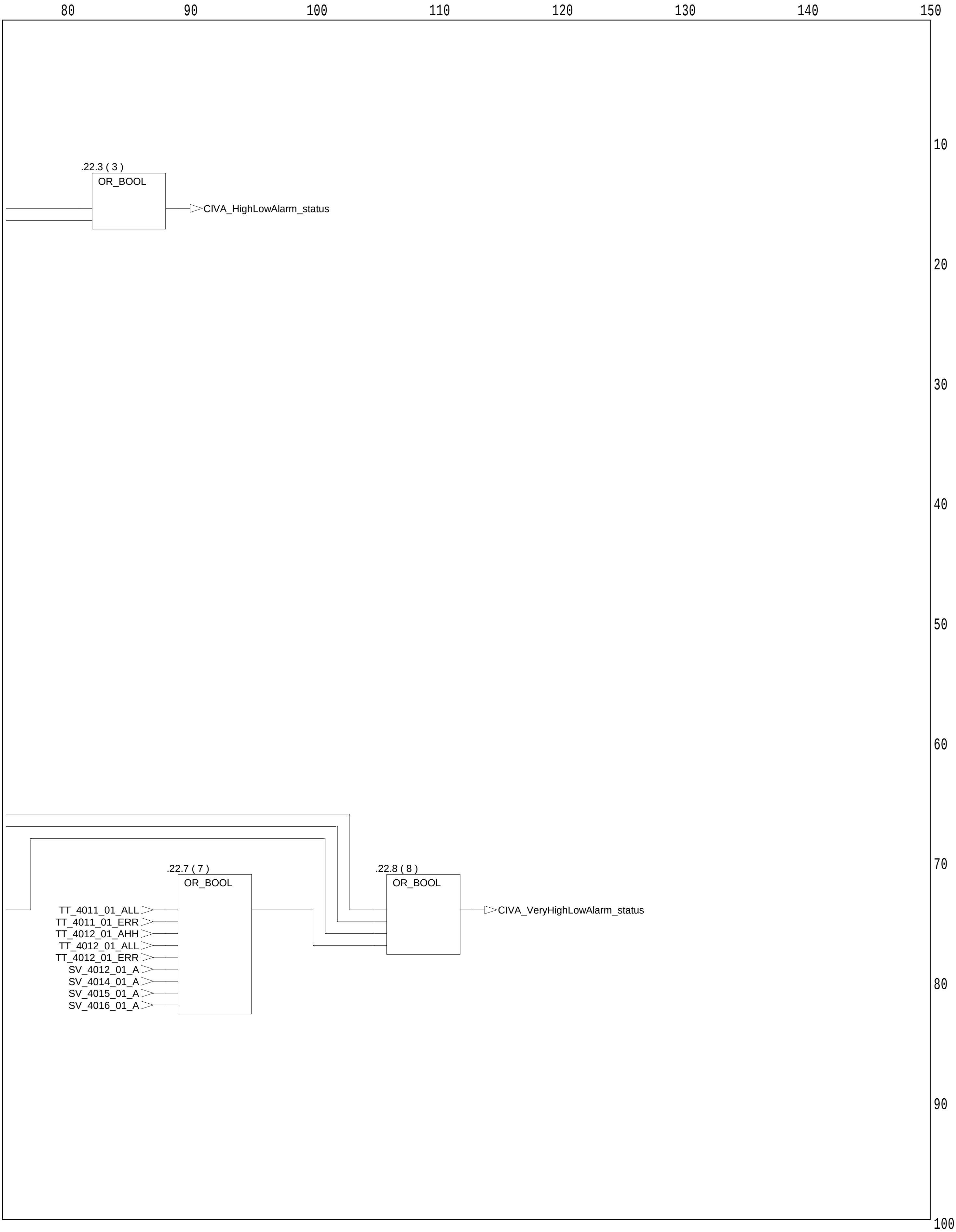
Graph of section ALARM_STATUS



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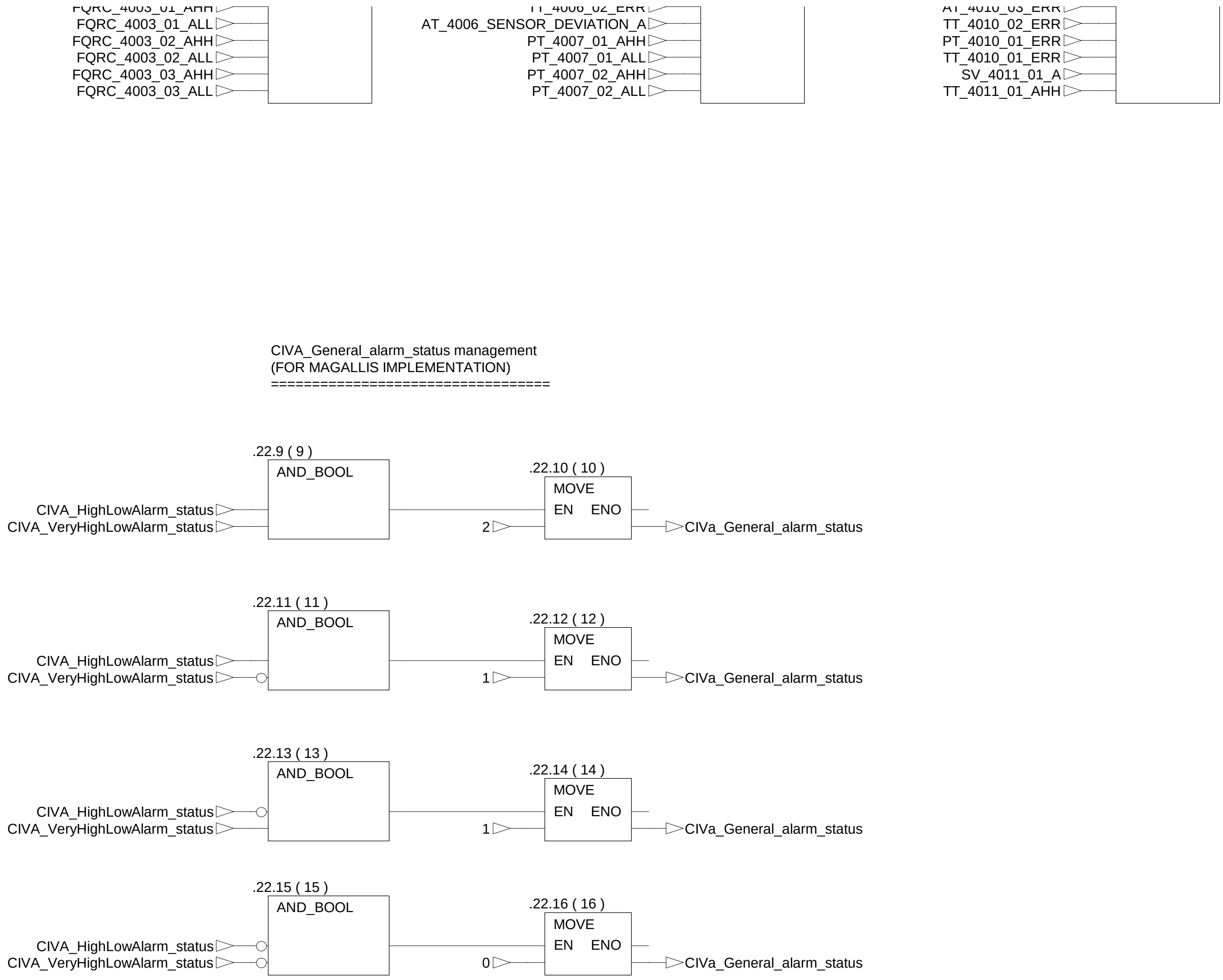
Graph of section ALARM_STATUS

< page 68



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Graph of section ALARM_STATUS

< page 69

80 90 100 110 120 130 140 150

110
120
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160
170
180
190
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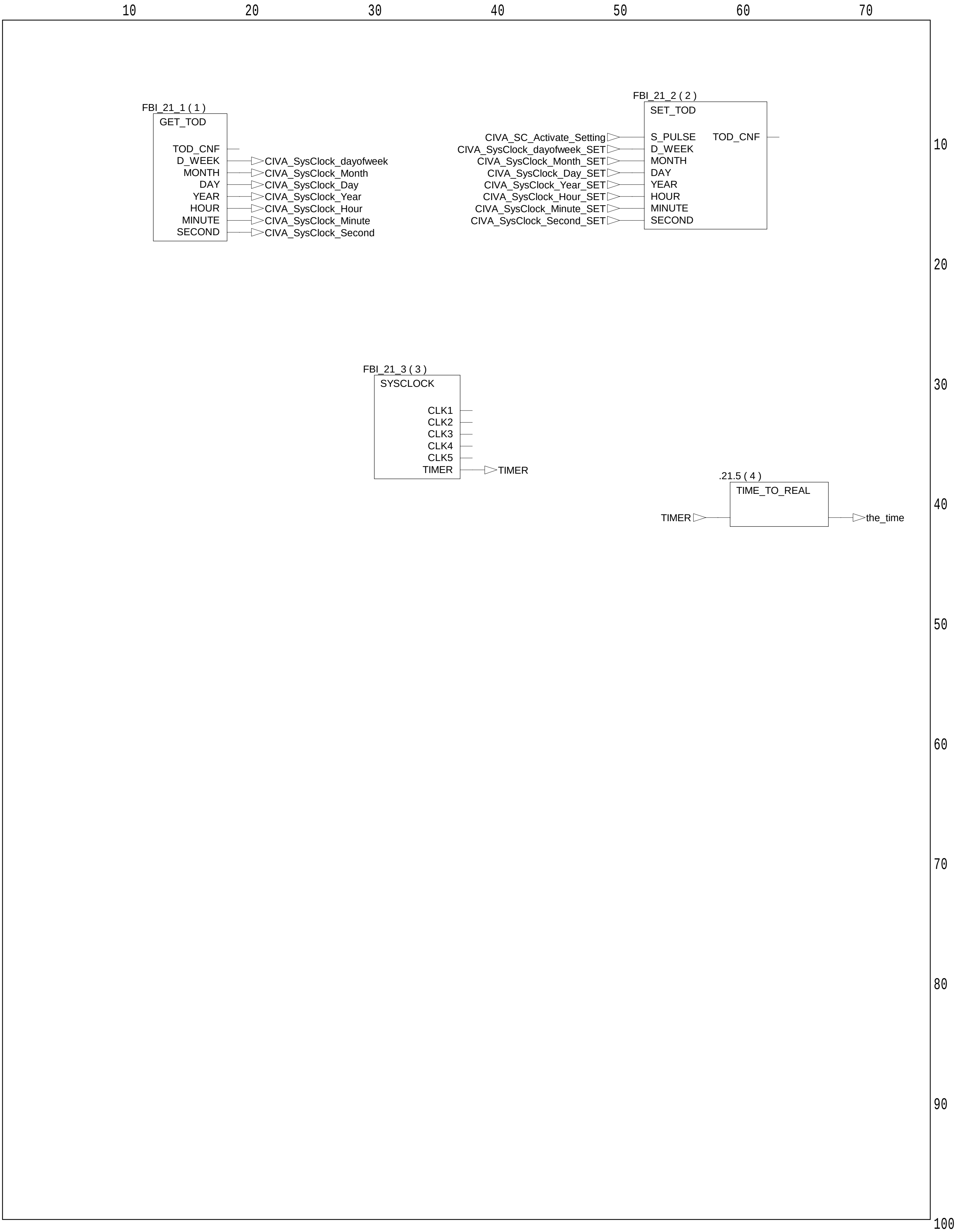
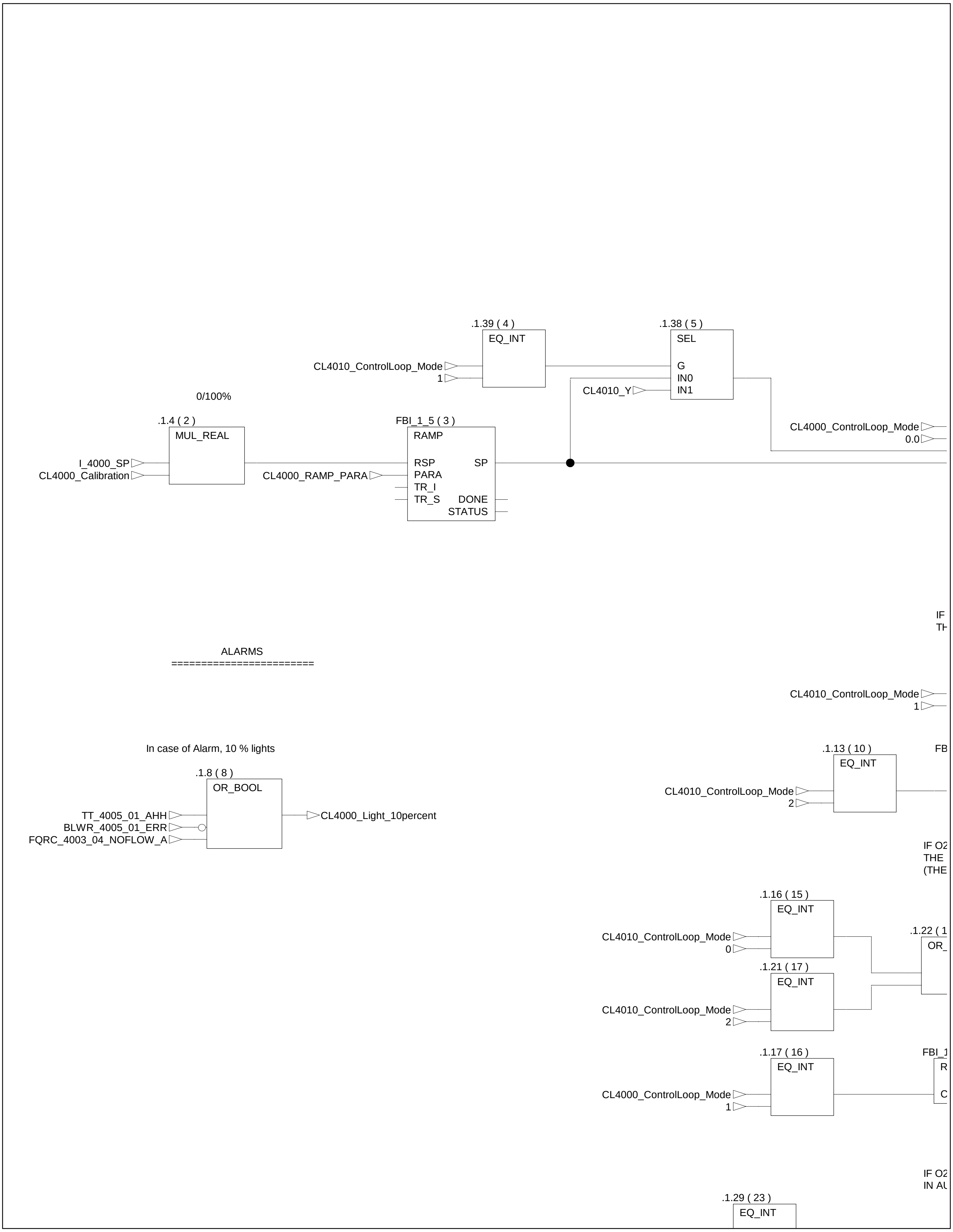
< page 70

Graph of section System_Clock



Graph of section CL4000_Lights



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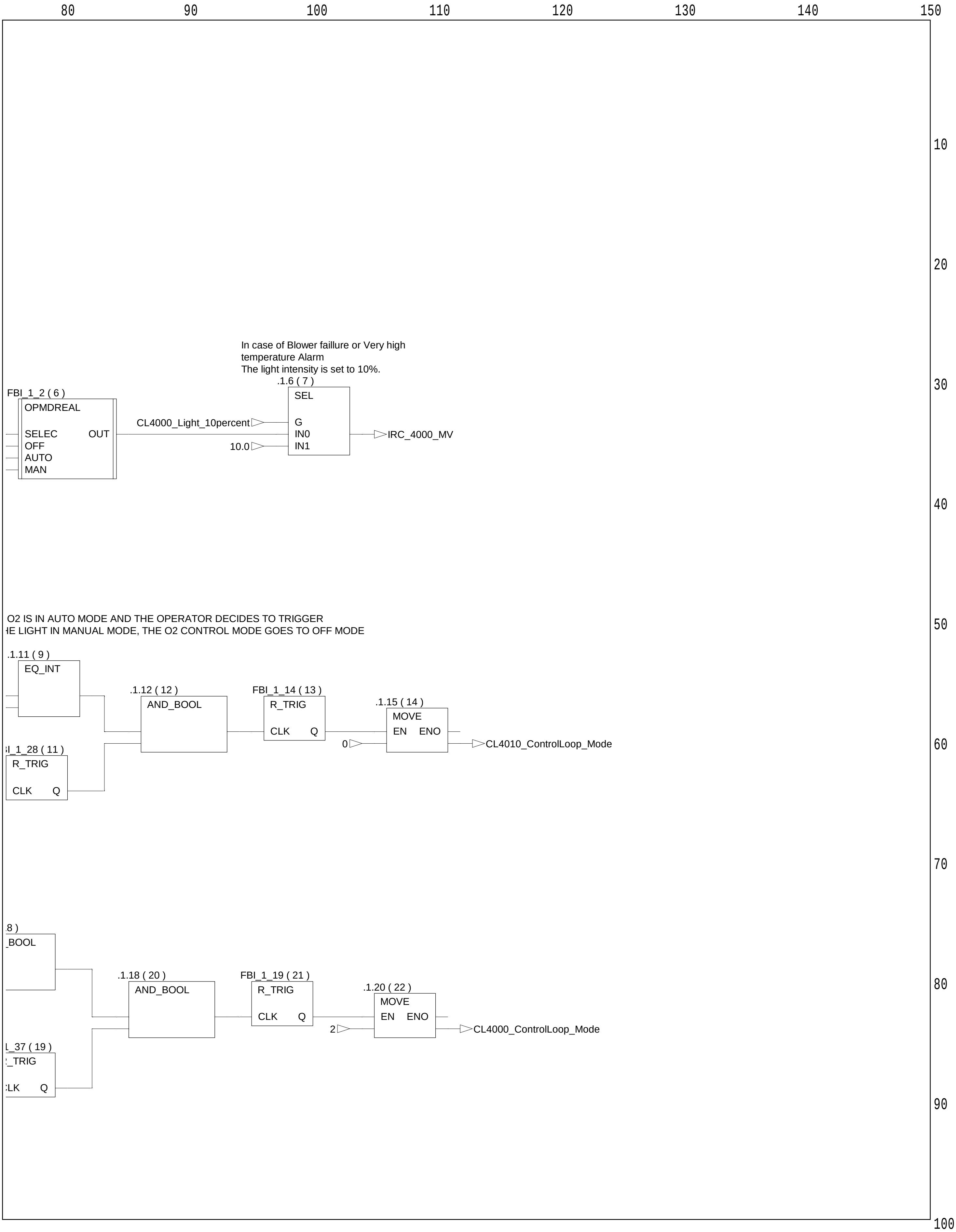
Graph of section CL4000_Lights



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Graph of section CL4000_Lights

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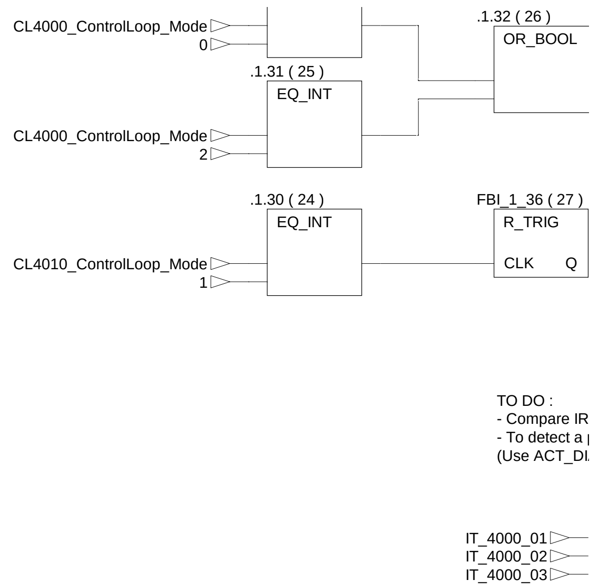

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Graph of section CL4000_Lights

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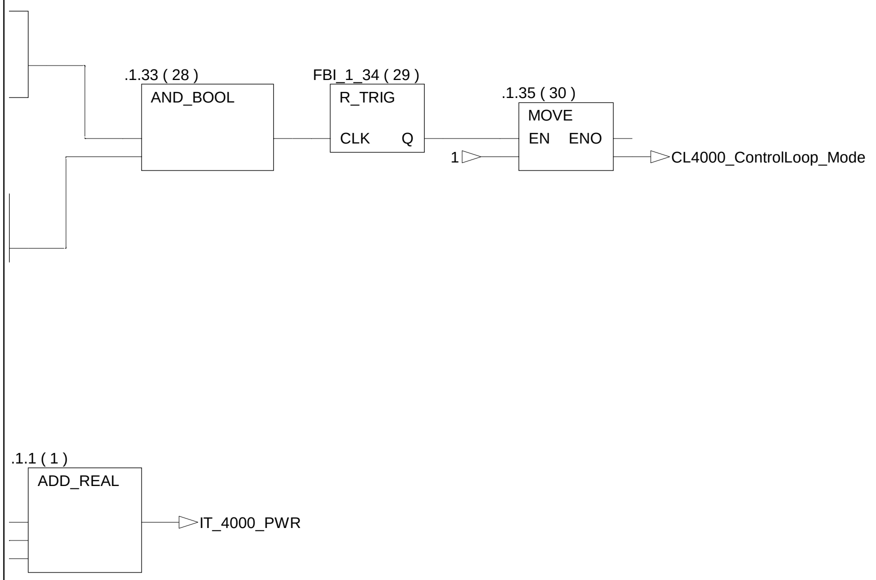

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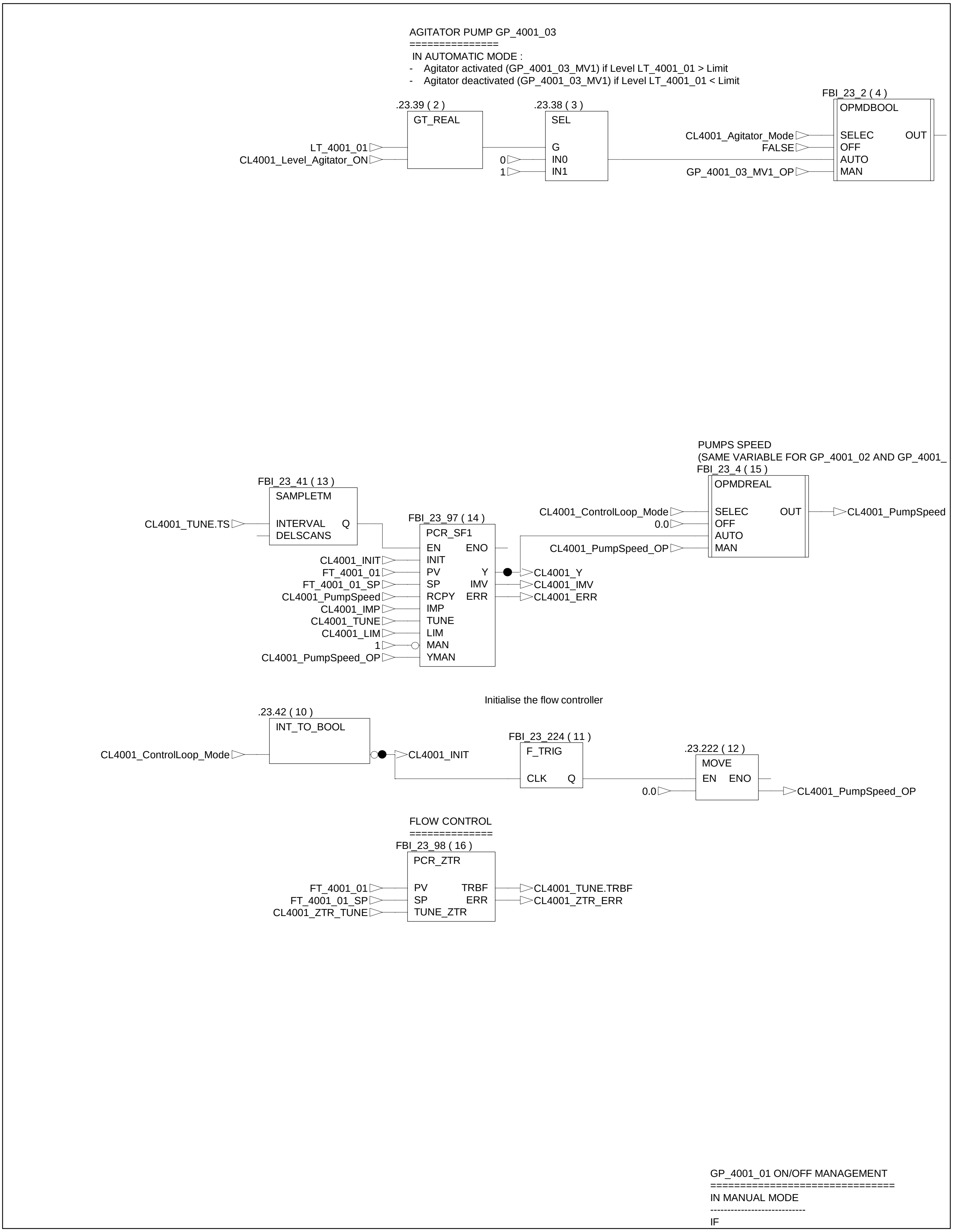
Graph of section CL4001_Inlet_Liquid_Flow



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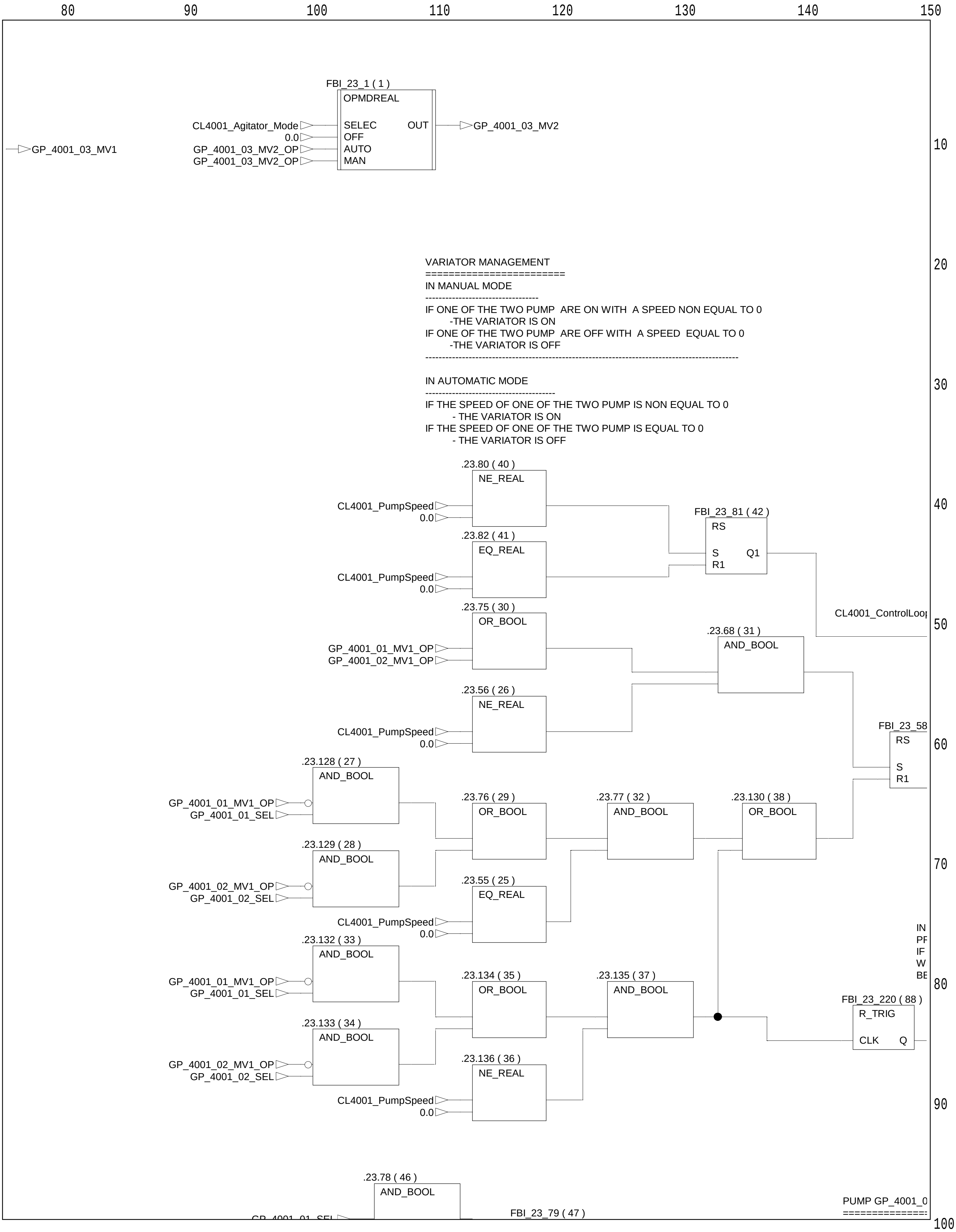
Graph of section CL4001_Inlet_Liquid_Flow

< page 77



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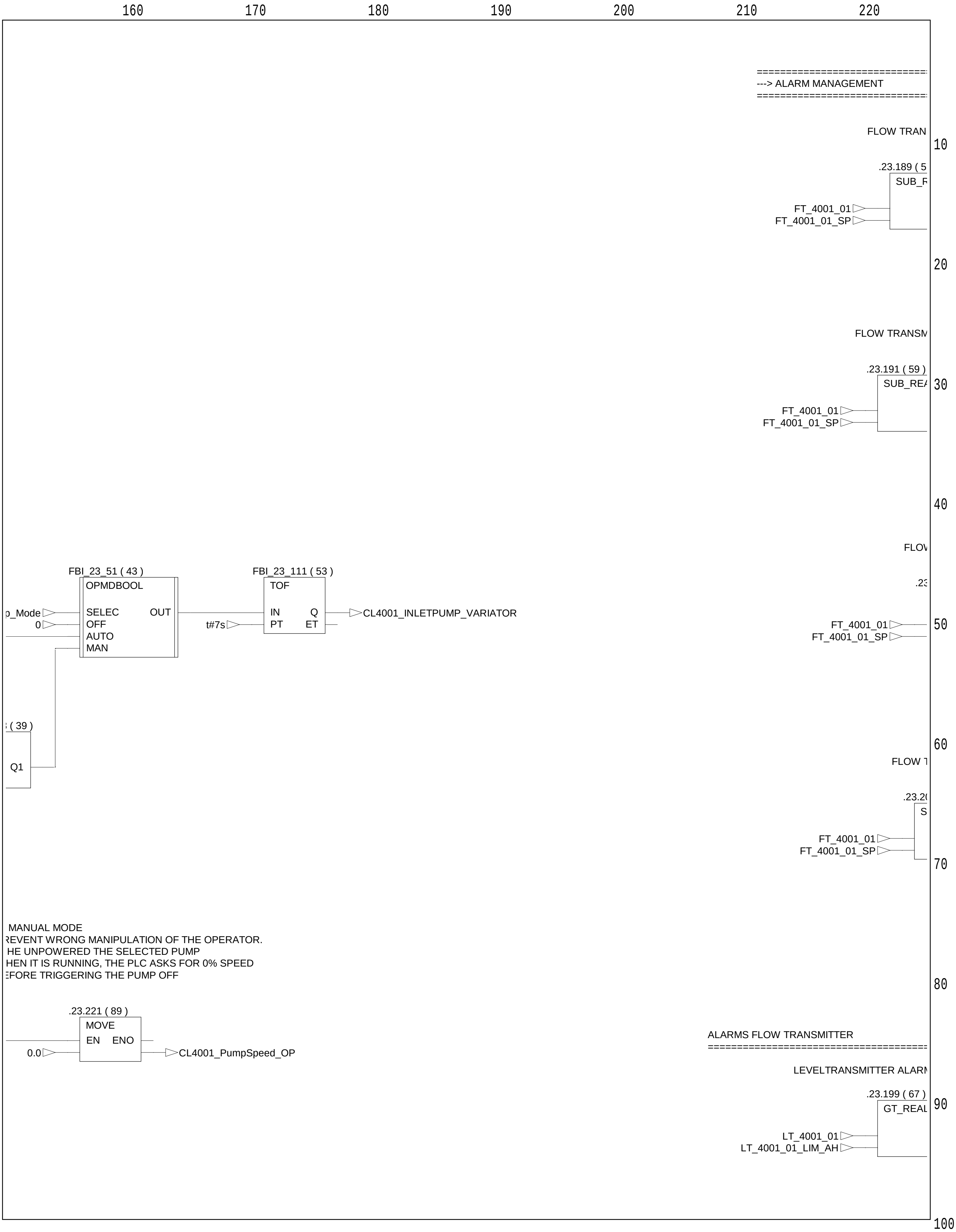
Graph of section CL4001_Inlet_Liquid_Flow



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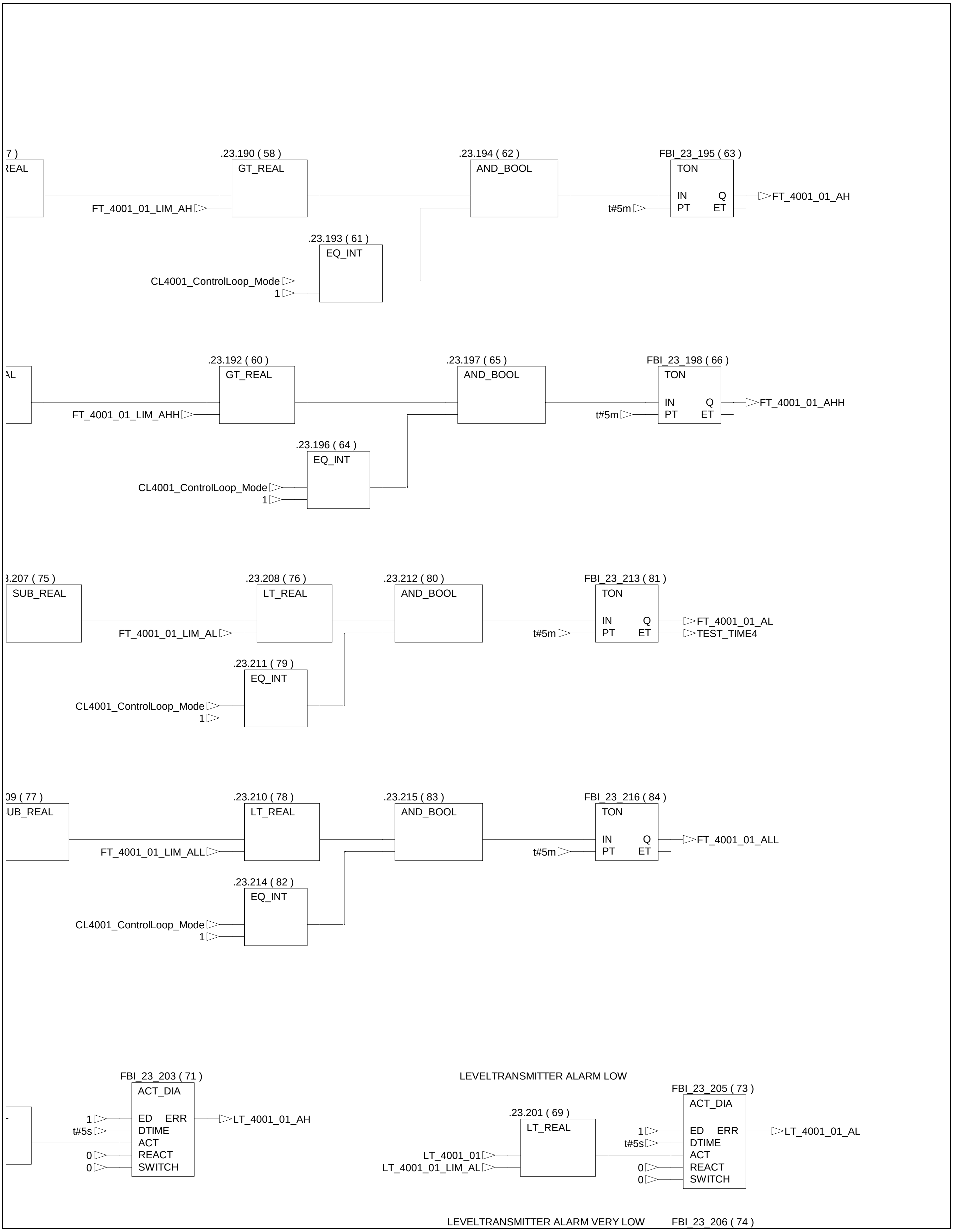
Graph of section CL4001_Inlet_Liquid_Flow



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> page 81

> page 85

Graph of section CL4001_Inlet_Liquid_Flow

< page 80

> page 86

Graph of section CL4001_Inlet_Liquid_Flow

< page 77

-THE OPERATOR SELECTS AND STARTS GP_4
-AND THE VARIATOR IS ON
THE PUMP GP_4001_01 IS ACTIVATED

IF
-THE OPERATOR ASKS FOR A STOP OF GP_40
-AND THE VARIATOR IS OFF
THE PUMP GP_4001_01 IS DESACTIVATED AFTE

IN AUTOMATIC MODE

IF
-THE THE PUMP IS SELECTED
-AND THE VARIATOR IS ON
THE PUMP GP_4001_01 IS ACTIVATED
IF
-THE VARIATOR IS OFF
THE PUMP GP_4001_01 IS DESACTIVATED AFTE

GP_4001_02 ON/OFF MANAGEMENT
==============================
IN MANUAL MODE

IF
-THE OPERATOR SELECTS AND STARTS GP
-AND THE VARIATOR IS ON
THE PUMP GP_4001_02 IS ACTIVATED

IF
-THE OPERATOR ASKS FOR A STOP OF GP_
-AND THE VARIATOR IS OFF
THE PUMP GP_4001_02 IS DESACTIVATED AF

IN AUTOMATIC MODE

IF
-THE THE PUMP IS SELECTED
-AND THE VARIATOR IS ON
THE PUMP GP_4001_02 IS ACTIVATED
IF
-THE VARIATOR IS OFF
THE PUMP GP_4001_02 IS ACTIVATED AFTER

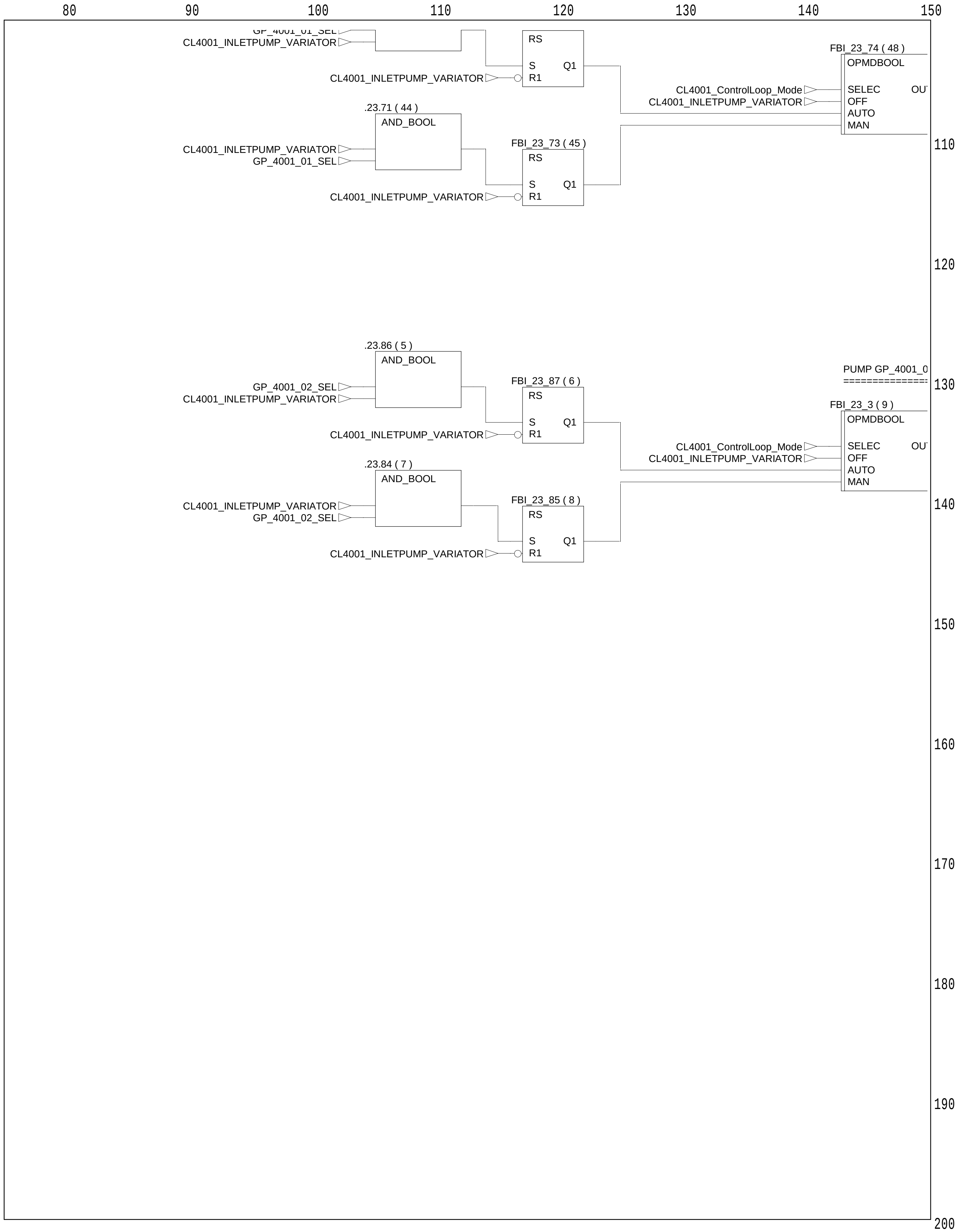
> page 83

> page 87

Graph of section CL4001_Inlet_Liquid_Flow

< page 78

< page 82



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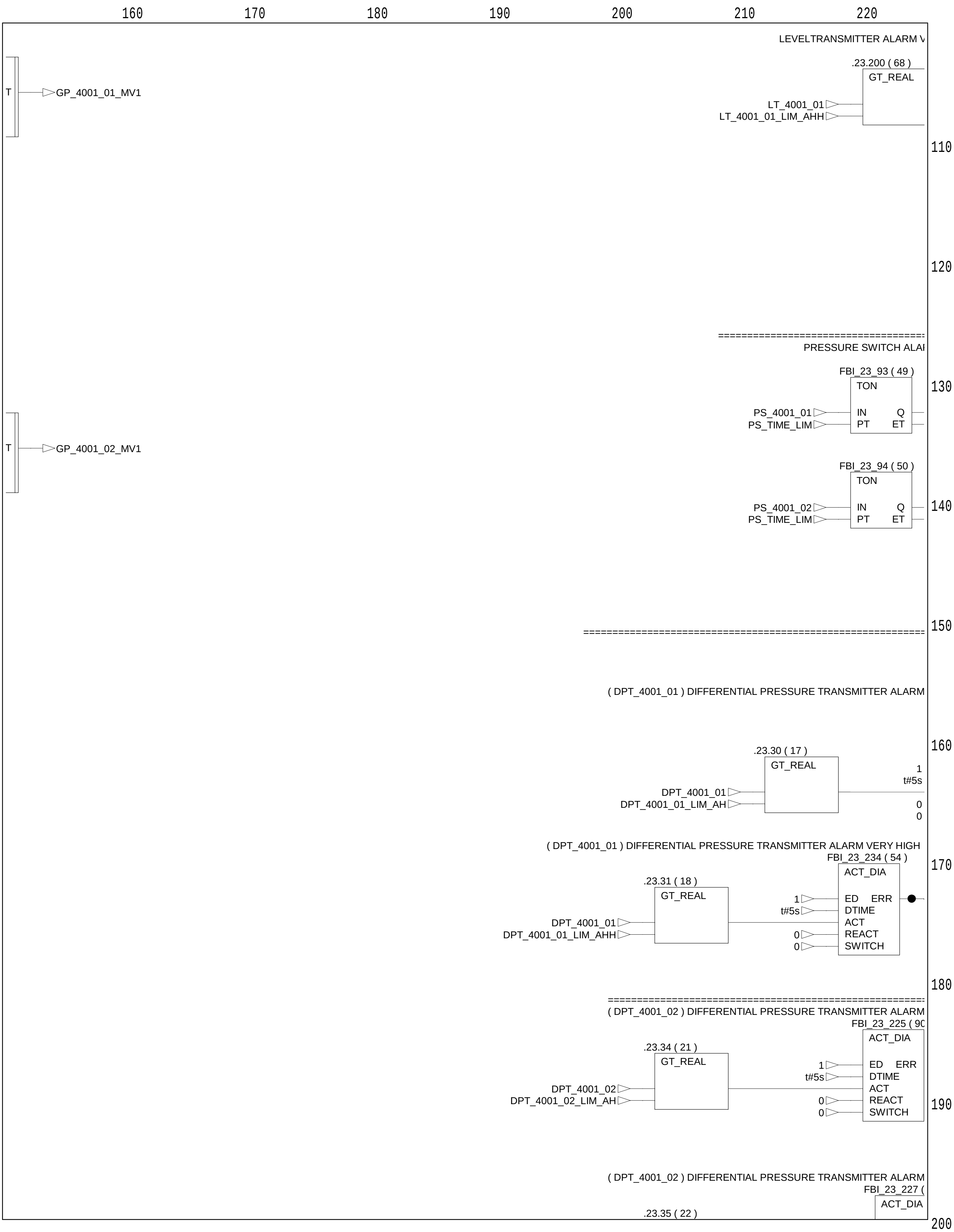
> page 88

Graph of section CL4001_Inlet_Liquid_Flow

< page 79



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> page 89

Graph of section CL4001_Inlet_Liquid_Flow

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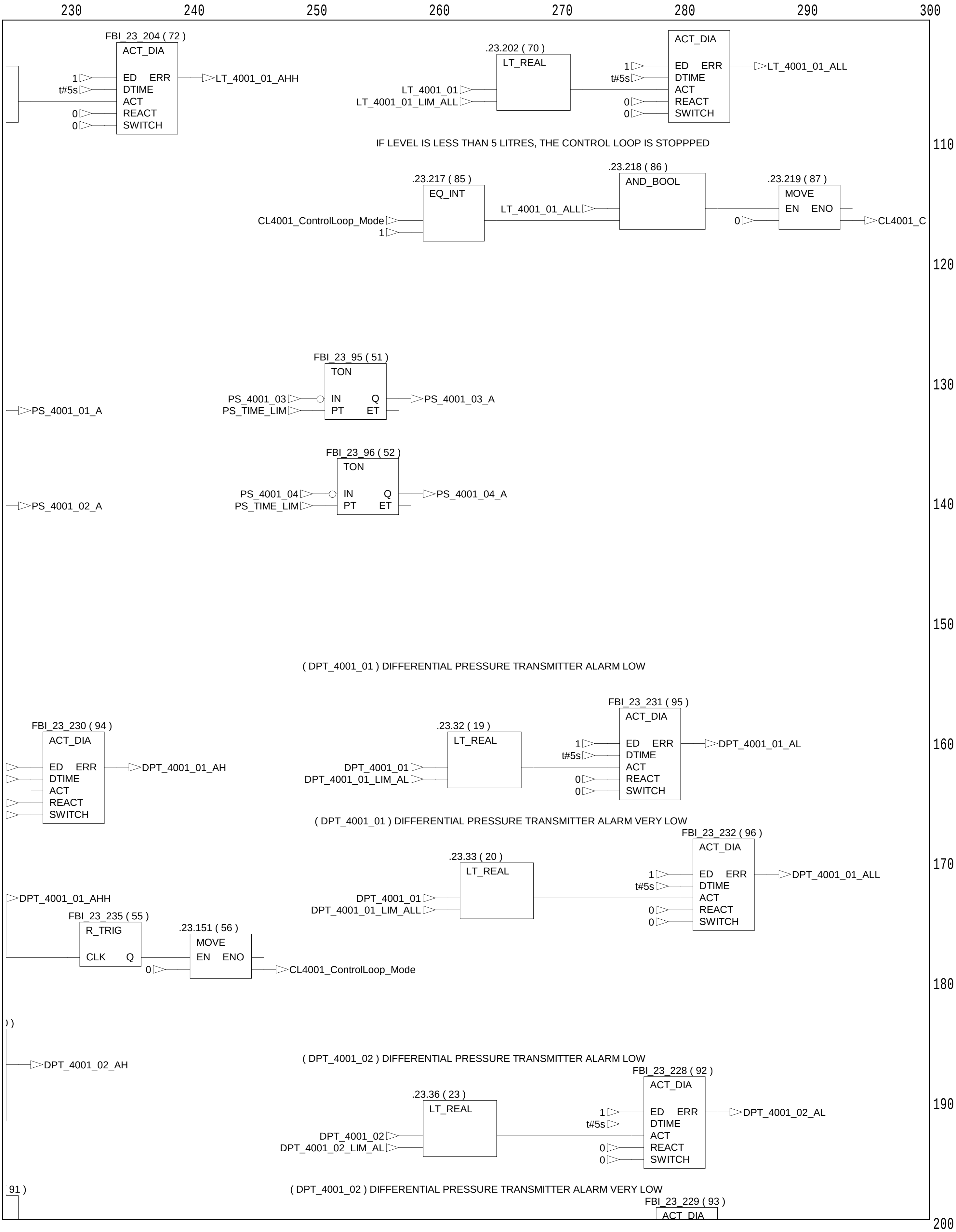

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Graph of section CL4001_Inlet_Liquid_Flow

< page 81

ontrolLoop_Mode

< page 85

> page 91

Graph of section CL4001_Inlet_Liquid_Flow

< page 82

10 20 30 40 50 60 70

210

220

230

> page 88

Graph of section CL4001_Inlet_Liquid_Flow

< page 83

80 90 100 110 120 130 140 150

210
220
230

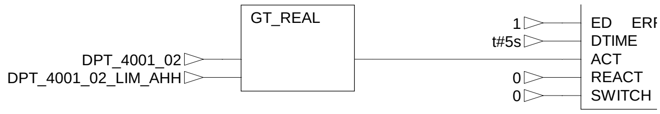
< page 87

> page 89

Graph of section CL4001_Inlet_Liquid_Flow

< page 84

160 170 180 190 200 210 220



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230

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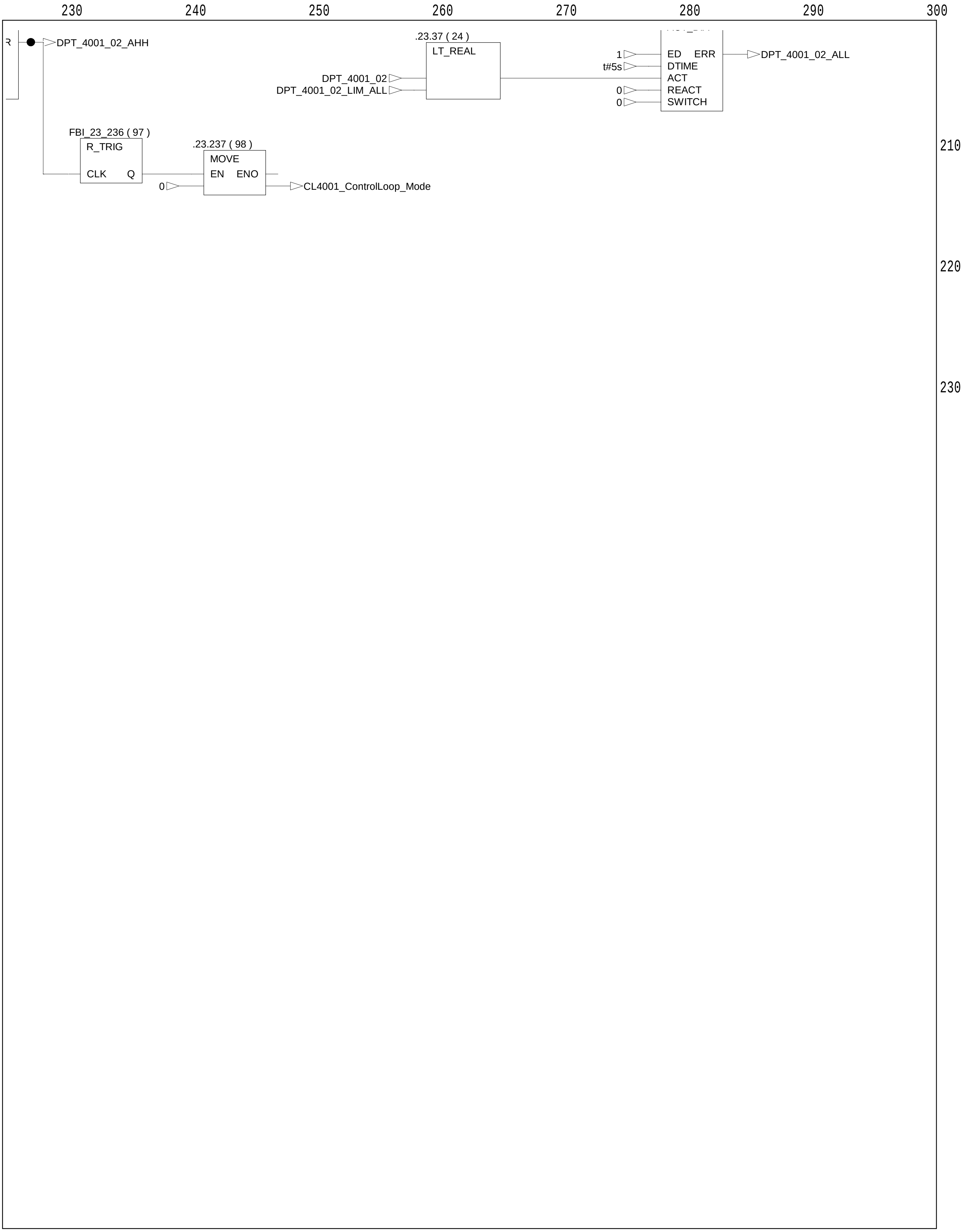
Graph of section CL4001_Inlet_Liquid_Flow

< page 85



< page 89

> page 91

Graph of section CL4001_Inlet_Liquid_Flow

< page 86

210

220

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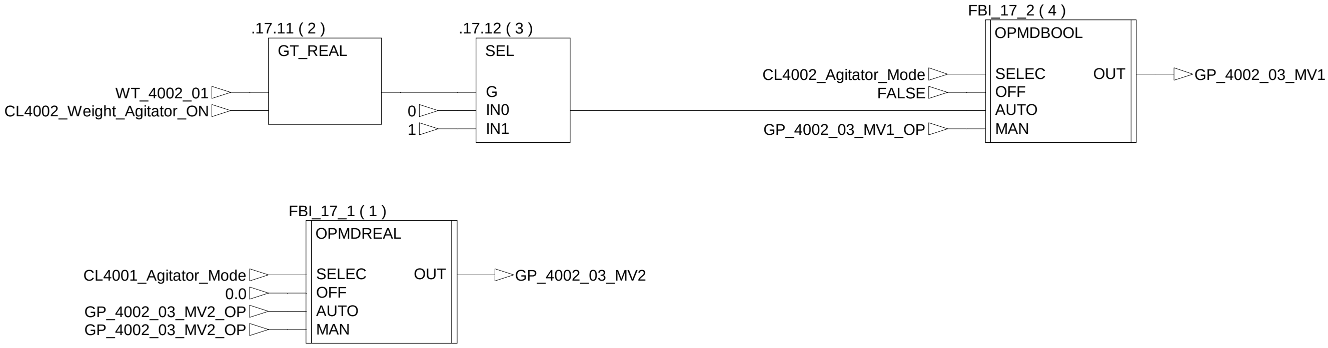
< page 90

Graph of section CL4002_Outlet_Liquid_Flow

AGITATOR PUMP GP_4002_03
===============

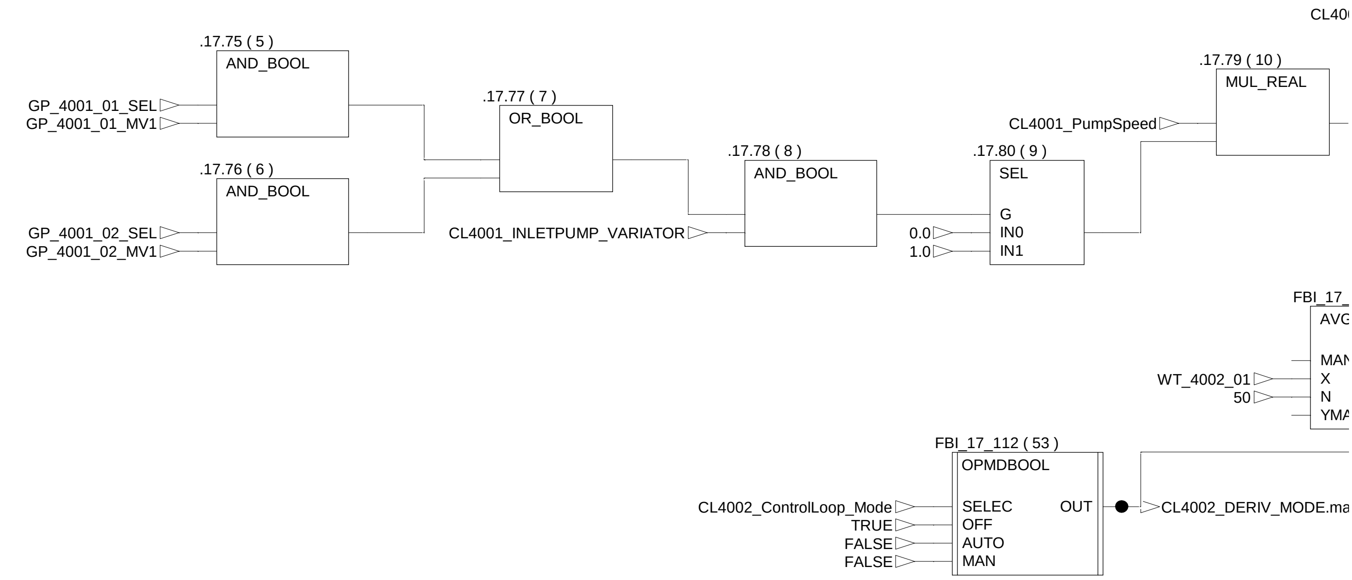
IN AUTOMATIC MODE :
- Agitator activated GP_4002_03_MV1 if WT_4002_01 > Limit
- Agitator deactivated GP_4002_03_MV1 if Level WT_4002_01 < Limit
- GP_4002_03_MV2 = Set Point (speed) fixed by the user, from the HMI

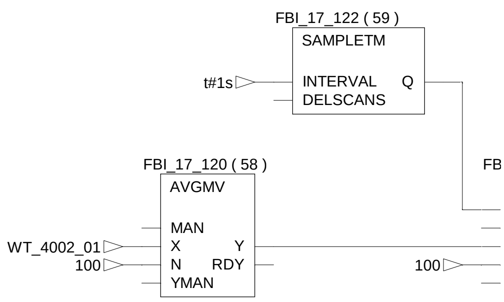


GP_4002_01 SPEED MANAGEMENT
==============================

AUTOMATIC MODE

THE PBR LEVEL CONTROLLER MANAGES THE SPEED PUMP





VARIATOR MANAGEMENT
=======================
IN MANUAL MODE

IF ONE OF THE TWO PUMP ARE ON WITH A SPEED NON EQUAL TO 0
-THE VARIATOR IS ON
IF ONE OF THE TWO PUMP ARE OFF WITH A SPEED EQUAL TO 0
-THE VARIATOR IS OFF

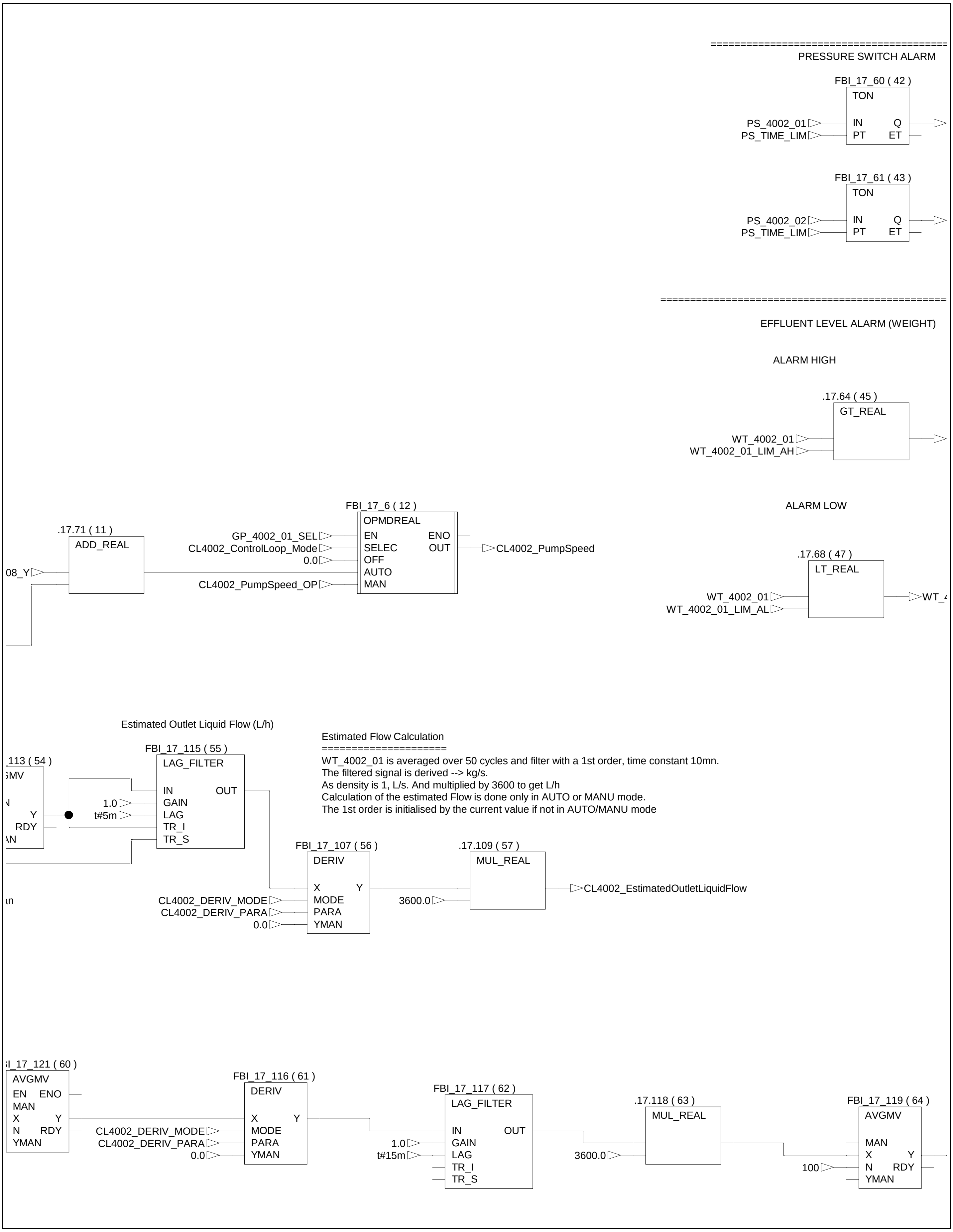
IN AUTOMATIC MODE

IF THE SPEED OF ONE OF THE TWO PUMP IS NON EQUAL TO 0
- THE VARIATOR IS ON

> page 95

Graph of section CL4002_Outlet_Liquid_Flow

< page 92



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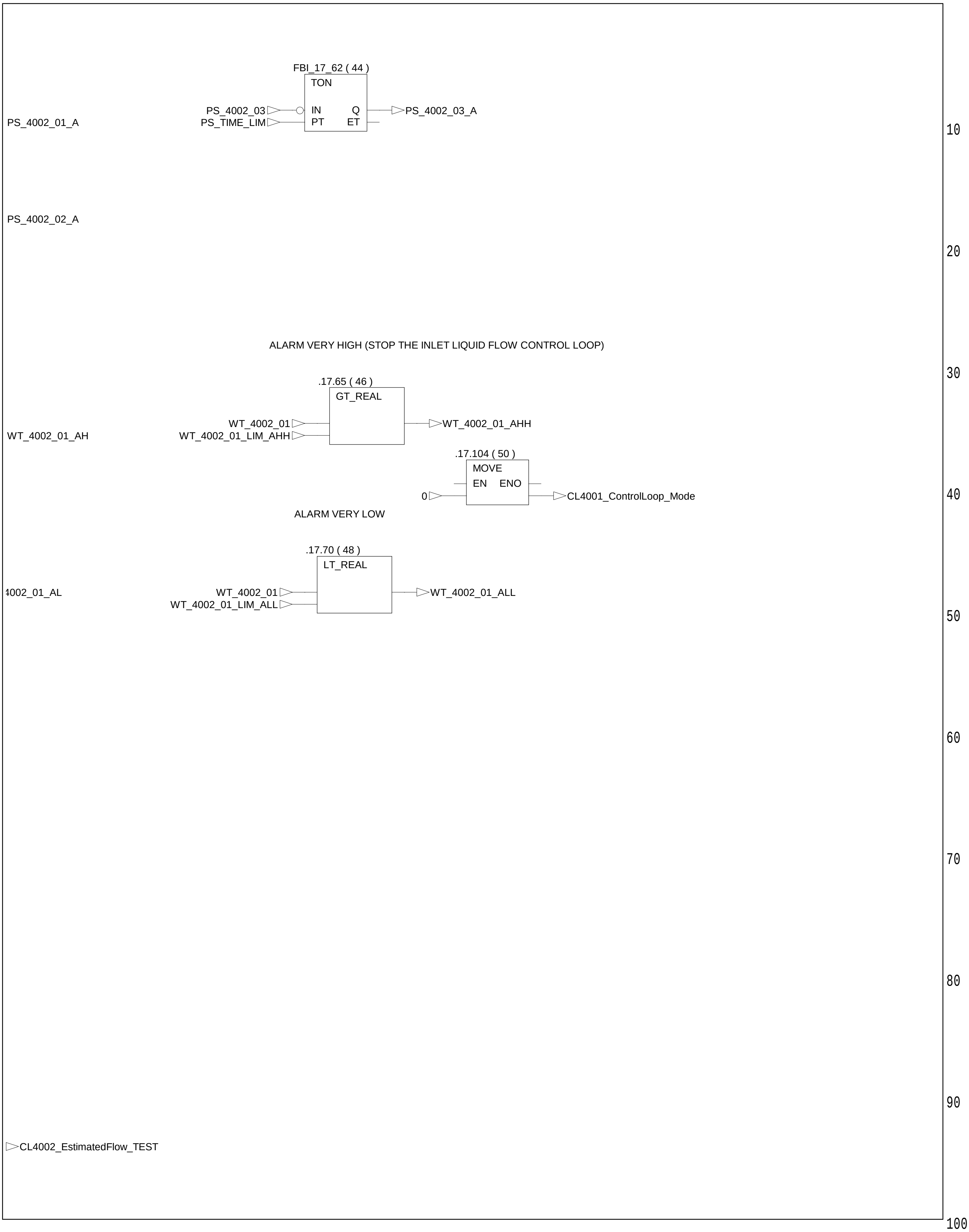
> page 96

Graph of section CL4002_Outlet_Liquid_Flow

160 170 180 190 200 210 220



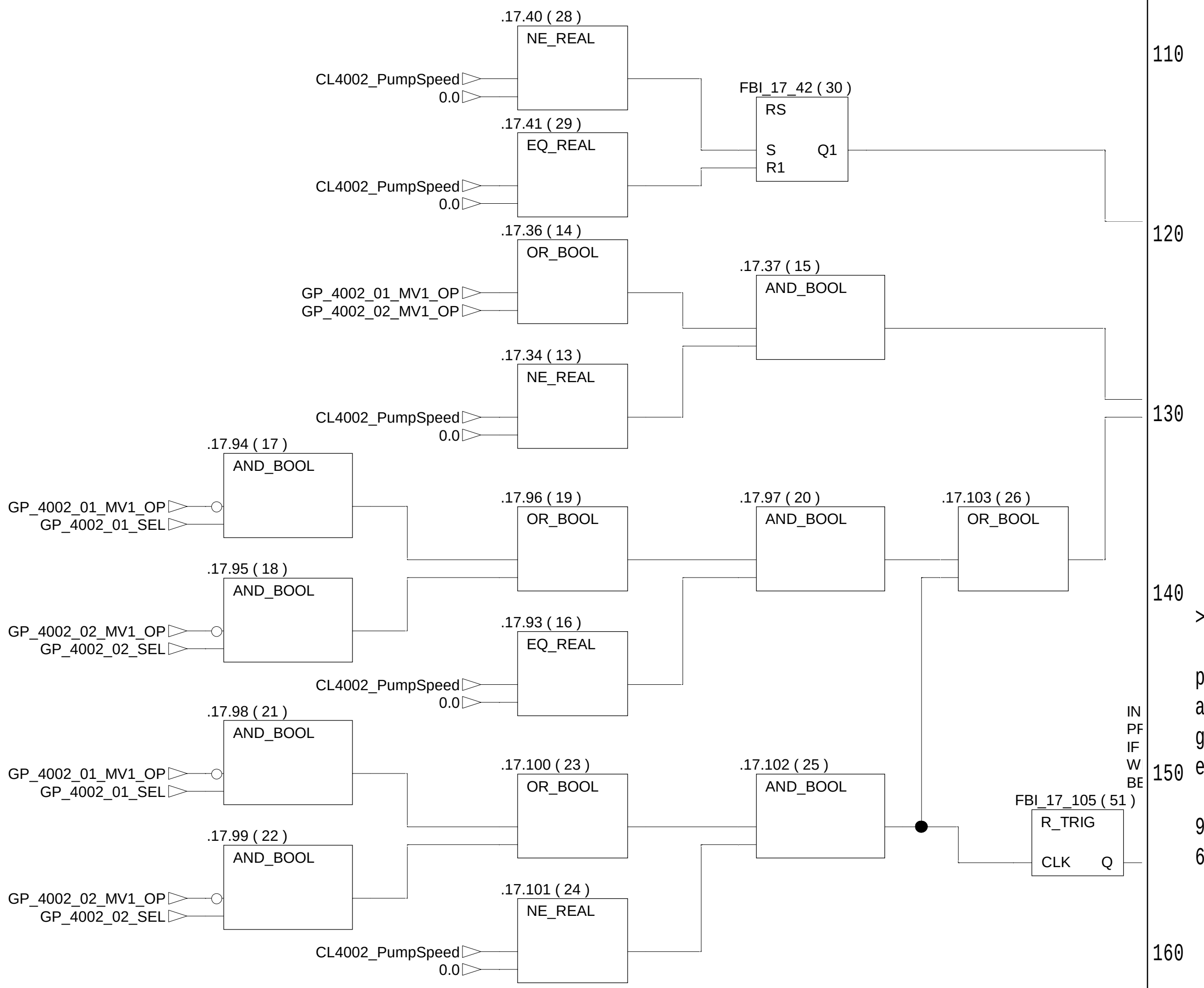
< page 93

> page 97

Graph of section CL4002_Outlet_Liquid_Flow

< page 92

IF THE SPEED OF ONE OF THE TWO PUMP IS EQUAL TO 0
- THE VARIATOR IS OFF



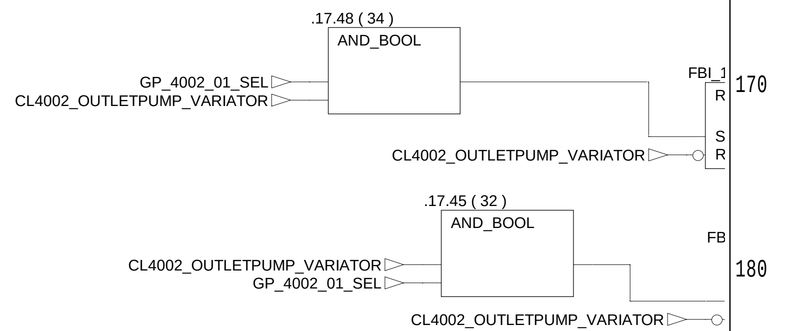
GP_4001_01 ON/OFF MANAGEMENT
==============================
IN MANUAL MODE

IF
-THE OPERATOR SELECTS AND STARTS GP_4001_01
-AND THE VARIATOR IS ON
THE PUMP GP_4002_01 IS ACTIVATED

IF
-THE OPERATOR ASKS FOR A STOP OF GP_4001_01
-AND THE VARIATOR IS OFF
THE PUMP GP_4002_01 IS DESACTIVATED AFTER 7 SECONDS

IN AUTOMATIC MODE

IF
-THE THE PUMP IS SELECTED
-AND THE VARIATOR IS ON
THE PUMP GP_4002_01 IS ACTIVATED
IF
-THE VARIATOR IS OFF
THE PUMP GP_4002_01 IS DESACTIVATED AFTER 7 SECONDS



GP_4001_02 ON/OFF MANAGEMENT
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IN MANUAL MODE

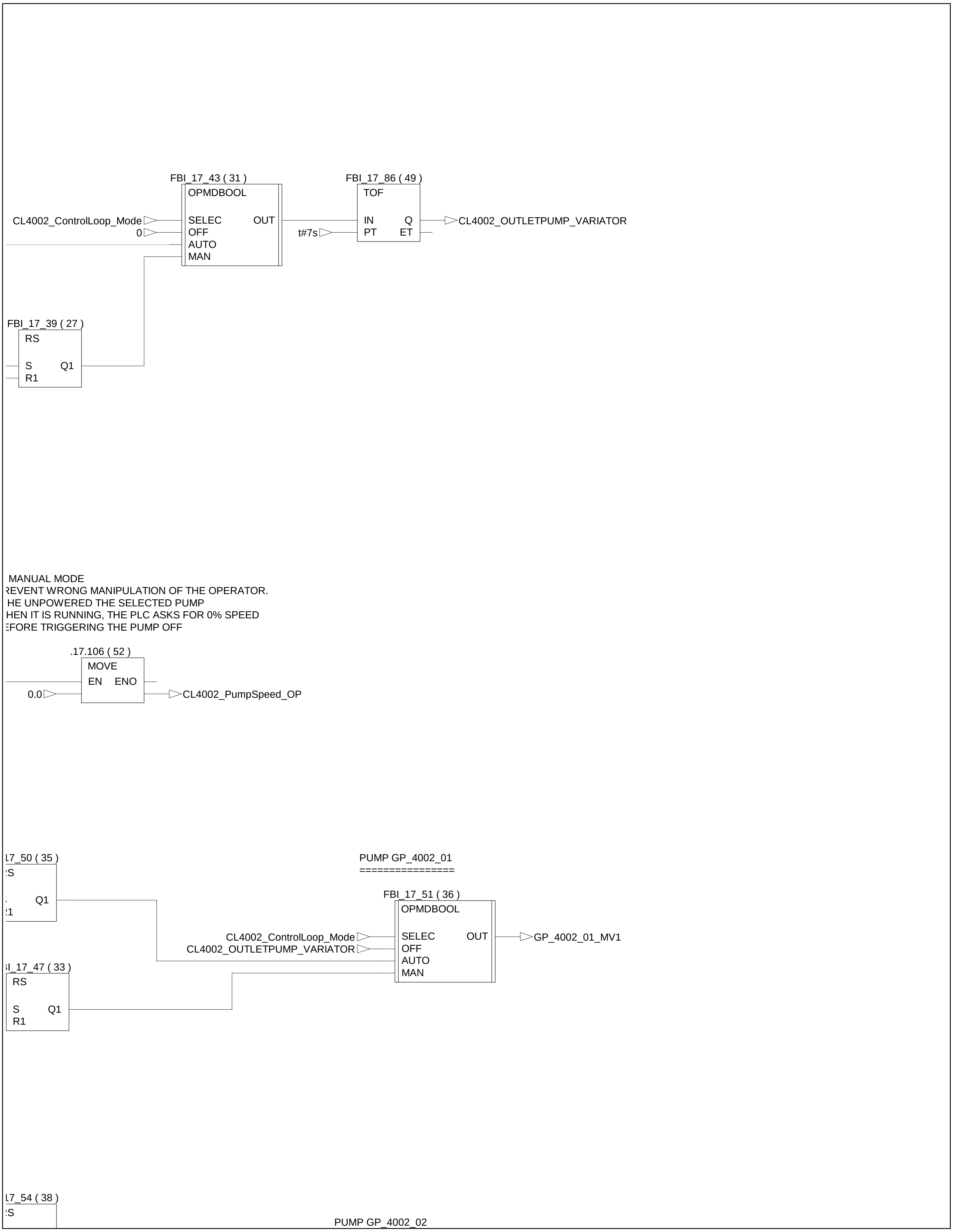
> page 98

> page 96

Graph of section CL4002_Outlet_Liquid_Flow

< page 93

80 90 100 110 120 130 140 150



110 120 130 140 150 160 170 180 190 200

< page 95

> page 97

> page 99

Graph of section CL4002_Outlet_Liquid_Flow

< page 94

160 170 180 190 200 210 220

< page 96

110 120 130 140 150 160 170 180 190 200

> page 100

Graph of section CL4002_Outlet_Liquid_Flow

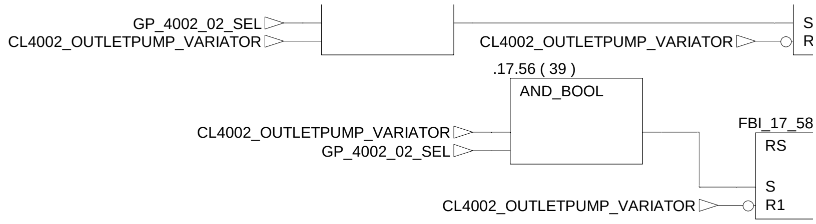
< page 95

IF
-THE OPERATOR SELECTS AND STARTS GP_4001_01
-AND THE VARIATOR IS ON
THE PUMP GP_4001_02 IS ACTIVATED

IF
-THE OPERATOR ASKS FOR A STOP OF GP_4001_01
-AND THE VARIATOR IS OFF
THE PUMP GP_4001_02 IS DESACTIVATED AFTER 7 SECONDS

IN AUTOMATIC MODE

IF
-THE THE PUMP IS SELECTED
-AND THE VARIATOR IS ON
THE PUMP GP_4001_02 IS ACTIVATED
IF
-THE VARIATOR IS OFF
THE PUMP GP_4001_02 IS ACTIVATED AFTER 7 SECONDS



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Graph of section CL4002_Outlet_Liquid_Flow

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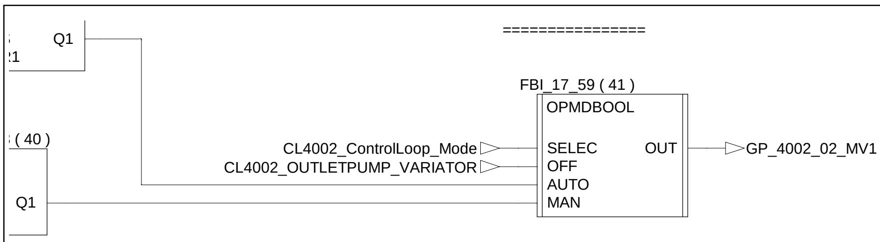

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Graph of section CL4002_Outlet_Liquid_Flow

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160 170 180 190 200 210 220

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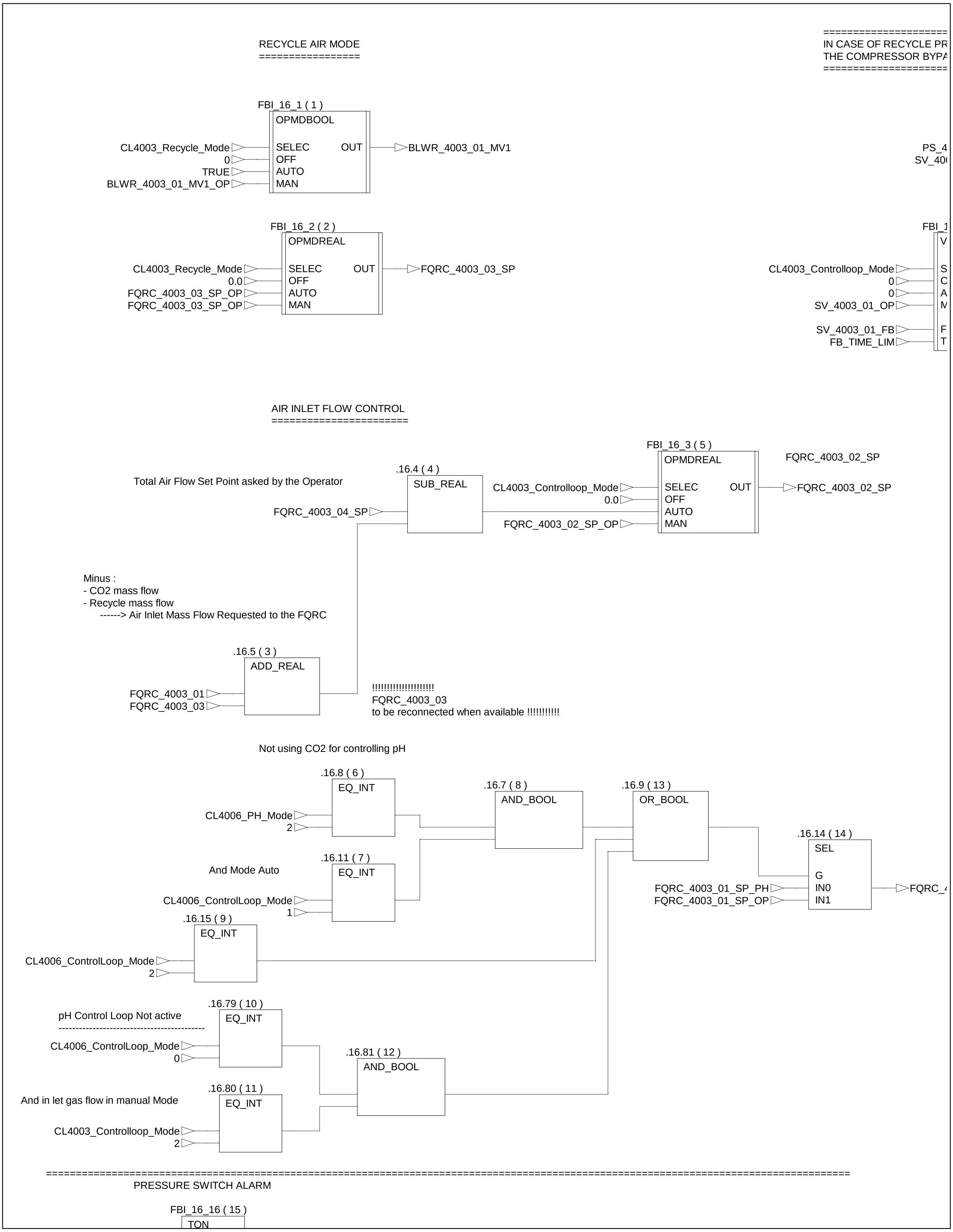
Graph of section CL4003_Inlet_Gas_Flow



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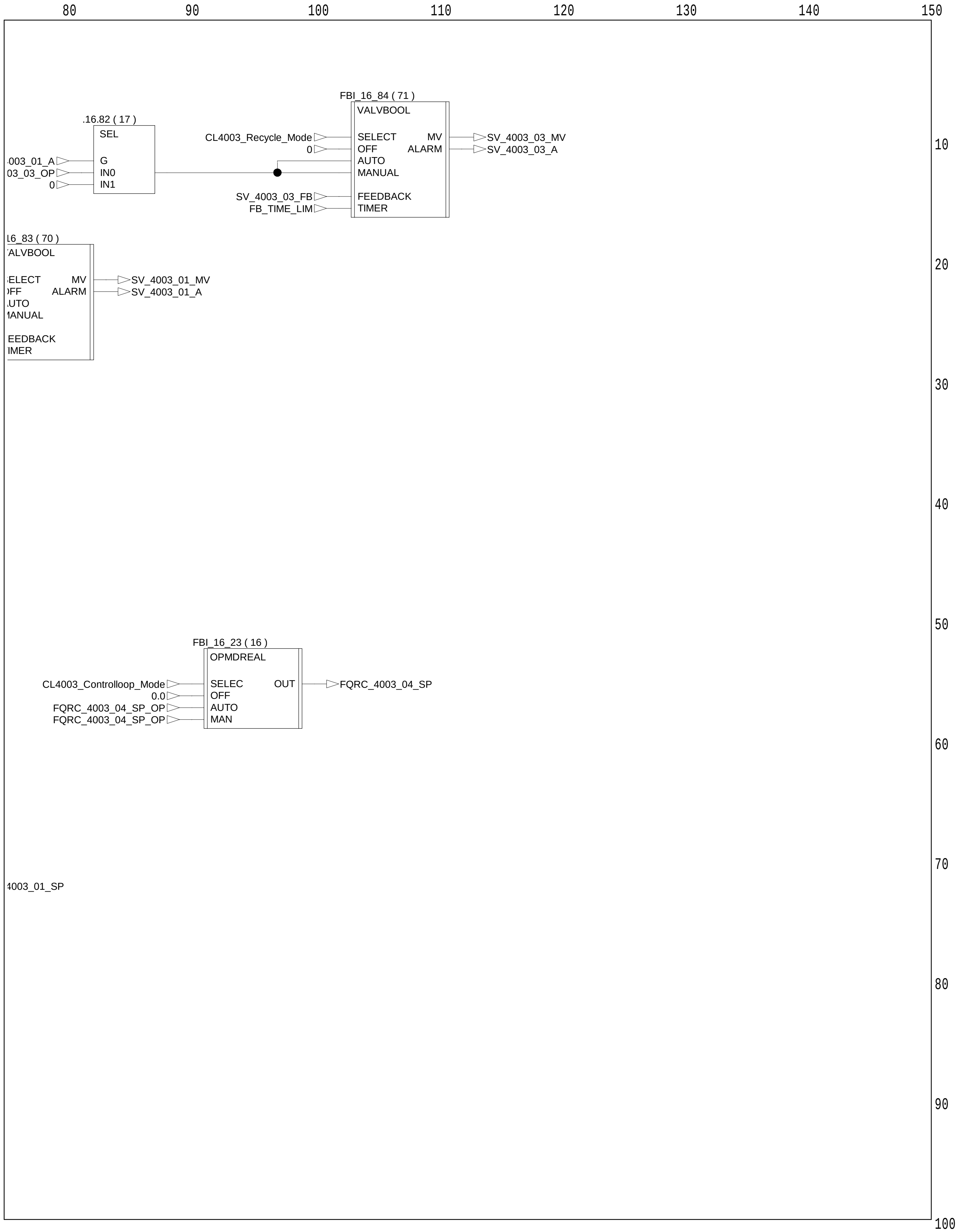
Graph of section CL4003_Inlet_Gas_Flow



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> page 106

Graph of section CL4003_Inlet_Gas_Flow

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< page 102

> page 104

> page 107

Graph of section CL4003_Inlet_Gas_Flow

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80
90
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Graph of section CL4003_Inlet_Gas_Flow

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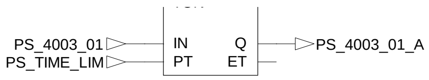


==

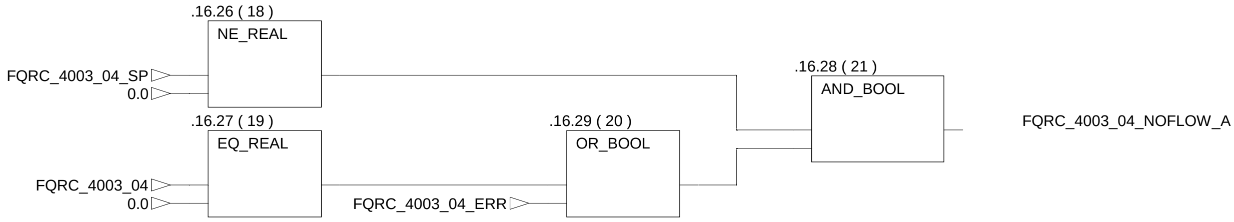
INLET GAS FLOW VALVES ALARM

==

INLET GAS FLOW ALARM

IF A FLOW IS ASKED BUT NOT DETECTED
OR THE FQRC_4003_04 IS IN ERROR
THE LIGHTS ARE SET TO 10%

!! PAY ATTENTION !!
FOR THE MOMENT THE TOTAL GAS FLOW VALUE IS UNREADABLE
THE SENSOR IS IN ERROR......
ITHE ALARM WILL BE RECONNECTED WHEN THE SENSOR WILL BE REPAIR



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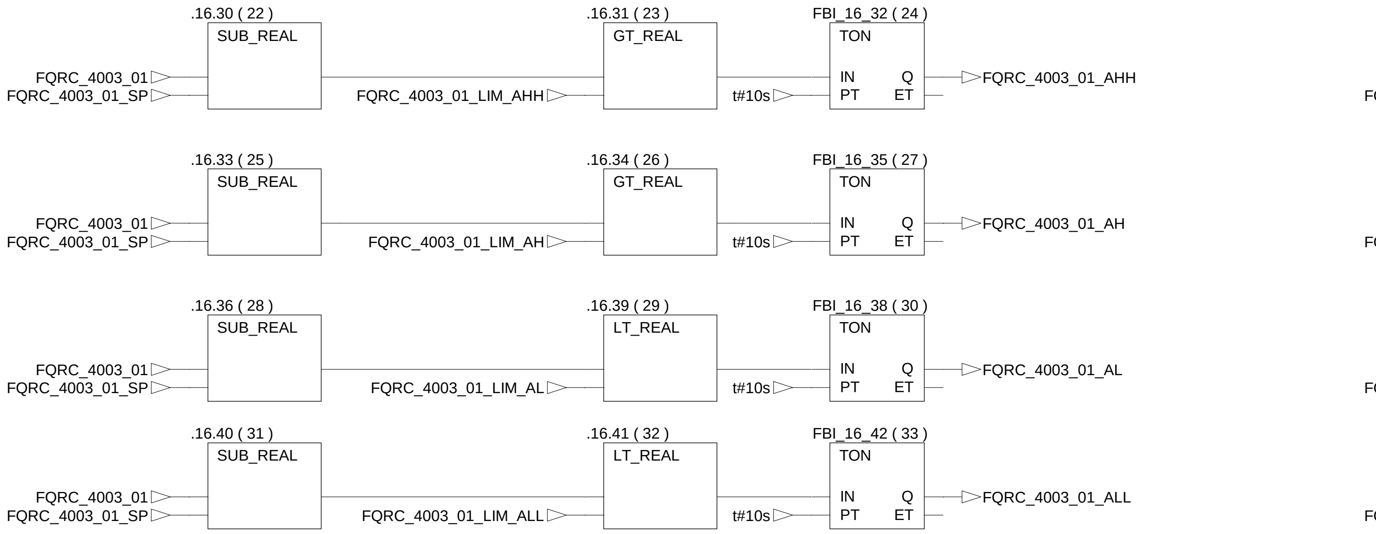
FQRC_4003_01 ALARM



> page 106

Graph of section CL4003_Inlet_Gas_Flow < page 102

< page 105
> page 107

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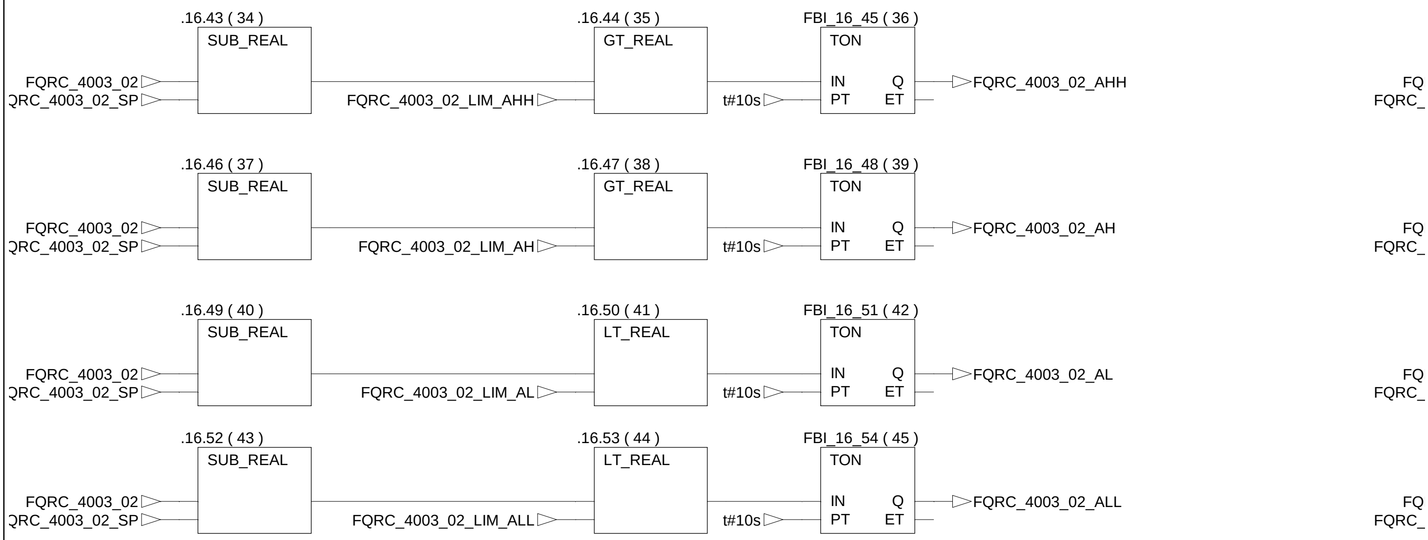
FQRC_4003_02 ALARM



Graph of section CL4003_Inlet_Gas_Flow

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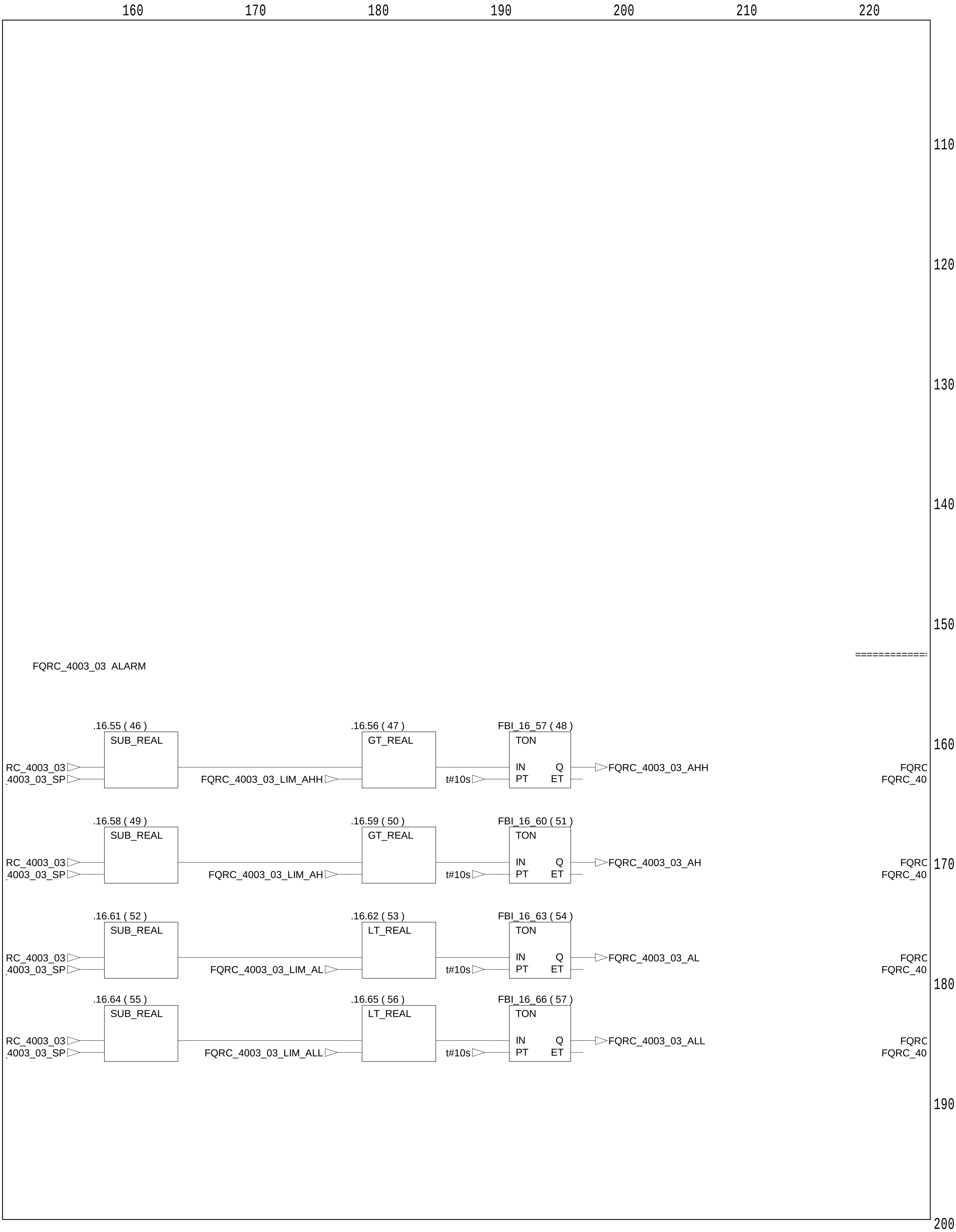

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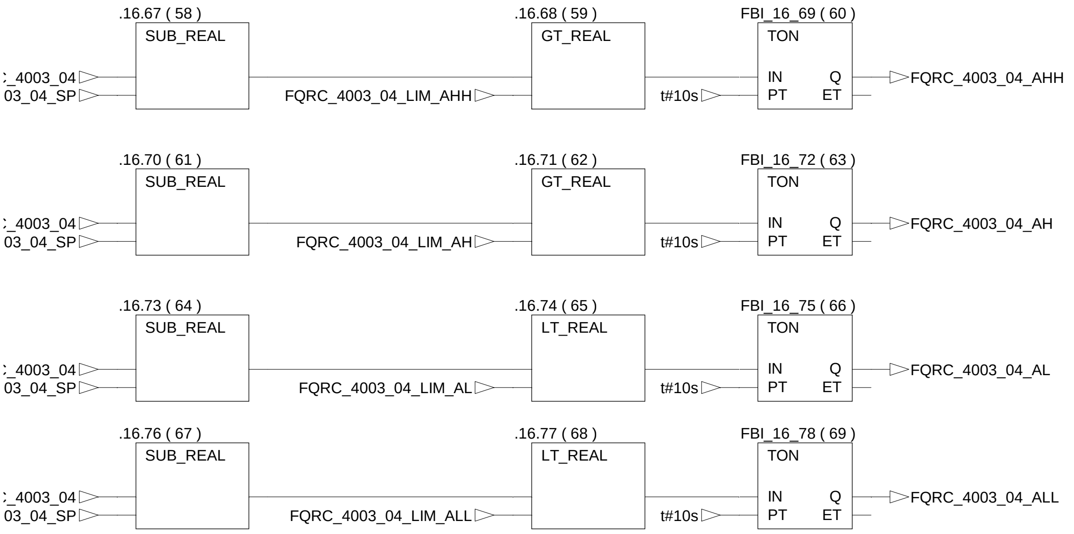
Graph of section CL4003_Inlet_Gas_Flow

< page 104

< page 107

FQRC_4003_04 ALARM



Graph of section CL4004_Oulet_Gas_Flow

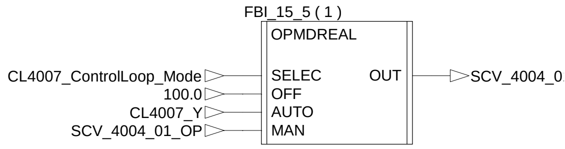
SCV_4004_01 MANAGEMENT
========================
IF PRESSURE REGULATION (CL4007_PBR_Pressure) IS IN AUTOMATIC MODE
THE CONTROLLER OUTPUT MANAGE THE PROPORTIONAL VALVE SCV_4004_01

IN AUTOMATIC MODE

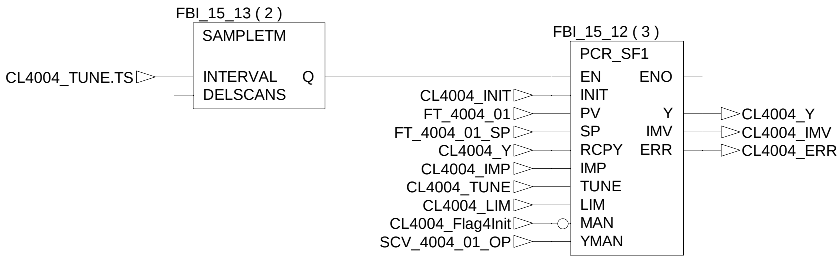
THE PRESSURE CONTROL (CL4007) HAS PRIORITY ON THE FLOW REGULATION (CL4004)

IN MANUAL MODE

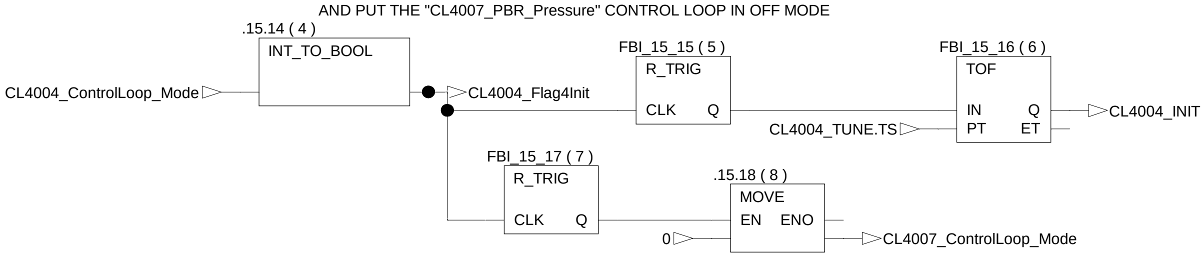
ONLY THE LOOP 4004 CAN MANAGE THE VALVE
(CL4007 DOESN'T HAVE MANUAL MODE)



FLOW CONTROL
===============



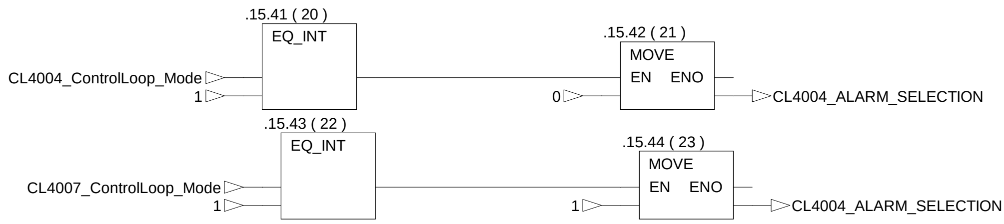
INITIALIZE THE FLOW CONTROLLER
AND PUT THE "CL4007_PBR_Pressure" CONTROL LOOP IN OFF MODE



===

OUTLET GAS FLOW ALARM

SELECTION OF THE SETPOINT LINKED TO THE ALARM
IF CONTROL LOOP OUTLET FLOW GAS IS IN AUTO MODE : SP= "FT_4004_01_SP"
IF CONTROL LOOP PBR PRESSURE : SP= "FT_4001_01_SP"



> page 112

Graph of section CL4004_Oulet_Gas_Flow

80 90 100 110 120 130 140 150

1_MV

< page 109

> page 111

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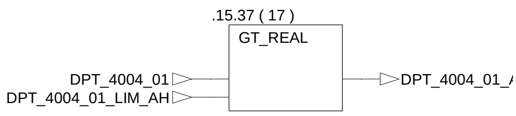
OUTLET GAS DIFFERENTIAL PRESSURE ALAF

ALARM HIGH DPT



ALARM LOW DPT

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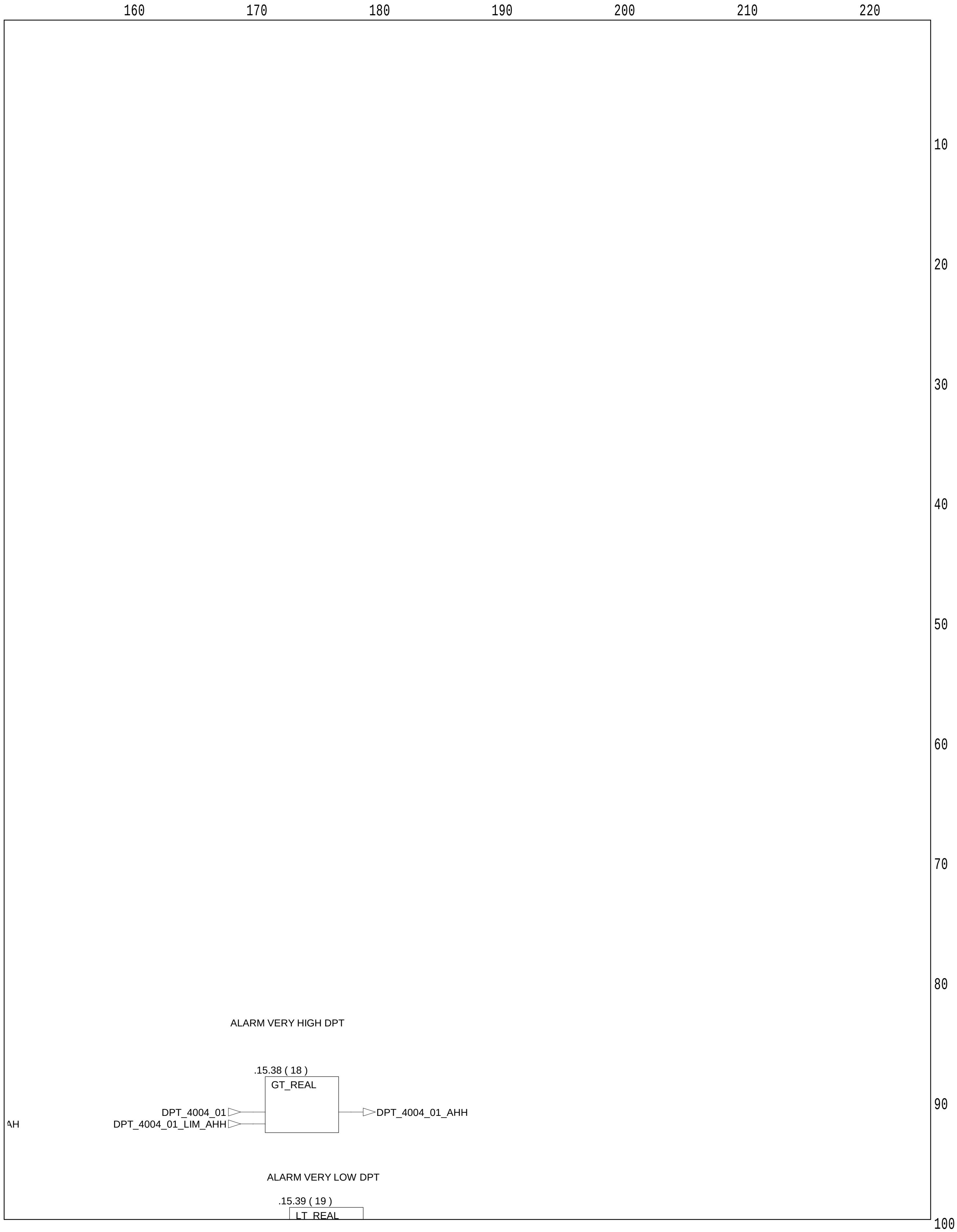
> page 113

Graph of section CL4004_Oulet_Gas_Flow



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Graph of section CL4004_Oulet_Gas_Flow

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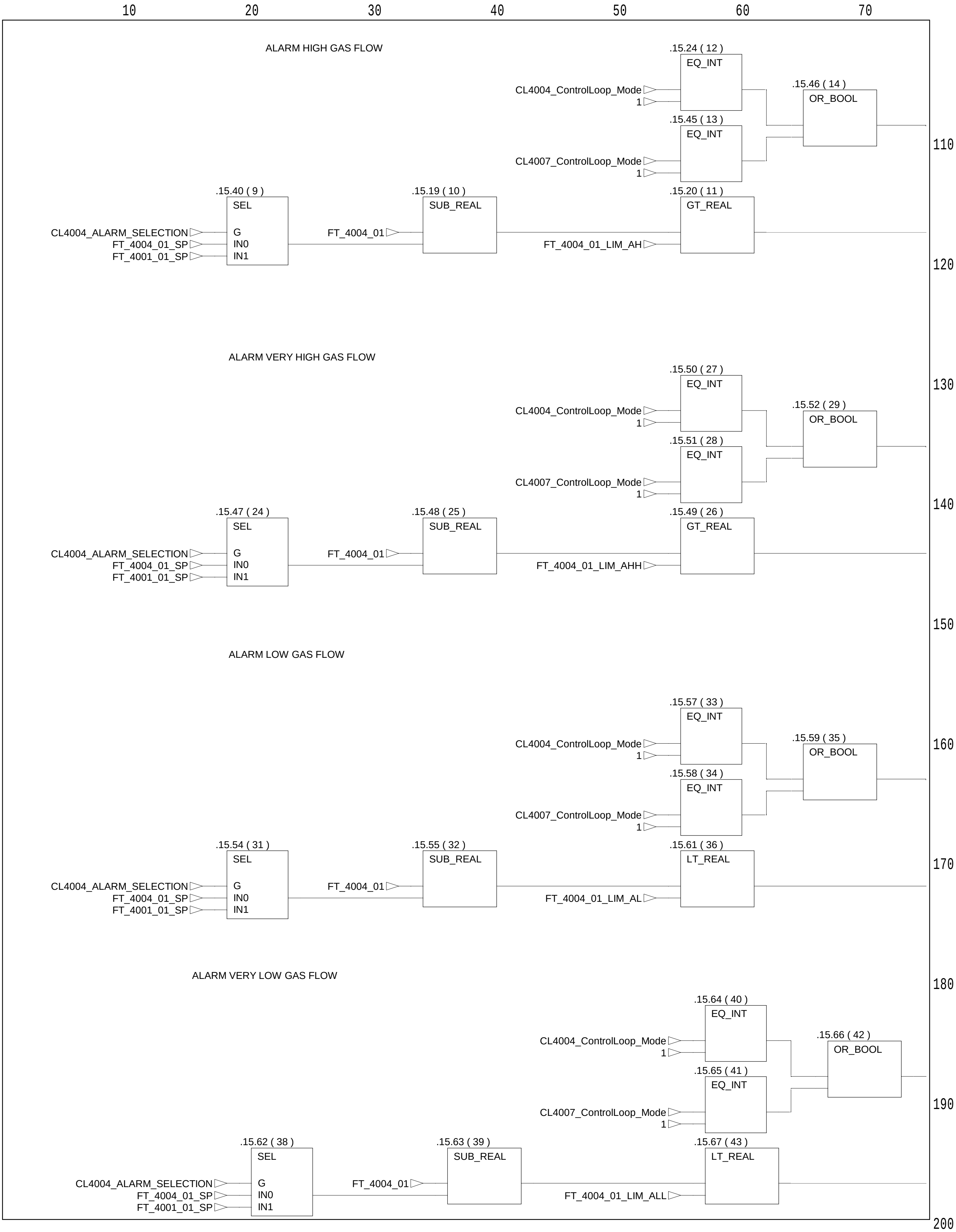

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Graph of section CL4004_Oulet_Gas_Flow

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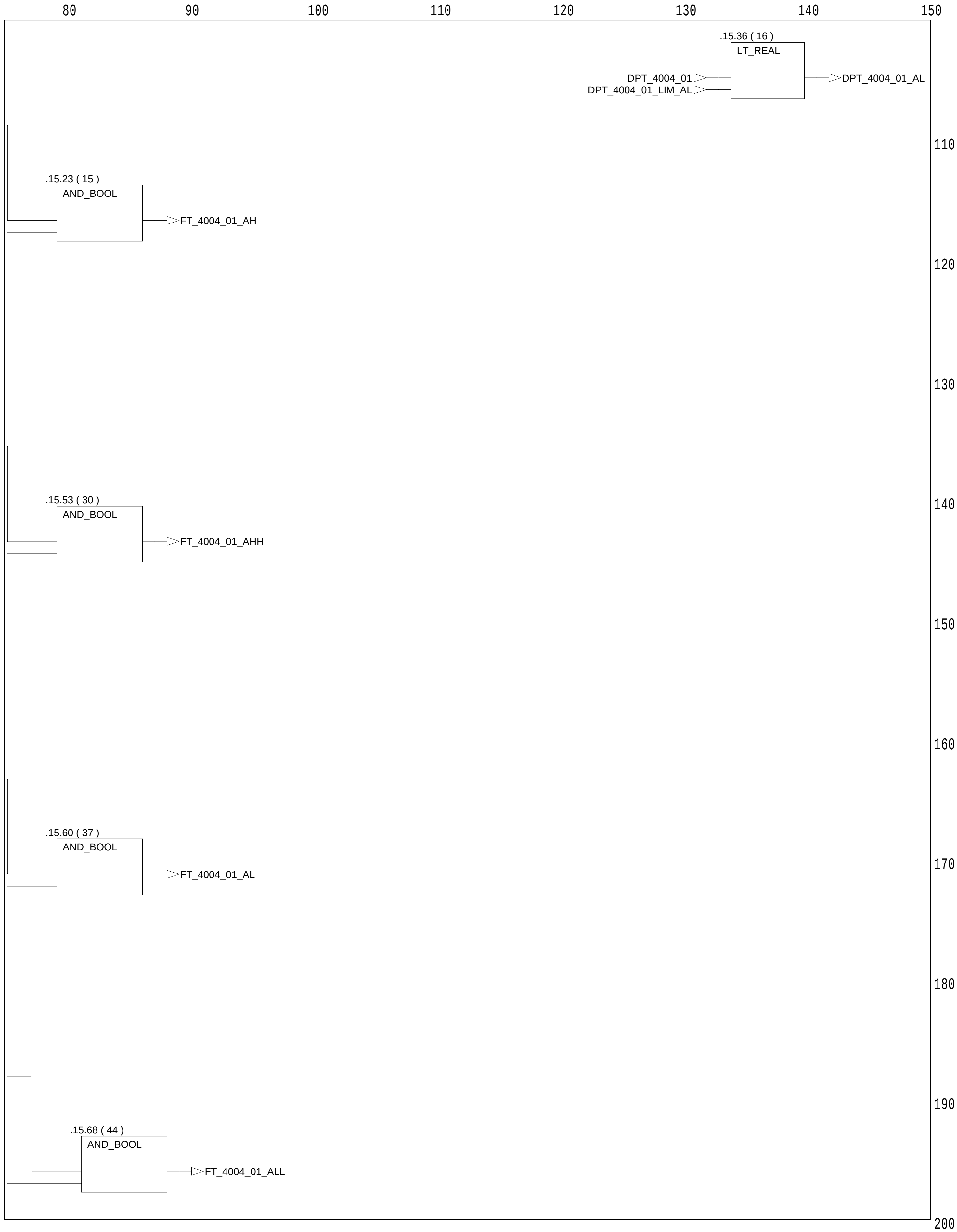

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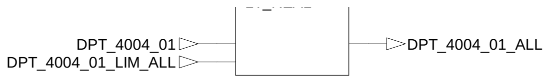
Graph of section CL4004_Oulet_Gas_Flow

< page 111

160 170 180 190 200 210 220



110 120 130 140 150 160 170 180 190 200

< page 113

> page 117

Graph of section CL4004_Oulet_Gas_Flow

< page 112

10 20 30 40 50 60 70

210

220

230

> p a g e 1 1 6

Graph of section CL4004_Oulet_Gas_Flow

< page 113

80 90 100 110 120 130 140 150

210
220
230

< page 115

> page 117

Graph of section CL4004_Oulet_Gas_Flow

< page 114

160 170 180 190 200 210 220

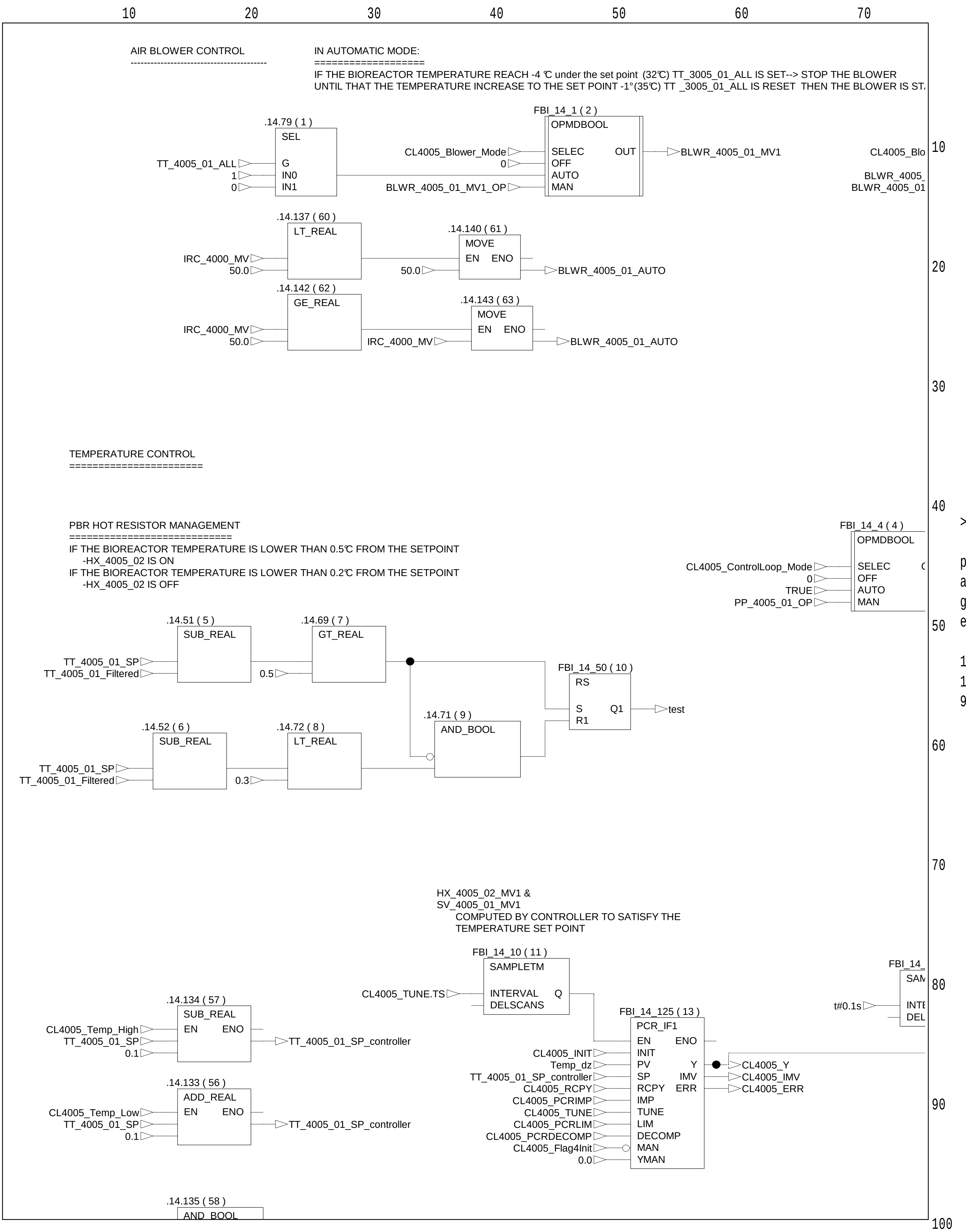
210

220

230

< page 116

Graph of section CL4005_PBR_Temp



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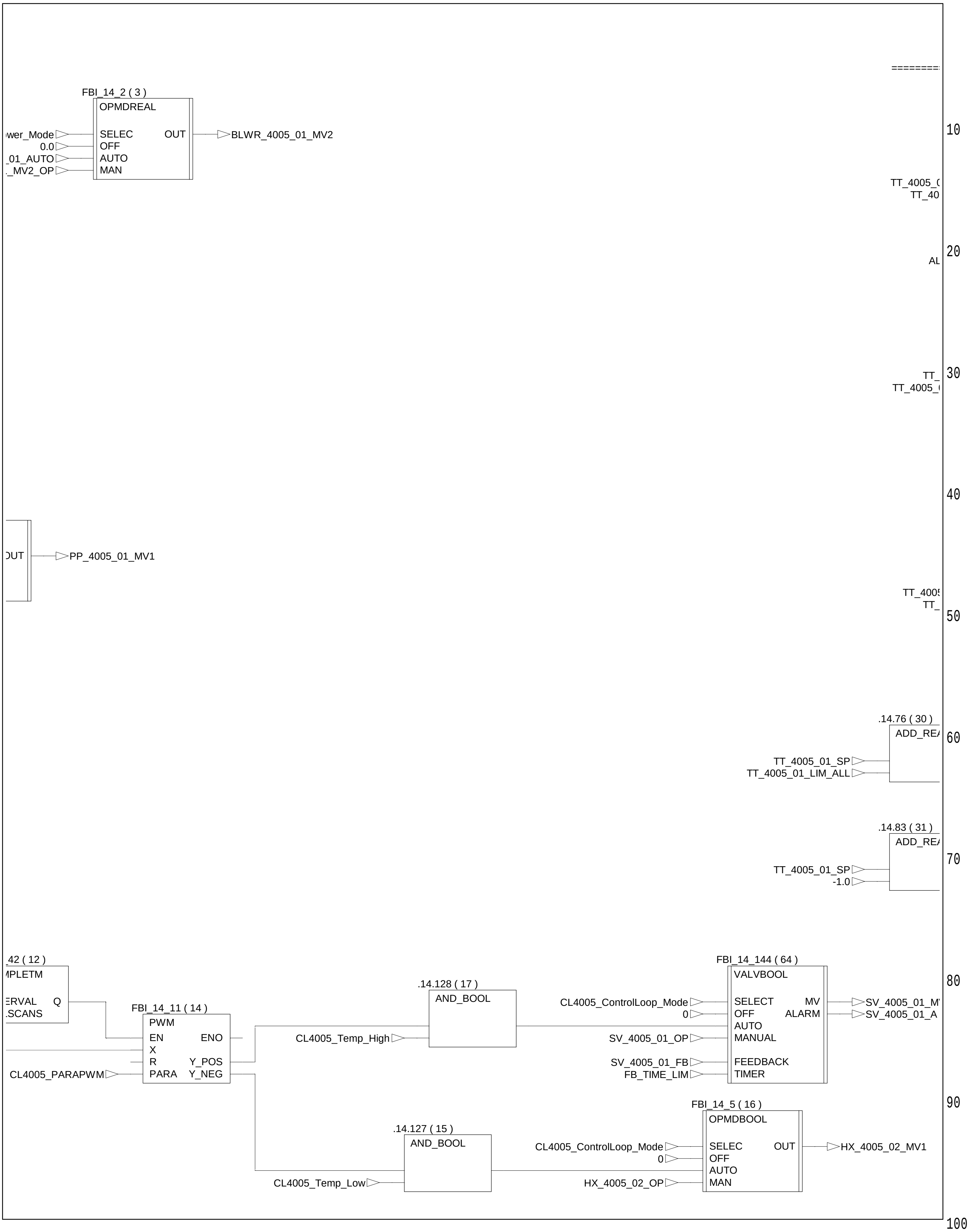
Graph of section CL4005_PBR_Temp



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Graph of section CL4005_PBR_Temp

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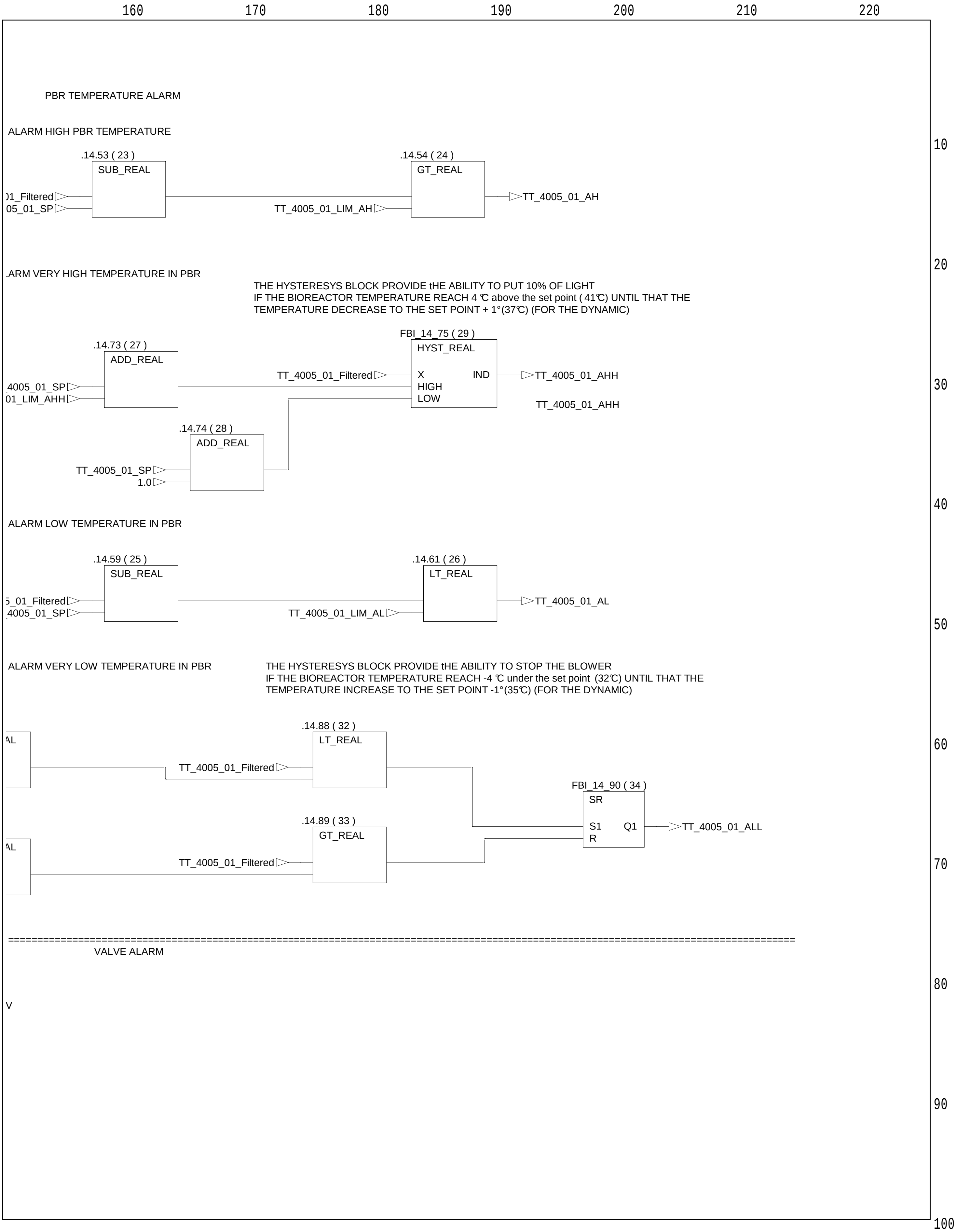

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Graph of section CL4005_PBR_Temp

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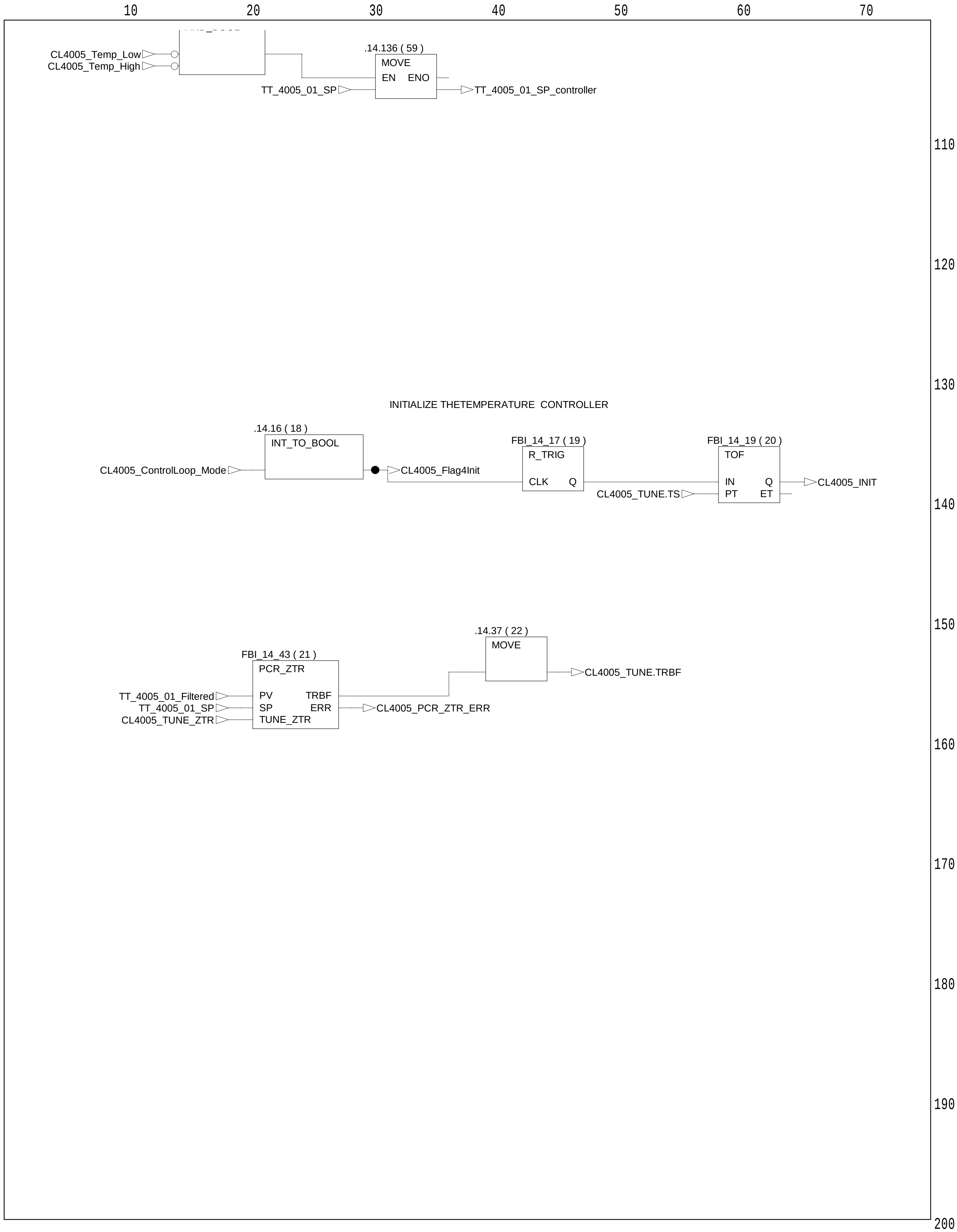

Graph of section CL4005_PBR_Temp

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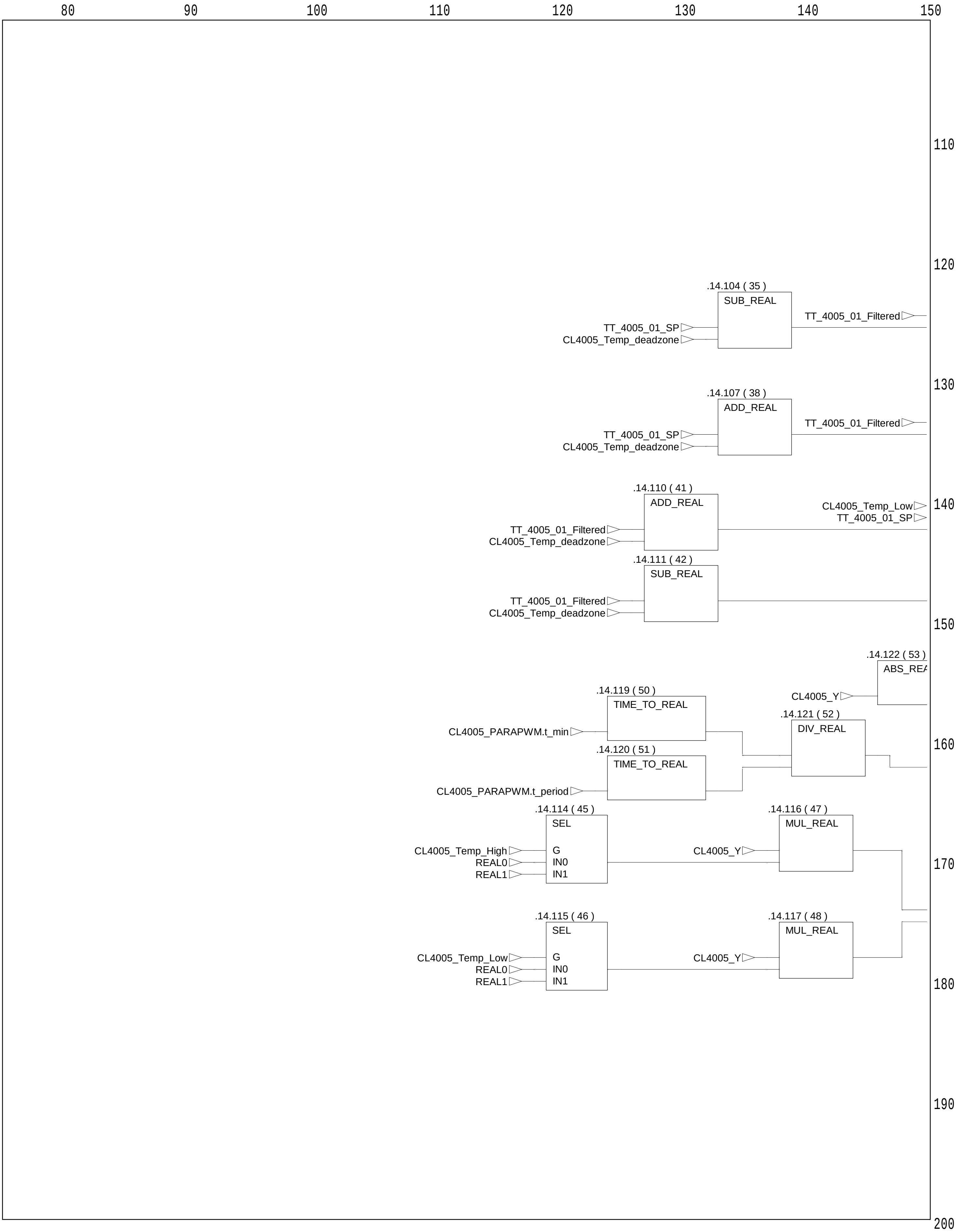

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Graph of section CL4005_PBR_Temp

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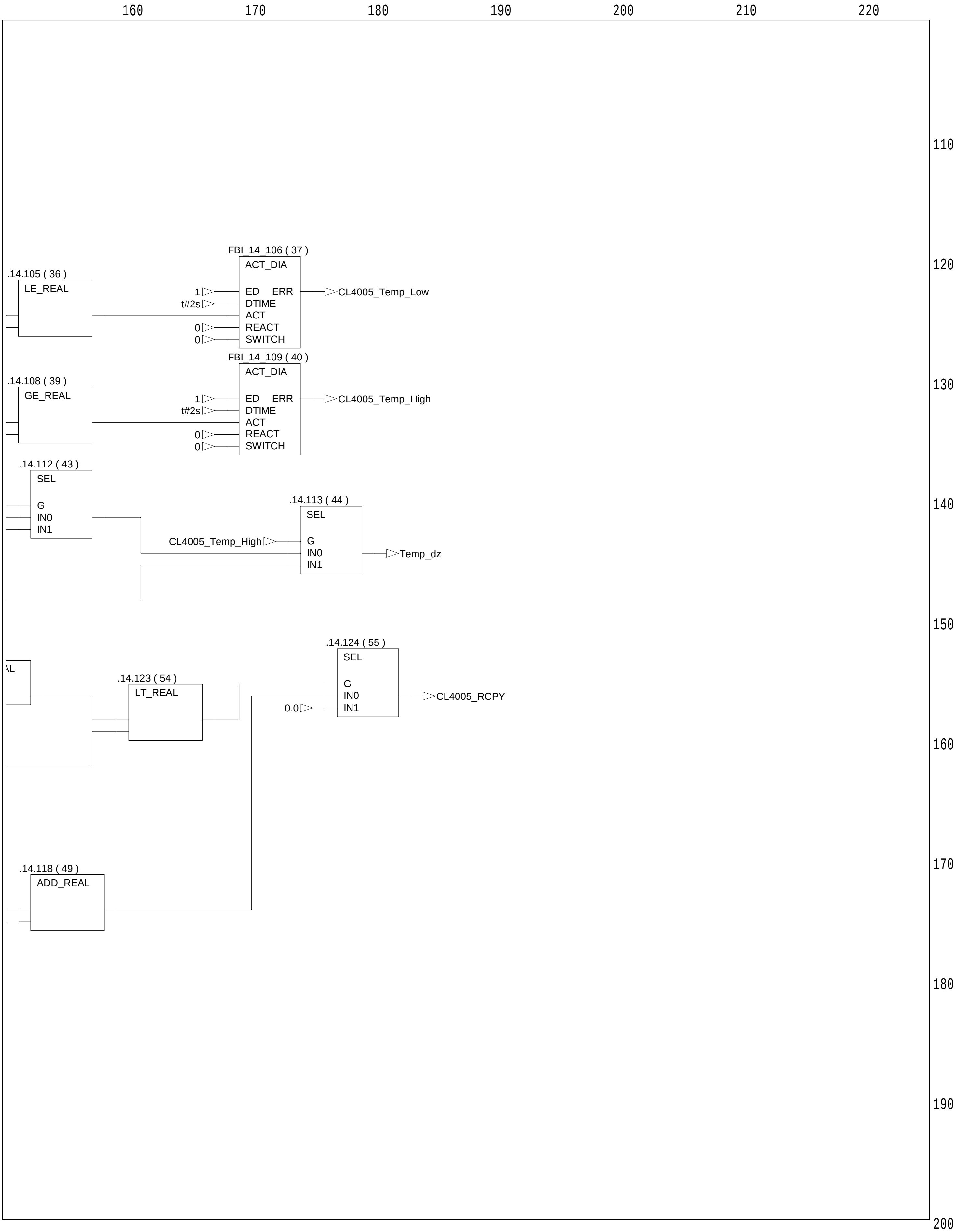

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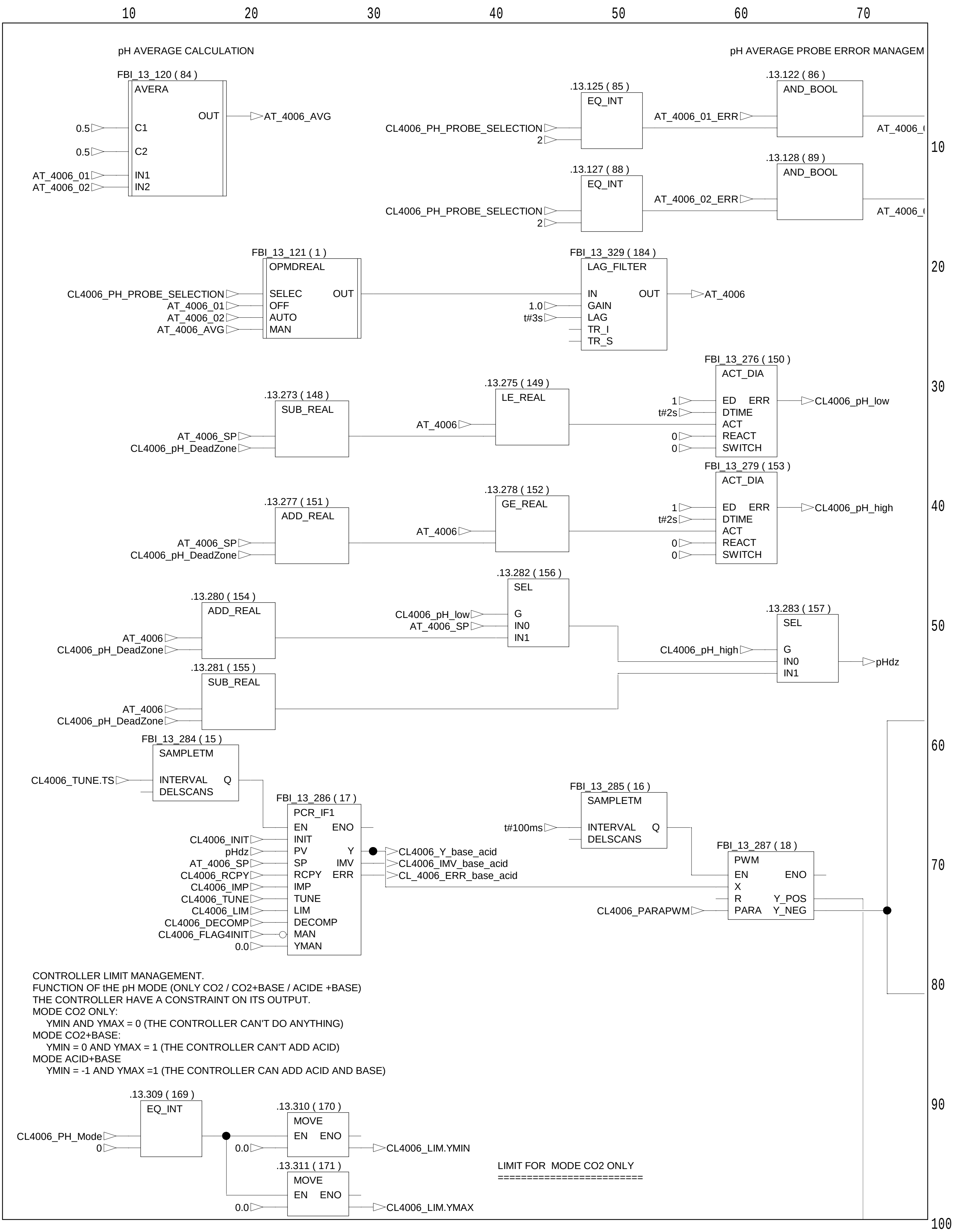
Graph of section CL4006_pH



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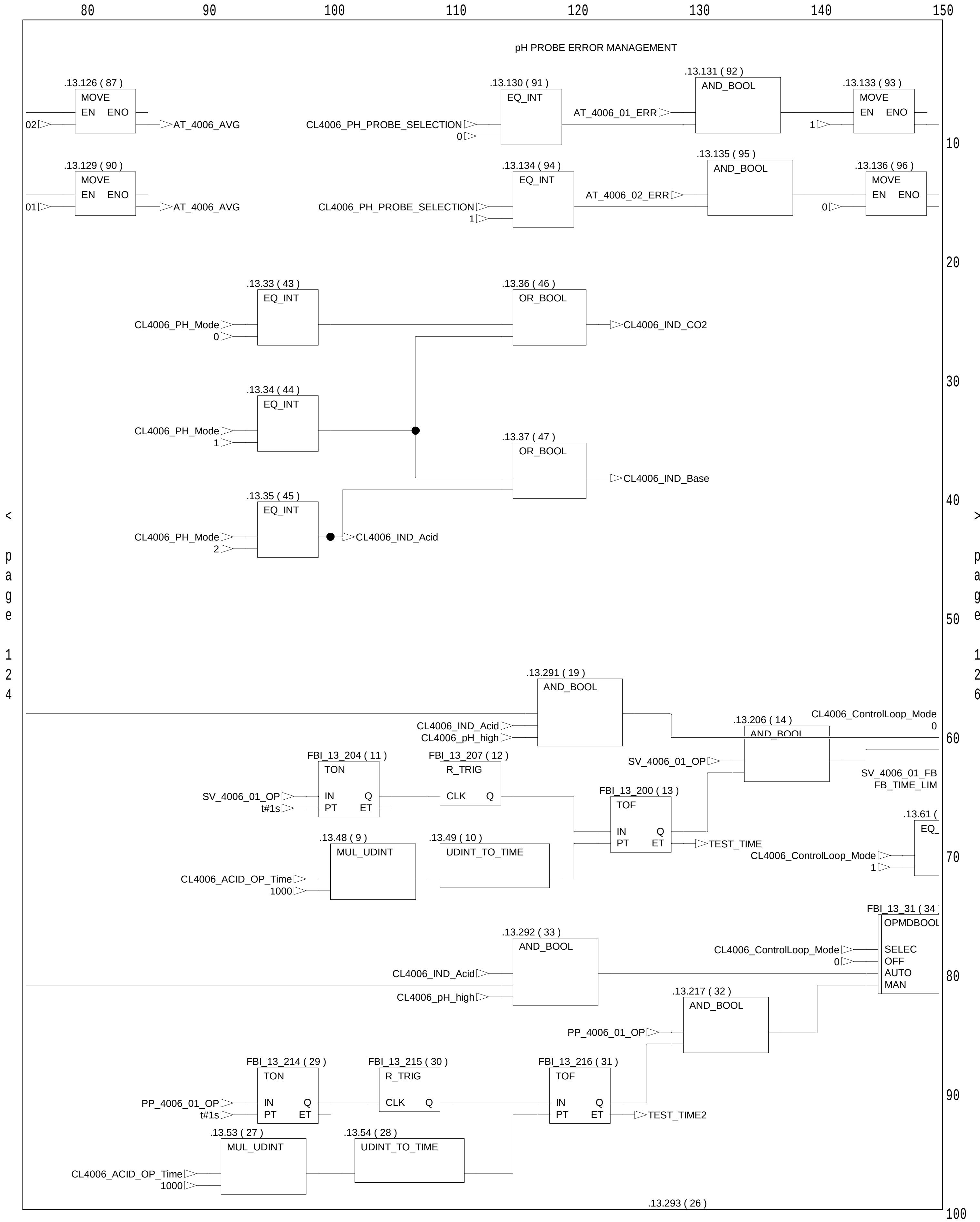
Graph of section CL4006_pH



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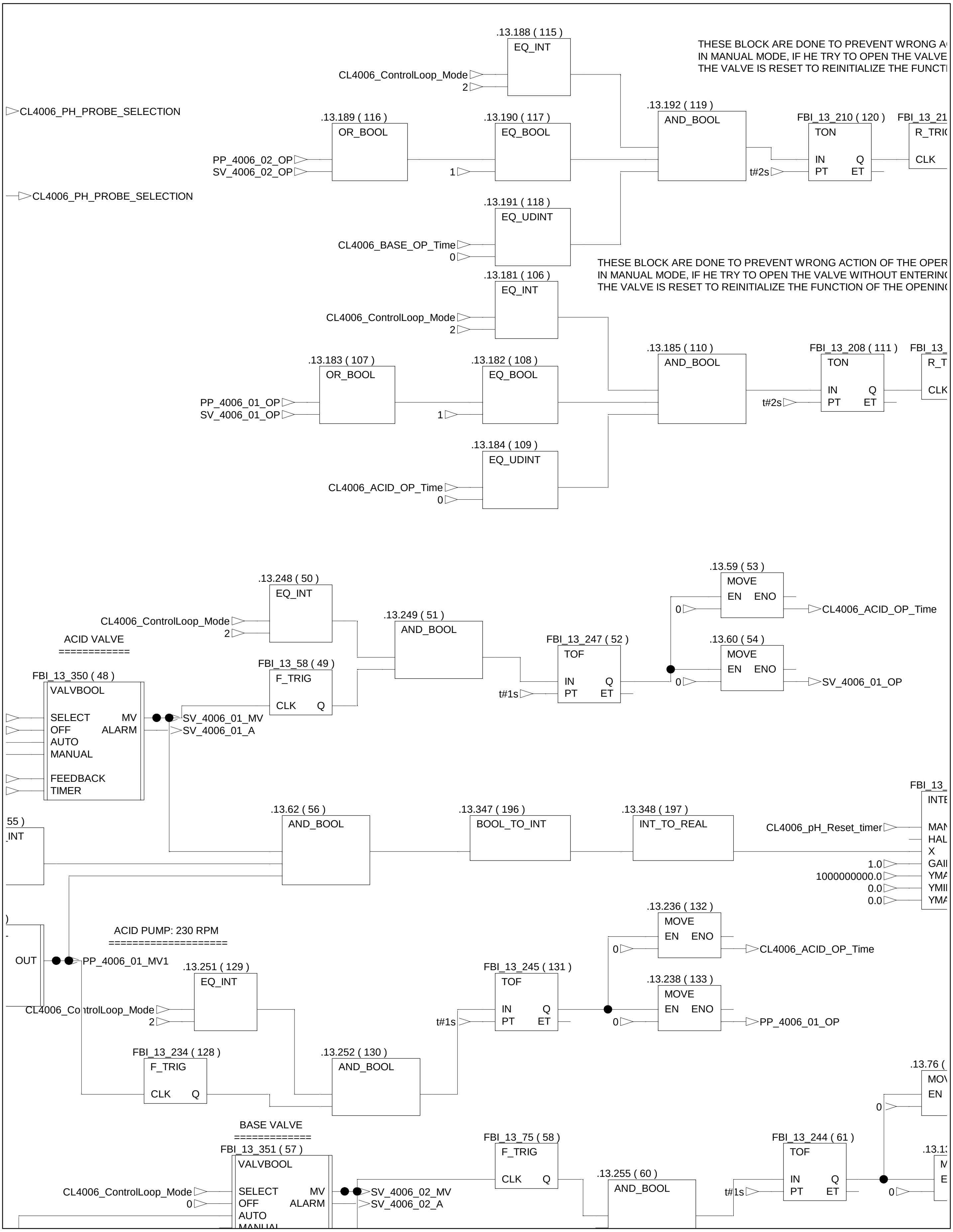
Graph of section CL4006_pH



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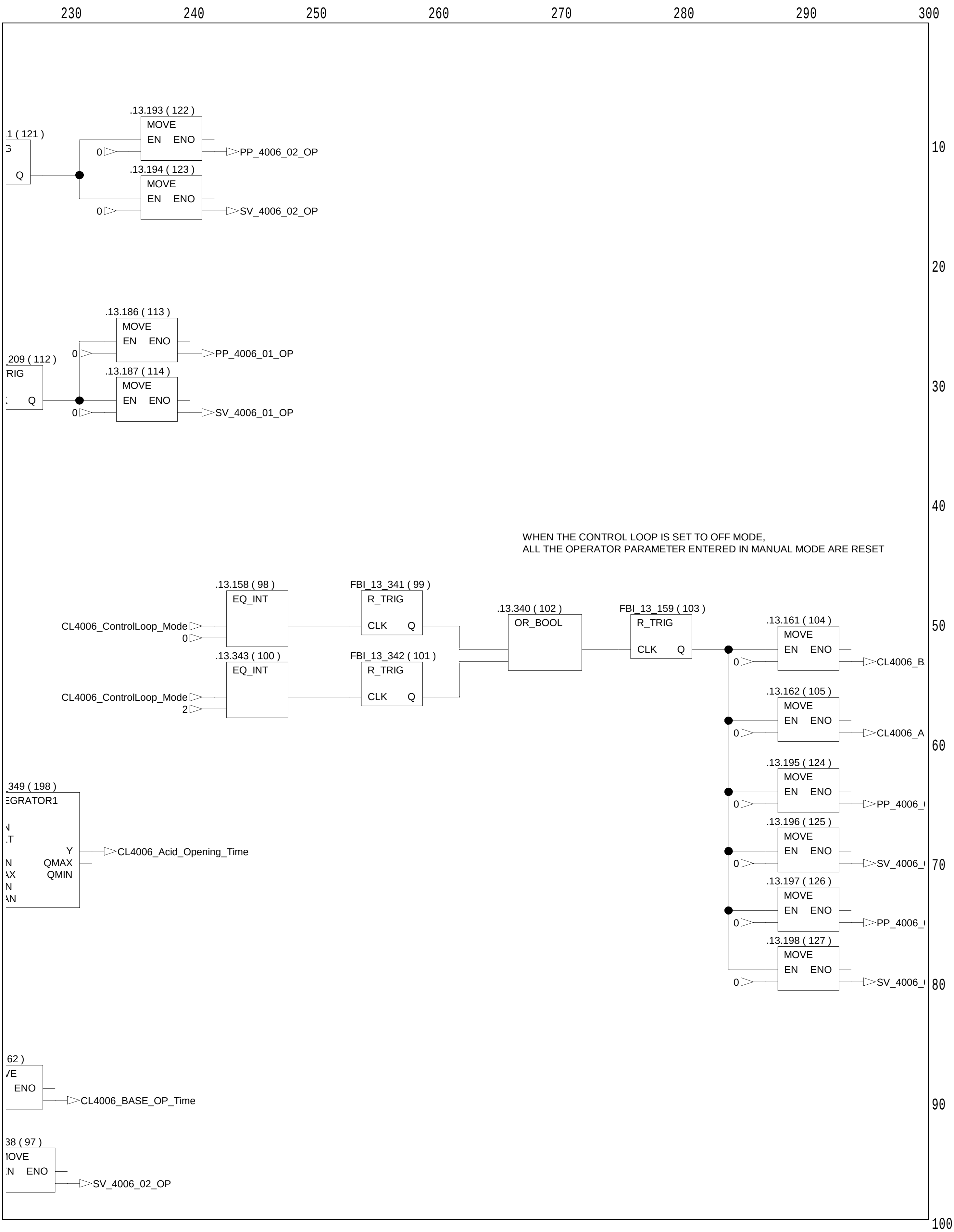
Graph of section CL4006_pH



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> page 132

Graph of section CL4006_pH

< page 127

ASE_OP_Time

CID_OP_Time

01_OP

01_OP

02_OP

02_OP

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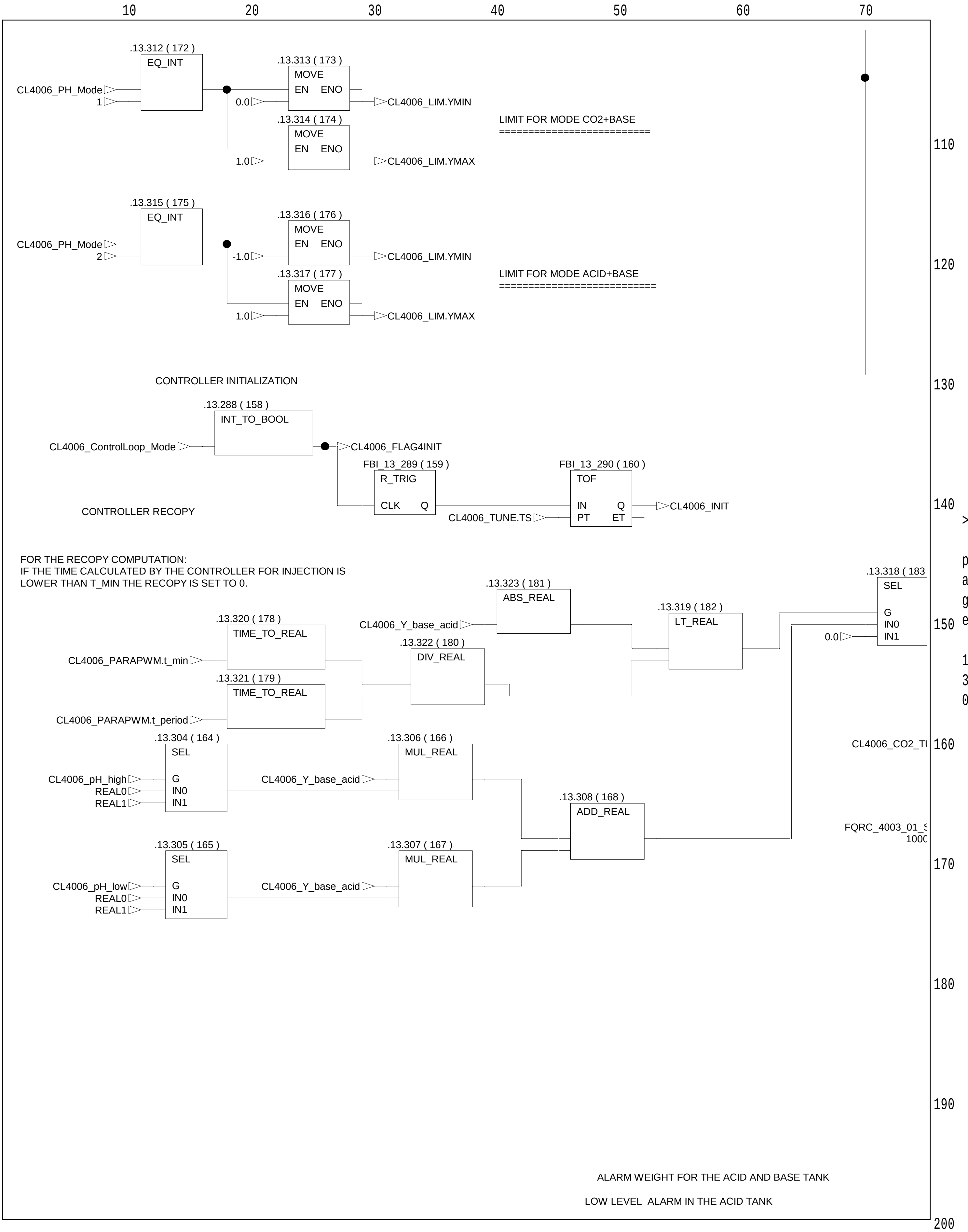
Graph of section CL4006_pH

< page 124



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Graph of section CL4006_pH

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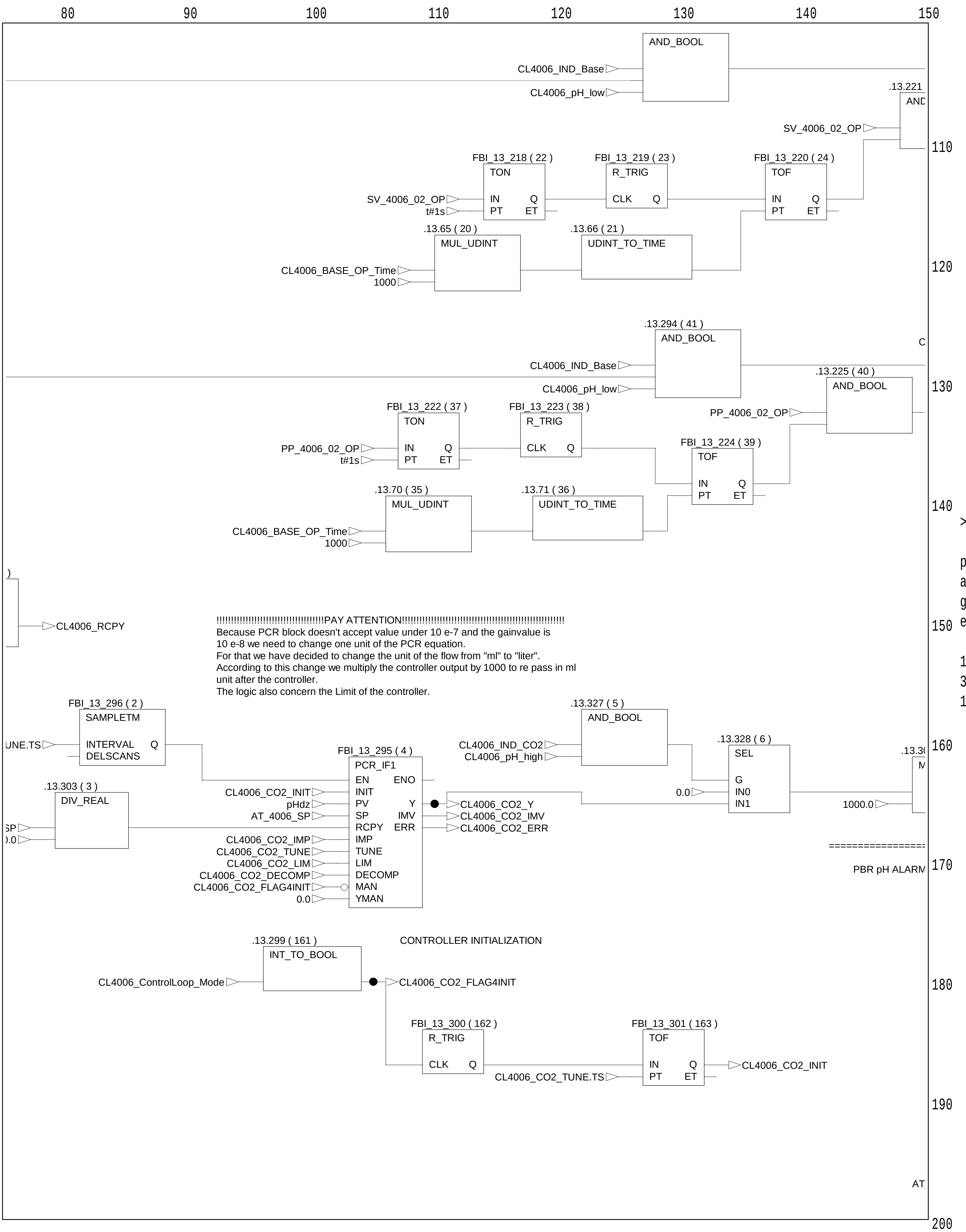

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Graph of section CL4006_pH

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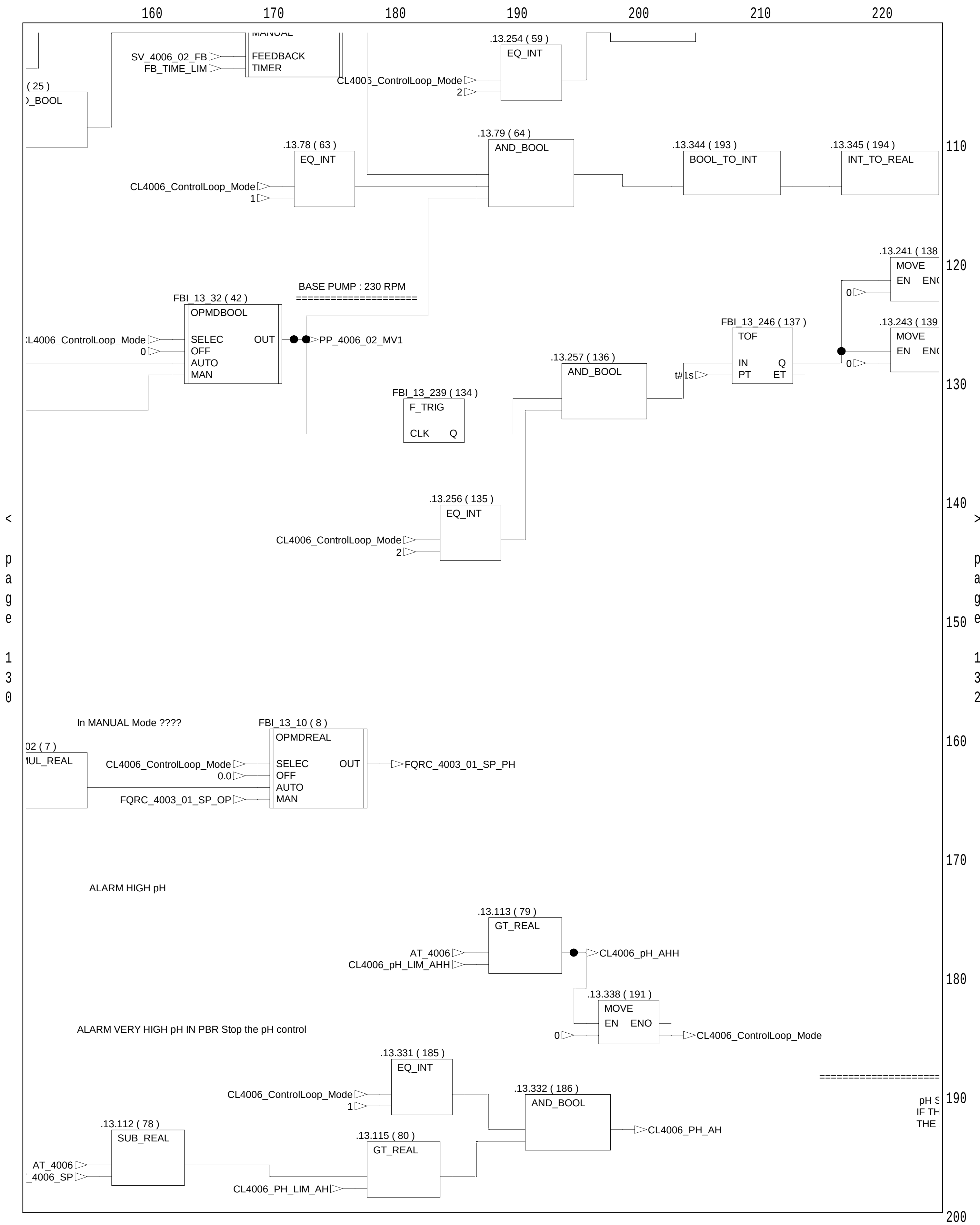

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Graph of section CL4006_pH

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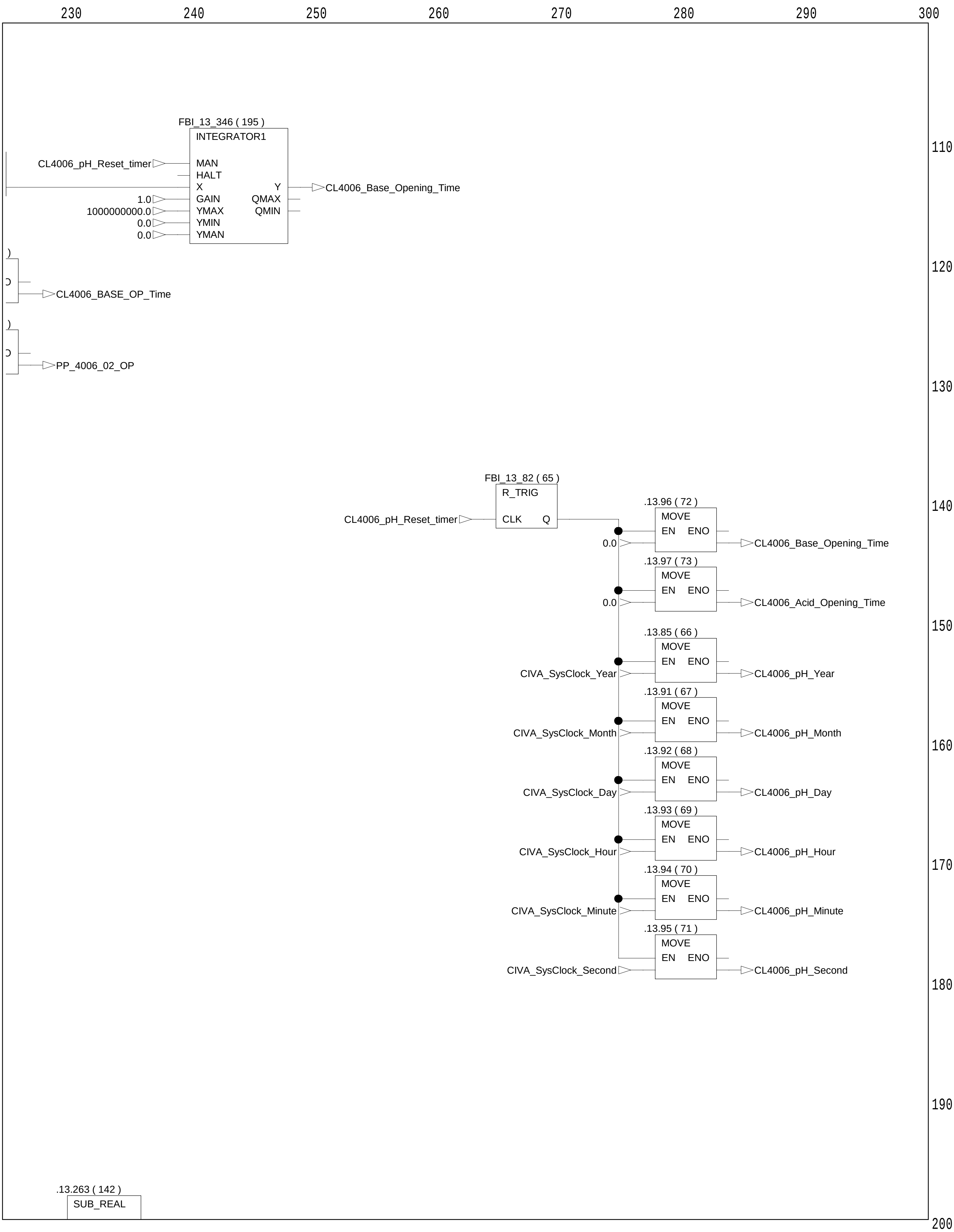

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Graph of section CL4006_pH

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120
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Graph of section CL4006_pH

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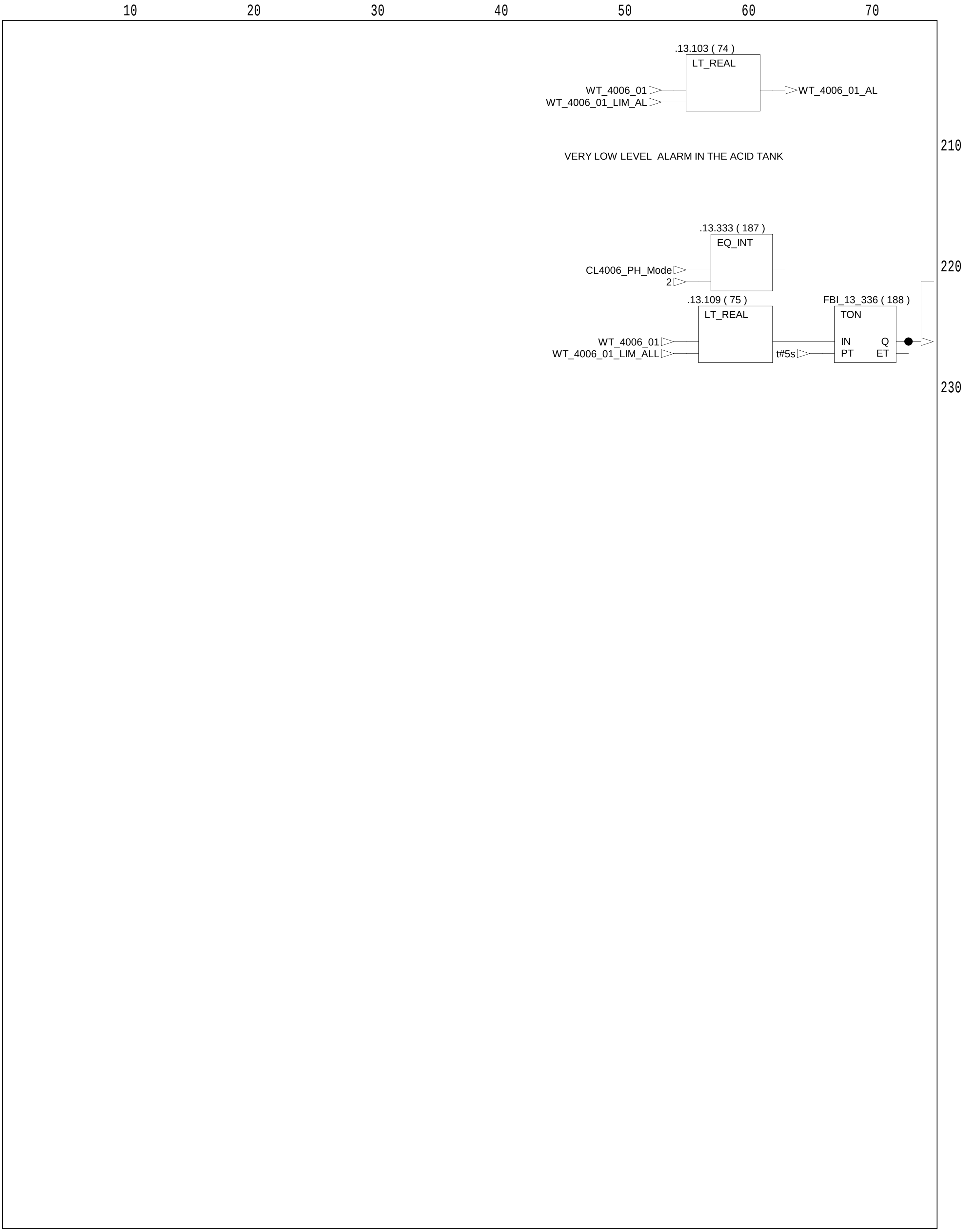

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Graph of section CL4006_pH

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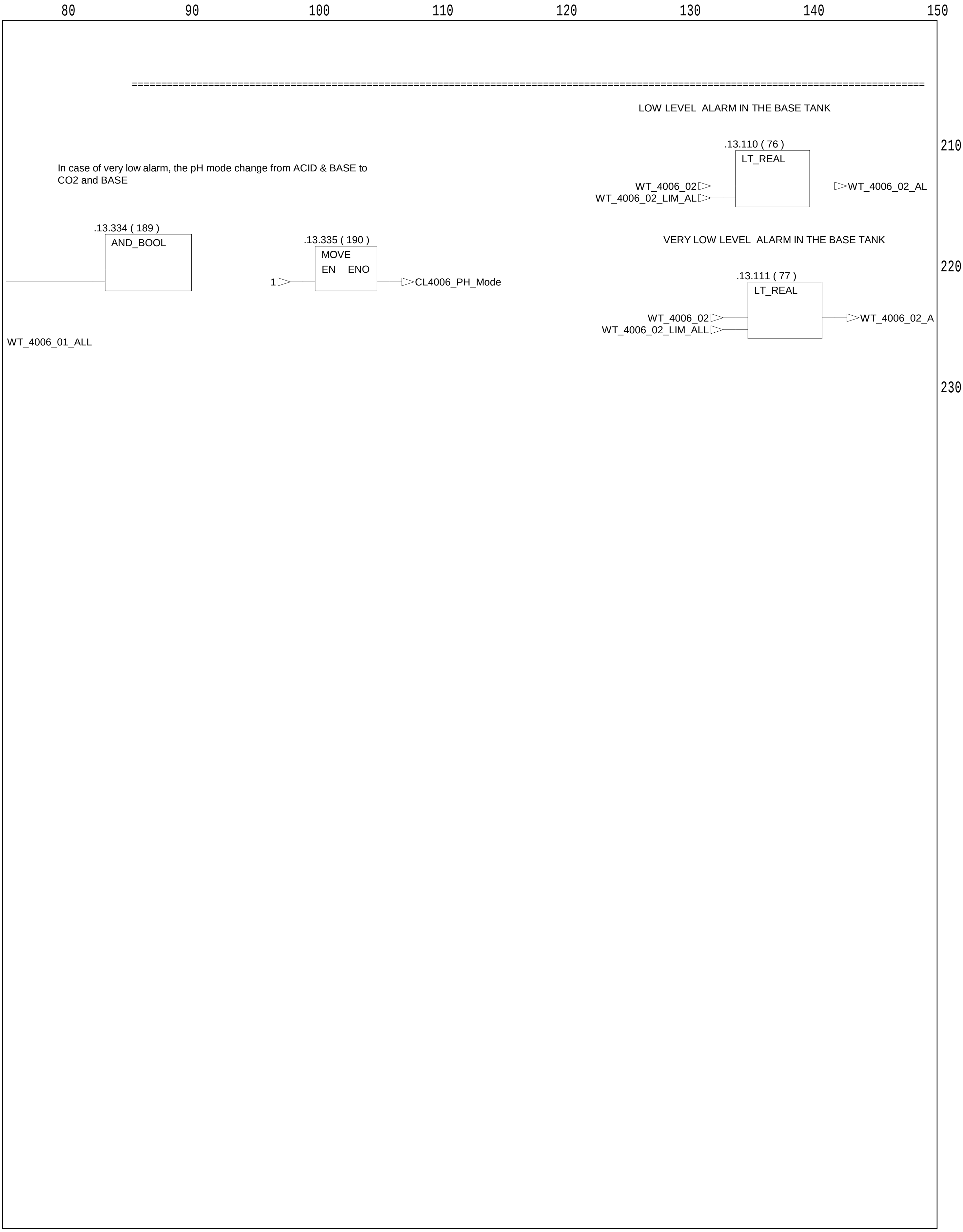

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Graph of section CL4006_pH

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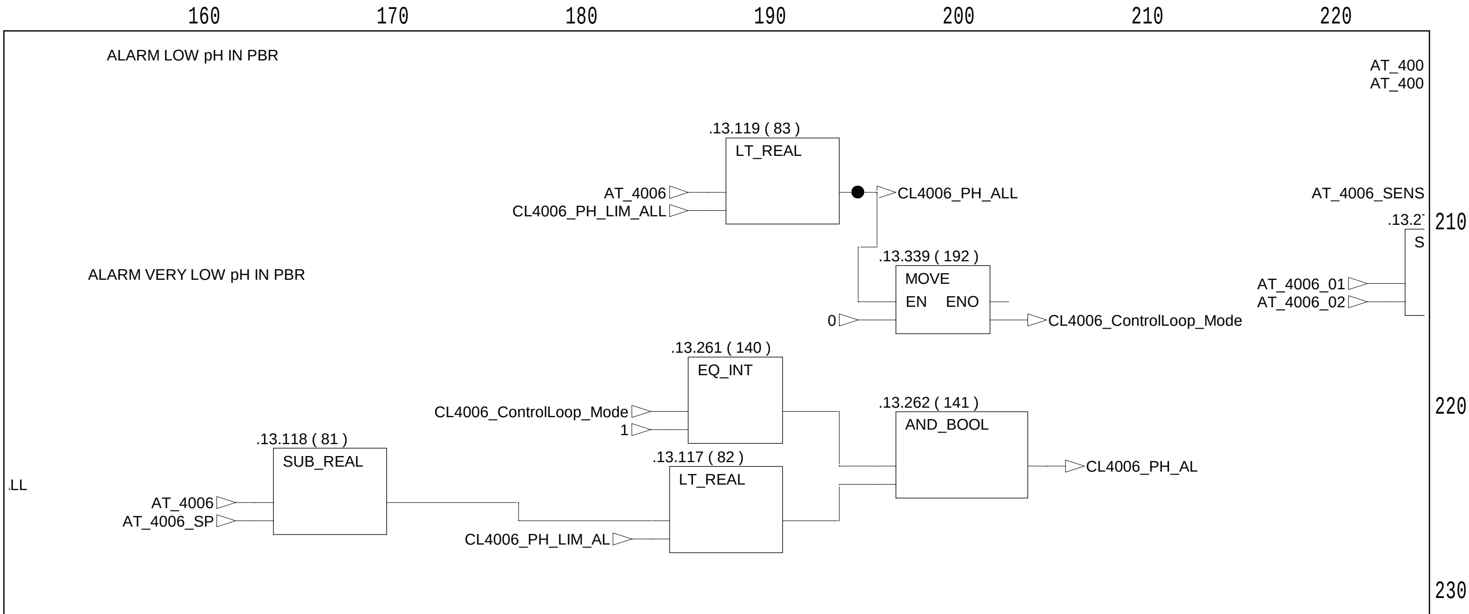

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Graph of section CL4006_pH

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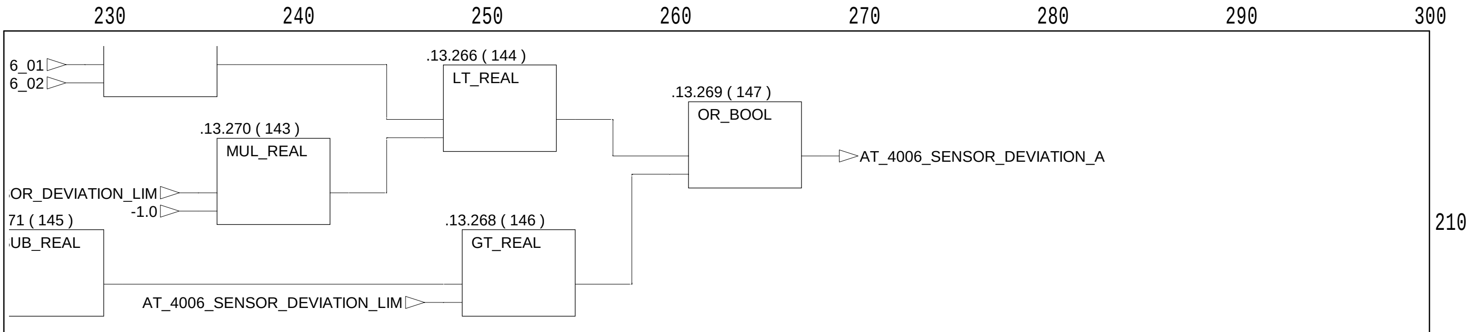

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Graph of section CL4006_pH

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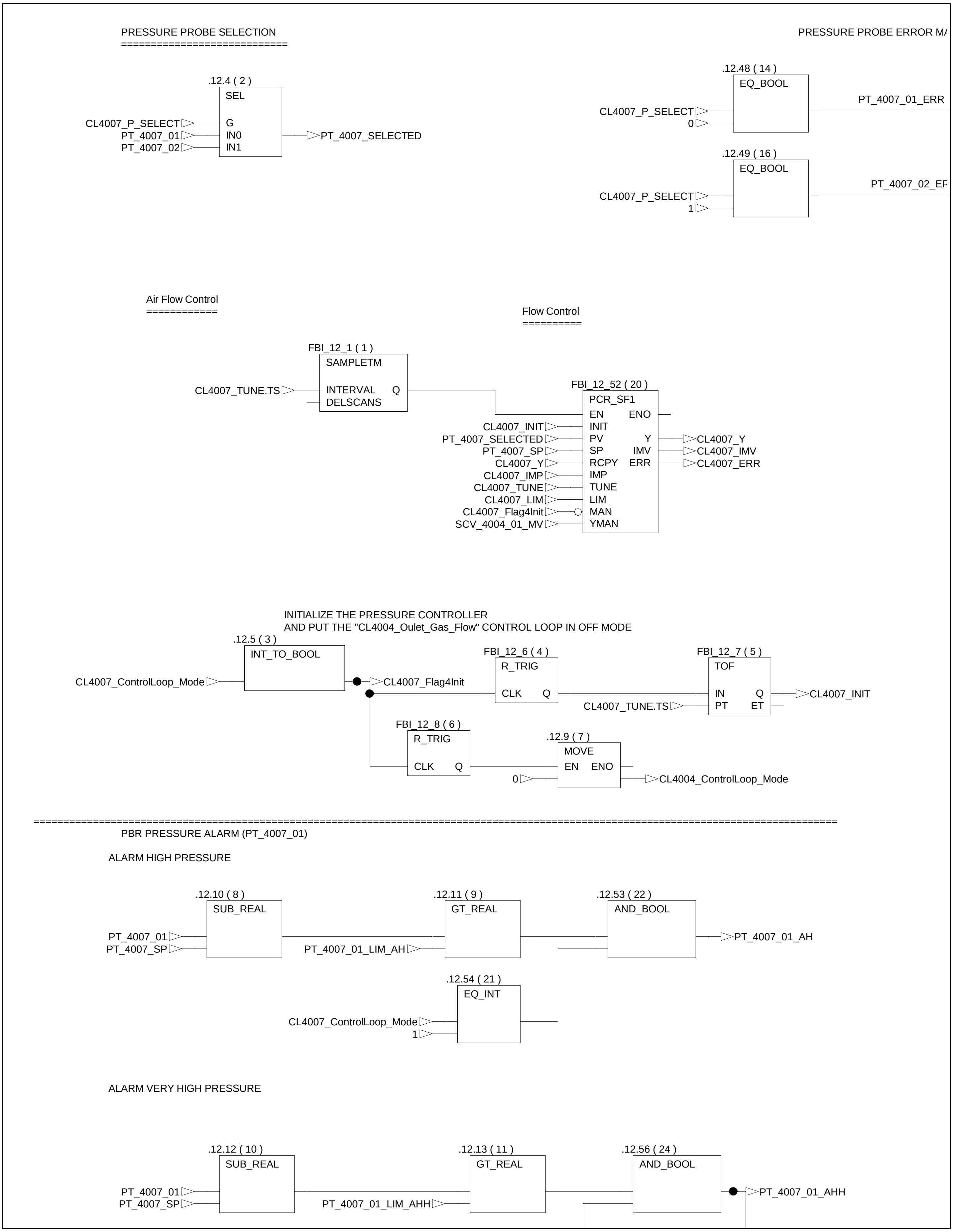
210

220

230

< page 137

Graph of section CL4007_PBR_Pressure



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Graph of section CL4007_PBR_Pressure

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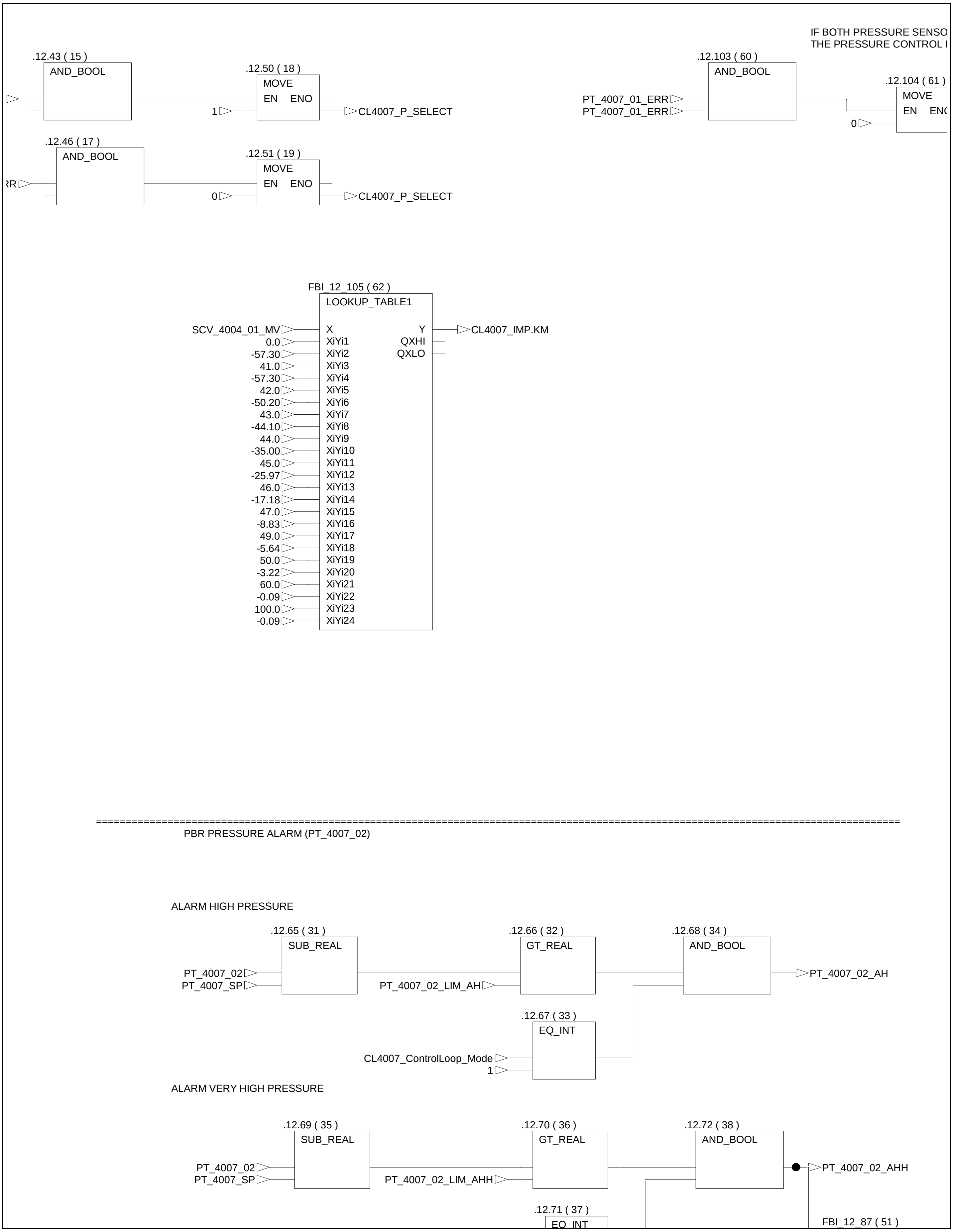

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Graph of section CL4007_PBR_Pressure

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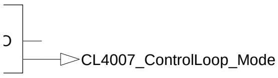

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Graph of section CL4007_PBR_Pressure

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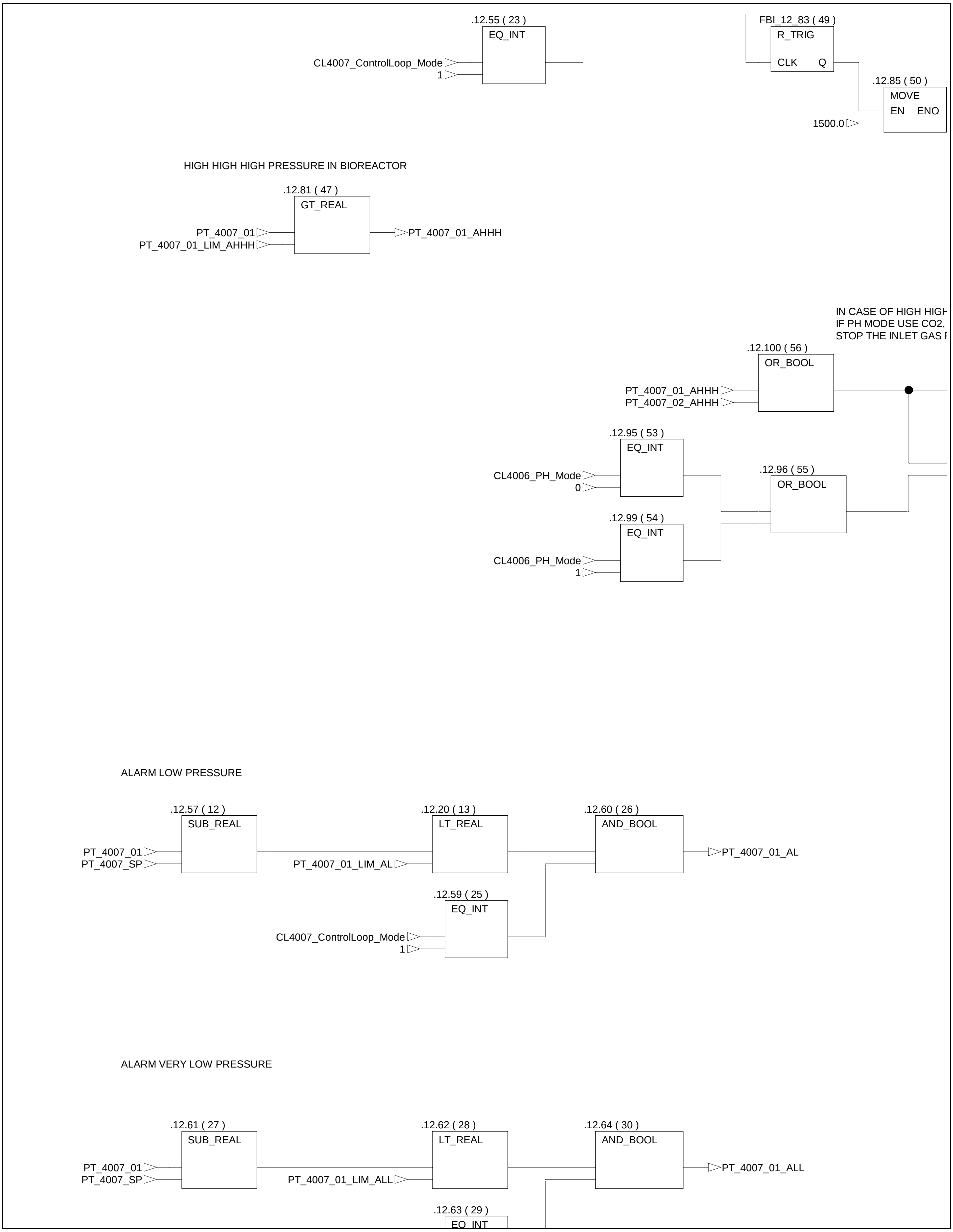

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Graph of section CL4007_PBR_Pressure

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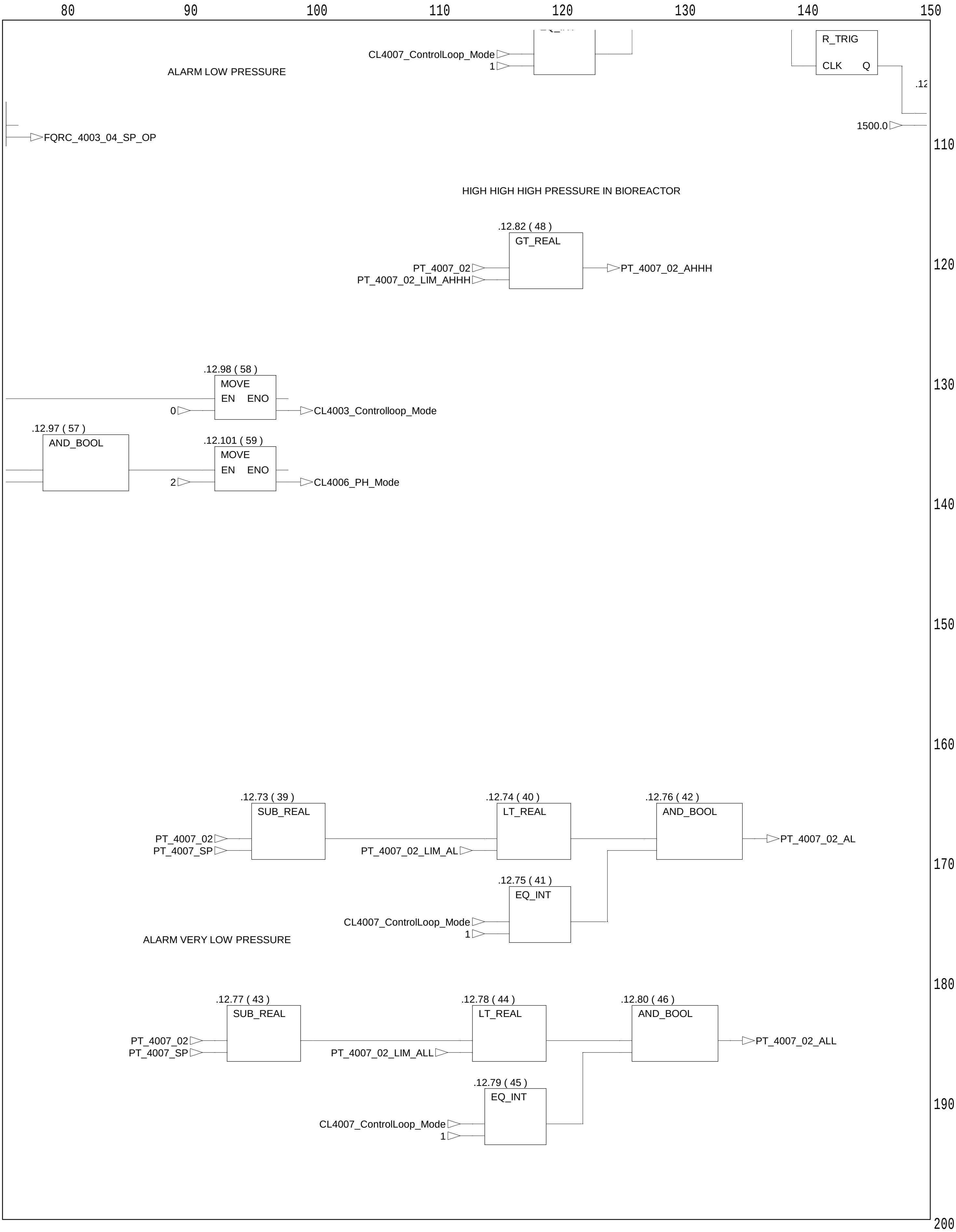

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Graph of section CL4007_PBR_Pressure

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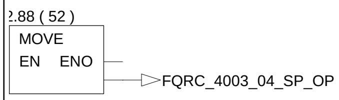

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Graph of section CL4007_PBR_Pressure

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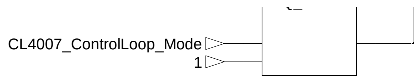

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Graph of section CL4007_PBR_Pressure

< page 143

80 90 100 110 120 130 140 150

210

220

230

< page 145

> page 147

Graph of section CL4007_PBR_Pressure

< page 144

160 170 180 190 200 210 220

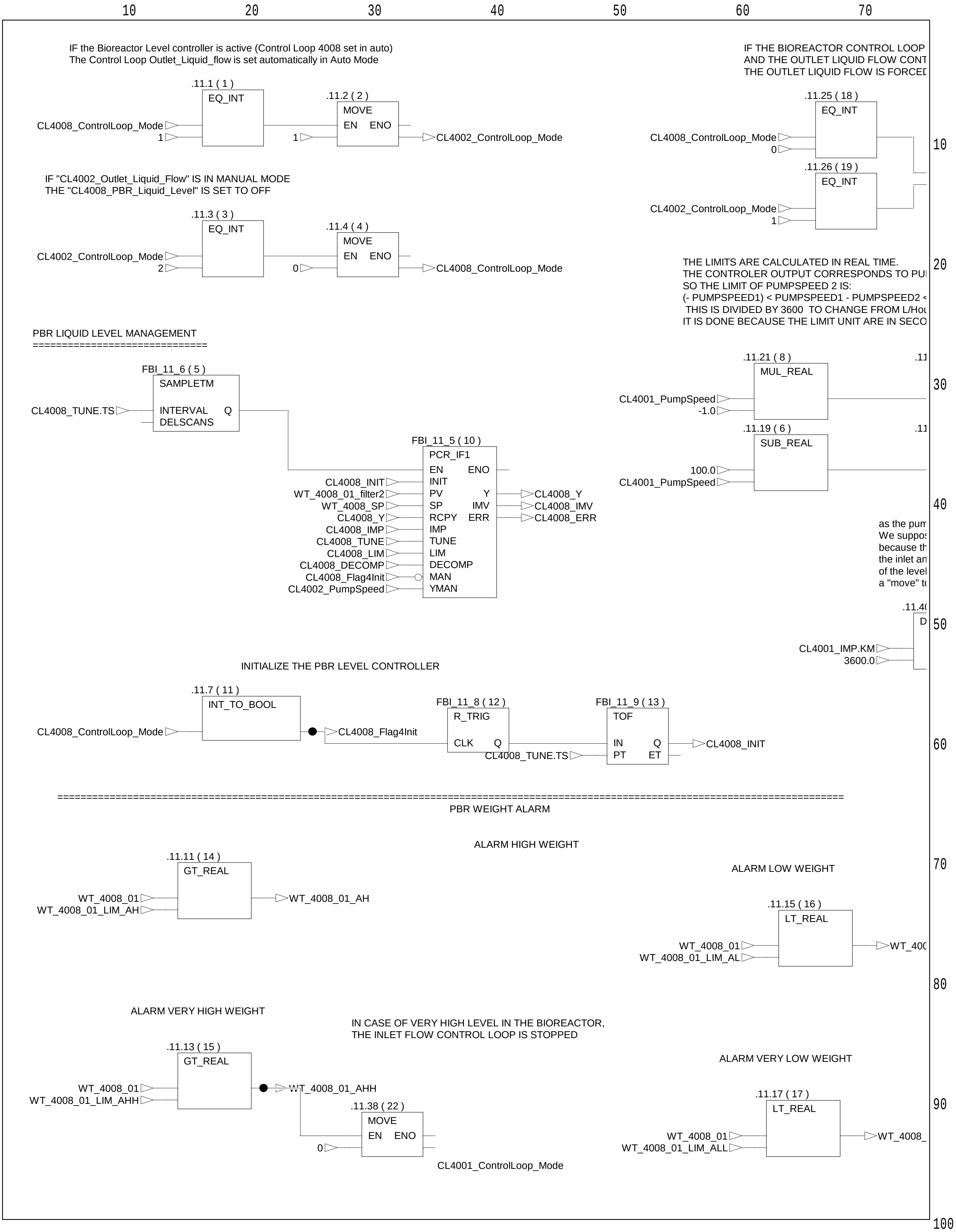
210

220

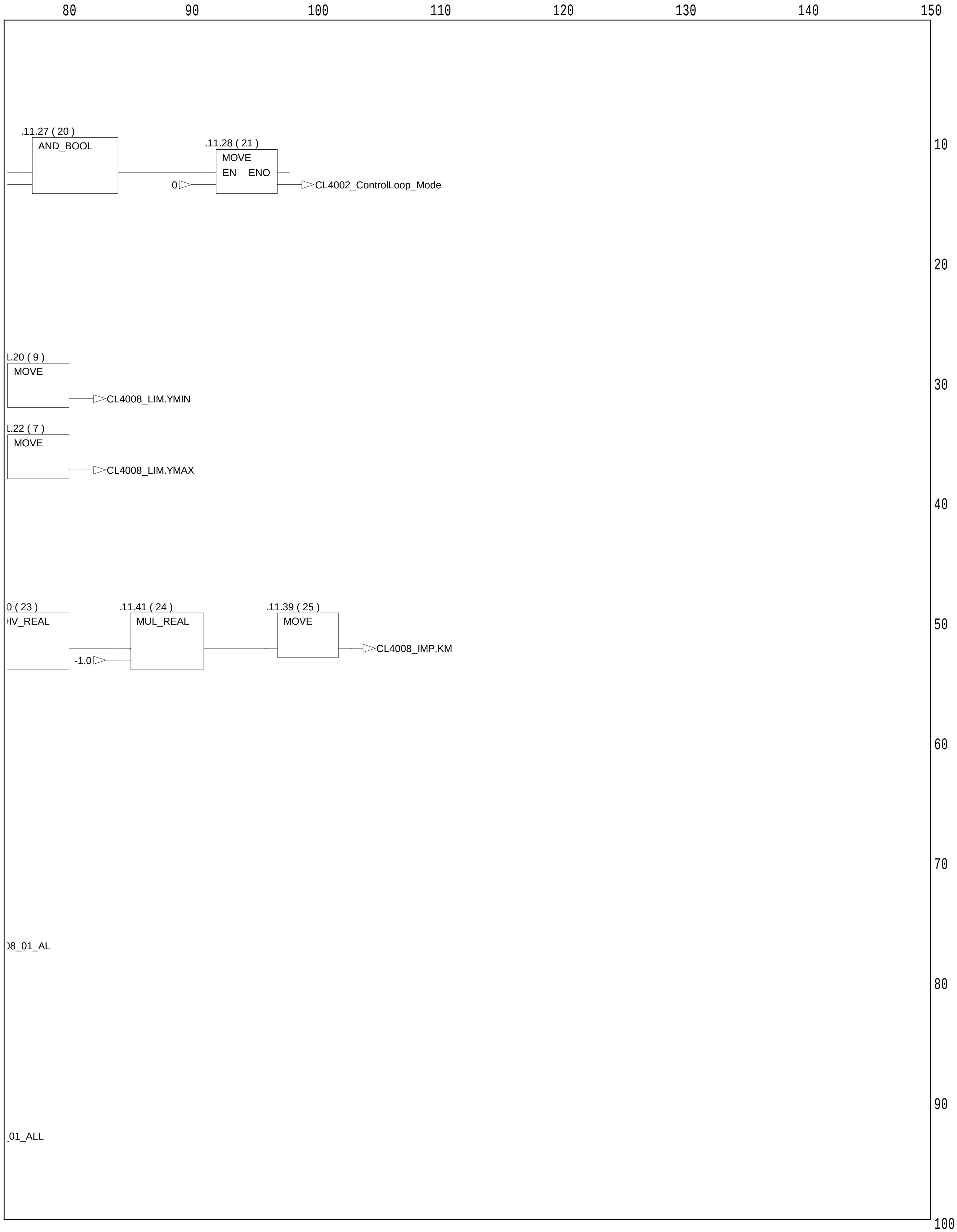
230

< page 146

Graph of section CL4008_PBR_Liquid_Level



Graph of section CL4008_PBR_Liquid_Level



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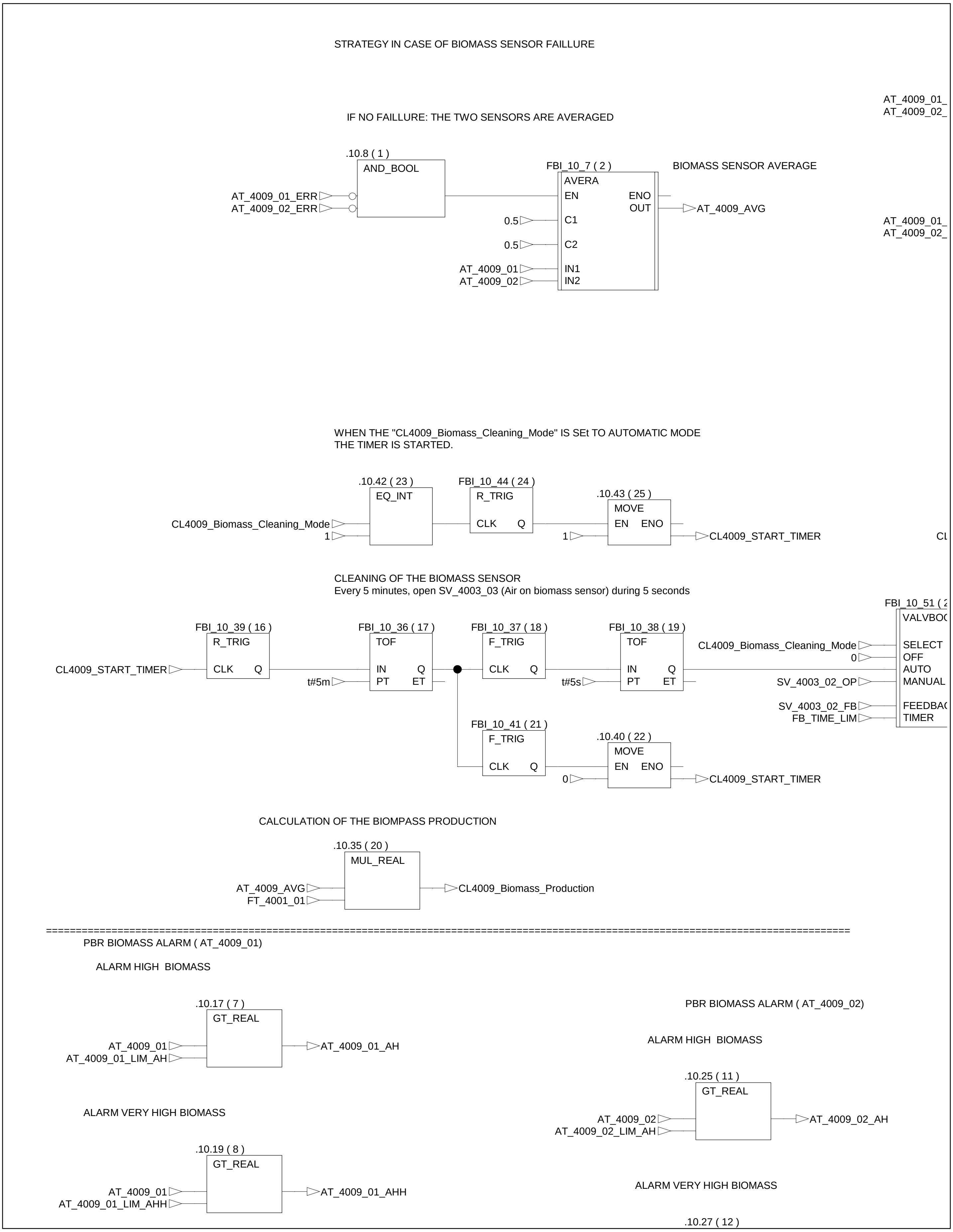
Graph of section CL4009_Biomass



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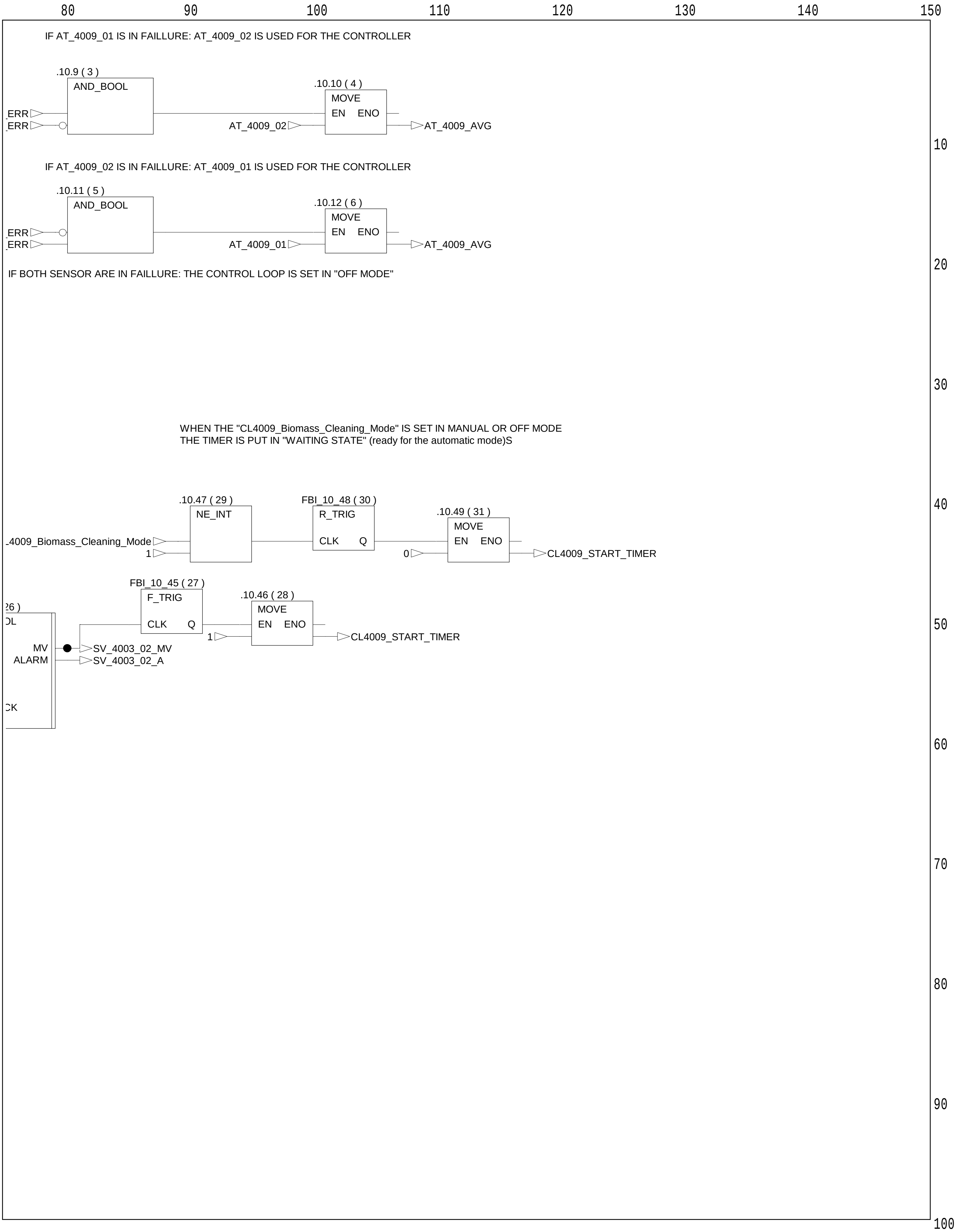
Graph of section CL4009_Biomass

< page 150



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Graph of section CL4009_Biomass

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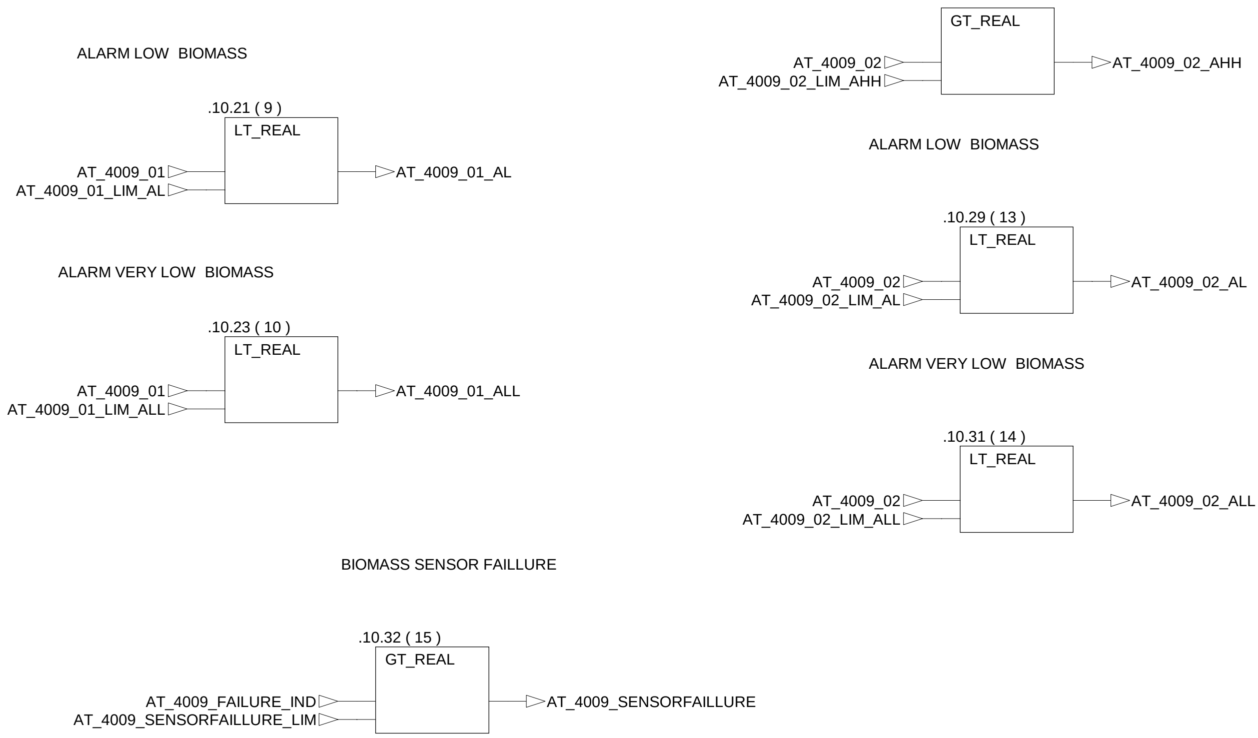

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Graph of section CL4009_Biomass

< page 151

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110
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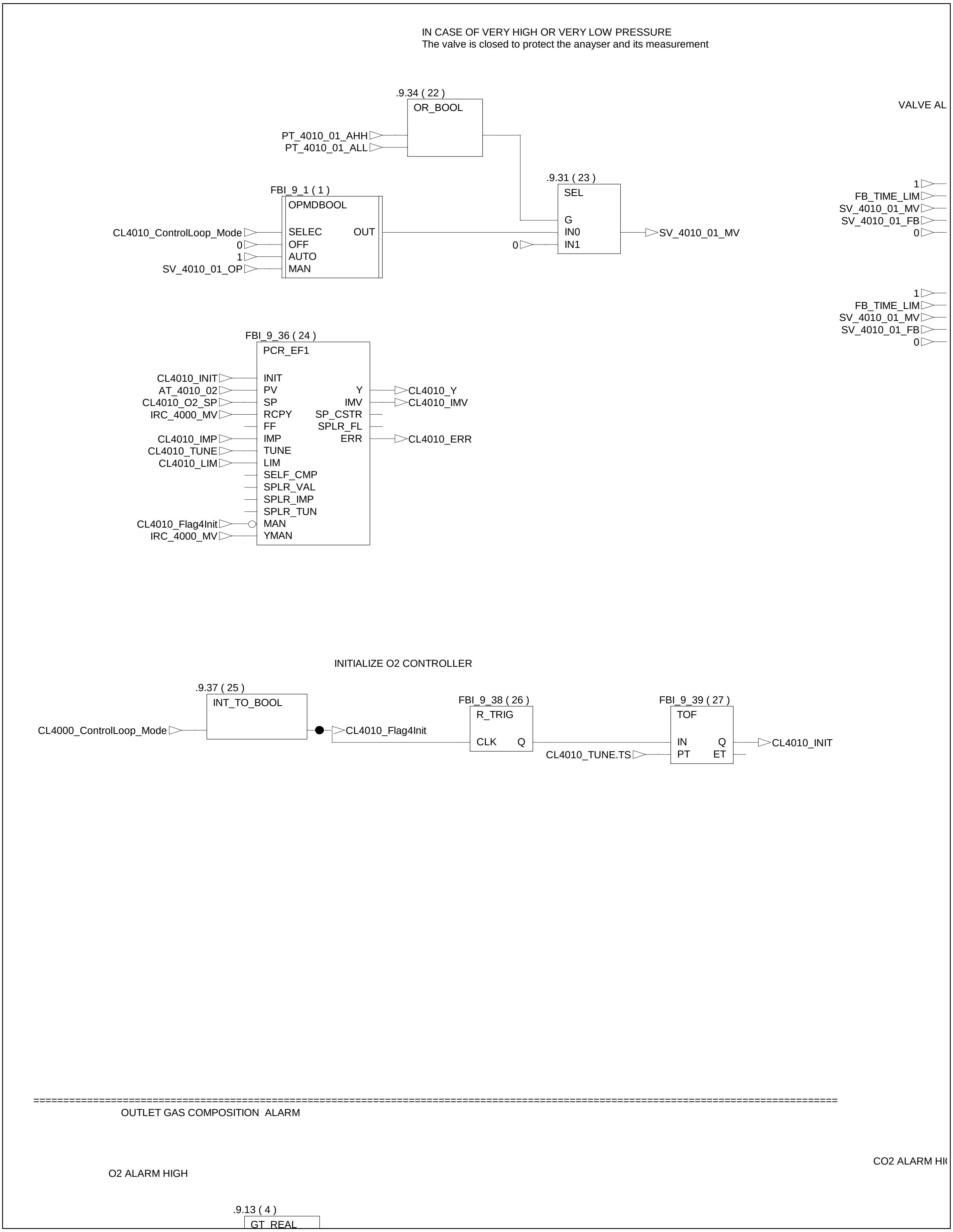
190
200

< page 152

Graph of section CL4010_OutletGasCompo



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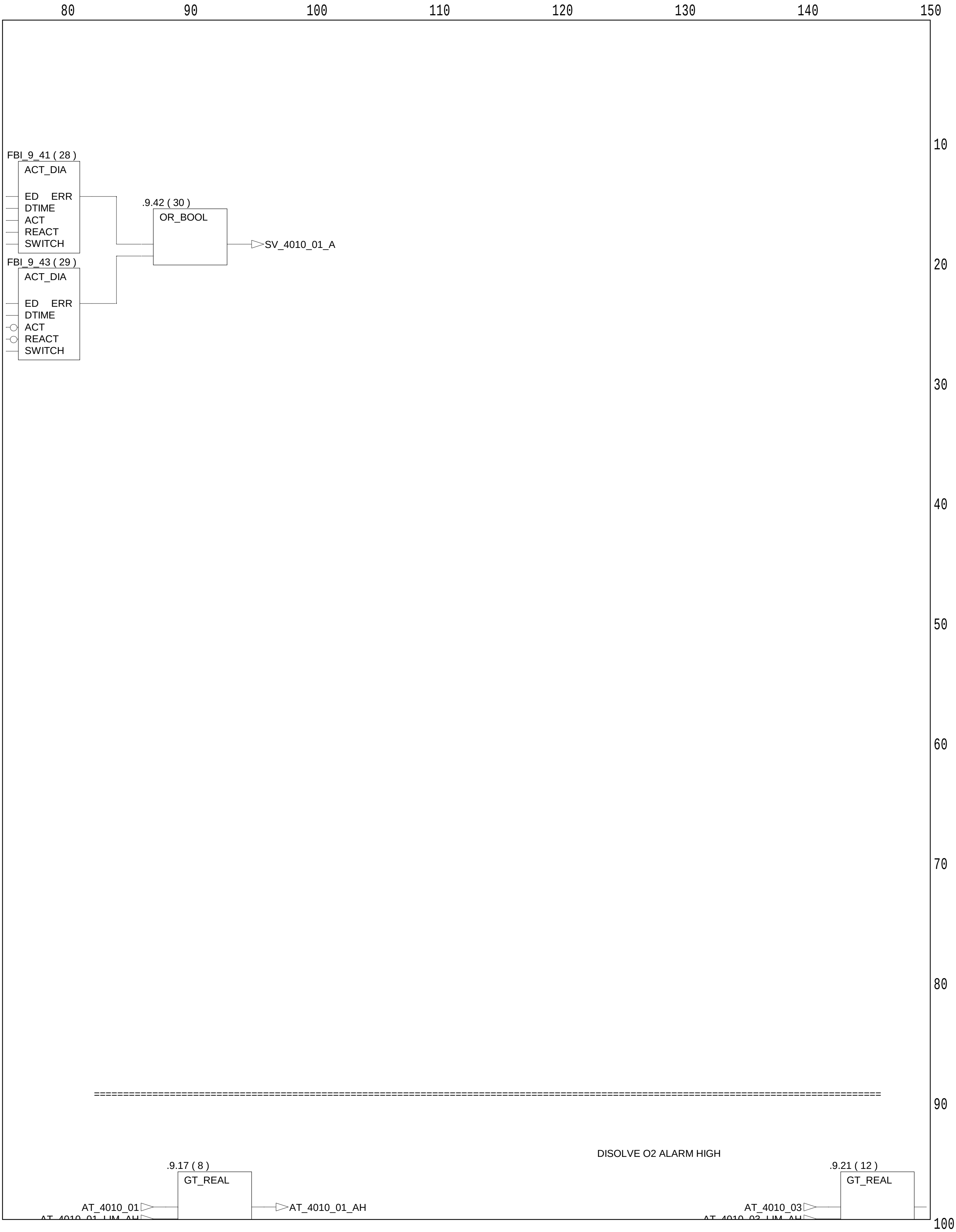
Graph of section CL4010_OutletGasCompo



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Graph of section CL4010_OutletGasCompo

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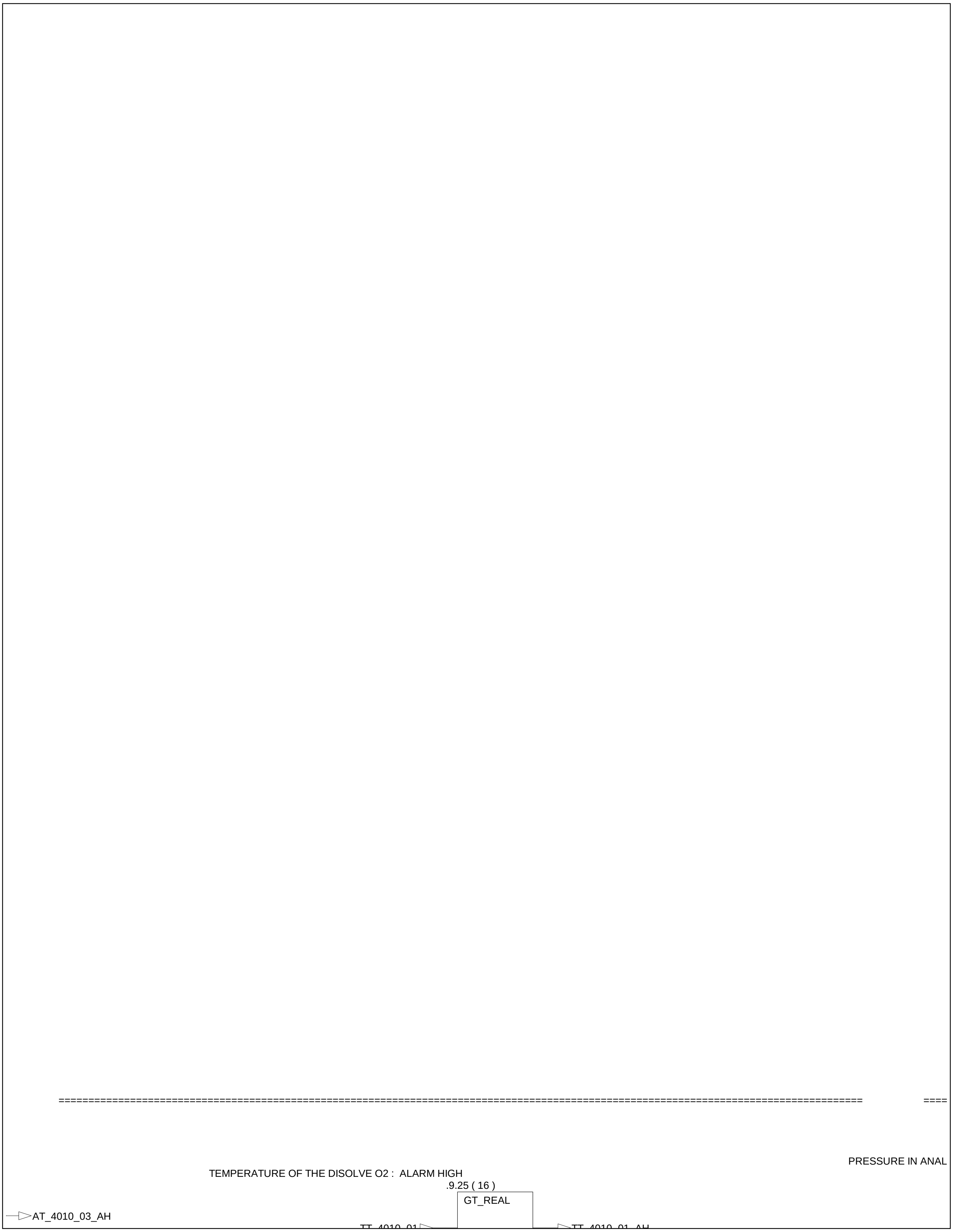

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< page 155

> page 157

> page 160

Graph of section CL4010_OutletGasCompo

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10
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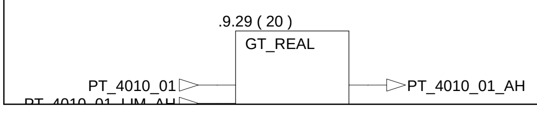
< page 156

50
60
70
80
90



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Graph of section CL4010_OutletGasCompo

< page 154

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> page 159

Graph of section CL4010_OutletGasCompo

< page 155

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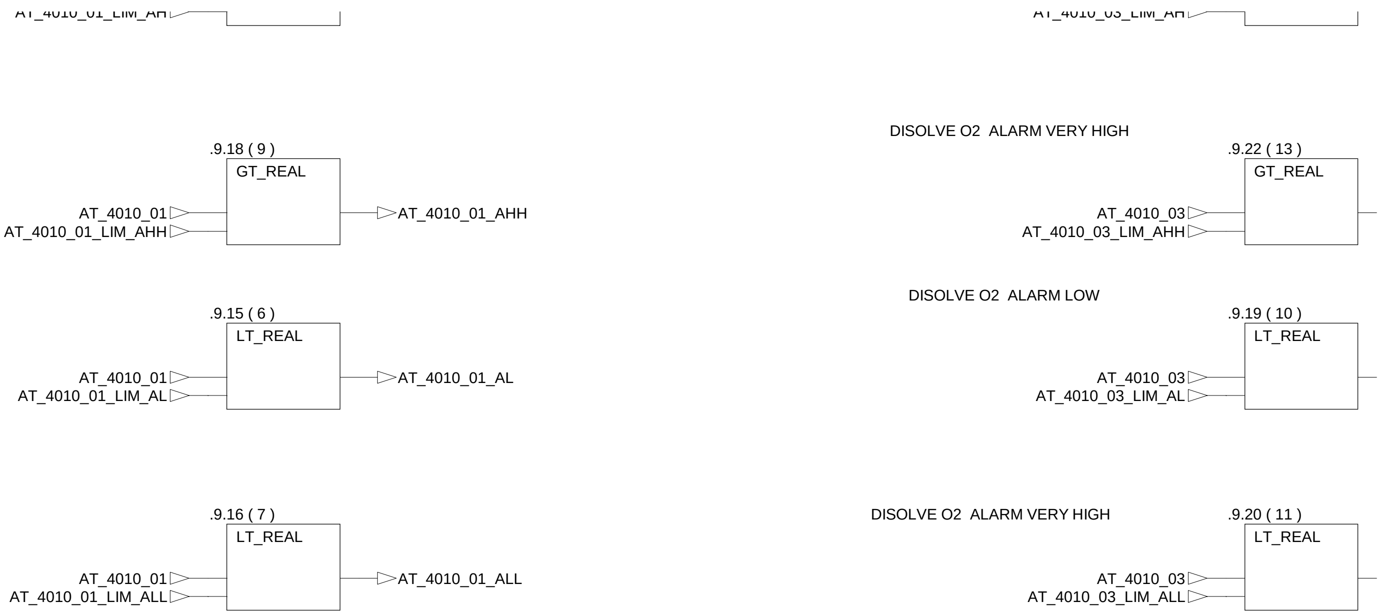

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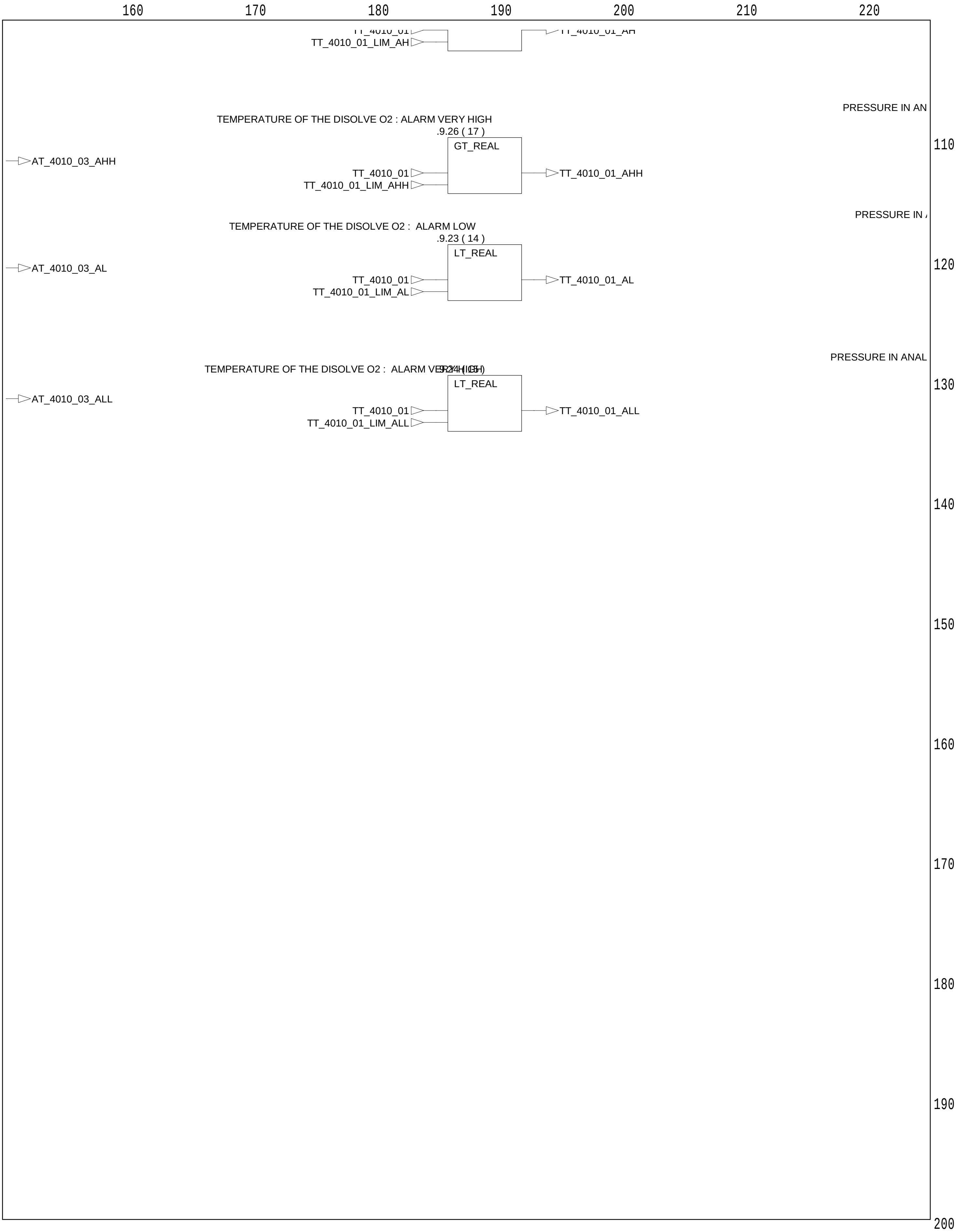
Graph of section CL4010_OutletGasCompo

< page 156



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Graph of section CL4010_OutletGasCompo

< page 157

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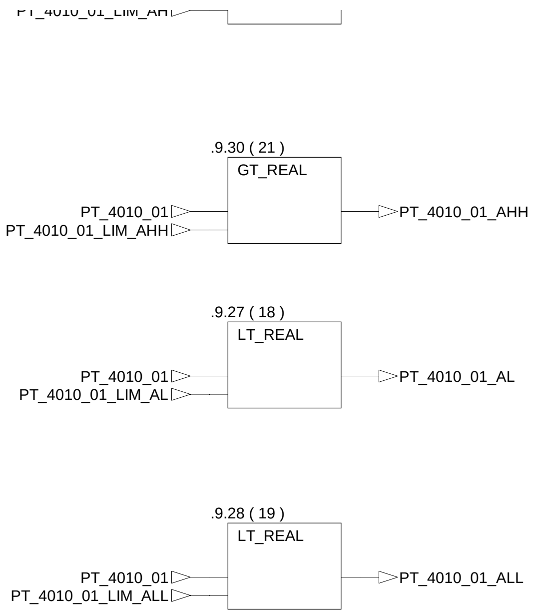

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190
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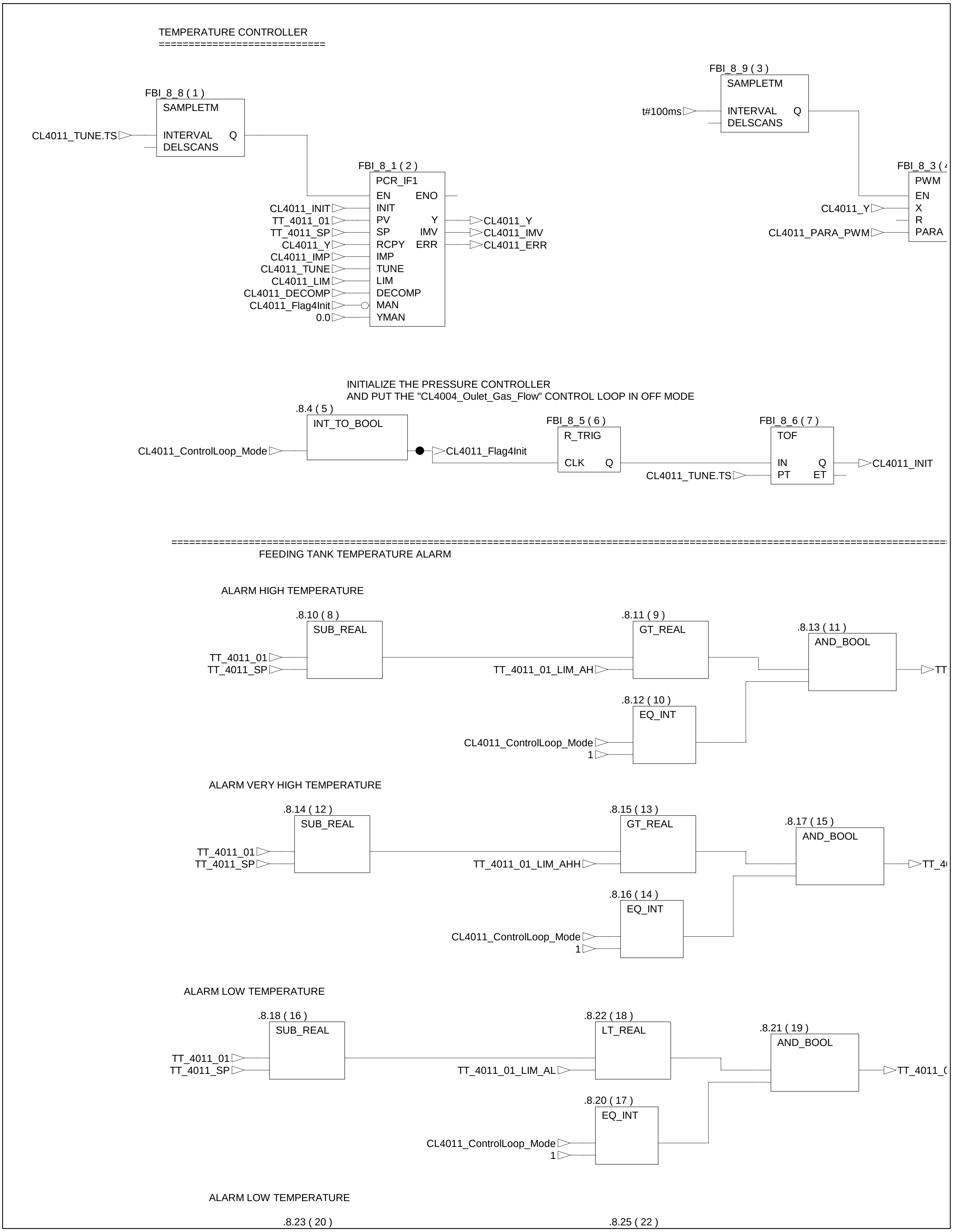
< page 160

Graph of section CL4011_Feeding_Temp



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Graph of section CL4011_Feeding_Temp

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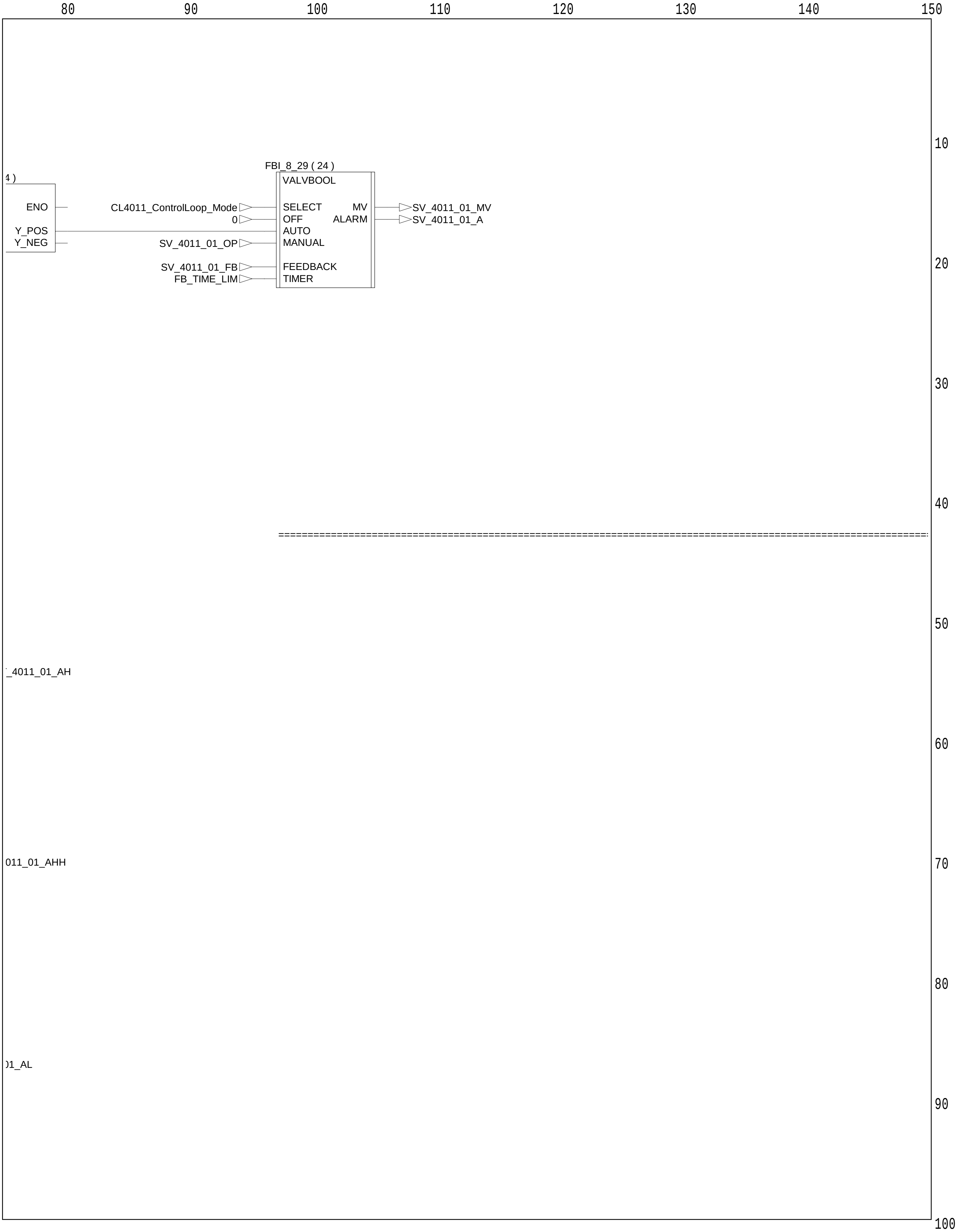

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Graph of section CL4011_Feeding_Temp

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10 20 30 40 50 60 70 80 90 100

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Graph of section CL4011_Feeding_Temp

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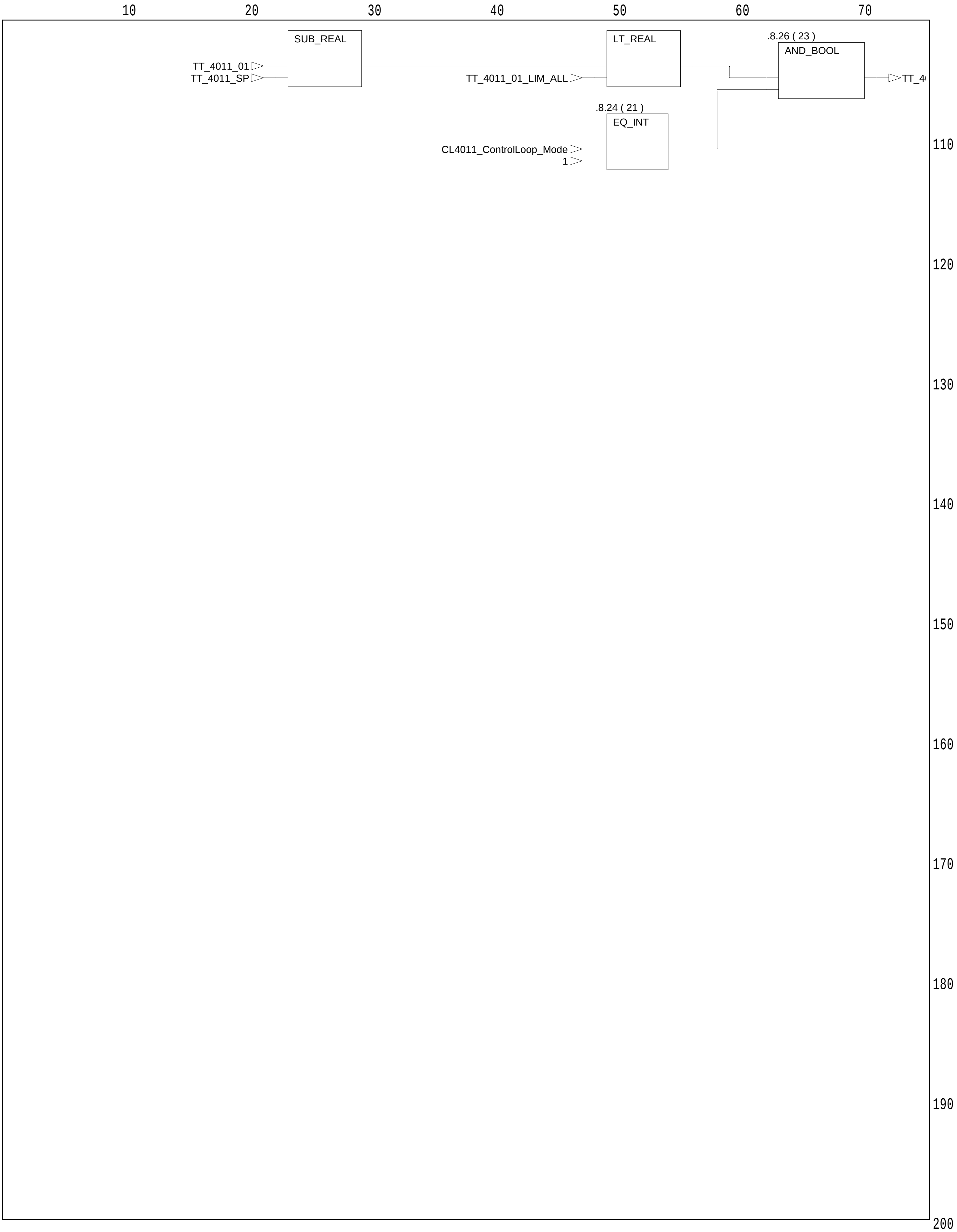

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Graph of section CL4011_Feeding_Temp

< page 163

80 90 100 110 120 130 140 150

011_01_ALL

110 120 130 140 150 160 170 180 190 200

< page 165

> page 167

Graph of section CL4011_Feeding_Temp

< page 164

160 170 180 190 200 210 220

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120
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170
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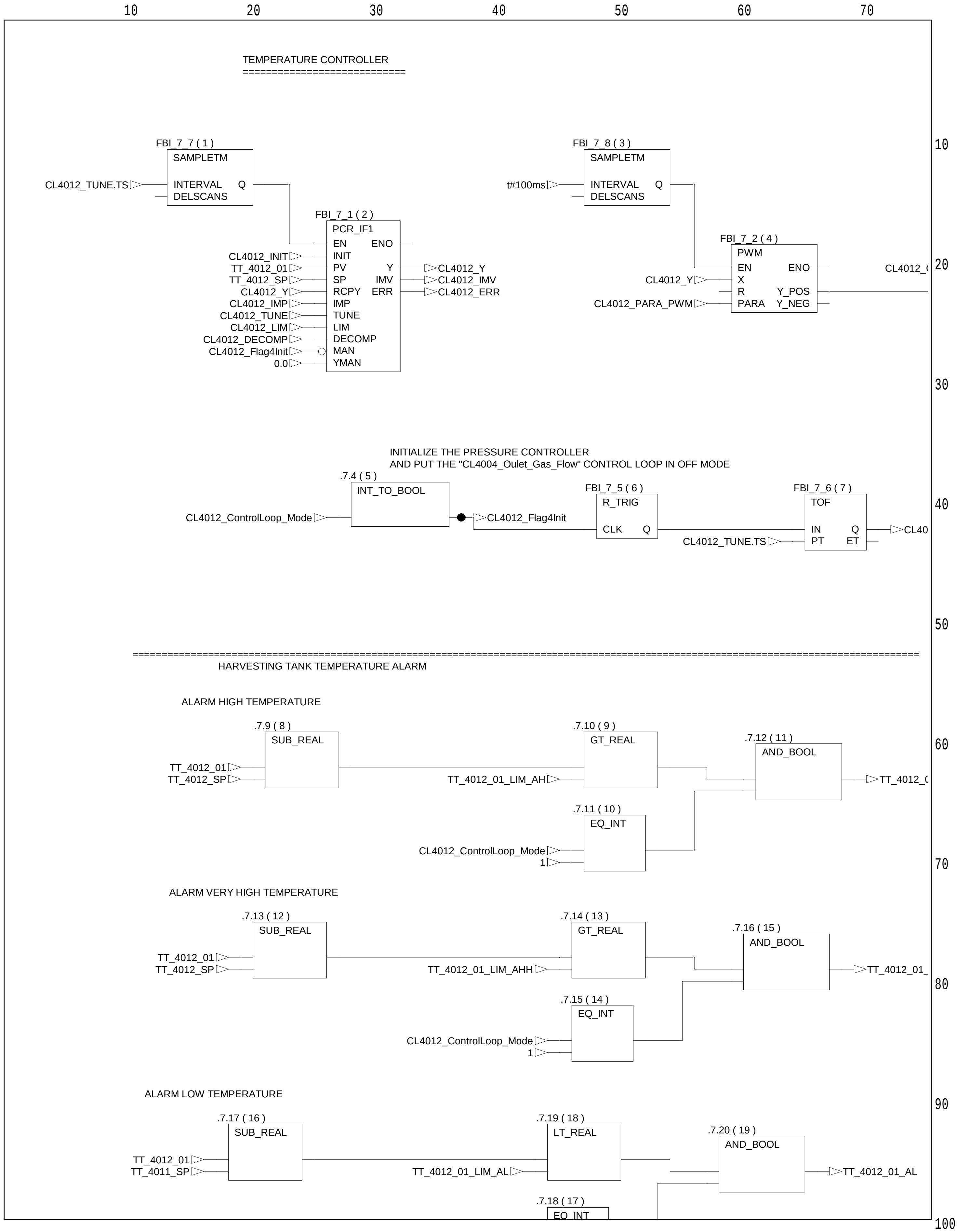
190
200

< page 166

Graph of section CL4012_Harvesting_Temp



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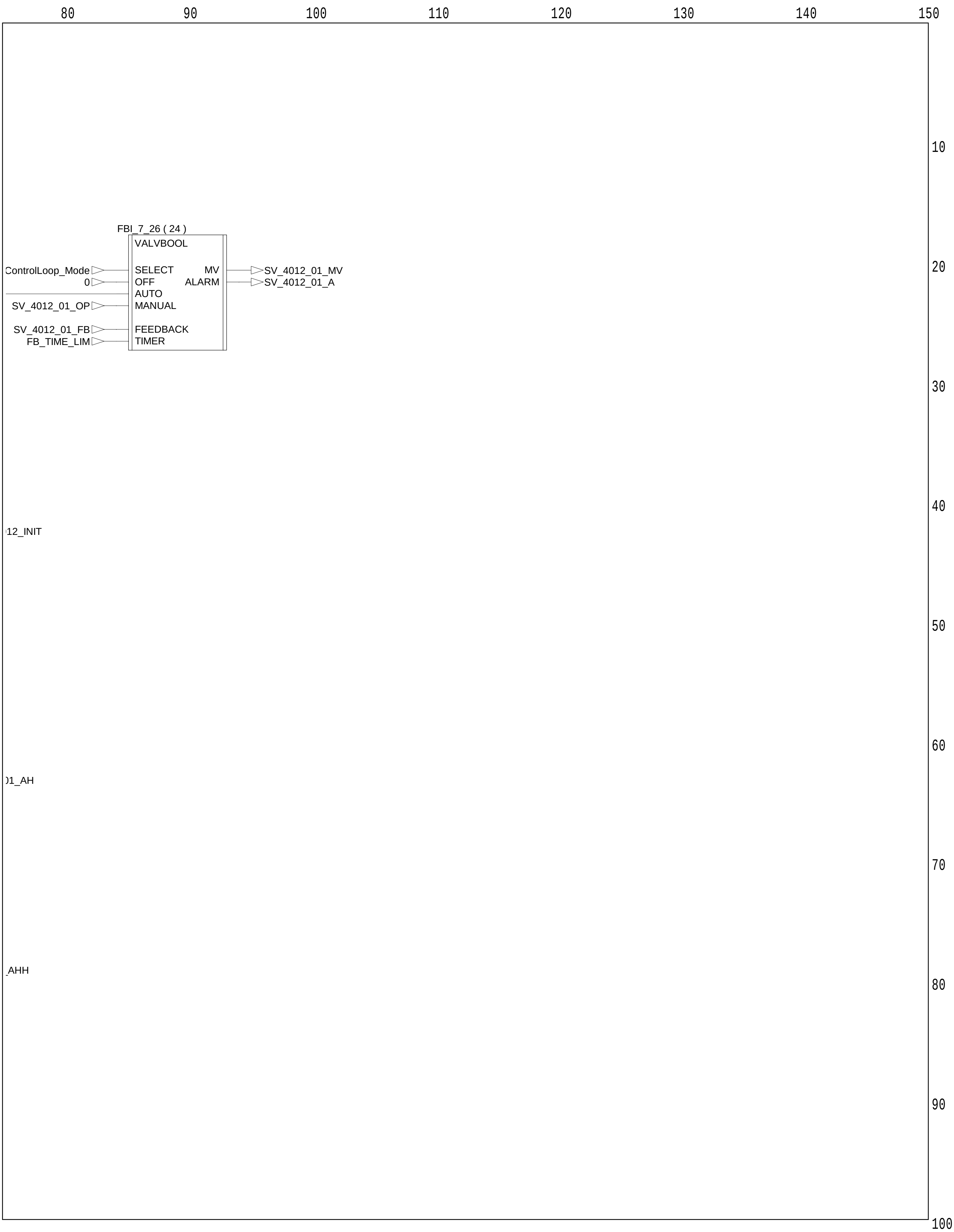
Graph of section CL4012_Harvesting_Temp



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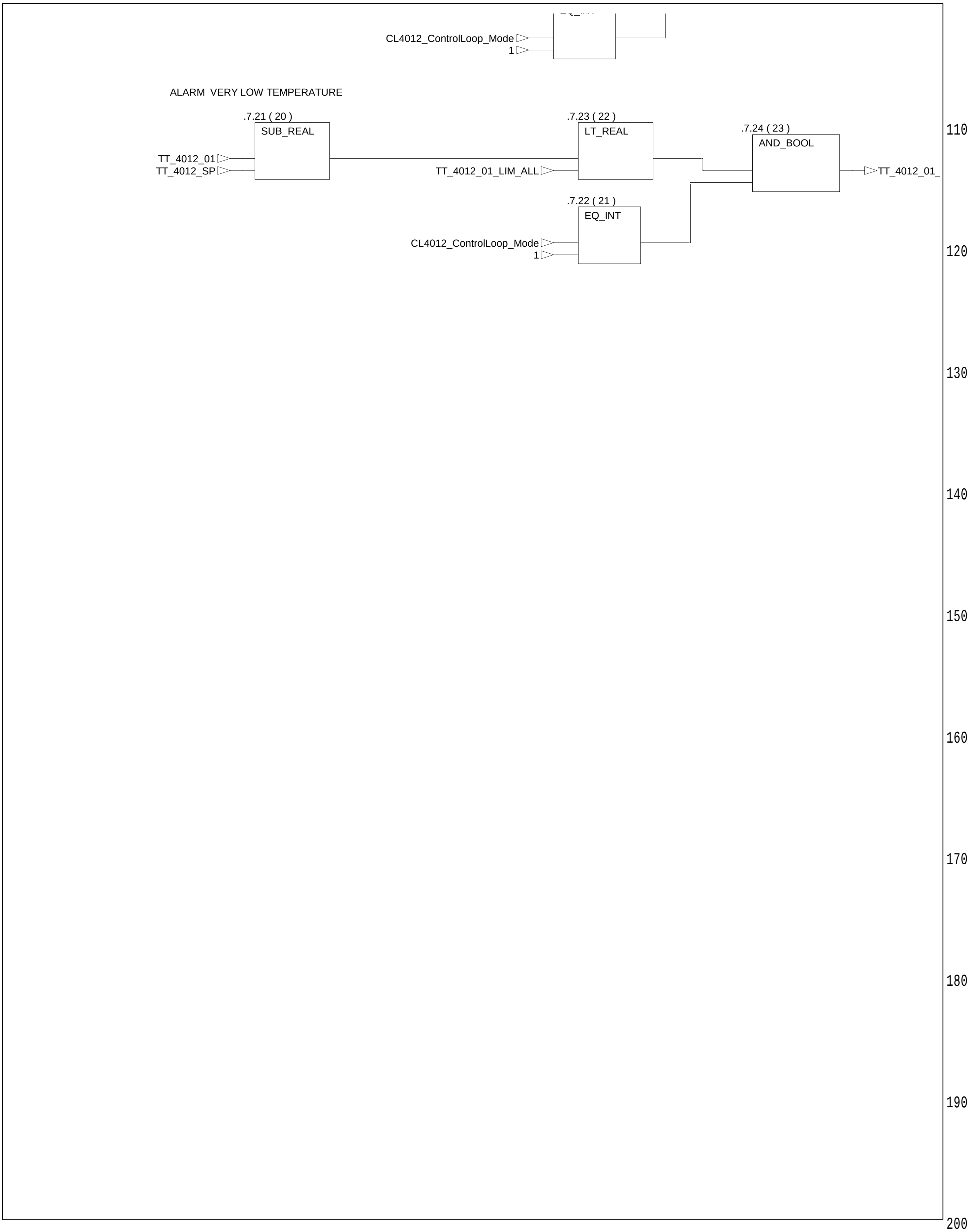
Graph of section CL4012_Harvesting_Temp

< page 168



> page 171

Graph of section CL4012_Harvesting_Temp

< page 169

80 90 100 110 120 130 140 150

_ALL

110 120 130 140 150 160 170 180 190 200

< page 170

Graph of section CL4013_Antifoam

10 20 30 40 50 60 70

10
20
30
40
50
60
70
80
90
100

Graph of section CL4014_Feeding_Sterilization

SV_4014_01 MANAGEMENT
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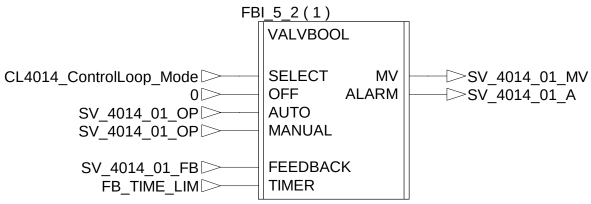

Graph of section CL4015_PBR_Sterilization

SV_4014_01 MANAGEMENT
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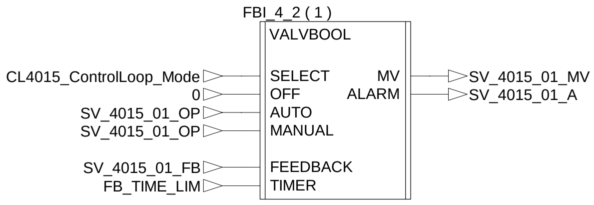

Graph of section CL4016_Harvesting_Sterilization

SV_4016_01 MANAGEMENT
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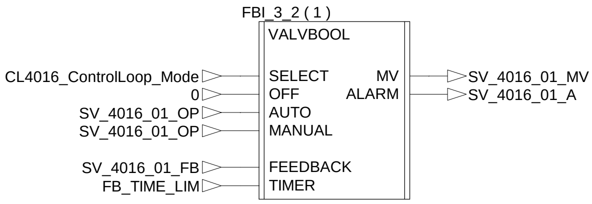

New Control Loop	***Control Loop Name***	***Location***	***FBD_Name***
4000	CIVa Bioreactor lighting control	PBR	CL4000_Lights
4001	Inlet liquid flow control	Inlet	CL4001_Inlet_Liquid_Flow
4002	Outlet liquid flow control	Outlet	CL4002_Outlet_Liquid_Flow
4003	Inlet gas flow control	Inlet	CL4003_Inlet_Gas_Flow
4004	Outlet gas flow control	Outlet	CL4004_Outlet_Gas_Flow
4005	Bioreactor temperature control	PBR	CL4005_PBR_Temp
4006	Bioreactor pH control	PBR	CL4006_pH
4007	Bioreactor pressure control	PBR	CL4007_PBR_Pressure
4008	Bioreactor liquid level control	PBR	CL4008_PBR_Liquid_Level
4009	Bioreactor biomass production control	PBR	CL4009_Biomass
4010	Bioreactor outlet gas composition control	PBR	CL4010_OutletGasCompo
4011	Feeding tank temperature control	Influent	CL4011_Feeding_Temp
4012	Harvesting tank temperature control	Harvest	CL4012_Harvesting_Temp
4013	Antifoam control	PBR	CL4013_Antifoam
4014	Feeding tank sterilization	Influent	CL4014_Feeding_Sterilization
4015	CIVa Bioreactor sterilization	PBR	CL4015_PBR_Sterilization
4016	Harvesting tank sterilization	Harvest	CL4016_Harvesting_Sterilization

CIVa EQUIPMENTS

#	Control Loop	Control Loop Name	Location	Equipment	Minimum	Tag Variable	PLC ADDRESS	Description	Function	I/O	Signal Type	Comments
1	4000	CIVa Bioreactor lighting control	PBR	Emergency Button 01		Emergency Button 01		Emergency Button 1		DI		
2	4000	CIVa Bioreactor lighting control	PBR	Emergency Button 02		Emergency Button 02		Emergency Button 2		DI		
3	4000	CIVa Bioreactor lighting control	PBR	Emergency Button 03		Emergency Button 03		Emergency Button 3		DI		
4	4000	CIVa Bioreactor lighting control	PBR	IRC 4000 01	Yes	IRC 4000 MV		Light Intensity (%age ?)		AO	4/20 mA	
5	4000	CIVa Bioreactor lighting control	PBR	IRC 4000 01		IT 4000 01		Light Power Phase1		AI	4/20 mA	
6	4000	CIVa Bioreactor lighting control	PBR	IRC 4000 01		IT 4000 02		Light Power Phase2		AI	4/20 mA	
7	4000	CIVa Bioreactor lighting control	PBR	IRC 4000 01		IT 4000 03		Light Power Phase3		AI	4/20 mA	
8	4001	Inlet liquid flow control	Inlet	PS 4001 01		PS 4001 01		Pressure pump GP 4001 01		DI		
9	4001	Inlet liquid flow control	Inlet	PS 4001 02		PS 4001 02		Pressure pump GP 4001 02		DI		
10	4001	Inlet liquid flow control	Inlet	GP 4001 01		GP 4001 01 ERR		Thermal protection to the pump		DI		
11	4001	Inlet liquid flow control	Inlet	GP 4001 02		GP 4001 02 ERR		Thermal protection to the pump		DI		
12	4001	Inlet liquid flow control	Inlet	GP 4001 03		GP 4001 03 ERR		Thermal protection of agitator motor		DI		
13	4001	Inlet liquid flow control	Inlet	GP 4001 01		GP 4001 01 MV1		Start/Stop of the pump		DO		
14	4001	Inlet liquid flow control	Inlet	GP 4001 02		GP 4001 02 MV1		Start/Stop of the pump		DO		
15	4001	Inlet liquid flow control	Inlet	GP 4001 03		GP 4001 03 MV1		Start/Stop of the agitator		DO		
16	4001	Inlet liquid flow control	Inlet	PS 4001 03		PS 4001 03		Pressure switch membrane GP 4001 01		DI		
17	4001	Inlet liquid flow control	Inlet	PS 4001 04		PS 4001 04		Pressure switch membrane GP 4001 02		DI		
18	4001	Inlet liquid flow control	Inlet	FT 4001 01		FT 4001 01		Total liquid inlet flow to reactor		AI	4/20 mA	
19	4001	Inlet liquid flow control	Inlet	LT 4001 01		LT 4001 01		Level (guided microwave)		AI	4/20 mA	
20	4001	Inlet liquid flow control	Inlet	DPT 4001 01		DPT 4001 01		Diff. Pressure Filter		AI	4/20 mA	
21	4001	Inlet liquid flow control	Inlet	DPT 4001 02		DPT 4001 02		Diff. Pressure Filter		AI	4/20 mA	
22	4001	Inlet liquid flow control	Inlet	GP 4001 01 MV2		GP 4001 01 MV2		Flow to the inlet pump		AO	4/20 mA	
23	4001	Inlet liquid flow control	Inlet	GP 4001 02 MV2		GP 4001 02 MV2		Flow to the inlet pump		AO	4/20 mA	
24	4001	Inlet liquid flow control	Inlet	GP 4001 03 MV2		GP 4001 03 MV2		Speed Agitator (VS 4001 01)		AO	4/20 mA	
25	4002	Outlet liquid flow control	Outlet	PS 4002 01		PS 4002 01		Pressure pump GP 4002 01		DI		
26	4002	Outlet liquid flow control	Outlet	PS 4002 02		PS 4002 02		Pressure pump GP 4002 01		DI		
27	4002	Outlet liquid flow control	Outlet	GP 4002 01		GP 4002 01 ERR		Thermal protection to the pump		DI		
28	4002	Outlet liquid flow control	Outlet	GP 4002 02		GP 4002 02 ERR		Thermal protection to the pump		DI		
29	4002	Outlet liquid flow control	Outlet	GP 4002 03		GP 4002 03 ERR		Thermal protection of agitator motor		DI		
30	4002	Outlet liquid flow control	Outlet	GP 4002 01		GP 4002 01 MV1		Start/Stop of the pump		DO		
31	4002	Outlet liquid flow control	Outlet	GP 4002 02		GP 4002 02 MV1		Start/Stop of the pump		DO		
32	4002	Outlet liquid flow control	Outlet	GP 4002 03		GP 4002 03 MV1		Start/Stop of the agitator		DO		
33	4002	Outlet liquid flow control	Outlet	PS 4002 03		PS 4002 03		Pressure switch membrane GP 4002 01		DI		
34	4002	Outlet liquid flow control	Outlet	PS 4002 04		PS 4002 04		Pressure switch membrane GP 4002 02		DI		
35	4002	Outlet liquid flow control	Outlet	WT 4002 01		WT 4002 01		Weight Balance (VS 4002 01)		AI	4/20 mA	
36	4002	Outlet liquid flow control	Outlet	GP 4002 01 MV2		GP 4002 01 MV2		Flow to the outlet pump		AO	4/20 mA	
37	4002	Outlet liquid flow control	Outlet	GP 4002 02 MV2		GP 4002 02 MV2		Flow to the outlet pump		AO	4/20 mA	
38	4002	Outlet liquid flow control	Outlet	GP 4002 03 MV2		GP 4002 03 MV2		Speed Agitator (VS 4002 01)		AO	4/20 mA	
39	4003	Inlet gas flow control	Inlet	SV 4003 04		SV 4003 04 MV		Circulated gas blower bypass		DO		
40	4003	Inlet gas flow control	Inlet	SV 4003 04		SV 4003 04 FB		Circulated gas blower bypass	Feedback	DI		
41	4003	Inlet gas flow control	Inlet	SV 4003 03		SV 4003 03 MV		Reactor air inlet (biomass cleaning)		DO		
42	4003	Inlet gas flow control	Inlet	SV 4003 03		SV 4003 03 FB		Reactor air inlet (biomass sensor cleaning)	Feedback	DI		
43	4003	Inlet gas flow control	Inlet	SV 4003 01		SV 4003 01 MV		Analyser gas inlet (reactor inlet)		DO		
44	4003	Inlet gas flow control	Inlet	SV 4003 01		SV 4003 01 FB		Analyser gas inlet (reactor inlet)	Feedback	DI		
45	4003	Inlet gas flow control	Inlet	SV 4003 02		SV 4003 02 MV		Analyser gas inlet (reactor inlet)		DO		
46	4003	Inlet gas flow control	Inlet	SV 4003 02		SV 4003 02 FB		Analyser gas inlet (reactor inlet)	Feedback	DI		
47	4003	Inlet gas flow control	Inlet	BLWR 4003 01		BLWR 4003 01 MV1		Start/Stop of the blower		DO		
48	4003	Inlet gas flow control	Inlet	PS 4003 01		PS 4003 01		Pressure switch bypass for recycling		DI		
49	4003	Inlet gas flow control	Inlet	FQRC 4003 01	Yes	FQRC 4003 01		Mass Flow CO2 Inlet		AI	0-5 V	
50	4003	Inlet gas flow control	Inlet	FQRC 4003 01	Yes	FQRC 4003 01 SP		Mass Flow CO2 Inlet set point		AO	0-5 V	
51	4003	Inlet gas flow control	Inlet	FQRC 4003 02		FQRC 4003 02		Mass Flow Air Inlet		AI	0-5 V	
52	4003	Inlet gas flow control	Inlet	FQRC 4003 02	Yes	FQRC 4003 02 SP		Mass Flow Air Inlet set point		AO	0-5 V	
53	4003	Inlet gas flow control	Inlet	FQRC 4003 03		FQRC 4003 03		Mass Flow Circulated Air		AI	0-5 V	
54	4003	Inlet gas flow control	Inlet	FQRC 4003 03		FQRC 4003 03 SP		Mass Flow Circulated Air set point		AO	0-5 V	
55	4003	Inlet gas flow control	Inlet	FQRC 4003 04	Yes	FQRC 4003 04		Total Mass Flow Air Inlet		AI	0-5 V	
56	4003	Inlet gas flow control	Inlet	FQRC 4003 04		FQRC 4003 04 SP		Total Mass Flow Air Inlet set point		AO	0-5 V	
57	4004	Outlet gas flow control	Outlet	FT 4004 01		FT 4004 01		Total air outlet from reactor		AI	4/20 mA	
58	4004	Outlet gas flow control	Outlet	SCV 4004 01		SCV 4004 01 MV		Flow control Air outlet valve		AO	4/20 mA	
59	4004	Outlet gas flow control	Outlet	DPT 4004 01		DPT 4004 01		Diff. Pressure Filter		AI	4/20 mA	
60	4005	Bioreactor temperature control	PBR	SV 4005 01	Yes	SV 4005 01 MV		Cooling water outlet valve		DO		
61	4005	Bioreactor temperature control	PBR	SV 4005 01		SV 4005 01 FB		Cooling water outlet valve	Feedback	DI		
62	4005	Bioreactor temperature control	PBR	BLWR 4005 01		BLWR 4005 01 ERR		Thermal protection of extractor		DI		
63	4005	Bioreactor temperature control	PBR	PP 4005 01		PP 4005 01 MV1		Start/Stop of the pump		DO		
64	4005	Bioreactor temperature control	PBR	BLWR 4005 01	Yes	BLWR 4005 01 MV1		Start/Stop of the extractor		DO		
65	4005	Bioreactor temperature control	PBR	HX 4005 02		HX 4005 02 MV1		Start/Stop electrical resistance		DO		

#	Control Loop	Control Loop Name	Location	Equipment	Minimum	Tag Variable	PLC ADDRESS	Description	Function	I/O	Signal Type	Comments
66	**4005**	Bioreactor temperature control	PBR	TT_4005_02	Yes	TT_4005_01		Reactor Temp.		AI	4/20 mA	
67	**4005**	Bioreactor temperature control	PBR	BLWR_4005_01_MV2		BLWR_4005_01_MV2		Blower air		AO	0-10 V	
68	**4006**	Bioreactor pH control	PBR	SV 4006 01	NotMand	SV_4006_01_MV		Acid Inlet reactor		DO		
69	**4006**	Bioreactor pH control	PBR	SV 4006 01		SV_4006_01_FB		Acid Inlet reactor	Feedback	DI		
70	**4006**	Bioreactor pH control	PBR	SV 4006 02	Yes	SV_4006_02_MV		Base Inlet reactor		DO		
71	**4006**	Bioreactor pH control	PBR	SV 4006 02		SV_4006_02_FB		Base Inlet reactor	Feedback	DI		
72	**4006**	Bioreactor pH control	PBR	PP 4006 01	NotMand	PP_4006_01_MV1		Start/Stop of the pump		DO		
73	**4006**	Bioreactor pH control	PBR	PP 4006 02	Yes	PP_4006_02_MV1		Start/Stop of the pump		DO		
74	**4006**	Bioreactor pH control	PBR	AT_4006_01	Yes	AT_4006_01		pH		AI	4/20 mA	
75	**4006**	Bioreactor pH control	PBR	TT_4006_01		TT_4006_01		Temp. For pH		AI	4/20 mA	
76	**4006**	Bioreactor pH control	PBR	AT_4006_02	Yes	AT_4006_02		pH		AI	4/20 mA	
77	**4006**	Bioreactor pH control	PBR	TT_4006_02		TT_4006_02		Temp. For pH		AI	4/20 mA	
78	**4006**	Bioreactor pH control	PBR	WT_4006_01		WT_4006_01		Balance acid		Eth	Ethernet	Ethernet through RS232
79	**4006**	Bioreactor pH control	PBR	WT_4006_02		WT_4006_02		Balance base		Eth	Ethernet	Ethernet through RS232
80	**4007**	Bioreactor pressure control	PBR	PT_4007_01		PT_4007_01		Reactor Pressure		AI	4/20 mA	
81	**4007**	Bioreactor pressure control	PBR	PT_4007_02		PT_4007_02		Reactor Pressure		AI	4/20 mA	
82	**4008**	Bioreactor liquid level control	PBR	WT_4008_01		WT_4008_01		Weight Balance (Reactor)		AI	4/20 mA	
83	**4009**	Bioreactor biomass production control	PBR	AT_4009_01		AT_4009_01		Biomass		AI	4/20 mA	
84	**4009**	Bioreactor biomass production control	PBR	AT_4009_02		AT_4009_02		Biomass		AI	4/20 mA	
85	**4009**	Bioreactor biomass production control	PBR	TT_4009_01		TT_4009_01		Temp. Meas. (Biomass Sensor)		AI	4/20 mA	
86	**4010**	Bioreactor outlet gas composition control	PBR	SV 4010 01		SV_4010_01_MV		Gas Inlet analyser (reactor outlet)		DO		
87	**4010**	Bioreactor outlet gas composition control	PBR	SV 4010 01		SV_4010_01_FB		Gas Inlet analyser	Feedback	DI		
88	**4010**	Bioreactor outlet gas composition control	PBR	HX_4010_01		HX_4010_01_MV1		Start/Stop Post condenser		DO		
89	**4010**	Bioreactor outlet gas composition control	PBR	AT_4010_01		AT_4010_01		CO2 analyser		AI	4/20 mA	
90	**4010**	Bioreactor outlet gas composition control	PBR	AT_4010_02		AT_4010_02		O2 analyser		AI	4/20 mA	
91	**4010**	Bioreactor outlet gas composition control	PBR	AT_4010_03		AT_4010_03		Dissolved O2		AI	4/20 mA	
92	**4010**	Bioreactor outlet gas composition control	PBR	TT_4010_02		TT_4010_02		Temp. Meas. (Dissolved O2)		AI	4/20 mA	
93	**4010**	Bioreactor outlet gas composition control	PBR	PT_4010_01		PT_4010_01		Outlet Gas Pressure		AI	4/20 mA	
94	**4010**	Bioreactor outlet gas composition control	PBR	TT_4010_01		TT_4010_01		Analyser Temp.		AI	4/20 mA	
95	**4011**	Feeding tank temperature control	Influent	SV 4011 01		SV_4011_01_MV		Cooling water outlet valve		DO		
96	**4011**	Feeding tank temperature control	Influent	SV 4011 01		SV_4011_01_FB		Cooling water outlet valve	Feedback	DI		
97	**4011**	Feeding tank temperature control	Influent	TT_4011_01		TT_4011_01		Inlet Vessel Temp.		AI	4/20 mA	
98	**4012**	Harvesting tank temperature control	Harvest	SV 4012 01		SV_4012_01_MV		Cooling water outlet valve		DO		
99	**4012**	Harvesting tank temperature control	Harvest	SV 4012 01		SV_4012_01_FB		Cooling water outlet valve	Feedback	DI		
100	**4012**	Harvesting tank temperature control	Harvest	TT_4012_01		TT_4012_01		Vessel Temp.		AI	4/20 mA	
101	**4013**	Antifoam control	PBR	LS_4013_01		LS_4013_01		Foam measurement		DI		
102	**4014**	Feeding tank sterilization	Influent	SV 4014 01		SV_4014_01_MV		Steam inlet valve		DO		
103	**4014**	Feeding tank sterilization	Influent	SV 4014 01		SV_4014_01_FB		Steam inlet valve	Feedback	DI		
104	**4015**	CIVa Bioreactor sterilization	PBR	SV 4015 01		SV_4015_01_MV		Reactor Steam inlet valve		DO		
105	**4015**	CIVa Bioreactor sterilization	PBR	SV 4015 01		SV_4015_01_FB		Steam inlet valve	Feedback	DI		
106	**4016**	Harvesting tank sterilization	Harvest	SV 4016 01		SV_4016_01_MV		Steam Inlet Valve		DO		
107	**4016**	Harvesting tank sterilization	Harvest	SV 4016 01		SV_4016_01_FB		Steam Inlet Valve	Feedback	DI		
										107		

PLC									
1	2	3	4	5	6	7	8	9	10
140CPS11420	140CPU43412A	140NOE77101	140ACI03000	140AVI03000	140AVO02000	140AVO02000	140ACO13000	140DDM39000	140XBE10000
Backplane Power Supply module	CPU module	Ethernet module	8 Analog current Input (ACI 1)	8 Analog voltage Input (AVI 1)	4 Analog voltage Output (AVO 1)	4 Analog voltage Output (AVO 2)	8 Analog current Output (ACO 1)	Digital Input/Output	Rack expansion
CIVa_PLC_CPS	CIVa_PLC_CPU	CIVa_PLC_NOE	CIVa_PLC_IO_ACI1	CIVa_PLC_IO_AVI1	CIVa_PLC_IO_AVO1	CIVa_PLC_IO_AVO2	CIVa_PLC_IO_ACO1	CIVa_PLC_IO_DDM1	CIVa_PLC_XBE
Address			300100 --> 300108	300109->300117	400100->400103	400104->400107	400108->400115	100065 ->100080	
			8 inputs available	**4 inputs available**	**No outputs available**	**3 outputs available**	**No outputs available**		

PLC EXPANSION									
1	2	3	4	5	6	7	8	9	10
140CPS11420	140DDI35300	140DDO35300	140ACI04000	140ACI04000	140ACO13000				140XBE10000
Backplane Power Supply module	32 Digital Input 24V	32 Digital Output 24V	16 Analog current Input (ACI 2)	16 Analog current Input (ACI 3)	8 Analog current Output (ACO 2)				Rack expansion
CIVa _PLC_CPS	CIVa_PLC_DDI1	CIVa_PLC_DDO1	CIVa_PLC_ACI2	CIVa_PLC_ACI3	CIVa_PLC_ACO2				CIVa_PLC_XBE
Address	100081->100112	000081 -> 000112	300118 -> 300134	300135 -> 300151	400116 --> 400123				
	no inputs available	**6 outputs available**	**No inputs available**	**3 INPUTS AVAILABLE**	**8 outputs available**				

CIVa EQUIPMENTS

#	Control Loop	Control Loop Name	Location	Equipment	Tag Variable	PLC ADDRESS	Description	FINAL CHEK	CHECK	I/O	Range (with unit)	Signal Type	PLC Card	Input In card	+ wire TRANSDUCER	- wire transducer	Comments	Cable connected	Module label	Relay number
1	**4000**	CIVa Bioreactor lighting control	PBR	IRC_4000_01	IT_4000_01	300145	Light Power Phase1	OKAI	OK	AI	?	4/20 mA	ACI 3	11	25	26				
2	**4000**	CIVa Bioreactor lighting control	PBR	IRC_4000_01	IT_4000_02	300146	Light Power Phase2	OKAI	OK	AI	?	4/20 mA	ACI 3	12	27	28				
3	**4000**	CIVa Bioreactor lighting control	PBR	IRC_4000_01	IT_4000_03	300147	Light Power Phase3	OKAI	OK	AI	?	4/20 mA	ACI 3	13	31	32				
4	**4000**	CIVa Bioreactor lighting control	PBR	IRC_4000_01	IRC_4000_MV	400115	Light Intensity (%age ?)	OKAO	OK	AO	0 to 100 %	4/20 mA	ACO 1	8	+ Loop Power supply	38				
7	**4001**	Inlet liquid flow control	Inlet	FT_4001_01	FT_4001_01	300130	Total liquid inlet flow to reactor	OKAI	OK	AI	OLD: 0 to 20 kg/H REAL:0-->4	4/20 mA	ACI 2	13	31	32				
8	**4001**	Inlet liquid flow control	Inlet	LT_4001_01	LT_4001_01	300131	Level (guided microwave)	OKAI	OK	AI	0 to 160L	4/20 mA	ACI 2	14	33	34	2009/11/13: before the range was 0-->100% NOW, it is 0 -->160 Litre (following discussion between UAB and Sherpa)			
9	**4001**	Inlet liquid flow control	Inlet	DPT_4001_01	DPT_4001_01	300138	Diff. Pressure Filter	OKAI	OK	AI	0 to 1017 mbar	4/20 mA	ACI 3	4	7	8				
10	**4001**	Inlet liquid flow control	Inlet	DPT_4001_02	DPT_4001_02	300139	Diff. Pressure Filter	OKAI	OK	AI	0 to 1017 mbar	4/20 mA	ACI 3	5	11	12				
11	**4001**	Inlet liquid flow control	Inlet	GP_4001_01_MV2	GP_4001_01_MV2	400109	Flow to the inlet pump	OKAO	OK	AO	0 to 100 Hz ? 0 to 4 L/H	4/20 mA	ACO 1	2	+ Loop Power supply	8				
12	**4001**	Inlet liquid flow control	Inlet	GP_4001_02_MV2	GP_4001_02_MV2	400110	SPARE	OKAO	OK	AO	0 to 100 Hz ? 0 to 4 L/H	4/20 mA	ACO 1	3	+ Loop Power supply	14				
13	**4001**	Inlet liquid flow control	Inlet	GP_4001_03_MV2	GP_4001_03_MV2	400113	Speed Agitator (VS_4001_01)	OKAO	OK	AO	50 Hz = 1400 rpm	4/20 mA	ACO 1	6	+ Loop Power supply	28				
25	**4002**	Outlet liquid flow control	Outlet	WT_4002_01	WT_4002_01	300132	Weight Balance (VS_4002_01)	OKAI	OK	AI	0 to 200 kg	4/20 mA	ACI 2	15	35	36				
26	**4002**	Outlet liquid flow control	Outlet	GP_4002_01_MV2	GP_4002_01_MV2	400111	Flow to the outlet pump	OKAO	OK	AO	0 to 100 Hz ? 0 to 4 L/H	4/20 mA	ACO 1	4	+ Loop Power supply	18				
27	**4002**	Outlet liquid flow control	Outlet	GP_4002_02_MV2	GP_4002_02_MV2	400112	SPARE	OKAO	OK	AO	0 to 100 Hz ? 0 to 4 L/H	4/20 mA	ACO 1	5	+ Loop Power supply	24				
28	**4002**	Outlet liquid flow control	Outlet	GP_4002_03_MV2	GP_4002_03_MV2	400114	Speed Agitator (VS_4002_01)	OKAO	OK	AO	See UAB	4/20 mA	ACO 1	7	+ Loop Power supply	34				
40	**4003**	Inlet gas flow control	Inlet	FQRC_4003_01	FQRC_4003_01	300109	Mass Flow CO2 Inlet	OKAI	OK	AI	0 to 5 (former equipment)	0-5 V	AVI 1	1	1	2				
41	**4003**	Inlet gas flow control	Inlet	FQRC_4003_02	FQRC_4003_02	300110	Mass Flow Air Inlet	OKAI	OK	AI	0 to 30 (former equipment)	0-5 V	AVI 1	2	5	6				
42	**4003**	Inlet gas flow control	Inlet	FQRC_4003_03	FQRC_4003_03	300111	Mass Flow Circulated Air	OKAI	OK	AI	0 to 30 (former equipment)	0-5 V	AVI 1	3	11	12				
43	**4003**	Inlet gas flow control	Inlet	FQRC_4003_04	FQRC_4003_04	300112	Total Mass Flow Air Inlet	OKAI	OK	AI	0 to 30 (former equipment)	0-5 V	AVI 1	4	15	16				
44	**4003**	Inlet gas flow control	Inlet	FQRC_4003_01	FQRC_4003_01_SP	400100	Mass Flow CO2 Inlet set point	OKAO	OK	AO	0 to 5 (former equipment)	0-5 V	AVO 1	1	1	2	Pin 1,3 and 5 jumpered. Pin 9 and 10 jumpered.			
45	**4003**	Inlet gas flow control	Inlet	FQRC_4003_02	FQRC_4003_02_SP	400101	Mass Flow Air Inlet set point	OKAO	OK	AO	0 to 30 (former equipment)	0-5 V	AVO 1	2	11	12	Pin 11, 13 and 15 jumpered. Pin 19 and 20 jumpered.			
46	**4003**	Inlet gas flow control	Inlet	FQRC_4003_03	FQRC_4003_03_SP	400102	Mass Flow Circulated Air set point	OKAO	OK	AO	0 to 30 (former equipment)	0-5 V	AVO 1	3	21	22	Pin 21, 23 and 25 jumpered. Pin 29 and 30 jumpered.			
47	**4003**	Inlet gas flow control	Inlet	FQRC_4003_04	FQRC_4003_04_SP	400103	Total Mass Flow Air Inlet set point	OKAO	OK	AO	0 to 30 (former equipment)	0-5 V	AVO 1	4	31	32	Pin 31, 33 and 35 jumpered. Pin 39 and 40 jumpered.			
58	**4004**	Outlet gas flow control	Outlet	FT_4004_01	FT_4004_01	300129	Total air outlet from reactor	OKAI	OK	AI	0 to 20 NL/min	4/20 mA	ACI 2	12	27	28				
59	**4004**	Outlet gas flow control	Outlet	DPT_4004_01	DPT_4004_01	300140	Diff. Pressure Filter	OKAI	OK	AI	0 to 3 bar	4/20 mA	ACI 3	6	13	14				
60	**4004**	Outlet gas flow control	Outlet	SCV_4004_01	SCV_4004_01_MV	400108	Flow control Air outlet valve	OKAO	OK	AO	0 to 100 %	4/20 mA	ACO 1	1	+ Loop Power supply	4	ACO1 Pin 36 has to be connected to power supply return.			
61	**4005**	Bioreactor temperature control	PBR	TT_4005_01	TT_4005_01	300141	Reactor Temp.	OKAI	OK	AI	0 to 150 °C (former equipment)	4/20 mA	ACI 3	7	15	16				
62	**4005**	Bioreactor temperature control	PBR	BLWR_4005_01_MV2	BLWR_4005_01_MV2	400104	Blower air	OKAO	OK	AO	2380 rpm ?	0-10 V	AVO 2	1	1	10	Pin 1 and 3 jumpered.			
69	**4006**	Bioreactor pH control	PBR	AT_4006_01	AT_4006_01	300127	pH	OKAI	OK	AI	0 to 12	4/20 mA	ACI 2	8	17	18				
70	**4006**	Bioreactor pH control	PBR	TT_4006_01	TT_4006_01	300128	Temp. For pH	OKAI	OK	AI	0 to 140 °C	4/20 mA	ACI 2	9	21	22				
71	**4006**	Bioreactor pH control	PBR	AT_4006_02	AT_4006_02	300125	pH	OKAI	OK	AI	0 to 12	4/20 mA	ACI 2	10	23	24				
72	**4006**	Bioreactor pH control	PBR	TT_4006_02	TT_4006_02	300126	Temp. For pH	OKAI	OK	AI	0 to 140 °C	4/20 mA	ACI 2	11	25	26				
82	**4007**	Bioreactor pressure control	PBR	PT_4007_01	PT_4007_01	300135	Reactor Pressure	OKAI	OK	AI	-1 to 1.5 bar	4/20 mA	ACI 3	1	1	2				
83	**4007**	Bioreactor pressure control	PBR	PT_4007_02	PT_4007_02	300136	Reactor Pressure	OKAI	OK	AI	-1 to 5 bar	4/20 mA	ACI 3	2	3	4				
84	**4008**	Bioreactor liquid level control	PBR	WT_4008_01	WT_4008_01	300133	Weight Balance (Reactor)	OKAI	OK	AI	0 to 100 kg	4/20 mA	ACI 2	16	37	38				
85	**4009**	Bioreactor biomass production control	PBR	AT_4009_01	AT_4009_01	300118	Biomass	OKAI	OK	AI	0 to 5 g/L (Former Equipment)	4/20 mA	ACI 2	1	1	2				
86	**4009**	Bioreactor biomass production control	PBR	AT_4009_02	AT_4009_02	300119	Biomass	OKAI	OK	AI	0 to 5 g/L	4/20 mA	ACI 2	2	3	4				
87	**4009**	Bioreactor biomass production control	PBR		TT_4009_01	300120	BIOMASS ANALYSER FAILLURE	OKAI	OK	AI	under 22 mA The sensor is in faillure	4/20 mA	ACI 2	3	5	6				
88	**4010**	Bioreactor outlet gas composition control	PBR	AT_4010_01	AT_4010_01	300121	CO2 analyser	AI		AI	See UAB	4/20 mA	ACI 2	4	7	8				
89	**4010**	Bioreactor outlet gas composition control	PBR	AT_4010_02	AT_4010_02	300122	O2 analyser	AI		AI	See UAB	4/20 mA	ACI 2	5	11	12				
90	**4010**	Bioreactor outlet gas composition control	PBR	AT_4010_03	AT_4010_03	300123	Dissolved O2	OKAI	OK	AI	6 ppb (part per billion) to ???? Saturation	4/20 mA	ACI 2	6	13	14				
91	**4010**	Bioreactor outlet gas composition control	PBR	TT_4010_01	TT_4010_01	300124	Temp. Meas. (Dissolved O2)	OKAI	OK	AI	0 to 70°C	4/20 mA	ACI 2	7	15	16				
92	**4010**	Bioreactor outlet gas composition control	PBR	PT_4010_01	PT_4010_01	300137	Outlet Gas Pressure	OKAI	OK	AI	-1 to 5 bar	4/20 mA	ACI 3	3	5	6				
93	**4010**	Bioreactor outlet gas composition control	PBR	TT_4010_01	TT_4010_01	300143	Analyser Temp.	OKAI	OK	AI	0 to 150 °C	4/20 mA	ACI 3	9	21	22				
96	**4011**	Feeding tank temperature control	Influent	TT_4011_01	TT_4011_01	300142	Inlet Vessel Temp.	OKAI	OK	AI	-10 to 150 °C	4/20 mA	ACI 3	8	17	18				
99	**4012**	Harvesting tank temperature control	Harvest	TT_4012_01	TT_4012_01	300144	Vessel Temp.	OKAI	OK	AI	-50 to 250 °C	4/20 mA	ACI 3	10	23	24				
111						300148	SPARE	OKAI	OK	AI	?	4/20 mA	ACI 3							
112							RESERVE	OKAO	OK	AO	2380 rpm ?	0-10 V	AVO 2							
113							RESERVE	OKAO	OK	AO	2380 rpm ?	0-10 V	AVO 2							

#	Control Loop	Control Loop Name	Location	Equipment	Tag Variable	PLC ADDRESS	Description	FINAL CHEK	CHECK	I/O	Range (with unit)	Signal Type	PLC Card	Input In card	+ wire TRANSDUCER	- wire transducer	Comments	Cable connected	Module label	Relay number	
114							RESERVE	OKAO	OK	AO	2380 rpm ?	0-10 V	AVO 2								
										50											

Legend-->	Button : B	Alarm : A	System Clock : SC
	User Input: U	Equipment: E	Indicator: I

#	Control Loop	Legend Choice	PLC FBD	PLC Tag Name	Signal / Variable Type	Physical Address	HMI Address	HMI Name	Button HMI Type	Comment
1	-	E	-	Emergency_Button_01	DI	100111	100111			Emergency Button 1
2	-	E	-	Emergency_Button_02	DI	100112	100112			Emergency Button 2
3	-	E	-	Emergency_Button_03	DI	100065	100065			Emergency Button 3
5	4000	E	CL4000_Lights	IRC_4000_MV	REAL-->AO	400115	400262	(Display Intensity)		Light Intensity
6	4000	E	CL4000_Lights	IT_4000_01	AI ->REAL	300145	400184	Not displayed		Light Power Phase1
7	4000	E	CL4000_Lights	IT_4000_02	AI ->REAL	300146	400186	Not displayed		Light Power Phase2
8	4000	E	CL4000_Lights	IT_4000_03	AI ->REAL	300147	400188	Not displayed		Light Power Phase3
22	4001	E	CL4001_Inlet_Liquid_Flow	PS_4001_01	DI	100082	100082			Pressure pump GP_4001_01
24	4001	E	CL4001_Inlet_Liquid_Flow	PS_4001_02	DI	100083	100083			Pressure pump GP_4001_02
29	4001	E	CL4001_Inlet_Liquid_Flow	PS_4001_03	DI	100106	100106			Pressure switch membrane GP_4001_01
31	4001	E	CL4001_Inlet_Liquid_Flow	PS_4001_04	DI	100107	100107			Pressure switch membrane GP_4001_02
33	4001	E	CL4001_Inlet_Liquid_Flow	GP_4001_01_MV1	DO	000091	000091			Start/Stop of the pump
34	4001	E	CL4001_Inlet_Liquid_Flow	GP_4001_02_MV1	DO	000090	000090			Start/Stop of the pump
35	4001	E	CL4001_Inlet_Liquid_Flow	GP_4001_03_MV1	DO	000110	000110			Start/Stop of the agitator
36	4001	E	CL4001_Inlet_Liquid_Flow	CL4001_PumpSpeed	REAL-->AO	400109	400250			Flow to the inlet pump (OLD NAME:GP_4001_01_MV2)
37	4001	E	CL4001_Inlet_Liquid_Flow	GP_4001_03_MV2	REAL-->AO	400113	400258			Speed Agitator (VS_4001_01)
38	4001	E	CL4001_Inlet_Liquid_Flow	FT_4001_01	AI ->REAL	300130	400148			Total liquid inlet flow to reactor
43	4001	E	CL4001_Inlet_Liquid_Flow	LT_4001_01	AI ->REAL	300131	400150			Level (guided microwave)
48	4001	E	CL4001_Inlet_Liquid_Flow	DPT_4001_01	AI ->REAL	300138	400162			Diff. Pressure Filter
53	4001	E	CL4001_Inlet_Liquid_Flow	DPT_4001_02	AI ->REAL	300139	400164			Diff. Pressure Filter
71	4001	E	CL4001_Inlet_Liquid_Flow	CL4001_INLETPUMP_VARIATOR	BOOL	000111	000111	START PUMP	ON/OFF	start the variator which control the inlet pump
72	4002	E	CL4002_Outlet_Liquid_Flow	PS_4002_01	DI	100084	100084			Pressure pump GP_4002_01
75	4002	E	CL4002_Outlet_Liquid_Flow	PS_4002_02	DI	100085	100085			Pressure pump GP_4002_01
80	4002	E	CL4002_Outlet_Liquid_Flow	PS_4002_03	DI	100108	100108			Pressure switch membrane GP_4002_01
82	4002	E	CL4002_Outlet_Liquid_Flow	GP_4002_01_MV1	DO	000089	000089			Start/Stop of the pump
83	4002	E	CL4002_Outlet_Liquid_Flow	GP_4002_02_MV1	DO	000104	000104			Start/Stop of the pump
84	4002	E	CL4002_Outlet_Liquid_Flow	GP_4002_03_MV1	DO	000109	000109			Start/Stop of the agitator
85	4002	E	CL4002_Outlet_Liquid_Flow	CL4002_PumpSpeed	REAL-->AO	400111	400254			Flow to the outlet pump (OLD NAME:GP_4002_01_MV2)
86	4002	E	CL4002_Outlet_Liquid_Flow	GP_4002_03_MV2	REAL-->AO	400114	400260			Speed Agitator (VS_4002_01)
87	4002	E	CL4002_Outlet_Liquid_Flow	WT_4002_01	AI ->REAL	300132	400152			Weight Balance (VS_4002_01)
103	4002	E	CL4002_Outlet_Liquid_Flow	CL4002_OUTLETPUMP_VARIATOR	BOOL	000112	000112	START OUTLET PUMP	ON/OFF	start the variator which control the Outlet pump
104	4003	E	CL4003_Inlet_Gas_Flow	SV_4003_03_FB	DI	100094	100094			Circulated gas blower bypass (OLD NAME: SV_4003_04_FB)
105	4003	E	CL4003_Inlet_Gas_Flow	SV_4003_02_FB	DI	100095	100095			Reactor air inlet (biomass sensor cleaning)(OLD NAME: SV_4003_03_FB)
106	4003	E	CL4003_Inlet_Gas_Flow	SV_4003_01_FB	DI	100097	100097			Analyser gas inlet (reactor inlet) (OLD NAME:SV_4003_02_FB)
107	4003	E	CL4003_Inlet_Gas_Flow	PS_4003_01	DI	100110	100110			Pressure switch bypass for recycling
109	4003	E	CL4003_Inlet_Gas_Flow	SV_4003_03_MV	DO	000096	000096			Circulated gas blower bypass (OLD NAME:SV_4003_04_MV)
110	4003	E	CL4003_Inlet_Gas_Flow	SV_4003_02_MV	DO	000095	000095			Reactor air inlet (biomass cleaning) (OLD NAME:SV_4003_03_MV)
111	4003	E	CL4003_Inlet_Gas_Flow	SV_4003_01_MV	DO	000093	000093			Analyser gas inlet (reactor inlet) (OLD NAME:SV_4003_02_MV)
115	4003	E	CL4003_Inlet_Gas_Flow	BLWR_4003_01_MV1	DO	000103	000103			Start/Stop of the blower
116	4003	E	CL4003_Inlet_Gas_Flow	FQRC_4003_01_SP	REAL-->AO	400100	400238			Mass Flow CO2 Inlet set point
117	4003	E	CL4003_Inlet_Gas_Flow	FQRC_4003_02_SP	REAL-->AO	400101	400240			Mass Flow Air Inlet set point
118	4003	E	CL4003_Inlet_Gas_Flow	FQRC_4003_03_SP	REAL-->AO	400102	400242			Mass Flow Circulated Air set point
119	4003	E	CL4003_Inlet_Gas_Flow	FQRC_4003_04_SP	REAL-->AO	400103	400244			Total Mass Flow Air Inlet set point
120	4003	E	CL4003_Inlet_Gas_Flow	FQRC_4003_01	AI ->REAL	300109	400176			Mass Flow CO2 Inlet
125	4003	E	CL4003_Inlet_Gas_Flow	FQRC_4003_02	AI ->REAL	300110	400178			Mass Flow Air Inlet
130	4003	E	CL4003_Inlet_Gas_Flow	FQRC_4003_03	AI ->REAL	300111	400180			Mass Flow recirculated Air
135	4003	E	CL4003_Inlet_Gas_Flow	FQRC_4003_04	AI ->REAL	300112	400182			Total Mass Flow Air Inlet
155	4004	E	CL4004_Outlet_Gas_Flow	SCV_4004_01_MV	REAL-->AO	400108	400248			Flow control Air outlet valve
156	4004	E	CL4004_Outlet_Gas_Flow	FT_4004_01	AI ->REAL	300129	400146			Total air outlet from reactor
161	4004	E	CL4004_Outlet_Gas_Flow	DPT_4004_01	AI ->REAL	300140	400166			Diff. Pressure Filter
171	4005	E	CL4005_PBR_Temp	BLWR_4005_01_ERR	DI	100103	100103			Thermal protection of extractor
172	4005	E	CL4005_PBR_Temp	SV_4005_01_MV	DO	000088	000088			Cooling water outlet valve
173	4005	E	CL4005_PBR_Temp	SV_4005_01_FB	DI	100086	100086	SV_4005_01 feed back		Feed back of the Cooling water outlet valve
175	4005	E	CL4005_PBR_Temp	PP_4005_01_MV1	DO	000102	000102			Start/Stop of the pump
176	4005	E	CL4005_PBR_Temp	BLWR_4005_01_MV1	DO	000099	000099			Start/Stop of the extractor
177	4005	E	CL4005_PBR_Temp	HX_4005_02_MV1	DO	000100	000100			Start/Stop electrical resistance
178	4005	E	CL4005_PBR_Temp	BLWR_4005_01_MV2	REAL-->AO	400104	400246			Blower air
179	4005	E	CL4005_PBR_Temp	TT_4005_01	AI ->REAL	300141	400168			Reactor Temp.
194	4006	E	CL4006_pH	SV_4006_01_FB	DI	100091	100091			Acid Inlet reactor
195	4006	E	CL4006_pH	SV_4006_02_FB	DI	100092	100092			Base Inlet reactor
196	4006	E	CL4006_pH	SV_4006_01_MV	DO	000083	000083			Acid Inlet reactor
197	4006	E	CL4006_pH	SV_4006_02_MV	DO	000082	000082			Base Inlet reactor
200	4006	E	CL4006_pH	PP_4006_01_MV1	DO	000098	000098			Start/Stop of the pump
201	4006	E	CL4006_pH	PP_4006_02_MV1	DO	000097	000097			Start/Stop of the pump
202	4006	E	CL4006_pH	WT_4006_01	Ethernet	Ethernet	400264			Balance Acid
205	4006	E	CL4006_pH	WT_4006_02	Ethernet	Ethernet	400266			Base Acid
208	4006	E	CL4006_pH	AT_4006_01	AI ->REAL	300127	400138			pH
209	4006	E	CL4006_pH	TT_4006_01	AI ->REAL	300128	400140			Temp. For pH
210	4006	E	CL4006_pH	AT_4006_02	AI ->REAL	300125	400142			pH
211	4006	E	CL4006_pH	TT_4006_02	AI ->REAL	300126	400144			Temp. For pH
242	4007	E	CL4007_PBR_Pressure	PT_4007_01	AI ->REAL	300135	400156			Reactor Pressure
248	4007	E	CL4007_PBR_Pressure	PT_4007_02	AI ->REAL	300136	400158			Reactor Pressure
259	4008	E	CL4008_PBR_Liquid_Level	WT_4008_01	AI ->REAL	300133	400154			Weight Balance (Reactor)
267	4009	E	CL4009_Biomass	AT_4009_01	AI ->REAL	300118	400124			Biomass
268	4009	E	CL4009_Biomass	AT_4009_02	AI ->REAL	300119	400126			Biomass
270	4009	E	CL4009_Biomass	AT_4009_FAILURE_IND	AI ->REAL	300120	400128			OLD NAME: TT_4009_01
289	4010	E	CL4010_OutletGasCompo	SV_4010_01_FB	DI	100093	100093			Gas Inlet analyser
290	4010	E	CL4010_OutletGasCompo	SV_4010_01_MV	DO	000081	000081			Gas Inlet analyser (reactor outlet)
292	4010	E	CL4010_OutletGasCompo	HX_4010_01_MV1	DO	NO CONNECTION	NO CONNECTION			Start/Stop Post condenser
295	4010	E	CL4010_OutletGasCompo	AT_4010_01	AI ->REAL	300121	400130			CO2analyser
296	4010	E	CL4010_OutletGasCompo	AT_4010_02	AI ->REAL	300122	400132			O2 analyser
297	4010	E	CL4010_OutletGasCompo	AT_4010_03	AI ->REAL	300123	400134			Dissolved O2
298	4010	E	CL4010_OutletGasCompo	PT_4010_01	AI ->REAL	300137	400160			Outlet Gas Pressure

Legend-->	Button : **B**	Alarm : **A**	System Clock : **SC**
	User Input: **U**	Equipment: **E**	Indicator: **I**

#	Control Loop	Legend Choice	PLC FBD	PLC Tag Name	Signal / Variable Type	Physical Address	HMI Address	HMI Name	Button HMI Type	Comment
299	**4010**	E	CL4010_OutletGasCompo	TT_4010_01	AI ->REAL	300143	400172			Analyser Temp.(OLD NAME: TT_4010_02)
326	**4011**	E	CL4011_Feeding_Temp	SV_4011_01_FB	DI	100087	100087			Cooling water outlet valve
327	**4011**	E	CL4011_Feeding_Temp	SV_4011_01_MV	DO	000087	000087			Cooling water outlet valve
329	**4011**	E	CL4011_Feeding_Temp	TT_4011_01	AI ->REAL	300142	400170			Inlet Vessel Temp.
338	**4012**	E	CL4012_Harvesting_Temp	SV_4012_01_FB	DI	100089	100089			Cooling water outlet valve
339	**4012**	E	CL4012_Harvesting_Temp	SV_4012_01_MV	DO	000085	000085			Cooling water outlet valve
341	**4012**	E	CL4012_Harvesting_Temp	TT_4012_01	AI ->REAL	300144	400174			Vessel Temp.
350	**4013**	E	CL4013_Antifoam	LS_4013_01	DI	100081	100081			Foam measurement
353	**4014**	E	CL4014_Feeding_Sterilization	SV_4014_01_FB	DI	100088	100088			Steam inlet valve
354	**4014**	E	CL4014_Feeding_Sterilization	SV_4014_01_MV	DO	000086	000086			Steam inlet valve
358	**4015**	E	CL4015_PBR_Sterilization	SV_4015_01_FB	DI	100098	100098			Steam inlet valve
359	**4015**	E	CL4015_PBR_Sterilization	SV_4015_01_MV	DO	000092	000092			Reactor Steam inlet valve
363	**4016**	E	CL4016_Harvesting_Sterilization	SV_4016_01_FB	DI	100090	100090			Steam Inlet Valve
364	**4016**	E	CL4016_Harvesting_Sterilization	SV_4016_01_MV	DO	000084	000084			Steam Inlet Valve

Legend--> WAIT FOR INFORMATIO N

INDEX	Control Loop	DFB Name	Threshold variable name	Type	HMI Address	Value	Unit	ACTION	Comments
1	All Valves	-	FB_TIME_LIM	TIME	400704	5	seconds		
2	All Pressure switch	-	PS_TIME_LIM	TIME	400706	10	seconds		
3	4000	CL4000_Lights	IT_4000_01_LIM_AH	REAL	400500	TBD	(W)	TBD	
4	4000	CL4000_Lights	IT_4000_01_LIM_AL	REAL	400502	TBD	(W)	TBD	
5	4000	CL4000_Lights	IT_4000_02_LIM_AH	REAL	400504	TBD	(W)	TBD	
6	4000	CL4000_Lights	IT_4000_02_LIM_AL	REAL	400506	TBD	(W)	TBD	
7	4000	CL4000_Lights	IT_4000_03_LIM_AH	REAL	400508	TBD	(W)	TBD	
8	4000	CL4000_Lights	IT_4000_03_LIM_AL	REAL	400510	TBD	(W)	TBD	
9	4001	CL4001_Inlet_Liquid_Flow	FT_4001_01_LIM_AHH	REAL	400512	0.2	(L/h)	Displays alarm on HMI only in automatic mode	Implement a time for triggering alarm (5min). Compare to the set point
10	4001	CL4001_Inlet_Liquid_Flow	FT_4001_01_LIM_AH	REAL	400514	0.1	(L/h)	Displays alarm on HMI only in automatic mode	Implement a time for triggering alarm (5min). Compare to the set point
11	4001	CL4001_Inlet_Liquid_Flow	FT_4001_01_LIM_AL	REAL	400516	-0.1	(L/h)	Displays alarm on HMI only in automatic mode	Implement a time for triggering alarm (5min). Compare to the set point
12	4001	CL4001_Inlet_Liquid_Flow	FT_4001_01_LIM_ALL	REAL	400518	-0.2	(L/h)	Displays alarm on HMI only in automatic mode	Implement a time for triggering alarm (5min). Compare to the set point
13	4001	CL4001_Inlet_Liquid_Flow	LT_4001_01_LIM_AHH	REAL	400520	140	Liter	Displays alarm on HMI	Feedind tank volume: 160 liters. Working Volume: 120 liters. The sensor need to be calibrated refering to the volume law provide by De
14	4001	CL4001_Inlet_Liquid_Flow	LT_4001_01_LIM_AH	REAL	400522	130	Liter	Displays alarm on HMI	Feedind tank volume: 160 liters. Working Volume: 120 liters. The sensor need to be calibrated refering to the volume law provide by De
15	4001	CL4001_Inlet_Liquid_Flow	LT_4001_01_LIM_AL	REAL	400524	20	Liter	Displays alarm on HMI	Feedind tank volume: 160 liters. Working Volume: 120 liters. The sensor need to be calibrated refering to the volume law provide by De
16	4001	CL4001_Inlet_Liquid_Flow	LT_4001_01_LIM_ALL	REAL	400526	6.5	Liter	Stop the inlet flow control loop (Only in automatic mode)	Feedind tank volume: 160 liters. Working Volume: 120 liters. The sensor need to be calibrated refering to the volume law provide by De
17	4001	CL4001_Inlet_Liquid_Flow	DPT_4001_01_LIM_AHH	REAL	400528	300	mBar	Stop the inlet flow control loop after 5 seconds	The maximum admissible pressure for the membrane has to be confirmed by Enrique / De dietrich
18	4001	CL4001_Inlet_Liquid_Flow	DPT_4001_01_LIM_AH	REAL	400530	200	mBar	Displays alarm on HMI	
19	4001	CL4001_Inlet_Liquid_Flow	DPT_4001_01_LIM_ALL	REAL	400532	TBD	mBar	Stop the inlet flow control loop	
20	4001	CL4001_Inlet_Liquid_Flow	DPT_4001_01_LIM_AL	REAL	400534	TBD	mBar	Displays alarm on HMI	
21	4001	CL4001_Inlet_Liquid_Flow	DPT_4001_02_LIM_AHH	REAL	400536	300	mBar	Stop the inlet flow control loop	The maximum admissible pressure for the membrane has to be confirmed by Enrique / De dietrich
22	4001	CL4001_Inlet_Liquid_Flow	DPT_4001_02_LIM_AH	REAL	400538	200	mBar	Displays alarm on HMI	
23	4001	CL4001_Inlet_Liquid_Flow	DPT_4001_02_LIM_AL	REAL	400540	TBD	mBar	Displays alarm on HMI	
24	4001	CL4001_Inlet_Liquid_Flow	DPT_4001_02_LIM_ALL	REAL	400542	TBD	mBar	Stop the inlet flow control loop	
25	4002	CL4002_Outlet_Liquid_Flow	WT_4002_01_LIM_AH	REAL	400544	100	kg	Displays alarm on HMI	Harvest tank volume: 120 liters. Working Volume: 90 liters. The sensor need to be calibrated refering to the volume law provide by De
26	4002	CL4002_Outlet_Liquid_Flow	WT_4002_01_LIM_AHH	REAL	400546	110	kg	Stop the inlet flow, the outlet flow and the bioreactor level control loop	Harvest tank volume: 120 liters. Working Volume: 90 liters. The sensor need to be calibrated refering to the volume law provide by De
27	4002	CL4002_Outlet_Liquid_Flow	WT_4002_01_LIM_AL	REAL	400548	20	kg	Displays alarm on HMI	Harvest tank volume: 120 liters. Working Volume: 90 liters. The sensor need to be calibrated refering to the volume law provide by De
28	4002	CL4002_Outlet_Liquid_Flow	WT_4002_01_LIM_ALL	REAL	400550	10	kg	Displays alarm on HMI	Harvest tank volume: 120 liters. Working Volume: 90 liters. The sensor need to be calibrated refering to the volume law provide by De
29	4003	CL4003_Inlet_Gas_Flow	FQRC_4003_01_LIM_AHH	REAL	400710	50	ml/min	Displays alarm on HMI (wait for information about action to do)	Alarm is triggered after 10s
30	4003	CL4003_Inlet_Gas_Flow	FQRC_4003_01_LIM_AH	REAL	400712	20	ml/min	Displays alarm on HMI	Alarm is triggered after 10s
31	4003	CL4003_Inlet_Gas_Flow	FQRC_4003_01_LIM_ALL	REAL	400714	-50	ml/min	Displays alarm on HMI	Alarm is triggered after 10s
32	4003	CL4003_Inlet_Gas_Flow	FQRC_4003_01_LIM_AL	REAL	400716	-20	ml/min	Displays alarm on HMI	Alarm is triggered after 10s
33	4003	CL4003_Inlet_Gas_Flow	FQRC_4003_02_LIM_AHH	REAL	400718	300	ml/min	Displays alarm on HMI	Alarm is triggered after 10s
34	4003	CL4003_Inlet_Gas_Flow	FQRC_4003_02_LIM_AH	REAL	400720	100	ml/min	Displays alarm on HMI	Alarm is triggered after 10s
35	4003	CL4003_Inlet_Gas_Flow	FQRC_4003_02_LIM_ALL	REAL	400740	-300	ml/min	Displays alarm on HMI	Alarm is triggered after 10s
36	4003	CL4003_Inlet_Gas_Flow	FQRC_4003_02_LIM_AL	REAL	400722	-100	ml/min	Displays alarm on HMI	Alarm is triggered after 10s
37	4003	CL4003_Inlet_Gas_Flow	FQRC_4003_03_LIM_AHH	REAL	400724	300	ml/min	Displays alarm on HMI	Alarm is triggered after 10s
38	4003	CL4003_Inlet_Gas_Flow	FQRC_4003_03_LIM_AH	REAL	400726	100	ml/min	Displays alarm on HMI	Alarm is triggered after 10s
39	4003	CL4003_Inlet_Gas_Flow	FQRC_4003_03_LIM_ALL	REAL	400728	-300	ml/min	Displays alarm on HMI	Alarm is triggered after 10s
40	4003	CL4003_Inlet_Gas_Flow	FQRC_4003_03_LIM_AL	REAL	400730	-100	ml/min	Displays alarm on HMI	Alarm is triggered after 10s
41	4003	CL4003_Inlet_Gas_Flow	FQRC_4003_04_LIM_AHH	REAL	400732	300	ml/min	Displays alarm on HMI	Alarm is triggered after 10s
42	4003	CL4003_Inlet_Gas_Flow	FQRC_4003_04_LIM_AH	REAL	400734	100	ml/min	Displays alarm on HMI	Alarm is triggered after 10s
43	4003	CL4003_Inlet_Gas_Flow	FQRC_4003_04_LIM_ALL	REAL	400736	-300	ml/min	Displays alarm on HMI	Alarm is triggered after 10s
44	4003	CL4003_Inlet_Gas_Flow	FQRC_4003_04_LIM_AL	REAL	400738	-100	ml/min	Displays alarm on HMI	Alarm is triggered after 10s
45	4004	CL4004_Outlet_Gas_Flow	FT_4004_01_LIM_AHH	REAL	400552	1	(L/min)	Displays alarm on HMI	When the Outlet gas flow control loop is in automatic mode, the threshold is linked to Outlet flow setpoint. When the bioreactor pressure control is in automatic mode, the threshold is linked to the
46	4004	CL4004_Outlet_Gas_Flow	FT_4004_01_LIM_AH	REAL	400554	0.5	(L/min)	Displays alarm on HMI	same than above
47	4004	CL4004_Outlet_Gas_Flow	FT_4004_01_LIM_ALL	REAL	400556	-1	(L/min)	Displays alarm on HMI	same than above
48	4004	CL4004_Outlet_Gas_Flow	FT_4004_01_LIM_AL	REAL	400558	-0.5	(L/min)	Displays alarm on HMI	same than above
49	4004	CL4004_Outlet_Gas_Flow	DPT_4004_01_LIM_AHH	REAL	400560	300	(mbar)	Displays alarm on HMI	
50	4004	CL4004_Outlet_Gas_Flow	DPT_4004_01_LIM_AH	REAL	400562	200	(mbar)	Displays alarm on HMI	
51	4004	CL4004_Outlet_Gas_Flow	DPT_4004_01_LIM_ALL	REAL	400564	TBD	(mbar)	Displays alarm on HMI	FOR THE MOMENT -300 mbar
52	4004	CL4004_Outlet_Gas_Flow	DPT_4004_01_LIM_AL	REAL	400566	TBD	(mbar)	Displays alarm on HMI	FOR THE MOMENT -200 mbar
53	4005	CL4005_PBR_Temp	TT_4005_01_LIM_AHH	REAL	400568	4	(ºC)	Put the light to 10%	The light will return to nominal intensity when the temperature is 1°C above the setpoint.
54	4005	CL4005_PBR_Temp	TT_4005_01_LIM_AH	REAL	400570	1	(ºC)	Displays alarm on HMI	
55	4005	CL4005_PBR_Temp	TT_4005_01_LIM_ALL	REAL	400572	-4	(ºC)	stop the blower	the blower will be restarted when the temperature reach -1° C compare to the setpoint
56	4005	CL4005_PBR_Temp	TT_4005_01_LIM_AL	REAL	400574	-1	(ºC)	Displays alarm on HMI	
57	4006	CL4006_pH	WT_4006_01_LIM_AL	REAL	400576	1	(Kg.)	Displays alarm on HMI	

58	4006	CL4006_pH	WT_4006_01_LIM_ALL	REAL	400578	0.5	(Kg.)	Start the CO2 and BASE pH mode in automatic mode	
59	4006	CL4006_pH	WT_4006_02_LIM_AL	REAL	400580	1	(Kg.)	Displays alarm on HMI	
60	4006	CL4006_pH	WT_4006_02_LIM_ALL	REAL	400582	0.5	(Kg.)	Displays alarm on HMI	
61	4006	CL4006_pH	CL4006_pH_LIM_AHH	REAL	400584	10.5(fix value)	(pH)	Cut the Controller	
62	4006	CL4006_pH	CL4006_PH_LIM_AH	REAL	400586	0.2	(pH)	Displays alarm on HMI	The value need To be ajusted with the control test done by sherpa
63	4006	CL4006_pH	CL4006_PH_LIM_AL	REAL	400588	-0.2	(pH)	Displays alarm on HMI	The value need To be ajusted with the control test done by sherpa
64	4006	CL4006_pH	CL4006_PH_LIM_ALL	REAL	400590	8.5 (fix value)	(pH)	Cut the Controller	
65	4006	CL4006_pH	AT_4006_SENSOR_DEVIATIO N_LIM	REAL	400708	0.5	(pH)	Displays alarm on HMI	The alarm is permanently checking the sensor deviation. Even if you choose only one of the two sensor.
66	4007	CL4007_PBR_Pressure	PT_4007_01_LIM_AH	REAL	400592	20	(mbar)	only in automatic mode Displays alarm on HMI	Compare to the set point
67	4007	CL4007_PBR_Pressure	PT_4007_01_LIM_AHH	REAL	400594	420	(mbar)	only in automatic mode reduce the total gas mix flow to 1500 ml/mn	Compare to the set point
68	4007	CL4007_PBR_Pressure	PT_4007_01_LIM_AHHH	REAL	400742	1500 (fix value)	(mbar)	stop all the inlet gas flow control loop. If pH use CO2, put pH mode in ACID and BASE.	Fix Value Threshold created for the bioreactor safety
69	4007	CL4007_PBR_Pressure	PT_4007_02_LIM_AHHH	REAL	400744	1500 (fix value)	(mbar)	stop all the inlet gas flow control loop. If pH use CO2, put pH mode in ACID and BASE.	Fix Value Threshold created for the bioreactor safety
70	4007	CL4007_PBR_Pressure	PT_4007_01_LIM_AL	REAL	400596	-40	(mbar)	only in automatic mode Displays alarm on HMI	Compare to the set point
71	4007	CL4007_PBR_Pressure	PT_4007_01_LIM_ALL	REAL	400598	-80	(mbar)	only in automatic mode Displays alarm on HMI	Compare to the set point
72	4007	CL4007_PBR_Pressure	PT_4007_02_LIM_AH	REAL	400600	20	(mbar)	only in automatic mode Displays alarm on HMI	Compare to the set point
73	4007	CL4007_PBR_Pressure	PT_4007_02_LIM_AHH	REAL	400602	420	(mbar)	only in automatic mode reduce the total gas mix flow to 1500 ml/mn	Compare to the set point
74	4007	CL4007_PBR_Pressure	PT_4007_02_LIM_AL	REAL	400604	-40	(mbar)	only in automatic mode Displays alarm on HMI	Compare to the set point
75	4007	CL4007_PBR_Pressure	PT_4007_02_LIM_ALL	REAL	400606	-80	(mbar)	only in automatic mode Displays alarm on HMI	Compare to the set point
76	4008	CL4008_PBR_Liquid_Level	WT_4008_01_LIM_AH	REAL	400608	88	(Kg.)	Displays alarm on HMI	
77	4008	CL4008_PBR_Liquid_Level	WT_4008_01_LIM_AHH	REAL	400610	90	(Kg.)	Stop the Inlet liquid Flow loop	
78	4008	CL4008_PBR_Liquid_Level	WT_4008_01_LIM_AL	REAL	400612	84	(Kg.)	Displays alarm on HMI	
79	4008	CL4008_PBR_Liquid_Level	WT_4008_01_LIM_ALL	REAL	400614	82	(Kg.)	Displays alarm on HMI	
80	4009	CL4009_Biomass	AT_4009_01_LIM_AH	REAL	400616	3(fix value)	(g/l)	Displays alarm on HMI	UAB need to confirmed the value
81	4009	CL4009_Biomass	AT_4009_01_LIM_AHH	REAL	400618	3.5(fix value)	(g/l)	Displays alarm on HMI	UAB need to confirmed the value
82	4009	CL4009_Biomass	AT_4009_01_LIM_AL	REAL	400620	1.2(fix value)	(g/l)	Displays alarm on HMI	UAB need to confirmed the value
83	4009	CL4009_Biomass	AT_4009_01_LIM_ALL	REAL	400622	1(fix value)	(g/l)	Displays alarm on HMI	UAB need to confirmed the value
84	4009	CL4009_Biomass	AT_4009_02_LIM_AH	REAL	400624	3(fix value)	(g/l)	Displays alarm on HMI	UAB need to confirmed the value
85	4009	CL4009_Biomass	AT_4009_02_LIM_AHH	REAL	400626	3.5(fix value)	(g/l)	Displays alarm on HMI	UAB need to confirmed the value
86	4009	CL4009_Biomass	AT_4009_02_LIM_AL	REAL	400628	1.2(fix value)	(g/l)	Displays alarm on HMI	UAB need to confirmed the value
87	4009	CL4009_Biomass	AT_4009_02_LIM_ALL	REAL	400630	1(fix value)	(g/l)	Displays alarm on HMI	UAB need to confirmed the value
88	4009	CL4009_Biomass	AT_4009_SENSORFAILLURE_	REAL	400632	10(fix value)	(mA)	Displays alarm on HMI	OLD TAG: TT_4009_01_LIM_AL
89	4010	CL4010_OutletGasCompo	AT_4010_01_LIM_AH	REAL	400640	450(fix value)	(ppm)	Displays alarm on HMI	
90	4010	CL4010_OutletGasCompo	AT_4010_01_LIM_AHH	REAL	400642	500(fix value)	(ppm)	Displays alarm on HMI	
91	4010	CL4010_OutletGasCompo	AT_4010_01_LIM_AL	REAL	400644	350(fix value)	(ppm)	Displays alarm on HMI	
92	4010	CL4010_OutletGasCompo	AT_4010_01_LIM_ALL	REAL	400646	300(fix value)	(ppm)	Displays alarm on HMI	
93	4010	CL4010_OutletGasCompo	AT_4010_02_LIM_AH	REAL	400648	22(fix value)	(%)	Displays alarm on HMI	To be defined after (related with the CV integration
94	4010	CL4010_OutletGasCompo	AT_4010_02_LIM_AHH	REAL	400650	24(fix value)	(%)	Put the light to 10%	To be defined after (related with the CV integration
95	4010	CL4010_OutletGasCompo	AT_4010_02_LIM_AL	REAL	400652	20(fix value)	(%)	Displays alarm on HMI	To be defined after (related with the CV integration
96	4010	CL4010_OutletGasCompo	AT_4010_02_LIM_ALL	REAL	400654	19.5(fix value)	(%)	Displays alarm on HMI	To be defined after (related with the CV integration
97	4010	CL4010_OutletGasCompo	AT_4010_03_LIM_AH	REAL	400656	90(fix value)	(%)	Displays alarm on HMI	To be defined after (related with the CV integration
98	4010	CL4010_OutletGasCompo	AT_4010_03_LIM_AHH	REAL	400658	95(fix value)	(%)	Displays alarm on HMI	To be defined after (related with the CV integration
99	4010	CL4010_OutletGasCompo	AT_4010_03_LIM_AL	REAL	400660	70(fix value)	(%)	Displays alarm on HMI	To be defined after (related with the CV integration
100	4010	CL4010_OutletGasCompo	AT_4010_03_LIM_ALL	REAL	400662	65(fix value)	(%)	Displays alarm on HMI	To be defined after (related with the CV integration
101	4010	CL4010_OutletGasCompo	PT_4010_01_LIM_AH	REAL	400672	80	(mbar)	Displays alarm on HMI	To be defined after (related with the CV integration
102	4010	CL4010_OutletGasCompo	PT_4010_01_LIM_AHH	REAL	400674	100	(mbar)	close the SV_4010_01 maintain the control of light to the same value.	To be defined
103	4010	CL4010_OutletGasCompo	PT_4010_01_LIM_AL	REAL	400676	20	(mbar)	Displays alarm on HMI	To be defined
104	4010	CL4010_OutletGasCompo	PT_4010_01_LIM_ALL	REAL	400678	0	(mbar)	close the SV_4010_01 maintain the control of light to the same value.	To be defined
105	4010	CL4010_OutletGasCompo	TT_4010_01_LIM_AH	REAL	400680	?	(ºC)	Displays alarm on HMI	UAB need to confirmed the value
106	4010	CL4010_OutletGasCompo	TT_4010_01_LIM_AHH	REAL	400682	?	(ºC)	close the SV_4010_01 maintain the control of light to the same value.	UAB need to confirmed the value
107	4010	CL4010_OutletGasCompo	TT_4010_01_LIM_AL	REAL	400684	?	(ºC)	Displays alarm on HMI	UAB need to confirmed the value
108	4010	CL4010_OutletGasCompo	TT_4010_01_LIM_ALL	REAL	400686	?	(ºC)	Displays alarm on HMI	UAB need to confirmed the value
109	4011	CL4011_Feeding_Temp	TT_4011_01_LIM_AH	REAL	400688	1	(ºC)	Displays alarm on HMI	Compare to the set point
110	4011	CL4011_Feeding_Temp	TT_4011_01_LIM_AHH	REAL	400690	2	(ºC)	Displays alarm on HMI	Compare to the set point
111	4011	CL4011_Feeding_Temp	TT_4011_01_LIM_AL	REAL	400692	-1	(ºC)	Displays alarm on HMI	Compare to the set point. Action will be defined after with the close
112	4011	CL4011_Feeding_Temp	TT_4011_01_LIM_ALL	REAL	400694	-2	(ºC)	Displays alarm on HMI	Compare to the set point
113	4012	CL4012_Harvesting_Temp	TT_4012_01_LIM_AH	REAL	400696	1	(ºC)	Displays alarm on HMI	Compare to the set point
114	4012	CL4012_Harvesting_Temp	TT_4012_01_LIM_AHH	REAL	400698	2	(ºC)	Displays alarm on HMI	Compare to the set point. Action will be defined after with the close
115	4012	CL4012_Harvesting_Temp	TT_4012_01_LIM_AL	REAL	400700	-1	(ºC)	Displays alarm on HMI	Compare to the set point
116	4012	CL4012_Harvesting_Temp	TT_4012_01_LIM_ALL	REAL	400702	-2	(ºC)	Displays alarm on HMI	Compare to the set point

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TECHNICAL NOTE TN22

CIVa - Control Loop Tests Plan
Control Loop Tests Report

Prepared by/Préparé par	Olivier Gerbi/Christophe Bourg
Reference/Référence	ESA/UAB Contract
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APPROVAL

Title *Titre*	**CIVa Control Loop Tests Plan & Report**	Issue *Edition*	1	Revision *Révision*	1

Author *Auteur*	Olivier Gerbi/ Christophe Bourg	Date *Date*	08/10/2010

Approved by *Approuvé par*		Date *Date*	

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Creation	1	0	Draft	January 2010
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Distribution List

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TABLE OF CONTENT

TABLE OF FIGURES

1. Introduction

CIVa compartment was rebuilt at the MPP location and the control loops have been defined and programmed in the Control System, Schneider Quantum PLC.

Specific Objectives of this Technical Note are

- To define the test plan for the control loops of the CIVa compartment as part of the complete functional tests of the process.
- To present the test report.

The dynamic control loops shall be tested validated in order to demonstrate that the process is controlled according to the requirements.

2. Test Plan

2.1. Closed Loop Tests

Here below the complete list of the control loops of the CIVa compartment.

New Control Loop	***Control Loop Name***	***Location***	***FBD_Name***
4000	CIVa Bioreactor lighting control	PBR	CL4000_Lights
4001	Inlet liquid flow control	Inlet	CL4001_Inlet_Liquid_Flow
4002	Outlet liquid flow control	Outlet	CL4002_Outlet_Liquid_Flow
4003	Inlet gas flow control	Inlet	CL4003_Inlet_Gas_Flow
4004	Outlet gas flow control	Outlet	CL4004_Outlet_Gas_Flow
4005	Bioreactor temperature control	PBR	CL4005_PBR_Temp
4006	Bioreactor pH control	PBR	CL4006_pH
4007	Bioreactor pressure control	PBR	CL4007_PBR_Pressure
4008	Bioreactor liquid level control	PBR	CL4008_PBR_Liquid_Level
4009	Bioreactor biomass production control	PBR	CL4009_Biomass
4010	Bioreactor outlet gas composition control	PBR	CL4010_OutletGasCompo
4011	Feeding tank temperature control	Influent	CL4011_Feeding_Temp
4012	Harvesting tank temperature control	Harvest	CL4012_Harvesting_Temp
4013	Antifoam control	PBR	CL4013_Antifoam
4014	Feeding tank sterilization	Influent	CL4014_Feeding_Sterilization
4015	CIVa Bioreactor sterilization	PBR	CL4015_PBR_Sterilization
4016	Harvesting tank sterilization	Harvest	CL4016_Harvesting_Sterilization

The dynamic control loops are :

- Inlet Liquid Flow Control (4001)
- Bioreactor Temperature Control (4005)
- Bioreactor pH Control (4006)
- Bioreactor Pressure Control (4007)
- Bioreactor Liquid Level Control (4008 and 4002)
- Bioreactor Outlet Gas Composition Control (4010 and 4000)
- Feeding Tank Temperature Control (4011)
- Harvesting Tank Temperature Control (4012)

Moreover:

- Inlet Gas Flow Control (4003) is not a dynamic control but adjusts Air Flow to maintain the desired Total Air Flow entering into the PBR.
- Outlet gas flow control (4004) can be used as an alternative to the Pressure control of the PBR.
- Bioreactor Biomass Production is not controlled as it is the result of the Biomass Concentration and the Inlet Flow Rate.
- Antifoam Control is not implemented as there is no sensor.
- Feeding Tank, Bioreactor and Harvesting Tank sterilization procedures have to be defined and tested in the global functional test plan. They are not defined as automatic sequences.

2.1.1.Inlet liquid flow control (4001)

Objective:

Validate that the inlet flow is well controlled. With the 1st or the 2nd pump.

2.1.1.1. *Operating Conditions*

Inlet Buffer Tank is not in Low Low Alarm	LT_4001_01 > 5 L
Inlet Flow Mode in OFF Mode	HMI : Inlet Flow Mode = OFF
Inlet Flow Set Point = 0 L/H	HMI : FT_4001_01_SP = 0
PBR Level is either controlled or the PBR level is not in High Alarm	
Inlet Liquid Line between Influent and PBR shall be full (not starting conditions of the PBR)	

2.1.1.2. *Variables to be recorded*

Inlet Flow and Set Point (FT_4001_01 and FT_4001_SP)
Inlet Pump Speed (CL4001_PumpSpeed).

2.1.1.3. *Test Procedure*

Select one pump and change the set point.
Wait for stabilization and change the set point.
To be done for both pumps

Seq Nb	Description	Required	Remarks	Status
1	(HMI) Select Pump GP_4001_01			
2	(HMI) Inlet Flow Mode = AUTO			
3	(HMI) Change Set Point FT_4001_01_SP = 0.6 L/H			
4	Wait For Stabilization	Indicate Time for Stabilisation and	Check that the set point is satisfied	

		Speed Velocity CL4001_PumpSpeed		
5	(HMI) Change Set Point FT_4001_01_SP = 0.7 L/H			
6	Wait For Stabilization	Indicate Time for Stabilisation and Speed Velocity CL4001_PumpSpeed	Check that the set point is satisfied	
7	(HMI) Change Set Point FT_4001_01_SP = 0.5 L/H			
8	Wait For Stabilization	Indicate Time for Stabilisation and Speed Velocity CL4001_PumpSpeed	Check that the set point is satisfied	
9	(HMI) Change Set Point FT_4001_01_SP = 0.0 L/H			
10	Wait For Stabilization	Indicate Time for Stabilisation and Speed Velocity CL4001_PumpSpeed	Check that the set point is satisfied	
11	(HMI) Select Pump GP_4001_02			
12	(HMI) Change Set Point FT_4001_01_SP = 0.6 L/H			
13	Wait For Stabilization	Indicate Time for Stabilisation and Speed Velocity CL4001_PumpSpeed	Check that the set point is satisfied	
14	(HMI) Change Set Point FT_4001_01_SP = 0.7 L/H			
15	Wait For Stabilization	Indicate Time for Stabilisation and Speed Velocity CL4001_PumpSpeed	Check that the set point is satisfied	
16	(HMI) Change Set Point FT_4001_01_SP = 0.0			

	L/H			
17	Wait For Stabilization	Indicate Time for Stabilisation and Speed Velocity CL4001_PumpSpeed	Check that the set point is satisfied	
18	(HMI) Inlet Flow Mode = OFF			

<u>Acceptance Criteria:</u>
(January 2010).
The Performances are not clearly defined. The liquid flow rate shall be controlled between 0.5 and 0.8 L/h.
Flow controlled at +/- 0.02

2.1.2.Outlet liquid flow control (4002)

There is no flow sensor for the outlet liquid line.
An estimator of the flow through the mass measurement of the harvesting tank is implemented. This estimator can not be used for flow control.
This control loop is only used in association with the PBR Level Control loop.

This Control loop can be used in MANual, in order to set the pump speed

2.1.3. Inlet gas flow control (4003)

Remark: it is not a dynamic control loop.

Objective:

Check that the total gas inlet flow is equal to the specified set point.

2.1.3.1. *Operating Conditions*

Gas Inlet Flow Mode in OFF Mode	HMI : Gas Inlet Flow Mode = OFF
Total Air Flow Set Point = 0 ml/mn	HMI : FQRC_4003_04_SP_OP = 0 ml/mn
Air Inlet Flow shall be available and Outlet gas line open.	
Cooler of the outlet gas line shall be ON	
Recycle in OFF mode	HMI : Recycle Mode = OFF
All necessary Hand Valves shall be opened	
CO2 air flow not used for pH control	
CO2 Set Point = 0 mL/mn	HMI : FQRC_4003_01_SP_OP = 0 ml/mn

2.1.3.2. *Variables to be recorded*

All Gas Flows and their set points :

- Total Air Flow and Set Point (FQRC_4003_04 and FQRC_4003_04_SP)
- Air Inlet Flow and Set Point (FQRC_4003_02 and FQRC_4003_02_SP)
- Recycle Flow and Set Point (FQRC_4003_03 and FQRC_4003_03_SP)
- CO_2 Inlet Flow and Set Point (FQRC_4003_01 and FQRC_4003_01_SP)

2.1.3.3. *Test Procedure*

Check that the total air flow set point is satisfied with the air flow in AUTOmatic mode.

Seq Nb	Description	Required	Remarks	Status
1	(HMI) Gas Inlet Flow Mode = AUTO			
2	(HMI) FQRC_4003_04_SP_OP			

	= 2000 ml/mn			
3	Wait For Stabilization		Check that the set point is satisfied	
4	(HMI) Change Set Point FQRC_4003_04_SP_OP = 2300 ml/mn			
5	Wait For Stabilization		Check that the set point is satisfied	
6	(HMI) Change Set Point for CO2 FQRC_4003_01_SP = 200 ml/mn			
7	Wait For Stabilization		Check that the set point is satisfied	
8	(HMI) Recycle Mode = AUTO			
9	(HMI) Change Set Point FQRC_4003_03_SP = 1000 ml/mn			
10	Wait For Stabilization		Check that the set point is satisfied	

Acceptance Criteria:
Total Air Flow Set Point is satisfied

2.1.4.Outlet gas flow control (4004)

No gas flow control is implemented.
The equipment (automatic valve) is used for the pressure control of the bioreactor.

2.1.5. PBR Temperature Control (4005)

Objective:

To validate the temperature controller.

2.1.5.1. *Operating Conditions*

This test can be performed during operation.
The controller can be previously running.

The temperature control is mainly used for cooling the bioreactor in order to maintain the temperature which increases with the lights.
In case of start-up or temperature lower than the set point, the resistance is used for increasing the temperature.

PBR temperature Mode in AUTO Mode	HMI : PBR Temperature Mode = AUTO
Bioreactor shall be filled (Water or Medium)	
Temperature set point = 36 °C	HMI : TT_4005_SP = 36 °C
Blower Mode in AUTO at 50 %	BLWR_4005_01_SP = 50 %
Lights Mode in MANual	HMI : Lights Mode = MANU
Lights ON at 20 %	I_4000_MV = 20 %
Level Control can be in AUTO or in OFF mode	HMI : Level Mode = AUTO or OFF
Inlet Gas Flow in AUTO Set Point set at 2000 mL/mn	HMI : Inlet Gas = AUTO FQRC_4003_04_SP = 2000 mL/mn
The cooling system shall be available	

2.1.5.2. *Variables to be recorded*

Temperature and set point (TT_4005_01 and TT_4005_01_SP).
Circulating pump PP_4005_01
Cooling valve and heating resistance (SV_4005_01 and HX_4005_02)
Lights Intensity (IRC_4000_MV)

2.1.5.3. *Test Procedure*

Perform Temperature set point changes to validate the control.

Seq Nb	Description	Required	Remarks	Status
1	(HMI) Temp Mode = AUTO	Temp = SP		
2	(HMI) TT_4005_SP = 35 °C			
3	Wait For Stabilization	Indicate Time for Stabilisation	Check that the set point is satisfied	
4	(HMI) TT_4005_SP = 36 °C			
5	Wait For Stabilization	Indicate Time for Stabilisation	Check that the set point is satisfied	
6	(HMI) Increase Lights to 50 %			
7	Wait For Stabilization		Check that the set point is satisfied	
8	(HMI) TT_4005_SP = 35 °C			
9	Wait For Stabilization	Indicate Time for Stabilisation	Check that the set point is satisfied	
10	(HMI) TT_4005_SP = 36 °C			
11	Wait For Stabilization	Indicate Time for Stabilisation	Check that the set point is satisfied	
12	(HMI) Increase Lights to 100 %			
13	Wait For Stabilization		Check that the set point is satisfied	
14	(HMI) TT_4005_SP = 35 °C			
15	Wait For Stabilization	Indicate Time for Stabilisation	Check that the set point is satisfied	
16	(HMI) TT_4005_SP = 36 °C			
17	Wait For Stabilization	Indicate Time for Stabilisation	Check that the set point is satisfied	

Acceptance Criteria:
Controlled Temperature TT_4005_01 is satisfied at +/- 0.2 °C in steady state.

2.1.6. pH Control Loop (4006)

Objective :

To Validate the pH controllers. Either with Acid and Base or CO_2.

2.1.6.1. *Operating Conditions*

pH control mode in OFF	(HMI) PH mode = OFF
Bioreactor shall be filled (Water or Medium) and level not in LL or HH alarm	
Acid Tank filled with Acid	
Base Tank filled with Base	
Acid Pump set at 230 RPM	
Base Pump set at 230 RPM	
No LL alarm for Acid Tank	
No LL alarm for Base Tank	
Appropriate Hand Valves of the Acid and Base Lines shall be opened	
CO_2 shall be available	

2.1.6.2. *Variables to be recorded*

pH, pH Set Point (AT_4006_01, AT_4006_02, AT_4006_AVG, AT_4006_SP)
Acid and Base Valves and pumps (SV_4006_01, PP_4006_01, SV_4006_02, PP_4006_02)
CO2 set point and measurement (FQRC_4003_01 and FQRC_4003_01_SP)

2.1.6.3. *Test Procedure*

pH should be steady before the test.

Change pH Set Point for different pH mode (Acid/Base/CO2) and wait until the stabilisation.

Seq Nb	Description	Required	Remarks	Status
1	(HMI) pH Probe selection = Average			
1	(HMI) pH Mode = Acid and Base			
2	(HMI) pH set point = pH_Average			
3	(HMI) pH Deadzone = 0.02			
4	(HMI) pH Mode from OFF to AUTO			
5	Wait for 15 minutes	pH = pH set point +/- Deadzone		
6	(HMI) Increase pH Set Point : + 0.1 Ex : From 9.7 to 9.8			
7	Wait for Stabilisation	Indicate Time for Stabilisation	Estimated time : 1 hour	
8	(HMI) Decrease pH Set Point : - 0.1 Ex : From 9.8 to 9.7			
9	Wait for Stabilisation	Indicate Time for Stabilisation	Estimated time : 1 hour	
10	(HMI) pH Mode = CO_2 and Base			
11	(HMI) Decrease pH Set Point : - 0.1 Ex : From 9.7 to 9.6			
12	Wait for Stabilisation	Indicate Time for Stabilisation	Estimated time : 2.25 hour	

Acceptance Criteria:
Controlled pH is satisfied in the dead zone in steady state.

2.1.7. Bioreactor pressure control (4007)

Objective:

To validate the pressure controller.

2.1.7.1. *Operating Conditions*

Pressure control mode in OFF	(HMI) Pressure mode = OFF
Bioreactor shall be full (Water or Medium)	
Outlet gas line open to atmosphere	HV_4004_05 open
Gas passing through analysers	(HMI) SV_4010_01 = ON
Recycle Mode in OFF mode	(HMI) Recycle = OFF
Inlet Gas Flow in AUTO mode	(HMI) Inlet Gas Flow Mode = AUTO
Total Gas flow set Point = 2000 mL/mn	FQRC_4003_04_SP = 2000 mL/mn

2.1.7.2. *Variables to be recorded*

Pressures in the Bioreactor, set point (PT_4007_01, PT_4007_02, PT_4007_SP)
Regulation Valve (SCV_4004_01_MV),
Inlet Gas flow and Outlet Gas flow (FQRC_4003_04_SP, FQRC_4003_04, FT_4004_01)
Analyser Valve (SV_4010_01)

2.1.7.3. *Test Procedure*

Seq Nb	Description	Required	Remarks	Status
1	(HMI) Pressure Probe selection = 1 (PT_4007_01)			
2	(HMI) Pressure Set Point = 80 mbar			

3	(HMI) Pressure Mode = AUTO			
4	Wait for Stabilisation			
5	(HMI) Change Inlet Gas Flow Ex : From 2000 mL/mn to 2100 mL/min			
6	Wait for Stabilisation			
7	(HMI) Change Inlet Gas Flow Ex : From 2100 mL/mn to 1900 mL/mn			
8	Wait for Stabilisation			
9	(HMI) SV_4010_01 = OFF			
10	Wait for Stabilisation			
11	(HMI) Recycle Mode = AUTO			
12	(HMI) FQRC_4003_03_SP = 1000 ml/mn			
13	Wait for Stabilisation			
14	(HMI) SV_4010_01 = ON			
15	Wait for Stabilisation			

<u>Acceptance Criteria:</u>
Pressure is maintained at the set point (80 mbar) +/- 5 mbar

2.1.8. Bioreactor liquid level control (4008)

Objective:

To validate the level controller.

2.1.8.1. *Operating Conditions*

Remark: when switching Level Control Mode from OFF to AUTO, the PLC switches also the Outlet Liquid Control Mode to AUTO.

Level Control Mode in OFF mode	(HMI) Reactor Level Mode = OFF
Bioreactor shall be full (Water or Medium)	
Inlet Buffer Tank is not in Low Low Alarm	LT_4001_01 > 5 L
Harvest Tank is not in High High Alarm	WT_4002_01 < 110 kg

Remark: depending on the effect of the cooling valve (of the PBR temperature control), the test can be performed either with PBR Temperature Control in AUTO or OFF Mode

2.1.8.2. *Variables to be recorded*

PBR level (WT_4008_01)
Feeding Tank Level (LT_4001_01)
Inlet Flow and Speed (FT_4001_01, FT_4001_01_SP, CL4001_PumpSpeed)
Outlet Flow Speed (CL_4002_PumpSpeed)
Harvest Tank weight (WT_4002_01)

2.1.8.3. *Test Procedure*

Remark: the proposed set point changes shall be adjusted to the adequate values.
Instead of 1 kg, it could be for instance 0.1 kg, 0.2 kg or 0.5 kg.

Seq Nb	Description	Required	Remarks	Status
1	(HMI) Inlet Flow Mode = OFF			

2	(HMI) Level Set Point = Measured Level			
3	(HMI) Level Control Mode = AUTO			
4	Wait for Stabilisation		Indicate Time for Stabilisation	
5	(HMI) Level Set Point = Measured Level – 1 kg			
6	Wait for Stabilisation		Indicate Time for Stabilisation	
5	(HMI) Change Set Point FT_4001_01_SP = 0.6 L/H			
6	(HMI) Inlet Flow Mode = AUTO			
7	Wait for Stabilisation		Indicate Time for Stabilisation	
8	(HMI) Level Set Point = Level + 1 kg			
9	Wait for Stabilisation		Indicate Time for Stabilisation	

<u>Acceptance Criteria:</u>
Level (weight) is maintained at the set point +/- TBD
Accuracy of the control is linked to the level (weight/balance) measurement accuracy.

2.1.9.Bioreactor biomass production control (4009)

There is no dynamic control associated.
The biomass production is displayed on the HMI as :
BiomassProduction (g/h) = BiomassConcentration (g/L) * InletFlow (L/h)

2.1.10.Bioreactor outlet gas composition control (4010)

Objective :

To Validate the O2 control with lights and Athrospira Platensis

2.1.10.1. *Operating Conditions*

O_2 composition (%) is controlled with the lights

Gas Composition Mode in OFF	(HMI) Gas Composition Mode = OFF
Bioreactor shall be full (Arthrospira)	
Lights shall be available	
Liquid Loops shall be in AUTO and the Level Controlled	(HMI) Level Mode = AUTO
Inlet Gas Loop in AUTO. Set Point to Nominal value (2000 L/mn)	(HMI) Inlet Gas Flow Mode = AUTO FQRC_4003_04_SP = 2000 mL/mn
Pressure Control Mode in AUTO and its set point is 80 mbar	(HMI) Pressure Mode = AUTO PT_4007_01_SP = 80 mbar
Biomass Concentration greater than 1 g/L	
O2 and CO2 analyser connected and calibrated	
Recycle Mode in OFF Mode	(HMI) Recycle Mode = OFF
pH controlled in Acid/Base Mode	

CO_2 injection or not (TBD with UAB)

2.1.10.2. *Variables to be recorded*

O2 and CO2 (AT_4010_02, AT_4010_01) and O2 set point (AT_4010_02_SP)
Light Intensity (IRC_4000_MV, I_4000_MV, I_4000_SP)
CO_2 flow rate if any (FQRC_4003_01_SP)

2.1.10.3. *Test Procedure*

Seq Nb	Description	Required	Remarks	Status
1	(HMI) O_2 Set Point = O_2 Measurement			
2	(HMI) Gas Composition Mode = AUTO			
3	Wait for Stabilisation		About 15 minutes?	
4	(HMI) O_2 Set Point + 0.1%			
5	Wait for Stabilisation		Indicate Time for Stabilisation	
6	(HMI) O2 Set Point + 0.1%			
7	Wait for Stabilisation		Indicate Time for Stabilisation	
8	Repeat the operation until lights are about 80 %			
9	Wait for Stabilisation		Indicate Time for Stabilisation	

<u>Acceptance Criteria:</u>
O2 set point is satisfied +/ % (TBD)
Time for Stabilisation?

2.1.11.Feeding tank temperature control (4011)

Objective :

To Validate the Feeding Temperature Control.

2.1.11.1. *Operating Conditions*

Feeding Tank shall be filled with medium And not in Low or High Alarm	(HMI) LT_4001_01 > 20 L and LT_4001_01 < 130 L
Feed Agitator in AUTO mode	(HMI) Feed Agitator = AUTO
MPP Cold Water available and associated HV opened	

2.1.11.2. *Variables to be recorded*

Feeding Temperature (TT_4011_01) and Set Point (TT_4011_01_SP)
Cooling Valve (SV_4011_01)
Feeding Tank Level (LT_4001_01)

2.1.11.3. *Test Procedure*

Seq Nb	Description	Required	Remarks	Status
1	(HMI) TT_4011_01_SP = 12 °C			
2	(HMI) Feeding Mode = AUTO			
3	Wait for Stabilisation			
4	(HMI) TT_4011_01_SP = 11°C			
5	Wait for Stabilisation		Indicate Time for Stabilisation	
6	(HMI) TT_4011_01_SP = 4°C			

7	Wait for Stabilisation		Indicate Time for Stabilisation and Temperature reached	

Acceptance Criteria:
Temperature Set Point is satisfied (if permitted by Utility Temperature itself)

This test permits to determine the minimum reachable temperature (depends mainly of the cold utility temperature).

2.1.12.Harvesting tank temperature control (4012)

Objective :

To Validate the Harvesting Tank Temperature Control.

2.1.12.1. *Operating Conditions*

Harvesting Tank shall be filled with harvest or liquid And not in Low or High Alarm	(HMI) WT_4002_01 > 20 kg and WT_4002_01 < 100 kg
Harvest Agitator in AUTO mode	(HMI) Harvest Agitator = AUTO
MPP Cold Water available and associated HV opened	

2.1.12.2. *Variables to be recorded*

Harvest Tank Temperature (TT_4012_01) and Set Point (TT_4012_01_SP)
Cooling Valve (SV_4012_01)
Harvest Tank weight (WT_4002_01)

2.1.12.3. *Test Procedure*

Seq Nb	Description	Required	Remarks	Status
1	(HMI) TT_4012_01_SP = 12 °C			
2	(HMI) Harvesting Mode = AUTO			
3	Wait for Stabilisation			
4	(HMI) TT_4012_01_SP = 11°C			
5	Wait for Stabilisation		Indicate Time for Stabilisation	

6	(HMI) TT_4012_01_SP = 4°C			
7	Wait for Stabilisation		Indicate Time for Stabilisation and Temperature reached	

<u>Acceptance Criteria:</u>
Temperature Set Point is satisfied (if permitted by Utility Temperature itself)

This test permits to determine the minimum reachable temperature (depends mainly of the cold utility temperature).

2.1.13.Antifoam control (4013)

There is no dynamic control associated.

2.1.14.Feeding tank sterilization (4014)

There is no dynamic control.
Procedures TBD with UAB

2.1.15.CIVa Bioreactor sterilization (4015)

There is no dynamic control.
Procedures TBD with UAB

2.1.16.Harvesting tank sterilization (4016)

There is no dynamic control.
Procedures TBD with UAB

3. Test Report

Following the test plan, the control loops have been tested. The results are described hereafter.

At the date of emission of this report, the weight measurement of the bioreactor was not working properly and so the level control was not tested.

The control of O2 was not properly tested as we have encountered probable non axenic conditions and the spirulina was contaminated.

3.1. Inlet liquid flow control (4001)

The test was performed March 16th 2010.

Test Prerequisites

Test Prerequisites		Status
Inlet Buffer Tank is not in Low Low Alarm	LT_4001_01 > 5 L	OK
Inlet Flow Mode in OFF Mode	HMI : Inlet Flow Mode = OFF	OK
Inlet Flow Set Point = 0 L/H	HMI : FT_4001_01_SP = 0	OK
PBR Level is either controlled or the PBR level is not in High Alarm		OK
Inlet Liquid Line between Influent and PBR shall be full (not starting conditions of the PBR)		OK

Seq Nb	Action Description	Required	Remarks	Date/Hour	Observed Results	C/NC
1	(HMI) Select Pump GP_4001_01			16/03/2010 11:01		
2	(HMI) Inlet Flow Mode = AUTO			16/03/2010 11:01		
3	(HMI) Change Set Point FT_4001_01_SP = 0.6 L/H			16/03/2010 11:01		
4	Wait For Stabilization	Indicate Time for Stabilisation and Speed Velocity CL4001_PumpSpeed	Check that the set point is satisfied		Time Response : 3mn. Natural Noise on the measurement very big (already filtered at 1mn)	C
5	(HMI) Change Set Point FT_4001_01_SP = 0.7 L/H			16/03/2010 11:13		
6	Wait For Stabilization	Indicate Time for Stabilisation and Speed Velocity CL4001_PumpSpeed	Check that the set point is satisfied		Time Response : 3mn. Natural Noise on the measurement very big (already filtered at 1mn)	C
7	(HMI) Change Set Point FT_4001_01_SP = 0.5 L/H			16/03/2010 11:22		

Seq Nb	Action Description	Required	Remarks	Date/Hour	Observed Results	C/NC
8	Wait For Stabilization	Indicate Time for Stabilisation and Speed Velocity CL4001_PumpSpeed	Check that the set point is satisfied		Time Response : 3mn. Natural Noise on the measurement very big (already filtered at 1mn)	C
9	(HMI) Change Set Point FT_4001_01_SP = 0.0 L/H			16/03/2010 11:30		
10	Wait For Stabilization	Indicate Time for Stabilisation and Speed Velocity CL4001_PumpSpeed	Check that the set point is satisfied		Time Response : 3mn for the filtered measurement	
11	(HMI) Select Pump GP_4001_02			16/03/2010 11:43	Line blocked (filter). Test stopped at 12:10	NC
12	(HMI) Change Set Point FT_4001_01_SP = 0.6 L/H			16/03/2010 18:32	Maintenance on the line (air) DPT_4001_02 > 300 mbar (AHH !!)	
13	Wait For Stabilization	Indicate Time for Stabilisation and Speed Velocity CL4001_PumpSpeed	Check that the set point is satisfied			

Seq Nb	Action Description	Required	Remarks	Date/Hour	Observed Results	C/NC
14	(HMI) Change Set Point FT_4001_01_SP = 0.7 L/H					
15	Wait For Stabilization	Indicate Time for Stabilisation and Speed Velocity CL4001_PumpSpeed	Check that the set point is satisfied			
16	(HMI) Change Set Point FT_4001_01_SP = 0.0 L/H					
17	Wait For Stabilization	Indicate Time for Stabilisation and Speed Velocity CL4001_PumpSpeed	Check that the set point is satisfied			
18	(HMI) Inlet Flow Mode = OFF					

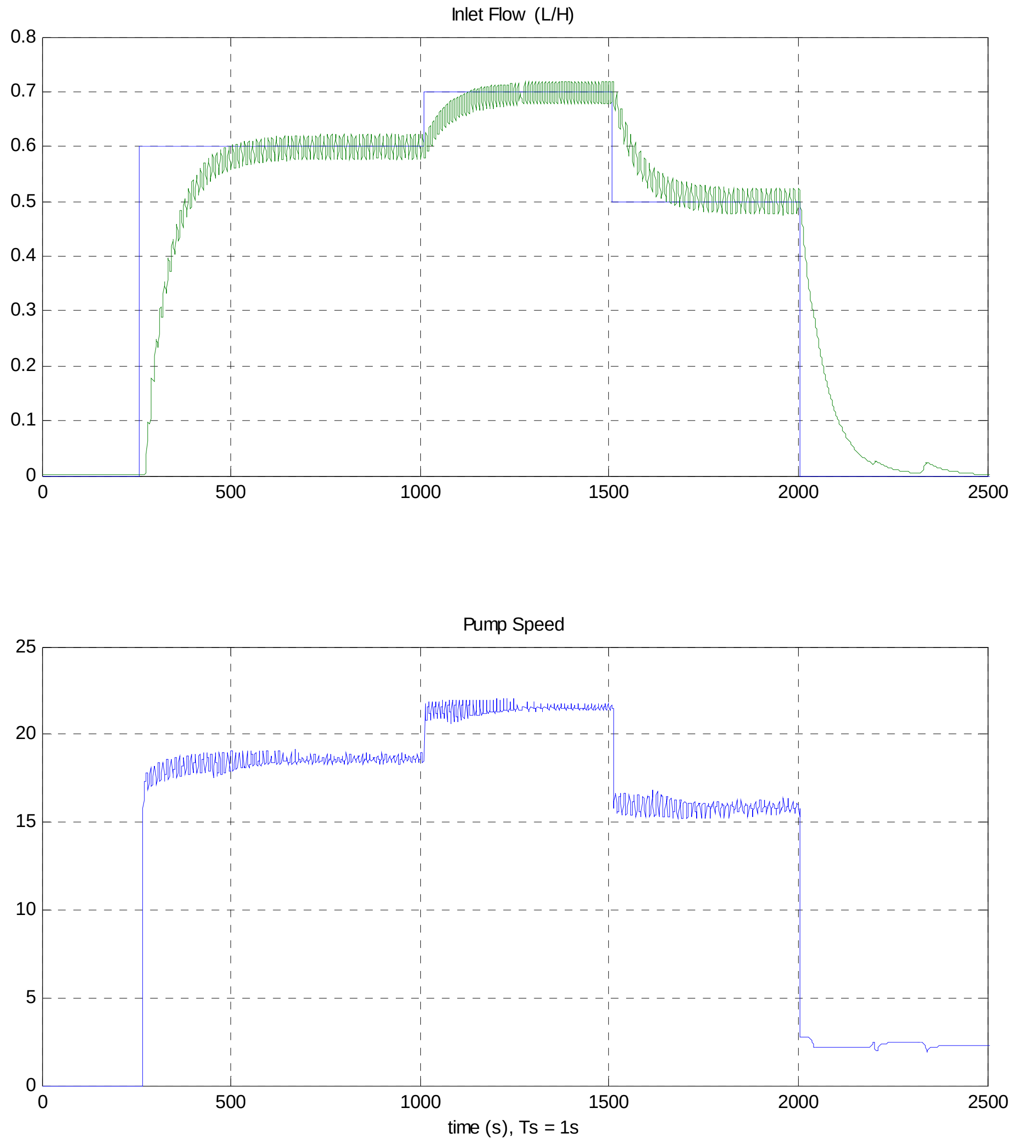

Figure 1: CL4001. Inlet liquid flow Control test

Data file : CL4001_test_20100316_1057.mat

Remarks :
It was not possible to test the second inlet line.

<u>Conclusion</u>:
Control loop 4001 is validated for the pump GP_4001_01

3.2. Inlet gas flow control (4003)

The test was performed June 16th 2010.

Test Prerequisites		Status
Gas Inlet Flow Mode in OFF Mode	HMI : Gas Inlet Flow Mode = OFF	Ok
Total Air Flow Set Point = 0 ml/mn	HMI : FQRC_4003_04_SP_OP = 0 ml/mn	Ok
Air Inlet Flow shall be available and Outlet gas line open.		Ok
Cooler of the outlet gas line shall be ON		Ok
Recycle in OFF mode	HMI : Recycle Mode = OFF	Ok
All necessary Hand Valves shall be opened		Ok
CO2 air flow not used for pH control		Ok
CO2 Set Point = 0 mL/mn	HMI : FQRC_4003_01_SP_OP = 0 ml/mn	Ok

Seq Nb	Action Description	Required	Remarks	Date/Hour	Observed Results	C/NC
1	(HMI) Gas Inlet Flow Mode = AUTO			16/06/2010 12:49		
2	(HMI) FQRC_4003_04_SP_OP = 2000 ml/mn			16/06/2010 12:49		
3	Wait For Stabilization		Check that the set point is satisfied		OK, There is always an offset between the set point and the measure. For all the mass flow controllers	C
4	(HMI) Change Set Point FQRC_4003_04_SP_OP = 2300 ml/mn			16/06/2010 12:52		
5	Wait For Stabilization		Check that the set point is satisfied		Idem Offset	C
6	(HMI) Change Set Point for CO2 FQRC_4003_01_SP = 200 mL/mn			16/06/2010 12:55		
7	Wait For Stabilization		Check that the set point is satisfied		Idem Offset	C

Seq Nb	Action Description	Required	Remarks	Date/Hour	Observed Results	C/NC
8	(HMI) Recycle Mode = AUTO			16/06/2010 12:58		
9	(HMI) Change Set Point FQRC_4003_03_SP = 1000 mL/mn					
10	Wait For Stabilization		Check that the set point is satisfied		Disturbance on total flow when Recycle Mode in AUTO Ok	C

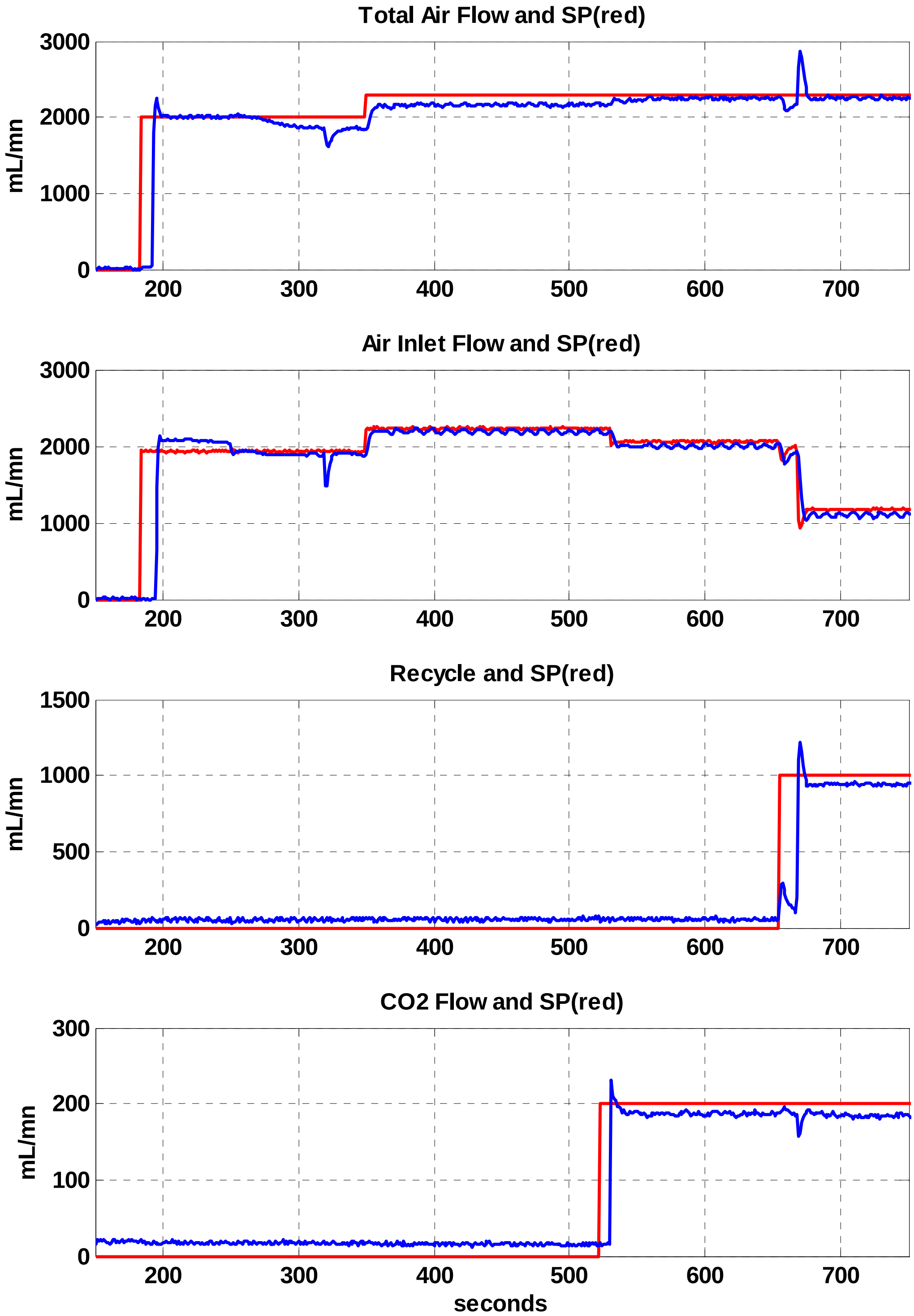

Figure 2: CL4003. Inlet gas flow Control test

Data file : CIVa_AllGas_20100616_1247.mat

Remarks :
All the mass flow controllers (old equipments) have an offset.
The strategy implemented works.

Conclusion:
Control loop 4003 is validated.

3.3. PBR Temperature Control (4005)

The test was performed July 22nd 2010.

Test Prerequisites		Status
PBR temperature Mode in AUTO Mode	HMI : PBR Temperature Mode = AUTO	OK
Bioreactor shall be filled (Water or Medium)		OK
Temperature set point = 36 °C	HMI : TT_4005_SP = 36 °C	OK
Blower Mode in AUTO at 50 %	BLWR_4005_01_SP = 50 %	OK
Lights Mode in MANual	HMI : Lights Mode = MANU	OK
Lights ON at 20 %	I_4000_MV = 20 %	30 % for the test
Level Control can be in AUTO or in OFF mode	HMI : Level Mode = AUTO or OFF	No Level Control
Inlet Gas Flow in AUTO Set Point set at 2000 mL/mn	HMI : Inlet Gas = AUTO FQRC_4003_04_SP = 2000 mL/mn	Ok
The cooling system shall be available		Ok

Seq Nb	Action Description	Required	Remarks	Date/Hour	Observed Results	C/NC
1	(HMI) Temp Mode = AUTO	Temp = SP		22/07/2010 10:18		
2	(HMI) TT_4005_SP = 35 °C			22/07/2010 10:36		
3	Wait For Stabilization	Indicate Time for Stabilisation	Check that the set point is satisfied		Observed closed loop response time: 15 minutes.	C
4	(HMI) TT_4005_SP = 36 °C			22/07/2010 11:36		
5	Wait For Stabilization	Indicate Time for Stabilisation	Check that the set point is satisfied		Observed closed loop response time: 15 minutes with 0.5°C overshoot	C
6	(HMI) Increase Lights to 50 %			22/07/2010 12:15		
7	Wait For Stabilization		Check that the set point is satisfied	22/07/2010 12:33	No disturbance	C
8	(HMI) TT_4005_SP = 35 °C			22/07/2010 12:33		

Seq Nb	Action Description	Required	Remarks	Date/Hour	Observed Results	C/NC
9	Wait For Stabilization	Indicate Time for Stabilisation	Check that the set point is satisfied		Disturbances for lights, during the test (Movie at the MPP). So lights were switched off/on several times.	C
10	(HMI) Increase Lights to 80 %			14:54		
11	Wait For Stabilization		Check that the set point is satisfied		No effect on temperature controller	C
12	(HMI) TT_4005_SP = 36 °C			22/07/2010 15:21		
13	Wait For Stabilization	Indicate Time for Stabilisation	Check that the set point is satisfied		Observed closed loop response time: 15 minutes with 0.5°C overshoot	C
14	(HMI) Decrease Lights to 40 %			22/07/2010 17:24		
15	Wait For Stabilization				No effect on temperature controller	c

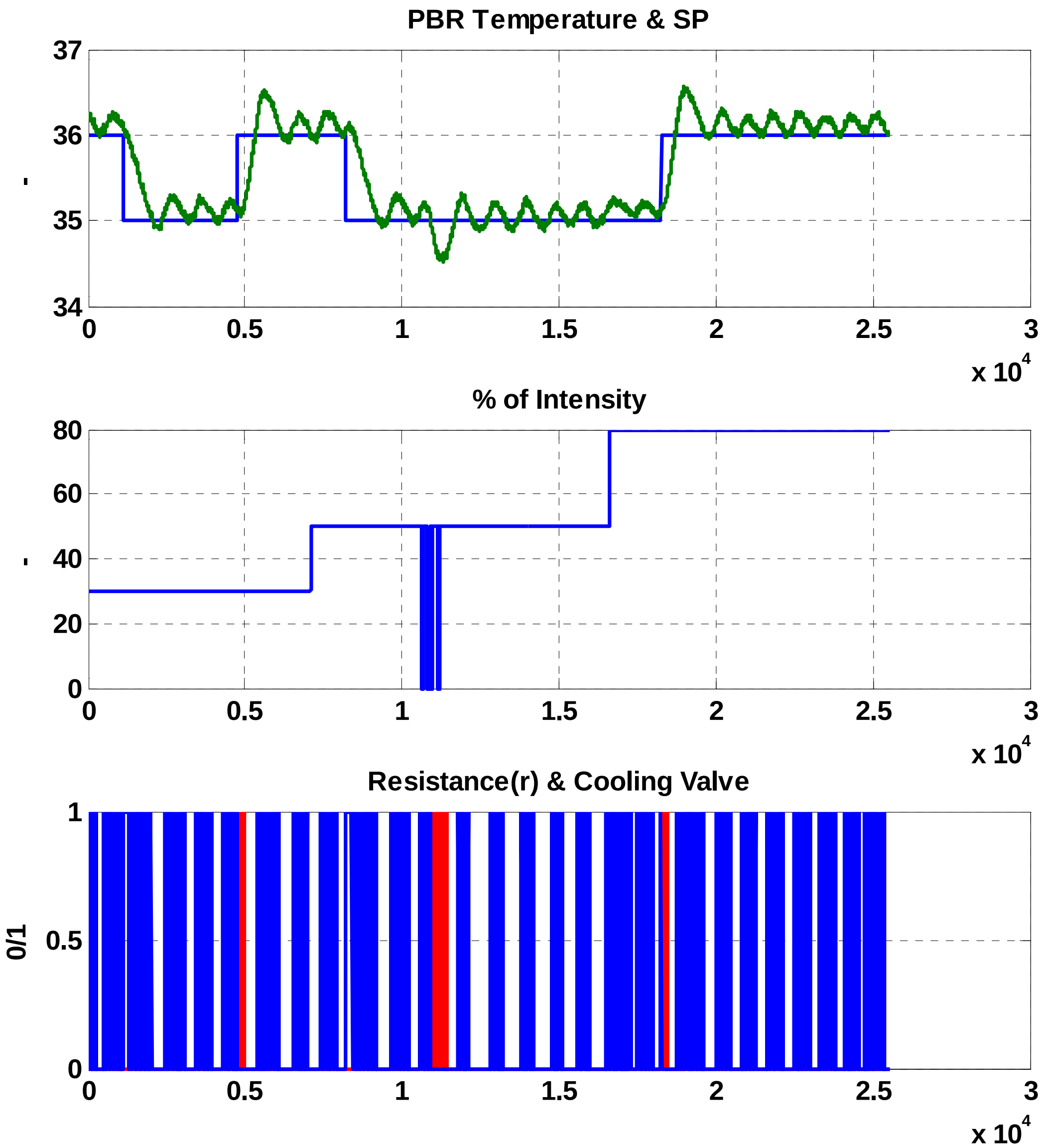

Figure 3: CL4005. PBR Temperature Control test

Time is displayed in seconds

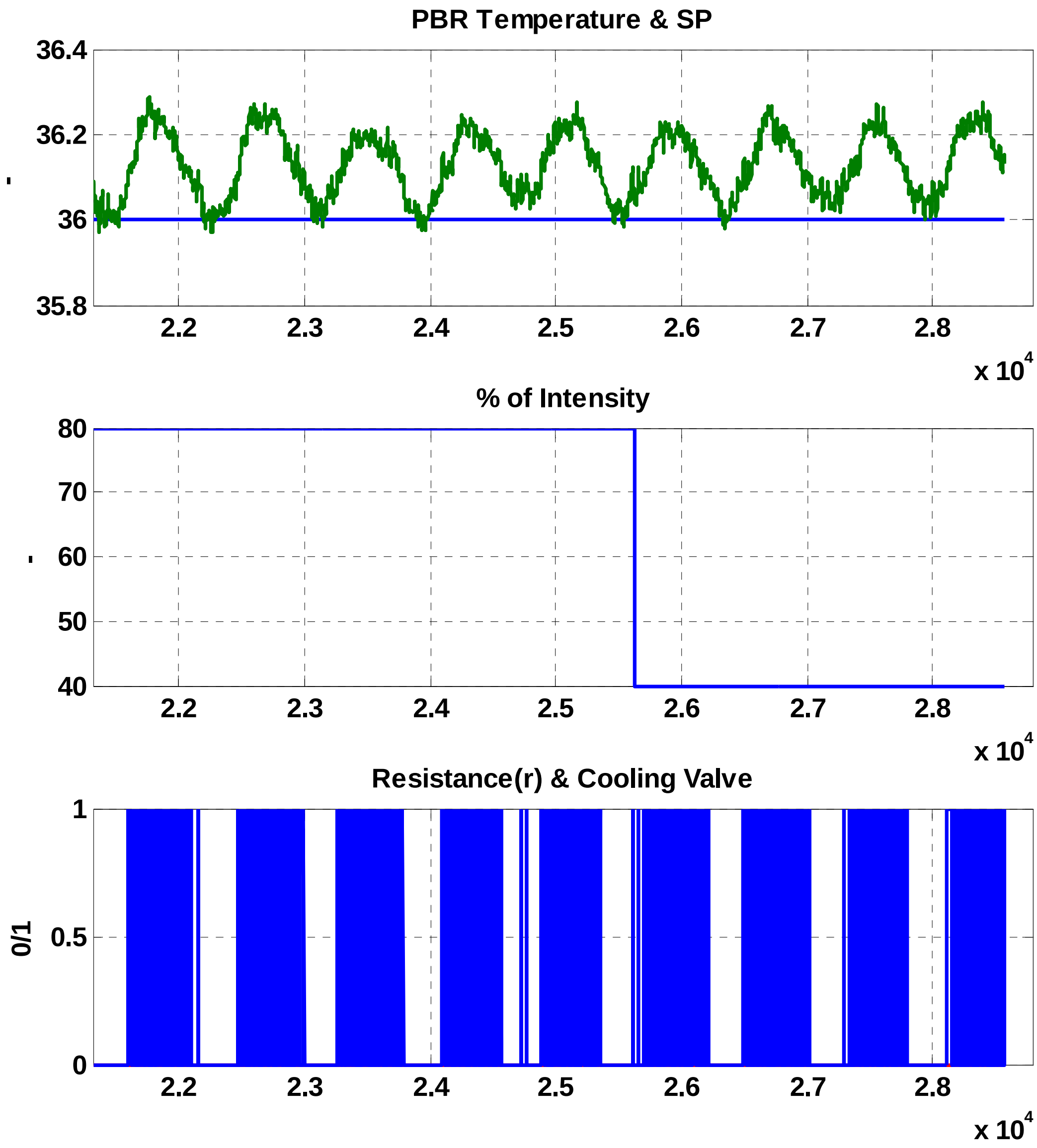

Figure 4: CL4005. PBR Temperature Control test (zoom)

Time is displayed in seconds
Data file: CL4005_test_20100722_1018.mat
Remarks :
The set point of the temperature is satidfied at +/-0.2 °C
Conclusion:
Control loop 4005 is validated.

3.4. pH Control Loop (4006)

The test was performed March 17th and 18th 2010.

Test Prerequisites		Status
pH control mode in OFF	(HMI) PH mode = OFF	Ok
Bioreactor shall be filled (Water or Medium) and level not in LL or HH alarm		HH alarm. No consequence
Acid Tank filled with Acid		OK
Base Tank filled with Base		Ok
Acid Pump set at 230 RPM		OK
Base Pump set at 230 RPM		OK
No LL alarm for Acid Tank		OK
No LL alarm for Base Tank		OK
Appropriate Hand Valves of the Acid and Base Lines shall be opened		OK
CO_2 shall be available		OK

Seq Nb	Action Description	Required	Remarks	Date/Hour	Observed Results	C/NC
1	(HMI) pH Probe selection = Average			17/03/2010 15:13		
2	(HMI) pH Mode = Acid and Base					
3	(HMI) pH set point = pH_Average					
4	(HMI) pH Deadzone = 0.02					
5	(HMI) pH Mode from OFF to AUTO			17/03/2010 15:16		
6	Wait for 15 minutes	pH = pH set point +/- Deadzone				
7	(HMI) Increase pH Set Point : + 0.1 From 9.55 to 9.65			17/03/2010 15:31	pH Set Point = 9.65	
8	Wait for Stabilisation	Indicate Time for Stabilisation			2.5 minutes of delay. 10 mn total response time	C
9	(HMI) Decrease pH Set Point : - 0.1 Ex : From 9.65 to 9.55			17/03/2010 15:48	until 16:30 : Problem with Acid pump not sucking.	

Seq Nb	Action Description	Required	Remarks	Date/Hour	Observed Results	C/NC
10	Wait for Stabilisation	Indicate Time for Stabilisation			Delay and Response Time cannot be estimated due to the failure of the pump Set Point satisfied (with deadzone)	C
11	(HMI) pH Mode = CO_2 and Base			17/03/2010 16:55:00 18/03/2010 10:24	CO2 was not connected at the beginning Test stopped at 18:00 (too long). 2nd test 18/03	
12	(HMI) Decrease pH Set Point : - 0.1 Ex : From 9.7 to 9.6			18/03/2010 10:24		
13	Wait for Stabilisation	Indicate Time for Stabilisation			Set Point change satisfied. Observed time response : 20 minutes	C

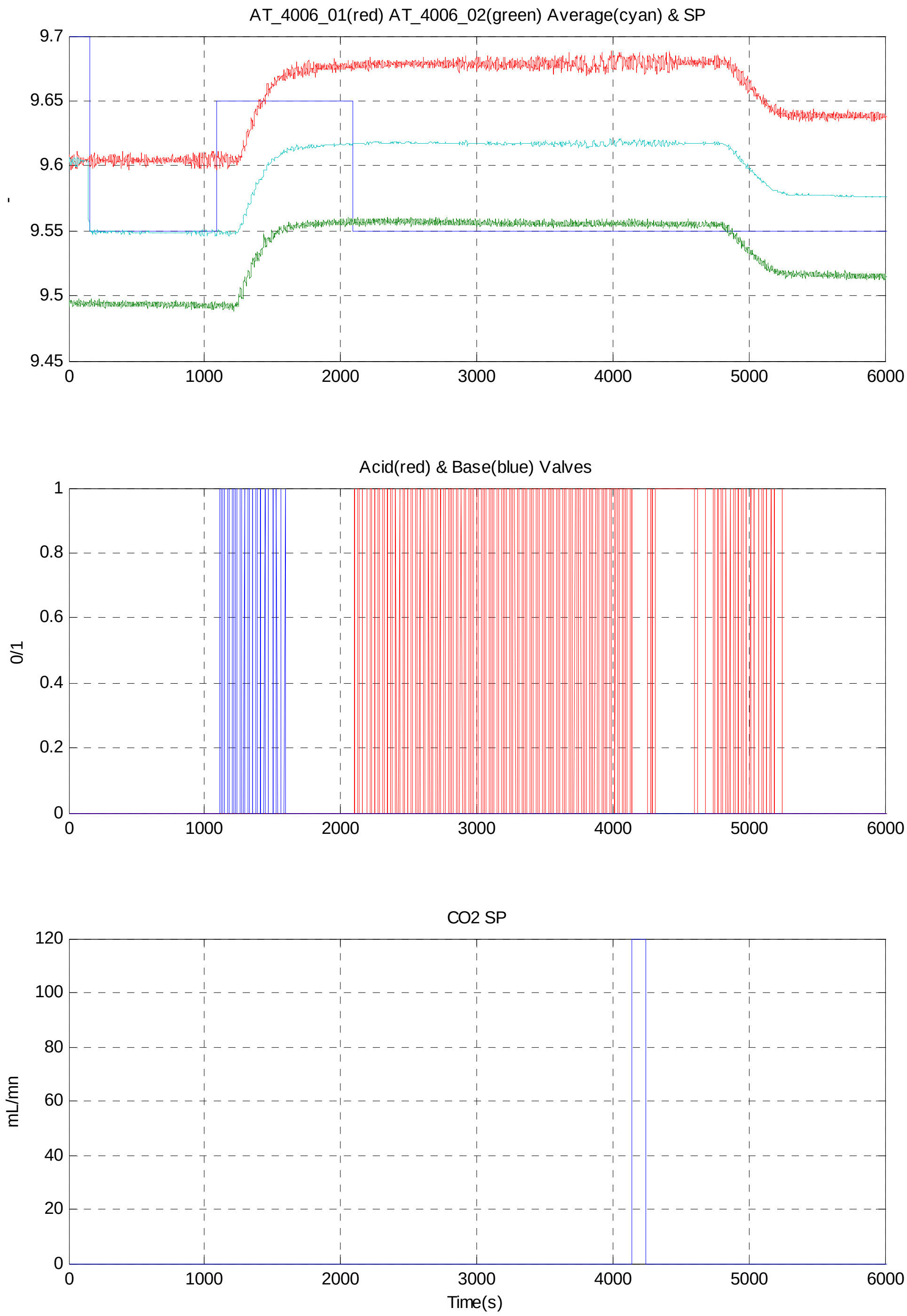

Figure 5: CL4006. pH Control test (part 1)

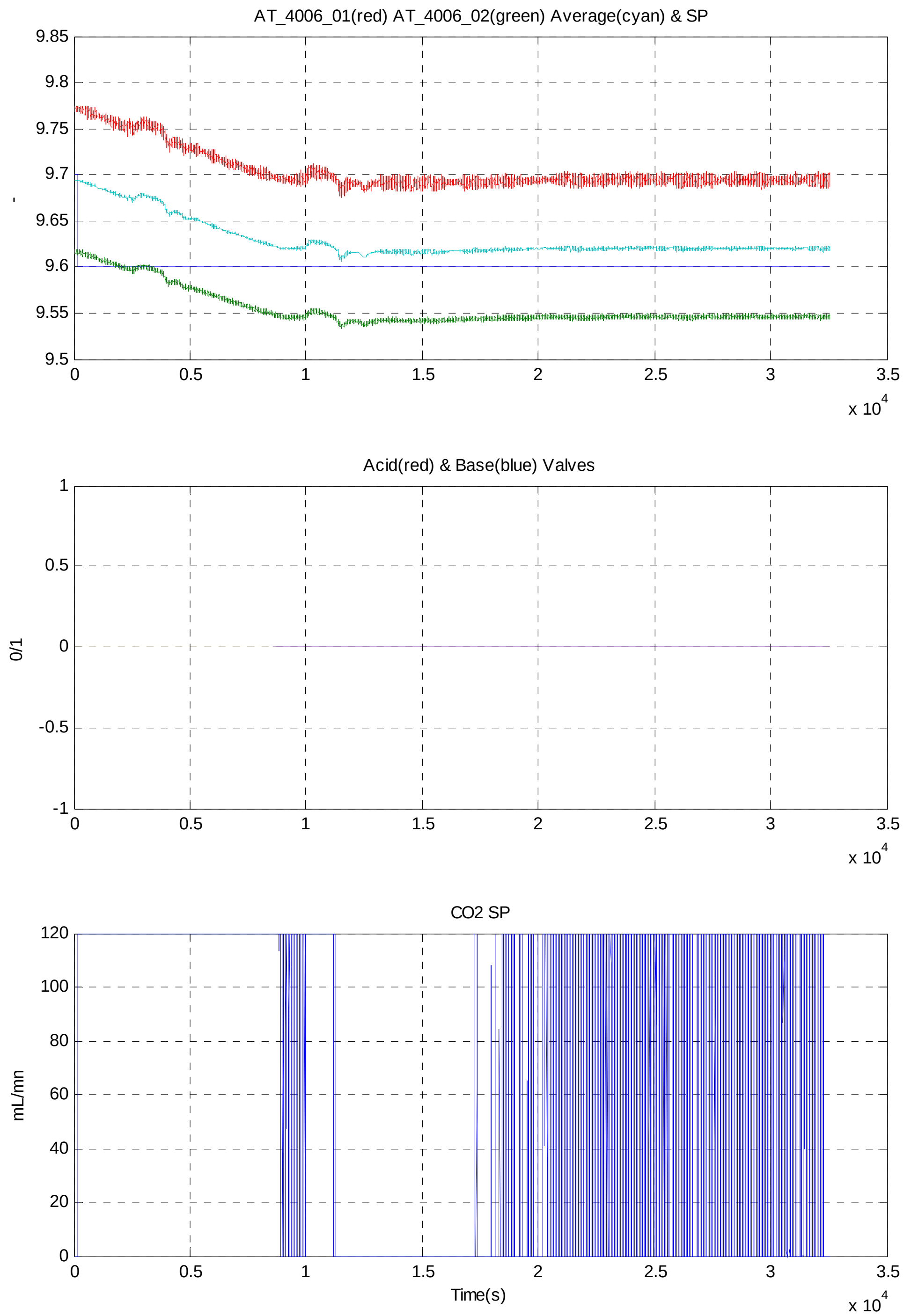

Figure 6: CL4006. pH Control test (part 2)

Data files: CL4006_test_20100317_1513.mat and CL4006_test_20100318_1022.mat

Remarks :

Conclusion:
pH can be controlled with Acid/Base/CO2
Control loop 4006 is validated.

3.5. Bioreactor pressure control (4007)

The test was performed June 16th 2010.

Test Prerequisites		Status
Pressure control mode in OFF	(HMI) Pressure mode = OFF	Ok
Bioreactor shall be full (Water or Medium)		
Outlet gas line open to atmosphere	HV_4004_05 open	Ok
Gas passing through analysers	(HMI) SV_4010_01 = ON	Ok
Recycle Mode in OFF mode	(HMI) Recycle = OFF	Ok
Inlet Gas Flow in AUTO mode	(HMI) Inlet Gas Flow Mode = AUTO	Ok
Total Gas flow set Point = 2000 mL/mn	FQRC_4003_04_SP = 2000 mL/mn	Ok

Seq Nb	Action Description	Required	Remarks	Date/Hour	Observed Results	C/NC
1	(HMI) Pressure Probe selection = 1 (PT_4007_01)			16/06/2010 18:18	Ok	
2	(HMI) Pressure Set Point = 80 mbar			16/06/2010 18:18	Ok	
3	(HMI) Pressure Mode = AUTO			16/06/2010 18:18	Ok	
4	Wait for Stabilisation				2.5 minutes to reach the set point	C
5	(HMI) Change Inlet Gas Flow Ex : From 2000 mL/mn to 2200 mL/min			16/06/2010 18:25	Ok. Disturbance : + 4mbar for the Pressure. Back in 100 seconds to the set point	
6	Wait for Stabilisation				Ok	C
7	(HMI) Change Inlet Gas Flow Ex : From 2200 mL/mn to 2000 mL/mn			16/06/2010 18:30	Ok. Disturbance : - 4mbar for the Pressure. Back in 100 seconds to the set point	
8	Wait for Stabilisation				OK	C
9	(HMI) SV_4010_01 = OFF			16/06/2010 18:34	Ok. + 2 mbar disturbance. Back in 40 seconds to the set point	
10	Wait for Stabilisation				OK	C
11	(HMI) Recycle Mode = AUTO			16/06/2010 18:37		

Seq Nb	Action Description	Required	Remarks	Date/Hour	Observed Results	C/NC
12	(HMI) FQRC_4003_03_SP = 1000 mL/mn			16/06/2010 18:37	Transient +/- 2 mbar	C
13	Wait for Stabilisation				Disturbances of MFC	
14	(HMI) SV_4010_01 = ON			16/06/2010 19:05	Ok	
15	Wait for Stabilisation				Ok	C

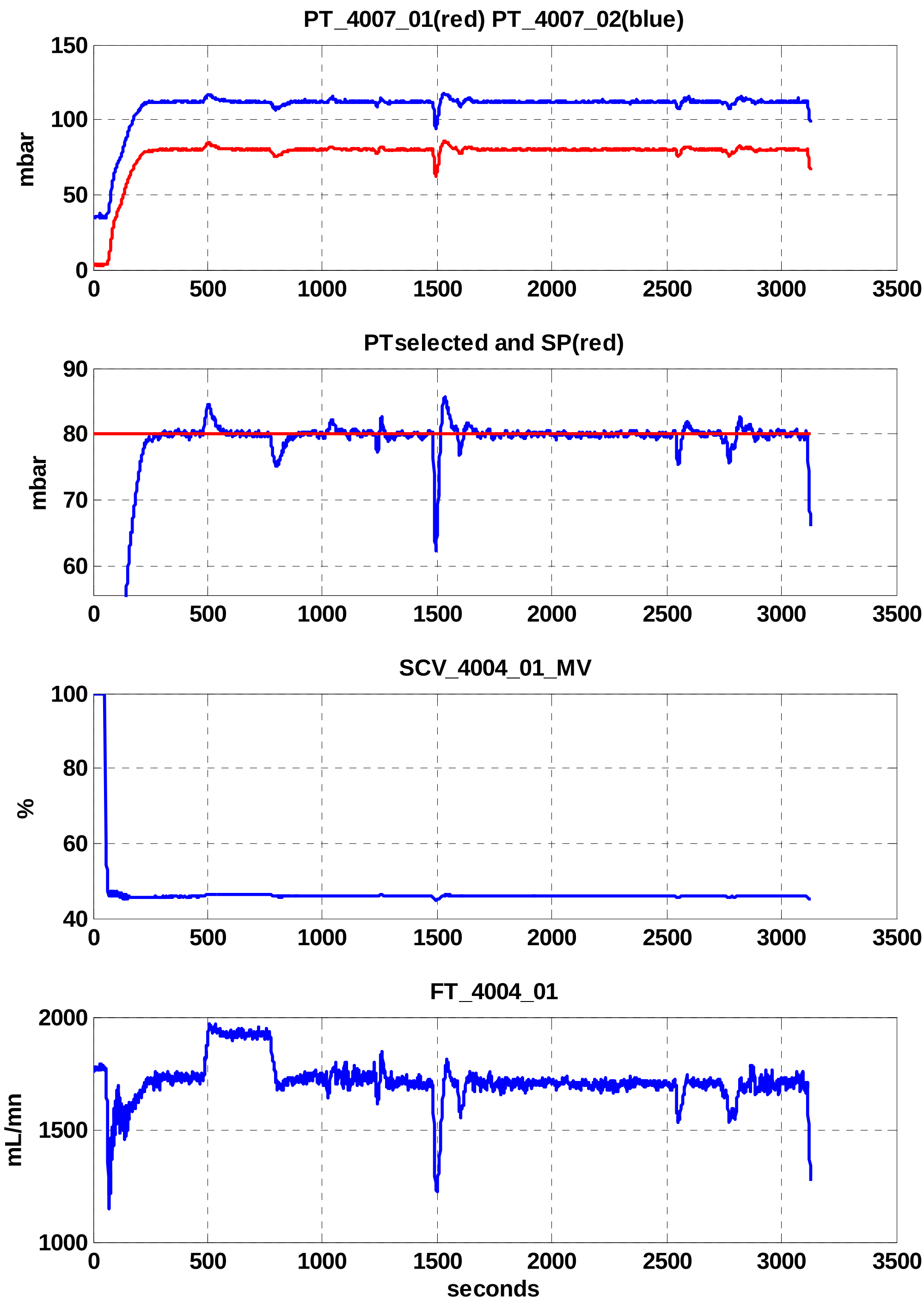

Figure 7: CL4007. Bioreactor Pressure Control test (part 1)

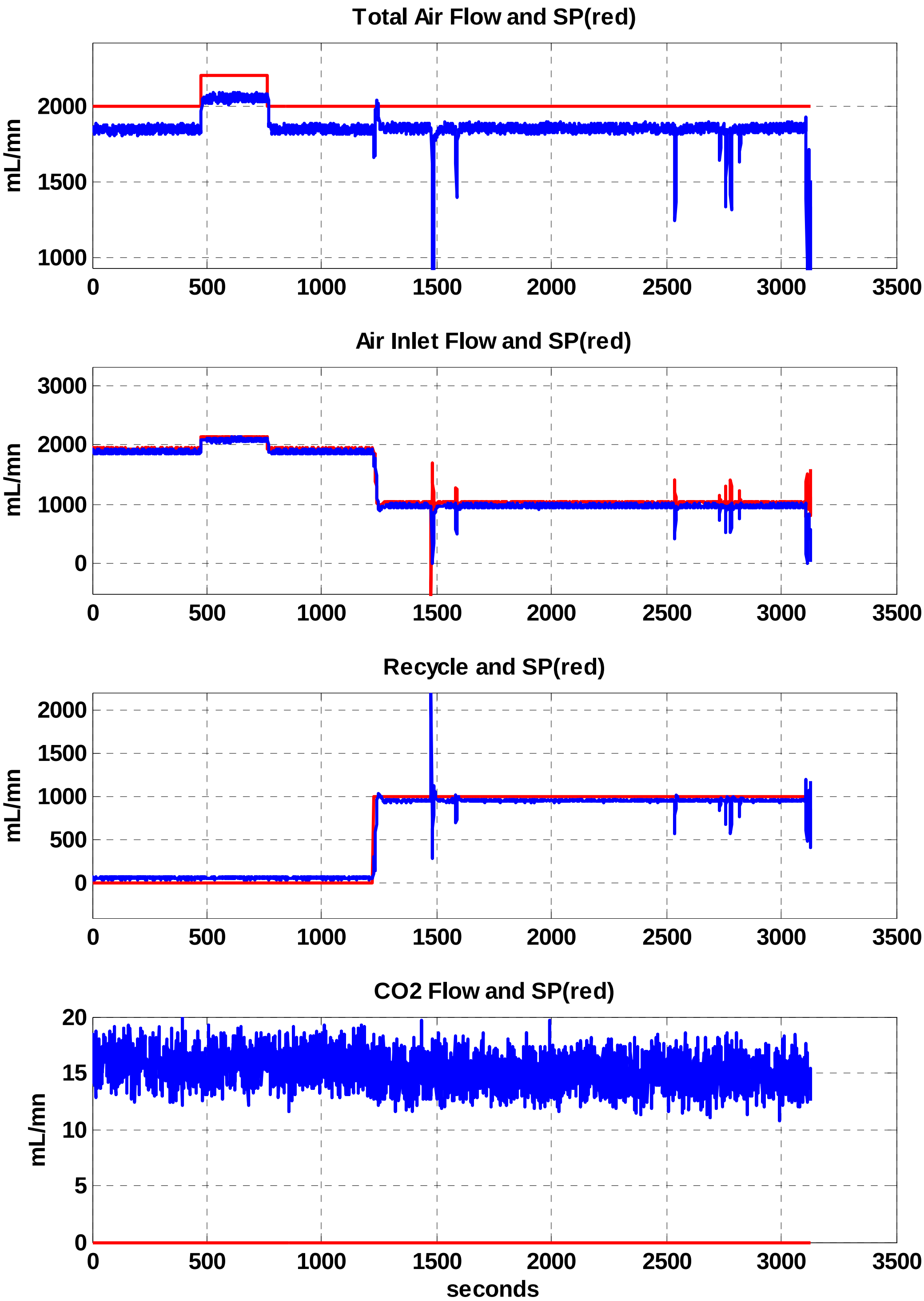

Figure 8: CL4007. Bioreactor Pressure Control test (part 2)

Data file: CIVa_AllGas_20100616_1817.mat

Remarks :
Some disturbances linked to the mass flow controllers.

Conclusion:
Control loop 4007 is validated.

3.6. Bioreactor liquid level control (4008) (Pending)

Pending

3.7. Bioreactor outlet gas composition control (4010) (Pending)

Pending

3.8. Feeding tank temperature control (4011)

The test was performed March 16th 2010.

Test Prerequisites		Status
Feeding Tank shall be filled with medium And not in Low or High Alarm	(HMI) LT_4001_01 > 20 L and LT_4001_01 < 130 L	LT_4001_01=118.1 L
Feed Agitator in AUTO mode	(HMI) Feed Agitator = AUTO	Ok, Speed = 100 % LT_4001_01=118.5 L
MPP Cold Water available and associated HV opened		Ok

Seq Nb	Action Description	Required	Remarks	Date/Hour	Observed Results	C/NC
1	(HMI) TT_4011_01_SP = 12 °C				Measured TT_4011_01 = 14 °C	
2	(HMI) Feeding Mode = AUTO			16/03/2010 09:02		
3	Wait for Stabilisation : Temperature = SP; no oscillations; during 5 minutes at least				Set Point is satisfied. Observed Response Time : 1 hour 06 min from 14 to 12 °C (at 95%)	C
4	(HMI) TT_4011_01_SP = 11°C			16/03/2010 11:07	test stopped at 12:15 (seeding)	
5	Wait for Stabilisation		Indicate Time for Stabilisation		Observed Time Response : 1 hour	C
6	(HMI) TT_4011_01_SP = 4°C				Not performed	
7	Wait for Stabilisation. As Temperature can not be reached : when temperatue is steady during 10 mn		Indicate Time for Stabilisation and Temperature reached			

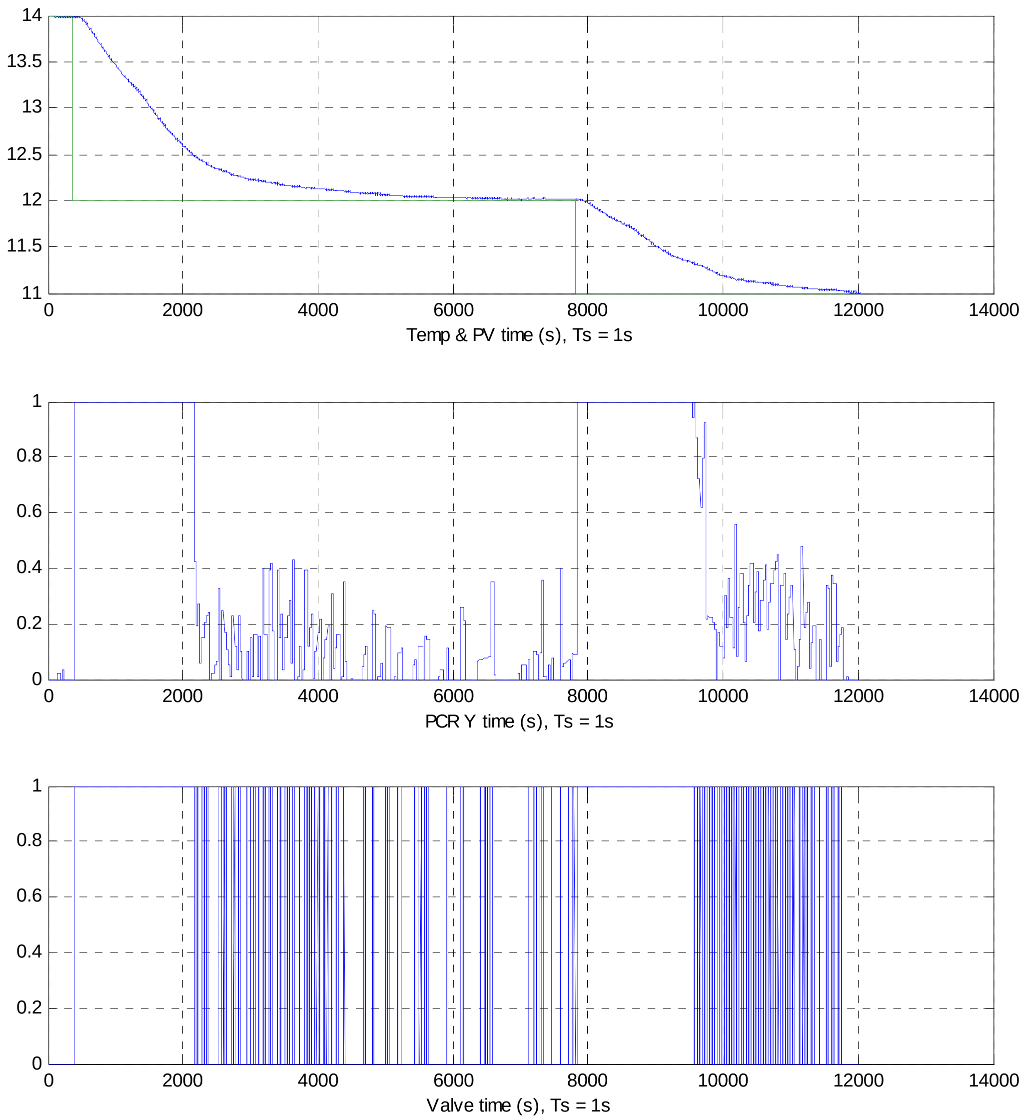

Figure 9: CL4011. Feeding tank temp. Control test

Data file: CL4011_test_20100316_1034.mat

Remarks :

- PCR Output represents the calculated analog value of the valve opening. This value, between 0 and 1 is converted to a ON/OFF sequence for the digital valve.
- It was demonstrated the capacity for the cooling system to decrease the set point of the influent tank.

It is not necessary to perform other tests with a lower set point.

Conclusion:

Control loop 4011 is validated.

3.9. Harvesting tank temperature control (4012)

The test was performed March 16th 2010.

Test Prerequisites		Status
Harvesting Tank shall be filled with harvest or liquid And not in Low or High Alarm	(HMI) WT_4002_01 > 20 kg and WT_4002_01 < 100 kg	OK
Harvest Agitator in AUTO mode	(HMI) Harvest Agitator = AUTO	OK
MPP Cold Water available and associated HV opened		OK

Seq Nb	Action Description	Required	Remarks	Date/Hour	Observed Results	C/NC
1	(HMI) TT_4012_01_SP = 12 °C				Measure Temperature : 13.89 °C	
2	(HMI) Harvesting Mode = AUTO			16/03/2010 11:42	test stopped at 12:15 (seeding)	
3	Wait for Stabilisation : Temperature = SP; no oscillations; during 5 minutes at least				The sensor of temperature has an important discretisation. Oberved Response Time : 30 minutes.	C
4	(HMI) TT_4012_01_SP = 11°C				Not performed	
5	Wait for Stabilisation		Indicate Time for Stabilisation			
6	(HMI) TT_4012_01_SP = 4°C				Not Performed	
7	Wait for Stabilisation. As Temperature can not be reached : when temperatue is steady during 10 mn		Indicate Time for Stabilisation and Temperature reached			

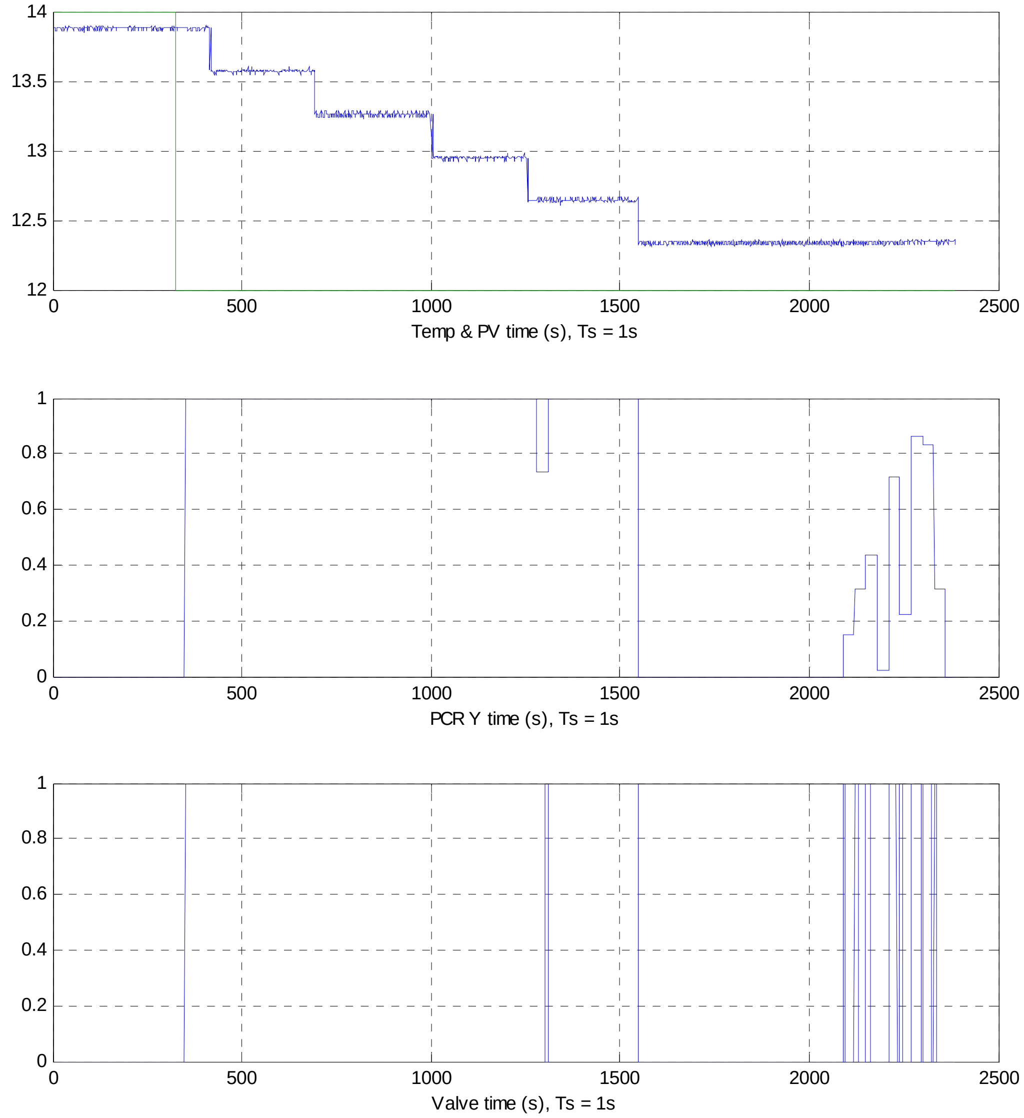

Figure 10: CL4012. Harvesting tank temp. Control test

Data file: CL4012_test_20100316_1136.mat
Remarks :

- PCR Output represents the calculated analog value of the valve opening. This value, between 0 and 1 is converted to a ON/OFF sequence for the digital valve.
- Sensor of temperature can only give values by step of 0.3°C.

It was demonstrated that the cooling system can decrease the temperature to the set point. It is not necessary to perform other tests.

Conclusion:
Control loop 4012 is validated.

4. Conclusion

Excepted the pending loops, all other control loops have been tested successfully and validated.

The pending loops are:

- Bioreactor level control, as the balance system is replaced by a differential pressure measurement
- Bioreactor outlet gas composition (O2). The O2 production during the test was not guaranteed by the axenicity.

Moreover, even if not necessary it has to be said that the second pump of the inlet flow was not tested.

5. Appendix

5.1. Document evolutions

5.2. Issue 1 / Revision 1

Page/Section	Comment	Answer

Modification Number	Modification reasons	Modification performed	date	Previous referenced version	New referenced version	Comments

SECTION 2: PLC Design and wiring				
Reference	Title	Version	Edition date	Pages Number
NTE-CIVaP2-ICD-002	CIVa HARDWARE INTERFACE DOCUMENT	1.1	30/04/10	35
NTE-CIVaP2-RP-006	MELISSA CIVa CONTROL CABINET HARDWARE DESIGN DOCUMENT	1	07/10/09	28

CIVa Hardware Interface Document

APPROVAL LIST		
NAME	SIGNATURE	DATE
Prepared by: Martí Bassas		30/04/10
Revised by: Jordi Duatis		30/04/2010
Approved by: Eva Creus		30/4/10
Authorised by: Jordi Duatis		30/04/2010

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CHANGE RECORD			
AUTHOR	ISSUE	DATE	CHANGE
Martí Bassas	1.0	04-05-2009	New Document
J.Carbonell	1.1	30/04/2010	Added DeDietrich to the distribution list. Updated reference documents.

CONTENTS

ACRONYMS LIST

CIVa	Compartment IVa
HPC	Higher Plants Compartment
I/O	Input / Output
PLC	Programmable Logic Controller
MELiSSA	Micro-Ecological Life Support System Alternative
MPP	MELiSSA Pilot Plant
UAB	Universitat Autònoma de Barcelona
UoG	University of Guelph

1. SCOPE

This document is meant to provide DeDietrich with the information needed to design and assemble compartment CIVa Power cabinet part meant to interface with Control Cabinet.

2. APPLICABLE AND REFERENCE DOCUMENTS

2.1 Applicable documents

AD1 NTE-CIVaP2-OF-001 NTE OFFER FOR CIVa CONTROL SYSTEM CABINET AND HMI UPDATE

2.2 Reference documents

RD1 Analog_Signals_Rev10.pdf. List of analog input/output for the CIVa compartment.

RD2 Quantum I/O module User Manual. Schneider Doc number: 35010516K01000
Downloadable from: http://www.download.schneider-electric.com/C12573FE002EC02D/all/42ECCC2380F718DBC1257536003F5E2E
Document: 35010516K01000.pdf (6.189mb)

RD3 PHOENIX PLC interface relay Datasheet. Document code 5156535. Downloadable from: http://select.phoenixcontact.com Document: 101780_en_02.pdf

RD4 Digital_Signals_Rev10.pdf. List of digital input/output for the CIVa compartment.

3. MELISSA CIVA CONTROL CABINET HARDWARE OVERVIEW

Figure 3.1 shows the general connections between CIVa and its control cabinets.

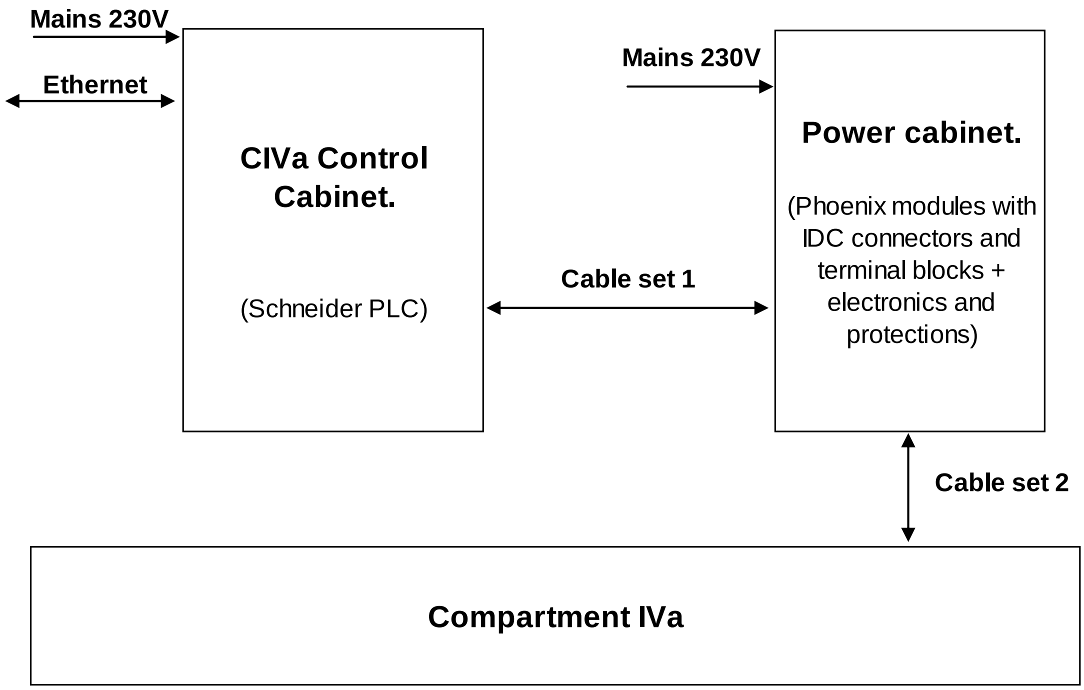

Figure 3.1: CIVa general conections diagram.

The software in CIVa Control Cabinet PLC controls CIVa compartment, monitoring sensors readouts and commanding actuators accordingly. Communication through Ethernet between the PLC and an iFix server provides general system control and monitoring. The power cabinet contains part of the electronics used in the cabinet, as well as a number of PHOENIX contact modules and relays to interface with the Control cabinet.

Communications between the “Control Cabinet” and the “Power cabinet” is featured by means of a set of cables type:

PHOENIX FLK 50/EZ-DR/ 1000/KONFEK/S & FLK 14/EZ-DR/ 1000/KONFEK/S.

Figure 3.2: 50-wire shielded cable with flat cable IDC connector termination.

(reference may change depending on required lengths)

The Power cabinet shall be equipped with PHOENIX modules to interface between IDC connectors coming from the PLC and terminal blocks, where wires coming from the sensors and actuators in the compartment are plugged. The different kind of modules used for interfacing and their connection details are described in this document.

4. LABELING

DIN rail modules and cables with flat cable connectors shall be labeled according to the following table:

Schneider PLC cards	Number of cards	I/O type	I/O per card	Interface module used in secondary connections cabinet	Number of Modules	Module label	Cable label
140DDI35300	1	digital IN	32	PLC-V8/FLK14/IN	4	DDI 1... DDI 4	DDI 1... DDI 4
140DDO35300	1	digital OUT	32	PLC-V8/FLK14/OUT	4	DDO 1… DDO 4	DDO 1… DDO 4
140DDM39000	1	digital IN/OUT	16/8	PLC-V8/FLK14/IN & PLC-V8/FLK14/OUT	1	DDO 5 -4Ch, DDO 6 -4Ch, DDI 5, DDI 6	DDO 5 -4Ch, DDO 6 -4Ch, DDI 5, DDI 6
140ACI03000	1	analog current IN	8	50/MODI-TSX/Q	1	ACI 1 - 8Ch	ACI 1 - 8Ch
140ACI04000	2		16	50/MODI-TSX/Q	1	ACI 2 - 16Ch	ACI 2 - 16Ch
				50/MODI-TSX/Q	1	ACI 3 - 16Ch	ACI 3 - 16Ch
140AVI03000	1	analog voltage IN	8	50/MODI-TSX/Q	1	AVI 1 -8Ch	AVI 1 -8Ch
140AVO02000	2	analog voltage OUT	4	50/MODI-TSX/Q	1	AVO 1 - 4Ch	AVO 1 - 4Ch
				50/MODI-TSX/Q	1	AVO 2 - 4Ch	AVO 2 - 4Ch
140ACO13000	2	analog current OUT	8	50/MODI-TSX/Q	1	ACO 1 - 8Ch	ACO 1 - 8Ch
				50/MODI-TSX/Q	1	ACO 2 - 8Ch	ACO 2 - 8Ch

Table 4.1: Cable and module labeling.

Cables PHOENIX FLK 50/EZ-DR/ 250/KONFEK/S & FLK 14/EZ-DR/ 400/KONFEK/S ().

Figure 4.1: 50-wire shielded cable with flat cable IDC connector.

(reference may change depending on required lengths)

Cables shall be labeled using wire strips PHOENIX KME (Figure *4.2*)

Figure *4.2: PHOENIX KME (code 0807083) wire strip for cable labeling.*

One strip with a label shall be placed close to each cable end.

The DIN rail modules and the relay modules are provided with a blank space for labeling, so there is no need to buy a specific label holder.

5. I/O CARDS AND INTERFACE WITH THE POWER CABINET.

The cards used for I/O interfacing with the compartment are the following:

Schneider PLC cards	***Number of cards***	***I/O type***	***I/O per card***	***Total available I/Os***
140DDI35300	1	digital IN	32	32
140DDO35300	1	digital OUT	32	32
140DDM3900 0	1	digital IN/OUT	16/8	16/8
140ACI03000	1	analog current IN	8	8
140ACI04000	2		16	32
140AVI03000	1	analog voltage IN	8	8
140AVO02000	2	analog voltage OUT	4	8
140ACO13000	2	analog current OUT	8	16

Table 5.1 I/O cards in Control cabinet

All these cards are assembled with a PHOENIX electric interface device to provide connectivity through 14-wire or 50-wires cables. These cables are ended with flat cable IDC connectors.

5.1 DIGITAL INPUT

A 140DDI35300 Schneider module in the Control Cabinet receives digital inputs from the compartment. This module is equipped with an FLKM 50/ 4-FLK14/PA-MODI-TSX/Q (*Figure 5.1*)

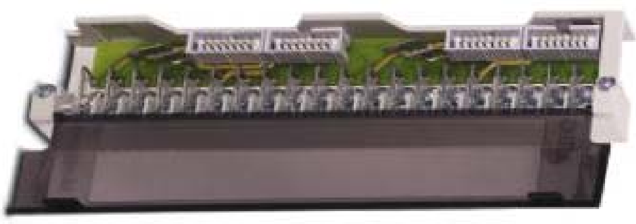

Figure 5.1 . PHOENIX FLKM 50/ 4-FLK14/PA-MODI-TSX/Q

The connector implements the interface between screw-like PLC terminal blocks and four 14 pins headers for flat ribbon cable connectors. The connectors are attached to four FLK 14/EZ-DR/ 400/KONFEK/S cables (*Figure 5.2*)

Figure 5.2: PHOENIX FLK 14/EZ-DR/ 400/KONFEK/S. One to One shielded cable with flat ribbon cable connector ends.

Reference is to be confirmed. It may change depending on required cable length.

These cables are used to interface between Control Cabinet and Power cabinet. They shall be labeled as:

- DDI 1, DDI 2, DDI 3 & DDI 4

Each of these cables shall be connected to a PLC-V8/FLK14/IN module (*Figure 5.3*)

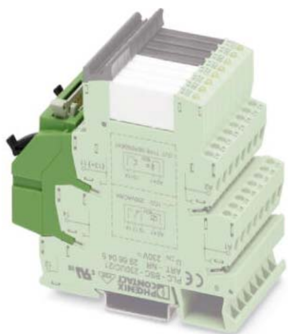

Figure 5.3: PHOENIX PLC-V8/FLK14/IN

Which are connected to 8 DIN rail relays PLC-RSC-24DC/21 (*Figure 5.4*)

Figure 5.4: PHOENIX PLC-RSC-24DC/21

PLC-V8/FLK14/IN module is connected to relay terminals 11 and 14. *Figure 5.5* shows this module connections:

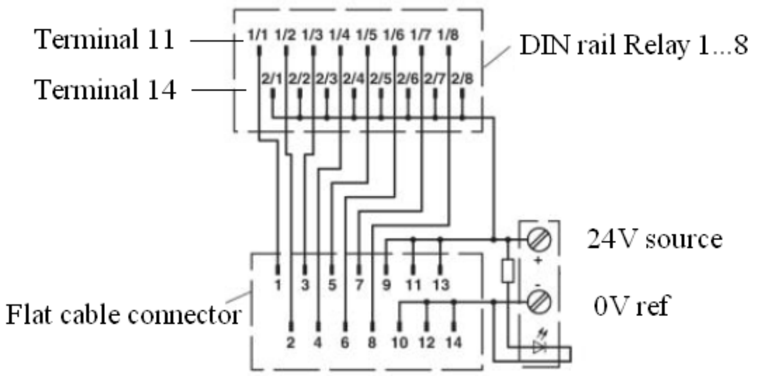

Figure 5.5: PLC-V8/FLK14/IN module connections.

The 0V ref and 24V source are used by the PLC DDI card as the input reference high and low levels. They should be connected to an arbitrary 24Vdc source. 100mA are enough for sensing, so a 0.5A fuse or magnetic switch protection is recommended.

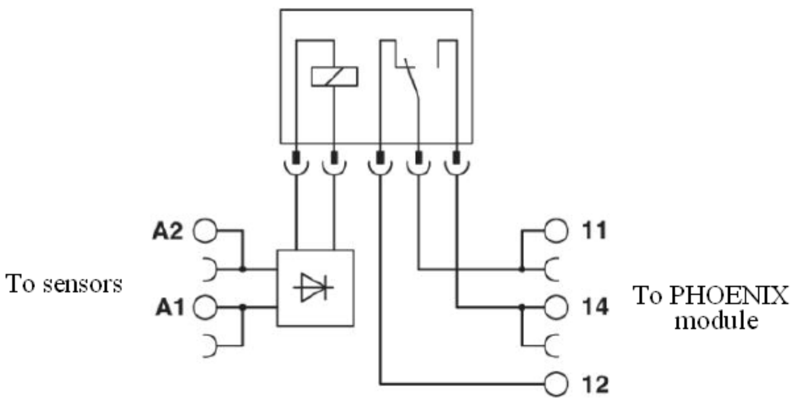

Figure 5.6: PHOENIX PLC-RSC-24DC/21 relay.

The suggested Relay (PHOENIX PLC-RSC-24DC/21) is intended to be controlled by a 24Vdc signal.

A1+ : 0V ➔ Relay open; +24Vdc ➔ Relay closed.

A2- : Reference (0V)

PHOENIX CONTACT provides many other relays compatible with PLC-V8/FLK14/IN module [RD3], with different commutation voltage levels, so that they can be individually replaced to meet the voltage provided by the sensors in the compartment. Notice that these replacements do not affect any connections at the PLC side of the relays (relay output).

The chosen relays can be extracted from their DIN rail chassis, so that they can be easily replaced after the cabling is done. This provides great flexibility in case of error or sensor replacement, etc.

PLC-V8/FLK14/IN modules shall be labeled according to *Table 5.2*:

Connected cable	Module label	Module type	Relay number	Relay type
DDI 1	DDI 1	PLC-V8/FLK14/IN	1	PLC-RSC-***xx***/21
			2	PLC-RSC-***xx***/21
			3	PLC-RSC-***xx***/21
			4	PLC-RSC-***xx***/21
			5	PLC-RSC-***xx***/21
			6	PLC-RSC-***xx***/21
			7	PLC-RSC-***xx***/21
			8	PLC-RSC-***xx***/21
DDI 2	DDI 2	PLC-V8/FLK14/IN	1	PLC-RSC-***xx***/21
			2	PLC-RSC-***xx***/21
			3	PLC-RSC-***xx***/21
			4	PLC-RSC-***xx***/21
			5	PLC-RSC-***xx***/21
			6	PLC-RSC-***xx***/21
			7	PLC-RSC-***xx***/21
			8	PLC-RSC-***xx***/21
DDI 3	DDI 3	PLC-V8/FLK14/IN	1	PLC-RSC-***xx***/21
			2	PLC-RSC-***xx***/21
			3	PLC-RSC-***xx***/21
			4	PLC-RSC-***xx***/21
			5	PLC-RSC-***xx***/21
			6	PLC-RSC-***xx***/21
			7	PLC-RSC-***xx***/21
			8	PLC-RSC-***xx***/21
DDI 4	DDI 4	PLC-V8/FLK14/IN	1	PLC-RSC-***xx***/21
			2	PLC-RSC-***xx***/21
			3	PLC-RSC-***xx***/21
			4	PLC-RSC-***xx***/21
			5	PLC-RSC-***xx***/21

			6	PLC-RSC-***xx***/21
			7	PLC-RSC-***xx***/21
			8	PLC-RSC-***xx***/21

Table 5.2: DDI relays and modules' types and labels. Relay type shall depend on the commutation voltage required, which depends on the kind of input sensor to be monitored.

Relays within every module shall also be labeled from 1 to 8 using labels such as

PHOENIX ZB 6,LGS:FORTL.ZAHLEN (*Figure 5.7*)

Figure 5.7: Numbered labels for Relays.

5.2 DIGITAL OUTPUT

A 140DDO35300 Schneider module in the Control Cabinet controls discrete (ON/OFF) actuators in the compartment. This module is equipped with an

FLKM 50/ 4-FLK14/PA-MODI-TSX/Q (*Figure 5.8*)

Figure 5.8. PHOENIX FLKM 50/ 4-FLK14/PA-MODI-TSX/Q

To electrically interface between screw-like PLC terminal blocks and four 14 pins headers for flat ribbon cable connectors. Connectors are attached to four Cables such as FLK 14/EZ-DR/ 400/KONFEK/S (*Figure 5.9*)

Figure 5.9: PHOENIX FLK 14/EZ-DR/ 400/KONFEK/S. One to One cable with flat ribbon cable connector ends.

Reference is to be confirmed. It may change depending on required length.

These cables are used to interface between Control Cabinet and Power cabinet. They shall be labeled as:

- DDO 1, DDO 2, DDO 3 & DDO 4

Each of these cables shall be connected to a PLC-V8/FLK14/OUT module (*Figure 5.10*)

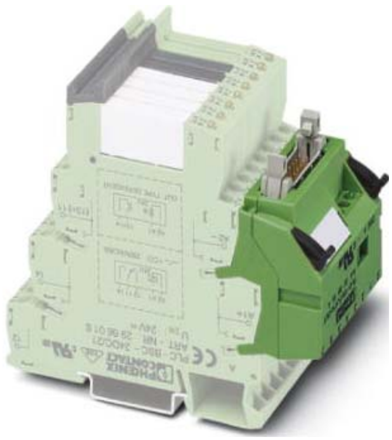

Figure 5.10: PHOENIX PLC-V8/FLK14/OUT

Which are connected to 8 DIN rail relays PLC-RSC-24DC/21 (*Figure 5.11*)

Figure 5.11: PHOENIX PLC-RSC-24DC/21

PLC-V8/FLK14/OUT module is connected to relay terminals A1 and A2. Figure 5.12 shows this module connections:

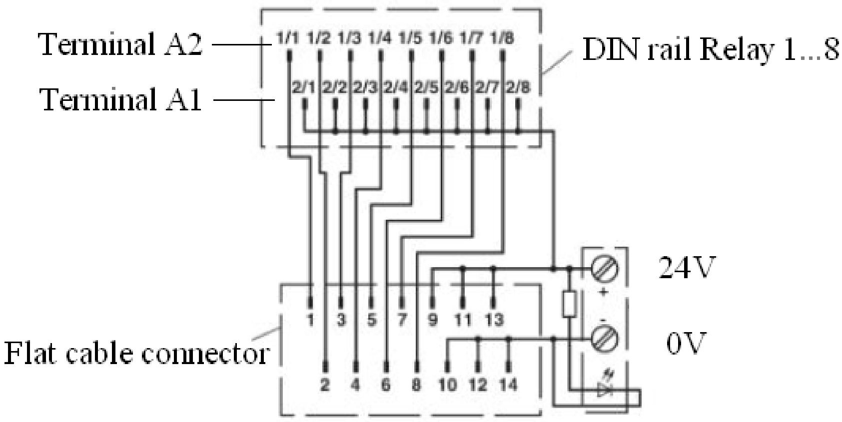

Figure 5.12: PLC-V8/FLK14/OUT module connections.

The 0V and 24V are used by the PLC DDO card as a power supply for the digital outputs. According to Schneider (PLC manufacturer) the 140DDO35300 card can supply 0.5A per output, so that a 24V 16A(minimum) power supply would be required to feed them. In our case the module outputs are just used to open/close a Relay whose minimum commutation current is 10mA.

This means that 320mA would be enough to have all 32 output Relays closed.

A sensible choice would be to connect these pins to the 24V power supply in the Power Cabinet through a 0.5A protection (fuse or magnetic switch).

The PLC-RSC-24DC/21 relays offer the following maximum switching values:

V (max, commutation) = 250Vac / 250Vdc

I (max, continuous) = 6A

so they can be used for a wide variety of actuators. Refer to manufacturer's (PHOENIX) RD3 product datasheet for further information.

The connections with terminals 11, 12 and 14 in the relay, as well as the choice of power supplies is up to DeDrietich, depending on the actuators to be switched.

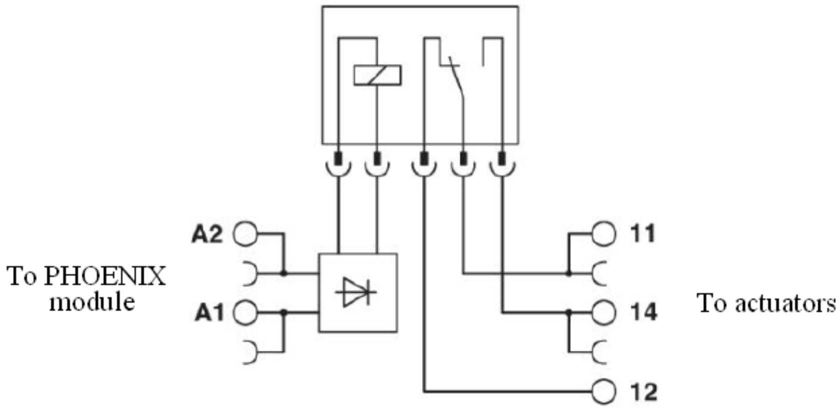

Figure 5.13: PHOENIX PLC-RSC-24DC/21 relay.

PLC-V8/FLK14/OUT modules shall be labeled according to *Table 5.3*:

Connected flat ribbon cable	Module label	Module type	Relay number	Relay type
DDO 1	DDO 1	PLC-V8/FLK14/OUT	1	PLC-RSC-24DC/21
			2	PLC-RSC-24DC/21
			3	PLC-RSC-24DC/21
			4	PLC-RSC-24DC/21
			5	PLC-RSC-24DC/21
			6	PLC-RSC-24DC/21
			7	PLC-RSC-24DC/21
			8	PLC-RSC-24DC/21
DDO 2	DDO 2	PLC-V8/FLK14/OUT	1	PLC-RSC-24DC/21
			2	PLC-RSC-24DC/21
			3	PLC-RSC-24DC/21
			4	PLC-RSC-24DC/21
			5	PLC-RSC-24DC/21
			6	PLC-RSC-24DC/21
			7	PLC-RSC-24DC/21
			8	PLC-RSC-24DC/21
DDO 3	DDO 3	PLC-V8/FLK14/OUT	1	PLC-RSC-24DC/21
			2	PLC-RSC-24DC/21
			3	PLC-RSC-24DC/21
			4	PLC-RSC-24DC/21
			5	PLC-RSC-24DC/21
			6	PLC-RSC-24DC/21
			7	PLC-RSC-24DC/21
			8	PLC-RSC-24DC/21
DDO 4	DDO 4	PLC-V8/FLK14/OUT	1	PLC-RSC-24DC/21
			2	PLC-RSC-24DC/21

			3	PLC-RSC-24DC/21
			4	PLC-RSC-24DC/21
			5	PLC-RSC-24DC/21
			6	PLC-RSC-24DC/21
			7	PLC-RSC-24DC/21
			8	PLC-RSC-24DC/21

Table 5.3: DDO relays and module types and labels.

Relays within every module shall also be labeled from 1 to 8 using labels such as

PHOENIX ZB 6,LGS:FORTL.ZAHLEN (*Figure 5.14*)

Figure 5.14: Numbered labels for Relays.

5.3 MIXED DIGITAL INPUT/OUTPUTS

A 140DDM35300 Schneider module in the Control Cabinet is used as a mixed discrete input and output module. This module is equipped with an FLKM 50/ 4-FLK14/PA-MODI-TSX/Q (*Figure 5.15*)

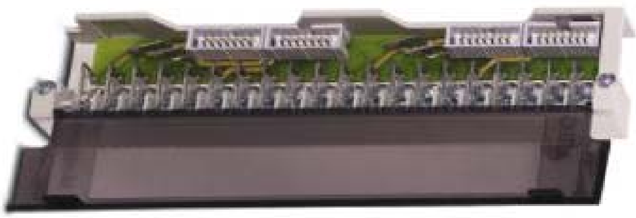

Figure 5.15. PHOENIX FLKM 50-PA-MODI-TSX/Q

The connectors implement the electrical interface between screw-like PLC terminal blocks and four 14-pins header for flat ribbon cable connectors. Connectors are attached to 4 FLK 14/EZ-DR/ 1000/KONFEK/S cables (*Figure 5.16*)

Figure 5.16: PHOENIX FLK 14/EZ-DR/ 1000/KONFEK/S One to One cable with IDC flat cable connectors.

Reference is to be confirmed. It may change depending on required length.

These cables are used to interface between Control Cabinet and Power cabinet. They shall be labeled as:

- DDO 5 -4Ch
- DDO 6 -4Ch
- DDI 5
- DDI 6

Cables labeled as DDO shall be connected to PLC-V8/FLK14/OUT modules

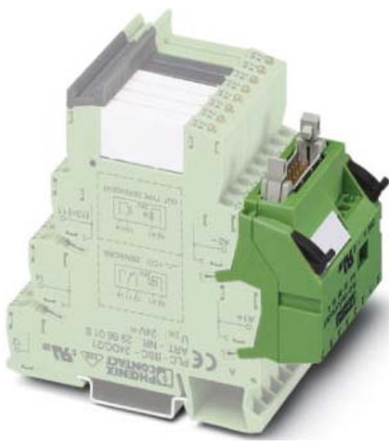

Figure 5.17: PHOENIX PLC-V8/FLK14/OUT

With 4 relays each module. The connections are as described in section DIGITAL OUTPUT, except that only 4 relays (instead of 8) are connected to each module. The gap spaces shall be filled with modules PLC-VT (passive terminal blocks) alternating one relay and one passive terminal block. Shown in table *Table 5.4*

Connected flat ribbon cable	Module label	Module type	Label number	Relay type
DDO 5 -4Ch	DDO 5 -4Ch	PLC-V8/FLK14/OUT	1	PLC-RSC-24DC/21
				PLC-VT
			2	PLC-RSC-24DC/21
				PLC-VT
			3	PLC-RSC-24DC/21
				PLC-VT
			4	PLC-RSC-24DC/21
				PLC-VT
DDO 6 -4Ch	DDO 6 -4Ch	PLC-V8/FLK14/OUT	1	PLC-RSC-24DC/21
				PLC-VT
			2	PLC-RSC-24DC/21
				PLC-VT
			3	PLC-RSC-24DC/21
				PLC-VT
			4	PLC-RSC-24DC/21
				PLC-VT

Table 5.4: DDO relays and module types and labels.

Passive terminal blocks PLC-VT (*Figure 5.18*) shall be left unconnected at compartment side.

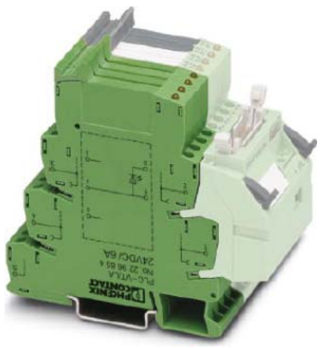

Figure 5.18: PHOENIX PLC-VT. Passive terminal block to fill empty gaps.

Cables labeled as DDI shall be connected to PLC-V8/FLK14/IN modules (*Figure 5.19*)

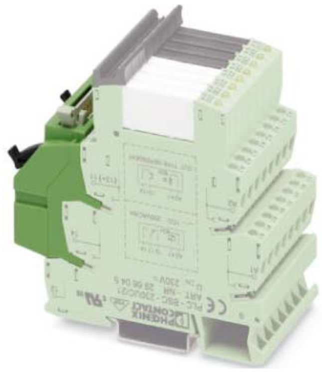

Figure 5.19: PHOENIX PLC-V8/FLK14/IN

Which are connected to 8 DIN rail relays PLC-RSC-24DC/21 each. Connections are exactly as described in section DIGITAL INPUT.

Labels according to *Table 5.5*:

Connected cable	**Module label**	**Module type**	**Relay number**	**Relay type**
DDI 5	DDI 5	PLC-V8/FLK14/IN	1	PLC-RSC-***xx***/21
			2	PLC-RSC-***xx***/21
			3	PLC-RSC-***xx***/21
			4	PLC-RSC-***xx***/21
			5	PLC-RSC-***xx***/21
			6	PLC-RSC-***xx***/21
			7	PLC-RSC-***xx***/21
			8	PLC-RSC-***xx***/21
DDI 6	DDI 6	PLC-V8/FLK14/IN	1	PLC-RSC-***xx***/21
			2	PLC-RSC-***xx***/21
			3	PLC-RSC-***xx***/21
			4	PLC-RSC-***xx***/21
			5	PLC-RSC-***xx***/21
			6	PLC-RSC-***xx***/21
			7	PLC-RSC-***xx***/21
			8	PLC-RSC-***xx***/21

Table 5.5: DDI relays and modules' types and labels. Relay type shall depend on the commutation voltage required, which depends on the kind of input sensor to be monitored.

5.4 ANALOG CURRENT INPUTS

A 140ACI03000 and two 140ACI04000 Schneider module in the Control Cabinet are installed to receive analog current inputs from the compartment. These modules are equipped with an FLKM 50-PA-MODI-TSX/Q (*Figure 5.20*)

Figure 5.20. PHOENIX FLKM 50-PA-MODI-TSX/Q

The connectors implement the electrical interface between screw-like PLC terminal blocks and a 50-pins header for flat ribbon cable connector. Attached to the connector there are two cables such as FLK 50/EZ-DR/1000/KONFEK/S (*Figure 5.21*)

Figure 5.21: PHOENIX FLK 50/EZ-DR/1000/KONFEK/S. One to One cable with IDC flat cable connectors.

Reference is to be confirmed. It may change depending on required length.

These cables are used to interface between Control Cabinet and Power cabinet. They shall be labeled as:

- ACI 1 - 8Ch (for 140ACI03000)
- ACI 2 - 16Ch (for 140ACI04000)
- ACI 3 - 16Ch (for 140ACI04000)

These cables shall be connected to a FLKM 50/MODI-TSX/Q module (*Figure 5.22*)

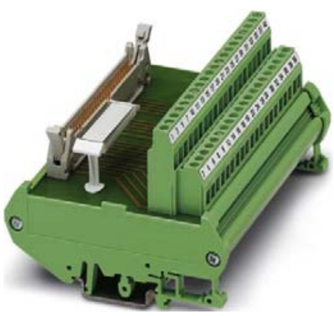

Figure 5.22: PHOENIX 50/MODI-TSX/Q

These modules are passive. They provide direct electric connections between a flat cable connector and terminal blocks.

The pinouts at terminals' blocks side are the same as at the corresponding PLC ACI module screw connections, which are as shown in *Figure 5.23*:

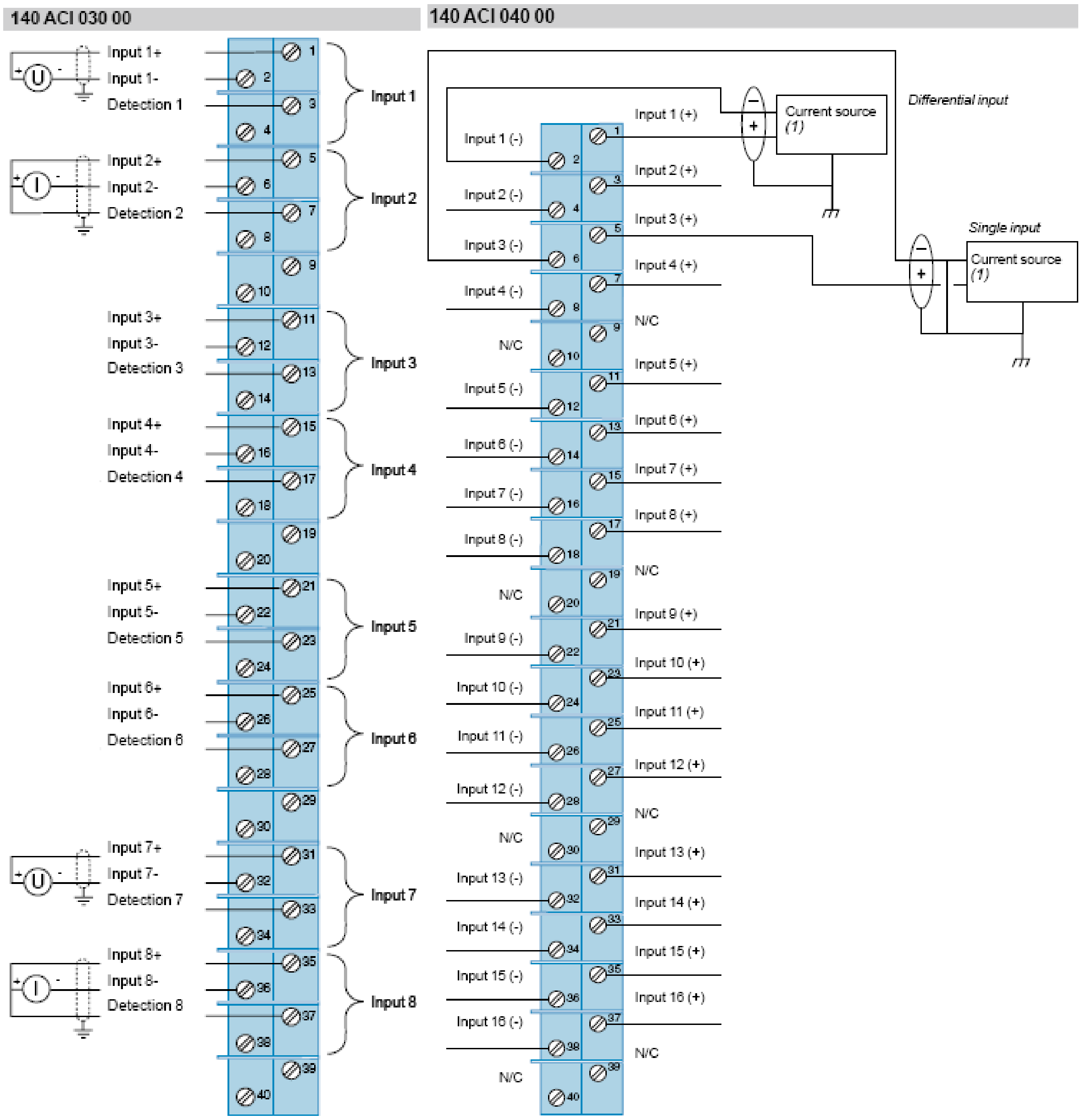

Figure 5.23: Pinout at 50/MODI-TSX/Q terminal block side (ACI).

At module 140ACI03000 notice that "Detection" pin should be short-circuited with Input+ pin whenever a 4..20mA input is to be monitored. In case of using 1…5V inputs the "Detection" pin shall not be connected.

140ACI04000 module inputs can be used either as differential current inputs and common point current inputs. Cabling differences are also shown in *Figure 5.23*.

Please, refer to Schneider documentation on Quantum 140ACI03000 and 140ACI04000 modules for further and more detailed information RD2.

PHOENIX 50/MODI-TSX/Q modules should be labeled as

- ACI 1 - 8Ch (for 140ACI03000)
- ACI 2 - 16Ch (for 140ACI04000)
- ACI 3 - 16Ch (for 140ACI04000)

5.5 ANALOG VOLTAGE INPUTS

A 140AVI03000 Schneider module in the Control Cabinet is used to receive analog voltage inputs from the compartment. This module is equipped with an FLKM 50-PA-MODI-TSX/Q (*Figure 5.24*)

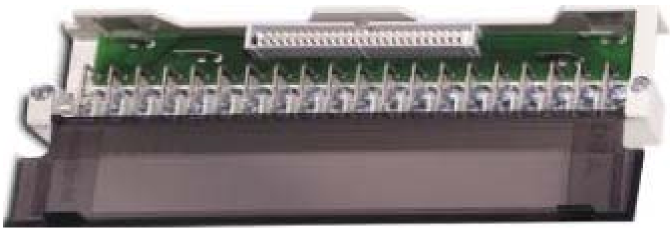

Figure 5.24. PHOENIX FLKM 50-PA-MODI-TSX/Q

The connectors implement the electrical interface between screw-like PLC terminal blocks and a 50-pins header for a flat ribbon cable connector. Connector is attached to a cable such as FLK 50/EZ-DR/1000/KONFEK/S (*Figure 5.25*)

Figure 5.25: PHOENIX FLK 50/EZ-DR/1000/KONFEK/S. One to One cable with IDC flat cable connectors.

Reference is to be confirmed. It may change depending on required length.

This cable is used to interface between Control Cabinet and Power cabinet. It shall be labeled as:

- AVI 1 - 8Ch

This cable shall be connected to a FLKM 50/MODI-TSX/Q module (*Figure 5.26*)

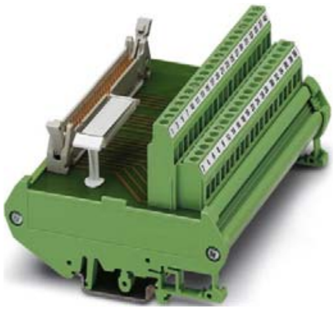

Figure 5.26: PHOENIX 50/MODI-TSX/Q

This module is passive. It provides direct electric connection between a flat ribbon cable connector and terminal blocks.

The pinout at terminals' blocks side is the same as at the corresponding PLC AVI module screw connections, which is the following (*Figure 5.27*):

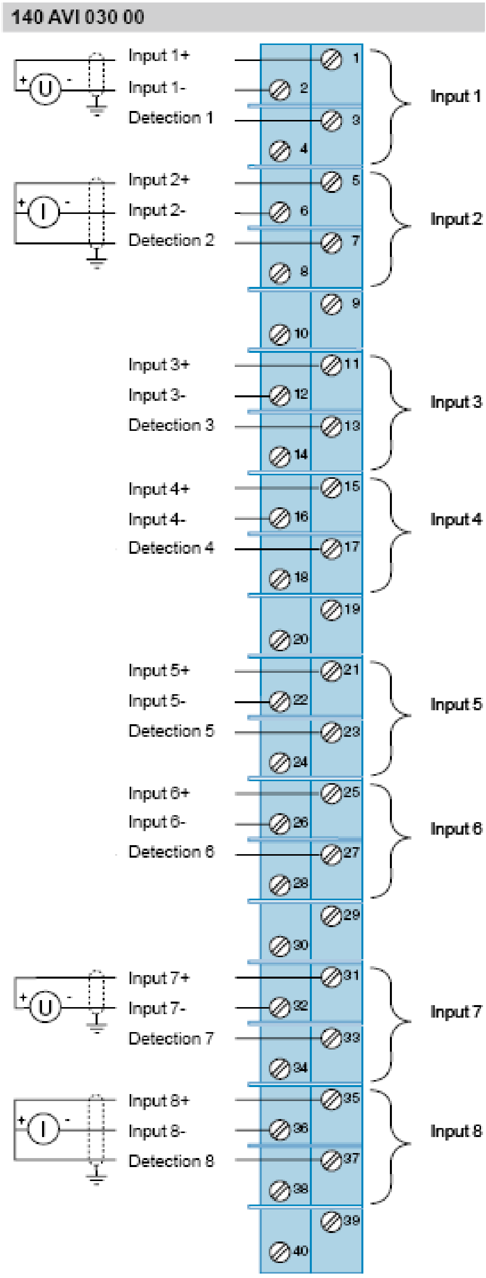

Figure 5.27 : Pinout at 50/MODI-TSX/Q terminal block side (AVI).

140AVI03000 module can be configured to sense the following kind of analog inputs: +/- 10V, +/- 5V, +/- 20mA, 0..10V, 0..5V, 0..20mA, 1..5V & 4..20mA. The “Detection” pin has to be short-circuited with Input+ pin for current sensing. This pin shall not be connected for voltage sensing.

Please, refer to Schneider documentation on Quantum 140AVI03000 modules for further and more detailed information RD2.

PHOENIX 50/MODI-TSX/Q modules should be labeled as

- AVI 1 – 8Ch

5.6 ANALOG VOLTAGE OUTPUTS

Two 140AVI03000 Schneider modules in the Control Cabinet are used to generate 8 analog voltage outputs (4 each module) to control actuators in the compartment. These modules are equipped with an FLKM 50-PA-MODI-TSX/Q (*Figure 5.28*)

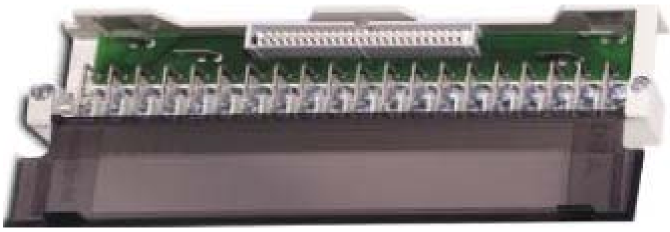

Figure 5.28. PHOENIX FLKM 50-PA-MODI-TSX/Q

The connector implements the electrical interface between screw-like PLC terminal blocks and a 50-pins header for flat ribbon cable connector. The connector is attached to a FLK 50/EZ-DR/1000/KONFEK/S (*Figure 5.29*) cable

Figure 5.29: PHOENIX FLK 50/EZ-DR/1000/KONFEK/S. One to One cable with IDC flat cable connectors.

Reference is to be confirmed. It may change depending on required length.

These cables are used to interface between Control Cabinet and Power cabinet. They shall be labeled as:

- AVO 1 - 4Ch
- AVO 2 - 4Ch

These cables shall be connected to FLKM 50/MODI-TSX/Q modules (*Figure 5.30*)

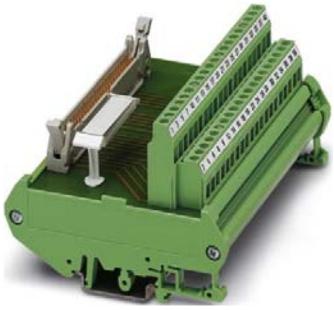

Figure 5.30: PHOENIX 50/MODI-TSX/Q

This module is passive. It provides direct electric connection between a flat ribbon cable connector and terminal blocks.

The pinout at terminal blocks side is the same as the corresponding PLC AVO module screw connections, which is the following (*Figure 5.31*):

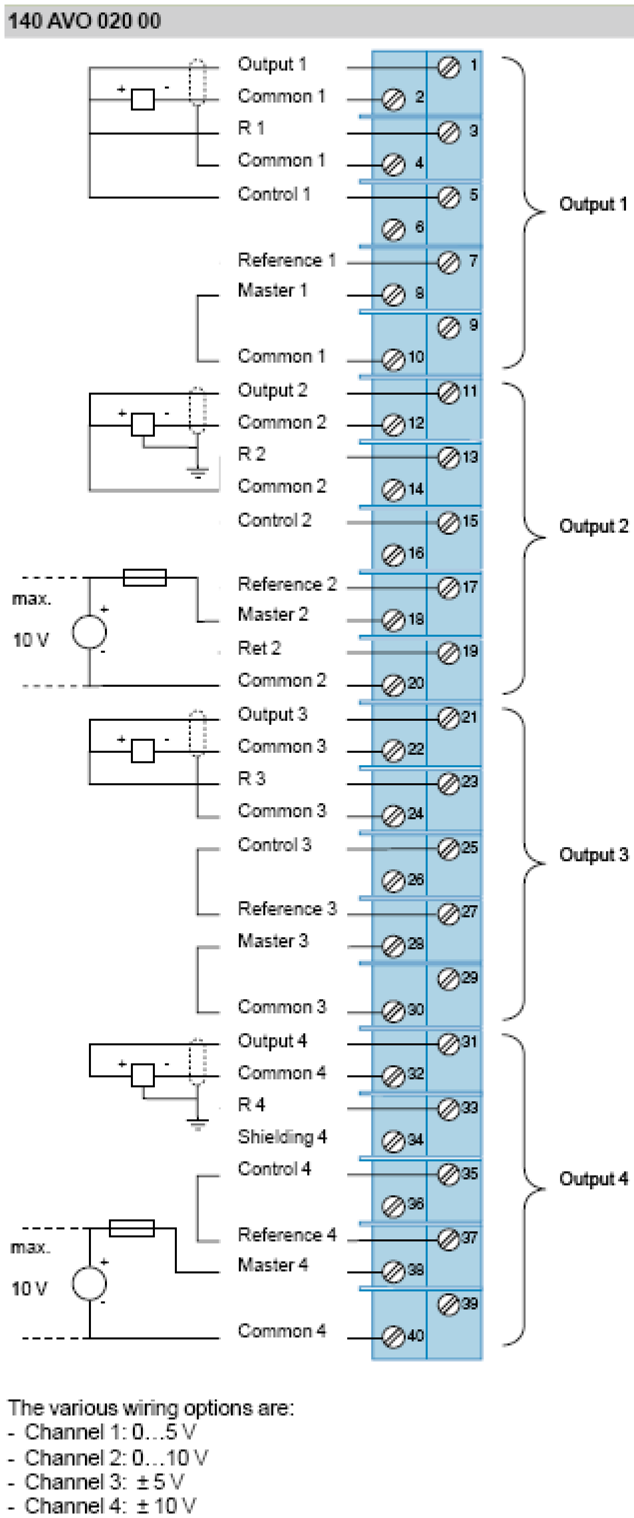

Figure 5.31 : Pinout at 50/MODI-TSX/Q terminal block side (AVO).

140AVO02000 module can be configured to provide 0..5V, 0..10V, +/- 10V, +/- 5V analog outputs. Connections differ depending on the selected kind of output, as shown in Figure 5.31, following the next rules:

- 0 to 5V: Output, R and Control jumpered.

- 0 to 10V: Output jumpered with R
- +/- 5V: Output jumpered with R and Control jumpered with Reference.
- +/- 10V: Control jumpered with Reference.

The Master pin is an input connected to the Output pin via a relay. It is meant to provide a “per default” output voltage when the module is not active. The module disables this connection when the module is active. In case this feature is not used It is recommended by the manufacturer to connect Master pin to its channel Common pin (Channel 1 & 3 cases in Figure 5.31)

Please, refer to Schneider documentation on Quantum 140AVO02000 modules for further and more detailed information RD2.

PHOENIX 50/MODI-TSX/Q modules should be labeled as

- AVO 1 – 4Ch
- AVO 2 – 4Ch

5.7 ANALOG CURRENT OUTPUTS

Two 140ACO13000 Schneider modules in the Control Cabinet are used to generate 16 **analog current sink** outputs (8 each module) to control actuators in the compartment. These modules are equipped with an

FLKM 50-PA-MODI-TSX/Q (*Figure 5.32*)

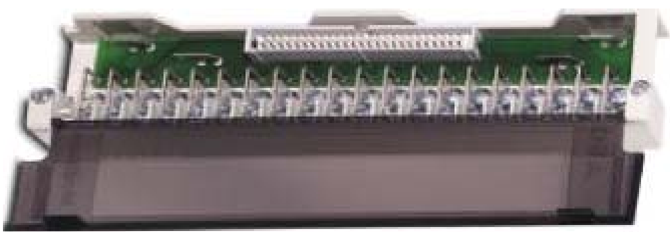

Figure 5.32. PHOENIX FLKM 50-PA-MODI-TSX/Q

To electrically interface between screw-like PLC terminal blocks and a 50-pins header for flat ribbon cable connector.

A FLK 50/EZ-DR/1000/KONFEK/S cable (*Figure 5.33*)

Figure 5.33: PHOENIX FLK 50/EZ-DR/1000/KONFEK/S. One to One cable with IDC flat cable connectors.

Reference is to be confirmed. It may change depending on required length.

These cable is used to interface between the Control Cabinet and the Power cabinet. They shall be labeled as:

- ACO 1 - 8Ch
- ACO 2 - 8Ch

These cable shall be connected to 2 FLKM 50/MODI-TSX/Q modules (*Figure 5.34*)

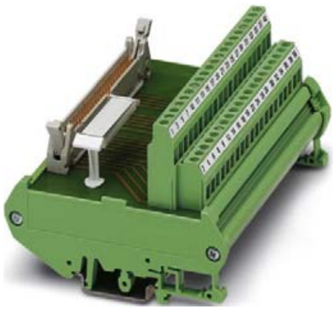

Figure 5.34: PHOENIX 50/MODI-TSX/Q

This module is passive. It provides direct electric connection between a flat ribbon cable connector and terminal blocks.

The pinout at terminal blocks side is the same as at the corresponding PLC ACO module screw connections, which is the following (Figure 5.35):

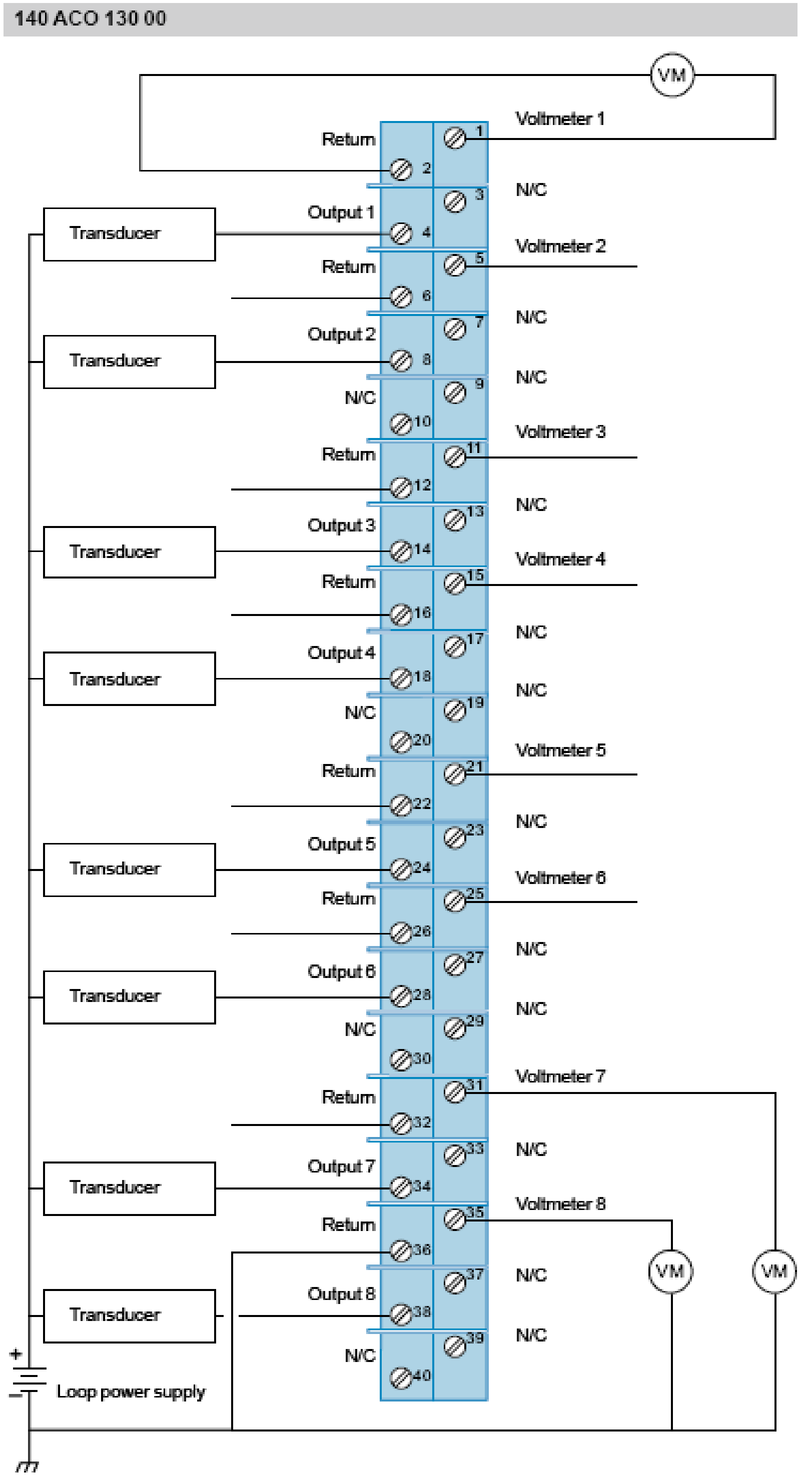

Figure 5.35 : Pinout at 50/MODI-TSX/Q terminal block side (ACO).

Voltmeter pins are outputs whose voltage is proportional to the current furnished by its channel.

140ACO13000 is an **analog current sink** output module. The current has to be generated externally with a power source. All return pins in the module are internally jumpered.

The outputs can be configured as 0..20mA, 4..20mA and 0..25mA.

Please, refer to Schneider documentation on Quantum 140ACO13000 modules for further and more detailed information RD2.

PHOENIX 50/MODI-TSX/Q modules should be labeled as

- ACO 1 – 8Ch
- ACO 2 – 8Ch

6. SHIELDED CABLES AND EARTHING

All cables used to interface between the power cabinet and the control cabinet are shielded.

Figure 6.1: 50-wire shielded cable with flat IDC cable connector termination.

They are provided with an extra wire (black wire in *Figure 6.1*) ended with a black ferrule.

A PHOENIX USLKG 2.5N terminal block (*Figure 6.2*) shall be used to plug this wire to the ground.

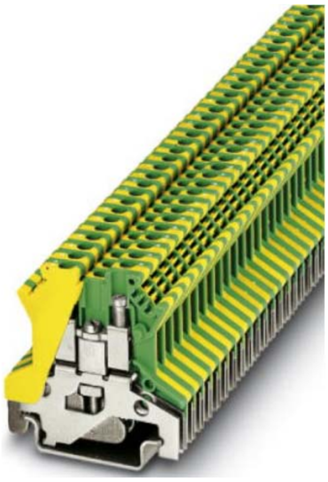

Figure 6.2: PHOENIX USLKG 2.5 N

This grounding terminal block is electrically connected to the DIN rail, so it is not necessary to add an earthing cable at the other side. On the other hand, however, the cabinet has to be designed so that the DIN rails have a proper connection to ground.

One of these terminal blocks should be placed next to every DIN rail module (for the analog inputs and outputs) or every 8 PLC relays (for digital inputs and outputs), to plug the corresponding shield wire coming from the Control cabinet cable.

7. LIST OF INPUT / OUTPUTS

This list is according to the information provided in [R1].

TAG	Description	Reference	Manufacturer	Elect Int.	Signal			
					DI	DO	AI	AO
LT 4013 01	Foam measurement				1			
PT 4001 02	Pressure switch transmitter		WIKA		1			
PT 4001 03	Pressure switch transmitter		WIKA		1			
PT 4002 01	Pressure switch transmitter		WIKA		1			
PT 4002 02	Pressure switch transmitter		WIKA		1			
SV 4005 01	Cooling water outlet valve/BALL	2652	BÜRKERT		1	1		
SV 4011 01	Cooling water outlet valve/BALL	2652	BÜRKERT		1	1		
SV 4041 01	Ball steam inlet valve		BÜRKERT		1	1		
SV 4012 01	Cooling water outlet valve/BALL	2652	BÜRKERT		1	1		
SV 4016 02	Ball steam inlet valve		BÜRKERT		1	1		
SV 4006 01	Acid inlet reactor	2031	BÜRKERT		1	1		
SV 4006 02	Basic inlet reactor	2031	BÜRKERT		1	1		
SV 4010 01	Gas inlet Analyzer	2031	BÜRKERT		1	1		
SV 4003 04	Compressed air to the biomass sensor	2031	BÜRKERT		1	1		
SV 4003 01	Gas inlet Analyzer	2031	BÜRKERT		1	1		
SV 4004 02	Gas inlet Analyzer	2031	BÜRKERT		1	1		
SV 4015 01	Ball steam inlet valve reactor	2031	BÜRKERT		1	1		
GP 4001 01	Thermal to the pump	Ecodos 4S1	LEWA		1			
GP 4001 02	Thermal to the pump	Ecodos 4S1	LEWA		1			
GP 4002 01	Thermal to the pump	Ecodos 4S1	LEWA		1			
GP 4002 02	Thermal to the pump	Ecodos 4S1	LEWA		1			
BLWR 4005 01	Extractor fan	SV250H	SODECA		1			
GP 4001 03	VS 4001 01 agitator motor	Sterimixer SMO 85/40	ROPLAN		1			
GP 4002 03	VS 4002 01 agitator motor		NORD		1			
GP 4001 01	Start/Stop to the pump	Ecodos 4S1	LEWA			1		
GP 4001 02	Start/Stop to the pump	Ecodos 4S1	LEWA			1		
GP 4002 01	Start/Stop to the pump	Ecodos 4S1	LEWA			1		

GP 4002 02	Start/Stop to the pump	Ecodos 4S1	LEWA			1		
GP 4001 03	Start/Stop to the motor	Sterimixer SMO 85/40	ROPLAN			1		
GP 4002 03	Start/Stop to the motor		NORD			1		
PP 4005 01	Start/Stop to the pump					1		
BLWR 4003 01	Start to the pump	N86KN.18	KNF			1		
BLWR 4005 01	Start/Stop to the pump	SV250H	SODECA			1		
PP 4006 01	Start/Stop to the pump					1		
PP 4006 02	Start/Stop to the pump					1		
PS 4001 01	Preostato break diafragm lewa pump	PSD10HB				1		
PS 4001 02	Preostato break diafragm lewa pump	PSD10HB				1		
PS 4002 01	Preostato break diafragm lewa pump	PSD10HB				1		
PS 4002 02	Preostato break diafragm lewa pump	PSD10HB				1		
PS 4003 01	Preostato by pass	PSD10HB				1		
ER 4005 01	Start Electrical Resistence					1		
ER 4005 01	Stop Electrical Resistence					1		
HX 4010 01	Start post condenser	MAX 10	SICK			1		
HX 4010 01	Stop post condenser	MAX 10	SICK			1		
	Emergency button 1				1			
	Emergency button 2				1			
AT 4009 01	Biomass measurement	CT08 Dual Probe A01 0044	MONITEK	4/20 mA			1	
AT 4009 02A	Biomass measurement	InPro 8200, In Trac 799M	METTLER TOLEDO	4/20 mA + RS232			1	
AT 4009 02B	Temperature measurement (biomass)	InPro 8200, In Trac 799M	METTLER TOLEDO	4/20 mA + RS232			1	
AI 4010 01	CO2/O2 gas analyzer	Multor 610	SICK MAIHAK	1x4/20 mA ---			1	
AI 4010 02	CO2/O2 gas analyzer	Multor 610	SICK MAIHAK	1x4/20 mA ---			1	
AI 4010 03A	Dissolved Oxygen measurement	InPro6800+In Trac 777	METTLER TOLEDO	4/20 mA ---			1	
AI 4010 03B	Temperature measurement (Dissolved Oxygen)	InPro6800+In Trac 777	METTLER TOLEDO	4/20 mA ---			1	
AI 4006 01A	pH measurement	InPro 3253, In Trac777. Transmitter M300	METTLER TOLEDO	4/20 mA ---			1	
AI 4006 01B	Temperature measurement (pH)	InPro 3253, In Trac777. Transmitter M300	METTLER TOLEDO	4/20 mA ---			1	
AI 4006 02A	pH measurement	InPro 3253, In Trac777. Transmitter M300	METTLER TOLEDO	4/20 mA			1	
AI 4006 02B	Temperature measurement(pH)	InPro 3253, In Trac777. Transmitter M300	METTLER TOLEDO	4/20 mA			1	
FT 4004 01	Total air outlet from reactor	F-111B-AGD	BRONKHORST	4/20 mA + RS232 ---			1	
FT 4001 01	Total liquid inlet to reactor	Promass 8A01	E&H	4/20 mA + Hart ---			1	
FQRC 4004 01	Pressure Control to Reactor Air outlet valve + Measuremet of mass fow	2833	BÜRKERT	4/20mA				1
LT 4001 01	Guided microwave -	Vegaflex 63	VEGA	4/20 mA + Hart --			1	
WI 4002 01	Weight Balance (VS 402)	IND560+PBA330-CC600	METTLER TOLEDO	4/20 mA ---			1	
WT 4002 01	Weight Cells (Reactor)	Ultramount 0972+IND110	METTLER TOLEDO	4/20 mA ---			1	
PT 4007 01	Reactor pres. measurement	Vegabar 52	VEGA	4/20 mA + Hart ---			1	
PT 4007 02	Reactor pres. measurement	Vegabar 52	VEGA	4/20 mA + Hart ---			1	
PT 4010 01	Outlet gas pres. measurement	Vegabar 52	VEGA	4/20 mA + Hart ---			1	
DPT 4001 01	Differential Pressure of filter	Vegadif 55	VEGA	4/20 mA + Hart ---			1	
DPT 4001 04	Differential Pressure of filter	Vegadif 55	VEGA	4/20 mA + Hart ---			1	
DPT 4004 01	Differential Pressure of filter	Vegadif 55	VEGA	4/20 mA +			1	

				Hart ---					
TT 4005 02	Reactor temperature measurement	PT-100 + transmitter	BIOENGINEER ING	4/20 mA ---				1	
TT 4001 01	Vessel temperature measurement	PT-100 + transmitter	E&H	4/20 mA ---				1	
TT 4010 01	Analyzer temperature measurement	PT-100 + transmitter TR45	E&H	4/20 mA ---				1	
TT 4012 01	Vessel temperature measurement	PT-100 + transmitter TR45	E&H	4/20 mA ---				1	
FQRC 4003 01	Measurement of mass flow air inlet	F202D-FA-44-V	BRONKHORST	0-5 Vda+ RS232				1	1
FQRC 4003 02	Measurement of mass flow CO2 inlet	F202D-FA-33-Z	BRONKHORST	0-5 Vda+ RS232				1	1
FQRC 4003 03	Measurement of mass flow CO2 inlet	F202D-FA-44-V	BRONKHORST	0-5 Vda+ RS232				1	1
FQRC 4003 05	Flow Control + Measuremet of mass flow	F202D-FA-44-V	BRONKHORST	0-5 Vda+ RS232				1	1
GP 4001 01	Flow to the pump	Ecodos 4S1	LEWA	4/20mA					1
GP 4001 02	Flow to the pump	Ecodos 4S1	LEWA	4/20mA					1
GP 4002 01	Flow to the pump	Ecodos 4S1	LEWA	4/20mA					1
GP 4002 02	Flow to the pump	Ecodos 4S1	LEWA	4/20mA					1
GP 4001 03	Speed agitator (VS4001 01)	Sterimixer SMO 85/140	ROPLAN	4/20mA					1
GP 4002 03	Speed agitator (VS4002 01)		NORD	4/20mA					1
BLWR 4005 01	Flow air	SV250H SODECA		0/10V					1
WT 4006 01	Balance acid		METTLER TOLEDO	RS232 ----					
WT 4006 02	Balance basic		METTLER TOLEDO	RS232 ---					
IRC 4000 01	INTENSIDAD LUZ BOMBILLAS			4/20 mA				1	1
TOTALS					30	38		33	12

MELISSA CIVa CONTROL CABINET HARDWARE DESIGN DOCUMENT

APPROVAL LIST		
NAME	SIGNATURE	DATE
Prepared by: M.Bassas		16/10/2009
Revised by: J.Carbonell		16/10/2009
Approved by: E.Creus		21/10/09
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CHANGE RECORD			
AUTHOR	ISSUE	DATE	CHANGE
Martí Bassas	1.0	0x/09/2009	First Version

CONTENTS

LIST OF ACRONYMS

CIVa	Compartment IVa
I/O	Input / Output
PLC	Programmable Logic Controller
MELiSSA	Micro-Ecological Life Support System Alternative
MPP	MELiSSA Pilot Plant
UAB	Universitat Autònoma de Barcelona
AI	Analogue input
AO	Analogue output
DI	Digital input
DO	Digital output
EPIC	Electrical Power Interface Cabinet

1. SCOPE

This document describes the design of the Control System for the Compartment IVa that is to be installed at the MELiSSA Pilot Plant, located at UAB's premises.

It contains the electrical design, mechanical design and implementation, identification of components and connectivity information with Compartment IVa EPIC and hardware.

2. APPLICABLE AND REFERENCE DOCUMENTS

2.1 APPLICABLE DOCUMENTS

Ref	Title	Reference	Issue	Date
[AD1]	NTE OFFER FOR CIVa CONTROL SYSTEM CABINET AND HMI UPDATE FOR THE MELISSA CS CIVa-P2.	NTE-CIVaP2-OF-001	1.0	03.2009

2.2 REFERENCE DOCUMENTS

Ref	Title	Reference	Issue	Date
[RD1]	CIVa HARDWARE INTERFACE DOCUMENT	NTE-CIVaP2-ICD-002	1.0	May 2009

3. MELISSA CIVA SYSTEM OVERVIEW

MELISSA Compartment IV is divided into two compartments:

- CIVa. Algae growth compartment.
- CIVb HPC High plant compartment)

The CIVa is meant to provide the proper environment to grow the Spirulina (*Arthrospira Platensis*), which is a phototrophic algae, inside a transparent bio-reactor surrounded by a set of bulbs to provide light for the photosynthesis. The algae growth consumes CO_2 and NO_3^{-*} produced in Compartment III.
The Spirulina produced is edible, and the oxygen coming from the photosynthesis can be further used for breathing.

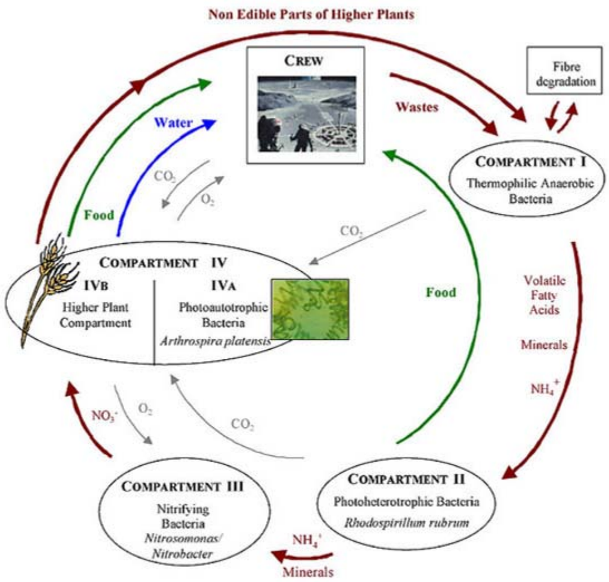

Figure 1 MELISSA LOOP CONCEPT

MELISSA CIVa system can be represented by two main hardware blocks: the reactor and the control cabinet. All these hardware is needed to maintain the proper conditions in the reactor. MELISSA CIVa system overview is shown in Figure 2

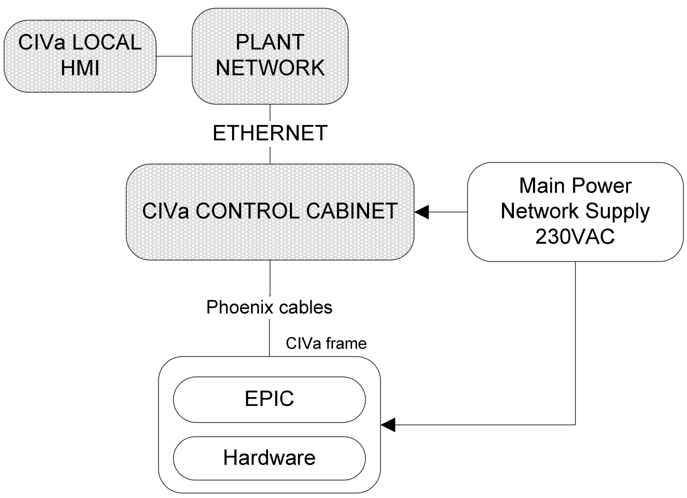

Figure 2: Melissa CIVa system overview

CIVa frame

From the control point of view the compartment can be seen as a set of sensors and actuators. There are about 100 devices, between sensors and actuators. All these signals are wired to two EPICs, placed in the CIVa frame. The EPICs have: electrical protection, power interfaces and the electrical interfaces necessary to connect directly to the control cabinet. This means that all the power circuits are in the EPICs, which is placed inside the CIVa frame, while the CIVa Control Cabinet only manages information signals.

Figure 3: Compartment IVa

CIVa Control Cabinet

The CIVa Control Cabinet houses the CIVa Control System equipment. It contains the PLC (Programmable Logic Controller) with the required processor, I/O cards and power supply modules, interface connectors, network elements and power safety devices. The Control Cabinet is to be installed next to the CIVa frame at MPP in UAB.

Plant Network

The plant network interconnects the PLC of every compartment of the Melissa loop, the SCADA server, SCADA clients, embedded PCs of the Biomass systems, EKI-1522 devices (to interface between the weight scales and Ethernet) and local HMIs (Magelis).

The following picture (Figure 4) shows the CIVa system structure.

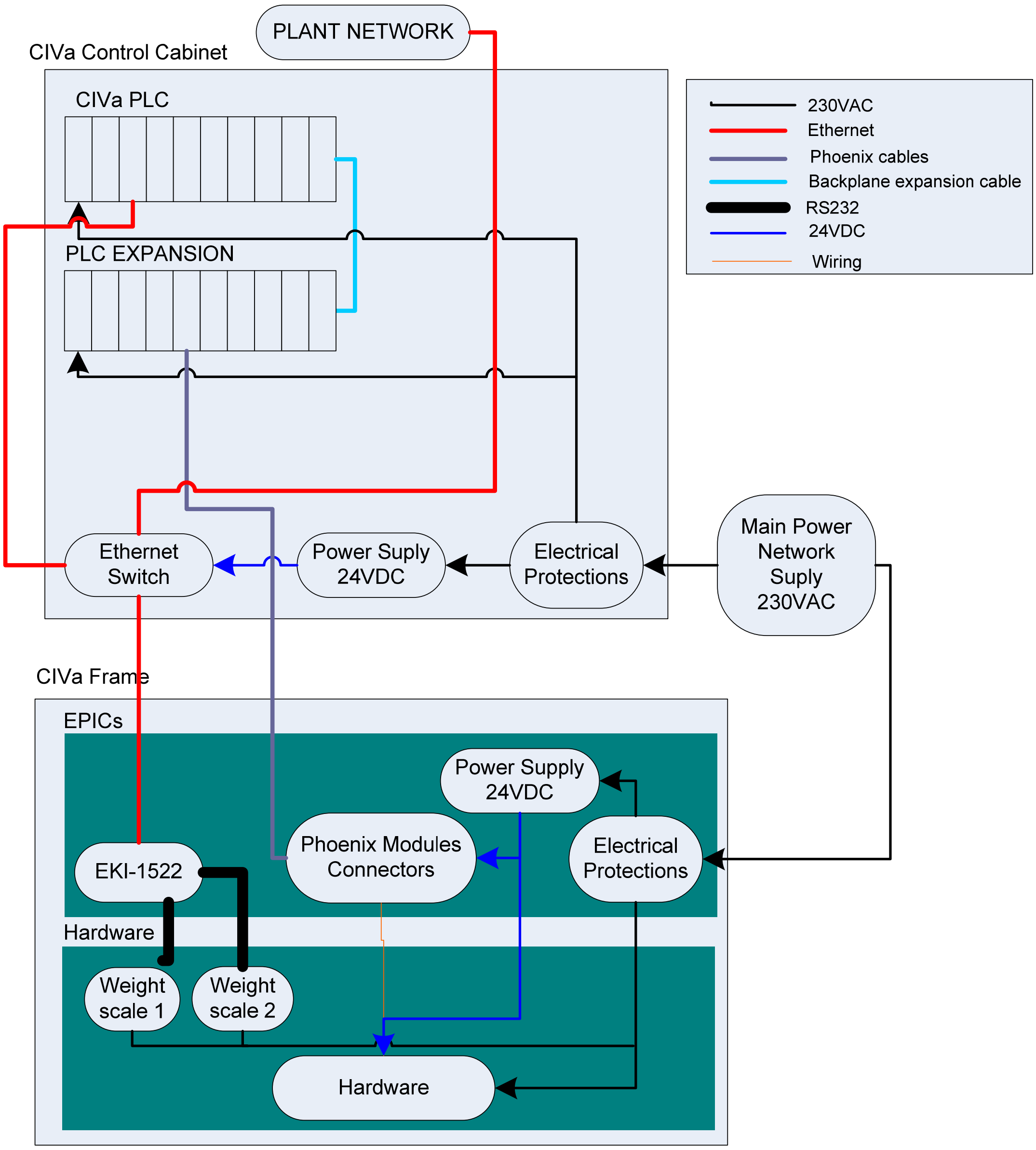

Figure 4: Melissa CIVa System

4. CIVA CONTROL CABINET DESCRIPTION

4.1 CIVa CONTROL CABINET OVERVIEW

4.1.1 Hardware overview

The MELISSA CIVa Control Cabinet acquires data from the CIVa and supplies control commands accordingly. Figure 4.describes the control concept and the main elements involved.

The control cabinet is a single 600x600x1800 mm Rittal electrical cabinet with one panel assembly and one synthetic glass door. See Figure 5.

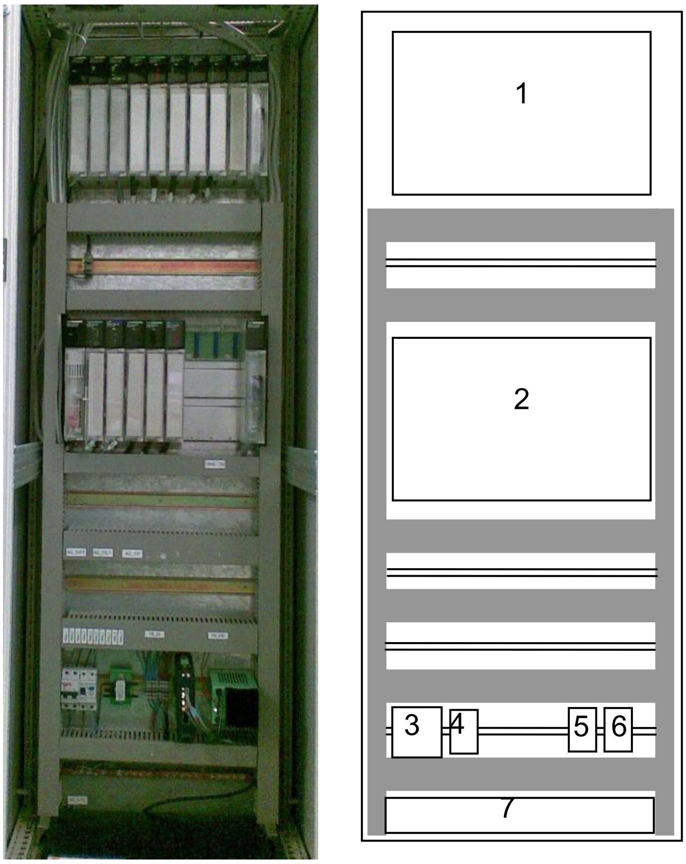

Figure 5: Mounted plate layout.

Mount plate layout component description:

1. PLC BACKPLANE
2. PLC EXPANSION BACKPLANE
3. ELECTRICAL PROTECTIONS
    a. Magnetothermic circuit braker:
    b. Differential circuit braker.
4. EMI FILTER
5. EKI-2525 (Ethernet Switch)
6. ±15Vdc Power Supply.
7. UPS

The CIVa Control Cabinet features three interfaces:

- Interface to the MPP power supply (mains) with European characteristics (220 - 230 VAC, 50 Hz)
- Interface with the CIVa Reactor by EPIC.
- Interface with the MPP Control Room using an Ethernet connection to allow the implementation of the monitoring and surveillance functions on the MPP's central computer

4.1.2 Functional overview

Control cabinet diagram is shown in Figure 4, upper side. It is divided in basically 3 subsystems:

1. ENERGY DISTRIBUTION
    - 1.1. ELECTRICAL PROTECTIONS
    - 1.2. POWER SUPPLIES
        - 1.2.1. 24 VDC
        - 1.2.2. PLC POWER SUPPLY
2. ELECTRONICS
    - 2.1. PLC
        - 2.1.1. PLC ETHERNET CARD.
        - 2.1.2. PLC PROCESSOR CARD
        - 2.1.3. PLC I/O CARDS
    - 2.2. ETHERNET SWITCH

All these subsystems details will be described in the following sections. The PHOENIX terminal blocks are placed in the EPICs, inside the CIVa frame.

4.2 MELISSA CIVa CONTROL CABINET ENERGY DISTRIBUTION

This subsystem supplies energy at all components of the control cabinet. Moderate or thigh power consuming devices like pumps, fans and other actuators will be feed from other sources.

Components of the ENERGY DISTRIBUTION SUBSYSTEM:

- ELECTRICAL PROTECTIONS
    - Magnetothermic AC_MGTH2: MERLIN GERIN MULTI9 C60HB B4
    - Differential: HAGER CDC748M (Imax: 40A; ΔImax: 0.03A).
- EMI Filter Yunpen YK06T1.
- POWER SUPPLIES
    - ±15 Vdc power supply. PHOENIX CM-90-PS-230AC/2x15DC/1
    - PLC POWER SUPPLY 140CPS11420.

4.3 CIVa CONTROL CABINET ELECTRONICS

4.3.1 PLC configurations

The Schneider PLC I/O cards installed are the following:

- Digital Input, DI cards → model ***140DDI35300***, with 32 ports.
- Digital Output, DO cards → model ***140DDO35300***, with 32 ports
- Digital Input and Output DDM card → model: ***140DDM39000***, with 16 input & 8 output ports.
- Analogue Voltage Input, AVI card → model ***140AVI03000***, with 8 ports
    - Voltage: (0 – 10 VDC) or (0 – 5 VDC) or Current (4 – 20 mA)
    - Resolution 16/15/14 bits, and bipolar option is available.
- Analogue Current Input, ACI cards,
    - Model ***140ACI04000***, with 16 ports, two units.
        - Current: (0-20mA, 0-25000counts) or (0-20mA, 0-20000counts) or (4-20mA, 0-16000counts) or (4-20mA, 4095 counts).
    - Model ***140ACI03000***, with 8 ports.
        - Current: 4…20mA.
        - Voltage: 1…5V
- Analogue Current Output (current sink), ACO cards → model ***140ACO13000***, with 8 ports, two units.
    - Current: (0-25mA, 0-25000counts) or (0-20mA, 0-20000counts) or (4-20mA, 0-16000counts) or (4-20mA, 4095 counts).
- Analogue Voltage Output, AVO cards → model ***140AVO02000*** with 4 ports, two units.
    - Voltage: (-/+ 10VDC), (-/+ 5VDC), (0-10VDC) or (0-5VDC).

Compartment CIVa Quantum (by Schneider) Programmable Logic Controller is mounted on two backplanes

- PLC primary (first backplane)
- PLC expansion (second backplane)

with 10 slots available in each backplane. The PLC module's distribution in the backplanes is displayed in the following tables (Table 1 & Table 2), showing the manufacturer reference identification.

An expansion module 140XBE10000 is installed in each backplane to provide connectivity between them. An expansion cable 140XCA71703 connects these two modules. The cable end labeled as "Primary" has to be connected to the primary backplane and must be installed before the PLC power-up.

PLC PRIMARY									
1	2	3	4	5	6	7	8	9	10
140CPS11420	140CPU43412A	140NOE77101	140ACI03000	140AVI03000	140AVO02000	140AVO02000	140ACO13000	140DDM39000	140XBE10000
Backplane Power Supply module	CPU module	Ethernet module	8 Analog current Input (ACI 1)	8 Analog voltage Input (AVI 1)	4 Analog voltage Output (AVO 1)	4 Analog voltage Output (AVO 2)	8 Analog current Output (ACO 1)	Digital Input/Output	Rack expansion
CIVa_PLC_CPS	CIVa_PLC_CPU	CIVa_PLC_NOE	CIVa_PLC_IO_ACI1	CIVb_PLC_IO_AVI1	CIVa_PLC_IO_AVO 1	CIVa_PLC_IO_AVO 2	CIVa_PLC_IO_ACO 1	CIVa_PLC_IO_DD M1	CIVb_PLC_XBE
Address			300100-->300108	300109->300117	400100->400103	400104->400107	400108->400115	100065->100080	

Table 1: PLC PRIMARY BACKPLANE CARD DISTRIBUTION

PLC EXPANSION									
1	2	3	4	5	6	7	8	9	10
140CPS11420	140DDI35300	140DDO35300	140ACI04000	140ACI04000	140ACO13000				140XBE10000
Backplane Power Supply module	32 Digital Input 24V	32 Digital Output 24V	16 Analog current Input (ACI 2)	16 Analog current Input (ACI 3)	8 Analog current Output (ACO 2)				Rack expansion
CIVa _PLC_CPS	CIVa_PLC_DDI1	CIVa_PLC_DDO1	CIVa_PLC_ACI2	CIVa_PLC_ACI3	CIVa_PLC_ACO2				CIVb_PLC_XBE
Address	100081->100112	000081 -> 000112	300118 -> 300134	300135 -> 300151	400116 -- >400123				

Table 2: PLC EXPANSION BACKPLANE CARD DISTRIBUTION

Figure 6: PLC assembly on backplanes

CIVa_PLC_IO_DDM1 card is not connected to any PHOENIX terminal block because there is no room in any EPIC to place such modules. Of course, no I/O of this card is used.

The following tables show the IOs available for each card reference.

CARD	Inputs available	Inputs used	Inputs free
140DDI35300 (DDI1)	32	32	0
140DDM39000 (DDM1) (only inputs)	16	0	16
TOTAL DI	**40**	**32**	**16**

CARD	Outputs available	Outputs used	Outputs free
140DDO35300 (DDO1)	32	29	3
140DDM39000 (DDM1) (only outputs)	8	0	8
TOTAL DO	**40**	**29**	**11**

CARD	Inputs available	Inputs used	Inputs free
140ACI03000 (ACI1)	8	0	8
140ACI04000 (ACI2)	16	16	0
140ACI04000 (ACI3)	16	13	3
140AVI03000 (AVI1)	8	4	4
TOTAL AI	**48**	**33**	**15**

CARD	Outputs available	Outputs used	Outputs free
140AVO02000 (AVO1)	4	4	0
140AVO02000 (AVO2)	4	1	3
140ACO13000 (ACO1)	8	8	0
140ACO13000 (AC)2)	8	0	8
TOTAL AO	**24**	**13**	**11**

4.3.2 Weight scales connection

Acid and Base tank levels are monitored by using weight scales to measure their containing tank weight. The scales send the measurements through a serial port (RS-232).To communicate scales with the SCADA server an EKI-1522 device (a serial device server that connects RS-232/422/485 serial devices to an IP-based Ethernet LAN) is used. The following figure shows connections implemented between scales and SCADA server.

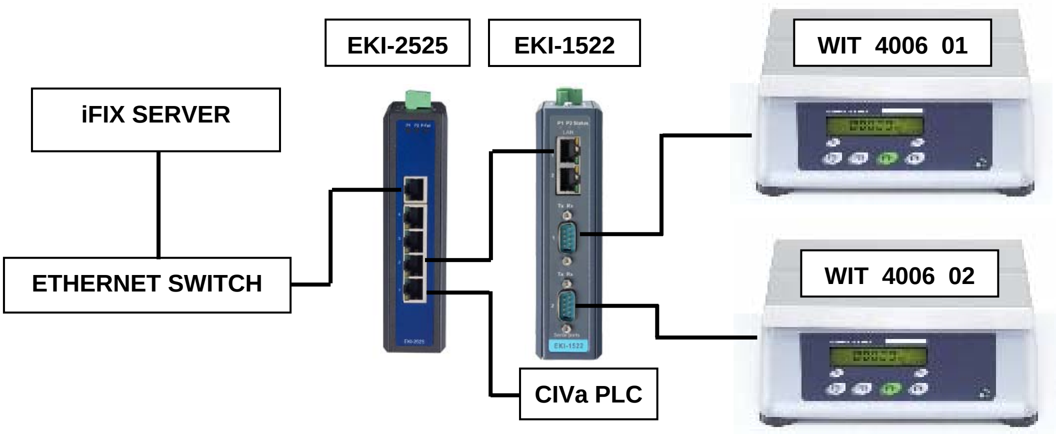

Figure 7: Scales connection

In the Scada server there is a schedule implemented in Visual Basic for Applications that is executed every 10 minutes. This routine sends a weight measurement request to the scales, receives an answer from them with the tanks' weight, and writes these value into a PLC registers. These values are used by the CIVa PLC control loops, and they are shown in the CIVa SCADA display.

4.4 CIVa TERMINALS BLOCKS

4.4.1 VARIOFACE PHOENIX PLUGGABLE SYSTEM

MELISSA CVIa is wired using PHOENIX VARIOFACE PLUGGABLE SYSTEM. In Figure 8, a traditional wiring system and a pluggable PHOENIX VARIOFACE wiring system are compared. PHOENIX system uses two IDC connectors instead of 80 screws of traditional plc wiring. Main parts of PHOENIX pluggable system are: plc Schneider adaptor, IDC PHOENIX wire and PHOENIX terminal block.

MELISSA CIVa control cabinet is wired from plc to PHOENIX terminals blocks. From user point of view all I/Os are disposable in terminal PHOENIX block. PlC manipulation I/Os is not necessary in any circumstance. All relationship between the PLC and terminal blocks are described in I/Os table section 4.5.

Further information is available in http://www.phoenixcontact.com

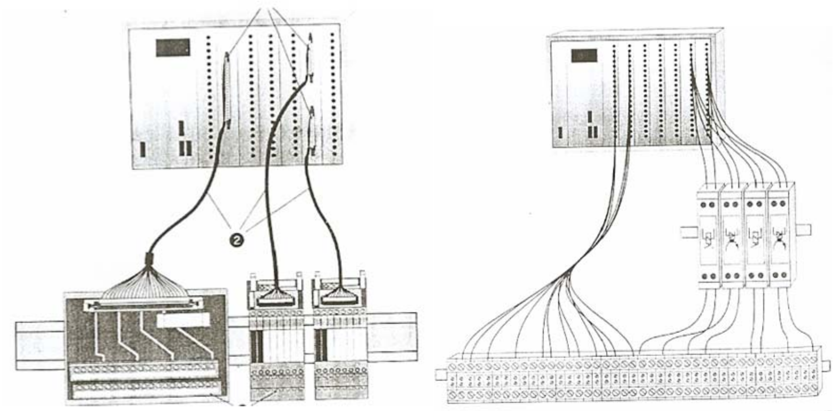

Figure 8: PHOENIX VARIOFACE PLUGGABLE SYSTEM vs TRADITIONAL WIRING SYSTEM

4.5 PHOENIX TERMINAL IDENTIFICATION

PHOENIX terminal blocks and relays are placed into two cabinets in the CIVa frame, which we call EPICs in this document.

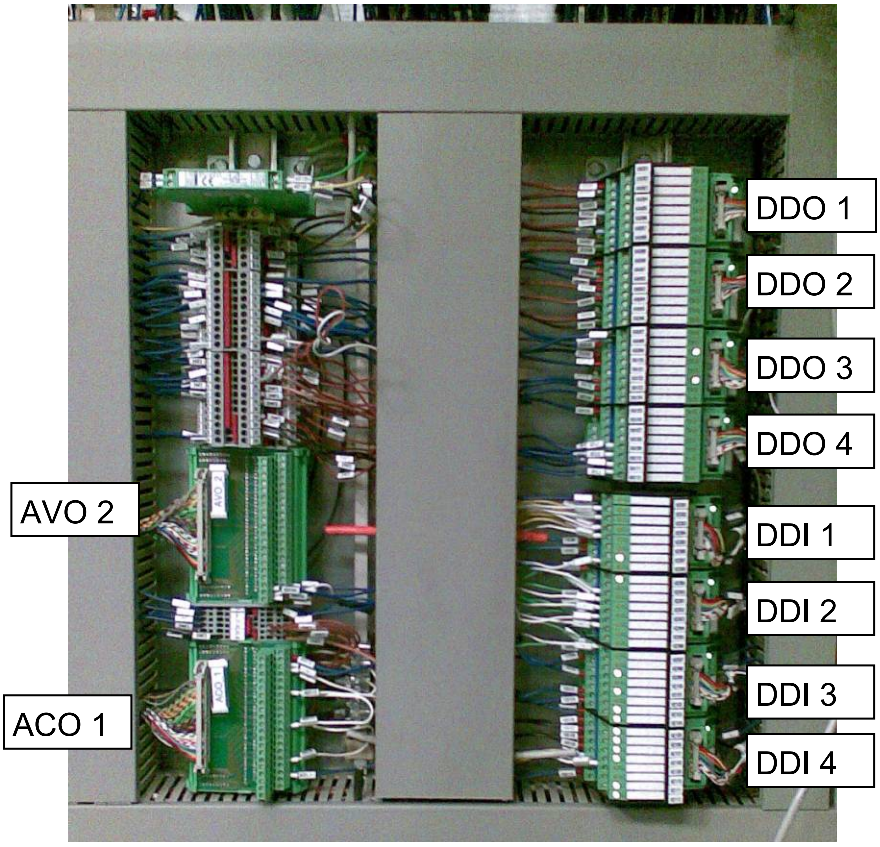

Figure 9: PHOENIX modules and relays in the main CIVa EPIC.

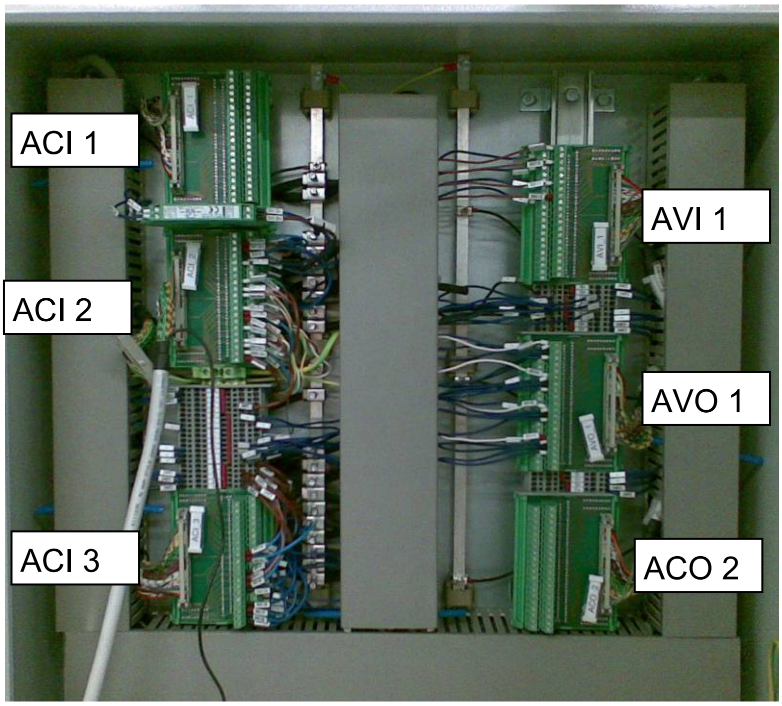

Figure 10: Seondary EPIC, with the remaining PHOENIX modules.

For more detailed information on the used PHOENIX modules and the interface with the PLC see [RD1].

4.5.1 CS CIVa control cabinet terminal identification

CS-CIVa control cabinet terminals are divided into four major BLOCKS (DI(48),DO(40),AI(48),AO(24)). Each of them is divided into TERMINAL SETs of (DI(32 or 16),DO(32 or 8),AI(16 or 8), AO (8 or 4)), depending on the PLC cards used for I/O. Again some of them are divided into SUBSETs (DI(8),DO(8 or 4)). See Figure 8. Each pin of each block is identified by a label with a number.

- PHOENIX Digital Input BLOCKS (32 DI)
  - PHOENIX TERMINAL SET DDI1:4 (32 DI)
    - PHOENIX TERMINAL SUBSET DDI1 (8 DI)
      - DDI1_1
      - …..
      - DDI1_8
    - PHOENIX TERMINAL SUBSET DDI2 (8 DI)
    - PHOENIX TERMINAL SUBSET DDI3 (8 DI)
    - PHOENIX TERMINAL SUBSET DDI4 (8 DI)
  - PHOENIX CARD DDM (16DI)
    - Not connected to any terminal block.(16DI)
- PHOENIX Digital Output BLOCKS (40 DO)
  - PHOENIX TERMINAL SET DDO1:4 (32 DO)
    - PHOENIX TERMINAL SUBSET DDO1 (8 DO)
      - DDO1_1
      - …
      - DDO1_8
    - PHOENIX TERMINAL SUBSET DDO2 (8 DO)
    - PHOENIX TERMINAL SUBSET DDO3 (8 DO)
    - PHOENIX TERMINAL SUBSET DDO4 (8 DO)
  - PHOENIX CARD DDM (8DO)
    - Not connected to any terminal block.(8 DO)
- PHOENIX Analog inputs BLOCKS (40 AI)
  - PHOENIX SET TERMINAL ACI1 (8 AI)
  - PHOENIX SET TERMINAL ACI2 (16 AI)
  - PHOENIX SET TERMINAL ACI3 (16 AI)
  - PHOENIX SET TERMINAL AVI1 (8 AI)
- PHOENIX Analog outputs BLOCKS (24 A0)
  - PHOENIX SET TERMINAL ACO1 (8 AO)
  - PHOENIX SET TERMINAL ACO2 (8 AO)
  - PHOENIX SET TERMINAL AVO1 (4 AO)
  - PHOENIX SET TERMINAL AVO2 (4 AO)

4.6 IOs Tables

4.6.1 Discrete Outputs

140DDO35300 (Backplane 2, Slot 3) 32 Discrete Outputs						
PLC INPUT	**PLC ADDRESS**	**PHOENIX MODULE**	**PHOENIX HARNESS**	**RELAY Nº**	**VARIABLE NAME**	**COMMENTS**
8	000088	DDO 1	DDO 1	1	SV_4005_01_MV	
7	000087			2	SV_4011_01_MV	
6	000086			3	SV_4014_01_MV	
5	000085			4	SV_4012_01_MV	
4	000084			5	SV_4016_01_MV	
3	000083			6	SV_4006_01_MV	
2	000082			7	SV_4006_02_MV	
1	000081			8	SV_4010_01_MV	
16	000096	DDO 2	DDO 2	1	SV_4003_04_MV	
15	000095			2	SV_4003_03_MV	
14	000094			3	SV_4003_01_MV	
13	000093			4	SV_4003_02_MV	
12	000092			5	SV_4015_01_MV	
11	000091			6	GP_4001_01_MV1	
10	000090			7	GP_4001_02_MV1	
9	000089			8	GP_4002_01_MV1	
24	000104	DDO 3	DDO 3	1	GP_4002_02_MV1	
23	000103			2	BLWR_4003_01_MV1	

140DDO35300 (Backplane 2, Slot 3) 32 Discrete Outputs						
PLC INPUT	**PLC ADDRESS**	**PHOENIX MODULE**	**PHOENIX HARNESS**	**RELAY Nº**	**VARIABLE NAME**	**COMMENTS**
22	000102			3	PP_4005_01_MV1	
21	000101			4	Free	
20	000100			5	HX_4005_02_MV1	
19	000099			6	BLWR_4005_01_MV1	
18	000098			7	PP_4006_01_MV1	
17	000097			8	PP_4006_02_MV1	
32	000112	DDO 4	DDO 4	1		used to start/stop the motor controller for pumps 4002_01 and 4002_02
31	000111			2		used to start/stop the motor controller for pumps 4001_01 and 4001_02
30	000110			3	GP_4002_03_MV1	
29	000109			4	GP_4001_03_MV1	
28	000108			5	Free	
27	000107			6	Free	
26	000106			7	Not assigned	EPIC red light ON/OFF
25	000105			8	Not assigned	EPIC green light ON/OFF

4.6.2 Discrete input cards

140DDI35300 (Backplane 2, Slot 2) 32 Discrete Inputs						
PLC INPUT	PLC ADDRESS	PHOENIX MODULE	PHOENIX HARNESS	RELAY Nº	VARIABLE NAME	COMMENTS
1	100081	DDI 1	DDI 1	1	LS_4013_01	
2	100082			2	PS_4001_01	
3	100083			3	PS_4001_02	
4	100084			4	PS_4002_01	
5	100085			5	PS_4002_02	
6	100086			6	SV_4005_01_FB	
7	100087			7	SV_4011_01_FB	
8	100088			8	SV_4014_01_FB	
9	100089	DDI 2	DDI 2	1	SV_4012_01_FB	
10	100090			2	SV_4016_01_FB	
11	100091			3	SV_4006_01_FB	
12	100092			4	SV_4006_02_FB	
13	100093			5	SV_4010_01_FB	
14	100094			6	SV_4003_04_FB	
15	100095			7	SV_4003_03_FB	
16	100096			8	SV_4003_01_FB	
17	100097	DDI 3	DDI 3	1	SV_4003_02_FB	
18	100098			2	SV_4015_01_FB	
19	100099			3	GP_4001_01_ERR	

140DDI35300 (Backplane 2, Slot 2) 32 Discrete Inputs						
PLC INPUT	**PLC ADDRESS**	**PHOENIX MODULE**	**PHOENIX HARNESS**	**RELAY Nº**	**VARIABLE NAME**	**COMMENTS**
20	100100			4	GP_4001_02_ERR	Not any longer used
21	100101			5	GP_4002_01_ERR	
22	100102			6	GP_4002_02_ERR	Not any longer used
23	100103			7	BLWR_4005_01_ERR	
24	100104			8	GP_4002_03_ERR	
25	100105	DDI 4	DDI 4	1	GP_4001_03_ERR	
26	100106			2	PS_4001_03	
27	100107			3	PS_4001_04	
28	100108			4	PS_4002_03	
29	100109			5	PS_4002_04	
30	100110			6	PS_4003_01	
31	100111			7	Emergency_Button_01	When any emergency button is pressed.
32	100112			8	Emergency_Button_02	System rearmed after an emergency stop.

4.6.3 Mixed Discrete input/output card

140ACI9000 (Backplane 1, Slot 9) 16 Discrete Inputs, 8 Discrete Outputs						
PLC INPUT	**PLC ADDRESS**	**PHOENIX MODULE**	**PHOENIX HARNESS**	**RELAY Nº**	**VARIABLE NAME**	**COMMENTS**
1	000065	N/A	N/A	N/A	Free	No PHOENIX module connected.
2	000066			N/A	Free	No PHOENIX module connected.
3	000067			N/A	Free	No PHOENIX module connected.
4	000068			N/A	Free	No PHOENIX module connected.
5	000069			N/A	Free	No PHOENIX module connected.
6	000070			N/A	Free	No PHOENIX module connected.
7	000071			N/A	Free	No PHOENIX module connected.
8	000072			N/A	Free	No PHOENIX module connected.
1	100065	N/A	N/A	N/A	Free	No PHOENIX module connected.
2	100066			N/A	Free	No PHOENIX module connected.
3	100067			N/A	Free	No PHOENIX module connected.
4	100068			N/A	Free	No PHOENIX module connected.
5	100069			N/A	Free	No PHOENIX module connected.
6	100070			N/A	Free	No PHOENIX module connected.
7	100071			N/A	Free	No PHOENIX module connected.
8	100072			N/A	Free	No PHOENIX module connected.
9	100073	N/A	N/A	N/A	Free	No PHOENIX module connected.
10	100074			N/A	Free	No PHOENIX module connected.

140ACI9000 (Backplane 1, Slot 9) 16 Discrete Inputs, 8 Discrete Outputs						
PLC INPUT	**PLC ADDRESS**	**PHOENIX MODULE**	**PHOENIX HARNESS**	**RELAY Nº**	**VARIABLE NAME**	**COMMENTS**
11	100075			N/A	Free	No PHOENIX module connected.
12	100076			N/A	Free	No PHOENIX module connected.
13	100077			N/A	Free	No PHOENIX module connected.
14	100078			N/A	Free	No PHOENIX module connected.
15	100079			N/A	Free	No PHOENIX module connected.
16	100080			N/A	Free	No PHOENIX module connected.

4.6.4 Analog Input Cards

140ACI03000 (Backplane 1, Slot 4) 8 Analog current Inputs						
PLC INPUT	**PLC ADDRESS**	**PHOENIX MODULE**	**PHOENIX HARNESS**	**RELAY Nº**	**VARIABLE NAME**	**COMMENTS**
1	300100	ACI 1	ACI 1	N/A	Free	
2	300101			N/A	Free	
3	300102			N/A	Free	
4	300103			N/A	Free	
5	300104			N/A	Free	
6	300105			N/A	Free	
7	300106			N/A	Free	
8	300107			N/A	Free	

140ACI04000 (Backplane 2, Slot 4) 16 Analog current Inputs						
PLC INPUT	**PLC ADDRESS**	**PHOENIX MODULE**	**PHOENIX HARNESS**	**RELAY Nº**	**VARIABLE NAME**	**COMMENTS**
1	300118	ACI 2	ACI 2	N/A	AT_4009_01	
2	300119			N/A	AT_4009_02	
3	300120			N/A	TT_4009_01	
4	300121			N/A	AT_4010_01	
5	300122			N/A	AT_4010_02	
6	300123			N/A	AT_4010_03	
7	300124			N/A	TT_4010_02	
8	300125			N/A	AT_4006_01	
9	300126			N/A	TT_4006_01	
10	300127			N/A	AT_4006_02	
11	300128			N/A	TT_4006_02	
12	300129			N/A	FT_4004_01	
13	300130			N/A	FT_4001_01	
14	300131			N/A	LT_4001_01	
15	300132			N/A	WT_4002_01	
16	300133			N/A	WT_4008_01	

140ACI04000 (Backplane 2, Slot 5) 16 Analog current Inputs						
PLC INPUT	**PLC ADDRESS**	**PHOENIX MODULE**	**PHOENIX HARNESS**	**RELAY Nº**	**VARIABLE NAME**	**COMMENTS**
1	300135	ACI 3	ACI 3	N/A	PT_4007_01	
2	300136			N/A	PT_4007_02	
3	300137			N/A	PT_4010_01	
4	300138			N/A	DPT_4001_01	
5	300139			N/A	DPT_4001_02	
6	300140			N/A	DPT_4004_01	
7	300141			N/A	TT_4005_01	
8	300142			N/A	TT_4011_01	
9	300143			N/A	TT_4010_01	
10	300144			N/A	TT_4012_01	
11	300145			N/A	IT_4000_01	
12	300146			N/A	IT_4000_02	
13	300147			N/A	IT_4000_03	
14	300148			N/A	Free	
15	300149			N/A	Free	
16	300150			N/A	Free	

140AVI03000 (Backplane 1, Slot 5) 8 Analog voltage Inputs						
PLC INPUT	**PLC ADDRESS**	**PHOENIX MODULE**	**PHOENIX HARNESS**	**RELAY Nº**	**VARIABLE NAME**	**COMMENTS**
1	300109	AVI 1	AVI 1	N/A	FQRC_4003_01	
2	300110			N/A	FQRC_4003_02	
3	300111			N/A	FQRC_4003_03	
4	300112			N/A	FQRC_4003_04	
5	300113			N/A	Free	
6	300114			N/A	Free	
7	300115			N/A	Free	
8	300116			N/A	Free	

4.6.5 Analog Outputs

140AVO02000 (Backplane 1, Slot 6) 4 Analog voltage Outputs						
PLC INPUT	**PLC ADDRESS**	**PHOENIX MODULE**	**PHOENIX HARNESS**	**RELAY Nº**	**VARIABLE NAME**	**COMMENTS**
1	400100	AVO 1	AVO 1	N/A	FQRC_4003_01_SP	
2	400101			N/A	FQRC_4003_02_SP	
3	400102			N/A	FQRC_4003_03_SP	
4	400103			N/A	FQRC_4003_04_SP	

140AVO02000 (Backplane 1, Slot 7) 4 Analog voltage Outputs						
PLC INPUT	**PLC ADDRESS**	**PHOENIX MODULE**	**PHOENIX HARNESS**	**RELAY Nº**	**VARIABLE NAME**	**COMMENTS**
1	400104	AVO 2	AVO 2	N/A	BLWR_4005_01_MV2	
2	400105			N/A	Free	
3	400106			N/A	Free	
4	400107			N/A	Free	

140ACO13000 (Backplane 1, Slot 8) 8 Analog current sink outputs						
PLC INPUT	**PLC ADDRESS**	**PHOENIX MODULE**	**PHOENIX HARNESS**	**RELAY Nº**	**VARIABLE NAME**	**COMMENTS**
1	400108	ACO 1	ACO 1	N/A	SCV_4004_01_MV	
2	400109			N/A	GP_4001_01_MV2	
3	400110			N/A	GP_4001_02_MV2	Not any longer used
4	400111			N/A	GP_4002_01_MV2	
5	400112			N/A	GP_4002_02_MV2	Not any longer used
6	400113			N/A	GP_4002_03_MV2	
7	400114			N/A	GP_4001_03_MV2	
8	400115			N/A	IRC_4000_MV	

140ACO13000 (Backplane 2, Slot 6) 8 Analog current sink outputs						
PLC INPUT	**PLC ADDRESS**	**PHOENIX MODULE**	**PHOENIX HARNESS**	**RELAY Nº**	**VARIABLE NAME**	**COMMENTS**
1	400116	ACO 2	ACO 2	N/A	Free	
2	400117			N/A	Free	
3	400118			N/A	Free	
4	400119			N/A	Free	
5	400120			N/A	Free	
6	400121			N/A	Free	
7	400122			N/A	Free	
8	400123			N/A	Free	

SECTION 3: PLC Cabinet assembly

Reference	Title	Version	Edition date	Pages Number
NTE-CIVaP2-PR-004	CIVa PLC CONNECTION TEST PROCEDURE	1	08/07/09	13
NTE-CIVaP2-RP-005	CIVa PLC CONNECTION TEST REPORT	1.1	30/04/10	10

CIVa PLC CONNECTION TEST PROCEDURE

FOR THE

CS MELISSA CIVa-P2

APPROVAL LIST		
NAME	SIGNATURE	DATE
Prepared by: Martí Bassas		8/07/2009
Revised by: Jordi Duatis	Duatis	8/7/2009
Approved by: Eva Creus		8/7/09
Authorised by: Jordi Duatis	Duatis	9/7/2009

DISTRIBUTION LIST		
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E. Peiró		MPP
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O. Gerbi		SHERPA

CHANGE RECORD			
AUTHOR	ISSUE	DATE	CHANGE
Martí Bassas	1.0	8-07-09	New document

CONTENTS

LIST OF ACRONYMS

CIVa	Compartment IVa
I/O	Input / Output
PLC	Programmable Logic Controller
MELiSSA	Micro-Ecological Life Support System Alternative
MPP	MELiSSA Pilot Plant
UAB	Universitat Autònoma de Barcelona
AI	Analogue input
AO	Analogue output
DI	Digital input
DO	Digital output
EPIC	Electrical Power Interface Cabinet

1. SCOPE

This document describes the PLC control cabinet connection with the CIVa compartment test procedure to be completed as part of the verification.

The purpose of the test is to verify that the CIVa Schneider PLC is correctly connected to the intermediate connectors in the EPIC cabinet and correct address assignation. To test this, the connections from the PLC cabinet until CIVa electronics cabinet are checked, signal per signal.

Tests will be performed in MPP facilites.

2. REFERENCE DOCUMENTS

2.1 APPLICABLE DOCUMENTS

Ref.	Title	Reference	Issue	Date
AD1	NTE Offer for CIVa Control System Cabinet and HMI update	NTE-CIVaP2-OFF-001	1	06/03/09
AD2	CIVa Hardware Interface Document	NTE-CIVaP2-ICD-002	1.0	04/05/09
AD3	Procedimiento de Control de No conformidades	NTE-PG-007	3	05/12/06
AD4	CIVA_List_Equipments_IO_ Tag_20090519.xls			19/05/09

2.2 REFERENCE DOCUMENTS

Ref.	Title	Reference	Issue	Date

3. GENERAL INSTRUCTIONS

3.1 Personnel

Test must be executed by NTE and the CIVa cabinet manufacturer (DeDietrich) personnel. Any subcontractor or product technician may be required in case their technical knowledge is needed during the test.

3.2 Test Conditions

The following environmental requirements are applicable to all tests.

- Temperature: 22 ºC +/- 10 ºC
- The areas in which materials and equipment preparation for test is to be carried out shall be maintained in a neat orderly fashion, with no loose material (dirt, dust, oils, etc) that can cause contamination of the parts.
- Other environmental conditions are the normal in laboratory.

3.3 Instrumentation used

The following instruments shall be used during this test:

• Laptop working with windows 2000 and with Concept 2.6
• Multimeter.

3.4 Non Conformances

Non Conformances will be issued in case of test deviations or test failures and will be handled as indicated in AD1.

3.5 Safety considerations

Laboratory safety considerations of MPP will apply.

3.6 Test Report

A report shall be prepared for the tests containing for each test executed:

- Device Under Test data, identification and configuration
- Test set-up
- Test Facility and Environmental Data
- Instrumentation used with reference to the corresponding calibration reports and calibration date when required
- As-run test procedures including deviations, NCRs raised and recommendations of corrective actions.
- The test sign-off sheet detailed in Annex #1 including:

- Remarks and Test Procedures deviations
- NCRs raised
- Test conductor name and signature
- Summary of tests results and conclusion

3.7 Pass / Fail Criteria

In general terms this test can be divided between inputs and outputs.

- For inputs, some kind of action is performed in the compartment hardware and a response is expected in the PLC.
- For outputs an action is performed in the PLC (changing a set-point or a boolean value) while a response is expected from the compartment hardware.

Whenever possible the test will be performed on the final device or hardware, that is, to check that actuators are working and sensors are measuring. In such cases it is assumed that if the device works the electrical connections are right. If, for installation status or hardware manipulation difficulties, such testing is not possible, it will be tested that the signal to/from the PLC reaches the compartment electronics as expected.

Testing the actual devices monitored/commanded by the PLC is out of the scope of this test, even if in many cases it has been done for ease.

The criteria used for testing are the following:

3.7.1 Criterion 1. Valves with feedback signal. DO & DI

While switching the digital output signal from the test control software, the switching valve is identified on the hardware (valve makes noise when switching). Corresponding digital input feedback signal switching is detected from the test control software.

3.7.2 Criterion 2. Valves without feedback signal. DO.

While switching the digital output signal from the test control software, the switching valve is identified on the hardware (valve makes noise when switching).

3.7.3 Criterion 3. Not connected or not installed devices. DI.

The output of relay in the electronics cabinet corresponding to the signal under test is jumpered, providing 0/24V to the corresponding PLC input. The switching is checked from the test control software.

3.7.4 Criterion 4. Unswitchable sensors, or cabled but not installed sensors. DI.

The connector to the sensor is jumpered, simulating the sensor switching. The corresponding signal switching is checked form the test control software.

3.7.5 Criterion 5. Not connected or not installed devices. DO.

The signal under test is switched from the test control software. The corresponding relay in the electronics cabinet switching is checked.

3.7.6 Criterion 6. Cabled but not installed actuators. DO.

The signal under test is switched from the test control software. Using a multimeter, the voltage variation in the actuator connector’s corresponding pin is checked.

3.7.7 Criterion 7. PH sensor. AI.

Sensor manufacturer’s technician manipulates the sensor to make the readout change. Corresponding AI signal variation is checked from the test control software.

3.7.8 Criterion 8. Actuators with no appreciated response. AO.

AO under test value changed from the test control software. Using a multimeter, set point signal is measured in the input of the controlled device. Value should be in the expected range (4..20mA, 0..10V depending on control type) and change accordingly with the set value.

3.7.9 Criterion 9. Motor controller thermal protection. DI.

Signal is ON when the motor controller is available. It falls to OFF when power supply is removed or there is a failure in the motor controller.

3.7.10 Criterion 10. Motors. DO & AO.

- AO (criterion 10.1) motor controller set point): Motor controller set point is changed and the corresponding motor speed variation is observed. This testing requires the motor controller to be activated and the motor to be selected.
- DO
  - Motor controller ON/OFF (criterion 10.2): Signal is switched and reaction on the motor controller in the cabinet is observed.
  - Motor selection (criterion 10.3) (only for motor controllers controlling two motors): Motor is selected and motor’s reaction is observed. This action requires the motor controller to be active and with a suitable set-point.

3.7.11 Criterion 11. Emergency stop and recovery. DI.

- 11.1 Emergency stop: DI switches when one of the emergency stop buttons is pushed. Feature tested with all 3 stop buttons installed in the compartment.
- 11.2 Recovery: After a previously pushed emergency stop button is released, DI switches when system is reset.

3.7.12 Criterion 12. Sensors with not easily modifiable read-out. AI.

Signal received when sensor is working is within the expected range. When the connector from the sensor is disconnected a zero (or broken wire flag) is received in the laptop test control software (PLC).

3.7.13 Criterion 13. Sensors with not easily modifiable read-out. Saturated. AI.

Signal received when the sensor is in working configuration is out of the expected range. When the connector from the sensor is disconnected a zero (or broken wire flag) is received in the laptop test control software (PLC).

3.7.14 Criterion 14. Actuators not installed or not responding. AO.

Actuator input is been replaced by a 147Ω resistor to close the control current loop. Current is measured. Current is between 4..20mA and changes with PLC set value.

3.7.15 Criterion 15. Level sensor LT_4001_01. AI.

Sensor has been disassembled and moved down and up into the vessel (deeper and shallower into the liquid). Readout in the test control software changes when moving.

3.7.16 Criterion 16. Weight balance. AI.

Weight readout changes when pushing the surface of the weight balance.

3.7.17 Criterion 17. Pressure sensors. AI.

Pressure readout in PLC changes when pushing the pressure sensor membrane. For differential pressure (DPT_...) only one probe (out of two) is manipulated.

3.7.18 Criterion 18. Reactor temperature sensor TT_4005_01. AI.

The temperature value received in the PLC (after considering sensor measuring rang) is the same as the one in the sensor display.

3.7.19 Criterion 19. Temperature sensor TT_4010_01. AI.

Readout value in the PLC increases when heating the probe with a lighter.

3.7.20 Criterion 20. Gas flow control. AO & AI.

- 20.1 AO: Set point values in the device display changes when changing the corresponding PLC AO from the test control software.
- 20.2 AI: Flow meter measurement changes when changing the set point.

3.7.21 Criterion 21. Heating resistor HX_4005_02_MV1. DO.

Resistor temperature increases when is left ON for some time.

3.7.22 Criterion 22. Light intensity IRC_4000_MV. DO.

Light intensity changes with set point.

3.7.23 Criterion 23. Pump PP_4005_01_MV1. DO.

Pump makes noise when DO is turned ON from the test control software.

3.7.24 Criterion 24. Weight scale. AI.

Using the Hyperterminal in the SCADA server, open the COM port assigned to the scale and send an “SI command”. Check that the scale responds with a weight value.

4. TEST SEQUENCE

Test steps shall not necessarily be executed in the order provided.

5. TESTS PROCEDURE

Test			
Requirements tested	Communications between the control PLC and CIVa electronics cabinet.		
Unit identification			
Ambient Temperature			
Start of Execution Date		End of Execution Date	
Test equipment	*Model*	*S/N*	*Calibration certificate*
Remarks			
Sign-off signatures			
Test executor: Date / Signature			

Step nb	Tag name	PLC address	Pass/Fail criteria	Remarks	OK/ NOK
1	LS_4013_01	100081	4		
2	PS_4001_01	100082	4		
3	PS_4001_02	100083	4		
4	PS_4002_01	100084	4		
5	PS_4002_02	100085	4		
6	SV_4005_01_MV	000088	1		
7	SV_4005_01_FB	100086	1		
8	SV_4011_01_MV	000087	1		
9	SV_4011_01_FB	100087	1		
10	SV_4014_01_MV	000086	2		
11	SV_4014_01_FB	100088	3		
12	SV_4012_01_MV	000085	1		
13	SV_4012_01_FB	100089	1		
14	SV_4016_01_MV	000084	2		
15	SV_4016_01_FB	100090	3		
16	SV_4006_01_MV	000083	1		
17	SV_4006_01_FB	100091	1		
18	SV_4006_02_MV	000082	1		
19	SV_4006_02_FB	100092	1		
20	SV_4010_01_MV	000081	1		
21	SV_4010_01_FB	100093	1		
22	SV_4003_04_MV	000096	1		
23	SV_4003_04_FB	100094	1		
24	SV_4003_03_MV	000095	1		
25	SV_4003_03_FB	100095	1		
26	SV_4003_01_MV	000094	5		

Step nb	Tag name	PLC address	Pass/Fail criteria	Remarks	OK/ NOK
27	SV_4003_01_FB	100096	3		
28	SV_4003_02_MV	000093	1		
29	SV_4003_02_FB	100097	1		
30	SV_4015_01_MV	000092	6		
31	SV_4015_01_FB	100098	4		
32	GP_4001_01_ERR	100099	9		
33	GP_4001_02_ERR	100100	9		
34	GP_4002_01_ERR	100101	9		
35	GP_4002_02_ERR	100102.	9		
36	BLWR_4005_01_ERR	100103	9		
37	GP_4001_03_ERR	100104	9		
38	GP_4002_03_ERR	100105	9		
39	GP_4001_01_MV1	000091	10.3		
40	GP_4001_02_MV1	000090	10.3		
41	GP_4002_01_MV1	000089	10.3		
42	GP_4002_02_MV1	000104	10.3		
43	BLWR_4003_01_MV1	000103	10.2		
44	PP_4005_01_MV1	000102	23		
45	GP_4001_03_MV1	000101	10.2		
46	GP_4002_03_MV1	000100	10.2		
47	BLWR_4005_01_MV1	000099	5		
48	PP_4006_01_MV1	000098	6		
49	PP_4006_02_MV1	000097	6		
50	PS_4001_03	100106	4		
51	PS_4001_04	100107	4		
52	PS_4002_03	100108	4		
53	PS_4002_04	100109	4		
54	PS_4003_01	100110	4		
56	HX_4005_02_MV1	000112	21		
57	HX_4010_01_MV1	000111	10.2		
58	Emergency_Button_01	100111	11.1		
59	Emergency_Button_02	100112	11.2		
60	Emergency_Button_03	100065	12		
61	AT_4009_01	300118	12		
62	AT_4009_02	300119	12		
63	TT_4009_01	300120	12		
64	AT_4010_01	300121	12		
65	AT_4010_02	300122	12		
66	AT_4010_03	300123	12		
67	TT_4010_02	300124	12		
68	AT_4006_01	300125	7		
69	TT_4006_01	300126	7		
70	AT_4006_02	300127	7		
71	TT_4006_02	300128	7		
72	FT_4004_01	300129	13		
73	FT_4001_01	300130	12		

Step nb	Tag name	PLC address	Pass/Fail criteria	Remarks	OK/ NOK
74	SCV_4004_01_MV	400108	14		
75	LT_4001_01	300131	15		
76	WT_4002_01	300132	16		
77	WT_4008_01	300133	16		
78	PT_4007_01	300135	17		
79	PT_4007_02	300136	17		
80	PT_4010_01	300137	17		
81	DPT_4001_01	300138	17		
82	DPT_4001_02	300139	17		
83	DPT_4004_01	300140	17		
84	TT_4005_01	300141	18		
85	TT_4011_01	300142	12		
86	TT_4010_01	300143	19		
87	TT_4012_01	300144	12		
88	FQRC_4003_01	300109	20.2		
89	FQRC_4003_01_SP	400100	20.1		
90	FQRC_4003_02	300110	20.2		
91	FQRC_4003_02_SP	400101	20.1		
92	FQRC_4003_03	300111	20.2		
93	FQRC_4003_03_SP	400102	20.1		
94	FQRC_4003_04	300112	20.2		
95	FQRC_4003_04_SP	400103	20.1		
96	GP_4001_01_MV2	400109	10.1		
97	GP_4001_02_MV2	400110	10.1		
98	GP_4002_01_MV2	400111	10.1		
99	GP_4002_02_MV2	400112	10.1		
100	GP_4001_03_MV2	400113	10.1		
101	GP_4002_03_MV2	400114	10.1		
102	BLWR_4005_01_MV2	400104	8		
103	WT_4006_01		24		
104	WT_4006_02		24		
105	IRC_4000_MV	400115	22		
106	IT_4000_01	300145	12		
107	IT_4000_02	300146	12		
108	IT_4000_03	300147	12		

ANNEX 1: Procedure sign-off sheet

PROCEDURE SIGN-OFF SHEET			
Test reference:		Issue:	Date:
NCRs :			

Test conductor			
Name:			
Date:			
Visa:			

CIVa PLC CONNECTION TEST REPORT

FOR THE

CS MELISSA CIVa-P2

APPROVAL LIST		
NAME	SIGNATURE	DATE
Prepared by: Martí Bassas		30/04/10
Revised by: Jordi Duatis		30/04/2010
Approved by: Eva Creus		30/4/10
Authorised by: Jordi Duatis		30/04/2010

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A. Fossen		MPP
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CHANGE RECORD			
AUTHOR	ISSUE	DATE	CHANGE
Martí Bassas	1.0	16-10-09	New document
J.Carbonell	1.1	30-04-10	Test report updated after pending verifications performed as per review comment EP-12 from MPP meeting 22/04/2010. Modify status of the WT_4006_01 and WT_4006_02 to OK because they have been already checked. Change input 63 of the as run procedures table, TT_4009_01 doesn't exist but analyzer gives and error signal (AT_4009_SENSORFAILURE). Modify status of the AT_4010_01 and AT_4010_02 (Gas analyzer signals) to OK.

CONTENTS

LIST OF ACRONYMS

CIVa	Compartment IVa
I/O	Input / Output
PLC	Programmable Logic Controller
MELiSSA	Micro-Ecological Life Support System Alternative
MPP	MELiSSA Pilot Plant
NCR	Non Conformance Report
UAB	Universitat Autònoma de Barcelona
AI	Analogue input
AO	Analogue output
DI	Digital input
DO	Digital output
EPIC	Electrical Power Interface Cabinet

1. SCOPE

This document is a report of the results of PLC control cabinet connection with the CIVa compartment Test.

This report includes:

- Device Under Test data, identification and configuration
- Test Facility and Environmental Data
- Instrumentation used with reference to the corresponding calibration reports and calibration date when required
- As-run test procedures including deviations, NCRs raised and recommendations of corrective actions.
- The test sign-off sheet detailed in Annex 1 including:
    - Test Procedures deviations
    - NCRs raised
    - Test conductor name and signature
    - Summary of tests results and conclusion

2. REFERENCE DOCUMENTS

2.1 APPLICABLE DOCUMENTS

Ref.	Title	Reference	Issue	Date
AD1	NTE Offer for CIVa Control System Cabinet and HMI update	NTE-CIVaP2-OFF-001	1	06/03/09
AD2	CIVa Hardware Interface Document	NTE-CIVaP2-ICD-002	1.1	30/04/10
AD3	Procedimiento de Control de No conformidades	NTE-PG-007	3	05/12/06
AD4	CIVA_List_Equipments_IO_ Tag_20090519.xls			19/05/09

2.2 REFERENCE DOCUMENTS

Ref.	Title	Reference	Issue	Date
RD1	CIVa PLC Connection Test Procedure	NTE-CIVaP2-PR-004	1	16/10/09

3. TEST SET-UP

For this test, a laptop is used to control and monitor the PLC inputs and outputs. An intended "*Concept*" project has been used, and the PLC program has been modified so that outputs are not automatically modified by the PLC software. A PLC registers table template has been created in this *Concept project* to control and monitor inputs and outputs. This working environment is referred to as "test control software" in this document.

4. DEVICE UNDER TEST

The device under test was CIVa control cabinet and connection with CIVa compartment electronics.

5. TEST FACILITY AND ENVIRONMENTAL DATA

The tests were carried out from the 08/07/09 to the 14/07/09 in MPP facilities (Universitat Autònoma de Barcelona).

6. INSTRUMENTATION USED

The instrumentation used is provided as part of the as-run procedures.

7. RESULTS SUMMARY

The following points found during this test may require further actions:

- PHOENIX cable labeled ACI 2 16 Ch has a short circuit, linking pins 15 & 16 of the PLC card. This cable was provisionally replaced during the test.
- A few AI could not be tested as the sensors providing them were not connected or not installed.

All other connections between the PLC cabinet and the compartment electronics were tested satisfactorily. See as run test procedures and remarks for further information.

8. ANNEX 1: AS RUN TEST PROCEDURES

Test	As described in RD1		
Requirements tested	Communications between the control PLC and CIVa electronics cabinet.		
Unit identification			
Ambient Temperature	*22ºC*		
Start of Execution Date	*08-07-2009*	End of Execution Date	*14-07-2009*
Test equipment			
LapTop with Concept installed			
Multimeter.			
Remarks			

Test executor: Date / Signature	As per report signature			

Step nb	Tag name	PLC address	Pass/Fail criteria	Remarks	OK/ NOK
1	LS_4013_01	100081	4		OK
2	PS_4001_01	100082	4		OK
3	PS_4001_02	100083	4		OK
4	PS_4002_01	100084	4		OK
5	PS_4002_02	100085	4		OK
6	SV_4005_01_MV	000088	1		OK
7	SV_4005_01_FB	100086	1		OK
8	SV_4011_01_MV	000087	1	R1	OK
9	SV_4011_01_FB	100087	1		OK
10	SV_4014_01_MV	000086	2		OK
11	SV_4014_01_FB	100088	3		OK
12	SV_4012_01_MV	000085	1	R1	OK
13	SV_4012_01_FB	100089	1		OK
14	SV_4016_01_MV	000084	2		OK
15	SV_4016_01_FB	100090	3		OK
16	SV_4006_01_MV	000083	1		OK
17	SV_4006_01_FB	100091	1		OK
18	SV_4006_02_MV	000082	1		OK
19	SV_4006_02_FB	100092	1		OK
20	SV_4010_01_MV	000081	1		OK
21	SV_4010_01_FB	100093	1		OK
22	SV_4003_04_MV	000096	1		OK
23	SV_4003_04_FB	100094	1		OK
24	SV_4003_03_MV	000095	1		OK
25	SV_4003_03_FB	100095	1		OK
26	SV_4003_01_MV	000094	5	R3	OK

Step nb	Tag name	PLC address	Pass/Fail criteria	Remarks	OK/ NOK
27	SV_4003_01_FB	100096	3	R3	OK
28	SV_4003_02_MV	000093	1		OK
29	SV_4003_02_FB	100097	1		OK
30	SV_4015_01_MV	000092	6	R4	OK
31	SV_4015_01_FB	100098	4	R4	OK
32	GP_4001_01_ERR	100099	9	R2	OK
33	GP_4001_02_ERR	100100	9	R2	NA
34	GP_4002_01_ERR	100101	9	R2	OK
35	GP_4002_02_ERR	100102.	9	R2	NA
36	BLWR_4005_01_ERR	100103	9		OK
37	GP_4001_03_ERR	100104 → 100105	9	R9	OK
38	GP_4002_03_ERR	100105 → 100104	9	R9	OK
39	GP_4001_01_MV1	000091	10.3	R6	OK
40	GP_4001_02_MV1	000090	10.3	R6	OK
41	GP_4002_01_MV1	000089	10.3	R7	OK
42	GP_4002_02_MV1	000104	10.3	R7	OK
43	BLWR_4003_01_MV1	000103	10.2		OK
44	PP_4005_01_MV1	000102	23		OK
45	GP_4001_03_MV1	000101 → 000109	10.2	R9	OK
46	GP_4002_03_MV1	000100 → 000110	10.2	R9	OK
47	BLWR_4005_01_MV1	000099	5	R10	OK
48	PP_4006_01_MV1	000098	6		OK
49	PP_4006_02_MV1	000097	6		OK
50	PS_4001_03	100106	4		OK
51	PS_4001_04	100107	4		OK
52	PS_4002_03	100108	4		OK
53	PS_4002_04	100109	4		OK
54	PS_4003_01	100110	4		OK
56	HX_4005_02_MV1	000112 → 000100	21	R9	OK
57	HX_4010_01_MV1	000111	10.2	R5	OK
58	Emergency_Button_01	100111	11.1	R11	OK
59	Emergency_Button_02	100112	11.2	R12	OK
60	Emergency_Button_03	100065	12	R13	NA
61	AT_4009_01	300118	12	R14	Not Tested
62	AT_4009_02	300119	12	R15	Not Tested
63	AT_4009_SENSORFAILUR	000273		R15	Not Tested
64	AT_4010_01	300121	12	R16	OK
65	AT_4010_02	300122	12	R16	OK
66	AT_4010_03	300123	12		OK
67	TT_4010_02	300124	12	R17	OK
68	AT_4006_01	300125	7		OK
69	TT_4006_01	300126	7		OK
70	AT_4006_02	300127	7		OK
71	TT_4006_02	300128	7		OK
72	FT_4004_01	300129	13		OK
73	FT_4001_01	300130	12		OK

Step nb	Tag name	PLC address	Pass/Fail criteria	Remarks	OK/ NOK
74	SCV_4004_01_MV	400108	14		OK
75	LT_4001_01	300131	15		OK
76	WT_4002_01	300132	16		OK
77	WT_4008_01	300133	16		OK
78	PT_4007_01	300135	17		OK
79	PT_4007_02	300136	17		OK
80	PT_4010_01	300137	17		OK
81	DPT_4001_01	300138	17		OK
82	DPT_4001_02	300139	17		OK
83	DPT_4004_01	300140	17		OK
84	TT_4005_01	300141	18		OK
85	TT_4011_01	300142	12		OK
86	TT_4010_01	300143	19		OK
87	TT_4012_01	300144	12		OK
88	FQRC_4003_01	300109	20.2		OK
89	FQRC_4003_01_SP	400100	20.1		OK
90	FQRC_4003_02	300110	20.2		OK
91	FQRC_4003_02_SP	400101	20.1		OK
92	FQRC_4003_03	300111	20.2	R18	OK
93	FQRC_4003_03_SP	400102	20.1		OK
94	FQRC_4003_04	300112	20.2	R18	OK
95	FQRC_4003_04_SP	400103	20.1		OK
96	GP_4001_01_MV2	400109	10.1		OK
97	GP_4001_02_MV2	400110	10.1	R2	NA
98	GP_4002_01_MV2	400111	10.1		OK
99	GP_4002_02_MV2	400112	10.1	R2	NA
100	GP_4001_03_MV2	400113 → 400114	10.1	R9	OK
101	GP_4002_03_MV2	400114 → 400113	10.1	R9	OK
102	BLWR_4005_01_MV2	400104	8	R10	OK
103	WT_4006_01		24		OK
104	WT_4006_02		24		OK
105	IRC_4000_MV	400115	22		OK
106	IT_4000_01	300145	12	R19	NA
107	IT_4000_02	300146	12	R19	NA
108	IT_4000_03	300147	12	R19	NA
109	No tag assigned	000112	10.2	R8	OK
110	No tag assigned	000105		R20	OK
111	No tag assigned	000106		R20	OK
112					
113	No tag assigned	000101	5	R21	OK
114	No tag assigned	000107	5	R21	OK
115	No tag assigned	000108	5	R21	OK
116					
117					

ANNEX 1: Procedure sign-off sheet

PROCEDURE SIGN-OFF SHEET

Test reference:		Issue: 1.0	Date: 17/07/2009

Remarks & Test Procedure Deviations :

R1: The pressurized air pipe was not connected to the valve. A provisional pipe was connected for testing.
R2: One frequency motor controller is used to control both motors 4001_01 and 4001_02. Only one alarm is generated, so GP_4001_02_ERR is not any longer used. Only one set point is used, so GP_4001_02_MV2 is not any longer used. Idem for motors 4002_01 and 4002_02.
R3: Device doesn't exist. However tested by other means.
R4: Device cabled but not yet installed. However tested by other means.
R5: DO with PLC address 000111 is not used to start/stop the post condenser, which is working continuously. PLC DO is used to start/stop the motor controller for pumps 4001_01 and 4001_02.
R6: DO with PLC address 000091 is used to select motor 1 out of 4001_01 and 4001_02. DO with PLC address 000090 is used to select motor 2
R7: DO with PLC address 000089 is used to select motor 1 out of 4002_01 and 4002_02. DO with PLC address 000104 is used to select motor 2.
R8: DO with PLC address 000112 is used to start/stop the motor controller for pumps 4002_01 and 4002_02.
R9: Addresses changed for electric connection convenience.
R10: BLWR_4005_01 dimmer seems to be damaged. Blower couldn't be tested. Device circuit breaker trigs when signal BLWR_4005_01_MV1 is switched ON.
R11: Emergency button 01 signal. Activated when one of the 4 stop buttons has been pushed.
R12: Now indicates that the system has been reset and it's ready to go after recovery from an emergency stop. This signal is important after a stop button has been pressed and released again. In this situation the system is not yet operative: it needs to be rearmed, This signal is meant to indicate this.
R13: Not implemented. Corresponding PHOENIX cable not routed from the PLC cabinet. Relays not assembled in the electronics cabinet.
R14: Sensor not installed. Test Pending.
R15: Sensor connector missing. Test Pending.
R16: Inputs checked first with HPC1 gas analyzer and then with CIVa gas analyzer.
R17: No signal within expected range is received from the sensor. Good connectivity with the PLC (address 300124) is checked using signal generated for Tag AT_4010_02 as a reference. PHOENIX 50 wire cable from PLC cabinet to electronics cabinet had to be replaced. Short circuit found between pins 15 & 16.
R18: Sensor actually returns no value to the PLC. Only the connection with the PLC was tested checking by jumpering the AI with a PLC AO in the sensor connector. 400103 jumpered with 300112 and 400102 with 300111. AI value in the PLC rises proportionally with AO set point. Notice that used AI and AO are both 0..5V.
R19: Device not installed. Pending.
R20: DO with address 000105 turns ON/OFF the green light on the electronics cabinet door. DO with address 000106 turns ON/OFF the red light on the electronics cabinet door.
R21: DO not used.

NCRs :
None

Test conductor			
Name:	Martí Bassas		
Date:	14-07-2009		
Visa:	As per report signature		

SECTION 4: Implementation of remote and local HMIs				
Reference	Title	Version	Edition date	Pages Number
NTE-CIVaP2-RP-007	MELISSA CIVa HMI DESIGN	1.2	30/04/10	41
NTE-CIVaP2-RP-003	MELISSA CIVa LOCAL HMI DESIGN	1.1	30/04/10	19
NTE-CIVaP2-HB-008	CIVa HMI SOFTWARE MANUAL	1.1	30/04/10	50
NTE-CIVaP2-MN-009	Review of CIVa HMI Displays minutes of meeting	1	15/01/10	3

MELISSA CIVa HMI DESIGN

FOR THE

MELISSA CS CIVaP2 Project

APPROVAL LIST		
NAME	SIGNATURE	DATE
Prepared by: J.Carbonell		30/04/2010
Revised by: J.Duatis	Duatis	30/04/2010
Approved by: E.Creus		30/4/10
Authorised by: J.Duatis	Duatis	30/04/2010

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CHANGE RECORD			
AUTHOR	ISSUE	DATE	CHANGE
J.Carbonell	1.0	18/11/2009	First Version
J.Carbonell	1.1	08/03/2010	Add section 4.8 CSV Export Data Screen and add in the Graph screen section the “Start Date/time” form description.
J.Carbonell	1.2	26/04/2010	Update CIVa Main screen (*Figure 4-2*), following tags have been added: • CIVa_Sysclock_Hour • CIVa_Sysclock_Minute • CIVa_Sysclock_Second • CL4010_O2_Production • CL4002_EstimatedOutletLiquidFlow Updated CIVa Liquid Screen (*Figure 4-4*), following tag has been added: CL4002_EstimatedOutletLiquidFlow Edit values form has been updated (*Figure 4-5*). Updated Gas screen, removed the following tags: FT_4004_01_SP and L4004_ControlLoop_Mode Added: CL4010_O2_production Sorted the alarm table. Updated Temperature screen (*Figure 4-9*): Added pH probes temperature and updated graph configuration with pH probes temperature tags. Updated pH screen (*Figure 4-11*) Add AT_4006_Sensor_deviation_A tag on

			the screen. Removed the following sections: 4.7 Graphs screen 4.8 Export Data screen 4.9 Alarms screen 5. Alarms and warning 6. Control loop mode operation 9. Global alarm indicators Information has been moved to NTE-CIVaP2-HB-011 Updated historical data table adding CL4010_O2_Production and CL4002_EstimatedOutletLiquidFlow tags. Updated files list table adding “MEL_CIV_Gas2.txt” gas screen graph configuration screen and updating versions. Updated Table 7-1 according to the real HTC content in the MPP. Section 4. HMI Database description clarified.

CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

ACRONYMS LIST

CIVa	Compartment IVa
CV	Compartment V
HMI	Human Machine Interface
HTC	Historical Collect iFix application
I/O	Input / Output
MELiSSA	Micro-Ecological Life Support System Alternative
MPP	Melissa Pilot Plant
PLC	Programmable Logic Controller
SP	Set-Point
CSV	Comma-separated Values

1. SCOPE

This document describes a preliminary design of the CIVa HMI screens. The screen design has been derived from Sherpa specifications in [R1]. The work developed herein describes the variables (pressure, temperature, pH, etc) -warnings and alarms- as well as the tools and the instrumentation in Compartment CIVa that will be monitored and/ or controlled through the computer as well as to know the entire system status.

2. REFERENCE DOCUMENTS

2.1 APPLICABLE DOCUMENTS

Ref	Title	Reference	Issue	Date
[A1]	NTE Offer for CIVa control cabinet and CIVa HMI	NTE-CIVaP2-OF-001	1.0	Mar.2009
[A2]	MPP rules for tags and labelling	TN 78.72	2.0	Sept. 2008

2.2 REFERENCE DOCUMENTS

Ref	Title	Reference	Issue	Date
[R1]	CIVa_PLC_HMI_20100317.xls	Sherpa		17/031/2010
[R2]	Functional Specifications	DeDietrich	Rev 5	04/02/2010
[R3]	P&ID Diagram & Control	DeDietrich	Rev 13	13/04/2010

3. INTRODUCTION

Compartment CIVa installed in the MELiSSA Pilot Plant has the objective to convert Nitrates and CO_2 into edible Biomass and O_2. It is based on a Photo Bioreactor with an illumination system of 350 halogen lamps. The process in this Compartment is carried out by the *Arthrospira platensis*, a photoautotrophic microscopic alga.

Its inputs are the Nitrate in liquid phase from the CIII compartment and CO_2 in the gas phase coming from other compartments via a buffer tank in closed loop operation.

The main outputs of the process are in the form of O_2 in gas phase and edible biomass in solid phase after harvesting (solid/liquid separation). The gas output is intended to be used by CV to provide O_2 to the rats.

The CIVa main functions are:

- Produce O_2.
- Produce biomass.
- Allow for stable biomass production.
- Allow for phase separation of the outputs.
- Deliver gaseous O_2 to the crew compartment (CV).
- Potentially deliver of edible biomass to crew compartment (CV)

Sections **¡Error! No se encuentra el origen de la referencia.**, **¡Error! No se encuentra el origen de la referencia.** and **¡Error! No se encuentra el origen de la referencia.** are common displays to all the compartments and the design has been defined in this document

4. HMI SCREENS

4.1 Screens Hierarchy:

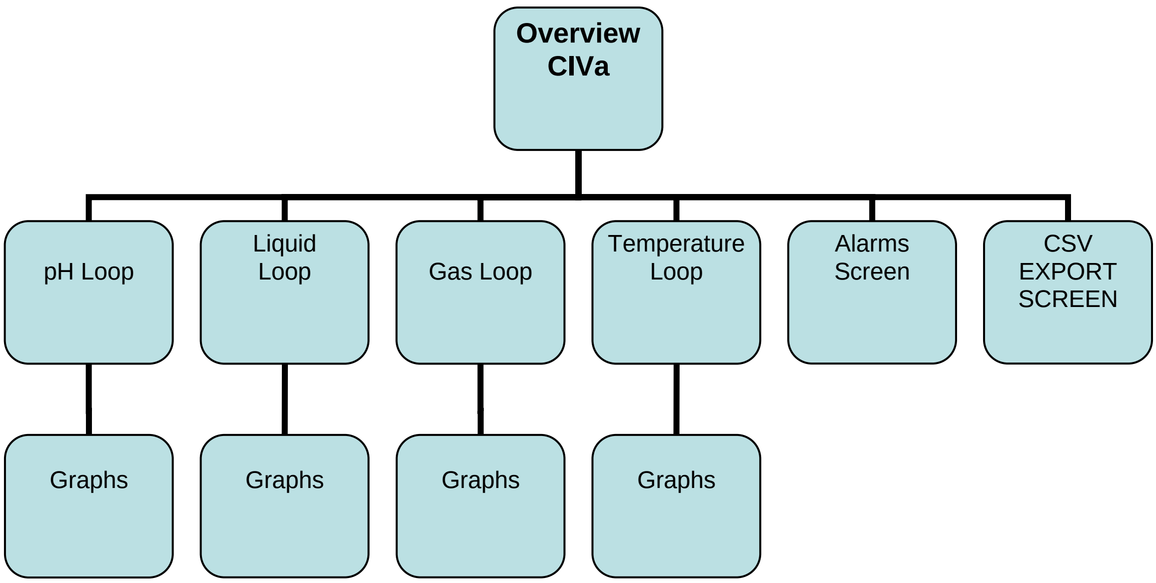

Figure 4-1: Interface architecture

The HMI will allow the user to interact with the PLC. Through the HMI the user can check and monitor the system operation, furthermore the user should be able to operate the compartment from it. Figure *4-1* shows the general structure of the different screens that will appear. These can be manipulated by the user in order to interact with the automation and control system. This map establishes the logical relations among the screens.

Therefore, as indicated in Figure *4-1*, the main screen will show an overview of the complete system. From there, the user will be able to navigate to the screens of second level that represent the different loops in the CIVa: pH, Liquid, Gas and Temperature. From these screens the user will be able to open graphs showing the history values of the different variables (pH, Temperature, Pressure, level, gas analysers, etc). Furthermore, the user will be able to open the alarms screen and CSV export screen.

4.2 System Overview Screen

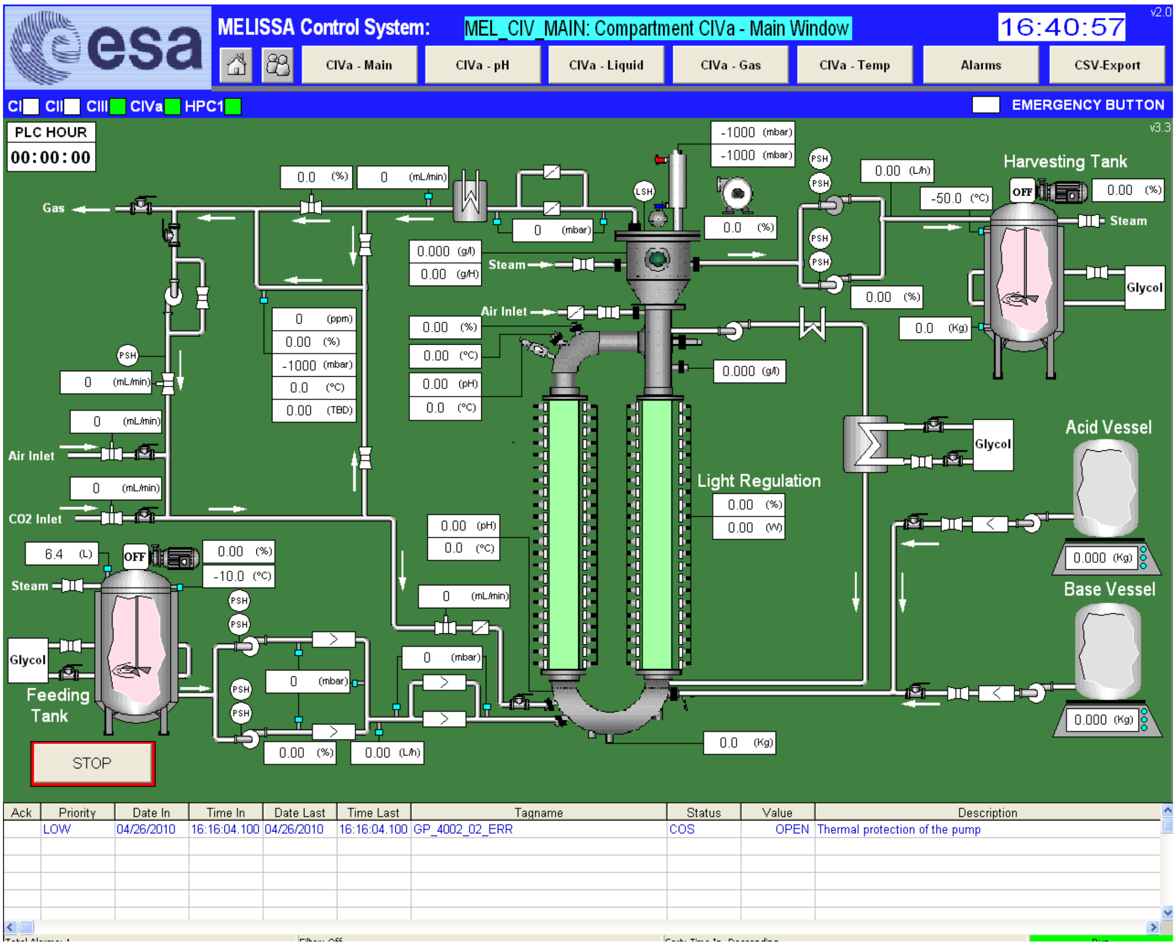

Figure 4-2: CIVa Main Screen

This screen provides a general overview of the Compartment CIVa. When accessing the CIVa, this first display displays a general schematic representing the values of more interest in the CVIa system. The diagram that represents the overview of the system will be something similar as shown in *Figure 4-2*. From this schematic user could call the other screens (pH, Liquid, Gas and Temperature). For instance, if the user calls the pH screen, a diagram of this unit will come into view and its instrumentation (valves, pumps, tanks, etc) can be distinguished as well as the different values of the variables that allow controlling it.

Moreover, all screens have a STOP button in order to stop regulation for all loops. Pressing it all control loop outputs will set to 0. To restore the automatic regulation (AUTO mode), user must navigate to every display and change it manually.

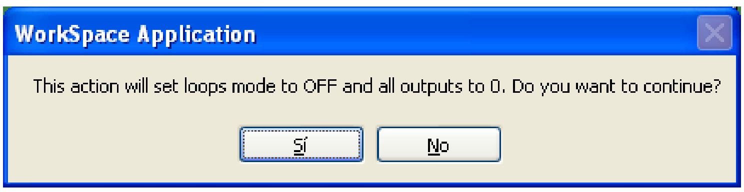

Figure 4-3: CIVa Stop Button Dialogue

The overview screen will also show, if user activates it, the on-line value of the most important parameters of CIVa when it is operating to check if the system works accurately as well as the status of the actuators. The actual parameters displayed in this screen are shown in Table 4-1.

4.2.1 Tag definition

The following tags are displayed in this screen.

Tag Name	Description	Type
CIVa_Sysclock_Hour	CIVa PLC system clock (hour)	Analogue indicator
CIVa_Sysclock_Minute	CIVa PLC system clock (minute)	Analogue indicator
CIVa_Sysclock_Second	CIVa PLC system clock (second)	Analogue indicator
IRC_4000_MV	Light Intensity (%)	Analogue indicator
IT_4000_PWR	Lights Power (W)	Analogue indicator
FT_4001_01	Total liquid inlet flow to reactor	Analogue indicator
LT_4001_01	Feeding tank level	Analogue indicator
DPT_4001_01	Differential pressure filter (feeding)	Analogue indicator
DPT_4001_02	Differential pressure filter (feeding)	Analogue indicator
GP_4001_01_MV1	Feeding Pump	Pump animated
GP_4001_02_MV1	Feeding Pump	Pump animated
GP_4001_03_MV1	Feeding tank agitator	Agitator animated
CL4001_PumpSpeed	Flow to the inlet pump	Analogue indicator
GP_4001_03_MV2	Speed of feeding tank agitator	Analogue indicator
PS_4001_01	Pressure Pump GP_4001_01	Digital Indicator
PS_4001_02	Pressure Pump GP_4001_02	Digital Indicator
PS_4001_03	Pressure switch membrane GP_4001_01	Digital Indicator
PS_4001_04	Pressure switch membrane GP_4001_02	Digital Indicator
WT_4002_01	Harvesting tank weight	Analogue indicator
CL4002_EstimatedOutletLiquidFlow	Outlet Liquid flow	Analogue indicator
GP_4002_01_MV1	Harvesting Pump	Pump Animated
GP_4002_02_MV1	Harvesting Pump	Pump Animated
GP_4002_03_MV1	Harvesting tank agitator	Agitator animated
CL4002_PUMPSPEED	Flow to the outlet pump	Analogue indicator
GP_4002_03_MV2	Speed of harvesting tank agitator	Analogue indicator
PS_4002_01	Pressure pump GP_4002_01	Digital indicator
PS_4002_02	Pressure pump GP_4002_02	Digital indicator
PS_4002_03	Pressure switch membrane GP_4002_01	Digital indicator
FQRC_4003_01	Mass flow CO2 inlet	Analogue indicator
FQRC_4003_02	Mass flow air inlet	Analogue indicator
FQRC_4003_03	Mass flow circulated Air	Analogue indicator
FQRC_4003_04	Total mass flow Air Inlet	Analogue indicator
BLWR_4003_01_MV1	Blower	Blower animated
SV_4003_01_FB	Analyser gas inlet valve	2-way valve animated
SV_4003_02_FB	Reactor air inlet vlave	2-way valve animated
SV_4003_03_FB	Circulated gas blower bypass valve	2-way valve animated
PS_4003_01	Pressure switch bypass for recirculation	Digital indicator
FT_4004_01	Total air outlet from reactor	Analogue indicator
DPT_4004_01	Differential pressure filter	Analogue indicator
SCV_4004_01_MV	Flow control air outlet valve	Analogue indicator
TT_4005_01	Reactor temperature	Analogue indicator
BLWR_4005_01_MV1	Start/Stop blower air	Blower animated
BLWR_4005_01_MV2	Speed of Blower air	Analogue indicator
SV_4005_01_FB	Cooling water outlet valve	2-way valve animated
PP_4005_01_MV1	Reactor temperature control pump	Pump animated
HX_4005_02_MV1	Electrical resistance	Resistance animated
WT_4006_01	Acid balance	Analogue indicator
WT_4006_02	Base balance	Analogue indicator

Tag Name	Description	Type
AT_4006_01	pH	Analogue indicator
TT_4006_01	pH probe Temperature	Analogue indicator
AT_4006_02	pH	Analogue indicator
TT_4006_02	pH probe Temperature	Analogue indicator
SV_4006_01_FB	Acid inlet valve to reactor	2-way valve animated
SV_4006_02_FB	Base inlet valve to reactor	2-way valve animated
PP_4006_01_MV1	Start/Stop acid pump	Pump animated
PP_4006_02_MV1	Start/Stop base pump	Pump animated
PT_4007_01	Reactor pressure	Analogue indicator
PT_4007_02	Reactor pressure	Analogue indicator
WT_4008_01	Reactor Weight	Analogue indicator
AT_4009_01	Biomass concentration	Analogue indicator
AT_4009_02	Biomass concentration	Analogue indicator
CL4009_BIOMASS_PRODUCTION	Biomass production	Analogue indicator
SV_4010_01_FB	Gas inlet analyser valve	2-way valve animated
HX_4010_01_MV1	Post condenser	Condenser animated
AT_4010_01	CO2 analyser	Analogue indicator
AT_4010_02	O2 analyser	Analogue indicator
AT_4010_03	Dissolved O2	Analogue indicator
PT_4010_01	Outlet Gas Pressure	Analogue indicator
TT_4010_01	Analyser temperature	Analogue indicator
CL4010_O2_PRODUCTION	Estimation of the O2 produced	Analogue indicator
TT_4011_01	Feeding tank temperature	Analogue indicator
SV_4011_01_FB	Feeding tank cooling water valve	2-way valve animated
TT_4012_01	Harvesting tank temperature	Analogue indicator
SV_4012_01_FB	Harvesting tank cooling water valve	2-way valve animated
LS_4013_01	Foam Measurement	Digital indicator
SV_4014_01_FB	Feeding tank steam inlet valve	2-way valve animated
SV_4015_01_FB	Reactor steam inlet valve	2-way valve animated
SV_4016_01_FB	Harvesting tank steam inlet valve	2-way valve animated

Table 4-1 Tags of the CIVa system main screen

4.2.2 Alarm definition

The following alarms are linked with the operation of the CIVa main screen.

TAG NAME	Description	HMI Address
FT_4001_01_ERR	FT_4001_01 sensor link error	000116
FT_4001_01_AHH	FT_4001_01 High high alarm	000207
FT_4001_01_AH	FT_4001_01 High alarm	000208
FT_4001_01_AL	FT_4001_01 Low alarm	000209
FT_4001_01_ALL	FT_4001_01 Low low alarm	000210
LT_4001_01_ERR	LT_4001_01 sensor link error	000117
LT_4001_01_AHH	LT_4001_01 High high alarm	000211
LT_4001_01_AH	LT_4001_01 High alarm	000212
LT_4001_01_AL	LT_4001_01 Low alarm	000213
LT_4001_01_ALL	LT_4001_01 Low low alarm	000214
DPT_4001_01_ERR	DPT_4001_01 sensor link error	000118
DPT_4001_01_AHH	DPT_4001_01 High high alarm	000215
DPT_4001_01_AH	DPT_4001_01 High alarm	000216
DPT_4001_01_AL	DPT_4001_01 Low alarm	000217
DPT_4001_01_ALL	DPT_4001_01 Low low alarm	000218
DPT_4001_02_ERR	DPT_4001_02 sensor link error	000119
DPT_4001_02_AHH	DPT_4001_02 High high alarm	000219
DPT_4001_02_AH	DPT_4001_02 High alarm	000220
DPT_4001_02_AL	DPT_4001_02 Low alarm	000221
DPT_4001_02_ALL	DPT_4001_02 Low low alarm	000222

TAG NAME	Description	HMI Address
PS_4001_01_A	Pressure switch alarm	000315
PS_4001_02_A	Pressure switch alarm	000316
PS_4001_03_A	Pressure switch alarm	000317
PS_4001_04_A	Pressure switch alarm	000318
GP_4001_01_ERR	GP_4001_01 thermal protection alarm	100099
GP_4001_02_ERR	GP_4001_02 thermal protection alarm	100100
GP_4001_03_ERR	GP_4001_03 thermal protection alarm	100105
WT_4002_01_ERR	WT_4002_01 sensor link error	000227
WT_4002_01_AH	WT_4002_01 high alarm	000223
WT_4002_01_AHH	WT_4002_01 high high alarm	000224
WT_4002_01_AL	WT_4002_01 low alarm	000225
WT_4002_01_ALL	WT_4002_01 low low alarm	000226
PS_4002_01_A	Pressure switch alarm	000319
PS_4002_02_A	Pressure switch alarm	000320
PS_4002_03_A	Pressure switch alarm	000321
GP_4002_02_ERR	GP_4002_02 thermal protection alarm	100102
GP_4002_03_ERR	GP_4002_03 thermal protection alarm	100104
FQRC_4003_01_ERR	FQRC_4003_01 sensor link error	000121
FQRC_4003_01_AHH	FQRC_4003_01 high high alarm	000337
FQRC_4003_01_AH	FQRC_4003_01 high alarm	000338
FQRC_4003_01_AL	FQRC_4003_01 low alarm	000339
FQRC_4003_01_ALL	FQRC_4003_01 low low alarm	000340
FQRC_4003_02_ERR	FQRC_4003_02 sensor link error	000122
FQRC_4003_02_AHH	FQRC_4003_02 high high alarm	000341
FQRC_4003_02_AH	FQRC_4003_02 high alarm	000342
FQRC_4003_02_AL	FQRC_4003_02 low alarm	000343
FQRC_4003_02_ALL	FQRC_4003_02 low low alarm	000344
FQRC_4003_03_ERR	FQRC_4003_03 sensor link error	000123
FQRC_4003_03_AHH	FQRC_4003_03 high high alarm	000345
FQRC_4003_03_AH	FQRC_4003_03 high alarm	000346
FQRC_4003_03_AL	FQRC_4003_03 low alarm	000347
FQRC_4003_03_ALL	FQRC_4003_03 low low alarm	000348
FQRC_4003_04_ERR	FQRC_4003_04 sensor link error	000124
FQRC_4003_04_AHH	FQRC_4003_04 high high alarm	000349
FQRC_4003_04_AH	FQRC_4003_04 high alarm	000350
FQRC_4003_04_AL	FQRC_4003_04 low alarm	000351
FQRC_4003_04_ALL	FQRC_4003_04 low low alarm	000352
PS_4003_01_A	Pressure switch alarm	000322
SV_4003_01_A	SV_4003_01 alarm	000230
SV_4003_02_A	SV_4003_02 alarm	000229
SV_4003_03_A	SV_4003_03 alarm	000228
FT_4004_01_ERR	FT_4004_01 sensor link error	000125
FT_4004_01_AHH	FT_4004_01 High high alarm	000231
FT_4004_01_AH	FT_4004_01 high alarm	000232
FT_4004_01_ALL	FT_4004_01 Low low alarm	000233
FT_4004_01_AL	FT_4004_01 low alarm	000234
DPT_4004_01_ERR	DPT_4004_01 sensor link erro	000126
DPT_4004_01_AHH	DPT_4004_01 High high alarm	000235
DPT_4004_01_AH	DPT_4004_01 high alarm	000236
DPT_4004_01_ALL	DPT_4004_01 Low low alarm	000237
DPT_4004_01_AL	DPT_4004_01 low alarm	000238
TT_4005_01_ERR	TT_4005_01 sensor link error	000127
TT_4005_01_AHH	TT_4005_01 High high alarm	000239
TT_4005_01_AH	TT_4005_01 High alarm	000240
TT_4005_01_ALL	TT_4005_01 Low low alarm	000241
TT_4005_01_AL	TT_4005_01 Low alarm	000242
BLWR_4005_01_ERR	Extractor thermal protection	100103

TAG NAME	Description	HMI Address
SV_4005_01_A	SV_4005_01 alarm	000323
WT_4006_01_AL	WT_4006_01 Low alarm	000245
WT_4006_01_ALL	WT_4006_01 Low low alarm	000246
WT_4006_02_AL	WT_4006_02 Low alarm	000247
WT_4006_02_ALL	WT_4006_02 Low low alarm	000248
CL4006_pH_AHH	pH control High high alarm	000249
CL4006_pH_AH	pH control High alarm	000250
CL4006_pH_AL	pH control Low alarm	000251
CL4006_pH_ALL	pH control Low low alarm	000252
AT_4006_01_ERR	AT_4006_01 sensor link error	000128
TT_4006_01_ERR	TT_4006_01 sensor link error	000129
AT_4006_02_ERR	AT_4006_02 sensor link error	000130
TT_4006_02_ERR	TT_4006_02 sensor link error	000131
SV_4006_01_A	SV_4006_01 alarm	000243
SV_4006_02_A	SV_4006_02 alarm	000244
PT_4007_01_ERR	PT_4007_01 sensor link error	000132
PT_4007_01_AHH	PT_4007_01 High high alarm	000253
PT_4007_01_AH	PT_4007_01 High alarm	000254
PT_4007_01_AL	PT_4007_01 Low alarm	000255
PT_4007_01_ALL	PT_4007_01 Low low alarm	000256
PT_4007_02_ERR	PT_4007_02 sensor link error	000133
PT_4007_02_AHH	PT_4007_02 High high alarm	000257
PT_4007_02_AH	PT_4007_02 High alarm	000258
PT_4007_02_AL	PT_4007_02 Low alarm	000259
PT_4007_02_ALL	PT_4007_02 Low low alarm	000260
WT_4008_01_ERR	WT_4008_01 sensor link error	000134
WT_4008_01_AH	WT_4008_01 High alarm	000261
WT_4008_01_AHH	WT_4008_01 High high alarm	000262
WT_4008_01_AL	WT_4008_01 Low alarm	000263
WT_4008_01_ALL	WT_4008_01 Low low alarm	000264
AT_4009_01_ERR	AT_4009_01 sensor link error	000135
AT_4009_01_AH	AT_4009_01 High alarm	000265
AT_4009_01_AHH	AT_4009_01 High high alarm	000266
AT_4009_01_AL	AT_4009_01 Low alarm	000267
AT_4009_01_ALL	AT_4009_01 Low low alarm	000268
AT_4009_02_ERR	AT_4009_02 sensor link error	000136
AT_4009_02_AH	AT_4009_02 High alarm	000269
AT_4009_02_AHH	AT_4009_02 High high alarm	000270
AT_4009_02_AL	AT_4009_02 Low alarm	000271
AT_4009_02_ALL	AT_4009_02 Low low alarm	000272
SV_4010_01_A	SV_4010_01 alarm	000277
AT_4010_01_ERR	AT_4010_01 sensor link error	000138
AT_4010_01_AH	AT_4010_01 High alarm	000278
AT_4010_01_AHH	AT_4010_01 High high alarm	000279
AT_4010_01_AL	AT_4010_01 Low alarm	000280
AT_4010_01_ALL	AT_4010_01 Low low alarm	000281
AT_4010_02_ERR	AT_4010_02 sensor link error	000139
AT_4010_02_AH	AT_4010_02 High alarm	000282
AT_4010_02_AHH	AT_4010_02 High high alarm	000283
AT_4010_02_AL	AT_4010_02 Low alarm	000284
AT_4010_02_ALL	AT_4010_02 Low low alarm	000285
AT_4010_03_ERR	AT_4010_03 sensor link error	000140
AT_4010_03_AH	AT_4010_03 High alarm	000286
AT_4010_03_AHH	AT_4010_03 High high alarm	000287
AT_4010_03_AL	AT_4010_03 Low alarm	000288
AT_4010_03_ALL	AT_4010_03 Low low alarm	000289
TT_4010_01_ERR	TT_4010_01 sensor link error	000143

TAG NAME	Description	HMI Address
TT_4010_01_AH	TT_4010_01 High alarm	000298
TT_4010_01_AHH	TT_4010_01 High high alarm	000299
TT_4010_01_AL	TT_4010_01 Low alarm	000300
TT_4010_01_ALL	TT_4010_01 Low low alarm	000301
PT_4010_01_ERR	PT_4010_01 sensor link error	000142
PT_4010_01_AH	PT_4010_01 High alarm	000294
PT_4010_01_AHH	PT_4010_01 High high alarm	000295
PT_4010_01_AL	PT_4010_01 Low alarm	000296
PT_4010_01_ALL	PT_4010_01 Low low alarm	000297
SV_4011_01_A	SV_4011_01 alarm	000302
TT_4011_01_ERR	TT_4011_01 sensor link error	000144
TT_4011_01_AH	TT_4011_01 High alarm	000303
TT_4011_01_AHH	TT_4011_01 High high alarm	000304
TT_4011_01_AL	TT_4011_01 Low alarm	000305
TT_4011_01_ALL	TT_4011_01 Low low alarm	000306
SV_4012_01_A	SV_4012_01 alarm	000307
TT_4012_01_AH	TT_4012_01 High alarm	000308
TT_4012_01_AHH	TT_4012_01 High high alarm	000309
TT_4012_01_AL	TT_4012_01 Low alarm	000310
TT_4012_01_ALL	TT_4012_01 Low low alarm	000311
SV_4014_01_A	SV_4014_01 alarm	000312
SV_4015_01_A	SV_4015_01 alarm	000313
SV_4016_01_A	SV_4016_01 alarm	000314

Table 4-2 Alarm tags of the Main Screen of CIVa system

4.3 Liquid control screen

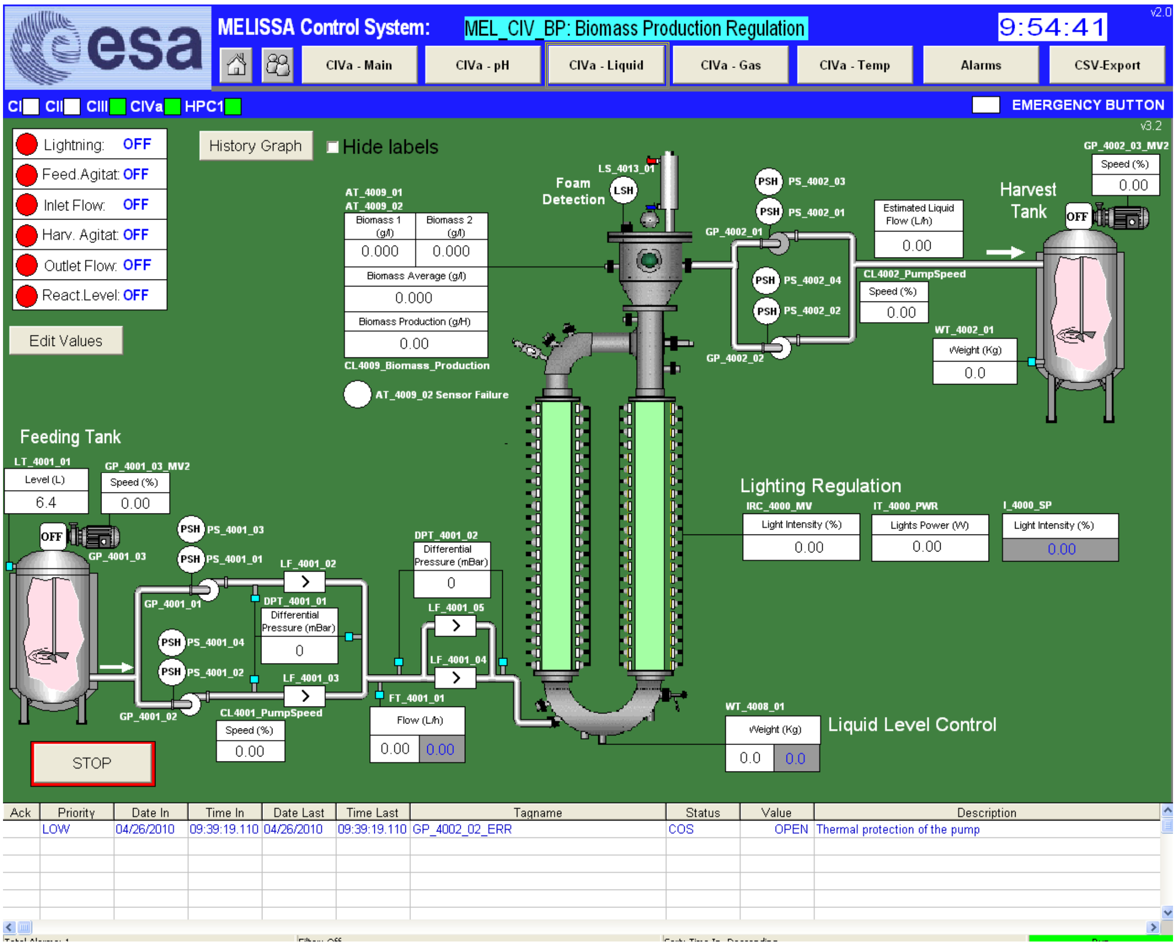

Figure 4-4: Main objects in CIVa Liquid Screen

The diagram that represents the Liquid control of the system will be something similar as the screen shown in *Figure 4-4*.

Navigating this screen the user will be able to:

- Monitor the measurements of the reactor's biomass concentration, biomass production, the liquid level of the reactor, the level of the feeding tank and harvesting tank, the speed of the feeding and harvesting tank agitators, input and output flows and lights intensity.
- Modify the Set-Points of the input flow, reactor's liquid level and light intensity.
- Display the history graph clicking on the History graph command button.
- Hide labels selecting the "Hide labels" check box
- Switch OFF the Lighting Mode, Feeding agitator mode, Inlet flow mode, Harvesting agitator mode, Outlet Flow mode and reactor's liquid level mode clicking on the "Stop" command button.
- Edit manual values clicking the "Edit Values" command button. In the Manual Values window user can switch between six submenus:
  - Feeding tank agitator: Allows activating the agitator GP_4001_03 and the manual value SP.
  - Harvesting tank agitator: Allows activating the agitator GP_4002_03 and the manual value SP.
  - Inlet flow pump selection: Allows selecting one of the inlet pumps, only one pump can be selected.
  - Inlet Pumps Manual Mode: Allows activating the pump selected (GP_4001_01 or GP_4001_02) and the manual value SP.

- Outlet flow pump selection: Allow selecting one of the outlet pumps, only one pump can be selected at a time. GP_4002_01 pump selection is disabled because pump is not mounted.
- Outlet pumps Manual mode: Allow activating the pump selected (GP_4002_01 or GP_4002_02) and the manual value SP. GP_4002_01 pump activation is disabled because pump is not mounted.

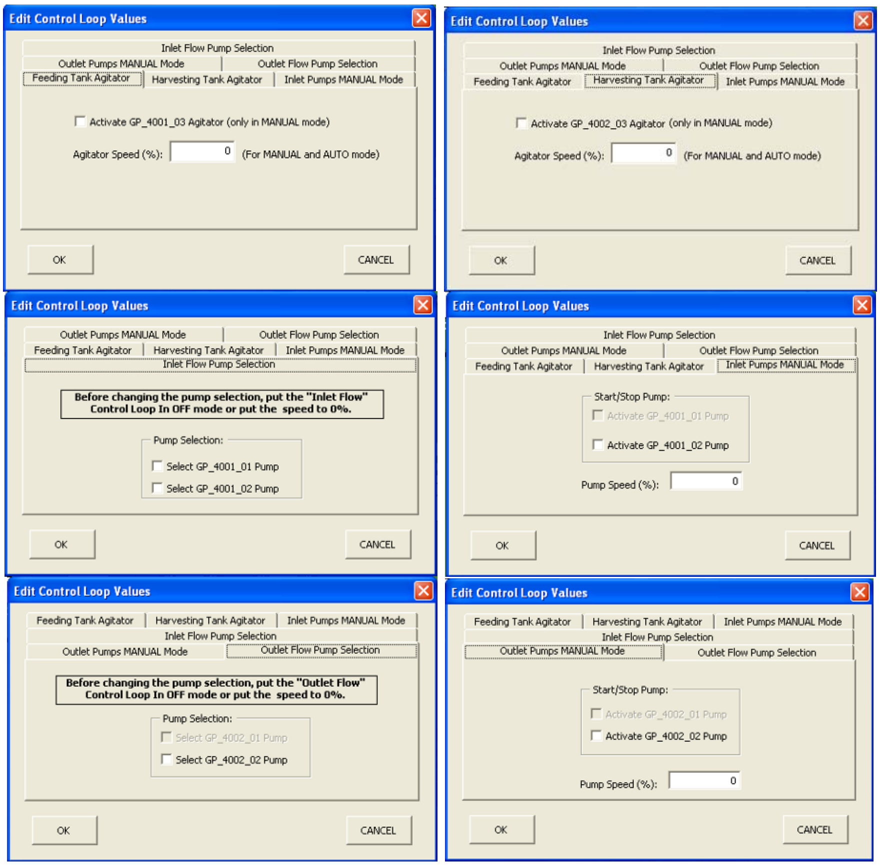

Figure 4-5: Edit Values Dialog

4.3.1 Control Loops

The following control loops are implemented on the screen:

Tag Name	Description	HMI address
CL4000_ControlLoop_Mode	Lighting mode	400268
CL4001_Agitator_Mode	Feeding agitator mode	400270
CL4001_ControlLoop_Mode	Inlet Flow mode	400272
CL4002_Agitator_Mode	Harvesting agitator mode	400274
CL4002_ControlLoop_Mode	Outlet flow mode	400276
CL4008_ControlLoop_Mode	Liquid level mode	400294

Table 4-3 Control Loops of the Liquid loop of CIVa system

4.3.2 Tag definition

The following tags are displayed in this screen. (The user inputs are highlighted in green)

Tag Name	Description	Type
IRC_4000_MV	Light Intensity (%)	Analogue indicator
IT_4000_PWR	Lights Power (W)	Analogue indicator
I_4000_SP	Light Intensity Set Point	Set Point User Input
PS_4001_01	Pressure Pump GP_4001_01	Digital Indicator
PS_4001_02	Pressure Pump GP_4001_02	Digital Indicator
PS_4001_03	Pressure switch membrane GP_4001_01	Digital Indicator
PS_4001_04	Pressure switch membrane GP_4001_02	Digital Indicator
GP_4001_01_MV1	Feeding Pump	Pump animated
GP_4001_01_SEL	GP_4001_01 pump selection	User Input
GP_4001_01_MV1_OP	Start/Stop pump in manual mode	User Input
GP_4001_02_MV1	Feeding Pump	Pump animated
GP_4001_02_SEL	GP_4001_02 pump selection	User Input
GP_4001_02_MV1_OP	Start/Stop pump in manual mode	User Input
GP_4001_03_MV1	Feeding tank agitator	Agitator animated
GP_4001_03_MV2_OP	Speed of the feeding tank agitator in manual mode	User Input
GP_4001_03_MV1_OP	Start/Stop feeding tank agitator in manual mode	User input
CL4001_PumpSpeed_OP	Speed of the inlet pump in Manual Mode	User Input
CL4001_PumpSpeed	Flow to the inlet pump	Analogue indicator
GP_4001_03_MV2	Speed of feeding tank agitator	Analogue indicator
FT_4001_01	Total liquid inlet flow to reactor	Analogue indicator
FT_4001_01_SP	Flow rate Set Point	User Input
LT_4001_01	Feeding tank level	Analogue indicator
DPT_4001_01	Differential pressure filter (feeding)	Analogue indicator
DPT_4001_02	Differential pressure filter (feeding)	Analogue indicator
PS_4002_01	Pressure pump GP_4002_01	Digital indicator
PS_4002_02	Pressure pump GP_4002_02	Digital indicator
PS_4002_03	Pressure switch membrane GP_4002_01	Digital indicator
GP_4002_01_MV1	Harvesting Pump	Pump Animated
GP_4002_01_SEL	GP_4002_01 pump selection	User Input
GP_4002_01_MV1_OP	Start/Stop pump in manual mode	User Input
GP_4002_02_MV1	Harvesting Pump	Pump Animated
GP_4002_02_SEL	GP_4002_02 pump selection	User Input
GP_4002_02_MV1_OP	Start/Stop pump in manual mode	User Input
GP_4002_03_MV1	Harvesting tank agitator	Agitator animated
GP_4002_03_MV2_OP	Speed of the harvesting tank agitator in manual mode	User Input
GP_4002_03_MV1_OP	Start/Stop harvesting tank agitator in manual mode	User input
CL4002_PumpSpeed_OP	Speed of the outlet pump in Manual Mode	User Input
CL4002_PUMPSPEED	Flow to the outlet pump	Analogue indicator
GP_4002_03_MV2	Speed of harvesting tank agitator	Analogue indicator
CL4002_EstimatedOutletLiquidFlow	Outlet liquid flow	Analogue indicator
WT_4002_01	Harvesting tank weight	Analogue indicator
WT_4008_01	Reactor Weight	Analogue indicator
WT_4008_SP	Reactor level Set Point	User Input
AT_4009_01	Biomass concentration	Analogue indicator
AT_4009_02	Biomass concentration	Analogue indicator
AT_4009_AVG	Biomass Average	Analogue indicator
AT_4009_SENSORFAILURE	Biomass sensor error	Digital indicator
CL4009_BIOMASS_PRODUCTION	Biomass production	Analogue indicator
LS_4013_01	Foam detection	Digital indicator

Table 4-4 Tags of the Liquid loop of CIVa system

4.3.3 Alarm definition

The following alarms are linked with the operation of the liquid control screen.

TAG NAME	Description	HMI Address
PS_4001_01_A	Pressure switch alarm	000315
PS_4001_02_A	Pressure switch alarm	000316
PS_4001_03_A	Pressure switch alarm	000317
PS_4001_04_A	Pressure switch alarm	000318
GP_4001_01_ERR	GP_4001_01 thermal protection alarm	100099
GP_4001_02_ERR	GP_4001_02 thermal protection alarm	100100
GP_4001_03_ERR	GP_4001_03 thermal protection alarm	100105
FT_4001_01_ERR	FT_4001_01 sensor link error	000116
FT_4001_01_AHH	FT_4001_01 High high alarm	000207
FT_4001_01_AH	FT_4001_01 High alarm	000208
FT_4001_01_AL	FT_4001_01 Low alarm	000209
FT_4001_01_ALL	FT_4001_01 Low low alarm	000210
LT_4001_01_ERR	LT_4001_01 sensor link error	000117
LT_4001_01_AHH	LT_4001_01 High high alarm	000211
LT_4001_01_AH	LT_4001_01 High alarm	000212
LT_4001_01_AL	LT_4001_01 Low alarm	000213
LT_4001_01_ALL	LT_4001_01 Low low alarm	000214
DPT_4001_01_ERR	DPT_4001_01 sensor link error	000118
DPT_4001_01_AHH	DPT_4001_01 High high alarm	000215
DPT_4001_01_AH	DPT_4001_01 High alarm	000216
DPT_4001_01_AL	DPT_4001_01 Low alarm	000217
DPT_4001_01_ALL	DPT_4001_01 Low low alarm	000218
DPT_4001_02_ERR	DPT_4001_02 sensor link error	000119
DPT_4001_02_AHH	DPT_4001_02 High high alarm	000219
DPT_4001_02_AH	DPT_4001_02 High alarm	000220
DPT_4001_02_AL	DPT_4001_02 Low alarm	000221
DPT_4001_02_ALL	DPT_4001_02 Low low alarm	000222
PS_4002_01_A	Pressure switch alarm	000319
PS_4002_02_A	Pressure switch alarm	000320
PS_4002_03_A	Pressure switch alarm	000321
GP_4002_01_ERR	GP_4002_01 thermal protection alarm	100101
GP_4002_02_ERR	GP_4002_02 thermal protection alarm	100102
GP_4002_03_ERR	GP_4002_03 thermal protection alarm	100104
WT_4002_01_ERR	WT_4002_01 sensor link error	000227
WT_4002_01_AH	WT_4002_01 high alarm	000223
WT_4002_01_AHH	WT_4002_01 high high alarm	000224
WT_4002_01_AL	WT_4002_01 low alarm	000225
WT_4002_01_ALL	WT_4002_01 low low alarm	000226
WT_4008_01_ERR	WT_4008_01 sensor link error	000134
WT_4008_01_AH	WT_4008_01 High alarm	000261
WT_4008_01_AHH	WT_4008_01 High high alarm	000262
WT_4008_01_AL	WT_4008_01 Low alarm	000263
WT_4008_01_ALL	WT_4008_01 Low low alarm	000264
AT_4009_01_ERR	AT_4009_01 sensor link error	000135
AT_4009_01_AH	AT_4009_01 High alarm	000265
AT_4009_01_AHH	AT_4009_01 High high alarm	000266
AT_4009_01_AL	AT_4009_01 Low alarm	000267
AT_4009_01_ALL	AT_4009_01 Low low alarm	000268
AT_4009_02_ERR	AT_4009_02 sensor link error	000136
AT_4009_02_AH	AT_4009_02 High alarm	000269
AT_4009_02_AHH	AT_4009_02 High high alarm	000270
AT_4009_02_AL	AT_4009_02 Low alarm	000271
AT_4009_02_ALL	AT_4009_02 Low low alarm	000272

Table 4-5 Alarm tags of the Liquid loop of CIVa system

4.3.4 History Graph

The following tags are monitored by default when the user access to the History Graph from the Liquid Control screen.

1.	LT_4001_01	Feeding tank level
2.	DPT_4001_01	Differential pressure filter (feeding)
3.	DPT_4001_02	Differential pressure filter (feeding)
4.	FT_4001_01	Total liquid inlet flow to reactor
5.	WT_4008_01	Reactor Weight
6.	AT_4009_01	Biomass concentration
7.	AT_4009_02	Biomass concentration
8.	IRC_4000_MV	Light Intensity (%)
9.	WT_4002_01	Harvesting tank weight

4.4 CIVa Gas Loop screen

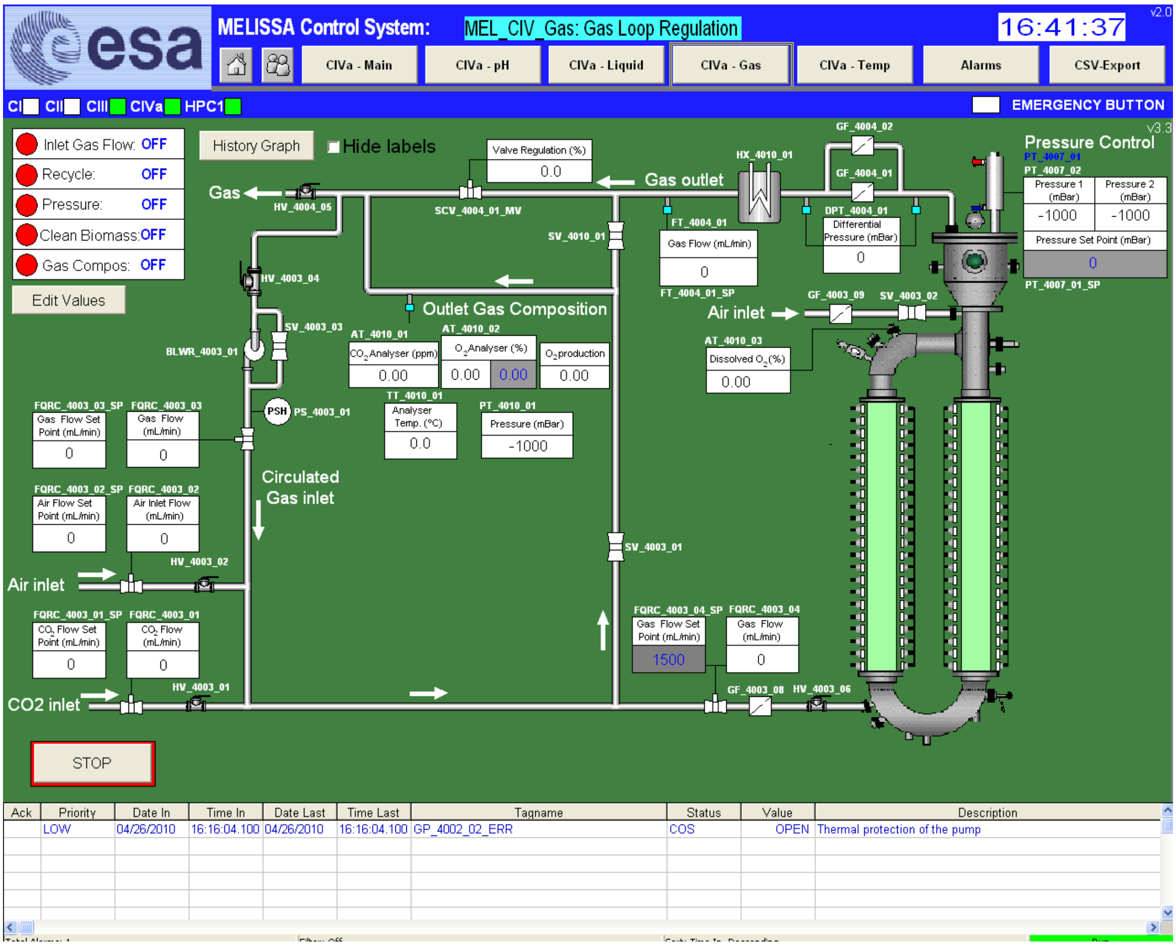

Figure 4-6: Main objects in CIVa Gas Screen

The diagram that represents the Gas loop of the system will be something similar as shown in *Figure 4-6*.

Navigating this screen the user will be able to:

- Monitor the mass flow controllers (CO_2 inlet, Air Inlet, Circulated Air and total Air Inlet), the dissolved O_2 concentration, temperature of the O_2 concentration probe, CO_2 concentration, O_2 concentration, outlet gas pressure, temperature of the analyzer, outlet gas flow and reactor's pressure.
- Modify the set-points of O_2, total air inlet and reactor's pressure.
- Display the history graph clicking on the History graph command button.
- Hide labels selecting the "Hide labels" check box
- Switch OFF the Inlet Gas Mode, Recycle Mode, reactor's pressure Mode, Biomass Cleaning Mode and Outlet Gas Composition Mode clicking on the "Stop" command button.
- Select the pressure probe for control clicking over the probe lecture:

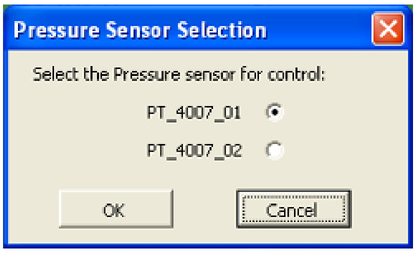

Figure 4-7: Pressure probe selection

- Edit manual values clicking the “Edit Values” command button. In the Manual Values window user can switch between five submenus:
  - o Inlet Gas Mode Manual: Allows activating analyzer gas inlet valve (SV_4003_01) and manual value SP of CO_2 (CO_2 set point will be only taken into account when the pH is in ACID BASE mode), Air Inlet and total air flow.
  - o Recycle Mode Manual: Allows activating circulated gas blower bypass valve (SV_4003_03), blower (BLWR_4003_01) and manual value SP of circulated air.
  - o Bioreactor Pressure Manual: Allows selecting the manual value SP of outlet Gas valve opening (SCV_4004_01).
  - o Biomass cleaning Manual: Allows activating reactor air inlet valve (SV_4003_02).
  - o Outlet Gas analyser Manual: Allow activating gas inlet analyzer valve from reactor outlet (SV_4010_01).

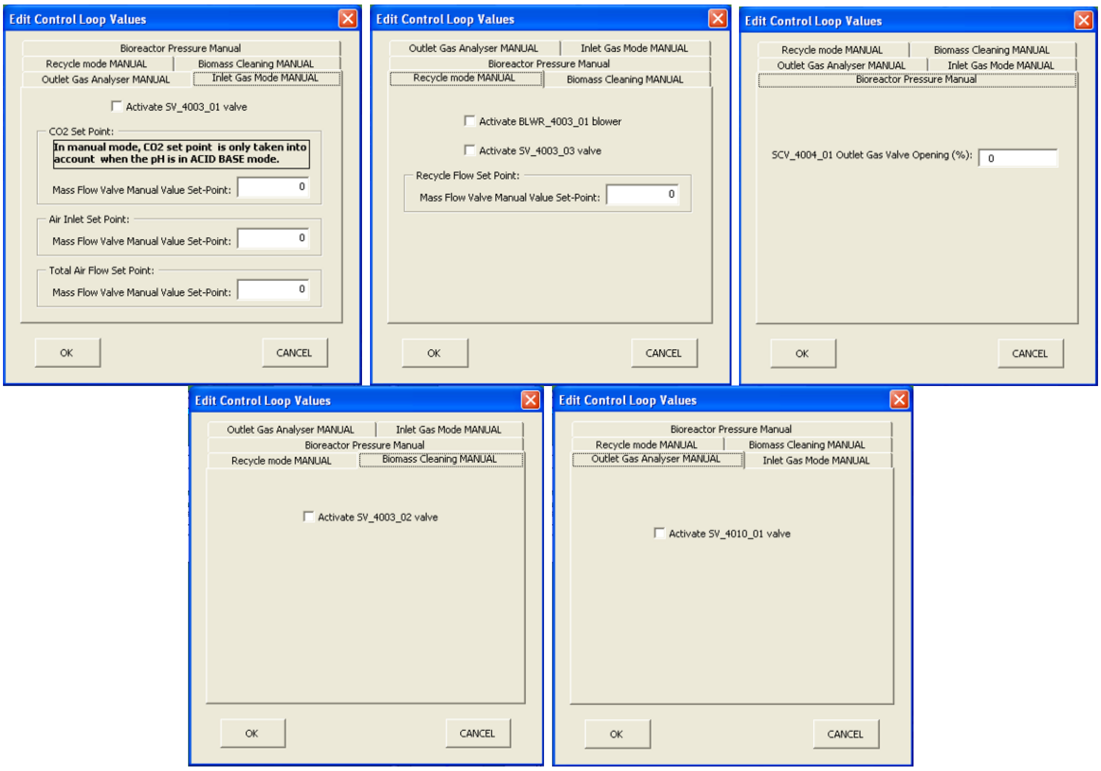

Figure 4-8: Edit Values Dialog

4.4.1 Control Loops

The following control loops are implemented on the screen:

Tag Name	Description	HMI address
CL4003_ControlLoop_Mode	Inlet Gas Mode	400280
CL4003_Recycle_Mode	Recycle Mode	400278
CL4007_ControlLoop_Mode	Reactor pressure mode	400292
CL4009_Biomass_Cleaning_Mode	Biomass cleaning mode	400296
CL4010_ControlLoop_Mode	Outlet Gas composition mode	400275

Table 4-6 Control Loops of the Gas loop of CIVa system

4.4.2 Tag definition

The following tags are displayed in this screen. (The user inputs are highlighted in green)

Tag Name	Description	Type
SV_4003_01_FB	Analyser gas inlet valve	2-way valve animated
SV_4003_01_OP	Activate valve in manual mode	User input
SV_4003_02_FB	Reactor air inlet vlave	2-way valve animated
SV_4003_02_OP	Activate valve in manual mode	User input
SV_4003_03_FB	Circulated gas blower bypass valve	2-way valve animated
SV_4003_03_OP	Activate valve in manual mode	User Input
PS_4003_01	Pressure switch bypass for recirculation	Digital indicator
BLWR_4003_01_MV1	Blower	Blower animated
BLWR_4003_01_MV1_OP	Start/Stop blower in manual mode	User input
FQRC_4003_01	Mass flow CO2 inlet	Analogue indicator
FQRC_4003_01_SP	Mass flow CO2 Inlet Set Point	Analogue Indicator
FQRC_4003_01_SP_OP	CO2 Set Point in Manual mode	User Input
FQRC_4003_02	Mass flow air inlet	Analogue indicator
FQRC_4003_02_SP	Mass flow air inlet set point	Analogue indicator
FQRC_4003_02_SP_OP	Air Inlet Set Point in manual mode	User input
FQRC_4003_03	Mass flow circulated Air	Analogue indicator
FQRC_4003_03_SP	Mass flow circulated air set poiont	Analogue indicator
FQRC_4003_03_SP_OP	Recycle flow set point in manual mode	User Input
FQRC_4003_04	Total mass flow Air Inlet	Analogue indicator
FQRC_4003_04_SP	Total Air flow inlet set point	Analogue indicator
FQRC_4003_04_SP_OP	Total air flow set point in manual mode	User input
SCV_4004_01_MV	Flow control air outlet valve	Analogue indicator
SCV_4004_01_OP	Proportional valve set point in manual mode	User input
FT_4004_01	Total air outlet from reactor	Analogue indicator
DPT_4004_01	Differential pressure filter	Analogue indicator
PT_4007_01	Reactor pressure	Analogue indicator
PT_4007_02	Reactor pressure	Analogue indicator
PT_4007_SP	Pressure Set Point	User input
SV_4010_01_FB	Gas inlet analyser valve	2-way valve animated
SV_4010_01_OP	Activate valve in manual mode	User input
HX_4010_01_MV1	Post condenser	Condenser animated
AT_4010_01	CO2 analyser	Analogue indicator
AT_4010_02	O2 analyser	Analogue indicator
AT_4010_03	Dissolved O2	Analogue indicator
CL4010_O2_SP	O2 Set Point	User input
PT_4010_01	Outlet Gas Pressure	Analogue indicator
TT_4010_01	Analyser temperature	Analogue indicator
CL4010_O2_PRODUCTIO N	Estimated O2 production	Analogue indicator

Table 4-7 Tags of the Gas loop of CIVa system

4.4.3 Alarm definition

The following alarms are linked with the operation of the gas control screen.

TAG NAME	Description	HMI Address
PS_4003_01_A	Pressure switch alarm	000322
SV_4003_01_A	SV_4003_01 alarm	000230
SV_4003_02_A	SV_4003_02 alarm	000229
SV_4003_03_A	SV_4003_03 alarm	000228
FQRC_4003_01_ERR	FQRC_4003_01 sensor link error	000121
FQRC_4003_01_AHH	FQRC_4003_01 High high alarm	000337
FQRC_4003_01_AH	FQRC_4003_01 High alarm	000338
FQRC_4003_01_AL	FQRC_4003_01 Low alarm	000339
FQRC_4003_01_ALL	FQRC_4003_01 Low low alarm	000340
FQRC_4003_02_ERR	FQRC_4003_02 sensor link error	000122
FQRC_4003_02_AHH	FQRC_4003_02 High high alarm	000341
FQRC_4003_02_AH	FQRC_4003_02 High alarm	000342
FQRC_4003_02_AL	FQRC_4003_02 Low alarm	000343
FQRC_4003_02_ALL	FQRC_4003_02 Low low alarm	000344
FQRC_4003_03_ERR	FQRC_4003_03 sensor link error	000123
FQRC_4003_03_AHH	FQRC_4003_03 High high alarm	000345
FQRC_4003_03_AH	FQRC_4003_03 High alarm	000346
FQRC_4003_03_AL	FQRC_4003_03 Low alarm	000347
FQRC_4003_03_ALL	FQRC_4003_03 Low low alarm	000348
FQRC_4003_04_ERR	FQRC_4003_04 sensor link error	000124
FQRC_4003_04_AHH	FQRC_4003_04 High high alarm	000349
FQRC_4003_04_AH	FQRC_4003_04 High alarm	000350
FQRC_4003_04_AL	FQRC_4003_04 Low alarm	000351
FQRC_4003_04_ALL	FQRC_4003_04 Low low alarm	00352
FT_4004_01_ERR	FT_4004_01 sensor link error	000125
FT_4004_01_AHH	FT_4004_01 High high alarm	000231
FT_4004_01_AH	FT_4004_01 high alarm	000232
FT_4004_01_ALL	FT_4004_01 Low low alarm	000233
FT_4004_01_AL	FT_4004_01 low alarm	000234
DPT_4004_01_ERR	DPT_4004_01 sensor link erro	000126
DPT_4004_01_AHH	DPT_4004_01 High high alarm	000235
DPT_4004_01_AH	DPT_4004_01 high alarm	000236
DPT_4004_01_ALL	DPT_4004_01 Low low alarm	000237
DPT_4004_01_AL	DPT_4004_01 low alarm	000238
PT_4007_01_ERR	PT_4007_01 sensor link error	000132
PT_4007_01_AHH	PT_4007_01 High high alarm	000253
PT_4007_01_AH	PT_4007_01 High alarm	000254
PT_4007_01_AL	PT_4007_01 Low alarm	000255
PT_4007_01_ALL	PT_4007_01 Low low alarm	000256
PT_4007_02_ERR	PT_4007_02 sensor link error	000133
PT_4007_02_AHH	PT_4007_02 High high alarm	000257
PT_4007_02_AH	PT_4007_02 High alarm	000258
PT_4007_02_AL	PT_4007_02 Low alarm	000259
PT_4007_02_ALL	PT_4007_02 Low low alarm	000260
SV_4010_01_A	SV_4010_01 alarm	000277
AT_4010_01_ERR	AT_4010_01 sensor link error	000138
AT_4010_01_AH	AT_4010_01 High alarm	000278
AT_4010_01_AHH	AT_4010_01 High high alarm	000279
AT_4010_01_AL	AT_4010_01 Low alarm	000280
AT_4010_01_ALL	AT_4010_01 Low low alarm	000281
AT_4010_02_ERR	AT_4010_02 sensor link error	000139
AT_4010_02_AH	AT_4010_02 High alarm	000282
AT_4010_02_AHH	AT_4010_02 High high alarm	000283
AT_4010_02_AL	AT_4010_02 Low alarm	000284
AT_4010_02_ALL	AT_4010_02 Low low alarm	000285
AT_4010_03_ERR	AT_4010_03 sensor link error	000140
AT_4010_03_AH	AT_4010_03 High alarm	000286

TAG NAME	Description	HMI Address
AT_4010_03_AHH	AT_4010_03 High high alarm	000287
AT_4010_03_AL	AT_4010_03 Low alarm	000288
AT_4010_03_ALL	AT_4010_03 Low low alarm	000289
TT_4010_01_ERR	TT_4010_01 sensor link error	000143
TT_4010_01_AH	TT_4010_01 High alarm	000298
TT_4010_01_AHH	TT_4010_01 High high alarm	000299
TT_4010_01_AL	TT_4010_01 Low alarm	000300
TT_4010_01_ALL	TT_4010_01 Low low alarm	000301
PT_4010_01_ERR	PT_4010_01 sensor link error	000142
PT_4010_01_AH	PT_4010_01 High alarm	000294
PT_4010_01_AHH	PT_4010_01 High high alarm	000295
PT_4010_01_AL	PT_4010_01 Low alarm	000296
PT_4010_01_ALL	PT_4010_01 Low low alarm	000297

Table 4-8 Alarm tags of the Gas loop of CIVa system

4.4.4 History Graph

The following tags are monitored by default when the user access to the History Graph from the Gas Control screen.

1.	PT_4007_01	Reactor pressure
2.	PT_4007_02	Reactor pressure
3.	AT_4010_01	CO_2 Analyser
4.	AT_4010_02	O_2 Analyser
5.	DPT_4004_01	Differential Pressure of the outlet gas
6.	AT_4010_03	Dissolved O2
7.	FT_4004_01	Total air outlet from reactor
8.	CL4010_O2_PRODUCTION	Oxygen production

Another graph configuration has been created. Its name is MEL_CIV_Gas2.txt and it can be changed but not removed.

1.	FQRC_4003_01	Inlet CO2 flow
2.	FQRC_4003_02	Inlet air flow
3.	FQRC_4003_03	Recirculation air flow
4.	FQRC_4003_04	Inlet total gas flow to reactor
5.	PT_4010_01	Gas Analyser Pressure
6.	TT_4010_01	Gas Analyser temperature

4.5 CIVa Temperature Loop screen

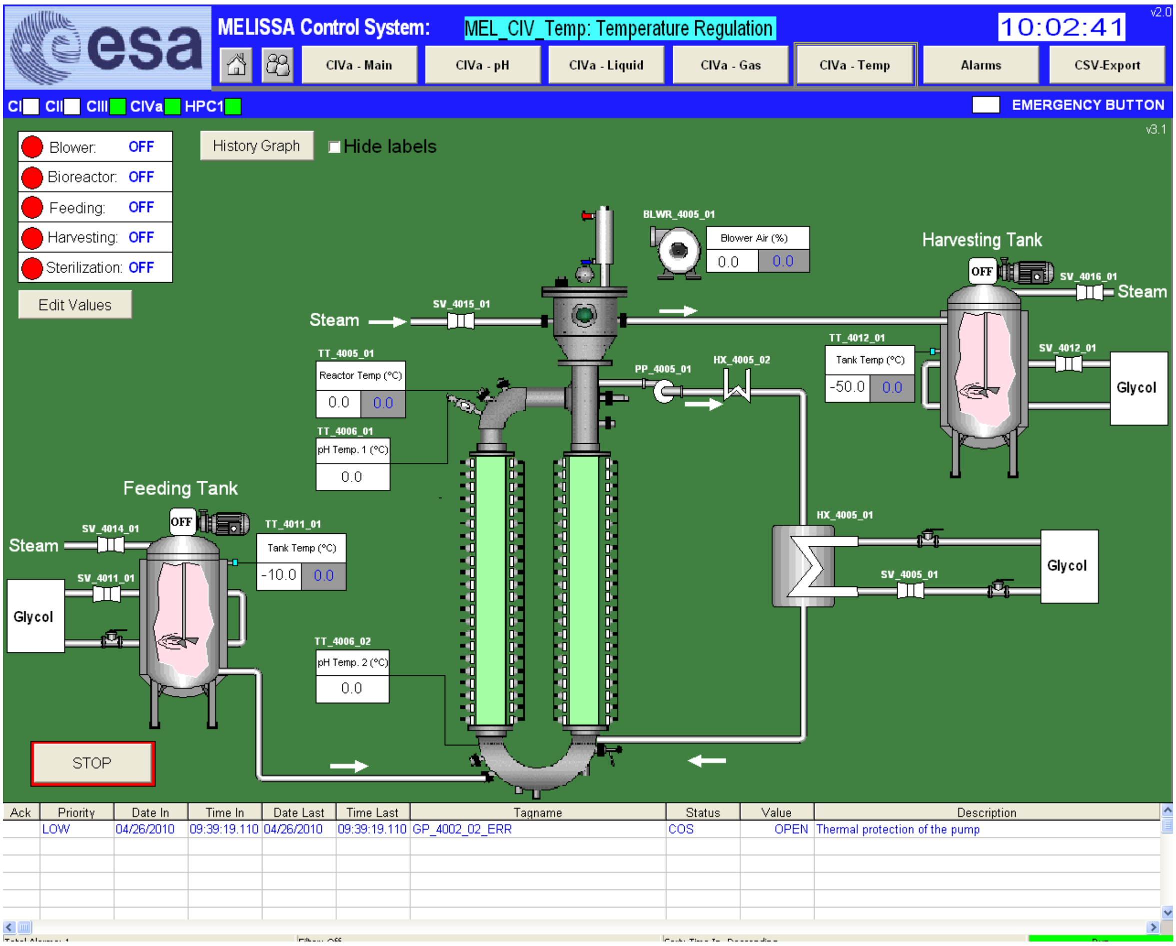

Figure 4-9: Main objects in CIVa Temperature Screen

The diagram that represents the Temperature loop of the system will be something similar as shown in *Figure 4-9*.

Navigating this screen the user will be able to:

- Monitor the temperature of each tank and the blower air speed.
- Modify the temperature set-points of each of the tanks, the bioreactor and the blower air.
- Display the history graph clicking on the History graph command button.
- Hide labels selecting the “Hide labels” check box
- Switch OFF the Blower Mode, Reactor’s Temperature Mode, Feeding Tank Temperature Mode, Harvesting Tank temperature Mode and Sterilization Mode clicking on the “Stop” command button.
- Edit manual values clicking the “Edit Values” command button. In the Manual Values window user can switch between five submenus:
  - Blower Manual Mode: Allows activating blower (BLWR_4005_01) and manual value SP of blower speed.
  - Reactor Temperature Manual Mode: Allows activating pump PP_4005_01, valve SV_4005_01 and electrical resistor HX_4005_02.
  - Feeding Tank Temperature Manual Mode: Allows activating SV_4011_01 valve.
  - Harvesting Tank Temperature Manual Mode: Allows activating SV_4012_01 valve.

- o Sterilization Manual Mode: Allows activating SV_4014_01 valve (inlet steam into feeding tank), SV_4016_01 valve (inlet steam into harvesting tank) and SV_4015_01 valve (inlet steam into reactor).

Figure 4-10: Edit Values Dialog

4.5.1 Control Loops

The following control loops are implemented on the screen:

Tag Name	Description	HMI address
CL4005_Blower_Mode	Blower Mode	400284
CL4005_ControlLoop_Mode	Reactor Temperature mode	400286
CL4011_ControlLoop_Mode	Feeding tank temperature control	400300
CL4012_ControlLoop_Mode	Harvesting tank temperature control	400302
CL4014_ControlLoop_Mode	Feeding tank sterilisation control	400269
CL4015_ControlLoop_Mode	Reactor sterilisation control	400271
CL4016_ControlLoop_Mode	Harvesting tank sterilisation control	400273

Table 4-9 Control Loops of the Temperature loop of CIVa system

4.5.2 Tag definition

The following tags are displayed in this screen. (The user inputs are highlighted in green).

Tag Name	Description	Type
GP_4001_03_MV1	Feeding tank agitator	Agitator animated

Tag Name	Description	Type
GP_4002_03_MV1	Harvesting tank agitator	Agitator animated
SV_4005_01_FB	Cooling water outlet valve	2-way valve animated
SV_4005_01_OP	Activate valve in manual mode	User Input
PP_4005_01_MV1	Reactor temperature control pump	Pump animated
PP_4005_01_OP	Start/Stop pump in manual mode	User Input
BLWR_4005_01_MV1	Start/Stop blower air	Blower animated
BLWR_4005_01_MV1_OP	Start/Stop blower in manual mode	User Input
HX_4005_02_MV1	Electrical resistance	Resistance animated
HX_4005_02_OP	Start/Stop electrical resistor in manual mode	User Input
BLWR_4005_01_MV2	Speed of Blower air	Analogue indicator
BLWR_4005_01_MV2_OP	Speed of Blower air in manual mode	User Input
TT_4005_01	Reactor temperature	Analogue indicator
TT_4005_01_SP	Reactor temperature set point	User Input
TT_4006_01	Temperature of the pH probe (AT_4006_01)	Analogue Indicator
TT_4006_02	Temperature of the pH probe (AT_4006_02)	Analogue Indicator
SV_4011_01_FB	Feeding tank cooling water valve	2-way valve animated
SV_4011_01_OP	Activate/Deactivate valve in manual mode	User input
TT_4011_01	Feeding tank temperature	Analogue indicator
TT_4011_SP	Feeding tank temperature set point	User Input
SV_4012_01_FB	Harvesting tank cooling water valve	2-way valve animated
SV_4012_01_OP	Activate/Deactivate valve in manual mode	User Input
TT_4012_01	Harvesting tank temperature	Analogue indicator
TT_4012_SP	Harvesting tank temperature set point	User input
SV_4014_01_FB	Feeding tank steam inlet valve	2-way valve animated
SV_4014_01_OP	Activate/Deactivate valve in manual mode	User Input
SV_4015_01_FB	Reactor steam inlet valve	2-way valve animated
SV_4015_01_OP	Activate/Deactivate valve in manual mode	User Input
SV_4016_01_FB	Harvesting tank steam inlet valve	2-way valve animated
SV_4016_01_OP	Activate/Deactivate valve in manual mode	User Input

Table 4-10 Tags of the Temperature loop of CIVa system

4.5.3 Alarm definition

The following alarms are linked with the operation of the Temperature control screen.

TAG NAME	Description	HMI Address
GP_4001_03_ERR	GP_4001_03 thermal protection alarm	100105
GP_4002_03_ERR	GP_4002_03 thermal protection alarm	100104
BLWR_4005_01_ERR	Extractor thermal protection	100103
SV_4005_01_A	SV_4005_01 alarm	000323
TT_4005_01_ERR	TT_4005_01 sensor link error	000127
TT_4005_01_AHH	TT_4005_01 High high alarm	000239
TT_4005_01_AH	TT_4005_01 High alarm	000240
TT_4005_01_ALL	TT_4005_01 Low low alarm	000241
TT_4005_01_AL	TT_4005_01 Low alarm	000242
TT_4006_01_ERR	pH probe temperature sensor link error	000129
TT_4006_02_ERR	pH probe temperature sensor link error	000131
SV_4011_01_A	SV_4011_01 alarm	000302
TT_4011_01_ERR	TT_4011_01 sensor link error	000144
TT_4011_01_AH	TT_4011_01 High alarm	000303
TT_4011_01_AHH	TT_4011_01 High high alarm	000304

TAG NAME	Description	HMI Address
TT_4011_01_AL	TT_4011_01 Low alarm	000305
TT_4011_01_ALL	TT_4011_01 Low low alarm	000306
SV_4012_01_A	SV_4012_01 alarm	000307
TT_4012_01_ERR	TT_4012_01 sensor link error	000145
TT_4012_01_AH	TT_4012_01 High alarm	000308
TT_4012_01_AHH	TT_4012_01 High high alarm	000309
TT_4012_01_AL	TT_4012_01 Low alarm	000310
TT_4012_01_ALL	TT_4012_01 Low low alarm	000311
SV_4014_01_A	SV_4014_01 alarm	000312
SV_4015_01_A	SV_4015_01 alarm	000313
SV_4016_01_A	SV_4016_01 alarm	000314

Table 4-11 Alarm tags of the Temperature loop of CIVa system

4.5.4 History Graph

The following tags are monitored by default when the user access to the History Graph from the Temperature Control screen.

1.	TT_4011_01	Feeding tank temperature
2.	TT_4005_01	Reactor Temperature
3.	TT_4012_01	Harvesting tank temperature
4.	BLWR_4005_01_MV2	Extractor speed
5.	TT_4006_01	Temperature of the pH sensor (TOP)
6.	TT_4006_02	Temperature of the pH sensor (BOTTOM)

4.6 CIVa pH Loop screen

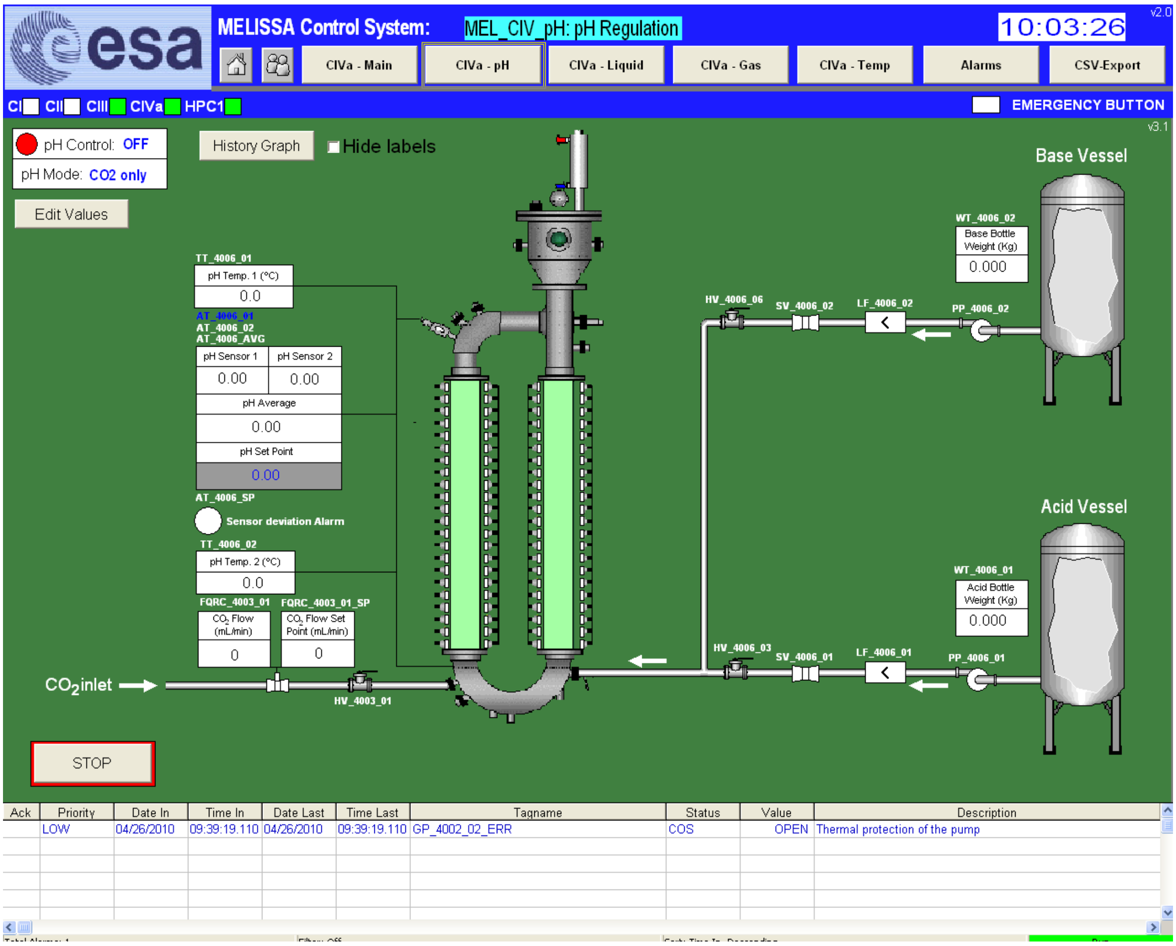

Figure 4-11: Main objects in CIVa pH Screen

The diagram that represents the pH loop of the system will be something similar as shown in *Figure 4-11*.

This loop controls the pH within the reactor. According to the measurement position in comparison to the pH set point the regulator activates the acid solution or base solution pumps. A probe placed on the top of the engine provides the pH measurement for the control system. There is another probe in the bottom of the engine. The user can select the usable probe to control the process.

There are three modes of regulation:

Mode	Description	CO_2 flow	Base pump	Acid pump
1	Only CO_2 is used to regulate pH	Enabled	Disabled	Disabled
2	CO_2 and Base medium is used to regulate pH.	Enabled	Enabled	Disabled
3	Base and additional Acid media is used to regulate pH.	Disabled	Enabled	Enabled

Actuating in mode 1 or 2, the inlet gas flow control is deactivated.

Navigating this screen the user will be able to:

- Monitor the pH values and the temperature of each pH sensor.
- Monitor the weight of acid and base vessels.
- Monitor the CO_2 flow.
- Select the pH probe to control, clicking over the pH sensor indicators. The label of the selected sensor will be highlighted in blue.

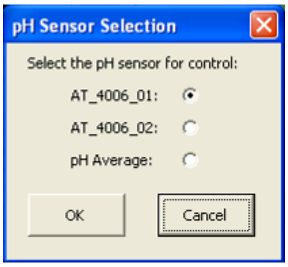

Figure 4-12: pH Sensor selection in CIVa pH Screen

- Modify the pH set-point.
- Display the history graph clicking on the History graph command button.
- Hide labels selecting the “Hide labels” check box
- Switch OFF the pH Control Mode clicking on the “Stop” command button.
- Edit manual values clicking the “Edit Values” command button. In the Manual Values window user can switch between two submenus:
    - pH Manual Mode: Allows activating the acid and base pumps and valves (PP_4006_01, PP_4006_02, SV_4006_01 and SV_4006_02 respectively) and select the opening time. Moreover allows selecting the Manual Value Set-Point for the CO_2 valve.
    - pH Automatic Mode: Allows resetting the pH timers and selecting the pH Set-Point and the pH dead zone. Furthermore it is possible to read the date and time of the last timer reset and the opened time of the acid and the base injections.

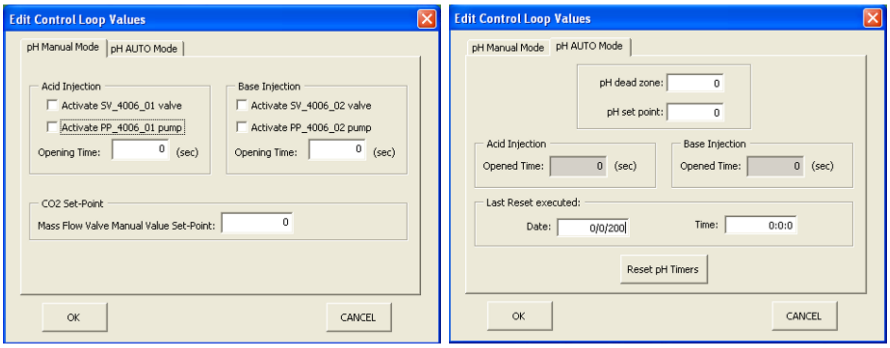

Figure 4-13: Edit Values Dialog

- Select the pH control mode, clicking over the pH mode indicator.

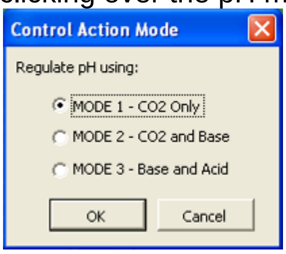

Figure 4-14: pH Mode

4.6.1 Control Loops

The following control loops are implemented on the screen:

Tag Name	Description	HMI address
CL4006_ControlLoop_Mode	pH Control Mode	400290

Table 4-12 Control Loops of the pH loop of CIVa system

4.6.2 Tag definition

The following tags are displayed in this screen. (The user inputs are highlighted in green)

Tag Name	Description	Type
FQRC_4003_01	Mass flow CO2 inlet	Analogue indicator
FQRC_4003_01_SP	Mass flow CO2 Set Point	Analogue indicator
FQRC_4003_01_SP_OP	Mass Flow CO2 Set Point in manual mode	User Input
SV_4006_01_FB	Acid inlet valve to reactor	2-way valve animated
SV_4006_01_OP	Activate/Deactivate valve in manual mode	User input
SV_4006_02_FB	Base inlet valve to reactor	2-way valve animated
SV_4006_02_OP	Activate/Deactivate valve in manual mode	User Input
PP_4006_01_MV1	Start/Stop acid pump	Pump animated
PP_4006_01_OP	Start/Stop acid pump in manual mode	User input
PP_4006_02_MV1	Start/Stop base pump	Pump animated
PP_4006_02_OP	Start/Stop base pump in manual mode	User Input
WT_4006_01	Acid balance	Analogue indicator
WT_4006_02	Base balance	Analogue indicator
AT_4006_01	pH	Analogue indicator
TT_4006_01	pH probe Temperature	Analogue indicator
AT_4006_02	pH	Analogue indicator
TT_4006_02	pH probe Temperature	Analogue indicator
AT_4006_AVG	pH average	Analogue indicator
AT_4006_SP	pH Set Point	User Input
CL4006_PH_DEADZONE	pH Dead Zone	User Input
CL4006_ACID_OP_Time	ACID time for injection	User Input
CL4006_BASE_OP_Time	BASE time for injection	User Input
CL4006_Base_Opening_Time	Base injection time (seconds)	Analogue indicator
CL4006_Acid_Opening_Time	Acid injection time (seconds)	Analogue indicator
CL4006_pH_Second	Date of the last reset done	Analogue indicator
CL4006_pH_Minute	Date of the last reset done	Analogue indicator
CL4006_pH_Hour	Date of the last reset done	Analogue indicator
CL4006_pH_Day	Date of the last reset done	Analogue indicator
CL4006_pH_Month	Date of the last reset done	Analogue indicator
CL4006_pH_Year	Date of the last reset done	Analogue indicator
CL4006_pH_Reset_timer	Reset of the pH timer	User Input

Table 4-13 Tags of the pH loop of CIVa system

4.6.3 Alarm definition

The following alarms are linked with the operation of the pH control screen.

TAG NAME	Description	HMI Address
FQRC_4003_01_ERR	FQRC_4003_01 sensor link error	000121
FQRC_4003_01_AHH	FQRC_4003_01 High high alarm	000337
FQRC_4003_01_AH	FQRC_4003_01 High alarm	000338
FQRC_4003_01_AL	FQRC_4003_01 Low alarm	000339
FQRC_4003_01_ALL	FQRC_4003_01 Low low alarm	000340
SV_4006_01_A	SV_4006_01 alarm	000243
SV_4006_02_A	SV_4006_02 alarm	000244
WT_4006_01_AL	WT_4006_01 Low alarm	000245
WT_4006_01_ALL	WT_4006_01 Low low alarm	000246
WT_4006_02_AL	WT_4006_02 Low alarm	000247
WT_4006_02_ALL	WT_4006_02 Low low alarm	000248
CL4006_pH_AHH	pH control High high alarm	000249
CL4006_pH_AH	pH control High alarm	000250
CL4006_pH_AL	pH control Low alarm	000251
CL4006_pH_ALL	pH control Low low alarm	000252
AT_4006_01_ERR	AT_4006_01 sensor link error	000128
TT_4006_01_ERR	TT_4006_01 sensor link error	000129
AT_4006_02_ERR	AT_4006_02 sensor link error	000130

TAG NAME	Description	HMI Address
TT_4006_02_ERR	TT_4006_02 sensor link error	000131
AT_4006_SENSOR_DEVIATION_A	Triggered when the pH gap between the two probe is more than 2	000336

Table 4-14 Alarm tags of the pH loop of CIVa system

4.6.4 History Graph

The following tags are monitored by default when the user access to the History Graph from the pH Control screen.

1.	AT_4006_01	Reactor pH sensor (top)
2.	AT_4006_02	Reactor pH sensor (bottom)
3.	AT_4006_AVG	Reactor pH average
4.	AT_4006_SP	Reactor PH Set Point
5.	TT_4006_01	Temperature of the pH sensor (TOP)
6.	TT_4006_02	Temperature of the pH sensor (BOTTOM)
7.	FQRC_4003_01	Inlet CO2 flow
8.	WT_4006_01	Acid bottle weight
9.	WT_4006_02	Base bottle weight

5. CIVA SYSTEM CLOCK UPDATE

As for the rest of compartments, from the screens of the CIVa compartment it will be able to synchronise the system clock. The user will be able to synchronise the system clock by double-clicking on the clock indicator on the right top corner of the screen. This action will show up a dialog where date/time information could be entered. Changing the date/time and confirming will update the date/time of all PLC and the server system time.

The following tags are used to update the system clock time:

Tag Name	Description	HMI address
CIVA_SysClock_dayofweek	1 = Sunday .. 7 = Saturday	400408
CIVA_SysClock_dayofweek_SET	configure the day of the week (1 = Sunday .. 7 = Saturday)	400415
CIVA_SysClock_Year	Year 0..99	400409
CIVA_SysClock_Year_SET	configure the Year (0..99)	400416
CIVA_SysClock_Month	Month 1..12	400410
CIVA_SysClock_Month_SET	configure the Month (1..12)	400417
CIVA_SysClock_Day	Day 1..31	400411
CIVA_SysClock_Day_SET	configure the Day (1..31)	400418
CIVA_SysClock_Hour	Hour 0..23	400412
CIVA_SysClock_Hour_SET	configure the Hour (0..23)	400419
CIVA_SysClock_Minute	Minute 0..59	400413
CIVA_SysClock_Minute_SET	configure the Minute (0..59)	400420
CIVA_SysClock_Second	Second 0..59	400414
CIVA_SysClock_Second_SET	configure the Second (0..59)	400421
CIVA_SC_Activate_Setting	Used to set the date and the clock of the PLC	000324

Table 5-1 System clock tags of CIVa system

6. HMI DATABASE

The HMI database is the Process Database that resides in the server memory, used to store the real time data coming from the PLC. The database defines the tag names, description, PLC address, low and high limit, enable alarming tags, etc. Definition of CIVa database tags is included in the excel file attachment.

7. HISTORICAL DATA

Following tags will be stored by the Historical Data Collection process (HTC) of iFix. Note that to configure these tags the iFix Historical Assign application shall be used.

- Gr: Group where the tag is configured. For CIVa is always Group 1.
- Tag: Tag identifier.
- Threshold: Threshold to store the value. Values are only archived in case that the change from the previous value is higher/lower than the threshold. This is to avoid overruns caused due to excessive simultaneous data accesses.
- Description: Description of the tag.
- Units: Units of the tag.

Gr	TAG	Threshold	Description	Units
1	IRC_4000_MV	0.01	Light Intensity (%)	(%)
1	FT_4001_01	0.01	Total liquid inlet flow to reactor	(L/h)
1	WT_4002_01	0.1	Harvesting tank weight	(Kg.)
1	WT_4008_01	0.1	Reactor Weight	(Kg.)
1	LT_4001_01	0.1	Feeding tank level	(L)
1	GP_4001_03_MV2	0.01	Speed of feeding tank agitator	(%)
1	GP_4002_03_MV2	0.01	Speed of harvesting tank agitator	(%)
1	DPT_4001_01	0.1	Differential pressure filter (feeding)	(mBar)
1	DPT_4001_02	0.1	Differential pressure filter (feeding)	(mBar)
1	FQRC_4003_01	1	Mass flow CO2 inlet	(mL/min)
1	FQRC_4003_02	1	Mass flow air inlet	(mL/min)
1	FQRC_4003_03	1	Mass flow circulated Air	(mL/min)
1	FQRC_4003_04	1	Total mass flow Air Inlet	(mL/min)
1	FQRC_4003_01_SP	1	Mass flow CO2 Inlet Set Point	(mL/min)
1	FQRC_4003_02_SP	1	Mass flow air inlet Set Point	(mL/min)
1	FQRC_4003_03_SP	1	Mass flow circulated Air Set Point	(mL/min)
1	FQRC_4003_04_SP	1	Total mass flow Air Inlet Set Point	(mL/min)
1	FT_4004_01	1	Total air outlet from reactor	(mL/min)
1	SCV_4004_01_MV	0.1	Flow control air outlet valve	(%)
1	PT_4007_01	0.1	Reactor pressure	(mBar)
1	PT_4007_02	0.1	Reactor pressure	(mBar)
1	TT_4005_01	0.01	Reactor temperature	(ºC)
1	BLWR_4005_01_MV2	0.1	Speed of Blower air	(%)
1	TT_4011_01	0.01	Feeding tank temperature	(ºC)
1	TT_4012_01	0.01	Harvesting tank temperature	(ºC)

Gr	TAG	Threshold	Description	Units
1	WT_4006_01	0.001	Acid balance	(Kg.)
1	WT_4006_02	0.001	Base balance	(Kg.)
1	IT_4000_PWR	0.1	Lights Power (W)	(W)
1	GP_4001_03_MV2_OP	0.01	Speed of the feeding tank agitator in manual mode	(%)
1	FT_4001_01_SP	0.01	Total liquid inlet flow Set point to reactor	(L/h)
1	GP_4002_03_MV2_OP	0.01	Speed of harvesting tank agitator in manual mode.	(%)
1	FQRC_4003_01_SP_OP	1	Mass flow CO2 Inlet Set Point in Manual mode	(mL/min)
1	FQRC_4003_02_SP_OP	1	Mass flow air inlet Set Point in manual mode	(mL/min)
1	FQRC_4003_03_SP_OP	1	Mass flow circulated Air Set Point in manual mode	(mL/min)
1	FQRC_4003_04_SP_OP	1	Total mass flow Air Inlet Set Point in manual mode	(mL/min)
1	SCV_4004_01_OP	0.1	Flow control air outlet valve in Manual mode	(%)
1	DPT_4004_01	1	Differential pressure filter	(mBar)
1	BLWR_4005_01_MV2_OP	0.1	Blower air speed in manual mode	(%)
1	TT_4005_01_SP	0.01	Reactor temperature Set Point	(ºC)
1	AT_4006_01	0.01	pH	(pH)
1	AT_4006_02	0.01	pH	(pH)
1	TT_4006_02	0.1	pH probe Temperature	(ºC)
1	TT_4006_01	0.1	pH probe Temperature	(ºC)
1	AT_4006_SP	0.01	pH Set Point	(pH)
1	PT_4007_SP	1	Reactor pressure set point	(mBar)
1	AT_4009_01	0.001	Biomass concentration	(g/l)
1	AT_4009_02	0.001	Biomass concentration	(g/l)
1	CL4009_BIOMASS_PRODUCTION	0.01	Biomass production	(g/H)
1	AT_4009_SP	0.001	Biomass concentration Set Point	(g/l)
1	AT_4010_01	0.1	CO2 analyser	(ppm)
1	AT_4010_02	0.01	O2 analyser	(%)
1	AT_4010_03	0.01	Dissolved O2	(%)
1	TT_4010_01	0.1	Analyser temperature	(ºC)
1	PT_4010_01	1	Outlet Gas Pressure	(mBar)
1	TT_4011_SP	0.1	Feeding tank temperature Set Point	(ºC)
1	TT_4012_SP	0.1	Harvesting tank temperature Set Point	(ºC)
1	WT_4008_SP	0.1	Reactor Weight Set Point	(Kg.)
1	I_4000_SP	0.1	Lights Intensity Set Point (%)	TBD
1	AT_4006_AVG	0.01	pH average	(pH)
1	CL4001_PumpSpeed	0.1	Flow to the inlet pump	(%)
1	CL4001_PumpSpeed_OP	0.1	Flow to the inlet pump in manual mode	(%)
1	CL4002_PUMPSPEED	0.1	Flow to the outlet pump	(%)
1	CL4002_PumpSpeed_OP	0.1	Flow to the outlet pump in manual mode	(%)
1	AT_4009_AVG	0.001	Biomass concentration average	(g/l)
1	CL4010_O2_SP	0.01	Oxygen Set Point	(%)
1	CL4010_O2_PRODUCTION	0.01	Oxygen Production	TBD
1	CL4002_EstimatedOutletLiquidFlow	0.01	Estimated Outlet liquid flow	(L/h)

Table 7-1 Historical Data tags of CIVa system

8. FILES LIST

In the following table there is a list of the files corresponding to the CIVa screens implementation and where they are located (path). All of them are stored in the server PC.

File name	Path	Description	Version
MEL_CIV_Main.grf	D:\Supervision\PIC	Melissa CIVa Main screen	3.3
MEL_CIV_MainMenu.grf	D:\Supervision\PIC	Melissa CIVa Main Menu screen	2.0
MEL_CIV_BP.grf	D:\Supervision\PIC	Liquid control screen	3.2
MEL_CIV_Gas.grf	D:\Supervision\PIC	Gas control screen	3.3
MEL_CIV_pH.grf	D:\Supervision\PIC	pH control screen.	3.1
MEL_CIV_Temp.grf	D:\Supervision\PIC	Temperature control screen	3.1
MEL_CIV_SAVEVALUES.evs	C:\Dynamics\PDB	Schedule executed every 5 minutes to save data in access file	1
MEL_CIV_DB.mdb	D:\Supervision\PIC\Database	Access file where acquired data is stored.	1
CIV_MDB.txt	D:\Supervision\PIC\Logs	SQL command executed to save in the access database is stored in txt file.	1
MEL_CIV_BP.txt	D:\Supervision\APP\Chart_cfg	Liquid graph tags configuration	2
MEL_CIV_Gas.txt	D:\Supervision\APP\Chart_cfg	Gas graph tags configuration	2
MEL_CIV_Gas2.txt	D:\Supervision\APP\Chart_cfg	Gas graph tags configuration	1
MEL_CIV_pH.txt	D:\Supervision\APP\Chart_cfg	pH graph tags configuration	2
MEL_CIV_Temp.txt	D:\Supervision\APP\Chart_cfg	Temperature control graph tags configuration	2

Table 8-1 File list of CIVa system

9. TAGS LIST

Tag Name	Description	Type	HMI address	Units	Range	Digits precision
I_4000_SP	Light Intensity Set Point	Set Point User Input	400192	(%)	0 to 100	(2)
IRC_4000_MV	Light Intensity (%)	Analogue indicator	400262	(%)	0 to 100	(2)
IT_4000_PWR	Lights Power (W)	Analogue indicator	400190	(W)	TBD	(2)
DPT_4001_01	Differential pressure filter (feeding)	Analogue indicator	400162	(mBar)	0 to 3000	(0)
DPT_4001_02	Differential pressure filter (feeding)	Analogue indicator	400164	(mBar)	0 to 3000	(0)
FT_4001_01	Total liquid inlet flow to reactor	Analogue indicator	400148	(L/h)	0 to 4	(2)
FT_4001_01_SP	Flow rate Set Point	User Input	400304	(L/h)	0 to 4	(2)
LT_4001_01	Feeding tank level	Analogue indicator	400150	(L)	0 to 160	(1)

Tag Name	Description	Type	HMI address	Units	Range	Digits precision
CL4001_PumpSpeed	Flow to the inlet pump	Analogue indicator	400250	(%)	0 to 100	(2)
CL4001_PumpSpeed_OP	Speed of the inlet pump in Manual Mode	User Input	400198	(%)	0 to 100	(2)
GP_4001_01_MV1	Feeding Pump	Pump animated	91	---	---	---
GP_4001_01_MV1_OP	Start/Stop pump in manual mode	User Input	149	---	---	---
GP_4001_01_SEL	GP_4001_01 pump selection	User Input	147	---	---	---
GP_4001_02_MV1	Feeding Pump	Pump animated	90	---	---	---
GP_4001_02_MV1_OP	Start/Stop pump in manual mode	User Input	150	---	---	---
GP_4001_02_SEL	GP_4001_02 pump selection	User Input	148	---	---	---
GP_4001_03_MV1	Feeding tank agitator	Agitator animated	109	---	---	---
GP_4001_03_MV1_OP	Start/Stop feeding tank agitator in manual mode	User input	146	---	---	---
GP_4001_03_MV2	Speed of feeding tank agitator	Analogue indicator	400258	(%)	0 to 100	(2)
GP_4001_03_MV2_OP	Speed of the feeding tank agitator in manual mode	User Input	400196	(%)	0 to 100	(2)
PS_4001_01	Pressure Pump GP_4001_01	Digital Indicator	100082	---	---	---
PS_4001_02	Pressure Pump GP_4001_02	Digital Indicator	100083	---	---	---
PS_4001_03	Pressure switch membrane GP_4001_01	Digital Indicator	100106	---	---	---
PS_4001_04	Pressure switch membrane GP_4001_02	Digital Indicator	100107	---	---	---
CL4002_PUMPSPEED	Flow to the outlet pump	Analogue indicator	400254	(%)	0 to 100	(2)
CL4002_PumpSpeed_OP	Speed of the outlet pump in Manual Mode	User Input	400204	(%)	0 to 100	(2)
GP_4002_01_MV1	Harvesting Pump	Pump Animated	89	---	---	---
GP_4002_01_MV1_OP	Start/Stop pump in manual mode	User Input	154	---	---	---
GP_4002_01_SEL	GP_4002_01 pump selection	User Input	152	---	---	---
GP_4002_02_MV1	Harvesting Pump	Pump Animated	104	---	---	---
GP_4002_02_SEL	GP_4002_02 pump selection	User Input	153	---	---	---
GP_4002_03_MV1	Harvesting tank agitator	Agitator animated	110	---	---	---
GP_4002_03_MV1_OP	Start/Stop harvesting tank agitator in manual mode	User input	151	---	---	---
GP_4002_03_MV2	Speed of harvesting tank agitator	Analogue indicator	400260	(%)	0 to 100	(2)
GP_4002_03_MV2_OP	Speed of the harvesting tank agitator in manual mode	User Input	400202	(%)	0 to 100	(2)
PS_4002_01	Pressure pump GP_4002_01	Digital indicator	100084	---	---	---
PS_4002_02	Pressure pump GP_4002_02	Digital indicator	100085	---	---	---
PS_4002_03	Pressure switch membrane GP_4002_01	Digital indicator	100108	---	---	---
WT_4002_01	Harvesting tank weight	Analogue indicator	400152	(Kg.)	0 to 600	(1)
BLWR_4003_01_MV1	Blower	Blower animated	103	---	---	---
BLWR_4003_01_MV1_OP	Start/Stop blower in manual mode	User input	156	---	---	---

Tag Name	Description	Type	HMI address	Units	Range	Digits precision
FQRC_4003_01	Mass flow CO2 inlet	Analogue indicator	400176	(mL/min)	0 to 5000	(0)
FQRC_4003_01_SP	Mass flow CO2 Set Point	Analogue indicator	400238	(mL/min)	0 to 5000	(0)
FQRC_4003_01_SP_OP	Mass Flow CO2 Set Point in manual mode	User Input	400212	(mL/min)	0 to 5000	(0)
FQRC_4003_02	Mass flow air inlet	Analogue indicator	400178	(mL/min)	0 to 30000	(0)
FQRC_4003_02_SP	Mass flow air inlet set point	Analogue indicator	400240	(mL/min)	0 to 30000	(0)
FQRC_4003_02_SP_OP	Air Inlet Set Point in manual mode	User input	400214	(mL/min)	0 to 30000	(0)
FQRC_4003_03	Mass flow circulated Air	Analogue indicator	400180	(mL/min)	0 to 30000	(0)
FQRC_4003_03_SP	Mass flow circulated air set poiont	Analogue indicator	400242	(mL/min)	0 to 30000	(0)
FQRC_4003_03_SP_OP	Recycle flow set point in manual mode	User Input	400208	(mL/min)	0 to 30000	(0)
FQRC_4003_04	Total mass flow Air Inlet	Analogue indicator	400182	(mL/min)	0 to 30000	(0)
FQRC_4003_04_SP	Total Air flow inlet set point	Analogue indicator	400244	(mL/min)	0 to 30000	(0)
FQRC_4003_04_SP_OP	Total air flow set point in manual mode	User input	400210	(mL/min)	0 to 30000	(0)
PS_4003_01	Pressure switch bypass for recirculation	Digital indicator	100110	---	---	---
SV_4003_01_FB	Analyser gas inlet valve	2-way valve animated	100097	---	---	---
SV_4003_01_OP	Activate valve in manual mode	User input	331	---	---	---
SV_4003_02_FB	Reactor air inlet vlave	2-way valve animated	100095	---	---	---
SV_4003_02_OP	Activate valve in manual mode	User input	167	---	---	---
SV_4003_03_FB	Circulated gas blower bypass valve	2-way valve animated	100094	---	---	---
SV_4003_03_OP	Activate valve in manual mode	User Input	332	---	---	---
DPT_4004_01	Differential pressure filter	Analogue indicator	400166	(mBar)	0 to 3000	(0)
FT_4004_01	Total air outlet from reactor	Analogue indicator	400146	(mL/min)	0 to 20000	(0)
FT_4004_01_SP	Flow Set Point	User Input	400216	(mL/min)	0 to 20000	(0)
SCV_4004_01_MV	Flow control air outlet valve	Analogue indicator	400248	(%)	0 to 100	(1)
SCV_4004_01_OP	Proportional valve set point in manual mode	User input	400218	(%)	0 to 100	(1)
BLWR_4005_01_MV1	Start/Stop blower air	Blower animated	99	---	---	---
BLWR_4005_01_MV1_OP	Start/Stop blower in manual mode	User Input	157	---	---	---
BLWR_4005_01_MV2	Speed of Blower air	Analogue indicator	400246	(%)	0 to 100	(1)
BLWR_4005_01_MV2_OP	Speed of Blower air in manual mode	User Input	400220	(%)	0 to 100	(1)
HX_4005_02_MV1	Electrical resistance	Resistance animated	100	---	---	---

Tag Name	Description	Type	HMI address	Units	Range	Digits precision
HX_4005_02_OP	Start/Stop electrical resistor in manual mode	User Input	159	---	---	---
PP_4005_01_MV1	Reactor temperature control pump	Pump animated	102	---	---	---
PP_4005_01_OP	Start/Stop pump in manual mode	User Input	158	---	---	---
SV_4005_01_FB	Cooling water outlet valve	2-way valve animated	100086	---	---	---
SV_4005_01_OP	Activate valve in manual mode	User Input	160	---	---	---
TT_4005_01	Reactor temperature	Analogue indicator	400168	(ºC)	0 to 150	(1)
TT_4005_01_SP	Reactor temperature set point	User Input	400222	(ºC)	0 to 150	(1)
AT_4006_01	pH	Analogue indicator	400138	(pH)	0 to 12	(2)
AT_4006_02	pH	Analogue indicator	400142	(pH)	0 to 12	(2)
AT_4006_AVG	pH average	Analogue indicator	400318	(pH)	0 to 12	(2)
AT_4006_SP	pH Set Point	User Input	400224	(pH)	0 to 12	(2)
PP_4006_01_MV1	Start/Stop acid pump	Pump animated	98	---	---	---
PP_4006_01_OP	Start/Stop acid pump in manual mode	User input	164	---	---	---
PP_4006_02_MV1	Start/Stop base pump	Pump animated	97	---	---	---
PP_4006_02_OP	Start/Stop base pump in manual mode	User Input	165	---	---	---
SV_4006_01_FB	Acid inlet valve to reactor	2-way valve animated	100091	---	---	---
SV_4006_01_OP	Activate/Deactivate valve in manual mode	User input	162	---	---	---
SV_4006_02_FB	Base inlet valve to reactor	2-way valve animated	100092	---	---	---
SV_4006_02_OP	Activate/Deactivate valve in manual mode	User Input	163	---	---	---
TT_4006_01	pH probe Temperature	Analogue indicator	400140	(ºC)	0 to 140	(1)
TT_4006_02	pH probe Temperature	Analogue indicator	400144	(ºC)	0 to 140	(1)
WT_4006_01	Acid balance	Analogue indicator	400264	(Kg.)	0 to 6	(3)
WT_4006_02	Base balance	Analogue indicator	400266	(Kg.)	0 to 6	(3)
CL4006_ACID_OP_Time	ACID time for injection	User Input	400370	(seconds)	1000	1
CL4006_Acid_Opening_Time	Acid injection time (seconds)	Analogue indicator	400314	(seconds)		1
CL4006_BASE_OP_Time	BASE time for injection	User Input	400372	(seconds)	1000	1
CL4006_Base_Opening_Time	Base injection time (seconds)	Analogue indicator	400312	(seconds)		1
CL4006_pH_Day	Date of the last reset done	Analogue indicator	400425	(day)	1 to 31	1
CL4006_PH_DEADZONE	pH Dead Zone	User Input	400316	(pH=	0 to 1	0.03

Tag Name	Description	Type	HMI address	Units	Range	Digits precision
CL4006_pH_Hour	Date of the last reset done	Analogue indicator	400424	(hour)	0 to 23	1
CL4006_pH_Minute	Date of the last reset done	Analogue indicator	400423	(minute)	0 to 59	1
CL4006_pH_Month	Date of the last reset done	Analogue indicator	400426	(month)	1 to 12	1
CL4006_pH_Reset_timer	Reset of the pH timer	User Input	326	---	---	---
CL4006_pH_Second	Date of the last reset done	Analogue indicator	400422	(seconds)	0 to 59	1
CL4006_pH_Year	Date of the last reset done	Analogue indicator	400427	(year)	9 to 99	1
PT_4007_01	Reactor pressure	Analogue indicator	400156	(mBar)	-1000 to 1500	(0)
PT_4007_02	Reactor pressure	Analogue indicator	400158	(mBar)	-1000 to 1500	(0)
PT_4007_SP	Pressure Set Point	User input	400226	(mBar)	-1000 to 1500	(0)
WT_4008_01	Reactor Weight	Analogue indicator	400154	(Kg.)	0 to 100	(1)
WT_4008_SP	Reactor level Set Point	User Input	400228	(Kg.)	0 to 100	(1)
AT_4009_01	Biomass concentration	Analogue indicator	400124	(g/l)	0 to 5	(3)
AT_4009_02	Biomass concentration	Analogue indicator	400126	(g/l)	0 to 5	(3)
AT_4009_AVG	Biomass Average	Analogue indicator	400310	(g/l)	0 to 5	(3)
AT_4009_SENSORFAILURE	Biomass sensor error	Digital indicator	273	---	---	---
CL4009_BIOMASS_PRODUCTION	Biomass production	Analogue indicator	400230	(g/H)	TBD	(2)
AT_4010_01	CO2 analyser	Analogue indicator	400130	(ppm)	0 to 5000	(2)
AT_4010_02	O2 analyser	Analogue indicator	400132	(%)	0 to 25	(2)
AT_4010_03	Dissolved O2	Analogue indicator	400134	(%)	0 to 100	(2)
PT_4010_01	Outlet Gas Pressure	Analogue indicator	400160	(mBar)	-1000 to 5000	(0)
CL4010_O2_SP	O2 Set Point	User input	400320	(%)	0 to 25	(2)
HX_4010_01_MV1	Post condenser	Condenser animated	111	---	---	---
TT_4010_01	Analyser temperature	Analogue indicator	400172	(ºC)	0 to 150	(1)
TT_4010_02	Dissolved O2 probe temperature	Analogue indicator	400136	(ºC)	0 to 70	(1)
SV_4010_01_FB	Gas inlet analyser valve	2-way valve animated	100093	---	---	---
SV_4010_01_OP	Activate valve in manual mode	User input	333	---	---	---
TT_4011_01	Feeding tank temperature	Analogue	400170	(ºC)	-10 to	(1)

Tag Name	Description	Type	HMI address	Units	Range	Digits precision
		indicator			150	
TT_4011_SP	Feeding tank temperature set point	User Input	400234	(ºC)	-10 to 150	(1)
SV_4011_01_FB	Feeding tank cooling water valve	2-way valve animated	100087	---	---	---
SV_4011_01_OP	Activate/Deactivate valve in manual mode	User input	168	---	---	---
TT_4012_01	Harvesting tank temperature	Analogue indicator	400174	(ºC)	-50 to 250	(1)
TT_4012_SP	Harvesting tank temperature set point	User input	400236	(ºC)	-50 to 250	(1)
SV_4012_01_FB	Harvesting tank cooling water valve	2-way valve animated	100089	---	---	----
SV_4012_01_OP	Activate/Deactivate valve in manual mode	User Input	169	---	---	---
LS_4013_01	Foam detection	Digital indicator	100081	---	---	---
SV_4014_01_FB	Feeding tank steam inlet valve	2-way valve animated	100088	---	---	---
SV_4014_01_OP	Activate/Deactivate valve in manual mode	User Input	327	---	---	---
SV_4015_01_FB	Reactor steam inlet valve	2-way valve animated	100098	---	---	---
SV_4015_01_OP	Activate/Deactivate valve in manual mode	User Input	328	---	---	---
SV_4016_01_FB	Harvesting tank steam inlet valve	2-way valve animated	100090	---	---	---
SV_4016_01_OP	Activate/Deactivate valve in manual mode	User Input	329	---	---	---

MELISSA CIVa LOCAL HMI DESIGN

FOR THE

MELISSA CS CIVP2 Project

APPROVAL LIST		
NAME	SIGNATURE	DATE
Prepared by: J.Carbonell		30/04/2010
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CHANGE RECORD			
AUTHOR	ISSUE	DATE	CHANGE
J.Carbonell	1.0	19/11/2009	First Version
J.Carbonell	1.1	30/04/2010	Update reference documents table. Update Magelis screens to version 5.1.

CONTENTS

ACRONYMS LIST

CIVa	Compartment IVa
HMI	Human Machine Interface
I/O	Input / Output
MELiSSA	Micro-Ecological Life Support System Alternative
MPP	Melissa Pilot Plant
PLC	Programmable Logic Controller
SP	Set-Point

1. SCOPE

This document describes the design of the CIVa Local HMI screens implemented with Magelis Software. The screen design has been derived from Sherpa specifications in [R1]. The work developed herein describes the variables (pressure, temperature, pH, etc) as well as the tools and the instrumentation in Compartment CIVa that will be monitored through the Magelis touch-screen as well as to know the entire system status.

2. REFERENCE DOCUMENTS

2.1 APPLICABLE DOCUMENTS

Ref	Title	Reference	Issue	Date
[A1]	NTE Offer for update CIVa PLC control cabinet and CIVa HMI	NTE-CIVaP2-OF-001	1.0	Mar.2009
[A2]	MPP rules for tags and labelling	TN 78.72	2.0	Sept. 2008

2.2 REFERENCE DOCUMENTS

Ref	Title	Reference	Issue	Date
[R1]	CIVa_PLC_HMI_20100317.xls			17/03/2010
[R2]	TN20.1: MELISSA CIVa, technical requirements of the control system	Sherpa	1.0	No data specified
[R3]	P&ID diagram and control	DD-8558-Z1-100-02	Rev.13	13/04/2010

3. LOCAL HMI SCREENS

3.1 Screens Hierarchy:

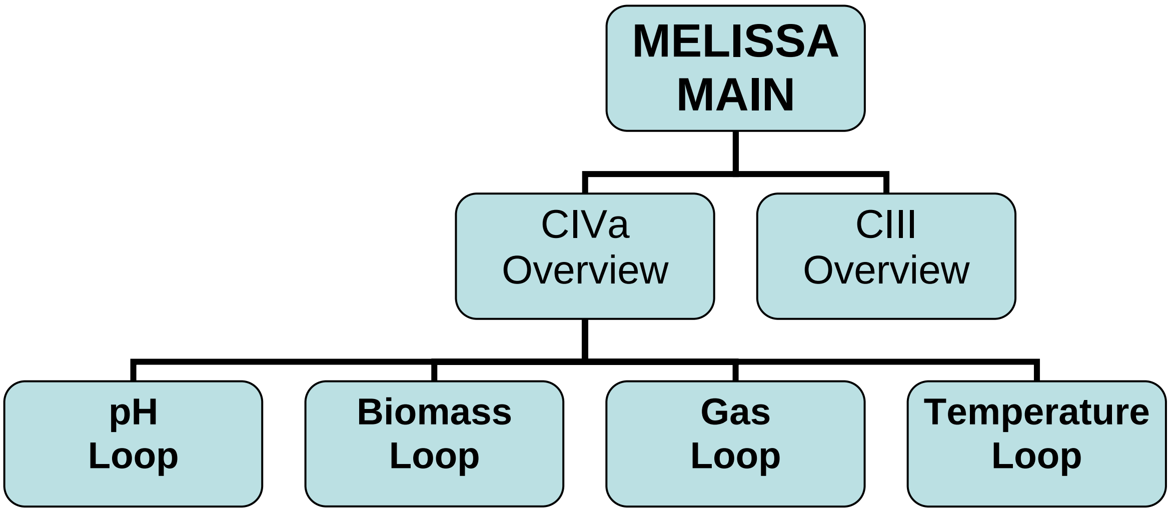


Figure 3-1: Interface architecture

The local HMI will allow the user to interact with the PLC. Through the HMI the user can check and monitor the system operation; however the user won't be able to modify control settings of the compartment from it.

Figure *3-1* shows the general hierarchy of the CIVa screens. The user can navigate through these screens in order to monitor the different loops implemented in the reactor. This tree establishes the logical relations among the screens. The MELiSSA Main displays general parameters from the CIII and CIVa reactors. In the next level, as can be seen in *Figure 3-3*, the main CIVa screen will show an overview of the most significant values of the CIVa. From there, the user will be able to navigate to the third level screens that represent the different loops in the CIVa: pH, Biomass, Gas and Temperature.

3.2 Melissa Main Screen

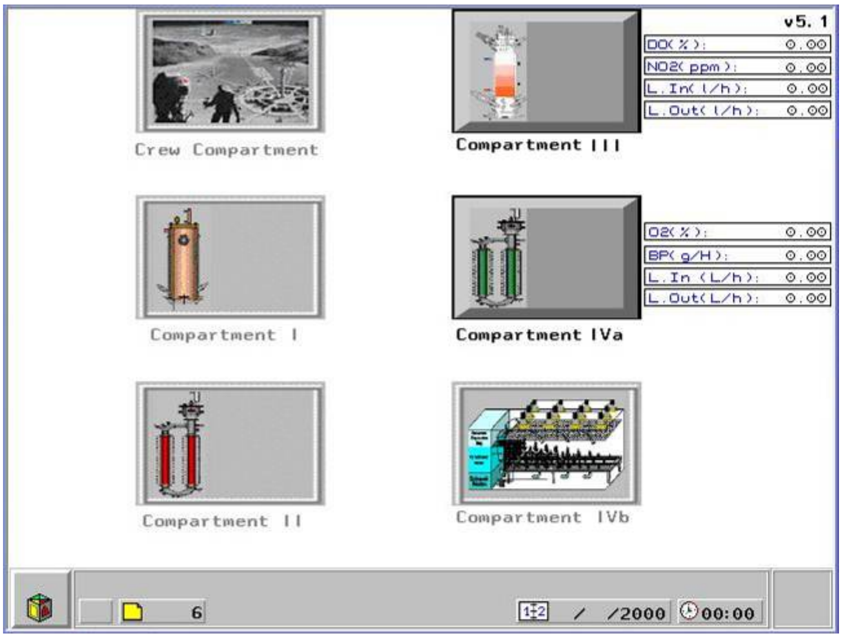


Figure 3-2: Melissa Main Screen

Melissa main screen is the default screen displayed when Magelis device is turn on. From this screen the user can access to the Compartment IVa and III screens. In this screen are displayed the most significant readings of each compartment.

3.2.1 Tag definition

The following tags are displayed in this screen.

Tag Name	Description	Type	HMI address	Units	Range
FT_3003_01	Feeding flow	Analogue	400080	(L/h)	0 to 2
AT_3009_02	Dissolved O_2	Analogue	400124	(%)	0 to 100
AT_3013_03	NO_2 analyser	Analogue	400148	(ppm)	0 to 20
FT_3018_01	Harvest flow	Analogue	400156	(L/h)	0 to 2
FT_4001_01	Inlet liquid flow to reactor	Analogue	400148	(L/h)	0 to 4
CL4002_PumpSpeed	Flow to the outlet pump	Analogue	400254	(%)	0 to 100
CL4009_Biomass_Production	Biomass Production	Analogue	400230	(g/H)	
AT_4010_02	O_2 Analyser	Analogue	400132	(%)	0 to 25

3.3 Overview of the CIVa complete system screen

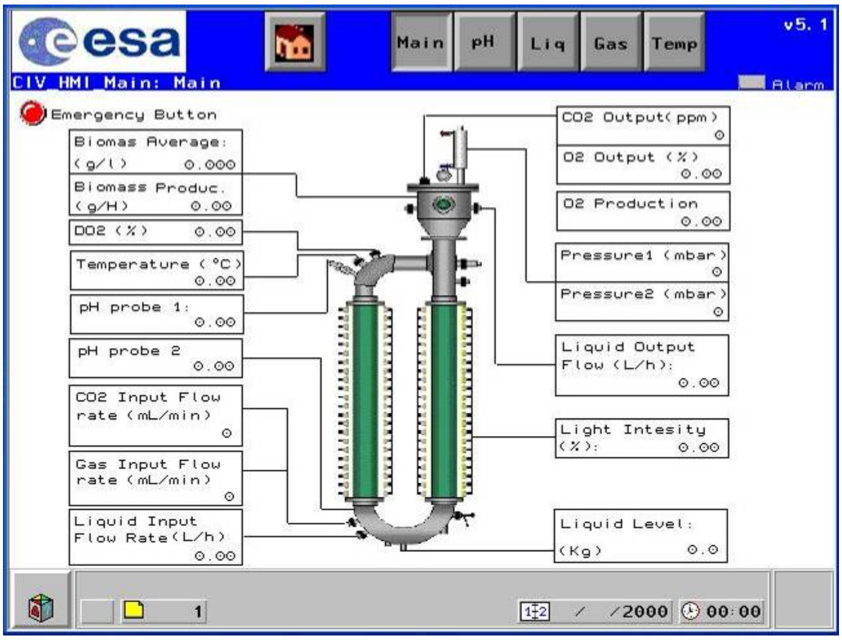


Figure 3-3: CIVa Main Screen

To have a general overview of the Compartment CIVa, a general schematic will appear in the computer display when user opens the CIVa system. The diagram that represents the overview of the system will be something similar as shown in Figure 3-3. From this screen the user can navigate to the other CIVa screens (pH, Biomass, Gas and Temperature). For instance, if the user calls the pH screen, a diagram of this unit will come into view and its instrumentation (valves, pumps, tanks, etc) can be distinguished as well as the different values of the variables that allow controlling it.

3.3.1 Tag definition

The following tags are displayed in this screen.

Tag Name	Description	Type	HMI address	Units	Range
IRC_4000_MV	Light intensity	Analogue	400262	(%)	0 to 100
FT_4001_01	Inlet liquid flow to reactor	Analogue	400148	(L/h)	0 to 4
CL4002_EstimatedOutletLiquidFlow	Estimated Outlet Liquid flow	Analogue	400326	(L/h)	TBD
FQRC_4003_01	Total mass flow CO2 inlet	Analogue	400176	(mL/min)	0 to 5000
FQRC_4003_04	Total mass flow air inlet	Analogue	400182	(mL/min)	0 to 30000
TT_4005_01	Reactor temperature	Analogue	400168	(ºC)	0 to 150
AT_4006_01	pH sensor	Analogue	400138	(pH)	0 to 12
AT_4006_02	pH sensor	Analogue	400140	(pH)	0 to 12
PT_4007_01	Reactor pressure	Analogue	400156	(mBar)	-1000 to 1500
PT_4007_02	Reactor pressure	Analogue	400158	(mBar)	-1000 to 5000
AT_4009_01	Biomass concentration	Analogue	400124	(g/l)	0 to 5

Tag Name	Description	Type	HMI address	Units	Range
AT_4009_02	Biomass concentration	Analogue	400126	(g/l)	0 to 5
CL4009_Biomass_Production	Biomass production	Analogue	400230	(g/H)	
AT_4010_01	CO2 Analyser	Analogue	400130	(ppm)	0 to 5000
AT_4010_02	O2 Analyser	Analogue	400132	(%)	0 to 25
AT_4010_03	Dissolved O2	Analogue	400134	(%)	0 to 100
CL4010_O2_PRODUCTION	Oxygen production	Analogue	400328	TBD	TBD
CIVa_Emergency_button	Emergency button pushed	Digital indicator	100111	---	---
CIVa_General_Alarm_status	CIVa general alarm status	Digital indicator	400279	---	---

Table 3-1 Tags of the CIVa system main screen

3.4 CIVa Biomass control screen

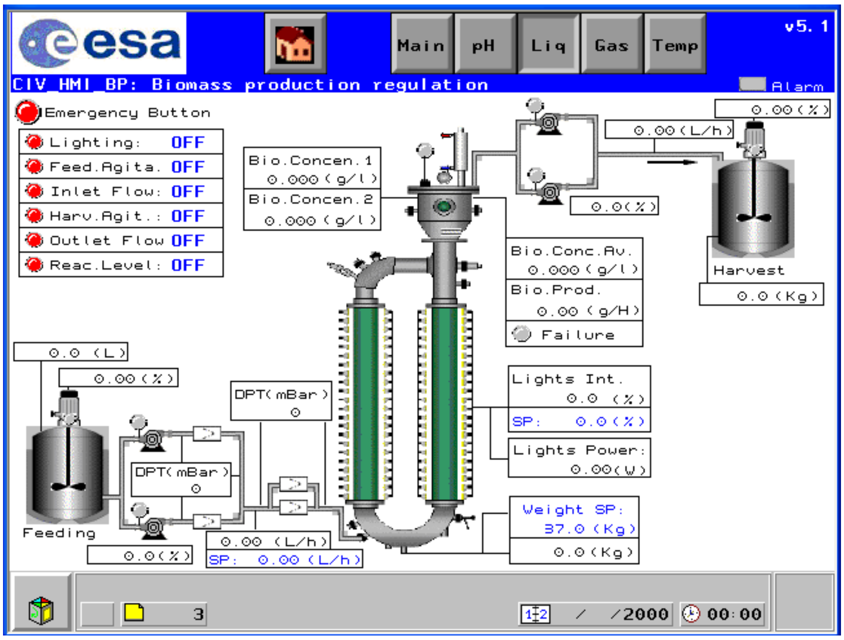


Figure 3-4: Main objects in CIVa Biomass production screen

The diagram that represents the Biomass production control of the system will be something similar as shown in *Figure 3-4*.
Navigating this screen the user will be able to:

- Monitor the measurements of the liquid level of the reactor, the level of input and output tank, the state and speed of the feeding and harvest tanks agitators, the input/output flow rates, biomass concentration, biomass production, input/output differential pressure and lights intensity.
- Monitor the Set-Points of the reactor level and biomass concentration.
- Monitor the emergency button indicator. Background colour switch to red when one of the Emergency buttons is pushed.
- Monitor the control loops mode (OFF, AUTO, MAN) implemented in the screen.

3.4.1 Control Loops

The following control loops are implemented on the screen:

Tag Name	Description	HMI address
CL4000_ControlLoop_Mode	Lighting Mode	400268
CL4001_Agitator_Mode	Feeding Agitator Mode	400270
CL4001_Flow_Mode	Inlet flow mode	400272
CL4002_Agitator_Mode	Harvest Agitator Mode	400274
CL4002_ControlLoop_Mode	Outlet flow mode	400276
CL4008_ControlLoop_Mode	Reactor level mode	400294

Table 3-2 Control Loops of the Biomass loop of CIVa system

3.4.2 Tag definition

The following tags are displayed in this screen.

Tag Name	Description	Type	HMI address	Units	Range
IRC_4000_MV	Light intensity (%)	Analogue indicator	400262	(%)	0 to 100
IT_4000_PWR	Lights power (W)	Analogue indicator	400190	(W)	
I_4000_SP	Light intensity set point	Analogue indicator	400192	(%)	0 to 100
LT_4001_01	Feeding tank level	Analogue indicator	400150	(L)	0 to 160
FT_4001_01	Liquid inlet flow to reactor	Analogue indicator	400148	(L/h)	0 to 4
FT_4001_01_SP	Liquid inlet flow rate set point	Analogue indicator	400304	(L/h)	0 to 4
DPT_4001_01	Differential pressure filter	Analogue indicator	400162	(mBar)	0 to 3000
DPT_4001_02	Differential pressure filter	Analogue indicator	400164	(mBar)	0 to 3000
GP_4001_01_MV1	Feeding pump state	Pump animated	000091	(%)	0 to 100
GP_4001_02_MV1	Feeding pump state	Pump animated	000090	(%)	0 to 100
GP_4001_03_MV1	Feeding tank agitator state	Digital indicator	000101	---	---
GP_4001_03_MV2	Feeding tank agitator speed	Analogue indicator	400258	(%)	0 to 100
CL4001_PumpSpeed	Flow to the inlet pump	Analogue indicator	400250	(%)	0 to 100
PS_4001_01	Pressure pump GP_4001_01	Pressure switch animated	100082	---	---
PS_4001_02	Pressure pump GP_4001_02	Pressure switch animated	100083	---	---
GP_4002_01_MV1	Harvest pump state	Pump animated	000089	---	---
GP_4002_02_MV1	Harvest pump state	Pump animated	000104	---	---
GP_4002_03_MV1	Harvest agitator state	Agitator animated	000100	---	---
GP_4002_03_MV2	Speed of harvest agitator	Analogue indicator	400260	(%)	0 to 100
CL4002_PumpSpeed	Flow to the outlet pump	Analogue indicator	400254	(%)	0 to 100
PS_4002_01	Harvest pump pressure	Pressure switch indicator	100084	---	---
PS_4002_02	Harvest pump pressure	Pressure switch indicator	100085	---	---
WT_4002_01	Weight harvest tank	Analogue indicator	400152	(Kg.)	0 to 600
CL4002_EstimatedOutletLiquid Flow	Estimated Outlet Liquid Flow	Analogue indicator	400326	(L/h)	TBD

Tag Name	Description	Type	HMI address	Units	Range
WT_4008_01	Weight Balance (reactor)	Analogue indicator	400154	(Kg.)	0 to 100
WT_4008_SP	Weight balance set point	Analogue indicator	400228	(Kg.)	0 to 100
CL4009_Biomass_production	Biomass production (g/l/h)	Analogue indicator	400230	(g/H)	
AT_4009_01	Biomass concentration (g/l)	Analogue indicator	400124	(g/l)	0 to 5
AT_4009_02	Biomass concentration (g/l)	Analogue indicator	400126	(g/l)	0 to 5
AT_4009_AVG	Biomass concentration average (g/l)	Analogue indicator	400310	(g/l)	0 to 5
AT_4009_SensorFailure	Indicates if biomass probe is failure	Analogue indicator	000273	---	---
LS_4013_01	Foam detection	Switch detection	100081	---	---
CIVa_Emergency_button	Emergency button pushed	Digital indicator	100111	---	---
CIVa_General_Alarm_status	Indicates if there is some alarm activated.	Digital indicator	400279	---	---

Table 3-3 Tags of the Biomass production screen of CIVa system

3.5 CIVa Gas Loop screen

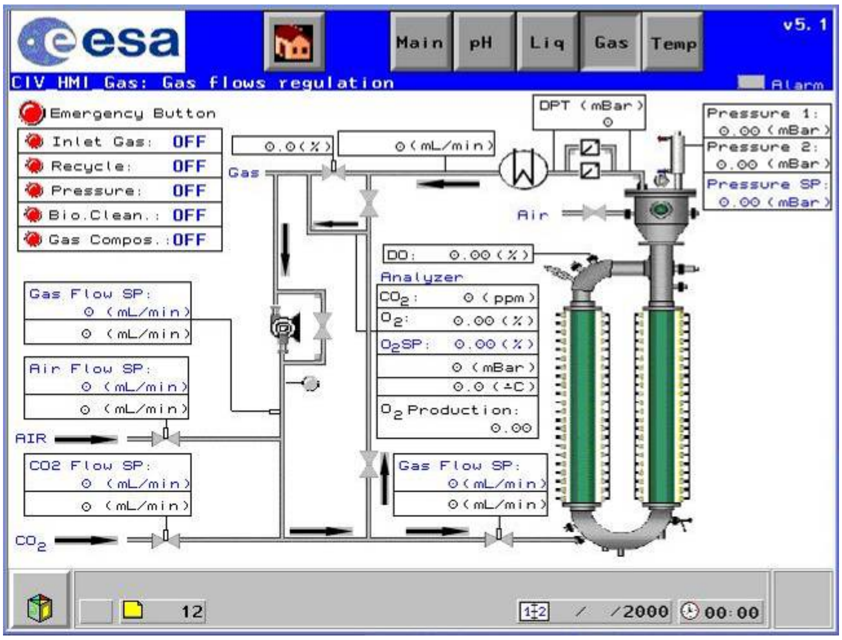


Figure 3-5: Main objects in CIII Gas Screen

The diagram that represents the Gas loop of the system will be something similar as shown in *Figure 3-5*.

Navigating this screen the user will be able to:

- Monitor the Air flow, the CO_2 gas flow, total gas flow inlet, total gas flow outlet, outlet gas pressure, outlet gas composition (CO_2 and O_2), reactor pressure and pressure switch state.
- Monitor the set-points of CO_2 input flow, air input flow, total gas input flow, total gas output flow, reactor pressure and oxygen dissolved.
- Monitor the emergency button indicator. Background colour switch to red when one of the Emergency buttons is pushed.
- Monitor the control loops mode (OFF, AUTO, MAN) implemented in the screen.

3.5.1 Control Loops

The following control loops are implemented on the screen:

Tag Name	Description	HMI address
CL4003_ControlLoop_Mode	Air inlet mode	400280
CL4003_Recycle_Mode	Recycle mode	400278
CL4007_ControlLoop_Mode	Pressure mode	400292
CL4009_Biomass_Cleaning_Mode	Biomass cleaning mode	400296
CL4010_ControlLoop_Mode	Outlet gas composition mode	400275

Table 3-4 Control Loops of the Gas loop of CIVa system

3.5.2 Tag definition

The following tags are displayed in this screen.

Tag Name	Description	Type	HMI address	Units	Range
FQRC_4003_01_SP	Mass flow CO2 inlet set point	Analogue indicator	400238	(mL/min)	0 to 5000
FQRC_4003_01	Mass flow CO2 inlet	Analogue indicator	400176	(mL/min)	0 to 50000
FQRC_4003_02	Mass flow air inlet	Analogue indicator	400178	(mL/min)	0 to 30000
FQRC_4003_02_SP	Mass flow Air inlet set point	Analogue indicator	400240	(mL/min)	0 to 30000
FQRC_4003_03_SP	Mass flow circulated air set point	Analogue indicator	400242	(mL/min)	0 to 30000
FQRC_4003_03	Mass flow circulated air.	Analogue indicator	400180	(mL/min)	0 to 30000
FQRC_4003_02_SP	Mass flow Air inlet set point	Analogue indicator	400240	(mL/min)	0 to 30000
FQRC_4003_04_SP	Total mass flow air inlet set point	Analogue indicator	400244	(mL/min)	0 to 30000
FQRC_4003_04	Total mass flow air inlet	Analogue indicator	400182	(mL/min)	0 to 30000
SV_4003_01_FB	Analyser gas inlet valve	2-way valve animated	100097	---	---
SV_4003_02_FB	Reactor Air Inlet	2-way valve animated	100095	---	---
SV_4003_03_FB	Circulated gas blower bypass valve	2-way valve animated	100094	---	---
BLWR_4003_01_MV1	Blower state	Blower animated	000103	---	---
PS_4003_01	Pressure switch bypass for recycling	Pressure switch animated	100110	---	---
FT_4004_01	Total air outlet from reactor.	Analogue indicator	400146	(mL/min)	0 to 20000
DPT_4004_01	Differential pressure filter	Analogue indicator	400166	(mBar)	0 to 3000
SCV_4004_01_MV	Flow control air outlet valve	Analogue indicator	400248	(%)	0 to 100
PT_4007_01_SP	Pressure set point	Analogue indicator	400226	(mBar)	-1000 to 1500
PT_4007_01	Reactor pressure	Analogue indicator	400156	(mBar)	-1000 to 1500
PT_4007_02	Reactor pressure	Analogue indicator	400158	(mBar)	-1000 to 5000
PT_4010_01	Outlet gas pressure	Analogue indicator	400160	(mBar)	-1000 to 5000
AT_4010_01	CO2 analyzer	Analogue indicator	400130	(ppm)	0 to 5000

Tag Name	Description	Type	HMI address	Units	Range
AT_4010_02	O2 analyzer	Analogue indicator	400132	(%)	0 to 25
AT_4010_03	Dissolved O2	Analogue indicator	400134	(%)	0 to 100
CL4010_O2_SP	O2 set point	Analogue indicator	400320	(%)	0 to 25
TT_4010_01	Temperature of the gas analyzer	Analogue indicator	400172	(ºC)	0 to 150
CL4010_O2_Production	Oxygen production	Analogue indicator	400328	TBD	TBD
SV_4010_01_FB	Gas inlet analyzer valve	2-way valve animated	100093	---	---
HX_4010_01	Exchanger post condenser state	Exchanger animated	000111	---	---
CIVa_Emergency_button	Emergency button pushed	Digital indicator	100111	---	---
CIVa_General_Alarm_status	Indicates if there is some alarm activated.	Digital indicator	400279	---	---

Table 3-5 Tags of the Gas loop of CIVa system

3.6 CIVa Temperature Loop screen

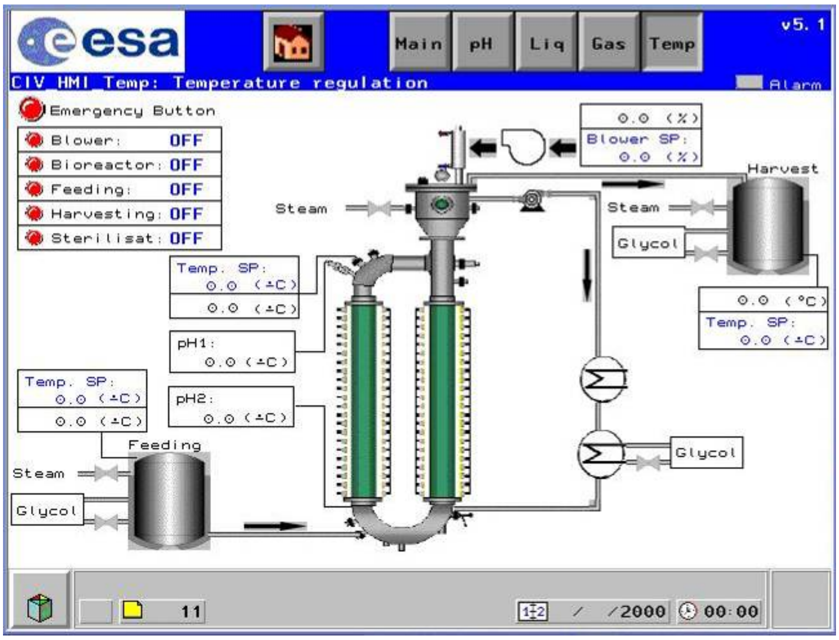


Figure 3-6: Main objects in CIVa Temperature Screen

The diagram that represents the Temperature loop of the system will be something similar as shown in Figure 3-6.
Navigating this screen the user will be able to:

- Monitor the temperature of the feeding tank, harvesting tank, reactor and blower speed.
- Monitor the temperature set-points of the feeding tank, harvest tank, reactor and speed of blower.

- Monitor the emergency button indicator. Background colour switch to red when one of the Emergency buttons is pushed.
- Monitor the control loops mode (OFF, AUTO, MAN) implemented in the screen.

3.6.1 Control Loops

The following control loops are implemented on the screen:

Tag Name	Description	HMI address
CL4005_Blower_Mode	Blower mode	400284
CL4005_ControlLoop_Mode	Temperature Mode	400286
CL4011_ControlLoop_Mode	Feeding tank temperature control	400300
CL4012_ControlLoop_Mode	Harvest tank temperature control	400302
CL4014_ControlLoop_Mode	Feeding tank sterilisation	400269
CL4015_ControlLoop_Mode	Reactor's tank sterilisation	400271
CL4016_ControlLoop_Mode	Harvesting tank sterilisation	400273

Table 3-6 Control Loops of the Temperature loop of CIVa system

3.6.2 Tag definition

The following tags are displayed in this screen

Tag Name	Description	Type	HMI address	Units	Range
TT_4005_01_SP	Reactor temperature set point	Analogue indicator	400222	(ºC)	0 to 150
TT_4005_01	Reactor temperature	Analogue indicator	400168	(ºC)	0 to 150
BLWR_4005_01_MV1	Blower state	Blower animated	000099	---	---
BLWR_4005_01_MV2	Blower speed	Analogue indicator	400246	(%)	0 to 100
BLWR_4005_01_MV2_OP	Blower speed set point	Analogue indicator	400220	(%)	0 to 100
SV_4005_01_FB	Cooling water outlet valve	2-way valve animated	100086	---	---
PP_4005_01_MV1	Peristaltic pump state	Pump animated	000102	---	---
HX_4005_02_MV1	Electrical resistance state	Exchanger animated	000112	---	---
TT_4006_01	Temperature of the pH probe (AT_4006_01)	Analogue indicator	400140	(ºC)	0 to 140
TT_4006_02	Temperature of the pH probe (AT_4006_02)	Analogue indicator	400144	(ºC)	0 to 140

Tag Name	Description	Type	HMI address	Units	Range
TT_4011_SP	Feeding tank temperature set point	Analogue indicator	400234	(ºC)	-10 to 150
TT_4011_01	Feeding tank temperature	Analogue indicator	400170	(ºC)	-10 to 150
SV_4011_01_FB	Cooling water outlet valve	2-way valve animated	100087	---	---
TT_4012_SP	Harvest tank temperature set point	Analogue indicator	400236	(ºC)	-50 to 250
TT_4012_01	Harvest temperature	Analogue indicator	400174	(ºC)	-50 to 250
SV_4012_01_FB	Cooling water outlet valve	2-way valve animated	100089	---	---
SV_4014_01_FB	Steam inlet valve	2-way valve animated	100088	---	---
SV_4015_01_FB	Steam inlet valve	2-way valve animated	100098	---	---
SV_4016_01_FB	Steam inlet valve	2-way valve animated	100090	---	---
CIVa_Emergency_button	Emergency button pushed	Digital indicator	100111	---	---
CIVa_General_Alarm_status	Indicates if there is some alarm activated.	Digital indicator	400279	---	---

Table 3-7 Tags of the Temperature loop of CIVa system

3.7 CIVa pH Loop screen

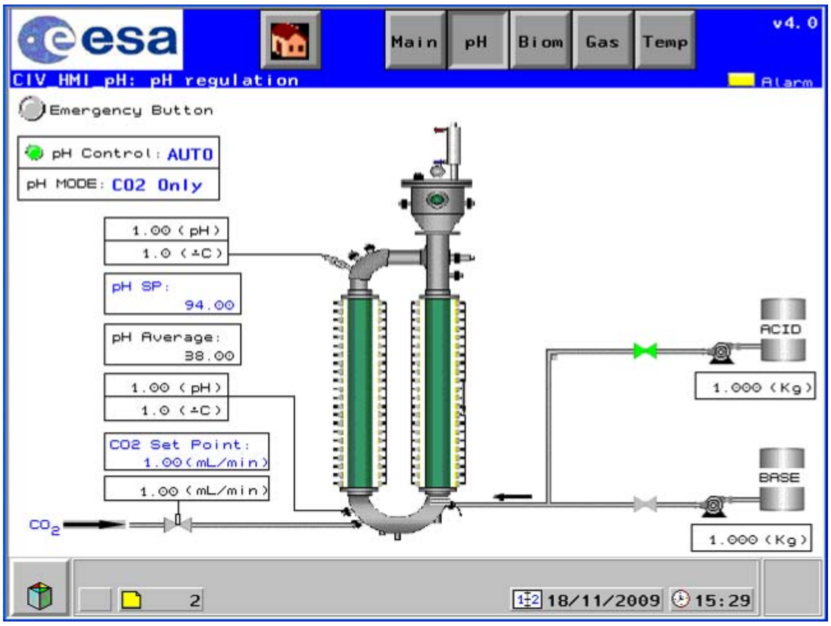


Figure 3-7: Main objects in CIVa pH Screen

The diagram that represents the pH loop of the system will be something similar as shown in Figure 3-7.

Navigating this screen the user will be able to:

- Monitor the pH values and the temperature of each pH sensor.
- Monitor the weight of acid and base vessels.
- Monitor the CO_2 flow.
- Monitor the pH set-point.
- Monitor the emergency button indicator. Background colour switch to red when one of the Emergency buttons is pushed.
- Monitor the control loops mode (OFF, AUTO, MAN) implemented in the screen.
- Monitor the pH mode for the bioreactor pH control (CO2 Only, CO2+base or Acid+base).

3.7.1 Control Loops

The following control loops are implemented on the screen:

Tag Name	Description	HMI address
CL4006_Control_Mode	pH control mode	400290

Table 3-8 Control Loops of the pH loop of CIVa system

3.7.2 Tag definition

The following tags are displayed in this screen.

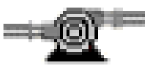
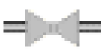
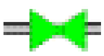
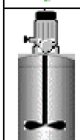
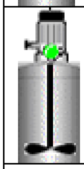
Tag Name	Description	Type	HMI address	Units	Range
FQRC_4003_01_SP	Mass flow CO2 inlet set point	Analogue indicator	400238	(mL/min)	0 to 5000
FQRC_4003_01	Mass flow CO2 inlet	Analogue indicator	400176	(mL/min)	0 to 5000
AT_4006_SP	pH set point	Analogue indicator	400224	(pH)	0 to 12
AT_4006_01	pH probe	Analogue indicator	400138	(pH)	0 to 12
TT_4006_01	Temperature of the pH probe (AT_4006_01)	Analogue indicator	400140	(ºC)	0 to 140
AT_4006_02	pH probe	Analogue indicator	400142	(pH)	0 to 12
TT_4006_02	Temperature of the pH probe (AT_4006_02)	Analogue indicator	400144	(ºC)	0 to 140
AT_4006_AVG	pH average	Analogue indicator	400318	(pH)	0 to 12
WT_4006_01	Acid vessel weight	Analogue indicator	400264	(Kg.)	0 to 6
WT_4006_02	Base vessel weight	Analogue indicator	400266	(Kg.)	0 to 6
PP_4006_01_MV1	Acid peristaltic pump	Pump animated	000098	---	---
PP_4006_02_MV1	Base peristaltic pump	Pump animated	000097	---	---
SV_4006_01_FB	Acid valve	2-way valve animated	100091	---	---
SV_4006_02_FB	Base valve	2-way valve animated	100092	---	---

Tag Name	Description	Type	HMI address	Units	Range
CL4006_pH_Mode	Mode of regulation (CO2 only, CO2+Base or Acid+Base)	Text animated	400288	---	---
CIVa_Emergency_button	Emergency button pushed	Digital indicator	100111	----	---
CIVa_General_Alarm_status	Indicates if there is some alarm activated.	Digital indicator	400279	---	0 to 2

Table 3-9 Tags of the pH loop of CIVa system

4. CIVA MAGELIS SYMBOLS

Symbols shall be consistently used, that is, same symbol shall be used in all schematics to represent the same type of device.

Device symbol	Description	Events
	Emergency button state indicator	Not pushed
		Pushed
	Generic pump state indicator	Not activated
		Activated
	Control loop mode indicator	OFF: Control loop stopped
		AUTO: Control loop in automatic mode
		MAN: Control loop in manual mode
	Valve feedback indicator	Valve closed
		Valve open
	Agitator indicator	Agitator not activated
		Agitator activated
	pH mode indicator	CO2 only
		CO2 + Base
		Acid + Base

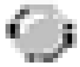
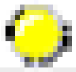
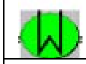
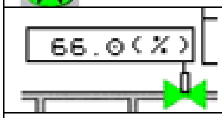
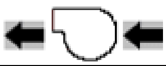
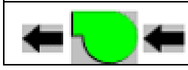
Device symbol	Description	Events
	Level and pressure switch indicator	Not activated
		Activated
	Analogue set point indicator	
	Analogue indicator (value and its units)	
	Flow Meter (value and its units)	
	Exchanger	Exchanger not activated
		Exchanger activated
	Proportional valve	
	Blower	Blower not activated
		Blower activated

Table 4-1 CIVa device symbol table

CIVa HMI SW USER MANUAL

FOR THE

MELISSA CS CIVaP2 Project

APPROVAL LIST		
NAME	SIGNATURE	DATE
Prepared by: J.Carbonell		30/04/2010
Revised by: J.Duatis		30/04/2010
Approved by: E.Creus		30/4/10
Authorised by: J.Duatis		30/04/2010

DISTRIBUTION LIST		
NAME	POSITION	COMPANY
O.Gerbi		SHERPA ENGINEERING
C.Bourg		SHERPA ENGINEERING
A.Fossen		MPP
E.Peiro		MPP
R.Moyano		MPP

CHANGE RECORD			
AUTHOR	ISSUE	DATE	CHANGE
J.Carbonell	1.0	03/08/2010	First Version
J.Carbonell	1.1	30/04/2010	Between parentheses the change as per discrepancies reported during the MPP meeting 22-04-2010. Updated reference documents table Removed from document the following sections: 4.8 Graph screen description 4.9 CSV Export data screen 4.10 Alarm screen 5 Master Control 6 Supervision Database 8 iFIX Security 9 Maintenance and Troubleshooting in favour of new NTE-CIVaP2-HB-011 user manual which contain all common HMI features. (EP-10) Update CIVa iFIX screens snapshots (*Figure 4-4, Figure 4-7, Figure 4-8, Figure 4-9, Figure 4-11, Figure 4-12, Figure 4-14*) to the latest version. Updated *Figure 4-8* according to review comment (CB-3). Update CIVa magelis screens snapshots (*Figure 5-1*, *Figure 5-4, Figure 5-5, Figure 5-6*) to version 5.1. Sorted tag tables (CB-9)

CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

1. SCOPE

The intention is that this document will provide a comprehensive guide of the Human Machine Interface (HMI) of the Compartment CIVa at the MELiSSA Pilot Plant (MPP). The work developed herein describes the functionalities of each screen, the variables (pressure, temperature, pH, etc) -warnings and alarms- as well as the tools and the instrumentation in Compartment CIVa that will be monitored and/ or controlled through the computer as well as to know the entire system status.

This Operations Manual is intended to help the operation and maintenance of the Control System Demonstrator for compartment IVa 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 Documents, [R4] and [R5] [R6] respectively.

1. REFERENCE DOCUMENTS

1.1 APPLICABLE DOCUMENTS

Ref	Title	Reference	Issue	Date
[A1]	NTE Offer for CIVa control cabinet and CIVa HMI	NTE-CIVaP2-OF-001	1.0	Mar.2009
[A2]	MPP rules for tags and labelling	TN 78.72	2.0	Sept. 2008

1.2 REFERENCE DOCUMENTS

Ref	Title	Reference	Issue	Date
[R1]	CIVa_PLC_HMI_20100317.xls	Sherpa		17/03/2010
[R2]	Functional Specifications	DeDietrich	Rev 5	04/02/2010
[R3]	P&ID Diagram & Control	DeDietrich	Rev 13	13/04/2010
[R4]	Melissa CIVa Control Cabinet Hardware Design Document	NTE-CIVaP2-RP-006	1.0	07/10/2009
[R5]	Melissa CIVa HMI design	NTE-CIVaP2-RP-007	1.2	30/04/2010
[R6]	Melissa CIVa Local HMI design	NTE-CIVP2-RP-003	1.1	30/04/2010
[R7]	Common HMI User Manual	NTE-CIVaP2-HB-011	1.0	30/04/2010

LIST OF ACRONYMS

CI	Compartment I
CII	Compartment II
CIII	Compartment III
CIVb-HPC1	High Plant Compartment
CIVa	Compartment IVa
CV	Compartment V (Crew)
HMI	Human Machine Interface
I/O	Input / Output
MELiSSA	Micro-Ecological Life Support System Alternative
MPP	Melissa Pilot Plant
PLC	Programmable Logic Controller
SP	Set-Point

2. INTRODUCTION

2.1 Intended Readership

This manual is intended for the 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.

2.2 Purpose

The purpose of this document is to provide the user with an understanding of the functions available in the MELISSA CIVa 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 CIVa HMI software utilisation.

2.3 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 [R7].

2.4 Problem reporting instructions

Problems found must be reported to NTE-SENER following the form included in APPENDIX B. Problem Report Form

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

3. OVERVIEW

Compartment CIVa has the objective to convert Nitrates and CO_2 into edible Biomass and O_2. It is based on a Photosynthetic reactor surrounded by an illumination system that consists of 350 halogen lamps. The process in this Compartment is carried out with *Arthrospira platensis*, photoautotrophic microscopic algae.

Its inputs are nitrate in liquid phase of the CIII and the gas outputs (CO_2) of the other compartments via a buffer tank in closed loop operation.

The output of the process is in the form of O_2 in gas phase and edible biomass in solid phase after harvesting of *Arthrospira*. O_2 is then used by CV and non edible part of the solid phase is intended to be reinjected into CI, along with some CIVa liquid phase output.

Figure 3-1: CIVa Frame

The CIVa main functions are:

- Produce O_2 from the liquid CIII output and the other compartments gas output.
- Produce edible biomass from the liquid CIII output and the CII or CI gas output.
- Allow for stable biomass production.
- Allow for phase separation of these outputs.
- Deliver gaseous O_2 to CIII and to the CV.
- Deliver edible biomass to crew (CV)

CIVa is, thus, differentiated in five control loops:

- Biomass Production Loop
  - **CL4000** Bioreactor lighting control
  - **CL4001** Inlet liquid flow control
  - **CL4002** Outlet liquid flow control
  - **CL4008** Bioreactor liquid level control
  - **CL4009** Bioreactor biomass production control
- pH Regulation Loop
  - **CL4006** Bioreactor pH control

- Temperature regulation Loop
  - **CL4005** Bioreactor temperature control
  - **CL4011** Feeding tank temperature control
  - **CL4012** Harvesting tank temperature control
  - **CL4014** Feeding tank sterilization
  - **CL4015** Bioreactor sterilization
  - **CL4016** Harvesting tank sterilization
- Gas regulation Loop
  - **CL4003** Inlet gas flow control
  - **CL4007** Bioreactor pressure control
- Anti-Foam Control Loop
  - **CL4013** Antifoam control

4. SCREENS

4.1 Screens Hierarchy

Supervision displays navigation is implemented as follows:

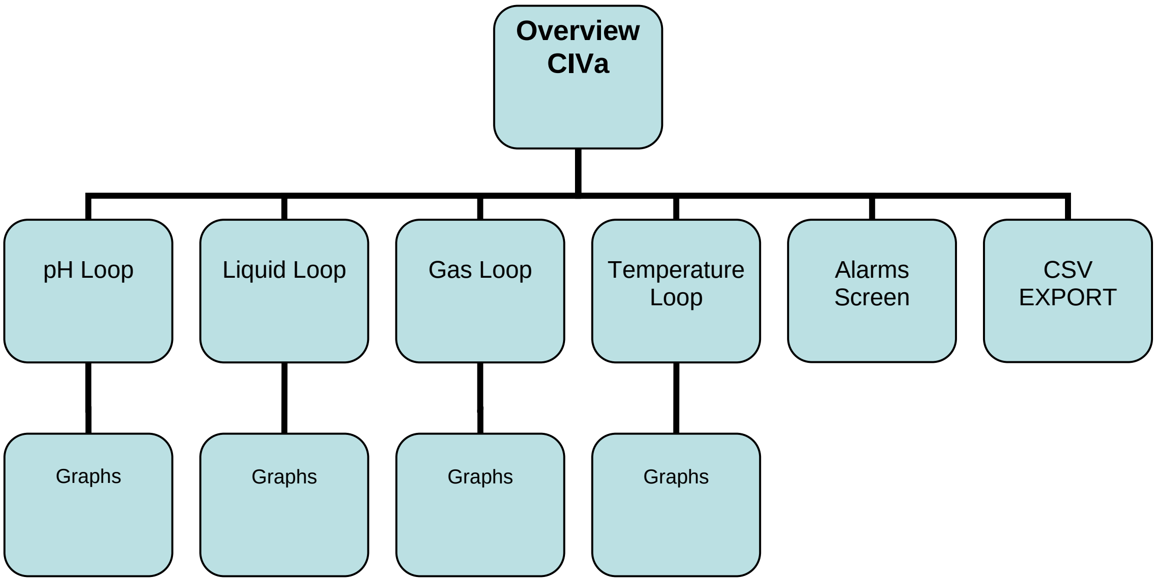


Figure 4-1: Display Hierarchy

The HMI allows the user to interact with the PLC. Through the HMI the user can check and monitor the system operation, furthermore the user can operate the compartment from it. Figure 4-1 shows the general structure of the different screens. These can be manipulated by the user in order to interact with the automation and control system. This map establishes the logical relations among the screens.

Therefore, following Figure 4-4, the main screen shows an overview of the complete system. From there, the user will be able to navigate through the screens of second level that represent the different loops in the CIVa: pH, Liquid, Gas and Temperature. From these screens the user can open graphs showing the history values of the different variables (pH, Temperature, Pressure, level, biomass production, gas production, etc). Furthermore, the user can open the alarms screen or CSV data export screen.

4.2 Melissa Main Screen

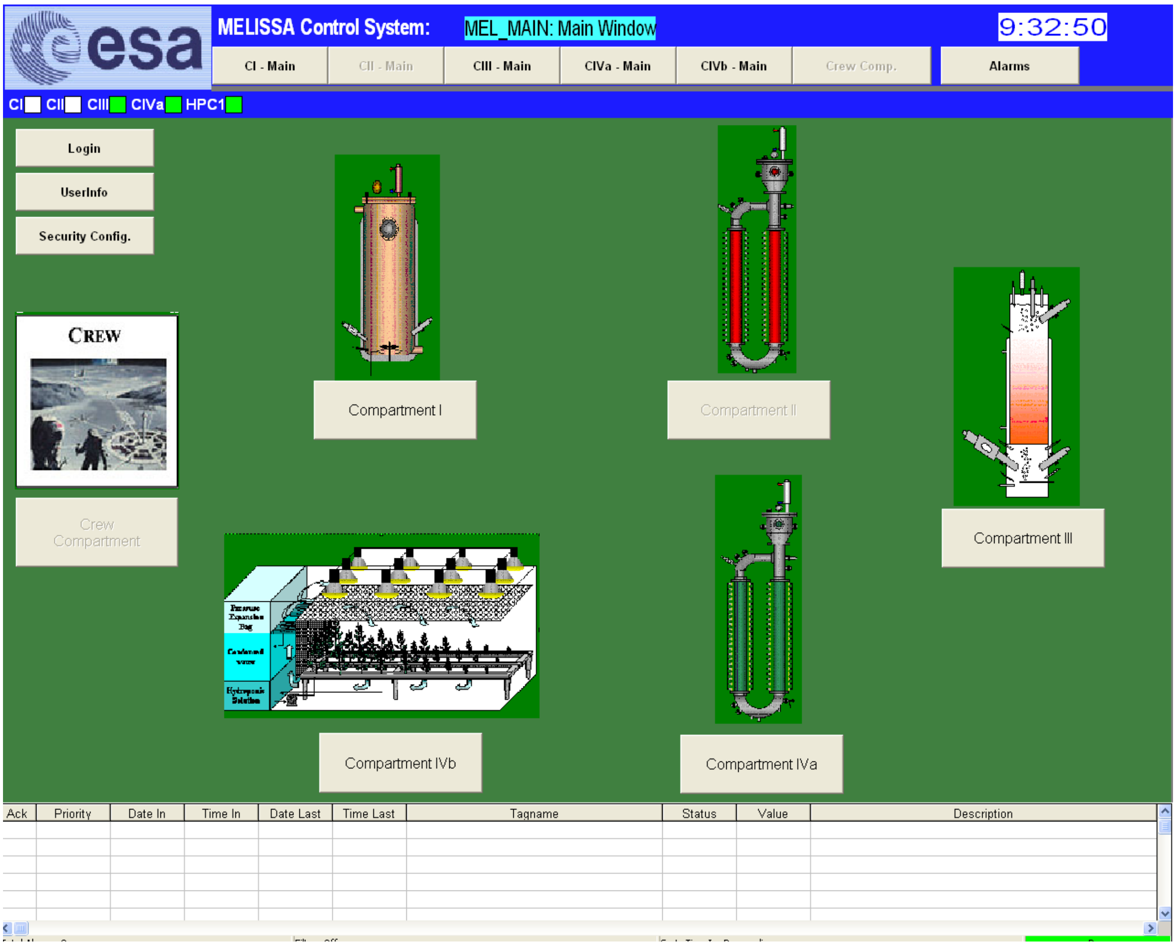


Figure 4-2: Melissa Main Window

In the Main Menu there are the general alarm indicators of 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.
- White: general alarms not implement in the compartment.

An example of the general alarm indicators is shown in the following picture, compartment CI and CII don't have general alarm indicator implemented (indicator in white), CIII has no alarm activated (indicator in green), in CIVa there is some level 1 alarm activated (indicator in yellow) and in the compartment CIVb HPC1 there is some level 2 alarm activated (indicator in red).

Figure 4-3: Global alarms

4.3 Compartment CIVa Main Screen

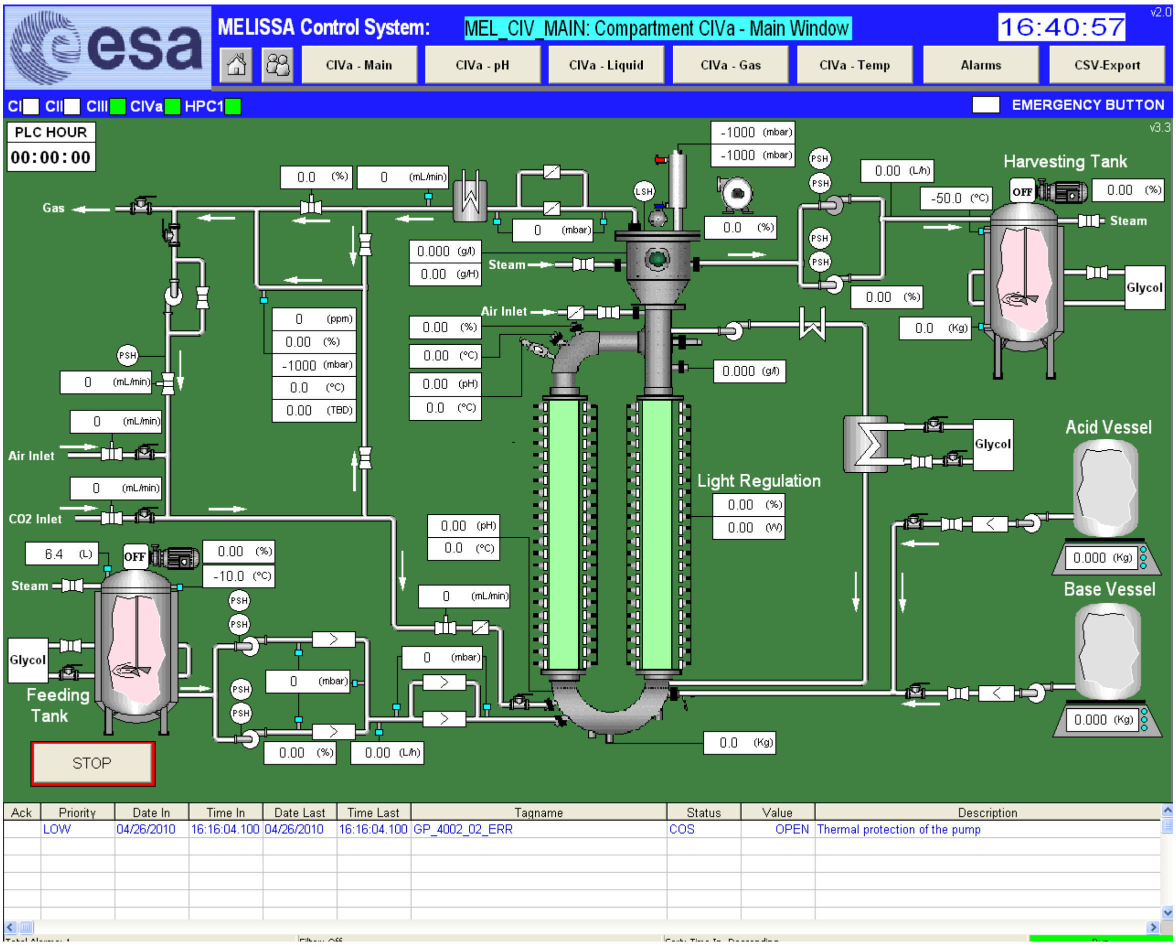


Figure 4-4: Compartment CIVa Main Window

4.3.1 CIVa Main Menu

On the top of the window it is placed the Compartment CIVa Main Menu which is used to navigate for each subsystem of the CIVa, to visualize general alarms indicators, to check if any of the emergency buttons has been pressed and to configure the PLCs system clock.

4.3.2 System clock configuration

The system PLC clock can be set from the HMI by double-clicking over digital clock placed in the CIVa Main Menu (Figure 4-5). Once clicked the configuration window (Figure 4-6) will be displayed.

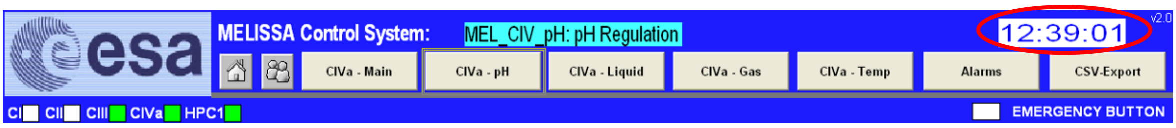


Figure 4-5: CIVa Main Menu Window

PLCs system clock configuration window is opened reading the following values from the PLC connected to the CIVa:

- Day of week
- Day
- Month

- Year
- Hour
- Minute
- Second

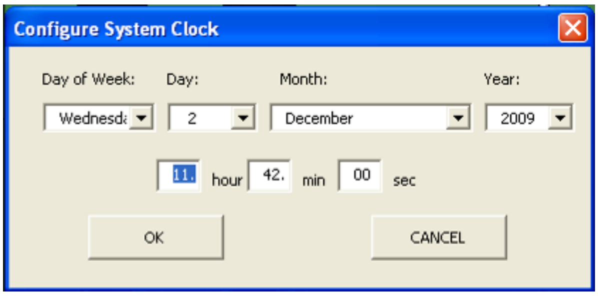


Figure 4-6: CIVa system clock configuration window

The user configures the system clock and press “Ok” command button to write updated values. Note that all PLCs in the network will be updated.

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

4.3.3 CIVa Main Window

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

- Monitoring the analogue indicators of the most significant readings.
- Visualizing object alarm animation.
- Visualizing 2-way valves, pumps, level switch, pipes, tank levels, blenders and blower animations.
- Pushing the emergency command button, it stops all control loops of the CIVa:
  - Lighting Mode (CL4000)
  - Feeding Agitator Mode (CL4001)
  - Inlet Flow Mode (CL4001)
  - Harvesting Agitator Mode (CL4002)
  - Outlet Flow Mode (CL4002)
  - Recycle Mode (CL4003)
  - Inlet Gas Mode (CL4003)
  - Blower Mode (CL4005)
  - Temperature Mode (CL4005)
  - pH Mode (CL4006)
  - Pressure control Mode (CL4007)
  - Bioreactor Level Mode (CL4008)
  - Biomass Cleaning Mode (CL4009)

- Biomass Control Mode (CL4009)
- Outlet Gas composition Mode (CL4010)
- Feeding tank temperature control mode (CL4011)
- Harvesting tank temperature control Mode (CL4012)
- Feeding tank sterilization control mode (CL4014)
- Reactor tank sterilization control mode (CL4015)
- Harvesting tank sterilization control mode (CL4016)

4.3.4 Tags

Tag Name	Description	Type	Units	Range
IRC_4000_MV	Light Intensity (%)	Analogue indicator	(%)	0 to 100
IT_4000_PWR	Lights Power (W)	Analogue indicator	(W)	TBD
PS_4001_01	Pressure Pump GP_4001_01	Digital Indicator	---	---
PS_4001_02	Pressure Pump GP_4001_02	Digital Indicator	---	---
PS_4001_03	Pressure switch membrane GP_4001_01	Digital Indicator	---	---
PS_4001_04	Pressure switch membrane GP_4001_02	Digital Indicator	---	---
GP_4001_01_MV1	Feeding Pump	Pump animated	---	---
GP_4001_02_MV1	Feeding Pump	Pump animated	---	---
GP_4001_03_MV1	Feeding tank agitator	Agitator animated	---	---
CL4001_PumpSpeed	Flow to the inlet pump	Analogue indicator	(%)	0 to 100
GP_4001_03_MV2	Speed of feeding tank agitator	Analogue indicator	(%)	0 to 100
FT_4001_01	Total liquid inlet flow to reactor	Analogue indicator	(L/h)	0 to 4
LT_4001_01	Feeding tank level	Analogue indicator	(L)	0 to 160
DPT_4001_01	Differential pressure filter (feeding)	Analogue indicator	(mBar)	0 to 3000
DPT_4001_02	Differential pressure filter (feeding)	Analogue indicator	(mBar)	0 to 3000
PS_4002_01	Pressure pump GP_4002_01	Digital indicator	---	---
PS_4002_02	Pressure pump GP_4002_02	Digital indicator	---	---
PS_4002_03	Pressure switch membrane GP_4002_01	Digital indicator	---	---
GP_4002_01_MV1	Harvesting Pump	Pump Animated	---	---
GP_4002_02_MV1	Harvesting Pump	Pump Animated	---	---
GP_4002_03_MV1	Harvesting tank agitator	Agitator animated	---	---
CL4002_PUMPSPEED	Flow to the outlet pump	Analogue indicator	(%)	0 to 100
GP_4002_03_MV2	Speed of harvesting tank agitator	Analogue indicator	(%)	0 to 100
WT_4002_01	Harvesting tank weight	Analogue indicator	(Kg.)	0 to 600
CL4002_EstimatedOutletLiquidFlow	Estimated Outlet liquid flow	Analogue indicator	(L/h)	TBD
SV_4003_01_FB	Analyser gas inlet valve	2-way valve animated	---	---
SV_4003_02_FB	Reactor air inlet valve	2-way valve animated	---	---
SV_4003_03_FB	Circulated gas blower bypass valve	2-way valve animated	---	---
PS_4003_01	Pressure switch bypass for recirculation	Digital indicator	---	---
BLWR_4003_01_MV1	Blower	Blower animated	---	---
FQRC_4003_01	Mass flow CO2 inlet	Analogue indicator	(mL/min)	0 to 5000
FQRC_4003_02	Mass flow air inlet	Analogue indicator	(mL/min)	0 to 30000
FQRC_4003_03	Mass flow circulated Air	Analogue indicator	(mL/min)	0 to 30000
FQRC_4003_04	Total mass flow Air Inlet	Analogue indicator	(mL/min)	0 to 30000
SCV_4004_01_MV	Flow control air outlet valve	Analogue indicator	(%)	0 to 100

Tag Name	Description	Type	Units	Range
FT_4004_01	Total air outlet from reactor	Analogue indicator	(mL/min)	0 to 20000
DPT_4004_01	Differential pressure filter	Analogue indicator	(mBar)	0 to 3000
SV_4005_01_FB	Cooling water outlet valve	2-way valve animated	---	---
PP_4005_01_MV1	Reactor temperature control pump	Pump animated	---	---
BLWR_4005_01_MV1	Start/Stop blower air	Blower animated	---	---
BLWR_4005_01_MV2	Speed of Blower air	Analogue indicator	(%)	0 to 100
HX_4005_02_MV1	Electrical resistance	Resistance animated	---	---
TT_4005_01	Reactor temperature	Analogue indicator	(ºC)	0 to 150
SV_4006_01_FB	Acid inlet valve to reactor	2-way valve animated	---	---
SV_4006_02_FB	Base inlet valve to reactor	2-way valve animated	---	---
PP_4006_01_MV1	Start/Stop acid pump	Pump animated	---	---
PP_4006_02_MV1	Start/Stop base pump	Pump animated	---	---
WT_4006_01	Acid balance	Analogue indicator	(Kg.)	0 to 6
WT_4006_02	Base balance	Analogue indicator	(Kg.)	0 to 6
AT_4006_01	pH	Analogue indicator	(pH)	0 to 12
TT_4006_01	pH probe Temperature	Analogue indicator	(ºC)	0 to 140
AT_4006_02	pH	Analogue indicator	(pH)	0 to 12
TT_4006_02	pH probe Temperature	Analogue indicator	(ºC)	0 to 140
PT_4007_01	Reactor pressure	Analogue indicator	(mBar)	-1000 to 1500
PT_4007_02	Reactor pressure	Analogue indicator	(mBar)	-1000 to 1500
WT_4008_01	Reactor Weight	Analogue indicator	(Kg.)	0 to 100
AT_4009_01	Biomass concentration	Analogue indicator	(g/l)	0 to 5
AT_4009_02	Biomass concentration	Analogue indicator	(g/l)	0 to 5
CL4009_BIOMASS_PRODUCTION	Biomass production	Analogue indicator	(g/H)	TBD
SV_4010_01_FB	Gas inlet analyser valve	2-way valve animated	---	---
AT_4010_01	CO2 analyser	Analogue indicator	(ppm)	0 to 5000
AT_4010_02	O2 analyser	Analogue indicator	(%)	0 to 25
AT_4010_03	Dissolved O2	Analogue indicator	(%)	0 to 100
PT_4010_01	Outlet Gas Pressure	Analogue indicator	(mBar)	-1000 to 5000
TT_4010_01	Analyser temperature	Analogue indicator	(ºC)	0 to 150
CL4010_O2_PRODUCTION	Oxygen production calculation	Analogue indicator	TBD	TBD
SV_4011_01_FB	Feeding tank cooling water valve	2-way valve animated	---	---
TT_4011_01	Feeding tank temperature	Analogue indicator	(ºC)	-10 to 150
SV_4012_01_FB	Harvesting tank cooling water valve	2-way valve animated	---	---
TT_4012_01	Harvesting tank temperature	Analogue indicator	(ºC)	-50 to 250
LS_4013_01	Foam Measurement	Digital indicator	---	---
SV_4014_01_FB	Feeding tank steam inlet valve	2-way valve animated	---	---
SV_4015_01_FB	Reactor steam inlet valve	2-way valve animated	---	---
SV_4016_01_FB	Harvesting tank steam inlet valve	2-way valve animated	---	---

Table 4-1: Tags of the Main Screen

4.3.5 Alarms

The following alarms are linked with the operation of the CIVa main screen.

TAG NAME	Description	Colour
PS_4001_01_A	Inlet pump GP_4001_01 pressure switch alarm	RED
PS_4001_02_A	Inlet pump GP_4001_02 pressure switch alarm	RED
PS_4001_03_A	Pressure switch membrane GP_4001_01 alarm	RED
PS_4001_04_A	Pressure switch membrane GP_4001_02 alarm	RED
GP_4001_01_ERR	Inlet pump GP_4001_01 thermal protection alarm	RED and “ERR” text in RED
GP_4001_02_ERR	Inlet pump GP_4001_02 thermal protection alarm	RED and “ERR” text in RED
GP_4001_03_ERR	Feeding tank agitator thermal protection alarm	RED and “ERR” text
FT_4001_01_ERR	Inlet liquid flow sensor link error	“ERR” text in RED
FT_4001_01_AHH	Inlet liquid flow reaches high level 2 alarm	RED
FT_4001_01_AH	Inlet liquid flow reaches high level 1 alarm	YELLOW
FT_4001_01_AL	Inlet liquid flow reaches low level 1 alarm	YELLOW
FT_4001_01_ALL	Inlet liquid flow reaches low level 2 alarm	RED
LT_4001_01_ERR	Feeding tank level sensor link error	“ERR” text in RED
LT_4001_01_AHH	Feeding tank level reaches high level 2 alarm	RED
LT_4001_01_AH	Feeding tank level reaches high level 1 alarm	YELLOW
LT_4001_01_AL	Feeding tank level reaches low level 1 alarm	YELLOW
LT_4001_01_ALL	Feeding tank level reaches low level 2 alarm	RED
DPT_4001_01_ERR	Inlet differential pressure sensor link error	“ERR” text in RED
DPT_4001_01_AHH	Inlet differential pressure filter reaches high level 2 alarm	RED
DPT_4001_01_AH	Inlet differential pressure filter reaches high level 1 alarm	YELLOW
DPT_4001_01_AL	Inlet differential pressure filter reaches low level 1 alarm	YELLOW
DPT_4001_01_ALL	Inlet differential pressure filter reaches low level 2 alarm	RED
DPT_4001_02_ERR	Inlet differential pressure sensor link error	“ERR” text in RED
DPT_4001_02_AHH	Inlet differential pressure filter reaches high level 2 alarm	RED
DPT_4001_02_AH	Inlet differential pressure filter reaches high level 1 alarm	YELLOW
DPT_4001_02_AL	Inlet differential pressure filter reaches low level 1 alarm	YELLOW
DPT_4001_02_ALL	Inlet differential pressure filter reaches low level 2 alarm	RED
PS_4002_01_A	Outlet pump GP_4002_01 pressure switch alarm	RED
PS_4002_02_A	Outlet pump GP_4002_02 pressure switch alarm	RED
PS_4002_03_A	Pressure switch membrane GP_4002_01 alarm	RED
GP_4002_01_ERR	Outlet pump GP_4002_01 thermal protection alarm	RED and “ERR” text in RED
GP_4002_02_ERR	Outlet pump GP_4002_02 thermal protection alarm	RED and “ERR” text in RED
GP_4002_03_ERR	Harvesting agitator thermal protection alarm	RED and “ERR” text
WT_4002_01_ERR	Harvesting tank weight sensor link error	“ERR” text in RED
WT_4002_01_AH	Harvesting tank weight reaches high level 1 alarm	YELLOW
WT_4002_01_AHH	Harvesting tank weight reaches high level 2 alarm	RED
WT_4002_01_AL	Harvesting tank weight reaches low level 1 alarm	YELLOW
WT_4002_01_ALL	Harvesting tank weight reaches low level 2 alarm	RED
PS_4003_01_A	Bypass pressure switch alarm	RED
SV_4003_01_A	Analyser gas inlet valve in wrong position	RED and “ERR” text in RED
SV_4003_02_A	Reactor air inlet (biomass cleaning) valve in wrong positions	RED and “ERR” text in RED
SV_4003_03_A	Circulated gas blower bypass valve in wrong position	RED and “ERR” text in RED
FQRC_4003_01_ERR	CO2 flow sensor link error	“ERR” text in RED
FQRC_4003_01_AHH	CO2 flow reaches high level 2 alarm	RED
FQRC_4003_01_AH	CO2 flow reaches high level 1 alarm	YELLOW
FQRC_4003_01_AL	CO2 flow reaches low level 1 alarm	YELLOW
FQRC_4003_01_ALL	CO2 flow reaches low level 2 alarm	RED
FQRC_4003_02_ERR	Air flow sensor link error	“ERR” text in RED
FQRC_4003_02_AHH	Air flow reaches high level 2 alarm	RED
FQRC_4003_02_AH	Air flow reaches high level 1 alarm	YELLOW
FQRC_4003_02_AL	Air flow reaches low level 1 alarm	YELLOW
FQRC_4003_02_ALL	Air flow reaches low level 2 alarm	RED
FQRC_4003_03_ERR	Recirculation air flow sensor link error	“ERR” text in RED

TAG NAME	Description	Colour
FQRC_4003_03_AHH	Recirculation air flow reaches high level 2 alarm	RED
FQRC_4003_03_AH	Recirculation air flow reaches high level 1 alarm	YELLOW
FQRC_4003_03_AL	Recirculation air flow reaches low level 1 alarm	YELLOW
FQRC_4003_03_ALL	Recirculation air flow reaches low level 2 alarm	RED
FQRC_4003_04_ERR	Total gas flow sensor link error	"ERR" text in RED
FQRC_4003_04_AHH	Total gas flow reaches high level 2 alarm	RED
FQRC_4003_04_AH	Total gas flow reaches high level 1 alarm	YELLOW
FQRC_4003_04_AL	Total gas flow reaches low level 1 alarm	YELLOW
FQRC_4003_04_ALL	Total gas flow reaches low level 2 alarm	RED
FT_4004_01_ERR	Reactor air outlet flow sensor link error	"ERR" text in RED
FT_4004_01_AHH	Reactor air outlet flow reaches high level 2 alarm	RED
FT_4004_01_AH	Reactor air outlet flow reaches high level 1 alarm	YELLOW
FT_4004_01_ALL	Reactor air outlet flow reaches low level 2 alarm	RED
FT_4004_01_AL	Reactor air outlet flow reaches low level 1 alarm	YELLOW
DPT_4004_01_ERR	Outlet gas differential pressure sensor link error	"ERR" text in RED
DPT_4004_01_AHH	Outlet gas differential pressure reaches high level 2 alarm	RED
DPT_4004_01_AH	Outlet gas differential pressure reaches high level 1 alarm	YELLOW
DPT_4004_01_ALL	Outlet gas differential pressure reaches low level 2 alarm	RED
DPT_4004_01_AL	Outlet gas differential pressure reaches low level 1 alarm	YELLOW
BLWR_4005_01_ERR	Extractor thermal protection	RED and "ERR" text in RED
SV_4005_01_A	Cooling water outlet valve in wrong position	RED and "ERR" text in RED
TT_4005_01_ERR	Reactor temperature sensor link error	"ERR" text in RED
TT_4005_01_AHH	Reactor temperature reaches high level 2 alarm	RED
TT_4005_01_AH	Reactor temperature reaches high level 1 alarm	YELLOW
TT_4005_01_ALL	Reactor temperature reaches low level 2 alarm	RED
TT_4005_01_AL	Reactor temperature reaches low level 1 alarm	YELLOW
SV_4006_01_A	Acid valve in wrong position	RED and "ERR" text in RED
SV_4006_02_A	Base valve in wrong position	RED and "ERR" text in RED
WT_4006_01_AL	Acid bottle weight reaches low level 1 alarm	YELLOW
WT_4006_01_ALL	Acid bottle weight reaches low level 2 alarm	RED
WT_4006_02_AL	Base bottle weight reaches low level 1 alarm	YELLOW
WT_4006_02_ALL	Base bottle weight reaches low level 2 alarm	RED
CL4006_pH_AHH	Reactor pH reaches high level 2 alarm	RED
CL4006_pH_AH	Reactor pH reaches high level 1 alarm	YELLOW
CL4006_pH_AL	Reactor pH reaches low level 1 alarm	YELLOW
CL4006_pH_ALL	Reactor pH reaches low level 2 alarm	RED
AT_4006_01_ERR	Reactor pH sensor (top) link error	"ERR" text in RED
TT_4006_01_ERR	Temperature of the pH sensor (top) link error	"ERR" text in RED
AT_4006_02_ERR	Reactor pH sensor (bottom) link error	"ERR" text in RED
TT_4006_02_ERR	Temperature of the pH sensor (bottom) link error	"ERR" text in RED
PT_4007_01_ERR	Reactor pressure sensor link error	"ERR" text in RED
PT_4007_01_AHH	Reactor pressure reaches high level 2 alarm	RED
PT_4007_01_AH	Reactor pressure reaches high level 1 alarm	YELLOW
PT_4007_01_AL	Reactor pressure reaches low level 1 alarm	YELLOW
PT_4007_01_ALL	Reactor pressure reaches low level 2 alarm	RED
PT_4007_02_ERR	Reactor pressure sensor link error	"ERR" text in RED
PT_4007_02_AHH	Reactor pressure reaches high level 2 alarm	RED
PT_4007_02_AH	Reactor pressure reaches high level 1 alarm	YELLOW
PT_4007_02_AL	Reactor pressure reaches low level 1 alarm	YELLOW
PT_4007_02_ALL	Reactor pressure reaches low level 2 alarm	RED
WT_4008_01_ERR	Reactor weight sensor link error	"ERR" text in RED
WT_4008_01_AH	Reactor weight reaches high level 1 alarm	YELLOW
WT_4008_01_AHH	Reactor weight reaches high level 2 alarm	RED
WT_4008_01_AL	Reactor weight reaches low level 1 alarm	YELLOW
WT_4008_01_ALL	Reactor weight reaches low level 2 alarm	RED
AT_4009_01_ERR	Biomass sensor (top) link error	"ERR" text in RED
AT_4009_01_AH	Biomass (top) reaches high level 1 alarm	YELLOW

TAG NAME	Description	Colour
AT_4009_01_AHH	Biomass (top) reaches high level 2 alarm	RED
AT_4009_01_AL	Biomass (top) reaches low level 1 alarm	YELLOW
AT_4009_01_ALL	Biomass (top) reaches low level 2 alarm	RED
AT_4009_02_ERR	Biomass sensor (bottom) link error	“ERR” text in RED
AT_4009_02_AH	Biomass (bottom) reaches high level 1 alarm	YELLOW
AT_4009_02_AHH	Biomass (bottom) reaches high level 2 alarm	RED
AT_4009_02_AL	Biomass (bottom) reaches low level 1 alarm	YELLOW
AT_4009_02_ALL	Biomass (bottom) reaches low level 2 alarm	RED
SV_4010_01_A	Gas inlet analyser in wrong position	RED and “ERR” text in RED
AT_4010_01_ERR	CO2 sensor link error	“ERR” text in RED
AT_4010_01_AH	CO2 analyser reaches high level 1 alarm	YELLOW
AT_4010_01_AHH	CO2 analyser reaches high level 2 alarm	RED
AT_4010_01_AL	CO2 analyser reaches low level 1 alarm	YELLOW
AT_4010_01_ALL	CO2 analyser reaches low level 2 alarm	RED
AT_4010_02_ERR	O2 sensor link error	“ERR” text in RED
AT_4010_02_AH	O2 analyser reaches high level 1 alarm	YELLOW
AT_4010_02_AHH	O2 analyser reaches high level 2 alarm	RED
AT_4010_02_AL	O2 analyser reaches low level 1 alarm	YELLOW
AT_4010_02_ALL	O2 analyser reaches low level 2 alarm	RED
AT_4010_03_ERR	Dissolved O2 sensor link error	“ERR” text in RED
AT_4010_03_AH	Dissolved O2 reaches high level 1 alarm	YELLOW
AT_4010_03_AHH	Dissolved O2 reaches high level 2 alarm	RED
AT_4010_03_AL	Dissolved O2 reaches low level 1 alarm	YELLOW
AT_4010_03_ALL	Dissolved O2 reaches low level 2 alarm	RED
PT_4010_01_ERR	Outlet gas pressure sensor link error	“ERR” text in RED
PT_4010_01_AH	Outlet gas pressure reaches high level 1 alarm	YELLOW
PT_4010_01_AHH	Outlet gas pressure reaches high level 2 alarm	RED
PT_4010_01_AL	Outlet gas pressure reaches low level 1 alarm	YELLOW
PT_4010_01_ALL	Outlet gas pressure reaches low level 2 alarm	RED
TT_4010_01_ERR	Analyser temperature sensor link error	“ERR” text in RED
TT_4010_01_AH	Analyser temperature reaches high level 1 alarm	YELLOW
TT_4010_01_AHH	Analyser temperature reaches high level 2 alarm	RED
TT_4010_01_AL	Analyser temperature reaches low level 1 alarm	YELLOW
TT_4010_01_ALL	Analyser temperature reaches low level 2 alarm	RED
SV_4011_01_A	Influent tank temperature control valve in wrong position	RED and “ERR” text in RED
TT_4011_01_ERR	Influent tank temperature sensor link error	“ERR” text in RED
TT_4011_01_AH	Influent tank temperature reaches high level 1 alarm	YELLOW
TT_4011_01_AHH	Influent tank temperature reaches high level 2 alarm	RED
TT_4011_01_AL	Influent tank temperature reaches low level 1 alarm	YELLOW
TT_4011_01_ALL	Influent tank temperature reaches low level 2 alarm	RED
SV_4012_01_A	Harvesting tank temperature control valve in wrong position	RED and “ERR” text in RED
TT_4012_01_ERR	Harvesting tank temperature sensor link error	“ERR” text in RED
TT_4012_01_AH	Harvesting tank temperature reaches high level 1 alarm	YELLOW
TT_4012_01_AHH	Harvesting tank temperature reaches high level 2 alarm	RED
TT_4012_01_AL	Harvesting tank temperature reaches low level 1 alarm	YELLOW
TT_4012_01_ALL	Harvesting tank temperature reaches low level 2 alarm	RED
SV_4014_01_A	Influent tank, steam inlet valve in wrong position	RED and “ERR” text in RED
SV_4015_01_A	Reactor steam inlet valve in wrong position	RED and “ERR” text in RED
SV_4016_01_A	Harvesting tank steam inlet valve in wrong position	RED and “ERR” text in RED

Table 4-2: Alarm tags of the Main Screen of CIVa system

4.4 Liquid Control screen

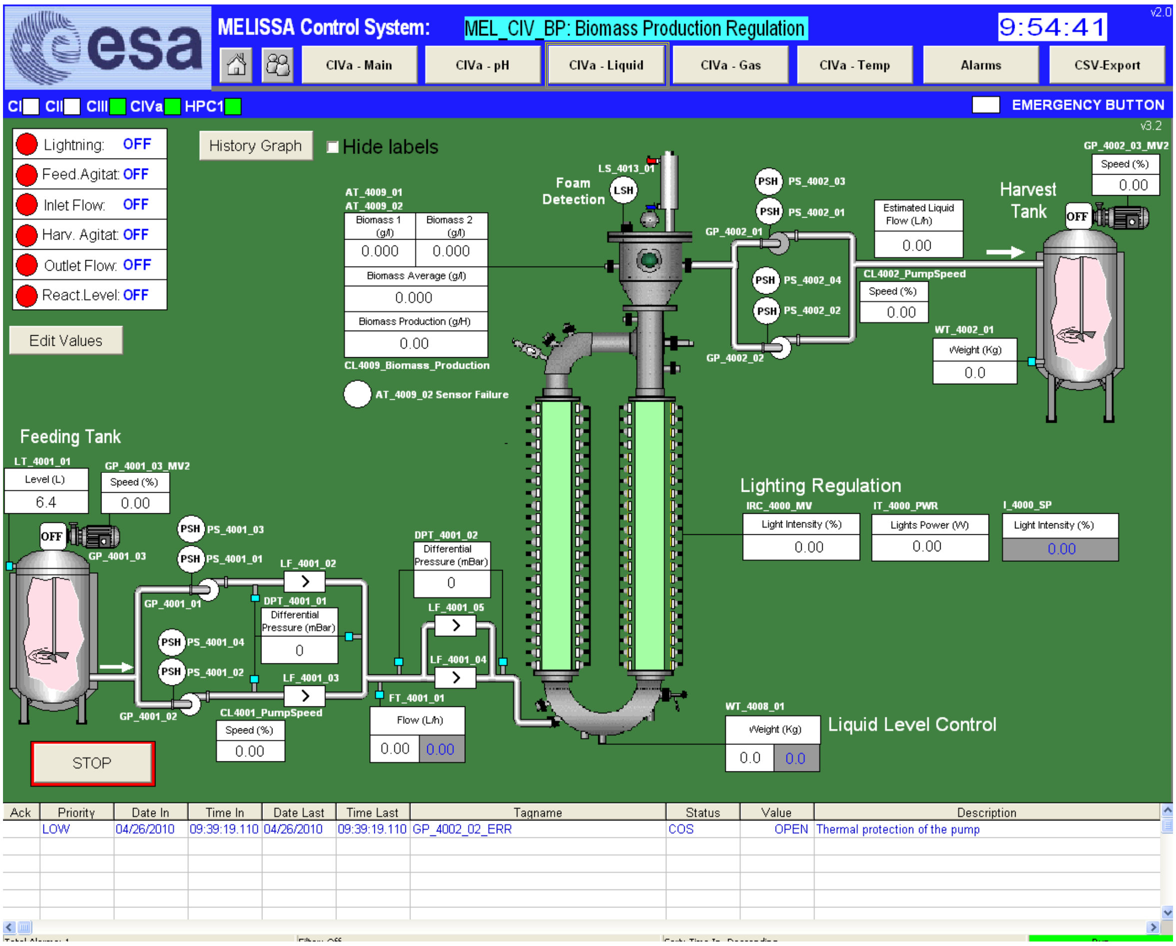


Figure 4-7: Main objects in CIVa Liquid Screen

4.4.1 General actions

This display allows the user to:

- Monitor the measurements of the reactor's biomass concentration, biomass production, the liquid level of the reactor, the level of the feeding tank and harvesting tank, the speed of the feeding and harvesting tank agitators, input and output flows and lights intensity.
- Modify the Set-Points of the input flow, reactor's liquid level and light intensity.
- Display the history graph clicking on the History graph command button.
- Hide labels selecting the "Hide labels" check box.
- Monitor the emergency button indicator. Background colour switch to red when one of the Emergency buttons is pushed.
- Stop all control loops implemented on the screen clicking "Stop" command button.
- Edit manual values clicking the "Edit Values" command button. In the Manual Values window user can switch between six submenus:
    - o Feeding tank agitator: Allows activating the agitator GP_4001_03 and the manual value SP.

- Harvesting tank agitator: Allows activating the agitator GP_4002_03 and the manual value SP.
- Inlet flow pump selection: Allows selecting one of the inlet pumps, only one pump can be selected.
- Inlet Pumps Manual Mode: Allows activating the pump selected (GP_4001_01 or GP_4001_02) and the manual value SP.
- Outlet flow pump selection: Allow selecting one of the outlet pumps, only one pump can be selected at a time. GP_4002_01 pump selection is disabled because pump is not mounted.
- Outlet pumps Manual mode: Allow activating the pump selected (GP_4002_01 or GP_4002_02) and the manual value SP. GP_4002_01 pump activation is disabled because pump is not mounted.

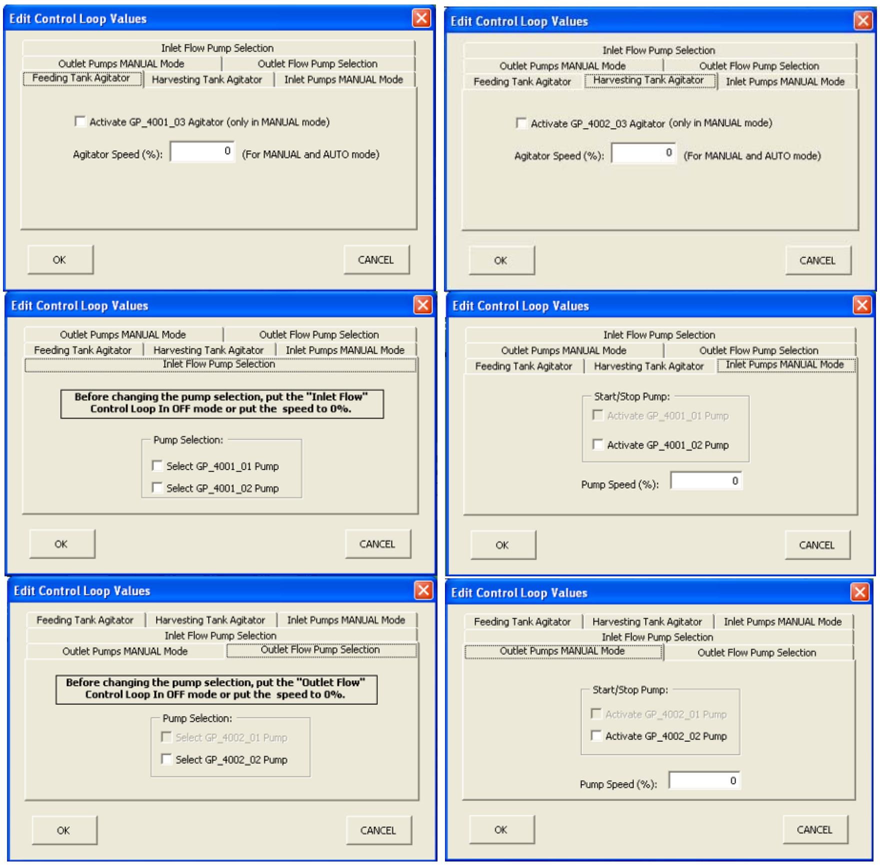


Figure 4-8: Edit Values Dialog

4.4.2 Alarms

The following alarms are linked with the operation of the liquid control screen.

TAG NAME	Description	Colour
PS_4001_01_A	GP_4001_01 pressure switch alarm	RED
PS_4001_02_A	GP_4001_02 pressure switch alarm	RED
PS_4001_03_A	Pressure switch membrane GP_4001_01 alarm	RED
PS_4001_04_A	Pressure switch membrane GP_4001_02 alarm	RED
GP_4001_01_ERR	Inlet pump GP_4001_01 thermal protection alarm	RED
GP_4001_02_ERR	Inlet pump GP_4001_02 thermal protection alarm	RED

TAG NAME	Description	Colour
GP_4001_03_ERR	Feeding tank agitator thermal protection alarm	RED and “ERR” text in RED
FT_4001_01_ERR	Inlet liquid flow sensor link error	“ERR” text in RED
FT_4001_01_AHH	Inlet liquid flow reaches high level 2 alarm	RED
FT_4001_01_AH	Inlet liquid flow reaches high level 1 alarm	YELLOW
FT_4001_01_AL	Inlet liquid flow reaches low level 1 alarm	YELLOW
FT_4001_01_ALL	Inlet liquid flow reaches low level 2 alarm	RED
LT_4001_01_ERR	Feeding tank level sensor link error	“ERR” text in RED
LT_4001_01_AHH	Feeding tank level reaches high level 2 alarm	RED
LT_4001_01_AH	Feeding tank level reaches high level 1 alarm	YELLOW
LT_4001_01_AL	Feeding tank level reaches low level 1 alarm	YELLOW
LT_4001_01_ALL	Feeding tank level reaches low level 2 alarm	RED
DPT_4001_01_ERR	DPT_4001_01 sensor link error	“ERR” text in RED
DPT_4001_01_AHH	Inlet differential pressure filter reaches high level 2 alarm	RED
DPT_4001_01_AH	Inlet differential pressure filter reaches high level 1 alarm	YELLOW
DPT_4001_01_AL	Inlet differential pressure filter reaches low level 1 alarm	YELLOW
DPT_4001_01_ALL	Inlet differential pressure filter reaches low level 2 alarm	RED
DPT_4001_02_ERR	DPT_4001_02 sensor link error	“ERR” text in RED
DPT_4001_02_AHH	Inlet differential pressure filter reaches high level 2 alarm	RED
DPT_4001_02_AH	Inlet differential pressure filter reaches high level 1 alarm	YELLOW
DPT_4001_02_AL	Inlet differential pressure filter reaches low level 1 alarm	YELLOW
DPT_4001_02_ALL	Inlet differential pressure filter reaches low level 2 alarm	RED
PS_4002_01_A	GP_4002_01 pressure switch alarm	RED
PS_4002_02_A	GP_4002_02 pressure switch alarm	RED
PS_4002_03_A	Pressure switch membrane GP_4002_01 alarm	RED
GP_4002_01_ERR	Outlet pump GP_4002_01 thermal protection alarm	RED
GP_4002_02_ERR	Outlet pump GP_4002_02 thermal protection alarm	RED
GP_4002_03_ERR	Harvesting agitator thermal protection alarm	RED and “ERR” text in RED
WT_4002_01_ERR	Harvesting tank weight sensor link error	“ERR” text in RED
WT_4002_01_AH	Harvesting tank weight reaches high level 1 alarm	YELLOW
WT_4002_01_AHH	Harvesting tank weight reaches high level 2 alarm	RED
WT_4002_01_AL	Harvesting tank weight reaches low level 1 alarm	YELLOW
WT_4002_01_ALL	Harvesting tank weight reaches low level 2 alarm	RED
WT_4008_01_ERR	Reactor weight sensor link error	“ERR” text in RED
WT_4008_01_AH	Reactor weight reaches high level 1 alarm	YELLOW
WT_4008_01_AHH	Reactor weight reaches high level 2 alarm	RED
WT_4008_01_AL	Reactor weight reaches low level 1 alarm	YELLOW
WT_4008_01_ALL	Reactor weight reaches low level 2 alarm	RED
AT_4009_01_ERR	Biomass sensor (top) link error	“ERR” text in RED
AT_4009_01_AH	Biomass (top) reaches high level 1 alarm	YELLOW
AT_4009_01_AHH	Biomass (top) reaches high level 2 alarm	RED
AT_4009_01_AL	Biomass (top) reaches low level 1 alarm	YELLOW
AT_4009_01_ALL	Biomass (top) reaches low level 2 alarm	RED
AT_4009_02_ERR	Biomass sensor (bottom) link error	“ERR” text in RED
AT_4009_02_AH	Biomass (bottom) reaches high level 1 alarm	YELLOW
AT_4009_02_AHH	Biomass (bottom) reaches high level 2 alarm	RED
AT_4009_02_AL	Biomass (bottom) reaches low level 1 alarm	YELLOW
AT_4009_02_ALL	Biomass (bottom) reaches low level 2 alarm	RED

Table 4-3: Alarm tags of the Liquid loop of CIVa system

4.4.3 Tags

The following tags are displayed in this screen. (The user inputs are highlighted in green)

Tag Name	Description	Type	Units	Range
IRC_4000_MV	Light Intensity (%)	Analogue indicator	(%)	0 to 100
IT_4000_PWR	Lights Power (W)	Analogue indicator	(W)	TBD
I_4000_SP	Light Intensity Set Point	Set Point User Input	(%)	0 to 100

Tag Name	Description	Type	Units	Range
PS_4001_01	Pressure Pump GP_4001_01	Digital Indicator	---	---
PS_4001_02	Pressure Pump GP_4001_02	Digital Indicator	---	---
PS_4001_03	Pressure switch membrane GP_4001_01	Digital Indicator	---	---
PS_4001_04	Pressure switch membrane GP_4001_02	Digital Indicator	---	---
GP_4001_01_MV1	Feeding Pump	Pump animated	---	---
GP_4001_02_MV1	Feeding Pump	Pump animated	---	---
GP_4001_03_MV1	Feeding tank agitator	Agitator animated	---	---
GP_4001_03_MV2_OP	Speed of the feeding tank agitator in manual mode	User Input	(%)	0 to 100
GP_4001_03_MV1_OP	Start/Stop feeding tank agitator in manual mode	User input	---	---
GP_4001_01_SEL	GP_4001_01 pump selection	User Input	---	---
GP_4001_02_SEL	GP_4001_02 pump selection	User Input	---	---
CL4001_PumpSpeed_OP	Speed of the inlet pump in Manual Mode	User Input	(%)	0 to 100
GP_4001_01_MV1_OP	Start/Stop pump in manual mode	User Input	---	---
GP_4001_02_MV1_OP	Start/Stop pump in manual mode	User Input	---	---
CL4001_PumpSpeed	Flow to the inlet pump	Analogue indicator	(%)	0 to 100
GP_4001_03_MV2	Speed of feeding tank agitator	Analogue indicator	(%)	0 to 100
FT_4001_01	Total liquid inlet flow to reactor	Analogue indicator	(L/h)	0 to 4
FT_4001_01_SP	Flow rate Set Point	User Input	(L/h)	0 to 4
LT_4001_01	Feeding tank level	Analogue indicator	(L)	0 to 160
DPT_4001_01	Differential pressure filter (feeding)	Analogue indicator	(mBar)	0 to 3000
DPT_4001_02	Differential pressure filter (feeding)	Analogue indicator	(mBar)	0 to 3000
PS_4002_01	Pressure pump GP_4002_01	Digital indicator	---	---
PS_4002_02	Pressure pump GP_4002_02	Digital indicator	---	---
PS_4002_03	Pressure switch membrane GP_4002_01	Digital indicator	---	---
GP_4002_01_MV1	Harvesting Pump	Pump Animated	---	---
GP_4002_02_MV1	Harvesting Pump	Pump Animated	---	---
GP_4002_03_MV1	Harvesting tank agitator	Agitator animated	---	---
GP_4002_03_MV2_OP	Speed of the harvesting tank agitator in manual mode	User Input	(%)	0 to 100
GP_4002_03_MV1_OP	Start/Stop harvesting tank agitator in manual mode	User input	---	---
GP_4002_01_SEL	GP_4002_01 pump selection	User Input	---	---
GP_4002_02_SEL	GP_4002_02 pump selection	User Input	---	---
CL4002_PumpSpeed_OP	Speed of the outlet pump in Manual Mode	User Input	(%)	0 to 100
GP_4002_01_MV1_OP	Start/Stop pump in manual mode	User Input	---	---
GP_4002_02_MV1_OP	Start/Stop pump in manual mode	User Input	---	---
CL4002_PUMPSPEED	Flow to the outlet pump	Analogue indicator	(%)	0 to 100
GP_4002_03_MV2	Speed of harvesting tank agitator	Analogue indicator	(%)	0 to 100
WT_4002_01	Harvesting tank weight	Analogue indicator	(Kg.)	0 to 600
CL4002_EstimatedOutletLiquidFlow	Estimated Outlet liquid flow	Analogue indicator	(L/h)	TBD
WT_4008_01	Reactor Weight	Analogue indicator	(Kg.)	0 to 100
WT_4008_SP	Reactor level Set Point	User Input	(Kg.)	0 to 100
AT_4009_01	Biomass concentration	Analogue indicator	(g/L)	0 to 5
AT_4009_02	Biomass concentration	Analogue indicator	(g/L)	0 to 5
AT_4009_AVG	Biomass Average	Analogue indicator	(g/L)	0 to 5
AT_4009_SENSORFAILURE	Biomass sensor error	Digital indicator	---	---

Tag Name	Description	Type	Units	Range
CL4009_BIOMASS_PRODUCTION	Biomass production	Analogue indicator	(g/H)	
LS_4013_01	Foam detection	Digital indicator	---	---

Table 4-4: Tags of the Liquid loop of CIVa system

4.4.4 Control loops

The following control loops are implemented on the screen:

Control Logic	Description
CL4000	Lighting mode
CL4001	Feeding agitator mode
CL4001	Inlet Flow mode
CL4002	Harvesting agitator mode
CL4002	Outlet flow mode
CL4008	Liquid level mode

Table 4-5: Control Loops of the Liquid loop of CIVa system

4.5 Gas Loop screen

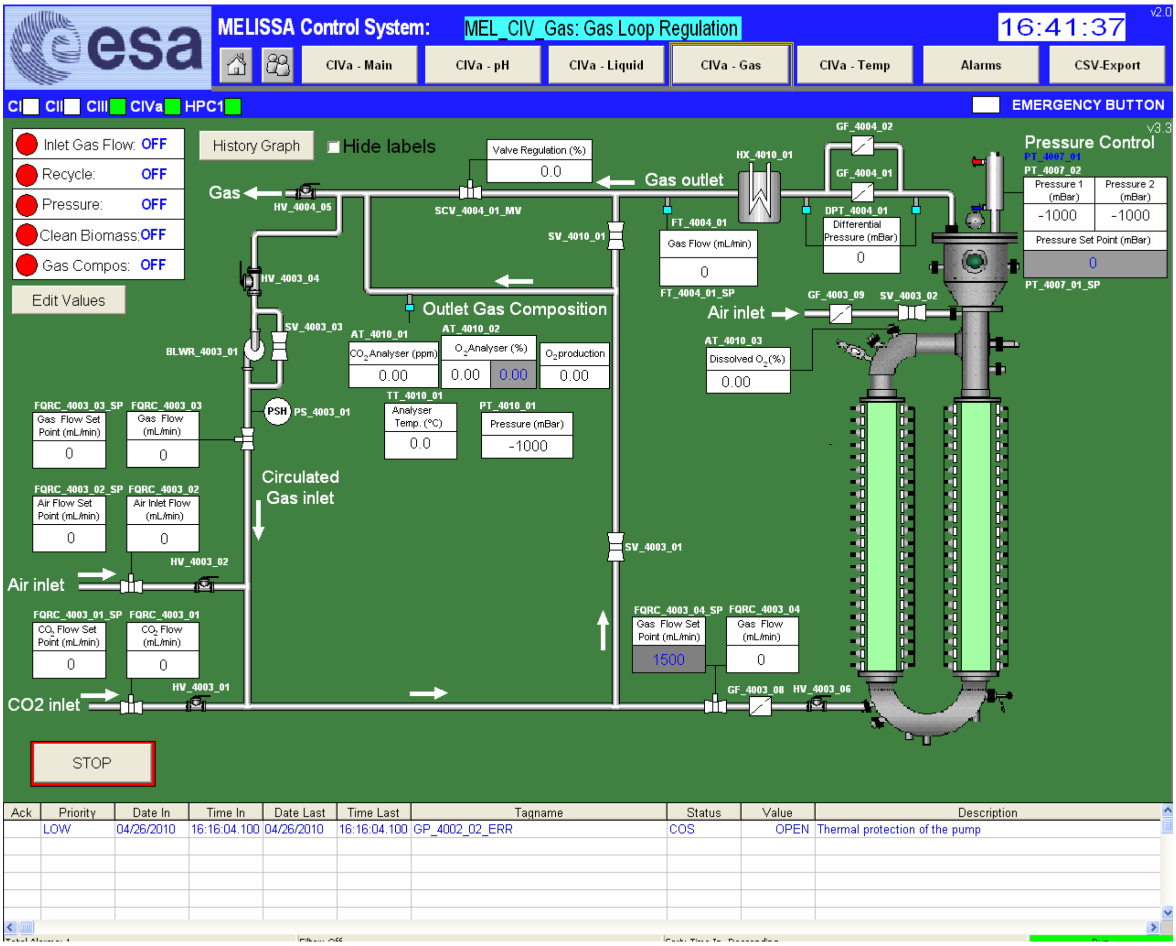


Figure 4-9: Main objects in CIVa Gas Screen

4.5.1 General actions

This display allows the user to:

- Monitor the mass flow controllers (CO_2 inlet, Air Inlet, Circulated Air and total Air Inlet), the dissolved O_2 concentration, CO_2 concentration, O_2 concentration, outlet gas pressure, temperature of the outlet gas composition analyzer, outlet gas flow and reactor's pressure.

- Modify the set-points of O_2, total air inlet and reactor's pressure.
- Display the history graph clicking on the History graph command button.
- Hide labels selecting the "Hide labels" check box
- Monitor the emergency button indicator. Background colour switch to red when one of the Emergency buttons is pushed.
- Stop all control loops implemented on the screen clicking "Stop" command button.
- Select the pressure probe for control clicking over the probe lecture:

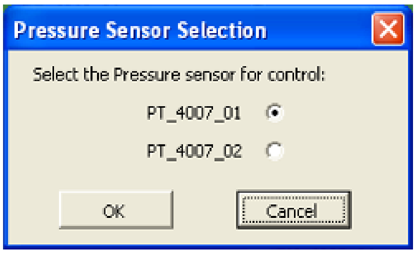


Figure 4-10: Pressure probe selection

- Edit manual values clicking the "Edit Values" command button. In the Manual Values window user can switch between five submenus:
    - Inlet Gas Mode Manual: Allows activating analyzer gas inlet valve (SV_4003_01) and manual value SP of CO_2 (CO_2 set point will be only taken into account when the pH is in ACID BASE mode), Air Inlet and total air flow.
    - Recycle Mode Manual: Allows activating circulated gas blower bypass valve (SV_4003_03), blower (BLWR_4003_01) and manual value SP of circulated air.
    - Bioreactor Pressure Manual: Allows selecting the manual value SP of outlet Gas valve opening (SCV_4004_01).
    - Biomass cleaning Manual: Allows activating reactor air inlet valve (SV_4003_02).
    - Outlet Gas analyser Manual: Allow activating gas inlet analyzer valve from reactor outlet (SV_4010_01).

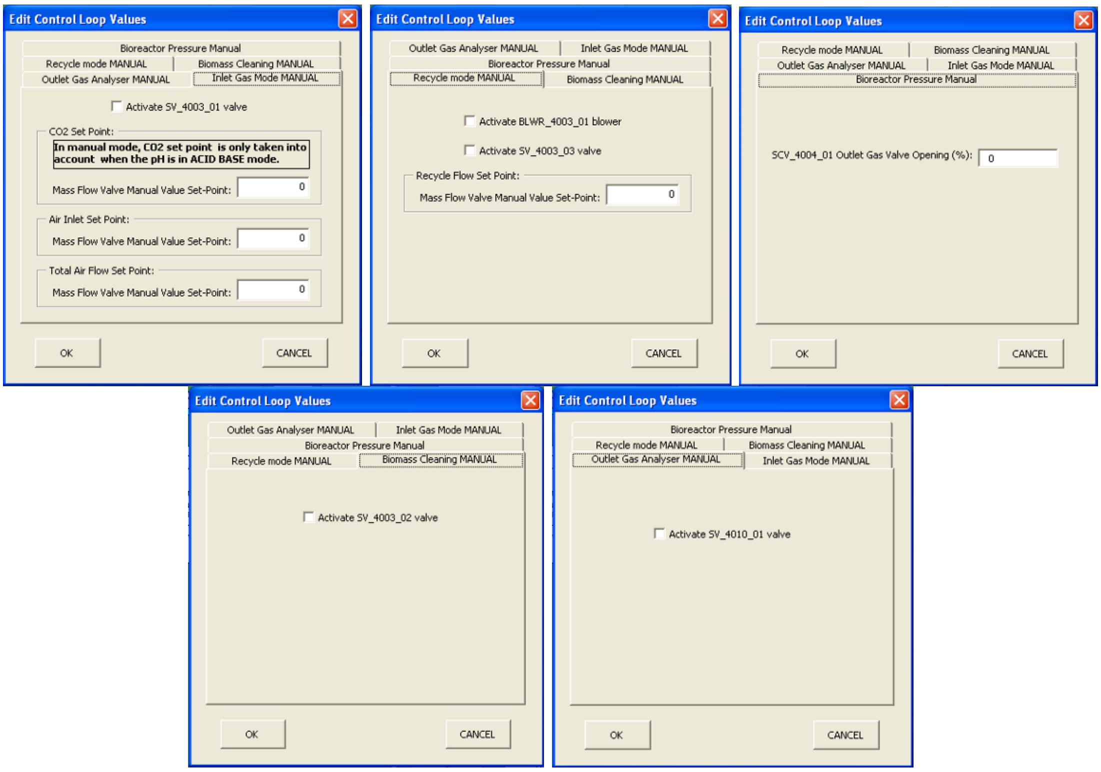


Figure 4-11: Edit Values Dialog

4.5.2 Alarms

The following alarms are linked with the operation of the gas control screen.

TAG NAME	Description	Colour
PS_4003_01_A	Bypass pressure switch	RED
SV_4003_01_A	Analyser gas inlet valve in wrong position	RED and “ERR” text in RED
SV_4003_02_A	Reactor air inlet (biomass cleaning) valve in wrong positions	RED and “ERR” text in RED
SV_4003_03_A	Circulated gas blower bypass valve in wrong position	RED and “ERR” text in RED
FQRC_4003_01_ERR	CO2 flow sensor link error	“ERR” text in RED
FQRC_4003_01_AHH	CO2 flow reaches high level 2 alarm	RED
FQRC_4003_01_AH	CO2 flow reaches high level 1 alarm	YELLOW
FQRC_4003_01_AL	CO2 flow reaches low level 1 alarm	YELLOW
FQRC_4003_ALL	CO2 flow reaches low level 2 alarm	RED
FQRC_4003_02_ERR	Air flow sensor link error	“ERR” text in RED
FQRC_4003_02_AHH	Air flow reaches high level 2 alarm	RED
FQRC_4003_02_AH	Air flow reaches high level 1 alarm	YELLOW
FQRC_4003_02_AL	Air flow reaches low level 1 alarm	YELLOW
FQRC_4003_02_ALL	Air flow reaches low level 2 alarm	RED
FQRC_4003_03_ERR	Recirculation air flow sensor link error	“ERR” text in RED
FQRC_4003_03_AHH	Recirculation air flow reaches high level 2 alarm	RED
FQRC_4003_03_AH	Recirculation air flow reaches high level 1 alarm	YELLOW
FQRC_4003_03_AL	Recirculation air flow reaches low level 1 alarm	YELLOW
FQRC_4003_03_ALL	Recirculation air flow reaches low level 2 alarm	RED
FQRC_4003_04_ERR	Total gas flow sensor link error	“ERR” text in RED
FQRC_4003_04_AHH	Total gas flow reaches high level 2 alarm	RED
FQRC_4003_04_AH	Total gas flow reaches high level 1 alarm	YELLOW
FQRC_4003_04_AL	Total gas flow reaches low level 1 alarm	YELLOW
FQRC_4003_04_ALL	Total gas flow reaches low level 2 alarm	RED
FT_4004_01_ERR	Reactor air outlet sensor link error	“ERR” text in RED
FT_4004_01_AHH	Reactor air outlet reaches high level 2 alarm	RED
FT_4004_01_AH	Reactor air outlet reaches high level 1 alarm	YELLOW
FT_4004_01_ALL	Reactor air outlet reaches low level 2 alarm	RED
FT_4004_01_AL	Reactor air outlet reaches low level 1 alarm	YELLOW
DPT_4004_01_ERR	Outlet gas differential pressure sensor link error	“ERR” text in RED
DPT_4004_01_AHH	Outlet gas differential pressure reaches high level 2 alarm	RED
DPT_4004_01_AH	Outlet gas differential pressure reaches high level 1 alarm	YELLOW
DPT_4004_01_ALL	Outlet gas differential pressure reaches low level 2 alarm	RED
DPT_4004_01_AL	Outlet gas differential pressure reaches low level 1 alarm	YELLOW
PT_4007_01_ERR	Reactor pressure sensor link error	“ERR” text in RED
PT_4007_01_AHH	Reactor pressure reaches high level 2 alarm	RED
PT_4007_01_AH	Reactor pressure reaches high level 1 alarm	YELLOW
PT_4007_01_AL	Reactor pressure reaches low level 1 alarm	YELLOW
PT_4007_01_ALL	Reactor pressure reaches low level 2 alarm	RED
PT_4007_02_ERR	Reactor pressure sensor link error	“ERR” text in RED
PT_4007_02_AHH	Reactor pressure reaches high level 2 alarm	RED
PT_4007_02_AH	Reactor pressure reaches high level 1 alarm	YELLOW
PT_4007_02_AL	Reactor pressure reaches low level 1 alarm	YELLOW
PT_4007_02_ALL	Reactor pressure reaches low level 2 alarm	RED
SV_4010_01_A	Gas inlet analyser in wrong position	RED and “ERR” text in RED
AT_4010_01_ERR	CO2 sensor link error	“ERR” text in RED
AT_4010_01_AH	CO2 analyser reaches high level 1 alarm	YELLOW
AT_4010_01_AHH	CO2 analyser reaches high level 2 alarm	RED
AT_4010_01_AL	CO2 analyser reaches low level 1 alarm	YELLOW
AT_4010_01_ALL	CO2 analyser reaches low level 2 alarm	RED
AT_4010_02_ERR	O2 sensor link error	“ERR” text in RED
AT_4010_02_AH	O2 analyser reaches high level 1 alarm	YELLOW
AT_4010_02_AHH	O2 analyser reaches high level 2 alarm	RED

TAG NAME	Description	Colour
AT_4010_02_AL	O2 analyser reaches low level 1 alarm	YELLOW
AT_4010_02_ALL	O2 analyser reaches low level 2 alarm	RED
AT_4010_03_ERR	Dissolved O2 sensor link error	"ERR" text in RED
AT_4010_03_AH	Dissolved O2 reaches high level 1 alarm	YELLOW
AT_4010_03_AHH	Dissolved O2 reaches high level 2 alarm	RED
AT_4010_03_AL	Dissolved O2 reaches low level 1 alarm	YELLOW
AT_4010_03_ALL	Dissolved O2 reaches low level 2 alarm	RED
PT_4010_01_ERR	Outlet gas pressure sensor link error	"ERR" text in RED
PT_4010_01_AH	Outlet gas pressure reaches high level 1 alarm	YELLOW
PT_4010_01_AHH	Outlet gas pressure reaches high level 2 alarm	RED
PT_4010_01_AL	Outlet gas pressure reaches low level 1 alarm	YELLOW
PT_4010_01_ALL	Outlet gas pressure reaches low level 2 alarm	RED
TT_4010_01_ERR	Analyser temperature sensor link error	"ERR" text in RED
TT_4010_01_AH	Analyser temperature reaches high level 1 alarm	YELLOW
TT_4010_01_AHH	Analyser temperature reaches high level 2 alarm	RED
TT_4010_01_AL	Analyser temperature reaches low level 1 alarm	YELLOW
TT_4010_01_ALL	Analyser temperature reaches low level 2 alarm	RED

Table 4-6: Alarm tags of the Gas loop of CIVa system

4.5.3 Tags

The following tags are displayed in this screen. (The user inputs are highlighted in green)

Tag Name	Description	Type	Units	Range
SV_4003_01_FB	Analyser gas inlet valve	2-way valve animated	---	---
SV_4003_01_OP	Activate valve in manual mode	User input	---	---
SV_4003_02_FB	Reactor air inlet vlave	2-way valve animated	---	---
SV_4003_02_OP	Activate valve in manual mode	User input	---	---
SV_4003_03_FB	Circulated gas blower bypass valve	2-way valve animated	---	---
SV_4003_03_OP	Activate valve in manual mode	User Input	---	---
PS_4003_01	Pressure switch bypass for recirculation	Digital indicator	---	---
BLWR_4003_01_MV1	Blower	Blower animated	---	---
BLWR_4003_01_MV1_OP	Start/Stop blower in manual mode	User input	---	---
FQRC_4003_01	Mass flow CO2 inlet	Analogue indicator	(mL/min)	0 to 5000
FQRC_4003_01_SP	Mass flow CO2 Inlet Set Point	Analogue Indicator	(mL/min)	0 to 5000
FQRC_4003_01_SP_OP	CO2 Set Point in Manual mode	User Input	(mL/min)	0 to 5000
FQRC_4003_02	Mass flow air inlet	Analogue indicator	(mL/min)	0 to 30000
FQRC_4003_02_SP	Mass flow air inlet set point	Analogue indicator	(mL/min)	0 to 30000
FQRC_4003_02_SP_OP	Air Inlet Set Point in manual mode	User input	(mL/min)	0 to 30000
FQRC_4003_03	Mass flow circulated Air	Analogue indicator	(mL/min)	0 to 30000
FQRC_4003_03_SP	Mass flow circulated air set poiont	Analogue indicator	(mL/min)	0 to 30000
FQRC_4003_03_SP_OP	Recycle flow set point in manual mode	User Input	(mL/min)	0 to 30000
FQRC_4003_04	Total mass flow Air Inlet	Analogue indicator	(mL/min)	0 to 30000
FQRC_4003_04_SP	Total Air flow inlet set point	Analogue indicator	(mL/min)	0 to 30000
FQRC_4003_04_SP_OP	Total air flow set point in manual mode	User input	(mL/min)	0 to 30000
SCV_4004_01_MV	Flow control air outlet valve	Analogue indicator	(%)	0 to 100
SCV_4004_01_OP	Proportional valve set point in manual mode	User input	(%)	0 to 100
FT_4004_01	Total air outlet from reactor	Analogue indicator	(mL/min)	0 to 20000
DPT_4004_01	Differential pressure filter	Analogue indicator	(mBar)	0 to 3000

Tag Name	Description	Type	Units	Range
PT_4007_01	Reactor pressure	Analogue indicator	(mBar)	-1000 to 1500
PT_4007_02	Reactor pressure	Analogue indicator	(mBar)	-1000 to 1500
PT_4007_SP	Pressure Set Point	User input	(mBar)	-1000 to 1500
SV_4010_01_FB	Gas inlet analyser valve	2-way valve animated	---	---
SV_4010_01_OP	Activate valve in manual mode	User input	---	---
HX_4010_01_MV1	Post condenser	Condenser animated	---	---
AT_4010_01	CO2 analyser	Analogue indicator	(ppm)	0 to 5000
AT_4010_02	O2 analyser	Analogue indicator	(%)	0 to 25
AT_4010_03	Dissolved O2	Analogue indicator	(%)	0 to 100
CL4010_O2_SP	O2 Set Point	User input	(%)	0 to 25
PT_4010_01	Outlet Gas Pressure	Analogue indicator	(mBar)	-1000 to 5000
TT_4010_01	Analyser temperature	Analogue indicator	(ºC)	0 to 150
CL4010_O2_PRODUCTION	Oxygen production calculation	Analogue indicator	TBD	TBD

Table 4-7: Tags of the Gas loop of CIVa system

4.5.4 Control loops

The following control loops are implemented on the screen:

Control Loop	Description
CL4003	Inlet Gas Mode
CL4003	Recycle Mode
CL4007	Reactor pressure mode
CL4009	Biomass cleaning mode
CL4010	Outlet Gas composition mode

Table 4-8: Control Loops of the Gas loop of CIVa system

4.6 Temperature Regulation screen

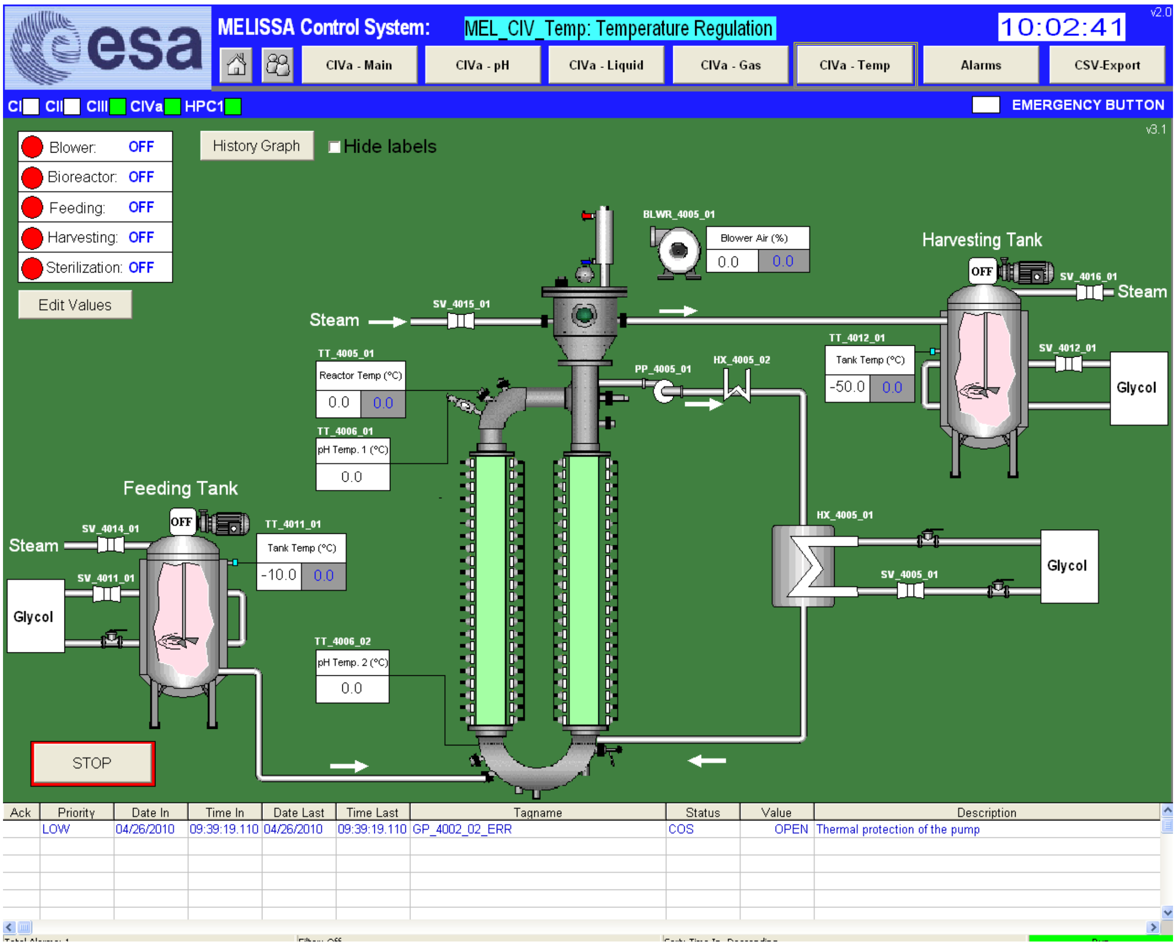


Figure 4-12: Main objects in CIVa Temp. Screen

4.6.1 General actions

This display allows the user to:

- Monitor the temperature of each tank and the blower air speed.
- Modify the temperature set-points of each of the tanks, the bioreactor and the blower air.
- Display the history graph clicking on the History graph command button.
- Hide labels selecting the “Hide labels” check box.

- Monitor the emergency button indicator. Background colour switch to red when one of the Emergency buttons is pushed.
- Stop all control loops implemented on the screen clicking “Stop” command button.
- Edit manual values clicking the “Edit Values” command button. In the Manual Values window user can switch between five submenus:
  - Blower Manual Mode: Allows activating blower (BLWR_4005_01) and manual value SP of blower speed.
  - Reactor Temperature Manual Mode: Allows activating pump PP_4005_01, valve SV_4005_01 and electrical resistor HX_4005_02.
  - Feeding Tank Temperature Manual Mode: Allows activating SV_4011_01 valve.
  - Harvesting Tank Temperature Manual Mode: Allows activating SV_4012_01 valve.
  - Sterilization Manual Mode: Allows activating SV_4014_01 valve (inlet steam into feeding tank), SV_4016_01 valve (inlet steam into harvesting tank) and SV_4015_01 valve (inlet steam into reactor).

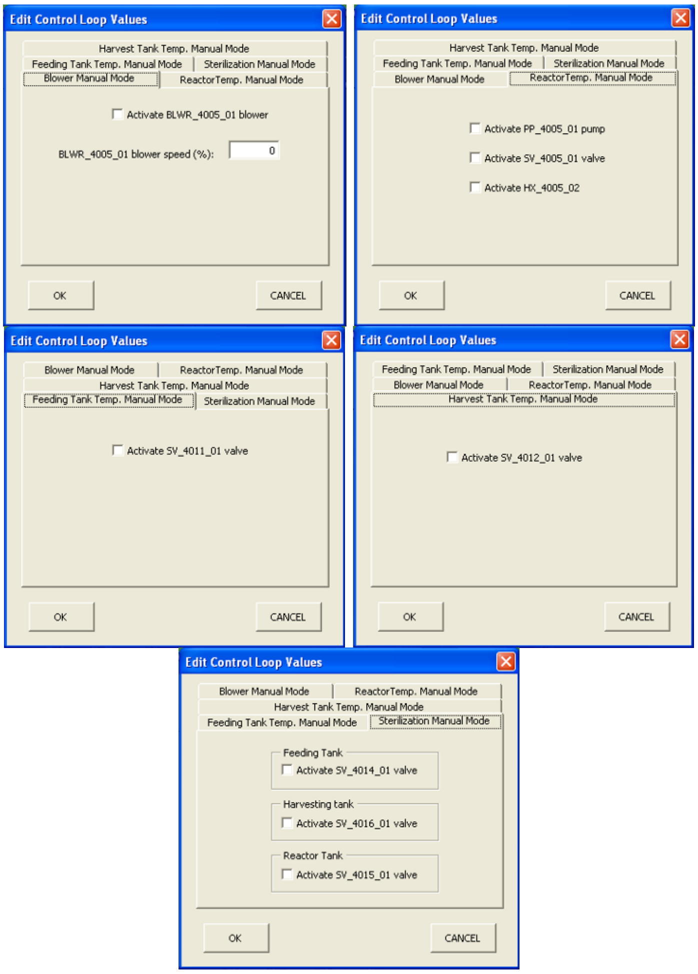


Figure 4-13: Edit Values Dialog

4.6.2 Alarms

The following alarms are linked with the operation of the gas control screen.

TAG NAME	Description	Colour
GP_4001_03_ERR	Feeding tank agitator thermal protection alarm	RED
GP_4002_03_ERR	Harvesting agitator thermal protection alarm	RED
BLWR_4005_01_ERR	Extractor thermal protection	RED
SV_4005_01_A	Cooling water outlet valve in wrong position	RED and “ERR” text in RED
TT_4005_01_ERR	Reactor temperature sensor link error	“ERR” text in RED
TT_4005_01_AHH	Reactor temperature reaches high level 2 alarm	RED
TT_4005_01_AH	Reactor temperature reaches high level 1 alarm	YELLOW
TT_4005_01_ALL	Reactor temperature reaches low level 2 alarm	RED
TT_4005_01_AL	Reactor temperature reaches low level 1 alarm	YELLOW
TT_4006_01_ERR	Temperature of the pH sensor (top) link error	“ERR” text in RED
TT_4006_02_ERR	Temperature of the pH sensor (bottom) link error	“ERR” text in RED
SV_4011_01_A	Influent tank temperature control valve in wrong position	RED and “ERR” text in RED
TT_4011_01_ERR	Influent tank temperature sensor link error	“ERR” text in RED
TT_4011_01_AH	Influent tank temperature reaches high level 1 alarm	YELLOW
TT_4011_01_AHH	Influent tank temperature reaches high level 2 alarm	RED
TT_4011_01_AL	Influent tank temperature reaches low level 1 alarm	YELLOW
TT_4011_01_ALL	Influent tank temperature reaches low level 2 alarm	RED
SV_4012_01_A	Harvesting tank temperature control valve in wrong position	RED and “ERR” text in RED
TT_4012_01_ERR	Harvesting tank sensor link error	“ERR” text in RED
TT_4012_01_AH	Harvesting tank temperature reaches high level 1 alarm	YELLOW
TT_4012_01_AHH	Harvesting tank temperature reaches high level 2 alarm	RED
TT_4012_01_AL	Harvesting tank temperature reaches low level 1 alarm	YELLOW
TT_4012_01_ALL	Harvesting tank temperature reaches low level 2 alarm	RED
SV_4014_01_A	Influent tank, steam inlet valve in wrong position	RED and “ERR” text in RED
SV_4015_01_A	Reactor steam inlet valve in wrong position	RED and “ERR” text in RED
SV_4016_01_A	Harvesting tank steam inlet valve in wrong position	RED and “ERR” text in RED

Table 4-9: Alarm tags of the Temperature screen of CIVa system

4.6.3 Tags

The following tags are displayed in this screen. (The user inputs are highlighted in green)

Tag Name	Description	Type	Units	Range
GP_4001_03_MV1	Feeding tank agitator	Agitator animated	---	---
GP_4002_03_MV1	Harvesting tank agitator	Agitator animated	---	---
SV_4005_01_FB	Cooling water outlet valve	2-way valve animated	---	---
SV_4005_01_OP	Activate valve in manual mode	User Input	---	---
PP_4005_01_MV1	Reactor temperature control pump	ºPump animated	---	---
PP_4005_01_OP	Start/Stop pump in manual mode	User Input	---	---
BLWR_4005_01_MV1	Start/Stop blower air	Blower animated	---	---
BLWR_4005_01_MV1_OP	Start/Stop blower in manual mode	User Input	---	---
HX_4005_02_MV1	Electrical resistance	Resistance animated	---	---
HX_4005_02_OP	Start/Stop electrical resistor in manual mode	User Input	---	---
BLWR_4005_01_MV2	Speed of Blower air	Analogue indicator	(%)	0 to 100
BLWR_4005_01_MV2_OP	Speed of Blower air in manual mode	User Input	(%)	0 to 100
TT_4005_01	Reactor temperature	Analogue indicator	(ºC)	0 to 150
TT_4005_01_SP	Reactor temperature set point	User Input	(ºC)	0 to 150
TT_4006_01	pH probe Temperature	Analogue indicator	(ºC)	0 to 140
TT_4006_02	pH probe Temperature	Analogue indicator	(ºC)	0 to 140
SV_4011_01_FB	Feeding tank cooling water valve	2-way valve animated	---	---
SV_4011_01_OP	Activate/Deactivate valve in	User input	---	---

Tag Name	Description	Type	Units	Range
	manual mode			
TT_4011_01	Feeding tank temperature	Analogue indicator	(ºC)	-10 to 150
TT_4011_SP	Feeding tank temperature set point	User Input	(ºC)	-10 to 150
SV_4012_01_FB	Harvesting tank cooling water valve	2-way valve animated	---	---
SV_4012_01_OP	Activate/Deactivate valve in manual mode	User Input	---	---
TT_4012_01	Harvesting tank temperature	Analogue indicator	(ºC)	-50 to 250
TT_4012_SP	Harvesting tank temperature set point	User input	(ºC)	-50 to 250
SV_4014_01_FB	Feeding tank steam inlet valve	2-way valve animated	---	---
SV_4014_01_OP	Activate/Deactivate valve in manual mode	User Input	---	---
SV_4015_01_FB	Reactor steam inlet valve	2-way valve animated	---	---
SV_4015_01_OP	Activate/Deactivate valve in manual mode	User Input	---	---
SV_4016_01_FB	Harvesting tank steam inlet valve	2-way valve animated	---	---
SV_4016_01_OP	Activate/Deactivate valve in manual mode	User Input	---	---

Table 4-10: Tags of the Temperature screen of CIVa system

4.6.4 Control loops

The following control loops are implemented on the screen:

Control Loops	Description
CL4005	Blower Mode
CL4005	Reactor Temperature mode
CL4011	Feeding tank temperature control
CL4012	Harvesting tank temperature control
CL4014	Feeding tank sterilisation control
CL4015	Reactor sterilisation control
CL4016	Harvesting tank sterilisation control

Table 4-11: Control Loops of the Temperature screen of CIVa system

4.7 pH Loop screen

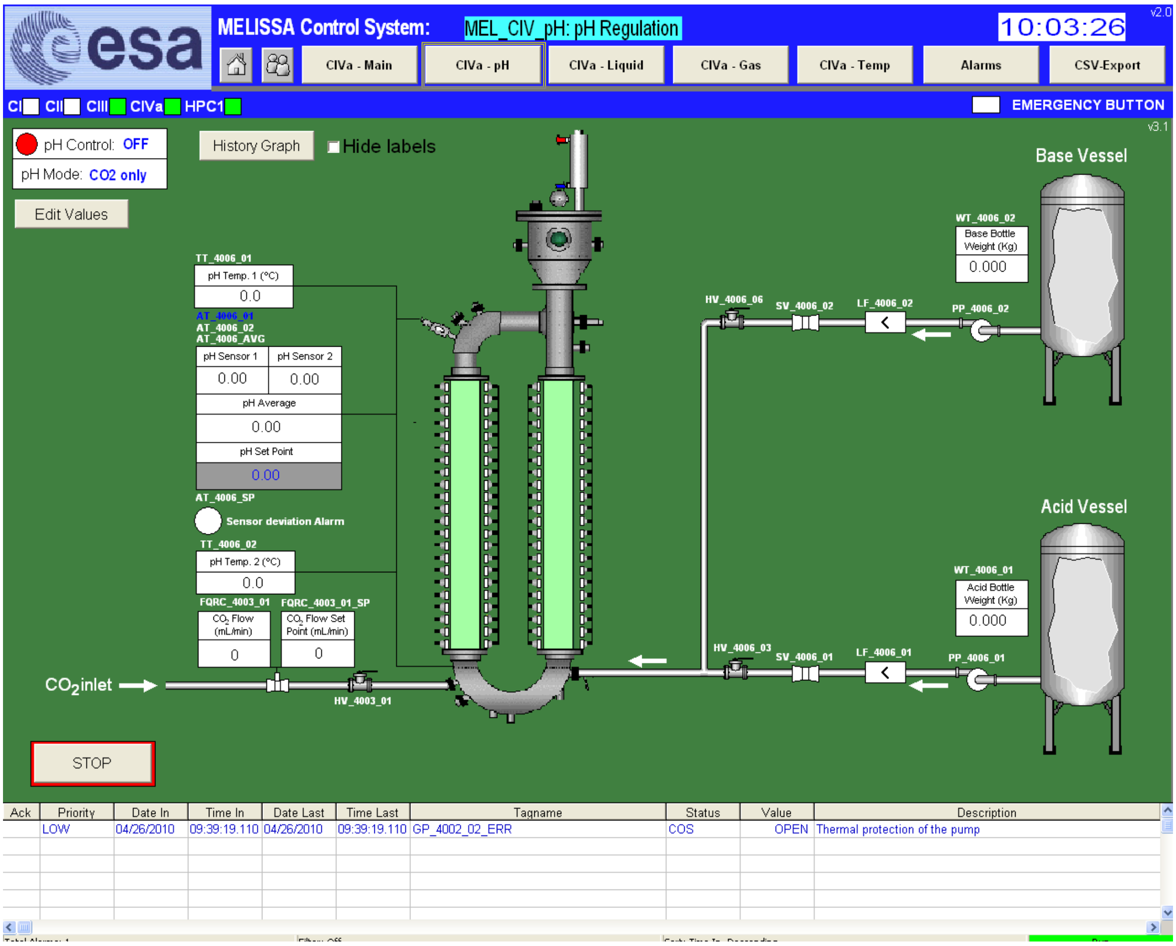


Figure 4-14: Main objects in CIVa pH Screen

4.7.1 General actions

This display allows the user to:

- Monitor the pH values and the temperature of each pH sensor.
- Monitor the weight of acid and base vessels.
- Monitor the CO_2 flow.
- Select the pH probe to control, clicking over the pH sensor indicators. The label of the selected sensor will be highlighted in blue.

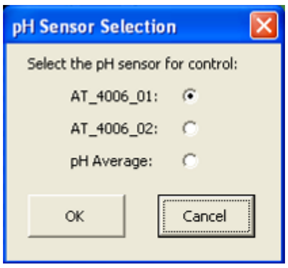


Figure 4-15: pH Sensor selection in CIVa pH Screen

- Modify the pH set-point.
- Display the history graph clicking on the History graph command button.

- Hide labels selecting the “Hide labels” check box.
- Monitor the emergency button indicator. Background colour switch to red when one of the Emergency buttons is pushed.
- Stop all control loops implemented on the screen clicking “Stop” command button.
- Edit manual values clicking the “Edit Values” command button. In the Manual Values window user can switch between two submenus:
    - pH Manual Mode: Allows activating the acid and base pumps and valves (PP_4006_01, PP_4006_02, SV_4006_01 and SV_4006_02 respectively) and select the opening time. Moreover allows selecting the Manual Value Set-Point for the CO_2 valve.
    - pH Automatic Mode: Allows resetting the pH timers and selecting the pH Set-Point and the pH dead zone. Furthermore it is possible to read the date and time of the last timer reset and the opened time of the acid and the base injections.

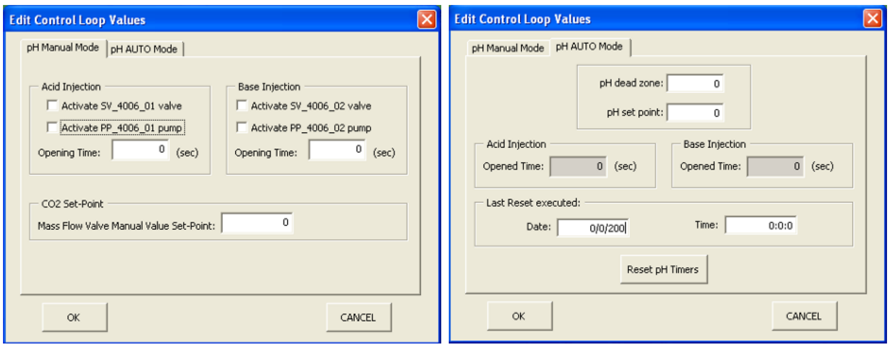


Figure 4-16: Edit Values Dialog

- Select the pH control mode, clicking over the pH mode indicator.

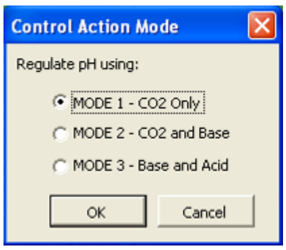


Figure 4-17: pH Mode

This loop controls the pH within the reactor. According to the measurement position in comparison to the pH set point the regulator activates the acid solution or basic solution pumps. A probe placed on the top of the engine provides the pH measurement for the control system. There is another probe in the bottom of the engine. The user can select the usable probe to control the process.

There are three modes of regulation:

Mode	Description	CO_2 flow	Base pump	Acid pump
1	Only CO_2 is used to regulate pH	Enabled	Disabled	Disabled
2	CO_2 and Base medium is used to regulate pH.	Enabled	Enabled	Disabled
3	Base and additional Acid media is	Disabled	Enabled	Enabled

	used to regulate pH.			

Actuating in mode 1 or 2, the inlet gas flow control is deactivated.

4.7.2 Alarms

The following alarms are linked with the operation of the pH control screen.

TAG NAME	Description	Colour
FQRC_4003_01_ERR	CO2 flow sensor link error	“ERR” text in RED
FQRC_4003_01_AHH	CO2 flow reaches high level 2 alarm	RED
FQRC_4003_01_AH	CO2 flow reaches high level 1 alarm	YELLOW
FQRC_4003_01_AL	CO2 flow reaches low level 1 alarm	YELLOW
FQRC_4003_01_ALL	CO2 flow reaches low level 2 alarm	RED
SV_4006_01_A	Acid valve in wrong position	RED and “ERR” text in RED
SV_4006_02_A	Base valve in wrong position	RED and “ERR” text in RED
WT_4006_01_AL	Acid bottle weight reaches low level 1 alarm	YELLOW
WT_4006_01_ALL	Acid bottle weight reaches low level 2 alarm	RED
WT_4006_02_AL	Base bottle weight reaches low level 1 alarm	YELLOW
WT_4006_02_ALL	Base bottle weight reaches low level 2 alarm	RED
CL4006_pH_AHH	Reactor pH reaches high level 2 alarm	RED
CL4006_pH_AH	Reactor pH reaches high level 1 alarm	YELLOW
CL4006_pH_AL	Reactor pH reaches low level 1 alarm	YELLOW
CL4006_pH_ALL	Reactor pH reaches low level 2 alarm	RED
AT_4006_01_ERR	Reactor pH sensor (top) link error	“ERR” text in RED
TT_4006_01_ERR	Temperature of the pH sensor (top) link error	“ERR” text in RED
AT_4006_02_ERR	Reactor pH sensor (bottom) link error	“ERR” text in RED
TT_4006_02_ERR	Temperature of the pH sensor (bottom) link error	“ERR” text in RED

Table 4-12: Alarm tags of the pH screen of CIVa system

4.7.3 Tags

The following tags are displayed in this screen. (The user inputs are highlighted in green)

Tag Name	Description	Type	Units	Range
FQRC_4003_01	Mass flow CO2 inlet	Analogue indicator	(mL/min)	0 to 5000
FQRC_4003_01_SP	Mass flow CO2 Set Point	Analogue indicator	(mL/min)	0 to 5000
FQRC_4003_01_SP_OP	Mass Flow CO2 Set Point in manual mode	User Input	(mL/min)	0 to 5000
SV_4006_01_FB	Acid inlet valve to reactor	2-way valve animated	---	---
SV_4006_01_OP	Activate/Deactivate valve in manual mode	User input	---	---
SV_4006_02_FB	Base inlet valve to reactor	2-way valve animated	---	---
SV_4006_02_OP	Activate/Deactivate valve in manual mode	User Input	---	---
PP_4006_01_MV1	Start/Stop acid pump	Pump animated	---	---
PP_4006_01_OP	Start/Stop acid pump in manual mode	User input	---	---
PP_4006_02_MV1	Start/Stop base pump	Pump animated	---	---
PP_4006_02_OP	Start/Stop base pump in manual mode	User Input	---	---
WT_4006_01	Acid balance	Analogue indicator	(Kg.)	0 to 6
WT_4006_02	Base balance	Analogue indicator	(Kg.)	0 to 6
AT_4006_01	pH	Analogue indicator	(pH)	0 to 12
TT_4006_01	pH probe Temperature	Analogue indicator	(ºC)	0 to 140
AT_4006_02	pH	Analogue indicator	(pH)	0 to 12
TT_4006_02	pH probe Temperature	Analogue indicator	(ºC)	0 to 140
AT_4006_AVG	pH average	Analogue indicator	(pH)	0 to 12
AT_4006_SP	pH Set Point	User Input	(pH)	0 to 12
CL4006_PH_DEADZONE	pH Dead Zone	User Input	(pH)	0 to 1
CL4006_ACID_OP_Time	ACID time for injection	User Input	(seconds)	1000
CL4006_BASE_OP_Time	BASE time for injection	User Input	(seconds)	1000
CL4006_Base_Opening_Time	Base injection time (seconds)	Analogue indicator	(seconds)	1000
CL4006_Acid_Opening_Time	Acid injection time (seconds)	Analogue indicator	(seconds)	1000
CL4006_pH_Second	Date of the last reset done	Analogue indicator	(seconds)	0 to 59
CL4006_pH_Minute	Date of the last reset done	Analogue indicator	(minute)	0 to 59
CL4006_pH_Hour	Date of the last reset done	Analogue indicator	(hour)	0 to 23
CL4006_pH_Day	Date of the last reset done	Analogue indicator	(day)	1 to 31
CL4006_pH_Month	Date of the last reset done	Analogue indicator	(month)	1 to 12
CL4006_pH_Year	Date of the last reset done	Analogue indicator	(year)	9 to 99
CL4006_pH_Reset_timer	Reset of the pH timer	User Input	---	---

Table 4-13 Tags of the pH screen of CIVa system

4.7.4 Control loops

The following control loops are implemented on the screen:

Control Loops	Description
CL4006	pH Control Mode

Table 4-14: Control Loops of the pH screen of CIVa system

5. LOCAL HMI SOFTWARE OPERATION

5.1 HMI GENERAL LAYOUT

HMI displays are composed by a navigation area, placed at the top of the window with blue background, a working area with a white background and an information area placed at the bottom of the window with grey background.

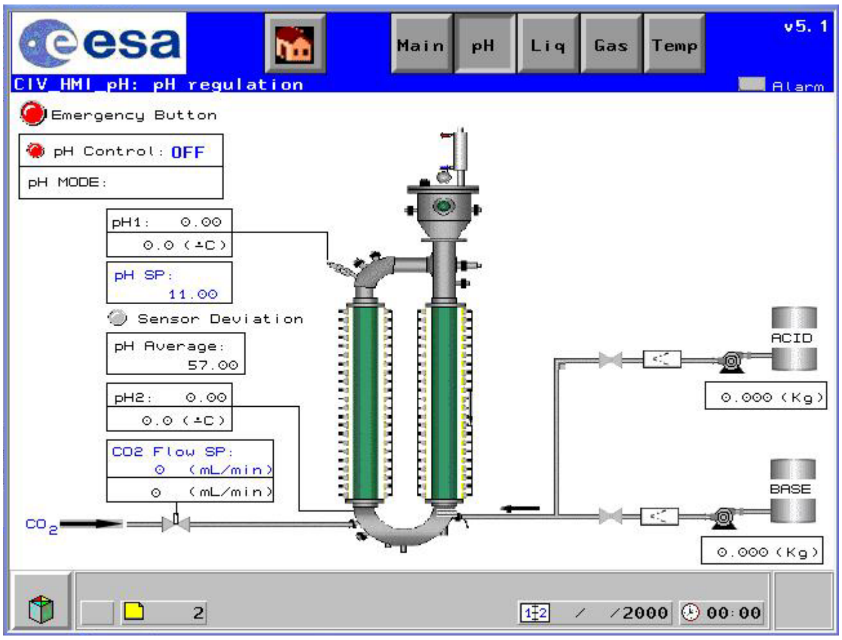


Figure 5-1: Local HMI Layout

5.1.1 Working Area

The working area is where the values are displayed in form of object animations (pumps, valves, etc.) and numerical values.

5.1.1.1 Emergency button indicator

Emergency button is placed on the upper left corner of the working area and changes to red colour when anyone of the stop buttons, placed in each side of the CIII frame, is pushed.

5.1.1.2 Control loop mode indicators

Under the Emergency button indicator, there are placed the control loops indicators of the process displayed. Circle colour and text are animated depending on 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”.

5.1.2 Navigation Area

Navigation area is placed on the top of the window. It consists of European Space Agency logo, title of the process displayed, buttons to navigate to the indicated process display or to come back to the HMI main display and CIII general alarm indicator.

5.1.3 Information Area

This area shows the display number, the date and the time.

5.1.3.1 System Button

The System Button is placed on the left corner of this area. By pressing this button the System Toolbar is displayed.

5.1.3.2 System Toolbar

ESC	Return to previous screen.
HOME	Navigate to the Main Display.
MENU	Access to system menu with generic system options (List of pages, List of recipes, List of forms, Password, List of Alarms, Alarm history, Stop printing, Screen lock mode).
SYST	Access to system information menu (Terminal parameters, Protocol parameters, Printer parameters, Password, Product references, Adjust page, PLCs in online mode)
ALARM	Access to alarm screen (not implemented).
HELP	No action (not implemented).

5.2 LOCAL HMI HIERARCHY

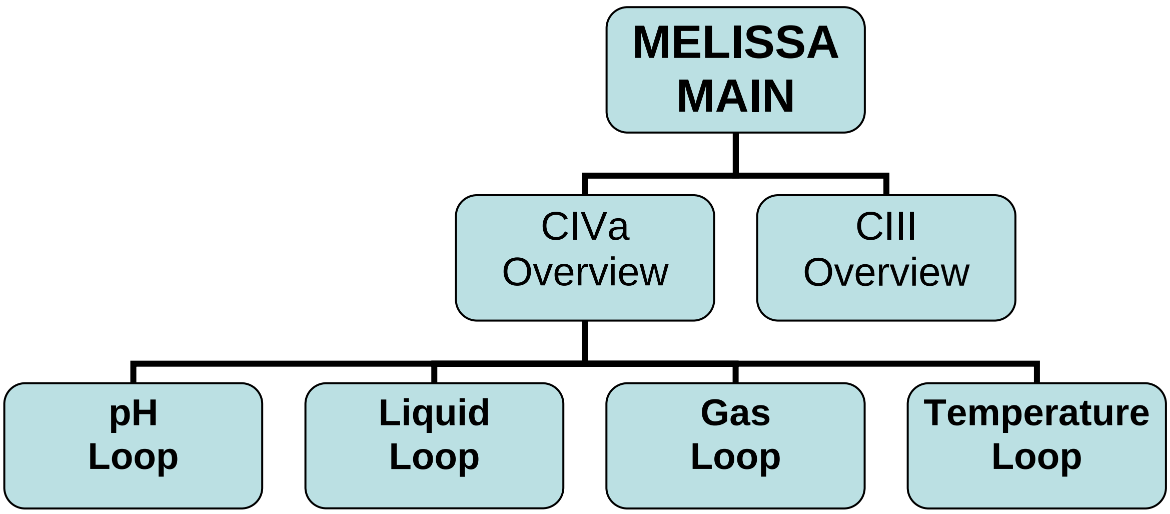


Figure 5-2: Local HMI Interface architecture

The local HMI will allow the user to interact with the PLC. Through the HMI the user can check and monitor the system operation; however the user won't be able to modify control settings of the compartment from it. Figure 5-2 shows the general hierarchy of the CIVa screens. The user can navigate through these screens in order to monitor the different loops implemented in the reactor. This tree establishes the logical relations among the screens. The MELiSSA Main displays general parameters from the CIII and CIVa reactors. In the next level, as can be seen in Figure 5-4, the main CIVa screen will show an overview of the most significant values of the CIVa. From there, the user will be able to navigate to the third level screens that represent the different loops in the CIVa: pH, Liquid, Gas and Temperature.

5.3 LOCAL HMI DISPLAYS

5.3.1 HMI Main Display

It displays principal values of the compartments III and IVa. It allows navigation to the compartments III and IVa specific displays.

Figure 5-3: Local HMI Main Display

5.3.1.1 Tag definition

The following tags are displayed in this screen.

Tag Name	Description	Type	Units	Range
FT_3003_01	Feeding flow	Analogue	(L/h)	0 to 2
AT_3009_02	Dissolved O_2	Analogue	(%)	0 to 100
AT_3013_03	NO_2^- analyser	Analogue	(ppm)	0 to 20
FT_3018_01	Harvest flow	Analogue	(L/h)	0 to 2
FT_4001_01	Inlet liquid flow to reactor	Analogue	(L/h)	0 to 4
CL4002_PumpSpeed	Flow to the outlet pump	Analogue	(%)	0 to 100
CL4009_Biomass_Production	Biomass Production	Analogue	(g/H)	TBD
AT_4010_02	O_2 Analyser	Analogue	(%)	0 to 25

Table 5-1: Tags of the HMi Main Screen

Date and system clock values displayed in the Melissa CIVa screens are read from CIVa PLC system clock. Following tags are displayed:

- Day: CIVa_SysClock_day (PLC address: 400411)

- Month: CIVa_SysClock_month (PLC address: 400410)
- Year: CIVa_SysClock_Year (PLC address: 400409)
- Hour: CIVa_SysClock_Hour (PLC address: 400412)
- Minute: CIVa_SysClock_Min (PLC address: 400413)

5.3.2 Compartment IVa – Main

It displays the principal values of the Compartment IVa.

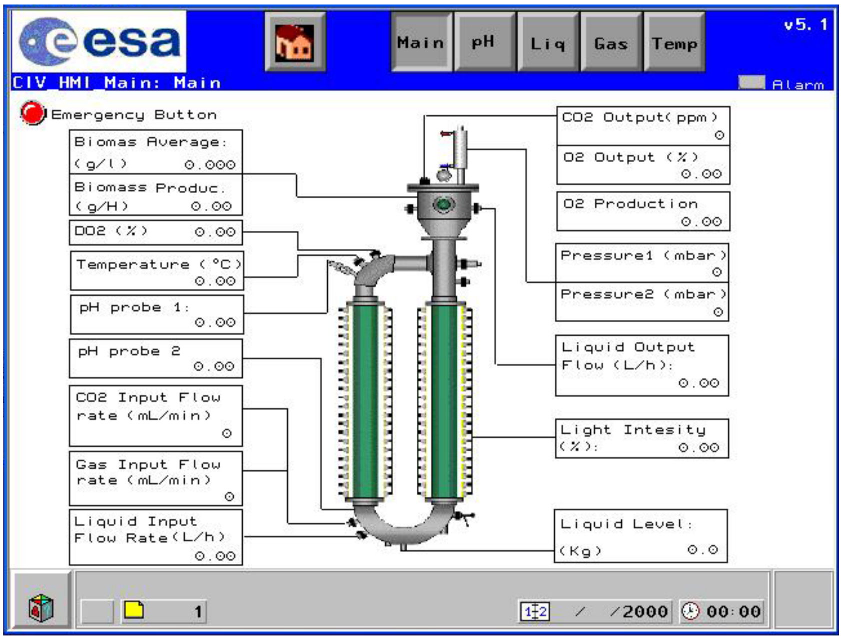


Figure 5-4: CIVa Main Screen

To have a general overview of the Compartment CIVa, a general schematic will appear in the computer display when user opens the CIVa system. The diagram that represents the overview of the system will be something similar as shown in *Figure 5-4*. From this screen the user can navigate to the other CIVa screens (pH, Biomass, Gas and Temperature). For instance, if the user calls the pH screen, a diagram of this unit will come into view and its instrumentation (valves, pumps, tanks, etc) can be distinguished as well as the different values of the variables that allow controlling it.

5.3.2.1 Tag definition

The following tags are displayed in this screen.

Tag Name	Description	Type	HMI address	Units	Range
IRC_4000_MV	Light intensity	Analogue	400262	(%)	0 to 100
FT_4001_01	Inlet liquid flow to reactor	Analogue	400148	(L/h)	0 to 4
CL4002_EstimatedOutletLiquidFlow	Estimated Outlet Liquid flow	Analogue	400326	(L/h)	TBD
FQRC_4003_01	Total mass flow CO2 inlet	Analogue	400176	(mL/min)	0 to 5000
FQRC_4003_04	Total mass flow air inlet	Analogue	400182	(mL/min)	0 to 30000
TT_4005_01	Reactor temperature	Analogue	400168	(ºC)	0 to 150

Tag Name	Description	Type	HMI address	Units	Range
AT_4006_01	pH sensor	Analogue	400138	(pH)	0 to 12
AT_4006_02	pH sensor	Analogue	400140	(pH)	0 to 12
PT_4007_01	Reactor pressure	Analogue	400156	(mBar)	-1000 to 1500
PT_4007_02	Reactor pressure	Analogue	400158	(mBar)	-1000 to 5000
AT_4009_01	Biomass concentration	Analogue	400124	(g/l)	0 to 5
AT_4009_02	Biomass concentration	Analogue	400126	(g/l)	0 to 5
CL4009_Biomass_Production	Biomass production	Analogue	400230	(g/H)	
AT_4010_01	CO2 Analyser	Analogue	400130	(ppm)	0 to 5000
AT_4010_02	O2 Analyser	Analogue	400132	(%)	0 to 25
CL4010_O2_PRODUCTION	Oxygen production	Analogue	400328	TBD	TBD
CIVa_Emergency_button	Emergency button pushed	Digital indicator	100111	---	---
CIVa_General_Alarm_status	CIVa general alarm status	Digital indicator	400279	---	---

Table 5-2: Tags of the CIVa system main screen of the local HMI

5.3.3 Compartment IVa – pH

It displays values related to the pH regulation.

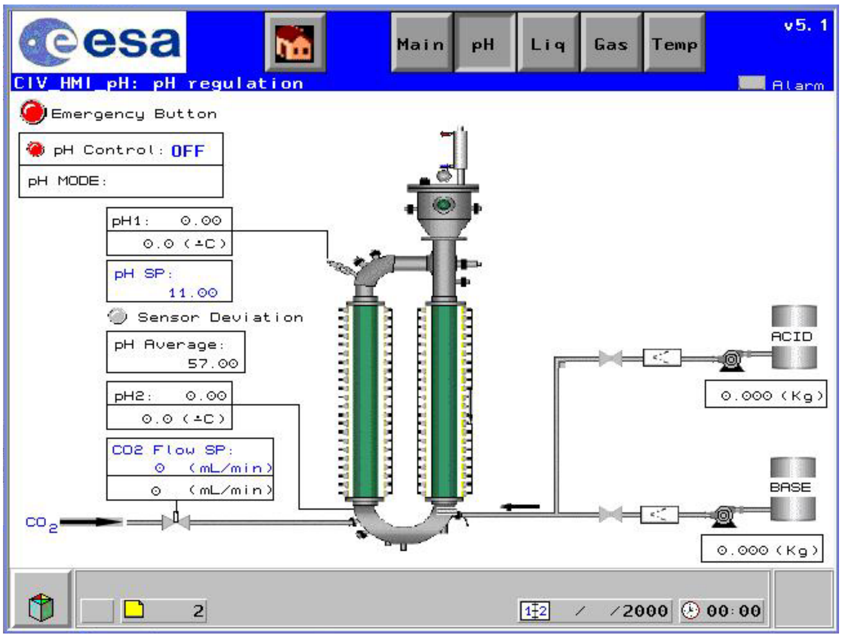


Figure 5-5: Local HMI Compartment IVa – pH Display

This display allows the user to:

- Monitor the pH values and the temperature of each pH sensor.
- Monitor the weight of acid and base vessels.
- Monitor the CO_2 flow.
- Monitor the pH set-point.
- Monitor the emergency button indicator. Background colour switch to red when one of the Emergency buttons is pushed.
- Monitor the control loops mode (OFF, AUTO, MAN) implemented in the screen.

- Monitor the pH mode for the bioreactor pH control (CO2 Only, CO2+base or Acid+base).

5.3.4 Control Loops

The following control loops are implemented on the screen:

Control Loops	Description
CL4006	pH control mode

Table 5-3: Control Loops of the pH loop of the CIVa system local HMI

5.3.4.1 Tag definition

The following tags are displayed in this screen.

Tag Name	Description	Type	Units	Range
FQRC_4003_01_SP	Mass flow CO2 inlet set point	Analogue indicator	(mL/min)	0 to 5000
FQRC_4003_01	Mass flow CO2 inlet	Analogue indicator	(mL/min)	0 to 5000
AT_4006_SP	pH set point	Analogue indicator	(pH)	0 to 12
AT_4006_01	pH probe	Analogue indicator	(pH)	0 to 12
AT_4006_02	pH probe	Analogue indicator	(pH)	0 to 12
TT_4006_01	Temperature of the pH probe (AT_4006_01)	Analogue indicator	(ºC)	0 to 140
TT_4006_02	Temperature of the pH probe (AT_4006_02)	Analogue indicator	(ºC)	0 to 140
AT_4006_AVG	pH average	Analogue indicator	(pH)	0 to 12
WT_4006_01	Acid vessel weight	Analogue indicator	(Kg.)	0 to 6
WT_4006_02	Base vessel weight	Analogue indicator	(Kg.)	0 to 6
PP_4006_01_MV1	Acid peristaltic pump	Pump animated	---	---
PP_4006_02_MV1	Base peristaltic pump	Pump animated	---	---
SV_4006_01_FB	Acid valve	2-way valve animated	---	---
SV_4006_02_FB	Base valve	2-way valve animated	---	---
CL4006_pH_Mode	Mode of regulation (CO2 only, CO2+Base or Acid+Base)	Text animated	---	---
CIVa_Emergency_button	Emergency button pushed	Digital indicator	----	---
CIVa_General_Alarm_status	Indicates if there is some alarm activated.	Digital indicator	---	0 to 2

Table 5-4: Tags of the pH loop of the CIVa system local HMI

5.3.5 Compartment IVa – Liquid

It displays values participating in the liquid input / output regulation.

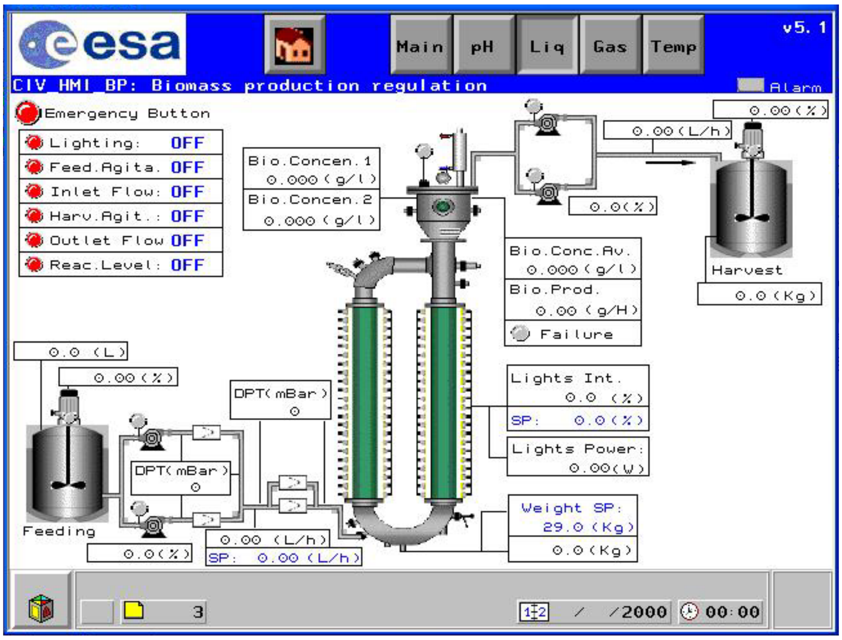


Figure 5-6: Local HMI Compartment IVa - Liquid

This display allows the user to:

- Monitor the measurements of the liquid level of the reactor, the level of input and output tank, the state and speed of the feeding and harvest tanks agitators, the input/output flow rates, biomass concentration, biomass production, input/output differential pressure and lights intensity.
- Monitor the Set-Points of the reactor level and biomass concentration.
- Monitor the emergency button indicator. Background colour switch to red when one of the Emergency buttons is pushed.
- Monitor the control loops mode (OFF, AUTO, MAN) implemented in the screen.

5.3.5.1 Control Loops

The following control loops are implemented on the screen:

Control Loops	Description
CL4000	Lighting Mode
CL4001	Feeding Agitator Mode
CL4001	Inlet flow mode
CL4002	Harvest Agitator Mode
CL4002	Outlet flow mode
CL4008	Reactor level mode

Table 5-5: Control Loops of the Biomass loop of the CIVa system local HMI

5.3.5.2 Tag definition

The following tags are displayed in this screen.

Tag Name	Description	Type	Units	Range
IRC_4000_MV	Light intensity (%)	Analogue indicator	(%)	0 to 100
IT_4000_PWR	Lights power (W)	Analogue indicator	(W)	TBD
I_4000_SP	Light intensity set point	Analogue indicator	(%)	0 to 100

Tag Name	Description	Type	Units	Range
LT_4001_01	Feeding tank level	Analogue indicator	(L)	0 to 160
FT_4001_01	Liquid inlet flow to reactor	Analogue indicator	(L/h)	0 to 4
FT_4001_01_SP	Liquid inlet flow rate set point	Analogue indicator	(L/h)	0 to 4
DPT_4001_01	Differential pressure filter	Analogue indicator	(mBar)	0 to 3000
DPT_4001_02	Differential pressure filter	Analogue indicator	(mBar)	0 to 3000
GP_4001_01_MV1	Feeding pump state	Pump animated	(%)	0 to 100
GP_4001_02_MV1	Feeding pump state	Pump animated	(%)	0 to 100
GP_4001_03_MV1	Feeding tank agitator state	Digital indicator	---	---
GP_4001_03_MV2	Feeding tank agitator speed	Analogue indicator	(%)	0 to 100
CL4001_PumpSpeed	Flow to the inlet pump	Analogue indicator	(%)	0 to 100
PS_4001_01	Pressure pump GP_4001_01	Pressure switch animated	---	---
PS_4001_02	Pressure pump GP_4001_02	Pressure switch animated	---	---
GP_4002_01_MV1	Harvest pump state	Pump animated	---	---
GP_4002_02_MV1	Harvest pump state	Pump animated	---	---
GP_4002_03_MV1	Harvest agitator state	Agitator animated	---	---
GP_4002_03_MV2	Speed of harvest agitator	Analogue indicator	(%)	0 to 100
CL4002_PumpSpeed	Flow to the outlet pump	Analogue indicator	(%)	0 to 100
PS_4002_01	Harvest pump pressure	Pressure switch indicator	---	---
PS_4002_02	Harvest pump pressure	Pressure switch indicator	---	---
WT_4002_01	Weight harvest tank	Analogue indicator	(Kg.)	0 to 600
CL4002_EstimatedOutletLiquidFlow	Estimated Outlet Liquid Flow	Analogue indicator	(L/h)	TBD
WT_4008_01	Weight Balance (reactor)	Analogue indicator	(Kg.)	0 to 100
WT_4008_SP	Weight balance set point	Analogue indicator	(Kg.)	0 to 100
CL4009_Biomass_production	Biomass production (g/l/h)	Analogue indicator	(g/H)	
AT_4009_01	Biomass concentration (g/l)	Analogue indicator	(g/l)	0 to 5
AT_4009_02	Biomass concentration (g/l)	Analogue indicator	(g/l)	0 to 5
AT_4009_AVG	Biomass concentration average (g/l)	Analogue indicator	(g/l)	0 to 5
AT_4009_SensorFailure	Indicates if biomass probe is failure	Analogue indicator	---	---
LS_4013_01	Foam detection	Switch detection	---	---
CIVa_Emergency_button	Emergency button pushed	Digital indicator	---	---
CIVa_General_Alarm_status	Indicates if there is some alarm activated.	Digital indicator	---	---

Table 5-6: Tags of the Biomass production screen of the CIVa system local HMI

5.3.6 Compartment IVa - Gas

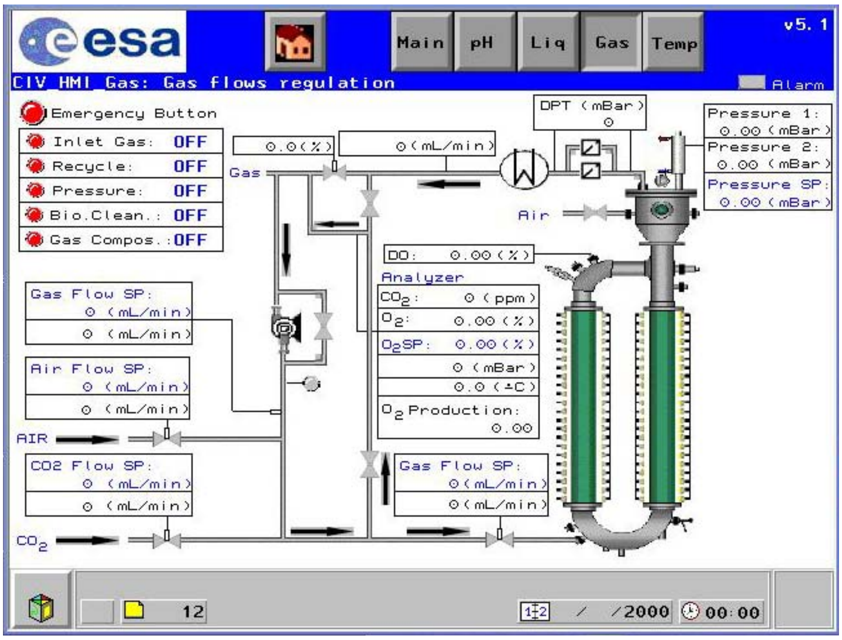


Figure 5-7: Local HMI Compartment IVa - Gas

This display allows the user to:

- Monitor the Air flow, the CO_2 gas flow, total gas flow inlet, total gas flow outlet, outlet gas pressure, outlet gas composition (CO_2 and O_2), reactor pressure and pressure switch state.
- Monitor the set-points of CO_2 input flow, air input flow, total gas input flow, reactor pressure and oxygen dissolved.
- Monitor the emergency button indicator. Background colour switch to red when one of the Emergency buttons is pushed.
- Monitor the control loops mode (OFF, AUTO, MAN) implemented in the screen.

5.3.6.1 Control Loops

The following control loops are implemented on the screen:

Control Loops	Description
CL4003	Air inlet mode
CL4003	Recycle mode
CL4007	Pressure mode
CL4009	Biomass cleaning mode
CL4010	Outlet gas composition mode

Table 5-7: Control Loops of the Gas loop of the CIVa system local HMI

5.3.6.2 Tag definition

The following tags are displayed in this screen.

Tag Name	Description	Type	Units	Range
FQRC_4003_01_SP	Mass flow CO2 inlet set point	Analogue indicator	(mL/min)	0 to 5000
FQRC_4003_01	Mass flow CO2 inlet	Analogue indicator	(mL/min)	0 to 50000
FQRC_4003_02_SP	Mass flow Air inlet set	Analogue indicator	(mL/min)	0 to 30000

Tag Name	Description	Type	Units	Range
	point			
FQRC_4003_02	Mass flow air inlet	Analogue indicator	(mL/min)	0 to 30000
FQRC_4003_03_SP	Mass flow circulated air set point	Analogue indicator	(mL/min)	0 to 30000
FQRC_4003_03	Mass flow circulated air.	Analogue indicator	(mL/min)	0 to 30000
FQRC_4003_04_SP	Total mass flow air inlet set point	Analogue indicator	(mL/min)	0 to 30000
FQRC_4003_04	Total mass flow air inlet	Analogue indicator	(mL/min)	0 to 30000
SV_4003_01_FB	Analyser gas inlet valve	2-way valve animated	---	---
SV_4003_02_FB	Reactor Air Inlet	2-way valve animated	---	---
SV_4003_03_FB	Circulated gas blower bypass valve	2-way valve animated	---	---
BLWR_4003_01_MV1	Blower state	Blower animated	---	---
PS_4003_01	Pressure switch bypass for recycling	Pressure switch animated	---	---
FT_4004_01	Total air outlet from reactor.	Analogue indicator	(mL/min)	0 to 20000
DPT_4004_01	Differential pressure filter	Analogue indicator	(mBar)	0 to 3000
SCV_4004_01_MV	Flow control air outlet valve	Analogue indicator	(%)	0 to 100
PT_4007_01_SP	Pressure set point	Analogue indicator	(mBar)	-1000 to 1500
PT_4007_01	Reactor pressure	Analogue indicator	(mBar)	-1000 to 1500
PT_4007_02	Reactor pressure	Analogue indicator	(mBar)	-1000 to 5000
PT_4010_01	Outlet gas pressure	Analogue indicator	(mBar)	-1000 to 5000
AT_4010_01	CO2 analyzer	Analogue indicator	(ppm)	0 to 5000
AT_4010_02	O2 analyzer	Analogue indicator	(%)	0 to 25
AT_4010_03	Dissolved O2	Analogue indicator	(%)	0 to 100
CL4010_O2_SP	O2 set point	Analogue indicator	(%)	0 to 25
TT_4010_01	Temperature of the gas analyzer	Analogue indicator	(ºC)	0 to 150
CL4010_O2_Production	Oxygen production	Analogue	TBD	TBD
SV_4010_01_FB	Gas inlet analyzer valve	2-way valve animated	---	---
HX_4010_01	Exchanger post condenser state	Exchanger animated	---	---
CIVa_Emergency_button	Emergency button pushed	Digital indicator	---	---
CIVa_General_Alarm_status	Indicates if there is some alarm activated.	Digital indicator	---	---

Table 5-8: Tags of the Gas loop of the CIVa system local HMI

5.3.7 Compartment IVa – Temperature

It displays values related to temperature regulation.

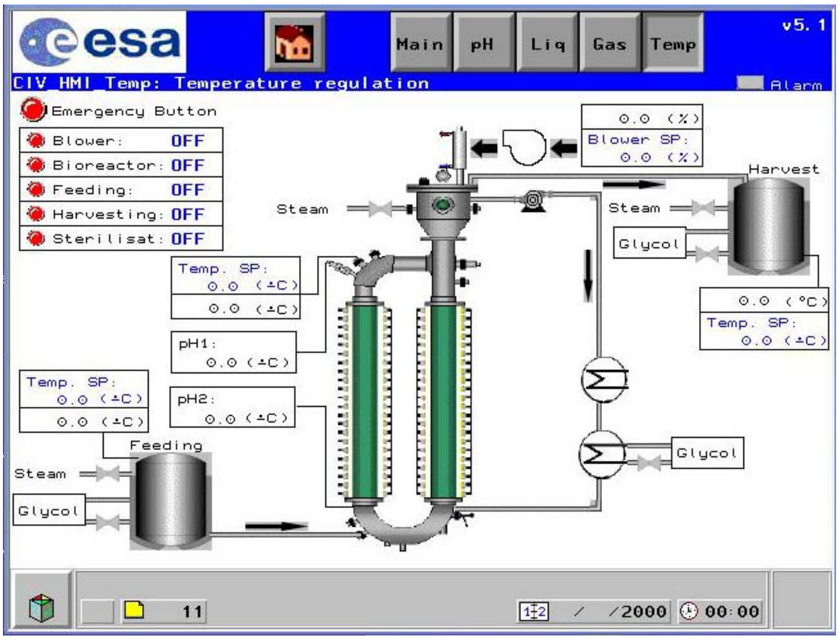


Figure 5-8: Local HMI Compartment IVa - Temperature

This display allows the user to:

- Monitor the temperature of the feeding tank, harvesting tank, reactor and blower speed.
- Monitor the temperature set-points of the feeding tank, harvest tank, reactor and speed of blower.
- Monitor the emergency button indicator. Background colour switch to red when one of the Emergency buttons is pushed.
- Monitor the control loops mode (OFF, AUTO, MAN) implemented in the screen.

5.3.7.1 Control Loops

The following control loops are implemented on the screen:

Control Loops	Description
CL4005	Blower mode
CL4005	Temperature Mode
CL4011	Feeding tank temperature control
CL4012	Harvest tank temperature control
CL4014	Feeding tank sterilisation
CL4015	Reactor’s tank sterilisation
CL4016	Harvesting tank sterilisation

Table 5-9: Control Loops of the Temperature loop of the CIVa system local HMI

5.3.7.2 Tag definition

The following tags are displayed in this screen

Tag Name	Description	Type	Units	Range
TT_4005_01_SP	Reactor temperature set point	Analogue indicator	(ºC)	0 to 150

Tag Name	Description	Type	Units	Range
TT_4005_01	Reactor temperature	Analogue indicator	(ºC)	0 to 150
BLWR_4005_01_MV1	Blower state	Blower animated	---	---
BLWR_4005_01_MV2	Blower speed	Analogue indicator	(%)	0 to 100
BLWR_4005_01_MV2_OP	Blower speed set point	Analogue indicator	(%)	0 to 100
PP_4005_01_MV1	Peristaltic pump state	Pump animated	---	---
HX_4005_02_MV1	Electrical resistance state	Exchanger animated	---	---
SV_4005_01_FB	Cooling water outlet valve	2-way valve animated	---	---
TT_4006_01	Temperature of the pH probe (AT_4006_01)	Analogue indicator	(ºC)	0 to 140
TT_4006_02	Temperature of the pH probe (AT_4006_02)	Analogue indicator	(ºC)	0 to 140
TT_4011_SP	Feeding tank temperature set point	Analogue indicator	(ºC)	-10 to 150
TT_4011_01	Feeding tank temperature	Analogue indicator	(ºC)	-10 to 150
SV_4011_01_FB	Cooling water outlet valve	2-way valve animated	---	---
TT_4012_SP	Harvest tank temperature set point	Analogue indicator	(ºC)	-50 to 250
TT_4012_01	Harvest temperature	Analogue indicator	(ºC)	-50 to 250
SV_4012_01_FB	Cooling water outlet valve	2-way valve animated	---	---
SV_4014_01_FB	Steam inlet valve	2-way valve animated	---	---
SV_4015_01_FB	Steam inlet valve	2-way valve animated	---	---
SV_4016_01_FB	Steam inlet valve	2-way valve animated	---	---
CIVa_Emergency_button	Emergency button pushed	Digital indicator	---	---
CIVa_General_Alarm_status	Indicates if there is some alarm activated.	Digital indicator	---	---

Table 5-10: Tags of the Temperature loop of the CIVa system local HMI

6. APPENDIX B. PROBLEM REPORT FORM

MELISSA Control System Demonstrator - Problem Report		
Reported by:	Identifier:	Date:
Title:		Reference:
Problem Found		
Suspected Cause		
Disposition Result		
Disposition option: ☐ *Reject* ☐ *Repair, rework* ☐ *Use as is*		
Disposition Date:		
Actions		
Close Out		
Verification results:		
Verified by: Date:	Authorised by: Date:	

Identification			
Project Name:	CS MELiSSA CIVa		
Subject:	Review of CIVa HMI displays		
Place:	UAB	*Date:*	2010-01-15
Chairman:	J. Duatis	*As Taken by:*	J. Duatis

Participants		
Organization	*Name*	*Signature*
NTE	J. Duatis	Duatis
NTE	J. Carbonell	
UAB	Enrique Peiró	Enrique Peiró
UAB	Raul Moyano	
ESA	Arnaud Fossen	

Additional copies to	
Organization	*Name*
NTE	Francesc Gallart
ESA	Brigite Lamaze
UAB	Francesc Gòdia
SHERPA	Olivier Gerbi

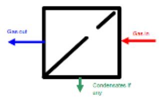
Agenda

- Review CIVa remote HMI screens (iFix).
- Review changes agreed in CIII remote HMI screens (iFix).
- Review of Graphs screen
- Review of data export screen
- Installation of Panel PC of CI
- Installation of Pancel PC in the CIII and CIVa
- Installation of RIO in HPC PLC
- Review of CIVa / changes in CIII local HMI screens (Magelis)

Actions Summary

Number	*Action*	*Actionee*	*Due Date*
A#23	NTE-SENER will ask to Christophe (SHERPA) for the results of the HMI review	NTE-SENER	22 Jan 2010
A#24	NTE-SENER to fix the labelling of the cable ACI-2 of CIVa PLC	NTE-SENER	05 Feb 2010
A#25	UAB to check CIVa MAIHAK analyser configuration and check HMI value	UAB	22 Jan 2010
A#26	NTE-SENER to check alarm control in HMI displays.	NTE-SENER	22 Jan 2010
A#27	NTE-SENER to change the filters representation in the synoptic diagrams	NTE-SENER	22 Jan 2010
A#28	NTE-SENER to add a time tag in the main displays of each compartment	NTE-SENER	22 Jan 2010
A#29	NTE-SENER to fix issues listed in the attached Excel NTE-CIVaP2-MN-009.xls	NTE-SENER	22 Jan 2010
A#30	NTE-SENER to update reactor bitmap in CIII HMI displays	NTE-SENER	22 Jan 2010
A#31	NTE-SENER to update sampling rate for scales to 1 minute	NTE-SENER	22 Jan 2010
A#32	NTE-SENER to perform a general review of comparisons with 0 in the HMI	NTE-SENER	22 Jan 2010
A#33	NTE-SENER to redesign the export data screen because now is too slow	NTE-SENER	22 Jan 2010
A#34	NTE-SENER to purchase the adaptor to hang the CI Panel Display to the wall	NTE-SENER	22 Jan 2010
A#35	UAB to propose a date to install the Panel Display	UAB	22 Jan 2010
A#36	NTE-SENER will issue the purchase orders of the displays and the iFix licenses for the CIII and CIVa.	NTE-SENER	22 Jan 2010
A#37	NTE-SENER to install RIO in HPC1 PLC and coordinate with SHERPA the update	NTE-SENER	05 Feb 2010
A#38	UAB to propose a date to start the CI Alarms and Maintenance activity no later than the first week of February	UAB	22 Jan 2010
A#39	UAB to propose a day to review CIVa cabling	UAB	22 Jan 2010
A#40	NTE-SENER to provide the tables with the proposed decimals according to the sensors accuracy for C3 and C4a.	NTE-SENER	22 Jan 2010

A#41	NTE-SENER perform the same decimals review for the C1 during the alarms and maintenance mode review.	NTE-SENER	31 March 2010
A#42	NTE-SENER to perform the same decimals review for the HPC1.	NTE-SENER	31 March 2010

Minutes	Action
<u>Review of CIVa remote HMI screens (iFix)</u>	
- During the same day UAB detected an error in the scales measurement. NTE-SENER explains that there was an error not handled when there is a power cut and the value displayed was incorrect. Now the error is handled and "Error" is displayed in case of power cut. The scales are not connected to the PLC but directly to the iFix server. They have a problem when there is a power cut and are not able to recover. The action to recover is to remove and put again the weight over the scale.	A#23 NTE
- NTE-SENER will ask to Christophe (SHERPA) for the results of the review he performed time ago of the displays and keep UAB informed.	
- MAIHAK analyser value is 0 and is giving an alarm. After checking PLC connections it was discovered that the cable that connects the card with the connections panel was wrongly labelled. NTE-SENER will fix the labelling of the cable. On this issue UAB observed that the analyser was not configured properly which seems the cause for the value error. UAB to check analyser configuration. Noted that when the analyser of the HPC was connected and it was working properly.	A#24 NTE A#25 UAB
- NTE-SENER to change the filters representation in the synoptic diagrams as per TN78.72 ed2:  LF_1000_01 Liquid filter  GF_ Gas filter	A#26 NTE A#27 NTE A#28 NTE A#29 NTE
- The Alarms list in the bottom of the display seems disabled. NTE-SENER to check the control.	
- NTE-SENER to add a time tag in the main displays of each compartment displaying the current time of the PLC to check if it is synchronised with the HMI server time.	
- NTE-SENER to fix other detected issues as listed in the attached Excel NTE-CIVaP2-MN-009.xls	
<u>Review of CIII remote screens (iFix)</u> The review was to check changes agreed during previous review.	
- NTE-SENER to update reactor bitmap	A#30 NTE
- NTE-SENER to update sampling rate for scales to 1 minute	A#31 NTE
- NTE-SENER to fix other detected issues as listed in the attached Excel NTE-CIVaP2-MN-009.xls	
- NTE-SENER to perform a general review of comparisons with 0, these comparisons with 0 are problematic if values involved are analog.	A#32 NTE
<u>Export data screen</u>	
- NTE-SENER to redesign the screen because now is too slow. The improvement will be to perform the sorting of data coded in the screen instead of using a direct query to iFix. Also for the generation of graphs, it was agreed to include the chart duration when setting the start time.	A#33 NTE
<u>CI Panel Display</u>	
- The display will be hanged to the wall in front of the filtration unit. NTE-SENER to purchase the adaptor to hang the display to the wall. To be discussed after using the display if an arm is required to provide more possibilities of orientating the display. The installation of the display would need to be coordinated between NTE-SENER and UAB. UAB to install the routing of the Ethernet and the connector, NTE-SENER to provide guidance for the routing of the power supply from the CI cabinet.	A#34 NTE
- UAB to propose a date to install the Panel Display.	A#35 UAB
<u>CIII and CIVa Panel PCs</u>	
- NTE-SENER will issue the purchase orders of the displays and the iFix licenses although the final location of the displays is not decided yet. The supports will be purchased when the final location is decided. All these items are already included in the current call off order 7 deliverables list.	A#36 NTE
<u>HPC PLC Expansion (RIO)</u>	
- NTE-SENER informs that they received the missing connectors and the installation of RIO modules can be performed. UAB explains that currently there is a crop test running which is expected to finish by the end of	A#37 NTE

the month. It is agreed to perform the installation of RIO when the test is finished to minimise risks. NTE-SENER will coordinate with SHERPA the configuration of the modules.		
CI Alarms and Maintenance - UAB will coordinate a meeting to start the activity. If SHERPA plans to come before first week of February, the meeting will take place then and no later than the first week of February. The meeting to start the discussion could even take place by teleconf.	A#38	UAB
AoB - UAB will propose a day to review CIVa cables. Some of the cables from the PLC cabinet to the Power cabinet are short. The task is to identify which are short in order to replace it and move all cables higher in the supports. NTE will perform theses tasks.	A#39	UAB/NTE
- NTE-SENER to provide the tables with the proposed decimals according to the sensors accuracy to be reviewed by UAB for C4a and C3.	A#40	NTE
- NTE-SENER will perform the indicator decimals review for the C1 at the same as the alarm and maintenance modes.	A#41	NTE
- NTE-SENER will also perform the review of the decimals for the HPC1 .	A#42	NTE

Conclusions
After the implementation of the attached modifications in the CIII and CIVa displays the HMI implementation activities will be considered finished. The Panel Displays will be delivered to UAB although will not be installed until the final location is decided. The Data Package for the CIII is expected by the end of January while the Data Package of the CIVa will be delivered by the mid of February. With these deliveries the projects concerning the Control System and HMI update for the CIII and CIVa (MELiSSA CS CIII P2 and MELiSSA CS CIVa P2) will be considered finished.