P100C-SX

AUTOMATIC VOLTAGE REGULATOR

Instruction Manual

Institute of Power Engineering
Gdansk Division

	INSTITUTE OF POWER ENGINEERING GDANSK DIVISION		
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CONTENTS

1 INTRODUCTION

This document describes all the information required for safe use of P100C-SX Automatic Voltage Regulator controller.

This manual is primarily aimed at the maintenance personnel of excitation systems. It is also a comprehensive source of information for engineers willing to design and build more complex excitation system based on P100C-SX controller. The intended persons should possess adequate knowledge of electrical engineering and have relevant experience.

In addition to this manual, local safety regulations should always be applied.

Symbols used:

 **Indicates possible source of danger**

 **Indicates important information and tips**

2 GETTING STARTED

2.1 SAFETY INSTRUCTIONS

Discharge any static electricity you may have accumulated

One of the ground terminals (terminal strip X1, terminals 5, 6) and the enclosure of the P100C-SX must be correctly grounded. Ground points are labeled: ⏚

If you communicate with the P100C-SX using a computer through the serial port, please ensure that the computer is grounded to the same ground as the relay

In case of using a portable computer, it is recommended to have it disconnected to its power supply, as in many cases they are not correctly grounded either due to the power supply itself or to the connector cables used. Powering the portable PC with its internal battery drastically decreases the possibility of producing permanent damage to the computer or the P100C-SX.

This is required not only for personal protection, but also for avoiding a voltage difference between the P100C-SX serial port and the computer port, which could produce permanent damage to the computer or the P100C-SX.

IEN GDANSK will not be responsible for any damage in the P100C-SX or connected equipment whenever this elemental safety rule is not followed.

2.2 COMMUNICATION & SYSTEM REQUIREMENTS

The P100C-SX Tuning Software application interface is the preferred method to view and edit settings of controller.

Tuning Software can communicate with the P100C-SX via the faceplate RS232 port or the Ethernet port. To communicate with the P100C-SX via the RS232 port, a standard “straight through” serial cable is used (1:1). The DB9 male end is connected to the P100C-SX and the DB9 female end is connected to the PC.

The following minimum requirements must be met for the P100C-SX Tuning Software to properly operate on a PC:

- Pentium® class or higher processor (Pentium® II 300 MHz or higher recommended)
- Windows® 2000, Windows® XP (Service Pack 3) or higher
- 64 MB of RAM (128 MB recommended)
- 40 MB of available space on system drive
- RS232C serial or Ethernet port for communications to the P100C-SX

2.3 SOFTWARE INSTALLATION

After ensuring the minimum requirements for using P100C-SX Tuning Software are met (see previous section), use the following procedure to install software from the enclosed CD.

1. Click the “Setup.exe”, then the following window appears:

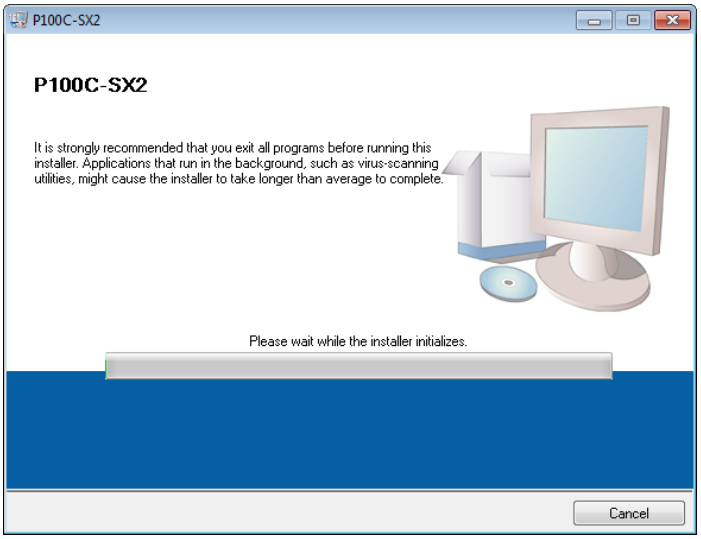


Fig. 1 First window of the installation process

2. Select the installation directory in the following window and click “Next”.

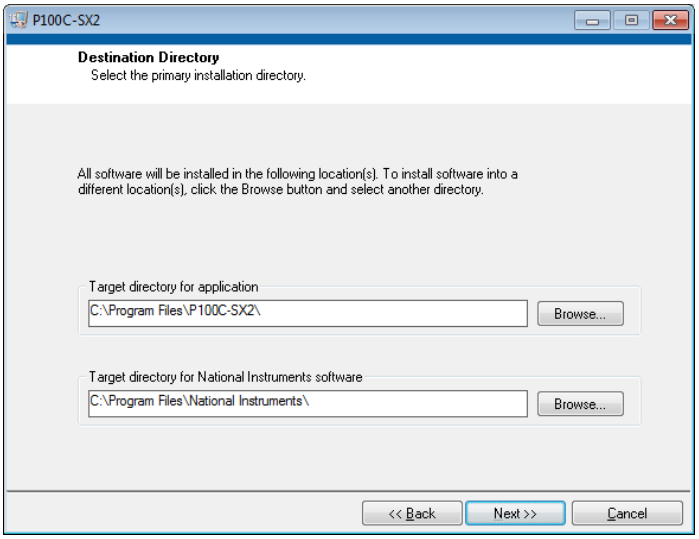


Fig. 2 Select the installation directory window

3. When the “installation-ready” window will appear, click “Next” and start the installation process.

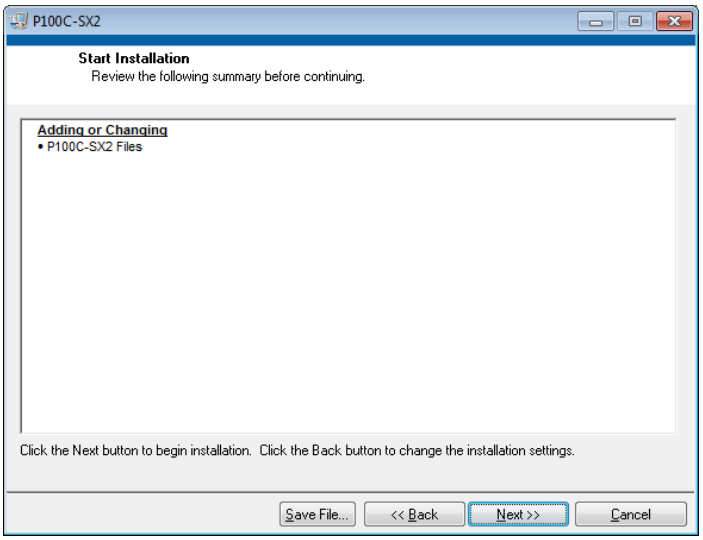


Fig. 3 Installation-ready window

4. To finish with the installation process, click “Finish”.

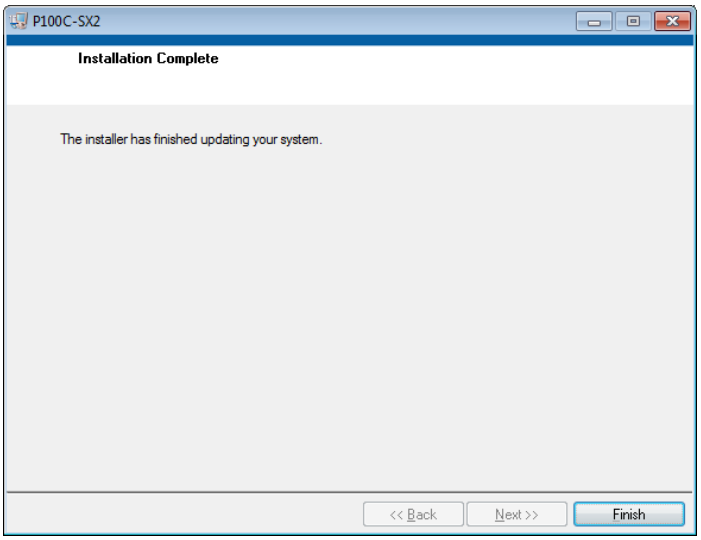


Fig. 4 Last window of the installation process

5. After installation it is recommended to restart your computer.

2.4 DEMO MODE

DEMO mode gives access all features of application without necessity to connect with a real controller. It helps to familiarize with a Tuning Software environment before connecting with a real system.

It allows to prepare a settings file for a future project and save it on hard drive using SAVE FILE button.

It also allows to read settings file from existing project using READ FILE button for analysis or modification.

To enter DEMO mode, run Tuning Software application from shortcut or go to install directory and run AVR32.exe file, then the following window of the P100C-SX Tuning Software appears:

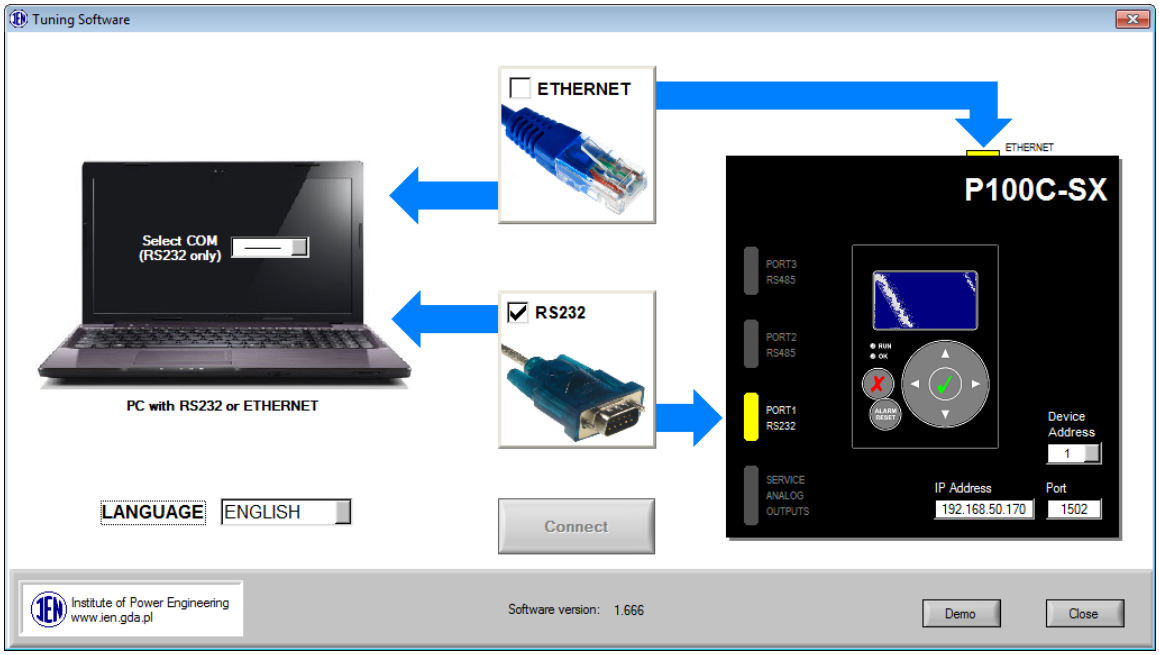


Fig. 5 First window of the P100C-SX Tuning Software

Click DEMO button located at the bottom of the screen.

2.5 MOUNTING & WIRING

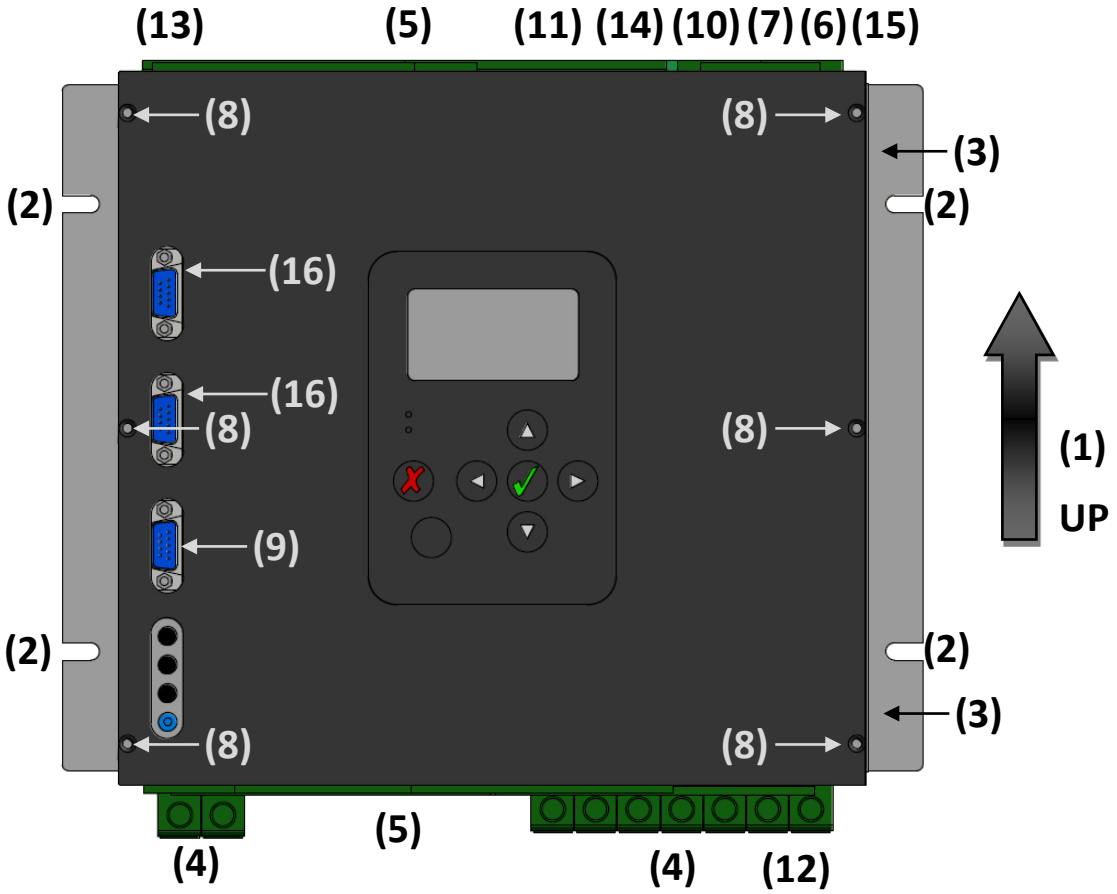
During installation follow the safety regulations listed in the SAFETY INSTRUCTIONS section of this document

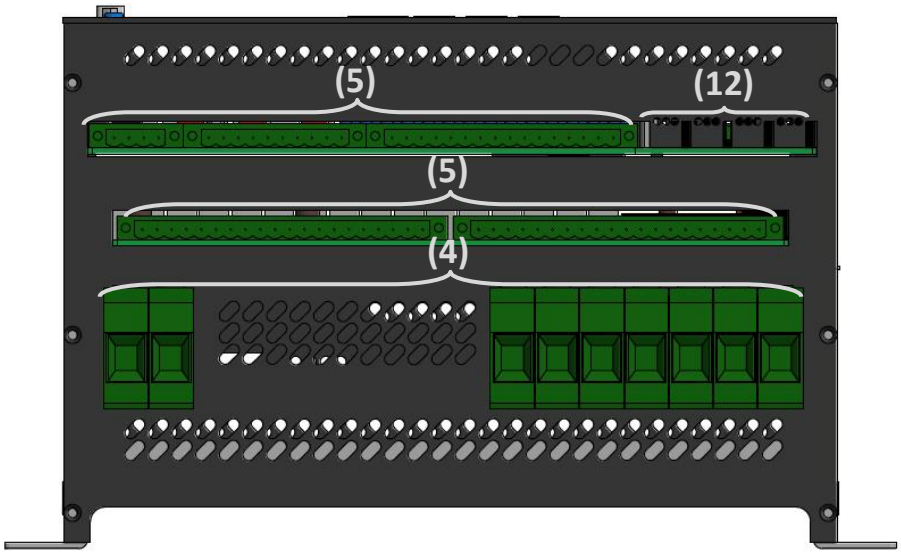
For a details on specific port pinout refer to INTERFACES AND TERMINAL STRIPS section of this document

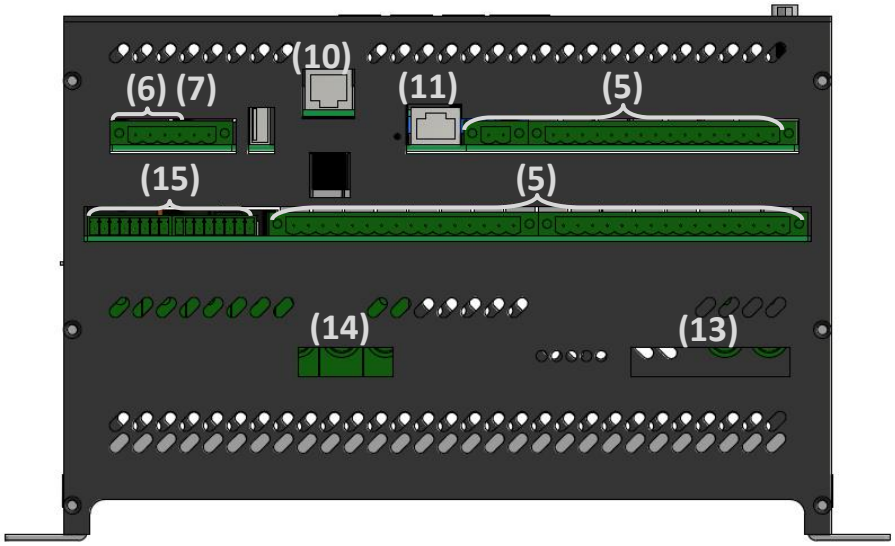
For a details on device's dimensions refer to DIMENSIONS section of this document

2.5.1 Box overview

An overview of controller's front, top and bottom faces. Parts indicated by numbers are described in more details in the following sections.







2.5.2 Environmental requirements

Note the following environmental requirements for the P100C-SX mounting location**:**

- This product is intended for indoor use only. Do not expose the unit to ambient conditions outside of the range of 10ºC to 50ºC and relative humidity outside the range 5% to 95% non-condensing (pollution degree 1).
- Do not mount the relay at elevation higher than 3000 meters above sea level
- Do not mount the relay in an area where excessive moisture, corrosive fumes, or explosive vapors are present.
- Despite high level of EMC noise immunity, avoid mounting in a location subject to electrical noise. This includes the proximity of large electrical contractors, electrical machinery, welding equipment, spark igniters, and variable frequency drives

2.5.3 Physical mounting

The following information applies about physically mounting the relay:

- Mount the relay in vertical orientation only. It guarantees proper cooling by natural air circulation **(1)**
- Attach relay to the mounting plate using 4 screws with a minimum diameter of 4mm and maximum diameter of 6 mm **(2)**
- Usually it is not recommended to remove front cover of the relay. However, if it is necessary, remove the front cover by unscrewing counterclockwise six screws using hex key with the diameter of 2mm **(8)**

2.5.4 Grounding

The following information applies about grounding the relay:

- Ground relay enclosure using minimum 2.5 mm^2 cross-section wire. Use wide or ring type cable lug with a diameter of 4 mm. Ground points are labeled ⏚ **(3)**
- Connect ground to X7:5,6 terminals using maximum 2.5 mm^2 cross-section wire **(7)**
- Use grounding cables as short as possible

2.5.5 Connecting IOs

Note the following information about wiring analog and binary signals:

- If power module is present, connect supply and load to X8,X9 terminals using maximum 25 mm^2 cross-section wire **(4)**. Make sure nominal current doesn't exceed 2A per 1 mm^2
- Connect IO wires and measurements to the terminals using maximum 2.5 mm^2 cross-section wire. If it is necessary to connect two wires to the same terminal use maximum 1 mm^2 wires **(5)**
- Connect supply to X7:1(+),2(-),3(+),4(-) terminals using maximum 2.5 mm^2 cross-section wire. If it's necessary to connect two wires to the same terminal use maximum 1 mm^2 wires. If only one source of supply is present, bridge 1 - 3 and 2 – 4 terminals **(6)**
- If field current measurement is done using external LEM, connect transducer to the terminals X17 using cables with maximum 1.5 mm^2 cross-section **(14)**
- If field current measurement is done using 4-20mA external transducer, connect transducer to the terminals X12 using cables with maximum 2.0 mm^2 cross-section **(15)**
- If relay controls external power converter directly, without Local Controller device, connect firing pulses from terminals X16 to the thyristor gates using twisted pair cables with maximum 1.5 mm^2 cross-section wire **(13)**

2.5.6 Communications

The following information applies about communication wiring:

- In order to establish connection between relay and Tuning Software, connect RS232 cable with DB9 male plug **(9)** or straight through CAT5 UTP patchcord Ethernet cable with RJ45 plug **(10)** to the relay. The factory-default IP address for P100C-SX is `192.168.50.170`, port `1502`.

- If controller operates in dual channel configuration, connect both relays together using cross-over CAT5 UTP patchcord Ethernet cable with RJ45 plugs **(11)**

- If relay controls external power converter using Local Controller device, connect up to four fiber optic patchcord duplex multi mode LC/UPC 50/125 OM2 cables to the relay **(12)**

- Two serial RS485 male connectors are provided. Both support 2-wire or 4-wire standard. The factory-default baud rate is `19200`, slave address `1` **(16)**

2.6 FACEPLATE KEYPAD & DISPLAY

The 7-key keypad and a 128x64 pixels LCD display (shown below) are used as elementary local HMI of the P100C-SX.

Fig. 6 P100C-SX keypad and display view

Ok, go deeper into menu tree, accept changes

Cancel, go to higher level of menu tree, discard changes

Up arrow

Down arrow

Left arrow

Right arrow

Alarms reset

RUN Communication module processor is working correctly

OK Regulator processor is working correctly

Fig. 7 P100C-SX keypad buttons and LED's description

Display messages are organized into menus under the several main headings (shown below). Using this keypad it is possible to access all the different menus in the P100C-SX and to view settings.

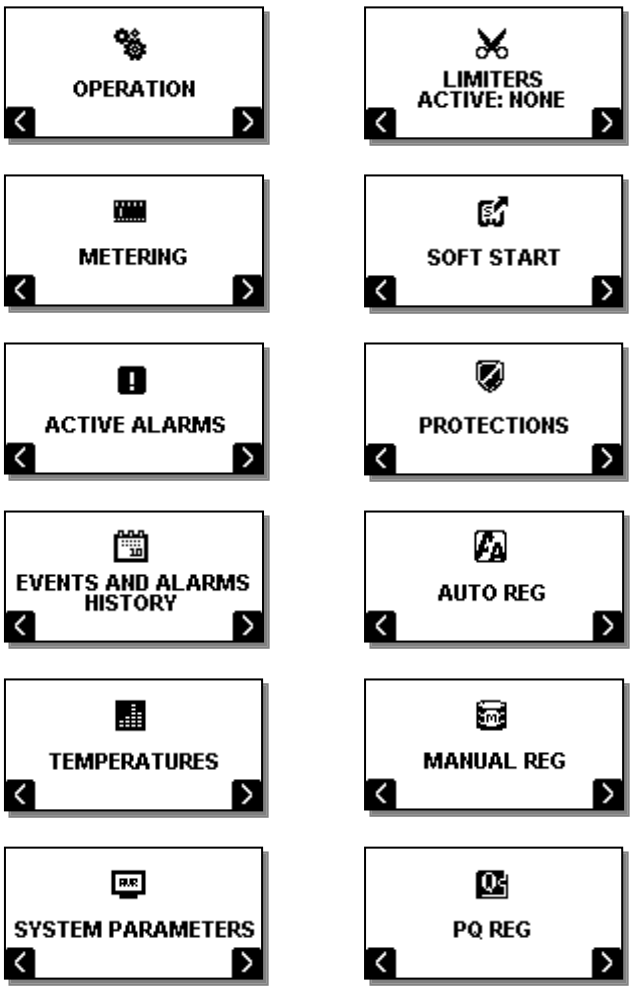


Fig. 8 Main headings of the P100C-SX display MENU

From the P100C-SX title screen navigation menu is accessed first by pressing  .

Then, navigation through remaining options is done by pressing arrows and ok button to go deeper into menu branch tree.

The menu system structure is illustrated on figures shown below.

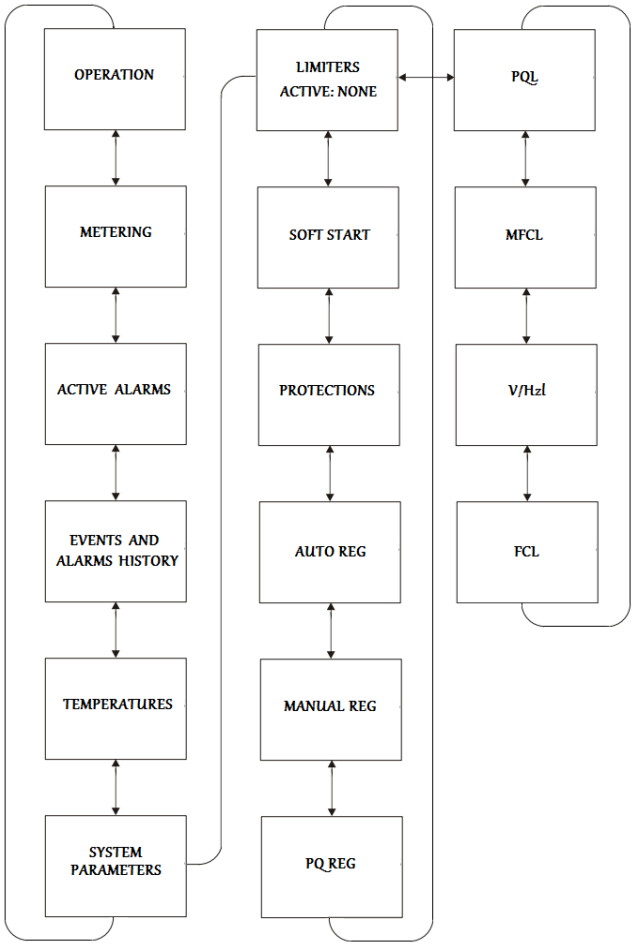


Fig. 9 Top-level menu of the P100C-SX display

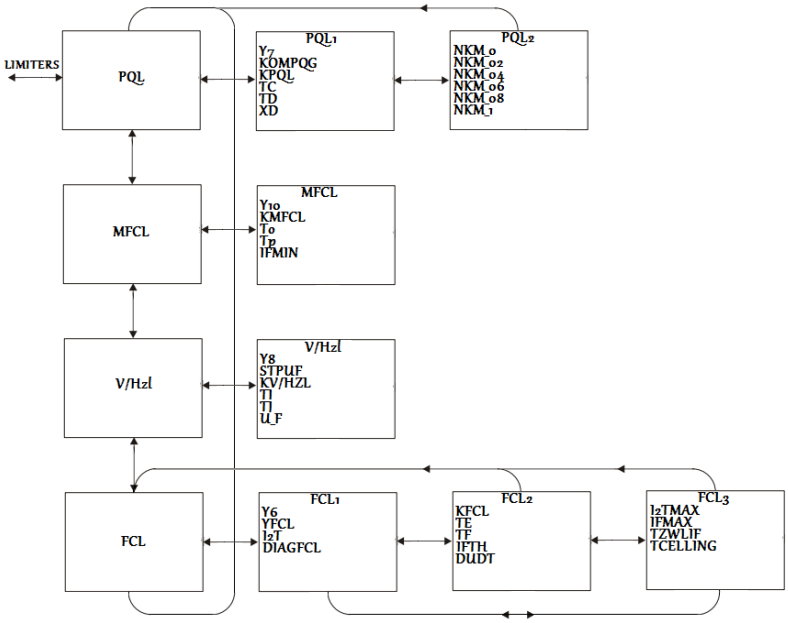


Fig. 10 Limiters menu branch details of the P100C-SX display navigation

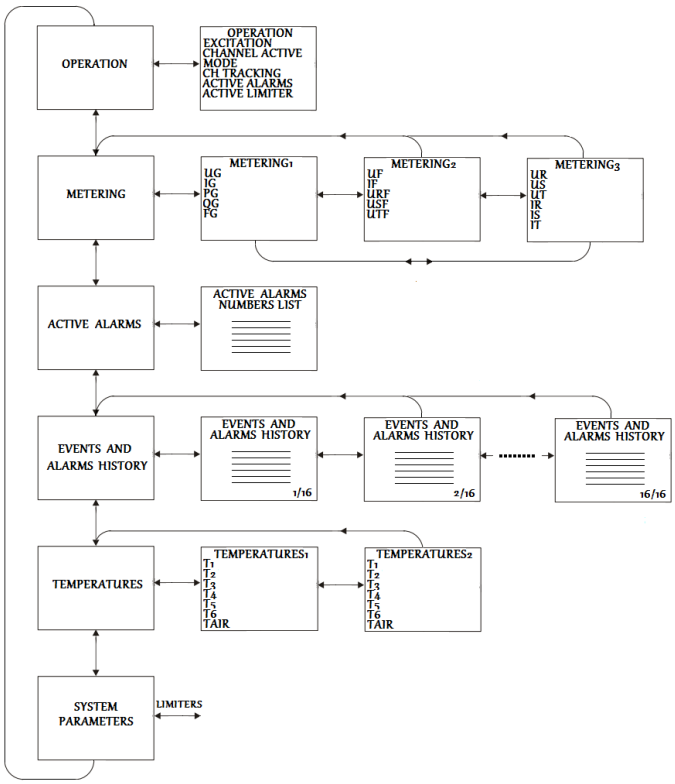


Fig. 11 Highest-level menu branch details of the P100C-SX display navigation

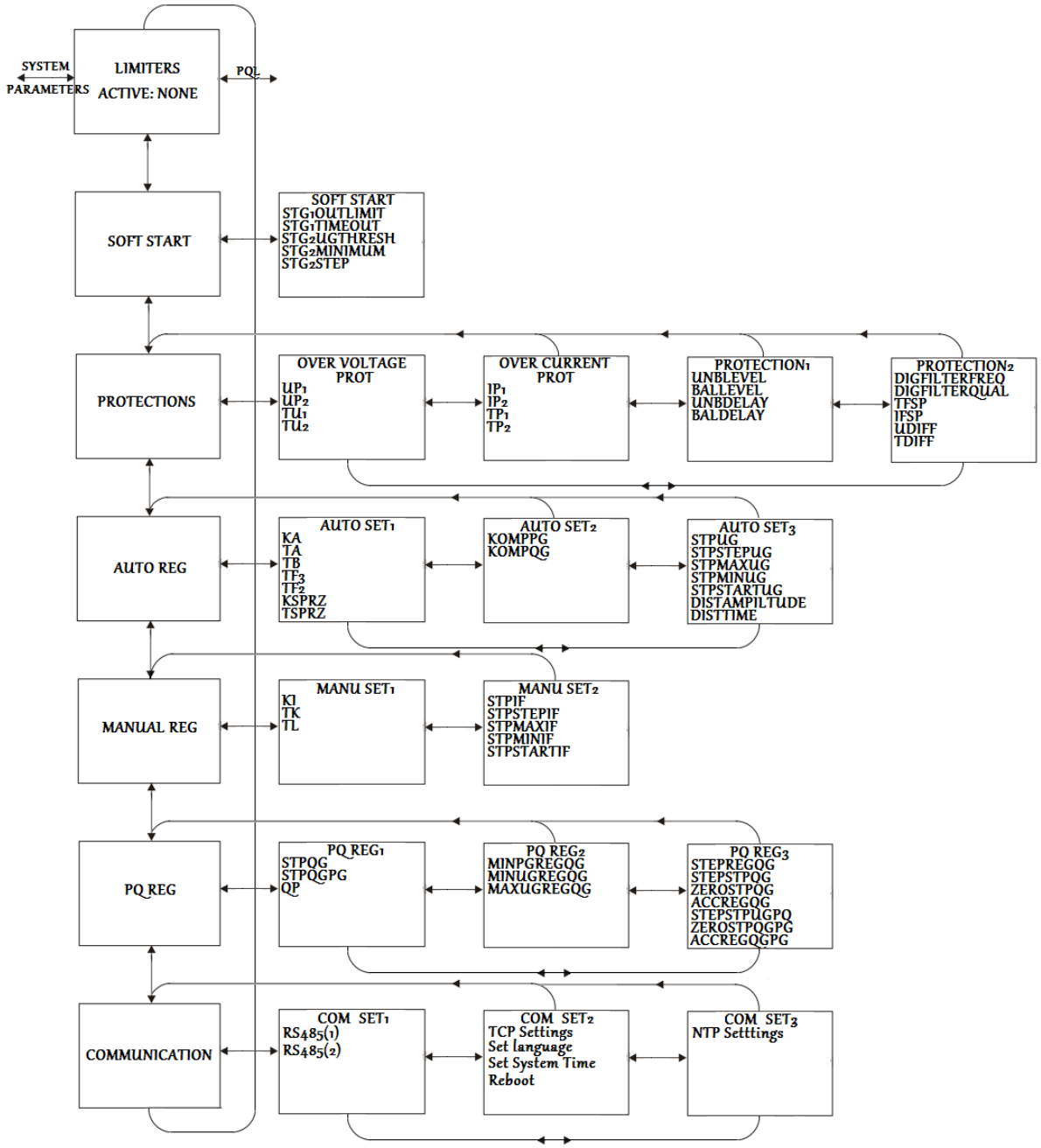
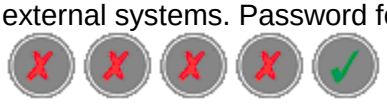


Fig. 12 Second level menu branch details of the P100C-SX display navigation

Access to “COMMUNICATION” menu parameters is protected with password as it allows to switch important parameters of P100C-SX regulator which affects communication with external systems. Password for this menu is as follows:



2.7 FIRST CONNECTION

1 After proper installation of P100C-SX Tuning Software run application from shortcut or go to install directory and run AVR32.exe file. The following picture will appear that allows selection of desired communication interface.

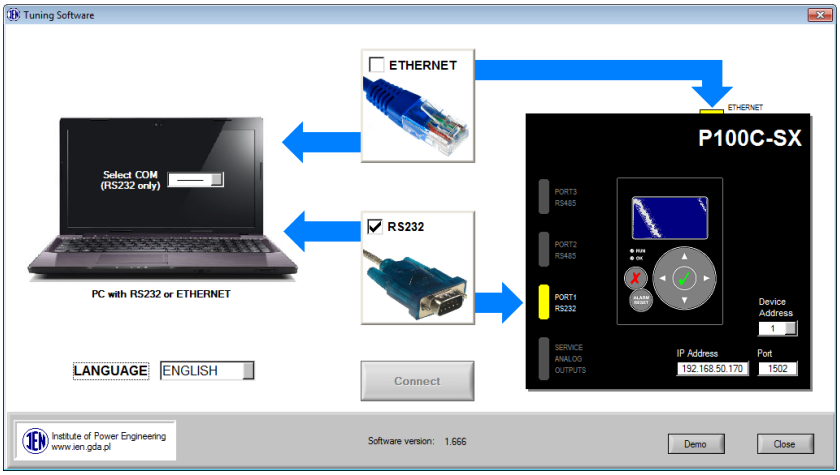


Fig. 13 First window of the P100C-SX Tuning Software

2 Select the connection type: ETHERNET or RS232 (after choosing RS232 select one of fifteen COM ports, in case of ETHERNET connection set right IP Address of P100C-SX and communication port number) and “Connect” button will become active. The factory-default IP address for P100C-SX is `192.168.50.170`, port `1502`.

If user computer is not supplied with RS232 port, there is possibility of using USB/DB9 hardware adaptor, such devices proven to work correctly with P100C-SX Tuning Software.

3 Click the “Connect”, then the main window of the P100C-SX Tuning Software appears:

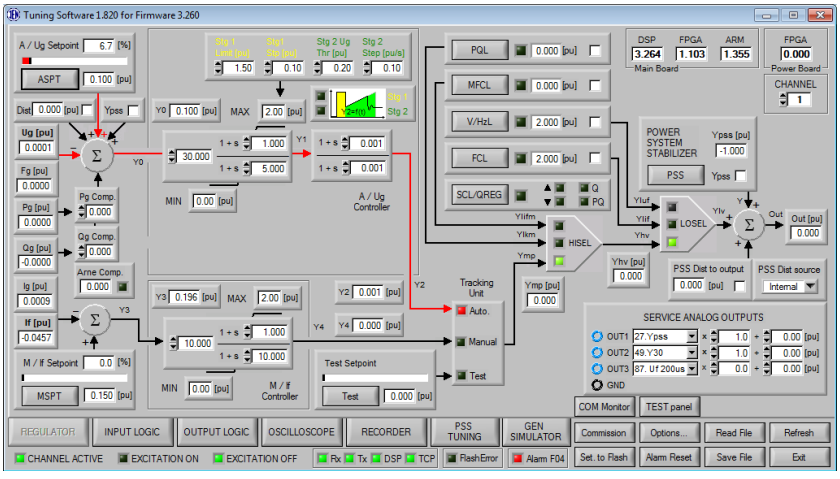


Fig. 14 Main window of the P100C-SX Tuning Software

Communication status between relay and computer is indicated by LED diodes at the bottom of the screen:

Rx Tx - Modbus RTU communication, red color indicates error

TCP - Modbus TCP communication, red color indicates error

2.8 INTRODUCTION

P100C-SX is an advanced excitation system and application adjusted device used for synchronous generator control and stabilization purposes. With single or dual channel configuration and a wide range of power converter modules, the system can be customized to meet all field data and customer requirements.

Primary applications of P100C-SX controller include static or brushless excitation systems for coal-fired, gas or hydro power plants.

2.9 P100C-SX FEATURES

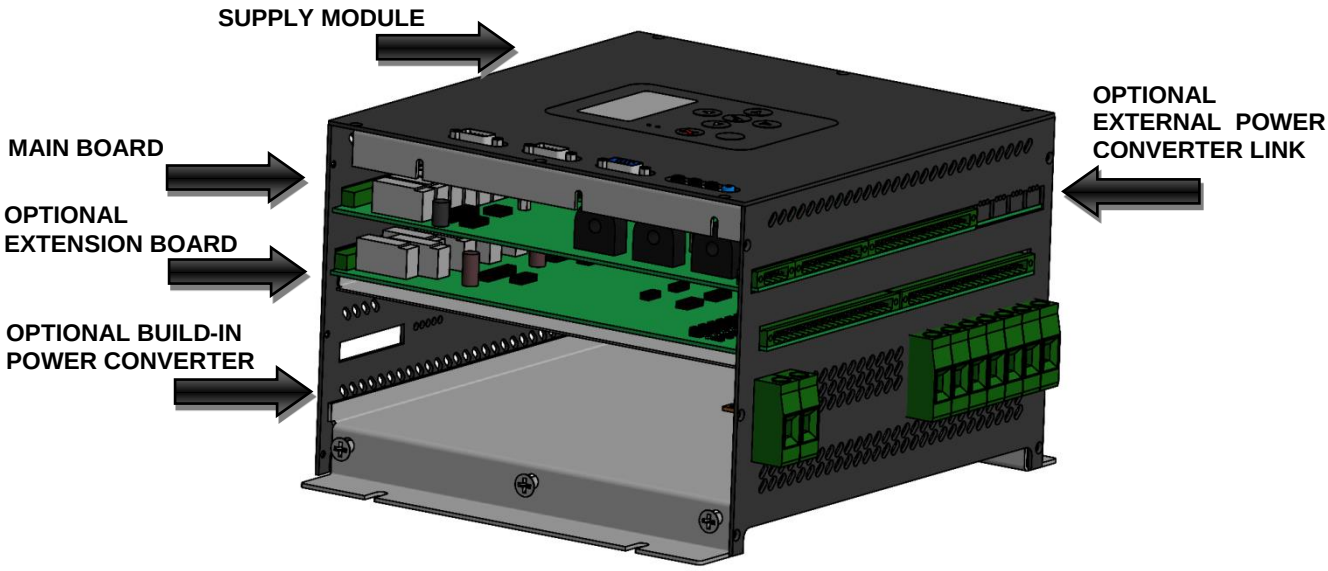
2.9.1 Overview

- **Control modes:**
  - Automatic regulation:
    - Voltage regulation
    - Power factor regulation (machine & network)
    - Reactive power regulation (machine & network)
    - Voltage matching function
  - Manual regulation
    - Excitation field current regulation
- **Different control structures:**
  - IEEE ST1A
  - IEEE ST4B
  - IEEE AC8B
  - IEEE AC5A
- **Power system stabilizer, type PSS2B**
- **Protective functions:**
  - Volts per Hertz protection with inverse time characteristic (24)
  - Undervoltage (27)
  - Reverse power (32)
  - Minimum field current (37F)
  - Overcurrent with inverse time characteristic (50/51)
  - Loss of field (40)
  - Overvoltage (59)
  - Overfrequency (81O)
  - Underfrequency (81U)
  - Field overcurrent with inverse time characteristic
  - Field overvoltage protection
  - Rotating diode protection
  - Loss of field current measurement
  - Loss of voltage measurement
  - Loss of synchronization voltage
  - Loss of sensing voltage
  - Loss of measuring voltage – difference between channels
  - Loss of thyristor firing pulses
  - Loss of thyristor conductance
  - Field flashing time limit
- **Limiters:**
  - Under-excitation limiter (PQL)
  - Minimal excitation field current limiter (MFCL)

  - Field current limiter with set-point correction by temperature (FCL)
  - V/Hz limiter (VHzL)
  - Stator current limiter with set-point correction by temperature (SCL)
- **Modern communication interfaces:**
  - 4 x Fiber optic serial communication between cubicles
  - 1 x Ethernet interface
    - IEC 61850
    - IEC 60870-5-104
    - MODBUS TCP
  - 2 x RS485
    - MODBUS RTU
  - 1 x RS232
    - MODBUS RTU
- **Temperature monitoring**
  - Up to 7 sensors without Local Controller
  - Up to 28 sensors with Local Controller
  - Rotor temperature measuring based on field current and voltage
- **Synchronous machine transient simulator**
- **Synchronous machine characteristic measuring module**
- Time synchronization via NTP protocol
- Auto-tracking between control modes
- Auto-tracking between channels
- Reactive and active power droop compensation
- 50 and 60 Hz system compatibility
- **Fast digital data recorder**
- **Alarms and events recorder**
- **Oscilloscope**
- Boosting sequence
- Supply source change over
- Voltage matching
- External set point control (auto ,reactive power & power factor)
- Current distribution control
- User friendly applications for configuration and monitoring

2.9.2 Modular design

Modular design of controller allows customization of product according to specific requirements helping to maximize performance and minimize cost of the project.



Main components of P100C-SX relay include:

- Supply Card – Essential part of controller providing supply voltage to all components
- Main Board – Essential part of controller with main CPU and communication coprocessor
- Extension Board – Optional part of controller providing 4-20mA inputs and outputs as well as additional binary IOs
- Build-in Power Converter – Optional part of controller in a form of board controlling thyristor bridge or IGBT transistor
- Power Converter link – Optional part of controller in a form of fiber optic serial communication link to external Local Controller devices

P100C-SX controller is offered in four different configurations based on power converter type:

1. Build-in power converter based on thyristors – GCU board – heat sink version
2. Build-in power converter based on IGBT module – MSP board – heat sink version
3. External power converter controlled directly – GCU board - slim version
4. External power converter controlled via Local Controller device – slim version

All build-in thyristor bridges proposed are air natural cooling type.

With build-in power converter P100C-SX controller can be offered for systems with nominal current up to 50A, typically brushless or small static. With external power converter there's no limitation for nominal current.

2.9.3 Supply Module

P100C-SX can be supplied from wild range of voltages thanks to the two types of isolated supply modules:

- 24V version of module for supply range 18VAC – 25VAC and 19VDC – 35VDC
- 230V version of module for supply range 105VAC – 250VAC and 120VDC – 330VDC

Each module has two independent power supply inputs. During normal operation both supplies operate on half of the nominal load. If one power supply fails, remaining power supply can take over and controller continues its operation without any disruption.

2.9.4 Main Board

Main board performs a number of essential functions such as:

- Distribution of internal supply for all components of the system
- Measurements of analog signals with 200us scan rate
- All control loops, limiters with 1ms scan rate
- Protective functions and logic with 2ms scan rate
- Communication serial protocols up to 10Mbit/s
- 14 x binary inputs with optical isolation
- 8 x binary outputs, dry contact
- 1 isolated analog input, ±10V
- 3 service analog outputs, ±10V

2.9.5 Extension Board

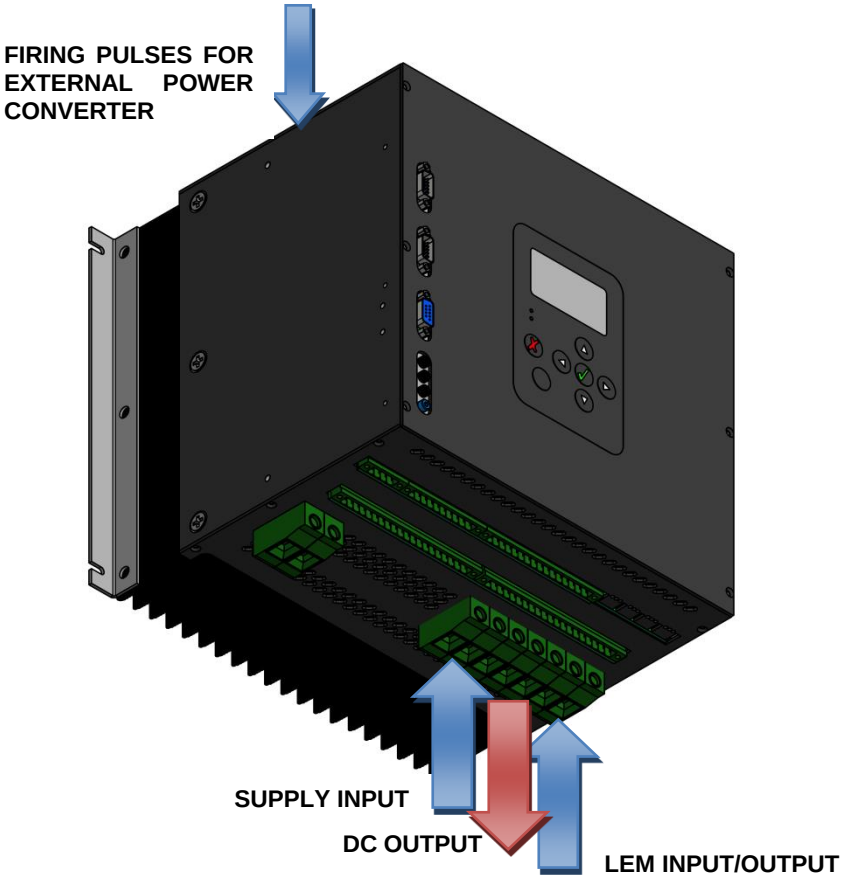
Extension board performs a number of optional functions such as:

- Additional 32 binary inputs with optical isolation
- Additional 16 binary outputs, dry contact
- 4 x 4-20mA analog inputs

- 4 x 4-20mA analog outputs

2.9.6 GCU module

This module is responsible for a control of single internal or external thyristor bridge.



GCU module is controlled directly by the main board. Both modules communicate using internal serial digital interface. Serial link allows fast exchange of critical data, such as:

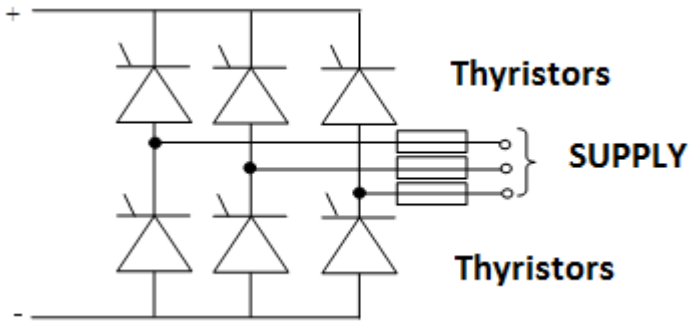
- From main board to GCU
  - Pulses enable/disable command
  - Firing angle from control loop

- From GCU to main board
  - Field current measurement from internal LEM transducer
  - Field voltage measurement
  - Synchronization voltage presence
  - Synchronization voltage sequence
  - Firing pulses status
  - Communication status

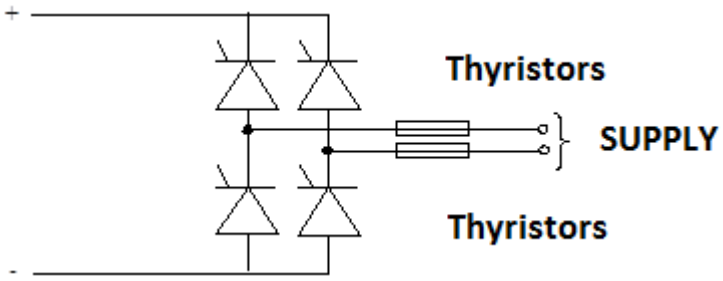
Main board writes to GCU output value of control loop with 1ms interval. Based on this value and synchronization signal calculated from synchronization voltage by modern FPGA based unit GCU forms firing pulses for thyristor bridge. Firing pulses goes to internal firing transformers providing electrical isolation between board and thyristors. For applications with external power converter controlled directly from GCU it is necessary to provide additional firing transformer card.

Three different types of bridge configurations are supported by GCU board:

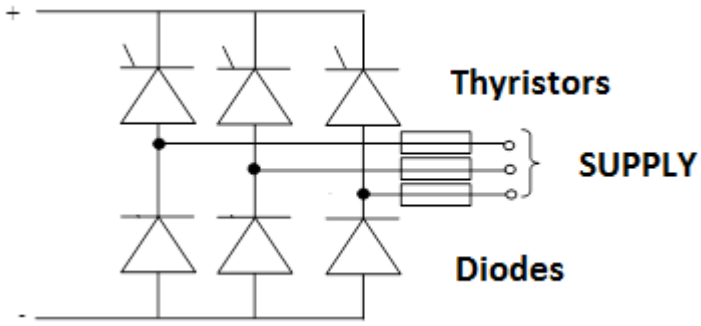
- 3-phase, 6-pulse full bridge B6C



- 1-phase, 4-pulse bridge B2C



- 3-phase, 3-pulse half bridge M3C



To select between bridge configuration options, choose Tuning Software/Options/Advanced/Power converter type.

Status of GCU module can be checked in Tuning Software/INPUT LOGIC/F02. Critical information is also present in a form of LED diodes on the top side of controller, next to X16 connector:

- PULSE FAULT – Failure in firing pulses circuit
- SYNCH.OFF – Loss of synchronization voltage
- DEEXCIT. – Deexcitation command from main board
- PULSES STOP – Firing pulses disable command from main board
- POWER OK – Indicates proper internal supply of electronic board

For list of alarms and events related with GCU module please refer to CONTROL LOGIC section of this document.

Output of control loop Yreg is specified in per unit values. GCU converts this value into firing angle in degrees. Relationship between those two parameters is presented in picture below.

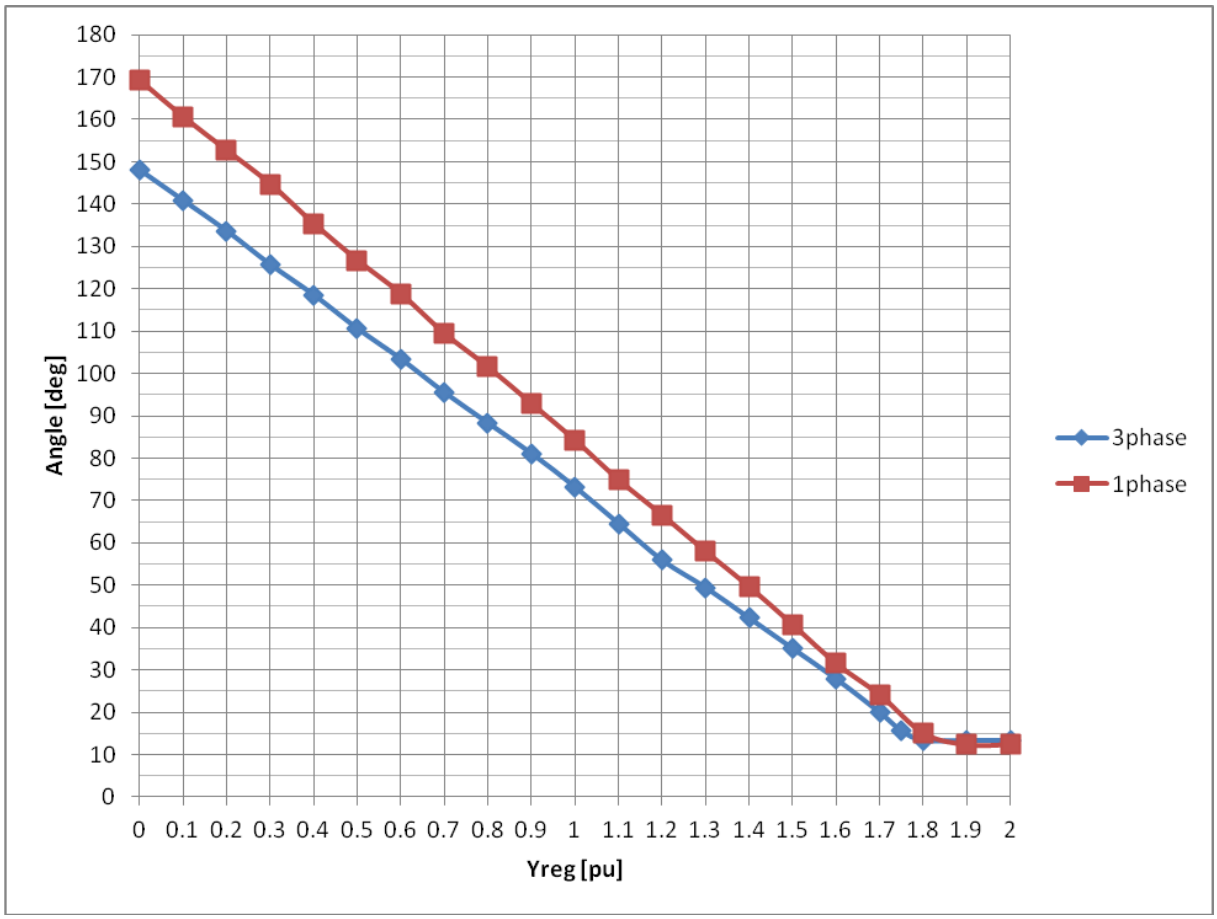


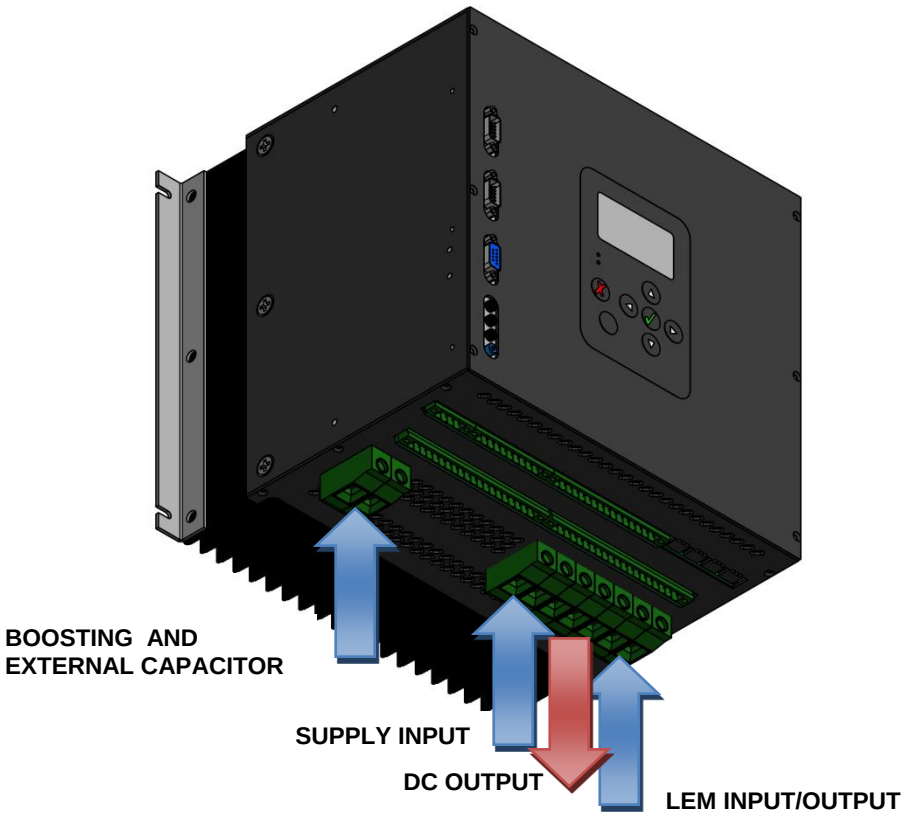
Fig. 15 Relationship between control signal Yreg and firing angle for GCU and Local Controller modules without output linearization

Key electrical parameters for GCU module are:

Parameter	Value	Description
(A) Ifn	50 A DC	Maximum excitation continuous current
(B) Ifmax	100 A DC	Maximum excitation ceiling current for 10s
(C) Unmax	230 V AC	Maximum supply voltage
(D) Ufmax	300 V DC	Maximum excitation continuous voltage
(E) Upulse	24 DC	Firing pulse supply voltage
(F) Uins	2000V AC	Dielectric isolation voltage of power circuit
(G) Uinspulse	500V AC	Dielectric isolation voltage of firing pulses circuit

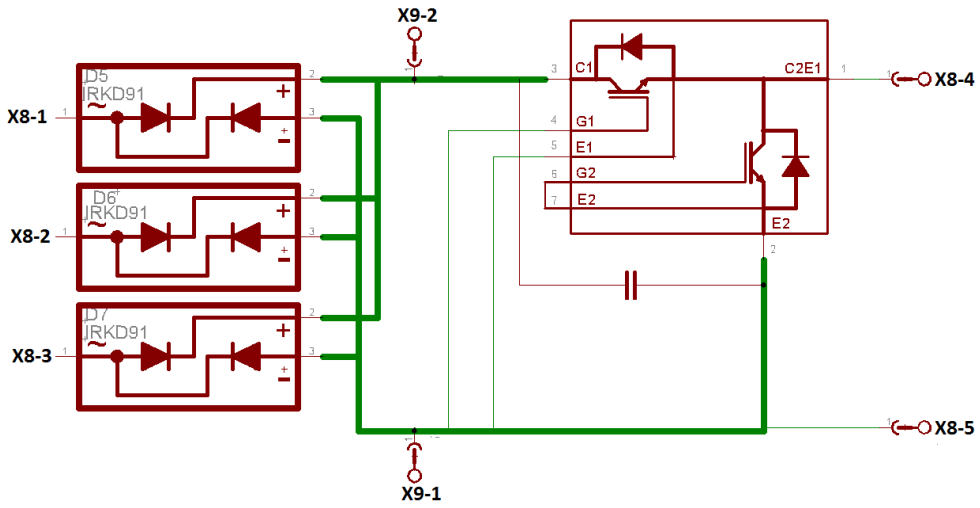
2.9.7 MSP module

This module is responsible for a control of build-in IGBT transistor.



MSP is controlled from the main board through analog interface. Main board sends output of control loop by means of 4-20mA analog signal that goes to MSP module. Main board updates control signal every 1ms. Based on this value modern FPGA unit forms PWM signal with 1ms inerval.
In MSP unit power supply goes to full 3-phase diode rectifier. Output of rectifier is connected directly to IGBT transistor. As a standard, 150uF 700VDC capacitor is mounted inside at the input of IGBT transistor. It is also connected, in parallel, to the boosting terminals. It allows to connect external capacitor if higher capacity is required.

Internal configuration of MSP module is show below:



Key electrical parameters of MSP board are:

Parameter	Value	Description
(A) Ifn	50 A DC	Maximum excitation continuous current
(B) Ifmax	100 A DC	Maximum excitation ceiling current for 10s
(C) Unmax	230 V AC	Maximum supply voltage
(D) Ufmax	300 V DC	Maximum excitation continuous voltage
(E) Uboost	300V DC	Maximum boosting supply voltage
(F) Uins	2000V AC	Dielectric insulation voltage of power circuit

2.9.8 Local Controller

This module is designed as an extension of P100C-SX controller and is commonly used to control excitation systems with two or more external power converters.

Local Controller communicates with a main controller using fast serial fiber optic interface with a speed of 10Mbit/s. It performs critical tasks in power converter cabinet, such as conversion of control signal to firing pulses, measuring thyristor temperatures, control of cooling fans. P100C-SX supports up to four independent power converters.

For details on Local Controller please refer to SL MANUAL document.

2.10 TYPICAL APPLICATIONS

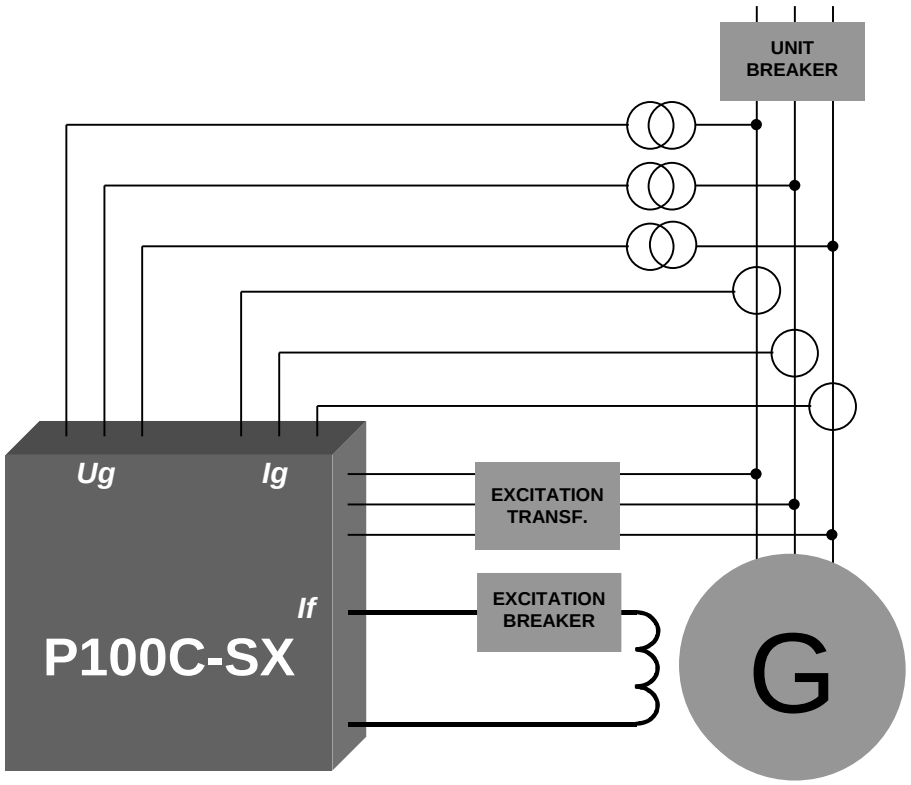


Fig. 16 Typical single channel P100C-SX application

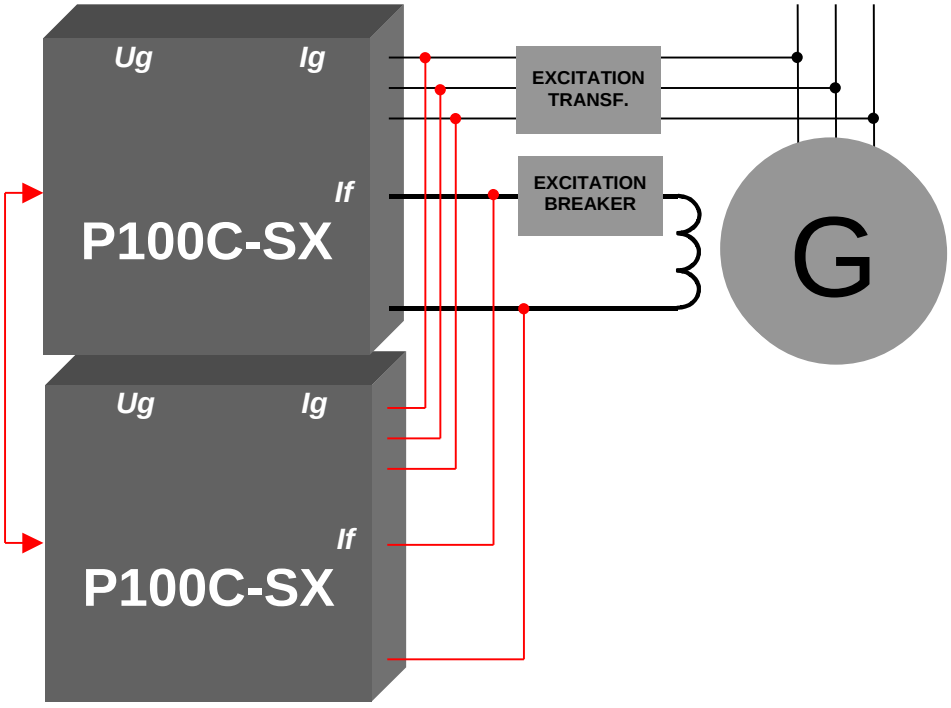


Fig. 17 Typical dual channel P100C-SX application

2.11 WIRING DIAGRAM FOR P100C-SX

2.11.1 Overview

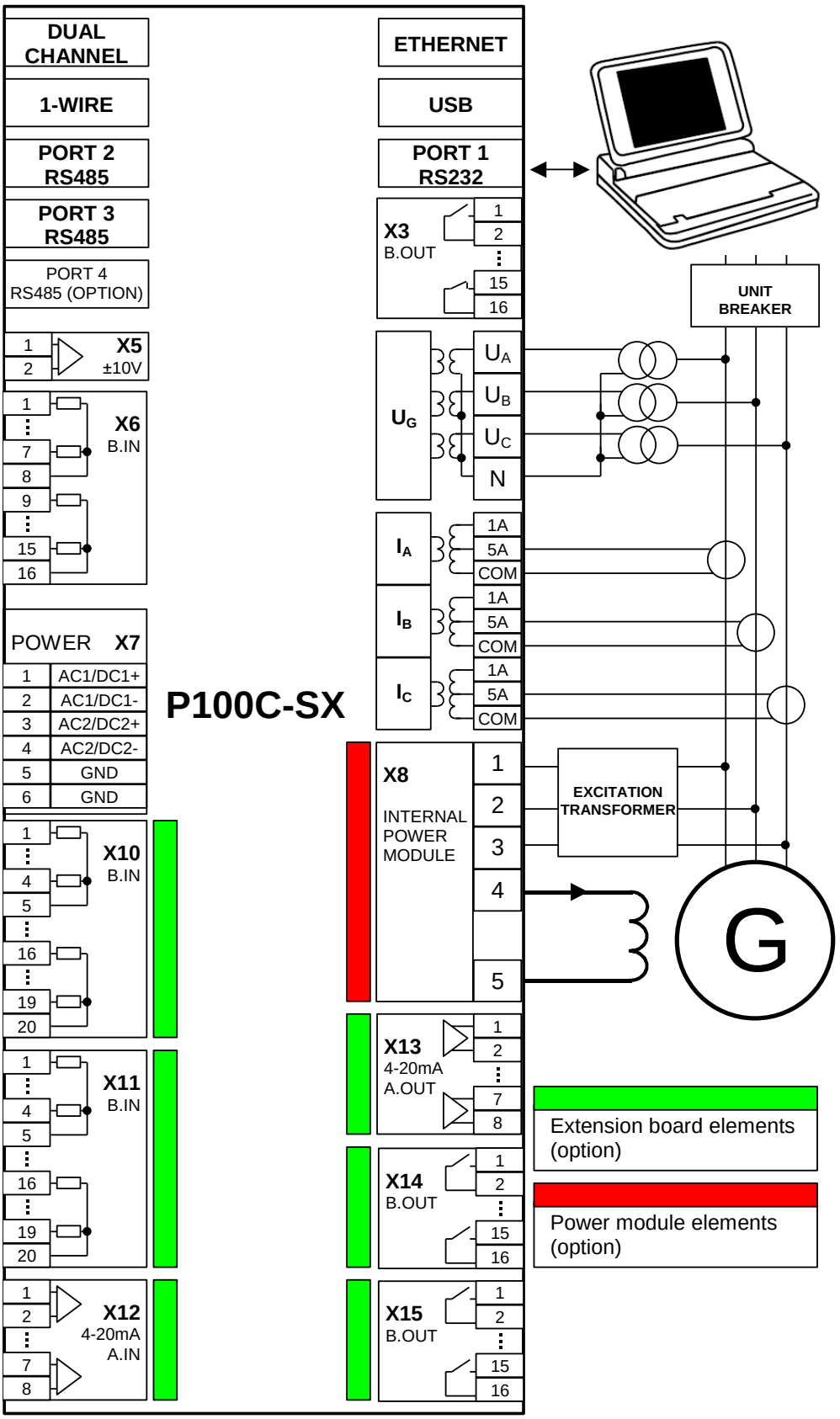


Fig. 18 Typical wiring diagram for P100C-SX

2.11.2 Internal Thyristor Bridge – GCU

For build-in thyristor configuration, supply voltage and load must be connected directly to the GCU board. No external field current measurement is required as it is taken directly from internal LEM.

An example of wiring for GCU with internal LEM is presented below. Additional AC field breaker is shown on the diagram.

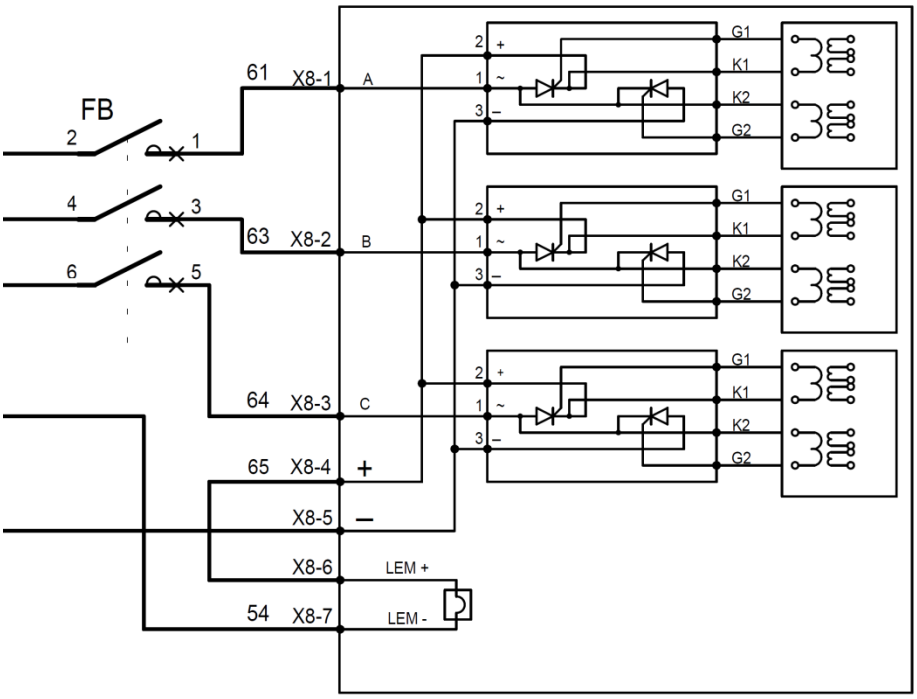


Fig. 19 GCU module wiring with three phase supply

2.11.3 Internal Transistor - IGBT

An example of wiring for MSP with internal LEM is presented below. Additional fuses are present on power supply side as well as additional capacitor connected to the boosting terminals. Supply voltage and load must be connected directly to the MSP board. No external field current measurement is required as it is taken directly from build-in LEM sensor.

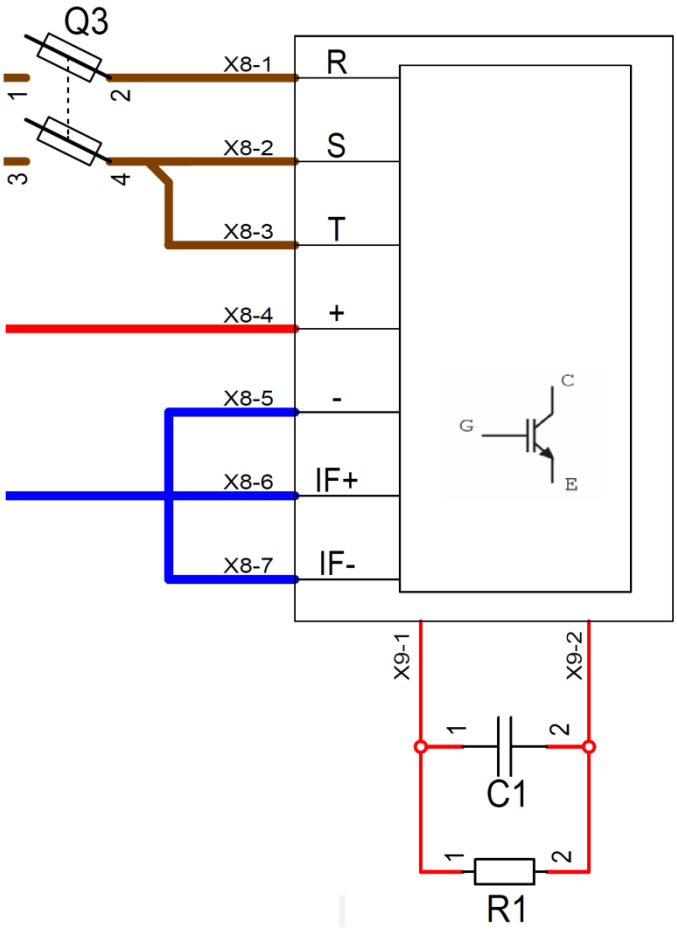


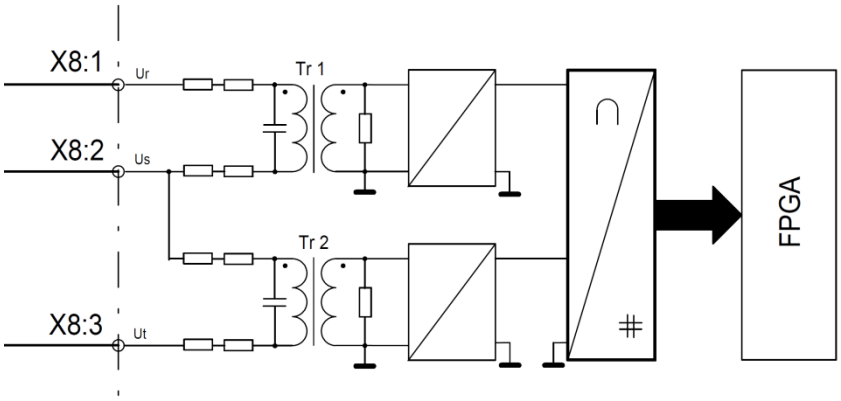
Fig. 20 MSP module wiring

2.11.4 External Thyristor Bridge - GCU

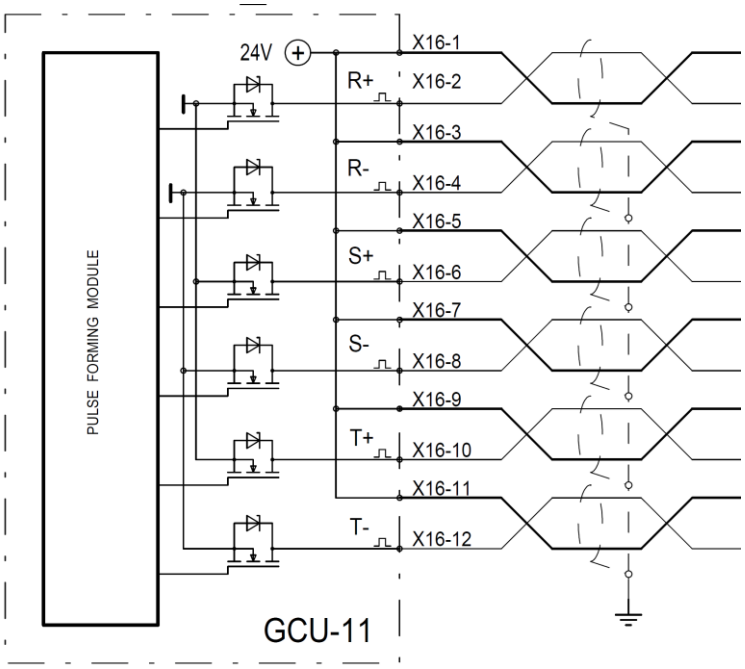
For external thyristor bridge controlled directly from GCU, supply voltage (synchronization voltage) must be connected to GCU board as well as external field current LEM sensor or different 4-20mA field current transducer. Additional firing pulses transformers must be used to provide insulation between firing pulses and thyristors.

Below are presented example electrical diagrams for external power converter controlled directly from GCU.

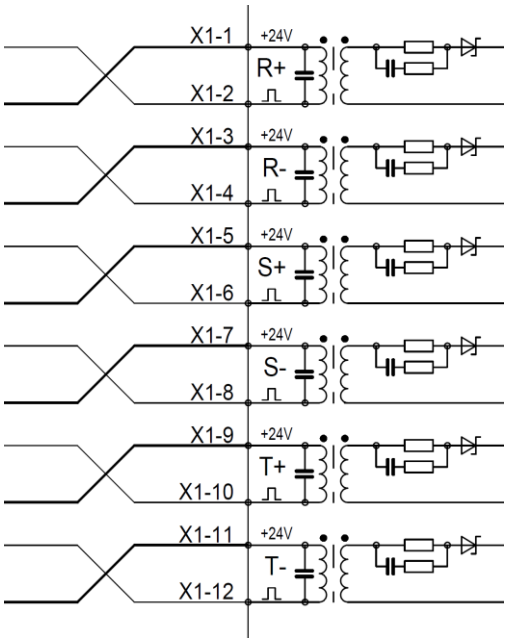
Synchronization voltage:



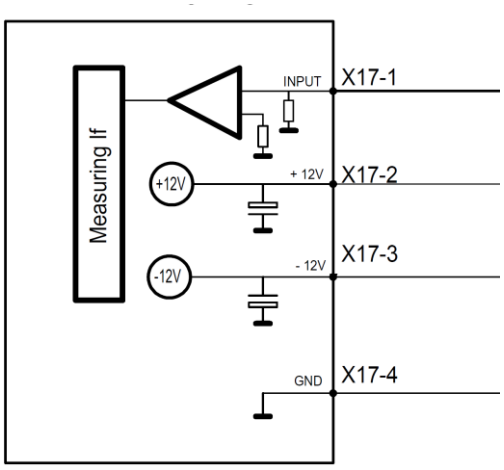
Firing pulses connection:



Firing pulses transformer card connections:



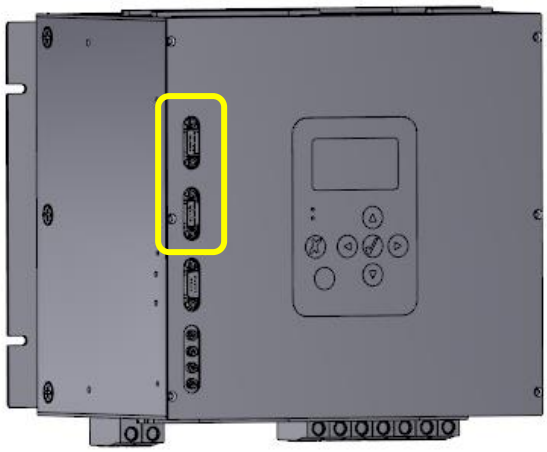
External field current sensor LEM connection:



2.12 INTERFACES AND TERMINAL STRIPS

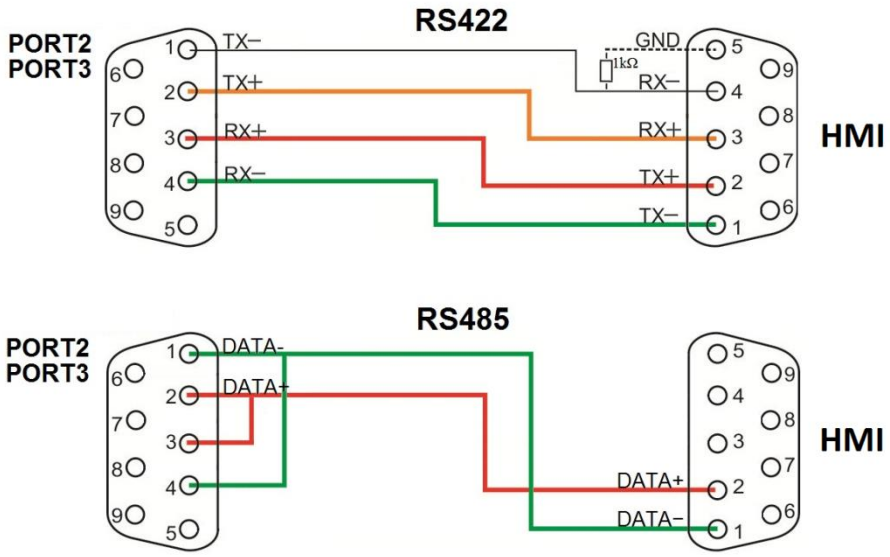
2.12.1 Communication

RS485

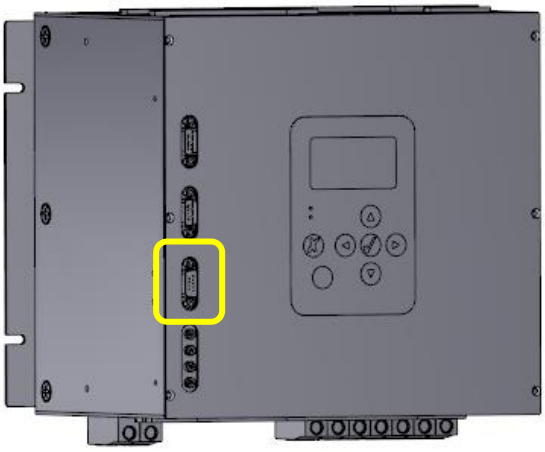


Label	Connector	Cable	Description
(A) PORT 2	DB9 Female	Shielded twisted pair	RS485 Protocols supported: • Modbus RTU 19200/115200-8-N-1 Default : 19200-8-N-1
(B) PORT 3			

Pinout diagram:

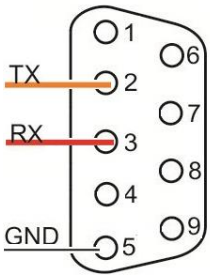


RS232

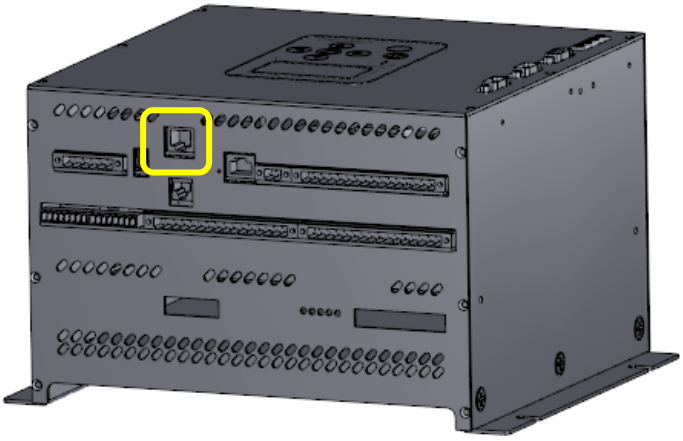


Label	Connector	Cable	Description
(A) PORT 1	DB9 Male	Shielded twisted pair	RS232 Protocols supported: • Modbus RTU 115200-8-N-1

Pinout diagram:



ETHERNET

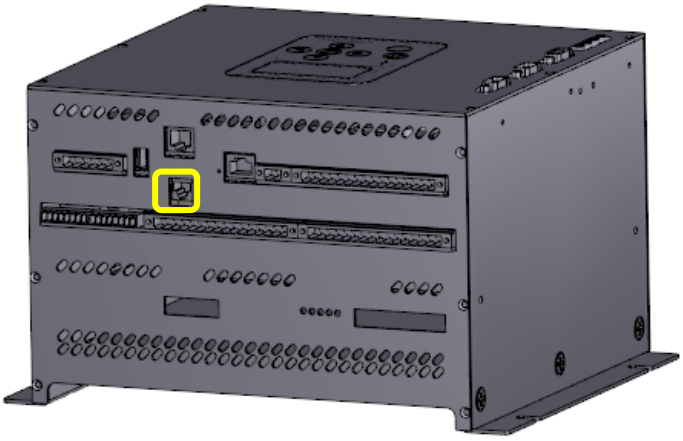


Label	Connector	Cable	Description
(A) ETHERNET	RJ45	Shielded twisted pair, Straight-through	Compliant with: IEEE 802.3/IEEE 802.3u 10Base-T/100Base-TX, ANSI X3T12 TP-PMD 1995 Auto-Negotiation IEEE 802.3u Protocols supported: • Modbus TCP • NTP • IEC 61850 • IEC 60870-5-104 Factory-default IP address: 192.168.50.170, port 1502

USB

Label	Connector	Cable	Description
(A) USB	USB standard type A	Standard	USB 2.0 Full Speed Device

1WIRE

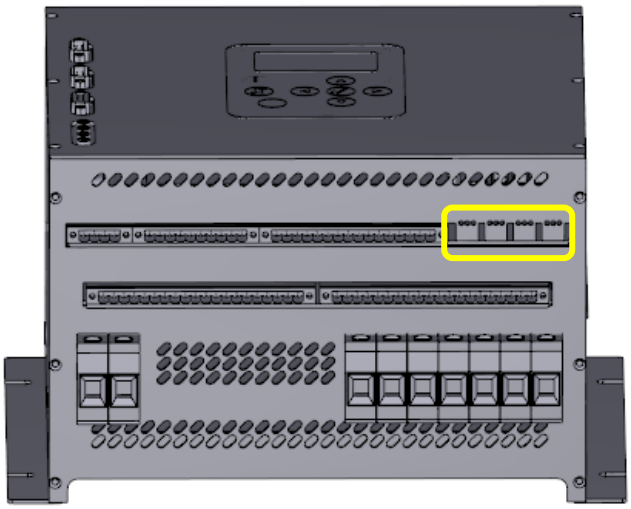


Label	Connector	Cable	Description
(A) 1WIRE	RJ11	Standard, Straight-through	1wire serial interface for temperature measurements, up to 7 thermometers

DUAL CHANNEL

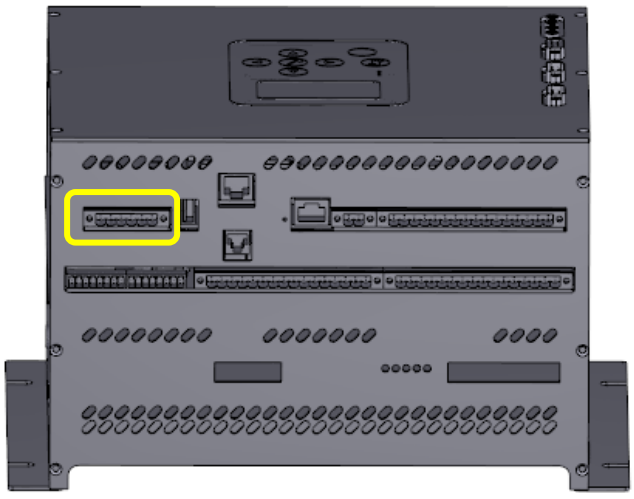
Label	Connector	Cable	Description
(A) DUAL CH.	RJ45	F/UTP Patch cord, Crossover	Serial interface for dual channel configuration

FIBER OPTIC



Label		Connector	Cable	Description
(A)	CH1	BROADCOM HFBR-5963ALZ	LC/UPC LC/UPC 50/125 OM2 Patch cord	10Mbit/s serial interface for Local Controller
(B)	CH2			
(C)	CH3			
(D)	CH4			

2.12.2 Electronics supply



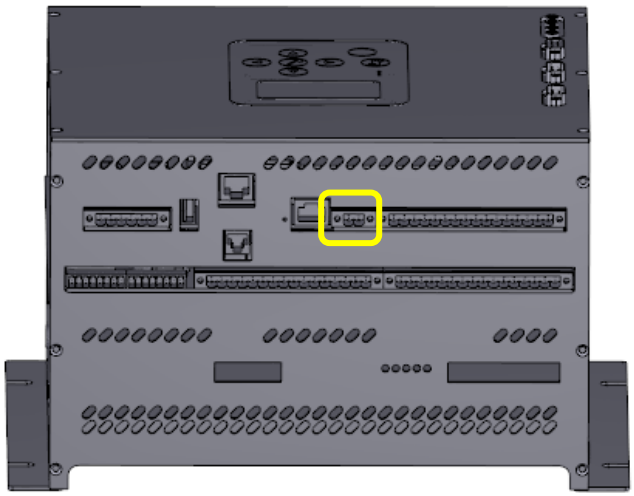
Pinout:

	Terminal	Connector	Cable	Description
(A)	X7 – 1(+),2(-)	PHOENIX CONTACT MSTB 2,5/6-ST-5,08	Solid or stranded copper wire with maximum 2,5mm^2 cross-section	Supply system 1
(B)	X7 – 3(+),4(-)			Supply system 2
(C)	X7 – 5,6			Ground

Technical data:

	Value	Description
(A)	2,5 mm^2	Nominal cross section
(B)	120VDC – 330VDC	DC Rated voltage (III/3) for 230V version
(C)	105VAC – 250VAC	AC Rated voltage (III/3) for 230V version
(D)	19VDC – 35VDC	DC Rated voltage (III/3) for 24V version
(E)	18VAC – 25VAC	AC Rated voltage (III/3) for 24V version
(F)	EN-VDE	Connection in acc. with standard
(G)	V0	Flammability rating according to UL 94
(H)	M3	Screw thread
(I)	0.5 Nm	Tightening torque, min
(J)	0.6 Nm	Tightening torque, max
(H)	1,5 kV	AC Isolation voltage

2.12.3 Isolated DC analog input



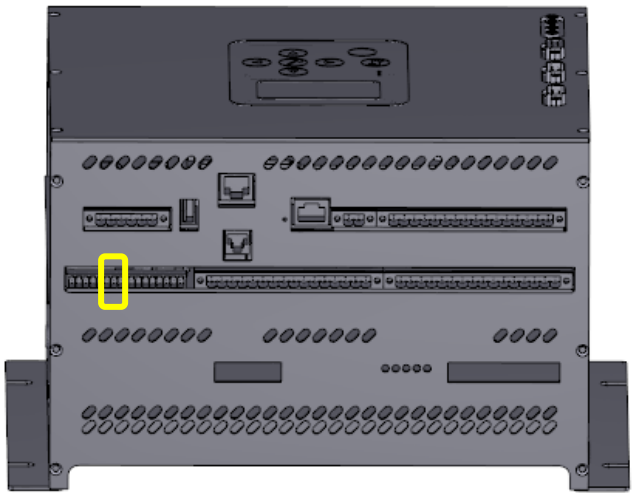
Pinout:

	Label	Connector	Cable	Description
(A)	X5 - 1,2	PHOENIX CONTACT MSTB 2,5/2-ST-5,08	Solid or stranded copper wire with maximum 2,5mm^2 cross-section	Isolated analog input for Voltage Matching or PSS disturbance signal

Technical data:

	Value	Description
(A)	2,5 mm^2	Nominal cross section
(B)	+/-10V	DC Rated voltage (III/3)
(C)	EN-VDE	Connection in acc. with standard
(D)	V0	Flammability rating according to UL 94
(E)	M3	Screw thread
(F)	0.5 Nm	Tightening torque, min
(G)	0.6 Nm	Tightening torque, max

2.12.4 Isolated AC Analog Input



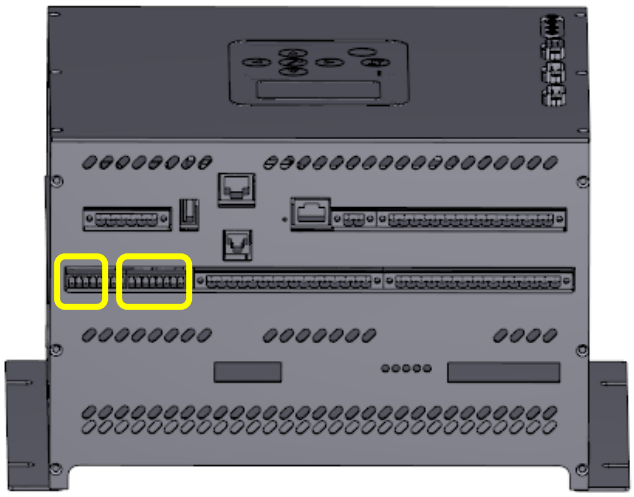
Pinout:

Label	Connector	Cable	Description
X12 - 7,8	TE CONNECTIVITY 284506-8	Solid or stranded copper wire with maximum 2,0mm^2 cross-section	Source change over dedicated voltage input (0-7,07V)

Technical data:

	Value	Description
(A)	2,0 mm^2	Nominal cross section
(B)	7,07 V	AC Rated voltage (III/3)
(C)	V0	Flammability rating according to UL 94
(D)	M2	Screw thread
(E)	0.31 Nm	Tightening torque, max

2.12.5 Analog Inputs and Outputs (4-20mA)



Pinout:

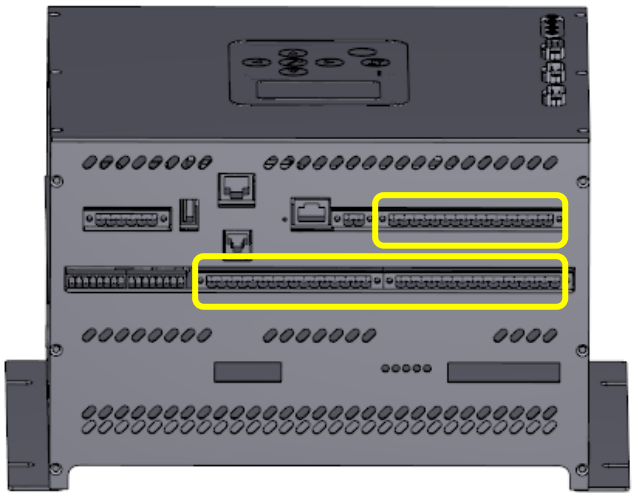
Label	Connector	Cable	Description
X12 - 1,2	TE CONNECTIVITY 284506-8	Solid or stranded copper wire with maximum 2,0mm^2 cross-section	4-20mA analog input 1
X12 - 3,4			4-20mA analog input 2
X12 - 5,6			4-20mA analog input 3
X13 - 1,2			4-20mA analog output 1
X13 - 3,4			4-20mA analog output 2
X13 - 5,6			4-20mA analog output 3
X13 - 7,8			4-20mA analog output 4

Technical data:

	Value	Description
(A)	2,0 mm^2	Nominal cross section
(B)	+/-20mA	Analog input DC Rated current
(C)	4-20mA	Analog output DC Rated current
(D)	V0	Flammability rating according to UL 94

	Value	Description
(E)	M2	Screw thread
(F)	0.31 Nm	Tightening torque, max
(G)	250 Ohm	Input resistance

2.12.6 Binary Outputs (Dry Contact)



Pinout:

Label	Connector	Cable	Description
X3 - 1,2	PHOENIX CONTACT MSTB 2,5/16-ST-5,08	Solid or stranded copper wire with maximum 2,5mm^2 cross-section	Binary output number 1 (NO)
X3 - 3,4			Binary output number 2 (NO)
X3 - 5,6			Binary output number 3 (NO)
X3 - 7,8			Binary output number 4 (NO)
X3 - 9,10			Binary output number 5 (NO)
X3 - 11,12			Binary output number 6 (**NC/NO**)
X3 - 13,14			Binary output number 7 (NO)
X3 - 15,16			Binary output number 8 (**NC/NO**), Hardware Watchdog
X15 - 1,2			Binary output number 9 (NO)

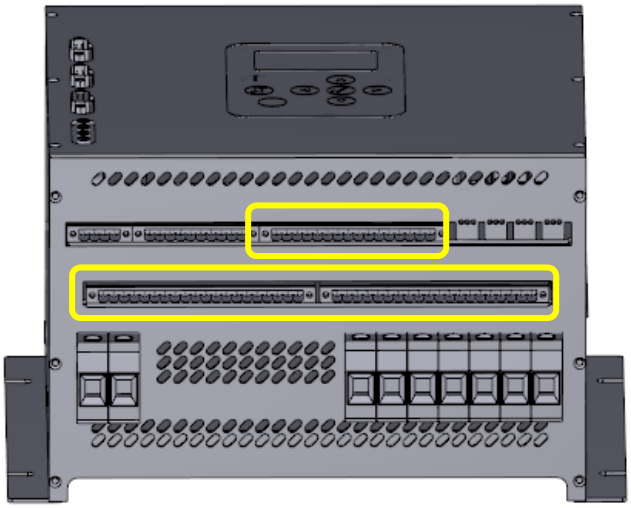
Label	Connector	Cable	Description
X15 - 3,4			Binary output number 10 (NO)
X15 - 5,6			Binary output number 11 (NO)
X15 - 7,8			Binary output number 12 (NO)
X15 - 9,10			Binary output number 13 (NO)
X15 - 11,12			Binary output number 14 (NO)
X15 - 13,14			Binary output number 15 (NO)
X15 - 15,16			Binary output number 16 (NO)
X14 - 1,2			Binary output number 17 (NO)
X14 - 3,4			Binary output number 18 (NO)
X14 - 5,6			Binary output number 19 (NO)
X14 - 7,8			Binary output number 20 (NO)
X14 - 9,10			Binary output number 21 (NO)
X14 - 11,12			Binary output number 22 (NO)
X14 - 13,14			Binary output number 23 (NO)
X14 - 15,16			Binary output number 24 (NO)

Technical data:

	Value	Description
(A)	250VDC/440VAC	Rated/max. switching voltage
(B)	10V	Min. switching voltage
(D)	8A/250V AC	Rated load (capacity): AC1
(E)	3A/120V; 1,5V/240V	Rated load (capacity): AC15
(F)	8A/24V DC	Rated load (capacity): DC1
(G)	0,22A/120V; 0,1A/250V	Rated load (capacity): DC13

	Value	Description
(H)	10mA	Min. switching current
(I)	15A	Max. inrush current
(J)	8A	Rated current
(K)	≤100mΩ	Contact resistance
(L)	600 cycles/hour	Max. operating frequency rated load
(M)	72000 cycles/hour	Max. operating frequency no load
(N)	400V AC	Insulation rated voltage
(O)	4000V, 1,2/50μs	Rated surge voltage
(P)	4000VAC	Dielectric between coil and contacts
(R)	1000VAC	Dielectric contact clearance
(S)	10ms/5ms	Operating/release time
(T)	$>10^5$, 8A, 250V AC	Electrical life resistive AC1
(U)	$> 2 \times 10^7$	Mechanical life (cycles)

2.12.7 Binary Inputs (Opto-isolated)



Pinout:

Label	Connector	Cable	Description
X6 - 1	PHOENIX CONTACT MSTB 2,5/16-ST-5,08 PHOENIX CONTACT MSTB 2,5/20-ST-5,08	Solid or stranded copper wire with maximum 2,5mm^2 cross-section	Binary input number 1
X6 - 2			Binary input number 2
X6 - 3			Binary input number 3
X6 - 4			Binary input number 4
X6 - 5			Binary input number 5
X6 - 6			Binary input number 6
X6 - 7			Binary input number 7
X6 - 8			Control voltage minus for inputs 1 - 7
X6 - 9			Binary input number 8
X6 - 10			Binary input number 9
X6 - 11			Binary input number 10
X6 - 12			Binary input number 11
X6 - 13			Binary input number 12

Label	Connector	Cable	Description
X6 - 14			Binary input number 13
X6 - 15			Binary input number 14
X6 - 16			Control voltage minus for inputs 8 - 14
X10 - 1			Binary input number 15
X10 - 2			Binary input number 16
X10 - 3			Binary input number 17
X10 - 4			Binary input number 18
X10 - 5			Control voltage minus for inputs 15 - 18
X10 - 6			Binary input number 19
X10 - 7			Binary input number 20
X10 - 8			Binary input number 21
X10 - 9			Binary input number 22
X10 - 10			Control voltage minus for inputs 19 - 22
X10 - 11			Binary input number 23
X10 - 12			Binary input number 24
X10 - 13			Binary input number 25
X10 - 14			Binary input number 26
X10 - 15			Control voltage minus for inputs 23 - 26
X10 - 16			Binary input number 27
X10 - 17			Binary input number 28
X10 - 18			Binary input number 29
X10 - 19			Binary input number 30
X10 - 20			Control voltage minus for inputs 27 - 30
X11 - 1			Binary input number 31

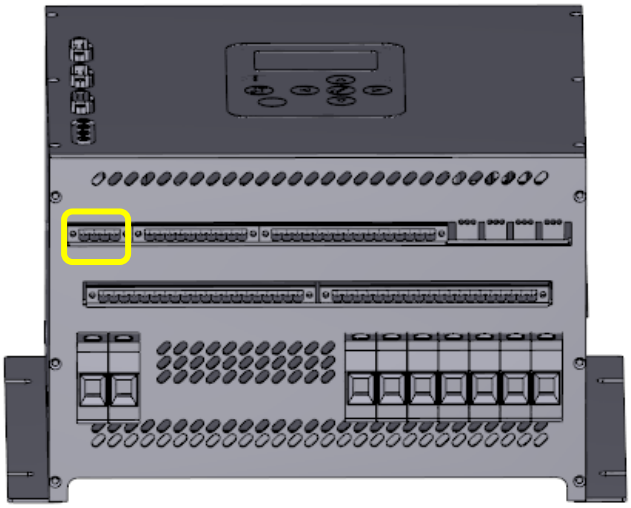
Label	Connector	Cable	Description
X11 - 2			Binary input number 32
X11 - 3			Binary input number 33
X11 - 4			Binary input number 34
X11 - 5			Control voltage minus for inputs 31 - 34
X11 - 6			Binary input number 35
X11 - 7			Binary input number 36
X11 - 8			Binary input number 37
X11 - 9			Binary input number 38
X11 - 10			Control voltage minus for inputs 35 - 38
X11 - 11			Binary input number 39
X11 - 12			Binary input number 40
X11 - 13			Binary input number 41
X11 - 14			Binary input number 42
X11 - 15			Control voltage minus for inputs 39 - 42
X11 - 16			Binary input number 43
X11 - 17			Binary input number 44
X11 - 18			Binary input number 45
X11 - 19			Binary input number 46
X11 - 20			Control voltage minus for inputs 43 - 46

Technical data:

	Value	Description
(A)	24V –20% / +30% (max. 0.5W / input)	Rated voltage for 24V configuration
(B)	48V ±25% (max. 0.5W / input)	Rated voltage for 48V configuration

	Value	Description
(D)	125V ±25% (max. 0.5W / input)	Rated voltage for 125V configuration
(E)	220V ±20% (max. 0.5W / input)	Rated voltage for 230V configuration
(F)	5 kV DC	Isolation voltage

2.12.8 Generator Voltage Measurement



Pinout:

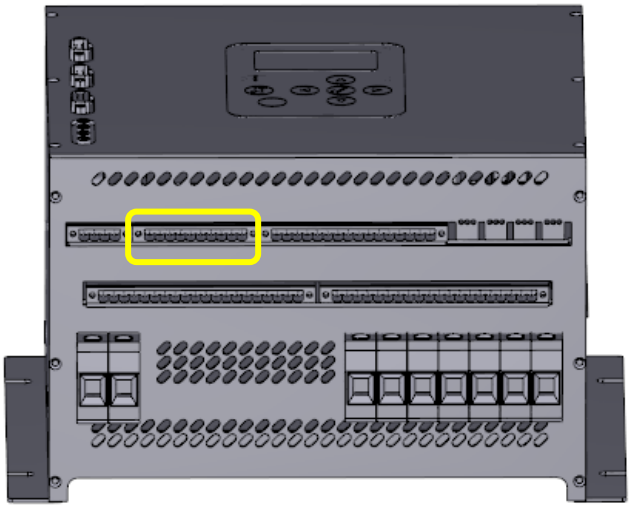
Label	Connector	Cable	Description
U_G - U_A	PHOENIX CONTACT MSTB 2,5/4-ST-5,08	Solid or stranded copper wire with maximum 2,5mm^2 cross-section	Voltage Transformer, phase A
U_G - U_B			Voltage Transformer, phase B
U_G - U_C			Voltage Transformer, phase C
U_G - N_-			Center neutral terminal of the Voltage Transformers

Technical data:

	Value	Description
(A)	2,5 mm^2	Nominal cross section
(B)	230 V	AC Rated voltage (III/3)

	Value	Description
(C)	EN-VDE	Connection in acc. with standard
(D)	V0	Flammability rating according to UL 94
(E)	M3	Screw thread
(F)	0.5 Nm	Tightening torque, min
(G)	0.6 Nm	Tightening torque, max
(H)	2 KV	AC Isolation voltage

2.12.9 Generator Current Measurement



Pinout:

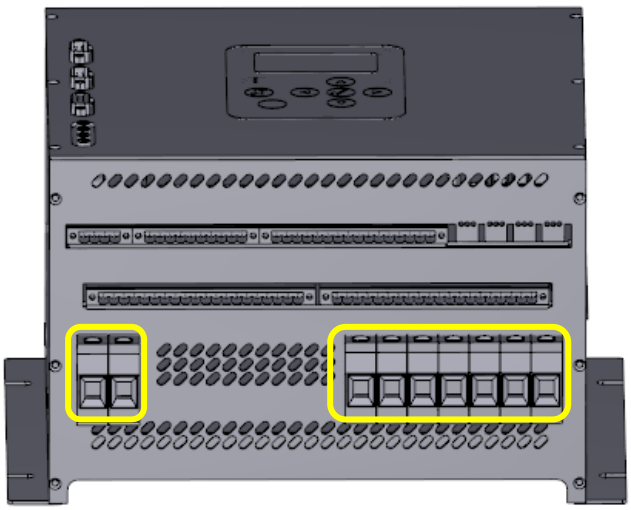
Label	Connector	Cable	Description
I_A - 1A	PHOENIX CONTACT MSTB 2,5/10-ST-5,08	Solid or stranded copper wire with maximum 2,5mm^2 cross-section	Current Transformer 1A, phase A
I_A - 5A			Current Transformer 5A, phase A
I_A - COM			Current Transformer COMMON, phase A
I_B - 1A			Current Transformer 1A, phase B
I_B - 5A			Current Transformer 5A, phase B
I_B - COM			Current Transformer COMMON, phase B
I_C - 1A			Current Transformer 1A, phase C

Label	Connector	Cable	Description
I_C - 5A			Current Transformer 5A, phase C
I_C - COM			Current Transformer COMMON, phase C

Technical data:

	Value	Description
(A)	2,5 mm^2	Nominal cross section
(B)	230 V	AC Rated voltage (III/3)
(C)	EN-VDE	Connection in acc. with standard
(D)	V0	Flammability rating according to UL 94
(E)	M3	Screw thread
(F)	0.5 Nm	Tightening torque, min
(G)	0.6 Nm	Tightening torque, max
(H)	2 kV	AC Isolation voltage

2.12.10 Internal Power Converter



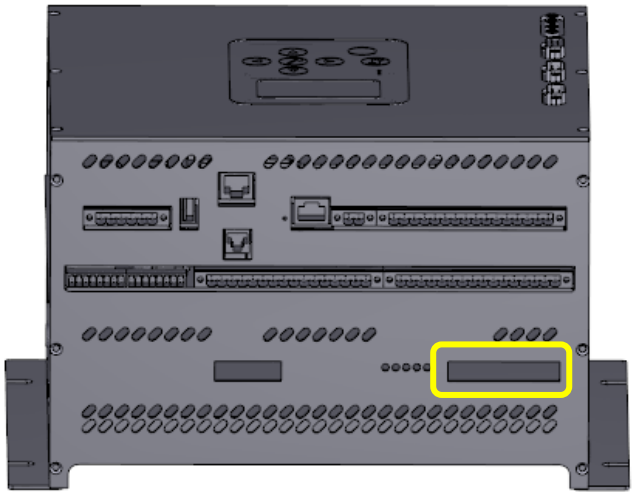
Pinout:

Label	Connector	Cable	Description
X8 - 1	MPT2515	Solid or stranded copper wire with maximum 25mm^2 cross-section	Internal power converter supply, phase L1
X8 - 2			Internal power converter supply, phase L2
X8 - 3			Internal power converter supply, phase L3
X8 - 4			Internal power converter output, + PLUS (max 300Vdc, 50A, 100A-10s forcing)
X8 - 5			Internal power converter output, – MINUS (max 300Vdc, 50A, 100A-10s forcing)
X8 - 6			LEM sensing input, + PLUS (max , 50A, 100A-10s forcing)
X8 - 7			LEM sensing output, + PLUS (max , 50A, 100A-10s forcing)
X9 - 1			Boosting or external capacitor, – MINUS (max 100A, 10s)
X9 - 2			Boosting or external capacitor, + PLUS (max 100A, 10s)

Technical data:

	Value	Description
(A)	25 mm^2	Nominal cross section
(B)	230 V	AC Rated voltage
(C)	300 V	DC Rated voltage
(D)	50 A	Rated current
(E)	100 A	Forcing current, 10s
(F)	V0	Flammability rating according to UL 94
(G)	M5	Screw thread
(H)	2 Nm	Tightening torque
(I)	2 kV	AC Isolation voltage

2.12.11 GCU - Firing Pulses



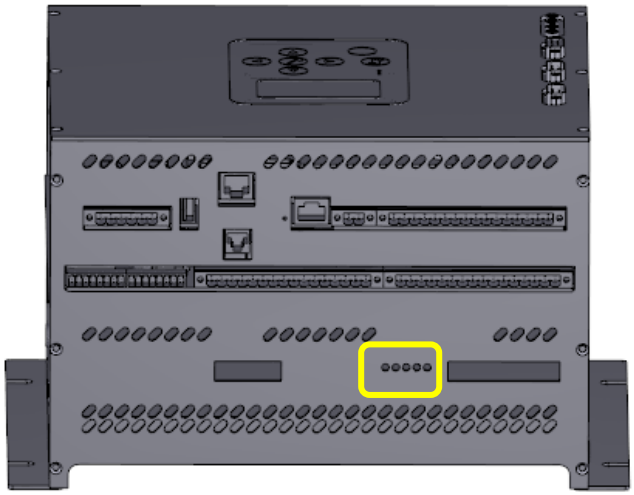
Pinout:

Label	Connector	Cable	Description
X16 – 1(+),2(pulse)	PHOENIX CONTACT MC 1,5/12-ST-3,5	Twisted pair wire with maximum 1,5mm^2 cross-section	Firing pulse, R+
X16 – 3(+),4(pulse)			Firing pulse, R-
X16 – 5(+),6(pulse)			Firing pulse, S+
X16 – 7(+),8(pulse)			Firing pulse, S-
X16 – 9(+),10(pulse)			Firing pulse, T+
X16 – 11(+),12(pulse)			Firing pulse, T-

Technical data:

	Value	Description
(A)	1,5 mm^2	Nominal cross section
(B)	24 V	DC Rated voltage
(D)	V0	Flammability rating according to UL 94
(E)	M2	Screw thread
(F)	0.25 Nm	Tightening torque, max
(G)	!	Non-isolated

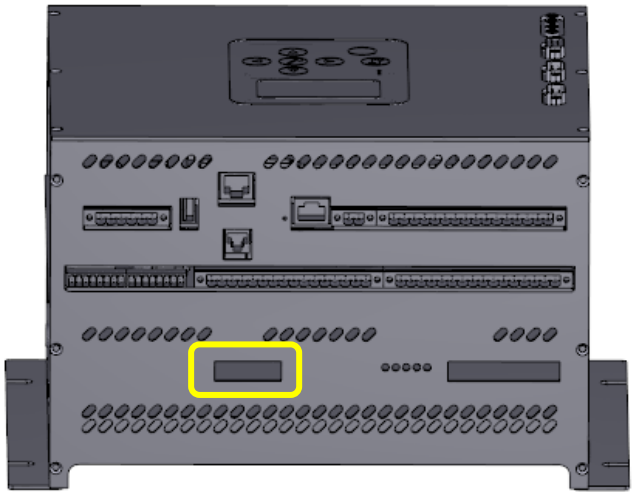
2.12.12 GCU - Status LEDs



Pinout:

Label	Connector	Cable	Description
PULSE FAULT	-	-	Failure in firing pulses circuit
SYNCH.OFF			Loss of synchronization voltage
DEEXCIT.			Deexcitation command from main board
PULSES STOP			Firing pulses disable command from main board
POWER OK			Indicates proper internal supply of electronics

2.12.13 External LEM



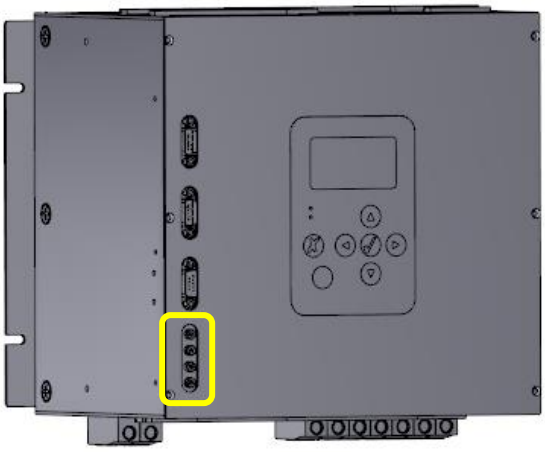
Pinout:

Label	Connector	Cable	Description
X17 – 1	PHOENIX CONTACT MC 1,5/6-ST-3,5	Wire with maximum 1,5mm^2 cross-section	Sensing input
X17 – 2			+12V supply
X17 – 3			-12V supply
X17 – 4			GND

Technical data:

	Value	Description
(A)	1,5 mm^2	Nominal cross section
(B)	12 V	DC Rated voltage
(D)	V0	Flammability rating according to UL 94
(E)	M2	Screw thread
(F)	0.25 Nm	Tightening torque, max
(G)	!	Non-isolated

2.12.14 Service Analog Outputs



Pinout:

Label	Connector	Cable	Description
1st from the top	Mini 2mm female banana	Patch cord	Analog output 1, ±10VDC
2nd from the top			Analog output 2, ±10VDC
3rd from the top			Analog output 3, ±10VDC
4th from the top			GND, common

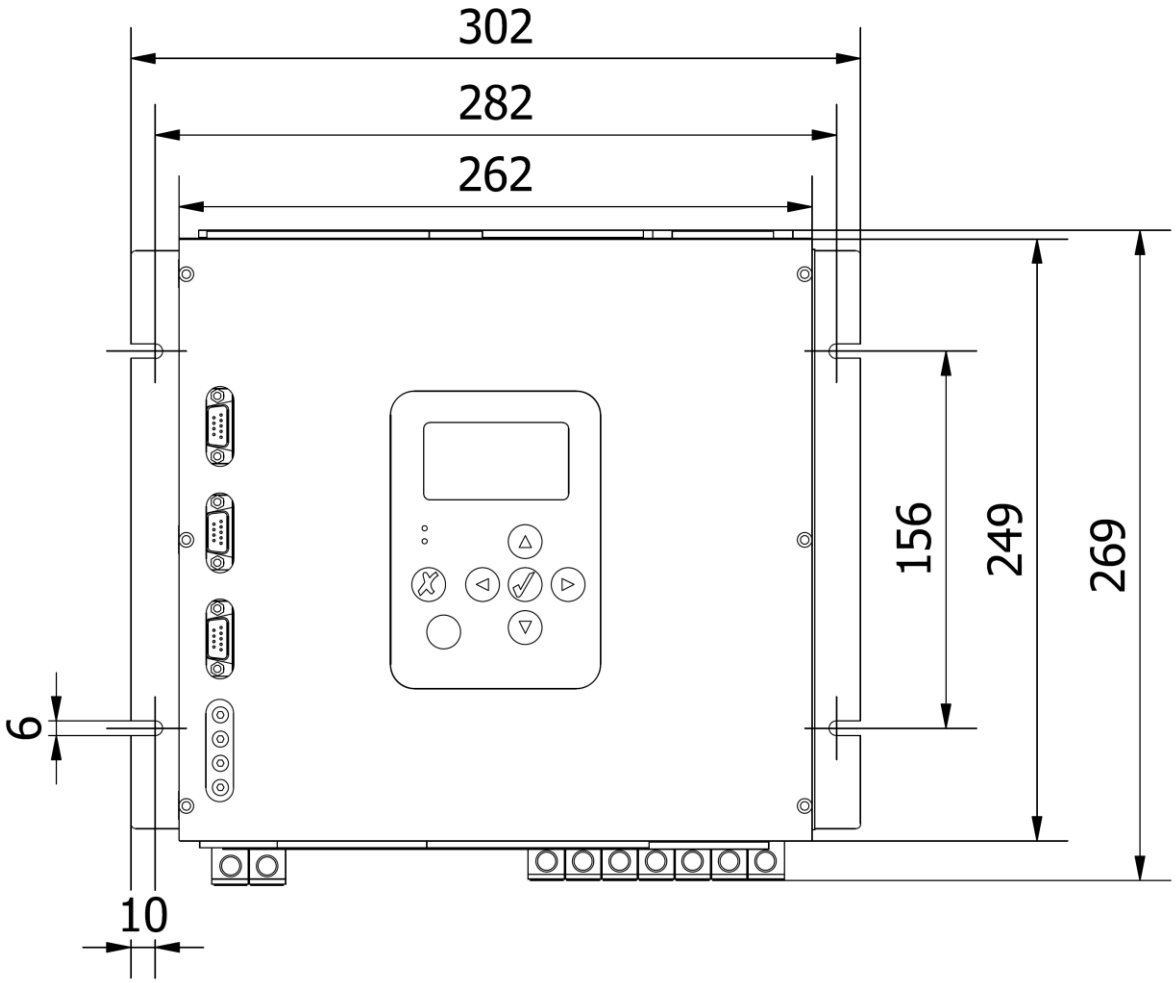
Technical data:

	Value	Description
(A)	2mm	Plug size
(B)	7.07 V	Rated AC voltage
(C)	!	Non-isolated
(D)	1 ms	Refresh rate for 1st output
(E)	1 ms	Refresh rate for 2nd output
(F)	10 ms	Refresh rate for 3rd output

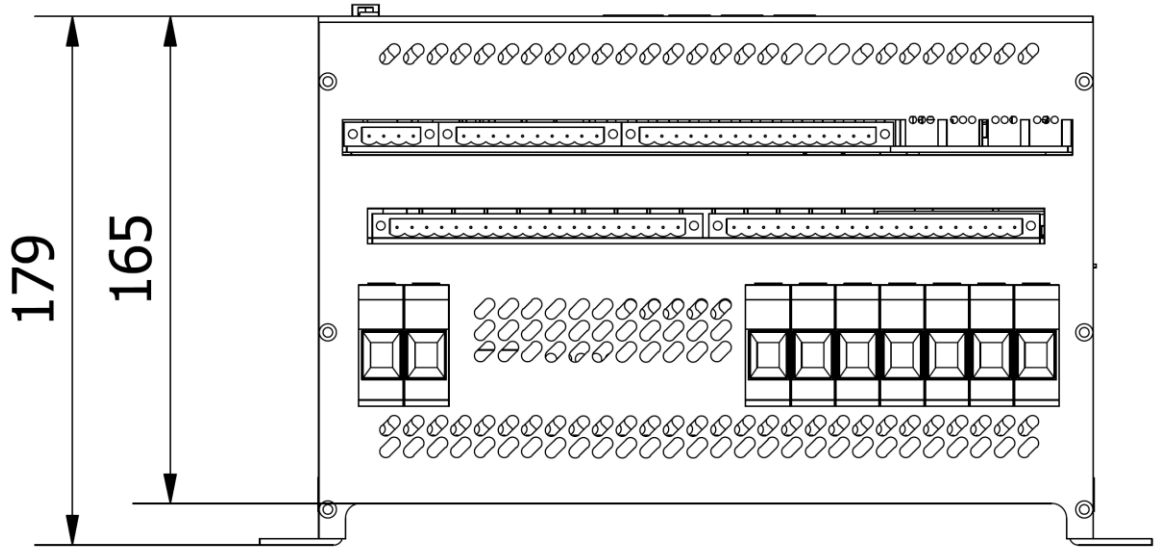
2.13 DIMENSIONS

All dimensions are specified in millimeters.

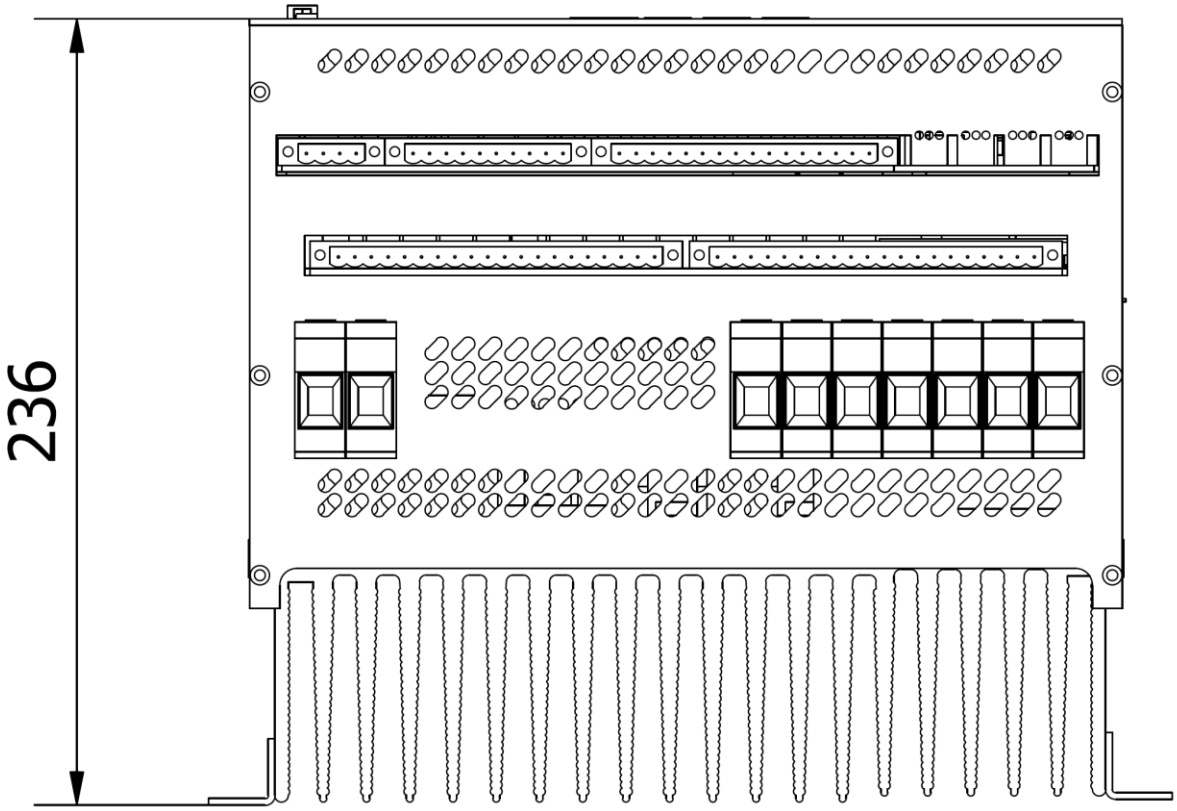
Front



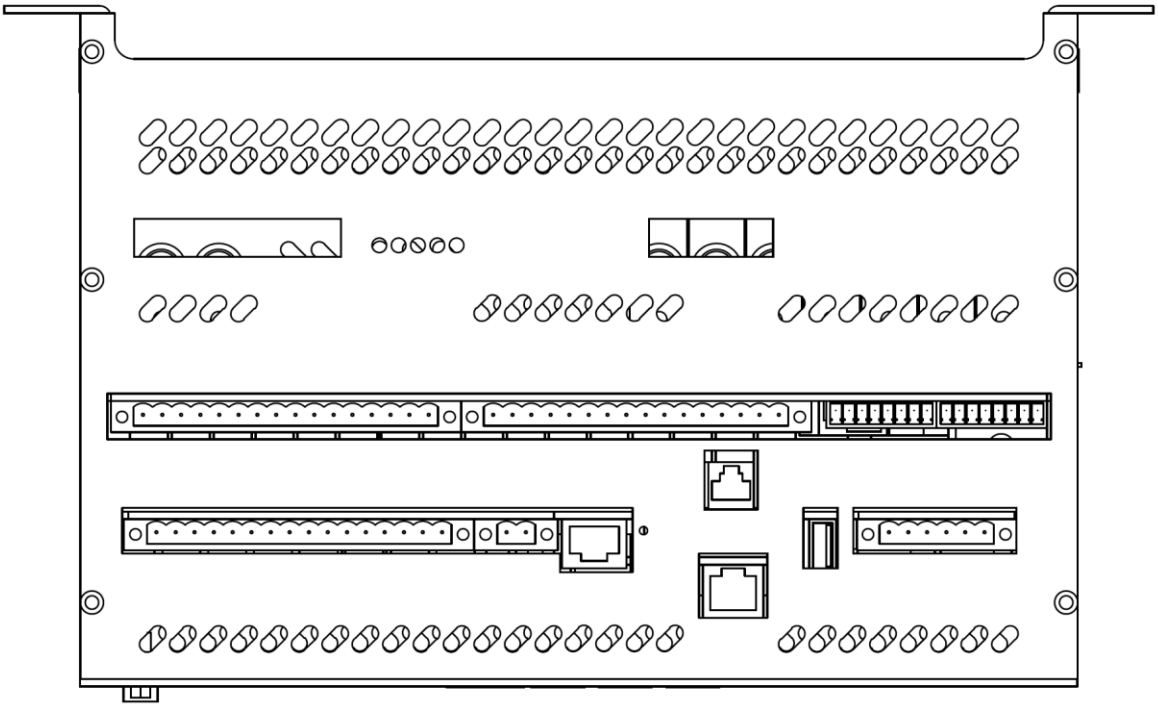
Bottom – slim version



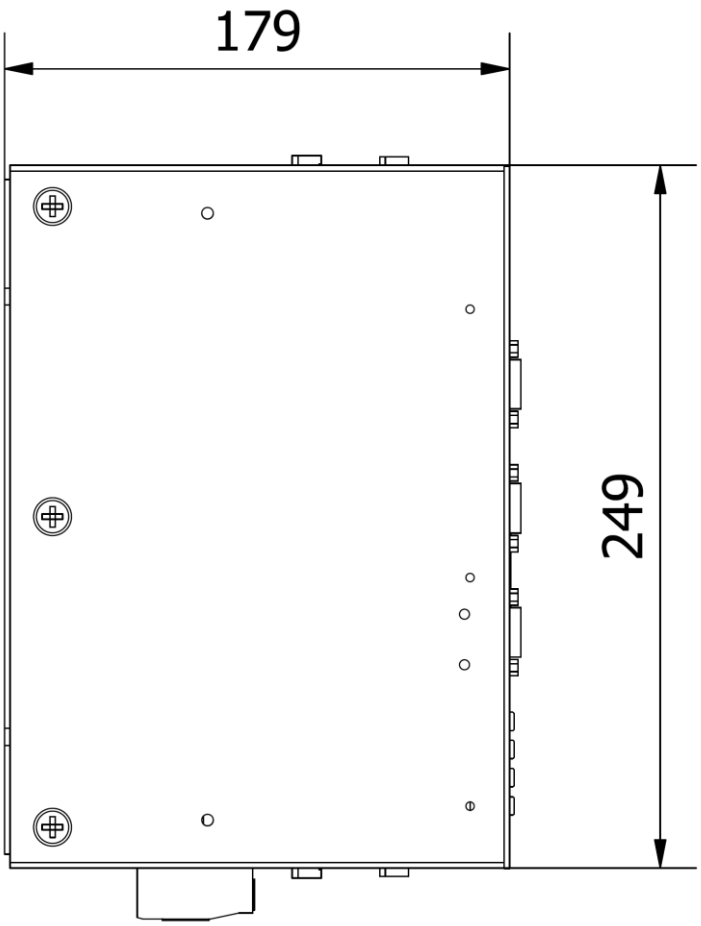
Bottom – heat sink version



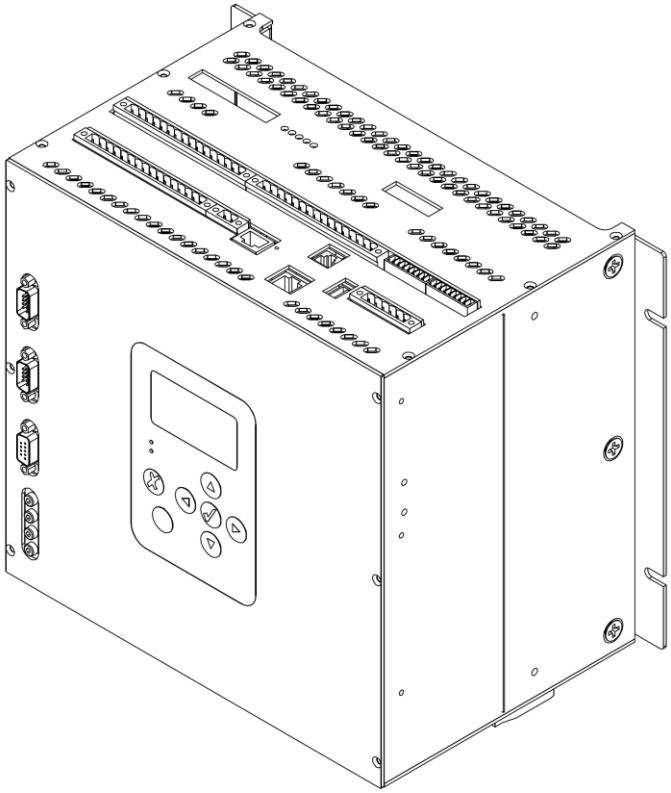
Top



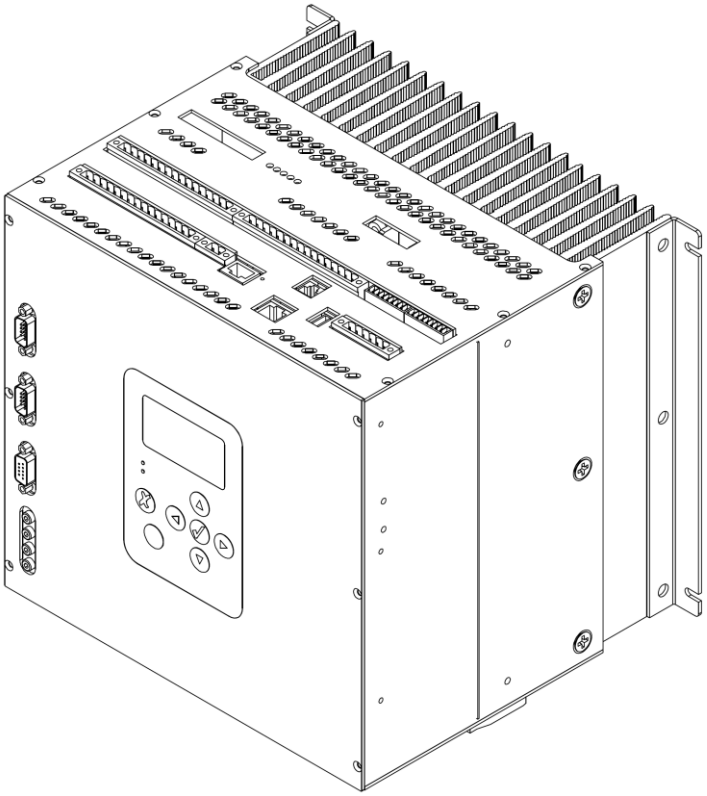
Side



Overview – slim version



Overview – heat sink version



3 SOFTWARE DESCRIPTION

3.1 INTRODUCTION

P100C-SX Tuning Software is a very useful tool for accessing regulator parameters, logic, limiters, recorder data and many others futures of regulator. It also provides a functional interface for P100C-SX operation monitoring.

For the details on how to establish a connection with regulator please refer to GETTING STARTED section of this document.

3.2 AUTOMATIC REGULATION LOOP

The automatic regulation loop means regulation of the generator voltage. This loop is considered to be primary control loop of excitation system.

The P100C-SX Tuning Software allows user to choose one of three structures of the automatic regulation loop, according to IEEE Std. 421.5. Structures are shown below:

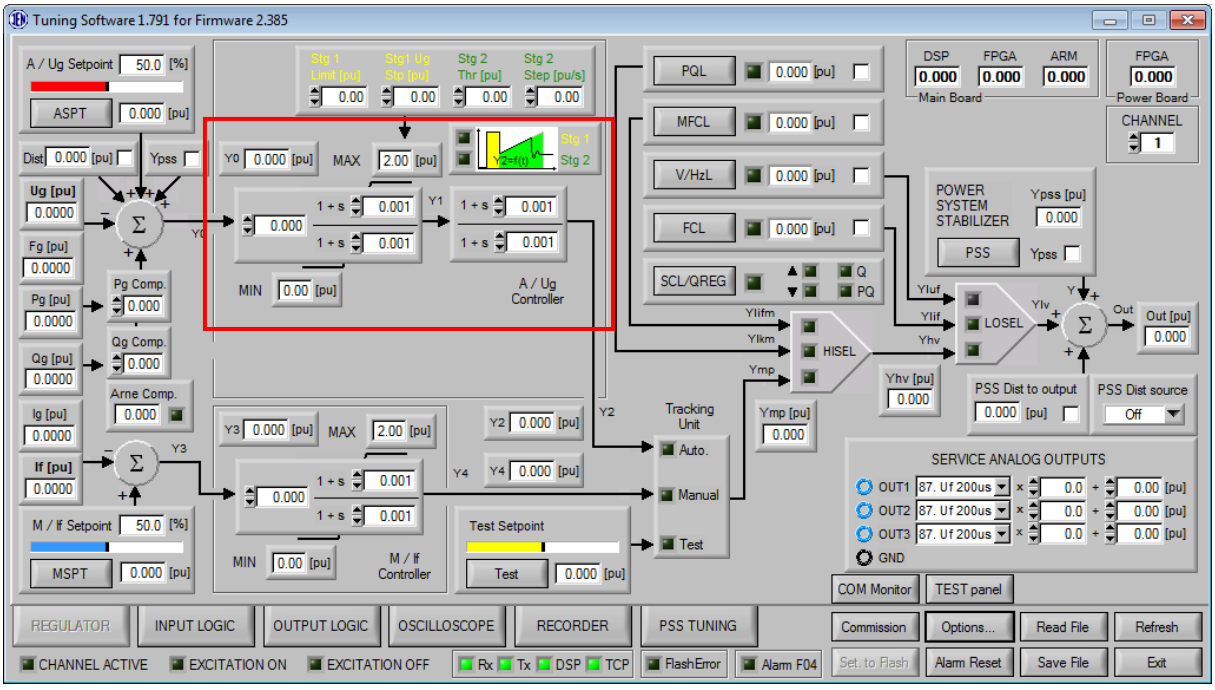


Fig. 21 Automatic regulation loop ST1A settings section

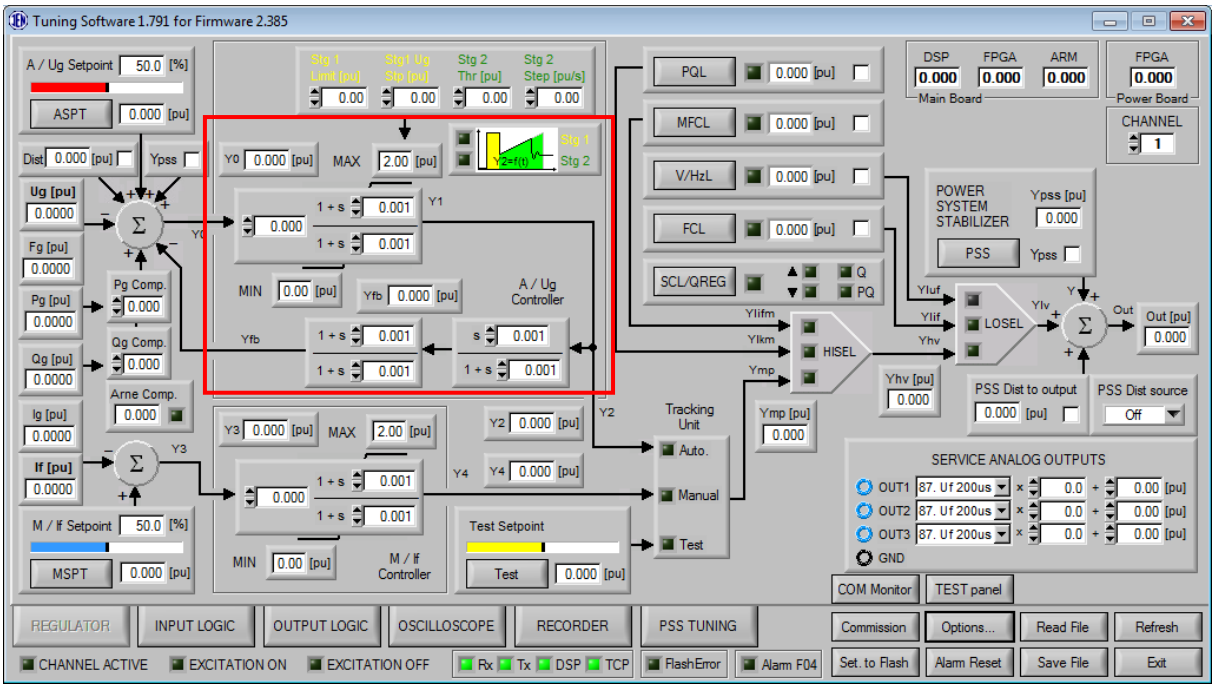


Fig. 22 Automatic regulation loop AC5A settings section

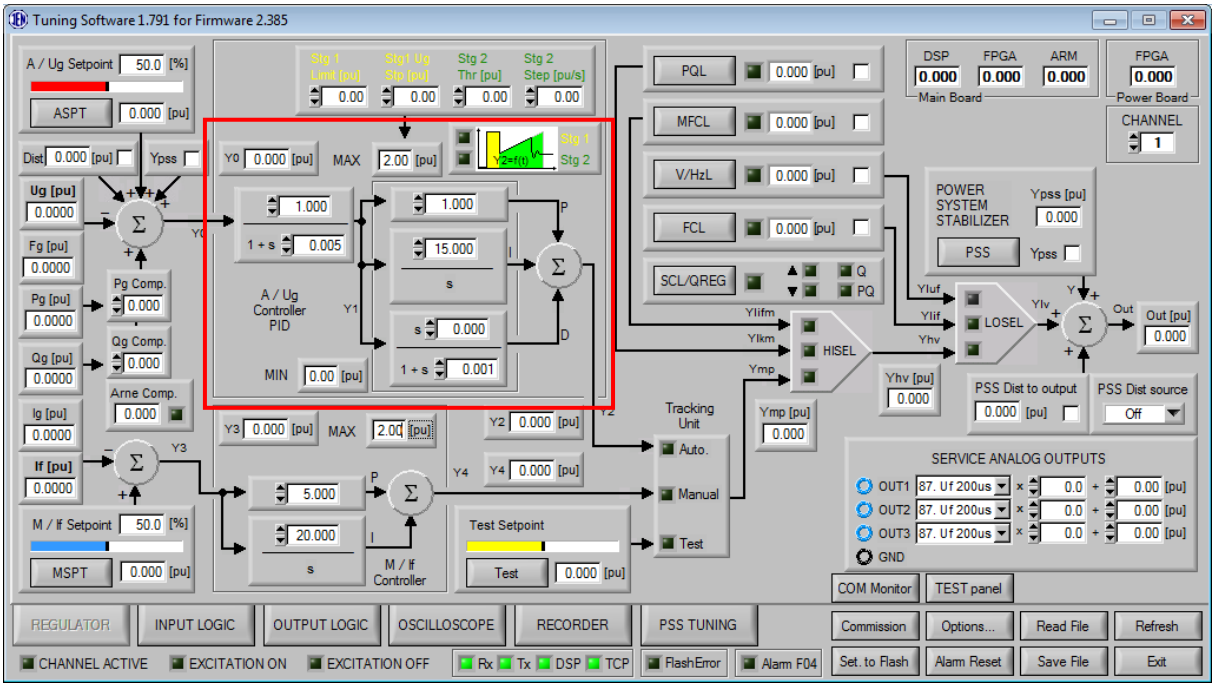


Fig. 23 Automatic regulation loop AC8B (PID) settings section

Switching between manual regulation loop can be done through Options/Misc “Excitation system structure” where:

- ST1A – LEAD/LAG structure
- AC5A – LEAD/LAG structure
- AC8B/ST4B (PID) – PID structure

3.2.1 Input limitation

To avoid control signal overshoot or oversaturation limitation component has been introduced to the input of automatic control loop in ST1A or AC5A configurations.

It limits input signal of automatic control loop according to the equation:

$$limit = \frac{1.45 \cdot \mathrm{Tb}}{\mathrm{Ka} \cdot \mathrm{Ta}}$$

Where:

Ka – Gain
Ta – Lead component
Tb – Lag component

Limitation value can vary from ±0.11 pu to ±2.0 pu and is calculated automatically.

3.3 SOFT START

The Soft Start facility is designed to avoid large overshoots in the automatic regulation loop during excitation start. The soft start limits the regulator structure output signal, until this signal is higher than the soft-start limit as shown below.

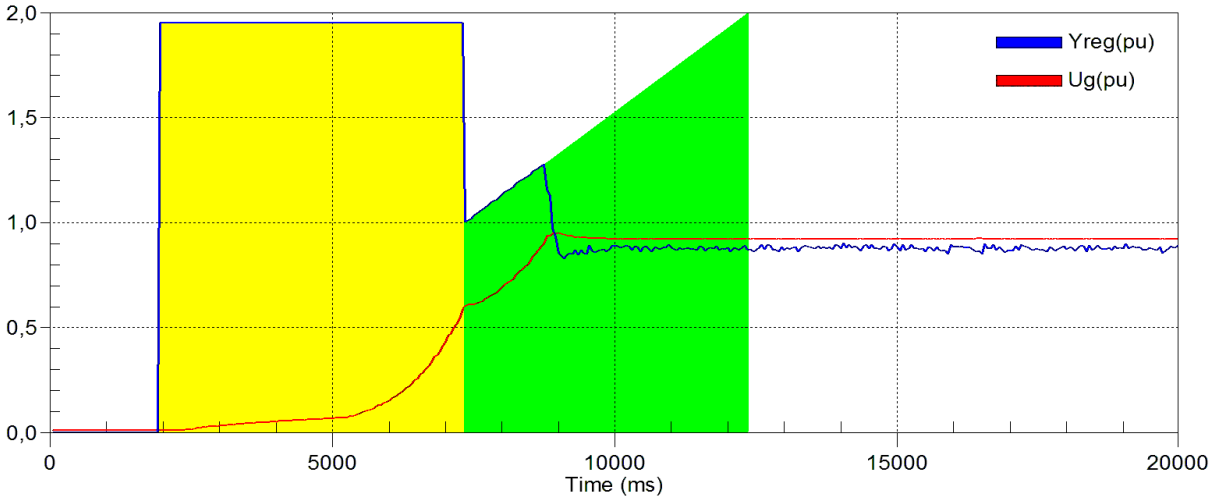


Fig. 24 Excitation soft start: 1st stage – yellow area, 2nd stage – green area

The Soft Start consists of two stages:

- 1st stage – field forcing
- 2nd stage – ramp

P100C-SX AVR output signal is limited to the value specified in “Stg 1 Limit [pu]”. During that time automatic loop setpoint is set to the value given by “Stg1 Ug Stp [pu]”. First stage lasts until generator voltage reaches value specified in “Stg 2 Thr [pu]”. In the second stage, automatic loop setpoint is gradually increased with speed specified in “Stg 2 Step [pu/s]” until it reaches its start value specified in automatic setpoint window – that corresponds to end of the Soft Start procedure.

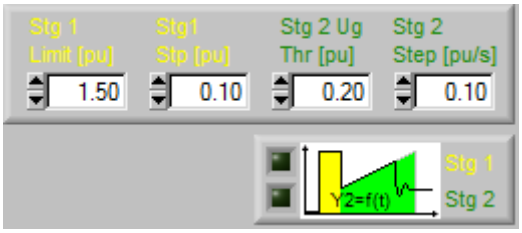


Fig. 25 Soft start settings

3.4 AUTOMATIC REGULATION SET POINT

To open the automatic regulation set point, click “ASPT” button. The following window will appear:

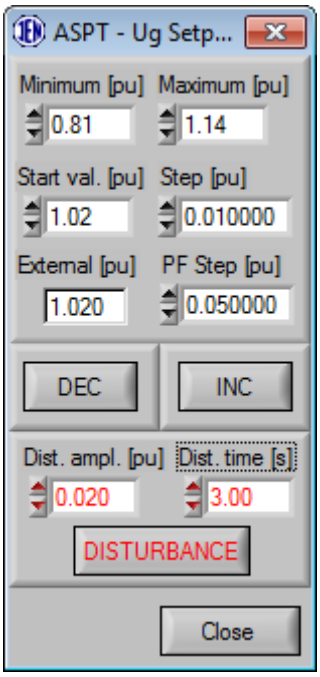


Fig. 26 Automatic regulation set point settings window

First step of working with automatic mode setpoint is setting a range of values for the loop we allow for regulation. This is done by setting “Minimum” and “Maximum” values for setpoint. Another important parameter is “Start val.” which sets automatic loop setpoint value after excitation.

Increasing or decreasing setpoint value of automatic loop is done using “DEC”, “INC” buttons. Step of regulation can be set with “Step” parameter [pu] where 0.01 Step equals to 1% of generator voltage. In addition also PF step setting can be set in ASPT window in the same way (for more details about PF regulation refer to limiters chapter of this documentation).

ASPT window allows to form disturbance signals of desired duration and amplitude for testing of regulation stability. Amplitude can be set with “Dist. ampl.”, disturbance duration “Dist. time” signal will be generated after pressing “DISTTURBANCE” button.

Applying negative amplitude will result in step down – step up disturbance sequence

Additional functionalities of P100C-SX regulator setpoint can be found in Input Logic – Function 8 described in details in chapter 3.19.8. Also it is important to note that Function 8 must be marked as active for setpoint increase/decrease to work.

3.5 MANUAL REGULATION LOOP

The manual regulation loop means regulation of the generator field current. It is considered to be a backup loop for primary automatic loop.

There are two available control loop structures as show in pictures below:

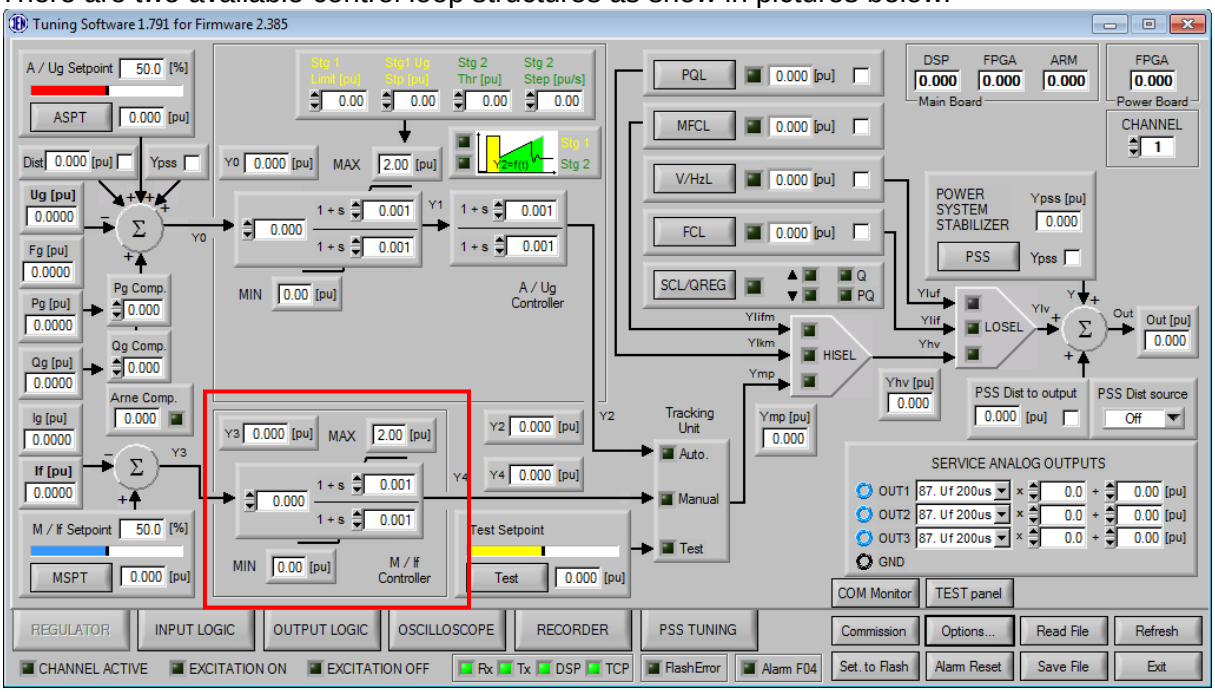


Fig. 27 Manual regulation loop settings section (LEAD/LAG structure)

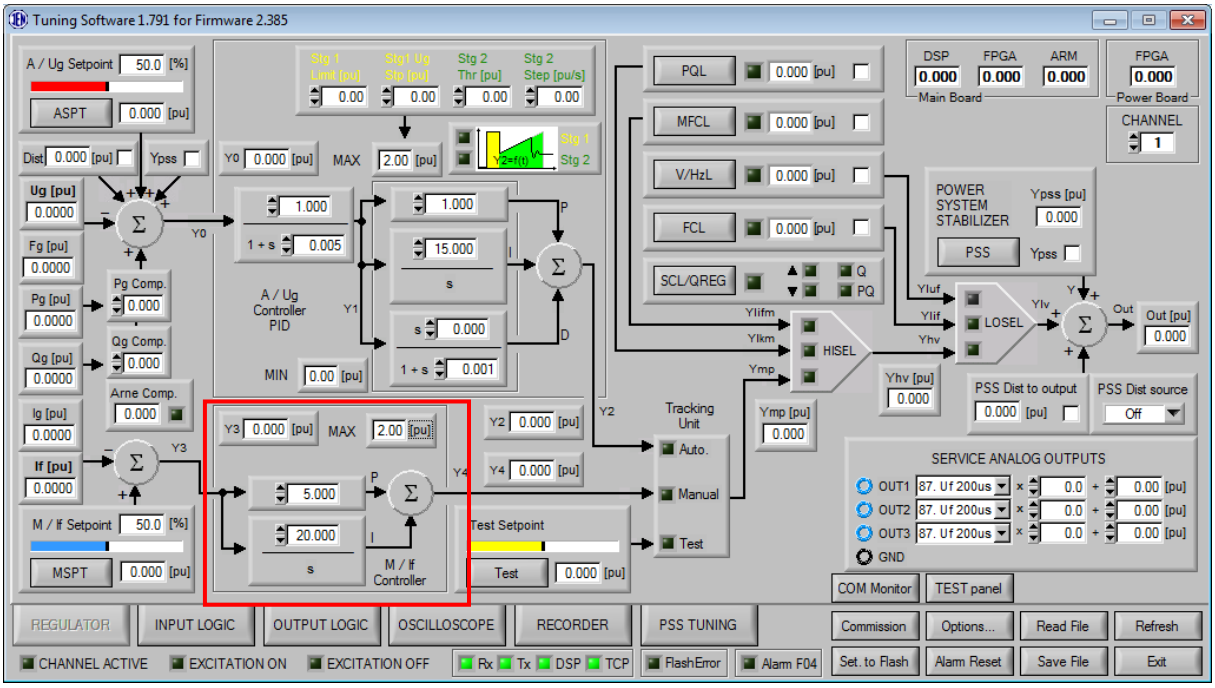


Fig. 28 Manual regulation loop settings section (PID structure)

Switching between manual regulation loop can be done through Options/Misc “Excitation system structure” where:

- ST1A – LEAD/LAG structure
- AC5A – LEAD/LAG structure
- AC8B/ST4B (PID) – PID structure

3.6 MANUAL REGULATION SET POINT

To open the manual regulation set point, click “MSPT” button. The following window appears:

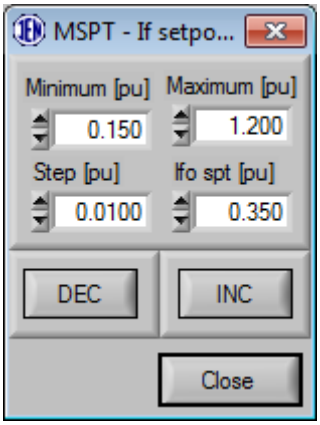


Fig. 29 Manual regulation set point settings window

First step of working with manual mode setpoint is setting a range of values for the loop we allow for regulation. This is done by setting “Minimum” and “Maximum” values for setpoint.

“Step” parameter specifies manual loop regulation step value which corresponds to field current step.

Increasing or decreasing setpoint value of manual loop is done using “DEC”, “INC” buttons.

After opening unit breaker when working in Manual mode regulator automatically decreases its setpoint to “Iff zero” which prevents generator insulation from damage due to overvoltage.

Additional functionalities of P100C-SX regulator setpoint can be found in Input Logic – Function 8 described in details in chapter 3.19.8. Also it is important to note that Function 8 must be marked as active for setpoint increase/decrease to work.

3.7 TRACKING

This functionality of excitation system provides smooth bumpless transfer mechanism between control modes and channels.

3.7.1 Active channel

ST1A/AC5A structures

To achieve bumpless control transfer between control modes, not active control loop adjust its output signal by changing its setpoint with 0.001pu step so that the output tracks the output of active control loop with accuracy of ±0.005pu.

AC8B/ST4B structures

To achieve bumpless control transfer between control modes, not active control loop adjusts its setpoint to track measurement input with 0.001pu step and accuracy of ±0.001pu. At the same time control block adjust its value to track output of active control loop.

3.7.2 Not active channel

ST1A/AC5A structures

To achieve bumpless control transfer between channels and modes, not active control loop adjust its output signal by changing its setpoint with 0.001pu step so that the output tracks the output of active channel with accuracy of ±0.005pu.

AC8B/ST4B structures

To achieve bumpless control transfer between channels and modes, not active control loop adjusts its setpoint to track measurement input with 0.001pu step and accuracy of ±0.001pu. At the same time control block adjust its value to track output of active channel.

3.8 TEST MODE & TEST SET POINT

Test mode is an open loop control mode. It allows direct control of firing angle for thyristors or PWM signal of IGBT transistor.
For details on correlation between output value of test mode in per unit and firing angle for different types of thyristor bridges please refer to PRODUCT DESCRIPTION section of this document.

There is no auto-tracking between test mode and automatic/manual control mode. Therefore, switching between these modes in excitation state would result in output signal difference.

Test mode is used for service purposes and enables stator voltage and exciter field current measurements inputs verification.

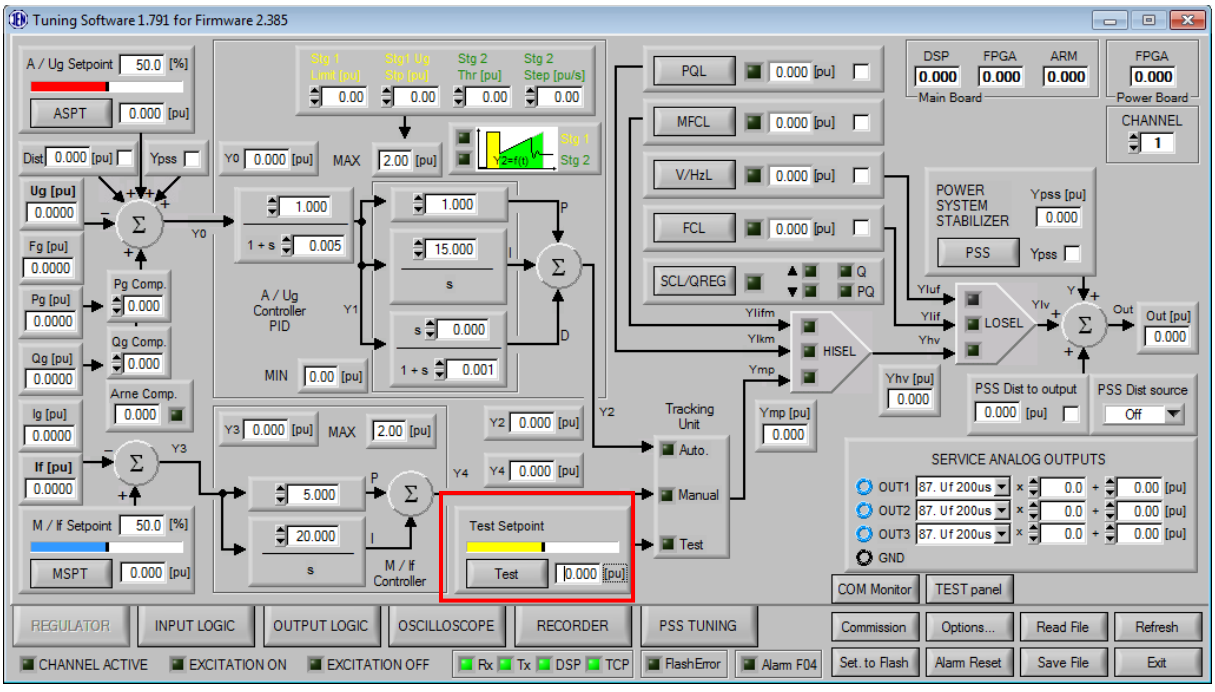


Fig. 30 Test set point section

To open the Test set point, click “Test” button. The following window appears:

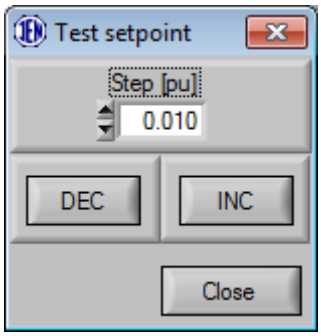


Fig. 31 Test set point settings window

From this window it’s possible to control output signal by pressing “INC” (setpoint increase) “DEC” (setpoint decrease) button with desired “Step” configurable value. Note that Function 8 must be marked as active for setpoint increase/decrease to work.

3.9 LIMITERS

The P100C-SX has five limiters. Their function is to keep the generator parameters inside the allowed operational area to avoid unnecessary trips caused by a protection relays.

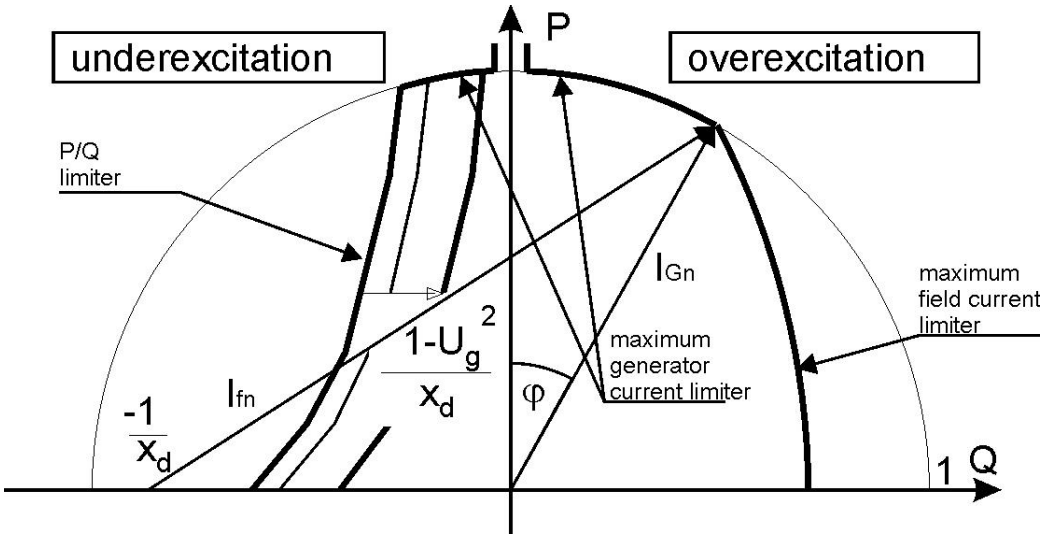


Fig. 32 Power chart

Signals from the regulation loops (automatic and manual) and four limiters go through two selection blocks:

- HVSEL – gives the highest input signal on the output (increase of field current)
- LVSEL – gives the highest input signal on the output (decrease of field current)

The Stator Current Limiter works only by changing value of the active set point.

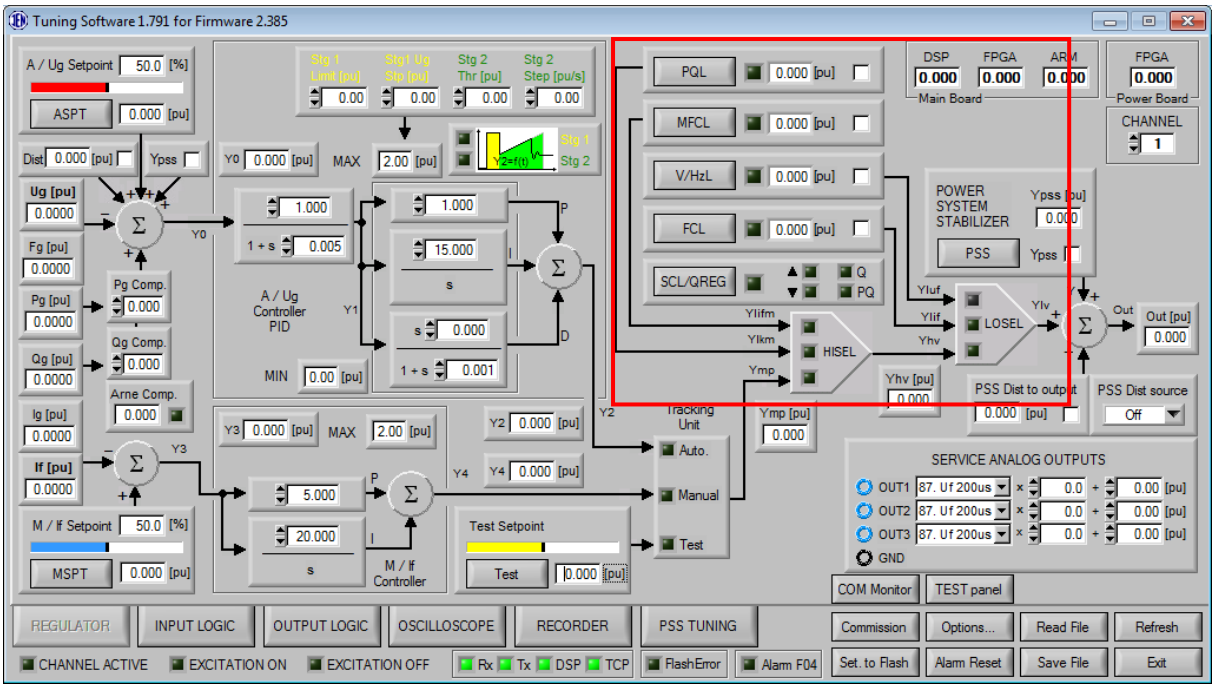


Fig. 33 Limiters section

3.9.1 Temperature correction of generator capability curve

Generator load characteristics can be modified based on cooling gas temperature. After activation, temperature measurement (or highest from two, if connected) modifies FCL or SCL setpoint based on three point characteristic allowing operation of generator with higher field and stator current.

On how to activate temperature modification please refer to FCL or SCL description below.

3.10 P/Q LIMITER

To open the P/Q Limiter settings window, click “PQL” button in the limiters section. The following window appears:

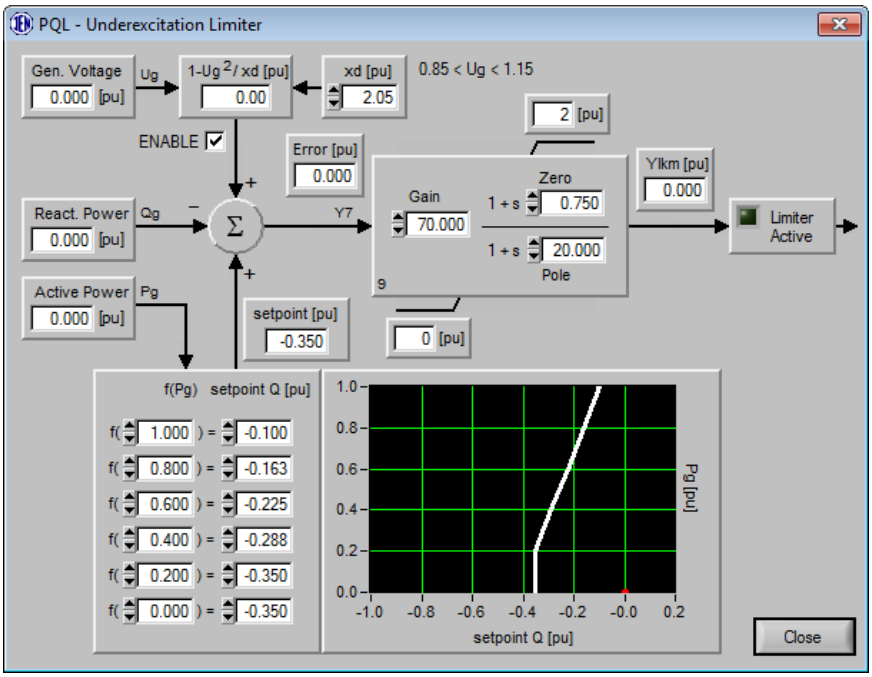


Fig. 34 P/Q Limiter settings window (LEAD/LAG structure)

PQL is under excitation limiter which is set by setting six setpoint Q positions for six values of Pg. All the values between those defined points are linearly estimated. If operating point of regulator will cross limiter setting then PQL will take control over output signal and will not allow control signal to drop lower.

“ENABLE” checkbox allows to add correction to limiter setting basing on current generator voltage value. In such case make sure that x_d (direct axis reactance) parameter is set correctly for this specific application. Modification of limiter curve coming from generator voltage is described as: $1\text{-}Ug^2/x_d$.

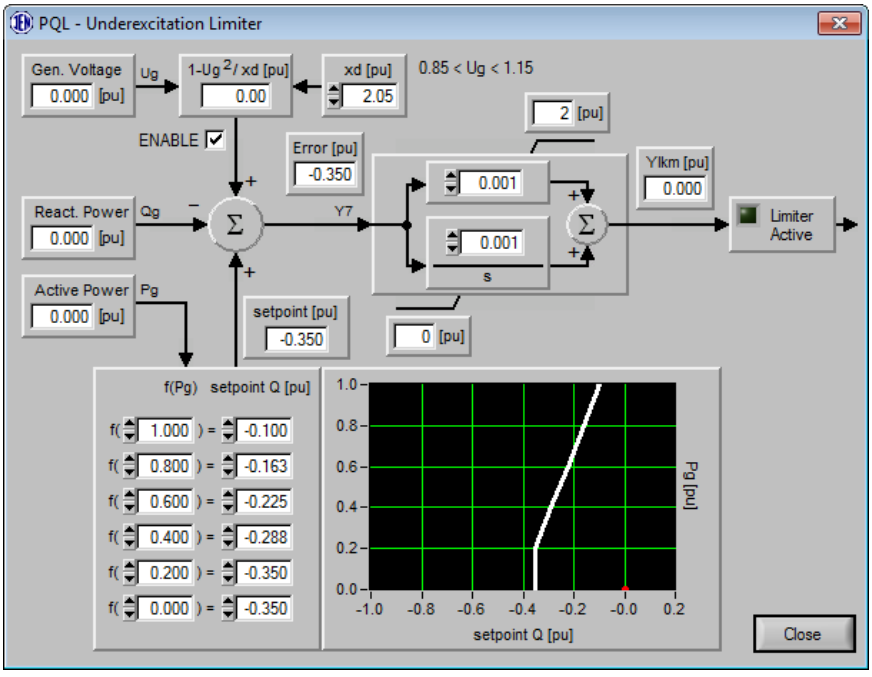


Fig. 35 P/Q Limiter settings window (PI structure)

3.11 MINIMAL EXCITER FIELD CURRENT LIMITER

To open the Minimal Field Current Limiter settings window, click “MFCL” button in the limiters section. The following window appears:

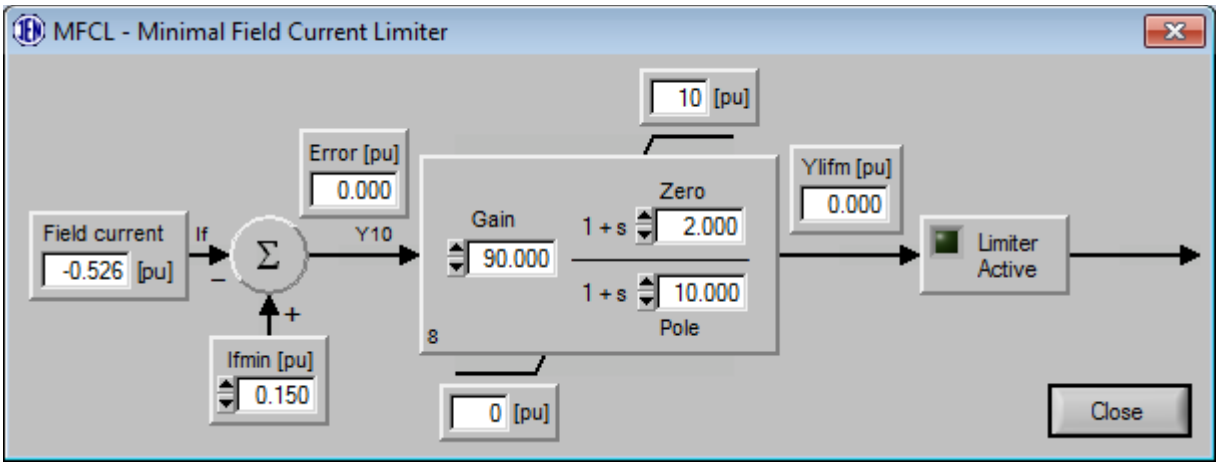


Fig. 36 Minimal Field Current Limiter settings window (LEAD/LAG structure)

Minimal Field Current Limiter do not allow field current to drop below bottom threshold set by “Ifmin” parameter. If such event occurs limiter takes over control of control loop and keeps operating point at place assuring field current is not lower than field current minimum. Note that in normal operation minimal value for field current should be set below the range given to control loops in MSPT and ASPT.

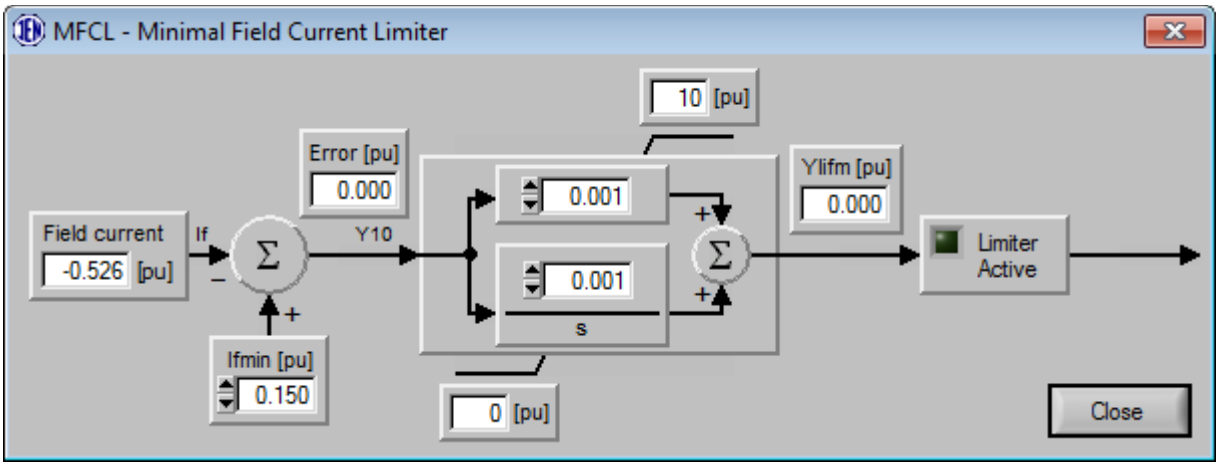


Fig. 37 Minimal Field Current Limiter settings window (PI structure)

3.12 VOLTS-PER-HERTZ LIMITER

To open the V/Hz Limiter settings window, click “V/HzL” button in the limiters section. The following window appears:

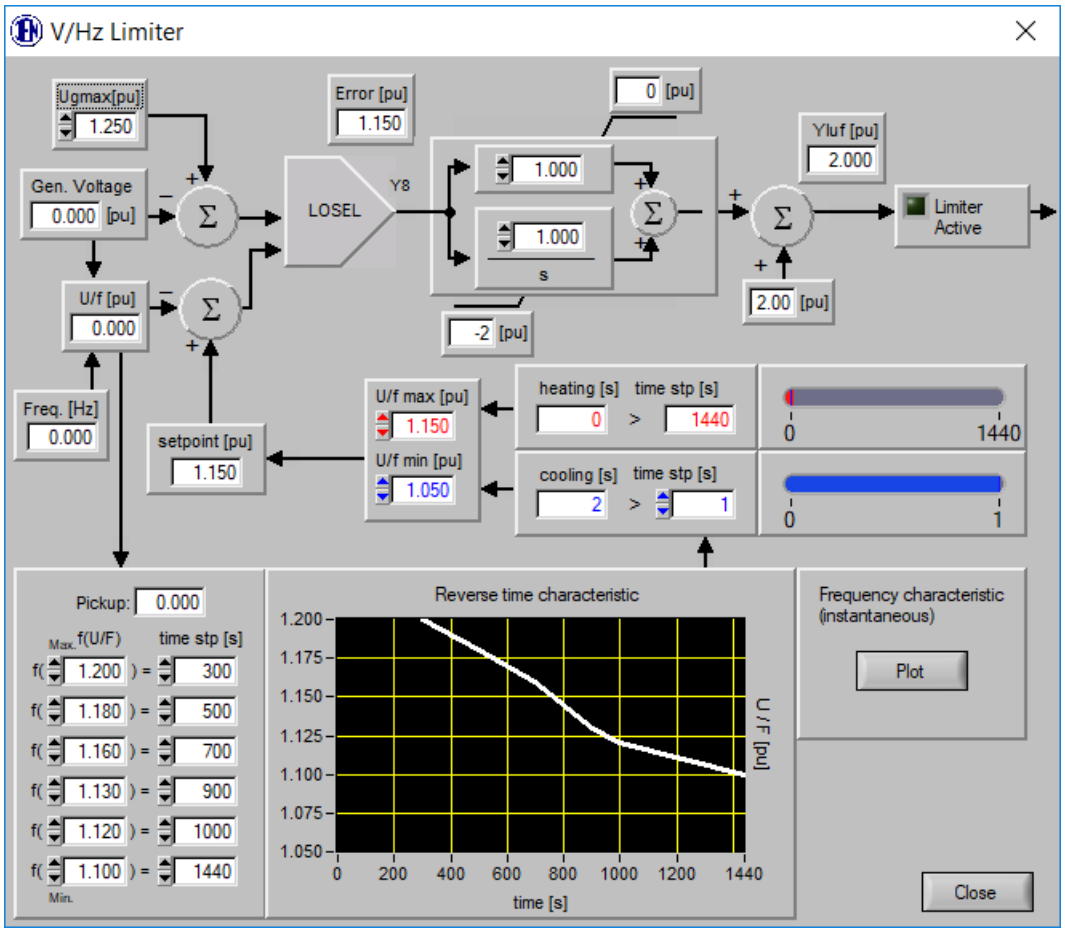


Fig. 38 V/Hz Limiter settings window (PI structure)

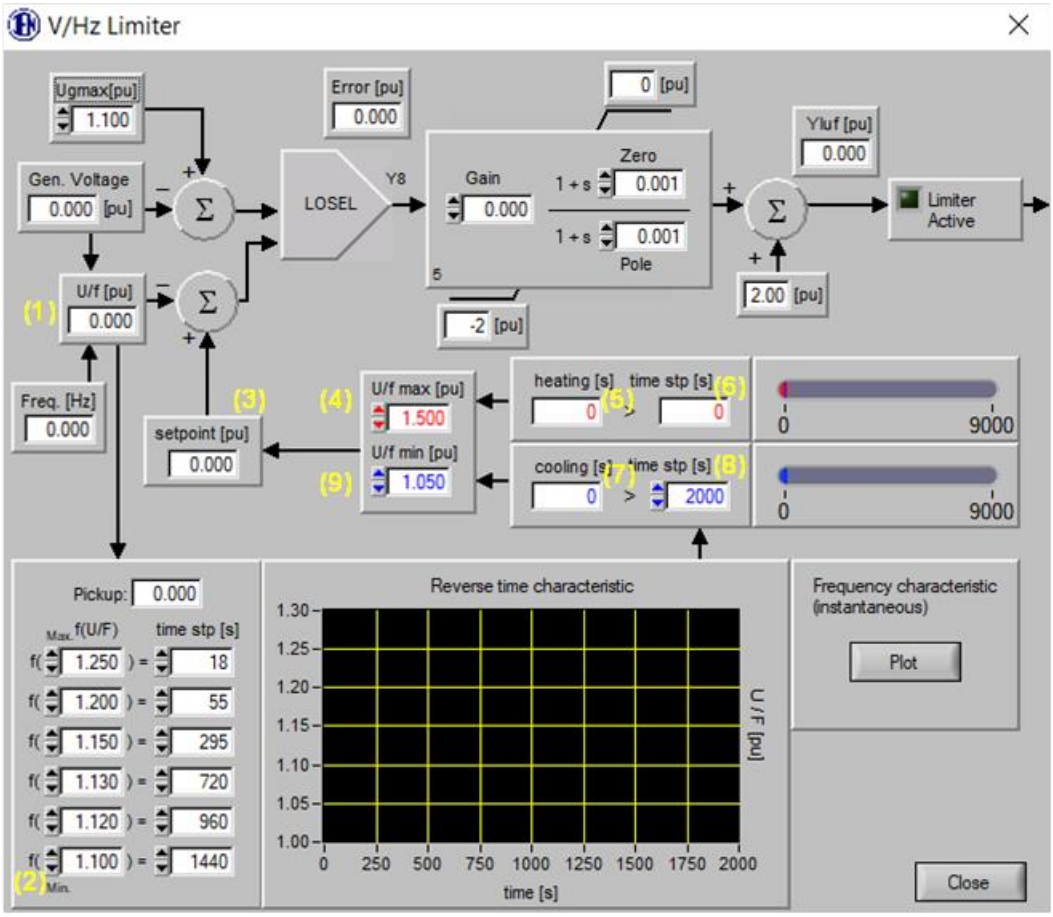


Fig. 39 V/Hz Limiter settings window (LEAD/LAG structure)

The Volts-per Hertz limiter is provided to prevent overheating that may arise from excessive magnetic flux due to under frequency operation or overvoltage operation, or both.

Limiter utilizes multi-point reverse time characteristic and two different setpoints to guarantee safe operation of generator and compliance with multi-point generator overexcitation protections:

1. If generator voltage to frequency ratio is lower than U/fMin (2) limiter calculates cooling time (7). If cooling time exceeds minimum required cooling time (8) limiter setpoint (3) is set to U/f max (4).
2. If generator voltage to frequency ratio is higher than U/fMin (2) limiter calculates heating time (5). If heating time exceeds maximum permissible heating time (6) taken from multi-point inverse time characteristic, limiter setpoint (3) is set to U/f min (9).

Additionally, limiter is equipped with Ugmax parameter preventing generator voltage from exceeding selected level. Correlation between U/fmax and Ugmax can be seen by clicking “Plot” button.

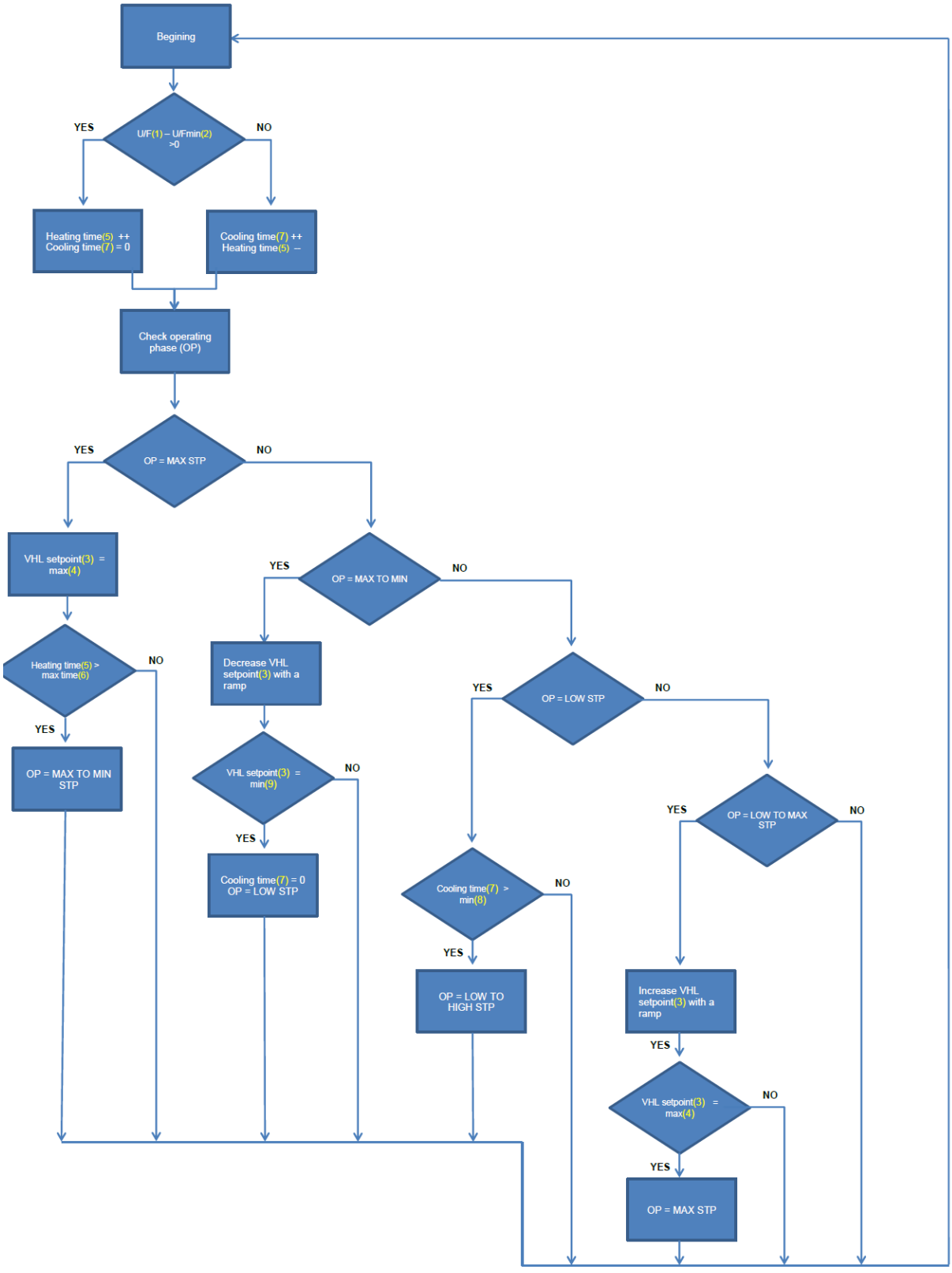


Fig. 40 V/Hz Limiter flowchart (thermal part only)

3.13 FIELD CURRENT LIMITER

To open the Field Current Limiter settings window, click “FCL” button in the limiters section. The following window appears:

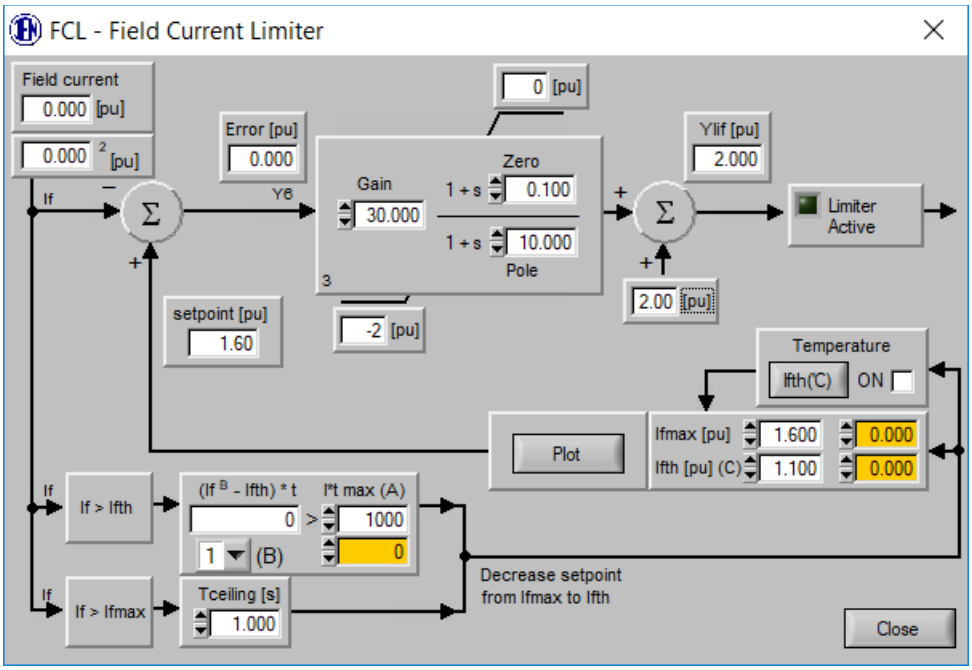


Fig. 41 Field Current Limiter settings window (LEAD/LAG structure)

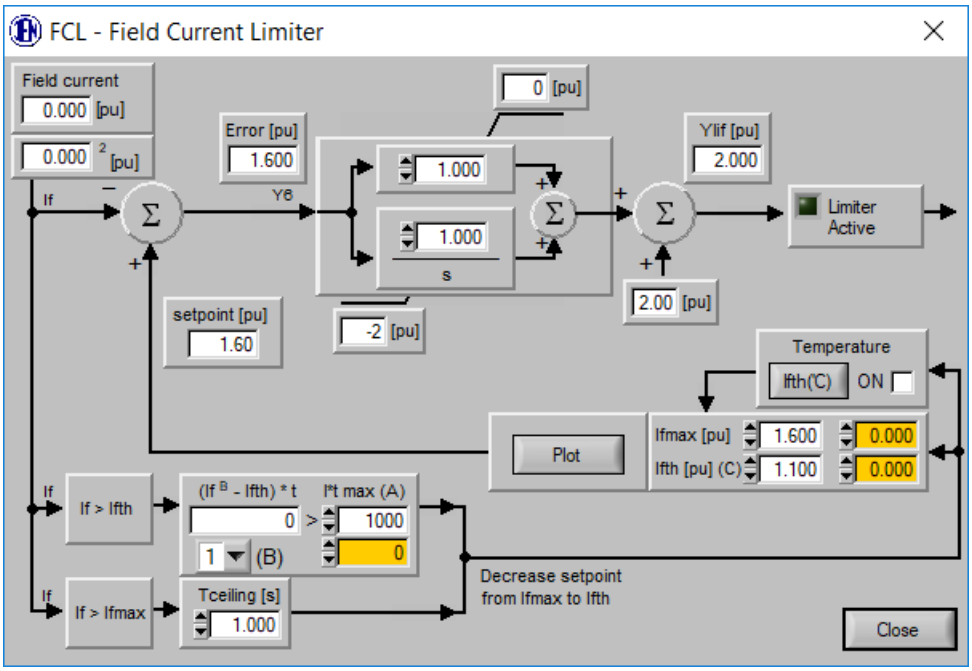


Fig. 42 Field Current Limiter settings window (PI structure)

FCL limiter activates if one or both conditions are true:

1.) Field current becomes higher than parameter Ifmax (field current maximal threshold)

2.) Field current becomes higher than parameter Ifth (field current threshold) over period of time longer than preset time resulting from field winding thermal capability limits

In the first case limiter keeps field current at Ifmax level, and after Tceilling time at Ifth level. In the second case limiter keeps field current at Ifth level.

Time before activation (inverted time characteristic) is calculated as follows:

$$\text{time} = A/(I_{FD}^{B} - C)$$

To be compliant with IEEE 421.5 field winding thermal capability calculation (where A=33.75, B=2, C=1) parameter A must be multiplied by 1000 and set as 33750.

FCL limiter threshold Ifth can be modified according to temperature measurement of cooling gas from one or two sensors. In case of two temperatures only higher measurement will be taken into calculations.

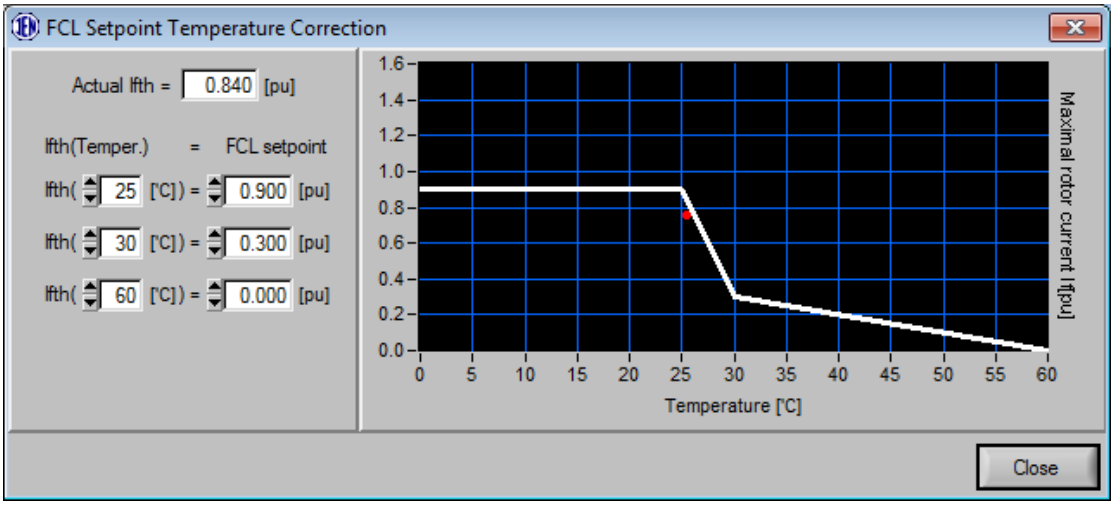


Fig. 43 Field Current Limiter temperature correction window

Settings window for temperature correction can be found by pressing “Ifth[C’]” button. It allows to configurate three point characteristic describing impact of temperature level on limiter’s Ifth threshold, increasing or decreasing maximum permissible field current. Operation point of generator is indicated by red dot.

For setpoint temperature correction to work it is required to have temperature measurement configurated correctly:

- One or two temperature measurement signals connected to P100C-SX and configurated in analog input options window
- In “External measurements” window “Temperature for FCL, SCL setpoint correction” must be checked and have proper scaling settings
- Correction characteristic activated by clicking “ON” checkbox in limiter window

3.14 STATOR CURRENT LIMITER & REACTIVE POWER REGULATOR

3.14.1 Stator Current Limiter

To open the Stator Current Limiter settings window, click “SCL” button in the limiters section. The following window appears:

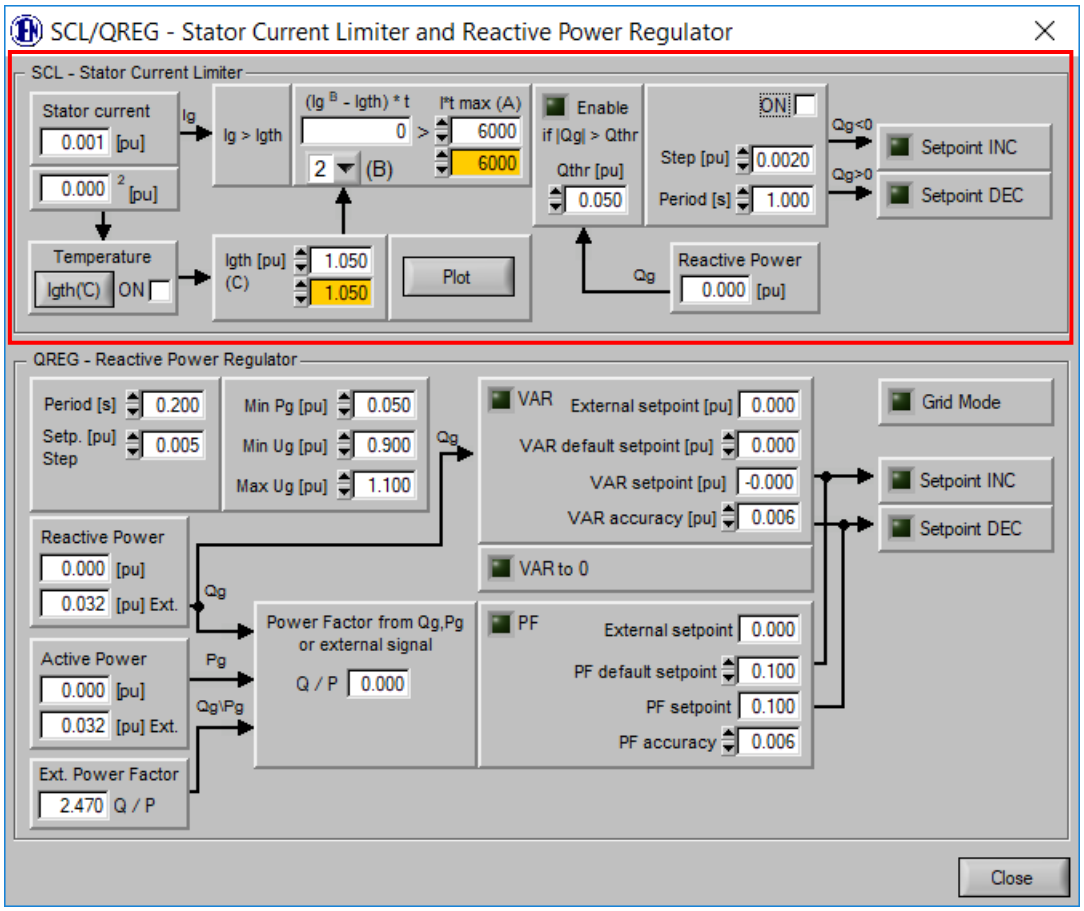


Fig. 44 Stator Current Limiter settings window

Stator Current Limiter activates when generator current value exceeds Igth threshold value over period of time longer than resulting from stator winding thermal capability limits. This limiter will be active only if $|Q_g| >$ Qthr condition is met. Specific thing about this limiter is fact that it doesn’t take over control of regulation loop. Instead it affects regulation loop setpoint directly by sending “INC”(increase) “DEC”(decrease) signals with preset “Step” and repetition “Period”.

Time before activation (inverted time characteristic) is calculated as follows:

$$\text{time} = A/(I_{FD}^{B} - C)$$

To be compliant with IEEE 421.5 thermal capability calculations parameter A must be multiplied by 1000 before being typed in.

SCL limiter threshold Igth can be modified according to the temperature measurement of cooling gas from one or two sensors. In case of two temperatures only higher measurement will be taken into calculations.

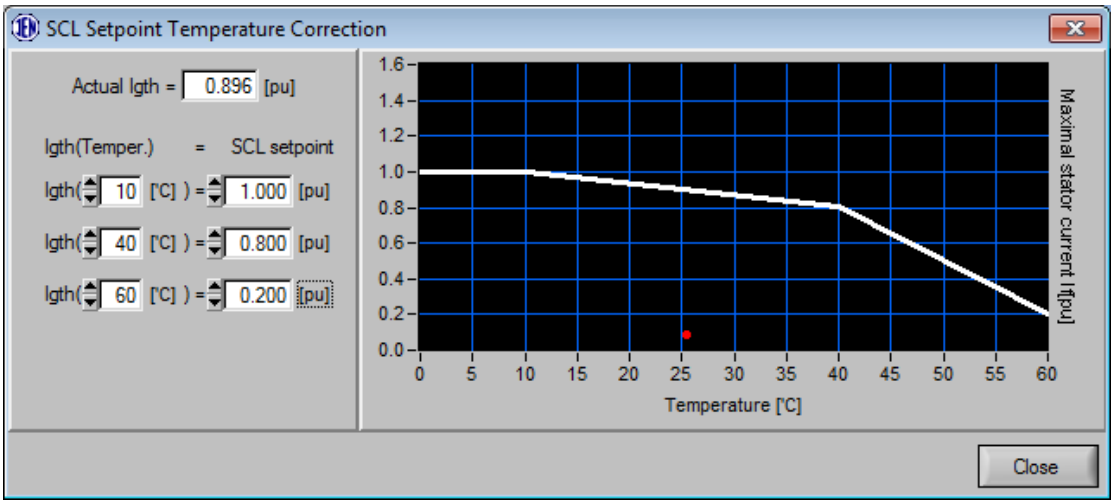


Fig. 45 Stator Current Limiter setpoint temperature correction window

Settings window for temperature correction can be found by pressing “Igth(C’)” button. It allows to configurate three point characteristic describing impact of temperature level on limiter’s Igth threshold, increasing or decreasing maximum permissible stator current. Operation point of generator is indicated by red dot.

For setpoint temperature correction to work it is required to have temperature measurement configurated correctly:

- One or two temperature measurement signals connected to P100C-SX and configurated in analog input options window
- In “External measurements” window “Temperature for FCL, SCL setpoint correction” must be checked and have proper scaling settings
- Correction characteristic activated by clicking “ON” checkbox in limiter window

3.14.2 Reactive Power Regulator

Reactive power regulator allows P100C-SX to operate in three master modes over automatic regulation loop:

- VAR regulation
- VAR to 0 regulation
- PF(power factor) regulation

To activate any of Q regulation modes regulator needs to be in automatic mode control and Active power must be higher than threshold set by “Min Pg” parameter. Activating any of three Q regulation modes can be done using Input Function 9 – Q,Q0,PF Regulator. When one of Q regulation modes is active user can switch between them but is not able to go back straight to Manual mode operation. To do so it is required to turn off Q modes regulation first by activating automatic mode regulation again.

When working in Q regulation to modify setpoint value function requires that generator voltage is higher than threshold set as “Min Ug” and lower than threshold set as “Max Ug”. If this condition is not met regulator will stay in Q regulation mode but will not attempt to control setpoint value.

In QREG tab it is possible to set “Period[s]” time which specifies how often function will modify setpoint by “Step[pu]” value. This setting is common for all three reactive power regulation modes.

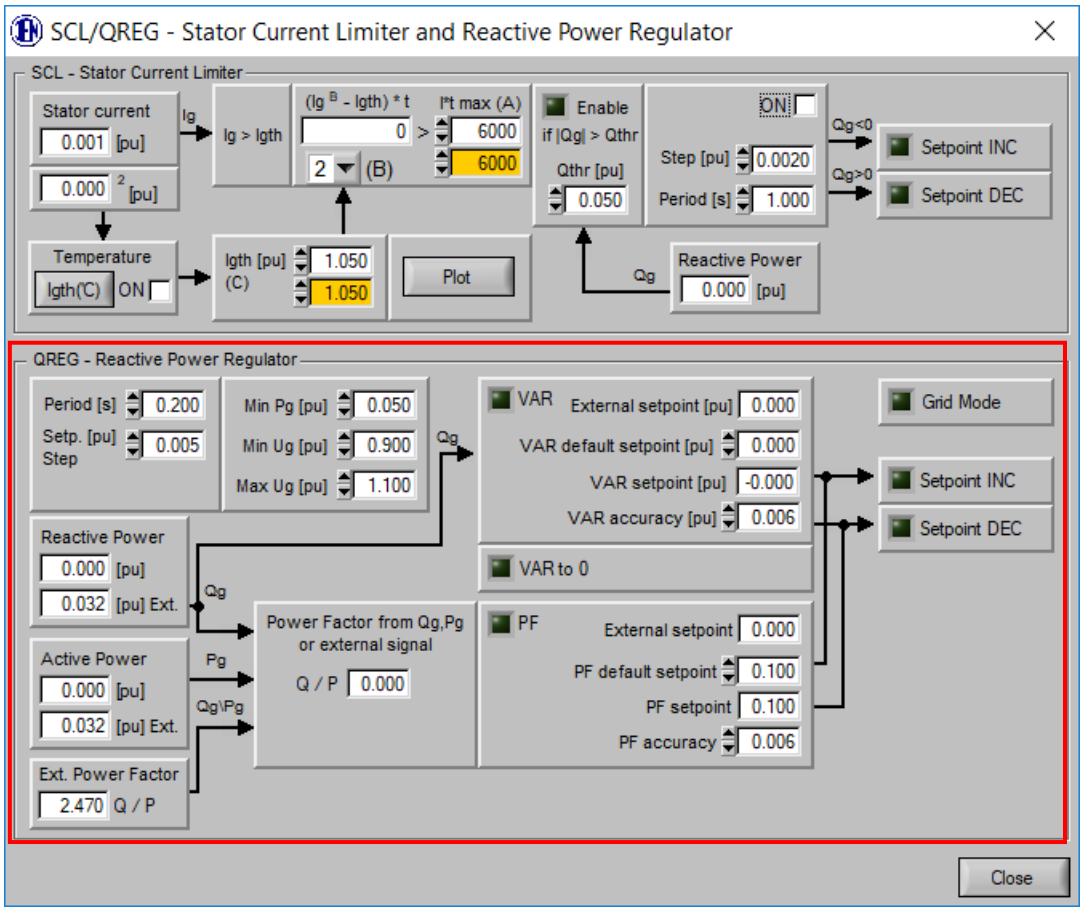


Fig. 46 Reactive Power Regulator settings window

In VAR regulation mode regulator gives possibility to take control directly over reactive power using ASPT setpoint. If this regulation mode is active green light next to VAR text will lit green. In this box two parameters show current value of setpoint: external setpoint if control over VAR setpoint comes from external source and normal VAR setpoint. Regulation step parameter for VAR regulation can be found in ASPT window under name “PF Step”.

Configurable parameters for VAR function are:
VAR default setpoint[pu] – if external setpoint are not connected after activating VAR control mode initial setpoint is set to this value. Exception of that is when working in grid mode and we have external Q measurement connected in such case VAR regulator will start with setpoint equal to such measurement and ignore “VAR default setpoint” value.
VAR accuracy[pu] – indicates dead-band among which regulator tolerates VAR value as accurate and will not try to correct it with additional “INC” “DEC” signals.

VAR to 0 regulation is regulation mode of P100C-SX which attempts to keep reactive power as close to 0 as possible by accordingly to current reactive power value increasing or decreasing setpoint value. Step of setpoint and Period time is shared among Q regulation modes so same value applies here as in VAR regulation. Same goes for regulation step parameter which can be found in ASPT window under name “PF Step”.

Power factor regulation is regulation mode which attempts to keep Qg/Pg parameter as static value basing on active power and reactive power measurements. P100C-SX is supplied with built-in Pg and Qg measurement system but allows also for external measurement connection and external setpoint control.

Configurable parameters for PF regulation are:

PF default setpoint[pu] – if external setpoint are not connected after activating PF control mode initial setpoint is set to this value. Exception of that is when working in grid mode and we have external Qg and Pg measurement connected in such case PF regulator will start with setpoint equal to such measurement and ignore “PF default setpoint” value.
PF accuracy[pu] – indicates dead-band among which regulator tolerates PF value as accurate and will not try to correct it with additional “INC” “DEC” signals.

Switching between QREG modes is handled by Function 9: Q,Q0,PF Regulator. Detailed information about how it works can be found in description of Function 09.

3.15 POWER SYSTEM STABILIZER

To open the Power System Stabilizer settings window, click “PSS” button in the limiters section. The following window appears:

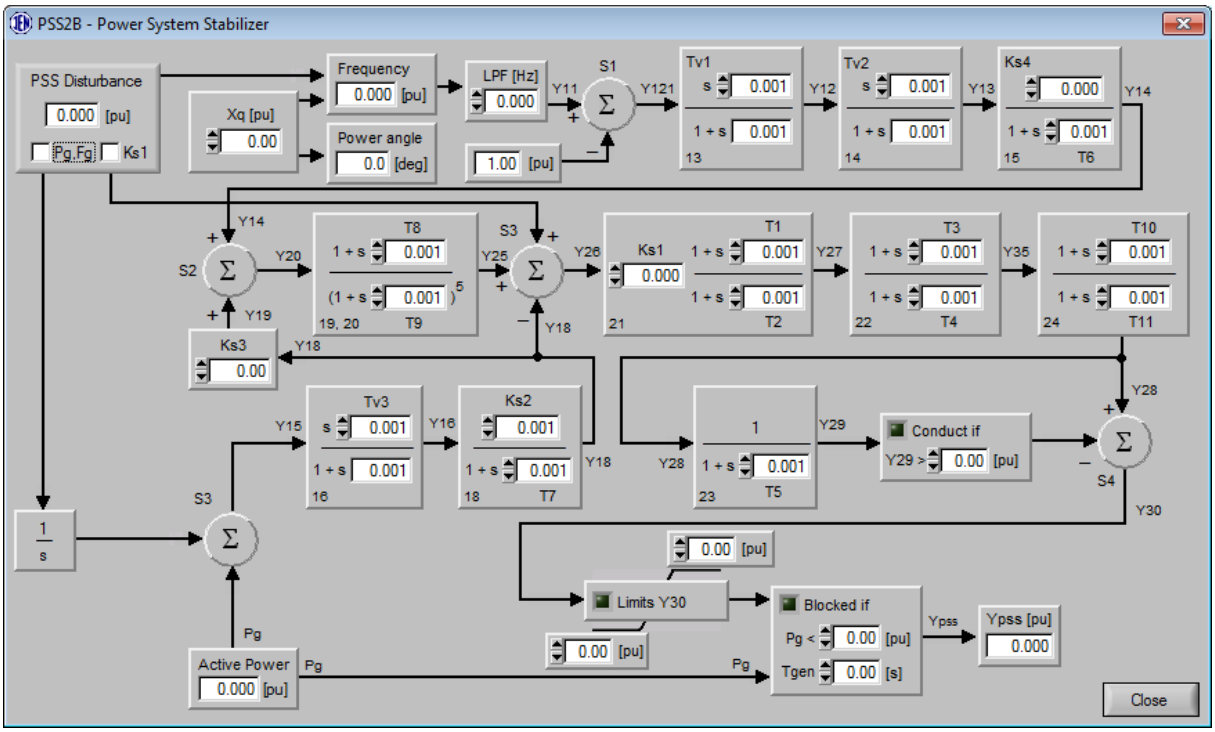


Fig. 47 Power System Stabilizer settings window

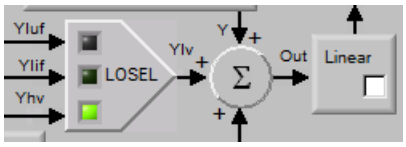
P100C-SX implements PSS2B structure of power system stabilizer based on two input parameters: active power and frequency, according to IEEE Std. 421.5. Purpose of using PSS block is to provide oscillation damping by modulating the excitation supplied to the synchronous machine. This way regulator improves stability of the system. Additional interlock is provided as PSS works only if active power is higher than preset value in [pu] for time longer than “Tgen”.

Output signal of the PSS can be connected either to the input of automatic control loop (1) or to the output signal of LOSEL gate, next to over excitation limiters (2).

3.16 OUTPUT LINEARIZATION

Output linearization allows to compensate non-linear characteristic of thyristor bridge and provides linear relationship between control loop signal and output voltage of thyristor bridge for inductive load.

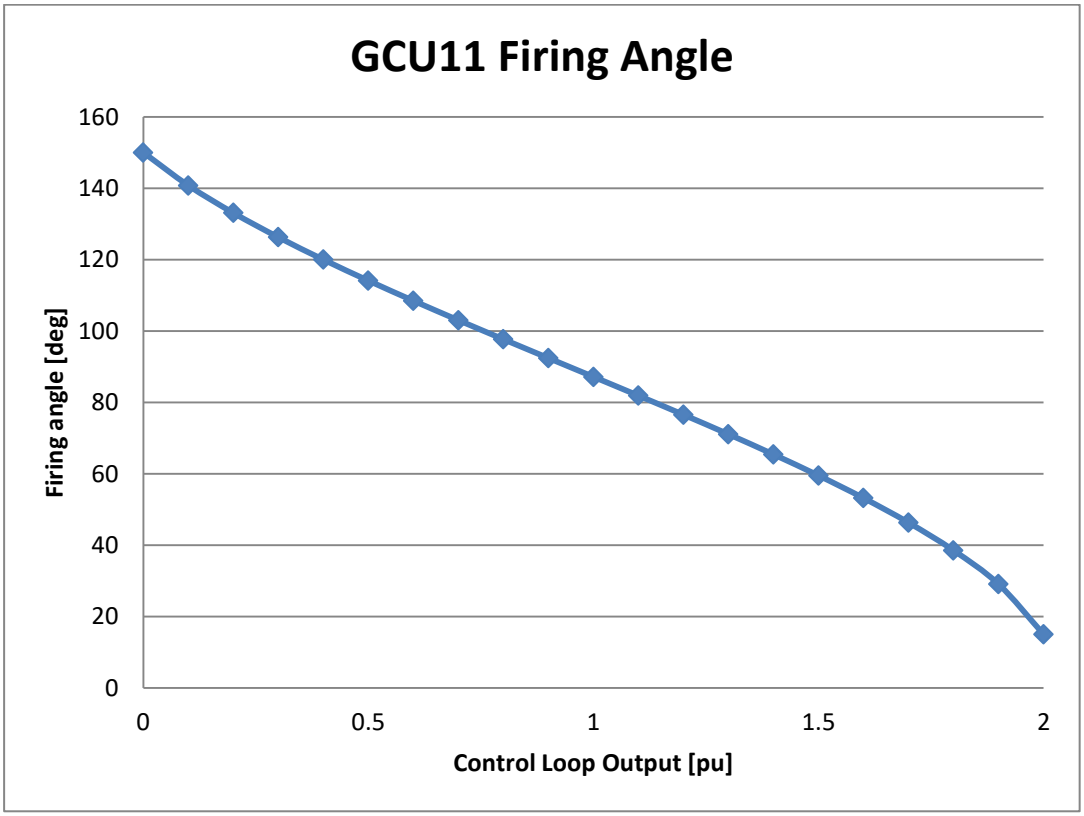
To enable output linearization set Linear checkbox in the right part of the REGULATOR screen:

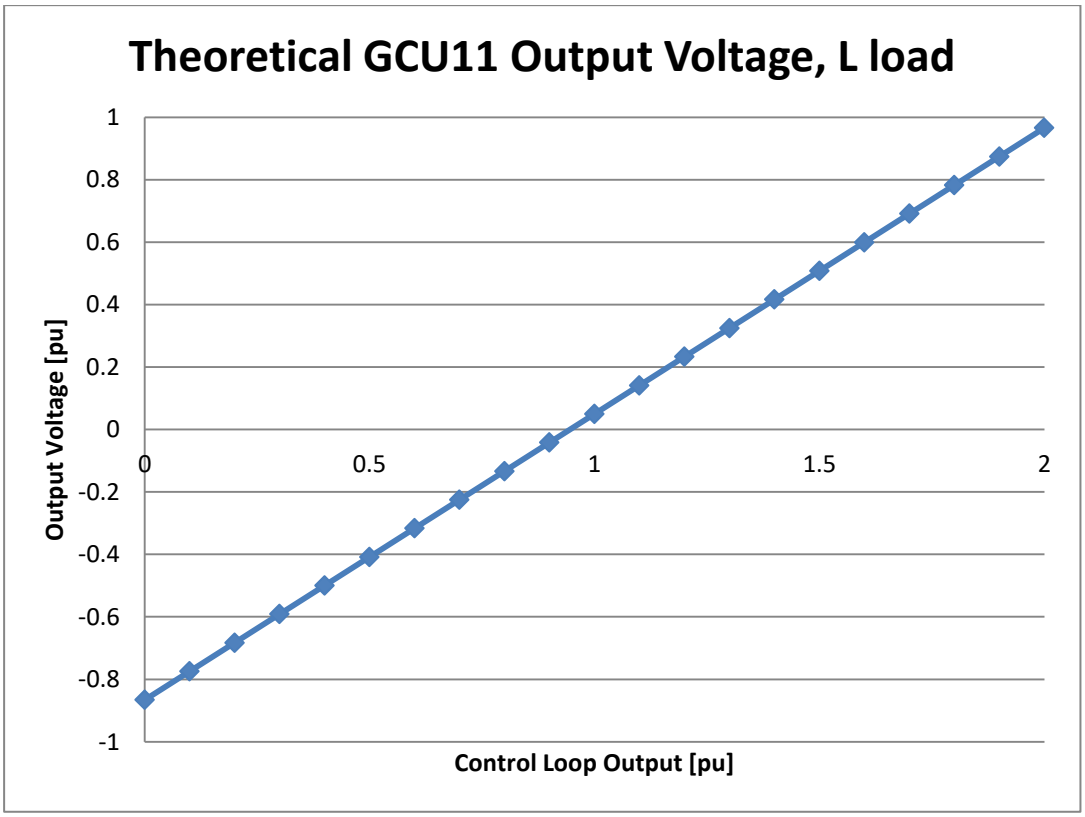


3.16.1 GCU-11

Once linearization is enabled, the following relationship between control loop output Ylv and firing angle applies:

$$\propto = \arccos(0.9159 \cdot Ylv - 0.866)$$

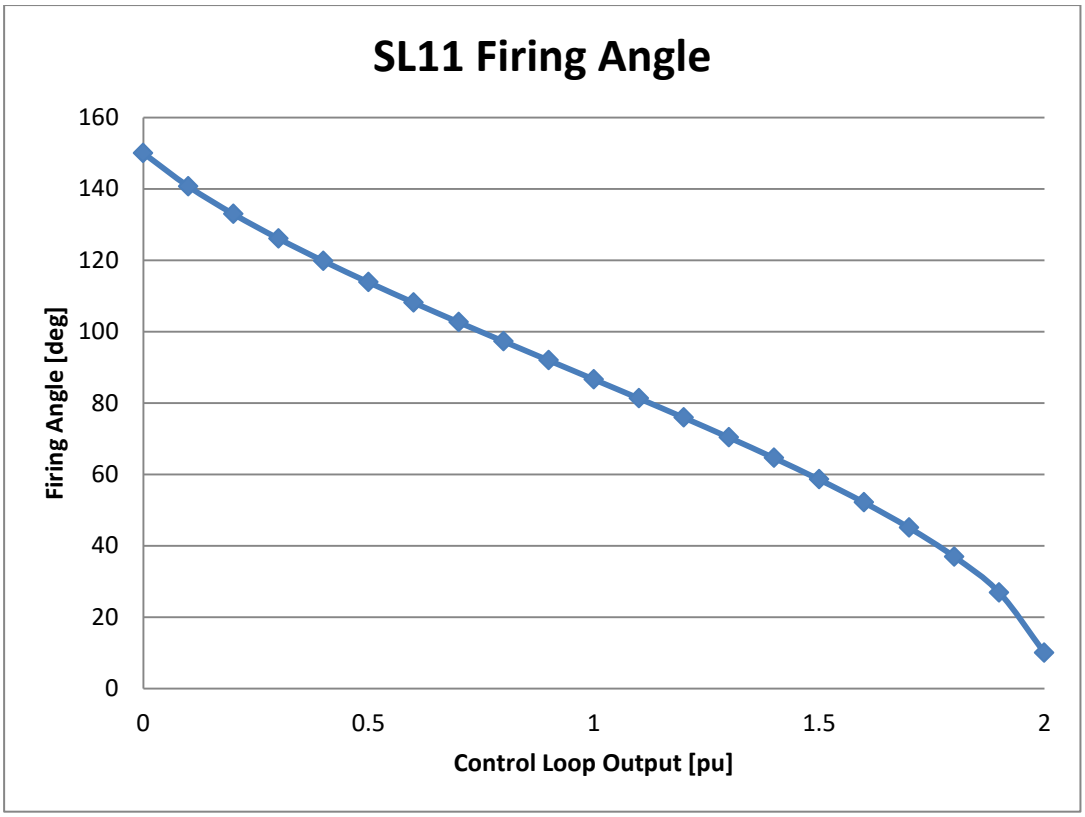


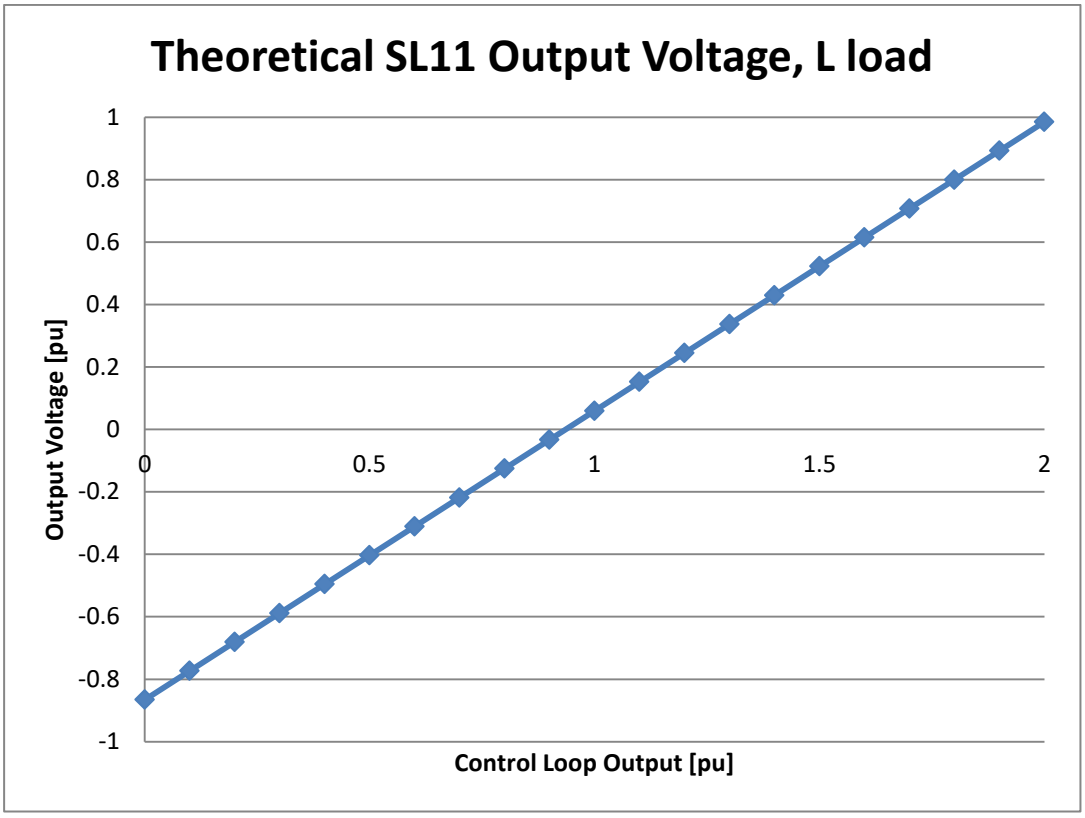


3.16.2 SL-11

Once linearization is enabled, the following relationship between control loop output Ylv and firing angle applies:

$$\propto = \arccos(0.9254 \cdot Ylv - 0.866)$$




Theoretical SL11 Output Voltage, L load
Output Voltage [pu]
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
0.5
1
1.5
2
Control Loop Output [pu]

3.17 COM MONITOR

To open the Communication Monitor window, click “COM Monitor” button in the lower part of Main window. The following window appears:

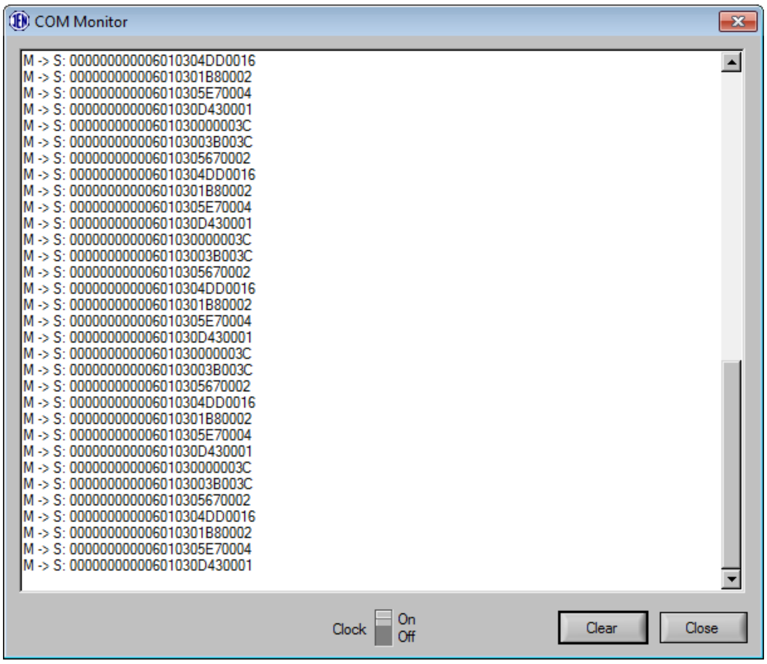


Fig. 48 Communication Monitor window

3.18 OPTIONS

To open the Options window, click “Options…” button in the lower part of Main window. The following window appears:

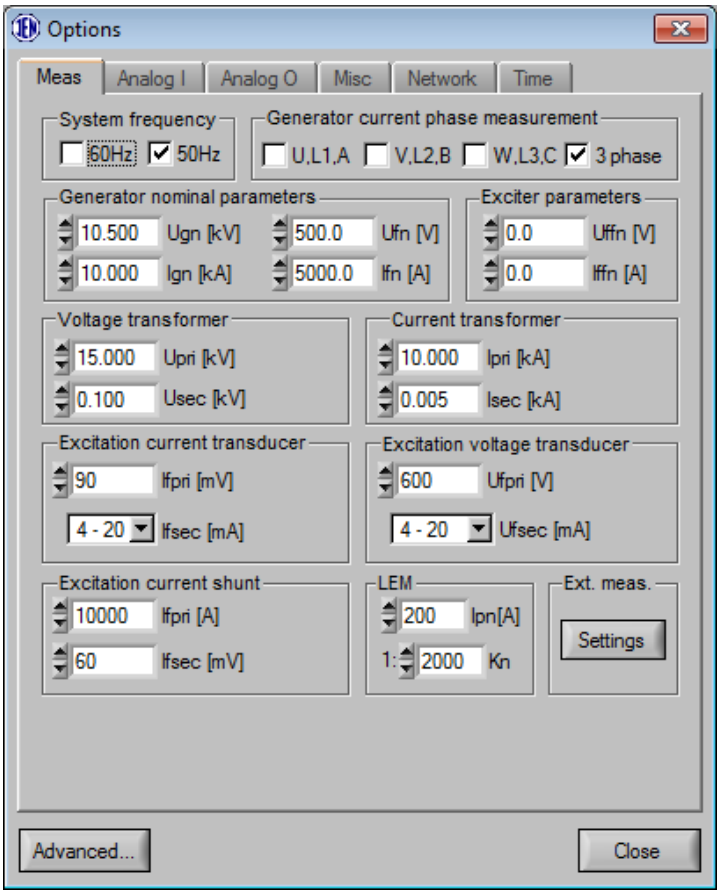


Fig. 49 First tab of the Options “Meas” window with example settings

3.18.1 Measurements

P100C-SX measurements are based on accurate zero phase shift transformers and high resolution sample-and-hold analog to digital converters sampled at 5000 samples per second. Particular measurements are calculated follows:

- Generator voltage as RMS value of three phase to phase voltages
- Generator current as RMS value of three phase to phase currents
- Active power as mean value of voltage and current product
- Reactive power as mean value of phase to phase voltages and current product
- Field current as mean value of field current samples
- Field voltage as mean value of field current samples
- Frequency as mean value of three frequencies, based on the following algorithm:

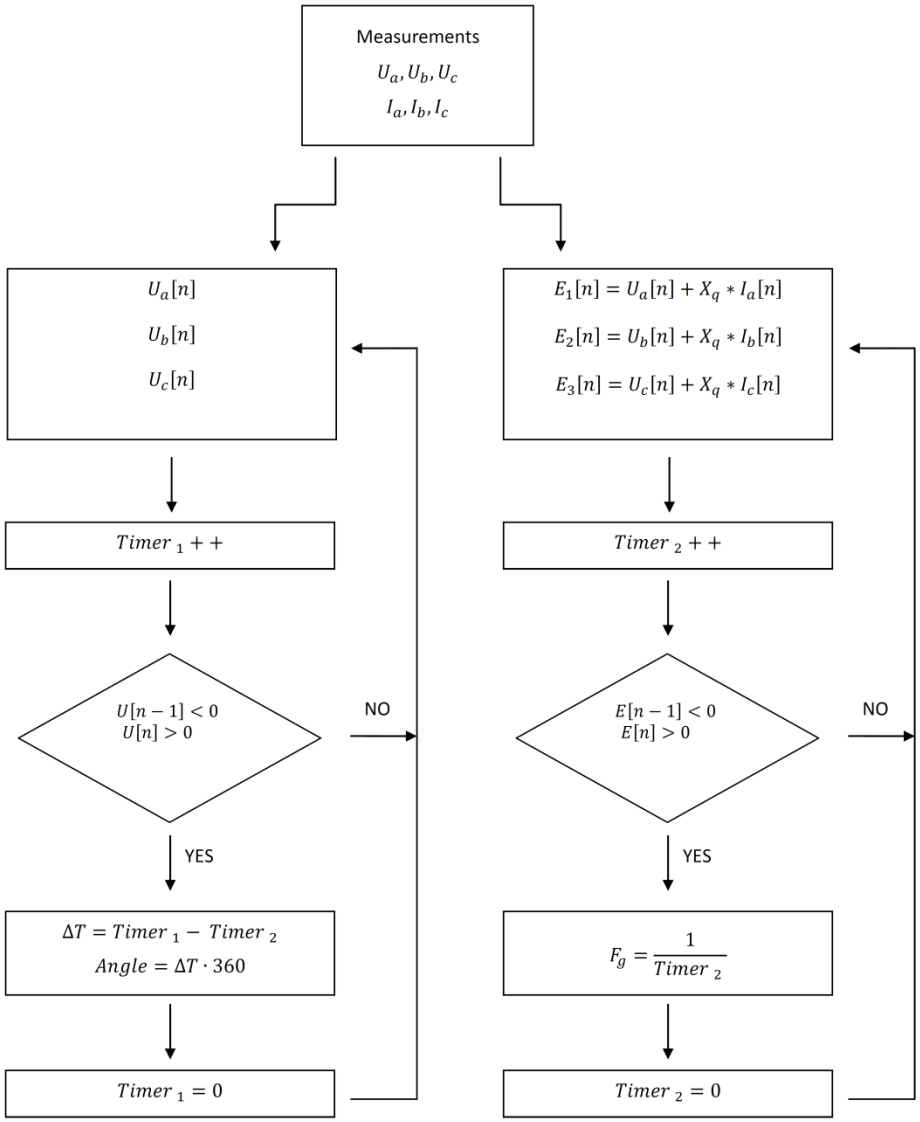


Fig. 50 Frequency calculation algorithm

All mean values are calculated using time-varying window, based on system base frequency (50Hz or 60Hz).

Measurement tab of options window allows to set parameters of system elements with which P100C-SX regulator will be working. Among possible settings there are following options:

System frequency: 50/60Hz
Generator current phase measurement:

- U,L1,A
- V,L2,B
- W,L3,C
- 3 phase

Generator nominal parameters:

- Ugn – generator nominal voltage
- Ign – generator nominal current
- Ufn – excitation nominal voltage
- Ifn – excitation nominal current

Those values are used later by regulator as base for per unit system which express system quantities as fraction of a defined base unit quantity. All quantities are specified as multiples of selected base values. Note that in this system different types of quantities are labeled with same symbol(pu) so name of variable is only indicator if quantity is voltage, current etc.

Voltage and current transformer primary and secondary side values for generator voltage and current measurements.

Excitation current transducer: If primary[mV], If secondary selectable between 4-20[mA] and +/-20[mA]. This selection affects input signal configuration for X12(1-6) if input is used in “Analog I” tab as Field Current If(or Iff) signal.

Excitation voltage transducer: Uf primary[mV], Uf secondary selectable between 4-20[mA] and +/-20[mA]. This selection affects input signal configuration for X12(1-6) if input is used in “Analog I” tab as Field Voltage Uf(or Uff) signal.

Excitation current shunt: If primary[A], If secondary[mV]

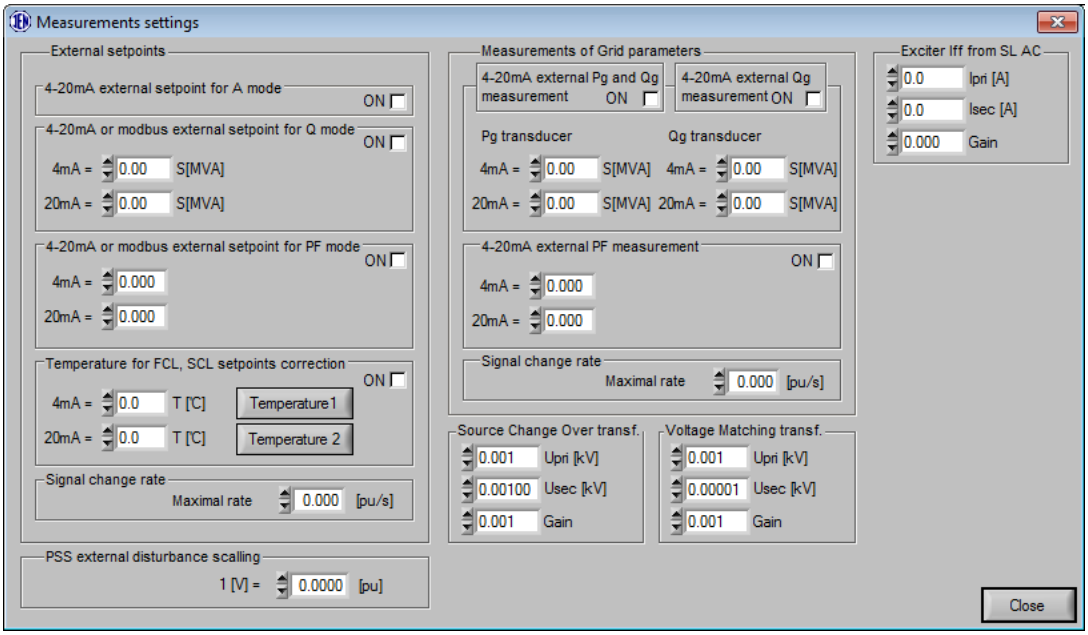


Fig. 51 External measurements settings window

External measurements window allows to configure and activate functionalities connected with analog inputs which can be set in “Analog I” tab of Options window.

Turning on of functionality is done by marking “ON” checkbox next to it. For each of those functionality it is also possible to scale maximum and minimum value of signal to set how it corresponds to analog input 4-20[mA].

For all parameters and external setpoint input - application gives possibility to limit maximum change rate of input signal for safety purposes.

This window allows also to set transformers primary and secondary voltage for Voltage Matching and Source Change Over functions, as well as gain for external PSS disturbance signal.

3.18.2 Analog Inputs

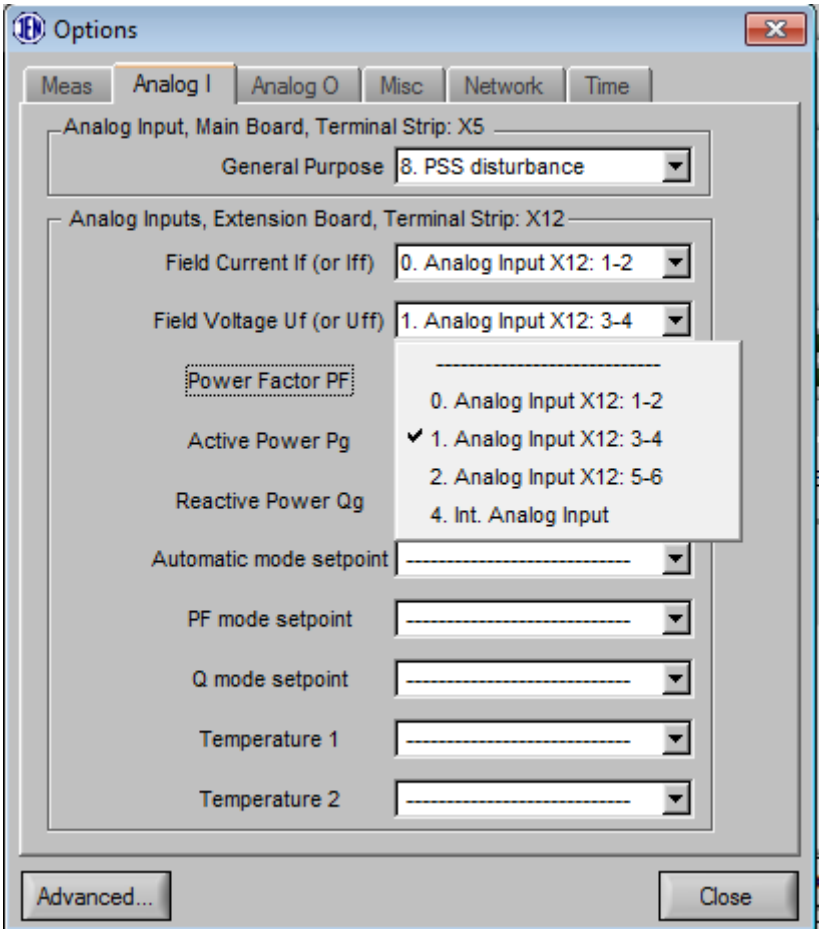


Fig. 52 Second tab of the Options window “Analog I” with examples settings

Analog inputs tab allows to assign input signals from X12: 1-6 to specific input logic signals in regulator. Possible options are:

- Field Current If (or Iff) – 4-20mA or +/-20mA input selectable in Meas tab
- Field Voltage Uf(or Uff) – 4-20mA or +/-20mA input selectable in Meas tab
- Power Factor PF – 4-20mA external PF measurement
- Active Power Pg – 4-20mA external Pg and Qg measurement
- Reactive Power Qg – 4-20mA external Pg and Qg measurement
- Automatic mode setpoint – 4-20mA external setpoint for A mode
- PF mode setpoint – 4-20mA external setpoint for PF mode
- Q mode setpoint – 4-20mA external setpoint for Q mode
- Temperature for FCL, SCL – Temperature for FCL, SCL setpoint correction

Assigning external signal from analog input does not equal to turning on functionality of function connected to this signal. To do so user need to go to “Transducer settings window” and mark corresponding function with “ON” checkbox (exception is Temperature for FCL,SCL setpoint correction which needs to be additionally turned on in limiters window).

At the top of the window functionality of analog input located at the main board X5 can be specified. Possible options are:

- PSS disturbance – external analog signal for PSS verification

- Voltage Matching – measurement for voltage matching function, F23

3.18.3 Analog Outputs

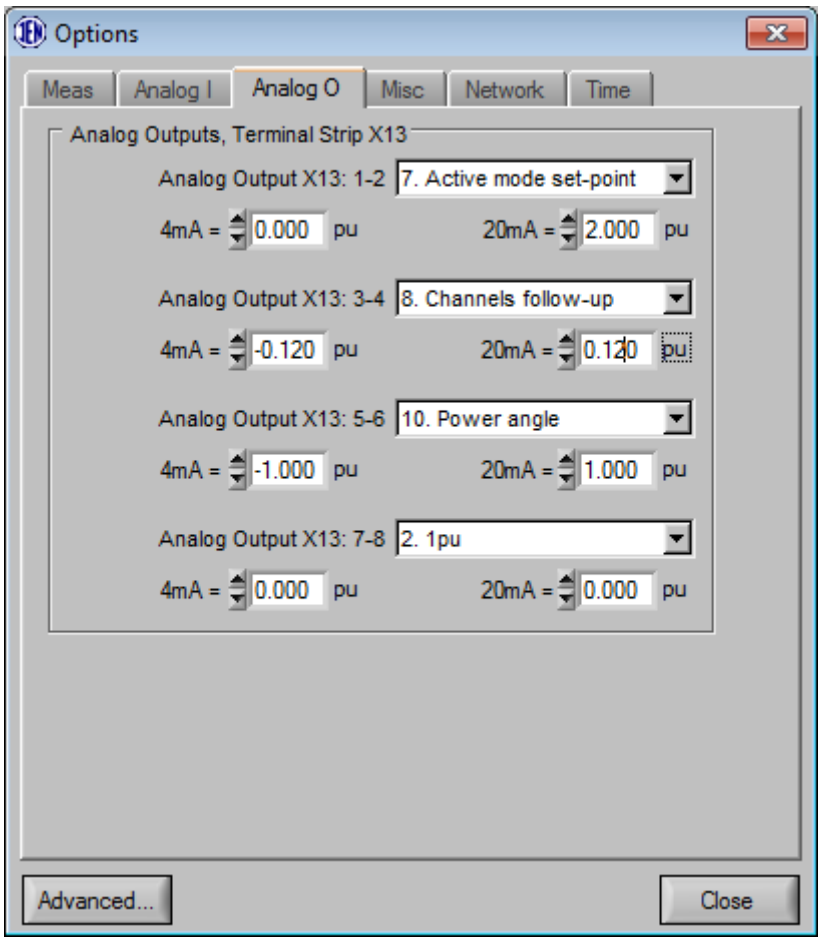


Fig. 53 Third tab of the Options “Analog O” window with examples settings

Analog outputs tab allows to assign signals to one of four configurable analog outputs which can be found on X13:1-8. Most important signals available from drop-down list box are:

- 0pu – this option is forcing 4mA output for test purposes
- 1pu – this option is forcing 12mA output for test purposes
- 2pu– this option is forcing 20mA output for test purposes
- Uf – Field voltage
- If – Field current
- Tf – Rotor temperature
- Active mode set-point – Setpoint value of operating regulation mode
- Channels follow-up – Follow-up between regulator channels(redundant application only)
- Control loops follow-up – Follow-up of automatic and manual loop
- Power angle – Difference between the generator induced voltage and the generator terminal voltage

Range of each signal can be configurated independently by selecting level of signal for 4mA and for 20mA.

3.18.4 Miscellaneous

On the fourth tab of the Option window in the setting ”Excitation system structure” (shown below) it is possible to select Possible regulation structures:

- ST1A
- AC5A
- AC8B/ST4B

Where AC8B option changes Automatic loop structure (PID), Manual loop structure (PI) and four limiters structure (PI).
Select Tuning software and built in panel language from possible options:

- ENGLISH
- POLISH

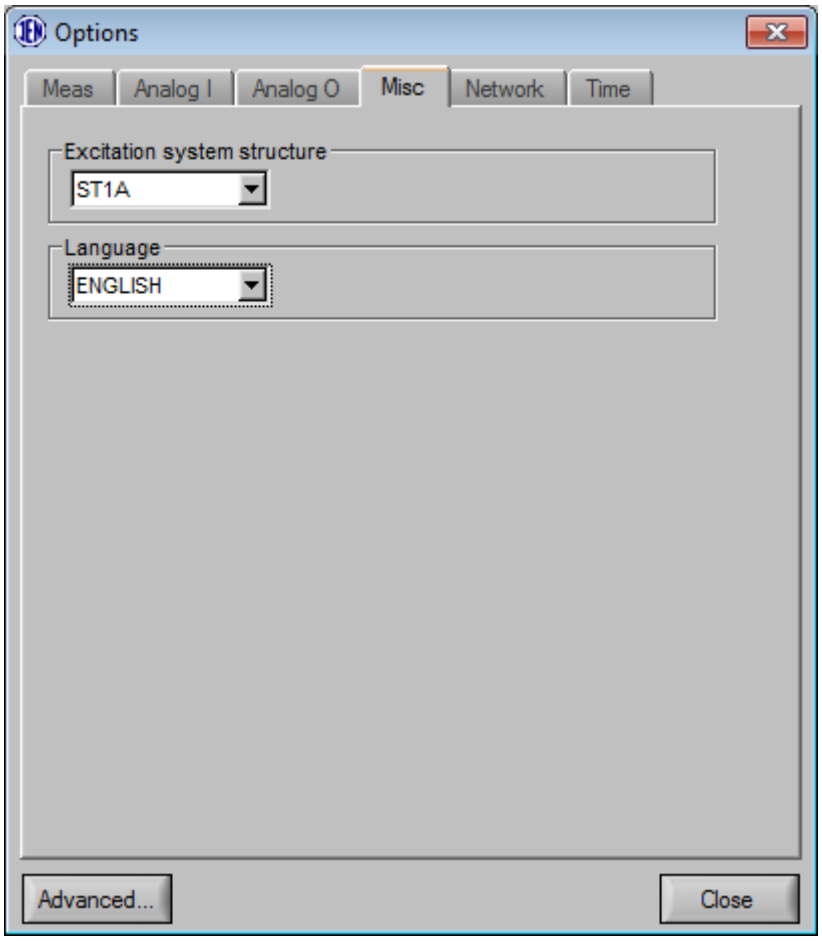


Fig. 54 Fourth tab of the Options “Misc” window with examples settings

3.18.5 Network

Next tab of Options window allows to set communication parameters of P100C-SX regulator.

From here it is possible to set TCP communication parameters which include:

- IP address
- Modbus TCP Slave ID
- TCP/IP Port

To apply new settings press Set button located in the right corner.

Network tab allows also to set parameters of both RS485 interfaces. From here user can set:

- Modbus Slave ID
- RS485 speed

All changes made in this section affect communication instantly and may interrupt current communication.

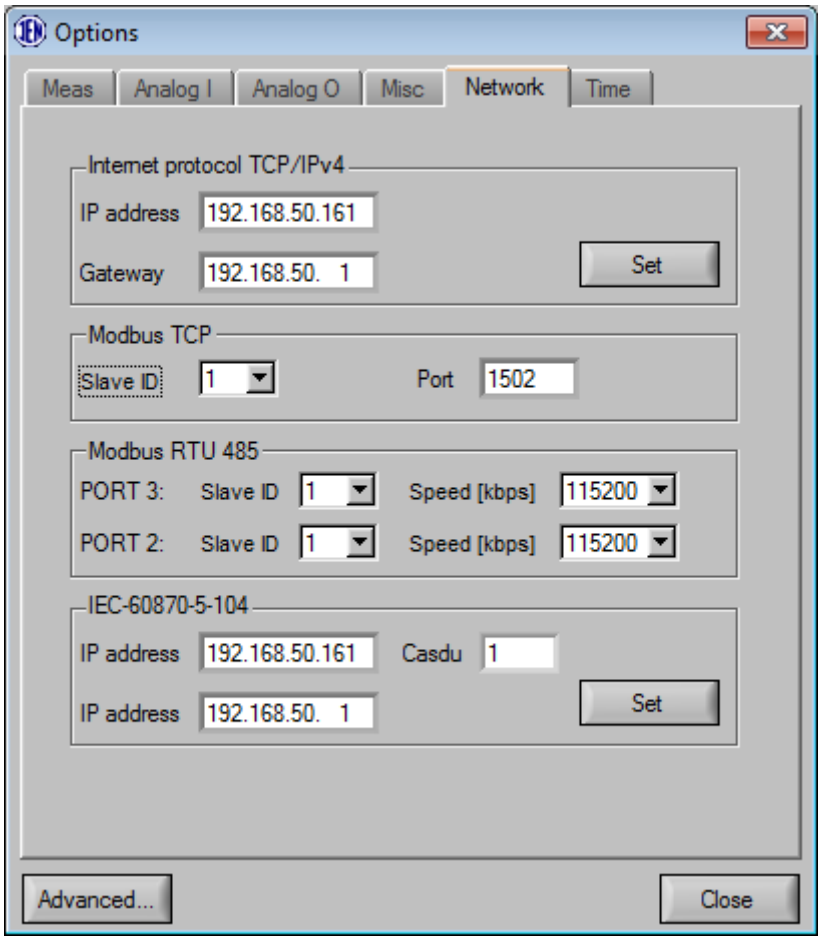


Fig. 55 Fifth tab of the Options “Network” window with examples settings

Additional RS485 communication settings are available using hardware jumpers which can be found on regulator main board after opening of avr casing. Those options allow to add terminating resistor to end of communication loop and switch between operating in RS485 2-wire and RS485 4-wire mode.

Jumper	Position	Port	Description
JP1	1-2	PORT2	Adds terminating resistor to end of communication loop
JP4	1-2	PORT3	Adds terminating resistor to end of communication loop
JP7	1-2	PORT3	Switch RS485 Port to RS485 2-wire mode
	2-3		Switch RS485 Port to RS485 4-wire mode
JP5	1-2	PORT2	Switch RS485 Port to RS485 2-wire mode
	2-3		Switch RS485 Port to RS485 4-wire mode

From here it is also possible to set IEC-60870-5-104 communication parameters which include:

- IP address of client no 1
- IP address of client no 2
- Casdu identifier

To apply new settings press Set button located in the right corner.

3.18.6 Time

On the fifth tab of the Option window settings related to internal time of controller are presented.

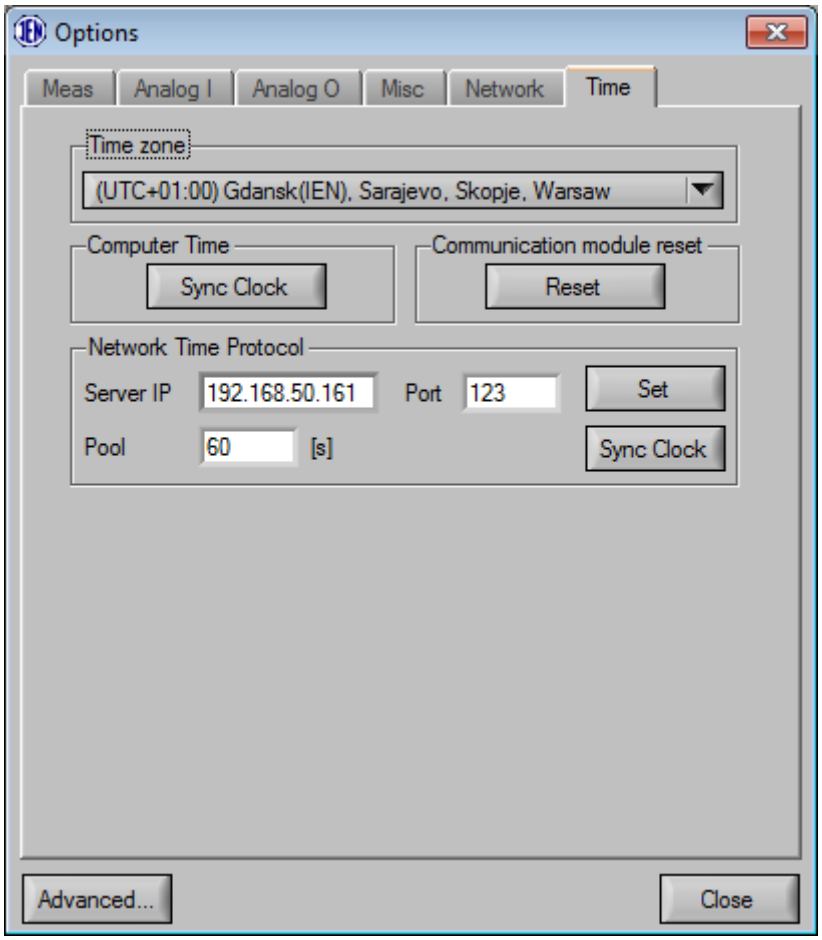


Fig. 56 Last tab of the Options “Time” window with examples settings

P100C-SX can be configurated to get current date and time from Network Time Protocol server. To synchronize with NTP server, following settings must be provided:

- Server IP address
- Port used for communication
- Pool frequency which specifies period of time at which time is updated

If NTP server is not available, P100C-SX date and time must be provided the other way. There are two possible options:

- Synchronize with computer by clicking Sync Clock button
- Update date and time manually from Communication section of P100C-SX build in display

3.19 OTHER BUTTONS

Please find bellow description of the other buttons present in the lower part of Main window.

SET. TO FLASH
After changes in settings bring an immediate effect, until the power loss. Power loss cause return to the settings before the changes. The button “Set. to Flash” (Settings to Flash) saves all settings to the FLASH memory and allows save changes in settings even power is loss.

ALARMS RESET
If no alarm active and alarm signalization is on, button “Alarm Reset” allows turning off alarm signalization above the button. The same function has the button “ALARM RESET” on the keypad (shown below).

Fig. 57 Button “ALARM RESET” on the keypad of P100C-SX

SAVE FILE
The button “Save File” allows save all settings to the text file with “.nas” extension.

READ FILE
The button “Read File” allows read all settings from the text file with “.nas” extension.

REFRESH
The button “Refresh” updates all settings shown in the P100C-SX Tuning Software.

EXIT
The button “Exit” close the P100C-SX Tuning Software.

3.20 OUTPUTS LOGIC

States of the 24 binary outputs (Out 1 – Out 24) are produced from the states of the 64 internal variables call “Events”. Each output has its own two logic gates (2 x AND or OR) and the timer. The “Events” through logic of gates and timer can activate all binary outputs.

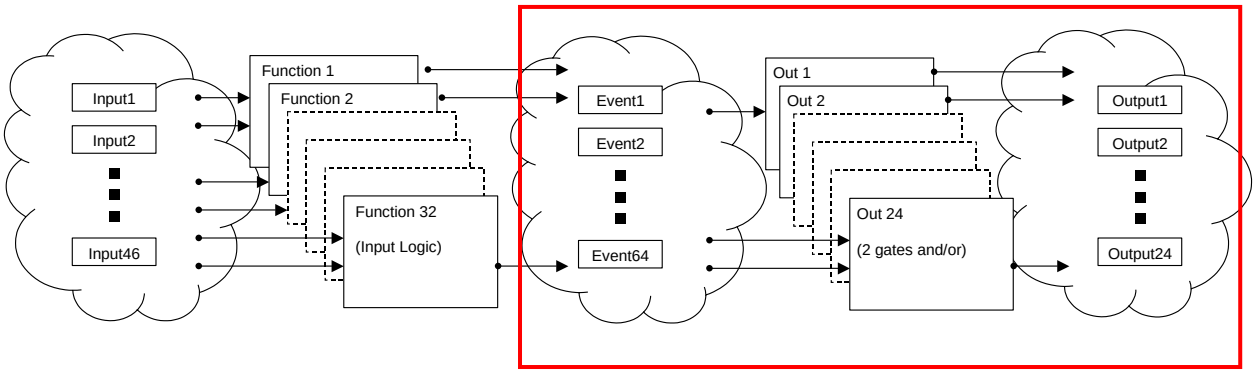


Fig. 58 Output logic philosophy

To open the output logic window, click “OUTPUT LOGIC” tab in the lower part of Main window. The following tab appears (1 of 24):

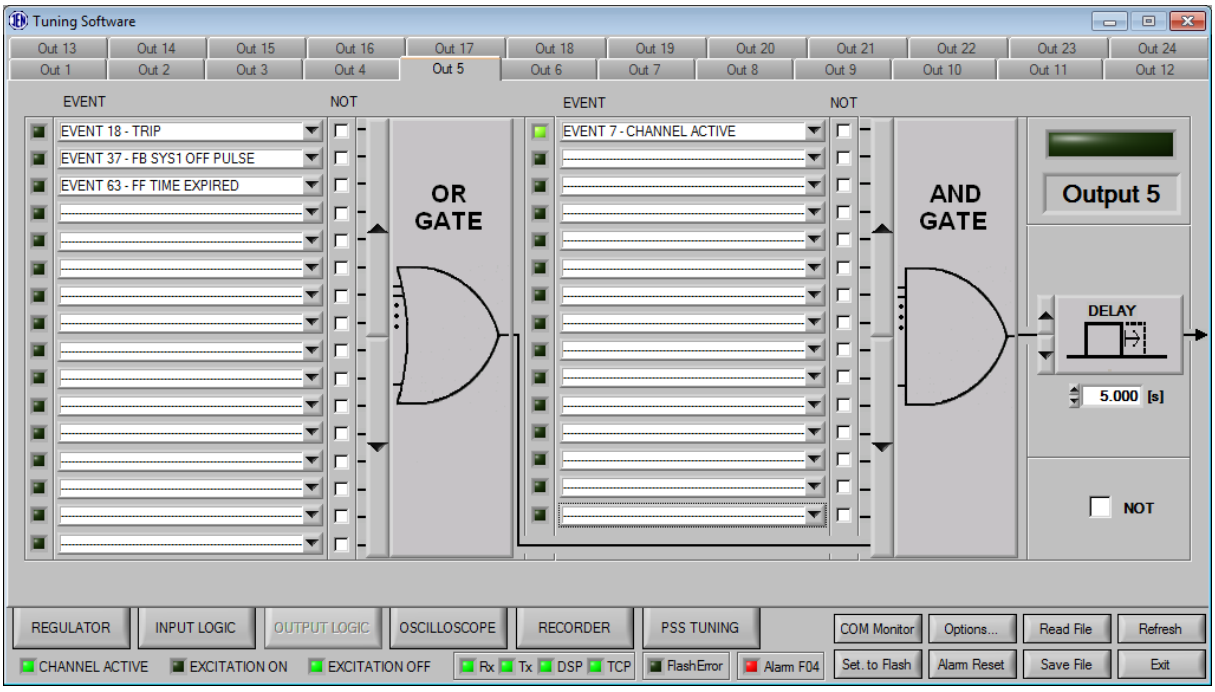
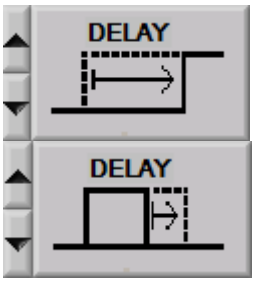


Fig. 59 Output logic tab of the binary output number 21 (Out21)

Output logic functions are organized into two selectable drop-down lists first has 16 positions and second 15 with input from gate of previous one. For each signal on the list led on the left of Event name indicates if such signal is currently active or not. Checkbox on the right from Event name allows to negate logically such signal. Each drop-down lists selected signals are

input for selectable gate (“AND” or “OR” gate). From such whole chain signal can be additionally negated with “NOT” checkbox. Signal current status can be observed on big led below output number information text.

Output signals from function can be handled in two ways basing on delay button position:



Output goes high when signal is active after short delay set by user in seconds then goes down after normal predefined amount of time.

Output goes instantly high when signal is active for duration shorter than normally by a time set by user in seconds.

Each selectable input position in Output logic function can be assigned to one of sixty four events. For full list of events please refer to APPENDIX section of this document.

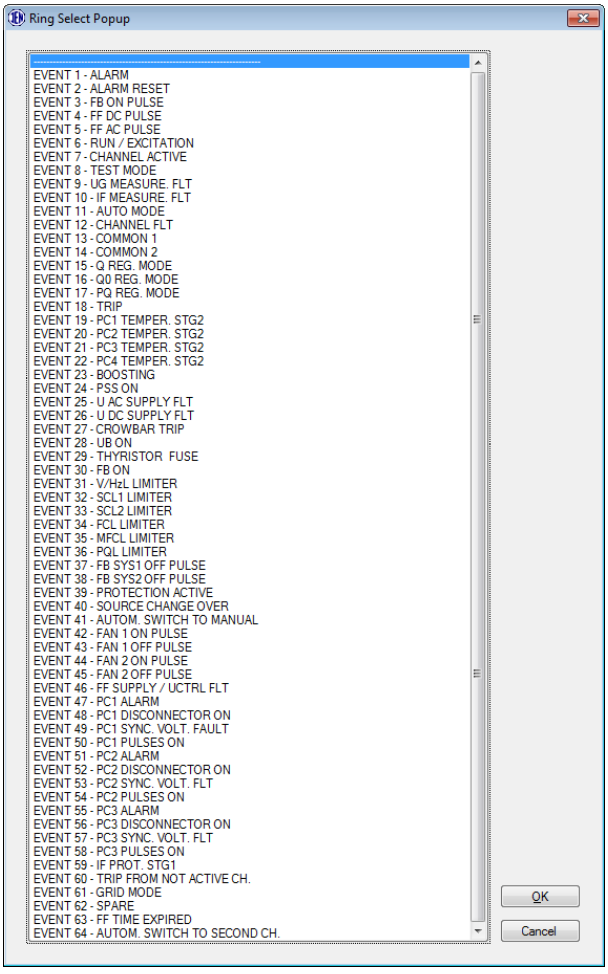


Fig. 60 Event selection window

3.21 INPUTS LOGIC

States of the 64 “Events” are produced from the states of the 46 binary inputs (Input1 – Input46). The binary inputs through logic of the 32 special functions (F01 – F32) can activate all “Events”.

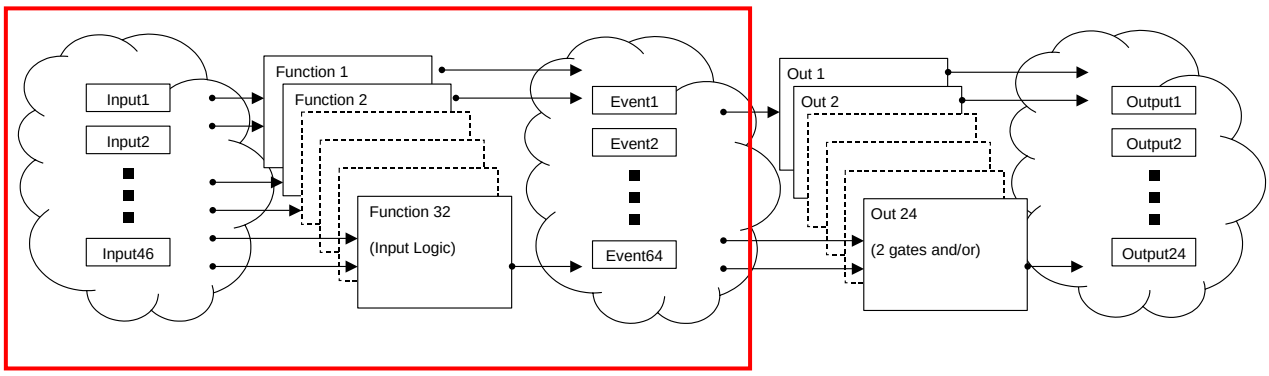


Fig. 61 Output logic philosophy

To open the input logic window, click “INPUT LOGIC” tab in the lower part of Main window. The following tab appears (1 of 32):

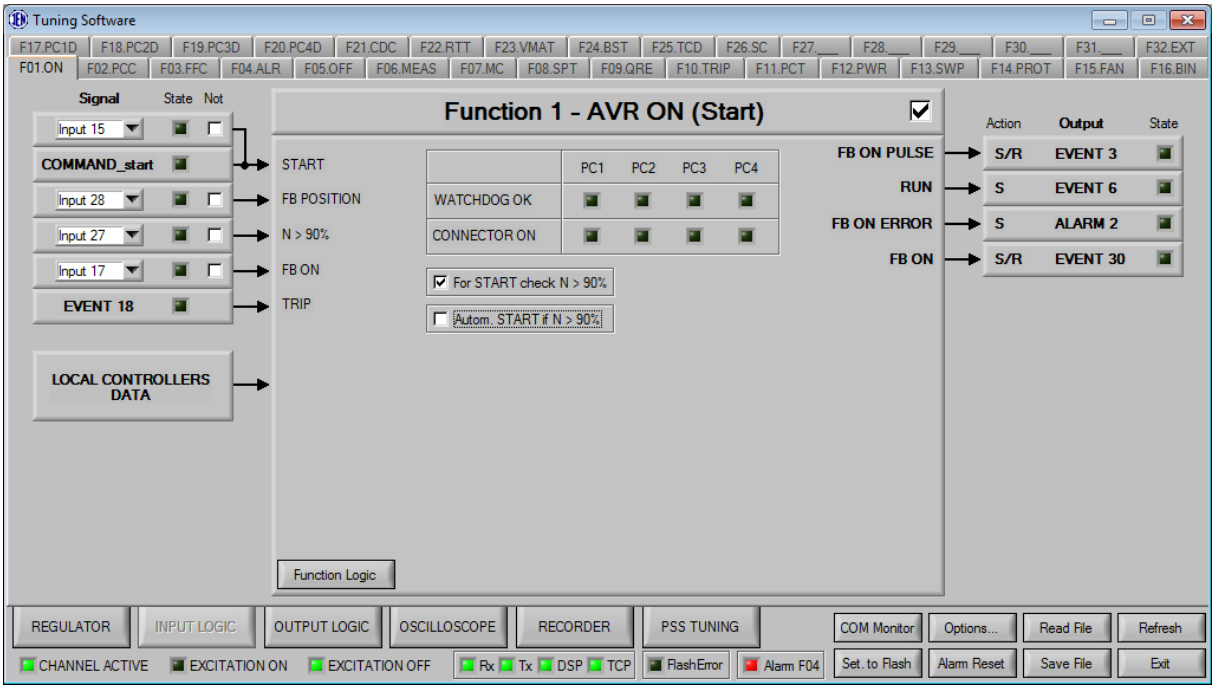


Fig. 62 Input logic tab of the Function number 1 (F01.ON)

To view the logic of the function, click “Function Logic” button in the lower part of the function tab. The following PDF file with function logic in the ladder language appears:

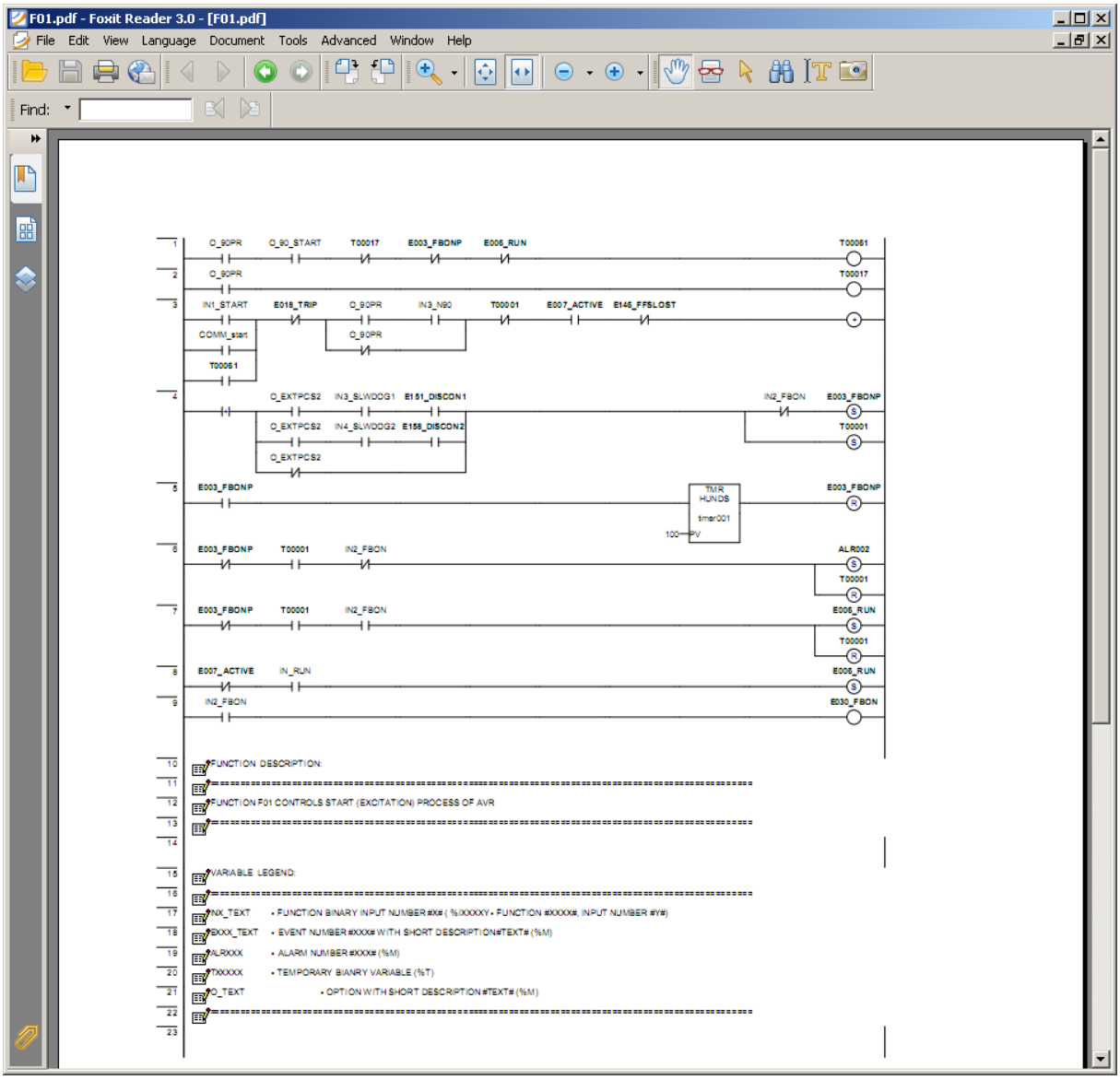
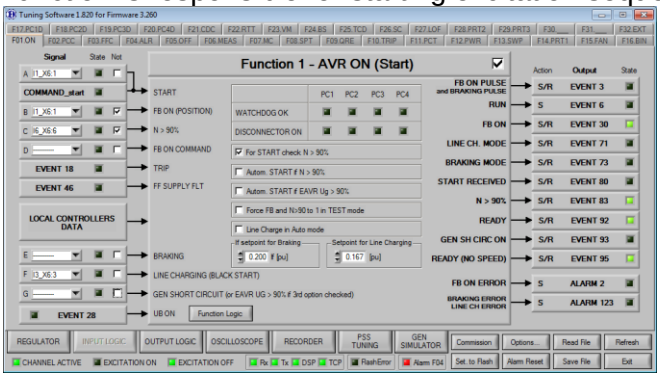


Fig. 63 Logic of the Function number 1 (F01.ON) in the ladder language

3.21.1 Function 1: AVR ON (Start)

Function is responsible for starting excitation sequence.



Operands

All function operands are listed in the table 1 below.

Name	Type	Description
(A) START	Binary input	Starts excitation if certain conditions are met **Logical high necessary to start excitation** (see description of configuration 1 in section below)
(B) FB ON (POSITION)	Binary input	Position of field breaker **Logical high necessary to start excitation** Logical low stops the excitation
(C) N > 90%	Binary input	Information about 90% of nominal speed of generator **Logical high necessary to start if option "For start check N>90%" is checked** (see description of configuration 2,3 in section below)
(D) FB ON COMMAND	Binary input	Energizes Event 3 – FB ON PULSE Can be used to switch on field breaker from DCS
(E) BRAKING	Binary input	Starts excitation in Braking mode if certain conditions are met Logical high necessary to enable Braking mode Logical low necessary to disable Braking mode (see description of Braking mode in section below)
(F) LINE CHARGING	Binary input	Starts excitation in Line Charge mode if certain conditions are met Logical high necessary to enable Line Charge Logical low necessary to disable Line Charge mode (see description of Line Charge mode in section below)
(G) GEN SHORT CIRCUIT	Binary input	Information about position of stator short circuit Logical high necessary to start Braking mode (see description of Braking mode in section below)
EVENT 18 - TRIP	Event input	Information about TRIP from AVR. **Logical low necessary to start.** **Source:** INPUT LOGIC/F10.TRIP **Pre-requirements:** - Channel is active (EVENT 7) and any of alarms specified as trip source in F10.TRIP active or: - Active channel is faulty (EVENT 12) as well as not active channel
EVENT 46 – FF SUPPLY FLT	Event input	Information about field flashing supply **Logical low necessary to start excitation** **Source:** INPUT LOGIC/F12.PWR.B **Pre-requirements:**

		- Directly from binary input
EVENT 3 - FB ON PULSE	Event output	Event lasting for **1,5 sec** typically used as command to close field breaker. Can be used in Braking sequence to close stator short circuit **Source:** INPUT LOGIC/F01.ON **Pre-requirements:** - Channel is active (EVENT 7), ready for excitation (EVENT 92), not running (EVENT 6), start command received (EVENT 80)
EVENT 6 - RUN	Event output	Indicates excitation of AVR Logical high - excited **Source:** INPUT LOGIC/F01.ON **Pre-requirements:** - Channel is active (EVENT 7), ready for excitation (EVENT 92), not excited (EVENT 6), start command received (EVENT 80), field breaker is closed (EVENT 30) and: *For routine operation* - Braking disabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit open (EVENT 93) *For Braking* - Braking enabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit closed (EVENT 93), manual mode enabled (EVENT 11) *For Line Charge* - Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), manual mode enabled (EVENT 11), option “Line charge in Auto mode” not checked or: - Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), auto mode enabled (EVENT 11), option “Line charge in Auto mode” checked
EVENT 71 – LINE CH. MODE	Event output	Indicates operation in Line Charge mode **Source:** INPUT LOGIC/F01.ON.F **Pre-requirements:** - Channel is not excited (EVENT 6), Pump mode disabled (EVENT 70), Braking mode disabled (EVENT 73), logic low to high transition on input F
EVENT 73 – BRAKING MODE	Event output	Indicates operation in Braking mode **Source:** INPUT LOGIC/F01.ON.E **Pre-requirements:** - Channel is not excited (EVENT 6), Line Charge mode disabled (EVENT 71), logic low to high transition on input E
EVENT 80 – START RECEIVED	Event output	Indicates that start command has been received **Source:** - INPUT LOGIC/F01.ON.A - Modbus command (1202) - IEC104 command - INPUT LOGIC/F01.ON.C if option

		"Autom.start if N >90%" is checked - INPUT LOGIC/F01.ON.G if option "Autom.start if EAVR Ug 90>90%" is checked - EVENT 73 - BRAKING **Pre-requirements:** - None
EVENT 83 – N > 90%	Event output	Indicates that machine speed is higher than 90 % **Source:** - INPUT LOGIC/F01.ON.C **Pre-requirements:** - None
EVENT 92 – READY	Event output	Indicates that system is ready for excitation **Source:** INPUT LOGIC/F01.ON **Pre-requirements:** - Channel is ready for excitation without speed (EVENT 95) and: *With speed control* - Option "For start check N>90" is checked , logic high on INPUT LOGIC/F01.ON.C *Without speed control* - Option "For start check N>90" is not checked
EVENT 93 – GEN SH CIRC ON	Event output	Indicates that stator short circuit is closed **Source:** INPUT LOGIC/F01.ON.G **Pre-requirements:** - Option "Autom.start if EAVR Ug 90>90%" is not checked, logic high on INPUT LOGIC/F01.ON.G
EVENT 95 – READY (NO SPEED)	Event output	Indicates that system is ready for excitation without machine running **Source:** INPUT LOGIC/F01.ON **Pre-requirements:** - TRIP not received (EVENT 79), TRIP not send (EVENT 18), STOP not received (EVENT 78), field flashing supply present (EVENT 46), generator short circuit open (EVENT 93) and: *With Local Controller* - "Thyristor Bridge, Local Controller mode" is selected on Options/Advanced/Option "Power converter type" list, number of healthy rectifiers is higher than specified in LOGIC/F02.PCC "Configuration" option, which includes: o Healthy Watchdog o Closed disconnector o Enabled F17-F20 function *Without Local Controller* - "Thyristor Bridge, Local Controller mode" is not selected on Options/Advanced/Option "Power converter type" list
EVENT 30 – FB ON	Event output	Position of field breaker Logical high - closed **Source:** INPUT LOGIC/F01.ON.B **Pre-requirements:**

		- logic high on INPUT LOGIC/F01.ON.B
ALARM 2 – FB ON ERROR	Alarm output	Field breaker not closed during start sequence **Source:** INPUT LOGIC/F01.ON.B
ALARM 144 – EXCITED AND NO SPEED	Alarm output	Generator is excited but speed is too low Delay: 10 sec **Source:** INPUT LOGIC/F01.ON
ALARM 115 – EXCITATION ON & PULSES OFF	Alarm output	Indicates situation when excitation is running but firing pulses for power converter are disable **Source:** INPUT LOGIC/F01.ON
ALARM 123 – BRAKING ERROR	Alarm output	Generator short circuit is open during Braking **Source:** INPUT LOGIC/F01.ON
ALARM 95 – START & TRIP	Alarm output	Commands to start and trip excitation received at the same time **Source:** INPUT LOGIC/F01.ON
ALARM 96 – START & NO SPEED	Alarm output	Command start excitation received but machine speed is too low **Source:** INPUT LOGIC/F01.ON
For start check N>90%	Option	Includes generator speed into start conditions
Autom. start if N>90%	Option	Automatically starts when generator reaches desired speed
Autom. start if EVAR Ug>90%	Option	Automatically starts when exciter voltage reaches desired value
Force FB and N>90 to 1 in TEST mode	Option	Forces events EVENT 30 – FB ON and EVENT 83 – N > 90% to logical high when TEST mode is active
Line Charge in Auto mode	Option	Specifies that Line Charge mode is performed in Auto control loop (generator voltage regulation) Otherwise Line Charge is performed in Manual control loop (generator field current)
If setpoint for Braking	Parameter	Setpoint value for Braking mode
Setpoint for Line Charging	Parameter	Setpoint value for Line Charge mode. If option “Line Charge in Auto mode” is checked it specifies setpoint of Auto control loop. Otherwise it specifies setpoint of Manual control loop.

Operation

This function is responsible for handling start sequence. It receives start command and after having verified that all conditions to start have been met energizes EVENT 6 – RUN and passes control to Function 02 – POWER CONVERTER CONTROL.

There are three main start scenarios, each requires different conditions to be satisfied:

No	Start Scenario	Start Sequence
1	Routine Start	**1. Start command for Routine Start:** EVENT 80 – START RECEIVED: - INPUT LOGIC/F01.ON.A, or Modbus command (1202), or IEC104 command, or INPUT LOGIC/F01.ON.C if option “Autom.start if N

		>90%" is checked, or INPUT LOGIC/F01.ON.G if option "Autom.start if EAVR Ug 90>90%" is checked **2. Start conditions verification:** EVENT 95 – READY (NO SPEED): - TRIP not received (EVENT 79) - TRIP not send (EVENT 18) - STOP not received (EVENT 78) - field flashing supply present (EVENT 46) - generator short circuit open (EVENT 93) and EVENT 92 – READY: *With speed control:* - Option "For start check N>90" is checked , logic high on INPUT LOGIC/F01.ON.C *Without speed control* - Option "For start check N>90" is not checked and *With Local Controller:* - Healthy Watchdog - Closed disconnector - Enabled F17-F20 function *Without Local Controller:* - "Thyristor Bridge, Local Controller mode" is not selected on Options/Advanced/Option "Power converter type" list
2	Electrical Braking	**1. Start command for Braking:** EVENT 73 – BRAKING MODE - Channel is not excited (EVENT 6) - Line Charge mode disabled (EVENT 71) - logic low to high transition on input INPUT LOGIC/F01.ON.E **2. Start conditions verification:** EVENT 80 – START RECEIVED: - braking active (EVENT 73) and EVENT 95 – READY (NO SPEED): - TRIP not received (EVENT 79) - TRIP not send (EVENT 18) - STOP not received (EVENT 78) - field flashing supply present (EVENT 46) - generator short circuit open (EVENT 93) and EVENT 92 – READY: *With speed control:*

		- Option “For start check N>90” is checked , logic high on INPUT LOGIC/F01.ON.C *Without speed control* - Option “For start check N>90” is not checked and *With Local Controller:* - Healthy Watchdog - Closed disconnector - Enabled F17-F20 function *Without Local Controller:* - “Thyristor Bridge, Local Controller mode” is not selected on Options/Advanced/Option “Power converter type” list
3	Line Charge (Black Start)	**1. Start command for Line Charging:** EVENT 80 – START RECEIVED: - INPUT LOGIC/F01.ON.A, or Modbus command (1202), or IEC104 command, or INPUT LOGIC/F01.ON.C if option “Autom.start if N >90%” is checked, or INPUT LOGIC/F01.ON.G if option “Autom.start if EAVR Ug 90>90%” is checked **2. Start conditions verification:** EVENT 71 – LINE CH. MODE - Channel is not excited (EVENT 6) - Pump mode disabled (EVENT 70) - Braking mode disabled (EVENT 73) - logic low to high transition on INPUT LOGIC/F01.ON.F and EVENT 95 – READY (NO SPEED): - TRIP not received (EVENT 79) - TRIP not send (EVENT 18) - STOP not received (EVENT 78) - field flashing supply present (EVENT 46) - generator short circuit open (EVENT 93) and EVENT 92 – READY: *With speed control:* - Option “For start check N>90” is checked , logic high on INPUT LOGIC/F01.ON.C *Without speed control* - Option “For start check N>90” is not checked and *With Local Controller:* - Healthy Watchdog - Closed disconnector - Enabled F17-F20 function

		Without Local Controller: - "Thyristor Bridge, Local Controller mode" is not selected on Options/Advanced/Option "Power converter type" list

After meeting conditions listed above, controller tries to establish EVENT 6 – RUN. Before that it energizes EVENT 3 - FB ON PULSE for 1,5 s and waits for field breaker to close. Following pre-requirements must be satisfied prior to enabling EVENT 6 – RUN:

No	Configuration	Conditions to establish EVENT 6 – RUN
1	Routine Start	- Channel is active (EVENT 7) - Ready for excitation (EVENT 92) - Not excited (EVENT 6) - Start command received (EVENT 80) - Field breaker is closed (EVENT 30) - **Braking disabled (EVENT 73)** - **Line Charge disabled (EVENT 71)** - **Generator short circuit open (EVENT 93)**
2	Electrical Braking	- Channel is active (EVENT 7) - Ready for excitation (EVENT 92) - Not excited (EVENT 6) - Start command received (EVENT 80) - Field breaker is closed (EVENT 30) - **Braking enabled (EVENT 73)** - **Line Charge disabled (EVENT 71)** - **Generator short circuit closed (EVENT 93)** - **Manual mode enabled (EVENT 11)**
3	Line Charge (Black Start)	- Channel is active (EVENT 7) - Ready for excitation (EVENT 92) - Not excited (EVENT 6) - Start command received (EVENT 80) - Field breaker is closed (EVENT 30) - **Braking disabled (EVENT 73)** - **Line Charge enabled (EVENT 71)** - **Generator short circuit open (EVENT 93)** and - Manual mode enabled (EVENT 11) if option "Line charge in Auto mode" not checked or: - Auto mode enabled (EVENT 11) if option "Line charge in Auto mode" checked

Applicable settings

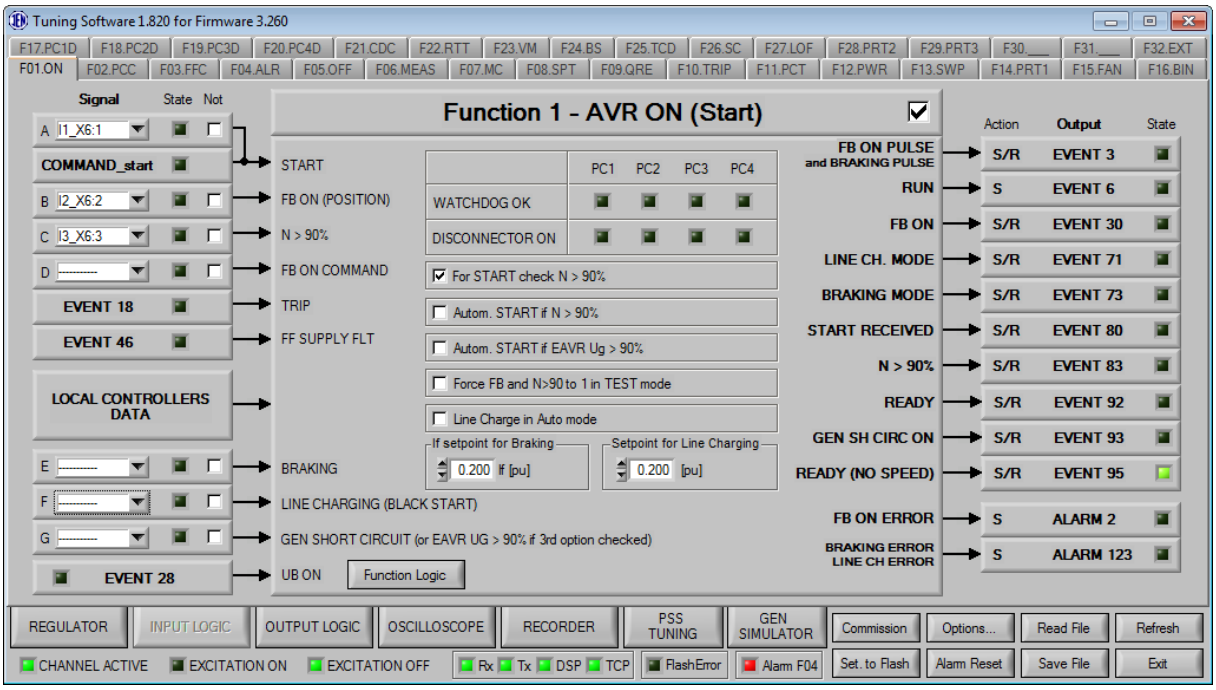


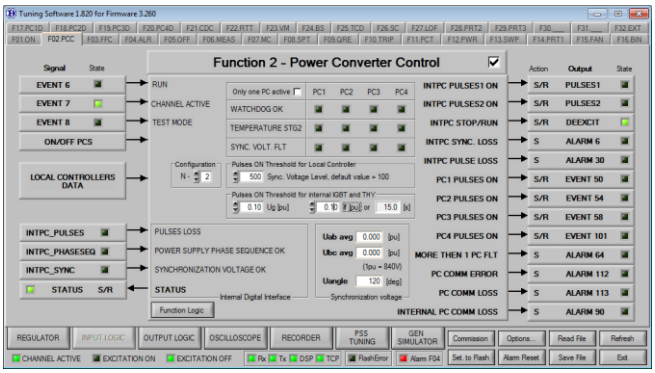
Fig. 64 Applicable settings

Tips:

- ✓ Status of all discrete inputs and outputs is displayed in function via LEDs
- ✓ NO and NC contacts can be used, use NOT to inverse logic
- ✓ If function still doesn't start make sure control voltage is present in Function 12 – POWER SUPPLY CONTROL

3.21.2 Function 2: Power Converter Control

This function is responsible for control of power converters. It receives EVENT 06 - RUN from Function 1 and enables firing pulses if certain conditions are met.



Operands

All function operands are listed in the table below.

Name	Type	Description
EVENT 6 - RUN	Event input	Indicates excitation of AVR Logical high - excited **Source:** INPUT LOGIC/F01.ON **Pre-requirements:** - Channel is active (EVENT 7), ready for excitation (EVENT 92), not excited (EVENT 6), start command received (EVENT 80), field breaker is closed (EVENT 30) and: *For routine operation* - Braking disabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit open (EVENT 93) *For Braking* - Braking enabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit closed (EVENT 93), manual mode enabled (EVENT 11) *For Line Charge* - Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), manual mode enabled (EVENT 11), option “Line charge in Auto mode” not checked or: - Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), auto mode enabled (EVENT 11), option “Line charge in Auto mode” checked
EVENT 7 – CHANNEL ACTIVE	Event input	Indicates activity of channel Logical high - active **Source:** INPUT LOGIC/F13.SWP **Pre-requirements:** - Other channel is faulty INPUT LOGIC/F13.IN8

		or - Other channel send SWAP command INPUT LOGIC/F13.IN7
EVENT 8 - TEST	Event input	Indicates that TEST mode is active Logical high - active **Source:** - Input INPUT LOGIC/F07.MC.F - INPUT LOGIC/F07/Option “Force Test Mode” **Pre-requirements:** - Channel is not excited (EVENT 06)
EVENT 49 – PC1 SYNC.VOLT.FLT	Event input	Indicates loss of synchronization voltage in power converter in configuration with Local Controller Logical high – loss Delay: 20ms **Source:** - INPUT LOGIC/F17.PC1 **Pre-requirements:** - Logical high at binary information from Local Controller PC1Data_SyncFuse (register 2, bit 8) or - Logical high at binary information from Local Controller PC1Data_SyncVolt (register 3, bit 7) or - Synchronization voltage lower that value specified in INPUT LOGIC/F02.PCC option “Pulses ON Threshold for Local Controller”
EVENT 53 – PC2 SYNC.VOLT.FLT	Event input	Indicates loss of synchronization voltage in power converter in configuration with Local Controller Logical high – loss Delay: 20ms **Source:** - INPUT LOGIC/F18.PC2 **Pre-requirements:** - Logical high at binary information from Local Controller PC2Data_SyncFuse (register 2, bit 8) or - Logical high at binary information from Local Controller PC2Data_SyncVolt (register 3, bit 7) or - Synchronization voltage lower that value specified in INPUT LOGIC/F02.PCC option “Pulses ON Threshold for Local Controller”
EVENT 57 – PC3 SYNC.VOLT.FLT	Event input	Indicates loss of synchronization voltage in power converter in configuration with Local Controller Logical high – loss Delay: 20ms **Source:** - INPUT LOGIC/F19.PC3

		Pre-requirements: - Logical high at binary information from Local Controller PC3Data_SyncFuse (register 2, bit 8) or - Logical high at binary information from Local Controller PC3Data_SyncVolt (register 3, bit 7) or - Synchronization voltage lower that value specified in INPUT LOGIC/F02.PCC option “Pulses ON Threshold for Local Controller”
EVENT 100 – PC4 SYNC.VOLT.FLT	Event input	Indicates loss of synchronization voltage in power converter in configuration with Local Controller Logical high – loss Delay: 20ms **Source:** - INPUT LOGIC/F20.PC4 **Pre-requirements:** - Logical high at binary information from Local Controller PC4Data_SyncFuse (register 2, bit 8) or - Logical high at binary information from Local Controller PC4Data_SyncVolt (register 3, bit 7) or - Synchronization voltage lower that value specified in INPUT LOGIC/F02.PCC option “Pulses ON Threshold for Local Controller”
LOCAL CONTROLLERS DATA	Register input	Data collected from local controllers of rectifiers
INTPC PULSES1 ON INTPC PULSES2 ON	Event output	Command to enable firing pulses in configuration with GCU or MSP Logical high - enabled **Source:** - INPUT LOGIC/F02.PCC **Pre-requirements:** - Channel excited (EVENT 06) - Channel active (EVENT 07) - “Thyristor Bridge, Local Controller mode” is not selected on Options/Advanced/Option “Power converter type” list And - Synchronization voltage INPUT LOGIC/F02.PCC.INTPC_SYNC is present or - “IGBT Transistor” is selected on Options/Advanced/Option “Power converter type” list

		And - Generator voltage higher than specified in INPUT LOGIC/F02.PCC option “Pulses ON threshold for internal IGBT or THY” if Auto mode is active or - Field current is higher than specified in INPUT LOGIC/F02.PCC option “Pulses ON threshold for internal IGBT or THY” if Manual mode is active or - Field flashing lasted longer than time specified in INPUT LOGIC/F03.FFC option “Field Flashing Max Time” if Manual mode is active
INTPC STOP/RUN	Event output	Command to disable firing pulses in configuration with GCU or MSP Logical low - disabled **Source:** - INPUT LOGIC/F02.PCC **Pre-requirements:** - Channel not excited (EVENT 06)
EVENT 50 – PC1 PULSES ON	Event output	Command to enable firing pulses in configuration with Local Controller Logical high - enabled **Source:** - INPUT LOGIC/F02.PCC **Pre-requirements:** - Channel excited (EVENT 06) - Channel active (EVENT 07) - “Thyristor Bridge, Local Controller mode” is selected on Options/Advanced/Option “Power converter type” list - Synchronization is present (EVENT 49) - Healthy Watchdog INPUT LOGIC/F17.PC1.A - Closed disconnector (EVENT 48) - Enabled INPUT LOGIC/F17.PC1 function
EVENT 54 – PC2 PULSES ON	Event output	Command to enable firing pulses in configuration with Local Controller Logical high - enabled **Source:** - INPUT LOGIC/F02.PCC **Pre-requirements:** - Channel excited (EVENT 06) - Channel active (EVENT 07) - “Thyristor Bridge, Local Controller mode” is selected on Options/Advanced/Option “Power converter type” list - Synchronization is present (EVENT 53) - Healthy Watchdog INPUT LOGIC/F18.PC2.A - Closed disconnector (EVENT 52) - Enabled INPUT LOGIC/F18.PC2 function

EVENT 58 – PC3 PULSES ON	Event output	Command to enable firing pulses in configuration with Local Controller Logical high - enabled **Source:** - INPUT LOGIC/F02.PCC **Pre-requirements:** - Channel excited (EVENT 06) - Channel active (EVENT 07) - "Thyristor Bridge, Local Controller mode" is selected on Options/Advanced/Option "Power converter type" list - Synchronization is present (EVENT 57) - Healthy Watchdog INPUT LOGIC/F19.PC3.A - Closed disconnector (EVENT 56) - Enabled INPUT LOGIC/F19.PC3 function
EVENT 101 – PC4 PULSES ON	Event output	Command to enable firing pulses in configuration with Local Controller Logical high - enabled **Source:** - INPUT LOGIC/F02.PCC **Pre-requirements:** - Channel excited (EVENT 06) - Channel active (EVENT 07) - "Thyristor Bridge, Local Controller mode" is selected on Options/Advanced/Option "Power converter type" list - Synchronization is present (EVENT 100) - Healthy Watchdog INPUT LOGIC/F20.PC4.A - Closed disconnector (EVENT 99) - Enabled INPUT LOGIC/F20.PC4 function
ALARM 6 – INTPC SYNC. LOSS	Alarm output	Loss of synchronization voltage in configuration with GCU module **Source:** INPUT LOGIC/F02.PCC
ALARM 30 – INTPC PULSE LOSS	Alarm output	Loss of firing pulses in configuration with GCU module **Source:** INPUT LOGIC/F02.PCC
ALARM 64 – MORE THAN 1 PC FAULT	Alarm output	Number of faulty power converters exceeds x value specified in "Configuration N – x" option **Source:** INPUT LOGIC/F02.PCC
ALARM 90 – INTERNAL PC COMM LOSS	Alarm output	Communication with internal power converter is lost **Source:** INPUT LOGIC/F02.PCC
ALARM 112 – PC COMM ERROR	Alarm output	Errors detected in communication with one or more local controllers **Source:** INPUT LOGIC/F02.PCC
ALARM 113 – PC COMM LOSS	Alarm output	Communication with at least one local controllers is lost **Source:** INPUT LOGIC/F02.PCC
Configuration N-x	Option	Minimum number of Power Converters that system can operate with, valid only for Local Controller configuration N – total number of Power Converters in the system X – maximum number of Power Converters that can be disabled

Pulses ON threshold for Local Controller	Option	Minimal level of synchronization voltage to enable firing pulses in Local Controller configuration
Pulses ON threshold for internal IGBT or THY	Option	Minimal level of generator voltage (Auto mode) or field current (Manual mode) to enable firing pulses or PWM control
Only One PC Active	Option	Only one external power converter controlled by Local Controller will be active at the time. Active converter is selected by common inputs G,H in INPUT LOGIC/F16.BIN

Operation

After receiving EVENT 06 – RUN functions checks status of power converters and enables control if all conditions are met. Function logic differs for different power module types:

No	Configuration	Conditions to generate pulses
1	Local Controller	- Channel excited (EVENT 06) - Channel active (EVENT 07) - "Thyristor Bridge, Local Controller mode" is selected on Options/Advanced/Option "Power converter type" list and - Synchronization is present (EVENT 49) - Healthy Watchdog INPUT LOGIC/F17.PC1.A - Closed disconnector (EVENT 48) - Enabled INPUT LOGIC/F17.PC1 function or - Synchronization is present (EVENT 53) - Healthy Watchdog INPUT LOGIC/F18.PC2.A - Closed disconnector (EVENT 52) - Enabled INPUT LOGIC/F18.PC2 function or - Synchronization is present (EVENT 57) - Healthy Watchdog INPUT LOGIC/F19.PC3.A - Closed disconnector (EVENT 56) - Enabled INPUT LOGIC/F19.PC3 function or - Synchronization is present (EVENT 100) - Healthy Watchdog INPUT LOGIC/F20.PC4.A - Closed disconnector (EVENT 99) - Enabled INPUT LOGIC/F20.PC4 function
2	GCU	- Channel excited (EVENT 06) - Channel active (EVENT 07) - "Thyristor Bridge, Local Controller mode" is not selected on Options/Advanced/Option "Power converter type" list - "IGBT Transistor" is not selected on Options/Advanced/Option "Power converter type" list - Synchronization voltage INPUT LOGIC/F02.PCC.INTPC_SYNC is present And - Generator voltage higher than specified in INPUT LOGIC/F02.PCC option "Pulses ON

		threshold for internal IGBT or THY" if Auto mode is active or - Field current is higher than specified in INPUT LOGIC/F02.PCC option "Pulses ON threshold for internal IGBT or THY" if Manual mode is active or - Field flashing lasted longer than time specified in INPUT LOGIC/F03.FFC option "Field Flashing Max Time" if Manual mode is active
3	MSP	- Channel excited (EVENT 06) - Channel active (EVENT 07) - "IGBT Transistor" is selected on Options/Advanced/Option "Power converter type" list And - Generator voltage higher than specified in INPUT LOGIC/F02.PCC option "Pulses ON threshold for internal IGBT or THY" if Auto mode is active or - Field current is higher than specified in INPUT LOGIC/F02.PCC option "Pulses ON threshold for internal IGBT or THY" if Manual mode is active or - Field flashing lasted longer than time specified in INPUT LOGIC/F03.FFC option "Field Flashing Max Time" if Manual mode is active

When conditions listed in table are met function activates firing pulses or PWM signal and starts to control power converter with an angle calculated from control loop output signal.

In the middle of function screen twelve LEDs can be found providing information about current state of each of four power converters watchdog, passing second stage of temperature threshold and disconnector positions.

Applicable settings

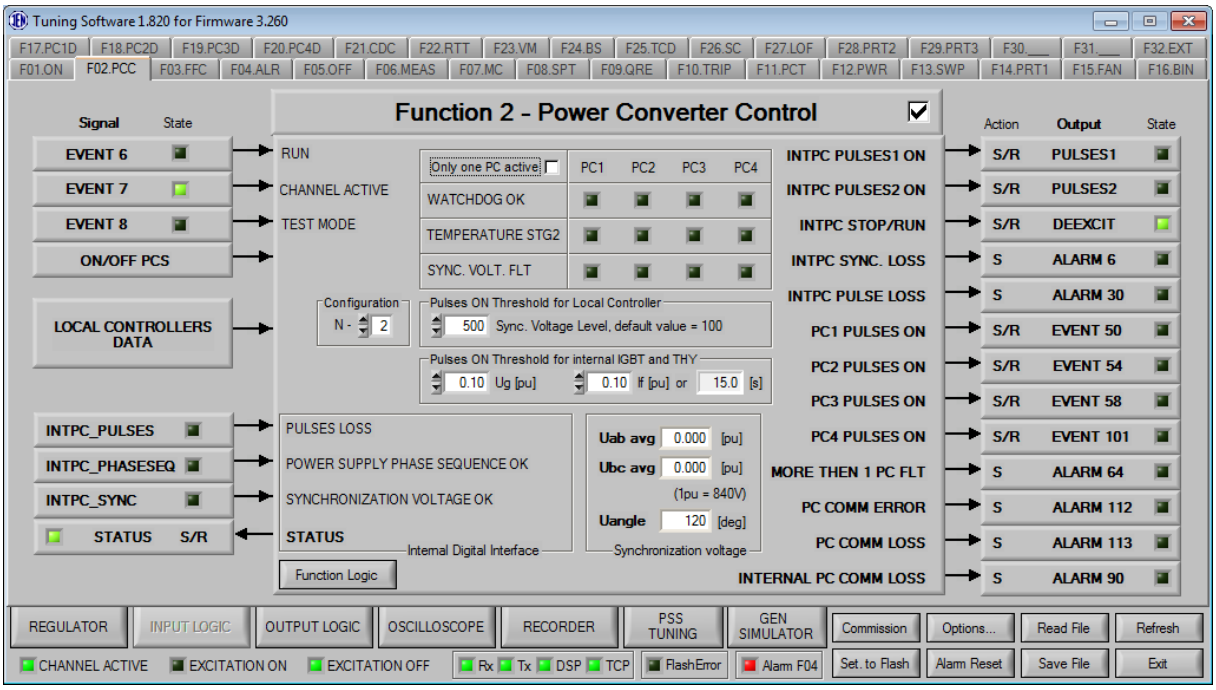


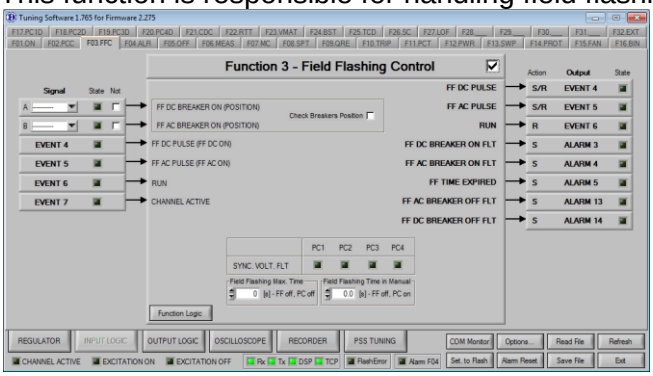
Fig. 65 Applicable settings

Tips:

- ✓ Firing pulses for particular rectifiers can be switched on and off from local control panel

3.21.3 Function 3: Field Flashing Control

This function is responsible for handling field flashing process.



Operands

All function operands are listed in the table below.

Name	Type	Description
(A) DC BREAKER POSITION	Binary input	Position of DC breaker required if option INPUT LOGIC/F03.FFC “Check Breaker’s Position” is checked
(B) AC BREAKER POSITION	Binary input	Position of DC breaker required if option INPUT LOGIC/F03.FFC “Check Breaker’s Position” is checked
EVENT 6 - RUN	Event input	Indicates excitation of AVR Logical high - excited **Source:** INPUT LOGIC/F01.ON **Pre-requirements:** - Channel is active (EVENT 7), ready for excitation (EVENT 92), not excited (EVENT 6), start command received (EVENT 80), field breaker is closed (EVENT 30) and: *For routine operation* - Braking disabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit open (EVENT 93) *For Braking* - Braking enabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit closed (EVENT 93), manual mode enabled (EVENT 11) *For Line Charge* - Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), manual mode enabled (EVENT 11), option “Line charge in Auto mode” not checked or: - Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), auto mode enabled (EVENT 11), option “Line charge in Auto mode” checked
EVENT 7 – CHANNEL ACTIVE	Event input	Indicates activity of channel Logical high - active **Source:** INPUT LOGIC/F13.SWP **Pre-requirements:**

		- Other channel is faulty INPUT LOGIC/F13.IN8 or - Other channel send SWAP command INPUT LOGIC/F13.IN7
EVENT 4 – FF DC PULSE	Event output	Command to close DC contactor of Field Flashing circuit Logical high - close **Source:** INPUT LOGIC/F03.FFC **Pre-requirements:** - Channel excited (EVENT 06) - Channel active (EVENT 07) and *With Local Controller* - "Thyristor Bridge, Local Controller mode" is selected on Options/Advanced/Option "Power converter type" list - Synchronization voltage is not present (EVENT 49,53,57,100) - *With GCU* - "Thyristor Bridge, Local Controller mode" is not selected on Options/Advanced/Option "Power converter type" list - "IGBT Transistor" is not selected on Options/Advanced/Option "Power converter type" list - Synchronization voltage INPUT LOGIC/F02.PCC.INTPC_SYNC is not present - Generator voltage lower than specified in INPUT LOGIC/F02.PCC option "Pulses ON threshold for internal IGBT or THY" if Auto mode is active or - Field current is lower than specified in INPUT LOGIC/F02.PCC option "Pulses ON threshold for internal IGBT or THY" if Manual mode is active - *With MSP* - "IGBT Transistor" is selected on Options/Advanced/Option "Power converter type" list - Generator voltage lower than specified in INPUT LOGIC/F02.PCC option "Pulses ON threshold for internal IGBT or THY" if Auto mode is active or - Field current is lower than specified in INPUT LOGIC/F02.PCC option "Pulses ON

		threshold for internal IGBT or THY" if Manual mode is active
EVENT 5 – FF AC PULSE	Event output	Command to close AC contactor of Field Flashing circuit Logical high – close Delay: 1 sec **Source:** INPUT LOGIC/F03.FFC **Pre-requirements:** - FF DC pulse active (EVENT 04)
EVENT 102 – FF DC ON PULSE	Event output	Pulse command to close DC contactor of Field Flashing circuit Logical high – close Duration: 1 sec **Source:** INPUT LOGIC/F03.FFC **Pre-requirements:** - FF DC pulse activated (EVENT 04)
EVENT 103 – FF DC OFF PULSE	Event output	Pulse command to open DC contactor of Field Flashing circuit Logical high – open Duration: 1 sec **Source:** INPUT LOGIC/F03.FFC **Pre-requirements:** - FF DC pulse deactivated (EVENT 04)
EVENT 63 – FF TIME EXPIRED	Event output	Field Flashing time lasted longer than specified in INPUT LOGIC/F03.FFC option "Field Flashing Max Time" Logical high – active **Source:** - INPUT LOGIC/F03.FFC **Pre-requirements:**
ALARM 3 – FF DC BRK ON FLT	Alarm output	DC breaker not switched on **Source:** INPUT LOGIC/F03.FFC.A
ALARM 4 – FF AC BRK ON FLT	Alarm output	AC breaker not switched on **Source:** INPUT LOGIC/F03.FFC.B
ALARM 5– FF TIME EXPIRED	Alarm output	Field Flashing time lasted longer than specified in INPUT LOGIC/F03.FFC option "Field Flashing Max Time" **Source:** INPUT LOGIC/F03.FFC
ALARM 13 – FF AC BRK OFF FLT	Alarm output	Field Flashing AC breaker not switched off **Source:** INPUT LOGIC/F03.FFC.B
ALARM 14 – FF DC BRK OFF FLT	Alarm output	Field Flashing DC breaker not switched off **Source:** INPUT LOGIC/F03.FFC.A
Check Breaker's Position	Option	Position of field breakers is checked during field flashing sequence **Source:** INPUT LOGIC/F03.FFC
Field Flashing Max Time	Option	Maximum duration of field flashing sequence **Source:** INPUT LOGIC/F03.FFC
Field flashing time in manual	Option	Duration of field flashing sequence in manual control mode after which firing pulses will be enabled. Only for GCU or MSP configurations **Source:** INPUT LOGIC/F03.FFC

Operation

After receiving EVENT 06 – RUN function starts field flashing sequence, based on "Check Breakers Position" option:

No	Configuration	Field Flashing Sequence
1	Check breakers position	**1. Check if DC and AC contactors are open** **2. Activate EVENT 4 – FF DC PULSE and EVENT 102 – FF DC ON PULSE** **3. After 1 sec, if DC contactor is closed activate EVENT 5 – FF AC PULSE** **4. If the following conditions are met:** *With Local Controller* - Synchronization voltage is present (EVENT 49,53,57,100) *With GCU* - Synchronization voltage INPUT LOGIC/F02.PCC.INTPC_SYNC is present - Generator voltage higher than specified in INPUT LOGIC/F02.PCC option “Pulses ON threshold for internal IGBT or THY” and Auto mode is active or - Field current is higher than specified in INPUT LOGIC/F02.PCC option “Pulses ON threshold for internal IGBT or THY” and Manual mode is active *With MSP* - Generator voltage higher than specified in INPUT LOGIC/F02.PCC option “Pulses ON threshold for internal IGBT or THY” and Auto mode is active or - Field current is lower than specified in INPUT LOGIC/F02.PCC option “Pulses ON threshold for internal IGBT or THY” and Manual mode is active **After 1 sec deactivate EVENT 5 – FF AC PULSE** 5. **After 3 sec, if AC contactor is open deactivate EVENT 4 – FF DC PULSE and activate EVENT 103 – FF DC OFF PULSE**
2	Ignore breakers position	**1. Activate EVENT 4 – FF DC PULSE and EVENT 102 – FF DC ON PULSE** **2. After 1 sec activate EVENT 5 – FF AC PULSE** **3. If the following conditions are met:** *With Local Controller* - Synchronization voltage is present (EVENT 49,53,57,100) *With GCU* - Synchronization voltage INPUT LOGIC/F02.PCC.INTPC_SYNC is present - Generator voltage higher than specified in INPUT LOGIC/F02.PCC option “Pulses ON threshold for internal IGBT or THY” and Auto mode is active or

		- Field current is higher than specified in INPUT LOGIC/F02.PCC option “Pulses ON threshold for internal IGBT or THY” and Manual mode is active *With MSP* - Generator voltage higher than specified in INPUT LOGIC/F02.PCC option “Pulses ON threshold for internal IGBT or THY” and Auto mode is active or - Field current is lower than specified in INPUT LOGIC/F02.PCC option “Pulses ON threshold for internal IGBT or THY” and Manual mode is active **After 1 sec deactivate EVENT 5 – FF AC PULSE** 4. **After 3 sec deactivate EVENT 4 – FF DC PULSE and activate EVENT 103 – FF DC OFF PULSE**

Field flashing procedure will be interrupted and switched off in one the following conditions:

- Channel becomes not active
- Deexcitation (TRIP or stop command)
- It was active longer than time specified in “Field Flashing Time in Manual” option

Applicable settings

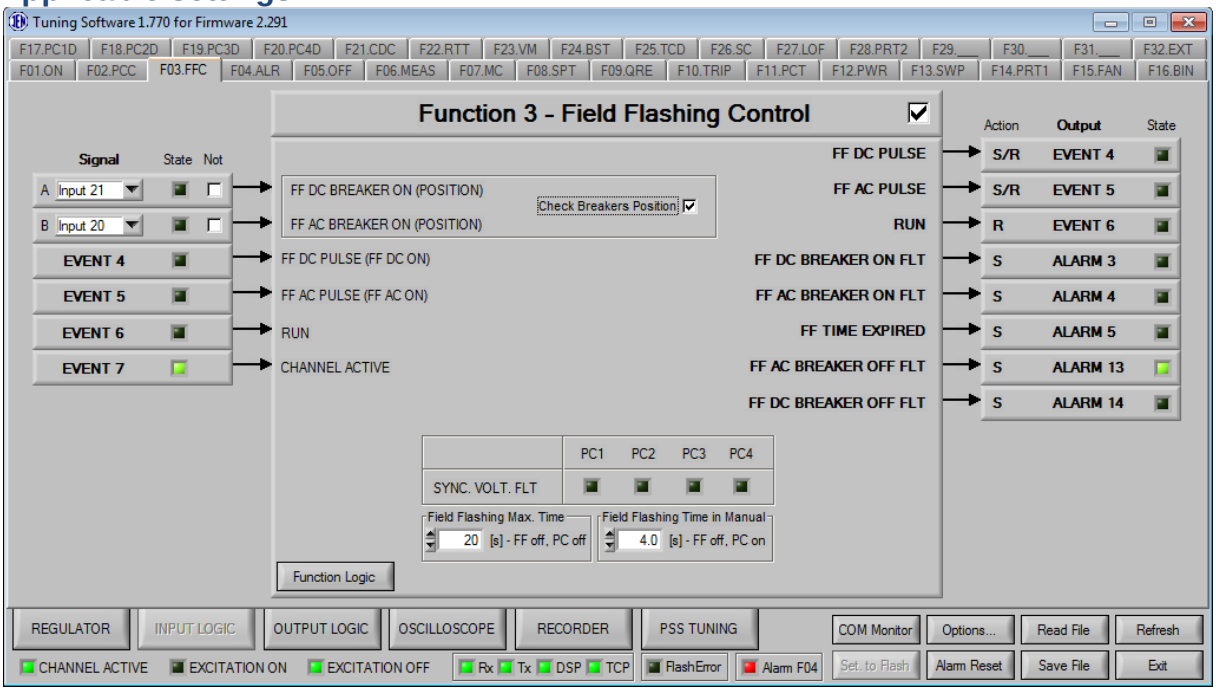


Fig. 66 Applicable settings

Tips:

- ✓ If field flashing system consists of only one field flashing breaker deactivate “Check Breakers Position” option

3.21.4 Function 4: ALARM Signal

Function is responsible for presenting information about active alarms. It also allows user to select alarms activating channel change-over

Operands

All function operands are listed in the table 1 below.

Name	Type	Description
(A) ALARM RESET	Binary input	Command to reset alarms
EVENT 1 - ALARM	Event output	Indicates active alarm Logical high – alarm present **Source:** INPUT LOGIC/F04.ALR **Pre-requirements:** - Active alarm in the system
EVENT 2 - ALARM RESET	Event output	Indicates active alarm reset command Logical high – alarm reset **Source:** - INPUT LOGIC/F04.ALR.A - Modbus command (1211) - IEC 104 command **Pre-requirements:**
EVENT 12 – CHANNEL FAULT	Event output	Information about channel's fault Logical high – channel fault **Source:** INPUT LOGIC/F04.ALR **Pre-requirements:** - Active alarm in the system - Checkbox "CHF" in INPUT LOGIC/F04.ALR is checked next to alarm
Alarms 1-172	Register information	Indication of active alarms
CHF	Register option	If checked, active alarm generates channel fault EVENT 12

Operation

Function is active all the time and indicates active alarms. It allows to select which of the possible alarms will cause channel change over. Function also handles alarms reset. Using three tabs (64 alarms each) user can specify alarm causing channel fault by marking checkbox next to alarm description. By looking at led next to each alarm it is possible to check if specific alarm was active since last alarm reset. In such case led box next to alarm description will be lit red.

For full list of alarms please refer to APPENDIX section of this document.

Applicable settings

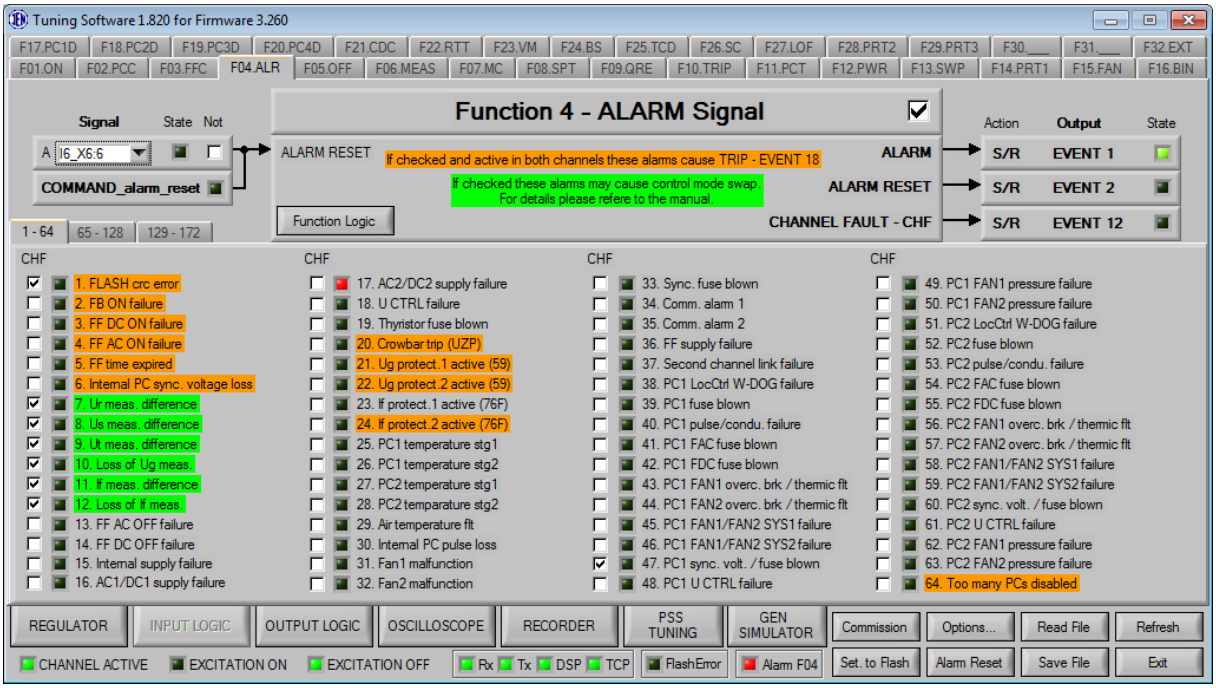


Fig. 67 Input logic tab of the Function number 4 - first alarm tab (F04.ALR)

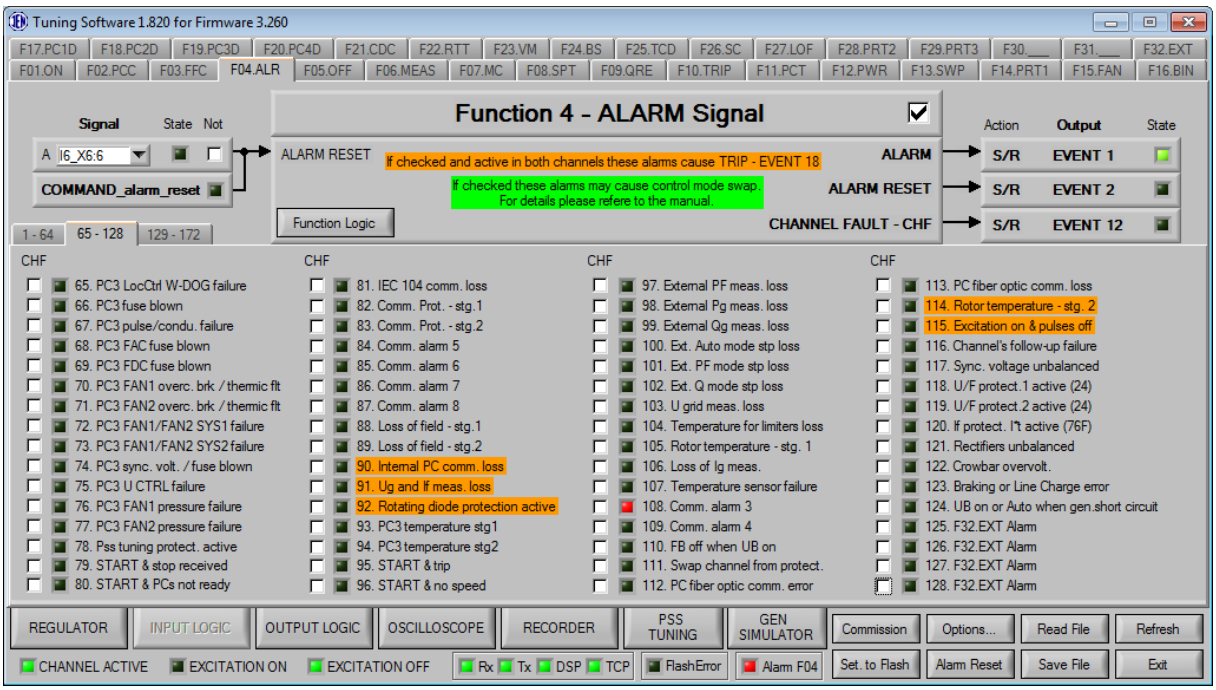


Fig. 68 Input logic tab of the Function number 4 - second alarm tab (F04.ALR)

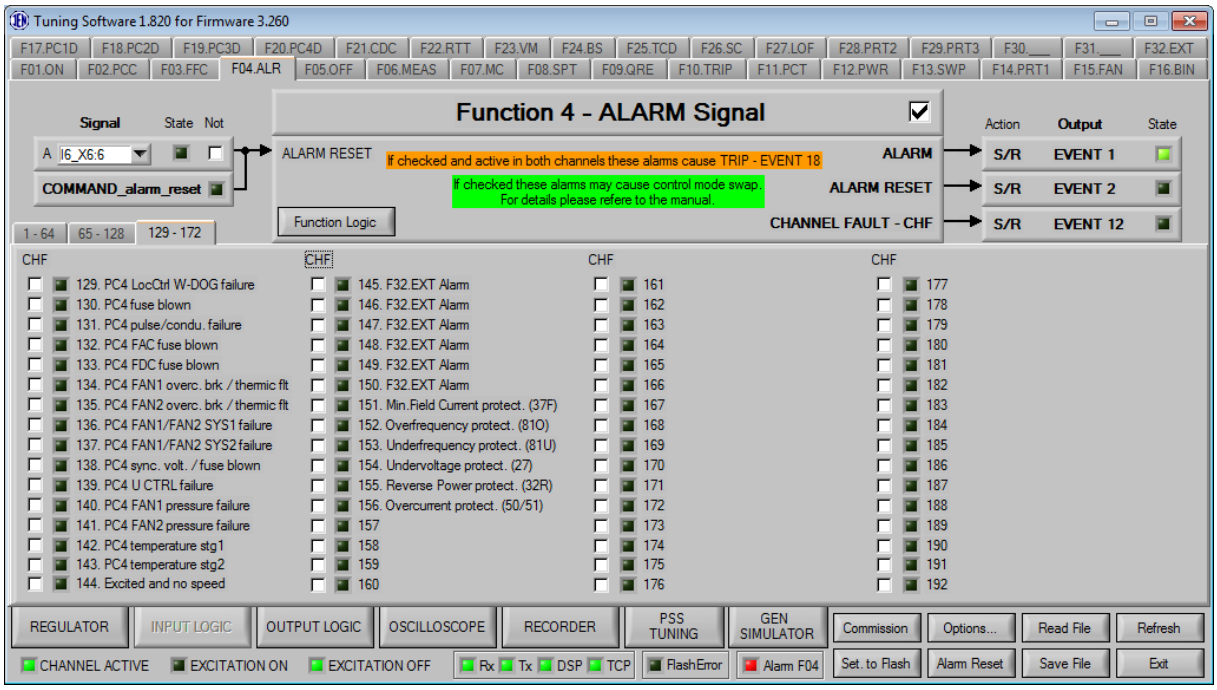
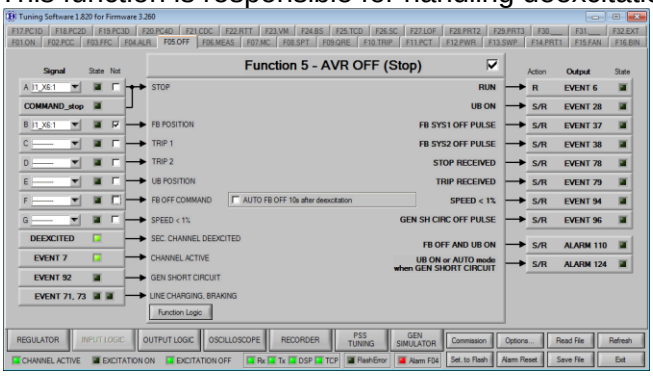


Fig. 69 Input logic tab of the Function number 4 - third alarm tab (F04.ALR)

3.21.5 Function 5: AVR OFF (Stop)

This function is responsible for handling deexcitation process.



Operands

All function operands are listed in the table below.

Name	Type	Description
(A) STOP	Binary input	Stops excitation if unit breaker is open
(B) FB ON (POSITION)	Binary input	Position of field breaker, if breaker is open stops excitation
(C) TRIP 1	Binary input	Deexcitation from protections system 1
(D) TRIP 2	Binary input	Deexcitation from protections system 2
(E) UB POSITION	Binary input	Position of unit breaker
(F) FB OFF COMMAND	Binary input	Command to open field breaker
EVENT 71 – LINE CH. MODE	Event input	Indicates operation in Line Charge mode **Source:** INPUT LOGIC/F01.ON.F **Pre-requirements:** - Channel is not excited (EVENT 6), Pump mode disabled (EVENT 70), Braking mode disabled (EVENT 73), logic low to high transition on input F
EVENT 73 – BRAKING MODE	Event input	Indicates operation in Braking mode **Source:** INPUT LOGIC/F01.ON.E **Pre-requirements:** - Channel is not excited (EVENT 6), Line Charge mode disabled (EVENT 71), logic low to high transition on input E
EVENT 93 – GEN SH CIRC ON	Event input	Indicates that stator short circuit is closed **Source:** INPUT LOGIC/F01.ON.G **Pre-requirements:** - Option “Autom.start if EAVR Ug 90>90%” is not checked, logic high on INPUT LOGIC/F01.ON.G
EVENT 6 - RUN	Event output	Indicates excitation of AVR, 1 - excited

EVENT 28 – UB ON	Event output	Position of unit breaker If closed it disables stop command Logical high – closed **Source:** - INPUT LOGIC/F05.OFF.E **Pre-requirements:**
EVENT 37 – FB SYS1 OFF EVENT 38 – FB SYS1 OFF	Event output	Command to open field breaker system 1, 2 Logical high – active Duration: 1 sec **Source:** - INPUT LOGIC/F05.OFF.F - Modbus command (1214,1217) - IEC 104 command **Pre-requirements:** - Channel not excited (EVENT 06) - Channel active (EVENT 07)
EVENT 78 – STOP RECEIVED	Event output	Stop command received Logical high – stop active **Source:** - Stop INPUT LOGIC/F05.OFF.A - Speed < 1% INPUT LOGIC/F05.OFF.G - Stop Modbus command (1203) - Stop IEC 104 command - High to low transition on Braking INPUT LOGIC/F01.ON.E - Braking if took longer than 100 sec - Common protection if option INPUT LOGIC/F14.PRT1 “OFF LINE ONLY” is checked **Pre-requirements:**
EVENT 79 – TRIP RECEIVED	Event output	Trip command received Logical high – trip active **Source:** - Trip INPUT LOGIC/F05.OFF.C - Trip INPUT LOGIC/F05.OFF.D **Pre-requirements:**
EVENT 94 – SPEED < 1%	Event output	Indication of machine speed lower than 1% Source of stop command if Unit Breaker is open Logical high – speed lower **Source:** - INPUT LOGIC/F05.OFF.G **Pre-requirements:**
EVENT 96 – GEN SH CIRC OFF PULSE	Event output	Command to open stator short circuit Logical high – active Duration: 30 sec **Source:** - TRIP (EVENT 79) - Stop (EVENT 78) - INPUT LOGIC/F05.OFF.F **Pre-requirements:** - Channel not excited (EVENT 06) and - Braking mode (EVENT 73) or - Stator short circuit closed (EVENT 93)
ALARM 110 – FB OFF AND UB ON	Alarm output	Indicates situation when field breaker is open and unit breaker is closed **Source:** INPUT LOGIC/F05.OFF
ALARM 124 – UB ON or AUTO MODE when GEN.SHORT CIRCUIT	Alarm output	Indicates situation when stator short circuit is closed but regulator is in Auto mode or Unit Breaker is closed **Source:** INPUT LOGIC/F05.OFF
AUTO FB OFF after deexc.	Option	Opens field breaker 10 sec after deexcitation **Source:** INPUT LOGIC/F05.OFF

Operation

Function operation depends on unit breaker position.

No	Configuration	Deexcitation source
1	Unit Breaker Closed	- Trip INPUT LOGIC/F05.OFF.C - Trip INPUT LOGIC/F05.OFF.D - Field breaker open INPUT LOGIC/F05.OFF.B
2	Unit Breaker Open	- Stop INPUT LOGIC/F05.OFF.A - Speed < 1% INPUT LOGIC/F05.OFF.G - Stop Modbus command (1203) - Stop IEC 104 command - High to low transition on Braking INPUT LOGIC/F01.ON.E - Braking if took longer than 100 sec - Common protection if option INPUT LOGIC/F14.PRT1 “OFF LINE ONLY” is checked - Trip INPUT LOGIC/F05.OFF.C - Trip INPUT LOGIC/F05.OFF.D - Field breaker position open INPUT LOGIC/F05.OFF.B

Applicable settings

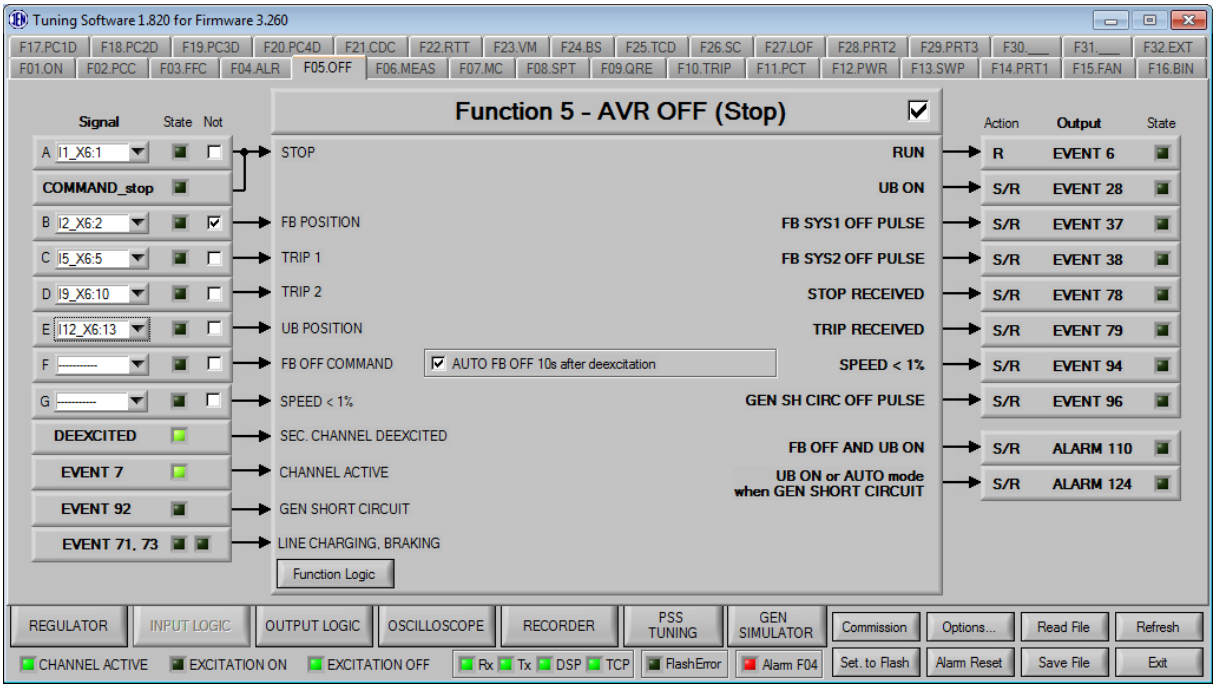
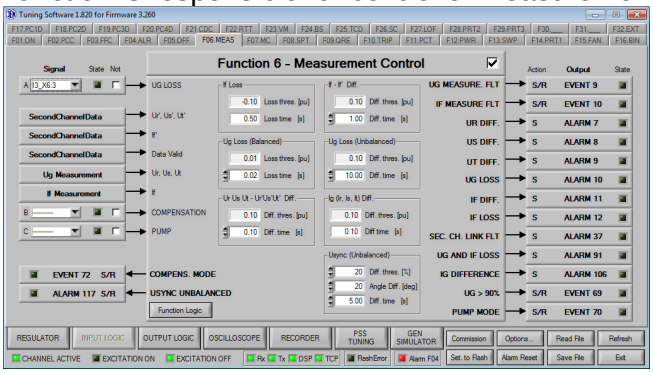


Fig. 70 Input logic tab of the Function number 5 (F05.OFF)

3.21.6 Function 6: Measurement Control

Function is responsible for control of measurement quality.



Operands

All function operands are listed in the table 1 below.

Name	Type	Description
(A) UG LOSS	Binary input	Position of fuses position of generator voltage measurement circuit
(B) COMPENSATION	Binary input	Compensation mode operation of generator
(C) PUMP	Binary input	Pump mode operation of generator
SecondChannelData	Register measurements	Measurements from second channel
Ug Measurement	Register measurements	Measurement of generator voltage
If Measurement	Register measurements	Measurement of field voltage
EVENT 9 - UG MEASURE.FLT	Event output	Generator voltage measurement fault Logical high – fault **Source:** INPUT LOGIC/F06.MEAS: - Input INPUT LOGIC/F06.MEAS.A - ALARM 7 - ALARM 8 - ALARM 9 - Ug balanced protection - Ug unbalanced protection **Pre-requirements:**
EVENT 10 - IF MEASURE.FLT	Event output	Field current measurement fault Logical high – fault **Source:** INPUT LOGIC/F06.MEAS: - ALARM 11 - ALARM 12 **Pre-requirements:**
EVENT 69 – UG>90%	Event output	Generator voltage higher than 90% of nominal Logical high – higher **Source:** - INPUT LOGIC/F06.MEAS **Pre-requirements:** - Ug > 0.9pu
EVENT 70 – PUMP MODE	Event output	Pump mode operation of generator Shifts generator current measurement phase by 180 degrees Shifts reactive power measurement phase by 180 degrees

Name	Type	Description
		Selects second bank of settings Logical high – active **Source:** - Input INPUT LOGIC/F06.MEAS.C **Pre-requirements:** - Not Line Charge (EVENT 71)
EVENT 72 – COMPENS.MODE	Event output	Compensation mode operation of generator Selects second bank of settings Logical high – active **Source:** - Input INPUT LOGIC/F06.MEAS.B **Pre-requirements:**
ALARM 7 – UR DIFF.	Alarm output	Difference in generator voltage measurement between channels in phase 1 **Source:** INPUT LOGIC/F06.MEAS
ALARM 8 – US DIFF.	Alarm output	Difference in generator voltage measurement between channels in phase 2 **Source:** INPUT LOGIC/F06.MEAS
ALARM 9 – UT DIFF.	Alarm output	Difference in generator voltage measurement between channels in phase 3 **Source:** INPUT LOGIC/F06.MEAS
ALARM 10 – UG LOSS	Alarm output	Loss of generator voltage measurement **Source:** INPUT LOGIC/F06.MEAS
ALARM 11 – IF DIFF.	Alarm output	Difference in field current measurement between channels **Source:** INPUT LOGIC/F06.MEAS
ALARM 12 – IF LOSS	Alarm output	Loss of field current measurement **Source:** INPUT LOGIC/F06.MEAS
ALARM 37 – SEC.CH.LINK FLT	Alarm output	Loss of communication with second channel **Source:** INPUT LOGIC/F06.MEAS
ALARM 91 – UG AND IF LOSS	Alarm output	Loss of both generator voltage and field current measurements **Source:** INPUT LOGIC/F06.MEAS
ALARM 106 – IG DIFFERENCE	Alarm output	Difference in generator current measurement between channels **Source:** INPUT LOGIC/F06.MEAS
ALARM 117 – USYNC UNBALANCED	Alarm output	Synchronization voltage unbalanced **Source:** INPUT LOGIC/F06.MEAS
Settings	Options	Settings covered in Operation description

Operation

This function controls if measurements of generator voltage, excitation current and power module supply voltage are correct. In dual channel configuration function also checks if difference between measurements in both channel do not exceeds preset thresholds. In case of measurement loss or difference automatic control mode swap or active channel swap will occur and proper alarm will be generated.

If Loss Protection
"Loss threshold" [pu] is minimal value of If measurement below which function will generate alarm 12 "IF LOSS" and event 10 "IF MEASURE FLT" but only if loss time will be longer than value set in "Loss time" [s].

Ig(Ir,Is,It) Difference Protection
If generator current measurement between two phases will differ more than value set in "Difference threshold" for longer than "Difference time" [s] function will generate alarm 106 "IG DIFFERENCE".

- Additional requirements:
  - Three phase Ig measurement
  - Ug > 0.9pu
  - Balanced phase voltage (difference < 0.1pu)

If Channel Difference Protection
If Field current measurements between two channel will differ more than value set in "Difference threshold" for longer than "Difference time" [s] function will generate alarm 11 "IF DIFF.".

Ur, Us, Ut Channel Difference Protection
If generator voltage measurements between two channel will differ in one phase more than value set in "Difference threshold" for longer than "Difference time" [s] function will generate corresponding to phase alarm 7/8/9 "UR/US/UT DIFFERENCE".

Ug loss balanced
If generator voltage measurement will drop below 0.05pu when AVR in AUTO mode, alarm 10 "Loss of Ug meas." will be generated after "Loss time [s]"

Ug loss unbalanced
If generator voltage measurement between two phases differs more than 0.1pu alarm 10 "Loss of Ug meas." will be generated after "Diff. time [s]"

Usync (Unbalanced)
If amplitude of synchronization voltage between phases differs more than specified in "Diff.thres" parameter or phase angle differs more than specified in "Angle Diff." parameter for time longer that "Diff. time [s]" function will generate alarm "Sync. voltage unbalanced"

For proper change over operation between modes in a situation of measurement loss, alarms 7 – 12 should be configurated in Function 4 to change over a channel.

Applicable settings

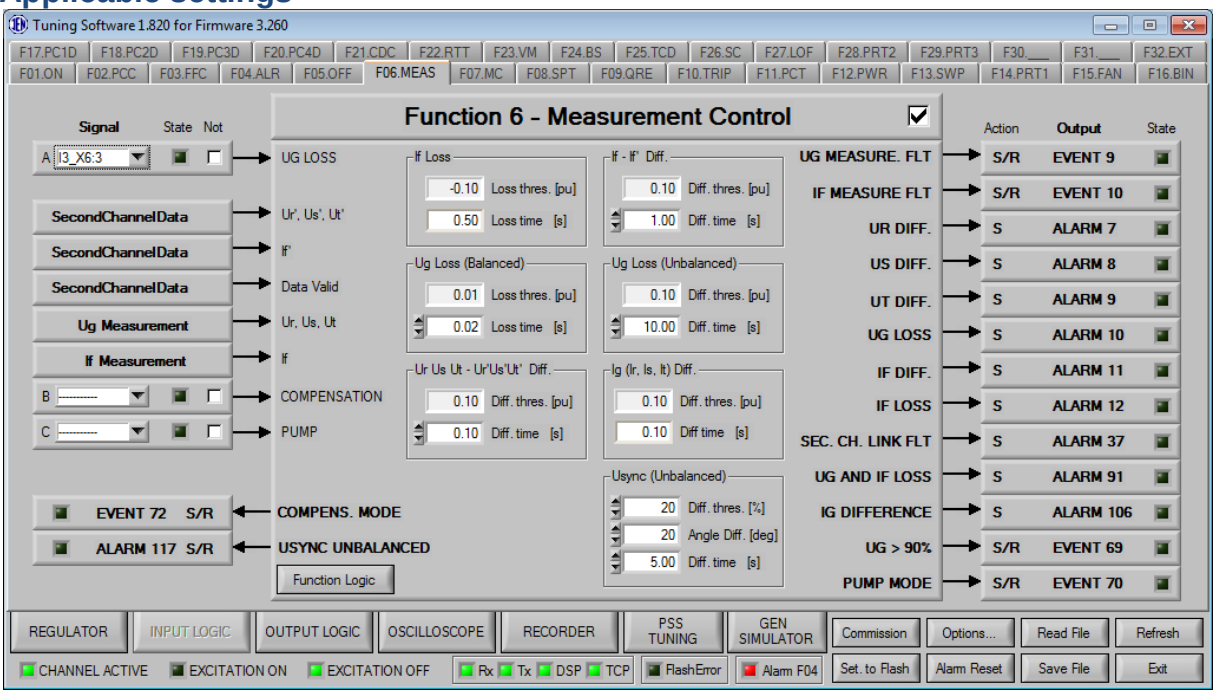


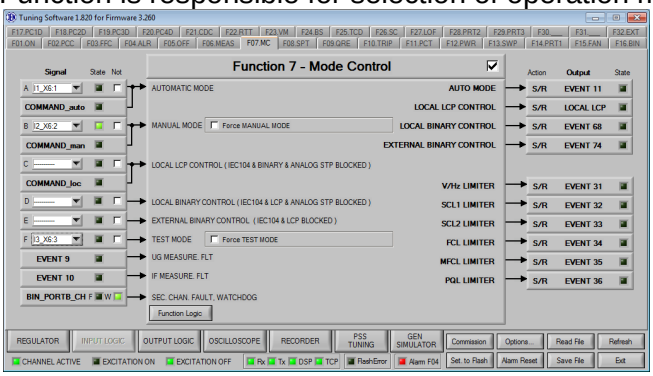
Fig. 71 Applicable settings

Tips:

- ✓ In pump mode operation current measurement direction is inverted

3.21.7 Function 7: Mode Control

Function is responsible for selection of operation mode



Operands

All function operands are listed in the table 1 below.

Name	Type	Description
(A) AUTOMATIC MODE	Binary input	Automatic (Ug) regulation mode command
(B) MANUAL MODE	Binary input	Manual (If) regulation mode command
(C) LOCAL LCP CONTROL	Binary input	Local control from LCP command
(D) LOCAL BINARY CONTROL	Binary input	Local control from binary inputs command
(E) EXTERNAL BINARY CONTROL	Binary input	Local control from binary inputs command
(F) TEST MODE	Binary input	Test (direct thyristor angle) regulation mode
EVENT 9 - UG MEASURE.FLT	Event input	Generator voltage measurement fault Logical high – fault **Source:** INPUT LOGIC/F06.MEAS: - Input INPUT LOGIC/F06.MEAS.A - ALARM 7 - ALARM 8 - ALARM 9 - Ug balanced protection - Ug unbalanced protection **Pre-requirements:**
EVENT 10 - IF MEASURE.FLT	Event input	Field current measurement fault Logical high – fault **Source:** INPUT LOGIC/F06.MEAS: - ALARM 11 - ALARM 12 **Pre-requirements:**
EVENT 11 – AUTO MODE	Event output	Automatic regulation mode Logical high – Auto Logical low – Manual **Source:** - Input INPUT LOGIC/F07.MC.A - Modbus (1204) - IEC 104 - Braking high to low transition - Line Charge high to low transition - Line Charge in manual and Ug > 0.9pu - If meas.loss (EVENT 10)

Name	Type	Description
		Pre-requirements: - Ug meas. present (EVENT 9) - Option INPUT LOGIC/F07.MC “Force MANUAL mode” not checked
LOCAL LCP MODE	Event output	Regulator in local LCP control Binary commands, IEC104 and external analog setpoints are blocked Logical high – Local Logical low – Remote **Source:** - Input INPUT LOGIC/F07.MC.C - Modbus command **Pre-requirements:**
EVENT 68 –LOCAL BINARY CONTROL	Event output	Regulator in local binary control Modbus commands, IEC104 and external analog setpoints are blocked Logical high – Local binary Logical low – Remote **Source:** - Input INPUT LOGIC/F07.MC.D **Pre-requirements:** - Local LCP mode deactivated
EVENT 74 –EXTERNAL BINARY CONTROL	Event output	Regulator in external binary control Modbus commands, IEC104 are blocked Logical high – External binary Logical low – Remote **Source:** - Input INPUT LOGIC/F07.MC.E **Pre-requirements:** - Local LCP mode deactivated - Local binary deactivated (EVENT 68)
EVENT 31 –V/Hz LIMITER	Event input	Volt per hertz limiter active Logical high – active **Source:** - AVR() procedure **Pre-requirements:** - Channel excited (EVENT 6) - Limiter option in REGULATOR tab enabled - Limiter output == LO GATE output
EVENT 32 –SCL1 LIMITER	Event input	Stator current limiter 1 active Logical high – active **Source:** - AVR() procedure **Pre-requirements:** - Channel excited (EVENT 6) - Limiter option in REGULATOR/SCL panel enabled - Reactive power above minimum, positive - Generator current higher than maximum
EVENT 33 –SCL2 LIMITER	Event input	Stator current limiter 2 active Logical high – active **Source:** - AVR() procedure **Pre-requirements:** - Channel excited (EVENT 6) - Limiter option in REGULATOR/SCL panel enabled - Reactive power above minimum, negative - Generator current higher than maximum
EVENT 34 –FCL LIMITER	Event input	Field current limiter active Logical high – active **Source:** - AVR() procedure **Pre-requirements:** - Channel excited (EVENT 6) - Limiter option in REGULATOR tab enabled

Name	Type	Description
		- Limiter output == LO GATE output
EVENT 35 –MFCL LIMITER	Event input	Minimum field current limiter active Logical high – active **Source:** - AVR() procedure **Pre-requirements:** - Channel excited (EVENT 6) - Limiter option in REGULATOR tab enabled - Limiter output == HI GATE output
EVENT 36 –PQL LIMITER	Event input	Underexcitation limiter active Logical high – active **Source:** - AVR() procedure **Pre-requirements:** - Channel excited (EVENT 6) - Limiter option in REGULATOR tab enabled - Limiter output == HI GATE output
EVENT 41 – AUTOM. SWITCH TO MANUAL	Event output	Indicates automatic changeover of control mode from Auto to Manual Logical high - active **Source:** INPUT LOGIC/F07.MC **Pre-requirements:** - Loss of Ug measurement (EVENT09) - Second channel is faulty
Force MANUAL mode	Options	Manual mode selected regardless of input state
Force TEST mode	Options	Test mode selected regardless of input state

Operation

This function allows to switch regulation mode between: automatic regulation, manual regulation, test mode regulation, local/external control.

Three operation modes specifies the way of controlling power converter

- Automatic regulation mode – primary control mode of AVR system, regulation of generator voltage
- Manual regulation mode – backup control mode of AVR system, regulation of field current
- Test mode – direct control of power converter independent of control loops and measurements

Others specifies source of commands for the controller:

- Local LCP – Binary commands, IEC104 and external analog setpoints are blocked
- Local Binary - Modbus commands, IEC104 and external analog setpoints are blocked
- External Binary - Modbus commands, IEC104 are blocked

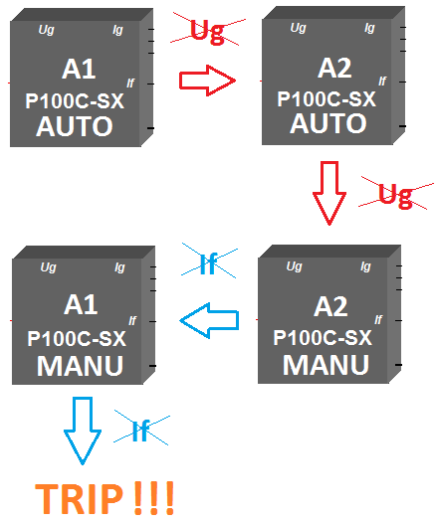
Two additional checkboxes are available in this function allowing to force manual mode/test mode.

- Forcing manual mode is available for safety issues. When it is turned on all other inputs which switch regulation mode are blocked and regulator will not switch to different regulation mode during tests.

- Forcing test mode works exactly in same way like forcing manual mode. Other inputs that would normally cause switching between regulation mode are disabled and regulator stays in test mode.

Function monitors regulator measurement and in case of failure in the measurement used in active control mode it automatically changes operation mode.

Picture below summarizes switchover sequence between channels and modes in case of measurement failure in dual channel configuration. For proper change over operation between modes in a situation of measurement loss, alarms 7 – 12 should be configurated in Function 4 to change over a channel.



Only loss of all control measurements from both channels results in emergency shutdown. Loss of each control measurement will be indicated by alarm generated in Function 06.

Braking and Line Charge operation modes may result in temporary control mode change between Auto and Manual

- Start of Braking sequence will result in automatic change over to Manual mode
- End of Braking sequence will result in automatic change over to Auto mode if Auto mode was previously active
- Start of Line Charge sequence will result in automatic change over to Manual mode if “Line Charge in Auto Mode” option in Function 1 is not checked
- Increasing generator voltage above 90% during Line Charge sequence in Manual mode will result in change over to Auto mode if high to low transition on Line Charge input occur.

Applicable settings

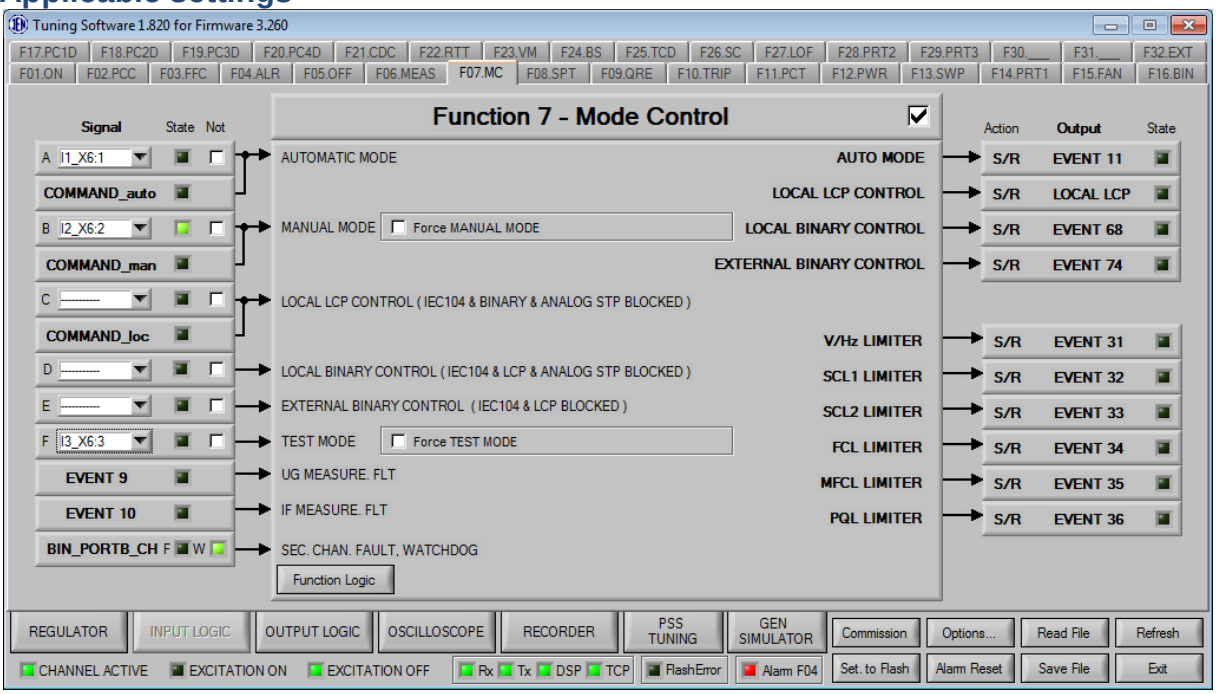


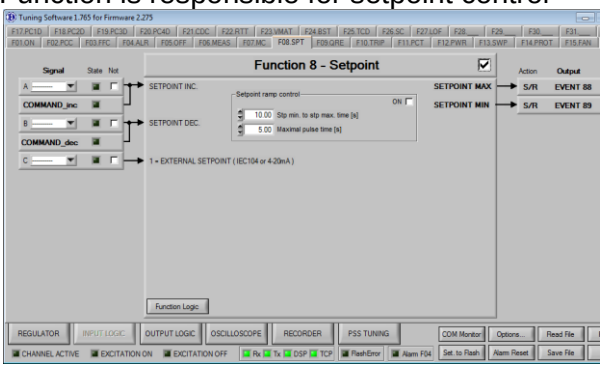
Fig. 72 Applicable settings

Tips:

- ✓ For power module test use TEST mode as it is independent from any external measurement
- ✓ Before running AVR in AUTOMATIC mode run it in MANUAL mode and check generator voltage measurement

3.21.8 Function 8: Setpoint

Function is responsible for setpoint control



Operands

All function operands are listed in the table below.

Name	Type	Description
(A) SETPOINT INC.	Binary input	Automatic (Ug) regulation mode command
(B) SETPOINT DEC.	Binary input	Manual (If) regulation mode command
(C) EXTERNAL SETPOINT	Binary input	Use external setpoint (4-20mA or serial comm.)
EVENT 88 – SETPOINT MAX	Event output	Setpoint of currently selected mode is at maximum Logical high – maximum **Source:** - INPUT LOGIC/F09.QRE **Pre-requirements:**
EVENT 89 – SETPOINT MIN	Event output	Setpoint of currently selected mode at minimum Logical high – minimum **Source:** - INPUT LOGIC/F09.QRE **Pre-requirements:**
EVENT 104 – MANU SETPOINT MAX	Event output	Setpoint of Manual mode is at maximum Logical high – maximum **Source:** - INPUT LOGIC/F09.QRE **Pre-requirements:**
EVENT 105 – MANU SETPOINT MIN	Event output	Setpoint of Manual mode is at minimum Logical high – minimum **Source:** - INPUT LOGIC/F09.QRE **Pre-requirements:**
EVENT 106 – AUTO SETPOINT MAX	Event output	Setpoint of Auto mode is at maximum Logical high – maximum **Source:** - INPUT LOGIC/F09.QRE **Pre-requirements:**
EVENT 107 – AUTO SETPOINT MIN	Event output	Setpoint of Auto mode is at minimum Logical high – minimum **Source:** - INPUT LOGIC/F09.QRE **Pre-requirements:**
Setpoint ramp control	Option	Activates ramp control (pulse width) of setpoint.
Setpoint min to max time	Option	Determinates time it takes for setpoint to change from minimum to maximum

Name	Type	Description
Maximal pulse time	Option	Determinates maximal permissible command pulse time

Operation

Function can react differently to setpoint increase/decrease commands, depending on “Setpoint ramp control” option.

No	Configuration	Conditions to enable
1	Internal setpoint, pulse edge control	• Parameter “Setpoint ramp control” is **OFF**
2	Internal setpoint, pulse width control	• Parameter “Setpoint ramp control” is **ON**

In configuration 1, pulse edge control, function responses to positive slope of binary command signal increasing or decreasing setpoint of currently active control mode with step selected in setpoint configuration window. In configuration 2, pulse width control, functions responses proportionally to the duration of binary command signal.

For increase/decrease commands coming from serial protocol it always edge type control.

It is possible to use external setpoints for Auto mode that completely overrides internal setpoint. In the following table all necessary conditions to enable external setpoint control are listed:

No	External setpoint for Auto	Conditions to enable
1	4-20mA analog signal	- Channel active - Soft Start finished - Option OPTIONS/EXT.MEAS/”4-20mA external setpoint for A mode” is checked - Analog input specified in OPTIONS/Analog I/”Automatic mode setpoint” - Setpoint value within a range specified by Auto mode setpoint minimum and maximum - Reactive power control modes are disabled - Local LCP and Local Binary control modes are disabled - Binary input external setpoint INPUT LOGIC/F08.STP.C is active - Binary input INPUT LOGIC/F09.QRE.D is not active

It is also possible to use external setpoint for reactive power regulation mode that completely overrides internal setpoint. In the following table all external sources and necessary conditions are listed.

No	External setpoint for Q	Conditions to enable
1	IEC104 protocol	- Channel active - Option OPTIONS/EXT.MEAS/"External setpoint for Q mode IEC 104" is checked - IEC 104 protocol is active - IEC 104 protocol is healthy - Setpoint absolute value below 1.05 pu - Local LCP and Local Binary control modes are disabled - Binary input external setpoint INPUT LOGIC/F08.STP.C is active - Binary input INPUT LOGIC/F09.QRE.D is not active
2	Modbus protocol	- Channel active - Option OPTIONS/EXT.MEAS/"External setpoint for Q mode MODBUS" is checked - Option OPTIONS/EXT.MEAS/"External setpoint for Q mode IEC 104" is not checked or 104 communication is faulty - Setpoint absolute value below 1.05 pu - Local LCP and Local Binary control modes are disabled - Binary input external setpoint INPUT LOGIC/F08.STP.C is active - Binary input INPUT LOGIC/F09.QRE.D is not active
3	4-20mA analog signal	- Channel active - Analog input specified in OPTIONS/Analog I/"Q mode setpoint" - Option OPTIONS/EXT.MEAS/"External setpoint for Q mode 4-20mA" is checked - Option OPTIONS/EXT.MEAS/"External setpoint for Q mode IEC 104" is not checked or 104 communication is faulty - Option OPTIONS/EXT.MEAS/"External setpoint for Q mode IEC MODBUS" is not checked or Modbus communication is faulty - 4mA signal is present - Local LCP and Local Binary control modes are disabled - Binary input external setpoint INPUT LOGIC/F08.STP.C is active - Binary input INPUT LOGIC/F09.QRE.D is not active

It is possible to use external setpoints for power factor regulation mode that completely override internal setpoint. In the following table all external sources together with necessary conditions are listed.

No	External setpoint for PF	Conditions to enable
1	Modbus protocol	- Channel active - Analog input **NOT** specified in OPTIONS/Analog I/"PF mode setpoint" - Option OPTIONS/EXT.MEAS/"4-20mA or Modbus external setpoint for PF mode" is checked - Local LCP and Local Binary control modes are disabled - Binary input external setpoint INPUT LOGIC/F08.STP.C is active - Binary input INPUT LOGIC/F09.QRE.D is not active
2	4-20mA analog signal	- Channel active - Analog input specified in OPTIONS/Analog I/"PF mode setpoint" - Option OPTIONS/EXT.MEAS/"4-20mA or Modbus external setpoint for PF mode" is checked - 4mA signal is present - Local LCP and Local Binary control modes are disabled - Binary input external setpoint INPUT LOGIC/F08.STP.C is active - Binary input INPUT LOGIC/F09.QRE.D is not active

Applicable settings

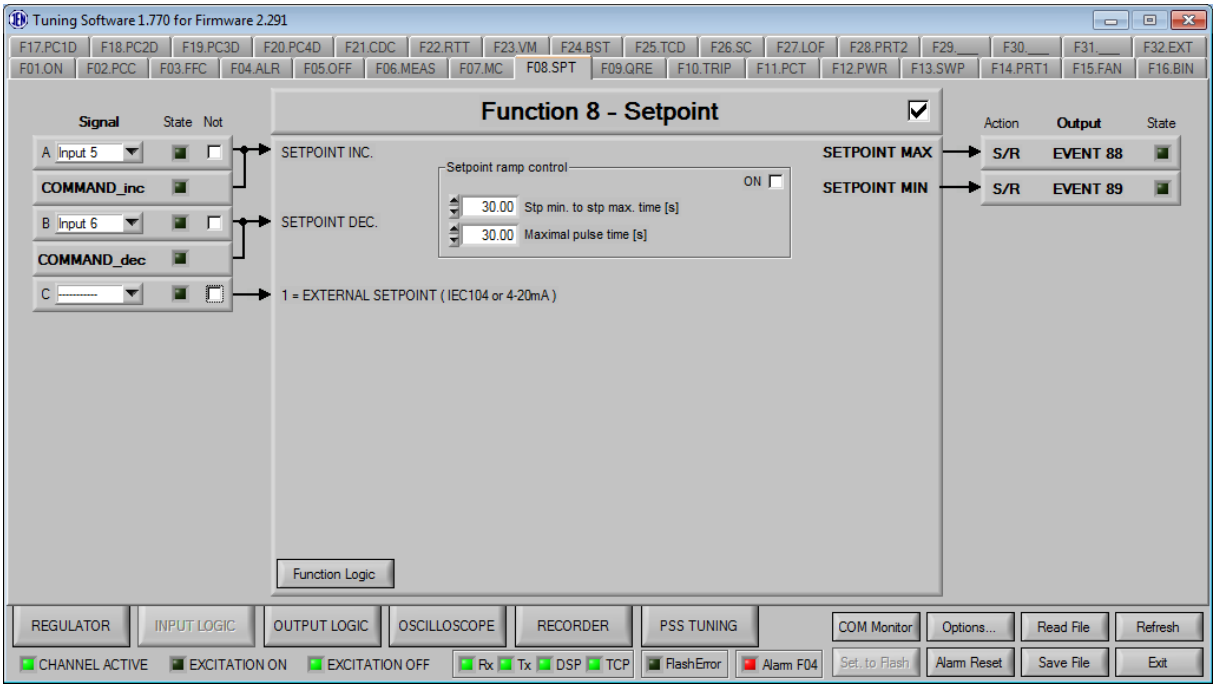
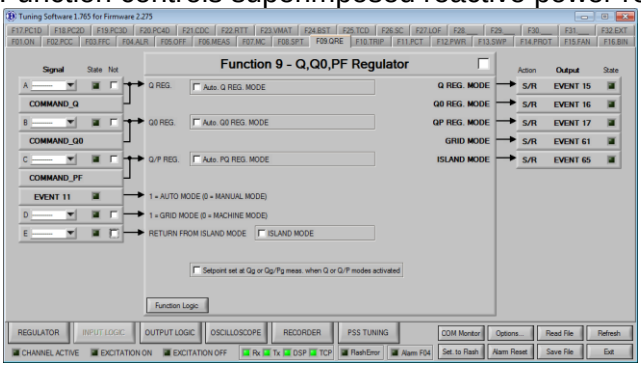


Fig. 73 Applicable settings

3.21.9 Function 9: Q,Q0,PF Regulator

Function controls superimposed reactive power regulator



Operands

All function operands are listed in the table below.

Name	Type	Description
(A) Q REG.	Binary input	Activate reactive power regulator
(B) Q0 REG.	Binary input	Activate reactive power to zero regulator
(C) Q/P REG.	Binary input	Activate reactive to active regulator
(D) GRID MODE	Binary input	Grid mode
(E) RETURN FROM ISLAND	Binary input	Return from island mode command
EVENT 11 – AUTO MODE	Event input	Automatic regulation mode Logical high – Auto Logical low – Manual **Source:** - Input INPUT LOGIC/F07.MC.A - Modbus (1204) - IEC 104 - Braking high to low transition - Line Charge high to low transition - Line Charge in manual and Ug > 0.9pu - If meas.loss (EVENT 10) **Pre-requirements:** - Ug meas. present (EVENT 9) - Option INPUT LOGIC/F07.MC “Force MANUAL mode” not checked
EVENT 15 – Q REG.MODE	Event output	Reactive power regulation mode active Logical high – active **Source:** - INPUT LOGIC/F09.QRE.A pulse - Modbus command - IEC 104 - INPUT LOGIC/F09.QRE option “Auto Q reg mode” and FB close pulse (EVENT 3) **Pre-requirements:** - Auto mode (EVENT 11) - Line Charge mode disabled (EVENT 71) - Braking mode disabled (EVENT 73)
EVENT 16 – Q0 REG.MODE	Event output	Reactive power to zero mode active Logical high – active **Source:**

Name	Type	Description
		- INPUT LOGIC/F09.QRE.B pulse - Modbus command - IEC 104 - INPUT LOGIC/F09.QRE option “Auto Q0 reg mode” and FB close pulse (EVENT 3) **Pre-requirements:** - Auto mode (EVENT 11) - Line Charge mode disabled (EVENT 71) - Braking mode disabled (EVENT 73)
EVENT 17 – QP REG.MODE	Event output	Power factor regulation mode active Logical high – active **Source:** - INPUT LOGIC/F09.QRE.C pulse - Modbus command - IEC 104 - INPUT LOGIC/F09.QRE option “Auto PQ reg mode” and FB close pulse (EVENT 3) **Pre-requirements:** - Auto mode (EVENT 11) - Line Charge mode disabled (EVENT 71) - Braking mode disabled (EVENT 73)
EVENT 61 – GRID MODE	Event output	Grid mode active Logical high – active **Source:** - INPUT LOGIC/F09.QRE.D **Pre-requirements:**
EVENT 65 – ISLAND MODE	Event output	Island mode active Logical high – active **Source:** - INPUT LOGIC/F09.QRE.E pulse **Pre-requirements:** - INPUT LOGIC/F09.QRE option “ISLAND MODE” checked
EVENT 75 – Q = 0	Event output	Reactive power is equal zero Logical high – zero **Source:** - Input INPUT LOGIC/F09.QRE **Pre-requirements:**
Auto. Q REG. MODE	Options	Automatically activate Q mode after synchronization
Auto. Q0 REG. MODE	Options	Automatically activate Q0 mode after synchronization
Auto. QP REG. MODE	Options	Automatically activate QP mode after synchronization
ISLAND MODE	Options	Support of island operation
Setpoint set at Qg or Qg/Pg	Options	Setpoint is set at current measurement value in the moment of mode activation

Operation

There are three superimposed control modes supported by P100C-SX controller. All are listed in the table below:

No	Regulator	Conditions to enable/disable

1	**Reactive power** – regulation of reactive power Qg	*Enable:*
		- Command to enable:
		  ○ INPUT LOGIC/F09.QRE.A pulse
		  ○ Modbus command
		  ○ IEC 104
		  ○ INPUT LOGIC/F09.QRE option “Auto Q reg mode” and FB close pulse (EVENT 3)
		- Auto mode (EVENT 11)
		- Line Charge mode disabled (EVENT 71)
		- Braking mode disabled (EVENT 73)
		Start regulation:
		- Ug measurement within a range specified in REGULATOR/SCL/QREG panel
		- Pg measurement above minimum specified in REGULATOR/SCL/QREG panel
		- Limiters are not active
		Disable:
		- Command to Auto mode
		- Manual mode active (EVENT 11)
		- Line Charge mode enabled (EVENT 71)
		- Braking mode enabled (EVENT 73)

2	**Reactive power to zero** – regulation of reactive power Qg to zero	*Enable:*
		- Command to enable:
		  ○ INPUT LOGIC/F09.QRE.B pulse
		  ○ Modbus command
		  ○ IEC 104
		  ○ INPUT LOGIC/F09.QRE option “Auto Q0 reg mode” and FB close pulse (EVENT 3)
		- Auto mode (EVENT 11)
		- Line Charge mode disabled (EVENT 71)
		- Braking mode disabled (EVENT 73)
		Start regulation:
		- Ug measurement within a range specified in REGULATOR/SCL/QREG panel
		- Pg measurement above minimum specified in REGULATOR/SCL/QREG panel
		- Limiters are not active
		Disable:
		- **Deexcitation (EVENT 6)**
		- Command to Auto mode
		- Manual mode active (EVENT 11)
		- Line Charge mode enabled (EVENT 71)
		- Braking mode enabled (EVENT 73)

3	**Power factor** – regulation of power factor Qg/Pg	*Enable:*
		- Command to enable:
		  o INPUT LOGIC/F09.QRE.C pulse
		  o Modbus command
		  o IEC 104
		  o INPUT LOGIC/F09.QRE option “Auto PF reg mode” and FB close pulse (EVENT 3)
		- Auto mode (EVENT 11)
		- Line Charge mode disabled (EVENT 71)
		- Braking mode disabled (EVENT 73)
		Start regulation:
		- Ug measurement within a range specified in REGULATOR/SCL/QREG panel
		- Pg measurement above minimum specified in REGULATOR/SCL/QREG panel
		- Limiters are not active
		Disable:
		- Command to Auto mode
		- Manual mode active (EVENT 11)
		- Line Charge mode enabled (EVENT 71)
		- Braking mode enabled (EVENT 73)

Superimposed regulator controls reactive power by means of automatic control loop setpoint control. If regulator is enabled all setpoint control commands are coming to internal setpoint of superimposed regulator. Regulator compares its internal setpoint value with a measurement (Qg or Qg/Pg) and modifies automatic mode setpoint to match both values.

Automatic mode setpoint is modified by step value specified in Auto mode setpoint window under REGULATOR/ASTP/“PF step” setting. Parameter “Period” available in REGULATOR/SCL/QREG determines how many times per second Auto mode setpoint is updated. Parameter “Step” under REGULATOR/SCL/QREG specifies step of internal setpoint of superimposed regulator.

It is possible to use external setpoints for superimposed regulation modes that completely override internal setpoint. For the details on how to enable them please refer to description of Function 08.

It is also possible to use external measurement source for superimposed regulation modes that overrides internal measurements. In the following table all external sources and necessary conditions are listed.

No	External setpoint	Conditions to enable
1	4-20mA external Pg and Qg measurement	- Analog input selected in OPTIONS/Analog I/”Reactive Power Qg” option - Analog input selected in OPTIONS/Analog I/”Active Power Pg” option - Option OPTIONS/EXT.MEAS/”4-20mA external Pg and Qg measurement” is checked - Both analog 4mA signal are present - Binary input INPUT LOGIC/F09.QRE.D is active

2	4-20mA external Qg measurement	- Analog input selected in OPTIONS/Analog I/"Reactive Power Qg" option - Option OPTIONS/EXT.MEAS/"4-20mA external Qg measurement" is checked - Analog 4mA signals are present - Binary input INPUT LOGIC/F09.QRE.D is active
3	4-20mA external PF (Qg/Pg) measurement	- Analog input selected in OPTIONS/Analog I/"Power Factor PF" option - Option OPTIONS/EXT.MEAS/"4-20mA external PF measurement" is checked - Analog 4mA signal are present - Binary input INPUT LOGIC/F09.QRE.D is active

P100C-SX supports Island Mode, which automatically disables superimposed reactive power regulator if grid voltage exceeds range specified in REGULATOR/SCL/QREG panel. This situation is indicated by EVENT 65 – ISLAND MODE. Return to superimposed regulation is possible by binary command INPUT LOGIC/F09.QRE.E RETURN FROM ISLAND MODE or Modbus command.

Applicable settings

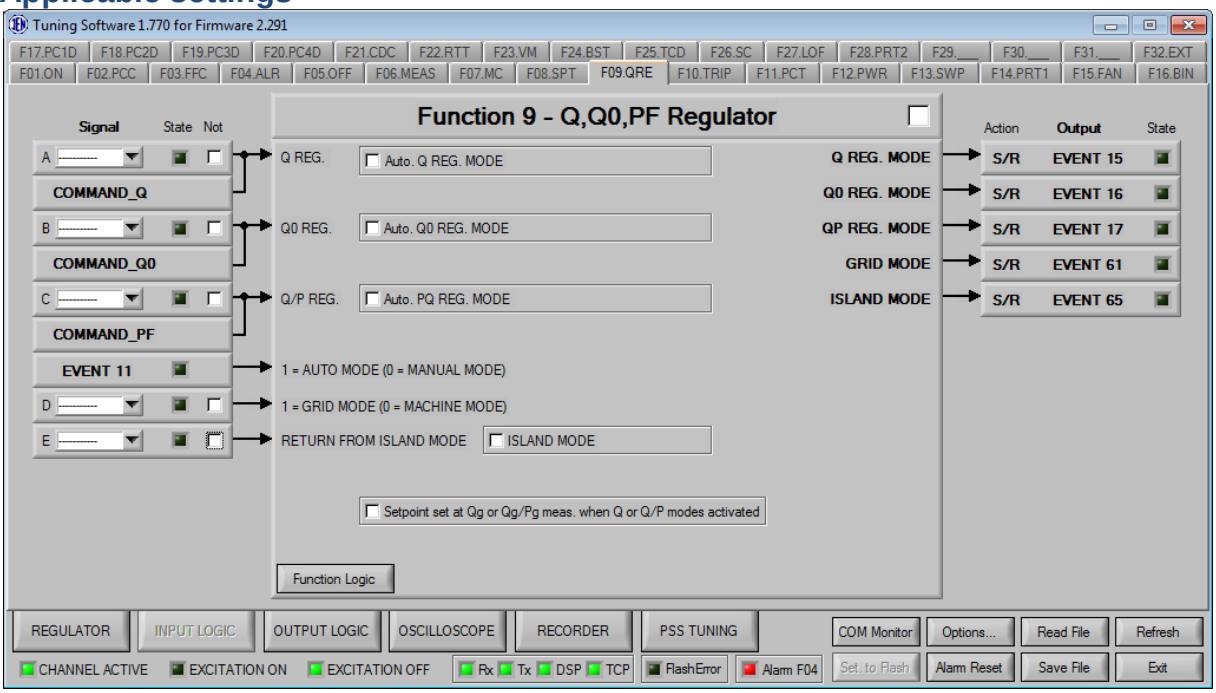
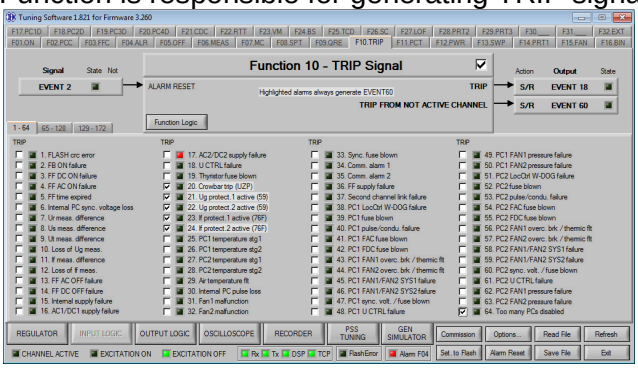


Fig. 74 Applicable settings

3.21.10 Function 10: TRIP Signal

Function is responsible for generating TRIP signal.



Operands

All function operands are listed in the table below.

Name	Type	Description
EVENT 1 - ALARM	Event input	Indicates active alarm Logical high – alarm present **Source:** INPUT LOGIC/F04.ALR **Pre-requirements:** - Active alarm in the system
EVENT 2 - ALARM RESET	Event input	Indicates active alarm reset command Logical high – alarm reset **Source:** - INPUT LOGIC/F04.ALR.A - Modbus command (1211) - IEC 104 command **Pre-requirements:**
EVENT 18 - TRIP	Event input	Information about TRIP from AVR. **Logical low necessary to start.** **Source:** INPUT LOGIC/F10.TRIP **Pre-requirements:** - Channel is active (EVENT 7) and any of alarms specified as trip source in F10.TRIP active or: - Active channel is faulty (EVENT 12) as well as not active channel
EVENT 60 - TRIP FROM NOT ACTIVE CHANNEL	Event output	Trip command from AVR to protections from not active channel Logical high – TRIP **Source:** - INPUT LOGIC/F10 **Pre-requirements:** - Channel not Active (EVENT 7)
TRIP	Register option	If checked, active alarm generates TRIP

Operation

Function is active all the time and generates trip if proper alarm is activated. TRIP signal in a form of EVENT 18 is latched until alarm causing TRIP is cleared by EVENT 2 – ALARM RESET.

EVENT 18 – TRIP will not automatically cause deexcitation. System waits for TRIP command from protection to disable firing pulses

Selection of alarms causing TRIP signal can be done using checkboxes next to each alarm name. Alarms are grouped into two tabs 64 alarms each. Lists of alarms available for selection for TRIP signal is exactly the same list as the one that can be found in F04.ALR function. This gives possibility to form TRIP signal from any alarm event that can be registered by regulator.

Applicable settings

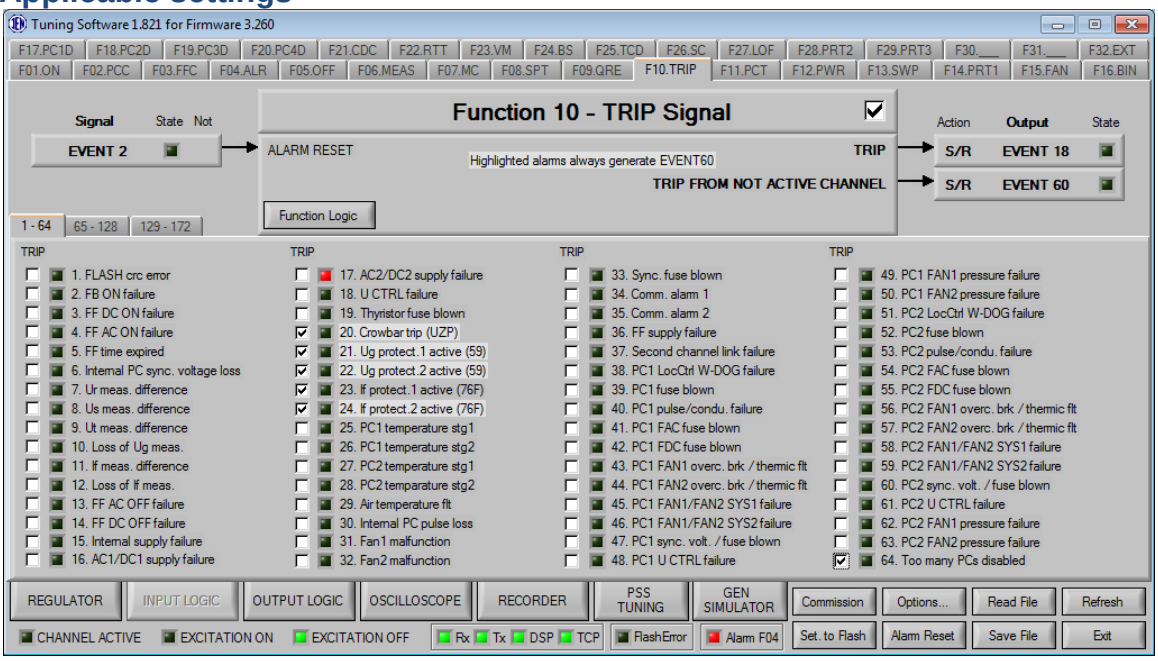


Fig. 75 Input logic tab of the Function number 10 - first alarm tab (F10.TRIP)

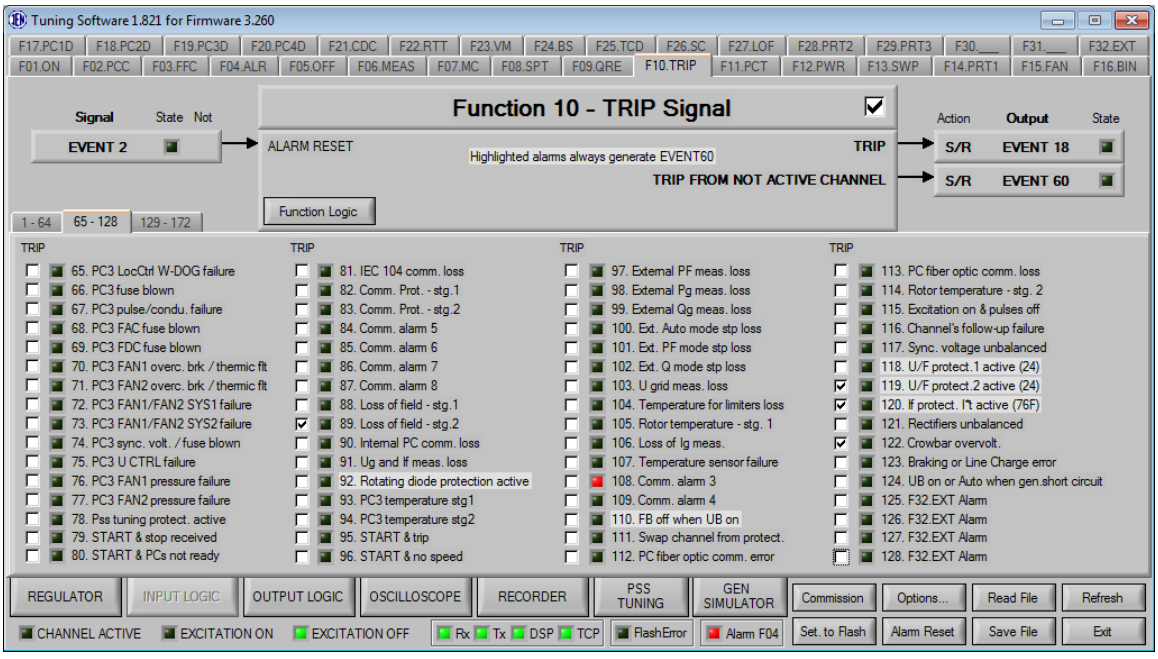


Fig. 76 Input logic tab of the Function number 10 - second alarm tab (F10.TRIP)

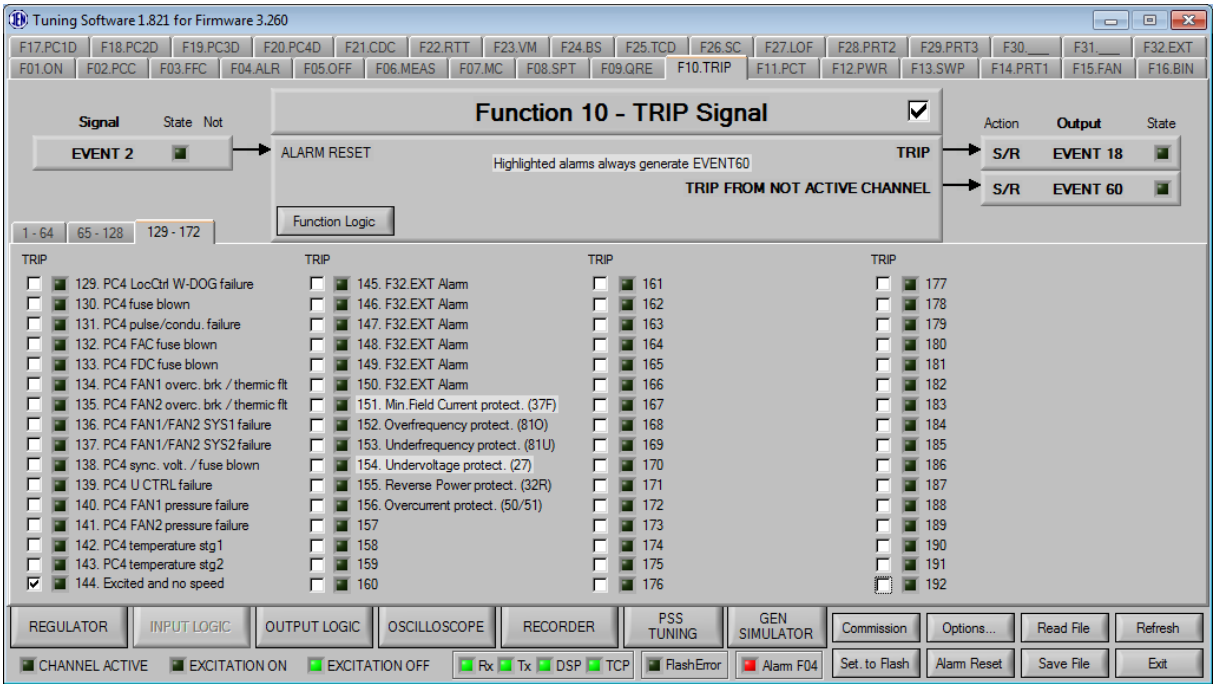


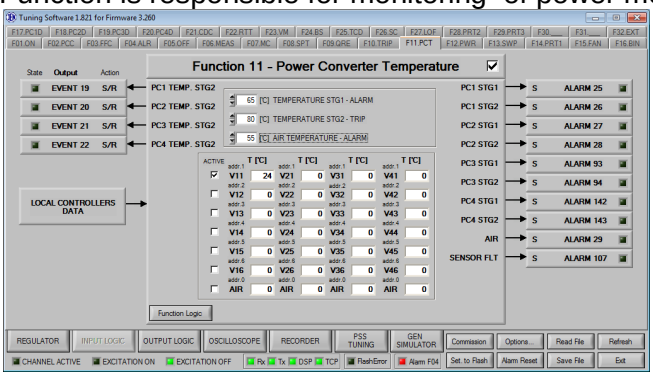
Fig. 77 Input logic tab of the Function number 10 - third alarm tab (F10.TRIP)

Tips:

- ✓ Generate TRIP only from alarms which pose a threat to the safety of the system

3.21.11 Function 11: Power Converter Temperature

Function is responsible for monitoring of power module temperature.



Operands

All function operands are listed in the table below.

Name	Type	Description
LOCAL CONTROLLERS DATA	Register input	Data collected from local controllers from rectifiers or internal power module
EVENT 19 – PC1 TEMP STG 2	Event input	Indicates that temperature of power converter exceeded predefined limit This event will automatically disable firing pulses in power converter Logical high – active Delay: 10 sec **Source:** - INPUT LOGIC//F11.PCT **Pre-requirements:**
EVENT 20 – PC2 TEMP STG 2	Event input	Indicates that temperature of power converter exceeded predefined limit This event will automatically disable firing pulses in power converter Logical high – active Delay: 10 sec **Source:** - INPUT LOGIC//F11.PCT **Pre-requirements:**
EVENT 21 – PC3 TEMP STG 2	Event input	Indicates that temperature of power converter exceeded predefined limit This event will automatically disable firing pulses in power converter Logical high – active Delay: 10 sec **Source:** - INPUT LOGIC//F11.PCT **Pre-requirements:**
EVENT 22 – PC4 TEMP STG 2	Event input	Indicates that temperature of power converter exceeded predefined limit This event will automatically disable firing pulses in power converter Logical high – active Delay: 10 sec **Source:** - INPUT LOGIC//F11.PCT **Pre-requirements:**
ALARM 25 - PC1 STG1	Alarm output	Over temperature rectifier 1 stage 1 **Source:** INPUT LOGIC/F11.PCT
ALARM 26 - PC1 STG2	Alarm output	Over temperature rectifier 1 stage 2 **Source:** INPUT LOGIC/F11.PCT

ALARM 27 – PC2 STG1	Alarm output	Over temperature rectifier 2 stage 1 **Source:** INPUT LOGIC/F11.PCT
ALARM 28 – PC2 STG2	Alarm output	Over temperature rectifier 2 stage 2 **Source:** INPUT LOGIC/F11.PCT
ALARM 93 – PC3 STG1	Alarm output	Over temperature rectifier 3 stage 1 **Source:** INPUT LOGIC/F11.PCT
ALARM 94 – PC3 STG2	Alarm output	Over temperature rectifier 3 stage 2 **Source:** INPUT LOGIC/F11.PCT
ALARM 142 – PC4 STG1	Alarm output	Over temperature rectifier 4 stage 1 **Source:** INPUT LOGIC/F11.PCT
ALARM143 – PC5 STG2	Alarm output	Over temperature rectifier 4 stage 2 **Source:** INPUT LOGIC/F11.PCT
ALARM 29 – AIR	Alarm output	Air over temperature **Source:** INPUT LOGIC/F11.PCT
ALARM 107 – SENSOR FLT	Alarm output	Temperature measurement sensor fault **Source:** INPUT LOGIC/F11.PCT
STG1 - ALARM	Option	Over temperature stage 1 level
STG2 - ALARM	Option	Over temperature stage 2 level
AIR ALARM	Option	Air over temperature level
ACTIVE	Option	Selection of temperature measurement source

Operation

Function is active all the time and check if any of thyristor/air temperature is not higher than preset specific alarm stage threshold.

There are two possible sources of temperature measurement, depending on power module configuration:

No	Configuration	Source
1	Local Controller	• Temperature sensors connected to Local Controller
2	GCU / MSP	• Temperature sensors connected to main board

In Local Controller configuration if temperature exceeds value specified in STG1 setting main controller will send command to Local Controller to activate second fan to cool down power converter. If temperature exceeds STG2 value main controller automatically disables firing pulses in power converter to protect equipment.

Applicable settings

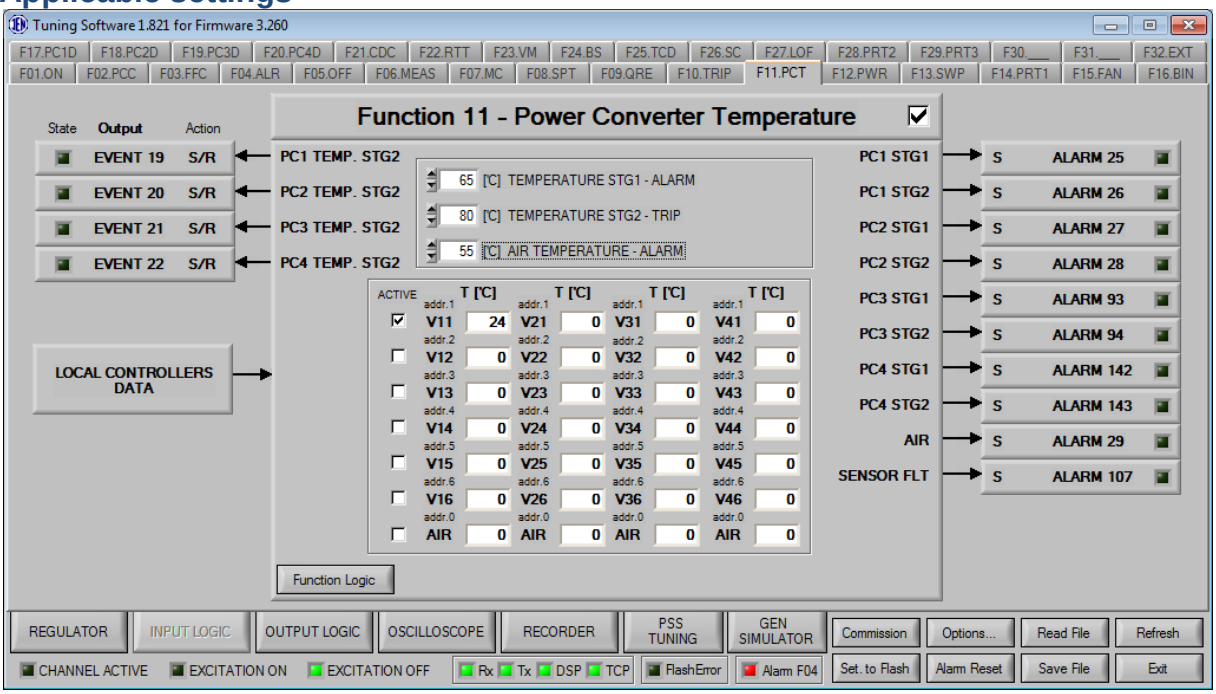


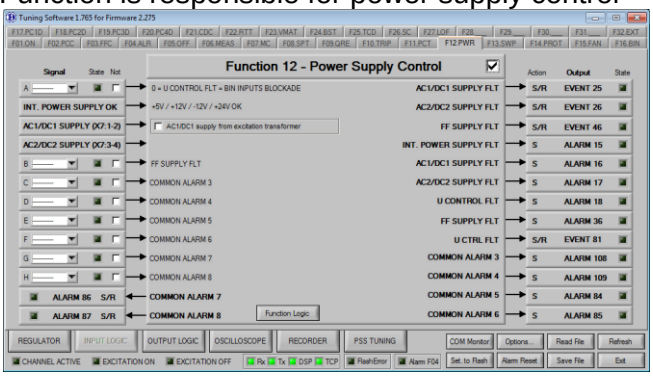
Fig. 78 Input logic tab of the Function number 11 (F11.PCT)

Tips:

- ✓ Set alarm 64 to activate TRIP in Function 10

3.21.12 Function 12: Power Supply Control

Function is responsible for power supply control



Operands

All function operands are listed in the table below.

Name	Type	Description
(A) U CONTROL FLT	Binary input	Control voltage detection, 0 – loss of control voltage
(B) FF SUPPLY FLT	Binary input	Field flashing supply detection
(C) COMMON ALARM 3	Binary input	Common alarm 3
(D) COMMON ALARM 4	Binary input	Common alarm 4
(E) COMMON ALARM 5	Binary input	Common alarm 5
(F) COMMON ALARM 6	Binary input	Common alarm 6
(G) COMMON ALARM 7	Binary input	Common alarm 7
(H) COMMON ALARM 8	Binary input	Common alarm 8
EVENT 25- AC1/DC1 SUPPLY FLT	Event output	Loss of supply AC1/DC1 detected Logical high – loss **Source:** - Input INPUT LOGIC/F12.PWR **Pre-requirements:** - 30 sec after excitation if INPUT LOGIC/F12.PWR “AC1/DC1 supply from excitation transformer” option is checked
EVENT 26- AC2/DC2 SUPPLY FLT	Event output	Loss of supply AC2/DC2 detected Logical high – loss **Source:** - Input INPUT LOGIC/F12.PWR **Pre-requirements:**
EVENT 46- FF SUPPLY FLT	Event output	Field flashing supply loss detected This event prevents excitation from start Logical high – loss **Source:** - Input INPUT LOGIC/F12.PWR **Pre-requirements:**
EVENT 81- U CTRL FLT	Event output	Control voltage loss detected **This event causes regulator to freeze binary inputs in last known state before event** Logical high – loss

Name	Type	Description
		Source: - Input INPUT LOGIC/F12.PWR.A **Pre-requirements:**
ALARM 15 – INT.POWER SUPPLY FLT	Alarm output	Controller internal power supply loss **Source:** INPUT LOGIC/F12.PWR
ALARM 16 – AC1/DC1 SUPPLY FLT	Alarm output	AC1/DC1 supply loss detected **Source:** INPUT LOGIC/F12.PWR
ALARM 17 – AC2/DC2 SUPPLY FLT	Alarm output	AC2/DC2 supply loss detected **Source:** INPUT LOGIC/F12.PWR
ALARM 18 – U CTRL FLT	Alarm output	Control voltage loss detected **Source:** INPUT LOGIC/F12.PWR
ALARM 36 – FF SUPPLY FLT	Alarm output	Field flashing supply loss detected **Source:** INPUT LOGIC/F12.PWR
ALARM 108 - COMMON ALARM 3	Alarm output	Common alarm 3 **Source:** INPUT LOGIC/F12.PWR
ALARM 109 - COMMON ALARM 4	Alarm output	Common alarm 4 **Source:** INPUT LOGIC/F12.PWR
ALARM 84 - COMMON ALARM 5	Alarm output	Common alarm 5 **Source:** INPUT LOGIC/F12.PWR
ALARM 85 - COMMON ALARM 6	Alarm output	Common alarm 6 **Source:** INPUT LOGIC/F12.PWR
ALARM 86 - COMMON ALARM 7	Alarm output	Common alarm 7 **Source:** INPUT LOGIC/F12.PWR
ALARM 87 - COMMON ALARM 8	Alarm output	Common alarm 8 **Source:** INPUT LOGIC/F12.PWR
AC1/DC1 supply from excitation transformer	Option	AC1/DC1 present only after excitation. Alarm 16 and Event 25 will be delayed by 30 seconds if this option is checked **Source:** INPUT LOGIC/F12.PWR

Operation

Function is active all the time and monitors supply voltage of regulator.

No	Configuration	Conditions
1	Supply of P100C-SX controller present all the time	• Option “AC1/DC1 supply from excitation transformer” is **OFF**
2	System AC1/DC1 of P100C-SX controller supply is present after excitation - Alarm 16 and Event 25 will be delayed by 30 seconds if this option is checked	• Option “AC1/DC1 supply from excitation transformer” is **ON**

Loss of control voltage causes regulator to freeze binary inputs in last known state before event

Applicable settings

This function is responsible for checking of supply and control voltage.

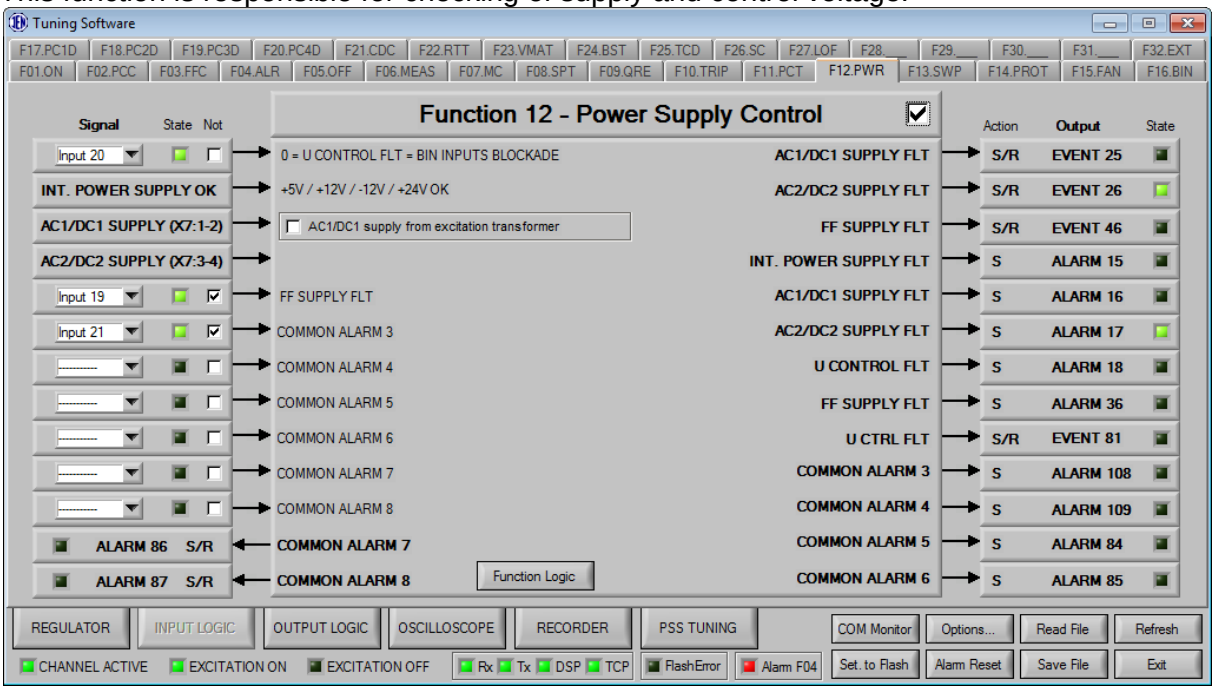


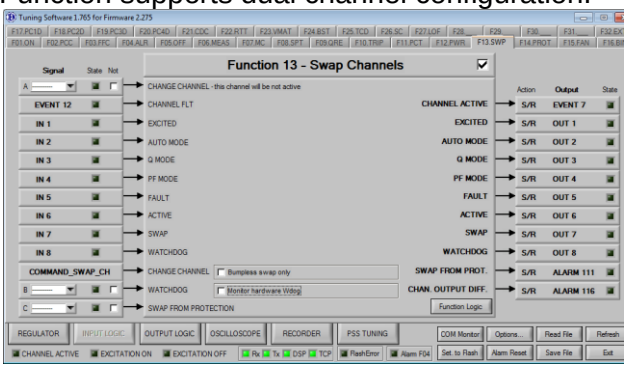
Fig. 79 Input logic tab of the Function number 12 (F12.PWR)

Tips:

- ✓ Always use common alarms to provide information about components not supported in other functions

3.21.13 Function 13: Swap Channels

Function supports dual channel configuration.



Operands

All function operands are listed in the table below.

Name	Type	Description
(A) CHANGE CHANNEL	Binary input	Command to swap channels, received by active channel
(B) WATCHDOG	Binary input	Second channel watchdog
(C) SWAP FROM PROTECTIONS	Binary input	Command to swap channels from protections
Second channel data	Register input	Binary information from second channel
EVENT 64 –AUTOM. SWITCH TO SECOND CHANNEL	Event output	Automatic changeover to second channel Logical high – active **Source:** - INPUT LOGIC/F13.SWP **Pre-requirements:** - Channel fault (EVENT 12) - Channel active (EVENT 7) - Second channel healthy
ALARM 111 – SWAP FROM PROT.	Alarm output	Swap from protection command received **Source:** INPUT LOGIC/F13.SWP
ALARM 116– SWAP FROM PROT.	Alarm output	Channels follow up failure **Source:** INPUT LOGIC/F13.SWP
Data for second channel	Register output	Binary information for second channel
Bumpless swap only	Option	Swap channels only if are followed up closely
Monitor hardware Wdog	Option	Swap channels only if second channel watchdog signal is present

Operation

This function is responsible for all the logic behind switching active channel (redundant configuration only). To provide this functionality each channel repeatedly is checking status of second channel – monitoring for any faults or change channel request and regulation mode. Standard procedure of channel swap is handled as request with confirmation so there is no way that as an result of channel swap to faulty channel regulator will deexcited generator and cause both channels to be inactive.

If regulator is working in single channel mode this function should be turned off as it is used by regulator logic to distinguish with how many regulating channels it works.
Function can react differently to change over command, based on selected options.

No	Configuration	Conditions
1	Channel change over on every command	• "Bumpless swap only" option is not checked
2	Bumpless swap only – channel change over only when output signal difference between channels is lower than ±0.05pu	• "Bumpless swap only" option is checked

Option "Monitor hardware Wdog" informs regulator that there is redundant binary connection between two regulation channels for watchdog signal exchange.

In case of loosing of communication between two channels when working without redundant binary watchdog connection:

- If status data between channels is lost but watchdog signal is still present regulator will set "ALARM37" and will not attempt to swap channels
- If status data between channels is lost and watchdog signal is not present anymore regulator will attempt to make currently inactive channel active one – because inactive channel will have information that severe fault happened to other channel

In case of loosing of communication between two channels when working with additional redundant binary watchdog connection:

- If status data between channels is lost but watchdog signal is still present regulator will set "ALARM37" and will not attempt to swap channels
- If status data between channels is lost and watchdog signal on communication link is not present anymore regulator will not attempt to swap channels – because inactive channel will still have information that active channel is working well

In addition one of the binary inputs can be set as a changeover request from external protections or second channel if needed.

Applicable settings

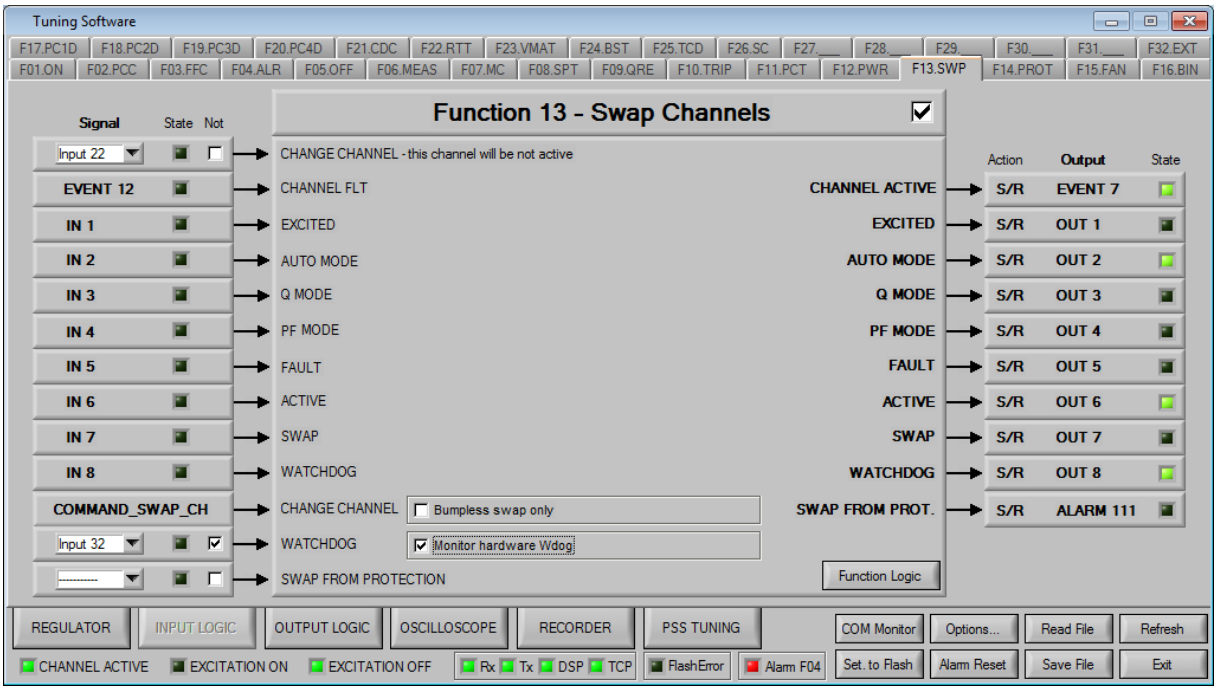
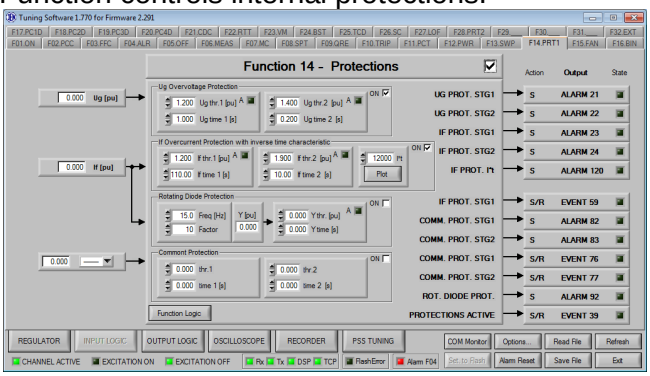


Fig. 80 Input logic tab of the Function number 13 (F13.SWP)

3.21.14 Function 14: Protections 1

Function controls internal protections.



Operands

All function operands are listed in the table below. Details on protection settings are covered in “Structures & Settings” section of this document.

Name	Type	Description
Ug	Register measurements	Generator voltage measurement
If	Register measurements	Field current measurement
Ug overvoltage protection	Option	Internal overvoltage protection active
If overcurrent protection	Option	Internal overcurrent protection active
EVENT 39 – PROTECTIONS ACTIVE	Event output	Indicates activation of any of the protections Logical high – active **Source:** - Input INPUT LOGIC/F14.PRT1 or - Input INPUT LOGIC/F28.PRT2 or - Input INPUT LOGIC/F29.PRT3 **Pre-requirements:**
EVENT 59 – IF PROT.STG1	Event output	Indicates activation of field current protection stage 1 Logical high – active **Source:** - INPUT LOGIC/F14.PRT1 **Pre-requirements:**
EVENT 76– COMM. PROT.STG1	Event output	Indicates activation of common protection stage 1 Logical high – active **Source:** - INPUT LOGIC/F14.PRT1 **Pre-requirements:**
EVENT 77– COMM. PROT.STG2	Event output	Indicates activation of common protection stage 2 Logical high – active **Source:** - INPUT LOGIC/F14.PRT1 **Pre-requirements:**
ALARM 21 – UG PROT.STG1	Alarm output	Indicates activation of overvoltage protection stage 1 **Source:** INPUT LOGIC/F14.PRT1

Name	Type	Description
ALARM 22 – UG PROT.STG1	Alarm output	Indicates activation of overvoltage protection stage 2 **Source:** INPUT LOGIC/F14.PRT1
ALARM 23 – IF PROT.STG1	Alarm output	Indicates activation of overcurrent protection stage 1 **Source:** INPUT LOGIC/F14.PRT1
ALARM 24 – IF PROT.STG2	Alarm output	Indicates activation of overcurrent protection stage 2 **Source:** INPUT LOGIC/F14.PRT1
ALARM 92 – ROT.DIODE PROT.	Alarm output	Indicates activation of rotating diode protection **Source:** INPUT LOGIC/F14.PRT1
ALARM 82 – COMM. PROT.STG1	Alarm output	Indicates activation of common protection stage 1 **Source:** INPUT LOGIC/F14.PRT1
ALARM 83– COMM. PROT.STG2	Alarm output	Indicates activation of common protection stage 2 **Source:** INPUT LOGIC/F14.PRT1
ALARM 120 – IF PROT I*t	Alarm output	Indicates activation of inverse time field overcurrent protection **Source:** INPUT LOGIC/F14.PRT1

Operation

This function is responsible for handling of overvoltage, overcurrent, common and rotating diode protection. Each of this protection can be individually turned on and off by using corresponding checkboxes next to their protections parameters.

For each protection and each stage two parameters need to be set: parameter threshold value and parameter time. Activation of protection will happen when parameter threshold will be exceeded for time longer than value set in parameter time.

Overvoltage Protection (59):
Controller is equipped with two definite-time stator overvoltage protection. There are two activation thresholds “Up thr 1” and “Up thr 2” and two activation delay times corresponding to them: “Up time 1” and “Up time 2”.
After exceeding one of the thresholds, when the corresponding time delay has expired, this protection generates Event 39 and ALARM 21/ALARM 22, which can be associated with hardware resources. It should be configured in such way to avoid conflicts with existing overvoltage protections in the power plant. Sending a “TRIP” signal is recommended as this event may result in generator damage.

Field Overcurrent Protection:
Controller is equipped with two definite-time field overcurrent protections and one inverse time protection.
For definite-time protections there are two activation thresholds “If thr 1” and “If thr 2” and two activation delay times “If time 1” and “If time 2” corresponding to the thresholds. After exceeding one of the thresholds, when the corresponding time delay has expired, this protection generates Event 39 and ALARM 23/ALARM 24, which can be associated with hardware resources. Sending a “TRIP” signal is recommended as field over-current may cause field winding damage.
Inverse time protection operates with an inverse current-tripping characteristic according to parameter I*t. This characteristic can be displayed together with FCL limiter characteristic using button Plot.

There is possibility to configure EVENT59 signal as one of inactive channel output and connect it to second channel input which is responsible for emergency channel switchover

from protections (Configurable in Function 13 “SWAP FROM PROTECTION”). This way user can have protection independent from currently active channel.

Rotating Diode Protection:
This protection detects increased amount of harmonic components in exciter field current A high harmonic component is found when a diode is damaged. This protection setting contains a digital band-pass filter and averaging system.

Protection can be turned on and off using “Protection ON” field. Middle frequency of the filter is set in “Frequency” field and its quality factor, which determines characteristic steepness in “Quality factor” field. Filter frequency dependence on nominal generator rotation speed and number of rectifier branches is expressed by equation:

$$f\,[Hz] = \frac{speed\ [rpm]}{60} \bullet number\_of\_poles$$

Output of the filter after passing averaging unit is compared with threshold value set in “Yfsp thr” control. Exceeding this value is signalized by LED “Yfsp>Yfsp thr” illumination. In case of active protection and averaging system, an output signal higher than set threshold, will cause the regulator sending a TRIP signal after time “Yfsp time” has expired.

Common Protection:
This universal protection is equipped with two activation thresholds “thr 1” and “thr 2” and two activation delay times “If time 1” and “If time 2” corresponding to the thresholds. After exceeding one of the thresholds, when the corresponding time delay has expired, this protection generates ALARM 82/83 and Event 76/77 which can be associated with hardware resources.

Note that some of the protection signals found in this function will be generated also by inactive channel and will affect active channel operation by generating TRIP from not active channel signal. Those signals are:

- Over-voltage protection stage 1
- Over-voltage protection stage 2
- Over-current protection stage 2
- Rotating diode protection

Applicable settings

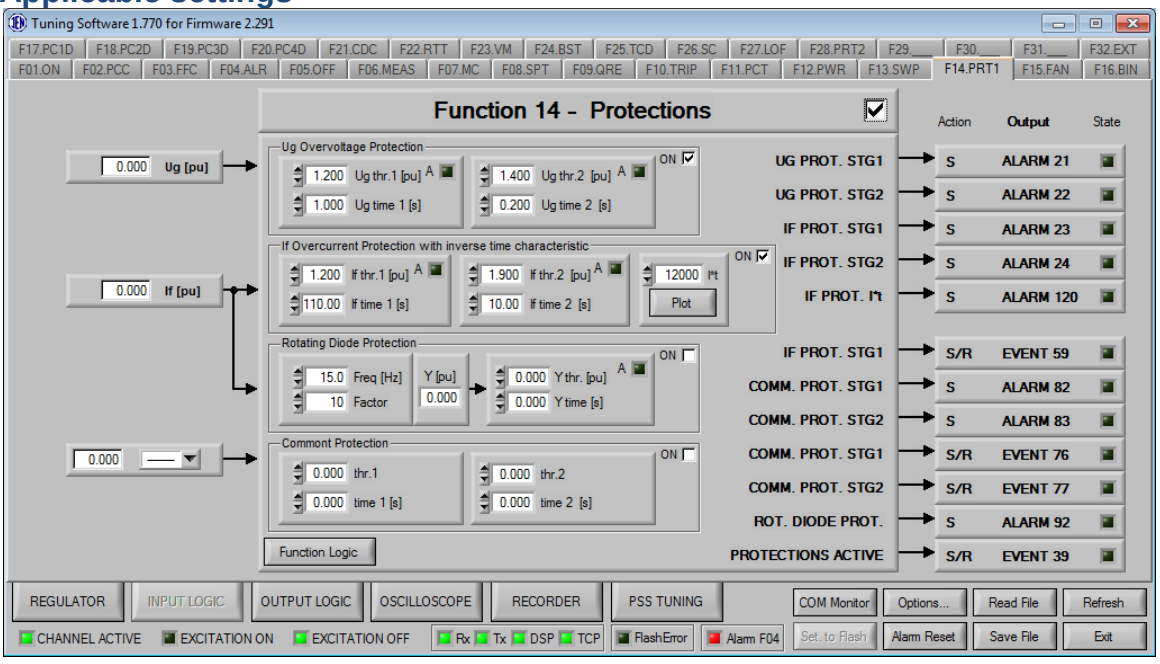


Fig. 81 Input logic tab of the Function number 14 (F14.PROT)

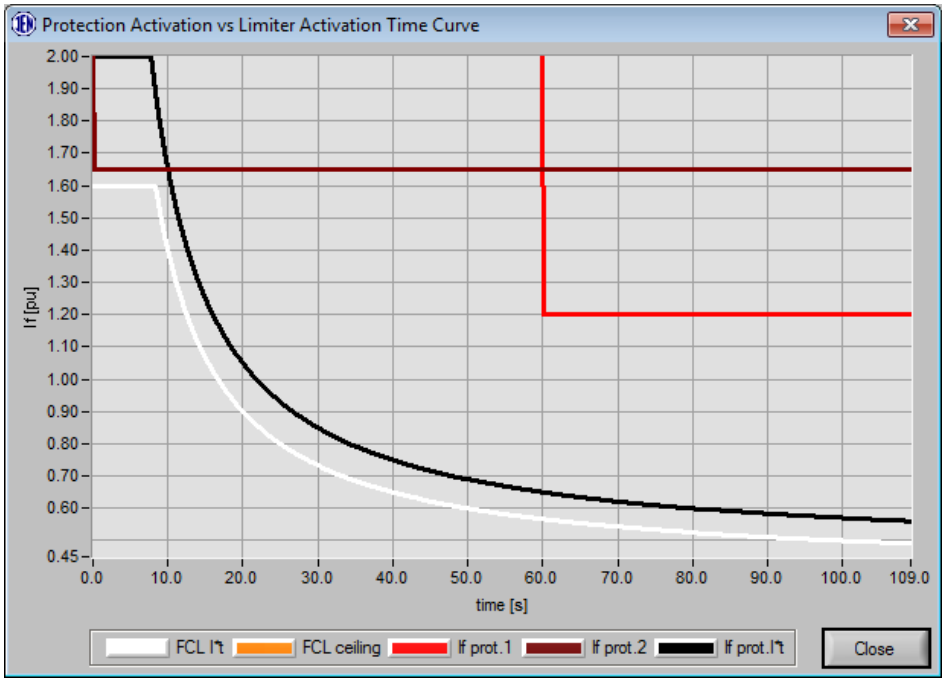


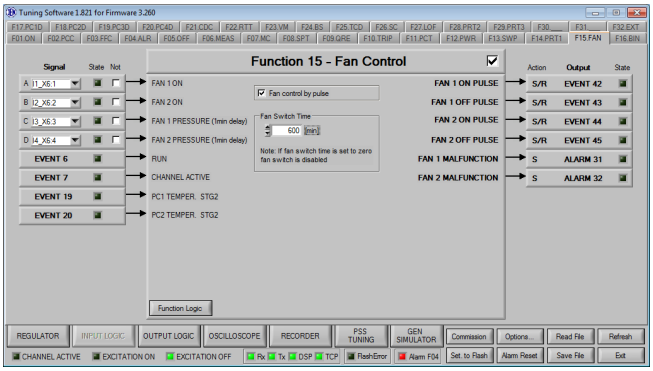
Fig. 82 Relationship between protection settings and limiter settings

Tips:

- ✓ Set protection in correlation with limiters settings

3.21.15 Function 15: Fan Control

This function is responsible for taking control over fans in case of working with internal power converters.



Operands

All function operands are listed in the table below.

Name	Type	Description
(A) FAN 1 ON	Binary input	Indication of fan 1 state, 1 - ON
(B) FAN 2 ON	Binary input	Indication of fan 2 state, 1 - ON
(C) FAN 1 PRESSURE	Binary input	Indication of fan 1 faultless operation, 1 - OK
(D) FAN 1 PRESSURE	Binary input	Indication of fan 2 faultless operation, 1 - OK
EVENT 6 - RUN	Event output	Indicates excitation of AVR Logical high - excited **Source:** INPUT LOGIC/F01.ON **Pre-requirements:** - Channel is active (EVENT 7), ready for excitation (EVENT 92), not excited (EVENT 6), start command received (EVENT 80), field breaker is closed (EVENT 30) and: *For routine operation* - Braking disabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit open (EVENT 93) *For Braking* - Braking enabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit closed (EVENT 93), manual mode enabled (EVENT 11) *For Line Charge* - Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), manual mode enabled (EVENT 11), option “Line charge in Auto mode” not checked or: - Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), auto mode enabled

Name	Type	Description
		(EVENT 11), option “Line charge in Auto mode” checked
EVENT 7 – CHANNEL ACTIVE	Event input	Indicates activity of channel Logical high - active **Source:** INPUT LOGIC/F13.SWP **Pre-requirements:** - Other channel is faulty INPUT LOGIC/F13.IN8 or - Other channel send SWAP command INPUT LOGIC/F13.IN7
EVENT 42– FAN 1 ON PULSE	Event output	Command to switch on fan 1 Logical high – active Duration: If INPUT LOGIC/F15.FAN “Fan control by pulse” option is checked duration is 3 sec. Otherwise event is constant **Source:** - INPUT LOGIC/F15.FAN **Pre-requirements:** - Channel is active (EVENT 7) - Channel is excited (EVENT 6)
EVENT 43– FAN 1 OFF PULSE	Event output	Pulse to switch off fan 1 Logical high – active Duration: If INPUT LOGIC/F15.FAN “Fan control by pulse” option is checked duration is 3 sec. Otherwise event is constant **Source:** - INPUT LOGIC/F15.FAN **Pre-requirements:** - Channel is active (EVENT 7) - Channel is excited (EVENT 6)
EVENT 44– FAN 2 ON PULSE	Event output	Pulse to switch on fan 2 Logical high – active Duration: If INPUT LOGIC/F15.FAN “Fan control by pulse” option is checked duration is 3 sec. Otherwise event is constant **Source:** - INPUT LOGIC/F15.FAN **Pre-requirements:** - Channel is active (EVENT 7) - Channel is excited (EVENT 6)
EVENT 45– FAN 1 OFF PULSE	Event output	Pulse to switch off fan 2 Logical high – active Duration: If INPUT LOGIC/F15.FAN “Fan control by pulse” option is checked duration is 3 sec. Otherwise event is constant **Source:** - INPUT LOGIC/F15.FAN **Pre-requirements:** - Channel is active (EVENT 7) - Channel is excited (EVENT 6)
ALARM 31 – FAN 1 MALFUNCTION	Alarm output	Indicates faulty operation of fan 1 **Source:** INPUT LOGIC/F15.FAN
ALARM 32 – FAN 2 MALFUNCTION	Alarm output	Indicates faulty operation of fan 2 **Source:** INPUT LOGIC/F15.FAN

Name	Type	Description
Fan switch time [min]	Option	Time in minutes between swapping active fans
Fan control by pulse	Option	Control events are in a form of pulses

Operation

Function can be used in different configurations, based on selected options.

No	Configuration	Conditions
1	One fan	• Fan switch time option is set to 0
2	Two fans	• Fan switch time option is set to 1 or more

In configuration 1 function controls operation of single fan. It generates independent pulses to switch on and to switch off fan. One sensor input is provided to monitor pressure generated by fan. If faulty operation is detected function generates alarm.

In configuration 2 function controls operation of two fans. It generates independent pulses to switch on and to switch off fans. Two sensor inputs are provided to monitor pressure generated by fans. If faulty operation is detected function generates alarm and runs second fan. If too high temperature of power converter is detected both fans are running until temperature drops below level specified in F11.

Function can control fans by generating constant signals or short 3 second pulse signals, based on “Fan control by pulse” option.

Applicable settings

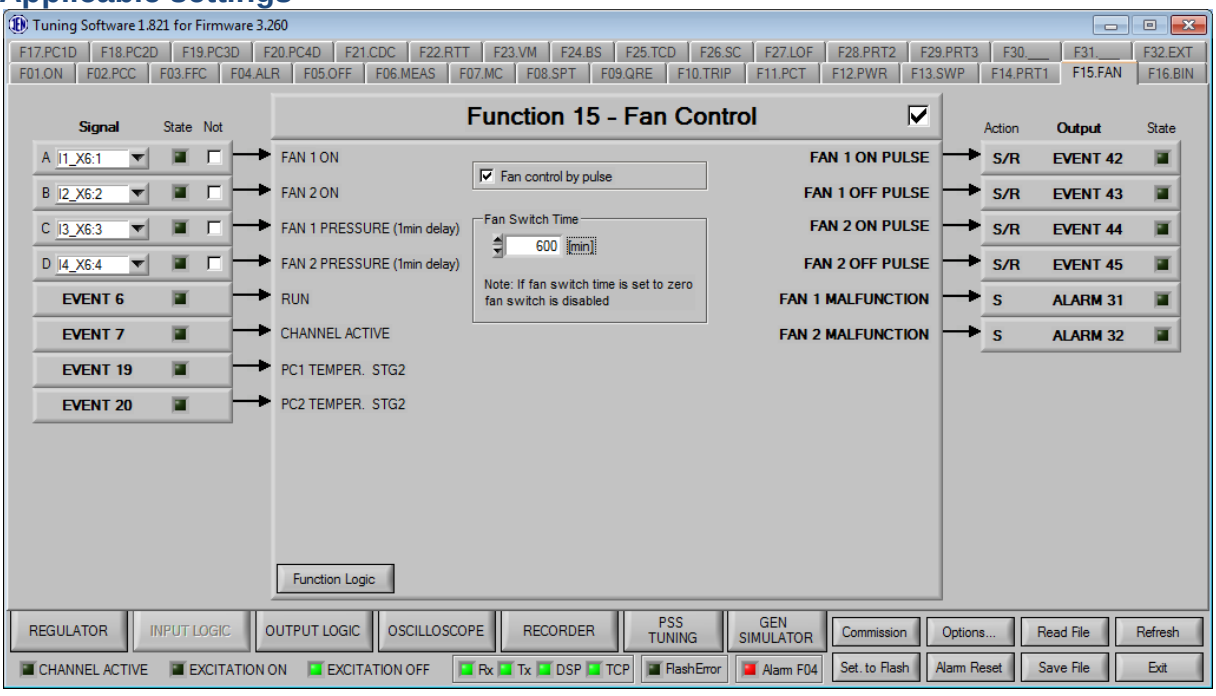
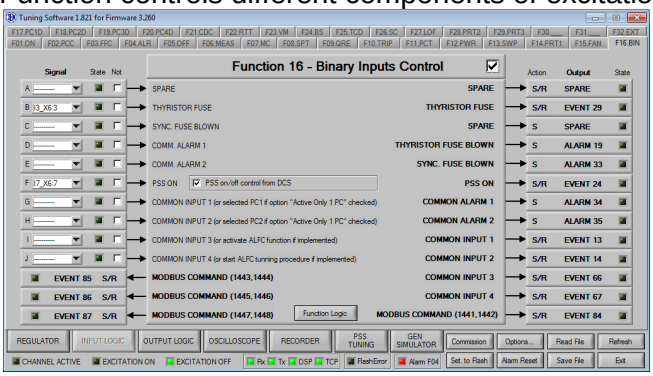


Fig. 83 Input logic tab of the Function number 15 (F15.FAN)

3.21.16 Function 16: Binary Inputs Control

Function controls different components of excitation system.



Operands

All function operands are listed in the table below.

Name	Type	Description
(A) SPARE	Binary input	Spare binary input
(B) THYRISTOR FUSE	Binary input	Status of thyristor fuses
(C) SYNC. FUSE BLOWN	Binary input	Status of synchronization fuses
(D) COMM. ALARM1	Binary input	Common alarm 1 active
(E) COMM. ALARM2	Binary input	Common alarm 2 active
(F) PSS ON	Binary input	Power system stabilizer activation command
PSS on/off from binary input	Option	Power system stabilizer activation/deactivation from binary input
EVENT 13 – COMMON EVENT 1	Event output	Corresponding binary input is energized If option INPUT LOGIC/F02.PCC ”Only one PC active” is selected this is command to enable Power Converter PC1 **Source:** - INPUT LOGIC/F16.BIN.G **Pre-requirements:**
EVENT 14 – COMMON EVENT 2	Event output	Corresponding binary input is energized If option INPUT LOGIC/F02.PCC ”Only one PC active” is selected this is command to enable Power Converter PC2 **Source:** - INPUT LOGIC/F16.BIN.H **Pre-requirements:**
EVENT 66 – COMMON EVENT 3	Event output	Corresponding binary input is energized **Source:** - INPUT LOGIC/F16.BIN.I **Pre-requirements:**
EVENT 67 – COMMON EVENT 4	Event output	Corresponding binary input is energized **Source:** - INPUT LOGIC/F16.BIN.J **Pre-requirements:**
EVENT 29 – THYRISOR FUSE	Event output	Thyristor fuse blown Logical high - active **Source:**

Name	Type	Description
		- INPUT LOGIC/F16.BIN.B **Pre-requirements:**
EVENT 24– PSS ON	Event output	Power system stabilizer is enabled Logical high - active **Source:** - INPUT LOGIC/F16.BIN - Modbus command **Pre-requirements:** • PSS connected to input or output of control loop in REGULATOR tab
ALARM 19 – THYRISTOR FUSE BLOWN	Alarm output	Thyristor fuse blown **Source:** INPUT LOGIC/F16.BIN
ALARM 20 – CROWBAR TRIP	Alarm output	Rotor winding protection activated **Source:** INPUT LOGIC/F16.BIN
ALARM 33 – SYNC FUSE BLOWN	Alarm output	Synchronization fuse blown **Source:** INPUT LOGIC/F16.BIN
ALARM 34 – COMMON ALARM 1	Alarm output	Common alarm 1 active **Source:** INPUT LOGIC/F16.BIN
ALARM 35 – COMMON ALARM 2	Alarm output	Common alarm 2 active **Source:** INPUT LOGIC/F16.BIN

Operation

This function is responsible for handling different binary inputs.

Additional checkbox „PSS on/off control from DCS" allows external control over PSS activation from DCS or other system. PSS may be enabled or disabled by Modbus command or edge of binary input (rising – enabled, falling – disabled). However, it requires PSS to be connected to the input or output of control loop in REGULATOR tab.

Applicable settings

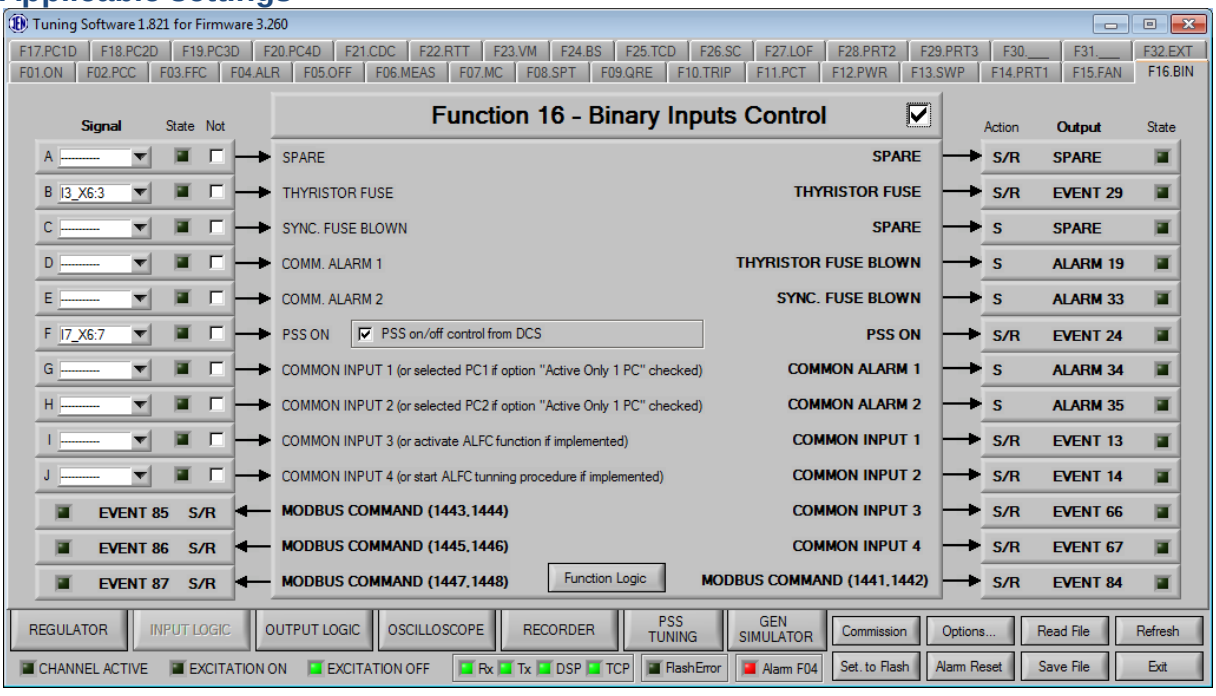
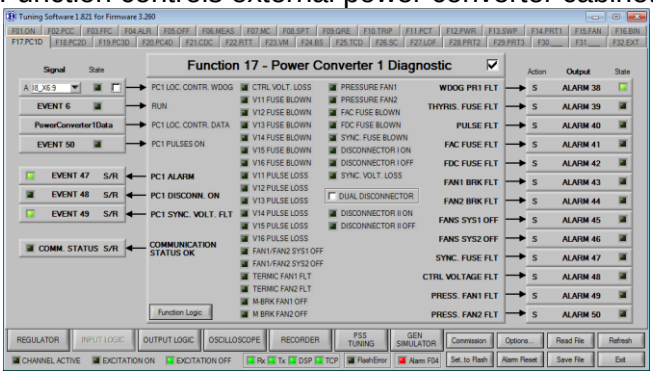


Fig. 84 Input logic tab of the Function number 16 (F16.BIN)

3.21.17 Function 17: Power Converter 1 Diagnostic

Function controls external power converter cabinet



Operands

All function operands are listed in the table below.

Name	Type	Description
(A) PC1 LOC.CONTR.WDOG	Binary input	Indicates that Local Controller is healthy
EVENT 6 - RUN	Event input	Indicates excitation of AVR Logical high - excited **Source:** INPUT LOGIC/F01.ON **Pre-requirements:** - Channel is active (EVENT 7), ready for excitation (EVENT 92), not excited (EVENT 6), start command received (EVENT 80), field breaker is closed (EVENT 30) and: *For routine operation* - Braking disabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit open (EVENT 93) *For Braking* - Braking enabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit closed (EVENT 93), manual mode enabled (EVENT 11) *For Line Charge* - Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), manual mode enabled (EVENT 11), option “Line charge in Auto mode” not checked or: Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), auto mode enabled (EVENT 11), option “Line charge in Auto mode” checked
EVENT 50 – PC1 PULSES ON	Event input	Command to enable firing pulses in configuration with Local Controller Logical high - enabled **Source:** - INPUT LOGIC/F02.PCC **Pre-requirements:** - Channel excited (EVENT 06)

Name	Type	Description
		- Channel active (EVENT 07) - "Thyristor Bridge, Local Controller mode" is selected on Options/Advanced/Option "Power converter type" list - Synchronization is present (EVENT 49) - Healthy Watchdog INPUT LOGIC/F17.PC1.A - Closed disconnector (EVENT 48) - Enabled INPUT LOGIC/F17.PC1 function
Power Converter Data	Register input	Data collected from local controller
EVENT 47 – PC1 ALARM	Event output	Indicates presence of alarm from Local Controller Logical high – alarm present **Source:** - INPUT LOGIC/F17.PC1 **Pre-requirements:**
EVENT 48 – PC1 DISCONN. ON	Event output	Indicates position of disconnector Logical high – closed **Source:** - INPUT LOGIC/F17.PC1 **Pre-requirements:**
EVENT 49 – PC1 SYNC.VOLT.FLT	Event output	Indicates loss of synchronization voltage in power converter in configuration with Local Controller Logical high – loss Delay: 20ms **Source:** - INPUT LOGIC/F17.PC1 **Pre-requirements:** - Logical high at binary information from Local Controller PC1Data_SyncFuse (register 2, bit 8) or - Logical high at binary information from Local Controller PC1Data_SyncVolt (register 3, bit 7) or - Synchronization voltage lower that value specified in INPUT LOGIC/F02.PCC option "Pulses ON Threshold for Local Controller"
ALARM 38 – WDOG PR1 FLT	Alarm output	Local Controller hardware failure **Source:** INPUT LOGIC/F17.PC1
ALARM 39 – THYRIS.FUSE FLT	Alarm output	Thyristor fuse blown in external power converter **Source:** INPUT LOGIC/F17.PC1
ALARM 40 – PULSE FLT	Alarm output	Loss of firing pulses in external power converter **Source:** INPUT LOGIC/F17.PC1
ALARM 41 – FAC FUSE FLT	Alarm output	AC filter fuse blown in external power converter **Source:** INPUT LOGIC/F17.PC1
ALARM 42 – FDC FUSE FLT	Alarm output	DC filter fuse blown in external power converter **Source:** INPUT LOGIC/F17.PC1
ALARM 43 – FAN1 BRK FLT	Alarm output	Fan 1 thermal protection active in external power converter **Source:** INPUT LOGIC/F17.PC1

Name	Type	Description
ALARM 44 – FAN2 BRK FLT	Alarm output	Fan 2 thermal protection active in external power converter **Source:** INPUT LOGIC/F17.PC1
ALARM 45 – FANS SYS1 OFF	Alarm output	Fan's system 1 supply turned off in external power converter **Source:** INPUT LOGIC/F17.PC1
ALARM 46 – FANS SYS2 OFF	Alarm output	Fan's system 2 supply turned off in external power converter **Source:** INPUT LOGIC/F17.PC1
ALARM 47 – SYNC FUSE FLT	Alarm output	Synchronization fuse blown in external power converter **Source:** INPUT LOGIC/F17.PC1
ALARM 48 – CTRL VOLTAGE FLT	Alarm output	Loss of control voltage in external power converter **Source:** INPUT LOGIC/F17.PC1
ALARM 49 – PRESS.FAN1 FLT	Alarm output	Fan 1 pressure failure in external power converter **Source:** INPUT LOGIC/F17.PC1
ALARM 50 – PRESS.FAN2 FLT	Alarm output	Fan 2 pressure failure in external power converter **Source:** INPUT LOGIC/F17.PC1
DUAL DISCONNECTOR	Option	Support for dual disconnector rectifier **Source:** INPUT LOGIC/F17.PC1

Operation

This function is responsible for external power converter control and diagnostics in the configuration with Local Controller device. Depending on number of external power converters used in the system appropriate number of Power Converter Diagnostic functions 17,18,19,20 should be activated in Tuning Software.

Function monitors binary W-Dog signal from Local Controller to check whether data transmitted by fiber optic link can be trusted and device is ready for operation..

Power converter with a Local Controller is considered healthy and ready for excitation if the following conditions are met:

- Watchdog signal is present, which includes
  - Internal supply voltage is present
  - Firing pulses supply is present
- Disconnector is closed

Power converter with a Local controller will be automatically disabled by main controller if any of following events occur:

- Watchdog signal loss, which includes
  - Loss of internal supply voltage
  - Loss of firing pulses supply
- Synchronization voltage loss
- Over temperature alarm STG 2
- Loss of communication

Power converter can be enabled/disabled at any time by user from HMI application. Necessary condition to execute disable command is that number of operating power converters must satisfy N-x where N is total number of power converters in the system and x

is maximum number of converters that may be disabled. This number is specified in Function 2.

Function supports two different types of power converters, based on type of disconnector used:

No	Configuration	Conditions
1	Dual Disconnector	• Option “DUAL DISCONNECTOR” is **ON**
2	Single Disconnector	• Option “DUAL DISCONNECTOR” is **OFF**

Typically single disconnector is in a form of 5-pole disconnector, dual disconnector in a form of independent 3-pole AC and 2-pole DC disconnectors. When option DUAL DISCONNECTOR is active both disconnectors must be closed to enable firing pulses.

Applicable settings

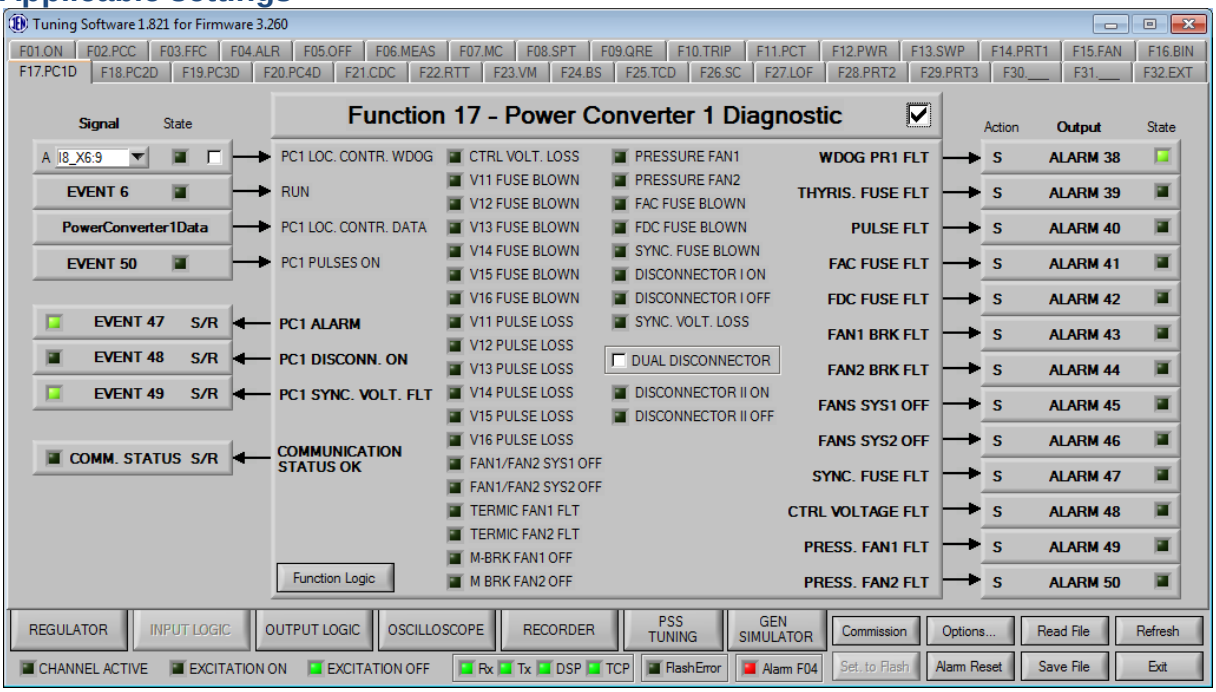


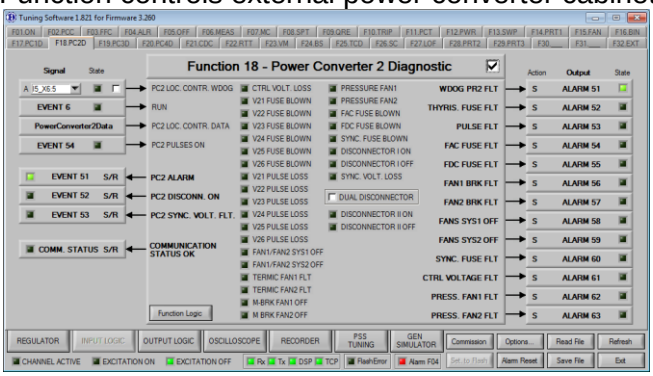
Fig. 85 Input logic tab of the Function number 17 (F17.PC1D)

Tips:

- ✓ Make sure Function 11 is activated to monitor temperature of power converter

3.21.18 Function 18: Power Converter 2 Diagnostic

Function controls external power converter cabinet



Operands

All function operands are listed in the table below.

Name	Type	Description
(A) PC1 LOC.CONTR.WDOG	Binary input	Indicates that Local Controller is healthy
EVENT 6 - RUN	Event input	Indicates excitation of AVR Logical high - excited **Source:** INPUT LOGIC/F01.ON **Pre-requirements:** - Channel is active (EVENT 7), ready for excitation (EVENT 92), not excited (EVENT 6), start command received (EVENT 80), field breaker is closed (EVENT 30) and: *For routine operation* - Braking disabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit open (EVENT 93) *For Braking* - Braking enabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit closed (EVENT 93), manual mode enabled (EVENT 11) *For Line Charge* - Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), manual mode enabled (EVENT 11), option “Line charge in Auto mode” not checked or: Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), auto mode enabled (EVENT 11), option “Line charge in Auto mode” checked
EVENT 54 – PC2 PULSES ON	Event input	Command to enable firing pulses in configuration with Local Controller Logical high - enabled **Source:** - INPUT LOGIC/F02.PCC **Pre-requirements:** - Channel excited (EVENT 06) - Channel active (EVENT 07) - “Thyristor Bridge, Local Controller mode” is

Name	Type	Description
		selected on Options/Advanced/Option "Power converter type" list - Synchronization is present (EVENT 53) - Healthy Watchdog INPUT LOGIC/F18.PC2.A - Closed disconnector (EVENT 52) - Enabled INPUT LOGIC/F18.PC2 function
Power Converter Data	Register input	Data collected from local controller
EVENT 51 – PC2 ALARM	Event output	Indicates presence of alarm from Local Controller Logical high – alarm present **Source:** - INPUT LOGIC/F18.PC2 **Pre-requirements:**
EVENT 52 – PC2 DISCONN. ON	Event output	Indicates position of disconnector Logical high – closed **Source:** - INPUT LOGIC/F18.PC2 **Pre-requirements:**
EVENT 53 – PC2 SYNC.VOLT.FLT	Event output	Indicates loss of synchronization voltage in power converter in configuration with Local Controller Logical high – loss Delay: 20ms **Source:** - INPUT LOGIC/F18.PC2 **Pre-requirements:** - Logical high at binary information from Local Controller PC2Data_SyncFuse (register 2, bit 8) or - Logical high at binary information from Local Controller PC2Data_SyncVolt (register 3, bit 7) or - Synchronization voltage lower that value specified in INPUT LOGIC/F02.PCC option "Pulses ON Threshold for Local Controller"
ALARM 51 – WDOG PR2 FLT	Alarm output	Local Controller hardware failure **Source:** INPUT LOGIC/F18.PC2
ALARM 52 – THYRIS.FUSE FLT	Alarm output	Thyristor fuse blown in external power converter **Source:** INPUT LOGIC/F18.PC2
ALARM 53 – PULSE FLT	Alarm output	Loss of firing pulses in external power converter **Source:** INPUT LOGIC/F18.PC2
ALARM 54 – FAC FUSE FLT	Alarm output	AC filter fuse blown in external power converter **Source:** INPUT LOGIC/F18.PC2
ALARM 55 – FDC FUSE FLT	Alarm output	DC filter fuse blown in external power converter **Source:** INPUT LOGIC/F18.PC2
ALARM 56 – FAN1 BRK FLT	Alarm output	Fan 1 thermal protection active in external power converter **Source:** INPUT LOGIC/F18.PC2
ALARM 57 – FAN2 BRK FLT	Alarm output	Fan 2 thermal protection active in external power converter **Source:**

Name	Type	Description
		INPUT LOGIC/F18.PC2
ALARM 58 – FANS SYS1 OFF	Alarm output	Fan's system 1 supply turned off in external power converter **Source:** INPUT LOGIC/F18.PC2
ALARM 59 – FANS SYS2 OFF	Alarm output	Fan's system 2 supply turned off in external power converter **Source:** INPUT LOGIC/F18.PC2
ALARM 60 – SYNC FUSE FLT	Alarm output	Synchronization fuse blown in external power converter **Source:** INPUT LOGIC/F18.PC2
ALARM 61 – CTRL VOLTAGE FLT	Alarm output	Loss of control voltage in external power converter **Source:** INPUT LOGIC/F18.PC2
ALARM 62 – PRESS.FAN1 FLT	Alarm output	Fan 1 pressure failure in external power converter **Source:** INPUT LOGIC/F18.PC2
ALARM 63 – PRESS.FAN2 FLT	Alarm output	Fan 2 pressure failure in external power converter **Source:** INPUT LOGIC/F18.PC2
DUAL DISCONNECTOR	Option	Support for dual disconnector rectifier **Source:** INPUT LOGIC/F18.PC2

Operation

This function is responsible for external power converter control and diagnostics in the configuration with Local Controller device. Depending on number of external power converters used in the system appropriate number of Power Converter Diagnostic functions 17,18,19,20 should be activated in Tuning Software.

Function monitors binary W-Dog signal from Local Controller to check whether data transmitted by fiber optic link can be trusted and device is ready for operation..

Power converter with a Local Controller is considered healthy and ready for excitation if the following conditions are met:

- Watchdog signal is present, which includes
  - Internal supply voltage is present
  - Firing pulses supply is present
- Disconnector is closed

Power converter with a Local controller will be automatically disabled by main controller if any of following events occur:

- Watchdog signal loss, which includes
  - Loss of internal supply voltage
  - Loss of firing pulses supply
- Synchronization voltage loss
- Over temperature alarm STG 2
- Loss of communication

Power converter can be enabled/disabled at any time by user from HMI application. Necessary condition to execute disable command is that number of operating power converters must satisfy N-x where N is total number of power converters in the system and x

is maximum number of converters that may be disabled. This number is specified in Function 2.

Function supports two different types of power converters, based on type of disconnector used:

No	Configuration	Conditions
1	Dual Disconnector	• Option “DUAL DISCONNECTOR” is **ON**
2	Single Disconnector	• Option “DUAL DISCONNECTOR” is **OFF**

Typically single disconnector is in a form of 5-pole disconnector, dual disconnector in a form of independent 3-pole AC and 2-pole DC disconnectors. When option DUAL DISCONNECTOR is active both disconnectors must be closed to enable firing pulses.

Applicable settings

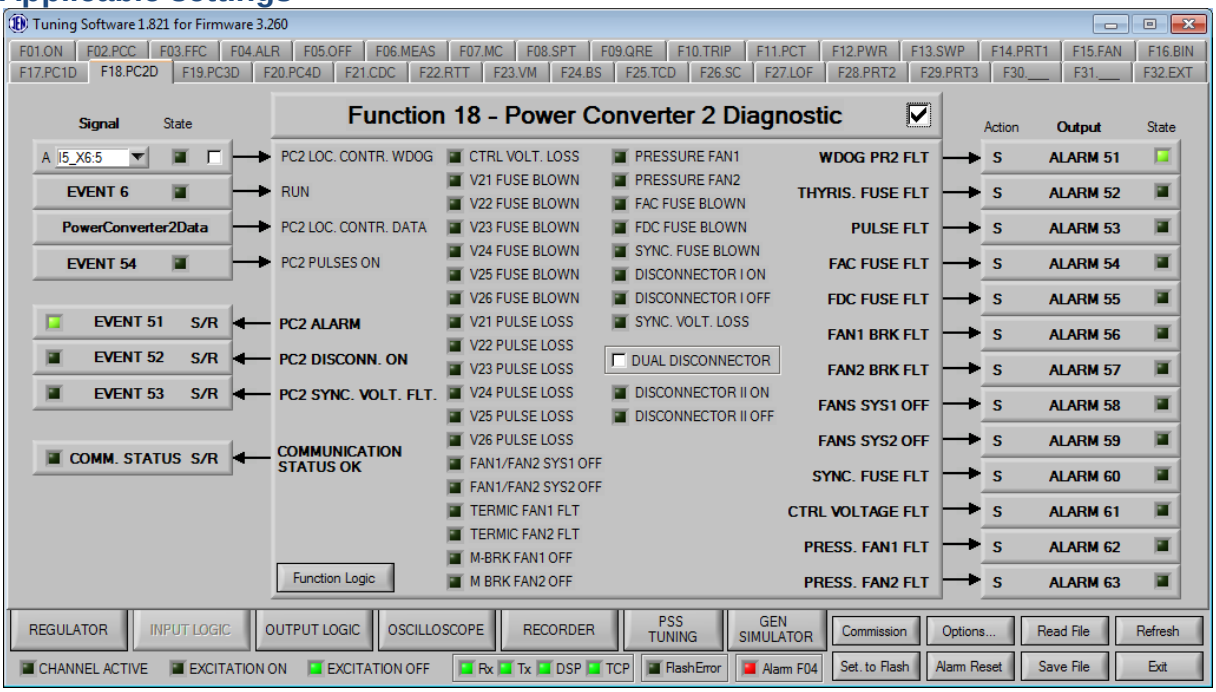


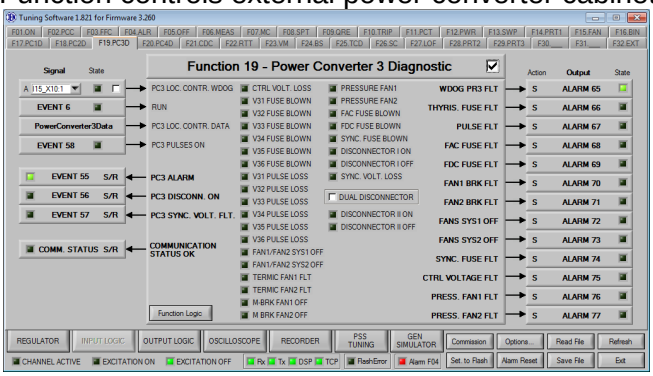
Fig. 86 Applicable settings

Tips:

- ✓ Make sure Function 11 is activated to monitor temperature of power converter

3.21.19 Function 19: Power Converter 3 Diagnostic

Function controls external power converter cabinet



Operands

All function operands are listed in the table below.

Name	Type	Description
(A) PC3 LOC.CONTR.WDOG	Binary input	Indicates that Local Controller is healthy
EVENT 6 - RUN	Event input	Indicates excitation of AVR Logical high - excited **Source:** INPUT LOGIC/F01.ON **Pre-requirements:** - Channel is active (EVENT 7), ready for excitation (EVENT 92), not excited (EVENT 6), start command received (EVENT 80), field breaker is closed (EVENT 30) and: *For routine operation* - Braking disabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit open (EVENT 93) *For Braking* - Braking enabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit closed (EVENT 93), manual mode enabled (EVENT 11) *For Line Charge* - Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), manual mode enabled (EVENT 11), option “Line charge in Auto mode” not checked or: Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), auto mode enabled (EVENT 11), option “Line charge in Auto mode” checked
EVENT 58 – PC3 PULSES ON	Event input	Command to enable firing pulses in configuration with Local Controller Logical high - enabled **Source:** - INPUT LOGIC/F02.PCC **Pre-requirements:** - Channel excited (EVENT 06) - Channel active (EVENT 07) - “Thyristor Bridge, Local Controller mode” is

Name	Type	Description
		selected on Options/Advanced/Option "Power converter type" list - Synchronization is present (EVENT 57) - Healthy Watchdog INPUT LOGIC/F19.PC3.A - Closed disconnector (EVENT 56) - Enabled INPUT LOGIC/F19.PC3 function
Power Converter Data	Register input	Data collected from local controller
EVENT 55 – PC3 ALARM	Event output	Indicates presence of alarm from Local Controller Logical high – alarm present **Source:** - INPUT LOGIC/F19.PC3 **Pre-requirements:**
EVENT 56 – PC3 DISCONN. ON	Event output	Indicates position of disconnector Logical high – closed **Source:** - INPUT LOGIC/F19.PC3 **Pre-requirements:**
EVENT 57 – PC3 SYNC.VOLT.FLT	Event output	Indicates loss of synchronization voltage in power converter in configuration with Local Controller Logical high – loss Delay: 20ms **Source:** - INPUT LOGIC/F19.PC3 **Pre-requirements:** - Logical high at binary information from Local Controller PC3Data_SyncFuse (register 2, bit 8) or - Logical high at binary information from Local Controller PC3Data_SyncVolt (register 3, bit 7) or - Synchronization voltage lower that value specified in INPUT LOGIC/F02.PCC option "Pulses ON Threshold for Local Controller"
ALARM 65 – WDOG PR2 FLT	Alarm output	Local Controller hardware failure **Source:** INPUT LOGIC/F19.PC3
ALARM 66 – THYRIS.FUSE FLT	Alarm output	Thyristor fuse blown in external power converter **Source:** INPUT LOGIC/F19.PC3
ALARM 67 – PULSE FLT	Alarm output	Loss of firing pulses in external power converter **Source:** INPUT LOGIC/F19.PC3
ALARM 68 – FAC FUSE FLT	Alarm output	AC filter fuse blown in external power converter **Source:** INPUT LOGIC/F19.PC3
ALARM 69 – FDC FUSE FLT	Alarm output	DC filter fuse blown in external power converter **Source:** INPUT LOGIC/F19.PC3
ALARM 70 – FAN1 BRK FLT	Alarm output	Fan 1 thermal protection active in external power converter **Source:** INPUT LOGIC/F19.PC3
ALARM 71 – FAN2 BRK FLT	Alarm output	Fan 2 thermal protection active in external power converter **Source:**

Name	Type	Description
		INPUT LOGIC/F19.PC3
ALARM 72 – FANS SYS1 OFF	Alarm output	Fan's system 1 supply turned off in external power converter **Source:** INPUT LOGIC/F19.PC3
ALARM 73 – FANS SYS2 OFF	Alarm output	Fan's system 2 supply turned off in external power converter **Source:** INPUT LOGIC/F19.PC3
ALARM 74 – SYNC FUSE FLT	Alarm output	Synchronization fuse blown in external power converter **Source:** INPUT LOGIC/F19.PC3
ALARM 75 – CTRL VOLTAGE FLT	Alarm output	Loss of control voltage in external power converter **Source:** INPUT LOGIC/F19.PC3
ALARM 76 – PRESS.FAN1 FLT	Alarm output	Fan 1 pressure failure in external power converter **Source:** INPUT LOGIC/F19.PC3
ALARM 77 – PRESS.FAN2 FLT	Alarm output	Fan 2 pressure failure in external power converter **Source:** INPUT LOGIC/F19.PC3
DUAL DISCONNECTOR	Option	Support for dual disconnector rectifier **Source:** INPUT LOGIC/F19.PC3

Operation

This function is responsible for external power converter control and diagnostics in the configuration with Local Controller device. Depending on number of external power converters used in the system appropriate number of Power Converter Diagnostic functions 17,18,19,20 should be activated in Tuning Software.

Function monitors binary W-Dog signal from Local Controller to check whether data transmitted by fiber optic link can be trusted and device is ready for operation..

Power converter with a Local Controller is considered healthy and ready for excitation if the following conditions are met:

- Watchdog signal is present, which includes
  - Internal supply voltage is present
  - Firing pulses supply is present
- Disconnector is closed

Power converter with a Local controller will be automatically disabled by main controller if any of following events occur:

- Watchdog signal loss, which includes
  - Loss of internal supply voltage
  - Loss of firing pulses supply
- Synchronization voltage loss
- Over temperature alarm STG 2
- Loss of communication

Power converter can be enabled/disabled at any time by user from HMI application. Necessary condition to execute disable command is that number of operating power converters must satisfy N-x where N is total number of power converters in the system and x

is maximum number of converters that may be disabled. This number is specified in Function 2.

Function supports two different types of power converters, based on type of disconnector used:

No	Configuration	Conditions
1	Dual Disconnector	• Option “DUAL DISCONNECTOR” is **ON**
2	Single Disconnector	• Option “DUAL DISCONNECTOR” is **OFF**

Typically single disconnector is in a form of 5-pole disconnector, dual disconnector in a form of independent 3-pole AC and 2-pole DC disconnectors. When option DUAL DISCONNECTOR is active both disconnectors must be closed to enable firing pulses.

Applicable settings

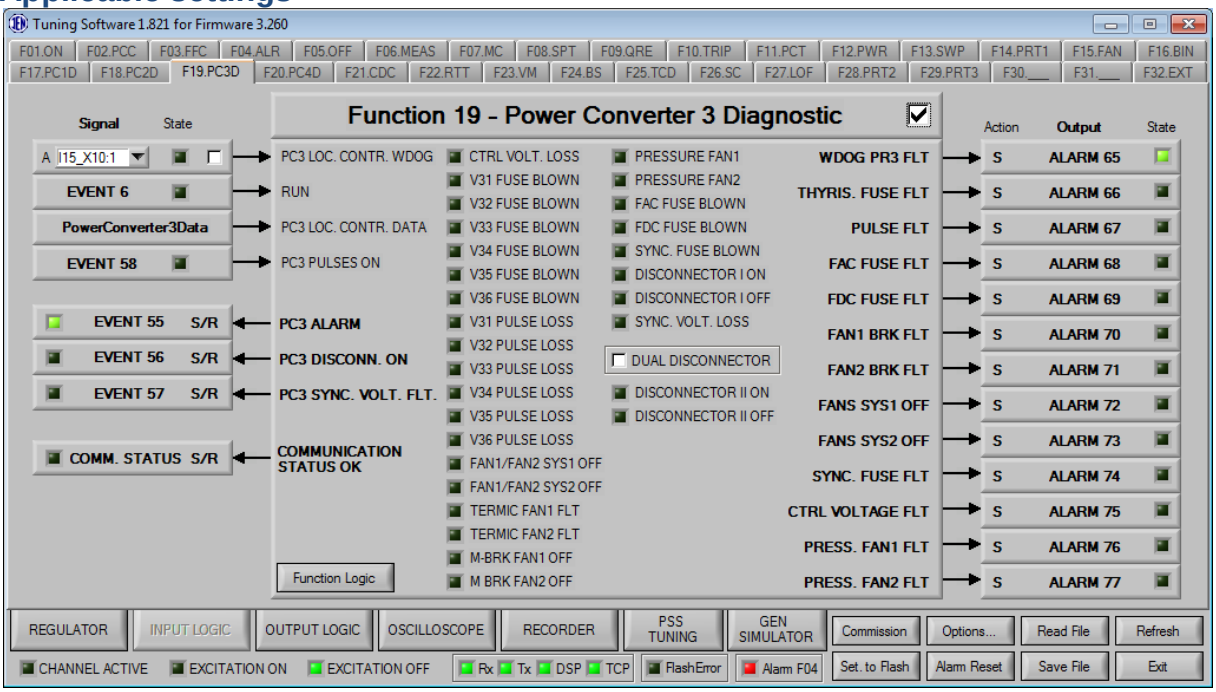


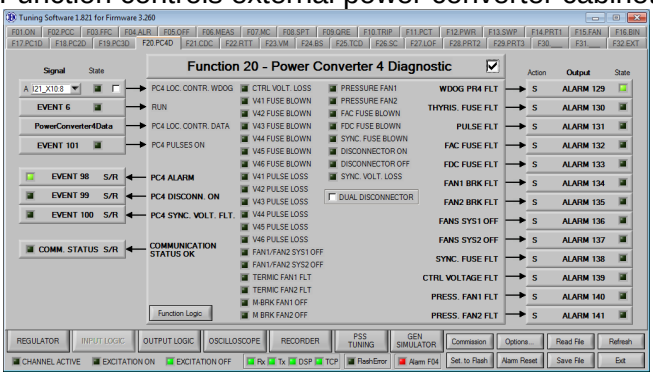
Fig. 87 Input logic tab of the Function number 19 (F19.PC3D)

Tips:

- ✓ Make sure Function 11 is activated to monitor temperature of power converter

3.21.20 Function 20: Power Converter 4 Diagnostic

Function controls external power converter cabinet



Operands

All function operands are listed in the table below.

Name	Type	Description
(A) PC4 LOC.CONTR.WDOG	Binary input	Indicates that Local Controller is healthy
EVENT 6 - RUN	Event input	Indicates excitation of AVR Logical high - excited **Source:** INPUT LOGIC/F01.ON **Pre-requirements:** - Channel is active (EVENT 7), ready for excitation (EVENT 92), not excited (EVENT 6), start command received (EVENT 80), field breaker is closed (EVENT 30) and: *For routine operation* - Braking disabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit open (EVENT 93) *For Braking* - Braking enabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit closed (EVENT 93), manual mode enabled (EVENT 11) *For Line Charge* - Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), manual mode enabled (EVENT 11), option “Line charge in Auto mode” not checked or: Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), auto mode enabled (EVENT 11), option “Line charge in Auto mode” checked
EVENT 101 – PC4 PULSES ON	Event input	Command to enable firing pulses in configuration with Local Controller Logical high - enabled **Source:** - INPUT LOGIC/F02.PCC **Pre-requirements:** - Channel excited (EVENT 06) - Channel active (EVENT 07) - “Thyristor Bridge, Local Controller mode” is

Name	Type	Description
		selected on Options/Advanced/Option "Power converter type" list - Synchronization is present (EVENT 100) - Healthy Watchdog INPUT LOGIC/F20.PC4.A - Closed disconnector (EVENT 99) - Enabled INPUT LOGIC/F20.PC4function
Power Converter Data	Register input	Data collected from local controller
EVENT 98 – PC4 ALARM	Event output	Indicates presence of alarm from Local Controller Logical high – alarm present **Source:** - INPUT LOGIC/F20.PC4 **Pre-requirements:**
EVENT 99 – PC4 DISCONN. ON	Event output	Indicates position of disconnector Logical high – closed **Source:** - INPUT LOGIC/F20.PC4 **Pre-requirements:**
EVENT 100 – PC4 SYNC.VOLT.FLT	Event output	Indicates loss of synchronization voltage in power converter in configuration with Local Controller Logical high – loss Delay: 20ms **Source:** - INPUT LOGIC/F20.PC4 **Pre-requirements:** - Logical high at binary information from Local Controller PC4Data_SyncFuse (register 2, bit 8) or - Logical high at binary information from Local Controller PC4Data_SyncVolt (register 3, bit 7) or - Synchronization voltage lower that value specified in INPUT LOGIC/F02.PCC option "Pulses ON Threshold for Local Controller"
ALARM 129 – WDOG PR2 FLT	Alarm output	Local Controller hardware failure **Source:** INPUT LOGIC/F20.PC4
ALARM 130 – THYRIS.FUSE FLT	Alarm output	Thyristor fuse blown in external power converter **Source:** INPUT LOGIC/F20.PC4
ALARM 131 – PULSE FLT	Alarm output	Loss of firing pulses in external power converter **Source:** INPUT LOGIC/F20.PC4
ALARM 132 – FAC FUSE FLT	Alarm output	AC filter fuse blown in external power converter **Source:** INPUT LOGIC/F20.PC4
ALARM 133 – FDC FUSE FLT	Alarm output	DC filter fuse blown in external power converter **Source:** INPUT LOGIC/F20.PC4
ALARM 134 – FAN1 BRK FLT	Alarm output	Fan 1 thermal protection active in external power converter **Source:** INPUT LOGIC/F20.PC4
ALARM 135 – FAN2 BRK FLT	Alarm output	Fan 2 thermal protection active in external power converter **Source:**

Name	Type	Description
		INPUT LOGIC/F20.PC4
ALARM 136 – FANS SYS1 OFF	Alarm output	Fan's system 1 supply turned off in external power converter **Source:** INPUT LOGIC/F20.PC4
ALARM 137 – FANS SYS2 OFF	Alarm output	Fan's system 2 supply turned off in external power converter **Source:** INPUT LOGIC/F20.PC4
ALARM 138 – SYNC FUSE FLT	Alarm output	Synchronization fuse blown in external power converter **Source:** INPUT LOGIC/F20.PC4
ALARM 139 – CTRL VOLTAGE FLT	Alarm output	Loss of control voltage in external power converter **Source:** INPUT LOGIC/F20.PC4
ALARM 140 – PRESS.FAN1 FLT	Alarm output	Fan 1 pressure failure in external power converter **Source:** INPUT LOGIC/F20.PC4
ALARM 141 – PRESS.FAN2 FLT	Alarm output	Fan 2 pressure failure in external power converter **Source:** INPUT LOGIC/F20.PC4
DUAL DISCONNECTOR	Option	Support for dual disconnector rectifier **Source:** INPUT LOGIC/F20.PC4

Operation

This function is responsible for external power converter control and diagnostics in the configuration with Local Controller device. Depending on number of external power converters used in the system appropriate number of Power Converter Diagnostic functions 17,18,19,20 should be activated in Tuning Software.

Function monitors binary W-Dog signal from Local Controller to check whether data transmitted by fiber optic link can be trusted and device is ready for operation..

Power converter with a Local Controller is considered healthy and ready for excitation if the following conditions are met:

- Watchdog signal is present, which includes
  - Internal supply voltage is present
  - Firing pulses supply is present
- Disconnector is closed

Power converter with a Local controller will be automatically disabled by main controller if any of following events occur:

- Watchdog signal loss, which includes
  - Loss of internal supply voltage
  - Loss of firing pulses supply
- Synchronization voltage loss
- Over temperature alarm STG 2
- Loss of communication

Power converter can be enabled/disabled at any time by user from HMI application. Necessary condition to execute disable command is that number of operating power converters must satisfy N-x where N is total number of power converters in the system and x

is maximum number of converters that may be disabled. This number is specified in Function 2.

Function supports two different types of power converters, based on type of disconnector used:

No	Configuration	Conditions
1	Dual Disconnector	• Option “DUAL DISCONNECTOR” is **ON**
2	Single Disconnector	• Option “DUAL DISCONNECTOR” is **OFF**

Typically single disconnector is in a form of 5-pole disconnector, dual disconnector in a form of independent 3-pole AC and 2-pole DC disconnectors. When option DUAL DISCONNECTOR is active both disconnectors must be closed to enable firing pulses.

Applicable settings

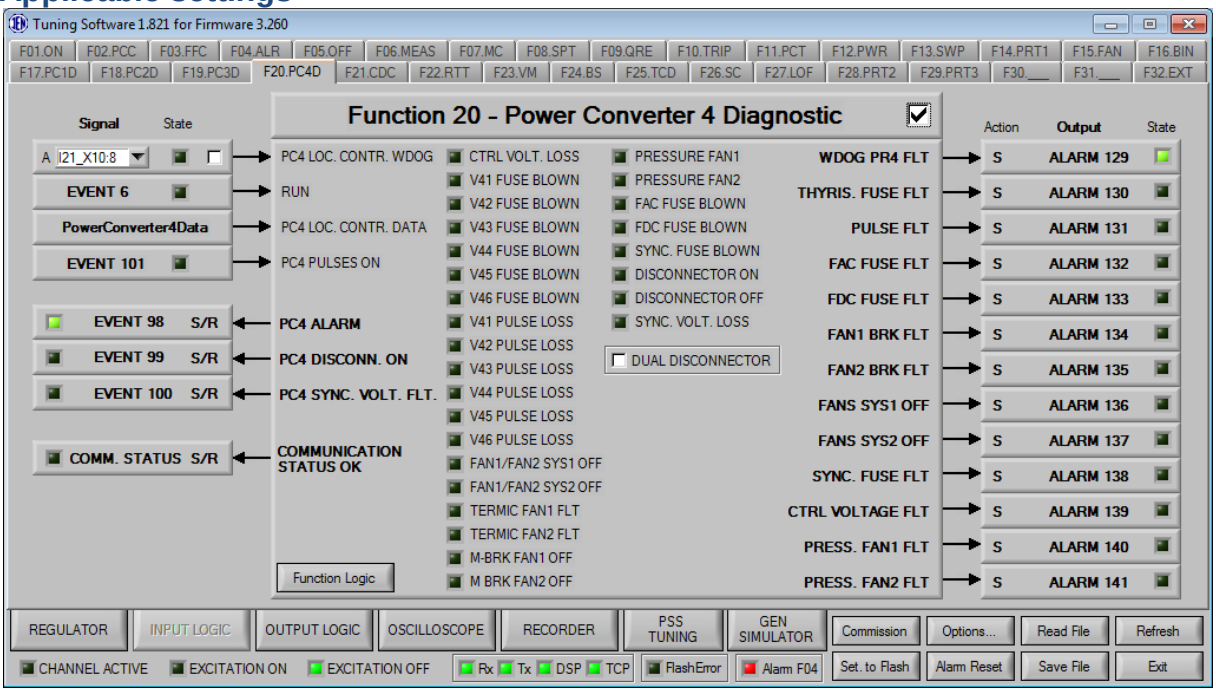


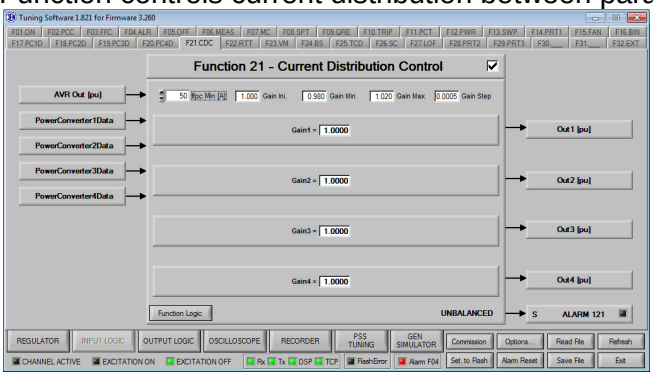
Fig. 88 Input logic tab of the Function number 20 (F20.PC4D)

Tips:

- ✓ Make sure Function 11 is activated to monitor temperature of power converter

3.21.21 Function 21: Current Distribution Control

Function controls current distribution between parallel power converters



Operands

All function operands are listed in the table below.

Name	Type	Description
Power Converter's Data	Register input	Data collected from all local controllers
AVR Out	Register input	Firing angle from control loop
Out 1	Register output	Firing angle gain for power converter 1
Out 2	Register output	Firing angle gain for power converter 2
Out 3	Register output	Firing angle gain for power converter 3
Out 4	Register output	Firing angle gain for power converter 4
ALARM 121 – UNBALANCED	Alarm output	Difference between currents in two power converters higher than 40% for time longer than 15 minutes **Source:** INPUT LOGIC/F21.CDC
Ifpc [A]	Option	Minimum current of power converter to activate distribution control

Operation

This function is responsible for control of distribution of Field current between power converters. Based on measurement of field current from every power converter in the system correction signal is calculated and added accordingly to their control signals. This functionality allows to distribute field currents between power converters equally.

Applicable settings

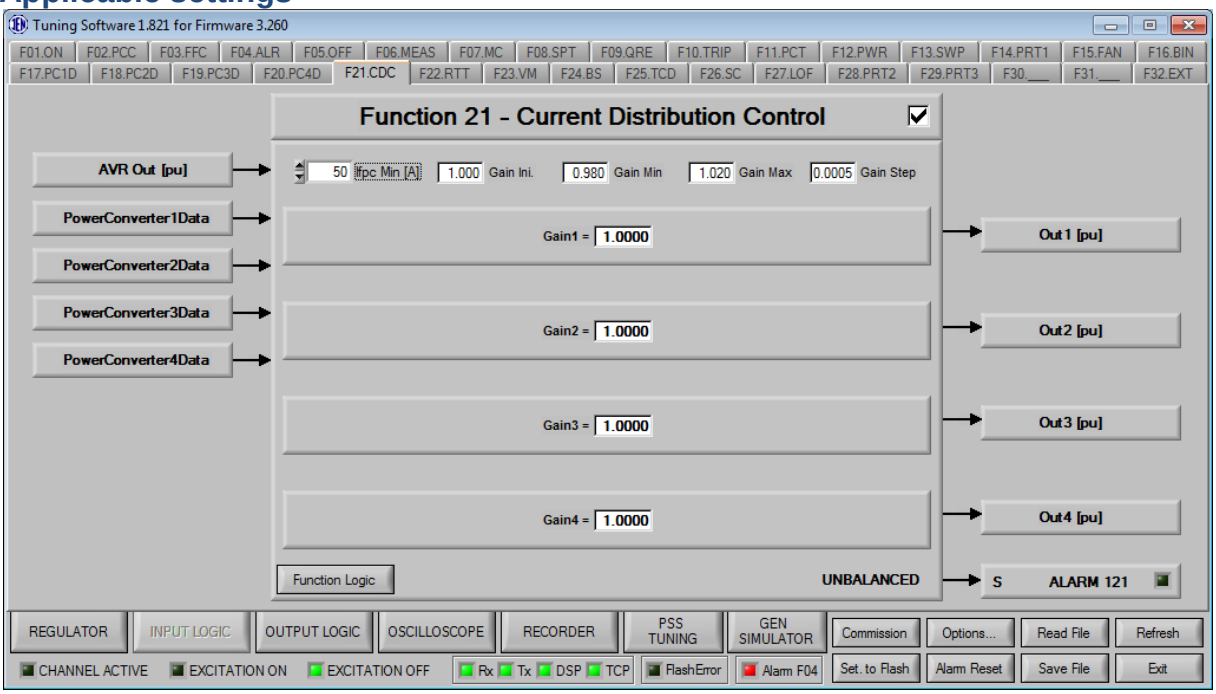
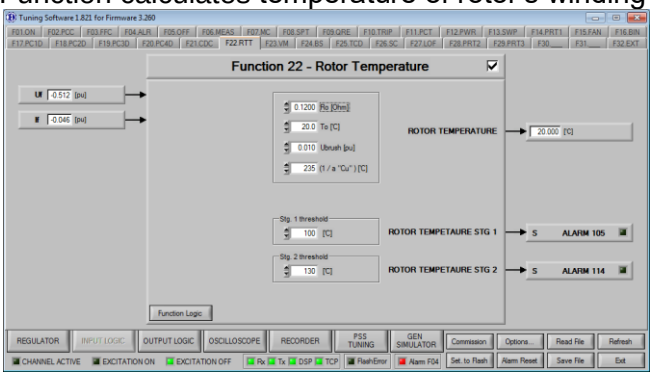


Fig. 89 Input logic tab of the Function number 21 (F21.CDC)

3.21.22 Function 22: Rotor Temperature

Function calculates temperature of rotor's winding



Operands

All function operands are listed in the table below.

Name	Type	Description
Uf	Register measurements	Field voltage measurement
If	Register measurements	Field current measurement
Rotor temperature	Register output	Calculated temperature of rotor's winding
ALARM 105 – ROTOR TEMPERATURE STG 1	Alarm output	Rotor temperature exceeded threshold 1 **Source:** INPUT LOGIC/F22.RTT
ALARM 114 – ROTOR TEMPERATURE STG 2	Alarm output	Rotor temperature exceeded threshold 1 **Source:** INPUT LOGIC/F22.RTT
Ro [Ohm]	Option	Rotor resistance at 'To' temperature
To ['C]	Option	Temperature at which 'Ro' was measured
Ubrush [pu]	Option	Voltage drop at brushes
1/a"Cu"	Option	Temperature coefficient
Stg1 threshold	Option	Level of temperature to generate alarm 105
Stg 2 threshold	Option	Level of temperature to generate alarm 114

Operation

This function calculates estimate of rotor temperature based on field voltage and current measurements. Monitoring over rotor temperature is handled by two stages of alarm threshold which constantly check if rotor temperature is not rising too high.

Applicable settings

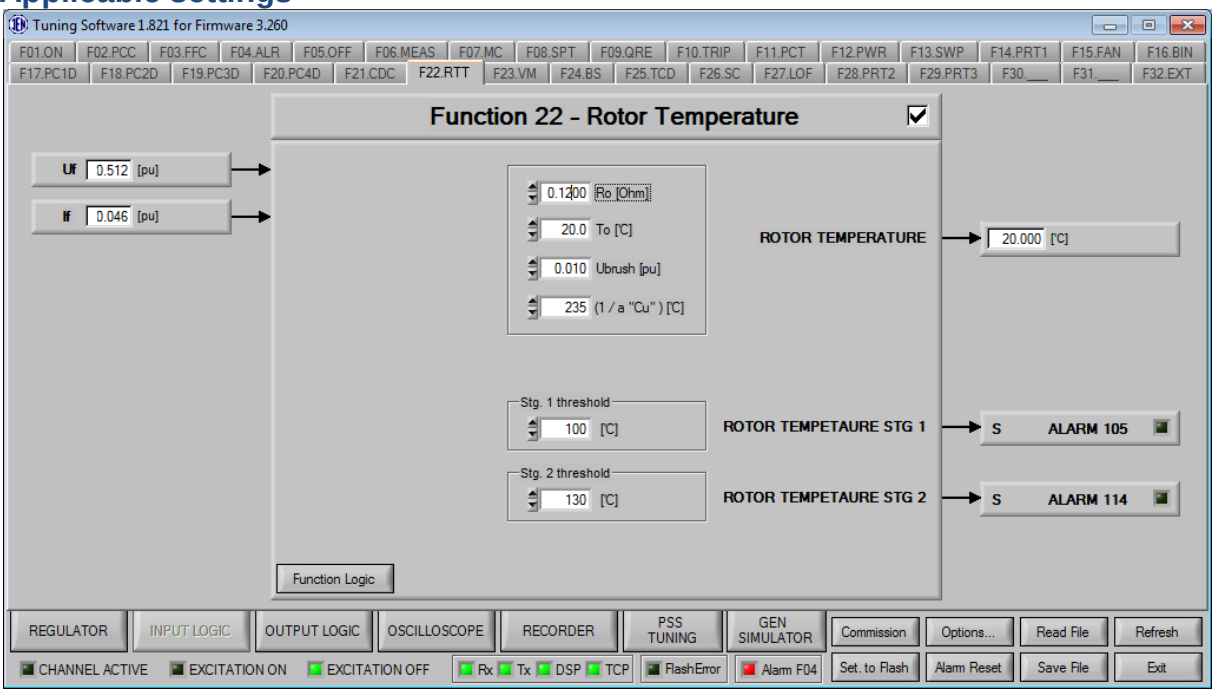


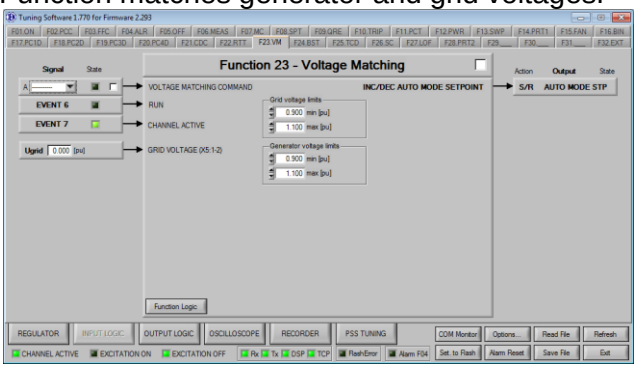
Fig. 90 Input logic tab of the Function number 22 (F22.RTT)

Tips:

- ✓ Make sure field voltage and current are measured precisely as function is vulnerable to measurement deviations. Especially negative amplitude of field voltage should be taken into account.

3.21.23 Function 23: Voltage Matching

Function matches generator and grid voltages.



Operands

All function operands are listed in the table below.

Name	Type	Description
(A) VOLTAGE MATCHING COMMAND	Binary input	Activates (high) or deactivates (low) voltage matching
EVENT 6 - RUN	Event input	Indicates excitation of AVR, 1 - excited
EVENT 7 – CHANNEL ACTIVE	Event input	Information about channel's activity, 1 - active
Ugrid [pu] – GRID VOLTAGE	Register measurements	Grid voltage measurement from input X5:1-2
AUTO MODE STP	Internal command	Command to increase/decrease automatic mode setpoint
ALARM 103 – U GRID MEAS LOSS	Alarm output	Loss of grid voltage measurement from terminals X5:1-2 **Source:** INPUT LOGIC/F23.VM
Grid voltage limits	Option	Range of grid voltage for function to operate
Generator voltage limits	Option	Range of generator voltage for function to operate

Operation

Function adjusts amplitude of generator voltage within specified range to match amplitude of grid voltage. Voltage matching is specific P100C-SX regulator functionality which allows to modify automatic mode step value by 25% of Auto mode setpoint step periodically to match generator voltage with grid voltage when working in no-load condition with accuracy of ±0.001 pu

.

This function is active if following conditions are met:

- Both generator voltage and grid voltage values are between min/max thresholds
- Generator breaker is closed
- System is excited
- AVR in automatic mode (stator voltage regulation)
- Binary command is active

Network measurement of grid voltage is applied to P100C-SX as +/- 10V input X5.1-2. Transformer values for scaling of Ugrid measurement can be set in “options” external transducer settings as “Uprimary”,”Usecondary” values

Applicable settings

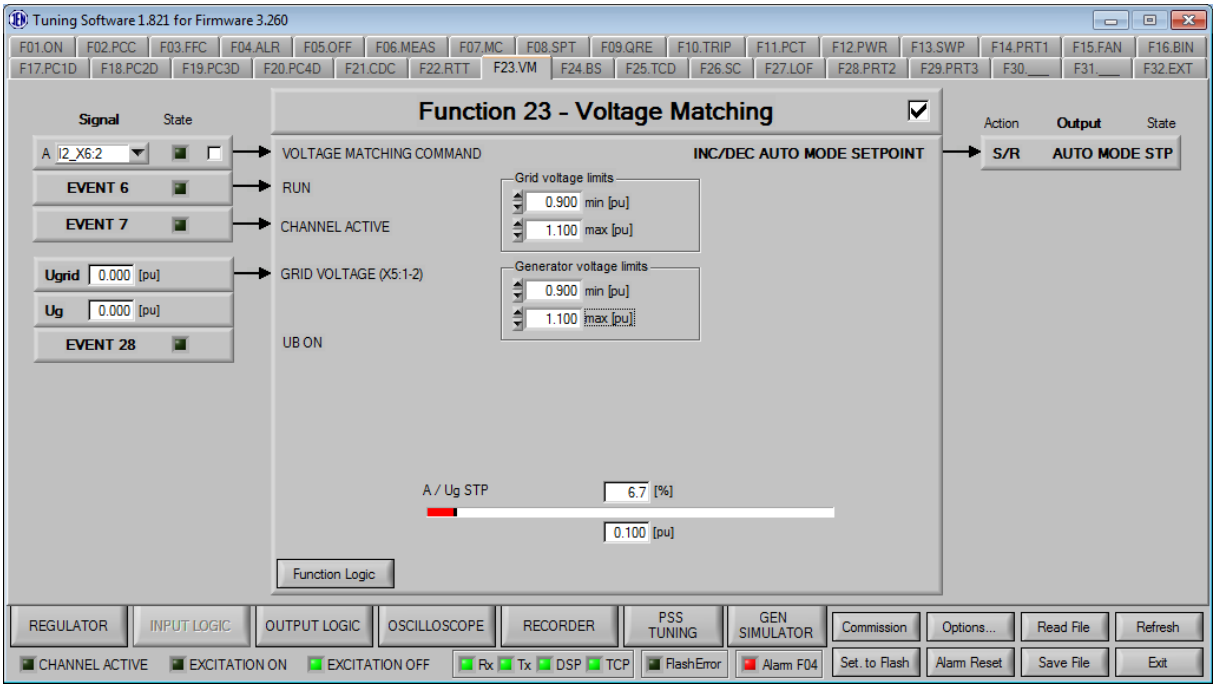


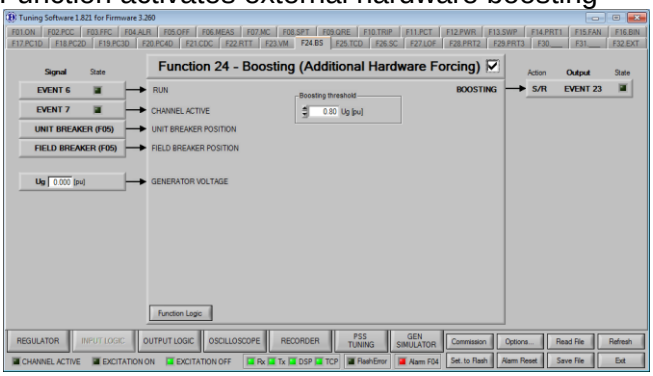
Fig. 91 Input logic tab of the Function number 23 (F23.VMAT)

Tips:

- ✓ Function will be automatically deactivated if generator breaker becomes closed

3.21.24 Function 24: Boosting

Function activates external hardware boosting



Operands

All function operands are listed in the table below.

Name	Type	Description
EVENT 6 - RUN	Event output	Indicates excitation of AVR Logical high - excited **Source:** INPUT LOGIC/F01.ON **Pre-requirements:** - Channel is active (EVENT 7), ready for excitation (EVENT 92), not excited (EVENT 6), start command received (EVENT 80), field breaker is closed (EVENT 30) and: *For routine operation* - Braking disabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit open (EVENT 93) *For Braking* - Braking enabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit closed (EVENT 93), manual mode enabled (EVENT 11) *For Line Charge* - Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), manual mode enabled (EVENT 11), option “Line charge in Auto mode” not checked or: - Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), auto mode enabled (EVENT 11), option “Line charge in Auto mode” checked
EVENT 7 – CHANNEL ACTIVE	Event input	Indicates activity of channel Logical high - active **Source:** INPUT LOGIC/F13.SWP **Pre-requirements:** - Other channel is faulty INPUT LOGIC/F13.IN8 or - Other channel send SWAP command INPUT LOGIC/F13.IN7

Name	Type	Description
EVENT 28 – UB ON	Event output	Position of unit breaker If closed it disables stop command Logical high – closed **Source:** - INPUT LOGIC/F05.OFF.E **Pre-requirements:**
EVENT 30 – FB ON	Event output	Position of field breaker Logical high - closed **Source:** INPUT LOGIC/F01.ON.B **Pre-requirements:** - logic high on INPUT LOGIC/F01.ON.B
Ug [pu] – GENERATOR VOLTAGE	Register measurements	Generator voltage measurement
EVENT 23 – BOOSTING	Event output	Command to activate boosting – additional source of current for field winding Logical high – enabled Duration: 10 seconds Disabled for 15 minutes after activation **Source:** - INPUT LOGIC/F24.BS **Pre-requirements:** - Channel excited (EVENT 06) - Channel active (EVENT 07) - Auto mode active (EVENT 11) - Field Breaker closed (EVENT 30) - Unit Breaker closed (EVENT 28) - Last activation of boosting was longer than 15 minutes before - Generator voltage dropped below INPUT LOGIC/F24.BS “Boosting threshold” - Generator voltage present (EVENT 9)
Boosting threshold	Option	Boosting activation level

Operation

Function activates boosting operation if sufficient drop in generator voltage is detected. After single boosting operation function provides time necessary for boosting hardware to cool down.

Boosting function can in emergency situation increase regulator current from for eg. external battery if generator voltage decreases below value set in “Boosting threshold” field. Thanks to boosting function it is possible to maintain regulation in response to load changes. For example boosting circuit can be used on shunt excitation to supply the excitation circuit when the shunt excitation transformer is too low (for example during network short circuit). In this way we help the generator to eliminate this fault.

The boosting current is limited to the excitation current ceiling value, for internal IGBT configuration 100 A.

To enable the boosting sequence following conditions must be met:

- AVR in automatic mode (EVENT 11)
- Channel active (EVENT 7)
- Excited (EVENT 6)
- Field breaker closed (EVENT 30)
- Generator / line breaker closed (EVENT 28)
- Generator voltage at least once 0.03 pu above boosting threshold value
- Generator voltage measurement present (EVENT 9)

- Generator voltage dropped below boosting threshold

Once enabled, boosting sequence will be stopped if generator voltage will increase 0.1pu above boosting threshold level or it will last for longer than 10 seconds.

After deactivation, boosting will be disabled for 15 minutes - time necessary to cool down boosting hardware.

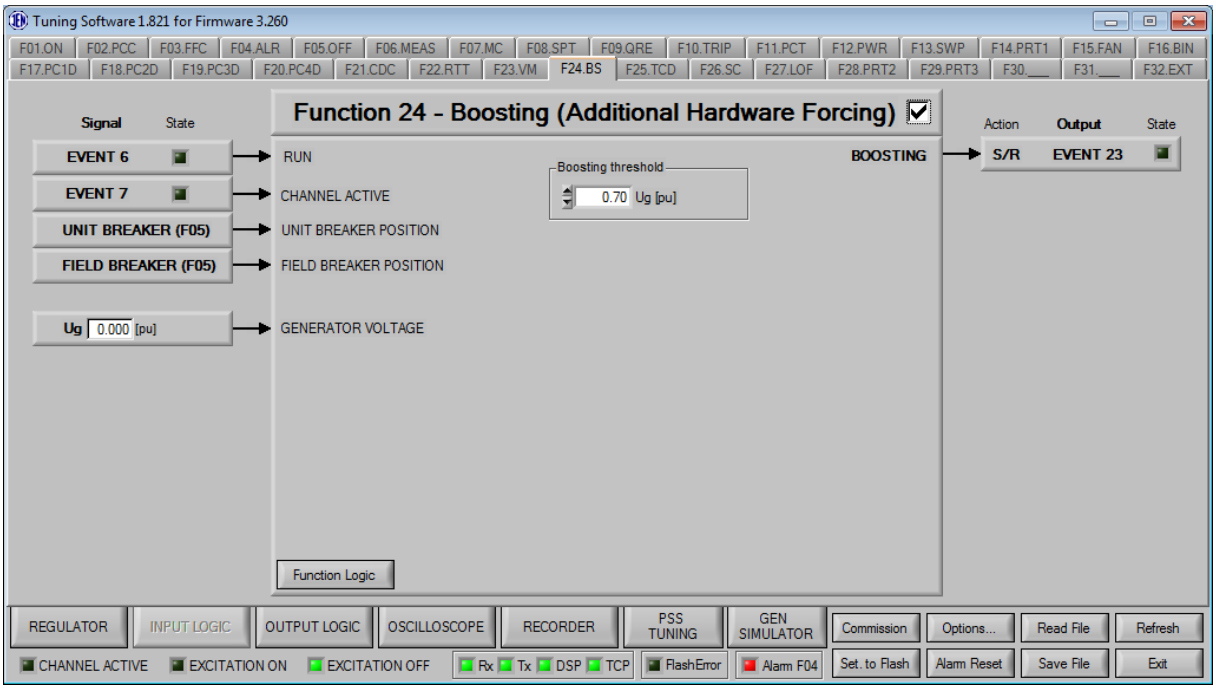


Fig. 3.41.26. Input logic tab of the Function number 24 (F24.BST)

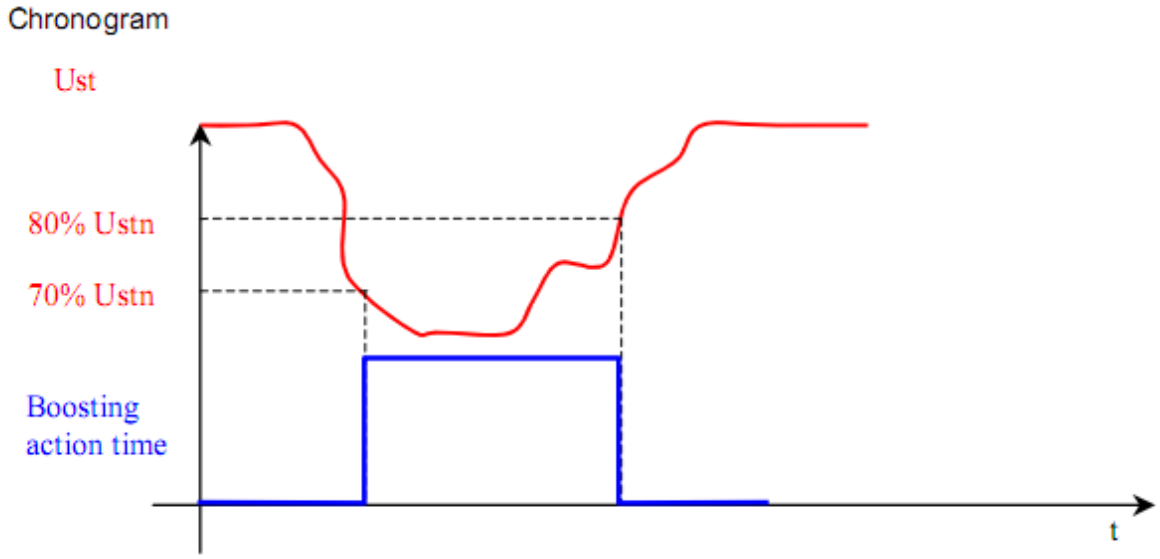


Fig. 92 Chronogram for boosting sequence action

Logic function for boosting sequence:

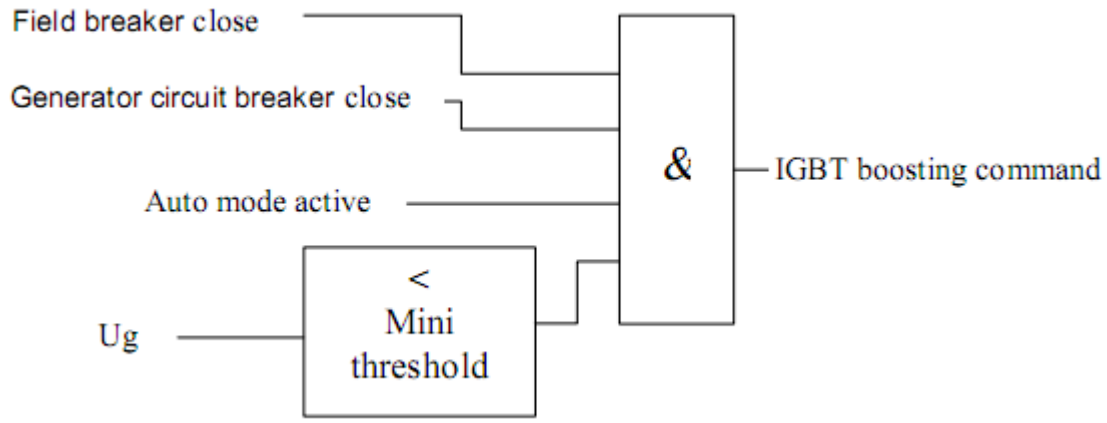


Fig. 93 Logic function for boosting sequence

In configuration with IGBT boosting circuit acts as a DC standby supply connected to terminals X9:1-2. Where T2 is used for boosting but it also can be used for field flashing.

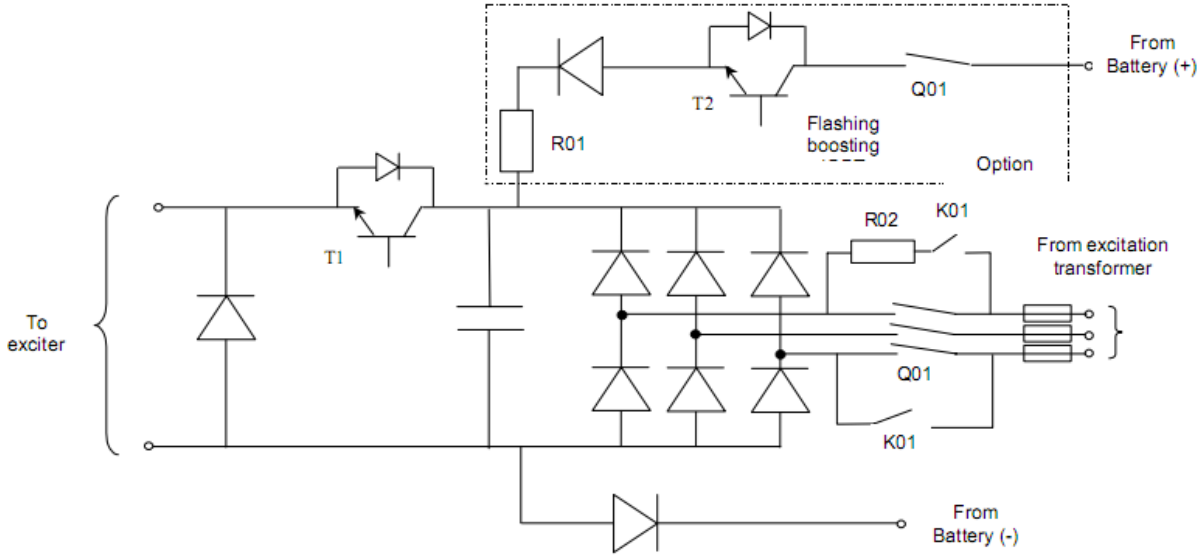


Fig. 94 Boosting circuit for configuration with IGBT rectifier

In configuration with a thyristor bridge rectifier the boosting circuit will be parallel to the main rectifier bridge.

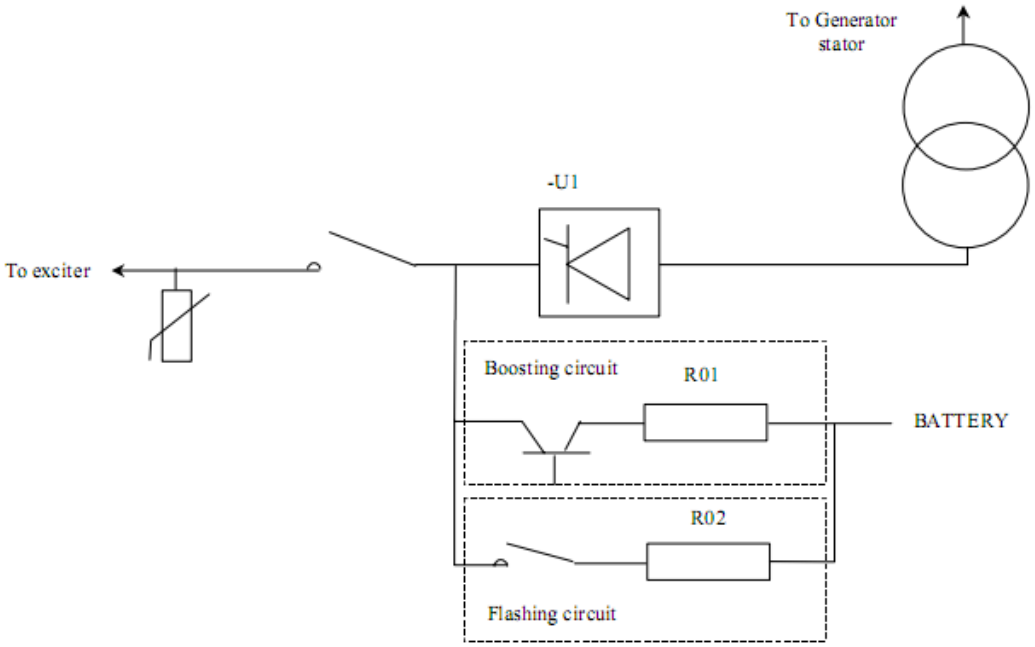
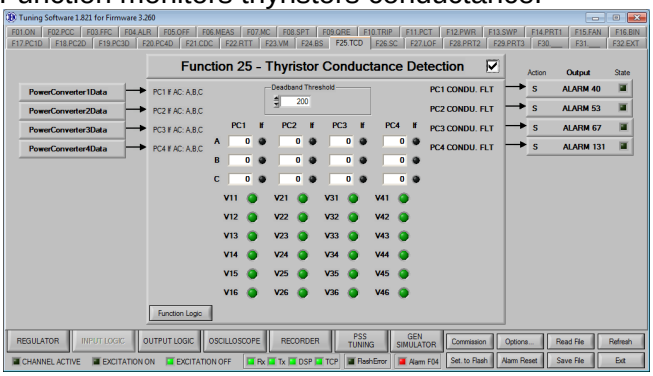


Fig. 95 Boosting circuit for configuration with thyristor bridge

3.21.25 Function 25: Thyristor Conductance Detection

Function monitors thyristors conductance.



Operands

All function operands are listed in the table below.

Name	Type	Description
Power Converter's Data	Register input	Data collected from all local controllers
ALARM 40– PC 1 CONDU. FLT	Alarm output	One or more thyristors in rectifier 1 is not conducting **Source:** INPUT LOGIC/F25.TCD or INPUT LOGIC/F17.PC1
ALARM 53– PC 2 CONDU. FLT	Alarm output	One or more thyristors in rectifier 2 is not conducting **Source:** INPUT LOGIC/F25.TCD or INPUT LOGIC/F18.PC2
ALARM 67– PC 3 CONDU. FLT	Alarm output	One or more thyristors in rectifier 3 is not conducting **Source:** INPUT LOGIC/F25.TCD or INPUT LOGIC/F19.PC3
ALARM 131– PC 4 CONDU. FLT	Alarm output	One or more thyristors in rectifier 4 is not conducting **Source:** INPUT LOGIC/F25.TCD or INPUT LOGIC/F20.PC4
Deadband threshold	Option	Deadband for conduction detection

Operation

Based on field current measurement on AC side of power converter this function monitors operation of thyristors and indicates if irregularity in conductance appears. For each active power converter under diagnostics field current measurement for each of three phases R, S, T can be found in the middle of function screen. If there would be a problem with conductance on any of the thyristors it will be indicated on red/green LEDs. Even single thyristor fault will cause conductance fault alarm from power converter. "TCD threshold" allows to set minimal value of field current required for conductance detection to work.

Applicable settings

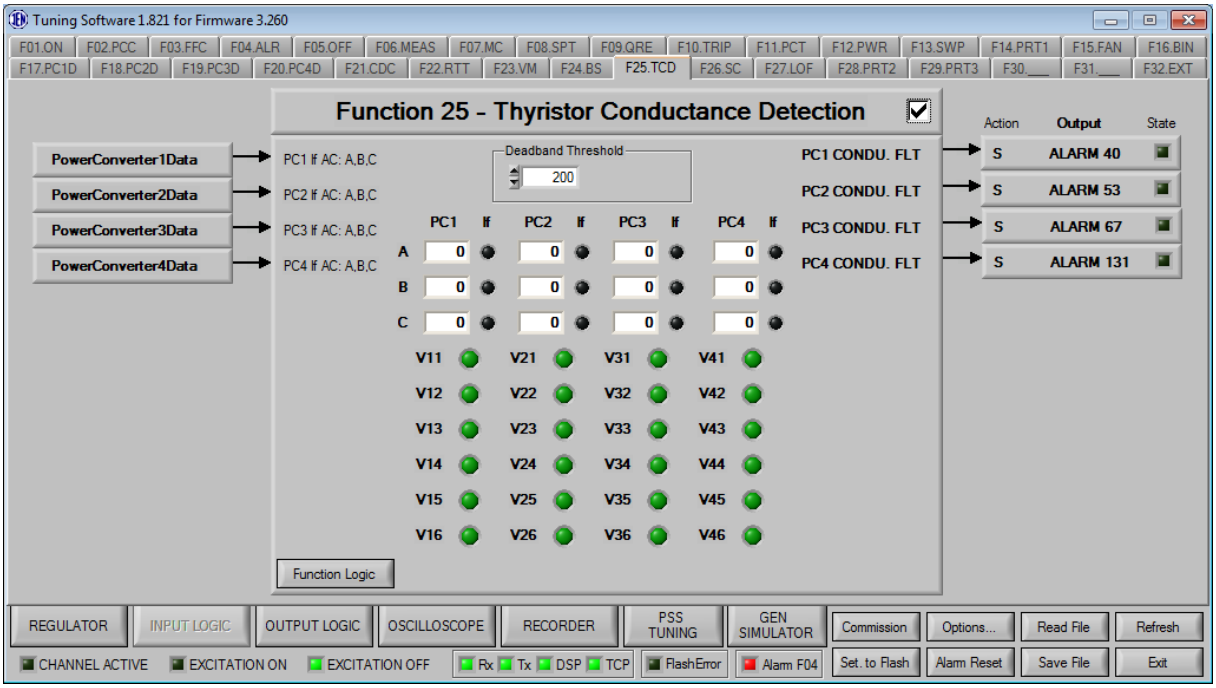
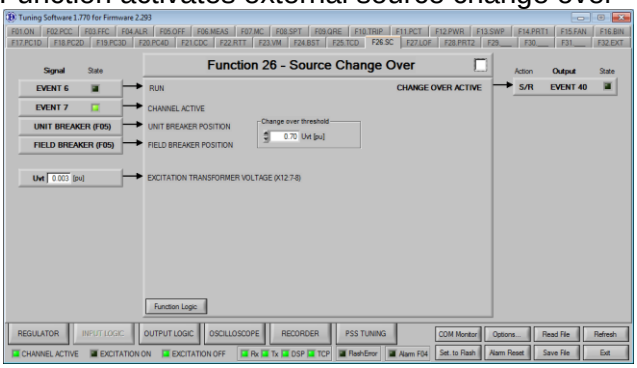


Fig. 96 Input logic tab of the Function number 25 (F25.TCD)

3.21.26 Function 26: Source Change Over

Function activates external source change over



Operands

All function operands are listed in the table below.

Name	Type	Description
EVENT 6 - RUN	Event output	Indicates excitation of AVR Logical high - excited **Source:** INPUT LOGIC/F01.ON **Pre-requirements:** - Channel is active (EVENT 7), ready for excitation (EVENT 92), not excited (EVENT 6), start command received (EVENT 80), field breaker is closed (EVENT 30) and: *For routine operation* - Braking disabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit open (EVENT 93) *For Braking* - Braking enabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit closed (EVENT 93), manual mode enabled (EVENT 11) *For Line Charge* - Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), manual mode enabled (EVENT 11), option “Line charge in Auto mode” not checked or: - Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), auto mode enabled (EVENT 11), option “Line charge in Auto mode” checked
EVENT 7 – CHANNEL ACTIVE	Event input	Indicates activity of channel Logical high - active **Source:** INPUT LOGIC/F13.SWP **Pre-requirements:** - Other channel is faulty INPUT LOGIC/F13.IN8 or - Other channel send SWAP command INPUT LOGIC/F13.IN7

Name	Type	Description
EVENT 28 – UB ON	Event output	Position of unit breaker If closed it disables stop command Logical high – closed **Source:** - INPUT LOGIC/F05.OFF.E **Pre-requirements:**
EVENT 30 – FB ON	Event output	Position of field breaker Logical high - closed **Source:** INPUT LOGIC/F01.ON.B **Pre-requirements:** - logic high on INPUT LOGIC/F01.ON.B
Uvt [pu] – EXCITATION TRANSFORMER VOLTAGE	Register measurements	Excitation transformer voltage measurement from X12:7-8 terminals
EVENT 40 – CHANGE OVER ACTIVE	Event output	Indicates activation of Source Change Over sequence Logical high - active **Source:** INPUT LOGIC/F26.SC **Pre-requirements:** - Channel excited (EVENT 06) - Channel active (EVENT 07) - Field Breaker closed (EVENT 30) - Unit Breaker closed (EVENT 28) - Excitation supply dropped below INPUT LOGIC/F26.SC “Change over threshold”
Change over threshold	Option	Source change over activation level

Operation

Function activates supply source change over if sufficient drop in excitation transformer voltage is detected.

For the application with a excitation transformer supplied by a LV transformer (which come from an Normal/standby supply of an LV switchboard) it can be possible to use second transformer in case of a loss of excitation transformer voltage like a source change over (the sequence is the same as the boosting but we monitor the excitation transformer voltage instead of the stator voltage and we activate the source change over on a low voltage level).

To enable source change over following conditions must be met:

- Channel active (EVENT 7)
- Excited (EVENT 6)
- Field breaker closed (EVENT 30)
- Generator / line breaker closed (EVENT 28)

If Uvt voltage becomes lower than threshold value set in “Change over threshold” function automatically will try to force change over.

To disable change over procedure measurement of supply voltage must increase 0.1 pu above change over threshold value.

Measurement of voltage transformer voltage needs to be connected to X12.7-8 analog input (no additional software configuration for input is required as it is predefined input for voltage transformer voltage). Transformer values for scaling of Uvt measurement can be set in “options” external transducer settings as “Uprimary”,”Usecondary” values.

With an IGBT circuit the current is regulated by the AVR and with a thyristor bridge same circuit is added as boosting in parallel with current limited to 2/3 of Ifn.

Applicable settings

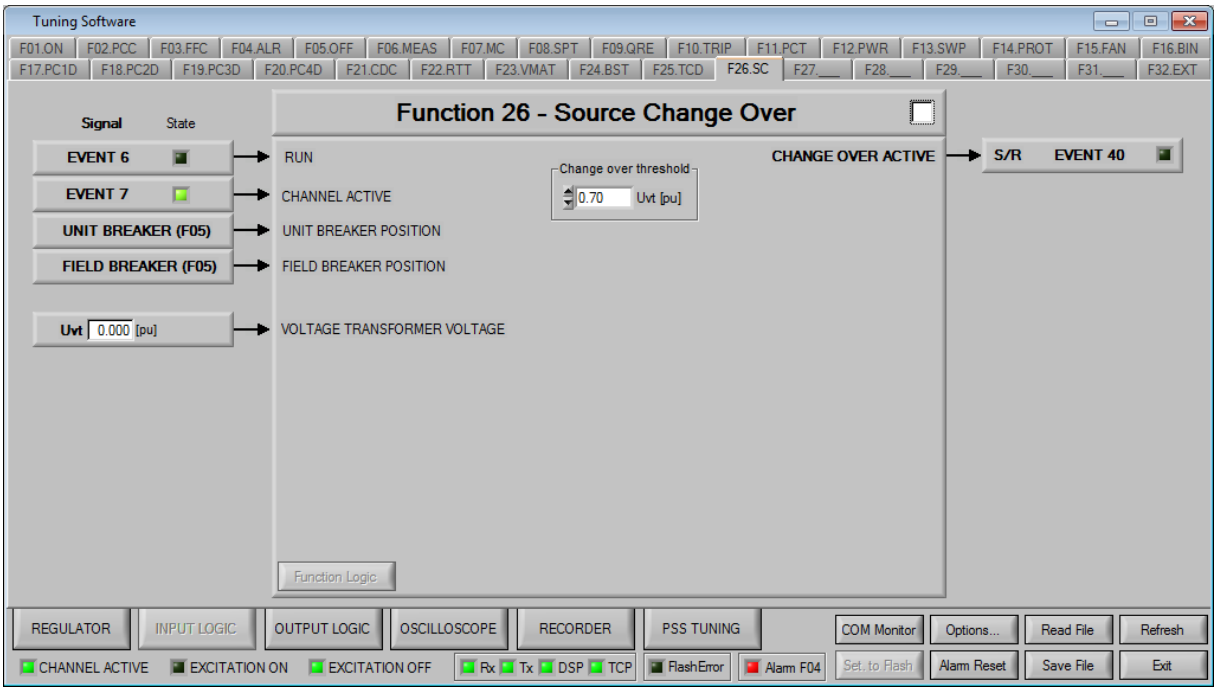
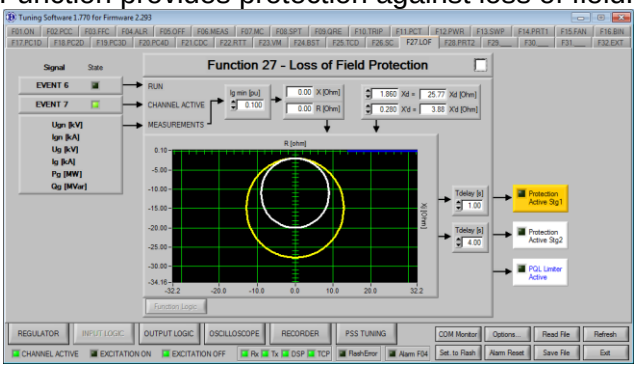


Fig. 97 Input logic tab of the Function number 26 (F26.SC)

3.21.27 Function 27: Loss Of Field Protection

Function provides protection against loss of field.



Operands

All function operands are listed in the table below.

Name	Type	Description
EVENT 6 - RUN	Event output	Indicates excitation of AVR Logical high - excited **Source:** INPUT LOGIC/F01.ON **Pre-requirements:** - Channel is active (EVENT 7), ready for excitation (EVENT 92), not excited (EVENT 6), start command received (EVENT 80), field breaker is closed (EVENT 30) and: *For routine operation* - Braking disabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit open (EVENT 93) *For Braking* - Braking enabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit closed (EVENT 93), manual mode enabled (EVENT 11) *For Line Charge* - Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), manual mode enabled (EVENT 11), option “Line charge in Auto mode” not checked or: - Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), auto mode enabled (EVENT 11), option “Line charge in Auto mode” checked
EVENT 7 – CHANNEL ACTIVE	Event input	Indicates activity of channel Logical high - active **Source:** INPUT LOGIC/F13.SWP **Pre-requirements:** - Other channel is faulty INPUT LOGIC/F13.IN8 or - Other channel send SWAP command INPUT LOGIC/F13.IN7

Name	Type	Description
Ug [kV], Ig [kA], Pg [MW], Qg [MVar]	Register measurements	Generator voltage, current, active and reactive power measurements
Ugn [kV], Ign [kA]	Option	Generator nominal voltage and current
Xd	Option	Generator synchronous reactance, determines protection activation levels
X'd	Option	Generator transient reactance, determines protection activation levels
Ig min [pu]	Option	Minimal generator current for protection activation
Tdelay I [s]	Option	Delay of protection activation stage 1
Tdelay II [s]	Option	Delay of protection activation stage 2
ALARM 88 – PROTECTION STG1	Alarm output	Loss of Field Protection stage 1 active (big circle) **Source:** INPUT LOGIC/F27.LOF
ALARM 89 – PROTECTION STG2	Alarm output	Loss of Field Protection stage 2 active (small circle) **Source:** INPUT LOGIC/F27.LOF

Operation

Function detects a loss of excitation by metering the apparent impedance based on generator parameters (nominal voltage and current) and measurements (generator current, active and reactive powers). In a loss of field situation, calculated apparent impedance is capacitive, and is located at the third and fourth quadrants of R-X diagram.

To recognize this situation, impedance circles are used, bigger one for detecting partial excitation losses, and a smaller one for detecting total losses. Their position and diameter are determined by generator reactance as follows:

The yellow circle: diameter = Xd, offset = 0.5 * X'd.
The white circle: diameter = 0.7 * Xd, offset = 0.5 * X'd.

Conditions required for a protection to operate:

1. AVR is excited
2. Channel is active
3. Field breaker is closed
4. Generator current is higher than predefined minimum Ig min
5. Generator impedance locus falls into a yellow (or white) circle and any of the following is true:
    - Falls permanently for a period of time longer than Tdelay1 (or Tdelay2)
    - Falls temporarily during oscillations period if the total time inside the circle is longer than Tdelay1 (or Tdelay2) and period outside is never longer than 2 seconds

For a protection to give a TRIP signal, alarms 88 and 89 should be configurated in Function 10.

To simplify selection and comparison of setting between underexcitation limiter PQL and protection, blue line representing underexcitation limiter is also plotted on the R-X diagram.

Applicable settings

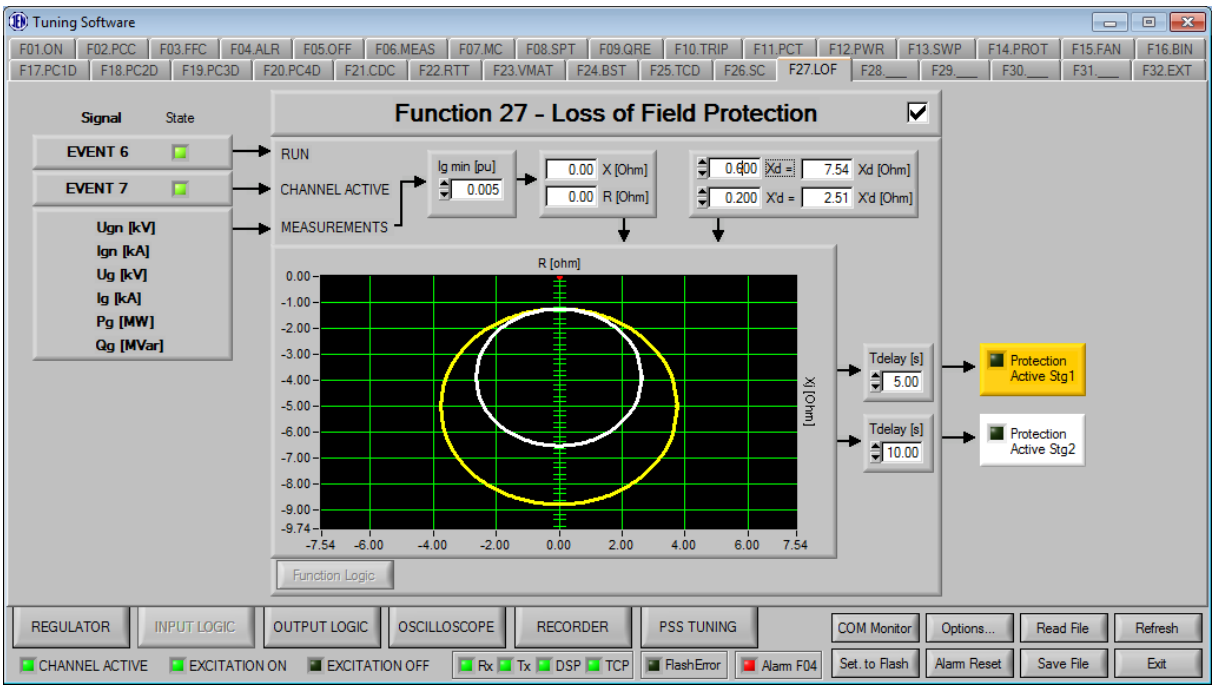
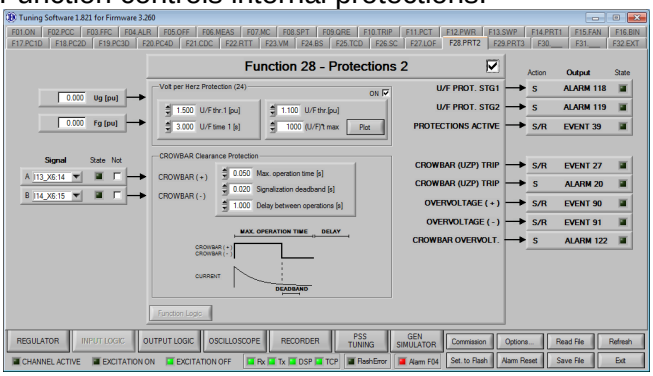


Fig. 98 Input logic tab of the Function number 27 (F27.LOF)

3.21.28 Function 28: Protections 2

Function controls internal protections.



Operands

All function operands are listed in the table below.

Name	Type	Description
(A) CROWBAR (+)	Binary input	Positive field overvoltage signalization from external CROWBAR device
(B) CROWBAR (-)	Binary input	Negative field overvoltage signalization from external CROWBAR device
Ug [pu] – GENERATOR VOLTAGE	Register measurements	Generator voltage measurement
Fg [pu] – GENERATOR FREQUENCY	Register measurements	Generator frequency measurement
ALARM 20 – CROWBAR (UZP) TRIP	Alarm output	CROWBAR field overvoltage protection trip **Source:** INPUT LOGIC/F28.PRT2
ALARM 118 – U/F PROT. STG 1	Alarm output	Volts per hertz protection activation stage 1 – definite time **Source:** INPUT LOGIC/F28.PRT2
ALARM 119 – U/F PROT. STG 2	Alarm output	Volts per hertz protection activation stage 2 – inverse time **Source:** INPUT LOGIC/F28.PRT2
ALARM 122 – CROWBAR OVERVOLT.	Alarm output	CROWBAR field overvoltage protection pickup **Source:** INPUT LOGIC/F28.PRT2
EVENT 27 – CROWBAR (UZP) TRIP	Event output	CROWBAR field overvoltage protection trip Logical high - activated **Source:** - INPUT LOGIC/ F28.PRT2 **Pre-requirements:**
EVENT 39 – PROTECTIONS ACTIVE	Event output	Indicates activation of any of the protections Logical high – active **Source:** - Input INPUT LOGIC/F14.PRT1 or - Input INPUT LOGIC/F28.PRT2 or - Input INPUT LOGIC/F29.PRT3 **Pre-requirements:**

Name	Type	Description
EVENT 90 – OVERVOLTAGE (+)	Event output	CROWBAR positive (+) field overvoltage protection pickup Logical high - activated **Source:** - INPUT LOGIC/ F28.PRT2.A **Pre-requirements:**
EVENT 91 – OVERVOLTAGE (-)	Event output	CROWBAR negative (-) field overvoltage protection pickup Logical high - activated **Source:** - INPUT LOGIC/ F28.PRT2.B **Pre-requirements:**

Operation

This function is responsible for handling of Volts per hertz (24) and CROWBAR protections. Each of this protection can be individually turned on and off by using corresponding checkboxes next to their protections parameters.

Volts per hertz (24):

Controller is equipped with one definite-time protection and one inverse time protection.
For definite-time protection there is one activation threshold “U/F thr 1” and one activation delay time “U/F time 1” corresponding to the thresholds. After exceeding one of the thresholds, when the corresponding time delay has expired, this protection generates Event 39 and ALARM 118/ALARM 119, which can be associated with hardware resources.

Sending a “TRIP” signal is recommended as excessive magnetic flux if sustained can cause serious overheating and may result in damage to the unit transformer and to the generator core

CROWBAR field overvoltage protection:

A crowbar circuit is an electrical circuit used to prevent an overvoltage condition of a power supply unit from damaging the circuits attached to the power supply. It operates by putting a low resistance path across the voltage output.

Protection can be configurated as passive or active:

- Active crowbar is a crowbar that can remove the short circuit when the transient is over thus allowing the device to resume normal operation. To configurate protection as active proper time settings must be provided:
    - Max operation time [s] – Maximum time for CROWBAR to successfully clear overvoltage, includes signalization Deadband time. When max operation time expires, EVENT 27 is generated.
    - Signalization Deadband [s] – Specifies time the protection is latched after signalization drops out. Ensures the overvoltage has been cleared permanently.
    - Delay between operations [s] – Minimum time between subsequent over voltages. If two over voltage events happens before this time expires, EVENT 27 is generated immediately.
- Passive crowbar, once activated will energize EVENT 27. To configurate protection as passive all time settings should be set to zero.

Sending a “TRIP” signal is recommended as overvoltage if sustained can cause serious damage to the isolation of rotor winding and power converter equipment.

Applicable settings

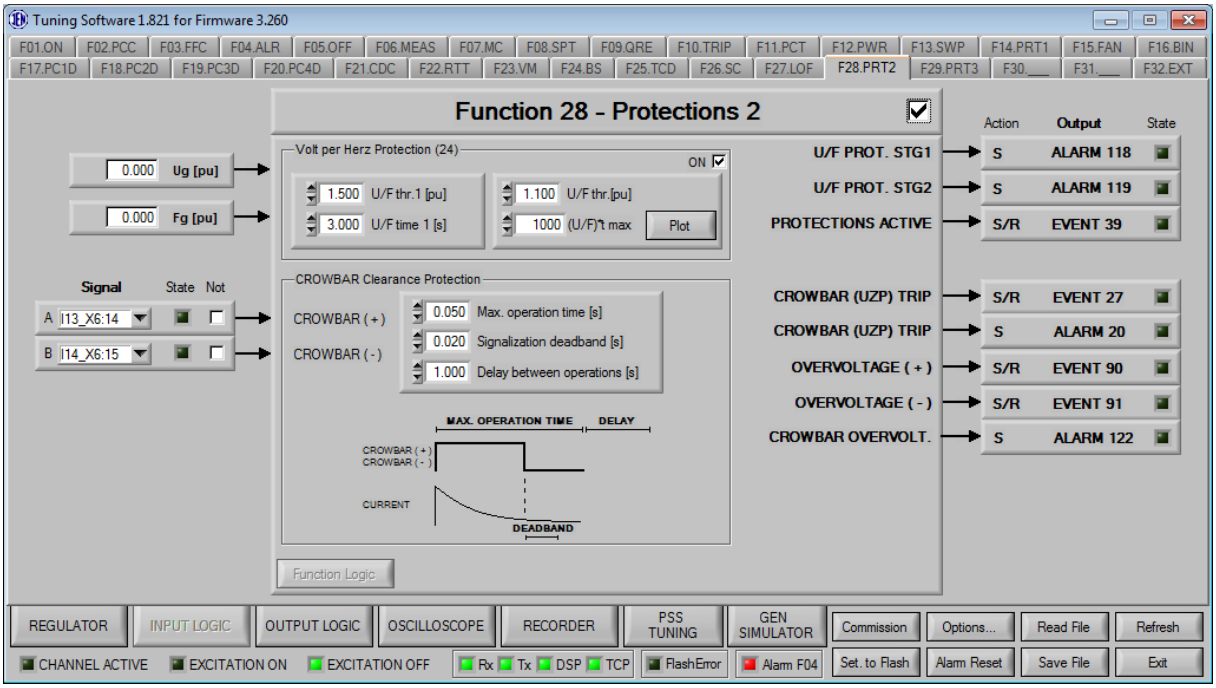
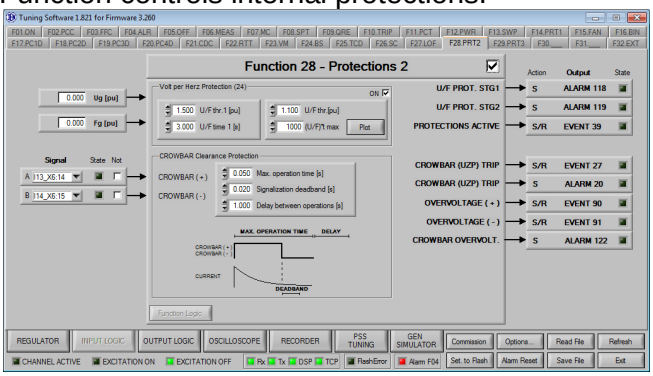


Fig. 99 Input logic tab of the Function number 28 (F28.PRT2)

3.21.29 Function 29: Protections 3

Function controls internal protections.



Operands

All function operands are listed in the table below.

Name	Type	Description
Ug [pu] – GENERATOR VOLTAGE	Register measurements	Generator voltage measurement
Fg [pu] – GENERATOR FREQUENCY	Register measurements	Generator frequency measurement
Pg [pu] – GENERATOR ACTIVE POWER	Register measurements	Generator active power measurement
Ig [pu] – GENERATOR CURRENT	Register measurements	Generator current measurement
ALARM 151 – MIN. FIELD CURRENT (37F)	Alarm output	Minimum field current protection activation **Source:** INPUT LOGIC/F29.PRT3
ALARM 152 – OVER FREQUENCY (81O)	Alarm output	Over frequency protection activation **Source:** INPUT LOGIC/F29.PRT3
ALARM 153 – UNDER FREQUENCY (81U)	Alarm output	Under frequency protection activation **Source:** INPUT LOGIC/F29.PRT3
ALARM 154 – UNDER VOLTAGE (27)	Alarm output	Under voltage protection activation **Source:** INPUT LOGIC/F29.PRT3
ALARM 155 – REVERSE POWER (32)	Alarm output	Reverse power protection activation **Source:** INPUT LOGIC/F29.PRT3
ALARM 156 – OVER CURRENT (50)	Alarm output	Over current protection activation **Source:** INPUT LOGIC/F29.PRT3

Operation

This function is responsible for handling of Minimum field current (37F), Over frequency (81O), Under frequency (81U), Under voltage (27), Reverse power (32) and Over current (50/51) protections. Each of this protection can be individually turned on and off by using corresponding checkboxes next to their protections parameters.

Minimum field current (37F):

Controller is equipped with definite-time Minimum field current protection.

There is one activation threshold “thr.[pu]” specified in per unit and one activation delay time “time[s]” specified in seconds. After exceeding the threshold, when the corresponding time delay has expired, this protection generates Event 39 and ALARM 151 which can be

associated with hardware resources. Sending a “TRIP” signal is recommended as conditions required for protection to operate, if sustained, can cause damage to the generator.

For protection to be activated, following pre-requirements must be satisfied:

- Channel excited (EVENT 6)
- Field current measurement present (EVENT 10)
- Soft start finished
- Protection enabled

Over frequency (81O):
Controller is equipped with definite-time Over frequency protection.
There is one activation threshold “thr.[pu]” specified in per unit and one activation delay time “time[s]” specified in seconds. After exceeding the threshold, when the corresponding time delay has expired, this protection generates Event 39 and ALARM 152 which can be associated with hardware resources. Sending a “TRIP” signal is recommended as conditions required for protection to operate, if sustained, can cause damage to the generator.

For protection to be activated, following pre-requirements must be satisfied:

- Generator voltage measurement present (EVENT 9)
- Generator voltage measurement higher than 0.6 pu
- Protection enabled

Under frequency (81U):
Controller is equipped with definite-time Under frequency protection.
There is one activation threshold “thr.[pu]” specified in per unit and one activation delay time “time[s]” specified in seconds. After exceeding the threshold, when the corresponding time delay has expired, this protection generates Event 39 and ALARM 153 which can be associated with hardware resources. Sending a “TRIP” signal is recommended as conditions required for protection to operate, if sustained, can cause damage to the generator.

For protection to be activated, following pre-requirements must be satisfied:

- Generator voltage measurement present (EVENT 9)
- Generator voltage measurement higher than 0.6 pu
- Protection enabled

Under voltage (27):
Controller is equipped with definite-time Under voltage protection.
There is one activation threshold “thr.[pu]” specified in per unit and one activation delay time “time[s]” specified in seconds. After exceeding the threshold, when the corresponding time delay has expired, this protection generates Event 39 and ALARM 154 which can be associated with hardware resources. Sending a “TRIP” signal is recommended as conditions required for protection to operate, if sustained, can cause damage to the generator.

For protection to be activated, following pre-requirements must be satisfied:

- Channel excited (EVENT 6)
- Generator voltage measurement present (EVENT 9)
- Soft start finished
- Line charge mode disabled (EVENT 71)
- Braking mode disabled (EVENT 73)
- Generator current measurement higher than 0.02 pu
- Protection enabled

Reverse power (32):
Controller is equipped with definite-time Reverse power protection.
There is one activation threshold “thr.[pu]” specified in per unit and one activation delay time “time[s]” specified in seconds. After exceeding the threshold, when the corresponding time delay has expired, this protection generates Event 39 and ALARM 155 which can be associated with hardware resources. Sending a “TRIP” signal is recommended as conditions required for protection to operate, if sustained, can cause damage to the generator.

For protection to be activated, following pre-requirements must be satisfied:

- Protection enabled

Over current (50/51):
Controller is equipped with definite-time Over current power protection and one Inverse time protection, without under voltage influence.

For definite-time there is one activation threshold “thr.[pu]” specified in per unit and one activation delay time “time[s]” specified in seconds. After exceeding the threshold, when the corresponding time delay has expired, this protection generates Event 39 and ALARM 156 which can be associated with hardware resources.

For inverse time there is one threshold specified as Stator Current Limiter threshold “Igth” multiplied by coefficient 1.05. The tripping time is calculated from the flowing excessive current by integrating measurement and comparing it with predefined “Ig*t max” parameter. After exceeding this value protection generates Event 39 and ALARM 156 which can be associated with hardware resources.

Sending a “TRIP” signal is recommended as conditions required for protection to operate, if sustained, can cause damage to the generator.

For protection to be activated, following pre-requirements must be satisfied:

- Protection enabled

Applicable settings

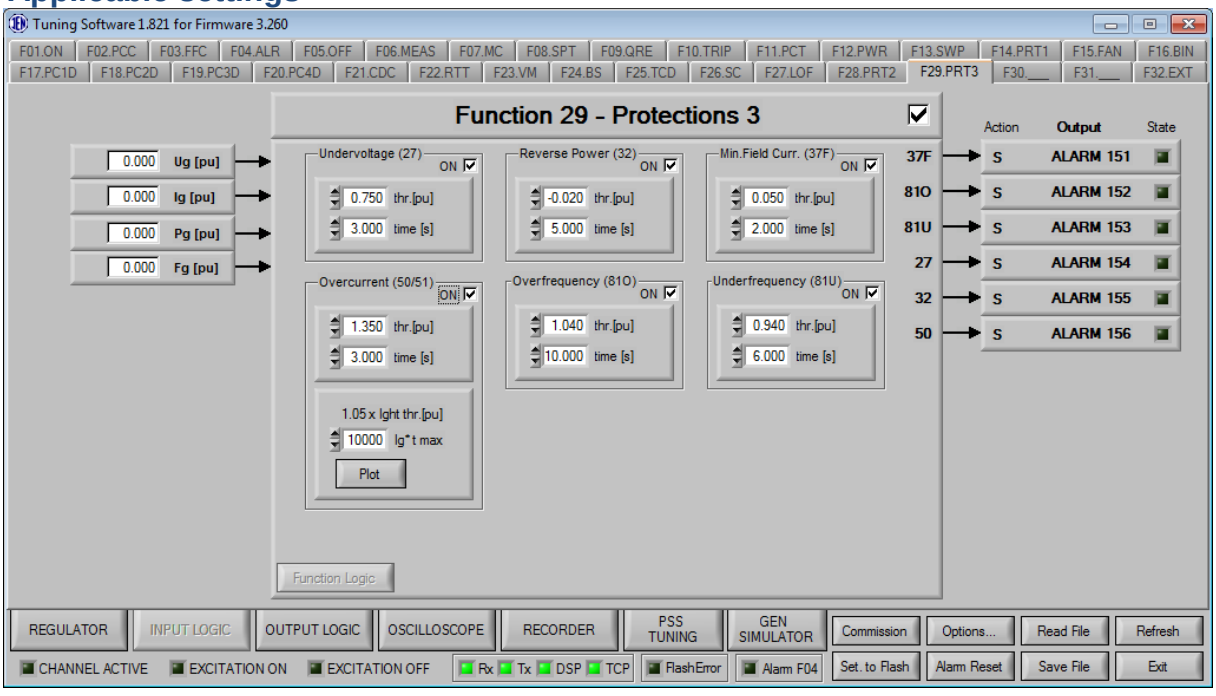
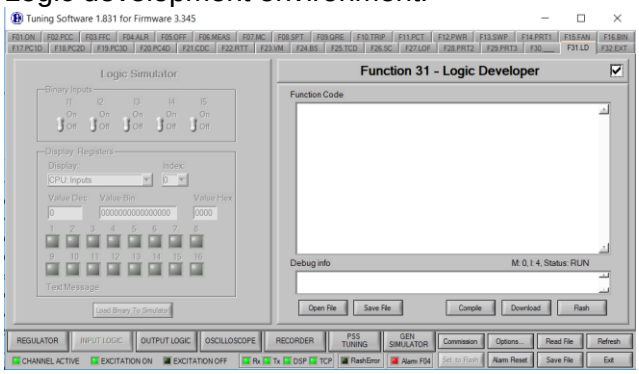


Fig. 100 Input logic tab of the Function number 29 (F29.PRT3)

3.21.30 Function 31: Logic Developer

Logic development environment.



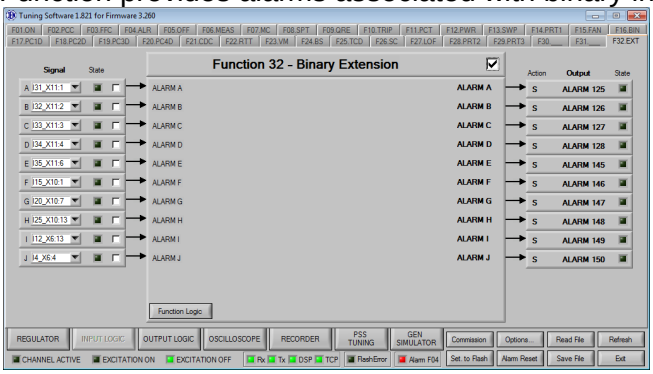
Operation

This function allows to create, compile, and load user designed programmable logic to the controller.

For details of function operation, please refer to SX Logic Developer document.

3.21.31 Function 32: Special Binary Extension

Function provides alarms associated with binary inputs



Operands

All function operands are listed in the table below.

Name	Type	Description
(A) ALARM A	Binary input	Activation of Alarm 125 **Source:** INPUT LOGIC/F32.EXT
(B) ALARM B	Binary input	Activation of Alarm 126 **Source:** INPUT LOGIC/F32.EXT
(C) ALARM C	Binary input	Activation of Alarm 127 **Source:** INPUT LOGIC/F32.EXT
(D) ALARM D	Binary input	Activation of Alarm 128 **Source:** INPUT LOGIC/F32.EXT
(E) ALARM E	Binary input	Activation of Alarm 145 **Source:** INPUT LOGIC/F32.EXT
(F) ALARM F	Binary input	Activation of Alarm 146 **Source:** INPUT LOGIC/F32.EXT
(G) ALARM G	Binary input	Activation of Alarm 147 **Source:** INPUT LOGIC/F32.EXT
(H) ALARM H	Binary input	Activation of Alarm 148 **Source:** INPUT LOGIC/F32.EXT
(I) ALARM I	Binary input	Activation of Alarm 149 **Source:** INPUT LOGIC/F32.EXT
(J) ALARM J	Binary input	Activation of Alarm 150 **Source:** INPUT LOGIC/F32.EXT
ALARM 125 – ALARM A	Alarm output	Binary input A activated **Source:** INPUT LOGIC/F32.EXT
ALARM 126 – ALARM B	Alarm output	Binary input B activated **Source:** INPUT LOGIC/F32.EXT
ALARM 127 – ALARM C	Alarm output	Binary input C activated **Source:** INPUT LOGIC/F32.EXT
ALARM 128 – ALARM D	Alarm output	Binary input D activated **Source:** INPUT LOGIC/F32.EXT

Name	Type	Description
ALARM 145 – ALARM E	Alarm output	Binary input E activated **Source:** INPUT LOGIC/F32.EXT
ALARM 146 – ALARM F	Alarm output	Binary input F activated **Source:** INPUT LOGIC/F32.EXT
ALARM 147 – ALARM G	Alarm output	Binary input G activated **Source:** INPUT LOGIC/F32.EXT
ALARM 148 – ALARM H	Alarm output	Binary input H activated **Source:** INPUT LOGIC/F32.EXT
ALARM 149 – ALARM I	Alarm output	Binary input I activated **Source:** INPUT LOGIC/F32.EXT
ALARM 150 – ALARM J	Alarm output	Binary input J activated **Source:** INPUT LOGIC/F32.EXT

Operation

This function is responsible for activation of alarms associated with binary inputs. Each alarm is activated immediately after 0 to 1 transition on binary input is detected.

Applicable settings

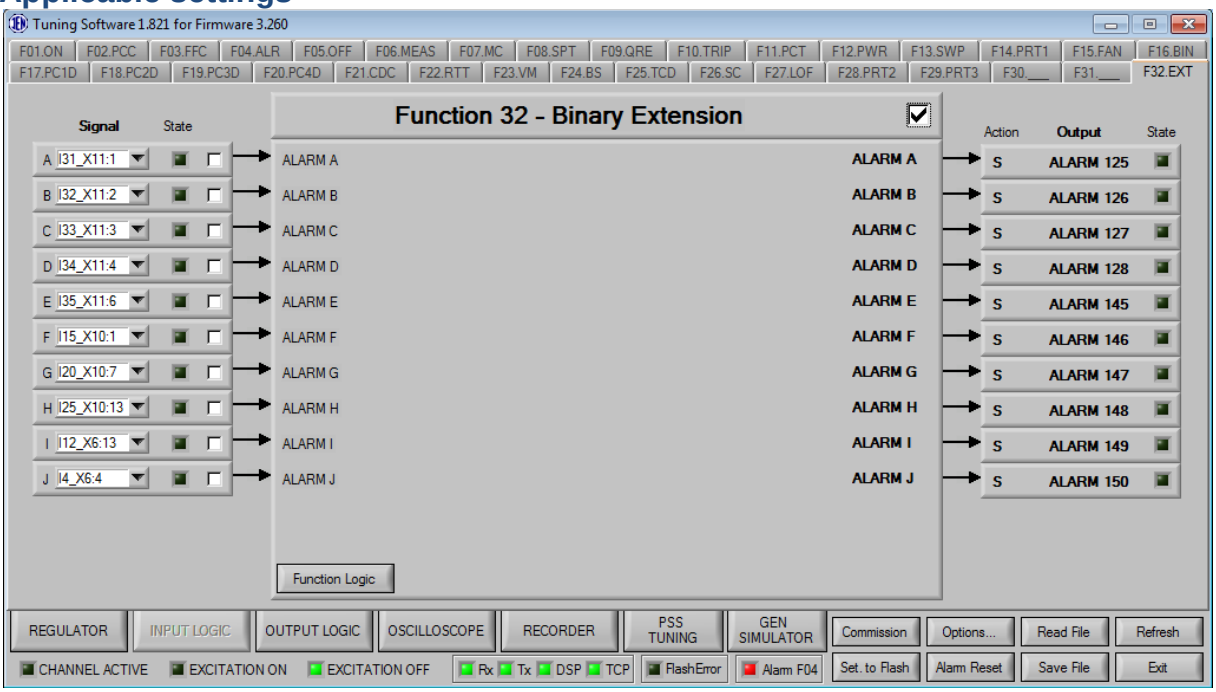


Fig. 101 Applicable settings

Tips:

- ✓ Use this function to monitor status of customized equipment installed in the system

3.22 OSCILLOSCOPE

To open the oscilloscope window (100ms resolution), click “OSCILLOSCOPE” tab in the lower part of Main window. The following tab appears:

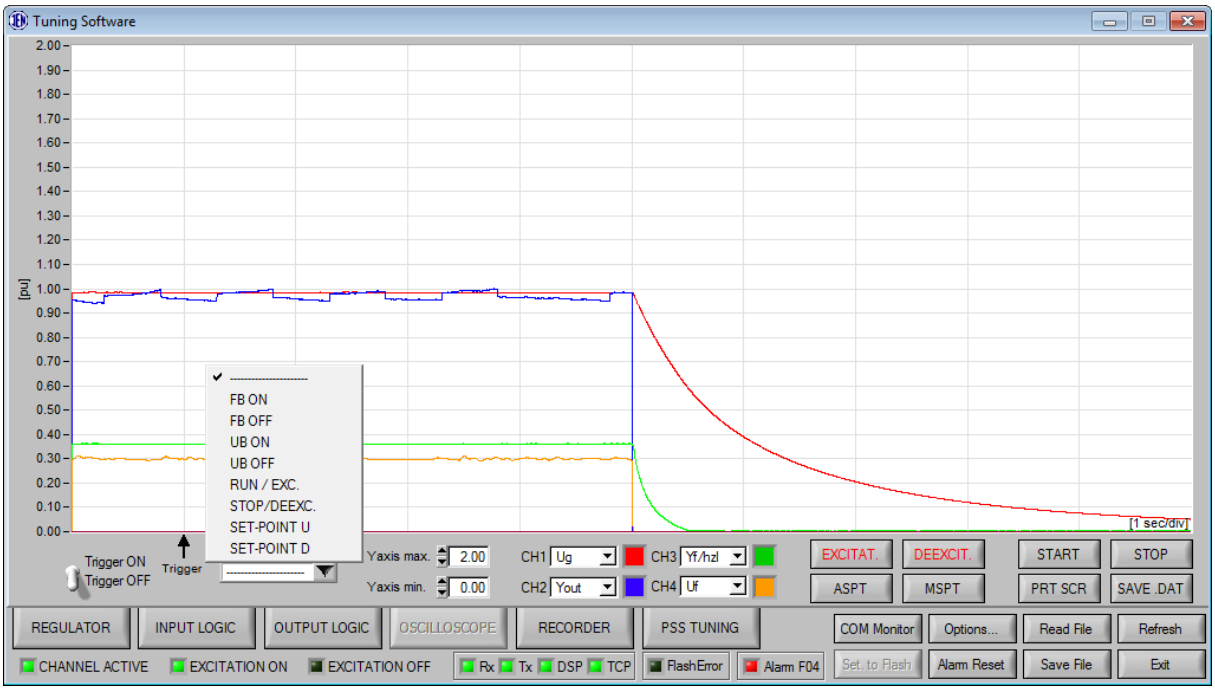


Fig. 102 Oscilloscope settings tab

First step when working with oscilloscope is to assign parameters to show to each of four possible channels by selecting them from drop down lists next to them. Available signals for selection are:

Ug	Ig	Pg	Qg	Fg	If
Yout	Ypql	Ymfcl	Yf/hzl	Yfcl	Yscl1
ASPT	MSPT	Ypss	Ygen	Ur	Us
Ut	Ir	Is	It	Ur rms	Us rms
Ut rms	Ir rms	Is rms	Ir rms	Uf	Yscl2

Then to show charts on the screen press “START” button or to stop refreshing charts on the screen for data analysis press “STOP” button.

Oscilloscope software allows automatic chart saving as a .bmp file. To do that press “PRT SCR” button. Other option is to save chart data using “SAVE .DAT” button which creates file in comtrade format.

In addition there is possibility to select trigger for registration. Possible triggers can be seen on list below:

- FB ON
- FB OFF
- UB ON
- UB OFF
- RUN/EXC
- STOP/DEEXC
- SET-POINT UP
- SET-POINT DOWN

Selecting trigger condition needs to be approved by changing „TRIGGER ON/OFF” switch position to “ON”. With such configured oscilloscope registration saves four seconds of regulator operation before trigger and 36 after trigger event happens.

For user comfort also two setting are available allowing to scale minimum and maximum chart values “Yaxis max.”, “Yaxis min.”. There are also two buttons allowing to access to automatic “ASPT” and manual “MSPT” regulation loop setpoint(same ones that can be accessed from main screen of Tuning software) while still having a view on oscilloscope chart. In same way user have access to “EXCITAT.”, “DEEXCIT.” buttons allowing to start/stop excitation without exiting oscilloscope tab.

3.23 RECORDER

To open the recorder window (1ms resolution), click “RECORDER” tab in the lower part of Main window. The following tab appears:

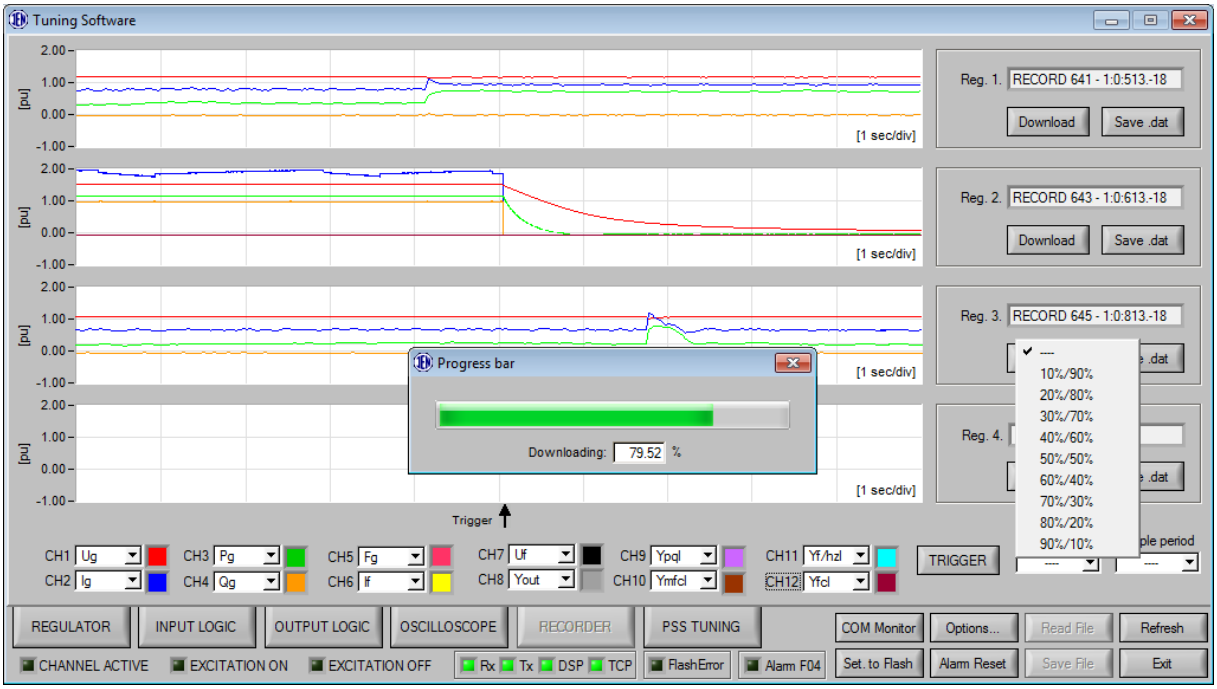


Fig. 103 Recorder settings tab

Recorder allows to assign up to twelve signals to analog channels. To assign signal to a channel select it from drop down list next to channel name – such parameter will be later indicated by the color on the chart.

Next to channels settings user can find “Time-sharing” option which allows to set how much time from total event time should be registered before event and how much after.

“Sample period” allows to select how often samples should be taken (registration has always 10000 samples). Possible values range from 1ms up to 10s.

By clicking “Download” button next to registration chart user can download registration and view it in chart window. Then chart can be also saved as comtrade format file for detailed analysis using specialized tools.

3.24 PSS TUNING

PSS Tuning is a powerful tool for engineers that allows to measure frequency characteristics of generator. Most common application of this functionality is verification and selection of Power System Stabilizer settings.

To access PSS Tuning window select penultimate option from main category tab called “PSS TUNING”. Following window should appear:

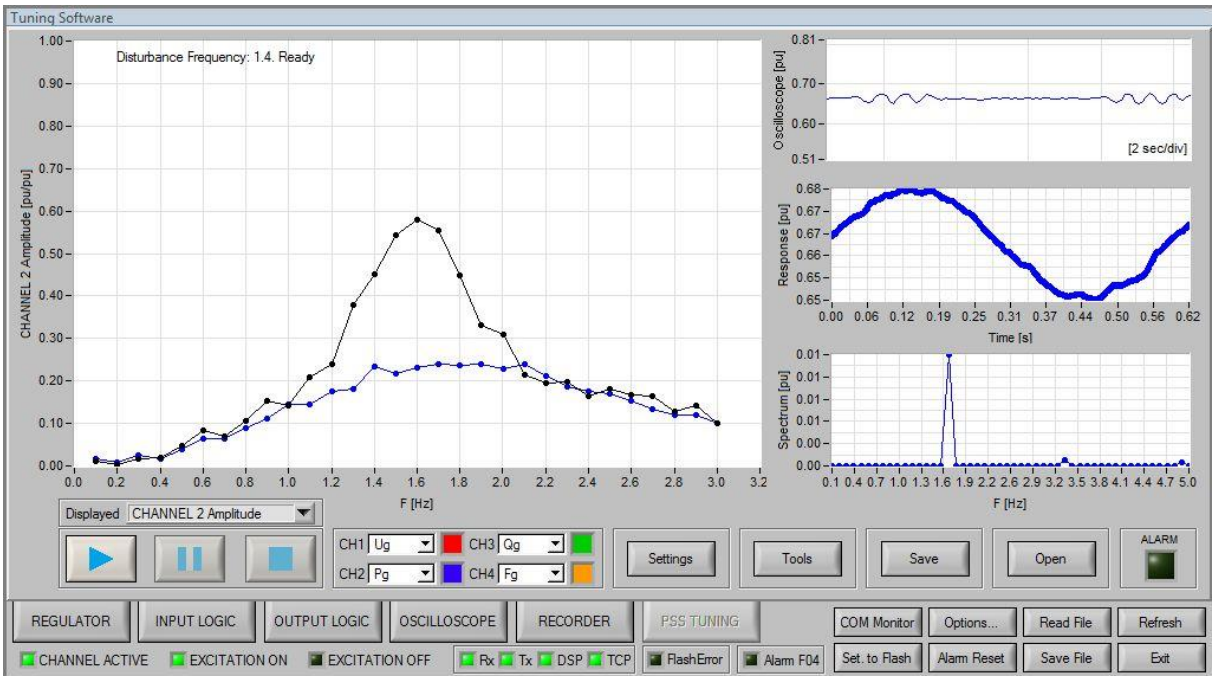


Fig. 104 PSS Tuning main window

Here user can see main chart which can be selected either to display amplitude or phase characteristic from any of four input channels. Comparison of amplitude characteristics measured with and without PSS gives information on how well PSS is tuned. Other than that on the right hand side three additional charts can be found:

- Oscilloscope chart – Shows in real time signal selected in specific channel [CH1,CH2,CH3,CH4]
- Response chart – Shows one period of disturbance taken as a sample from what could be seen in oscilloscope chart (zoomed in)
- Spectrum chart – This chart shows response after Fourier transformation to make it easier to distinguish harmonic mods in signal

To start, stop and pause of the PSS test use following three buttons:

	Start PSS tuning test and collecting of the characteristics. Special attention must be paid as this will induce disturbances in active and reactive power of generator proportional to disturbance amplitude.
	Pause test, by pressing play again it is possible to resume test. It stops generating disturbances.
	Stop current test, pressing play again will start new test. It stops generating disturbances.

For each channel user can select specific signal which will be taken for analysis. On each of the channels possible outputs signals are:

1. Ug – Generator Voltage
2. Ig – Generator Current
3. Pg – Active Power
4. Qg – Reactive Power
5. Fg – Generator Frequency
6. If – Excitation Current
7. Uf – Excitation Voltage
8. Yout – AVR output
9. Ypql – PQL limiter output
10. Ymfcl – MFCL limiter output
11. Yf/hzl – V/Hz limiter output
12. Yfcl – FCL limiter output
13. Ypss – PSS output
14. Ygen – Output of disturbance signal
15. Ur – Phase A of generator voltage measurement
16. Us – Phase B of generator voltage measurement
17. Ut – Phase C of generator voltage measurement
18. Ir – Phase A of generator current measurement
19. Is – Phase B of generator current measurement
20. It – Phase C of generator current measurement
21. Ir rms – Phase A of generator current measurement in rms
22. Is rms – Phase B of generator current measurement in rms
23. It rms – Phase C of generator current measurement in rms
24. Ur rms – Phase A of generator voltage measurement in rms
25. Us rms – Phase B of generator voltage measurement in rms
26. Ut rms – Phase C of generator voltage measurement in rms
27. Ydist – Disturbance signal

Measured characteristics can be saved to disc using “Save” button located at the bottom of PSS Tuning window. Three file types are allowed:

- Txt – File can be open in any text editor and besides raw characteristics data also contains information about test conditions and PSS parameters.
- IEEE Comtrade – File can be open in any software supporting Comtrade format as The Output Processor, which allows user to edit easily parameters of graph.
- Bmp – Graphic file format containing screen of main window

Files saved in txt or comtrade format can be restored by using “Open” button on the right hand bottom side of the menu.

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3.24.1 PSS Settings Window

This window allows to modify all important parameters of PSS testing process and is divided into four sections.

Disturbance signal parameters section allows to set parameters of disturbance used to generate amplitude and phase characteristics. User can modify frequency range of test in range of 0.1Hz to 3 Hz by setting First freq. and Last freq. values. Disturbance amplitude is set by Amplitude parameter (range of allowed values 0.01[pu] to 0.199[pu]), number of periods of disturbance signal is set with Periods 2 Gen(number of periods of disturbance

signal generated for the tests), Period 2 Acq(number of periods of disturbance signal taken for acquisition) setting (allowed value range from 1 to 10). Delay time in seconds between iterations with disturbance signal is set by Delay[s] parameter. Frequency resolution of test can be changed by switching Step[Hz] parameter (allowed range from 0.1Hz to 2Hz).

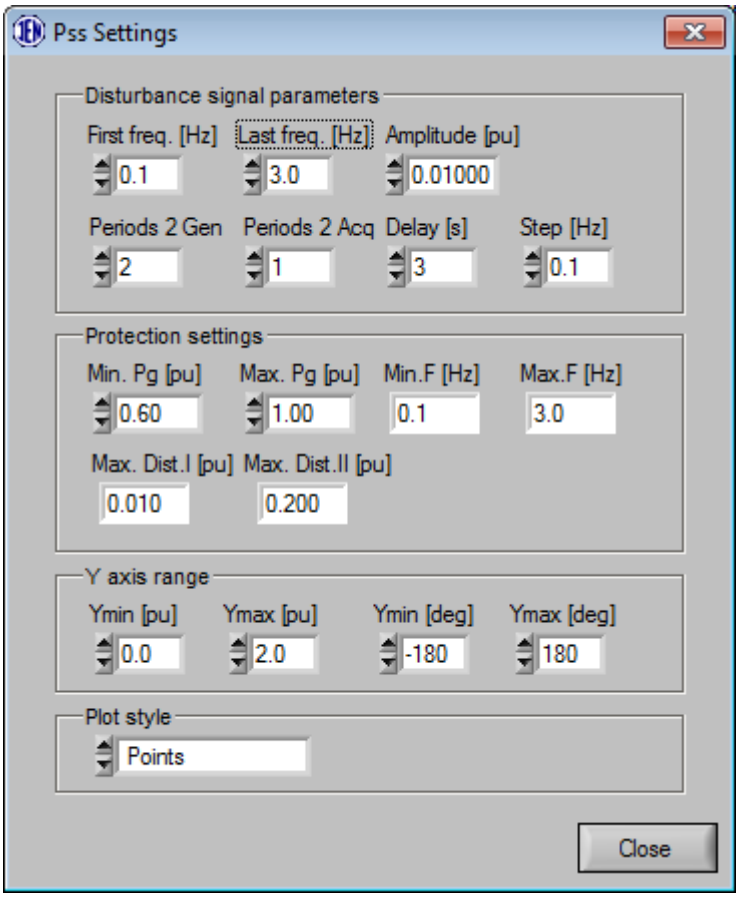

Fig. 105 PSS Settings window

Protection settings allow to set limits for maximum and minimum active power value that shouldn't be reached during tests. This option is provided for test safety purposes. If one of this limits is reached during PSS tuning, test is instantly stopped, disturbance signal is immediately stopped and alarm no. 78 is generated. To continue PSS testing process alarm must be cleared.

Y axis range options allow to set display range of values on y axis. In case of Amplitude chart parameters Ymin[pu], Ymax[pu] set maximum and minimum value visible on the chart. In case of Phase chart parameters Ymin[deg], Ymax[deg] are used analogically.

Plot style option allows to change the way charts are displayed on main chart window. Two possible options are:

- Points - chart is drawn with dots in sample points not connected together with lines
- Connected Points – chart is drawn with dots in sample points connected together with lines

3.24.2 PSS Tools Window

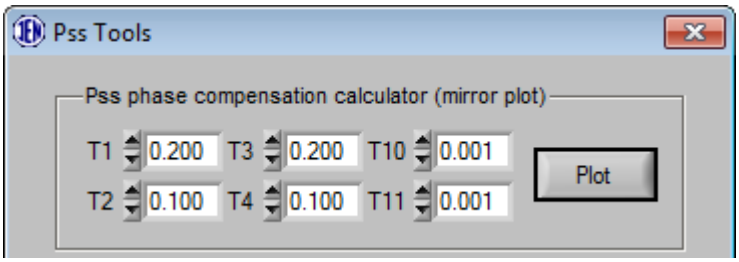

Fig. 106 PSS Tools window

PSS Tools window allows to draw on main chart characteristic of currently set PSS phase compensation block. Well set compensation block is critical for PSS performance. Measured phase characteristic can be compared with characteristic calculated from T1,T2,T3,T4,T10 and T11 parameters showing if PSS is over or undercompensated. Note that changing those parameters here does not equal to changing PSS structure in regulator logic – those parameters must be retyped in PSS window manually or copied there directly using Plot button.

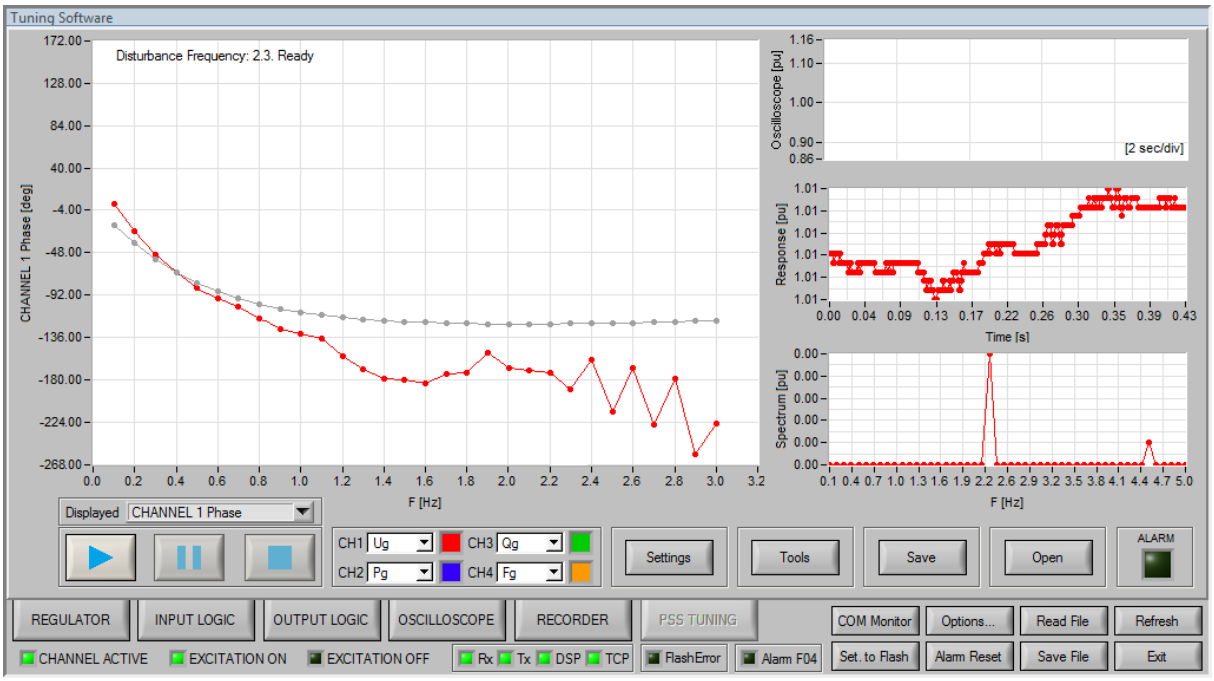

Fig. 107 Example phase characteristic measured by PSS Tuning software

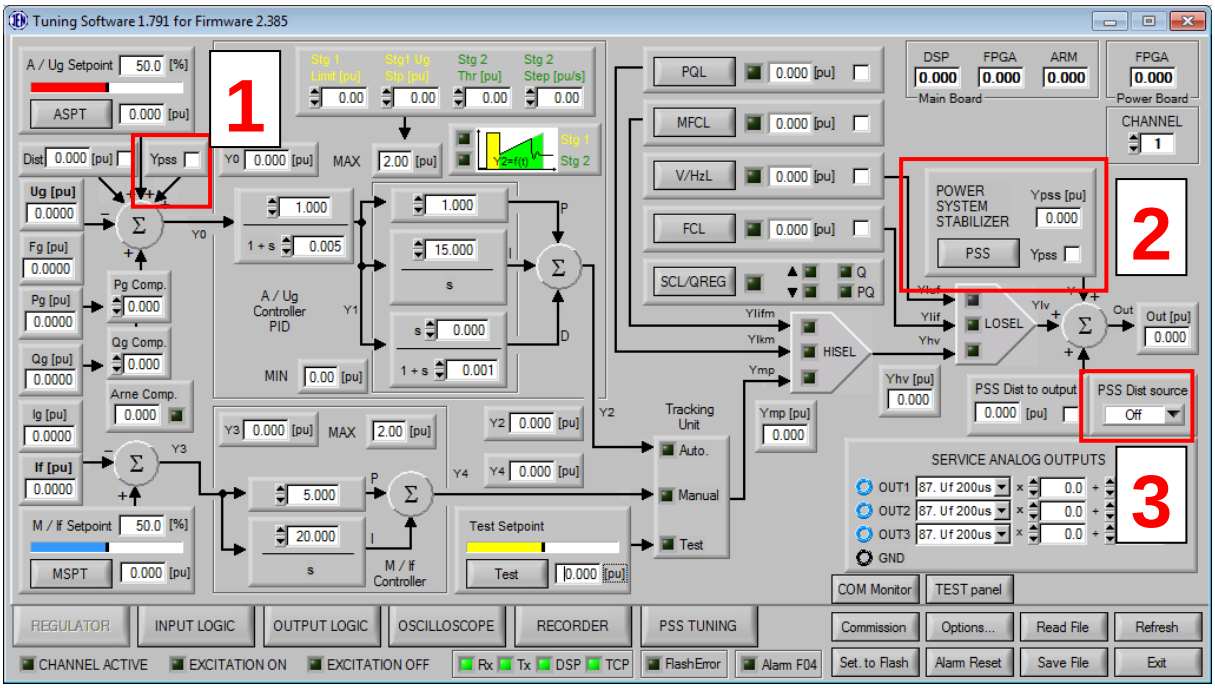

Fig. 108 PSS disturbance connection options

3.24.3 Connecting disturbance signal

For the tuning and commissioning purposes, it is possible to apply disturbance signal to the control structure. Source of this signal can be either external analog input or internally generated signal from build in PSS tester module. It can be selected from option (3). For details on external analog input refer to “OPTIONS” section, for details on test module refer to “PSS TUNING” section of this manual.

Selected disturbance signal can be connected to different parts of control structure:

- Input of automatic control loop (4)
- Output of LOSEL gate (5)
- Active power and frequency inputs of PSS (6)
- S3 component of PSS (7)

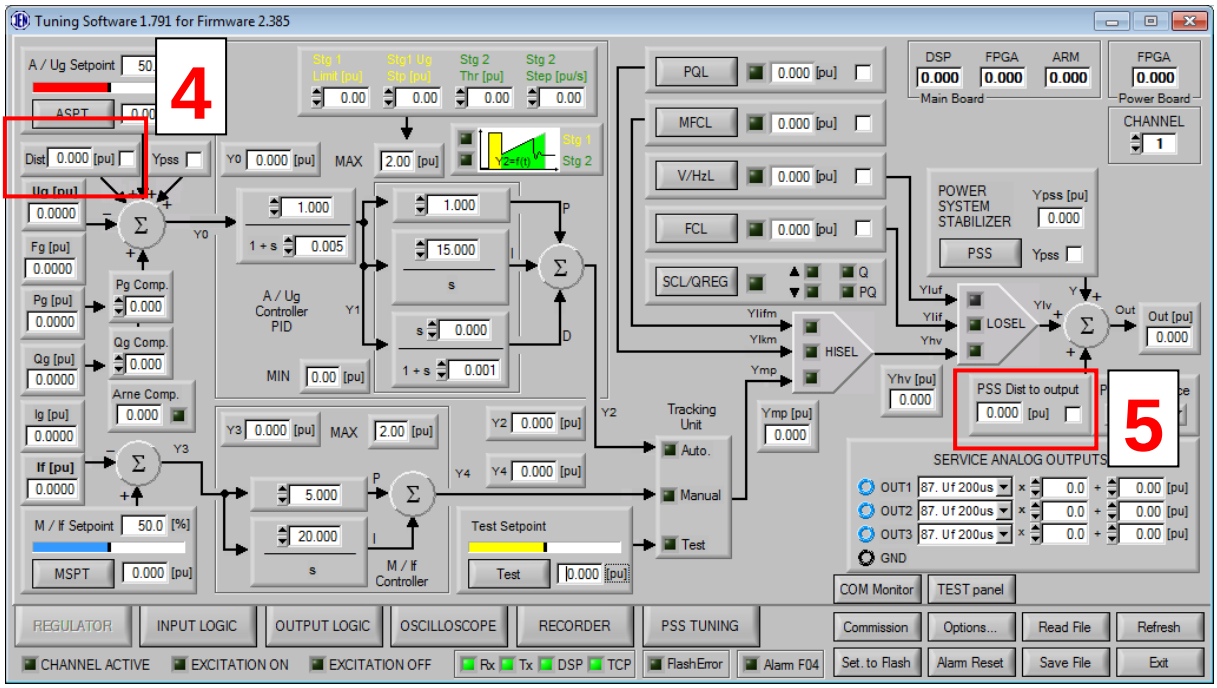

Fig. 109 PSS disturbance connection options

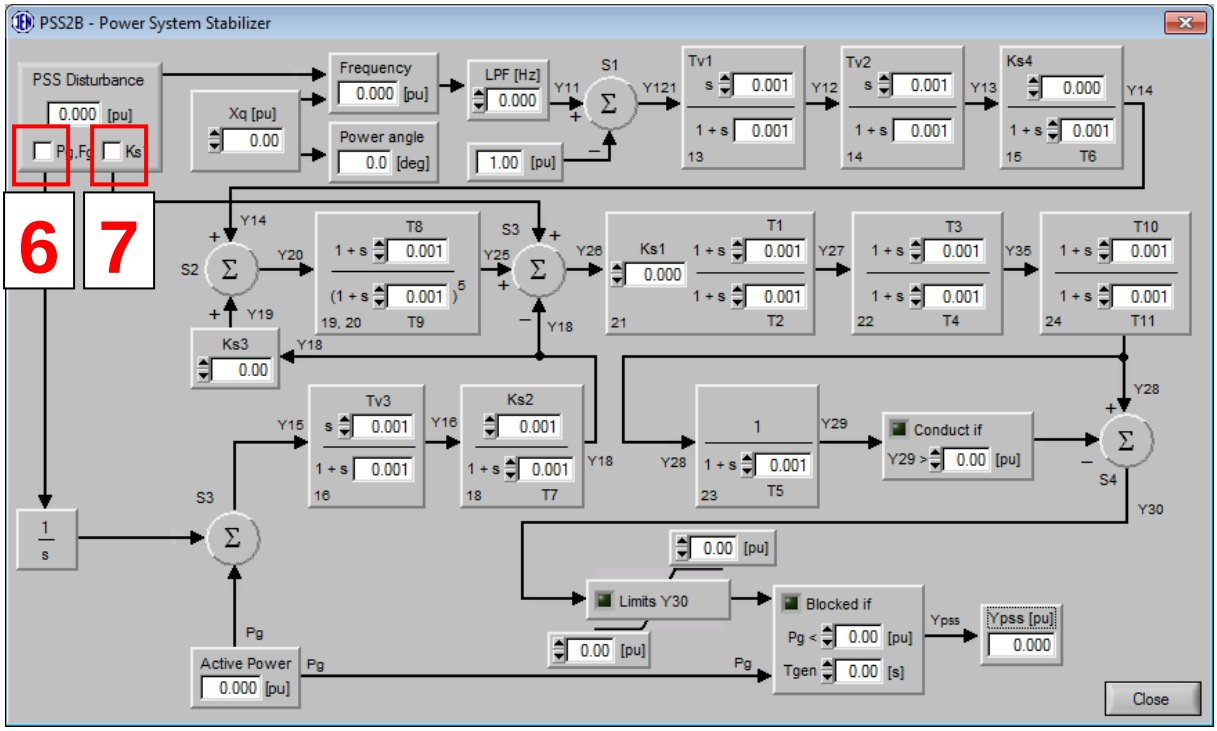

Fig. 110 PSS disturbance connection options

All these options give possibility to fully test PSS performance.

P100C-SX allows for control over enabling or disabling PSS from external binary signal. Input for such signal can be found in Function 16 – Binary Inputs Control.

3.25 GENERATOR SIMULATOR

Generator simulator is a powerful tool for engineers working in the fields of excitation systems and power distribution. The software, which runs directly on DSP processor of P100C-SX controller, enables user to perform most complex simulations involving a synchronous generator quickly and easily. It simplifies process of cold commissioning of excitation system by simulating parts of system that are not available at the time. It also allows to adjust and check performance of control loops, limiters and power system stabilizer before first excitation, which guarantees more safe an smooth hot commissioning process.

To get access to the simulator click last option from main category tab called “GEN SIMULATOR”. Following window will appear:

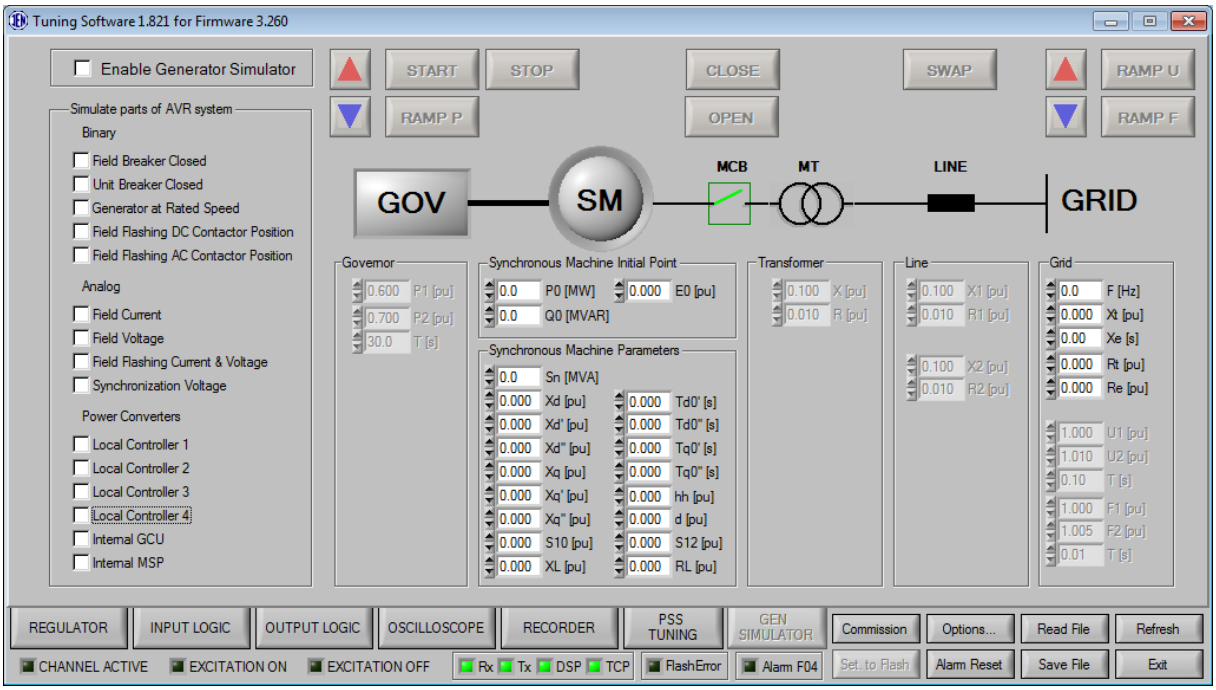

Fig. 111 Generator simulator main window

3.25.1 Settings

Simulate parts of AVR system

User can predefine which parts of excitation system should be replaced by virtual ones during simulation process. It allows to run simulation without having complete excitation system or to check operation of selected parts only. It can be done by selecting options in the “Simulate parts of AVR system” panel on the left side of the main window. Options are divided into 3 sections:

- Binary – binary status of essential devices
- Analog – analog measurements
- Power Converters - complete power converter modules

Synchronous Machine Initial Point

This panel specifies initial conditions of synchronous machine operation after closing generator breaker MCB. Available parameters are:

Name	Unit	Description
P0	MW	Initial active power after closing MCB
Q0	MVAR	Initial reactive power after closing MCB
E0	MVAR	Initial armature voltage after closing MCB

Synchronous Machine Parameters

The model takes into account following parameters of synchronous machine:

Name	Unit	Description
Sn	MVA	Nominal apparent power
Xd	pu	Synchronous reactance d-axis
Xd’	pu	Transient reactance d-axis
Xd’’	pu	Subtransient reactance d-axis
Xq	pu	Synchronous reactance q-axis
Xq’	pu	Transient reactance q-axis
Xq’’	pu	Subtransient reactance q-axis
Td’	s	Short-circuit transient time constant d-axis
Td’’	s	Short-circuit subtransient time constant d-axis
Tq’	s	Short-circuit transient time constant q-axis
Tq’’	s	Short-circuit subtransient time constant q-axis
XL	pu	Stator leakage reactance
RL	pu	Stator resistance
S10	pu	Saturation factor when open circuit terminal voltage is 1.0 pu
S12	pu	Saturation factor when open circuit terminal voltage is 1.2 pu

Grid

The following parameters of the network are available:

Name	Unit	Description
F	Hz	Grid frequency
Xt	pu	
Xe	pu	
Rt	pu	
Re	pu	

3.25.2 Running simulation

No load operation

1. In “Simulate parts of AVR system” panel select parts of excitation system that should be simulated.
2. After selection go to INPUT LOGIC/F01 and check status of EVENT 92 – READY FOR EXCITATION. Event should be active.
3. During no load operation generator circuit breaker must remain open – option “Unit breaker closed” in “Simulate parts of AVR system” area must not be checked
4. Set desired generator parameters in the section “Synchronous machine parameters”.
5. Run generator simulator by selecting checkbox “Enable Generator Simulator”.
6. Open Commission window located in the right bottom corner of main window.
7. Click OSCILLOSCOPE tab, select generator signals to observe, start oscilloscope.
8. Start excitation from Commission window

Under load operation

1. Start simulation for no load operation (see above).
2. Set desired machine initial parameters for grid operation.
3. Set desired grid parameters in the section “Grid”.
4. Simulate MCB closed position or select “Unit Breaker Closed” option in “Simulate parts of AVR system” panel.

Applicable settings

Applicable settings are presented below

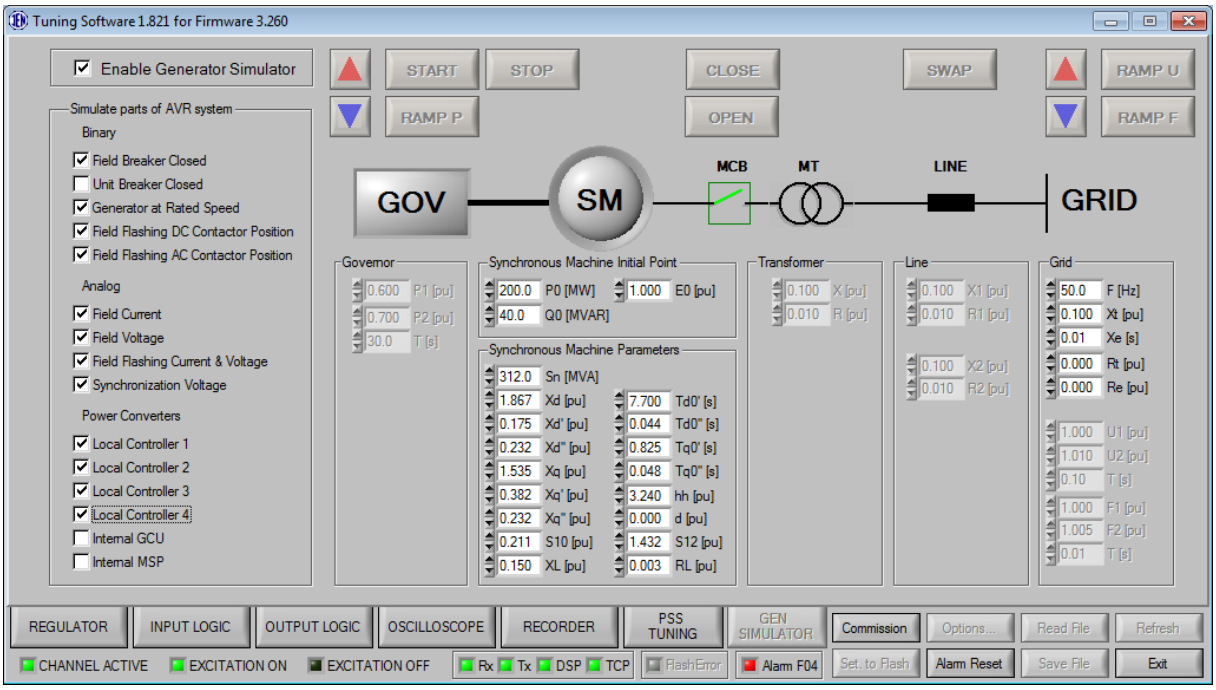

Fig. 112 Applicable settings

3.26 APPENDIX

3.26.1 List of Events

Name	Source	Description
EVENT 1 - ALARM	Event output	Indicates active alarm Logical high – alarm present **Source:** INPUT LOGIC/F04.ALR **Pre-requirements:** - Active alarm in the system
EVENT 2 - ALARM RESET	Event output	Indicates alarm reset command Logical high – alarm reset **Source:** - INPUT LOGIC/F04.ALR.A - Modbus command (1211) - IEC 104 command **Pre-requirements:**
EVENT 3 - FB ON PULSE	Event output	Event lasting for **1,5 sec** typically used as command to close field breaker. Can be used in Braking sequence to close stator short circuit **Source:** INPUT LOGIC/F01.ON **Pre-requirements:** - Channel is active (EVENT 7), ready for excitation (EVENT 92), not running (EVENT 6), start command received (EVENT 80)
EVENT 4 – FF DC PULSE	Event output	Command to close DC contactor of Field Flashing circuit Logical high - close **Source:** INPUT LOGIC/F03.FFC **Pre-requirements:** - Channel excited (EVENT 06) - Channel active (EVENT 07) and *With Local Controller* - “Thyristor Bridge, Local Controller mode” is selected on Options/Advanced/Option “Power converter type” list - Synchronization voltage is not present (EVENT 49,53,57,100) - *With GCU* - “Thyristor Bridge, Local Controller mode” is not selected on Options/Advanced/Option “Power converter type” list - “IGBT Transistor” is not selected on Options/Advanced/Option “Power converter type” list - Synchronization voltage INPUT LOGIC/F02.PCC.INTPC_SYNC is not present - Generator voltage lower than specified in INPUT LOGIC/F02.PCC option “Pulses ON threshold for internal IGBT or THY” if Auto mode is active or

		- Field current is lower than specified in INPUT LOGIC/F02.PCC option “Pulses ON threshold for internal IGBT or THY” if Manual mode is active - *With MSP* - “IGBT Transistor” is selected on Options/Advanced/Option “Power converter type” list - Generator voltage lower than specified in INPUT LOGIC/F02.PCC option “Pulses ON threshold for internal IGBT or THY” if Auto mode is active or - Field current is lower than specified in INPUT LOGIC/F02.PCC option “Pulses ON threshold for internal IGBT or THY” if Manual mode is active
EVENT 5 – FF AC PULSE	Event output	Command to close AC contactor of Field Flashing circuit Logical high – close Delay: 1 sec **Source:** INPUT LOGIC/F03.FFC **Pre-requirements:** - FF DC pulse active (EVENT 04)
EVENT 6 - RUN	Event output	Indicates excitation of AVR Logical high - excited **Source:** INPUT LOGIC/F01.ON **Pre-requirements:** - Channel is active (EVENT 7), ready for excitation (EVENT 92), not excited (EVENT 6), start command received (EVENT 80), field breaker is closed (EVENT 30) and: *For routine operation* - Braking disabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit open (EVENT 93) *For Braking* - Braking enabled (EVENT 73), Line Charge disabled (EVENT 71), generator short circuit closed (EVENT 93), manual mode enabled (EVENT 11) *For Line Charge* - Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), manual mode enabled (EVENT 11), option “Line charge in Auto mode” not checked or: - Braking disabled (EVENT 73), Line Charge enabled (EVENT 71), generator short circuit open (EVENT 93), auto mode enabled (EVENT 11), option “Line charge in Auto mode” checked
EVENT 7 – CHANNEL ACTIVE	Event output	Indicates activity of channel Logical high - active **Source:** INPUT LOGIC/F13.SWP **Pre-requirements:** - Other channel is faulty INPUT LOGIC/F13.IN8 or - Other channel send SWAP command

		INPUT LOGIC/F13.IN7
EVENT 8 - TEST	Event output	Indicates that TEST mode is active Logical high - active **Source:** - Input INPUT LOGIC/F07.MC.F - INPUT LOGIC/F07/Option “Force Test Mode” **Pre-requirements:** - Channel is not excited (EVENT 06)
EVENT 9 - UG MEASURE.FLT	Event output	Generator voltage measurement fault Logical high – fault **Source:** Input INPUT LOGIC/F06.MEAS: - Input INPUT LOGIC/F06.MEAS.A - ALARM 7 - ALARM 8 - ALARM 9 - Ug balanced protection - Ug unbalanced protection **Pre-requirements:**
EVENT 10 - IF MEASURE.FLT	Event output	Field current measurement fault Logical high – fault **Source:** Input INPUT LOGIC/F06.MEAS: - ALARM 11 - ALARM 12 **Pre-requirements:**
EVENT 11 – AUTO MODE	Event output	Automatic regulation mode Logical high – Auto Logical low – Manual **Source:** - Input INPUT LOGIC/F07.MC.A - Modbus (1204) - IEC 104 - Braking high to low transition - Line Charge high to low transition - Line Charge in manual and Ug > 0.9pu - If meas.loss (EVENT 10) **Pre-requirements:** - Ug meas. present (EVENT 9) - Option INPUT LOGIC/F07.MC “Force MANUAL mode” not checked
EVENT 12 – CHANNEL FAULT	Event output	Information about channel’s fault Logical high – channel fault **Source:** INPUT LOGIC/F04.ALR **Pre-requirements:** - Active alarm in the system - Checkbox “CHF” in INPUT LOGIC/F04.ALR is checked next to alarm
EVENT 13 – COMMON EVENT 1	Event output	Corresponding binary input is energized If option INPUT LOGIC/F02.PCC ”Only one PC active” is selected this is command to enable Power Converter PC1 **Source:** - INPUT LOGIC/F16.BIN.G **Pre-requirements:**
EVENT 14 – COMMON EVENT 2	Event output	Corresponding binary input is energized If option INPUT LOGIC/F02.PCC ”Only one PC active” is selected this is command to enable Power Converter PC2 **Source:** - INPUT LOGIC/F16.BIN.H **Pre-requirements:**
EVENT 15 – Q REG.MODE	Event output	Reactive power regulation mode active Logical high – active **Source:** - INPUT LOGIC/F09.QRE.A pulse - Modbus command

		- IEC 104 - INPUT LOGIC/F09.QRE option “Auto Q reg mode” and FB close pulse (EVENT 3) **Pre-requirements:** - Auto mode (EVENT 11) - Line Charge mode disabled (EVENT 71) - Braking mode disabled (EVENT 73)
EVENT 16 – Q0 REG.MODE	Event output	Reactive power to zero mode active Logical high – active **Source:** - INPUT LOGIC/F09.QRE.B pulse - Modbus command - IEC 104 - INPUT LOGIC/F09.QRE option “Auto Q0 reg mode” and FB close pulse (EVENT 3) **Pre-requirements:** - Auto mode (EVENT 11) - Line Charge mode disabled (EVENT 71) - Braking mode disabled (EVENT 73)
EVENT 17 – QP REG.MODE	Event output	Power factor regulation mode active Logical high – active **Source:** - INPUT LOGIC/F09.QRE.C pulse - Modbus command - IEC 104 - INPUT LOGIC/F09.QRE option “Auto PQ reg mode” and FB close pulse (EVENT 3) **Pre-requirements:** - Auto mode (EVENT 11) - Line Charge mode disabled (EVENT 71) - Braking mode disabled (EVENT 73)
EVENT 18 - TRIP	Event output	Information about TRIP from AVR. **Logical low necessary to start.** **Source:** INPUT LOGIC/F10.TRIP **Pre-requirements:** - Channel is active (EVENT 7) and any of alarms specified as trip source in F10.TRIP active or: - Active channel is faulty (EVENT 12) as well as not active channel
EVENT 19 – PC1 TEMP STG 2	Event output	Indicates that temperature of power converter exceeded predefined limit This event will automatically disable firing pulses in power converter Logical high – active Delay: 10 sec **Source:** - INPUT LOGIC//F11.PCT **Pre-requirements:**
EVENT 20 – PC2 TEMP STG 2	Event output	Indicates that temperature of power converter exceeded predefined limit This event will automatically disable firing pulses in power converter Logical high – active Delay: 10 sec **Source:** - INPUT LOGIC//F11.PCT **Pre-requirements:**
EVENT 21 – PC3 TEMP STG 2	Event output	Indicates that temperature of power converter exceeded predefined limit This event will automatically disable firing pulses in power converter Logical high – active Delay: 10 sec **Source:**

		- INPUT LOGIC//F11.PCT **Pre-requirements:**
EVENT 22 – PC4 TEMP STG 2	Event output	Indicates that temperature of power converter exceeded predefined limit This event will automatically disable firing pulses in power converter Logical high – active Delay: 10 sec **Source:** - INPUT LOGIC//F11.PCT **Pre-requirements:**
EVENT 23 – BOOSTING	Event output	Command to activate boosting – additional source of current for field winding Logical high – enabled Duration: 10 seconds Disabled for 15 minutes after activation **Source:** - INPUT LOGIC/F24.BS **Pre-requirements:** - Channel excited (EVENT 06) - Channel active (EVENT 07) - Auto mode active (EVENT 11) - Field Breaker closed (EVENT 30) - Unit Breaker closed (EVENT 28) - Last activation of boosting was longer than 15 minutes before - Generator voltage dropped below INPUT LOGIC/F24.BS “Boosting threshold”
EVENT 24– PSS ON	Event output	Power system stabilizer is enabled Logical high - active **Source:** - INPUT LOGIC/F16.BIN - Modbus command **Pre-requirements:** • Pss connected to input or output of control loop in REGULATOR tab
EVENT 25- AC1/DC1 SUPPLY FLT	Event output	Loss of supply AC1/DC1 detected Logical high – loss **Source:** - Input INPUT LOGIC/F12.PWR **Pre-requirements:** - 30 sec after excitation if INPUT LOGIC/F12.PWR “AC1/DC1 supply from excitation transformer” option is checked
EVENT 26- AC2/DC2 SUPPLY FLT	Event output	Loss of supply AC2/DC2 detected Logical high – loss **Source:** - Input INPUT LOGIC/F12.PWR **Pre-requirements:**
EVENT 27 – CROWBAR (UZP) TRIP	Event output	CROWBAR field overvoltage protection activation Logical high - activated **Source:** - INPUT LOGIC/ F28.PRT2 **Pre-requirements:**
EVENT 28 – UB ON	Event output	Position of unit breaker If closed it disables stop command Logical high – closed **Source:** - INPUT LOGIC/F05.OFF.E **Pre-requirements:**
EVENT 29 – THYRISOR FUSE	Event output	Thyristor fuse blown Logical high - active **Source:** - INPUT LOGIC/F16.BIN.B **Pre-requirements:**
EVENT 30 – FB ON	Event output	Position of field breaker Logical high - closed **Source:**

		INPUT LOGIC/F01.ON.B **Pre-requirements:** - logic high on INPUT LOGIC/F01.ON.B
EVENT 31 –V/Hz LIMITER	Event output	Volt per hertz limiter active Logical high – active **Source:** - AVR() procedure **Pre-requirements:** - Channel excited (EVENT 6) - Limiter option in REGULATOR tab enabled - Limiter output == LO GATE output
EVENT 32 –SCL1 LIMITER	Event output	Stator current limiter 1 active Logical high – active **Source:** - AVR() procedure **Pre-requirements:** - Channel excited (EVENT 6) - Limiter option in REGULATOR/SCL panel enabled - Reactive power above minimum, positive - Generator current higher than maximum
EVENT 33 –SCL2 LIMITER	Event output	Stator current limiter 2 active Logical high – active **Source:** - AVR() procedure **Pre-requirements:** - Channel excited (EVENT 6) - Limiter option in REGULATOR/SCL panel enabled - Reactive power above minimum, negative - Generator current higher than maximum
EVENT 34 –FCL LIMITER	Event output	Field current limiter active Logical high – active **Source:** - AVR() procedure **Pre-requirements:** - Channel excited (EVENT 6) - Limiter option in REGULATOR tab enabled - Limiter output == LO GATE output
EVENT 35 –MFCL LIMITER	Event output	Minimum field current limiter active Logical high – active **Source:** - AVR() procedure **Pre-requirements:** - Channel excited (EVENT 6) - Limiter option in REGULATOR tab enabled - Limiter output == HI GATE output
EVENT 36 –PQL LIMITER	Event output	Underexcitation limiter active Logical high – active **Source:** - AVR() procedure **Pre-requirements:** - Channel excited (EVENT 6) - Limiter option in REGULATOR tab enabled - Limiter output == HI GATE output
EVENT 37 – FB SYS1 OFF EVENT 38 – FB SYS1 OFF	Event output	Command to open field breaker system 1, 2 Logical high – active Duration: 1 sec **Source:** - INPUT LOGIC/F05.OFF.F - Modbus command (1214,1217) - IEC 104 command **Pre-requirements:** - Channel not excited (EVENT 06) - Channel active (EVENT 07)
EVENT 39 – PROTECTIONS ACTIVE	Event output	Indicates activation of any of the protections Logical high – active **Source:** - Input INPUT LOGIC/F14.PRT1 or

		- Input INPUT LOGIC/F28.PRT2 or - Input INPUT LOGIC/F29.PRT3 **Pre-requirements:**
EVENT 40 – CHANGE OVER ACTIVE	Event output	Indicates activation of Source Change Over sequence Logical high - active **Source:** INPUT LOGIC/F26.SC **Pre-requirements:** - Channel excited (EVENT 06) - Channel active (EVENT 07) - Field Breaker closed (EVENT 30) - Unit Breaker closed (EVENT 28) - Excitation supply dropped below INPUT LOGIC/F26.SC “Change over threshold”
EVENT 41 – AUTOM. SWITCH TO MANUAL	Event output	Indicates automatic changeover of control mode from Auto to Manual Logical high - active **Source:** INPUT LOGIC/F07.MC **Pre-requirements:** - Loss of Ug measurement (EVENT09) - Second channel is faulty
EVENT 42– FAN 1 ON PULSE	Event output	Command to switch on fan 1 Logical high – active Duration: If INPUT LOGIC/F15.FAN “Fan control by pulse” option is checked duration is 3 sec. Otherwise event is constant **Source:** - INPUT LOGIC/F15.FAN **Pre-requirements:** - Channel is active (EVENT 7) - Channel is excited (EVENT 6)
EVENT 43– FAN 1 OFF PULSE	Event output	Pulse to switch off fan 1 Logical high – active Duration: If INPUT LOGIC/F15.FAN “Fan control by pulse” option is checked duration is 3 sec. Otherwise event is constant **Source:** - INPUT LOGIC/F15.FAN **Pre-requirements:** - Channel is active (EVENT 7) - Channel is excited (EVENT 6)
EVENT 44– FAN 2 ON PULSE	Event output	Pulse to switch on fan 2 Logical high – active Duration: If INPUT LOGIC/F15.FAN “Fan control by pulse” option is checked duration is 3 sec. Otherwise event is constant **Source:** - INPUT LOGIC/F15.FAN **Pre-requirements:** - Channel is active (EVENT 7) - Channel is excited (EVENT 6)
EVENT 45– FAN 1 OFF PULSE	Event output	Pulse to switch off fan 2 Logical high – active Duration: If INPUT LOGIC/F15.FAN “Fan control by pulse” option is checked duration is 3 sec. Otherwise event is constant **Source:** - INPUT LOGIC/F15.FAN **Pre-requirements:** - Channel is active (EVENT 7) - Channel is excited (EVENT 6)

EVENT 46- FF SUPPLY FLT	Event output	Field flashing supply loss detected This event prevents excitation from start Logical high – loss **Source:** - Input INPUT LOGIC/F12.PWR **Pre-requirements:**
EVENT 47 – PC1 ALARM	Event output	Indicates presence of alarm from Local Controller Logical high – alarm present **Source:** - INPUT LOGIC/F17.PC1 **Pre-requirements:**
EVENT 48 – PC1 DISCONN. ON	Event output	Indicates position of disconnector Logical high – closed **Source:** - INPUT LOGIC/F17.PC1 **Pre-requirements:**
EVENT 49 – PC1 SYNC.VOLT.FLT	Event output	Indicates loss of synchronization voltage in power converter in configuration with Local Controller Logical high – loss Delay: 20ms **Source:** - INPUT LOGIC/F17.PC1 **Pre-requirements:** - Logical high at binary information from Local Controller PC1Data_SyncFuse (register 2, bit 8) or - Logical high at binary information from Local Controller PC1Data_SyncVolt (register 3, bit 7) or - Synchronization voltage lower that value specified in INPUT LOGIC/F02.PCC option “Pulses ON Threshold for Local Controller”
EVENT 50 – PC1 PULSES ON	Event output	Command to enable firing pulses in configuration with Local Controller Logical high - enabled **Source:** - INPUT LOGIC/F02.PCC **Pre-requirements:** - Channel excited (EVENT 06) - Channel active (EVENT 07) - “Thyristor Bridge, Local Controller mode” is selected on Options/Advanced/Option “Power converter type” list - Synchronization is present (EVENT 49) - Healthy Watchdog INPUT LOGIC/F17.PC1.A - Closed disconnector (EVENT 48) - Enabled INPUT LOGIC/F17.PC1 function
EVENT 51 – PC2 ALARM	Event output	Indicates presence of alarm from Local Controller Logical high – alarm present **Source:** - INPUT LOGIC/F18.PC2 **Pre-requirements:**
EVENT 52 – PC2 DISCONN. ON	Event output	Indicates position of disconnector Logical high – closed **Source:** - INPUT LOGIC/F18.PC2 **Pre-requirements:**

EVENT 53 – PC2 SYNC.VOLT.FLT	Event output	Indicates loss of synchronization voltage in power converter in configuration with Local Controller Logical high – loss Delay: 20ms **Source:** - INPUT LOGIC/F18.PC2 **Pre-requirements:** - Logical high at binary information from Local Controller PC2Data_SyncFuse (register 2, bit 8) or - Logical high at binary information from Local Controller PC2Data_SyncVolt (register 3, bit 7) or - Synchronization voltage lower that value specified in INPUT LOGIC/F02.PCC option “Pulses ON Threshold for Local Controller”
EVENT 54 – PC2 PULSES ON	Event output	Command to enable firing pulses in configuration with Local Controller Logical high - enabled **Source:** - INPUT LOGIC/F02.PCC **Pre-requirements:** - Channel excited (EVENT 06) - Channel active (EVENT 07) - “Thyristor Bridge, Local Controller mode” is selected on Options/Advanced/Option “Power converter type” list - Synchronization is present (EVENT 53) - Healthy Watchdog INPUT LOGIC/F18.PC2.A - Closed disconnector (EVENT 52) - Enabled INPUT LOGIC/F18.PC2 function
EVENT 55 – PC3 ALARM	Event output	Indicates presence of alarm from Local Controller Logical high – alarm present **Source:** - INPUT LOGIC/F19.PC3 **Pre-requirements:**
EVENT 56 – PC3 DISCONN. ON	Event output	Indicates position of disconnector Logical high – closed **Source:** - INPUT LOGIC/F19.PC3 **Pre-requirements:**
EVENT 57 – PC3 SYNC.VOLT.FLT	Event output	Indicates loss of synchronization voltage in power converter in configuration with Local Controller Logical high – loss Delay: 20ms **Source:** - INPUT LOGIC/F19.PC3 **Pre-requirements:** - Logical high at binary information from Local Controller PC3Data_SyncFuse (register 2, bit 8) or - Logical high at binary information from Local Controller PC3Data_SyncVolt (register 3, bit 7) or - Synchronization voltage lower that value specified in INPUT LOGIC/F02.PCC option “Pulses ON

		Threshold for Local Controller”
EVENT 58 – PC3 PULSES ON	Event output	Command to enable firing pulses in configuration with Local Controller Logical high - enabled **Source:** - INPUT LOGIC/F02.PCC **Pre-requirements:** - Channel excited (EVENT 06) - Channel active (EVENT 07) - “Thyristor Bridge, Local Controller mode” is selected on Options/Advanced/Option “Power converter type” list - Synchronization is present (EVENT 57) - Healthy Watchdog INPUT LOGIC/F19.PC3.A - Closed disconnector (EVENT 56) - Enabled INPUT LOGIC/F19.PC3 function
EVENT 59 – IF PROT.STG1	Event output	Indicates activation of field current protection stage 1 Logical high – active **Source:** - Input INPUT LOGIC/F14.PRT1 **Pre-requirements:**
EVENT 60 - TRIP FROM NOT ACTIVE CHANNEL	Event output	Trip command from AVR to protections from not active channel Logical high – TRIP **Source:** - INPUT LOGIC/F10 **Pre-requirements:** - Channel not Active (EVENT 7)
EVENT 61 – GRID MODE	Event output	Grid mode active Logical high – active **Source:** - INPUT LOGIC/F09.QRE.D **Pre-requirements:**
EVENT 62 – SPARE	Event output	Not used **Source:** **Pre-requirements:**
EVENT 63 – FF TIME EXPIRED	Event output	Field Flashing time lasted longer than specified in INPUT LOGIC/F03.FFC option “Field Flashing Max Time” Logical high – active **Source:** - INPUT LOGIC/F03.FFC **Pre-requirements:**
EVENT 64 –AUTOM. SWITCH TO SECOND CHANNEL	Event output	Automatic changeover to second channel Logical high – active **Source:** - INPUT LOGIC/F13.SWP **Pre-requirements:** - Channel fault (EVENT 12) - Channel active (EVENT 7) - Second channel healthy
EVENT 65 – ISLAND MODE	Event output	Island mode active Logical high – active **Source:** - INPUT LOGIC/F09.QRE.E pulse **Pre-requirements:** - INPUT LOGIC/F09.QRE option “ISLAND MODE” checked
EVENT 66 – COMMON EVENT 3	Event output	Corresponding binary input is energized **Source:** - INPUT LOGIC/F16.BIN.I **Pre-requirements:**

EVENT 67 – COMMON EVENT 4	Event output	Corresponding binary input is energized **Source:** - INPUT LOGIC/F16.BIN.J **Pre-requirements:**
EVENT 68 –LOCAL BINARY CONTROL	Event output	Regulator in local binary control Modbus commands, IEC104 and external analog setpoints are blocked Logical high – Local binary Logical low – Remote **Source:** - Input INPUT LOGIC/F07.MC.D **Pre-requirements:** - Local LCP mode deactivated
EVENT 69 – UG>90%	Event output	Generator voltage higher than 90% of nominal Logical high – higher **Source:** - INPUT LOGIC/F06.MEAS **Pre-requirements:** - Ug > 0.9pu
EVENT 70 – PUMP MODE	Event output	Pump mode operation of generator Shifts generator current measurement phase by 180 degrees Shifts reactive power measurement phase by 180 degrees Selects second bank of settings Logical high – active **Source:** - Input INPUT LOGIC/F06.MEAS.C **Pre-requirements:** - Not Line Charge (EVENT 71)
EVENT 71 – LINE CH. MODE	Event output	Indicates operation in Line Charge mode **Source:** INPUT LOGIC/F01.ON.F **Pre-requirements:** - Channel is not excited (EVENT 6), Pump mode disabled (EVENT 70), Braking mode disabled (EVENT 73), logic low to high transition on input F
EVENT 72 – COMPENS.MODE	Event output	Compensation mode operation of generator Selects second bank of settings Logical high – active **Source:** - Input INPUT LOGIC/F06.MEAS.B **Pre-requirements:**
EVENT 73 – BRAKING MODE	Event output	Indicates operation in Braking mode **Source:** INPUT LOGIC/F01.ON.E **Pre-requirements:** - Channel is not excited (EVENT 6), Line Charge mode disabled (EVENT 71), logic low to high transition on input E
EVENT 74 – EXTERNAL BINARY CONTROL	Event output	Regulator in external binary control Modbus commands, IEC104 are blocked Logical high – External binary Logical low – Remote **Source:** - Input INPUT LOGIC/F07.MC.E **Pre-requirements:** - Local LCP mode deactivated - Local binary deactivated (EVENT 68)
EVENT 75 – Q = 0	Event output	Reactive power is equal zero Logical high – zero **Source:** - Input INPUT LOGIC/F09.QRE **Pre-requirements:**
EVENT 76– COMM. PROT.STG1	Event output	Indicates activation of common protection stage 1 Logical high – active **Source:** - INPUT LOGIC/F14.PRT1 **Pre-requirements:**

EVENT 77– COMM. PROT.STG2	Event output	Indicates activation of common protection stage 2 Logical high – active **Source:** - INPUT LOGIC/F14.PRT1 **Pre-requirements:**
EVENT 78 – STOP RECEIVED	Event output	Stop command received Logical high – stop active **Source:** - Stop INPUT LOGIC/F05.OFF.A - Speed < 1% INPUT LOGIC/F05.OFF.G - Stop Modbus command (1203) - Stop IEC 104 command - High to low transition on Braking INPUT LOGIC/F01.ON.E - Braking if took longer than 100 sec - Common protection if option INPUT LOGIC/F14.PRT1 “OFF LINE ONLY” is checked **Pre-requirements:**
EVENT 79 – TRIP RECEIVED	Event output	Trip command received Logical high – trip active **Source:** - Trip INPUT LOGIC/F05.OFF.C - Trip INPUT LOGIC/F05.OFF.D **Pre-requirements:**
EVENT 80 – START RECEIVED	Event output	Indicates that start command has been received **Source:** - INPUT LOGIC/F01.ON.A - Modbus command (1202) - IEC104 command - INPUT LOGIC/F01.ON.C if option “Autom.start if N >90%” is checked - INPUT LOGIC/F01.ON.G if option “Autom.start if EAVR Ug 90>90%” is checked - EVENT 73 - BRAKING **Pre-requirements:** - None
EVENT 81- U CTRL FLT	Event output	Control voltage loss detected **This event causes regulator to freeze binary inputs in the last known state before event** Logical high – loss **Source:** - Input INPUT LOGIC/F12.PWR.A **Pre-requirements:**
EVENT 82 - COMPENS ARNE	Event output	Compensation of reactive power from ARNE enabled Logical high – enabled **Source:** - Modbus command **Pre-requirements:**
EVENT 83 – N > 90%	Event output	Indicates that machine speed is higher than 90 % **Source:** - INPUT LOGIC/F01.ON.C **Pre-requirements:**
EVENT 84 – MODBUS 1	Event output	Event controlled via Modbus protocol **Source:** - Modbus command ON:1441 OFF:1442 **Pre-requirements:**
EVENT 85 – MODBUS 2	Event output	Event controlled via Modbus protocol **Source:** - Modbus command ON:1443 OFF:1444 **Pre-requirements:**
EVENT 86 – MODBUS 3	Event output	Event controlled via Modbus protocol **Source:** - Modbus command ON:1445 OFF:1446 **Pre-requirements:**
EVENT 87 – MODBUS 4	Event output	Event controlled via Modbus protocol **Source:** - Modbus command ON:1447 OFF:1448 **Pre-requirements:**

EVENT 88 – SETPOINT MAX	Event output	Setpoint of currently selected mode is at maximum Logical high – maximum **Source:** - INPUT LOGIC/F09.QRE **Pre-requirements:**
EVENT 89 – SETPOINT MIN	Event output	Setpoint of currently selected mode at minimum Logical high – minimum **Source:** - INPUT LOGIC/F09.QRE **Pre-requirements:**
EVENT 90 – OVERVOLTAGE (+)	Event output	CROWBAR positive (+) field overvoltage protection pickup Logical high - activated **Source:** - INPUT LOGIC/ F28.PRT2.A **Pre-requirements:**
EVENT 91 – OVERVOLTAGE (-)	Event output	CROWBAR negative (-) field overvoltage protection pickup Logical high - activated **Source:** - INPUT LOGIC/ F28.PRT2.B **Pre-requirements:**
EVENT 92 – READY	Event output	Indicates that system is ready for excitation **Source:** INPUT LOGIC/F01.ON **Pre-requirements:** - Channel is ready for excitation without speed (EVENT 95) and: *With speed control* - Option “For start check N>90” is checked , logic high on INPUT LOGIC/F01.ON.C *Without speed control* - Option “For start check N>90” is not checked
EVENT 93 – GEN SH CIRC ON	Event output	Indicates that stator short circuit is closed **Source:** INPUT LOGIC/F01.ON.G **Pre-requirements:** - Option “Autom.start if EAVR Ug 90>90%” is not checked, logic high on INPUT LOGIC/F01.ON.G
EVENT 94 – SPEED < 1%	Event output	Machine speed is lower than 1% Source of stop command if Unit Breaker is open Logical high – speed lower **Source:** - INPUT LOGIC/F05.OFF.G **Pre-requirements:**
EVENT 95 – READY (NO SPEED)	Event output	Indicates that system is ready for excitation excluding machine speed **Source:** INPUT LOGIC/F01.ON **Pre-requirements:** - TRIP not received (EVENT 79), TRIP not send (EVENT 18), STOP not received (EVENT 78), field flashing supply present (EVENT 46), generator short circuit open (EVENT 93) and: *With Local Controller* - “Thyristor Bridge, Local Controller mode” is selected on Options/Advanced/Option “Power converter type” list, number of healthy rectifiers is higher than specified in LOGIC/F02.PCC “Configuration” option, which includes: o Healthy Watchdog o Closed disconnector o Enabled F17-F20 function

		Without Local Controller - "Thyristor Bridge, Local Controller mode" is not selected on Options/Advanced/Option "Power converter type" list
EVENT 96 – GEN SH CIRC OFF PULSE	Event output	Command to open stator short circuit Logical high – active Duration: 30 sec **Source:** - TRIP (EVENT 79) - Stop (EVENT 78) - INPUT LOGIC/F05.OFF.F **Pre-requirements:** - Channel not excited (EVENT 06) and - Braking mode (EVENT 73) or - Stator short circuit closed (EVENT 93)
EVENT 97 – IF < 1%	Event output	Field current lower than 0.01 pu **Source:** **Pre-requirements:**
EVENT 98 – PC4 ALARM	Event output	Indicates presence of alarm from Local Controller Logical high – alarm present **Source:** - INPUT LOGIC/F20.PC4 **Pre-requirements:**
EVENT 99 – PC4 DISCONN. ON	Event output	Indicates position of disconnector Logical high – closed **Source:** - INPUT LOGIC/F20.PC4 **Pre-requirements:**
EVENT 100 – PC4 SYNC.VOLT.FLT	Event output	Indicates loss of synchronization voltage in power converter in configuration with Local Controller Logical high – loss Delay: 20ms **Source:** - INPUT LOGIC/F20.PC4 **Pre-requirements:** - Logical high at binary information from Local Controller PC4Data_SyncFuse (register 2, bit 8) or - Logical high at binary information from Local Controller PC4Data_SyncVolt (register 3, bit 7) or - Synchronization voltage lower that value specified in INPUT LOGIC/F02.PCC option "Pulses ON Threshold for Local Controller"
EVENT 101 – PC4 PULSES ON	Event output	Command to enable firing pulses in configuration with Local Controller Logical high - enabled **Source:** - INPUT LOGIC/F02.PCC **Pre-requirements:** - Channel excited (EVENT 06) - Channel active (EVENT 07) - "Thyristor Bridge, Local Controller mode" is selected on Options/Advanced/Option "Power converter type" list - Synchronization is present (EVENT 100) - Healthy Watchdog INPUT LOGIC/F20.PC4.A - Closed disconnector (EVENT 99) - Enabled INPUT LOGIC/F20.PC4 function

EVENT 102 – FF DC ON PULSE	Event output	Pulse command to close DC contactor of Field Flashing circuit Logical high – close Duration: 1 sec **Source:** INPUT LOGIC/F03.FFC **Pre-requirements:** - FF DC pulse activated (EVENT 04)
EVENT 103 – FF DC OFF PULSE	Event output	Pulse command to open DC contactor of Field Flashing circuit Logical high – open Duration: 1 sec **Source:** INPUT LOGIC/F03.FFC **Pre-requirements:** - FF DC pulse deactivated (EVENT 04)
EVENT 104 – MANU SETPOINT MAX	Event output	Setpoint of Manual mode is at maximum Logical high – maximum **Source:** - INPUT LOGIC/F09.QRE **Pre-requirements:**
EVENT 105 – MANU SETPOINT MIN	Event output	Setpoint of Manual mode is at minimum Logical high – minimum **Source:** - INPUT LOGIC/F09.QRE **Pre-requirements:**
EVENT 106 – AUTO SETPOINT MAX	Event output	Setpoint of Auto mode is at maximum Logical high – maximum **Source:** - INPUT LOGIC/F09.QRE **Pre-requirements:**
EVENT 107 – AUTO SETPOINT MIN	Event output	Setpoint of Auto mode is at minimum Logical high – minimum **Source:** - INPUT LOGIC/F09.QRE **Pre-requirements:**

3.26.2 List of Alarms

Name	Type	Description
ALARM 1 – FLASH CRC ERROR	Alarm output	Field breaker not closed during start sequence **Source:** Flash memory on BCC-06 board
ALARM 2 – FB ON ERROR	Alarm output	Field breaker not closed during start sequence **Source:** INPUT LOGIC/F01.ON.B
ALARM 3 – FF DC BRK ON FLT	Alarm output	DC breaker not switched on **Source:** INPUT LOGIC/F03.FFC.A
ALARM 4 – FF AC BRK ON FLT	Alarm output	AC breaker not switched on **Source:** INPUT LOGIC/F03.FFC.B
ALARM 5– FF TIME EXPIRED	Alarm output	Field Flashing time lasted longer than specified in INPUT LOGIC/F03.FFC option “Field Flashing Max Time” **Source:** INPUT LOGIC/F03.FFC
ALARM 6 – INTPC SYNC. LOSS	Alarm output	Loss of synchronization voltage in configuration with GCU module **Source:** INPUT LOGIC/F02.PCC
ALARM 7 – UR DIFF.	Alarm output	Difference in generator voltage measurement between channels in phase 1 **Source:** INPUT LOGIC/F06.MEAS
ALARM 8 – US DIFF.	Alarm output	Difference in generator voltage measurement between channels in phase 2 **Source:** INPUT LOGIC/F06.MEAS
ALARM 9 – UT DIFF.	Alarm output	Difference in generator voltage measurement between channels in phase 3 **Source:** INPUT LOGIC/F06.MEAS
ALARM 10 – UG LOSS	Alarm output	Loss of generator voltage measurement **Source:** INPUT LOGIC/F06.MEAS
ALARM 11 – IF DIFF.	Alarm output	Difference in field current measurement between channels **Source:** INPUT LOGIC/F06.MEAS
ALARM 12 – IF LOSS	Alarm output	Loss of field current measurement **Source:** INPUT LOGIC/F06.MEAS
ALARM 13 – FF AC BRK OFF FLT	Alarm output	Field Flashing AC breaker not switched off **Source:** INPUT LOGIC/F03.FFC.B
ALARM 14 – FF DC BRK OFF FLT	Alarm output	Field Flashing DC breaker not switched off **Source:** INPUT LOGIC/F03.FFC.A
ALARM 15 – INT.POWER SUPPLY FLT	Alarm output	Controller internal power supply loss **Source:** INPUT LOGIC/F12.PWR
ALARM 16 – AC1/DC1 SUPPLY FLT	Alarm output	AC1/DC1 supply loss detected **Source:** INPUT LOGIC/F12.PWR
ALARM 17 – AC2/DC2 SUPPLY FLT	Alarm output	AC2/DC2 supply loss detected **Source:** INPUT LOGIC/F12.PWR
ALARM 18 – U CTRL FLT	Alarm output	Control voltage loss detected **Source:** INPUT LOGIC/F12.PWR

ALARM 19 – THYRISTOR FUSE BLOWN	Alarm output	Thyristor fuse blown **Source:** INPUT LOGIC/F16.BIN
ALARM 20 – CROWBAR (UZP) TRIP	Alarm output	CROWBAR field overvoltage protection trip **Source:** INPUT LOGIC/F28.PRT2
ALARM 21 – UG PROT.STG1	Alarm output	Indicates activation of overvoltage protection stage 1 **Source:** INPUT LOGIC/F14.PRT1
ALARM 22 – UG PROT.STG1	Alarm output	Indicates activation of overvoltage protection stage 2 **Source:** INPUT LOGIC/F14.PRT1
ALARM 23 – IF PROT.STG1	Alarm output	Indicates activation of overcurrent protection stage 1 **Source:** INPUT LOGIC/F14.PRT1
ALARM 24 – IF PROT.STG2	Alarm output	Indicates activation of overcurrent protection stage 2 **Source:** INPUT LOGIC/F14.PRT1
ALARM 25 - PC1 STG1	Alarm output	Over temperature rectifier 1 stage 1 **Source:** INPUT LOGIC/F11.PCT
ALARM 26 - PC1 STG2	Alarm output	Over temperature rectifier 1 stage 2 **Source:** INPUT LOGIC/F11.PCT
ALARM 27 – PC2 STG1	Alarm output	Over temperature rectifier 2 stage 1 **Source:** INPUT LOGIC/F11.PCT
ALARM 28 – PC2 STG2	Alarm output	Over temperature rectifier 2 stage 2 **Source:** INPUT LOGIC/F11.PCT
ALARM 29 – AIR	Alarm output	Air over temperature **Source:** INPUT LOGIC/F11.PCT
ALARM 30 – INTPC PULSE LOSS	Alarm output	Loss of firing pulses in configuration with GCU module **Source:** INPUT LOGIC/F02.PCC
ALARM 31 – FAN 1 MALFUNCTION	Alarm output	Indicates faulty operation of fan 1 **Source:** INPUT LOGIC/F15.FAN
ALARM 32 – FAN 2 MALFUNCTION	Alarm output	Indicates faulty operation of fan 2 **Source:** INPUT LOGIC/F15.FAN
ALARM 33 – SYNC FUSE BLOWN	Alarm output	Synchronization fuse blown **Source:** INPUT LOGIC/F16.BIN
ALARM 34 – COMMON ALARM 1	Alarm output	Common alarm 1 active **Source:** INPUT LOGIC/F16.BIN
ALARM 35 – COMMON ALARM 2	Alarm output	Common alarm 2 active **Source:** INPUT LOGIC/F16.BIN
ALARM 36 – FF SUPPLY FLT	Alarm output	Field flashing supply loss detected **Source:** INPUT LOGIC/F12.PWR
ALARM 37 – SEC.CH.LINK FLT	Alarm output	Loss of communication with second channel **Source:** INPUT LOGIC/F06.MEAS
ALARM 38 – WDOG PR1 FLT	Alarm output	Local Controller hardware failure **Source:** INPUT LOGIC/F17.PC1
ALARM 39 – THYRIS.FUSE FLT	Alarm output	Thyristor fuse blown in external power converter **Source:** INPUT LOGIC/F17.PC1
ALARM 40– PC 1 CONDU. FLT OR	Alarm output	One or more thyristors in rectifier 1 is not conducting or

ALARM 40 – PULSE FLT		Loss of firing pulses in external power converter **Source:** INPUT LOGIC/F25.TCD or INPUT LOGIC/F17.PC1
ALARM 41 – FAC FUSE FLT	Alarm output	AC filter fuse blown in external power converter **Source:** INPUT LOGIC/F17.PC1
ALARM 42 – FDC FUSE FLT	Alarm output	DC filter fuse blown in external power converter **Source:** INPUT LOGIC/F17.PC1
ALARM 43 – FAN1 BRK FLT	Alarm output	Fan 1 thermal protection active in external power converter **Source:** INPUT LOGIC/F17.PC1
ALARM 44 – FAN2 BRK FLT	Alarm output	Fan 2 thermal protection active in external power converter **Source:** INPUT LOGIC/F17.PC1
ALARM 45 – FANS SYS1 OFF	Alarm output	Fan's system 1 supply turned off in external power converter **Source:** INPUT LOGIC/F17.PC1
ALARM 46 – FANS SYS2 OFF	Alarm output	Fan's system 2 supply turned off in external power converter **Source:** INPUT LOGIC/F17.PC1
ALARM 47 – SYNC FUSE FLT	Alarm output	Synchronization fuse blown in external power converter **Source:** INPUT LOGIC/F17.PC1
ALARM 48 – CTRL VOLTAGE FLT	Alarm output	Loss of control voltage in external power converter **Source:** INPUT LOGIC/F17.PC1
ALARM 49 – PRESS.FAN1 FLT	Alarm output	Fan 1 pressure failure in external power converter **Source:** INPUT LOGIC/F17.PC1
ALARM 50 – PRESS.FAN2 FLT	Alarm output	Fan 2 pressure failure in external power converter **Source:** INPUT LOGIC/F17.PC1
ALARM 51 – WDOG PR2 FLT	Alarm output	Local Controller hardware failure **Source:** INPUT LOGIC/F18.PC2
ALARM 52 – THYRIS.FUSE FLT	Alarm output	Thyristor fuse blown in external power converter **Source:** INPUT LOGIC/F18.PC2
ALARM 53– PC 2 CONDU. FLT	Alarm output	One or more thyristors in rectifier 2 is not conducting **Source:** INPUT LOGIC/F25.TCD or INPUT LOGIC/F18.PC2
ALARM 54 – FAC FUSE FLT	Alarm output	AC filter fuse blown in external power converter **Source:** INPUT LOGIC/F18.PC2
ALARM 55 – FDC FUSE FLT	Alarm output	DC filter fuse blown in external power converter **Source:** INPUT LOGIC/F18.PC2
ALARM 56 – FAN1 BRK FLT	Alarm output	Fan 1 thermal protection active in external power converter **Source:** INPUT LOGIC/F18.PC2
ALARM 57 – FAN2 BRK FLT	Alarm output	Fan 2 thermal protection active in external power converter

		Source: INPUT LOGIC/F18.PC2
ALARM 58 – FANS SYS1 OFF	Alarm output	Fan's system 1 supply turned off in external power converter **Source:** INPUT LOGIC/F18.PC2
ALARM 59 – FANS SYS2 OFF	Alarm output	Fan's system 2 supply turned off in external power converter **Source:** INPUT LOGIC/F18.PC2
ALARM 60 – SYNC FUSE FLT	Alarm output	Synchronization fuse blown in external power converter **Source:** INPUT LOGIC/F18.PC2
ALARM 61 – CTRL VOLTAGE FLT	Alarm output	Loss of control voltage in external power converter **Source:** INPUT LOGIC/F18.PC2
ALARM 62 – PRESS.FAN1 FLT	Alarm output	Fan 1 pressure failure in external power converter **Source:** INPUT LOGIC/F18.PC2
ALARM 63 – PRESS.FAN2 FLT	Alarm output	Fan 2 pressure failure in external power converter **Source:** INPUT LOGIC/F18.PC2
ALARM 64 – MORE THAN 1 PC FAULT	Alarm output	Number of faulty power converters exceeds x value specified in "Configuration N – x" option **Source:** INPUT LOGIC/F02.PCC
ALARM 65 – WDOG PR2 FLT	Alarm output	Local Controller hardware failure **Source:** INPUT LOGIC/F19.PC3
ALARM 66 – THYRIS.FUSE FLT	Alarm output	Thyristor fuse blown in external power converter **Source:** INPUT LOGIC/F19.PC3
ALARM 67– PC 3 CONDU. FLT	Alarm output	One or more thyristors in rectifier 3 is not conducting **Source:** INPUT LOGIC/F25.TCD or INPUT LOGIC/F19.PC3
ALARM 68 – FAC FUSE FLT	Alarm output	AC filter fuse blown in external power converter **Source:** INPUT LOGIC/F19.PC3
ALARM 69 – FDC FUSE FLT	Alarm output	DC filter fuse blown in external power converter **Source:** INPUT LOGIC/F19.PC3
ALARM 70 – FAN1 BRK FLT	Alarm output	Fan 1 thermal protection active in external power converter **Source:** INPUT LOGIC/F19.PC3
ALARM 71 – FAN2 BRK FLT	Alarm output	Fan 2 thermal protection active in external power converter **Source:** INPUT LOGIC/F19.PC3
ALARM 72 – FANS SYS1 OFF	Alarm output	Fan's system 1 supply turned off in external power converter **Source:** INPUT LOGIC/F19.PC3
ALARM 73 – FANS SYS2 OFF	Alarm output	Fan's system 2 supply turned off in external power converter **Source:** INPUT LOGIC/F19.PC3
ALARM 74 – SYNC FUSE FLT	Alarm output	Synchronization fuse blown in external power converter **Source:** INPUT LOGIC/F19.PC3

ALARM 75 – CTRL VOLTAGE FLT	Alarm output	Loss of control voltage in external power converter **Source:** INPUT LOGIC/F19.PC3
ALARM 76 – PRESS.FAN1 FLT	Alarm output	Fan 1 pressure failure in external power converter **Source:** INPUT LOGIC/F19.PC3
ALARM 77 – PRESS.FAN2 FLT	Alarm output	Fan 2 pressure failure in external power converter **Source:** INPUT LOGIC/F19.PC3
ALARM 78 – PSS TUNING PROTECT. ACTIVE	Alarm output	Indicates activation of common protection internal protection of PSS Tuning module **Source:** PSS TUNING MODULE
ALARM 79 – START & STOP RECEIVED	Alarm output	Commands to start and stop excitation received at the same time **Source:** INPUT LOGIC/F01.ON
ALARM 80 – START & PC'S NOT READY	Alarm output	Command start excitation received but power converter module not ready **Source:** INPUT LOGIC/F01.ON
ALARM 81 – IEC 104 COMM LOSS	Alarm output	Loss of communication via IEC 104 protocol **Source:** Communication module
ALARM 82 – COMM. PROT.STG1	Alarm output	Indicates activation of common protection stage 1 **Source:** INPUT LOGIC/F14.PRT1
ALARM 83– COMM. PROT.STG2	Alarm output	Indicates activation of common protection stage 2 **Source:** INPUT LOGIC/F14.PRT1
ALARM 84 - COMMON ALARM 5	Alarm output	Common alarm 5 **Source:** INPUT LOGIC/F12.PWR
ALARM 85 - COMMON ALARM 6	Alarm output	Common alarm 6 **Source:** INPUT LOGIC/F12.PWR
ALARM 86 - COMMON ALARM 7	Alarm output	Common alarm 7 **Source:** INPUT LOGIC/F12.PWR
ALARM 87 - COMMON ALARM 8	Alarm output	Common alarm 8 **Source:** INPUT LOGIC/F12.PWR
ALARM 88 – PROTECTION STG1	Alarm output	Loss of Field Protection stage 1 active (big circle) **Source:** INPUT LOGIC/F27.LOF
ALARM 89 – PROTECTION STG2	Alarm output	Loss of Field Protection stage 2 active (small circle) **Source:** INPUT LOGIC/F27.LOF
ALARM 90 – INTERNAL PC COMM LOSS	Alarm output	Communication with internal power converter is lost **Source:** INPUT LOGIC/F02.PCC
ALARM 91 – UG AND IF LOSS	Alarm output	Loss of both generator voltage and field current measurements **Source:** INPUT LOGIC/F06.MEAS
ALARM 92 – ROT.DIODE PROT.	Alarm output	Indicates activation of rotating diode protection **Source:** INPUT LOGIC/F14.PRT1
ALARM 93 – PC3 STG1	Alarm output	Over temperature rectifier 3 stage 1 **Source:** INPUT LOGIC/F11.PCT
ALARM 94 – PC3 STG2	Alarm output	Over temperature rectifier 3 stage 2 **Source:** INPUT LOGIC/F11.PCT
ALARM 95 – START & TRIP	Alarm output	Commands to start and trip excitation received at the same time **Source:** INPUT LOGIC/F01.ON

ALARM 96 – START & NO SPEED	Alarm output	Command start excitation received but machine speed is too low **Source:** INPUT LOGIC/F01.ON
ALARM 97 – EXTERNAL PF MEAS. LOSS	Alarm output	Loss of 4-20mA analog measurement of power factor **Source:** Measurement control logic
ALARM 98 – EXTERNAL PG MEAS. LOSS	Alarm output	Loss of 4-20mA analog measurement of active power **Source:** Measurement control logic
ALARM 99 – EXTERNAL QG MEAS. LOSS	Alarm output	Loss of 4-20mA analog measurement of reactive power **Source:** Measurement control logic
ALARM 100 – EXT AUTO MODE STP LOSS	Alarm output	Loss of 4-20mA analog setpoint for Auto mode **Source:** Measurement control logic
ALARM 101 – EXT PF MODE STP LOSS	Alarm output	Loss of 4-20mA analog setpoint for Power Factor control mode **Source:** Measurement control logic
ALARM 102 – EXT Q MODE STP LOSS	Alarm output	Loss of 4-20mA analog setpoint for Reactive Power control mode **Source:** Measurement control logic
ALARM 103 – U GRID MEAS LOSS	Alarm output	Loss of grid voltage measurement from terminals X5:1-2 **Source:** INPUT LOGIC/F23.VM
ALARM 104 – TEMPERATURE FOR LIMITERS LOSS	Alarm output	Loss of 4-20mA analog temperature measurement for limiter setpoint correction **Source:** Measurement control logic
ALARM 105 – ROTOR TEMPERATURE STG 1	Alarm output	Rotor temperature exceeded threshold 1 **Source:** INPUT LOGIC/F22.RTT
ALARM 106 – IG DIFFERENCE	Alarm output	Difference in generator current measurement between channels **Source:** INPUT LOGIC/F06.MEAS
ALARM 107 – SENSOR FLT	Alarm output	Temperature measurement sensor fault **Source:** INPUT LOGIC/F11.PCT
ALARM 108 - COMMON ALARM 3	Alarm output	Common alarm 3 **Source:** INPUT LOGIC/F12.PWR
ALARM 109 - COMMON ALARM 4	Alarm output	Common alarm 4 **Source:** INPUT LOGIC/F12.PWR
ALARM 110 – FB OFF AND UB ON	Alarm output	Indicates situation when field breaker is open and unit breaker is closed **Source:** INPUT LOGIC/F05.OFF
ALARM 111 – SWAP FROM PROT.	Alarm output	Swap from protection command received **Source:** INPUT LOGIC/F13.SWP
ALARM 112 – PC COMM ERROR	Alarm output	Errors detected in communication with one or more local controllers **Source:** INPUT LOGIC/F02.PCC
ALARM 113 – PC COMM LOSS	Alarm output	Communication with at least one local controllers is lost **Source:** INPUT LOGIC/F02.PCC
ALARM 114 – ROTOR TEMPERATURE STG 2	Alarm output	Rotor temperature exceeded threshold 1 **Source:** INPUT LOGIC/F22.RTT

ALARM 115 – EXCITATION ON & PULSES OFF	Alarm output	Indicates situation when excitation is running but firing pulses for power converter are disable **Source:** INPUT LOGIC/F01.ON
ALARM 116– SWAP FROM PROT.	Alarm output	Channels follow up failure **Source:** INPUT LOGIC/F13.SWP
ALARM 117 – USYNC UNBALANCED	Alarm output	Synchronization voltage unbalanced **Source:** INPUT LOGIC/F06.MEAS
ALARM 118 – U/F PROT. STG 1	Alarm output	Volts per hertz protection activation stage 1 – definite time **Source:** INPUT LOGIC/F28.PRT2
ALARM 119 – U/F PROT. STG 2	Alarm output	Volts per hertz protection activation stage 2 – inverse time **Source:** INPUT LOGIC/F28.PRT2
ALARM 120 – IF PROT I*t	Alarm output	Indicates activation of inverse time field overcurrent protection **Source:** INPUT LOGIC/F14.PRT1
ALARM 121 – UNBALANCED	Alarm output	Difference between currents in two power converters higher than 40% for time longer than 15 minutes **Source:** INPUT LOGIC/F21.CDC
ALARM 122 – CROWBAR OVERVOLT.	Alarm output	CROWBAR field overvoltage protection pickup **Source:** INPUT LOGIC/F28.PRT2
ALARM 123 – BRAKING ERROR	Alarm output	Generator short circuit is open during Braking **Source:** INPUT LOGIC/F01.ON
ALARM 124 – UB ON or AUTO MODE when GEN.SHORT CIRCUIT	Alarm output	Indicates situation when stator short circuit is closed but regulator is in Auto mode or Unit Breaker is closed **Source:** INPUT LOGIC/F05.OFF
ALARM 125 – ALARM A	Alarm output	Binary input A activated **Source:** INPUT LOGIC/F32.EXT
ALARM 126 – ALARM B	Alarm output	Binary input B activated **Source:** INPUT LOGIC/F32.EXT
ALARM 127 – ALARM C	Alarm output	Binary input C activated **Source:** INPUT LOGIC/F32.EXT
ALARM 128 – ALARM D	Alarm output	Binary input D activated **Source:** INPUT LOGIC/F32.EXT
ALARM 129 – WDOG PR2 FLT	Alarm output	Local Controller hardware failure **Source:** INPUT LOGIC/F20.PC4
ALARM 130 – THYRIS.FUSE FLT	Alarm output	Thyristor fuse blown in external power converter **Source:** INPUT LOGIC/F20.PC4
ALARM 131– PC 4 CONDU. FLT	Alarm output	One or more thyristors in rectifier 4 is not conducting **Source:** INPUT LOGIC/F25.TCD or INPUT LOGIC/F20.PC4
ALARM 132 – FAC FUSE FLT	Alarm output	AC filter fuse blown in external power converter **Source:** INPUT LOGIC/F20.PC4
ALARM 133 – FDC FUSE FLT	Alarm output	DC filter fuse blown in external power converter **Source:** INPUT LOGIC/F20.PC4

ALARM 134 – FAN1 BRK FLT	Alarm output	Fan 1 thermal protection active in external power converter **Source:** INPUT LOGIC/F20.PC4
ALARM 135 – FAN2 BRK FLT	Alarm output	Fan 2 thermal protection active in external power converter **Source:** INPUT LOGIC/F20.PC4
ALARM 136 – FANS SYS1 OFF	Alarm output	Fan's system 1 supply turned off in external power converter **Source:** INPUT LOGIC/F20.PC4
ALARM 137 – FANS SYS2 OFF	Alarm output	Fan's system 2 supply turned off in external power converter **Source:** INPUT LOGIC/F20.PC4
ALARM 138 – SYNC FUSE FLT	Alarm output	Synchronization fuse blown in external power converter **Source:** INPUT LOGIC/F20.PC4
ALARM 139 – CTRL VOLTAGE FLT	Alarm output	Loss of control voltage in external power converter **Source:** INPUT LOGIC/F20.PC4
ALARM 140 – PRESS.FAN1 FLT	Alarm output	Fan 1 pressure failure in external power converter **Source:** INPUT LOGIC/F20.PC4
ALARM 141 – PRESS.FAN2 FLT	Alarm output	Fan 2 pressure failure in external power converter **Source:** INPUT LOGIC/F20.PC4
ALARM 142 – PC4 STG1	Alarm output	Over temperature rectifier 4 stage 1 **Source:** INPUT LOGIC/F11.PCT
ALARM143 – PC5 STG2	Alarm output	Over temperature rectifier 4 stage 2 **Source:** INPUT LOGIC/F11.PCT
ALARM 144 – EXCITED AND NO SPEED	Alarm output	Generator is excited but speed is too low Delay: 10 sec **Source:** INPUT LOGIC/F01.ON
ALARM 145 – ALARM E	Alarm output	Binary input E activated **Source:** INPUT LOGIC/F32.EXT
ALARM 146 – ALARM F	Alarm output	Binary input F activated **Source:** INPUT LOGIC/F32.EXT
ALARM 147 – ALARM G	Alarm output	Binary input G activated **Source:** INPUT LOGIC/F32.EXT
ALARM 148 – ALARM H	Alarm output	Binary input H activated **Source:** INPUT LOGIC/F32.EXT
ALARM 149 – ALARM I	Alarm output	Binary input I activated **Source:** INPUT LOGIC/F32.EXT
ALARM 150 – ALARM J	Alarm output	Binary input J activated **Source:** INPUT LOGIC/F32.EXT
ALARM 151 – MIN. FIELD CURRENT (37F)	Alarm output	Minimum field current protection activation **Source:** INPUT LOGIC/F29.PRT3
ALARM 152 – OVERFREQUENCY (81O)	Alarm output	Over frequency protection activation **Source:** INPUT LOGIC/F29.PRT3
ALARM 153 – UNDERFREQUENCY (81U)	Alarm output	Under frequency protection activation **Source:** INPUT LOGIC/F29.PRT3
ALARM 154 – UNDER VOLTAGE (27)	Alarm output	Under voltage protection activation **Source:**

		INPUT LOGIC/F29.PRT3
ALARM 155 – REVERSE POWER (32)	Alarm output	Reverse power protection activation **Source:** INPUT LOGIC/F29.PRT3
ALARM 156 – OVER CURRENT (50)	Alarm output	Over current protection activation **Source:** INPUT LOGIC/F29.PRT3