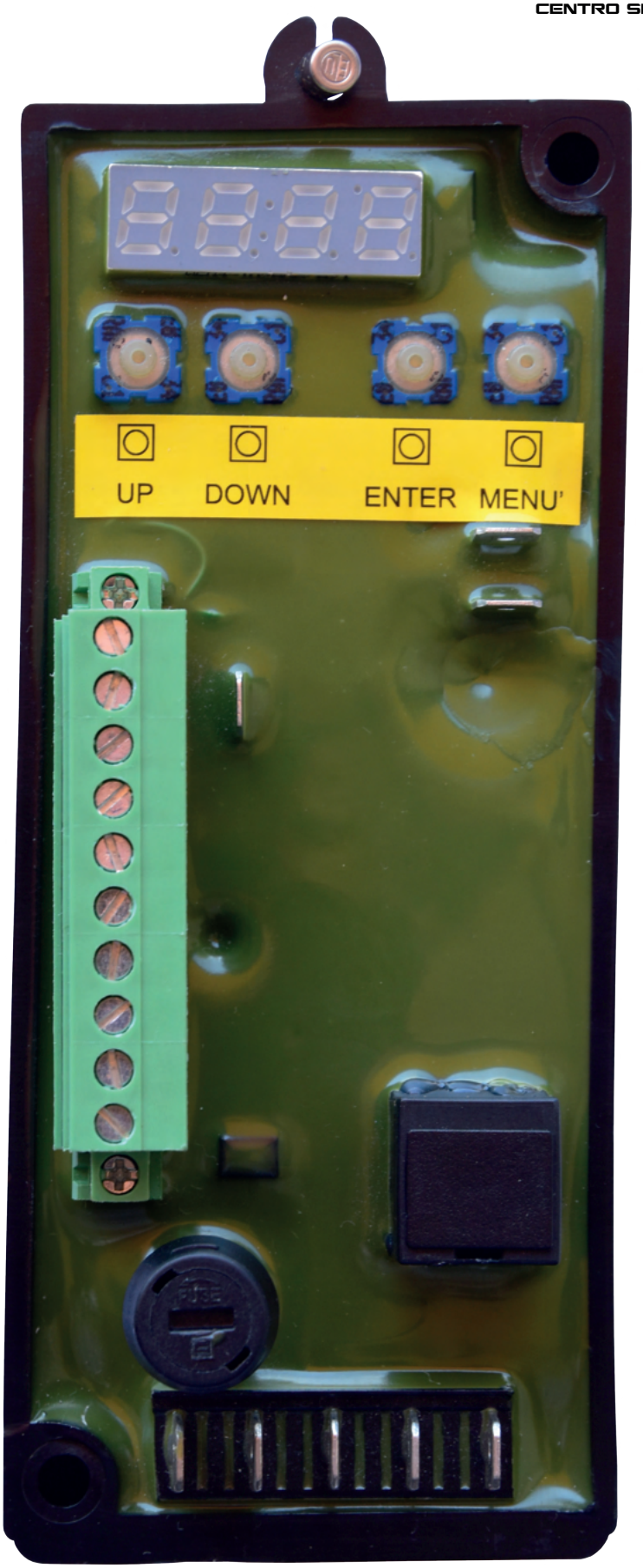
S 2014

BELTRAME
CENTRO SERVIZI ENERGIA

USER'S MANUAL



Rev. 4.0

CONTENTS

IMPORTANT INFORMATION

Our experience has shown that, if the information and recommendations contained in this Operating Instructions are observed, the best possible reliability of our products is assured.
The data contained herein purports solely to describe the product and it is not a warranty of performance or characteristics. It is with the best interests of our customers in mind that we constantly strive to improve our products and keep them abreast of advances in technology. This may, however, lead to discrepancies between a product and its "Technical Description" or "Operating Instructions".

This document has been carefully prepared and reviewed, however should in spite of this the reader find an error, he is requested to inform us at his earliest convenience.
It is scarcely possible for the operating instructions for technical equipment to cover every eventuality, which can occur in practice. We would therefore request you to notify us or our agent in the case of all unusual behavior that does not appear to be covered by these operating instructions.
It is pointed out that all local regulations in force must be observed when connecting and commissioning this equipment in addition to these operating instructions.
We cannot accept any responsibility for damage incurred as a result of mishandling the equipment regardless of whether particular reference is made in these operating instructions or not.

1. SAFETY INSTRUCTIONS

1.1 General

The safety instructions shall be followed during installation, commissioning, operation and maintenance of the excitation system. Read all instructions carefully before operating the device and keep this manual for future reference.

Required Qualification

Personnel involved in installation work and commissioning of the S2014 must be familiar, specially instructed and informed about the residual danger areas according to the regulations currently in force. Operating personnel is not permitted to work at the control system. Only specially instructed personnel must carry out maintenance and repair work. The maintenance personnel must be informed about the emergency shutdown measures and must be capable of turning off the system in case of emergency. The maintenance personnel must be familiar with the accident prevention measures at their workplace and must be instructed in first aid and firefighting.
It is the owner's responsibility to ensure that each person involved in the installation and commissioning of the S2014 has received the appropriate training or instructions and has thoroughly read and clearly understood the safety instructions in this chapter.

1.2 Safety Instructions

The safety instructions precede any instruction in the context where a potentially dangerous situation may appear. The safety instructions are divided into three categories, and each one is introduced by a symbol with its description:

DANGER!
This symbol indicates an imminent danger resulting from mechanical forces or high voltage. A non-observance leads to life-threatening physical injury or death.

WARNING!
This symbol indicates a dangerous situation. A non-observance may lead to bad or life-threatening physical injury or death. It may cause also possible damages to the devices.

NOTICE!
This symbol emphasizes important information. A non-observance may cause damage to the device or to objects close to it.

2. DEVICE DESCRIPTION

2.1 Introduction

S2014 is a last generation Automatic Voltage Regulator for Generators excitation control. The unit contains the most advanced microprocessor technology together with IGBT semiconductor technology (Insulated Gate Bipolar Transistor).

A practical and simple-to-operate on board panel is used for all control operations. In addition, user friendly software facilitates the commissioning and allows the optimization of the performances.

2.2 S2014 Main Specifications

MECHANICAL DETAILS	Weight: Protection class: Dimensions (LxWxH)	Approx. 600 gr IP2X (limited by fast-on type terminals) 138x58x55 mm
AMBIENT CONDITION	Temperature range for operation: Temperature range for storage: Vibration:	From -20°C to +65°C From -40°C to +80 °C 5 mm, 2 G, 5<f<150 Hz
ELECTRICAL DETAILS	Power electronics supply: Excitation output: Frequency range:	3±300 Vac from 10 to 500Hz Max continuous current 8 A Current reduction for ambient temperatures > 50 °C: 1 A/degree Forcing (max 10 s): 16 A From 10 to 500 Hz
Other	Accuracy	< ±0.25%
	Voltage inputs	Not insulated
	Ambient condition	AVR has to be protected against dust, moisture, rain

2.3 CE / EU Compliance

This product has been evaluated and complies with the relevant essential requirements requested by the EU legislation.

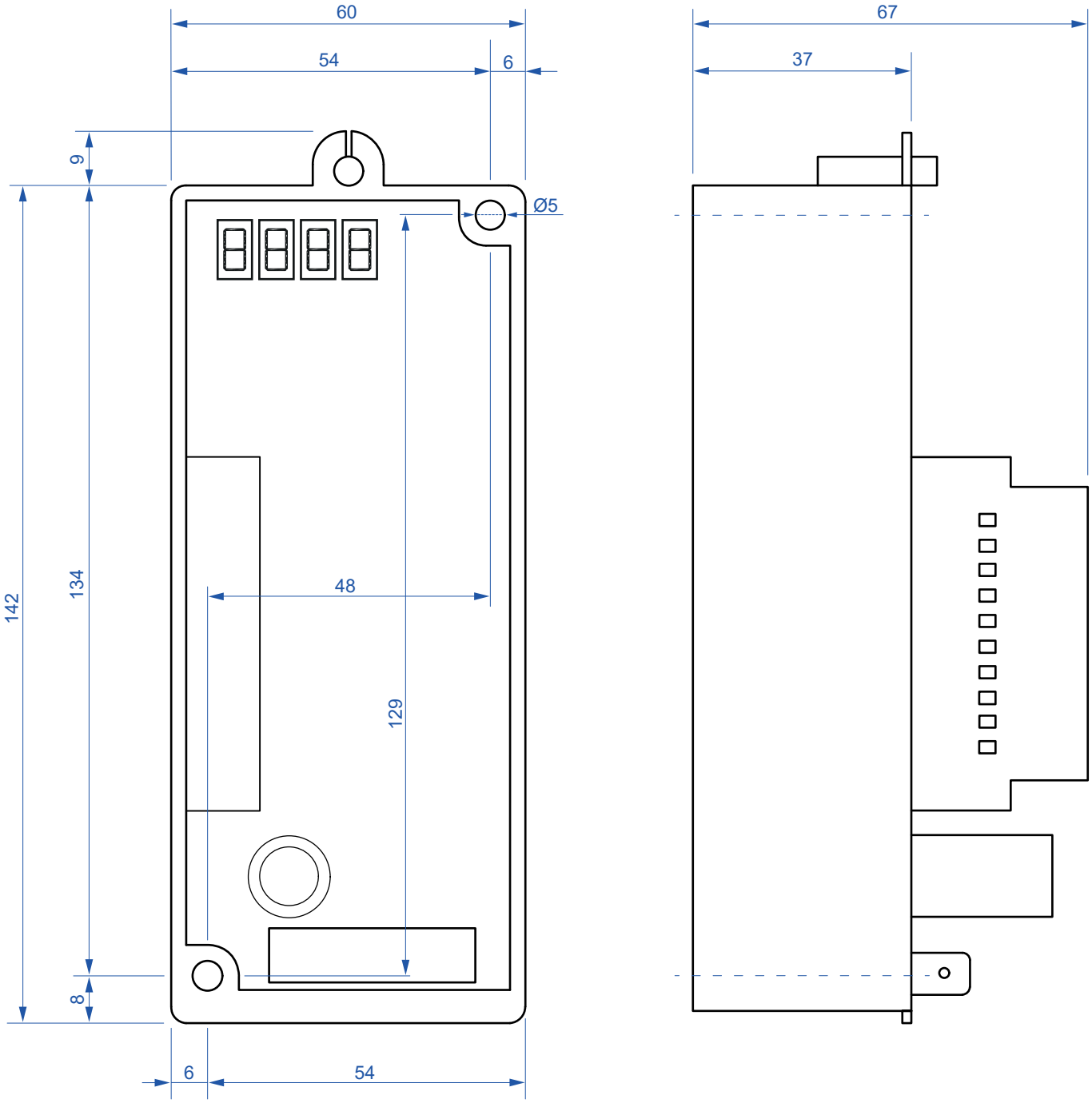
It complies with the following EU Directives:

- LVD 2014/35/EU;
- EMC 2014/30/EU;
- ROHS 2 2011/65/EU.

The harmonized standards used for the evaluation are:

- EN 50178 - Electronic Equipment for use in Power Installations;
  - EN 61000-6-4 - Electromagnetic Compatibility (EMC), Generic Standards, Emission Standard for Industrial Environments;
  - EN 61000-6-2 - Electromagnetic Compatibility (EMC), Generic Standards, Immunity for Industrial Environments.

2.4 Overall Dimensions and Fixing Holes



2.5 Application Area

This AVR is used for the excitation of synchronous machines. This unit is suitable for this only application area.
The AVR can manage several regulations. Among them:

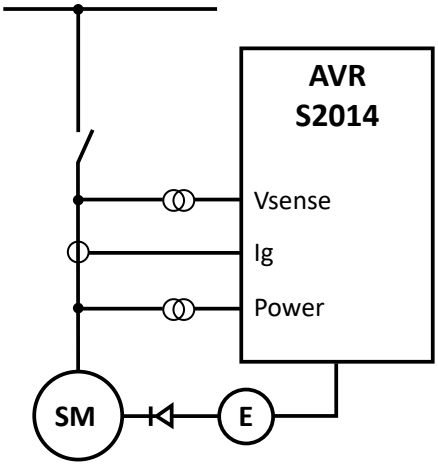
- Voltage regulation;
- Field Current Regulation (FCR);
- Power Factor regulation (PF);
- Reactive power regulation (VAR).

2.6 Basic Insertion Configurations

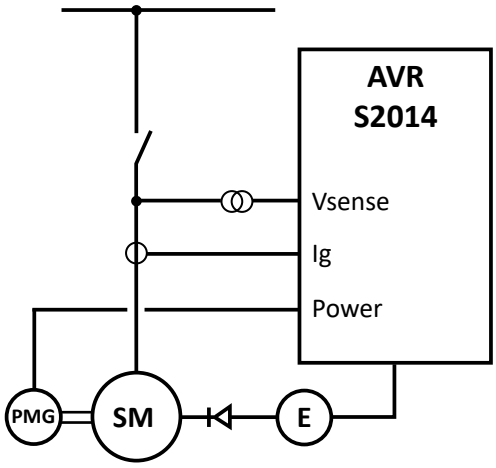
The following SLD show some basic insertion configurations of the S2014.

SM: Synchronous Machine **E**: Exciter **PMG**: Permanent-Magnet-Generator **D**:Direct Current machine

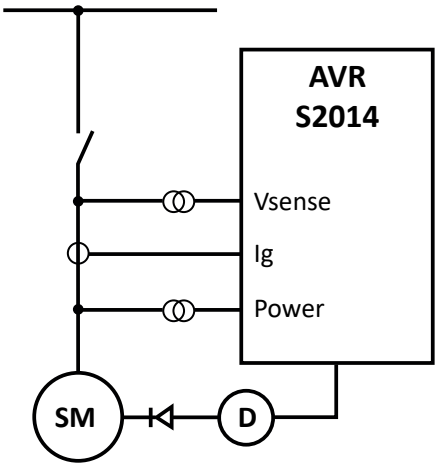
In this configuration the AVR is powered directly from the generator output (or from an auxiliary winding). The AVR DC output is feeding the stator of the exciter.



In this configuration the AVR is powered from a PMG. The AVR DC output is feeding the stator of the exciter.



This configuration shows a possible replacement of a Direct Current excitation machine.



2.7 Hardware

Structure:

The device is assembled inside a plastic case with aluminum base, and it is fixed on a heat dissipater.
The connection terminals are integrated on the top of the circuit boards.

Power electronics:

- The power circuit is designed with IGBT semiconductors.
- A fuse protects the output against short-circuits.

Control elements:

- The operating keys and the display are located on board.
- The communication port connector is located on the front of the AVR.

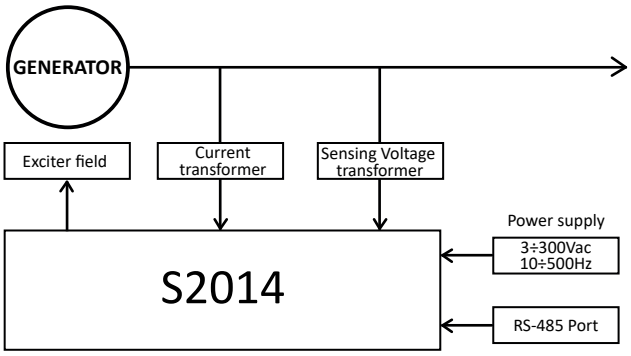
Installation:

- The site of installation must be dry and free of dust. The AVR can be installed in vertical or in horizontal position.

Mounting:

- The AVR must be installed inside the Generator or inside the control panel in order to obtain protection against accidental contacts. To fasten the regulator, use the 4 MA through-screws in two corners holes. It is recommendable to use self-locking nuts. It is recommended also to bind the regulator back on a metal plate for better heat dissipation.

Connection block diagram:



2.8 Control elements and interfaces

Carrying out settings on the unit

The displays and the four keys allow complete operation.
All settings can be carried out directly on the unit without additional equipment.

- Inputs and outputs configuration;
- Parameter setting;
- Selection on the display of the main measured values.

Interface with PC (see the dedicated chapter)

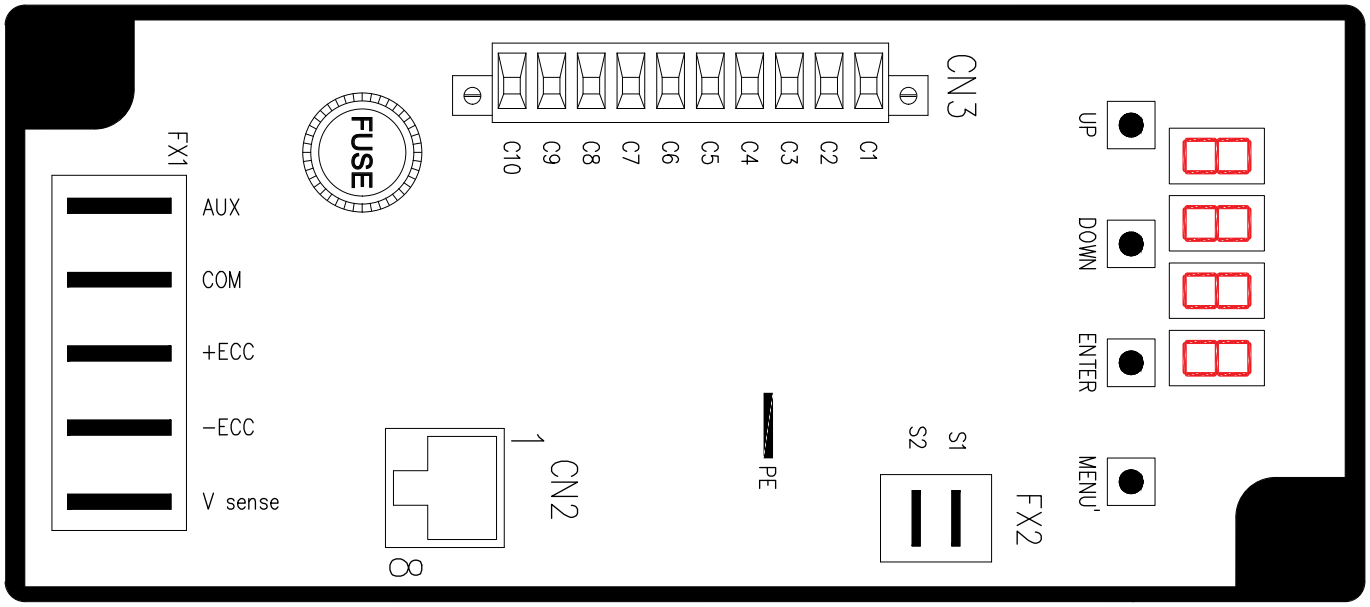
Parameter setting and optimization is possible using the user-friendly *S2014 Config* for Microsoft Windows. Using an USB/RS485 cable (made by Beltrame - Optional), with USB insulator, for the connection between PC and AVR, is possible to:

- Configure inputs and outputs;
- Set all parameter;
- Select on the display all the measured values;
- Download, upload, save and open config files;
- … and a lot more.

Note: The interface is not isolated from the power supply: in order to connect with a pc or other devices an interface isolator must be used.

2.9 Terminal blocks

Overview of the device connections:



Description of the terminals:

CN2 – RS 485 Serial Interface		**CN3 – Control connections**	
1	GND	**C1**	Com
2	GND	**C2**	Increase reference adjust
3	-RESERVED-	**C3**	Decrease reference adjust
4	LINK –	**C4**	52G status (parallel feedback)
5	LINK +	**C5**	±5V analog input
6	-RESERVED-	**C6**	1Kohm Potentiometer input
7	-RESERVED-	**C7**	+6V Aux
8	-RESERVED-	**C8**	N.C.
Note: the reserved pins have to be left **unconnected**		**C9**	OUT (E)
		C10	OUT (C)
FX1 - Power connections		**FX2 – Current sensing inputs**	
AUX	AUX	**S1**	C.T. input S1
COM	Com	**S2**	C.T. input S2
+Ecc	Excitation output +		
-Ecc	Excitation output -		
Vsense	Voltage sensing input		
PE	PE		

3. DEVICE CONNECTIONS

Required Qualification

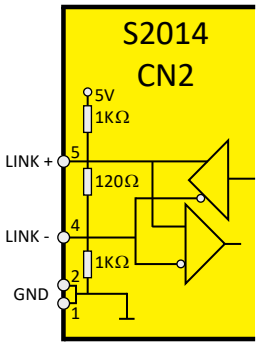
Personnel involved in installation work and commissioning of the S2014 must be familiar, specially instructed and informed about the residual danger areas according to the regulations currently in force.

Only specially instructed personnel must carry out maintenance and repair work.

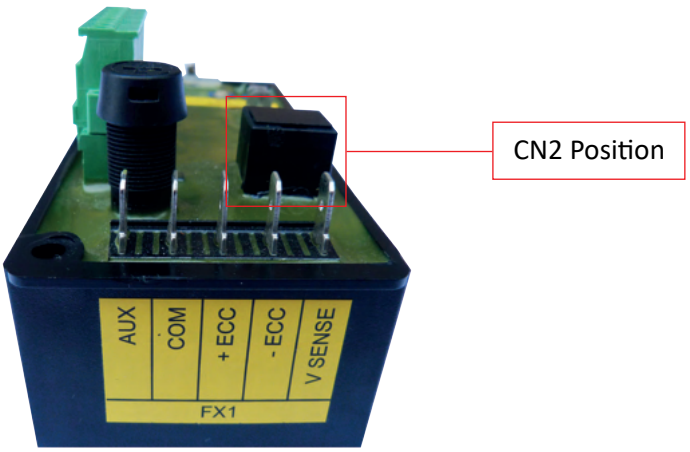
3.1 Input/Output power connection / rated data

Terminal designation (FX1 AND FX2)	Terminals	Signal	Specifications
Power electronics supply	AUX - COM	ADC input voltage (single-phase)	3÷300 Vac 10÷500 Hz
Measurements inputs	COM - Vsense	Generator voltage	0 ÷ 500 Vrms (sensing) Not isolated versus the power supply (AUX)
	TA s1 - TA s2	Generator current	0÷5 Arms With galvanic isolation
Excitation ouput	+ECC -ECC	Excitation voltage	3÷200 VDC (<0.8 V_{AUX})
		Excitation current	0÷8 A (16 A for 10s)

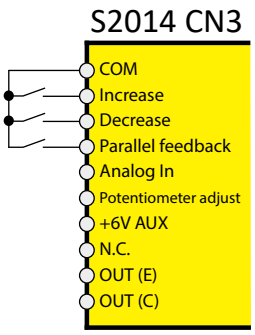
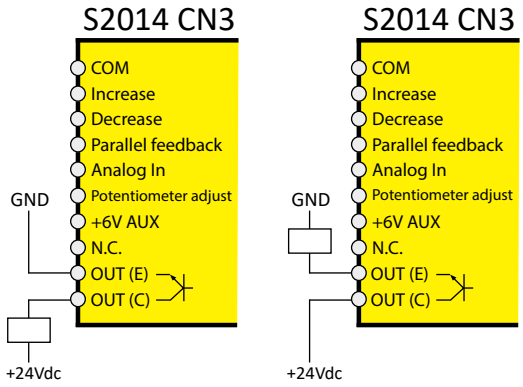
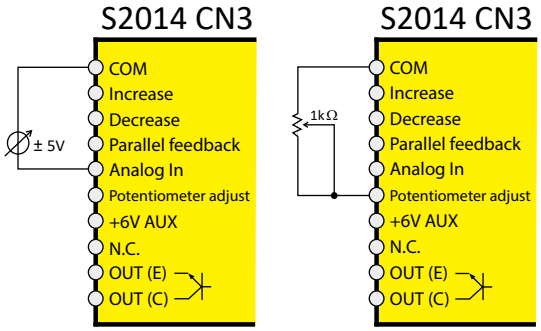
3.2 Device connections: CN2 Interface

Terminal designation	Description	Diagram
Communication	Modbus RTU and proprietary protocols half duplex **Not isolated from power supply** 	

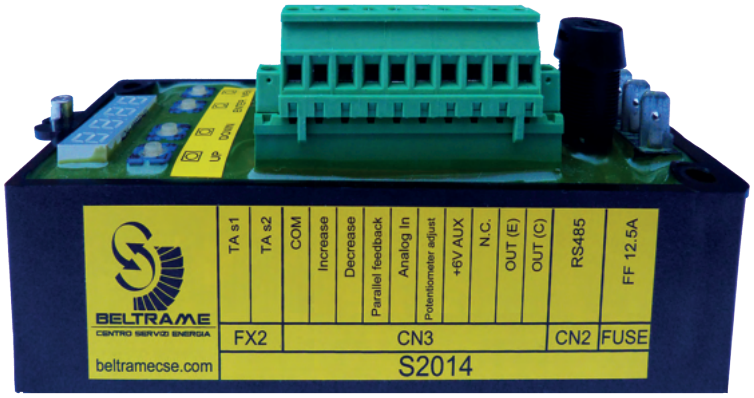
CN2 picture:



3.3 Device connections: CN3 I/O control signals

Terminal designation	Description	Diagram
CN3 Digital inputs	3 programmable digital inputs • 4mA • Up / Down / programmable function • AVR/FCR/PF/VAR mode **Not isolated from power supply** 	
CN3 Digital outputs	N.1 programmable digital output **Max Load 65mA 24Vdc**	
2x Analog inputs	**Not isolated from power supply** 	 Analog input: ± 5V | Potentiometer input: 1kohm

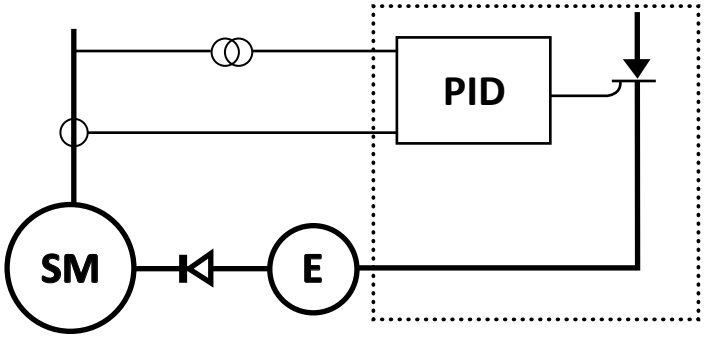
CN3 picture:



4. OPERATING MODES

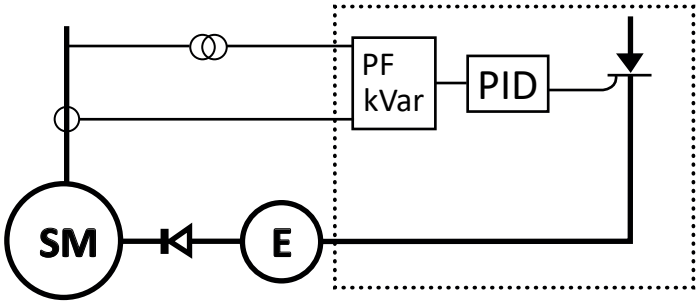
S2014 allows bump less changeover between all operation modes:

Automatic voltage regulator (AVR)
It regulates the output voltage of the synchronous machine.
Note: Output Generator Current measurement is optional: it is used only for droop compensation



Field Current Regulation (FCR)
It regulates the excitation (field) current of the synchronous machine.
This operation mode is quite useful during commissioning and/or troubleshooting.

PF or Var regulation (PF, Var)
Regulates the power factor or reactive power of the synchronous machine.
Note: these functions are available only if the machine is working in parallel (and with closed 52G signal)

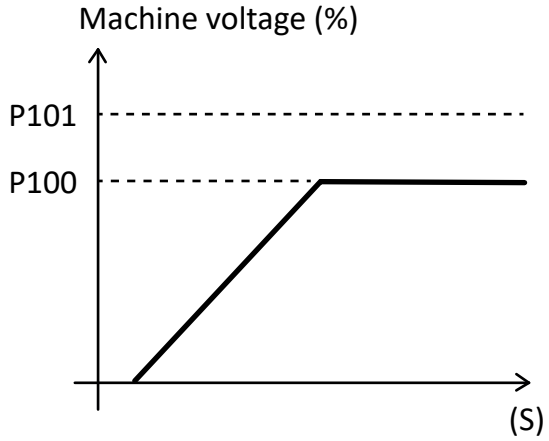


5. FUNCTIONS DESCRIPTION

5.1 Soft Start

Setting the following parameters, it is possible to set up the excitation ramp of the Generator (Output Voltage vs Time):

Parameter	*Description (short)*	*Description*
P.100	*Gen rated voltage*	Generator rated voltage [V]
R.002	*Ramp slope*	Ramp slope [%/s]



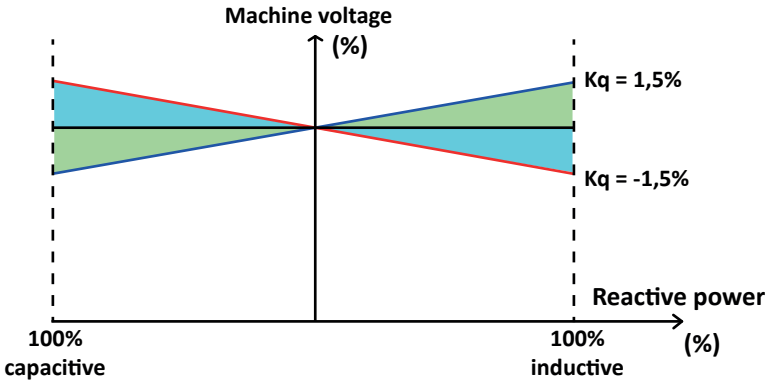
The soft start function is working only in the AVR mode.

The slope of the ramp is controlled by the V/Hz limiter.

5.2 Compensation and Droop functions

The compensation function (K> 0) is used in order to reduce the voltage drop created by the possible presence of a power transformer mounted after the Generator.
The 'droop' function (K<0) is recommendable in case of operation with more generators in parallel. It applies a machine output voltage reduction according to the reactive power output. The "droop" function reduces the output voltage according the reactive power output (higher is the reactive power, lower will be the output voltage).

Compensation and droop functions require:
- AVR mode
- alternator current reading
- digital input 3 programmed as I002= 4 (52G closed + Droop regulation)



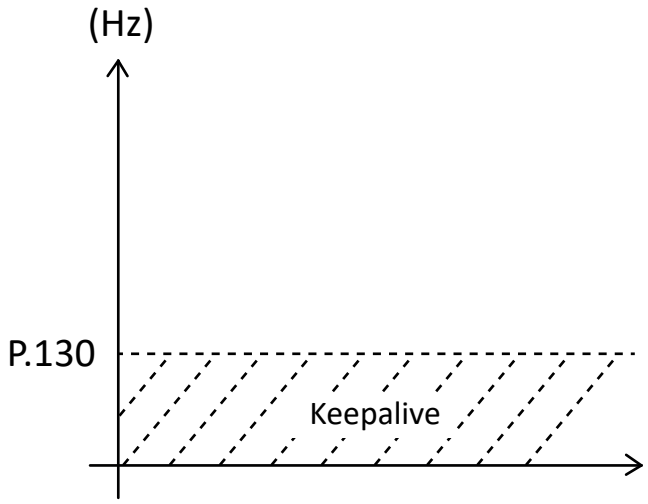
Parameter	*Description (short)*	*Description*
P.400	Voltage comp K	Voltage comp [%]

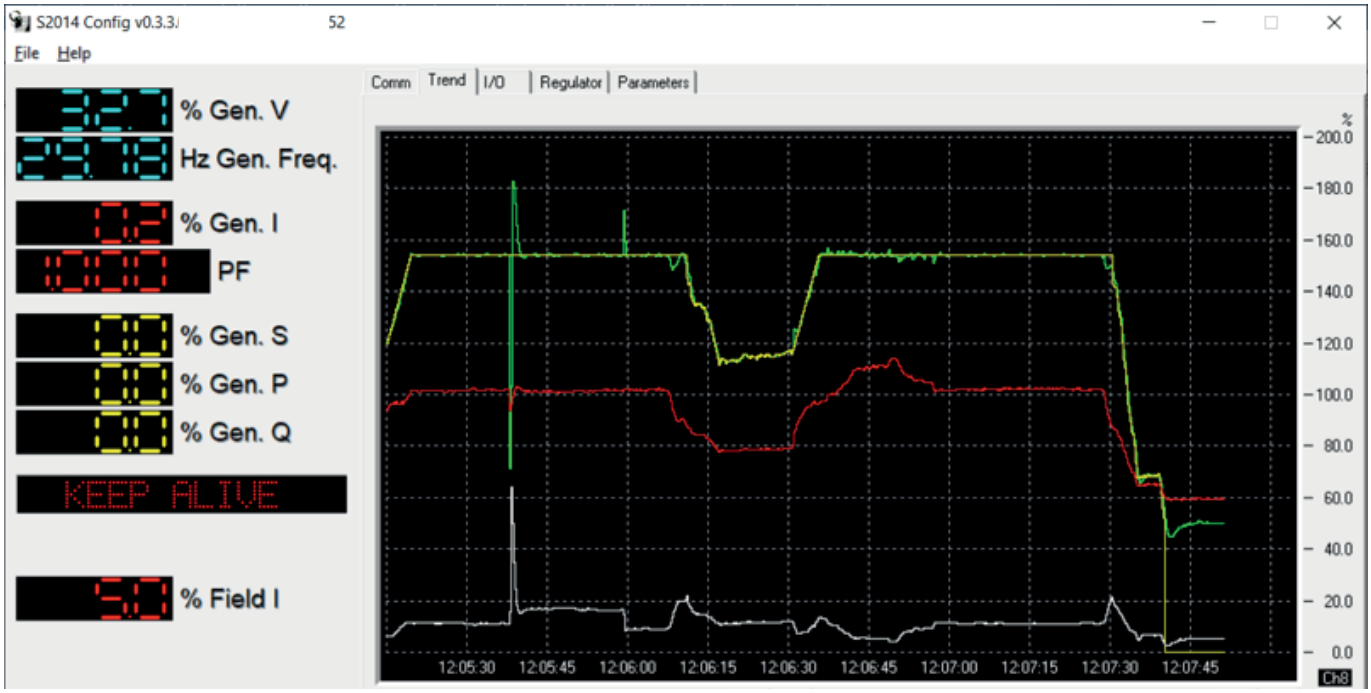
5.3 Keep Alive

This feature helps/allows the self-excitation of the Generator in case the AVR input power line is connected to the generator terminal or to a generator auxiliary winding.
With “keep alive” enabled (P.250>0), the S2014 will try to keep a minimum excitation current during the start-up.
As default P.250 is adjusted to 5. This means that the S2014, during the start-up, will try to keep the excitation current to 5% of the rated excitation current (P.000). Once the frequency will be higher the P.130 (Generator minimum frequency), the AVR will leave the “keep alive” area and will enter in the V ramp area.

In case the AVR is powered with a PMG or with an external power source the “Keep Alive” function has to be disabled (set P.250=0).

Parameter	*Description (short)*	*Description*
P.250	*Keep Alive min I*	% of the rated exc current (P.000) from 0Hz to P.130 Hz
P.130	*Gen. V/f min freq*	Generator minimum frequency (Hz)



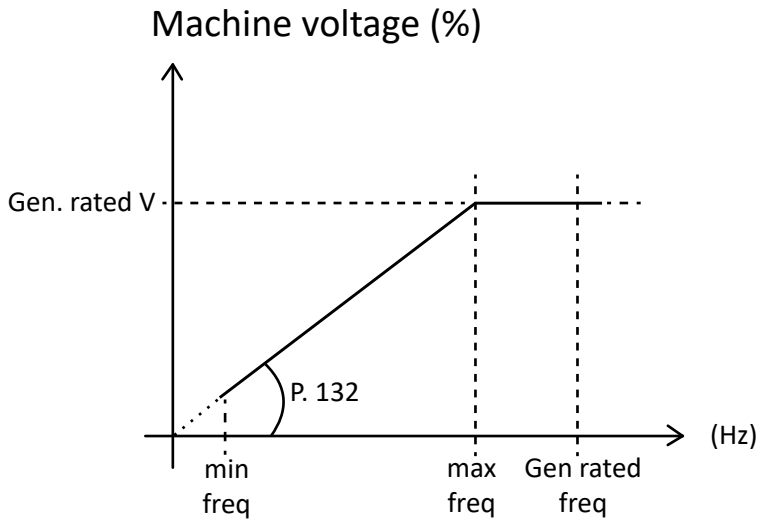


Above screenshot shows the keep alive function effect during generator shutting down. Once the frequency drops below P.130 the AVR activates the keep alive function and works in order to maintain the excitation current to the P.250 keep alive setting (in this case 5%)

5.4 Limiters

5.4.1 V/F Limiter

The V / Hz limit is active during the voltage control phase. It works by limiting the Generator voltage as the frequency falls below the maximum frequency P.131. This operation can avoid the Generator over-flushing in case of a reduction of speed.



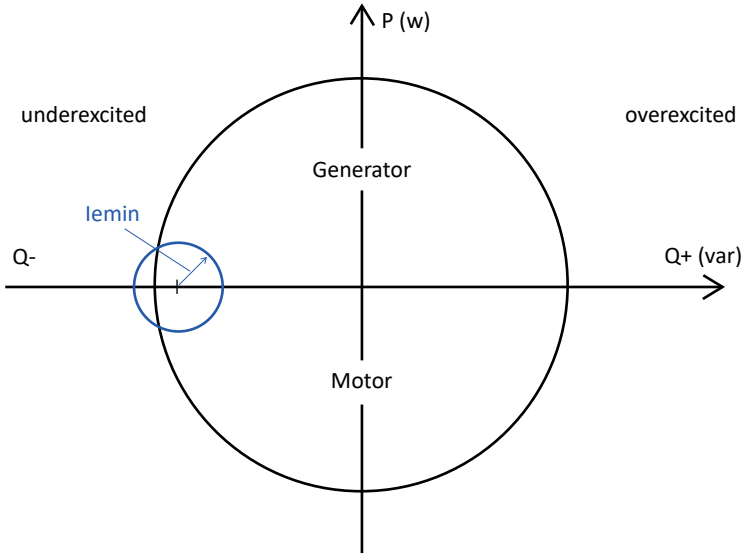
The relation between output voltage and frequency is:

$$V(Hz) = P.100 * \frac{Hz}{P.131} * \frac{1}{P.132}$$

Parameter	*Description (short)*	*Description*
P.100	*Gen. rated voltage*	Generator rated voltage [V]
P.130	*Gen. V/f Min freq*	Generator minimum frequency ramp (Hz)
P.131	*Gen. V/f Max freq*	Generator maximum frequency ramp (Hz)
P.132	*V/f slope*	Generator V/f slope

5.4.2 Minimum excitation current: Under Excitation limiter

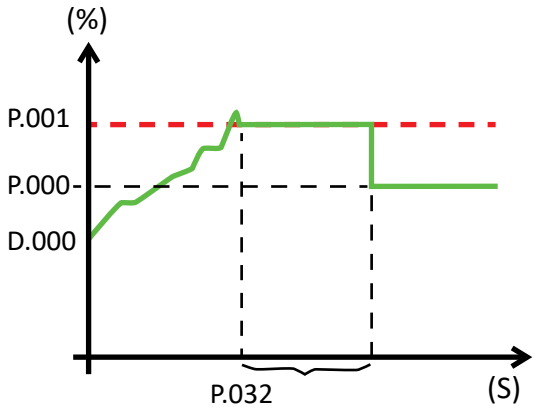
The limit of minimum excitation current is only active when the Generator is in parallel [digital input 52G (machine in parallel) closed].
It represents the minimum excitation current below which the Generator cannot work.



Parameter	*Description (short)*	*Description*
P.002	*F. UE Lim*	OE/UE Lim reg TI
r.900	*OE/UE Lim reg KP*	OE/UE Lim. Reg. KP
r.901	*OE/UE Lim reg TI*	OE/EU Lim. Reg. TI

5.4.3 Maximum excitation current: Over Excitation limiter

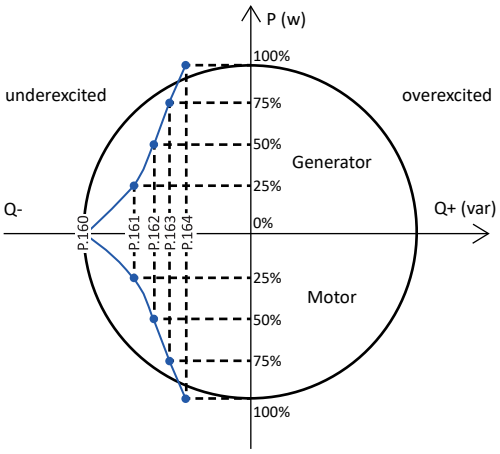
The limit of maximum excitation current operates a limitation on the maximum excitation current.
The limit works in order to avoid to overtake the P.001 value, and if the excitation current remains on P.001 for longer than P.032, the AVR reduce the excitation current to 102%. If the excitation current goes in the area between P.000 and P.001, the AVR calculate the i*t integral and once P.001xP.032 is reached, the AVR reduces the excitation current to P.000.



Parameter	*Description (short)*	*Description*
P.100	*Gen. rated voltage*	Generator rated voltage [V]
P.130	*Gen. V/f Min freq*	Generator minimum frequency ramp (Hz)
P.131	*Gen. V/f Max freq*	Generator maximum frequency ramp (Hz)
P.132	*V/f slope*	Generator V/f slope
P.132	*V/f slope*	Generator V/f slope

5.4.4 Minimum capability: Q- limiter

The curve of minimum capability represents the reactive power limit absorbed by the machine. It is determined by interpolating 5 data:

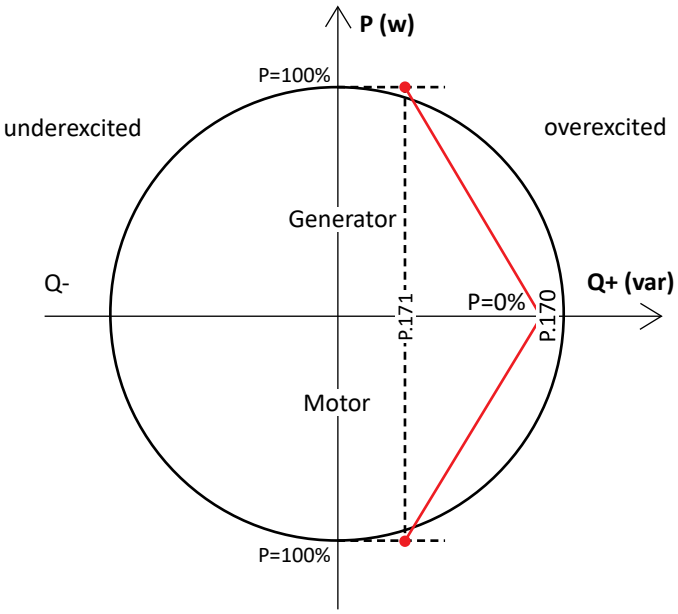


Parameter	*Description (short)*	*Description*
P.160	*Q – lim @ P 0%*	Limit Q- a P=0%
P.161	*Q – lim @ P 25%*	Limit Q- a P=25%
P.162	*Q – lim @ P 50%*	Limit Q- a P=50%
P.163	*Q – lim @ P 75%*	Limit Q- a P=75%
P.164	*Q – lim @ P 100%*	Limit Q- a P=100%

5.4.5 Maximum capability: Q+ limiter

The curve of maximum capability represents the reactive power limit delivered by the machine. It is determined by interpolating 2 data:

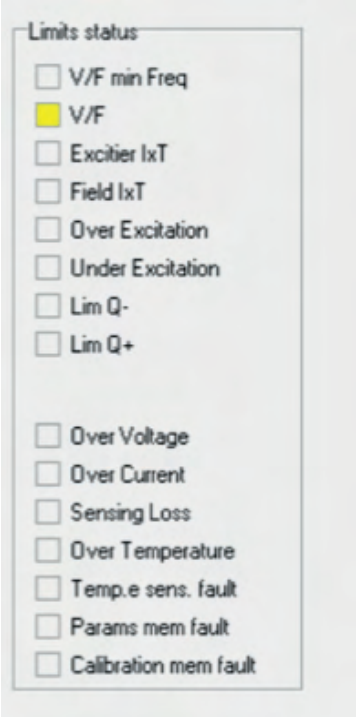
- Q+ limit a P=0% P.170 [%]
- Q+ limit a P=100% P.171 [%]



Parameter	*Description (short)*	*Description*
P.170	*Q + lim @ P 0%*	Limit Q+ a P=0%
P.171	*Q + lim @ P 100%*	Limit Q+ a P=100%

5.4.6 S2014 Config: Limits status

The S2014 Config software reports an overview of the limiters status:



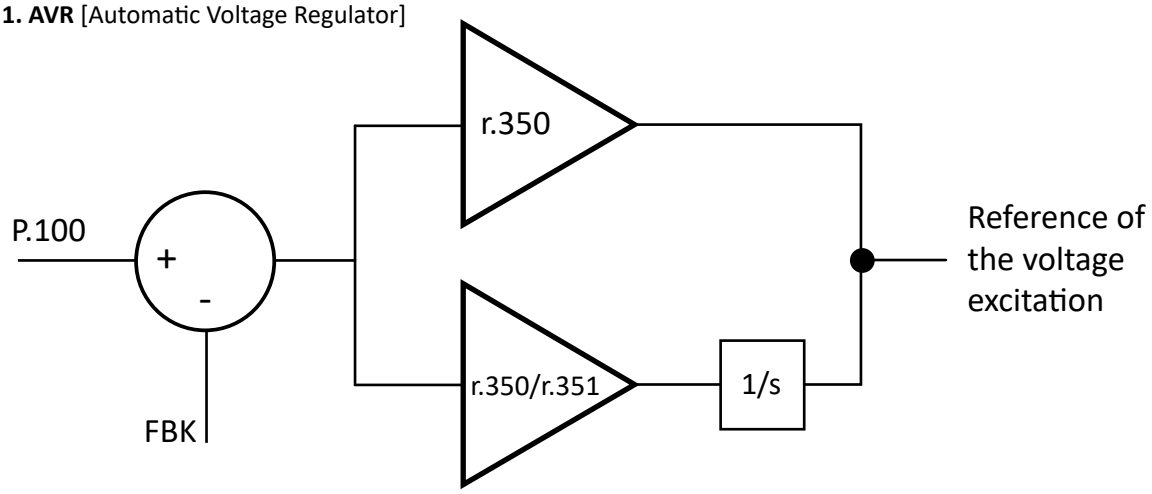
The reported limiters status shows that the V/Hz (underfrequency or underspeed limiter) is active.

6. WORKING MODE AND REGULATIONS

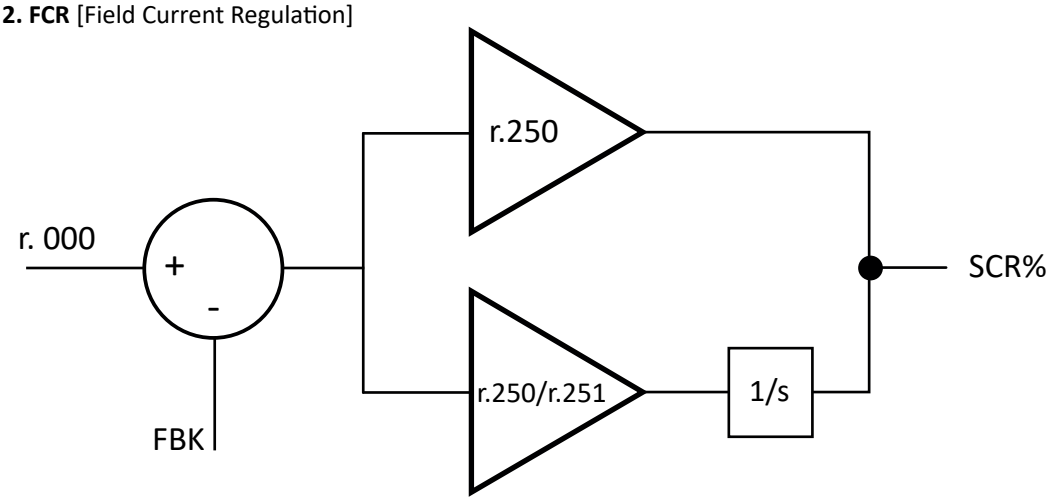
Basically, there are 4 working modes (4 regulation mode):

- **AVR** [Automatic Voltage Regulator]: S2014 works in order to keep the output voltage to the ref value
- **FCR** [Field Current Regulation]: S2014 works in order to keep the excitation current to the ref value
- **PF Control** [Power Factor Regulator]: S2014 works in order to keep the PF to the ref value
- **VAR Control** [Reactive Power Regulator]: S2014 works in order to keep the Reactive Power to the ref value

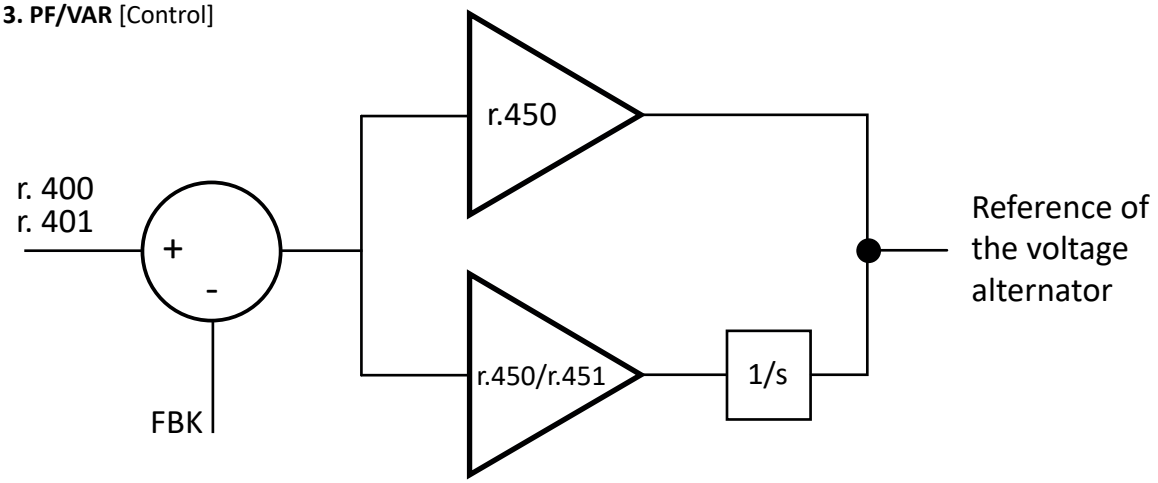
1. AVR [Automatic Voltage Regulator]



2. FCR [Field Current Regulation]



3. PF/VAR [Control]



6.1 Automatic voltage regulator (AVR)

The AVR automatically controls the output voltage at the generator terminals. This is the main working mode.
The AVR function is active if **P300=1**.
As alternative it is possible to activate the AVR function programming the digital input I002=4, and closing the external contact.

Parameter	*Description*	*Note*
P.100	*Generator rated voltage*	*V rms*
r.002	*Ramp slope [s]*	*%/s*
r.350	*Generator V Reg KP*	
r.351	*Generator V Reg TI*	
r.010	*Delta Ref calibrator*	*%*
r.011	*Delta Ref analog*	*%*
r.012	*Delta ramp slope*	*%/s*

6.2 Field Current Regulation (FCR)

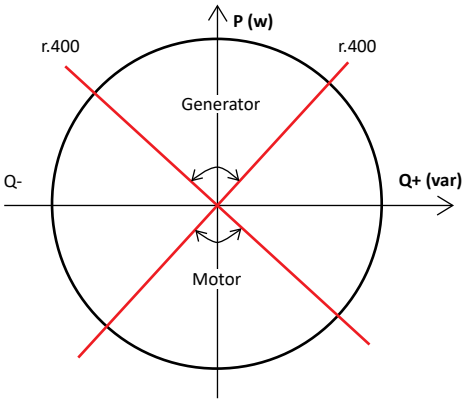
This working mode allows to control the AVR output field current. In this case the AVR controls only the output current to the regulator excitation terminals, without considering other effects.
This situation can be potentially dangerous.
This functioning mode could become useful during the regulator commissioning, or in case of troubleshooting activities.

FCR function will be activated setting **P300=0**.
As alternative it is possible to activate the FCR function programming the digital input I002=3, and closing the external contact.

Parameter	*Description*	*Note*
r.000	*F. I digital*	*% compared to P.000*
r.002	*Ramp slope [s]*	*%/s*
r.250	*Field I Reg KP*	
r.251	*Field I Reg TI*	
r.010	*Delta Ref Calibrator*	*%*
r.011	*Delta Ref analog*	*%*
r.012	*Delta ramp slope*	*%/s*

6.3 Power Factor regulation (PF)

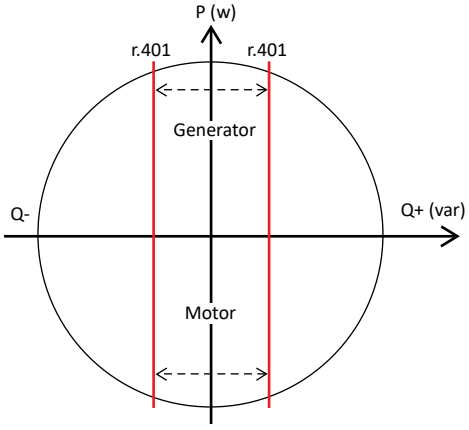
The AVR controls in automatic mode the power factor at generator terminals.
The PF function is active when P300= 1, and I002= 5; once the 52G digital input (generator in parallel) is closed, the PF function starts to work. Generator current reading is necessary to use this function. Be aware of the correct PF reading.



Parameter	Description	Note
r.400	*Generator PF digital ref*	
r.402	*Ramp slope*	
r.450	*PF/VAR Reg KP*	
r.451	*PF/VAR Reg TI*	
r.410	*Delta Ref Calibrator*	
r.411	*Delta Ref analog*	
r.412	*Delta ramp slope*	

6.4 Reactive power regulation (VAR)

The AVR controls in automatic mode the reactive power at generator terminals.
The VAR function is active when P300= 1, and I002= 6; once the 52G digital input (generator in parallel) is closed, the VAR function starts to work. Generator current reading is necessary to use this function. Be aware of the correct VAR reading.



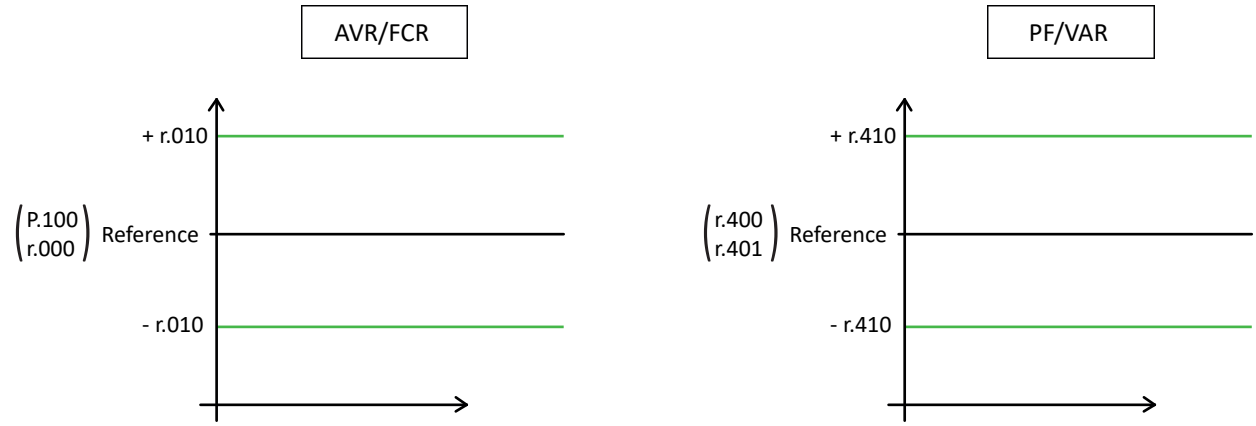
Parameter	Description	Note
r.400	*Generator PF digital ref*	*% compared to P.100 x P.110*
r.402	*Ramp slope*	
r.450	*PF/VAR Reg KP*	
r.451	*PF/VAR Reg TI*	
r.410	*Delta Ref Calibrator*	
r.411	*Delta Ref analog*	
r.412	*Delta ramp slope*	

6.5 Digital reference adjustment by calibrator (Up/Down)

In AVR mode, by programmed digital inputs (I.000=1 increase, I.001=2 decrease) on CN3 connector, it is possible to adjust the nominal voltage set point in a range between -r.010% and +r.010%. The same function is available in FCR mode, in this case the UP/DOWN input is influencing the excitation current.

After closing of 52G (programmed as I.002=5 (Parallel + PF regulation)), the “increase” and “decrease” commands increase or decrease the Power Factor value.

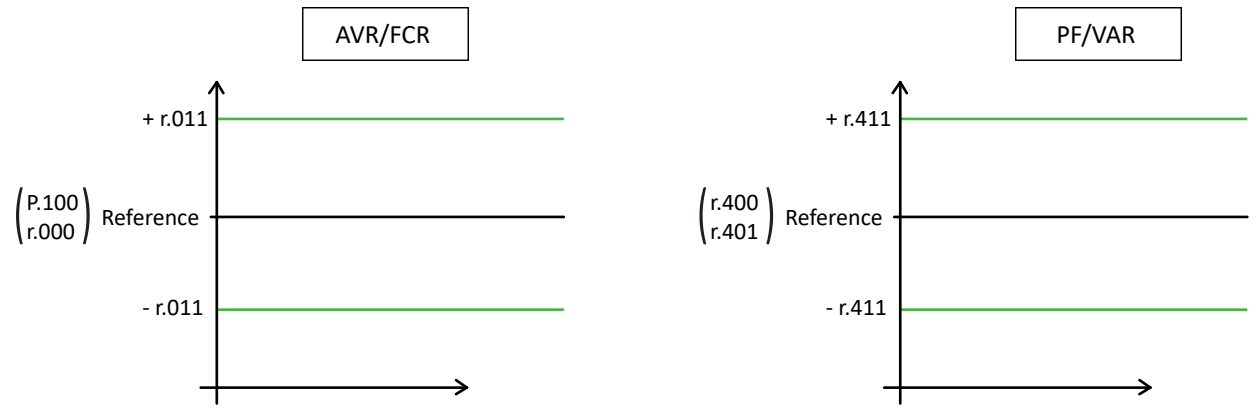
After closing of 52G (programmed as I.002=6 (Parallel + VAR regulation)), the “increase” and “decrease” commands increase or decrease the Reactive Power value.



As default r.010 is programmed to 0%, this means the Up/Down function is disabled.
Set the desired adjustment range to activate the function.

6.6 Digital reference adjustment by analog inputs

As above, using the analog inputs (Potentiometer or ±5Vdc) on CN3 connector, it is possible to adjust the set point in a range between -r.011% and +r.011%.

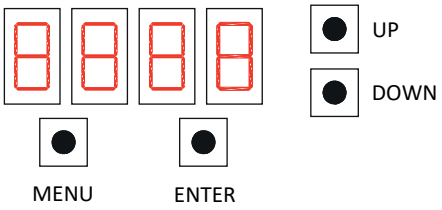


IT IS RECOMMENDED TO DO NOT USE SIMULTANEOUSLY ANALOG AND DIGITAL INPUTS FOR SET POINTS MODIFICATIONS.

7 OPERATOR INTERFACE

In this chapter, it is described how parameters are managed by using the on-board programming keypad.

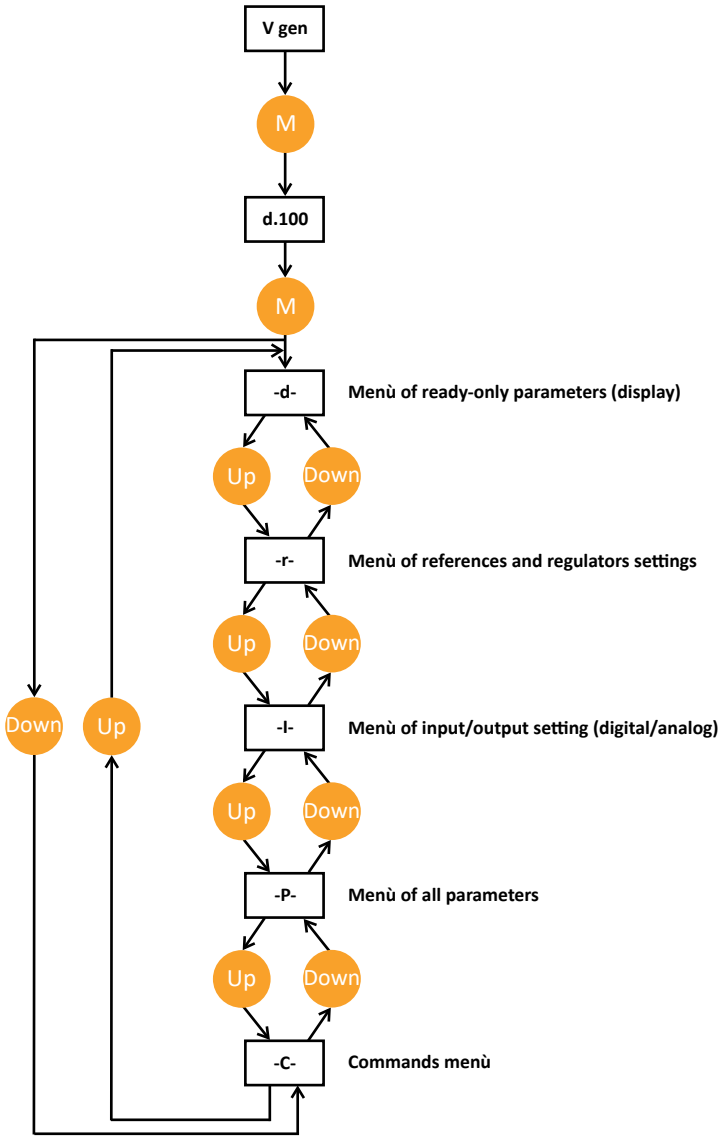
7.1 Control Keypad and display



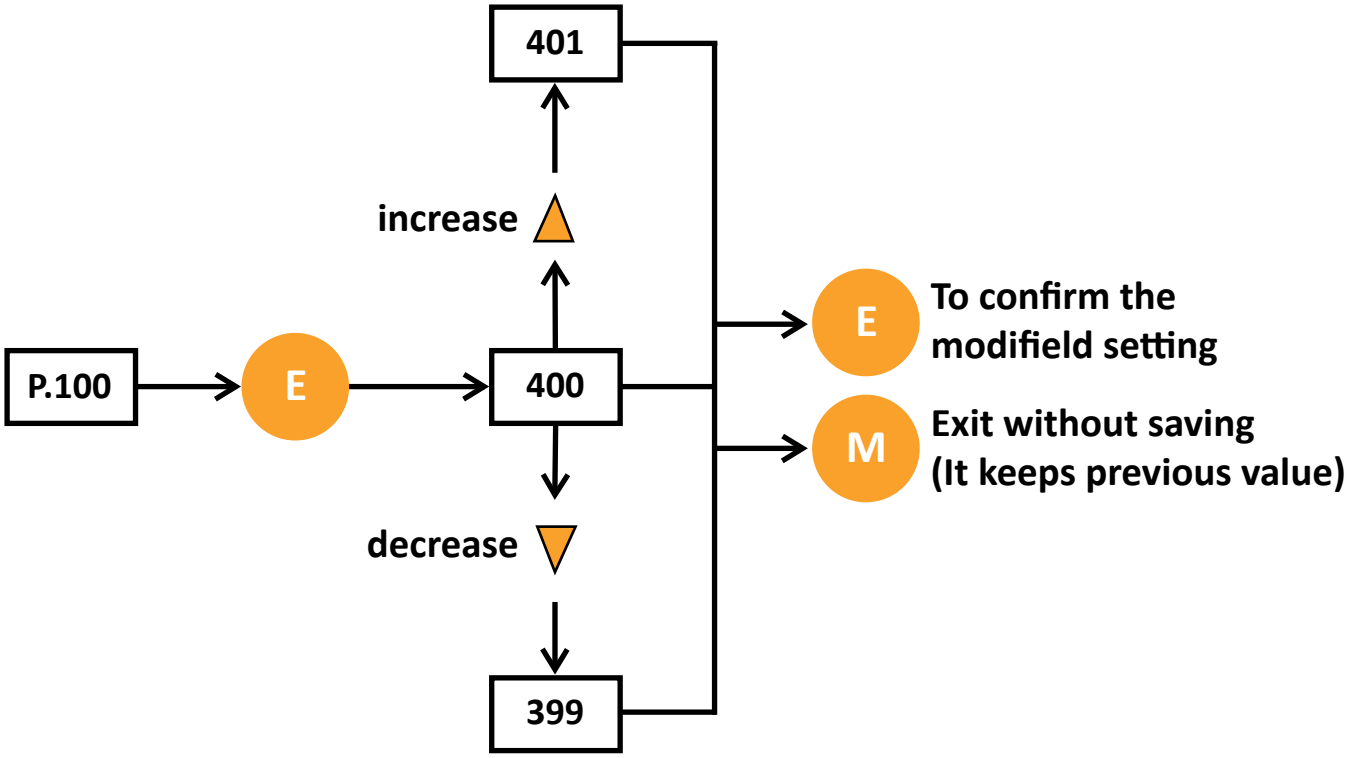
MENU: allows to quit a parameter or a menu.
ENTER: allows to enter a parameter or a menu.
UP: allows to move from a parameter or menu to the following one and/or increase the value.
DOWN: allows to move from a parameter or menu to the previous one and/or decrease the value.

7.2 Navigating inside the menus

Once the S2014 is ON, the display shows automatically the parameter d100 (Generator voltage).

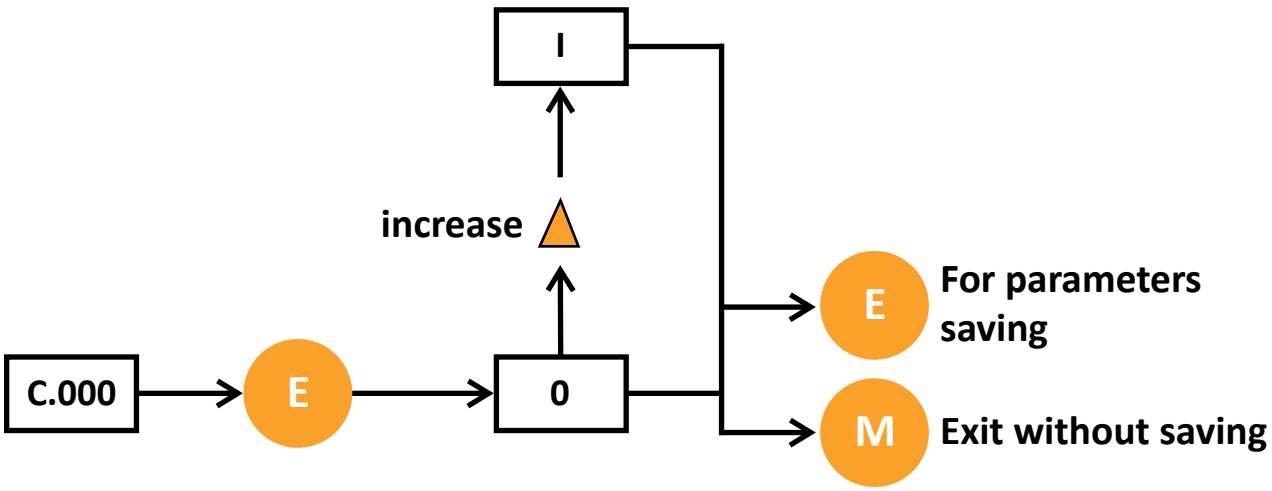


Example: how to change the rated voltage generator setting



7.3 Parameters Saving

IMPORTANT: even if the modifications on the parameters are immediately active, they are not automatically saved. To save them you need to use command “C.000” [save parameters].



7.4 Menu Description

7.4.1 **Menu "D" – Display (readings)**

DISPLAYS	Terminals	IPA	Description	[U.M.]	Min	Default	Max	Notes, values
Field data	**d.000**	0	Field Current	%	0,0	-	200,0	% of P.000
	d.020	1	Out Duty Cycle	%	0,0	-	100,0	
Generator data	**d.100**	2	Gener. V	%	0,0	-	-	% of P.100
	d.104	3	Gener. Freq.	Hz	0,00	-	440,0	
	d.110	4	Gener. Current	%	0,0	-	-	% of P.110
	d.111	5	Gener. Power Factor	-	0,25 c	-	0,25 i	Capacitive / Inductive
	d.120	6	Gener. Power S	%	0,0	-	-	% of P.100xP.110
	d.121	7	Gener. Power P	%	-d.120	-	d.120	% of P.100xP.110
	d.122	8	Gener. Power Q	%	-d.120	-	d.120	% of P.100xP.110
AVR data	**d.950**	9	FW ver. & rev.	-	-	-	-	xx.yy(hex)
	d.952	10	SN	-	-	-	-	y.nnn
	d.997	11	Heatsink Temp.	°C	-40	-	+115	
	d.997	12	AUX V	V	0,0	-	-	

7.4.2 **Menu "r" – References and Regulators**

REFERENCES & REGULATORS	Terminals	IPA	Description	[U.M.]	Min	Default	Max	Notes, values
Primary regulator	**r.000**	200	F. I digital ref	%	0	**0,0**	P.001	% of P.000
	r.002	201	Ramp slope	%/s	0,1	**5,0**	999,9	
	r.010	202	Delta Ref calib	%	0	**0**	200	
	r.011	203	Delta Ref analog	%	0	**20**	200	
	r.012	204	Delta ramp slope	%/s	0,1	**1,0**	10,0	
Field current regulator	**r.250**	205	F. I Reg KP	-	0,01	**0,50**	99,99	
	r.251	206	F. I Reg TI	1/(2*AuxF)	0,1	**20,0**	100,0	Related to Aux supply period
Generator voltage regulator	**r.350**	207	G. V Reg KP	-	0,01	**0,50**	99,99	
	r.351	208	G. V Reg TI	1/(2*GenF)	0,1	**20,0**	100,0	Related to generator period
Secondary regulator	**r.400**	209	G. PF dig. ref	-	0,50c	**1,00**	0,50i	Capacitive / Inductive
	r.401	210	G. VAR dig. ref	%	-100	**0**	100	% of P.100xP.110
	r.402	211	Ramp slope	%/s	0,1	**1,0**	100,0	
	r.410	212	Delta Ref calib	%	0	**20**	100	
	r.411	213	Delta Ref analog	%	0	**0**	100	
	r.412	214	Delta ramp slope	%/s	0,1	**1,0**	10,0	
PF,VAR	**r.450**	215	PF/VAR Reg KP	-	0,01	**0,50**	99,99	
	r.451	216	PF/VAR Reg TI	10/(2*GenF)	0,1	**20,0**	100,0	Related to generator period
Aux voltage Regulator	**r.650**	217	AuxV Reg KP	-	0,01	**0,50**	99,99	
	r.651	218	AuxV Reg TI	1/(2*AuxF)	0,1	**20,0**	100,0	Related to Aux Supply period
Limiters Regulator	**r.900**	219	OE/UE LIM Reg KP	-	0,01	**0,25**	99,99	
	r.901	220	OE/UE LIM Reg	1/(F reg)	0,1	**40,0**	100,0	Related to generator period

7.4.3 **Menu "I" – Inputs and Outputs**

I/Os	Name	IPA	Description	[U.M.]	Min	Default	Max	Notes, values
Digital inputs	**I.000**	600	Dig inp 1 cnf	-	0	**1**	6	0 NONE 1 INCREASE 2 DECREASE
	I.001	601	Dig inp 2 cfg	-	0	**2**	6	3 FCR Remote enabling
	I.002	602	Dig inp 3 cfg	-	0	**5**	6	4 52G: Parallel + DROOP 5 52G: Parallel + PF reg. 6 52G: Parallel +VAR reg.
Digital outputs	**I.100**	603	Dig out 1 cnf	-	0	**3**	4	0 NONE 1 FAULT 2 NOT FAULT 3 LIMIT 4 NO LIMIT
RS485	**I.400**	604	RS485 config	-	0	**1**	4	0 custom protocol 1 Modbus RTU 8N1 2 Modbus RTU 8E1 3 Modbus RTU 8O1 4 Modbus RTU 8N2
	I.401	605	RS485 bitrate	-	0	**3**	5	0 4800 1 9600 2 19200 3 38400 4 57600 5 115200
	I.402	606	RS485 node ID	-	1	**1**	247	
	I.403	607	RS485 delay	s	0,001	**0,005**	0,100	

7.4.4 **Menu "C" – Commands**

COMMANDS	Name	IPA	Description	[U.M.]	Min	Default	Max	Notes, values
Utility commands	**C.000** **C.002**	1600 1601	Params save Default Params reload	- -	0 0	**0** **0**	1 1	
	C.200	1602	Test step	-	-8192	**0**	8192	8192=100%
	C.201	1603	Test step type	-	0	**1**	4	1= Field I ref 2= Generator V ref 3= Generator PF ref 4= Generator VAR ref

7.4.5 **Menu "P" – Parameters**

This is the most important menu for normal operation. In the majority of the applications it will be necessary to access to the Parameter menu only.

PARAMETERS	Name	IPA	Description	[U.M.]	Min	Default	Max	Notes, values
Field excitation data	**P.000**	1000	F. rated I	A dc	1,0	**5,0**	12,0	
	P.001	1001	F. OE Lim	%	100	**150**	250	% of P.000
	P.002	1002	F. UE Lim	%	0	**5**	50	% of P.000
	P.032	1004	F. OE Lim time	s	1	**10**	240	
Generator data	**P.100**	1005	G. rated V	V rms	50	**400**	500	
	P.101	1006	G. max V	%	105	**120**	120	% of P.100
	P.110	1007	G. rated I	A rms	0,20	**2,5**	5,00	(*)
	P.130	1008	G. V/f min freq	Hz	20	**30**	150	
	P.131	1009	G. V/f max freq	Hz	P.130	**45**	250	
	P.132	1010	G. V/f slope	%/Hz	1,0	**2,0**	4,0	
	P.160	1012	Q – lim @ P 0%	%	-100	**-40**	-5	% of P.100 x P.110
	P.161	1013	Q – lim @ P 25%	%	-100	**-35**	-5	% of P.100 x P.110
	P.162	1014	Q – lim @ P 55%	%	-100	**-30**	-5	% of P.100 x P.110
	P.163	1015	Q – lim @ P 75%	%	-100	**-25**	-5	% of P.100 x P.110
	P.164	1016	Q – lim @ P 100%	%	-100	**-20**	-5	% of P.100 x P.110
	P.170	1017	Q + lim @ P 0%	%	5	**80**	100	% of P.100 x P.110
	P.171	1018	Q + lim @ P 100%	%	5	**60**	100	% of P.100 x P.110
Power supply	**P.250**	1019	KeepAlive Field I	%	0	**5**	100	% of P.000 set 0 for PMG or other independent Power Supply
Control mode	**P.300**	1020	Primary reg.	-	0	**1**	1	0 FCR 1 AVR
Voltage Droop Compensation	**P.400**	1021	Voltage comp K	%	-10,0	**0,0**	10,0	
Access control	**P.981**	1022	Password	-	0	**1**	9999	For S2014 the password is disabled

(*) P.110 setting influences the power readings. Following example will help to understand how to manage this setting:

- Rated Generator Power = 500kVA
- Rated Generator Voltage= 400V
- Rated Generator Current= 722A
- CT mounted on the Generator= 1000/5 (CT ratio = 200)

With above configuration, the rated power of the generator (100%) is reached when the CT will read 722/200= 3.61A
In this case it is correct to set P.110=3.61 A

8. TROUBLE SHOOTING

DANGER!
The AVR is NOT insulated from the power supply and from field circuit.
The maintenance operations MUST be done ONLY when the AVR is disconnected and the protection devices are mounted and/or activated.
Disconnect the AVR in case of High Voltage Test on the alternator windings.

8.1 First Inspection

When the system is shut-down, check the fastening of fast-on terminals on the AVR. Generally, check all connections to avoid loose contact.

8.2 Trouble shooting

The following instructions are supposed to help to find out the fault location within the whole excitation system. However, it is not possible to deal with all eventualities.

List of Possible Faults	Checks, action
Machine is not exciting	
• Field circuit interrupted	• Check connection wiring
• No electronics supply	• Measure power supply Aux - Com • Check for tripped protective circuit-breaker • Check the built-in fuse
• Set point error	• Check operating mode • Check programmable digital input setting and connection • Check set point
Overvoltage during start-up	
• Overvoltage caused by voltage regulator	• Measure the Generator voltage directly on the voltage sensing input • Check configuration • Check set point • Check overvoltage threshold • Check regulator settings
Unstable Output Voltage in no-load operation	
• Regulator error	• Check operating mode • Check programmable digital input setting and connection • Check set point • Check parameters of voltage regulator • Check/adjust stability settings r.350 and r.351
• Set point error	• Unstable Increase/Decrease inputs • Unstable External analog input
• Control element fault	• Check wiring for loose contacts, check input voltages, check field

Unstable or Low Output Voltage under load operation	
• Regulator error	• Compared excitation voltage with power supply voltage • Check programmable digital input setting and connection • Check parameters of voltage regulator • Check/adjust stability settings r.350 and r.351
• Set point error	• Unstable Increase/Decrease inputs • Unstable External analog input
• Control element fault	• Check wiring for loose contacts

Unstable parallel operation with grid **Periodic oscillation of reactive and active power (instability)**	
• Not correct regulator settings	• Were changes made to the grid configuration? • Are additional outputs, loads etc. installed? Yes: re-set regulator No: check parameters of Auto and PF, Var regulator • Check/adjust stability settings

Irregular instability, i.e. sporadic over - or under excitation which is not caused by grid variation	
• Poor effect of the Droop influence on the voltage regulator or C.T. defective measurement	• Check droop compensation setting • Check external current transformer circuit • Gen CB Closed Status not active • Check programmable digital input setting and connection
• Some limiters are active: machine within inadmissible operating range	• Bring machine into normal operating range by adjusting the set point. • Check setting of limiters

Operating point cannot be adjusted	
• Set point error	• Check operating mode • Check set point • Check connections • Check programmable analog and digitale input
• Limiter active	• Bring machine into normal operating range by adjusting the set point • Check setting of limiters

Problems with External (remote) controls	
• No external control voltage	• Measure control voltage • Check wiring
• Configuration of the digital or analog inputs are not correct	• Check configuration

8.3 Repairing

In case it is confirmed that the AVR is defective, we recommend to contact Beltrame CSE to agree about repairing conditions.
We strongly recommend to avoid to return back any devices without previous agreement.
The user is responsible for the correct packaging of the regulator.

9. CONNECTING DIAGRAMS

DANGER!
Only specially instructed personnel must carry out connection and repair activities.

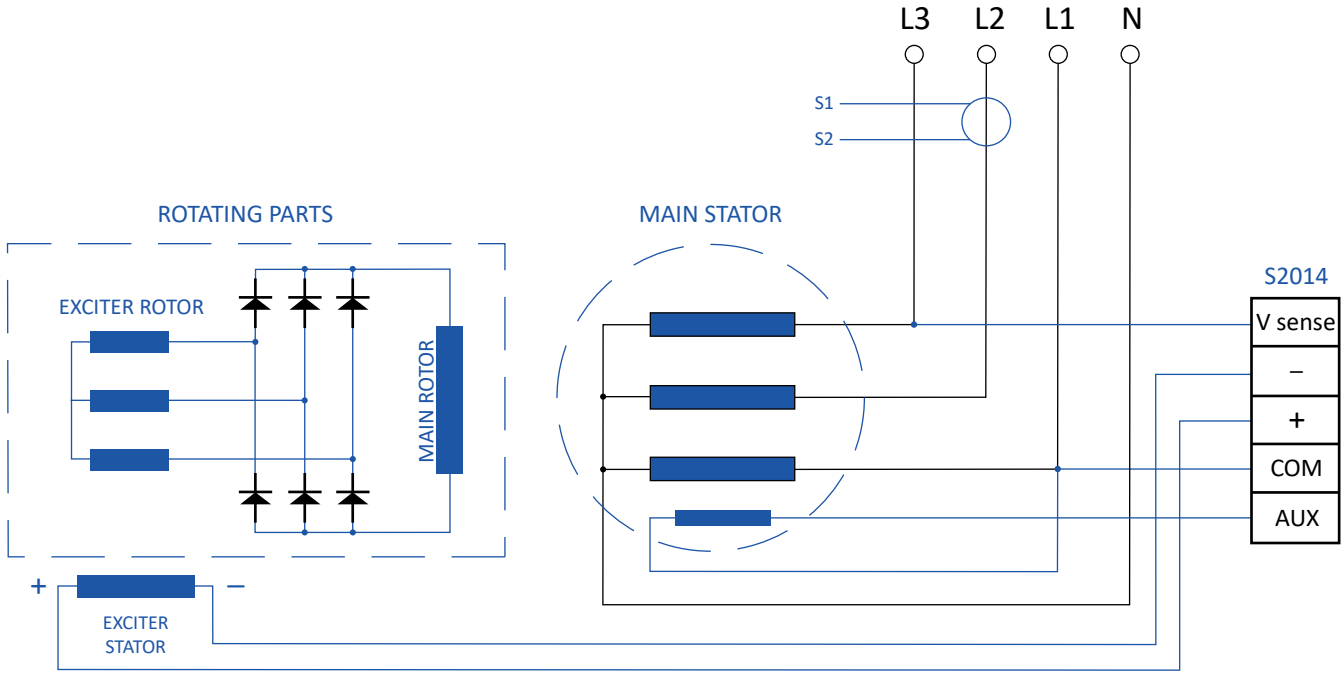
Each person involved in the installation and commissioning of the S2014 has to have received the appropriate training or instructions and has thoroughly read and clearly understood the safety instructions reported in this manual.

9.1 Introduction

Basically, the S2014 AVR needs:

- A power supply source connected between AUX and COM
- A sensing input source, connected between COM and Vsense
- The connection of the exciter, between +ECC and -ECC

Following diagram shows a connection example of 3ph brushless alternator with internal auxiliary winding:



IMPORTANT!
CT has always to be connected in quadrature compared the sensing voltage. This means:

- With sensing voltage between L1 and L3, install the CT on phase L2 (as above)
- With sensing voltage between L1 and L2, install the CT on phase L3
- With sensing voltage between L2 and L3, install the CT on phase L1

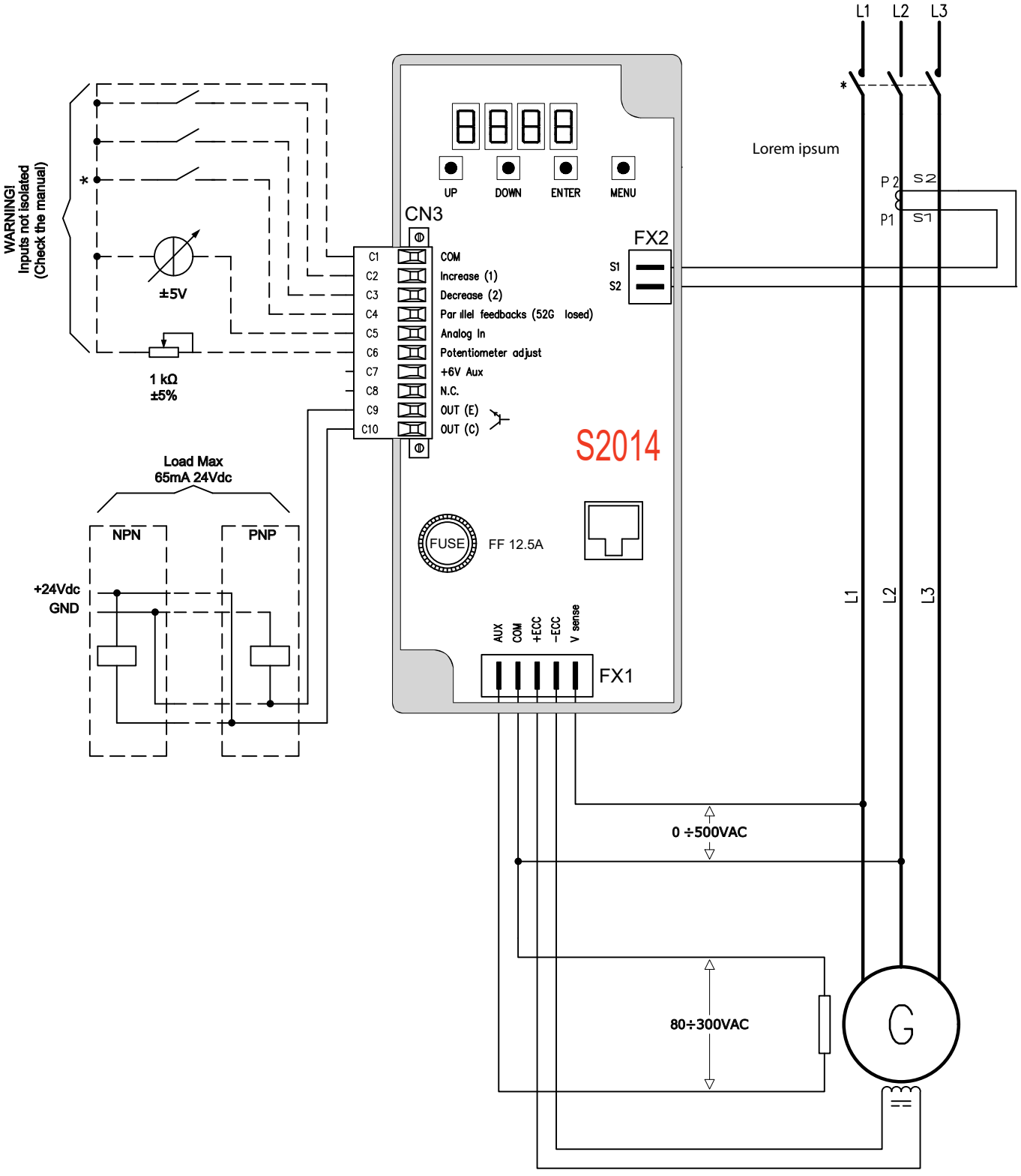
CAUTION!
It is strongly recommended to completely disconnect the AVR in case of High Voltage Test on the alternator windings

9.2 Basic S2014 Connection Diagrams

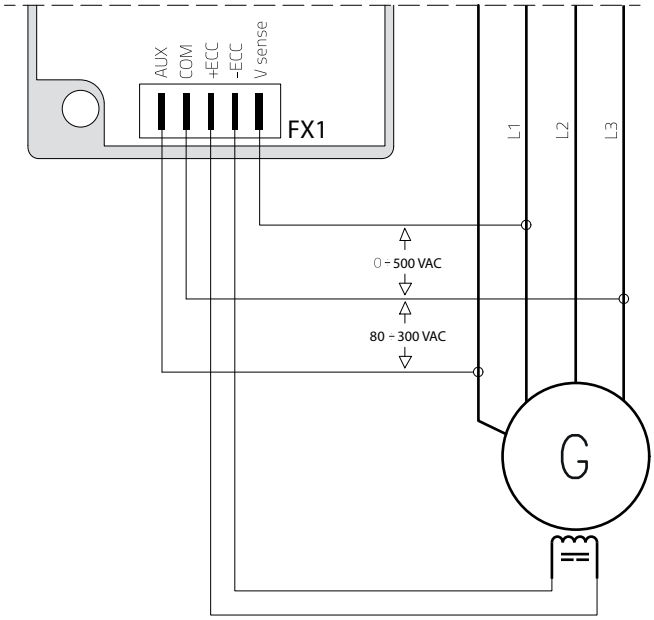
Following diagram shows how to connect the S2014 to a low voltage generator with:

- Sensing voltage between phase-phase (max 500Vac), L1 and L3
- Aux power supply between phase and neutral (max 300Vac)
- CT mounted on L2

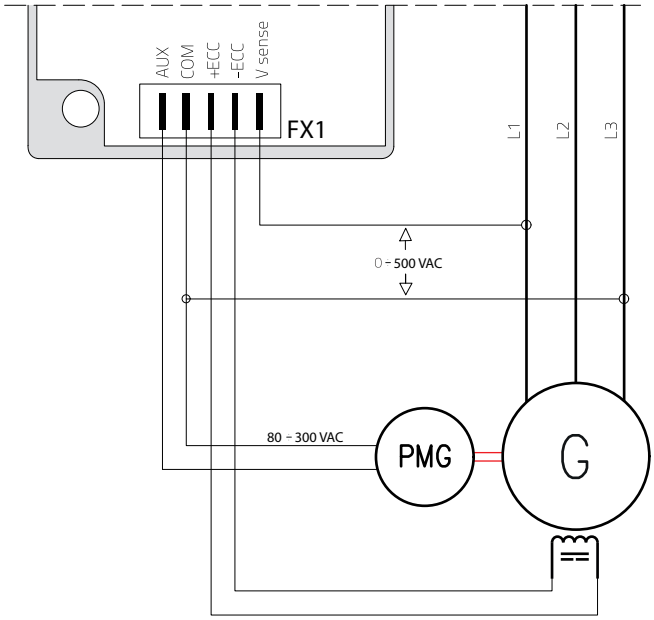
All other combinations can be obtained from this one.



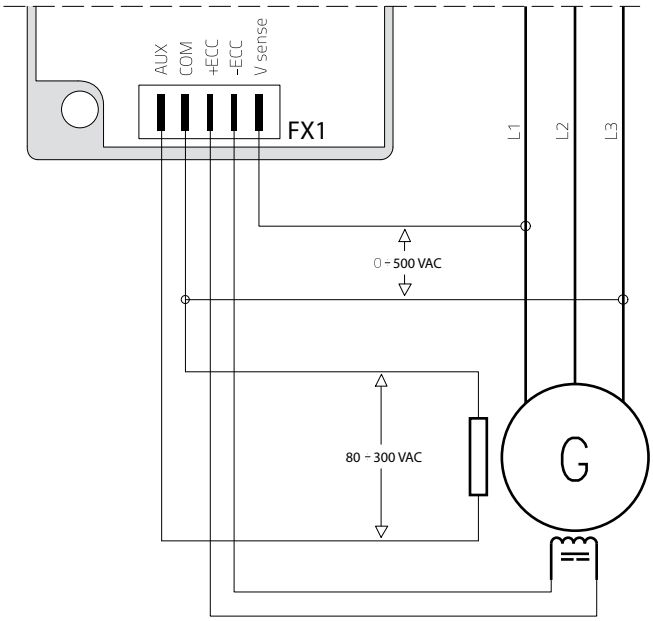
9.3 S2014 Connection Diagrams with Low Voltage Alternator



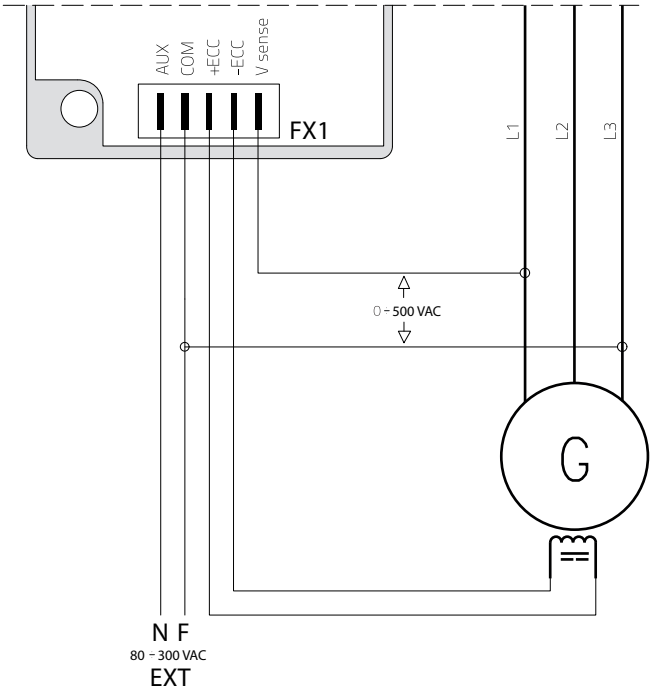
Basic Connection Diagram for LV alternator:
Sensing voltage: phase-phase (max 500Vac)
Aux power supply: phase and neutral (max 300Vac)



LV alternator with PMG:
Sensing voltage: phase-phase (max 500Vac)
Aux power supply: from PMG (max 300Vac)

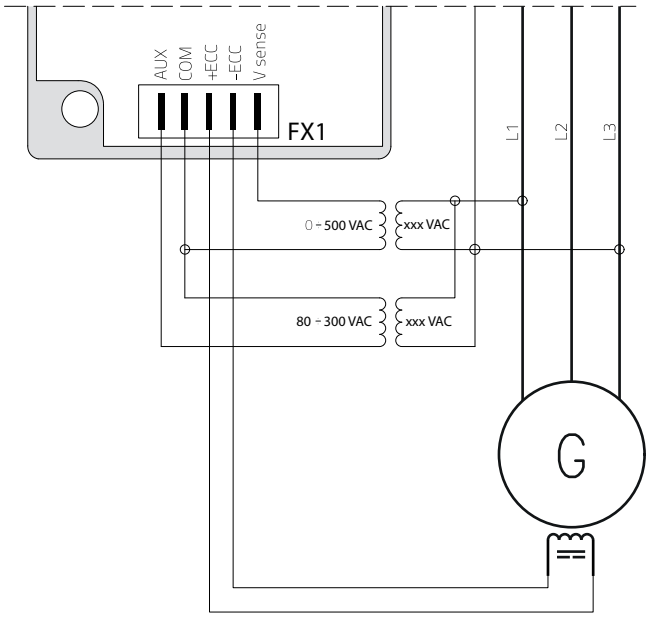


LV alternator with Aux winding:
Sensing voltage: phase-phase (max 500Vac)
Aux power supply: from Aux winding (max 300Vac)

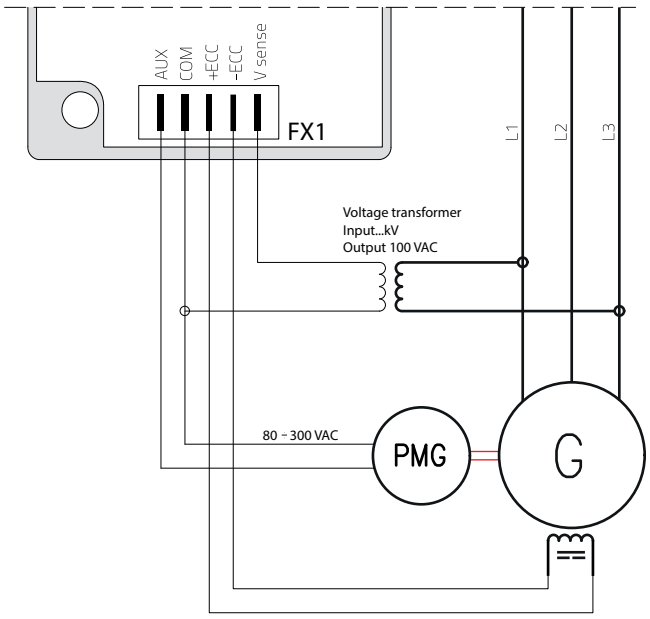


LV alternator with external power supply:
Sensing voltage: phase-phase (max 500Vac)
Aux power supply: from ext power supply (max 300Vac)

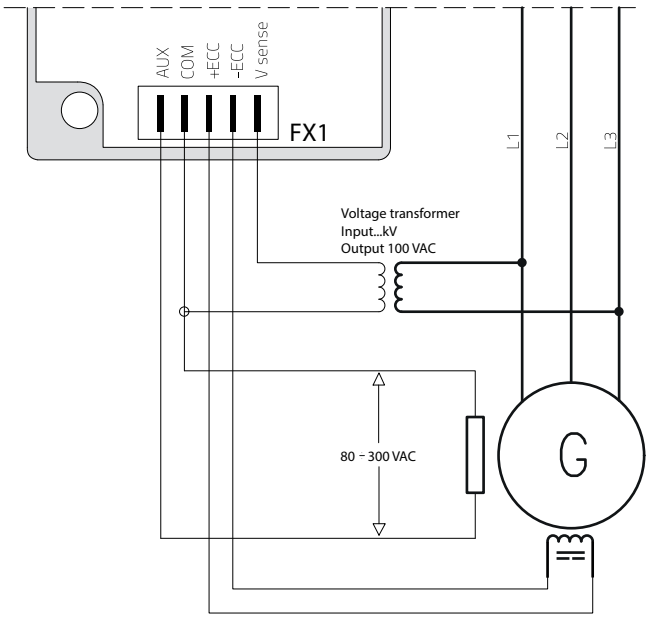
9.4 S2014 Connection Diagrams with Medium Voltage Alternator



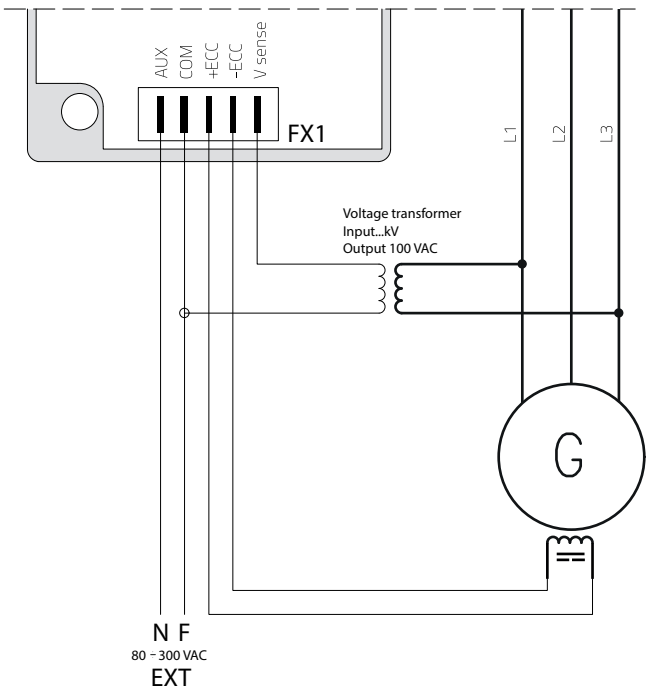
Connection Diagram for MV alternator:
Sensing voltage: from Volt Transf. (max 500Vac)
Aux power supply: from Volt Transf. (max 300Vac)



MV alternator with PMG:
Sensing voltage: from Volt Transf. (max 500Vac)
Aux power supply: from PMG (max 300Vac)



MV alternator with Aux winding:
Sensing voltage: from Volt Transf. (max 500Vac)
Aux power supply: from Aux winding (max 300Vac)



MV alternator with external power supply:
Sensing voltage: from Volt Transf. (max 500Vac)
Aux power supply: from ext. power supply (max 300Vac)

10. BELTRAME CONFIGURATOR: THE PC SOFTWARE

WARNING!
The PC software allows to modify the working mode and the settings of the AVR. The modification can be potentially dangerous. Only specially instructed personnel must carry out AVR's setting adjustments. The maintenance personnel must be informed about the emergency shutdown measures and must be capable of turning off the system in case of emergency.

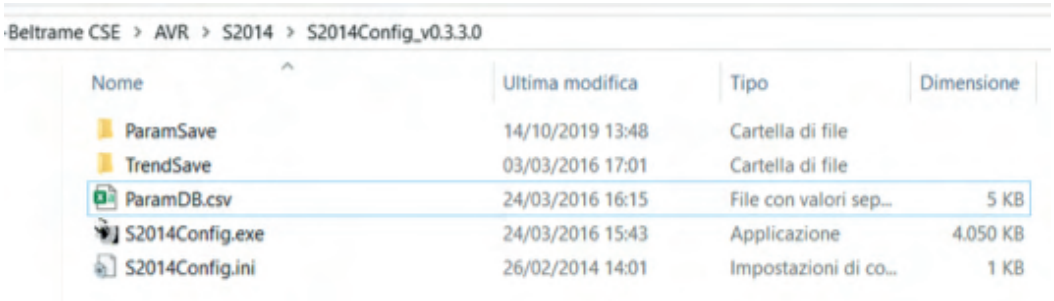
The S2014 Config is useful during the regulator commissioning, or in case of troubleshooting activities.

10.1 Connection between AVR and PC

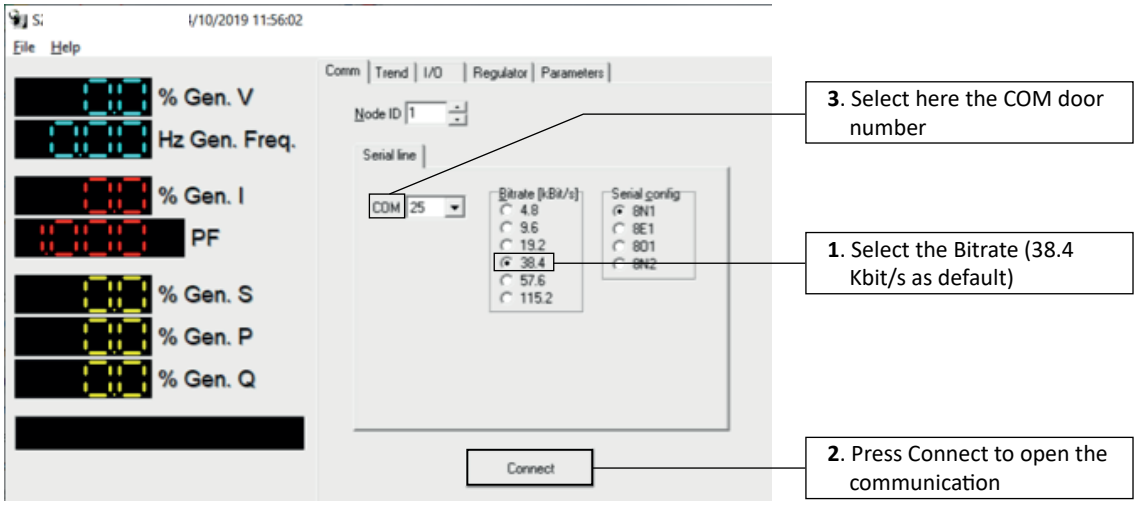
For the PC-AVR connection we recommend the following diagram, with USB isolator Using an USB/RS485 cable (Beltrame's production – available as optional):

10.2 Installation and Communication setup

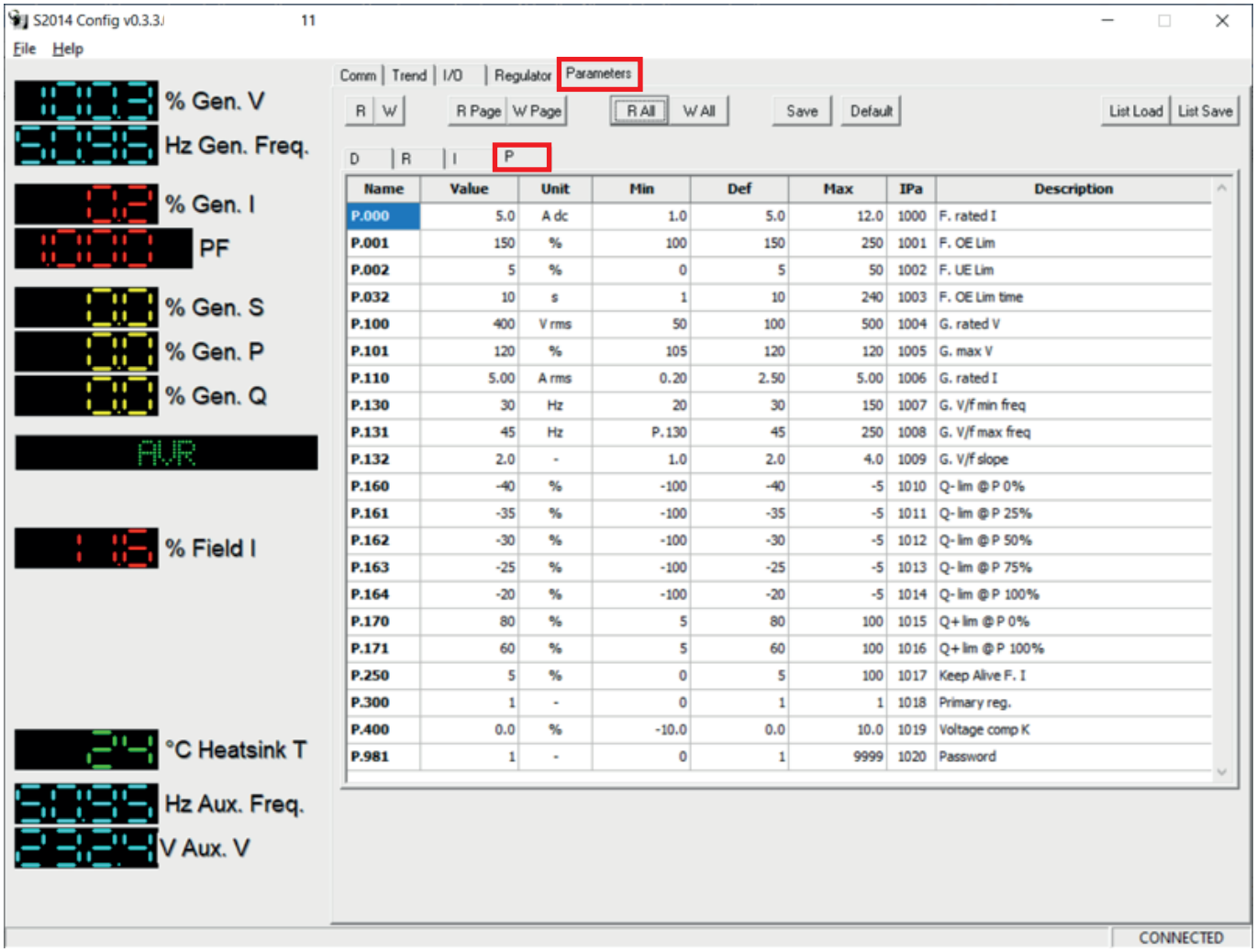
The S2014Config is distributed as a zip file. Once unzipped, the software will create a folder with inside the S2014Config.exe:



To run the program, double click on S2014Config.exe. It will open the Comm window.
To operate it is necessary to establish the communication between PC and AVR, see the following instructions:



10.3 Parameters setting: P.xxx and procedure



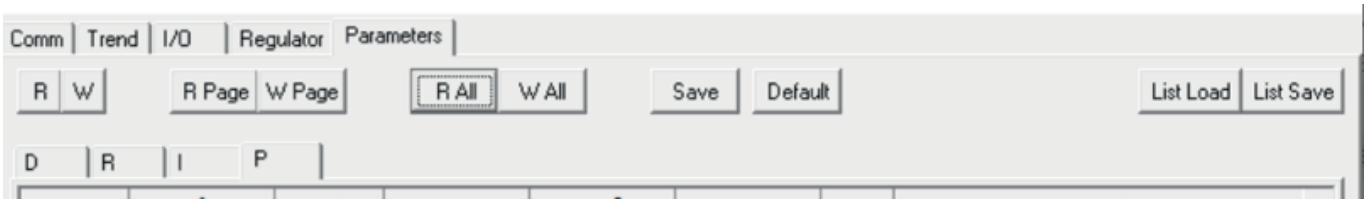
Recommended procedure for parameters modification:

1. **R All**: download all the parameters (P, R, I, D) from AVR to PC.
2. **List Save**: save the original AVR setting as a .pli file inside the PC (inside the ParamSave folder).
3. Modify the requested parameter. The modification is immediately active, but it is not stored inside the AVR memory. This means that if you switch OFF the AVR, the modification will be lost.
4. **Save**: If the modification is correct press Save to store the new setting inside the AVR. The modification will be active even after AVR switching off.
5. **List Save**: to save a copy of the new setting inside the PC (with a different name compared the original .pli filename).

6. **List Load**: to upload from the PC the suitable parameters list

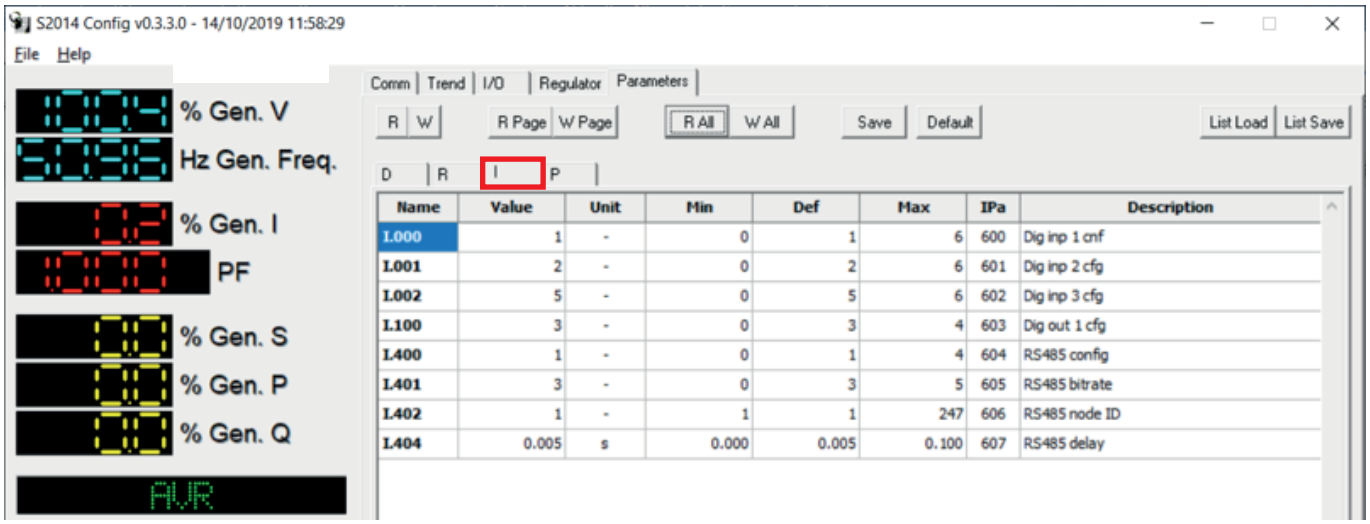
Other commands:

7. **R Page/W Page**: to read / write a single page.
8. **R /W**: to read / write a single value.



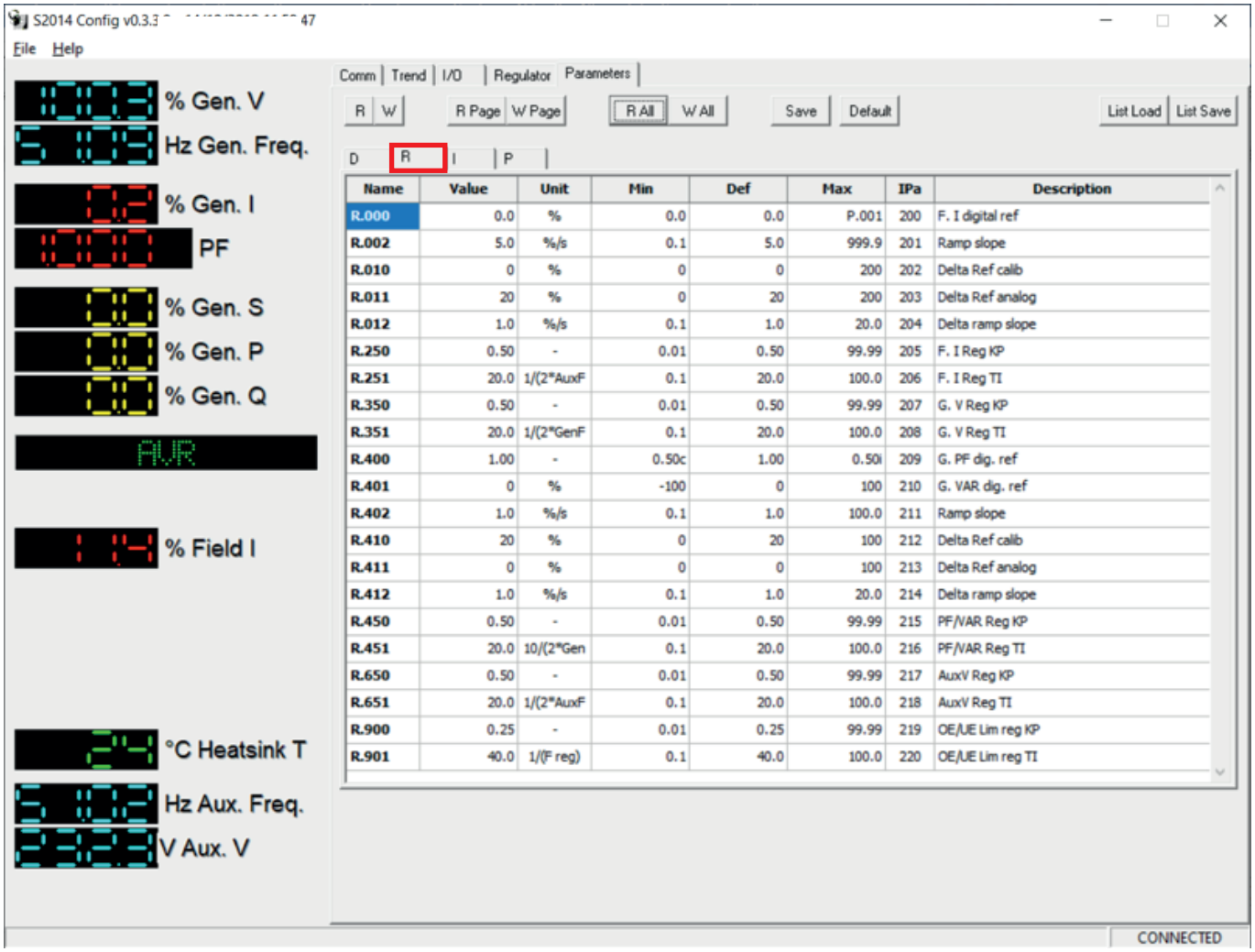
10.4 Parameters setting: P.xxx

Remaining on the Parameters windows, click on the I label to access to I.xxx setting:



Name	Value	Unit	Min	Def	Max	IPa	Description
I.000	1	-	0	1	6	600	Dig inp 1 cnf
I.001	2	-	0	2	6	601	Dig inp 2 cfg
I.002	5	-	0	5	6	602	Dig inp 3 cfg
I.100	3	-	0	3	4	603	Dig out 1 cfg
I.400	1	-	0	1	4	604	RS485 config
I.401	3	-	0	3	5	605	RS485 bitrate
I.402	1	-	1	1	247	606	RS485 node ID
I.404	0.005	s	0.000	0.005	0.100	607	RS485 delay

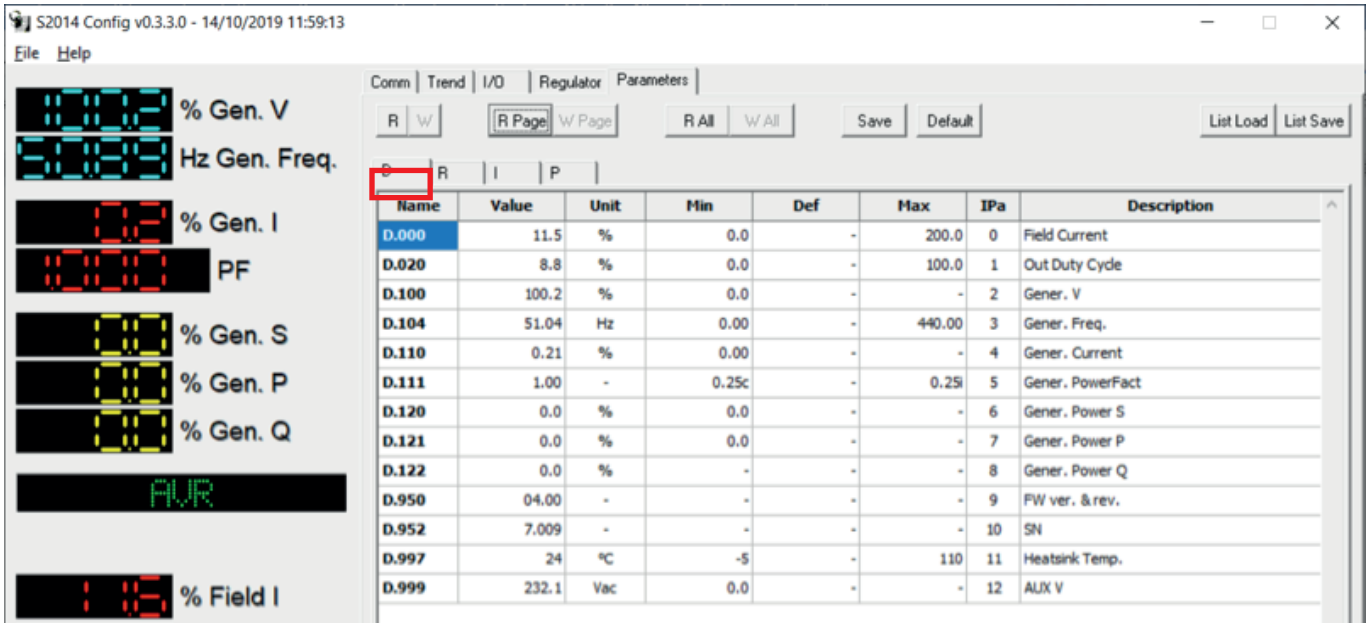
As above, remaining on the Parameters windows, click on the R label to access to R.xxx setting:



Name	Value	Unit	Min	Def	Max	IPa	Description
R.000	0.0	%	0.0	0.0	P.001	200	F. I digital ref
R.002	5.0	%/s	0.1	5.0	999.9	201	Ramp slope
R.010	0	%	0	0	200	202	Delta Ref calib
R.011	20	%	0	20	200	203	Delta Ref analog
R.012	1.0	%/s	0.1	1.0	20.0	204	Delta ramp slope
R.250	0.50	-	0.01	0.50	99.99	205	F. I Reg KP
R.251	20.0	1/(2*AuxF	0.1	20.0	100.0	206	F. I Reg TI
R.350	0.50	-	0.01	0.50	99.99	207	G. V Reg KP
R.351	20.0	1/(2*GenF	0.1	20.0	100.0	208	G. V Reg TI
R.400	1.00	-	0.50c	1.00	0.50i	209	G. PF dig. ref
R.401	0	%	-100	0	100	210	G. VAR dig. ref
R.402	1.0	%/s	0.1	1.0	100.0	211	Ramp slope
R.410	20	%	0	20	100	212	Delta Ref calib
R.411	0	%	0	0	100	213	Delta Ref analog
R.412	1.0	%/s	0.1	1.0	20.0	214	Delta ramp slope
R.450	0.50	-	0.01	0.50	99.99	215	PF/VAR Reg KP
R.451	20.0	10/(2*Gen	0.1	20.0	100.0	216	PF/VAR Reg TI
R.650	0.50	-	0.01	0.50	99.99	217	AuxV Reg KP
R.651	20.0	1/(2*AuxF	0.1	20.0	100.0	218	AuxV Reg TI
R.900	0.25	-	0.01	0.25	99.99	219	OE/UE Lim reg KP
R.901	40.0	1/(F reg)	0.1	40.0	100.0	220	OE/UE Lim reg TI

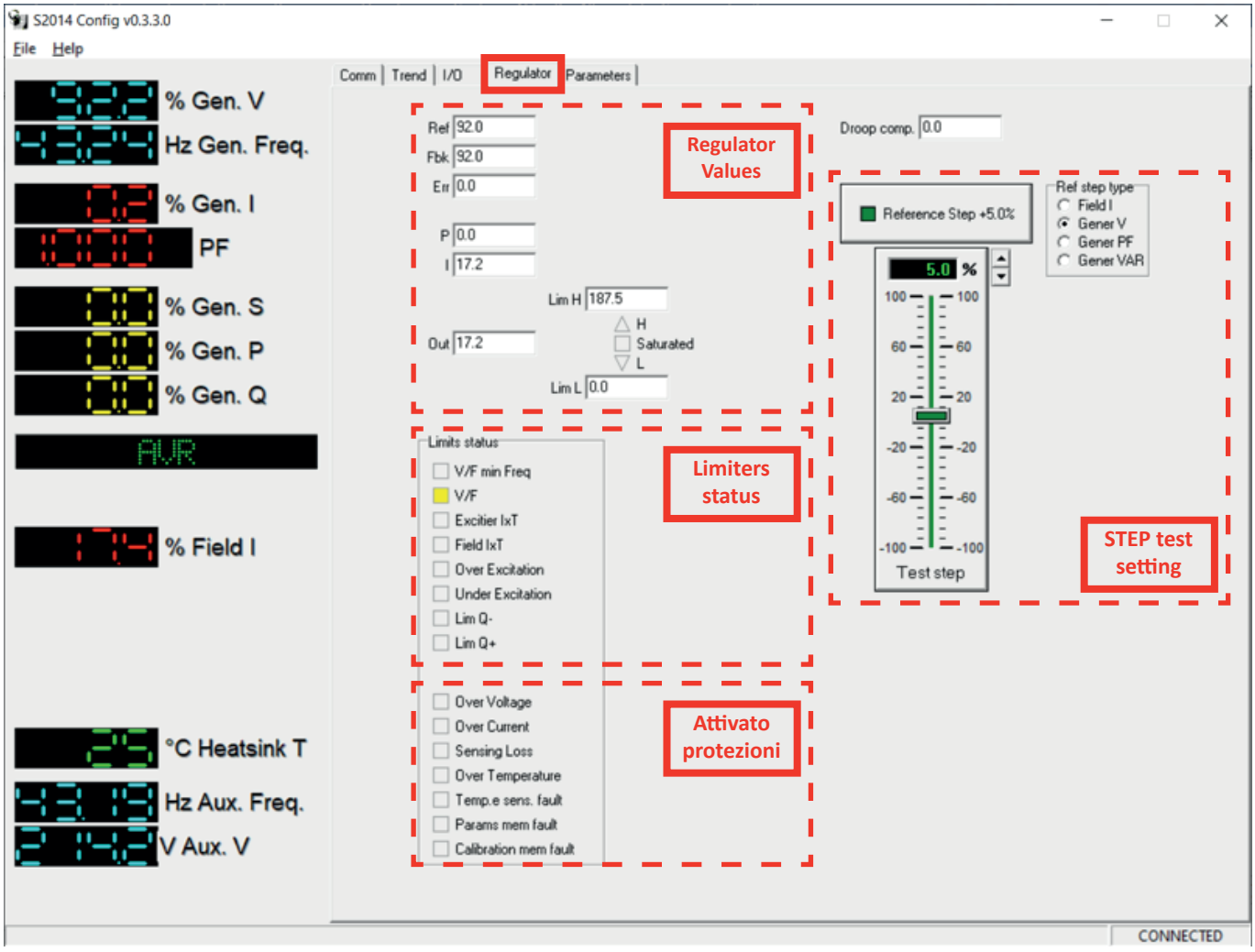
10.5 Parameters setting: D.xxx

The D.xxx windows allows to read all the values available on the on board display. To update the values press R Page.
The readings can help the troubleshooting activities.



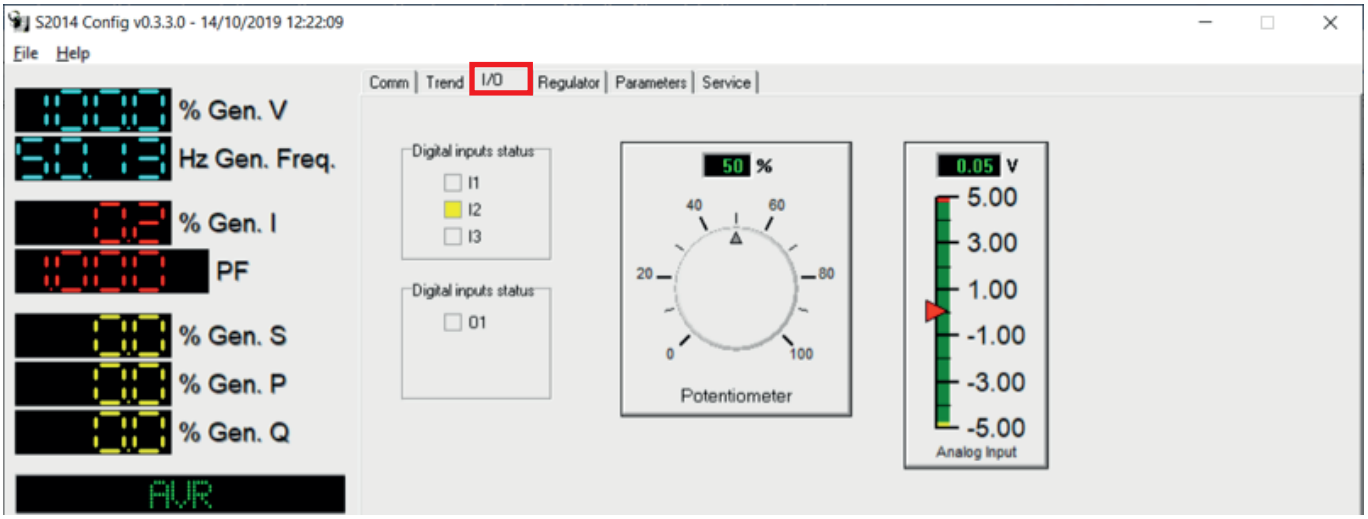
10.6 Regulator Windows

Selecting the Regulator window, you can access/read the following values:



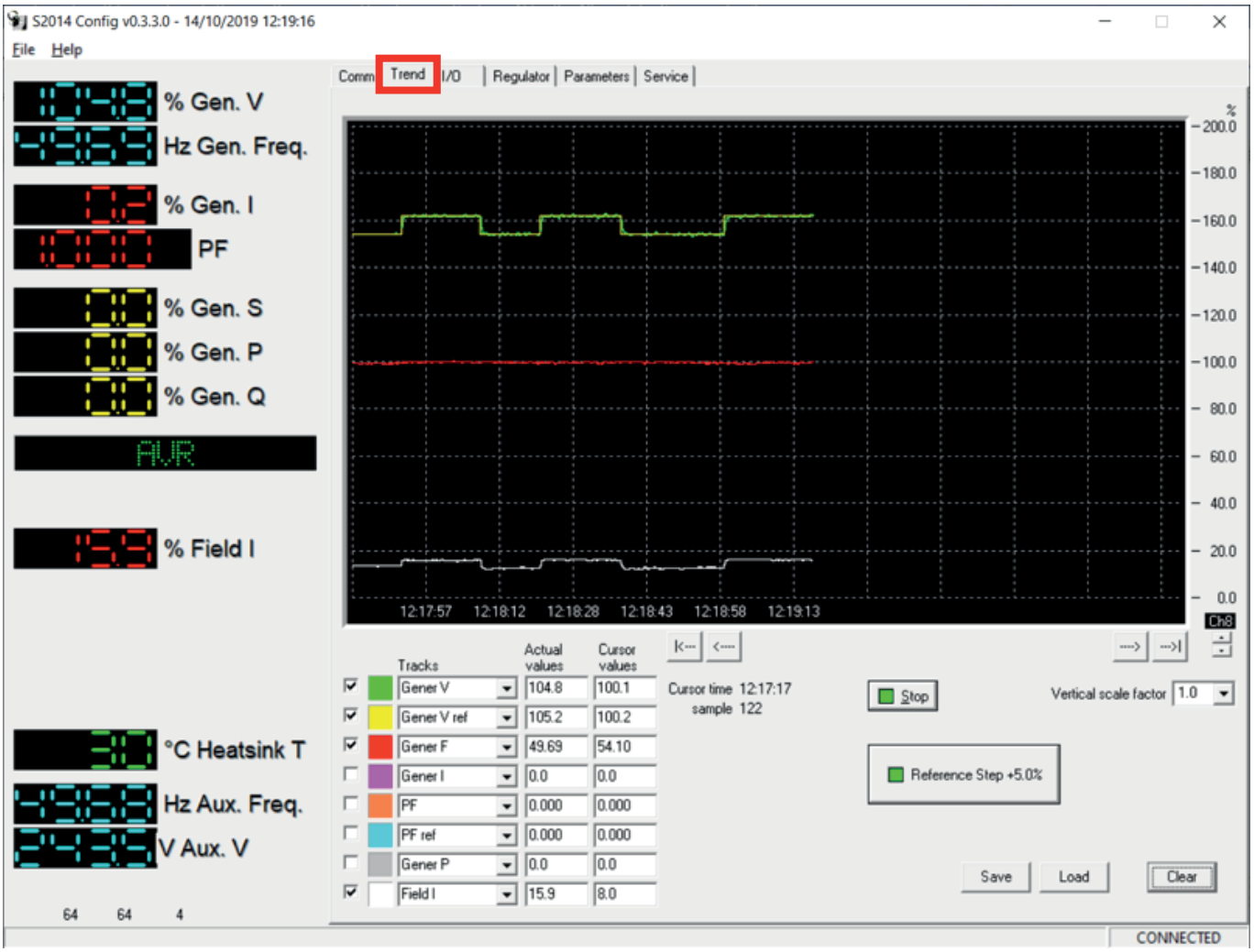
10.7 Input/Output window

Selecting the I/O window, you can access/read the following values:

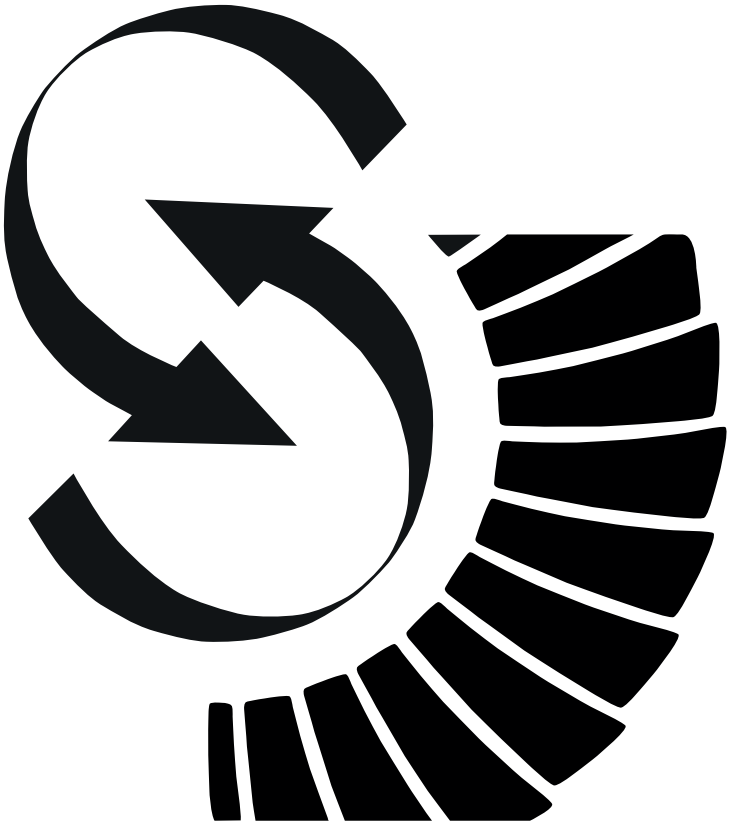


10.8 Trend window

Selecting the Trend window, you have available a powerful tool for commissioning and/or troubleshooting:



Above trend shows some step tests (+5% on the reference voltage) effect.



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