

A.V.R.

D510 C

Installation and maintenance

D510 C A.V.R.

**This manual concerns the alternator A.V.R. which you have just purchased.
We wish to draw your attention to the contents of this maintenance manual.**

SAFETY MEASURES

Before using your machine for the first time, it is important to read the whole of this installation and maintenance manual.

All necessary operations and interventions on this machine must be performed by a qualified technician.

Our technical support service will be pleased to provide any additional information you may require.

The various operations described in this manual are accompanied by recommendations or symbols to alert the user to potential risks of accidents. It is vital that you understand and take notice of the following warning symbols.

WARNING

Warning symbol for an operation capable of damaging or destroying the machine or surrounding equipment.



Warning symbol for general danger to personnel.



Warning symbol for electrical danger to personnel.



All servicing or repair operations performed on the AVR should be undertaken by personnel trained in the commissioning, servicing and maintenance of electrical and mechanical components.



When the generator is driven at a frequency less than 28 Hz for more than 30 seconds with an analogic regulator, the AC power must be disconnected.

WARNING

This A.V.R. can be incorporated in a machine marked C.E.

This manual is be given to the end user.

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New functionalities:

The table below describes the list of major changes on EasyReg 2.50 and the D510C firmware 2.20.

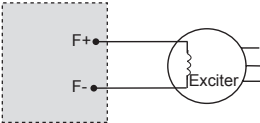
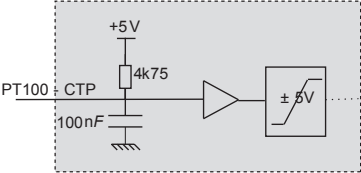
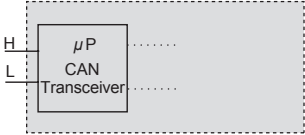
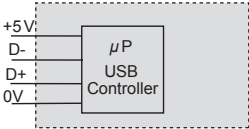
Softwares releases	Evolutions
EasyReg 2.50	Possibility to modify the reactive power convention.
	Add of CAN check box to manage voltage bias through the CANBUS.
	Add of parameter to reset the Soft Start.
	Update of the alternators database.
	Improvement of the monitor when in PF regulation mode.
	Improvement of the management of the maximum excitation current in continuous operation.
Firmware 2.20	Improvement of the CT phase correction.
	Add of a control flag allowing to manage the voltage bias signal comes which can come from the CAN BUS or the remote analog input.
	Improvement of Stator current measurement and current limitation.
	Improvement of Grid code function.
	Improvement of temperature measurement through PT100
	Add of a parameter to reset the Soft Start function.

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Terminals	Signals	Scheme
X1 X2 Z1 Z2	Power supply - Auxiliary winding input - PMG input - SHUNT input	
L1 L2	Mains voltage measurement	
U V W	Alternator voltage measurement For single-phase: use V and W	
IU = (s1, s2) IV = (s1, s2) IW = (s1, s2)	Alternator current measurement	
AI1 AI2	Analog inputs: External setting	
DI1 DI2	Digital inputs: U=U and PF/kVAR regulation	
B+ B-	DC power supply	

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Terminals	Signals	Scheme
F+ F-	Field excitation: 6 A up to 15 A/10 s	
CTP PT100_1 PT100_2 PT100-3	Temperature sensors	
CAN_H CAN_L	CAN BUS	
USB_D+ USB_D-	USB 2.0 communication port	

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• **Power:** It varies according to the type of field excitation (3 types).

- **AREP:** The AVR is powered by two auxiliary windings which are independent of the voltage sensing circuit.

The first winding has a voltage in proportion with that of the alternator and the second has a voltage in proportion with the stator current.

- **PMG:** A permanent magnet generator (PMG) added to the alternator supplies the AVR with voltage which is independent of the main alternator winding.

- **SHUNT:** The AVR is powered by the main winding (140 V – 50/60 Hz).



Two fuses 10A/250VAC, Ref. Mersen: E084414P - MI6SA25V10/50 or equivalent, mounted externally of the D510C must be used in the three types of excitation.

• **Battery:** This is used to supply the AVR with between 11 V and 30 V. **It must always be present.**



The battery supply must be protected by a 1 A Ref. Mersen : A217028Q - GDL1 or equivalent fuse.

• **Mains:** This input is dedicated to the measure phase-to-phase mains voltage which will be taken as the reference when voltage matching is performed.

• **Alternator voltage:** This input measures the alternator output voltage to the AVR in:

- three-phase (U, V, W)
- single-phase (V, W)

• **Current transformer(s):** This input measures the current supplied by the alternator. **It must always be present** when the alternator is running in parallel operation or at PF or KVAR regulation or stator current limitation.

• The possible configurations are:

- 1 CT on phase U
- 3 CTs on phases U, V and W

• **Temperature sensor(s):** These are used to measure the alternator temperature and alert the user if there is a rise in temperature. This measurement can be taken either with 1 PTC or 3 PT100s.

• **Communication:**

- **USB port:** This is used to connect the AVR to a computer and creates the link between the EasyReg software and the D510C.

- **CAN port:** This is used to connect the AVR to a bus CAN interpreter in order to exchange parameters with the D510C.

• **I/O: This part is used to:**

- Enter settings
- Send information from the D510C
- Receive information from the alternator

• **LEDs:** These light-emitting diodes inform the user whether the AVR is working correctly or not.

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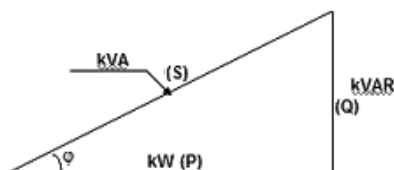
1.2-Characteristics

The different functions of the D510C are:

- Voltage regulation
- Regulation of the power factor (PF)
- Regulation of the reactive power
- Manual regulation (Iexc)

• **Voltage regulation:** The D510C regulates the alternator output voltage. Regulation is applied to the mean value or the true rms value (TRMS).

• **Regulation of the power factor:** The D510C regulates the power factor. This is the ratio between the active power ($P = \sqrt{3} \cdot U \cdot I \cdot \cos \varphi$) and the apparent power ($S = \sqrt{3} \cdot U \cdot I$).



- *Inductive P.F. $[0; \pi/2]$* means that the current is lagging behind the voltage. The load is inductive (induction motor, transformer, etc).

- *Capacitive P.F. $[\pi/2; \pi]$* means that the current is leading the voltage. The load is capacitive (fluorescent lighting, etc).

• **Regulation of the reactive power:** The D510C regulates the reactive power ($Q = \sqrt{3} \cdot U \cdot I \cdot \sin \varphi$) at a fixed value.

• **Manual regulation:** The D510C can regulate the excitation current.

These functions are selected when setting the AVR parameters.

1.3-Specifications

1.3.1-Characteristics

Name	Minimum value	Maximum value	Adjustable
Battery power supply	11 V	30 V	-
Alternator frequency	10 Hz	100 Hz	Yes
Mains frequency	10 Hz	100 Hz	-
Single-phase mains voltage	50 V	530 V	-
Mains voltage ratio	1	100	Yes
Excitation current	0 A	6 A	-
Max. excitation current	0 A	15 A/10s	-
Single-phase alternator voltage	0 V	530 V	-
Three-phase alternator voltage	0 V	530 V	-
Alternator current input	1 A	5 A	Yes
Alternator I u	0 A	5000 A	-
Alternator I v	0 A	5000 A	-
Alternator I w	0 A	5000 A	-

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Name	Minimum value	Maximum value	Adjustable
LAM knee-point	37 Hz*	100 Hz*	Yes*
Adjustable LAM	70% of Voltage reference	100% of Voltage reference	Yes
Variable U/F	1.0	3.0	Yes
Voltage reference setpoint	90 V	530 V**	Yes
Adjustment of external accuracy	- 10%***	+ 10%***	Yes***
Quadrature droop	0%	+ 10%	Yes
Soft start acceleration	0.1 s	120 s	Yes
Loading acceleration	0.1 s/10 Hz	30.0 s/10 Hz	Yes
Voltage drop compensation	0%	10%	Yes
Excitation current manual reference	0 A	10 A	Yes
Rated cosine <i>P.F.</i>	-0.6 (LEAD)	+0.6 (LAG)	Limited by settings
kVAR	-100%	+100%	Limited by settings
Proportional action	0*	1500*	Yes*
Integral action	0*	200*	Yes*
Derivative action	0*	12000*	Yes*
Loop gain	0*	100*	Yes*
Scale	1/50*	1/1*	Yes*

* in expert mode - ** without voltage transformer - *** 30% in expert mode

1.3.2 - Status and faults

Name	Minimum value	Maximum value	Adjustable
Short-circuit delay	0.5s	10s	no
Short-circuit excitation current demand	0A	10A	no
Underexcitation delay	0.1s	5.0s	no
I EXC SHUT down	0A	5A	no
Overvoltage time	0s	100s	no
Overvoltage threshold	0%	120%	no
PT100 temperature	0°Celsius	250°Celsius	no
PT100 temperature threshold	50°C	200°C	no
PTC input	0%	100%	no

1.3.3 - Environments

Storage temperature: -55°C +85°C

Functioning temperature: -40°C +65°C

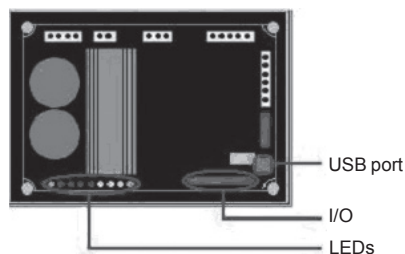
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2 - HUMAN-MACHINE INTERFACE

The D510C human-machine interface consists of 3 elements:

- The USB link
- The I/O
- The LEDs



2.1 - Communication

USB link

The EasyReg software and the D510C communicate via a USB cable (Universal Serial Bus).



Connect to the PC



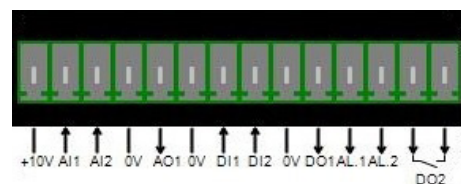
Connect to the D510C

Warning: In **SHUNT** operation, please use a USB isolator to connect the PC to the D510C.

Do not connect the USB during the starting if the DC supply of the AVR is switched off.

2.2 - Analog I/O

This part of the board allows the operator to use the inputs to make manual settings and the outputs to check certain data or to indicate whether certain AVR functions are working correctly or not. An external voltage (0 V - 10 V) is present which can be used as a reference for an electronic device.



The minimum analogic input setting is 0% and the maximum is 100%.

External by setting is either:

- from an external potentiometer (1k Ω),
- 4 - 20 mA,
- 0 - 10 V,
- \pm 10V.

The two analog inputs can also be used to achieve digital functions + / -.


NB : make sure that the voltage applied on analogue input does not exceed 10V.

2.3 - Digital I/O

E/S	Type	Characteristics
DI ₁ DI ₂	Pull up input	To be connected to 0V
DO ₁	Opened collector	Max current: 60mA Voltage: 0 - 24V
DO ₂	Dry contact	6A, 30Vdc/250V AC (on resistor)
AL ₁ AL ₂	Opened collector	Max current: 60mA Voltage: 0 - 24V

2.4 - LEDs

The LEDs serve to inform the user whether the AVR is working correctly or not.

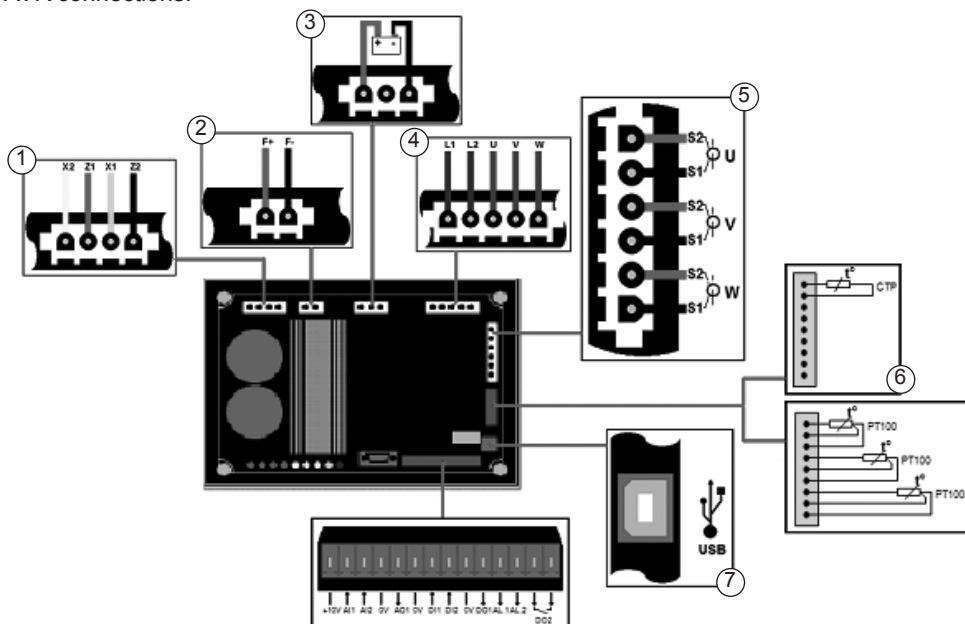
Name	Colour	Meaning
Power ON	Green	The board is supplied with power
↓ Hz	Red	Speed drop
↑ / ↓ Volt	Red	Problem of overvoltage or undervoltage
↑ / ↓ Exc.	Red	Problem of overexcitation or underexcitation
 Fault	Red	Problem on the exciter field diode bridge
Manu	Yellow	Manual mode enabled
PF / KVAR	Yellow	Regulation of the power factor or reactive power enabled
U = U	Yellow	Alternator voltage = Mains voltage
USB	Blue	AVR connected to a PC

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2.5 - Wiring scheme

AVR connections:



1 - Power :

- AREP : Yellow wire on X2 - red wire on Z1 - green wire on X1 - black wire on Z2
- PMG : X2, X1 and Z2
- SHUNT : X1 and X2

2 - Field excitation: The field winding + to the terminal F+ The field winding - to the terminal F-

3 - Battery: Ensure the polarity is correct when connecting

4 - Voltage sensing:

- Mains voltage: L1 and L2
- Alternator voltage: - single-phase: V and W
- three-phase: U, V and W

5 - Current transformer(s):

- Placing in parallel and measurement: CT on U
- Measurements: CTs on V and W

6 - Temperature sensor:

- PTC: see mounting above
- PT100: see mounting above

7 - USB port

8 - Digital I/O

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3 - SETTING THE FUNCTION PARAMETERS

EasyReg is a Leroy Somer Software which allows to :

- Easily configure the digital regulator D510C
- Monitor several important parameters such as alternator output voltage, excitation current, active and reactive power, etc...
- Optimize the regulation loop

- Set the AVR parameters.
- Configure the inputs and outputs.
- Display faults and parameter measurements.

It is the interface between the user and the digital AVR.

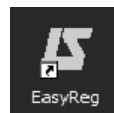
3.1 - Installation

Double click on the installer EasyReg and follow the installation instructions.

3.2 - Startup

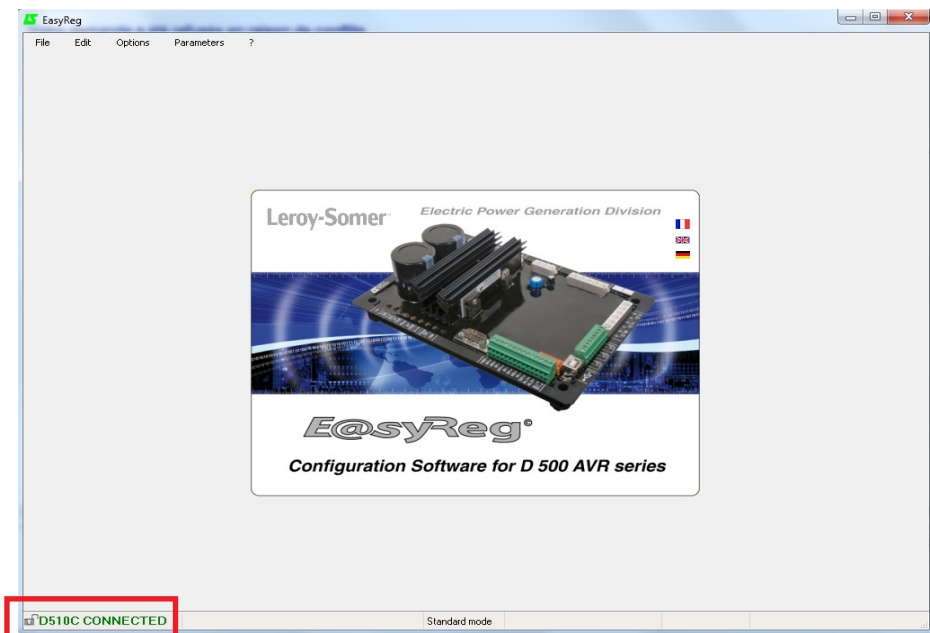
Connect the AVR to the computer with a USB cable. Check that the blue «USB» LED is on.

To start the software, go to «Start», «Programs» then «EasyReg».



3.3 - Appearance

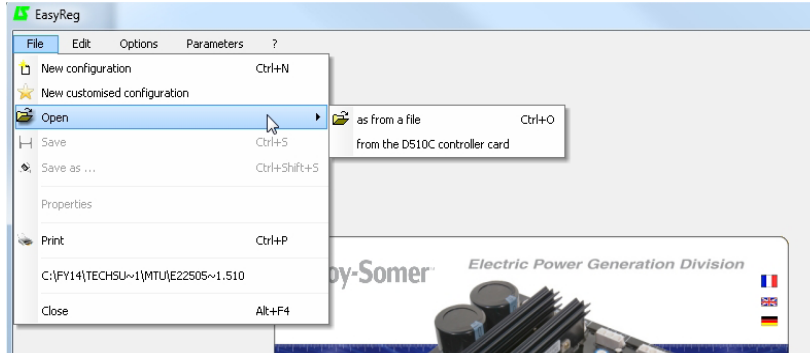
The regulator is connected to the PC via standard USB cable, the blue LED (labeled LED) of the regulator is then ON and the information « D510C CONNECTED » is displayed on the screen left bottom.



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<h1 style="text-align: center;">D510 C</h1> <h2 style="text-align: center;">A.V.R.</h2>		

There are four options when using this software:

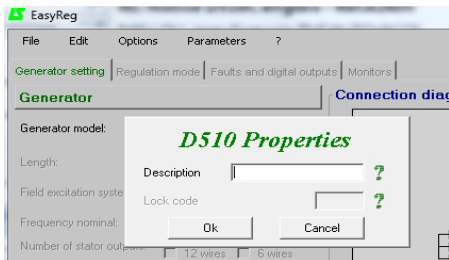
- New configuration
- Open a configuration from a file
- Open a configuration from the pre-programmed AVR.
- Create customised configuration (Expert mode)



If the AVR is not connected or has never been configured, it is impossible to «Open from a D510C».

PROPERTIES

The user can choose to lock the regulator to avoid the configuration modification. In that case, the configuration description and a lock code must be entered. In customised mode, only the lock code can be entered.



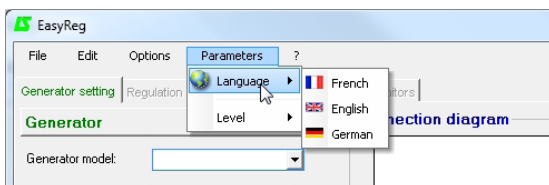
PRINT

The configuration can be edited in a Word or PDF format file.

3.3.1 - Languages and modes

3.3.1.1 - Languages

Three languages are available on EasyReg: French , English and German.



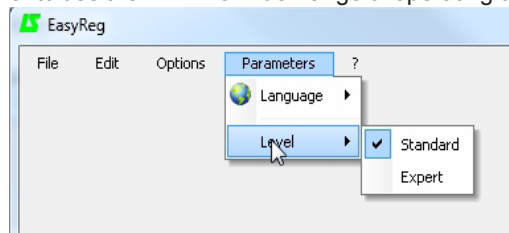
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3.3.1.2 - Modes

Two operation modes are possible:

- Standard mode by default
- Expert mode which offers additional functions

This mode is reserved for users who possess the skills to make certain more complex adjustments or to use the AVR in a wider range of operating conditions.



If you require the Expert mode access code, please use the main menu: click on « ? » then « About... ». The following window is displayed



Click on « Copy code » and email the PC code to: SupportTechniqueSillac.IALS@Emerson.com. The access code will be sent you back.

⚠ Incorrect settings can harm the AVR and the alternator and can cause serious damage (to users, loads). Select the duty type and the class according to your specification.

3.3.2 - Saving and loading the configuration

Save your configuration (for the 1st time):

- Go into the «File» menu and click «Save As»
- Choose where you wish to save to
- Name your saved configuration
- Click Save As

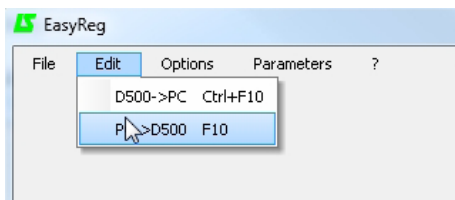
Subsequently, to save the configuration, you just need to go into the «File» menu and click «Save».

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Send the configuration to the AVR:

- check that the AVR is connected correctly (blue LED on) at the bottom left-hand side of the screen.
 - go into the «Edit» menu.
 - Go to : • PC --> D510C
 - D510C --> PC
 - click « PC -> D510C ».
- Wait for loading to complete.



By default, the software is in standard mode. The AVR is programmed step by step. Access to the «Regulation Mode» page is only possible if the «Alternator Configuration» page has been filled in. The program is transferred to the D510C via the «Edit» menu then «PC => D510C» or by pressing F10 on the keypad.

This software must be used in the order indicated below:

1. Alternator configuration
2. Regulation mode:
 - Voltage regulation
 - Underspeed settings
 - Other types of regulation (PF, reactive power, manual) depending on the user's selections.
3. Faults and digital outputs
4. Monitors

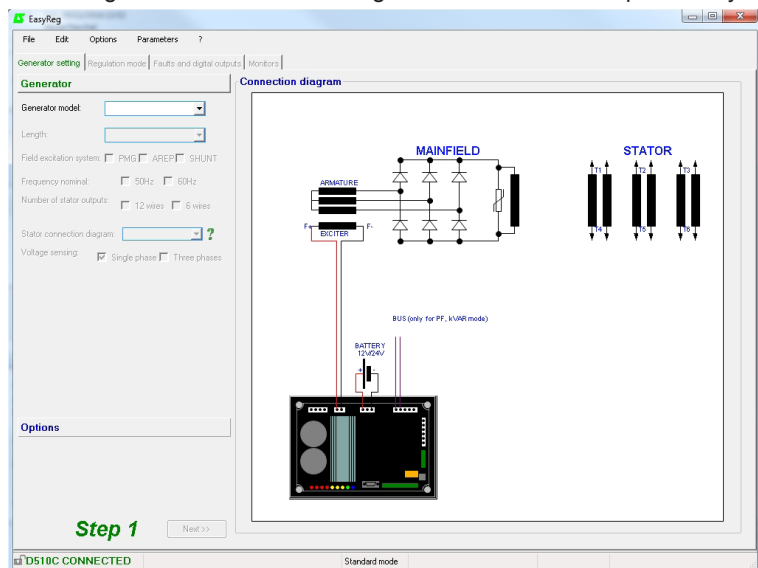
3.3.3 - New configuration

There are two possible configuration levels: standard or expert.

3.3.3.1 - Alternator Configuration

Open «New configuration» from the menu bar, which takes you to the «Alternator Configuration» window. The parameters for this page are set in two parts: Alternator, Options.

The wiring scheme varies according to the characteristics specified by the user.



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• Alternator

EasyReg

File Edit Options Parameters ?

Generator setting Regulation mode Faults and digital outputs

Generator

Generator model: [dropdown] ← 1

Length: [dropdown] ← 2

Field excitation system: ☐ PMG ☐ AREP ☐ SHUNT ← 3

Frequency nominal: ☐ 50Hz ☐ 60Hz ← 4

Number of stator outputs: ☐ 12 wires ☐ 6 wires ← 5

Stator connection diagram: [dropdown with ?] ← 6

Voltage sensing: ☒ Single phase ☐ Three phases ← 7

In the dropdown lists or boxes, select:

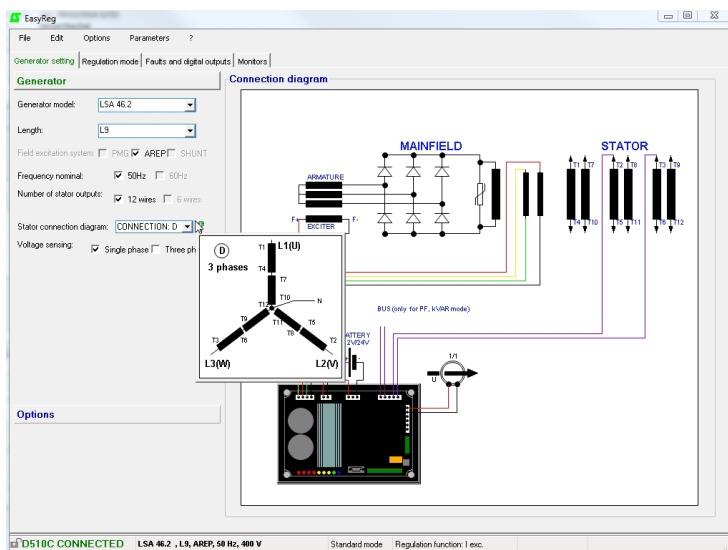
1. The **type of alternator**
2. The **length**
3. The **type of field excitation**
4. The **frequency**
5. The **number of stator outputs**
6. The **stator connections**
7. The **voltage sensing (single or three-phase)**

Note: The information relating to items 1, 2, 3 and 4 can be found on the nameplate.

[Expert mode]: the alternators list is more expanded. In this mode it is also possible to select the Service, the temperature rise class and the alternator power.

Note: FF and G electrical connections are dedicated to single phase application, no three-phase sensing is possible.

Stator connections: Click on the question mark to get help on the stator connections.



The alternator configuration is recalled at the screen left bottom

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• Options

☒ Temperature sensing
☒ PTC ☐ PT100

☒ Current transformer(s) (C.T.)
 Number: ☐ 1 ☒ 3 ☐ 3 ☒ IN Sensing
☐ IN/2 Sensing ☐ IN/4 Sensing
 Ratio: /

☒ Generator voltage transformer (P.T.)
 Primary U (kV): Secondary U (V):

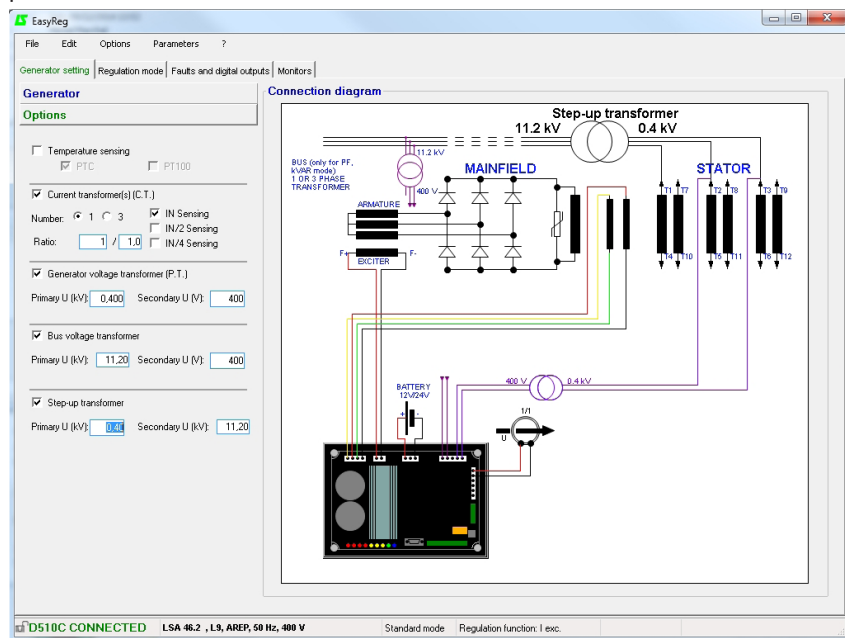
☒ Bus voltage transformer
 Primary U (kV): Secondary U (V):

☒ Step-up transformer
 Primary U (kV): Secondary U (kV):

To obtain the following options, tick the boxes:

- Temperature sensors**, select either 1 PTC or 3 PT100s.
- Current transformers (CTs)**, select the number (1 or 3), the measurement (IN, IN/2 or IN/4) and the ratio. unless one CT is mandatory for parallel operation, PF or kVAR regulation, stator over current, unbalanced current.
- Alternator voltage transformer**, enter the voltage values at the primary and at the secondary if a transformer is connected..
- Bus voltage transformer**, enter the voltage values at the primary and at the secondary if a transformer is connected.
- Step-up transformer**, fill the values of primary and the secondary.

The electrical schematic below shows how the «wiring scheme» part changes according to the parameters selected.



After entering the data in this page, go to the second page by clicking «Next». In some cases, you will need to adjust the workscreen in order to access the «Next» button.

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3.3.3.2 - Regulation mode

After entering the «Alternator Configuration» part settings, fill in the «Regulation Mode» part.



4 types of regulation are offered:

- Voltage
- Power factor (P.F.)
- Reactive power (kVAR)
- Manual (I exc)

Always setting begins with voltage regulation.

Caution, regulation of the reactive power PF and the quadrature droop can only be enabled if there is a CT on phase U and it has been selected.

A - Voltage regulation

This page consists of two parts :

- Voltage Regulation

- Underspeed settings

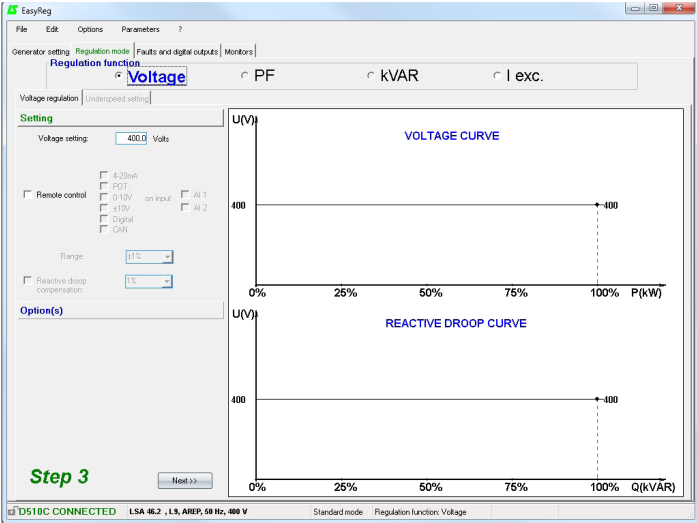
Setting the parameters for this part starts with the «Voltage regulation» page and ends with the «Underspeed settings» page.

A1 - Voltage regulation

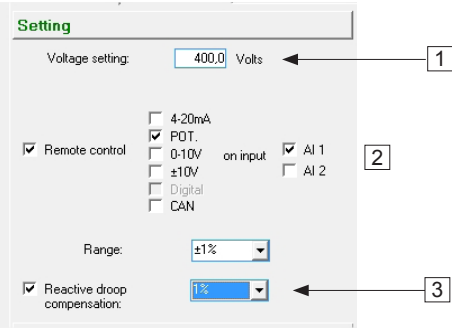
This page is split into two parts:

- Settings

- Options



A1.1 - Settings



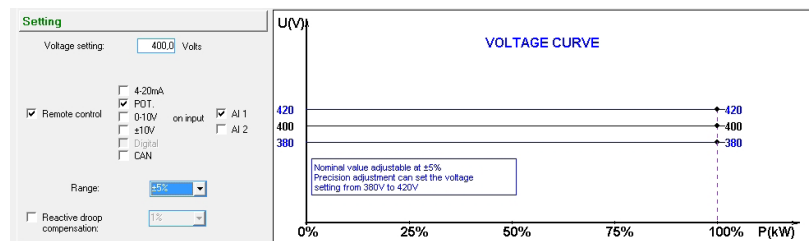
1. The displayed value comes from Easyreg® database. It can be adjusted in the range $\pm 10\%$ maximum.

Expert Mode: The adjustment range can be extended to $\pm 30\%$

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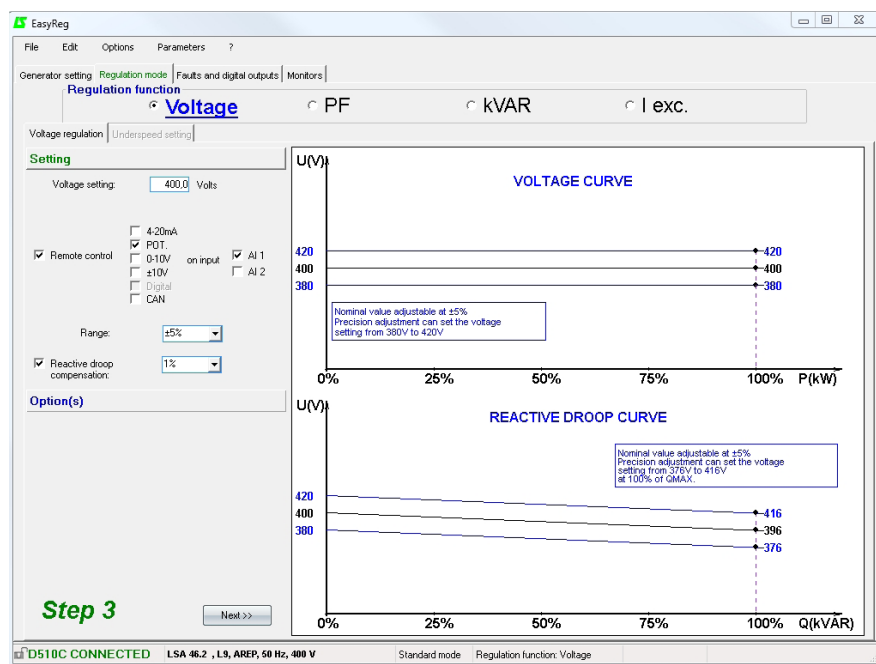
2. To set the voltage externally, tick the box, define by what means (POT, 0-10 V, etc) this setting will be made as well as the selected input (AI1 or AI2), then enter the desired setting range.



The setting « Digital » is used for the « +/- » mode thanks to the analogue inputs AI1 and AI2. It allows to modify the regulation reference thanks to successive pulses on AI1 and AI2.

3. If you wish to have voltage quadrature droop, tick the box and select the quadrature droop percentage.

This function is only available if a CT is used.
It can be adjusted up to 10% maximum.



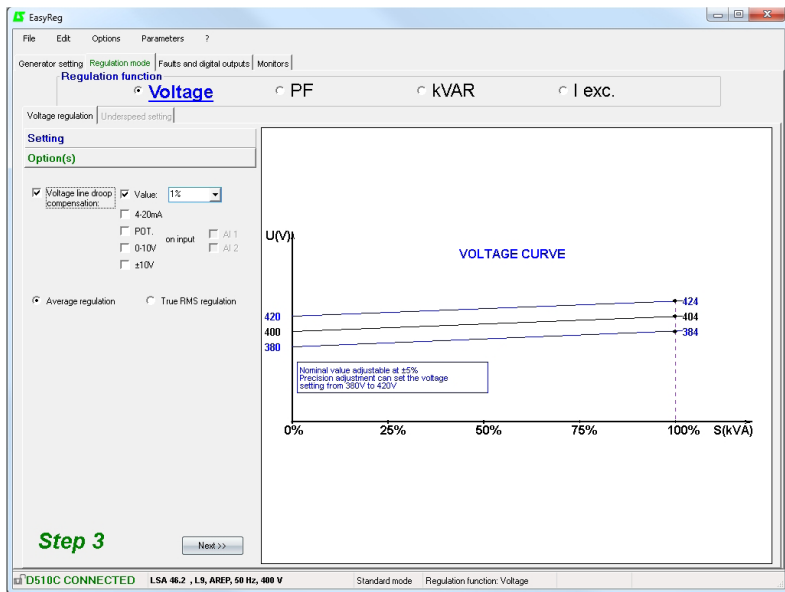
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A1.2 - Options

1. If you wish to have line drop compensation, tick the box and select the type of setting by a % value or an external setting. The standard setting is 3%.

This function is only available if a CT is used.



The function « Voltage line drop compensation » cannot be simultaneously activated with « reactive droop compensation ».



It is possible to impose the desired compensation by direct entry of the % value or make an external adjustment (10% max)

2. Select which value regulation should apply to :

- mean value
- true rms value

To go to the next step « Underspeed settings », click « Next ».

Step 3

Next >>

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A2 - Underspeed settings

This page is split into three parts:

- Starting
- Underspeed
- Engine

A2.1 - Starting

Start

☒ Soft-start: ?

During Second(s)

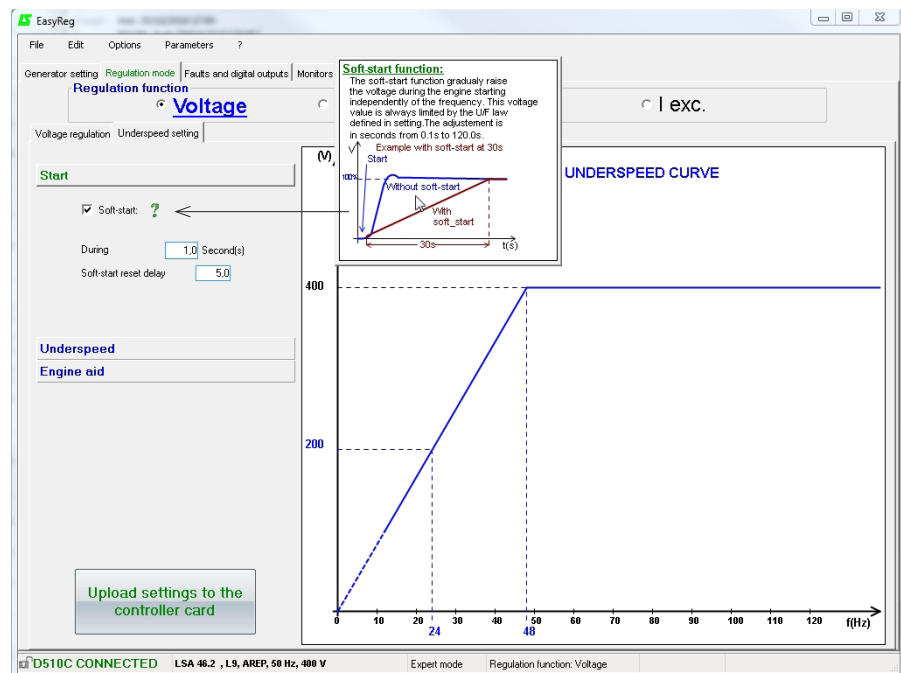
Soft-start reset delay

Factory setting: disabled

To adjust Soft-start, check the box and select the duration between 0.1 s and 120 s (1 step = 0.1 s).

Clicking on the question mark give help information on this function.

The Soft-start reset delay (default 20s), can be adjusted from 5s to 20s.



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A2.2 - Underspeed

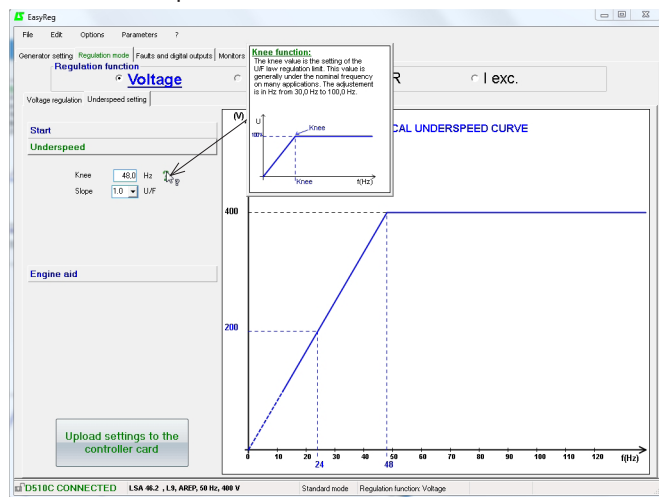
Underspeed

Knee 48.0 Hz ?

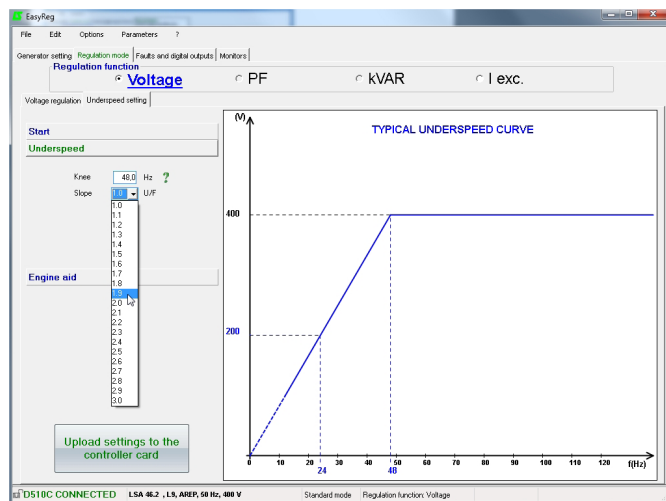
Slope 1.0 U/F

Factory setting: 48 Hz for 50 Hz
58 Hz for 60 Hz

1. Enter the knee-point value between 47.5 and 52.5 Hz (1 step = 0.1 Hz). An error message appears when the value displayed is outside the permitted range. The extended range is accessible in expert mode.



2. Enter the gradient value between 1.0 and 3.0 U/F (1 step = 0.1 U/F). Factory setting: 1/U/F.



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A2.3 - Motor help

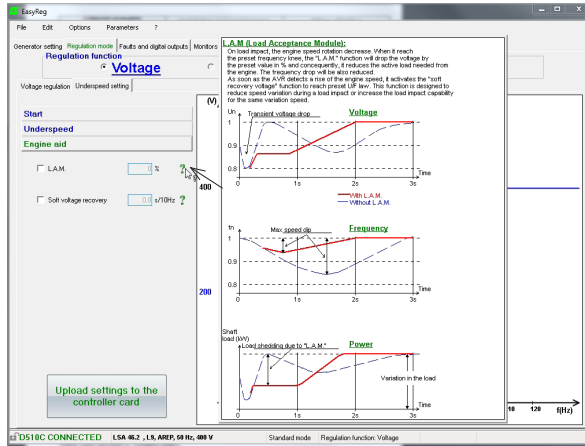
Engine aid

☒ L.A.M. % ? 1

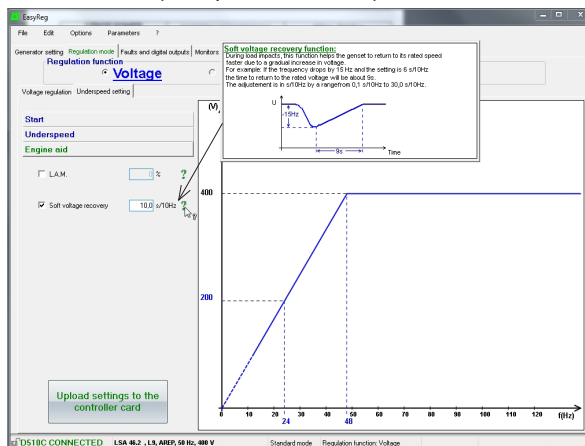
☒ Soft voltage recovery s/10Hz ? 2

1. If the LAM function is required, tick the box and select its value between 0% and 30% (1 step = 1%).

Soft recommended setting: LAM 9% - U/F 1.7%



2. If you wish to have a gradual increase, tick the box and select the value between 0.1 s/10 Hz and 30.0 s/Hz (1 step = 0.1 s/10 Hz).



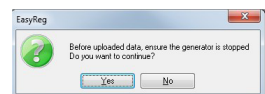
Note: the recommended setting is 7 s/10 Hz

Save (see section 3, «Save» part).

Load the configuration in the regulator :

- By clicking on the button Upload settings to the controller card
- Or by using the key F10
- Or PC→D500 in « Edition » menu

Then a warning message is displayed.



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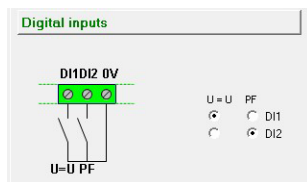
B - Regulation of the power factor

Caution: You can only enable selection of regulation by power factor PF or selection of regulation of the reactive power KVAR, and the quadrature droop, if there is a CT on phase U which has been enabled on the alternator configuration page.

This page is split into two parts:

- Digital inputs
- Settings

B1 - Digital inputs



Check the digital input on which the voltage match circuit has been placed in order to enable it. The second digital input is reserved for enabling power factor regulation mode.

B2 - Settings

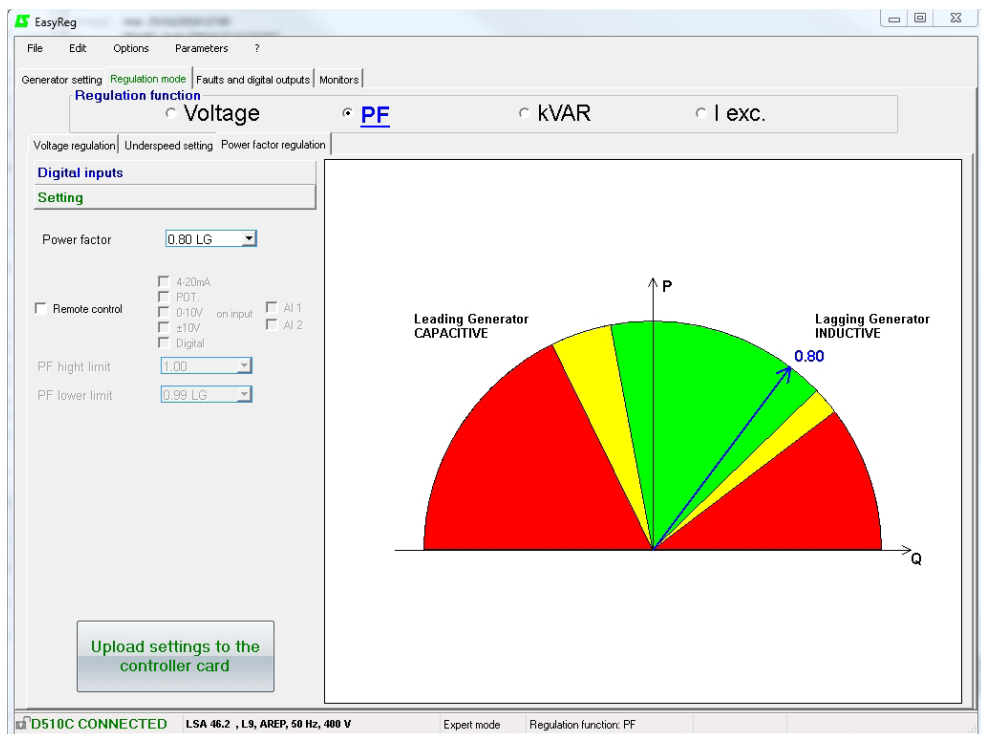
It is possible to set a fix value or use a remote adjustment in a predefined range.

1. Select the power factor value.
The value depend on the alternator type.



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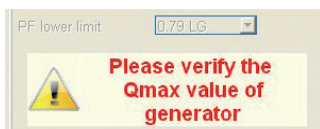
■ Database Authorized area

■ Database not recommended area

■ Forbidden area

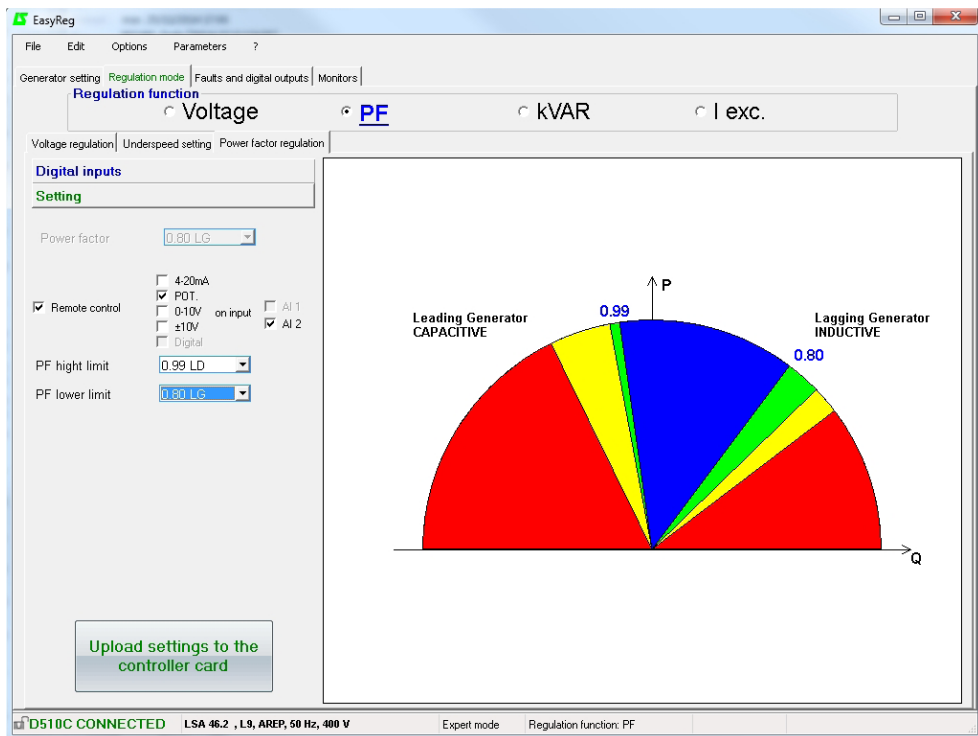
It is impossible to enter a reference value outside the limit values which are automatically set from the data on the alternator database.

Warning: When a value is outside the database recommended area, a message appears as indicated below.



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D510 C A.V.R.		

2. To set the power factor externally, tick the box, select the source (POT, 0-10 V, etc) for this setting and also the input (AI1 or AI2). One of the inputs may be greyed-out if it is already being used by another function.



- Remote adjustment operation area
- Database Authorized area
- Database not recommended area
- Forbidden area

Save (see section 3, «Save» section).

Load the settings into the AVR by clicking the following button :



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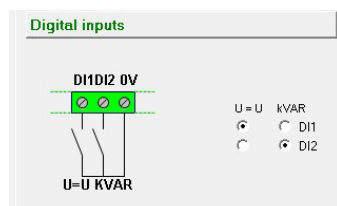
C - Regulation of the reactive power kVAR

Caution, regulation of the reactive power PF, and the quadrature droop can only be enabled if there is a CT on phase U and it has been configured.

This page is split into two parts:

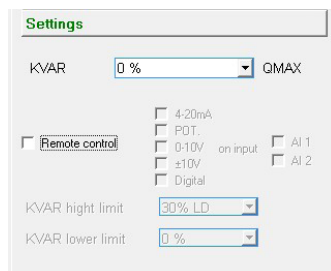
- Digital inputs
- Settings

C1 - Digital inputs



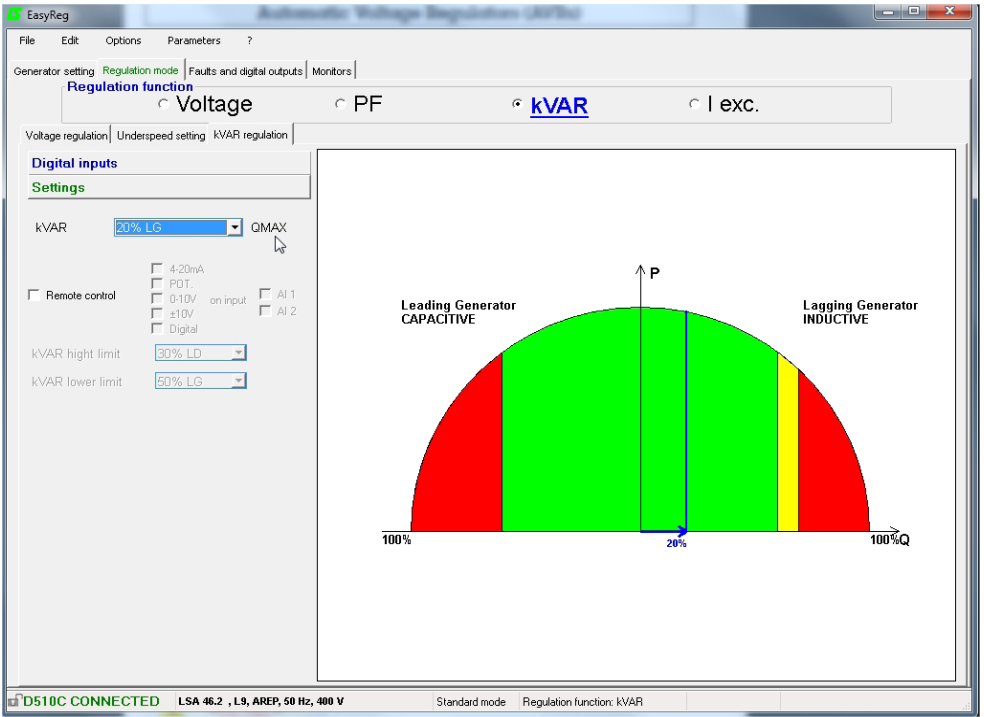
Check the digital input on which the voltage match circuit has been placed in order to enable it. The second digital input is reserved for enabling reactive power regulation mode.




C2 - Settings



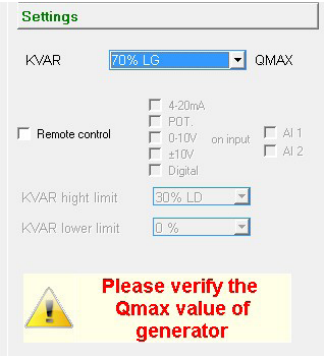
Select the value of the reactive power according to the load. This value depends on the alternator type.

It is possible to set a fix value or use a remote adjustment in a predefined range.



-  Database Authorized area
-  Forbidden area
-  Database not recommended area

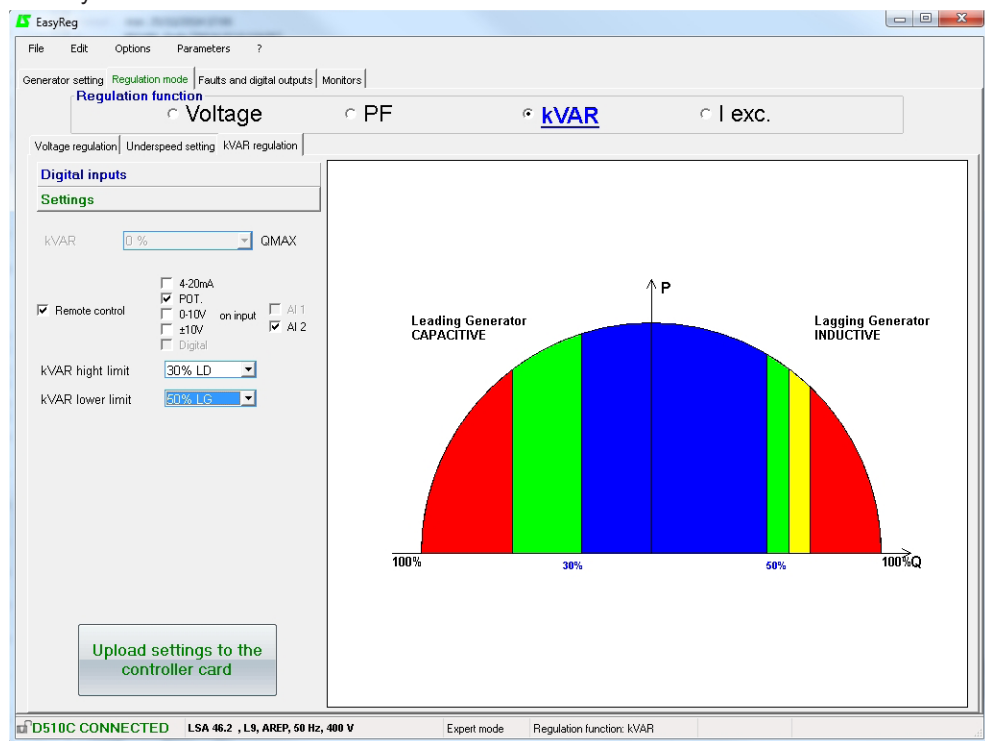
Warning: When a value is outside the database recommended area, a message appears as indicated below.



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2. To set the reactive power externally, tick the box, select the source (POT, 0-10 V, etc) for this setting and also the input (AI1 or AI2). One of the inputs may be greyed-out if it is already being used by another function.



 Remote adjustment operation area

 Database Authorized area

 Database not recommended area

 Forbidden area

Save (see section 3, «Save» part).

Load the settings into the AVR by clicking the appropriate button:



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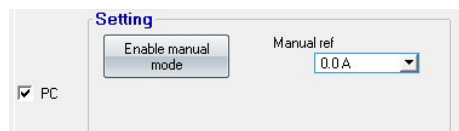
D - Manual regulation: I exc

This page is split into three parts:

- PC (settings)
- External control
- Follower mode

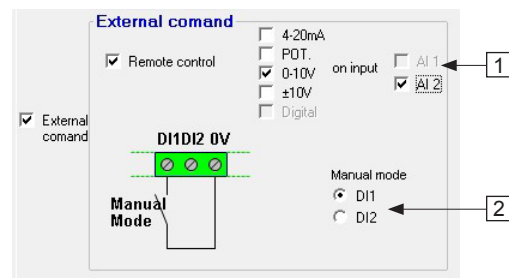
The manual mode can be activated and adjusted either with the PC (via EasyReg software) or remotely. In that last case, a switch allowing the activation/ deactivation of the manual mode must be connected to one of the digital inputs and the excitation current setting is achieved by the remote analogue device through the AI1 or AI2.

D1 - PC



Enter the desired excitation current value between 0.0 A and 10.0 A (1 step = 0.1 A). Manual mode is enabled by clicking the corresponding button.

D2 - External control



1. To set the excitation current externally, tick the box, select the source (POT, 0-10 V, etc) for this setting and also the input (AI1 or AI2). One of the inputs may be greyed-out if it is already being used by another function.

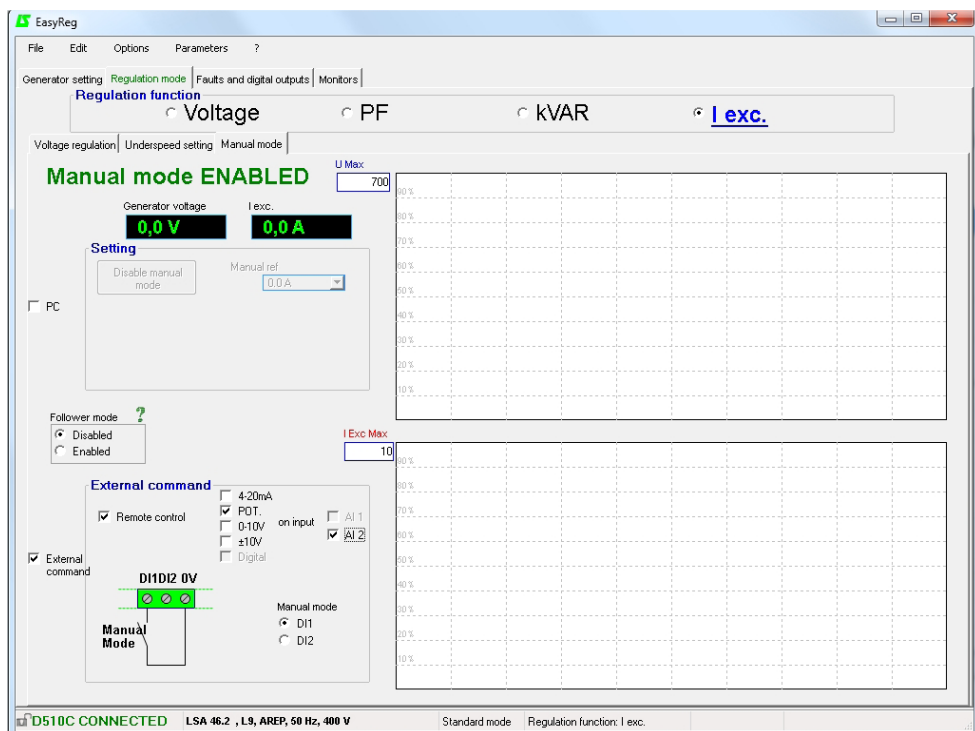
2. Check the digital input on which manual mode has been placed in order to activate it.

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D3 - Follower mode

If this function is enabled, it allows to switch in manual mode with initial setting value as a copy of the last excitation current measurement before the switching.



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3.3.3 - Faults and digital outputs

This page is split into three parts in standard mode:

- Assignment of faults
- Assignment of digital outputs
- faults options

- Assignment of faults and digital outputs

The main faults can be supervised by assigning them to digital outputs.

EasyReg

File Edit Options Parameters ?

Generator setting | Regulation mode | **Faults and digital outputs** | Monitors

Faults affectation and logical output

AL1
None

AL2
None

DO1
None

DO2
None

Fault options

Level PT100-1 160 °C

Level PT100-2 160 °C

Level PT100-3 160 °C

Unbalance threshold 20 % I AVR average

Detection from 50 % In

AVR Overcurrent Threshold 110 % In

D510C CONNECTED LSA 46.2, L9, AREP, 50 Hz, 400 V Standard mode Regulation function: I exc.

NOTA : The fault « Unbalance current » is only selectable if 3 CT are checked.

This page offers the possibility of assigning faults and operating modes to 4 outputs (AL1, AL2, DO1 and DO2).

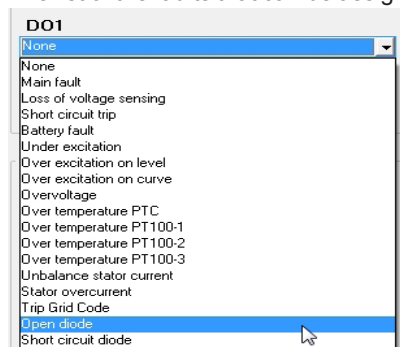
Example of settings:

- Assignment of «Overvoltage» fault to AL1
- Assignment of «PT100-1 overtemperature» fault to AL2 with the maximum temperature set at 200°C
- Assignment of «Loss of voltage sensing» fault to DO1
- Assignment of «PF/kVAR» digital output to DO2

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The list of the faults that can be assigned to the outputs are given below.

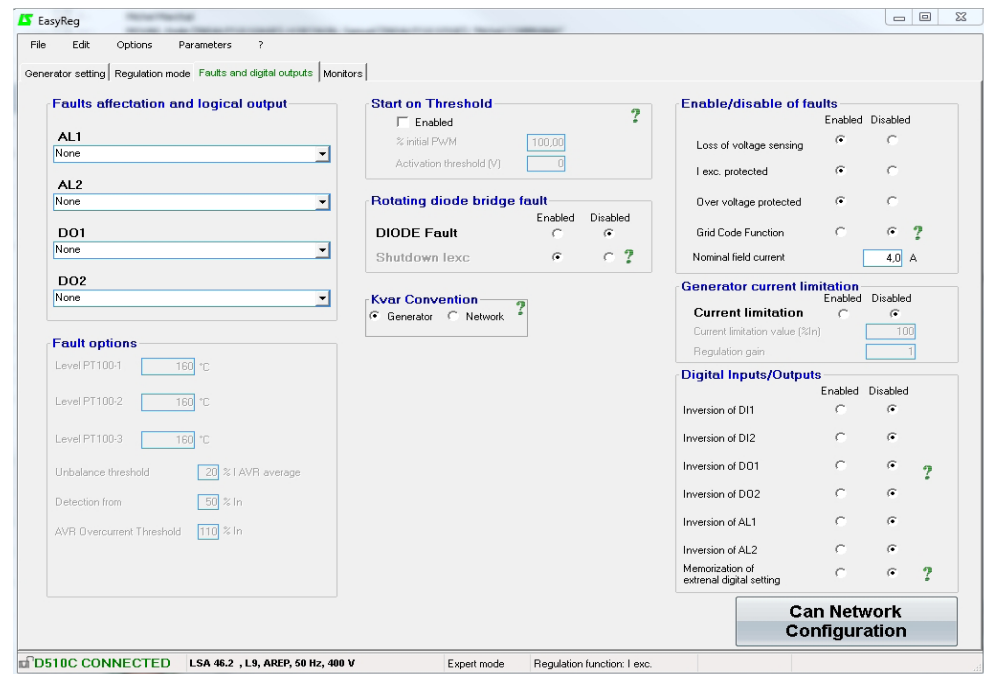


- Faults options

It is possible to configure the thresholds for triggering certain faults:

- On temperature measurement (PT100)
- On stator current unbalance: it is possible to set the level for sensing and unbalancing level compare to the current mean value.
- On Stator Overcurrent: The current level above which the fault is activated can be set.

- The Expert mode offers other functions



D510 C A.V.R.

• [Expert mode] Start on Threshold

Activate and set this function. This function allows an initialisation of the voltage regulation in a way which avoids the voltage overshoots during voltage build up. The PMW % level reduce the excitation current up the voltage threshold voltage level. The Start on threshold can be tuned on “Faults and digital outputs” tab.

NB : this function is reset 20 seconds after the engine is stopped.

• [Expert mode] Enable/disable of Faults

Allows to activate/deactivate the regulator protections (overvoltage, over-excitation,...).

• [Expert mode] Grid Code Function

Allows to activate/deactivate this function. At least one CT is necessary to use this function. It allows to switch from PF regulation mode to voltage regulation mode when the voltage is out of the range -90% and 110% of the rated voltage.

• [Expert mode] Nominal excitation current

This value comes from the database but can be changed by the user. This value must be set according to the admissible excitation current for the generator.

• [Expert mode] digital input/ outputs

It is possible to reverse these digital IOs.

• [Expert mode] Digital external setting memorization

This function is use in « +/- » mode; it allows to keep the regulation mode adjustment in case of DC supply cut off.

3.3.4 - [Expert mode] D510C Options

The regulator D510C offers several functions accessible by clicking on the button:

**Can Network
Configuration**

• [Expert mode] rotating diode bridge fault

Activate/deactivate the rotating diodes state supervision of exciter

In case of the supervision of activation of this feature, the « shutdown lexc » function must be also enabled.

• [Expert mode] Generator current limitation

Set this function

• [Expert mode] CAN network configuration

Enable CAN

Set the data transfer rate

Choose the regulator identifier

Select the broadcast protocol (J1939 and/or Owner CAN)

In the case of Owner CAN, choose the parameters to broadcast.

kVAR convention: when generator convention is selected then the kVAR is considered negative when generator is consuming reactive power and vice versa.

Kvar Convention

☒ Generator ☐ Network



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CAN Network configuration

Enabled Disabled



Data transfer Rate

1 Mb (L < 30m)

CAN activation delay (s)

0.0

IDD510C ID

144 0x90

☒ Broadcast parameters☐ Broadcast J1939

Broadcast sent parameters

Parameter 1

Generator frequency

Sending period (ms)

50

Parameter 2

Grid input voltage one phase

Parameter 3

trip state 1

Parameter 4

None

PC--> Option D510C

Option D510C -->PC

OK

Click on OK to validate the configuration

Nota: the key F10 doesn't allow to transfer the CAN parameters.

Nota: The selection « Broadcast J1939 » locks the transfer rate at 250Kb/s



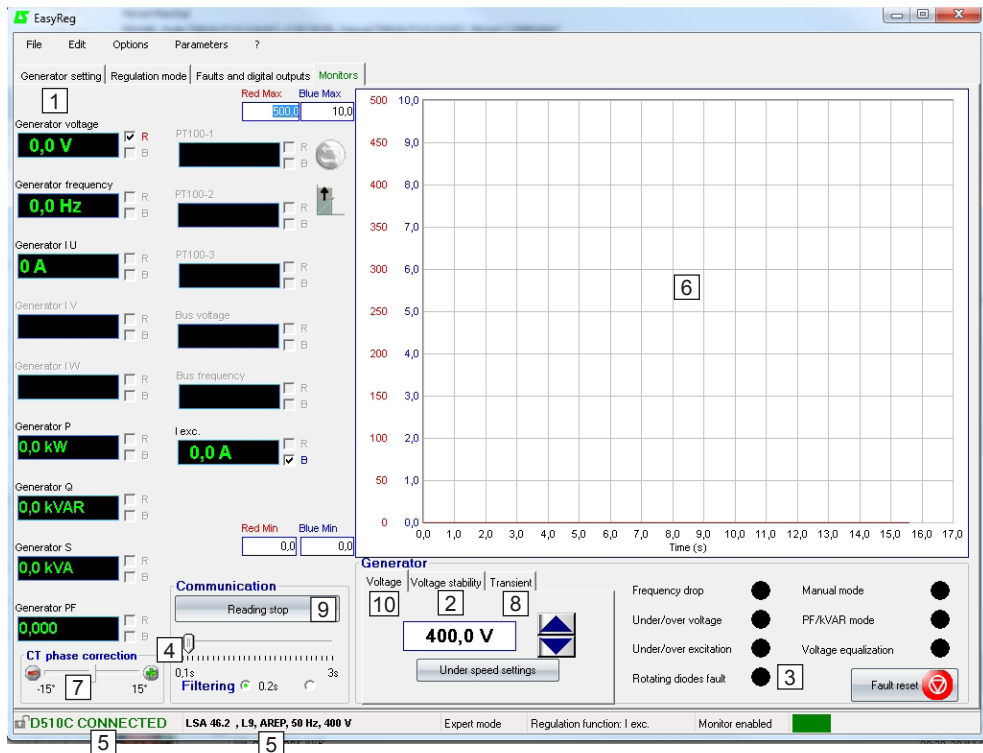
WARNING - CAN communication port (DB9) must not be connected while the D510C is energized.

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3.3.5 - Monitors

This page is only displayed when the AVR is connected to the computer. It consists of 15 digital control screens (voltage, frequency, current, etc), an analogue screen, 3 adjustment tabs (voltage, voltage stability and transient test) and displays the LED states.



1. The 15 windows display the alternator values compared to the enabled options.
By selecting 1 CT you can display: Alternator I U, Alternator P, Alternator Q, Alternator S, Alternator PF.
By selecting 3 CTs you can also display: Alternator I V, Alternator I W.
By selecting PT100 temperature sensors you can display: PT100-1, PT100-2, PT100-3.
2. Click this button to adjust the stability.
3. This part displays the LED status.
4. Click on the button «start reading» to display the values. The filtering parameters can also be set.

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5. These 2 indications show that the AVR is connected and its characteristics have been selected.

6. 2-signal display screen. Simply tick in one of the boxes (R or B) and set the scale (Max-Min).

7. The CT phase angle should be compensated to improve the accuracy of the display by moving the «CT phase angle correction» slider.

8. Transient test:  **Do not start this test if in load operation.**

- Click on «Transient test»,
- The test voltage level setting window appears,
- Enter the values, confirm, wait for the process to end.

Note: Set the minimum and maximum values within the range permitted by the generator voltage sensing device.

9. To start reading, click «Start reading». The filter value can be adjusted by 0.1 s to 3 s.

10. The voltage to track is displayed and can be adjusted thanks to the buttons  .

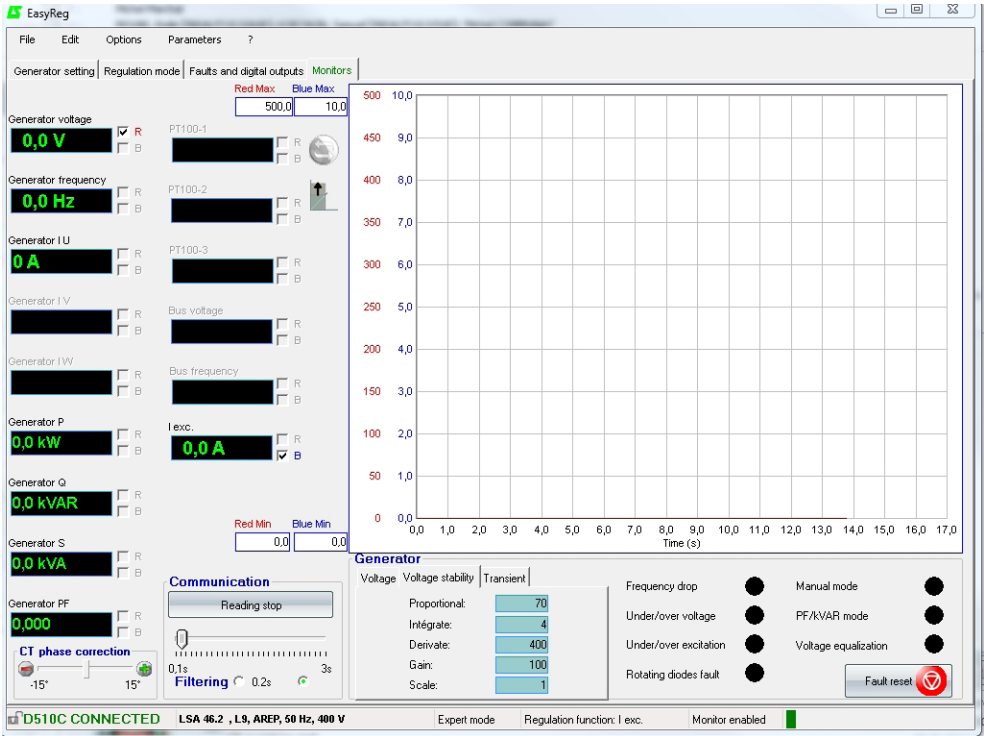
The setting of Underspeed is also directly accessible.

The approach is the same for the other regulation modes (PF, kVAR et Iexc)

Transient test


It is possible to configure a transient test in order to evaluate the regulation performances.


The Expert mode offers other functions.




[Expert mode] monitors

The graph is memorized using up to 150 000 sliding points.

It is possible to move the curve by clicking on the button  and by flying over the graph

[Expert mode] An auto-scale can be obtained by clicking on the button .

[Expert mode] Fault reset

It is possible to clear fault display by clicking on the button 

[Expert mode] PID

The digital potentiometer is replaced by the PID numerical values in READ/WRITE mode.

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Voltage	Voltage stability	Transient
Proportional:	<input type="text" value="54"/>	
Intégrate:	<input type="text" value="3"/>	
Derivate:	<input type="text" value="300"/>	
Gain:	<input type="text" value="100"/>	
Scale:	<input type="text" value="0"/>	

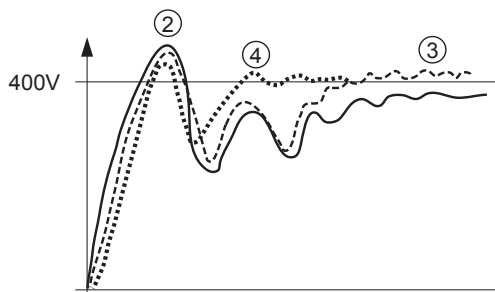


Warning: A wrong setting of the PID can damage the alternator.

PID setting methodology:

Please use Transient Test:

- ① Initial conditions:
 - Proportionnal = 10
 - Integral = 1
 - Derivative = 1
 - Gain = 10
 - Scale = 1
- ② Adjust the proportional part to obtain a response as given in the figure below.
- ③ Adjust the integral part to have the output voltage in steady states equal to desired voltage (reference voltage).
- ④ Adjust the derivative part to obtain response without oscillations.
- ⑤ Adjust the gain if necessary.
- ⑥ Change the scale value if the setting is unsuccessful and go back to step ②.



The table below summarises the effects which may be influenced by the PID actions.

PID controller	Effect
Proportional action	Speed
Integral action	Accuracy
Derivative action	Stability

3.4 - Configuration in customized mode

3.4.1 - Useful data

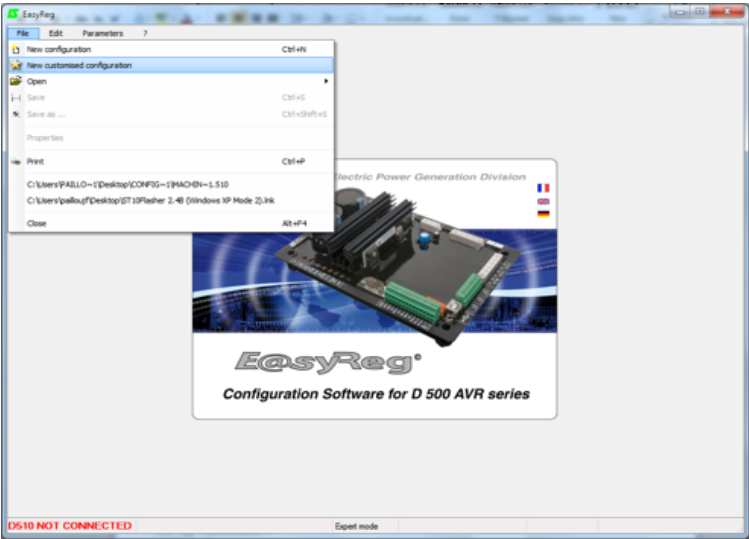
To create a file for customized configuration, you will need following data.

- Excitation:
 - type,
 - excitation current value at no load,
 - excitation current value at full load,
 - excitation current value on short circuit 3xIn,
 - exciter resistance.

- Machine:
 - machine rated power,
 - rated voltage,
 - frequency,
 - power factor,
 - PQ curve with the maximum power absorbed.
- Regulation:
 - values of voltage sensing PT,
 - value of the droop CT,
 - the possible additional configuration: push button, diodes default, follower on manual mode, etc.

3.4.2 - Creation of configuration file

On EasyReg®, go to « File » then « New customized configuration ».



A page, containing 2 tabs « Customized » and « Protections and limitations » appears: **all the values need to be filled in order to let the configuration being taken into account.**

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3.4.3 - Tab « Customize »

3.4.3.1 - Alternator part

- **Type Alternator:** 20 free characters, enter the type of the machine first.

Generator	
Generator model	LSA54 MZL 105 4P
Nominal voltage (V)	11 000
Nominal frequency (Hz)	50.0
Apperant power (kVA)	3 129
Field excitation system	AREP
Nominal field excitation current (A)	5.7
Field inductor resistance (Ohms)	6.50
PF Ref	0.80
Voltage sensing:	
<input checked="" type="checkbox"/> Single phase	
<input type="checkbox"/> Three phases	

- **Nominal voltage:** enter the nominal voltage of the machine.

- **Nominal frequency:** enter the nominal frequency of the machine.

- **Voltage sensing:** check “Single phase” or “Three phases” box.

- **Apparent power:** enter the nominal power of the machine.

- **PF Ref:** enter the nominal power factor of the machine.

- **Field excitation system:** choose the excitation type of the machine.

- **Nominal field excitation current:** enter the nominal field current value of the machine.

- **Field inductor resistance:** enter the exciter resistance value.

3.4.3.2 - Regulation

- This part is relative to different PID used for the machine.

Regulations			
	Voltage	PF	Iexc
Proportional	60	10	100
Integral	3	1	10
Derived	1 200	20	500
Gain	80	50	100
<input checked="" type="checkbox"/> Negative forcing			
<input checked="" type="checkbox"/> VBus compensation			
Scale of PID Gain			
1/1			

- **Voltage for this particular case:**

- Proportional: 60
- Integral: 3
- Derivative: 1200
- Gain: 80

- **PF and kVAR by default:**

- Proportional: 10
- Integral: 1
- Derivative: 20
- Gain: 50

- **Iexc by default:**

- Proportional: 100
- Integral: 10
- Derivative: 500
- Gain: 100

- Select also the negative forcing, the compensation VBus if needed.

- Reselect the scale of gains PID to 1/1 or 1/50 depending on the alternator size.

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3.4.4 - Tab « Protections and limitations »

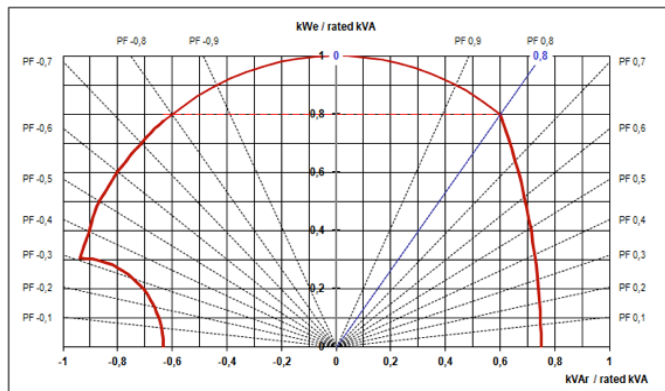
3.4.4.1 - General

- The page appears in two parts:
 - the left part is relative the values to enter by the user,
 - the right part shows the schematics corresponding to the adjustments.
- According to the limitation adjustments, a red arrow appears to allow a better understanding to what this configuration is corresponding.
- In the following figure, for example, the low limit for P.F instruction.



3.4.4.2 - Limitations and protections P.F. and kVar

- Use the Capability curve of the machine. In this case, we suppose that the following diagram is:



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In our case we can configure the values:

Limitations and protections

Leading PF limit	0.50
Lagging PF limit 1	0.75
Lagging PF limit 2	0.70
Leading KVAR limit (%)	60
Lagging KVAR limit 1 (%)	62
Lagging KVAR limit 2 (%)	65
Overvoltage level (%)	11
Delay (s)	10.0

- **Leading PF limit (min):** 0.5
- **Lagging PF limit 1 (max):** 0.75
- **Lagging PF limit 2 (max):** 0.70
- **Leading kVAR limit (%):** -60% (we can read « -0.6 » on kVAR/kVA of the diagram PQ)
- **Lagging kVAR limit 1 (%):** for power factor 0.75 : nearly « 0.62 », either 62%
- **Lagging kVAR limit 2 (%):** for power factor 0.70 : nearly « 0.65 », either 65%
- **Over voltage level:** 110%
- **Delay:** 10s

3.4.4.3 - Under-excitation Limitation

Under excitation limitations

lexc run limitation (A)	2.2
lexc reset limitation (A)	2.5
Under-excitation delay (s)	2.0

- This limitation is more sensible.
- **lexc run limitation (A):** it corresponds to the minimum value from which the limitation will enter in action.
- **lexc reset limitation (A):** value from which the limitation is not active anymore.
- **Under-excitation delay (s):** it must be very short such as 2s.

3.4.4.4 - Over-excitation Limitation

Over excitation limitations

lexc run limitation (A)	11.0
lexc reset limitation (A)	10.0
lexc shutdown (A)	0.5
lexc short-circuit (A)	0.4
Short-circuit delay (s)	5.0

- **lexc run limitation (A):** this corresponds to the highest value of the field current when ceiling in short-circuit.
- **lexc reset limitation (A):** this corresponds to the lowest value of the field current when ceiling in short-circuit.
- **lexc shutdown (A):** is the shutdown current.
- **lexc short-circuit (A):** excitation current value to reach the short-circuit.
- **Short-circuit delay (s):** adjusted à 10s.

Click on the “Next >>” button

The customized part of the configuration is done and the remaining settings are the same as described in the sections above.

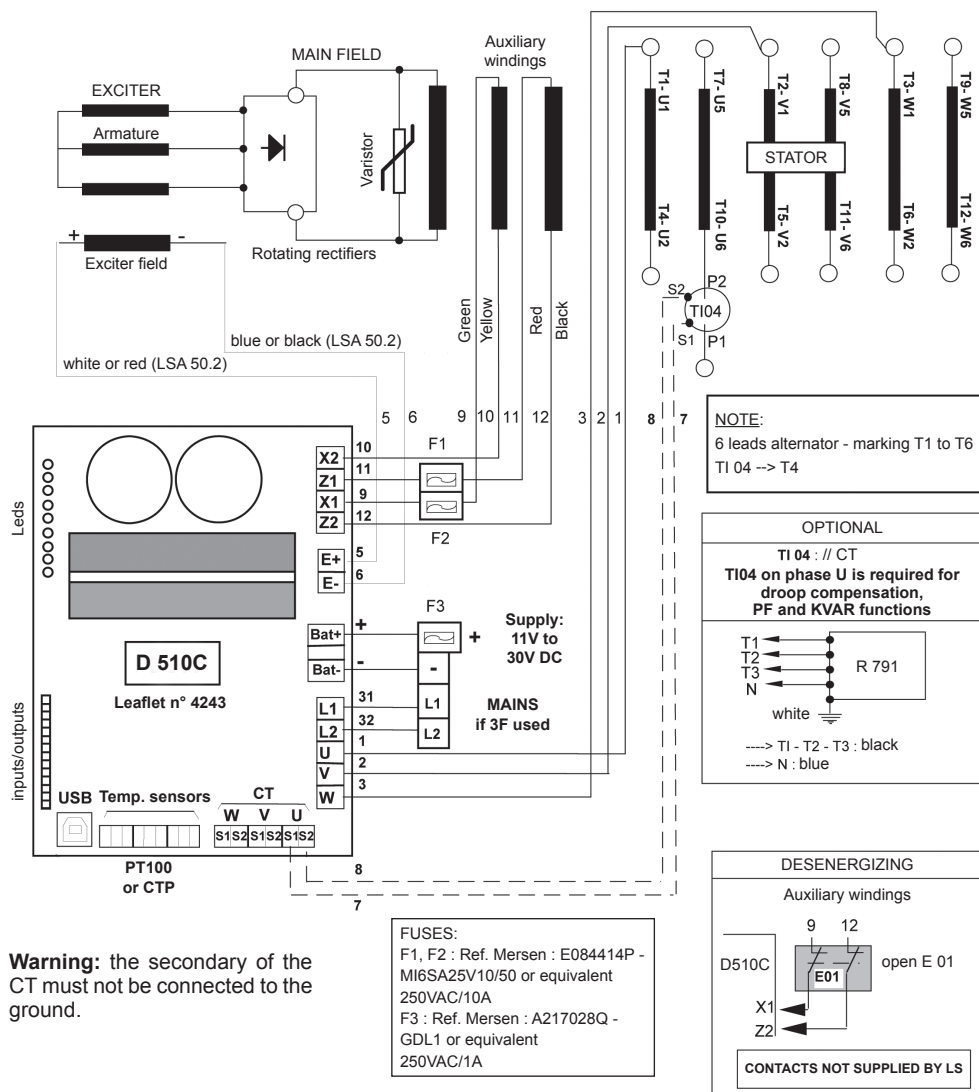
D510 C

A.V.R.

4 - CONNECTION DIAGRAMS

Digital AVR D510 C

Terminal block with fuses

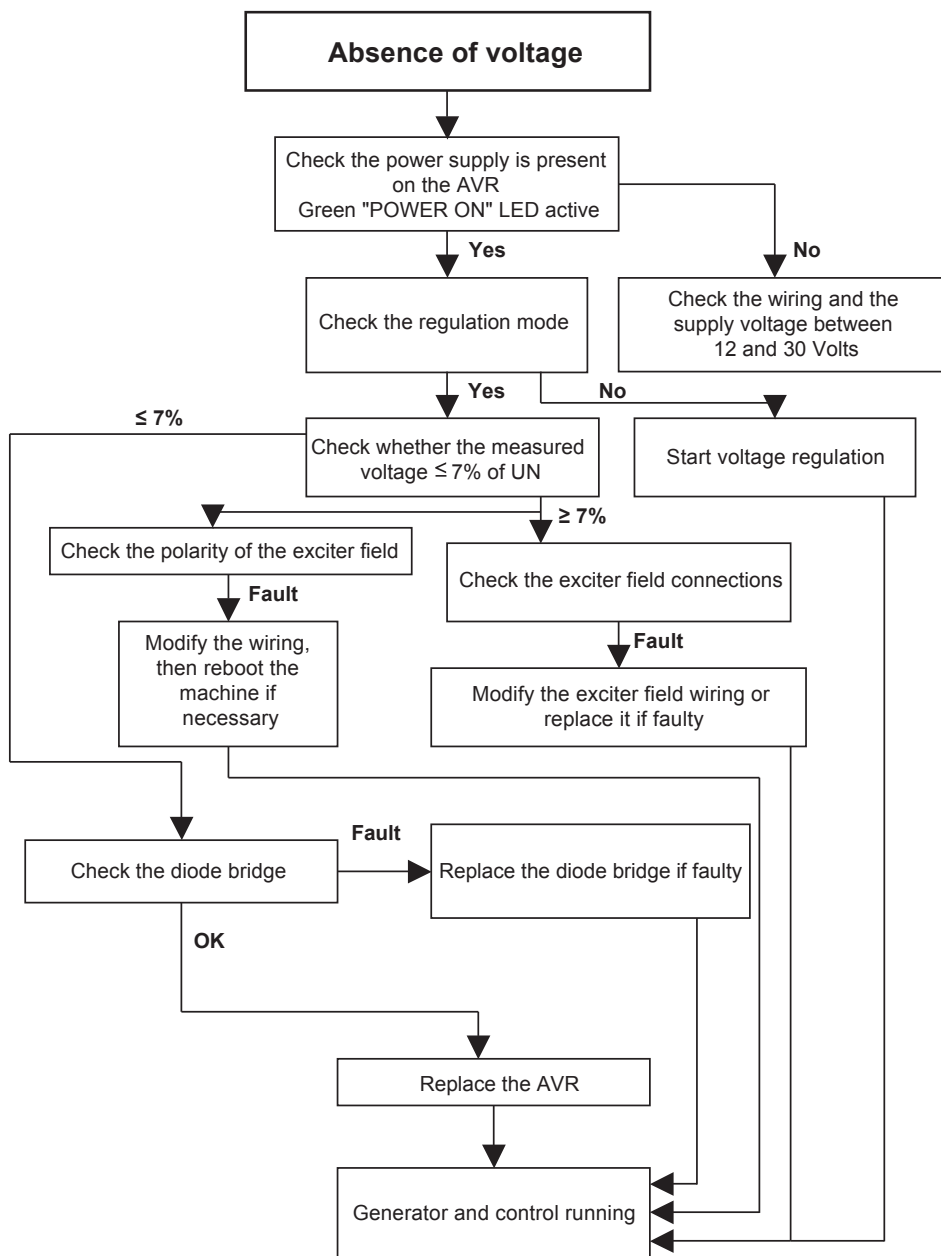


Warning: the secondary of the CT must not be connected to the ground.

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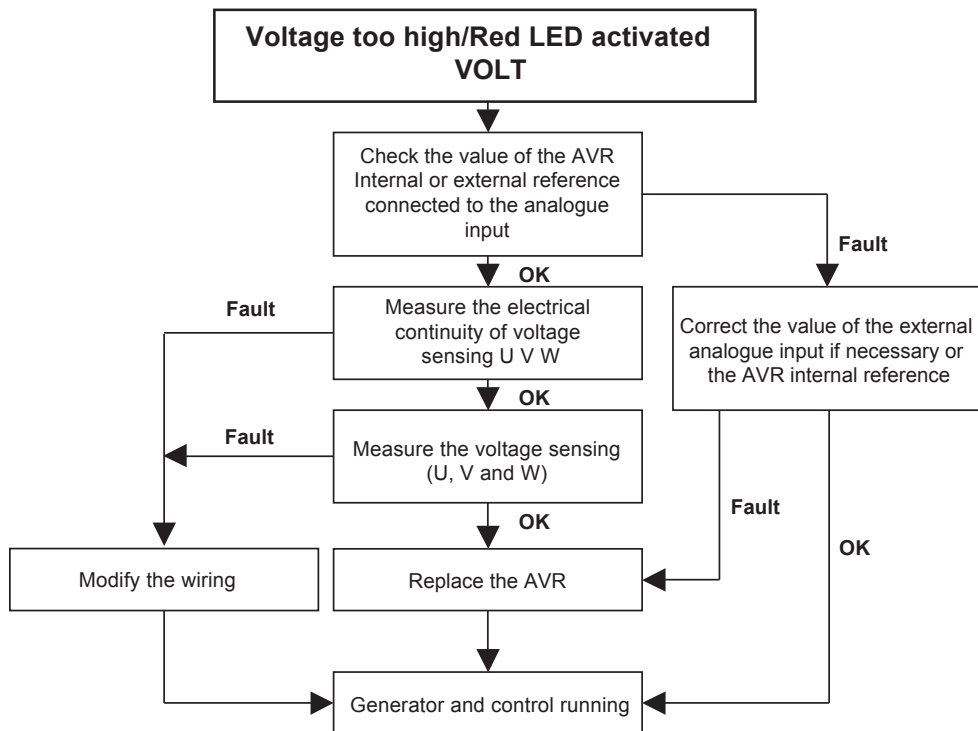
A.V.R.

5 - FAULT FLOW CHARTS



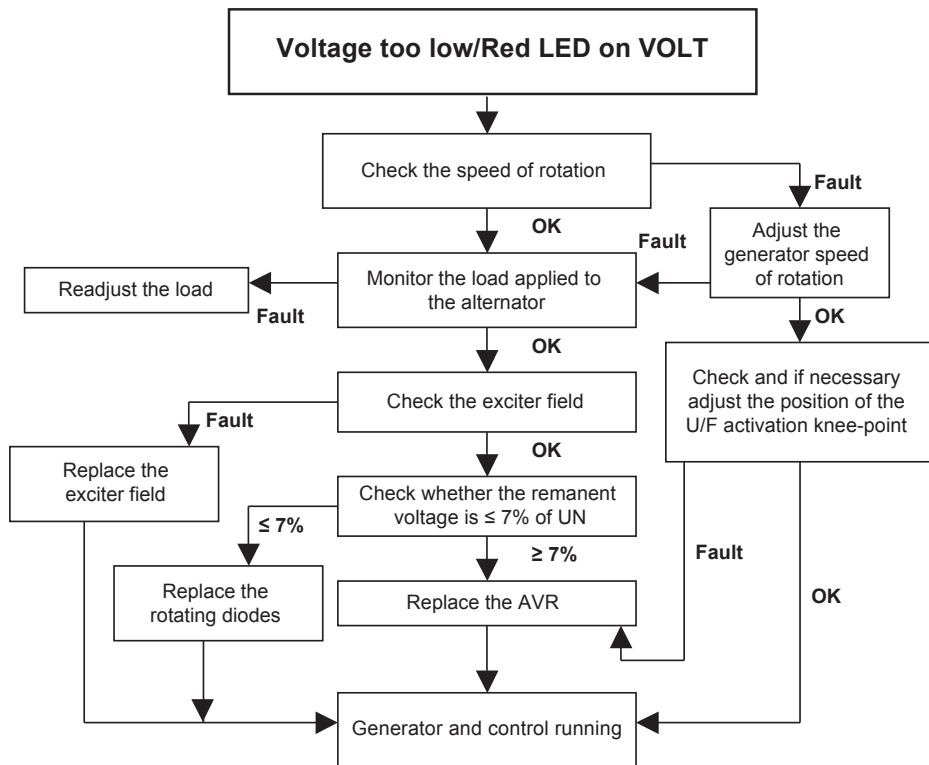
D510 C

A.V.R.



D510 C

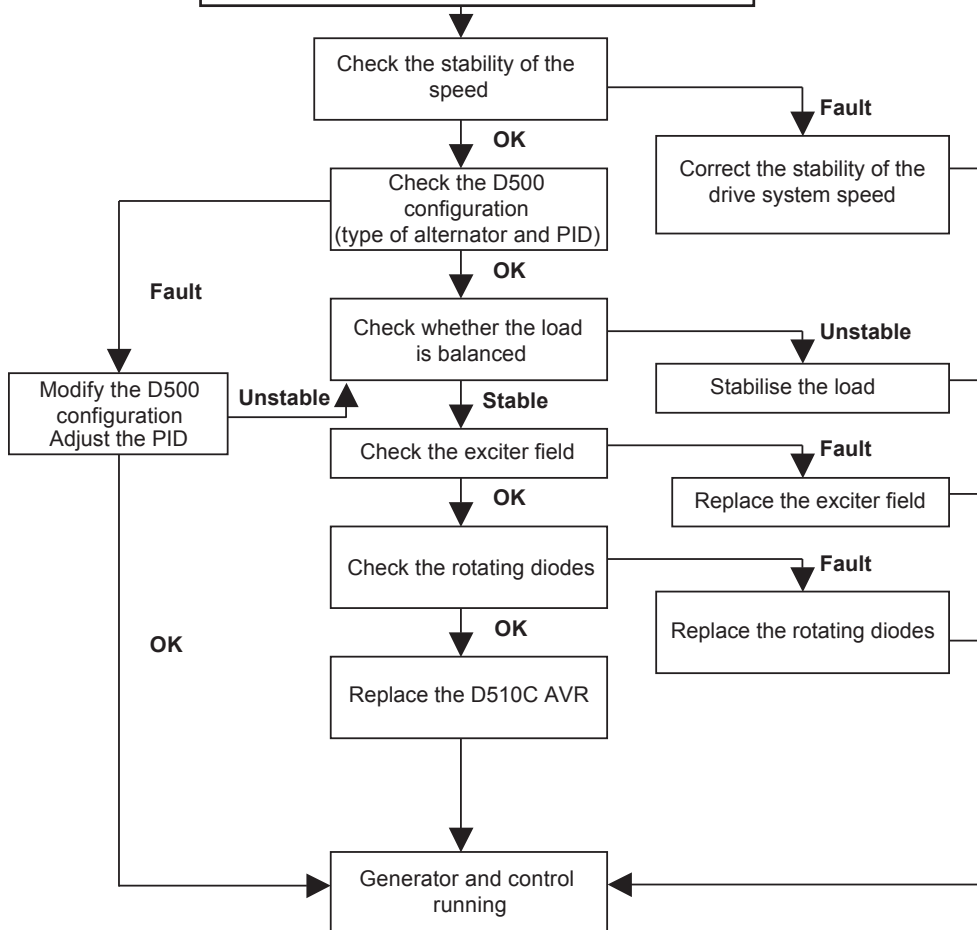
A.V.R.



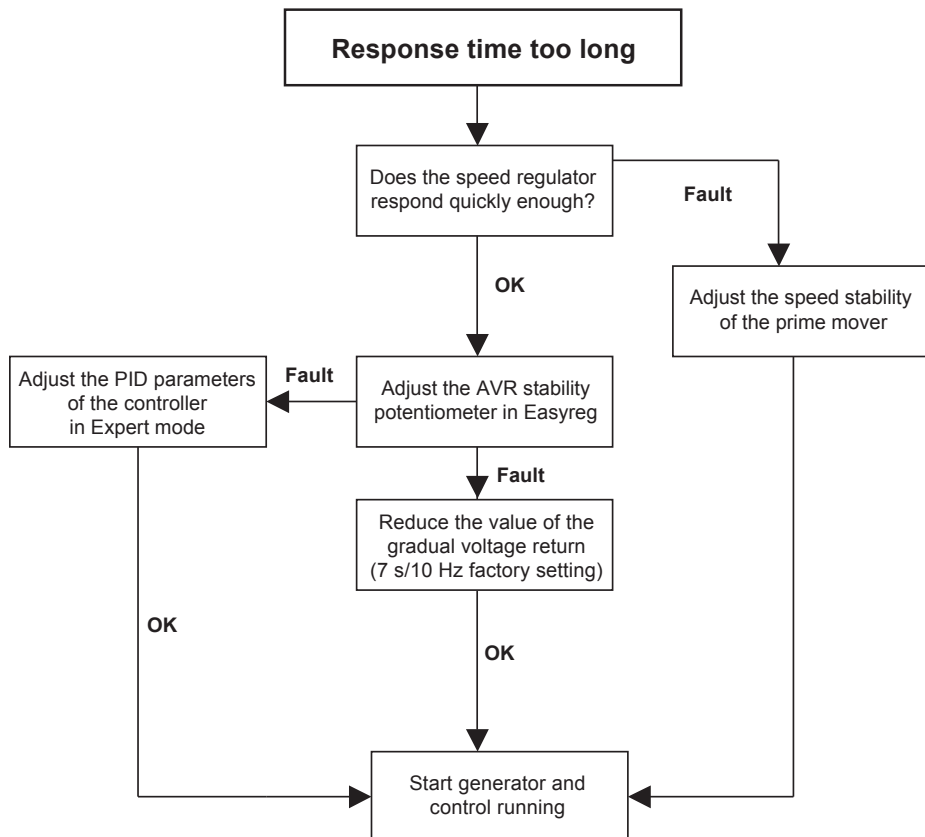
D510 C

A.V.R.

Incorrect regulation or Voltage unstable

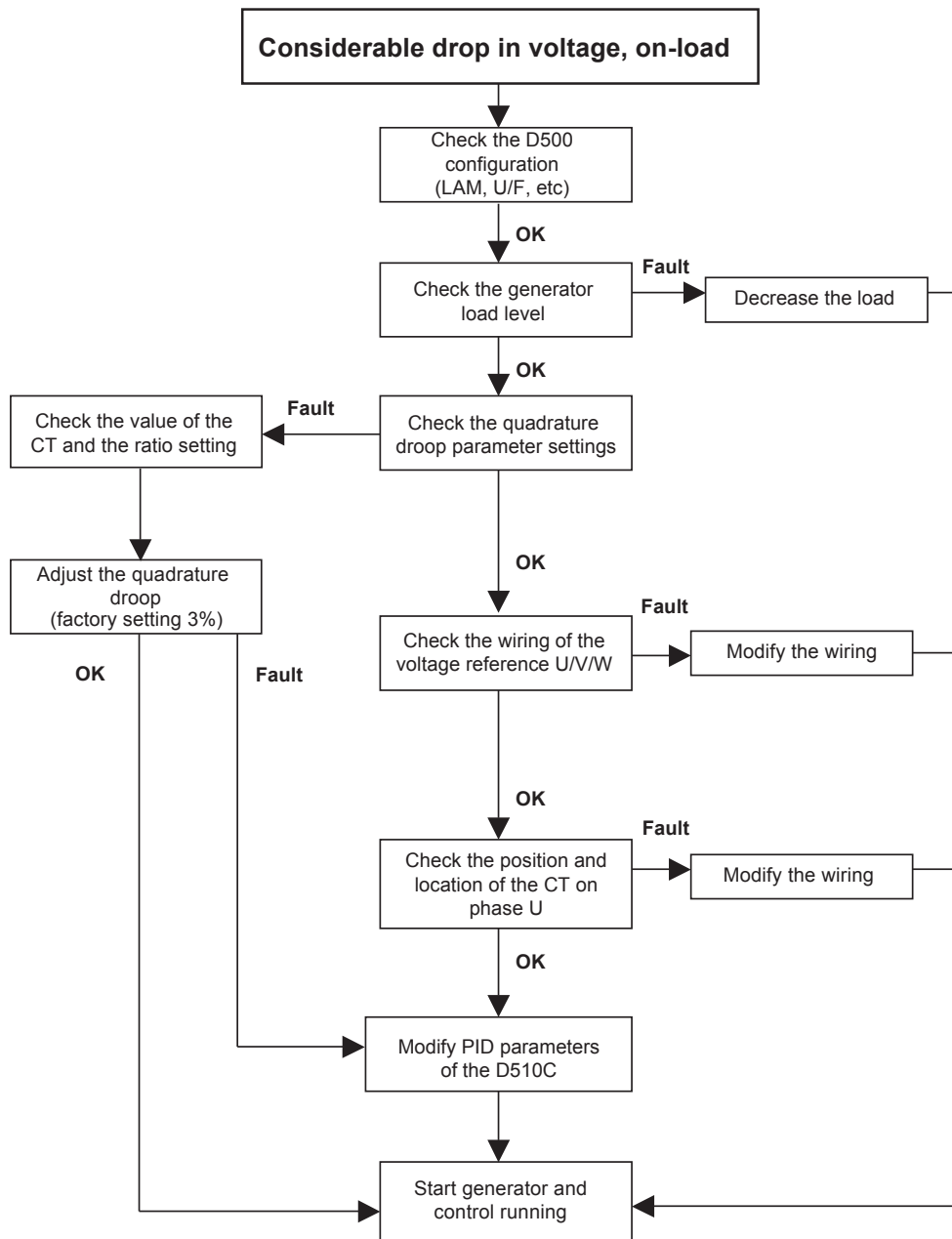


D510 C A.V.R.



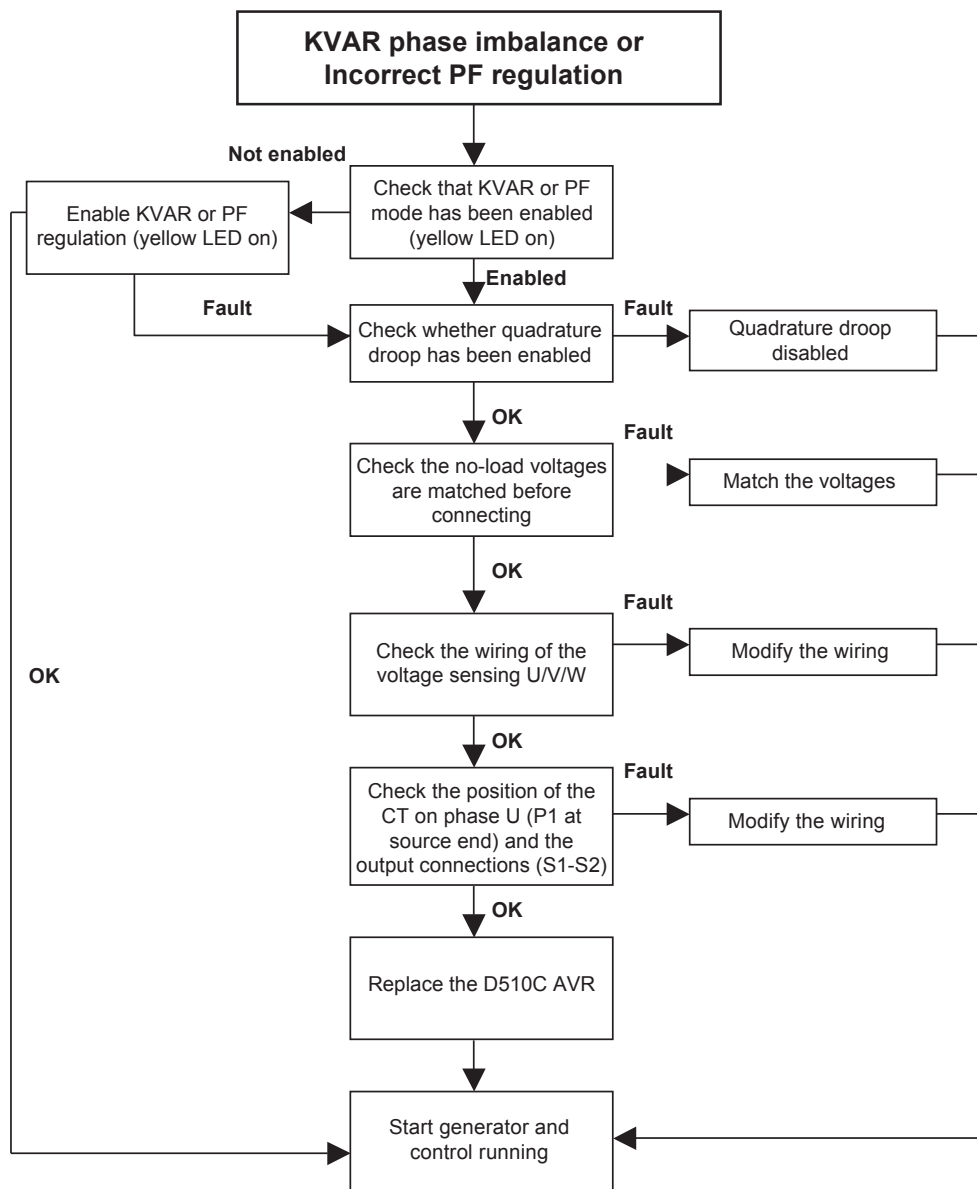
D510 C

A.V.R.

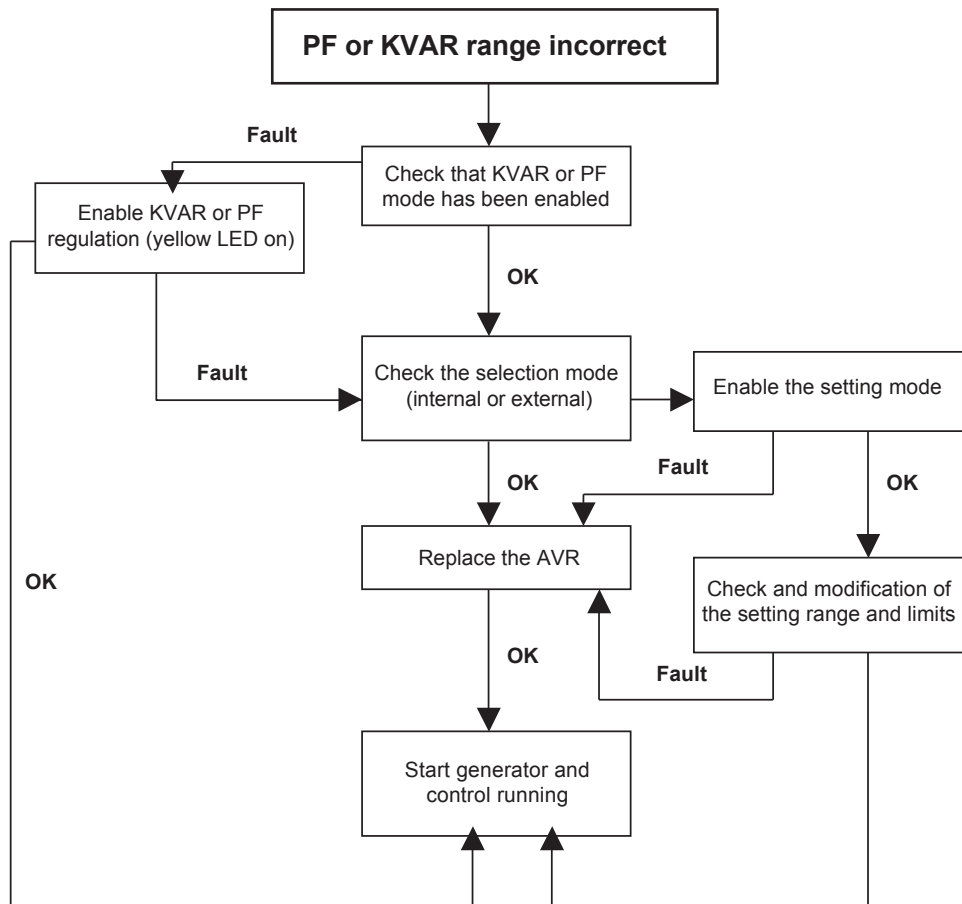


D510 C

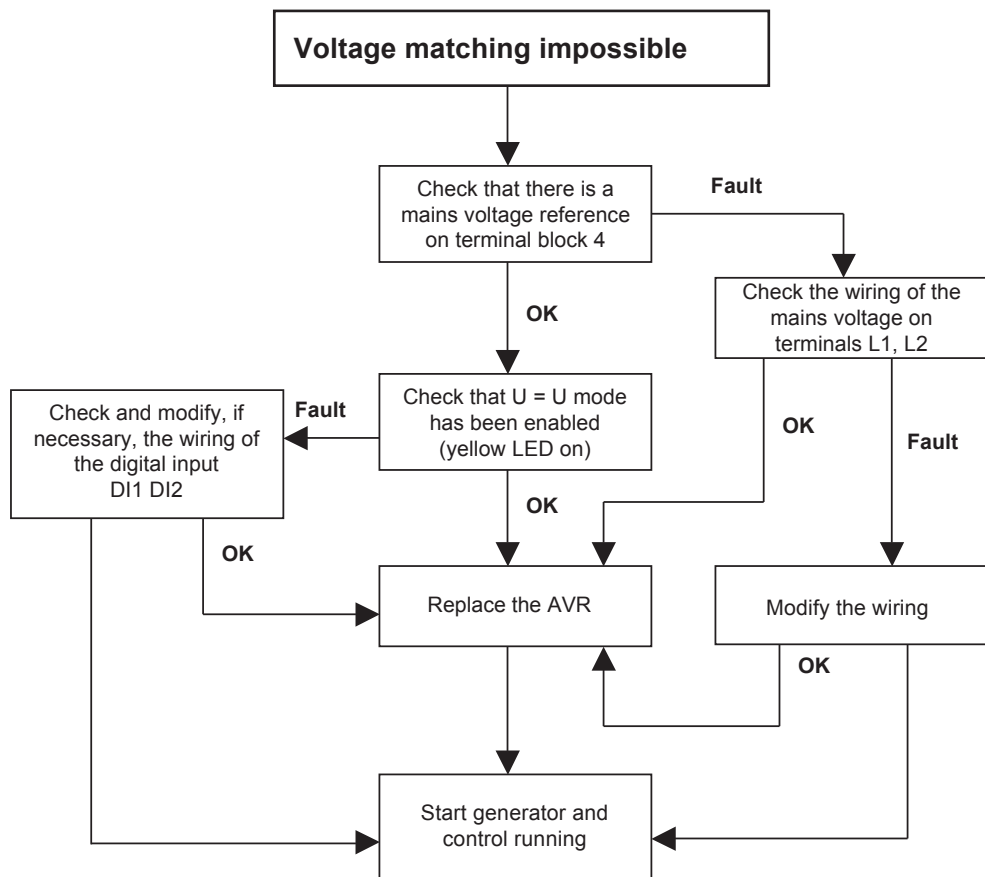
A.V.R.



D510 C A.V.R.



D510 C A.V.R.



D510 C A.V.R.

LED status

Green "POWER
ON" LED active

Board supplied with power

↓ Hz Red LED
on

Speed drop

↑ / ↓ Volt Red
LED on

Problem of overvoltage
or undervoltage

↑ / ↓ Exc Red
LED on

Problem of over-excitation
or under excitation

Manu yellow
LED on

Manual mode enabled

PF/KVAR
Yellow LED on

Regulation of the power
factor or reactive
power enabled

Manu Yellow
LED on

Alternator/mains
voltage matching

Blue USB
LED on

EasyReg software/
D510C communication

Electric Power Generation	Installation and maintenance	4243 en - 2015.11 / j
D510 C A.V.R.		

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