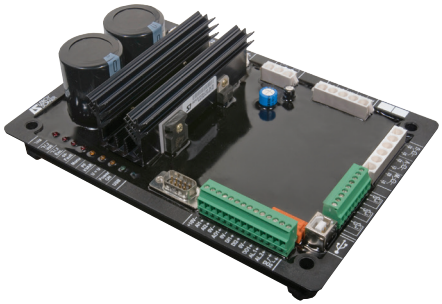
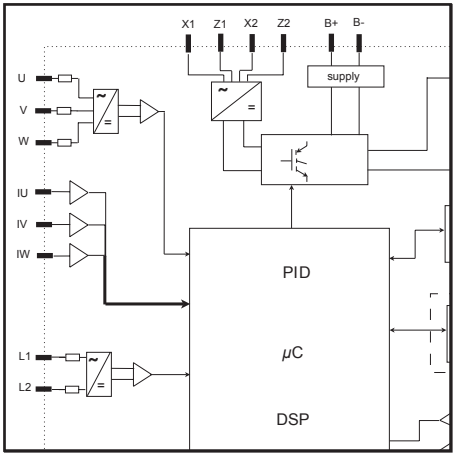
LEROY SOMER

4243 en - 2014.04 / g



This manual is to be given to the end user



D510 C

Automatic Voltage Regulators (AVRs)

Installation and maintenance

D510 C
Automatic Voltage Regulators (AVRs)

This manual concerns the alternator AVR which you have just purchased.

We wish to draw your attention to the contents of this maintenance manual. By following certain important points during installation, use and servicing of your alternator, you can look forward to many years of trouble-free operation.

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 interventions 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 various warning symbols used.

This AVR can be incorporated in a CE-marked machine.

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.

© - This document is the property of Moteurs Leroy-Somer, it can not be reproduced in any form without prior written authorization. Moteurs Leroy-Somer reserves the right to modify the design, technical specifications and dimensions of the products shown in this document. The descriptions cannot in any way be considered contractual.

D510 C
Automatic Voltage Regulators (AVRs)

CONTENTS

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.

New functionalities:

The table below describes the list of major changes on EasyReg 2.40 and the D510C firmware 1.30.

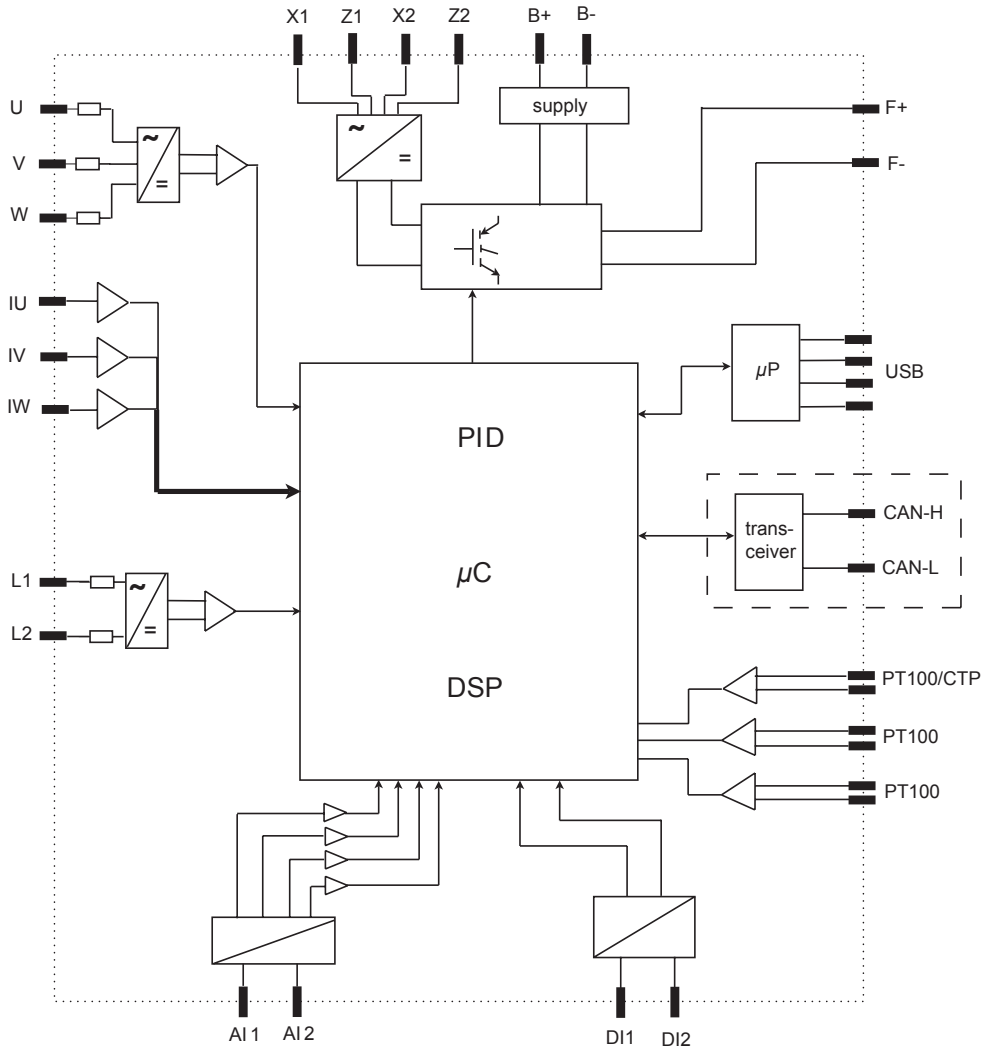
Softwares releases	Evolutions
EasyReg 2.40	Improvement of "transformer ratio" in Customized mode
	Modification of data import method
	Modification of the configuration windows
	Update of the alternators database
	Adding of a Step-up transformer
	Modification of the bus transformer
	Faults assignment through combo list
	Inhibition of mains voltage and frequency reading in regulation and manual mode
	Access to diodes fault and stator current limitation on the «Faults and digital outputs» tab when in Expert mode
Firmware 1.30	Improvement of the power calculation (kVAR, kW et kVA) when using J1939 messages
	Improvement of Power measurement accuracy
	Management of «BUS» and «Step-up» transformers
	Improvement of temperature measurement through PT100
	Adding of a parameter for lagging current (mainly for single phase applications)
	Modification of overvoltage fault detection method
	New management of stator current limitation: adding of a flag indicating the status of this function and protection against unexpected deactivation of the current limitation mode
	Improvement of the voltage and frequency measurement
	Adding of the possibility to reset the soft start function via the CAN communication regardless the D510C operation steps
	Using of the voltage transformer ratio for J1939 messages

D510 C
Automatic Voltage Regulators (AVRs)

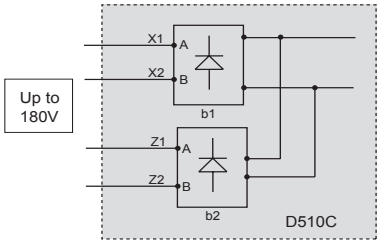
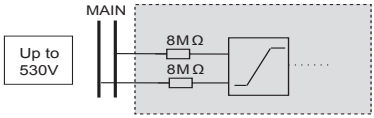
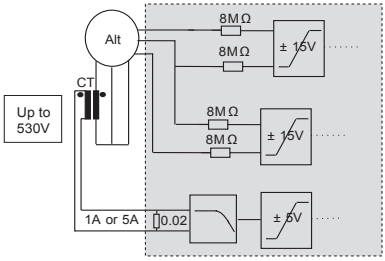
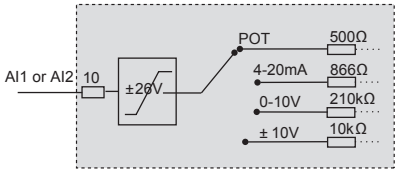
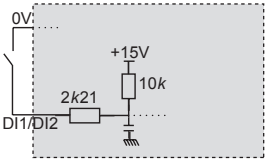
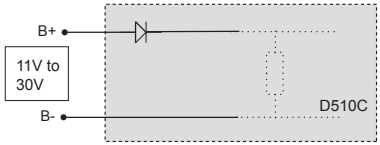
1 - PRESENTATION

1.1 - Operation

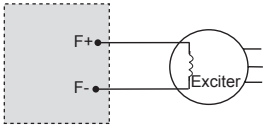
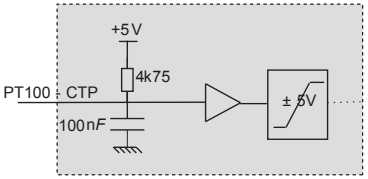
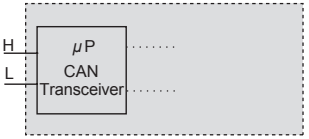
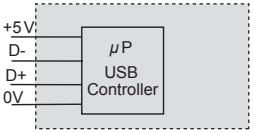
A schematic diagram of the D510C appears below.



D510 C
Automatic Voltage Regulators (AVRs)

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	

D510 C
Automatic Voltage Regulators (AVRs)

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

• **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).

⚠ **10A fast fuses externally mounted the D510C must be used in the three cases.**

• **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 temporised 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

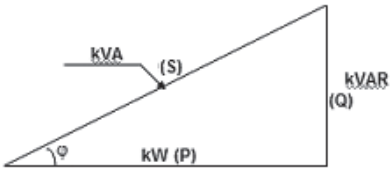
• **LEDs:** These light-emitting diodes inform the user whether the AVR is working correctly or not.

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 ($P = \sqrt{3}*U*I*\cos\varphi$) and the apparent power ($S = \sqrt{3}*U*I$).



- *Inductive P.F. [0; π/2]* means that the current is lagging behind the voltage. The load is inductive (induction motor, transformer, etc).
- *Capacitive P.F. [π/2; π]* 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 ($Q = \sqrt{3}*U*I*\sin\varphi$) 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	-

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 *P.F.*	-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	-
PT100 temperature threshold	50°C	200°C	-
PTC input	0%	100%	-

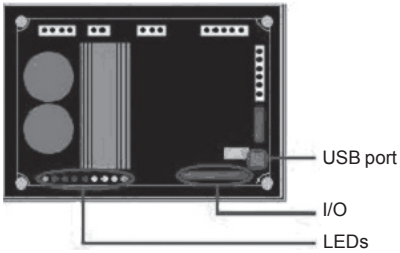
1.3.3 - Environments

Storage temperature : -55°C +85°C
Functioning temperature : -40°C +65°C

D510 C
Automatic Voltage Regulators (AVRs)

2 - HUMAN-MACHINE INTERFACE

The D510C human-machine interface consists of 3 elements:
- The USB link
- The I/O
- The LEDs



2.1 - Communication

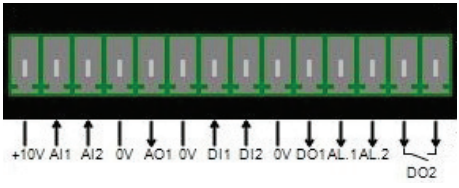
USB link

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

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

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,
- ± 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	Pull up input	To be connected to 0V
DI_2		
DO_1	Opened collector	Max current: 60mA Voltage: 0 - 24V
DO_2	Dry contact	6A, 30Vdc/250V AC (on resistor)
AL_1	Opened collector	Max current: 60mA Voltage: 0 - 24V
AL_2		

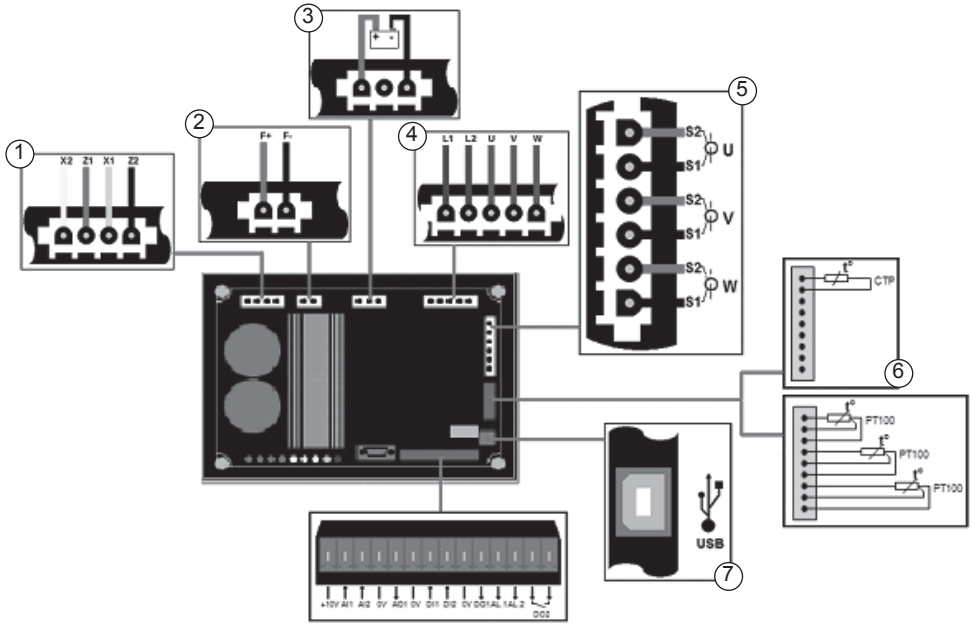
2.4 - LEDs

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

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

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.

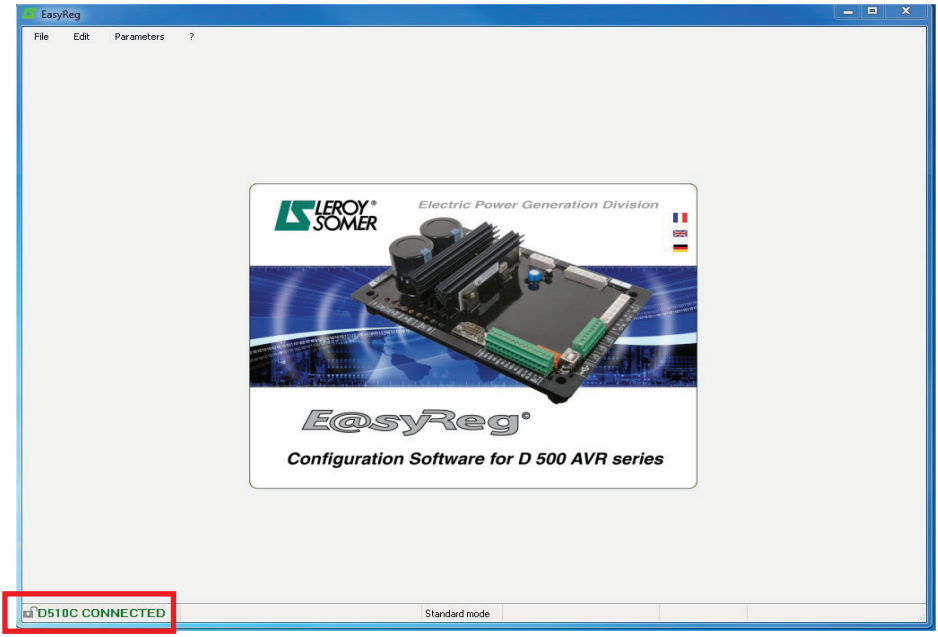
3.2 - Startup

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

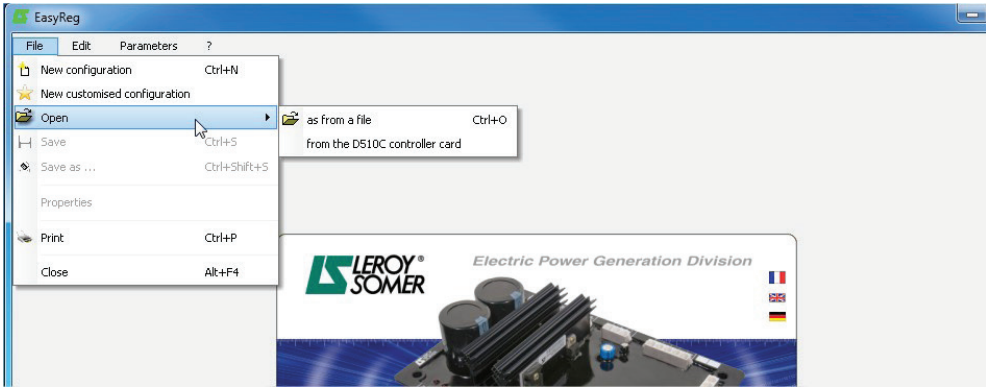
To start the software, go to «Start», «Programs» then «EasyReg».

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.



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

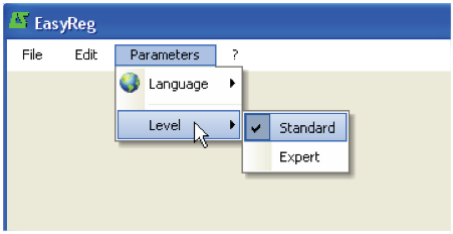
3.3.1.1 - Languages

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

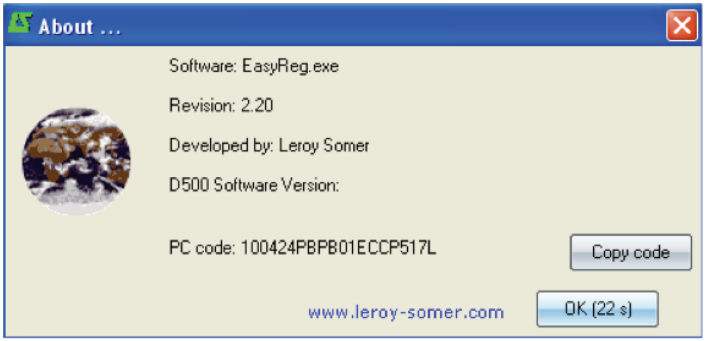
3.3.1.2 - Modes

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.

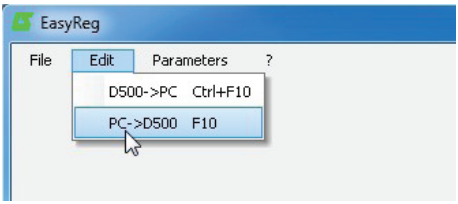
⚠ **Incorrect settings can harm the AVR and the alternator and can cause serious damage (to users, loads)**. Select the duty type and the class according to your specification.

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».

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.



3.3.3 - New configuration

There are two possible configuration levels: standard or expert.

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.

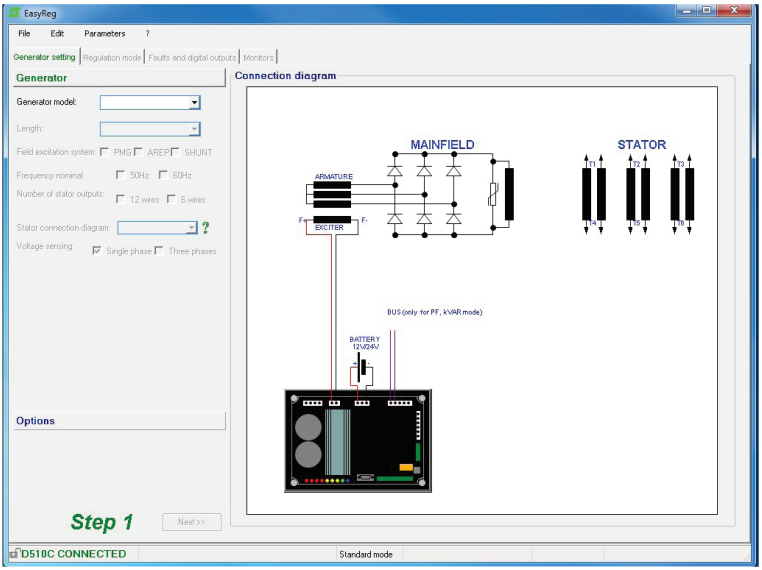
This software must be used in the order indicated below:

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

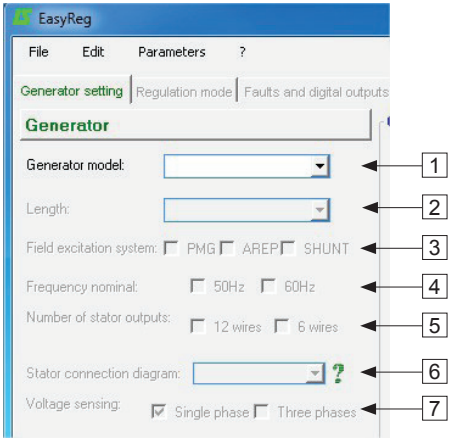
3.3.3.1 - Alternator Configuration

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.



• **Alternator**



In the dropdown lists or boxes, select:

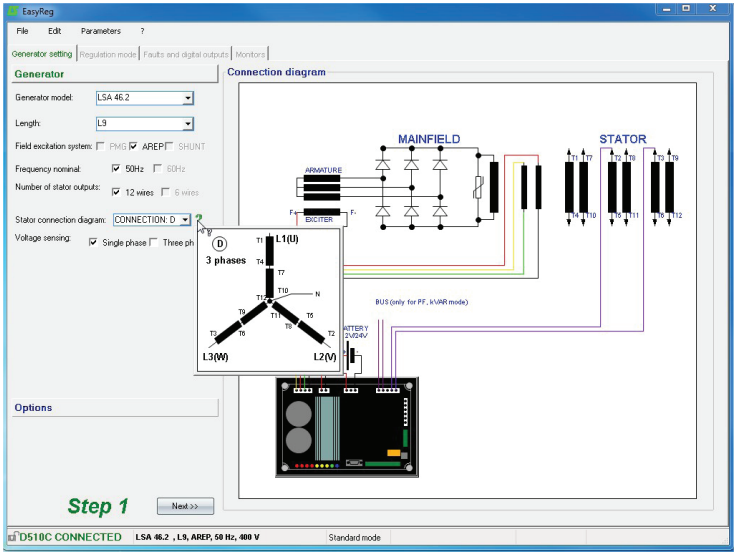
1. The **type of alternator**
2. The **length**
3. The **type of field excitation**
4. The **frequency**
5. The **number of stator outputs**
6. The **stator connections**
7. The **voltage sensing (single or three-phase)**

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.

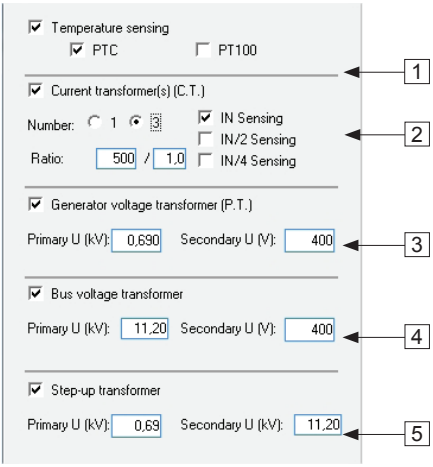
Stator connections: Click on the question mark to get help on the stator connections.



The alternator configuration is recalled at the screen left bottom

D510 C
Automatic Voltage Regulators (AVRs)

• Options



To obtain the following options, tick the boxes:

1. **Temperature sensors**, select either 1 PTC or 3 PT100s.

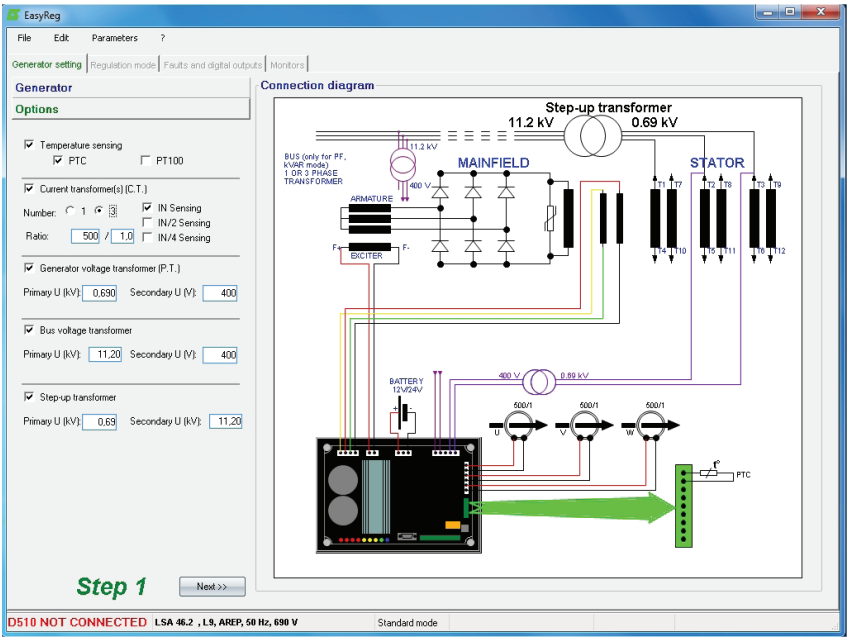
2. **Current transformers (CTs)**, select the number (1 or 3), the measurement (IN, IN/2 or IN/4) and the ratio. unless one CT is mandatory for parallel operation, PF or kVAR regulation, stator over current, unbalenced current.

3. **Alternator voltage transformer**, enter the voltage values at the primary and at the secondary if a transformer is connected..

4. **Bus voltage transformer**, enter the voltage values at the primary and at the secondary if a transformer is connected.

5. **Step-up transformer**, fill the values of primary and the secondary.

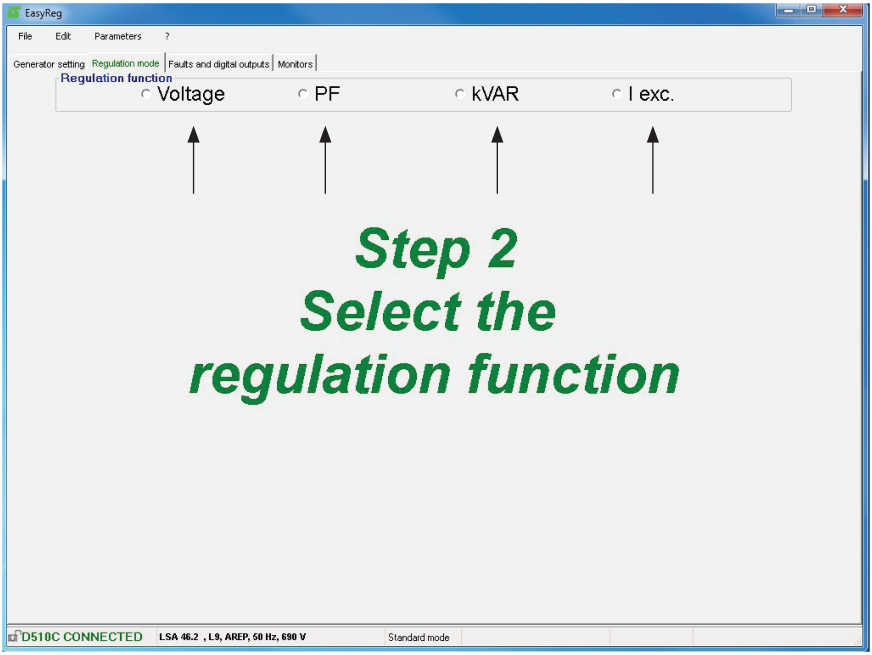
The electrical schematic below shows how the «wiring scheme» part changes according to the parameters selected.



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.

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 :

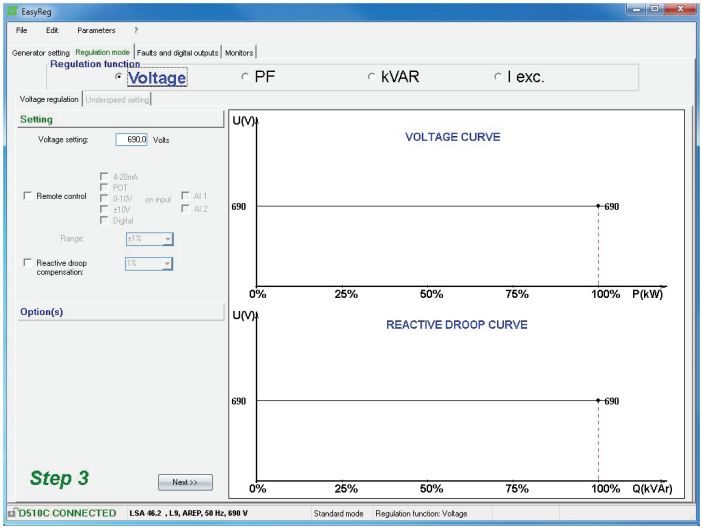
- Voltage Regulation

- Underspeed settings

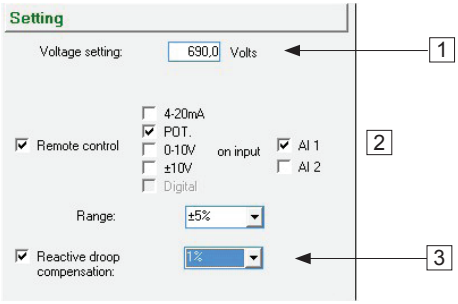
Setting the parameters for this part starts with the «Voltage regulation» page and ends with the «Underspeed settings» page.

A1 - Voltage regulation

This page is split into two parts:
- Settings
- Options



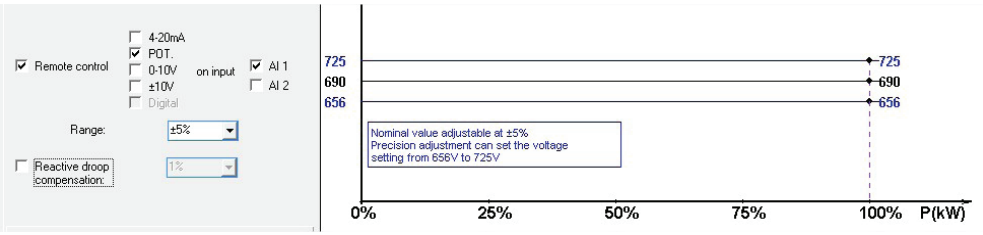
A1.1 - Settings



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

Expert Mode: The adjustment range can be extended to ± 30%

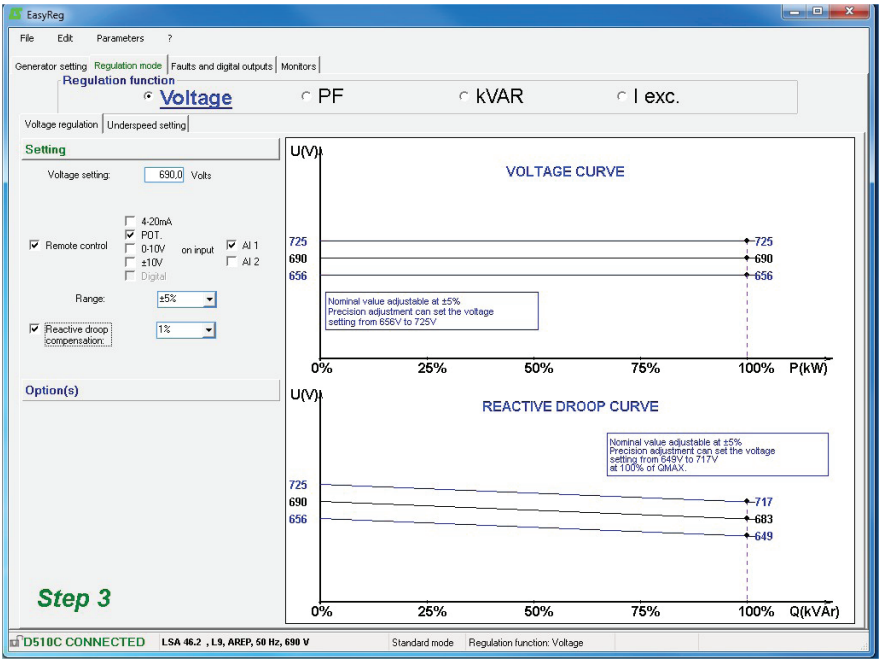
2. To set the voltage externally, tick the box, define by what means (POT, 0-10 V, etc) this setting will be made as well as the selected input (AI1 or AI2), then enter the desired setting range.



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.

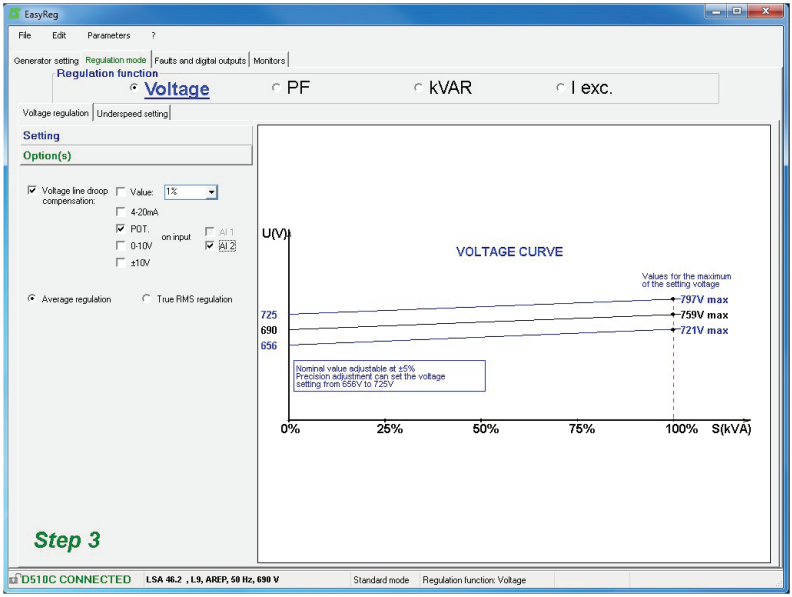
3. If you wish to have voltage quadrature droop, tick the box and select the quadrature droop percentage.

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

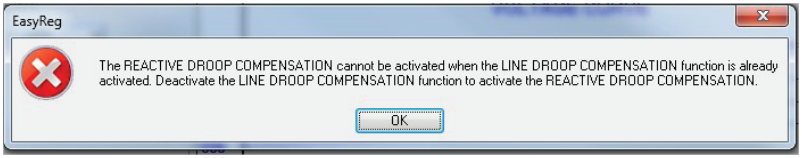


A1.2 - Options

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 droop compensation » cannot be simultaneously activated with «reactive droop compensation».

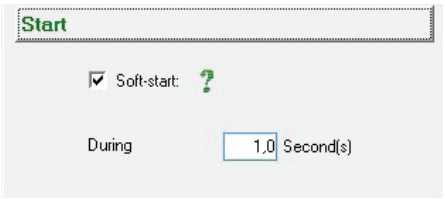


It is possible to impose the desired compensation by direct entry of the % value or make an external adjustment (10% max
2. Select which value regulation should apply to :
- mean value
- true rms value
To go to the next step «*Underspeed settings*», click «Next».

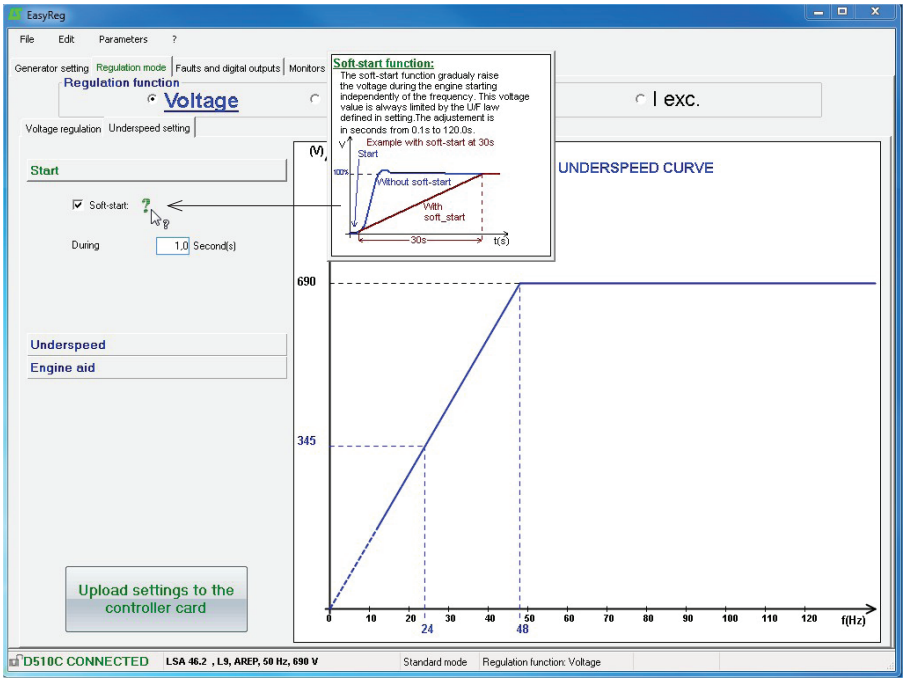
A2 - Underspeed settings

This page is split into three parts:
- Starting
- Underspeed
- Engine

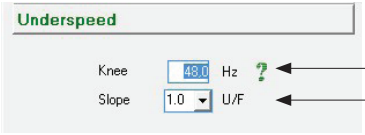
A2.1 - Starting



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.

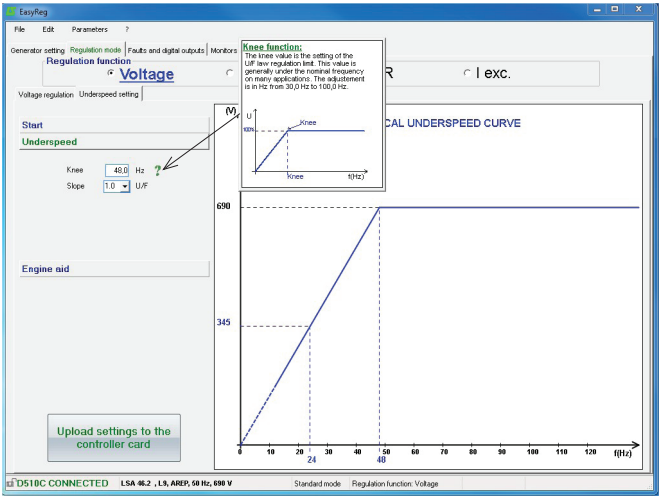


A2.2 - Underspeed

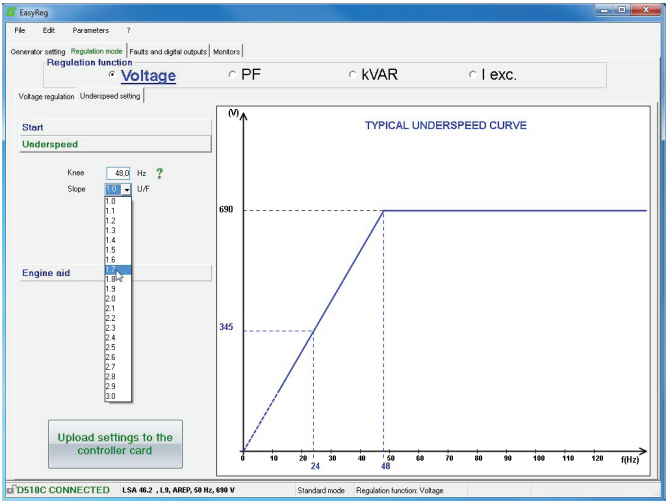


Factory setting: 48 Hz for 50 Hz
58 Hz for 60 Hz

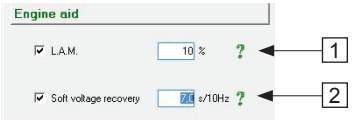
1. Enter the knee-point value between 47.5 and 52.5 Hz (1 step = 0.1 Hz). An error message appears when the value displayed is outside the permitted range. The extended range is accessible in expert mode.



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

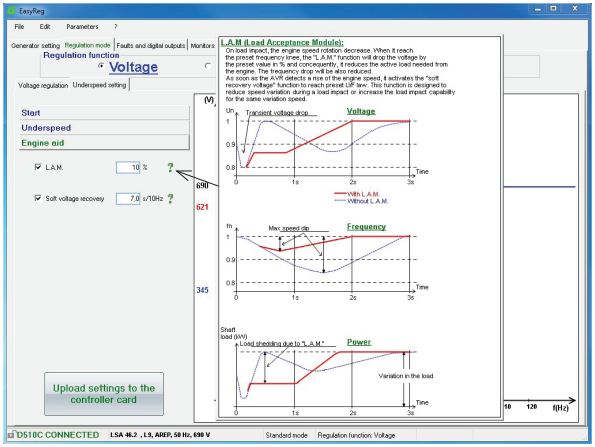


A2.3 - Motor help

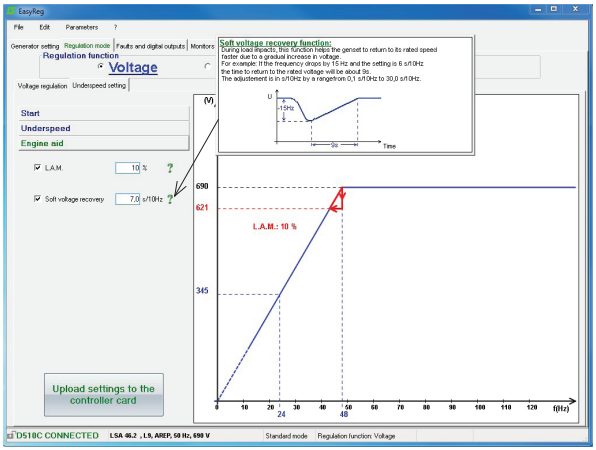


1. If the LAM function is required, tick the box and select its value between 0% and 30% (1 step = 1%).

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

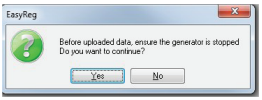
Save (see section 3, «Save» part).

Load the configuration in the regulator :

- By clicking on the button 

- Or by using the key F10
- Or PC→D500 in « Edition » menu

Then a warning message is displayed.

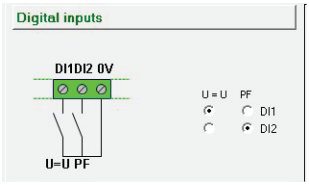


B - Regulation of the power factor

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

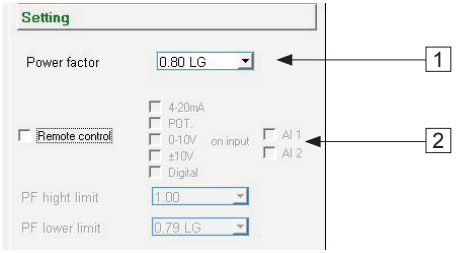
B1 - Digital inputs



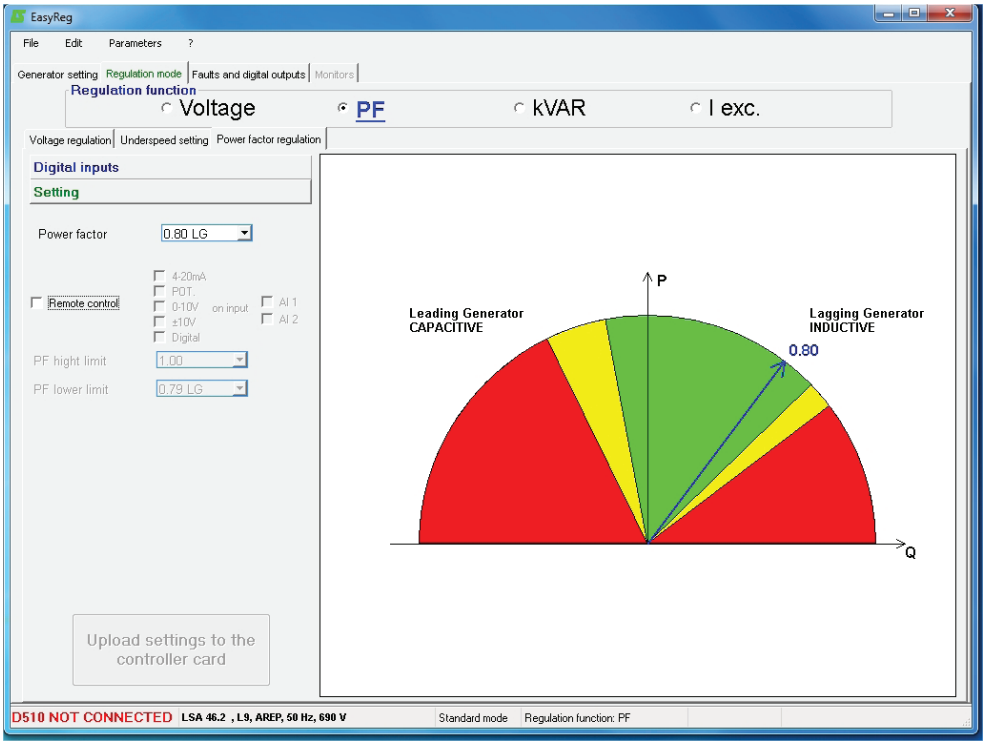
Check the digital input on which the voltage match circuit has been placed in order to enable it.
The second digital input is reserved for enabling power factor regulation mode.

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.



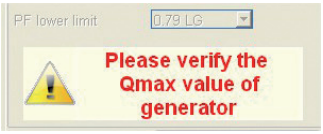
Database Authorized area

Database not recommended area

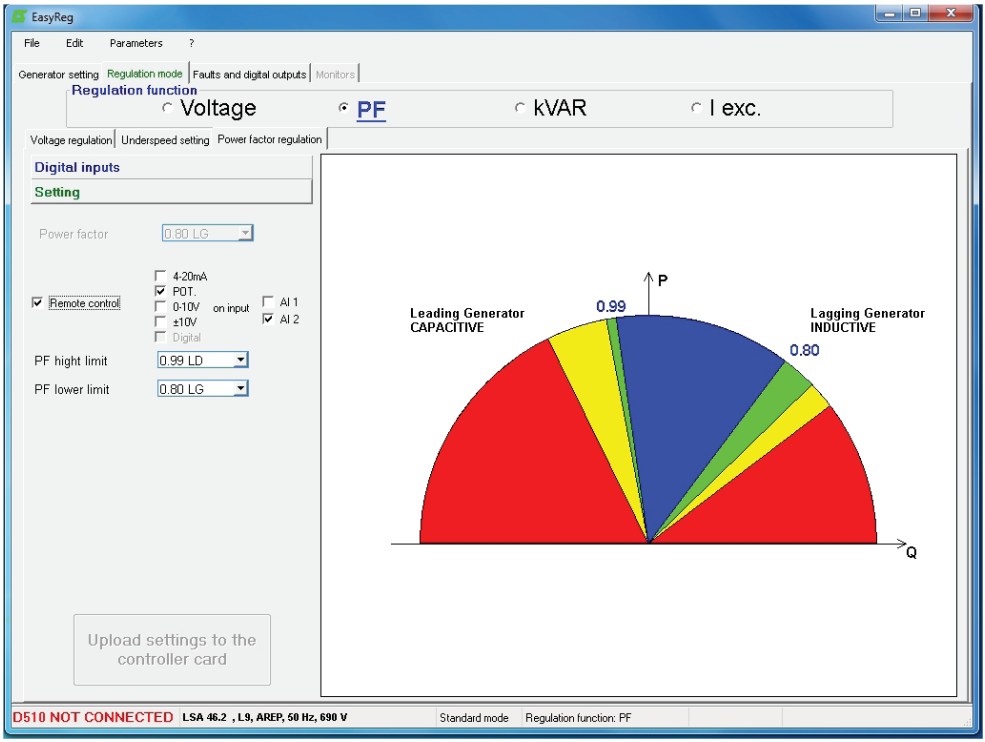
Forbidden area

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.



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

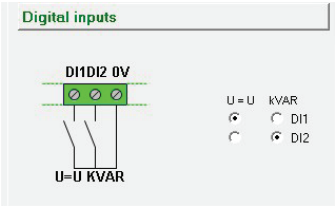
Save (see section 3, «Save» section).
Load the settings into the AVR by clicking the following button : Upload settings to the controller card

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.

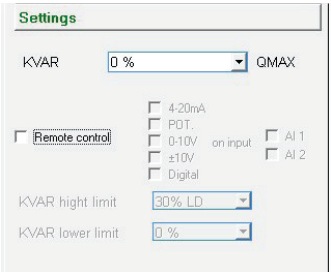
This page is split into two parts:
- Digital inputs
- Settings

C1 - Digital inputs



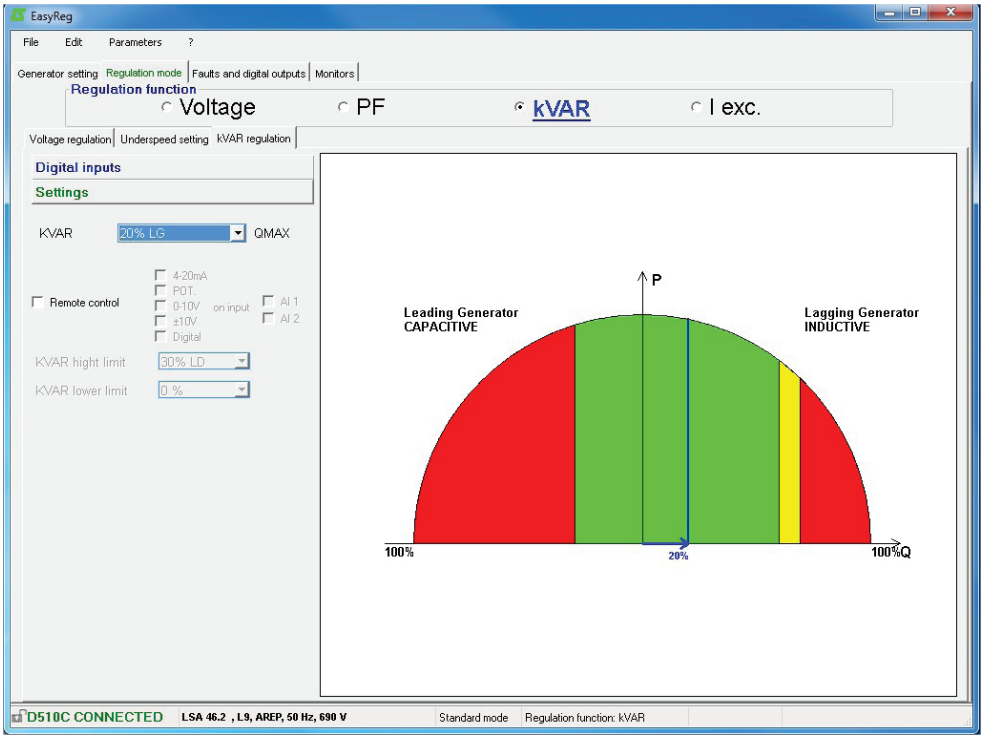
Check the digital input on which the voltage match circuit has been placed in order to enable it.
The second digital input is reserved for enabling reactive power regulation mode.

C2 - Settings



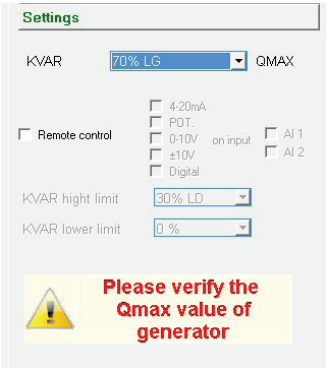
Select the value of the reactive power according to the load. This value depends on the alternator type.

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

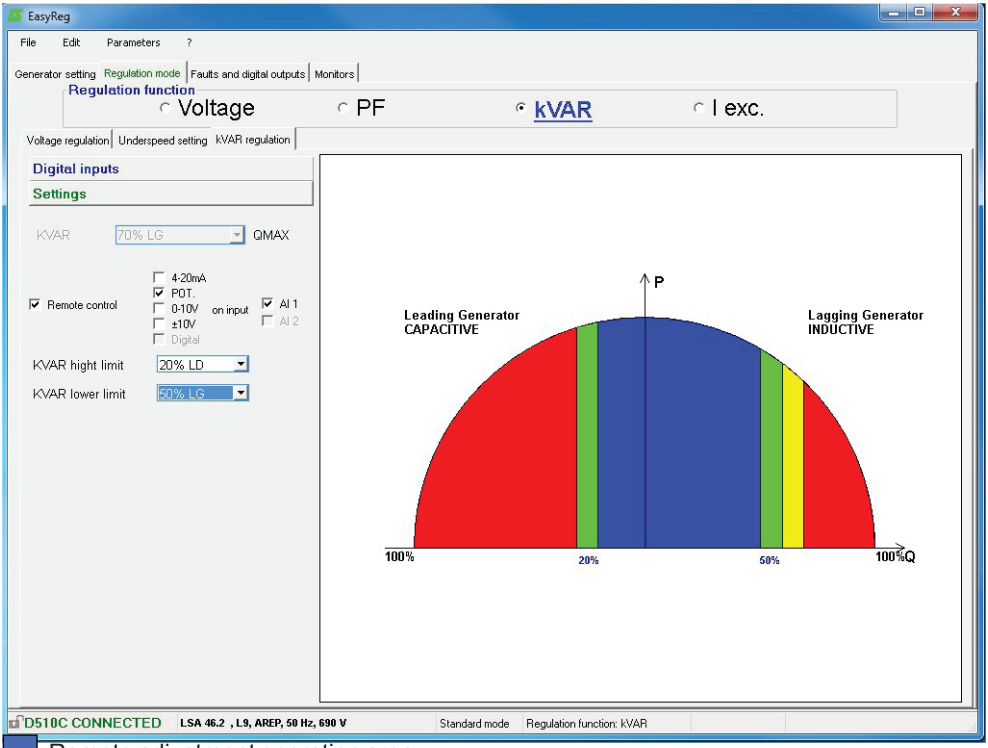


Database Authorized area | Database not recommended area | Forbidden area

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



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).

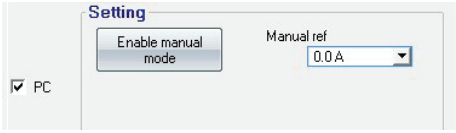
Load the settings into the AVR by clicking the appropriate button: Upload settings to the controller card

D - Manual regulation: I exc

This page is split into three parts:
- PC (settings)
- External control
- Follower mode

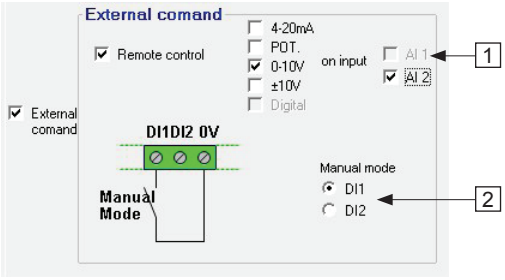
The manual mode can be activated and adjusted either with the PC (via EasyReg software) or remotely. In that last case, a switch allowing the activation/ deactivation of the manual mode must be connected to one of the digital inputs and the excitation current setting is achieved by the remote analogue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

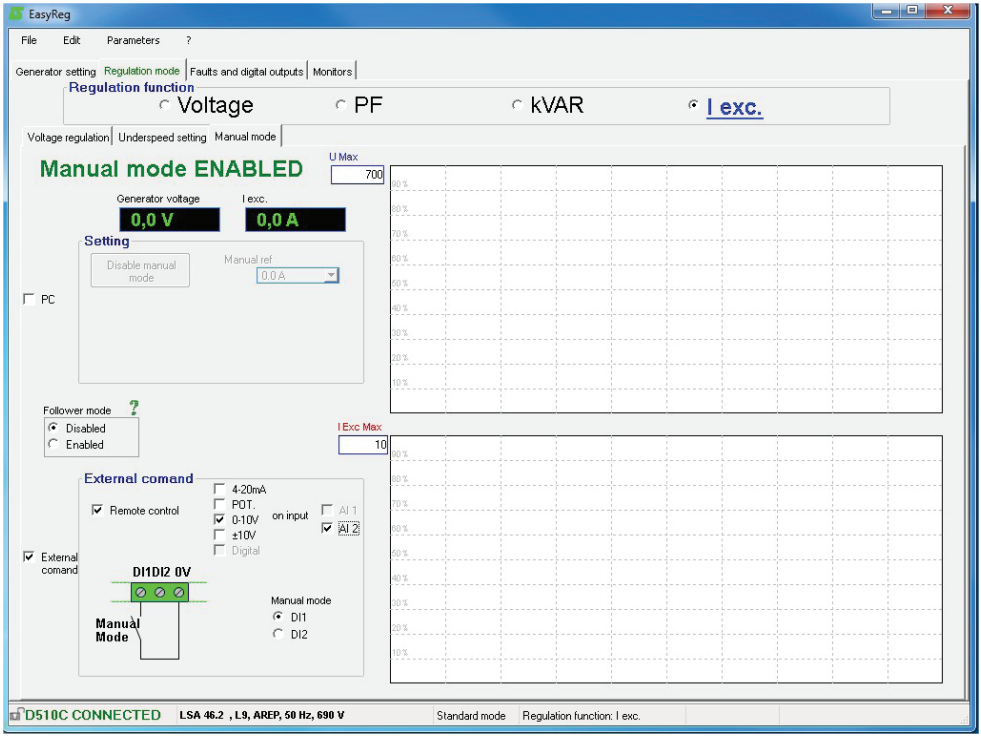


1. To set the excitation current externally, tick the box, select the source (POT, 0-10 V, etc) for this setting and also the input (AI1 or AI2). One of the inputs may be greyed-out if it is already being used by another function.

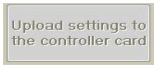
2. Check the digital input on which manual mode has been placed in order to activate it.

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 cirrent measurement before the switching.



Save (see section 3, «Save» part).

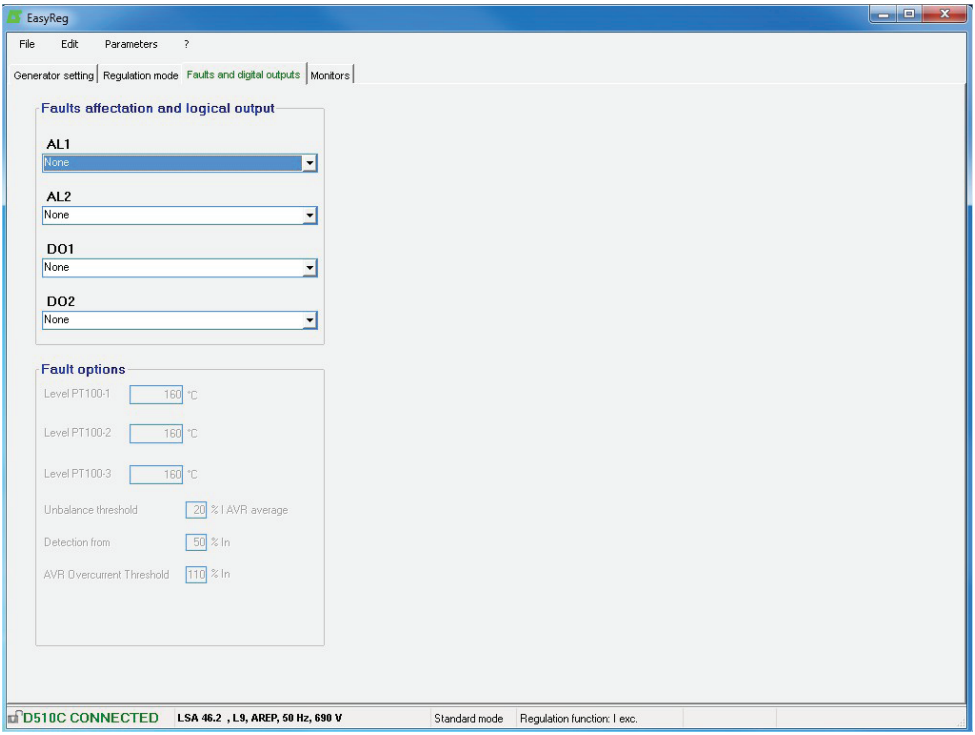
Load the settings into the AVR by clicking the button : 

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.



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, D01 and D02).

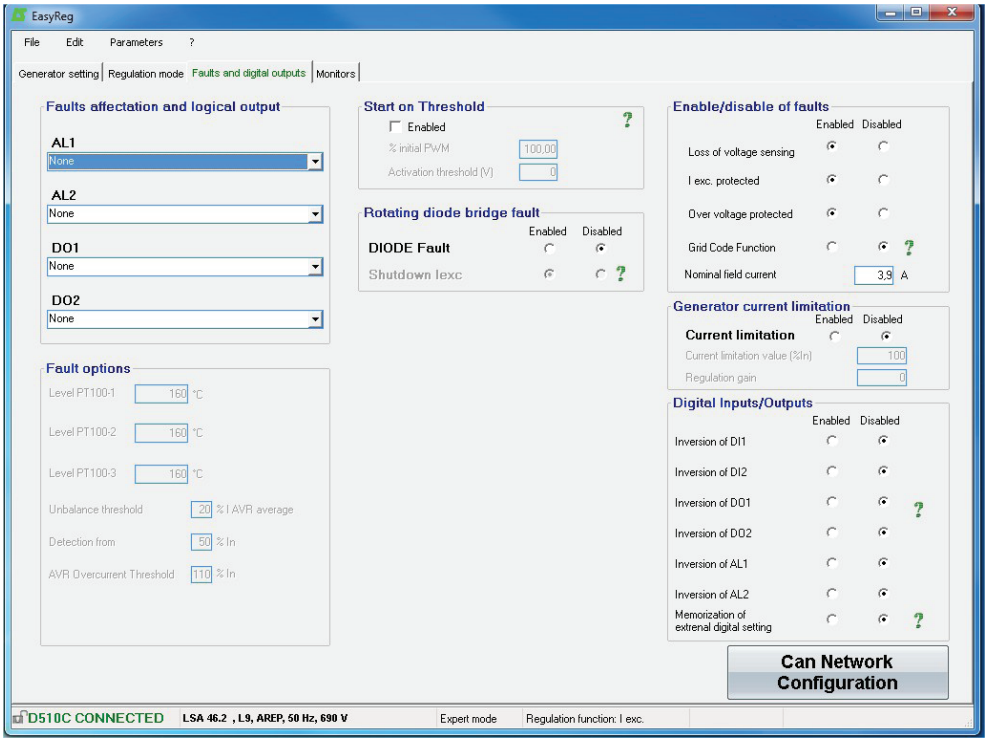
Example of settings:
- Assignment of «Overvoltage» fault to AL1
- Assignment of «PT100-1 overtemperature» fault to AL2 with the maximum temperature set at 200°C
- Assignment of «Loss of voltage sensing» fault to DO1
- Assignment of «PF/kVAR» digital output to D02

- 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



• [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 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

• [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.

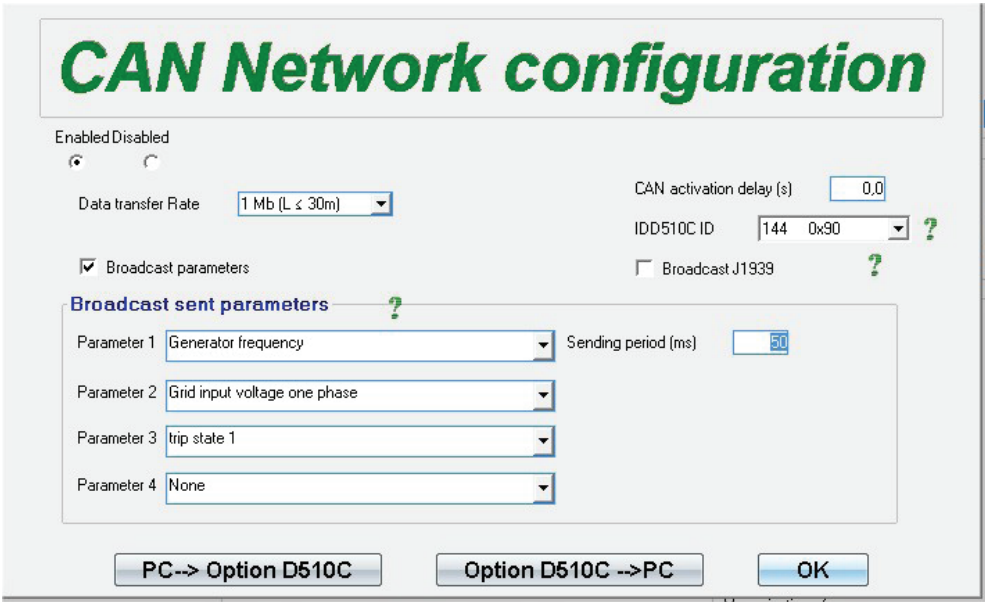
3.3.4 - [Expert mode] D510C Options

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

• [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 Iexc » 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.



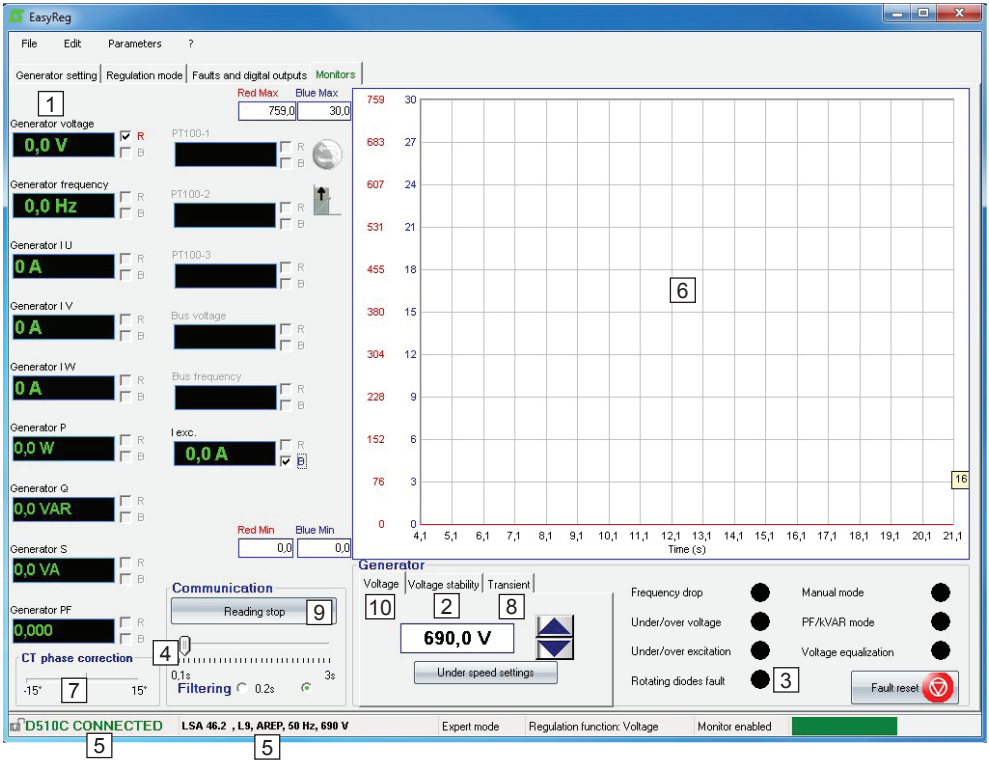
Click on OK to validate the configuration

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.

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 filtring parameters can also be set.

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.

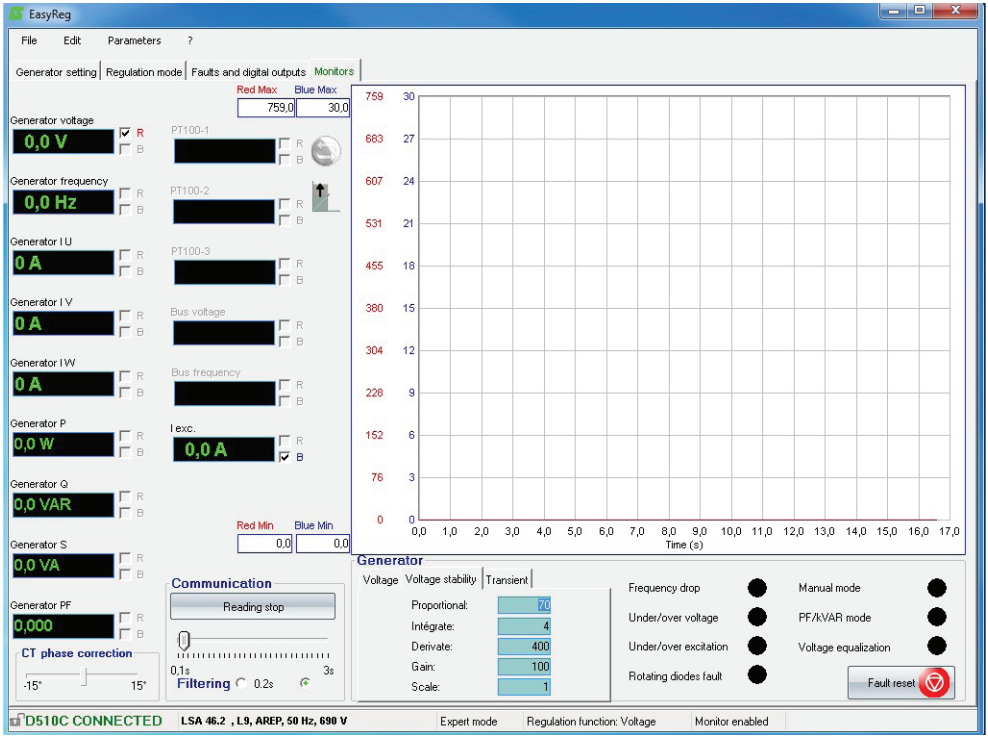
Note: Set the minimum and maximum values within the range permitted by the generator voltage sensing device.

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.



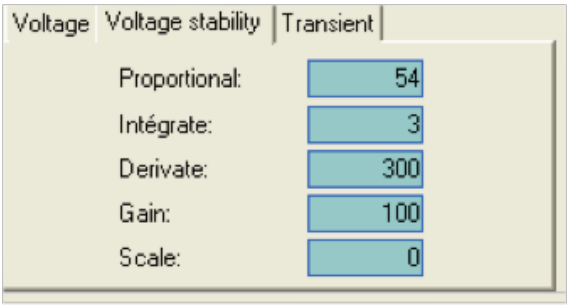
[Expert mode] monitors
The graph is memorized using up to 150 000 sliding points.

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.



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

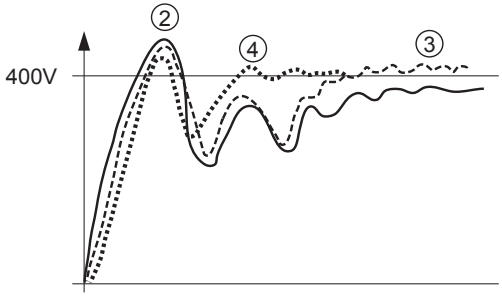
② Adjust the proportional part to obtain a response as given in the figure below.

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.



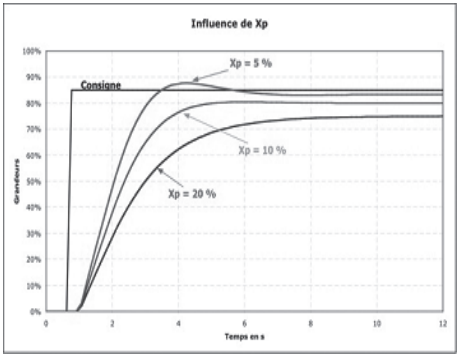
PID controller

The PID controller is an important system for the AVR. It is used to adjust the static gain with the proportional part, stability with the derivative action and speed thanks to the integral action.

- Proportional action

This action affects the speed.

The smaller the proportional band, the lower the static error and the shorter the response time.



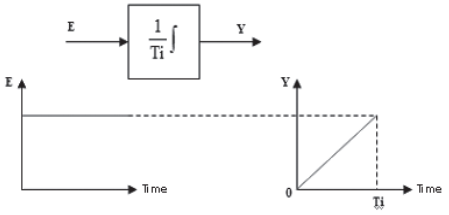
If Xp (proportional band) is small, there may be an overrun but if Xp is too large, the static error is greater.

- Integral action

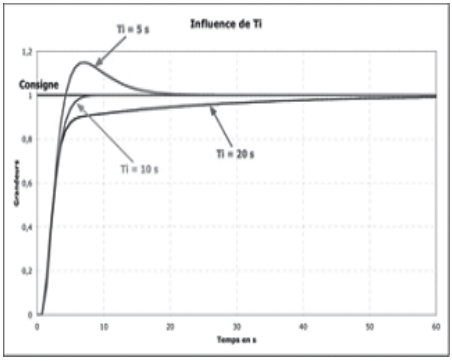
This action changes over time and is used to reduce the static error.

It is filled in by the «Integral in relation to the time» mathematical operator.

In an AVR, the integral action is defined using one of two parameters: Ti integral time or Ki integral gain.



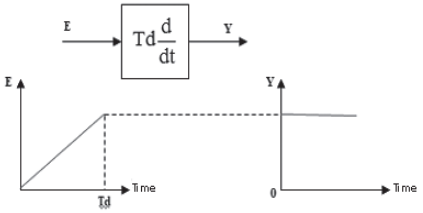
The smaller Ti is, the more quickly the value of output Y increases. The time Ti is the time it takes command Y to increase with the value of input E.



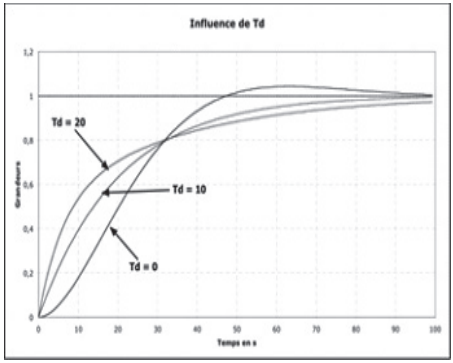
If Ti is too short, there is a strong possibility that the reference will be exceeded but if Ti is too long, the measurement takes longer to reach the reference.

- Derivative action

This action amplifies abrupt variations in the reference. It has the opposite action to the integral action. This function is filled in by the «Derivative in relation to the time» mathematical operator. In an AVR, the derivative action is defined using the derivative time Td.



The larger Ti is, the greater the value of the Y output. The time Td is the time it takes input E to increase by the value of output Y.



Si Td est trop long, une erreur statique apparaît mais si Td est très court, la réponse est plus longue et un dépassement de la consigne se forme.

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

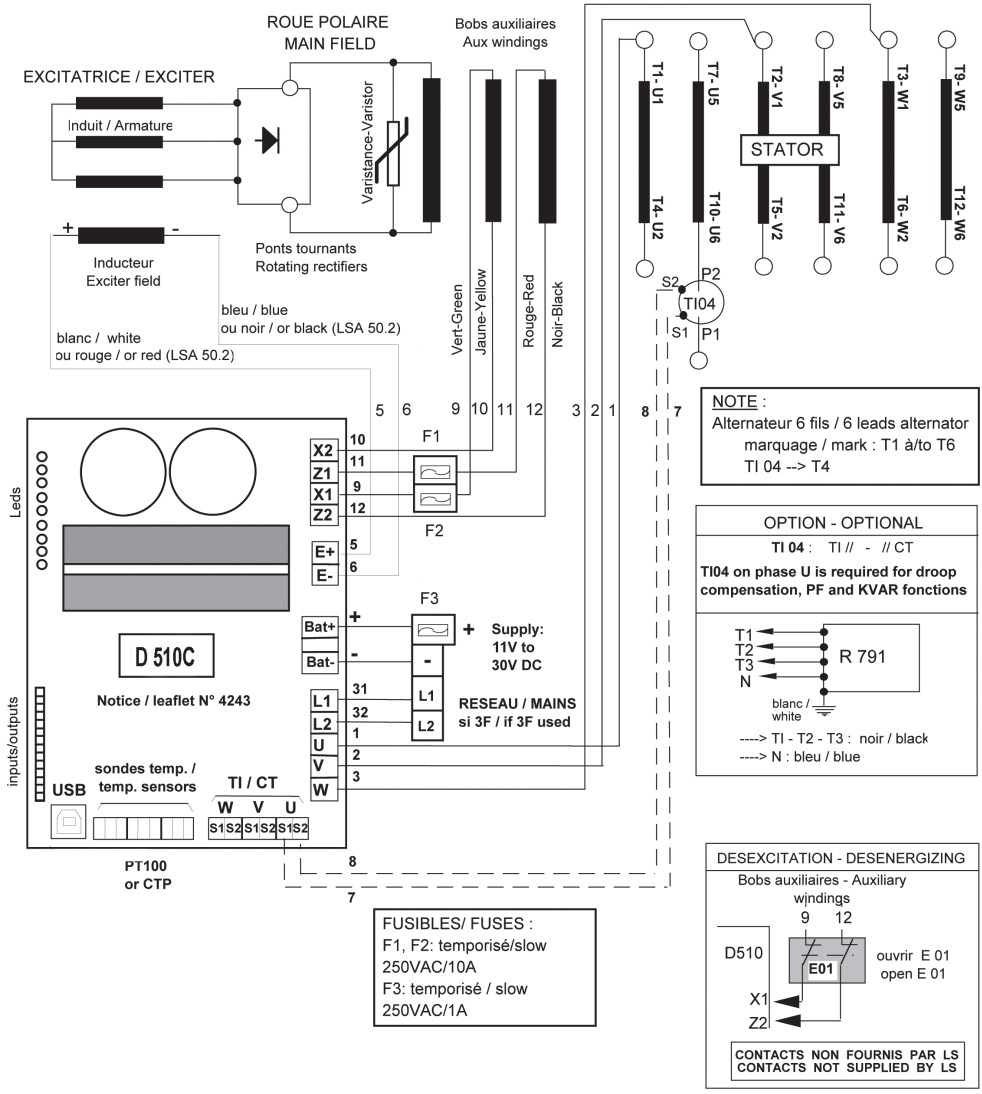
PID controller	Effect
Proportional action	Speed
Integral action	Accuracy
Derivative action	Stability

D510 C
Automatic Voltage Regulators (AVRs)

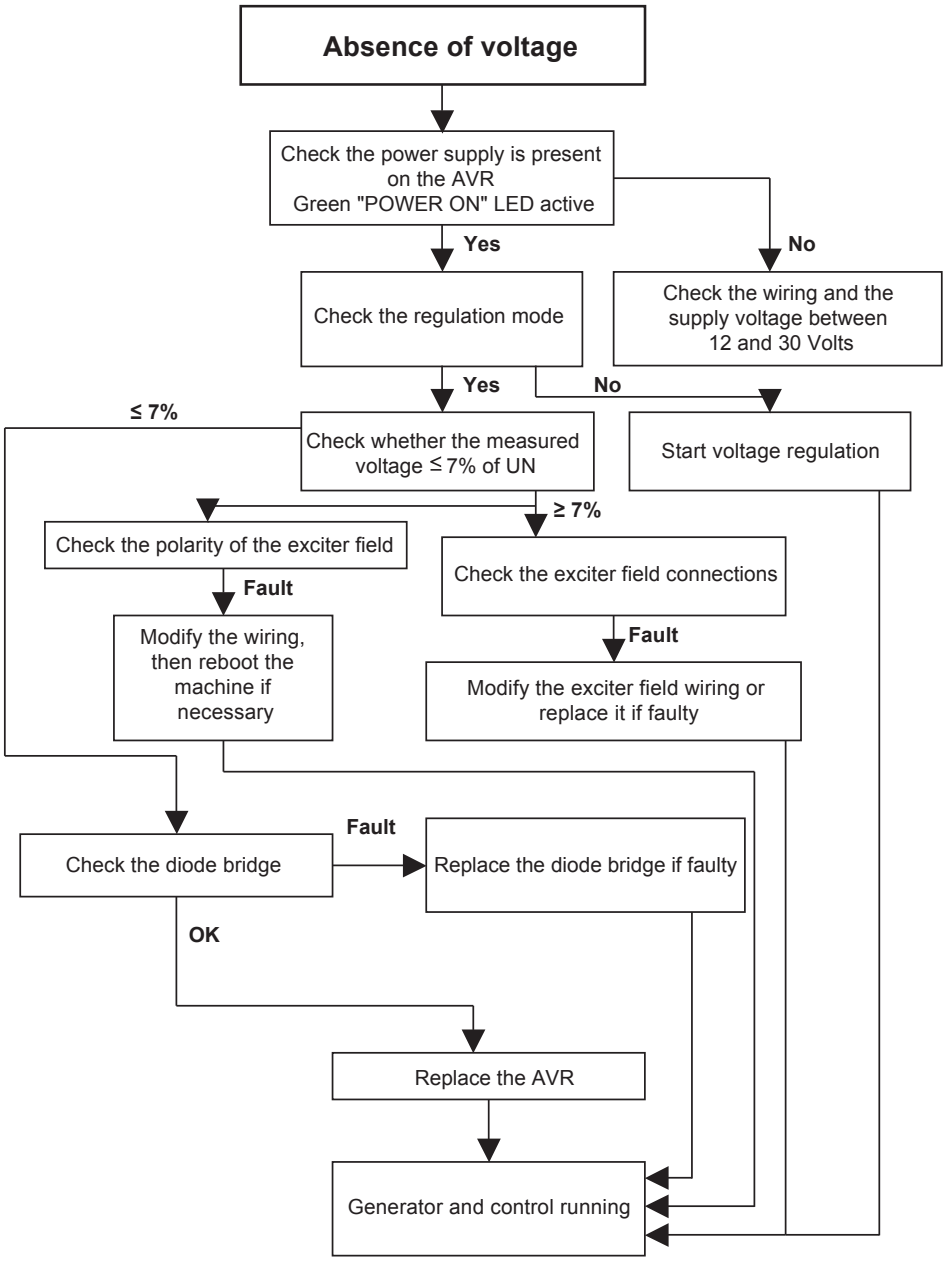
4 - CONNECTION DIAGRAMS

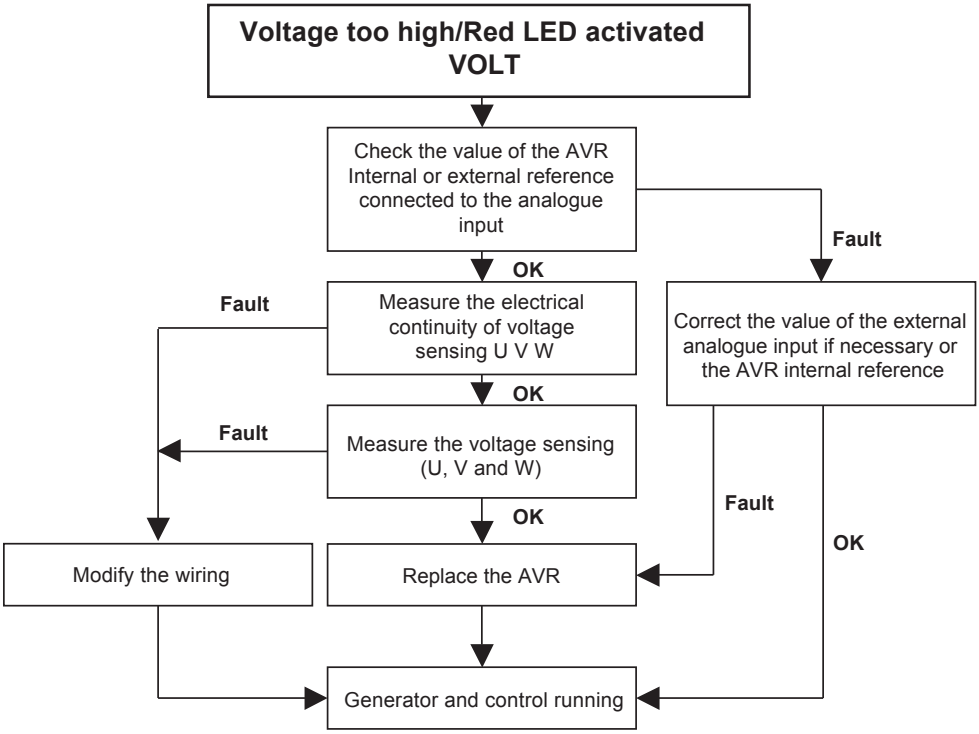
Régulateur Numérique D510C/digital AVR D510C

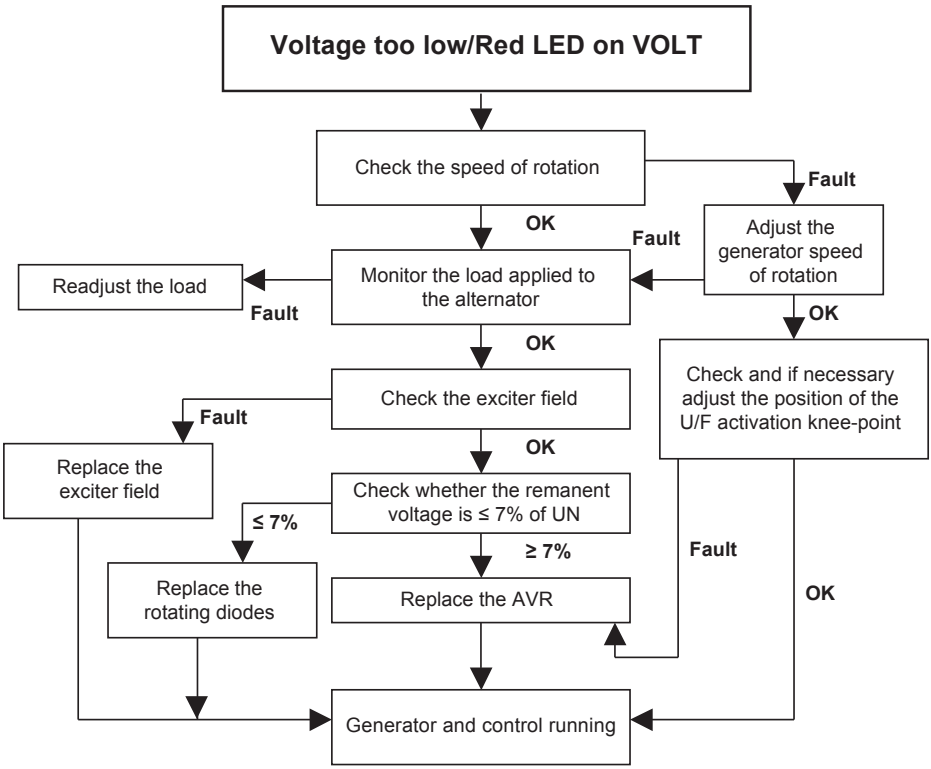
Bornier avec porte-fusibles / teminal block with fuses

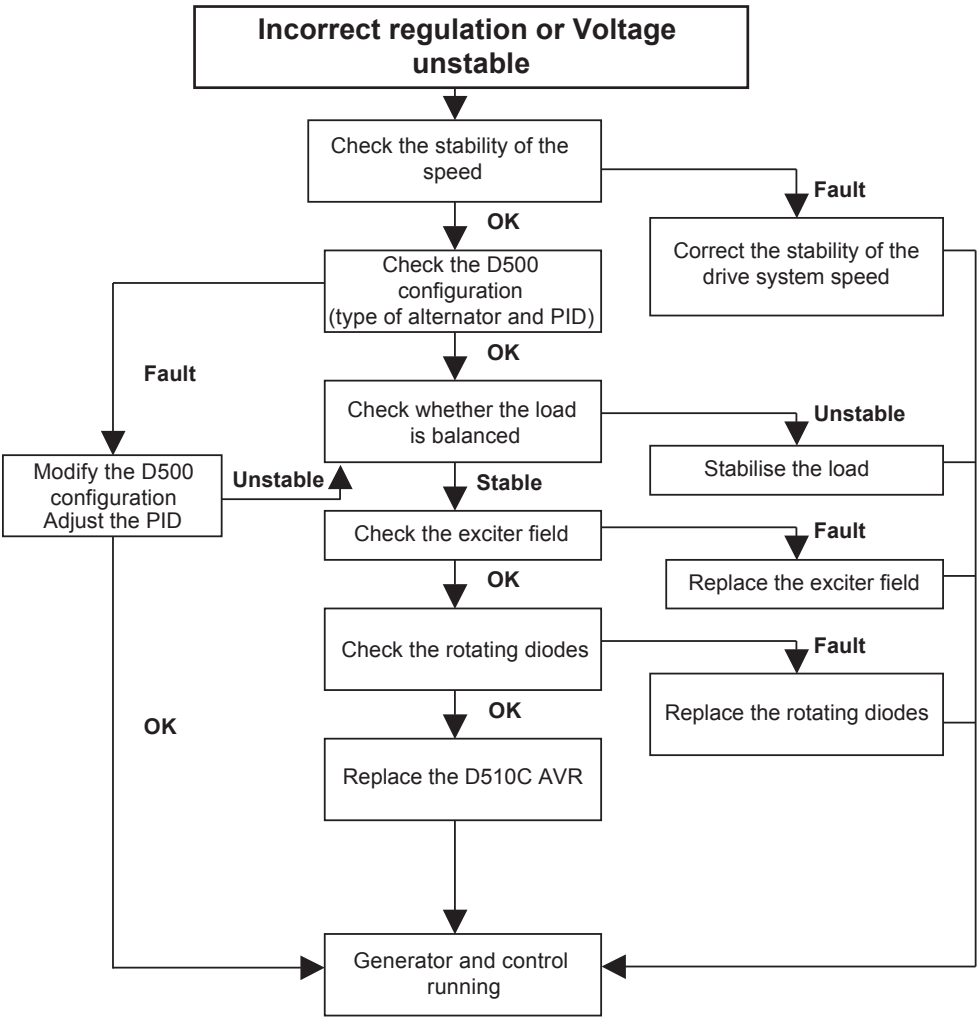


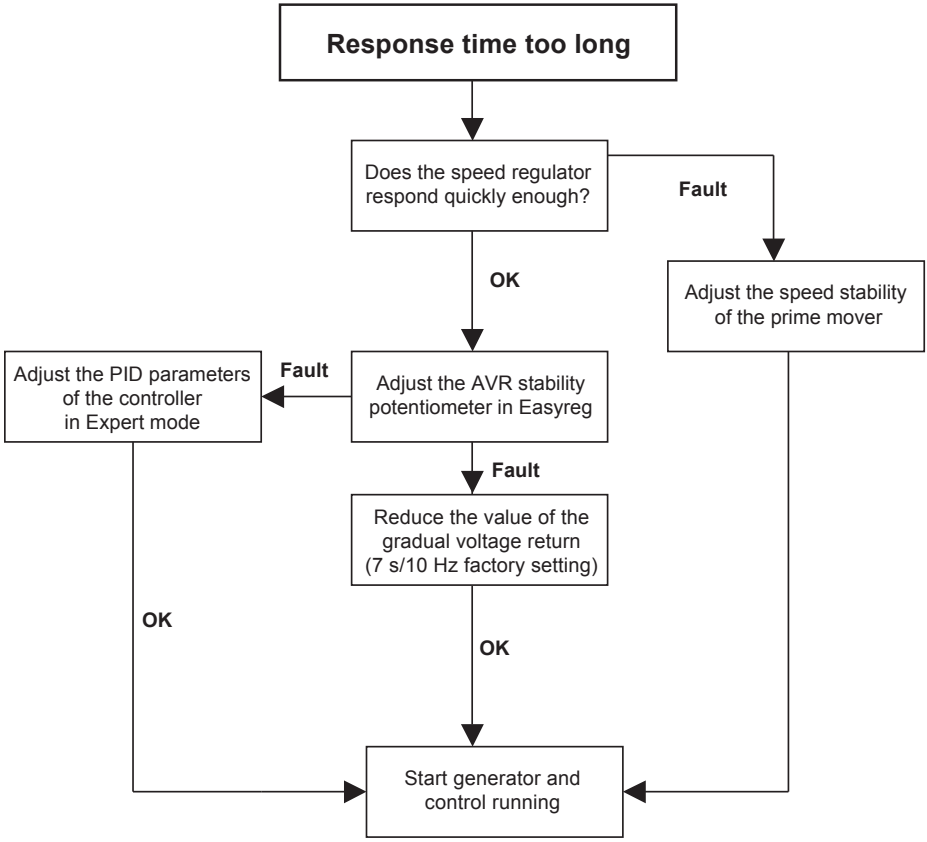
5 - FAULT FLOW CHARTS



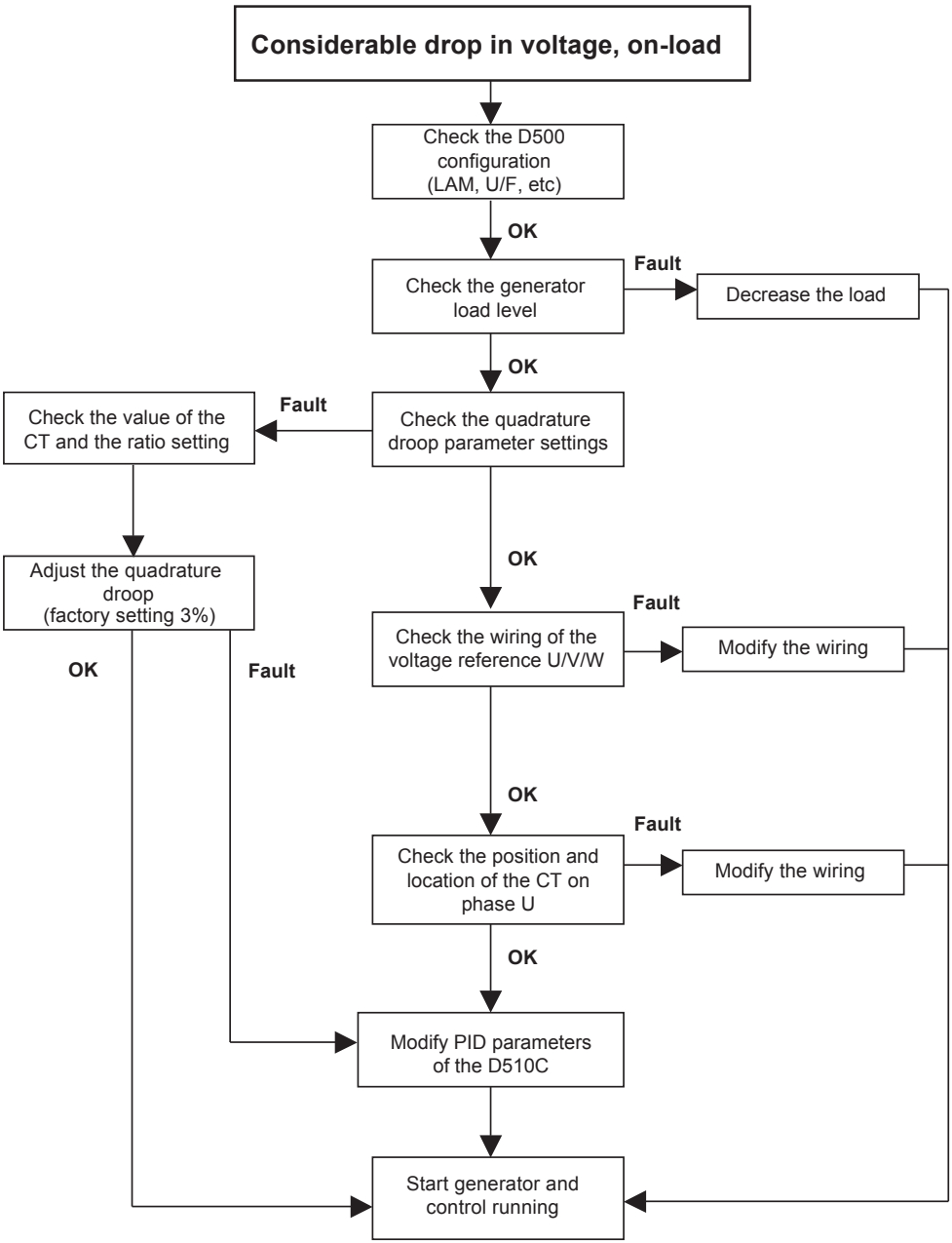

Voltage too high/Red LED activated
VOLT
Check the value of the AVR Internal or external reference connected to the analogue input
Fault
OK
Measure the electrical continuity of voltage sensing U V W
Fault
Correct the value of the external analogue input if necessary or the AVR internal reference
OK
Measure the voltage sensing (U, V and W)
Fault
Fault
OK
Modify the wiring
Replace the AVR
OK
Generator and control running


Voltage too low/Red LED on VOLT
Check the speed of rotation
Fault
OK
Fault
Adjust the generator speed of rotation
Readjust the load
Monitor the load applied to the alternator
Fault
OK
OK
Check and if necessary adjust the position of the U/F activation knee-point
Check the exciter field
Fault
OK
Replace the exciter field
Check whether the remanent voltage is ≤ 7% of UN
≤ 7%
≥ 7%
Fault
OK
Replace the rotating diodes
Replace the AVR
Generator and control running

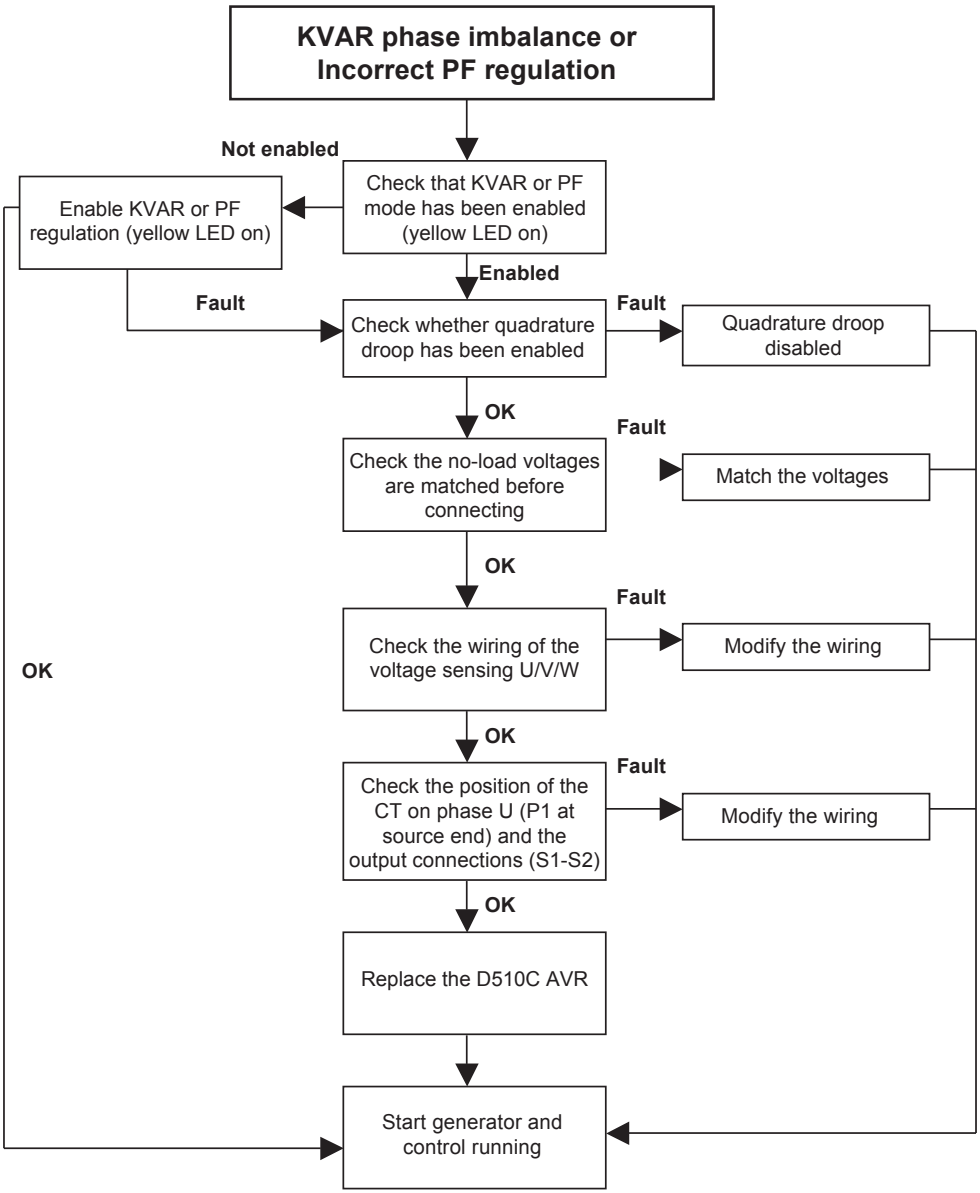

Incorrect regulation or Voltage unstable
Check the stability of the speed
Fault
Correct the stability of the drive system speed
OK
Check the D500 configuration (type of alternator and PID)
OK
Fault
Check whether the load is balanced
Unstable
Stabilise the load
Modify the D500 configuration Adjust the PID
Unstable
Stable
Check the exciter field
Fault
Replace the exciter field
OK
Check the rotating diodes
Fault
Replace the rotating diodes
OK
OK
Replace the D510C AVR
Generator and control running

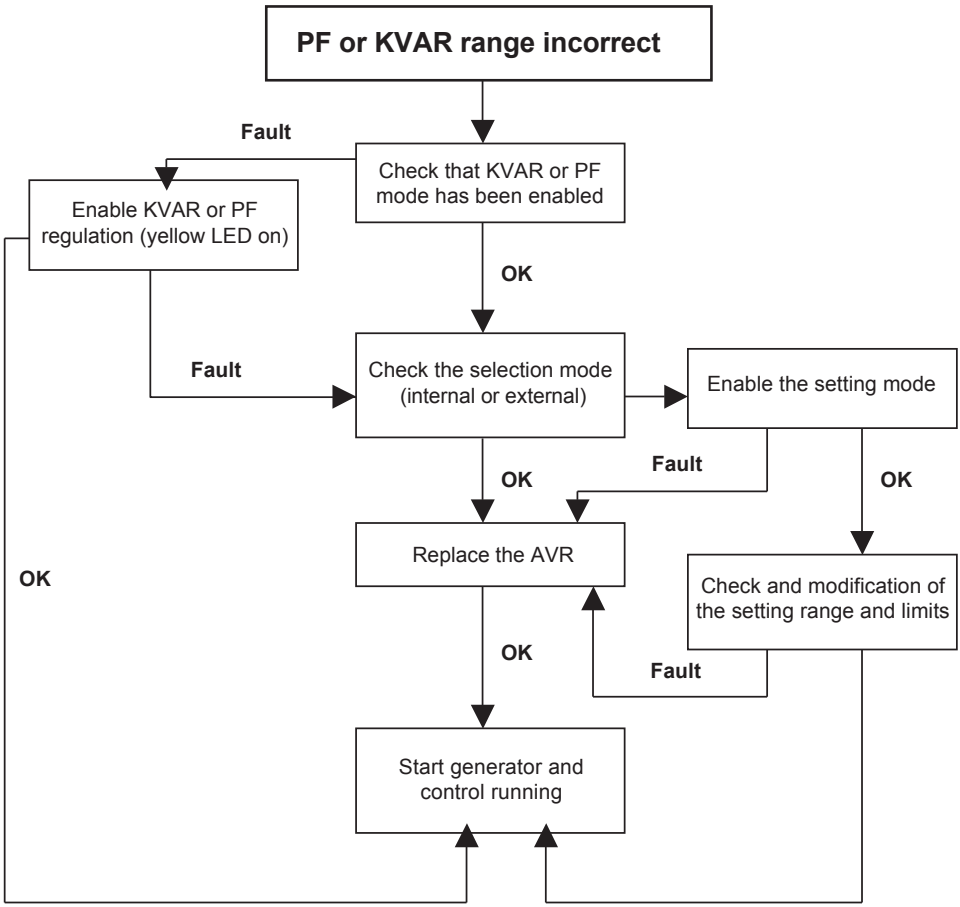

Response time too long
Does the speed regulator respond quickly enough?
Fault
Adjust the speed stability of the prime mover
OK
Adjust the PID parameters of the controller in Expert mode
Fault
Adjust the AVR stability potentiometer in Easyreg
Fault
Reduce the value of the gradual voltage return (7 s/10 Hz factory setting)
OK
OK
Start generator and control running

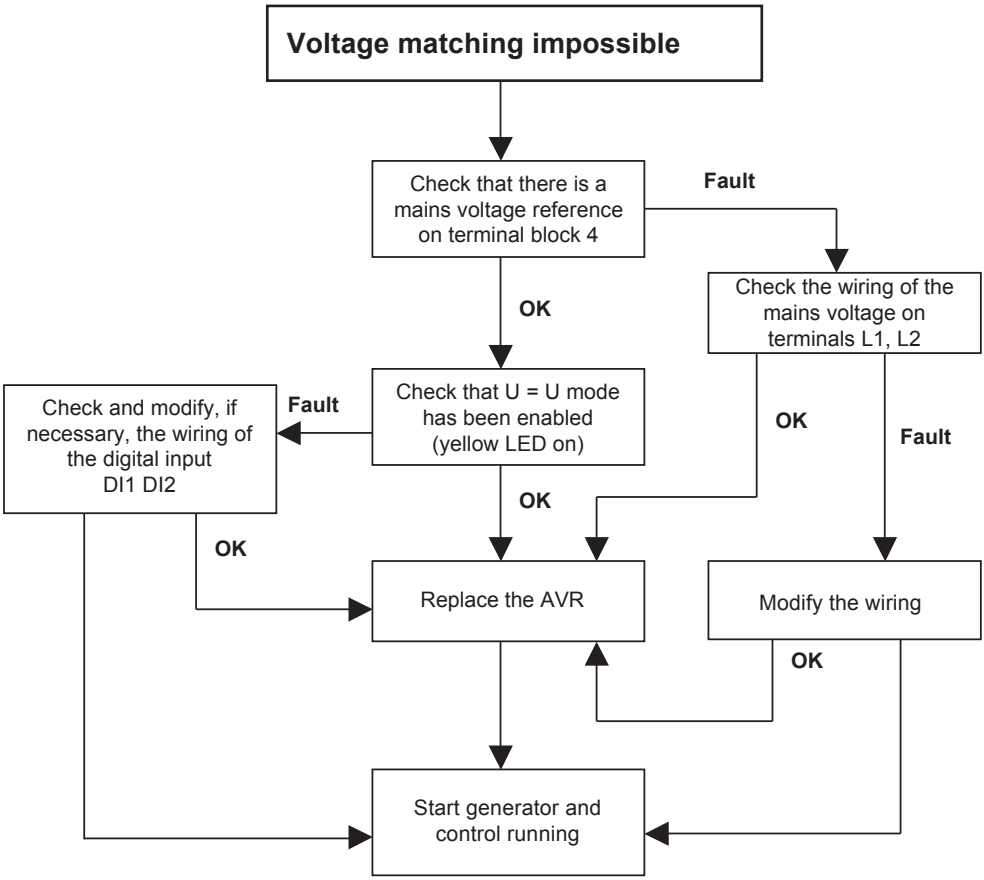
D510 C
Automatic Voltage Regulators (AVRs)



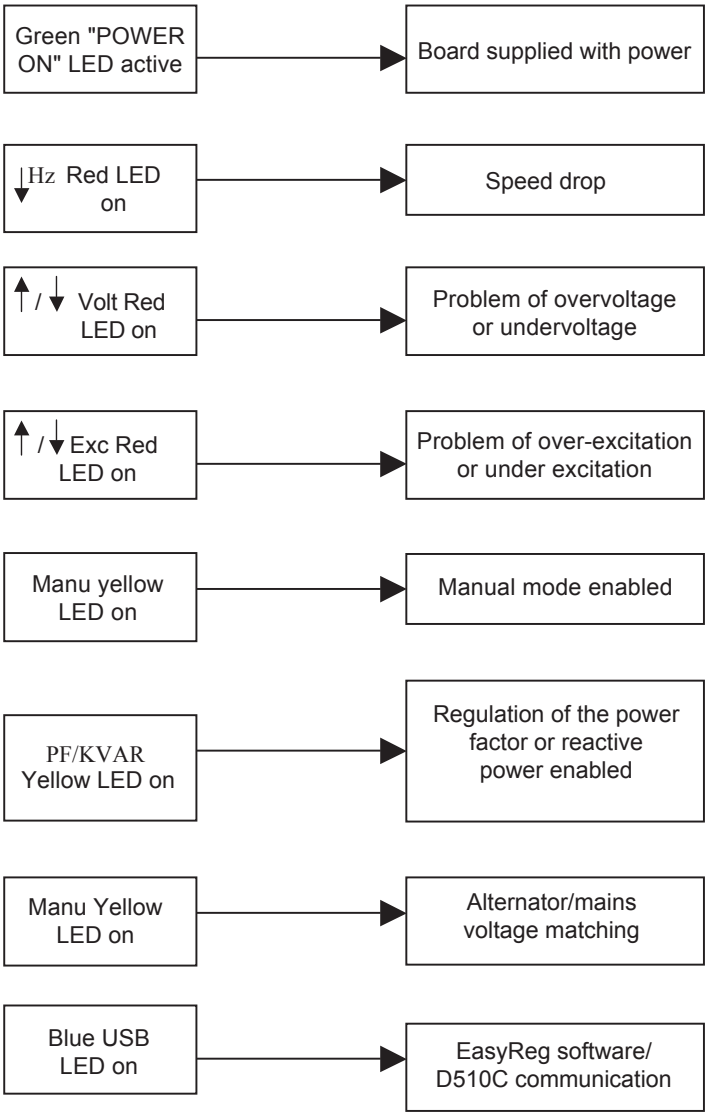
D510 C
Automatic Voltage Regulators (AVRs)



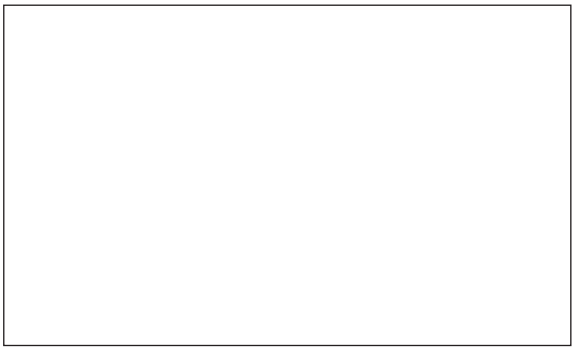

PF or KVAR range incorrect
Fault
Check that KVAR or PF mode has been enabled
Enable KVAR or PF regulation (yellow LED on)
OK
Fault
Check the selection mode (internal or external)
Enable the setting mode
OK
Fault
OK
Replace the AVR
OK
Check and modification of the setting range and limits
OK
Fault
Start generator and control running


Voltage matching impossible
Check that there is a mains voltage reference on terminal block 4
Fault
Check the wiring of the mains voltage on terminals L1, L2
OK
Check that U = U mode has been enabled (yellow LED on)
Fault
Check and modify, if necessary, the wiring of the digital input DI1 DI2
OK
OK
Fault
OK
Replace the AVR
Modify the wiring
OK
Start generator and control running

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

LEROY SOMER®



www.leroy-somer.com