This manual is to be given to the end user

X1 Z1 X2 Z2 B+ B-

U
V
W

IU
IV
IW

PID

L1
L2

μC (XC164CS)

DSP

D500

Automatic Voltage Regulators (AVRs)

Installation and maintenance

D500
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.

Note: LEROY-SOMER reserves the right to modify the characteristics of its products at any time in order to incorporate the latest technological developments. The information contained in this document may therefore be changed without notice.

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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.

D500
Automatic Voltage Regulators (AVRs)

1 - PRESENTATION

1.1 - Operation

A schematic diagram of the D500 appears below.
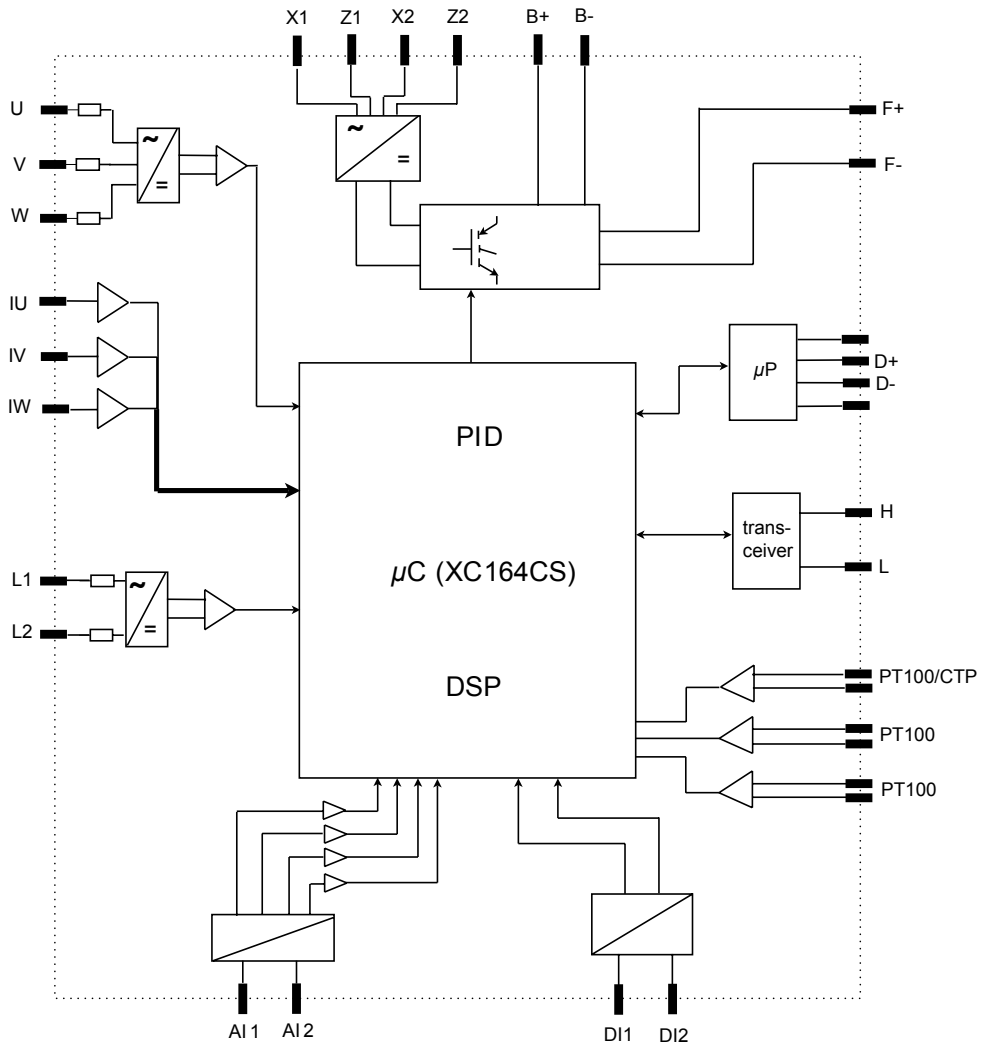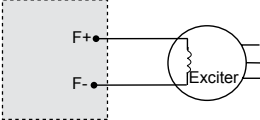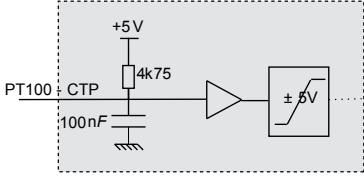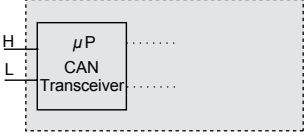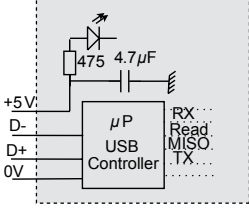
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Terminals	Signals	Scheme
X1 X2 Z1 Z2	Power supply - Auxiliary winding input - PMG input - SHUNT input	
L1 L2	Mains voltage measurement	
U V W	Alternator voltage measurement For single-phase: use V and W	
IU = (s1, s2) IV = (s1, s2) IW = (s1, s2)	Alternator current measurement	
AI1 AI2	Analogue inputs: External setting	
DI1 DI2	Digital inputs: U=U and PF/kVAR regulation	
B+ B-	DC power supply	

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Terminals	Signal	Scheme
F+ F-	Field excitation: up to 10 A	
PTC PT100_1 PT100_2 PT100-3	Temperature sensor	
CAN_H CAN_L	Optional: CAN	
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).

• **Battery:** This is used to supply the AVR with between 12 V and 30 V. **It must always be present.**

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

• **Alternator voltage:** This sends 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.

• 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 D500.

- *CAN port*: This is used to connect the AVR to a computer and creates the link between the EasyReg software and the D500.
The CAN link is only available in the CAN version identified by the letter C (eg: D510-C).

• **I/O: This part is used to:**
- Enter settings
- Send information from the D500
- 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 D500 are:
- Voltage regulation
- Regulation of the power factor (PF)
- Regulation of the reactive power
- Manual regulation (Iexc)

• **Voltage regulation:** The D500 regulates the alternator output voltage. Regulation is applied to the mean value or the true rms value (TRMS).

• **Regulation of the power factor:** The D500 regulates the power factor. This is the ratio between the active power (P = √3*U*I*cos φ) and the apparent power (S = √3*U*I).
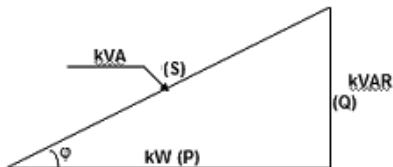
- *Inductive cos φ [0; π/2]* means that the current is lagging behind the voltage. The load is inductive (induction motor, transformer, etc).
- *Capacitive cos φ [π/2; π]* means that the current is leading the voltage. The load is capacitive (fluorescent lighting, etc).

• **Regulation of the reactive power:** The D500 regulates the reactive power (Q = √3*U*I*sin φ) at a fixed value.

• **Manual regulation:** The D500 can regulate the voltage manually by altering the value of 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	5 Hz	100 Hz	
Single-phase mains voltage	50 V	600 V	
Mains voltage ratio	1	100	Yes
Excitation current	0 A	6 A	
Max. excitation current	0 A	10 A	
Single-phase alternator voltage	0 V	341 V	
Three-phase alternator voltage	0 V	600 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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1.3.2 - Characteristics

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	690 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	-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*

* ± 30% in expert mode

1.3.3 - Status and faults

Name	Minimum value	Maximum value	Adjustable
Short-circuit delay	0.5 s	10 s	
Short-circuit excitation current demand	0 A	10 A	
Underexcitation delay	0.1 s	5.0 s	
I EXC SHUT down	0 A	5 A	
Overvoltage time	0 s	100 s	
Overvoltage threshold	0%	120%	
PT100 temperature	0°Celsius	250°Celsius	
PT100 temperature threshold	50°C	200°C	
PTC input	0%	100%	

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2 - HUMAN-MACHINE INTERFACE

The D500 human-machine interface consists of 3 elements:
- The USB link
- The I/O
- The LEDs

USB port
I/O
LEDs
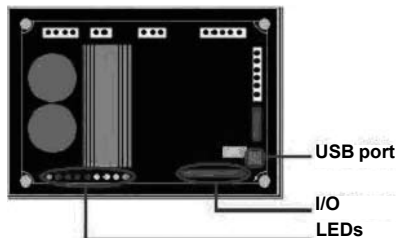
2.1 - Communication
USB link

The EasyReg software and the D500 communicate via a USB cable (Universal Serial Bus).

Connect to the PC

Connect to the D500
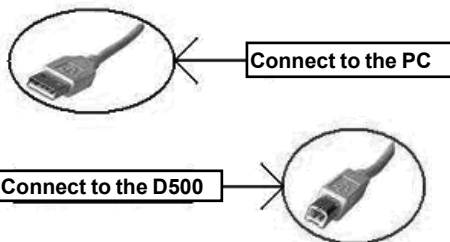
2.2 - I/O

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 power supply (0 V – 10 V) is present which can supply an external component (bulb, alarm, etc).

+10V AI1 AI2 0V AO1 0V DI1 DI2 0V DO1 AL.1 AL.2 DO2
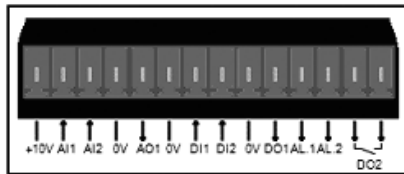
The minimum input setting is 0% and the maximum is 100%.
External setting is either:
- from an external potentiometer
- 4 - 20 mA
- 0 - 10 V
- ± 10 V

Scaling:

x —— **Formula** —— y (AVR part)

x	Formula	y
4 – 20 mA	$A * x + B = y$ A = 6250 and B = -25	0 – 100%
0 – 10 V	$A * x + B = y$ A = 10 and B = 0	0 – 100%
-10 – 10V	$A * x + B = y$ A = 5 and B = 50	0 – 100%

2.3 - 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

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2.4 - Wiring scheme

AVR connections:
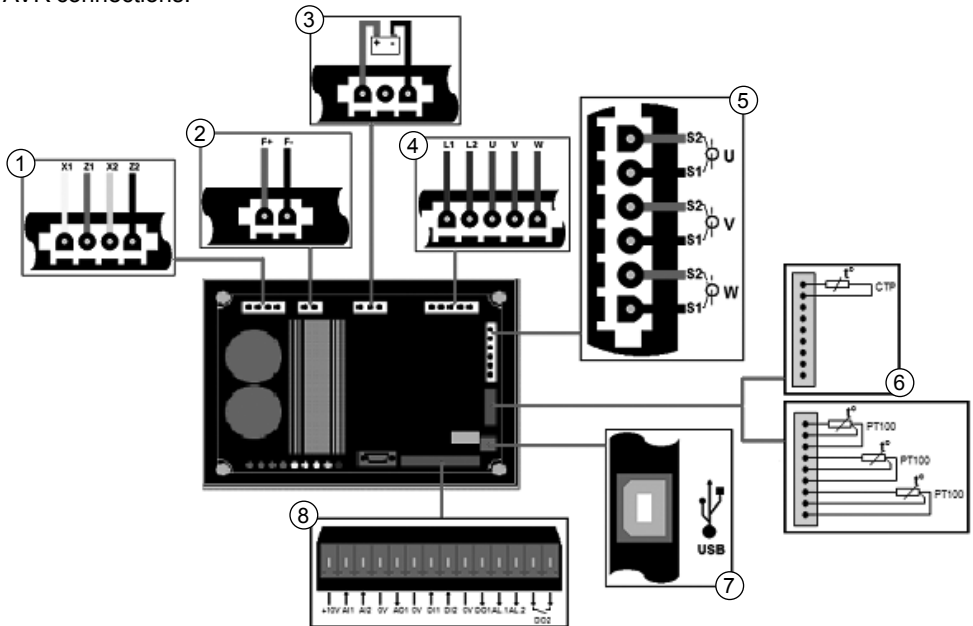
① Power:
  - AREP: Yellow wire on X1 - red wire on Z1 - green wire on X2 - black wire on Z2
  - PMG: X2, X1 and Z2
  - SHUNT: X1 and X2

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
  - Measurement: 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

Help with explanation of the function.
The EasyReg software is used to:
- 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

A CD-ROM is used to install the software on a PC. Subsequently, the link between the computer and the AVR will be via USB cable. The PC therefore needs to have a CD-ROM drive and a USB port.

1 - Installation procedure: insert the installation CD-ROM in the computer drive.

2 - The installation menu appears. Click on the "install" button and follow the instructions.

If the menu does not appear, go to My Computer and double-click on the CD-ROM drive.

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".
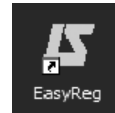
3.3 - Appearance

The home page below appears:

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There are three options when using this software:
- New configuration
- Open a configuration from a file
- Open a configuration from the pre-programmed AVR

If the AVR is not connected or has never been configured, it is impossible to "Open from a D500".

3.3.1 - 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
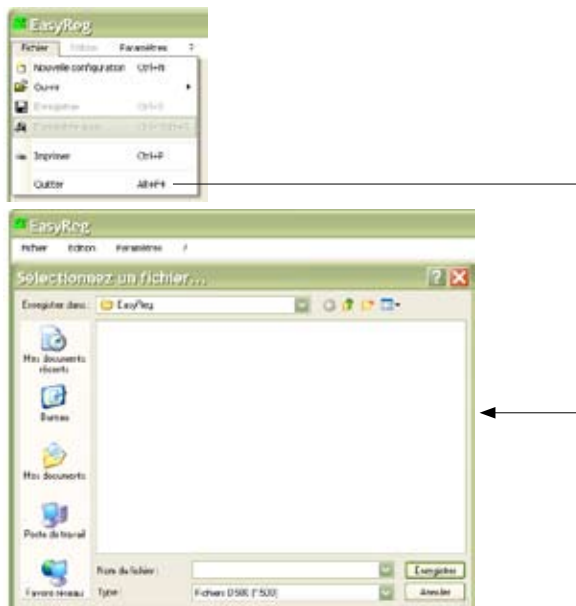
Subsequently, to save the configuration, you just need to go into the "File" menu and click "Save".

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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 and click "PC −> D500".
Wait for loading to complete.

- Select the communication type: USB or Serial.
- Go to: • PC --> D500
         • D500 --> PC

3.3.2 - New configuration
There are two possible configuration levels: standard or expert.

By default, the software is in standard mode.

3.3.2.1 - Standard
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 D500 via the "Edit" menu then "PC => D500" 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

3.3.2.1.1 - 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

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.

Stator connections: Click on the question mark to get help on the stator connections.
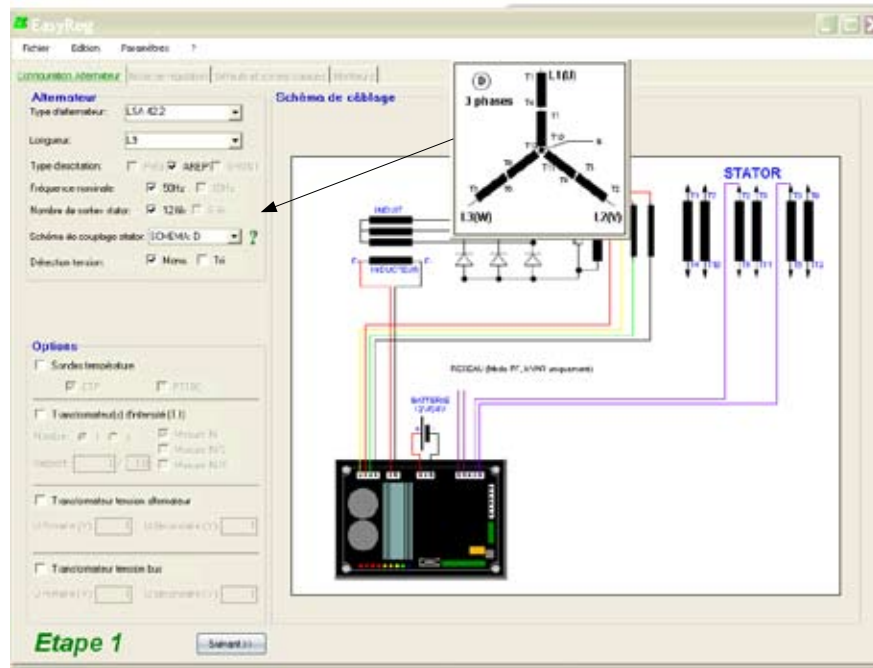
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The electrical schematic below shows how the "wiring scheme" part changes according to the parameters selected.
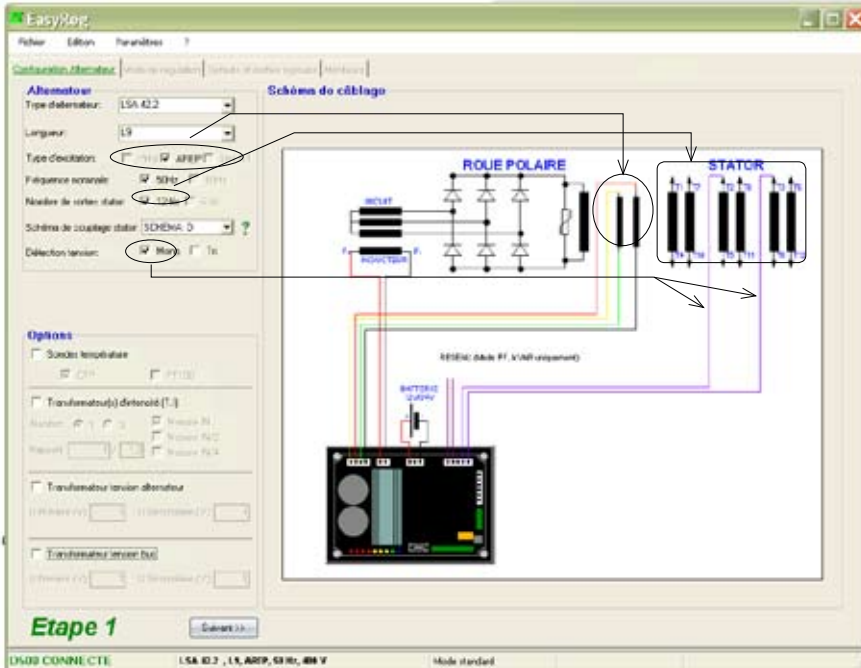
• **Options**

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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 (). They are compulsory for parallel operation.

3. **Alternator voltage transformer**, enter the voltage values at the primary and at the secondary.

4. **Bus voltage transformer**, enter the voltage values at the primary and at the secondary.

The electrical schematic below shows how the "wiring scheme" part changes according to the parameters selected.
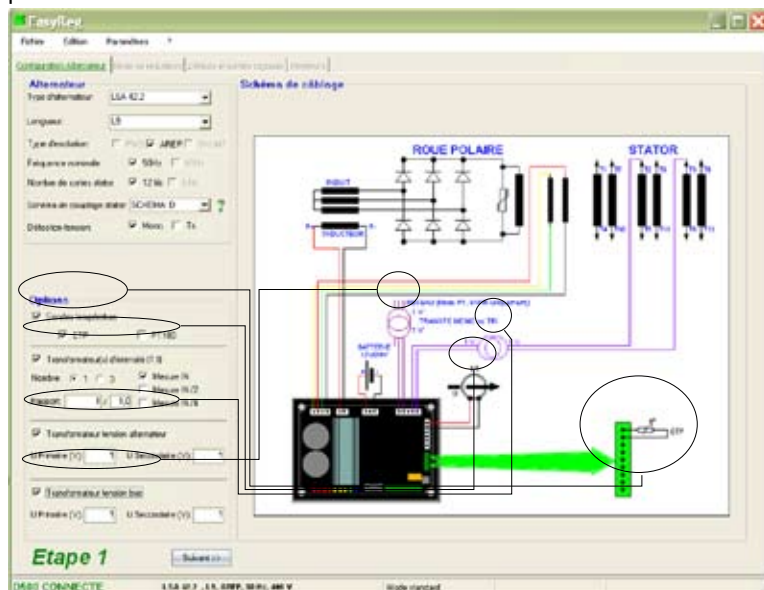
After entering the data in this page, go to the second page by clicking "Next". In some cases, you will need to adjust the workscreen in order to access the "Next" button.

3.3.2.1.2 - Regulation mode

After entering the "Alternator Configuration" part settings, fill in the "Regulation Mode" part. Click "Next".

4 types of regulation are offered:
- Voltage
- Power factor
- Reactive power
- Manual

Always start 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.

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A - Voltage regulation
This page consists of two parts:

A1 - Voltage Regulation
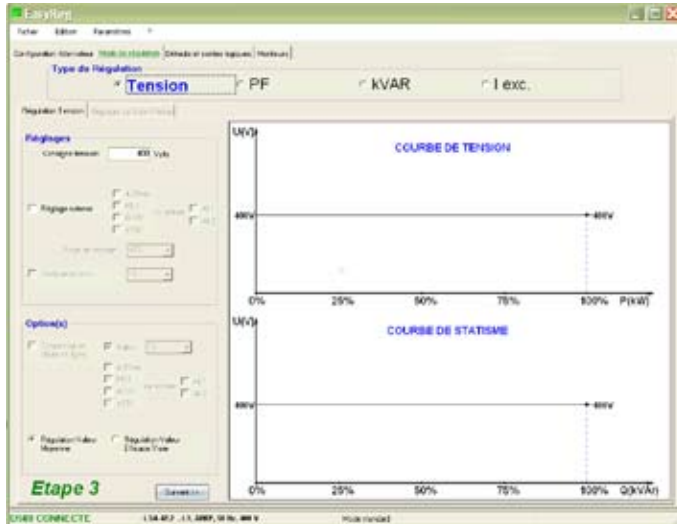
To confirm, click "Next".

A2 - Underspeed settings
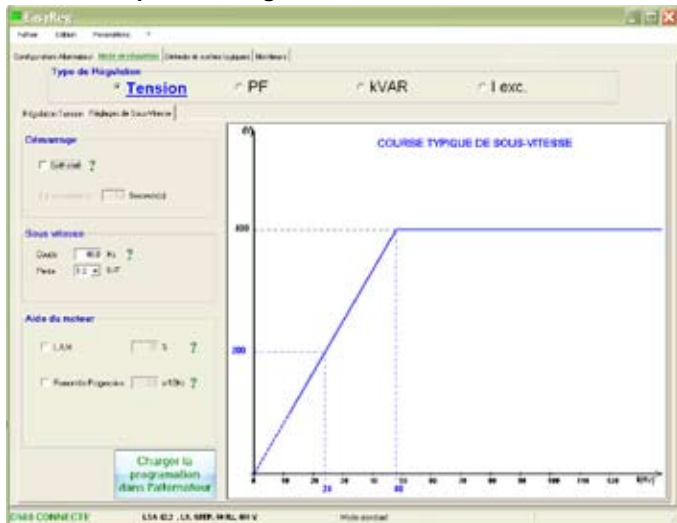
Setting the parameters for this part starts with the "Voltage regulation" page and ends with the "Underspeed settings" page.

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A1 - Voltage regulation

This page is split into two parts:
- Settings
- Options
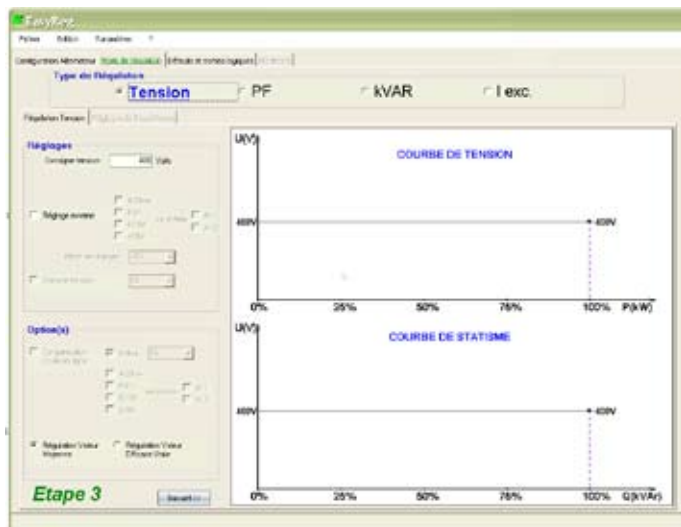
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A1.1 - Settings
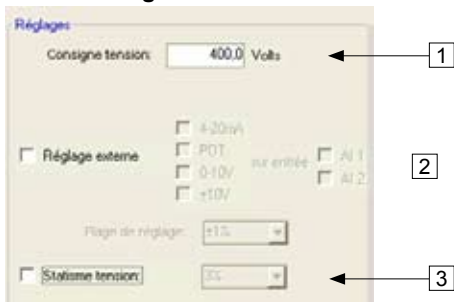
1. Write the desired voltage at the alternator output in the appropriate box.

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.
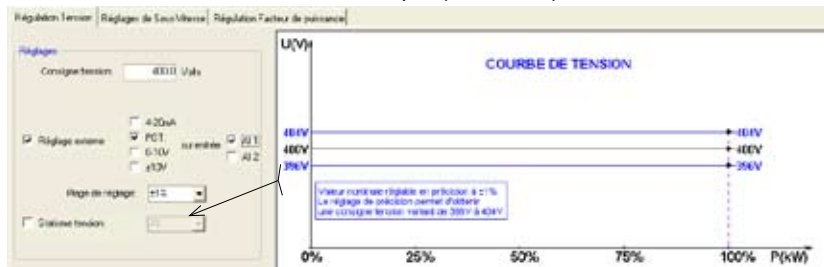
3. If you wish to have quadrature droop, tick the box and select the quadrature droop percentage.
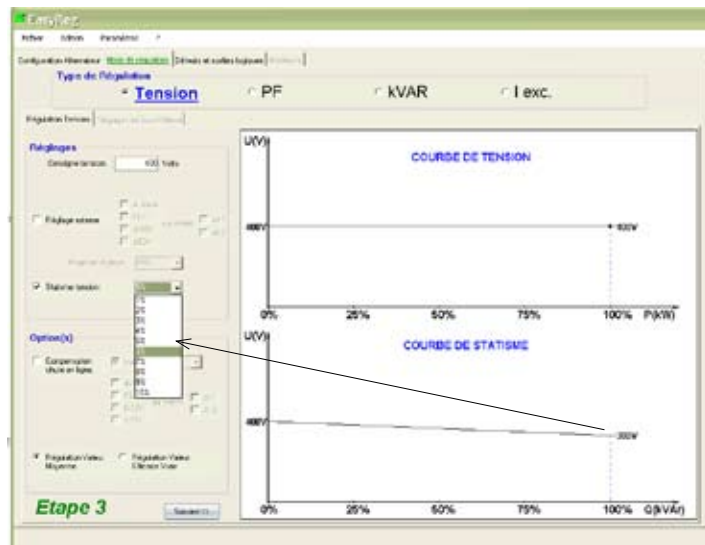
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A1.2 - Options

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%.
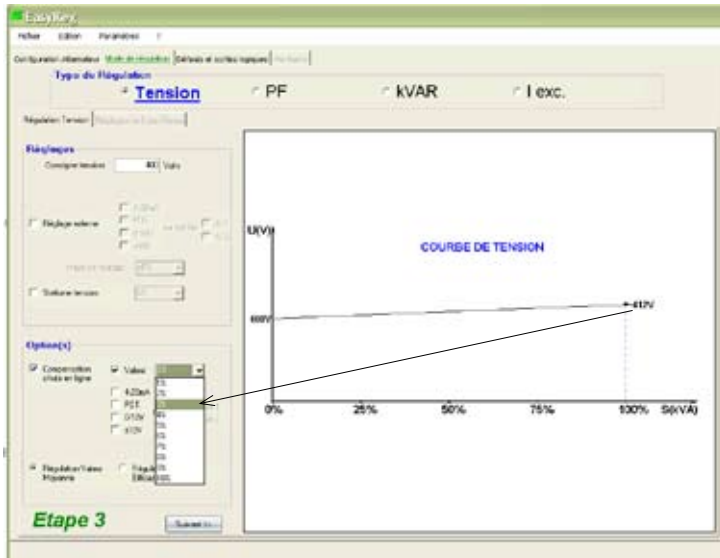
Line drop compensation by value

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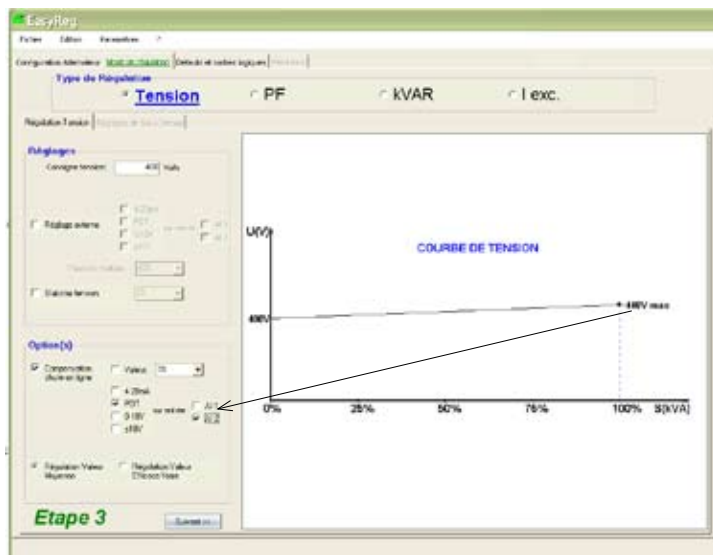
Line drop compensation by external setting

Line drop compensation cannot be selected when quadrature droop has been enabled.

2. Select which value regulation should apply to:
- mean value
- true rms value

To go to the next step "*Underspeed settings*", click "Next".

Etape 3   Suivant >>

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A2 - Underspeed settings

This page is split into three parts:
- Starting
- Underspeed
- Motor help
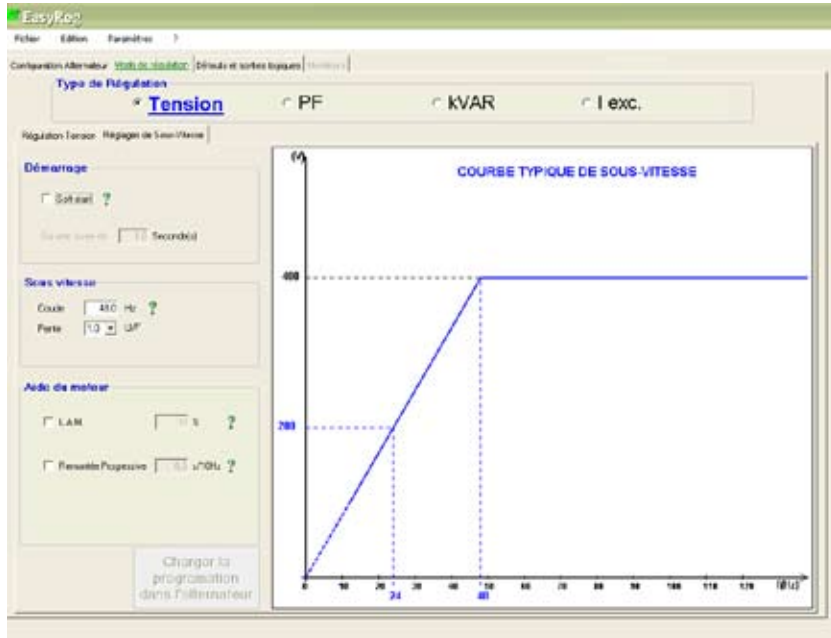
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A2.1 - Starting

Factory setting: disabled

To adjust Soft-start, tick the box and select the duration between 0.1 s and 120 s (1 step = 0.1 s).
Clicking on the question mark takes you to the help information on this characteristic.

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.
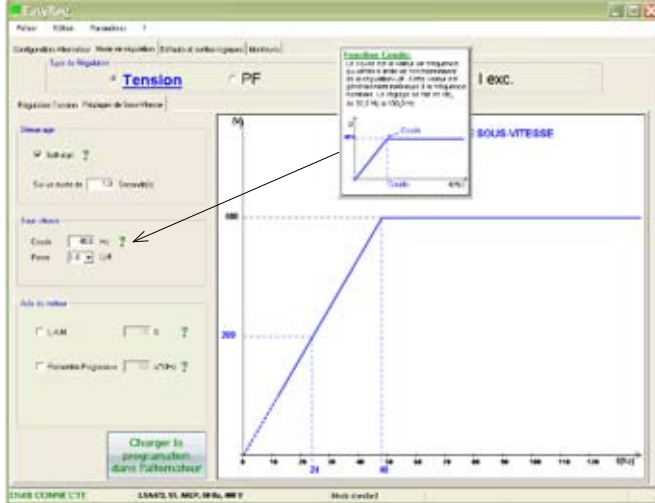
2. Enter the gradient value between 1.0 and 3.0 U/F (1 step = 0.1 U/F). Factory setting: 1/U/F.
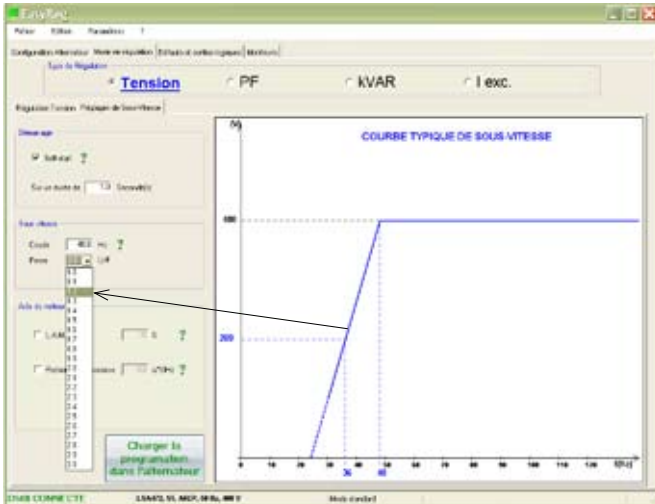
A2.3 - Motor help
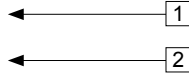
1. If the LAM function is required, tick the box and select its value between 0% and 30% (1 step = 1%).

Factory setting: LAM 9% - U/F 1.7%
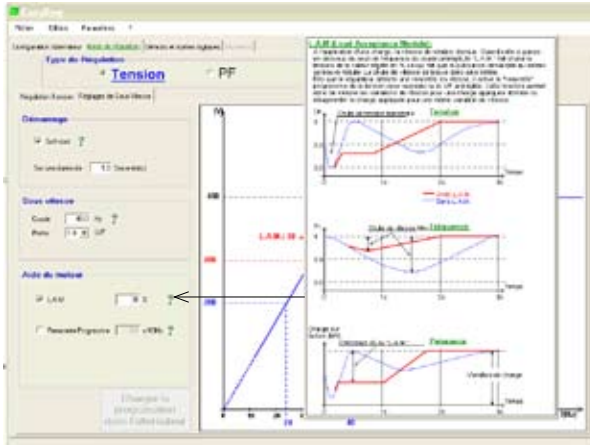
2. If you wish to have a gradual increase, tick the box and select the value between 0.1 s/10 Hz and 30.0 s/Hz (1 step = 0.1 s/10 Hz).
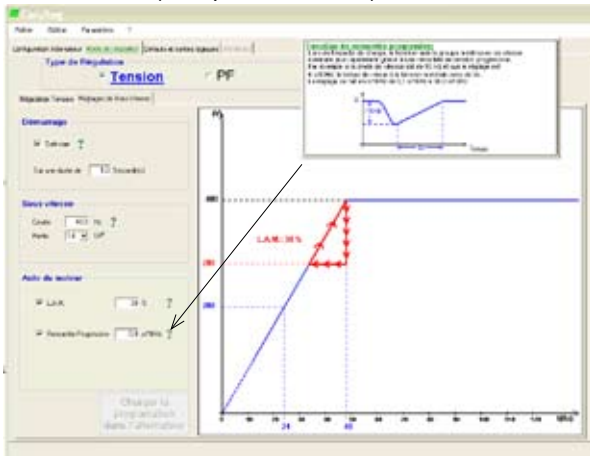
Save (see section 3, "Save" part).

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

Charger la programation dans l'alternateur

To configure another function, click the "Next" button and go to the corresponding page in this manual.

Etape 4

Suivant >>
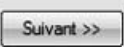
B - Regulation of the power factor

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
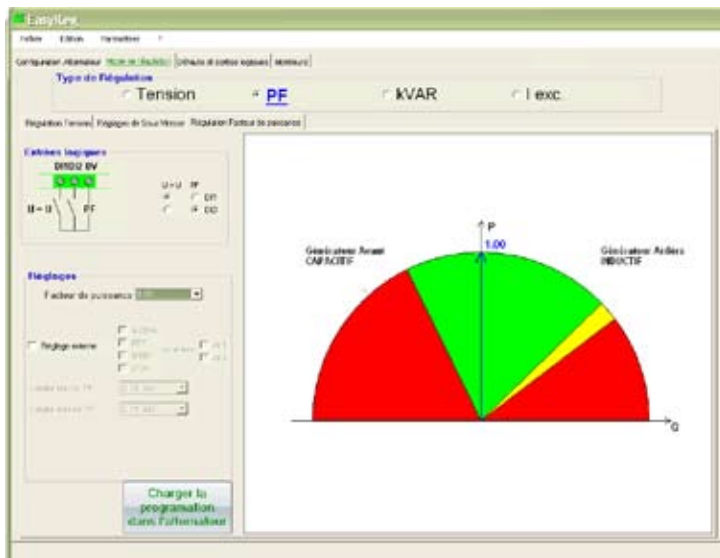
B1 - Digital inputs
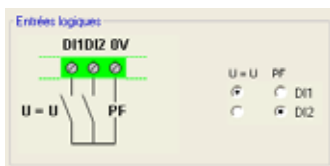
Check the digital input on which the voltage match circuit has been placed in order to enable it. The second digital input is reserved for enabling power factor regulation mode.

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B2 - Settings
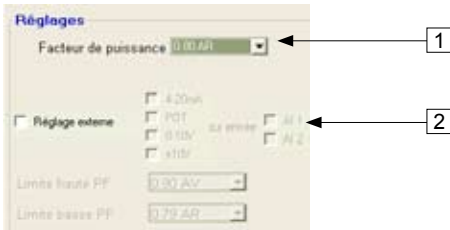
1. Select the power factor value between 0.9 LEAD and 0.60 LAG (1 step = 0.01).
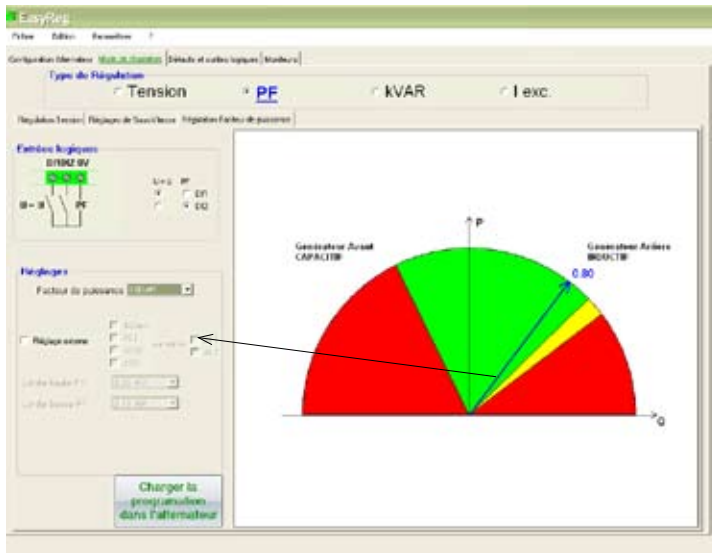
It is impossible to enter a reference value outside the limit values which are automatically set from the data on the 1st configuration page.

Warning: When a value is outside the operating limits, a message appears as indicated below.

D500
Automatic Voltage Regulators (AVRs)
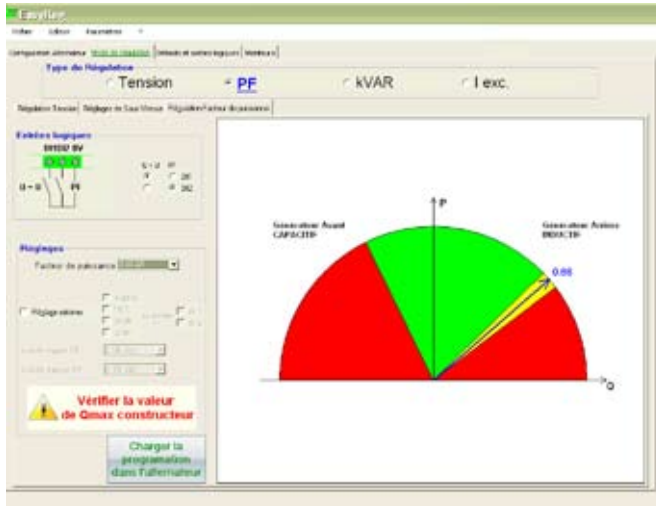
2. To set the power factor externally, tick the box, select the source (POT, 0-10 V, etc) for this setting and also the input (AI1 or AI2). One of the inputs may be greyed-out if it is already being used for setting the alternator output voltage externally.
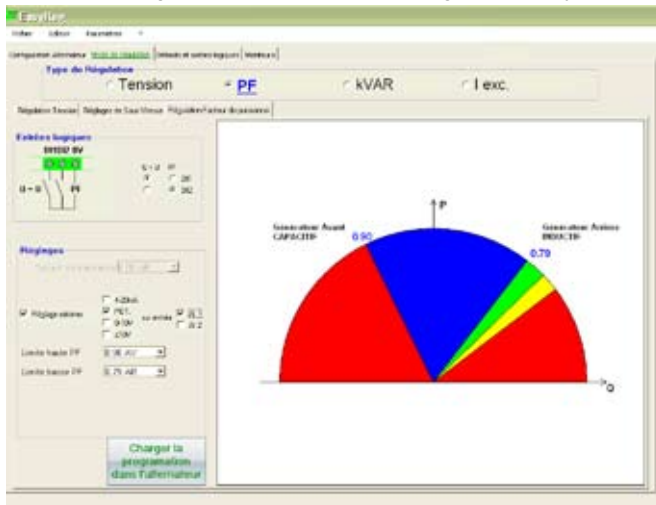
Save (see section 3, "Save" part).

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

Charger la
programation
dans l'alternateur

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 selected.

This page is split into two parts:
- Digital inputs
- Settings
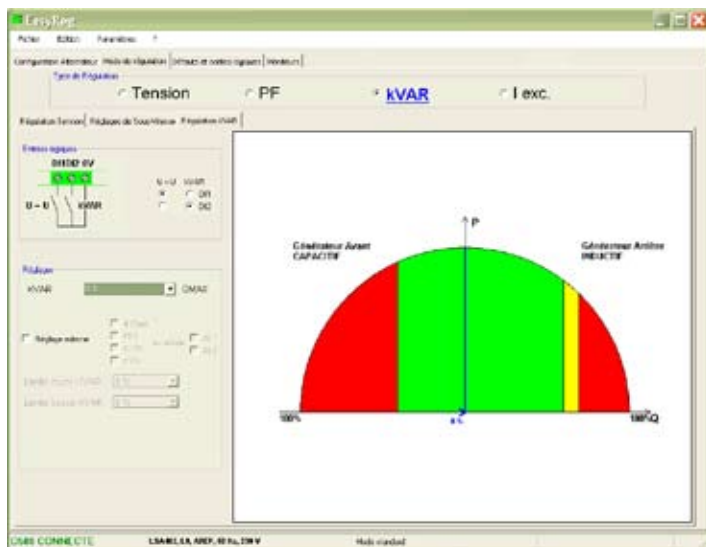
C1 - Digital inputs

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.

D500
Automatic Voltage Regulators (AVRs)

C2 - Settings
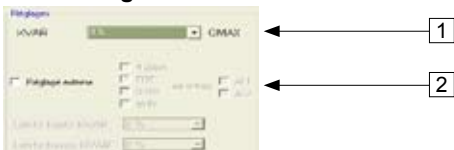
1. Select the value of the reactive power according to the load. This value is between 40% LEAD and 70% LAG.

Warning: When a value is outside the operating limits, 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 for setting the alternator output voltage externally.

Save (see section 3, "Save" part).

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

D - Manual regulation: I exc

This page is split into two parts:
- PC (settings)
- External control

Choose one of these two excitation current settings.
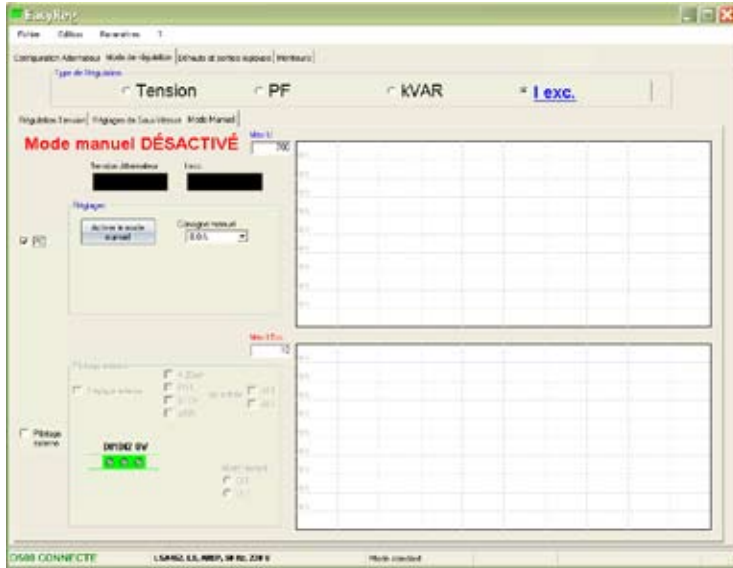
D1 - PC

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.

D500
Automatic Voltage Regulators (AVRs)
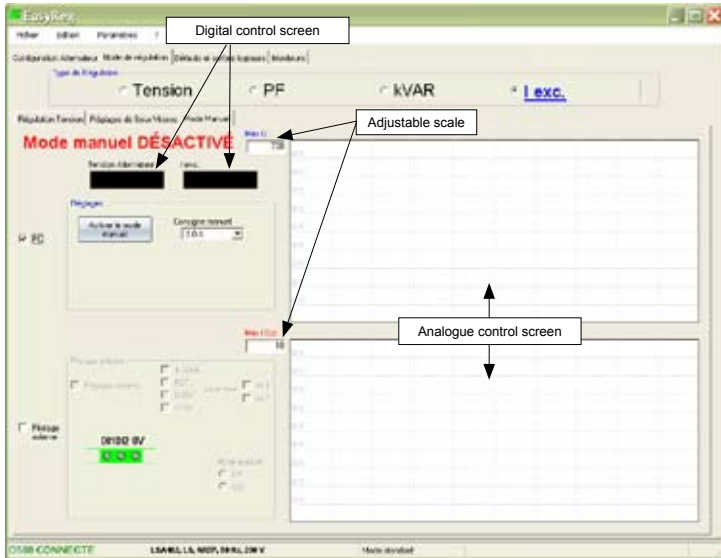
D2 - External control
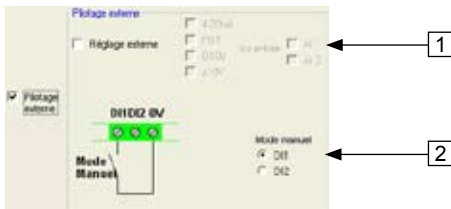
1. To set the excitation current externally, tick the box, select the source (POT, 0-10 V, etc) for this setting and also the input (AI1 or AI2). One of the inputs may be greyed-out if it is already being used for setting the alternator output voltage externally.

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

Save (see section 3, "Save" part).

Load the settings into the AVR by clicking the button:

Charger la programation dans l'alternateur

D500
Automatic Voltage Regulators (AVRs)

3.3.2.1.3 - Faults and digital outputs

This page is split into two parts:
- Assignment of faults
- Assignment of digital outputs
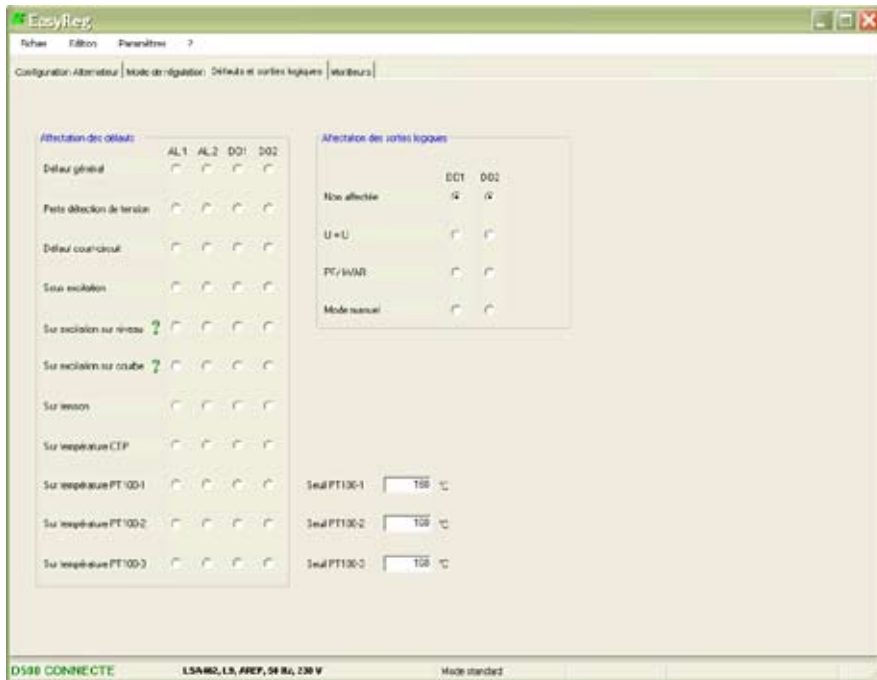
This page offers the possibility of assigning faults and operating modes to 4 outputs (AL1, AL2, D01 and D02).

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

D500
Automatic Voltage Regulators (AVRs)

D500
Automatic Voltage Regulators (AVRs)

3.3.2.1.4 - 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.
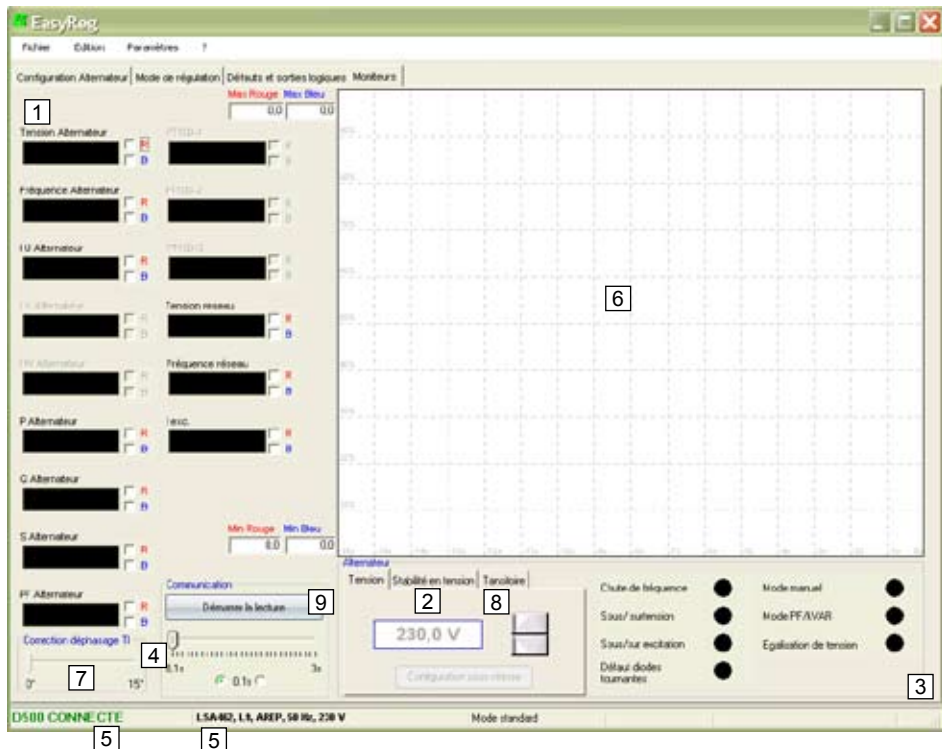
1. The 15 windows display the alternator values compared to the enabled options. Both screens (Alternator I V and Alternator I W), framed in burgundy, are greyed-out when neither of the CTs have been selected.

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 to display the values. The speed at which data is read can also be set.

D500
Automatic Voltage Regulators (AVRs)

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:
- Select the alternator voltage and the excitation current
- 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 reading speed can be adjusted by 0.1 s to 3 s.
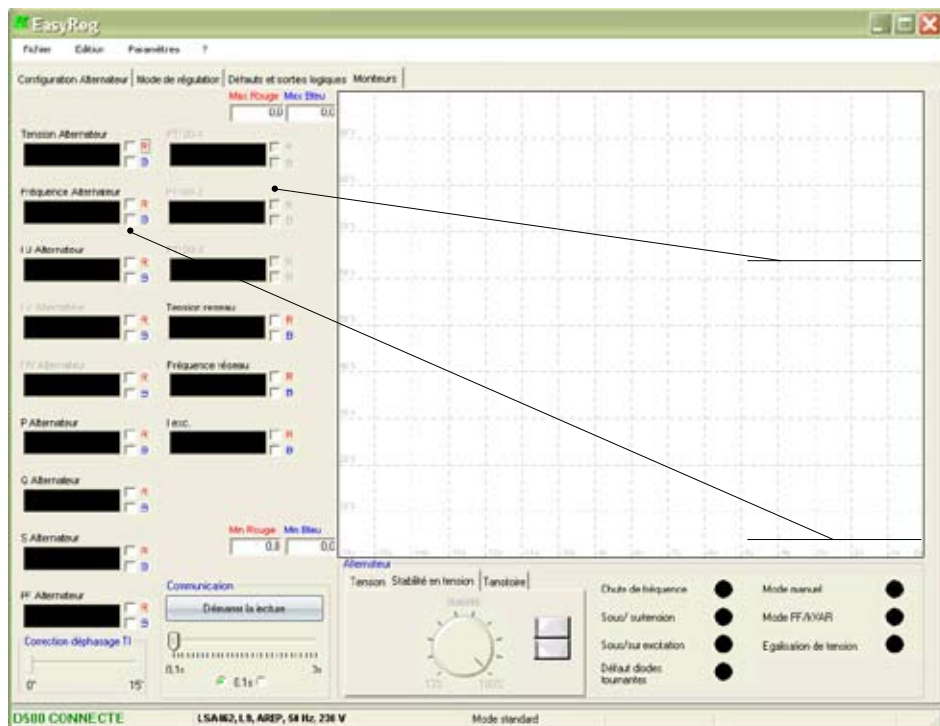
3.3.2.2 - Expert

Expert mode is obtained by clicking on the "Parameters" menu, then "Level". The software offers the choice of either standard or expert. Click "Expert". A page opens and asks for a password.
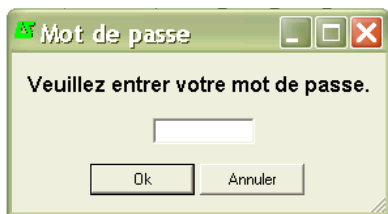
This mode is reserved for users who possess the skills to make certain more complex adjustments or to use the AVR in a wider range of operating conditions.

⚠ **Incorrect settings can harm the AVR and the alternator and can cause serious damage (to users, loads)**.

Programming the AVR with the software in expert mode is similar to the method used in standard mode. The difference is apparent with certain operating ranges and some new settings:

Page	New setting
Alternator Configuration	Duty/Class
Faults & digital outputs	Enabling/Disabling faults
Monitors	PID actions

3.3.2.2.1 - Duty/Class
This setting can be found in the "Alternator Configuration" page.
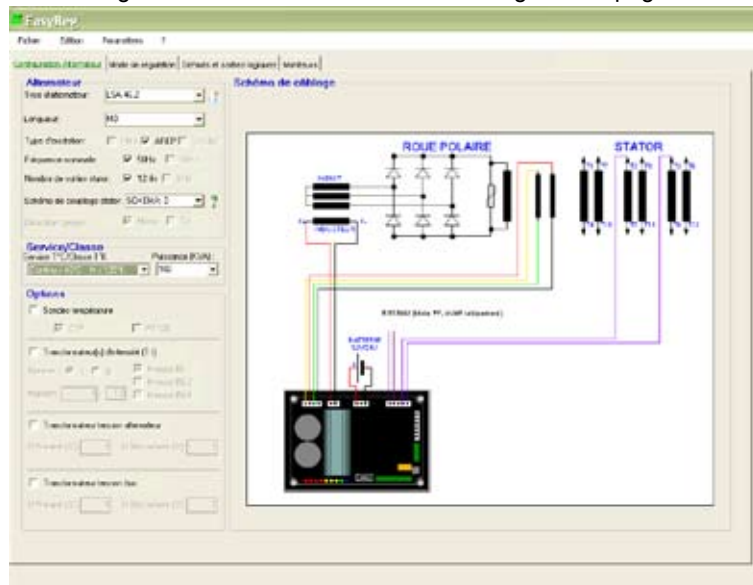
Select the duty type and the class according to your specification.
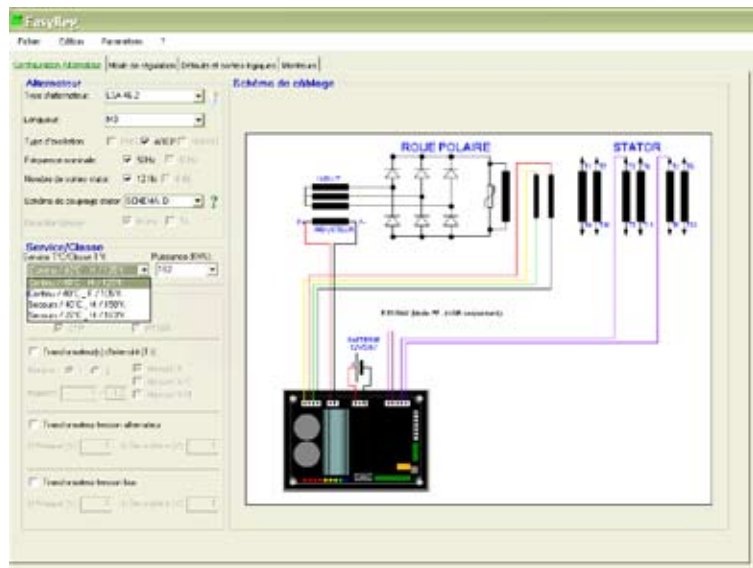
Caution: This setting modifies the power ratings. Make sure all your choices are correct.

D500
Automatic Voltage Regulators (AVRs)

3.3.2.2.2 - Enabling/Disabling faults
This setting can be found in the "Faults & digital outputs" page.
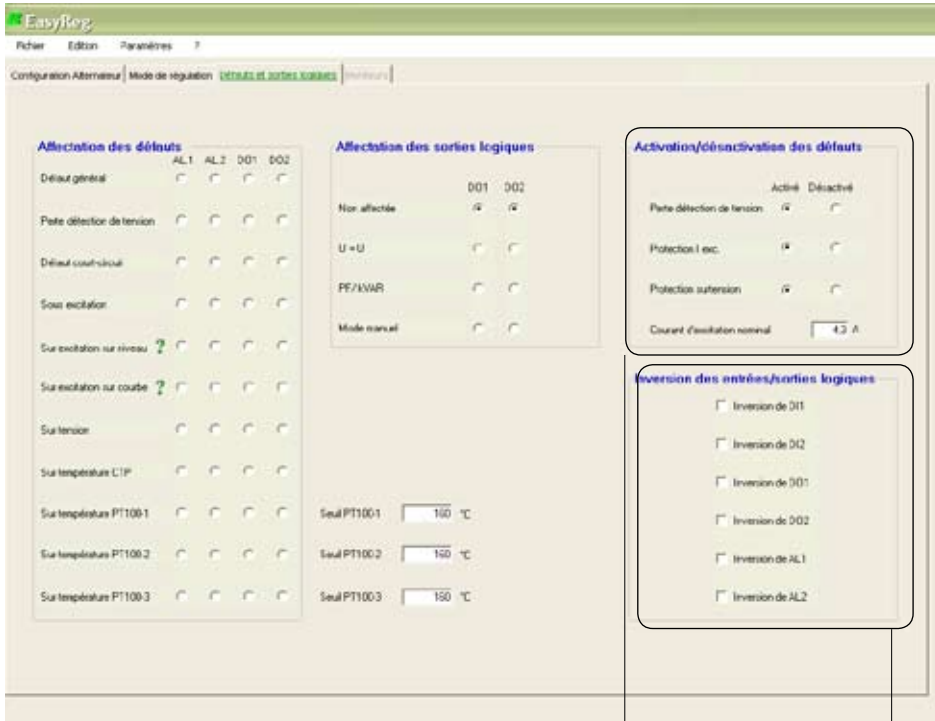
1. To disable "Loss of voltage sensing", check the "Disabled" box
2. To disable "Iexc. protection", check the "Disabled" box
3. To disable "Overvoltage protection", check the "Disabled" box
4. To change the rated excitation current value, write the new value in the appropriate box.

3.3.2.2.3 - PID action

This module can be found in the "Monitors" page.
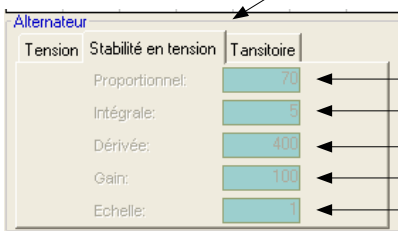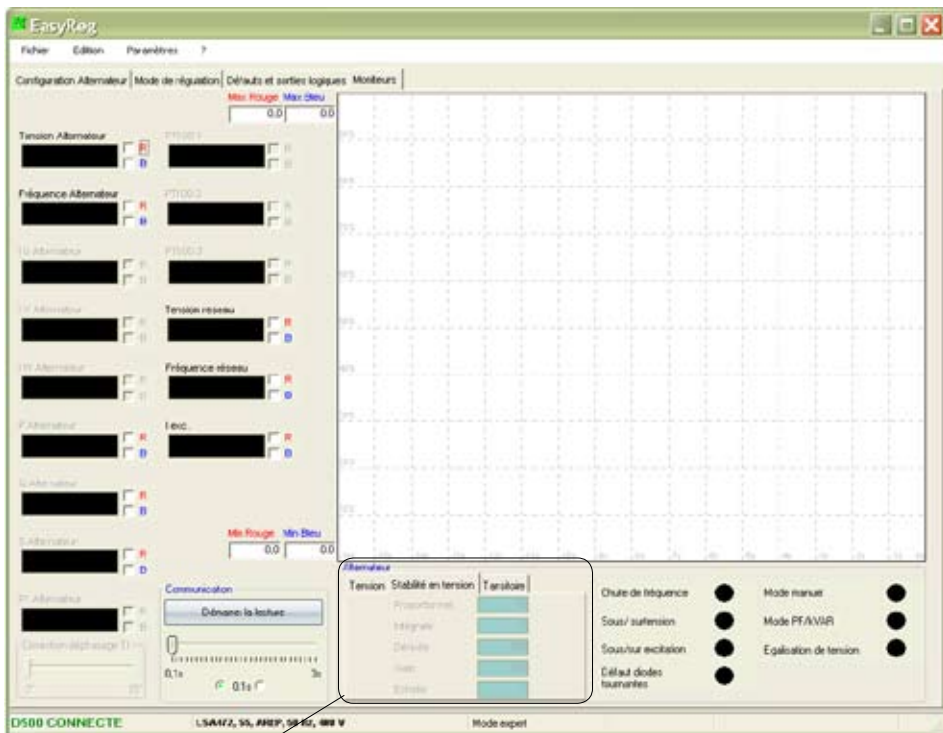
Proportional action value — Proportionnel: 70
Integral action value — Intégrale: 5
Derivative action value — Dérivée: 400
Gain value — Gain: 100
Scale value — Echelle: 1

To change the standard values, write in the blue boxes.

Caution: Setting the PID controller incorrectly may disturb the AVR operation, resulting in instability.

D500
Automatic Voltage Regulators (AVRs)

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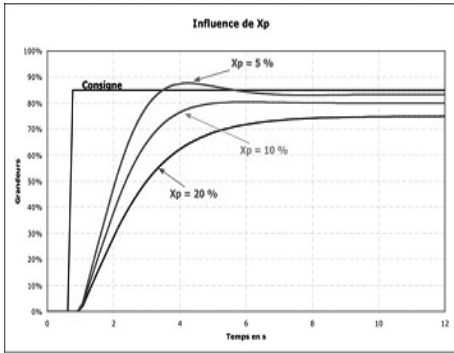
If Xp (proportional band) is small, there may be an overrun but if Xp is too large, the static error is greater.

- 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.
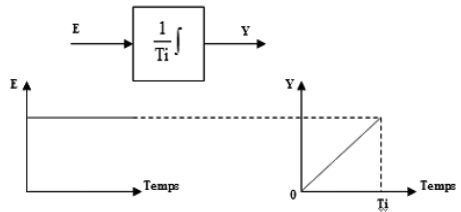
The smaller Ti is, the more quickly the value of output Y increases. The time Ti is the time it takes command Y to increase with the value of input E.
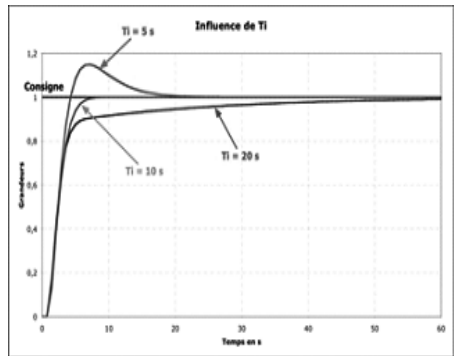
If Ti is too short, there is a strong possibility that the reference will be exceeded but if Ti is too long, the measurement takes longer to reach the reference.

D500
Automatic Voltage Regulators (AVRs)

- 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.

If Td is too long, a static error appears but if Td is very short, the response is longer and a reference overrun occurs.

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.

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

D500
Automatic Voltage Regulators (AVRs)

4 - CONNECTION DIAGRAMS

Régulateur Numérique D510 / digital AVR D510

Bornier avec porte-fusibles / teminal block with fuses
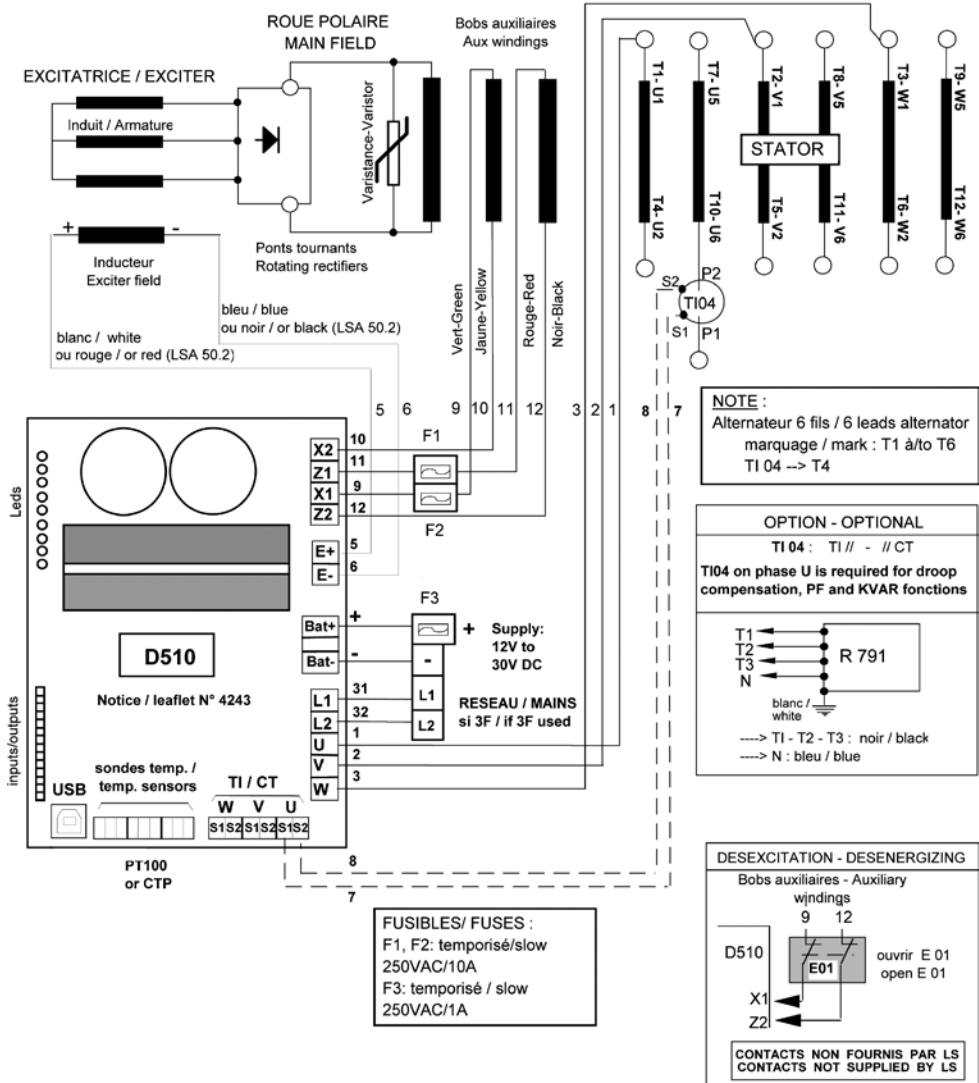
D500
Automatic Voltage Regulators (AVRs)

Régulateur Numérique D510 / digital AVR D510
Bornier avec porte-fusibles / teminal block with fuses

+10V — AI 1 — AI 2 — 0V — AO 1 * — 0V — DI 1 — DI 2 — 0V — DO 1 — AL.1 — AL.2 — DO 2

* AO1 réservé / reserved
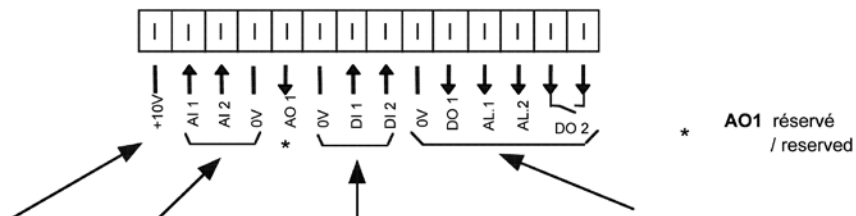
	ENTREES LOGIQUES (DI) / ANALOGIQUES (AI) LOGIC INPUTS (DI) / ANALOGIC INPUTS (AI)			SORTIES LOGIQUES AFFECTEES A UN DEFAUT LOGIC OUTPUTS AFFECTED TO A DEFECT	
+10V	0V - AI1 / 0V - AI2	0V - DI1 / 0V - DI2		0V - DO1 / 0V - AL1 / 0V - AL2	DO2
Reference +10V pour étalonnage source analogique for adjusting analogic supply	Potentiomètre/potentiometer ou/or Alimentation/supply : 0 -10V ou/or +/-10V ou/or 4/20 mA	U = U ou/or PF ou/or mode manuel		Voir tableau d'affectation possible ci dessous See below a possible affectation of defects	sortie relais relay output

SONDES DE TEMPERATURE / TEMPERATURE SENSORS

USB

PT100 ph. 3   PT100 ph. 2   PT100 ph.1

OR

USB

CTP ph.1
CTP ph.2
CTP ph.3
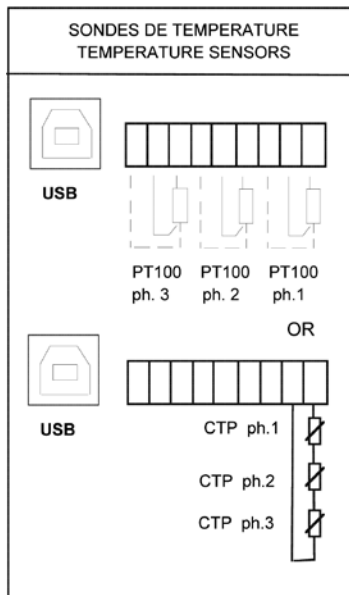
AFFECTATION POSSIBLE DES DEFAUTS / POSSIBLE AFFECTATION OF DEFECTS

	AL.1	AL.2	DO1	DO2
défaut général / general defect	o	o	o	o
perte détection tension / loss of sensing	o	o	o	o
défaut court-circuit / short-circuit defect	o	o	o	o
sous excitation / under excitation	o	o	o	o
niveau sur-excitation / over-excitation level	o	o	o	o
limitation de l'excitation / excitation limitation	o	o	o	o
surtension / over voltage	o	o	o	o
CTP activée / PTC activated	o	o	o	o
sur température / over temperature PT100-1	o	o	o	o
sur température / over temperature PT100-2	o	o	o	o
sur température / over temperature PT 100-3	o	o	o	o

D500
Automatic Voltage Regulators (AVRs)

5 - FAULT FLOW CHARTS

```
                    ┌─────────────────────────────┐
                    │     Absence of voltage       │
                    └─────────────────────────────┘
                                  │
                                  ▼
                    ┌─────────────────────────────┐
                    │ Check the power supply is    │──────────────┐
                    │ present on the AVR           │              │
                    │ Green "POWER ON" LED active  │              │
                    └─────────────────────────────┘              │
                          Yes                      No            │
                           ▼                        ▼            │
                 ┌──────────────────┐   ┌──────────────────────┐
                 │ Check the        │   │ Check the wiring and │
                 │ regulation mode  │   │ the supply voltage   │
                 └──────────────────┘   │ between 12 and 30 V  │
                    Yes          No      └──────────────────────┘
                     ▼            ▼                 │
           ≤ 7%  ┌──────────────────┐   ┌──────────────────────┐
                 │ Check whether the│   │ Start voltage        │
                 │ measured voltage │   │ regulation           │
                 │ ≤ 7% of UN       │   └──────────────────────┘
                 └──────────────────┘
                     ▼           ≥ 7%
   ┌─────────────────────────┐  ┌──────────────────────────┐
   │ Check the polarity of   │  │ Check the exciter field  │
   │ the exciter field       │  │ connections              │
   └─────────────────────────┘  └──────────────────────────┘
              Fault                        Fault
               ▼                             ▼
   ┌─────────────────────┐       ┌──────────────────────────┐
   │ Modify the wiring,  │       │ Modify the exciter field │
   │ then reboot the     │       │ wiring or replace it if  │
   │ machine if necessary│       │ faulty                   │
   └─────────────────────┘       └──────────────────────────┘
               ▼
   ┌─────────────────────┐ Fault ┌──────────────────────────┐
   │ Check the diode     │──────▶│ Replace the diode bridge │
   │ bridge              │       │ if faulty                │
   └─────────────────────┘       └──────────────────────────┘
              OK
               ▼
        ┌─────────────────────┐
        │ Replace the AVR     │
        └─────────────────────┘
               ▼
   ┌─────────────────────────────────┐
   │ Generator and control running   │◀──
   └─────────────────────────────────┘
```

D500
Automatic Voltage Regulators (AVRs)

```
┌──────────────────────────────────────┐
│   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**

OK

Measure the voltage sensing on terminal block 4 (380 - 220 Volt)   **Fault**

OK

Correct the value of the external analogue input if necessary or the AVR internal reference

Fault   **OK**

Check the USB link to terminal block 7 Blue LED on

OK   **Fault**

Modify the wiring

Replace the AVR

Check the connections or Replace the USB cable Re-install Easyreg

OK

Generator and control running

D500
Automatic Voltage Regulators (AVRs)

```
┌─────────────────────────────────────────┐
│   Voltage too low/Red LED on VOLT        │
└─────────────────────────────────────────┘
                    │
                    ▼
        ┌──────────────────────────┐          Fault
        │ Check the speed of rotation │──────────────┐
        └──────────────────────────┘              ▼
                    │ OK                   ┌──────────────┐
                    ▼            Fault      │ Adjust the    │
        ┌──────────────────────┐◄──────────│ generator speed│
┌──────────────┐│ Monitor the load applied │          │ of rotation   │
│ Readjust the ││◄──────────to the alternator │◄────────└──────────────┘
│ load         ││   Fault   └──────────────────────┘          │ OK
└──────────────┘                │ OK                           ▼
                                ▼                   ┌──────────────────────┐
                    ┌──────────────────────┐        │ Check and if necessary│
            Fault   │  Check the exciter field │     │ adjust the position of│
        ┌───────────│                          │     │ the U/F activation    │
        ▼           └──────────────────────────┘     │ knee-point            │
┌──────────────┐            │ OK                      └──────────────────────┘
│ Replace the  │            ▼                              │ Fault
│ exciter field│  ┌──────────────────────┐                 ▼
└──────────────┘  │ Check whether the remanent│   ┌──────────────────────┐
        │    ≤ 7% │ voltage is ≤ 7% of UN    │   │ Check the USB link to  │
        │         └──────────────────────────┘   │ terminal block 7       │
        ▼               │ ≥ 7%                    │ Blue LED on            │
┌──────────────┐        ▼                         └──────────────────────┘
│ Replace the  │  ┌──────────────────────┐   OK      │ Fault
│ rotating diodes│ │   Replace the AVR    │◄──────────┤
└──────────────┘  └──────────────────────┘           ▼
                        │    OK              ┌──────────────────────┐
                        │                    │ Check the connections or│
                        │                    │ Replace the USB cable │
                        ▼                    │ Re-install Easyreg     │
          ┌──────────────────────────┐      └──────────────────────┘
          │ Generator and control running │◄──────── OK
          └──────────────────────────┘
```

D500
Automatic Voltage Regulators (AVRs)

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

Left branch boxes:

```
┌─────────────────────────┐
│ Check the USB link to   │  OK
│ terminal block 7        │────────
│ Blue LED on             │
└─────────────────────────┘
         │ Fault
         ▼
┌─────────────────────────┐  OK
│ Check the connections or│────────
│ Replace the USB cable   │
│ Re-install Easyreg      │
└─────────────────────────┘
```

D500
Automatic Voltage Regulators (AVRs)

Response time too long

Does the speed regulator respond quickly enough?

Fault

OK

Adjust the speed stability of the prime mover

Set the Monitor Screen stability

Fault

Adjust the AVR stability potentiometer in Easyreg

Fault

Reduce the value of the gradual voltage return (7 s/10 Hz factory setting)

Fault

Fault

Replace the D500 AVR

OK

OK

Start generator and control running

D500
Automatic Voltage Regulators (AVRs)

Considerable drop in voltage, on-load

Check the D500
configuration
(LAM, U/F, etc)

OK

Check the generator
load level — **Fault** → Decrease the load

OK

Check the value of the
CT and the ratio setting ← **Fault** — Check the quadrature
droop parameter settings

Adjust the quadrature
droop
(factory setting 3%)

OK **Fault**

OK

Check the wiring of the
voltage reference U/V/W — **Fault** → Modify the wiring

OK

Check the position and
location of the CT on
phase U — **Fault** → Modify the wiring

OK

Replace the D500 AVR

Start generator and
control running

D500
Automatic Voltage Regulators (AVRs)

```
                    ┌─────────────────────────────┐
                    │  KVAR phase imbalance or    │
                    │  Incorrect PF regulation    │
                    └─────────────────────────────┘
                                   │
        Enabled                    ▼
┌──────────────────────┐   ┌─────────────────────────┐
│ Enable KVAR or PF    │◄──│ Check that KVAR or PF   │
│ regulation (yellow   │   │ mode has been enabled   │
│ LED on)              │   │ (yellow LED on)         │
└──────────────────────┘   └─────────────────────────┘
         │                            │ Inactive
  OK     │ Fault                      ▼                  Fault
         ▼                  ┌─────────────────────────┐        ┌─────────────────────┐
┌──────────────────────┐   │ Check whether quadrature│───────►│ Quadrature droop    │
│ Check the USB link   │   │ droop has been enabled  │        │ disabled            │
│ to terminal block 7  │   └─────────────────────────┘        └─────────────────────┘
│ Blue LED on          │              │ OK                 Fault
└──────────────────────┘              ▼
         │            OK     ┌─────────────────────────┐        ┌─────────────────────┐
  OK     │                   │ Check the no-load       │───────►│ Match the voltages  │
         ▼                   │ voltages are matched    │        └─────────────────────┘
┌──────────────────────┐    │ before connecting       │
│ Check connections    │    └─────────────────────────┘
│ or                   │               │ OK                 Fault
│ Replace the USB cable│               ▼
│ Re-install Easyreg   │    ┌─────────────────────────┐        ┌─────────────────────┐
└──────────────────────┘    │ Check the wiring of the │───────►│ Modify the wiring   │
         │                  │ voltage sensing U/V/W   │        └─────────────────────┘
         │                  └─────────────────────────┘
         │                             │ OK                 Fault
         │                             ▼
         │                  ┌─────────────────────────┐        ┌─────────────────────┐
         │                  │ Check the position of   │───────►│ Modify the wiring   │
         │                  │ the CT on phase U (P1 at│        └─────────────────────┘
         │                  │ source end) and the     │
         │                  │ output connections(S1-S2)│
         │                  └─────────────────────────┘
         │                             │ OK
         │                             ▼
         │                  ┌─────────────────────────┐
         └─────────────────►│ Replace the D500 AVR    │
                            └─────────────────────────┘
                                       │
                                       ▼
                            ┌─────────────────────────┐
                            │ Start generator and     │
                            │ control running         │
                            └─────────────────────────┘
```

D500
Automatic Voltage Regulators (AVRs)

```
                        ┌────────────────────────────────┐
                        │   PF or KVAR range incorrect    │
                        └────────────────────────────────┘
                                      │
        Fault                         ▼
  ┌──────────────────┐     ┌────────────────────────┐
  │ Enable KVAR or PF │◄────│ Check that KVAR or PF  │
  │ regulation        │     │ mode has been enabled  │
  │ (yellow LED on)   │     └────────────────────────┘
  └──────────────────┘              │ OK
          │                         ▼
   OK     │  Fault          ┌────────────────────────┐     ┌──────────────────────┐
          ▼                 │ Check the selection     │────►│ Enable the setting    │
  ┌──────────────────┐      │ mode (internal or      │     │ mode                  │
  │ Check the USB link│     │ external)               │     └──────────────────────┘
  │ to terminal       │     └────────────────────────┘
  │ block 7           │       OK    │ OK    Fault        OK
  │ Blue LED on       │             ▼                       ▼
  └──────────────────┘      ┌────────────────────────┐     ┌──────────────────────┐
          │  Fault          │    Replace the AVR       │    │ Check and modification│
          ▼                 └────────────────────────┘     │ of the setting range  │
  ┌──────────────────┐     OK        │ OK                   │ and limits            │
  │ Check connections │              │         Fault        └──────────────────────┘
  │ or                │              ▼
  │ Replace the USB   │     ┌────────────────────────┐
  │ cable             │     │ Start generator and     │
  │ Re-install Easyreg│     │ control running         │
  └──────────────────┘     └────────────────────────┘
```

D500
Automatic Voltage Regulators (AVRs)

Voltage matching impossible

Check that there is a mains voltage reference on terminal block 4

Fault

Check the wiring of the mains voltage on terminal block 4

OK

Check that U = U mode has been enabled (yellow LED on)

Fault

Check and modify, if necessary, the wiring of the digital input on terminal block 8 DI1 DI2

OK

OK

Fault

OK

Replace the AVR

Modify the wiring

OK

Start generator and control running

D500
Automatic Voltage Regulators (AVRs)

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 overvoltage or undervoltage
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	→	AvrSoft software/ D500 communication