

D510 C

Digital voltage regulator

Installation and maintenance

LEROY-SOMER™

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All for dreams

D510 C

Digital voltage regulator

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

SAFETY MEASURES

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

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

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

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

WARNING

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



Warning symbol for general danger to personnel.



Warning symbol for electrical danger to personnel.



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



When the generator is driven at a frequency below 28 Hz for more than 30 seconds with an analogue AVR, its AC power supply must be disconnected.

WARNING

This AVR can be incorporated in a EC-marked machine. This manual is to be given to the end user.

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Disposal and recycling instructions



The temperature can more than 70°C in surface, the product must be place inside the terminal box or an electrical panel.

The AVR is IP00, it must be incorporated in an environment which ensures it a IP20 protection.

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General description

This manual describes how to install, use, set up and maintain the D510 C AVR.

The purpose of this AVR is to regulate alternators with a field current of less than 6 A in continuous operations, and 15 A maximum in the event of short-circuit for 10 seconds maximum.

It is designed for mounting in a generator terminal box or a control cabinet. It must be installed in compliance with local protection and safety standards, especially those specific to electrical installations with a maximum voltage of 300VAC phase/neutral.

It is an electronic card molded in a polyurethane resin.

EasyReg software

The D510C must be configured using the dedicated EasyReg software (only compatible with PCs). The EasyReg software is available on the Leroy-Somer website:

www.leroy-somer.com/epg



Scan the code or go to <http://lrsm.co/d510>
to access product documentation and software.

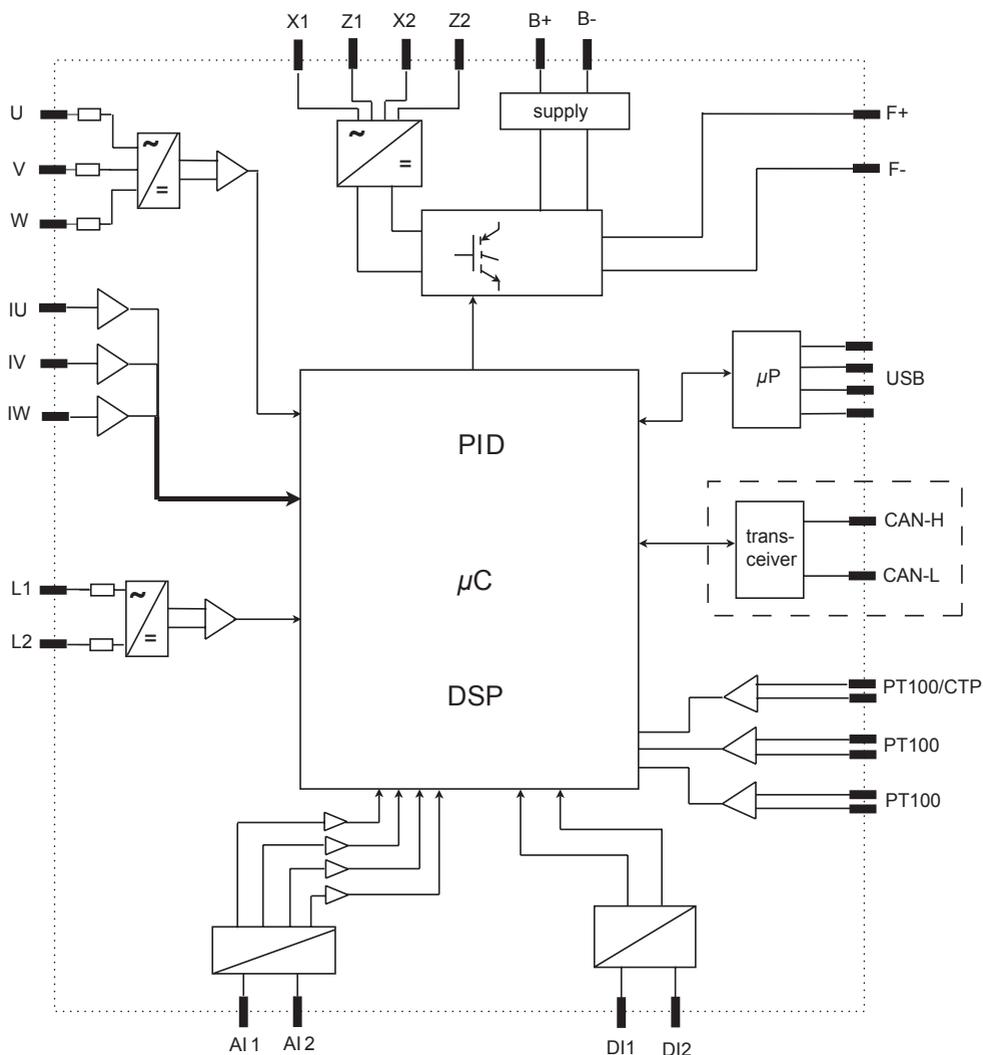
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1 - PRESENTATION

1.1 - Operation

A schematic diagram of the D510C appears below.



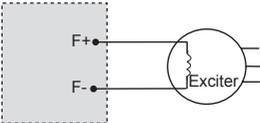
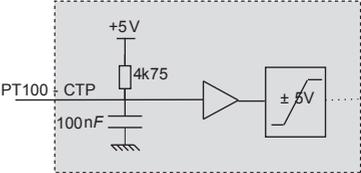
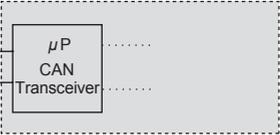
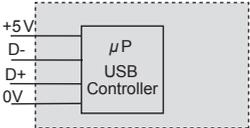
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Terminals	Signals	Scheme
X1 X2 Z1 Z2	Power supply - Auxiliary winding input - PMG input - SHUNT input	
L1 L2	Mains voltage measurement	
U V W	Alternator voltage measurement For single-phase: use V and W	
IU = (s1, s2) IV = (s1, s2) IW = (s1, s2)	Alternator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

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

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

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

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

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

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

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

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

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

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

• **Alternator voltage:** This input measures the alternator output voltage to the AVR in:
- three-phase (U, V, W)
- single-phase (V, W)

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

• The possible configurations are:

- 1 CT on phase U

- 3 CTs on phases U, V and W

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

• **Communication:**

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

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

• **I/O: This part is used to:**

- Enter settings

- Send information from the D510C

- Receive information from the alternator

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

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1.2 - Characteristics

The different functions of the D510C are:

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

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

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



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

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

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

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

These functions are selected when setting the AVR parameters.

1.3 - Specifications

1.3.1 - Characteristics

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

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Name	Minimum value	Maximum value	Adjustable
LAM knee-point	37 Hz*	100 Hz*	Yes*
Adjustable LAM	70% of Voltage reference	100% of Voltage reference	Yes
Variable U/F	1.0	3.0	Yes
Voltage reference setpoint	90 V	530 V**	Yes
Adjustment of external accuracy	- 10%***	+ 10%***	Yes***
Quadrature droop	0%	+ 10%	Yes
Soft start acceleration	0.1 s	120 s	Yes
Loading acceleration	0.1 s/10 Hz	30.0 s/10 Hz	Yes
Voltage drop compensation	0%	10%	Yes
Excitation current manual reference	0 A	10 A	Yes
Rated cosine 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	no
PT100 temperature threshold	50°C	200°C	no
PTC input	0%	100%	no

1.3.3 - Environments

Storage temperature: -55°C +85°C

Operating temperature: -40°C +65°C

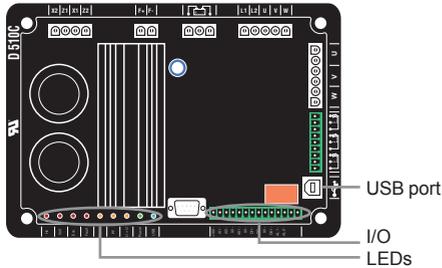
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2 - HUMAN-MACHINE INTERFACE

The D510C human-machine interface consists of 3 elements:

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



2.1 - Communication

USB link

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



Connect to the PC

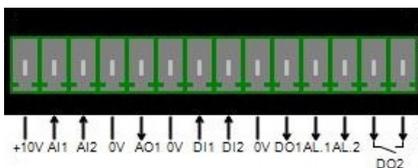


Connect to the D510C

Warning: In **SHUNT** operation, please use a USB isolator to connect the PC to the D510C. Do not connect the USB during the starting if the DC supply of the AVR is switched off.

2.2 - Analog I/O

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



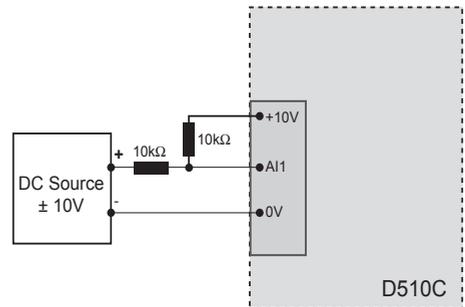
The minimum analogic input setting is 0% and the maximum is 100%.

External by setting is either:

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

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. For applications requiring the use of +/-10V, the D510C must be configured as 0-10V and the following schematic must be used.



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.

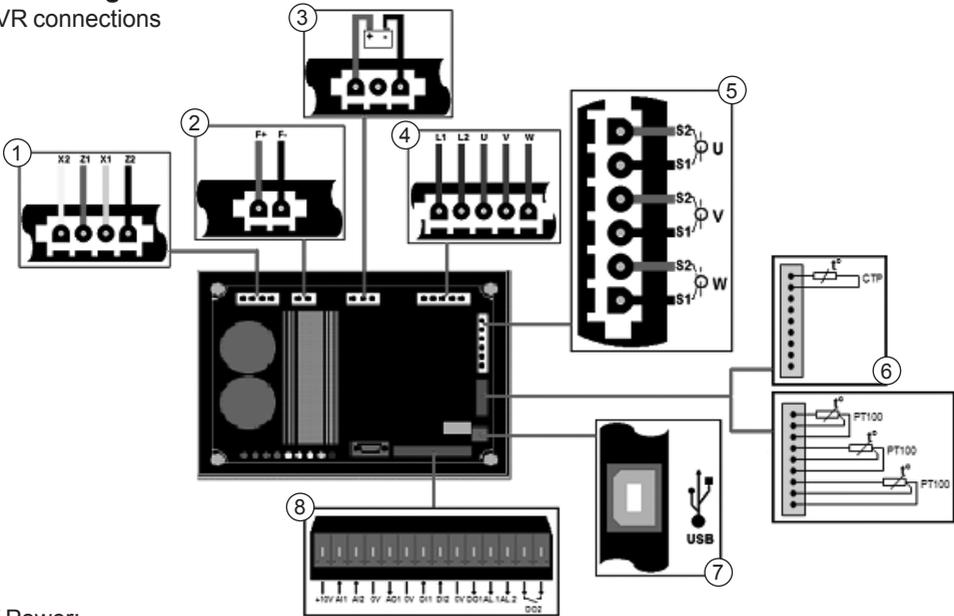
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Name	Colour	Meaning
Power ON	Green	The board is supplied with power
↓ Hz	Red	Speed drop
↑ / ↓ Volt	Red	Problem of overvoltage or undervoltage
↑ / ↓ Exc.	Red	Problem of overexcitation or underexcitation
 Fault	Red	Problem on the exciter field diode 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

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3 - SETTING THE FUNCTION PARAMETERS

EasyReg is a Leroy Somer Software which allows to :

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

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

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

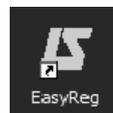
3.1 - Installation

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

3.2 - Startup

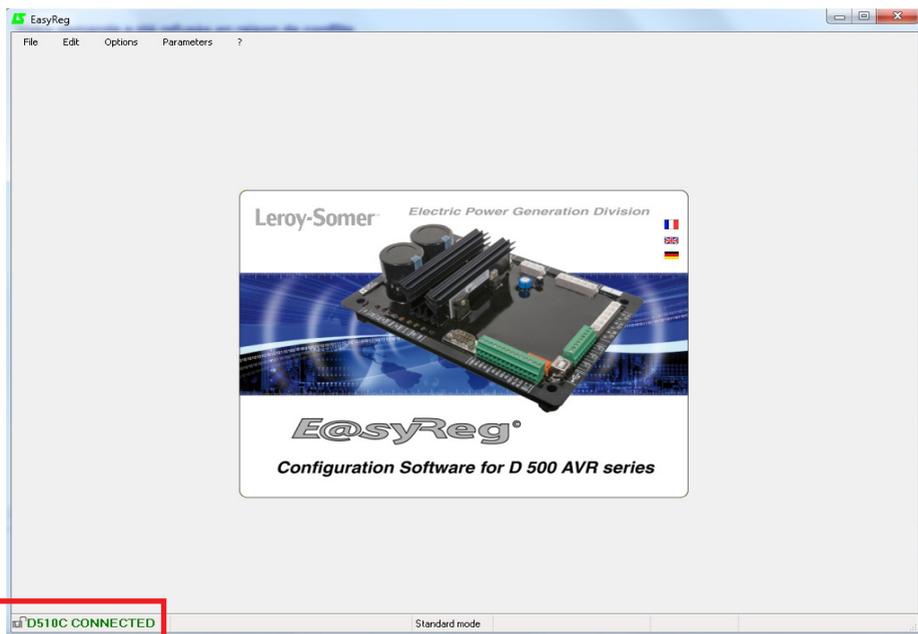
Connect the AVR to the computer with a USB cable. Check that the blue «USB» LED is on.

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



3.3 - Appearance

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

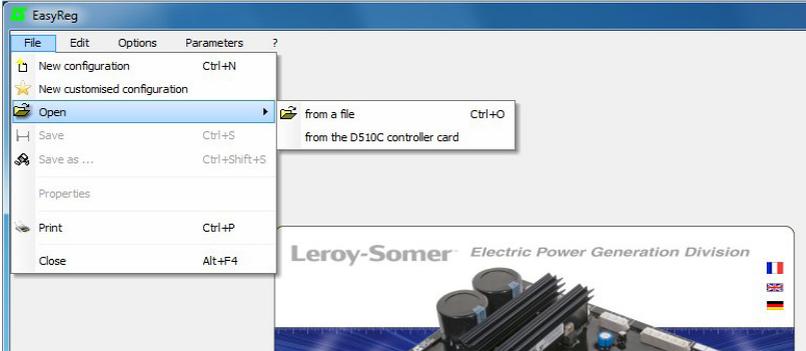


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There are four options when using this software:

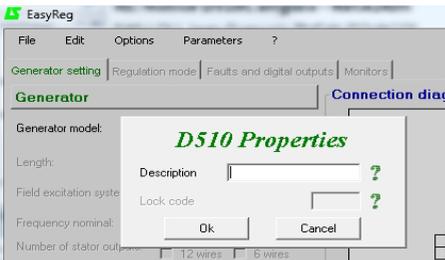
- New configuration
- Open a configuration from a file
- Open a configuration from the pre-programmed AVR.
- Create customised configuration (Expert mode)



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

PROPERTIES

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



PRINT

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

3.3.1 - Languages and modes

3.3.1.1 - Languages

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



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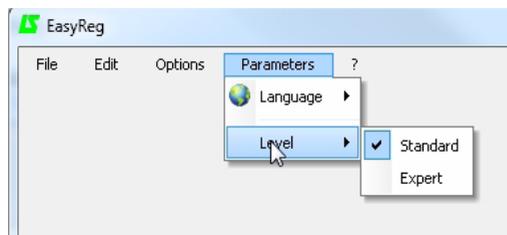
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3.3.1.2 - Modes

Two operation modes are possible:

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

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



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



Click on « Copy code » and email the PC code to: LS-SillacTechSupport.IALS@mail.nidec.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).

3.3.2 - Saving and loading the configuration

Save your configuration (for the 1st time):

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

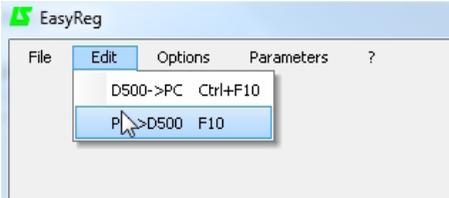
Subsequently, to save the configuration, you just need to go into the «File» menu and click «Save».

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Send the configuration to the AVR:

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

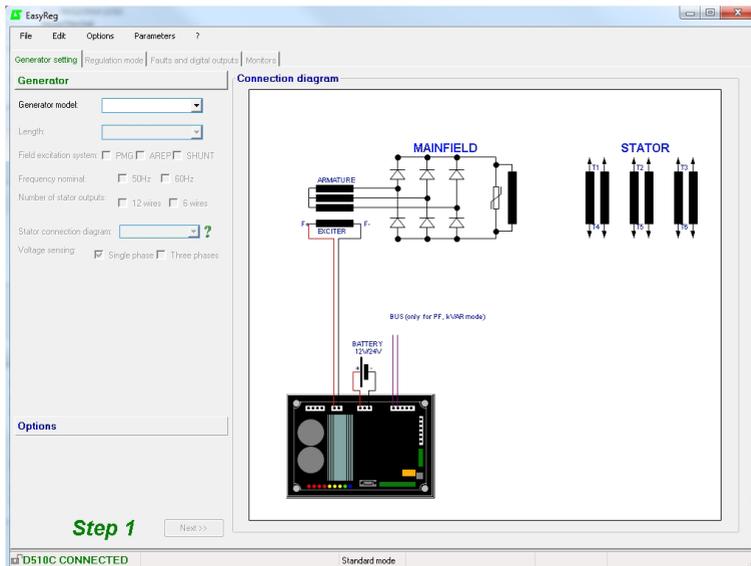


3.3.3 - New configuration

There are two possible configuration levels: standard or expert.

3.3.3.1 - Alternator Configuration

Open «New configuration» from the menu bar, which takes you to the «Alternator Configuration» window. The parameters for this page are set in two parts: Alternator, Options. The wiring scheme varies according to the characteristics specified by the user.



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.

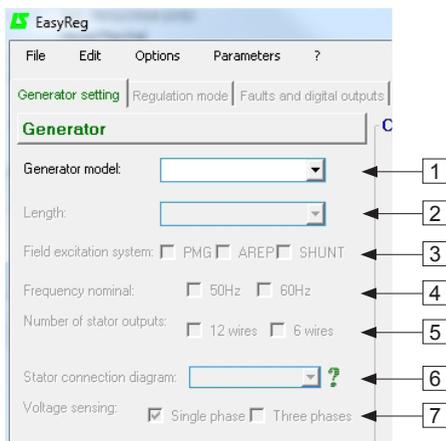
This software must be used in the order indicated below:

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

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• Alternator



In the dropdown lists or boxes, select:

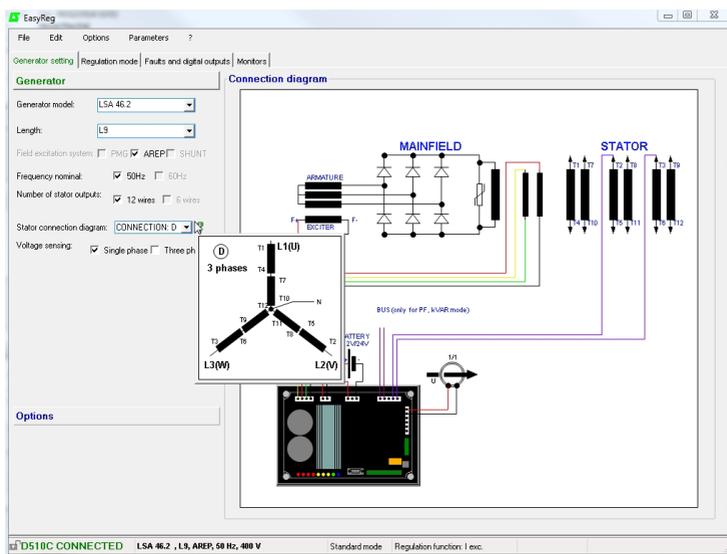
1. The **type of alternator**
2. The **length**
3. The **type of field excitation**
4. The **frequency**
5. The **number of stator outputs**
6. The **stator connections**
7. The **voltage sensing (single or three-phase)**

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

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

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

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



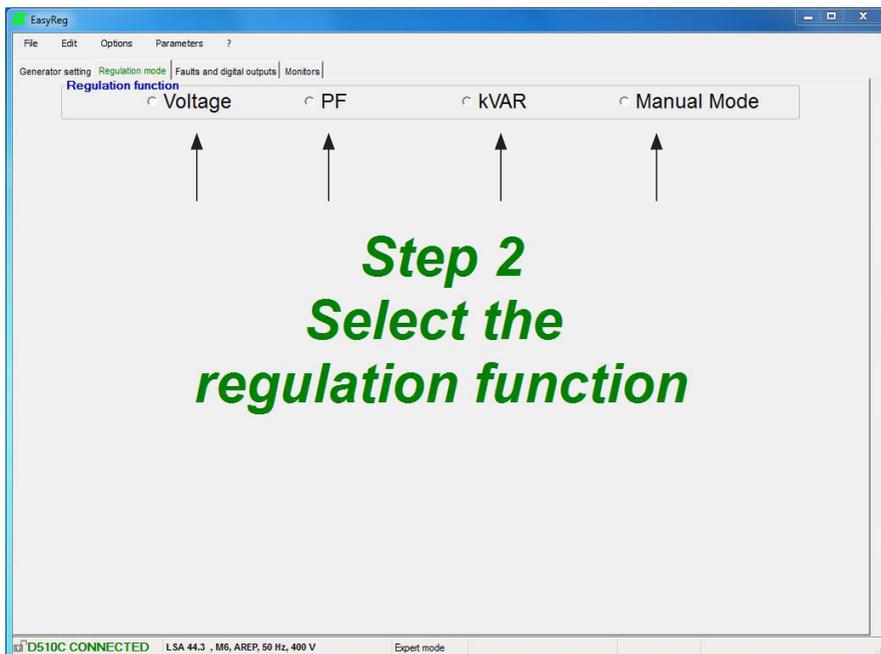
The alternator configuration is recalled at the screen left bottom.

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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 (PF)
- Reactive power (kVAR)
- Manual Mode

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.

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A - Voltage regulation

This page consists of two parts :

- Voltage Regulation

- Underspeed settings

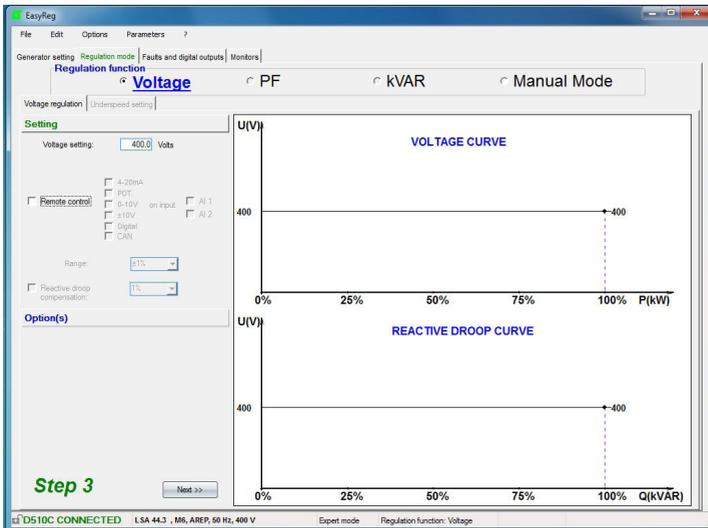
Setting the parameters for this part starts with the «Voltage regulation» page and ends with the «Underspeed settings» page.

A1 - Voltage regulation

This page is split into two parts:

- Settings

- Options



A1.1 - Settings

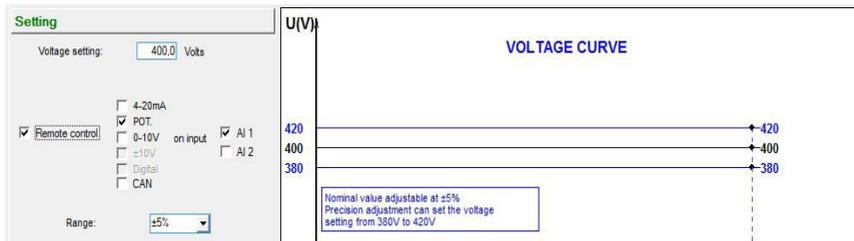
1. The displayed value comes from Easyreg® database. It can be adjusted in the range $\pm 10\%$ maximum.

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

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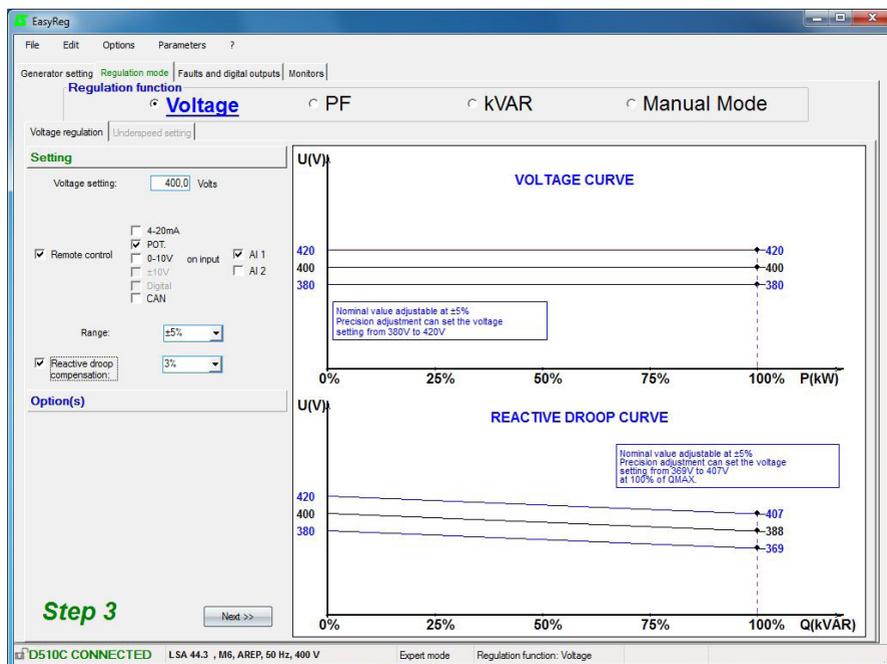
2. To set the voltage externally, tick the box, define by what means (POT, 0-10 V, etc) this setting will be made as well as the selected input (AI1 or AI2), then enter the desired setting range.



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

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

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



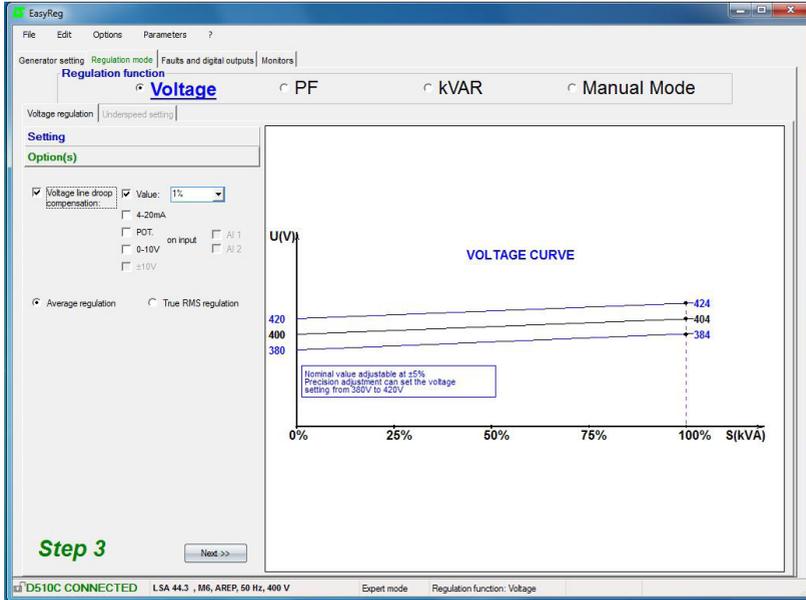
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A1.2 - Options

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

This function is only available if a CT is used.



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



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

2. Select which value regulation should apply to :

- mean value
- true rms value

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

Step 3

Next >>

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A2 - Underspeed settings

This page is split into three parts:

- Starting
- Underspeed
- Engine

A2.1 - Starting

Start

Soft-start: ?

During Second(s)

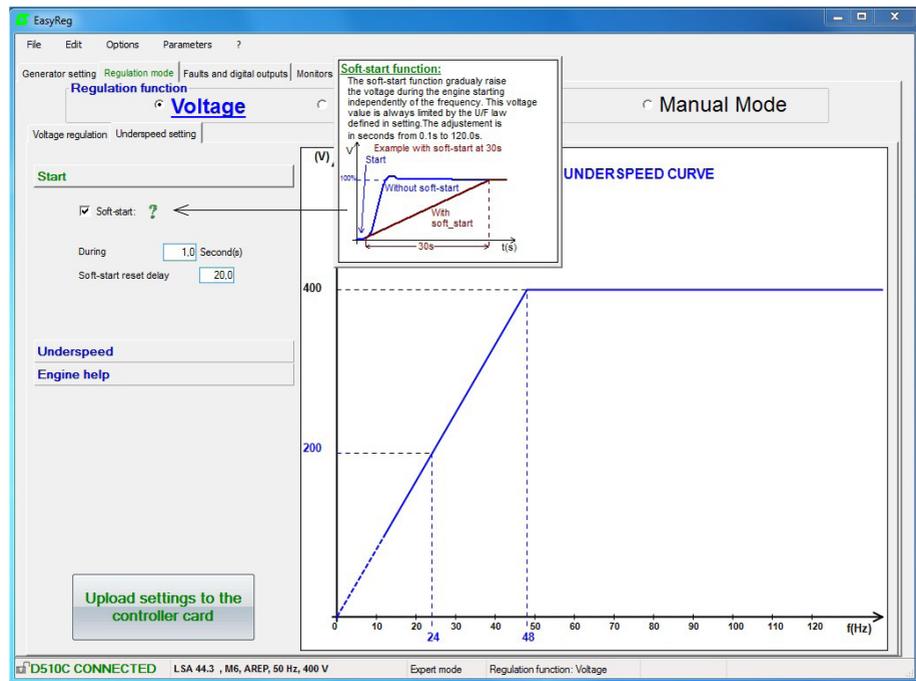
Soft-start reset delay

Factory setting: disabled

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

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

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



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A2.2 - Underspeed

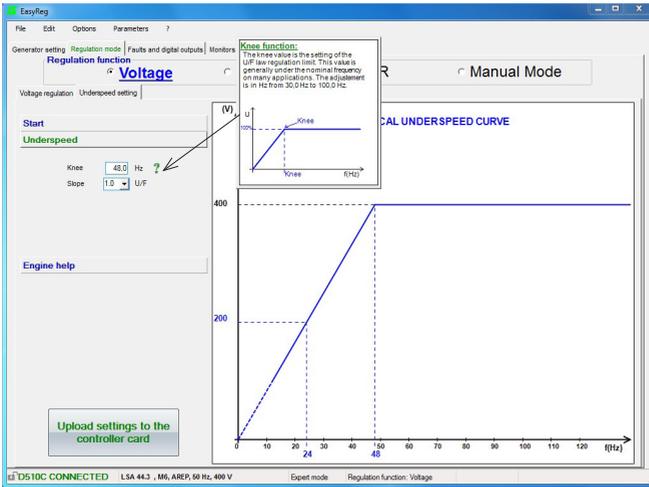
Underspeed

Knee Hz ? ← 1

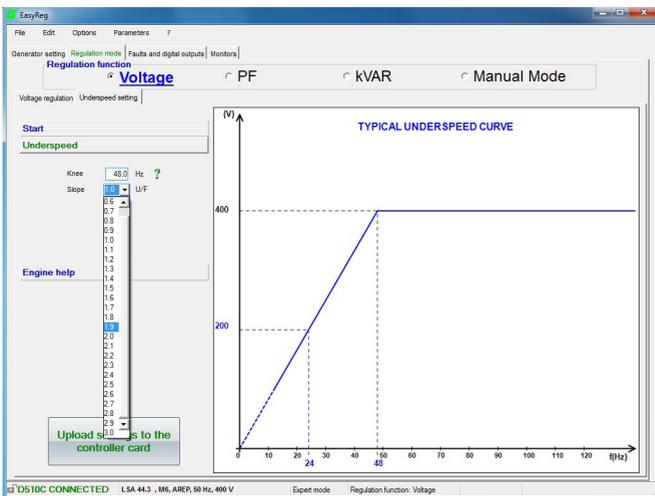
Slope U/F ← 2

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.



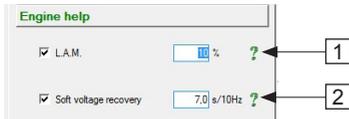
2. Enter the gradient value between 1.0 and 3.0 U/F (1 step = 0.1 U/F). Factory setting: 1/U/F.



D510 C

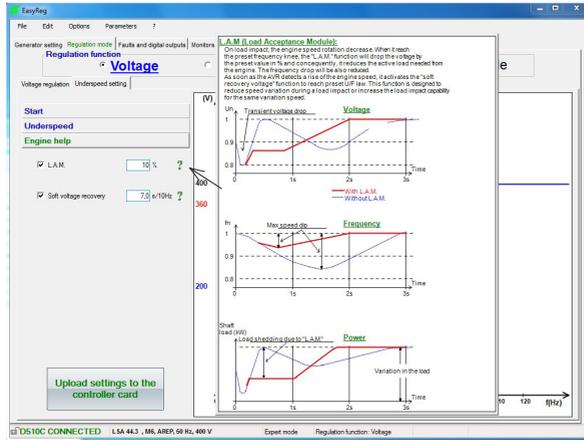
Digital voltage regulator

A2.3 - Motor help

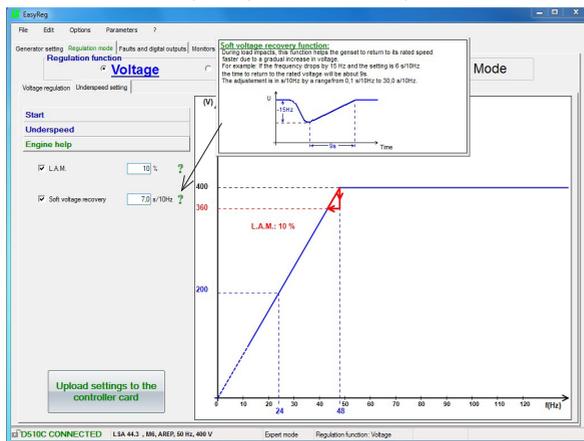


1. If the LAM function is required, tick the box and select its value between 0% and 30% (1 step = 1%).

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/10 Hz (1 step = 0.1 s/10 Hz).



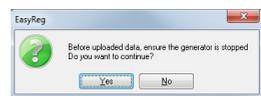
Note: the recommended setting is 7 s/10 Hz

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.



D510 C

Digital voltage regulator

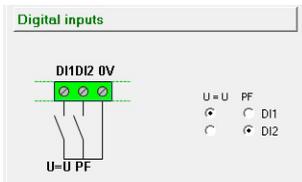
B - Regulation of the power factor

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

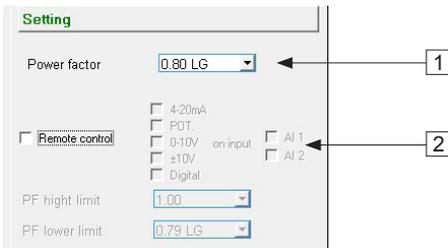
B1 - Digital inputs



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

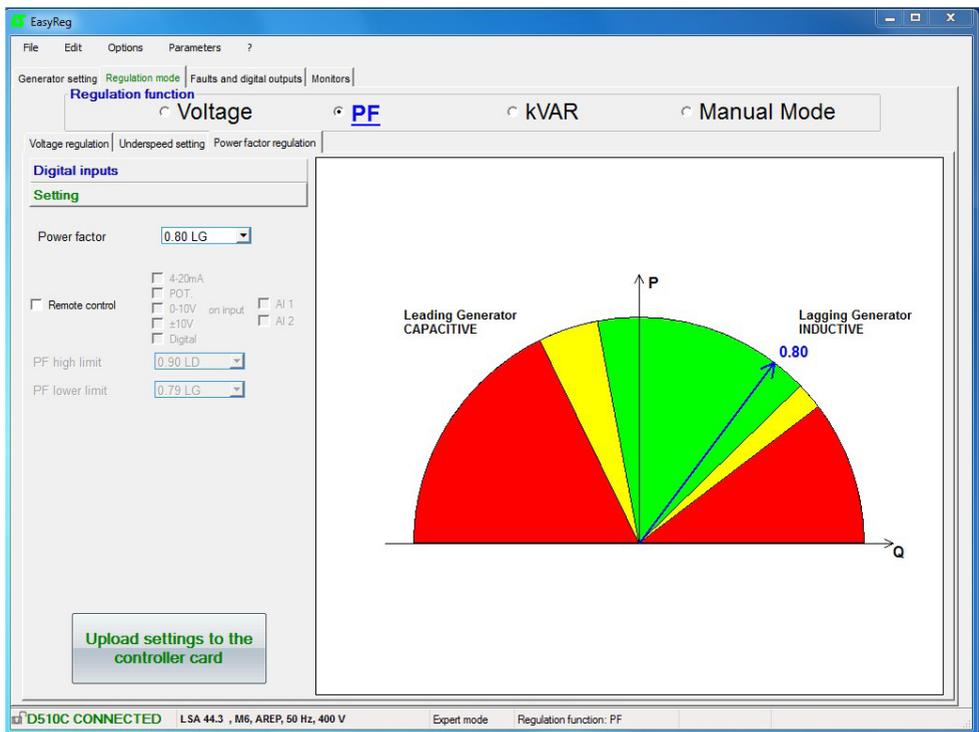
It is possible to set a fix value or use a remote adjustment in a predefined range.



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

D510 C

Digital voltage regulator



- 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.



D510 C

Digital voltage regulator

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.

EasyReg

File Edit Options Parameters ?

Generator setting Regulation mode Faults and digital outputs Monitors

Regulation function

Voltage PF kVAR Manual Mode

Voltage regulation Underspeed setting Power factor regulation

Digital inputs

Setting

Power factor 0.80 LG

Remote control

4-20mA POT 0-10V on input ±10V Digital AI1 AI2

PF high limit 0.99 LD

PF lower limit 0.90 LG

Upload settings to the controller card

D510C CONNECTED LSA 44.3, M6, AREP, 50 Hz, 400 V Expert mode Regulation function: PF

- 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

D510 C

Digital voltage regulator

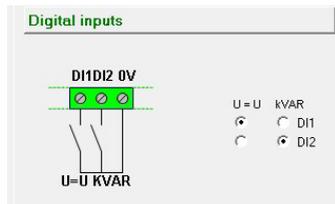
C - Regulation of the reactive power KVAR

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:

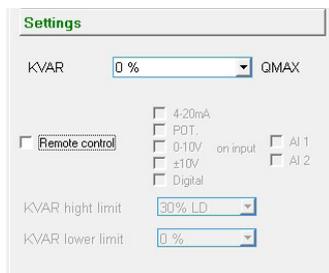
- Digital inputs
- Settings

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.

D510 C

Digital voltage regulator

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

EasyReg

File Edit Options Parameters ?

Generator setting Regulation mode Faults and digital outputs Monitors

Regulation function

Voltage PF kVAR Manual Mode

Voltage regulation Underspeed setting kVAR regulation

Digital inputs

Settings

kVAR 20% LG QMAX

Remote control

4-20mA
POT.
0-10V on input AI 1
±10V AI 2
Digital

kVAR high limit 10% LD

kVAR lower limit 0 %

Leading Generator CAPACITIVE

Lagging Generator INDUCTIVE

100% 20% 100% Q

Upload settings to the controller card

D510C CONNECTED LSA 44.3 , M6, AREP, 50 Hz, 400 V Expert mode Regulation function: kVAR

 Database Authorized area

 Forbidden area

 Database not recommended area

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

Settings

kVAR 70% LG QMAX

Remote control

4-20mA
POT.
0-10V on input AI 1
±10V AI 2
Digital

kVAR high limit 30% LD

kVAR lower limit 0 %

 Please verify the Qmax value of generator

D510 C

Digital voltage regulator

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.

The screenshot shows the EasyReg software interface. The main window is titled "EasyReg" and has a menu bar with "File", "Edit", "Options", "Parameters", and "?". Below the menu bar, there are tabs for "Generator setting", "Regulation mode", "Faults and digital outputs", and "Monitors". The "Regulation mode" tab is active, and the "kVAR" sub-tab is selected. The "Regulation function" section shows "Voltage", "PF", "kVAR", and "Manual Mode" options, with "kVAR" being the active selection. The "Voltage regulation" sub-tab is also active. The "Digital inputs" section shows "Settings" for "kVAR" set to "20% LG" and "QMAX". There are checkboxes for "Remote control" (checked), "4-20mA", "POT", "0-10V on input", "±10V", and "Digital". There are also checkboxes for "AI 1" and "AI 2". The "kVAR high limit" is set to "30% LD" and the "kVAR lower limit" is set to "50% LG". A button labeled "Upload settings to the controller card" is visible. The main display area shows a power factor diagram with a vertical axis labeled "P" and a horizontal axis labeled "Q". The diagram is a semi-circle divided into colored regions: red (Forbidden area), green (Database Authorized area), blue (Remote adjustment operation area), yellow (Database not recommended area), and red (Forbidden area). The diagram is labeled "Leading Generator CAPACITIVE" on the left and "Lagging Generator INDUCTIVE" on the right. The horizontal axis has markers at 100%, 30%, 50%, and 100%.

 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:



D510 C

Digital voltage regulator

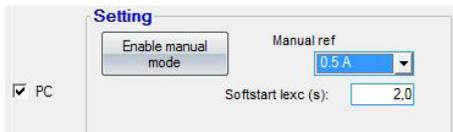
D - Manual regulation: I exc

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.

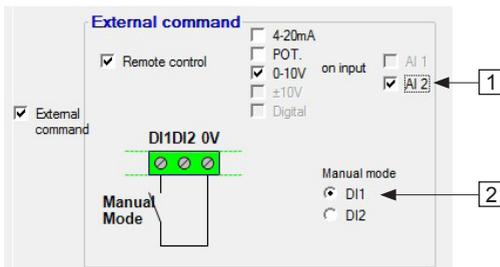
D1 - PC



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.

"Softstart Iexc(s)" allows to gradually increase the excitation current up to the setpoint. A timer up to 5 seconds can be entered.

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.

D510 C

Digital voltage regulator

D3 - Follower mode

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

The screenshot displays the EasyReg software interface for the D510C digital voltage regulator. The main window is titled "EasyReg" and contains several tabs: "Generator setting", "Regulation mode", "Faults and digital outputs", and "Monitors". The "Regulation mode" tab is active, showing three radio buttons for "Voltage", "PF", "kVAR", and "Manual Mode", with "Manual Mode" selected. Below this, there are sub-tabs for "Voltage regulation", "Underspeed setting", and "Manual mode".

In the "Manual mode" sub-tab, the status "Manual mode ENABLED" is displayed in green. The "U Max" is set to 700. The "Generator voltage" is shown as 0,0 V and the "I Exc." is 0,0 A. A "Setting" box contains a "Disable manual mode" button, a "Manual ref" dropdown set to 0.0 A, and a "Softstart lexc (s):" field set to 2,0. A "PC" checkbox is checked.

The "Follower mode" section has a dropdown menu with "Disabled" selected and "Enabled" as an option. The "I Exc Max" is set to 10.

The "External command" section includes a "Remote control" checkbox (checked), a "Digital" checkbox (checked), and a "Manual mode" dropdown menu with "DI1" selected. A "DI1DI2 0V" indicator shows two green circles.

Two empty grid plots are visible on the right side of the interface. The status bar at the bottom indicates "D510C CONNECTED", "LSA 44.3 , M6, AREP, 50 Hz, 400 V", "Expert mode", and "Regulation function: Manual Mode".

D510 C

Digital voltage regulator

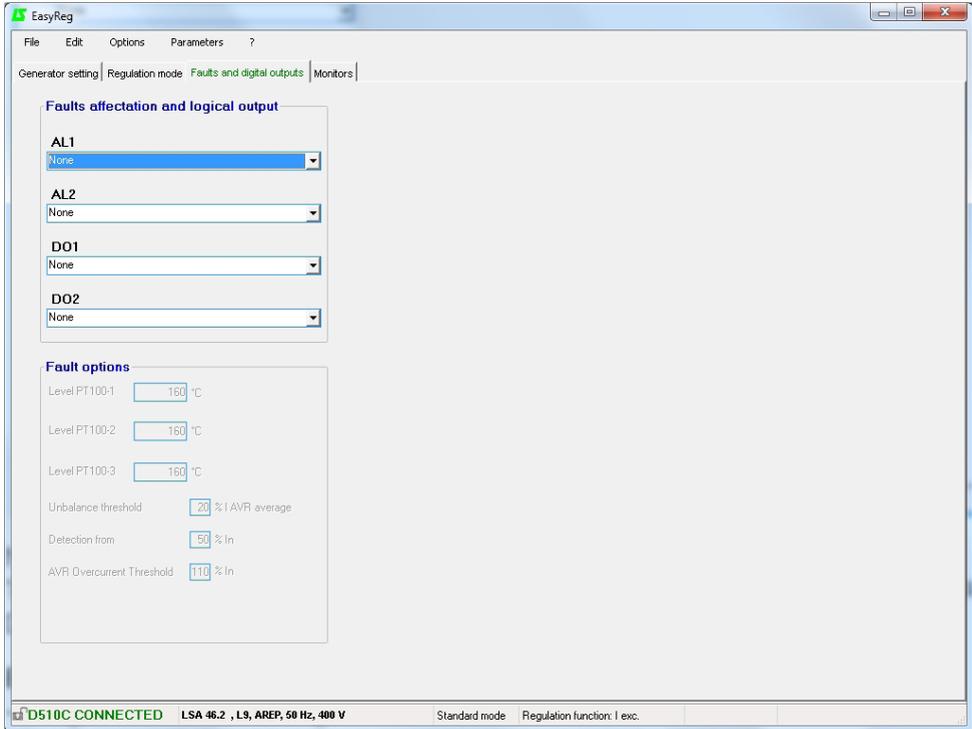
3.3.3 - Faults and digital outputs

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, DO1 and DO2).

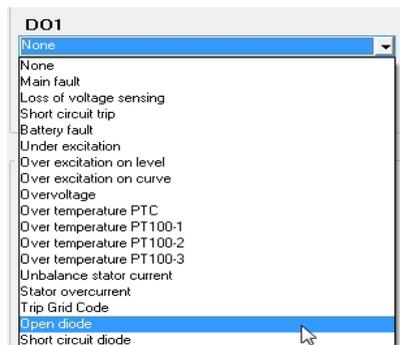
Example of settings:

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

D510 C

Digital voltage regulator

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



- Faults options

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

- On temperature measurement (PT100)
- On stator current unbalance: it is possible to set the level for sensing and unbalancing level compare to the current mean value.

- The Expert mode offers other functions

EasyReg

File Edit Options Parameters ?

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

Faults affection and logical output

AL1: None

AL2: None

D01: None

D02: None

Fault options

Level PT100-1: 160 °C

Level PT100-2: 160 °C

Level PT100-3: 160 °C

Unbalance threshold: 20 % I_{AVR} average

Detection from: 50 % I_n

AVR Overcurrent Threshold: 110 % I_n

Start on Threshold

Enabled ?

% initial PWM: 100.00

Activation threshold (V): 0

Rotating diode bridge fault

DIODE Fault Enabled Disabled

Shutdown lexc: ?

Kvar Convention ?

Generator Network

Enable/disable of faults Enabled Disabled

Loss of voltage sensing:

I exc. protected:

Over voltage protected:

Grid Code Function: ?

Nominal field current: 4.0 A

Generator current limitation Enabled Disabled

Current limitation Enabled Disabled

Current limitation value (3In): 100

Regulation gain: 1

Digital Inputs/Outputs Enabled Disabled

Inversion of D1:

Inversion of D2:

Inversion of D01: ?

Inversion of D02:

Inversion of AL1:

Inversion of AL2:

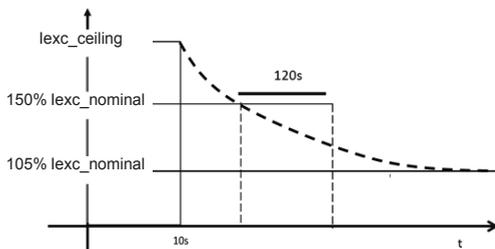
Memorization of external digital setting: ?

Can Network Configuration

D510C CONNECTED LSA 46.2 , L3, AREP, 50 Hz, 400 V Expert mode Regulation function: I exc.

- On Stator Overcurrent: The current level above which the fault is activated can be set.

- Over-excitation on curve protection



The over-excitation on curve prevents the rotor over-heating by limiting the excitation current to the 105% of its rated value. The activation delay of this function depends on the level of the excitation current. When for instance, the excitation is 150% of the nominal current, it will take 120s before the limitation is applied.

D510 C

Digital voltage regulator

- [Expert mode] Start on Threshold

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

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

- [Expert mode] Enable/disable of Faults

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

- [Expert mode] Grid Code Function

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

- [Expert mode] Nominal excitation current

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

- [Expert mode] digital input/ outputs

It is possible to reverse these digital IOs.

- [Expert mode] Digital external setting memorization

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

3.3.4 - [Expert mode] D510C Options

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



Can Network
Configuration

- [Expert mode] rotating diode bridge fault

Activate/deactivate the rotating diodes state supervision of exciter.

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

- [Expert mode] Generator current limitation

Set this function.

- [Expert mode] CAN network configuration

Enable CAN.

Set the data transfer rate.

Choose the regulator identifier.

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

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

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



Kvar Convention

Generator Network

D510 C

Digital voltage regulator

CAN Network configuration

Enabled Disabled



Data transfer Rate

1 Mb (L < 30m)

CAN activation delay (s)

0,0

IDD510C ID

144 0x90

 Broadcast parameters Broadcast J1939

Broadcast sent parameters

Parameter 1

Generator frequency

Sending period (ms)

50

Parameter 2

Grid input voltage one phase

Parameter 3

trip state 1

Parameter 4

None

PC--> Option D510C

Option D510C -->PC

OK

Click on OK to validate the configuration

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

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



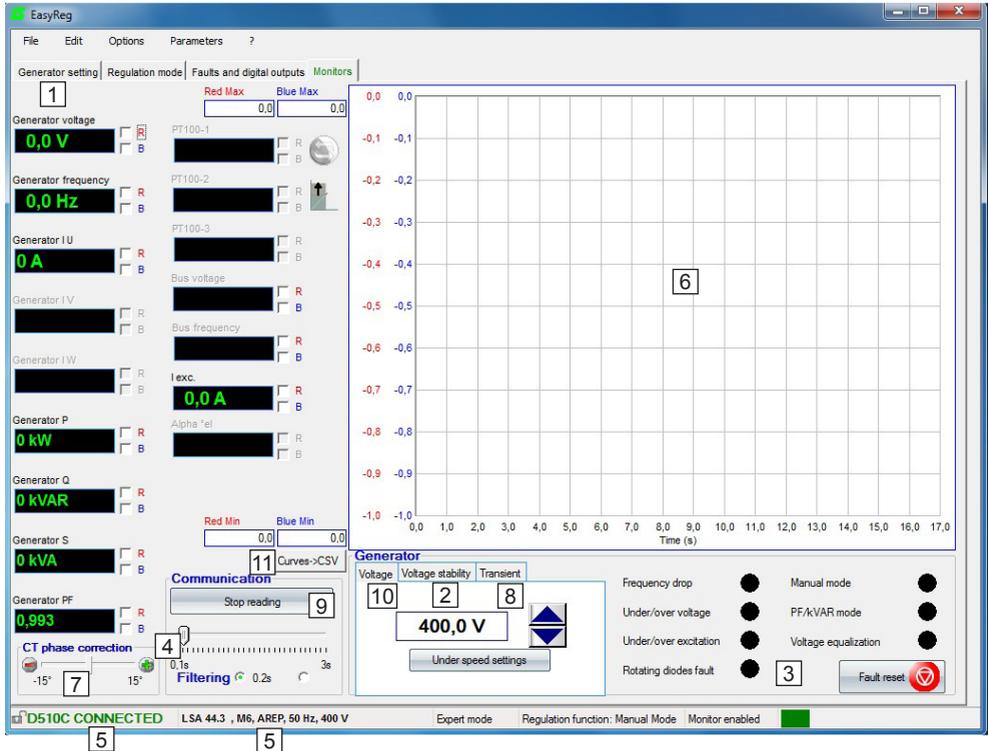
WARNING - When connecting a female DB9 connector onto the D510C CAN port, please ensure that the D510C is powered OFF beforehand.

D510 C

Digital voltage regulator

3.3.5 - Monitors

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



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

D510 C

Digital voltage regulator

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).

11. This button allows to export the data displayed on the monitor in CSV format.

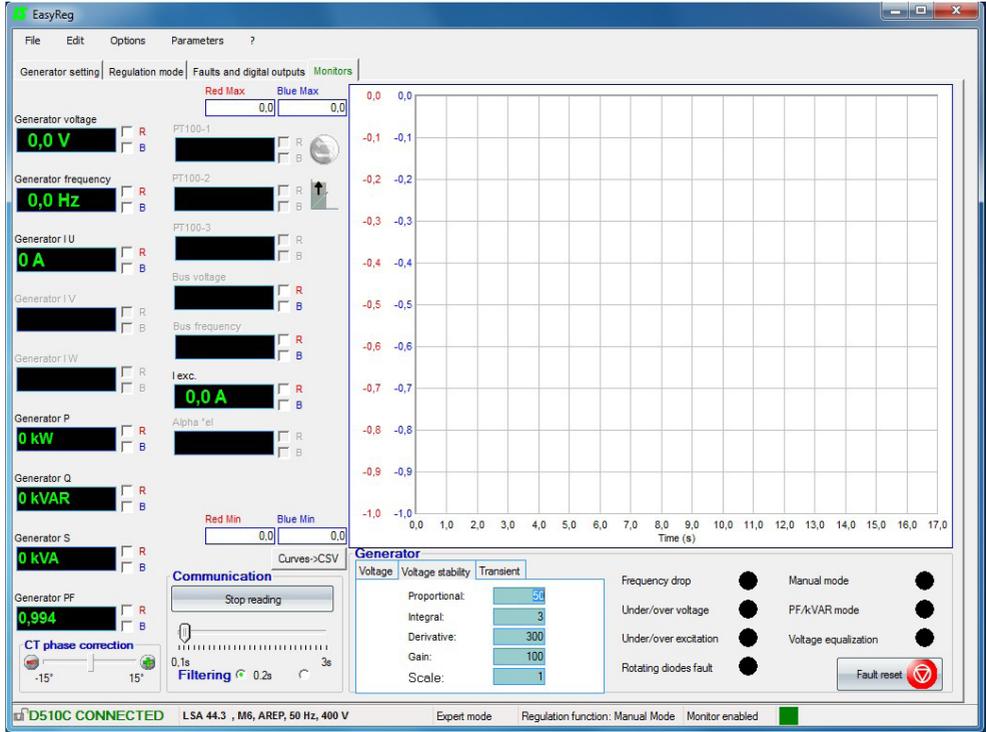
D510 C

Digital voltage regulator

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.

D510 C

Digital voltage regulator

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

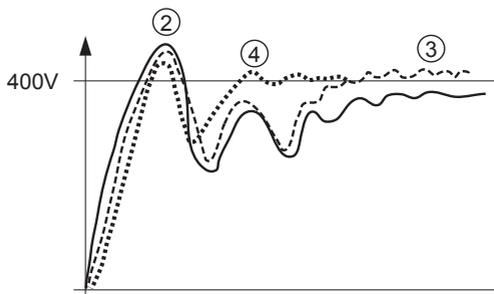


Warning: A wrong setting of the PID can damage the alternator.

PID setting methodology:

Please use Transient Test:

- ① Initial conditions:
 - Proportionnal = 10
 - Integral = 0
 - Derivative = 0
 - Gain = 100
 - 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.



D510 C

Digital voltage regulator

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

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

3.4 - Configuration in customised mode

3.4.1 - Useful data

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

- Excitation:

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

- Machine:

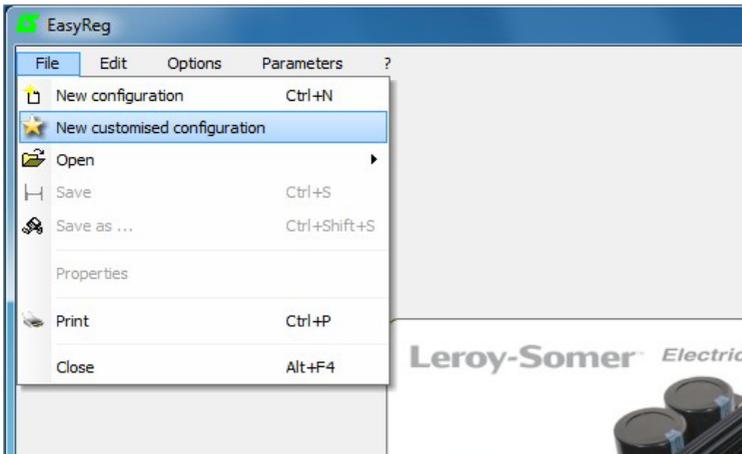
- machine rated power,
- rated voltage,
- frequency,
- power factor,
- PQ curve with the maximum power absorbed.

- Regulation:

- values of voltage sensing PT,
- value of the droop CT,
- the possible additional configuration: push button, diodes default, follower on manual mode, etc.

3.4.2 - Creation of configuration file

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



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

D510 C

Digital voltage regulator

3.4.3 - Tab « Customise »

3.4.3.1 - Alternator part

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

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

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

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

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

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

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

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

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

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

3.4.3.2 - Regulation

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

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

- **Voltage for this particular case:**

- Proportional: 60

- Integral: 3

- Derivative: 1200

- Gain: 80

- **PF and kVAR by default:**

- Proportional: 10

- Integral: 1

- Derivative: 20

- Gain: 50

- **lexc by default:**

- Proportional: 100

- Integral: 10

- Derivative: 500

- Gain: 100

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

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

D510 C

Digital voltage regulator

3.4.4 - Tab « Protections and limitations »

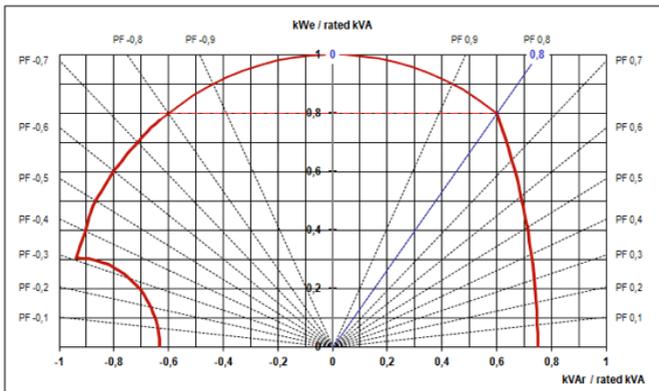
3.4.4.1 - General

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

The screenshot shows the 'EasyReg' software interface. On the left, the 'Limitations and protections' tab is active, with the 'Leading PF limit' set to 0.80. Below this are settings for lagging PF and KVAR limits, overvoltage level (120%), and delay (10.0). The main area contains four graphs: 'I EXC' (excitation current), 'P.F.' (power factor), 'U ALT' (under/over excitation), and 'KVAR' (reactive power). A red arrow in the P.F. graph points to the 'Leading Generator CAPACITIVE' region. At the bottom, a status bar indicates 'D510 NOT CONNECTED' and 'Expert mode'.

3.4.4.2 - Limitations and protections P.F. and kVAR

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



D510 C

Digital voltage regulator

In our case we can configure the values:

Limitations and protections	
Leading PF limit	<input type="text" value="0.50"/>
Lagging PF limit 1	<input type="text" value="0.75"/>
Lagging PF limit 2	<input type="text" value="0.70"/>
Leading KVAR limit (%)	<input type="text" value="60"/>
Lagging KVAR limit 1 (%)	<input type="text" value="62"/>
Lagging KVAR limit 2 (%)	<input type="text" value="65"/>
Oversvoltage level (%)	<input type="text" value="11"/>
Delay (s)	<input type="text" value="10.0"/>

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

3.4.4.3 - Under-excitation Limitation

Under excitation limitations	
lexc run limitation (A)	<input type="text" value="2.2"/>
lexc reset limitation (A)	<input type="text" value="2.5"/>
Under-excitation delay (s)	<input type="text" value="2.0"/>

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

3.4.4.4 - Over-excitation Limitation

Over excitation limitations	
lexc run limitation (A)	<input type="text" value="11.0"/>
lexc reset limitation (A)	<input type="text" value="10.0"/>
lexc shutdown (A)	<input type="text" value="0.5"/>
lexc short-circuit (A)	<input type="text" value="0.4"/>
Short-circuit delay (s)	<input type="text" value="5.0"/>

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

Click on the “Next >>” button

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

3.5 - Advanced Grid code function

The D510C provides new features such as generator internal angle calculation, data log, LVRT monitoring and recording. For more information please refer to the dedicated manual ref 5507.

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3.6 - Dead bus synchronization

The principle is to synchronize the generators while in standstill and then start them simultaneously. The system should ensure a limited reactive power sharing between the generators. The authorization to switch to the regulation mode may be given either automatically or via an external command.

Note: the power plant manager must ensure that all the dead bus synchronized gensets correctly started and we are not responsible of huge reactive power absorption by a genset which start sequence failed during the dead bus synchronization (DBS) sequence.

3.6.1 - DBS Automatic management

In this case, the D510C manages the pre-excitation and the switching to the voltage regulation mode without any external command. To do so, the «Start on Threshold» function is used as given below.

Start on Threshold ?

Enabled

% initial PWM

Activation threshold (V)

Note: it is mandatory to have the same activation threshold on the whole synchronized generators. As regards the initial PWMs, they can be set according to the excitation type, e.g 5% for generator with PMG excitation and 15% for those with AREP excitation.

Step 1: each D510C pre-excites the alternator to which it is connected following the initial PWM. Each generator will have its

voltage gradually increased according to the genset speed.

Step 2: when the activation threshold is reached (e.g 200V), all the D510C will switch to voltage regulation. The voltage will gradually reach the final reference value following a slope depending on the selected Soft Start value.

Note: here also, it is mandatory to have the same « Soft Start » on all the D510C used in the application.

Start

Soft-start: ?

During Second(s)

Soft-start reset delay

3.6.2 - DBS management via external command

Here, an external command such as a digital input or CANBUS flags is used. The pre-excitation of each generator is done with a constant value (not necessary to have the same excitation reference when different generators sizes are used) and when the conditions are respected, a command is sent to ensure the switching to the regulation mode. The approach involving the CANBUS is presented below.

Step 1: the genset controller sends the command to the D510C to enable the Manual mode regulation (parameter 5.49) with a constant reference (parameter 5.33). During this phase, reactive power sharing may occur, but it can be minimized thanks to appropriate definition of the excitation current references on each generator.

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Step 2: when the genset reach the appropriate speed, a new command is sent to the D510C to switch to the voltage regulation mode (parameter 5.30=1). The voltage, as in the previous automatic management, will gradually reach the final reference voltage with limited reactive power sharing between the generators.

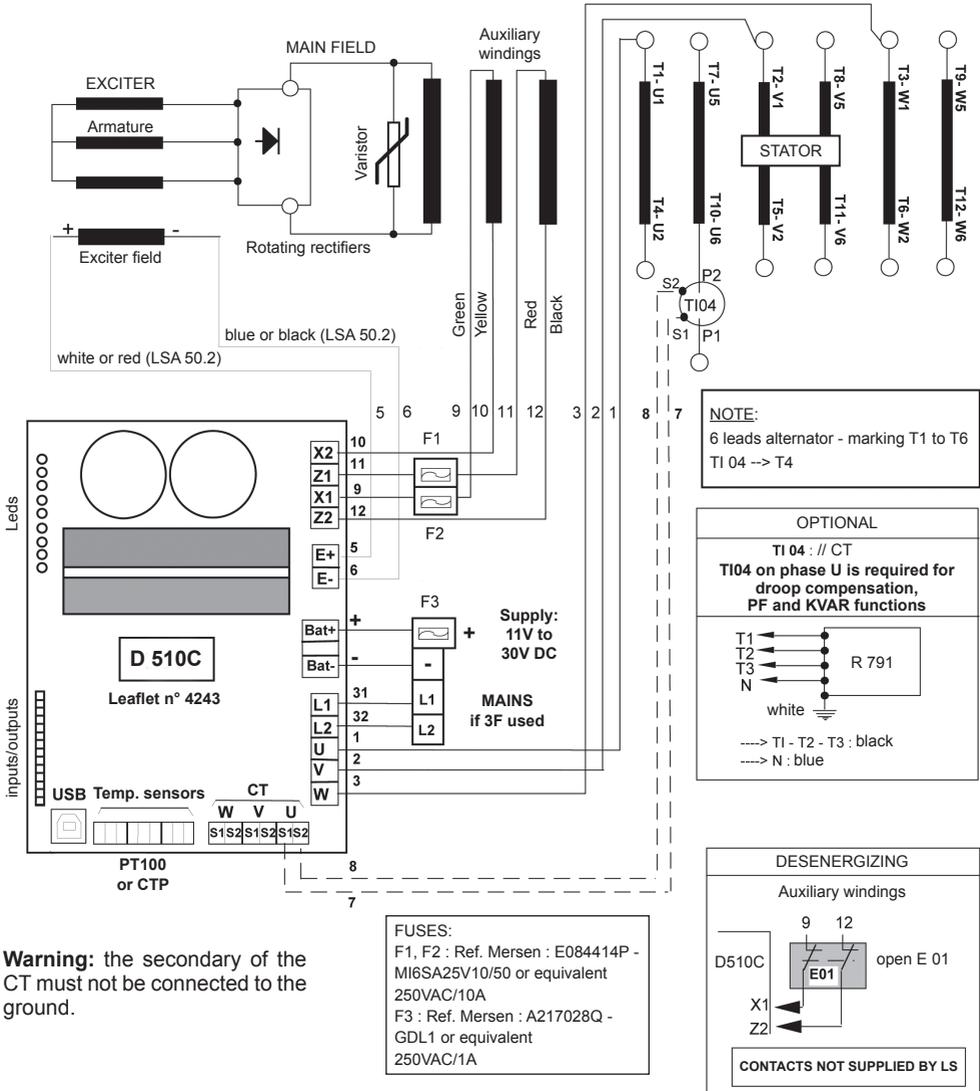
Note: more details on the CANBUS communication are accessible on the manual ref 4971.

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4 - CONNECTION DIAGRAMS

Digital AVR D510 C Terminal block with fuses



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

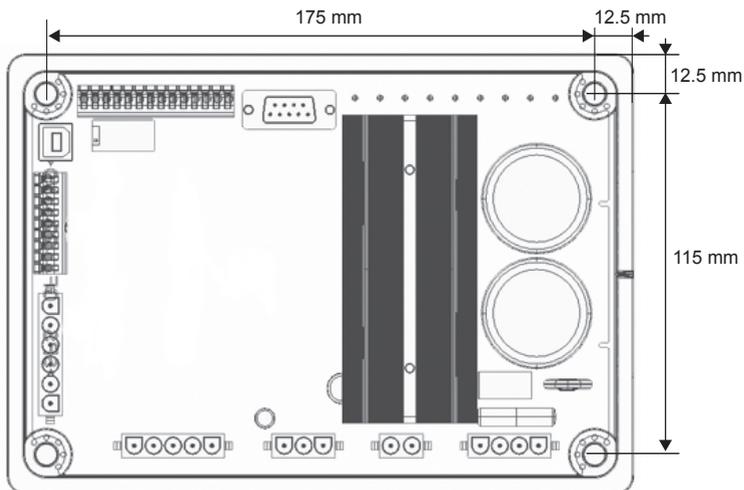
FUSES:
 F1, F2 : Ref. Mersen : E084414P - MI6SA25V10/50 or equivalent 250VAC/10A
 F3 : Ref. Mersen : A217028Q - GDL1 or equivalent 250VAC/1A

D510 C

Digital voltage regulator

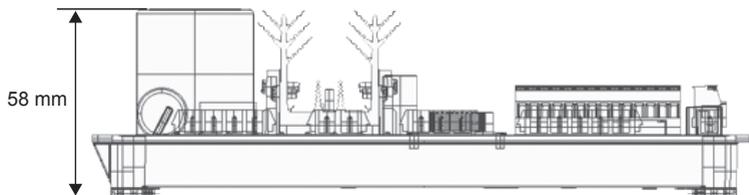
5 - DIMENSIONS AND MOUNTING

5.1 - Top view



The mounting is done via 4xM5 type screws and the nominal torque must be 2.5 N.m.

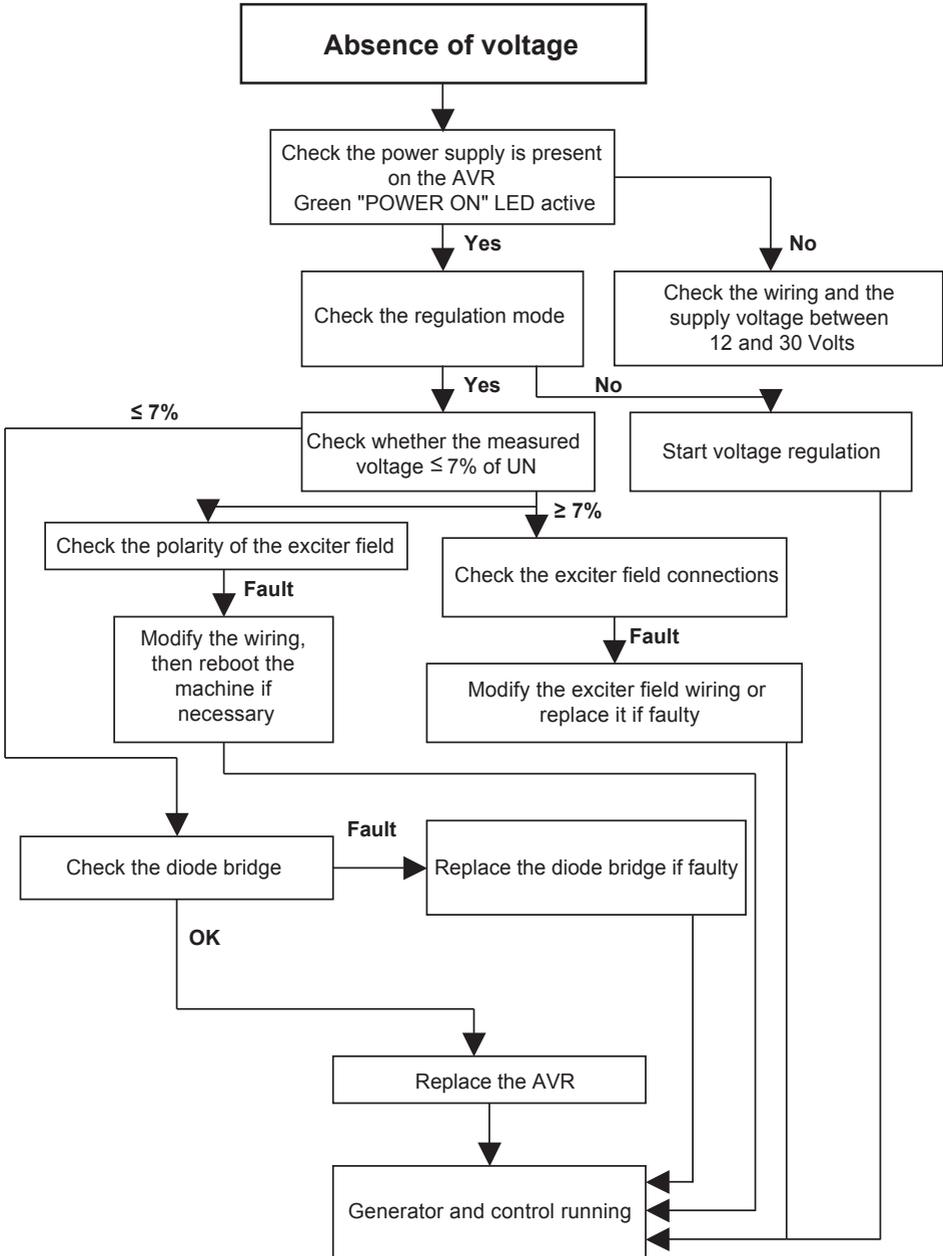
5.2 - Side view



D510 C

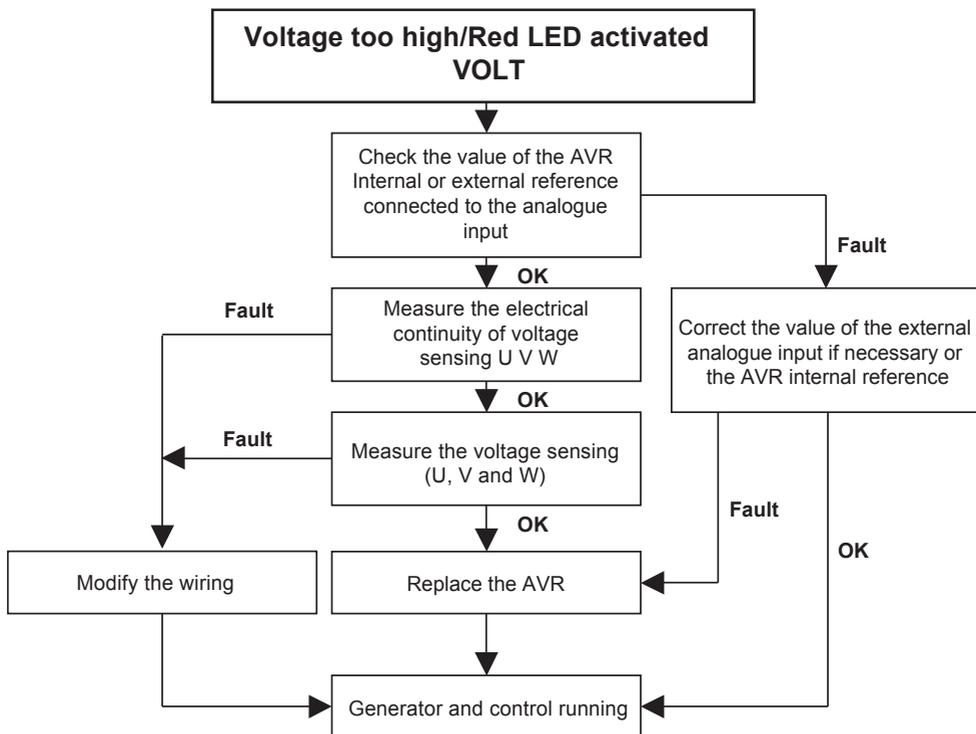
Digital voltage regulator

6 - FAULT FLOW CHARTS



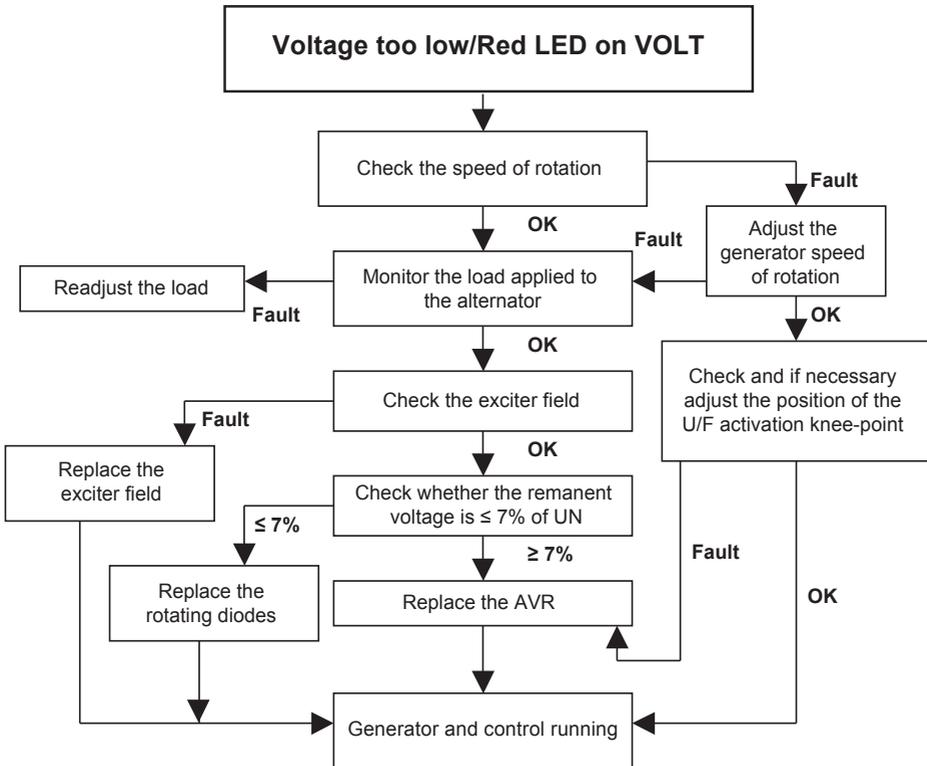
D510 C

Digital voltage regulator



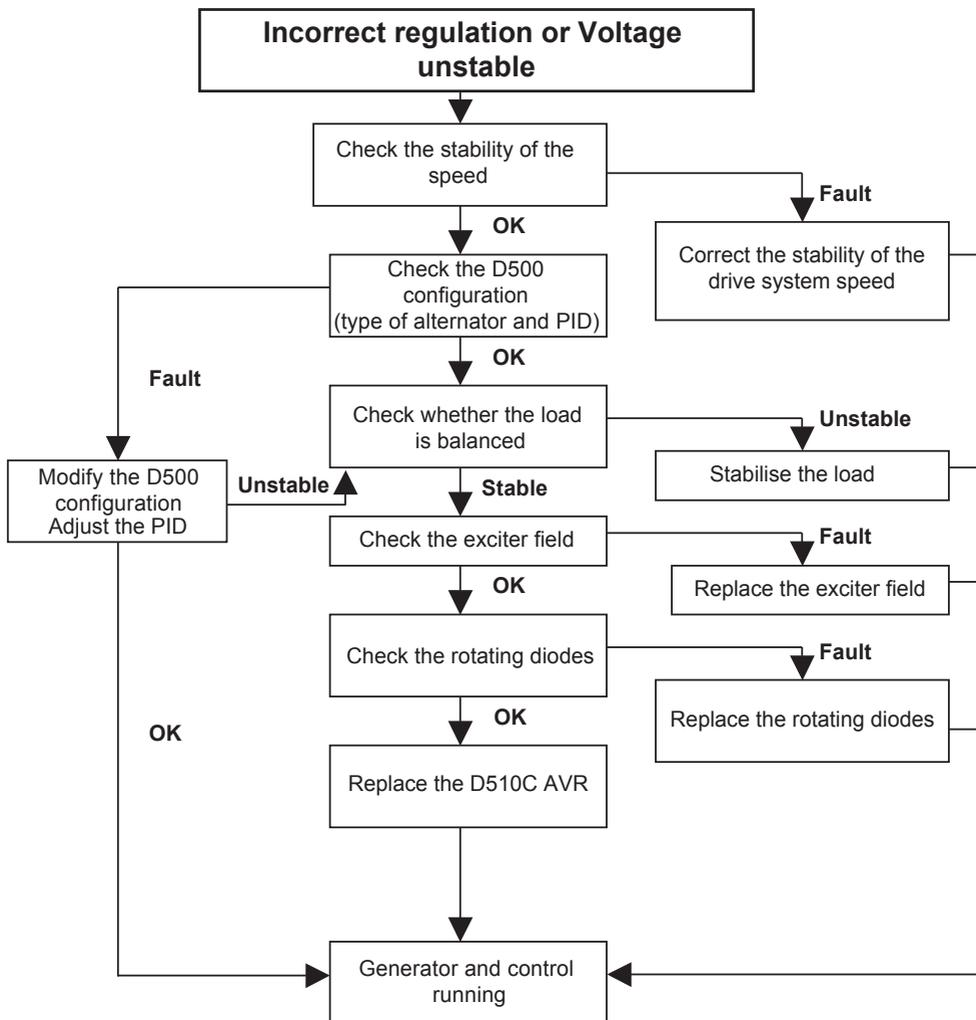
D510 C

Digital voltage regulator



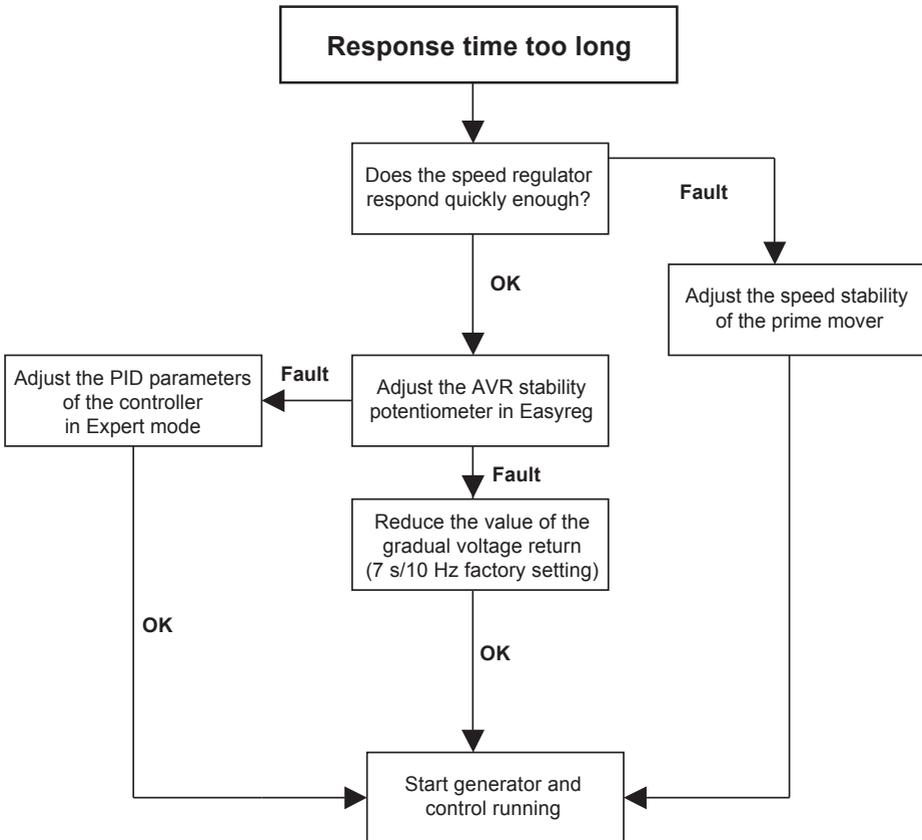
D510 C

Digital voltage regulator



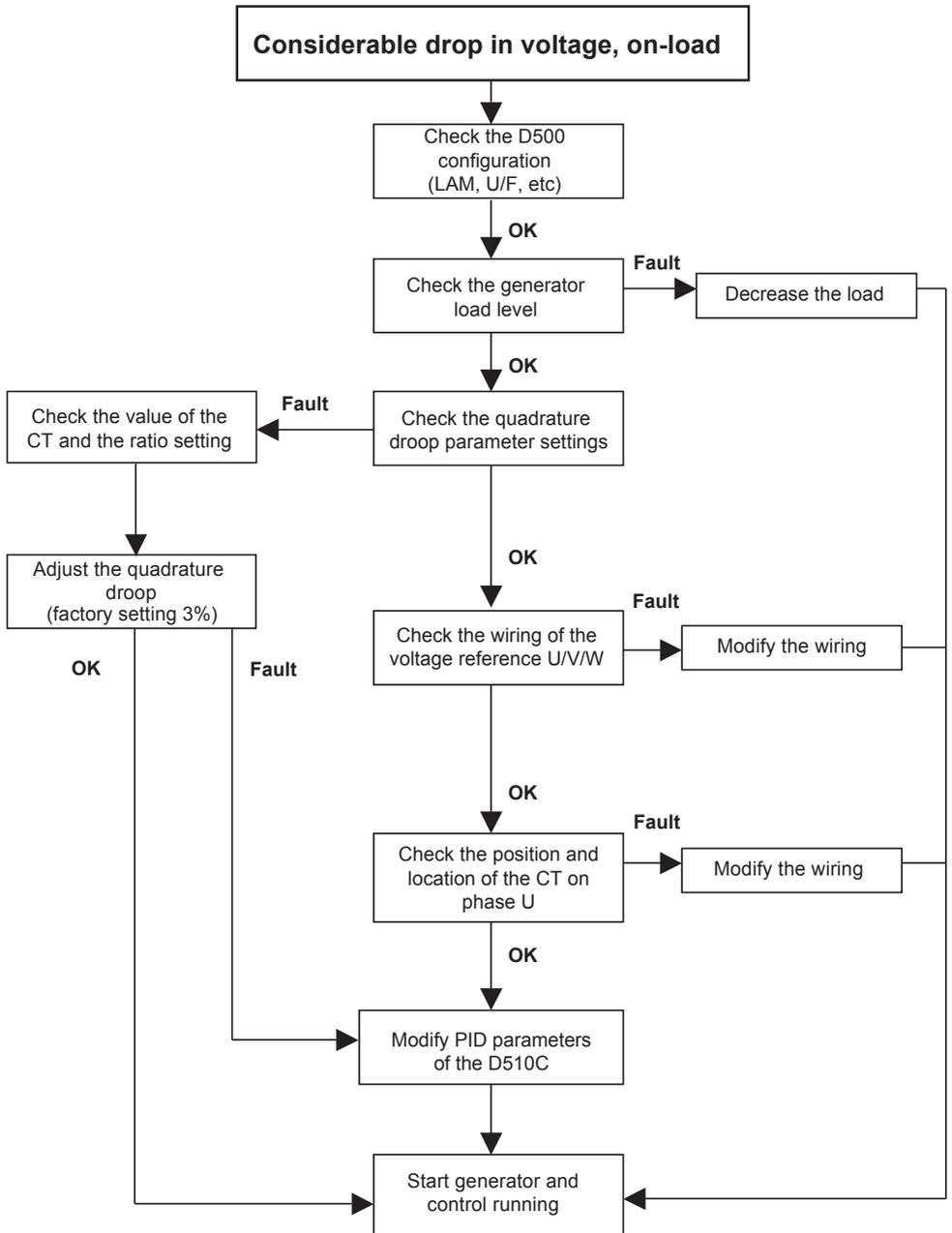
D510 C

Digital voltage regulator



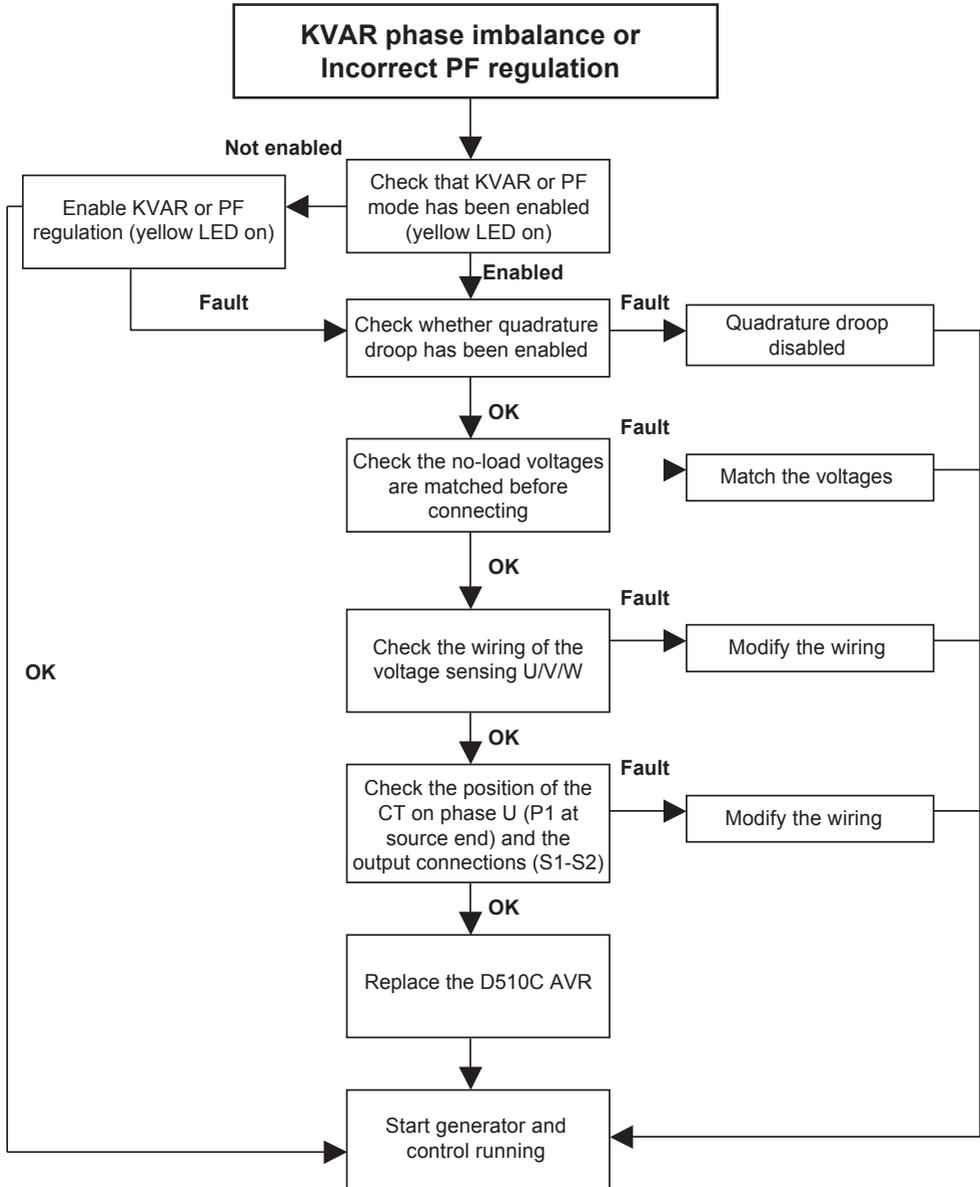
D510 C

Digital voltage regulator



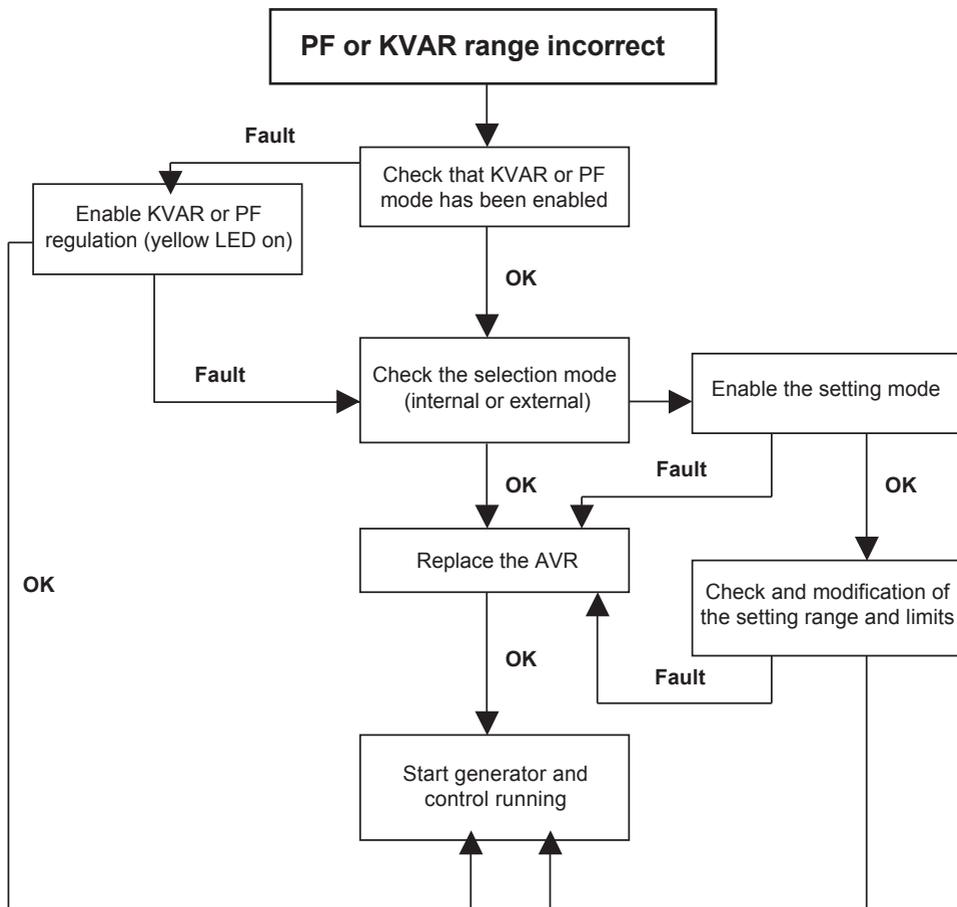
D510 C

Digital voltage regulator



D510 C

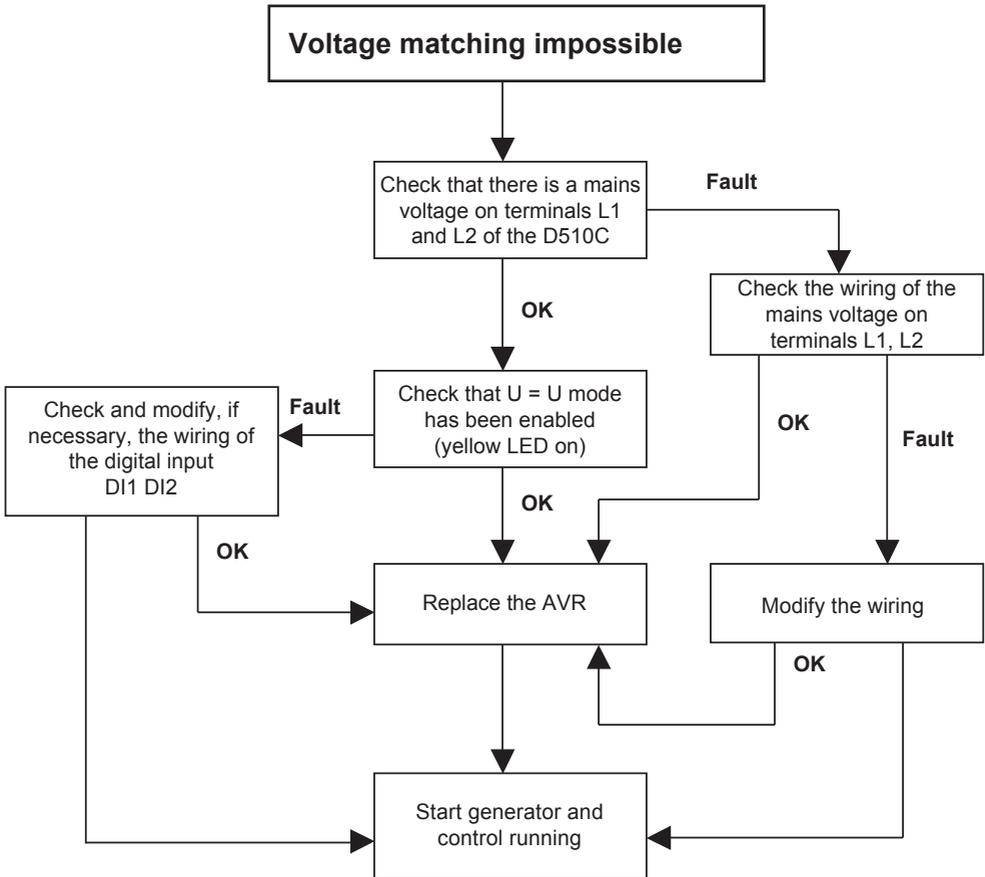
Digital voltage regulator



D510 C

Digital voltage regulator

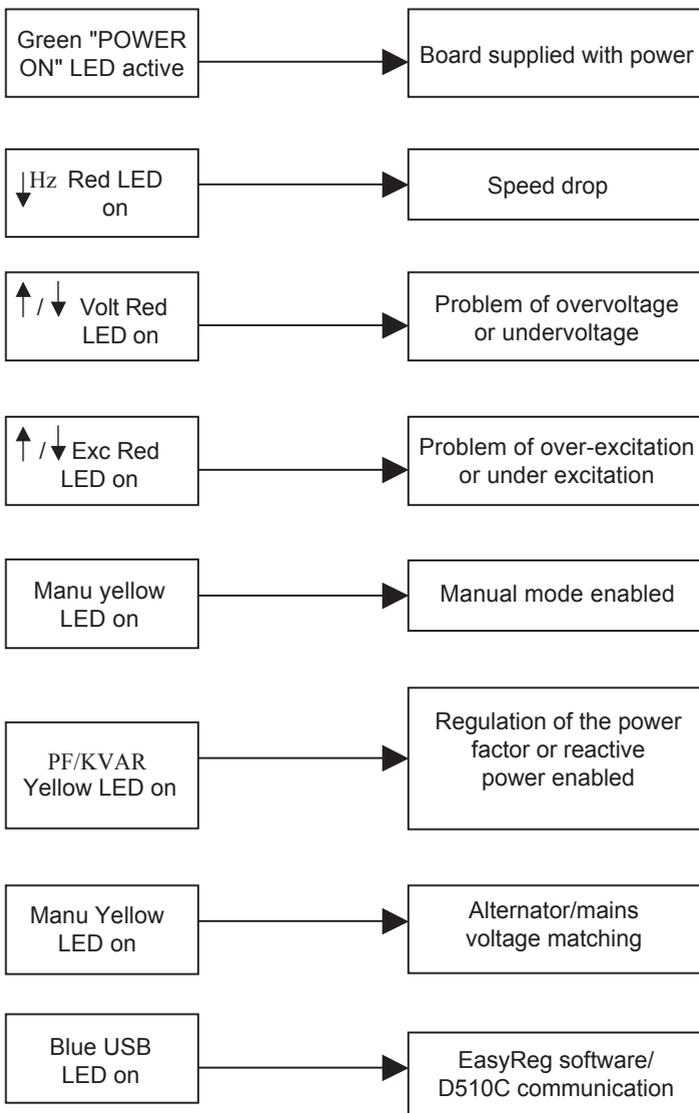
Voltage matching impossible



D510 C

Digital voltage regulator

LED status



D510 C

Digital voltage regulator

7 - SPARE PARTS

7.1 - Designation

Description	Code
First installation kit	4814176
Replacement kit	4818634
Adaptation kit $\pm 10V$	5090072

7.2 - Technical support service

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

For all spare parts orders or technical support requests, send your request to service.epg@leroy-somer.com or your closest contact, whom you will find at www.lrsm.co/support indicating the type and the code number of the AVR.

To ensure that our products operate correctly and safely, we recommend the use of original manufacturer spare parts.

In the event of failure to comply with this advice, the manufacturer cannot be held responsible for any damage.

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Disposal and recycling instructions

We are committed to limiting the environmental impact of our activity. We continuously monitor our production processes, material sourcing and product design to improve recyclability and minimise our environmental footprint.

These instructions are for information purposes only. It is the user's responsibility to comply with local legislation regarding product disposal and recycling.

Recyclable materials

Our alternators are mainly constructed from iron, steel and copper materials, which can be reclaimed for recycling purposes.

These materials can be reclaimed through a combination of manual dismantling, mechanical separation and melting processes. Our technical support department can provide detailed directions on how to dismantle products on request.

Waste & hazardous materials

The following components and materials require special treatment and must be separated from the alternator before the recycling process:

- electronic materials found in the terminal box, including the automatic voltage regulator (198), current transformers (176), interference suppression module (199) and other semi-conductors.
- diode bridge (343) and surge suppressor (347), found on the alternator rotor.
- major plastic components, such as the terminal box structure on some products. These components are usually marked with information concerning the type of plastic.

All materials listed above need special treatment to separate waste from reclaimable materials and should be entrusted to specialist recycling companies.

The oil and grease from the lubrication system should be treated as hazardous waste and must be treated in accordance with local legislation.

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Service & Support

Our worldwide service network of over 80 facilities is at your service.

This local presence is our guarantee for fast and efficient repair, support and maintenance services.

Trust your alternator maintenance and support to electric power generation experts. Our field personnel are 100% qualified and fully trained to operate in all environments and on all machine types.

We have a deep understanding of alternator operation, providing the best value service to optimise your cost of ownership.

Where we can help:



Contact us:

Americas: +1 (507) 625 4011

Europe & Rest of the world: +33 238 609 908

Asia Pacific: +65 6250 8488

China: +86 591 88373036

India: +91 806 726 4867

Middle East: +971 4 5687431



Scan the code or go to:

 service.epg@leroy-somer.com

www.lrsr.co/support

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Nidec
All for dreams